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ARTEMIS: A Semantic Web Service-Bases P2P Infrastructure for the Interoperability of Medical Information Systems

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IST-2103 STP Artemis: A Semantic Web Service-based P2P Infrastructure for the Interoperability of Medical Information systems



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- **OFFIS e.V. Healthcare Information and Communication Systems , Germany**



- **South and East Belfast Health and Social Services Trust (SEBT), UK**



- **ALTEC S.A. Information and Communication Systems , Greece**



- **Tepe Technology, Turkey**



- **IT Innovation Center, University of Southampton, UK**



Challenges of Healthcare Informatics



- **The most common and prominent strategic aims in Europe are:**
 - Improving access to clinical records
 - Enabling patient mobility and cross border access to healthcare
 - Reducing clinical errors and improving safety
 - Improving access to quality information
 - Improving efficiency of healthcare processes
 - (ref: CEN/ISSS Report Draft V4.1, 2004-08-16)
- **All this implies the need for interoperability!**

Challenges - why we do this project?



- Today no universally accepted standard for the digital representation of clinical data exists
- There is a multitude of medical information systems on the market, storing clinical information in all kinds of proprietary formats
- Most of the health information systems today are proprietary
- A patient's health information may be spread out over a number of different institutes which do not interoperate
- This makes it very difficult for clinicians to capture a complete clinical history of a patient

Functional and Semantic Interoperability



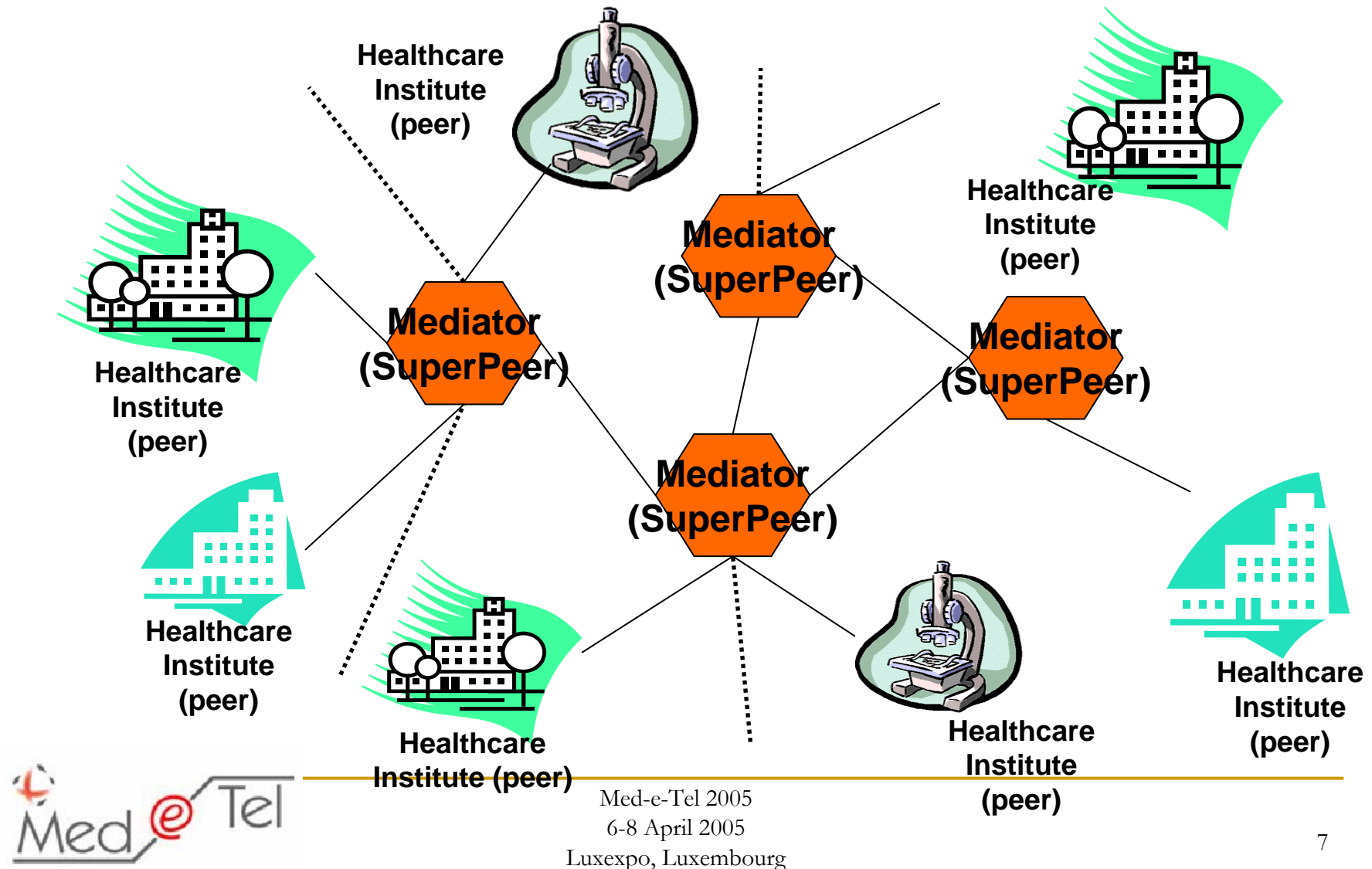
- **The Functional (syntactic) interoperability** is the ability of two or more systems to exchange information
- This involves agreeing on
 - The common network protocols such as Internet or Value Added Networks;
 - The common transport binding such as HTTP, FTP or SMTP and
 - The common message format like ASCII text, XML (Extensible Markup Language) or EDI (Electronic Data Interchange)
- **Semantic interoperability** is the ability for information shared by systems to be understood at the level of formally defined domain concepts so that the information is computer processable by the receiving system

