Lecture Notes

Big Data in Medical Informatics

Week 6:
Semantic Interoperability of EHR

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Semantic Interoperability

- Interoperability definition:
  - "ability of two or more components to exchange information and to use the information that has been exchanged."
- Semantic Interoperability definition:
  - "ability for information shared by systems to be understood *at the level of formally defined domain concepts*"

Semantic interoperability refers to common and precise understanding of exchanged information.

- LEVEL 1: Syntactic interoperability
  - two or more systems are capable of communicating with each other
  - The information between different components, systems or organisation can be exchangeable via specified data formats, communication protocols
  - It does not require special involvement of human.
  - From the perspective of language, syntax can be considered as the grammar to convey semantics and structure.

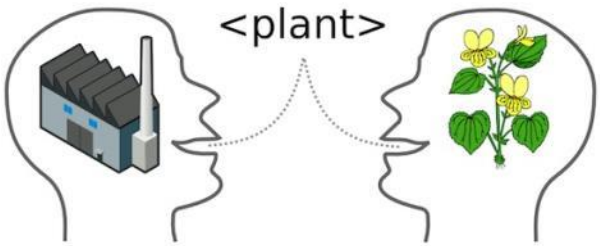
Semantic Interoperability

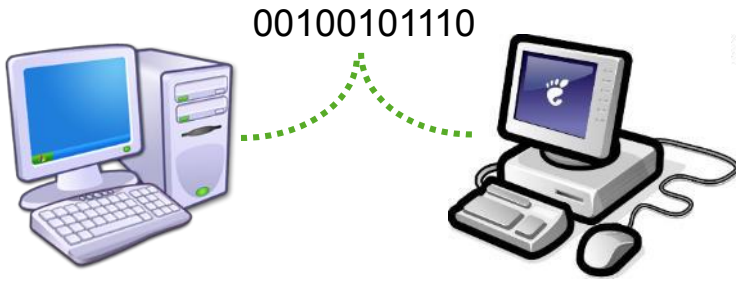
- Level 2: Functional interoperability
  - The semantics of the information or knowledge provided is explicit and can be analysed by domain experts.
  - In other words, the end users should understand the meaning of the information exchanged between information systems.

- LEVEL 3: Semantic interoperability
  - A part from realizing functional interoperability, it requires that the information system understands the semantics of information request and those of requesting information.
  - The information requester and the information provider should have a common understanding of the “meaning” of the exchanging information.
  - The information shared by systems should be understood at the level of formally defined domain concepts so that information is computer processable by the receiving system.

Semantic Interoperability

- computational services should be able to interpret safely clinical data that has been transferred / integrated from diverse sources





- Semantic interoperability is the ability of sharing, aggregating, analyzing and using external information automatically and in a meaningful way.

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Semantic Interoperability

- Why do we need Semantic Interoperability of health records ?

- Discuss possible use cases that you might need to set up an semantic interoperability infrastructure ….

Semantic Interoperability

Possible use cases ….

- Manage increasingly complex clinical care.
- Connect multiple locations of care delivery.
- Support team based care.
- Deliver evidence-based health care.
- Support clinical trials
- Enable secondary use for big data analytics
- Improve patient safety.
- Reduce errors and inequalities.
- Reduce duplication and delay.
- Provide personalized decision support
- Support everyday care.
- Empower and involve citizens.
- Underpin population health and research. ….

Semantic Interoperability

- Goal of semantic interoperability :
  - Data to be transferred and structurally mapped into a receiving database
  - Moreover it's clinical content can be mapped to a commonly understood meaning
    - For this goal we need an information infrastructure to be able to communicate (share) meaning, and in particular, clinical meaning.
    - It is much more complex than sharing data structures, data elements and individual values.

Semantic Interoperability

- Task: To harmonise meaning

- A strait forward solution: Harmonise meaning by developing a standard, precise and comprehensive terminology, in which each clinical concept is clearly defined and has a unique representation.

- Question : Does it work ? Why and why not ?

Semantic Interoperability

- Answer: Not really , One size does not fit all !

- Although semantic interoperability ideally requires standards, this level of standardization is not achievable.

Clinical practice is inherently diverse. Representation for each clinical expression is not realistic, and is probably not desirable:

- different levels of detail, different levels of granularity are needed for different clinical settings;
- clinical practice is too diverse and evolving for fine grained standards;
- different cultures, and natural languages need to represent health phenomena and clinical meaning differently;
- patients and carers need a different level of jargon from health care professionals.

Semantic Interoperability

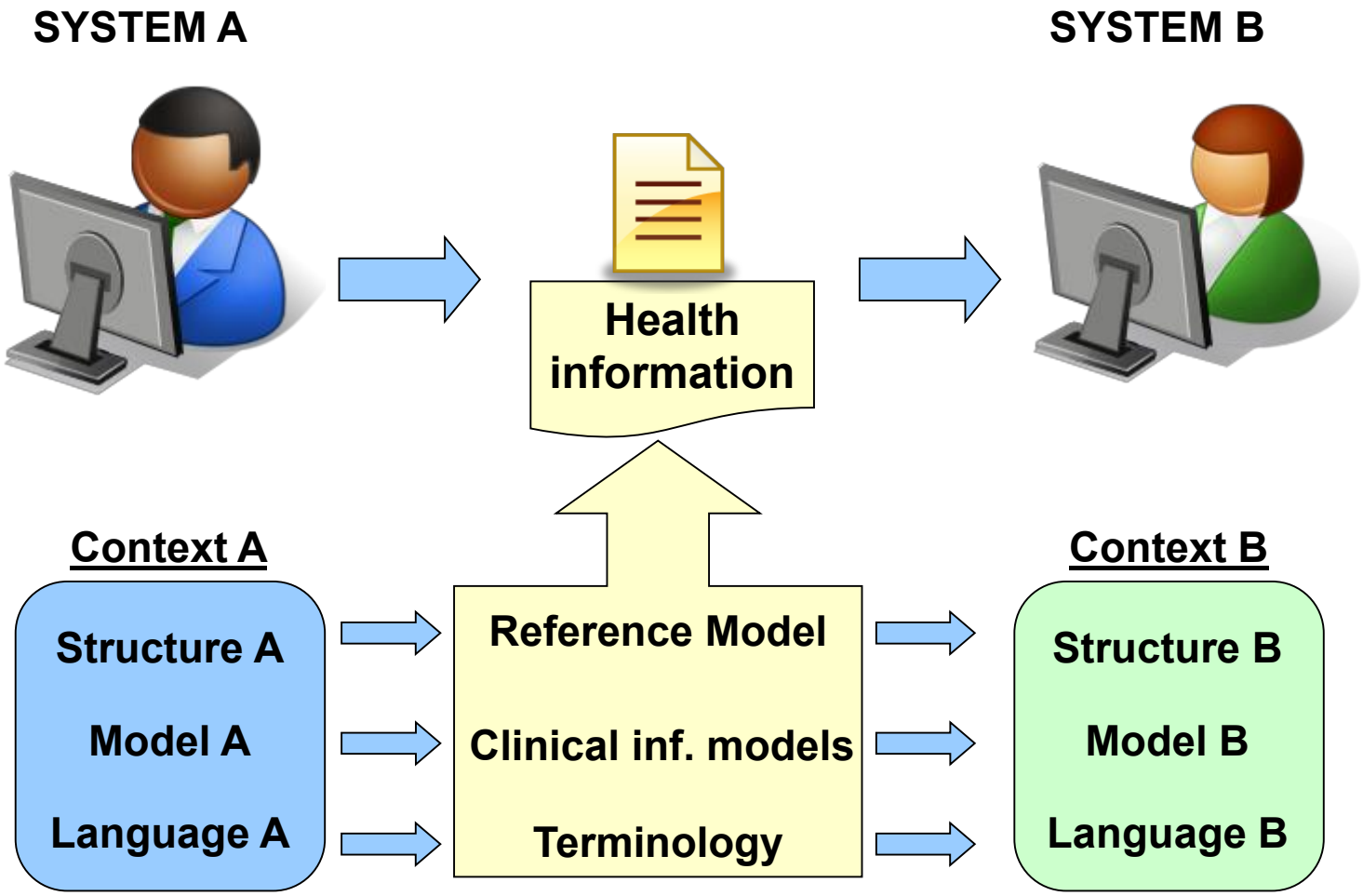
Goal of Semantic Interoperability is :

- to be able to recognise and process semantically equivalent information homogeneously, even if instances are heterogeneously represented

- i.e. if they are differently structured, and/or using different terminology systems, and/or using different natural languages.
  This equivalence needs to be robustly computable, and not just human readable but in machine interpretable way.

- When heterogeneous systems can communicate and combined:
  - guidelines, care pathways, alerting and decision support components can function effectively and safely across EHRs
  - Diverse clinical and genomic data sources can be harmonized and re utilized for big data analytics
  - Knowledge repositories and clinical data can be coupled to support evidence based medicine

Semantic Interoperability



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Semantic Interoperability

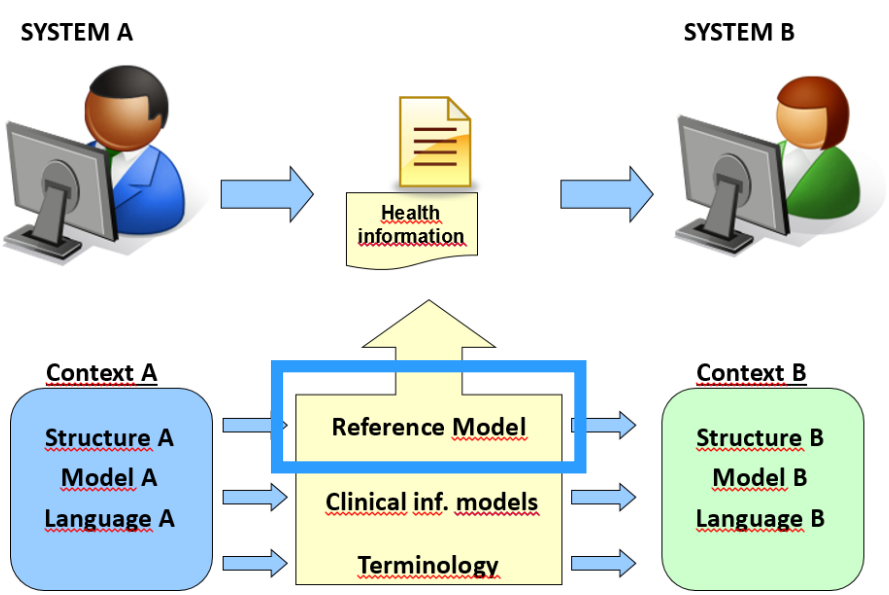
- Solutions for Semantically Interoperable EHR Systems:

- 1) Generic reference models for representing clinical (EHR) data
  - e.g. ISO/EN 13606 Part 1, HL7 CDA Release 2, the openEHR Reference Model.

