Canada Health Infoway Inforoute Santé du Canada

March 31, 2006

Dear partners and collaborators:

I am pleased to present the revised version of the Electronic Health Record Solution (EHRS) Blueprint, Canada Health Infoway's road map guiding the sustainable development of the interoperable Electronic Health Record (EHR) for all Canadians.

Based on interoperability (the ability of different systems to communicate seamlessly with one another), the Blueprint addresses the challenge of providing healthcare professionals with the patient information they need to support informed decision-making.

It provides a framework for accessing and consolidating information and presents the information in a way that meets the needs of healthcare professionals. It takes into consideration the fact that tens of thousands of health information systems could be part of the Electronic Health Record across Canada. It supports the sharing of patient health information between health services providers -- including GPs, specialists, nurses and pharmacists -- across care settings, including hospitals, emergency rooms, clinics and homecare settings, and across geographical distances.

The Blueprint guides all of *Infoway*'s investment decisions. First published in 2003, the Blueprint has recently been enhanced to provide more detail on how standards-based technology can be used to support sharing of EHR information. The current version also integrates elements of the Privacy and Security Architecture, which provides for the private and secure sharing of health information. It shows how Telehealth and Public Health Surveillance fit in with the Electronic Health Record.

The Blueprint was developed based on extensive consultations with stakeholders. I wish to thank all of the representatives from the jurisdictions and the privacy and security community as well as technology vendors, healthcare professionals and others for the time and energy devoted to enriching the Blueprint. I am pleased to note that many stakeholders who have previewed the enhanced Blueprint refer to it as a detailed, practical and valuable tool to guide EHR planning and implementation.

The Blueprint is a foundational piece guiding our efforts to ensure that the EHR becomes a standard of care in Canada. The end result will be a renewed, sustainable healthcare system providing improved quality, productivity and access to health care for all Canadians.
Thank you again to all who have contributed for your continued support.

Sincerely,

Richard C. Alvarez
President and CEO
Canada Health Infoway

Canada Health Infoway
Inforoute Santé du Canada

EHRS BLUEPRINT

an interoperable EHR framework

Version 2

March 2006

FOREWORD

It is my pleasure to introduce the second version of the Electronic Health Record Solution (EHRS) Blueprint. This is a very significant evolution from the first version, and is the result of significant design evaluations and collaborations with many stakeholders and subject matter experts across the country.

There is consensus in Canada and other countries about the value of health information technology in the healthcare industry. Our efforts around the interoperable EHR are about providing each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The interoperable EHR will ultimately be available electronically to authorized health providers and the individual anywhere, anytime in support of high quality care. Additionally, this record is designed to facilitate the sharing of data – across the continuum of care, across healthcare delivery organizations and across geographies. In order to achieve these objectives, the information technology solutions must be founded on interoperability. This is the fundamental driver for developing and publishing the Blueprint, and associated health information systems standards.

The Blueprint is a set of standards and guidelines for our jurisdictional partners and vendors such that systems will be compatible and interoperable. Interoperability is a critical factor in renewing our healthcare system. Without interoperability, there can be no interoperable Electronic Health Record and information will continue to be trapped in silos, to the detriment of healthcare providers and patients

Allow me to provide a high level overview of what you will find in this document.

Objectives of EHRS Blueprint Version 2

While the first version of the Blueprint was helpful in defining the vision for EHR Solutions in Canada, it was understood from the outset that more work would be needed to successfully apply the concepts effectively in real-world solutions. With this in mind, the recent work on extending the Blueprint had the following objectives:

- To improve its breadth and depth in terms of the scope of Infoway investment programs and in the level of detail in expressing architectural components.

- To ensure its relevance and coherence as a vision statement for stakeholders, by furthering the business case for the use of EHR Solutions in health services, and by better illustrating how the EHRS is used in the context of service delivery.

- To provide a fuller specification to guide: solution vendors, service provider organizations, regions, and federal/provincial/territorial jurisdictions in actually building and implementing EHR Solutions and their associated Infostructures (the software services common to and reusable among the diverse set of healthcare point of service systems).

What is New in Blueprint v2

Just after the first version of the EHRS Blueprint was published, Infoway's mandate was increased to address two additional health domains; Telehealth, and Public Health Surveillance. Given the vast geography of the country and population distribution in Canada, and the sobering lessons learned from public encounters with SARS and West Nile virus, it is easy to understand the importance of these mechanisms for delivery health services and in preserving and promoting the health of Canadians.

The Blueprint incorporates the requirements for these domains into the evolving EHRS architecture, in support of the respective investment program strategies and with an objective of leveraging the EHR Infostructure to support real world projects in these domains.

Telehealth

For Telehealth, the key requirement is the ability to share consistent and comprehensive EHR information to health service providers and their patients at distances from each other. The essence of the Blueprint is enabling this sharing of information wherever it is required, and in the ability to see a consistent view of that information, regardless of the viewer's location and in addition to the abilities of local applications and the information they hold.

For this reason, Telehealth requirements were met in the Blueprint by extending the representation of how the EHRS would meet these needs for different purposes. The EHRS architecture was already well suited for supporting this program as we already had a key requirement of sharing clinical information across geographies.

Public Health Surveillance

In the case of Public Health Surveillance (PHS), the impact to the Blueprint was much more far reaching. When considering the needs of PHS, it became clear that the concept of EHR infostructure was much more than a convenience, it could and should be an integral component of a set of applications that are being developed in conjunction with the development of a consistent set of standards for capture and use of information for PHS purposes. As a result, PHS introduced the concept of value-add "Ancillary" services that take advantage of the infostructure to leverage EHR data for health surveillance purposes. For example, public health provides rely heavily on information that is core to the EHR, such as immunization history and laboratory test results.

In addition, the PHS program brings to the Blueprint the need to represent the use of Data Warehousing in a secure context for analysis.

Privacy Security Architecture

This version of the Blueprint is also aligned with the Privacy and Security Architecture (PSA), another project funded and led by Infoway. The PSA is a Canadian first, developed with the collaboration of all Canadian jurisdictions, in consultation with numerous other stakeholders, and with the privacy and security subject matter experts. It addresses the requirements for protecting the confidentiality and privacy of personal health information in the EHR on a pan-Canadian basis.

This is a complex and critically important component of the Blueprint. While each jurisdiction has its own policy related to securing personal health information, every jurisdiction and its stakeholders must be able to trust that their requirements are satisfied with the most appropriate privacy enhancing strategies and technologies when placing or accessing information in the EHR.

The Privacy and Security Architecture has been available publicly for some time now, and it is being formally published in concert with the Blueprint v2 as it has shaped many aspects of the architecture, particularly in the Common Services section.

EHRS Reference Architecture

Another major addition to the Blueprint in this version is the EHRS Reference Architecture (ERA). The Reference Architecture defines the set of formalisms, or documentation patterns, which express in a structured manner both the requirements for the interoperable EHR and the components and mechanisms to meet those requirements. The ERA includes:

- Clinical Reference Framework or the “Life of the Lamberts”. This is the set of use cases developed by Infoway to document our assumptions about the context for use of the interoperable EHR and the clinical requirements for communicating information. These use cases are not intended to represent every possible process in health care, but rather to focus on how EHR information is to be collected, shared and used in clinical decision making.

- EHRi Conceptual Data Model. This model provides a representation of how the Shared Health Record component of the EHR should be structured to flexibly support information collected and used in many different care settings and disciplines.

- EHR Interoperability Profiles. These are high level specifications of the mechanisms used by Point of Service applications to interact with the EHR infostructure.

- Infostructure Interoperability Profiles. These are high level specifications of how requests for placing or accessing data in the EHR are handled within the EHR infostructure.

All of the information in the ERA has been represented using Unified Modeling Language representations and captured in an automated tool that has resulted in a repository of specifications that can be reused by projects with UML capable software engineering tools.

Functioning Principles

As Blueprint v2 evolved, there were many assumptions made that, once implemented in the architecture, can no longer be considered assumptions anymore: they are now principles about the function of EHR Infostructures and EHR Solutions that need to guide detailed design and development of solutions.

What is Different in Blueprint v2

The current version of the Blueprint expresses many aspects of the architecture in more detail, expanding on the previous work and providing additional information.

Longitudinal Record Services (LRS)

The Blueprint diagram exposes the concept of Longitudinal Record Services (LRS). The LRS is responsible for all the business services (e.g. rules, data quality, normalization) and data access services (e.g. find, read and write a person’s personal health information) that are required at the heart of an EHR solution. None of the services represented within this concept are really new, however it was realized that specifying these services separately from the Common Services greatly facilitated understanding of how the multiple repositories and registries are managed in the EHR infostructure.

Extended Services Description

This version of the Blueprint provides additional detail on the many services expressed in the original version. Basic execution patterns for invoking Infostructure services have been provided and more detailed descriptions of the various functions within the services are provided.

Infostructure Configurations and Potential Interim States

The Blueprint now more fully expresses the possible deployment models for Blueprint based architectures in small, medium-sized, and large jurisdictions.

Proposed COTS Configurations

The use of Commercial-Off-The-Shelf (COTS) products as components of a functioning EHR infostructure is also addressed at a high level, providing various configurations for the use of currently available commercial products that would meet the requirements expressed in the Blueprint.

New and Extended Value of the Blueprint

The new version of the Blueprint is expressed in terms that should allow vendors and service provider organizations to more confidently engage in high level component and systems design. The Blueprint provides more information on how the various architectural elements must work together as a coherent set of EHR services.

The UML modeling in the EHRS Reference Architecture can be reused by design and development projects, providing a quick start for solutions based around a shared perspective on the high-level requirements.

The “Life of the Lamberts” has been very well received by many audiences, and will serve as a powerful baseline for continuing to refine and express requirements for EHR Solutions.

How the Blueprint is Applied Today

In the course of creating version 2 of the Blueprint, Infoway shared much of the work-in-process with our jurisdictions. Working closely with Infoway, some jurisdictions have already used the Blueprint v2 materials in their tendering processes for EHR related products and services.

In addition, the early EHR projects across Canada have been relying upon the new representation for their planning and EHR Solutions design.

The Blueprint is actively being used by the all of our standards projects, which were underway at the time of this publication. This project is tasked with the core set of messages for Point of Service applications to interface with the EHR infostructure. The message and terminology specifications produced by these projects are a direct extension of the Blueprint.

How the Blueprint Will Be Maintained and Extended

Looking to the Future (Near and Far)

Infoway fully understands that we have a responsibility to our jurisdictional partners to sustain and continue to evolve the Blueprint as the roadmap for interoperable EHR solutions.

The EHRS Blueprint v2 is the last planned major revision. From this point forward the Blueprint will be decomposed into its various logical sections and the resulting documents will be loaded into the Infoway Artefacts Repository (AR) where they will be managed and new releases version controlled.

The Artefacts Repository is a tool that includes a web-enabled database that holds many knowledge artefacts from the Blueprint, as well as from Infoway's standards projects, and the projects in each investment program. The AR categorizes the content and provides information on each artefact stored in it. It is publicly accessible, and can accept submission of artefacts from external sources as well.

In Conclusion: Many Thanks

Infoway is both inspired and humbled by the incredible energy, passion, and dedication to this work shown by our collaborators and stakeholders across the country. We understand that adherence to a higher level architectural framework means that EHR project teams must think beyond their local requirements. With many pressing issues needing to be addressed, thinking on a pan-Canadian scale is not easy. Yet we have seen a willingness to embrace the Blueprint concepts and embed them in planning and actions that go beyond the imperative of Blueprint conformance as eligibility criteria for Infoway investments. Our team at Infoway hopes this document reflects those contributions.

As jurisdictions invest in implementing the Blueprint, it has become much more than an Infoway artefact. This belongs to the Federal / Provincial / Territorial jurisdictions, it belongs to the country. All Canadians should be proud of the commitment and passion that their health community has for realizing the benefits that Electronic Health Record Solutions can bring. The Blueprint is one component of "bringing the vision of the EHR to life" for the benefit of all Canadians.

Santé !

Dennis Giokas
Chief Technology Officer
Canada Health Infoway Inc.

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1 VERSION TABLE

Version #	Published Date	Comments
1.0	2003-07-21	First public version of the EHRS Blueprint
2.0	2006-03-29	Second public version of the EHRS Blueprint

2 EHRS BLUEPRINT CONTEXT

This section presents elements of definition that were considered key in establishing the context for the EHRS Blueprint (Electronic Health Record Solution Blueprint). Most of these elements emanated from the Business Plan of *Infoway* and the many surveys and studies that accompanied its creation. The elements presented here include key terminology, overarching concepts, forefront elements of the value proposition and business case, as well as guiding principles for the architecture.

2.1 KEY DEFINITIONS AND OVERARCHING CONCEPTS

2.1.1 Design Levels (Conceptual vs. Logical vs. Physical)

The objective of the EHRS Blueprint is to provide a collaborative and shared vision of an interoperable EHR (iEHR) for all jurisdictions in Canada.

In keeping with the practice of enterprise architecture, the EHRS Blueprint presents a number of “views” or “perspectives” of the envisioned future state representing the points of view of various stakeholders involved in EHR initiatives.

Due to its Pan-Canadian scale and the complexities inherent to implementing solutions across large numbers of jurisdictions, organizations, and facilities, the EHRS Blueprint has been intentionally articulated at a high level of abstraction. Several principles guided this design to create a common, interoperable architecture that leveraged existing systems and solutions while remaining extensible to support future growth and innovations. Reconciling these goals requires a flexible solution that is inevitably influenced (and constrained) by the general EHR strategies already underway across the country.

Consequently, the project team was allowed to take some liberties in regards to the formalisms typically applied in more conventional enterprise-level architectures. First, the conceptual view contains some aspects of logical components to better reflect common aspects of many of the EHR strategies currently in development in Canadian jurisdictions. Secondly, a physical view is not provided as it would bind the architecture too tightly to specific hardware configurations, vendor applications and operating systems, which is not a goal of this piece of work.

The Blueprint addresses the following perspectives of the definition of an EHRS:

1. Business Architecture: The EHRS business architecture section presents the key business requirements that drive the definition of the proposed solution. These requirements have been matured through the various initiatives that led to the creation of Canada Health Infoway, among them the Advisory Committee on Health Infostructure (ACHI). These requirements are also representative of the evolution of thinking that has occurred in various Canadian jurisdictions since the inception of *Infoway* and the publishing of the first version of the EHRS Blueprint. The main objective of this section is to establish the business requirements that influence key architectural decisions in leading to the solution described in the document.

2. Conceptual Architecture: The conceptual architecture addresses the “what” question for different aspects of an interoperable EHR Solution including: what work processes are supported, what system services are required and what information is manipulated. The conceptual architecture also

identifies key technical challenges that need to be addressed in the form of functioning principles for an EHR Solution.

3. Logical Architecture (Using the Blueprint in EHRS projects): This section provides an introduction to the EHRS Reference Architecture, a fully documented architecture driving into logical level definitions. The scope of diagrams and definitions provided addresses all aspects of the architecture including:
   a. people and system use cases;
   b. data models;
   c. sequence diagrams for processing flows; and
   d. other representations as they have evolved in our dialogs with our stakeholders.

   While integrating the conceptual level of definition, this reference architecture also explores the description of dynamic interaction and processing patterns in order to provide examples of how transactions could be processed by EHR Solutions. This architecture is provided as a separate document and is generated from a CASE (Computer Assisted System Engineering) tool so that it can easily be reused as a framework for documenting and building EHR solutions.

4. Deployment Models: The EHRS Blueprint incorporates features from many different EHR strategies that are currently being planned and/or deployed in various Canadian jurisdictions. This section provides emerging models for EHRi deployment in Canada and outlines the architecture's flexibility and adaptability.

5. Potential Applications: Finally, this section surfaces the different potential uses of the Blueprint architecture in interoperable EHR solutions. This section describes both a short term perspective in terms of the availability and usage of EHR Solutions as well as a longer term view.

2.1.2 Enterprise

The EHRS Blueprint focuses on the *enterprise* architecture for the electronic health record (EHR) in Canada. Enterprise, in this context, refers to the health system in Canada which in turn is made up of the healthcare and public health service delivery as governed and operated by the Provinces and Territories, or across jurisdictions as in the case of Federal payer organisations such as Veterans Affairs, the Military, first nation communities, correctional services and others.

2.1.3 Jurisdiction

A jurisdiction refers to a geopolitical entity that governs the administration, operation and delivery of public health or healthcare services and the governance of an Electronic Health Record Solution and is typically represented by a Federal agency, Province, Territory, or Regional Authority.

2.1.4 Patient vs. Person vs. Client

Throughout this document, the terms patient, person and client have the same meaning and refer to an individual needing or accessing care through the health system. These terms are used interchangeably in the document.

2.1.5 EHRS

An Electronic Health Record Solution (EHRS) is a combination of people, organizational entities, business processes, systems, technology and standards that enable the interaction and exchange of clinical data to provide high quality and effective health services. At an enterprise level, this includes the broad range of existing Point of Service (PoS) applications, the health information they hold, as well as the EHR infostructure (EHRi) articulated in this Blueprint that allows this information to be securely and appropriately shared. It is made up of:

- Mechanisms to find and uniquely identify people, providers and locations;
- Patient-centric Electronic Health Records (EHR);
- Presentation solutions and intelligent agents;
- Common services and standards to enable integration and interoperability;
- Workflow and case management;
- Decision support services;
- Services to support health surveillance and research;
- Services to ensure privacy and security;
- Physical infrastructure to support reliable and highly available electronic communications;

2.1.6 EHRi

An EHR Infostructure (EHRi) is a collection of common and reusable components in the support of a diverse set of health information management applications. It consists of software solutions, data definitions and messaging standards for the EHR. It is made up of:

- Registry systems to manage and provide the information required to uniquely identify the actors and resources in the EHR. Specifically, these are the patient/client, the provider of care, the location of care, the end users of applications and the terminologies used to describe diseases, acts or other clinically relevant information. Registries which hold patient/client consent information are part of the EHRi as well.
- EHRi domain repositories that manage and persist subsets of clinical data pertinent to the clinical picture of a client. A diagnostic imaging PACS solution is an example of a Domain Repository.
- The Shared Health Record repository that holds information on health service events and the clinical observations associated with those events.
- A Longitudinal Record Service to coordinate the patient centric accesses, updates and location of data across multiple domains and registries.
- Standardized common services and communication services to sustain the interoperability of the different components within the infostructure, as well as to sustain interoperability and a high degree of abstraction between the EHR infostructure and the Point of Service (PoS) applications.
- Standardized information and message structures as well as business transactions to support the exchange of information in and out of the EHR;
- An EHR viewer as a generic presentation application allowing end-users to access, search and view relevant and authorised clinical data about clients.

2.1.7 EHR Service

An EHR Service provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The record is available electronically to authorized health care providers and the individual anywhere, anytime in support of high quality care.

2.1.8 LRS

In an EHRi, the Longitudinal Record Service (LRS) is the central component that coordinates and manages the existence and location of clinical information about clients. One of the main features of the LRS is an index of all events tracked or maintained in an EHRi. Through this index, a consistent longitudinal and cross-domain view of the clinical information of a client is always available.

2.1.9 EHR Data and Services (Domain Repositories)

An EHR Domain Repository is a component of an EHRi that stores, manages and persists a specific clinical subset of data, typically at a jurisdictional level. While such systems play a key role in enabling sharing of certain types of information across the continuum of care, they may also play the role of operational level systems in a jurisdiction.

The extent of the clinical information sustained by an EHR Infostructure may vary based primarily on the presence or absence of EHR Domain Repositories. The key data domains recognized as part of an EHR are the shared health record, drugs, laboratory and diagnostic imaging. In Canada today, some of these data domains may already be the subject of deployed jurisdictional level systems. In order to provide the complete clinical picture of a patient/client, the EHR infostructure must be able to assemble information transparently from these EHR Domain Repositories

2.1.10 Ancillary Data and Services

Ancillary data and services represent a generic class of auxiliary capabilities that rely on, need or complement EHR domain data in order to support health services delivery. Examples of potential ancillary services include: outbreak management, communicable disease reporting to support the realm of public health. Other valid examples could include: enterprise scheduling, wait list monitoring, cross-continuum workflow services and others.

2.1.11 Health Information Data Warehouse

The Health Information Data Warehouse represents a separate capability to compile, aggregate and consolidate EHR data for reporting and statistical or research analysis. The EHR data domains, ancillary services or registry services data will be highly optimized and preserved to support online patient centric accesses to Electronic Health Records by caregivers and other types of end-users.

While this is the primary goal of the EHR Infostructure, a lot can be said for the healthcare value derived from being able to use this information for research, analysis and health prevention initiatives. Key examples of such uses include public health surveillance, public health reporting and tracking of key health indicators, health research analysis, cancer care research, etc…

To support these types of uses, a separate data analysis environment is required and online transactional data needs to be moved to a data warehouse environment where data can easily be manipulated and transformed to meet such analysis requirements.

2.1.12 Registries

A Registry is a directory-like system that focuses solely on managing data pertaining to one conceptual entity. In an EHRi, registries store, maintain and provide access to peripheral information not necessarily clinical in nature but required to operate an EHR. The primary purpose of a Registry is to respond to searches using one or more pre-defined parameters in order to find and retrieve a unique occurrence of an entity. Examples of registries include: Client Registry, Provider Registry and Location Registry.

2.1.13 HIAL: The Health Information Access Layer

The Health Information Access Layer (HIAL) is a gateway that acts as an abstraction layer to separate PoS applications from the EHR Infostructure. It is made up of service components, service roles, information models and messaging standards required for the exchange of EHR Data and the execution of interoperability profiles between EHR Services. The HIAL is broken down into two layers of services: the common services and the communication bus services.

The common services layer is an aggregation of services that provides common and reusable functions for the systems that participate in an EHR Infostructure. It is focused on integration, privacy and security, system configuration, management and monitoring functions and makes those common functions available for all services in a given EHRi.

The communication bus services layer is an aggregation of services that pertain specifically to enabling communication capabilities. It is focused on the receiving and sending of messages and the support of valid communication modes primarily between PoS applications and an EHRi, EHRi to EHRi and possibly between components within an EHRi (e.g. LRS to Client Registry).

2.1.14 EHRS Locator

The EHRS Locator maintains information describing which EHR Infostructure(s) keeps a record for a given individual. It allows each EHRi to trace and retrieve the address of other EHR Infostructures where clinical data is maintained about a person. It is used in the context of transactions to know where data is located and to subsequently enable an LRS to query those locations.

2.1.15 Overarching Concepts

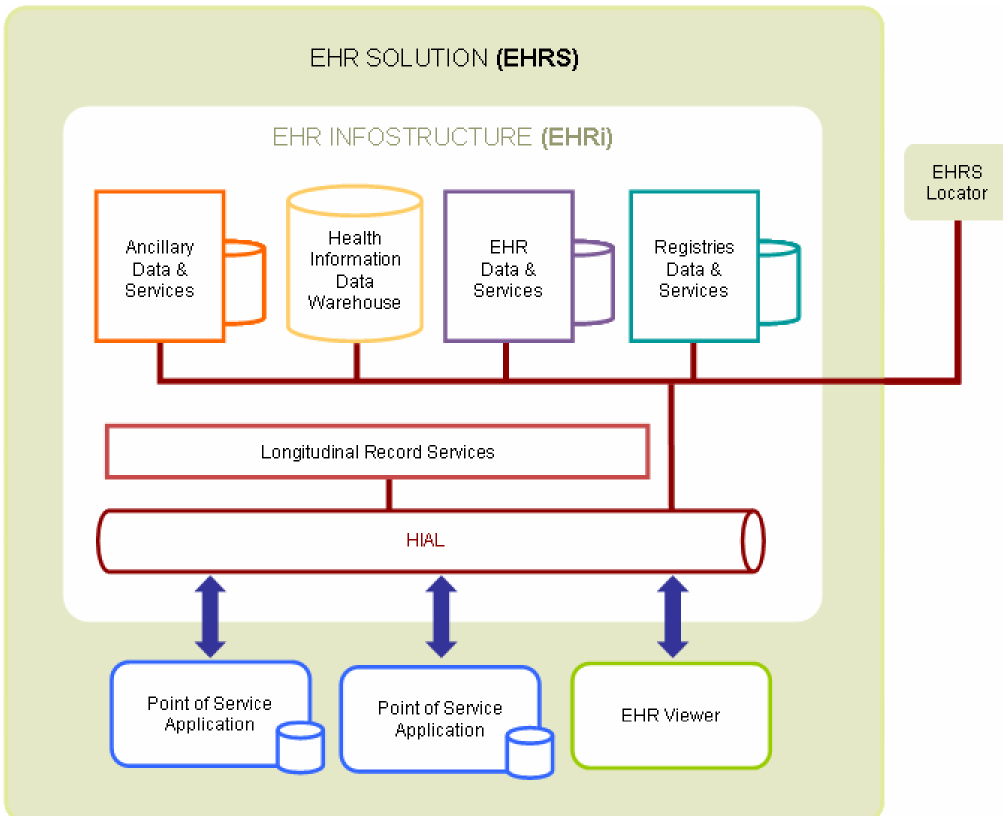

Figure 2-1 Key EHRS Architecture Concepts

The above diagram describes the previously defined key concepts and illustrates how they assemble into the *Infoway* architecture for an EHRS. The key business architecture and technical architecture elements of the EHRS include the following:

- The information stored in the EHR Data and Services Repositories is patient/client-centric and longitudinal. Logically it forms a “womb–to-tomb” health history for the patient/client. Together the PoS applications participating in an EHRi and their associated databases form the complete electronic health record of a patient/client;
- Across a network of EHR Solutions a patient/client is perceived by the PoS applications and their end-users (caregivers) as existing logically in one single EHR. Given the way healthcare is delivered in Canada it is important that there be flexibility in the solution architecture with respect to where a patient/client’s physical EHR data is located. By way of example, the EHR data about a client will typically stay physically in the province/territory where they received care.

  Over time, this may mean that a client’s EHR data is distributed across several EHR infostructures. However, each time that a caregiver is accessing this client’s EHR, the EHR infostructure handling this request will compile all the data relevant across any number of EHR infostructures where relevant data is kept. From the system’s perspective, and more importantly the users of those systems, the person’s data is perceived as being in one EHR;

- The EHR is an authoritative and reliable source of the clinical information. It is meant to be used as a valid source of information in support of health services providers assessing and making clinical decisions for clients on a continual basis;
- Conceptually, an EHR is a structured set of clinical information for a patient/client. Information for the patient/client may be organized into "multi-dimensional" categories such as time, clinical data type (e.g. encounter events, lab order or result, drugs prescription or dispense, clinical notes), practice area, disease classes and others;
- The EHR holds a history of health service delivery events for each patient/client. Events can be flexibly associated with, or organized as, an Encounter, or as part of a larger Episode of Care. This allows the organizing of a patient/client's health history in a way that is meaningful to providers of services;
- All clinically relevant data required to share the clinical picture of a patient/client across the continuum of care is kept in the EHR;
- An EHRi is NOT an on-line transaction processing (OLTP) store for any clinical system used in a point of service;
- An EHRi is enabled by registries, a LRS, EHR Data domain repositories, ancillary services, a health information data warehouse and a HIAL;
- The PoS applications are key elements of the solution. PoS applications are used by authorized caregivers to view and navigate the EHR of a patient/client. These include applications at the point of care that a provider is interacting with. This may be a piece of medical equipment that is generating or reading clinical data for a patient/client or an intelligent agent (i.e. without a human-computer interface) implementing some specific business rules;
- Data produced in PoS settings is pushed or published into the EHRi from PoS applications;
- PoS applications store encounter related data in their local data store and are also publishing or replicating the parts of this data that is declared as clinically relevant for sharing, in near real-time into the EHR via the EHRi.
- The same set of PoS applications read and use data out of the EHRi. Thus, the EHRi is used for clinical purposes by these applications. EHRi data is viewed from PoS applications that caregivers or providers use in their daily activities. For example, a primary care doctor using an electronic medical record (EMR) application may be viewing four sets of data on their system. One set of data coming from the patient's EHR; another from the EMR application order entry module (i.e. for a new prescription or lab test); another from the EMR's local database regarding the patient's latest visit; and a fourth set for an input screen for the doctor's clinical notes pertaining to the visit.
- The interface between PoS applications and EHRi must comply with pan-Canadian EHR standards. Several modes of communication have to be supported in order to cover the different types of interactions that are needed. Most of the communications rely on a service oriented messaging framework for the purposes of reading and writing clinical information in and out of the EHRi. Some communications rely on streaming protocols (e.g. diagnostic imaging). Pan-Canadian EHRi communication standards are based on industry standards such as HL7, DICOM, EBXML, SOAP, SHTTP and TCP/IP.

2.1.16 Primary Use vs. Secondary Use

This descriptor of "primary" or "secondary" use of the Electronic Health Record is intended to distinguish between the different purposes for accessing the EHR. The perspective driving this definition is that of the end user and the work processes carried on by such users. The qualifier of primary versus secondary uses refers to the data coming from an EHR and the way in which the data contained in the EHR contributes directly to the functioning of work processes involved in the provision of care to a patient.

Primary Use

Primary Use of the EHR refers to usage of the EHR data to directly contribute to the provision of care for a patient/client for a given encounter or episode. In most provinces today, primary uses are conducted under some form of implied consent with or without notification. In general we recognize the following categories as representing uses that would be considered as primary:

1. Health services provision
2. Patient-focused outcome analysis where names are required

Examples of primary usage would include, but are not limited to, the following:

- A General Practitioner (GP) using their Electronic Medical Record (EMR) to access the referral summary from a Cardiologist for a patient/client they are seeing.
- A radiologist contributing the digital image and report for a CT Scan to a patient's/person's EHR.
- A pharmacist, in a drugstore, accessing a patient's/person's electronic prescription and medication profile to fulfill and contribute an electronic dispensing event.
- A patient/client contributing blood glucose results from their digital glucometer for the purposes of monitoring gestational diabetes.
- A health care facility nurse accessing demographic data to contact a specific patient/client in the context of a product recall for a faulty heart device;
- An Emergency Room (ER) nurse accessing the health history of a patient/client and contributing a summary of the assessment and treatment provided during the encounter.
- A physiotherapist, in a community-based clinic, contributing observations in the context of an interdisciplinary rehabilitation care plan for a burn victim;

Secondary Use

Secondary Use of the EHR refers to usage of the EHR data for activities that are not directly related to the care of a specific patient/client for a given encounter or episode. In most provinces today, secondary uses of the data are done via anonymized data and require some form of consent. Secondary uses may also pertain to identifiable data and in that case always require explicit consent from the patient/client. In general we recognize the following categories as representing uses that would be considered as secondary:

1. Governance and health service delivery administration
2. Program management – conducted by Programs and Health Authorities
3. Education – e.g. teaching hospitals etc. Where education is bundled with care provision it is considered care first and foremost, not education.
4. Insurance
5. Research
6. Public health surveillance

Examples of secondary usage would include, but are not limited to, the following:

- A public health organization makes a request to access EHR data in an anonymized format to review mortality rates for patients/clients living in a given geographic area.
- A health research organization makes a request to access EHR data in an anonymized format to review the health status of all patients/clients who have undergone open heart surgery for the implementation of heart valve devices over the last 10 years.
- A pharmaceutical company makes a request to access EHR data in an anonymized format to review all potential side effects of a given drug protocol.
- A provincial Ministry of Health retrieves, from the EHR, a list of all men over the age of 45 living in the province who have not had a prostate exam to initiate a targeted health promotion campaign.
- A patient/client arrives at a hospital where they wish to have students attend various clinical procedures for the benefit of the education of the students. The students are not participating in the patient's care but require patient/client data to have a meaningful educative experience. In this instance patient/client consent is sought and obtained for this purpose.
- A person donating blood is asked to allow the use of their personally identifiable data as part of a study on a specific infectious disease. This study requires linking data with a regional infectious disease reporting program. Named data is used because the organizations have no common identifier available to them both.

The data stored in the EHRi will be optimized for patient/client driven access performed by healthcare professionals in the context of providing services to individuals. This is usually not very conducive for research and statistical analysis types of applications that need to perform queries addressing large subsets of data. In most cases, to sustain the purposes of research and analysis, it is understood that the preferred approach would be to extract large sets of data from the EHRi and load such data into the Health Information Data Warehouse where it can be optimized and massaged for research purposes.

2.2 USES AND BENEFITS OF THE EHRS BLUEPRINT

The purpose of this section is to put the Infoway EHRS Blueprint into context. It provides potential uses and benefits of the EHRS Blueprint architecture as they may apply to various healthcare jurisdictions and stakeholders.

The EHRS Blueprint is a framework for enterprise architecture focused on the business needs and requirements of large scale clinical information sharing initiatives in Canada. Such initiatives are becoming more and more common and are appearing, mostly in industrialized countries, under such names as Community Health Records, Electronic Health Records, National Health Records, etc… Canada Health Infoway (Infoway) is actively sponsoring and directly funding health government based EHR initiatives. In this context, the purpose of the EHRS Blueprint is to act as a starting point and a common definition for anyone in Canada who is pursuing large scale health information sharing initiatives.

The benefits include:

- Increased Agility

- o Adaptability to meet the changing needs of the healthcare system and of healthcare providers and patients/clients
- o Faster delivery of new applications and continued ROI from legacy applications
- o Easier integration of diverse applications and more flexibility during mergers, acquisitions and new business relationships, as they pertain to information systems and technologies

- Facilitated Integration
    - o Timely access to critical clinical patient/client information across the enterprise with consistency and accuracy
    - o An enterprise knowledge of what you (organization, department, service) know, where that knowledge resides, and how you (provider, administrator) can access it
    - o Adoption of a common set of technical and data standards and of a common architectural model
- Cost efficiencies
    - o Requirements to facilitate appropriate technology procurement and vendor management
    - o Facilitates concentration of required skill-sets
    - o Increased reuse of technology investments
    - o Enhanced opportunity for financial ROI from legacy applications
- Documented and clearer system development and migration strategies
    - o Priorities, timelines, options and benefits
    - o Focuses investment in the right areas at the right time

2.2.1 Promoting EHR Standardization Across Canada

A common understanding of the desired future state allows for a more coordinated effort across the country where each jurisdiction can act locally while sustaining the objective of a pan-Canadian interoperable set of EHR solutions.

The use of a common architectural model also establishes a consistent terminology that facilitates communications between stakeholder groups. Much of the discussion on the subject of EHR will occur within jurisdictions, involving governmental agencies, regional health authorities, provider organizations, healthcare professionals and technology vendors. Although those participating in these initiatives will have different perspectives and interests in relation to the EHR, the EHRS Blueprint provides a common framework to better enable stakeholders to express their visions and requirements and to identify and resolve issues.

The EHRS Blueprint puts forward several key architectural decisions that can be taken into consideration with respect to how EHR infostructures will be deployed in any jurisdiction. This, by itself, is a key area of standardization in that every stakeholder group will adopt the common approach established by those decisions.

2.2.2 Reference For Strategic Planning

Many stakeholders participate in the healthcare industry. The EHRS Blueprint describes what the EHR is from a business and system perspective and how and where interoperability would be created. The EHRS Blueprint, therefore, stands as a key input into the strategic planning exercises for healthcare funders, providers, organizations and associations.

2.2.2.1 For Provinces

Jurisdictions, within the context of developing, governing and operating EHR solutions are defined by each Province. For example, a Province may decide to have many jurisdictions (regional health authorities, hospital groups, etc…) that implement EHR solutions. A province could also decide to establish only one governing structure or a province may select to enter into an accord with another province(s) to deploy a single governing structure across multiple provinces.

Many components make up the parts of an EHR infostructure. The optimized path to the implementation of an EHR infostructure may vary greatly between provinces and among jurisdictions within a province. Influencing factors may include:

- Readiness
- Healthcare system priorities
- Results of early adopter pilot projects
- Pre-existing EHR initiatives
- Change management capabilities
- Financial and human resources
- Pre-existing infostructure(s)
- And others

The Blueprint will serve as a valuable strategic input document that can assist the provinces in their decision-making related to the initial and ongoing funding and implementation of governmental (Ministry of Health), jurisdictional and/or provincial EHR strategies and solutions.

2.2.2.2 For Healthcare Organizations

Another use of the EHRS Blueprint is its contribution to EHR Solution planning processes ongoing in healthcare organizations, including hospitals, private clinics, regional health authorities, home care agencies, long term care and tertiary care facilities and agencies, etc. These organizations are at different stages in assessing or transforming their operations in regards to the use of an EHR. In that sense, the EHRS Blueprint can contribute to the strategic EHR planning activities of these organizations.

- Identification of business and technical requirements to support procurement activities
- Planning the integration of their clinical and operational systems to support the creation of the organizational EHR
- Managing the change and adoption of these new capabilities by users, including physicians, nurses and allied health professionals
- Identifying opportunities to further benefit from the use of an EHR:
  - Reengineering work processes
  - Upgrading systems and infrastructure
  - Creating new policies and guidelines
  - Enhance the delivery of patient/client care

2.2.2.3 For Provider Associations

Provider associations can use the EHRS Blueprint to better understand the impact and benefits of a large scale deployment of electronic health records. Healthcare professionals have for many years studied the opportunities that can be created with the information sharing that an EHR enables. The EHRS Blueprint gives stakeholders a framework from which to plan for a phased implementation approach for an EHR infostructure in their own jurisdictions. In particular, provider associations can use the EHRS Blueprint to plan for:

- Member education
- Representation in regards to the EHR and its phased rollouts within the community of providers

- o Policies, such as how professionals will be represented and recognized in provider registries
- o Identifying opportunities to further benefit from the capabilities offered by an EHR, including:
  - ▪ Reengineering work processes
  - ▪ Improving the quality of patient/client care delivery and outcomes
- o Facilitate the process of enabling provider access to expert knowledge (e.g. drug-drug interaction databases) and to conduct research
- o Assist their members in their decision making related to the procurement and implementation of EHR solutions

2.2.2.4 For Providers (Healthcare Professionals)

Healthcare professionals have for many years studied the opportunities that can be created with the information sharing that an EHR enables. In particular, providers can use the EHRS Blueprint to:

- o Education to better understand the capabilities offered by an EHRS in their jurisdiction and participate and influence the development, implementation and usage of it in their own practice setting
- o Assist them in their decision making related to the procurement and implementation of EHR solutions, such that there is interoperability between providers.

2.2.2.5 For Healthcare Informatics Solution Vendors

EHR Solution vendors, in collaboration with their partners and customers, will design, develop, implement and support the components that make up the EHR infostructure for a particular jurisdiction. The EHRS Blueprint provides the high-level roadmap that vendors can leverage when defining their product development and marketing strategy. The deployment of a standard-based, interoperable EHR solution across Canada creates enormous opportunities for greater reusability of existing systems and, most importantly, for creating new, high value-add solutions. It also serves to significantly reduce vendor development and implementation costs that are incurred in the non-standards based environment that currently exists.

By incorporating the concepts and standards set forth in the EHRS Blueprint, vendors can align or evolve their information systems solutions or services to quickly capitalize on adopted EHR Infostructures.

2.2.2.6 For Privacy and Security Initiatives

The EHRS Blueprint should be used in discussions at every jurisdiction and/or with every stakeholder association and community to identify privacy and security issues/risks that should be addressed by the jurisdiction and/or the stakeholders as part of their individual EHR strategy development, and design and implementation activities.

2.2.3 Enabling Project Specific Architecture, Design and test Phases

Projects financed by *Infoway* will be selected, in part, on the basis of the component(s) of the EHRS Blueprint that the projects develop, implement or otherwise sustain. This means that, in many cases, within the context of deployment or development projects, the EHRS Blueprint would provide the conceptual view of what needs to be deployed or developed. Thus, conceptual architecture phases can be reduced in scope by using the EHRS Blueprint.

Projects can more quickly complete the architecture phase and initiate design and development phases.

The EHRS Blueprint, by way of providing a vetted shared conceptual definition of an EHR components and software services, stands to save anywhere between 5% to 10% of effort spread across the Preliminary Analysis, Architecture and Design phases of any project.

The EHRS Blueprint is a conceptual level statement of work process, information and functions for an EHR Solution. In that sense, the EHRS Blueprint could be used by system test analysts and quality assurance managers to build test plans and validation grids for system testing. The Blueprint can also be used as a vehicle for supporting design activities; for acquiring funding; for garnering stakeholder support; as input into communications and change management strategies and plans, including user training; etc.

2.2.4 Critical to the Mission of Infoway

In considering project opportunities, Infoway will look for initiatives that support its mission and vision. One of the key selection criteria for investment is conformance to the EHRS Blueprint.

Knowledge Objects Assets Reference Model: One of the key objectives of Infoway is to structure, maintain and operate a knowledge repository for all intellectual assets that pertain to EHRs. The EHRS Blueprint establishes a shared terminology that can be used to describe and identify the different components required to enable an interoperable EHR. This terminology is a key reference model used to categorize and structure available assets for Infoway

Enabling Replication (Reuse): Enabling the replication of assets is also a strategic goal of Infoway. The cost and operational efficiencies (benefits) expected to be derived from a consolidated and shared approach to develop and deploy EHR Solutions, depend a great deal on the ability of different jurisdictions to replicate and deploy components developed in other jurisdictions. Recognized best practices in IT towards reusability prescribe that it can only be maximized in contexts where solutions are architected and designed with reuse in mind. The EHRS Blueprint has been designed and developed specifically to enable reuse and replication at the architecture level. In that sense, it is an ideal vehicle to promote reusability by providing each jurisdiction with a tool to identify a pathway by which it will create, replicate and deploy the different components of an EHR infostructure.

2.2.5 Base to Engage In International EHR Standards Initiatives

The EHRS Blueprint represents a collaborative stated vision of how an EHR infostructure can be created at the jurisdictional level to enable Electronic Health Records across multiple organizations, jurisdictions and provider communities. It stands as a useful base from which Canada can proactively and effectively engage in international health informatics standardization efforts.

2.2.6 Base to Engage In Pan-Canadian EHR Standards Initiatives

Different national organizations and provincial standards bodies that are taking active roles in the definition, development, implementation and evolution of healthcare informatics standards in, and for, Canada can use the EHRS Blueprint as a foundation for their discussions, analyses, and decisions. For example, the EHR Data Definitions and Standards Project from Infoway which aims at defining Pan-Canadian standards for the data models, vocabularies, coding standards, and messaging structures, is further defined and scoped by the Blueprint. This enables the team to focus on those elements of its mandate which are required in the definition of a complete solution architecture.

2.2.7 Enabling education and training initiatives

The EHRS Blueprint is a key asset which can support the development of jurisdictional or stakeholder-based education and/or training initiatives related to the design and development of EHR solutions.

2.3 KEY ARCHITECTURAL DECISIONS

The following is a list of the key architectural decisions made to-date. This list provides a quick summary of the key aspects of the EHRS Blueprint.

Generalities

- The EHR has a common definition across Canada, is essential for reuse of components and to achieve interoperability
- The services based approach set forth enables granularity, flexibility and reusability throughout the different layers of functionality described in the architecture

EHR Data and Services

- EHR Data domain repositories enable reuse and continued ROI on existing or upcoming jurisdiction level solutions
- Information contained in the EHR data repositories includes all clinically relevant longitudinal data which maximizes the potential for completeness, timeliness and accuracy of access to data across time and across the continuum of care for any patient/client.

EHR Infostructure

- There is a high degree of separation or abstraction between the PoS applications used by caregivers of clients and the EHR Infostructure. The EHR Infostructure is seen as a transactional gateway by way of which any PoS application can update a client EHR or access data in a client EHR. It is perceived as a single black-box with a set of supported transactions.
- The EHR Infostructure combines the capabilities of a network of interconnected EHR Solutions to insure the availability of accurate and complete health records to any authorized user in Canada.
- The EHR infostructure assembles data stores and services required to constitute and operate a patient/client centric data repository for data declared as clinically relevant for sharing.
  - ➢ Enables a Controlled Environment Under which Privacy and Security Policies can be applied
  - ➢ Limits the number of interfaces that have to be developed recognizing the heterogeneous nature of PoS applications and their operating environments
  - ➢ Enables Timely, Accurate and Complete Delivery of Information
- Information available in an EHR infostructure is composed of data replicated from PoS applications into separate EHR data domains. Some of these domain solutions may play both the role of an EHR service and a PoS application (e.g. a DI PACS domain solution).
- The EHR infostructure is established as an authoritative source of data for PoS applications and their end-users.

- An EHR infostructure may be implemented at any jurisdictional level which allows for a high level of flexibility and configuration around local and provincial needs.
- Internal identifiers are required within an EHR Infostructure to allow for all participating systems to maintain easily accessible data. These internal identifiers are generated by registries and security services and need to be provided to any of the systems that maintain EHR data in an infostructure. These internal identifiers are only valid within the frontiers an EHR Infostructure and should never be exposed to PoS applications.

Longitudinal Record Services (LRS)

- The Longitudinal Record Services is the kernel of an EHR Infostructure. It is the control center where transactions that need to be executed against a view of information that crosses domains and registries, can be established and processed;
- The Longitudinal Record Services maintains an index of all events posted to a patient/client health record. It has the ability to use this index in order to find information about a patient/client and subsequently obtain the address where the detailed clinical data associated to an event is located. It provides for the ability to have a cross-domain longitudinal view of the information available in the EHR of a patient/client;
- The Longitudinal Record Services include the ability to figure out where data exists in other EHR Infostructures and use that information to spawn transactions to other EHRi's in order to compile a complete response to a query;
- The Longitudinal Record Service has the ability to process complex composite transactions that need to combine information from many different domains and EHR Infostructures. This allows for a level of efficiency and optimization that is otherwise unachievable.

Health Information Access Layer (HIAL)

- The message based approach enables loose coupling of rigid data structures and optimizes openness towards new business transactions and data domains;
- Different modes of communication will need to be supported by the HIAL. They are: structured data, unstructured (document) data, object streaming, security management and system management communication modes
- Two main classes of EHR transactions will need to be handled by the HIAL.
  - The first type is a single domain transaction that is directly targeted at a specific EHR data service. Usually these transactions will be EHR update transactions hitting a single domain solution (e.g. "put new radiology report"). These transactions will trigger notification transactions towards the LRS once and update is processed.
  - The second types are transactions that need to utilize a comprehensive cross-domain or cross-Infostructure view of the data available for a patient/client. Those are transactions that require the use of the index and where a significant amount of processing is required to discover where all relevant data exist.
- Information is normalized (consistent semantic meaning) whenever possible on input to optimize timely and accurate delivery of information;

- Each patient/client may be known in many EHR Infostructures where their clinical data is maintained, the complexity associated with the access to data in multiple EHR Infostructures is abstracted from the PoS applications. PoS application perceive that a given patient/client has a single EHR;
- HL7 v3.0 facilitates the rigor and robustness required for true standardization of messages for system-to-system communications;
- HIAL enables common specifications and normalized processing:
  - Provides a simple message based approach to support all interactions between PoS applications and an EHR infostructure;
  - Facilitates consistent semantic meaning of information across points of care;
  - Enables consistent application of security rules to accessed data (read or write);
  - Enables consistent application of privacy related policies including consent, access rights, logging, auditing, cross-jurisdictional uses, surveillance uses and others;
  - Enables standardized integration approach with any PoS application through a UDDI compatible approach;
  - Abstracts the complexities associated with components that make up the infostructure - allows non-disruptive evolution of infostructure capabilities and applications at the point of service;
  - Enables a controlled environment in an EHR Infostructure to apply Service Level Agreements (SLA's) for intra and cross-jurisdictional interoperability;
  - Enables publish/subscribe and notification/alerts mechanisms across points of care which are key to support the accuracy of data as well as workflow and decision support capabilities.

PoS Applications

- Applications write data to their operational data stores and replicate data to the EHR;
- Messages are initiated by PoS applications to populate an EHR with clinical data:
  - Applications can promote data to an EHRi dynamically;
  - Applications can promote data in bulk using messages designed for this purpose;
- Applications read data out of the EHR dynamically via standards based messaging interfaces in addition to their operational data stores;
- The standard web services based messaging interface approach to the connectivity with PoS applications allows for a minimal disruptive change to such applications in terms of the way they operate in a PoS organisation. All the while, allowing for a high degree of interoperability and hence achieving optimal clinical information sharing for caregivers and patients/clients.
- The standard web services based messaging interface approach to the connectivity with PoS applications allows reducing the effort required by any technology vendor to adapt their application for interoperability with an EHR Infostructure. This allows vendors to spend more effort and time to innovate, compete and extend value added services in their products.

2.4 BLUEPRINT VALUE PROPOSITION

2.4.1 September 2004 Milestone

In the recent years, there was a growing consensus on the value of an EHR. The Romanow Commission Final Report cited "*Electronic health records are one of the keys to modernizing the health system and improving access and outcomes for Canadians*." Similarly, the Kirby Senate Committee found that "*Not only can an EHR system greatly improve quality and timeliness in health care delivery; it can also enhance health care system management, efficiency and accountability*."

In September 2004, this consensus has been formalized by all Canadian Jurisdictions through the First Ministers' Health Accord statement: "*Electronic health records and telehealth are key to health system renewal, particularly for Canadians who live in rural and remote areas. Recognizing the significant investment that has been made and achievements to date, First Ministers agree to accelerate the development and implementation of the electronic health record, including e-prescribing. To this end, First Ministers commit to work with Canada Health Infoway to realize the vision of the electronic health record through an ambitious plan and associated investment. First Ministers have also asked for acceleration of efforts on telehealth to improve access for remote and rural communities.* "

2.4.2 EHR in action

Healthcare professionals make clinical decisions based on knowledge. Access to relevant and reliable clinical information is a critical input for the process of knowledge creation. In fact, information is the lifeblood of an effective health care system. To ensure the best possible care, the information must be accurate, up-to-date, available, and accessible whenever those who provide health care services need it.

This version of the EHRS Architecture introduces a Use Case framework to depict in details the use and the value of the EHR in the clinical processes. This is described in the Clinical Work Process Architecture section of this document.

As an introduction, let's consider a few examples of the EHR in action, that is, in supporting clinical processes. The following table illustrates the impact the EHR can have on two typical care processes: a primary care visit and an emergency room visit.

Primary Care Visit	Current Process	Process with an EHR
Patient presents with problem and requires workup.	• Paper lab and DI requisitions.	• Online ordering of diagnostics.
Patient presents for follow-up visit.	• Paper copies of lab and DI results reviewed and put in patient's chart. • Manual review of previous relevant diagnostics. • Patient forgets to tell about a recent visit in another health care	• Online viewing of current and appropriate past results. • Retrieval of relevant information, from another health care center.

Primary Care Visit	Current Process	Process with an EHR
	center.	
Patient needs to be referred to a specialist.	• Telephone or fax referral. • Relevant material in the chart is faxed, mailed, or sent with patient to specialist.	• Online referral. • Specialist can view all relevant historical clinical information (notes, diagnostics, drugs, etc.)
Patient treatment plan established and follow-up arranged.	• Paper script written by specialist. • Call from pharmacy to office for interpretation. • Consult summary dictated and mailed to PCP office and filed in patient/client chart.	• ePrescribing from specialist office. • Primary Care Provider (PCP) can view specialist notes and treatments. • eDispensing information available for purposes of monitoring compliance.

Emergency Department (ED)	Current Process	Process with an EHR
Patient presents alone requiring urgent acute medical care.	• History & physical ascertained through interview with patient. • Patient did not bring medications. • Call to patient's physician office or pharmacy to get records.	• Providers can view patient history including relevant diagnostics and drugs. • eDispensing information available for purposes of monitoring compliance.
Patient requires diagnostics.	• Paper lab and DI requisitions. • Results are faxed/phoned to ED.	• Online ordering of diagnostics. • Online viewing of results.
Patient diagnosis is confirmed and care plan developed.	• Physician writes script. • Patient is instructed to go to PCP for follow-up. • Patient visit summary mailed to PCP office and filed in patient/client chart.	• PCP can view notes and treatments from ED visit. • eDispensing information available for purposes of monitoring compliance.

As exemplified in the above examples, by breaking down some of the information silos that currently exist, the EHR can provide integrated patient-centric clinical information that extends beyond the walls of any one health care setting or the boundaries of a provider's context of practice to support the 5 R's of clinical decision-making: the **right information**, about the **right patient**, available to the **right person**, in the **right place** and at the **right time.**

In addition, the EHR provides opportunities to support coordinated patient/client assessment and improve patient/client safety, facilitate the identification of potential and real health risks as well as contributors to health, and provide decision-makers and health managers with the comprehensive data they need to plan and allocate resources appropriately and efficiently.

2.4.3 EHR Value

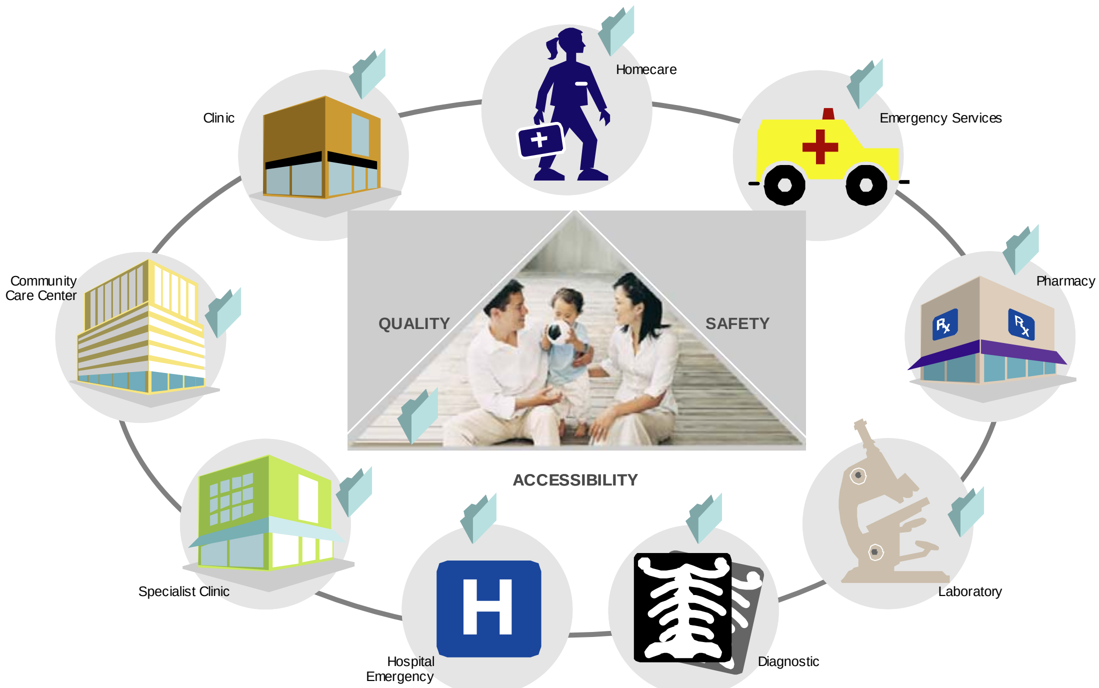

Figure 2-2 Integrated View of an EHR

How does the EHR deliver value?

- EHR can support and enhance clinical practice by improving access to information that is not currently available in a consistent or timely way to support clinical decision-making. Through this, the EHR can leverage the time of providers for high value activities.
- Through the EHR, there is a capability to accumulate vast amounts of structured patient/client centric data, normalize the data to be easily understood by any reader, and make it available for systems and/or end-users.
- Similarly, the EHR provides an opportunity to process vast amounts of data to find patient/client information. It can search for critical clues through a patient/client history of care episodes.
- The EHR can facilitate the referral process by allowing for the interoperability of information between points of care and ensuring levels of speed, accuracy, completeness, reliability and clarity never before achievable.

- Finally, the EHR can support decision-making processes by applying validated scientific and business oriented rules to patient/client information.

As implicitly stated here, the value of an EHR for patients, families, and their providers increases with the completeness of the information contained within the EHR, as illustrated in Figure 2-x. This completeness of the information increases through a number of mechanisms:

- First, the extent to which clinical information is accessed and contributed at all points along the continuum of care is a key value driver of the EHR. Through this, providers can share their data with other relevant and authorized providers in a more timely and consistent way than is currently possible.

- Similarly, as the domains of clinical data that are included in the EHR increase, the overall value of the information for a given patient and their providers increases. In this way, it is possible to create a comprehensive multi-disciplinary picture of a patient's status or condition to support collaborative decision-making across all providers.

- Finally, the EHR value also increases as the access to the clinical information contained within the EHR extends across the natural referral area of care.

2.4.4 Timing

Pen, paper, and error-prone human memory are the primary information tools by which modern health care is managed today. It is paradoxical and cause for deep concern that in the 21st century, an endeavour as complex and critical as the Canadian health care is managed by such basic means!

Information technology, which is the cornerstone of quality improvement and efficient management in less complex industries, has been woefully underutilized in the health care sector. It has been estimated that the banking industry spends approximately twice as much on information technology as the health care industry. Such anachronistic means of managing health care information are juxtaposed with the stunning scientific and technological advances that have been made in recent decades. The Romanow report frames it well: "*We live in an age of laser surgery and are unlocking the mystery of the human gene, yet our approach to health information is mired in the past. And much of the information we gather cannot be properly analyzed or shared.*"

Additionally to the September 2004 consensus formalized by all Canadian First Ministers, timing to implement is right also because:

- Patients/clients are demanding more from the health care system. They want improved access to services and expect optimal quality of care. At the same time, healthcare organizations are feeling constant pressure to provide comprehensive services within fixed budgets.

- Administrators, providers, and patients/clients alike are growing more attuned to the technology that is available and are beginning to understand the value that such technology can generate. There is a willingness to collaborate and participate in initiatives of this type.

- Infrastructures (e.g. network, user interface devices) are being deployed and are becoming increasingly available. In addition, networked application technologies are mature and proven.

Infoway has many current investment programs underway that have included key building blocks for an EHR. They concentrate on the collection and storage of patient data: registries, laboratory systems, diagnostic imaging systems, and drug information systems. These systems account for 80% of patient data. Now, *Infoway* is starting to support jurisdictions through new investments in the integration of this data through the Interoperable EHR and the Telehealth programs.

2.4.5 EHR and telehealth

EHR and telehealth describe complementary and overlapping technologies that are subsets of the larger domain of e-health. Telehealth is sometimes defined as follows: the use of communications and information technology to deliver health and health care services and information over large and small distances.[1] If a primary function of the EHR is to electronically aggregate health information recorded at different places and times, and make that data available at the point of care, the parallel objectives of these technologies become clear.

Canada has been a world leader in applying telehealth technology to address health care challenges. The NORTH Network in Northern Ontario is perhaps the world's largest and most robust telehealth service. This network connects more than 100 hospitals and has performed over 10,000 consultations in over 70 specialties since its creation in 1998. More than 80% of Ontario's hospitals are already connected to SSHA's network.

Both telehealth and EHR systems can share a common IT infrastructure and be interoperable at the national level. As telehealth and EHR technologies mature, they will increasingly converge; and the foundation for each should facilitate that convergence so that digitized voice, video, imaging, monitoring, lab, pharmacy, and written documentation data are aggregated in a manner that makes all necessary information available when needed at the point of care.

2.5 BUSINESS CASE FOR THE EHR

Healthcare professionals make clinical decisions based on knowledge. Access to relevant and reliable clinical information is a critical input for the process of knowledge creation. In fact, information is the lifeblood of an effective health care system. To ensure the best possible care, the information must be accurate, up-to-date, available, and accessible whenever those who provide health care services need it.

The EHR can provide integrated patient-centric clinical information that extends beyond the walls of any one health care setting or the boundaries of a provider's context of practice to support the 5 R's of clinical decision-making:

- The **right information**
- About the **right patient**
- Available to the **right person**
- In the **right place**
- At the **right time**

[1]Telemedicine in Other Countries and International Initiatives. Industry Canada. Available at http://strategis.ic.gc.ca/epic/internet/inict-tic.nsf/en/it07545e.html Accessed August 2004.

In addition, the EHR provides opportunities to support coordinated patient/client assessment and improve patient/client safety, facilitate the identification of potential and real health risks as well as contributors to health, and provide decision-makers and health managers with the comprehensive data they need to plan and allocate resources appropriately and efficiently.

How does the EHR deliver value? It can support and enhance clinical practice by improving access to information that is not currently available in a consistent or timely way to support clinical decision-making. Through this, the EHR can leverage the time of providers for high value activities.

Through the EHR, there is a capability to accumulate vast amounts of structured patient/client centric data, normalize the data to be easily understood by any reader, and make it available for systems and/or end-users.

Similarly, the EHR provides an opportunity to process vast amounts of data to find patient/client information. It can search for critical clues through a patient/client history of care episodes.

The EHR can facilitate the referral process by allowing for the interoperability of information between points of care and ensuring levels of speed, accuracy, completeness, reliability and clarity never before achievable.

Finally, the EHR can enable decision support (not decision making) by applying validated scientific and business oriented rules to patient/client information.

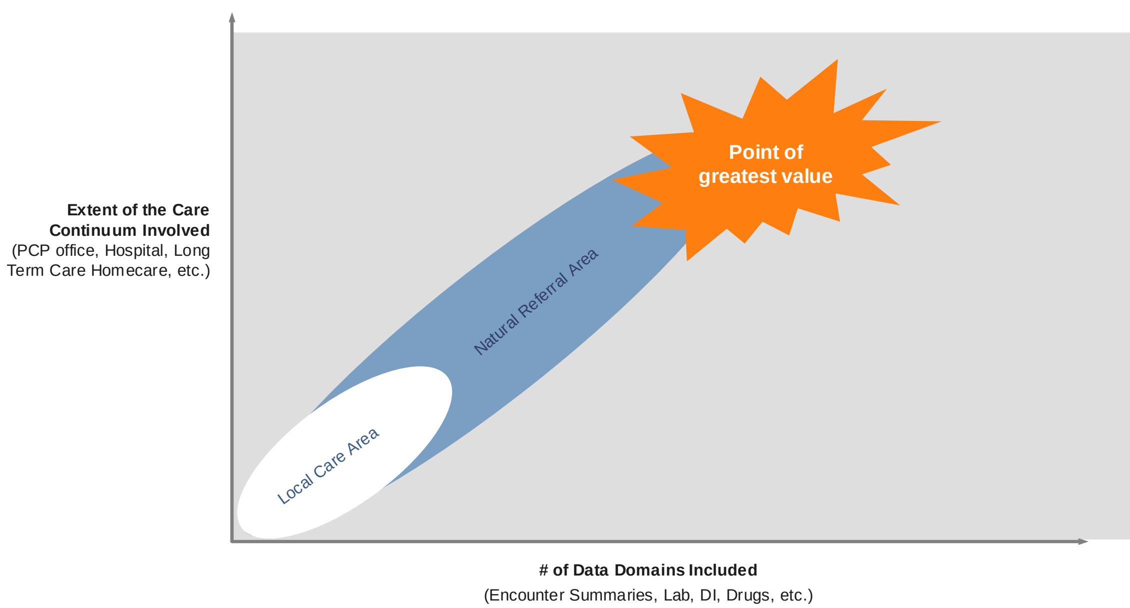

Figure 2-3 Increasing Value of an EHR

The value of an EHR for patients, families, and their providers increases with the completeness of the information contained within the EHR. The completeness of the information increases through a number of mechanisms:

1. First, the extent to which clinical information is accessed and contributed at all points along the continuum of care is a key value driver of the EHR. Through this, providers can share their data with other relevant and authorized providers in a more timely and consistent way than is currently possible.

2. Similarly, as the domains of clinical data that are included in the EHR increase, the overall value of the information for a given patient/client and their providers increases. In this way, it is possible to create a comprehensive multi-disciplinary picture of a patient's status or condition to support collaborative decision-making across all providers. Finally, as the access to the clinical information contained within the EHR extends across the natural referral area of care, the value increases. For 85-95% of patients, the natural referral area is confined to their local and/or regional environment; however, for 5-15% of patients, the natural referral area may cross regional and/or provincial boundaries.

The time has never been better to undertake an initiative of this magnitude. There is a convergence of will, capacity, and capability.

Patients/clients are demanding more from the health care system. They want improved access to services and expect optimal quality of care. At the same time, healthcare organizations are feeling constant pressure to provide comprehensive services within fixed budgets. Administrators, providers, and patients/clients alike are growing more attuned to the technology that is available and are beginning to understand the value that such technology can generate. There is a willingness to collaborate and participate in initiatives of this type.

Infrastructures (e.g. network, user interface devices) are being deployed and are becoming increasingly available. In addition, networked application technologies are mature and proven. Therefore, these are not barriers to the deployment of an EHR, but rather true enablers that need to keep evolving as more and more information will be shared outside the walls of the organisations where it is created.

2.5.1 The International Experience

Like Canada, other industrialized nations have identified the need to implement EHRs in a comprehensive fashion. Cultural, political, financial, and technical factors have driven different approaches in different countries, making direct cost comparisons challenging. What is clear, however, is that affluent industrialized nations have embraced the need to move forward quickly with EHR initiatives. Although financial benefits will likely accrue with time, the primary driver for these initiatives is the ethical requirement to maximize the quality and safety of care for all citizens. Some on-going EHR initiatives are:

Australia – In 1995, a retrospective review of 14,000 records in 28 hospitals found a rate of adverse events of 16.6%, 51% of which were considered to be preventable.[2] Extrapolating, it was estimated that hospital errors caused 18,000 deaths a year. Studies such as these spurred the discussion of the use of EHRs to reduce medical errors. In 2002, the National Electronic Health Records Taskforce Australia initiated an EHR system known as HealthConnect, currently in its fourth year of a planned 10-year rollout. MediConnect, the current national electronic medication record system, will be connected to HealthConnect to increase its robustness. It was estimated that such an Australian health EHR system

[2] Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JD. The Quality in Australian Health Care Study. *Med J Aust*. 1995;163(9):458-71.

could bring $500M AUS ($456M CAN)/year in benefits,[3] including $231M AUS ($210M CAN) in avoidance of ADEs. See www.healthconnect.gov.au (accessed July 2005)

France – In August 2004, France adopted a new law toward the reorganization of the national Medicare plan. This law created the *Dossier médical personnel* (DMP), an EHR that is owned by the patient (patient consent is required to use it). The DMP initiative has the medical objective of providing continuum of care for the patient and the economic objective of better controlling health costs (e.g. elimination of redundant complementary exams). France aggressive goal is to have a DMP set for each beneficiary by mid 2007, so it can then start to be populated during medical encounters. France also planned to have in 2007 a populated DMP for the 6.5 millions beneficiaries who are suffering from long term diseases and for which health information is already available.
See www.droit-technologie.org/1_2.asp?actu_id=1062&motcle=DMP&mode=motamot and www2.fulmedico.org/a/rubrique.php?id_rubrique=12 (accessed July 2005)

United Kingdom – Beginning in 1998, the UK National Health Service (NHS) identified and documented the benefits of a national EHR with the main driver of improved patient safety. The *Information for Health* strategy charts a seven-year course for a staged implementation of EHRs anchored in general practice. The National Programme for IT (NpfIT), which is being delivered by the NHS Connecting for Health agency, is bringing modern computer systems into the NHS to improve patient care and services. The aim of the NpfIT is to ensure health professionals, patients, and caregivers have "the right information, in the right place and at the right time." Over the next ten years, the NpfIT will connect over 30,000 GPs in England to almost 300 hospitals and give patients access to their personal health and care information, transforming the way the NHS works. See www.connectingforhealth.nhs.uk (accessed July 2005)

United States – The public-private mix of the U.S. health care system, superimposed on 50 separate states, makes "national planning" a challenge. The federal sector, however, has led the way in EHR adoption through the efforts of the Veterans Administration (VA). The Veterans Health Information Systems and Technology Architecture (VistA) is servicing 172 hospitals, over 600 outpatient clinics, 200 nursing homes and other health care venues. VistA is a robust clinical tool that has created a paperless environment in the VA and has dramatically improved the quality of care. The justification for VistA was not primarily financial—it was driven by the imperative to deliver the highest quality of care possible to the veteran. Response by the private sector in the United States has been less robust. Although most physician offices are computerized on the practice management side, few are using EHRs. Currently it is estimated that only 13% of the United States' more than 6,000 hospitals have an EHR in place.[4] However, organizations like Intermountain Healthcare, Columbia –Presbyterian Medical Center, Kaiser Permanente [Northwest and Ohio], and the University of Illinois at Chicago Medical Center are some recognized examples of best practices in the deployment of EHR systems.[5] See www.citl.org and www.himss.org (accessed July 2005)

Canada – In September 2004, all Canadian Jurisdictions have formalized, through the First Ministers' Health Accord statement, a consensus on adopting a cooperative and collaborative approach to implement a pan-Canadian interoperable EHR. The driving forces include achieving synergy, synthesis of common capabilities and economies of scale. Infoway has been recognized by the First Ministers as a key player in implementing this approach. Launched in 2001, Infoway and its public sector partners have over 100 projects either completed or underway delivering EHR solutions in all Canadian Jurisdictions.

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[3] DMR Consulting. HealthConnect Indicative Benefits Report. 2002. Available at www.healthconnect.gov.au/publications/index.htm (accessed on July 2005).

[4] Department of Health and Human Services. The Decade of Health Information Technology: Delivering Consumer-centric and Information-Rich Health Care*. 2004.* Available at www.hhs.gov/news/press/2004pres/20040721.html. (accessed on July 2005).

[5] Source: Advisory Committee on Health Infostructure. A white paper on Electronic Health Record Interoperability. March 1, 2002.

$321M of the $1.044B approved investment envelopes have been allocated since Infoway inception. See www.infoway-inforoute.ca and www.cihi.ca (accessed July 2005)

2.5.2 Interoperable EHR Benefits

Interoperable EHRs have the potential to deliver a broad spectrum of benefits. Below we briefly discuss some of the more commonly cited benefits of this technology:

- Quality Improvement
- Improved Health Care Access
- Contributions to Community and Public Health
- Cost Control

Section 3.1.3 also provides additional information on a study done by Booze Allan Hamilton for Infoway that provides metrics around the expected benefits of broadly available interoperable EHR's in Canada.

Quality Improvement

EHRs improve quality of health care and the health of individuals and populations by promoting a patient-centric process. In a patient-centric environment, the information follows the patient as the patient moves through the system. Complete information is therefore available to all providers as needed. This procedure promotes better care for the patient and is also respectful of the patient's time. The patient does not have to repeat the same history to multiple providers. Patients do not have to lug bags of pills from provider to provider to show what medicines they take, and they do not have to endure repeated needle sticks and x-rays because a clinician can't access needed information that is in an unavailable paper chart. In each case, this information is readily accessible in the electronic record.

By promoting patient centricity, the EHR has the potential to fundamentally alter the paradigm of modern health care delivery. This shift will have a significant impact on the way that patients experience health care. In the emerging world of more targeted, individualized medicine, the EHR will facilitate the customization of prevention and care. Patients will be engaged in a manner that may lead to more accurate collection of health information and more informed patients may adhere more to treatment regimens. This greater involvement will empower patients and may be a significant source of improvement in patient satisfaction.

EHRs also improve quality of care by helping to reduce medical errors via the use of alerts, reminders, and decision support. With the explosive growth in medical knowledge, new discoveries, and new clinical trials outcomes, a clinician's ability to stay current with his or her medical knowledge has become a daunting task. EHRs help to make this sometimes overwhelming task manageable by bringing standardized, evidence-based protocols, order sets, and care pathways to the physician at the point of care. By providing support to clinicians at the point of care, EHRs can promote best medical practices to improve quality, reduce variance of care, and reduce medical errors.

Improved Health Care Access

A digitized medical information system has been recognized as a means to improve access to health services. This can be achieved through a variety of complementary electronic approaches. Telehealth is a critical piece of this strategy for remote populations. The EHR can also be a valuable tool for managing health care for these populations. The advanced EHR can help guide the provider in the decision-making process, and physicians may receive evidence-based support in real time at the point of care. If necessary, the patient's entire chart can be viewed electronically by a specialist thousands of kilometres away so that a second opinion may be rendered.

Appointment and scheduling programs may improve access by ameliorating workflow and utilization. Jurisdictional appointment and scheduling programs, as opposed to institutional systems, can provide data on the geographic distribution of patients and available resources. This information facilitates planning and the more efficient use of limited resources, reducing wait times for health interventions. For instance, such data can help plan the appropriate specialty mix and facility requirements for a given geographic location. A regional system that matches needs to resources will increase the probability that all cancellations will be detected immediately and that alternative patients will be promptly identified to fill those openings.

EHRs may help address health care workforce issues, particularly regarding the shortage of physicians, nurses, and pharmacists, by increasing efficiency and job satisfaction. For instance, evidence exists that EHRs increase nurses' efficiency in clinical documentation. This not only enables nurses to devote more time to patients but also contributes to job satisfaction. Increased satisfaction may result in improved recruitment and retention rates. Allowing a finite workforce to be more efficiently utilized is also a key factor in reducing wait times for critical services.

Contributions to Community and Public Health

To maximize the health of communities, it is important to have ready access to information regarding public health vulnerabilities and efforts to address those vulnerabilities. This need for ready access to information applies to childhood illnesses that may be prevented with vaccines, as well as to efforts to promote pap smears among women. Electronic access to clinical information can help us understand how successful our public health interventions have been.

International mobility has significantly diminished the geographic barriers that inhibited the spread of infectious diseases in the past. The recent SARS outbreak illustrates some of the deficiencies in the ability to efficiently detect and respond to such threats. The economic impact of such outbreaks may be significant. Toronto experienced a 3.8% decrease in its retail sales in April 2003, and the estimated cost of the public health response exceeded one billion dollars.[6] EHRs can provide the data required for effective surveillance and management of the public health. The EHR provides this data in near real time, extending the scope of capture of information relevant to the public health to every clinician and health service provider. This provides a more comprehensive and timely source of information for detecting and managing disease outbreaks.

Cost Control

A certain tension exists between cost and quality, but cost-efficiency can be an important vehicle to promote the quality of care. Providing high-quality care at lower cost yields savings that can be reinvested in other parts of the health care system. This is a key element in the sustainability of a publicly funded health care system. In the face of finite resources, there is an ethical responsibility to manage them as efficiently as possible. The EHR may promote cost savings through a variety of mechanisms, including the following:

[6] The Toronto Board of Trade. SARS Frequently asked questions: Important information for Business leaders. At www.bot.com/ContentIslands/PublicPages/FloatingPages/SARSFAQS_06_17_03.asp (accessed July 2005).

- Reduce administrative costs: chart pulls and filing, transcriptions, phone calls, photocopying of charts, faxing medical information
- Reduce duplicate testing that occurs when providers cannot find test results
- Reduce the treatment costs associated with effects of reduced medical errors
- Reduce costs through more effective care management and disease management
- Reduce costs by increasing provider efficiency and productivity
- Reduce costs of clinical trials and other forms of research.

The EHR can electronically incorporate lab, x-rays, and other data, obviating the need to manually file each discrete data element; and EHRs do not need to be "pulled" or "re-filed" each time the chart is consulted. An interoperable EHR can be shared between providers with no copying, faxing, or calling required. Test results can be electronically captured in the lab and made available to all providers. Radiographic images can be captured digitally and stored in picture archiving systems (PACS). These images can be viewed by multiple providers at multiple locations and can be shared between institutions thousands of kilometres away. Not surprisingly, the evidence shows that EHRs can have a significant impact on cost savings by reducing the incidence of duplicate testing. A 2005 Infoway financed study, made by Booz Allen Hamilton, has estimated that as a result of implementing a pan-Canadian EHR, a cost savings of $3.6B will accrue over 20 years due to the reduction of duplicate and unnecessary radiological tests. The cost savings from the reduction of duplicate and unnecessary laboratory tests is estimated to be $10.4B.

Medical errors may occur in hospitals, ambulatory settings, or in long-term care environments, though the most commonly cited error data in North-America pertain to hospital-based errors. Medical errors are potentially costly because they may lead to additional care to treat error-related complications. Bates et al. found that preventable adverse drug events (ADE) led to an increase in length of stay (LOS) of 4.6 days.[7] In Canada, CAES estimates that 1.1 million days are added each year to hospitalizations as a result of medical errors.[8] The above Infoway study has estimated that use of a pan-Canadian EHR would reduce ambulatory, hospital and long-term care ADEs by 29 million over 20 years and generate cost savings of $48.3B.

2.6 GUIDING PRINCIPLES

The following are a list of key guiding principles that have guided architecture decisions for the EHRS Blueprint:

- **Patient-centric**
  The EHR is meant to store and provide access to information for the purpose of providing health services to patients/clients, making relevant clinical data available for sharing between authorized caregivers and service providers. For this reason the EHR is patient/client-centric and event-driven, capturing information as events occur. Historically, many health-related IT systems tend to be provider-centric or organizationally-centric.
- **Mass customized views of all clinical data**
  Patients/clients as well as several types of caregivers and healthcare authorities will access the EHR in different contexts of care. Regardless of the significant quantities of data amassed and/or the location

[7] Bates DW, Spell N, Cullen DJ, et al. The costs of adverse drug events in hospitalized patients. *JAMA.* 1997; 277: 307-311.

[8] Baker GR, Norton PG, Flintoft V, et al. The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. CMAJ. 2004: 170 (11); 1678-1686.

of authorized requestors of information, the EHR must be able to provide customized views of data aligned with each requestor's needs and purpose. Mass customization of data gives the user the ability to:

- View the data they want
- In the form they want
- When they want it
- With data that is presented and formatted in the context of the use case
- Supporting the "what if" scenarios of the provider

- **Value add for the provider**
  The EHR must be architected with a constant focus on the added value that its data can bring to caregivers and caregiver organizations. The EHR must be ready to fulfil the requirements of today's and tomorrow's mission-critical activities accomplished in the day-to-day delivery of care by healthcare professionals and their organizations.

- **Timely and accurate information**
  Patients/clients and healthcare professionals need to make decisions on an ongoing basis in the process of treating illnesses and other health related conditions. An EHR is expected to provide health service providers and decision-makers with timely, complete, and accurate information. The EHR is viewed as an authoritative and reliable source of clinical information.

- **Think, build and act at all levels (local, regional, national)**
  The development, implementation and operation of EHR solutions across different areas of the country may be done under a number of circumstances and contexts. The EHRS Blueprint must allow for a high degree of flexibility that may be required to successfully implement it in different jurisdictions. First and foremost, it must support providers across the continuum-of-care in the local and regional jurisdictions.

- **Interoperable and Integrated**
  The EHRS Blueprint architecture must ensure that the components of an EHR infostructure provide interoperability of EHR information for every system integrated with the EHRi. It must allow for gradual implementation paths in any given jurisdiction.

- **Standards-based**
  EHR solutions must be standards-based in order to interoperate. The EHRS Blueprint architecture must rely on recognized information and communications technology (ICT) standards and information and messaging standards specific to the world of Healthcare for the development of services-oriented architectures. These standards are fundamental to the successful sharing of information. Each domain system must be able to communicate with other key components of the solution. Currently there are many incompatible and non-interoperable systems and standards. There are also incompatible versions within the same standard that have been deployed across the country. In order to achieve adoption of EHR solutions, standardization must occur. Standardization also implies a common definition of the overall EHR solution architecture. This standardization will save costs on a national basis, enabling cost effective systems integration and interoperability.

- **Replicable solution — patterns, components**
  The EHRS Blueprint architecture must be built to maximize the potential for reusability at all levels. It must be based on recognized industry practices that favour component designs and reusability driven by design patterns that support care delivery in Canada. This principle is expected to be vital in generating economies of scale in the development of a pan-Canadian EHR.

- **Leverage legacy systems and solutions**
  The EHRS Blueprint architecture must take into account systems and solutions that exist as applications in healthcare organizations or as jurisdictional level solutions. It must leverage the established capabilities and information repositories of such solutions and allow for integration and added value to be provided by EHR data. Existing investments in Information Technology for any jurisdiction or organization must be allowed to survive and prosper through their normal life-cycle. The EHRS Blueprint architecture must support integration strategies to support legacy and upcoming IT solutions in healthcare.
- **Design for a phased rollout with near term results**
  Different jurisdictions must be able to create rollout strategies that can be adapted to their existing planning strategies, capabilities, resources, systems and business objectives. The EHRS Blueprint architecture must provide sufficient granularity and flexibility in its design for initiatives to be put in place and succeed in small incremental steps, thus generating near term business results and return on investment.
- **Scalable**
  The EHRS Blueprint architecture must offer solutions that can be deployed in small operational contexts and sustain growth both in terms of geographical coverage, number of systems, number of users and concurrent transactions.
- **Extensible to support future growth**
  The EHRS Blueprint architecture must be built to handle today's healthcare practice needs and provide openness towards needs that may arise in the future. Healthcare and medicine are dynamic domains that sustain constant changes over time. The architecture must also provide flexibility towards business domains, such as social health, that it may not directly address today but may be called upon to address in the future.
- **Cost-effective**
  The EHRS Blueprint architecture must be defined to maximize the effectiveness of every dollar invested towards EHRs across different jurisdictions. It must support a cost-effective operational model that permits incremental change and effective measurement of the performance of the underlying infostructure.
- **Secure and private**
  The creation of an EHR across Canada generates a new level of accessibility for health related information on individuals. The EHRS Blueprint architecture must provide for stringent, rigorous and best-of-breed security and privacy policies and principles to be applied continually and throughout every aspect of any of its components.
- **Allow for innovation and competition**
  The creation of EHRs across Canada creates the potential for new classes of applications that may leverage health related information to provide better care or even change the way care is delivered. The EHRS Blueprint architecture must be vendor neutral and allow for innovation and competition from any organization or vendor who wishes to develop EHR enabled solutions. We seek to design elements of the solution that are "plug-and-play" with interface facades such that one vendor component may be plugged out and another plugged in.
- **Comprehensive**
  The EHRS Blueprint architecture must be comprehensive in covering all areas of business process, information, system services and technology to sustain the full scope of EHRs in every jurisdiction in Canada.

2.7 EHRS BLUEPRINT EVOLUTION

The first version of the EHRS Blueprint was created in response to a need for a coherent and viable strategy for achieving standards-based interoperable EHR solutions in the Canadian context. EHRS Blueprint v1 represented an enterprise architecture approach to enabling the sharing of electronic health information. The EHRS Blueprint V1 was focused on the conceptual level of definition (see Figure 2-4 Blueprint Versions and Level of Content). This architecture addressed a high-level understanding of what the information sharing needs were for health service providers across the continuum of care, and expressed a services-oriented systems approach that leveraged existing investments in health information systems while at the same time enabling use of recent improvements in information and communication technologies.

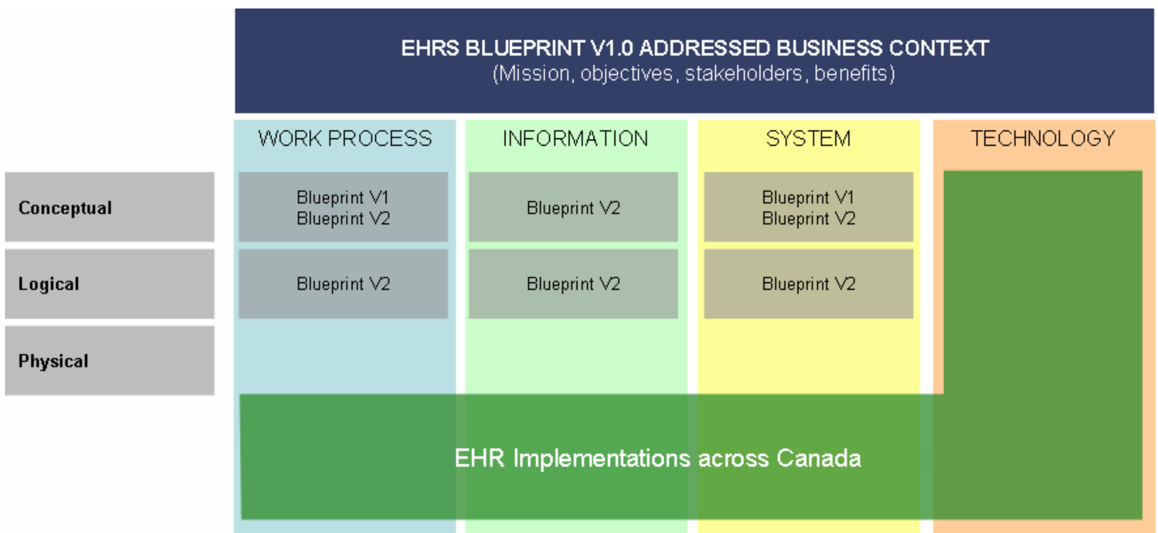

Figure 2-4 Blueprint Versions and Level of Content

While version 1 of the EHRS Blueprint was appropriate for assisting in the definition of *Infoway*'s investment strategies and in achieving a common perspective among our stakeholders, it was understood from the outset that this level of expression for the architecture would not be sufficient for the detailed planning and subsequent execution of investment projects that actually design, build, and implement the many components for working interoperable EHR solutions.

For this reason, in January of 2005, *Infoway* launched a project to update the first version of the EHRS Blueprint that would improve the breadth and depth of the Blueprint to work beyond the conceptual level. Version 2 of the EHRS Blueprint is intended, as an Enterprise Architecture, to provide a level of logical expression that would allow designers, builders, and integrators of EHR infostructure components and services to progressively achieve their regional and jurisdictional needs for interoperability while at the same time delivering solutions that would interoperate in a larger context and provide components that would be reusable by other projects and jurisdictions.

Additionally, the original version of the Blueprint was meant to express a target state for a fully interoperable, standards based, services oriented architecture that would meet the need for sharing of

Canadians' Electronic Health Records for the next 2 decades. *Infoway* has referenced the Gartner Generations Model for CPR Systems (see section 3.4.1 for more details) to express the level of sophistication and capability that would be possible in the next 10 to 20 years. Version 2 of the Blueprint maintains that target state, but also provides an additional level of definition appropriate for meeting our target of having 50% of Canadians with an EHR by the end of 2009.

2.7.1 Objectives in Evolving the EHRS Blueprint

It is important to emphasize that, in the process of broadening and refining the Blueprint, it was not the intent to model every aspect of healthcare, but rather stayed focused on understanding those aspects that best define what an interoperable EHR must do in support of health services delivery, with a focus on the point of service where clinicians interact with their patients/clients.

Version 2 of the EHRS Blueprint was done with the following objectives:

- To improve breadth and depth of the Blueprint as an enterprise architecture
- To declare what the clinical requirements are for sharing of EHR information and to demonstrate how the architecture meets those requirements
- To incorporate into the conceptual architecture the new Infoway investment programs of Telehealth and Public Health Surveillance
- To be more precise on the possible implementation options of an EHR infostructure based on which deployment model is being adopted
- To incorporate the Privacy Security Architecture work done by *Infoway* and it's stakeholders
- To ensure its relevance and coherence as a stable vision statement for stakeholders

2.7.2 Blueprint v2 Deliverables

To achieve these objectives, the EHRS Blueprint team delivered the following sets of documentation as part of Blueprint version 2:

- Refined descriptions of the clinical domains the EHRS Blueprint is intended to support, clarifying assumptions and the scope of the EHRS Blueprint.
- A Clinical Reference Framework ("The Life of the Lamberts") used as the basis for defining and demonstrating the use cases for sharing EHR information in the course of delivering a broad spectrum of health services. This reference framework includes:
    - Storyboards that define multiple encounters around common health situations and the information sharing requirements across and between those encounters
    - Encounters documenting the activities and uses of EHR information in the context of delivering health services

  - ➢ EHRi Conceptual Data Model that provides a representation of how shared EHR information can be retained and managed to support the broadest range of possible uses

- o EHR Functioning Principles that consolidate and formalize any previous assumptions that now become pre-requisites or assumed as necessary for the architectural constructs in version 2 of the EHRS Blueprint

- o EHR Interoperability Profiles (EIP) that describe how applications at the point of service can interact with an EHR infostructure to get, put, or list information

- o Infostructure Interoperability Profiles (I-IP) that describe how an operational EHR infostructure handles requests as expressed by EHR IP's for the provision of shared EHR information

- o Extended Service Definitions providing further description of the expected services behaviour and the interface requirements

- o Infostructure Deployment Options describing various ways in which infostructure components can be deployed to meet varying requirements based on regional / jurisdictional size and complexity

- o Extension of the Conceptual Architecture to address Telehealth and Public Health Surveillance

- o Incorporation of the EHRS Privacy and Security Architecture, published by *Infoway* during the summer of 2005.

2.7.3 Process for Producing Blueprint Version 2

It is helpful for the readers of the Blueprint to understand how this particular version was developed. This section describes the tools and methodologies used to produce the document and its reference materials, and the formalisms used to express the specifications.

Tooling and Methodology

In documenting the next major version of the Blueprint, it was understood from the outset that this work must be represented in a manner that could be quickly and directly incorporated into the work of project teams building EHR infostructures and integrating PoS solutions to them. For this reason the Blueprint team used the HL7 Development Framework (HDF) methodology as the basis for documenting the high level design represented in the Blueprint. The HDF uses industry accepted methods for modeling and design concepts, and considering that HL7 messaging is a key enabler of interoperability, this approach should lead to architecture artefacts that are reusable when doing detailed level design.

Initial textual work was done using MS Word and graphics in a combination of MS Visio and MS Powerpoint. Once this initial work was reviewed by our validation and focus groups, the work was transposed into Unified Modeling Language representations using a tool called MagicDraw. This tool has the capability to generate HTML representations of the work, making the resulting models and specifications readily accessible to the broadest range of end-users of the Blueprint. In addition, the tool has the ability to export the UML representations in XML Interchange format (XMI) which can be imported into other software engineering tools

Formalisms

Constructs for expressing the EHRS Blueprint as a Logical Architecture required the formalising of "packages" of information that allowed suitable structuring of the information. This resulted in the following formalisms:

- EHRS Reference Framework
    - Storyboard
    - Encounter
    - Clinical Activities
- EHRi Functioning Principles
- EHR Interoperability Profiles
- Infostructure Interoperability Profiles
- EHRi Conceptual Data Model
- Extended Service Definitions

Each of these formalisms is used consistently to express the high level requirements for EHR infostructure components and interfaces. The Blueprint artefacts based on these formalisms have been developed iteratively and in reference to each other, so that the whole package of documentation would have coherence.

The following chapters provide some insight into how each of the formalisms was used in the development of the second version of the Blueprint.

Developing the EHRS Reference Framework

In the process of building the EHRS Reference Framework a matrix was developed of the various clinical aspects to be covered and then as the "Life of the Lamberts" was being built the matrix was used to ensure appropriate coverage of the spectrum of clinical roles, care settings, types of encounters, and services in the matrix. The matrix included: 8 types of episodes of care representing a wide spectrum of clinical information subject areas, 29 different roles for actors in the provision of health services, 27 different care settings reflecting a range of departmental perspectives and geographical settings.

These use case scenarios provided the basis for all of the subsequent work done to identify the triggers for interaction between software applications at the Point-of-Service (PoS) and the EHR infostructure, and the information that needed to be exchanged in each of those circumstances.

Developing EHRS Functioning Principles

During the development of version 1 of the Blueprint, there were many assumptions and constraints underlying the EHRS Architecture that were frequently and consistently referenced when giving presentations on the Blueprint, but were never documented in any degree of detail.

For Blueprint version 2, the formalism adopted to do this is the concept of Functioning Principles. Each Functioning Principle declares a position towards a specific challenge or constraint associated to the operation of an EHR infostructure, and then the Principle is defined and potential implications and considerations for applying that Principle to the architecture is discussed.

Issues that were considered for this section were those concepts that must be uniformly applied in each infostructure implementation in order for the overall framework to function properly, or issues that *Infoway* feels jurisdictions must engage with specifically as pre-requisites, either to the development of infostructure components and integration of EHR solutions with the infostructure, or to the ongoing ownership and operation of an infostructure.

An understanding of the Functioning Principles is essential for designers to effectively interpret and extend the Blueprint specifications in their respective initiatives.

Developing the EHRi Conceptual Data Model

Supporting the definition of the key entities and relationships utilized in various use case scenarios, the Canadian Conceptual Health Data Model was adapted to provide the framework for what EHR data would be stored amongst the different repositories and systems that make up an EHR Infostructure. Several available data and information models were reviewed In the course of developing the EHRi CDM, using an alignment process where those models were mapped against the CDM as it evolved, ensuring that it would support the same subject attributes and represent the relationships between data subjects correctly. These reference data models came from several Canadian jurisdictions, and some international models were also reviewed.

In addition, the EHRi CDM was strongly aligned with the HL7 Reference Information Model (RIM). This is very important, as the HL7 RIM forms the basis for the data structures used to exchange information between information systems, and is a key component of the EHRS Blueprint v2.

The CDM was then used as the foundation for the subjects referenced in the EHR Clinical reference Framework (CRF) Storyboards, Encounters, Clinical Activities, and EHR Interoperability Profiles (EIP). To test these subject definitions and their attribution, we developed views of the CDM needed for the information in representative encounters and clinical activities.

As a result, the CDM is an Event based data model that holds shared EHR information in a manner that supports a broad range of information sources and prospective uses. It is important to state, however, that the EHRi CDM is a conceptual model, not a logical model ready for implementation as a physical data store.

Developing EHR Interoperability Profiles

Working from the Clinical Reference Framework, the Blueprint team developed descriptions of how the PoS applications would interact with an EHR infostructure using a formalism called an EHR Interoperability Profile. An EIP is a package of structured context and specifications that describe how an external application interoperates with the EHRi to put, list, or get EHR information from the shared repositories. The EIPs developed for the Blueprint act as design patterns for detailed interface specifications to be developed in the course of Infoway iEHR investment projects, providing context for sending and receiving application roles, trigger events, message payload, and message handling requirements.

Developing Infostructure Interoperability Profiles

During the evolution of the Blueprint, it was quickly recognized that there were two very distinct types of specifications required, one formalism for the interfacing with the EHR infostructure (EHR IP) and another for expressing how the services within the infostructure layers would be invoked to execute transactions. This second formalism is called an Infostructure Interoperability Profile (I-IP).

Each I-IP describes the processing flow for the three basic interface patterns of PUT, LIST, and GET. The I-IP uses sequence diagrams and text to describe the Infostructure process flow for invoking services to satisfy the interaction with external PoS systems as well as with EHRi domain repositories and the various registries.

Developing Extended Services Definitions

The other significant part of the Blueprint evolution process is the refinement and restructuring of what was included in the original Common Services layer of the Health Infostructure Access Layer (HIAL). Version 2 of the Blueprint contains a different representation of these services, the Privacy/Security and Management service groupings were refined to incorporate the results of the Privacy Security Architecture project, and a new services layer introduced called “Longitudinal Record Services” (LRS).

The LRS was developed to better differentiate the services associated with data orchestration, business rules, data assembly, normalization, and with particular emphasis on the EHR indexing service and the role of the EHRi Client Registry service to locate EHR information within and across infostructures.

In Blueprint v2 services are more fully described, with the inputs and outputs to each service described at a high level, along with the expected behaviour of the service.

Developing EHR Infostructure Deployment Configurations

This component of the architecture represents various implementation configurations of the EHRS infostructure that are likely based on the respective differences in the governance of health service delivery, policy and legal requirements, and population density and size in the regions and jurisdictions across the country.

It also is intended to address the challenge of assisting the implementers of EHR infostructures in translating the conceptual and logical framework the Blueprint represents into physical implementations that work for and within the jurisdictions respective needs and constraints.

To help illustrate the potential range of workable infostructure configurations, the Blueprint represents what might be typical configurations for small, medium, and large infostructures. Additionally, it was considered helpful to the planning for implementing and operating EHR infostructure for the Blueprint to express some possible interim states that may occur as each jurisdiction evolves their EHR solutions and capabilities.

Another section of the Blueprint expresses different configuration models for potential uses of commercial off-the-shelf software (COTS) as a technical foundation to develop working EHR infostructures. This section was developed iteratively since version 1 of the Blueprint, integrating lessons learned from engagement with vendors and in the planning phases of different investment projects in Canada.

2.7.4 Blueprint v2.0 Validation with Stakeholders

At the outset of the Blueprint evolution project, it was recognized that a few key groups of people needed to be convened to provide review, guidance, and validation of our approach and intermediate deliverables. These groups were in two broad categories:

- the Validation Group, comprised of representatives nominated by the CIO's from each of the F/P/T jurisdictions, and representation from key national health services professional associations.

- the Focus Groups, smaller groups of individuals tasked with engaging in a detail on the topic areas of clinical requirements, data modeling, and system architecture. The Focus groups were instrumental in the establishment of the formalisms used to express the specifications, and establishing the appropriate level of detail for Blueprint documentation.

These groups were established with an initial face-to-face meeting in early 2005, sustained through a series of web-casts and teleconferences in the course of Blueprint content development, and supported by a dedicated online forum on the *Infoway* forums web site. Another face-to-face meeting was convened in the summer of 2005 with all group participants, where the draft Blueprint material was presented.

2.7.5 EHRS Blueprint Version 2 Publication

Version 2 of the EHRS Blueprint as been published in a similar fashion as the first version, using Adobe™ PDF format as the primary means of publishing the narrative content. Because of the complexity of the topic, and the tightly interdependent nature of the other EHRS Blueprint work products, producing only a narrative paper form was not viewed as the best publishing method.

In addition to the PDF document, there are annotated versions of the Blueprint v2 graphics available in MS PowerPoint format for reference and public presentation purposes.

The EHRS Reference Framework is published as a set of navigable HTML documents using UML notations and conventions. It is also provided in XMI format for import of the UML models and documentation into UML based software engineering and modeling tools. For those users of the Blueprint who use MagicDraw or have the MagicDraw reader software, the original XML source files are also available.

All of this material is available as downloads from the *Infoway* Knowledgeway, and from time to time will be distributed on CD-ROM for the convenience of attendees at various conferences or meetings.

2.7.6 EHRS Blueprint - Beyond Version 2

Version 2 of the Blueprint is the last version to be produced as a monolithic set of documentation. From the point of publication forward, the various components of the Blueprint document will be decomposed into self-contained artefacts (as much as possible) and published on the *Infoway* Artefact Repository, and hence, made available to the general public. The ability of the Artefact Repository to provide documents with contextual information (meta-data) and to allow the upload of revised content for editorial review and subsequent versioning is a key component in making the Blueprint a living document that evolves along with the knowledge harvested from ongoing projects and standards activities in Canada, whether this work is done in the context of *Infoway* investment projects or independently.

Project teams that engage with EHRS Blueprint content and extend or revise the content, based on real world experience and implementations, are able to post these extensions or updates back to the Artefact Repository for sharing with the health IT community. The editorial and maintenance responsibility for the EHRS Blueprint will live in the *Infoway* Standards Function with the Solution Architecture Group acting as editor.

As *Infoway* investment projects draw to a conclusion, the ownership of the Blueprint and the Artefact Repository will likely shift to the EHR Standards Maintenance Organization, and will become a key component of the Health ICT Conformance function that will be evolving in Canada.

2.8 STAKEHOLDER ENGAGEMENT

The EBE Project Team set to develop the different components of the version 2 of the EHRS Architecture was made of Infoway architects, clinicians, project manager, adoption specialist, etc. However, this was not considered as sufficient by Infoway to ensure success. Stakeholder validation of the planning and the content of this material is considered essential to get minimal adoption of the material to be delivered to the field.

2.8.1 Structure

To accomplish this, the EBE Steering Committee approved in December 2004 the creation of supporting stakeholder groups and a mechanism to optimize exchanges between these groups and the project team. Figure 2-4 depicts the Stakeholder Engagement Process used throughout the EBE Project.

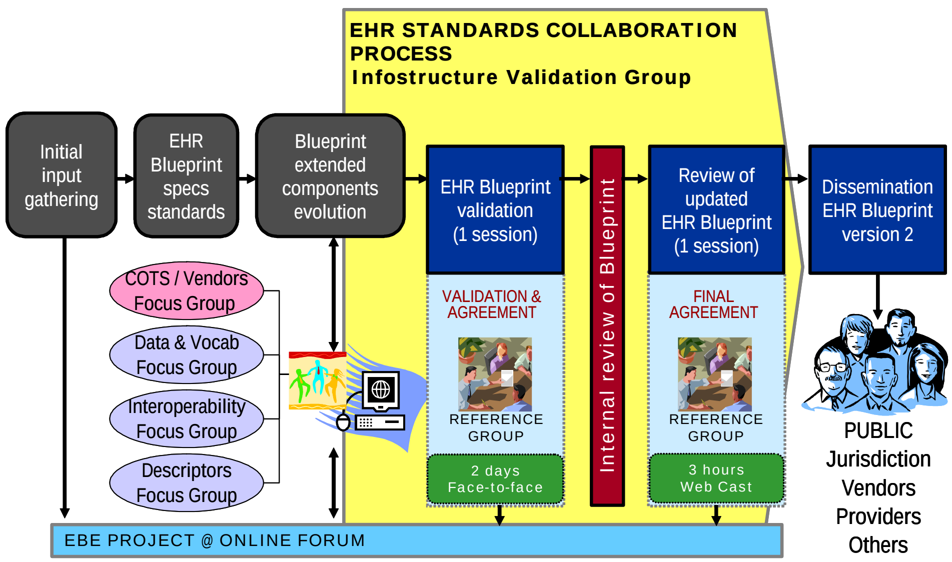

Figure 2-5 Stakeholder Engagement Process

The Infostructure Validation Group is a central entity in this process. This group was representing a variety of health management or clinical functions (business analyst, architecture director, chief information officer, information standards architect, etc.) from all Canadian jurisdictions and from several regional or pan-Canadian associations such as:

- Atlantic Institute for Market Studies
- Canadian Dental Association
- Canadian Health Information Management Association

- Canadian Institute for Health Information
- Canadian Medical Association
- Canadian Nurses Association
- Canadian Pharmacists Association
- Federal Healthcare Partnership

The COTS/Vendor Focus Group was made of 21 people having different functions such as technical architect, consultant, integration specialist, chief security advisor, market analyst, etc. and coming from 17 private organizations. The role of this group was to provide advice on the feasibility of the components developed in the EHRS Blueprint and on the industry trends.

The other Focus Groups were addressing specific issues in the areas of descriptors, interoperability, data and terminology. They were made of 13 data architects, system architects and clinical processes specialists from several jurisdictions and health related organizations.

2.8.2 Key Events

The Validation Group has been very active through the course of the project. As shown in the following Table, many face-to-face and webcast events have happened on a regular base. Added to that, numerous exchanges, through a specialized forum created specifically for this group on the Infoway Knowledge Way extranet, have occurred to get precisions or expand on specific subjects.

Validation Group Event	Achievement
Jan 27, Montréal Face-to-face Kick-off meeting (16 participants from : 9 jurisdictions, 2 pan-Canadian associations)	- The Validation Group has become well aware of the project scope, issues and table of contents of the version 2 of the EHRS Architecture; its members have also become well aware of their role in the EBE project and the role of the other project groups and team members. - Through a survey exercise, all participants and project team members became well aware of which components of the EHRS Blueprint V1 were the most useful and which one of V2 are expected to be the most useful to help jurisdictions achieve their EHRS objectives: o About version 1, participants expressed that it is essential to have one common EHRS framework to rely on, and important to know that Infoway uses this framework to assess investments; o Participants expressed that version 2 is to provide more detailed specifications to help guide the decision process of the jurisdictions in implementing their interoperable EHRS; o Participants expressed they want to be involved in developing V2.
March 10 Webcast (26 participants from : 8 jurisdictions, 5 pan-Canadian associations)	- The Validation Group has reviewed the following material around use cases and HIAL Services : o Clinical Reference Framework o List of planned Clinical Use Cases o A sample Clinical Use Case o EHR Interoperability Profiles Structure o List of HIAL Extended Services
April 12 Webcast (14 participants from :	- The Validation Group has reviewed the following material around data model and interoperability profiles : o Draft Data Model o EHR Interoperability Profiles samples

Validation Group Event	Achievement
10 jurisdictions, 2 pan-Canadian associations)	o Generic Interface Specifications o List of upcoming Design Artefacts
May 18 Webcast (24 participants from : 10 jurisdictions, 5 pan-Canadian associations)	- The Validation Group has reviewed the following material around Blueprint Artefacts : o Final Draft of Blueprint Design Artefacts o Deployment Models
June 7-8, Toronto Face-to-face Review meeting (21 participants from : 6 jurisdictions, 5 pan-Canadian associations)	- The Validation Group with some additional experts from the Focus Groups has adjusted and has agreed on the detailed content of version 2 such as the EHR information model, the use of HL7 templates, the interoperability profiles, the use cases and the generic interface specifications. - Also, through an Edward de Bono Six Thinking Hats workshop, participants have developed creative ideas to optimize the adoption of the EHRS Blueprint version 2 by the jurisdictions, vendors, professional associations and other key stakeholders: o About version 1, participants have shared their observations as well as their negative and positive ideas about what has happened during the implementation of version 1; o They have then provided their 'guts feeling' and their creative ideas on what should be done for version 2, so it is widely adopted; o Afterward, Infoway has transformed these ideas into an Action Plan, which is being implemented.
February 2006	- The Validation Group is engaged at the end of the writing and editing process to review all materials and comment before the formal publication in March.

Focus Groups have met three times during the project. Numerous exchanges, through a specialized forum created specifically for them on the Infoway Knowledge Way extranet, have also occurred to get precisions or expand on specific subjects.

2.8.3 Looking to the Future

The results of the Stakeholder Engagement Process can be considered as a success. Infoway has been able to validate a series of important subjects and the participants have been able to influence the EHRS Architecture. In the June 7-8 face-to-face meeting, participants have expressed the idea to move on to a 'permanent engagement' process so that stakeholders can continue to be involved in the evolution of the Blueprint. This is part of the Action Plan, Infoway is now considering for the future.

3 BUSINESS ARCHITECTURE

The EHRS Business Architecture section presents the key business requirements that drive the definition of the solution. It also offers a high level view of the proposed solution to meet those requirements.

3.1 BUSINESS AND SOCIO-ECONOMIC DRIVERS

This section focuses on the key business requirements that drive the definition and choices made to establish the proposed architecture for EHR Solutions in Canada

3.1.1 Base Business Requirements

The following are established as the base requirements for the Electronic Health Record of an individual in Canada.

3.1.1.1 Life-long longitudinal record of clinical data

The EHR is defined as a life-long longitudinal record of clinical data. The assumption is that the EHR will accumulate and keep clinical information about an individual health record from womb to tomb. Although the value of clinical data about a patient is generally recognized in the healthcare industry as diminishing rapidly over time, it is impossible to predict what element of data may or may not become clinically relevant or critical over time as the health status of an individual evolves. Additionally, one of the great dimensions of value of the EHR for the healthcare system is its ability to provide data (de identified or not) for authorised secondary uses such as surveillance, research, local or regional health prevention initiatives, bio-medical device recall or maintenance, or execution of public health mandated programs. Authorised secondary uses is based on the legislative obligations of a given jurisdiction and where required by law, authorised by individuals.

To support these business requirements where permissible by law, in a sustainable and robust fashion, data recorded in an EHR may stay available for access for the duration of the life of an individual plus a retirement grace period. This retirement grace period would also exist to keep data active in an individual EHR for as long as permitted by law and significant business value can be derived from its potential secondary uses.