Artemis Objectives: Interoperability through Semantically Enriched Web services in the Healthcare Domain



- Achieving interoperability among Medical Information systems through:
 - **Web service technology (Functional Interoperability), and**
 - **Semantic Mediation to provide semantic interoperability**
- Furthermore to facilitate the discovery of Web services and for the scalability of the infrastructure, the use of **Peer-to-peer** networks

We will locate Semantically Enriched Web services through P2P



Basic Artemis Features



- Web services to **wrap and expose** existing healthcare applications
- Annotating Web services through **Service Functionality Ontologies** to describe what they are doing
- Annotating the Service Messages through **Clinical Concept and Service Message Ontologies**
- In Artemis, healthcare institutes are not expected to conform to a single common ontology
- The differences between disparate Service Functionality, Service Message and Clinical Concept Ontologies are mediated through **Ontology Mapping**

Healthcare Informatics

Semantics



- **Semantics is domain knowledge!**
- **Medicine is one of the few domains to have extensive domain knowledge defined through standards**
- **These standards offer significant value in developing ontologies to express the semantics of Web services**

What kind of Semantics?



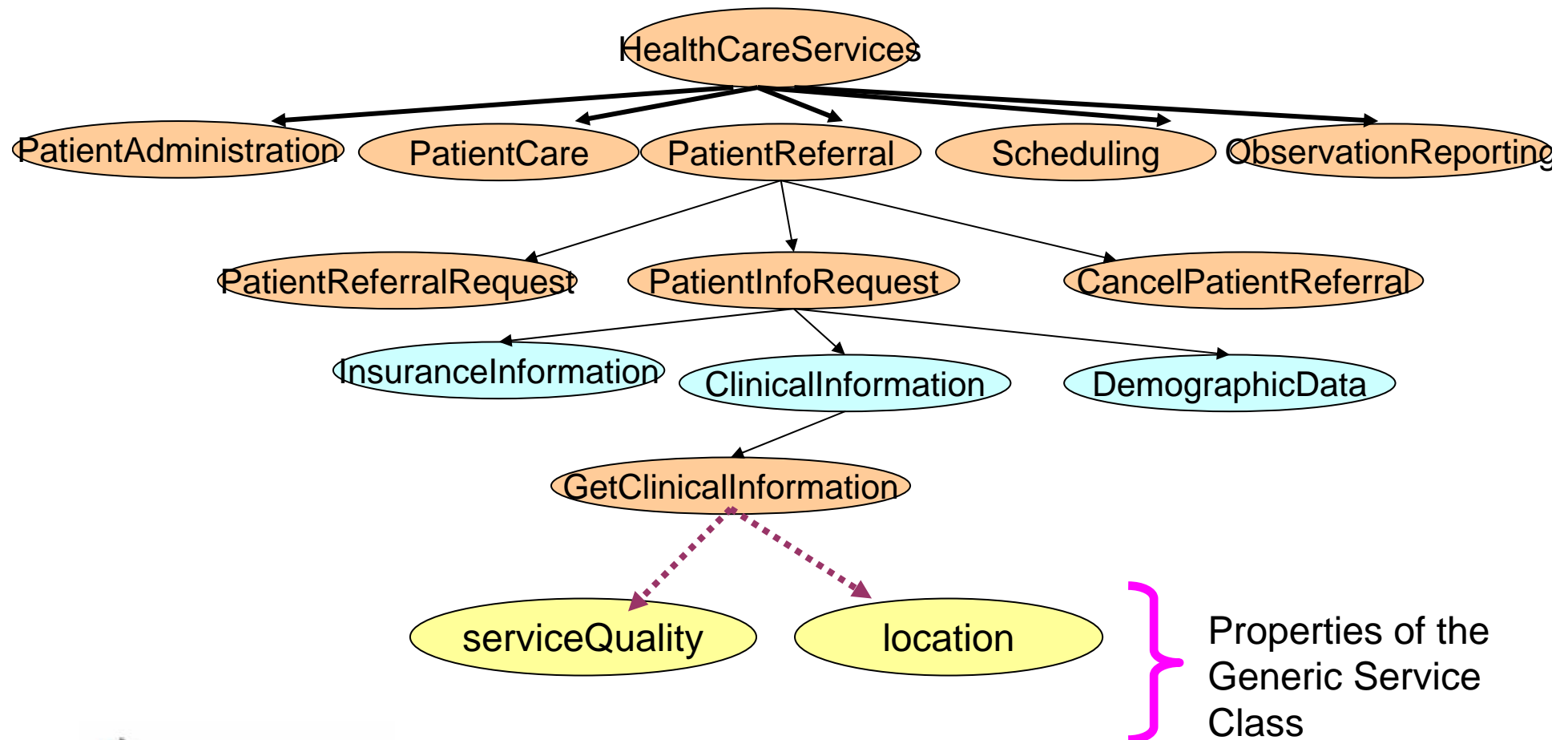
■ Service Functionality Semantics:

- HL7 has categorized the events in healthcare domain by considering service functionality which reflects the business logic in this domain
- This classification can be used as a basis for defining the service action semantics through a Service Functionality Ontology

■ Service Message Semantics:

- Electronic healthcare record (EHR) based standards like HL7 CDA (Clinical Document Architecture), GOM (GEHR Object Model), and CEN TC251's ENV 13606 define **meaningful components of EHR** so that when transferred, the receiving party can understand the record content better
- The **meaningful components** defined by these standards can be used in developing clinical concept ontologies (CCO)
- The medical institutes can directly benefit from these CCOs or map their message ontologies to one of the CCO.

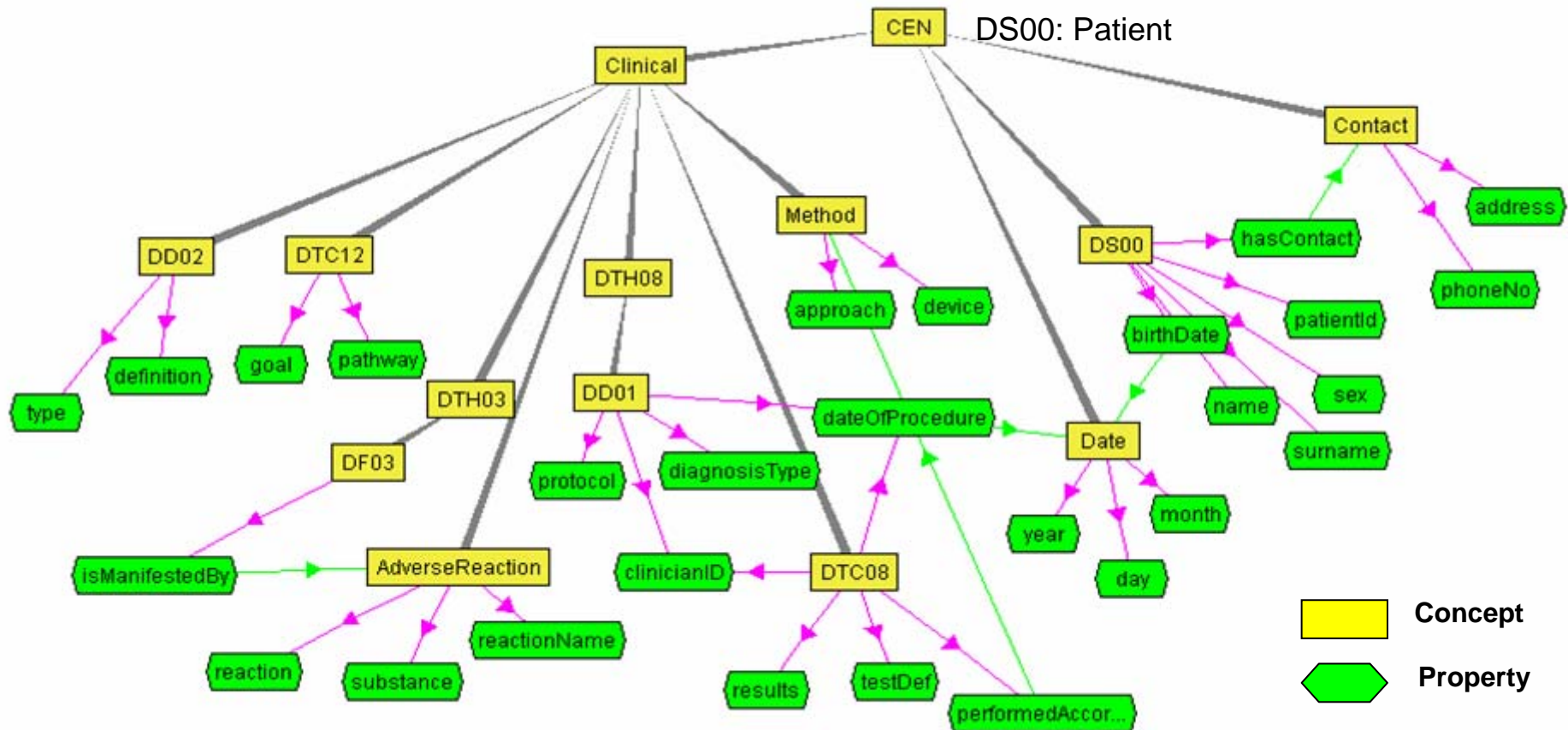
An Example Service Functionality Ontology



