**Preliminary-Report on**

CIMI-FHIM-SOLOR Integration: Observations, Recommendations and Challenges

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**Session**: Recommendations for an Integrated Approach

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## Executive Summary

The scope for this preliminary-report is the discussions about how the CIMI, FHIM, SOLOR and other modeling initiatives, such as CQI and CQF, can work together to unify modelling efforts to address the inconsistencies of the “models, models everywhere” situation. This preliminary report covers the January-July HL7 CIMI and August HIEA Technical Forum preparatory meetings’ observations, recommendations and challenges. So far, modelling-SME’s agreed to the following foundational principles: 1) A clean separation of model semantics[[3]](#footnote-3) 2) using SNOMED, LOINC and RxNORM.

Building on these two foundational principles, we should next collaborate to construct a non-overlapping work-plan for autonomous governance-and-program-execution; where, we can independently build models for computably-interoperable implementations, harmonized by the foundational principles. The final report adds the August meeting’s observations, recommendations and challenges in preparation to develop a 2017 HL7 Project Scope Statement for Federal Partner and HL7 management vetting and approval after initial vetting at the September HL7 meeting.

Our focus is “Information Modelling: Foundation to Semantic Interoperability”; where, we collectively believe 1) the integrated CIMI-FHIM-SOLOR models are the basic foundation and 2) this stable foundation’s reuse is profoundly essential for seamless computable semantic-interoperability e.g., to ensure we don’t lose our way on the path-to “all-things-FHIR[[4]](#footnote-4)” based computable-interoperability. Many subject matter experts are concentrating on the essential role that information models and associated tooling have in relation to computable semantic-interoperability, from a full software development lifecycle perspective. In this way, we are supporting key recommendations the Congress asked the HITPC[[5]](#footnote-5) to make to the National Coordinator in 2015. Chief among these is that the federal government take a leadership role in defining the “right” approach to enable widespread interoperability in the near-term.

We present a path-forward by weaving together many concurrent threads to create a foundational-and-reusable health information-model “stack” for future modeling and development efforts. This integration draws upon many existing efforts, and coordinates those efforts around a single, powerful goal of creating consistent logical-specifications for interoperable-implementations for the content of computable electronic health records, care-plans and other shared healthcare information.

* The SMEs recommend the recommended “stack” be a CIMI curated (or similar entity curated[[6]](#footnote-6)) HL7/ISO Common Logical Information Model (CLIM) standard, based on the integrated CIMI-FHIM-SOLOR; where, CLIM is a coined term for the collection of independently-created consistent-models harmonized by the principles, discussed above.
* This integration approach harmonizes clinical practice needs with domain requirements models, clinical ontologies, medical vocabularies and existing healthcare information standards.

There are, of course, many barriers to interoperability (including intentional information blockage, privacy and security, workflow and other organizational issues). However, achieving a basic level of computability across healthcare systems—defined by the HITPC as the ability of a receiving system to understand the meaning of data transmitted—has been frustratingly difficult. Agreeing on universal adoption of standards-based EHR systems (and requiring certification) was considered key, but at a more foundational level, we now recognize that we must agree on common, non-overlapping, but, connected logical-and-physical information models to enable computable-interpretability among systems; where, tools can transform the logical to physical models and vice-versa. We are addressing this issue front-and-center and will next focus on a WBS (Work Breakdown Structure) to make this goal a reality.

Here is our concise assessment:

* **The problem** is that today’s systems do not capture information and its context consistently, and consequently, cannot easily share-or-merge information from different sources to create a computable operational-picture (aka longitudinal patient-records, care-plans and other shared healthcare information across time, multiple care locations and differing contexts).
* **The information modelling goal** is to define compose-able common healthcare information artifacts and terminology value sets, that can serve as the basis for patient-safe frictionless information-sharing, analytics and the creation of deterministic, aggregated, portable and computable patient-records, care-plans and other shared healthcare information.
* **The recommended solution** involves the integration and standardization of the integrated CIMI-FHIM-SOLOR foundational healthcare information-model “stack” composed of a rich collection of re-usable information artifacts used to specify computable patient-health data-sets compose-able into actionable patient-information. These computable data-sets are for exchange, research, analytics and clinical decision support. Each information model and each model’s data-set (e.g., Fast Healthcare Interoperability Resource) is defined with an unambiguous and computable meaning, employ a specific, shared vocabulary, have a specific information structure and is compose-able into higher-level concepts (aka actionable information). Analogous ISO-CIMI models are being harmonized.
* **The benefit** of a standardized reusable modelling-foundation is computable-interoperability aka interpretability across time, locations and care contexts, assuming the re-usable “stack” is standardized and has widespread implementation. This information-model “stack” foundation is mission-essential for
  + collection, communication, aggregation and interpretation of patient data to accelerate secondary uses in public health, disease surveillance, post-approval monitoring, and patient-centered outcomes research.
  + health-related services including telecare, clinical decision support, research, and quality measurement, improving healthcare access, quality, and uniformity.
  + patients, clinicians, and the public to realize major benefits from improved care coordination, reduction of medical errors, and decreased costs resulting in healthier lives.

## Introduction

Since January 2016, the CIMI sponsored HL7 “CIMI-FHIM integration Investigative-Study” and more recently the “CIMI-FHIM Integration Task-Force” developed “Observations, Recommendations and Challenges for an Integrated CIMI-FHIM-SOLOR and other models, e.g., CQI and CQF is based on review of the following initiatives and teams:

* **FHIM** is Federal Healthcare Information Model, which is a high-level logical healthcare model, which covers approximately 30 clinical domains and has been vetted by Federal Agency SMEs and clinicians.
* **CIMI** is Clinical Information Model Initiative which defines Terms-of-Reference AKA Principles and modelling style guidelines; where, a CIMI Model is a clear, complete, concise, correct and consistent logical semantic-and-syntactic description of a healthcare concept, which can be instantiated as a computable implementation object that is interoperable among systems. CIMI creates thousands of detailed clinical models **(DCMs**); where, each DCM can have hundreds of context-specific variations, such as vital signs for cardiology, pediatrics, geriatrics, orthopedics, etc. CIMI is based on work by Intermountain Healthcare, Mayo Clinic, OpenEHR, ISO 13606, and was formalized and vetted by IHTSDO and HL7 participants. **HSPC** (Healthcare Service Platform Consortium) is a provider-led organization using CIMI in their quest to accelerating the delivery of a platform that supports innovative healthcare applications for the improvement of health and healthcare.
* **LEGO/SOLOR** creates Lightweight Expression of Granular Objects using SNOMED, LOINC, RxNorm within DCMs**.** VA is investigating LEGOs to be wholly representable within the CIMI Observation result and SNOMED/LOINC observable Model.
* **CQF** is Clinical Quality Framework to support Continuous Quality Improvement (**CQI**) with a Quality Improvement and Clinical Knowledge or **QUICK** data model, Clinical Quality Language (**CQL)** supporting clinical decision support (**CDS**) and clinical quality measures (**CQM**). CQF Framework is a collaborative community of participants from the public and private sectors focused on providing the tools, services and guidance to facilitate the functional exchange of health information.
* **MDHT and MDMI** are Model Driven Healthcare Tools and Model Driven Message Interface are complementary Model Driven Architecture (**MDA**) tooling projects, based on Object Management Group (**OMG**) standards, that deliver the capability for a Semantic Interoperability Guide Generator (**SIGG**). MDHT is an open source project at Eclipse.org that supports a full development lifecycle using the Unified Modeling Language (**UML**) for model design, transformation between alternative model representations, Java code generation, and testing/validation of instance data. MDMI open-source tools define and leverage a shared dictionary of semantic business artifacts that are assigned to model artifacts in various logical and implementation models for healthcare data, including FHIM, C-CDA, FHIR, and others. MDMI + MDHT enables automated generation of Traceability and Gap Analysis reports between any of the mapped models, plus generation of target model profiles for the identified gaps, e.g. FHIR profiles. MDMI tools also include a runtime platform for transforming mapped instances of healthcare data, e.g. C-CDA documents to FHIR resources.
* **FHIR** is Fast Healthcare Interoperability Resources (FHIR, pronounced "Fire") defines a set of "[Resources](http://wiki.hl7.org/index.php?title=Resource)" that represent granular clinical concepts. The resources can be managed in isolation, or aggregated into complex documents. Technically, FHIR is designed for the web; the resources are based on simple XML or JSON structures, with an http-based RESTful protocol where each resource has predictable URL. Where possible, open internet standards are used for data representation. The **Argonaut Project** addresses the recommendations of the JASON Task Force, a joint task force of the HIT Standards and Policy Committees. The purpose of the Argonaut Project is to develop a first-generation API and Core Data Services specification to enable expanded information sharing for electronic health records, documents, and other health information based on the FHIR specification.
* **S&I Framework** isThe Standards and Interoperability (**S&I**) Framework was established by ONC's Office of Standards and Interoperability (**OSI**). The S&I Framework empowered healthcare stakeholders to establish standards, specifications and other implementation guidance that facilitate effective healthcare information exchange. The S&I Framework created a forum – enabled by integrated functions, processes, and tools – where healthcare stakeholders could focus on solving real-world interoperability challenges. The S&I Framework is one approach adopted by ONC's Office of Standards & Interoperability to fulfill its charge of enabling harmonized interoperability specifications to support national health outcomes and healthcare priorities, including Meaningful Use and the ongoing efforts to create better care, better population health and cost reduction through delivery improvements.

Using ONC’s OSI Nationwide Health Information Network (**NwHIN**) 1.0 Portfolio, you can implement solutions that meet Meaningful Use objectives and other national healthcare priorities. The NwHIN 1.0 Portfolio is a collection of standards, services, and policies that form the foundation for meaningful electronic exchange of health information. This portfolio represents a hybrid of existing industry best-practices partnered with new artifacts developed by the S&I Framework community.

* **Interoperability Proving Ground (IPG)**, established by ONC in 2016, replaces the S&I framework; where, IPG is an open community platform to share, learn, and be inspired by interoperability projects taking place across the nation. IPG is the first output of the ONC Tech Lab approach; where, the ONC Tech Lab represents the way in which ONC organizes and approaches its standards and technology work. This principled approach is designed to provide stakeholders with common connection points to ONC's standards and technology efforts.
* **ISO EN** analogous models and standards.
* ISO/tc215 and CEN/tc251 Concurrent Use
  + ISO EN 13606 1-5 (EHRcom)
  + ISO EN 12967 (HISA)
* ISO EN 13940 (ContSys)
* ISO TS 13972 (DCMs)
* SIAMM (Internal Document)

All these initiatives and teams are each interested in working out ways to a coordinated Integrated Information Modelling Approach. Each is interested in ideas on how best to do that, as well as ideas about how they can be useful to HL7, the FHA and our international, federal, corporate and academic stakeholders, and how to address perceptions of barriers to this coordinated approach. As example: All use different formats and rules for ‘simple’ things like: name, address, dates. Resulting in EHR-systems that after decades cannot exchange this ‘simple’ ubiquitous data; let alone clinical / health data.

**NEXT STEP:** is for the CIMI-FHIM Task Force’s observations, challenges and recommendations in this Preliminary Report to be augmented by the HIEA Technical Forum’s “Information Modeling: Foundation to Semantic Interoperability” additions; and where, these combined observations, challenges and recommendations be consolidated and reported in the September Final Report. The final report will be transformed into a DRAFT CIMI sponsored FY2017-FY2019 HL7 Project Scope Statement (**PSS**) and Recommended Work Break Down Structure (**WBS**), to be presented-to and vetted-by the FHA Federal Partners for potential leadership endorsement and appropriate sponsorship. The PSS will also be presented and discussed at the September 2016 HL7 meeting in Baltimore, MD and approved after successful FHA, Federal Partner and HL7 management vetting and update. Following are Frequently Asked Questions.

## What’s the Problem?

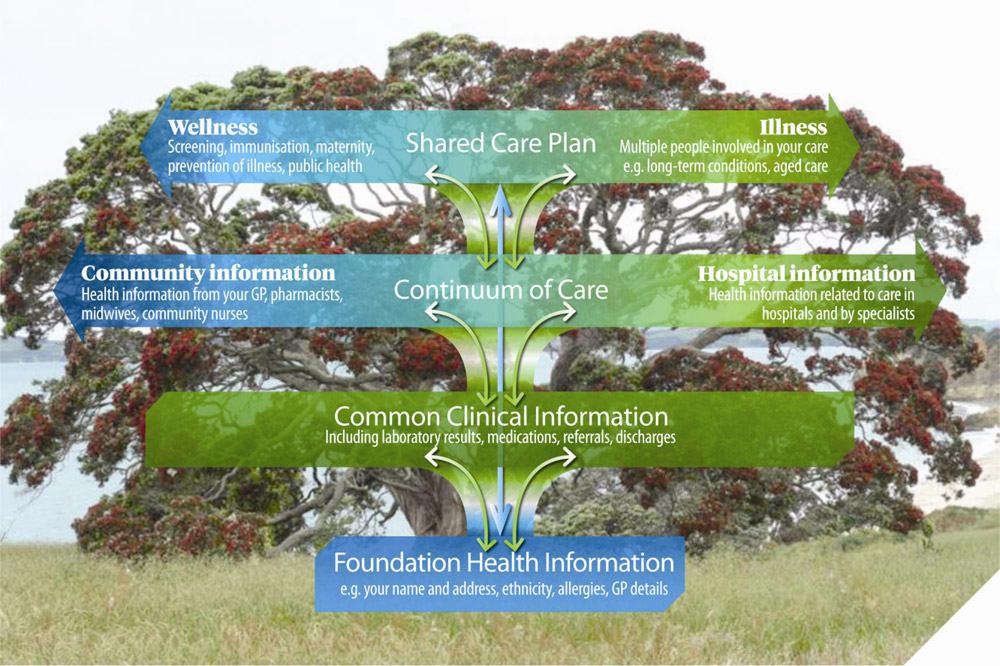


Figure 1 Shared Health Information-Model ‘Tree’ Diagram

The Figure 1 metaphor[[7]](#footnote-7) of the IT solutions required to achieve an eHealth vision. An individual’s health information collected over time can be thought of as being like a ‘tree’. This ‘tree’ has levels which build on each other to provide a connected, health information story:

* + an individual’s foundation health information provides the ‘roots’
  + an effective and secure system for sharing information represents the ‘trunk’
  + common clinical information, continuum of care, and a shared care plan represent the ‘branches’ of the tree.

Healthcare remained a paper-based system long after most other domains had embraced modern IT infrastructure and electronic data capture. It is only recently that electronic specification of data has been emerging as the norm. While the adoption of this IT infrastructure has been a significant step forward, the opportunity for an evolutionary process towards data consensus was not possible. Where other industries shifted to electronic records and data gradually, healthcare is very rapidly making the shift with many provider organizations and vendors developing capabilities in parallel; where, everyone wants their data specification and management approach to be “The Standard”; but, as long as we don't work together we’re just creating more divergence. This rapid progress locked in many inconsistencies in data capture and representation.

The industry has looked towards interoperability standards as a way to address the lack of consistency in healthcare data. However, the very lack of data consistency has led to exchange standards that are purposefully left extremely flexible, leaving many options to model the same thing differently. Even very recent standards like FHIR have made the decision to remain very flexible. This has led to inconsistent implementation, low levels of semantic interoperability and complex resource intensive message implementation methods needing an additional organization, such as IHE and their implementation guides. HL7 FHIR Resources, with extensions and profiles, have inconsistencies similar to those which legacy HL7 V2 with Z segments had 10-20 years ago. As an example, the HL7 EHR Interoperability workgroup, in its analysis “Record Entry Lifecycle Event Metadata using FHIR,” found substantial inconsistencies among FHIR resources. The resulting gap can be described in terms of the need to “standardize the standards”.

**However, the real problem lies much deeper than the flexibility of information exchange standards.** Referring to Figure 1, the healthcare industry currently lacks consistent “Foundational Health Information” and consistent and reusable “Common Clinical Information”. This means that two healthcare information systems often contain **semantically incompatible** information. By this, we mean that there is no feasible path to transform the information in one system from information in the other system. This can occur at a micro level, for example, using gender value set with 4 values instead of 3 values, thereby preventing accurate mapping (e.g., recording gender as male, female, or unknown versus male, female, undifferentiated, and other). It can also occur at a macro level, such as one system modeling information using a clinical findings paradigm, versus another modeling observations and conditions. It can also be a matter of what content and context information is routinely recorded for something as common as patient vital signs.

With semantic incompatibility, adopting common information standards for data in motion is not enough. Data mapping can help reorganize existing information, but mapping can neither change the meaning of information, nor create new meaning, nor fundamentally reconcile different views of the world. Thus, when there are semantic incompatibilities between two systems, the solution must lie in using a **common system of models of information and its context**, from the outset. In systems thus aligned, data exchange becomes almost trivial. Information can be understood and used by sharing systems. The challenge, therefore, is early semantic alignment of information in all cooperating systems.

