Semantic Web Services: Application Areas

John Domingue
Knowledge Media Institute,
The Open University,
UK

Contents

- Emergency planning
  - eGovernment use case within the DIP project
- Applying semantic Web services to business process modelling in the Super project
- Applying semantic Web services to eLearning in the Luisa project

DIP

Data, Information and Process Integration with Semantic Web Services

- 3 Year 17M Euro project
  - Finished end of 2006
  - Involved 21 partners
- Focus on Semantic Web Services
- One (of 3) use case was on eGovernment

DIP Consortium

- Research partners

- Industry partners

- Use case partners

Supporting Emergency Planning for Essex County Council

Essex County Council

- A large local authority in South East England
- Comprised of 13 boroughs
- Population of 1.3M.

Emergency Planning Context

News Front Page
World
UK
England
N Ireland
Scotland
Wales
Politics
Business
Entertainment
Science/Nature
Technology
Health
Education

Talking Point

Country Profiles
In Depth

Friday, 31 January, 2003, 10:27 GMT

'My 20-hour battle through the snow'

Motorists have been stuck in lengthy jams

While motorists across Britain have been struggling in to work along icy roads, few have suffered as much as those stuck on the M11 in Cambridgeshire.

Adam Harley, who pulled on to

WATCH/LISTEN
REAL MEDIA
ON THIS STORY

The BBC's Samantha Simmonds "Hundreds of passengers are still stranded at Heathrow and Gatwick airports"

Jonathan Smith, E. Midlands Electricity "We've 30,000 customers without electricity"

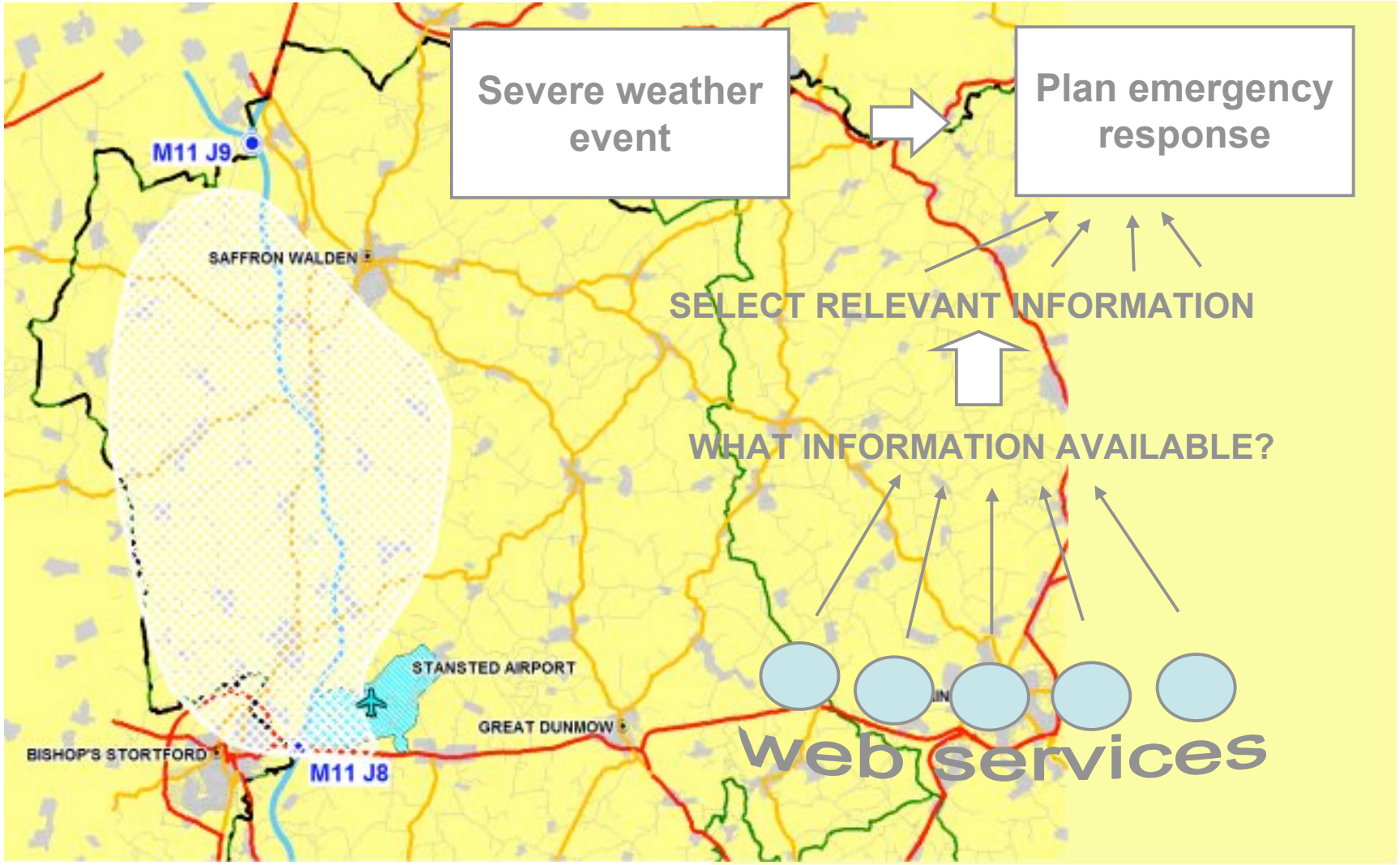
Rebecca Rees, AA "People have spent the whole night in their cars"

TALKING POINT

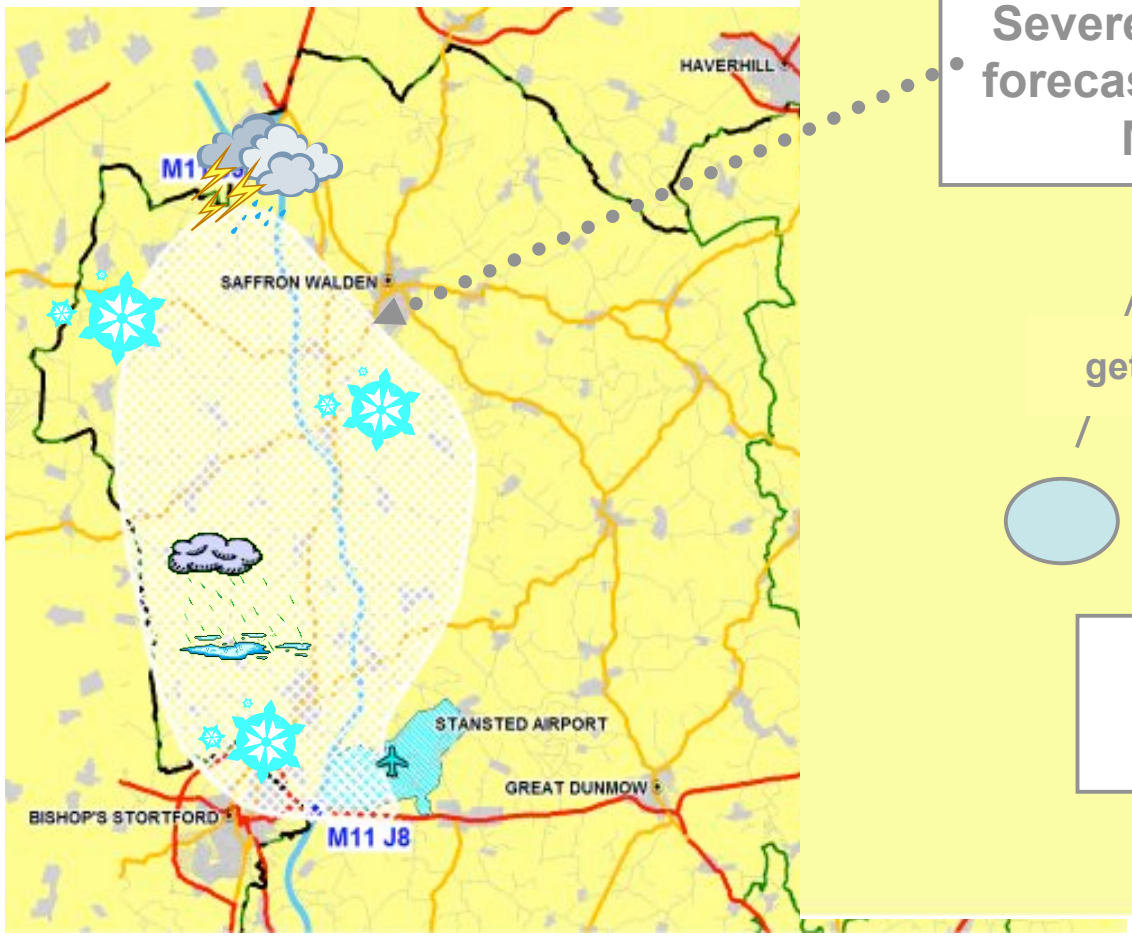
Snow storm

Your

Emergency planning scenario



Emergency planning scenario

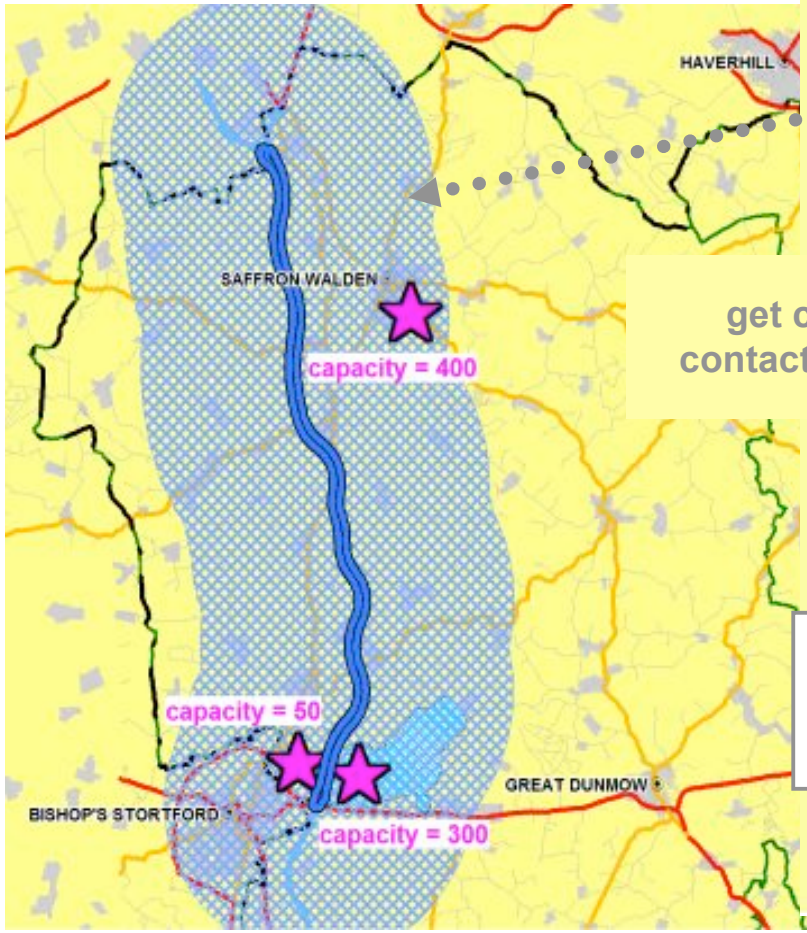


Severe weather event forecast in the area by Met Office

get event details

Met Office

Emergency planning scenario



Identify most appropriate rest centres

get centre contact details

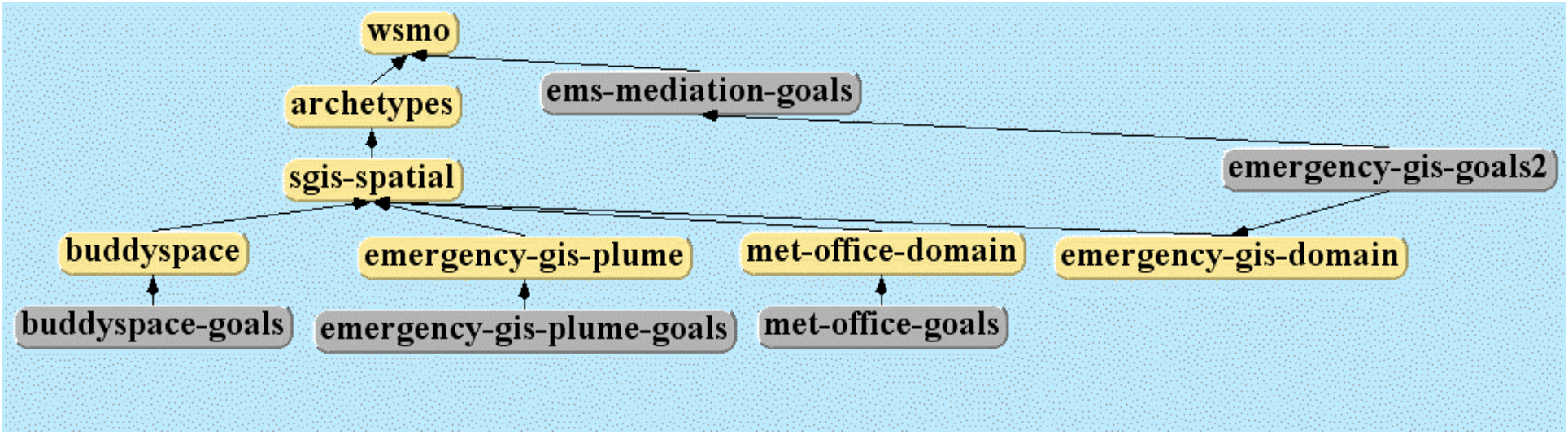
get facilities
kitchen, showers, number of beds, cookers, heaters…

