

Systems interoperability through use of semantic technologies

Semantic Days' 2009

Arne J. Berre, SINTEF

Arne.J.Berre@sintef.no

Systems interoperability through use of semantic technologies

- The talk will give an overview of the major challenges related to system interoperability in general and the specific issues related to interoperability on the semantic level. Examples on solution approaches based on use of semantic technology from current European projects will be given.
- Arne J. Berre, Chief Research Scientist, SINTEF,
- Svein Johnsen, Research Scientist, SINTEF

Summary

- Challenges related to system interoperability, Interoperability on the semantic level
- **COIN – Collaboration and Interoperability – Using SAWSDL architecture for semantic annotations, - experimenting with different technologies for realisation**
- Related projects presented at Semantic Days:
- *SWING/ENVISION: Tue: 1700-1730 Semantic annotation for web services and their relevance to environmental models (ENVISION, SWING)*
- *SHAPE: Wed 1030-1100 Supporting intelligent and automated integrated operations with agent technologies in a services architecture (using SoaML and Agents) (SHAPE)*
- *EMPOWER/MEMPOWER Wed: 1130-1200 IT architecture for supporting semantic interoperability through use of semantic annotations (and SAWSDL) (EMPOWER)*

The COIN Vision & Motto



COIN VISION: *“By 2020 enterprise collaboration and interoperability services will become an invisible, pervasive and self-adaptive knowledge and business utility at disposal of the European networked enterprises from any industrial sector and domain in order to rapidly set-up, efficiently manage and effectively operate different forms of business collaborations, from the most traditional supply chains to the most advanced and dynamic business ecosystems.”*

The COIN Consortium & Funnel Model

Industrial Partners



Academic & Research Partners



User Partners



14 Meuro,
21 partners



FP7-1
IP project
Objective 1.3

4 years:
2008-2011

COIN Market: starting point

EC form / EI challenge	Knowledge i/op	Business i/op
Supply Chains	Aerospace DTA Lazio (ITA)	Automotive Slovenian Net (SLO)
Collaborative Networks	ICT Network (HUN)	Aeronautic Cluster of Andalusia (SPA)
Business Ecosystems	Pulp & Paper Poyry (FIN)	Healthcare VEN (UK)

COIN Side A: main innovations

• The COIN Interoperability Space

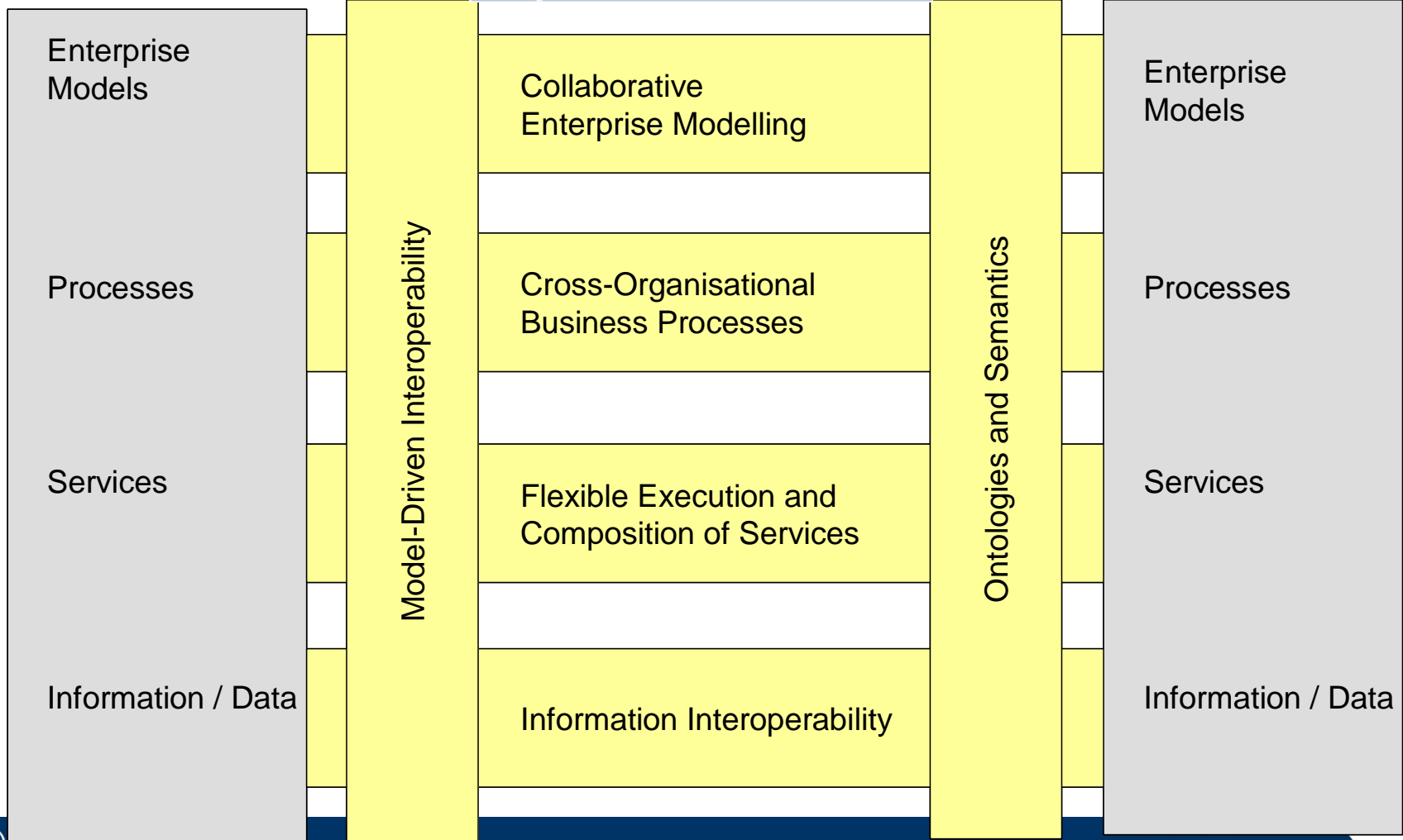
- To address **Information, Knowledge and Business** interoperability
 - To support the **Federated** interoperability approach
- To integrate **Model- and Semantic- driven** interoperability methods
 - To enable **Knowledge Profiles** semantic mediation
- To synchronize and optimize **collaboration Business Processes**
 - To go beyond state-of-the-art 1:1 transactions:
 - ✓ Supporting **1:1 negotiations** (e.g. supplier-customer)
 - ✓ Enabling **1:n relations** (e.g. tender-bidders)
 - ✓ Allowing **n:m agreements** (e.g. sellers-buyers)