3.1.1.2 Focused on clinically relevant data shared beyond organizational boundaries

The EHR is established as a consolidated and structured set of data that describes and documents important information generated anywhere in the context of health care or health prevention events occurring for an individual. Data in the EHR is focused on sharing an integrated view of the information required to paint a valid and complete clinical picture of a patient. The EHR will focus on the collection and dissemination of clinically relevant data for the purposes of creating that shared integrated view across the continuum. Valid examples of data subjects carried in the EHR of an individual are:

- The historic index of health services events;
- The blood, allergy, immunization profile;
- The critical observations and problem lists;

- The summary of hospitalizations;
- The medication profile including prescriptions, dispense and refills;
- The laboratory and diagnostic imaging test orders and results;
- The referral orders and their notes;

On the other hand, the requirements associated with the collection, storage and use of data in any single point of service (PoS) will have a different focus then the cross-continuum requirements for the EHR. The data collected locally in a PoS will typically have more depth and granularity and will often be coupled with specific data associated to the management of work activities or the automation of workflow processes dedicated to the single organization where the data is generated. Examples of data subjects that would not be posted to the EHR of an individual are:

- Hourly temperature and pulse readings as part of the post-operation protocol of a surgery. Only observations seen as evidence to a key decision or for the summary of an encounter would be promoted to the EHR;
- ECG – graph reading out of an ECG device where the reading shows everything within normal range as part of a yearly check-up routine for a client. Again this type of detailed data would only be seen as valuable for promotion to the EHR if clinical decisions would be based on it, which would typically not be the case here;
- Daily nursing care activities as part of the application of a nursing care plan during a hospitalisation. This could be events such as the routine protocol to get a patient up and walking after a surgical procedure requiring anaesthesia;
- Workflow specific data associated to the work activities occurring within the walls of a health delivery organization during the course of an encounter. For example the data form a clinical information system allowing tracking of time and duration of the different activities and departments where a patient needs to show up and obtain services in the context of a one day surgery managed from the ambulatory care department of a hospital.

Establishing what data elements will be included or not in the EHR is a critical decision that requires an educated opinion from many categories of stakeholders including the public. Healthcare professionals are best positioned to determine what information needs to be available to them in order to create a positive impact on the services they offer. Clients and their representatives need to understand and agree with the rationale for the availability of this data in an EHR setting and the means at their disposal to insure their privacy rights are respected. Healthcare governance and administration organizations need to understand the costs and administrative requirements associated to the sharing of data. Finally, health IT professionals need to make sure that sharable data is defined and managed through formal standards so that the value of sharing can be optimized as quickly as possible and in a scalable fashion.

3.1.1.3 Support for accurate, complete and timely delivery of information

For any care provider accessing the data in an EHR, the system must insure that the data is accurate, complete and is delivered in a timely manner. The EHR is viewed as a reliable and authoritative source of information.

Accurate

Accurate means that the data is the most up-to-date and relevant information available at a point in when a request is made. Provided that the EHR will compile data from multiple sources, there must be mechanisms in place to insure the integrity of the data is managed. The accuracy of the data may be affected by many phenomenon, examples include:

- Data coming from a device or equipment that has a specific calibration;
- Data coming from a device that measures differently then an accepted standard and has a different set of acceptable ranges;
- Identical type and occurrence of data coming from different sources, for example a lab result about a unique lab order being promoted to the EHR by two different laboratory systems. This could easily happen in the context of lab orders being decomposed into separate order-sets going to different testing facilities and consolidated back-up when results are generated;
- Caregivers offering different opinions about individual elements of a clinical profile, for example allergies.

The EHR must be able to track all updates and their sources and keep a time sensitive history of all changes made to an individual health record.

Complete
Complete means that on any given request for data, the system must be able to provide all the information that it possesses at this point in time to respond to such request within the context of a patients informational consent directives where permissible by law. In a network of interoperated EHR Solutions, this means finding all the places where data may exist to provide a complete response. The term complete is not used to designate the extent to which an EHR could contain any type of clinical information ever generated about an individual through time. Parts of a medical record may still be in a paper file somewhere or may have been lost or never formally recorded. The assumption is that more information about a patient/client is better then less and that clinicians understand that medical records can never be complete *per se.* In that context, the proposed approach for EHR Solutions in Canada stands to provide a higher level of completeness than might have been available in the past.

Timely
Timely means quick access to information about a patient/client. This is generally thought of as being a matter of seconds as opposed to current situations today that typically involve hours, days and potentially weeks. A typical example is a family physician or a specialist wanting to obtain results from a lab test ordered in the past. Such requests would generally have to be made to an administrative assistant who would communicate with a lab which may be in the same location or a completely different organization. A search must then be processed to find the patient/client file, get the results and usually fax them back to a requestor, who would forward them to the physician. The existence of the EHR would reduce this entire process to a matter of seconds.

3.1.1.4 Shared across multiple organizations and jurisdictions

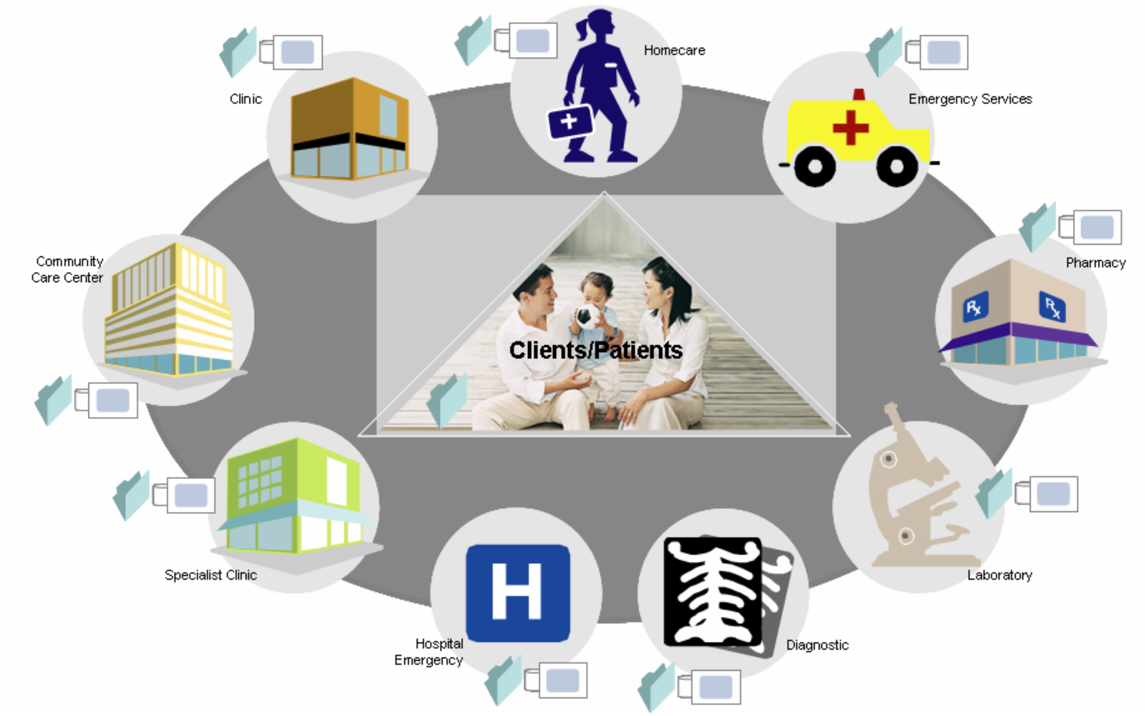

Figure 3-1 Health continuum of care serving the client

Clinical data about individuals is generated and collected in many different places. Valid examples are:

- The site of an accident
- A hospital;
- A long term care hospital;
- A nursing home;
- A family physician office;
- A cardiology specialist practice;
- A private laboratory testing facility;
- A retail pharmacy;
- A radiology department in a hospital;
- A rehabilitation clinic;
- A private physiotherapy clinic;
- The home of a patient.

Information technologies are often times used today within the walls of an organization to collect, maintain and disseminate clinical information in patient records. This computerized information is used in these settings to allow authorized access to patient records. The value of this use of technology is limited as it only provides a limited perspective on the clinical information relevant to an individual.

The EHR is defined as a service established above the operational layer of the healthcare system to allow for a broader scope of information sharing. First, by widening the breadth of sources of information used to depict the clinical picture of patients so that observations, decisions, and treatment activities can be related in a consolidated view that is not limited by the administrative boundaries of health organizations. Second, by making that view of information accessible to any authorized caregiver wherever they practice care as long as they have access to a suitable trust worthy private and secure device to connect via their favourite EHR enabled application. Thirdly, in the future by making that view of information accessible directly to consumers.

This service must allow information as a resource to be available and flowed freely between organizations and jurisdictions. This ability to share information regardless of the organisation where it is generated or viewed is a critical infrastructure evolution required to migrate to care models of the 21st century.

The above requirements state the case for establishing an EHR service allowing for the free flow of information between the legal and administrative boundaries of care organisations within a Province or region. There is also a growing requirement to allow for clinical information to flow freely beyond the borders of individual jurisdictions deploying EHR capabilities. The main requirements for interoperable EHR solutions across regions stems from the following socio-economic tendencies:

- Tertiary and quaternary levels of specialized care are more and more centralized. In that context, the people representing the heaviest needs for information sharing, since they are typically complex cases requiring the management and exchange of large volumes of information between many caregivers, need to have their health records shared not just between the health organizations of a given jurisdiction but most often between organizations located in different regions and provinces.
- Whether it is in the context of professional activities or leisure, a growing category of the population is more and more mobile. These people are all subjects to receiving or conducting clinically relevant transactions anywhere in the country. Valid examples may be filling a prescription, getting access to emergency care services, or renewing a prescription.
- Another key segment of the population that requires EHR services that can cross borders are people living in border towns. Major urban settings are located geographically near or on the borders of administrative health regions or Provincial boundaries. In this context, a large percentage of these populations end up receiving care from organizations that would maintain their EHR information in separate EHR Infostructures. Achieving the true value of an EHR for these people requires the ability to share information between EHR Infostructures that cross jurisdictional and provincial boundaries.
- Smaller Provinces and Territories in Canada operate health by constantly using referral corridors where clients travel small or large distances to access specific health services not available where they reside. In many of these cases, clients will be accessing facilities located in separate jurisdictions served by a different EHR service then the one available in their place of residence. Often times, the people who are subject to these referrals are the one that stand to benefit the most from the clinical information sharing capabilities offered by the EHR. Again, to support this population, the EHR requires the ability to share information between EHR Infostructures that cross jurisdictional and provincial boundaries.
- A growing number of health services consumers are acting as autonomous decision makers when it comes to choosing the healthcare services they will use. That is, they will not let the healthcare system route them towards the nearest or most available service in their locality, they will pro-actively choose to request the services of a certain facility which may be located close to their place of residence or very far from it. This hard tendency in the medium and long term will generate more and more clients travelling to different administrative regions or Provinces to obtain the services that they need. Typically, these people are the ones requiring more complex or specialized health services where large amounts of clinical information are needed to support proper documentation and efficient transfers

between care professionals involved. Again, to support this tendency, the EHR requires the ability to share information between EHR Infostructures that cross jurisdictional and provincial boundaries.

3.1.1.5 Private and secure

A separate architecture initiative on privacy and security has been conducted by Infoway and has resulted in a set of documents that address the requirements as well as a detailed definition of the privacy and security architecture required to meet them. These documents are available from the Infoway knowledge way located at: http://knowledge.infoway.ca . The following paragraph is an excerpt of the introduction to the requirements definition from this work.

"All members of the Canadian healthcare community share in the responsibility to maintain patient privacy and data protection of Personal Health Information (PHI). No matter how much care and attention is devoted to the technology behind the EHRi, it will never be enough if the policies, procedures, practices, and training needed for its proper and secure operation are neglected. The technical security measured implemented in the EHRi can work flawlessly and yet If the system is administered by those who lack the training to ensure its proper and secure operation, if its users do not understand the confidential nature of the information that they access and do not treat it accordingly, if user registration procedures are sufficiently lacking in rigor that unauthorized third parties can become authorized users, or if the infostructure is used to collect and retain personal information of a kind that patients would not have countenanced had they known, then patient/client privacy will have been breached. It is essential therefore to state the administrative requirements for the secure use and operation of EHRi, as well as the technical requirements for its design and implementation. In stating these administrative requirements, Infoway is keenly aware that it has no mandate to develop policy or to assess compliance with policy, nor will it ever have such a mandate. The administrative requirements have been developed in close consultation with Canadian health informatics experts and with healthcare representatives of Canada's federal, provincial and territorial jurisdictions and professions. This document continues to evolve within this collaborative framework and it is expected that broad consensus will indeed be achieved. Indeed, it is hoped that the overwhelming majority of healthcare professionals involved with privacy and security issues will come to agree with the requirements as stated either in this document or in a future revision. Nevertheless, the question of exactly what the requirements are for the secure and privacy protective design, implementation and ongoing operation of the EHRi is ultimately a question to be resolved by whatever information governance structure is put in place to guide the deployment of the EHRi across Canada and the future inter-jurisdictional flow of information that the EHRi will facilitate. Many EHRi governance issues are unresolved at the time of this writing. In stating that governance is outside the scope of this document, the authors in no way wish to diminish the important task of resolving these important governance issues."

All members of the Canadian healthcare community share in the responsibility to maintain patient privacy and data protection of PHI. This responsibility is not easily borne. Overlapping privacy, legislation, regulations that are open to interpretation and complex security technology, all combine to overwhelm the unwary and most busy healthcare professionals who are neither trained in depth in information technology nor do they have the time to keep up with rapidly changing technology. The conceptual architecture for EHRi privacy and security is intended to surmount these difficulties by providing a solid foundation for the design and implementation of the EHRi that meets all of the legislative, regulatory, policy, administrative and technical requirements on patient/client privacy and the security of PHI. The P&S conceptual architecture fulfils several needs:

1. It describes all the services needed to meet the P&S requirements described in the requirements document. Because the requirements are crafted in part to satisfy the legislative and regulatory

requirements of Canada's healthcare jurisdictions, the conceptual architecture meets these legislative and regulatory requirements as well. Appendix B of the P&S conceptual architecture relates each requirement described in the Requirements document to the P&S service or services that fulfill the requirement.

2. It allows a single flexible EHRi architecture to meet the many requirements of Canadian healthcare jurisdictions without saddling one jurisdiction with unnecessary technical machinery required by the regulations of another jurisdiction. The philosophy of "build once and use many times" is central to Infoway's investment strategy and a unified conceptual architecture is an essential component of building an EHRi that meets the P&S requirements of multiple jurisdictions.
3. It maximises the effective use of resources by tackling P&S services in a coordinated and systematic way. The optimal use of P&S services reduces the number of interfaces, simplifies the architecture, and facilitates the achievement of cost savings due to the shared use of P&S services among applications.
4. Interoperability is simplified due to a common and unified approach to P&S. The EHRi must ultimately support inter-jurisdictional access and therefore interoperability across jurisdictions. Without a conceptual architecture for P&S, it is difficult to imagine how meaningful interoperability could be effectively achieved.
5. PoS system and EHRi component vendors have a coherent roadmap from which to build and enhance their products with P&S features and services.

3.1.1.6 Adaptive to the future of healthcare delivery in the 21st Century

The proposed solution for the EHR is focused on the needs and requirements of the health system as it exists today and as we see it evolving in the short term. That said, given the level of effort and capital investment required to deploy and operate EHR solutions, it is critical that these solutions be built with a long term perspective. The EHR solution architecture must take into account the evolution of needs and requirements as healthcare service delivery evolves in the 21st century.

As we consider collectively embarking on this path towards electronic health records solutions, it is highly interesting to try to imagine what our world would be like in a context where these solutions become an integral part of way the healthcare system operates. To this end we have provided an appendix (Appendix B) taken from a book that describes our world as consumers in 2025 and the impact of EHR capabilities on healthcare service delivery.

One does not have to look very far to see the fundamental changes that are occurring in the health care industry. Economic, social and many other drivers are forcing changes to the focus of health care. First and foremost, health care is becoming a more patient-driven industry. There is a palpable commitment to building a foundation that is grounded in the principles and values of patient/client and family focused care. Similarly, there is a demonstrated understanding of the need to shift the focus of health care efforts from the management of illness to the maintenance/promotion of wellness. As a result, we are seeing increased emphasis on the management of diseases across the continuum of care and along the lifecycle of the disease. To support this, the industry is experiencing a significant shift in how clinical decision-making occurs. Specifically, we are replacing the “lone ranger” decision-making practices of the past with truly collaborative, interdisciplinary, and evidence-based approaches. We are also seeing a move from decentralized and generalized care to more centralized and specialized care.

Figure 3-2 The Changing World of Healthcare

These changes are driven by the continual quest for optimization in the healthcare system. Over years to come, the healthcare system in most Canadian jurisdictions will not be able to sustain the increase in demand for service that it will face. The sustainability of the healthcare system depends, to an extent, on its ability to find ways to gain efficiencies and effectiveness in every aspect of its activity. One of the key enablers for this rejuvenation is the deployment interoperable EHR Infostructure solutions to enable cross organization sharing of health information.

In the new world we require access to health information not only across different systems but across different jurisdictions and domain boundaries. We require the ability to view clinical information from all sources and to use the EHR infostructure to initiate or follow through on orders and referrals to a broader range of care and service providers than is currently available with traditional mechanisms. This happens by extending the capabilities of our monolithic and even integrated but tightly coupled information technologies to work within a framework of interoperability. Through an interoperable EHR we can extend, expand, and harmonize the sources of information available to clinicians in their work.

3.1.1.7 Requires governance and operation management

EHR Infostructure will be established in Canadian jurisdictions as a publicly available business service. This EHR service requires infrastructures that need to be capitalized, established and then governed, managed and operated on a continual basis. EHR Infostructures by nature will reside at a level above health delivery organizations and offer a service that crosses the administrative boundaries of any single care delivery point of service. Organisations will need to be setup or mandated to carry on the governance, management and ongoing operation of EHR Infostructures.

These organisations will be responsible for:

1. The governance of the EHR service in a given jurisdiction which includes:
   - Understand the legal framework proper to an individual jurisdiction with regards to the many different aspects that need to be policy driven in an EHR Solution. For example: data ownership, data custodianship, professional liability, administrative responsibilities for service delivery, identification of clients, identification of health providers, authentication of computer system users, use of digital signatures, service level agreements and others;

- Establish policies to apply the legal framework or to supplement them in areas that need specific interpretations or where no legal framework exist;
- Guide the application of all established policies so that they are enacted through manual or automated processes;
- Participate and influence the development or modification of legislation and policy frameworks so as to further enable the benefits that can be derived from EHR solutions;
- Establish the development and operational budget required to sustain the operation and evolution of the EHR service in a jurisdiction;
- Insure proper staffing levels for the ongoing operation of the EHR service;
- Manage and guide evolution projects adding capabilities to the EHR service;
- Manage and guide hosting and/or outsourcing of assets and services required to operate the EHR service;
- Direct and manage the definition and ongoing application of trust relationships and agreements between PoS organisations contributing or getting data from the EHR
- Direct and manage the definition and ongoing application of trust relationships and agreements between jurisdictions to interconnect EHR Infostructures in order to expand the value and applicability of the EHR service offered in a given jurisdiction.
- Plan, direct and control the business of operating the EHR service.

2. The operation of the EHR service in a given jurisdiction which includes:

- Managing the availability of the EHR service in a given jurisdiction through the ongoing monitoring and maintenance of the live EHR Infostructure production environment.
- Planning, monitoring, evolution and maintenance of the infrastructures required to operate the EHR service.
- The ongoing operation of the peripheral technical environments required to support the evolution and maintenance of the EHR Service. This would typically require the existence of multiple distinct server environments such as those to sustain EHR Infostructure development or customization, testing, pre-production, production and an integration environment to test connectivity with point of service applications.
- An integration services group and service offering to support and execute technical projects to connect point of service applications or other EHR Infostructures to an existing EHR Infostructure.
- An educational and adoption specialists group or service offering to support the implementation or end-user adoption of the EHR viewer or the use of EHR enabled applications in their work environment.
- A benefits monitoring and communication function to manage the dissemination of information about the benefits of the EHR and raise awareness with different stakeholder groups about the social and health management value brought to life through the EHR service.

Jurisdictions considering the deployment of an EHR service will need to establish how they want to configure and operate these different business functions. Many different business models could be used to adequately support these administrative requirements.

3.1.2 Key Economic Driver

In simplistic terms, the objective of the EHR is to allow for the clinical information generated in the health system about a client to be available to any authorized caregiver regardless of where he is or which organisation he is working for. Multiple architectural approaches could be crafted to attain this objective.

This section will focus on a key economic driver, the cost of integration, to sustain and demonstrate that the only economically viable approach is the one recommended in the EHRS Blueprint.

3.1.2.1 A large integration problem

In analyzing the problem associated with the sharing of clinical data in an integrated health record, one has to understand where and in how many places clinical information is generated and collected. To represent that number, there needs to be an estimate built of the number of point of service applications in existence in the health system. Since that data is not available on a Pan-Canadian basis, the following table is built by extrapolating numbers from the "Canadian Directory of Healthcare Facilities" to determine the number of connection points potentially in existence in the healthcare system.

Types of facilities	# of facilities	# of POS Applications Per Connection Point	Total # of POS Applications to Interconnect
HIAL Central Connection	48	1	48
HIAL Peer to Peer Connections	48	1	48
EHR Shared Care Record	48	1	48
HIAL Central Connection-Client Registry Link	13	1	13
HIAL Central Connection-Provider Registry Link	13	1	13
HIAL Central Connection-Location Registry Link	13	1	13
Drugs Domain Network Link	13	1	13
Diagnostic Imaging Network Link	48	1	48
Labs Domain Network Link	48	1	48
Community Health Centre	198	3	594
Community Medical Clinic	5	3	15
District Health Councils	19	1	19
Head Office	37	1	37
Home Care	68	1	68
Hospital	982	10	9,820
Long Term Care	2,399	5	11,995
Nursing Station	88	3	264
Outpatient Centre	583	5	2,915
Public Health Unit	50	3	150
Other Acute (Hospitals)	144	10	1,440
Private Physician Offices	3,809	2	7,618
Other (Physio, Dentists, Vision)	3,809	1	3,809
Totals	***12,483***		***39,036***

Table 3-1 Number of PoS applications in the health network

As this table shows, a valid estimate for the number of applications where clinical data is generated or collected is approximately 39,036. This estimate assumes that larger facilities in the healthcare systems would operate multiple different clinical applications that would participate in an EHR service. This model also assumes that 48 EHR Infostructures will be deployed in order to cover 100% of Canada. Each EHR Infostructure would include a HIAL, a Shared Care Record repository, a diagnostic imaging domain solution and a laboratory domain solution. Each EHR Infostructure would also integrate the services of a client, provider and location registry solution as well as drug information domain solution established at the rate of one per Province/Territory. Peer to peer connections would also be established between HIAL solutions, achieving the level of connectivity required to share data between EHR Infostructures.

To understand the extent of the economic problem that this level of integration causes, we need to establish clearly the work involved in integrating to independent systems so that they can exchange data between each others. The following picture establishes a framework to understand and calculate the amount of effort involved.

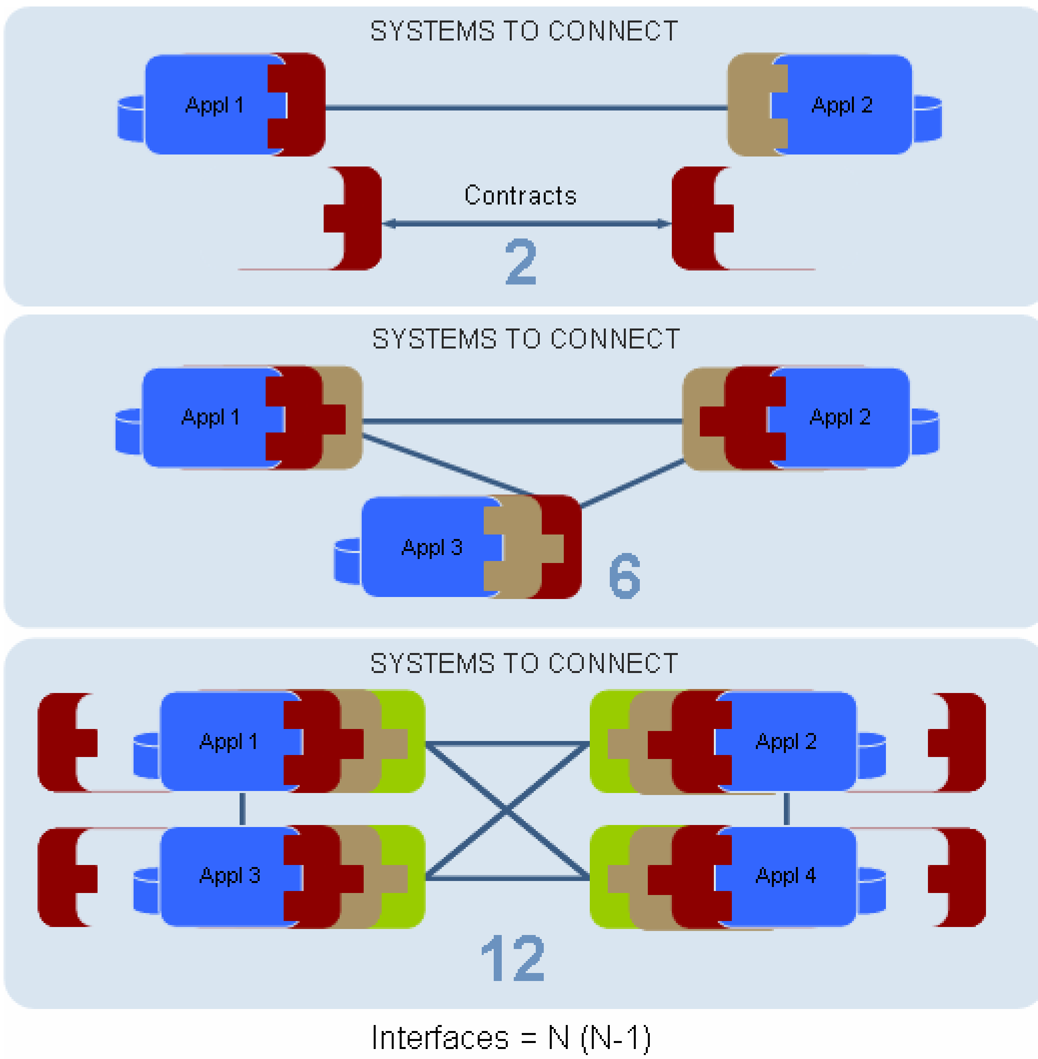

Figure 3-3 Formula for integration of systems

For this exercise, we will assume that communication standards exist. This means that the integration work involved in connecting systems will always be done in reference to the implementation and use of an existing standard describing protocols, structures, vocabularies and expected meaning for data transferred between applications. If a communication standard did not exist, then the parties involved in the integration exercise would first need to establish such a standard on the basis of the information and functions that aim to share. This establishment of communication standards becomes a very expensive and timely exercise as more and more parties are impacted by it.

Integrating 2 systems:

Formal contractual agreements will need to be negotiated and established between organisations involved in connectivity initiatives. These agreements need cover perspectives such as the business, legal and administrative implications in case of errors or unavailability and service failures. Service level expectations need to be established with adequate processes to fix problems when they occur. Data custodianship, liability and accountability frameworks also need to be addressed in a context where organisations agree to operate on the basis of each others data.

To integrate the two systems called Appl 1 and Appl 2 in a world where a communication standard is in use, a software engineer has to first analyze the data structures of each system to understand to what level they can support the data structure specifications of the communication standard. Core modifications or transformation algorithms may need to be programmed, implemented and tested to meet the specifications of the communication standard. If this is the case, the vendor or developer of the application will typically need to be involved.

When using a communication standard, typically a communication protocol will be prescribed and will cover networking, security, error handling and application communication rules. Again the two systems involved in the integration will need to be assessed in terms of their ability to integrate these specifications. Depending on the flexibility and openness of the applications, changes by the vendor or developer may need to be made in that regard as well.

The existing data will need to be assessed in terms of the expectations of content and meaning for the data already in existence in respective databases of the applications being integrated. Often times in the way applications are used on a daily basis, specific data fields end up being filled for different purposes then what they were meant for or data is corrupted or misplaced upon entry or updates. While these errors may not have any impacts locally, they may become major concerns when the data of an application is exposed externally in the context of an EHR. Data cleanup procedures and efforts may need to be conducted to fix such issues as applications are prepared to be interconnected.

In a context where two systems are being connected, this integration effort and the implementation of technical interfaces need to be done twice, once in each of the systems involved in the network.

Integrating 3 systems:

In a context, where three systems are being integrated, the integration effort and the implementation of interfaces will need to be done six times, two different interfaces per system if we expect each system to be able to interact with any other two systems in the network.

This is, of course, is we expect all data to be shared and accessible form any point in this network of system, which is exactly our goal with the clinical data of clients in the context of the EHR.

Integrating 4 systems:

In a context, where four systems are being integrated, the integration effort and the implementation of interfaces will need to be done 12 times, four different interfaces per system if we expect each system to be able to interact with any other two systems in the network.

Integrating 39,036 systems:

In order to apply this to our problem of 39,036 point of service clinical applications, we need to derive a formula out of these 3 examples. The formula is: N(N-1) where "N" represents the total number of nodes or connection points in the network.

In that context, the number of integration points to consider becomes 1,523,770,260 or 1.5 billion integration points.

3.1.2.2 Different approaches have different costs

Our goal in this section is to understand the costs of system integration and how a sound architectural framework can be used as mean to control it. In light of the previous description of the work involved in integrating a single application into a shared data network, we need to put a costing number on an effort of this kind. To do so we will recognize variable levels of complexity in the integration work involved with any single node:

1. Low complexity will be represented as a $31,655 integration effort
2. Medium complexity will be represented as a $94,966 integration effort
3. High complexity will be represented as a $189,933 integration effort

The variation can come from the degree of openness of the application architecture, the level of integrity of the data, the level of compatibility of data encoding schemes, or other factors.

Assuming that these costing metrics are representative, we will describe different approaches to solve our problem of creating a shared data network where all caregivers can access relevant clinical data established as sharable in other applications and also share the data that they generate in the applications that they use.

Model 1 Each PoS application can interact directly with any other application in the network

Point to point interfaces are the way systems are being connected today in the healthcare system. Usually standards are used but adapted to the proprietary nature of the data shared or the systems being connected. In this model we assume that there would not be any jurisdictional level system solutions other then the registries systems. The registries systems are assumed to be necessary so that identifiers of core entities can be resolved when data is shared between systems. The table below presents the global costs of such an approach if our goal was to create a network covering the country.

Types of facilities	# of facilities	# of POS Applications Per Connection Point	Total # of POS Applications to Interconnect	# applications to connect with	# of Integration Points	Complexity	Costs in x1000$	Total Integration Cost x 1000$
HIAL Central Connection	48	0	0	38 782	0	Lo	$32	$0
HIAL Peer to Peer Connections	48	0	0	38 782	0	Med	$95	$0
EHR Shared Care Record	48	0	0	38 782	0	Med	$95	$0
HIAL Central Connection-Client Registry Link	13	1	13	38 782	504 166	Med	$95	$47 878 828
HIAL Central Connection-Provider Registry Link	13	1	13	38 782	504 166	Med	$95	$47 878 828
HIAL Central Connection-Location Registry Link	13	1	13	38 782	504 166	Med	$95	$47 878 828
Drugs Domain Network Link	13	0	0	38 782	0	Hi	$190	$0
Diagnostic Imaging Network Link	48	0	0	38 782	0	Hi	$190	$0
Labs Domain Network Link	48	0	0	38 782	0	Hi	$190	$0
Community Health Centre	198	3	594	38 782	23 036 508	Lo	$32	$729 231 379
Community Medical Clinic	5	3	15	38 782	581 730	Med	$95	$55 244 801
District Health Councils	19	1	19	38 782	736 858	Lo	$32	$23 325 583
Head Office	37	1	37	38 782	1 434 934	Lo	$32	$45 423 503
Home Care	68	1	68	38 782	2 637 176	Lo	$32	$83 481 033
Hospital	982	10	9 820	38 782	380 839 240	Hi	$190	$72 333 860 029
Long Term Care	2 399	5	11 995	38 782	465 190 090	Med	$95	$44 177 426 225
Nursing Station	88	3	264	38 782	10 238 448	Med	$95	$972 308 505
Outpatient Centre	583	5	2 915	38 782	113 049 530	Hi	$190	$21 471 812 830
Public Health Unit	50	3	150	38 782	5 817 300	Med	$95	$552 448 014
Other Acute (Hospitals)	144	10	1 440	38 782	55 846 080	Hi	$190	$10 607 001 878
Private Physician Offices	3 809	2	7 618	38 782	295 441 276	Med	$95	$28 056 993 162
Other (Physio, Dentists, Vision)	3 809	1	3 809	38 782	147 720 638	Lo	$32	$4 676 165 527
Totals	***12 483***		***38 783***		***1 504 082 306***			***$183 928 358 955***

Table 3-2 Point to point integration cost model

The costs of this purely theoretical approach would be **$183 trillion dollars**. Needless to say, we need a different approach!

Model 2 Clinical data sharing initiatives emanate from hospitals

In this model we are going to assume that initiatives to share clinical data are going to emanate from hospitals in the country. According to our data, there are 1,126 hospitals in Canada. For our model we will further assume that each hospital will, overtime, expand its clinical data sharing network to 44 external nodes or connection points. Each one of these connection points could be a clinical information system application in another point of service including another hospital, a physician office, a long term care facility, a rehabilitation center, a private diagnostic center, a pharmacy, etc… Some of those connection points could also be an interface engine in a hospital or long term care facility already tying together a set of clinical applications in an organisation. In this model, none of the registries or other jurisdictional system capabilities is represented. The theory being that since these clinical information networks would be based on a hospital system at the core, the resolution of key entities such as clients, provider and location would be offered by the hospital systems themselves. Another key point of this model is that each one of these care networks would grow along the natural referral patterns of a hospital; this would inevitably involve connecting other hospitals. In the long run, this could well result in duplicated links between many application points with no easy way to manage and coordinate who is connecting to who between networks. The table below presents the global costs of such an approach if our goal was to create a network covering the entire country.

Types of facilities	# of facilities	# of POS Applications Per Connection Point	Total # of POS Applications to Interconnect	# applications to connect with	# of Integration Points	Complexity	Costs in x1000$	Total Integration Cost x 1000$
HIAL Central Connection	48	0	0	0	0	Lo	$32	$0
HIAL Peer to Peer Connections	48	0	0	0	0	Med	$95	$0
EHR Shared Care Record	48	0	0	0	0	Med	$95	$0
HIAL Central Connection-Client Registry Link	13	0	0	0	0	Med	$95	$0
HIAL Central Connection-Provider Registry Link	13	0	0	0	0	Med	$95	$0
HIAL Central Connection-Location Registry Link	13	0	0	0	0	Med	$95	$0
Drugs Domain Network Link	13	0	0	0	0	Hi	$190	$0
Diagnostic Imaging Network Link	48	0	0	0	0	Hi	$190	$0
Labs Domain Network Link	48	0	0	0	0	Hi	$190	$0
Community Health Centre	198	0	0	0	0	Lo	$32	$0
Community Medical Clinic	5	0	0	0	0	Med	$95	$0
District Health Councils	19	0	0	0	0	Lo	$32	$0
Head Office	37	0	0	0	0	Lo	$32	$0
Home Care	68	0	0	0	0	Lo	$32	$0
Hospital	982	44	43,208	43	1,857,944	Lo	$32	$59,454,208
Long Term Care	2,399	0	0	0	0	Med	$95	$0
Nursing Station	88	0	0	0	0	Med	$95	$0
Outpatient Centre	583	0	0	0	0	Hi	$190	$0
Public Health Unit	50	0	0	0	0	Med	$95	$0
Other Acute (Hospitals)	144	44	6,336	43	272,448	Lo	$32	$8,718,336
Private Physician Offices	3,809	0	0	0	0	Med	$95	$0
Other (Physio, Dentists, Vision)	3,809	0	0	0	0	Lo	$32	$0
Totals	***12,483***		***49,544***		***2,130,392***			***$68,172,544***

Table 3-3 Hospital networks cost model

The costs of this approach would be **$68 billion dollars**. Keeping in mind that this cost only represents the costs of integrating systems and not the capitalization and services costs required to purchase or upgrade hospital systems so that they could play this role. It is clear, that even if we were to consider this investment over several years, it is a very expensive proposition. Again, we need a different approach!

Model 3 EHRS Blueprint approach: HIAL connection to all PoS applications

This model follows the suggested architectural framework of the EHRS Blueprint. It assumes that the clinical software applications located in a point of service are connected to a single EHR Infostructure (through its HIAL interface). The connection of a point of service application to the HIAL would allow it to promote its data to the EHR Infostructure and to read and present data from the EHR back to its end users as long as they are authenticated and authorized. In this model, any single piece of data promoted to the EHR of an individual becomes automatically available for access to any other application connected to this same EHR Infostructure or to applications connected to any other interoperable EHR Infostructure.

Types of facilities	# of facilities	# of POS Applications Per Connection Point	Total # of POS Applications to Interconnect	# applications to connect with	# of Integration Points	Complexity	Costs in x1000$	Total Integration Cost x 1000$
HIAL Central Connection	48	1	48	1	48	Lo	$32	$1,519
HIAL Peer to Peer Connections	48	1	48	1	48	Hi	$190	$9,117
EHR Shared Care Record	48	1	48	1	48	Med	$95	$4,558
HIAL Central Connection-Client Registry Link	13	1	13	1	13	Med	$95	$1,235
HIAL Central Connection-Provider Registry Link	13	1	13	1	13	Med	$95	$1,235
HIAL Central Connection-Location Registry Link	13	1	13	1	13	Med	$95	$1,235
Drugs Domain Network Link	13	1	13	1	13	Hi	$190	$2,469
Diagnostic Imaging Network Link	48	1	48	1	48	Hi	$190	$9,117
Labs Domain Network Link	48	1	48	1	48	Hi	$190	$9,117
Community Health Centre	198	3	594	1	594	Lo	$32	$18,803
Community Medical Clinic	5	3	15	1	15	Med	$95	$1,424
District Health Councils	19	1	19	1	19	Lo	$32	$601
Head Office	37	1	37	1	37	Lo	$32	$1,171
Home Care	68	1	68	1	68	Lo	$32	$2,153
Hospital	982	10	9,820	1	9,820	Hi	$190	$1,865,140
Long Term Care	2,399	5	11,995	1	11,995	Med	$95	$1,139,122
Nursing Station	88	3	264	1	264	Med	$95	$25,071
Outpatient Centre	583	5	2,915	1	2,915	Hi	$190	$553,654
Public Health Unit	50	3	150	1	150	Med	$95	$14,245
Other Acute (Hospitals)	144	10	1,440	1	1,440	Hi	$190	$273,503
Private Physician Offices	3,809	2	7,618	1	7,618	Med	$95	$723,454
Other (Physio, Dentists, Vision)	3,809	1	3,809	1	3,809	Lo	$32	$120,576
Totals	***12,483***		***39,036***		***39,036***			***$4,778,519***

Table 3-4 Interoperable EHR Infostructure cost model

The costs of this approach would be **$4.8 billion dollars**. Again, this cost only represents the costs of integrating point of service applications to EHR Infostructure once it has been deployed. It does not include the capitalization and services costs required to deploy EHR Infostructures (HIAL, registries and domain systems). Assuming that the connection of the diverse point of service and applications is going to be an evolutionary process in any jurisdiction, this range of costs is starting to become more palatable as one can look at it over several years.

Model 4 EHRS Blueprint approach: HIAL connection to all PoS applications including EAI in large PoS

It is interesting to look at this model with a slight modification from the previous. If we recognize the existence of interface engines in large points of service, we can consider all the applications involved in such organisations to be connected and integrated with the EHR Infostructure through a single point of interface. Assuming that this would be true in hospitals and long term care facilities, we get the following result with our cost analysis.

Types of facilities	# of facilities	# of POS Applications Per Connection Point	Total # of POS Applications to Interconnect	# applications to connect with	# of Integration Points	Complexity	Costs in x1000$	Total Integration Cost x 1000$
HIAL Central Connection	48	1	48	1	48	Lo	$32	$1,519
HIAL Peer to Peer Connections	48	1	48	1	48	Hi	$190	$9,117
EHR Shared Care Record	48	1	48	1	48	Med	$95	$4,558
HIAL Central Connection-Client Registry Link	13	1	13	1	13	Med	$95	$1,235
HIAL Central Connection-Provider Registry Link	13	1	13	1	13	Med	$95	$1,235
HIAL Central Connection-Location Registry Link	13	1	13	1	13	Med	$95	$1,235
Drugs Domain Network Link	13	1	13	1	13	Hi	$190	$2,469
Diagnostic Imaging Network Link	48	1	48	1	48	Hi	$190	$9,117
Labs Domain Network Link	48	1	48	1	48	Hi	$190	$9,117
Community Health Centre	198	3	594	1	594	Lo	$32	$18,803
Community Medical Clinic	5	3	15	1	15	Med	$95	$1,424
District Health Councils	19	1	19	1	19	Lo	$32	$601
Head Office	37	1	37	1	37	Lo	$32	$1,171
Home Care	68	1	68	1	68	Lo	$32	$2,153
Hospital	982	1	982	1	982	Hi	$190	$186,514
Long Term Care	2,399	1	2,399	1	2,399	Hi	$190	$455,649
Nursing Station	88	3	264	1	264	Med	$95	$25,071
Outpatient Centre	583	5	2,915	1	2,915	Hi	$190	$553,654
Public Health Unit	50	3	150	1	150	Med	$95	$14,245
Other Acute (Hospitals)	144	1	144	1	144	Hi	$190	$27,350
Private Physician Offices	3,809	2	7,618	1	7,618	Med	$95	$723,454
Other (Physio, Dentists, Vision)	3,809	1	3,809	1	3,809	Lo	$32	$120,576
Totals	12,483		19,306		19,306			$2,170,267

Table 3-5 EHR Infostructure with hospital and long term care EAI cost model

The costs of this approach would be **$2.1 billion dollars**. Again, this cost only represents the costs of integrating point of service applications to EHR Infostructure once it has been deployed. It does not include the capitalization and services costs required to deploy EHR Infostructures (HIAL, registries and domain systems). Assuming that the connection of diverse point of service and applications is going to be an evolutionary process in any jurisdiction, this range of costs is definitely feasible as one can look at it over several years.

3.1.2.3 The only economically viable approach

This section demonstrates that the only economically viable approach to the deployment of electronic health records is the architectural framework promoted in the EHRS Blueprint. A limited set of interoperable EHR Infostructures that can be interconnected where each one creates and maintains an electronic record of the health events and associated data occurring in its geographic area of service. What is important is this analysis is not really the actual number of $2.1 billion that we reach as an optimized scenario, but rather the order of magnitude of difference between the different approaches when one looks at the costs of integration.

Models to connect applications and share data	Costs
Point to point interfaces	$183,928,358,955,000
Hospital based networks of clinical data sharing	$68,172,544,000
Interoperable EHR Infostructures	$4,778,519,000
Interoperable EHR Infostructures with EAI interfaces	$2,170,267,000

3.1.3 BAH Study on 10 years cost

The last section has concentrated on the one specific area of the costs associated to the deployment of EHR solutions across the country, that being the cost of integration between PoS applications and EHR Infostructures. While many of the architectural decisions behind the proposed solution of the EHRS Blueprint are driven from the perspective of lowering that cost of integration, it is also important to gain an understanding of the other elements of costs associated with building and deploying the information system solutions required to build a large capacity in Canada to manage electronically the clinical records of the population.

To that end, Infoway has mandated Booz Allen Hamilton to provide data to project the costs and benefits of such an implementation. Booz Allen Hamilton was not constrained by Infoway's current mandate and investment areas; but was instead commissioned to recommend an ideal Pan-Canadian approach. The report is intended to provide Infoway and its stakeholders with insights around challenges, critical success factors, efficiencies and benefits realization. As a result, the implementation approach and estimated costs and benefits presented transcend Infoway's current mandate. In that context, the scope of the Booz Allen Hamilton study included:

- The costs of acquiring, customizing, deploying and operating EHR Infostructure solutions covering all Provinces and Territories
- The costs of acquiring, customizing, deploying and operating EMR (Electronic Medical Records) solutions for all private and public clinical physician practices including organisations such as community care centers.
- The costs of acquiring, customizing, deploying and operating EPR (Electronic Patient Records) solutions for all hospitals and long term care organisations.
- The costs of acquiring, customizing, deploying and operating specialized EMR (Electronic Medical Records) solutions for home care services.

This analysis was tailored to capture the unique characteristics of clinical IT systems and the Canadian health care environment. Factors considered for analysis included vendor selection, system effectiveness, procurement strategy and volume discounts, implementation strategy and sequencing, provider adoption and usage, and the presence of existing systems. Some of the clinical benefits analyzed included quality of care and outcomes related to adverse drug events, as well as the impact of decision support systems used in conjunction with creating computer orders for ancillary services, such as pharmacy, laboratory, and diagnostic imaging. One of the challenges faced in trying to estimate system costs was the difficulty in obtaining detailed cost data. Booz Allen therefore leveraged its relationship with the Center for Information Technology Leadership (CITL) in Boston, Massachusetts. CITL had previously published work on a model that was used to estimate costs and benefits relevant to certain EHR functions in the United States.

The 10-year cost of acquisition for a Pan-Canadian EHR is estimated to be $9.99B: $1.4B for Physician Practice Systems, $3.9B for Inpatient Systems, $1.8B for a Long-Term Care System, $0.05B for the Home Health extension, and $2.9B for EHR Infostructure costs. In relation to the last section on the cost of integration, as the Booz Allen Hamilton study assumed that new PoS (Point Of Service) clinical information systems (EMR's, EPR's) would be acquired and implemented in every facility, the study also assumed that each of these clinical information systems would be already compatible to EHR Infostructure standards. In that sense, the costs of integration of 2.1 billions (optimal model) surfaced in the previous section is assumed to be fully integrated in the Booz Allen Hamilton costs of acquisition, customisation and deployment of EHR Infostructures, EMR's and EPR's. The 10-year total cost of ownership for a Pan-Canadian EHR, which includes both acquisition and recurring costs, is estimated to be $22.7B.

The current evidence supports significant benefits in terms of healthcare quality and access and a strongly positive societal return on investment over a 20-year period. In the health care sector, total EHR savings per annum grow to more than $6B CAN at peak levels of use and adoption. Over 20 years, significant savings are anticipated through reduced adverse drug events (29 million events, with a savings of $48.3B), reduced duplicate or unnecessary radiological tests ($3.6B), and reduced duplicate or unnecessary laboratory tests ($10.4B). In addition, pan-Canadian EHR is anticipated to reduce costs through increased administrative efficiency, more effective care and disease management and increased provider efficiency and productivity.

Using the Booz Allen implementation approach, gross annual savings are anticipated to outpace expenditures by Year 7, and the $10B investment is anticipated to breakeven by Year 11.

The Booz Allen Hamilton's report has been published in the Canada Health Infoway website.

3.1.4 Complexity of EHR Solutions

The implementation and integration of EHR Solutions in the delivery of health services creates challenges for solution providers and users by introducing some complexity that is not already present. This complexity is present in many dimensions, and if properly anticipated and planned for will help ensure the benefits of the EHR to patients/clients, health service providers, and the health system as a whole.

The complexities of EHR Solutions that need to be considered and managed include the following dimensions:

- Human complexity: incorporating the use of shared EHR information in the day to day life of a caregiver or health service provider requires additional training in aspects of information use, including:
    - Considerations for professional practice and patient safety when using information from external sources, such as changes to subjective client interviewing techniques to verify the information already provided by the EHR rather than relying solely on the interview process for histories and clinical context.
    - Proper use of system login procedures to ensure capturers and users of EHR information are properly authenticated for appropriate access.
    - Respecting confidentiality and privacy for information captured by other sources.

- Information complexity: consolidation and use of shared EHR data from multiple provider roles and care settings increases the complexity of: how data is structured, the minimum content of data as recorded in these structures, and how data is encoded to improve the consistency, reliability, and safe interpretation of data.

- System complexity: regional and jurisdictional level systems solutions must be robust enough to ensure a high degree of availability, they must be engineered in a way to provide appropriate response times appropriate to care setting needs, and the solution components that are part of an

EHR Infostructure must behave as one service to all points of service. Configuring EHR infostructures to be able to manage the orchestration of data and services across multiple repositories and point-of-service systems is also complex.

- Technology complexity: the ability to manage the various protocols required for heterogeneous PoS systems access to the EHRi infostructure, as well as ensuring the scalability, redundancy, and availability of EHRi components introduces additional complexity that must be planned for by the designers, implementers, and operator of EHR infostructures.

Managing Complexity

Managing the many dimensions of complexity must be anticipated and incorporated in the planning and execution of projects to develop, integrate, and implement EHR infostructures and solutions. For each of these dimensions, this can best be accomplished by:

- Using an evolutionary approach where change and complexity is introduced in small incremental steps using a strategy that focused on delivering concrete clinical value to caregivers early, and at every subsequent step.

- Using a standards-based approach to maximize reusability and interoperability of solutions components as they are acquired or developed. This allows the implementers of EHR Solutions to focus on the true value add capabilities of the solution, rather than spending valuable time and resources on establishing system connectivity and interoperability.

- Taking advantage of the EHRS Blueprints Services Oriented Architecture to allow encapsulation of data and functions into plug & play capabilities that can be readily upgraded or replaced over time with minimal impact to the rest of the system

- Use of parameterized systems that can use Business rules services that allow new or changing legal, professional, administrative or political policies, rules and regulations to be introduced into the systems with a minimum of effort. This use of rules driven solutions also retains a history of configuration changes that are critically important in understanding the changes in EHR information and measuring the affect of those changes over time.

3.1.5 Supporting Availability and Scalability

A significant challenge for EHR solutions is the requirement of health care services for information solutions and applications that are available 24 hours a day, 7 days a week. This high availability is required because:

- EHR information must be available at the fingertips of care givers when they need it to make decisions to treat their patients/clients. More than that, once this information has been referenced and played a part in care planning and service delivery, it must be persistently and consistently available. Not having subsequent access to it is unacceptable.

- Particularly in the early adoption of interoperable EHR solutions, there is an expectation that for certain types of caregivers; the EHR is going to be the only electronic means of accessing available client data. If this service becomes unavailable, they may not be able to operate.

- As end-users start using the EHR, their work processes are going to quickly change to rely on it for certain types of key information. As this happens, the ability of care givers to revert back to the way they were obtaining information is going to fade. Over time, this will put more and more impact on an EHR system becoming unavailable.

In addition to having high availability, EHR Solutions need to be scalable. This means that EHR infostructures and associated solutions are engineered in a fashion that permits significant growth without requiring reengineering, particularly of the primary functional components. Ideally, this scalability is designed to allow changes to the configuration of the systems without removing the operational components from service, for example:

- Adding end-users: it must be possible to administer addition of new users or the changing of existing user profiles

- Adding PoS applications: it should be possible to attach a new instance of a Point of Service application

- Adding EHR Infostructures: it should be possible for a new instance of an infostructure to begin operation and seamlessly integrate into the existing peer network of infostructures

- Deployed applications or services should be able to support increased use without creating problems for pre-existing users or the other applications and services that interact together

- Extending the geographical scope served by an infostructure should be possible without significant reconfiguration

Additional information on these issues can be found in the Functioning Principles section of the EHRS Blueprint.

3.1.6 Semantic Interoperability

Infoway defines Semantic Interoperability as "the ability for information from many different sources to be consistently understood and utilized by other persons and information systems". In the case of a shareable longitudinal EHR, this can be extended to say the information must also be consistently understood over the passage of time. So another way of expressing this is "consistent meaning across sources and over time".

The essence of a patient-centric EHR is to provide a life-long source of information that can be contributed to and used by health service providers across the spectrum of health care and health promotion. In order for the benefits of the EHR to be realized, the information it holds must be meaningful: of sufficient quality, detail, and consistency. This is critical so that users of the information are confident they can rely on it for the benefit of the patient.

Semantic Interoperability as a Requirement of the EHR

Semantic Interoperability is a fundamental requirement for the EHR for many reasons including:

- Patient Safety – clinicians who utilize information from other sources must be confident that the information they access be reliable and clearly understandable. Information that is ambiguous or not expressed clearly may be interpreted incorrectly, possibly jeopardizing the safety of patients.

- Quality of Care – beyond "doing no harm" the EHR must support the provision of consistent, high-quality care
- Continuity of Care – the delivery of effective quality care requires that providers in many disciplines be able to access and understand information in the EHR that is relevant for their purposes.
- Meaning over Time – regardless of the changes that occur over time in the disciplines that provide health services, or in the technologies that capture and transport related information (for example changes in the codification of medical concepts) information needs to retain its original meaning.

This requirement exists anywhere EHR information is shared: within and between health disciplines, service delivery organizations, health regions, and F/P/T jurisdictions. It is particularly challenging when you consider that the broad range of potential sources of information in the EHR, for example:

- acute care
- ambulatory care
- chronic disease management
- dentistry
- home care
- long term care
- medical specialities
- nursing
- pharmacy
- primary care
- public health

Each of these settings / disciplines has their own jargon, processes, and standards related to the expression of clinical concepts and the provision of services. In addition, within each discipline and care setting there are typically a variety of IS solutions and custom applications utilized.

Levels of Semantic Interoperability

Infoway recognizes two basic levels of semantic interoperability: human interpretable and computable interoperability.

Human interoperability presumes that information can be captured and subsequently shared with enough context that the human reader can resolve any ambiguities in expression and assess the level of specificity, precision, and timeliness relevant for their needs. This form of interoperability works if there is a shared basic foundation of concepts and understanding of the processes involved in the capture and use of information. For example terms or acronyms that are known to be specific to one particular context can be captured and shared along with clear-text descriptions that can be expected to be understood

Computable interoperability is possible if business processes between interoperating systems are tightly integrated using a completely uniform set of standards for representation of information or, where that is not possible, sufficient contextual information is provided to allow interoperating systems to map between dissimilar representations provided that the same semantic meaning is retained. In cases where the level of precision of expression of a concept is not equivalent, it may also be possible to generalize the concept to a less refined representation and still provide enough contextual information for the reading system to convey the same meaning. For example where varying ranges or norm thresholds are used by dissimilar lab equipment for the same basic observation, provision of codified data along with identifying and versioning information on the technology used to capture the original data may permit another system to understand and represent that data understandably.

Infoway's ultimate goal is for Computable semantic interoperability, where disparate systems can reliably capture, present, and reuse information across sources and over time. *Infoway* investment projects are expected to achieve this capability wherever possible, both through applying rigour in their acquisition and development of new ICT solutions, and through their participation in the establishment of common standards in the codification and use of terminologies and classifications.

However, it is recognized this ability is constrained by the ability of the capturing and reading systems to map data based on different standards, or to provide sufficient meta-data for interpretation. For this reason *Infoway* recognizes that Human Interpretable semantic interoperability is more practical and possible in the early stages of establishing interoperability based on shared EHR data. Having said that, it must be stressed that most data captured only in human interpretable format will not be conducive to the evolution of the EHR into higher end capabilities such as decision support or workflow automation. Also noteworthy is the fact that human interpretable format cannot effectively be repurposed or reused easily to support secondary uses of information such as research, detection, prevention, or surveillance programs.

Factors Promoting Semantic Interoperability

While the goal of semantic interoperability across the vast number and instances of information systems in Canada seems daunting, it is important to emphasize that *Infoway*'s approach to the EHRS architecture and the establishment of the EHR Standards Collaboration Process have been done expressly to provide a means for the Canadian Health Sector to have access to meaningful shared data.

Infoway's Architectural Approach

The following aspects of *Infoway*'s EHRS Blueprint are architectural components that inherently promote semantic interoperability.

HL7 Messaging

The use of a structured and internationally adopted messaging paradigm (HL7) is a significant enabler in achieving semantic interoperability. Use of a messaging paradigm rather than tightly coupled interfaces is a fundamental enabler by promoting low coupling between systems. This, in turn, allows systems to use shared data while at the same time allowing them to manage that data in ways they require. This approach is predicated on a set of common business requirements for the exchange of information where proponents adhere to the sending and receiving roles associated with each message.

Use of HL7, and particularly v3.0 of HL7, provides further value by providing a common Reference Information Model to support mapping from Point of Service and EHRi systems to a common message format and content, as well as a health specific framework of application roles and message constructs. As well, HL7 v3.0 provides the ability to structure messaging content and vocabularies to be consistently implemented within the context of a national realm. This, combined with the fact that HL7 v3.0 is an ANSI-accredited consensus-based standard driven by the health software industry, itself is another huge enabler and should provide confidence in our stakeholders that computable semantic interoperability is possible using this architectural precept.

EHRi Conceptual Data Model

The EHRi Conceptual Data Model has been designed to provide the maximum flexibility possible in representing information captured by disparate systems, and to support evolving capabilities that use of shared EHR information will require. The model is event-driven, and has normalized the representation of fundamental health service delivery concepts and their relationships in a way that will permit reuse of data for sharing and will be conducive to semantic interoperability.

The EHRi Conceptual Data Model has also been aligned with the HL7 Reference Information Model, providing an effective means for mapping data to and from HL7 v3.0 messages.

Standards collaboration and Change Management

Consistent use of data standards at a national level is a key enabler for semantic interoperability. The consistent definition and representation of health concepts across jurisdictions can only be achieved through their commitment to the active implementation of such standards. The EHR Standards Collaboration Process has established a steering committee with representation by these major stakeholders to ensure each jurisdiction is aware of the standards required, the work being done to establish them, and the costs, requirements, and consequences of implementing them.

The use of standards also requires the collaboration of governance organisations in various health disciplines that provide standards for professional practice used by their members. The SCP Pan-Canadian Standards Advisory Committee has been established to both inform and solicit the participation of these professional organizations in the harmonization of practice and the use of information that is necessary to achieve interoperability between their respective disciplines. Their participation in the SCP process is critical to ensure that interoperable EHR solutions co-evolve with interoperable care practices, and to provide the jurisdictions who invest in standardized EHR solutions with the confidence that their investment will yield a return through active use and the meaningful sharing of patient-centric information.

Finally *Infoway*, through the SCP process, relies on pan-Canadian Standards Working Groups in each investment domain to ensure that as EHR solutions are evolved and implemented, they do so in a manner that applies national standards consistently and appropriately.

3.1.7 Integrating Information Flow Across Jurisdictions

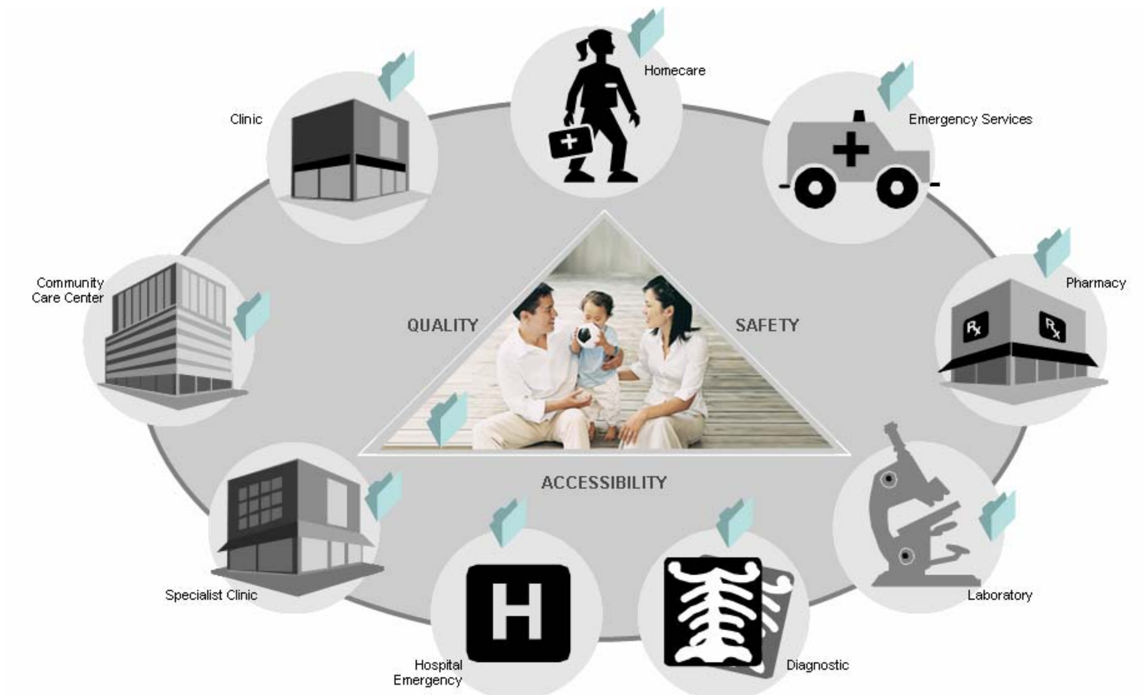

Figure 3-4 Why pursue the EHR ?

There are many different and entirely valid perspectives on what it means to enable the use of Electronic Health Records. Certainly there is a significant benefit just to see every major health service domain using information technology effectively in providing and managing health services.

However the real benefit, to patients and providers alike, is in sharing information. In our publicly-funded universal-access model we know the following things:

- The responsibility for meeting the health care needs of Canadians is shared across many care settings, disciplines, provider and governance organizations
- Information that is timely, accurate, and accessible to the right people at the right time is critically important in reducing errors, wait times, improving outcomes, and reducing costs (or increasing service levels for the same cost)

These benefits cannot be realized if electronic health records are held in isolation from each other. The EHR must integrate information flow related to the patient across the various sources and consumers of health information in each jurisdiction. This requires that patients and providers of health services, in all care settings in a jurisdiction, can contribute and have access to an integrated view of the patient's EHR information.

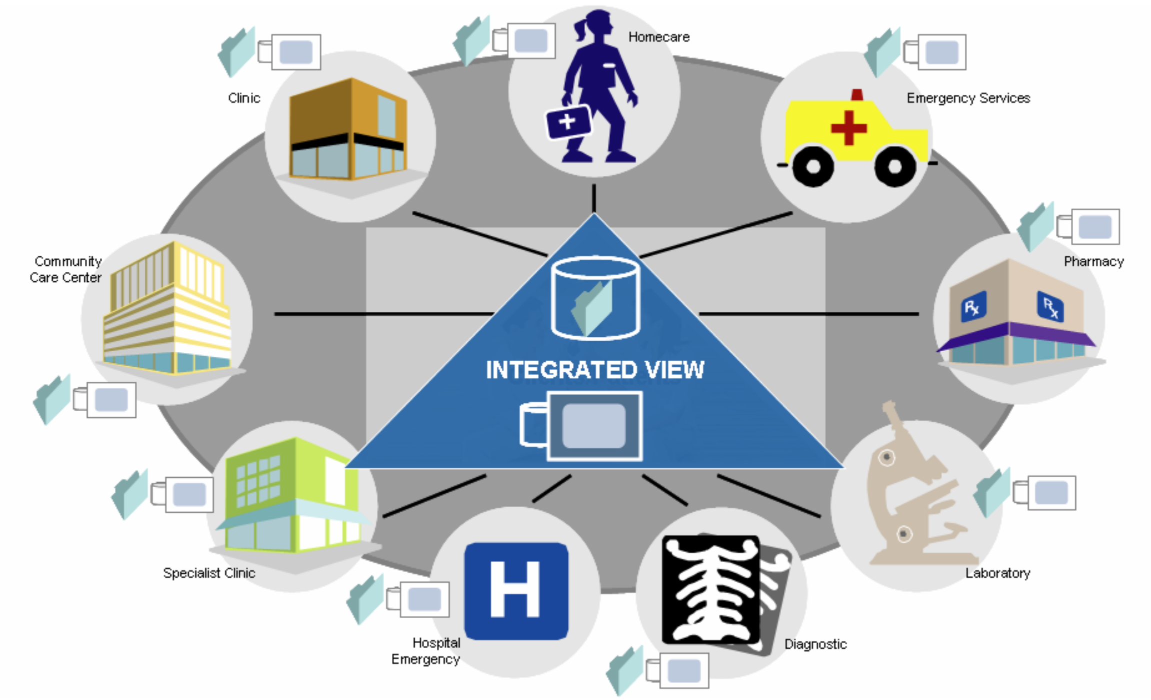

Figure 3-5 Sharing Information From Multiple Systems

The EHRS Blueprint provides a model for how this sharing can be accomplished in a manner that ensures consistent, timely access to all of the information about a patient that is available in electronic form. However, ubiquitous access alone is not sufficient to ensure patient safety and effective use of the information. EHR information must be also persisted and presented in a fashion that allows all users of that information to be able to interpret it reliably and act on the information appropriately, regardless of how the source of the information represents it in its own system.

3.2 BUSINESS DOMAINS

This section presents the potential impact of an EHRS in various healthcare business domains.

3.2.1 Healthcare Delivery

As medical research and breakthroughs continue to grow in leaps and bounds, it has created an exponential growth in the number and types of tests available, the number of potential healthcare providers in the continuum of care, and the amount of information and data associated with these activities. This explosion of information has accelerated the shift towards evidence-based approaches to practicing medicine.

Evidence-based approaches to practicing medicine make it imperative to find ways to manage a patient's health record, the ever increasing amount of information associated with it, and ensuring this information can be provided and subsequently accessed on a timely basis. An EHR provides electronic access to information and the ability to organize and manage this information to ensure it is delivered at the time that it is needed in a standardized format. It provides appropriate access to quality information and data from trusted sources in a secure environment.

To illustrate the impact this can have on healthcare delivery, consider the following examples:

Scenario: John Smith has had pain in his abdominal area that has persisted for several weeks, and has grown increasingly debilitating. Unable to diagnose the problem, his family doctor recommends a series of tests be conducted and that John visit a specialist.		
Without an EHR • Test results are forwarded to the specialist via fax or courier • The specialist reviews the test results • The specialist meets with John to discuss previous medical history to determine if there are other factors that may be contributing to his condition • Unable to pinpoint an exact cause, the specialist recommends a few more tests to help narrow down the cause further	**With an EHR** • Test results are available electronically through the EHR • The specialist reviews the test results and John's medical history and notices a prior condition several years ago that may be impacting his current condition • The specialists consults with John around this procedure to confirm some details • Based on the evidence and consultation, the specialist makes a diagnosis and prescribes a treatment	**Benefits** ➢ Save time and money on delivery of results directly to the point of care ➢ Provides entire context to enable medical practitioners to make the most accurate diagnosis ➢ The provider no longer relies solely on patients for anecdotal and supplemental information; instead having access to accurate and comprehensive historical information ➢ Providing the complete context increases the likelihood of proper and quicker diagnosis

Scenario: Jane Lewis is visiting her niece Donna in British Columbia, when she suddenly collapses. Donna rushes Jane to the nearest emergency department, where doctors attempt to diagnose her situation quickly.		
Without an EHR • Doctors attempt to stabilize Jane's condition • Doctors consult with Donna for some clues to Jane's medical history. Donna, who hasn't seen her aunt in years is only able to provide very basic information • Doctors order tests to help diagnose Jane's condition	**With an EHR** • Doctors attempt to stabilize Jane's condition • Doctors locate Jane's electronic health record, which lists her current condition and medications • Jane's condition is diagnosed and a treatment prescribed	**Benefits** ➢ Access to Jane's medical history provides an up to date picture that helps diagnose her condition quickly ➢ Quick diagnosis based on medical history reduce the need for additional tests ➢ An EHR provides the potential for quicker

• Jane's condition is diagnosed and a treatment prescribed		diagnoses by providing access to up to date health records, resulting in rapid, accurate treatment in a circumstance where time is often a critical factor in intervention and recovery

Scenario: David Lee has just been diagnosed with brain cancer. His doctor recommends a treatment that involves a number of treatments and prescriptions. David is having difficulty adjusting to his new situation, and his doctor suspects he will have difficulty complying with all the treatment requirements, but given he is only one point of treatment, can only hope that David will comply with the rest of the treatment regimen.		
Without an EHR • Doctor makes note of David's condition and given his reluctance, notes in his paper file to follow up with David personally • The pharmacist issues the drugs prescribed to David, noting his dejected behaviour	**With an EHR** • Doctor makes note of David's condition and given his reluctance, notes this in the electronic medical record, setting an electronic reminder to follow up with David in a few days • Reading about David's condition and the doctor's concerns, the pharmacist emphasizes the importance of how each drug will help in David's treatment	**Benefits** ➢ David's reluctance is important context that is now available electronically to all providers (nurses, specialists, pharmacists) in the care continuum who may encounter David. ➢ The EHR provides a prompt to the doctor for follow up with David in a timely fashion, contributing to David's compliance and a better outcome ➢ Continued context across the care continuum enables care providers to remain sensitized to a patient's specific needs

Scenario: Dr. Jones has just read about a new flu strain coming that has several symptoms that at the least are debilitating, but at worst dangerous for patients in particular demographics. With over 35,000 patients, he would like to find the best way to ensure that the patients particularly susceptible to strain within his clinic have receive a newly issued flu shot that should inoculate them against this new strain.		
Without an EHR • Dr. Jones decides to post a notice in the clinics waiting room, and instructs the receptionist to inform patients of this new development when they check in. Between this and	**With an EHR** • With electronic access to the medical histories of all of the patients in the clinic, Dr. Jones can quickly identify those patients in particular demographics	**Benefits** ➢ Access to an EHR can help turn medical practice from reactive treatment to proactive prevention.

the news of the new flu bug, she hopes that she can catch the majority of patients needing the shot	and contact them directly to come in for a flu shot.	

The EHR's ability to provide secure and ubiquitous access to healthcare providers across the continuum of care will transform the delivery of healthcare from discrete points of treatment in time from multiple healthcare providers to a connected continuum of information that will truly enable a patient centric approach to evidence based medical practice.

While the simple availability of this foundational data and information through an EHR can provide substantial impacts in itself, it only represents the tip of the iceberg. An EHR can provide this information not only to healthcare providers to read and analyze, but to their clinical applications as well.

An EHR serves as a platform to provide information in a secure and standardized manner to clinical applications so that:

- logic and workflows ***within*** a clinical application can be applied based on the information and data to improve and automate aspects within that application's clinical domain (e.g. trigger a reminder for a mammogram that needs to be done every 3 years) and
- logic and workflows ***across*** different clinical applications (e.g. DIS, RIS) can be applied based on the information and data to improve and automate aspects of healthcare delivery across a network of care providers while ensuring appropriate access and
- entirely new classes of clinical applications can be built to help providers track and manage the health profile of a patient on a cross-continuum basis.

These additional benefits represent opportunities to revolutionize healthcare delivery over and above the powerful benefit and improvements to quality of having this information available to providers in a timely manner. By feeding this information into clinical applications, it will:

- help increase efficiencies of the workflow and processes those applications support
- offer unprecedented integration between healthcare providers to optimize current healthcare delivery that runs across multiple providers
- unleash new possibilities and provide a platform to adapt to new processes as more medical breakthroughs occur and new practices evolve

3.2.2 Healthcare Management

Healthcare managers must find ways to cope with the exponential growth of information inherent in today's medical practices. Finding the most effective ways to store and ensure that healthcare practitioners can access this information in a timely manner is a challenge at the best of times, particularly in common instances where the data or information is not resident in their organization.

Furthermore, healthcare activities generate a wealth of information and business intelligence that could help managers operate specific facilities more efficiently (e.g. better understanding patient inflow channels by using patient referral data), providing insight into services that could improve a patient's healthcare experience (e.g. understanding patient demographics), or on an even higher level provide population data to help manage healthcare services on a regional, provincial, or national level. Often this information may be difficult to mine for these types of insights in its current form.

An EHR can provide a basis to solve these issues by providing electronic access to information and the ability to organize and manage this information to ensure it is delivered at the time that it is needed in a standardized format. It provides access to quality information and data from trusted sources in a secure environment. Because this information is for and about the delivery of health services to individual persons, and because it will be reused in that context, the healthcare manager can have confidence the information is reliable, which is not the case today for much information that comes from administrative processes superimposed on health care processes, or gathered as an afterthought.

To illustrate the impact this can have on healthcare management, consider the following examples:

Scenario: Robert Park had an emergency procedure performed at the hospital several weeks ago. He is following up on his treatment with his family doctor Dr. Lewis and is going for his first follow up visit.		
Without an EHR	**With an EHR**	**Benefits**
• Dr. Lewis places a call to the hospital to request a copy of Robert's medical file • A hospital administrator pulls Robert's file, makes a copy and faxes it over to Dr. Lewis' office • The administrator at Dr. Lewis' office receives the fax and appends it to Robert's existing file • The administrator makes Robert's file available for his appointment	• When Robert comes in for his appointment Dr. Lewis retrieves Robert's health record electronically	➢ Reduces administrative work ➢ Reduces the time required to pull charts, duplicate materials, and deliver them to the point of care ➢ Minimizes need for storage requirements ➢ More time is spent concentrating on patient care

Scenario: Dr. Smith a hospital administrator is currently preparing next year's staffing budget, and has had requests from a number of departments for an increase in practitioners and specialists. She knows that all of the departments were extremely overtaxed last year, but cannot possibly accommodate everyone's requests in the budget.		
Without an EHR	**With an EHR**	**Benefits**
• Analysis built from multiple information sources that may be available in existing systems, or that has been collected on paper forms using processes not inherently part of the delivery of services at the point of care	• Analysis initially built from single data source representing accurate and comprehensive data captured at the point of care, and complemented by additional systems as required	➢ Provide a single source of qualitative, quantifiable data that can be used in analysis to determine effective options

The above scenarios represent an opportunity for reduced costs, productivity gains, as well as access to business intelligence not previously available to healthcare managers that can be provided with an EHR. While cost savings productivity gains, and the value of business intelligence will be dependent on the context for each healthcare practice, they serve as basic metrics that healthcare managers to evaluate the value they attribute to an EHR.

3.2.3 Healthcare Research

Healthcare researchers have had to rely on collecting large quantities of survey information and extrapolations or inferences from samples or trials to support their hypotheses. These are often time consuming efforts and in some cases where the data was unavailable or only small subsets were available, the results were susceptible to inaccuracies and discrepancies. However, given lack of consistent, comparable, quantitative data, these methods have been the only way in which research could be done in a controlled and reliable manner.

Rolling up timely, accurate, comprehensive, and semantically consistent EHR data into population based information available for data mining opens up new avenues for analysis and potential discovery that have not previously been available. The availability of up to date data also provides an ability to compress certain time cycles required to understand cause and effect.

To illustrate the impact this can have on healthcare research, consider the following examples:

Scenario: The University of Montreal would like to conduct a study the correlation between patient compliance and relapses in illness.

Without an EHR	With an EHR	Benefits
• Study would likely be conducted through clinical trial on a small sample population and extrapolated	• Factors attributed to patient compliance and relapses identified are mined from EHR data and analyzed	➢ Reduced efforts and compressed time to produce supporting evidence based not on a sample but on comprehensive analysis of a significant population

Scenario: The Saskatchewan government would like to understand the prevalence of depression in their population

Without an EHR	With an EHR	Benefits
• Results would have to be collated through a coordinated effort of pharmaceutical vendors, associations, and medical practices based on a pre-coordinated set of indicators that are captured differently in every organization, and which often must be inferred from	• Results are tabulated through population based data and prescription information consistently represented in the EHR	➢ Methods for analysis and discovery can be used that were not previously available with higher confidence conclusions reflect the actual occurrence in the population

other data		

Of course, there are privacy and security concerns that must be addressed with this type of capability and these are paramount considerations dealt with in the EHRS Blueprint.

3.2.4 Public Health

In April of 2004, *Infoway* was provided an additional allocation of investment capital to accelerate the establishment of electronic information systems supporting Public Health Surveillance, including the integration of PHS enabling concepts into the EHRS Blueprint architecture.

For this purpose then, and for the discussion in this document, Public Heath surveillance can be defined as: The systematic gathering and analysis of information on infectious diseases to support:

- Effective testing of individual clients who may have a infectious disease or may have been in contact with a person who has an infectious disease;
- Detection of potential infectious disease outbreaks that could pose a public health threat;
- Administration of measures (e.g., immunization) that can prevent or mitigate infectious disease incidence; and
- The timely issuing of alerts to the appropriate public health authorities when risks and outbreaks are detected.
- The reporting of infectious disease cases and outbreaks

In considering the implications of this new *Infoway* investment program for the EHRS Blueprint, it is important to understand the business drivers for Public Health Surveillance. The emergence of new threats to public health demand new approaches to detection and control, for diseases such as SARS, Antibiotic Resistant Organisms (AROs), West Nile Virus, and the Avian Influenza Virus. Given recent events, there is concern by many that public health authorities' ability to respond to infectious disease threats may be inadequate, which also results in increased demand for preventative measures (e.g., flu shots).

Finally, the release of reports from recent threats outlines the lessons learned and possible preventive measures:

- "Report of the Walkerton Inquiry – Events of May 2000 and related issues" – 2002
- "Learning from SARS: Renewal of Public Health in Canada ("Naylor Report") – 2003
- The SARS Commission Interim Report: SARS and Public Health in Ontario ("Walker Report") – 2004

Public Health Surveillance Domains in the Infoway Investment Scope

Given this compelling context, the *Infoway* Public Health Surveillance investment program is focused on the following public health business domains:

Business Domain	Description

infectious disease management	Identification, tracking and monitoring of infectious disease clients and the testing and treatment they receive, in order to optimize patient outcomes and safeguard public health and safety.
immunization management	The administration of vaccines to selected population groups to prevent or mitigate vaccine preventable infectious disease incidence or morbidity.
infectious disease surveillance	Systematically collecting and analyzing clinical data to categorize infectious disease cases and identify disease outbreaks in a population, across geography and time
infectious disease outbreak management	The timely detection, response and control of infectious diseases outbreaks.
health alert management	The timely notification of appropriate first responders when outbreaks or specific cases of infectious diseases of concern to public health are detected.
infectious disease reporting	The timely reporting of the incidence of infectious diseases at local, regional, provincial/territorial, national and international levels of surveillance

A pan-Canadian Solution for PHS

During the process of defining the scope of the PHS program, it became clear that the stakeholders across the country preferred that a common set of modular capabilities based on pan-Canadian requirements be defined from the outset. This includes an understanding that the information and communication standards to be used in the solution also need to be defined at a pan-Canadian level and be used consistently across the country. It was also recognized that although there were some government sponsored solutions already developed, the entire set of solutions should be architected to be interoperable with the EHR, and to use the EHR infostructure as a scalable framework to support regional, jurisdictional, and pan-Canadian sharing and management of PHS related information.

This presents a unique opportunity for the EHRS Blueprint to incorporate and shape, from the outset, the approach to integration of EHR data as a source of information to the PHS solutions. The integration of PHS capabilities in the EHRS offers some significant benefits to the PHS sector and Canadians in general. To illustrate the benefits that EHRS can have on Public Health, consider the following examples:

Scenario: Disease Management		
Without an EHR	**With an EHR**	**Benefits**
• Public health case workers collect copious data on medical history, encounters, medications, etc.	• Relevant clinical and encounter data can be downloaded from EHR repositories	➢ the EHR provides a comprehensive and near real-time history of all relevant encounters
• surveillance systems must develop separate interfaces with each lab's systems	• Surveillance systems can access/import order and test result from JLISs and other EHR repositories.	➢ lab orders and test results are visible across all sources and labs on a near-real time basis
• public health staff must collect complete demographic data on	• demographic data stored in the Client Registry can be	➢ patient/client data is stored in a single repository

Scenario: Disease Management		
Without an EHR	**With an EHR**	**Benefits**
the patient/client	accessed by the surveillance system	accessible to multiple applications.

Scenario: Immunization Management		
Without an EHR	**With an EHR**	**Benefits**
• immunization data is captured in a combination of paper records and fragmented immunization registries maintained by public health, institutions and physicians	• immunization data captured in standards-based immunization registries is accessible by both surveillance systems and EHR systems	➢ Immunization data captured consistently across a broad spectrum possible immunization sources
• immunization data is maintained in a combination of paper records and fragmented immunization registries maintained by public health, institutions and physicians	• once captured, immunization records are maintained in the immunization registry modules of surveillance systems, and in EHR repositories	➢ The EHR provides a central source of immunization history regardless of where a person is immunized in Canada ➢ Each Canadian's immunization history travels with them, providing continuity
• Required immunizations must be determined based on incomplete clinical data, which might exclude key items (e.g., vaccine allergies)	• Public health staff are able to determine a patient's required immunizations on a basis fully informed by his/her medical history	➢ Comprehensive immunization histories, combined with other clinical data, enable optimal immunization decisions and planning – by both acute care providers and public health staff

Scenario: Disease Surveillance		
Without an EHR	**With an EHR**	**Benefits**
• Physician and hospital staff must transcribe data to report infectious disease cases to public health authorities.	• Reporting to public health of notifiable cases occurs as a by-product of capture of case information by providers	➢ mandatory reporting requirements for clinicians and labs can be met by existing EMR / CIS systems by defining appropriate trigger events and using the EHR infostructure to send the data in near real time to the shared PHS repository
• Costly special studies are	• Routine and extraordinary	➢ data can be routinely

Scenario: Disease Surveillance		
Without an EHR	**With an EHR**	**Benefits**
undertaken to explore specific analyses of infectious disease patterns and trends	surveillance analysis is supported by fully-accessible clinical data from EHR systems.	extracted from the EHR to PHS data warehouse services and analyzed on an ongoing basis

Scenario: Outbreak Management		
Without an EHR	**With an EHR**	**Benefits**
• Extraordinary efforts are required to identify contacts and other exposed parties, including health care workers who may have been exposed through clinical encounters	• With the benefit of clinical history from the EHR, all individuals exposed to an outbreak can be more easily identified.	➢ the EHR allows Outbreak managers to quickly and accurately identify and assess the recent encounters of infected persons with the health systems itself, providing rapid notification and containment
• Interviews and other mechanisms are necessary to identify persons at risk from an outbreak	• Data accessed from the EHR repository provides public health staff with input on identifying persons at risk from exposure to an infectious case	➢ the EHR has the ability to hold "social set" information on each patient, identifying their family members, persons who live with them, and potentially holding information on where the patient regularly works or has recreation
• location data (e.g., home, workplace) must be collected from infected individuals as part of the case investigation	• Some location data will be accessible from EHR systems, combined with the geocoordinates needed to facilitate plotting on maps, to more easily gauge the spread of certain outbreaks	➢ the EHR supports the ability to store geo-coded information on locations of services as well as on the other "named-locations" that are relevant, including addresses for home, school, or work environments. This can be very helpful when assessing disease vectors and correlating outbreak information received from various sources
• co-determinants and risk factors must be inferred from data gathered on each outbreak victim through case investigation	• information on co-determinants (e.g., allergies, demographics, auto-immune disorders, medications) can be accessed from the health	➢ Risk factors related to an outbreak can be more accurately and quickly defined, to aid in containment measures

Scenario: Outbreak Management		
Without an EHR	**With an EHR**	**Benefits**
	records of outbreak victims	

Scenario: Alert Management		
Without an EHR	**With an EHR**	**Benefits**
• Alerts will generally be restricted to public health staff and staff at selected institutions	• With the benefit of more specific and comprehensive data on risk factors from EHR systems, more focused alerts can be sent to providers whose clients are at greatest risk	➢ EHR information can be used to tailor alerts to clinicians for their patients who are most at risk

Scenario: Disease Reporting		
Without an EHR	**With an EHR**	**Benefits**
• Physician and hospital staff must transcribe data to report infectious disease cases to public health authorities.	• Reporting to public health of notifiable cases occurs as a by-product of capture of case information by providers	➢ mandatory reporting requirements for clinicians and labs can be met by existing EMR / CIS systems by defining appropriate trigger events and using the EHR infostructure to send the data in near real time to the shared PHS repository
• Providers encountering a case of notifiable disease use a variety of fragmented channels (phone, FAX, etc.) to notify public health authorities	• Mechanisms routinely used by providers to access patient data are also used to report notifiable disease cases	➢ for those clinicians without local EMR or CIS software, integrated EHR viewers can be readily augmented with automated versions of current paper forms, simplifying reporting, improving the timeliness of reporting, and ensuring the data is captured in a standardized reusable format

3.2.5 Telehealth

Telehealth is defined as the use of information and communication technologies to deliver health services over distances in contexts where the providers and clients are in separate locations. Telehealth has evolved into a significant enabler of healthcare service delivery in Canada, both as a means of providing health services and education to persons living in remote areas of the country, and as an effective method for monitoring patients in the home setting in urban and suburban environments.

As technology capabilities have evolved to provide more access through Internet and satellite-based communications channels, telehealth has largely focused around: video-consults between specialists and patients in remote settings, tele-education for both service providers and clients, and on teletriage. Teletriage is defined as the availability of specially trained nursing and medical staff teams located in call centres to provide triage services and over-the-phone consults for the public at large. Services offered in these settings focus on helping people deal with health issues where they live and work, and to help them determine if a visit to a healthcare provider is necessary.

There have been some significant developments in the area of bio-metric monitoring from homecare settings, but this technology is far from pervasive across the country. Nevertheless, so called tele-homecare initiatives are emerging in many industrialised countries and are increasingly being used in Canada. Teleradiology has also emerged as an effective application of ICT in healthcare, with a strong business case supporting the sharing of diagnostic imaging and empowering the collaboration of care providers and patients. At the very sophisticated level, there have been remote tele-robotic surgeries performed, and as this technology is proven it is expected to become more common, however at this time, it is considered to be highly specialised and in its infancy.

In most cases, the evolution of Telehealth as a new delivery vehicle for health services has not been done in the context of the mainstream of conventional health care services delivery. This is largely due to:

- the inherent cross-organisational nature of the services being delivered through Telehealth solutions;
- the specialized technologies and facilities required;
- the need for funding outside of the conventional health funding models;
- the willingness and availability of health providers to work within the constraints of such a program;
- the non-traditional reimbursement models required for participating health providers.

As a result, Telehealth services provided today are typically poorly integrated with existing organisational structures, governance, processes and information system infrastructures. A good example of such challenges exists with the scheduling processes involved with Telehealth events. In a Telehealth event, the scheduling of facilities, medical staff, teleconsultation devices, video workstations and clients will inherently involve resources located in multiple organisations, located in different places and often times operating under separate authorities and governance bodies. Sometimes involving locations and staff operating under different sets of laws and regulations in cases where jurisdictional borders are being crossed. To support scheduling properly in this context, an application needs to be able to integrate resources and schedules from all the point of service involved in the Telehealth event or minimally to be able to record information about all of them.

The applications typically deployed to manage scheduling in any single point of service, are not built to meet these kinds of requirements. As a result, telehealth events are not being scheduled within existing physician or organizational scheduling applications which in turn creates all sorts of headaches and ultimately limits the usage and accessibility of Telehealth based services for people that really need it. Most importantly, this also means that contextual clinical data related to patients is not provided or captured electronically as part of telehealth encounters. This lack of integration is detrimental to the value of the EHR as service events provided via Telehealth are not easily publishable to an EHR Infostructure as long as they cannot be collected in an information system.

To be sure the EHR for a patient is complete and reflects all encounters with the healthcare system, Telehealth applications need to be better integrated into the EHR environment or the use of the EHR must be better utilized to complement telehealth as the service modality of choice. The same demographic information, clinical data, orders and results, and event history that are available to a health service provider in more traditional settings should be available (and be contributed to) in the context of Telehealth service provision. In this sense, Telehealth should be viewed as just another method of health service provision.

To illustrate the impact the EHR can have on Telehealth, consider the following examples:

Scenario: A dermatology video consult between Lutselk'e NWT with the patient and a nurse practitioner present, and a specialist in Edmonton, AB		
Without an EHR	**With an EHR**	**Benefits**
• Nurse practitioner sets up the video conference at the remote site and prepares the patient for the imaging needed for the consult • Specialist uses faxed or printed paper forms to review the basic client information for the referral, then connects to the remote site • Specialist performs the video consult relying on the patient and the nurse practitioner to provide information to assist in a diagnosis and appropriate course of treatment • Specialist concludes the consult with an analysis, prescription of medication, and patient compliance instructions delivered verbally, with both the nurse practitioner and the specialist recording in their paper charts • The specialist faxes copies of his hand written notes, orders, and prescription to the remote site	• In addition to the setup of the video conference session, the nurse practitioner at the remote site accesses the EHR record for the patient using an EHR enabled EMR application or using an integrated EHR viewer • The specialist located in Edmonton does the same using his local CIS application • Both providers familiarize themselves with the recent encounter history and clinical notes of the patient, current medications and recent test results, viewing the same information even though the applications they use are quite different and the data comes from at least two different jurisdictions • The specialist consults with the patient, confirming key information presented in the electronic record • The specialist records the diagnosis, orders, and prescriptions electronically in their local application, and this information is now	➢ Improved confidence by all participants in the diagnosis and the appropriateness of the physician orders and approach ➢ Timely, accurate, and consistent representation of information at both locations, regardless of where data was originally captured ➢ Even if only an integrated EHR web viewer is available at the remote location, the entire encounter as well as the new prescription and orders are available electronically, and in this situation may be printed at the remote location, a significant improvement over faxed images of hand-written notes

	available to the nurse-practitioner at the remote location, allowing local printing of prescriptions and other supporting documentation • The EHR for the patient is updated with information from two concurrent service delivery events, each with its own location and service provider present	

Scenario: Teletriage		
Without an EHR	**With an EHR**	**Benefits**
• A person calls the 1-800 tele-triage centre number, providing identifying information • The triage nurse takes the call, interviewing the person for the reason of the call and then taking the caller through some triage pathways to assess the nature and urgency of the situation • The triage nurses makes a recommendation on the course of action for the caller, including the need and urgency for a follow up with an appropriate health service provider • The nature of the call and the determination made is logged • Depending on the jurisdiction rules and requirements, the caller may or may not need to provide positive identification. In the cases where they do, the triage nurse is able to access information from any previous contacts by this client to the tele-triage centre	• In the case where the patient is positively identified[9], the triage nurse (in this specialized role) is authorized to have access to the EHR record for the caller using their EHR enabled call management application or an EHR integrated viewer[10] • The triage nurse has access to recent encounter history, drug profile, test results, and if necessary, imagery for the caller • The call to the triage centre and the resulting recommendation becomes part of the EHR	➢ The teletriage nurse is better able to direct the triage pathway for the caller, quickly confirming information presented from the EHR and establishing context for the call (for example: a recent discharge from hospital) ➢ It is possible to assess results of the use of the teletriage, for example by correlating teletriage recommendations for access to health services, allowing measurement of reductions in emergency admissions or conversely alerting care providers to the fact that a patient never presented for subsequent care even though recommend by the teletriage consult.

[9] This scenario makes a very strong case for requiring positive identification wherever possible in the interests of providing the best possible advice to the caller and to ensure patient safety.
[10] Providing that jurisdictional privacy / security / and consent requirements are met.

Teleradiology is considered as an extended virtual diagnostic imaging department that encompasses available physical and human resources over a wide region to support remote diagnostic procedures and patient management.

Scenario: Teleradiology		
Without an EHR	**With an EHR**	**Benefits**
• Patient identification may provide information on any previous encounters using the specific teleradiology application.	• The teleradiology application accesses the shared Client Registry services to assure the client referenced in the consult is the correct person • Demographic information needed for the consult are presented in the application via integration with the EHR, or by using an integrated EHR viewer	➢ Positive identification of the patient is achieved through the Client Registry EHR service, even if the client has not received teleradiology services before. ➢ Clinically relevant demographics information is made available to the TR application before and during the consult
• Information to support verifying the providers participating in the consult must be kept by the TR application • Each provider participating in the consult must keep their own records of the encounter	• The provider's identify can be verified by access to the shared Provider Registry EHR service • The encounter(s) are automatically recorded as an event in the EHR	➢ Providers eligible to participate in a TR consult do not need to be pre-identified to the TR application, and this information does not need to be managed and synchronized over time ➢ Other users of the EHR can be confident that all encounters, including TR consults and associated results, are incorporated in the client's event history
• Notes are exchanged over the teleradiology link and persisted in the teleradiology application's record of the event	• Notes exchanged or used in the context of the consult may be inserted directly into the client's EHR	➢ The results of the TR consult are available to the client's family physician and other clinicians responsible for providing services to the client, improving the quality and consistency of service delivery

3.3 THE PROPOSED SOLUTION

In order to address all of the business requirements of an EHR, and also to meet the design principles that were described in the business and socio-economic drivers section, *Infoway* proposes a peer-to-peer connected network of interoperable electronic health record solution infostructures deployed across Canada.

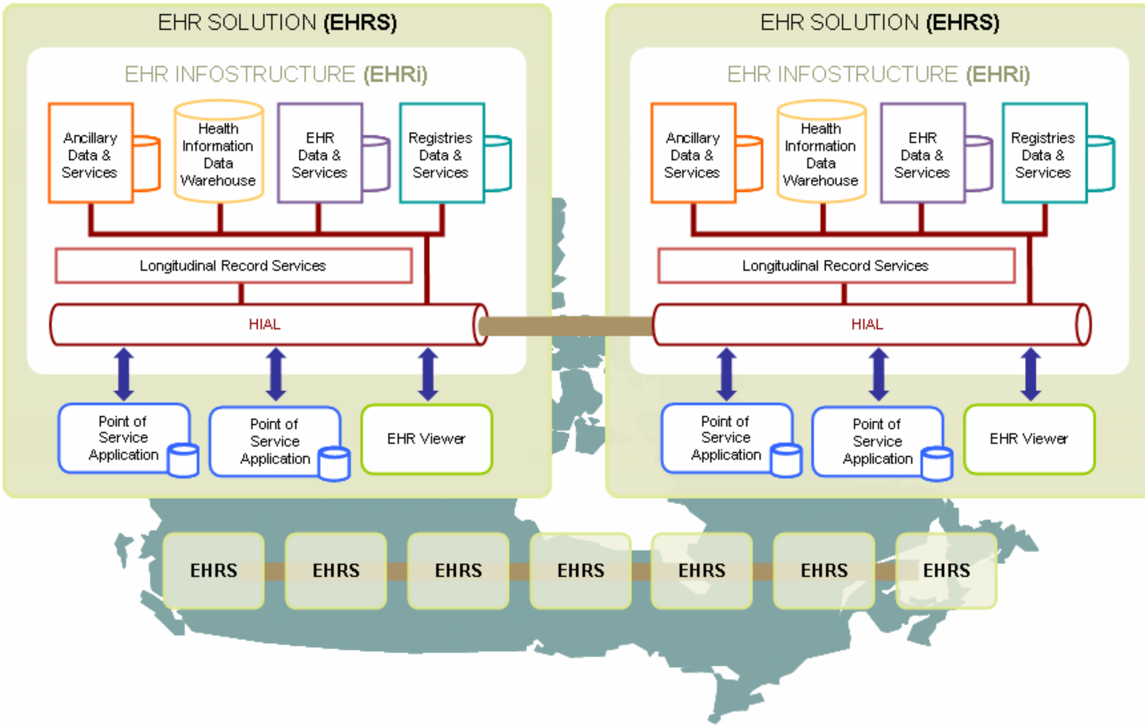

Figure 3-6 The Proposed Solution

3.3.1 Overview of diagram

The above diagram presents a conceptual view of the components of any EHRS. It also represents two EHR infostructures and shows how they interconnect with one another through the services of the HIAL. This capability to interconnect EHRi's across the country enables this vision of a peer to peer network of interoperated systems. These interoperated systems could exist at different levels in any province; they could exist at the local level, at the regional level, at the provincial level or even at the national level to meet requirements of certain healthcare organizations like the military, veterans' affairs or aboriginal communities. Each EHRS would enable communications with a given set of operational systems covering a defined geography of health points of service. Health points of service include clinical software applications used by patients/clients or caregivers from homes, business offices or points of practice. Once connected to any one of the EHRS implementations, these points of service applications have secured, authorised, and audited access to all shared EHR information available across the network.

3.3.2 Components

Within one EHRS, an EHRi will store, maintain and provide access to shared EHR data about patients/clients that have had access to health services in the jurisdiction where it exists. This EHRi will receive data from Point of Service applications used in healthcare organizations or directly by caregivers and patients/clients. Conversely, it will also provide data back to the same Point of Service applications for use by other caregivers involved in the circle of care of any given patient/client at any point in the future.

The EHRi is composed of multiple classes of service that need to participate and interact with one another in a coordinated fashion, namely:

- The Longitudinal Record Services (LRS) which represent a grouping of capabilities that acts as the kernel of the EHR Infostructure. It is namely responsible for the orchestration of services in order to realise transactions. It is also in charge of providing a coordinated and centralised view of what data is in the EHR for any single patient/client. In other words, it is the engine that coordinates and executes any transaction that needs to have a longitudinal perspective of the clinical data of a patient/client.
- The Shared Health Record repository maintaining encounter history data as well as clinical data not otherwise maintained in specific domain repositories; examples of classes of data could include encounter or visit summary documents, referral orders and notes, diagnosis data, observations, care protocols, care plans;
- Registry systems providing data and resolution services for persons or entities needing to be identified uniquely in the context of a transaction to an EHRi. Examples include: Patients/clients, Providers, Service Delivery Locations, Organisations and potentially others relating to the application of security frameworks such as user, PoS applications, Provider Role, End User Role;
- Domain repositories that store, maintain and provide subsets of clinical information that pertain to the clinical picture of a patient/client such as drugs or medication profiles, laboratory orders and tests results, shared diagnostic imaging orders and results including image repositories (a.k.a. PACS – Picture Archiving Communication System);
- A HIAL made up of common services and communication bus to enable a high level of abstraction and independence between PoS applications and an EHR Infostructure. It provides reusable services that can be shared by any component of the EHRi. It also acts as a centralised entry point or connection point for any PoS application to interact with an EHR Infostructure or for multiple EHR Infostructures to connect to each others.
- Point of Service applications represent all the systems used by healthcare organizations or caregivers that store, manage and or provide access to clinical data for patients/clients. PoS applications interact with one EHRi in a given jurisdiction. This interaction is accomplished by way of messages being exchanged between the applications and the HIAL.

3.3.3 Objectives

Here are some of the key objectives pursued with the proposed solution:

- Enable an open and standards based architecture that can address the key performance, robustness, economic, semantic as well as the privacy and security challenges associated with the deployment of EHR Solutions in Canada.
- Create a framework where solutions can evolve progressively to meet the ultimate goal of a cross-jurisdictional network of interconnected EHR Infostructures. This framework needs to allow for solutions to concentrate first on sharing clinical information between a limited number of participants and then grow to large and wide ranging scales of sharing health organisations.
- Clearly delineate where standards are required for interoperability.
    - PoS applications must be able to rely on standards based communications to connect and obtain services from an EHRi;

- Security, privacy, transactional, policy and administrative meta-data must be exchanged and interpreted similarly between EHRi's;
- EHRi's must be able to communicate by way of exchanging messages between each other across any number of jurisdictions;
- Semantic interoperability principles, guidelines and standards must also be established so that all participants in the EHRS can agree on the semantic meaning of the shared information placed and accessed in the EHRi.

• Define the interoperability needs between the core components of an EHRi (LRS, Registries, Shared Health Record, Domain Repositories and Ancillary Services) so that they can work in a coordinated fashion to deliver EHR services.

• Establish a reference framework to allow for discussions and definitions to take place on the operational requirements of an EHR solution, including:
  - Policies, guidelines and agreements within the area of coverage where an EHR Infostructure would operate and where multiple PoS organisations would be in scope;
  - Policies, guidelines and agreements for the organisations and entities operating different parts of an EHR Infostructure. For example the client registry service may be operated by a different department or organisation then the diagnostic imaging EHR domain.
  - Policies, guidelines and agreements between jurisdictions and governing authorities that maintain and operate EHR Infostructures.
  - Policies, guidelines and agreements with external governing authorities that are touched by the scope of an EHR service in a Province/Territory. This could include any regional health authority, a Privacy Commissioners Office, an e-Government initiative authority, a college of physicians, etc…

3.4 EHR GENERATION ROADMAP

3.4.1 A common language for generations of EHR capabilities

3.4.1.1 Gartner Generations Model for CPR Systems

This section presents the Gartner Generations Model for CPR Systems. This industry recognized model is used as a basis to establish a common language to represent generations of capabilities for an electronic health record capability. This model is published as part of a research note called "An Interoperability Road Map for the Computer-Based Patient Record System" by Wes Richel (ID Number: G00129914) from Gartner, Inc. (www.gartner.com). This industry research paper was published on December 29th., 2005.

Gartner uses a generation model to track the progression in capabilities of CPR systems (see the following Figure and "The 2004 Gartner Computer-Based Patient Record System Generation Model").

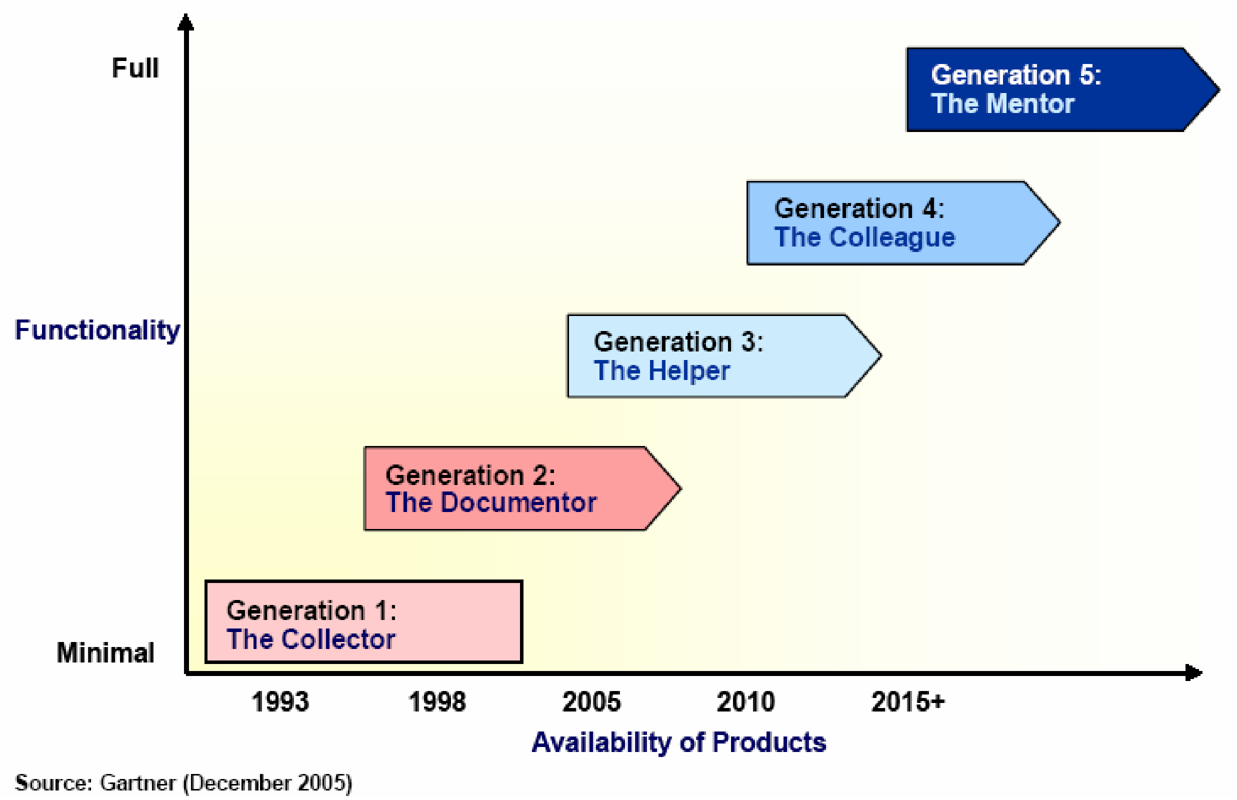

Figure 3-7 The Gartner Generations Model for CPR Systems

Table 1. Interoperability Requirements by CPR System Generation

Generation	Requirement
1 (Collector)	Accept computer-processable data from admitting and registration systems. Accept data from lab, pharmacy, radiology and other clinical or transcription systems.
2 (Documentor)	Send computer-processable billing data to patient accounting systems. Send reports of visits and procedures documented in the systems.
3 (Helper)	Accept computer-processable clinical results and medicine-administration data. Send computer-processable orders. Accept computer-processable order status information for progress tracking. Send computer-processable medication administration. Accept link to PACS or incoming clinical data to permit the user to link to that third-party system to view or manipulate the image.
4 (Colleague)	Accept new rules and treatment protocols in computer-processable form for review and possible incorporation into the workflows and decision rules of the CDO.
5 (Mentor)	This generation is sufficiently far in the future that it is difficult to forecast any interoperability requirements unique to the generation.

Source: Gartner (December 2005)

At its optimal evolution, the CPR represents a comprehensive knowledge management system that tightly integrates all the core capabilities for healthcare delivery, with an emphasis on order management, clinical decision support, clinical workflow, and controlled medical vocabulary.

CPR vs. Electronic Health Record
In the U.S., the term "electronic health record" (EHR) has been used in several senses, one of which is equivalent to the CPR. Gartner continues to use CPR to emphasize that the system must be more than an electronic file cabinet. EHR is used in a different sense globally.

3.4.1.2 Context for use of the Gartner model in the EHRS Blueprint

The model proposed by Gartner focuses on a generic definition of capabilities which is inherently targeting the operational needs found in facilities and PoS where healthcare services are delivered. The EHRS Blueprint focuses on the definition of an information service residing outside of any single facility and providing a shared EHR available to caregivers and people living in a defined geography. This community level positioning of the EHR impacts the amount of capabilities expected in an EHR Infostructure as per the Gartner model. While in a single facility, one could hope to address the challenges of implementing a very advanced CPR set of capabilities that would engage with the theory of Generation 3, 4 or 5 described above. The definition of EHR capabilities, as per the expected early state implementations in coming years, focuses on the more simple and basic capabilities of Generation 1 – The Collector and Generation 2 – The Documentor. Later in time, more advanced capabilities addressing decision support, automation of business and clinical workflows and intelligent agents acting as mentors to support caregivers or clients are also expected to appear as new version and evolutions of EHR solutions. The ability to deploy functions of CPR that have a broad and holistic view of the clinical data on a person that crosses the continuum of care (between facilities and POS) and has a large time span (cradle to end-of-life) is seen as very different and new. The EHRS Blueprint as an architecture defines EHR infostructures as the foundation to enable the development of this new world.

That said, the tangible benefits pursued today in EHR Solution initiatives reside in the more simple early generations (Collector and Documentor). While the objective is to enable this future, solutions being deployed today are focused on compiling client clinical data and making that data available for viewing for health professionals involved in delivering care to clients in different settings..

3.4.2 Incremental Approach

As EHR solutions emerge in Canada, different jurisdictions will take different paths to achieve full featured EHR Infostructures. Several different business drivers will drive the planning and definition of the evolutionary roadmap to EHR solutions in any given jurisdiction. These business drivers include:

- Jurisdictional health spending priorities;
- Availability of external funding to support such initiatives, such as the funding being deployed by Infoway;
- Governance organisations human resources capacity to execute these large IT projects;
- Availability of reusable assets in terms of jurisdictional level systems that can play an active role in an EHRi. Examples include large history databases of health events, claims management systems that can be repurposed to play a role as EHR data services, eGovernment reusable knowledge, assets or operational infrastructures such as enterprise level authentication and authorisation services, and others;

- Readiness and appetite of caregivers to use such solutions;
- Readiness, appetite and capacity of operational level PoS organisations to engage in these initiatives;
- Availability of clinical data in electronic format inside the PoS organisations that can be leveraged for sharing in the context of EHR solutions.

While every jurisdiction in Canada will come to a different compromise in balancing the pro's and con's of such business drivers, it is expected that a lot of similarities will exist between the roadmaps of each F/P/T solutions.

A key factor in establishing the roadmap to a comprehensive EHR solution is the ability to focus on a manageable incremental approach that delivers value for health professionals and clients at every step of the process. Focusing on a small steps, quick win approach is always a good idea but can become especially hard to do when considering the inherent multi-organisation, multi-layer structures that make up the health system in every jurisdiction. Several factors come into consideration when defining each one of those steps:

- The geopolitical scope of any single initiative, in other words, what population is it going to serve;
- The number and profile of PoS organisations involved;
- The types of health services delivery settings (primary care clinics, acute care hospitals, community care centers, physiotherapy, etc…) that will be involved as providers of data towards the EHR;
- The types of health services delivery settings that will be involved as users of data towards the EHR Business Service;
- The number and profile of health professionals who will be involved as end-users of the solution;
- The services and capabilities that will be brought to fruition in the EHR Infostructure;
- The expected volumes of health service delivery events that would be able to rely on the EHR for information sharing;
- The expected volumes of clients and data having to follow corridors of service to different geographical locations and PoS organisations in the context of distinct episodes of care and the impacts this can have on an ability to represent comprehensive integrated views of a client EHR;
- The profile for these volumes of transactions: expected transaction peaks, etc…;
- The technology assets and people already in use in PoS organisations for interfacing between systems

The definition of each step needs to focus on a thorough rationalisation of the balance between:

- The clinical needs or pains of health professionals that can be helped or solved by better sharing of information across PoS organisations through an EHR solution;
- The financial and human resources capacity of both the governance and operational organisations that run the health system in scope for an initiative;
- The expertise, human resources capacity and technical advancement of private sector vendors that serve the health IT market in scope for an initiative;
- The technical feasibility of a given solution in light of the integration requirements of a project initiative.