- 2) Agreed data structure definitions: clinical information models
  - e.g. openEHR archetypes, ISO/EN 13606 Part 2, HL7 templates, generic templates and data sets.

- 3) Clinical terminology systems
  - e.g. LOINC, SNOMED-CT, ICD.

Reference Models

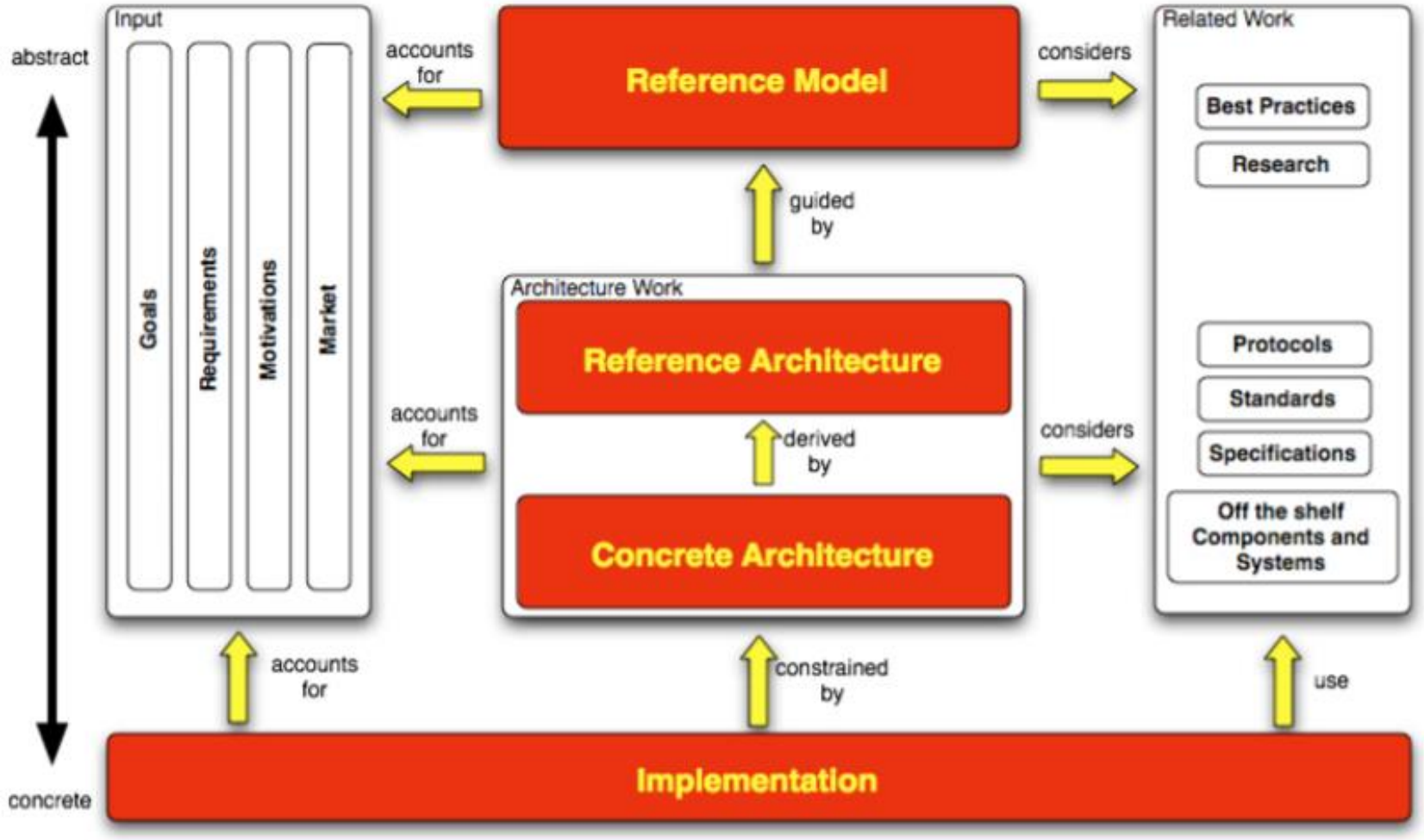


Reference Models

- Reference model :
  - is an abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts in order to ensure clear communication.
  - *In software design:* a division of functionality into elements together with the data flow among those elements
- Reference architecture:
  - is an architectural design pattern indicating an abstract solution that implements the concepts and relationships identified in the Reference Model
  - *In software design:* A reference architecture mapped onto software elements that implements the functionality defined in the reference model

- Reference Models are frequently confused with Reference Architecture.
  - The Reference Models serves as the common communication platform. It establish the architecture taxonomy .
  - Reference Architectures on the other hand are the architecture template which can be reuse to create architecture design (elements, relations among them, and properties of both elements and relations) .

Reference Models



Ref: Learning, Enhanced. "DL. org: Coordination Action on Digital Library Interoperability, Best Practices and Modelling Foundations."

Reference Models

Reference Model:

- An abstract framework for understanding significant relationships among the entities of some environment
- Consists of minimal set of unifying concepts, axioms and relationships within particular problem domain
- provide common language for understanding important features of domain
- Provide a structure which allows modules and interfaces of a system to be described in consistent manner
- Not directly tied to any standards, technologies or other concrete implementation details

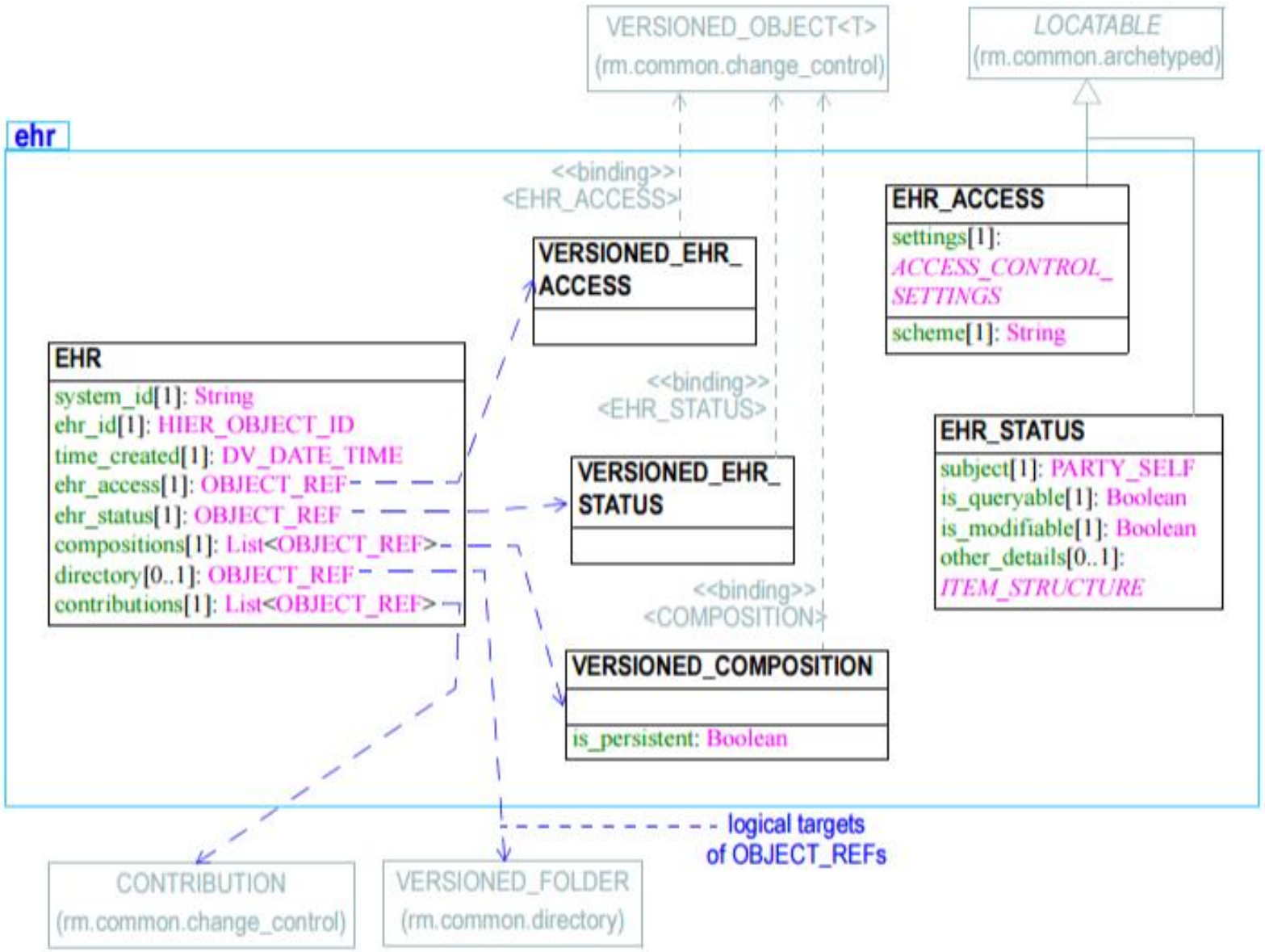
EHR Reference Models

- EHR Reference Models
  define the high-level logical model for any kind of EHR and the information properties that will be common to all of the entries contained in it:
  - dates and times of when observations occurred, health events took place and when information was recorded;
  - persons who provided, composed, entered or authorised (signed) particular entries, or who played particular roles in a health care process;
  - version management information, including who changed any of the entries, when and why;
  - the degree of sensitivity of the information and who should be allowed to access it;
  - who the information is about, if not the patient (e.g. if it about a family member, or a third party);
  - the ability to label each point in the record hierarchy i.e. to include a name for each folder, document, heading and the parts of each detailed entry;
  - a standard way of representing coded clinical terms, measured quantities, dates, times and various kinds of multimedia data.