COIN Side A: state-of-the-art



Provided

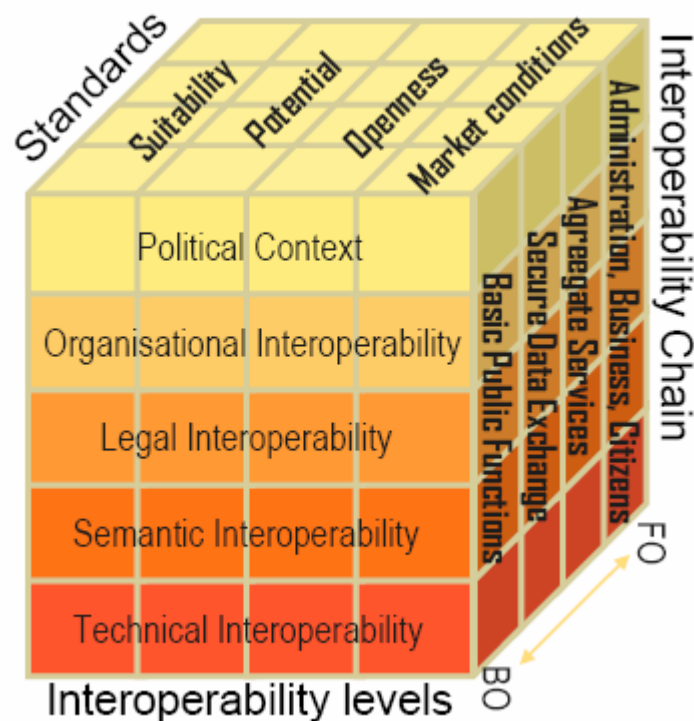
Required



EIF version 2.0 (2009)

European Interoperability Framework

EIF - Dimensions of Interoperability

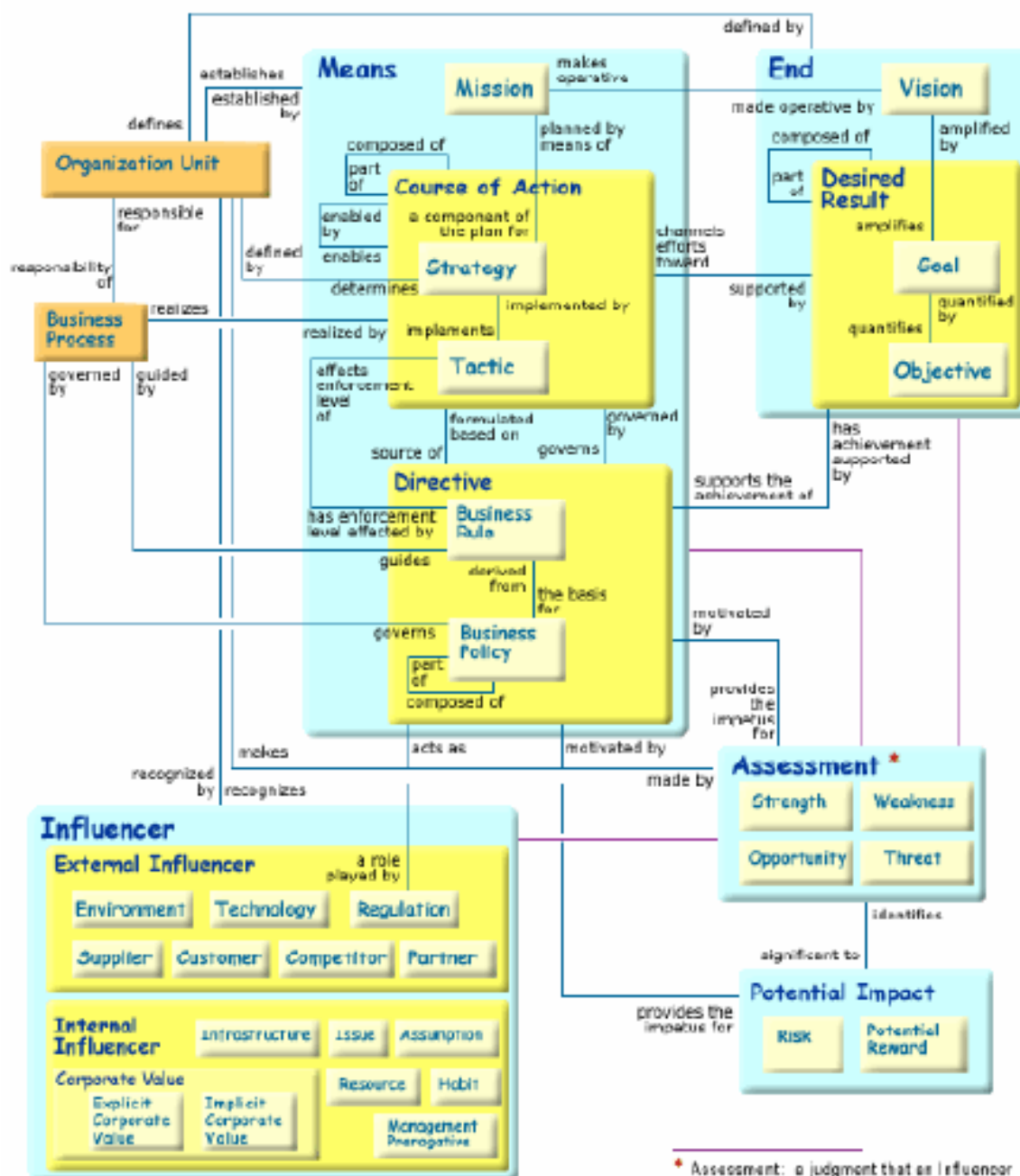


Definition: Interoperability (Revised in 2008 in EIF v2, to include common goals !)

"Interoperability is the ability of disparate and diverse organisations¹ to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems."