get capacity

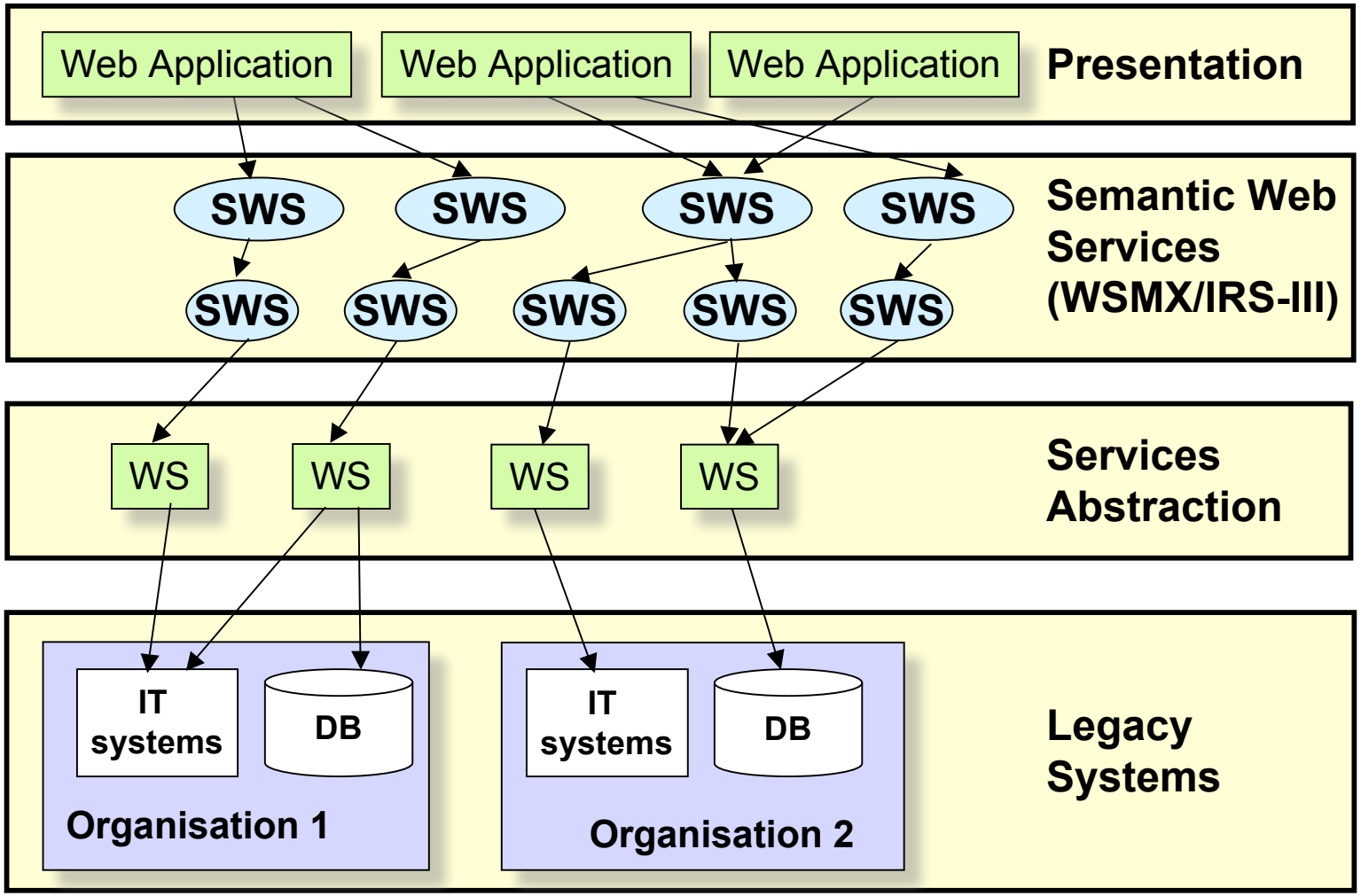
ViewEssex spatial data

District data

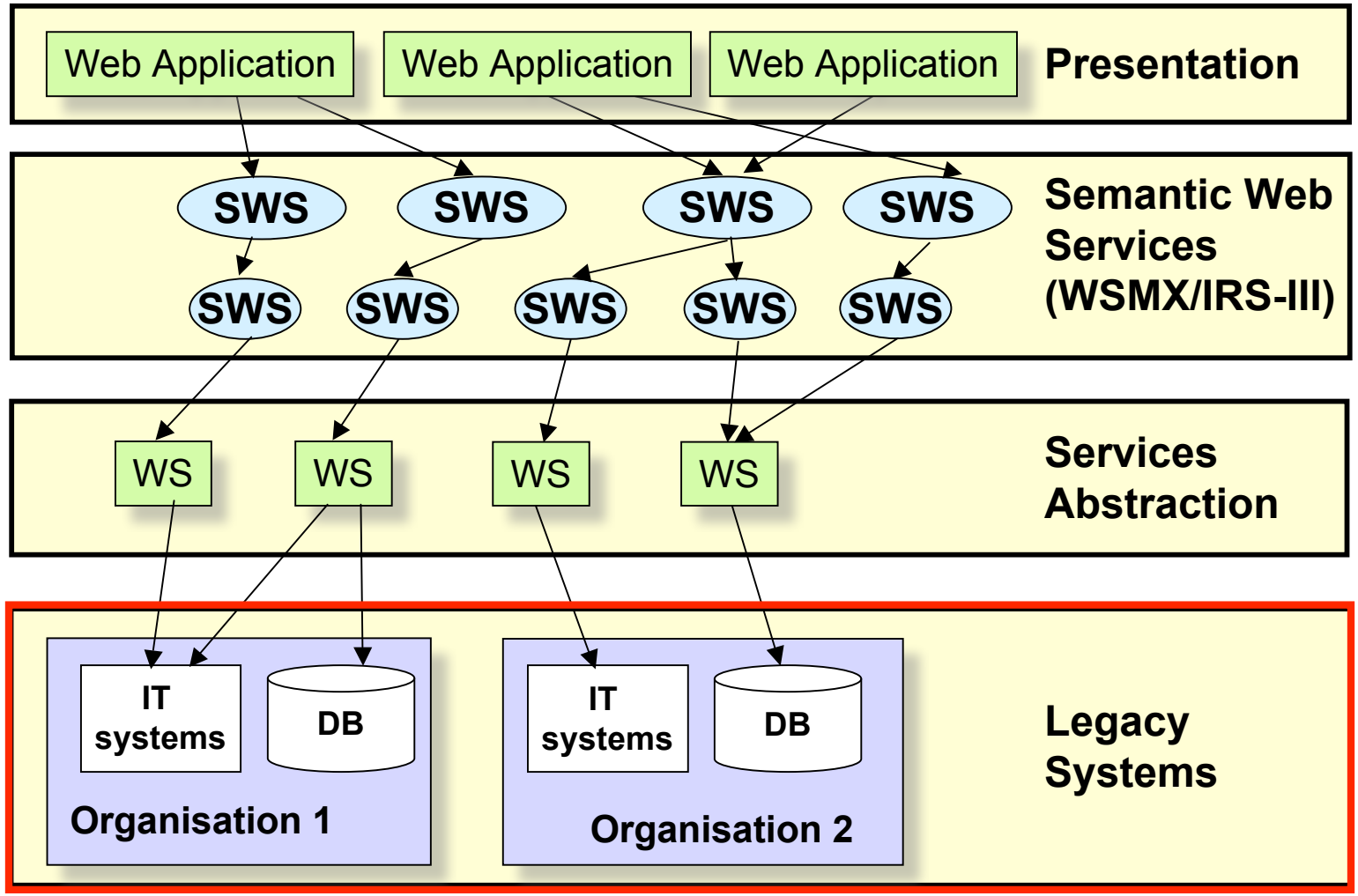
eMerges Ontologies



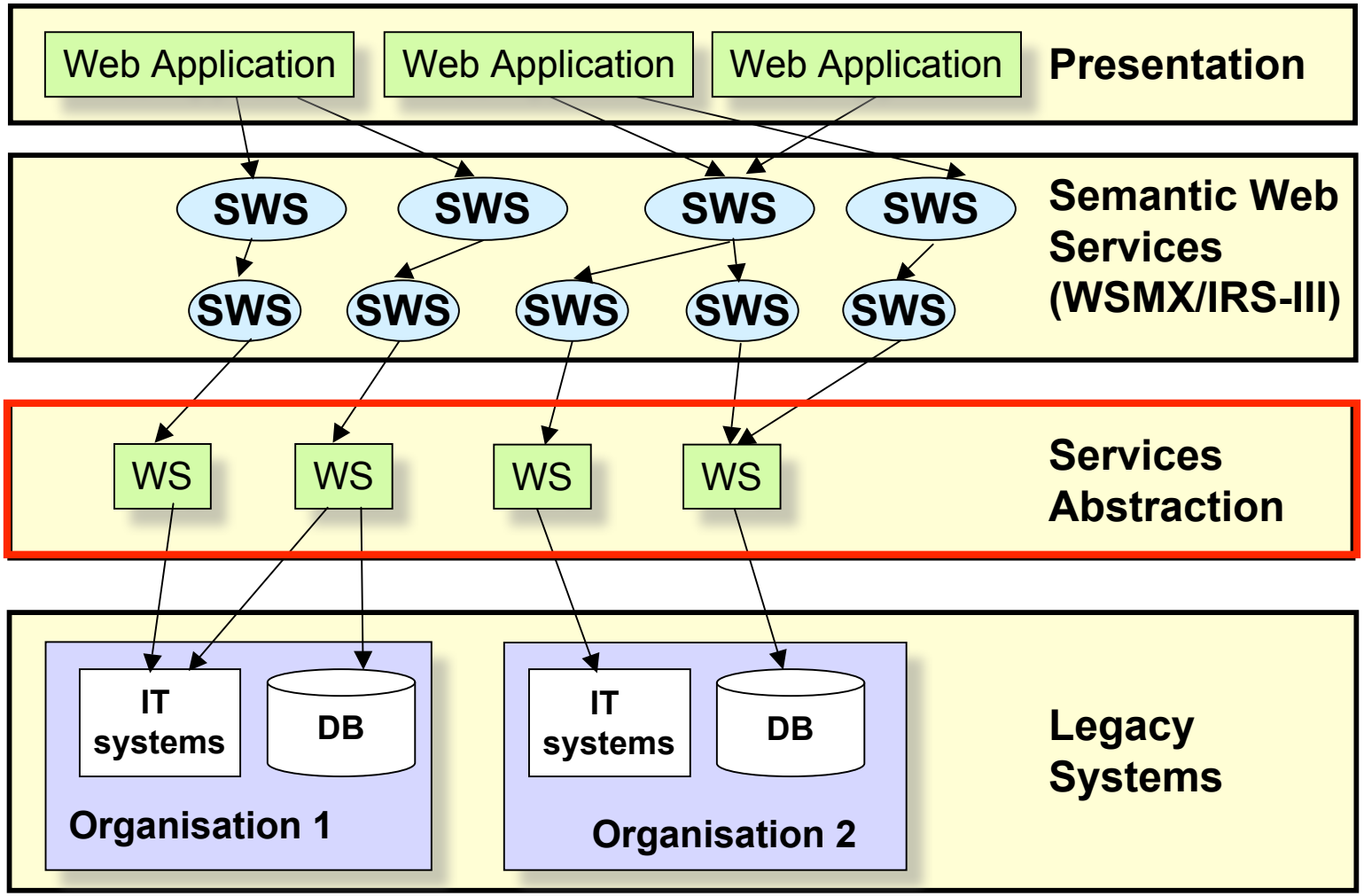
Generic Application Structure



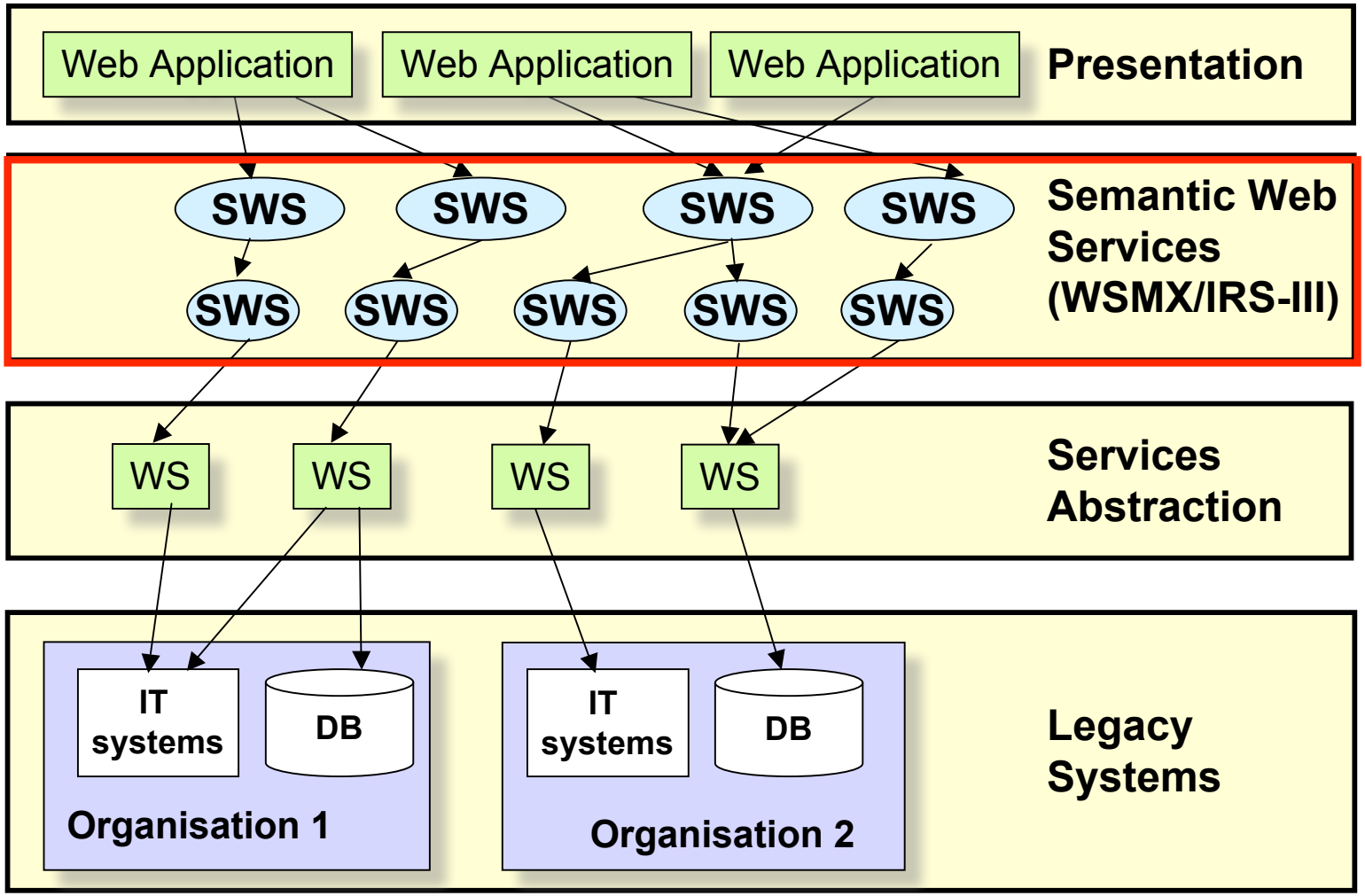
Generic Application Structure



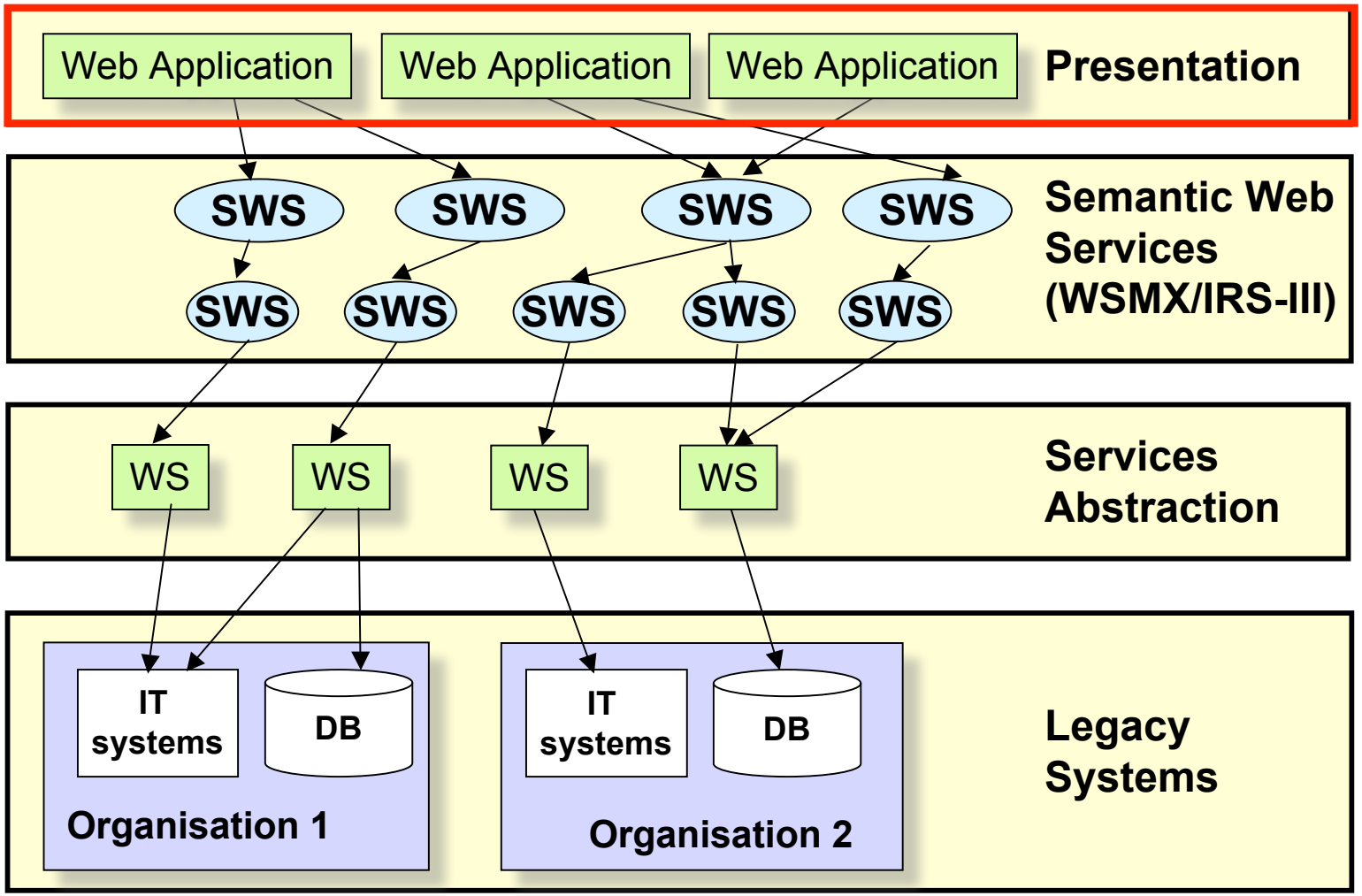
Generic Application Structure