The rest of this section will present a set of four representative technical states for an EHR Solution. For each state represented a short discussion of key integration challenges is presented. Those are shown only as examples and not necessarily as a the only applicable roadmap.

State 1 - No EHR Services

Here, a jurisdiction moves forward and starts deploying jurisdictional level services such as a client registry and a clinical drug (or pharmacy) information system. The ability to manage large scale deployments of these services, in terms of the PoS applications that could be connected is limited. Any changes or evolutions to the services offered in the client registry or drug information system will impact and require changes with every PoS application that is connected. The clinical value comes from independent services being made available, it is hard to support any kind of integrated view of the information. Caregivers have to deal with multiple separate applications or viewers to gain access to different types of services and data.

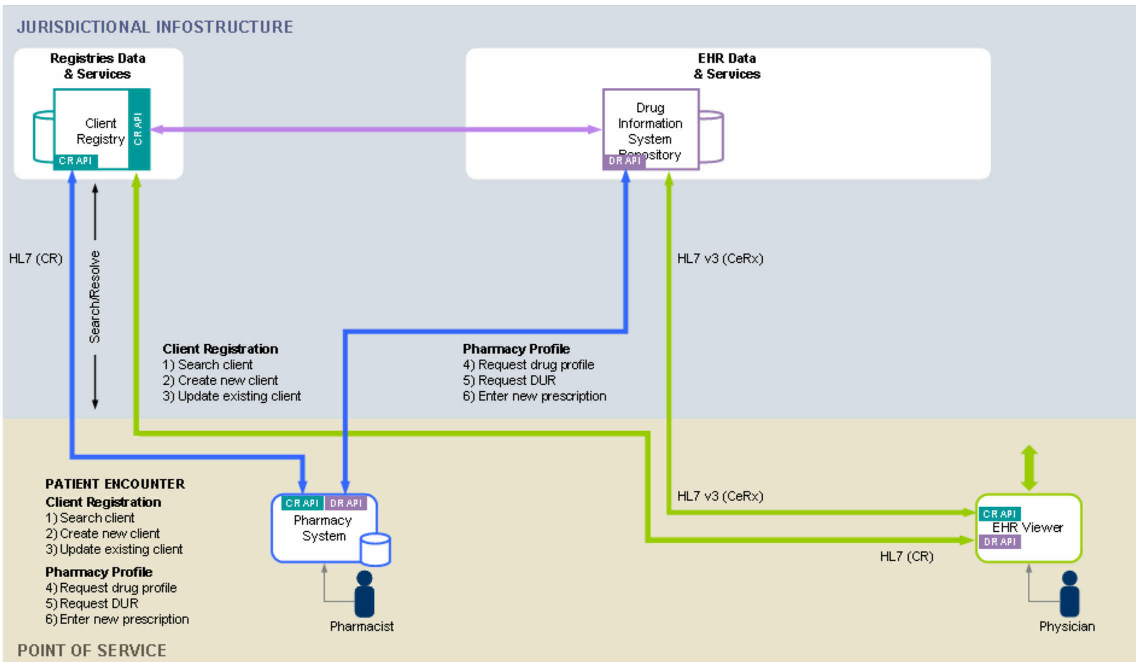

Figure 3-8 No EHR Services

Each Jurisdiction Infostructure level system uses patient and other required strong identifiers (e.g. provider, encounter) based on point-of-service generated IDs (e.g. MRNs). The CR-EMPI source systems make the CR-EMPI aware of client identifiers. The Point-of-Service applications and Infostructure systems query the CR EMPI for these identifiers in order to access data within any Infostructure System. The level of queries and maintenance of MRNs in the EMPI is not scalable to hundreds or thousands of Point-of-Service systems. There are performance issues accessing CR/EMPI for every Drug system interaction.

State 2 - HIAL without LRS

Here a set of common and communication services is brought in the form of a HIAL implementation. This creates a layer of independence between the PoS applications and the services offered by the client registry and drug information system. PoS applications being connected still have to be aware of the target systems they are trying to reach (i.e. CR or DIS). This state allows to accelerate and ease the transition for connecting any PoS application that is trying to access the services offered by the client registry or by the drug information system. It becomes easier to connect more source systems feeding data into the client registry or the drug information system. However when accessing EHR information, PoS applications have to handle the intricacies of managing control and data access logic required to talk to the services offered in the EHR Infostructure. The clinical value comes from the ability to extend the implementation scope by easily integrating more PoS applications acting either as sources of information or as users of the information maintained in the client registry and drug information system.

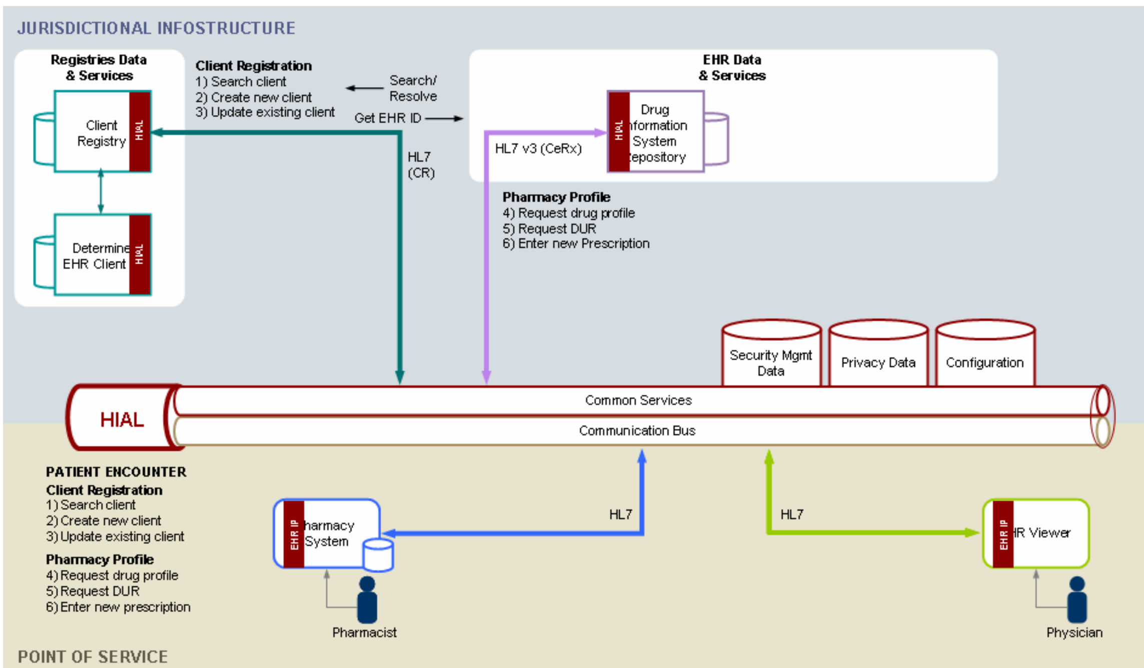

Figure 3-9 HIAL without Longitudinal Record Services

The Client Registry system "determines" a global unique ID **(EHR ID)** for patients. The **Drug Information System (DIS)** will use the EHR patient ID to store prescribing and dispensing data. Point-of-Service applications query the Client Registry and obtain the EHR patient ID and will use this ID as a token throughout the entire business transaction. This model eliminates the need for communication between the DIS and CR and reduces the transactions to the CR to one per business transaction

State 3 - First Level LRS

Here a new service (the LRS) is created above the HIAL and as part of the EHR Infostructure to start managing and coordinating transaction processing to the EHR. PoS applications being connected to the EHR do not have to worry anymore about an understanding of the individual system components that make up the EHR Infostructure. In this picture these are still limited to the client registry and drug information systems, but adding services to the EHR has now become a lot less challenging and much more transparent for the PoS applications trying to use them. Interfacing with PoS applications is strictly limited to the interactions managed with the HIAL. The clinical value comes from the ability to increase the deployment scope of PoS applications faster and moving into large scale deployments, so getting more PoS organizations and users involved. The clinical value also comes from creating for the first time a capacity to provide an integrated and combined view of the clinical information maintained in the client registry (demographic data) and in the drug information system. It also enables a platform where more services will be added in a seamless fashion for end-users.

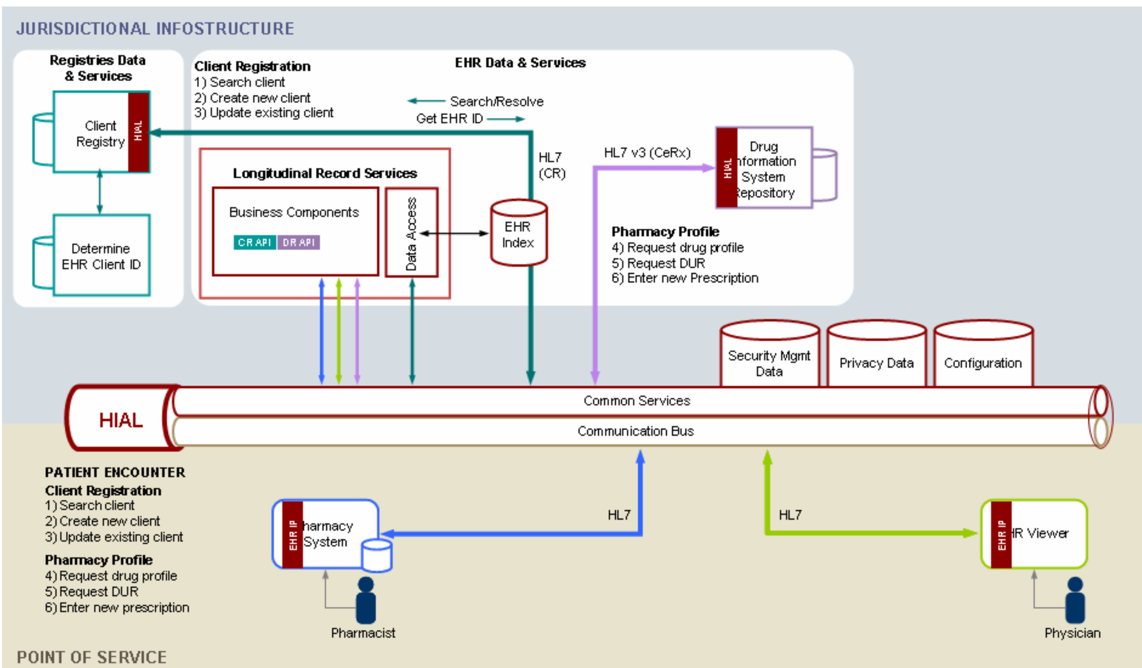

Figure 3-10 HIAL with first level Longitudinal Record Services

The Client Registry determines a global unique ID (EHR ID) for patients. The DIS will use the EHR patient ID to store prescribing and dispensing data. EHR services will use the CR to map any local MRN found within transactions to the corresponding EHR client ID. The PoS applications do not necessarily have to be aware of the EHR client ID or they can continue to provide this ID themselves after querying the CR (compatible with prior model).

State 4 - Full featured EHRi

Here, all the services of the EHRi have been deployed and are available through a unique set of standards based interaction mechanisms supported by the HIAL. New services can easily be added or existing services can be modified in the EHR Infostructure with virtually no impact to the PoS applications that are connected. PoS applications can be connected quickly and are provided with a true business level service where they are isolated form the complexities of gathering all the data necessary to form a comprehensive response when accessing a client's EHR. Clinical value is increased as services are added in the EHR Infostructure. Applications or viewers connecting to the EHR Infostructure can tap into a truly integrated view of the clinical data available for a client. Privacy and security services are applied consistently in accordance with the privacy and security policies applicable to each jurisdiction. Data is comprehensive and can span multiple Infostructures, in that sense the more complex healthcare cases which typically end-up following corridors of service to different locations for specialized treatment are well served by the EHR.

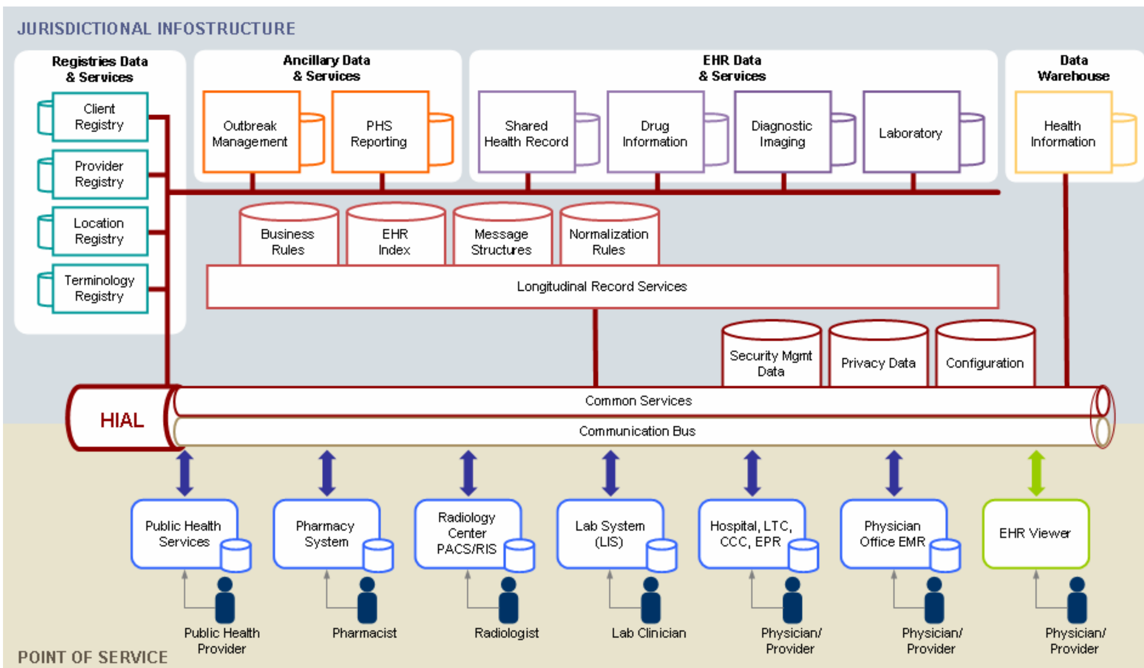

Figure 3-11 Full featured EHR Infostructure

The client, provider, location registries and EHR Services determine (respond with) global unique ids for patient, providers, encounters and other required strong identifiers. All Infostructure systems use these unique IDs to store clinical data about a person. The EHR Services will map any local ID to the corresponding EHR ID. The Domain services (DIS, DI, Lab) systems rely on the EHR Services to ensure that the necessary EHR IDs are provided with every transaction

3.4.3 EHR Infostructure as a service

The EHR infostructure provides a mechanism to support the secure, appropriate, timely sharing of clinically-relevant, person-centric health information between health service providers who share the same patients/clients. The infostructure supports sharing between these providers despite the fact they may be using different information systems and technologies, in different care settings, and at different locations. As long as the PoS application knows and supports the necessary interface standards to interact with the EHRi, it can contribute to, and access, the shared “virtual” EHR. In this sense, the EHRi provides an information-sharing “utility” that each application connects to uniformly.

The EHRi, as a utility, supports information sharing between applications without requiring the applications to “know” about each other or to have developed an interface between each other for a particular purpose. In the course of using an EHRi-enabled PoS application, certain predefined events cause the application to interact with the EHRi, either sending a subset of information relevant for sharing to the EHRi, or requesting the same types of information from the EHRi. The EHRi essentially “holds” the shared information for this purpose, without having to anticipate when or how the information will be needed after it is place in the shared repositories.

In this manner the EHRi provides interoperability between applications, and information sharing between providers, at many levels. Because the information is person-centric, and used primarily to support direct provision of health services, the most common use of the shared information will be between providers within a regional or local set of health service delivery organizations. The providers may be in the same organization but in different departments, locations, or programs. They may belong to different organizations, or different health disciplines, but they all share the same primary focus, a particular patient/client.

This EHRi service interface hides the complexities of the underlying configuration of the infostructure from applications that participate in the infostructure. The infostructure knows how or where the shared information is held, and it manages this shared information to ensure that the content is associated with the correct patient, provider, and service delivery location. Because each implementation of an infostructure must be configured to meet the specific resource requirements and constraints of a particular region or jurisdiction, the EHRi is not a closed application. It is a collaboration of applications based on the EHRS Blueprint, and configured in a Services Oriented Architecture to provide consistent behaviour when interacting with external applications.

Because each EHRi implementation is based upon the EHRS Blueprint, this ability to share information can extend beyond a particular region to enable sharing between service providers anywhere in a province or territory, or between providers in other jurisdictions that also have implemented EHR infostructures.

4 CONCEPTUAL ARCHITECTURE

4.1 OVERVIEW

The conceptual architecture is the highest-level view of the EHRi architecture, which is focused on answering the "what" question for the definition of an EHR Solution. This includes what work processes are covered by the solution, what data is in the system, what system services are required, what communication is required to make the solution work. The view in this section is provided at a conceptual level and does not attempt to decompose the systems described to a level that could be used to develop specific components, nor does it make any considerations or assumptions about the physical location of servers or services or the actual technologies or application packages that could be used. It is primarily intended to give the reader a perspective on the scope of capabilities of an EHR Infostructure and define where key interoperability features and interfacing standards are required.

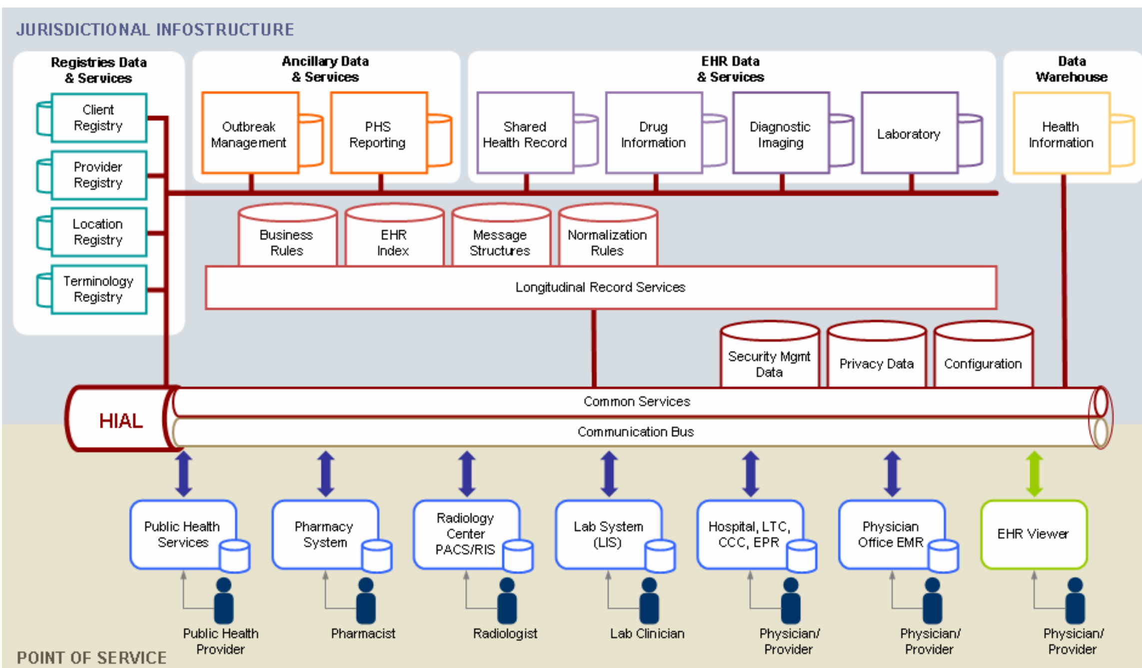

Figure 4-1 EHRS Conceptual View - Detailed

This section covers the EHRi architecture at its highest level, providing a first look at the key systems in the solution and how these components work in collaboration. The conceptual architecture is seen from the following points of view: Clinical Work Process Architecture, System Architecture, Information Architecture, and Integration and Deployment Models.

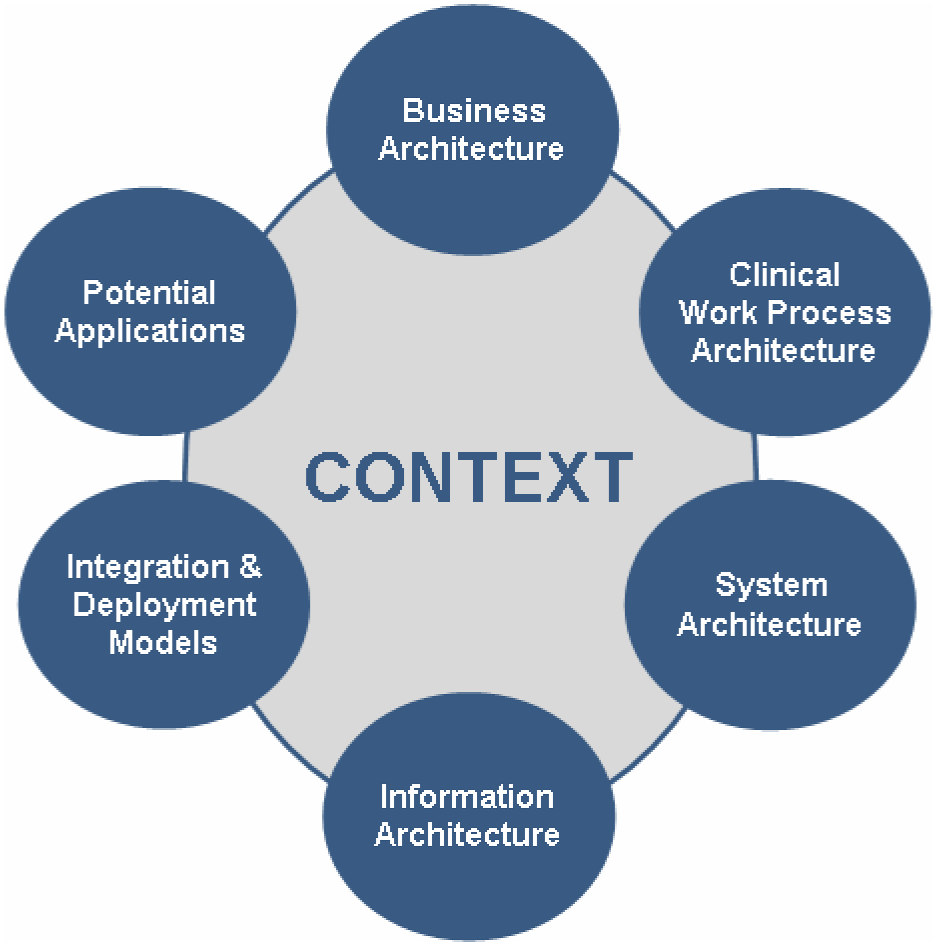

Figure 4-2 EHRS Blueprint scope

In the picture above, this section addresses the clinical work process architecture, system architecture and information architecture. This clearly shows that the architecture definitions are only a component of the scope of the EHRS Blueprint.

Clinical Work Process Architecture

The Clinical Work Process Architecture describes the business requirement use-cases and the role of the EHRi when positioned within the larger context of the Canadian healthcare enterprise, as well as identifying the other important systems and actors that interact with the EHRi.

System Architecture

The conceptual system architecture view describes the future state of the EHRS system components within the context of a Service Oriented Architecture (SOA). It is a given that intermediate solutions that meet these requirements can and will be deployed. The importance of this system architecture is that it establishes a strategic direction towards which all partial implementations will aim while still delivering specific short-term results.

Information Architecture

This view describes the different data domains and types of data that are contained in the EHRi repositories as well as the key types of metadata, clinical vocabularies, data persistence and data integrity requirements.

Technical Architecture

This section takes more of a technical perspective on the definition of key elements or foundations for the development and operation of EHR Infostructure solutions. It includes a definition of key functioning principles as well as a perspective on how commercial off the shelf software can be used to deploy an EHR Infostructure solution.

4.2 CLINICAL WORK PROCESS ARCHITECTURE

The Clinical Work Process Architecture contains the business requirements in use-cases that describe how health care providers will interact with the EHRi System. These use-cases were authored by medical experts working with the Blueprint team, and have been validated by practitioners and health information professionals familiar with EHR requirements and implementations. It is expected that as more detailed business requirements are understood, these use-cases will be added to, refined and elaborated on an on-going basis. Infoway is committed to the task of evolving the Pan Canadian EHR over the next several years and will provide the governance processes and technical mechanisms for authorized users and stakeholders to add to, change and republish the EHRS Clinical Work Process Architecture over time.

The structure of the EHRS Clinical Work Process Architecture uses the following hierarchy of constructs to express typical patient care scenarios from the highest business process level to a very granular level of detailed use-cases that can be realized as system design artefacts.

Business Process / Use Case documents	Description
• Life of Lamberts	An overview of health issues and interventions of the members of a fictional extended family who are the subjects of care in all subsequent use-cases. This use of a persistent set of actors is intended to provide commonality for discussion of information requirements, and to effectively illustrate the need for relevant health information to be captured and reused: o in many different care settings o across many different disciplines o over time.
o Storyboard	A one page high level use-case that, in narrative form describes: o the health services delivery context for each encounter, o who the principle actors are,

Business Process / Use Case documents	Description
	o the specific expectation for information capture and reuse across and between encounters, o the major outcomes expected from the use of this information. Within each Storyboard the patient may have one or more Encounters in different health care settings. The Encounters relevant to each Storyboard are included as references.
▪ Encounter	An Encounter (Clinical Use Case) describes in narrative form the interactions a patient has with a provider in a health care setting such as the Emergency Room, an Outpatient Clinic, a Physician Office etc.
• Clinical Activity	The Clinical Activities are the lowest level of detail that describes the workflow event step for each actor's (provider and patient) interactions with the Point of Service systems and information sent or retrieved from the EHRi System. The specific points where a PoS application interacts with the EHRi System are documented as EHR Interoperability Profiles (EHRIP). EHRIPs are the entry point for understanding the services provided by the EHRi System.

In summary the BLUEPRINT Use Cases:

- Are a first class of deliverables that are both contextual and informational.
- Describe the end-user actor actions and system functional requirements and assumptions for use of an EHR Solution.
- Establish when and how PoS applications are expected to interact with an EHRi System in the context of daily work activities for caregivers.
- Do not attempt to document all forms of potential uses of an EHR but rather are representative of the spectrum of use.
- Have broad enough scope to cover a large spectrum of healthcare and public health service delivery to achieve a representative set.

Consent Disclaimer

In many of these use-cases, the patients' consent regarding accessing and sharing their health information is obtained by an individual other than a clinician. The clinic receptionist, for example, is often cited as the person obtaining and recording consent. These use-cases are not meant to dictate who should appropriately obtain consent from patients. Rather, they were written to balance current common practice with the behaviours we might anticipate when the patients health information is available from the interoperable EHRS.

Life of the Lamberts

At the top level of the use-cases, the Life of the Lamberts timeline describes how different members of a (fictional) family interact with the Health Care system in different jurisdictions in Canada. The types of illnesses and medical conditions was selected to show how these kinds of patients would be treated by a broad range of health care providers in different clinical settings, over time, in a number of geographical locations across the country and how an EHR would be used to facilitate these interactions with different types of Point of Service systems. In general, these use-cases describe a 'future state' of the health system where a "Generation 2" EHR is able to function as a key decision support tool to healthcare providers in the delivery of health care services to patients.

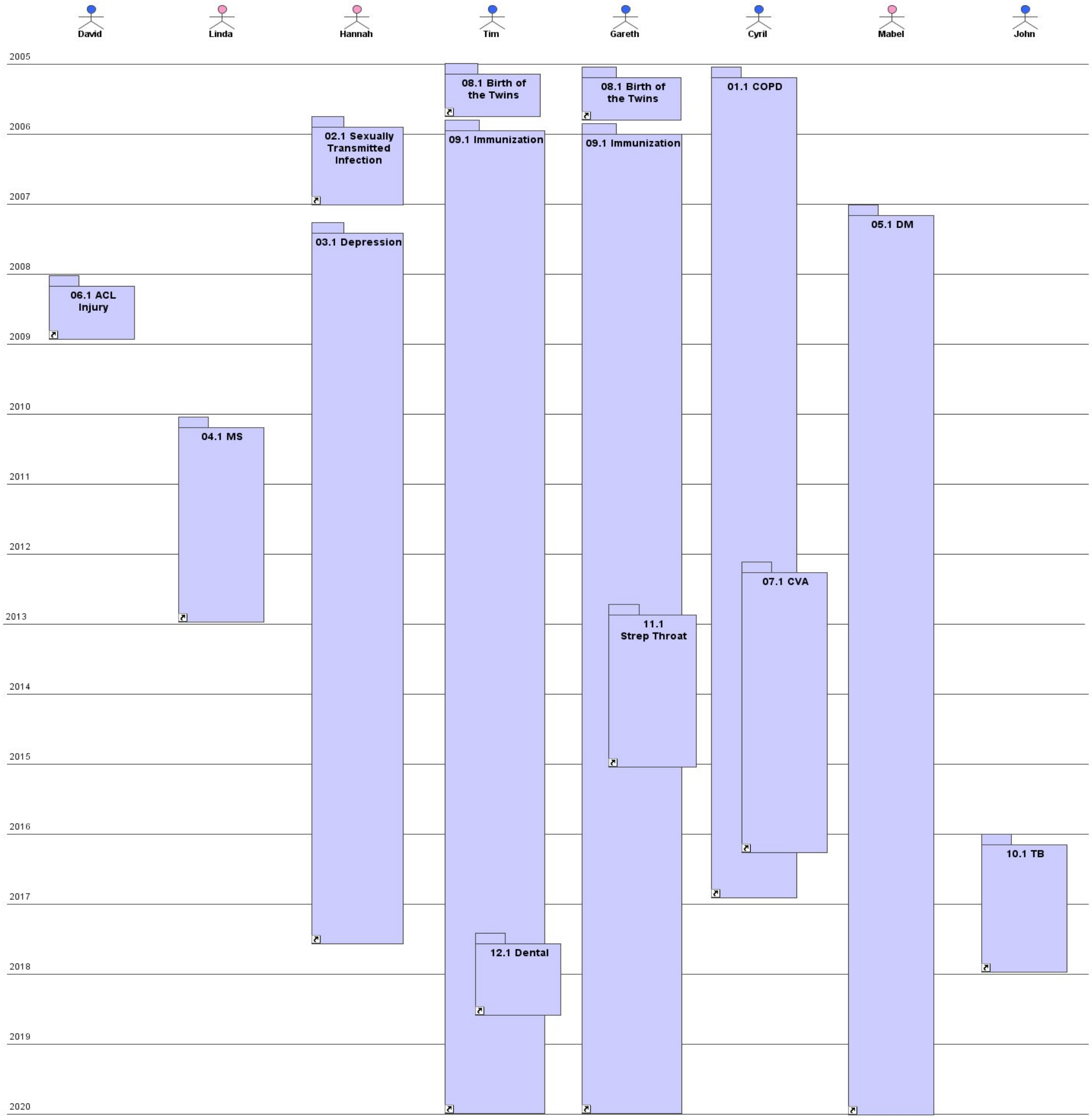

Figure 4-3 Life of the Lamberts Timeline

The Life of the Lamberts Timeline diagram describes the following medical conditions for the different members of this fictional family during the course of their lives. These use-cases emphasize the fact the EHR is a longitudinal record that will help providers see a current medical condition they are presented with in the context of the patient's medical history and other related encounters:

- ACL (Anterior Cruciate Ligament) Injury
- Birth
- COPD (Chronic Obstructive Pulmonary Disease)

- CVA (Cerebrovascular Accident - stroke)
- Dental
- Depression
- DM (Diabetes Mellitus)
- Immunizations
- Sexually Transmitted Infection
- Tuberculosis

Use Case Model

As stated above, the core business requirements for the Blueprint v2 are captured in a hierarchy of The Life of Lamberts Storyboards, Encounters and Clinical Activity use-cases. The following two use-case diagrams describe the actors who participate in the Storyboards and Encounter use-cases. The actors on the left are the providers who initiate the Storyboards and have overall responsibility of ensuring the patient receives the appropriate care while using an EHR. The actors on the right are the specialists and providers who perform discrete health services within an Encounter. Information from these Encounters is recorded in the EHR either directly or indirectly from the Point of Service systems these providers use.

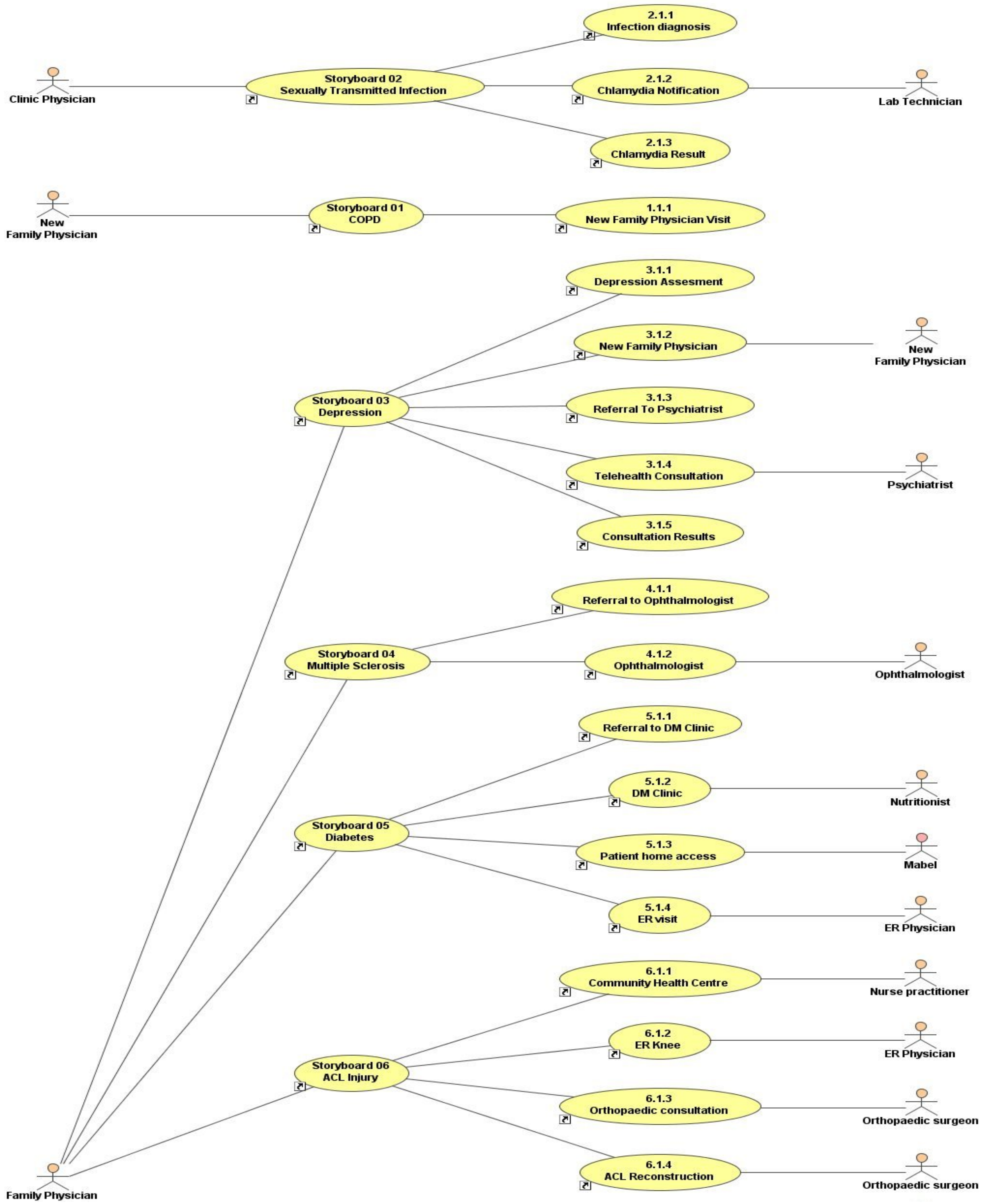

Figure 4-4 Use Cases Diagram – part 1

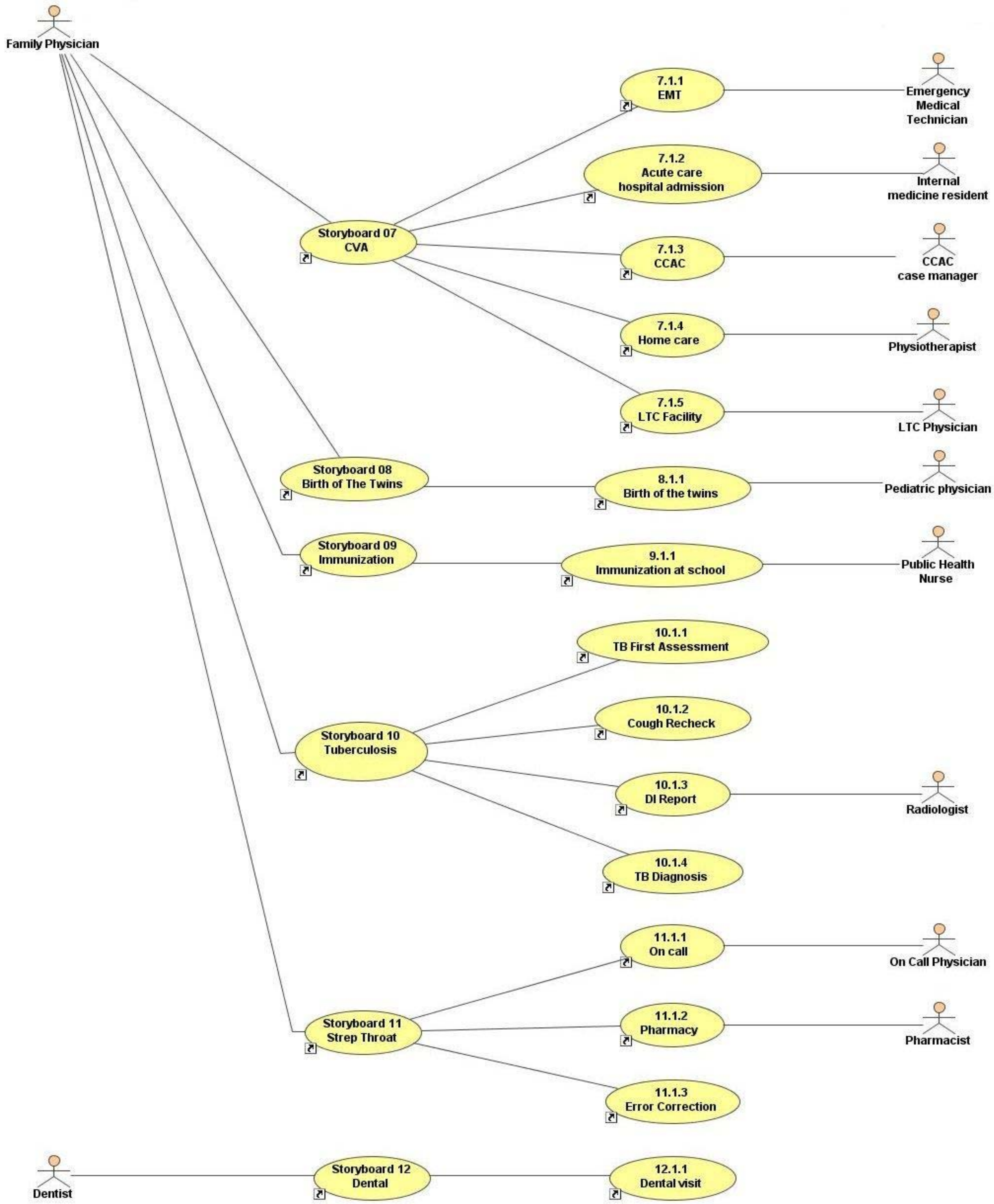

Figure 4-4 Use Cases Diagram – part 2

Methodology

The Blueprint project uses the HL7 HDF methodology as a guideline to gather business requirements into a set of use-cases at increasing level of detail and then realize those use-cases into a collection of high level system design documents. For this reason, the artefacts used to document the Clinical Work Process are expected to be reusable uniformly within established standards and structured software engineering methodologies, such as HL7 HDF, IHE and others. *See section 5.2.1 for more details on the EHRi System design and specification methodology guidelines.*

A summary of the HL7 HDF Chapter 2 – Requirements Documentation process is to:

1. Document Business Process: Dynamic Behaviour and Static Structure
2. Capture Process Flow: Activity Diagram
3. Capture Structure: Domain Analysis Model and Glossary
4. Capture Business Rules: Relationships, Triggers, and Constraints
5. Harmonize the Domain Analysis Model with HL7 Reference Models

4.2.1 Document Business Process

Storyboards

At the top level business process requirements are captured in Storyboards. Each Storyboard is a one page summary describing a scenario of related encounters, set around various health issues in the Lambert family. All the Blueprint Storyboards were completed, first to ensure the scope for the Blueprint project business requirements was set at the right level, and second to ensure complete coverage of the different types of health care settings where an EHR would be used. Each Storyboard references one or more Encounter use-cases.

Each Storyboard uses the following format:

- *<Title>*
- *< Narrative summary>*
- <Encounter document reference(s)>

Encounters

Each Encounter use-case elaborates the interactions between health service providers and patients as they progress through the health system events summarized in the Storyboard. An Encounter focuses on one section of the Storyboard and describes the health care setting, the type of provider and more details of the medical condition and diagnoses and treatments the patient receives. The use of the EHR by the provider is highlighted as well descriptions of the kinds of patient demographic and clinical information used both manually and electronically.

In addition to this one page narrative, each encounter includes some key assumptions and tables of the types of information used in the Encounter.

Each Encounter uses the following format:

- *<Title>*
- *<Clinical use-case document reference><Storyboard document reference>*
- *<Narrative detail>*
- *<Assumptions>*
- *<Tables> - Sets of tables describing the information types and the attributes used in the Encounter narrative detail.*

4.2.2 Capture Process Flow

Clinical Activity

Each Clinical Activity describes the Health Service Encounter in more detail. The document breaks down each sequence of activities into Health Service Event sections.

The introduction to each Health Service Event section documents the principle actor and the other actors and systems who participate in these workflow events as well as any assumptions that may apply.

Each Health Service Event section describes the workflow events an actor such as a provider follows in the care of a patient using the following table.

WORKFLOW EVENT STEP	POS ACTION	EHRI SYSTEM ACTION	EHR IP REFERENCE

The columns of the Health Service Event describe:

- Workflow Event Step
  The actions an actor takes either manually or with a Point Of Service System to deliver care to the patient.

- PoS Action
  The actions a Point of Service system take in response to the actors activities. In some cases the PoS fulfils the actor's requests. In other instances, the EHRi system is invoked.

- EHRi System Action
  The actions the EHRi System performs in response to the Point of Service actions to either put data into or list or get data from the EHR.

- EHRIP Reference
  The name of the interface standard document and section that describes the responsibilities of the Point of Service system while interacting with the EHRi System.

Each Clinical Activity uses the following format:

- *<Title>*

- *<Clinical use-case document reference><Storyboard document reference>*
- *< Narrative detail>*
- *<Assumptions>*
- *<Health Service Event section>*
    - *<Actors>*
    - *<Assumptions>*
    - *<Workflow Event Steps>*
    - *A tabular description of the actor and system actions*

4.2.3 Capture Structure: Domain Analysis Model and Glossary

During the course of the above activities, the EHR use-cases are analyzed for data structures and attributes used during the PoS actions and EHRi System Actions. These information structures are summarized and then correlated and aligned to equivalent classes and attributes in the EHRi Conceptual Health Data Model. This model has been developed using the HL7 Reference Information Model as a basis and represents a wide stakeholder input from all Canadian jurisdictions.

A glossary of terms is documented to capture each unique information concept as well as define the terminology used by the Blueprint project.

4.2.4 Capture Business Rules: Relationships, Triggers, and Constraints

The first level of EHRi system business rules are captured both in the EHR Conceptual Data model and at the points of interaction between the PoS systems and the EHRi System in high level design documents. The business triggers to invoke the EHR are documented in EHR Interoperability Profiles and their dependent EHR Communication Steps.

Note: EHR IPs and EHR Communication Steps are described in more detail in section 4.3.10 Interoperability Profiles

In summary, the Blueprint provides high level design requirements for the EHRi and interoperable EHR solutions in the form of Interoperability Profiles that:

- are stable and consistent, and specify the interfaces between PoS applications and the EHR
- are derived from detailed use-cases to provide traceability between EHRi System functions and the business requirements
- include descriptions of the types of service requests that will be made to an EHRi
- include descriptions of the data to be exchanged by referring to data views of the data model
- assume web services calls where XML encoded HL7 V3 message requests and responses are carried between the PoS applications and the EHRi

4.2.5 Harmonize the Domain Analysis Model with HL7 Reference Models

The harmonization of the Domain Analysis Model with HL7 Reference Models at this stage is done at a very high level using the EHR Conceptual Health Data Model to ensure the information captured during the business requirement / use-case phases are consistent with already established clinical domains and processes. As the requirements for the HL7 message interactions become more defined, this step is elaborated in more detail.

4.3 SYSTEM ARCHITECTURE

The EHR infrastructure includes a broad set of electronic information sources that capture and hold data related to the provision of health services to individuals. This definition encompasses every care setting and health discipline that is oriented towards health promotion, the diagnosis and treatment of illness, or the management of care processes that directly affect individuals and the public at large.

While this definition incorporates a significant number of source systems, the data they hold cannot be considered a coherent Electronic Health Record unless that data can be assembled consistently, reliably, when and where it is required, regardless of when or where it was captured. This presents a daunting challenge both technically and systemically for the health system. The EHRS system architecture suggests a response to address those challenges.

The EHRS Blueprint is an Enterprise Architecture that defines “the Enterprise” as the entire health care delivery system in Canada. It addresses the problem of consolidating disparate and dispersed data into a coherent whole by providing a common set of standards-based interfaces for placing and retrieving information in a set of shared data repositories held within each instance of an EHR infostructure.

Rather than reaching into the operational systems that capture and hold the data at the Point of Service, the EHRi provides a mechanism for those PoS applications to push appropriate subsets of data to these shared data repositories in near real-time. As more source systems are modified to participate in the EHRi, the amount and variety of clinically-relevant data increases significantly. Because each instance of an EHR infostructure exists as a peer to the other infostructures, implemented within the same jurisdiction or in other jurisdictions across the country, the EHRi also permits the retrieving of all information related to a person, regardless of where they received their health services.

The EHR infostructure organizes EHR data into repositories that have clinically-relevant person-specific data supporting use by health service providers, as well as specialized information supporting:

- Public Health service delivery and surveillance
- Lab services
- Diagnostic Imaging
- Drug utilization and e-prescribing.

In order to provide their domain specific value and features to care providers, these domain-specific repositories are more closely integrated with the systems that provide and require this data. For example, the consolidation of lab orders and results in a repository shared at the jurisdiction level will result in reduced duplication of test orders, more efficient handling of results, and more timely assessment of results for improved health care. The amount of data and the number of specialized repositories may change over time, and the Longitudinal Record Services would be reconfigured to accommodate such changes.

In order to correctly organize the information in these repositories, a series of identifier registries are used to uniquely identify and manage the identifying characteristics of:

- clients of the health system

- providers of health services
- the locations where services are provided

In the EHRS Blueprint vision for the EHRi, the identifying and demographic information held in the registries are consolidated for an entire jurisdiction, and are used by all Point of Service applications in that jurisdiction. The EHR infostructure incorporates these registries, enabling them as services within the architecture and using them to link the persistent internal EHR identifiers to the external identifiers known to the clients and service providers.

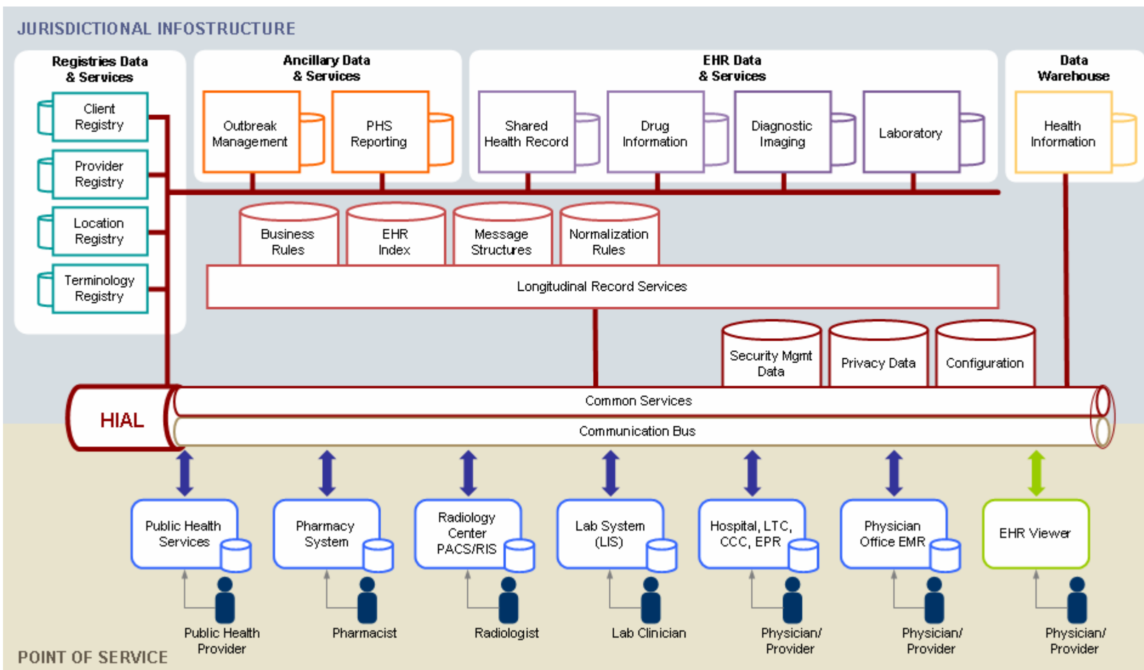

Figure 4-5 EHRS Conceptual View

This conceptual diagram describes the highest-level view of the EHRS Blueprint. Its purpose is to identify the key components that participate in and enable the creation of an Electronic Health Record Solution (EHRS).

The model is further documented in the **EHRS Reference Architecture**. The EHRS Reference Architecture is a fully documented architecture definition of an EHR Solution expressed in a CASE (Computer Assisted System Engineering) tool. Further information on the EHRS Reference Architecture can be found in section 5 of this document.

The model is organized into two layers that are based on the geographical and functional context of the various components. Components are colour-coded; for ease of understanding, subsequent models and slides adopt the same convention.

The **Jurisdictional Layer** represents components of an EHR Infostructure that will act as a shared service and therefore exist as a single instance to serve an EHR jurisdiction (e.g. Province, Territory, Supra-Regional or Regional Health Authority). It is expected that Governance models and implementation choices for each EHR Infostructure will vary from jurisdiction to jurisdiction.

The **Point of Service (PoS) Layer** includes all operational application systems that generate, collect, manage and use the clinical data that can be published to the EHR. These systems will be found at all point of service locations where healthcare is delivered to the population.

Superimposed on the Jurisdictional Layer representation are groupings of types of services that provide the foundation capabilities of an EHR infostructure. Types of services represented in the EHRS System Architecture diagram are:

- **Registries Data & Services** – This category groups the services that manage the information about people and places and resources that need to be identified uniquely in order to compile health event information in an EHR. This includes people acting as clients or providers of care, as well as locations where health events occur and terminologies as a key resource required to normalise the meaning of information kept about such health events.
- **EHR Data & Services** – This category groups all the core EHR data repositories that make up an Electronic Health Record Solution. This includes the Shared Health Record repository that keeps the basic clinical profile information that any caregiver would expect to find in a clinical record such as blood-type, allergy, immunisation profile, critical observations, diagnosed chronic conditions, health encounter summaries, diagnosis, etc... It also includes the data shared about orders and results for key clinical domains of information such as diagnostic imaging, drug information and laboratory tests information.
- **Ancillary Data & Services** – This category groups services that generally require the presence of core EHR data and are able to bring added value to such data to support specialized functions that are part of the health system. Current examples include services related to Public Health Surveillance like outbreak management and Communicable Disease Reporting. In the future this group of service could incorporate capabilities such as wait-time management services or enterprise scheduling services.
- **Data Warehouse Services** – This category groups services that enable a separate data repository capability where data is compiled and classified based on diverse requirements for aggregation and consolidation. The objective of these services is to support data analysis, research and reporting that could not otherwise be served directly by the operational data repositories that support online transaction processing, or where anonymization is required.[11]
- **Longitudinal Record Services (LRS) –** These services provide functional support for EHRS Business Services. They include:
    - Services to manage and record patient data within the EHRi repositories and registries,
    - Business Rules Services to perform data validation, Assembly Services to format EHRi response information,
    - Normalization services to standardize data content,
    - Orchestration services to manage the process flow of an EHRi interaction,

[11] For the purposes of this document, the term "anonymous" includes de-identified data that cannot be associated with a particular person or facility, or pseudonymized data that can be re-associated with a particular person or facility if necessary. For example, detection of an infectious disease outbreak using this anonymized data may require that some data be reidentified to a client/patient so that they can be contacted and case managed.

- o EHR Index services to maintain summary information about patient event content and location.

- **Health Information Access Layer Services** – All EHRS Services will require and share several common software functions (e.g. error handling, security, privacy, message communication etc). *EHRS Integration Components* are made up of *HIAL Common Services* and *HIAL Communication Bus Services* using best-of-breed industry standards, approaches and technologies that have been tried and proven in many other non-EHRS implementations. Promoting the re-usability of these already existing services will provide for a faster, more consistent adoption of the HIAL service oriented architecture.

4.3.1 Service Oriented Architecture (SOA)

The EHR solution described in the EHRS Blueprint is based on the principles of a Service Oriented Architecture that emphasizes a separation of software component responsibilities into different tiers. This concept is a refinement of previous n-tier software architectures used to create applications using client / server and object oriented component based design principles. Services are the building blocks of SOA applications and provide a level of transparency between a client application and the business logic components that provide the system's functions. In an SOA environment, services are published and consumed by applications that subscribe to these services.

The SOA presentation tier manages user interface components in client applications and consumes software services offered by an application; Services in turn use the operations provided by the business logic tier in business logic components; and the data access tier manages data access components responsible for persistence of data.

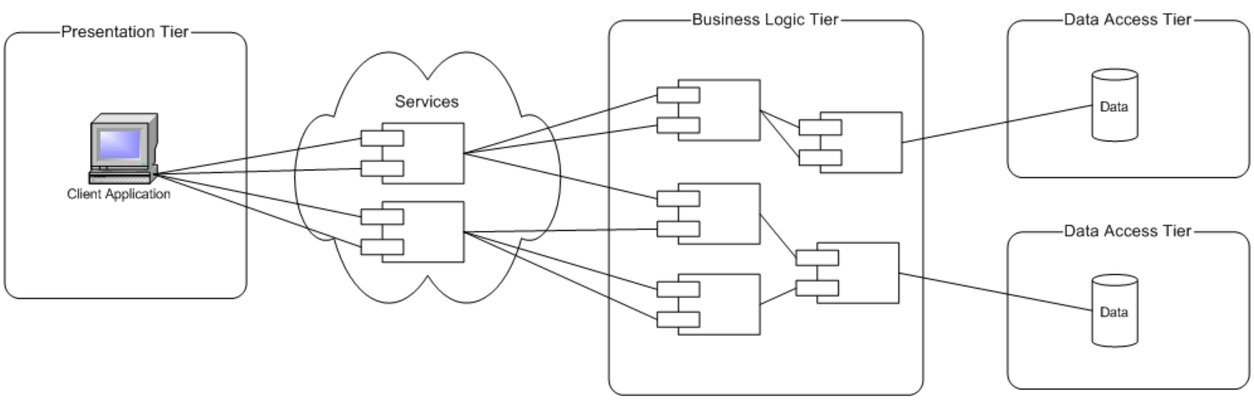

Figure 4-6 Service Oriented Architecture

In a service-oriented architecture, client applications consume services of business functions, rather than invoking discreet business object methods directly. The services tier provides black-box encapsulation of business logic component functionality to the presentation tier.The underlying principle of an SOA is that one tier should only communicate with a tier next to it. This reduces some of the complexity associated with client applications service requests and responses traversing complex object models and the separation of component responsibilities provides for fault tolerance, easier maintenance of changes, and an efficient way to manage errors and exceptions.

When the SOA is mapped to the EHR Infostructure architecture, two separate degrees of SOA design have to be recognized. First, the services offered by the EHRi are the EHR Interoperability Profiles

(EHRIPs) which represent the different transactions that any PoS application can leverage in a given jurisdiction. A whole other level of use of the SOA exists inside the EHRi where Infostructure Interoperability Profiles (I-IPs) are executed. Those encapsulate the business logic tier supported by the LRS functions, the HIAL services as well as all the other registries, ancillary and EHR data services that participate in an EHR Infostructure.

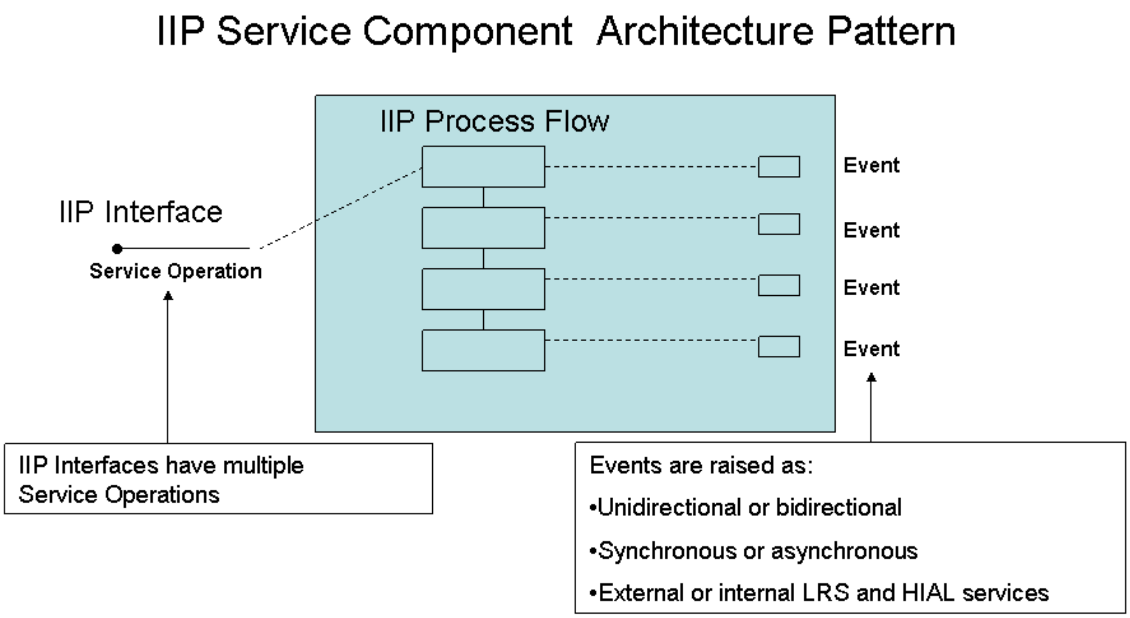

Figure 4-7 Infostructure Interoperability Profile (I-IP) Pattern

Using an SOA approach to describe these different levels of services of the EHRi allows analysts and designers to compare requirements of a jurisdiction against a core EHRS System Architecture and create a logical architecture of a “to be” EHRi System. The underlying assumption is that wherever possible the principles of standard interfaces and software component reuse will be applied to ensure each new instance of an EHRi will be interoperable within the pan-Canadian EHR environment.

4.3.2 Key Areas of System Responsibilities

At the highest level the EHRS System Architecture consists of the following areas of system responsibilities.

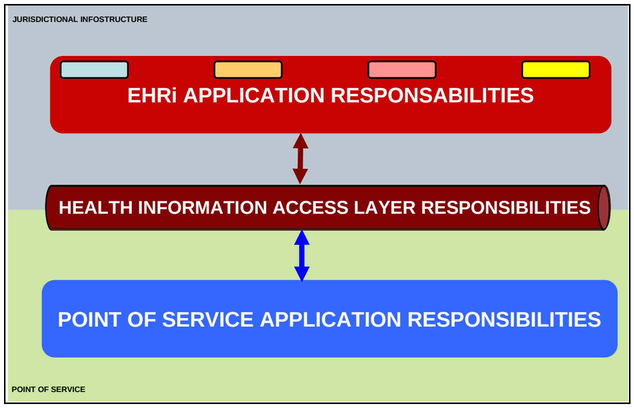

Figure 4-8 Delineation of System Responsibilities

Point of Service Applications

Point of Service (PoS) applications are the clinical application software (e.g. ADT, HIS, LIS, etc.) that operate at the many locations where healthcare services are delivered to patients/clients. These applications may have human - computer interfaces or be medical equipment, generating or collecting data about a client. Some of this data is deemed relevant for sharing and is copied to the EHRi by way of an active communication interface. It is expected that PoS applications will evolve to not only feed data to the EHRi but also to be able to access, download and integrate EHR data into the data displayed in the PoS user interface.

The following table lists the responsibilities of the Point of Service applications and provides pointers to key artefacts in the EHRS Reference Architecture where these responsibilities are represented:

PoS Application Responsibility	EHRS Reference Architecture Pointers:
To support a set of local business or clinical requirements to manage information and/or automate workflows in a specific domain of health services delivery (e.g. drug, diagnostic imaging, laboratory, ADT, etc...)	• Use Cases (Storyboards, Encounters and Clinical Activities)
To support the business or clinical requirements associated with the sharing of local clinical data through the EHRi.	• Use Cases (Storyboards, Encounters, Clinical Activities)
Support of the PoS application communication requirements needed to interact with the EHRi system.	• EHR Interoperability Profiles (EHR IP)
The integration and presentation of EHR data in the PoS application processing flow and end-user interface via: • An integrated view of local application data and EHR data • An EHR Viewer	

Health Information Access Layer

The EHRi Health Information Access Layer describes the components and services responsible for system to system interactions between Point of Service applications and the EHRi System. In the EHRS Reference Architecture, these interaction requirements are described in the form of UML system use cases accessible from EHR Communication Steps and the PoS components that interact with the Health Information Access Layer (HIAL) at the network and protocol level.

In the EHRS Conceptual Architecture, EHRi System Interface responsibilities include the following:

EHRi System Interface Responsibility	**EHRS Reference Architecture Pointers:**
The messaging requirements to support the PoS application business functions that need to interact with the EHRi system	• EHR Communication Steps
The protocol requirements to interact with the EHRi System to support communications for: • Structured Data • Unstructured Data • Data Streaming • System Management • Security Management	• EHRi Generic Interface

EHRi Application Responsibilities

The EHRi application responsibilities include: the Longitudinal Record Services (LRS), the EHR Data Services, the Registries Services, the Ancillary Services as well as the Data Warehouse Services.

EHRi Application Responsibilities	**EHRS Reference Architecture Pointers:**
The interfaces and design patterns to manage transaction processing with PoS applications	• Infostructure Interoperability Profiles (I-IP)
The services to manage the processing of business and system functions to complete a PoS application interaction	• Longitudinal Record Services • EHRS Business Services • EHRS Integration Components

4.3.3 Registry Services

The registries and their respective services provide unique and unambiguous identification of key entities in the EHR: Clients, Providers, Service Delivery Locations, and Terminologies. Registries can be used actively by both PoS applications (for their local use) and the different components of the EHRi itself. Each registry has the ability to manage and resolve the identification of singular entities using multiple identifiers. The registries hold, as one of those unique identifiers, internal unpublished identifiers, unique to a particular EHR instance, that are used to represent the specific Client, Provider, or Location data (or any other key system entities) in the EHRi repositories.

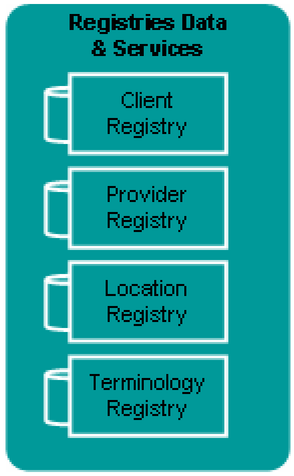

Figure 4-9 Registries Data & Services

Registries also contain enough basic demographic information about each key entity to assist in unambiguously identifying them, should a public identifier not be available or should its use return duplicate or uncertain results. Examples of this basic demographic information for a client would include: address information, gender, date of birth, next-of-kin, phone numbers, etc.

PoS applications access these registry services to search for these key entities when first encountering them, associating the preferred public identifier with the identifiers used internally by the PoS application.

The EHRi uses the registries to validate that the key entities referenced in interactions are uniquely identifiable and to assign the EHRi internal identifier to the data as it is stored in the EHRi data repositories.

4.3.3.1 Client Registry

A Client Registry is the jurisdictional system where current patient health identification numbers, demographic information (i.e. Name, Address, Health Access #, etc) is securely stored and maintained and made available to other systems and users that interact with an EHR Infostructure. The Client Registry plays two main roles in the EHR Infostructure, it is the single authoritative source and, as much as possible, the only source of demographic information about persons recognized as clients/patients of the health system. Obviously the bulk of transactions handled in an EHR Infostructure are patient centric, so this registry is critical. The other role involves the capability to resolve the multiple identifiers that may be used across multiple systems to identify a single client. Client registry services are integral to the successful operation of an EHRi System to ensure that clients, whose information is recorded in the EHR, are uniquely identified and their data is consistently managed and never lost.

The existence of an EHRi Client Registry is predicated upon the definition and existence of a jurisdictional level strategy, plan and governance policies for assigning and managing unique identifiers to support the delivery of EHR services.

The primary EHRi Client Registry service operations* used in EHR related transactions include:

Client Registry Operation	Description	SCP EHR Standard
Search Patient	Search for patient(s) with partial identifying information	Find Candidates Query
Get Client ID	Validate patient identity with fully qualified information	Find Candidates Query
Add New Client Registry Patient	Create a new patient that does not exist in the Client Registry	Add Client Notification

**Note: The Client Registry services depicted above are a subset of all the available Client Registry services. For a complete description of Client Registry services, see the Infoway "Client Registry Messaging Overview Package. This package is available as part of the pan-Canadian EHR standards package for the Client Registry domain published on the Infoway Artefact Repository.*

Other Client Registry service operations are supported by the following standard message interactions:

- No Matched Candidate; Add Request
- No Matched Candidates; Add Request; Notify Subscribers
- No Matched Candidates; Add Notify to Registry
- Matched Client Found; Revise Information Request; Notify Subscriber
- Matched Candidate Found; Revise Notify to Registry
- Resolve Duplicates Notify to Subscribers
- Resolve Duplicates Notify to Registry
- Find EHR Identifier; Positive Response
- EHR Identifier Not Found; Add Client

In a typical scenario of a transaction between a PoS application and an EHRi. The Client Registry service will always be solicited to resolve the identity of the client involved in the transaction. In the response to this query, upon a successful resolution, the Client Registry will provide an ECID (EHRi Client Identifier) that will then be used in the context of the individual transaction that is to be completed in the EHRi. The ECID is an internal identifier only seen and available to the systems that participate inside an EHRi. This process insures that the management of client identifiers between systems that participate in the EHRi can be optimized and that data integrity challenges associated with client identification merge/unmerge and link/unlink operations can be adequately managed within the EHRi and more importantly, that these kinds of operations can be conducted independently within the EHRi systems as opposed to the hundreds or thousands of PoS applications that can be connected to an EHRi.

In the context of each transaction with an EHRi however, an identifier representing the resolved client must be returned to the calling application. Recognized privacy enhancing best practices mandate that the identifier returned to the PoS application be represented as a separate MBUN (meaningless but unique number) rather than the number used as the ECID within the EHRi. These concepts are further detailed under the functioning principles sections 4.5.1.2 and 4.5.1.14

A typical EHR use case example to illustrate this point would involve the following use of client registry services:

EHR Use Case step	Description
Search Patient	Search for patient(s) with partial identifying information in

	the Client Registry
Get Client ID	Select the desired patient in the Client Registry and validate the patient's identity with fully qualified information as well as retrieve the patient's (temporary) unique patient identifier.
Put Event	Send a transaction to record an EHR clinical event for this patient using the patient's (temporary) unique patient identifier. The EHRi System resolves the patient's (temporary) unique patient identifier with the Client Registry EHRi Client ID and records the EHR clinical event information.

4.3.3.2 Provider registry

A Provider is a person or organization that provides goods or services to (within, or on behalf of) the health system. They are a Person or Organization that is authorized to provide health care services by a recognized authority or agency who also participates in an EHRi system solution.

An EHRi Provider Registry is a single directory service providing a comprehensive and unambiguous identification of all providers practicing in the jurisdiction including doctors, dentists, pharmacists, nurses, health records professionals, lab clinicians, diagnostic imaging technicians and any other healthcare professionals. An EHRi Provider Registry system is where a health care provider's information (i.e. name, address, practice licences, etc…) is securely stored and maintained at a jurisdictional level and made available to other systems and users that interact with the EHRi System.

The existence of an EHRi Provider Registry is predicated upon the definition and existence of a jurisdictional level strategy, plan and governance policies for identifying authorities, professional associations and other licensing bodies in charge of the management of unique identifiers, practice rights and other identifying or demographic data on providers.

Provider registry services are primarily used to validate the unique identity of a provider that is involved in the provision care to a patient, usually in the context of a transaction emanating from a PoS application to interact with the EHRi. The primary EHRi Provider Registry service operations* used in EHR interactions include:

Provider Registry Operation	Description	SCP EHR Standard
Get Provider ID	Validate provider identity with fully qualified information	Find Associated Identifiers Query

**Note: The Provider Registry services needed to support EHR user point of service to EHRi system interactions are a subset of all the available Provider Registry services. For a complete description of the following Provider Registry services, see the Canadian Provider Registry (RP502) Messaging Overview Package. This package is available as part of the pan-Canadian EHR standards package for the Provider Registry domain accessible on the Infoway Artefact Repositor.*

Other messaging interactions described include:

- Add Provider Request
- Add Provider Notification
- Revise Provider Request
- Revise Provider Notification
- Provider Details Query

Provider Registry and User Registry

The Provider Registry also participates in the administration and maintenance of User information. There will be a correlation made between Provider and User registries. The EHRi User Registry will include not only registered health service providers, but any person with authorization to access the EHR. The EHRi User Registry is maintained as part of the security services offered within the HIAL. An EHRi User Registry contains an entry for each EHRi user who is registered under the EHRi trusted user management model to use the EHRi System. The User Registry will play an important role in user registration, authentication, and access control for the EHRi; *see in the EHRi Privacy and Security Conceptual Architecture, section 7.2.3 Implications for Provider Registries and User Registries and section 8.4 Provider Registry and User Registry services. The Privacy and Security Conceptual Architecture can be accessed through the Infoway Artefact Repository.*

4.3.3.3 Location registry

The Location Registry or Service Delivery Location Registry (SDLR) is a component of an EHRi providing a comprehensive directory of all service delivery locations which are intended to deliver patient care (hospitals, clinics, physician offices etc). It is a trusted source of location information, which uniquely identifies where health services are provided. It is used in the context of transactions between PoS applications and an EHRi in order to resolve the identification of the locations so that a single normalised identifier is used across systems that maintain EHR information about a client. Secondly, the Location Registry is supporting EHR interoperability and other health information systems' needs by providing services that maintain and communicate a current and accurate source of health service location information.

The existence of an EHRi Location Registry is predicated upon the definition and existence of a jurisdictional level strategy, plan and governance policies for the establishment and management of unique identifiers of service delivery locations.

The EHRi Location Registry service is primarily used to validate the unique identity of a Location where the provision of care to a patient happens. The primary EHRi Location Registry service operations* used in EHRi interactions include:

Location Registry Operation	Description	SCP EHR Standard
Get Location ID	Validate Location identity with fully qualified information	TBD

**Note: The Location Registry services needed to support EHR user point of service to EHRi system interactions are a subset of all the available Location Registry services.*

Other Location Registry service operations include:

- Put New Service Delivery Location
- List Service Delivery Locations
- Get Service Delivery Location Details

4.3.4 EHR Data & Services

The EHR Data and Services represent a collection of repositories holding the shared clinically-relevant information used in the course of providing health services directly to clients. This set includes the Shared Health Record repository as well as distinct repositories for Lab, Diagnostic Imaging, and Drugs.

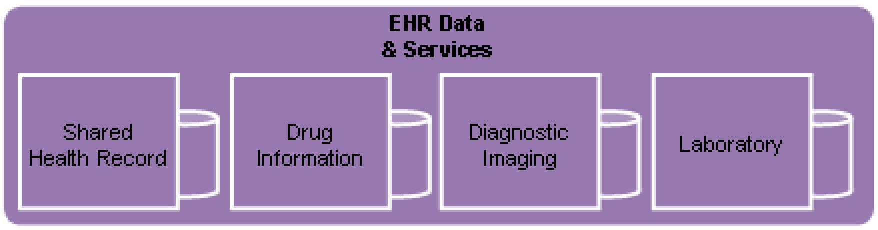

Figure 4-10 EHR Data & Services

The Lab, Diagnostic Imaging, and Drug repositories are considered specialized stores of data with sets of services meant to support very specific uses of the information they contain. Not every instance of an EHR Infostructure will contain all of these specialized repositories. In this case, this data would be held in the Shared Health Record, but it would not provide any specialized services around those data domains.

The domain repositories can be characterized as groupers of information for the following uses:

- Lab: The Lab domain holds data and provides services to support the placing, fulfilling, and reporting on various forms of medical testing. This repository provides detailed information on the status of test orders and results. The information it contains can be associated with (using the various registry services):

    - clients the tests are for
    - providers that order the tests and receive the results
    - providers and locations where samples are captured
    - providers and modalities used to perform the testing
    - the labs that process the tests

- Drugs: The Drug domain holds information on all drugs ordered (or prescribed) and dispensed in the health system (a.k.a. all drugs for all people) and any other drugs known or believed to be consumed by the patient. This repository consolidates drug information by patient, and provides the ability to perform drug utilization reviews, assess for contraindications and potential medication conflicts, be aware of known medication allergies, and track adverse responses to medications.

- o Diagnostic Imaging: The Imaging domain provides consolidated access to shared images and other media used for diagnostic purposes. This includes diagnostic reports associated with specific imagery and held in PACS networks.

As a general rule, the data held by a particular domain repository should be only the data that is directly required by systems participating in the specific functions provided by that service. For example: although it may be useful to Pharmacy systems to have access to information on the current providers of health services to a specific client, the Pharmacy domain repository should not “hold” that data. The health service event data that tells us which service providers are linked to the client (from the EHR Index as part of the Longitudinal Record Services), and the specific contact information about the providers (from the Provider Registry) is sourced from applications other than those participating in the Pharmacy domain and cannot be considered exclusive to that domain.

This presents a challenge for the domain specific systems as the implementation of EHR infostructure capabilities evolves. In early states, the “common” data that would be held and managed in other repositories is not necessarily available, so the data repository specific to a particular domain needs to hold it, in order to properly provide services. However, once that specific domain repository is integrated into the EHR infostructure, it needs to devolve handling of that data to the appropriate service managing the “shared” data. The Longitudinal Record Services are a critical component in managing these interim states, and in determining where information is held when it is sent to the EHRi and how it is collected in response to queries to the EHRi. See section 4.3.7 Longitudinal Record Services for more information on the LRS.

Many of these jurisdictional registry and domain repository systems described in the EHRS Architecture will already exist or will be created to support business services inside the scope of an EHRi system. As such, the services presented in this section are typically a subset of all available services and are restricted to support the EHRi system requirements that would be consumed by an EHR user / provider or their delegates.

4.3.4.1 Shared Health Record Domain

The Shared Health Record (SHR) repository and its associated services are the mechanism for sharing of all person-specific clinically-relevant data not held in other domain repositories. This repository and the services that make it accessible to the EHRi are separate from the PoS applications and their local data stores. The SHR holds a copy of subsets of information captured in the PoS applications. The EHRS Blueprint does not propose mechanisms to ensure active synchronization between information in the SHR and the source PoS applications where that information is sourced. Instead, the responsibility for publication of the clinical information collected in PoS applications lies within the PoS environment and the EHR Infostructure will only become aware of a change if such a publication event occurs.

The data maintained in the SHR can grow to be very wide ranging both in terms of scope and volume. In early generations of EHR Infostructure solutions however we expect the scope of this data to be fairly limited and constrained. These limitations are largely due to the need to focus on only clinically relevant data appropriate for sharing, and on the fact that current systems are not engineered to take advantage of more advanced EHR infostructures capabilities. The early definition of this scope includes the following facets of information:

- Encounter Basic Information
- Referral Orders and Referral Notes
- Encounter Summaries

- Clinical Observations primarily focused on critical observations that impact the health status of an individual.
- Problems/Conditions/Diagnosis

As PoS applications become more EHRi-enabled, additional facets of information could include:

- Care Plans
- Care Protocols
- Client Health Status indicators including level of comfort, likelihood to die, function and severity
- And others

In this context, the following services allow EHR users / PoS applications to record, list and retrieve Shared Health Record repository information.

SHR Service Operation	**Description**	**SCP EHR Standard**
Put Encounter	Records a new encounter in the SHR with the base information that describes it including start date, planned end date, end date, state, reason for admission/visit.	TBD
Put Referral	Records a new referral in the SHR with its supporting information including a type of referral, the date of the referral, referral target service, referral state.	TBD
Put Encounter Summary	Records a new encounter summary with all of its supporting information. Both coded and non-coded entries are incorporated. An encounter summary should always be associated to at least one Encounter record maintained in the EHR Index.	TBD
Put Clinical Observation	Records a new observation in the SHR. Both coded and non coded entries are accepted.	TBD
Put Problem / Condition / Diagnosis	Records a problem, condition or diagnosis in the SHR. Both coded and non coded entries are accepted.	TBD
List Encounters	Searches for a range of encounter records based on a set of research criteria including client id, provider id, location id, date range, reason for admission/visit, status.	TBD
List Referrals	Searches for a range of referral events in the SHR based a set of research criteria including client id, provider id, location id, date range, status.	TBD

SHR Service Operation	Description	SCP EHR Standard
List Observations	Searches for a range of observation records in the SHR based on a set of research criteria including client id, provider id, location id, observation type, date range, status.	Review Basic Patient Observations from CeRx
List Problems / Conditions / Diagnosis	Searches for a range of problems, conditions or diagnosis records in the SHR based on a set of research criteria including client id, provider id, location id, problem type, condition type, diagnosis type, date range, status.	TBD
Get Encounter	Retrieves a specific encounter record with all of its supporting information	TBD
Get Referral	Retrieves a specific referral event and all of its supporting information	TBD
Get Encounter Summary	Retrieves a specific encounter summary entry and all of its supporting information	TBD
Get Observation	Retrieves a specific observation and all of its supporting information	TBD
Get Problem / Condition / Diagnosis	Retrieves a specific problem, condition or diagnosis record with all of its supporting information	TBD
Get SHR Complete Record	An extended feature allowing the retrieval of the entire health record maintained in the SHR for a single client. This will return several types of data structures packaged into a single message. The criteria includes client id, date range, last record fetched bookmark and paging size value. See Note 2	TBD
List Relevant SHR records	An extended feature allowing for a free text search to be launched in the SHR and retrieve any record that match the criteria for a given client, provider or location. Search criteria includes client id, provider id or location id as well as last record fetched bookmark and a paging size value. See Note 2.	TBD

Note 1 : This table does not include the “List Encounter Summaries” transaction profile. This is not a mistake, encounter summaries are expected to be accessed from the basic encounter records to which they are associated. The SHR is not expected to support a search and find capability on encounter summary records per say. Users would first list encounter records with their basic information and then access more details which may include the encounter summary.

Note 2: This kind of transaction will require the SHR to maintain a paging ability as part of its search algorithm. This way the system always limits the extraction of record to a limited set. Over time multiple queries may come back towards the SHR to further retrieve valid responses.

4.3.4.2 Drug domain

The Drug domain system – also known as a Drug Information Systems (DIS) is a core jurisdictional component of the EHRS System Architecture. A DIS records patient prescriptions and medications and provides complete patient drug profiles as well as decision support services for clinicians prescribing and dispensing drugs.

The EHRi Drug Domain services support EHR user requests to retrieve patient clinical data from the Drug domain repository system interface for display.

The following EHRi Drug Domain service operations represent the subset of patient centric queries that would be consumed by an EHR user in the context of an EHRi system. These services are supported by the Canadian Clinical Drug (CeRx) Messaging standard. For more detail information of all drug domain services see Infoway Canadian Clinical Drug (CeRx) Messaging Standard, the first version of the CeRx messaging standard specification and design artefacts can be accessed through Infoway Artefact Repository. Information on messaging standards that are in process can be found in the related Infoway project forums accessible through our KnowledgeWay site.

Drug Domain Service Operation	Description	SCP EHR Standard
List Prescription Dispenses	Find all dispenses for a specific prescription (for a patient).	Get Dispenses for a Drug Prescription
List Dispense History	Find what drugs have been dispensed / filled for a specific patient over a specified time period. a.k.a. Patient Dispensed Drugs Query.	Get Patient Drug Dispense History
Get Dispense Details	Dispense details for a specific drug dispense, including notes.	Get Single Drug Dispense Details
List Unfilled Prescriptions	Find all prescriptions, for a specific patient, that have never been filled.	Get Patient Prescriptions, Never Dispensed
List Outstanding Prescriptions	Find all prescriptions for a specific patient that are either [1] never filled or [2] have outstanding refills or [3] both [1] & [2], by prescriber	Get Patient Prescriptions, Remaining Dispenses
Get Prescription Order Summary	Provide a list of prescriptions that have been prescribed for a specific patient	Get Patient Prescription Order Summary
Get Prescription Order	Used to get all the details about a specific prescription searching by	Get Prescription Order with Associated

Drug Domain Service Operation	Description	SCP EHR Standard
	prescription number. Dispenses are not included in the response.	Dispense Details
Get Medication Details	For a specific patient, list all prescriptions ordered but not filled + ordered and partially or completely filled + other active medications + filled with no order. Focus is on complete details for included prescriptions.	Get Patient Medication Details
Get Drug Profile	For a specific patient, list all prescriptions ordered but not filled + ordered and partially or completely filled + other active medications + filled with no order. Focus is on summary information for included prescriptions.	Get Patient Medication Summary
Get Other Medication Details	Used to get all the details for one specific other active medication for a patient.	Get Patient Other Active Medication Details
Get Drug Complete Record	An extended feature allowing to retrieve the entire record maintained in the drug domain service for a single client. This will return several types of data structures packaged into a single message. The criteria includes client id, date range, last record fetched bookmark and paging size value.	TBD

4.3.4.3 Diagnostic Imaging Domain

The Diagnostic Imaging (DI) domain is used to maintain and manage information about orders and results for diagnostic imaging tests which constitute a vital part of a client Electronic Health Record. The technical requirements associated with the management and efficient communication of large images and other types of binary files is what sets this apart from the other domain services.

This service allows for the centralised capture and sharing of DICOM compatible objects across a large distributed network. These networks include Picture Archiving and Communication Systems (PACS) implemented in hospitals or diagnostic centers as well as diagnostic modalities used to produce such pictures. Typically, there are two key pieces of data associated with a diagnostic imaging test, a written report outlining the conclusions of a study and the imaging artefacts which may take different forms such as video or sound but most often will take the form of one or more pictures. Both the written reports as well as the key picture(s) used to reach the conclusions expressed in such report are expected to be available from the DI service.

The diagnostic images discussed herein are typically the end result of a business process that starts with an order created by a clinician for a certain type of test. The order itself is expected to be represented within the DI domain service as a set of data in support of a given diagnostic image result and therefore is expected to be available as part of the electronic health record of clients.

Other types of large binary objects could also be handled by the DI domain capabilities, examples of those include clips of video streams coming from a telehealth session seen as clinically-relevant for a person's health record, or eventually any digital stream coming from different modalities (ECG, Respiratory Monitors, etc…).

Providing fast, easy and responsive access to large picture or other types of streaming objects presents a challenge. The EHRi DI Domain services support EHR user requests to retrieve patient clinical data from the DI domain repository system for display. The centralized jurisdictional EHR Index service, provided as part of the Longitudinal Record Services, performs a vital role in recording the location and types of DI information a patient has received. This indexing mechanism is core to the operation of the DI domain service whenever an end-user is trying to access an image (or any object) for viewing.

The following EHRi DI Domain service operations represent the patient centric queries initiated by an EHR user in the context of an EHRi system.

DI Domain Service Operation	**Description**	**SCP EHR Standard**
Get DI Order	Allows to view a DI order already placed in a DI domain system.	TBD
Get DI Report	Allows to view a DI report (final, addendum, first impression) either in plain text or PDF format.	TBD
Get DICOM Object	Allows to view DI images or evidence documents. This service will allow the retrieval of the following types of DI documents: Full set of images (Exam) Set of pertinent images (Key Images) Evidence documents (requisition, technologist impressions, screening forms, etc)	TBD
List DI Orders	Allows to query and retrieve a list of a patient's DI orders using search criteria such as: Client ID (ECID) Type of DI Orders Modality Date Range Service Location Ordering Physician	TBD
List DI Exams	Allows to query and retrieve a list of a patient's DI Exams using search criteria such as: Client ID (ECID) Document type – images, diagnosis, progress	TBD

DI Domain Service Operation	Description	SCP EHR Standard
	report, preliminary report, etc. Date Range Service Location Ordering Physician Relevant metadata for this query includes: Exam date Modality Body part/anatomical region Procedure code	
Get DI Complete Record	An extended feature allowing to retrieve the entire record maintained in the DI domain service for a single client. This will return several types of data structures packaged into a single message. The criteria includes client id, date range, last record fetched bookmark and paging size value.	TBD

4.3.4.4 Laboratory domain

The Laboratory domain system – also known as a Jurisdictional Laboratory Information System (JLIS), is a provincial / territorial system that manages patient laboratory test orders and / or disseminates patient test results to clinicians. The laboratory domain system is expected to take different shapes and sizes in different jurisdictions.

A key distinction needs to be made between solutions focused on enabling a view into laboratory results and order information as a supporting set of data for results. This is in contrast with more elaborate jurisdictional laboratory information system solutions designed to enable the management, and potentially the automation of, the workflows associated with the process of laboratory based testing.

Early generation solutions are expected, at a minimum, to be able to compile laboratory results as well as the accompanying data (such as the preceding orders) so that a view of this consolidated information can be provided to caregivers. In its simplest state, the Laboratory domain system will compile laboratory testing related events from source systems such as an order, a sample, and a result and allow for access to this data on the basis of standards-based message queries to retrieve any of this information. More advanced solutions will provide that basic capability and will also support workflow automation and business logic to manage the status of orders and result generation and will also interact with source systems in a much more proactive fashion to generate alerts and notifications or to expedite processing.

The Laboratory Domain service is expected to interact, through standards-based messaging, with laboratory systems used for generating and managing orders in facilities as well as with systems used in sampling and testing facilities to produce results. In other words users acting as clinicians and lab technicians in laboratory facilities are expected to use their local information system solutions to conduct their work. These applications, by way of being connected to an EHRi will be able to publish or promote key relevant results data to the Electronic Health Record of patients. Similarly, CPOE applications used by caregivers in hospitals, clinics will be able to promote order information to patient health records through the same type of connectivity with the EHRi.

The following EHRi Lab domain service operations represent the patient centric queries initiated by an EHR user in the context of an EHRi system.

Laboratory Domain Service Operation	Description	SCP EHR Standard
Get Lab Orders	Allows to retrieve a specific lab order for a patient.	TBD
Get Lab Results	Allows to retrieve a specific lab result for a patient.	TBD
List Lab Orders	Allows to query a list of a patient's lab order with criteria such as: Type of Lab Orders Date Range Service Location Ordering Physician	TBD
List Lab Results	Allows to query a list of a patient's lab results with criteria such as: Type of Lab Results Date Range Service Location Ordering Physician	TBD
Get Lab Complete Record	An extended feature allowing to retrieve the entire record maintained in the Lab domain service for a single client. This will return several types of data structures packaged into a single message. The criteria includes client id, date range.	TBD

4.3.4.5 EHR Index Notification Process

The Drug domain, the Diagnostic Imaging domain and the Laboratory domain are expected to interact directly with specialised PoS applications used to generate and manage source data in health facilities or in dedicated testing facilities. Data update transactions coming to the EHR Infostructure from these applications are expected to flow through the HIAL and be brokered directly to their respective domain service. When this occurs, a process has to exist for the domain service to notify the Longitudinal Record Services (namely the EHR Index), that a new order or result event has occurred and is now a part of the EHR of the client. This process is the only way to insure that a cohesive and comprehensive view of the clinical data of a client is maintained whenever that client record is accessed.

EHR Index Notification Service Operation	Description	SCP EHR Standard
Put EHR Index Event	Generic transaction pattern allowing any service to request the creation of an event in the EHR Index of a client.	TBD

EHR Index Notification Service Operation	Description	SCP EHR Standard
	See EHR Index Functioning Principle in section 4.5.1.4 for more details on EHR Index capabilities and data.	

4.3.5 Ancillary Data & Services

With the inclusion of Public Health Surveillance (PHS) in *Infoway*'s mandate, additional enterprise modeling was done to ensure the high level requirements for Public Health were addressed in the architectural blueprint. It became readily apparent that PHS and the Canadian population could benefit tremendously from participating in a shared EHR, however it also became evident that additional architectural constructs would be required to support use of the EHR infostructure for Outbreak Management and Reporting.

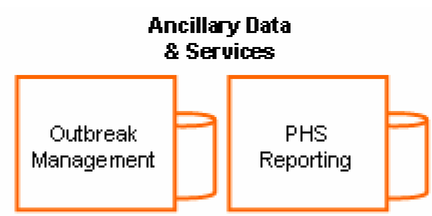

Figure 4-11 Ancillary Data & Services

Because PHS will not be the only health discipline that will benefit from the provision of specialized and value add services as an inherent part of the EHR infostructure, these capabilities are presented somewhat generically in our architecture as Ancillary Data & Services, and Data Warehouse. This generic representation leaves room for additional value-add capabilities to be incorporated into the Blueprint framework.

The Outbreak Services Domain within EHRi Services represents one architecture alternative in the acquisition or development of a Public Health Surveillance solution. The split of Outbreak Management functions between PHS point-of-service applications and "outbreak services" is to be determined by the PHS project underway in 2005.

The Outbreak domain may send requests to the Laboratory domain for communicable disease case information, or may respond to automated reporting of cases by the Lab domain or a point of service system. Automated reporting of a communicable disease case or "event" may be supported by the Lab domain, the point of service systems/portals, or might be initiated by a business rule within Longitudinal Record Services.

The following table lists the functions within Outbreak Management, some of which may be deployed as services within the EHRi.

Outbreak Management Service Operation	Description	SCP EHR Standard
Integrate Case Management	Receives communicable disease case reports from PHS or other point of service systems, or from the Lab Domain and makes the case information available to Public Health staff through a PHS point of service application or portal.	TBD
Identify Outbreak	A combination of automated and human assisted functions determining that a case or set of cases represents an Outbreak.	TBD
Manage Outbreak	Provide services to point of service systems, PHS portals, and inter-provincial to monitor and manage a communicable disease outbreak.	TBD
Support Outbreak Analysis	Supports exporting data to a Data Warehouse environment where general purpose analysis tools and domain-specific analysis tools will be used.	TBD
List Immunization Detail	Retrieves immunizations a patient has received and when.	Patient Immunization Query in CeRx

Public Health Systems (PHS)

Key information types to be shared in the EHRi Public Health Domain are text-based Reportable Diseases and Immunizations. These are communicated between PHS PoS applications and jurisdictional Immunization systems via structured HL7 messages from Public Health labs and Immunization Management systems.

PHS Immunization Management (IM) has three parts:

1. IM Health Surveillance user function;
2. IM "supply chain" (serum and antiviral sources, inventory, distribution);
3. IM "clinical" (where immunization service events are recorded)

IM Clinical events can occur in multiple settings, performed by different providers (PH Nurse, Physician or Nurse in a primary care or hospital setting, etc.), using different systems: i.e., PHS IM System, Physician Office EMR system, Acute Care (Hospital) system; IM Clinical events is therefore a combination of IM "reporting" from PoS applications (directly or via EHR & domain repositories) and an IM-specific PoS application.

It is expected that these types of functions will be available in commercial PHS software applications and can be accessed using generic Portal technologies rather than separate interfaces.

If a separate PHS domain repository does not exist, the EHR Shared Health Record Repository must, at minimum, provide the ability to record patient Immunizations using standard HL7 messages. In this scenario, the EHR Index must also be updated to describe the type, location and access method of the data.

Public Health Systems will also share or reuse components/services described in the EHRi such as:

- The Common Services and Communication Bus (Health Information Access Layer – HIAL) will service the entire architecture
- Inter-jurisdiction communication or messaging for PHS purposes uses the same HIAL to HIAL mechanisms as inter-jurisdictional EHR messaging
- A PHS Portal could share the same technology platform as an EHR Viewer
- The “Immunization Repository Services” (aka “Immunization Registry”) should be shared for PHS and EHR purposes; there is a need for Immunization Services to be implemented with both purposes in mind; this will mean using EHR messaging standards
- Jurisdiction Data Warehouse services (where they already exist) should provide services to PHS along with other business requirements; if these services and solutions are not in place, they need to be implemented with other possible Data Warehouse business function in mind
- EHR and Domain Repositories are potential sources of inputs to PHS, especially Laboratory results, and potentially other clinical information
- The Jurisdiction Registry Services should be used directly by PHS applications and services, either in transactional mode (for developed components), or as integrated source and consumer systems (for purchased components).
- “Reference Management” and “Content & Knowledge Management” may be sharable resources (with EHR), or implied or contained within each PHS application or services
- “Reporting” of clinical events (e.g., reportable Lab results, reportable PoS events) should evolve to become messages from EHR and Domain repositories, via EHR services, to PHS functions, instead of separate messages from PoS systems to PHS services.

4.3.6 Data Warehouse

The Data Warehouse service is defined as an integral component of an EHR infostructure.

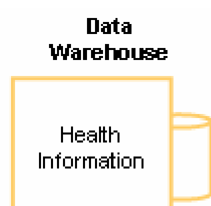

Figure 4-12 Data Warehouse

The EHR Infostructure is made up of multiple systems that participate in enabling the full set of domains of information required to have a complete health record for any individual. All of the systems that compile active operational data such as: a client registry, a shared health record, a laboratory domain, an outbreak management domain solution, the longitudinal record services, or the HIAL are expected to be optimised for near real time updates and more importantly optimised to sustain quick and responsive access to data. This is critical as the EHR is being built to support caregivers in their daily activities as they provide care to patients. The transaction profile expected of any running EHR Infostructure is one where the bulk of daily transactions is going to be data access transactions as opposed to updates, and will grow to a high volume of data access transactions as more and more users become aware and trained on the use of the electronic health record as a tool.

Given the read-optimised performance model for the EHRi, the role of the data warehouse is to provide an independent environment in which data can be transferred to be manipulated, searched, massaged and retrieved without affecting the critical performance service level required of EHRi system components. This is necessary to support the analysis, research and management value associated with the operational data compiled in an EHRi.

The data warehouse environment may be called upon to support many different types of needs. Formal requirements for this environment are primarily emanating from the public health surveillance business domain at this stage. The public health domain needs to support processes whereby research and analysis is conducted in order to detect potential communicable disease outbreaks or to run other types of public health programs. For example a program to trace all potential receivers of a certain type of heart valve medical device, in the context of a product recall campaign by a medical device company.

Other requirements for data warehousing and data-marts are expected in the future. At this stage, no detailed functional requirements have been established for the data warehousing environment. However, it is clear that this type of capability needs to be planned for as a separate environment within an EHR Infostructure. The data warehousing environment is defined within the boundaries of the EHR Infostructure because it is seen as an integral function of an EHR business service. It is also expected to capitalise on many of the common services and communication services offered by the HIAL. This is especially true in the ability of the HIAL to provide a consistent and normalised application of privacy and security related features that are seen as applicable and required to protect the legitimacy of access to data in the context of such secondary uses. The Longitudinal Record Services is also defined as offering capabilities to extract/transfer/load transactions which may well be very useful to fulfill any migration of data from the EHRi operational systems into this data warehouse service.

4.3.7 Longitudinal Record Services (LRS)

The Blueprint incorporates a grouping of services, called the Longitudinal Record Services, to handle the complexities associated with localizing and managing data within the EHRi. Theses services include the indexes that link the data held in the various repositories to a particular client, provider, and care delivery location, and to the points in time that data is observed. The LRS is responsible for parsing the information from the external sources, placing the data appropriately in the repositories, and conversely for retrieving, assembling, and returning data in response to external PoS requests. The LRS is also aware of peer infostructures that may hold additional data on clients, and is capable of forwarding requests for data to those infostructures, and then consolidating the returned data with local information. Conversely, the LRS can also respond to information requests from its other peers.

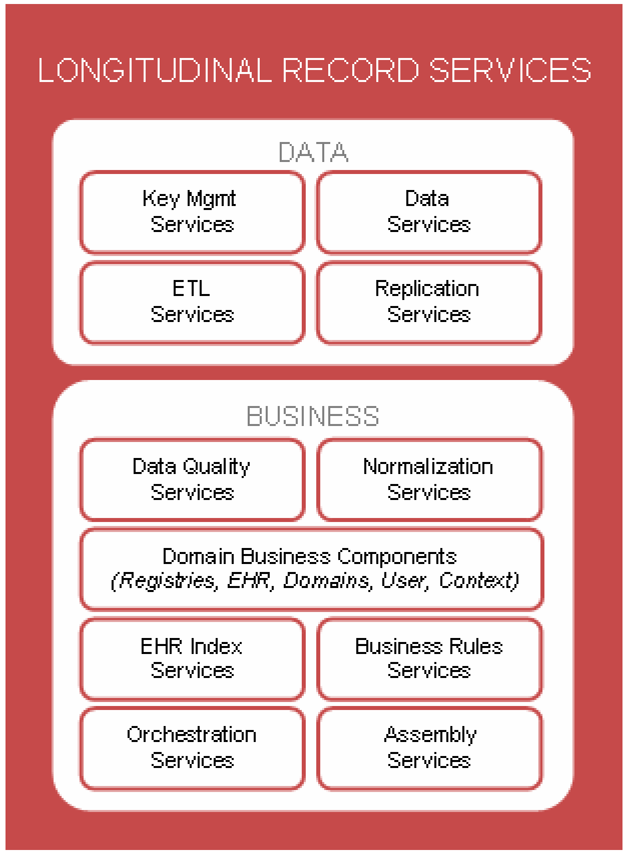

Figure 4-13 HIAL Longitudinal Record Services

The EHRi Longitudinal Record Services or LRS (formerly known as EHR Services in the EHRS Blueprint Version 1) are a core component of the EHRi HIAL architecture. These services provide functional support for EHRS Business Services. These services are responsible for the execution of Infostructure Interoperability Profiles (I-IP) which may include the use of any components and services offered within an EHR Infostructure or interactions with other EHR Infostructures to perform a transaction.

In a sense, the Longitudinal Record Services is considered as the central nervous system or the kernel for the execution of EHR data access transactions. In general, data update transactions may or may not require the use of the LRS, many data update transactions are expected to be brokered directly to specific Registry, EHR Data or Ancillary Services. Examples of such data update transactions include a new drug dispensing event being communicated from a pharmacy system or a new lab result being published to the EHR from the laboratory application in a laboratory testing facility or a new diagnostic imaging result set being published to the EHR from a hospital PACS application.

On the other hand, all transactions aiming at accessing data in client's health records are expected to be processed by the LRS. The LRS is the only component of an EHR Infostructure that knows the transaction and business logic and data access rules required to compile a true longitudinal and comprehensive view of any data subject being accessed.

The following tables outline the expected services and capabilities of an LRS. Please note that these are not expected necessarily to materialise as individual self-contained callable services in the solutions that get assembled and implemented in Canadian Provinces and Territories. They are rather meant to describe the types of capabilities expected of a solution fulfilling the role of an LRS in an EHR infostructure.

4.3.7.1 Business Services

This component is made up of services to handle the processing of EHR data access transactions. Together these services establish a context for processing and managing such EHR access transactions. This is the one single place in an EHR Infostructure where the coordination and execution of a transaction needing to touch multiple services and systems in an EHRi or needing to go across to other EHRi's is occurring. Services in this component manages the overarching representation of a transaction in an EHRi, orchestration flows, assembly of responses, application of business rules and data access with various other systems or services in an EHR Infostructure. The following table further breaks down the Business Services into a functional representation of the capabilities expected of the business services handling in an LRS:

Service Component	***Description***
Assembly Services	The execution of an EHR I-IP may include calls to various components providing multiple result sets. These result sets will be assembled together in the appropriate output format by the assembly service. These services will use assembly templates to carry out their function. Once a response is assembled, calls will be made to HIAL services to communicate a response back to a calling PoS application.
Orchestration Services	These services manage the registration, storage and retrieval and more importantly the orchestration of the processing flow for each type of I-IP. It is the engine that drives transaction execution. It knows about the steps that need to take place and it knows how to invoke services in order to trigger and manage the realisation of each step concurrently or sequentially as the case may be. Ideally, in an EHRi, it will rely on a very parameterized and open platform where new orchestration flows can easily be added or existing ones modified without having to have to call upon developers and an extensive software development process to do so.
Business Rules Services	The Business Rules Service component is a collection of finely grained validation and logical process rules objects that are assembled at run time to execute the business logic applicable to a given type of I-IP transaction being processed. The business rules can be hard coded into Domain Business Components or can be applied dynamically through the Business Rules Services.
EHR Index Services	The EHR Index records summary information about patient clinical events recorded in the EHR. It maintains a sequential list of all events that affect the client / patient. It also provides the location where the data relevant to each event is kept in the EHRi. It can be used to retrieve the history of events for a client or to trace the information about a specific event. More information about the EHR Index can be found in section 4.5.1.4.
Domain Business	These are the specific business or transaction information objects that need

Service Component	Description
Components	to be instantiated to represent the context and substance needed to execute a given I-IP transaction. The lifespan of these objects will start and end with the execution of each I-IP being processed. The type of objects represented depends on the nature of the I-IP being processed.
Normalization Services	These services are called upon in the context of execution of an I-IP to transform data in order to represent it in a different form. The service is typically used to apply standards and modify a given input stream to make it correspond to a standards-based encoding stream. Both the format and the actual substance of the data maybe transformed. Specific logic and coding tables are used to achieve these transformations. The use of normalisation in an EHRi is further described in the functioning principles under section 4.5.1.20.
Data Quality Services	These services are used to track and monitor the level of quality of the information maintained in an EHRi. As data in an EHRi is expected to be used for research, surveillance and clinical decision making, the ability to track levels of quality of the information maintained in the EHR is a required feature. These services can be used to support people-driven manual data quality assessment processes or in the future to even completely automate the assessment of data quality indicators. For example, such indicators can be driven from the monitoring of results of business logic algorithms being applied.

4.3.7.2 Data Services

These services provide functional support for EHRS Business Services to execute the proper data access procedures and transformations required to interact with different registry, EHR Data, Ancillary or Data Warehouse services. In general, the LRS can interact with internal components of an EHRi in one of two ways. It can rely on existing standards-based communication mechanisms and use the HIAL to perform such interactions or it can use more direct or proprietary interfacing mechanisms to access or update data into any one of the registries, EHR data or ancillary services. The data services described herein are used to support the latter method of more proprietary interfacing mechanism. EHR Data services are used both in the online business scenarios where EHR data is recorded and retrieved as well as in the administration functions to load and manage EHR repository and registry information. The following table further breaks down the Data Services into a functional representation of the capabilities expected of such services in an LRS:

Service Component	Description
Replication Service	This service would provide data replication capabilities between systems or databases that exist within an EHR Infostructure.

Service Component	Description
ETL Services	The Extract, Transform, and Load (ETL) services manage batch processes to extract and insert data from different repositories. These services may be used to execute initial data loading procedures or data maintenance procedures. They may also be used in conjunction with Replication Services to carry out ongoing synchronisation between systems or databases, and to provide the extracts needed to populate the various data warehouses used in the context of the EHR infostructure.
Key Management Services	As data is accessed in various sources, there will be cases where certain primary or secondary indexing keys are not unique across source systems or aren't available. The key management service will generate and manage keys during insert and update operations in the EHR repository.
Data Access Services	Provides support for proper invocation of data access procedures with different registry, EHR or Ancillary services. It holds metadata about data structures and invocation procedures for operations carried out on repositories in the context of the execution of I-IPs or for data maintenance types of procedures.

4.3.7.3 Transaction Handling and LRS Operators

As discussed above, the LRS is expected to handle data access transactions that require a comprehensive and longitudinal perspective on the view into a person's health record. This means that, in terms of invocation and processing, the LRS will be equipped to co-ordinate the processing all of the "List" and "Get" transactions that have been described in the different sections of this document. For any of those transactions, it will establish a context to manage the transaction; it will know how to invoke a specific orchestration flow and will conduct the execution of that orchestration flow allowing for proper services to be called upon in the realisation of such transaction. This will typically involve:

- Calls to the client, provider and location registries to resolve the identification of each of these entities and obtain the internal EHR identifiers involved in their use,

- Calls to HIAL services to invoke consent, encryption, digital signature, access control, anonymisation or any other service that need to be used to apply proper controls to the realisation of a transaction.

- Calls to an EHRS Locator service to determine what other EHR Infostructures need to be queried in the context of a given transaction for a given client that may have data in different jurisdictional repositories.

- Calls to EHR data domain services (SHR, Drug, Lab, DI) or Ancillary services to access or retrieve facets of data required in executing a given I-IP.

- Calls to HIAL services to broker sub transaction calls to other EHR Infostructures where relevant data exist for the client.

- Calls to HIAL services to communicate an assembled response for the I-IP being executed.

In order to act as the kernel for processing EHR data access transactions, the LRS needs to be able to rely on a holistic view of a client's health record. This is provided by the EHR index within the LRS. The LRS, as it is processing transactions will rely heavily on the EHR Index to know what data exists in a person's health record and to know where that data is located within the numerous systems that participate in an EHR Infostructure. As the LRS is the owner of the EHR Index it will also support a specific set of transactions to manage, maintain and use the data in the EHR Index.

The LRS is not expected in early generations of EHR solution to manage data update (creation or modification) transactions other than the specific updates targeted at the EHR Index capability. The LRS is a layer of transaction processing focused on handling complex composite transactions that need to gain a multi-domain or multi-infostructure view of the information. Most EHR data access transactions are expected to require this kind of capability since data from registries, access and consent management services, and often one or many ancillary or EHR data services must be combined in order to fulfill a request. In essence, updates or "PUT" events coming to an EHR Infostructure are expected to be specific to a single domain and limited in scope to the single clinical data repository component that handles that specific domain. For the early generations of EHR Infostructure solutions, "PUT" transactions are expected to be brokered (or routed) directly from the HIAL brokering and interoperability services into their respective domain systems and therefore not handled by the LRS.

The following table presents the published service interfaces expected to be supported as a set of functional requirements by the Longitudinal Record Services.