In fact, interoperability is often confused with other, related concepts. It can be therefore a useful exercise to observe explicitly what interoperability is NOT:

- Interoperability is not Integration, which is a means of changing loosely coupled systems to make them into more tightly coupled systems.
- Interoperability is not Compatibility, which is more about the interchangeability of tools in a particular context
- Interoperability is not Adaptability, which is a means of changing a tool, adding additional capabilities as needed even on an ad-hoc basis, whereas interoperability refers to inherent capabilities



OMG BMM Business Motivation Model

* Assessment: a judgment that an Influencer affects the employment of Means or the achievement of Ends

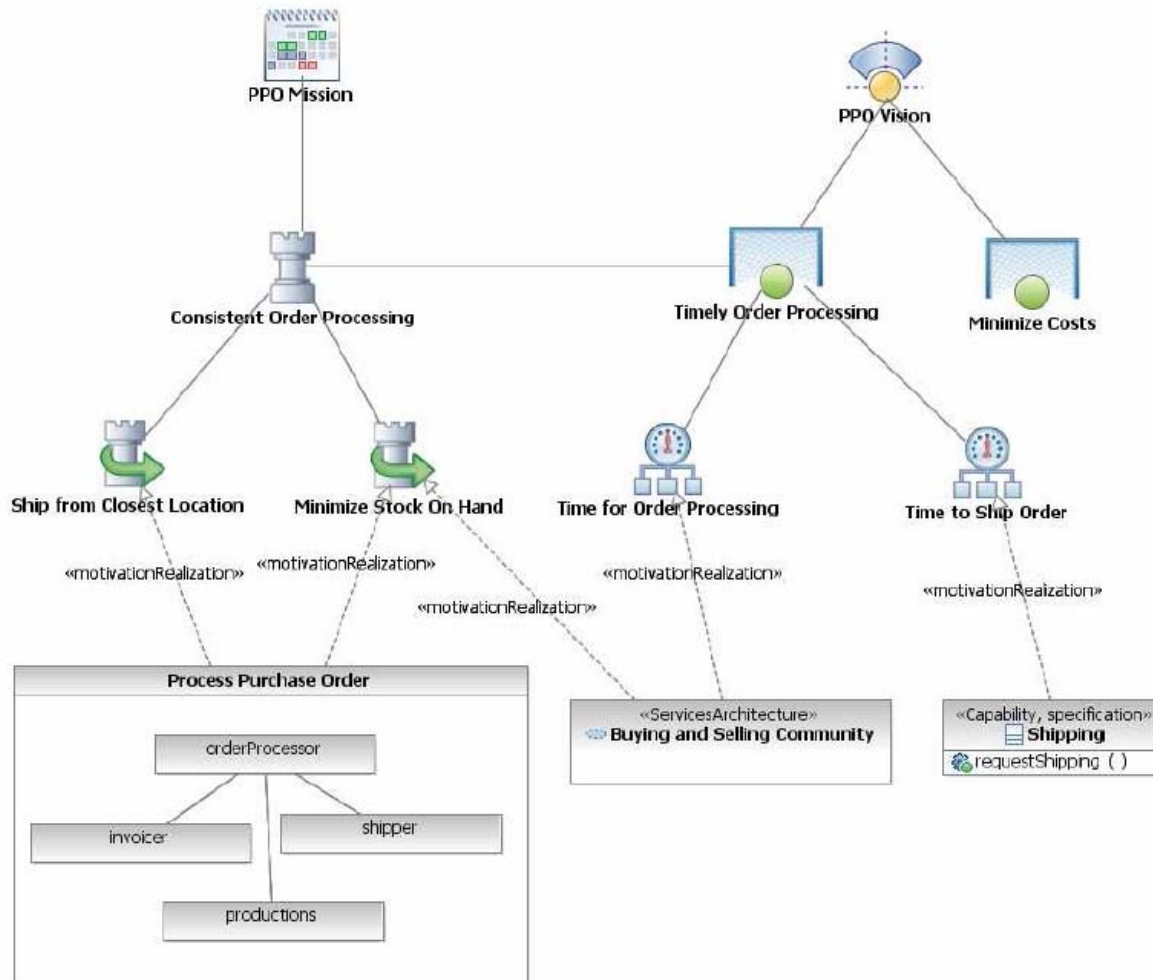
Goal alignment with BMM and service collaboration with SoaML

Figure on the left shows an example of a business motivation model that captures the following business requirements concerning the processing of purchase orders:

- Establish a common means of processing purchase orders.
- Ensure orders are processed in a timely manner, and deliver the required goods.
- Help minimize stock on hand.
- Minimize production and shipping costs

This example of a BMM model shows the business vision, the goals that amplify that vision, and the objectives that quantify the goals. It also shows the business mission, the strategies that are part of the mission plan, and the tactics that implement the strategies. Finally the strategies are tied to the goals they support.

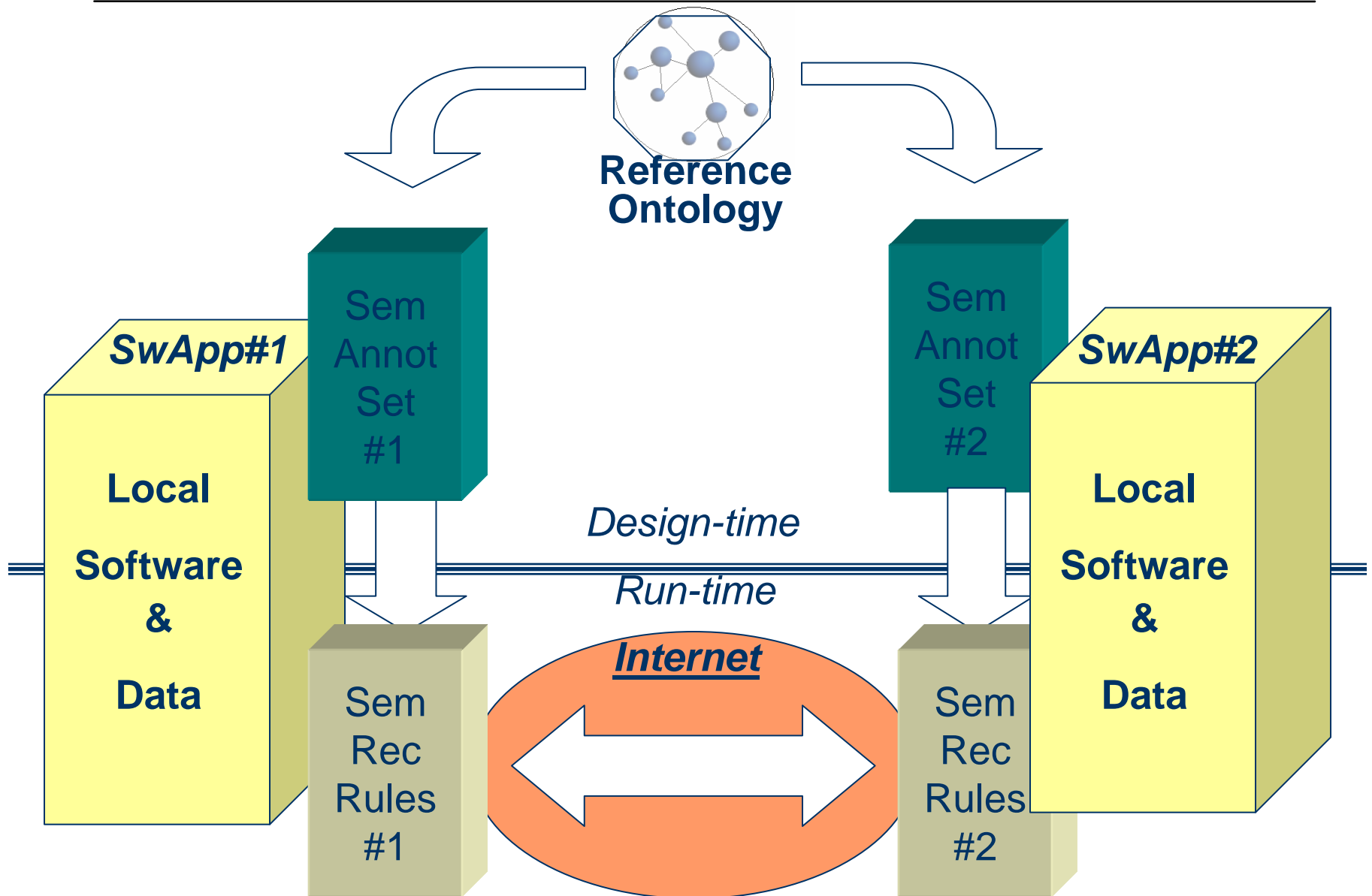
The example also shows a Process Purchase Order contract that formalizes the requirements into specific roles, responsibilities, and interactions. The Contract indicates what motivation elements it realizes through MeansRealizations.