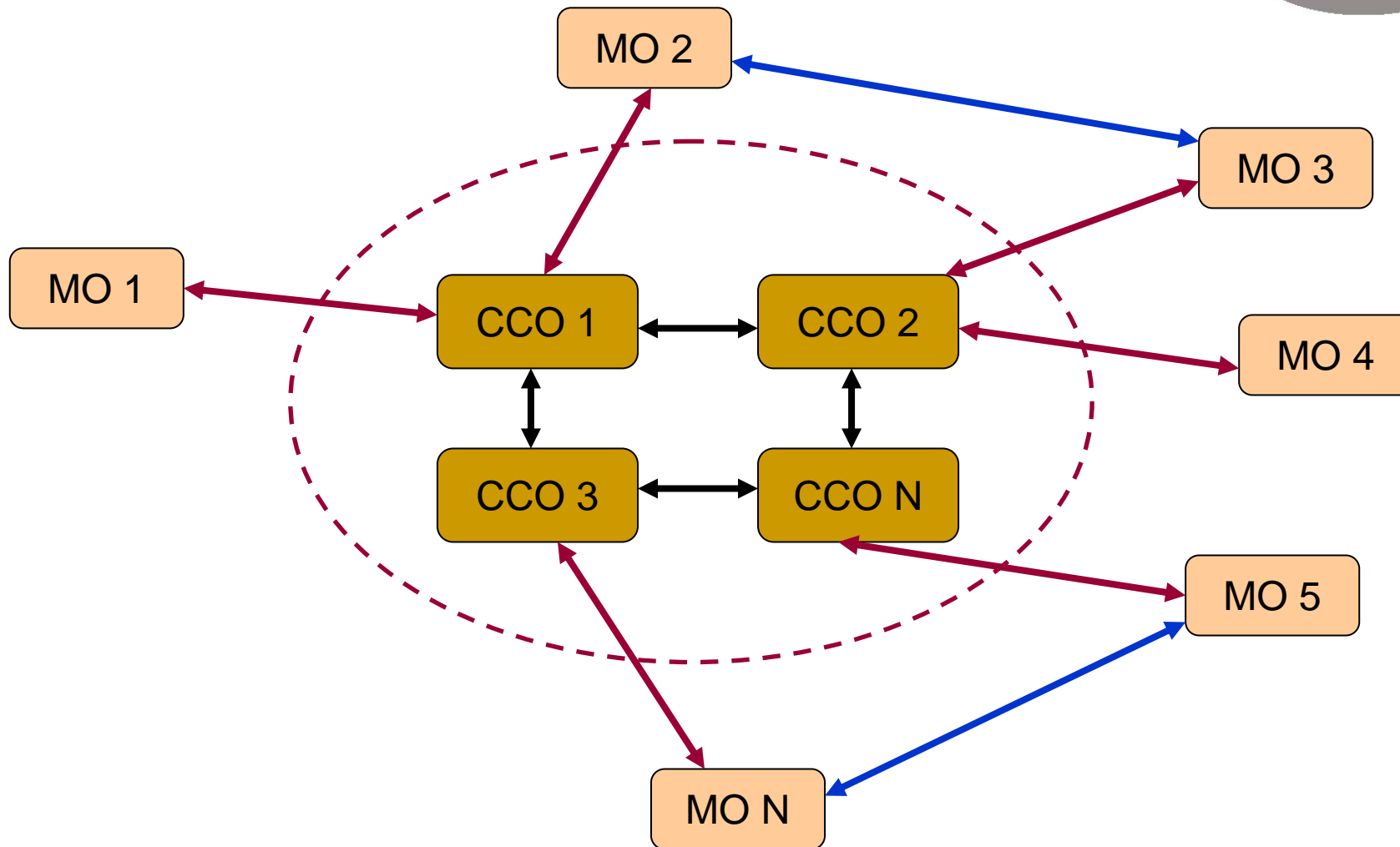
An example Clinical Concept Ontology



- DD02: Problem
- DTC12: CarePlan
- DF03: AllergyState
- DTH03: Ongoing Problems
- DTH08: Present Interpretations
- DD01: Diagnosis
- DTC08: Diagnostic Test Results
- DS00: Patient



