Ontology building and XML-Based Cross-Domain Semantic Interoperability

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Abstract

The variety of domain standards at the application level complicates the interoperability among different application domains. The maturity of application domains relates to the ease of communication of terms between different actors. This is central in defining standards for communication of information among organizations in the same domain. In this context, most research activities are focused towards standardization and interoperability among the legacy systems within the same domain. However, an emerging challenge is to address the exchange of information among heterogeneous legacy systems in different domains. This requires data extraction to obtain common subsets of information in collaborating domains, e.g., healthcare and insurance. The second step would be to provide intra-domain and inter-domain semantic interoperability through proprietary and shared ontology systems. In this paper, we address the above challenges through description of a framework that employs healthcare standards and clinical terminology systems to achieve semantic interoperability between distributed systems among different application domains. A real world case study will be message- oriented integration of business processes between healthcare and insurance.

State of the Art

- European Interoperability Framework for Pan-European E-Government Services
- Different efforts in this area:
  - Scope:
    - Global level, National/federal level, Sub-domain level.
  - Owner:
    - Governmental programs and initiatives vs. Research initiatoves
  - Modeling perspective:
    - Data, Process/Service, Organizational

Data Modeling

- Most popular in the eGovernment modeling area.
- Efforts vary significantly both in scope and representation power.
- Some of the popular modeling efforts are based on XML schemas.
- E.g. JXDM, GovML, …
- Efforts above XML: the Canadian government online metadata standard.

Standards used in eGovernment Models

	Initiative	Standards	Standard Body	Standard type
Data modelling	UK GovTalk	XML, XML Schema	W3C	Open
	Hong Kong Library of XML Schemas	XML, XML Schema	W3C	Open
	Finnish Parliament, RASKE project	XML, XML Schema	W3C	Open
	Component Organization and Registration Environment, USA	XML, XML Schema	W3C	Open
	The US Global Justice XML model, USA	XML, XML Schema	W3C	Open
	Policy Content at Social Security with XML & Semantic Metadata	Dublin Core Element Set, XML, Topic maps	DCMI, W3C, ISO	Open
	DiBIS, Hamburg	XML, XML Schema, RDF, OWL	W3C	Open

Process/Service Modeling

- SOA has evolved software modeling from process orientation to service orientation.
- Service-oriented ontologies: WSMO, SWSF, and the semantic annotations for WSDL and XML Schema.
- Process-oriented models: Government Process Classification Framework, SAP Public Sector Solution Map.

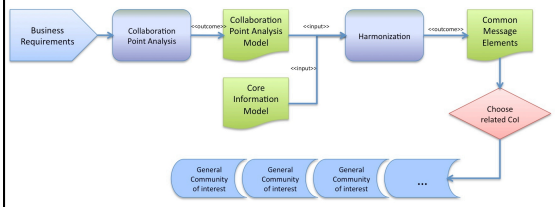
Standards used in eGovernment Models

Process modelling	Government Process Classification Framework	Organizational	N/A
	The Federal Enterprise Architecture Business Reference Model	Semantic	Data integration,
	A Model of Business Process Support System for E-Government	Technical, Organizational	Interconnection
	Inter-workflow for eGovernment, India	Organizational	N/A
	The IMPULSE IST project	Technical, Organizational	Interconnection, Data integration,
Service modelling	Workflow versus Serviceflow	Semantic, Organizational	Data integration,
	Using Dublin Core for eGovernment service description	Technical	Content management
	The ONTOGOV Service Model	Technical, Semantic	Interconnection, Data integration
	OWL-S Service Registry	Technical, Semantic	Interconnection, Data integration
	WSMO-PA (SemanticGov)	Technical, Semantic	Interconnection, Data integration
	The Access-eGov System	Technical, Semantic	Interconnection, Data integration
	Public e Services Value model	Organizational	N/A

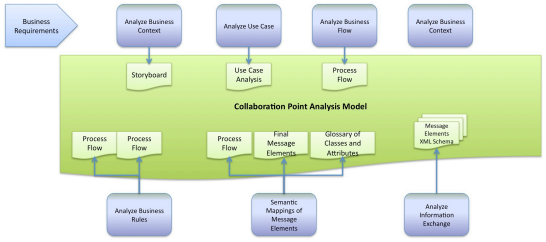
When it comes to cross-domain interoperability…

- Collaboration points between different domains are not clearly specified.
- Organizations choose a short term solution for interoperability which is not cost-effective:
  - Point-to-point pattern for semantic interoperability
- Each domain has its own standard for interoperability which is adopted and used for a long time.
- It is not cost-effective to change the whole interoperability choices to make semantic interoperability happen among different domains
- There is need for transparency among domain standards and an evolving information model and ontology to make this happen.
- Change management is critical here.