Generic Application Structure

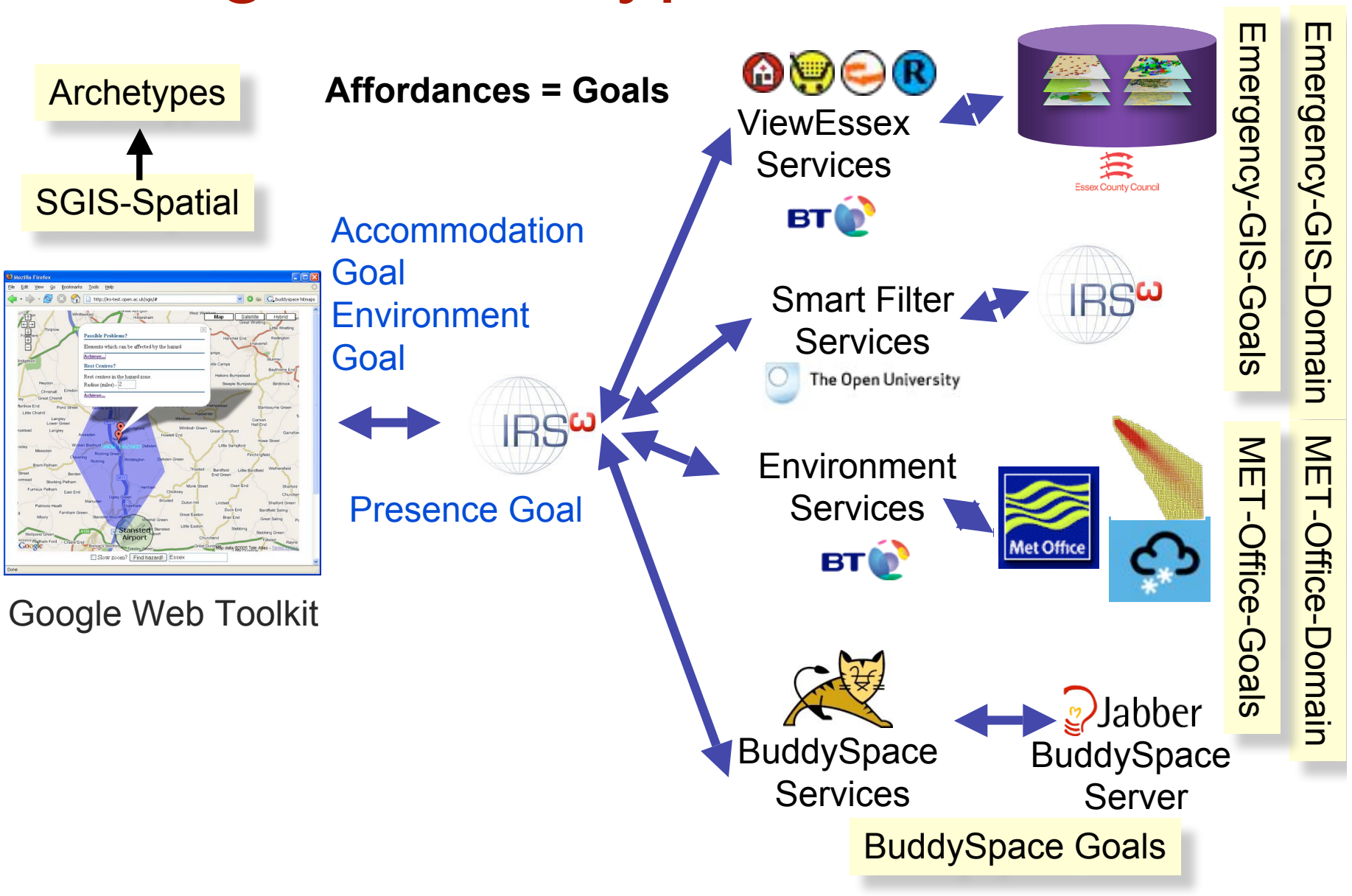


Generic Application Structure



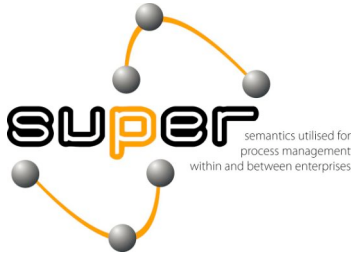
Demonstration of Emergency Planning (GIS) Prototype V1

EMerges Prototype Architecture



SWS and Business Process Modelling

Super Project



- Super is a 3-year 17M EU funded project
  - Started in April 2006
  - 19 partners