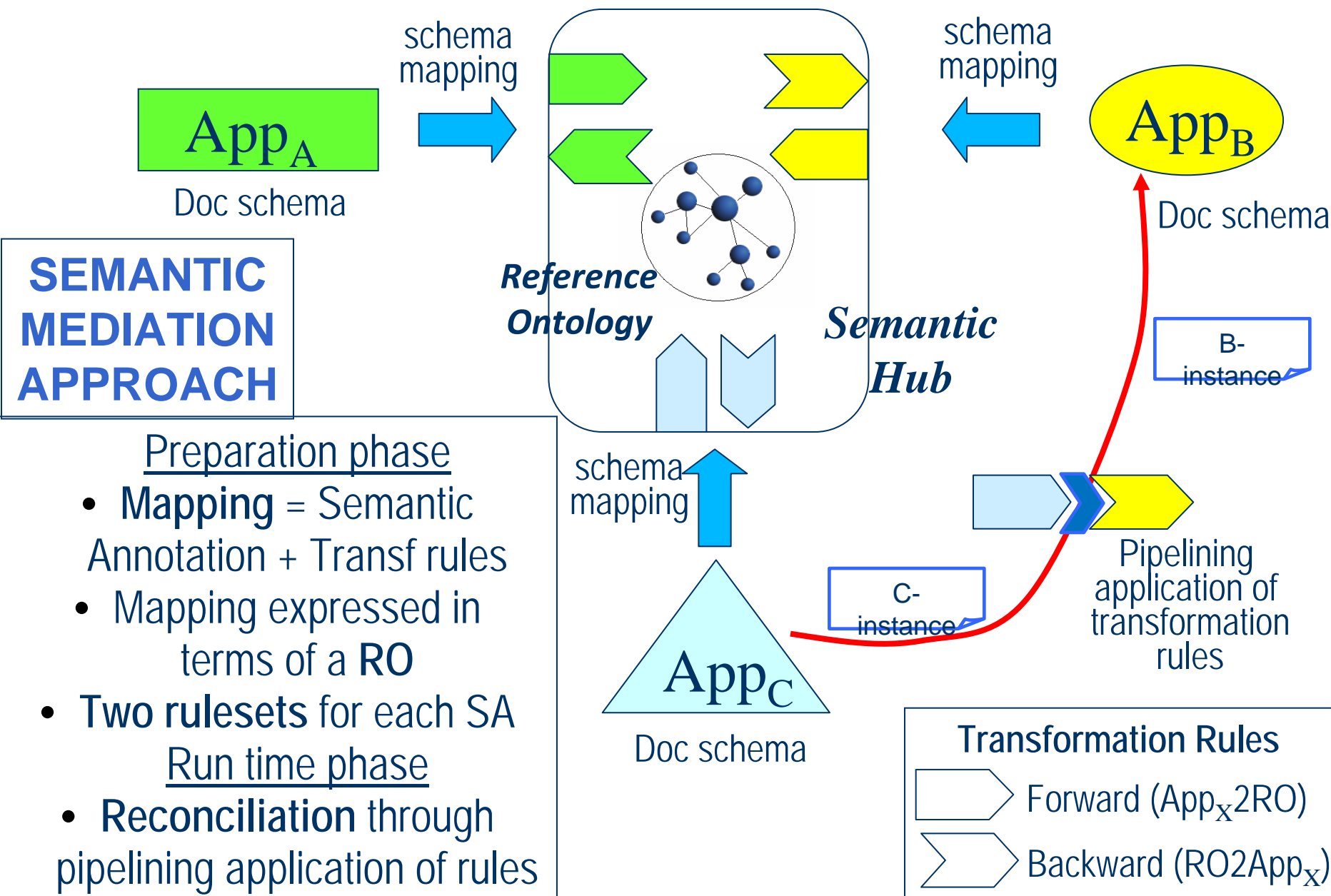


SAWSDL - Semantic Annotations for WSDL and XML Schema

- W3C Recommendation, August 2007
- This specification defines a set of extension attributes for the Web Services Description Language and XML Schema definition language that allows description of additional semantics of WSDL components. The specification defines how such semantic annotation is accomplished using references to semantic models, e.g. ontologies
- 3 constructs: `modelReference`, `liftingSchemaMapping`, `loweringSchemaMapping`