Ontology Network



Semantic Mediation



- Healthcare Institutes usually exchange XML or EDI messages
- In Artemis architecture, the healthcare institutes can develop their own ontologies, called message ontologies (automatically with the normalization tool provided)
- However these ontologies are proprietary
- The ontology mappings are achieved through semantic mediation
 - OWL2OWL mapping tool (OWLmt) developed

Semantic Mediation



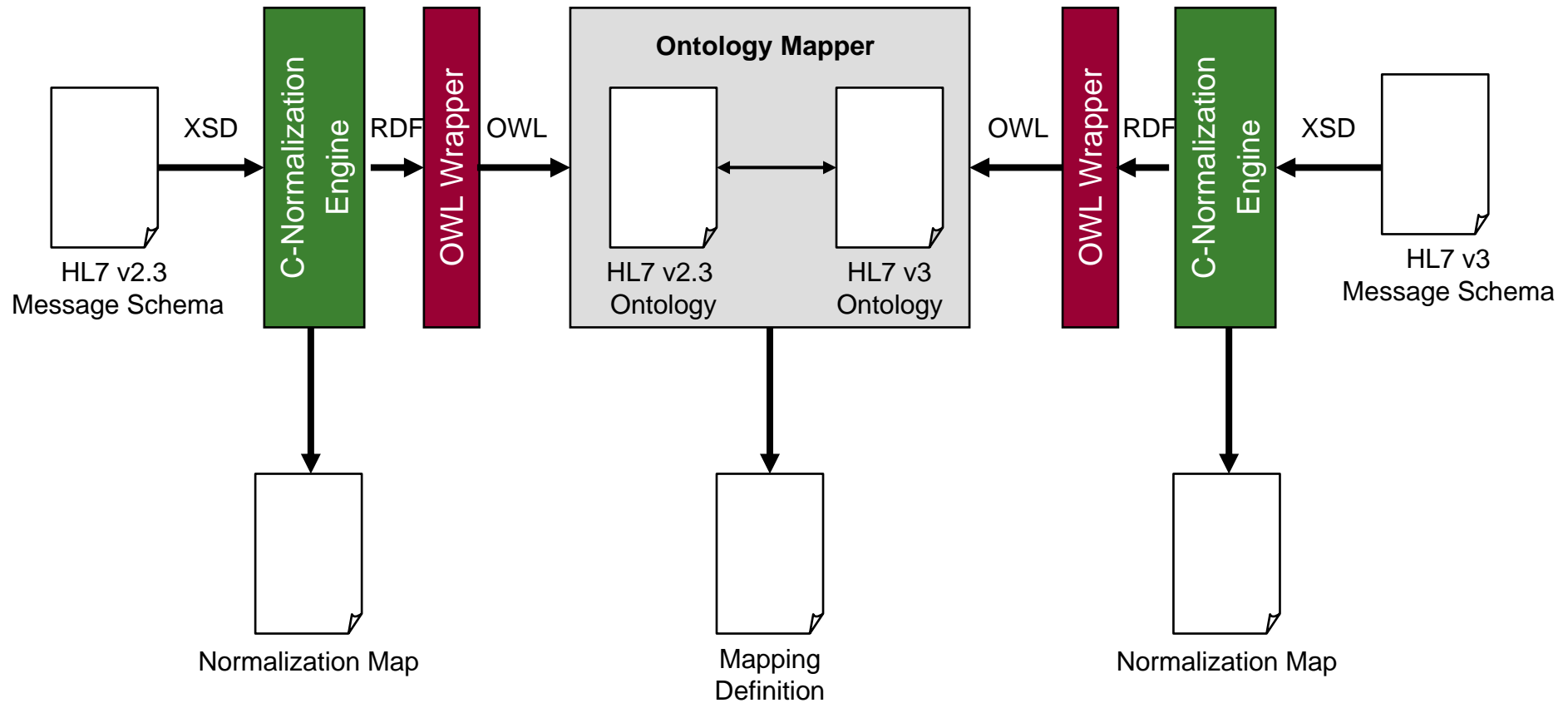
- Artemis Mediator
 - Normalizes XML messages to OWL to create message Ontologies
 - Maps them to the target message ontology
 - This may involve mappings to and between CCO
 - De-normalizes them to XML or EDI