SUPER Consortium

Motivation

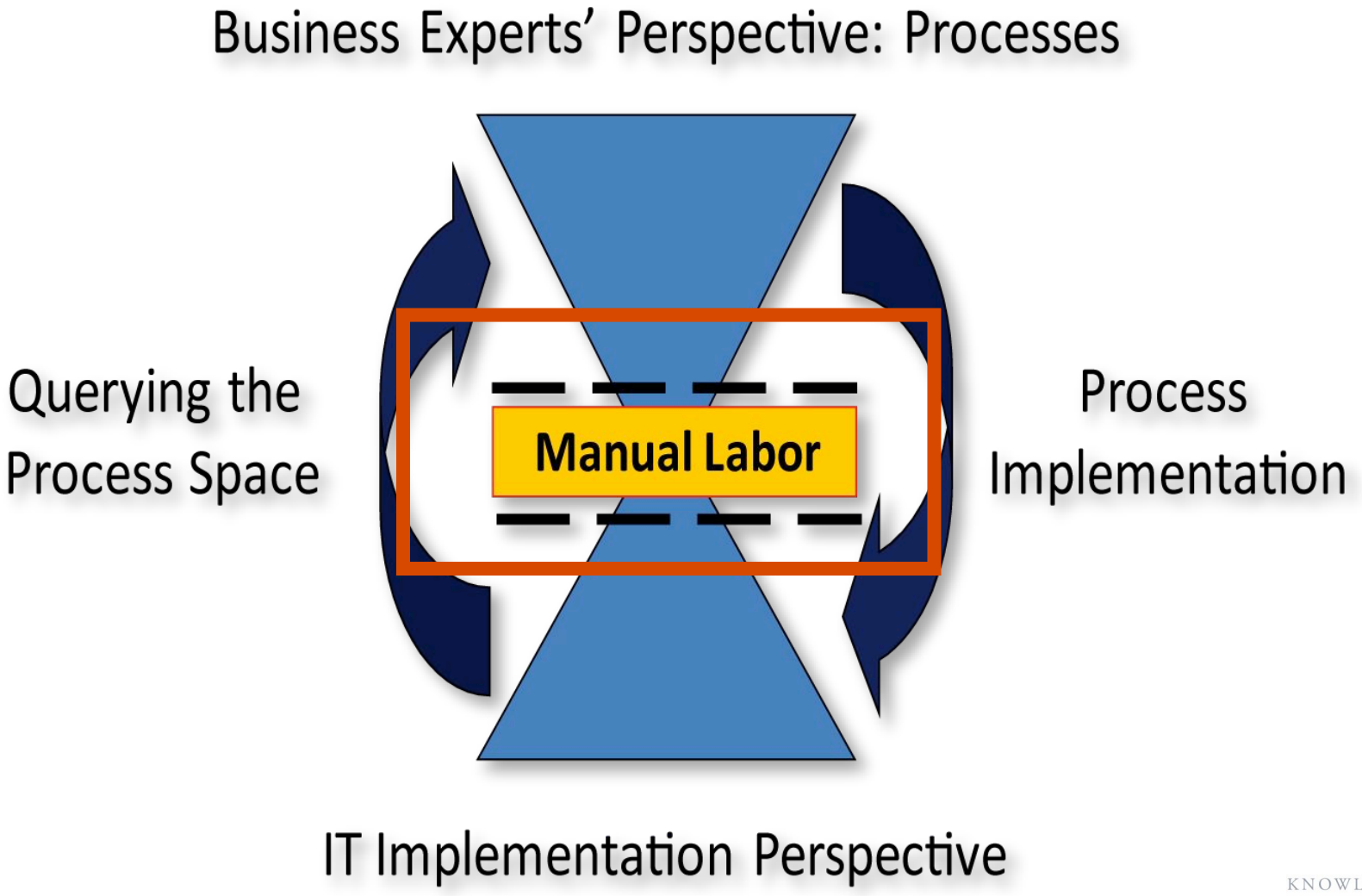
Querying the Process Space

"In which of our food manufacturing machines are we processing meat or raw eggs?"

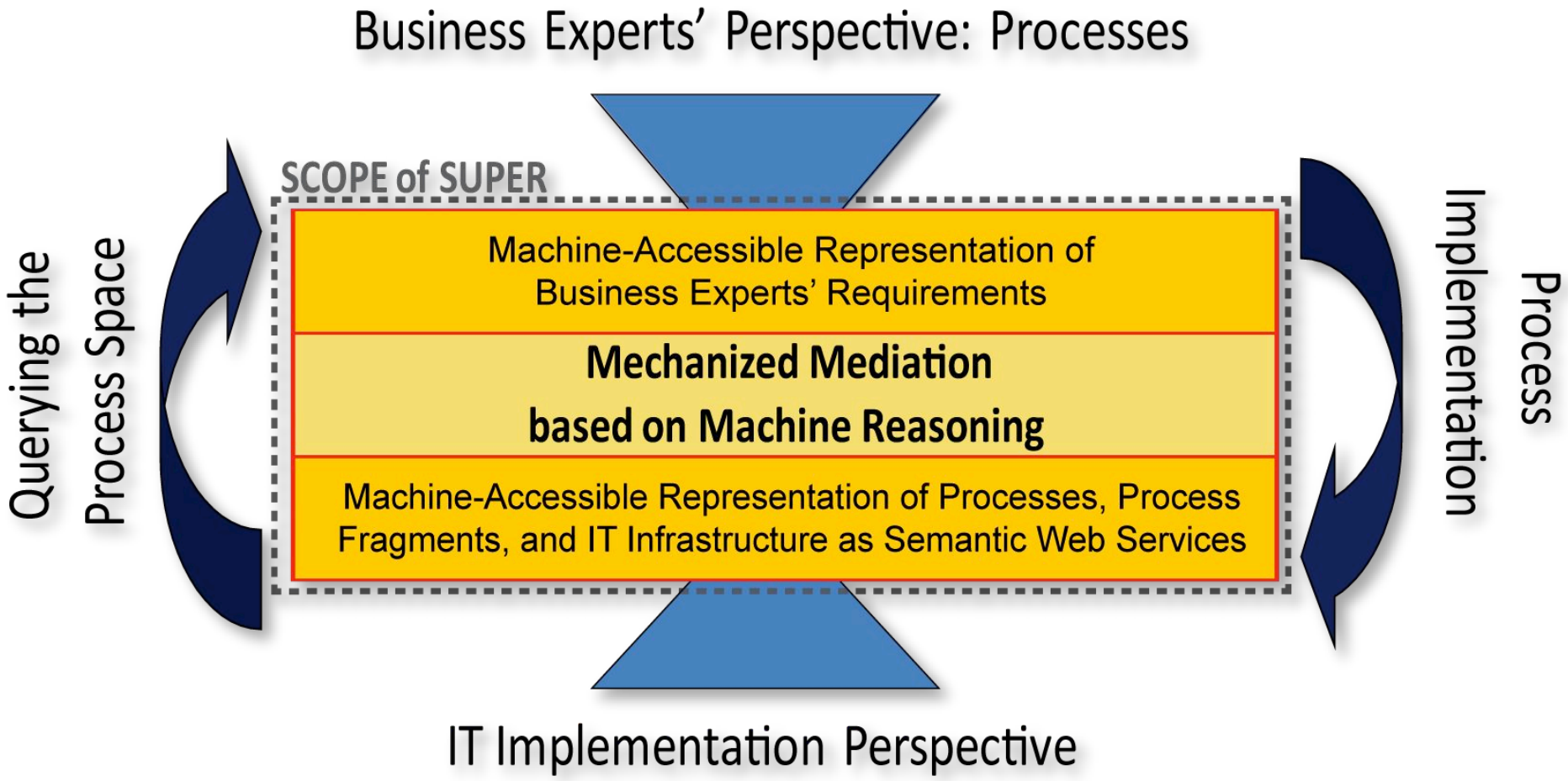
"Do we have a cost approval process for items below $ 200?"

"How many inventory management methods are currently in use?"

The Critical IT / Process Divide



The Critical IT / Process Divide



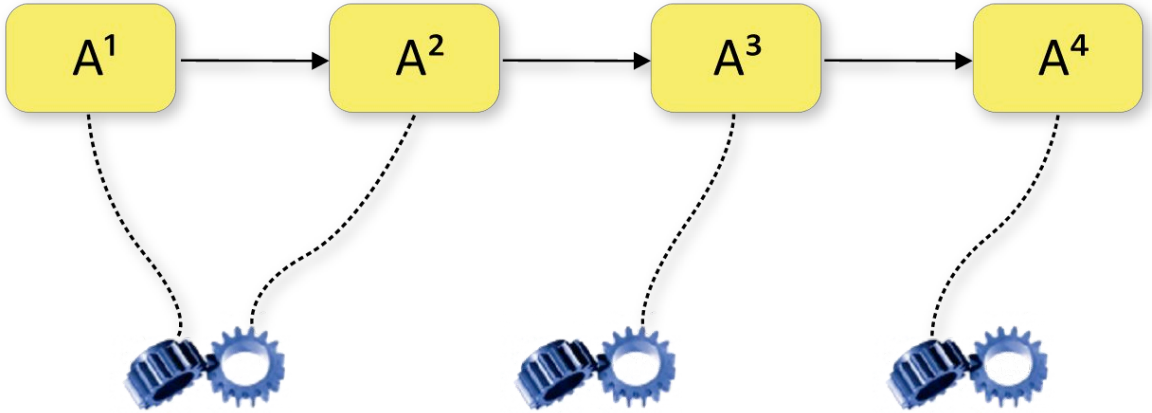
What Are My Services?

Here is my business process!
I think this solves my business problem nicely…

Nice try, but it won't run…
You need to specify the services that perform each step!

What Are My Services?

I don't understand about these technical details!
This is my view on the process…



o.k. no problem, I will help you…

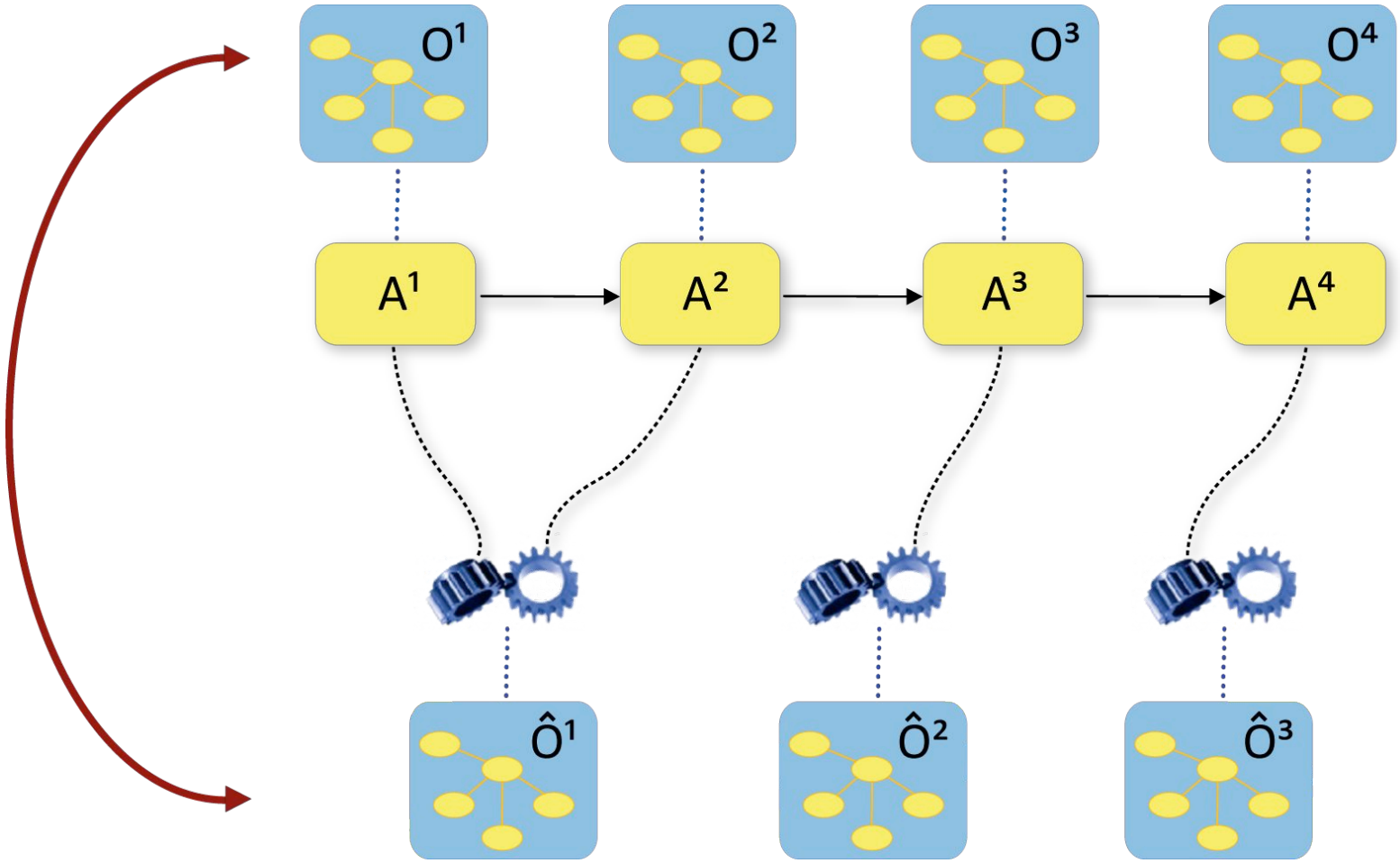
What are my services?