LRS Service Operation	**Description**	**SCP EHR Standard**
Put New Object	Allows registering a new data or controlling object class. These can then be instantiated and used by orchestration flows.	TBD
Put New Orchestration Flow	Allows registering a new orchestration flow in the LRS. Each type of EHR IP that focuses on listing or getting data from the EHR is expected to have its own orchestration flow.	TBD
Put New Business Rule	Allows registering a new business rule in the LRS. This assumes the use of parameterized business rules engine.	TBD
Put New Normalisation Rule	Allows registering a new normalisation algorithm.	TBD
Put New Assembly Template	Allows registering a new response assembly template used to create a standards-based formatted response when a transaction is ending.	TBD
Put New EHR Index Event	Allows invoking the EHR Index to record a new event entry in it. This transaction is triggered by a domain repository service as part of the process to complete a clinical data insert (or create) transaction and its goal is to make the EHR Index aware of the existence of the new piece of data	TBD

LRS Service Operation	Description	SCP EHR Standard
	relevant to a client's EHR. Invocation parameters include all of the data and metadata maintained by the EHR Index. This data includes basic subject identifiers (client, provider, location, user, pos application, source id) as well as event typing data so that the event is adequately categorised and searchable in the Index. The data created as part of an Index entry also includes a Unique Resource Identifier (URI) acting as the callable address to be used later in the context of access transactions to this specific event. For details on this subject, see section 4.5.1.4. The LRS will search for any existing duplicate to protect integrity of the EHR Index and proceed to create a new event with an active status. Any subsequent queries towards the EHR Index would be able to find the newly available data in the person's EHR.	
Put Update EHR Index Event	This transaction is triggered by a domain repository service as part of the process to complete a clinical data update transaction. This transaction pattern is used to reflect the update in the EHR Index. The LRS will search for the existing original event, turn its status to inactive, create a new event and link the new and old events. Any subsequent queries towards the EHR Index should only find the corrected and most up-to-date event as active.	TBD
Put Deactivate EHR Index Event	This transaction is triggered by a domain repository service as part of the process to complete a clinical data delete transaction. As a principle, data in the EHR is never deleted, rather, it is identified as being nullified or logically deleted. The LRS will search for the existing original event, turn its status to inactive, create a new special type of event to identify this data record in the client EHR as nullified along with the specific subject identifiers describing the context of the deletion including client, provider, location, user,	TBD

LRS Service Operation	Description	SCP EHR Standard
	PoS application, source ID. It would also link this new delete event to the EHR Index entry being inactivated. Any subsequent queries towards the EHR Index will not find this data as part of the EHR of the client. Special types of maintenance processes can however be used to access these records for audit or archiving purposes.	
Put Health Profile	The health profile transaction is an advanced feature that would allow an application to publish a "freeze frame" representation of a client health information available in the EHR as used at a certain point in time to make decisions or conduct health service delivery activities. The idea is that by packaging together all the events of the EHR Index that correspond to the data used, the EHR Service would be able to recognize a special type of event that records the health profile of the patient which has been used at a specific point in time. New clinical notes or observations would typically not be a part of this health profile. This feature would allow caregivers to record the fact that they had used a certain representation of a client health state when making a decision and publish that as an event in the EHR of the client.	TBD
List EHR Index Events	Allows a calling service to obtain a list of events from the EHR Index. Parameters when invoking this service focus on search parameters including client, provider, location ID, date range, type or type(s) or events, type or types of medical acts tracked by the EHR Index. The response includes basic data about each event including URLs usable to query the details of any single event found in the Index.	TBD
List Data Quality Indicators	Allows a calling service to retrieve a list of different data quality indicators from the data quality service of the LRS	TBD
Get Data Quality Indicator	Allows a calling service to retrieve a specific data quality indicator from the data quality service of the LRS.	TBD

LRS Service Operation	Description	SCP EHR Standard
Get Orchestration Flow Executed	Allows a calling service, normally the Broker Service of the HIAL, to launch the execution of a given orchestration flow. The EHR IP request data is passed as a parameter in its canonical form.	TBD
Get EHR Index Event	Allows a calling service to obtain the detailed metadata about a single event in the EHR Index. Since events in the EHR Index can be nested, this may return a structure containing the data of multiple events. Parameters when invoking this service include the specific Event ID of the event being accessed. EHR index data must have been queried prior to this service being used.	TBD
Get Health Profile	The get health profile transaction is a special kind of “Get EHR Index Event” transaction. It allows caregivers to retrieve form the EHR of a client, the detailed representation of all the health events that make up the specific representation of data used on a patient when making a certain decision. See “Put Health Profile” for more information.	TBD

The level of granularity of service fragmentation within an EHR Infostructure does not necessarily need to be standardised across solutions, although there are reuse and switching cost advantages to this. The set of operators described above may materialise in very different forms as EHR solutions get built and implemented. They may be grouped into large sets of proprietary software applications or they may be very granular and based on open service-oriented architecture solutions. But the functions described here will need to be a part of these solutions and more importantly these functions must exist as pan-Canadian EHR standards. *Infoway* is pursuing the development of such standards under the Standards Collaboration Process. More information about the ongoing development of standards is available in section 5.5.

4.3.8 Health Information Access Layer (HIAL)

The Health Information Access Layer acts as a layer to isolate the EHR Infostructure from the world of the PoS applications. Its role is to enable a unified gateway for any PoS application that wants access to the EHRi. In creating this layer of independence, the HIAL isolates any of the PoS applications from the intricacies and complexities associated with the connectivity and integration between the large information systems that make up an EHR Infostructure. As an example, once a PoS application has implemented a set of interfacing standards to communicate with an EHR Infostructure by using the HIAL interface, it will be able to send requests to an EHR and obtain responses.

Within the EHR infostructure, an intricate network of systems and multiple calls between them may have to occur in order to fulfill a comprehensive response to the request. The calling PoS application does not have to understand or worry about any of these interactions as it will get a single bulk response from the EHRi through the HIAL.

As time goes by, the EHR Infostructure will likely see a lot of its components evolve as well. New EHR data domains will appear, new registry capabilities will appear, some components maybe deprecated and replaced with new ones. The isolation enabled by the HIAL insures that these changes will have no impact (or minimal impact) on the transaction interfaces already implemented in any PoS application.

Secondly, the HIAL offers a platform, within the EHRi to centralise many common and reusable functions so that they can be applied consistently for any system participating in the Infostructure. This also insures that investment in them can be leveraged to their fullest extent. Examples of this leveraging exists in the HIAL with authentication services, where a unique and common authentication service can be used throughout the system and applied consistently to any transaction coming into an EHR Infostructure.

4.3.8.1 HIAL Communication Bus Services

This section describes the various service components that make up the HIAL Communication Bus.

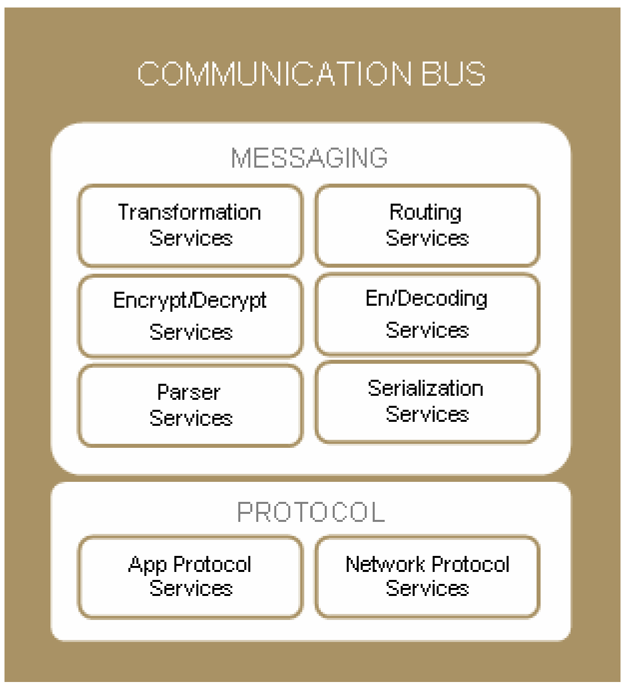

Figure 4-14 HIAL Communication Bus Services

These services support the low-level communication between the EHR Services, other EHRS Business Services and the point of service applications. The following tables' further break down the HIAL Communication Bus Services into a set of functional representation of expected capabilities.

4.3.8.1.1 *Messaging Service Components*

This component is made up of services that handle the message after the application and network protocol wrappers are stripped off by the Protocol service components. Some of the services in this component include parsing, serialization, encryption and decryption, encoding and decoding, transformation and routing. It is expected that jurisdictional EHRi System solutions will combine several of these services into larger self-contained services enabled by commercial software and probably encompassing both the Communication Bus and Common Services layer.

Service Component	Description
Encoding/Decoding Services	These services will encode and/or decode message from and to different coding formats such as Unicode, UTF-8, and Base64 etc.
Encryption/Decryption Services	These services encrypt and decrypt messages to ensure Personal Health Information is not susceptible to eavesdropping or tampering while in transit across networks. Encryption services will be based on industry best practices including consideration for use of IPSEC, X509 V3 digital certificates, and a common set of baseline cryptographic algorithms and key lengths.
Parser Services	These services will parse the messages processed via the Protocol Service Components. The parser will provide support for input formats such as XML, flat files positional, flat file fixed field length etc.
Routing Services	These services will route messages to the various internal integration channels based on a publish/subscribe model and message properties.
Serialization Service	This service will package the message in the destination format from the internal canonical form. This could be XML, flat file positional, flat file fixed field length etc. The serialization service is concerned with data/message construction and transmission.
Transformation Service	These services manage transformation maps and applies them in the transformation of messages from the internal data structures to the desired format during the execution of the message interaction process flow

4.3.8.1.2 *Protocol Service Components*

These service components deal with the network, transport and application level protocols. These services will support pluggable modules to support various application level protocols such as Web Services (WS-I), ebXML, SOAP and remote invocation protocols such as RMI, DCOM, .NET etc. These would typically be available using plug-ins from commercial integration platforms and they will typically be able to operate on different networking protocols. The standards-based approach to the development; implementation and reuse of EHR solutions in Canada will tend to limit the number of such protocols. It is expected that jurisdictional EHRi System solutions will combine several of these services into larger self-contained services enabled by commercial software and probably encompassing both the Communication Bus and Common Services layer.

Service Component	Description
Application Protocol Services	These services will support the use of application level communication protocols to enable communication channels with PoS applications or other EHR Infostructures. These protocols are focused on handling payload as well as application level wrappers for messages or other types of communication streams. Such protocols include Web Services (WS-I), EBXML, SOAP and

Service Component	Description
	others.
Network Protocol Services	These services handle the network protocols that provide communication capabilities over physical networks. The primary network protocols that will be supported are TCP/IP and HTTP.

4.3.8.2 HIAL Common Services

This section describes the various service components that are part of the HIAL Common Services.

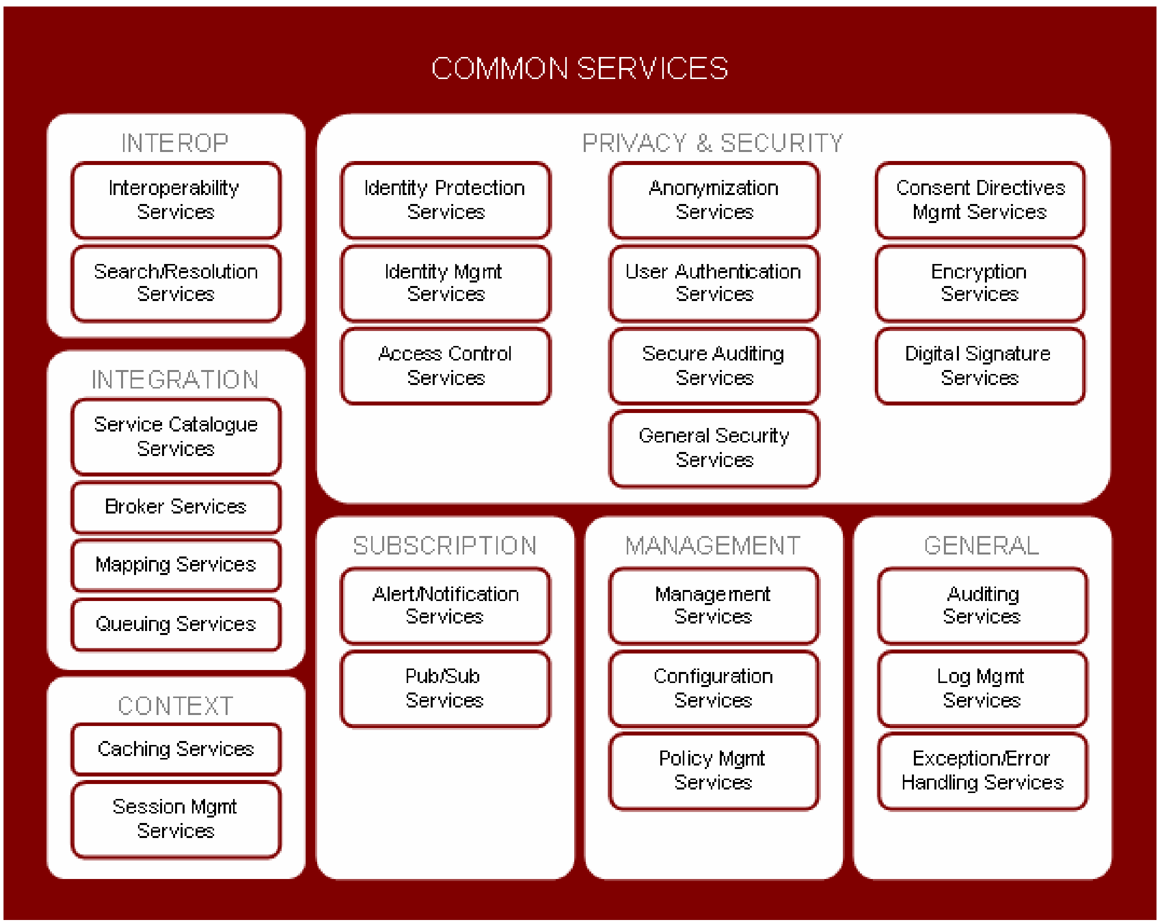

Figure 4-15 HIAL Common Services

These services provide common software functions (e.g. error handling, security, message communication etc) reusable across the EHRi System. It is expected that jurisdictional EHRi System solutions will combine several of these services into larger self-contained services enabled by commercial software and probably encompassing both the Communication Bus and Common Services layer. These services have been grouped into the following categories for the purposes of documenting the EHRS Blueprint system architecture.

4.3.8.2.1 *Context*

These services manage the context of a PoS to EHRi system interaction as well as provide caching and session services.

Service Component	Description
Caching Services	These services are used to manage the cache and will provide functions related to cache responses based on configured settings. These settings may include time to live, persistence, cache cycling, role based caching etc.
Session Management Services	These services manage user sessions. A user session will contain information such as session ID, function and role information, authorization information and other information that the system may choose to store to provide efficient access to information.

4.3.8.2.2 *General*

These components provide services for auditing; log management and general error and exception handling

Service Component	Description
Auditing Services	These services provide the capability to configure auditing of information and provides the interfaces that would need to be accessed within other services for audit support. The audit service will manage its own data source and use other services such as orchestration, data service, log management services, reporting etc.
Error/Exception Handling Services	These services provide an interface to raise and manage errors and other business level exceptions. Exceptions can range from system/application level exceptions to exceptions found as a result of corrupt or dirty data and other such conditions. The Error / Exception Handling Services will use the Log Management Service to record error information.
Log Management Services	These services are used to manage application, system, security and other such logs. Log events will be raised in various services. These events, based on configuration will be logged in an event log. The log could be persisted in a flat file, a relational database, a system event log repository etc. Other services such as the alert/notification services could be integrated with the log management service to provide other value add capabilities.

4.3.8.2.3 *Integration*

These components provide services that manage integration via message brokering, mapping services, queuing services and service catalogue functions.

Service Component	Description
Broker Services	These services read the structured business message to understand the type of transaction being processed. Based on this, the entire tranaction is brokered as a unit to the proper service for execution. This may be the orchestration services if a formal orchestration flow needs to be used, or it may be brokered directly to a Registry, EHR, Ancillary or Data Warehouse Service depending on the type of Infostructure Interoperability Profile.
Mapping Services	These services help create a map file that translates a source document format to the destination format. This service can be used to map from XML to flat file and other formats and vice versa.
Queuing Services	These services provide store and forward capabilities. They can use message queues as well as other persistence mechanisms to store information. They can be used for asynchronous types of operations.
Service Catalogue Services	Every business message that is supported by the EHR is registered using the service catalogue services. These services manage the service catalogue along with a service description. Proxy generators can use service description to create proxy classes.

4.3.8.2.4 *Interoperability*

These components provide services that handle search / resolution functions which interact with various repositories, registries. These components also include services that provide interoperability between EHRi's such as handling the execution of transactions with remote EHR Infostructures. Interoperability between EHRi systems is instantiated by way of exchanging standard messages and business transactions from one EHRi system to another. The HIAL will use Interoperability services to trigger and manage these inter-EHRi transactions.

Service Component	Description
Interoperability Services	These services are used to manage the invocation of service from the HIAL towards different systems inside a given EHR infostructure (Registries, Ancillary, EHR Data or Data Warehouse services) or when transactions need to launched towards remote EHR Infostructures.
Search/Resolution Services	These services are used to handle the specific interactions with resolution services such as the ones offered in client, provider and location registries. These services would also be involved in the use of EHR Locator services.

4.3.8.2.5 *Management*

These components provide services to configure the EHRi system and the associated HIAL as well as providing services to carry out management functions.

Service Component	Description
Configuration Services	These services are used to configure the EHRi. This could include configuration of the SHR data repository, the overall system, the metadata, the service components, schema support, security, session and caching mechanism etc. They offer an opportunity to centralise the mechanisms and processes used to configure and manage the parameters that affect the behaviour of separate pieces of an EHR Infostructure.
Management Services	This service provides a common interface to manage and monitor various aspects of the EHRi. Whereas configuration services handle the system level configuration, management services handle the user configuration aspects of the system. Management services also offer monitoring capabilities where administrators can track the ongoing operational performance of an EHR business service.
Policy Management Services	This service manages policy profiles based on the jurisdictional governance policies and procedures to control the operation of an EHRi system. It supports centralized management and parameterization of polices for multiple EHRi components and services.

4.3.8.2.6 *Privacy and Security*

These services offer the specific capabilities required to protect a patient's privacy and to apply the privacy and security policies recognised in every jurisdiction.

Service Component	Description
Anonymization Services	These services protect a patient's privacy and security by ensuring the patient's information used within the context of the EHRi system and outside the normal delivery of health care services (e.g. in planning, administration, and some forms of research) does not reveal the patient's identity to unauthorized users
Consent Directives Management Services	Consent Directives Management Services translate privacy requirements arising from sources such as legislation, policies, and individuals' specific consent directives, and applies these requirements in an EHR environment. These services are applied to Personal Health Information (PHI) prior to providing access to or transmitting PHI via the EHRi to determine whether or not patients'/persons' consent directives allow or restrict the use and/or disclosure of PHI. These services also allows EHRi users to manage a patient/client's specific consent directives, such as blocking or masking PHI from a certain care provider or disclosing PHI without consent for emergency treatment, as required or permitted by law.
Identity Protection Services	This service resolves the identity of a patient/client to an EHR Client Identifier (ECID). Patients/clients will typically be identified by a public identifier such as

Service Component	Description
	a Health Card number that correlates to one ECID in each identity domain containing Personal Health Information (PHI) about the patient/client. An EHR Client Identifier is a protected information that is only known to systems “above the HIAL”.
Digital Signature Services	Digital signatures are created by users of PoS applications to ensure the non-repudiation of clinical data such as: a data file, a record, a field within a record, a security assertion, or an XML document, including elements of an HL7 message or object rendered as an XML document. This service verifies a digital certificate has not been revoked prior to the generation of the signature.
Encryption Services	These services include: • Key Management services to create and manage secure encryption keys for data storage • Database encryption services to encrypt and decrypt fields (columns) and records (rows) within database tables to protect PHI and other security critical system data in active use within the EHRi • Data Storage Encryption services to encrypt and decrypt files and other data blocks and is used to protect data (other than databases – see above) in active storage, backup, or long-term archive.
General Security Services	The following general security services are only briefly described in this section because their implementation will be inextricably tied to jurisdictional variations in EHRi operations and in part because there is nothing in the design and deployment of the services which is unique to a healthcare environment. These services include: • Scan for and protect against malicious programs • Secure Backup/Restoration of data • Data Archiving • Secure Data Destruction
Identity Management Services	These provide foundational services for other higher-level services such as user registration, authentication, authorisation, including generating unique identifiers for users, looking up user ID for a user, suspending/revoking user access
Access Control Services	These services determine the user’s role based access permissions to the EHRi application functions. These services also provide the capability to configure and manage permissions to users and more specifically defined roles for access to functions and data.
Secure Auditing Services	These services provide the ability to report on the system(s), user(s), provider(s), patients/clients, and health data involved in each EHRi transaction. They are also critical to meet other operational needs such as system administration and transaction monitoring and recording significant

Service Component	Description
	privacy and security related events.
User Authentication Services	This service validates a user's identity. This service is called upon in the context of the execution of transactions between PoS applications and an EHR Infostructure to authenticate users involved in transactions.

4.3.8.2.7 *Subscription*

These services provide the capabilities to subscribe to events and manage the alerts and notifications functions when enabled.

Service Component	Description
Alerts/Notification Service	Alerts are parameters that a user can specify to control a system or agent's behaviour. When an alert condition trips, the service will notify the user. This service ties into and works very closely with the Publish/subscribe service described below. An example of an alert could be "Alert me if the blood test result is outside the normal range". The notification service could then post a message for the ordering physician with the result along with other relevant information.
Publish/Subscribe Service	This service manages subscribers and publishers. It provides functions at two levels. One at the integration level where subscribers are provided with content according with the mechanisms defined by the integration parameters. The other is set at a higher level, where users can subscribe to specific content. When the specific condition is observed or a subscribed content is published then the user is notified with that information. Alerts and notifications are handled by the service described above.

4.3.9 The EHR Viewer

The EHR Viewer is a web based application that will provide access to client's electronic health records for end users. The objective of the EHR viewer is to create a user friendly environment where authorised health professionals can easily access the data kept in the EHR about their clients. The EHR Infostructure is made up of several domain system solutions each targeted at a specific audience of health professionals. For example, the DI domain service is predicated on the needs of radiologists and radiology staff, the pharmacy domain is focused on the needs or prescribing physicians and the pharmacists filling these scripts. Each of these domain solutions offer an end-user interface capability which is typically specific to the set of data and special functions required by the domain at hand.

The EHR viewer is different in that it is meant to be generic and focused on enabling a cross-domain integrated view of any information available in a client's health record. This includes data tied to any event tracked by the EHR Index including registries, EHR data repositories and ancillary services. As EHRi Systems are implemented, evolve, and mature over time it is expected that users will want functions provided by an EHR Viewer to be integrated into their existing PoS applications or other Web enabled applications. For users who do not have access to these types of systems, the viewer will always provide a "standalone" user interface to the EHR. The following diagram presents the positioning of the EHR Viewer in an EHR Solution and clearly shows how it exists as another PoS application set to interact with the EHR Infostructure through the same standards-based communication mechanisms that other PoS applications would use.

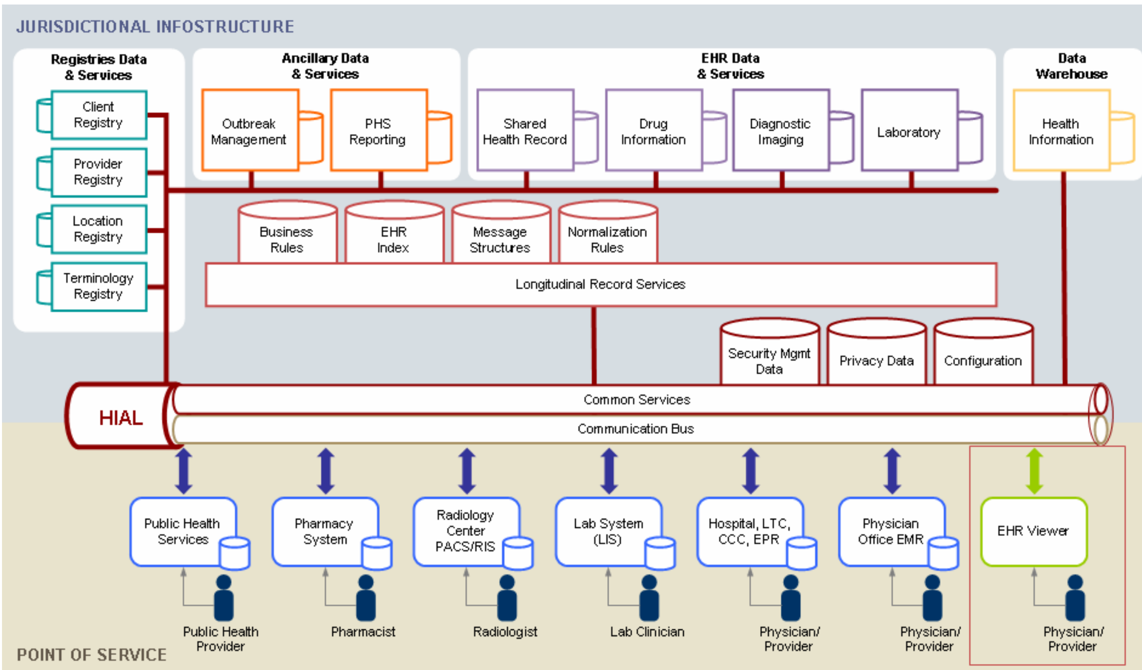

Figure 4-16 EHR Viewer as PoS application in an EHR Solution

Note that the EHR Viewer is included as just one of the many "Point of Service" applications, but it is distinguished by the fact that it does not rely on a local data store (i.e. the blue cylinder shown with the other PoS systems), but must obtain all its information from the EHRi

The EHR Viewer deals with the presentation of EHR data to end-users using software solutions that have been in existence and in use in hospitals and other facilities for years. Since there is a mature market for these solutions and since the EHR brings a whole new perspective on their potential use, it is expected that there will be different technical approaches considered for the EHR Viewer. The following sections will layout these different approaches. To do so, the framework offered by the Gartner Generations Model for CPR Systems (see section 3.4.1) is used to delineate the generations of capabilities expected of the EHR Viewer.

4.3.9.1 Gen 2 Solutions (EHR Thin Client)

The simplest model is that of a view-only, web-based clinical application that allows providers to access their patients' longitudinal record through the EHR infostructure. Clinical portals are the best example of these EHR Thin Client.

The Gen-2 solution is effectively the "ideal" EHR Viewer: web application, with no local storage and fully leveraging the EHRi for retrieving a patient's longitudinal clinical information.

Different approaches are seen to delivering a Gen-2 EHR Viewer solution:

- Extending the user interface from a Commercial Off-the-Shelf (COTS) Clinical Information System (CIS) application to move beyond the acute care setting to family physicians and other clinicians.
- Using a specialized application for viewing images and other non-structured objects (e.g. videos, voice, etc.)
- Developing a tailored solution using COTS portal technology
- Using one of the new generation of Clinical Portals

COTS CIS

The use of COTS CIS is an attractive option for smaller jurisdictions that have standardized and integrated their acute care hospitals using the same vendor solution. In this case, it is a natural progression to extend that solution to external users, leveraging the technology and wealth of data available within the CIS.

Very often this approach reduces the time required for the rollout and reduces project risks as the solution is already known and in operation within the jurisdiction. However, current licensing models may increase the cost of this type of solution, in particular because these user interfaces provide much more then just viewing capability (this will be discussed in more detailed in sections 3.4 and 3.5 ahead).
Another characteristic of many CIS systems is the use of “rich-clients” that are not necessarily web-based systems. In these cases, the application is likely to be deployed using Microsoft Terminal Services, Citrix, Tarantella or similar technologies. Besides adding another layer of software to the solution, these products will also increase the TCO of the approach. Some vendors do provide their clients with a choice between “rich” and “thin” clients, but often these do not have the same level of functionality, ease of use and extensibility.

When compared with the requirements for the EHR Viewer, the COTS CIS can provide many of the necessary functions, but currently existing products have some issues that will have to be resolved. In particular, CIS are not typically aware of any EHR Data beyond that which is contained within their own repository. These systems will have to be somehow made EHRi aware, so that they can search, display and retrieve the EHR Data together with their own internal records. These solutions could also be deployed in stand alone mode to leverage only their data presentation capabilities. In other words, purchase this kind of solution but only to leverage the clinical viewer portion of the product. Again, key issues arise as vendor licensing patterns typically work awkwardly for this, and more importantly as products are not design inherently to act in this capacity which usually results in a lot of overhead software operating with very little added value.

Specialized UI

A second family of Gen-2 EHR Viewers includes what we shall call “Specialized UI”. These are applications that provide sophisticated capabilities for not only viewing but also manipulating EHR Data. In particular these systems provide tools (or larger toolkits) to manage, transform, and convert images and other multi-media objects. The most common example we have seen are the DICOM image viewers typically available from PACS vendors.

These UIs still provide many of the characteristics of the more general EHR Viewer described previously, although due to their very nature, these solutions tend to be limited to a particular clinical domain (e.g.

Diagnostic Imaging), rather then providing, out of the box, full cross-domain longitudinal records. Although this might seem to be a severe restriction, there are two typical approaches that have been used to mitigate the issue.

The first approach is to use "context-sharing" (also know as context management) between the specialized UI and a more full-feature viewer, such as the COTS CIS viewer described in the previous section. Context sharing is the term used to describe technologies that allow two separate applications to share some limited amount of knowledge about what is happening (the context) in each system. Typically these applications will share simple elements of data, such as which patient is actively being viewed by the user. So in our example, if the user selects a different patient using the CIS, the identifier for that patient is "shared" or "passed" to the PACS viewer, allowing it to switch its view to the very same person. To the user this is seen as an automatic synchronization, saving him/her from having to make the switch manually. The same is true if the CIS knows about a specific DI study ID, in which case the DI viewer can not only switch to the appropriate patient, but also bring forward the images associated with a particular study that has been selected by the user.

Over the last few years, we have seen many different ways of accomplishing this context-sharing but in healthcare one particular mechanism, CCOW, has been quite successful and has become a standard for the industry. Today, many commercial applications claim to be CCOW compliant. In addition, IHE has created specific integration profiles that help developers implement plug-and-play capabilities, including the ability to deal with situations where the two (or more) applications belong to different patient identification domains.

The second approach leverages the linking and re-directing capabilities of web technologies (HTTP). In this approach, one of the applications (typically the CIS or EMR system) contains links to the corresponding object (for example the DI study). Obviously, this knowledge would have to be shared directly between the two host applications and not through the corresponding viewers. Once the user selects one of these links, the main application will generate a redirection to the other application through the URL associated with the link, invoking the specialized viewer to display the desired image. This approach has been used very successfully in many settings and is the most common technique used with DI viewers, although it is more easily deployed in settings that allow for single sign-on capabilities between the applications.

Although the DICOM image viewer is the most prominent example of specialized UI, it is not the only one. Similar solutions exist for viewing scanned or bitmap documents (e.g. PDF viewer), movies (e.g. JPEG) and sound. Also, some early adopters of EHR repositories, in particular for Drug Information Systems, have implemented specialized UIs for e-dispensing, e-prescribing and access to patient's drug profiles. These solutions are certainly simpler then the DICOM example, but leverage the same integration approaches described above.

Tailored UI

The next family of solutions includes projects that have preferred to develop a tailored system built on COTS portal platforms. Starting from a detailed set of user-defined requirements, developers create a new user interface with the desired capabilities, look-and-feel and customization features. Depending on which portal technology is used, many of these features will be provided directly by the tool and the developers can focus their efforts on screen flows, look-and-feel design and cross-links between the various data elements.

The advantage of this approach is that the final product will be tailored to user's expectations, avoiding unnecessary complexity and feature overload. It also allows the creation of UIs that follow existing guidelines for graphics, language support and seamless integration with the EHRi, other non-EHR repositories and clinical systems (such as the specialized UIs described before).

On the other hand, tailored solutions have issues of their own. First, software development has inherent risks, costs and complexities that have caused many similar projects to fail. For those projects that are successful, there are still on-going issues that have to be addressed, such as the on-going support and maintenance of the solution.

Also, user interface design is a complex practice as it must address several usability issues. The final product must provide a solution that allows the clinician to easily and quickly select their patients, display an index and/or summary of their EHR Data and drill-down, on-demand, to any item of interest. CIS vendors invest significant resources, time and money over several years and with feedback from many users to build a satisfactory solution. These systems have evolved into the clinical portals that are described next.

Clinical Portal [12]

Finally, the fourth approach is to use COTS clinical portal technology offerings. Since there are many current definitions for a clinical portal, for the purpose of this paper we shall consider solutions that are:

1. A commercial product offered and supported by a software vendor
2. Specifically designed to provide a clinical results view of data to the physicians
3. Web enabled application that allows remote access from any location, including, for example, a caregiver's home where no special software has to de downloaded.

There are at least two types of vendors providing portals today: (1) CIS vendors who build extensive connectivity to their own products and provide some level of integration to other third party products, and (2) systems integrators that work to bring a common view to many disparate applications.

The typical profile of the CIS vendor portal is:

- Integrates their own applications to a Web view
- Provides either a pure Web view, a view through Citrix (e.g. terminal server); or both
- Connects to other system via a URL link
- Finds integration with other vendor's legacy application challenging
- More rigid view of the data and less customizable

The typical profile of the pure Web Portal provider (i.e. system integrators) is:

- Recognize the needs of large environments with many source systems for clinical data
- Offer a portal approach for dealing with complicated multi-vendor environments
- Allows tailoring with custom views
- Provides high levels of integration expertise
- Less likely to compete with single-vendor, fully integrated environments

The difference between the CIS portal and the COTS CIS described previously is that the portal is a new class of applications designed specifically for the purpose of integrating multiple views of data for a large cross-section of clinicians, while the later is simply an extension of an application originally designed for a user working within a hospital environment. In this sense, the CIS portal is very similar to the pure Web

[12] Some of the information contained in this section was adapted from the KLAS Physician/Clinician Portal Study (September 2005)

portal, with the exception that it will provide a much tighter integration with the vendors' own suite of clinical applications.

Both classes of solutions have much in common, in particular their heritage links to the Web portal technologies developed in the last decade. Created for the purpose of bringing together large number of information sources into a single view, web portals have become the de facto standard for web integration. It is only natural that Clinical Portal vendors have incorporated many of the features and capabilities of these more generic tools into their solutions. Some of the critical portal features by which these product will be evaluated and measured by are:

> ***Personalization*** is a critical feature of the physician's portal. Personalization allows each physician to have his/her specific view of what is seen and how it is displayed. Power users of the system are more likely to customize their view to enhance workflow and get quick and easy access to patients' data.
>
> ***Display Management*** is the ability to appropriately pull disparate information together in a productive view. Data coming from several systems can be displayed on one view for the physician or clinician. This assists with medical decision-making, time spent finding information and ease of use. The customization of workflow by role is considered an important portal feature.
>
> ***Single sign-on (SSO)*** is a key benefit for users. Clinicians do not want to individually authenticate to every systems he/she looks for information.
>
> ***Context Management*** described previously is another time saving capability. It is unproductive for clinicians to look for an individual patient in separate systems and it also avoids the possibility of errors that can occur due to the different approaches systems have to identifying patients.
>
> ***Access Controls and Consent Management*** is critically relevant to the use any data access tool in any field that touches personal health information. Features that allow for the management and application of privacy related requirements and policies need to exist as integral and not second thought add-on capabilities to these portal environments.

There are many other important features that will distinguish Clinical Portal solutions, but early adopter projects have shown that the five described above are essential to the success of any implementation.

Clinical Portals solutions are still in their early generations and more new products and vendors are becoming available in the market.

4.3.9.2 Gen-2 (plus) Solutions

In many cases, basic Gen-2 EHR Viewer solutions are not sufficient to meet the business requirements for a particular implementation. Often, access to additional information beyond what is provided by the EHR repositories is needed as well. Although the actual functionality varies between jurisdictions, typically Gen-2 (plus) solutions will allow their users to access:

- external knowledge bases, such as drug formularies, medical journals, reference libraries, etc.
- other, non-EHRi sources of clinical patient centric data, such as hospital information systems (e.g. HIS, CIS, PACS, hospital pharmacy, ADT, and others), clinical domain repositories, provider billing records, etc.

It is expected that in most cases these "extended" viewing capabilities will be mostly inherent to the portal technology used in the viewer. This should be particularly true with the clinical portal products as they have been designed to facilitate integration with a broad set of information sources. Tailored solutions might or might not have the same level of extensibility, depending on how they have been implemented.

For the purpose of evaluating these solutions in the context of the EHRS deployment, Gen-2 and Gen-2(plus) systems should be considered as essentially equivalent, since in either case the primary purpose of the solution is the access to the EHR data provided by the EHRi. These additional viewing capabilities will only be relevant to specific jurisdictions and will not likely evolve into common, Pan-Canadian requirements. Consequently, they will not be the subject of any Infoway managed standards development initiative. However, these functions can be of vital importance to the clinician community and a key motivator to the wide adoption of the EHR solution within the jurisdiction.

4.3.9.3 Gen-3 (light) Solutions

The next level of EHR user interfaces includes solutions that provide some basic capabilities for data entry. To distinguish these systems from the true Gen-3 ("The Helper") solutions, they will be classified for the purpose of this document as ***Gen-3 (light).*** These systems should provide all the capabilities of a Gen-2 or Gen-2 (plus) solution and complement these with one or more simple update actions such as:

- electronic signing of documents and reports;
- adding observations to any part of a patient's EHR (e.g. health status indicators, a personal note attached to a lab result and/or a structured encounter summary).
- secure messaging (e.g. e-mail)
- data entry forms for reportable diseases in pubic health
- etc.

Although simple in nature, these functions can have a profound impact on the EHR viewer users. The KLAS Physician/Clinician Portal Study notes that:

"The ability to approve (electronic signature), from their home or office after they have seen a report is important for improving productivity and timely turnaround, *adding a strong reason for a physician to use the portal.*"

In fact, 76% of respondents to the study identified "Electronic Signature" as one of their main uses of a clinical portal, while only 12% selected "Order Entry".

As with the Gen-2 (plus) solutions, this class of user interfaces complement the EHR viewing functions with several "value-added" features that promote the adoption of the solution. They differ from a full Gen-3 solutions (described next) because they lack the more complex decision support functions required for order entry.

4.3.9.4 Gen-3 Solutions

The final class of EHR user interfaces is the Gen-3 Solutions ("The Helper"). These include applications that have integrated EHR viewing capabilities (Gen-2) with sophisticated workflow tools such as:

- Computerized Physician Order Entry (CPOE) – ability to order tests (i.e. Diagnostic imaging, procedures and laboratory), prescribe and dispense medications

- Enterprise Scheduling – ability to request and update appointments for procedures, consultations and other medical encounters across a large number of points of service
- Case Management – ability to view and manage multiple encounters and events relating to the treatment for a patient with a specific problem across a the continuum of care (e.g. diabetes)

Typically, these functions are supported by evidence-based rules and algorithms (e.g. Drug Utilization Review – DUR) that help the physician or clinician complete their task and can avoid some not-so trivial errors (e.g. drug-allergy interactions) or even suggest some preferred alternatives for a given clinical situation (e.g. CAT scan v. simple x-ray).

These Gen-3 solutions and decision support algorithms rely completely on the availability of reliable, structured clinical data about the patient in order to reach their full potential and benefits. They are a natural evolution of the prior classes of EHR viewers and UIs and provide a strong argument for the accelerated availability of an EHR.

4.3.9.5 EHR Viewer Services Architecture Breakdown

The following diagram presents the generic functional breakdown of the services expected of an EHR Viewer.

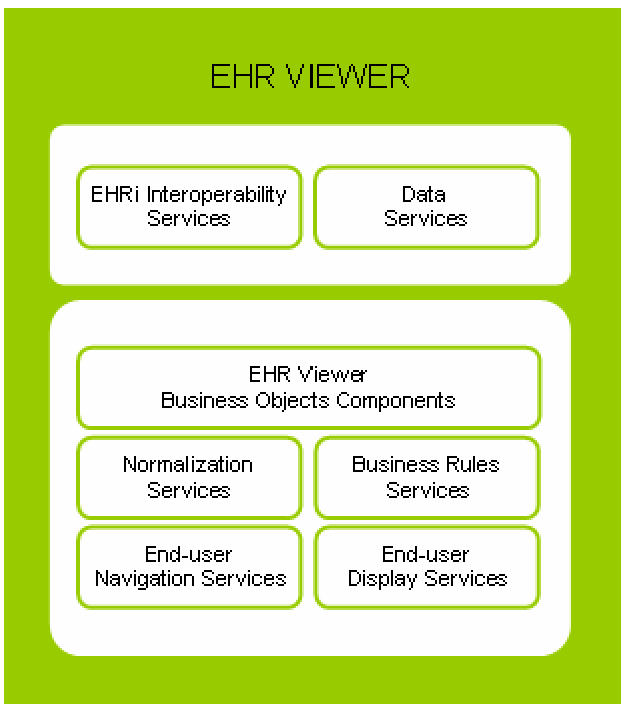

Figure 4-17 EHR Viewer Services

4.3.9.6 Visual Integration with PoS applications via CCOW

For some EHRi System implementations, it may be desirable to integrate the functionality of an EHR Viewer with existing PoS applications that participate in an EHR solution. One way to achieve this is through a technical approach called “Visual Integration”. Visual integration is the capability of one application to be controlled by another application at the user interface level. Clinical Context Object Workgroup (CCOW) is an HL7 standard that supports visual integration. It is vendor independent and allows clinical applications to share information at the point of care.

An example of Visual Integration is when a PoS application, such as a Clinical Information System (CIS) that is CCOW enabled sees its user interface layer modified such that it can execute another separate application (e.g an EHR Viewer) within the same session with the ability to exchange context information such as user id and patient identification data between them. The end result would be a user seamlessly interacting with the CIS user interface as well as having the ability to execute functions of the EHRi System via the EHR Viewer user interface without re-keying information such as their user id, password or patient identity information.

This approach will allow PoS vendors who support the CCOW standard, a quicker way to enable the use and adoption of the EHRi System within the context of their applications.

4.3.9.7 EHR Viewer Requirements

The EHR Viewer requirements listed below are presented as a suggested set of valid functional and technical requirements:

General Requirements

- As an instance of a typical web application, the EHR Viewer does not persist any clinical data locally. Users can access the same patient information regardless of which workstation they are logged on.

- The main purpose of the EHR viewer is to provide users with a window into a patient's longitudinal record. Consequently it must be able to display any EHR data available in the EHR repositories (SHR, DI, Rx and Labs, Registries and other ancillary data services).

- Registries should be the only source of EHRi identifiers for the EHR viewer, in particular when selecting clients and providers or resolving the identity of a service delivery location.

- Provides capabilities to search for patients using the services of the EHR infostructure client registry services;

- Provides capabilities to navigate easily between clients records while maintaining user-specific session context information such as user id, password and patient identifying information

- Provides capabilities to remember a list of active patients with optimized mechanisms to access the records of patients on the active roster (pre-emptive querying, caching, etc…);

- The EHR index contained within the longitudinal record services (lrs) should be the starting point (i.e. level 1) for any and all historical (i.e. longitudinal) queries into a patient's EHR. The EHR viewer should allow users to "drill-down" into any specific event, document or other published items that are indexed by the LRS.

- For a given selected client, provides capabilities to represent an overarching view of the contents of the client EHR;

- Provides for different approaches to these overarching views, e.g. accessing a client EHR by events sorted by dates, by provider, by service delivery location, accessing by specific domains represented in view panes, etc…;

- Provides easy and flexible information navigation features such as changing sort orders on lists, or changing column locations, variable visible lengths, etc…;

- The EHR viewer is used in the context of supporting live day to day care delivery activities for different types of caregivers. Use cases of an EHR viewer include a general practitioner gaining access to a client's health record during a patient interview or in the immediate context of that interview. To favor the adoption of these solutions, the EHR viewer needs to be easy to use and navigate, easy to learn, efficient in the way it presents data and very effective in the way that it interacts with an EHRi to access the data being presented or navigated.

Privacy & Security Requirements

- The EHR viewer should be deployed at the jurisdictional level and leverage the EHRi trusted model for security purposes. In other words, users should be registered and known to the EHRi domain.

- Provides capabilities to interact with the user to execute authentication and authorization access controls by applying policies, rules and controls maintained in the EHR Infostructure HIAL and applicable to EHR access by end-users;

- Provides features to apply jurisdictional policies for consent management e.g. break the glass features, consent collection, etc…

- Logs all system/user transactions that result in an access or update to any component of the EHRi System within the appropriate system secure logging mechanisms

- Utilizes existing technology and industry standards where applicable, such as LDAP based authentication, authorization or Web Services Security model

Technical & EHRi System integration requirements:

- The EHR viewer application accesses all the EHRi services through the standardized messages that implement the EHR interoperability profiles (eip)

- Interacts with an EHR Infostructure using pan-Canadian EHR technical standards including the support of standard protocols support for:

  1- structured data messaging interface
  2- unstructured document messaging interface
  3- BLOB streaming communication interface
  4- security management communication interface
  5- system management communication interface

- Relies on pan Canadian EHR standards for all interactions with the EHR Infostructure. This includes data messaging standards, vocabulary standards as much as protocol and other technical standards.

- Runs on any client side desktop / laptop/ wireless computing device that supports any current industry standard web browser

- Relies on industry recognized web based approach to a “thin client” solution that minimizes the cost of ownership including the maintenance and evolution costs. E.g. Uses a Web interface with no requirement to download code other then the use of applicable run time compiled objects or scripting languages such as Java, .Net or JavaScript to a client computing device

- Based on recognized web portal technologies that provide for a flexible, open, component driven, service oriented application architecture e.g. web based portal and portlet technologies

- Provides the ability to be integrated easily into an existing PoS application user interface environment based on open W3C standard interoperable technologies such as HTML, HTTP, XML etc

- Provides the ability to be integrated with existing Point of Service applications at the user interface level using context management technologies and standards such as CCOW i.e to transfer the context of a user session and patient identity between one or more software applications

Performance / Scalability requirements

- Provides high performance when accessing client EHR data. Any single access to the EHRi for data communication must provide a visual response back on the end-user screen within 5 seconds 80% of the time.

- Has the ability to support all projected users for an EHR Infostructure

- Has the ability to support user request / transaction peak volumes for expected user base within an EHR Infostructure

- Supports the concept, design and implementation of a service based n-tiered architecture (I.e. not client server) with loosely coupled software components that allows new functionality to easily be changed or added

Language requirements

- Presents all electronic literals and reports viewed by clinicians or to patients in English or French depending upon their language preference.

- Present all screens and reports configurable by a user in English or French.

- Allows an end-user to switch dynamically between English and French

4.3.10 Interoperability Profiles

Interoperability Profiles are used to describe the requirements and context of use of an EHR infrastructure. In essence, the collection of interoperability profiles collectively describes the transactional nature of an EHR Solution. There are two types of Interoperability Profiles. The first type is an **"EHR Interoperability Profile" (EHR IP)** that describes the interface between a Point of Service (PoS) application and the EHR Infostructure seen as a single EHR business service accessible through the standardised communication mechanisms of the HIAL. Each EHR IP expresses a type of transaction request that an EHR Infostructure will have to process and respond to.

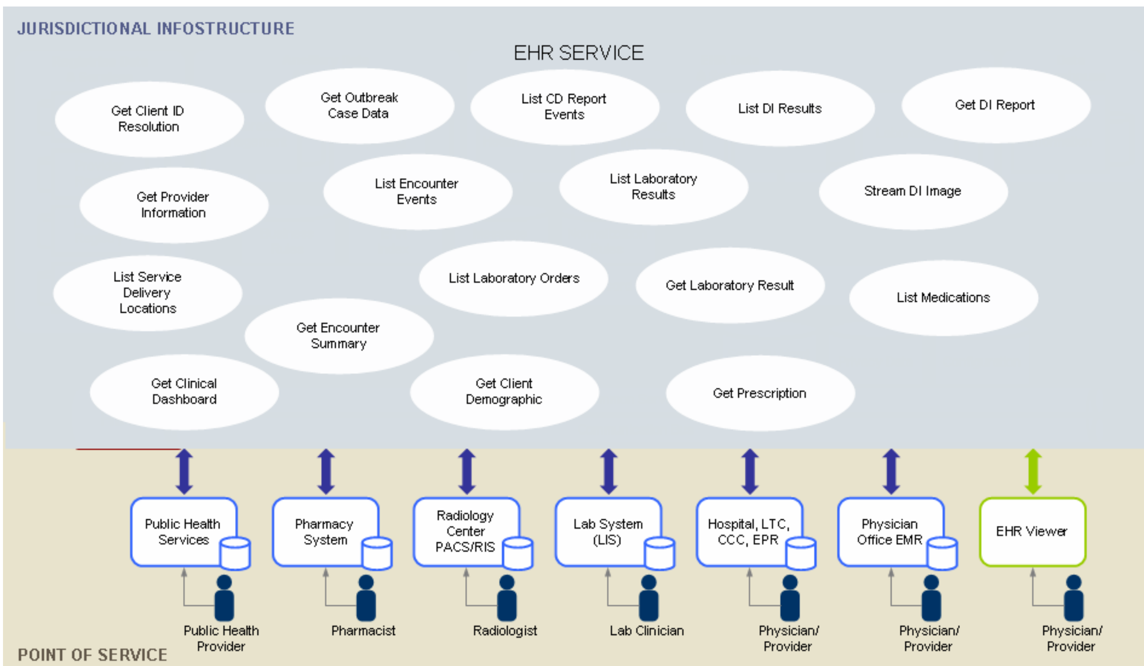

Figure 4-18 EHR IP

The second type is an **"Infostructure Interoperability Profile" (I-IP)** that describes sequence of activities and services interactions that need to take place inside the EHR Infostructure in order to fulfil an EHR IP request. Both EHR IPs and I-IPs are used to express functional requirements for interactions located at different levels. They are not intended as actual technical specifications of communication interfaces between parts. Rather, they express a context and a set of functional requirements for the use of such technical specifications. For example, the implementation and realisation of any given EHR IP will require specific HL7 Messages, IHE integration profiles or other technical standards, as a set of technical specifications used to fulfil the requirements expressed by an EHR IP.

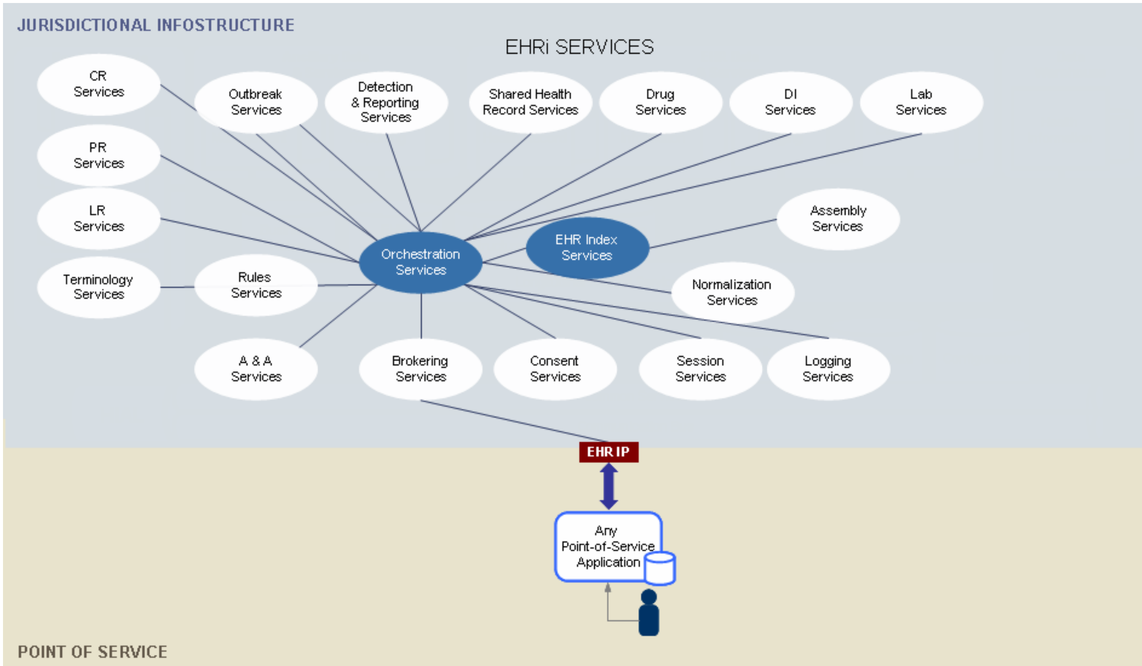

Figure 4-19 Infostructure IP (I-IP)

EHR Interoperability Profiles (EHR IP)

EHRIPs are created to support the end-user functional requirements and assumptions for use of an EHR Solution described in the EHR Use Cases. They describe the functions PoS applications are expected to perform including the service request interactions with an EHRi System in the context of daily work activities for caregivers. Each EHR IP includes descriptions of :

- The use of one or more EHR Communication Steps to define the specific interaction sequences between PoS applications and an EHRi to fulfil the EHR IP;
- The service invocation requests, i.e. which I-IP will be invoked, that will be made to an EHRi through the EHR IP;
- Which data is to be exchanged by referring to data views of the data model.

The following diagram shows the parts that describes a PoS application interaction with the EHRi System

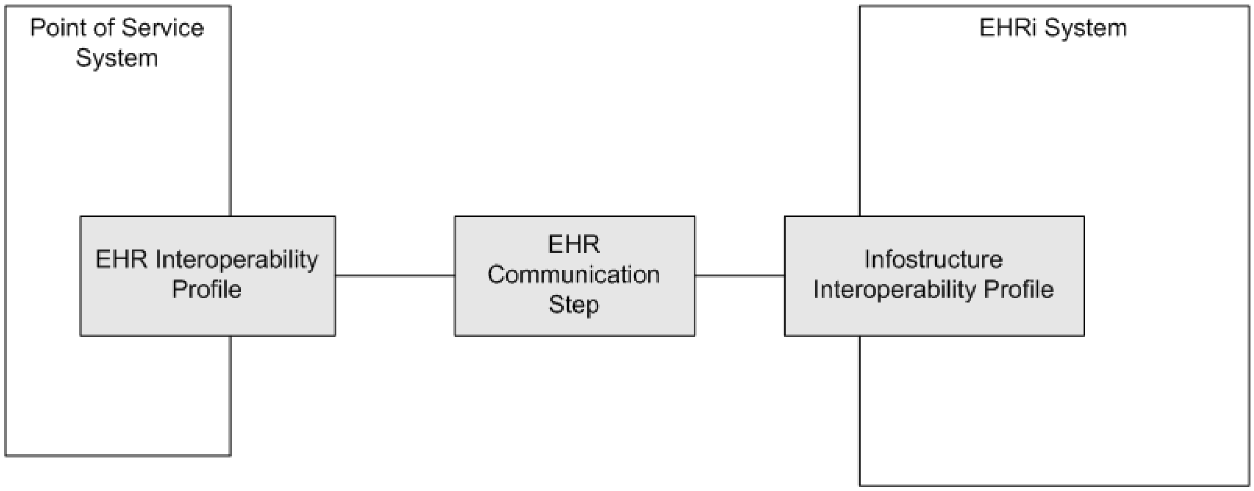

Figure 4-20 PoS to EHRi Interaction

The following is a sample list of EHR interoperability profiles that a PoS application could use to interact with the EHRi.

EHR IP	Description
Get Client Encounter Summary	Request the detailed information about a specific encounter summary event available in the EHR of a given client
Get Client Identifier Resolution	Request the resolution of client identification from the EHR based on a set of search criteria. The response could include a list of candidate responses if it cannot be resolved to a single match. If it is conclusive then the response includes demographic data and a specific set of public identifiers for the specific client. The ECID (EHR Client ID) would not be provided back in the response as it is defined as a proprietary ID used only in the EHRi.
Get Provider Identifier Resolution	Request the resolution of provider identification from the EHR based on a set of search criteria. The response could include a list of candidate responses if it cannot be resolved to a single match. If it is conclusive then the response includes demographic and professional data and a specific set of public identifiers for the specific provider. The EPID (EHR Provider ID) would not be provided back in the response as it is defined as a proprietary ID used only in the EHRi.
Get Laboratory Result Details	Request the detailed information about a specific laboratory result event available in the EHR of a client.
Get Provider Role Details	Request the details about a specific assignment of role to a given Provider

EHR IP	Description
Get Communicable Disease Report Details	Request the detailed information available in the EHR about a specific communicable disease report event
List Encounters/Visits	Requests the list of available encounter related events (admission, discharge, transfers) in the EHR of a given client
List Medication Profile	Request the list of available drug related events available in the EHR of a given client
List Health Profiles	Requests a list of health profiles recorded and available in the EHR of a given client
List Providers	Request a list of known providers from the EHR based on a set of search criteria
List Provider Laboratory Results	Request a list of known laboratory results available in the EHR and destined to a specific Provider
List Client's Providers	Request the list of providers involved in offering services according to events published in the EHR of a given client
List Location Communicable Disease Reports	Request a list of communicable disease report events for a given service delivery location or for a collection of service delivery locations
Put New Client	Requests the addition of a new client record in the EHR.
Put New Prescription	Requests the addition of a new unfilled prescription in the EHR of a given client
Put New Client Consent Directive	Request the addition of a new consent directive in the EHR of a given client
Put New Consent Override Reason	Request the addition of a new log record in the EHR of a client to justify the override of consent directives
Put Update Lab Order	Requests a modification to existing data already recorded in the EHR for a given Lab Order of a given client
Put Update Client Demographic Data	Request a modification to the demographic data in the EHR of a client
Put Deactivate DI Result	Request the inactivation of an existing diagnostic imaging result in the EHR of a given client

The table provided above presents examples of valid EHR Interoperability Profiles. The actual EHR Interoperability Profiles for each domain of use of an EHR will be established and documented through the pan Canadian EHR standards development initiatives attributable to each domain. These transaction patterns are further documented in the EHRS Reference Architecture where a fully documented set of sample transactions is represented in a CASE (Computer Assisted System Engineering) tool environment. More information about the EHRS Reference Architecture can be found in section 5.0

Infostructure Interoperability Profiles (I-IP)

Infostructure Interoperability Profiles are focused on the internal processing that needs to go on in an EHR Infostructure in order to process an EHR IP. Infostructure Interoperability Profiles establish the basic requirements for the processing steps required in the execution of a transaction. Their definition achieves the following:

- Present a functional view of the capabilities required inside an EHR Infostructure solution to process transactions
- Present and help standardise the activities and sequences of processing of EHR transactions. This is seen as critical to achieve interoperability and highly opened reusable services based solutions for EHR Infostructure components.
- Enable a language and a framework to entertain advanced design level decision making to address optimisation patterns and scalability discussions in the context of procurement, assembly, configuration, test planning and operations planning for EHR Infostructure solutions.

The following table presents the generic transaction patterns forming the base Infostructure Interoperability Profiles of an EHR Infostructure:

Infostructure Interoperability Profile (I-IP)	Description	SCP EHR Standard
I-IP Get	This is the generic transaction pattern used to access the detailed data associated with an event maintained in a person's EHR. Allows a calling PoS application to request the retrieval of the clinical data associated with a specific event from the EHR. This is typically called upon following the use of a List Event transaction and the invocation parameters include the specific Event Id being queried as well as all of the other basic identifiers required to process a query transaction with the EHR. This would include the Client ID, Provider ID, Location ID, PoS Application ID, User ID. From this invocation, the LRS will establish a context to process the transaction and will proceed to query the EHR Index and subsequently registry, EHR or Ancillary data domain services in order to assemble a response and send it back to the calling application. Certain types of events will represent groupings of events, and queries to access them may generate elaborate responses representing the details of many sub-events. The query for an Encounter Summary may spawn queries towards sub-events included as part of that Encounter's data. See functioning principle section for more details on	TBD

Infostructure Interoperability Profile (I-IP)	Description	SCP EHR Standard
	transaction scope and expected interaction behaviours.	
I-IP List	This is the generic transaction pattern used to find data in a person's EHR. Allows a calling PoS application to search for event(s) based on a set of search criteria. Invocation parameters include the type of search being performed, the search criteria (date range, type range, etc…) as well as all of the other basic identifiers required to process a query transaction with the EHR. This would include the Client ID, Provider ID, Location ID, PoS Application ID, User ID. From this invocation, the LRS will establish a context to process the transaction and will proceed to query the EHR Index in order to assemble a response and send it back to the calling application. The scope of access of a List Event is limited to the EHR Index data and metadata. The search process may spawn search queries to other EHR Infostructures if required. Types of searches include search by client, search by provider, search by location search by user, and potentially others. See functioning principle section for more details on transaction scope and expected interaction behaviours. List operations will require a paging ability that needs to be pervasive across all services involved in fulfilling a list request.	TBD
I-IP Put (New Event)	This is the generic transaction pattern used to create data in a person's EHR. Invocation parameters include the type of I-IP being performed, the created data as well as all of the other basic identifiers required to process the transaction with the EHR. This would include the Client ID, Provider ID, Location ID, PoS Application ID, User ID.	TBD
I-IP Put (Update Event)	This transaction pattern is used to complete a clinical data update transaction. It is assumed that the data being updated was previously searched and retrieved from the EHR, so that unique identifier of records are available when updates are sent to the EHR. Invocation parameters include the type of I-IP being performed, the unique event identifier for the event being updated, updated data as well as all of the other basic identifiers required to process the transaction with the EHR. This would include the Client ID, Provider ID, Location ID,	TBD

Infostructure Interoperability Profile (I-IP)	Description	SCP EHR Standard
I-IP Put (Deactivate Event)	PoS Application ID, User ID. This transaction pattern is used to complete a clinical data delete transaction. It is assumed that the data being deleted was previously searched and retrieved from the EHR, so that unique identifier of records are available when updates are sent to the EHR. Invocation parameters include the type of I-IP being performed, the unique event identifier for the event being updated, updated data as well as all of the other basic identifiers required to process the transaction with the EHR. This would include the Client ID, Provider ID, Location ID, PoS Application ID, User ID.	TBD

The number of actual Infostructure Interoperability Profiles is unknown today and may vary between EHR Solutions as they get procured, assembled and implemented in the coming years. The expectation is that there will not be a one to one association between EHR IP's and I-IP's. The table above presents a highly generalised model that will definitely need to be refined in the context of true implementations and as different types of EHR IP transactions are being considered for use in EHR solutions.

That said the ability to rely on a highly standardised approach to do this can only be beneficial to the stakeholders that face the challenge of implementing and operating these solutions. A set of technical standards needs to be established so that I-IP's can easily be transported from one EHR Infostructure solution to another without having to rely on system developers and some form of updates to the software code of a solution. The work of the OASIS organisation (http://www.oasis-open.org/) on web services with protocols such as SOAP, EBXML and WS-I are promising alternatives to achieve this degree of standardisation. Whatever protocols are chosen, they have to be implemented uniformly across EHR Solutions to achieve the promise of interoperability and the economies of scale warranted by service oriented architectures and reusable solutions.

These transaction patterns are further documented in the EHRS Reference Architecture where a fully documented set of sample transactions is represented in a CASE (Computer Assisted System Engineering) tool environment. More information about the EHRS Reference Architecture can be found in section 5.0

4.4 INFORMATION ARCHITECTURE

This section focuses on the definition of the information maintained in an EHR Infostructure. It describes the different data domains in the EHRS. The data domains represent the highest level groupings of data, which are then refined into classes and then into entities and their attributes. This section that takes a viewpoint focused on describing the classes of data that will be found in an EHR Infostructure as well as a definition of the logical links between them, is an extension of the other aspects of the conceptual architecture.

The following figure presents the highest level view of the EHRi Conceptual Data Model (CDM). A detailed diagram and its documentation is available as part of the EHRS Reference Architecture. The highest level representation of the EHRi data model is focused primarily on a depiction of the transactional nature of an EHR Infostructure solution. The role of the EHR Infostructure is to recognise and maintain information about patient/client related events that occur in the health system. This is the focus of the highest level representation of the CDM. From that highly generalised representation, one can derive definitions of specific classes of information that will be associated to different event types.

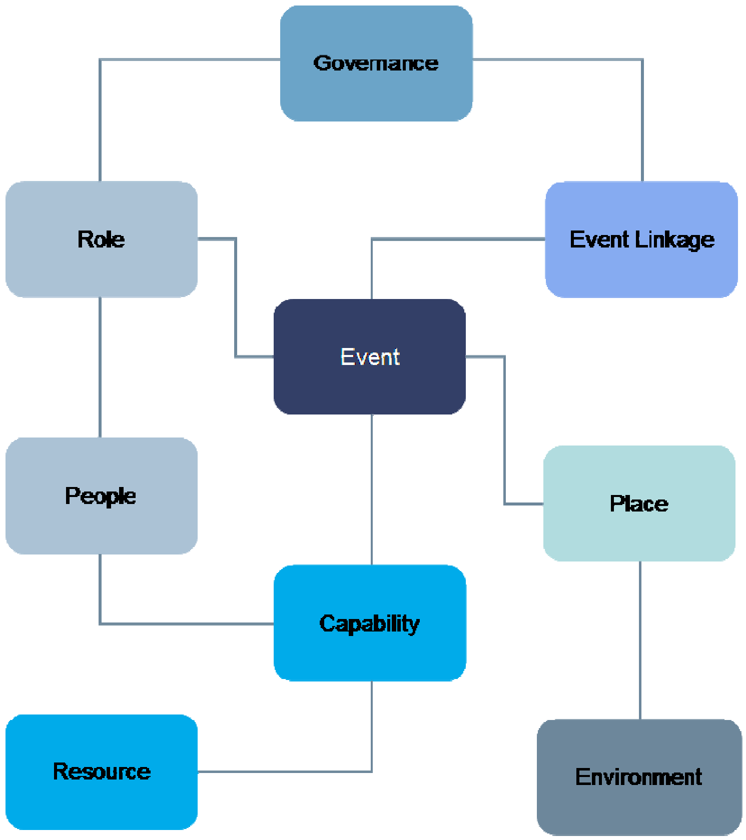

Figure 4-21 EHRi Conceptual Data Model

This data model presents a generalisation of the data used in the context of an EHR Infostructure that maintains person specific health data deemed as clinically relevant for sharing by the caregivers who provide health services.

The expressions: “person-specific”, “clinically-relevant”, and “relevant-for-sharing” help define the scope and range of data stored in the EHRi.

The term “***person-specific***” means that all data in the EHRi must be connected to a person/patient. This is in support of the primary purpose of the EHRi, to support effective delivery of health services to individuals. The EHRi is not intended to contain things like: information on staffing levels for an organization, information used for running of departments, or information on supply inventories.

The term "***clinically-relevant***" helps in further defining the scope of data in the EHRi. Every person receiving health services in the Canadian context of universal accessibility has the right to expect that all clinically objective and quantitative information that affects the quality, appropriateness, and timeliness of their care is made accessible to health service providers appropriately engaged with that person. For example all direct observations, test results, diagnostic images, medications prescribed and dispensed all represent clinically-relevant information that must be shared.

The term "***relevant-for-sharing***" assists those who are sources or capturers of the kinds of data described here to further decide what, when, and how that data needs to be provided. This is an extremely important point: the shared EHR is **not** a mirror image of **everything** that exists at the Point-of-Service. For example, clinicians often keep subjective notes about patients that are used as personal cues to assist in treatment. The clinician might wish to share this subjective information with a specialist in a referral, for example. In that case, the information might be incorporated into a patient summary document provided for the specialist to access from the EHRi. In this case, the clinician decides on the clinical relevance and that they feel they need to share it in the best interests of their shared patient/client.

Moreover, both historical and scheduled health service events are considered clinically relevant. The knowledge of past clinical encounters as well as imminent encounters, test orders, imaging procedures, or outstanding prescriptions is very useful information to a health service provider in a clinical context.

A borderline concept is that of problem lists. Problem lists and other "working information" used by a clinician is certainly potentially useful information, but whether they must be shared or are optionally shared is something that health service providers themselves will need to establish as the effects of having a shared EHR manifests itself in the evolution of current professional practice.

Having said this, the term "clinically-relevant" also means that not all data about patients is necessary to be shared. For example, a clinician's subjective observations that are used primarily as cues for their engagement with a patient are not necessarily relevant for health services provided by others. In this sense, this information is about the patient, but only for the clinician who recorded it, and is not copied to the EHRi. However, in some cases the clinician may wish to annotate the Shared Health Record with information that other clinicians may find useful and may materially benefit the patient. The EHRi will support methods for storing subjective observations made by any health provider that they wish to have associated with the patient's EHR.

In the same sense, intermediate test-results or any transitional information that leads to a direct observation are not necessary to be shared in the EHR.

NOTE: The EHRS Blueprint Enterprise Architecture uses a messaging paradigm that ensures that no person or system will ever have the ability to directly and freely access the shared EHR repositories. Any CIS or other application that participates in the EHR infostructure does so by exchanging data through carefully defined interfaces that ensure consistent logging, auditing, and management of these accesses. Furthermore, it should be noted that only the data elements authorized under the legislation of a given jurisdiction will be available for sharing.

Event Based Data

The data in the EHRi is event-based. This means that, at the most fine-grained level, all information in the repository is tied to an event that has either occurred in the past, is occurring now or is planned to occur in the future.

All information about a person/patient is tied to events. Examples of events include examinations, review of test results, a new lab result becoming available, writing a prescription, surgical interventions, diagnostic testing, interviews and clinical assessments, immunizations, radiotherapy, chemotherapy, counselling, etc. just to name a few.

The key to recording these events is to accurately, consistently, and unambiguously identifying who the client is, who the provider is, what type of event occurred, where the event occurred, when the event occurred, and the detailed data about the event. To do this uniformly across all possible sources and care settings require use of shared registries for client, provider, and location, and using standardized representations of the events themselves and the detailed information kept for any event type.

Data Communication

The simplest metaphor is that the PoS applications and EHR infostructure speak to each other using pre-defined, standardized, and constrained language. The *Infoway* Standards Collaboration Process ensures that as these interfaces are designed and built, their purpose and the content they exchange will be defined by representatives of those health service providers who will both capture and use this information. Standards established by the *Infoway* Standards Collaboration Process can be found at: http://forums.infoway-inforoute.ca .

4.4.1 EHRi Conceptual Data Model

The EHRi Conceptual Data Model (ECDM) provides a framework for the development of repositories to share clinically relevant patient/client data in an EHR infostructure. The ECDM is derived from the Canadian Conceptual Health Data Model (CHDM), which is a product of the CIHI Partnership for Health Information Standards. The use of the CHDM as a baseline is very important, as that model had already been validated as an effective, flexible, and comprehensive model from representing data collected and used in the Health sector in Canada. It has the added advantage of being a model that was developed from a clean slate and in consideration of all of the service delivery disciplines and setting, not a model that was derived from one particular clinical perspective and then “stretched” to incorporate other viewpoints.

As it was developed, the ECDM was also mapped against certain reference models to be sure the ECDM would support concepts as they were represented in these specific models:

- Clinical Information Project v1.1 March 31st, 2005, Australia
- Electronic Medical Summary, March 09th, 2005, British Columbia
- CDS / EmHR Project v1.9, May 20th, 2003, Ontario
- Public Health Surveillance Model v4, September 24th, 2004, Canada Health *Infoway*
- Corporate Conceptual Data Model v1.0, October 19th, 2004, Quebec

During these mapping exercise, specific classes/sub-classes/entities and their attributes were analysed and “placed” in the class representations of the ECDM. While the ECDM has not been extended to explicitly model these concepts, it was demonstrated that virtually every concept expressed can be represented in the ECDM.

The ECDM was also actively aligned with the HL7 Reference Information Model (RIM) version 2.08. The core concepts in the ECDM map readily to the RIM, but more than that, many of the key attributes of the ECDM have been adapted directly from the RIM. This is very important considering that most of the clinical content provided to, and accessed from, the shared EHRi repositories will be done using HL7 v3.0 messages that rely on the RIM for their payload definitions. This greatly simplifies mapping from the messages to the target repositories.

The resulting ECDM was then captured in UML notation in the EHRS Reference Architecture (ERA). The ECDM is linked to all of the use cases captured as part of the Clinical Reference Framework within the ERA. For an interactive walkthrough of the ECDM, go to the EHRS Reference Architecture available through the Artefact Repository.

To help illustrate how the ECDM would be applied in various used cases, views were also created that were specific to some of the use cases and EHR Interoperability Profiles. An example is provided here for the ECDM View - Register New Patient.

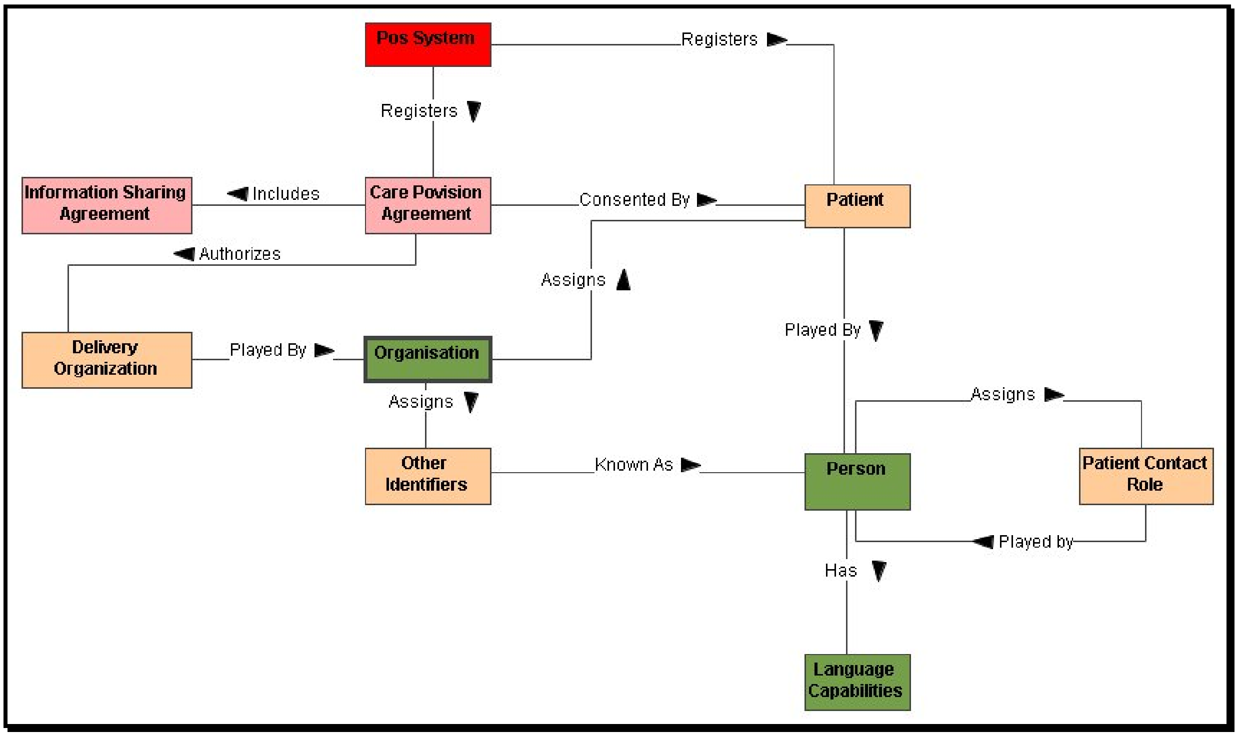

Figure 4-22 ECDM View - Register New Patient

The ECDM was not fully attributed as part of Blueprint v2.0. The model is expected to be populated at a logical definition level by *Infoway* projects as they work on particular clinical domains. Each project is expected to work from the model and then provide their updates and revisions to the original model. Review and approval of ECDM revisions will be the responsibility of the *Infoway* Solutions Architecture Group and will be managed through the iEHR pan-Canadian Standards Working Group.

The following section describes the concepts expressed in the ECDM.

4.4.2 EHRi Data Domains

The data domains of the EHRi Conceptual Data Model (CDM) are listed here:

- The event domain
- The event linkage domain
- The governance domain
- The people domain
- The place/environment domain
- The resource domain
- The role domain

In this section, each domain is introduced and high level view of the key relationships between domains is expressed.

The Event Domain

The event domain is the foundation of the definition of an EHR Infostructure from a data perspective. The clinical data shared in an EHR is always associated with the event from which it was generated. The event domain is used to represent and describe the different types of events occurring in the health system. Its scope is limited to the types of events that have value for the sharing of patient/clients' electronic health records.

An event is generally defined as "a situation considered as occurring, a record of a change in state of some object of interest at a particular time." The notion of time expressed in this definition maybe a single point in time or a time span defined by a starting point and an end point.

The Event Linkage Domain

The event linkage domain describes associations between events. Events are recorded in an EHR Infostructure as they occur. Depending on the capabilities of PoS applications that will feed events to the EHR Infostructure, data may or may not be present to recognise how a given event is associated with other events that have already been recorded in a person's health record. For example, when a laboratory result is produced and entered in a laboratory facility information system, that system will publish that result to the EHR Infostructure. When it does that, it may or may not have the ability to pass on enough information to recognise what laboratory order had generated the execution of the laboratory test. Similarly, it may or may not be able to pass on enough information to recognise the health encounter context under which that laboratory test had been ordered.

Nevertheless, the EHR infostructure is expected to support the capability to associate events between each others, and the event linkage domain is there to represent the data required to support this capability. The EHRi needs to recognise different types of associative relationships between events, such as historical links, composition links, dependency links and correlation links. Third and fourth generation software solutions need to be created to fully exploit this capability of the CDM.

The Governance Domain

The governance domain represents the information kept in an EHR Infostructure about any structural entity or policy that dictates, predicates or otherwise influences the rules of operation of the electronic health record service available in a jurisdiction. This domain represents a data definition for classes of objects that would often be recognised as metadata in a system. Objects such as accountability rules for information sharing, health service programs, policies stemming from legislation or adopted standards are examples of the types of entities included in this domain.

While this domain is represented in the conceptual data model, this does not mean that such entities must be established in the Point-of-Service applications that provide data to the EHRi. The classes of objects represented in this domain may well be populated through the application of business rules on message interactions between the EHRi and PoS applications. For example: a "Care Provision Agreement" could be created the first time the EHRi associates a particular Provider with a specific Patient. These information concepts represented as part of the governance domain are definitely needed to establish and operate an EHR Infostructure solution which is why they are represented in this model.

The People Domain

The people domain includes all entities or classes of information used to represent persons, organisations or other types of groups that participate in the health system. Basically the people domain is meant to address the information required in an EHR Infostructure so that we can recognise who a health event is about, i.e. the patient(s), and who is involved in the health service offering associated to the event, i.e the caregivers and the organisations that they belong to. A key concept included in the definition of the people domain is the notion of groupings, which may represent a group of patients being the object of health event. An example of this would be a cohort of patients involved in a communicable disease outbreak under the public health service domain.

The Place/Environment Domain

The place and environment domain can be summarized as being the information describing the concept of location in the EHR Infostructure. Basically this is where we address the question of the "Where" of the health events in a person's health record. Through this domain we describe the information kept in an EHR to address where a health event occurs, where an organisation is located, where a facility is located, where an accident took place, where a patient receives homecare services, etc… The Place domain supports the concept of a discrete coordinate such as a physical address, or a set of boundary coordinates that contain other "Places".

"Environment" is defined as the set of physio-chemical attributes that are present at a Place at a particular point in time. This concept, linked to the Place domain, is the key to many Health Surveillance requirements where environmental factors affect the health of persons or when vectors for communicable diseases need to be isolated. In this sense Environment is not meant to represent socio-economic or other frames of reference that depict the context within which a person exists.

The basic concept of a uniquely identified Place is a fundamental building block for the EHR, however the manner in which this and Environment are modeled will also support other more advanced capabilities that will be required by third and fourth generation applications.

The Resource Domain

The resource domain maintains information about the different types of resources used to fulfill the health activities that get represented as events in the EHR Infostructure. The information maintained in this domain is used to answer the question of "what resources were involved in delivering a given health service". The scope of the resource domain includes human resources, equipment resources, information resources, physical resources and supply resources.

The set of capabilities of any given resource is also maintained in association to this domain. The capabilities of a resource are a key aspect of the information required to apply policies and business rules in the EHR Infostructure. The resource capabilities may state for example that a human resource of type "doctor" cannot practice between date X and Y.

This domain will be very important when scheduling, wait listing, and other 3rd and 4th generation solutions are incorporated in the EHR infostructure.

The Role Domain

The role domain maintains information about the competencies that a certain type of entity can assume as it is involved in obtaining or providing health services. Roles are generally allocated to people or resources. Classes of roles include, provider, service recipient or client, supporter, authorized information recipient, authorized system user, authorized application, governor or administrator and delivery site.

Key domain level relationships

The following relationships exist between the information domains described above.

1. Events are linked to each other through the Event Linkage domain;
2. Events are associated to people and resources that participate in events through instances of roles they play;
3. People and resources are located in places.
4. Environments are the characteristics of a Place at the time they are measured.
5. Governance rules define events, event linkage, roles, resource capabilities and places.

4.4.3 Clinical Terminologies

4.4.3.1 What do we mean by clinical terminologies?

Standards are a key foundational element of the pan-Canadian EHRS. The importance of standards, including standard clinical terminologies to ensure interoperability of clinical information in the EHR, is broadly recognized.

In order to realize the benefits of an interoperable EHR, it is paramount that common clinical terminologies are used for any health information that needs to be shared between health information systems. However, the “universe” of clinical terminologies in health care is vast and complex. Overlapping within this universe is common. Each terminology has different scope, granularity levels, and inherent quality. While the iEHR could choose from a dozen or more terminologies for coding clinical information, interoperability is clearly impossible if all these terminologies were allowed. The combinations and permutations of sending and receiving EHR data would mean dozens of mapping solutions to create and maintain. However, a *common terminology standard* for the interoperable EHR allows patient data across the clinical spectrum to be encoded with the same coding system, thus enabling electronic healthcare systems to understand one another’s data – facilitating semantic interoperability[13].

Various types of information needs in delivering and managing patient care have resulted in different levels of codification of health care information. These codifications or ‘terminologies’ are *standardized ways to describe and share clinical information*. The levels of codification can be identified as Reference

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[13] Semantic interoperability can be defined as the ability for information from many different sources to be meaningfully understood, compared, and measured. The most fundamental level of semantic interoperability is that which supports consistent human interpretation, the most desirable form of semantic interoperability is the next level, which is computable semantic interoperability. This later from of interoperablity is only possible with standardized terminologies.

Terminology, Classification and Group. The word ‘terminology’ typically encompasses all three levels. Figure 4-4 identifies the general purpose of each level and provides examples for a health problem. The type of terminology required for the iEHR is at the Reference Terminology level.

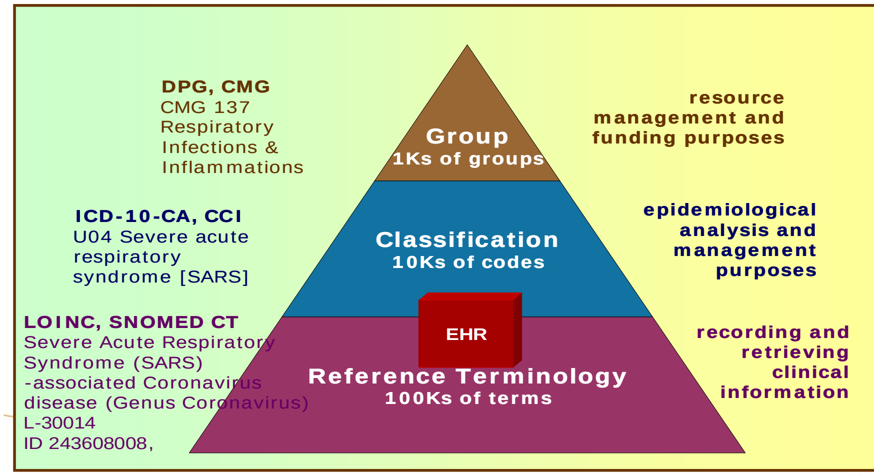

Figure 4-23 Reference Terminology, Classification and Group

4.4.3.2 What groups of information will be the object of clinical terminology standards?

Some examples of the types of clinical information that should be standardized in the iEHR are:

- Problem – clinical condition added to a problem list by a healthcare provider during an encounter.
- Family history – any significant health problem, diagnosis, or procedure pertaining to a member of the patient's family that may indicate a risk factor for the patient's health
- Clinical findings – clinical observations, assessments and information about recurring undiagnosed health problems, or chronic health conditions experienced by the patient, that is recorded by healthcare providers during the course of an encounter with a patient
- Interventions such as prior medical or surgical procedures undertaken::
  - To diagnose a health problem
  - Correct or treat a health problem
  - To support treatment, or
  - To assess the impact of treatment the patient receives.
- The patient’s adverse reactions and/or allergic reactions and severities of those reactions to medications, food, environmental or other agents
- Medications
- Immunizations
- Laboratory tests performed and the results of those investigations
- Alerts and special needs - additional patient information which may indicate the need for preventative measures, or which may affect the delivery of care.
- Risk factors such as physical, social, environmental, occupational, or lifestyle factors particular to a patient that may affect his/her health.

- Diagnosis – the confirmed or suspected nature of the patient's illness or injury

4.4.3.3 What is the process to standardize clinical terminologies?

All *Infoway* standards initiatives leverage the EHR Standards Collaboration Process[14] (SCP) established by *Infoway* to facilitate pan-Canadian review, validation and approval in the establishment of pan-Canadian EHR standards. Pan-Canadian EHR Standards Principles and Guidelines were developed and approved for the selection of EHR standards.

The SCP process is based on a standard life cycle comprising 9 stages as illustrated in the figure below. The focus of Infoway standards projects is on the first 5 stages.

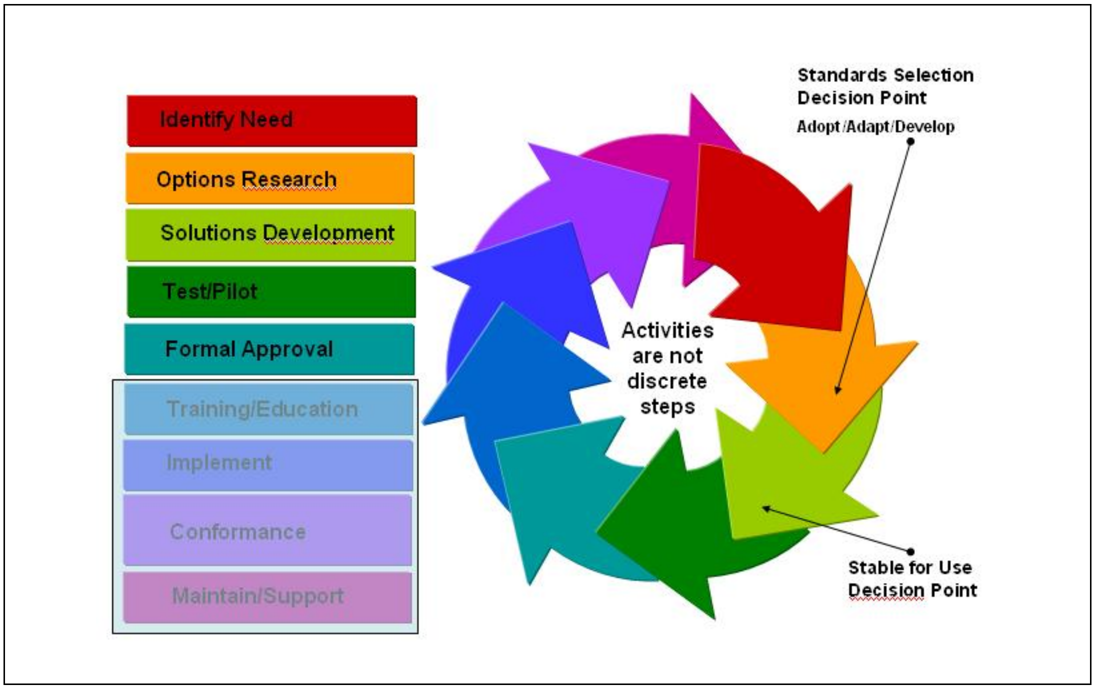

Figure 4-24 Infoway's role in the standards life cycle

The Standards Life Cycle (SLC) contains two decision points that have significant impact on members of the EHR SCP:

- Decision to adopt, adapt or develop a health information standard for use in the pan-Canadian EHR;
- Decision to formally approve a health information standard as a pan-Canadian EHR information standard.

Infoway's role is to ensure that EHR standards are brought to the approval stage.

The document detailing the approach and additional supporting documentation about the current status of the selection and assessment of clinical terminologies and the process to adopt and implement approved

[14] http://www.infoway-inforoute.ca/en/HowWeWork/StandardsCollaboration.aspx

pan-Canadian standards for the iEHR is located on the *Infoway* CTI forum, which is is accessible from the *Infoway* Knowledgeway website[15].

4.4.4 Data Communication

EHR data flows, from a business perspective, between different Point of Service (PoS) systems via the use of the EHRi. The PoS systems could be in different organizations, or in the same organization. In either case the process is the same.

A key point is that the different PoS applications do not communicate with one another directly – they communicate via the EHRi, and therefore there is no need for one PoS system to even know about (or have any code or communication protocols relevant to) the existence of another PoS system. The only knowledge (or interface specification) required for a PoS system is that required to communicate with the EHRi.

In a typical scenario a physician enters medical notes about a patient into PoS System 1. This creates a trigger within PoS System 1 to send the medical notes up to the EHRi. The information is sent from PoS System 1 to the EHRi using a predefined communication protocol – for example, using an HL7 message. The EHRi persists the information in a repository which in this case would be the Shared Health Record repository. In other cases it could be the Drug Information repository, Diagnostic Imaging repository, or Laboratory repository.

Continuing the scenario, at a later stage, an authorized person may want to review the medical notes from another PoS system (PoS System 2), which could be in another organization. In order to do so, PoS System 2 will query the EHRi, most likely using a pan-Canadian EHR Standard message, to request the desired information. The EHRi will retrieve the information from the Shared Health Record repository (or another repository if it was stored elsewhere), format it appropriately and package it into a response message also based on a pan-Canadian EHR standard. PoS System 2 will receive this message, read the information contained in it, and present it or otherwise use it in an appropriate manner.
In summary, the following is the high level business view of the process for data communication between PoS systems:

1. When data is created in a PoS system a trigger is set to send that data to the EHRi using a standards based communication protocol
2. The EHRi receives the data and persists it in the appropriate repository
3. When a PoS system wishes to retrieve data that it does not have locally it queries the EHRi using a standard communication protocol
4. The EHRi searches in the Longitudinal Record Services, namely using the EHR Index service and, if necessary, drills down into EHR Data repositories to find the data
5. The EHRi responds to the query with the data that is found in the repositories
6. The PoS system receives the data and formats it appropriately for presentation

The above description exposes a process by which clinical data is promoted to an EHRi for exposure and persistence into a person's electronic health record. A key principle behind this is that the EHR is predicated on holding and exposing only information that is declared as relevant for sharing on a large scale between PoS organisations or eventually directly with the clients in the health system. It is important to also recognize that PoS organisations may generate, hold and use a much more detailed level of

[15] CTI Forum website: http://forums.infoway-inforoute.ca/CTI/

granularity of information in the context of supporting the operational level needs associated to the delivery of health services. This detailed operational data is expected to live in the PoS application databases of systems used in these organisations.

From a data communication perspective, this detailed granular information may, and in most cases is already being exchanged between systems inside PoS organisations today. In certain cases that fined grained data may also need to be communicated between different PoS organisations and their respective applications. For example, a complete record for a client dealing with cancer may need to be transferred from one hospital to another. This level of communication is of a different nature and may very well use the HIAL services of the EHRi for processing, but it would not interact with the mechanisms of the EHRi to compile or retrieve information from EHR data services. In that context of use, the HIAL would act as an intelligent router. While these transactions may and should also rely on the same standards based communication protocols deployed for EHRi processing, they may rely on different message sets or for that matter different communication protocols as well.

4.4.5 Data Persistence

This section discusses data persistence as it relates to the EHRi. When data that is clinically relevant for sharing is entered into Point of Service application (PoS) by providers, or captured in diagnostic imaging systems, laboratory systems or drug information systems, it should be sent to the EHRi to be persisted within the EHRi.

There are four main repositories used for data persistence within the EHRi:

1. Shared Health Record Repository
2. Drug Information Repository
3. Diagnostic Imaging Repository
4. Laboratory Repository

Other data repositories may come into existence to support ancillary services, namely in the area of public health surveillance, wait list management, case management, etc... The list above focuses on the primary needs of an EHR to support health service delivery.

The EHRi may transform the data that is sent to it as normalisation algorithms may be used to adapt the representation of the information sent to a common language established as a pan-Canadian EHR standard (for use of a specific vocabulary for laboratory orders for example). That said, the EHRi has a responsibility to always keep a representation of the information in the original state that was used when it was communicated from a PoS application. This in turn, means that when data is accessed in the EHR of a client, two separate representations of the information may have to be persisted for any single piece of data, the normalised version and the raw version as it came from the PoS application source.
There have been concerns raised about the duplication of PoS data in the EHRi, and the fact that data previously owned by Providers, and for which Providers have legal responsibilities in many jurisdictions, is now duplicated in another location. For more information on these aspects please see the Privacy and Security Architecture documentation.

From a practical point of view it is not an option to follow an alternative approach (such as jurisdictional indexing mechanisms pointing at local data in PoS organisations) to persisting data in EHRi repositories. That would create additional, unreasonable requirements for many PoS applications that they are not equipped to meet today. There are very different business needs and requirements associated with the nature, type and level of granularity of the data maintained in an operational setting into a PoS organisation (e.g. a health clinic or a hospital), versus the data declared as clinically relevant for sharing across the continuum of care or eventually with clients. For example detailed workflow metadata is usually engrained into PoS application data structures and this data, typically, has very little relevance in the context of an EHR focused on representing the clinical picture of client/patient across the continuum. Also, the PoS applications would have to be as reliable and provide similar uptime capabilities as the EHRi infrastructure, which is not feasible for smaller medical practices such as provider offices where there is a single provider, or only a small number of providers. Thus the data must be sent to the EHRi, where it is persisted and made available in a reliable manner, rather than just storing pointers to multiple local PoS systems.

Once persisted in the EHRi repositories, data should be retained according to the regulations of the jurisdiction holding the data. In many cases this translates to the requirement for retention for an indefinite timeframe.

Data that is persisted in a particular jurisdiction should not be persisted in other jurisdictions – an instance of an EHRi should be designed and sized to store data for that jurisdiction, and to handle requests for data from that jurisdiction as well as others. Therefore, if data is requested from an EHRi in another jurisdiction it should not be maintained or stored in the requesting EHRi.

4.4.6 Data Integrity

Data integrity is about the following very important requirements:

- The data represented in the EHRi has to be structurally sound, meaning that the structures used to communicate and persist the information must be robust, including data types used, field lengths, grouping of information into entities that are logically unique, relationships and their cardinalities between entities properly established to support the business requirements and data access paths to the EHR.
- The information placed into data fields needs to be the appropriate information for each field. In other words, we need to make sure that the client drug code field in a prescription actually contains the drug code and not the therapeutic intent code.
- Finally the need to make sure that the vocabularies or code sets used for any encoded information are properly used and that the descriptors that they point to can be tracked, referenced and used when it comes time to access and represent the information maintained in a person's EHR.

Many different technical, environmental and operational factors can influence the integrity of the data either in the source system where it was originally generated or in the EHRi once it has been promoted to be apart of a person's health record. While every possible means must be taken to insure data integrity from the moment where data is created in an application, it is impossible to control all the factors that can influence it over time. Therefore, it is key that data integrity be addressed specifically a certain points in time. In the context of connecting a PoS application to an EHRi, there are very important points in time where data integrity can be addressed:

- When an EHR Infostructure is being deployed or new or upgraded components of it are being installed. Initial data loads procedures where several sources of data are addressed, sometimes massive in geographical scope and volume, is an ideal time to address the validation of data integrity and the application of corrective measures before data is promoted to an EHRi.

- When a PoS application is being connected for the first time to an EHR Infostructure. As some of the historical data may be promoted in bulk to an EHRi, it is critical to analyse and assess the quality of the data produced or stored in the PoS application. Corrective measures may be applied to insure data integrity before information is promoted to the EHR Infostructure and active connectivity is implemented.
- When a PoS application is being replaced or significantly upgraded. Generally these types of project initiatives conducted in a PoS organisation will and should definitely involve a data integrity assessment and corrective measures if problems are found. In this context, if data from the PoS application had already been promoted to an EHR Infostructure, then the corrective measures need to be assessed in light of the changes they need to affect in the EHR Infostrutcure as well. In the early stages of EHR infostructure deployments, it is highly probable that no automated means of supporting such corrective measures would exist, therefore project teams addressing such upgrades would have to combine specific operational expertise from the organisation managing the EHRi.
- When a specific error or problem is detected by a provider accessing a person's health record. Specific individual problems of data integrity will be identified by end-users. For example a clinical note of some sort represented in text field associated to client demographic information. When these are detected, providers or other types of end-users must have capabilities to alert the system administrators of an EHR Infostructure and highlight these problems. Fixing these issues, would ideally include some kind of feedback mechanism towards the PoS organisations that this data was sourced from.
- In the future, pattern based searching algorithms could be built as part of an EHR Infostructure to run intelligent data integrity detection processes on the different parts of an EHR infostructure.

In general, PoS that provide data to the EHRi must ensure the integrity of their data at the point where it is packaged in a message to be sent to the EHRi. The fact that rigid standards based messaging interfaces are being used to connect to the EHRi will inherently promote a certain degree of data integrity. The above principle (i.e. that the onus is on source systems that supply data to ensure data integrity) applies to all data that is sent to the EHRi, whether via regular messages, or via a batch load interface.

It is important to point out that there is a difference between data quality and data integrity. The above discussion refers only to data integrity, and not to data quality. Thus, the quality of the data is not known by the EHRi. If the quality of the data sent to the EHRi is found to be low, or inadequate, it can not be changed by/in the EHRi. Note that the manner in which the data quality could be found lacking would not be via EHRi services or functionality, but rather by the viewing/reviewing of the information after it was requested by another system or service and presumably by a different provider. In such a case there could be an ability to notify the EHRi of the data quality problems, and then for the EHRi to notify the source system of the errors, which could then correct the data and submit an amendment. The old data would then be marked as "superseded" in the EHRi, and the amended (new) data would then be retrieved for subsequent data requests from EHRi.

4.5 TECHNICAL ARCHITECTURE

This section presents both the functioning principles underlying the proposed architecture and key considerations related to the use of commercial of-the-self solutions (COTS) to build an EHRS.

4.5.1 Functioning Principles:

4.5.1.1 "No home" EHR framework

Each implementation of an EHR infostructure is a peer to other EHRi's. Each EHRi is responsible for holding and orchestrating access to EHR data for every client who has received health services in the jurisdiction the EHRi serves. If a client has, over time, received services in 4 different jurisdictions, then their single virtual EHR actually exists in 4 different EHR infostructures. In this sense, there is no single "home" for the client's Electronic Health Record.

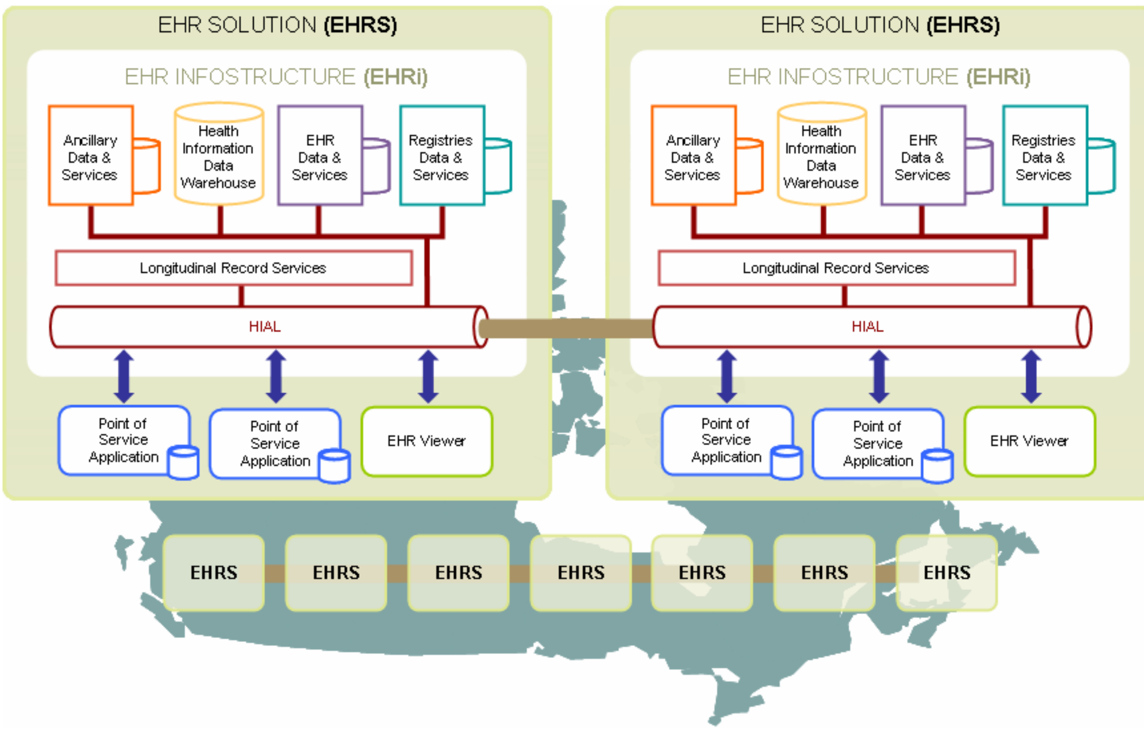

Figure 4-25 EHR as a network of peer-to-peer EHR Infostructures

This is a critically important functioning principle for the EHRi, as the EHRS Blueprint supports this requirement while hiding the underlying complexity of where the information lives from the Point of Service (PoS) applications. As far as the PoS applications are concerned, once they are connected to an EHRi, the data they need to share and the capabilities the application provides becomes part of the EHRi for all of Canada.

In order to provide this level consistency and transparency of the EHR across all jurisdictional implementations, certain architectural constructs are necessary. The following details what is required to accomplish this principle.

The EHRi is supported by a Client Registry (CR) service for the jurisdiction within which the EHRi "lives":

1. If a client is identified in the CR, identity information exists in the jurisdiction, and EHR data may also be available in the jurisdiction (determined by entries in the EHR Index)

2. The CR also contains pointers to other jurisdictions' CR entries if the client has presented for care and has been registered in the other jurisdictions

Because of the symmetric nature of the solution, maintenance of CR to CR linkages is required (and possibly EHR Index to EHR Index linkages):

- Whenever a change is made in one CR, a notification must be sent to all other CRs. It is through this notification that cross-CR linkages are detected and established.

The "No Home" EHR Framework means that:

- no single jurisdictional CR is the "master" for each client's demographics

- no jurisdiction EHRi contains the client's EHR data. EHR data is kept in each jurisdiction where the person has presented for care, for a variety of business and legal reasons.

With this option, a client's demographics and EHR data are maintained in the client registry and EHRi of the jurisdiction in which the person receives healthcare, regardless of whether or not the person is eligible for healthcare insurance coverage in that jurisdiction. This may span multiple jurisdictions over a person's lifetime if they receive healthcare in multiple jurisdictions.

When a client presents for the first time (after an EHRS has been deployed) to receive healthcare service in a given jurisdiction, a health event is elevated to the EHR, in this context the client registry service in the jurisdiction where the event occurs (in addition to making updates to its own database) broadcasts a notification message to all other jurisdictional client registries incorporating the relevant demographic data. Any other client registries containing records that match the demographics in the message return their active demographics for the client in question, and create a link to the other registry on the client's record. In this manner, bi-directional links are established between the jurisdiction in which the event occurs and all other jurisdictions that possess demographics (and associated EHR data) for the person.

The receiving client registry must process this CR-to-CR notification message differently than a notification arriving from a source system. Although we refer to them both as "notifications" and they contain the same data, the meaning of the message and the processing required are different.

When a person changes their permanent residence from one province to another, no action is necessarily taken on the part of the CRs. No demographic updates are made until a person presents for a health service in their new province, at which time the CR is updated and a broadcast message is sent out to other CRs. In some cases, if the client is a visitor to another jurisdiction, they will never be assigned a new public health care identifier for that jurisdiction. However, the CR for the jurisdiction will still be updated to contain their demographic information, linked to the public identifier they have for the jurisdiction they reside in.

Although it's not an integral part of the "No Home" EHR Framework, a client registry will work more effectively when a jurisdictional health insurance system is integrated as a source system to the CR. Jurisdictions implementing these features need to give consideration to ensuring that the development of these functions are done in a privacy protective manner. The use of additional privacy services , such as the Identity Protection Service defined in the PSA are strongly recommended. If this is done, when a person moves from one province to another, the respective client registries will be notified as a normal business process within the health insurance applications, assuming the person is eligible for coverage. As a source system, the health insurance system would send notification of a new client with new demographics to its associated jurisdictional CR. If this notification contains either the previous demographics or the previous health card number, this new client notification will trigger the creation of a cross-CR link with the CR of the province from which the person moved. Note, however, that this requirement for the previous address or previous health card number in order to increase the effectiveness of making cross-CR linkages, makes the health insurance system integration different from other source systems.

Once the jurisdictional CR service has the identifying information for the client, the Longitudinal Record Services (LRS) are the architectural mechanism used to hold and orchestrate access to that information. The LRS that receives the initial request for access to the information from a "local" PoS application, first resolves the identity of the client with its own CR, then checks for the presence of EHR client information in it's own index and other EHRi implementations, forwards the request to the LRS service in the respective peer EHRi's, and then assembles the consolidated results for presentation back to the PoS application. This mechanism has the benefit that each LRS applies the "local" privacy / security constraints to the data it holds, and this assembly of data, compliance with business rules, and auditing of access is all accomplished in a standard manner, without the PoS application needing to be aware of those complexities.

For more information on how client-specific EHR information is held and orchestrated in a network of peer-to-peer EHRi implementations see the sections:

- 4.5.1.2 EHRi Identifier Management
- 4.5.1.4 EHR Index
- 4.5.1.5 EHRi Locator

4.5.1.2 EHRi Identifier Management (Client, Provider, Location)

The EHRi will maintain unique private internal identifiers for Clients, Providers, and Locations that are linked to external public identifiers maintained by their respective registry services. The EHRi internal identifiers are never exposed to PoS applications external to the EHRi.

The main reason for using these internal identifiers rather than public ids is to allow the correct, consistent and persistent association of health information generated from a variety of sources with one client/patient. Considering the vast number of different systems, care settings, and health disciplines represented by shared data in the EHR, the use of this principle in concert with the use of jurisdictional registries allows resolution of data without forcing legacy systems and health system processes to completely readapt to using a single public identifier (although there are benefits to the health system of doing so). There is also considerable benefit to this approach where Client records must be merged or unmerged, or when there are duplicate entries for a particular provider or location. This allows the "detaching" or "reattaching' of information to the correct entities with much less risk and effort.

This section describes how "identifiers" are supported and used for EHRi purposes. This includes the EHR Client ID (ECID), EHR Provider ID (EPID), and EHR Location ID (ELID). These identifiers share the following common characteristics:

1. These identifiers uniquely identify clients, providers and locations for EHR related services and clinical data repositories.

2. The jurisdictional Client Registry (CR), Provider Registry (PR) and Service Delivery Location Registry (SDLR) will create or provide an ECID, EPID or ELID, respectively. This EHRi identifier will be associated with the public identifier(s) managed by the respective registry service.

3. It is proposed that each EHR identifier is an internal, i.e. not published, identifier. It may be described as a "shadow number" in some jurisdictions.

4. In this framework the EHR ID should not be used for any purposes within operational point-of-service systems below the HIAL in the EHRS Blueprint model.