Architecture for semantic annotation and reconciliation





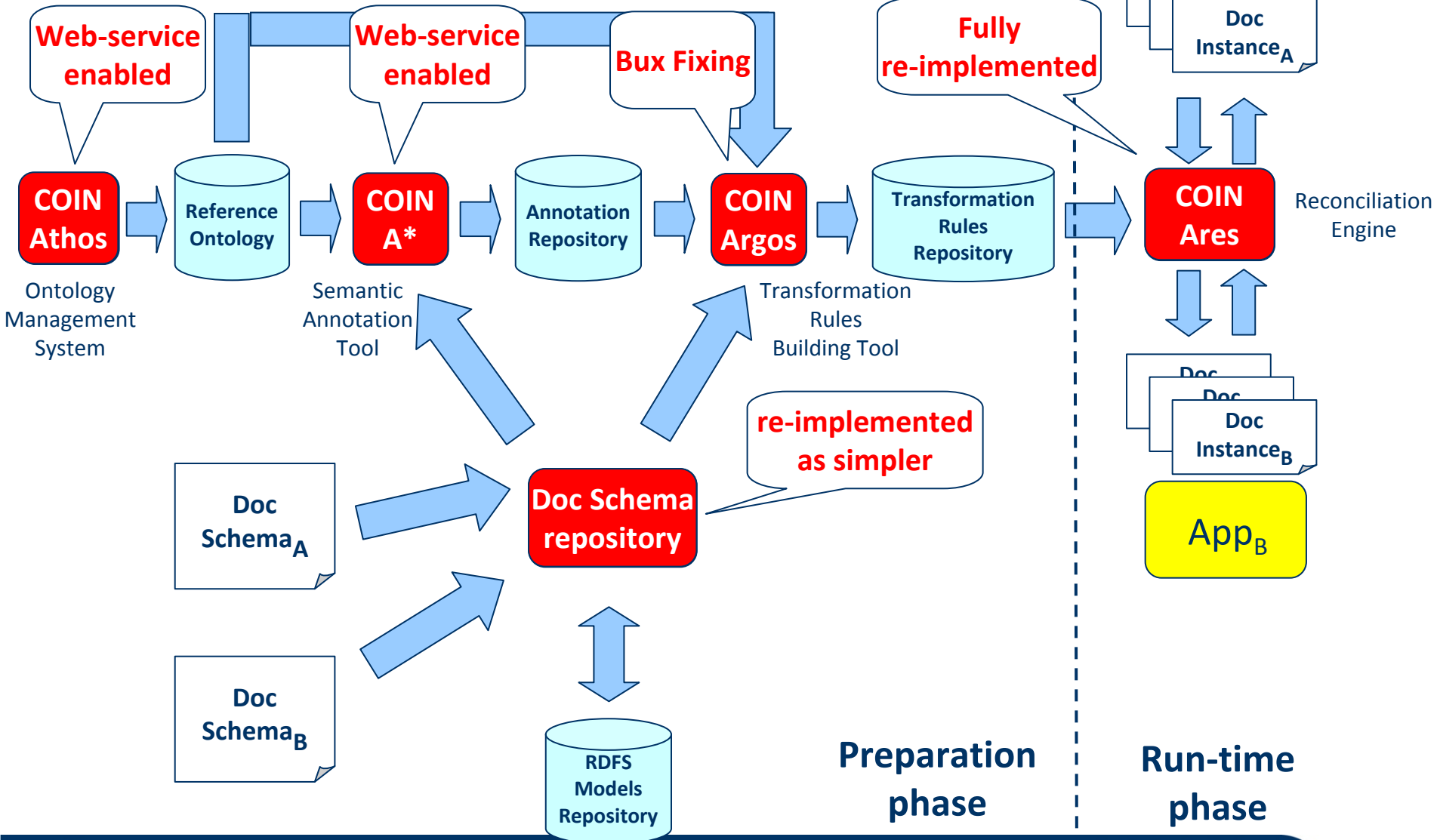
SEMANTIC MEDIATION APPROACH

- Preparation phase
- **Mapping** = Semantic Annotation + Transf rules
 - Mapping expressed in terms of a **RO**
 - **Two rulesets** for each SA
- Run time phase
- **Reconciliation** through pipelining application of rules

Transformation Rules

 Forward (App_x2RO)
 Backward (RO2App_x)

Semantic Reconciliation Suite: from Athena to COIN



Example of Mismatch

EnterprA (Buyer)

EnterprB (Supplier)

Purchase Order

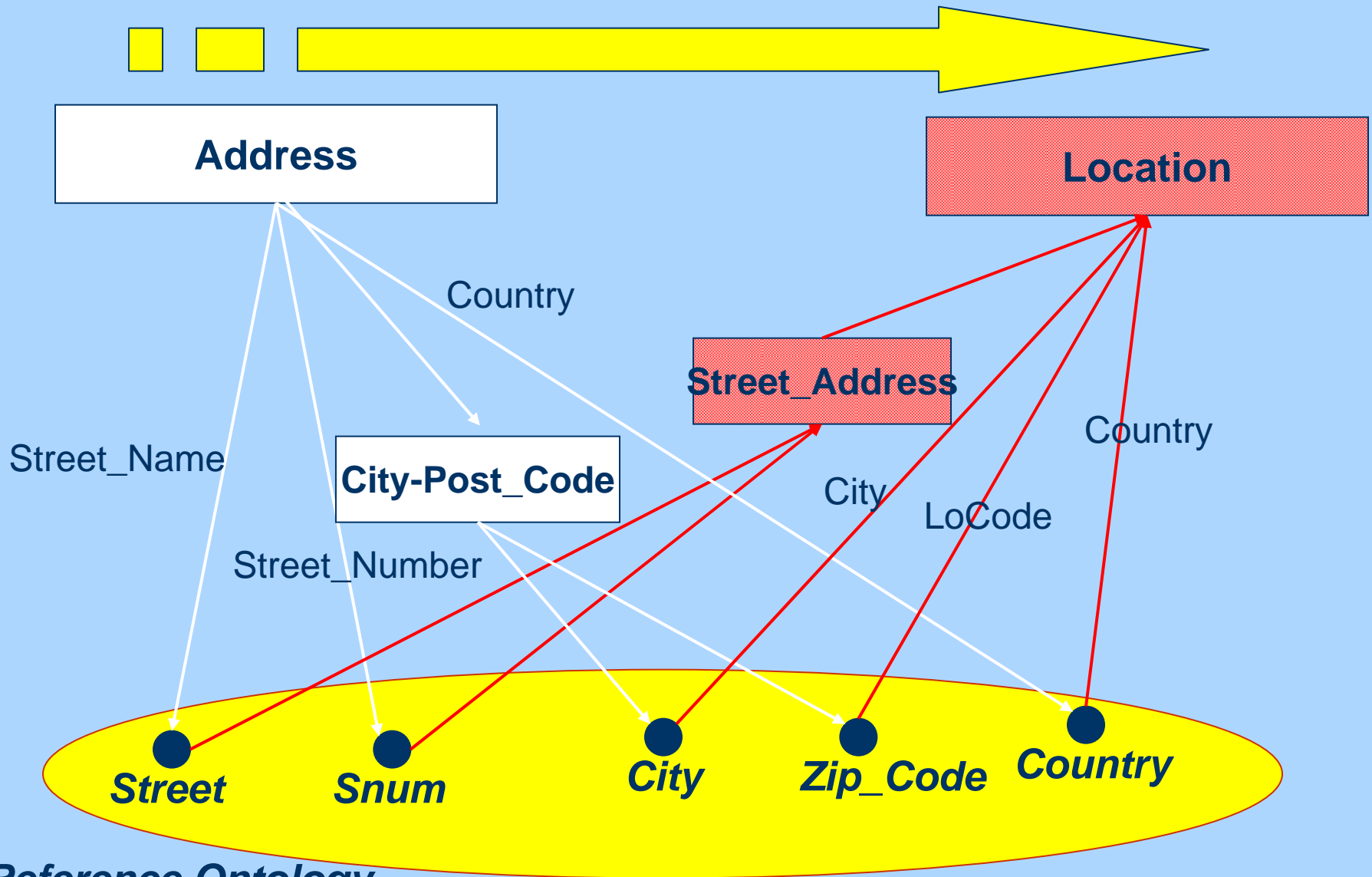
- Order_Number
- Order_Date
- Buyer_Info
 - Name
 - Address
 - Street_Name
 - Street_Num
 - City_Post_Code
 - Country
 - Telephone
- Products_Info
 - Product_Code
 - Description
 - Quantity
 - Price (unitary)
- Currency (Dollar, Euro, Pound)
- Charge
- RequestedDeliveryDate

