HL7 Version 3: the use case for the Reference Information Model

Interoperability among standards: Creating an e-Health foundation for semantic interoperability

Mark Shafarman
HL7 Chair

with additional HL7 "roles" of
past co-chair International Committee
past co-chair Control/Query TC
ex-officio member Architectural Review Board
member Early Adopters Forum

Applications Architect,
Oracle Corporation
mark.shafarman@oracle.com
1 415 491 8104

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Agenda

- Introduction
- The use case for the Reference Information Model
- Vocabulary and the RIM
- Summary

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Interoperability & Innovation

- Main Entry: **in·ter·op·er·a·bil·i·ty**
  Function: *noun*
  Date: 1977
  : ability of a system (as a weapons system) to use the parts or equipment of another system
  Source: Merriam-Webster web site
- **interoperability**
  : ability of ***two or more*** systems or components to exchange information and to use the information that has been exchanged.
  Source: IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries, IEEE, 1990]

Functional interoperability

Semantic interoperability

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Interoperability & Innovation

HL7's **mission** is clinical interoperability

"To provide 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. Specifically, to create flexible, cost effective standards, guidelines, and methodologies to enable healthcare information system interoperability ***and sharing of electronic health records***." (Source: HL7 Mission statement, revised 2001)

HL7's **strategy** is innovation – both by ourselves and by our users

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Interoperability defined: more specifically…

- “Functional” interoperability is the capability to reliably exchange information without error
- “Semantic" interoperability is the ability to interpret, and, therefore, to make effective use of the information so exchanged.
  - In our context, ‘effective use’ means that the information can be used in any type of computable algorithm (appropriate) to that information

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Extending Semantic Interoperability

- Not only can any two systems understand and use each other's information…but note that the definition says ***'two or more systems'***
- Thus the information can be ***re-used*** in multiple arbitrary contexts that are supported by the '**2+**' interoperable systems.
- In other words, if the semantic interoperability is based on standard models (with bindings to standard vocabularies), then any (additional) system that 'understands' these models (and their vocabulary bindings) can ***re-use*** information as needed.

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Extending Semantic Interoperability

- The V3 RIM and the V3 HDF (HL7 Development Framework) support this extension of semantic interoperability across the healthcare information space
- I.e. across all types of clinical and related information systems
  - including systems that support electronic health records, healthcare delivery, patient administration, patient finance, clinical decision support, and clinical research
- The HDF has a formal (and pragmatic) methodology to map (without semantic loss) any healthcare domain into the V3 framework

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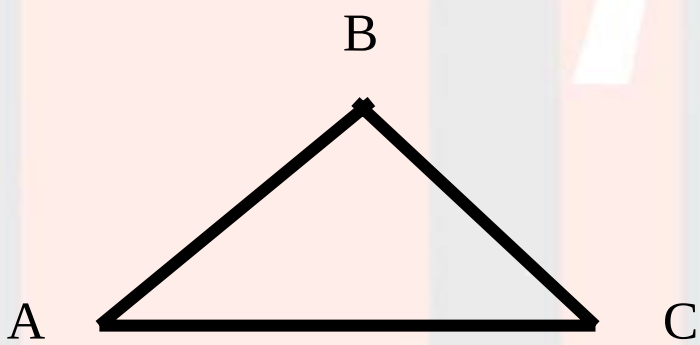
Background: why standard interfaces?

- Some history:
  - Back in the early 80's, people developing distributed healthcare application systems noted that the number of interfaces increases as one half of the square of the number of systems being interfaced. For example:

2 systems, 1 interface



3 systems, 3 interfaces

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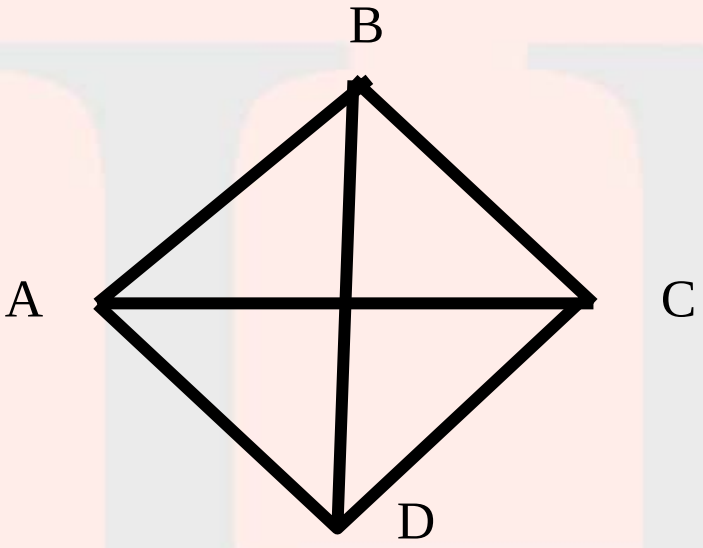
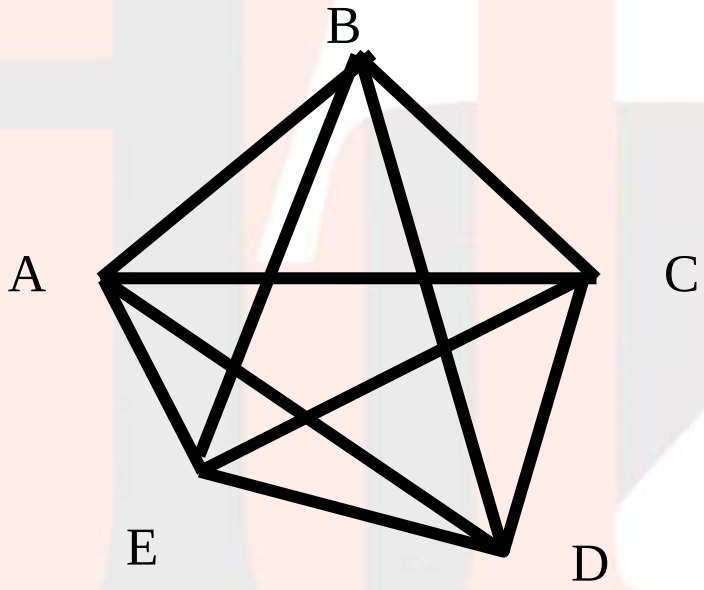
***standard induction proof available on request…or draw your own*

Background: why standard interfaces?



4 systems, 6 interfaces



5 systems,
10 interfaces

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Background: why standard interfaces?

- Notice that the number of interfaces needed increases much faster than the number of systems
- Those of you who liked algebra in high school may remember the formula for the "number of combinations of ***n*** things taken ***r*** at a time: n!/(n-r)!r!
- For r=2, and arbitrary n, this is n(n-1)/2, which gives**:

Systems:	Interfaces:
3	3
4	6
5	10

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***standard induction proof available on request…*

Background: why standard interfaces?

Systems:	Interfaces:
6	15
8	28
10	45
20	190
30	435
40	780
50	1225
100	4950

But $n(n-1)/2=(n^2-n)/2$ is not maintainable !

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Background: why standard interfaces?

- Note that large organizations in the U.S., such as Mayo Fdn or Duke typically have between 50-100 such interfaces. The situation is similar for regional or national systems in Europe
- At a cost of 50-100k USD per custom interface, it's clearly much cheaper to have an interface standard. This reduces the number of interfaces for n systems to the cost of (n-1) interfaces, a huge savings.
- This also allows, in most cases, a single interface to be changed without impacting the others.
- This last feature enables a practical maintenance approach, as well as a practical systems evolution approach.