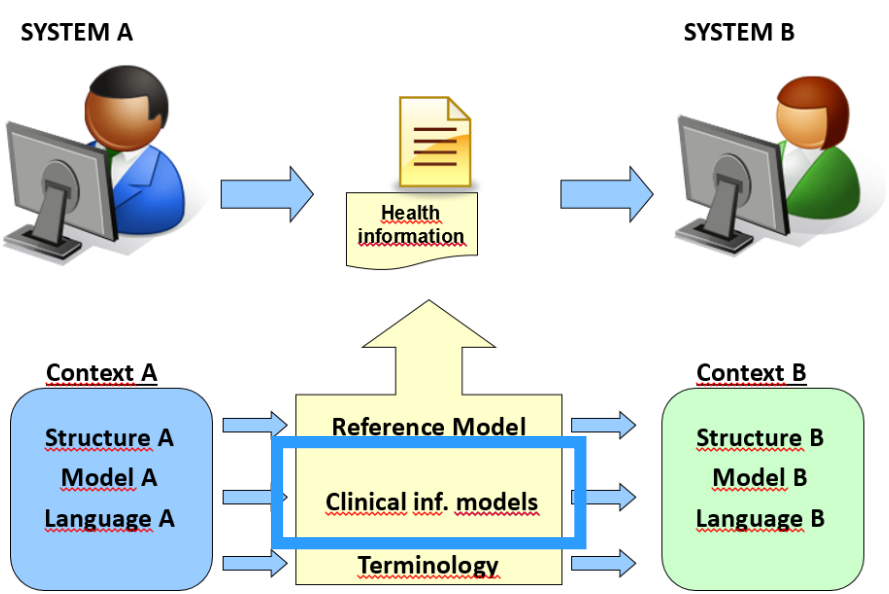
EHR Reference Models

- The reference model
  - shall be used by both sending and receiving information systems
  - contain all of the structure, names and medico-legal information required for it to be represented faithfully on receipt
  - the nature of the clinical content not need to be “agreed” in advance.
  - This is sometimes termed structural or syntactic interoperability.
  - The kinds of meaning that are represented are predominantly medico-legal rather than related to clinical knowledge.

EHR Reference Models



Clinical Information Models



Clinical Information Models (CIM)

- CIM as a generic term that encompasses all technical specifications defining how clinical information is organized and described inside an EHR system or repository, or for EHR communication.
- This approach is used for the clinical (semantic) data structures that will be communicated via the reference model
- A CIM defines both the information structure and formal semantics of documented clinical concepts.

Clinical Information Models (CIM)

- Benefit : equivalent clinical information is represented consistently or at least can be mapped to a consistent representation for interpretation.

- CIMs are structural and semantic artefacts that facilitate
  - organizing, storing, querying, and displaying clinical data
  - exchanging that data between different information systems; and
  - performing data analytics.

- Examples:
- A standard set of domain-specific concept models, i.e. archetypes and templates for clinical, demographic and other domain-specific concepts

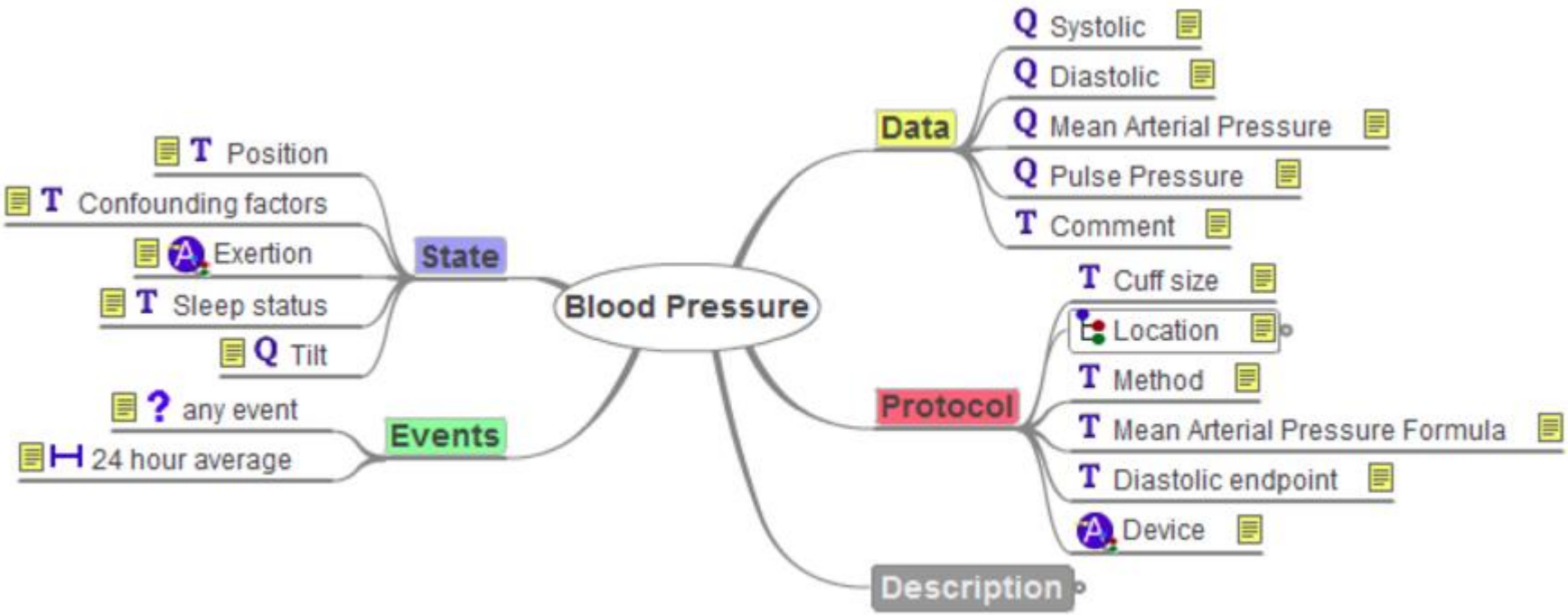
Clinical Information Models (CIM)

- A CIM is defined by constraining the generic data structures of an underlying reference model (RM)
  - RM provides the basic characteristics and attributes needed to represent data instances.

- Terminologies such as SNOMED CT, ICD, or LOINC also play an important role in defining CIMs.
  - The structure of CIMs can be bound (precisely mapped) to clinical terminologies to provide a unambiguous definition of the model.
  - terminologies are also used to specify value sets, ie, the set of possible terms that can be assigned as clinical information values.

- a complete semantically interoperable definition of CIMs can only be achieved by using both a standard RM and terminologies to describe the semantics of the information structures.

Clinical Information Models (CIM)