## How does CIMI-FHIM-SOLOR Integration help?

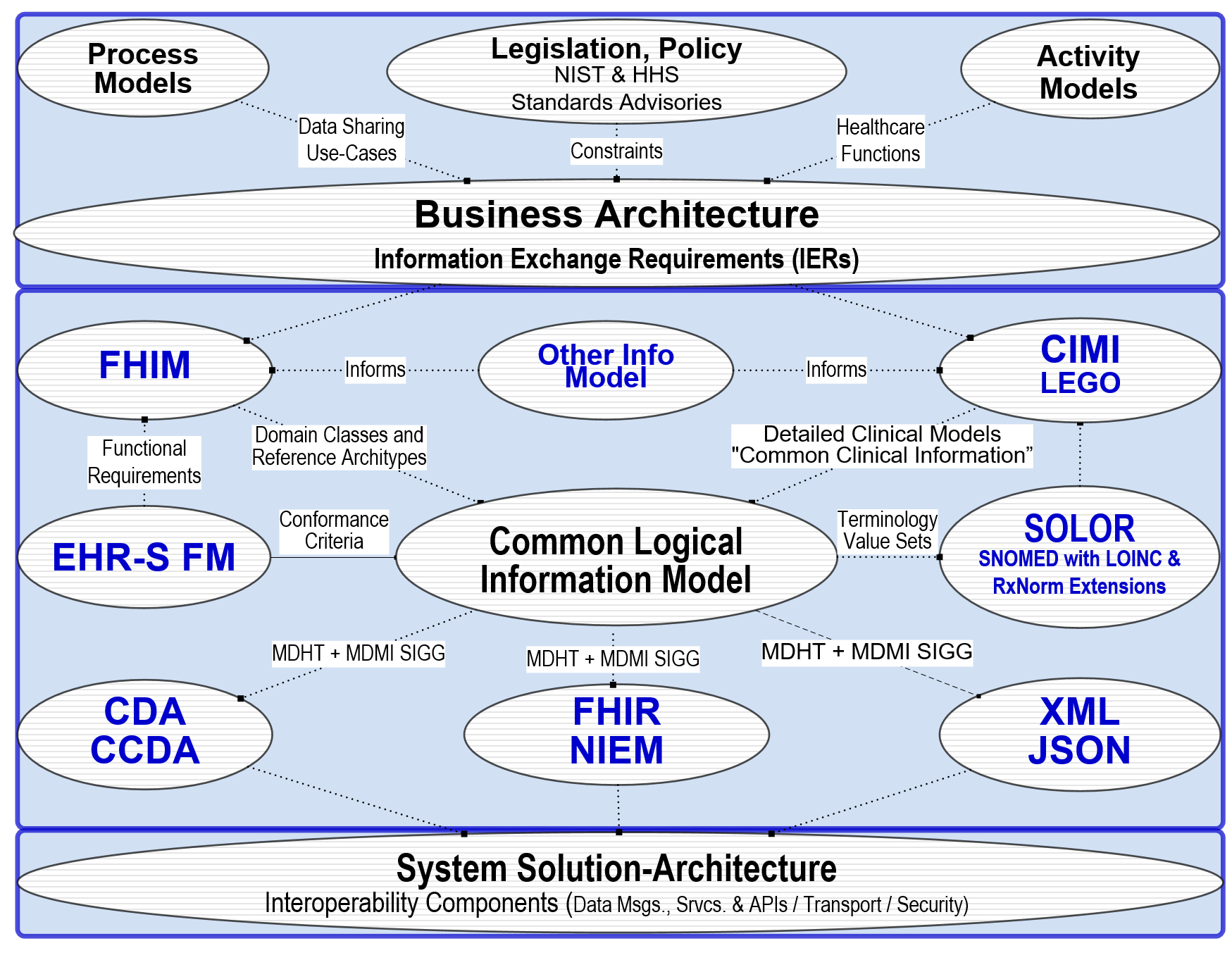


Figure 2 High-Level Architectural-View of how FHIM-CIMI-SOLOR Integration enables Consistent “Foundational Health Information” and “Common Clinical Information” to support Computable Semantic-Interoperability in Implementations

To align the Figure 1 Clinical metaphorical tree with a Figure 2 Architectural metaphorical tree consider the tree to the left; where, half of the tree is visible (e.g., the business architecture) and the other foundational half (e.g., the informatics and system solution-architecture) is and must be hidden; but where, this foundation is essential for the tree’s survival.

In Figure 2, the top **Business Architecture** typically includes:

* Legal, ethical requirements, policies and rules
* Societal/organizational (e.g., cities, states and countries) requirements
* EHR-system requirements (EHR, Management, Resources, clinical/ administrative/ financial services)
* Language (Shared: Syntax, words, phrases)
* Ways to present and enter data via screens, forms, etc.
* Notions about archiving/documentation/information security

This report’s focus is the Figure 2’s center **Information architecture**, including:

* **ISO-ContSys, FHIM, EHRS-FM and CQF**, which are based on and consolidate the Business Architecture and Health domain requirements = knowledge based on Business Architecture’s SME interviews, Clinical text books, Best practices and clinical guidelines.
* **CIMI and LEGO**; where, LEGO is the Q&A subset of CIMI, using the CIMI Observation Model and Description Logic.
  + **CIMI Reference Model and ISO 13606-1** (Not Shown): allows the technical construction and exchange of archetypes and deals with legal-and-ethically correct documentation of structured data.
  + **Archetypes** as expressed using **13606 AOM (Archetype Object Model)** as constraints on a Reference Model
  + **CIMI Reference Archetypes** - common high-level re-usable patterns expressed as Archetypes used to create meaningful Phrases and Statements
  + **CIMI meaningful Phrases[[8]](#footnote-8) or Statements** - CIMI Logical Clinical Information/ panels, models informed by the business architecture represented by ISO System of Concepts for Continuity of Care[[9]](#footnote-9), FHIM and EHRS-FM
  + **CIMI Compositions:** authored expressions of the HL7 SAIF (aka ISO RM/ODP) Information viewpoint for Interfaces, consisting of Phrases and Statements
* **SOLOR** Terminology and Value Sets based on SNOMED-CT expressions.

In Figure 2, the bottom **Solution Architecture** includes:

* EHR-systems with **CCDA, FHIR, NIEM, JSON API** interfaces among EHR-system Services. (**ISO HISA**)
* Supporting services (Terminologies, Terminology servers (e.g., **SOLOR),** Value set servers, Protocol servers, Clinical guideline servers, clinical decisions support servers, Presentation/data input services, Exchange services)
* Technical Infrastructural services: networks, internet, information security,
* Hardware and Software

The recommended approach involves the definition of consistent information artifacts to be used in a computable health record. Each information entity will be defined with an unambiguous and computable meaning, employ a specific, shared vocabulary, and have a specific information structure shown within Table 1.

Table 1 Simplified Healthcare Information-Model “Stack”[[10]](#footnote-10)

**Computable-Interpretability Mission-Need Concept Models**

1. **FOUNDATIONAL HEALTH INFORMATION** – domain model concepts =**FHIM, ContSys[[11]](#footnote-11)**
2. **RELATIONSHIPS AMONG CONCEPTS** – ontologies = knowledge =**SNOMED-CT[[12]](#footnote-12)**
3. **CODING SYSTEMS & VALUE SETS** – terminologies =**SOLOR[[13]](#footnote-13), ISO13940**
4. **REFERENCE ARCHETYPES** – syntax =**CIMI-FHIM[[14]](#footnote-14), ISO13606**
5. **COMMON PATTERNS** – archetype or templates =**CIMI, LEGO, CQF, SIAMM[[15]](#footnote-15)**
6. **COMMON CLINICAL INFORMATION** – Object Model[[16]](#footnote-16) =**CLIM & EHRS-FM**
7. **COMMUNITY & HOSPITAL INFORMATION** – Data documentation model[[17]](#footnote-17) =**HL7 FHIR & CCDA**

**And NIEM & Service APIs IAW[[18]](#footnote-18) CLIM**

1. **SECURITY and TRANSPORT** – Post office (protocols and mechanisms) **=IHE, NIST & IEEE standards**

Figure 2, Table 1 and Figure 3 (below) present perspectives, which all should follow the Appendix E CIMI principles to address achieving both architectural traceability and computable-semantic-interoperability by creating “Information Models and Terminology Models, which contain clear, complete, concise correct and consistent “Foundational Health Information” organized into “Common Clinical Information,” which can be composed into computable semantically-interoperable patient records and care plans.

The recommended CIMI-FHIM-SOLOR integrated HL7/ISO “Common Logical Information Model” and tools support a “Model Driven Architecture” of data, services, applications and tools needed for “Population Based Analytics” within “Interoperable implementations” across the “Continuum of Care” resulting in effective-and-efficient “Shared Care Plans” which can improve “Patient-Safety and Quality-of-Care” while reducing IT costs’. But, is CIMI-FHIM-SOLOR integration enough?

Semantic **Interopera**bility is NOT enough; because, **Semantic Interopera**bility is updating cells in a database from data in cells in other databases; where, we leave context data behind. Historic message standards, including FHIR currently need implementation guides and human intervention to apply implicit knowledge with a focus on **Semantic Interpreta**bility and computability.

CIMI-FHIM-SOLOR integration is necessary; but, it is not sufficient for automated **Semantic Interpreta**bility and computability. We also need shared use of a foundation or standard healthcare information-model “stack” that define re-usable archetype patterns used to construct Semantic Artefacts that are universally shares.

1. models that model the clinical/health delivery and co-operation
2. models that capture data in their full context, epistemology, confounding factors
3. models that model documentation processes
4. a collection of shared concepts and their relations needed to document generic healthcare delivery; including, the main Patient System categories of Healthcare Actors, Healthcare Matters, Activities, Healthcare Processes, Healthcare Planning, Time related concepts, Responsibilities, Information Management
5. one clear cut delineation of boundaries between the models/layers of the Semantic Stack

Unfortunately, it is impossible to have one figure or table, such as those shown above, that effectively describes all layers and relationships of healthcare for all possible kinds of readers; where, you get something like the next figure, which can easily be further complicated.

Figure 3 places Coding systems, ISO standards, SOLOR and CIMI where they should be. Each of the boxes of the right site can be considered a world in itself with a set of supporting standards, models, and best practices.

**But, one thing must be absolutely clear.** Without a shared collection of models for all orthogonal layers/components of the Semantic Stack we never will have Computable-Semantic Interpretability that ensures that:

* data can be reused fully and safely
* by humans, yet to be born,
* by computer systems, yet to be developed.

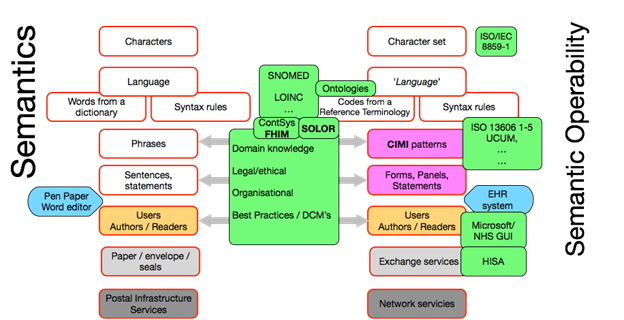
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Figure 3 More Realistic View of the Complexity of Healthcare Informatics

Observe that in Figure 3, what is shown for CIMI, Reference Terminology, Ontologies, etc. is the intersection with the simplified Figure 1, Figure 2 and Table 1 high-level models. The problem is how to depict this multi-dimensional collection of models; where, each model is orthogonal to some others; and where, each is autonomous, governed by its own organizational community.

This report identifies some of the more obvious challenges and more obvious recommends to build consistent “Foundational Health Information” that is organized into consistent “Common Clinical Information,” which can support a consistent and reusable “Model Driven Architecture” healthcare information-model “stack” of data, services, applications and tools needed for applications, such as “Population Based Analytics” within “**Interopera**ble, **interpreta**ble and computable implementations” across the “Continuum of Care” resulting in effective-and-efficient computable longitudinal patient records and “Shared Care Plans” which can improve “Patient-Safety and Quality-of-Care” while reducing healthcare IT costs!

## What are the Basics?

The intent of this Information Modeling: Foundation to Semantic Interpretability[[19]](#footnote-19) meeting is to promote consensus among stakeholders on how best to share requirements and specifications to support mutually intelligible health information.

* Where, mutually intelligible health information depends on stakeholders agreeing on information semantics and formats. This is historically done in the form of point-to-point interface agreements or published standards designed to remove the need for point-to-point development.
* However, there are many standards[[20]](#footnote-20), and not only is there overlap among them, but they change over time. Technologies are available that support translation among standards, but it is critical that they be harmonized – that an X12 discharge reason and a CDA discharge reason be semantically as well as syntactically iso-semantic in a round-trip transformation.
* Analysis models provide a way for stakeholders to articulate their requirements independently of any particular implementation technology; where, Design models, express those requirements in predictable patterns to support automated processing.
* Assets in this effort include industry-based standards organizations (e.g., HL7, X12, Oasis), non-profit and professional organizations that supply clinical content (AMA, IHTSDO, Regenstrief), governmental organizations tasked with helping industry to support the public interest (ONC), and “momentum” efforts aimed at encouraging adoption of standards (Meaningful Use, Argonauts).

The goal of this meeting is to ascertain the best way to leverage and coordinate these assets to enhance the quality and value of healthcare data, for care provision as well as secondary uses.

* [EN13606](http://www.en13606.org/the-ceniso-en13606-standard/semantic-interoperability): Interoperability is a property referring to the ability of diverse systems and organizations to work together (inter-operate) . . . semantic interoperability is the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results as defined by the end users of both systems.
* [Wikipedia](https://en.wikipedia.org/wiki/Semantic_interoperability): Semantic interoperability is the ability of computer systems to exchange data with unambiguous, shared meaning. Semantic interoperability is a requirement to enable machine computable logic, inferencing, knowledge discovery, and data federation between information systems.
* [HIMSS](http://www.himss.org/library/interoperability-standards/what-is-interoperability): In healthcare, interoperability is the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged.
* [IEEE](https://www.healthit.gov/buzz-blog/meaningful-use/interoperability-health-information-exchange-setting-record-straight/): ability of two or more systems or components to exchange information and to use the information which has been exchanged.

## Models, Models Everywhere?

**Mark Kramer, MITRE**: “I constantly hear the assertion that “FHIR is not a model”. I don’t think there is common agreement or understanding in the healthcare standards community of:

* what is a ‘model’?
* If there are multiple types of models, what are they, and how do they relate to each other?
* What type of model(s) do we need to exchange health data?
* Why do we or do we not need ‘models’ to exchange health data?

For example:

* Are FHIR resource definitions a model? What type?
* Is CCDA a model? What type?
* Is FHIM a model? What type?
* Is HL7 V 2.x a model? What type?
* Is SNOMED-CT a model? What type?
* All of the above (except FHIM) can be used to exchange data.

Without establishing terms of reference[[21]](#footnote-21), I think we will have

chaos and misunderstanding.” (see Appendix E Terms-of-Reference white paper)

Additionally, I have one suggestion, which is to avoid the term understanding, unless we are talking about people. Understanding is something human beings do, whereas for computers, information is either usable (aka computable in this report) or unusable.

Being usable, from the computer standpoint, breaks up into several elements:

* Being able to identify the received information or query, and validate it conforms to a known format (syntax)
* Being able to break that information up into its component parts, e.g. fields, values, parameters (syntax, structure)
* In the case of receiving new data, being able to integrate that data with other data already possessed (mapping, translation, deduplication, merging, etc.)
* In the case of queries, being able to respond appropriately to queries, providing the information being sought (proof of semantic interoperability)

A **CIMI compliant model[[22]](#footnote-22)** conforms to CIMI principles given in Appendix E) resulting in a clear, complete, concise, correct and consistent logical semantic-and-syntactic description of a healthcare concept, that can be instantiated as an implementation object, which is computable and interoperable among systems. CIMI compliant models are compose-able to support shared-care, such as population-based analytics, research, longitudinal-patient-records and care-plans.

Models provide a way to a) agree on operational definitions of information and b) document those agreements in ways computers can process. CIMI’s technical objective is to curate an HL7 Common Logical Information Model (**CLIM**), which is a set of standards-based logical archetypes that are at the same time: a human readable logical specification and a technical format, which can be used to ensure computable and interoperable implementations.

## How Good is Good Enough?

CIMI focus is on semantic interpretability; that is, ensuring that interoperability is computable; where, data is defined fully and precisely enough to support logical inference and decision making independent of human interaction. ONC’s HITSP and S&I Framework recommended that syntax, semantics, security plus transport mechanisms-and-protocols be included in healthcare inter-system interoperability specifications. Recently, provenance (who, what, when, where and how) meta-data has emerged as essential to interpretability.

## What about Cross Organizational Boundaries?

Ideally, the more data is defined, transported in an Interpretable way[[23]](#footnote-23), the less we need Implementation guides that specify all the information needed for a safe and uniform implementation. In the interim, **IHE** (Integrating the Healthcare Enterprise) implementation guides describes Cross-Enterprise Document Sharing (**XDS**) focused on providing a standards-based specification for managing the sharing of documents between any healthcare enterprise, ranging from a private physician office to a clinic to an acute care in-patient facility and personal health record systems. IHE XDS standards add requirements for transport mechanisms-and-protocols, security including affinity-domain business rules and exchange protocols being part of the interoperability requirements. These type of requirements are often embedded into a multi-organization Data Use and Reciprocal Support Agreement (**DURSA**) or equivalent Service Level Agreement (**SLA**).

## How about an Orientation to existing modeling efforts?

For a state-of-the-art overview of what is currently going on, see APPENDIX *C: Glossary of Healthcare Information Modelling Initiatives* and Section 5) CIMI-FHIM Related Implementation Lessons-Learned.

## What about tools?

Currently there are many initiative-specific tools, which should converge into an interoperable suite of full lifecycle tools, such as:

**UML**: such as Sparks EA, IBM RSA and Open-Source Papyrus

**UML/AML**: Sparx EA and MagicDraw

**ADL**: OpenEHR Workbench, LinkEHR by UPV, Spain

**SNOMED**: IHTSDO Workbench

**LEGO**: IHTSDO Workbench with Open-Source ISAAC Plugin

**SIGG**: Open-Source MDHT & MDMI

## Opportunities for coordination & collaboration?

Section 6 presents the preliminary information model integration recommendations, challenges and a recommended Work Breakdown Structure (**WBS**) to support coordination and collaboration.

