Semantic Interoperability of Clinical Data

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First Workshop on Model-Driven Interoperability (MDI'2010)
Oslo, Norway, October 5, 2010

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Outline

- Motivation and goal
- Ontology for EHR interoperability
- Transfer mechanism
- Conclusions

Scenario

Hospital A

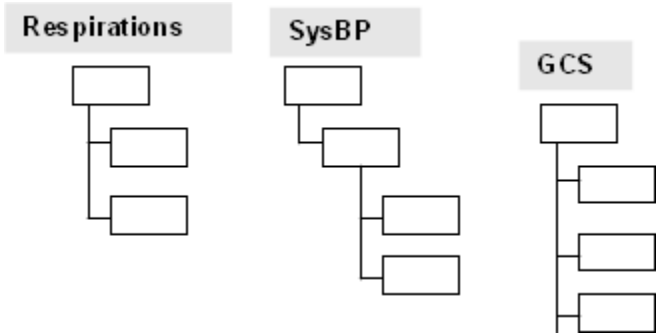
Revised Trauma Score

#	hasL_RR	hasAS_SBP	hasER	hasMR	hasVR	total
1	22	102	4	5	4	7.84

L_RR: Lying Respiration Rate
AS_SBP: Aneroid Sphygmomanometer Systolic Blood Pressure
ER: Eye Response
MR: Motor Response
VR: Verbal Response

Proprietary data structures and logic

Hospital B



openEHR standard

Goal

Hospital B can
- seamlessly access,
- interpret and
- store

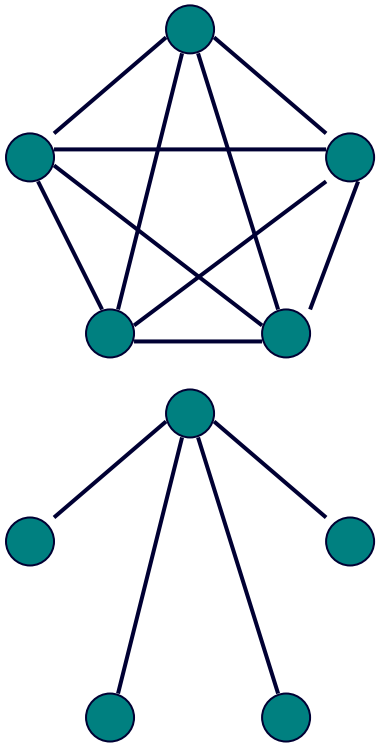
an EHR from *Hospital A* (and viceversa)

Approaches

- A-Model to B-Model transformation
  - $O(n^2)$ transformations needed
- A-Model, B-Model to Standard-Model
  - O(n) transformations needed

But

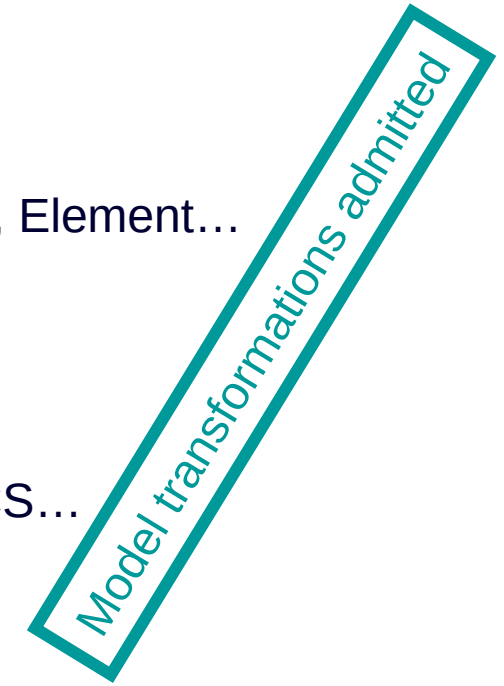
- There are more than one possible standard
  - openEHR, CEN/ISO 13606, HL7 CDA …
  - A universal standard is not expected