5. The EHR identifier is assigned at the first time a unique new client, provider or location is added to the CR, PR or SDLE. The ECID becomes the client identifier associated with or representing the linkage set if the EMPI function or manual intervention determines that two source system records are for the same Client. The EPID and ELID serve an equivalent purpose for Providers and Locations.

6. A key principle is that there is one, and only one, EHR ID for each Client, Provider and Service Delivery Location within a jurisdiction. For example, if a Provider is identified by two separate licensing organizations the two identities are linked and represented by one EPID. Although this principle is required to ensure the unique identification of patients and beneficial from a design / performance perspective it must be balanced with the need for privacy enhanced system design. The use of the PSA Identity protection Service in conjunction with this functionality should be considered.
7. In the "No Home" EHR Framework, a Client or Provider may have more than one ECID or EPID within Canada, however the Client Registry and Provider Registry within each jurisdiction will maintain pointers to the identifiers in other jurisdictions resulting in a single "set" of ECIDs or EPIDs from a Pan-Canadian perspective.

8. The unique EHRi identifiers will be based on the use of registered Object Identifiers (OIDs), comprised of a "root" component that is consistent for each jurisdiction and signifies "this is for jurisdiction alpha's ECID", and an "extension" that is the meaningless but unique number assigned for each entity (client, provider, or location). See the Functioning Principle in section 4.5.1.19 "OIDS as a Principle".

Public Versus Private Internal EHR Identifiers

While the preferred approach is as expressed above, an alternative to using system generated private internal identifiers for EHR purposes is for the jurisdiction to use existing public identifiers, e.g.:

1. Client identifier such as a health insurance number or health card number

2. Provider identifier such as a provincial registration number.

This however, has certain issues that must be carefully considered. This approach requires, as a pre-requisite, that a jurisdiction formally decide to use identifiers that were set up for health insurance or administrative purposes for the new purpose of supporting the Electronic Health Record. Furthermore, this also requires pervasive deployment and consistent use of these identifier numbers across all clinical systems in the jurisdiction (not just the eligibility and administrative systems). This is a significant change management problem. There are also potential privacy concerns associated with the use of public identifiers as the main identifiers for persisting clinical data in all the systems of an EHRi. Since these numbers are inherently exposed to the public, the level of privacy of the data in the systems of the EHRi is negatively impacted. Jurisdictional privacy legislation, policies, rules and regulations must be considered when determining the privacy implications of this approach.

4.5.1.3 HL7 V3 (Messaging and templates)

*A*ll new communication interfaces for structured and unstructured communication modes between a PoS application and an EHRi or between EHRi's must be deployed using HL7 v3 messaging in compliance with pan-Canadian EHR standards.

More than one communication paradigm will be required for a Point of Service (PoS) application interacting with the HIAL of an EHR infostructure. For example there are requirements for supporting:

- user authentication – in this case LDAP is among many appropriate protocols for consideration
- streaming of images – in this case DICOM or WADO are appropriate protocols
- communication of clinical information – in this case we are prescribing a messaging paradigm using HL7 v3.0 as the protocol of choice

Infoway has opted for HL7 v3 due to its significant advantages over the earlier v2 or non-standard based messaging applications. In addition HL7 v3 is becoming the desired messaging standard of choice internationally for countries working towards EHRs (Capgemini, Sept. 2004, HL7 Inc. presentation, Atlanta). HL7 v3 is being selected as the standard when solutions that offer wide-scale integration are required (city, region, province, nation). V3 also provides support for semantic interoperability – the ability that allows two or more systems to exchange information and use it safely, meaningfully, and reliably

HL7 v3 is still evolving, and is expected to achieve critical mass of market penetration over the next two to five years. Retrofitting interoperable EHR application interfaces from v2 to v3 after they have widespread implementation in Canada would be hard to justify from a costs/benefits perspective. However, a significant amount of new interfaces will have to be deployed in the context of EHR implementation projects. These interfaces may be different in many respects to existing interfaces that might have been communicating similar data in the past. The following are examples of where these differences may come from:

- The interoperability requirements of an EHR Infostructure will require a significant overhaul of the message wrappers so as to include key identifiers required for coordinating data persistence in an EHR. Examples include, the EHR client identifier (ECID), the EHR provider identifier, the EHR service delivery location identifier, the User ID, the EHRi User Role, the ID of the PoS application, the EHR type of transaction and focal act descriptor for a transaction;
- The level of robustness required of the messaging framework will also likely require changes to message envelopes to support the security, guaranteed delivery. These types of requirements are expected to have a different flavour or level of robustness in an EHR service as compared to the types of settings where they might have been deployed in the past;
- The clinical payload for a single data domain (a lab result for example) required through a pan-Canadian EHR standard to nourish the EHR of a client, might have needs for data elements that weren't being communicated by existing messages.

- This last point may also be true for the meta-data describing the content. This is especially true with regards to semantic interoperability, where having context information around any data value may be seen as much more critical then in prior uses of an existing interface. An example would be the descriptors of a coding scheme for a lab result code and its valid range

Ultimately, since many new interfaces would have to be deployed and that costs would be incurred in the projects that deploy EHR Infostructure solutions, it seems logical to try and rely on a standard that is robust and offers a promise of stability for the future.

Having said this, the following points must be stressed:

1. Many vendors have full v2.x messages sets used in active product implementations. These can be considered for reuse as long as they can meet the functional and technical requirements for pan-Canadian EHR standards.

2. In many cases, HL7 v3 standards may not (yet) have a pre-defined message that supports the interaction requirement of a certain domain, in such cases standards projects established under the *Infoway* Standards Collaboration Process will design and develop the required messages. This work will be subject to the processes and methodologies of the HL7 standard organization, HL7 Inc. and will be submitted for eventual standardization at the international and/or Canadian level.

Current Assumptions about HL7 v3 Message Use in EHRS

a) The common elements necessary for any interaction with the EHRi will be mapped to the HL7 v3 message wrappers already defined as part of the standard. These common interface elements will be tested in the early interoperable EHR projects, and validated for use by subsequent projects. This is a significant component of each HL7 v3 message, and is work that will not need to be repeated for every message implementation, it can be reused, leaving only the clinical payload to be defined and agreed upon for other new messages.

b) Another interesting aspect of this asynchronous “Put” of information to the EHRi is that it is not possible to anticipate when and how the information provided will subsequently be used. The context of use that is assumed or established in a more tightly coupled system-to-system interaction cannot be assumed when communicating with an EHRi. For this reason, each “Put” message will need to contain enough contextual information and meta-data to allow the data to be reused reliably and safely.

c) Many messages that are used to retrieve clinical content from the EHRi will be less discrete in the clinical data they return, supporting the transport of larger more complex data constructs with potentially many repeating elements. For example a request to return all of the encounters the EHRi knows about for a particular patient in the last 5 months would return highly variable amounts of data, depending on the number of encounters the patient had and the number of jurisdictions where those encounters occurred. This set of returned data will also change as new source PoS applications are added as contributors to the shared EHRi.

d) The nature of the EHRS as a shared source of clinically relevant data suggests a new kind of sending and receiving responsibility between PoS applications and the EHRi. Queries to an EHRS are likely to be different than those used in point-to-point messaging between PoS applications that are collaborating for a specific purpose. These queries are likely to be higher level with several optional parameters around types of events, types of providers, time ranges, clinical domain content, etc.

e) Some “simple” HL7 v3 queries will result in complex requests for information that span multiple domain repositories, and possibly multiple instances of EHR infostructures. The Longitudinal Record Services (LRS) will be responsible for knowing the location of relevant data, and for passing through v3 queries to other EHR instances, and then collating and applying local jurisdictional business rules (such as Patient and jurisdictional consent and privacy directives) to that information, and then packaging that collected information into one or more response messages as appropriate.

4.5.1.4 EHR Index

The responsibility of the EHR Index within the framework of an interoperable, Pan-Canadian EHR is to offer an efficient discovery mechanism within the EHR infostructure (EHRi) that provides EHR consumer applications a normalized, patient-specific and aggregated list of EHR data components that fit a given search criteria.

The EHR Index holds metadata about each person’s records. As information about a patient is published to any of the EHRi data repositories, the repository sends selected attributes to the EHR Index which will allow faster and easier selection of that EHR data in subsequent queries. All queries for longitudinal view will be applied against the EHR index allowing for very fast discovery of which EHR data fits the given selection criteria. If the EHR consumer desires more complete and detailed information about the particular EHR data entry, then a specific transaction will be sent directly (via the EHRi) to the repository where that particular EHR data is stored. This retrieval system interaction will use the specific set of messages that are applicable to the class of EHR data being retrieved by the EHR consumer.

There are, however, two basic assumptions for the approach to work most effectively:

1. the metadata on stored events is sufficient to address the EHR Index queries
2. the metadata is normalized at the time the EHR index is updated by the repositories.

The result of the above strategy is that for each EHRi instance, an EHR Index will maintain a sequential list of all events, documents and other EHR data that create the clinical picture of a client. It also provides the location where the detailed data relevant to each entry is kept in the EHRi. It can be used to retrieve the history of events for a client or to trace the information about a specific event.

As one of the components of the Longitudinal Record Services (LRS) in each jurisdictional EHRi, the EHR Index must support a wide range of queries of different types of EHR data and provide consistent responses to the EHR consumers. The figure below shows the various components that make up the LRS, including the EHR Index Services (aka EHR Index).

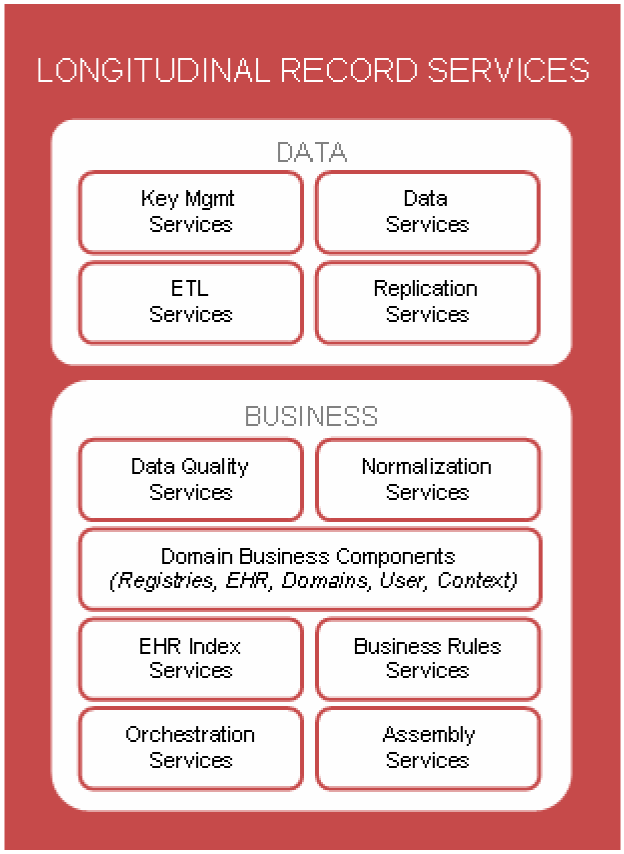

Figure 4-26 Components of the Longitudinal Record Services

Key Business Requirements

The following section summarizes the key business requirements of the EHR Index

- The EHR Index uses the principle that metadata for the index entries is established at the time when clinical Data is first published to the EHRi.
    - This requires the existence of a set of internal interactions between the EHR Index and the corresponding EHR data repositories such as Shared Health Record, DI, Drug, Lab or the registries..
    - For every new data object that is published to an EHR Infostructure, a registration message including all related metadata has to be transmitted to the EHR Index.
        - This may be done as part of a single transaction being processed through the Longitudinal Record Services to update data in an EHR repository.
        - Or it may me done in sequence by a transaction directly targeting a specific data repository for update, with subsequent transaction emanating from this data repository system to register the event in the EHR Index.

- The EHR Index acts as a mechanism to create a high level of abstraction between the Point Of Service (PoS) applications and the logical location of clinical data in an EHR Infostructure. In that regard, it is a critical service to enable the entire EHR Infostructure to be seen as a single EHR data service from the point of view of PoS applications. The level of abstraction enabled by the EHR Index allows for a great deal of flexibility in terms of the creation, maintenance and evolution of data repository systems that participate in an EHR Infostructure. Over time, systems keeping different subsets of clinical data may be added, changed and retired. Single data domains may be transitioned between different components of an EHR Infostructure with no impact on the way hundreds or thousands of PoS applications access data in the EHR Infostructure, thanks to the EHR Index coordinating where data records reside. The costs of ownership and flexibility inherent in this approach stand as a critical business benefit towards the long term sustainability of EHR solutions.
- Given that the EHR Index acts as the source of truth in an EHR Infostructure for the location of data, all queries for EHRi patient data must use the EHR Index.
- The value of the EHR Index and the optimisation that it provides is predicated on the depth of the vocabulary and metadata used to capture the types of events within the index. For example, consider an event being published to an EHR Infostructure from a laboratory system where a laboratory order for a Complete Blood Count test is being posted to the EHR. If the level of encoding stays very high, the EHR Index may only be able to recognize that an order for the patient has been published. This would already provide a useful level of information to an end-user accessing this person's health record. If the level of encoding is increased then the EHR Index may recognize that a laboratory order has been published and if we move further down that path one can go all the way to recognizing a laboratory order of type CBC. In this context, one can easily imagine the complexity associated with this vocabulary when considering all the different types of health events that may be recognized in an EHR Infostructure.

  The language (terminology and vocabulary are synonyms) used to describe the types of events that make-up an EHR Index is a critical element for interoperability. The EHR Index and the event types that it maintains provide the mechanism through which any system interacting with an EHRi can interpret what type of data is being manipulated. This is equally as important for PoS applications that access data in a person's EHR as it is for a system playing the role of the Longitudinal Record Service in executing the orchestration of transactions or more advanced features in the future. Achieving interoperability on a large scale either in a jurisdiction or across jurisdictions will depend significantly on the ability to standardize the language and metadata associated with the description of events in the EHR Index.
- From an architectural point of view, the EHR Index approach requires that the service be developed and deployed in (at least) each instance of an EHR Infostructure. It acts as the central nervous system and in essence is the core of an EHR Infostructure.
  - The EHR Index could be deployed at different levels in regards to its coupling with key EHR data repositories such as the drug, laboratory or diagnostic imaging. That said the existence of an EHR Infostructure is defined by an instance of the Longitudinal Record Service with its EHR Index service.
  - The EHR Index must also support the strategies and requirements of locating a patient's data across different jurisdictions (Inter-Jurisdiction) described in section *4.5.1.5 EHRS Locator*
- EHR Index must be integrated with other EHRi business services such as Security Services, Privacy Services, Client Registry Services etc.

- As a component of the Longitudinal Record Services (LRS), the EHR Index is expected to leverage all common services available in the EHRi.

- The EHR Index must be maintained when the LRS is notified of any changes to the registries such as the Client Registry that impact previously published entries in the EHR Index.
- Another aspect to consider is the form that data may take as it is being published to an EHR Infostructure. The EHR Index must support the indexing of the following categories of EHR Data
  - Clinical documents

    This category describes documents such as clinical reports, images, discharge summaries, CDA documents, etc that :

    - are published individually and only once to the EHRi (e.g. no versioning or updates)
    - cannot change over time – very long “shelf-life”
    - can be “electronically signed” by a clinician or an institution using the PSA Digital Signature Service.
    - are uniquely identified by its documentID
    - are clinically understandable (i.e. human readable with proper viewer)
    - can include structured data, but more often are a representation of unstructured data
    - can be related directly to a real world encounter
    - are in each instance represented by a single corresponding index entry, which in turn contains the pointer (generated by the Document Repository) that allows access to the document.

      Metadata for these EHR Index entries would include: EHR Client ID (ECID), provider ID (author), document ID, document type (e.g. DI report), encounter period (begin/end), location (institution), status (available/deprecated), and others, such as Consent Metadata.

  - Event Notifications

    This category describes documents such drug dispensing, admission and registration transactions, etc that will typically be created in the EHR via HL7 structured messages triggered by events in Point of Service systems such as ADT, HIS and Lab systems.

    Event Notifications:

    - are limited to a specific domain content (e.g. patient demographic) and are related to a single point in time (e.g. patient admitted)
    - are triggered by either business and/or system events
    - cannot change over time and have a very long “shelf-life”
    - are uniquely identified by a transactionID created by the source system
    - contain mostly structured and codified data elements that must be standardized

  - may contain references to one or more clinical document
  - are in each instance represented by a single EHR index entry containing a pointer to where the Event transaction details are stored.
    - the EHR Index metadata required for Event Notifications is basically the same as described for Clinical Documents.
    - each Event transaction may be recorded in the EHR with one or more sub events details which can be retrieved as a logical unit when requested

- Dynamic workflow objects

  This category describes patient EHR data that is created and used in various steps to support a specific clinical workflow such as orders for exams or tests and schedules etc. These types of EHR data, such as an order, will transition through several different states during its 'lifetime'. In each state, information about the order will grow and can be recorded in the EHR, creating a history record that can effectively reconstruct the order at any point in time.

  Dynamic workflow objects:

  - are dynamic nature – will change over time as new events (transactions) occur
  - have a well-defined structured data
  - have a state or status (e.g. new, open, closed, cancelled, etc.)
  - require lifecycle management (e.g. create, amend, cancel, close, etc.) that will result in state and/or content changes driven by event transactions
  - are uniquely identified by its objectID
  - may require current and historical view of object attributes (e.g. status on a prior date)
  - require complex access and privilege management (e.g. who can do what)
  - can be represented in a single point in time by a clinical document

  The representation of these artifacts in the EHR Index is somewhat more complex, as there is a clear overlap with clinical document and event notifications that are related to artifacts.

- Just-in-time views (aka health profiles)

  This category describes dynamic collections of EHR data that can be shown to a provider via predefined requests for a consolidated view of clinical information about a patient at a defined point in time. Examples of dynamic just-in-time views are Drug Profiles, chart snapshots, clinical dashboard, etc.

  Just-in-time views:

  - are a compilation of data provided by prior events (transactions)

- are composed of well-defined structured data
- are dynamic in nature, the view is created "on-the-fly" at the time of the request
- have no "shelf-life" , the view is only valid for the duration of the request
- hide all historic components (e.g. transaction trail) that led to current view
- have no unique identifier

Representing this category of EHR data in the EHR Index is somewhat more challenging as it does not fit to the models described for the other categories.

EHR Index Functional requirements

As part of the EHR Infostructure, the EHR Index will have to expose its functions through well defined services operations supported by message interactions. This section describes at a high level the functional requirements for the various interactions to be provided by the EHR Index.

Register EHR Data

The first step is to have some collection of EHR data for a particular client packaged together and registered with the EHRi. This service provides the means by which a data source can effectively let the EHRi know that it has shareable EHR data. The service operation should include all the metadata that describes what is being registered as well as a pointer or link to where the full content of that EHR data can be retrieved.

Query EHR Data

The next step is to provide the EHR consumer applications with a mechanism to query the metadata that is now available in the EHR Index. This service provides the means by which the EHR consumers (e.g. Point of Service applications) can inquire about EHR data belonging to a particular client. These queries use the metadata stored in the EHR Index to refine their search without involving the data sources. The EHR consumer is returned a result set with all EHR Index entries that meet the given selection parameters.

Retrieve EHR Data

With the result set on-hand, the EHR user, through a local EHR Point of Service application, can then pick which particular entries needs to be reviewed. This service provides the means by which the EHR consumers can request access to the full content of one of the EHR data entries previously queried via the EHR Index. The service operation will include the pointer or link to the data that is part of the entry's metadata. The Longitudinal Record Service will forward the request to the corresponding data source, which will provide the information using the response message that is appropriate to the EHR data type.

Merge/Unmerge ECID

Data in the EHR Index is going to be most often accessed by way of a distinct client's EHR being queried. In that regard the EHR Index needs to keep a very close synchronization with the Client Registry service in order to always maintain the integrity of the internal Client identifier. Merge or unmerge operations triggered in the Client Registry service will need to be broadcasted to the EHR Index and executed in it.

See also.

The following functioning principles are key and need to be considered to understand the full scope of operation of the EHR index service:

- 4.5.1.2 Identifier Management
- 4.5.1.5 EHRS Locator
- 4.5.1.7 Level of Parameterization
- 4.5.1.14 Transaction Scope

4.5.1.5 EHRS Locator

Each EHR infostructure will have a service that provides an up-to-date list of all other EHR infostructure locations that hold information on a specific person.

The EHRS Locator maintains information describing which EHR Infostructure(s) keeps a record for a given individual. It allows each EHRi to trace and retrieve the address of other EHR Infostructures where clinical data is maintained about a person. It is used in the context of transactions to know where data is located and to subsequently enable querying those locations.

In all likelihood, the EHRS Locator will not be needed in the early generations of EHR Solutions as these solutions will be created first and foremost to serve the information sharing needs of their defined area of coverage in terms of health organisations, caregivers and the clients they serve. There is a need however, to plan for this level of interoperability and to consider the potential approaches that could be used to achieve this interoperability.

Given its cross jurisdictional nature, the implementation choices and design level definitions of the EHRS Locator must be established as a Pan-Canadian EHR Standard. Such standards are expected to be established in the context of the work activities conducted of the EHR Standards Collaboration Process sponsored by Infoway. This document will focus on a conceptual definition and different approaches that could be used to establish the services of the EHRS Locator.

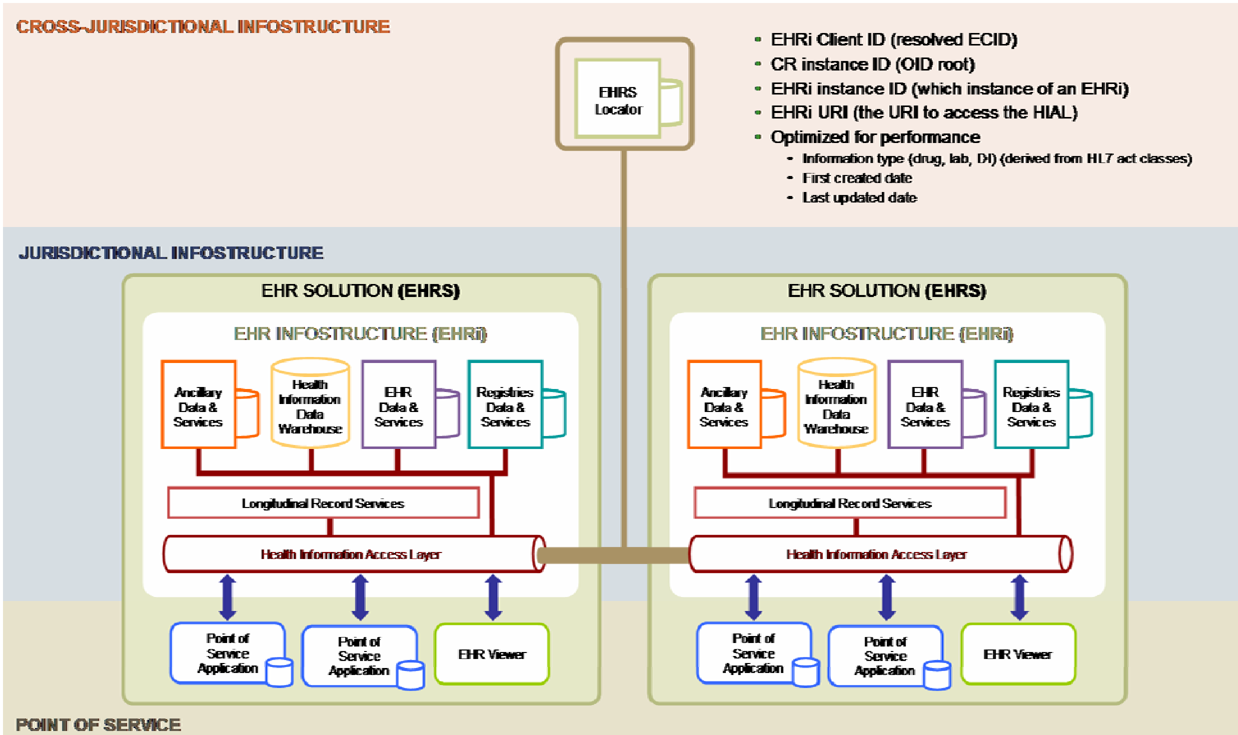

Figure 4-27 EHRS Locator Conceptual Definition

Defining the EHRS Locator Service

The concept of the EHRS Locator is to have a service, comparable to a directory, allowing a requesting system to find out where EHR data about a given individual is maintained. The EHRS Locator is a both a performance and integrity enhancing mechanism. The process of determining where a given individual has EHR data can be achieved without an EHRS locator by having each EHRi send individual queries to all other active EHR Infostructures asking if they have data for a specific person.

However, EHR Infostructures are expected to be optimized to allow read access to a person's EHR data. Response time, from the clinicians perspective, is expected to be a key criteria of adoption. EHR Infostructures are also built to support high scalability in the number of systems connected and actively feeding or reading data; and the number of concurrent end-users requesting access to EHR data over daily peak periods (e.g. end of the afternoon shift in hospitals).

Given that a limited percentage of the population in Canada would see eligible clinical information existing in many EHR Infostructures not having an EHRS locator ability would create significant processing overhead just to answer that question and it would happen for every single query to an EHRi. This is clearly not practical.

Also part of the rational, is the expectation that cross-jurisdictional accesses to information in the context of any single transaction will be the most taxing component of the processing in terms of an impact on the response time.

Considering these key requirements for optimized access to the information, the ability to pre-emptively compile and maintain this directory becomes a critical element of the achievement of an interoperable EHR.

Characteristics of an EHRS Locator Service

The main characteristics of this service are the following:

1. At a logical level: the EHRS Locator is a single directory available for controlled access from any EHR Infostructure system in Canada. All systems accessing this service have the perception of one active instance of the EHRS Locator across all operational EHR Infostructures.

2. The foundation of the EHRS Locator service is the ability to index a list of addresses of EHR Infostructures for a given client.

3. The ability to use a unique identifier for a client is critical to the functioning of an EHRS Locator. Ideally, this unique identifier would be valid and unique across all jurisdictions and EHRi's, this however would introduce potential privacy concerns. An effective compromise to one unique identifier and it's privacy implications is to have as small a number of identifiers to deal with as possible. See the following section entitled ***The EHRS Locator and Unique Client Identifiers*** for a discussion on unique identifiers.

4. The performance and value of the EHRS Locator can be increased by way of adding to the level of precision of the data maintained in the directory. In other words, if the EHRS Locator is able to recognize which EHR Infostructure has data about a person, one has a basic level of capabilities. If the EHRS Locator is able to recognize what type of data is maintained in a given EHR Infostructure about a person, one gains a much greater level of granularity in the indexing mechanism and in the overall precision of the directory service. This translates to less irrelevant data communication requests to EHR Infostructures that would not have a certain type of data about a person.

   Another level of precision that could be added is the time span of a given type of data maintained in an EHR Infostructure. In this case, each EHRi infostructure would publish both the earliest and most recent dates for information held on a particular client. This would preclude unnecessary communications based on the time span of the incoming request, for example: the locator could very efficiently handle a request for all Lab data for a given client in the last 4 weeks. However this efficiency on read of the EHRS Locator comes at the cost of increased level of complexity of the EHRS Locator itself, more frequent updates to the Locator service, and the challenges of ensuring the integrity of the data in it.

5. The ability for an EHRS Locator to declare not just which EHR Infostructure has data for a person but also what type of data is maintained, requires a common language to describe the types of data maintained in the EHR for a person. Largely, this could be achieved with a standardized coding scheme or terminology. This requirement for establishing a common language, is already present within each EHR Infostructure and is a required enabler for the EHR Index service. In the context of the EHRS Locator, it becomes critically important that this language be common across jurisdictions wishing to interconnect their EHR Infostructures. The EHRS Blueprint data model suggests a definition of events and event types as being the foundation to recognize and understand the contents of the EHR for a

person, and this would be the foundation for these typing terminologies.

6. The general profile for use of the EHRS Locator service is that every transaction accessing data in the EHRi for a person would minimally have to run a check with the EHRS Locator to figure out if the request needs to be forwarded to other EHR Infostructures. To support this, the EHRS Locator service needs to be highly optimized for speed and as a result it is expected that the general profile of transactions targeted at the EHRS Locator would be small highly structured data query/response transactions.

7. All PUT's of data to a local EHRi result in an asynchronous notification to the associated EHRS locator. Depending upon the degree of complexity for the locator, the locator is only updated if the new data is earlier or later than the established dates, and/or is for a type of data not currently referenced in the locator.

The Compelling Case for the EHRS Locator

The need for this EHRS locator capability is compelling. As we move forward into the deployment of EHR capabilities and services in different provinces and territories, clinical data about people receiving care in Canada will start to become available in EHR Infostructures. It is expected that each EHR Infostructure will be created to serve a finite and geographically-limited number of health organisations, caregivers and the clients obtaining services from them. As caregivers and patients become more and more accustomed to the availability and use of EHR infostructures, business, clinical and political pressures will build up to interconnect EHR Infostructures and insure that clinical data sharing can cross the boundaries established around these solutions.

We expect many clinical factors to influence such pressures, examples are:

- Clients that are critically ill or have needs for specialized care stand to benefit from the ability to share clinical data. Often times these clients will be referred to health organisations located in different cities or Provinces and Territories. In some cases clients actively choose where they will receive a particular form of care. It is important to note that while these clients may not represent a high number of people in the population, they are often times the largest consumers of healthcare services. The ability to share clinical data between borders is a high requirement for them and stands to have a high economic impact in the health system.

- Every year, segments of populations living in urban, rural or semi-rural settings move. The concept of a Longitudinal EHR that includes information captured over time, regardless of care setting is not possible without some mechanism for locating and correlating that information. The ability of caregivers in their new locations to have access to a client's clinical data generated and maintained elsewhere stands to make a big difference for them. This is especially true for clients suffering chronic diseases or diseases that affect them over long periods of time, but also true for the average family needing to re-establish a network of contacts and a relationship with health professionals in their new location (family physician, emergency clinics, paediatrics, dentist, eye care, etc…)

- Many clients are mobile workers, a growing category of the working population, and are faced with situations where they need to obtain health services in locations away from their home base. Whether it is for fulfilling or renewing a prescription or because they need to present into a health clinic or a hospital emergency department for a pressing need. Caregivers involved in offering services to these clients stand to benefit greatly from an ability to access clinical data about a person stored in multiple EHR Infostructures.

- There are many clients living in border towns between areas serviced by different EHR Infostructures. This could be a patient living in a city like the Ottawa/Hull region where clients constantly use health services governed by two separate provincial authorities. In this case, in all likelihood, the citizens in Ottawa would see their data maintained in an EHR Infostructure governed and operated by Ontario, where as the citizens in Hull would see their data maintained in an EHR Infostructure governed and operated by Quebec. The ability of caregivers in these settings to easily have access to the data in separate EHR Infostructures becomes self-evident in these cases. The same situation prevails within a large Province where multiple EHR Infostructures may be required to support a large population.

- Populations living in Territories in Canada are a key representative case of people that stand to benefit from the ability to share clinical data between EHR Infostructures. Often, people living in aboriginal communities and cities located in remote areas will see most of their acute and tertiary care needs fulfilled in other jurisdictions.

Functions of the EHRS Locator Service

The following is an early definition of the main services offered by the EHRS Locator. This is not meant to be a specification but rather a way to express the main functions expected from the service.

1. Locate client clinical data : This service discovers and retrieves the list of addresses of EHR Infostructure(s) where a certain type of clinical data exists for a given client.

2. Validate existence of clinical data elsewhere: This service checks for the existence of a specific client, specific type of data, over a specific period of time in the EHRS Locator. It allows quick validation of whether or not the client has data in other EHR Infostructures. It also allows for a quick validation that the local EHRi address for the client already exists in the EHRS Locator.

3. Create/update a location record in the EHRS Locator: This service allows modifying the contents of the EHRS Locator for a client. It allows for the creation of a record when one does not exist and allows for the update of a record when one already exists. Parameters include: the identifier of the EHR Infostructure making the request, the resolved EHR unique internal ID of the client, the type of data having been recorded and the timestamp representing when the data was created.

4. Process ECID Merge/Unmerge: This service would allow the EHRS Locator to execute updates and re-indexing required if the EHR Unique Client ID (ECID) for a person changes. The client registry service is responsible for requesting such operations and a high degree of security, control and logging is required around the execution of such operations. Parameters include the ID of the EHR Infostructure making the request, the ID of Client Registry instance making the request for the merge operation, the EHR Client ID being merged, where there could be multiple IDs being merged to a single new ID, the new EHR Client ID to be used for the client, the timestamp representing the date/time of the request for the merge operation.

5. Retire records from the EHRS Locator: This service allows retirement of certain types of data or all the records for a given client from active use. Like all other systems that participate in an EHR Infostructure, data records never get deleted per say, instead they are logically deleted, meaning they are flagged as inactive. This insures the proper level of traceability within the system and maintains the cross-linking logic that may have been used at any point in time to access information in a person’s EHR. Parameters include the ID of the EHR Infostructure requesting to deactivate a client’s record from the EHRS Locator, the ID of the client, the specific data type to

be inactivated and the date range of the data to be retired.

6. The EHRS Locator needs to support live maintenance services. As the network of EHR Infostructures will evolve, new EHR Infostructures may be added, other ones may be merged, or dismantled over time. The EHRS Locator needs to support these types of capabilities without being stopped, as this service supports not just one but a network of live EHR Infostructures that will span multiple time zones.

7. Auditing and logging capabilities: like all services that participate in an EHR Infostructure and that process transactions with clinical data about clients, the EHRS Locator must have it's own secure logging and auditing capabilities, modeled after those implemented in each EHR infostructure. The EHRS Locator cannot rely on the logging services of connected infostructures as it must maintain one coherent view of the data it manages.

Availability requirements of the EHRS Locator.

The EHRS Locator stands as a key enabler of interoperability and once EHR Infostructures start using it to interconnect, it cannot stop working. The requirements for availability and robustness are of the highest level. They are described as 5 x 9 availability (99.99999) with 24/7 (24 hours per day every day) operation.

The EHRS Locator and Unique Client Identifiers

The EHRS locator is an index or a directory based on the identification of clients. Its purpose in life is to allow for the privacy enhanced tracking of the availability of clinical data for one client across any number of EHR Infostructures. By definition then the identification of any single client must be valid and preferably unique across all active EHR Infostructures. Use of the Identity Protection Service should be considered in order to enhance the privacy of this function. This is a big challenge with many issues. To be more precise, an example is provided here that involves two EHR Infostructures: EHRi A and EHRi B.

When data is created in the EHR about a client:

1. The system (presumably in a point of service (PoS) of the healthcare system e.g. a physician clinic) making the request to update the Electronic Health record of a client in jurisdiction A only knows this client by a local number that it is using.

2. This local number is sent to the EHR Infostructure A that services this specific PoS. There, the Client Registry resolves this client identifier to a valid ECID (EHR Client ID). At this stage this ECID only needs to be valid between the systems that participate in the EHR Infostructure A.

3. When these transactions are done, the EHRS Locator is updated and records are created in it to represent the fact that clinical data about a client is available in this EHRi A. The records created refer to the internal identifier (ECID) established as part of the resolution process in that transaction.

4. The same client travels to jurisdiction B and receives health services there. The EHRi in jurisdiction B publishes to the EHRS Locator with ECIDs resolved in jurisdiction B, which is a different internal number than the one used for the ECID in jurisdiction A.

When data is accessed:

1. A PoS application in jurisdiction A makes a request to access the EHR of the same client. When this happens the EHRi A goes through the previously described process of resolution of the client identifier and establishes the ECID valid only in jurisdiction A for this person.

2. At that point, a request is sent to the EHRS Locator to determine if any other EHR Infostructures should be involved in providing the response to the query. The resolved ECID is passed to the EHRS Locator as the search key. Unfortunately, at that point the ECID passed provided as a search is only valid in EHRi A.

   In this situation, the client identifier needs to be resolved at a higher level because the data kept in the EHRS Locator needs to represent the client as he is known in all other EHR Infostructures that maintain data about him or her. Different options can be considered to solve this problem:

   - We can accept that multiple IDs for a given client may exist when considering the identification of a client across jurisdictions. In this case, the EHRS Locator would need to request all of those IDs from a service that knows about them, namely the Client Registry service. Once the locator has all of those IDs, a query for each returned identifier would be conducted in the EHRS Locator in order to compile a full response. The use of Federated Identifiers described in the PSA Identity Protection Service is strongly recommended.

   - A single Client ID valid on a Pan Canadian basis can be created and maintained by and between client registry solutions. This would allow the EHRS Locator to be much more efficient as it would allow it to consider the ECID as a true unique primary key to index its data. Efficiencies aside, EHRS Locator designers must give consideration to privacy issues associated with this approach. Proper Privacy Impact Assessments and Threat Risk Assessment processes must be performed to determine privacy risks and identify mitigation strategies associated with this approach.

At this stage, when considering that EHR Infostructure solutions are in their infancy and are being built first and foremost to serve the needs of local data sharing, we do not believe that there is an appetite or enough of a business requirement to justify the creation of Pan Canadian valid IDs for clients. The political, administrative, privacy and policy implication of creating and managing client IDs at a Pan-Canadian level, even if they are only internal system identifiers, cannot be justified.

So for now, the recommended approach is to maintain the scope of resolution of client identifiers at the level where client registry solutions are established. This means that EHRS Locator service must obtain from the client registry, all of the valid EHR internal client IDs (ECID's) used to represent a client in different jurisdictions in order to conduct its business of identifying which EHR Infostructure maintains data about a client.

Approaches to Deploying EHRS Locator Services

Potential deployment approaches that have been studied include:

- **Centralized pan-Canadian service**: In this approach every EHR Infostructure would be able to invoke a single instance of the EHRS Locator and obtain this service from a single location. This approach requires the same governance, political, administrative, privacy and policy implications as implementing a pan-Canadian Client Id and could not be justified at a very early stage of EHR

Solution development in Canada.

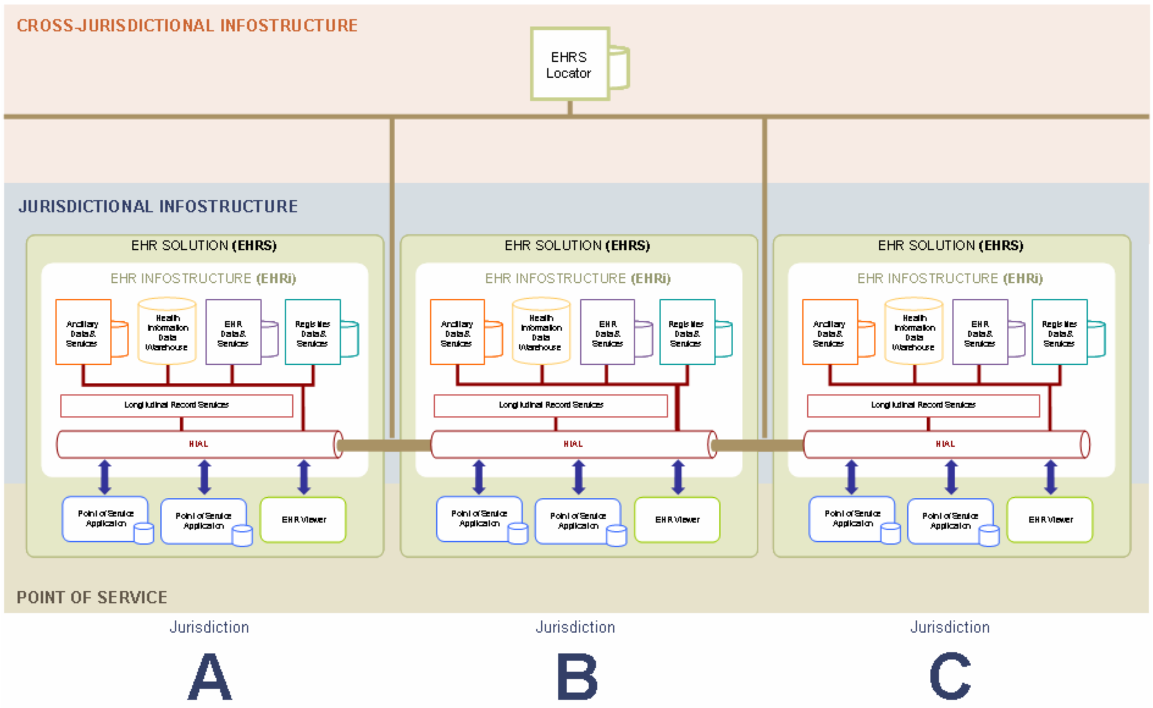

Figure 4-29 Centralized Locator Service

- **Distributed service:** A distributed service where each EHR Infostructure would have its own instance of the EHRS Locator service. In this context, the different instances of the EHRS Locator service would have to support mechanisms to synchronize their data as it is being updated.

  Fortunately, data in the Electronic Health Record of a person is going to be accessed much more often then it is updated. Additionally, the need to update the EHRS locator only exists when a person is obtaining health services in a different jurisdiction for the first time, or depending on the level of granularity of the information maintained in the EHRS Locator, when certain types of data are appearing for the first time.

  This approach represents an interesting evolutionary path and it is seen as a valid future state when EHR Infostructures will be deployed and heavily used and when business requirements and volumes of cross-jurisdictional access to clinical data will warrant more performance from the mechanisms allowing to reference data about a person across the network of EHR Infostructures.

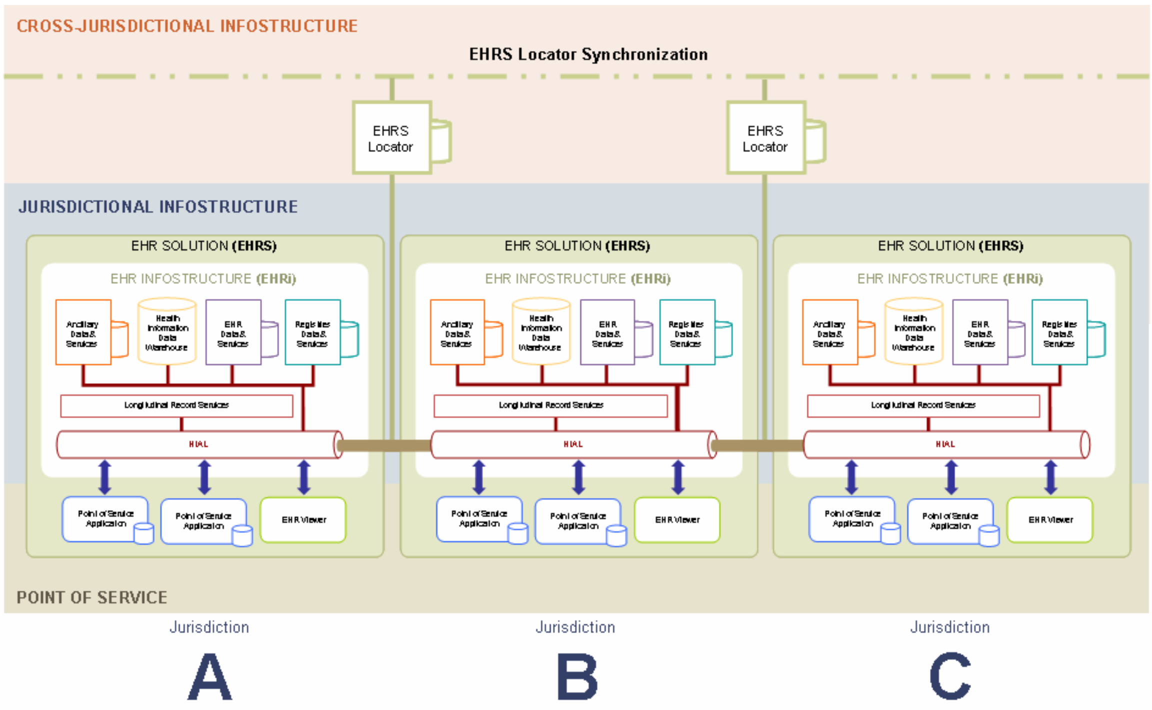

Figure 4-30 Distributed Locator Service

- **LRS integrated service:** In the coming years and for as long as initiatives are focused on the foundations and the implementation of early generation components of EHR Infostructures, we believe that there will be few opportunities and low volumes of actual data shared between EHR Infostructures. In that context, the services and capabilities required to support the location of clinical data between EHR Infostructures can be handled completely by the Longitudinal Record Services (LRS) and the Client Registry.

  The EHR Index, as part of the LRS, is responsible for the maintenance of the index of events about a client and allows tracking of the locations within an EHR Infostructure where detailed clinical data is kept. The LRS is also defined as the central nervous system where a transaction being executed in an EHR Infostructure is managed from beginning to end. It is through this capability of executing and managing the logical steps of a transaction in an EHR Infostructure that the LRS can take ownership of the services described for the EHRS Locator.

  The perspective is that by querying the client registry for all known EHRi Client Ids (ECID's) of a given client, the LRS can conclude whether or not to spawn queries to the LRS of other EHR Infostructures. Basically, if more then one response is brought back, then transactions have to be spawned to other EHR Infostructures.

  This approach assumes that the client registry is able to keep these multiple ECIDs for a client and that the data structure of the ECID itself supports identifying which EHR Infostructures the ECID belongs to. In effect, this transfers all of the services responsibilities of the EHRS Locator to the Client Registry and LRS. However, this approach represents a simplistic and non-optimized solution to the problem. We do believe this approach to be valid for the early generations of EHR Solutions across the country. As EHR Infostructure usage will mature and volumes of data and clients represented in them will increase, we will believe also that other models will need to be considered to optimize the performance of this type of location service.

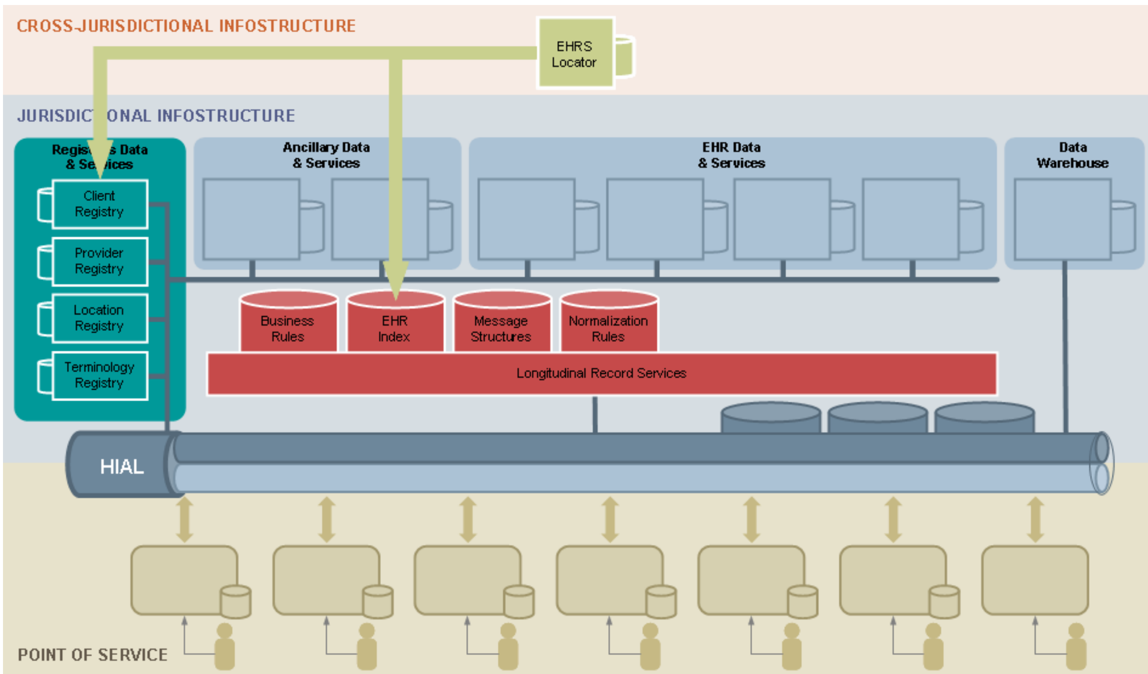

Figure 4-31 LRS Integrated Locator Service

Client registry impact: To make this solution work, client registries will need to synchronize on an ongoing basis between each other and maintain all of the internal EHR Client IDs (ECID) that might be generated in different active EHR infostructures to represent a given client. These requirements towards client registry solutions will need to be addressed as soon as two or more jurisdictions have a valid business requirement to interconnect their EHR Infostructures.

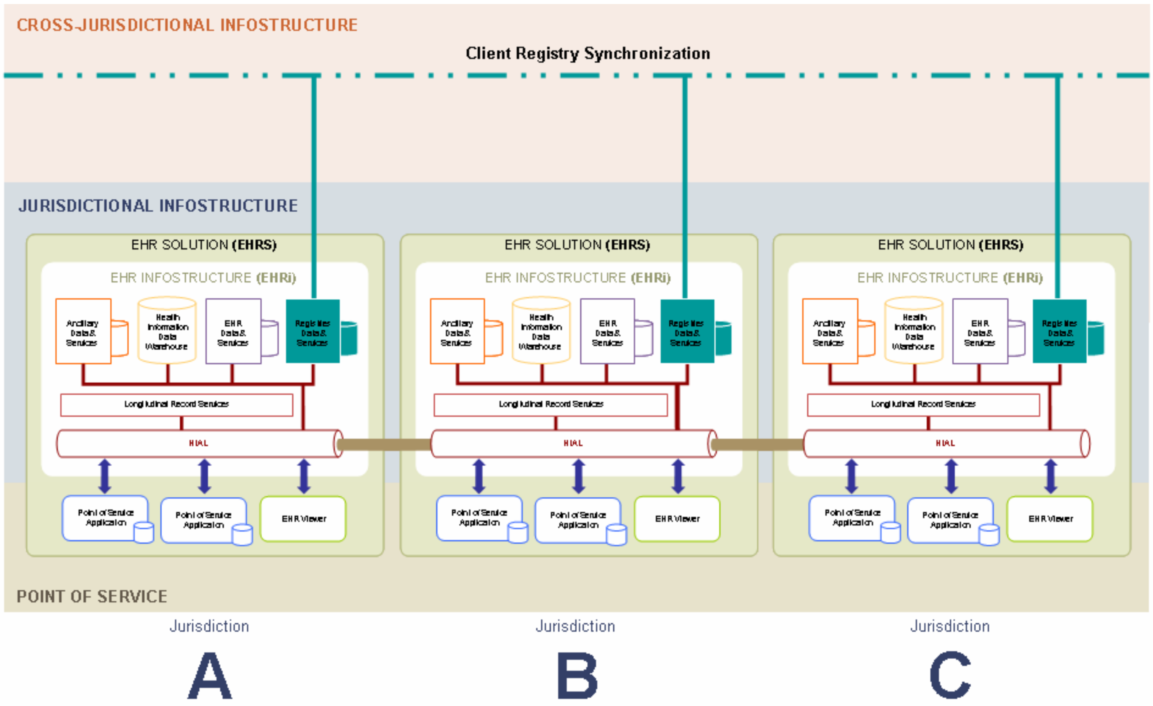

Figure 4-32 Client Registry Synchronization

The processes, mechanisms and architectures for cross-jurisdictional interoperability between EHR Infostructures need to be established as technical standards for EHR Solutions in Canada. A standards development initiative, sponsored by Infoway, is currently underway to establish the Pan-Canadian EHR Standards table along with a separate standard development initiative to address all of the so called “Technical Standards” required to enable interoperable EHR solutions. This standards development initiative is the framework under which the approaches and recommendations of the EHRS Blueprint will be pursued to finer levels of detail and established as formal specifications.

4.5.1.6 PoS to EHRi interface

*A*ll interactions between a Point of Service application and an EHR Infostructure (EHRi) are to be enacted through the use of a limited set of common interfaces established as pan-Canadian standards for EHR solutions.

Clinical data available in electronic form and compiled today in PoS applications will come in different form factors. For example, a clinical note maintained as a single document, a large high-resolution image coming from a diagnostic imaging device, structured data elements maintained in the patient record system database of an application, a stream of numerical values coming from a digital stethoscope. The mechanisms by way of which PoS applications will exchange data with an EHRi need to account for the different types of data formats that exist. In supporting the complete spectrum of data types that are present, different communication modes or types of interfaces have to be considered, each relying on specific combinations of communication protocols. The following table presents a list of these modes of communication:

EHRi Communication Modes	Example uses
1. Structured data	HL7 messages Business and system component service operations via web services Administration of Consent Directives
2. Unstructured / semi-structured data	Clinical documents
3. Streaming multi-media	Diagnostic imagery, waveforms, video, etc
4. Security Management	Registration, Enrolment, Authorization and Authentication of users and PoS applications, remote renewal of cryptographic keys
5. System Management	NTP (time synchronisation) System performance tuning System monitoring

There is a significant business driver behind this approach of trying to standardize the protocols used to exchange information between the PoS applications and an EHR Infostructure. Over time, when considering the extensive number of PoS applications that stand to benefit from being connected to an EHR Infostructure, there are significant dollars that will need to be spent to connect each application. The ability to maximize the reusability and replicability by standardizing these interfaces is the most important enabler to get cost down into a manageable range. The magnitude of this cost is expressed in section ***3.1.2 Key Economic Drivers***. The more the interface specifications can be tightly defined, the more we stand to attain the following benefits:

- reduced level of complexity in deploying similar interfaces between initiatives, by not having to discover and understand the intricacies of different protocols at play
- ability to consolidate pools of human expertise around the connection of new PoS applications that feed and/or read data from the EHR Infostructure
- accelerated time to “go live” for any single PoS application connection project
- reduced level of complexity and time when changes or evolution to an existing standard are being put in place
- reduced level of complexity and time for a health system vendors to implement an existing standard
- increased ability to insure conformance and standards compliance via certification processes,
- increased reuse of tooling developed to address or facilitate the integration challenges such as message proxies, test harnesses or live simulation environments
- ability of vendors of HIAL solutions to focus their development and optimisation efforts around a limited set of well formed and known protocol choices, which in turn means increased reliability, robustness and performance for this very important component

The words “communication protocol” actually designates several protocol choices that need to be addressed when trying to implement an interface between a PoS application and an EHR Infostructure or between two EHR Infostructures. The following picture depicts the protocol layers that would need to be specified in terms of concrete choices of protocols:

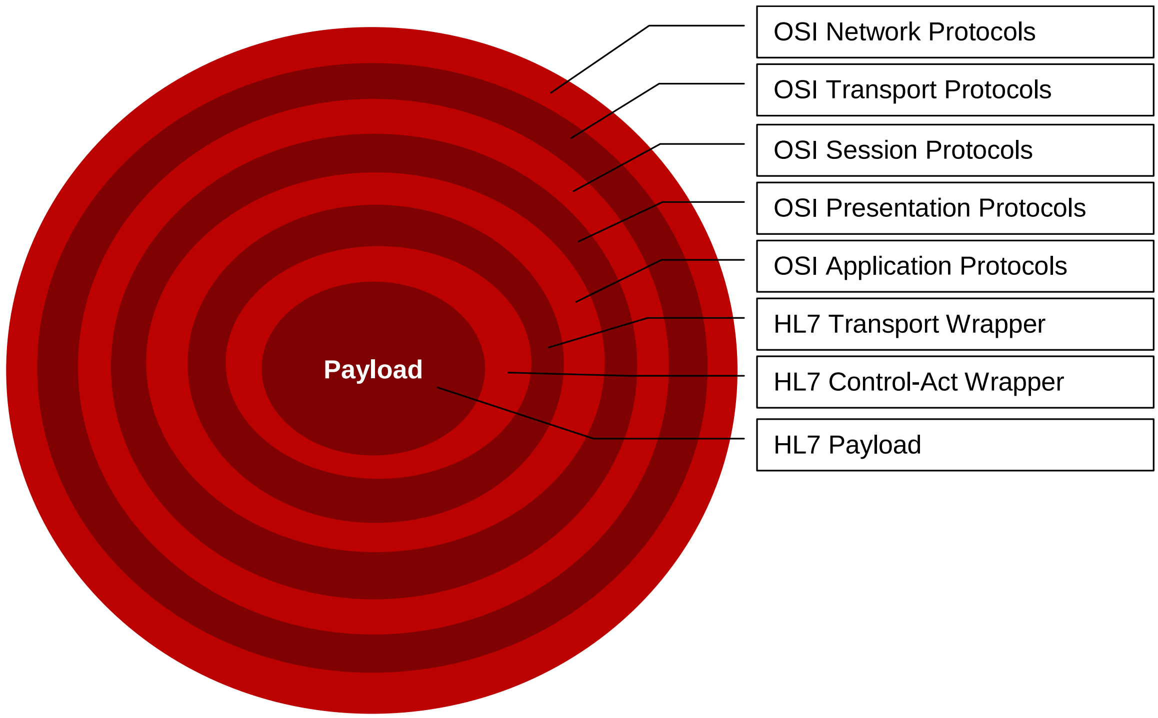

Figure 4-33 EHRi Interface Protocols

The first two layers of the OSI model (data link and physical) are intentionally left out of this diagram and would not be under consideration as part of any interoperability profile specifications. In order to maximize the benefits described above, decisions and choices about each of these protocol layers would need to be made and published as a specification for each of the communication modes. These choices need to be done in a context that relies on the EHR Standards Collaboration Process so that we establish those choices as declared standards for EHR Solutions in Canada.

The OSI layers of protocols can easily be covered by making choices between recognized and mature industry standards such as TCP/IP, Secure HTTP, SMTP, etc..

The EHRS Blueprint is defined as a service oriented architecture and in that sense, transactions available from an EHRi are expected to be exposed as services (see Transaction Scope functioning principle). A core set of standards need to be defined in order to address the Web Services framework that will be used to implement the EHRi interfaces. There are two industry standards available to address this, the eBXML standard and the WS-I standard. . The scope of those standards covers the presentation and application level described above. Later in this document there is a discussion of the pros and cons of these methods.

The business layer is made up of various layers defined by the HL7 standards. HL7 defines message (interaction) specifications by using a series of layers, where outer wrappers such as the batch and transmission wrappers deal with delivery and routing, inner wrappers such as the ControlAct wrapper and Query wrappers define the event represented by the interaction and information such as location and responsibility. Inner layers deal with the specific business or clinical object being created, queried or modified by the interaction.

There is tight integration between the scope of specification covered by eBXML or WS-I and the scope of specification covered by the HL7 Transport Wrappers.

The Control-Act Wrapper and Payload tie directly into the business requirements and define the type of transaction as well as key enablers to process any transaction The following table outlines an early definition of the key identifiers and data elements required for every transaction:

Name
Consent information (e.g. keywords, break-the-glass reason)
EHRi Event ID
EHRi Client ID – (JHN or similar public identifier outside the HIAL, ECID within the HIAL)
EHRi Domain ID
EHRi Trigger Event Type
EHRi Interaction Type Identifier
EHRi Provider ID – (License number or similar public identifier outside the HIAL, EPID within the HIAL)
EHRi Application Instance ID
EHRi Transaction Client ID
EHRi User ID - EUID
EHRi User Role ID
External ECID
PoS Application EHRi Session ID
PoS Application Instance ID
PoS Application Location ID
PoS Application Organization ID
PoS Application User ID

The inner layers obviously focus on the actual data content of a message.

All communication modes will be able to rely on the above definition. One particular communication mode will need to address the specificities of data streaming to handle large binary objects such as high-resolution images, video clips, audio streams and others. This is why the streaming communication mode was identified separately.

Implementation requirements

The system integrators involved in the implementation of an EHRi face a number of challenges and responsibilities in the successful creation of an interoperable EHR within a jurisdiction. As a guideline the following requirements should be applied both from an implementation and governance process point of view.

Communication solutions enabled by the HIAL in an EHRi need to:

1. Support PoS applications interfacing with the EHRi through the use of "pan-canadian EHR standards for EHRi interface specifications" that encapsulate all of the common elements

needed for the EHRi to effectively process a communication. Each communication mode must have a unique set of specifications to cover, as per the OSI model:

a) Network layer protocol choices
b) Transport layer protocol choices
c) Session layer protocol choices
d) Presentation layer protocol choices including encryption, encoding and others
e) Application layer protocol choices
f) Business layer protocol choices covering clinical events and their information, audit logs, user and PoS application authorization and authentication, patient consent directives management, identification of the client, provider and location associated with patient clinical events as well as all the necessary metadata for these interactions etc

2. Rely on common definitions for business requirements for communication described in EHR Interoperability Profiles, EHR Communication Steps and Infostructure Interoperability Profiles

3. Rely on the EHR Standards Collaboration Process and the work of the different pan-Canadian Standards Working Groups (Registries, Drug, DI, Lab, iEHR messaging and iEHR technical) the mechanism to insure a collaborative, common and thorough process for the establishment of such standards.

4. Rely on the use of the same set of standards-based interfaces for interactions across EHR Infostructures

5. Support transactional integrity through industry standard protocols and techniques such as NTP for time synchronization services, guarantee of delivery.

6. Be implemented in the context of projects where solution providers (both PoS and jurisdictional) must:

   a) Demonstrate how their interfacing solutions support and comply with the pan-Canadian EHR standards for communication

   b) Establish a software development process to ensure the quality of these interfaces are (at minimum) unit tested against pan-Canadian EHR specifications, integration tested, system tested and have completed user acceptance test against user requirements

   c) Represent the certification process they have undergone to certify the compliance of their solutions with the pan-Canadian EHR standards

   d) Establish a version control process for all software assets that will guarantee backward compatibility of interfacing capabilities between versions.

   e) Maintain reliable sets of test scripts and test data that can be used to support the above processes

   f) Establish service level agreements for these interfaces that guarantee system performance, availability, reliability, scalability as well as quality of service and semantic interoperability through interface specifications using agreed-upon vocabularies for exchanging information supported by industry standards such as OWL-S, DAML-S

eBXML versus Web Services

In the world of Service Oriented Architecture and the development of large scale service oriented networks, there are a limited number of choices if one wants to identify and stabilize a single specification. These choices today revolve around two main communication frameworks. The eBXML communication framework and the Web Services communication framework.

In this document, a brief description of each of these communication framework is presented. At this stage, no formal choices have been made with regards to the use of either one of these frameworks. This decision is scheduled to be addressed in the context of a formal pan-Canadian EHR standard development initiative that will focus on all of the technical standards required to enable an EHR Infostructure solution.

Accessing the EHR via eBXML

ebXML is a framework that was developed by The Organization for the Advancement of Structured Information Standards [OASIS] in January 2002. It consists of the following main components

- Business Process Specification Schema (BPSS): This is an XML based specification language that formally defines "public" business processes. It focuses on the collaborations partners (a.k.a. trading partners) and the business transaction activities they perform in the context of the collaboration. The BPSS is strongly influenced by UMM, a modeling language developed by UN/CEFACT.
- Core Components: These provide the business information that is encoded in business documents that are exchanged between business partners. These components can be assembled from public and private registries.
- Collaboration Protocol Profiles and Agreement (CPP/A): these are XML documents that encode a party's business capabilities or two parties' business agreements. Additionally, CPP/A may be used as a convenient way of expressing trading partner parameters. They are closely related to BPSS. With the registry they support business discovery and the process of setting up new business relations.
- Transport, routing and packaging: the ebXML Message Service (ebMS) defines the message enveloping and header document schema used to transfer ebXML messages over a communications protocol such as TCP/IP, HTTP or SMTP and the behaviour of software sending and receiving ebXML messages. The ebMS is defined as a set of layered extensions to the base Simple Object Access Protocol [SOAP] and SOAP Messages with Attachments [SOAPAttach] specifications. This document provides security and reliability features necessary to support international electronic business. These security and reliability features are not provided in the SOAP or SOAP with Attachments specifications.

Workflow in eBXML

The following steps provide a typical scenario in the development of run time and design time artefacts using ebXML.

1. A project team analyzes a particular process in order for organizations to engage in a business transaction. This will result in a formal description of the process encoded to the BPSS. This description will reference certain roles that partners may fulfill and will consist of a number of choreographed business transaction activities.
2. An authorised organization that wants to provide business functionality can use the ebXML registry's search functionality to find business processes in which it can perform a particular role. It checks to see what kind of ebXML Message interactions it needs to support to perform the selected role. Once this is done it needs to build the functionality – this requires development of interfaces to its backend systems.
3. The organization can then formally state its capability to fulfill its role in a document known as a collaboration protocol profile. In addition to referencing the business process document, this document encodes information such as message payload packing information and digital signatures.
4. Other authorised organizations can browse the registry to find relevant business processes
5. Once the company has been found the same business process, it can start a search for business partners that offer complimentary services. It will then find the CPP registered and the find the associated company.
6. The company can create a proposal for a trading partner agreement called a collaboration protocol agreement (CPA).
7. The companies can agree with the CPA or reply to it with a counter proposal. Once there is an agreement, companies can configure their systems needed to support the business interactions controlled by the CPA
8. Messages can be exchanged based on the CPA using the facilities provided by the ebXML messaging service.

This process indicates that ebXML is built for multi partner collaboration. In the healthcare field, this would include collaboration between partners that provide different services to fulfill a given scenario.

Accessing the EHR via Web Services

Web Services are a way for applications to expose software services using standard interoperable protocols, regardless of the platform on which they are implemented. The development of interoperable standards and the focus on communication and collaboration among people and applications have created an environment where Web Services are becoming a protocol/technology of choice for application integration. There are many definitions of Web Service, but almost all definitions have these things in common:

- Web Services expose useful functionality to authorised users through the Web Services protocols.
- Web services provide a way to describe their interfaces in enough detail to allow a user to build a client application to talk to them. This description is usually provided in an XML document called a Web Services Description Language (WSDL) document.
- Web services are registered so that potential users can find them easily. This is done with Universal Discovery Description and Integration (UDDI).

Advanced Web Services Protocols (WS-* Protocols) are built on top of the foundation for Web Services constituted by XML, SOAP and WSDL to express additional functionalities. These are specifications that are developed with the intention of broad adoption and interoperability and focus on security, reliability, transactions, description and discovery.

While the first implementations of Web Services were built with the Internet in mind, there is really nothing in the specifications themselves that prevents the use of these standards with other protocols (protocol binding), extending the use of Web Services from business to business (B2B) integration over the internet and HTTP, to Enterprise Application Integration (EAI) inside the company's firewall using different protocols like TCP/IP or MLLP (Minimum Lower Layer Protocol as defined by HL7).

In this environment Independent Software Vendors (ISV) and corporate developers implementing HL7 interfaces can write generic and reusable classes, subroutines, and modules consistent with the guidelines set forth by the HL7 standard for Web Services standards in order to handle HL7 message traffic from a potentially unlimited number of connecting applications and services. Applications that "expose" HL7 messages (e.g. Web Services servers) will do so according to the HL7 Web Services Profile (WSP) guidelines; "consumers" of HL7 messages (e.g. Web Services clients) can be written without prior knowledge of the application that they will ultimately end up talking to. In addition, this "plug-n-play" environment will take advantage of supporting discovery protocols such as UDDI to break the rigidity of the current hard-coded message routing infrastructures of most Healthcare enterprises.

Workflow in Web Services

Following is a step-by-step breakdown of the workflow used to send and receive the HL7 Message

The **Message Receiver** is the application or service that exposes the Web Service and provides the WSDL document. The **Message Sender** is the application or service that acts as a client and *consumes* the Web Service.

1. The Sender locates the service, downloads the message definition (WSDL) and builds the appropriate proxies and interfaces. This process is usually accomplished out-of-band at configuration or development time.

2. Message Sender constructs the HL7 payload.

3. Message Sender constructs SOAP message headers and body according to the rules set in the WSDL and encapsulates the HL7 message in the body of the SOAP message.

4. Message Sender sends the SOAP message to the selected service end point as specified in the WSDL.

5. The message is routed and delivered to service end point.

6. Message Receiver receives SOAP message containing the HL7 payload.

7. Message Receiver extracts, parses, and validates encapsulated HL7 payload.

8. Message Receiver constructs the response HL7 payload (acknowledgement, query response …) in the case that a response is required, for asynchronous and one-way messages this step is not

necessary.

9. Message Receiver constructs the SOAP reply message headers and body according to the rules set in the WSDL.

10. Message Receiver returns the SOAP reply message to the Message Sender.

11. Reply message is routed and delivered to Message Sender.

12. Message Sender receives SOAP reply message containing the HL7 payload.

13. Message Sender extracts, parses, and validates encapsulated HL7 payload.

4.5.1.7 Level of parameterization

The EHRS Blueprint suggests the use of a reasonably fragmented set of encapsulated services to maximize the ability to change and evolve the degree of functionality offered within an EHRi while limiting the amount of reengineering and retesting associated with such evolutions.

In the practice of information system architecture, decisions regarding the level of parameterization of a system involve a compromise between the level of flexibility and adaptability of a solution versus the level of complexity and often times a potential negative impact on the run-time performance of a solution. The more a system is parameterized and can be configured to meet different business needs and deployment configurations, the more it becomes complex, which in turn influences the costs of maintenance and evolution. To achieve optimal levels of configurability, run-time parameters can be considered. These can modify the behaviour of a system on the fly while it is operating. There can be significant advantages to such an approach, namely not having to go through expensive maintenance windows where systems are taken down from active duty, modified, tested and brought back up into production environments.

The EHRS Blueprint suggests a framework that relies on a Service Oriented Architecture (SOA). The degree of abstraction imposed by a service oriented architecture already suggests a level of parameterization that stands to offer great benefits for the health system in Canada. There are 2 types of abstraction that need to be considered when describing the level of parameterization offered by an EHR Infostructure (EHRi) solution. The extra-EHRi and intra-EHRi.

First, the extra-EHRi: the EHRi as a whole, is perceived and seen by all the Point Of Service (PoS) applications as a single system entity that offers services in the form of EHR Interoperability Profiles (EHR IPs). Each EHR IP can be invoked from a PoS application to feed to or get data from an EHR infostructure. This, in essence, constitutes the first degree of separation and corresponds to a level of parameterization. From the business point-of-view of the health system, this entire EHR Infostructure is a parameterized system solution that can easily be configured to support more data transactions and hence both current and future clinical information sharing needs.

Secondly, the intra-EHRi abstraction level. Within an EHRi, all services need to be coordinated and interact with one another in a coordinated fashion. Parameters and subsets of transactions need to be passed back and forth as different services are invoked in order to process each transaction. This coordination of service is handled by a central component described as the Longitudinal Record Services. Longitudinal Record Services is itself made up of services to handle the sequencing of operations (orchestration) and to maintain key metadata required to understand how to conduct such operations (transaction templates). Services such as the orchestration service, the EHR Index, business objects and business rules, as well as the registries and clinical domain services all play key roles inside an EHRi to insure the processing of transactions. The degree of parameterization of this set of Longitudinal Record Services along with all the other service components of an EHRi is important to insure the flexible and evolutionary nature of EHR Solutions in Canada. For example the ability to introduce a new step in the processing of a lab result "put" transactions to apply business rules on the detection of communicable diseases may be seen as a critical enhancement in the future. The amount of work and level of change required to achieve this is directly influenced by the level of parameterization offered inside the EHRi.

Another key level of parameterization that drives to an open architecture is the generic event-driven model for data collection and data access that is described under the EHR Index functioning principle. This approach of data abstraction of the contents on a person's EHR to a generalized representation of the events is a foundation to enable the openness and flexibility required to support evolution of the EHR Infostructure over time.

Defining Levels of Parameterization

The rest of this section discusses specific aspects of an EHRi that may be considered as parameterized, and provides a baseline viewpoint as to the degree of parameterization that should be implemented. The following table identifies potential topics of parameterization and the expected degree of parameterization along with the rationale for this position. The degree of parameterization is defined as:

Hard Coded: Means that the functional behaviour about the topic is not parameterized. Basically this means that this behaviour is hard coded in the solution and that the solution needs some degree of reengineering to address a change in this regard. In other words, a new version of the solution needs to be packaged, tested and brought to production to address a change.

Initialisation: Means that the functional behaviour associated with the topic is parameterized to a high degree but a change to such a parameter can only taken into account by shutting down and restarting an instance of the system.

Run-time dynamic: Means that the functional behaviour associated with the topic is parameterized to the highest degree and that changes to such a parameter can be done on the fly and will be taken into account as processing of data occurs.

Run-time data driven: Means that this change should be handled by a regular data transaction handled by the EHRi and an EHR IP and that the behaviour will vary independent of any maintenance intervention.

Topic	Degree of parameterization	Rationale
A new EHR Interoperability Profile to be supported by an EHR Infostructure	Initialisation	The configuration of multiple components of the EHRi would have to be adjusted and tested to implement a new I-IP in support of a new EHR IP
One or many new services are deployed inside an EHR Infostructure such as a	Hard Coded	Depending on the scope of change imposed by the new service to other

DI/PACS domain or a Drug Information Domain		components of the EHR Infostructure, new versions and system level testing maybe required.
A new type of clinical data is added to the system. For example new data attributes are implemented in the system to handle the specifics of the mental health domain	Hard Coded	Changes to the databases, and many services layers such as the data access and privacy rules layers, the integration and messaging layers would need to be done. Many of those would not be parameterized.
A new business rule is implemented in the system. For example, all event codes referring to a hysterectomy procedure can only be assigned to a female gender.	Hard Coded Or Initialisation	In early generations of EHR solutions, we would not expect systems to support the evolution or introduction of business, rules in run-time mode. Minimally they would require a system initialisation, if not a new version of software.
A new terminology to be used in mapping message elements such as a diagnosis code	Initialisation	Mapping engines typically need to initialise with the set of applicable terminologies
A new value is inserted in an existing code set or vocabulary used in several message sets	Run-Time Dynamic	Inserting a new value in a code table should not require any maintenance
A new PoS application, an ADT system in a hospital, is being connected to the EHRi to feed data	Run-Time Dynamic	Adding a source system that feeds data relying on existing EHR IPs should be done by creating an entry in a database table used for validation of EHR enabled software instances. .
A new EHR Infostructure is being connected to the network of available EHR Infostructures	Initialisation	Adding an EHRi to the network of recognized EHRi's should be done simply by resetting an instance to now take it into account. This assumes the CR to CR synchronisation would have been done offline a priori.
A new user is being added in a PoS application and will have to be recognized as a user of the EHR. In this context a role is also associated to this user	Run-Time Dynamic Or Run-Time Data Driven	In early generations, administrative functions should allow to add users and associate a role without any major impact on system maintenance. Eventually this would transform to administration EHR IPs that would allow for automating the process of synchronisation of user databases with the EHRi
A new user role is being added to the EHRi in order to recognize specific access rights permissioning for physiotherapists	Run-Time Dynamic	In early generations, administrative functions should allow to add roles without any major impact on system maintenance.
Consent directives are provided by a user as he is seeing a specialists about a potential tumour	Run-Time Data Driven	Privacy administration EHR IPs would allow PoS application enabled to manage consent to send and register

		such consent directives for application in the EHRi.
A new hospital organisation consolidates an existing hospital and 3 other ones into a single entity	Initialisation	In early generations, administrative functions should allow to reconfigure organisations and their service delivery locations without any major impact on system maintenance. Eventually, administration EHR IPs could allow for the automation of these transactions so as to automate them from the sources systems where they are generated.

Although all EHRi's must behave in the same manner when interfacing with a PoS system or other EHRi's, the degree of parameterization may vary significantly between different solutions used to deploy such EHRi's. Decisions regarding the level and aspects of parameterization are predicated on:

- What configuration elements may change?
- How likely they are to change?
- How frequently they will change?

The analysis and decisions made with regards to the level of parameterization can significantly impact the cost of ownership of a given solution. For example, if the level of parameterization is not correct and additional changes are needed as the EHRi develops and evolves, then each time a change is made, the level and degree of testing required will be far higher than if the additional functionality could have been added by making configuration/parameter changes to the EHRi. Another example is where parameters are specified at service initialization, but in practice require changes more frequently. This would require dropping either the entire EHRi to reinitialize, or dropping of services that will at best cause delays in transactions or at worse cause transaction failures.

Additionally, there may be more optimal potential for reuse and replication of a solution if there is a higher degree of configurability. Lastly, it is understood that there is likely to be some degree of trial and error before reaching the appropriate level of configurability / parameterization. This requires testing environments that closely mirror actual live operating conditions.

4.5.1.8 Other uses of the HIAL (PoS to PoS)

The HIAL Communication and Common Services layers must be able to support the use of the HIAL for purposes other than its use as an infostructure dedicated to the sharing of EHR data.

There is a significant investment involved in developing, implementing and maintaining the HIAL, and it is well understood that its inherent abilities, such as:

- Client ID resolution
- Provider ID resolution
- Service Delivery Location resolution
- End-user authentication, and authorisation
- PoS application authentication
- Auditing and logging capabilities
- Application of consent directives
- Service level capabilities for guaranteed delivery of messages
- Messaging infrastructure

- Standards based protocols

are useful components that should be leveraged for many other business needs besides those directly related to the EHR.

In order to maximize the return on investment from building the HIAL, and to get maximum benefit from the HIAL, other uses of the HIAL are up to the discretion of each jurisdiction implementing an EHR infostructure. Great care should be practiced however, in considering such requirements, for these uses may negatively impact the operation and security of the HIAL and its ability to support the EHR and maintain the privacy of personal health information under it's custody. Proper risk management processes must be employed when considering this option.

Other potential uses of the HIAL could be:

- Communication of data from one point of service application to a different point of service application directly. Consult/Referral letters or requests and responses should become electronic. The request could include specific data from the EMR such as a clinical note of specific lab or DI results. The response would contain the specialist's report that could then be stored in the EMR.
- Communication of data between two jurisdictional level organisations, such as a College of Physicians and the Canadian Congress of Neurological Sciences
- Patient transfers, i.e. packaging up the entire clinical profile of a client to transfer it from one primary care physician to another.
- Access control to non-patient data such as monitoring of hospital administrative functions by a health region.
- In the future, as solutions evolve into the realm of process automation across the continuum of care, several opportunities may arise to leverage the HIAL infostructure in order to support such needs. Examples include:
    - Secured exchanges of notes or observations and alerting capabilities (not email) between applications used by providers practicing in different settings;
    - Provider practice support, i.e. communication to/from a Help Desk or peer support group

Note that the above discussion applies only to the Communication and Common Services layers of the HIAL as well as the registry services, and not to the Longitudinal Record Services, the EHRi repositories, and their associated services.

4.5.1.9 Multi-lingual capabilities

The EHRS must support both official languages – French and English.

The language that is used affects the following items:

- User interface
- Data that is fed into the system and stored in repositories
- Vocabularies and code sets used by the system
- Normalisation services and mapping algorithms
- Help files
- Error messages, warning messages, alarms, notifications
- Text and string indexing algorithms
- "Sounds like" algorithms for EMPI solutions

At a minimum, the EHRi and PoS application solutions must be easily configured from one language to another (i.e. configured to behave properly in English or French, and potentially others

For the purpose of the functioning principles discussed in this section, it has been assumed that some of the data is language sensitive (e.g. text strings used for descriptions), and some data is not influenced by spoken language (e.g. identifiers, codes, images, measurements etc.).

The EHRS will adhere to the following functioning principles:

- Data will be stored in the EHR in the language in which it was generated and uploaded by the PoS application acting as a source system
    - The EHRS will not perform any automated translation of data

- Language-sensitive data stored in an EHR may be in French or in English, depending upon where it originated. Therefore, a query to an EHRi in areas such as Quebec, New-Brunswick, Ontario and Saskatchewan may return data to an end-user interface that mixes English and French

- Meta-data structures are mandatory to be able to record, maintain and provide the language used to express the data. This meta-data construct is required and should be driven by sets of codes or terminologies established as Pan-Canadian standards.

- Code sets and vocabularies need to exist in both official languages

    - Solution projects could choose to implement only one language, or both English and French
    - Standards initiatives and bodies that create code sets and vocabularies need to provide descriptions and annotations for codes in both supported languages (English and French)

- The EHR Index will maintain a record, in the form of metadata, of the language of the data expressed as part of the transaction

- Programmatic naming, such as service names and calls, communication protocols, data entities, attributes etc. will only be available in English

- Pan-Canadian standards should attempt to capture key data using coded elements where possible to maximize data that can be read by clinicians of both official languages.

- For applications providing an end-user presentation interface, minimally the application needs to support the two official languages in such a way where it can be initialised to work in English or in French. Ideally, applications will allow for switching dynamically between languages, it must support English and French and could support others.). In terms of the end-user interface for an EHR Viewer for example, it is assumed that many vendor products can be adapted relatively easily to meet this principle, as they have been created to support both French and English in Canada or Spanish and English in the U.S.

- Provided that most of the accesses to the EHR will be conducted on the basis of resolved identifiers (i.e. client ID, Provider ID, Service Delivery location ID), capabilities to support full text searches and hence, indexing of text and strings data fields is not seen as a core requirement at this stage.

Business requirements for legislatively enabled and patient approved secondary and tertiary uses of the information are expected. For example, exploiting the data of the EHR to discover any individuals that might have had a heart valve replacement surgical procedure in the context of a medical device recall from a vendor. In order to perform that kind of a search through the EHR, one might refer to coded data elements, but one might also need to search through records on the basis of non coded text fields expressing procedures or clinical notes of encounters.

This would generally not be done in the operational setting of the EHR Infostructure, rather, data would be transferred or loaded into the health information data warehouse in order to conduct that search. It is expected that the intricacies pertaining to the indexing of data fields covering multiple languages would be handled either in the context of these data loading processes or in the data warehouse itself.

- Another key aspect to the presence of multi-lingual data is the way that it affects specialised algorithms for person name indexing in Enterprise Master Person Indexing solutions. Solutions used in Canada for EMPI solutions must have capabilities to handle both French and English name derivatives when they build the "sound like" indexes that they use for person resolution.

- As patient access to EHR data becomes a reality, there will likely be a requirement to express record contents in a wide variety of languages.

The above functioning principles do not propose how to solve the issue of interpreting data in various languages to an end user, and this issue is not addressed from a technical perspective in this document. However, from a clinical practice perspective, as information starts to flow more pervasively in the health system, there could be a gradually increasing need for the translation of health information in cases where a provider does not understand the language used for the information in the EHR. One scenario to solve this would be a call-centre service with translators trained in medical concepts, who would be able to access the same EHR information using a browser and do live translation where necessary. Many other approaches could be defined and jurisdictions across Canada involved in deploying EHR solutions will need to address this issue in light of their individualised context and populations.

4.5.1.10 Runtime environment

This section will describe both the EHR infostructure runtime environment as well as the PoS runtime environment, including the steps a PoS has to perform in order to access the EHRi Data.

EHR Infostructure Runtime Environment

The runtime environment of an EHR infostructure is defined as an online transactional environment and its processing capacity is reserved for answering queries and performing updates from PoS applications and the EHR Multi Domain Viewer. The EHR infostructure environment and all of its components will be available on a continual basis (24/7) to support the availability requirements described in section 3.1.5.

The EHR infostructure environment and all of its components (including any distributed nodes) must be built for no downtime scalability so that the EHRi System transactional capacity can be increased as its functional features and number of connected applications and users increase over time to the maximum capacity of the jurisdiction it services.

An additional aspect of the EHR infostructure is that it will operate mechanisms to feed authorized and anonymized subsets of its data to data-warehouse systems (also part of the EHRi) used for surveillance, research or administrative analysis. This will be done in a way that does not affect the transactional capacity or performance of the EHRi.

EHR infostructures will have a limited geo-political scope (typically a Province or a supra-regional level in large Provinces/Territories). In time, multiple EHR infostructures will become operational in Canada. They will be interconnected and able to participate concurrently in resolving the consolidation of relevant data about an individual. EHR infostructures will communicate with each other using the same HIAL interface mechanisms as described for PoS applications interacting with a given EHRi.

Point of Service System Runtime Environment

Triggers to interact with the EHRi will be initiated by PoS applications (including the EHR Multi Domain Viewer) to connect to the EHRi to read data or post data to an individual patient's EHR. These interactions with the EHRi will be executed in the context of, and at different stages of, local transactions being performed by authenticated and authorised users of these PoS applications.

All PoS applications interact with an EHRi through the HIAL of that EHRi. The communication bus layer of the HIAL will expose TCP/IP sockets that will be used as the connection point for PoS transactions sending information to the EHRi System as well as for all PoS queries that retrieve EHR data.

PoS applications will interact with an EHRi by addressing requests to the EHRi using the pan-Canadian EHR standards for communication protocols and EHR Interoperability Profiles. These requests can read or post data to an individual EHR either with single domain interactions or multi domain composite interactions.

The EHRi will process transactions in a stateless model: i.e. it will not maintain state or context between PoS (EHR IP) interactions with the EHRi System.

The EHRS Multi Domain Viewer may rely on these standard communication and EHR IPs or it may use a more direct coupling method to interact with the EHR data using standard API type technologies. *(See section 4.3.9)*

A given PoS application instance should be configurable to have the capacity to connect to multiple different EHR infostructures. However, it is required that a given PoS application instance, at any single point in time, be actively connected to only one EHR infostructure. Allowing one application to have simultaneous EHRi connections introduces the risk of splitting transactions across infostructures, which could create problems with EHR indexing, EHRS locator services, data integrity problems, Trust model and IT security issues. The underlying principle is that if data needs to be coordinated between two EHR infostructures this should be done by the Longitudinal Record Services (LRS).

PoS applications may connect directly to an EHRi or they may connect through one or more integration bus (or interface engines) as long as each layer of integration can support the minimal communication protocol requirements expressed in the EHRi interface specification (e.g communication, error handling, guaranteed delivery, retries with threshold requirements etc). Applications acting as a PoS in an EHR solution do not need to be available on a continual (24/7) basis.

For the most part, PoS applications do not need to be actively aware of the services of the EHRi, other than to establish a background for the behaviour the application can expect of its interactions with the EHRi.

For a detailed description of how Point of Service applications access the EHRi to PUT or GET information see section 4.5.1.6 PoS to EHRi Interfaces.

4.5.1.11 Level of transparency of EHR to PoS applications

Data sourced from the EHRi should be clearly evident to the application end-user, while at the same time the interfaces between the PoS applications and the EHRi should be as simple and invisible to the application as possible.

One of the goals of the EHRi is to have a minimal impact on existing applications such as PoS systems. When PoS applications send information to the EHRi there is likely to be no change to the existing user interface, however when displaying information from the EHRi it is desirable (and possibly very necessary for patient safety and physician accountability purposes) to ensure the data not-sourced from the local application is obvious to the end-user.

The source of information displayed in a PoS application should be clear. This can be implemented in a number of different ways, including simply separating local PoS data from EHRi data on the screen, or using completely different screen sets to browse local data versus EHRi data. However, PoS applications are encouraged to provide integrated views differentiating by color, symbols or formatting such that users can see the comprehensive state of a patient without switching between screens or windows.

It is understood that vendors may want to make it clear that their applications participate in the EHR, and for this reason would also want to differentiate EHR data from local data. The minimum requirement from the EHR point of view is that it should be clear if information is sourced externally. Refinements or enhancements about how to further differentiate or present data are at the discretion of the vendors or clients requesting such features.

There may be implications due to privacy legislation that require data to be displayed in a certain manner. In such cases these requirements should override any default configurations, and allow for appropriate application behaviour. An example of this is the navigational and presentation behaviours associated with masked or locked data due to patient informational consent directives.

Comparability of information must be considered when it is displayed. The EHR accepts all information that is sent to it, even if the terminology is not conformant with national standards. In some cases there will be agreed-upon mappings (i.e. mappings which it has been agreed will not affect clinical safety), which the EHRi will perform, while still maintaining the original data. However, in other cases there will not be mappings, and it may be necessary to display the full textual equivalents of the codified data. The Pan-Canadian standards will make clear where such ‘original text’ support is required.

In all cases it must be clear where the data is sourced from so that the information can be considered in the appropriate context. The minimal requirements for expressing this source include:

- The EHRi location where the data came from
- the service delivery organisation where the data originated from
- the service delivery location where the data originated from;
- the types and names of the provider(s) involved in the event that posted the data to the EHRi
- the date and time that the data was established
- the date and time that the data was provided to the EHRi

Secondly, PoS applications displaying normalised data that has been translated from its original form to a common form based on a standard for the EHR, must allow for the availability and access to the originally sourced data if the user desires to see it. This original data may have been coded using a different encoding scheme or may be free text.

Filtering Externally Sourced Data

Local PoS applications send data to the EHRi, and retrieve data from the EHRi. However, they also have their own repositories of local information. Therefore each EHRi has a "duplicate" copy of whatever information it was sent from the PoS application. There needs to be some coordination between the EHRi and PoS applications in order to ensure that this data is not displayed twice to the user. The following mechanism is proposed to help solve this problem.

Whenever a PoS application communicates with the EHRi, it will provide a unique application instance identifier as part of the message wrapper. The EHRi tags all transactions with this unique identifier. This application identifier is used for many purposes including: auditing and PoS application authentication. This identifier can be used to filter externally sourced data from data placed in the EHR by the local PoS application. This filtering would need to occur at the level of the PoS application as part of its process to interact with the EHRi. Namely, because the state of the data existing at the local level cannot be assumed to be the exact same as the state of the data in the EHRi. Therefore the decision algorithm that would need to be applied to decide whether or not to display a record coming from the EHRi for the same PoS application instance, can only be expressed locally and involves an intricate knowledge of the functional behaviour of this application. This issue of filtering would be a key part of the analysis involved in designing an interface to the EHRi for a PoS application that persists EHR data locally.

Transferring Externally Sourced Data

Local PoS applications that access and display data from the EHRi for end-users can offer capabilities to allow for the transfer of data coming from the EHR Infostructure into the locally maintained data structures and databases of such PoS applications. This could help a provider in building a more detailed and local clinical record for a patient. It is generally understood that clinical PoS applications will keep more detailed information and other types of information then the limited data available for sharing in the EHR.

While such capabilities could be built, there are significant caregiver practice policy dimensions associated to such practices especially in the area of applying a patient's informational consent directives in addition to jurisdictional privacy policies with regards to the use and disclosure of information. The EHRS Blueprint does not preclude or promote such practices. The evolution of health practices in the context of an increased and eventually pervasive flow of information will mandate the evolution of policies required to sustain such practices.

4.5.1.12 Performance principles – targets

The response time from the EHRi (message sent to message received) should be no more than 3 seconds for 80% of the interactions. Additionally, the EHRi should have 7/24 availability 99.9% of the time.

This section contains principles, guidelines and requirements for the EHRi, which have been identified in order for an EHRi to consistently meet performance expectations.

The “80%” above is based on an assumption that most interactions are local to the EHRi. This, therefore, excludes situations where the request is an inter-EHRi request, or where it contains components that require inter-EHRi messaging. It also excludes instances where streaming of data is required.

Its is assumed that the EHRi will operate with a level of abstraction from the PoS applications that are accessing its data. At the same time, another assumption is that providers of care are using data coming from an EHRi in the context of providing care to a client or at least in a context where they are actively working on a client case (e.g. reviewing a case to make decisions, discussing it with peers, etc…). In this context, the adoption and continued usage of the EHRi by providers is highly dependent on its responsiveness when data is accessed. Key decisions must be made in the design of an EHRi solution to address this issue. In cases where the EHRi has to go through extensive and time consuming processing, an approach must be put in place to insure that this responsiveness is adhered to. One example of such a situation is where some data needs to be compiled from the local EHRi and from other EHRi’s as well.

A suggested approach to deal with this is to establish a two-step process for applications listening for a response for all query/response interactions. To make this work, the EHRi would operate with two main thresholds when executing a data read transaction. The first threshold would establish a time span under which the EHRi would have to provide a first level of answer, with the understanding that the data local to the EHRi would always be provided within this timeframe. This threshold would be 3 seconds for 80% of transactions as presented above. The second threshold would be a maximum “time to live” for the transaction. Under this framework, the EHRi would provide a first level response to any query within an optimal timeframe but would have the capability to pursue the compilation of additional data up to a limit expressed by this “transaction time to live”. This involves a corresponding behaviour implemented with the PoS applications that read data from the EHRi.

Early generations of EHR Infostructure solutions are not expected to have a high degree of cross-jurisdictional interoperability implemented, so this type of capability may not be required in early implementations. That said, this kind of optimisation may have valuable clinical impact for the end-users even in a context where a single EHR Infostructure is in play. This type of generic pattern for the processing of transactions needs to be standardised between EHR infostructure solutions.

Pan-Canadian EHR standards must be developed to address this.

The Privacy and Security Architecture document (available from Infoway) expresses the potential legal and policy implications when so called “incomplete” results sets are provided by an EHR Infostructure in response to a query. This would be based on jurisdictional and or patient derived informational consent directives. One key characteristic that needs to be considered in this discussion on performance is that, some jurisdictional legislative requirements and policies that govern the use of EHRi’s may require that end-users be made aware of the level of completeness of a the data they are looking at. Therefore, the concept of thresholds mentioned above would have to apply the principles associated with this awareness for end-users.

Another key stream of optimization to solve issues with slow response times is the use of technology and application level strategies relying on caching mechanisms. Caching can be driven at different levels such as data caching strategies within databases, query-response data clusters controlled by programming, caching of response messages at the communication level of an application. It is assumed that the most efficient forms of such caching mechanisms would be controlled by business logic and privacy requirements. Provided that the use of EHRi solutions will be limited to a set of relatively simple data access paths:

- Find the data for patient XYZ

- Find the data for provider XYZ
- Find the data for service delivery location XYZ

One could easily imagine that an application playing the role of the Longitudinal Record Service could use a pre-emptive data querying scheme to start caching data likely to be accessed as soon as a transaction comes into the EHRi to search for the identification of a client. Another example of a trigger for such caching schemes, would be a provider logging on to an EMR application in a clinic. There, the EHRi could immediately start caching data for the patients the clinician is scheduled to meet with in the very near future. Again, the Longitudinal Record Service would be able to do this on the basic data available form the EHR Index.

Service Level Agreements (SLA) must be in place for all of the services provided by the EHRi. SLA's must adhere to IT best practices in the procurement of large scale IT solutions and should cover topics such as:

- response time requirements
- availability requirements
- product maintenance support
- technical support
- end-user support (when applicable)
- contractual support
- operational contingency plans
- etc…

ITIL (the IT Infrastructure Library http://www.itil.org) provides a valid framework and stands as an international standard to define and describe the IT service management requirement of large scale governmental IT solutions.

Performance thresholds must be tailored to the nature of the service, as, for example, some services will be more resource intensive, while others will be dependent on the latency of the network, external services and external EHRi instances.

In establishing SLA's, it will be critical to consider the two types of abstraction existing between the PoS applications, the EHRi and the components that make up the EHRi.

The first degree of separation involves the organisations that operate PoS applications and the way they will look at the EHR as being a single sourced service coming from the jurisdictional health ministry (or an organisation mandated by it) to operate the EHR Infostructure. The organisations that govern and operate PoS applications such as hospitals, clinics, pharmacies, diagnostic centers, whether they are public or private corporations, will enter into agreements with the organisation that govern and operate the EHRi. The SLA's established at that level will need to address the concerns expressed here in terms of response time and availability of the EHR Infostructure service. Of concern to this type of SLA will be the following issues:

- How many users are registered users in the EHRi

- How many client clinical health records exist in the EHRi

- How many transactions were processed from each PoS application connected to the EHRi

- How many transactions of a given type (e.g. based on EHR IPs) were processed by an EHRi, allowing to distinguish between updates and reads and then to do finer grain analysis of the types of data being used

- What was the average response time over a given period of time for all transactions processed by an EHRi
- What was the average response time over a given period of time for all transactions of a certain type (e.g. based on EHR IPs) processed by an EHRi
- What was the average response time over a given period of time for transactions coming from a single PoS
- What were the longest and shortest response times across all transactions and for singled out PoS applications
- How many transactions were serviced locally (within an EHRi) and what where there average response time
- How many transactions resulted in cross-EHRi processing and what where there average response time
- Etc…

The second type of abstraction has to do with the way different services and components are used to fabricate an operating EHR Infostructure. The EHR Infostructure will be potentially made up of different systems. As these different parts are being acquired and implemented, each one will become the object of a set of SLA's between the organisation that governs the implementation of an EHR Infostructure in a Province/Territory and the software/hardware vendors and/or the system integrators involved in providing these solution parts. The SLA's established for any of the parts of an EHRi (e.g. a client registry solution) will need to take into account the participation of the solution into the broader EHRi service in a jurisdiction. Following is an example of performance issues addressed for a client registry component:

- How many individual clients are registered in the CR
- How many transactions were processed by the CR from each PoS
- How many transactions of a given type (e.g. based on EHR IPs) were processed by the CR, allowing to distinguish between updates (including merge/unmerge and link/unlink) and patient search or reads and broadcasted notifications;
- What was the average response time over a given period of time for transactions coming from the HIAL;
- What was the average response time over a given period of time for transactions coming from the other sources (e.g. direct access to CR from a claims management system);
- What was the average response time over a given period of time for all transactions of a certain type (e.g. based on EHR IPs) coming from the HIAL;
    - o Perspective here, as an example, would be to validate a performance target of 0.5 seconds for client resolution transactions.
- Etc…

In some jurisdictions one service provider will be responsible for all services in the HIAL, LRS, registries and clinical domain repositories, and therefore a single “umbrella” SLA can be appropriate. However, in many cases different EHRi services will be provided by different service providers. In such situations it is expected that there will be multiple SLAs, to cover the different vendors and services separately. These must be carefully crafted to ensure that responsibilities are clearly delineated and that there are minimal areas where responsibility cannot be clearly limited to a single service provider.

In order to be able to easily measure the performance of the EHRi, it is assumed that the HIAL will have the capability to capture and report performance metrics on demand, with auditing done actively not only on interaction content and wrappers, but also on the performance of the EHRi services and components themselves. These systems performance audit processes should also have a parameter to dynamically increase or decrease the amount of detail captured by the audit logs.

4.5.1.13 PoS Integration environment

Connecting a PoS application to an EHRi will involve a small to medium size software integration project. The scope of such an integration project will depend on the size and types of data maintained at the site being integrated to the EHR service. This project environment would be responsible for crafting the interfaces in the PoS application environment, and for engaging with the providers of the PoS applications to integrate their products to an EHR Infostructure.

The types of integration done in this environment will range from enabling DICOM image streaming capabilities, implementing HL7 standard messages to handle data exchanges, dealing with security interfaces including cryptography services, to employing UDDI services for managing and interacting with directories.

When doing enterprise level integration, it is recognized as an ICT industry best practice to establish a center of excellence for integration, so as to concentrate knowledge, expertise and resources focusing on solving integration challenges. In the context of EHR Infostructure solutions, governance organisation in charge of the operation of EHR Infostructures should also consider creating this kind of capability as an ongoing service offering. As examples, this center of excellence for integration would be in charge of:

- publishing and maintaining a website for PoS application software integration engineers;
- producing and publishing valid integration agents or proxy’s representing available transactions in their EHR Infostructure. The PoS integration agents can then implement these deliverables with the correct communication protocols and interface specifications to interact with an EHRi. The end result will be modified PoS applications that expose the functionality of EHR IPs, EHR Communication Steps needed to interoperate with an EHRi System.;
- producing and publishing tests scripts and tests databases;
- maintaining and coordinating testing environments;
- maintaining and coordinating live tests sessions and error reports for interfaces being implemented;
- offering technical support to software integration teams running into problems;

EHRi System Development

The EHRi system development teams will need standard replicable system development environments to design, develop, unit test, system test, and user acceptance test the solution. Examples of these environments include a development environment, an integration environment, a live testing environment, a pre-production and production environment etc. These environments will be used in the following ways:

- The development environment is used to test the configuration of the system to allow for existing or new clinical applications to be recognized, connected and interact with the EHRi. It also allows developers of PoS applications (possibly vendors) to prototype functionality that will support the EHRi requirements. In this environment, rebooting servers and applications on the EHRi side will be common.

- The integration environment is used to do the early system testing of interfaces as they are being configured and implemented locally in a live application of a valid healthcare system PoS. The EHRi system development teams will be responsible for robust and validated tests data sets to be made available, managed and used in this environment.

  Software and communication engineers should be available to execute and validate interaction tests with PoS side implementation teams. Initial data loads and configurations of system meta-data and parameters are also tested in this environment as well

- The live testing environment is used to confirm final test runs and configurations with live (potentially anonymized) data to test scalability, availability, capacity and performance. Copies of this environment may be used for final user acceptance testing.

- The pre-production environment is a scaled down duplicate of technologies used on the live production environment and is used to consolidate, test and automate production migration scripts.

  It is very important that the EHRi integration team build (as early as possible) a coherent set of starter data and a spectrum of test cases / scripts than can be used repeatedly, with predictable results, to validate appropriate application behaviour and interaction with the EHRi. This test data environment must be maintained to match changes in the production environment, and should be refreshed with a new set of reference data after every major reconfiguration of the EHRi data environment

- The production environment is the live environment which only gets upgraded in the context of managed upgrade windows from migration scripts in the pre-production environment

PoS Application Vendor Organization

A typical scenario would involve a team made up of business process engineers, data architects, software and communication engineers as well as vendor's application subject matter experts tasked with connecting the PoS application to the EHR Infostructure. The team analyses the impacts of connecting the PoS to the EHRi and identifies software and data assets (such as patient EMRs) eligible for integration into a jurisdictional EHR that require validation and cleanup. From this analysis an EHR software and data migration strategy and plan can be established. The vendor organization must also plan for building user awareness and creating and disseminating training materials.

The vendor's users, providers, client base, applications, facilities and organizations are identified and prepared as initial parameters to be loaded and incorporated in the EHRi. After the PoS software upgrades are done as described below, incorporating the integration agents and the ability to communicate with the EHRi, integration and live tests are conducted as well as End-user training completed. Once the EHRi System interface is brought to the production environment and the site is connected, the PoS application is ready to go live.

PoS Application Vendor System Development

PoS application software engineers will commence the task of building an interface to the EHRi in their product. Ideally they can do this by downloading the generic framework for PoS integration agents from the PoS developers section of the jurisdiction's EHRi website. As they prepare and configure the testing environment they will modify the PoS application to implement the EHRi agent software and recompile or regenerate their software which now integrates the ability to communicate with the EHR Infostructure. After the standard cycle of development tests and modifications are completed up to a point where the application is considered ready for production, the application is brought to the EHRi testing environment, where pre-production testing validates and confirms it meets the interoperability requirements for the EHRi. Information about the application version and the services it is certified as compliant to perform will be captured in the EHRi to allow control of which PoS applications are authorized to perform various services.

EHRi / PoS Design and Runtime Requirements

In order for a PoS application to be able to exchange information with the EHRi System, PoS application designers and developers responsible for these systems need to find and incorporate the appropriate EHRi messages and services into these applications and test the interactions using the agreed upon network and transport protocols.

On the EHRi System side, the HIAL communication services need to support the network and transport protocols to receive the messages sent by the PoS system. Designers and developers need to make sure that appropriate messaging adapters are in place to parse, validate, map and route the messages to the appropriate EHRi system services.

In order for the EHRi System and PoS systems to communicate properly there are both runtime and design time configuration steps required. These include modification of EHRi services to be exposed and design time setup of the EHR. The PoS also needs to be configured during design time so it is setup to properly access the EHR.

Both the PoS and the EHRi System will also make use of the design time configuration during runtime.

The following diagram illustrates the various run time and design time aspects of the PoS application and the EHR when implementing HL7 messages. A very similar process is used for other protocol interactions with the EHRi and these will be specified in the appropriate EHR IPs.

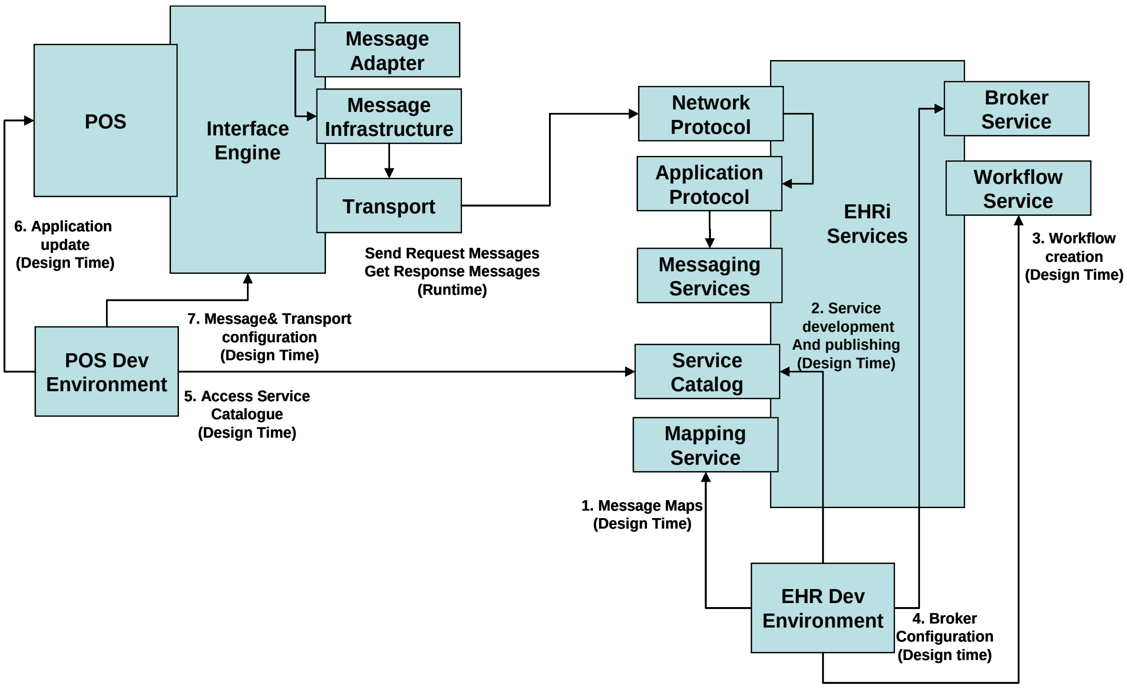

Figure 4-34 Aspects of HL7 Messaging

EHR Design Time and Runtime Requirements

As new messages need to be supported, the EHRi System designers and developers need to do the following at design time: [16]

1. Specifications for the interface requests will have to be created or referenced from an existing interface specification repository.

2. Suitable EHRi business components / services will have to be developed to support a given EHRi access request.

3. The Orchestration process flow necessary to fulfill the service request would have to be created and registered in the Orchestration Services

4. The service would have to be registered in a service catalogue.

5. The broker service would need to be configured to map the interface to the appropriate Orchestration process flow.

At run time the EHRi will go through the steps outlined in "PoS to EHRi Integration" in section 4.5.1.6 of this document

PoS Design Time and Run Time Requirements

[16] It is assumed that message, application and network protocol components have been installed and properly setup. Tools are available to automate most of the requirements listed here.

If the PoS application needs to use an interface that is supported by the EHRi, it will have to do the following at design time to be configured appropriately to access EHR data using that message.

1. Query the catalogue to find out if the message or service is supported by the EHR to communicate the desired information

2. Download the service description and the location of the service

3. Create the appropriate proxy for the service (most tools do this automatically)

4. Develop the appropriate program code to call the service and to create the HL7 message payload

5. Configure the interface engine to use the appropriate

    - message adapter (Web Service, ebXML, MLLP)
    - message infrastructure (Web Service, ebXML, MLLP)
    - message transport (HTTP, UDP, TCP, SMTP)

Once this is all done, the PoS application is then set to test the interface against an EHRi System conformance environment and be used to access the EHRi during run time. At run time the PoS application will execute the interface with the EHRi using the appropriate transport protocol.

4.5.1.14 Transaction scope

There are three broad types of transactions that have been identified – pass-through transactions, single domain transactions and composite transactions. All transactions, no matter which of the three types, include similar information that is required for any transaction with the EHRi.

The following is included in the wrappers:

- Source organization
- Source facility
- Source application instance identifier
- Interaction type
- Client
- Author / provider
- Data enterer
- Person responsible
- User id
- User EHRi Role

Each interaction defined in an EHR IP is self-contained from the perspective of the EHRi and the state of the transaction will not be maintained in the EHRi beyond the scope of its execution.