Overview of the Ontology Building Phase



Collaboration Point Analysis



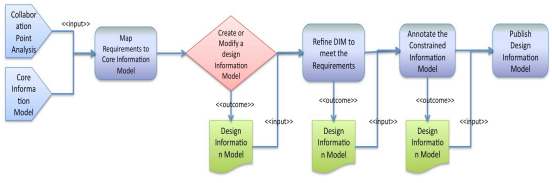
Semantic Matching Algorithm

Procedure 1 SemanticXMLSchemaMapping(*source*, *target*)
candidates: HashTable < *key* > < *value* >;
key: *source.nodes*;
value: **list** <*node*>;
if *source.parent* is **root then**
SemanticMatchVisit(*source*, *target*);
else
SemanticMatchVisit(*source*, *candidates*[*source.parent*]);
end if
for all *v* in *source.children* **do**
SemanticMatchDFS(*v*, *candidates*[*source*]);
end for

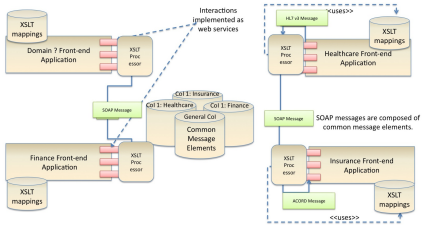
Procedure 2 SemanticMatchDFS(*source*, *candidates*)
if *source* is an atom **then**
SemanticMatchVisit(*source*, *candidates*[*source.parent*]);
else
SemanticMatchVisit(*source*, *candidates*[*source.parent*]);
for all *v* in *source.children* **do**
SemanticMatchDFS(*v*, *candidates*[*source*]);
end for
end if

Procedure 3 SemanticMatchVisit(*node*, *candidates*)
for all *v* in *candidates* **do**
Create a QUEUE *Q*;
ENQUEUE(*Q*, *v*);
while *Q* is not empty **do**
for all *v*1 in *Q* **do**
if *v*1 is unexplored **then**
if *v*1 is in semantic relationship with *node* **then**
ENQUEUE(*Q*, *v*);
else if *v*1 is not in semantic relationship with *node* **then**
DEQUEUE(*Q*,*v*1);
else if *v*1 is in the same level of granularity as *node* **then**
candidates[*node*].add[*v*1];
else if *node* is an atom and *v*1 is an atom too **then**
use XSLT template match to map related atoms.
else if *node* is an atom and no candidate atom is found **then**
set a constant default value for node.
end if
end if
end for
end while
end for

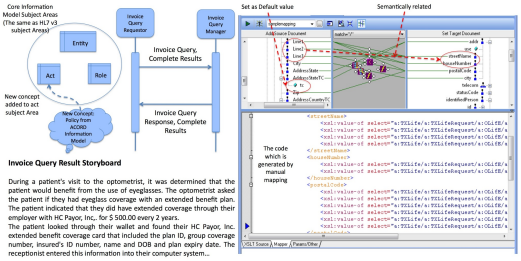
Harmonization Process



Interoperability Infrastructure



Case Study: Insurance and Healthcare Semantic Interoperability



Invoice Query Result Storyboard

During a patient's visit to the optometrist, it was determined that the patient would benefit from the use of eyeglasses. The optometrist asked the patient if they had eyeglass coverage with an extended benefit plan. The patient indicated that they did have extended coverage through their employer with HC Payor, Inc., for $ 500.00 every 2 years.
The patient looked through their wallet and found their HC Payor, Inc. extended benefit coverage card that included the plan ID, group coverage number, insured's ID number, name and DOB and plan expiry date. The receptionist entered this information into their computer system...