Interoperability standards

- openEHR, CEN/ISO 13606, HL7 CDA

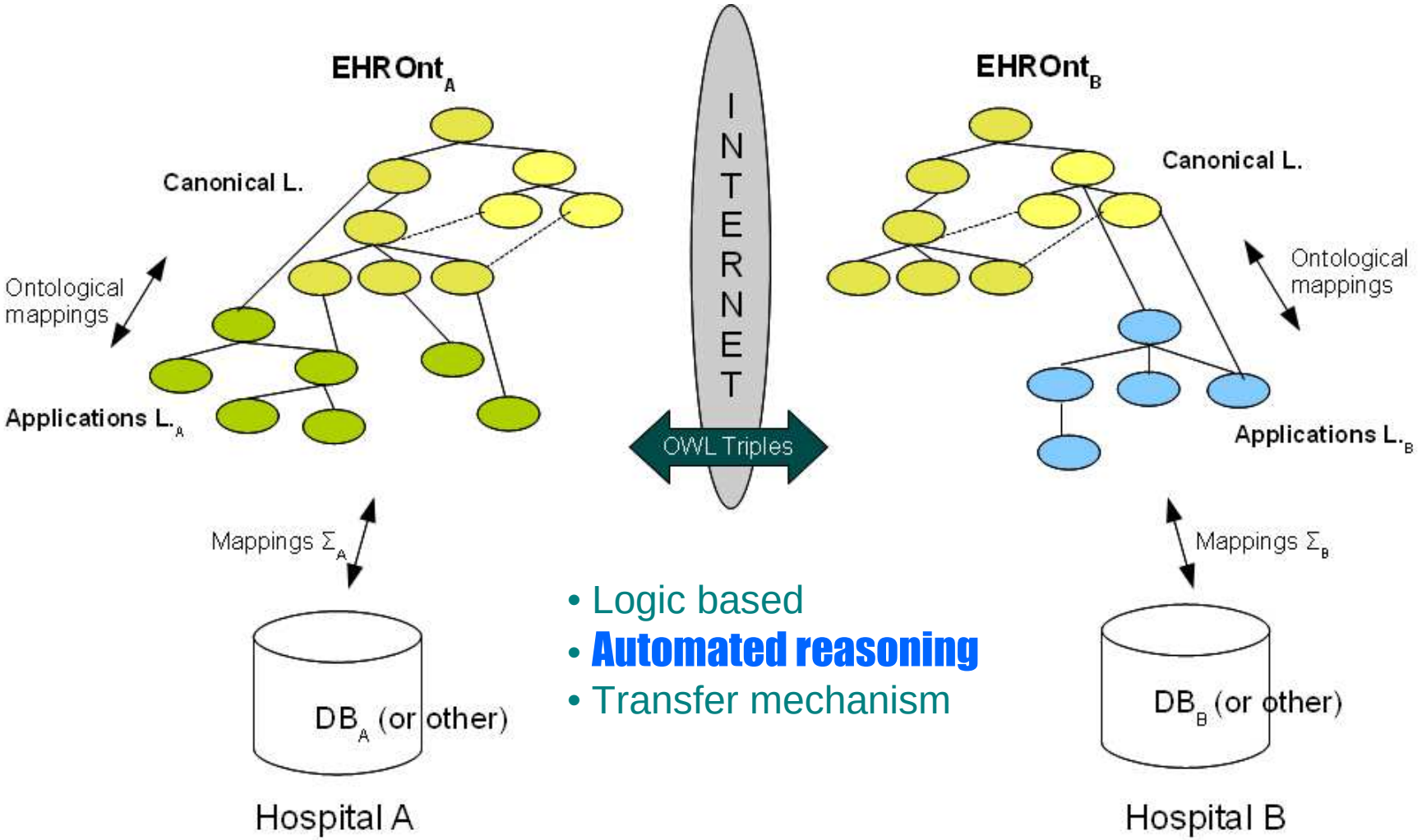
- Dual model-based architecture
  - Reference information model (RIM)
    - Building blocks: List, Table, Cluster, Entry, Element…
    - Stable model
  - Archetype model
    - Knowledge concepts: Blood Pressure, GCS…
    - Subject to change over the time



But

- Different information systems should **previously agree** on abstract archetype models

Ontology-based approach



- Logic based
- **Automated reasoning**
- Transfer mechanism

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- **Ontology for EHR interoperability**
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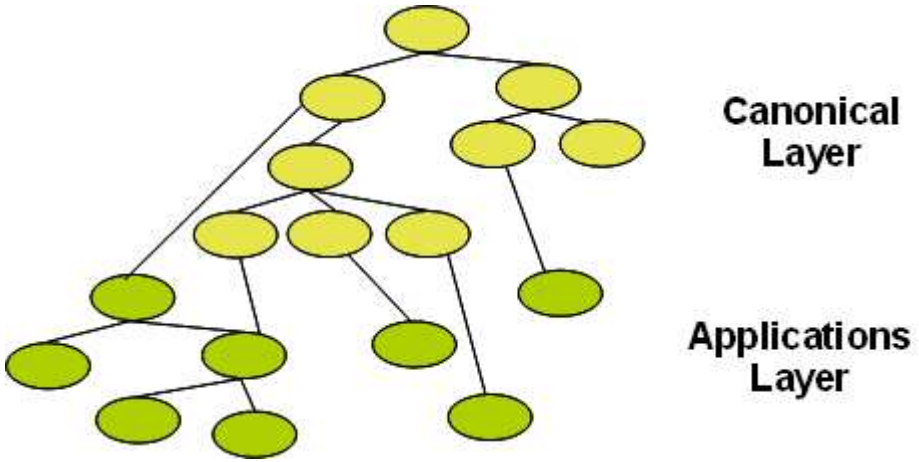
EHROnt ontology (I)