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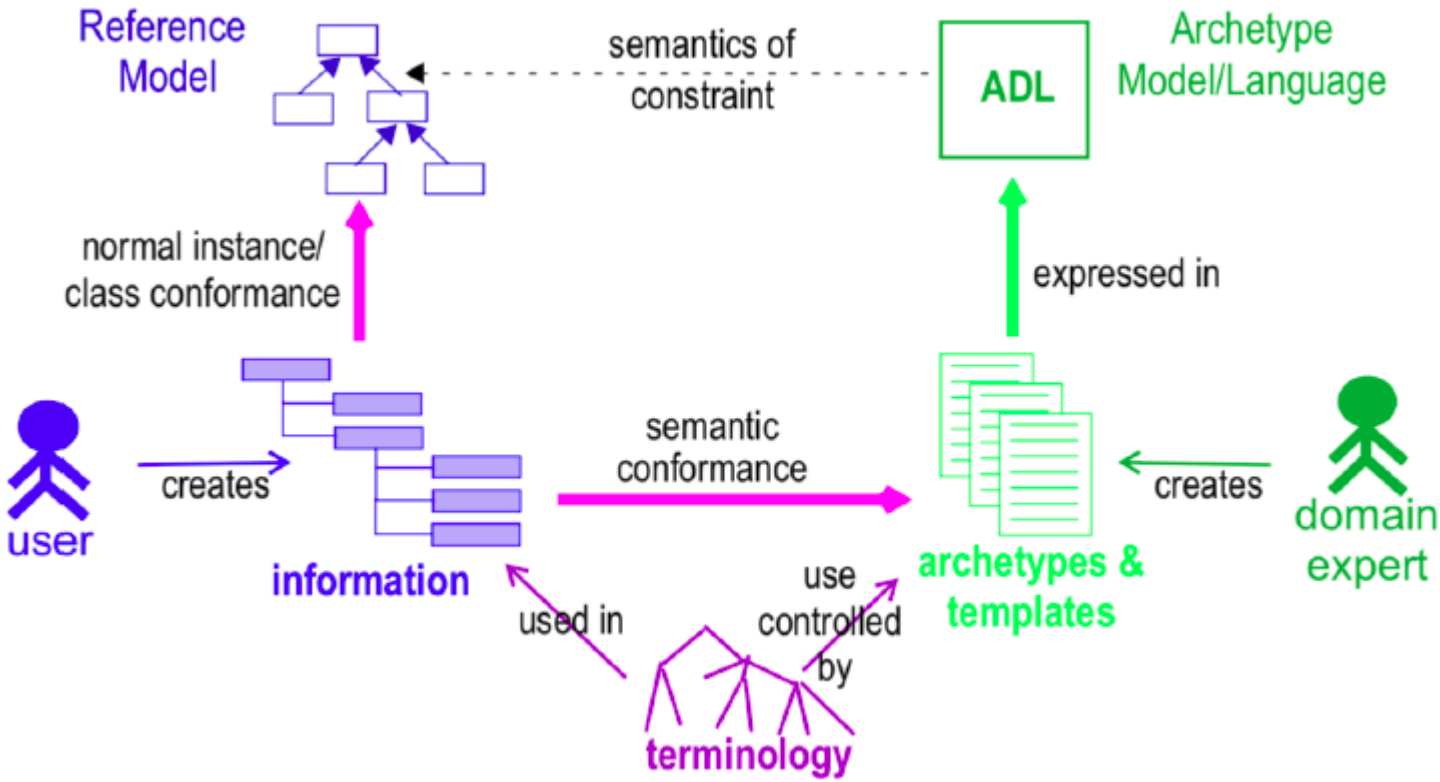
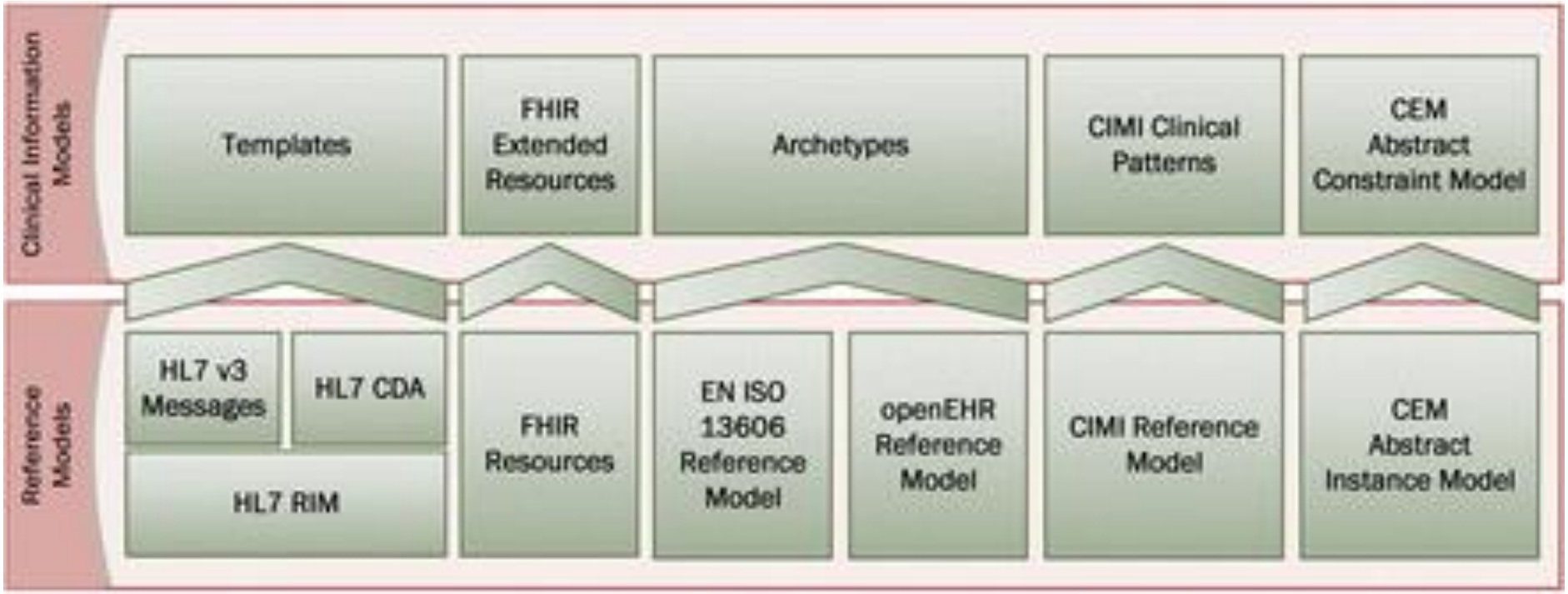
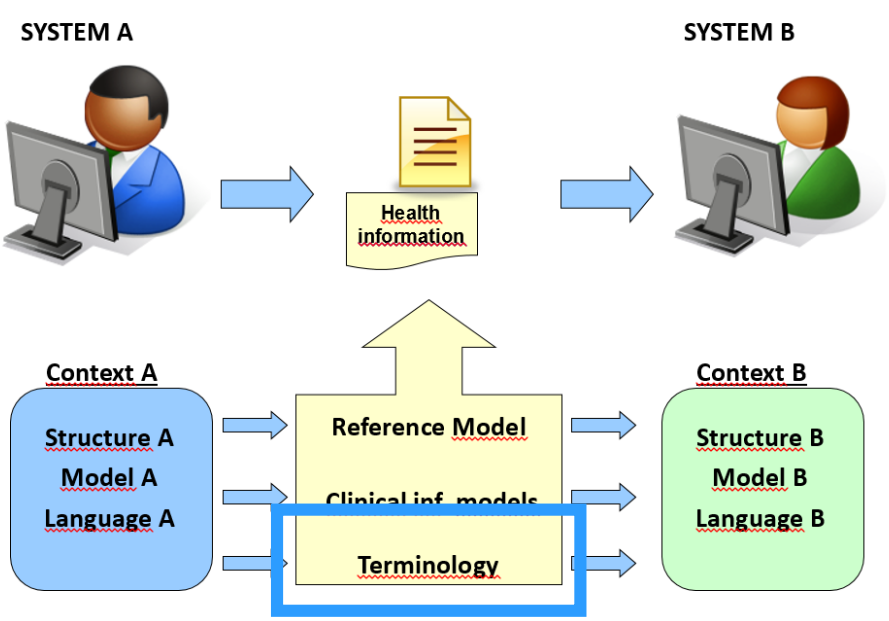

Reference Model
semantics of constraint
ADL
Archetype Model/Language
normal instance/ class conformance
expressed in
user
creates
information
semantic conformance
archetypes & templates
creates
domain expert
used in
use controlled by
terminology

- Summary of reference models and their clinical information model definition artefacts.



Ref: Moreno-Conde, Alberto, et al. "Clinical information modeling processes for semantic interoperability of electronic health records: systematic review and inductive analysis." Journal of the American Medical Informatics Association (2015): ocv008.

Terminologies



Clinical Terminologies

- clinical terminology serves to provide a systematised and restricted (controlled) vocabulary of clinically relevant phrases that can be used during data entry to provide a more precise and shareable expression

- It also permits EHRs to be shared across languages - the translation of a terminology to another natural language is moderately scalable

- nomenclatures,
- controlled vocabularies
- simple hierarchical classifications of diseases,
- aetiologies and treatments to facilitate the entry and analysis of healthcare data

- ICD, ICPC, SNOMED ….

Interoperability Communication Standards and Standard Setting Organizations

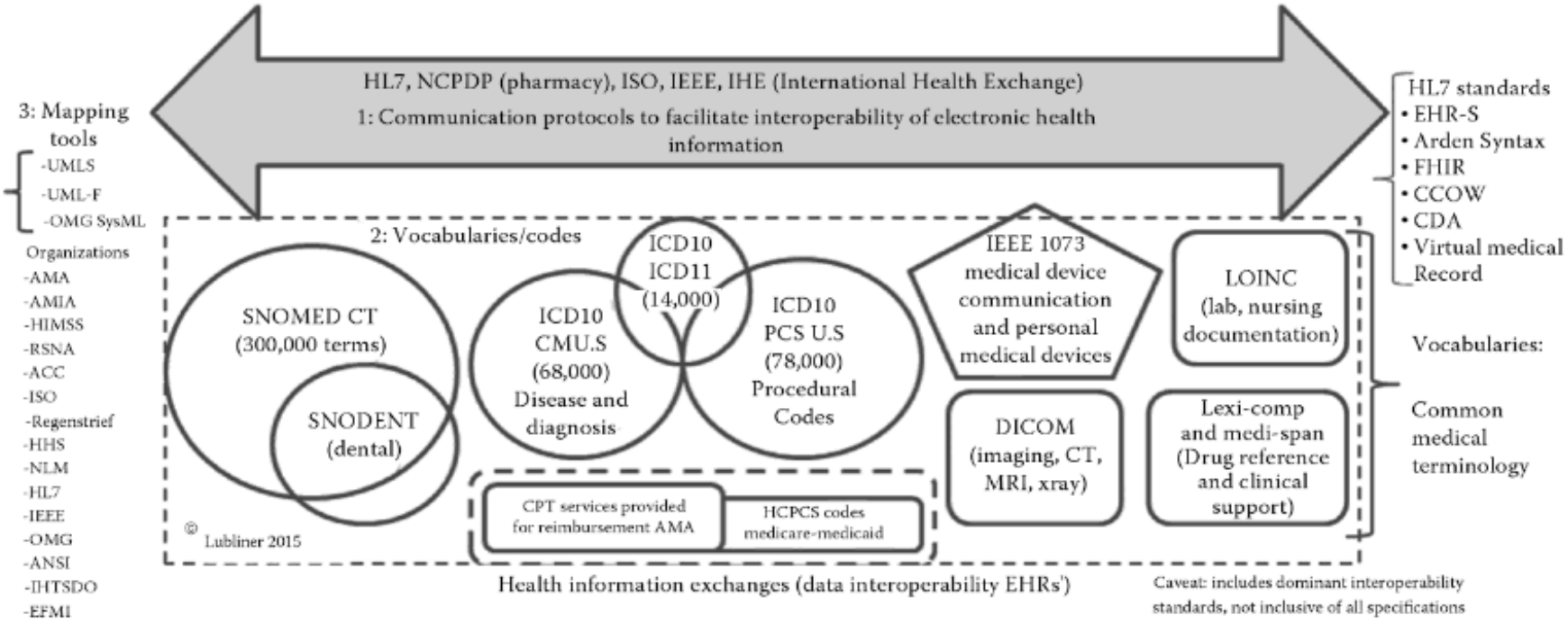


FIGURE . Interoperability: communication, terminology, and mapping standards.