This is cumbersome!
Why do I always need IT staff
to solve my business problems?

It takes too long to get these folks,
they use different terminology than I do…

I am happy to describe what
the activities do in my terms.
Can the system be smart enough
and find the right services itself???

Matching Activities and Port Types Based on Semantics



Semantic Web Services

Supporting Business Users Better

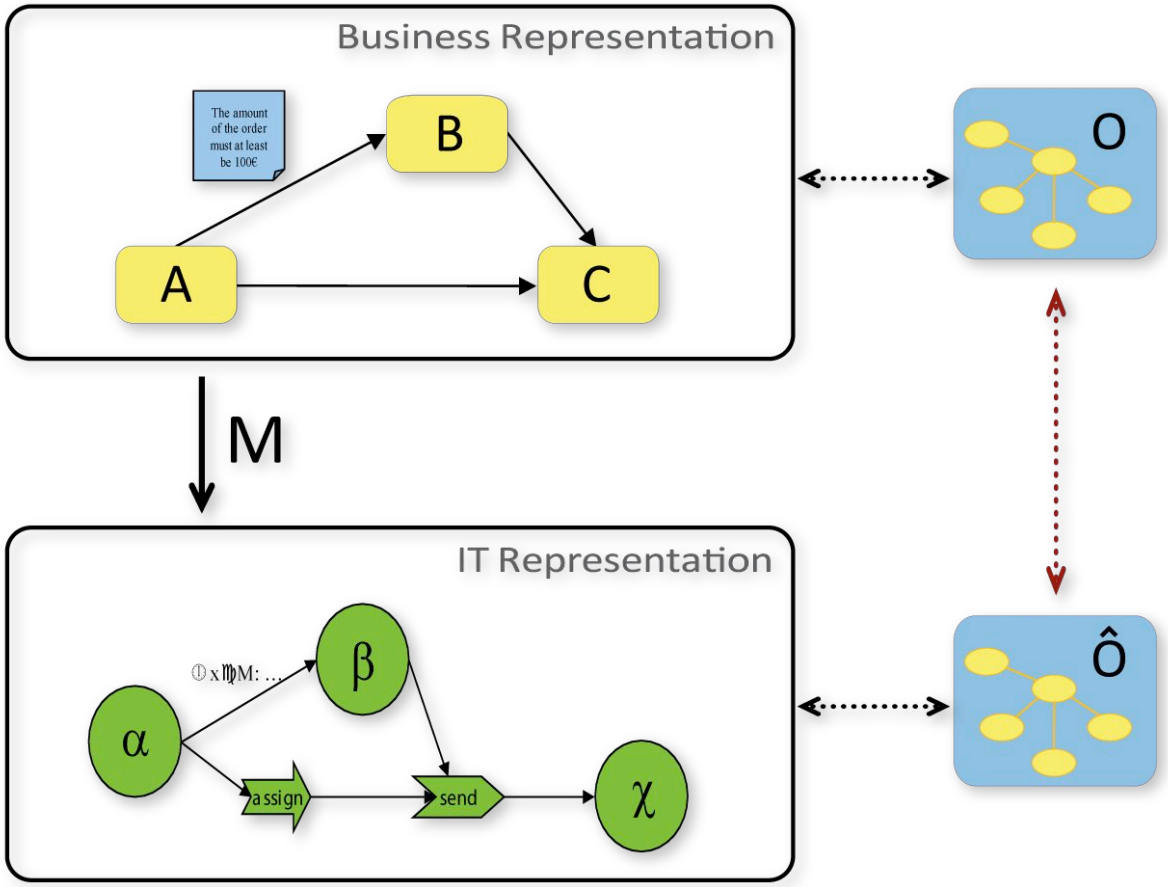
Why do I have to draw everything?

Why do I have to use “expressions” and that technical stuff at all?

Why isn’t my description sufficient?

Matching Model Representations & Semantics

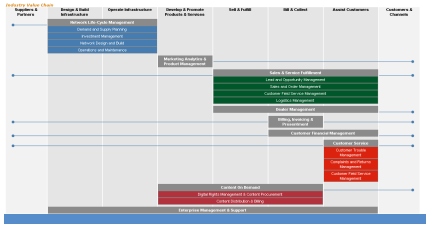
Here is my business process!



Wow! This is perfect – nothing left to do for me!

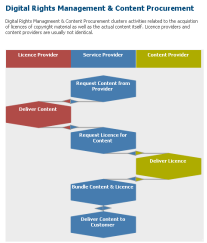
The SUPER Stack

Modelling Stack



- Making sense of a domain \problem
- Communication tool
- What is it all about ?

- Solution maps
- Mind maps
- Ad-hoc modelling techniques
- …

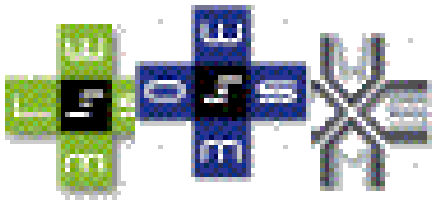


- Visualizing \specifying business process
- Focus : Business Problem
- Who does what , when , how and why ?
- Usually multiple layers

- Business Scenario Maps
- Event - driven process chains
- Flowchart techniques
- BPMN
- …

- Process execution specification
- Formal , clearly specified grammar
- Focus : Implementation
- Which component is called when , how, by whom with which data ?

- BPEL
- …



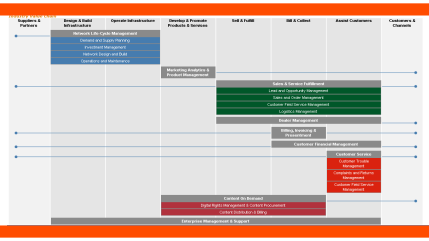
- Web service encapsulation
- Focus : Implementation
- Which components can and should be exposed how as services ?

- WS*
- …

- Implementation of components

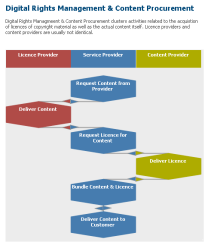
- Programming languages
- …

Modelling Stack



- Making sense of a domain \problem
- Communication tool
- What is it all about ?

- Solution maps
- Mind maps
- Ad-hoc modelling techniques
- …

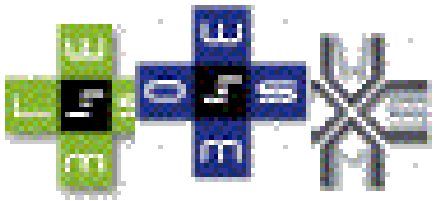


- Visualizing \specifying business process
- Focus : Business Problem
- Who does what , when , how and why ?
- Usually multiple layers

- Business Scenario Maps
- Event - driven process chains
- Flowchart techniques
- BPMN
- …

- Process execution specification
- Formal , clearly specified grammar
- Focus : Implementation
- Which component is called when , how, by whom with which data ?

- BPEL
- …



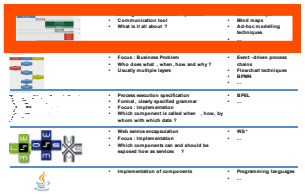
- Web service encapsulation
- Focus : Implementation
- Which components can and should be exposed how as services ?