## HIEA Technical Forum and Next Step objectives?

The HIEA Technical Forum agenda will help us:

* Agree on requirements or desiderata (aka highly desirable features) for supporting interoperability within the Healthcare Realm
* Perform an assessment of current efforts and options for coordination of efforts and ideally agree on promising-options and dead-ends.
* Agree to cooperate, reflected in a WBS (work breakdown structure) for

Ideally, the HIEA Technical Forum SMEs will first provide recommendations, including pros and cons, to meet the information model integration goal, without schedule and funding constraints. That is, what is the best full lifecycle technical model driven approach to meet all of the respective healthcare interoperability requirements so that we converge the models in support of consistent and interoperable tooling to ultimately make implementations efficient and effective.

Next Step: We will finalize this report prior to the September HL7 meeting and HL7 PSS, which will include a Program Plan and WBS refinement on how to proceed; where, schedule and funding constraints can be introduced by the respective program managers.

## Recommended Principle

Over the past year, CIMI has vetted, built consensus, voted on the principles and decision that represent the Terms-of-Reference, Definitions, and Framing of a CIMI compliant information model, which is given in Appendix E. During the CIMI Task-Force deliberations the following additional CIMI principle was recommended. (See Appendix E for the current set of CIMI Principles aka CIMI Terms-of-Reference)

**PREFACE (Keith Campbell):** Model bindings cannot be asserted in isolation. Any data element bound to a semantic attribute must be bound in a way that reflects the full context of the terminology model semantics and the domain model semantics. Failure to reconcile overlapping and incoherent semantic aspects of the models being bound may result in data that cannot be reliably interpreted. Therefore:

**PRINCIPLE (Keith Campbell):** We agree to a clean separation of semantic responsibility between terminology models and other domain models[[24]](#footnote-24).

**COROLLARY (Jay Lyle):** Model stewards must specify unambiguous and unique (i.e., not redundant) semantics for data elements[[25]](#footnote-25).

**EXAMPLE (Jay Lyle)**

* <https://1drv.ms/p/s!AlkpZJej6nh_k9NaTCaFPmazsIclbw>

## CIMI-FHIM Related Implementation Lessons-Learned

## Intermountain Healthcare

**Technical POCs:** 'Stan Huff MD' <Stan.Huff@imail.org>

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'Patrick Langford' <patrick@neuronsong.com>

CIMI DCMs are the core of what we at Intermountain HC have been doing for the past 15+ years; where, CIMI makes logical information models that are used to generate FHIR profiles and other physical data representations Its hard, but it is essential work to get to true semantic interoperability. Historically, we developed Clinical Element Models (CEMs) not using the CIMI preferred ADL (Archetype Description Language) and have developed a CEM browser for our models ( [www.clinicalelement.com/](http://www.clinicalelement.com/) ); because, we were unaware of ADL at that time.

Our current initiates include:

* We are making tools to import CIMI models from Intermountain CEMS and from openEHR.
* Creation of FHIR profiles from CIMI models.
* Implementation of SOLOR as the primary terminology server for CIMI.
* Improved tools
* We are working to unify CIMI and FHIM.

We will be connected with other models/tools and projects by:

* We plan to use CIMI models to create very detailed FHIR profiles. The CIMI derived FHIR profiles will augment the profiles created by the Argonauts[[26]](#footnote-26).
* We will use the SNOMED-CT concept model to help with CIMI model content.
* We will use SNOMED-CT relationship concepts for semantic binding of CIMI attributes.
* We will use SNOMED-CT content to support transformation between pre and post coordinated representations of data.
* We will use FHIM models as the high level definition for “classes” of data that will be further constrained to create detailed CIMI models.

Our tooling and other implementer support includes:

* We have early versions of model authoring tools.
* We are working on first versions of tools to create FHIR profiles from CIMI models.
* We are working on first versions of tools to import Intermountain CEMs to CIMI.

In conclusion our Integrated Approach, using FHIM and SOLOR provides rich content that can be used to enhance CIMI DCMs. These CIMI DCMs are needed to bridge the gap between the work of the Argonauts and true plug-n-play interoperability.

## HL7 Patient Care

**Technical POCs**: 'Jay Lyle' <jay.lyle@jpsys.com>;

'Susan Matney' <Susan.Matney@imail.org>

The CIMI-Patient Care Skin model project is designed to take existing requirements (the Patient Care Pressure Ulcer Risk Assessment DAM) and use it to create detailed clinical models -- specifically CIMI models -- in order both to confirm that the DAM information is complete and to prove that the CIMI formalism can represent it.

So far, we have found that there are areas of the HL7 PC Domain Analysis Model (DAM) that are too general to support the creation of CIMI models. We have constricted the scope of the project to focus on the assessment of the wound by examination, excluding germane but complex domains such as nutrition, medications, conditions, and devices.

We have also been able to contribute materially to the discussion of CIMI design:

A. Foregrounding the question of the alignment of semantic binding at the model level (as opposed to the element level)

B. Advancing pattern design to support physical examination

C. Supporting the effort to decompose archetypes for the purpose of reusing constituent patterns (viz., topic/modality)

Details are available on the HL7 Wiki at <http://wiki.hl7.org/index.php?title=PC_CIMI_Proof_of_Concept>

## HL7 CQI/CQF/CDS

**Technical POC**: 'Claude Nanjo' <cnanjo@cognitivemedicine.com>

Cognitive Medical Systems is a service-disabled veteran-owned small business (SDVOSB) best known for delivering clinical informatics and analytics solutions that empower clinical decision support (CDS). Cognitive has participated in a number of projects funded by the VA and DoD and has been an active contributor to national and international health standards initiatives including the S&I Health eDecision and Clinical Quality Framework initiatives.

In addition to contributing towards the development of standards, Cognitive is also playing an important role validating whether recommended standards are implementable and can lead-to true syntactic and semantic interoperability primarily through the development of pilot prototypes and proof-of-concepts based on real clinical use cases.

What has become clear through our participation at HL7 is the need for a formal logical model, intuitive to clinicians and computable, that can be referenced in evidence-based clinical quality knowledge artefacts, useable in both rules engines and for clinical analytics. This logical model must provide the common ‘source-of-truth’ for both clinical information serving as input and output to clinical decision support systems and for the knowledge artifacts that act on this information. While FHIR provides a standard message syntax for clinical resources and an API to manage such resources, FHIR alone cannot act as such a source of truth. A single FHIR resource can be profiled in many, potentially inconsistent, ways. Hence, we argue that a formal and explicit logical model is needed to define formal requirements and constraints, which are then translated into FHIR profiles definitions.

After an initial attempt to use FHIR directly as such a model, the CDS and CQI communities decided that this approach was not optimal. Some reasons are listed below:

* Artifacts based on FHIR are too difficult to understand. For instance, logic defined on FHIR extensions is cumbersome. To address this challenge, the group has explored surfacing the ‘logical view’ underlying a given FHIR profile and presenting that view to content authors and rule engines.
* FHIR resources are not hierarchical. Thus, relationships between resources are difficult to establish or use for inferencing. For instance, it is not possible in FHIR to establish that a DiagnosticOrder is a type of ProcedureRequest.
* The core FHIR specification does not offer a formalism to express presence or absence or whether an act was performed or not performed. Yet, the ability to express such information is essential to clinical quality, should be captured in a logical model, and subsequently expressed in FHIR profiles.
* Clinical Decision Support artifacts should be decoupled from the underlying physical representation of clinical data. This allows for more stable and robust rules that can apply to other physical representation of clinical data such as proprietary formats or other HL7 standard formats.
* In order to act as an international physical message syntax, FHIR cannot be closely coupled to any particular terminology or ontology. However, the same does not hold true for logical models. Logical models such as CIMI MUST be developed in conjunction with models of meaning such as SNOMED-CT or more general ontologies such as SOLOR. This provides for a clear ‘separation of concerns’ and can have powerful implications for clinical decision support and workflows.
* The harmonization of profiles derived from different ‘implicit’ logical models is complex and currently not supported by tooling. For instance, our team found that aligning QI-Core and DAF profiles was no easy task. Despite the modest constraints imposed by these profiles, identifying inconsistencies between them required significant programming effort and coordination between independent teams. We feel that such coordination should be done at the level of preferred CIMI archetypes (single source-of-truth) in order to ensure that generated profiles are compatible.

While the community recognizes the need for an underlying and explicit logical model, the choice of potential models for consideration is large. Should one use the FHIM, vMR? QDM? QUICK (the harmonization of the vMR and QDM)? DAF? QI-Core? SDC? OpenEHR? CEM? CIMI? CDA? V2? And so on. It became clear that, in order to be successful, our teams should converge on a single model. This would eliminate duplication of effort, consolidate our efforts, and lead towards convergence. The CDS and CQI community have decided that CIMI offered the right convergence opportunity for a logical model provided that FHIM and CIMI would agree to converge on areas where both models shared a common scope.

The CDS and CQI community feel that CIMI provides the right convergence point for the following reasons:

* CIMI aims to define a platform-independent logical model that is computable, hierarchically structured, and semantically precise
* CIMI models are accessible to knowledge authors and clinical end users
* There are plans to support the transformation of CIMI archetypes into FHIR profiles and CIMI-derived FHIR extensions, thus supporting the use of FHIR at the message exchange level, a key requirement for both the CDS and CQI communities
* CIMI has now become a working group at HL7
* CIMI is working closely with the VA and IHTSDO to define a common ontological foundation for CIMI archetypes. In other words, CIMI is developing an information model in conjunction with terminology SDOs to ensure that all aspects of the model are semantically consistent and that the information model does not contradict recognized terminology models.

We recognize that much work lies ahead if one is to define a logical model that can meet some of the requirements outlined in this paper. CIMI is still in its infancy. In the short term, the community will need to work together to define the requirements for currently missing archetypes, to further expand relevant standard terminologies, to develop the necessary tools to support easier authoring and collaboration, to validate the models in actual systems, and to translate CIMI models into a number of physical representations such as the ones specified by FHIR. If we are to make progress in this direction, constant vigilance will be required to prevent fragmentation and to promote collaboration on a roadmap to achieve a single formal logical model.

## Radiology Project

**Technical POC**: 'Richard Esmond' <richard.esmond@gmail.com>

PenRad, Inc. has spent the last several years parsing and transforming a wide variety of non-Clinical Ontologies that are not already expressed in Description-logic, as-well-as numerous non-Ontological data-sets - together into a single coherent Description-Logic based ontology.

Our intent within the standards communities is to now to move and evolve these efforts to support a completely 'public' generation of what we have produced internally.

We strive for a single coherent Ontology of all clinical topics:

1. This reduces the challenge to produce knowledge-based clinical systems by an order of magnitude
2. A Model-of-Meaning for data fields, as well as data-values is critical
3. It should be based on Description-Logic (EL+)
4. It should be centered around SNOMED-CT
5. It must not be encumbered by any additional commercial IP

To this end, we have currently incorporated ICD-10-CM, ICD-10-PCS, LOINC, RxNorm, NDF-RT, ATC, CVX, FDA Product-labeling, Medline-Plus and MeSH and SNOMED-CT into a unified Ontology.

We also leverage NLP (Natural Language Processing) licensed from CliniThink; to harvest statistically significant clinical-data to facility clinical knowledge extraction from the real-world.

The coming generation of Healthcare standards have dramatically expanded their scope beyond simply exchanging information.

“We believe that FHIR + CIMI + CQL finally provides enough momentum and gravity to bring standardized scripting and sophisticated 'machine process-able' metadata standards into its orbit.”

While the ability to share standardized medical records across platforms is obviously important... the ability to share standardized Clinical Rules, Coding and Billing Logic, Treatment Protocols and Population Health Metrics across all EMR platforms can lead to profound improvements in the cost and quality of care.

**What is coming from the HL-7 Community**:

1. Fast Healthcare Interoperability Resources - Exchange and Query using an extensible, standardized Clinical-Schema
2. Archetype Definition Language for Clinical Models - Enables the exchange of machine-computable libraries defining the complex details of the clinical topic.
3. Clinical Quality Language - Layers on-top of FHIR and Clinical-Models to enable SME's with modest programming experience to author complex clinical logic and extract sophisticated analytical results.

**What this means**:

1. The science of healthcare can finally be synthesized into standardized assets that can evolve and applied anywhere.
2. The impact of clinical choices across populations can immediately be assessed[[27]](#footnote-27).
3. Software platforms can become a partner, instead of a burden, in the practice of medicine.

**To that end, CIMI needs to exhibit the following characteristics:**

1. Be developed, evolve and be released in-sync with FHIR / CQL
2. Share a compatible set of policies and processes with FHIR / CQL
3. Resolve issues of overlap and integration with FHIR / CQL
4. Provide integrated documentation and tooling with FHIR / CQL
5. Integrate cleanly and be architecturally aligned with FHIR / CQL

**The following groups must be routinely involved in CIMI design choices:**

1. FHIR Implementers
2. Clinical Decision Support
3. Clinical Quality Improvement
4. TermInfo
5. Vocabulary
6. Patient-Care
7. OpenEHR team-members
8. ISO TC215 team-members

## HSPC and CIMI

**Technical POC**: 'Stan Huff MD' <Stan.Huff@imail.org>

**HSPC** (Healthcare Service Platform Consortium) is a provider-led organization accelerating the delivery of a platform that supports innovative healthcare applications for the improvement of health and healthcare.

**SLIDE DECK: “A Brief Review of CIMI and HSPC”**

* <https://1drv.ms/p/s!AlkpZJej6nh_kqxsRQwngc_4H3nNow>

## FHIR and CIMI

**Technical POC**: Graham Grieve

Fast Healthcare Interoperability Resources (FHIR, pronounced "Fire") defines a set of "[Resources](http://wiki.hl7.org/index.php?title=Resource)" that represent granular clinical concepts. The resources can be managed in isolation, or aggregated into complex documents. Technically, FHIR is designed for the web; the resources are based on simple XML or JSON structures, with an http-based RESTful protocol where each resource has predictable URL. Where possible, open internet standards are used for data representation.

**Slide Deck by Graham Grieve**

* <https://1drv.ms/p/s!AlkpZJej6nh_kqxtr_pcjXpJeeCL7g>

## MDHT and MDMI

**Technical POCs**: 'Dave Carlson (dcarlson@xmlmodeling.com)'

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**SLIDES**: <https://1drv.ms/p/s!AlkpZJej6nh_k9Nw7SALCyvz8n3OQA>

The SAMHSA sponsor is Ken Salyards; where, his objective was to provide an open source solution for interoperability using the appropriate industry standard and between the healthcare domains of behavioral and physical health; where, a semantic interoperability framework (SIF) set of processes, tools (e.g., IExHUB (Information Exchange Hub), and content developed by SAMHSA were reused in the FHA Project described below. MDMI design-time tools were used to auto-generate computable object instances for C-CDA documents and FHIR DAF profiles and other SAMHSA tools were used to create JSON APIs.

Although SAMSHA does not currently use CIMI, the MDMI/MDHT team has done research on a model driven approach for interoperability between models that uses a “pre-coordinated” (AHIMA) representation of a semantic concept and a different model that uses a “post-coordination” (C-CDA) representation for the equivalent semantic concept.

The FHA sponsor is Gail Kalbfleisch; where, MDHT and MDMI were used to auto-generate a semantic interoperability traceability and gap analysis report between FHIM and FHIR DAF Profiles scoped by the **FPG JET** (FHIR Proving Ground Joint Exploratory Teams) Phase 1 project. In addition, FHIR DAF profiles were generated based on the FHIM model. The capability is called Semantic Interoperability Guide Generator (**SIGG**), which can be used to do a logical semantic model map-and-gap among various models to show correspondence and “impedance” mismatches.

Technically, the FHA SIGG uses the SIF which integrates MDHT and MDMI. The design environment uses MDHT to import the FHIM, CDA templates, and FHIR profiles and MDMI to manage a Referent Index containing meta data associated with business data elements. The business data elements are mapped to the MDHT models. Source data from a Federal agency, an EHR or HIE can also be imported and then mapped to the Referent Index business data elements completing the design process. The SIGG can then be used to generate Traceability and Gap Analysis Reports between exchange models, FHIR profiles based on semantic concepts that have been identified as missing, and other artifacts based driven by the clinical use case.

## Preliminary Recommendations, Challenges & WBS

The plan is for the CIMI-FHIM Task Force’s recommendations to be augmented by the HIEA Forum’s recommendations and to be transformed into a CIMI sponsored FY2017 HL7 Project Scope Statement (**PSS**) and recommended 2017-2018 Work Break Down Structure (**WBS**), which will be presented-to and vetted-by the FHA Federal Partners for potential leadership sponsorship. The PSS will also be presented and discussed at the September 2016 HL7 meeting in Baltimore, MD and approved after successful FHA and Federal Sponsor vetting and HL7 management review.