Ref: Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health. David J. Lubliner

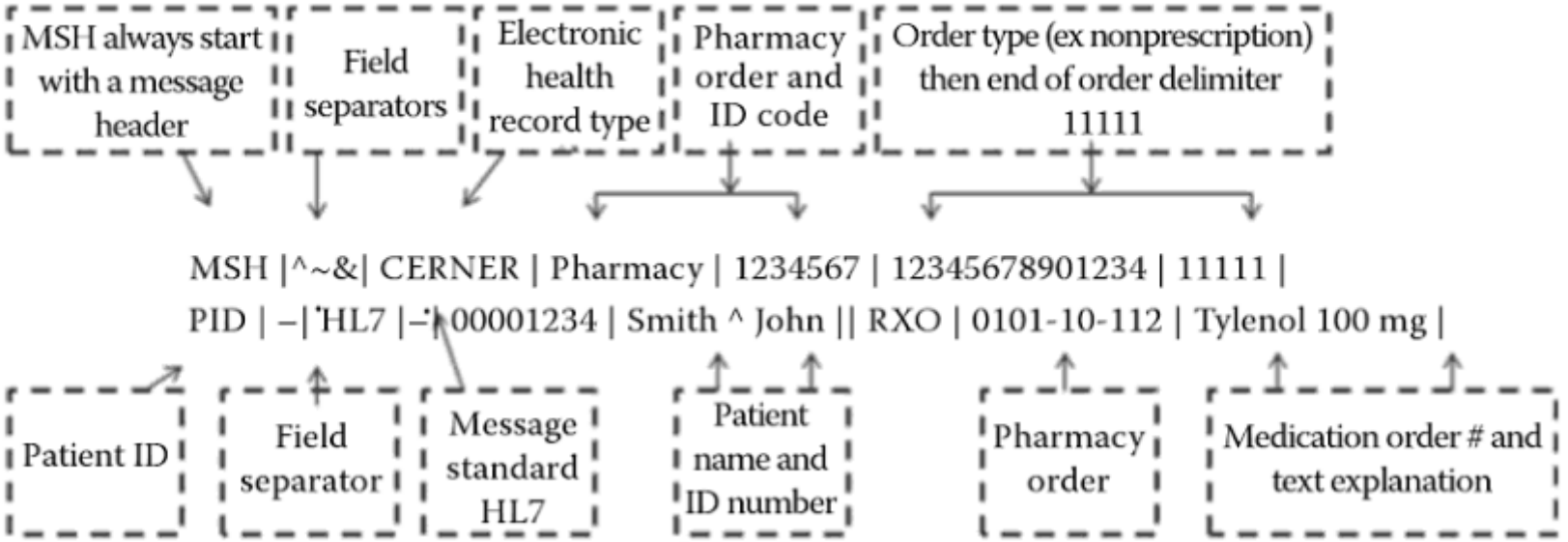
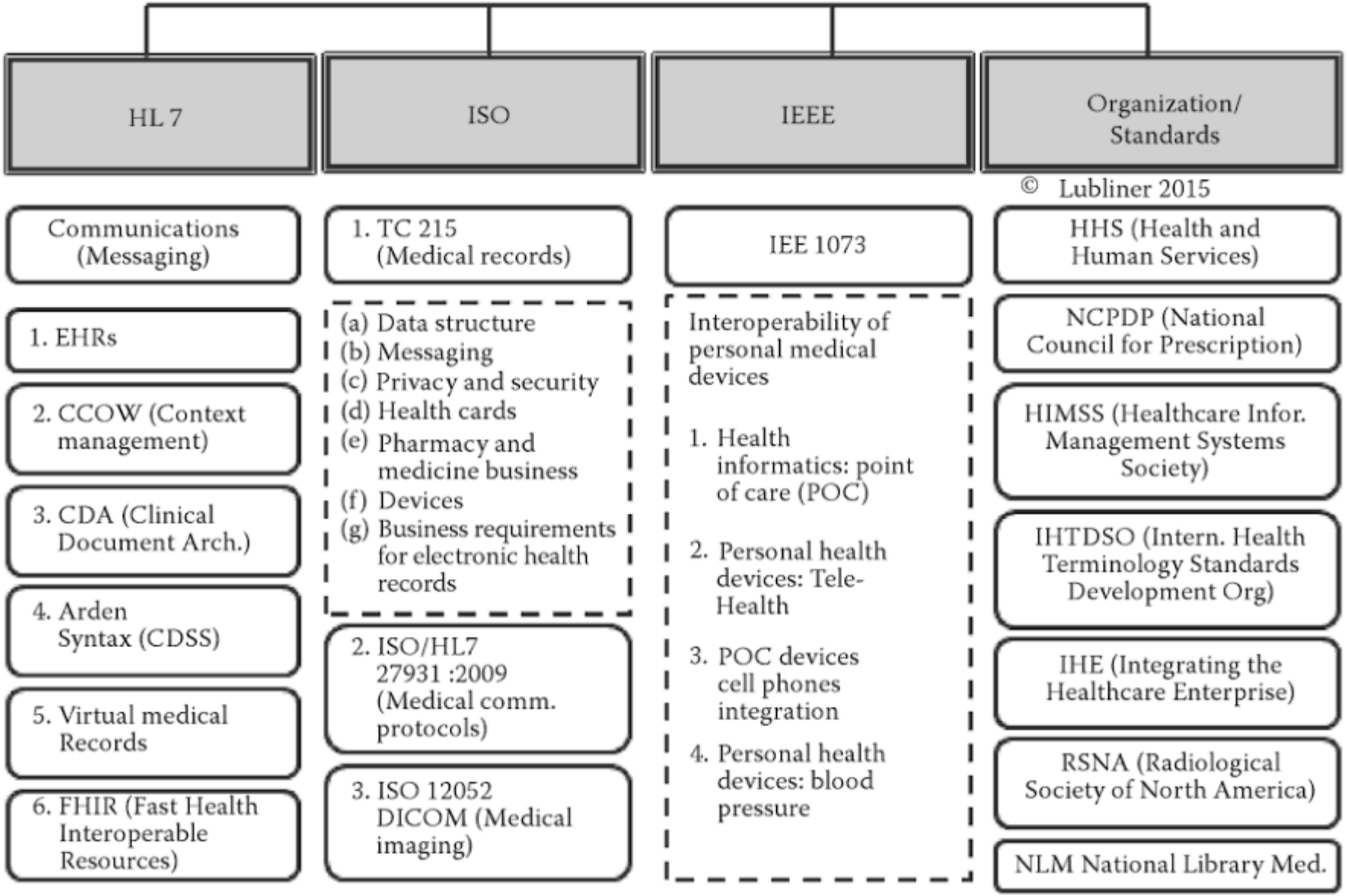


FIGURE . Health Level 7 (HL7) sample pharmacy, HL7 *communications message* between systems.

Ref: Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health. David J. Lubliner



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Standard Setting Organizations

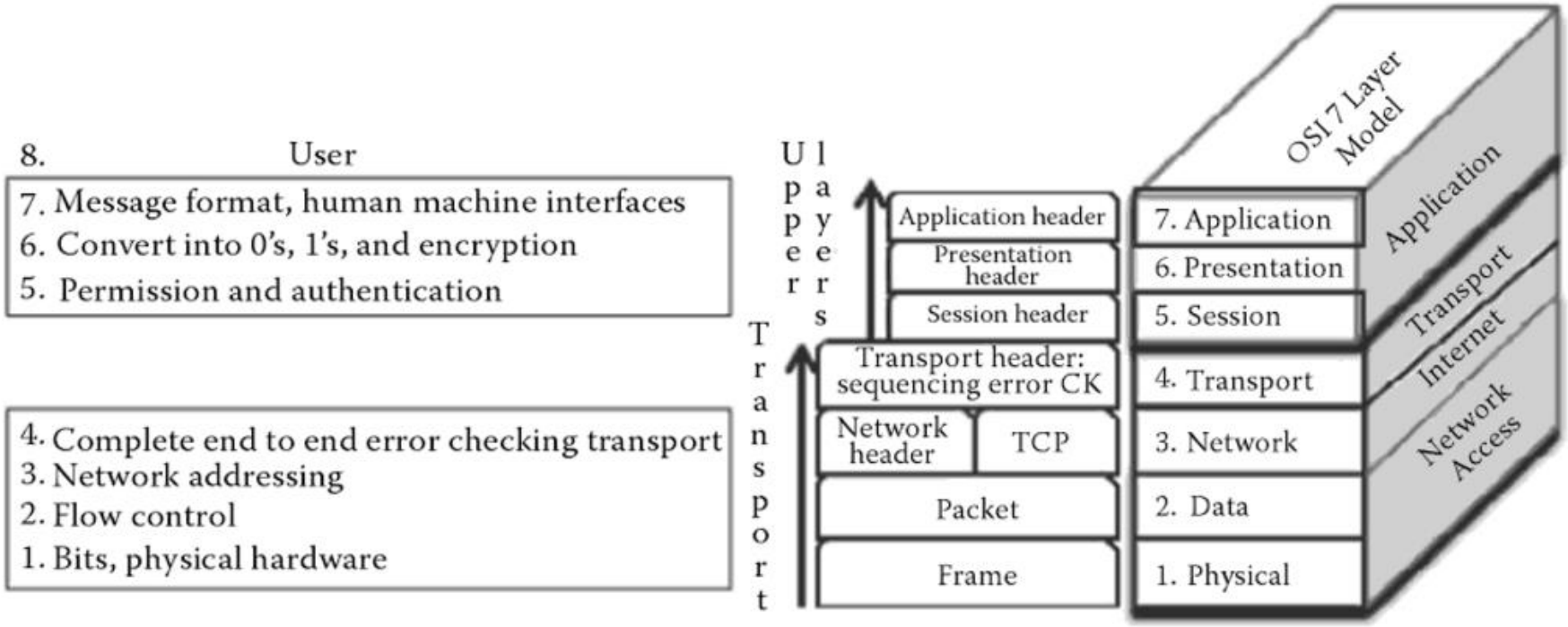
- ISO is an International Organization for Standardization
  - it is a network of the national standards institutes of 157 countries.
  - They work on the basis of one member per country, with a Central
  - Secretariat in Geneva, Switzerland, that coordinates the system.
  - ISO produces EHR standards that are limited to the structure and function of the EHR and the system that processes EHR.