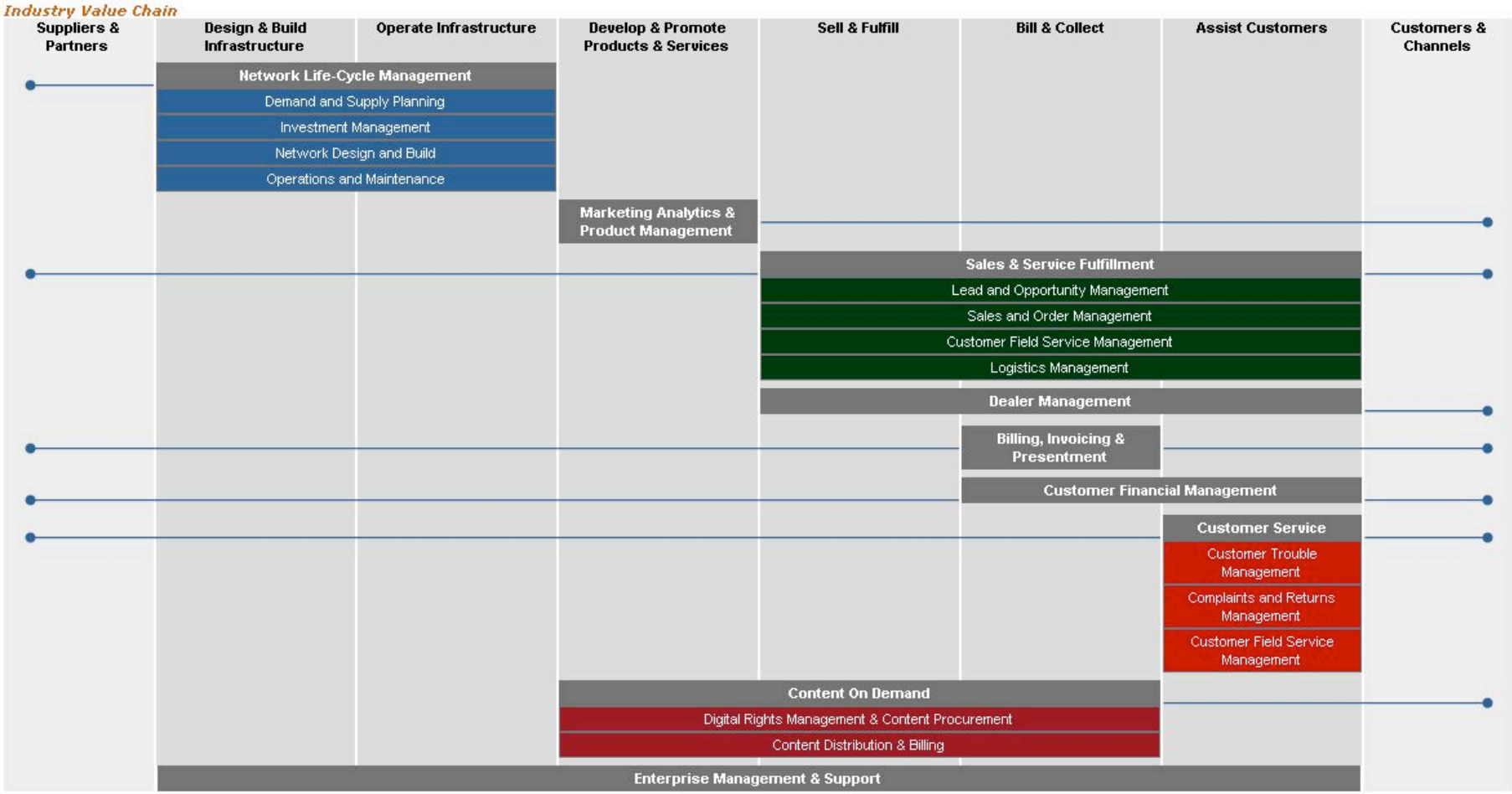
- WS*
- …

- Implementation of components

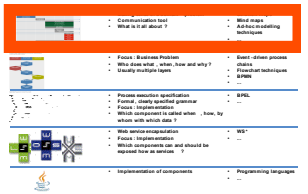
- Programming languages
- …

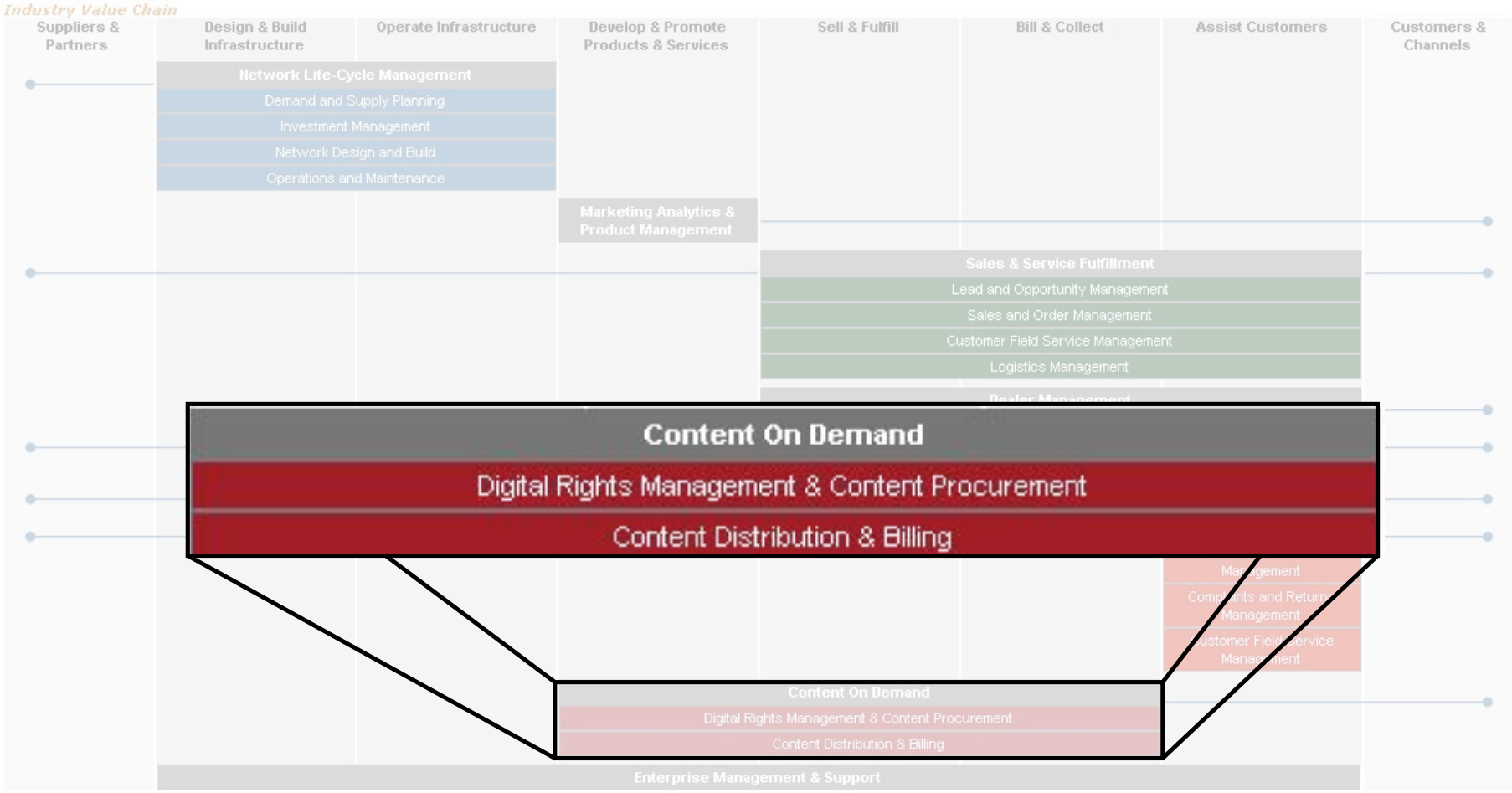
Telecommunications Solution Map



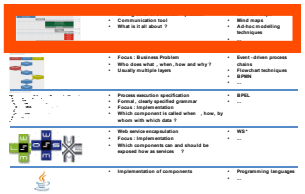


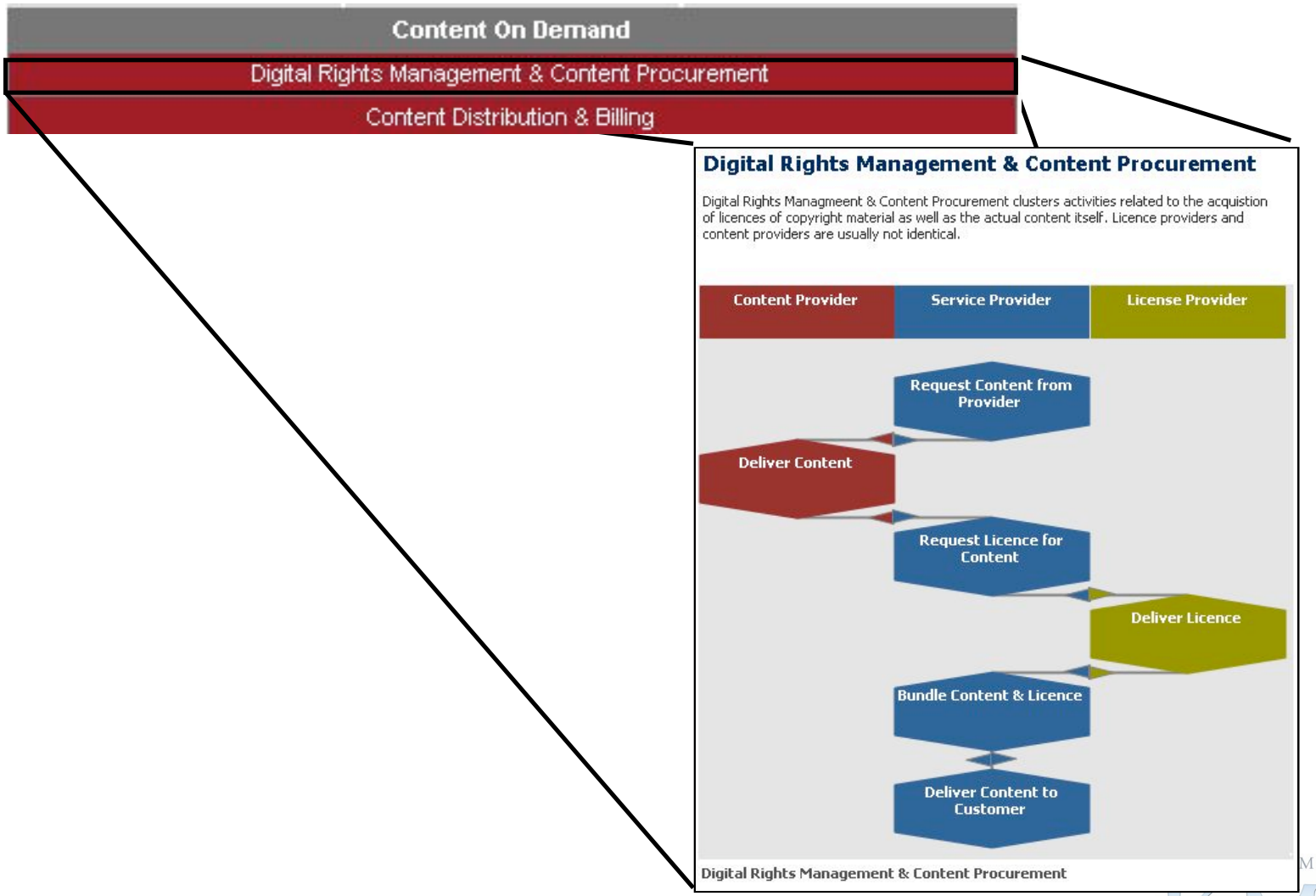
Content on Demand



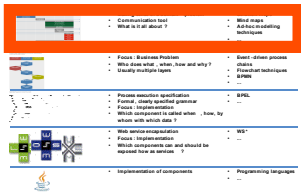


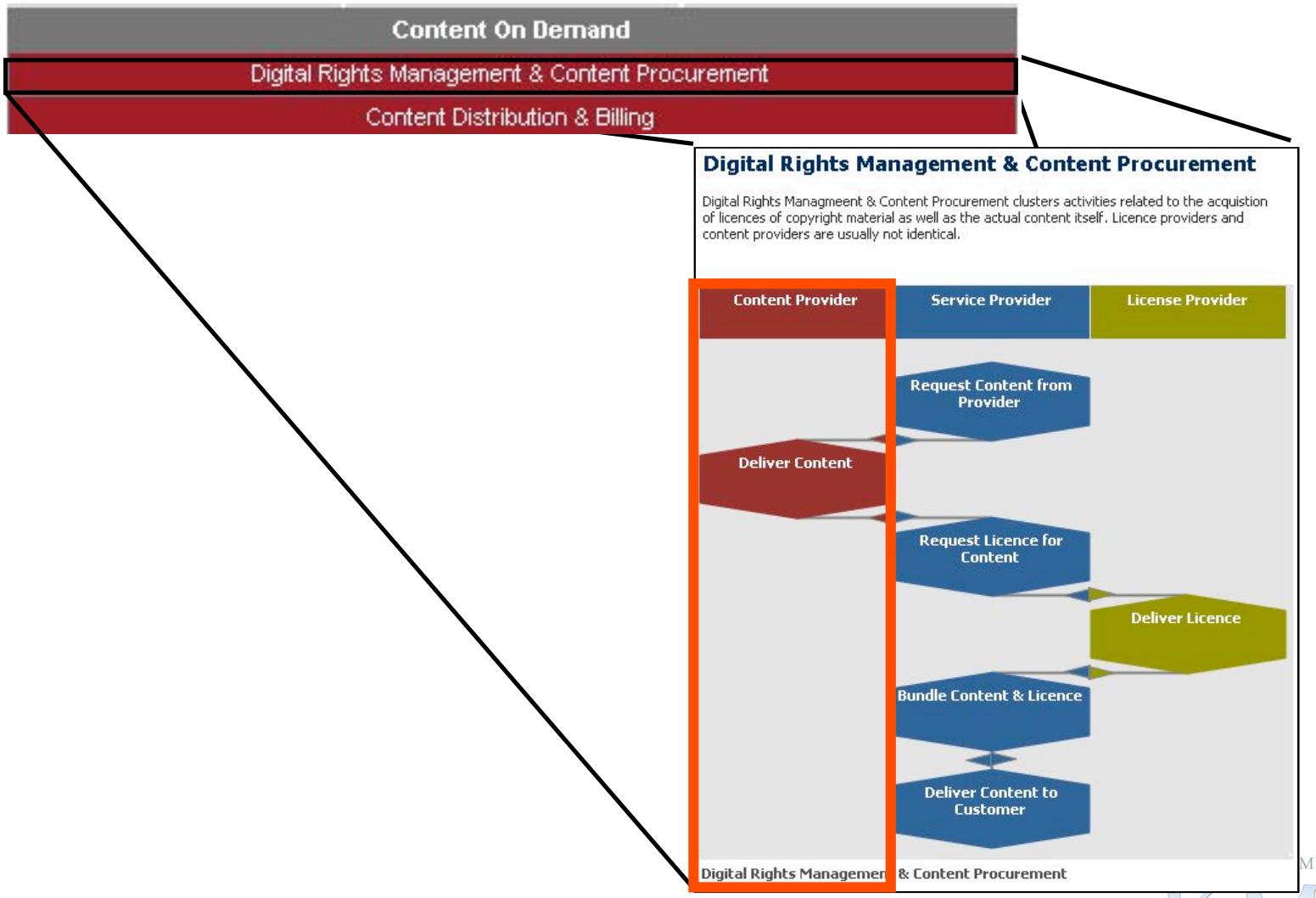
Digital Rights Management & Content Procurement