Sale Order

- Date
- Organization_Name
- Contact_Person
- Location
 - Street_Address
 - City
 - LoCode
 - Country
- Phone_Number
 - Area_Code
 - Number
 - Ext
- Client_Order_Number
- Order_Lines
 - Product_Code
 - Description
 - Quantity
 - Price (total per line)
- Currency (USD, Euro, Yen)
- Total

■ Structuring

Ontology-based Reconciliation Approach



Reference Ontology

Semantic annotations

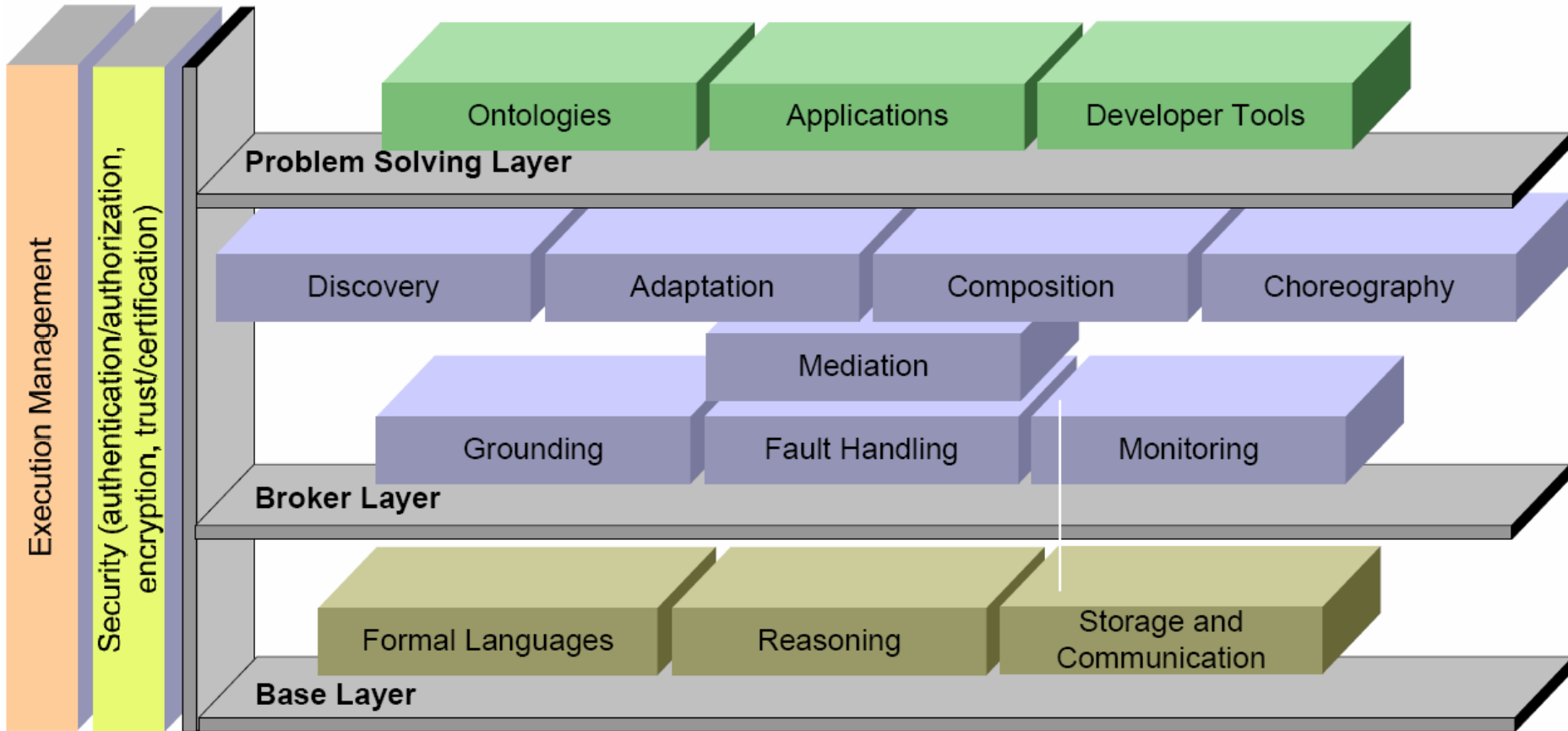
Local Schema (XML Schema)

```
...  
<xsd:element name="Address">  
  <xsd:complexType>  
    <xsd:sequence>  
      <xsd:element name="Street Name"  
        type="xsd:string"/>  
      <xsd:element  
        name="Street_Number"  
        type="xsd:positiveInteger"/>  
      <xsd:element name="City-  
        Post_Code" type="xsd:string"/>  
      <xsd:element name="Country"  
        type="xsd:string">  
    </xsd:sequence>  
  </xsd:complexType>  
</xsd:element>  
...
```

Reference Ontology (OWL)

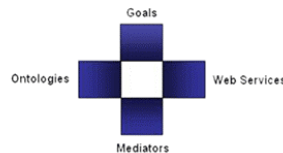
```
...  
<owl:Class rdf:ID="Address"/>  
<owl:DatatypeProperty rdf:ID="Street">  
  <rdfs:domain rdf:resource="Address"/>  
  <rdfs:range rdf:resource="&xsd:string"/>  
</owl:DatatypeProperty>  
<owl:DatatypeProperty rdf:ID="Snum">  
  <rdfs:domain rdf:resource="Address"/>  
  <rdfs:range rdf:resource="&xsd:positiveInteger"/>  
</owl:DatatypeProperty>  
<owl:DatatypeProperty rdf:ID="City">  
  <rdfs:domain rdf:resource="Address"/>  
  <rdfs:range rdf:resource="&xsd:string"/>  
</owl:DatatypeProperty>  
<owl:DatatypeProperty rdf:ID="Zip_Code">  
  <rdfs:domain rdf:resource="Address"/>  
  <rdfs:range rdf:resource="&xsd:string"/>  
</owl:DatatypeProperty>  
<owl:DatatypeProperty rdf:ID="Country">  
  <rdfs:domain rdf:resource="Address"/>  
  <rdfs:range rdf:resource="&xsd:string"/>  
</owl:DatatypeProperty>
```