## Preliminary CIMI-FHIM-SOLOR Integration Recommendations

1. **CIMI curated HL7/ISO Common Logical Information Model (CLIM)**
   * FHIM Domain Classes
   * CIMI/LEGO Detailed Clinical Models
   * SOLOR Terminology
   * Formalized CLIM governance/ Configuration Mgmt. at HL7,
   * include Federal Partners and key contributors
2. **Harmonize CIMI-FHIM-SOLOR Models and Tools**
   * Include CQI/CQF
   * Harmonize with ISO Models
   * SHORT TERM: Use VA SOLOR terminology/ value set server
   * LONG TERM: Transition to NLM terminology/ Value set server
3. **Inculcate CLIM (CIMI-FHIM-SOLOR-CQF) use.** 
   * Documentation, Training, mentorship and Outreach
   * CIMI Practitioners’ Guide
4. The recommended principle be accepted[[28]](#footnote-28)
   * A consistent architecture makes implementations easier
   * Bindings at the pattern level should be hierarchically consistent
   * Principle applies to preferred models, which are the immediate parent of instance data; but, may be violated in abstract models.
5. Use the VA SOLOR Terminology server and a sandbox development server with the long term intention to transition to the NLM Value Set Authority Center (VSAC)
   * SHORT TERM: CIMI use VSAC for value sets and VA server for code systems. Define how CIMI’s SOLOR SNOMED extension works[[29]](#footnote-29) and provide code-system requirements to NLM.
   * MEDIUM TERM: CIMI use VSAC exclusively, when it supports CIMI code system requirements.
6. FHIM be transitioned to a CIMI compliant style and become part of the HL7 “CIMI Common Logical Information Model” (CLIM) balloted artifact.
   * AML modelling style
   * Incorporate CIMI Reference Archetypes and optionally CIMI Patterns as CIMI DCM transition-points.
7. CQF data model be integrated into FHIM-CIMI harmonization effort.
8. Future Clinical interoperability initiatives use and contribute to the HL7 FHIM-CIMI Common Logical Information Model (CLIM) to maximize consistency and interoperability.
9. CIMI-FHIM harmonize with ISO EN 13606 parts 1-5 (EHRcom), ISO EN 12967 (HISA), ISO EN 13940 (ContSys) and ISO TS 13972 (DCMs) and SIAMM[[30]](#footnote-30).
10. Change CIMI Core Reference Model
    * [http://wiki.hl7.org/index.php?title=Recommended\_CIMI\_Reference\_Model#Disadvantage\_of\_Recommended\_Approach](http://wiki.hl7.org/index.php?title=Proposed_CIMI_Reference_Model#Disadvantage_of_Proposed_Approach)
    * CIMI Full Reference Model TBD

The benefit of widespread implementation of these shared information elements is that it will help result in interoperability across locations and care contexts. Health-related services supported including telecare, clinical decision support, and quality measurement will be supported by the portability of standardized health records, improving healthcare access, quality, and uniformity. Standardizing health records in this manner will provide the foundation for collection, communication, and aggregation of patient data, accelerating secondary uses in public health, disease surveillance, post-approval monitoring, and patient-centered outcomes research. Patients, clinicians, and the American public will realize major benefits from improved care coordination, reduction of medical errors, and decreased costs that accompany healthier lives.

## Preliminary CIMI-FHIM-SOLOR Integration Challenges

1. This effort draws upon many existing efforts, and must coordinate these efforts around a single, powerful goal of creating standards for the content of an electronic health record across the US. It will require combining clinical practice needs with domain modeling, ontologies, medical vocabularies, and information modeling, leveraging existing healthcare information standards.
2. Distributed implementation of the path forward for health information and interoperability in the US, weaving together many concurrent threads by creating a common target for future modeling and development efforts, as presented here and in the CIMI-FHIM-SOLAR Task-Force Report.
3. Appropriate FHA FHIM licensing and/or Memos of Understanding (**MOUs**) be established to support HL7 CLIM (CIMI-FHIM) balloting
4. Appropriate FHIM UML/AML Reference Archetypes as touchpoints for CIMI DCMs, such as observation, procedure, order, problems[[31]](#footnote-31), CDS rule
5. Appropriate HL7 CIMI governance, procedures, configuration management, licensing to support innovation, continued evolution and consistent and interoperable implementations based on CLIM.
6. The Open Group and HL7 Memo of Understanding for future collaboration
7. With CIMI as a common denominator, to what extent should each model (CIMI, FHIM, CQI/CQF and LEGO/SOLOR) change to harmonize with the other models?
8. Who will edit and configuration manage the CIMI SOLOR terminology server? How long and who can use it? Development Sandbox too?
9. CIMI conformant LEGO models?
10. Which models should be a part of the HL7 CLIM balloted standard[[32]](#footnote-32)? What is the scope of Change to FHIM, CQI/CQF, LEGO/SOLOR to be CIMI compliant as a part of the CIMI sponsored HL7 balloted CLIM?
11. Stability of CIMI Core Reference Model (base classes): the current CIMI reference Model is simple; where, additional data elements must be built into the Reference Archetypes, using cluster-element pairs. OpenEHR and ISO13606 have larger and more complex reference models; but less flexibility to change or adapt[[33]](#footnote-33). Changing the reference model impacts the compatibility with tooling and shared tools. The following changes have been suggested.
    1. Recommended CQI/CDA additions [Claude Nanjo]
    2. Align with OpenEHR [Thomas Beale]
    3. Align with ISO/tc215 and CEN/tc215 13606 [Gerard Freriks]
12. CIMI Reference Model Requirements [Jay Lyle]
    1. The model must represent information that may be compositional.
       * This is met by the item\_group composition.
    2. The model must allow composition to recurse indefinitely.
       * This is met by making composition recursive via the item\_group - item specialization
    3. The model must allow the identification of some information groups as "statements" that can be found and understood in isolation, irrespective of the compositional structure in which they are physically recorded.
       * I believe this is what Claude is proposing with data (in this case, 'processing directive' or ‘metadata’ or whatever name we identify)
       * as opposed to a prior suggestion to have two separate compositional hierarchies.
       * I prefer the property-based approach to the separate hierarchies, but the proposal seems to me to be awfully generic -- with a structure like that, we've reinvented RDF and made the rest of the model redundant.
    4. There is some requirement to allow or prohibit certain kinds of composition--the topic that held up the RM for a year or two.
       * Is this whether statements can contain statements?
    5. Is there a requirement or desideratum to align with ISO13606?
    6. Is it thinkable to assert in the RM that properties require explicit semantics?
13. Proliferation of terminology servers and the potential loss of the “source of truth”
14. CIMI Terminology Server Requirements[[34]](#footnote-34)? How can VSAC be used?
    1. Models should obtain **existing** value sets that align with the defined need from a Source Of Truth (SOT) for the content wherein authors make sure the content is vetted by authoritative sources. That means a model must be able to get UTD content from multiple sources because often the SOT is focused on specific content only. VSAC is a SOT for a number of useful value sets (in essence a SOT of last resort) because we provide the tools for authors to do the necessary work.
    2. Models should build new content in a tool that provides UTD code system content and supports easy maintenance of the value sets using the code systems. VSAC can provide that but it’s not the only place.
    3. Models should obtain value set content from a place that supports open collaboration to determine the best value set content for a given use. VSAC Collaboration was created to support this hence models wishing to utilize this input and confirm the SOT used has UTD content should consider VSAC. We consider this VSAC function a critical value and hence encourage the use of VSAC so many value set users can come to one place to get and comment on (and hence improve) content.
    4. Models often need to create their own value sets. Authors should use a tool that provides all the above if possible when creating general, model-specific value sets. Hence VSAC is a good place for that. Again, it’s not the only place but if you have authors working in multiple places, things get confusing.
    5. Models may need to create temporary code system content to support their value sets. VSAC does not support this yet.
    6. Implementers of models may(will) need access to entire code systems, including code system knowledge (based on relationships) in order to create running systems. This is a terminology service and these functions are not available via VSAC, but are available via the UMLS.

That sort of foundation may help the less technically sophisticated among us stay un-lost.

## Preliminary CIMI-FHIM-SOLOR-Integration WBS

**REQUESTED ACTION:** Program and Technical POCs, please add provide short term (2017), Mid-term (2018) and long-term (2018+) refinements.

The Work Breakdown Structure (**WBS**) objective is a CIMI compliant, CIMI curated and HL7 balloted International-Realm Common Logical Information Model (**CLIM**), suitable for ONC:FHA endorsement as a Healthcare Reference Information Model suitable for use by Federal Agencies and their commercial and academic partners. Ultimately, the WBS should list short-term 2017 tasks, mid-term 2018 tasks and long-term 2019-and-beyond tasks, identified by the respective projects’ program-and-technical POCs.

PREMIMINARY Work Breakdown Structure (**WBS**)

1. The Open Group Healthcare Forum facilitation
   1. CLIM harmonization workshops
   2. Industry outreach/advocacy/feedback
2. HL7 CIMI
   1. ISO/tc215 13606-1 core Reference Model alignment
   2. ISO/tc215 13606-2 Archetype Object Model alignment
   3. CIMI core model adjustment recommended by CDS project.
   4. Governance and configuration management
      1. CLIM use license
      2. CLIM (FHIM-CIMI models) configuration management and balloting
   5. HL7 workgroup outreach/advocacy/feedback (e.g., Vocabulary, SOA, FHIR, Orders and Observations, etc.)
   6. CIMI related Implementation and Test support
   7. CIMI documentation and web-site on a par with FHIR
3. FHA FHIM alignment with CIMI
   1. Federal Agency and Academia outreach/advocacy/feedback
   2. FHIM use License
   3. CIMI-FHIM documentation and training for Federal Partners, their contractors and partners.
   4. FHIM configuration managed version / profile for HL7 CIMI curated CLIM Ballot
   5. Independent FHIM development by Federal Agencies, with periodic convergence with HL7 CIMI curated CLIM ballots (DSTUs, then normative ballots, approximately every 1-2 years)
   6. FHIM update to include AML specification of CIMI Reference Archetypes and Patterns (e.g., observation, order, procedure, etc.).
   7. FHIM alignment with ISO/tc215 13940 System of Concepts for Continuity of Care
4. HL7 CQI/CQF alignment with CIMI
5. FHA MDHT-MDMI alignment with FHIM, CIMI and FHIR
   1. ADL to UML/AML bi-directional model Transformations
   2. Import FHIM versions
   3. Import CIMI DCLs and generate FHIR profiles
   4. Class to attribute b-directional model transformations
   5. FHIR Implementation Guide
   6. Documentation and training for analysts, architects, implementers
6. VA LEGO-SOLOR alignment with FHIM-CIMI
   1. CIMI compliant LEGOs
   2. SOLOR harmonization with FHIM-CIMI
   3. LEGO/SOLOR documentation and training for implementers

## Acknowledgements

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CIMI Co-Chairs:

* Linda Bird BIT, IHTSDO, [lbi@ihtsdo.org](mailto:lbi@ihtsdo.org)
* Galen Mulrooney, FHA and VA, [galen.mulrooney@jpsys.com](mailto:galen.mulrooney@jpsys.com)
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* Stanley Huff, Intermountain Healthcare, [stan.huff@imail.org](mailto:stan.huff@imail.org)

Members of the following SDOs have participated in CIMI:

* IHTSDO, POC: Linda Bird BIT
* HL7 Work Groups (PC, CDS, CIC, EHR, SOA, Vocab)
* The Open Group Healthcare Forum, Jason Lee POC
* ISO/tc215 and CEN/tc251: William Goossen and Gerard Freriks, Gary Dickinson POCs

Federal Agency staff and contractors have participated in CIMI:

* Department of Defense
* Veterans Administration
* Interagency Program Office
* ONC Federal Health Architecture

Members of the following Healthcare Organizations have participated IN HL7 CIMI:

* Intermountain Healthcare
* PenRad, Inc.

Staff and students from the Following Universities have participated in CIMI:

* The University of Utah

## APPENDIX A: References

* **CIMI website:** <http://opencimi.org/>
* **CIMI model browser:** <http://www.clinicalelement.com/cimi-browser/>
* **CIMI model repository:** <https://github.com/opencimi/>
* **CIMI Mayo Wiki:** [www.informatics.mayo.edu/CIMI/index.php/Main\_Page](http://www.informatics.mayo.edu/CIMI/index.php/Main_Page)
* **CIMI HL7 Wiki:** [www.hl7.org/Special/Committees/cimi/index.cfm](http://www.hl7.org/Special/Committees/cimi/index.cfm)
* **CIMI reference model:** <https://github.com/opencimi/rm/tree/master/model/Release-3.0.5/>
* **CIMI Practitioners Guide to**

**HIE Interoperability:** <http://1drv.ms/1TuV8PD>

* **FHIM website** [www.fhims.org](http://www.fhims.org)
* **FHIR website** [www.wiki.hl7.org/index.php?title=FHIR](http://www.wiki.hl7.org/index.php?title=FHIR)
* **HSPC:** <https://healthservices.atlassian.net/wiki/display/HSPC/Healthcare+Services+Platform+Consortium>
* **Health IT Standards Committee:** <https://www.healthit.gov/facas/health-it-standards-committee>
* **2016 ONC Interoperability Standards Advisory** 
  + <https://www.healthit.gov/standards-advisory/2016>
* **Standards: 2017 Interoperability Standards Advisory Task Force Jul 19, 2016 slides**
  + <https://www.healthit.gov/facas/sites/faca/files/ISATF_Meeting_Slides_2016-07-19.pptx>

## APPENDIX B: The Open Group Healthcare Forum Contributions

**Technical POC**: 'Jason Lee (j.lee@opengroup.org)'

In 2016, The Open Group Healthcare Forum joined the “HL7 CIMI-FHIM Integration Investigative Study” to provide an Industry Centric SDO perspective to CIMI’s work; where, The Open Group’s Healthcare Forum published the following white papers from a business community perspective.

## Enhancing Healthcare Information Exchange with FHIM

* [“Enhancing Health Information Exchange with the FHIM”](https://www2.opengroup.org/ogsys/catalog/W153)

## Healthcare Interoperability

* [Healthcare Interoperability](https://www2.opengroup.org/ogsys/catalog/W163)

## Advancing Healthcare Interoperability: Coordinating Model Development

* White Paper is under development.
* TBD Link to be provided by Jason Lee, Open Group Healthcare Forum Chair

## APPENDIX C: Glossary of Healthcare Information Modelling Initiatives

## CIMI

**Technical POC**: 'Stan Huff MD' <Stan.Huff@imail.org>

**CIMI Overview, Plans and Status Slides**

* <https://1drv.ms/p/s!AlkpZJej6nh_k6ge2iigbYKDQWeHRw>

**CIMI Background**

**CIMI** (Clinical Information Model Initiative) started in 2010 under IHTSDO and transitioned to HL7 in 2016. CIMI’s models and modelling approach were adopted by **HSPC** (Healthcare Service Platform), which is a provider-led organization accelerating the delivery of a platform that supports innovative healthcare applications for the improvement of health and healthcare.

Since Jan 2016, the HL7 CIMI sponsored “CIMI-FHIM Integration Investigative Study” and follow-on “CIMI-FHIM-SOLOR-Integration Task-Force” have been investigating a CIMI compliant Federal Health Information Model (**FHIM)** and related Computer Aided Design (**CAD**) Tooling. The CIMI workgroup has also been looking at the Clinical Quality Framework (**CQF**) and **LEGO/SOLOR** (Lightweight Expression of Granular Objects / SNOMED, LOINC, RxNorm) models.

We refer to the task force’s objective as an “integrated information modelling approach”; but, our objective might better be described as a harmonized iso-semantic modelling approach; where, we expect to converge on a set of CIMI compliant models collectively referred to as the HL7 Common Logical Information Model (CLIM), with CIMI-curated governance and configuration management, which will ideally be balloted as an HL7 standard and then an ISO standard.

**CIMI’s Mission**

**CIMI’s** mission is to "improve the interoperability of healthcare systems through shared implementable clinical information models".

The main challenge that the CIMI community is addressing is supporting iso-semantic models, and translation of data into a canonical computable-form that can be consistently processed by applications (e.g., decision support, user interfaces or data querying); and where, the FHIR community also has this challenge.

**CIMI Approach**

**HL7 CIMI[[35]](#footnote-35)** models Detailed Clinical Models (**DCMs**), where the preferred modelling style uses ISO 13606 Archetype Description Language (**ADL**). CIMI prefers the “class semantic modeling style” or “specialization by constraint style[[36]](#footnote-36)” whereby model nodes are constrained by changing the name of the node or attribute in the model; and where, not only the names/concepts change; but also, the structure of the model can change during context specific refinement.Terminology is bound to class attributes.

## FHIM

**Technical POCs:** 'Galen Mulrooney' Galen.Mulrooney@JPSys.com

' ‘Jay Lyle' jay.lyle@jpsys.com

**SLIDE DECK: “FHIM Value Proposition”**

* <https://1drv.ms/p/s!AlkpZJej6nh_k9QuQ09vXE7zWr5USg>

**FHIM’s Objective**

**FHIM’s** objective is to define healthcare domains and high-level information-exchange classes (aka entities) in those domains; and where, FHIM classes are the context for CIMI Clinical Modelling Patterns constrained into Detailed Clinical Models (**DCMs**); that is, DCMs define the subtypes or leaves of the FHIM and can be the logical specifications for design and implementation objects.

**FHA FHIM[[37]](#footnote-37)** models Domain Class models, where the preferred modelling style uses OMG’s Unified Modeling Language (**UML**) with an Archetype Modelling Language (**AML**) profile. FHIM prefers the same “class semantic modelling style” as CIMI models; where, terminology is bound to class attributes.

**Class Modelling Style Example**

The node has a name and the data field holds, for instance, a number as result.

**<Node: LabTest> has result <a number>**

When this gets **specialized**, the node name changes and so does its meaning

**<Node: LabTest Blood Glucose Measurement> has result < a number>**

## SOLOR

**Technical POC:** 'Keith E. Campbell' <campbell@informatics.com>

**VA SOLOR is** an integration of SNOMED, LOINC, and RxNorm that can be treated as a single, coherent terminology systems with description-logic semantics. It is based on existing SNOMED/LOINC integration work, and will incorporate relevant aspects of RxNorm so that we can use SOLOR as a foundation for semantic exchange of data using appropriate higher-level models such as FHIR resources.