- CEN is a European Committee for Standardisation.
  - It is involved in developing multi-disciplinary standards including health care systems and their interoperability.
  - CEN covers European Union (EU) countries and some affiliated countries outside the EU.
- HL7 stands for Health Level Seven.
  - It is one of the several American National Standards Institute (ANSI) - accredited Standards Developing Organizations, which operates in the healthcare arena.
  - Its purpose is to provide standards for data exchange between different types of healthcare computer applications.
  - HL7's domain includes clinical and administrative data

HL7

- HL7 standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services

- ISO seven layer model



Ref: Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health. David J. Lubliner

TABLE . HL7 Communications Standards Categories

	HL7[a]
1. Primary standards (used most often)	Structure and semantics of clinical documents to communicate between healthcare providers
	Point of use CCOW
	Messaging for data exchange
	Specification based on RIM V3
	Document markup standard based on structure product labeling specification that is attached to any medicine
	Continuity of care fosters interoperability of data by physicians
2. Foundational standards	Arden syntax for procedural clinical knowledge to share health knowledge databases
	DSS that recommends possible treatments; its AI software with embedded rules (see DSS in Chapter 3)
	Control data for the contents of each data field
	Service-oriented architecture
3. Clinical and administrative domains	Messaging standards
	Claims and reimbursements
	Genomics
	Drug stability reporting
4. EHR profiles	Child health profiles
	Clinical research profiles
	Medication
	Behavioral Health Functional Profile
5. Implementation guides	ANSI orders and observations
	Clinical oncology
	Questionnaire assessment
6. Rules and references	Arden syntax reference V1.6
	GELLO version 3
	DSS release 1
7. Education and awareness	Books and guides
	Data access rules/consent
	Quality reporting documents

[a] Core standards categories (http://www.hl7.org/implement/standards/product_matrix.cfm?ref=nav).

Ref: Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health. David J. Lubliner

HL7 Version 2.x Messaging Standard

HL7 Version 2.x

- HL7 v2 is designed to make sure that the communication is feasible,
- But it does not guarantee that the clinical information in EHR is semantically interoperable.
- According to the standard [HL7 version 2.7, 2011], the purpose of HL7 v2 is to "serve as a way for inherently disparate applications and data architectures operating in a heterogeneous system environment to communicate with each other".
- It ensures syntactic interoperability but not the higher levels of interoperability.
- (HL7 version 3, using a different approach, tries to promote interoperability to a higher level in health domain.)

What are HL7 messages

- Used to transfer electronic data between disparate healthcare systems.
- Each HL7 message sends information about a particular event such as a patient admission.
- HL7 messages are in human-readable (ASCII) format, though they may require some effort to interpret.

Contents of HL7 Messages

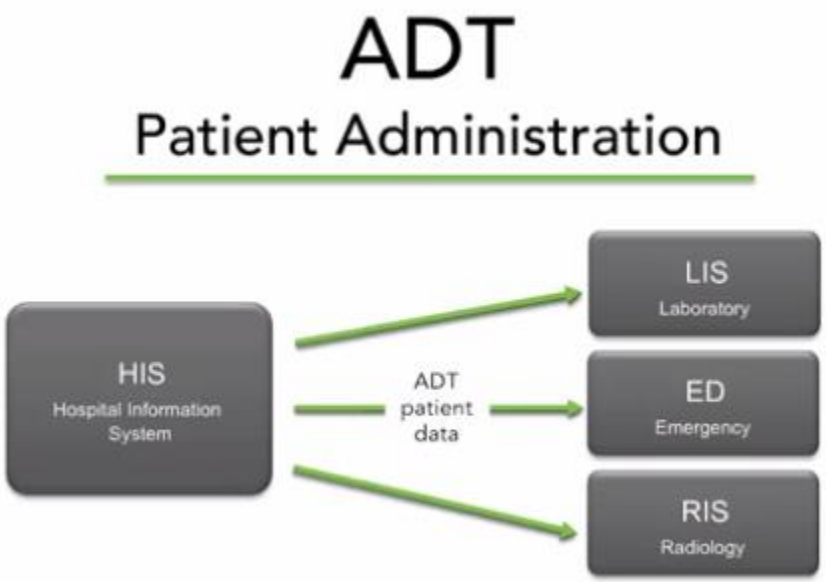
- There are four primary HL7 standard message types:
  - Patient Administration (ADT)
  - Orders (ORMs)
  - Results (ORUs)
  - Charges (DFTs)

Contents of HL7 Messages

Patient Administration (ADT)

- HL7 ADT messages carry patient demographic information for HL7 communications
- they provide important information about trigger events (such as patient admit, discharge, transfer, registration, etc.).
- Some of the most important segments in the ADT message are the
- PID (Patient Identification) segment, the PV1 (Patient Visit) segment, and occasionally the IN1 (Insurance) segment.
- ADT messages are extremely common in HL7 processing and are among the most widely used of all message types.

- 51 ADT Message Events



Segment ID	Description
A01	Admit/visit notification
A02	Transfer a patient
A03	Discharge/end visit
A04	Register a patient
A05	Pre-admit a patient
A06	Change an outpatient to an inpatient
A07	Change an inpatient to an outpatient
A08	Update patient information
A09	Patient departing - tracking
A10	Patient arriving - tracking
A11	Cancel admit/visit notification
A12	Cancel transfer
A13	Cancel discharge/end visit
A14	Pending admit
A15	Pending transfer

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Contents of HL7 Messages

- Orders (ORMs):
  - a general order message that is used to transmit information about an order.
  - There is only one type of ORM message – the ORM-O01 message.
  - Trigger events for the ORM-O01 message involve changes to an order such as new orders, cancellations, information updates, discontinuation

Contents of HL7 Messages

- Results (ORUs):
  - observations and results from the producing system/filler i.e. LIS, EKG system) to the ordering system/placer (i.e. HIS, physician office application).
  - It may also be used to transmit result data from the producing system to a medical record archival system, or to another system not part of the original order process.
  - ORU messages are also sometimes used to register or link to clinical trials, or for medical reporting purposes for drugs and devices.
- Types of observations reported in the ORU-R01 message include:
  - Clinical lab results
  - Imaging study reports
  - EKG pulmonary function study results
  - Patient condition or other data (i.e. vital signs, symptoms, allergies, notes, etc.)

Contents of HL7 Messages

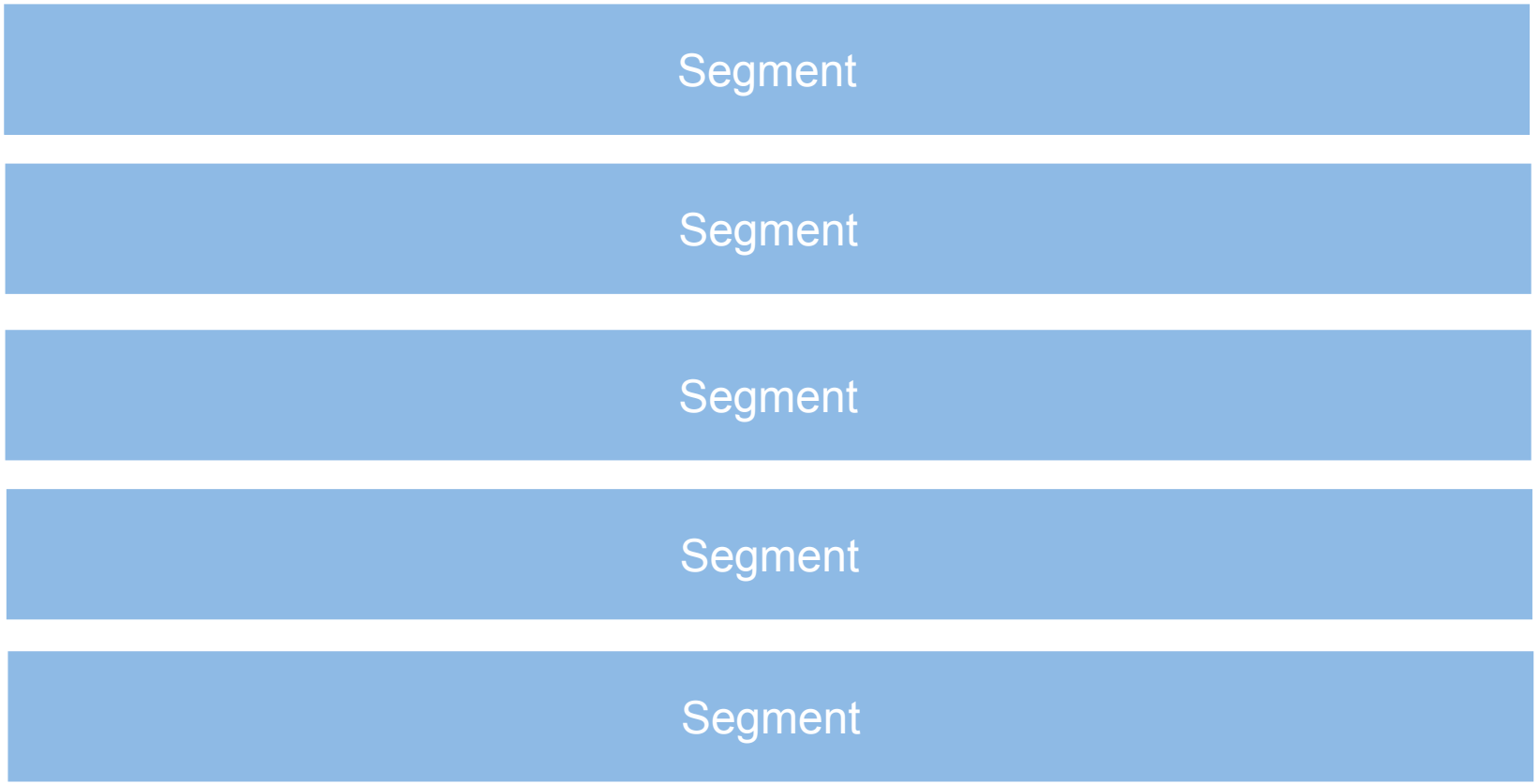
- Charges (DFTs)
  - describes a financial transaction that is sent to a billing system and is used for patient accounting purposes.
  - This message might include things like ancillary charges or patient deposits, and is sent between the DSS/Order Filler and the Charge Processor.
  - The DSS/Order Filler would then verify that the procedure had been completed.
  - Trigger events for the DFT-P03 message include:
    - Procedure ordered
    - Procedure scheduled
    - Procedure completed
    - Future will define Report events for professional fees

Contents of HL7 Messages

- They are made up of sequence of Segments.
- Each segment serves as a building block of HL7 messages.
- Each segment is located on it‘s own line in the message and has a specific purpose, to group the relevant pieces of information.