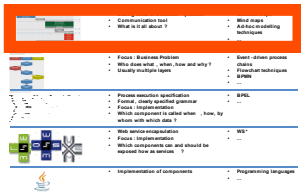


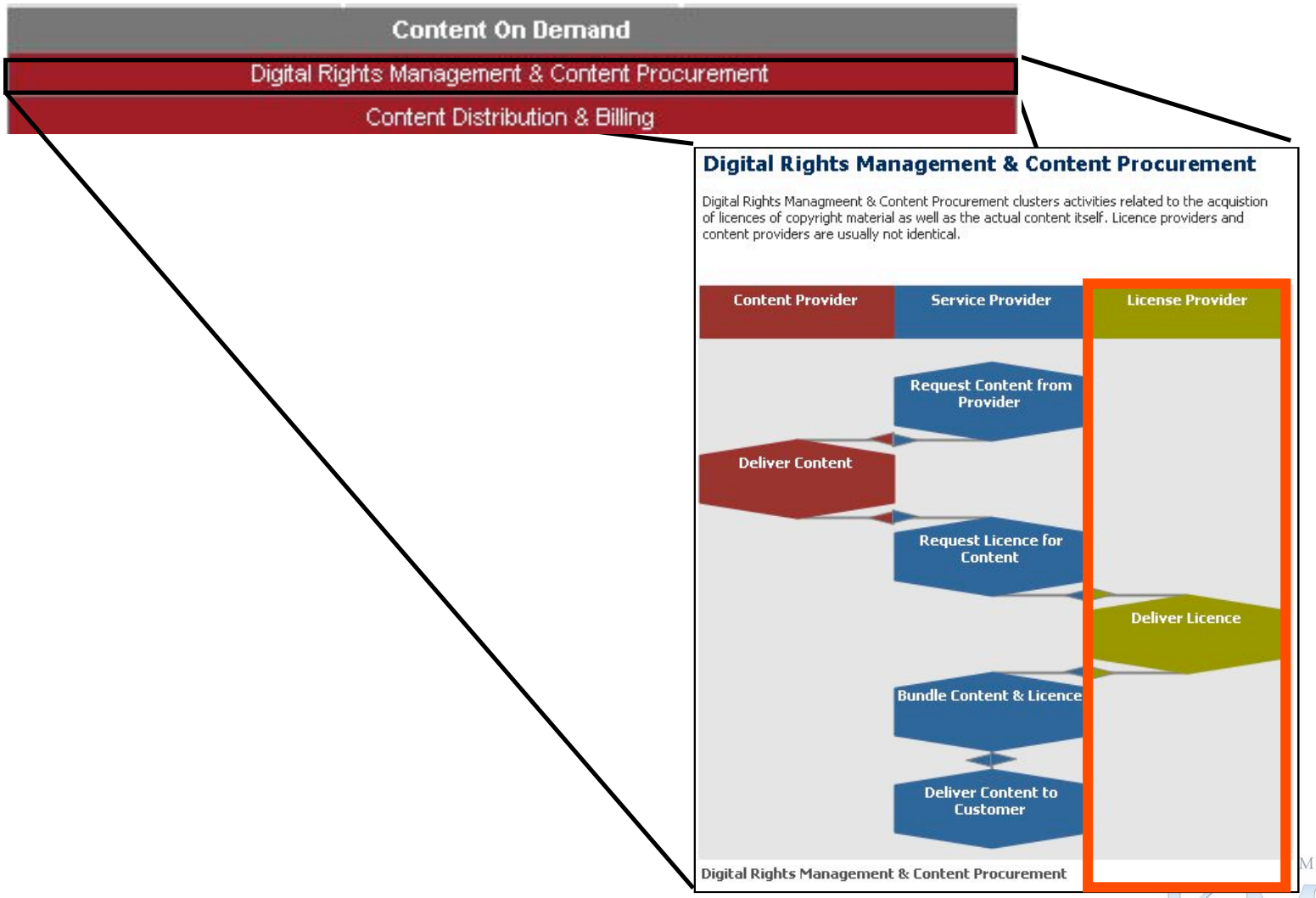
Digital Rights Management & Content Procurement



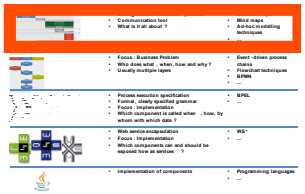


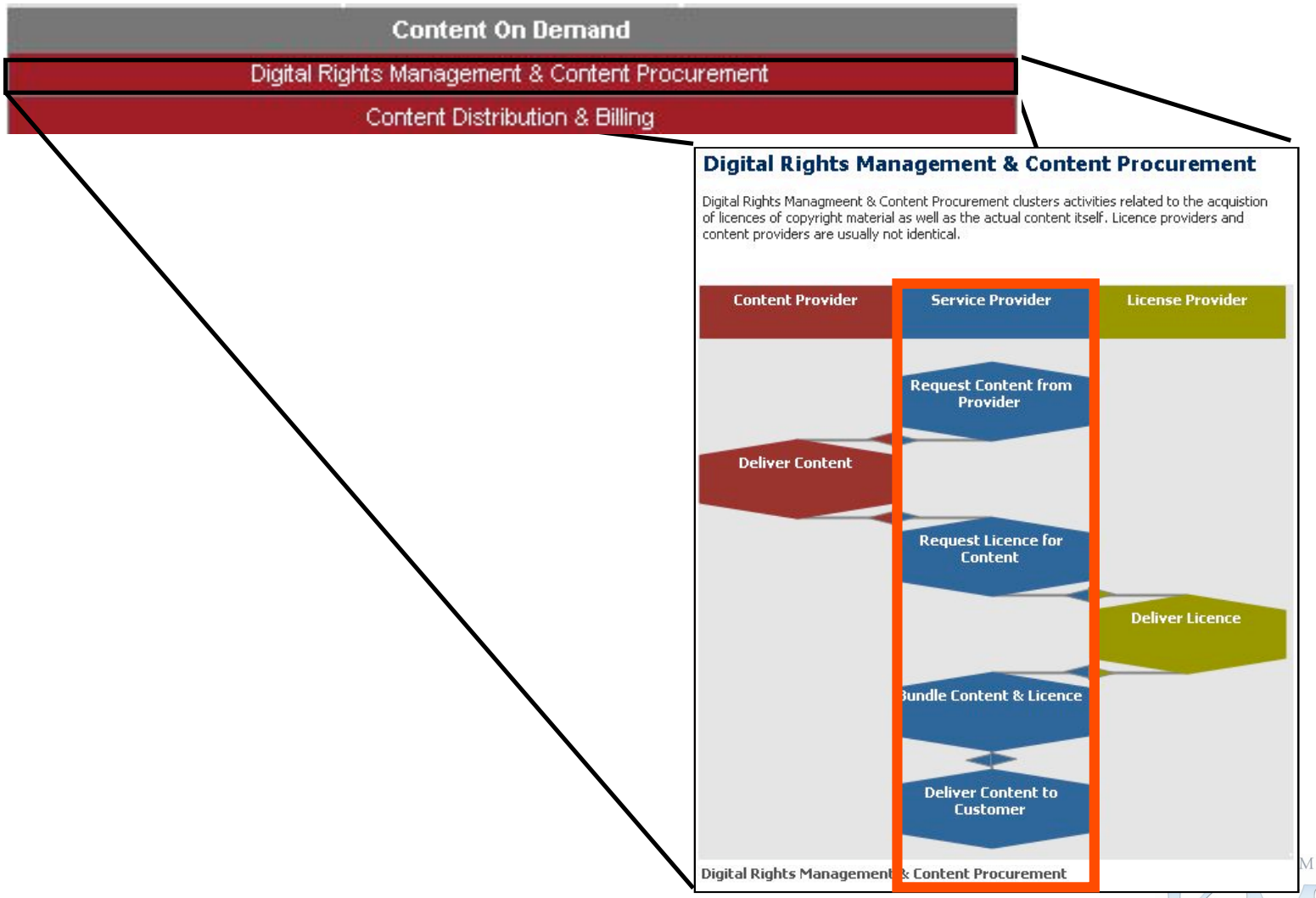
Digital Rights Management & Content Procurement



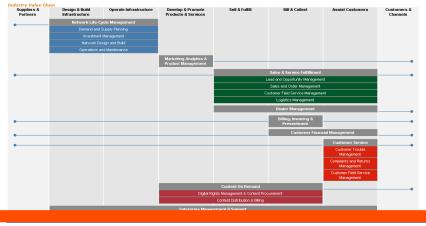


Digital Rights Management & Content Procurement



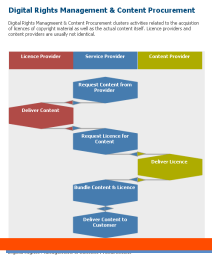


Modelling Stack



- Making sense of a domain \problem
- Communication tool
- What is it all about ?

- Solution maps
- Mind maps
- Ad-hoc modelling techniques
- …

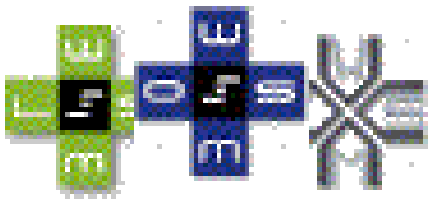


- Visualizing \specifying business process
- Focus : Business Problem
- Who does what , when , how and why ?
- Usually multiple layers

- Business Scenario Maps
- Event - driven process chains
- Flowchart techniques
- BPMN
- …

- Process execution specification
- Formal , clearly specified grammar
- Focus : Implementation
- Which component is called when , how, by whom with which data ?

- BPEL
- …



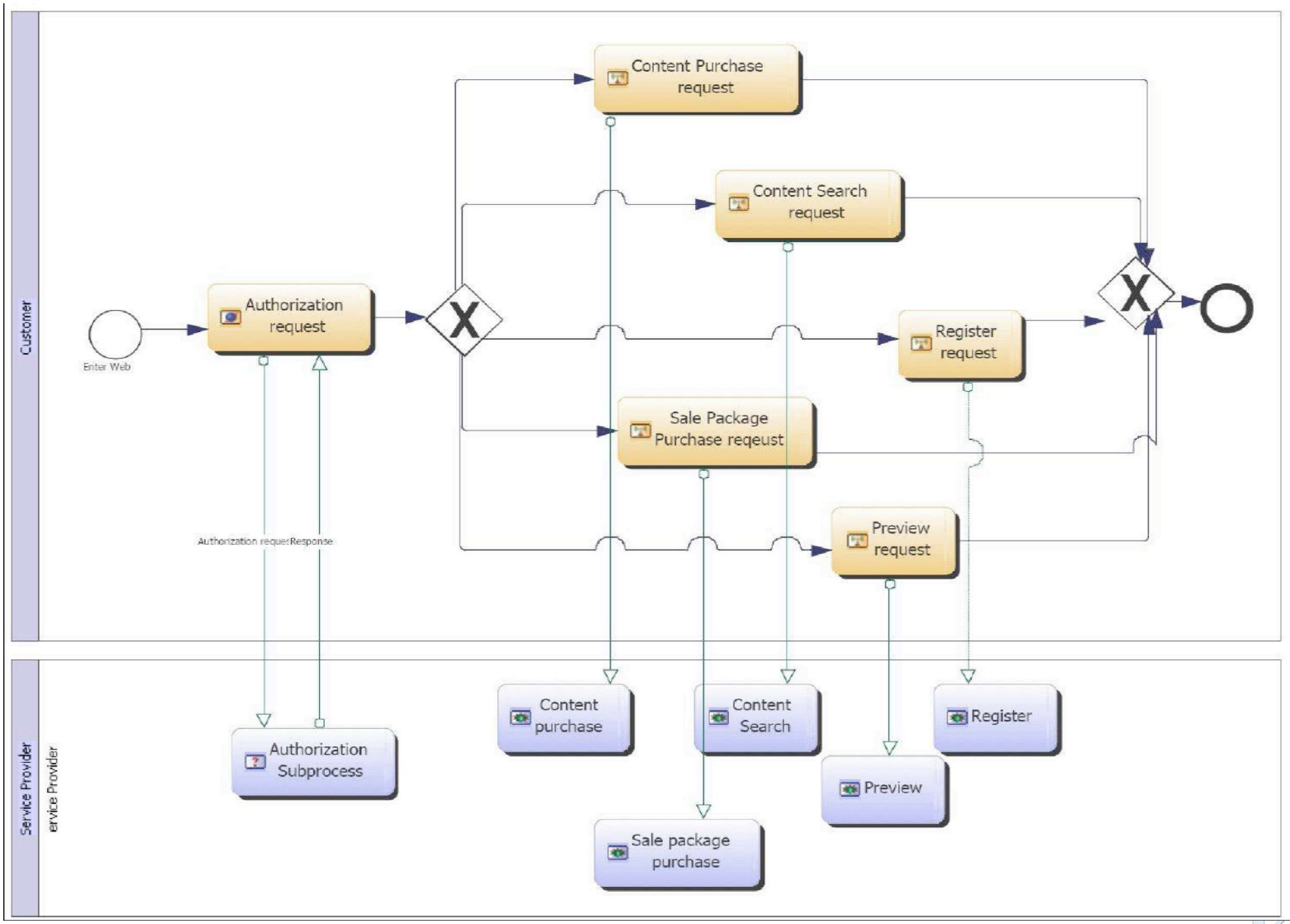
- Web service encapsulation
- Focus : Implementation
- Which components can and should be exposed how as services ?

- WS*
- …

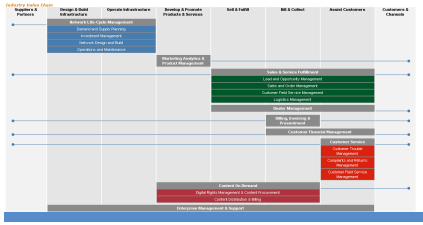
- Implementation of components

- Programming languages
- …

Business Process Notations

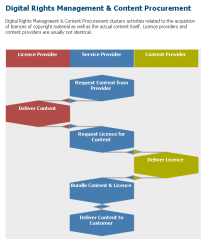


Modelling Stack



- Making sense of a domain \problem
- Communication tool
- What is it all about ?

- Solution maps
- Mind maps
- Ad-hoc modelling techniques
- …

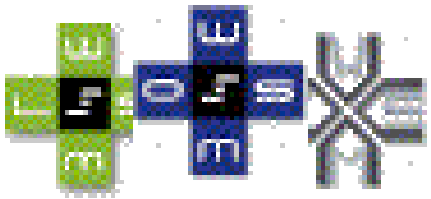


- Visualizing \specifying business process
- Focus : Business Problem
- Who does what , when , how and why ?
- Usually multiple layers

- Business Scenario Maps
- Event - driven process chains
- Flowchart techniques
- BPMN
- …

- Process execution specification
- Formal , clearly specified grammar
- Focus : Implementation
- Which component is called when , how, by whom with which data ?