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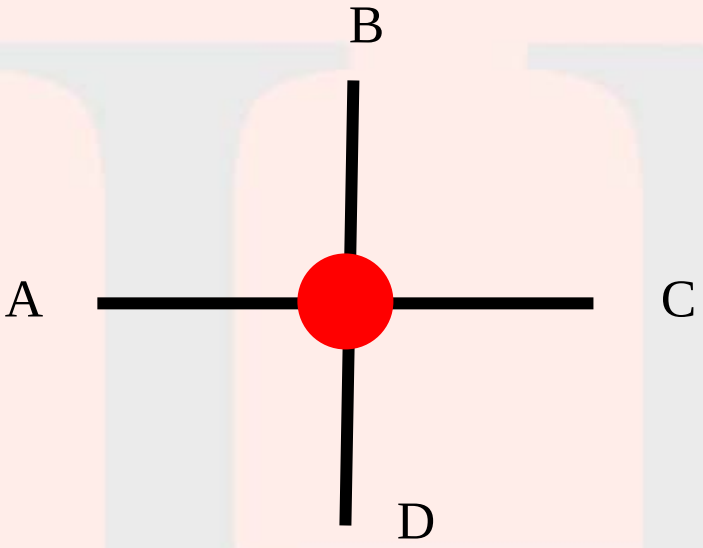
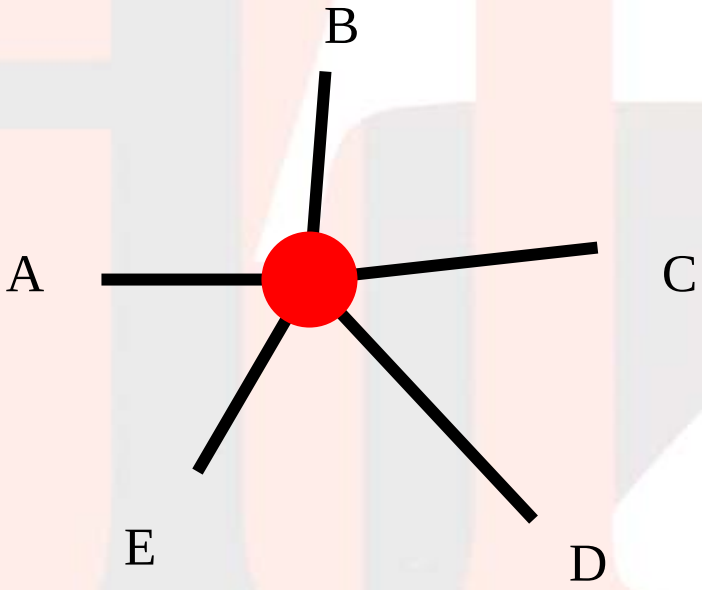
Background: if standard interfaces?



4 systems, 4 interfaces



5 systems,
5 interfaces

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***standard induction proof available on request…or draw your own*

Background: if standard interfaces?

Systems:	Interfaces:
6	6
8	8
10	10
20	20
30	30
40	40
50	50
100	100

N (once for each system) is maintainable !

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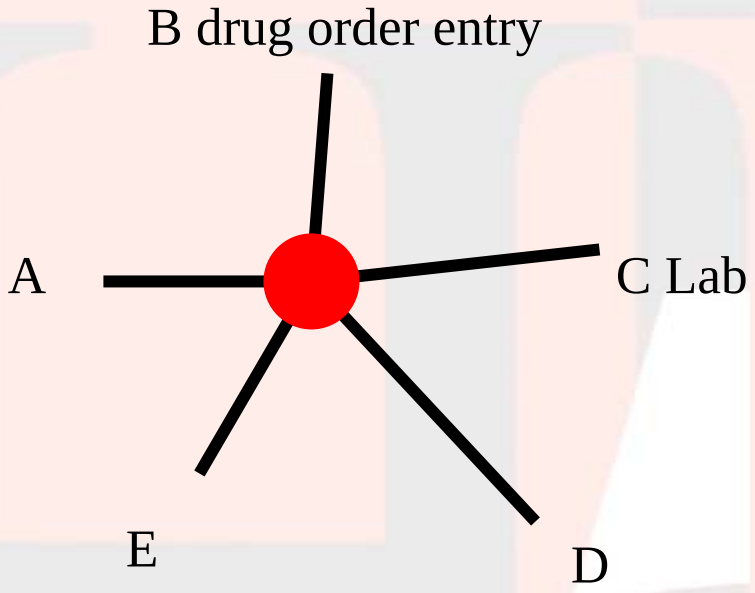
Remember our 5 systems with 5 standard interfaces:



5 systems,
5 interfaces

- This actually means that whatever vendor makes “C”, their internal lab data structures and vocabulary are mapped into a common (standard) semantic structure. And systems A, B, D and E all map the standard-defined semantic lab structures into their internal lab data structures.
- Interfacing means MAPPING to/from Standard semantic structures.