Message Schema Mapping



Healthcare Institute A

Healthcare Institute B

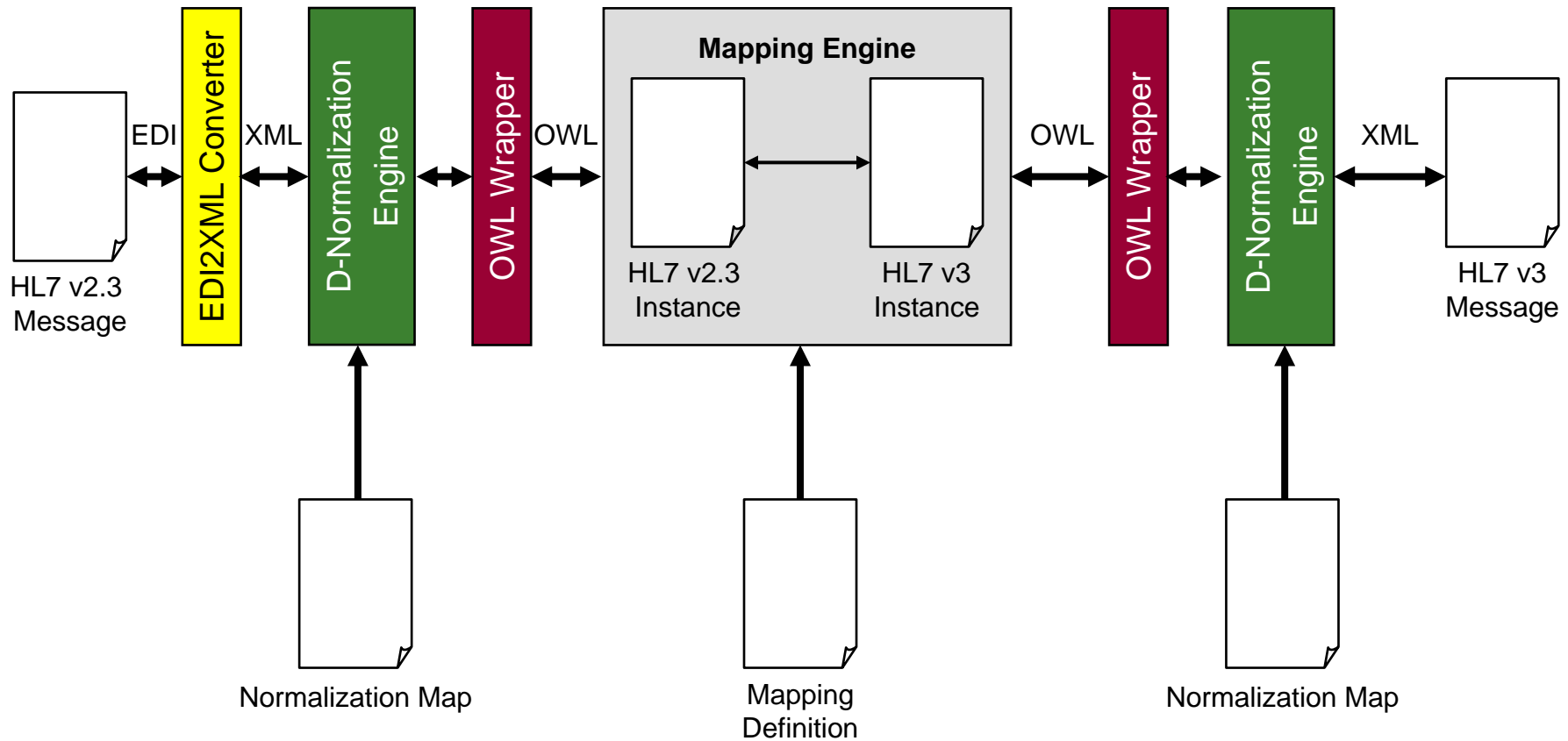


Message Instance Transformation



Healthcare Institute A

Healthcare Institute B



Additional Tools Used for creating HL7 v3 Message Schemas



- HL7 RoseTree Tool is used to create HL7 v3 messages
- RoseTree allows the user to graphically build a HMD (Hierarchical Message Definition) from the HL7 v3 Reference Information Model
- In order to translate the HMD to XSD, HL7 v3 Schema Generator Tool is used
- Conceptual Normalization Engine of the Harmonize project is used for XSD to OWL (and vice versa) mappings