Cont.

- Segments are separated by <cr>
- They are separete lines



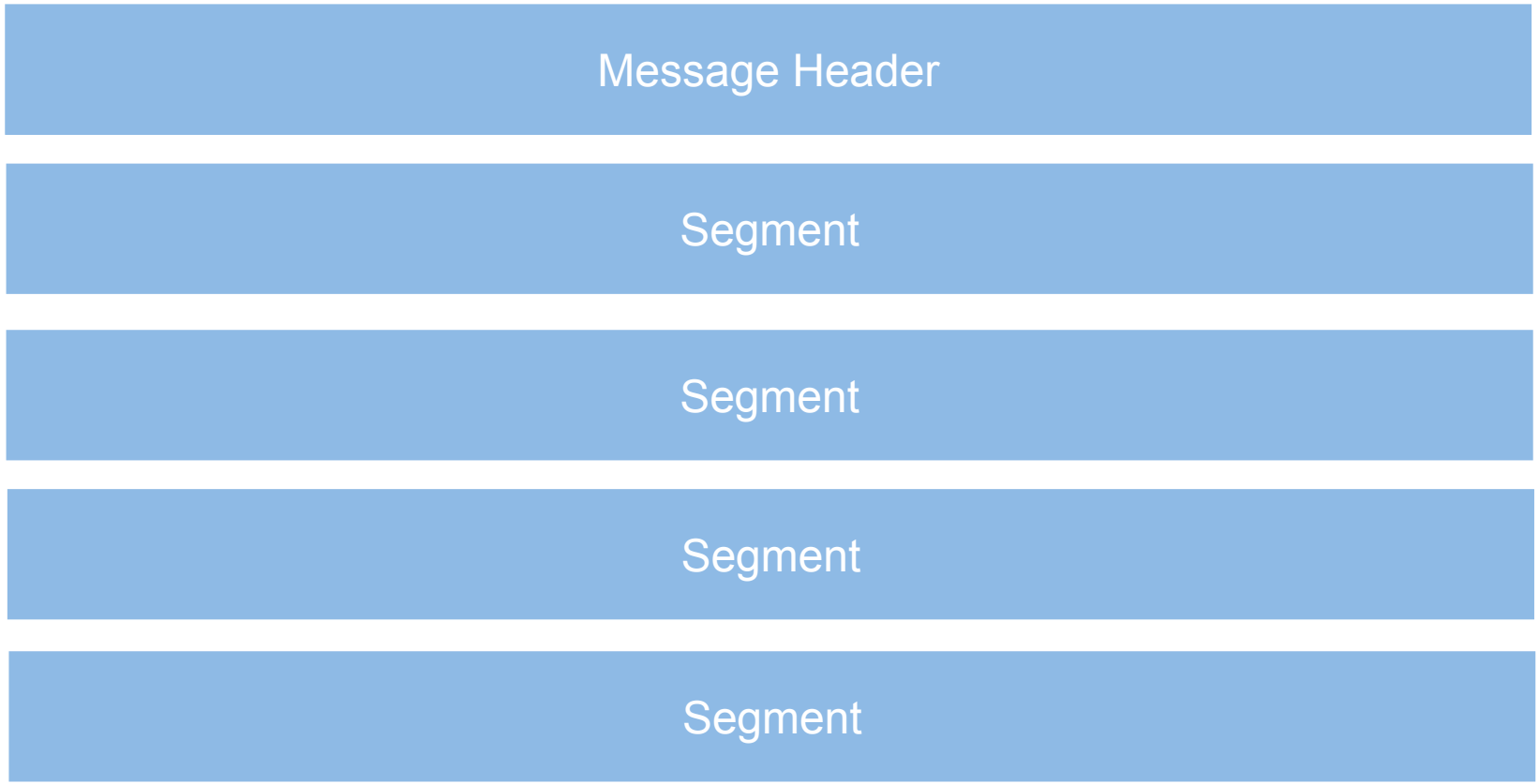
- Each segment is defined in a table such as that shown below for the MSH message header segment. The columns of this table show:

SEQ Field sequence number
LEN Maximum fi eld length
DT Data type
Usage Optionality
Cardinality Repeatable field. If Y can repeat any number of times a number, such as Y/3, indicates a maximum number of three repeats
TBL# The reference number of the HL7 table which contains a controlled vocabulary from which values can be taken
Item# HL7's internal database item number
Element name Human-readable name of the field

SEQ	LEN	DT	Usage	Cardinality	TBL#	Item #	Element name
1	1	ST	R			00001	Field separator
2	4	ST	R			00002	Encoding characters
3	180	HD	O			00003	Sending application
4	180	HD	O			00004	Sending facility
5	180	HD	O			00005	Receiving application
6	180	HD	O			00006	Receiving facility
7	26	TS	O			00007	Date/time of message
8	40	ST	O			00008	Security
9	7	CM	R			00009	Message type
10	20	ST	R			00010	Message control ID
11	3	PT	R			00011	Processing ID
12	8	ID	R		0104	00012	Version ID
13	15	NM	O			00013	Sequence number
14	180	ST	O			00014	Continuation pointer
15	2	ID	O		0155	00015	Accept acknowledgment type
16	2	ID	O		0155	00016	Application acknowledgment type
17	2	ID	O			00017	Country code
18	6	ID	O	[0..3]	0211	00692	Character set
19	60	CE	O			00693	Principal language of message

Cont.

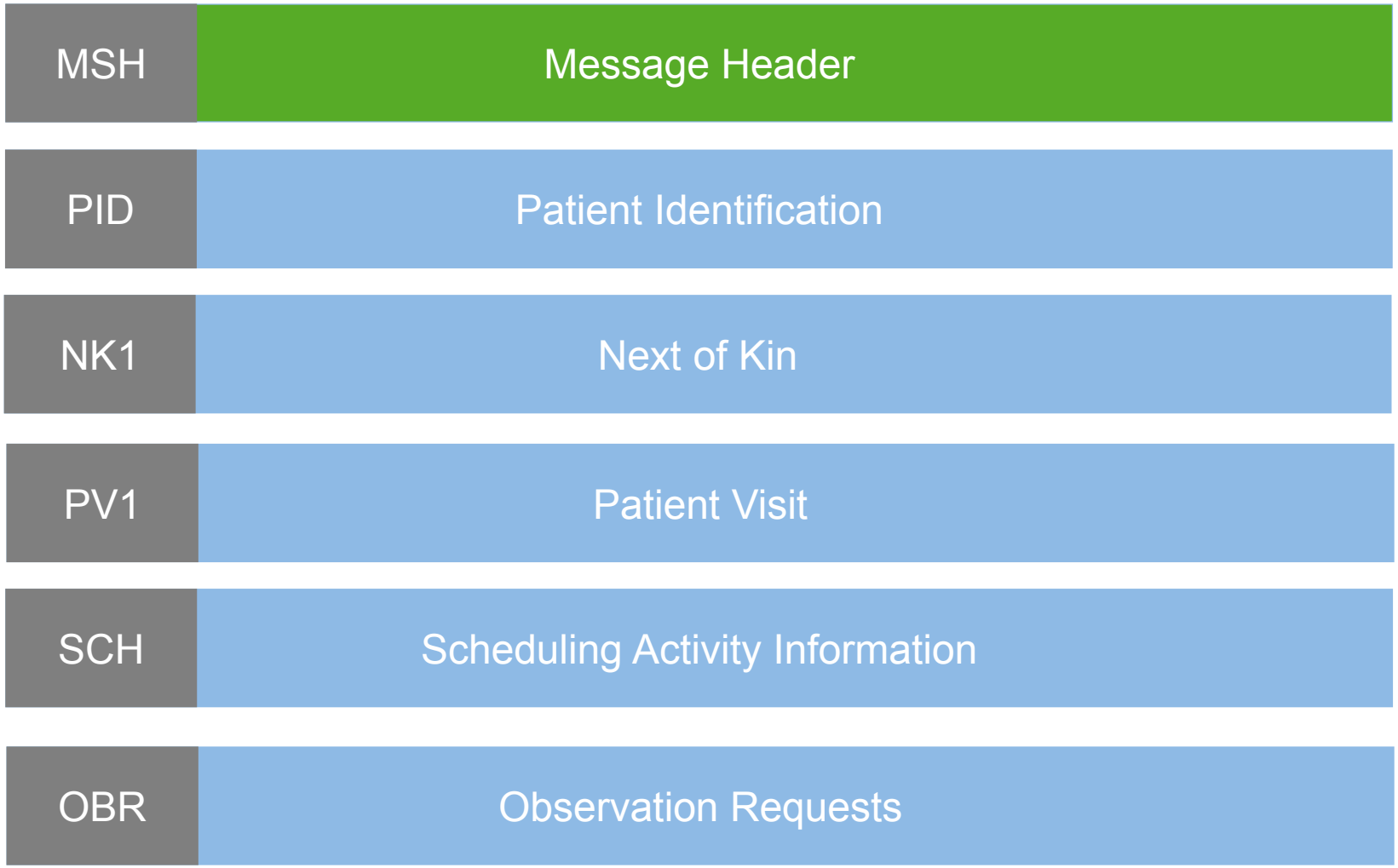
- First segment is always Message Header



Message Header

- Conveys the metadata of the message like who sent it and when.
- It is indicated in the first three letters of the segment as MSH.

Common Message Header



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Message Field

- Segments are further divided into Field

- They are separated by |

Cont.