A key component, when it comes to the processing of transactions is the orchestration service. The nature of the orchestration service may vary greatly between different EHRi solutions. In some cases it will be a generalized, rules driven, engine where generic templates for transactions can be defined and then executed as a set of steps by the engine. This is seen as a preferred choice as it offers the greatest flexibility and openness for the evolution of EHR Infostructure solutions. In other cases, however, the sequencing logic associated with the processing of transactions may well be hard coded into an interface wrapper that surrounds a piece of software acting as a clinical information system and offering the services expected of the LRS and EHR domain repositories. In the descriptions below, the orchestration service is represented as being part of the Longitudinal Record Services, the reader has to keep in mind that depending on the configuration of an EHRi solution, there may be a very high degree of coupling between the HIAL and Longitudinal Record Services or they may be two completely distinct components invoking there individual services through public interfaces.

Pass-through Transactions

Pass-through transactions are transactions that do not involve directly the EHR Index (some of them may impact the EHR Index indirectly as is described later). These transactions do not involve the use and recognition of a holistic view of a person's health record either because the transaction does not pertain to the EHR of a person or because the transaction only affects a single component of the EHR of a person.

From the perspective of a PoS application interacting with the EHR Infostructure, the HIAL provides different services such as PoS application and end-user authentication, end-user access control, application of consent directives, logging, even client, provider and location resolution may be seen as services that would be of use for pass-through transactions. The different levels of service applied to a transaction would be driven by the orchestration flow associated with the execution of such transaction. Every transaction sent to an EHR Infostructure needs to have a "transaction type" (Control-Act Type in HL7 lingua) in order for the EHRi to know what orchestration flow it needs to execute. Here are valid examples of pass-through transactions:

1. A new prescription is being sent from a physician office EMR application to the EHR Infostructure, its destination is a separate system as part of the EHR infostructure that maintains drug information (i.e. a drug domain solution). In that context, all services of the HIAL would be triggered to apply security, resolution services etc… Such a behaviour assumes that the domain system, in this case a drug information system, must notify the EHR Index of this new prescription event.

2. A client identification resolution request is being sent from a PoS application to the EHRi. Security, logging and location resolution services would be invoked in such a context, then the transaction would simply be routed for execution to the Client Registry.

3. A new patient has been created in a hospital ADT system and this transaction has triggered an EHR IP that is coming to the EHR Infostrutcure. In that case, the destination is another independent component of the EHRi, the Client Registry component. Again in that context all services of the HIAL would be applied.

4. A new outbreak case has been created in an application used by a public health clinician, this outbreak case is being published to the EHR Infostructure so that it can be seen and made available to any other authorized public health agent involved. Here, the destination is another independent component of the EHRi, the Outbreak Management component. In that context, security, logging and resolution services would be used. It is also assumed in such a case that the Outbreak management system would send notifications to the EHR Index so that caregivers accessing the EHR of people subject to this outbreak would see such events in there records (provided that their access rights allow them to see such events).

5. A transaction carrying an encounter summary is being sent from a hospital medical record application to an EMR application in a family physician clinic. In this case, the EHR Infostructure

via its HIAL would act as an intelligent router. The orchestration flow being launched would only validate the source and destination locations and log the transaction, then it would proceed to pass the message on to the EMR application using the right protocols and addresses, with a guarantee of delivery, to the EMR application.

Single Domain Transactions

Single Domain Transactions are limited to a single domain of data in terms of their scope – querying data such as a Client Registry resolution request, get medication, get allergies, list prescriptions, list lab results, or putting small discrete pieces of data into the EHR Shared Health Record such as the notice of an admission, a transfer or a discharge with an encounter summary, the notice of a referral order with accompanying notes. It is assumed that "put" (update) transactions destined to independently established EHR domain repositories, registries or ancillary components would be, in most cases, "pass-through" transactions as described above. These transactions are focussed on a single subject of clinical data and the EHR index is being queried or updated as part of the processing of the orchestration flow belonging to the transaction.

With transactions spawning multiple EHRi's, it is important to note that the parent EHRi (the EHRi instance for the jurisdiction within which the PoS application is running) has the ultimate determination about which information is returned to the PoS application. This is important from a privacy point of view – the source EHRi applies all appropriate jurisdictional privacy rules, next the parent EHRi applies all the local jurisdiction rules, and only then is the data returned to the PoS application.

These types of transactions will be handled in the following manner, by the Longitudinal Record Services:

- Recognize the type of transaction, log it, invoke the orchestration services which will find the right orchestration flow template and launch its execution;
- The PoS authentication, end-user authentication, client, provider and location resolution will take place;
- A query will be sent to the EHRS Locator, as per the functioning principle on the EHRS Locator, this might well be a query sent to the Client Registry in early generations of EHR Infostructure interoperability. If need be, query/response transactions will be spawned to other EHRi's.
- Depending on the type of transaction (get, list or put), the EHR Index is invoked to either find data relevant to the get, list or update transaction or it is updated with a new event to represent the data being added to the client EHR.
- If the transaction is querying data (list or get), then the results of the client, provider and location resolution as well as the lookup from the EHR Index are taken into account and are appended to the original transaction. This new transaction is passed on to the domain repository that needs to be queried and the resulting responses come back (this may be done through the use of data access services is the data is accessible locally from the LRS or it may me done by sending a query/response message to a single EHRi domain repository through the HIAL interoperability services. If the transaction is updating data, then the same process goes through to support the update.
- The Longitudinal Record Services will create and maintain an application context (programmatic objects to maintain the business and control data required) to execute the transaction. This application context will be used to compile responses coming from the systems involved in the transaction. This might be one or many other EHRi's as well as any of the repositories in the local EHRi where the transaction is being executed. When all the components of the response are

back or when transaction time to live thresholds have been attained, the orchestration service will launch a process to compile and assemble the response to the original query and send this back to the calling application.

Composite Transactions

Composite transactions involve a complex processing flow that can spawn requests to multiple domains. Their generic processing approach is similar to the single domain transactions but the degree of complexity resulting from the inherent need to combine data from multiple domains will require extended services and optimisation . The PoS application assumes that there is information in the EHRi that it requires, and assumes that the EHRi has enough intelligence to gather and package the information appropriately and ship it back. Therefore a simple request from a PoS application to the EHRi, such as a request for a clinical dashboard, a health profile, results in a series of messages in the EHRi, across multiple domains and to other EHRi's. These composite transactions are only seen as being used for querying interactions, not for updates.

With transactions spawning multiple EHRi's, it is important to note that the parent EHRi (the EHRi instance for the jurisdiction within which the PoS application is running) has the ultimate determination about which information is returned to the PoS application. This is important from a privacy and security point of view – the source EHRi applies all appropriate jurisdictional privacy and security rules, next the parent EHRi applies all the local jurisdiction rules, and only then is the data returned to the PoS application.

Composite transactions are handled in the following manner by the Longitudinal Record Services:

- Recognize the type of transaction, log it, and process the client, provider and location resolution
- Check the EHRS Locator
- Establish a transaction context and a set of business objects which will be able to process and assemble the different parts of the transaction with the domains involved, and apply appropriate business logic to the resulting sub-queries
- Broker the different parts of the transaction to the various domain systems and wait for the responses to those queries
- Populate the business objects as the responses to the queries are returned
- Broker the transaction to other EHRi's if required, and assemble those responses
- Apply business logic and assemble the response to be returned to the calling PoS system

This is, to a large extent, the exact same process as for single domain transactions. The differences here would lie in the optimisation approaches and mechanisms that would need to be put in place to support these "large multi-system fetch" transactions. For example, it is assumed that these types of composite queries would have meta-data incorporated in them to allow to qualify the number of records for any domain of data being requested (latest 40 lab events or latest 20 encounter events, etc…). In this context single transaction caching approach may be used where, upon the recognition of the type of transaction and simply by obtaining the resolved client identifier (ECID), background processes can be launched towards systems to start caching potential responses in order to accelerate the resolution of such queries.

Transaction Session (EHR IP)

In order to decrease the overhead involved in authenticating a user, PoS system, client ID, provider ID etc. multiple times during a single interaction between the PoS user and the EHRi, the EHRi supports the concept of a transaction session. A transaction session can last longer than just a single message receipt and response by the EHRi – usually it is for a discrete business transaction. The following example identifies four separate business transactions, which would require three separate transaction sessions, within a single patient encounter: A transaction session corresponds to the transactional scope of a single EHR Interoperability Profile (EHR IP).

1. A new client arrives at a physician's office, and is registered into the admitting system. This is the first transaction session.

2. The client then moves on to a nurse doing triage. The nurse could perform a number of queries, and possibly update some information in the PoS system. This is the second transaction session.

3. The physician sees the client and makes some notes on paper, or by dictating them into a recorder. In this case there is no interaction with the PoS system or EHR, and therefore there is no transaction session.

4. Later on clerical staff capture the dictated notes into the PoS system, and these are uploaded to the EHR. This is the third transaction session.

The above example helps to explain the definition of an EHRi transaction session, which is a *single business interaction between a discrete system user, using a single PoS application, representing at least one provider(s) servicing a specific client in a service delivery location belonging to the geographic area of coverage of a single EHR Infostructure*.

The technical handling of the transaction session would be as follows:

- When the PoS system first initiates an interaction with the EHRi, the EHRi will perform all appropriate validation and authentication.

- If the interaction is valid, the EHRi will generate a cryptographically protected authorisation and authentication token to represent the transaction session

- The EHRi will pass the token back to the PoS system in the message response

- The PoS system should maintain the token for the duration of the transaction, and include it in each subsequent message to the EHRi

- For each of the subsequent messages the EHRi will not perform the validation covered in the first bullet above, as long as the token is provided, and is still valid (time to live and cryptographically valid)

- The EHRi should ensure that after a predetermined period of time, if a token has not been used, the token should no longer be considered valid.

- The EHRi should employ some mechanisms to ensure that the PoS system does not abuse the use of tokens, for example, by attempting to use a single token for multiple transaction sessions. This could be achieved by associating each token with the user, system, and client.

The Privacy and Security Architecture (PSA) has established two separate models of trust defining the relationship between a PoS application and an EHR Infostructure. Under the OTUM (Organisationally Trusted User Management), the EHRi will consider as valid and trusted the processes by way of which users are authenticated and access rights are verified in the PoS application. In such a context, the authentication and authorisation tokens established for users to interact with the EHRi would be more open and have a longer longevity. For example, the data maintained in such tokens could be limited to: the end-user identifier, the PoS organisation identifier, the EHRi Identifier. This kind of a token could be established as soon as the user logs in to an application and maintained for use for as long as a user is logged in. This process does not take away from the fact every transaction session with the EHRi would involve the validation and resolution of the client, provider, location.

The other model suggested as valid by the PSA work is the ETUM (EHRi Trusted User Management), there system user authentication and access rights are established and controlled at the level of the PoS are <u>not deemed to be</u> of sufficient trust, therefore are not valid at the level of the EHR Infostructure. Every transaction session then needs to establish a new token and the process of user authentication and access rights validation occurs for every transaction session (or EHR IP).

See also:

1. For more information on trust models, see the Privacy and Security Architecture document available from the Infoway Knowledge Way
2. See section **4.5.1.16 Trust Models valid for an EHRi** functioning principle in this document.

4.5.1.15 Error Handling

The EHR solutions described in the EHRS Blueprint are based on the principles of a Service Oriented Architecture that emphasizes a separation of component responsibilities in different tiers. For example, the presentation tier manages presentation components; the business logic tier manages business logic components; and the data access tier manages data access components.

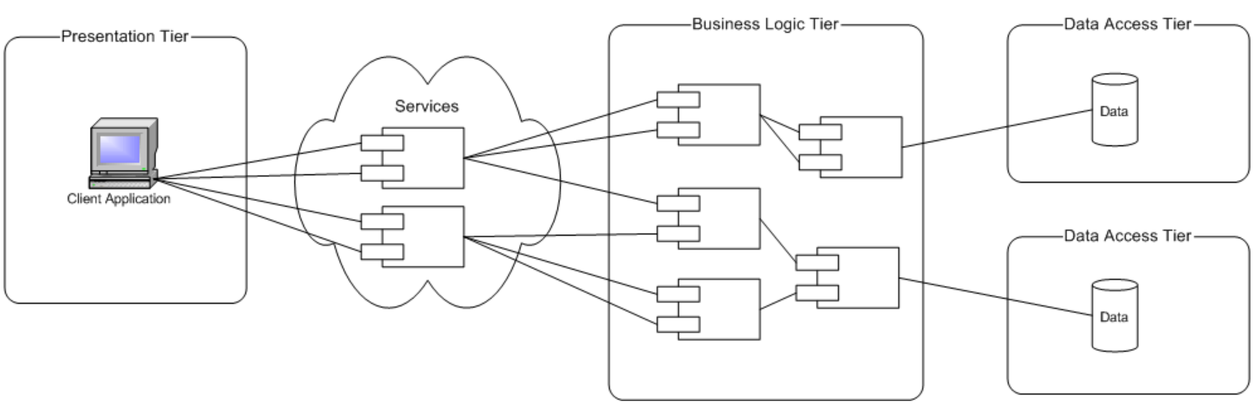

Figure 4-35 SOA Multi-Tier Components

In a service-oriented architecture, client applications consume services of business functions, rather than invoking discreet business object methods directly. The services tier provides black-box encapsulation of business logic component functionality to the presentation tier.The underlying principle is that one tier should only communicate with a tier next to it. This reduces some of the complexity associated with client applications service requests and responses traversing complex object models and the separation of component responsibilities provides for fault tolerance, easier maintenance of changes, and an efficient way to manage errors and exceptions.

In order to handle exceptions in this type of environment, exception handling services should adhere to the design principles of an SOA by processing an error within the scope of the tier where it occurred. Exceptions should be made visible to the presentation tier only when it is completely necessary. Each calling component should catch exceptions and process them appropriately. For example, an exception could be moved up a call stack from the Data service tier where it occurred, to the Business Logic tier, to the Presentation tier and presented to the end-user. In the case where exceptions are sent over SOAP for example, these should be communicated as SOAP exceptions.

The presentation layer where errors are actually surfaced and made visible will vary depending on the type of exception. For example, application errors that relate to the completion of an end user's business request will be displayed within the context of the user's PoS application. EHRi System and Infrastructure errors and warnings that do not affect a user's business request that relate to the EHRi system components as well as the performance and operation of the supporting technical infrastructure would typically be displayed to system administrators responsible for EHRi system support and help desk functions.

End-to-end reliable messaging is also an SOA design approach that can dramatically reduce the error conditions that an EHRi System development team must provide for. For example, without reliable messaging, messages sent to a service may never reach their intended destination, or communicate a notification of failure to the sender. In other examples, messages may be received out of order or duplicated. These types of partial system failures are extremely difficult to detect, manage, and recover from. A reliable messaging system manages this complexity for developers in a consistent manner. **WS-Reliability** is a specification for open, reliable Web services messaging - including guaranteed delivery, duplicate message elimination and message ordering - enabling reliable communication between Web services.

Types of Errors

In general three types of errors will need to be managed within an EHR Solution:

- Application Errors
  These are errors occurring within an EHRi system that affect the ability of this system to play its role in accomplishing an I-IP or business transaction. These errors need to be declared (or published) to a common error handling service within the EHRi so that proper actions can be taken to surface the right severity and conditions back as a response to the PoS application. The behaviour and error handling interactions for this class of error needs to be the object of standards.

- EHRi System Errors
  These are errors occurring within any EHRi system (registry, domain repository or ancillary service) that do not affect the responsibilities of this service in regards to its role in a EHR Infostructure. These could be qualified as internal errors and would stay within the perimeters of the error handling of that system.

- Infrastructure Errors
  These are communication failures or problems occurring at a level where the EHRi is not even aware that a transaction is taking place, communication network or devices failures. These need

to be addressed from a standardisation perspective as well so that common behaviours for retries or failure alerts with PoS applications can be established.

EHRi Exception / Error handling are generic services within the HIAL Common Services that provide operations to raise and manage application errors and other business level exceptions. The Error / Exception Handling Services will use the Log Management Service to record error information and should ensure that all EHRi System application errors, warnings, information messages and override processing are managed and communicated to the user / PoS system consistently across all interactions to indicate severity.

The following table describes the types of EHRi application errors expected in an EHRi system implementation.

EHRi Application Error Type	Definition
Error	The request could not be processed successfully and has been rejected because of the following condition. E.g. The patient id could not be found
Warning	The request was successfully processed, but it was processed differently than the requester had asked, or an anomaly was encountered which the requester should be aware of. E.g. The client registry was unable to resolve the identification of the client, the transaction has been processed using a temporary ID.
Information	The request was successfully processed and there were no issues, however some information regarding the transaction is being returned that may be of interest. E.g. The patient's consent for you to view their information will expire in 10 days.

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As a guideline, the following generic EHRi Exception Handling service requirements are provided:

- The ability to configure and register errors and their values / responsibilities during the implementation of the EHRi services
- The ability to easily manage and maintain error & exception messages in a centralized manner that can be replicated to distributed systems if necessary.
- The ability to support multi lingual error and help messages.
- The ability to classify different levels of error messages such as: error, warning and informational.
- Each application or component that participates in the EHRi System solution should be able to write exceptions/errors to the appropriate log file of the tier / semantic boundary of the component/application where they occur.

- The ability to trap application server business rule exceptions and display error messages that conform to the application user interface / usability standards.

- The ability to report, manage and resolve errors created by unsuccessful transactions

- Use of open standards for error handling features to allow for ease of integration and consistent presentation.

- Provide aggregate operations to manage system errors and other application level exceptions raised at a lower level.

- Ability to identify allowed and/or previous overrides for a particular error/provider/client combination and return these with an overridable error

- Ability to distinguish overridable from non-overridable errors and to distinguish what types of overrides are acceptable for a given error

- Ability to convey related minimal clinical information related to errors and warnings tied to clinical contraindications (e.g. drug-drug interactions, duplicate lab orders, etc.)

EHRi System and Infrastructure Exception Handling Design Considerations

Other exception handling design considerations that must be discussed during the architecture and design phases of an EHRi System and it's supporting technical infrastructure would include detailed descriptions of:

- Expected level of separation in responsibility to report and manage errors, retries between the PoS to HIAL, HIAL to LRS, LRS to domain and registry systems

- Expected capabilities of the error/handling service in the HIAL to handle errors and raise awareness about problems

- Expected responsibilities in terms of committing transactions between the PoS and the HIAL/LRS and or distributed EHRi domain systems

- The standards needed for the errors that can be communicated between the HIAL / LRS and the PoS applications or between EHR Infostructures

4.5.1.16 Trust Models Valid for an EHRi

The EHRi needs to ensure that all users of EHRi services have verified identities, are authenticated during each EHRi session, and are authorised to access data and services. The conceptual architecture proposes two components that make up the trusted EHRi connections: organisational trusted user management and EHRi trusted user management. The functional principles for these two trust models are as follows:

- All connections to the EHRi must be trusted. If they are not trusted, then they must not be allowed to connect to the EHRi. The Privacy and Security Conceptual Architecture does not define or impose a definition of what constitutes an acceptable level of Trust, this determination is to be made by individual jurisdictions taking into consideration their own needs, requirements and legislatives obligations. However, consideration should also be taken as to the needs and legislation of other jurisdictions with which they wish to connect.

- Through a pan-Canadian governance framework, there should be the ability to define the minimum requirements for a trust framework which would facilitate "Trusted" interoperability within and across jurisdictions.
- If a PoS system is trusted, then it can be connected to the EHRi and the organisational trusted user management model can be used
- If a PoS system is not trusted, then the EHRi trusted user management model must be followed
- For either model the following principles apply:
    - The users role must be determined
    - The user must be authenticated
    - The user must be an approved person, or part of an approved group
    - The following data elements should be available:
        - Organisation ID
        - PoS System Instance
        - PoS User ID
        - User Role

(For additional information,see EHRi Privacy and Security Conceptual Architecture section 7.2 Trusting Connections to the EHRi)

4.5.1.17 Authentication & Authorisation

The user identity management service includes service components that address the need to accurately identify and authenticate users of the EHRi and their PoS applications. The following functioning principles apply to this service:

- Organisations need to be registered and assigned unique identifiers before applications under their governance are connected to the EHRi
- PoS Application Locations belonging to these organisations need to be identified, named and assigned unique identifiers before applications running in such locations are connected to the EHRi
- Each of the organisation's PoS applications that are to be connected to the EHRi must be accredited against a set of minimum criteria for trusted connection to the EHRi and assigned a PoS application instance ID (PoSAID)
- PoS applications must be authenticated and authorised to conduct a transaction with an EHRi.
- In the EHRi, users must be defined and roles must be assigned to individual users
- Access privileges must be assigned to roles
- For organisational trusted user management, the OTUM model:
    - The authentication and authorisation of the user taking place in the PoS application is trusted, therefore, the process of authentication and general access authorisation will not be repeated in the EHRi when processing transactions. Data describing who the user is

(User ID or other credentials) will still be sent as part of each transaction to the EHRi, namely so that logging and auditing functions can perform their duties adequately.

  - Locally (PoS level), upon registering a new user sufficient information must be recorded to later determine exactly who an authenticated user with a given user ID actually is
  - There must be the ability to trust the assertion, made by the PoS application, that a user has been authenticated and has a particular role. This could be done by sending a token to the EHRi, where the validity of the token can be verified e.g. via a cryptographic signature that is non-reputable

- For EHRi trusted user management, the ETUM model:
  - In the ETUM model, local PoS system user authentication is not trusted by the EHRi, therefore the process of authentication and authorisation needs to take place with every transaction being processed. Needless to say, in this context, the data describing who the user is also needs to be sent as part of every transaction with the EHRi.
  - Remote user registration is required and there must be a pre-populated repository of information that can be used to positively verify the identities of such prospective users and authenticate them for the purposes of establishing secure communications
  - Registration could also take place by having a local healthcare organisation act as a "local registration authority" to attest to the identity of a prospective user. In such cases, a secure communication from the local authority to the administrators of the EHRi must be supported
  - Functionality must be provided to allow a user to log on to the EHRi, and sign in with their EHRi role

(For additional information, see EHRi Privacy and Security Conceptual Architecture section 7.3 User Identity Management in the Desired Future State)

The following functional principles for authorization are primarily for users that are authorized via EHRi trusted user management:

- There should be a common user authentication service for all users logging onto the EHRi
- The user authentication service should support multiple techniques for user authentication
- If authentication depends on data stored in user repositories, then these user repositories and the authentication service must be continuously available

(For additional information, see EHRi Privacy and Security Conceptual Architecture section 7.4 Authentication in the Desired Future State)

Distinction between end-user access authorisation and provider authorisation

The end-user authorisation's intent is to validate whether or not a given type of service (or transaction) can be invoked by the end-user sitting in front of a PoS application. The level of logic and complexity involved in making that validation may vary between EHRi solutions. The application of such logic may be a function of a diverse set of parameters such as : the PoS application ID and the metadata describing it, the PoS application location, the PoS application organisation, the time of day, the end-user role as defined in the EHRi, and others. The role based access controls in this case are used as a mechanism to standardize and facilitate the management of assigned access rights to end-users. The spectrum of roles that need to be taken into account for end-users would include end-users that are not involved in the delivery or management of health services, such as system administrators, system auditors, or others. This type of service capability would typically be conducted as part of the HIAL and would be done as part of the early steps of processing.

The provider authorisation's intent is to establish whether or not a certain health service provider can be associated with a certain type of health event being posted to the EHRi. The role validation in this context is directly associated with the delivery of care and the application of policy though business rules as part of the management of a person's health record. This type of capability requires a lot more contextual information about the transaction being conducted and the data in it. Compared to the end-user authorisation described above, the provider authorisation rules would be conducted as part of the processing in the longitudinal record services (LRS).

4.5.1.18 Informational Consent Directives

Informational Consent directives in association with the collection or use of Personal Health Information(PHI) should be applied as close to the source of the information as possible.

The informational consent directives management service helps EHRi users and their organisations comply with requirements in applicable legislation, as well as requirements for the handling of PHI found in various privacy policies and in patients'/persons' specific consent directives.

The following functional principles apply to this service when required by legislation or best practice:

- Business requirements for the handling of PHI must be applied by the EHRi
- Whenever possible, consent directives should be applied *prior* to disclosure of PHI
- All applicable consent directives must be processed prior to disclosing PHI to an authorised EHRi user and disclosure must be prohibited where directed
- When disclosure has been prohibited, it must be logged
- Before providing any PHI, consent directives must be verified and applied
- Before applying consent directives the service needs to verify the users role to determine if they are authorized to access this info, or have an appropriate role to override the consent directives
- There should be a common privacy vocabulary to translate and apply consent requirements from legislation, policies and individuals' specific consent directives in an interoperable manner
- This service must also allow for consent directives to be given by an authorised representative (such as the patient's/person's legal guardian, etc.)
- It is preferable that consent directives are stored centrally in an EHRi data repository, or an associated consent repository, rather than with domain information
- Fine-grained level of granularity for consent (complex, with complex algorithms typically applicable to specific domains) is best stored in a domain repository, but more coarse grained-level of consent should be stored at a consent layer
- This service should support the execution of data level consent directives (i.e. directed at specific fields or groupings of fields)
- Where required by law, there needs to be the ability to override consent directives (e.g. if personal safety is at risk). In such a situation there should be a secure log of the event, including the reason. There must therefore be the capability to encode rules for exceptions, and laws which override consent directives

- The individual accountable for facilitating privacy compliance in the organisation where the accessing user works as well as in the organisation where the information was collected when a consent override has occurred, must be alerted if a consent directive is overridden
- If consent directives are overridden, an alert must be generated, in addition to the logging of the activity
- This service must remain continuously operational. However, there should be functionality to address situations where it is not available. In such a situation, a clear policy decision is required by the operational governance entity of the iEHR, either all PHI should be provided upon request, or no PHI should be provided on request. If all is provided, there should be a log of the event, along with the functionality to review what information was provided and whether consent directives were upheld, once the service is once again available
- Any administration of consent directives (changes, overrides etc) must be logged

(For additional information, see EHRi Privacy and Security Conceptual Architecture section 7.6 Consent Directives Management in the Desired Future State)

4.5.1.19 OIDS as a principle

The EHRi will use registered OIDs[17] for uniquely identifying entities and events in both the communication of data between PoS applications and in the data held in the EHRi repositories. This principle particularly applies to the "strong" internal unique identifiers, such as EHRi Client Id's (ECIDs), EHRi Provider Id's (EPIDS), and EHRi Service Location Id's (ELIDs). The registration and use of OIDs will be subject to the processes and policies established by HL7 Canada for the use of OIDs in the Canadian realm.

A key challenge in accomplishing interoperability between multiple systems is the ability to resolve the identity of entities and events uniquely. Most "closed" information systems that operate within the boundaries of a particular organization have the ability to assign and manage identifiers within the span of governance and accountability of that organization (assuming they are following an enterprise architecture model). However, once those systems begin to communicate and share information across those organizational boundaries, the probability of duplication (or really multiplication) of information about shared entities and events rapidly becomes a problem.

This problem is particularly severe in the Health sector, where the history of compartmentalized (or silo'd) systems, regional consolidation and devolution of service delivery responsibilities, and the subsequent rationalization of facilities and information systems results in a vast number of identifiers being used for the same clients, providers, service locations, etc.

For this reason the EHRS Blueprint is setting forth a key functioning principle to address the normalization of such strong identifiers, the OIDS mechanism is a means of ensuring truly unique identification within and across EHRi implementations.

[17] OID Definition: An OID is a globally unique string representing an ISO (International Organization for Standardization) identifier in a form that consists only of numbers and dots (e.g., "2.16.840.1.113883.3.1"). OIDs are paths in a tree structure, with the left-most number representing the root and the right-most number representing a leaf (from: http://hl7.amg-hq.net/oid/frames.cfm). An OID is a permanent number assigned to an object or category of objects for storage (persistence). For example: OIDs are used within HL7 v3.0 for all Instance Identifier (II) datatypes, universally identifying coding schemes and identifier name spaces.

This creates some unique challenges, given that the Blueprint is using a "No Home" EHR framework (see EHRS Blueprint section: 4.5.1.1) and assumes there will not be a single set of national level identifiers for key entities tracked in the health system (see section 4.5.1.2 EHRi Identifier Management). The OIDS registered for use in the Canadian health system must incorporate some mechanism that, as part of the OID construct, indicates the jurisdiction that declares the identifier as well as what the identifier is used for. Fortunately, the OIDs standard provides a mechanism that allows the registration of a "root" for each OID that creates a unique value of the OID for a specific purpose. This "root" is then combined with an "extension" that is the meaningless-but-unique-number (MBUN) for that instance of the entity.

For example: the OID root could be for a type of identifier specified by Manitoba, say the ECID generated by the EHRi in Manitoba when a client's information is captured. The registered OID "root" used for Manitoba's ECID would be used in combination with the EHRi internal unique identifier for that client. It should be noted that the "root" also can act as the namespace for a real-world public identifier.

Under the governance of ISO, HL7 (Inc./International) has it's own "tree" within the ISO OID registry. This is entirely appropriate given HL7's role in defining message-based interoperability between systems in the health sector. HL7 Inc. has a registry of all OIDS that are approved for use in HL7 message instances, including OIDS under the HL7 tree and OIDS from other trees (or domains that manage OIDS).

The implementation of interoperable EHR solutions across Canada means that health information can be shared across jurisdictional boundaries. This will require that OID roots be defined for the various unique identifiers used or generated within each EHR infostructure, and that these OIDS be registered consistently and in one place. It is recommended that HL7 Canada, particularly the Realm Localization Committee, be charged with the responsibility for defining and managing how OIDs are used on a pan-Canadian basis.

It is also recommended that OIDS originating within the Canadian health context be registered with an international body established to ensure the appropriate and effective use of OIDS in the health sector. HL7 Canada will be expected to work with HL7 Inc. and the other International Affiliates in establishing the mechanism for registration and subsequent maintenance of OIDS roots. To facilitate this, *Infoway* will recommend that each jurisdiction engaged in an iEHR project be represented in the HL7 Canada Realm Localization group.

4.5.1.20 Normalization

All data sent to the EHRi repositories is stored as it is provided. In order for this data to be uniformly understood and safely used, it must be provided in as standardized a form as possible. Where this is not possible, additional metadata should be provided to help ensure unambiguous, uniform understanding of the data.

Infoway recognizes that normalization of concepts is challenging to achieve within health disciplines, and even more so across disciplines and jurisdictional boundaries. As much as possible this will be achieved through the establishment of pan-Canadian standards, using existing standards where possible, and harmonizing their use. Additionally, Infoway has established the pan-Canadian Standards Collaboration Process for this purpose, and has invested in the Clinical Terminologies Integration (CTI) project to identify a strategy for the common use of terminologies (classifications, vocabularies, terminologies). It is expected that Infoway investment projects commit to the above principles, participate in the Standards Collaboration Process, and conform to recommendations from the CTI project.

In order to ensure a common understanding of information across all of the various sources that will contribute to the EHR, normalization of the data and data structure is essential. All of the data that is sent to the EHRi will be stored as is, without transformation or alteration. It is expected that all data coming in or out of the EHRi will conform to the relevant pan-Canadian EHR standards. This conformance inherently provides a significant degree of normalization as the result of assembling the information using recognized standards (namely HL7 V3) for data structures and vocabularies. Therefore, there will be direct transportability between the message constructs and the Shared Health Record repository. The sending applications will need to harmonize the information they send with the pan-canadian EHR standards, so the remaining challenge is for each sending/receiving application (or vendor) to perform the transformation between their data structure and the representation in the pan-Canadian EHR format.

Where pan-Canadian normalization is not possible, sufficient meta-data must be provided to allow for correct interpretation. Essentially this means that in the case where a non-standard terminology is being used, there must either be a clear mapping to the standard terminology, or the full text descriptions of codified terms should be sent along with the source codes, and these will also be stored in the EHRi. Consequently, when this type of data is requested from the EHRi the full text descriptions will also be provided.

The above discussion does not preclude normalization through the addition of mapped or transformed versions of original data with the data stored in the EHRi, provided that the original data still remains. This normalized version could be provided to applications that identify their ability to accept data in normalized form. This transformation will only take place for well-established mappings, where it has been determined that it is a clear transform and it is clinically safe to do so.

4.5.1.21 Auditing, Logging and the Use of Logs

Each EHRi infostructure must have the capability to log, and subsequently audit, all interactions with the Health Information Access Layer (HIAL). Logging and auditing services are to be commonly and consistently used by all processes and services associated with the EHRi, including the domain repositories, registries, internal EHRi services and external PoS applications.

Auditing and logging serves multiple purposes for an EHR infostructure, including:

- tracking of infostructure performance (systems logging)
- tracking of infostructure access (security and privacy logging)
- tracking of information use (logging of clinical / personal health information accesses)

This section of the blueprint documents the requirements for logging and subsequent auditing of those logs. One common requirement of all logging functions is the ability to dynamically modify (on the fly) the level of detail captured in each log. The particular level of detail required depends upon the type of logging and its purpose.

Logging requires the ability to record chronologically the actions of certain system components and the parameters that govern their behaviour. Log content must be determined based on key indicators of performance or requirements to understand and assess the appropriateness of system behaviour and access. The level of detail available in the log should be modifiable depending on the level of scrutiny required (which may be variable). The level of detail logged should be set by a parameter that can be modified in real time.

Auditing includes the technology, processes, and policies that apply to the composition of the logs, their review, and required actions to be taken based upon the log contents. Auditing takes many forms, including:

- real-time alerts
- on-demand queries
- exception reporting
- random log event validation
- regular review of detailed logs
- verification of log integrity

NOTE: this section of the Blueprint does not specifically address the types of logging performed on infrastructure components, things like: network performance, monitoring of hard disks, CPU operating temperatures, etc. These typical infrastructure metrics are assumed to be provided to the levels necessary to operate hardware, operating systems, and networks on a 7/24 basis.

Tracking Infostructure Performance

In order to monitor the relative performance of an infostructure, and particularly to support Service Level Agreements that may be in place, key infostructure performance metrics must be logged. Examples of key performance metrics are:

- latency between the time a request to GET information is received by the HIAL and when the response is provided
- latency between the invocation of an internal service and the response
- latency in communication from the HIAL in one infostructure to the HIAL in another
- profiling usage (peaks and valleys) across an EHR Infostructure and for specific components

Tracking Infostructure Access

All authentication and authorization access attempts must be logged and monitored to ensure that privacy of the personal health record is protected.

- Authentication requests and responses must be logged. Persistent failed attempts at accessing the EHRi should be clearly flagged and alerts automatically generated
- Authorization requests and responses must be logged, whether authorization is provided on an individual or role basis. Overriding of consent restrictions must be clearly flagged and there must be clear policy and processes for timely follow-up of those overrides
- The integrity, security and privacy of these logs themselves must be protected as they hold critical and personal health information about whom, when and for what purpose the EHRi is accessed. This may be accomplished by a number of mechanisms, including cryptographic verification of log contents or use of the mechanisms described in the Secure Auditing Service defined in the Privacy and Security Architecture.
- Interactions with other EHR infostructures must be logged

Tracking Information Use

The EHRi holds a broad spectrum of personally identified health information (PHI) that must be securely held in the various repositories, and securely accessed. This security imperative extends to the logging of the content and key identifying information used in messages to and from the infostructure. For this reason all logging that includes PHI, or suggests a particular use of PHI, must be subject to a secure auditing service.

As with tracking infostructure access, the logs themselves must be protected from inappropriate access and the integrity of the contents must be verifiable.

The secure auditing service provides the ability to log and audit transactions and events taking place within the EHRi, which includes the functionality to report on the system(s), user(s), provider(s), patients/clients, and health data involved in each EHRi transaction as well as system administration and transaction monitoring. The Secure Auditing service also provides for mechanisms that ensure that logs that contain PHI are designed and implemented in a privacy protective manner.

(For additional information, see EHRi Privacy and Security Conceptual Architecture section 7.11 Secure Auditing in the Desired Future State)

The following functional principles apply to this service:

- Clinical log files contain sensitive information (e.g. the logging of HL7 request and response messages), thus secure logging and secure auditing are required
- There must be the ability to log, for a given user or a given provider, what PHI they accessed, created or updated and when
- For a given element of PHI, identify which users have accessed, created or updated it and when
- Any encryption rules and Identity Protection Service mechanisms established for PHI in the EHRi must apply equally to the logs and audit processes where PHI and key identifying information may be included

4.5.1.22 Prospective Events

The Shared Health Record (SHR) repository holds not only actual events, but also holds prospective health service events, such as planned clinician visits, orders, and referral requests.

The SHR repository in each EHR infostructure implementation is based on the EHRi Conceptual Data Model, which is an Event Driven model. The repository holds a record of all EHR relevant clinical acts or other health-services events, and the data relevant for that event.

The primary function of the SHR repository is to hold copies of patient-centric information generated by Point of Service applications that are relevant for the provision of health services to individuals and groups. The Clinical Reference Framework (Life of the Lamberts) and the associated use cases have made it clear that knowledge of scheduled events (such as planned visits, surgeries, or referrals to specialists) or orders for services (such as lab tests, prescriptions, physiotherapy) are useful and clinically relevant information.

For this reason our definition of Prospective Events includes types of events for which a date/time, location, and service provider are known, but also events for which we know only the date/time the prospective event was ordered, the specific service requested, and the class (or type) of provider required.

It is important to state that, initially, there is no expectation for the SHR repository to manage or resolve the prospective events with actual events as they occur. It is considered useful to for the user of this information to see that an event was planned or expected, and that a corresponding event has (or has not) actually occurred. The correlation of the prospective versus actual events is entirely up to the viewer of the shared EHR information. The Case Management and Resource Utilization capabilities associated with the coordination of clinical activities for a patient across service providers requires other specialized applications and processes. These types of features are considered Generation 3 or 4 services that are expected to surface as EHR Solutions evolve.

4.5.1.23 Primary Purpose of EHRi data

The primary purpose of the EHRi data repositories is to securely and appropriately provide timely, accurate, and relevant health information that is used to support the safe and effective provision of health services directly to individual persons and/or groups[18] of persons.

It is understood that the information captured in the course of providing health services has many other potential uses by the health system. These potential uses must be based on an assessment of the legislative framework of a given jurisdiction in order to determine if legislatively authorised. For example this information could potentially be used for:

- outcomes analysis
- determination of best practices
- determining resource allocations
- managing resource utilization
- various forms of research and analysis

Infoway characterizes these as authorised secondary uses of the SHR that may have great value to different stakeholders in the health system, but must not interfere with or affect the primary purpose for use of the EHR; both in terms of technology performance and availability, and in terms of the reliability of the patient data it contains. Infoway considers authorised secondary uses to be those authorised by either and/or the individual to whom the information pertains and uses authorised by jurisdictional legislation. For this reason, authorised secondary use must never occur using the EHR data directly. Authorised secondary use can only occur against extracted subsets (for example in separate data warehouses) of the primary EHR data that have been appropriately anonymized or pseudonomized[19] as needed. In either case, for primary or secondary use, this data must be subject to the privacy / security constraints established in each jurisdiction.

Underlying this principle is the premise that allowing direct use of the EHR for secondary purposes opens the door for potentially serious and debilitating privacy sides effects for both the EHR and the health system it is intended to serve. Even the suspicion of the use of EHR data for other purposes, particularly where those purposes are perceived as being potentially prejudicial to the privacy or welfare of patients or their service providers, could result in skewed or dysfunctional data being provided to the EHR. This prospect would completely undermine confidence in the authority, accuracy, and reliability of the data in EHR. This lack of trust would potentially severely prohibit adoption, and potentially jeopardize the safety of patients.

[18] In the case of Public Health and other services delivered to groups or cohorts of people.

[19] There are very effective technology approaches that can be utilized to anonymize extracted information, or to allow re-identification through pseudonymized patient information when necessary to protect the health information of individuals or the general public in a timely, well managed fashion.

The data in the EHRi data repositories must be protected from this risk through architectural means that ensure all access to the data is through discrete, predefined, controlled, and actively audited means (a significant advantage of the messaging paradigm proposed in the EHRS Blueprint). This protection should extend to all repositories that participate in an EHR Infostructure including client, provider and location registry as much as drug, DI, laboratory or any ancillary services

In addition no entity, including the health ministries responsible and accountable for the establishment of the EHR infostructure, should be permitted unrestrained access to the EHR data.

For these reasons, *Infoway* recommends, if not already done so, that each jurisdiction define and formalize the role of an EHR Infostructure Custodian (a person or organization) to ensure that the personal health information contained in the EHR is used directly only for its Primary Purpose and jurisdictionally and patient authorised secondary uses. This custodian must have the governance structure established that empowers them to require, review, and approve requests for one-time and/or recurring scheduled extracts of personal health information for secondary use, working against a set of clearly established guidelines and principles to guide the decision making process, and to help those who can bring real value from secondary use to understand the associated constraints and obligations. It is strongly recommended that EHR Infostructure Custodians require users of PHI for secondary uses apply an equivalent of data safeguards to their environments.

4.5.2 Mapping Services to Standards and Technology (Use of COTS)

COTS stands for Commercial Off-The-Shelf, and is the acronym used to describe the world of software applications available from private or public sector organisations acting as vendors in the industry. As different Federal/Provincial/Territorial authorities in Canada are moving forward to establish EHR solutions, a lot of time and attention will be on the role of commercially available software. This section discusses the potential uses of Commercial off the Shelf software to assemble a working EHR Infostructure. Some of the key reasons to rely on COTS include:

- being able to leverage and capitalize on the long term and material intellectual and dollar investments made by vendors in developing commercial product platform in Health IT
- being able to minimize the risks typically associated with large scale software application development approaches
- being able to leverage the economies of scale associated with product licensing that inherently fragments the costs of development, maintenance and evolution over large market bases of clients. This allows the shift of resources towards deployment and integration as opposed to expending them on core functionality development that may already be available in COTS.

Technologies and products that could support components of the EHRi Architecture requirements are described in generic language with examples of known solutions. Products are described based on a high level categorisation of technology solutions. Vendors may offer products in multiple categories or specialise in one segment.

⚠	**Disclaimer:** Infoway does not endorse or promote any specific vendor or any vendor products. Any direct or indirect reference to a company, product, solution, standard or technology in this document is included only as an example. These references do not

	represent a complete or preferred list of all available products that may be used for components of an EHRi solution.

COTS products and Open Systems

In order to put the strengths and weaknesses of using COTS for software solutions into perspective, this section includes quotes from **Carnegie Mellon, Software Engineering Institute (SEI)**[20]. This article describes lessons learned using COTS for national enterprise solutions that have evolved over a very long period of time (30 to 50 years) such as information systems for the US Department of Defence (DoD). It also touches on the importance of interface standards and the ability of COTS software to meet such standards requirements.

> *"COTS products and an open systems approach are both means to important system goals of improving the quality and performance of our systems, developing them more quickly, and sustaining them more cost-effectively. The greatest advantage can be gained from using these two approaches together.*
>
> *COTS products are not necessarily open. That is, they do not necessarily conform to any recognized interface standards. Thus it is possible (in fact, likely) that using a COTS product commits the user to proprietary interfaces and solutions that are not common with any other product, component, or system. If the sole objective is the ability to capture new technology more cheaply, then the use of COTS products that are not open will do. But when one considers the future of such a system, the disadvantages of this approach become apparent. Many (US) DoD systems have a 30- to 50-year lifetime, while the average COTS component is upgraded every 6 to 12 months and new technology appears on the scene about every 18 to 24 months. Thus any money that is saved by procuring a COTS product with proprietary interfaces will quickly be lost in maintenance as products and interfaces change- the ability to migrate cost-effectively to other products and other technologies in the future will have been lost.*
>
> *Even if the expected lifetime of a system is only 5 to 10 years, the fluctuations in COTS products and technology result in a state of constant change for any system employing them. Interface standards provide a source of stability in the midst of all this. Without such standards every change in the marketplace can impose an unanticipated and unpredictable change to systems that use products found in the marketplace. This situation is particularly painful when the vendor stops supporting the product or goes out of business altogether, thus forcing a change to a different product or vendor"*

4.5.2.1 COTS and Standards

For this reason, *Infoway* encourages the jurisdictions responsible for implementing and operating EHR infostructures to engage with those vendors whose solutions are developed using industry accepted interface standards, and who are actively participants in the development and maintenance of those standards at an industry level.

Confidence in the selection of COTS based solutions can be increased by a commitment on the part of *Infoway* and the jurisdictions in the pan-Canadian Standards Collaboration Process. This will help ensure

[20] (http://www.sei.cmu.edu/str/descriptions/cots.html#110707)

that, as infostructure solutions are implemented across the country, a uniform set of requirements for standards is identified and these requirements are actively positioned with the vendors and Standards Development Organizations in their ongoing standards development and maintenance activities.

The ideal scenario is for the vendors themselves to be advocates for the standards required by their customer base. This implies that the vendor of the COTS solution has made a strategic investment in the standard and will then have an ongoing commitment to the standard to realize the financial benefits from that investment. Having a consolidated set of requirements from the Canadian Health Sector is critical in a vendor's willingness to commit to those standards and in their ability to realize a return on that investment.

While the consumers of COTS solutions often feel they are subject to the decisions of their vendors in terms of the use of standards, virtually every vendor tells us that their decisions related to the use of standards are entirely dependant on their customer base's requirements. If there is an overall demand from their customers to do this, and it will either protect their existing market or provide access to an expanded customer base, they will make that commitment.

For this reason it is equally important that *Infoway* monitor, participate in, and influence the standards activities at a North American and global level, ensuring that Canada's requirements are well aligned with the other markets that drive vendors' commitments to the use of standards.

4.5.2.2 Categories of technology solutions in an EHR Infostructure

The EHRS Blueprint presents a functional definition of an EHR Infostructure built from a list of services that are consolidated into logical components. These include client, provider, location and terminology registries, a shared health record, drug, laboratory and diagnostic imaging domains, the LRS, the HIAL as well as ancillary services and data warehouse.

When one looks at the private sector and the offering of products and services that exists in the Health IT industry, it is obvious that products today are not necessarily defined according to the functional requirements of an EHR Infostructure. In fact, multiple categories of products can be identified as candidate technologies to fulfill the functional requirements expressed by the architecture. Jurisdictional level (aka community level) EHR solutions such as what is represented in the EHRS Blueprint are a fairly recent breed of business opportunities for IT vendors active in the Health sector. Given the size of their overall scope, the level of integration required with existing systems and the limited maturity of the market in responding to the needs for these solutions, no single out of the box solution is expected to meet the set of requirements for an EHR Infostructure.

Rather valid EHR solutions forming over the coming years are expected to combine technologies from different product categories. The following diagram positions these different product categories in relation to the functional requirements described by the EHRS Blueprint:

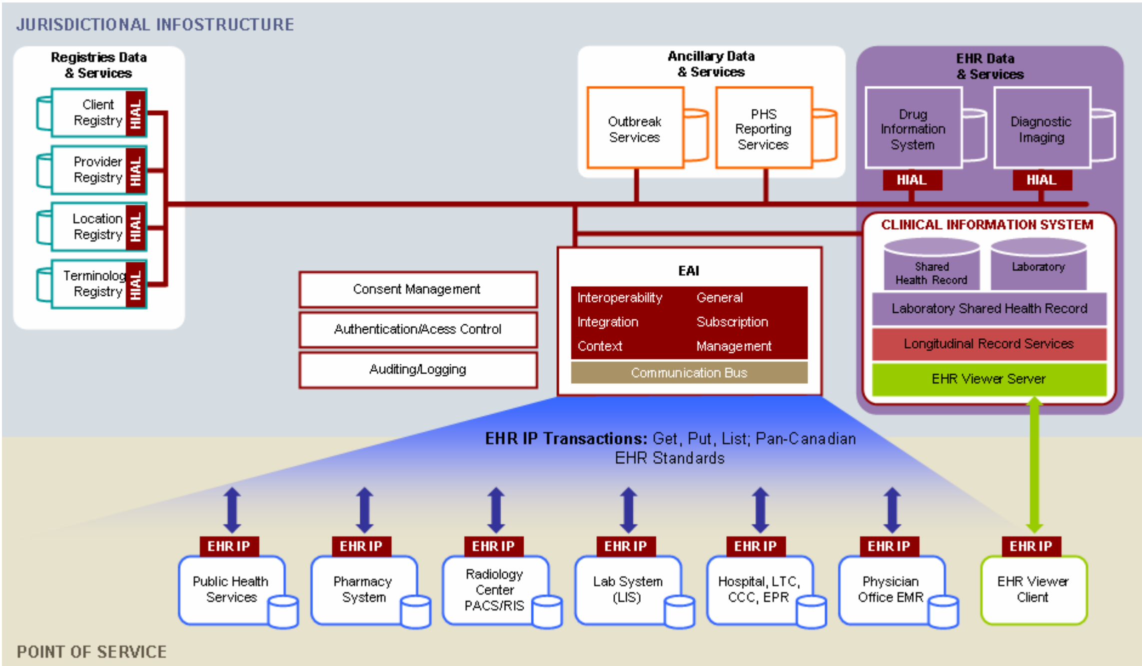


Figure 4-36 COTS product categories in the EHRS

Starting from the bottom of this diagram, the general categories of products represented include:

PoS Clinical Applications

These clinical applications are used in different points of service in the health system and are an integral part of EHR Solutions. The market for these solutions is mature and has been in existence ever since the introduction of computerized information management solutions (Mid 1970's). These products include ADT, CIS, EPR, Drug, Lab, RIS/PACS, Blood Management, ER systems, etc., which are found in acute care settings, as well as EMRs for clinics, and generally any information system solution that manipulates clinical information and serves the direct needs of caregivers as they provide care to patients.

EHR IP Transactions: PoS applications are to integrate with the EHR Infostructure by implementing standards-based EHR Interoperability Profiles to communicate with the EHR Infostructure. EHR standards are required for all solutions in Canada, and the implementation of a single set of standards for communication between PoS and the EHRi and eventually between EHRi's is seen as the one of the most critical objectives to achieve a true interoperable EHR in Canada.

In order to position the reader, the following is a list of COTS vendor and/or products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: Cerner, Clinicare, Dinmar, Eclipsys, IBM, IDX/GE, McKesson, MédiSolution, Meditech, Misys, Omni-Med, Oracle, Purkinje, Siemens, etc.

EHR Viewer

The EHR Viewer is a special kind of PoS application that sits as a generic EHR access tool for health professionals providing an integrated and comprehensive view of the information available in the electronic health records of their clients. The EHR Viewer provides an application that lets authorized end-users log-on to an EHR Infostructure and access EHR of the clients to whom they provide care. COTS software is available to deploy EHR Viewer applications.

In order to position the reader, the following is a list of COTS vendor and/or products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: Dinmar, Misys, Orion, Park City Solutions, etc…

Generic web portal development platforms may be used as more of a “build” approach to the creation of EHR Viewer solutions. Generic web portal development and management platform examples include: BEA Web Logic Portal, IBM Websphere, Microsoft Sharepoint, etc.

EAI engines or ESB engines

Many of the basic communication bus and common services of the HIAL are encompassed by commercial products described as Enterprise Application Integration (EAI) products in the IT software industry. So called integration engines are typically used as a tool to enable connectivity between separate IS applications that may be located on a single LAN (Local Area Network) or on separate and distant networks across WANs (Wide Area Networks).

Over the last five years, the industry of IT has been driven towards the migration to SOA based solutions, offering greater promises of openness, flexibility and scalability. In this context, many EAI vendors are rebuilding, transforming or evolving their products to enable connectivity and integration in a more SOA oriented world. These new products are called Enterprise Service Bus (ESB) engines. In relation to the scope of capabilities described in the EHRS Blueprint for the HIAL, EAI solutions available as COTS are generally not positioned as accomplished “enterprise” level solutions for certain types of services such as the Privacy and Security Services and the System Management and Monitoring services. For this reason, we identify them as separate categories of COTS products.

In order to position the reader, the following is a list of COTS vendor and/or products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: IBM MQ Series and Websphere, Microsoft BizTalk, Orion Rhapsody, Quovadx QDX, SUN eGate, etc.

Consent Management Solutions

The functional requirements described as part of the HIAL Privacy and Security services correspond to an emerging market where very few proven or mature products exist. Consent management services in particular require customized solutions that are adapted to the specific laws, policies and regulations of any distinct jurisdiction.

Authentication / Access Control / Auditing and Logging

Most of the functional requirements described as part of the HIAL Privacy and Security services can be addressed from the offerings of mature players in the industry of IT/IS security software solutions.

In order to position the reader, the following is a list of COTS vendor and/or products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: CA eTrust, Entrust, IBM Tivoli, RSA Security, etc.

System Management / Monitoring

This is another category of service represented as part of the common services of the HIAL where specific types of commercial products exist. Enterprise level system management and monitoring solutions have been in existence for many years to help large companies IT operations departments or in our case, the operator of an EHR Infostructure, to centralise functions associated with the surveillance, ongoing reporting and management functions of large integrated system infrastructures.

In the context of an EHR Infostructure solution, several independent applications are acting together in order to provide a business service (the EHR) to large sets of PoS applications. Given the nature of the information provided to caregivers by an EHR Infostructure, information that stands to have direct impact on the health status of a client, there will be enormous pressure to maintain the highest degrees of availability and responsiveness from this EHR Business Service. In order to manage the availability and continuity of service of an EHR Infostructure, the state of several systems have to be monitored and managed concurrently. The products offering represented in this category are specialized in handling these needs.

In order to position the reader, the following is a list of COTS vendor products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: BMC Patrol, CA Unicenter, HP OpenView, IBM Tivoli, etc.

Clinical Information Systems

Clinical information systems have been in existence for many years in the industry of health IT solutions. Clinical information systems solutions vary in shape, size, format and scope. Generally, they are targeted at solving information management challenges in acute care delivery settings. They are typically made up of a database management system and centered on a core data repository along with one or more software applications to address different needs of presentation, business and data access logic in an integrated fashion. These solutions may be made up of several independent applications addressing different functions such as ADT, CPOE, patient charting, lab, drug, radiology and others, or they may be built as a much more integrated unique application with all of these same kinds of functionalities. In general, the solution offerings for these products will include integration capabilities that again show-up as an independent application layer or is highly integrated into the core of the clinical application capabilities.

These types of solutions can be used to address many of the EHR data services required as part of an EHR Infostructure. In fact, product solutions belonging to this category that are built on open architectures may also be valid potential answers to sustain the core services (LRS) of an EHR Infostructure. In order to fulfil the services requirements of the LRS, SHR and possibly other data domains, solutions of this realm have to be opened enough to process internal clinical data transactions, but yet also to combine under the same transaction processing engine the ability to openly invoke externalised services such as a independent drug information system or a client registry service running on completely separate applications. Also, in order to meet interoperability requirements, these solutions have to be configurable in such a way where they respect the data and functional standards associated with the LRS services, especially with regards to the EHR Index and the ability to apply standardised orchestration flows.

Clinical information system solutions as a product category may also be positioned to act as EHR data and services domains like the SHR, Drug, Laboratory services. Such clinical information systems solutions often can be profiled and configured as specialised solutions. Often times, vendors of clinical information systems have independent products in their portfolio to address the needs of drug information systems or laboratory information systems requirements acting as domain services in the EHR Infostructure.

Providers in this category are the same as the one cited in the PoS Clinical Applications category. Diagnostic Imaging solutions, on the other hand are expected to be centered on PACS product offerings which also stands as a separate category of products. In order to position the reader, the following is a list of Diagnostic Imaging solutions vendors cited strictly as a set of examples and not meant to be preferred or exhaustive: AGFA, GE, Siemens, etc.

Registry Services

Registry services in an EHRi typically correspond to a very basic and simple set of needs which is to identify people involved as clients or providers in the health system as well as service delivery locations where health services are offered. While most clinical information system solutions will provide internal capabilities to address this kind of need, the transactional volume, as well as the specialised needs associated with the effectiveness and performance of identity resolution, requires specialised products that focus on solving these problems on very large scales. Person Identity Management Software also known as Enterprise Master Person Index solutions qualify as a distinct category of products.

In order to position the reader, the following is a list of COTS vendor and/or products for this category cited strictly as a set of examples and not meant to be preferred or exhaustive: IBM, Initiate, Oracle etc…

Others

Other product categories may also become part of the EHR Infostructure as we move forward. An example of this is the specialised sets of products that exist to address the needs of the public health services industry. Special categories of products and/or vendors exist in this industry with dedicated solutions to address such capabilities as communicable disease case management for different disease categories, communicable disease outbreak management, immunisation program delivery, and public health alerts management.

Other types of business needs may also be addressed in the future by EHR Infostructures, for example, enterprise scheduling, wait list monitoring and healthcare continuum case management. These types of business need would in turn introduce even more product categories as potential solutions to be integrated in an EHR Infostructure.

4.5.2.3 Key COTS Considerations for EHR Infostructure solutions

Positioning the LRS

The Longitudinal Record Services, as discussed before, provides the kernel of transaction processing for an EHR Infostructure. One key architectural decision in establishing a COTS based approach to the development of an EHR Infostructure is the positioning of this LRS capability. There generally two distinct approaches to this. The first commands for a Clinical Information System Product to sit as the kernel of the EHR Infostructure. This would suggest that the integration of the shared health record, the LRS and the EHR Viewer functionality reside in the same application and act as this kernel. This also suggests an approach where the EAI product category focuses strictly on enabling the brokering and communication features of the HIAL. Clinical Information System solutions designed to manage patient charting, care protocols and generally integrate or provide departmental capabilities such as CPOE for drug, lab, DI or others are seen as viable platforms to provide the services of the LRS and combine the scope of the core EHR data repositories.

One key consideration in taking this kind of an approach is to consider the level of openness and flexibility of a CIS to actually act as a transaction engine that can both run transactions with its internal data access and data storage capabilities, but can also branch out to separate domain systems or registries in the course of executing any given transaction. This is especially important in a context where both the EHR Index and Orchestration service are seen as key enablers of interoperability that would be the object of a high degree of standardisation. Solutions providers facing these types of requirement, would need to be able to configure, adapt and/or customize CIS solutions in order to meet such standards.

In this approach, the type of customisation being asked of the vendor has to do with a more standardised use of the core internal functions already provided by a CIS application. In cases where the CIS application is built on open architectures and with object-oriented platforms, this should be easier to consider, but it does require a significant customisation of a COTS product and touches on an important piece of the core of a CIS application. In other cases, either because the CIS doesn't entertain, even internally, the concepts of managing events and indexing them, or because it is not built on an open architecture, the kind of customisation required to achieve the functional behaviour of the LRS may simply not be possible. The diagram presented in Figure 4-36 above depicts a CIS based approach to the deployment of an EHR Infostructure.

The other approach for addressing the kernel of the EHR Infostructure on the basis of COTS products, is to rely on the use of a healthcare oriented Enterprise Application Integration (EAI) or Enterprise Service Bus technology and build on top of it by using the toolsets and integration environment provided by such a technology to achieve the functionality of the EHR Index, orchestration service and other services of the LRS. This, as opposed to the previous option, focuses on more of a development approach to things.

This approach provides for an ability to rely heavily on COTS for what is available and mature in the industry, i.e. the basic communication and integration functions, and to focus the development effort only on the new capabilities demanded for EHR solutions. EAI or ESB engines, over the last few years have evolved extensively towards the implementation of rules and parameter driven transaction flow automation. These capabilities are ideal to build an orchestration service as depicted in the LRS. The basic assembly, data access functions as well as component business objects are typical features of EAI engines as well. The EHR Index, normalisation, data quality and business rules services are subject to the custom development work as they are the services where the specialised functional behaviour expected of EHR Infostructure solutions will have to be implemented.

In the picture below, we represent this configuration approach. As displayed, CIS solutions would also play a key role in this kind of an approach, but their role is concentrated on enabling the EHR data domain solutions.

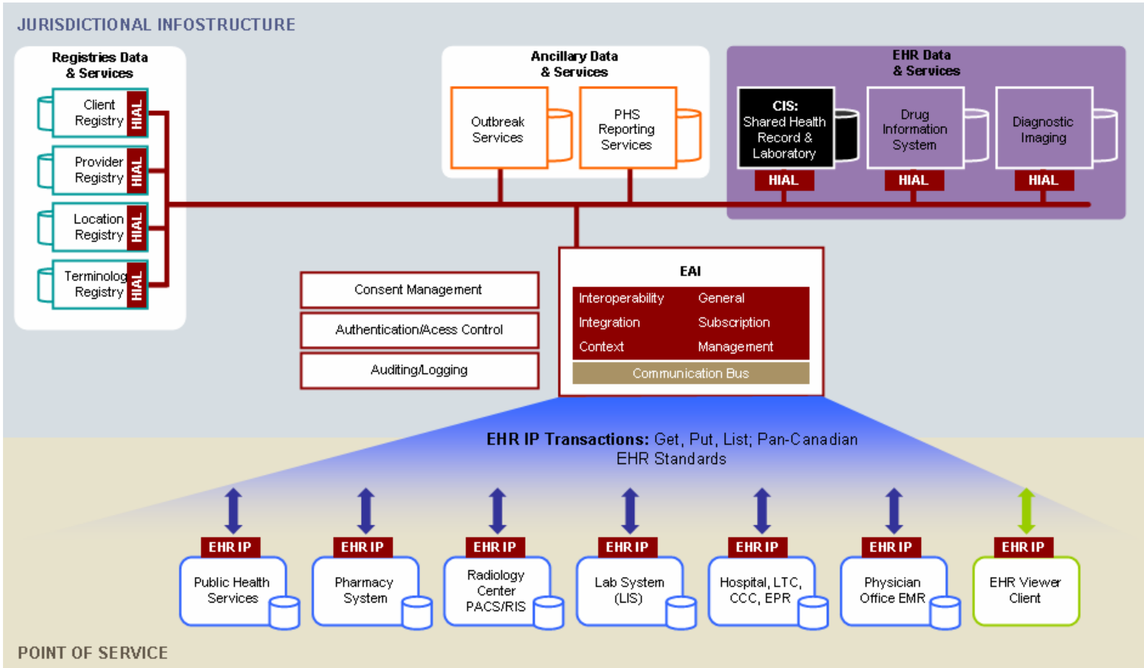


Figure 4-37 EAI Centric LRS Capability

Complexity

The development of a functional solution for an EHR Infostructure that can scale is by no means an easy task. One of the key considerations in making architectural decisions is the management of the level of complexity that the solution will represent. A reasonable balance between many complexity factors has to be struck, namely:

- The number of independent EHR domain systems that participate in an EHR Infostructure. The more separate systems exist in an EHR Infostructure, the more complex the EHR Infostructure will become.

- The positioning of the LRS functionality, as discussed above is a key consideration that influences complexity. If the LRS is hidden as part of the internal workings of a CIS based solution, then the complexity will reside in the ability of that CIS to be able to orchestrate transactions with other external parts of the EHR Infostructure and to be able to apply a set standards for data structures, vocabularies and functional behaviour for the EHR Index. If the LRS is built on top of an EAI technology playing the role of the HIAL, then the degree of complexity comes from the risks typically associated with any development initiative (scope creep, unproven solution or approaches, overruns on time and/or costs). Also, in this case, the HIAL with the LRS inherently becomes more complex as it has to deal with multiple different parts for communication, integration, interfacing with other EHRi systems, orchestration, EHR Index, normalisation, scalable transaction processing, etc…

- The interfacing choices to connect components of an EHR Infostructure with the HIAL. The actual number of different ways to connect and interface different systems together that will be used inside the HIAL and from the HIAL to other parts of an EHR Infostructure constitutes a key complexity consideration. For example, inside the HIAL the core EAI engine may need to connect to an Enterprise A&A (Authentication & Authorisation) solution. That same core EAI engine will need to connect to the client registry service, the SHR service, the DIS service and one or many different DI services. Each of these interfaces will need to be highly optimised, so that coordinated access to these different systems can meet the response times expected of an EHR Infostructure. The number of these interfaces as well as the characteristics of each one and especially, the level of difference between each, is a key factor that raises complexity.

- Response time service level expectations. Although the number of components to interconnect is a key factor of complexity, it is not just inherently the fact that they need to interconnect and operate in a coordinated fashion that creates complexity in an EHRi. The most important factor is the level of performance expected of an EHR Infostructure to support data access transactions. End-users of EHR Infostructure data are caregivers making decisions in their day to day and sometimes critical activities to provide care for clients being serviced in the health system. In this context, the response time for most data access transactions is going to become a key determinant for adoption of EHR Solutions. Interfaces between different parts in an EHR Infostructure will have to be highly optimised to achieve the type of responsiveness expected of an EHR Infostructure without compromising the application of rigid and auditable privacy and security policies and requirements. The EHR Index, as a functioning principle exists in part to address this key concern.

- The volume of transactions expected to touch different EHR Infostructure components. Understanding the specific volumes of transactions as well as their growth curve for each component of an EHR Infostructure is critical, and the higher the peak volumes will be for any component, the more complexity has to be dealt with both on the side of the HIAL/LRS (the core) and on the side of the target component (CR, PR, LR, SHR, Drugs, DI, Lab, etc…)

- The volume of transactions expected to touch multiple EHR Infostructures. One key consideration that impacts the level of complexity is the number of times where the processing of a transaction will have to include sub-transactions being spawned to other EHR Infostructures. The definition and planning of the scope of coverage of any EHR Infostructure is a critical component that will influence complexity. If the natural reference patterns of patients in the health system or their natural mobility patterns demonstrate a high volume of clients moving between two regions, then as much as possible, these two regions should be serviced by the same EHR Infostructure as opposed to separate ones. This approach is critical in order to limit the volume of transactions that would inherently have to query multiple EHR Infostructures when trying to access data.

Every component in an EHR Infostructure will have its own degree of complexity. As an example, a drug information system solution playing the role of the EHRi drug domain repository and handling features such as electronic prescribing, medication profiles, dispensing events, drug to drug interaction reviews is by no means a simple solution, especially when deployed at a jurisdictional level. The same will be true of any of the other individual components of an EHR Infostructure. That said, a much higher degree of complexity exists in creating a transaction processing system that is able to run data access queries across many if not all of those components in a single transaction. This is especially true considering that this transaction engine will also have to deal with the aggregation of clinical data kept in other EHR Infostructures and complete all of that processing within a matter of 3 to 5 seconds. In order to deal with this complexity, a high level of customized integration work is expected to be necessary. The planning, detailed architecture, design and development of this custom integration work will have to be done in collaboration with COTS vendors, system engineers and system integration experts.

The level and type of integration work required, will vary greatly between the two different approaches for the positioning of the LRS. In the CIS centric approach, it is expected that a lesser degree of custom integration work will need to be dealt with. In this case the CIS is expected to cover a large scope of data processing by relying on its own internal functions and in that context act as a black box. While this CIS approach still commands the integration of external parts such as the connectivity to the HIAL, acting purely as a communication broker, and connectivity to other externalized components such as the client, provider, location registry or the drug information system or diagnostic imaging system, this approach inherently represents less complexity. That said, the compromise will lie in the degree of flexibility, openness and scalability of the CIS solution to meet the increasing transactional and functional needs of an evolving EHR Infostructure. Since smaller jurisdictions are expected to deal with smaller volumes of data as well as more concentrated patterns of clinical data availability, the CIS centric approach may be best suited for them.

Larger jurisdictions, on the other hand, are dealing with higher quantities of clients and clinical data, higher transactional volumes, the possibility of multiple EHR Infostructures deployed within their geographical scope, and generally a higher degree of complexity towards any single components of their EHR Infostructures. In this context, the flexibility, openness and scalability of an EAI/ESB centric approach is expected to be most likely required.

5 USING THE BLUEPRINT IN EHRS PROJECTS

This section describes the tools and methodologies being promoted by *Infoway* to assist jurisdictions that are planning or implementing EHR infostructure projects. As the number of initiatives increases across Canada, *Infoway* has the opportunity to leverage knowledge, best practices and many technical arterfacts being created throughout the country and facilitate the dissemination of this information.

5.1 TOOLS: ARTEFACT REPOSITORY

Achieving functional interoperability between the systems that make up the EHR within a region and eventually across jurisdictions is a complex technical challenge. The deployment of re-usable and interoperable EHR solutions to address this challenge requires access to design models, technical specifications and standards. Stakeholders in the healthcare industry, whether planning or implementing an EHR solution, can benefit greatly from having available electronically the latest versions of these documents and models in an easy to use library.

In order to assist the jurisdictions with their projects, *Infoway* has created a web accessible repository of key work products (or artefacts) produced by *Infoway* investment projects and from any other publicly available sources. The Artefact Repository application is designed to be a trusted and reliable source to provide the EHR community in Canada with the ability to capture, maintain, and disseminate interoperability specifications and standards for EHR solutions.

The Artefact Repository supports *Infoway* in its mission to accelerate adoption of interoperable EHR solutions by:

- Providing a tool that has the capability to publish and disseminate specifications and standards;
- Making available to the EHR community in Canada a reliable source of interoperability artefacts that can be reused and that provide a common framework for EHR data sharing across Canada;

At the same time, it is important to emphasize certain things the Artefact Repository is not designed to do:

- It is not meant to replace development case tools, version or source management tools or specific repositories used to support development within each deployment project;
- It is not a workflow tracking tool, it will not automate processes to support active versioning and will not employ any form of check-out mechanism.

Structure of the Repository

The Artefact Repository is a bilingual tool in support of the EHR community in Canada and is available 24 hours a day, 7 days a week. It is an easy-to-use web application which is accessible through a portal dedicated to EHR standards in Canada.

Artefacts in the repository can be easily downloaded, often in multiple formats, to assist users in repurposing this information for their own use. In some cases, supporting materials will also be provided in the form of templates and/or suggested formalisms to further encourage reuse.

Initial content for the repository is collected from *Infoway* funded EHR initiatives, but once operational is provided by the EHR community at large. Submissions will also be accepted from other sources and projects; however these will be moderated (filtered and annotated) to ensure their appropriateness for publication in the repository.

Each artefact is catalogued by a set of metadata to support queries of the repository and to assist in assessing the current state of objects. Updates or versioning of items in the repository is done manually, with the existing metadata entry updated with a new version identifier, along with a textual entry explaining the differences between the previous and the current version. The new artefact is then linked to this metadata and uploaded to the repository.

Projects conducted in Canada or elsewhere are expected to extend definitions of the EHRS Blueprint as they consume and refine the material during analysis, design and implementation. The reusable architectural specifications of the Blueprint are made available through Infoway's Artefact Repository a freely available, web-enabled software tool that will be used for this purpose. It will allow any organisation or person to submit a request for publication of any new requirement or specification that extends or refines the EHRS Blueprint definitions and specifications for other EHR solutions in Canada.

The key EHRS Blueprint analysis and design deliverables, that will be recorded and maintained in the Artefact Repository, use UML as a foundation for the following notations and documentation for design and development:

- Use Cases – Use Case diagrams
- Data Model
  - Conceptual – Class diagrams
  - Data Domain Views – Class diagrams
  - Transaction Views – Collaboration diagrams
- System Services Definitions – Class Hierarchies
- EHRi Transactions
  - EHR IPs/Communication Steps – System Use Case diagrams
  - I-IPs – Sequence diagrams
- HL7 Message class models, interaction diagrams and descriptions
- IHE Integration Profiles
- Other message standards documentation

Other artefacts associated with the implementation and deployment phases of EHRS related projects that may also be of value for the Artefact Repository could include:

- Implementation plans
- Training plans and materials
- Database schemas
- Test plans
- Test scripts
- Test databases
- Code Snippets / Examples
- Interface proxies

Infoway's Knowledge Management program is responsible for capturing strategic project deliverables that are not directly related to system design and development. These "knowledge objects" include project artefacts such as strategy documents, project management plans, business case documentation, business workflow documentation, benefits evaluation documentation, change management deliverables etc. This information is assembled from Infoway's Investment Programs, Change & Evaluation Services, Benefits Evaluation Services into Infoway program toolkits particular to a domain such as Client Registry, Provider Registry, DI, Telehealth, Lab, Drug, iEHR and Health Surveillance that are distributed for use by different projects.

Examples of Repository Content

The Artefact Repository will include many different kinds of artefacts, among them:

Example Artefacts	Format
UML representation of EHRS Reference Framework	ZIP file of HTML pages Native Magic Draw file XMI format exchange file
Implementation Guide for Client Registry HL7 v3.0 messages	PDF
White Paper on the use of EHR Client IDs (ECID)	PDF
Domain Information Model for Provider Registry Messaging	VISIO

Target Audience

The primary audience for the Artefact Repository are business analysts, architects, developers and standards experts from jurisdictions or vendors who are engaged in planning or implementing EHR solutions in Canada. Other possible users include individuals engaged in similar activities from other countries.

Access to the tool is free but interested persons will have to register to the website first, through a simple registration process.

Contributing Content to the Artefact Repository

Any person can register with the Artefact Repository and upload an artefact submission using the simple web-enabled application interface. All submitted artefacts will be reviewed by the repository manager before being accepted. The submitter will also have to ensure that all of the required metadata describing the artefact is included with the submission along with at least one classification for the artefact. Classifications supported by the Artefact Repository include:

- Artefact Type
- Program / Project Name
- Infoway or Non-Infoway Projects
- Zachman Framework
- HIPF Classification Guidelines
- Geography

A user of the Artefact Repository can then select a particular classification scheme to search for similar published Artefacts. Figure 5-1 below shows a sample screen of the Artefact Repository after a user has selected the classification 'Artefact Type' from the main page. Note that under each level 1 classification, documents are further grouped according to sub-classification categories.(e.g. Application Design | Behavioural Logic).

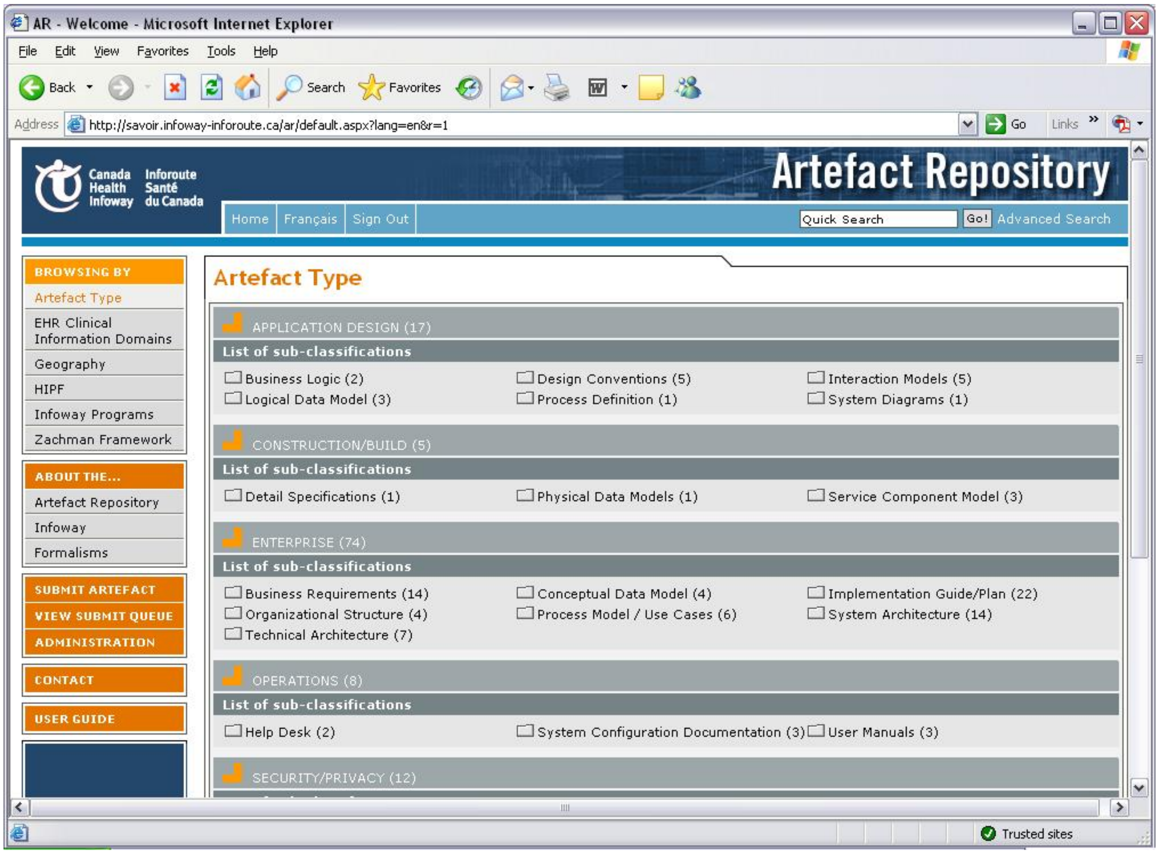


Figure 5-1 Artefact Repository Sample Screen

More information about the capabilities of the Artefact Repository and how to upload or find EHR related material will be found at *Infoway*'s web-site (www.infoway-inforoute.ca)

5.2 METHODOLOGY: EHR DESIGN AND SPECIFICATION

The strategy for coordinating development of EHR solutions simultaneously in different jurisdictions is based on using the EHRS Blueprint as a consistent framework that is continuously refined through close collaboration between the many stakeholders engaged in EHR implementation projects across Canada. After dozens of projects, experience has shown that the EHRS Blueprint provides an excellent starting point and key input to building the EHR enterprise architecture in a Province or Territory.

The objective of the EHRS Blueprint is to provide conceptual level definitions and initial logical level definitions for key interoperability enablers. Comprehensive specifications for interoperability between the systems that participate in an EHR solution will be established in the context of pan-Canadian EHR standards development initiatives. Detailed specifications for the component implementations of EHR solutions will be established in the context of projects with or without Infoway involvement. Overall, solution definitions designed and developed by projects related to EHR initiatives must all derive directly from the conceptual and logical level definitions of the EHRS Blueprint.

The EHRS Blueprint does not require or recommend the use of any specific system design methodology, as EHR investment projects are expected to rely on the methodology of their choice. Regardless of which methodology is applied, EHRS Blueprint definitions and artefacts are expected to be reused whenever possible. The methodologies that have been adapted and used in the creation of the EHRS Blueprint conceptual and logical architecture deliverables are the Zachman Framework's scope, business model, system model and technology model, and HL7 HDF's process of object oriented analysis and design of reusable components using UML.

5.2.1 Infoway Investment Project Phases

The EHR Solution development process should be conducted within the context of Infoway's investment and funding phase activities (where applicable) as well as in coordination with pan-Canadian Standards Groups (pCSG) who are responsible for coordinating the adaptation or development of pan-Canadian Standards for EHR standards. In order to provide an overview, the Infoway Phases for investment in an Interoperable EHR (iEHR) Project include the following architecture, design and standards development activities and deliverables.

Infoway Phase 0 - Current State Analysis

- Description of current state for EHR solution capabilities in the jurisdiction
- Description of existing messaging and terminology standards and any interoperability profiles currently in use
- Description of any existing provincial standards governance and processes in place
- High level overview of the EHR solution requirements in the jurisdiction
- High level overview of the pan-Canadian standards required for the EHR solution
- Description of approach to participate in the Standards Collaboration Process (SCP)

Infoway Phase 1 – Business Requirements & Standards Assessment

- The business requirements for an iEHR project in a jurisdiction are gathered and compared to the business use cases and EHRS Blueprint Logical Architecture to create an initial future state EHRi Solution Architecture document with logical level specifications
- Plan EHRi implementation depending on the decision whether to buy, build or customize
- Complete a standards assessment to understand which pan-Canadian EHR standards are required in the jurisdiction's solution (future state) and then to develop an implementation/transition plan to move from the current state (as defined in Phase 0) to the Future State.
- Complete procurement of required EHRS solutions, components and technologies

Infoway Phase 2 – Implementation & Governance

- Implementation
  - Iterate and refine design & specification artifacts to a level to implement the EHRi solution components for a jurisdiction
  - Action the standards implementation plan developed in Phase 1
  - Demonstrate compliance to the pan-Canadian standards.
  - Complete solution detailed design and implementation

- Planned Governance Model

- Detailed description of governance structure, membership, accountabilities, reporting and other relationships including relationships with provincial, national and international standards bodies
- Detailed plan for identifying potential change requests to the pan-Canadian standard to meet the implementation requirements. This should include pan-Canadian review of any proposed changes/modifications through the Infoway Standards Collaboration Process.

The EHRS Blueprint will save a lot of time for initial phases of projects that focus on a conceptual level definition as they evaluate opportunities and conduct preliminary analysis. These activities correspond to Infoway Phase 0 and early Phase 1 work.

The design level decisions and specifications in these projects will vary between solutions but they must all comply with key interoperability enablers established as pan-Canadian EHR standards. The EHRS Blueprint is meant to be used as a starting point for architecture, solution design or detailed specification and requirements phases of projects. These activities correspond to advanced Phase 1 work such as procurement as well as early Phase 2, typically qualified as solution detailed design work.

EHR System Development Process

Infoway encourages that EHR investment projects use industry standard Object Oriented Analysis and Design (OOA/D) techniques with UML to capture requirements, analyze the problem domain, design and develop the interfaces, domain models and solution components that will be implemented in an EHRi system.

During requirements gathering, analysis and design, the EHRS Blueprint Evolution Project followed the OOA/D process using HL7 HDF (see description below) as a guideline to create the initial version of the EHRS Logical Architecture. The completed package contains a Business Architecture, Clinical Work Process Architecture, Information Architecture and System Architecture each with their own sets of deliverables constructed using a UML compatible tool called Magic Draw. It is expected that projects engaged in developing EHRi systems within jurisdictions will consume these EHRS Logical Architecture UML deliverables as a starting point, conduct gap analysis steps to document the differences for their environments and create a solution architecture based on modified versions of these artefacts.

⚠	***Note:*** *The methodology for developing EHRS design and specification artefacts described in this section will be refined as projects engage in the creation of EHR solutions in different jurisdictions.*

The EHRS Blueprint Logical Architecture UML artefacts will be made publicly available via Infoway's web enabled Artefact Repository.

<u>Process Description</u>

The key activities and steps to be followed in the EHR Solution Design & Specification process are to:

1. Gather and compare jurisdiction business requirements in use case models
   - Consume the EHRS Blueprint use cases – LOB Timeline, Storyboards, Encounters, Clinical Activities (UML artefacts)

- o Conduct a Business / Work Process Architecture gap analysis to determine which business requirements are missing or need to be changed or deleted
- o Create a Business Architecture with updated versions of these use case artefacts that are reviewed by the pan- Canadian Standards Groups for consistency with other jurisdictions

2. Realize use cases into high level Information Architecture artefacts:
    - o Consume the EHRS Blueprint Logical Architecture EHR Conceptual Data Model (UML Class Diagram artefacts)
    - o Conduct an Information Architecture gap analysis to determine which data model and nomenclature concepts are missing or need to be changed
    - o Create an Information Architecture with updated versions of these UML artefacts that are reviewed by the pan-Canadian Standards Groups for consistency with other jurisdictions

3. Realize use cases into high level Interface Architecture artefacts:
    - o Consume the EHRS Blueprint Logical Architecture, Interface Architecture EHR Interoperability profiles (EHRIP) and EHR Communication Steps (UML use cases, class diagrams, sequence diagrams)
    - o Conduct a high level Interface Architecture gap analysis to determine which EHRIP and EHRCS artefacts are missing or need to be changed
    - o Create an Interface Architecture model with updated versions of these artefacts for the different types of interfaces required – (*see EHRi System Interface Types & Design Methodologies described below)* that are reviewed by the pan-Canadian Standards Groups for consistency with other jurisdictions

4. Conduct detailed EHRi Solution Architecture design
    - o Consume the EHRS Logical Architecture EHRi System Architecture design UML artefacts
        - ▪ Infostructure Interoperability Profile (I-IP) – UML classes and sequence diagrams
        - ▪ EHRi Service Orientated Architecture components (SOA) – UML classes
    - o Conduct a detailed EHRi System Architecture gap analysis to determine which I-IP and SOA components and operations are missing and/or need to be changed
    - o Create an EHRi System Architecture model with updated versions of these artefacts to support the different types of interfaces required (*see EHRi System Interface Types & Design Methodologies described below)* that are reviewed by the pan-Canadian Standards Groups for consistency with other jurisdictions

5. Create a Software Architecture Document that describes the complete EHR logical solution design for the:
    - o PoS system integration
    - o EHR Interface Architecture
    - o EHRi System Architecture
    - o EHR Viewer

6. Create UML Subsystem packages and design level class models using design patterns to describe:
    - o Interfaces classes and operations for each subsystem
    - o Domain classes and operations for each persistent data domain

7. Develop detailed specifications for:

- o Subsystem interface service operations, messages and attributes
  (See EHRi System Interface Types & Design Methodologies described below)
- o Domain data model classes, associations, methods and attributes

8. Implement, assemble, configure, customize and test the solution
   - o Testing should include (at minimum); unit testing against written specifications, integration testing, system testing against service level agreement requirements and user acceptance testing against business requirements

9. Conduct Project Review
   - o Review project artefacts that can be reused by Infoway's Knowledge Management program
   - o Review project requirements, analysis, design and implementation deliverables that can be used to update or refine EHRS Blueprint Project UML model in Infoway's Artefact Repository
   - o Create a lesson's learned document regarding the resolution of key issues encountered during the project that can be shared by other EHR related projects in Canada.

Design Methodologies and Notations for Key Interoperability Features

The EHRi System must support different types of interfaces using various technologies and standards. This means at the design and specification level there is a need to coordinate system development activities that use different and sometime overlapping design methodologies.

The key areas of design and specification of EHRi System interfaces are the elaboration of the EHRIPs and Communication Steps into HL7 v3 messages and other message interactions to support the different types of communication exchanges of patient clinical and administration information between PoS systems and the EHRi.

The following table describes the types of EHR data to be communicated and the types of EHRi System interfaces that need to be designed using the appropriate design methodology:

EHR Data to be communicated	Types of PoS to EHRi System Interfaces	Design Methodology
Structured data*	Structured data messaging interface	HL7 Message Development
Unstructured data	Unstructured document messaging interface (e.g. Clinical Document Architecture – CDA)	HL7 Message Development
Binary Large Objects / Images	BLOB streaming communication interface	IHE / XDS Integration Profile Development
Security data	Security management communication interface	Standard security management interface development
System Management data	System management communication interface	Standard system management interface development

*Structured data messaging interfaces using HL7 v3 is the default standard.

In general, the first three interfaces types (structured, unstructured and BLOB) represent the core business requirements that describe the patient demographic and clinical information that needs to be exchanged between a PoS system and an EHRi System. The last two interface types (Security and System Management) represent the majority of interactions needed to support the security, administration and configuration functions of the EHRi System.

5.2.2 HL7 Message Development

As described in the introduction to this section 5.2.1 in order to ensure that each jurisdiction that implements an EHRi Solution will standardize on a core set of EHR compatible HL7 messages, the responsibility and governance of coordinating the development of HL7 messages has been taken on by the pan-Canadian Standards Groups (pCSG) working with EHR solution project development teams.

These teams will use the HL7 Development Framework (HDF) as the design methodology to create and develop iEHR HL7 v3 messages. HDF methodology is based on OOA / OOD methods and techniques to analyze use case requirements and design standardized HL7v3 messages based on existing HL7 specific artefacts such as the Reference Information Model (RIM), HL7 archetypes and templates.

In summary, HDF uses the following key phases to develop HL7 messages.

	Note: *See www.hl7.org for a complete description of the HDF process*

During the HDF Requirements Documentation phase, the problem domain is defined, a model of the domain is produced, and the problem domain model is harmonized with HL7 reference models. The primary deliverable produced during requirements documentation is the Requirements Specification:

1. Document Business Process: Dynamic Behavior and Static Structure
2. Capture Process Flow: Activity Diagram
3. Capture Structure: Domain Analysis Model and Glossary
4. Capture Business Rules: Relationships, Triggers, and Constraints
5. Harmonize the Domain Analysis Model with HL7 Reference Models

It is recommended that a Peer Review Process be used to gain agreement /sign-off of the Requirements Specification.

The HDF Specification Modeling Process defines that during specification modeling, reference models are constrained into design models through a process of iterative refinement driven by requirements specifications and following specification design rules, conventions, and guidelines. The primary deliverable produced during specification modeling is a set of specification design models:

1. Build design models of static information views
2. Construct design models of behavioral views
3. Define reusable design model components

4. Construct design models of collaboration and interaction
5. Harmonize design models with HL7 Reference Models

During the HDF Specification Documentation steps, the specification design models are packaged into logical units, supplemented with explanatory text, and prepared for approval. The primary deliverable produced during specification documentation is a proposed specification:

1. Organize design model elements into logical packages
2. Compose explanatory text, examples, and design rationale
3. Update design models and requirement specifications
4. Assemble a proposed specification package
5. Submit specification for approval

HL7 HDF methodology is used for both HL7 v3 structured data messaging interfaces and unstructured documents (CDA) type messaging interfaces.

5.2.3 IHE Integration Profile Development

Integrating the Healthcare Enterprise (IHE)[21] is a multinational healthcare initiative that develops and publishes domain-based (e.g., radiology, laboratory, etc.) Technical Frameworks (i.e., implementation guides) that consist of internationally-accepted and vendor-neutral implementations of existing healthcare IT data standards, including but not limited to Health Level 7 (HL7) and Digital Imaging and Communications in Medicine (DICOM). The Technical Frameworks allow the established standards to be implemented in a uniform fashion; therefore, allowing the seamless passing of vital health information from application to application, system to system, and setting to setting within and across the entire healthcare enterprise.

IHE Technical Frameworks

IHE Technical Frameworks consist of common language for humans to use to unambiguously discuss how to integrate heterogeneous information systems. Also, they consist of the common, standards-based vocabularies for systems to use in exchanging medical information. IHE Technical Frameworks are process-oriented. The Technical Frameworks refer to each process (or problem / solution scenario or specific set of capabilities of integrated systems) as an “**Integration Profile**”. IHE Integration Profiles organize the processes to address specific patient care needs and to conveniently reference the functionality described in the Technical Frameworks.

For example, version 1.0 of the IHE IT Infrastructure Technical Framework has the following five Integration Profiles, which were demonstrated at the joint HL7-IHE Interoperability Demonstration at the 2004 Annual HIMSS Conference and Exhibition:

- Retrieve Information for Display (RID)
- Enterprise User Authentication (EUA)
- Patient Identifier Cross-Referencing (PIX)
- Patient Synchronized Applications (PSA)

[21] Notes from: *Integrating the Healthcare Enterprise (IHE)*: an international approach to the development of implementation guides for Electronic Health Record systems.

- Consistent Time (CT)

	Note: *See www.ihe.net for a complete description of the IHE Technical Frameworks and Integration Profiles*

IHE Integration Profile development involves an ongoing process of collaboration and communication among key stakeholders, which takes place in four phases:

1. Problem Identification:
   Clinicians and IT experts identify common health system integration problems such as: access to information, clinical workflow, administration and underlying infrastructure.

2. Integration Profile Specification:
   The participating stakeholders document requirements and select standards and technologies that address each identified health system integration requirement. After an analysis and design step, the technical specifications for implementing these standards and technologies are documented in an IHE Technical Framework as Integration Profile specifications.

3. Implementation and Testing:
   Vendors implement these Integration Profiles and test their systems with software tools at a face-to-face in a yearly IHE Connectathon technical conference, where they test their interoperable functions with other vendors' systems.

4. Integration Statements and RFPs:
   Vendors publish IHE Integration Statements to document the level of their product's conformance to the Integration Profiles. Users can reference Integration Profiles in requests for proposals, simplifying the systems acquisition process.

Infoway is currently evaluating IHE's approach and strategies to sharing patient information in EHR Longitudinal Records via Integration Profiles. IHE's Technical Framework leverages existing healthcare IT data standards, such as HL7's Clinical Document Architecture (CDA) and ASTM's CCR. Also, it leverages a developing IHE Integration Profile called EHR-Cross-Enterprise Clinical Document Sharing (XDS), which complements both HL7 CDA and CCR clinical information sharing strategies.

Based on work that Infoway has conducted with IHE to develop XDS-I Integration Profiles to use the XDS architecture to record and locate DICOM objects within an EHR related XDS Affinity Domain (a regional collection of health service delivery locations such as local health information infrastructures, specialty networks, etc.), Infoway is proposing that XDS be the core technology that will support the EHRi System requirement for a cross domain EHR Index capability.

	Note: *See section 4.3.7 Longitudinal Record Services for more information about the EHR Index requirements*

The overall process to create IHE XDS compatible Integration Profiles is:

- Configure an XDS Affinity Domain
  - A number of systems implementing IHE Actors defined in the XDS Integration Profile need to be identified and configured to communicate.

- Patient Identification

  - o Initialize the XDS Document Registry with the proper patient identification information

- Specify XDS Registry Related Vocabularies
  - o Initialize the XDS Document Registry with the proper vocabulary information

- Establish Document Sharing Practice Policies
  - o Define the care events and the corresponding expected level of information that is expected to be shared within the EHR-LR.
  - o Define the usage policies for XDS Folder (creation and update) in the selected care pathways supported.

- Define XDS Document Content
  - o For each Document Format Code Value, establish the necessary interoperability agreements (e.g. by selecting IHE Document Content Profiles) to ensure that the document consumers may find (e.g. Document UniqueId structure) and process the XDS documents content (e.g. MIME type, template definitions, archetypes, etc.) they retrieve from the XDS repositories of the XDS Affinity Domain.

- Document Update and Maintenance Policies
  - o Document Sources are responsible for the on-going accuracy (custodianship) of the XDS documents they have elected to share in the EHR-LR supported by the Affinity Domain. This includes:
    - Replacement of documents in the EHR-LR
    - Cases and means to possibly delete documents in the EHR-LR

- Establish Security and Privacy Policies
  - o Establish agreed policies and procedures among care delivery organizations in the Affinity Domain.
  - o Establish operational security infrastructure, including certificate exchange.
  - o Maintain operational security infrastructure, configuration management, audit management, periodic inspections, etc.

Because IHE Integration Profiles use different standards such as DICOM, WADO and HL7, there is some overlap at the design level when creating HL7 messages that are also consumed by an IHE artifact. It will be the responsibility of the iEHR design and implementation teams to ensure HL7 messages used for different purposes are packaged and maintained to ensure their usage in an EHRi System solution is consistent.

5.2.4 Standard Security Management Interface Development

It is recommended that any EHRi System security management related interfaces not addressed by the HL7 message development or IHE Integration Profile development processes described above should be designed and implemented using industry standard OOA / OOD software development model-driven methods and techniques with UML.

Security management interfaces must be developed within the context of a Security Architecture that is applicable to the EHRi System. The steps to create a Security Architecture at the level required for a jurisdictional EHR System should include a Privacy Impact Assessment (PIA), a Threat Risk Assessment (TRA) and should adopt the recommendations and conclusions described in Infoway's EHR Privacy and

Security Standards Assessment document (*see section 6.1 Standards for Security Management Practices with reference to ISO/IEC 17799 Code of Practice for Information Security Management*).

EHRi security management interfaces must support the requirements and standards defined by *Infoway* in the *Privacy and Security Architecture.* Appendix A of this conceptual security architecture document describes the EHR Privacy and Security Service operations at conceptual level. It is expected that vendors and solution providers will map these EHRi security service descriptions to existing security infrastructure type components in the customization and development of security management operations that support the EHRi System.

5.2.5 Standard system management interface development

It is recommended that any EHRi system management related interfaces not addressed by the HL7 message development or IHE Integration Profile development processes described above should be designed and implemented using industry standard OOA / OOD software development model-driven methods and techniques with UML.

EHRi system management interfaces must support the requirements and standards described in the HIAL Communication Bus services and the HIAL Common Services documented in the EHRS Reference Architecture. It is expected that vendors and solution providers will map these service descriptions to existing system management and infrastructure type components in the customization and development of security operations that support the EHRi System.

5.3 DESIGN ARTEFACTS

As described in the previous design and methodology section the EHR business requirements are captured in use cases and the EHRi system components, interfaces and service operations are captured in design specifications. These artefacts are created, documented and available as part of the EHRS Reference Architecture. The EHRS Reference Architecture is a UML based design representation of the architecture for an EHR Infostructure, it is available as a separate deliverable associated with the EHRS Blueprint Version 2.

Design Artefact	Purpose
Clinical Activity Use Case	Describes a user's workflow event steps and when a Point of Service system initiates an interaction with an EHRi system via an EHR Interoperability Profile (EHRIP). Clinical Activities are inputs to the following design artefacts.
EHR Interoperability Profile (EHRIP)	Point of Service system interface responsibilities
EHR Communication Step (EHRCS)	PoS to EHRi message specification
Infostructure Interoperability Profile (I-IP)	EHRi system interface responsibilities
EHR Infostructure Service	A description of the EHRi components and services that

Design Artefact	Purpose
Oriented Architecture (SOA)	make up the EHRi SOA.
EHRi Data Model	A data model expressing the scope of data maintained in an EHR Infostructure

This section presents these different types of artefacts and provides examples of how they are used.

5.3.1 Clinical Activity Use Case

The Clinical Activity document describes the detail use case steps taken when a patient receives a medical service by a provider. These documents are created with a future EHR system in mind to show how providers would use the EHR in their daily practice and use the following format.

Description of Use Case Encounter
a one page summary of all the activities that occur in this use case

Tables
a listing of the main data types and attributes used in this use case

Health Service
an introduction to the different Health Service Events that make up this use case

Health Service Event (#n)
a description of a the all workflow event steps completed by one actor (e.g. provider) either manually or with one type of Point of Service system in the delivery of a health service to a patient

Actors
a list of the actors that participate in the Health Service Event
each Health Service Event describes the actions of one principle actor

Assumptions
a list of assumptions that apply to this Health Service Event

Workflow Events
a table of the actor's workflow events and the PoS actions, EHRi System actions and EHR IPs invoked using the following columns

the flow of events is from top to bottom and left to right if the actor initiates a PoS system which in turn invokes an EHRi System Action via an EHR IP. Once an EHRIP is invoked the responses are shown from right to left in each subsequent row until the response is returned and displayed to the actor

EHR IP's are maintained in an EHRS Logical Architecture model which will have to be updated if new EHR IP's are discovered or need to be changed

Workflow Event Step	PoS Action	EHRi System Action	EHR IP Reference
The actor's action which	This column is	This column is	This column is

WORKFLOW EVENT STEP	POS ACTION	EHRI SYSTEM ACTION	EHR IP REFERENCE
may be manual or an interaction with a Point of Service system.	documented if the actor interacts with a PoS system. This column may also show if the EHRi System is invoked.	documented if the PoS system initiates an interaction with the EHRi	documented if an EHRIP is invoked to fulfil the PoS system request to the EHRi System
		This column will show the EHRi System response if the previous row initiates an interaction with the EHRi	
	This column will show the PoS system response if the EHRi system response is in the previous row		
This column will show the actor's response if the PoS system response is in the previous row			

5.3.2 EHR Interoperability Profile (EHR IP)

The EHR IP design document describes the responsibilities of the PoS application when interacting with the EHRi.

EHR IP Summary

Description
a one paragraph description of the purpose of this EHR Interoperability Profile

EHR Business Requirement reference
a list of the Clinical Activity use cases where this EHR IP is used for backward traceability

Clinical Activity Document Id	Name

Actors
a list of the actors that participate in this EHR IP interactions with the EHRi System

Actor	Description

Preconditions
a list of business and technical preconditions that must exist in order for the interactions described in this EHR IP to take place

Interaction diagram

This sequence diagram describes the system to system interactions between the PoS application and the EHRi System that take place for this EHR IP

This diagram also indicates in a note which type of Infostructure Interoperability Profile (I-IP) will be used when interacting with the EHRi System

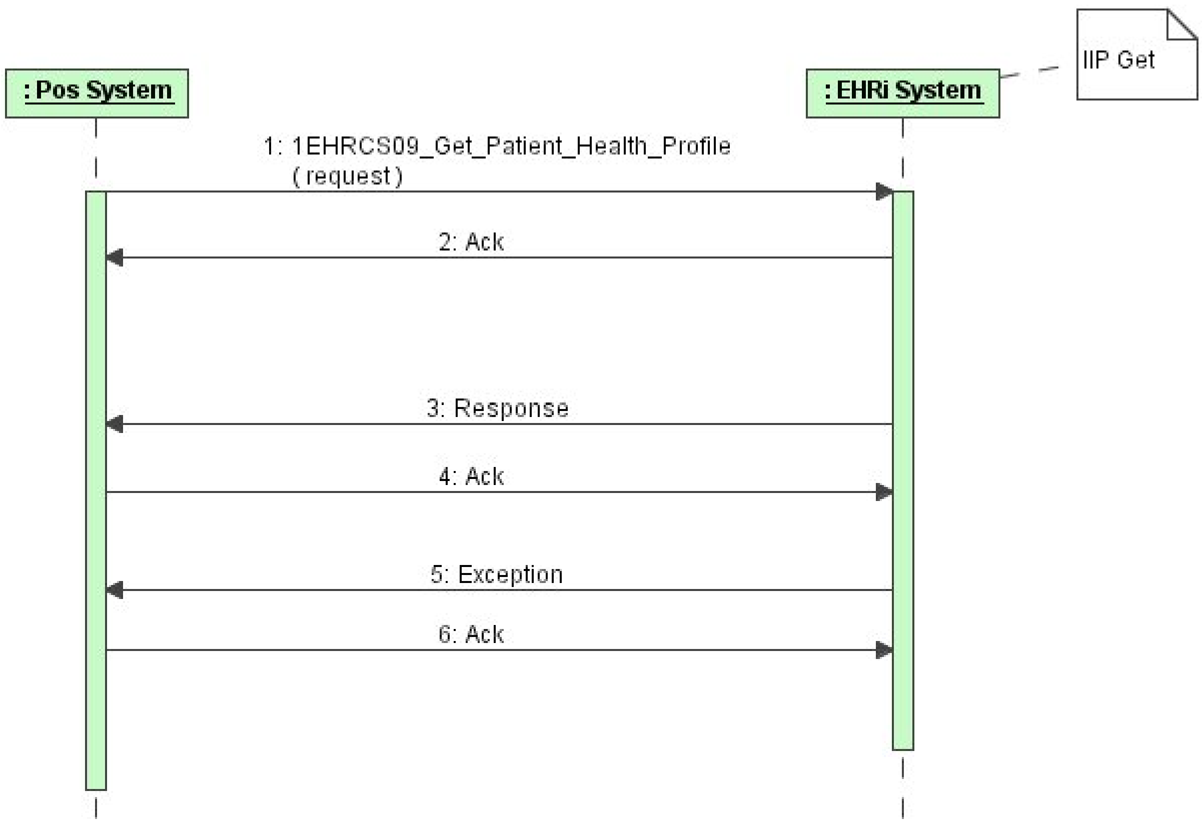


Figure 5-2 EHR IP Interaction Diagram

Process Steps

This section describes the responsibilities of a user, the PoS and the EHR Communication Steps used to complete the interaction with the EHRi System including a summary of the information sent and received

Process Step	PoS	EHR Communication Step
.		

Issues

This section describes any issues related to this EHRIP

Assumptions / Constraints

This section describes any assumptions or constraints that apply to this EHRIP

Notes

This section allows consumers of the EHRIP to add notes and comments

5.3.3 EHR Communication Step (EHRCS)

The EHRCS describes the message interactions between a Point of System application and the EHRi. Each EHRCS is an elaboration of one message found in the PoS to EHRi system sequence diagram used to describe an EHRIP.

Communication Step Summary

Description
a one paragraph description of the purpose of this Communication Step

Used by
reference(s) to the EHRIP(s) that consumes this Communication Step for backward traceability

Uses
a reference to the EHR Infostructure Interoperability Profile (I-IP) that this Communication Step uses e.g. I-IP Put, I-IP List, I-IP Get

Communication Structure

a description of the standard communication structure this Communication Step uses such as the HL7 Composite Message Structure. Note there will be other types of standard communications

HL7 Trigger:
the type of HL7 trigger that initiates this Communication Step

Communication Step Type
the type of Communication Step interaction such as Put, List, Get

Domain
the type of domain repository that this Communication Step interacts with such as: EHR, Drug, DI, Lab etc

Constraint
the subject area this Communication Step is constrained to

Message
a description of the message this Communication Step uses to interact with the EHRi system including:

- Inputs
  EHR Conceptual Data Model business view

- Response
  EHR Conceptual Data Model business view

Exceptions
a description of the expected errors or exceptions this Communication Step message will raise

Rationale

a description of why this Communication Step is needed

5.3.4 Infostructure Interoperability Profile (I-IP)

The I-IP describes the responsibilities of the EHRi system in response to an EHRCS message interaction sent by a Point of Service system.

The format of this generic interface design artefact is used to describe the different types of PoS interactions with the EHRi system such as I-IP Put, I-IP Get and I-IP List

Introduction

Description
a one paragraph description of the purpose of this I-IP

I-IP Interface Description
a summary of the I-IP Interface Message Structure, and EHR Communication Step parameters used when invoking this IISP such as :
- Communication Step Type
- Communication Step Domain
- Communication Step Constraint
- Communication Step Message

I-IP Process Flow

This section describes the interactions of components at a conceptual level to provide the reader with an overview of which HIAL, LRS and EHRi services are used when a Point of Service system sends a message to the EHRi that uses this I-IP

Process Flow Diagram

a sequence diagram that describes the process flow of EHRi components within this type of I-IP invoked by a Point of Service system via and EHR Communication Step.

The different types of I-IPs are, I-IP Put, I-IP List and I-IP Get. These I-IPs will be added to and refined as different types of EHRi communication standards are defined

The following example shows a Point of Service system invoking an I-IP Get type of process flow

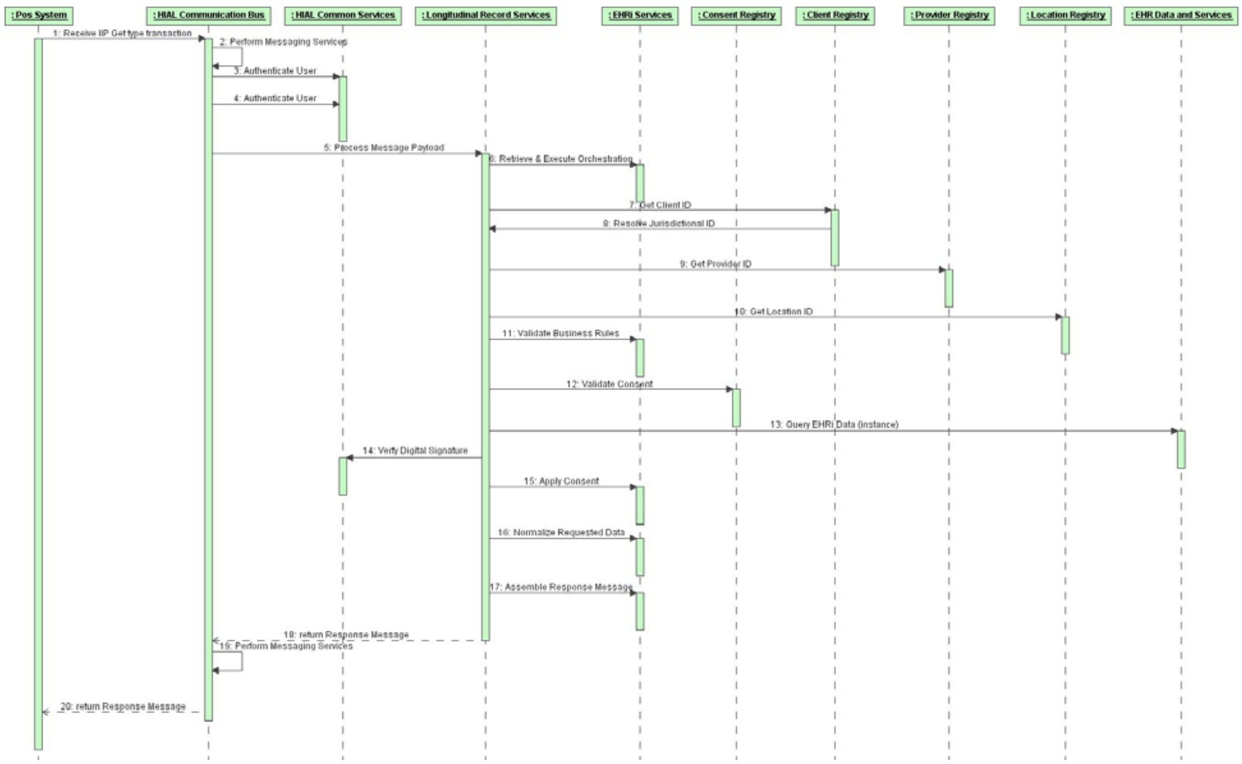


Figure 5-3 I-IP Process Flow Diagram

Process Flow Description

this table describes each of the steps in the above process flow sequence diagram as well as the EHRi components that are invoked

Issues

This section describes any issues related to this I-IP

Assumptions / Constraints

This section describes any assumptions or constraints that apply to this I-IP

Notes

This section allows consumers of this I-IP to add notes and comments

References

This section allows consumers of this I-IP to add references to standards and technology information relevant to this I-IP

5.3.5 EHRi System Services

As described in previous sections, the EHRi is a Service Oriented Architecture comprised of different levels of components that provide both external service operations for applications outside the EHRi to consume as well as internal service operations to support the EHR Infostructure interactions.