## LEGO

**Technical POC:** 'Keith E. Campbell' <campbell@informatics.com>

**VA LEGO[[38]](#footnote-38)** is Lightweight Expression of Granular Objects using SOLOR within DCMs**.** VA is investigating LEGOs to be wholly representable within the CIMI Observation result to represent detailed clinical data in a consistent and computable manner that can support multiple use cases. LEGOs represent question/answer pairs on clinical data collection forms, where a question is modeled by a (usually) post-coordinated SNOMED-CT expression. LEGOs transform electronic patient data into a normalized consumable, which means that the expressions can be treated as extensions of the SNOMED-CT hierarchies for the purpose of performing subsumption queries (incorporating something under a more general category) and other analytics. Utilizing the LEGO approach for modeling clinical data assessments provides a foundation for data exchange across disparate information systems and software applications. Clinical data exchange of computable LEGO patient information enables the development of more refined data analytics, data storage and clinical decision support; where, the preferred modelling style uses XML. LEGO prefers the “attribute modeling style” or “LEGO modeling style”, which is to constrain nodes by changing the value of an attribute (e.g., SNOMED descriptor) in the model; where, nodes get their meaning from the name they get and/or annotations. VA is investigating LEGOs to be wholly representable within the CIMI Observation result and SNOMED/LOINC observable Model. In this modeling style the archetype stays fixed.

**Attribute Modelling Style Example**

**<Node: NAME> has value <LabTest>**

**<Node: RESULT> has value <a number>**

When this gets specialized the node names are not changed.

Only one data field is changed.

**<Node: NAME> has value <LabTest: Blood Glucose Measurement>**

**<Node: RESULT> has value <a number>**

**SLIDE DECK: Post-Coordinated Expressions in Forms and FHIR Objects**

* <https://1drv.ms/b/s!AlkpZJej6nh_k9NetwYx57qPeMa_IA>

## MDHT and MDMI

**Technical POCs**: 'Dave Carlson (dcarlson@xmlmodeling.com)';

'Ken Lord' klordmdmi@gmail.com and [sean.muir@jkmsoftware.com](mailto:sean.muir@jkmsoftware.com)

**SLIDES**: <https://1drv.ms/p/s!AlkpZJej6nh_k9Nw7SALCyvz8n3OQA>

MDHT (Model Driven Healthcare Tools) and MDMI (Model Driven Message Interface) are complementary Model Driven Architecture (**MDA**)[[39]](#footnote-39) tooling projects, based on Object Management Group (**OMG**) standards, that deliver the capability for a Semantic Interoperability Guide Generator (**SIGG**) for healthcare standards and semantic interoperability; where,

* **Model Driven Health Tools (MDHT) [[40]](#footnote-40), (VHA, ONC, FHA, and others)** is an open source project at Eclipse.org that supports a full development lifecycle using the Unified Modeling Language (UML) for model design, transformation between alternative model representations, Java code generation, and testing/validation of instance data. MDHT provides consistency across new implementation models, such as CDA/CCDA, FHIR, NIEM, etc. MDHT has been used to design and implement the complete HL7 C-CDA standard (with ONC and VHA support), import/export HL7 FHIR standards to/from UML models, apply terminology value set bindings to FHIM model elements, transform FHIM logical models to C-CDA, NIEM, and FHIR implementation models, and support ONC/NIST test and validation tools for C-CDA Meaningful Use requirements. MDHT produces Implementation Guides (**IG**).
* **MDMI (Model Driven Message Interoperability)[[41]](#footnote-41), (FHA, SAMHSA, and others)** is an open source tool framework based the OMG MDMI standard. MDMI brings semantic meaning (both concepts and values) among legacy implementation models, such as CDA/CCDA, FHIR, NIEM, etc. The MDMI tools define and leverage a shared dictionary of semantic business elements that are assigned to model elements in various logical and implementation models for healthcare data, including FHIM, C-CDA, FHIR, and others. UML models created and maintained using MDHT are used as the definition for many of these mapped models. Use of the MDMI business element dictionary (aka, Referent Index) for map definitions eliminates maintenance of many point-to-point mapping spreadsheets between alternative content models, and enables automated generation of Traceability and Gap Analysis reports between any of the mapped models, plus generation of target model profiles for the identified gaps. Current proof-of-concept tooling generates FHIR profiles from FHIM, based on gaps identified after mapping FHIM to existing HL7 FHIR standards (using MDHT UML models for FHIR). FHA refers to this capability as the Semantic Interoperability Guide Generator or **SIGG**. MDMI tools also include a runtime platform for transforming mapped instances of healthcare data, e.g. C-CDA documents to FHIR resources.

## CQI/CQF/CDS

**Technical POC**: 'Claude Nanjo' <cnanjo@cognitivemedicine.com>

**HL7/ONC/VA CQI / CQF[[42]](#footnote-42)** (Continuous Quality Improvement / Clinical Quality Framework) has a Quality Improvement and Clinical Knowledge or **QUICK** data model, Clinical Quality Language (**CQL)** to suit the needs of implementers interested in supporting clinical decision support (**CDS**) and clinical quality measures (**CQM**). CQF Framework is a collaborative community of participants from the public and private sectors focused on providing the tools, services and guidance to facilitate the functional exchange of health information.CQF framework focuses on identifying, defining, and harmonizingstandards that promote integration between CDS and eCQM. An ongoing HL7 FHIR based project is investigating the use of FHIR in a Clinical Quality Framework context with the goal of identifying best practices for the use of FHIR in support of the primary use cases of Clinical Decision Support and Clinical Quality Measurement.

## ISO/CEN Models/Standards

**Technical POCs**: Gerard Freriks, ISO/CEN TC 251 ISO EN 13606 EHRcom

William Goossen, ISO/DTS 13972 Detailed Clinical Models

To insure we don’t take a provincial approach, we asked Gerard Freriks and William Goossen to review this document from an international perspective. In addition to this section, their feedback is included as footnotes and in the Recommended Principle discussion sections.

The CEN/TC251 Concurrent Use Initiative has the goal of showing the sustainable value of three basic CEN/TC251 standards for semantic interoperability:

* ISO EN 13606 (EHRcom - Electronic Health Record (EHR) Communication),
* ISO EN 12967 (HISA - Health Informatics - Service Architecture) and
* ISO EN 13940 (ContSys - System of Concepts to Support Continuity of Care). Concurrent Use provides decision makers with a coherent strategy for improving the health and care of Europe’s citizens and opens up the US, regional, national and local markets to quality solutions by using these three standards. You can get more information in [this flyer](http://www.en13606.org/images/docs/ConcurrentUseFlyer.pdf) or Download the [complete report](http://www.ehealth-interop.nen.nl/dynamics/modules/SFIL0100/view.php?fil_Id=1260)

Semantic Interoperability Artefact Modeling Method (SIAMM) is a reasoned set of principles, concepts, models, that results in shared patterns that capture data in their full context (epistemology), and confounding factors, modifiers and qualifiers.[[43]](#footnote-43)SIAMMS recommends the idea of patterns that are “able to ‘catch’ as much of the full semantics as possible. In this sense the SIAMM pattern acts as an ontology for documentation of health/care data in and between EHR’s”.

The SIAMMs generic pattern, for the purpose of concurrent use, would comprise subsets of ContSys concepts that as a whole form a particular ‘intersection’ between the specifications; where, the CIMI work and the Detailed Clinical Models (DCM) are related to this work and it is suggested that distinction and clarity between these initiatives and SIAMMs would benefit all.William Goossen, editor of prEN ISO/DTS 13972 Detailed Clinical Models, has said that much of the SIAMM’s activity overlaps the work on DCM; but, the work on 13972 has not followed the method of patterns as in SIAMM, and that DCM unfortunately did not base itself upon a ContSys foundation.

The work done in HL7 FHIR seems to be following a realistic implementation path for the industry. After all, “We are not creating these models/patterns for ourselves, but for the user community”. [cen Health Informatics, "Towards concurrent use of ContSys, 13606, and HISA” WG1 Report from 2nd Workshop (Madrid), 7th and 8th March 2013, Convenor: Stephen Kay][[44]](#footnote-44)

## CLIM

**CLIM** collectively refers to the FHIM domain model’s, Reference Archetypes, CIMI-patterns and CIMI DCMs, with the objective to be HL7 balloted and then ISO balloted, as the CIMI curated “HL7/ISO Common Logical Information Model (**CLIM**)”.

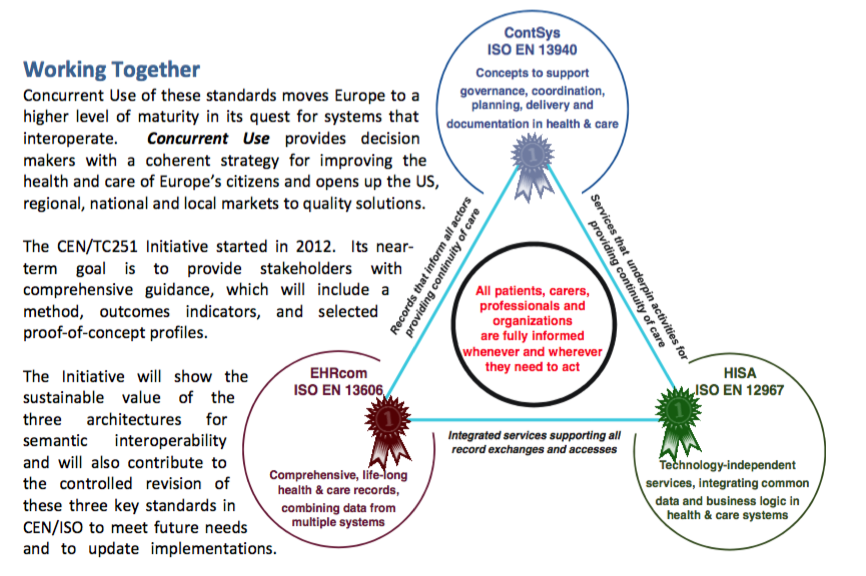
CLIM is the set of CIMI compliant “computable logical models” with explicit SOLOR terminology bindings, which can be used to generate clear, complete, concise, correct and consistent Implementation Guides (**IG**s) for CDA/CCDA, NIEM, FHIR (profiles and extensions) and XML/JSON Message/ Service APIs; where, CIMI compliant means that CLIM conforms to the Appendix E CIMI Principles, Reference Archetypes and Clinical Modeling Patterns. Following the principle of parsimony, it is useful to think of CLIM as the aggregation of CIMI compliant models; rather than, yet another uber-model to be maintained.

## APPENDIX D: ISO/CEN Contributions

A request has been made to the ISO secretariat for the following standards. ISO documents are copyrighted. If you are a CIMI WG member, contact [SHufnagel@ApprioInc.com](mailto:SHufnagel@ApprioInc.com) to get a review copy of the ISO standards or you can purchase them from ISO or CEN.

## ISO/tc215 and CEN/tc251 Concurrent Use

Three ISO/CEN standards are known under the name of ‘Concurrent Use standards[[45]](#footnote-45)



## ISO EN 13606 1-5 (EHRcom)

The CEN/ISO EN13606 is a European norm from the European Committee for Standardization (CEN) also approved as an international ISO standard. It is designed to achieve semantic interoperability in the electronic health record communication.

The overall goal of the CEN/ISO 13606 standard is to define a rigorous and stable information architecture for communicating part or all of the electronic health record (EHR) of a single subject of care (patient) between EHR systems, or between EHR systems and a centralized EHR data repository. It may also be used for EHR communication between an EHR system or repository and clinical applications or middleware components (such as decision support components) that need to access or provide EHR data, or as the representation of EHR data within a distributed (federated) record system.

To achieve this objective, CEN/ISO 13606 follows an innovative Dual Model architecture. The Dual Model architecture defines a clear separation between information and knowledge. The former is structured through a Reference Model that contains the basic entities for representing any information of the EHR. The latter is based on archetypes, which are formal definitions of clinical concepts, such as discharge report, glucose measurement or family history, in the form of structured and constrained combinations of the entities of a Reference Model. It provides a semantic meaning to a Reference Model structure.

The interaction of the Reference Model (to store data) and the Archetype Model (to semantically describe those data structures) provides an unseen capability of evolution to the information systems. Knowledge (archetypes) will change in the future, but data will remain untouched.

## ISO EN 12967 (HISA)

The European Committee for Standardization ([CEN](https://en.wikipedia.org/wiki/European_Committee_for_Standardization)) **Standard Architecture for Healthcare Information Systems** (ENV 12967), **Health Informatics Service Architecture** or **HISA** is a standard that provides guidance on the development of modular open [information technology](https://en.wikipedia.org/wiki/Information_technology) (IT) systems in the healthcare sector. Broadly, architecture standards outline frameworks which can be used in the development of consistent, coherent applications, databases and workstations. This is done through the definition of hardware and software construction requirements and outlining of protocols for communications.[[1]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-1) The HISA standard provides a formal standard for a [service-oriented architecture](https://en.wikipedia.org/wiki/Service-oriented_architecture) (SOA), specific for the requirements of health services, based on the principles of [Open Distributed Processing](https://en.wikipedia.org/wiki/Open_Distributed_Processing).[[2]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-2) The HISA standard evolved from previous work on healthcare information systems architecture commenced by Reseau d’Information et de Communication Hospitalier Europeen (RICHE) in 1989, and subsequently built upon by a number of organizations across Europe.[[3]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-3)

EN/ISO 12967 is broken down into three parts: Enterprise Viewpoint; Information Viewpoint; and Computational Viewpoint, all of which deal with different aspects of ensuring service architecture supports openness and vendor-independence.[[7]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-7)

* **Part One: Enterprise Viewpoint:** The Enterprise Viewpoint component of EN/ISO 12967 provides health services with guidance in describing, planning and developing new IT systems, utilizing an open distributed processing approach. In addition to this it provides direction for the integration of existing information systems, within the one enterprise and across different healthcare organizations. Part one of the standard sets forth the common enterprise-level requirements (e.g. workflows, authorizations) that must be supported through the HISA, which integrates the common data and business logic into a specific architectural layer (i.e. the middleware), accessible throughout the whole information system of the health service.[[8]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-8)
* **Part Two: Information Viewpoint:** The Information Viewpoint component of EN/ISO 12967 sets forth the fundamental characteristics of the information model to be implemented by the middleware to provide comprehensive, integrated storage of the common enterprise data and to support the fundamental business processes of the healthcare organization, as defined in ISO 12967 Part One. The specifications were designed to be universally relevant, whilst being sufficiently specific to allow implementers to derive an efficient design of the system for their organization. This specification does not aim to provide a fixed, complete specification of all possible data that may be necessary for any given health service. It specifies only a set of characteristics, in terms of overall organization and individual information objects, identified as fundamental and common to all healthcare organizations.[[9]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-9)
* **Part Three: Computational Viewpoint:** The Computational Viewpoint component of EN/ISO 12967 provides details on the fundamental characteristics of the computational model to be implemented by the middleware, to provide a comprehensive and integrated interface to the common, fundamental business processes of the health service. The computational model, like the information model is designed to be universally relevant, whilst still being sufficiently specific to allow implementers to derive an efficient design of the system for their organization, irrespective of the specifics of the pre-existing information technology environment in which it will be implemented.[[10]](https://en.wikipedia.org/wiki/Health_Informatics_Service_Architecture#cite_note-10)

## ISO EN 13940 (ContSys)

The system of concepts to support continuity of care, often referred to as **ContSys**, is an ([ISO](https://en.wikipedia.org/wiki/International_Organisation_for_Standardization) and [CEN](https://en.wikipedia.org/wiki/European_Committee_for_Standardization) standard (EN ISO 13940).,[[1]](https://en.wikipedia.org/wiki/System_of_concepts_to_support_continuity_of_care#cite_note-ISO_13940:2015-1)[[2]](https://en.wikipedia.org/wiki/System_of_concepts_to_support_continuity_of_care#cite_note-EN_ISO_13940:2016-2) Continuity of care is an organizational principle that represents an important aspect of quality and safety in health care. [Semantic interoperability](https://en.wikipedia.org/wiki/Semantic_interoperability) is a basic requirement for continuity of care. [Concepts](https://en.wikipedia.org/wiki/Concept) that are needed for these purposes must represent both the content and context of the health care services.

The concept models are created according to ISO TR 24156. Concept modelling may be used for two purposes. The main purpose is to graphically describe a concept system within a subject field. This description can clarify the relationships between the concepts and illustrate some of their definitions. The other purpose is to let a concept modelling tool set up a data base organising the concept system, in order to keep track of its concepts and relationships, as well as check its consistency. Information modelling has the purpose of organising the information objects, each one representing knowledge about a concept. There is however additional information in an information model about the properties of the information objects, shown as attributes to the objects and operations describing behavior of the objects.

## ISO TS 13972 (DCMs)

ISO/TS 13972:2015: Health informatics -- Detailed clinical models, characteristics and processes Abstract

* Describes requirements and recommended methods against which clinicians can gather, analyse and, specify the clinical context, content, and structure of Detailed Clinical Models.
* Defines Detailed Clinical Models (DCMs) in terms of an underlying logical model. They are logical models of clinical concepts and can be used to define and to structure clinical information.
* Describes requirements and principles for DCMs, meta-data, versioning, content and context specification, data element specification and data element relationships, and provide guidance and examples.
* Specifies DCM governance principles to ensure conceptual integrity of all DCM attributes and logical model accuracy.
* Describes DCM development and the methodology principles for use that will support the production of quality DCMs to minimize risk and ensure patient safety.