- Fields each have an assigned value type that relates to its position in the Segment

Common Field Delimiter

- | knows as Field Delimiter (pipe)
- ^ known as Sub-field Delimiter (caret)
- ~ known as Repeating Field Delimiter (tilde)
- \ known as Escape Character (backslash)
- & known as Sub-sub Field Delimiter (ampersand)
- <cr> Segment terminator

Example Message

```
MSH|^~\&|HL7Soup|Instance1|HL7Soup|Instance2|201407271408||ADT^A04|1817457|D|
2.5.1|123456||AL
PID||0797675^^^^MR|454721||Brown^Sam^^^^^B|Smith^Mary^^^^|19780203|M||2106-3|254
East St^^Howick^OH^3252^USA||(216)671-4859|||S|AGN|400003603~1629086|999-8888|
NK1||Brown^Mary^^^^|MTH||(216)891-3459||EC|||||||||||||||||||||||||
PV1||O|O/R|A|||060277^Allen^Katrina^J^^^|||||||||| ||
2668684|||||||||||||||||||||||||201407271408|
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Example Message

```
MSH|^~\&|HL7Soup|Instance1|HL7Soup|Instance2|201407271408||ADT^A04|1817457|D|
2.5.1|123456||AL
PID||0797675^^^^MR|454721||Brown^Sam^^^^^B|Smith^Mary^^^^|19780203|M||2106-3|254
East St^^Howick^OH^3252^USA||(216)671-4859|||S|AGN|400003603~1629086|999-8888|
NK1||Brown^Mary^^^^|MTH||(216)891-3459||EC|||||||||||||||||||||||||
PV1||O|O/R|A|||060277^Allen^Katrina^J^^^|||||||||| ||
2668684|||||||||||||||||||||||||201407271408|
```

Figure 3-2. PID attributes

SEQ	LEN	DT	OPT	RP/#	TBL#	ITEM#	ELEMENT NAME
1	4	SI	O			00104	Set ID - PID
2	20	CX	B			00105	Patient ID
3	20	CX	R	Y		00106	Patient Identifier List
4	20	CX	B	Y		00107	Alternate Patient ID - PID
5	48	XPN	R	Y		00108	Patient Name
6	48	XPN	O	Y		00109	Mother's Maiden Name
7	26	TS	O			00110	Date/Time of Birth
8	1	IS	O		0001	00111	Sex
9	48	XPN	O	Y		00112	Patient Alias
10	80	CE	O	Y	0005	00113	Race
11	106	XAD	O	Y		00114	Patient Address
12	4	IS	B		0289	00115	County Code
13	40	XTN	O	Y		00116	Phone Number - Home
14	40	XTN	O	Y		00117	Phone Number - Business
15	60	CE	O		0296	00118	Primary Language
16	80	CE	O		0002	00119	Marital Status
17	80	CE	O		0006	00120	Religion
18	20	CX	O			00121	Patient Account Number
19	16	ST	B			00122	SSN Number - Patient
20	25	DLN	O			00123	Driver's License Number - Patient
21	20	CX	O	Y		00124	Mother's Identifier
22	80	CE	O	Y	0189	00125	Ethnic Group

Practise

MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853

RWTH Informatik 5 | Ahornstr. 55 D-52056 Aachen Germany |
Tel +49/241/8021501 | Fax +49/241/8022321 | http://dbis.rwth-aachen.de/cms

Practise

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||||
||2688684|||||||||||||||||||199912271408|||||002376853
```

Note

PID||0493575^^^2^ID

1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET

AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086

- The four ^^^^ characters at the end of this composite indicates that it has a total of six sub-composites, and that only the first two of the sub-composites are defined. In this composite, DOE represents the family name of the patient, and JOHN is the patient's given name.

Cont.

- In order to be as flexible as possible, the HL7 committees were forced to define many segment fields as optional.
- The downside of this decision is that you cannot be certain that particular information will be present in a given message.
- This is one of the reasons why the same message may vary significantly from vendor to vendor.

HL7 Message Type

- Message type indicates what health-related information is being provided in this message.
- The message type also determines what segments can be included as part of the message
- The message type is normally the ninth field of this segment

Cont.

- For example, consider this MSH segment, which you have seen before:

```
MSH|^~\&|HL7Soup|Instance1|HL7Soup|Instance2|201407271408||ADT^A04|1817457|D|
2.5.1|123456||AL
PID||0797675^^^^MR|454721||Brown^Sam^^^^^B|Smith^Mary^^^^|19780203|M||2106-3|254
East St^^Howick^OH^3252^USA||(216)671-4859|||S|AGN|400003603~1629086|999-8888|
NK1||Brown^Mary^^^^|MTH||(216)891-3459||EC|||||||||||||||||||||||||
PV1||O|O/R|A|||060277^Allen^Katrina^J^^^|||||||||| ||
2668684|||||||||||||||||||||||||201407271408|
```

- Here, the HL7 message type is ADT^A04, which is “Register a Patient”.

Repeating and Optional Segments

- Repeating segments are useful for messages that contain contact information, as they make it possible to provide more than one contact.
- For instance, multiple NK1 (Next of Kin) segments may be provided if a patient has more than one person that can be contacted in case of emergency.

Cont.

- Optional segments are useful for providing information that is not provided in all messages.
- For instance, an AL1 (Patient Allergy Information) segment may be included if a patient has allergies.

Practise

- Determine the Repeating Segments in this HL7 Message

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|999-|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^JOHN ^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^ROBERT ^^^^|SPO||(216)123-4568||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

Practise

- Determine the Repeating Segments in this HL7 Message

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|999-|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^JOHN ^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^ROBERT ^^^^|SPO||(216)123-4568||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

Repeating Segments

HL7 Segment Group

- A segment group is a collection of segments that always appear together.
- Some segment groups can be optional or repeating.
- Messages of type ORU^R01 (Lab Result) can have one or more Result Group segment groups defined.
- Each Result Group consists of one OBR (Observation Request) segment and one or more OBX (Observation/Result) segments

Cont.

- For instance, the following message includes two Result Group segment groups:

```
MSH|^~\&|MESA_RPT_MGR|EAST_RADIOLOGY|REPOSITORY|XYZ|||ORU^R01|MESA3b781ae8|P|2.5|
|||||||
PID|||CR3^^^ADT1||CRTHREE^PAUL||||||||||||PatientAcct||||||||||||
OBR||||4550|||20010501141500.0000|||||||||||||||||F|||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.30.2.1|||||F||||||
OBX|2|TX|SR Text||Lungs expanded and clear. Conclusions Normal PA chest x-ray.||||||F||||||
OBR||||4551|||20010501141500|||||||||||||||||F|||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.10.2.1.603|||||F||||||
OBX|2|HD|Study Instance UID|1|1.113654.1.2001.10|||||F||||||
OBX|3|HD|Series Instance UID|1|1.113654.1.2001.10.1|||||F||||||
```

HL7 Segment Grammar Notation

- In the standard segment grammar notation, segments are listed from left to right, starting with the first segment in the message (which is always MSH). For example.

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

- The segment grammar notation for this message would be:

MSH PID NK1 PV1

Cont.

- Optional segments are enclosed in square brackets []. For example, if a PV2 (Patient Visit – Additional Information) segment can be optionally included with messages such as the one shown above, the segment grammar looks like this:

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

MSH PID NK1 PV1 [PV2]

Cont.

- Repeating segments are enclosed in curly brackets {}. For example, if multiple NK1 segments can be included, the segment grammar looks like this:

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|999-|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^JOHN ^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
NK1||DOE^ROBERT ^^^^|SPO||(216)123-4568||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

MSH PID {NK1} PV1 [PV2]

Cont.

- A segment that is both optional and can be repeated is enclosed in both square brackets and curly brackets. For example, if the NK1 segment is optional but can be repeated, the segment grammar looks like this:

```
MSH|^~\&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|D
|2.5|
PID||0493575^^^2^ID
1|454721||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M||B|254 MYSTREET
AVE^^MYTOWN^OH^44123^USA||(216)123-4567|||M|NON|400003403~1129086|
NK1||ROE^MARIE^^^^|SPO||(216)123-4567||EC|||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^|||277^ALLEN
MYLASTNAME^BONNIE^^^^|||||||||
||2688684|||||||||||||||||||||||199912271408|||||002376853
```

MSH PID [{NK1}] PV1 [PV2]

Practice

- Determine the Segment Grammar of this HL7 message

```
MSH|^~\&|MESA_RPT_MGR|EAST_RADIOLOGY|REPOSITORY|XYZ|||ORU^R01|MESA3b781ae8|P|2.5|
||||||
PID|||CR3^^^ADT1||CRTHREE^PAUL||||||||||||PatientAcct||||||||||||
OBR||||4550|||20010501141500.0000|||||||||||||||||||F|||||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.30.2.1||||||F||||||
OBX|2|TX|SR Text||Lungs expanded and clear. Conclusions Normal PA chest x-ray.||||||F||||||
OBR||||4551|||20010501141500|||||||||||||||||||F|||||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.10.2.1.603||||||F||||||
OBX|2|HD|Study Instance UID|1|1.113654.1.2001.10||||||F||||||
OBX|3|HD|Series Instance UID|1|1.113654.1.2001.10.1||||||F||||||
```

Practice

- Determine the Segment Grammar of this HL7 message

```
MSH|^~\&|MESA_RPT_MGR|EAST_RADIOLOGY|REPOSITORY|XYZ|||ORU^R01|MESA3b781ae8|P|2.5|
||||||
PID|||CR3^^^ADT1||CRTHREE^PAUL||||||||||||PatientAcct||||||||||
OBR||||4550|||20010501141500.0000|||||||||||||||||F||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.30.2.1||||||F||||||
OBX|2|TX|SR Text||Lungs expanded and clear. Conclusions Normal PA chest x-ray.||||||F||||||
OBR||||4551|||20010501141500|||||||||||||||||F||||||||||||||||
OBX|1|HD|SR Instance UID||1.113654.1.2001.10.2.1.603|||||F||||||
OBX|2|HD|Study Instance UID|1|1.113654.1.2001.10|||||F||||||
OBX|3|HD|Series Instance UID|1|1.113654.1.2001.10.1|||||F||||||
```

MSH PID [{OBR {OBX}}]

Here, OBR {OBX} is the segment grammar notation for a Result Group. The Result Group is enclosed in both square and curly brackets, as it is optional and can be repeated

References

- Kalra, Dipak, and B. G. M. E. Blobel. "Semantic interoperability of EHR systems." *Studies in health technology and informatics* 127 (2007): 231.
- Moreno-Conde, Alberto, et al. "Clinical information modeling processes for semantic interoperability of electronic health records: systematic review and inductive analysis." *Journal of the American Medical Informatics Association*(2015): ocv008.
- Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health. David J. Lubliner