Additional Tools Used for Instance Transformation

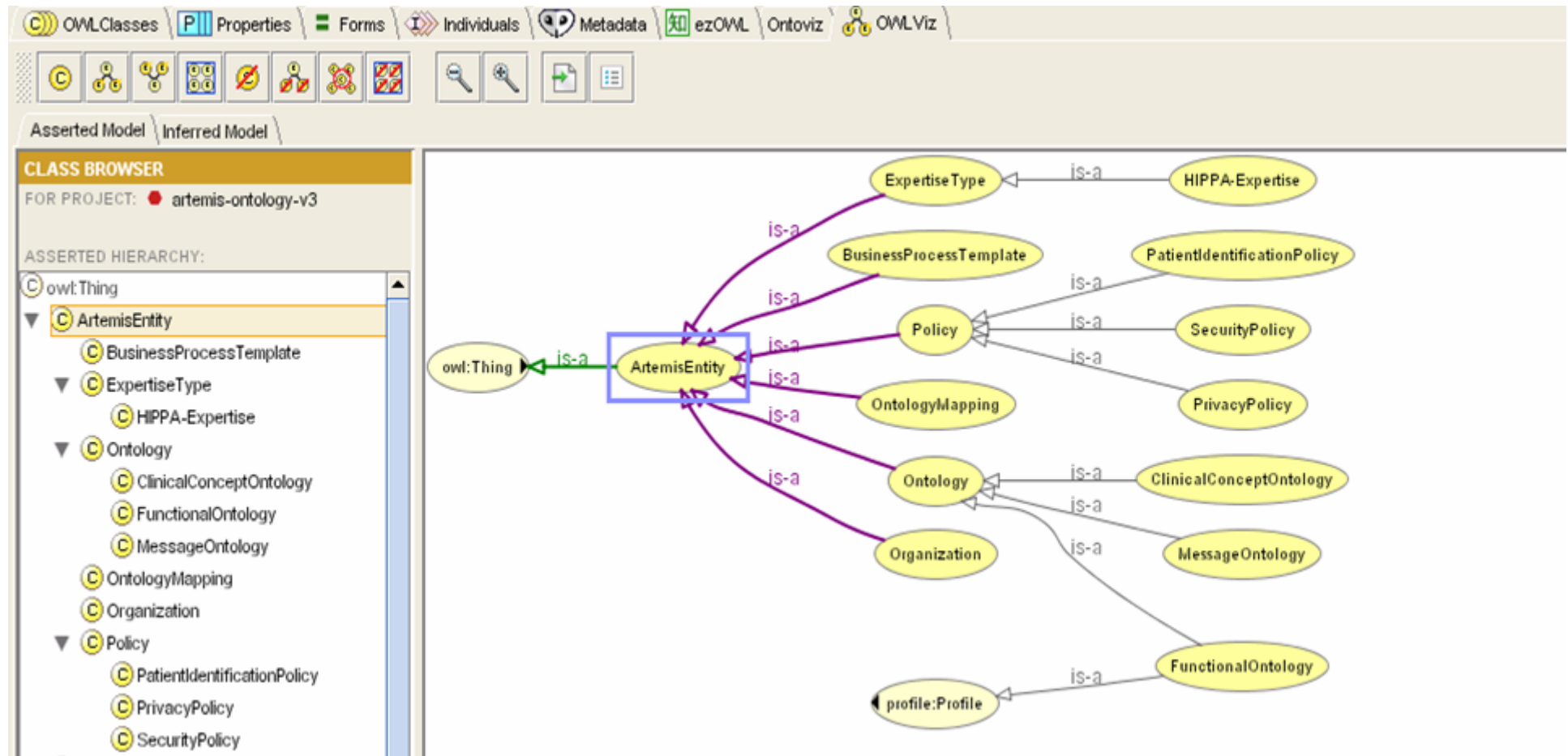


- EDI to XML Conversion in HL7: HL7 Application Programming Interface (HAPI) Assembler/Disassembler Tool is used to transform the HL7 v2 EDI messages into their XML representations
- Data Normalization Engine of the Harmonize project is used to transform XML Message instances to OWL instances