These services are described in the I-IP Services Catalogue, which is represented as a hierarchy of classes in the EHRS Reference Architecture using the following high level structure.

I-IP Services Catalogue
- Longitudinal Record Services
- HIAL Common Services
- HIAL Communication Bus

Note: See section 4.3 System Architecture for a complete description of these services

Service classes and operations included in EHRi system SOA are described at a conceptual level and use the following format:

Description
A brief description of the service operation

Used by
The application functions or other services that use this operation

Uses
The service components this service operation uses

Required Inputs
The mandatory attributes this service operation needs as input

Response
The types of response data this service operation provides on completion

Rationale
A description of the context and reason(s) why and when this service operation is used

Each class is documented with UML in the following format which is shown using Assembly Services as an example:

Classes
Class **Assembly Services**

```
Business Services
   |
   +--Assembly Services
```

These services assemble business request data output from different EHRS Business Service components using predefined assembly templates that are designed by development / integration teams responsible for implementing the EHRi messaging infrastructure. The services are used by all I-IP's to assemble EHR business requests into the appropriate data structures.

General Info

Name	Assembly Services
Visibility	Public
Active	False
Owner	Classes

Operations

Name	Return Type
Apply Assembly Template()	
Register Assembly Template()	

Relations

Name	Type	Begins	Ends
→ unnamed	generalization	Assembly Services	Business Services

Figure 5-4 Sample Service Class – Part 1

Example (cont'd)

Operation **Apply Assembly Template**

Description:

When a message is to be assembled by the HIAL services responsible for managing transactions, the appropriate Assembly Template is retrieved from the Message Registry and used to construct the message with data returned from the business components participating in the transaction.

Used by: I-IP Get, I-IP Put, I-IP List - Assemble

Uses: Messaging Registry

Inputs:

- Assembly Template ID

Response:

- Assembly Template Details

Rationale:
This service provides the ability to automate the EHRi message assembly from a table driven Messaging Registry

General Info	
Name	Apply Assembly Template
Owner	Assembly Services
Concurrency	Sequential
Query	False
Visibility	Public
Scope	Instance

Figure 5-4 Sample Service Class – Part 2

5.3.6 Data Model

The data model section of the EHRS Reference Architecture uses a class diagram notation to represent conceptual view of the data that will exist in an EHR Infostructure. This model is built using a top-down approach that represents different levels of abstraction of the data entities that would make up an EHRi. A first model is delivered as the top most representation of the data domains and facets of information maintained in an EHR Infostructure. From this model, finer grained domain views are created to represent a more detailed view of the entities and relationships belonging in each, at this stage (March 2006), only the higher level conceptual model is available.

This data model is focused on an overarching definition of the data that will be persisted across all the repositories that make up an EHR Infostructure, from registries to SHR, Lab domain, etc. From this data model, different types of views can be created or derived, to address the specification of data involved in different aspects of EHR Solutions. For example, data communication views can be created to represent the data used in EHR Interoperability Profiles (EHR IPs) or transactional views can be created to represent the data used in the processing of a transaction in the EHRi.

The documentation template for data classes includes the definition of the class itself, its attributes and relationships to other classes. The following is an example of a documented class:

Class **People**

Direct Subclassifiers:
Group, Individual

Definition
An organizer that includes individual persons, formal organizations, and other types of groups of interest to the health system.

Synonyms
EHRi Identifier

Definition References
HL7 Care Provision DMIM

Rationale

Business Process Implications

Implementation Implications

Figure 5-5 Sample Data Class – Part 1

Example (cont'd)

General Info

Name	People
Visibility	public
Active	false
Abstract	false
Leaf	false
Root	false
Owner	People

Attributes

Name	Type	Initial Value
Class Code		
Code		
Description		
Determiner Code		
Identifier		
Name		

Relations

Name	Type	Begins	Ends
Affected by	association	People Event	People
Affected by	association	People Event	People
Are Located at	association	People	Place
Are Located at	association	People	Place
Defines Participation of	association	Role	People
Defines Participation of	association	Role	People
Is a	association	People	Human
Is a	association	People	Human
	generalization	Group	People
	generalization	Individual	People

Figure 5-5 Sample Data Class – Part 2

5.4 ONGOING SOLUTION DEVELOPMENT

The development of full featured EHR Solutions that cover every jurisdiction in Canada is not going to occur overnight. It is a long road that involves an evolutionary path that will see early solutions succeed and fail and will see maturity being reached over the next decade and more. This section provides a perspective on the intended role of the EHRS Blueprint as a planning statement to undertake and guide decisions as we collectively embark on the road to Electronic Health Records in this country.

The EHRS Blueprint defines the components that make up an interoperable EHR. The key operative word in this statement is “interoperable”. The EHRS Blueprint defines the business context and expected benefits of EHR solutions positioned at the jurisdictional level or above the PoS layer. It defines what this system is, it identifies its different parts and the capabilities they are expected to support. It defines the importance of standards as the foundation to achieve connectivity on a large scale insuring interoperability both with PoS organisations and applications as well as between the EHR Infostructures. The EHRS Blueprint positions and defines key principles for how these solutions can achieve similarity in functional behaviour and standardisation on key requirements for interoperability.

In light of these considerations, the EHRS Blueprint is a key definitional statement that must be adhered to by any private or public organisation participating in the development, deployment or eventually operation of EHR solutions in Canada. It sets out a vision for a level of capability and integration that may take decades to attain, nevertheless it offers the flexibility of a progressive growth approach where small incremental steps can be taken to achieve clinical value every step of the way.

5.4.1 Diversity of EHR solution development settings

The development of EHR Solutions will be supported by many different types of initiatives over time. The following is a list of some of the expected key contributors to the development of EHR Solutions:

- Infoway funded projects: projects funded by Canada Health Infoway are actively deploying the foundations and diverse components of early generation EHR Solutions. These projects are inherently subject to the application of the EHRS Blueprint as an investment criteria to obtain funding.

- EHR projects without Infoway participation: other projects may be led by large hospital groups or by associations or may be funded directly by F/P/T health authorities without the participation of Infoway as a funding organisation. These projects must also take vested interest in applying the EHRS Blueprint architecture, so that they can participate in the interoperable EHR network and be in a position to leverage and contribute to the clinical data already shared in people’s EHRs.

- Vendor product R&D: Another source of development for EHR solutions is the privately funded efforts made by health IT technology vendors to develop or upgrade their product offerings in order to play in the emerging field of EHR solutions. Vendors are actively encouraged to use the EHRS Blueprint and consider it as a framework definition in the context of any R&D efforts they are willing to undertake in order to position their products in the Canadian EHR Infostructure landscape.

- International EHR initiatives: Other countries are actively pursuing the development of EHR Infostructure solutions to enable large scale sharing of clinical data. They do not necessarily use the same language as established by the EHRS Blueprint to describe their system infrastructures. For example, in the UK, the NHS (National Health Service) is actively pursuing the deployment of an 8 billion pounds program to implement clinical systems in every PoS and enable sharing of clinical data nationwide through a system infrastructure called "the spine". On our side of the pond, the USA are also starting to be active in developing capabilities to share electronic health records, while ONCHIT (Office for the National Coordination of Health Information Technology) is active in starting to coordinate efforts at a National level, so called "Community EHR" initiatives our appearing in many states. Many European countries as well as key industrialised countries in Asia and the Pacific are actively developing capabilities to share EHR as well. All of this activity worldwide is creating a solid market base to justify R&D investments by global and national health IT vendors in the space of interoperable EHR solutions.

5.4.2 An evolutionary path

Early solutions are expected to be simple in nature and compile information from a small number of sources carrying limited types of clinical data that can be published to an EHR Infostructure. As time goes by, different F/P/T jurisdictions in Canada will move forward in implementing EHR solutions, each at a different pace. Obviously that pace will be driven by the will and capacity of any given jurisdiction to invest in these types of capabilities. This creates a dynamic where multiple EHR solutions will be under way in Canada and will exist at different levels of capability and maturity. The EHRS Blueprint sits as an architecture definition and planning framework, which can always be referenced in the context of pursuing development or in the context of extending connectivity within or between EHR Infostructures. The EHRS Blueprint is an integral part of the solution, and as EHR solutions and systems are developed and deployed, it should evolve and be kept current. The Artefact Repository is the intended tool for doing this, see section 5.1 for more details on it.

- Without declaring or requiring that any particular path be followed, certain logical progressions are likely to occur in the evolution of EHRS in Canada. For example:

- Client and Provider Registries must evolve early in the process as they form the foundation for correctly associating health information with the subjects and sources of services across different care settings in a jurisdiction. These registries will not likely spring up in isolation, their development and implementation will typically be paired either with an encounter history in the Shared Health Record repository, or in support of a particular clinical domain such as shared Diagnostic Imaging, Lab, or Pharmacy information.

- Basic HIAL components will also be developed early, focused on Authorization and Authentication, and on basic auditing and protocol management services.

- Longitudinal Record Services may initially be satisfied by a common Clinical Information System in certain circumstances, evolving to an externalized LRS as more care delivery settings and other types of systems become EHRi enabled.

- Infostructures may not be implemented either concurrently or in quick succession within a jurisdiction. A jurisdiction may decide to implement one infostructure to develop a baseline for operational performance and management, and to assess change implications for the users, and then progressively deploy subsequent infostructure implementation in other health authorities.

- In some areas, the need to link infostructures in a peer-to-peer network may occur more slowly than in other jurisdictions. Those areas where there is a significant overlay of federally employed patients/clients (such as DND, RCMP, First Nations, or Veterans) who receive their health services in a local setting may be early implementers of peer-to-peer infostructures.

- One of the key advantages of the EHRS Blueprint approach is that the Services Oriented Architecture permits the incremental addition of new or improved services without impacting previous implementations of enabling services. In the same manner, the EHR infostructure allows providers of ICT solutions are able to EHR-enable their applications at a pace they can rationalize with their customer base, gradually increasing the number of sources and consumers of shared EHR information.

- The use of a shared infostructure also permits the re-rationalizing of health service delivery in a health authority or across a jurisdiction. As more and more information is shared in the EHRi, it becomes possible for service delivery organizations to restructure, retiring antiquated systems while incorporating new and better systems to meet changing needs, all while relying on the infostructure to protect previous event histories and relevant clinical information.

- It is important to note that the shared EHR can be effective right from the outset with even a limited number of sources of information. An incremental strategy may be to provide basic encounter information from key sources that provide significant coverage of the continuum of care, without necessarily providing a lot of clinical detail. There is great value in just knowing what providers have seen a particular patient/client and when. This would permit a jurisdiction time to effectively deal with the change management issues associated with consolidating their systems' use of a pan-Canadian clinical terminology.

As have been illustrated, there are many potential evolutionary paths that can be taken, providing that every jurisdiction adheres to the EHRS Blueprint as a common underlying architecture that supports change over time.

5.5 ONGOING STANDARDS DEVELOPMENT

Canada Health Infoway (Infoway) has the mandate to accelerate the adoption of interoperable Electronic Health Record Solutions (EHRS) across Canada. To fulfill this mandate, Infoway requires the use of standards in the projects it invests in, and is a key player in the standards employed across healthcare information systems. In meeting the challenge of the interoperable EHR, it is clear that uniform adoption of sustainable standards including a well defined architecture in support of the EHR will be a key to success.

Following extensive consultations with standards experts from across the county Infoway released, in April of 2004, its EHR Standards Needs Analysis, setting the direction for establishing pan-Canadian electronic health record standards[22]. The EHR Standards Needs Analysis set out the basic principles to promote effective collaboration with stakeholders in selecting and implementing standards on a pan-Canadian basis in what has been termed the Standards Collaboration Process (SCP).

[22] Link to standards needs analysis can be found on the Infoway Knowledgeway at http://knowledge.infoway-inforoute.ca/CHIPortal/EHRSearch/EHRS+Blueprint/

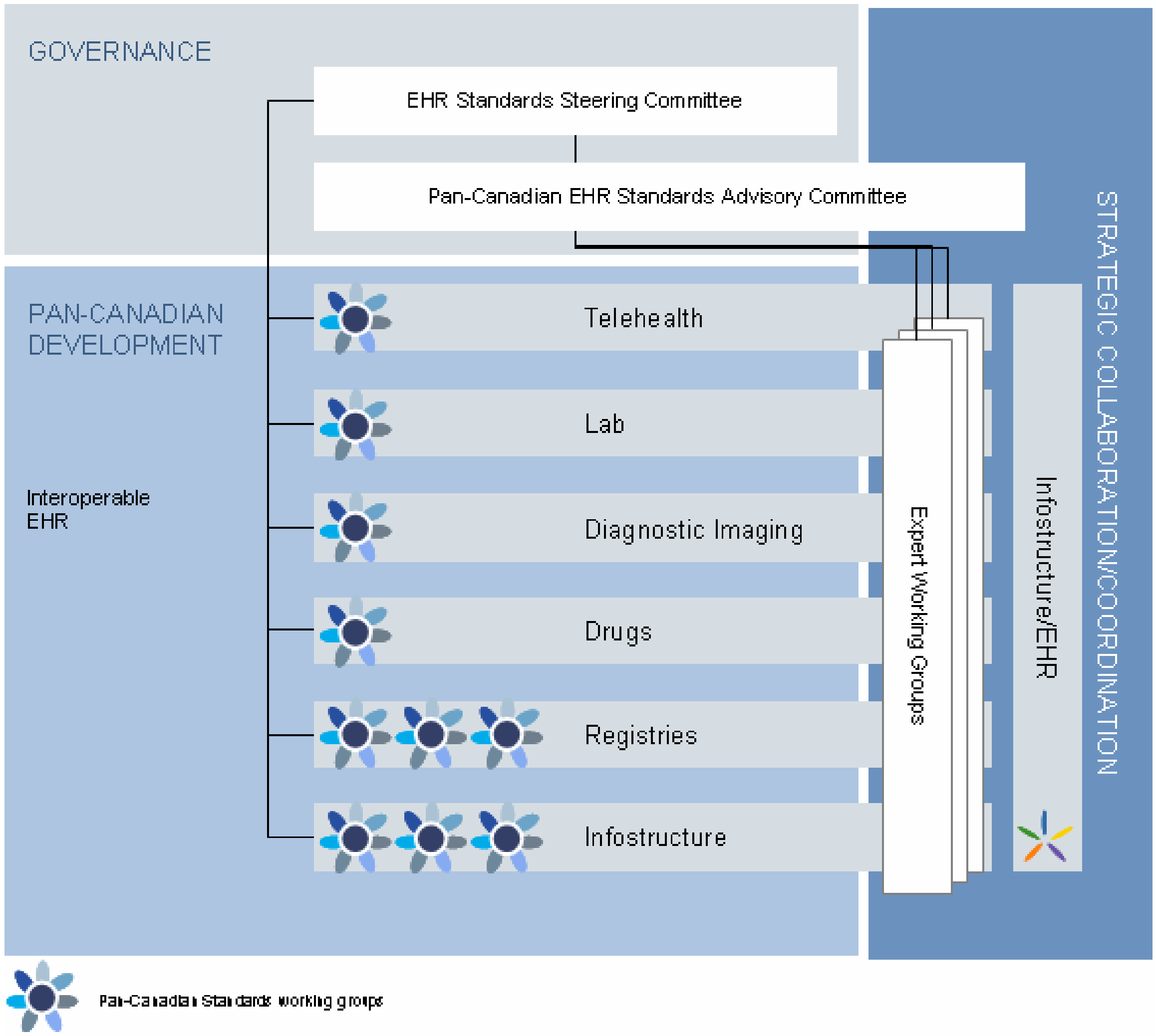


Figure 5-6 Standards Collaboration Process

The above diagram outlines the collaborative framework and committee structure used for the SCP to support the standards establishing work within Infoway.

The SCP process has been structured to provide mechanisms for ensuring that, as standards are adopted, adapted or developed in *Infoway* investment projects, the requirements used in these projects meet not just the needs of a specific project, but also the needs of other EHR stakeholders across the country. In addition, it provides the mechanisms for validating the requirements with key representative pan-Canadian stakeholder groups, and also for obtaining formal consensus and commitment to implementing these standards by the F/P/T jurisdictions across the country.

Uniform implementation of EHR related ICT standards is critical in obtaining the maximum return on the investments made by *Infoway* on the behalf of Canadians. *Infoway* recognizes the current ICT environment is not making consistent use of standards, and understands there are implicitly significant costs and change issues in bringing the health sector to this point of convergence. The SCP is a key mechanism for accomplishing this on an ongoing basis.

5.5.1 Scope of Standards Related Work

The Infoway Standards Collaboration Process is well underway and establishing standards in several information domains. The real work in realizing EHR standards is done by the Pan-Canadian Standards Groups (PCSG) established for each *Infoway* investment program area, and actively involved in the various projects in each program.

PCSG's have been established for:

- Client Registries
- Provider Registries
- CeRx – E-prescribing and clinical pharmacy
- Diagnostic Imaging/Teleradiology
- Laboratory
- Public Health Surveillance
- Clinical Terminology
- iEHR – Interoperable Electronic Health Record

The work of the pan-Canadian Standards Group can be found on the Infoway Forums at http://knowledge.infoway-inforoute.ca/CHIPortal/Home/ .

In addition to the Infoway Standards Collaboration Process, to achieve the vision of the interoperable EHR, Infoway and its projects must leverage (adopt, adapt or develop) and influence standards through standard development organizations such as HL7 Inc (Health Level 7 Inc), ISO (International Standards Organization), IHE and others. In order for the pan-Canadian interoperable EHR to develop, scale and grow Infoway is committed to leverage standards (adopt, adapt or develop) and influence standards now and in the future. As part of Infoway's strategic direction for the development of the interoperable EHR, Health Level 7 version 3 (HL7 v3) has been chosen as the desired standard for clinical messaging.

Infoway engages directly with HL7 Inc, HL7 Canada, ISO, IHE and other Standards Development Organizations through the standards projects. Through that engagement Infoway can ensure that the pan-Canadian standards leverage and align with international standards. Engaging the international and national organizations provide opportunities to influence those standards to ensure the Canadian requirements are included. One of the catalysts that will facilitate adoption includes the ability for vendors to build to a standard and market that product to many communities, jurisdictions and countries. Having a potential pan-Canadian implementation is more attractive to vendors than a jurisdictional implementation and increasing the potential marketability to other counties escalates their interests even further. Aligning with international standards provides this opportunity to vendors.

5.5.2 The Standards Development Lifecycle

The diagram below highlights specific activities within the standards lifecycle. While activities and timeframes will be driven by the specific standard, the activities generally will not be linear. Activities will often occur simultaneously and may be iterative. Stakeholder engagement is important at all stages. Infoway's mandate until 2006 included only the first 6 stages (identify need to formal approval) and in 2006 was expanded to include all phases of the standards life cycle.

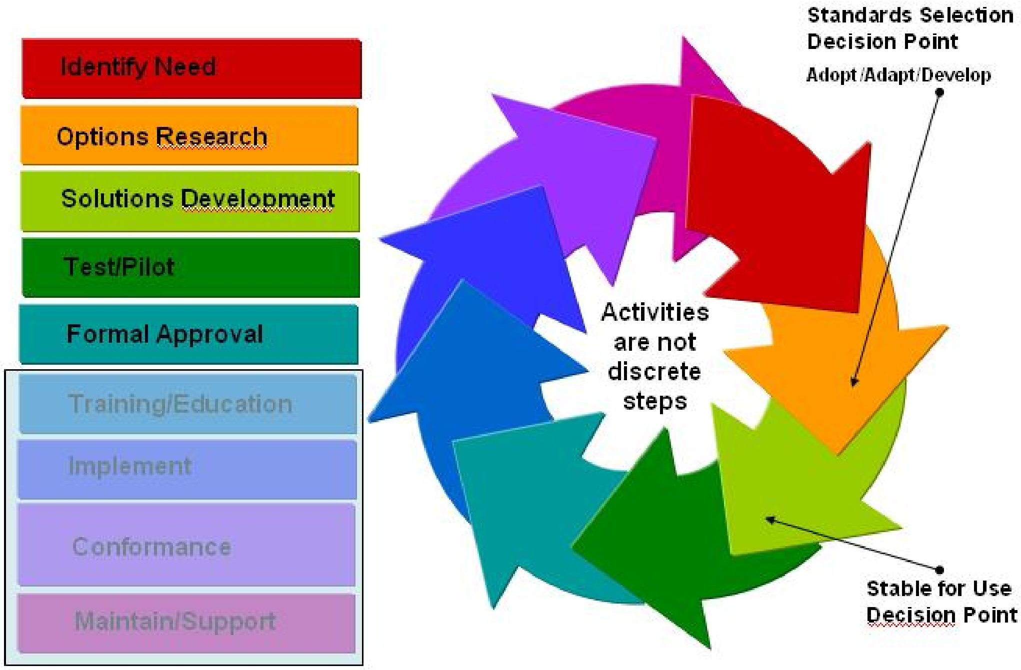


Figure 5-7 Standards Development Life Cycle

Initially there is an identified need of where a standard is required to achieve the interoperable electronic health record. Once the need is established work begins to develop the business definition and scope of the standard needed. During the business definition stage work can also begin to determine what standards are available that may support the need. If there are standards available the decision can be made to adopt a current standard, adapt the current standard to meet the Canadian requirements, or if no standard is available or the current standards are not sufficient the decision to develop is made. At the end of the adapt/adopt/develop stage, a standard is established as available for implementation.

5.5.3 Ongoing Work Timeline

There are a number of standards that have finished the adopt/adapt/develop portion of the standards life cycle and are ready for implementation as of December 2005. Those standards include:

- Client Registry Messaging and Terminology Standards – HL7 v3 & HL7 2.4 Conformance Profiles
- Provider Registry Messaging and Terminology Standards – HL7 v3
- CeRx – E-prescribing and pharmacy clinical messaging & terminology – HL7 v3
- Diagnostic Imaging – IHE XDS-I Interoperability Profile
- Clinical Terminology – Decision to proceed with investigating the use of SNOMED CT as clinical terminology in Canada for the pan-Canadian EHR

The following outlines the anticipated timelines for the standards to be available for implementation. This includes laboratory and iEHR standards which are estimated to be ready for implementation in summer 2006 and Public Health Surveillance for December 2006.

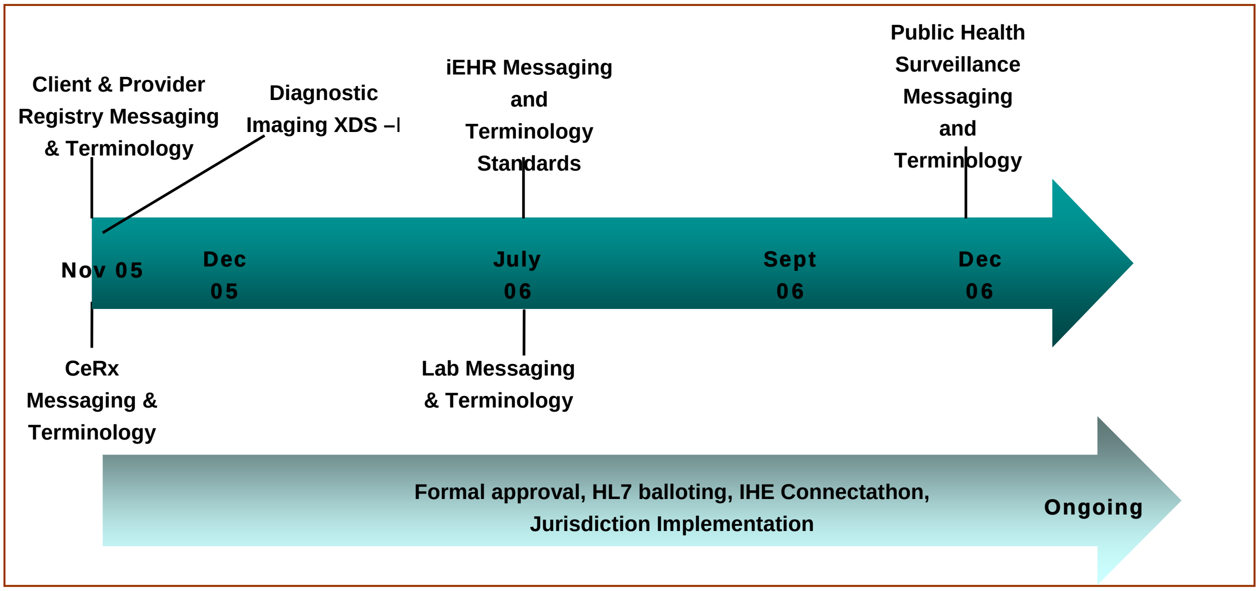


Figure 5-8 Standards Development Timeline

In addition to the terminology, messaging standards and integration profiles outlined above, work will be undertaken during 2006 to begin to address the technical standards and protocol choices that are required to reach an optimal level of reusability in support of EHR Solutions. This will include protocol choices for network, transport, session, presentation and application layers as well specifics for HL7 transport and control-act wrappers. More information on the requirements for standardized communication protocols can be found under the functioning principle section, particularly with section 4.5.1.6 PoS to EHRi interface.

5.5.4 Accessibility of EHR Standards Work

PCSG Forums

Each of the PCSGs set up for the various programs provides access to its work on the related Forum provided on the *Infoway* web site. In accordance with the principle of transparency as defined for the SCP, all interim standards working materials by the projects and their PSCGs are posted to these forums. These materials are publicly available, and the PCSG will use that mechanism to periodically validate interim work in a structured fashion. These forums provide the formal storage and publishing platform for standards artefacts during the development phases.

Artefact Repository

Once standards materials have been finalized by the project teams and are ready for use, the Artefact Repository provides the formal, living, central place to store Interoperability Specifications & Standards that must be implemented by all Infoway Investment projects. It will also identify methods, formalisms and templates to capture Interoperability specifications and standards from all Infoway Investment projects using a common language to ensure consistency. The Artefact Repository will also be used for providing updated releases of formalized architecture and design specifications and standards as they evolve to meet changing requirements or emerging capabilities of EHR solutions.

6 DEPLOYMENT MODELS

6.1 EHRI DEPLOYMENT MODELS

This section provides examples of how EHRi can be deployed using different configurations. It outlines the flexibility of the architecture and explains the different options that may be considered to deploy EHR infostructures.

6.1.1 Assumptions

The following are some of the assumptions made while coming up with the various deployment models.

- It is important to look at these models as patterns or templates. These are not the only possible deployment models. They are presented in order to facilitate understanding of the possible alternatives, support creation of models appropriate to each jurisdictions needs, and to guide the use of the architecture in the actual implementation of an infostructure.
- The architecture does not prescribe a single deployment model. More than one deployment model could apply over a deployment timeline for a given jurisdiction based on different business and project realities
- The EHRi will interoperate with existing provincial Domain Repositories that already manage clinical data in part or in full and are considered sources of truth for such data
- The bulk of the transactions that the EHRi will support will be system-to-system exchanges between operational HIS systems, registries, Domain Repositories and other EHRi's

Some of the elements in these architectures will be pre-existing systems and there will clearly be an integration challenge in order to implement any particular deployment.

6.1.2 Deployment Architecture

Looking at the EHRi from a deployment perspective, one point that quickly surfaces is how are the different systems going to be deployed, how will they interact with each other, where is the data going to be stored and how will data be accessed? This section describes the options that are available for storing patient/client data in interoperating EHRi's and some of the implications. Logically, the EHRi is a single point to get patient/client centric and longitudinal clinical information. Physically, the EHRi can be implemented in a few different ways:

6.1.2.1 The Logical View

The logical view simply states that from the point of view of an application or source system, only one access is necessary to the EHRi (via the HIAL) in order to communicate about a patient/client. Logically, clinical information for a person resides in only one place.

This approach has many benefits, not the least of which is that there are no constraints placed on the implementation of the EHRi systems and their data models related to how the system is used by the applications. It is also important to remember that there are a number of systems and policies such as consent, security and custodianship whose architecture could impact the physical implementation of the options described later.

6.1.2.2 Physical View

The physical view depicts where the patient/client's EHR record data will by stored, physically. However, once again, individual components of an EHR could be implemented as distributed databases. Think of these options as an explanation for "which EHRi holds the Data?" and a subsequent question, "which component in the EHRi (such as a Domain Repository) holds the data?", without descending into the details of how an EHRi is implemented.

⚠	**Note:** In the previous EHRS Blueprint the concepts of "Home EHRi" and " Care EHRi" were introduced to distinguish between the closest EHRi to where the patient resides and the EHRi where the patient / person is receiving care. These concepts have been retired in this EHRS Blueprint version 2. There is no "Home EHRi" distinct from a "Care EHRi" as the patient may receive care and have records in an EHR in any jurisdiction or region which is of equal importance. No matter which of the following options are used, EHRi's will always interoperate on a peer-to-peer basis. The pattern does not foresee any hierarchy of EHRi's.

These are major EHRi options *Infoway* considered with the models *Infoway* is proposing:

- Option 1: The Cross jurisdictional (Pan-Canadian) EHRi
- Option 2: The Single EHRi for each Province / Territory
  - Single EHR Infostructure (Model 1)
  - Shared EHR Infostructure (Model 2)
- Option 3: Distributed EHR Infostructures (Model 3)

Option 1: The Cross jurisdictional (Pan-Canadian) EHRi

In this option, there would be one EHRi for all of Canada. This EHRi has the requirement to contain all data for all of the over 30 million Canadian residents and connectivity to all healthcare providers in Canada. The benefit of taking this approach is that it could greatly simplify the architecture from an interoperability perspective.

However, the issues with this approach make this option not realistic. Healthcare is provided at a provincial / territorial level and rules and laws are developed to reflect this, hence this architecture cannot easily accommodate necessary jurisdictional policy differences and funding models. Other issues and challenges include scalability, performance, availability, maintainability etc.

Option 2: The Single EHRi for each Province / Territory

In this set of options, an EHRi is deployed at the provincial / territorial level, and interconnects with other peer EHRi's via the HIAL network. The following paragraphs describe the options for this deployment approach.

2a: Single EHR Infostructure (Model 1)

In this option, when clinical data about a patient/client is pushed into the EHRi (via the HIAL or through other interfaces) it is automatically (and transparently) routed to the EHRi of the patient/client where it is stored.

The benefit with this approach is that retrieval is straightforward and response time is good. It is clear where data for a patient/client is stored. Consent rules and regulations are simplified on retrieval, since they will be consistent for the province or region. Retrieval of large image sets in Home province is facilitated.

Some issues with this approach are:

- Data can only be pushed at the least common denominator level. If an EHRi in one jurisdiction doesn't support the details in another, that level of data is lost forever. More importantly, if care is provided in a remote province or region and that province or region has an EHRi but another province does not, then that data is lost from an EHR perspective.
- Propagation of updates, even in an environment where no data is ever deleted, could be difficult to track. There are data integrity challenges with regards to links to providers, etc.
- Custodianship of the data could be a problem. Some provinces may simply not allow this option. Data may be duplicated in Domain Repositories in the different jurisdictional EHRis.

2b: Shared EHRi Infostructure (Model 2)

In this option, the EHR Record exists only virtually. Episodes of care are recorded in multiple regional Shared Care Record and domain repositories and it can be imagined that some data would be recorded in the jurisdictional repositories such as drug allergies, chronic condition information and registry information.

The assumption in this model is that there is only one instance of the EHR Infostructure HIAL and Longitudinal Record Services that is shared by all regions in the province / territory.

The benefit with this approach is that data loading from the point of service systems is straightforward since it goes directly to the regional repository while the location of the data is recorded in the EHR Index at the jurisdictional level.

There are some issues with this approach:

- Getting a patient/client's complete EHR Record is a challenge since it could potentially require retrieval from a number of regional repositories.
- It could be hard to implement summary type information (such as allergies) and the replacement/refreshing of such data or the correction of data erroneously recorded in multiple repositories.

- o Viewing large DI sets could take a lot of time at the moment when they are required (however this depends on bandwidth, not location).
- o Consent rules and how they are handled in the system can get very complicated.

Option 3: Distributed EHR Infostructures ((Model 3)

In this scenario the Province / Territory is divided into several distinct regions, each with a unique EHR Infostructure complete with EHR data and services, LRS and HIAL services. Registry data and services may be kept at a cross-regional / jurisdictional level as well as jurisdictional domain repositories such as a Drug Information System.

The complexity in this deployment option rises significantly, since there are far more systems to worry about. The success of these options is only possible if standardization is almost complete for all aspects of an EHR record.

The decision on where to store each individual item of information of an EHR Record is highly complex. One way to facilitate decision-making is to look through the lenses that make up the decision criteria. The following are three lenses that were considered:

- Business Lens: What does this system have to do in order to work properly? If the following data is omitted, can the EHRi perform the required functions?
- Political and Legal Lens: What are the laws that affect where data can live? Who is custodian of the data once it has arrived at a particular point? What are the consent rules?
- Technical Lens: What are the performance implications of storing data in one regional location versus another? Will retrieval performance be acceptable? Will uptime performance be acceptable?

Some of the views through these lenses may be permanent, temporary or overlapping and this needs to be taken into account especially from the perspective of evaluating the flexibility and extensibility of the architecture. It is extremely important that the ultimate solution to the deployment architecture resolve these problems.

Infoway's view is that the patient/client information is logically in one EHR, and the architecture supports the various options expressed above. As each jurisdiction drills down into a more specific design of a jurisdiction wide EHRi system, they must take into account the business, technical, legal and political requirements in order to adopt the most appropriate solution.

6.1.3 Deployment Model Examples

The deployment model examples are a graphical demonstration of how EHRi's can be deployed in the different jurisdictions. It is important to remember that this is not a complete list of possible models, but simply a starting point. Some of these models are based on observed patterns in the jurisdictions that were visited during the course of this project.

Each model represents a number of systems that interoperate in the EHRi pattern in a particular way. In each case, there are differing numbers of systems involved in the pattern. In each case, the functionality of the overall EHRi is intended to remain constant as compared to the other models.

Finally, these example models were used in order to help vet other aspects of the architecture. Certain components and their functionality have been designed with the deployment options in mind. Had there been fewer or different deployment options, certain architectural decisions would have been tackled in other ways.

These deployment models were designed using the recommended Integration Model in which applications and source systems connect to the EHRi via the HIAL only. Other integration models are also possible, but not depicted here. Any of the integration models, which is how the applications and source systems connect to the EHRi, can work with these deployment models

6.1.3.1 Model 1: Single EHR Infostructure

In this model there is an EHR repository, a HIAL and the Point of Service source systems that connect to the EHRi both for feeding data to the EHRi as well as getting information back. There are four Domain Repositories, Shared Care Record, DI, Lab and Drug as well as a Client, Provider, Location and Terminology Registries. The EHR Index is represented as an LRS service to provide for indexing and retrieval of a patient's EHR data located in different repositories.

This is a simple deployment model with separate Domain Repositories that will require the EHRi LRS services to tie together data from a number of different repositories in order to pull back a complete EHR Record. The HIAL integrates the systems connected to it, providing a single unified view to the Point of Service systems.

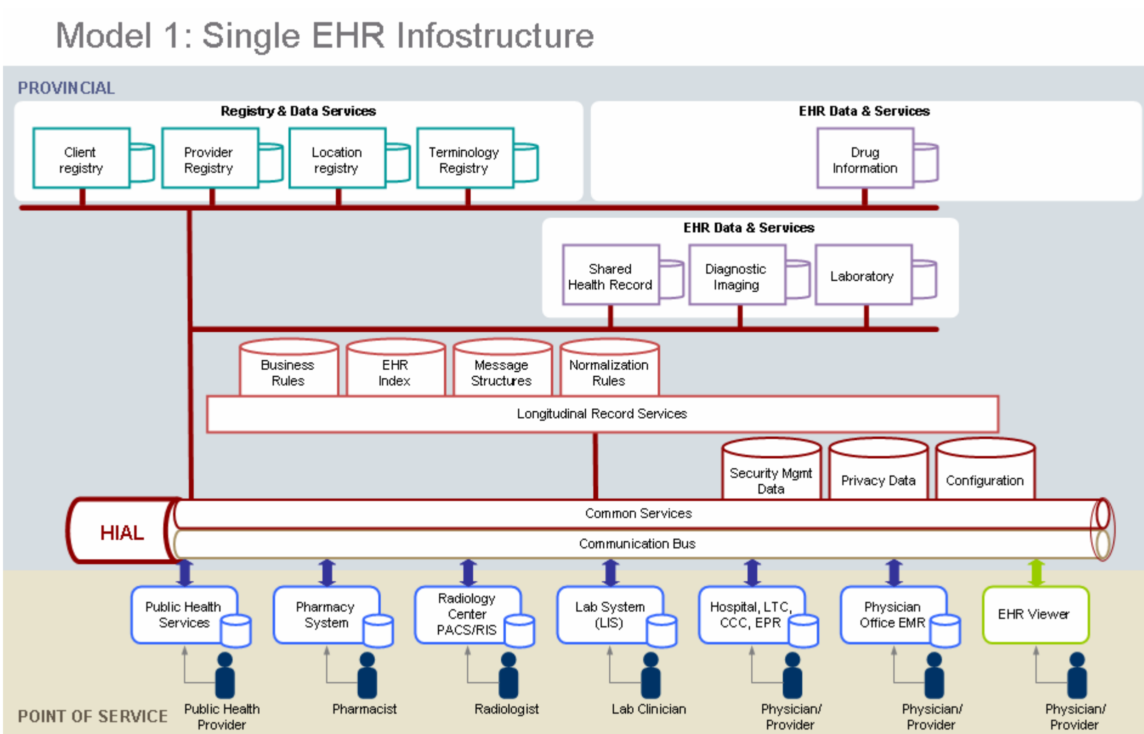


Figure 6-1 Model 1: Single EHR Infostructure

6.1.3.2 Model 2: Shared EHR Infostructure

In this model example, the main thing to note is that there are multiple Regions that will be responsible for Shared Care, Diagnostic Imaging and Lab repositories connecting to the provincial level Registries Data and Services. In this case, a Drug Information System is maintained at the provincial level.

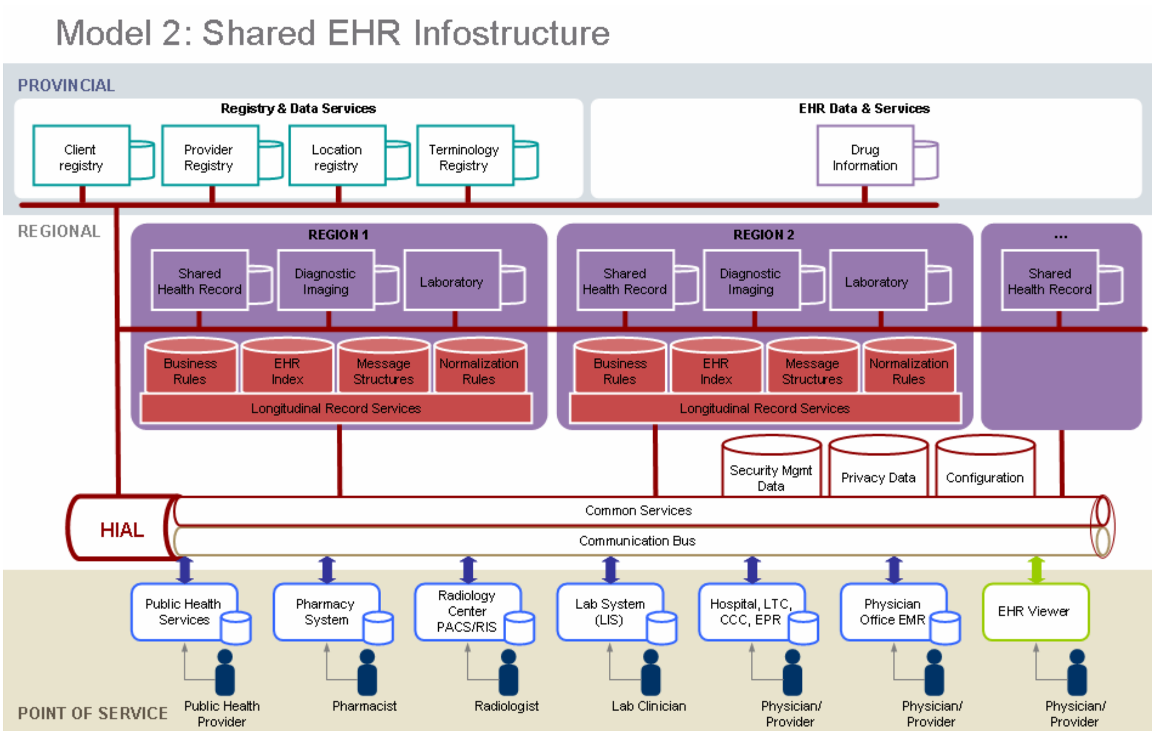


Figure 6-2 Model 2: Shared EHR Infostructure

6.1.3.3 Model 3: Distributed EHR Infostructures

In this model we see a number of EHRi's within the same province / territory. The assumption being the Registries data and services would remain at the cross-regional level. In this example a Drug Information System is also kept at the provincial level.

This model describes the situation in which many regions (could be any number) have agreed to standardize on all interfaces that will allow these types of complex interoperability to work as a whole. There is significant risk of duplication of services and investment in technical infrastructures that can be mitigated by provincial level strategies for leveraging software and hardware assets for reuse.

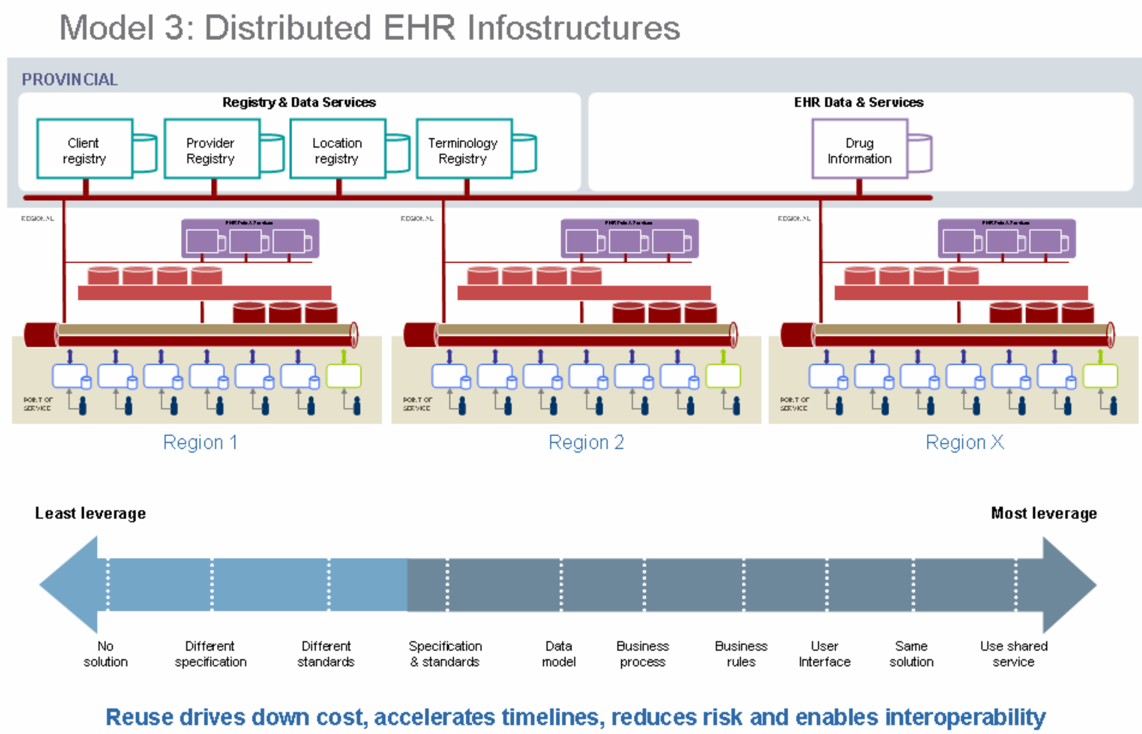


Figure 6-3 Model 3: Distributed EHR Infostructures

As depicted in the horizontal arrow at the bottom of the diagram, the level of reuse of software and technical infrastructure assets between regional solutions can range from the least amount of leverage (on the left) to the most leverage (on the right). The types of reuse from left to right do not necessarily describe a structured process of moving towards a provincial Enterprise architecture (which is highly recommended), but does describe the types of business and architectural alignment topics that need to be addressed in order to achieve a functioning EHR solution using this type of distributed model.

6.2 OPERATIONAL CONSIDERATIONS FOR THE EHRI

As *Electronic Health Records solutions* are being designed and deployed in Canada, it is important to consider the sustainability and "total cost of ownership" of these solutions. One premise to this discussion is the distinction between the business of developing EHR solutions and the business of operating EHR solutions. The development side involves the governance, strategic planning, the architecture, the design, the acquisition and integration of solutions and their deployment into active production environments. The development side is typically conducted under a project driven business model. By comparison, the business of operating an EHR focuses on the governance, resources and activities that have to be put in place to handle the ongoing operation of such a solution once it has been deployed and stabilized as an online service.

This section describes different aspects foreseen as key to the operation of an EHR Business Service in a jurisdiction. An "EHR Business Service" in this sense refers to the business of operating an EHR

Service made available to a defined audience of clients, caregivers and point of service organizations (PoS). It is a transactional service made available to the people involved in the delivery and execution of healthcare services. The following diagram describes an EHR Business Service model with examples of the types of services provided:

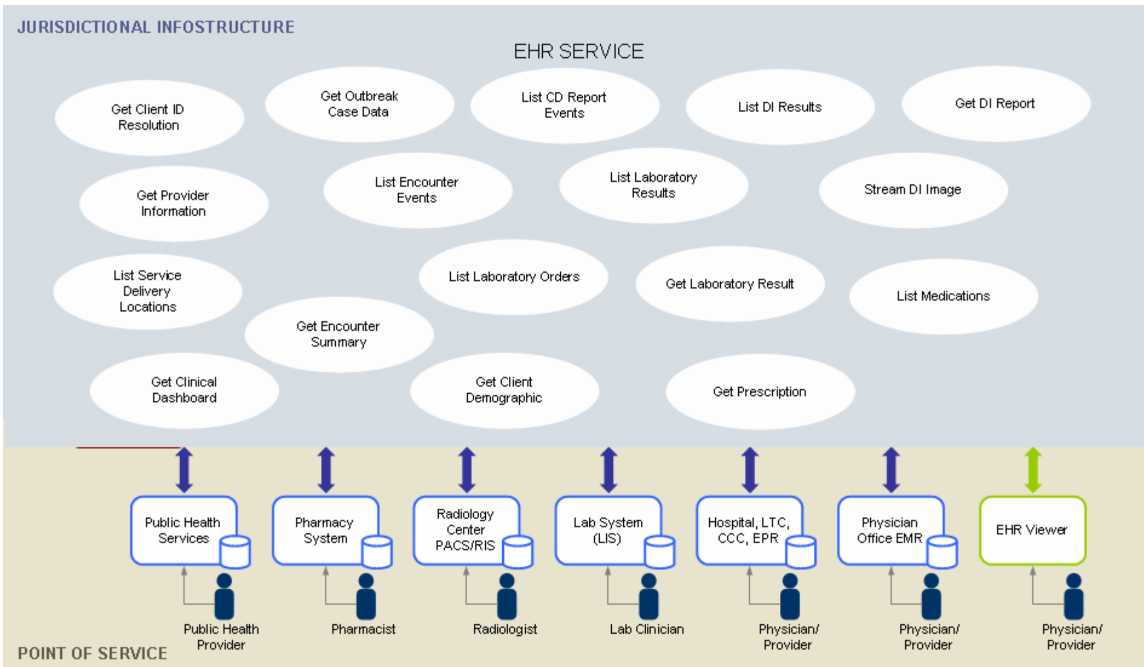


Figure 6-4 The EHR seen as a Business Service

Analogous to a client consuming the services of a phone company (for a dial tone) or an electric power utility (for electricity), the EHR as a business service is offered and consumed by caregivers as they deliver care to clients. The consumers of an EHR Business Service can be separated into two groups, the direct clients and the indirect clients. Direct clients will have to deal directly with the authority that operates the EHR Business Service, they will be the consumers of the service on a daily basis. Indirect clients benefit from the value of the service but are not usually involved in such a way where they have to interact directly with the authority that operates the service.

Direct clients of an EHR Business Service are:

- **Point of service organizations:** they are the formal governing authority that own responsibility for operating the delivery of healthcare services in specific delivery settings (hospitals, clinics, diagnostic centers, etc…). Their staff will use the EHR viewer and local applications connected to the EHR, their IT departments will see and operate the PoS applications that are connected to the EHR service, their clients will be asked for consent statements (depending on local regulations) towards the sharing of information and will see benefits through advanced clinical knowledge made available to their clinicians when caring for patients.
- **Caregivers:** In the early days, they are the main group of end-users of an EHR Business Service; they will touch and see the data coming from the EHR Business Service through generic EHR Viewer applications or through the local clinical applications that they use. Through these same applications, they will contribute new information to the Electronic Health Record's of patients they care for.

- **Administrative Staff:** Also part of the key user groups, they will often access client's electronic health records with properly established access rights, to provide adequate documentation and information to doctors or other types of caregivers that they support. They will also typically deal with the registration process with clients when they access services in different types of facilities.
- **Medical Records Specialist:** The Medical Records function in any PoS organization is seen as a critical provider of information for a patient's electronic health records. Medical records specialists use clinical applications and specialized documentation tools to computerize and record clinical information that would be published to an EHR.
- **IT Application and Network Administrators:** People in charge of configuring, running and monitoring the clinical information systems used in a PoS organization are also seen as direct clients of an EHR Business Service. They will be the people dealing with any incident, problems or evolution requirements for the applications connected to an EHR Business Service.
- **Healthcare Managers:** They will use the EHR in a capacity described as secondary uses. Their focus is expected to be with the use of reporting tools and/or analysis tools so as to leverage anonymized / pseudonymized EHR information to better manage the flow of service or any other management requirement that could benefit from operational data.
- **Healthcare Research Teams:** They will use the EHR in a capacity described as secondary uses. Their focus is expected to be with the use of reporting tools and/or analysis tools so as to leverage anonymized / pseudonymized EHR information to their research projects.
- **Healthcare Information System Vendors:** They are direct clients in that they will be expected to provide the technology to enable implementation of interfaces between PoS applications and EHR Business Services. In that regard, the organization responsible for the EHR Business Service will have to be able to support the ongoing development and testing of these interfaces and in that way can offer integration and support services to this community of vendors for other customers.
- **PoS organization Interface or Integration Project teams:** Perhaps the most important technical client of an EHR Business Service, these project teams will be in charge of using Healthcare Information System vendor interface technologies in implementing the connectivity required between existing clinical applications in a healthcare organization and an EHR Business Service. These teams will need integration and technical support from the organization responsible for the EHR Business Service as well as the Healthcare Information System vendors to plan, design, test, implement and launch any single running interface deployed in the field.

Indirect Clients of an EHR Business Service are:

- **Patients or Clients:** Although the patient is the primary beneficiary of the EHR, from an operational point of view the clients of the health system are seen as indirect customers of an EHR Business Service. Until Personal Health Record applications allowing individuals to access and/or manage their own electronic health records become mainstream, individuals will be seen as indirect customers. They are described as such since the information from the EHR is used by caregivers to provide enhancements to the quality, safety and accessibility of their care. Thus, they are not directly accessing or engaging with the EHR Business Service. This definition does not diminish the importance of the clients as being the central focus and reason for existence of an EHR Business Service.
- **Political Leaders and Healthcare Management Authorities:** Given the importance of healthcare on the F/P/T political scene, the ability to establish a working EHR Business Service capability in any kind of large scale deployment will be seen as a high-leverage success story for any political party / organization. In that sense, political leaders stand as high-profile indirect clients of an EHR Business Service.
- **Medical and Other Health Professionals Associations**
- **Privacy Advocacy Groups and Privacy Auditing Bodies**
- **General Public**

This section of the EHRS Blueprint is built on the assumption that the customers of the EHR Business Service will want to see it offered to them as an integrated business offering. Healthcare in Canada is publicly funded and managed by governmental agencies established in a hierarchy that starts with the Ministry of Health in every F/P/T jurisdiction. Strategic thinking and formal plans will need to be thought through in every jurisdiction to rationalize the best approach for setting up this EHR Business Service. Clearly, the clients that use or are impacted by the EHR, will not want to interact with a plethora of different organizations because the EHR is made up of several different solutions potentially operated in different places or different agencies, on different technologies. While the inner workings of the operation of the different components of an EHR Infostructure might involve different platforms, people, solutions and organizations, this should, as much as possible, be transparent to the clients of the EHR Business Service.

The adoption and usage growth of an EHR presents a lot of inherent challenges as it requires profound changes in behaviors, work processes and the value chains that caregivers and health delivery organizations are operating with today. The ability to represent and implement the EHR through an integrated business service offering is seen as a valid mitigation mechanism to alleviate some of the risks associated with these challenges.

6.2.1 Governance

The operation of an EHR Business Service, regardless of how it is structured organisationally, introduces significant new requirements of Governance. The following list outlines some of those requirements:

- Financial sustainability – budget, deploy and manage the ongoing costs of operation including evolution to new generations of capabilities
- Establish and manage Legal and Administrative Policies – running an EHR Business Service requires a clear policy framework to establish clear rules of engagement for all of the different stakeholders impacted by an EHR Solution. This includes setting policies in areas such as: data custodianship, liability protection, privacy and security, standards management, funding of operation, funding of integration for PoS applications, staffing, help desk and support, private sector involvement, relationship with professional associations, communications with general public, and others
- Define, establish, execute governance structure including investors and shareholders, Board Of Directors, Senior Executive Team.
- Maintain and manage relationships with MOH authorities and other agencies related to EHR Business Service operations

Governance Considerations / Issues

The following text is an extract from the *EHRi Privacy and Security Conceptual Architecture section 10 Governance of the EHRi.* It further outlines key considerations that need to be addressed by the governance of an EHR Business Service.

Governance is required so that healthcare custodians have assurance that their custodial responsibilities are not compromised. Without such assurance there will be no trust in the system, and the users will not make widespread and effective use of the system. Effective governance rests on the following core components:

- Clear articulation of trust and accountability,
- Setting of minimum standards,

- Conformance criteria and compliance measurement, and
- Frameworks and detailed policies and procedures

The question of exactly how the secure and privacy protective design, implementation and ongoing operation of the EHRi is achieved must ultimately be resolved by whatever information governance structure is put in place to guide the deployment of the EHRi across Canada and the future inter-jurisdictional flow of information that the EHRi will facilitate.

The following two governance issues are particularly relevant to this discussion:

1. There is an assumption that every implementation of the EHRi will store PHI under the governance of the implementing jurisdiction. This has implications for inter-jurisdictional transfers of information, and for the maintenance of sovereignty over information held in custody. Concerns surrounding the US Patriot Act and it's effects on Canadian policy continue to concern healthcare custodians
2. The privacy of healthcare providers is also important. Health care providers must be confident that information collected for the purposes of treatment and care will not be used secondarily to monitor the practice habits of individual (identifiable) healthcare providers without their express consent or beyond the bounds of the legislation that applies their practice within a jurisdiction

In the development of governance models and a governance framework, issues surrounding transfer of PHI across interoperable systems need to be addressed. Even within a jurisdiction, governance models would need to be established to address intra-jurisdictional transfers of PHI from one institution to another.

Considerable uncertainty remains among jurisdictional representatives as to the custodial responsibilities of healthcare custodians, especially as they relate to inter-jurisdictional disclosures of PHI. An example where this issue will become more visible is when patient EHR information is to be shared between jurisdictions that have very different legislation regarding consent. It should also be noted that even within a jurisdiction, consent policies may differ between one EHR clinical domain and another.
While these governance issues are far beyond the scope of an architectural document, the development and implementation of the EHRi depends critically upon these governance and policy issues being adequately addressed.

However governance issues may be resolved in the future, jurisdictional representatives have clearly indicated that effective governance is critical to ensuring the confidence of healthcare providers and the general public in the safety, integrity and trustworthiness of electronic health records.

The following EHR Operational policies and procedures will have to be developed as part of a governance framework (the following is not an exhaustive list):

1. An access control policy
2. A mapping, where applicable, of organisational user roles to EHRi user roles
3. A mapping of roles and access privileges from one jurisdiction's EHRi to another's
4. A policy for the withholding or revocation of consent and masking patient information
5. A policy on the use of ECDIs “above the HIAL” and the mapping of ECIDs between jurisdictions via FIDs
6. A policy on what constitutes adequate levels of authentication
7. A nationally adopted and jurisdictionally supported and applied consent messaging schema that can support the different jurisdictional consent models

In developing an EHR Operational governance framework, the following components should be considered:

1. Assessment of possible legislative changes
2. Determination of legislative obligations
3. Setting of responsibilities, accountability and liabilities for all concerned stakeholders
4. System rules, standards, processes and procedures for data sharing and access
5. Data sharing agreements
6. Incident response policies and procedures
7. Privacy, IT security and disaster incidents
8. SLA agreements
9. Dispute resolution rules, processes and mechanisms
10. Definition of the risk management framework, processes and procedures
11. Minimum operational, security and privacy standards
12. Trust model definition
13. Conformance and compliance to governance model, policies and procedures
    a. Accreditation
    b. Monitoring of conformity policies, processes
    c. Audit requirements and toolkits
    d. Frequency of statement of compliance
    e. Independent third party or self assessment

Diverse Operational Models

Different models or approaches could be used to establish the EHR as an integrated business service. This section outlines four different operational models all seen as valid options that could emanate in the Canadian market. These models outline options to operate an EHR Infostructure solution. This is focused on the different business conditions under which these solutions could be run and not how they would be built.

The EHRS Blueprint does not recommend or discard any of these options, which are simply provided as a starting point to support decision making processes that will need to take place in every jurisdiction as EHR solutions are being put in place.

Operational Model Option 1 - Jurisdiction Lead

Single jurisdiction government agency acts as the operator and decides:

- Deployment Configuration - How to deploy based on the various EHRS Blueprint deployment models. This may involve some components shared between two or more jurisdictions.
- Deployment Timeline – the timelines driving the activation of EHR Infostructure services is in the hands of individual jurisdictions.
- Release Strategy – the level of functionality offered by EHR Infostructure services is driven by jurisdictions.
- Operational Strategy – Data centers, servers, software and networking for the solutions have to be put in place as well as services to maintain, evolve and monitor these components
- Integration Services – The operational systems in different points of service will have to be interconnected into the EHR Infostructure. This integration will happen over time and through different

cycles in each point of service. Services have to be created to support the integration of clinical systems at different points in time as well as maintenance and evolution of these connection points. This will be an ongoing task of operating an EHR Infostructure solution in any jurisdiction.
- Governance and funding model – The operation of an EHR Infostructure is a 24/7 high-availability business that needs a functional governance model as well as a sustainable economic model

Operational Model Option 2 - Shared Services Model

Multiple health regions/provinces/territories come together in a collaborative of jurisdictions to share services and operate a common EHR Infostructure solution

- Configuration, timelines, releases, operations and integration services are decided and operated by the collaborative. Operations may include one or several front line sites.
- Collaborative decides the governance and self-sustainable economic model
- Operational costs, resources and expertise in operating the EHR Infostructure are shared
- Different service groupings may be instantiated by the collaborative to sustain individual jurisdiction needs as part of the collaborative.
- Collaborative will have to decide on the level of centralized versus distributed services as well as the organizations, facilities and network infrastructure that can support 24/7 high-availability EHR Infostructure operations
- Complexity of operation is increased as diverse jurisdiction politico-legal considerations as well as administrative profiles have to be understood and consolidated into one model of operation.
- Service offerings available in the solution evolve by way of jurisdictions requesting evolutions to the collaborative. Collaborative needs to agree with members on a balance between responding to needs and resources available.
- The relationship between jurisdictions and the collaborative is a member to member partner relationship

Operational Model Option 3 - Utility Model

A utility Company / Consortium offers the operation of an EHR Infostructure solution as a service to Canadian jurisdictions

- The utility Company may be made up of a single vendor, a consortium of vendors or a public-private partnership between jurisdiction(s) and vendor(s)
- A viable economic model of business has to exist for the consortium.
- Governance, economic models and ROI defined jointly by users, consortium and Infoway
- More then one consortium offering has to exist in order to avoid monopolistic situations and behaviors
- No geographic boundary to the utility “service area”
- Consortium is allowed to target other international markets
- Configuration, timelines, releases, operations and integration services are decided and operated by the consortium. Operations may include one or several front line sites.
- Service offerings available in the solution evolve by way of customer jurisdictions requesting evolutions to the consortium. Consortium needs to strike balance between responding to needs and resources available.
- The relationship between the jurisdiction and the utility is client-customer relationship

Operational Model Option 4 – Publicly Created Agency

A jurisdiction or a group of jurisdictions create an independent publicly funded not-for-profit agency to offer the operation of an EHR Infostructure solution as a service to Canadian jurisdictions

- A viable economic model of business has to exist for the agency.
- Governance, economic models and ROI defined jointly by users, agency and MOH with the assistance of Infoway if requested
- Since this is entirely publicly funded and not-for-profit, the agency could operate under a monopolistic situation
- No geographic boundary to the agency "service area"
- Agency is allowed to target other international markets
- Configuration, timelines, releases, operations and integration services are decided and operated by the agency. Operations may include one or several front line sites.
- Service offerings available in the solution evolve by way of customer jurisdictions requesting evolutions to the agency. Agency needs to strike balance between responding to needs and resources available.
- The relationship between the jurisdiction and the agency is a client-customer relationship

6.2.2 Functional Requirements of EHRi Operation

This section outlines a set of business functions provided as key examples of the capabilities required as part of the operation of an EHR Business Service. Any governance body setting up an EHR Business Service may choose to outsource these functions in part or in whole, or may choose to grow an internal capability to sustain them.

Administrative Support

- Executive Management
- Legal Council
- Procurement / Warranties / Maintenance Management
- Facilities Management
- Accounting
- Human resources
- Secretarial Services
- Internal IT Services

Communication

- Public relations
- PoS Organisations relations
- Private Sector vendor relations
- Health Professionals relations
- Health Management relations
- Training & Education

Privacy Management

- Direction – Chief Privacy Officer
- Privacy Management (PIA, TRA)
- Privacy Auditing

- Liability Management

Medical Affairs
- Direction – Chief Medical Officer
- Secretariat

Research & Development
(focused on new generation capabilities, prototyping, software/solution versioning, etc…)
- Project Management Office
- Standards Management
- Solution Architecture
- Project Based Development Teams
- Implementation & Distribution Teams

Integration Service
(established as center of excellence for EHR integration focused on supporting PoS application integration and integration of new services within EHR Infostructures)
- Account Management
- Integration Teams
- Quality Assurance / Testing
- Implementation & Distribution

Operations Management
- Service Delivery (based on ITIL – www.itil.org):
  - i. Service Level Management
    1. Intra-EHRi Service Levels
    2. PoS Organizations Service Levels
  - ii. Financial Management
  - iii. Capacity Management
  - iv. Availability Management
  - v. IT Service Continuity Management
  - vi. Security Management
- Service Support (based on ITIL: www.itil.org):
  - vii. Service Desk
    1. First Line Support
    2. Second Line Support
  - viii. Configuration Management
  - ix. Incident Management
    1. Ownership, monitoring, tracking and communications
  - x. Problem Management
    1. Tracking & Monitoring of Problem
    2. Tracking & Monitoring of Errors
  - xi. Release Management
    1. Development Environment
    2. Controlled Test Environment
    3. Live (Production) Environment
  - xii. Change Management

While this is an early definition of the functional process requirements for the setup of an operational entity in charge of running an EHR Infostructure, most F/P/T healthcare jurisdictions in Canada already operate large IT/IS application solutions. In that sense the basic capabilities, most times are already present. For the EHR Infostructure, the important point is that it should be operated and seen by its customers as a single integrated business service. From that point of view, existing operations management capabilities would have to be structured and integrated to act in a coordinated fashion in order to provide this EHR Business Service.

7 POTENTIAL APPLICATIONS

The true value of any new information management technology relies on its ability to sustain and drive efficiency and effectiveness out of existing business processes as well as to support the growth and reengineering of how enterprises are operated. Implementation of interoperable EHR solutions in every jurisdiction will provide these benefits to the enterprise of healthcare in Canada.

The EHRS in any given jurisdiction is made up of an interoperable EHR infostructure that is accessed by applications at the point-of-service. *Infoway* is mandated to act as a catalyst and insure the development of electronic health records in Canada. *Infoway* achieves this mission by making investments in projects that support or realize the development and/or implementation, in whole or in part, of such interoperable infostructures. Once these infostructures are in place, there are two levels of value that to realized. A first level of value results from the simple fact that more clinical information about more patients / persons is available to more caregivers. A second level of value is realized from the use of that information by intelligent applications to better sustain and / or improve the way healthcare is delivered.

True to its guiding principles, *Infoway* remains vendor neutral. *Infoway* recognizes that the deployment of EHR infostructures across the different jurisdictions will create opportunities for vendors to innovate in many areas that are not possible without an interoperable EHR. This section covers these different areas from a high level viewpoint.

7.1 ENABLING THE EHR INFOSTRUCTURE

Over the next five to seven years, *Infoway* will participate in the development and deployment of systems required to instantiate EHR infostructures. These projects may pertain to many different aspects of the strategy, development, or implementation of EHR infostructures in any jurisdiction. The following picture shows a list of these different areas of activities and potential investment:

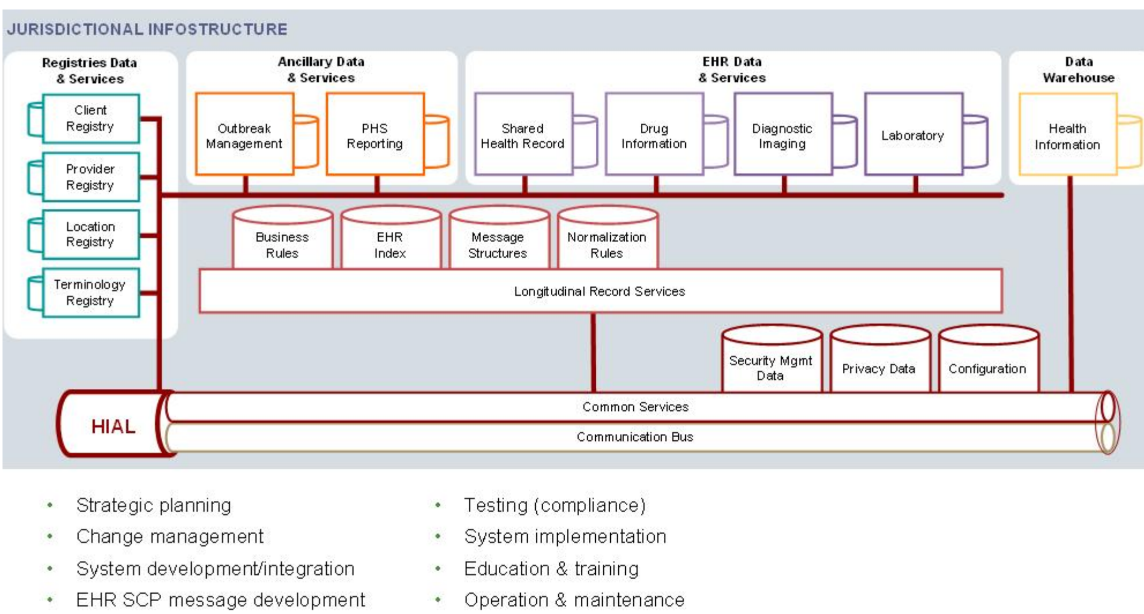


Figure 7-1 Business Opportunity Around EHRi

- Strategic planning at different levels in every jurisdiction will be required to identify best of breed approaches and plan for the deployment and gradual uptake of EHR Infostructure (EHRi) components across the continuum of care.
- Change management planning and initiatives will be required to inform, educate and manage the adoption of EHR solutions for all stakeholders and end-user communities.
- System development and system integration mandates will be required at many levels to potentially develop new key components of an EHRi or to adapt and integrate components that may be reused from other jurisdictions or vendor solutions. System integration mandates may also be required to connect existing operational systems with the EHR infostructure.
- HL7 messages will be developed or reused and implemented to cover all data elements supported by the EHRi. The interoperability requirement of the EHR will mandate that these messages be defined around a pan-Canadian consensus building process that will insure a formal definition for each message.
- Testing capabilities will need to be put forward in the form of mandates or ongoing operations to insure compliance of EHRi components with specifications for interoperability. The same is true for messages that will be exchanged with applications or between EHRi's across jurisdictions.
- System implementation mandates will need to address the deployment of these components including, capacity planning, infrastructure implementations, system installation, data acquisition and transfer.
- Education and training mandates will have to be carried to educate stakeholders, system administrators, managers, IT personnel, healthcare organizations and caregivers within the context of deploying these solutions within any given jurisdiction;

The EHRi and its components will need to be operated on highly available and secure computer platforms for any jurisdiction. Hosting service providers may be solicited in many cases. The maintenance and support of these infostructures will also be critical to insure the proper operation of the different applications existing in any EHRi.

7.2 EXTENDING CURRENT APPLICATIONS

Inherent in the implementation of EHR solutions, there is significant value to the business of health services delivery and the quality of care. The ability to make clinical information available to care givers across the continuum of care brings about a first level of value. This first level provides more and better data to support decisions that caregivers make in their day-to-day activities. *Infoway* believes that the initial development and implementation of EHR infostructure will be driven by the inherent business value associated with the availability and accessibility of clinical information for caregivers.

This level of value alone offers substantial and sustainable return on investments that address some of the fundamental problems found in healthcare today. Problems such as:

- pharmacists not being able to see the medication history of a patient/client when dispensing medication;
- doctors not being able to see drug allergies of a patient/client when prescribing medication;
- ER doctors not being able to see critical information about patients/clients upon admission; family care physicians not being able to access ordered tests results timely and accurately.

The following picture shows the EHRi seen by applications as a virtual data repository. This picture illustrates that simply connecting an existing point-of-service application that manipulates and presents clinical data to an EHRi is enough to significantly increase the value of the PoS application. Connecting existing applications to an EHRi allows them to present more information about more patients/clients to the caregivers already familiar with the use of their applications.

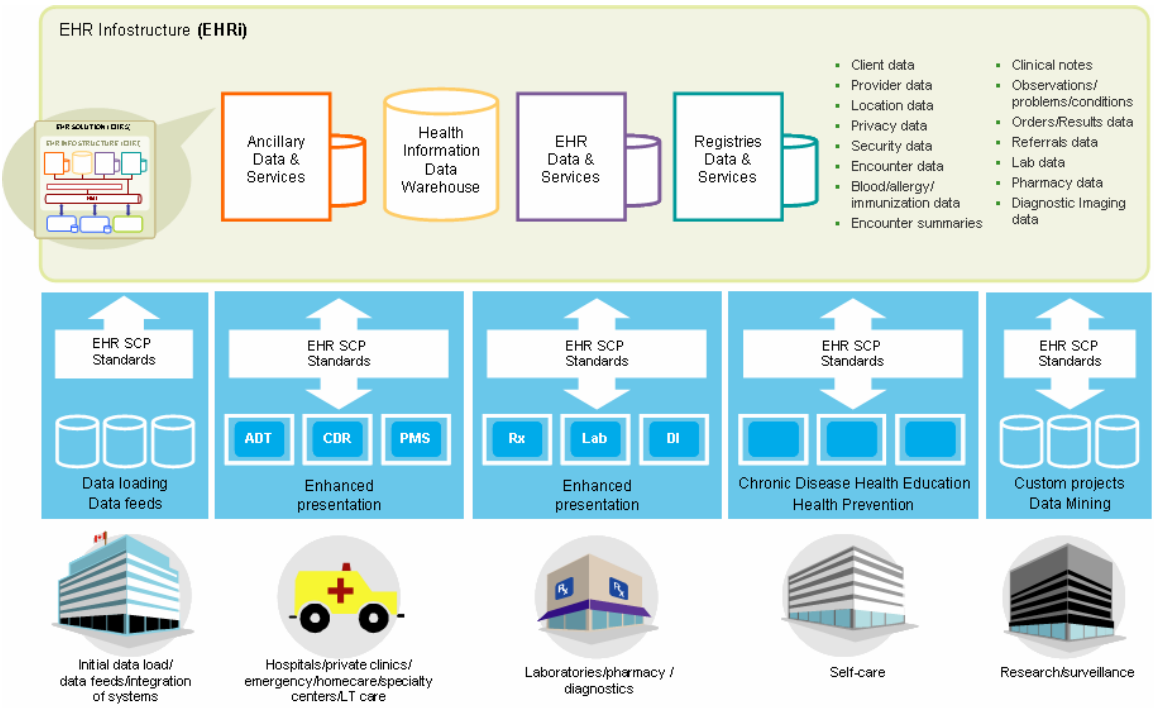


Figure 7-2 EHRS Data - Value Enabler for Existing Applications

However, in order to achieve these benefits, the following must be done:

- The EHR Infostructure must be loaded and fed data from existing operational systems located in healthcare organizations in a given jurisdiction.
- Existing applications must be modified to support interaction with the EHRi, so that information coming from the EHR may be viewed by caregivers. Existing applications that manipulate clinical data today in healthcare organizations include:
    - ADT systems (Admission, Discharge, Transfer),
    - Emergency Systems,
    - Surgery Systems,
    - Blood Bank Systems,
    - Clinical Information Systems,
    - Nursing Information Systems,
    - Patient Management Systems in private clinics or hospitals,
    - Radiology,
    - Pharmacy
    - Laboratory systems in hospitals, private clinics or drugstore chains,

- Home Care applications that may be used by healthcare providers or patients/clients themselves and others.

All of these applications stand to benefit greatly from being connected to an EHRi in any given jurisdiction. Health prevention, disease management and surveillance organizations may consider the EHRi as a key data repository for the research they need to pursue. Recent examples such as the outbreak of SARS and the Walkerton experience are good examples where an EHR and integrated applications might have facilitated the analysis and population management work that needed to be done.

7.3 NEW CLASSES OF APPLICATIONS

There is also a third level of value that can be achieved by creating new classes of applications. These new applications could aggregate and summarize EHR data and apply inference rules and expert knowledge databases in order to supplement and better support the decision making of caregivers. These types of application would provide significant value for care providers and the healthcare system in general. In many cases, these new applications will also support the reengineering of work functions to achieve new levels of efficiency and effectiveness in the daily delivery of care.

Many of these new types of applications can only be envisioned today as their value proposition can only be realized in the context of working interoperable EHR infostructures. These applications will be conceived and developed by vendors when market dynamics create a demand for them. The deployment of EHR infostructures will trigger this demand as forward-thinkers in healthcare authorities and in the vendor community will start imagining the potential reengineering of work functions that could be achieved and see the potential business benefits associated with this reengineering. The next level of value brought about by the availability of EHR solutions in a jurisdiction will be realized by innovators who can identify the winning conditions and obtain the stakeholder commitment to embrace the profound change this will have to the health system.

The following picture presents some of the categories or areas where new applications may be created.

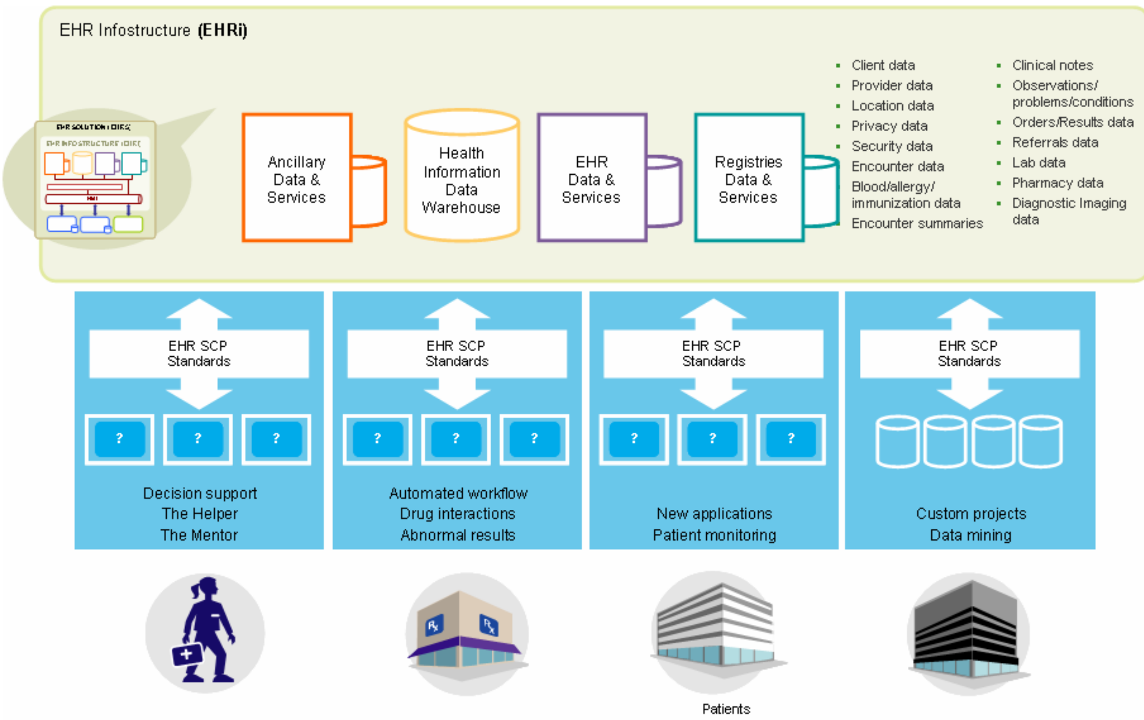


Figure 7-3 EHRS Data – Potential Application Areas

Many different types of new "intelligent" applications could be created to exploit the data available in an EHRi. The following is a list of some of the most obvious examples where significant value could be created for healthcare organizations and society in general:

- Specific decision support tools or intelligent agents may be created around particular topics such as disease categories or healthcare best practices. Such intelligent agents would rely on knowledge bases which are not inherently part of the EHRi, but would be able to apply those intelligence rules in applications to find data patterns or interpret information about a given patient/client. These applications could then generate alerts routed pro-actively to a key healthcare provider in charge of a patient/client (a family physician for example).

  Such applications may also apply their rules only when a given patient/client file is being accessed in a certain context (driven for example by the type of practice of a given physician). As an example, a diabetic specialist might get an alert generated by a system when accessing a patient/client file where several previous blood tests showed results that are just above an abnormal mark.

- Intelligent workflow driven applications could also help automate and manage the flow of information between different caregivers involved in the circle of care for a patient/client. Such an application may generate reminders when test results get recorded, or may generate alerts when due time expires on requests. Applications could be developed to address case management on a much broader basis then what has existed to date.

- Applications involving the patient/client directly in the management and or treatment of certain chronic illnesses would be possible. This direct involvement of the patient would allow family physicians or chronic disease specialists to be alerted when abnormal or suspect patterns of information appear.

- Studies done in the United States have demonstrated that patients/clients will provide more personal information when responding to questions on a computer screen then in an interview with a caregiver. Applications could be developed to assess patient/client's needs by combining historical clinical information and intelligent interviewing software to identify and automate routing of a patient/client in the healthcare system when accessing the system.

  This could help address some of the key issues around the accessibility of the healthcare system in the different jurisdiction. It might also help reduce waiting lines in emergency rooms by routing patients/clients to the right type of caregiver. Coupled with scheduling applications these types of solutions could have a significant impact on the delivery of care.
- By providing for a central and normalized approach to the collection of health related information about patients/clients, data in the EHR could be use to push the area of healthcare prevention to new heights. With longitudinal availability of clinically related data on individuals, healthcare prevention programs could be built to recognize potential healthcare problems before they become problematic and address then in a preemptive manner.

The list of these examples could go on and on, each one of these applications has a certain cost and a price point that is acceptable to healthcare organizations and consumers. That price point is determined by a balance between the costs of its initial development, the recurring costs of implementation, operation and maintenance (and in the case of commercial products, a gross margin) and the valuation of the benefits that it brings about. In all these cases, the existence of an EHRi is a fundamental requirement and is a component whose cost can never be justified for the sole purpose of one of these initiatives. From that perspective, the deployment of interoperable EHRi's across Canada stands to bring major benefits that we cannot even imagine today.

7.4 SECONDARY USES

The EHRS Blueprint suggests a valid framework to enable interoperability between electronic health record solutions deployed across Canada. As F/P/T jurisdictions in Canada move forward and start deploying and operating these secured and private clinical data sharing solutions, more and more data will be gathered into these solutions. While the primary focus for the usage of this data is the support of caregivers in their daily activities as they deliver care, there may be other valid uses that will emerge in the future. As caregivers learn or relearn to practice care in environments where evidence data is available at their fingertips, interesting transformations of healthcare delivery may occur over time. Some of the most basic practices associated with client/patient interviews and live data gathering techniques stand to evolve significantly in light of valid electronic data sources available to health professionals. More importantly the provision of health services stands to be reengineered towards more care prevention and pro-active care delivery as oppose to the "lets fix your problem" approach available today.

Appendix B presents an extract from a book called "Internet 2025 – The Importance of Imagining the Future" which presents well crafted examples of a world we could envisage soon if we accelerate the deployment of interoperable EHR solutions as described in the EHRS Blueprint.

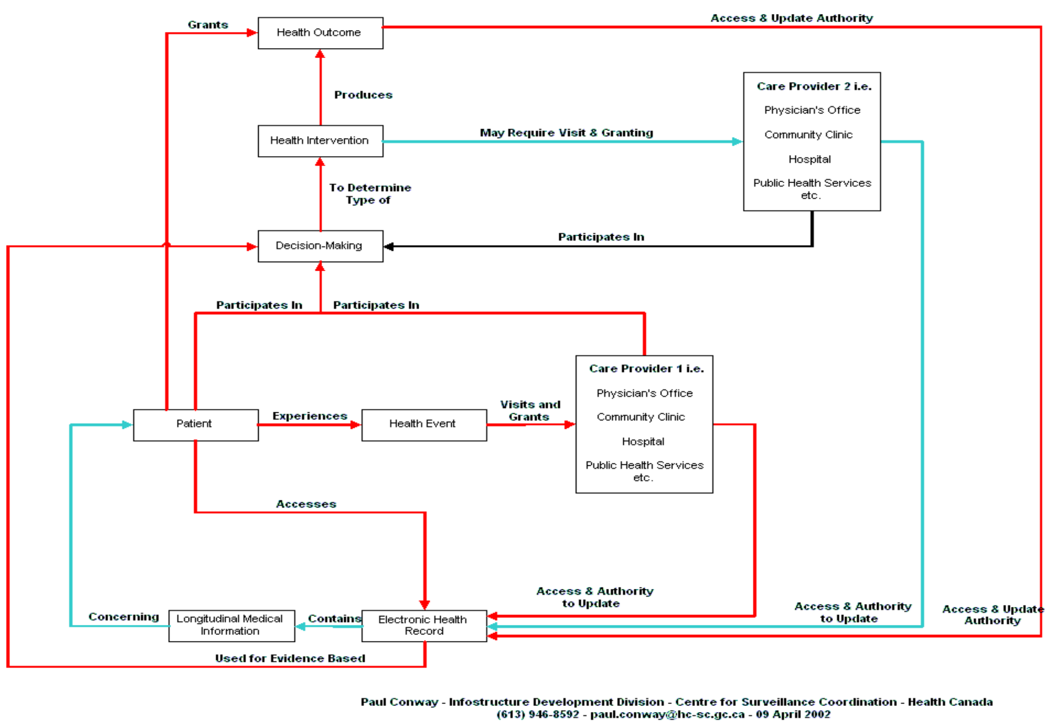
8 APPENDIX A – MODEL BY HEALTH CANADA

We are thankful for the collaboration of Health Canada in providing this model to be published as part of the EHRS Blueprint. Our regards sent especially to Mr. Bob Tate, Paul Conway, Gregory Sherman, Sarah Rosser, Zoltan Fabian and David Mowat for their efforts.

8.1 BACKGROUND

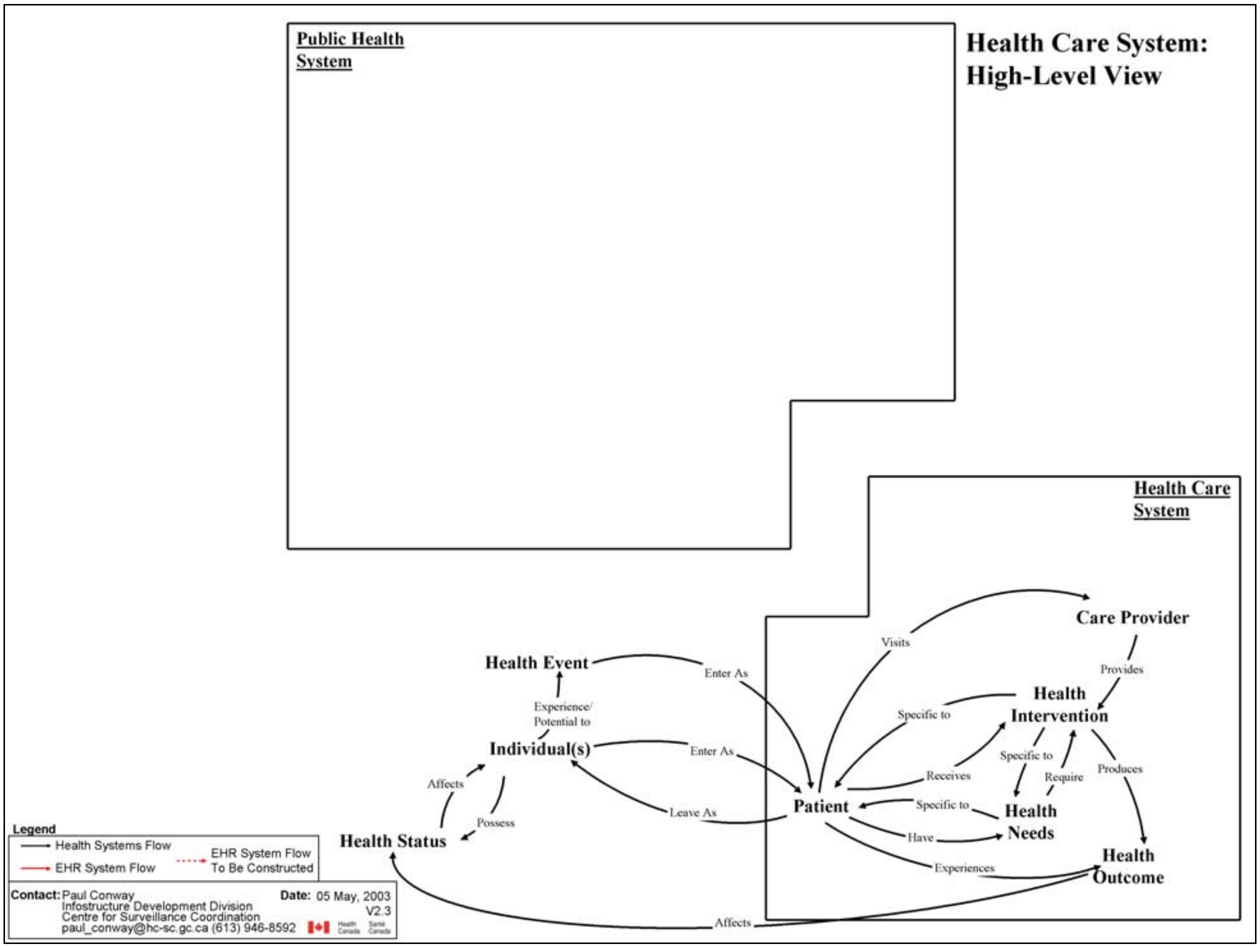
During the past several months, the Infostructure Development Division of the Centre for Surveillance Coordination, within Health Canada, has been conducting several health-modelling exercises. Our modelling philosophy is predicated on the overall health “system” being comprised of many different sub-systems. Each sub-system possesses its own set of strategies, structures and decision-rules. Some of these sub-systems are isolative and discontinuous by design, while others are integrated and aligned. As with any functioning system, there are several internal and external interpretations as to how it functions and “what it looks like”.

Each conceptual representation was built and communicated to people that worked within the model’s defined boundaries. The purpose of this exercise was to achieve internal agreement on the accuracy of our model. As acceptance for each sub-system was granted, we then began the process of “putting the pieces together” by identifying the areas in which the various sub-systems interacted, aligned and integrated. As the pieces were put into place, we developed the overarching high-level model for Public Health and Health Care. This model is by no means comprehensive; there are other sub-systems to be built. It does, however, provide us with a beginning point to better understand how a conceptual Electronic Health Record (EHR), (illustrated below), will “fit” into the realms of Public Health and Health Care.



8.2 INTRODUCTION

The following pages are comprised of iterations of the Public Health/Health Care model. This model contains variables and relationships. Variables are "things" or groups of "things" that are represented by words in bold letters. Relationships are arrows (with words on them) that are used to define the degree of "influence" that one variable has on another reflecting the systematic flow of the real world.



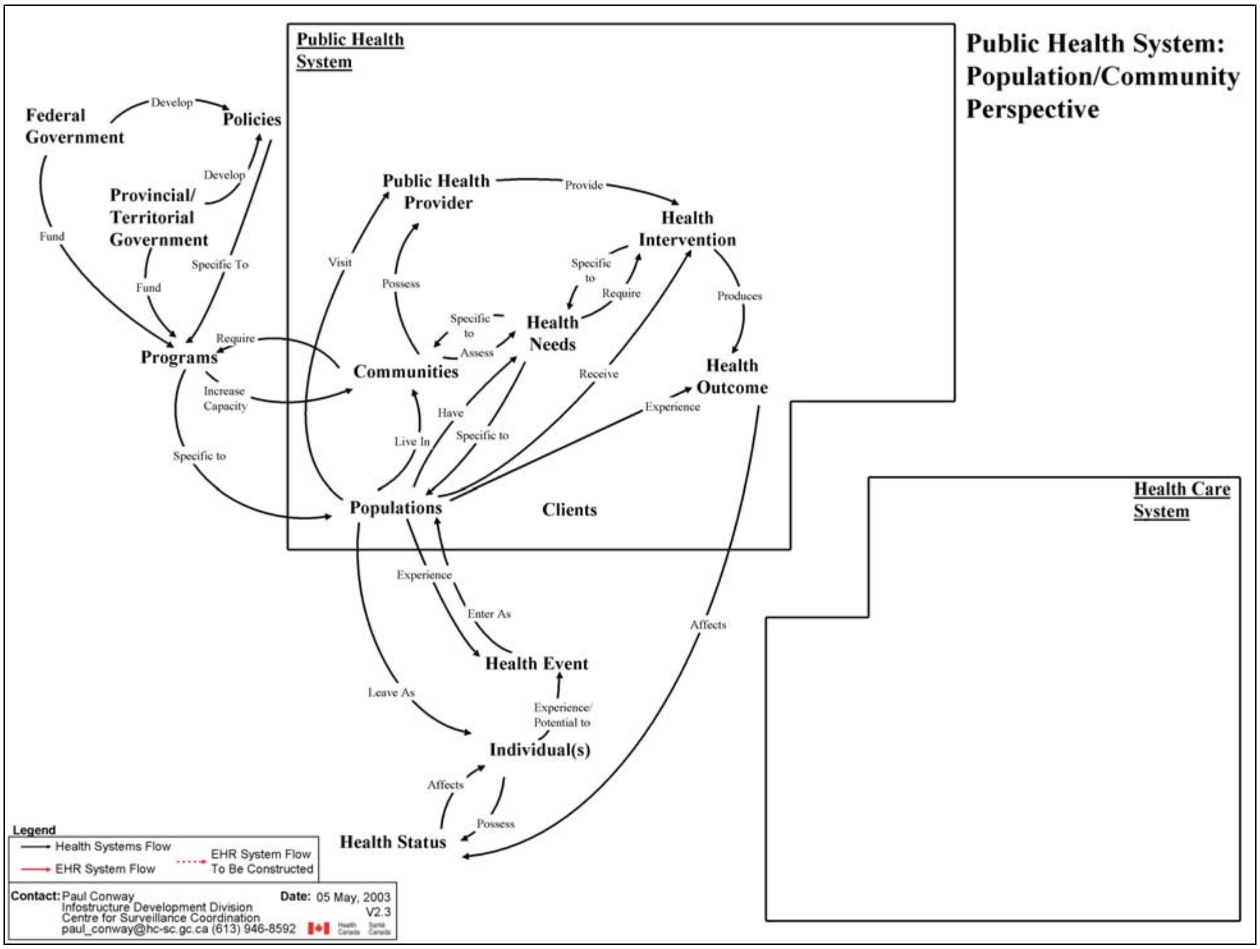
8.3 Health Care System

Explanation

The above iteration of the Public Health/Health Care model provides a high-level view of the relationships amongst *Individual(s)*, *Patients, Health Needs, Health Interventions*, *Health Outcomes*, and *Health Status* within the realm of the Health Care System. *Individual(s)* possesses a *Health Status* that measures their associated "degree of health". The *Individual(s)* can enter the Health Care System directly as a *Patient/client* or through experiencing a *Health Event*. The *Patient/client* visits a *Care Provider* who provides a *Health Intervention*. This intervention is specific to the *Patient/client* and his/her *Health Need* and produces a *Health Outcome*. The *Health Outcome* can be positive (patient/client is healthier than before entering), negative (patient/client is less healthy than before entering) or null (no effect). The result of the *Health Outcome* affects the *Health Status* of the *Individual(s)* in the same manner.

Conclusions

Within this system the Health Intervention is the control mechanism for addressing Health Needs and affecting Health Outcomes. Health Outcomes possess a positive reinforcing relationship with Health Status. As the Patient's Health Outcome increases (getting healthier), the Individual(s) Health Status increases, meaning the Individual(s)'s "degree of health" increases. The Individual(s) may be less likely to re-enter the Health Care System to seek an additional intervention pertaining to the originally experienced Health Event. Also, Individual(s) may or may not continue to directly enter the Health Care System, at their historical rates, for annual physicals or other non-Health Event related activities.



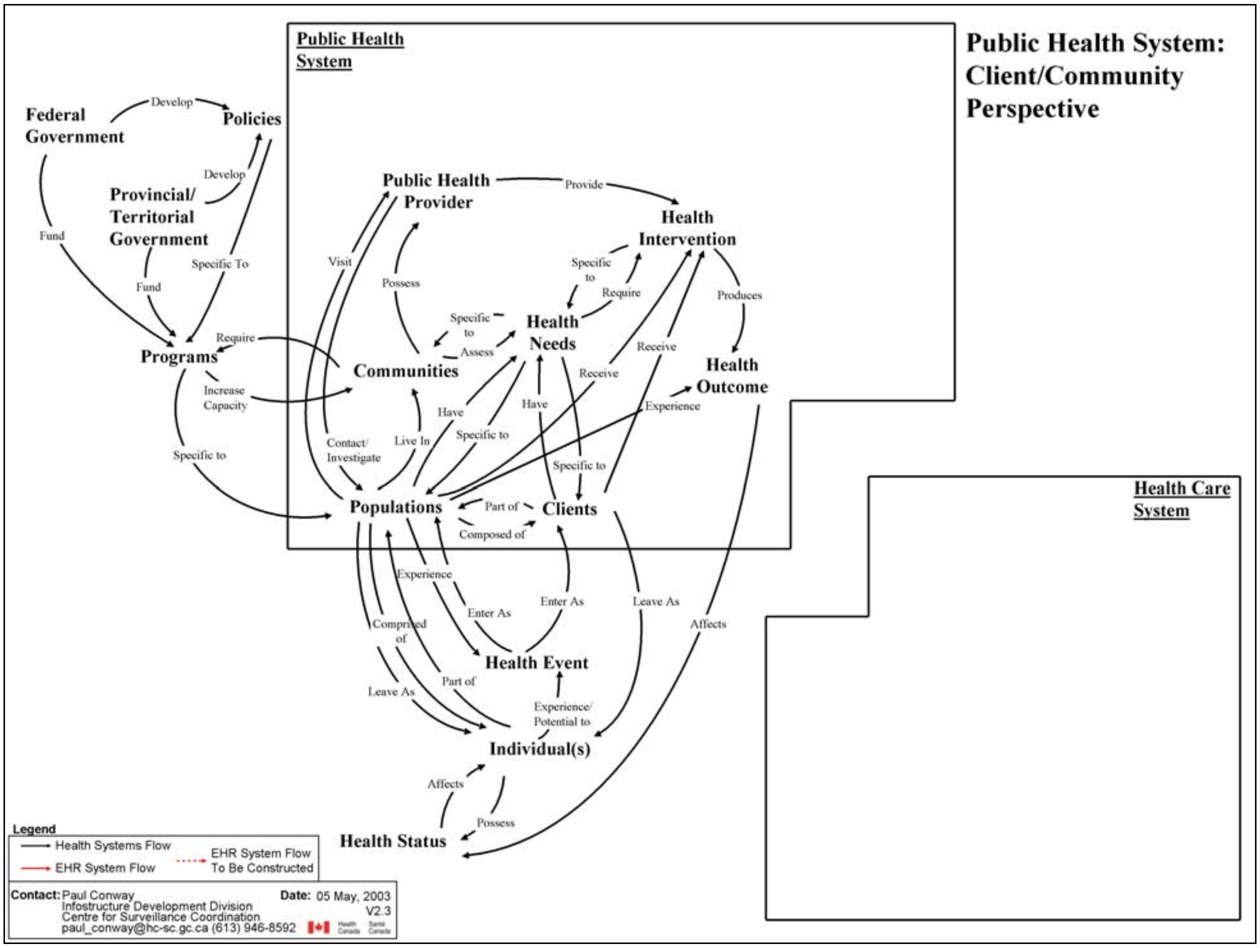
8.4 PUBLIC HEALTH SYSTEM: POPULATION/COMMUNITY PERSPECTIVE

Explanation

The above model provides a high-level view of the relationships amongst *Health Status*, *Individual(s)*, *Populations*, *Health Needs*, *Health Outcomes* and the *Federal/Provincial/Territorial Governments*. The Public Health System perspective views groups of *Individual(s)* as *Populations*. *Populations* also possess a *Health Status*. Upon experiencing a *Health Event*, *Individual(s)* enter into the Public Health System as *Populations*. *Populations* require *Health Interventions* that are specific to their aggregated *Health Needs*. *Communities* require *Programs* to increase their capacity to provide *Health Interventions*, through *Public Health Providers*. The required *Health Interventions* are based on the *Communities'* assessments of the *Health Needs* of specific *Populations*. Both the *Federal* and *Provincial/Territorial Governments* provide funding for these *Programs* and develop *Policies* that are specific to each *Program*. *Populations* visit *Public Health Providers* and receive a *Health Intervention*. This intervention is designed specifically for the focus *Population*. The *Health Intervention* produces a *Health Outcome* that is experienced by the *Population*. The *Population* leaves the system as groups of *Individual(s)*. The *Health Outcome* affects the *Health Status* of the groups of *Individual(s)*.

Conclusions

Within the Public Health System, Policies, Programs, and Health Interventions become the control mechanisms. As new Health Needs arise, governments must respond with new Programs to develop interventions or modify the existing Policies that are specific to these Programs. A positive reinforcing relationship is established. As Health Needs increase, more Interventions are required. As more Interventions are required, more government funding for Programs is required. As within the Health Care System, Health Outcomes possesses a positive reinforcing relationship with Health Status.



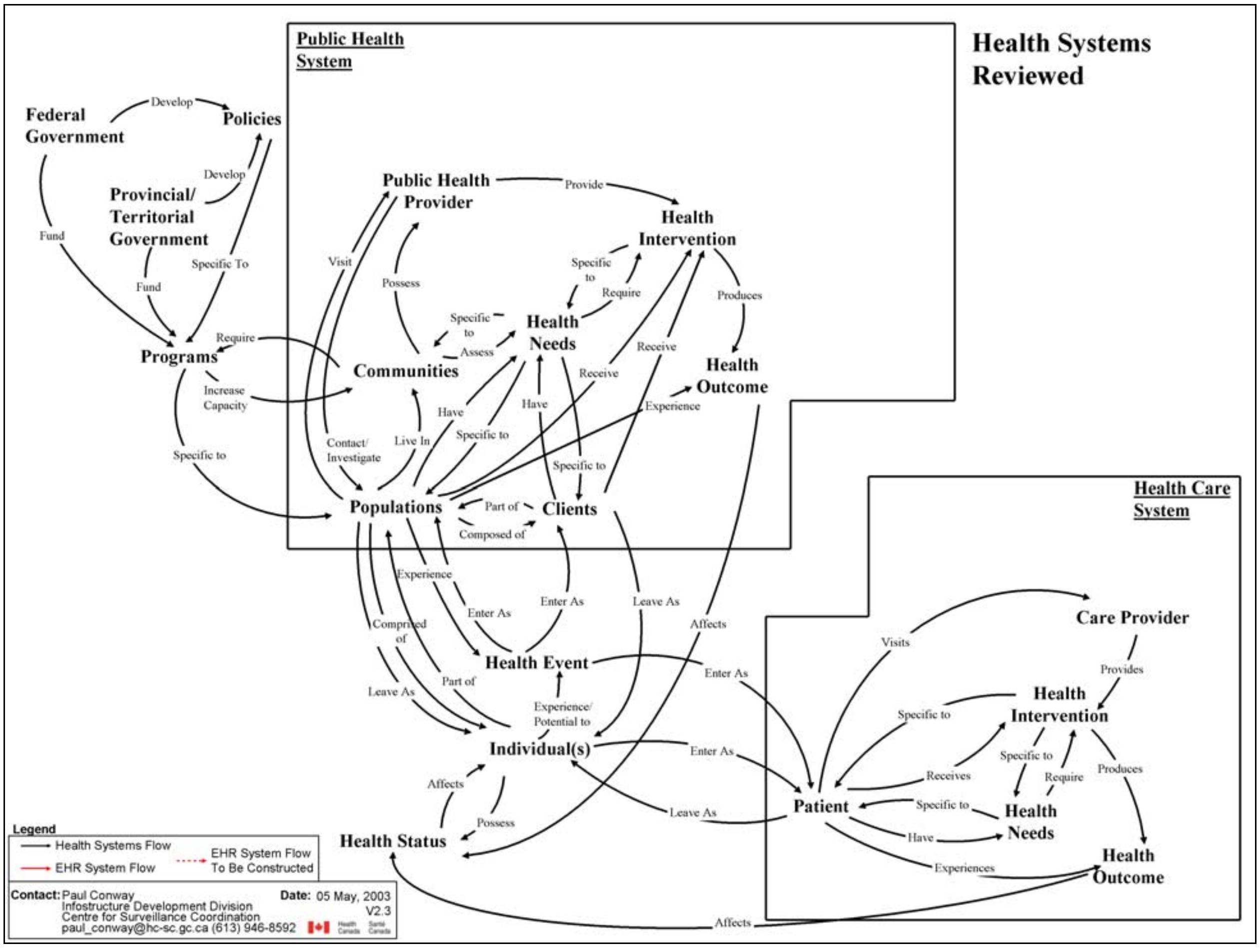
8.5 PUBLIC HEALTH SYSTEM: CLIENT/COMMUNITY PERSPECTIVE

Explanation

The Client/Community perspective slightly differs from the Population/Community perspective. One difference is in the relationship to *Health Event*. *Individual(s)* may be unaware that they have experienced a *Health Event.* There is also a "potential" for them to experience one (i.e. food poisoning). In this case a *Public Health Provider* will contact the *Individual(s)*, who are now viewed as *Clients.* The *Health Intervention* that the *Client* receives has been designed through the *Programs* for the *Health Needs* of the *Population* (who experienced the same *Health Event*), but tailored for the *Health Needs* that are specific to the *Client*. *Clients* are viewed as parts of *Populations*. Upon receiving the tailored *Health Intervention*, a *Health Outcome* is produced that affects the *Health Status* of the *Client*. The *Client* leaves the system as an *Individual(s)*.

Conclusions

The essence of this model is that you may not care about Public Health, but Public Health cares about you! The control mechanisms in this perspective are the same as per the population/community perspective.



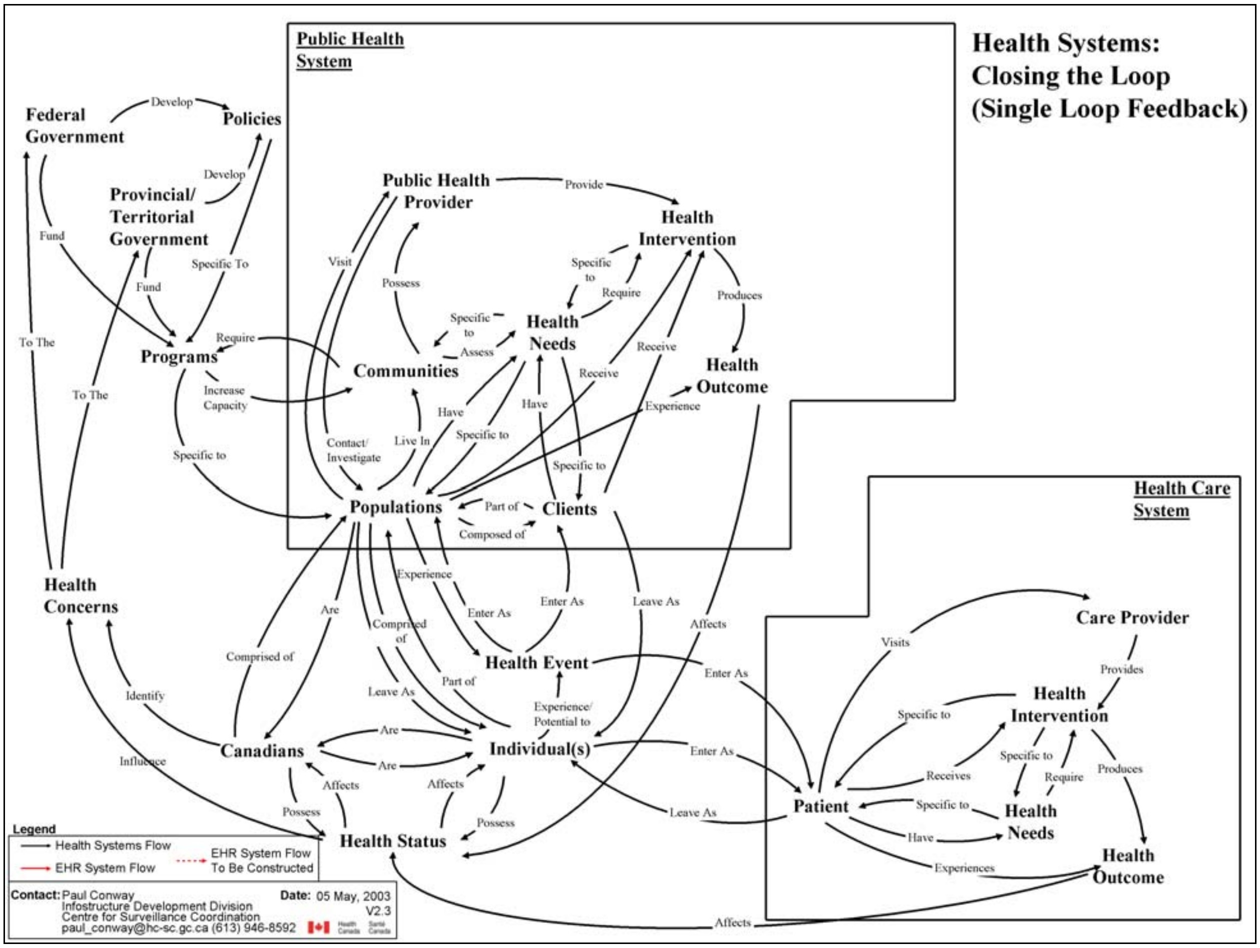
8.6 HEALTH SYSTEMS REVIEWED

Explanation

There are similarities and differences between the Health Care System and Public Health. For similarities, both systems possess *Providers*, *Health Needs, Health Interventions* and *Health Outcomes*. The *Health Outcomes* from both systems affect the *Health Status* of Individual(s) upon their exit. The major difference is that the Public Health System focuses on the aggregated *Health Needs* of *Populations* while the Health Care System focuses on the *Health Needs* of the *Patient*.