- Ontology for representing EHR information

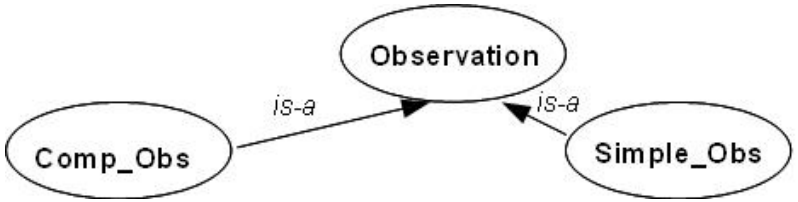
  ⟹ We will focus on medical observations

- Two interrelated layers
  - Canonical layer
  - Application layer



EHROnt ontology (II)

- Canonical layer
  - Abstract description of medical observations



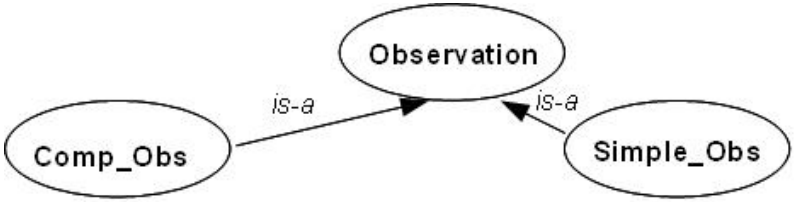
$$\mathtt{Observation} \equiv \mathtt{Simple\_Obs} \sqcup \mathtt{Comp\_Obs}$$

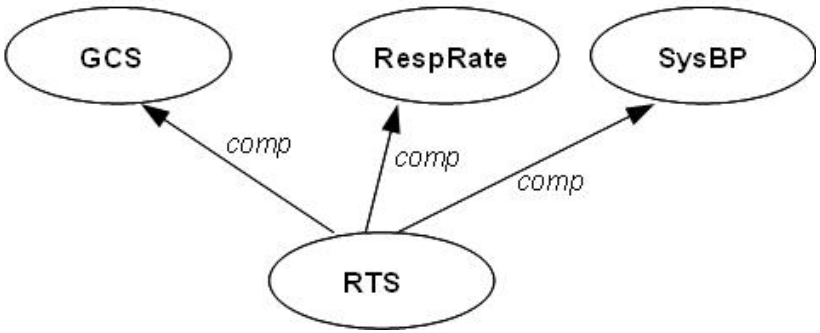
$$\mathtt{Comp\_Obs} \equiv \geq 2\ \mathtt{comp.Observation}$$

$$\mathtt{Simple\_Obs} \equiv =0\ \mathtt{comp}$$

$$\mathtt{Simple\_Obs} \sqsubseteq =1\ \mathtt{value} \sqcap \leq 1\ \mathtt{unit} \sqcap \leq 1\ \mathtt{protocol.Protocol} \sqcap \forall\ \mathtt{state.State} \sqcap \leq 1\ \mathtt{site.AnatomicalSite}$$

EHROnt ontology (II)