## SIAMM (Internal Document)

**SIAMM POC**: Gerard Freriks, +31 620347088, [gfrer@luna.nl](mailto:gfrer@luna.nl)

Position Paper: “SemanticHealthNet Semantic Interoperability, Processes and Semantic Resources" Author: Gerard Freriks Co-authors: René Schippers, David Moner Members of the EN13606 Association Board, Final version, dd 20-03-2015

* **SIAMM** (Semantic Interpretability Artefact Modeling Method) is a complete set of requirements, defined concepts of things related to archetypes, systems and organizations they are used in. It also selects standards needed to create archetypes, and standard patterns to construct DCMs expressed as archetypes.
* SIAMM is loosely related to the EN13606 Association. It defines concepts and a method to create re-usable patterns needed for Semantic Interpretability. It overlaps with CIMI and tales part in the CIMI project.
* <https://1drv.ms/b/s!AlkpZJej6nh_k9NVZccvKSQ7HJyYiQ>
* The present SIAMM full version is ±150 pages and is expected by 2016 Q3 and Q4; where, it contains a large section on the concepts in and around EHR’s, and Archetypes in EHR system Interfaces followed by a section on shared archetype patterns, etc.

## APPENDIX E: Other Contributions

This appendix includes documents, slides and links, which were provided to or used by the HL7 CIMI-FHIM Integration Task Force.

## FHIM Desiderata by Galen Mulrooney

* <https://1drv.ms/p/s!AlkpZJej6nh_k9NU7ecx_oqHlIQjCw>

## CIMI Concentric Semantics by Jay Lyle

* <https://1drv.ms/p/s!AlkpZJej6nh_k9NKAQyr30tfIwfIaQ>

## Reference Model Change Request by Claude Nanjo

* <https://1drv.ms/p/s!AlkpZJej6nh_k9NL-NnvhKFil04C5Q>
* [http://wiki.hl7.org/index.php?title=Recommended\_CIMI\_Reference\_Model#Disadvantage\_of\_Recommended\_Approach](http://wiki.hl7.org/index.php?title=Proposed_CIMI_Reference_Model#Disadvantage_of_Proposed_Approach)

## Terms of Reference, Definitions, and Partial Framing by Mark Kramer and Ken Hood

**for HIEA Technical Forum, Aug 17-18**

From Mark Kramer and Ken Lord

**Domain model**: An explicit description of a domain in terms of concepts, properties and attributes, and constraints, defining a common vocabulary. Domain model characteristics: Closed (but extensible), useful for defining objects, properties, and relationships, often (not exclusively) expressed in UML. Sometimes called “conceptual” or “domain analysis” model.

In discussing any specific domain model, it is important to understand its **purpose**, **scope** and **modeling perspective**.

* **Purpose** can be defined in terms of a certain set of use cases, such as medication management, and the intended users (e.g., PCP, hospitalist, payer, or patient).
* **Scope** defines the breadth of the model; e.g., whether to include or exclude over-the-counter medications
* **Perspective** deals with how the same thing can be seen from different points of view; for example, hospital operations can be modeled from the perspectives of resource management, patient treatment, safety and quality, finance, etc.

Example: Pressure Ulcer Prevention Domain Analysis Model (http://wiki.hl7.org/images/b/be/PressureUlcerPreventionDomainAnalysisModel\_May2011.pdf)

**Information model**: A representation of what data is associated with a domain and how that data is structured. Similar to a domain model, but with a focus on representing the information associated with the domain, rather than the domain objects themselves. Information models commonly are developed at the logical level, that is, they are specific about what data is captured, but do not specify database structures. Should include metadata (information about the information collected). Information model characteristics: Closed, includes metadata, useful for constructing artifacts using Model-Driven Architecture.

Example: FHIM, FHIR

**Ontology:** A formal naming and definition of the types, properties, and interrelationships of the concepts that really or fundamentally exist for a particular domain. An ontology can be developed for specific domain model or it can also be used across multiple domain models. Ontology characteristics: Open, useful for automated reasoning, often (but not exclusively) expressed in OWL.

Example: SNOMED-CT

**Taxonomy:** A taxonomy is similar to an ontology, but taxonomy is usually only a hierarchy of concepts, while an ontology supports complex relationships between concepts.

Example: CMS Healthcare Provider Taxonomy Code Set (https://www.cms.gov/medicare/provider-enrollment-and-certification/medicareprovidersupenroll/taxonomy.html)

**Data Element:** A unit of data for which the definition, identification, representation, and permissible values are specified. May not, in itself, provide complete context. May also be posed as a question-answer pair.

Example: US National Library of Medicine Data Element Catalog (https://www.nlm.nih.gov/healthit/dec/)

**Exchange package:** A set of information that is transferred between systems. The logical contents of exchange packages will be defined in terms of individual or groups of data elements. The logical content is independent of the wire format (syntax), but often the definition of an exchange package includes a specific syntax (how the information is serialized for transport).

Example: HL7 V2.5 ADT message, Continuity of Care Document

**Transformation (often just called mapping)** is the process of mapping between data fields and the translation of terminology needed when the source information model, the local contents of the exchange package, or the target information models are not identical.

**Questions and Answers (Open for Discussion)**

* + 1. **What is required for data exchange between systems?**

To transfer data between systems, and to use the data that is transferred, the exchange partners need to decide on:

* + - 1. The logical contents of the exchange package(s)
      2. The wire format of exchange packages (how the logical contents are rendered for exchange) – e.g. FHIR JSON or FHIR XML
      3. Mechanism by which exchange packages are requested, sent, and secured (API, transport, encryption, etc.)
      4. Any business rules associated with sending and receiving exchange packages

Exchange partners then must provide data transformation between the local information model and the information required by the exchange package.

* + 1. **Are common models required for data exchange?**

No. Defining exchange packages requires definition of data elements to be exchanged, and must be enough in-band or out-of-band context to use that information, but that does not require a model. HL7 V2 messages communicate very effectively without requiring an explicit healthcare model.

* + 1. **Then why have common models?**

A common domain model (also called a reference model, federated model) is useful for aligning different domain models, helping people understand exactly how things relate to in other domain models. A common information model, aka the common logical model (CLM), shows how different information models relate to each other. A common ontological model has similar value in relating concepts built can also be used by applications required to support reasoning across multiple domain models.

* + 1. **In what ways can a common logical model (CLM) be “common”?**

In three ways. The CLM can be adopted for **data at rest**, adopted for **data in motion**, or both.

* + 1. **Does adopting a CLM make data exchange easier?**

If the CLM is used to align **data at rest**, then data exchange can be greatly simplified. If the CLM is only used to define a **common exchange standard**, but data at rest (local data store) is not aligned, it doesn’t necessarily help. The difficulty of exchanging information (and being able to use the information that is exchanged) is primarily controlled by the semantic distance between the at-rest data representations.

* + 1. **But isn’t a common exchange standard good thing, in and of itself?**

The theory is that having a common exchange standard reduces the overall mapping effort from O(N2) to O(N). But in practice, it is more complicated.

* + 1. **How so?**

It all depends on the **permissiveness** of the exchange standard. A standard can be more or less flexible in terms of how it represents data. For example, it might permit multiple vocabularies (e.g., allowing diagnosis codes from SNOMED, ICD-9, or ICD-10), or it might be restrictive, and only allow one. In general, the more the flexible standard, the harder it is for the information receiver to use the information that is exchanged. A system based on C32 (an earlier version of C-CDA) may require a special adaptor for each exchange partner. Then we are back to N2, rather than N.

* + 1. **Are current standards that permissive?**

The lack of consistency in healthcare data has led to exchange standards that are purposefully left extremely flexible in how they represent data.Even very recent standards like FHIR have made the decision to remain very flexible because the inconsistency of healthcare data. Achieving consistency in healthcare data is an extremely difficult problem to solve.

* + 1. **How did this come about?**

Healthcare was a paper based system long after most other domains had embraced modern IT infrastructure and electronic data capture. It is only in the last 10 years that electronic specification of data has been the norm. While the adoption of this IT infrastructure is an excellent step forward, the opportunity for an evolutionary process towards data consensus was not possible. Where other industries shifted to electronic records and data gradually, healthcare very rapidly made the shift with many provider organizations and vendors developing capabilities in parallel. This rapid progress locked in many inconsistencies in data capture and representation. As a result, exchange standards are not enough to solve the interoperability problem in healthcare. We have to look at the data itself.

* + 1. **Does “permissiveness” have something to do with FHIR Profiling?**

It does. FHIR is not a perfect solution for solving the exchange problem, but it provides a far more solid foundation then previous standards. FHIR out of the box, without profiles, it is very easy to use because it is very flexible. But there is a high risk of an information receiver not being able to interpret information they. If we create specific, constrained profiles, there are many more rules to comply to, but if senders and receivers are able to comply to those rules, the increased predictability it easier for the receiver to process the information exchanged.

* + 1. **That sounds like a classic tradeoff**

Absolutely. A tight exchange standard makes it harder to join the exchange, but the result is a greater level of semantic interoperability. A looser, more permissive exchange standard makes it easier to join the exchange, but lowers semantic interoperability.

* + 1. **Where is the optimal point on that tradeoff?**

No one really knows. But the only way to fundamentally break the tradeoff is to move towards standardizing healthcare data across providers. There will be significant resistance and building consensus will be an enormous challenge. If this were easy to solve, we wouldn’t have the massive problem we have today. However, if we can provide a target and start working towards achieving fundamental data consistency, the benefits will be significant.

**Other terms of possible interest:**

* **Abstraction**: a reduction in information content for the purpose of emphasizing what’s most important and removing the details that matter less.
* **Encoding**: A representation, or a change in representation, without a difference in information content. (For example, a number can be represented in base 10 or base 2, but it is still the same number).
* **Vagueness**: Not clearly or explicitly stated or expressed; not clear in meaning
* **Granularity**: The level of detail that can be represented in an information model; the degree to which different concepts are distinguishable. High granularity means fine details are visible; low granularity hides these details. For example, to describe a geographic area, zip+4 is more granular than a 5-digit zipcode.
* **Approximation**: value or quantity that is nearly but not exactly correct. In terms of semantics, a term that is close but does not exactly capture what is meant.

**Interoperability Levels**: HIMSS, HL7, ISO and other organizations have defined different levels of interoperability. This table is an attempt to align a few of those definitions.

|  | **HIMSS** | **HL7** | **CITL** | **ISO** | **Description** |
| --- | --- | --- | --- | --- | --- |
| 1 | Founda-tional | Technical | Machine transportable | Technical | Data sent electronically; could be fax or email |
| 2 | Structural (Syntactic) | Semantic | Machine organismal | Information is serialized for transport using a defined, structured format |
| 3 | Semantic | Information is apportioned to defined data fields, each field with defined contents and restrictions |
| 4 | Semantic | Machine interpretable | Information is communicated with unambiguous, shared meaning, using controlled vocabularies and taxonomies |
| 5 | ------ | Process | ------ | Organiza-tional | System interactions implement workflows and are coordinated under agreed business rules |
| 6 | ------- | ------- | ------- | Legal | Interactions are aligned under legal, regulatory, and incentive systems |

HIMSS, <http://www.himss.org/library/interoperability-standards/what-is-interoperability>, retrieved 6/29/2015

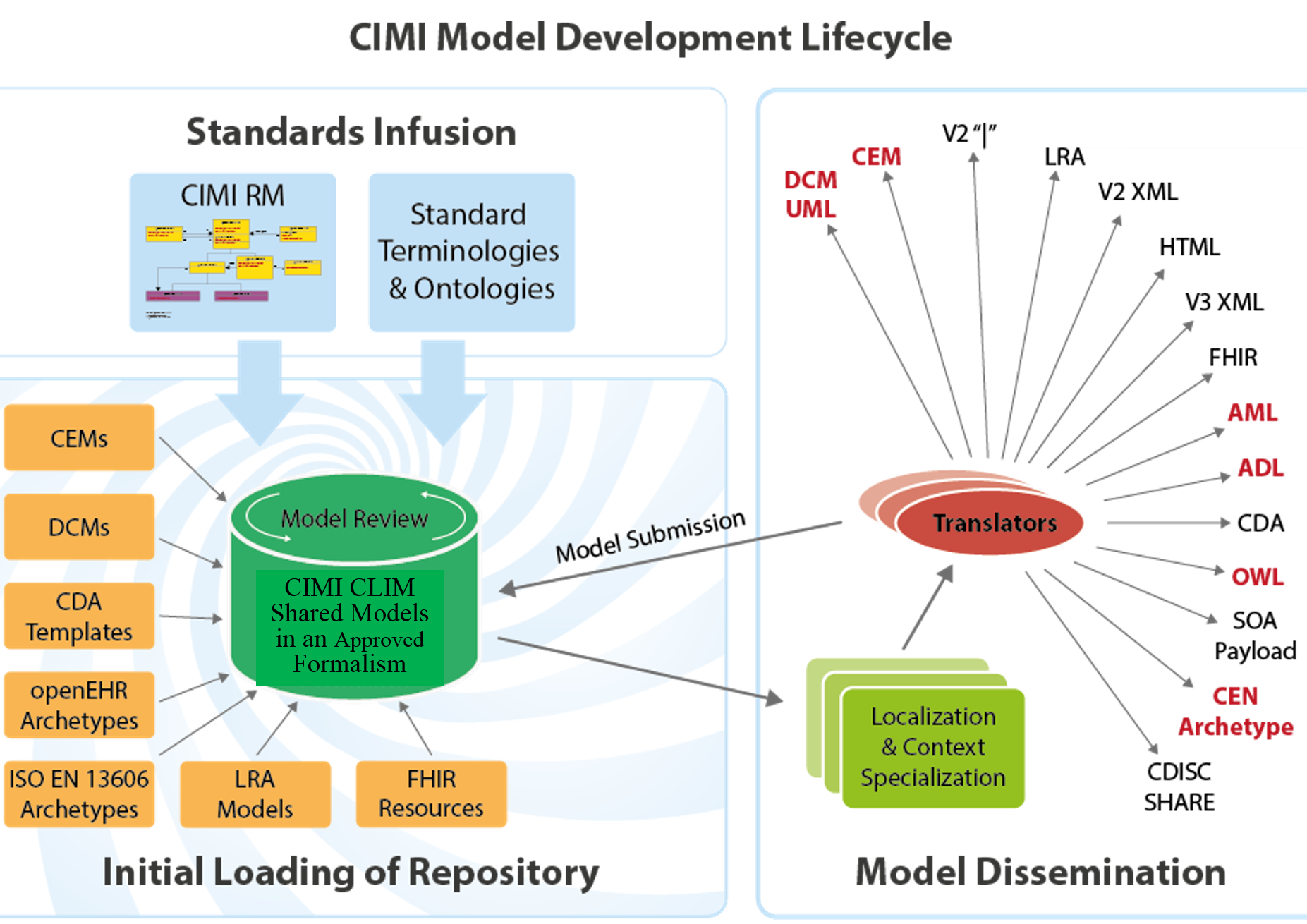
HL7, [Coming to Terms: Scoping Interoperability for Health Care](http://www.hln.com/assets/pdf/Coming-to-Terms-February-2007.pdf), February 2007

Center for Information Technology Leadership, "The Value of Healthcare Information Exchange and Interoperability," Wellesley, MA

ISO: http://www.iso.org/iso/home/news\_index/news\_archive/news.htm?refid=Ref1536

## CIMI Principles aka CIMI Terms-of-Reference approved by HL7 CIMI Workgroup

This section presents the CIMI Principles – Preferred Modelling decisions, which represent the CIMI Terms-of-Reference or the scope and limitations of CIMI activities and area of knowledge.



Decisions are categorized as [principles], [process guide] or [style guide]

* Mar 24, 2016 Version 12 was CIMI WG approved, pending “class” and “attribute” modeling style examples
* Mar 31, 2016 Version 13, adds “class” and “attribute” modeling style examples

1. CIMI approved Detailed Clinical Models (**DCMs**) must be in a CIMI approved syntax: [style]
   1. ADL 2.X. – most current approved version
   2. AML – most current approved version
   3. An alternative syntax must be transformable into the CIMI Preferred syntax.
      1. e.g., RDF, LEGO.
2. CIMI approved DCMs must use the most current approved CIMI core reference model. [style]
3. CIMI approved DCMs must use CIMI reference archetypes where applicable. [style]
   1. Reference Archetypes are marked by a reference archetype annotation
   2. Reference Archetypes have names that are all uppercase in the ADL Workbench
   3. Reference Archetypes are Constrained from the CIMI Core Reference Model and can be constrained into a hierarchy of reusable CIMI Patterns to build CIMI leaf DCMs
4. CIMI Clinical Information models support interoperability[[46]](#footnote-46) across a federation of enterprises by supporting transformations among the enterprises’ respective interface standards. [principle], such as
   1. CCDA, FHIR, NIEM, HL7 V2 or V3 messaging
5. CIMI Clinical Information Models support semantic classification. [principle]
   1. E.g., A CIMI hemoglobin lab observation can be classified as a lab observation.
6. CIMI supports iso-semantic alternatives for modeling the same clinical data. [principle]
   1. Iso-semantic models are models that have exactly the same information content, but the models differ in terms of structure and/or the degree of pre or post coordination of concepts that are used in the models.
      1. **ACTION**: define iso-semantic vs logically/semantically equivalent
   2. Models in a iso-semantic family can use different levels of pre and post coordination. A SNOMED-CT template can be a preferred representation to translate between the iso-semantic families for those parts of the model, which are covered in SNOMED-CT.
7. The default CIMI preferred model is the most explicitly modeled (i.e., post-coordinated) member of an iso-semantic family. [principle]
8. **CIMI terminology binding principles**:
   1. CIMI models must have complete terminology bindings before the models attain a status of “Complete” or “Ready for Trial Use.” [process guide]
   2. CIMI has obtained and will use a CIMI SNOMED-CT Extension to create, track, and submit needed concepts to SNOMED-CT. Concepts that are not appropriate for SNOMED-CT will be submitted to other standard terminology developers. [process guide]
   3. CIMI models must be bound to standard terminologies: [principle. Subheadings are style guidance.]
      1. SNOMED-CT relationship concepts will be used for the parent – child binding relationships.
      2. LOINC codes will be used for observation identifiers.
      3. SNOMED-CT codes will be used for non-medication related clinical concepts in value sets.
   4. CIMI will specify one preferred unit of measure for models of physical quantities for use in accessing and storing data via services.SI[[47]](#footnote-47) units are preferred by default.
      1. The CIMI preferred strategy is to use SNOMED-CT codes for units of measure in models, rather than a UCUM expression. Each unit of measure must have a single unique mapping to a valid UCUM expression. This strategy was chosen because it allows units of measure to be specified and constrained in the same manner as any coded field. However, for unit conversion, the related UCUM expression can be referenced from the code, and then UCUM unit conversion libraries can be used to convert to a new unit of measure.
      2. RxNorm codes will be used for medication related concepts temporarily; where, an International standard will be used, when available.
      3. Other standard codes and code systems will be approved as needed.
      4. CIMI model bindings will be informed by the SNOMED-CT concept model where appropriate. [principle]
9. Logical CIMI models will only include identifiers of value sets, not the enumerated list of allowed values. Value sets are configuration controlled separately from CIMI models. [style guide]
10. CIMI is creating “computable logical models.” CIMI’s definition of “computable logical models” is: [process guidance]
    1. The models are algorithmically process-able (computable). It must be possible for the models to be translated algorithmically from one formal representation to another. CIMI logical models must support lossless round-trip logical transformations through CIMI approved representations.
    2. Hierarchical models classify the structural relationship of the model elements (containment).
    3. Coded elements have explicit binding to allowed value sets of coded values.
    4. Models are independent of any specific programming language, implementation technology, or type of database.
    5. The models must support explicit, unambiguous query statements against data instances.
    6. Models may support inclusion of “processing knowledge” (default values, etc.).
11. One or more examples of logical instance data will be created for each model or class of models. [style guide]
    1. The examples will show both proper and improper use
12. Values for codes and for value set identifiers will always be represented within the model using URIs. [style guide]
13. CIMI preferred Modelling style: [principle]
    1. CIMI archetypes include all valid clinical requirements, regardless of prevalence of use; where, CIMI archetypes may exclude source requirements deemed to be implementation-design constraints.
    2. The CIMI preferred models include all possible attributes (maximal set of data elements) for which there is a valid use case; that is, CIMI models are superset reference models. [principle]

CIMI prefers the “class modeling style” or “specialization by constraint style” whereby model nodes are constrained by changing the name of the node or attribute in the model; where, the usual modeling style most archetype modelers use is the Class modeling style; where, not only the names/concepts change; but also, the structure of the model can change.