Conclusions

Individual(s) can enter each system separately and transparently pass from one system to another. The Provider can also be the same person. Individuals that enter the Health Care System and experience similar patterns of Health Events and/or negative Health Outcomes may, in fact, be exhibiting the beginnings of a Public Health outbreak. The existing feedback processes of "discovering" or identifying these patterns can be extremely time-consuming. This can lead to a slow Public Health reaction in Program and/or Policy development/implementation.



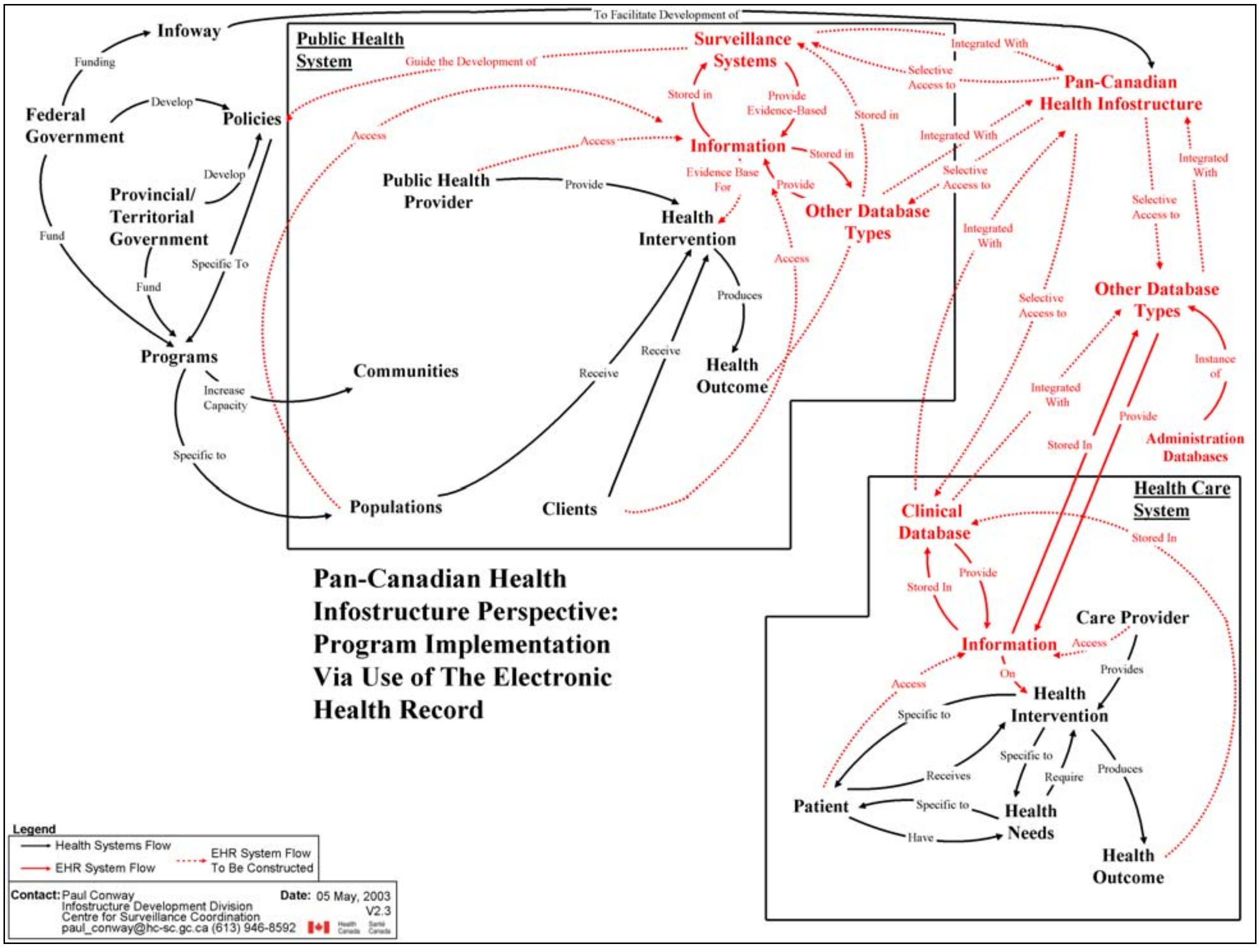
8.7 HEALTH SYSTEMS: CLOSING THE LOOP (SINGLE LOOP FEEDBACK)

Explanation

This iteration of the model illustrates the feedback mechanism that presently exists from *Health Outcome* to *Program* and *Policy* development. This feedback is in response to the fluctuations in *Health Status* and *Health Concerns*. *Health Status* can be measured against *Individual(s)*, *Populations* and *Canadians* as a whole. These groups express their *Health Concerns* to the *Federal Government* and *Provincial/Territorial Government* who respond through *Program* and/or *Policy* development management.

Conclusions

The feedback loop (Health Outcome to Policy/ Program development) is lengthy and arduous. An argument can be made that Health Records exist they are just not electronic and are not documented. There is a flow from Health Outcome, through Health Status and Health Concerns resulting in government action. The time delays in this process can be enormous. The Conceptual EHR model from the first page illustrates how the Patient/client (also read Client and Population) and the Care Provider (both Public and non-Public) use longitudinal information in the decision-making process of determining the health intervention that will produce the "best" possible health outcome. As we have seen, within the Public Health perspective, Health Interventions must meet the Health Needs of Populations and Clients. Without an Electronic Health Record, the reaction time of the governments to respond and react to these changing Health Needs, usually expressed through stakeholder organizations, will continue to be measured in months and years.



Pan-Canadian Health Infostructure Perspective: Program Implementation Via Use of The Electronic Health Record

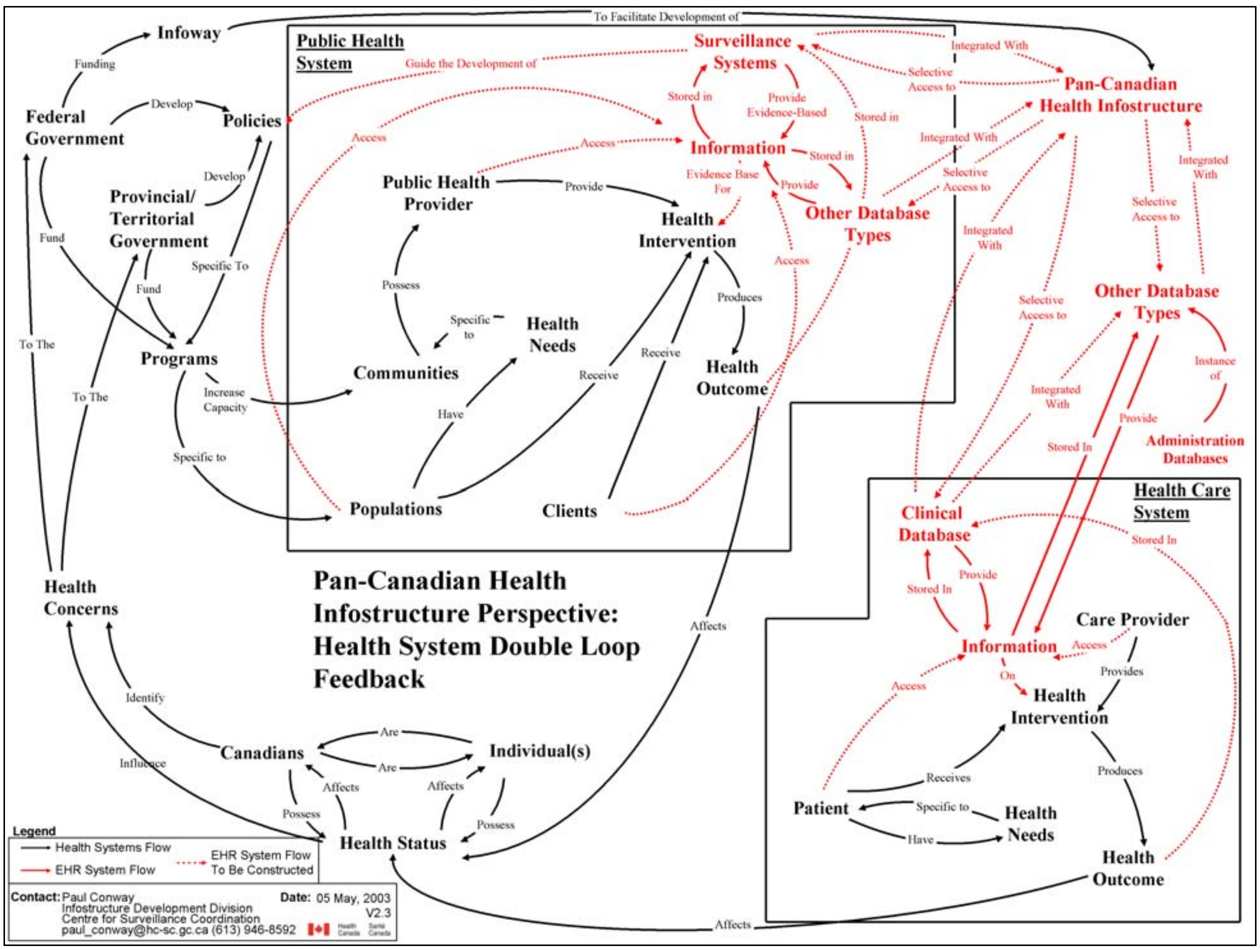
8.8 PAN-CANADIAN HEALTH INFOSTRUCTURE PERSPECTIVE: PROGRAM IMPLEMENTATION VIA USE OF THE EHR

Explanation

In order to reduce the time delay in feeding back useful *Program* and *Policy* development information to the *Federal* and *Provincial/Territorial Government*, *Health Outcomes* must be electronically documented (within an EHR), passed through the various types of databases that exist within each sub-system and become aggregated (with no personal identifiers) within *Surveillance Systems*. Analyses can then be conducted to determine the effect (positive, negative, or null) that *Health Interventions* have on producing *Health Outcomes*. This information can then flow back into both Health Systems and can be accessed by *Patients*, *Populations*, *Clients* and *Providers* to assist in the decision-making process in determining *Health Interventions* for specific *Health Needs*. The Pan-Canadian Health Infostructure is the aggregation of health information and infrastructure. This aggregation is a road map. The EHR will be the vehicle travelling along it.

Conclusions

The establishment and application of an EHR will reduce the time cycles of the feedback of the existing system from months and years to hours and days. Patterns resulting from the Populations, Clients, and Patients/clients interacting with Health Interventions, producing Health Outcomes in relation to Health Needs can be fed back into the governmental perspective and impact the development/maintenance of Health Policies on Programs. The EHR will lead to the accessing of information from various databases to assist in the decision-making process between Providers and Patients, Populations and Clients.



8.9 PAN-CANADIAN HEALTH INFOSTRUCTURE PERSPECTIVE: HEALTH SYSTEM DOUBLE LOOP FEEDBACK

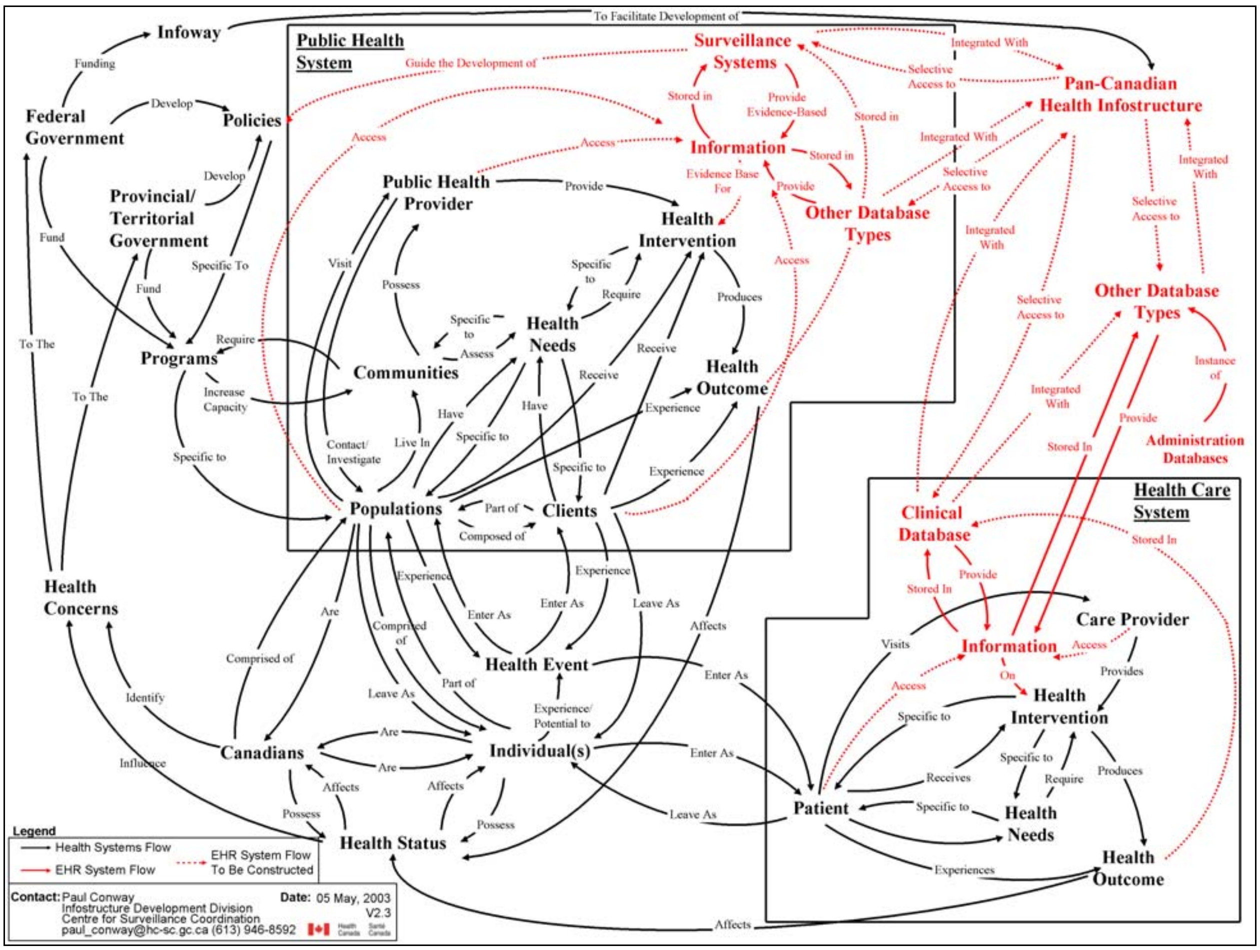
Explanation

This iteration of the overall model illustrates the two mechanisms for influencing government *Policies* and *Programs*. We had seen earlier how the feedback mechanism of *Canadians* identifying *Health Concerns* to the *Federal Government* and *Provincial/Territorial Governments* impacts the level of funding to Programs. This existing process is slow and arduous. We have also seen how through the use of an EHR, we are able to provide feedback within the health system much faster.

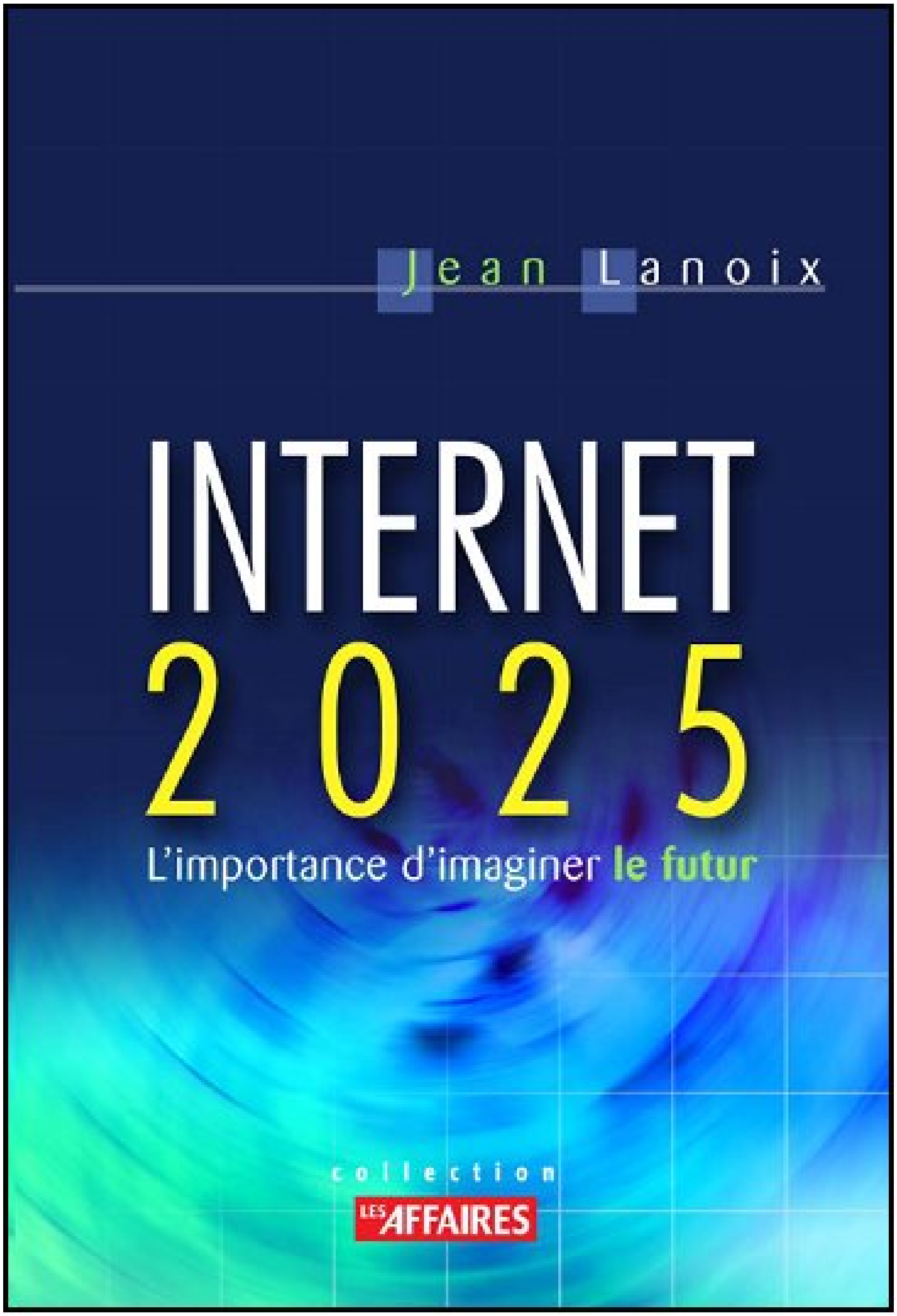
Conclusions

The EHR will be the integrating vehicle that allows data and information to flow from health sub-system to health sub-system. We have seen radical changes in the Health Needs of Communities over the last several years. If the health system, in general, and the Federal and Provincial/Territorial Governments, in particular, wish to employ a rapid, flexible response to emerging Health Needs, it requires a concept for moving data. That concept is the Electronic Health Record.

8.10 COMPLETE MODEL



9 APPENDIX B - INTERNET 2025



Chapter 2

The single patient record: the starting point for improving health services

In Canada and the United States, cases of obesity, diabetes, cancer, and respiratory and cardiovascular disease have increased alarmingly over the past three decades. Numerous scientific studies confirm that the main causes of these diseases are smoking, poor diet, lack of exercise, alcohol, stress and pollution.

Despite this information, North American medical practice at the dawn of the 21st century continues to focus its efforts on treating disease using biomedical interventions. Several rare exceptions aside, such as breast cancer, prevention is not high on the organization's list of concerns or priorities in terms of health care funding.

At the same time, Canada is faced with hard economic reality. The population is aging and every year the constant rise in the number of medical interventions costs additional billions of dollars. Since Canadian personal income taxes are already among the highest in the world, the federal and provincial governments must quickly find alternative solutions to stop the haemorrhaging.

In the United States, an increasing number of people are unable to afford the skyrocketing cost of private health insurance. In the richest country in the world, over 40 million people still do not have health insurance. Numerous plans to reform the health service have been presented by the federal government and various states, but the scale of the economic interests at play makes the task extremely complex, even more so than in Canada.

FUTURE SCENARIO

Canada becomes a world model for health

We are in the year 2025 and 98% of Canadians have access to the new generation of Internet technologies. In terms of health services, Canada has the most enviable model on the planet.

Representatives from governments and health institutions around the world regularly visit Canada to better understand the recipe for this success.

The national reform of health services really began in 2005 when the prime minister at the time managed to persuade his provincial counterparts of the fundamental importance of prevention under a project to develop a single health record.

The single record for Canadian patients became truly operational in 2014. Thanks to this system, all of a patient's medical information, including test results and x-rays, are permanently recorded and made available through a single electronic record. Whether in a clinic, a hospital or during a home visit, the medical record is always the same, accessible 24/7, anywhere in the world.

Initially, groups of protestors opposed the single medical record in the name of privacy protection. Posters appeared showing an image of the Canadian prime minister and bearing the name “Big Brother,” the celebrated character in George Orwell's science fiction novel *1984*. The prime minister had to intervene to reassure the public. He affirmed that the system was extremely safe and that it had been designed to protect people's privacy. A department was created to receive and investigate complaints, and to inform the public about the sophisticated security measures put in place.

With the Canadian central record, only health professionals with a genuine need to access a medical record for professional reasons are able to do so. Every patient can access his/her own record on the Internet; this record contains a list of the names and employee numbers of all health care professionals having consulted the record, as well as the place, date and time of these consultations.

The system even allows individuals to bar access to their medical record, if desired. In such cases, no one can consult the medical information of these patients without using their electronic card and secret access code. In 2025, only a few rare individuals request such discretion, the system’s confidentiality having proven itself over the years.

Preventive medicine that easily integrates into the system

In a speech, the prime minister set out the primary objective of the single patient record, namely "[…] to improve the health and quality of life of all Canadians. With this single record, it will be easier and less expensive to provide top-quality health care. Our goal is not only to give patients better care, but also to prevent disease whenever possible. We are truly going to apply the old proverb 'prevention is better than cure.'"

The Canadian strategy quickly proves itself and enables savings of several billions of dollars per year.

The following example describes a visit to a doctor in Canada in 2020.

Diane, a 28-year-old mother, goes to the medical clinic with her 18-month-old son. The child has not stopped crying for several hours. The doctor examines him and tells the mother that her son has otitis media, a very common ear infection among children.

"I have a video that explains the problem very well." On his desk, the doctor touches a monitor screen with his finger and a video begins. This 90-second clip explains the cause of otitis and states that "medical data on over 64 million children from the past ten years show that otitis cures itself in 91% of cases, without need for antibiotics. It is recommended to allow the child's own immune system three to four days to resolve the problem naturally."

The doctor stops the video and reassures the mother: "Your child will probably continue to cry, but a prescription will not change anything. To sooth the child's pain, use a pediatric analgesic." The doctor enters his diagnosis in the child's electronic medical record.

Three days later, the automated system reports the need for a follow-up. A nurse places a video conference call to the mother to find out how her child is progressing. He is doing better, and the information is entered in the record.

Three months later, Diane returns to the clinic with her son for the same problem. The doctor again diagnoses an ear infection. The Canadian 2020 treatment efficacy database indicates that a session with a qualified osteopath resolves recurrent otitis in young children in over 70% of cases. This statistic comes from empirical medical studies conducted with numerous control groups, as well as data collected from all medical records of children with otitis. The doctor therefore advises the mother to make an appointment with an osteopath.

The following week, the osteopath manipulates the child's ear and neck. The whole process is free of pain and the osteopath writes the details of her intervention directly in the child's record. Diane's child has no further ear infections.

Several years later, Diane had a second son. She consulted the osteopath the first time he had an ear infection.

Just ten years after the introduction of the single patient record and preventive measures, the number of clinical consultations for otitis in young children had dropped by 42%, and the number of surgical interventions for ear tube insertion by 94%. The total value of these improvements represents savings of close to a billion dollars a year in Canada, for otitis alone. During the same period, the number of antibiotic prescriptions for treating otitis fell by 74%.

The ability to predict disease

In 2025, disease prevention is more than ever front and centre in the Canadian health system. There is a recommendations section in everyone's personal medical record referring specifically to the person's current and future health, based on hereditary factors, personal history, lifestyle and close to 15 years' analysis of the medical records of all Canadians. In the following example, Jacques, age 41, goes to his doctor for a routine check-up.

Jacques accesses the Internet appointment system and simultaneously sees the information he needs and the clinic secretary, directly on screen. Given that three years have elapsed since his last medical check-up and certain personal factors, the secretary explains to Jacques that the system has automatically allocated a one-hour session with the doctor, preceded by a visit to a laboratory for blood and urine tests. Jacques has the tests, and the results are entered in his record before his appointment. All of the information is exchanged electronically, with little or no paperwork required.

Two weeks later, the doctor sees Jacques and asks him what he thinks about his health in general. Jacques says he has gained a little weight and feels more tired than before: “You know, with the children and work, I don't have any time to exercise.”

The doctor draws Jacques into a discussion of his eating habits and continues with questions about his work, stress levels, how he sits at the computer, etc. Since 2010, all Canadian general practitioners have been given special training on how to better question patients on the numerous factors affecting their physical and mental health.

After a full medical examination, based on Jacques' age and condition, the doctor enters some data in the electronic record, including Jacques' weight and waist measurement. Then he looks Jacques right in the eyes and says bluntly, “You know, there's not much of a mystery. Your cholesterol level is too high, you're 12 kg overweight for your age and height, you don't do any exercise, you pay little attention to your diet, and in your immediate family, both your father and your brother had heart attacks. According to the statistics I see on screen, if you carry on this way, you have a 60% likelihood of having a cardiac incident before you're 50. And I assure you that our new prediction system is reliable, since it continuously analyzes the health status of every Canadian, and hundreds of specialists and researchers help analyze and interpret the data.”

The doctor goes on, “The good news is that we can really help you. For the past few years, there has been a customized program for people like you. It's fully funded by the government and is extremely effective. A team of specialists will help you and encourage you to eat better and to do exercises suited to your needs. If you agree to participate, I can assure you that in just four months you'll feel 15 years younger. You'll sleep better. And, what's more, you won't have to follow a draconian diet. You will eat well, I promise you!”

Jacques says, “It’s really free?” The doctor replies, “Yes, absolutely free for a full year. Look, here on the screen. If you don't change your behaviour, your future health problems will cost the government between $200,000 and $850,000. This is why the program is called 'Prevention is Better than Cure'! If you conscientiously follow the program for the entire year, you'll have an excellent chance of continuing to look after your health for the rest of your life and avoid not only a heart attack, but also many other diseases. In paying for the nutrition and physical fitness courses for thousands of people like you, the government predicts it will save billions of dollars every year.”

An effective collaboration between specialists

The Canadian medical prevention program was developed with the single patient record in mind. In the case of nutrition, for example, government-certified nutritionists can access the “Nutrition” section of their clients’ medical records. When Jacques met with the nutritionist, she analyzed his eating habits in detail and entered the information in his record. Based on this information, the system automatically proposed a diet suited to Jacques' health condition and genetic profile, while taking into account his tastes and preferences.

The Canadian dietary program is the result of fifteen years of research into diet and the most effective methods for helping and motivating people to change their eating habits. The Internet's multimedia features are used to the full. At home, the system offers Jacques a complete weekly menu suited to his likes and dislikes. Every meal proposed can be replaced if Jacques wants to eat something different. He need only touch the screen to obtain a dozen equivalent choices for each meal.

The dietary program is a veritable education in international cuisine. It contains excellent recipes from every corner of the world. Each recipe is explained step by step. If an instruction is not clear, Jacques has only to touch the screen to see a video clip showing the hands of a master chef performing the step in question. In 2025, there are wireless, flat-screen monitors in almost every kitchen.

The nutritionist had a video conference call with Jacques at least once a week for six months to answer his questions and encourage him. The scenario is similar for physical fitness. After his visit to the doctor, Jacques also met with a physical fitness specialist with a diploma in heart disease prevention. The fitness trainer and four of his colleagues set up their own clinic to participate in the Canadian medical prevention program. They work closely with general practitioners, cardiologists, nutritionists and other professionals, as needed.

In Jacques' case, the specialist used a cardiologist-approved decision-support system to define a personalized physical fitness plan. As Jacques does not like physical fitness centres, his initial program was divided into six 20-minute workouts per week, which he can do at home—three on a special stationary bicycle (rented to him for only $5/month) and three in front of his giant-screen T.V. doing physical exercises.

Jacques was also given a free miniature medical computer designed specifically to monitor and record the heart rate and blood pressure of people at risk. This wireless device transmits data directly to Jacques' medical record. If his heart reacts abnormally, the system will tell Jacques to stop all activities immediately. In more serious cases, a signal is automatically sent to an emergency control centre, and a specialized nurse immediately calls the patient to inquire out about his/her condition. If the person does not answer, the satellite detection system is able to accurately determine his/her location anywhere on the planet.

Fortunately for Jacques, this technology was not put to the test, since his body reacted very well to the diet and physical fitness program. At the end of the fifth month, Jacques had lost 14 kg and his cholesterol level and blood pressure had returned to normal. He has much more energy and his immune system has regained its full strength. For the next five years, he had no problem requiring medical attention, not even the flu.

Access to better medical knowledge

The single patient record system was initially designed for direct connection to a decision-support tool for doctors and all other health care professionals. This database contains the best medical information available on all pathologies and known treatments.

In 2008, the governments of Canada, the United States, several European countries, Australia and New Zealand joined forces to create an international team whose sole task was to analyze the best possible treatments for all known diseases.

This team was free of all commercial and government constraints. The results of the specialists' work are presented in two versions, one for doctors and health specialists, and the other on the Internet for the general public.

The information presented to doctors rapidly became the most useful and effective decision-support tool in the history of medicine. Since its inception, the international team has upgraded the content by viewing it from the perspective of the health professionals who use it. Mock-ups and service prototypes were first tested on doctors and other professionals to ensure they were easy to use and truly corresponded to their needs and expectations. These services included context-based feedback functions, making it easy for health professionals to give their comments and suggestions for improving the information. The international team analyzes these comments and makes adjustments where necessary.

The system is not perfect. Some specialists criticize the approach, since they consider it far too closely linked to biomedical medicine, i.e. relying too heavily on drugs, technological treatments and surgical interventions. Despite the criticisms, the system has an irreproachable quality—it works like an open book. All these services and recommendations are available to the public and especially to any international specialist who wishes to criticize their validity.

An excellent medical information service for the public

In parallel, the Internet medical information service for the general public has become a global reference. Previously, online medical information services were almost all funded by pharmaceutical companies or vendors of all types of products, which inevitably affected their degree of objectivity. The international site, for its part, is free of all commercial influence.

Considerable sums have been invested to simplify the content and facilitate users' search for information. The site uses the full multimedia capacity of the Internet. For each explanation, specialists in interactive communication use whichever medium is the most effective—video, animation, sound, images or text. The content is constantly tested with users to ensure people can find their way and to determine whether explanations are really clear.

New methods of finding information quickly and effectively have been developed. For example, the section on first aid provides various ways to access information. The most popular method with the public involves touching specific parts of the human body.

Imagine that a two-year-old has burned his fingers on the kitchen stove. The parent turns to the flat screen on the kitchen counter and says “Oscar: first aid,” Oscar being the name given to the computer. Instantly, the first aid page appears on screen with a series of illustrations representing people of various age groups. The parent touches the illustration corresponding to the body of a 2-to-5-year-old boy. The illustration of the child’s body expands and immediately fills the screen.

The parent touches the child’s fingers on the illustration and these automatically change colour. The parent touches the “Go” icon, and a list of possible problems immediately appears—e.g. cut, burn, frostbite, swelling. The parent selects “burn,” and a presentation of different types of possible burns to the fingers appears. Thanks to this user-friendly method of navigation, the parent finds the exact information needed in less than 10 seconds. A video document then gives a demonstration on what needs to be done. The recommendation is based on the best available medical knowledge concerning first aid for burns to the fingers. The same information is given in many languages, with illustrations.

The information provided to the public often goes beyond the medical field. For example, an adult with tennis elbow will find more than excellent medical advice. The system also displays the following message: “How you hit the ball could be the cause of your elbow discomfort. Take a moment to look at this video.”

In 60 seconds, the video clearly explains how many players have their arms and body poorly positioned at the moment of striking the ball. It shows the proper position (adopted by professionals), which helps lessen the impact on the elbow and increases the power of the shot. “If your position is not good, we recommend you take the following virtual courses on the Internet or, even better, consult a professional tennis instructor in your area.”

A central service working for medical research and public health

The database comprising the medical records of all Canadians is a goldmine for researchers and public health professionals. From the outset, the Canadian system was designed to enable the extraction of totally anonymous data from the medical records. It is impossible for researchers to establish a relation between an actual patient and the data to which they have access.

For example, the central system enables an analysis of the impact of air quality on Canadians' health. When patients are affected by respiratory problems such as asthma or pneumonia, the doctor asks additional questions specific to these conditions, such as a description of the type of work and the exact location of the workplace: a factory, a building, outdoors, on the road, at home or elsewhere. The doctor also notes factors such as the type of family residence, the air-conditioning and heating system, and the presence or not of smokers.

This precise data has proven invaluable for public health researchers and professionals. Among other things, systematic analysis of the data has enabled automatic detection of private and public buildings, including factories, where the ambient air causes the greatest health problems. It has also made it possible to analyze the impact of various types of home air-conditioning and heating systems.

Since 2012, a group of researchers specializing in breast cancer have used numerous data sources, including an automated system that analyzes thousands of digital x-rays every day. These lifelong analyses, which are done for all Canadian women, contribute to evaluating the efficacy of the various preventive measures and cancer treatments based on a broad variety of criteria.

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an interoperable EHR framework

Information campaigns and numerous newspaper reports have shown the public the many benefits of the system. For example, it was designed to rapidly detect the risk of an epidemic. As soon as an abnormally high number of cases of infectious diseases or food poisoning occurs, the system automatically reacts and immediately draws the attention of the public health authorities.

Also, the existence of the central system for medical records has resulted in many public health sectors working more closely together. For example, specialists in drinking water analysis maintain a constant collaboration with Agriculture Canada and specialized researchers to analyze the ecological repercussions of large livestock operations on the health of Canadians in different areas of the country on an ongoing basis.

In 2025, statistical data from the single patient records in Canada and many other industrialized nations constantly remind governments that medical prevention and improvement in the quality of drinking water, air and food must remain their central preoccupations.

BACK TO PRESENT-DAY REALITY

In health, the future begins today

In 2003, an organization called Canada Health Infoway was given the mandate to assemble the components of what it called the electronic health record. Considerable sums, running into billions of dollars, will be invested in this Canadian initiative over the coming years.

The first step in this mega-project consists of establishing a common infrastructure and standards that will make it possible to integrate and interconnect information from multiple sources into a single record for each patient. This infrastructure will make it possible to interconnect electronic image files, such as x-rays, laboratory results and critical information on medications prescribed to the patient. The system also foresees multiple uses, including knowledge management, which will enable doctors to access the best medical knowledge and actively collaborate in developing these knowledge bases.

Currently, the Canadian single patient record system does not necessarily plan to integrate the components of preventive medicine and collaborative mechanisms connecting specialists such as nutritionists and physical fitness instructors, as described previously. Canada Health Infoway is currently trying to establish a sufficiently flexible structure to enable the addition of new functions over the years. But since these are computerized systems, it is always best to determine fairly accurately in advance what we expect to accomplish in the future. There is nothing to guarantee that in 5, 10 or 15 years' time it will possible to connect new components to the system.

The development of the electronic patient record must not be limited to improving current services focused on recovery and biomedical interventions. Such a system would undoubtedly make it possible in Canada to improve the effectiveness of health care, reduce waiting lists, save thousands of human lives and hundreds of millions of dollars per year. On the other hand, these savings would represent only a fraction of the cost of health care, which will rise over the coming decades, primarily as a result of the aging of the population.

Clearly, the ideal way to control—and possibly reduce—health service budgets lies in improving the state of health of Canadians and in preventing disease. This is an enormous challenge, and success in this area depends on major changes in people's attitudes and behaviours. The organization of future health services will have to play the role of catalyst in a project of this magnitude.

To develop a health services model capable of taking on such a challenge, we must first and foremost imagine and define this model of future medical practice. This essential creative exercise must start today to be able to draw maximum benefit from the new interactive communication technologies over the coming decades.

The reflection process will require the involvement of numerous Canadian and international experts in the health field and many aspects of prevention. A strategy and an action plan must be developed. Financial projections will have to be prepared, particularly in regard to the cost of prevention programs, compared with the savings such programs should generate in the future.

Since the next generation of Internet technologies already exists at the laboratory level, we can simulate future services to provide participants in the numerous organizations involved in the health record with a better view of future possibilities. The goal is to imagine today, to the best of our ability, an ideal health care model for the future. Such a creative exercise would help us better orient the development of health services between now and 2025.

Note: For more information regarding the book INTERNET 2025 consult www.jeanlanoix.com/english

10 APPENDIX C - GLOSSARY

Term	Definition	Acronym	Reference	Synonym
.NET (dot NET)	.NET is both a business strategy from Microsoft and its collection of programming support for what are known as Web services. The .NET platform includes servers; building-block services, such as Web-based data storage; and device software. It also includes Passport, Microsoft's fill-in-the-form-only-once identity verification service.		*Infoway*	
A				
Access Control	A security technology that selectively permits or prohibits certain types of data access based on the identity of the accessing entity and the data object being accessed.		*Infoway*	
ADT	Admission, Discharge and Transfer system located in a Hospital. The Admitting Discharge and Transfer module is used to track a patient/client's bed use from admission to discharge. In identifying and registering clients, the system makes it possible for the institution to track client location and encounters, and to produce statistical reports. Pre-admission and admitting information can be collected prior to actual admittance. Service, transfer and discharge information is also collected and input as close to the source as possible.	ADT	*Infoway*	
Alert / Notification Services	Part of the HIAL Common Services, this service provides support for handling system alerts. When an alert condition is triggered, the service will notify the corresponding users and/or systems. This service ties into and works closely with the Publish/Subscribe Service.		*Infoway*	
Alerts	Electronic notification of an event or immediate action required. In general terms, system alerts are parameters that a user (or another system) can specify to control a system or agent's behaviour.		*Infoway*	
Ambulance IS	Ambulance Information System. Considered as a client application.		*Infoway*	
American National Standards Institute	Organization responsible for approving U.S. standards in many areas, including computers and communications. ANSI is a member of ISO	ANSI	ANSI	
ANSDIT	American National Standard Dictionary of Information Technology		ANSDIT	
API	See Application Programming Interface.	API	IEEE	

Term	Definition	Acronym	Reference	Synonym
App/Protocol Services	These are services that will support application level protocols that hold the payload. Simple Object Access Protocol (SOAP) will be supported. Other remote protocols such as RMI, DCOM etc. can be plugged into the application protocol service.		*Infoway*	
Application Architecture	Defines how applications are designed and how they cooperate, promotes common presentation standards to facilitate rapid training and implementation of new applications and functions. Good application architecture enables a high level of system integration, reuse of components and rapid deployment of applications in response to changing business requirements			
Application Programming Interface	1: A set of standard software interrupts calls, functions, and data formats that can be used by an application program to access network services, devices, applications or operating systems. 2: A set of pre-made functions used to build programs. APIs ask the operating system or another application to perform specific tasks. There's an API for almost everything, including messaging APIs for email, telephony APIs for calling systems, Java APIs and graphics APIs such as DirectX.	API	*Infoway*	
Application Programming Interface	A set of standard software interrupts, calls, functions, and data formats that can be used by an application program to access network services, devices, or operating systems.	API	IEEE	
Application Role	A role played by a healthcare information system component when sending or receiving HL7 messages; a set of responsibilities with respect to an interaction.		HL7	
Application Server	1: Program on a distributed network that provides business logic and server side execution environment for application programs. 2: A computer that handles all operations between a company's back-end applications or databases and the users' computers' Web browsers	App Server	*Infoway*	
Application Software	Any data entry, update, query or report program that processes data for a user. It includes generic productivity software (spreadsheets, word processors, database programs, etc.) as well as custom and packaged programs for any industry or purpose.	Apps	*Infoway*	Application, Application Program
Arch 1	See Architecture Project 1			
Arch 2	See Architecture Project 2			

Term	Definition	Acronym	Reference	Synonym
Architectural Pattern	Fundamental structural organizational schema for software systems. It provides a set of pre-defined sub-systems, specifies their responsibilities, and includes rules and guidelines for organizing the relationships between them.		Bushmann, et al. (group of four)	
Architecture	A software architecture is an abstraction of the run-time elements of a software system during some phase of its operation. A system may be composed of many levels of abstraction and many phases of operation, each with its own software architecture.		[RoyFielding Thesis]	
Architecture	Architecture is a term applied to both the process and the outcome of specifying the overall structure, logical components, and the logical interrelationships of a computer, its operating system, a network, or other conception.		ANSDIT	
Architecture	The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components, and the relationships among them.		[Soft Arch Pract]	
Architecture Project 1	Electronic Health Record Solution Blueprint. This initiative will define the "common blueprint" for the overall EHR solutions including the technology standards and guidelines that will help determine how the system is designed and built. One of the key advantages of this blueprint is that it will help jurisdictions develop their technical roadmaps and ensure rapid development and deployment of EHR solutions at lower costs. It will also ensure the integration of existing systems and systems from various vendors into the EHR solution. The architecture will be developed with experts from the field and end users. The project will also compare the current state of solution architecture in jurisdictions with the planned future state in order to develop a plan to help jurisdictions migrate to and adopt the reusable components of the EHR solution.	Arch 1	*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Architecture Project 2	Architecture - Data Definitions and Standards. This initiative will ensure the development of common standards and data definitions for EHR solutions. The purpose of this project is to accelerate the development of EHR solution components. Phase I of the project has been initiated to develop a detailed plan and stakeholder engagement strategy for Phase 2, where the EHR data definitions and standards will be further defined. Stakeholders will be involved throughout the process and the approach will endeavour to build on the collaborative efforts of existing standards groups and EHR initiatives in Canada and internationally. *Infoway* is collaborating with the Canadian Institute for Health Information (CIHI) on this initiative.	Arch 2	*Infoway*	
Assembly Services	A business request may include calls to various components providing multiple result sets. These result sets will be assembled together in the appropriate output format by the assembly service. This service will use assembly templates to carry out its function.		*Infoway*	
Auditing Services	This service provides the capability to configure auditing of information and provides the interfaces that would need to be accessed within other services for audit support. The audit service will manage its own data source and use other services such as workflow, data service, reporting etc.		*Infoway*	
Authentication	Establishes the validity of a claimed identity and provides protection against fraudulent transactions. It could include 2-factor authentication, 3-factor authentication, authentication function, digital signature, personal identification number, token etc.		*Infoway*	
Authentication Services	This service provides an interface to validate the user accessing EHR business services. The authentication service will attach to various configured mechanisms for authentication such as userid/password, certificates, FOBs etc.		*Infoway*	
Authoritative Source of Data	Application system that provides data that is guaranteed to be correct.		*Infoway*	
Authorization	1: Process of determining what activities are permitted, usually in the context of authentication. 2: The permission to perform certain operations or use certain methods or services.		*Infoway*	
Availability	The assurance that a system/resource is always assessable. This aspect of the system is often coupled with measures of its performance.		[Sun J2EE]	

Term	Definition	Acronym	Reference	Synonym
B				
Best Practices	Practices that have been shown in actual application to be of value.		*Infoway*	
Biometrics	Electronic capture and analysis of biological characteristics, such as fingerprints, facial structure or patterns in the eye. Through advancements in smart cards and cheaper reader prices, biometrics is catching on as a security alternative to passwords.		*Infoway*	
Broker	Application system that acts as a intermediary between two collaborating systems or services		*Infoway*	
Broker Services	This service reads business messages that have been transformed to a canonical form and instantiates the appropriate workflow that will be used to process the business request.		*Infoway*	
Business Architecture	Defines the organization and functions of the business and the business processes that support those functions.		*Infoway*	
Business Process	A set of interacting activities that produce one or more products or services for customers of the business enterprise.		*Infoway*	
Business Rule	A business rule is a statement that defines or constrains some aspect of the business. It is intended to assert business structure or to control or influence the behaviour of the business.		*Infoway*	
Business Rule Services	This service will provide a collection of business rule components and associated data that will be used to process business functions. These rules will be data driven instead of being hard-coded in program logic.		*Infoway*	
Business Services	Group of services that deal with specific business messages that are sent for processing. Services in this group manage internal business workflow, assembly of responses, application of business rules and integration with various other business engines and components.		*Infoway*	
C				
Cache	A small fast memory holding recently-accessed data, designed to speed up further access		*Infoway*	
Caching Services	This service is used to manage the cache and will provide functions related to cache responses based on configured settings. These settings may include time to live, persistence, cache cycling, parameter/role/facility based caching etc.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Capability	Non-functional, observable system qualities that do not represent specific functions and cannot be satisfied by any one component. These are emerging properties that are observed in a collection of components working together.		[Sun J2EE]	
Capacity	The ability to run a number of jobs per unit of time.		[Sun J2EE]	
CDA	See Clinical Document Architecture			
CDR	See Clinical Data Repository.			
Certificate Authority	An independent licensing agency that vouches for a person's identity in encrypted electronic communication. Acting as a type of electronic notary public, a CA verifies and stores a sender's public and private encryption keys and issues a digital certificate, or "seal of authenticity," to the recipient.	CA	*Infoway*	
Change Management	A set of principles, techniques, and prescriptions applied to the human aspects of executing major change initiatives in organizational settings.	CM	*Infoway*	
CIS	See Clinical Information System.	CIS		
Client	A client is a specific individual within the health care industry.		*Infoway*	Patient, Person
Client Application	Application systems that access/use one or more EHRS services.		*Infoway*	
Client Browser	See Web Browser.			
Client Registry	A Client Registry is the area where a patient/client's information (i.e. Name, Date Of Birth, SIN, Health Access #) is securely stored and maintained.		*Infoway*	
Client Registry Index	This index provides a single system identifier for clients and maps with multiple identifiers in various client registries.		*Infoway*	
Client Registry Service	An EHRS Business Service that provides access to the list of all clients (persons) in a particular jurisdiction, where each individual is assigned a single, unique, life-long client identification number. This service supports capabilities to search for a client based on a set of parameters.		*Infoway*	
Clinical Data	Any information element obtained during an encounter relating to the assessment of a client's health state, diagnostic of ailments/diseases and/or treatments.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Clinical Data Repository	An operational data store that holds and manages clinical data collected from service encounters at the point of service locations (e.g. hospitals, clinics, etc.). Data from a CDR can be fed to the EHR for that client, in that sense the CDR is recognized as a source system for the EHR.	CDR	*Infoway*	
Clinical Document Architecture	The CDA, which was until recently known as the Patient Record Architecture (PRA), provides an exchange model for clinical documents (such as discharge summaries and progress notes)—and brings the healthcare industry closer to the realization of an electronic medical record. The CDA Standard is expected to be published as an ANSI approved standard by the end of the year.	CDA	HL7	
Clinical Information System	A clinical information system is a system dedicated to collecting, storing, manipulating and making available clinical information important to the delivery of healthcare. Clinical information systems may be limited in scope to a single area (e.g. lab system, ECG management system) or they may be comprehensive and cover virtually all facets of clinical information (e.g. electronic patient/client the original discharge summary residing in the chart, with a copy of the report sent to the admitting physician, another copy existing on the transcriptionist's machine, etc.)	CIS	*Infoway*	
Clinical System	See Clinical Information System.	CIS		
Clinically Relevant Data	Any clinical data about a client that is deemed necessary or desirable to have available during an encounter. Relevance is expressed in relation to different perspectives set by factors such as disciplines in healthcare practice or context around an episode of care or elapsed time. Therefore relevance of data varies greatly and is hard to assess firmly.		*Infoway*	
Common Services	A type of software service that can be shared across multiple applications. These include services such as messaging, security, logging, auditing, mapping, etc. Common Services are part of the Health Information Access Layer (HIAL).		*Infoway*	
Common Terms and Codes Repository	A collection of accepted terminology and codification schemes used to describe clinical information, classifications and states.		*Infoway*	
Communication Bus	Part of the Health Information Access Layer (HIAL) that allows applications to communicate according to standard messages and protocols.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Component	A component is a software object, meant to interact with other components, encapsulating certain functionality or a set of functionalities. A component has a clearly defined interface and conforms to a prescribed behaviour common to all components within an architecture.		[CCA T&D]	
Component	Individual part of the whole. The discrete parts that must be combined to produce a working and useful result. Examples of technology infrastructure components include hardware platforms, operating systems, database systems, networks, etc.		*Infoway*	
Component Object Model	1: Microsoft's framework for object- oriented programming and the basis for ActiveX. Objects created using COM can be accessed by any other COM-compliant application. 2: COM+ is an extension of Component Object Model (COM), Microsoft's strategic building block approach for developing application programs. COM+ is both an object-oriented programming architecture and a set of operating system services. It adds to COM a new set of system services for application components while they are running, such as notifying them of significant events or ensuring they are authorized to run. COM+ is intended to provide a model that makes it relatively easy to create business applications that work well with the Microsoft Transaction Server (MTS) in a Windows NT or subsequent system.	COM(+)	Microsoft	
Conceptual Architecture	1: A general design that indicates the overall intent and outline of the target architecture, architecture lays the foundation and defines the process that will be used to develop the target architecture. 2: A Conceptual Architecture describes or defines a technology solution at the functional level, without regard to a particular physical implementation. The Conceptual Architecture is used to create a comprehensive view of the system components, relationships, and interfaces needed to meet a technology requirement.		*Infoway*	
Confidentiality	A security technique that permits read access and retrieval by authorized entities only.		IEEE	
Configuration Repositories	Part of the EHR Services, these databases contain all parameters required to configure, tune and operate the service.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Configuration Services	This service is used to configure the EHRS. This includes configuration of the EHR data repository, the system, the metadata, the service components, EHR indexes, schema support, security, session and caching mechanism etc.		*Infoway*	
Consent	Explicit granting of access to specified information.		*Infoway*	
Context Services	Part of the HIAL Common Services Layer. This group of services manages the context and provides session and caching management services.		*Infoway*	
Continuum of Care	A holistic approach to healthcare delivery across multiple providers, aiming to improve the quality of care and promote wellness.		*Infoway*	
D				
Data Dimensions	Different views of patient/client data, for example by disease, by encounter, by time, etc.		*Infoway*	
Data Mart	1: A well organized, user- centred, searchable database system. A data mart picks up where a data warehouse stops- by organizing the information according to the user's needs (usually by specific subjects), with ease of use in mind. 2: A repository of data that serves a particular community of knowledge workers. The data may come from an enterprise wide database or a data warehouse.		*Infoway*	
Data Model	Describes the organization of data in an automated system. The data model includes the subjects of interest in the system (or entities) and the attributes (data elements) of those entities. It defines how the entities are related to each other (cardinality) and establishes the identifiers needed to relate entities to each other (primary and foreign keys). A Data Model can be expressed as a Conceptual, Logical, or Physical model.		*Infoway*	
Data Services	Group of services that will hold metadata for operations that are carried out on repositories and abstract data access services for specific database management systems.		*Infoway*	
Data Types	The categories of data that will be persisted in the EHR. They include voice, waveforms, clinical notes and summaries, diagnostic imaging, lab and pharmacy information.		*Infoway*	
Data Warehouse	A database of information intended for use as part of a decision support system. The data is typically extracted from an organization's operational databases		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Database Management System	Systems that manage large structured sets of persistent data, offering ad hoc query facilities to many users. They are widely used in business applications: commercial examples include DB2, Oracle, SQL-Server, Sybase etc.	DBMS	*Infoway*	RDBMS
DBMS	See Database Management System			
Decision Support System	Software that taps into database resources and massages and presents data to assist users in making business decisions. A clinical decision support system gives physicians structured (rules-based) information to help make decisions on diagnoses, treatment plans, orders and results.	DSS	*Infoway*	
Delivery Site	A geographic or physical point of the specific site where a service is delivered, along with the attributes and capabilities of that point. Types of delivery Site are Facility, Multi-function structure and Scene		CIHI and Alberta Health and Wellness	
Deployment Architecture	1: The "roll-out" configuration for a technical architecture (see Architecture). 2: Detailed plan of how systems will be implemented as part of a technical project.		*Infoway*	
Design	1: Phase of software development following analysis, and concerned with how the problem is to be solved. 2: The process and result of describing how a system or process is to be automated. Design must thoroughly describe the function of a component and it's interaction with other components. Design usually also identifies areas of commonality in systems and optimizes reusability.		*Infoway*	
Design Pattern	Scheme for refining the sub-systems or components of a software system, or the relationships between them. It describes a commonly recurring structure of communicating components that solves a general design problem with any particular context.		Gamma, et al. (group of four)	
DI	See Diagnostic Imaging.			
Diagnostic Imaging	The use of digital images and textual reports prepared as a result of performing diagnostic studies such as x-rays, cat scans, MRI, etc.		*Infoway*	
DICOM	See Digital Imaging and Communications in Medicine.			
Digital Imaging and Communications in Medicine	A standard developed by the American College of Radiology and the National Equipment Manufacturers Association to define the connectivity and communication protocols of medical imaging devices.	DICOM	*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Digital Certificate	A digital document issued by a certification authority that contains the holder's name, serial number, public key and the document's expiration date. Digital certificates are used in public key infrastructure to send and receive secure, encrypted messages.		*Infoway*	
Digital Signature	An electronic equivalent of a signature used to verify authorship or information source.		*Infoway*	
Domain	The problem or subject to be addressed by a set of HL7 messages or by a system ("application domain"). A particular area of interest in healthcare.		HL7	
Domain Data	Clinical data that is specific to a particular domain. (e.g. drug, lab, diagnostic imaging, etc.)		*Infoway*	
Domain Repository	A Domain Repository is a component of an EHRi that stores, maintains and provides access to specific clinical subset of data at a jurisdictional level. The key data domains recognized as part of an EHR are drugs, laboratory and diagnostic imaging. In Canada today, some of these data domains may be already deployed as jurisdictional level systems in given jurisdictions. An EHR Infostructure must be able to assemble information transparently from these domains in order to provide the complete clinical picture of a patient/client.		*Infoway*	
DSS	See Decision Support System			
E				
EAI	See Enterprise Architecture Integration.			
EHR	See Electronic Health Record.			
EHR Data	The collection of all clinical data related to a particular patient/client.		*Infoway*	
EHRi	See Electronic Health Record Infostructure.			
EHR Index Services	This is an index of EHRs. Provides the means by which location of information in an EHR or Domain Repository can be discovered for a client.		*Infoway*	
EHR Infostructure	Collection of common and reusable components in the support of a diverse set of health information management applications. It consists of software solutions for the EHR, data definitions for the EHR and messaging standards for the EHR.		*Infoway*	
EHR Services	High-level software components that encapsulate all business processing and accessibility functions relating to EHR data.		*Infoway*	
EHRS	See Electronic Health Record Solution.			

Term	Definition	Acronym	Reference	Synonym
EHRS Locator	Service that enables the discovery of specific EHRS where a given client has data across a network of EHRS systems.		*Infoway*	
Electronic Health Record	1. An Electronic Health Record (EHR) provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The record is available electronically to authorized health care providers and the individual anywhere, anytime in support of high quality care. 2. In an EHRi, the EHR is the central component that stores, maintains and manages clinical information about patients/clients. The extent of the clinical information sustained by the EHR component may vary based namely on the presence or absence of Domain Repositories in any given jurisdiction.	EHR	*Infoway*	
Electronic Health Record Solution	The Electronic Health Record Solution is a combination of people, organizational entities, business processes, systems, technology and standards that interact and exchange clinical data to provide high quality and effective healthcare.	EHRS	*Infoway*	
Electronic Patient Record	Electronic set of information about a single patient/client. An Electronic patient record system is a system specifically designed to provide patient/client records electronically. This is not necessarily restricted to a single clinical information system.	EPR	*Infoway*	
EMPI	See Enterprise Master Person Index.		*Infoway*	
Encoding-Decoding Services	This service will encode and/or decode message from and to different coding formats such as Unicode, UTF-8, and Base64 etc.		*Infoway*	
Encounter	An Encounter is a service event that occurs within an Episode of Care.		*Infoway*	
Encryption-Decryption Services	This encrypts and decrypts messages. It could use X.509 certificates and other cryptography mechanisms.		*Infoway*	
Enterprise Architecture	A framework that defines the overall structure of a business. It uses different perspectives or views such as business processes, information, systems and technology required to operate a business.	EA	*Infoway*	
Enterprise Architecture Integration	Tools and techniques that promote, enable and manage the exchange of information and distribution of business processes across multiple application systems, typically within a sizeable electronic landscape, such as large corporations, collaborating companies and administrative regions.	EAI	*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Enterprise Master Patient Index or Enterprise Master Person Index	An EMPI (Enterprise Master Person Index) is a system which coordinates client identification across multiple systems namely by collecting and storing IDs and person-identifying demographic information from source system (track new persons, track changes to existing persons). These systems also take on several other tasks and responsibilities associated with client ID management. See Client Registry section of the EHRS Blueprint.	EMPI	*Infoway*	
Enterprise Scheduling	The ability to schedule procedures, exams and appointments across multiple systems and/or locations spanning an entire jurisdiction.		*Infoway*	
Episode	See Episode of Care.			
Episode of Care	An Encounter or series of Encounters related to the detection and subsequent care for a particular healthcare requirement.		*Infoway*	
ETL Services	Extract Transform and Load (ETL) service will interact with ETL tools or ETL like components to bulk load transactions into the EHR repositories.	ETL	*Infoway*	ETL Tool
ETL Tool	System or utilities that extract data from various data sources, transform them to the required destination format and load them in the target data sources.		*Infoway*	ETL Services
Exception Error Handling Services	This service provides an interface to raise and manage errors and other business level exceptions. Exceptions can range from system/application level exceptions to exceptions found as a result of corrupt or dirty data and other such conditions.		*Infoway*	
Extensibility	The ability to economically modify or add functionality.		[Sun J2EE]	
Extensible Mark-up Language	XML is a mark-up language for structuring arbitrary data based on element tags and attributes.	XML	*Infoway*	
Extensible Mark-up Language	Describes a class of data objects called XML documents and partially describes the behaviour of computer programs which process them. XML is an application profile or restricted form of SGML, the Standard Generalized Mark-up Language [ISO 8879]. By construction, XML documents are conforming SGML documents	XML	[XML-1.0]	
Extensible Stylesheet Language	Stylesheet Language that can be used for displaying XML documents. XSL Transformation (XSLT) is used to transform the XML document and XSL Formatting Objects (XSL-FO) is used to render the transformed document.	XSL	*Infoway*	

Term	Definition	Acronym	Reference	Synonym
F				
Facility	A type of Delivery Site that has constant capability and capacity to provide health services, and is administered by a health service organization. See Delivery Site		*CIHI*	
Facility Registry	An application service supporting the creation and administration of unique identifiers for health services delivery sites. See Delivery Site)		*Infoway*	
Feeder Systems	Operational systems that will feed patient/client data to the EHR in the form of real-time single, multiple messages or batch file uploads. Also see Source Systems.		*Infoway*	
File Transfer Protocol	1: A standard high-level protocol for transferring files of different types between computers over a TCP/IP network. FTP can be used with a command line interface or graphical user interface 2: The name of a utility program available on several operating systems which makes use of this protocol to access and transfer files on remote computers.	FTP	*Infoway*	
Firewall	A computer networking security device that controls access to network resources (e.g. computers and systems) using pre-defined security policies and rules		*Infoway*	
Flexibility	The ability to support architectural and hardware configuration changes.		Sun J2EE	
Framework	In object-oriented systems, a set of classes that embodies an abstract design for solutions to a number of related problems. Frameworks can be horizontal or vertical. An example of a horizontal framework is the Presentation framework (GUI); and example of a vertical framework is a business accounting framework.		*Infoway*	
G				
Gen 1	"The Foundation" – First generation of development and deployment of EHRS solution components, which includes the common building blocks needed to support subsequent generations.		*Infoway* Business Plan	
Gen 2	"The Documentor" – Second generation of development and deployment of EHRS solution components, where authorized healthcare professionals can view clinical information on-line, through an EHR, in their work environment using "customized viewers" (e.g., for Physicians, nurses, etc.)		*Infoway* Business Plan	

Term	Definition	Acronym	Reference	Synonym
Gen 3	"The Helper" – Third generation of development and deployment of EHRS solution components, where authorized healthcare professionals can view AND record integrated information & do on-line ordering through an EHR. The EHR solution tracks a patient/client through the system & initiates alerts.		*Infoway* Business Plan	
Gen 4	"The Mentor" – Fourth generation of development and deployment of EHRS solution components, where complex, sophisticated & fully integrated systems provide EHR solutions across the continuum of care. Systems can actually guide clinicians based on standardized protocols.		*Infoway* Business Plan	
General Services	Part of the HIAL Common Services, this group of services provides auditing log management and general error and exception handling.		*Infoway*	
Graphical User Interface	An interface to an application that allows users to do things by clicking on a visual screen, as opposed to typing commands on a line. GUIs (pronounced "gooey") feature the following components: a pointing device (such as a mouse), icons, windows and menus.	GUI	*Infoway*	
Groupware	Any technology that allows people to collaborate electronically, including email, real-time networking and conference tools based on telephony, video or the Web. Workflow automation, enterprise resource planning and even telemedicine systems are all groupware at the root.		*Infoway*	
Groupware	Software that permits multiple users on a network to work together; for example, software for electronic mail, for scheduling and planning, and for file sharing.		ANSDIT	
GUI	See Graphical User Interface			
H				
Harmonization of Roles	The attempt to synchronize different health care professional roles (i.e. PCP to specialist to hospital) via an EHR.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Health Insurance Portability and Accountability Act of .1996	A complex law that protects a person's credit for previous healthcare insurance to cover pre-existing conditions when changing health plans and institutes new mandates concerning electronic healthcare transactions and data. It requires that the Department of Health and Human Services adopt standards for electronic health transactions, including health claims and attachments, enrolment / dis-enrollment, eligibility, payments and premiums, claims status, referral authorizations and digital signatures. It also requires the creation of unique identifiers and standards for data confidentiality.	HIPAA	*Infoway*	
Health Authority	See Regional Health Authority.	HA		
Health Information Access Layer	The Health Information Access Layer is an interface specification for the EHR Infostructure (OSI Layer 7) that defines service components, service roles, information model and messaging standards required for the exchange of EHR Data and execution of interoperability profiles between EHR Services	HIAL	*Infoway*	
Health Level Seven	Health Level Seven is one of several ANSI-accredited Standards Developing Organizations (SDOs) operating in the healthcare arena. Most SDOs produce standards (sometimes called specifications or protocols) for a particular healthcare domain such as pharmacy, medical devices, imaging or insurance (claims processing) transactions. Health Level Seven's domain is clinical and administrative data.	HL7	HL7	
HIAL	See Health Information Access Layer			
HIS	See Hospital Information System.			
HL7	See Health Level Seven.			
HL7 V3	Refers to Version 3.X of the HL7 standard.		*Infoway*	
Home Care	Delivery of health care services to the place of residence of the patient/client.		*Infoway*	
Hospital Information System	Generic term to describe application systems that manage all facets of a hospital operation, including administrative and clinical records.	HIS	*Infoway*	
HTTP	See Hyper Text Transfer Protocol.			
Hyper Text Transfer Protocol	An Internet protocol that defines message format and transmission for media objects in a TCP/IP network. HTTP is typically used to transmit HTML documents between a web server and a web client, e.g., a browser.	HTTP	IEEE	

Term	Definition	Acronym	Reference	Synonym
Hyper Text Transfer Protocol	Hyper Text Transfer Protocol is the protocol used for information exchange on the World Wide Web (WWW). HTTP defines how messages are formatted and transmitted, and what actions a HTTP server and an HTTP client should take in response to various messages. HTTP is the set of rules for exchanging files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.	HTTP	*Infoway*	
Hyper Text Transfer Protocol	Name of an application protocol providing means to transfer hypertext documents between servers and clients. HTTP is the abbreviation for Hypertext Transfer Protocol.	HTTP	ANSDIT	
Hyper Text Transfer Protocol over Secure Socket Layer (HTTP over SSL)	HTTPS is a secure way of using HTTP. It supplements HTTP's transport layer, the insecure TCP, with Secure Socket Layer (SSL), a secure transport layer. HTTPS is a Web protocol developed by Netscape and built into its and other browsers that encrypts and decrypts user page requests as well as the pages that are returned by the Web server.	HTTPS	*Infoway*	
I				
IEEE	Institute of Electrical and Electronics Engineers, Inc.		IEEE	
Ilities	Represents the different factors that have to be analyzed in the context of enterprise architecture. It includes scalability, reliability, availability, extensibility, portability, maintainability, performance etc.		*Infoway*	
Implementation	Implementation is the carrying out, execution, or practice of a plan, a method, or any design for doing something. Implementation is the action that must follow any preliminary thinking in order for something to actually happen.		*Infoway*	
Information Model	A structured specification of the information requirements of a project. An information model expresses the classes of information required and the properties of those classes, including attributes, relationships, and states. Examples are the Domain Reference Information Model, Reference Information Model, and Refined Message Information Model.		HL7	
Integrated Client	Existing applications in hospitals and other medical facilities that will provide EHR functionality by integrating with the EHRi using specified HL7 v3 messages.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Integration	1: The process of bringing together related parts into a single system. To make various components function as a connected system. 2: Combining separately developed parts into a whole so that they work together. The means of integration may vary, from simply mating the parts together at an interface to radically altering the parts or providing something to mediate between them.		*Infoway*	
Integration Layer	Software component that presents a single, consolidated point of access to several systems and/or services.		*Infoway*	
Integration Services	This group of services is made up of services that manage the integration, message brokering and service catalogue functions.		*Infoway*	
Intelligent Agent	A program, usually small in scope and size, that represents a person, a system or an organization in the context of automating a task or a part of a task. Intelligent agents will typically gather information, apply business logic to that information and deliver information as a result of that logic to a person, an organization and/or another system.		*Infoway*	
Interaction Model	Logical diagram or narrative describing the exchange of data and sequence of method invocation between objects to perform a specific task within a use case.		*Infoway*	
Interface	1: A set of logical constructs whose purpose is to enable the connection between two or more entities in order to exchange information. Examples of interfaces are: the graphic user interface (GUI) between a system and an end user; a programming interface, consisting of the set of statements, functions, options, and other ways of expressing program instructions; the logical arrangement supporting the attachment of any device to connect to another device. 2: The electronic connection where two parts of a system are joined such as where a software program meets a hardware component, or where hardware meets an input device. Also used to describe software that joins two different information systems		*Infoway*	
Interop Services	Part of the HIAL common services layer. Group of services that insure the interoperability between systems involved in an EHR infostructure. It includes services such as interoperability services and search and resolution services.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Interoperability	1: The ability of hardware and software from different vendors to understand each other and exchange data, either within the same network or across dissimilar networks. 2: The ability of autonomous systems to work with other dissimilar systems. Interoperable systems interact through standardized interfaces. They are often loosely coupled and exchange information in an asynchronous manner. Interoperable systems can function without knowing the internal processes, functions, and data representations of other systems.		*Infoway*	
Interoperability	The ability of two or more systems to exchange information or function together.		IEEE	
ISO	International Organization for Standardization. Note that ISO is not an acronym; instead, the name derives from the Greek word "isos" which means equal. Founded in 1946, ISO is an international organization composed of national standards bodies from over 75 countries. For example, ANSI (American National Standards Institute) is a member of ISO. ISO has defined a number of important computer standards, the most significant of which is perhaps OSI (Open Systems Interconnection), a standardized architecture for designing networks.		ISO	
IT Blueprint	1: Document which outlines the structure and necessary components of a technology plan that will satisfy various stakeholder guidelines/requirements. Its purpose is to be a tool to assist in designing a technology plan to meet business objectives. 2: Specific code plans to build an IT solution. More commonly known as "Technical Architecture".		*Infoway*	
J				
Java	Java is a groundbreaking computing platform released by Sun Microsystems in 1995 that opens up a wealth of exciting possibilities for consumers. It enables the same application to run on lots of different computers and devices.		[Sun J2EE]	
Jurisdiction	A geopolitical entity that governs the administration, operation and/or delivery of healthcare. Typically represented by Provinces, Territories, Regional Authorities or localized hospital partnerships.		*Infoway*	
Jurisdictional Health Database	Data repository containing clinical data pertaining to a particular jurisdiction, typically with or for the purpose of health surveillance.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
K				
Key Management Services	As data is brought in from various sources, there will be cases where certain primary source identity keys are not unique across source systems. The key management service will generate and manage keys during insert and update operations in the EHR repository.		*Infoway*	
L				
Laboratory Information System	Generic term to describe application systems that manage all facets of a clinical laboratory operation, including acquiring and distributing results of laboratory exams as part of clinical records.	LIS	*Infoway*	
Legacy System	Generic term that is often used to reference application/processing systems that were designed and deployed in the past.		*Infoway*	
LIS	See Laboratory Information System.			
Location	See Place		*Infoway*	
Log Management Services	A basic system component that is responsible for creating and managing details of system and application events.		*Infoway*	
Logical Observation Identifiers, Names and Codes	A database protocol aimed at standardizing laboratory and clinical codes for use in clinical care, outcomes management and research. Developed by the Regenstrief Institute for Health Care, LOINC is touted as a middleman solution to potential translation problems between labs that use HL7 reporting and recipient systems that may not be able to translate such data	LOINC	*Infoway*	
Longitudinal	Involving the repeated observation or examination of a set of subjects over time with respect to one or more study variables (as general health, the state of a disease, or mortality).		Webster	
Longitudinal Record	Patient/client centric electronic health information spanning from the earliest event to the most recent encounter.		*Infoway*	
Loosely coupled	Loosely coupled application roles do not assume that common information about the subject classes participating in a message is available to system components outside of the specific message.		HL7	
LTC	Long Term Care.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
M				
Maintainability	A measure of the ease with which maintenance of a functional unit can be performed using prescribed procedures and resources. Synonymous with serviceability.		ANSDIT	
Malleability	See Flexibility.			
Manageability	The ability to manage a system to ensure the continued health of a system with respect to the other capabilities.		Sun J2EE	
Management Services	1: Part of the HIAL Common Services Layer. This group of services provides services to configure the EHRi and the associated HIAL as well as providing services to carry out management functions. 2: This service provides a common interface to manage various aspects of the EHRi. Whereas configuration services handle the system level configuration, management services handle the user configuration aspects of the system.		*Infoway*	
Mapping Services	The mapping service helps create a map file that translates a source document format to the destination format. This service can be used to map from XML to flat file and other formats and vice versa.		*Infoway*	
MDF	See Message Development Framework			
Message	A package of information communicated from one application to another. See Message Type and Message Instance.		HL7	
Message Development Framework	Message Development Framework. The collection of models, methods, and tools that comprise the methodology for specifying HL7 Version 3 messages. This framework is used by developer of the HL7 standards. The HL7 V3 Guide is a summary of the content of the methodology.	MDF	HL7	
Message Instance	A message as formatted for a specific transmission. Two messages may be described by the same message type and identified with the same interaction and yet vary in the instance because of variations in values, presence or absence of the data being sent and different cardinalities of collections. Otherwise identical messages may be different instances if they are sent at different times or by a different sender.		HL7	

Term	Definition	Acronym	Reference	Synonym
Message Type	The organization of message elements that is specified in a Hierarchical Message Description. Each message type is communicated as part of one or more interactions in the interaction model. A message type in effect constitutes a set of rules for constructing a message given a specific set of instance data. It also defines the rules for parsing a message to recover the instance data. The message type is independent of the Implementation Technology Specification, so that if the same data is sent using the same message type and different implementation technology specifications it will be possible to transliterate from one to the other.		HL7	
Messaging Services	Part of the HIAL Communication Bus, group of services that handle messages. Services in this group include parsing, serialization, encryption and decryption, encoding and decoding, transformation and routing.		*Infoway*	
Metadata	Data definitions describing aspects of the actual data items, such as name, format etc.		*Infoway*	
Middleware	Software systems that facilitate the interaction of disparate components through a set of commonly defined protocols. The purpose is to limit the number of interfaces required for interoperability by allowing all components to interact with the Middleware using a common interface.		*Infoway*	
Migration Plan	See Transition Plan			
Model	A representation of a problem or subject area that uses abstraction to express the relevant concepts. A model is often a collection of schema and other documentation.		HL7	
Modifiability	Modifiability refers to the way the logical constructs of systems are designed and built to allow for them to be easily changed in the future. Elements such as comments and documentation of code, approaches used to separate elements of programs, clarity and cleanliness around the reuse of common functions, are all examples that influence the modifiability of a system.		*Infoway*	
Modularity	The design goal of separating code into self sufficient, highly cohesive low coupling pieces.		[Sun J2EE]	
Multi-Function Structure	A type of Delivery Site where services may be delivered by specific arrangement with a Delivery Organization, but otherwise has some other primary purpose (e.g., a school). See Delivery Site		CIHI	

Term	Definition	Acronym	Reference	Synonym
N				
Network Protocol Services	The network protocol service will provide communication capabilities over the physical network. The primary network protocol that will be supported is TCP/IP.		*Infoway*	
Non-Clinical Data	Information that is not specifically related to health (i.e. phone number, address… etc.)		*Infoway*	
Non-Repudiation	Assurance that a principal (user) cannot deny being the originator of a message (or transaction) after sending it.		*Infoway*	
Normalization	The process of creating a uniform and agreed upon set of standards, policies, definitions and technical procedures to allow for interoperability.		*Infoway*	
Normalization Services	This service will take various concepts from different sources, normalize and store them in the EHRs internal form. This service could be extended to include normal values based on incoming and outgoing profiles.		*Infoway*	
O				
Object	1: In computer security, an entity to which access is controlled; for example, a file, a program, an area of main storage; data collected and maintained about a person. 2: In programming languages, a set of operations and data that store and retain the effect of the operations. Objects are implemented as packages or tasks in Ada, as "modules" in Modula-2, and as "objects" in Smalltalk. In object-oriented programming, an object is an instance corresponding to a class definition. 3: In artificial intelligence, a physical or conceptual entity that may have one or more attributes		ANSIDT	
Object	An object is a unit which exists and acts inside a computer system. Each object is an instance of a class and contains information represented by attributes whose structure is defined in the class. An object can receive the messages defined in its class, that is, it has appropriate operations for each message defined.		UML	
Object Model	Conceptual representation, typically in the form of a diagram, which describes a set of objects and their relationship.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Object-Oriented	Applied to analysis, design and programming. The basic concept in this approach is that of objects, which consist of data structures encapsulated with a set of routines, often called "methods" which operate on the data. Operations on the data must be performed via these methods, which are common to all instances of objects of a particular class. Thus, the interface to objects is well defined, and allows the code implementing the methods to be changed so long as the interface remains the same	OO	*Infoway*	
Object-Oriented	Pertaining to a technique or to a programming language that supports objects, classes, and inheritance. Some authorities list the following requirements for object-oriented programming: information hiding or encapsulation, data abstraction, message passing, polymorphism, dynamic binding, and inheritance.		ANSDIT	
ODS	See Operation Data Store			
OLTP	See On-Line Transaction Processing			
On-Line Transaction Processing	Mode of operation used by application systems where requests for information or updates (transactions) are executed in real time.	OLTP	*Infoway*	
Open Source Software	Open source refers to any program whose source code is made available for use or modification as users or other developers see fit. OSS is developed as a public collaboration and made freely available. Definition model of distribution terms require that: (1) The software must be redistributed without any restriction, (2) The source code must be made available (3) The license can require improved versions of the software to carry a different name or version from the original software. Linux is the most common form of OSS.	OSS	*Infoway*	
Open Systems Interconnection	A seven-layer reference model developed by ISO as a framework for the development of standards for interconnecting heterogeneous computers. The layers from the top are Application, Presentation, Session, Transport, Network, Data Link and Physical.	OSI	*Infoway*	
Open Systems Interconnection	The interconnection of open systems in accordance with ISO/IEC standards and ITU-T Recommendations for the exchange of data.		ANSDIT	
Operational Data Store	Repository of clinical data used by Client Applications to create, update and process encounter specific information at the points of service.	ODS	*Infoway*	
OR / ER	Operating Room, or Emergency Room		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Order Entry System	An application system that provides the ability to create and manage orders for exams, drugs, procedures and/or other materials.		*Infoway*	
P				
PACS	See Picture Archiving and Communications System			
Parser	A function that recognizes valid sentences of a language by analyzing the syntax structure of a set of tokens passed to it from a lexical analyzer.		*Infoway*	
Parser	A software tool that parses programs or other text, often as the first step of assembly, compilation, interpretation, or analysis.		ANSDIT	
Parser Services	This service will parse the messages that come in through the protocol layer. The parser will provide support for input formats such as XML, flat files positional, flat file fixed field length etc.		*Infoway*	
Patient Centric	A design goal or characteristic that establishes that all information in an application system shall be grouped and/or indexed according to the patient/client.		*Infoway*	Person Centric
Patient Record	A Patient record is information about a single patient/client. The Patient record system is the set of components that comprise the mechanism by which patient/client records are created, used, stored and retrieved. The system includes the patient/client records and associated metadata. Patient record system metadata is data about the patient/client record system. This includes administrative metadata (lists of doctors, assembly order, copies of allowable forms, etc. and clinical metadata (current nursing procedures, historical practice standards, charting by exception standards). Metadata is required to describe the patient record system more fully and to define the standard of practice at the time of the recorded events, thus providing context for historical decisions.		*Infoway*	
Patterns	See Design Pattern or Architectural Pattern.		*Infoway*	
PCP	See Primary Care Physician			
Peer-to-peer	A variant of the client-server architectural pattern in which components can serve as both servers and clients to each other.		*Infoway*	
Peer-to-Peer Network	A computer network that contains only equivalent nodes with respect to their capability of control or operation.		ANSDIT	
Performance	The ability to execute functions fast enough to meet requirements.		[Sun J2EE]	S43

Term	Definition	Acronym	Reference	Synonym
Permission Management Services	This service will provide the capability to configure and manage permissions to users and more specifically define roles for access to functions and data.		*Infoway*	
Personal Health Information	Expression that generally describes all clinical and non-clinical information that is health related for an individual	PHI	*Infoway*	
Personal Information Protection and Electronic Document Act	An Act to support and promote electronic commerce by protecting personal information that is collected, used or disclosed in certain circumstances, by providing for the use of electronic means to communicate or record information or transactions and by amending the Canada Evidence Act, the Statutory Instruments Act and the Statute Revision Act.	PIPEDA	The Privacy Commissioner of Canada	
PET	See Privacy Enhancing Technologies			
PHI	See Personal Health Information			
PGP	See Pretty Good Privacy			
Pharmacy IS	Pharmacy Information System. See PMS.		*Infoway*	
Pharmacy Management System	An application used by Pharmacy to manage fulfillment of prescriptions, claims processing and other administrative functions.	PMS	*Infoway*	
Physician Management System	An application used by Doctors to manage patient/client records, profiles, appointments, billing and other administrative functions.	PMS	*Infoway*	PPM
Physician Practice Management System	See Physician Management System.	PPM		PMS
Picture Archiving and Communications System	1: Application system that uses an image server to exchange X-rays, CT scans and other medical images over a network. Mini-PACS specialize in one type of image such as an ultra- sound. 2: Application system that is used to store, retrieve and manage digital images.	PACS	*Infoway*	
PIPEDA	See Personal Information Protection and Electronic Document Act	PIPEDA	PIPEDA	S121
Place	A Place is a named physical geographic location. The name and set of coordinates (i.e. a geographic point or set of points) allows any point or area that is of interest to the health system to be represented in space. A place may be a point, line, area or three-dimensional structure. See also Delivery Site		*CIHI*	Location

Term	Definition	Acronym	Reference	Synonym
Platform for Privacy Preferences	A project of the World Wide Web Consortium (W3C) that will give consumers a way to learn about and react to the way websites may be using personal information.	P3P	*Infoway*	
PMS	1: See Pharmacy Management System 2: See Physician Management System 3: See Practice Management System			
Policy Management Services	Policy management services will provide an interface to configure and manage policies for access, auditing, logging, consent and other policies required for operation of the EHRi.		*Infoway*	
Portability	The capability of a program to be executed on various types of data processing systems with little or no modification and without converting the program to a different language.		ANSDIT	S43
PoS	Physician Office System		*Infoway*	
Practice Management System	Generic term used to reference a management system. See Pharmacy Management System, or Physician Management System			
Prescription	1: a written direction for the preparation, compounding, and administration of a medicine 2: a prescribed remedy 3: a written formula for the grinding of corrective lenses for eyeglasses 4: a written direction for the application of physical therapy measures (as directed exercise or electrotherapy) in cases of injury or disability	Rx	Merriam Webster	
Presentation Services	1: Service that provides user interface capabilities and deals with formatting and presenting data to the user. May use user profiles/preferences, personalization, stylesheets etc. 2: Client Application systems that allows authorized users to access and view patient/client EHR Data in as easily customizable manner. Also know as Presentation Systems or EHR Portal.		*Infoway*	
Pretty Good Privacy	A popular and low-cost encryption tool for sending, receiving and storing secure email, including digital signatures. PGP uses a public/private key system built on one of two main encryption algorithms (RSA or Diffie-Hellman)	PGP	*Infoway*	
Primary EHR	In a peer-to-peer network of EHR Solutions deployed across many jurisdictions, the primary EHR is the one system across a chain of EHR systems recognized as the main locator of information for a given client.		*Infoway*	S94

Term	Definition	Acronym	Reference	Synonym
Primary Care Physician	A physician involved in a practice that acts as the first line of access to the healthcare system. Usually a general practitioner (GP).	PCP	*Infoway*	
Privacy	Freedom from intrusion into the private life or affairs of an individual when that intrusion results from undue or illegal gathering and use of data about that individual.		ANSDIT	
Privacy	The right of an individual to live free of intrusive monitoring of their personal affairs by third parties not of their choosing.		*Infoway*	
Privacy Enhancing Technologies	Technologies used to protect privacy rights and secure transactions on the Internet or other networks. It includes methods such as encryption, digital signatures and digital certificates as well as both private and public key methods encryption environments.	PET	*Infoway*	
Protocol	1: A set of rules that determines the behaviour of functional units in achieving communication. 2: In programming languages, the set of rules that determines the behaviour of objects in the exchange of messages. 3: In OSI, a set of semantic and syntactic rules that determine the behaviour of entities in the same layer in performing communication functions.		ANSDIT	
Protocol	1: An agreement about how to transmit data, especially across networks. Low level protocols define the electrical and physical standards to be observed, and deal with the transmission and error detection and correction of the bit stream. High level protocols deal with the data formatting, including the form of messages, the terminal to computer dialogue, files, etc. 2: A way of doing things that has become an agreed-upon convention, or "rule." In electronic communication, if several systems use the same protocols, they operate in a similar way and can easily exchange data. Standard protocols have evolved on a national and international basis for data exchange, language translation and use of the Internet, to name a few. 3: a detailed plan of a medical experiment, procedure, or treatment.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Protocol Services	Part of the HIAL Communication Bus, group of services that deal with the network, transport and application level protocols. These services will support pluggable modules to support various protocols. For example protocol support for application level protocols such as SOAP and remoting protocols such as RMI, DCOM etc. could be available using plug-ins.		*Infoway*	
Prototype	A model created to simulate all aspects of a product. Some offer the end-user the ability to review all aspects of the user interface and the structure of documentation and reports before code is generated.		*Infoway*	
Provider	Any supplier of a healthcare service		*Infoway*	
Provider Registry	A Provider Registry is a system or a combination of systems where a health care provider's information (i.e. name, address, practice licences, etc…) is securely stored, maintained and made available to other systems and users.		*Infoway*	
Proxy Generator	A software tool that will be able to generate reusable interface components for a variety of technical environments. This software tool is able to discover and read integration profiles descriptions from the service catalog services of the HIAL common services layer. These descriptions allow a proxy generator to create object classes or other software components that become available for other systems to interact with. These components, called "proxies" will be specific to particular programming languages such as Java, C++ or correspond to higher level environments such as XML templates or others…		*Infoway*	
Publish Subscribe Services	This service provides functions at two levels. One at the integration level where subscribers of data are provided with content over appropriate integration channels. The other is at a higher level, where users can subscribe to specific content. When the specific condition is observed or a subscribed content is published then the user is notified with that information. This service manages subscribers and publishers.		*Infoway*	
Public Key Infrastructure	The architecture, organization, techniques, practices and procedures that collectively support the implementation and operation of a certificate based public key cryptographic system	PKI	*Infoway*	
Public Key/Private Key	In cryptography, a public key is used to encrypt or decrypt text and can live anywhere and travel through e-mail or other public channel. A private key lives on a hard drive or other secret place.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Q				
Queue	A storage concept in which data are ordered in such a manner that the next data item to be retrieved is the one stored first. This concept is characterized as "first-in-first-out" (FIFO).		*Infoway*	
Queuing Services	This service provides store and forward capabilities. It can use message queues as well as other persistence mechanisms to store information. This service can be used for asynchronous types of operations.		*Infoway*	
R				
Reference Architecture	Generalized architecture of several end systems that share one or more common domains. The reference architecture defines the infrastructure common to the end systems and the interfaces of components that will be included in the end systems. The reference architecture is then instantiated to create a software architecture of a specific system. The definition of the reference architecture facilitates deriving and extending new software architectures for classes of systems. A reference architecture, therefore, plays a dual role with regard to specific target software architectures. First, it generalizes and extracts common functions and configurations. Second, it provides a base for instantiating target systems that use that common base more reliably and cost effectively.		w3.org	
Region	A geographic area definable by boundaries.		*Infoway*	
Regional Health Authority	Administrative organization responsible for managing the operation and delivery of healthcare to the community of a defined geographical region within a Province or Territory.		*Infoway*	
Registration Authority	A registration authority is an authority in a network that verifies user requests for a digital certificate and tells the certificate authority (CA) to issue it. RAs are part of a public key infrastructure (PKI), a networked system that enables companies and users to exchange information and money safely and securely.	RA	*Infoway*	
Registry	Directory-like system that focuses solely on managing data pertaining to one conceptual entity. In an EHRi, registries store, maintain and provide access to peripheral information not categorized as clinical in nature but required to operationalize an EHR. The primary purpose of a Registry is to respond to searches using one or more pre-defined parameters in order to find and retrieve a unique occurrence of an entity. Examples of registries include: Client Registry, Provider Registry, Location Registry, and Consent Registry.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Relational Database Management System	A Database management system based on the relational model developed by Codd. It allows the definition of data structures, storage and retrieval operations, and integrity constraints. In such a database, the data and relations between them are organized in tables. Ingres, Oracle, Microsoft SQL Server are well-known examples.	RDBMS		
Reliability	The ability to ensure the integrity and consistency of an application and its transactions.		[Sun J2EE]	
Remote Procedure Call	A call to a routine that results in code being executed on a different system from the one where the request originated. An RPC system allows calling procedures and called procedures to execute on different systems without the programmer needing to explicitly code for this.	RPC		
Replication	The process of making a copy of something. When using a groupware product, replication means copying a database from one server to another so that all users share the same information.		*Infoway*	
Replication Services	This service would provide data replication to other data sources. It may be used to keep data synchronized with source systems or with other systems participating in the EHR infostructure.		*Infoway*	
Repository	1: A collection of information. 2: An implementation of a collection of information along with data access and control mechanisms, such as search, indexing, storage, retrieval and security.		IEEE	
Reusability	The ability to use code developed for one application in another application-traditionally achieved using program libraries.		*Infoway*	
Reference Information Model	HL7 information model from which all other information models (e.g., R-MIMs) and messages are derived.	RIM	HL7	See R-MIM,
RIM	See Reference Information Model.			
R-MIM	Information structure that represents the requirements for a set of messages. A constrained subset of the RIM which may contain additional classes that are cloned from RIM classes. Contains those classes, attributes, associations, and data types that are needed to support one or more HMDs. A single message can be shown as a particular pathway through the classes within an R-MIM.	R-MIM	HL7	See RIM

Term	Definition	Acronym	Reference	Synonym
R-MIM diagram	A diagrammatic representation of an R-MIM. Possible formats include UML and the HL7 R-MIM graphic format.		HL7	
Roadmap	See Transition Plan.			
Role Based Access Control	Security environment in which users' rights to access or change information are controlled by the role or roles they fulfill within the organization; that is 'what' they are, rather than 'who' they are.	RBAC	*Infoway*	
Routing Services	This service will route messages to the various internal integration channels based on a publish/subscribe model.		*Infoway*	
Rx	See Prescription.			
S				
Scalability	The ability to support the required quality of service as load increases.		[Sun J2EE]	
Scene	A type of Delivery Site that may have characteristics of interest, but has no persistent capability to deliver services. There may or may not be a physical structure. See Delivery Site		*CIHI*	
Search/ Resolution Services	This service is used to interface with resolution services present in registries such as client, provider and other registries. It is also used to resolve situations where clinical data about a client resides in different locations and systems across an interoperated network of EHRS.		*Infoway*	
Security	The ability to ensure that information is neither modified nor disclosed except in accordance to the security policy.		[Sun J2EE]	
Security Architecture	A plan and set of principles for an administrative domain and its security domains that describe the security services that a system is required to provide to meet the needs of its users, the system elements required to implement the services, and the performance levels required in the elements to deal with the threat environment. A complete security architecture for a system addresses administrative security, communication security, computer security, emanations security, personnel security, and physical security, and prescribes security policies for each. A complete security architecture needs to deal with both intentional, intelligent threats and accidental threats. A security architecture should explicitly evolve over time as an integral part of its administrative domain's evolution.		[RFC 2828]	

Term	Definition	Acronym	Reference	Synonym
Security Domain	An environment or context that is defined by security models and a security architecture, including a set of resources and set of system entities that are authorized to access the resources. One or more security domains may reside in a single administrative domain. The traits defining a given security domain typically evolve over time.		[RFC 2828]	
Security Infostructure	Mechanisms to authenticate and authorize a user to access the EHR.		*Infoway*	
Security Model	A schematic description of a set of entities and relationships by which a specified set of security services are provided by or within a system.		[RFC 2828]	
Security Policy	A set of rules and practices that specify or regulate how a system or organization provides security services to protect resources. Security policies are components of security architectures. Significant portions of security policies are implemented via security services, using security policy expressions.		[RFC 2828]	
Security Repositories	Set of databases used by the EHR Services that contain Security Policies and user authentication.		*Infoway*	
Security Service	A processing or communication service that is provided by a system to give a specific kind of protection to resources, where said resources may reside with said system or reside with other systems, for example, an authentication service or a PKI-based document attribution and authentication service. A security service is a superset of AAA services. Security services typically implement portions of security policies and are implemented via security mechanisms.		[RFC 2828]	
Security Services	1: Part of the HIAL Common Services, this group of services is made up of authentication and authorization services and includes policy and permission management functions as well as interfaces to security mechanisms used for the above functions. 2: This service will manage the implementation of security from the perspective of confidentiality, encryption of data and integrating with the authentication, authorization and auditing functions.		*Infoway*	
Serialization Services	This service will package the message in the destination format from the internal canonical form. This could be XML, flat file positional, flat file fixed field length etc. The serialization service is concerned with data/message persistence		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Service	Discrete units of application logic that expose loosely coupled message-based interfaces suitable for being accessed across a network.		*Infoway*	
Service	Encapsulated functionalities that serve multiple components, hiding the details of implementation and providing API's to allow use of the service.		[Sun J2EE]	
Service Catalogue Services	Every business message that is supported by the EHR is registered using the service catalog service. This service manages the service catalog along with a service description. Proxy generators can use the service description to create proxy classes.		*Infoway*	
Service Event	The act of providing a health related service.		*Infoway*	
Service Oriented Architecture	An infrastructure where many N-tier applications are deployed, sharing common software services that are accessible from any user interface. In this environment, any application can access any service, provided the application has the proper security permissions. The greatest strength of a service-oriented architecture is the potential for repeatable rapid development of new applications. It depends on interoperable services for the provision of high-value business logic processing.		*Infoway*	Event
Session Management Service	This service manages user sessions. A user session will contain information such as ticket number, function and role information, authorization information and other information that the system may choose to store to provide efficient access to information.		*Infoway*	
Simple Object Access Protocol	Lightweight protocol intended for exchanging structured information in a decentralized, distributed environment. It uses XML technologies to define an extensible messaging framework providing a message construct that can be exchanged over a variety of underlying protocols. The framework has been designed to be independent of any particular programming model and other implementation specific semantics.	SOAP	[SOAP-1.2]	
Site-of-Care	Location where healthcare is delivered to the patient/client.		*Infoway*	
SNOMED	See Systematized Nomenclature of Human and Veterinary Medicine		*Infoway*	
SOAP	See Simple Object Access Protocol.			
Source of Truth System	System of record for clinical information about patients/clients. Considered to be the definitive and authoritative information source.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Source Systems	Application systems where service encounter data is collected (e.g. laboratory information systems, pharmaceutical information systems, immunization systems and so on). This clinical data is extracted from the source system and transformed prior to it being used in the electronic health record.		[ACHI-EHR]	
Subscription Services	Part of the HIAL Common Services, this group of services provides the capabilities to subscribe to events and manage the alerts and notifications functions when enabled.		*Infoway*	
Surveillance Data Source	Application system or services that provide clinical and demographic data to be used by Health Surveillance Systems		*Infoway*	
System Interface	See Interface.			
Systematized Nomenclature of Human and Veterinary Medicine	A standardized vocabulary system for medical databases. Current modules contain more than 144,000 terms and are available in at least 12 languages.	SNOMED	*Infoway*	Feeder Systems
T				
TCP	See Transmission Control Protocol.		*Infoway*	
TCP/IP	See Transmission Control Protocol-Internet Protocol.		*Infoway*	
Technical Architecture	1: A technical architecture identifies and describes the types of applications, platforms, and external entities; their interfaces; and their services, as well as the context within which the entities interoperate. The technical architecture is the basis for selecting and implementing the infrastructure to establish the target architecture. 2: The specific code plans to build an IT solution is called the Technical Architecture. It is the IT "blue print" of the planned technical roll out.		*Infoway*	
Testability	The ability to determine what the expected results should be.		[Sun J2EE]	
Tightly coupled	Tightly coupled application roles assume that common information about the subject classes participating in a message is available to system components outside of the specific message.		HL7	
Transaction	A unit of interaction with a DBMS or similar system. It must be treated in a coherent and reliable way independent of other transactions.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Transformation Services	This service will use the maps generated by the mapping service for the different message definitions and transform them to the EHRs canonical form. This service will also transform messages from the canonical form to the output format.		*Infoway*	
Transition Plan	A high level strategy/map that will guide the adoption of the EHRS blueprint by jurisdictions across Canada.		*Infoway*	Migration Plan, Roadmap
Transmission Control Protocol/Internet Protocol	1: Transmission Control Protocol/Internet Protocol (TCP/IP) is the language governing communications between all computers on the Internet. TCP/IP is a set of instructions that dictates how packets of information are sent across multiple networks. It also includes a built-in error-checking capability to ensure that data packets arrive at their final destination in the proper order. 2: A reliable connection-oriented protocol originated by DARPA for internetworking, encompassing both network and transport level protocols. While the terms TCP and IP specify two protocols, TCP/IP is often used to refer to the entire DoD protocol suite based upon these, including Telnet, FTP, UDP, and RDP.	TCP/IP	*Infoway*	
Transmission Control Protocol-Internet Protocol	Suite of interrelated protocols used for data transfer and routing on the Internet.	TCP/IP	IEEE	
Transmission Control Protocol-Internet Protocol	Two interrelated protocols that are part of the Internet Protocol suite. TCP operates in the transport layer and breaks data into packets and uses IP to route them between and into networks to produce an end-to-end capability. TCP/IP is the abbreviation for Transmission Control Protocol/Internet Protocol.	TPC/IP	ANSIDT	
Transmission Control Protocol	A connection-oriented protocol designed to provide a communications protocol used in the Internet. TCP provides a reliable host-to-host protocol between hosts in packet-switched communications networks and in interconnected systems of such networks. TCP corresponds approximately to the transport layer protocols within the OSI reference model.	TCP	ANSIDT	
Trust based security	Security management and access provision based on trusted domains or facilities.		*Infoway*	
Trust Relationship	A relationship between two entities (systems or individuals) which defines what each party is allowed to do or access within the other party's security domain, typically guaranteeing a certain minimum level of security.		*Infoway*	

Term	Definition	Acronym	Reference	Synonym
Two/Three Factor Authentication	Authentication process using two factors, typically with something you have and something you know e.g. FOB and password. 3-factor authentication process uses three factors: something you have, something you know and something you are e.g. FOB, password and fingerprint.		*Infoway*	
U				
UDDI	See Universal Description, Discovery, and Integration.			
UDP	See User Datagram Protocol.			
Uniform Resource Locator	The term "Uniform Resource Locator" (URL) refers to the subset of URI that identify resources via a representation of their primary access mechanism (e.g., their network "location"), rather than identifying the resource by name or by some other attribute(s) of that resource. Much like a postal system, every page on the World Wide Web has a unique address, or URL. To visit a Web site, the user simply types the address into the browser program.	URL	*Infoway*	
Uniform Resource Identifier	Uniform Resource Identifiers (URI) provide a simple and extensible means for identifying a resource. A URI can be further classified as a locator, a name, or both.	URI	*Infoway*	
Universal Description, Discovery, and Integration	UDDI (Universal Description, Discovery, and Integration) is an XML-based Registry for businesses worldwide to list themselves on the Internet. Its ultimate goal is to streamline online transactions by enabling companies to find one another on the Web and make their systems interoperable for e-commerce. UDDI is often compared to a telephone book's white, yellow, and green pages. The project allows businesses to list themselves by name, product, location, or the Web services they offer.	UDDI	*Infoway*	
Usability	Quality attributed to an application system that describes its effectiveness and ease of use as determined by its users.		*Infoway*	
Use Case	A use case describes a set of activities of a system from the point of view of its actors, which lead to a perceptible outcome for the actors. A use case is always initiated by an actor. In all other respects, a use case is a complete, indivisible description.		UML	
User	1: A person, device, program, or computer system that uses a computer system for the purpose of data processing and information exchange. 2: In electronic mail, a person or a functional unit that participates in message handling as a potential source or destination.		ANSDIT	

Term	Definition	Acronym	Reference	Synonym
User Datagram Protocol	A connectionless communication protocol, that corresponds approximately to transport layer protocols within the OSI reference model.	UDP	ANSDIT	
User Datagram Protocol	Internet standard protocol for sending datagrams between user programs. This protocol neither guarantees delivery nor does it require a connection. As a result it is lightweight and efficient, but all error processing and retransmission must be taken care of by the application program. This protocol is built on top of IP and uses IP for datagram delivery.	UDP	*Infoway*	
V				
VB	Microsoft™ Visual Basic programming language.		*Infoway*	
Vendor	A company/consortium that provides EHRS products and/or services.		*Infoway*	
Virtual Private Network	Refers to a network in which some of the parts are connected using the public Internet, but the data sent across the Internet is encrypted, so the entire network is "virtually" private.	VPN	*Infoway*	
Virtual Private Network	Secure and encrypted connection between two points across the Internet. VPNs transfer information by encrypting and encapsulating traffic in IP packets and sending the packets over the Internet. That practice is called tunnelling. Most VPNs are built and run by Internet service providers and secure protocols like Point to Point Tunnelling Protocol (PPTP) to ensure that data transmissions are not intercepted by unauthorized parties.	VPN	*Infoway*	
Visit	An episode of care at a healthcare facility.		*Infoway*	Encounter Episode
VPN	See Virtual Private Network.			
W				
W3C	See World Wide Web Consortium.			
Web Browser	Software used to access, display, and navigate hypermedia information on the Web.		IEEE	
Web Services	A Web service is a software system identified by a URI [RFC 2396], whose public interfaces and bindings are defined and described using XML. Its definition can be discovered by other software systems. These systems may then interact with the Web service in a manner prescribed by its definition, using XML based messages conveyed by Internet protocols.		W3.org	

Term	Definition	Acronym	Reference	Synonym
Web Services	An application capable of being defined, located via the Internet protocol, and interacting with other software applications, identified by a Uniform Resource identifier.		ANSIDT	
Web Services Description Language	Provides a model and an XML format for describing Web services. WSDL enables one to separate the description of the abstract functionality offered by a service from concrete details of a service description such as "how" and "where" that functionality is offered.	WSDL	[WSDL-1.2]	
Workflow	1: A process description of how tasks are done, by whom, in what order and how quickly. Workflow can be used in the context of electronic systems or people, i.e. an electronic workflow system can help automate a physician's personal workflow. 2: The way in which work units (information or actions) are routed through an organization or through a system. It can be formalized in terms of rules incorporating dependencies, staff roles etc. and hence automated.		*Infoway*	
Workflow Services	The workflow service is responsible for maintaining lists of active components and the workflow schedules/process. It assembles the components and uses an executable engine to execute the workflow.		*Infoway*	
World Wide Web	1: A project originated at CERN, aimed at providing hypertext-style access to information from a wide range of sources. 2: The graphical interface with which millions of users access Internet files that conform to the hypertext protocol (HTTP) The Web is the most accessible and widely used branch of the Internet.	WWW	*Infoway*	
World Wide Web Consortium	An international organization that develops programming and interoperability standards for the Web. Among its many projects, W3C is involved in initiatives for digital signatures, XML and Dynamic Hypertext Mark-up Language (DHTML).	W3C	*Infoway*	
WSDL	See Web Services Description Language			
WWW	See World Wide Web			
X				
XML	See Extensible Mark-up Language.			
Y				
Z				

11 APPENDIX D - ACKNOWLEDGEMENTS

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- Mr. Geoff Rabbie, New Brunswick Health and Wellness
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- Mr. John Waldron, Courtyard Group
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- Mr. Trevor Cook, Microsoft Canada

Infoway would also like to celebrate the involvement of the many different groups and teams within the organization that have provided their input and support to the realization and publication of the EHRS Blueprint. Namely the Information Management & Technology team, the Change & Evaluation Services team, the Communications Group, the Solutions Architecture Group and all *Infoway* staff members who contributed to the writing and reviewing of the Blueprint materials.

Finally, but not least, the EHRS Blueprint project team itself deserves a lot of credit for all the hard work that was accomplished in setting forward an updated pan-Canadian validated vision of the Electronic Health Record. True to the collaborative nature of *Infoway*, the EHRS Blueprint project succeeded in involving IT and Healthcare specialists with different backgrounds and from different organizations to put their resources together and leverage their respective knowledge to accomplish this daunting task. Our special thanks go to the members of the core team:

- Mr. Bill Gilliam, System Architect, Canada Health *Infoway*
- Dr. Brent Jones, Sierra Systems
- Mr. Claude Rheault, Project Manager, Canada Health *Infoway*
- Ms. Jane Curry, Health Information Strategies
- Mr. Robert Caron, Group Director of Architecture, Canada Health *Infoway*
- Mr. Ron Parker, Director of Architecture, Canada Health *Infoway*
- Mr. Stephen D'Silva, Silvacorp
- Ms. Sylvie Limoges, R3D Information and Technology

As well as everyone who has provided their support, help and feedback in the course of the project.

12 APPENDIX E - FUTURE CHANGES

The EHRS Blueprint architecture is expected to evolve constantly. Several sources may influence the evolution of the architecture, namely:

- User groups and ongoing consultations in the healthcare industry provide a constant feed of new information that may lead to evolutions of the architectural concepts set forth in the Blueprint
- New projects financed by Infoway can apply their findings against the original architectural concepts and induce changes or additions to parts of the Blueprint
- Other initiatives pertaining to EHR and ongoing in Canada may provide new concepts that need to be integrated in the EHRS Blueprint
- Other International EHR initiatives advancing the cause around the world can also induce changes or additions to the architecture on an ongoing basis
- Internationally recognized standards organizations addressing the EHR or peripheral domains of information such as registries, health surveillance or others can also provide advances that may be integrated in the EHRS Blueprint

Infoway keeps track of all requests for changes and evaluates those for integration in the EHRS Blueprint on a regular basis.

As stated in section 2.7.6 Version 2 of the Blueprint is the last version to be produced as a monolithic set of documentation. Further refinements and updates that may be required following requests for changes will be published through the Artefact Repository.

13 APPENDIX F - CONTACT INFORMATION

Resource	Address
To reach the Architecture team at *Infoway*	archinfo@*Infoway*-inforoute.ca
To access Infoway's Knowledge Way Portal and the discussion forum on the EHRS Blueprint – look at the Communities of Practice	http://knowledge.infoway-inforoute.ca/
To reach *Infoway* for any other matters	info@*Infoway*-inforoute.ca
To access the *Infoway* website	http://www.infoway-inforoute.ca/
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Toronto Office	150 King Street West, Suite 1300 Toronto, Ontario, Canada, M5H 1J9
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14 APPENDIX G - LEGAL DISCLAIMER

Canada Health *Infoway* Inc. (**"*Infoway*"**) is a not-for-profit corporation formed at the beginning of 2001. Its members are made up of the Deputy Ministers of Health for Canada, its Provinces and Territories. The corporate mission of *Infoway* is to foster and accelerate the development and adoption of electronic health information and compatible standards and communication technologies on a pan-Canadian basis with tangible benefits to Canadians and their health care system through collaborative partnerships. As part of its mission, *Infoway*, through consultation with health care providers, information technology experts and consultants, has sought to formulate a blueprint for an electronic health record solution (the **"EHRS Blueprint"**). The following is the latest version of this EHRS Blueprint. The EHRS Blueprint is continuously being updated as a result of ongoing consultations with, and feedback from, members of the health care and information technology community with whom *Infoway* is in contact.

It is the intent of *Infoway* that the EHRS Blueprint will serve as the basis of the architecture of the electronic health record solution on a pan-Canadian basis.

Any person reviewing the EHRS Blueprint agrees to the following:

1. **The EHRS Blueprint represents solely the views of *Infoway* and should not be construed as having been endorsed by, or representing the view of, any of its members or any government, public authority, public body or regulatory agency, although the input of various organizations was obtained. Infoway's views are based on information that has been obtained in the existing EHR environment, which Infoway believes is sound and reliable, as well as the input received as a result of various consultations as set out before.**

2. **As the EHR is in constant evolution Infoway's views as well the EHRS Blueprint may be amended or updated at any time and from time to time by *Infoway*, without notice. It is your responsibility to verify if any changes have been made to the EHRS Blueprint, by *Infoway* from time to time.**

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reference may be made directly or indirectly to any such technology or solution in the EHRS Blueprint.

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10. **The EHRS Blueprint is the property of *Infoway* and *Infoway* reserves all rights therein.**

15 APPENDIX H – INDEX

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