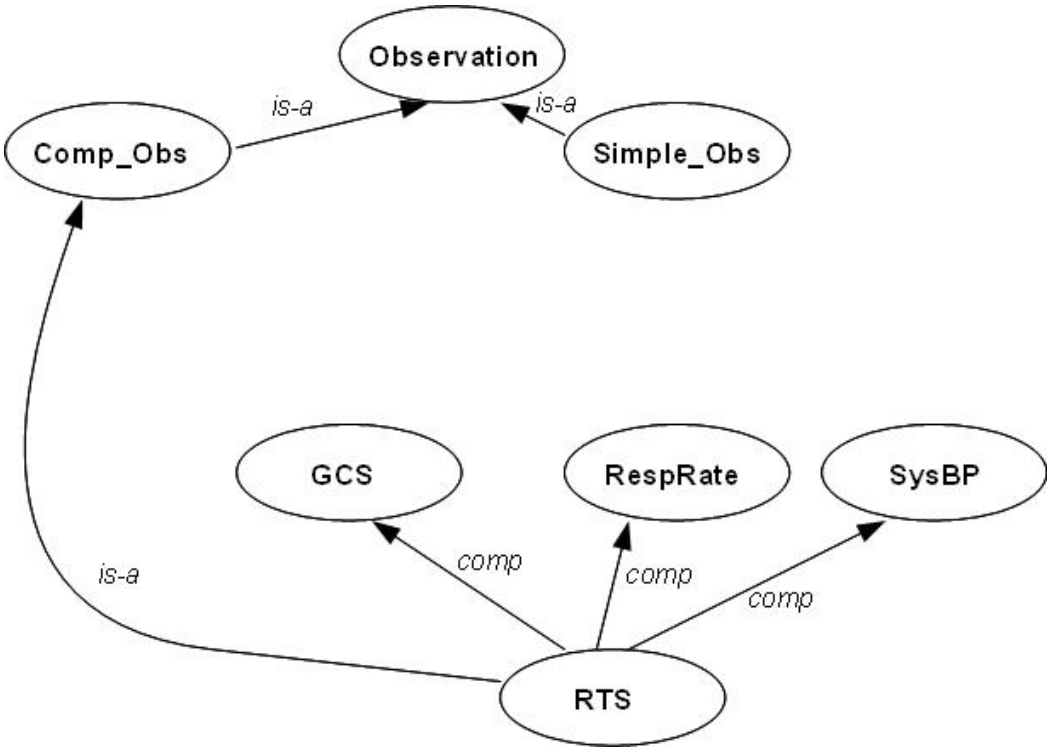




RTS ≡ Comp_Obs =1 comp.GCS ⊓ =1 comp.RespRate ⊓ =1 comp.SysBP

RTS ≡ snomed.{“273885003”}

EHROnt ontology (II)



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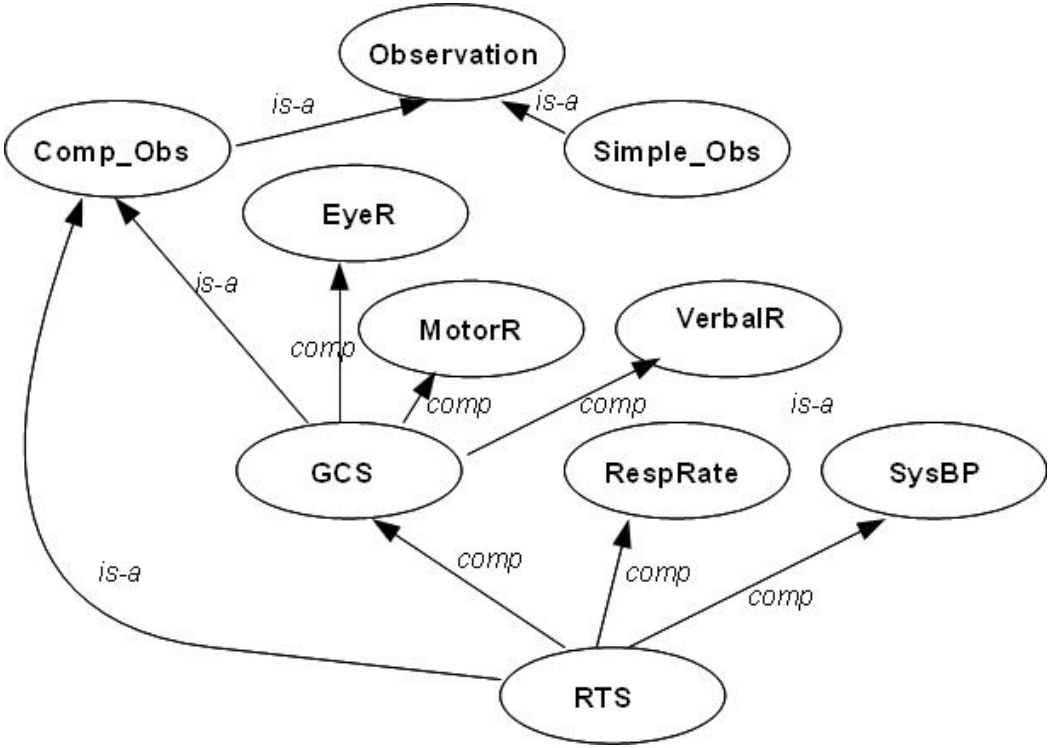
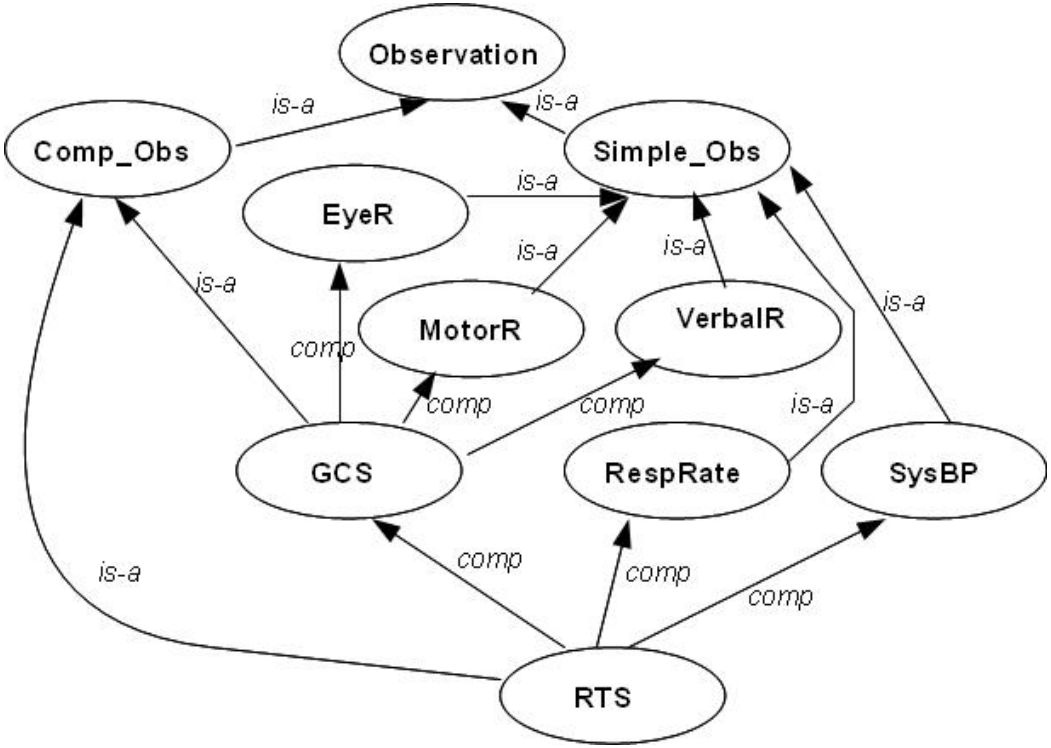