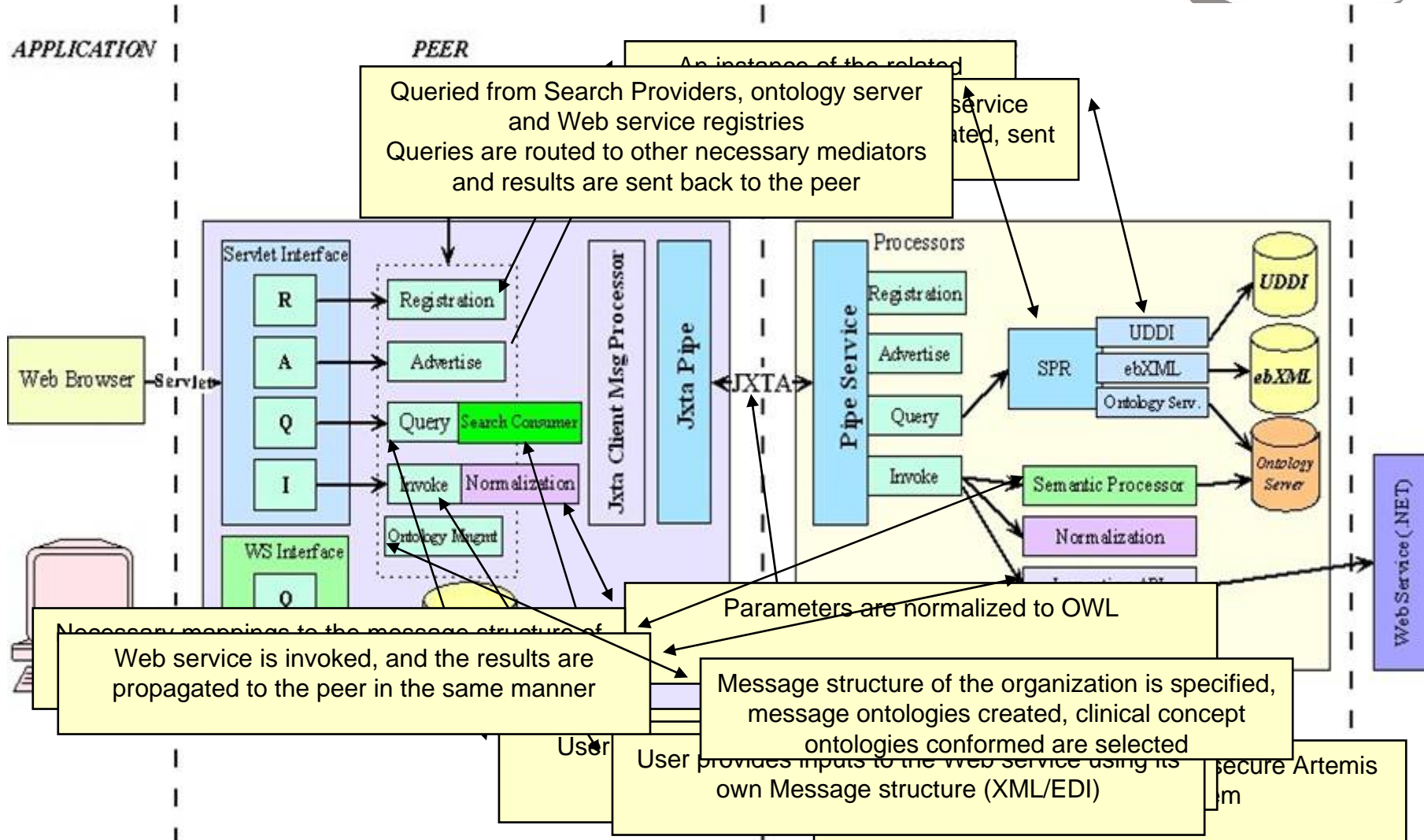
Semantically Enriched Discovery Mechanism



- **Artemis Ontology:** All of the Artemis entities are represented in an Ontology called *Artemis Ontology*



System Architecture



Patient Identification and IHE RID



- A patient Identification protocol to locate hospitals that have information about a patient in Artemis P2P network
 - With comprehensive measures for security and privacy
 - Using cryptographic techniques
- Semantically enriched IHE RID implementation for retrieving medical documents

End result of the Artemis Project



- A middleware providing the interoperability of Medical Information Systems
- The project has been developing:
 1. Semantic mediation infrastructure for healthcare Web services
 2. Tools for semantically annotating and creating healthcare Web services
 3. Web service composition tool based on BPEL4WS
 4. Web service registries (UDDI and ebXML) enriched with healthcare semantics, Integrating Web services and Web services registries with P2P networks
 5. Secure, Semantic P2P discovery mechanism
 6. Semantic routing on the P2P networks for discovery of healthcare related information
 7. A distributed patient identification protocol with comprehensive security and privacy policies
 8. Artemis compliant IHE RID implementation

Market



- Artemis project will be one of the first initiatives to use Web services in the healthcare domain
- We plan to produce an early prototype to demonstrate system capabilities to the widest possible audience
- The market size will depend upon the system capabilities and how wide we can disseminate the results

Artemis Project: References



- <http://www.srdc.metu.edu.tr/artemis/>
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 - Thomas Aden, Marco Eichelberg, Wilfried Thoben, "[A fault-tolerant cryptographic protocol for patient record requests](#)" to appear in the Proceedings of EuroPACS-MIR 2004 in the enlarged Europe, Trieste(Italy), September 2004.
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Artemis Demonstration



- Artemis Project is being demonstrated at MedETel Exhibition Hall
 - We are looking forward to hosting you in our stand
 - To present you detailed Artemis functionalities



Thank you for your attention!