In the **Class modeling style** archetypes are specialized by changing the name of a node or add or remove structures.

EXAMPLE: The node has a name and the data field holds for instance a number as result.

**<Node: LabTest> has result <a number>**

When this gets **specialized**, the node name changes and so does its meaning

**<Node: LabTest Blood Glucose Measurement> has result < a number>**

* + 1. An alternative “attribute modeling style” or “LEGO[[48]](#footnote-48) modeling style” is to constrain nodes by changing the value of an attribute (e.g., SNOMED descriptor) in the model; where, nodes get their meaning from the name they get and/or annotations.

The **Attribute modeling style** is used because of the fact that the archetypes (clinical models) need more rigor and are constructed using re-usable patterns. In this modeling style the archetype stays fixed.

**<Node: NAME> has value <LabTest>**

**<Node: RESULT> has value <a number>**

When this gets specialized the node names are not changed. Only one data field is changed.

**<Node: NAME> has value <LabTest: Blood Glucose Measurement>**

**<Node: RESULT> has value <a number>**

[Examples provided by Gerard Freriks, March 2016]

**OUT OF SCOPE**: Implementations characteristics are out of scope.

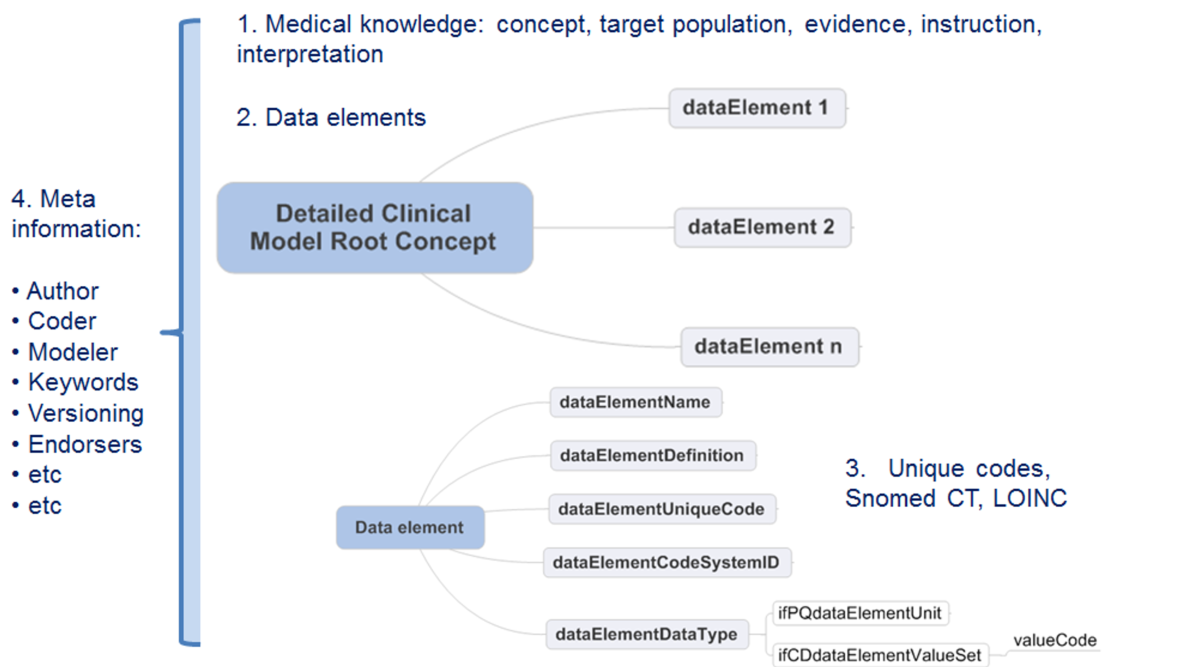
1. CIMI is not directly concerned with wire formats. [principle]
2. Realms may choose non-CIMI preferred units of measure and terminology for communications; where, it is the realm’s responsibility to have an equivalent concept in their terminology and to produce the mapping to the standard code.
3. Implementations of user facing point-of-capture and point-of-use applications may use any units of measure or terminologies that they like, as long as communications use CIMI preferred SI units and standard terminologies. [principle, style guide/implementation guidance]
4. Transformation fidelity (e.g., Millimeters to whole inches may be imprecise, inches to lb. /sq. ft. may be meaningless) and safety as a whole are design specifications, beyond CIMI’s scope.

## Discussion on Recommended New Principle

This section illustrates the vigorous debate that occurred to converge on each of the principles in the previous CIMI Principles section.

**RECOMMENDED PRINCIPLE[[49]](#footnote-49) (Keith Campbell):** We agree to a clean separation of semantic responsibility between terminology models and other domain models.

* **Rob McClure**: I agree with the principle (assuming I understand) but what I’m a bit unclear on is will our task be to take what I see as guiding principles and fit real-world typical terminologies into the final product, or is the intent to arrive at a final point based on only those models and terminologies that can fully utilize the principles?
* **Keith Campbell**: From my perspective, the goal is to accept a principle that can direct development activities such as FHIM, CIMI, FHIR, etc.; where,
  + The boundary between terminology and FHIM, CIMI, V3 RIM, FHIR, etc., has historically been fuzzy and inconsistent, and recommended value sets may contradict the underlying terminology model—whatever it may be.
  + All this principle is trying to state is that this fuzzy boundary needs to be made into a "clean separation of semantic responsibility between terminology models and other domain models.”
  + It’s not saying where the separation should take place, or how the separation should be represented (some have recommended specific model binding value sets for domain and range as the representation—I’m neutral on how this representation should be done at the moment).
  + If we can agree we need a clean separation of semantic responsibility should be created, then the next questions may be “where should the boundary be” and “how should it be represented”.
  + I have straw-man ideas about where the separation should be, but there is no point going to the next step if we can’t agree that we should create a clean separation of responsibilities in the first place.
  + Some may ask “isn’t this obvious, and aren’t we doing that already?” The simple answer is no we are not, and a critical look at the FHIR resource objects, and trying to match those up to SNOMED would make this very apparent.
  + That said, the principle is not specific to FHIR and SNOMED.
* **Jay Lyle**: I think I am in accord with your perspective on the problem I have heard called "model impedance," whereby a model adopts a terminology that has semantic overlap with bits of the model not anticipated--or, perhaps, anticipated but not addressed--by the adopter.
  + It seems to me that the model designer needs to specify the semantics of each element, whether that specification is done by natural language in a definition annotation,
    - by a model binding to a terminology concept model,
    - by reference to some other model, or
    - by some other way,
    - and that such a specification should be done in a way that is logically consistent--i.e., does not allow one concept to be specified twice, in potential contradiction.
  + "Separation of responsibility " (division of semantic specifications into groups by steward?) is one probable result of the requirement to specify semantics, but it is neither the only one (we also get specified semantics) nor is it even necessary (if all semantics come from one place, then calling it "separation" brings up all kinds of interesting but unproductive questions about set theory).
  + If we modified this, we must agree to a clean separation of semantic responsibility between terminology models and other domain models to something like this
    - “Model stewards must specify unambiguous and unique (i.e., not redundant) semantics for data elements.”…Would we lose anything important, or pick up anything undesirable?
* **Keith Campbell**: I think: “Model stewards must specify unambiguous and unique (i.e., not redundant) semantics for data elements. “Is a fine additional principle, but I don’t think it really overlaps with: “We must agree to a clean separation of semantic responsibility between terminology models and other domain models.”
  + Perhaps the statement of uniqueness is trying to imply clean separation of semantic responsibility, but it does not really clearly state that to me. It is more saying that within a model, the semantics must be unambiguous, and does not really specify what to do when dealing with more than one model.
  + So I’m ok adding an additional principle, that: Model stewards must formally specify unambiguous and unique semantics for data elements within their model[[50]](#footnote-50).
* **Steve Hufnagel:** I suggest a postscript, such as: Pre or post coordinated expressions, class modelling style or attribute modelling style or SNOMED expression templates or descriptive logic expressions may be the locally preferred style; where, these alternative modelling styles are acceptable as long as they are clear, complete, concise, correct, consistent, computable and iso-semantically equivalent to the generally preferred CIMI class modelling style bound to post coordinated SNOMED, LOINC and RxNorm expressions[[51]](#footnote-51).
* **Stan Huff:** I agree with adding the additional principle recommended by Jay. I don’t agree with the suggested addition that Steve recommended (yet).It may be a good addition, but I don’t actually think that “CIMI prefers the “class modeling style” or “specialization by constraint style”. That may be true, but I think it requires further discussion and clarification. I would rather approve the principle as stated by Keith, and then at a later time add the information Steve has recommended after it has been discussed, clarified, and approved. In the meantime, I think Keith’s statement is clear enough to provide guidance on many issues without the additional statement.
* **William Goossen**: I do agree with your principle (s). These are well known in information modeling where domain terminologies are handled. Many principles are laid out in the terminfo guidelines and the clinical modelling principles are much more detailed and clearly specified in ISO TS 13972 detailed clinical modelling. Although I do agree with the principle and that it needs to guide CIMI, I am afraid that not using TS 13972 is setting the CIMI group back instead of advancing. Why reinvent what has already been well established as a technical specification? The 2010 paper analyses 1,2,4 below plus HL7 v3 templates and a Korean approach (not available online anymore) were the foundational material for ISO TS 13972 detailed clinical modelling; where, the approach we take is using UML and transform the UML with code bindings to XML, HL7 v3 clinical statements and to JSON.



Although FHIR is gaining momentum, v3 is still superior in many aspects, such as a consistent handling of clinical content and procedures to govern it. That will cause governance issue for FHIR and will change soon I agree. But the baseline for all 8 items below plus the OWL / RDF approach missing in your list is that we worry too much about the technical representation format, where the real difficulties are in the data element specification, their relationships, their binding to codes and where value sets apply, to specify and identify these. And that fact is continuously ignored, in particular by CIMI. And, these concepts are specified in detail in ISO TS 13972 with substantive input from OpenEHR, 13606, Intermountain, HL7 v3 specialists and FHIR godfathers. (Ewoud Kramer is responsible for the logical model description in this ISO work).

Significant sections from this TS have been submitted to CIMI in the past 6 years, either allowed full summaries of e.g. meta data, the specification rules for data elements and more. Also, the drafts of the standard have been submitted to CIMI in past years. Interestingly this TS took > 6 years, and all the fuzz was about how to set up the governance and the core is represented by this model, universally applicable to the formats you list below. In my humble opinion is the core of CIMI clinical modelling is unfortunately introducing yet another technical formalism, not compatible with FHIR and nor with openEHR or 13606; where, My principle is that the data element core part in the figure above are the logical model components that are required for a proper clinical model. And as Stan says over and over: must be iso-semantic. Well this is, given current implementations of this modelling approach in HL7 v3 messaging, as functional design for EHRs, as data definition in a clinical data ware house and now with a new approach into a FHIR extension format, truly iso-semantic; where, I agree that clinical modelling must be insert-able into FHIR resources and profiles. As I wrote before: this approach is much more helpful than to stick into technical representations, because these will change every quarter, where the logical model of clinical content will be much more stable. So even with a budget of billions by US and worldwide vendors, it will not be possible to create a useful approach as long as the clinical content itself is not sorted out, specified and modeled properly and logically.

* **Gerard Freriks:** Am I correct to interpret the Principles as:

- The terminology model dictates the structure of the Archetype?

- In other words what is meant by ‘reflects’?

- In the way I create Reference Archetypes all nodes have one fixed meaning. When codes are available for these nodes that is fine, but experience shows that many codes cannot be found in either LOINC or SNOMED. I’m leaning to a solution where CIMI creates and maintains these codes to annotate nodes. But reuses as much as possible codes from existing systems.

* **Gerard Freriks**: I disagree:
* When it is suggested that Structures must follow the Ontologies behind Terminologies,
* A careful analysis is needed to either change the structure or the ontology.
* So far it is my experience that SNOMED’s ontology is and always will stay incomplete. Its cope (for use in interpretability) is overextended and overlaps too much the world of documentation of statements in the full context.
* **Gerard Freriks:** I want to introduce some SIAMM notions (see Appendix). First the Semantic Stack; where, each of the layers is based on one model, which one or more other models might influence. SIAMM is defined as part of work for EN13606 Association:
* Rules for the boundary between Structure and Coding Systems
* Patterns to name ‘things’, define kinds of results, how to place things in space and time, including the patient system, defined participating things, reasons why, methods and confounding factors, qualifiers and modifiers
* Modeling styles: Attribute modeling style, Process modeling style
* Modeled Process Function, Process Context, Artefact Use
* Process Statement, Panel Statement and ‘simple’ Statement
* Relationship with other standards (ContSys ISO 13940)

## APPENDIX F: Acronym Index

**ADL**, 19, 21, 35, 38, 55, 56

**AML**, 19, 30, 32, 35, 39, 55

**Argonaut**, 7

ATC, 26

**CAD**, 38

**CCDA**, 13, 17, 41, 42, 44, 56

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**CDS**, 6, 23, 24, 25, 32, 35, 36, 42

CEM, 22, 25

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1. The Jan-Sep 2016 CIMI-Sponsored HL7 **CIMI-FHIM Integration Investigative-Study** includes: The Open Group Healthcare Forum, HL7 CIMI WG, HL7 EHR WG and HL7 CIC WG [↑](#footnote-ref-1)
2. The Mar-Sep 2016 CIMI-Sponsored HL7 **CIMI-FHIM Integration Task-Force** includes: 'Linda Bird' <lbi@ihtsdo.org>; ‘Bishop, Robert J.’ <Robert.Bishop2@va.gov>; 'Richard Esmond' <richard.esmond@gmail.com>; 'Jay Lyle' jay.lyle@jpsys.com; 'Stan Huff MD' Stan.Huff@imail.org; ‘Stephen Hufnagel’ [SHufnagel@ApprioInc.com](mailto:SHufnagel@ApprioInc.com); 'Galen Mulrooney' <Galen.Mulrooney@JPSys.com>; 'Claude Nanjo' <cnanjo@cognitivemedicine.com> [↑](#footnote-ref-2)
3. See explanation of “A clean separation of model semantics” statement in Section 3 Recommended Principle footnote and discussion in APPENDIX E Section 11.6 Discussion on Recommended New Principle [↑](#footnote-ref-3)
4. FHIR is Fast Health Interoperability Resources [↑](#footnote-ref-4)
5. Several Health IT Policy Committee (HITPC) workgroups have been formed as subcommittees to the parent FACA (Federal Advisory Committee Act (FACA). These workgroups meet periodically to discuss their topics, present their findings at Health IT Policy Committee meetings, and make recommendations to the Health IT Policy Committee.