GCS ≡ Comp_Obs =1 comp.EyeR ⊓ =1 comp.Motor ⊓ =1 comp.VerbalR

GCS ≡ snomed.{“248241002”}

EHROnt ontology (II)



EyeR ⊑ Simple_Obs

EyeR ≡ snomed.{“281395000”}

EHROnt ontology (III)

- Application layer
  - Specific for each Information system
  - Classes and properties to describe the knowledge concepts of the particular system
  - Related to the canonical layer via equivalence or subclass relationships

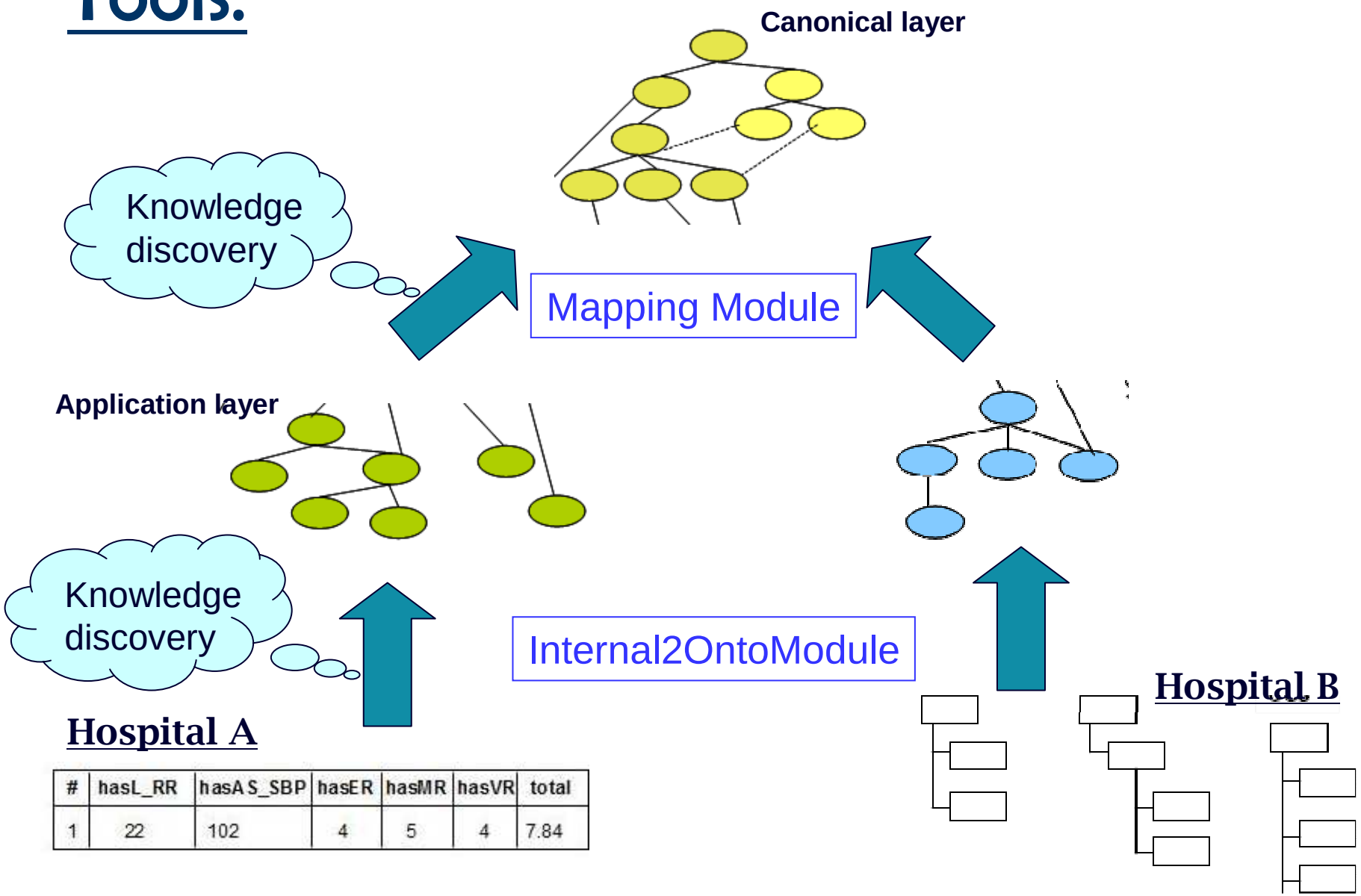
$sa{:}HighTemperature \sqsubseteq eo{:}Temperature$