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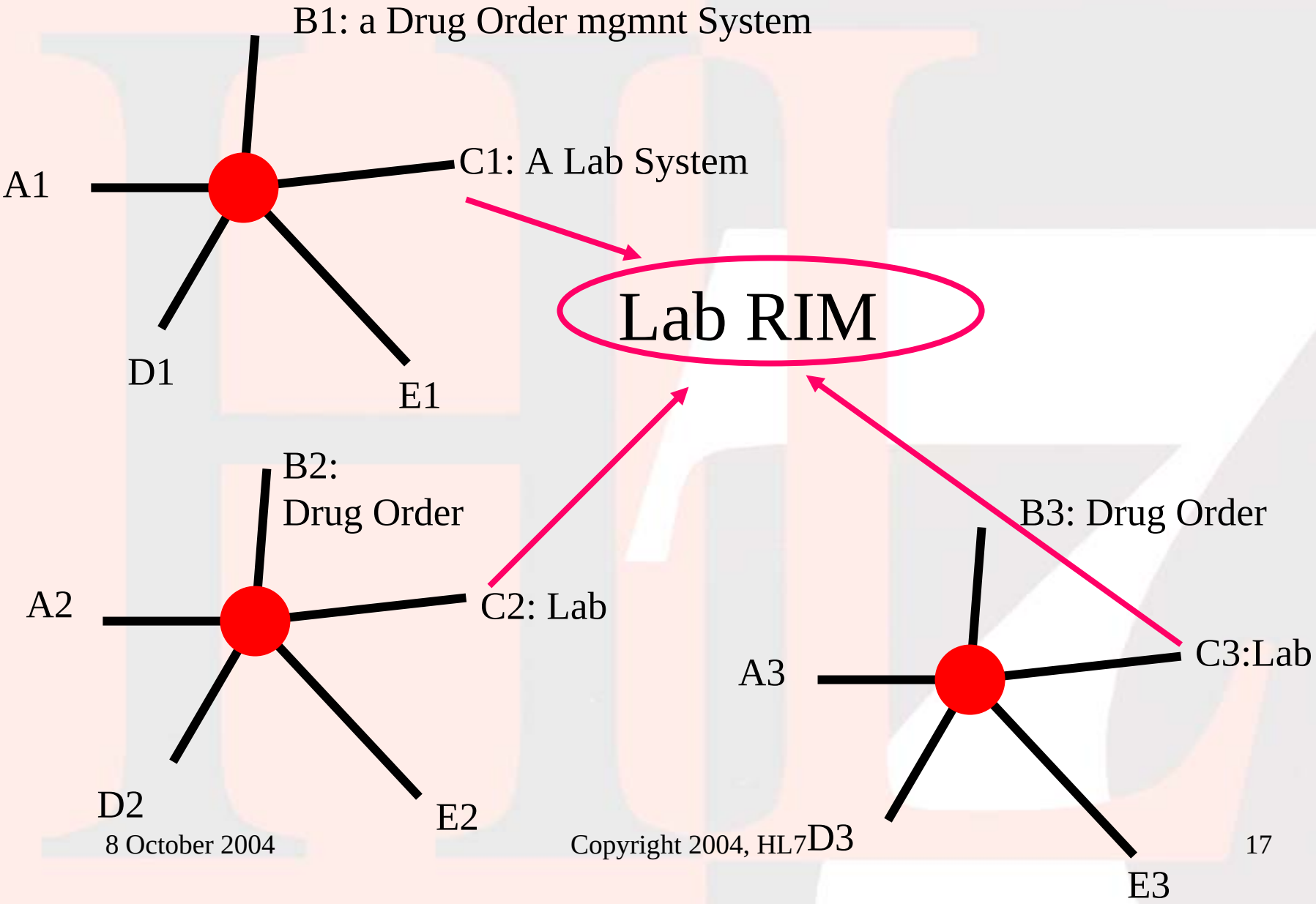
Use case for a Reference Information Model



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Use case for a Reference Information Model

- In other words, at a particular site, Systems A1…E1, a local lab standard or reference information model will be developed.
- But if that site needs to interoperate with other sites (site 2: A2…E2, and site 3: A3…E3), there needs to be an overall lab reference model that each site can map its information into and out of.
- And when we add another system, we only have to add the new information domain into our reference model
  - I.e. if we already have lab and patient administration, for a Radiology Information System, we only need to add the information about radiology reports (and images) to our reference model. Everything else is already present.