   The Health IT Policy Committee workgroups are:

   * [Advanced Health Models and Meaningful Use](https://www.healthit.gov/facas/FACAS/health-it-policy-committee/hitpc-workgroups/advanced-health-models-and-meaningful-use-workgroup)
   * [Consumer](https://www.healthit.gov/facas/FACAS/health-it-policy-committee/hitpc-workgroups/consumer-workgroup)
   * [Interoperability and Health Information Exchange](https://www.healthit.gov/facas/FACAS/health-it-policy-committee/hitpc-workgroups/interoperability-and-health-information-exchange)
   * [Privacy and Security](https://www.healthit.gov/facas/FACAS/health-it-policy-committee/hitpc-workgroups/privacy-and-security-workgroup)

   [↑](#footnote-ref-5)
6. Curation involves governance and configuration management (CM) and is hierarchical; that is, curation is done by independent organizations developing models and there also is the curation at HL7 to govern and configuration-manage the CLIM (set of CIMI compliant models) for periotic HL7 and/or ISO balloting and versioning, such as for Draft Standards for Trial Use or normative standards. CIMI curation involves two classes of models preferred and non-preferred styles-of-modelling; where preferred models conform to the CIMI Principles (e.g., Terms of Reference in this report’s appendix E); and where, non-preferred models are iso-semantic with preferred CIMI models; where ideally, these models can be round-trip transformable by a tool. [↑](#footnote-ref-6)
7. Developed by the NZ National Health IT Board <http://healthitboard.health.govt.nz/about-us/ehealth-vision/shared-health-information-model-%E2%80%93-%E2%80%98tree%E2%80%99-diagram> [↑](#footnote-ref-7)
8. The analogue is ‘Air Speak’ or ‘Sea Speak’. In health and care the name could be ‘Med Speak’.An example phrase from ‘Sea Speak’ is "Say again”; where, the benefit of Sea Speak is the use of a single short or carefully crafted phrase to replace a multitude of phrases. In the example, the phrase "say again" could replace any of the following:

   * Could not hear what you said, please repeat!
   * I did not understand, say that again.
   * Too much noise, repeat what you said!
   * I am having difficulty hearing what you are saying! Please repeat what you were trying to say.
   * There is too much noise on the line - I cannot understand you.
   * What did you say?

   [↑](#footnote-ref-8)
9. “System of Concepts for Continuity of Care” (ISO 13940) is a formal standard that defines all concepts and their relations needed for the documentation in an EHR of shared care. It defines a generic health delivery model, also. [↑](#footnote-ref-9)
10. Our stack can be made 3 dimensional to use for architectural compliance-and-conformance by adding the ISO 12967 (HISA), RM-ODP or HL7 SAEF behavioral, Information and enterprise views; where, we define a Reference Architecture for computable-**interopera**bility/ **interpreta**bility specifications; and where, solution architecture models/implementations can be tested for compliance-and-conformance. [↑](#footnote-ref-10)
11. FHIM overlaps with ISO EIN 13940 (System of Concepts for Continuity of Care); where, a recommendation is to harmonize the two. [↑](#footnote-ref-11)
12. SNOMED is both an ontology and a terminology model; but, for Logical Clinical Information Models SNOMED is driven by an Ontology; where, this Ontology model intersects and produces codes (as atomic as possible). [↑](#footnote-ref-12)
13. SNOMED codes intersect with Archetypes in the structure of archetypes and data points defined in archetypes. More coding systems will be needed, SOLOR can be that harmonized collection. [↑](#footnote-ref-13)
14. Reference Archetypes are CIMI-FHIM touchpoints for Observation, Assessment/Inference, Planning, Ordering, Execution, etc. [↑](#footnote-ref-14)
15. Harmonization with CIMI, LEGO and CQF is desirable. [↑](#footnote-ref-15)
16. Useful meaningful sentence [↑](#footnote-ref-16)
17. ISO 13606-1 covers Archiving / Data Documentation model [↑](#footnote-ref-17)
18. IAW is “in accordance with”. See the “Acronym Index” to decode the other acronyms [↑](#footnote-ref-18)
19. **Semantic Interpretability** means,

    * that as much as possible, implicit knowledge is made explicit, making patient safe interpretation possible by clinical reasoners or humans that do not share this implicit epistemological knowledge; where, epistemology is the investigation of what distinguishes justified belief from opinion.
    * and, Semantic Interpretability provides the possibility to safely use data plus its epistemology, confounding factors, and qualifiers/modifiers in clinical reasoners.

    [↑](#footnote-ref-19)
20. Gerrard Freriks: **Semantic Interpretability requires**:

    * Model for documentation of statements / documents/Interfaces. (ISO 13606-1)
    * Model to create and exchange Semantic Interoperability Artefacts (SIO’s) (ISO 13606-2)
    * Codes from Reference Terminology to associate them with nodes in the SIO’s. (LOINC)
    * Codes from Reference Terminologies to populate Data fields (results)
    * Ontologies that drive the Reference Terminologies.

    Missing in this list are methods/patterns to create SIO’s and models for the clinical treatment cycle, co-operation between humans / organizations (ISO 13940 System of Concepts for Continuity of Care and CIMI/SIAMM patterns. [↑](#footnote-ref-20)
21. Terms of Reference is the scope and limitations of an activity or area of knowledge. [↑](#footnote-ref-21)
22. Appendix E and the “CIMI Practitioners Guide to HIE Interoperability” presents CIMI principles (aka Terms of Reference) necessary to be CIMI compliant. Current MS Word version is available at: <http://1drv.ms/1TuV8PD> [↑](#footnote-ref-22)
23. Gerard Freriks: “System of Concepts for Continuity of Care” (ISO 13940) is a formal standard that defines all concepts and their relations needed for the documentation of shared care. It defines a generic health delivery model, also. [↑](#footnote-ref-23)
24. **Mark Kramer asked**: “For clarity, can you state explicitly what model semantics is separated **from**?

    **Steve Hufnagel replied**: It means a separation (no duplication) of model structure (attributes in a class) with model semantics (bound terminology to the class attributes); where, an example might be ‘body site’; where, ‘body site’ might be specified with one or more FHIM attributes or ‘body site’ might be included in a SNOMED expression bound to an observation, such as pulse. Both modelling styles might be ‘correct’; but, both modelling styles should not be used simultaneously.”

    **Keith Campbell clarified**: YES, but, model structure vs model semantics may not be universally understood, and there is a little overlap, in that, model semantics also have structure. So, we describe it as “between domain models” where one model may be the “terminology model” (model semantics in Steve’s example), and a higher model, such as a CIMI or FHIR observation (model structure in Steve’s example). Today, in HL7 FHIR at least, FHIR tries to define things such as attributes for anatomy, that are not based on a particular model of anatomy, and thus you get semantic overlap, with the burden of reconciliation (may not even be possible) left to the end user. If instead we say “SNOMED defines the semantics of anatomy, and we use that model in this way, in this resource” then you have cleanly separated the semantic responsibility (SNOMED defines anatomy), and you have specifically stated the correspondence between the observation attributes related to anatomy, and the SNOMED attributes related to anatomy. Although anatomy is an example, it is pervasive… Who owns the model of severity? Who owns the model of an Observable (as opposed to an Observation Result—CIMI’s term—which is like the FHIR Observation Resource (it is really an observation result)? Who owns the model of a procedure? Of the Anatomy related to a procedure? Etc. The split between model structure and model semantics is a challenging one to keep consistent. Each model that builds on another introduces new semantics, otherwise, it is not a new model. See Appendix E for further discussion on the principle. [↑](#footnote-ref-24)
25. Gerard Freriks: The separation of concerns leads to autonomous intersecting models. [↑](#footnote-ref-25)
26. The **Argonaut Project** is a private sector initiative to advance industry adoption of modern, open interoperability standards. The purpose of the Argonaut Project is to rapidly develop a first-generation FHIR-based API and Core Data Services specification to enable expanded information sharing for electronic health records and other health information technology based on Internet standards and architectural patterns and styles. This effort follows on recommendations from the Joint HIT Standards and Policy Committee's [*JASON Task Force Report*](http://www.healthit.gov/facas/sites/faca/files/Joint_HIT_JTF%20Final%20Report%20v2_2014-10-15.pdf), the HIT Standards Committee’s [*NwHIN Power Team*](http://healthit.gov/FACAS/health-it-standards-committee/hitsc-workgroups/nationwide-health-information-network-nwhin-power), the MITRE JASON Reports of [*2013*](http://healthit.gov/sites/default/files/ptp13-700hhs_white.pdf) and [*2014*](http://www.bostonglobe.com/business/2014/12/11/tufts/yaRVe0uBCrfE4FZlFqPFOJ/story.html), and the [*2010 PCAST Report*](https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd-report-2010.pdf). See <http://argonautwiki.hl7.org/index.php?title=Main_Page/Background> for more information. [↑](#footnote-ref-26)
27. Gerard Freriks: Provided that data points are stored together with all epistemological, etc. data [↑](#footnote-ref-27)
28. Gerard Freriks: With my comments elsewhere in the text; but, we also need to agree on the “Provenance” Patterns we need for What, Where, Who, Why and How plus modifiers and qualifiers; plus, we need to agree on how to deal with documenting processes. [↑](#footnote-ref-28)
29. Rob McClure stated the CIMI’s approach to SNOMED extensions must be clearly defined to obtain HL7 Vocab concurrence to HL7 ballot CIMI models. [↑](#footnote-ref-29)
30. Semantic Interoperability Artefact Modeling Method is loosely related to the EN13606 Association. It defines concepts and a method to create re-usable patterns needed for Semantic Interpretability. It overlaps with CIMI and tales part in the CIMI project. [↑](#footnote-ref-30)
31. Gerard Freriks: I agree with these but prefer the next list is harmonized with ContSys:

    * Observation about the Patient System process and other (administrative) processes
    * Inference about the Patient system, and assessments about other processes
    * Planning processes,
    * Ordering processes and
    * Process execution

    [↑](#footnote-ref-31)
32. Gerard Freriks: The SIAMM Semantic Stack [↑](#footnote-ref-32)
33. Gerard Freriks: CIMI must create CLUSTER models and ENTRY models for each of the following list of processes that get documented: Observation, Assessment/Inference, Planning, Ordering, Execution; where, CLUSTER/ELEMENT models provide all the flexibility one need and are extremely generic Classes [↑](#footnote-ref-33)
34. Jay Lyle: CIMI needs the ability to author content, as well as specify it for standards in a way that users can get. If Stan and Keith agree that SOLOR infrastructure is the place for CIMI to author, that’s good—though I have a hard time seeing that being another publishing node. (Unless, of course, we adopt a CTS2 style federated architecture, which for reasons unknown remains unmentioned.)

    * I do not think that’s the end game, even for authoring, nor is NLM, to the extent CIMI is international.
    * Short answer: a lot of unanswered questions. We’re not going to settle them among ourselves. The first thing we need to do is get the federal partners to agree we need a point of coordination for this sort of thing, and second to agree that the things to coordinate are the FHIM for a framework, CIMI for clinical knowledge, SOLOR for semantics, etc. Technical details about exactly how they fit together seem to me to be too heavy to address well, too inchoate at this point to not be scary, and too distracting to help the case.

    Rob McClure: I suspect CIMI needs the VA terminology server because it can extend SNOMED to create new concepts that are then incorporated into DCMs. VSAC cannot do that. Plus, the idea of SOLAR is perfect for their needs. Jay is right, we need to push for a federation and common set of APIs. CIMI will not only use hand crafted stuff, and when they are referencing value sets where VSAC is the SOT, they should be **pushed hard** to not re-create them in the VA, but instead get them from VSAC. That is the starting point. [↑](#footnote-ref-34)
35. See “*CIMI Practitioners Guide to HIE Interoperability*” Current MS Word version is available at: <http://1drv.ms/1TuV8PD> [↑](#footnote-ref-35)
36. Gerard Freriks: I predict that there are situations that a generic CIMI pattern needs data fields in the archetype to create flexibility using that pattern; where, the need for shared patterns suggest an AttributeStyle models. That is, when CIMI is creating patterns that can be reused the Attribute modeling style allows the re-usable patterns and use the data filed attributes of ELEMENT nodes in Archetypes. [↑](#footnote-ref-36)
37. See [www.fhims.org](http://www.fhims.org) [↑](#footnote-ref-37)
38. LEGOs represent clinical assertions, following a standard XML syntax and using SOLOR.using the International Health Terminology Standards Development Organization (IHTSDO) Workbench and its EL++ Classifier to properly parse the XML encoded data stream generated by the SMARTForm prior to transmission to the VA’s Health Data Repository (HDR), its Corporate Data Warehouse (CDW) and the VA Informatics and Computing Infrastructure (VINCI). LEGO focus is:

    1. Automated and semi-automated methods to improve the quality, efficiency, and safety of terminology content development and maintenance;
    2. Improvements in integrating post-coordinated expressions with patient data repositories and data warehouses;
    3. Tools to help with the management of change in the terminology systems over time;
    4. Terminology Visualization and editing capabilities.
    5. support the use of post-coordinated expressions to retrofit question/answers from legacy system questionnaires to native-standards representations. LEGOs will be consolidated with the CIMI observation result model in the near future.

    [↑](#footnote-ref-38)
39. Gerard Freriks: Ideally, the Semantic Stack needs one basis model, one basis standard, such as the one defined by SIAMM (see appendix). Is there a better, alternative, way? If so, what are the What are the layers? and What are the Models? [↑](#footnote-ref-39)
40. See <https://projects.eclipse.org/proposals/model-driven-health-tools> [↑](#footnote-ref-40)
41. See <http://www.omg.org/mdmi/> [↑](#footnote-ref-41)
42. See <https://ecqi.healthit.gov/ecqm-tools/tool-library/si-clinical-quality-framework> [↑](#footnote-ref-42)
43. A new version of SIAMM, updated with new developments in the last 2 years will be published Q3/4 2016. [↑](#footnote-ref-43)
44. Gerard Freriks: It is my position that HL7 FHIR is much entrenched in solutions for existing systems. Existing systems that at best can be partially interoperable. FHIR patterns are created that cover what in general exists in present day systems. FHIR as method is superior to the messaging paradigm, but too pragmatic; where, Semantic Interpretability needs a complete fresh approach that gives guidance to this next level of interoperability. Semantic Interpretability needs to draw on best of breed standards that intersect in well controlled places without overlap. [↑](#footnote-ref-44)
45. <http://www.en13606.org/images/docs/ConcurrentUseFlyer.pdf> [↑](#footnote-ref-45)
46. **The HIMSS Board approved the following definition of interoperability on April 5, 2013:** In healthcare, interoperability is the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged.1 Data exchange schema and standards should permit data to be shared across clinicians, lab, hospital, pharmacy, and patient regardless of the application or application vendor.2

    Interoperability means the ability of health information systems to work together within and across organizational boundaries in order to advance the effective delivery of healthcare for individuals and communities.3 There are three levels of health information technology interoperability: 4 1) Foundational; 2) Structural; and 3) Semantic.

    **1 - “Foundational”** interoperability allows data exchange from one information technology system to be received by another and does not require the ability for the receiving information technology system to interpret the data.

    **2 - “Structural”** interoperability is an intermediate level that defines the structure or format of data exchange (i.e., the message format standards) where there is uniform movement of healthcare data from one system to another such that the clinical or operational purpose and meaning of the data is preserved and unaltered. Structural interoperability defines the syntax of the data exchange. It ensures that data exchanges between information technology systems can be interpreted at the data field level.

    **3 - “Semantic”** interoperability provides interoperability at the highest level, which is the ability of two or more systems or elements to exchange information and to use the information that has been exchanged.5 Semantic interoperability takes advantage of both the structuring of the data exchange and the codification of the data including vocabulary so that the receiving information technology systems can interpret the data. This level of interoperability supports the electronic exchange of patient summary information among caregivers and other authorized parties via potentially disparate electronic health record (EHR) systems and other systems to improve quality, safety, efficiency, and efficacy of healthcare delivery.6 [↑](#footnote-ref-46)
47. SI units International System of Units is a system of physical units (SI *Units*) based on the meter, kilogram, second, ampere, kelvin, candela, and mole, together with a set of prefixes to indicate multiplication or division by a power of ten. [↑](#footnote-ref-47)
48. VA is investigation Lightweight Expression of Granular Objects (LEGOs) to be wholly representable within the CIMI Observation result and SNOMED/LOINC observable Model. [↑](#footnote-ref-48)
49. What we’re trying to get across with this principle, which comes from software architectural principles; where, the “clean separation of semantics responsibility” is meant to be the terminology/ modeling analogy to the “separation of concerns” which is frequently referenced. <https://msdn.microsoft.com/en-us/library/ee658124.aspx>

    * **Separation of concerns**. Divide your application into distinct features with as little overlap in functionality as possible. The important factor is minimization of interaction points to achieve high cohesion and low coupling. However, separating functionality at the wrong boundaries can result in high coupling and complexity between features even though the contained functionality within a feature does not significantly overlap.
    * **Single Responsibility principle**. Each component or module should be responsible for only a specific feature or functionality, or aggregation of cohesive functionality.
    * **Principle of Least Knowledge**(also known as the Law of Demeter or LoD). A component or object should not know about internal details of other components or objects.
    * **Don’t repeat yourself (DRY)**. You should only need to specify intent in one place. For example, in terms of application design, specific functionality should be implemented in only one component; the functionality should not be duplicated in any other component.
    * **Minimize upfront design.**Only design what is necessary. In some cases, you may require upfront comprehensive design and testing if the cost of development or a failure in the design is very high. In other cases, especially for agile development, you can avoid big design upfront (BDUF). If your application requirements are unclear, or if there is a possibility of the design evolving over time, avoid making a large design effort prematurely. This principle is sometimes known as YAGNI ("You ain’t gonna need it").

    [↑](#footnote-ref-49)
50. Gerard Freriks: We are in need of principles that govern the production of Structures and Codes/Annotations. [↑](#footnote-ref-50)
51. Gerard Freriks: We need rules about how to use codes. In principle I am against pre- and post-coordinated codes in Semantic Interpretability. We should use ‘simple’ codes as if they are lemma’s in a dictionary. And only use pre- and post- coordinated codes in well-defined domains (e.g. anatomical names) or in screen presentation/data entry. SNOMED today is overextended and allows pre- and post- coordination code definition that include the epistemology. Epistemology -in my mind- is reserved to be handled by structures only. [↑](#footnote-ref-51)