COIN Metal: Baseline – Semantic SOA



WSMO/WSML

Provide the formally specified terminology of the information used by all other components



Semantic description of Web Services:
 - Capability (*functional*)
 - Interfaces (*usage*)

Connectors between components with mediation facilities for handling heterogeneities



Research Institute for Information Technology

Service oriented architecture Modeling Language (SoaML) - Specification for the UML Profile and Metamodel for Services (UPMS)

Revised Submission

OMG document: ad/2008-08-04

Submitters

Adaptive
Capgemini
EDS
Fujitsu
Fundacion European Software Institute
Hewlett-Packard
International Business Machines
MEGA International
Model Driven Solutions
Rhysome
Softeam

Supporters

BAE Systems
STI/University of Innsbruck
DFKI
Everware-CBDi
France Telecom R&D
General Services Administration
Visumpoint
MID GmbH
NKUA - University of Athens
Oslo Software
SINTEF
THALES Group
University of Augsburg
Wilton Consulting Group

<http://www.omg.org/cgi-bin/doc?ad/08-11-01.pdf>

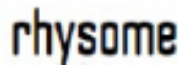
Revised submission per November 10th, 2008



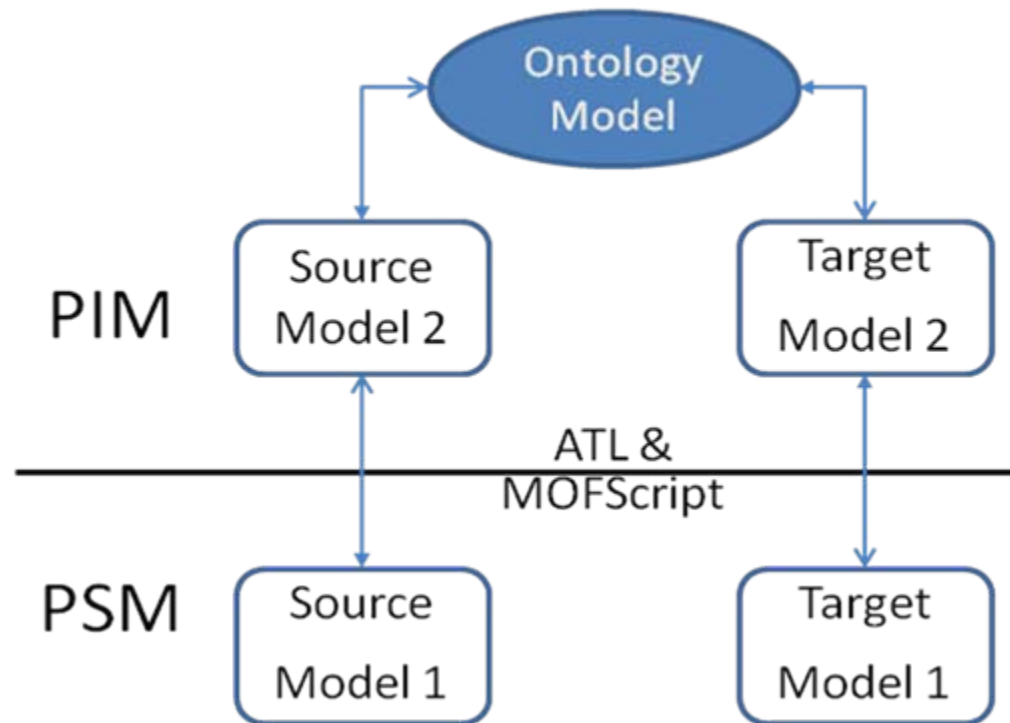
Primary Contact:

Arne J. Berre, SINTEF
email: Arne.J.Berre@sintef.no

See also: www.soaml.org



Platform independent annotations



“Address” in the source and target transformation rules

```
rule Address2OnAddress(  
  helper context Ontology!Address def totalAddress :String =  
    self.address.toString() + self.addressProvince.toString() + self.addressRegion.toString();  
  from  
    sc: ABW!AddressInfo (sc.oclIsTypeOf(ABW!AddressInfo))  
  to  
    t: Ontology!Address(  
      addressType <- sc.AddressType,  
      addressCountryCode <- sc.CountryCode,  
      addressPostCode <- sc.ZipCode,  
      addressRegion <- sc.Place,  
      addressSequenceNo <- sc.SequenceNo,  
      address <- sc.Address,  
      addressProvince <- sc.Province,  
      addressUpdateFlag <- sc.UpdateFlag,  
      contactName <- sc.ContactName,  
      contactPosition <- sc.ContactPosition,  
      hasPhones <- sc.Phone,  
      hasInternets <- sc.InternetInfo  
    )  
  )  
  lazy rule Address2ContactInfo(  
    from  
      a: Ontology!Address  
    to  
      t: CCS!ContactInfo(  
        Address <- a.totalAddress,  
        AddressType <- a.addressType,  
        Postcode <- a.addressPostCode,  
        Email <- thisModule.OneEmail,  
        Telephone <- thisModule.OnePhone  
      )  
    --do (thisModule.info <- t;)  
  )  
)
```

Create mapping rules from source to ontology, and ontology to target using ATL

Source to Ontology

Ontology to Target

“Address” transformations from source.xml and target.xmi

The image shows a side-by-side comparison of two XML files in a transformation tool. The left window, titled 'ABT.xml', shows the source XML with the following structure:

```
<PayMethod>DD</PayMethod>
<BankAccount>13101010958</BankAccount>
<Swift>45</Swift>
<ClearingCode>123</ClearingCode>
<IntruleId>IK1</IntruleId>
<Status>N</Status>
</PaymentInfo>
</SupplierCustomer>
<AddressInfo>
  <UpdateFlag>0</UpdateFlag>
  <AddressType>1</AddressType>
  <ContactName>CS15 kontakt person</ContactName>
  <ContactPosition>CS15</ContactPosition>
  <Address>CS15 address</Address>
  <Place>CS15 place</Place>
  <Province>CS15 Province</Province>
  <ZipCode>CS15 ZipCode</ZipCode>
  <CountryCode>GB</CountryCode>
  <SequenceNo>0</SequenceNo>
</AddressInfo>
</SupplierCustomer>
</PaymentInfo>
</ABT>
```