$sa{:}HighTemperature \equiv eo{:}Temperature \sqcap =1\ sa{:}value(>38) \sqcap =1\ sa{:}unit.\{\text{“ºC”}\}$

$sa{:}value \equiv eo{:}value$

Namespaces:
sa: Application. Layer for system A
eo: Canonical Layer EHROnt

Tools:



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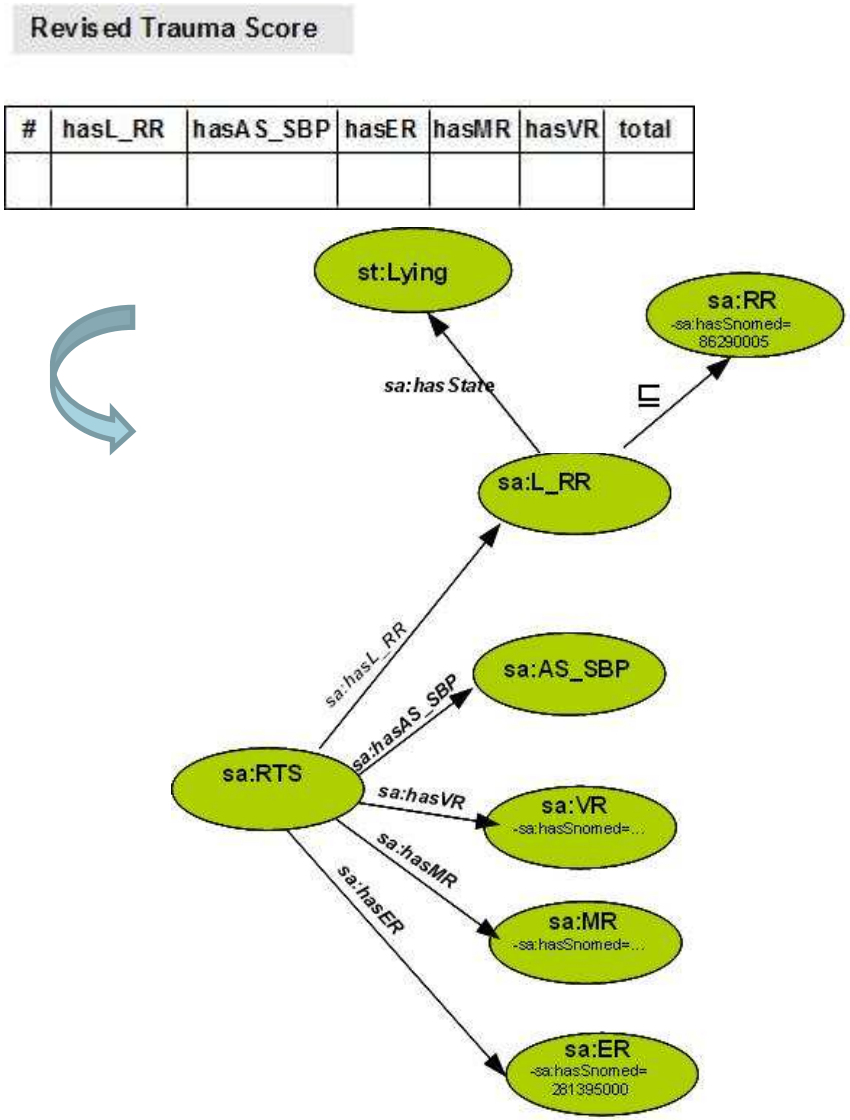
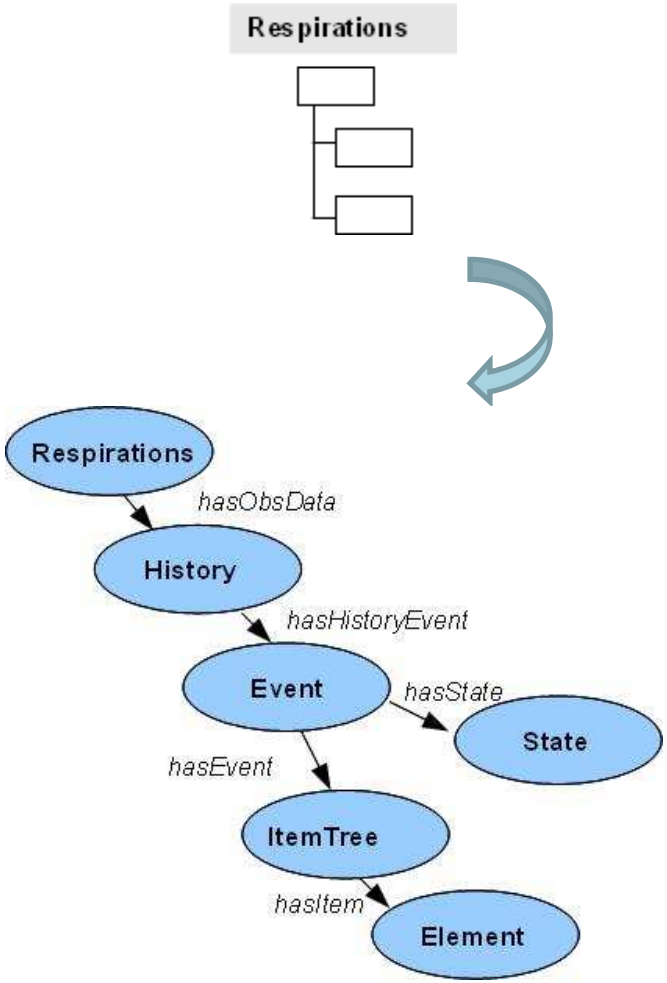
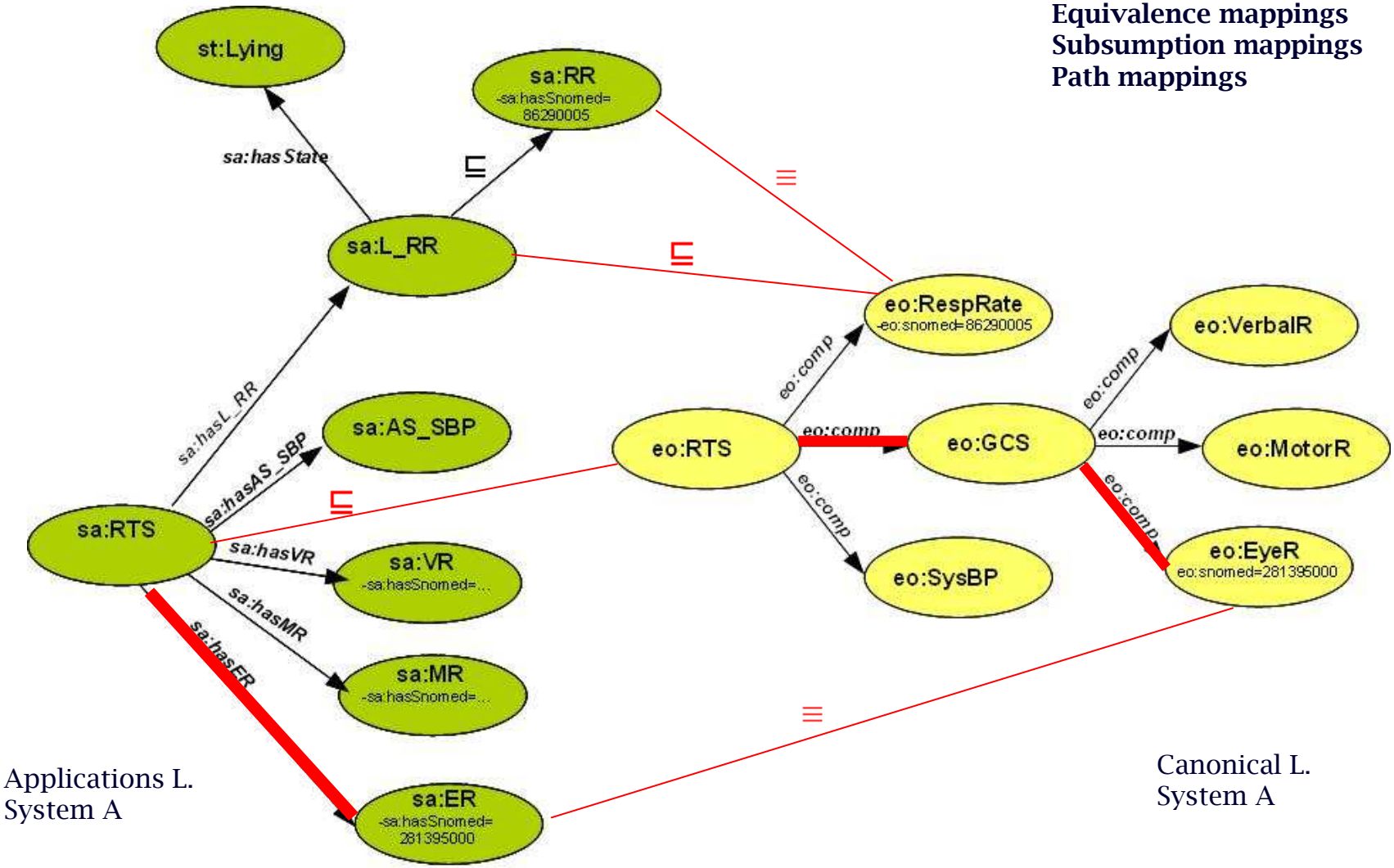
Internal2OntoModule