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Use case for a Reference Information Model

- The same is true for other patient related data: administrative/encounter management, financial, other types of clinical information. The overall reference model needs to accommodate each of these domains, with several additional constraints:
  - Non-clinical healthcare-related domains need to be able to use clinical domain data without it being stored and maintained in multiple models/structures.
    - Thus the non-clinical domain application may need to map its lab data needs into and out of the common lab reference model.
    - But this is the same concept as our original 5 systems, just on a much broader scale.
  - Vocabulary and identifiers must be coordinated across local domains.

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The RIM is important "*beyond just messaging*"

- The HL7 RIM is a mature version of a common (reference) healthcare ***applications*** information model
  - It supports both interfaces and system design
    - See not just MDF (message development framework), but the HDF (HL7 development framework)
    - Not just messages, but CDR/E.H.R. applications, Structured Documents, templates, rules, etc.
    - Not just clinical but patient administrative, financial, public health, genomics

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Semantic interoperability & Vocabulary

To understand the data being transmitted you must know **both**:

1. The definition of each element of data, and its relationship with each of the other elements – you must have a semantic model of the data

and

2. The terminology to be used to represent coded elements, including the definitions, and relationships within the terminology

3. <u>The HL7 V3 RIM and associated methodologies promote and facilitate semantic interoperability</u>

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Why aren't standard terminologies "enough"?

OR: If I've got an ontology (e.g. Snomed CT), do I still need a reference information model?

Yes, since:

- a single concept may have multiple meanings according to it's clinical context
  - e.g. WBC (white blood count) may be used to name an order (intent), or a result (observation), or a goal (target value), and a problem (extreme value)
  - e.g. dyspnea (shortness of breath) may refer to a diagnosis, or an observation

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Why aren't standard terminologies "enough"?

- A reference information model provides a formal way of expressing that context.
- The structures provided by the reference information model implement the context by binding the coded vocabulary term from the ontology to a specific place in the model.

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Some examples of Structure-based Context

3 instances of act, specialization observation, act.code attribute = "wbc" (actually, the corresponding LOINC code for WBC)

Mood=RQO

effectiveTime ="12/12/04@ 2pm PST"

(No Value Attribute in this model)

Wbc Order to occur on 12/12/04@2pmPST

Mood=EVN

effectiveTime ="10/1/04@ 1pm PST"

(Observation) Value="xxx"

Wbc Observation of 'xxx' made on 10/1/04@1pmPST

Mood=Goal

effectiveTime ="11/1/04"

(Goal) Value="yyy"

Wbc goal of specific value of 'yyy' to be attained by 11/1/04

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Advantages: combining a RIM & standard vocabulary

- **When standard (reference) terminologies are mapped to a standard (reference) information model**
  - Whenever a term is used, we know it's clinical context and hence it's actual meaning in the care of a patient
  - if the information model and the terminology are both standard, we have a basis for interoperability of information across all applications and all users
  - this interoperability is the basis for all "interfaces"
    - including knowledge based interfaces
    - including object interfaces (methods)
    - including messaging interfaces
    - including API's

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Integration of Terminology with the Information Model

Algorithmically:

- to determine whether two terms from two different terminologies are equivalent or not, one would take term ***x*** from terminology ***x'***, and ask: what are the possible contexts this term may be used in?; and for each context, how does that term map to the information model? Then, one can ask the same questions for term ***y*** in terminology ***y'***. Then, for any context and mapping that the two terms have in common, one can determine whether or not they are equivalent.

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Why do we need a RIM?

- The creation of a ‘reference information model’ for healthcare *supports*
  - The creation of a ***standard set of structures*** (models) to use for the sharing of healthcare information
- And the ability to bind a set of standard terminologies to these models *supports*
  - The sharing of these standard structures with standard (coded) names ***and also***
  - The extension of the model via ***structural (coded) terminology***

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Why do we need a RIM?

- Thus (a formal word!), we can create standard structures (models) with standard names (codes)
  - An '***ontology of structures'*** can be created
- And if we can create sufficiently generic and granular models in our ontology of structures, we can ***map*** any healthcare application's "***domain***" model into (and out of) the "***reference***" model

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Why do we need a RIM?

- Once we have done this for a given application, (and we only need to do this one time for a given application), we can ***re-use*** the information from that application in (any) other healthcare application. This guarantees both ***interoperability*** and ***re-use*** of all healthcare data.

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…*finis*…

- Questions?
- Thank you!

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