The right window, titled 'CCS_A.xmi', shows the target XML with the following structure:

```
version="1.0" encoding="ISO-8859-1"
xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://www.
ount xsi:type="ContactInfo" Address="CS15 addressCS15 ProvinceCS15 place" Ad
nal>jon.blund@osserga.on</Email>
Telephone>11151515</Telephone>
Telephone>22151515</Telephone>
Telephone>33151515</Telephone>
Telephone>44151515</Telephone>
Currency>GBP</Currency>
AccountType>C</AccountT
Language>EN</Language>
Block>N</Block>
PaymentMethod>DD</PaymentMethod>
ContactInfo
ountFile>
```

Annotations in the image include:

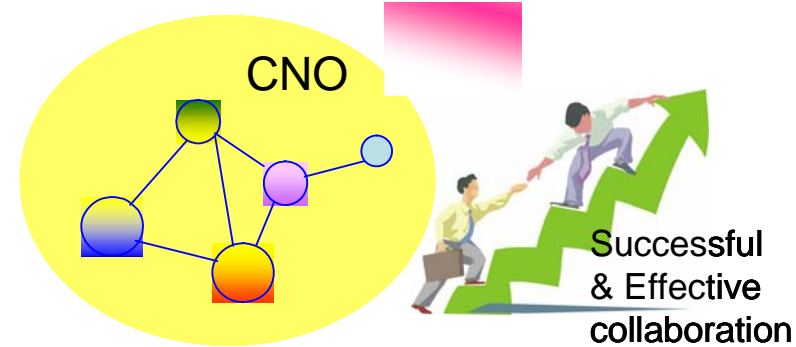
- A red circle around the source element: `<Place>CS15 place</Place>`
- A red circle around the target element: `Address="CS15 addressCS15 ProvinceCS15 place"`
- A red box containing the transformation rule: `addressRegion="CS15 place" address="CS15 address" addressProvince="CS15 Province"`
- A blue callout box with the text: "Transform source into ontology and ontology into target"

COIN Side B: state-of-the-art



Short window
of opportunity

Fast configuration of
a temporary
consortium well suited
to the needs



Preparedness

Breeding
Environments { VBE
PVC

Management
/ Governance

CNO creation

Metamorphosis

© The ECOLEAD Integrated Project



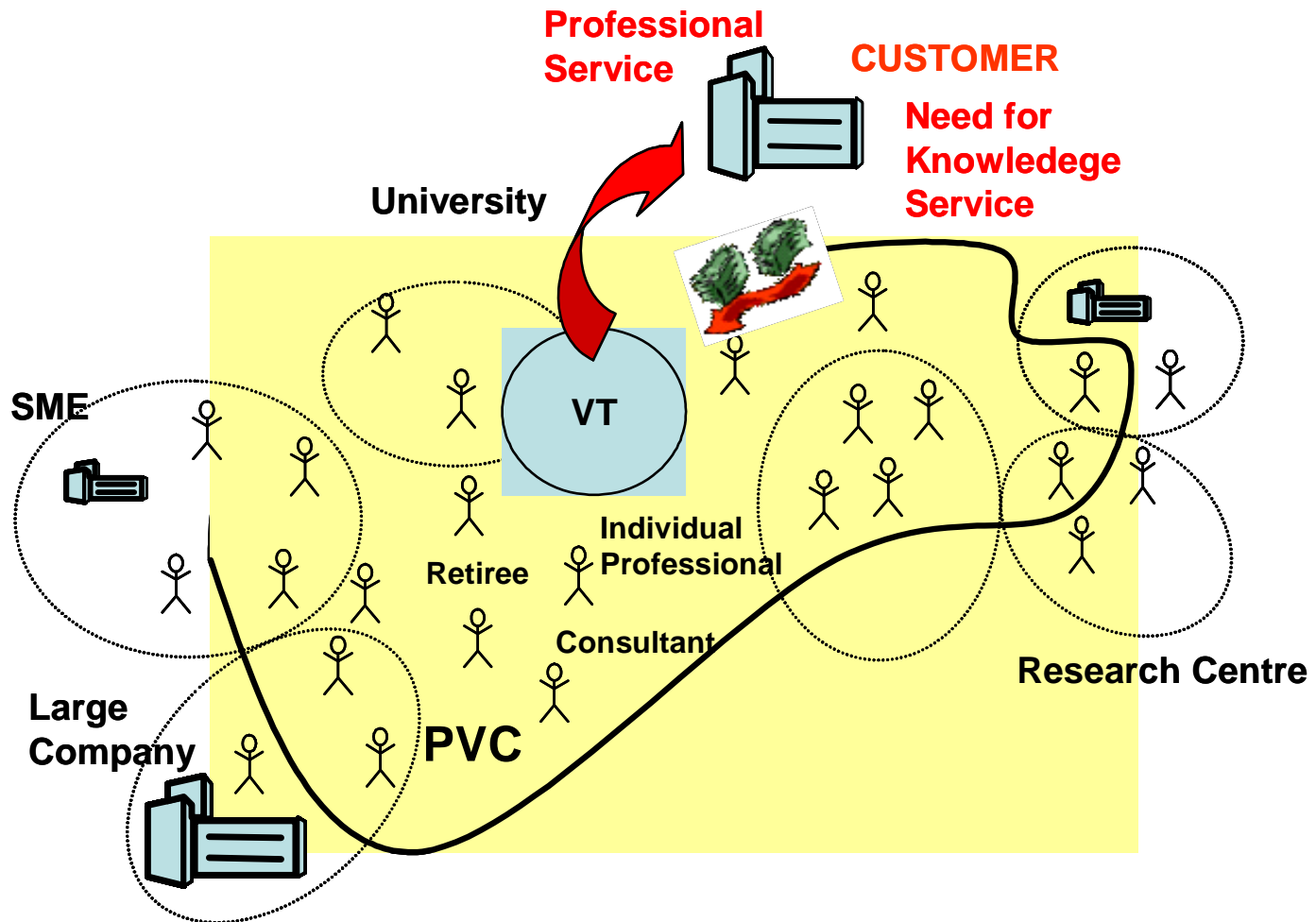
COIN Side B: main innovations

• The COIN Collaboration Space

- To allow **Endogenous** generation of Business Opportunities (LivingLabs & Open Innovation)
 - To support **Product Design, Production Planning, Project Mgmt**
- To enable **Co-operativity** of Enterprise Applications (groups as users)
 - To support **Web 2.0** and participative services (Enterprise 2.0)
 - To involve also the Customers in the whole life-cycle of **Virtual Organizations (VOs)**:
 - ✓ **VO preparation** (get the enterprises prepared to form VOs)
 - ✓ **VO creation** (select partners and competencies)
 - ✓ **VO operations & mgmt** (performance indicators definition-governance)
 - ✓ **VO dissolution** (inheritance and knowledge transfer)

COIN Side B: future outlook

- The Innovation Knowledge Ecosystem



Summary

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