MappingModule



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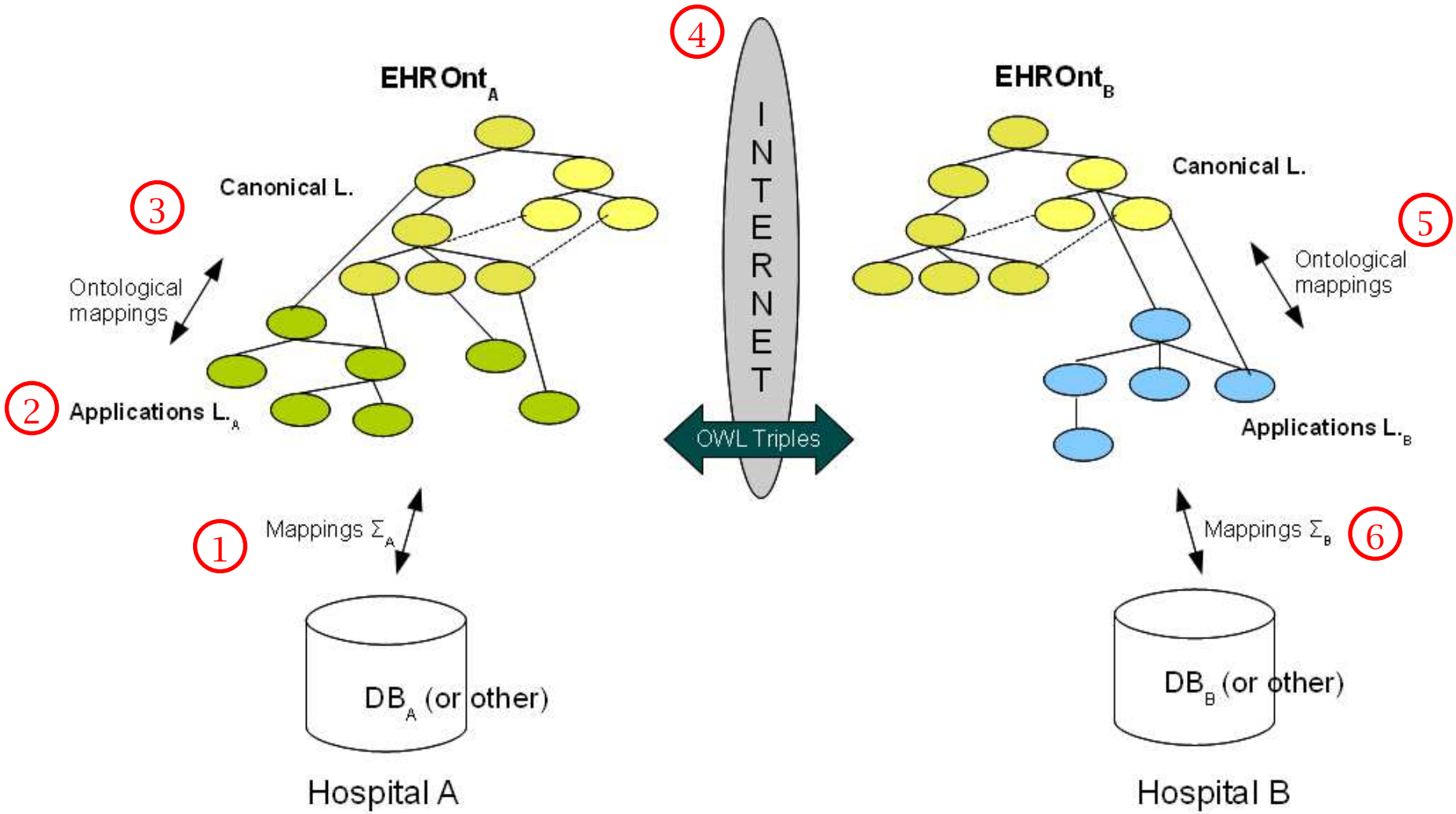
Transfer mechanism



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Conclusions

- Logic-based framework that allows the interoperability of medical observations
  - Focus on semantic aspects independent of languages/technologies
  - Favors the notion of extensibility to different models
  - Reasoning to discover implicit knowledge

Thank you for your attention !