- BPEL
- …

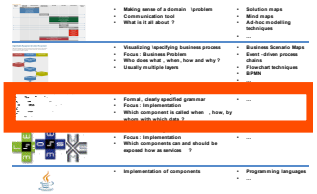


- Web service encapsulation
- Focus : Implementation
- Which components can and should be exposed how as services ?

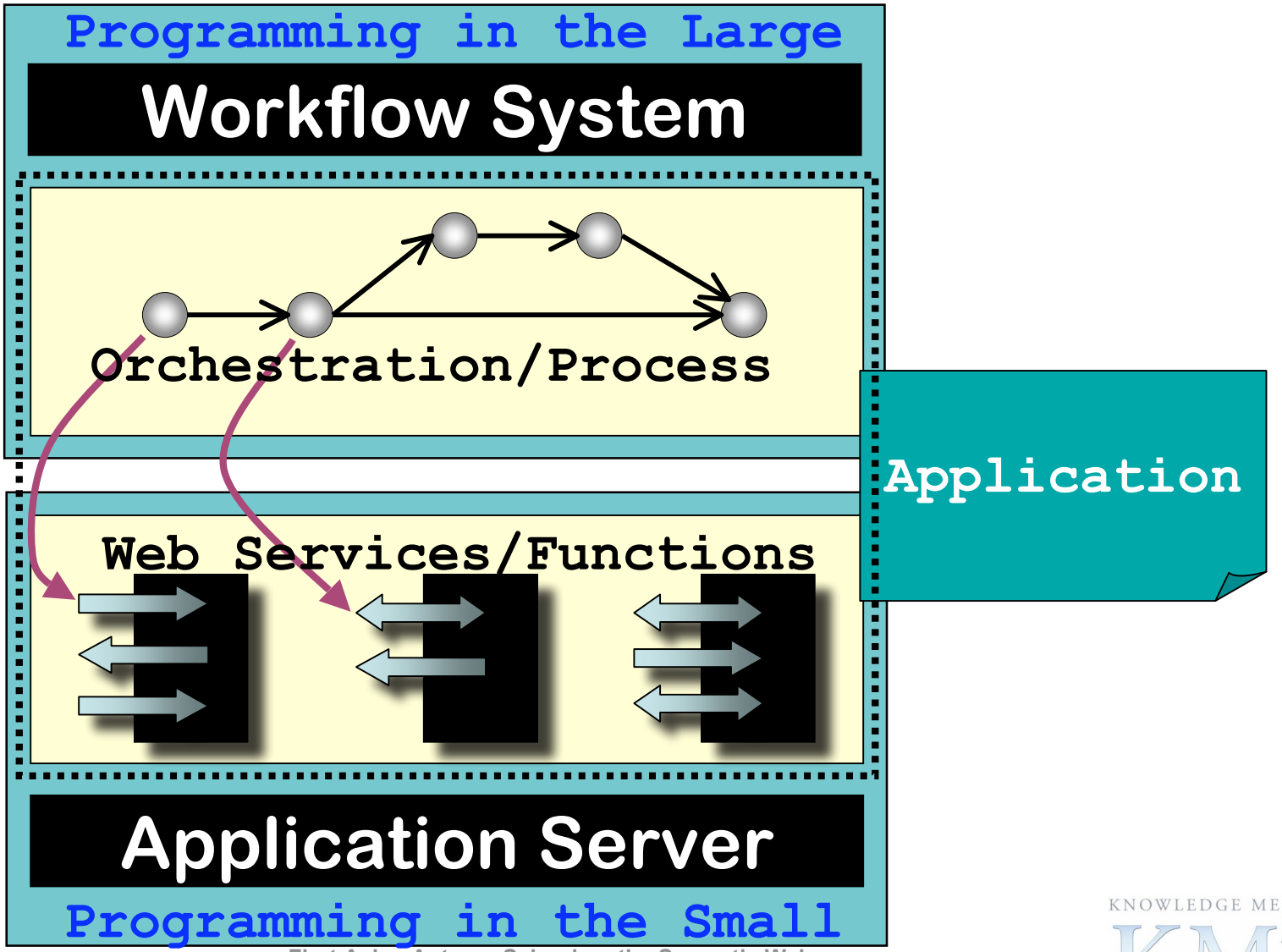
- WS*
- …

- Implementation of components

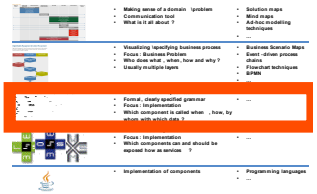
- Programming languages
- …

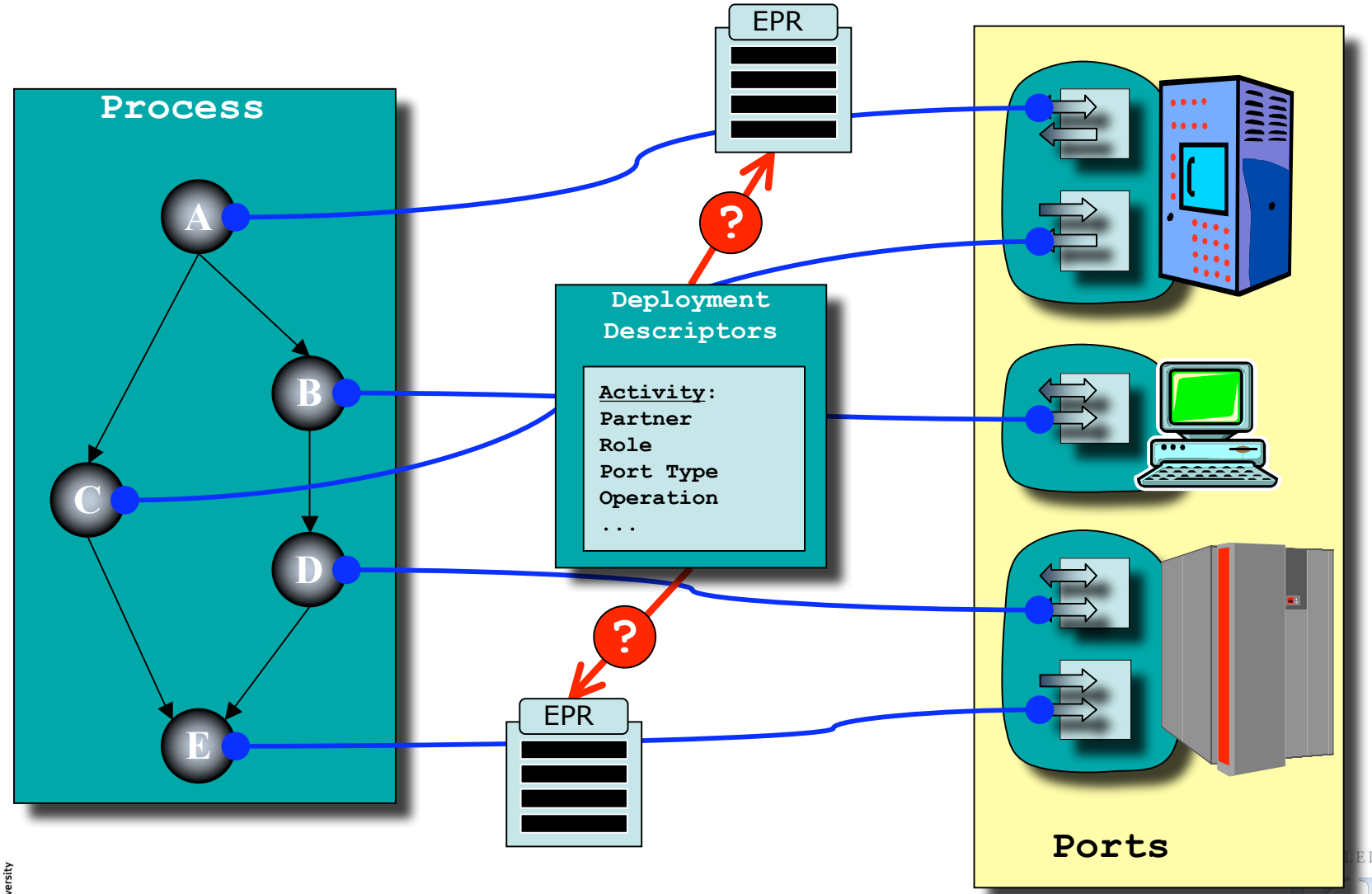


Programming Model

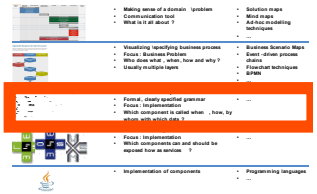


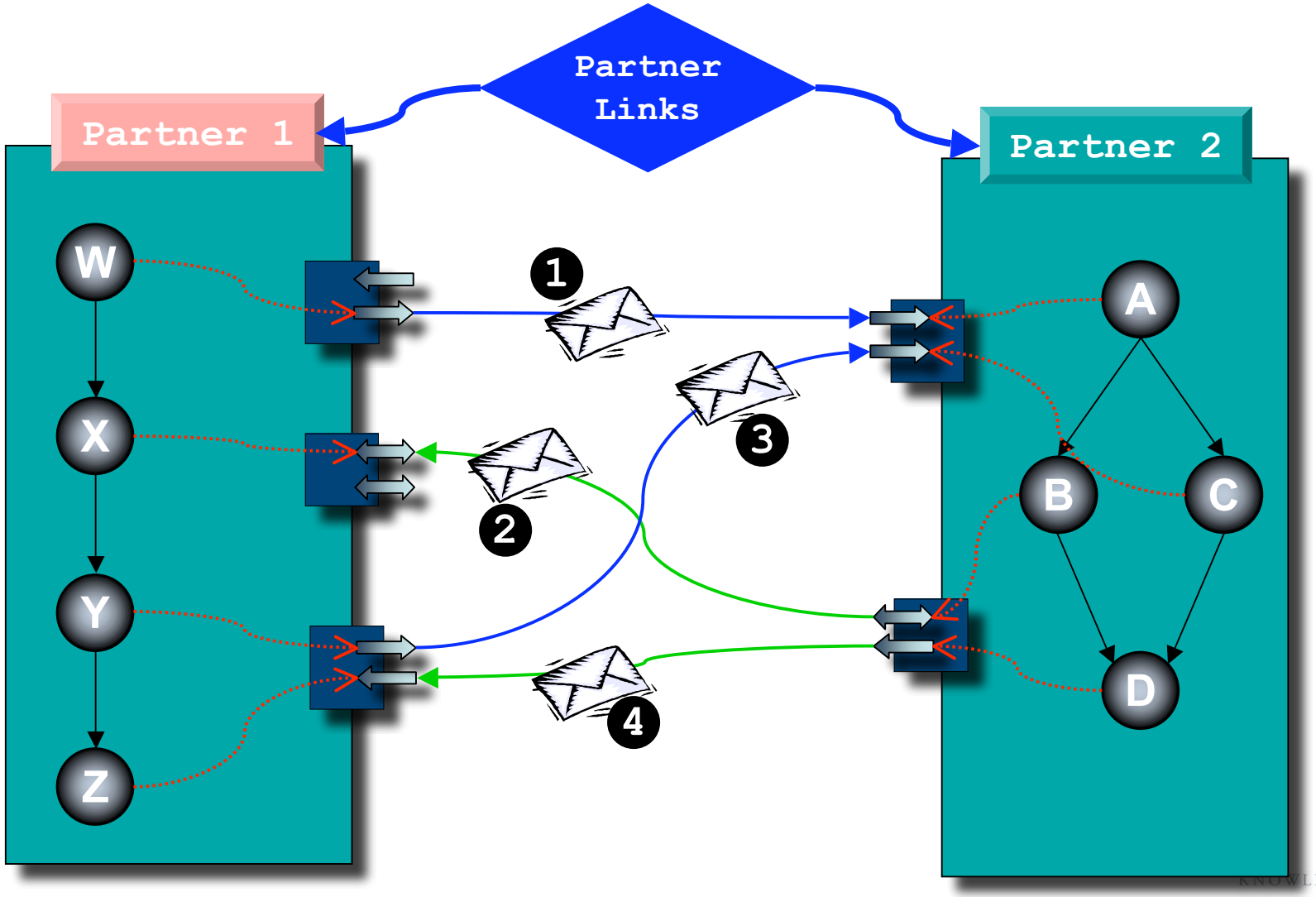
Deploying Applications



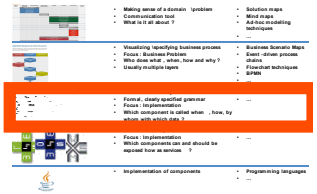


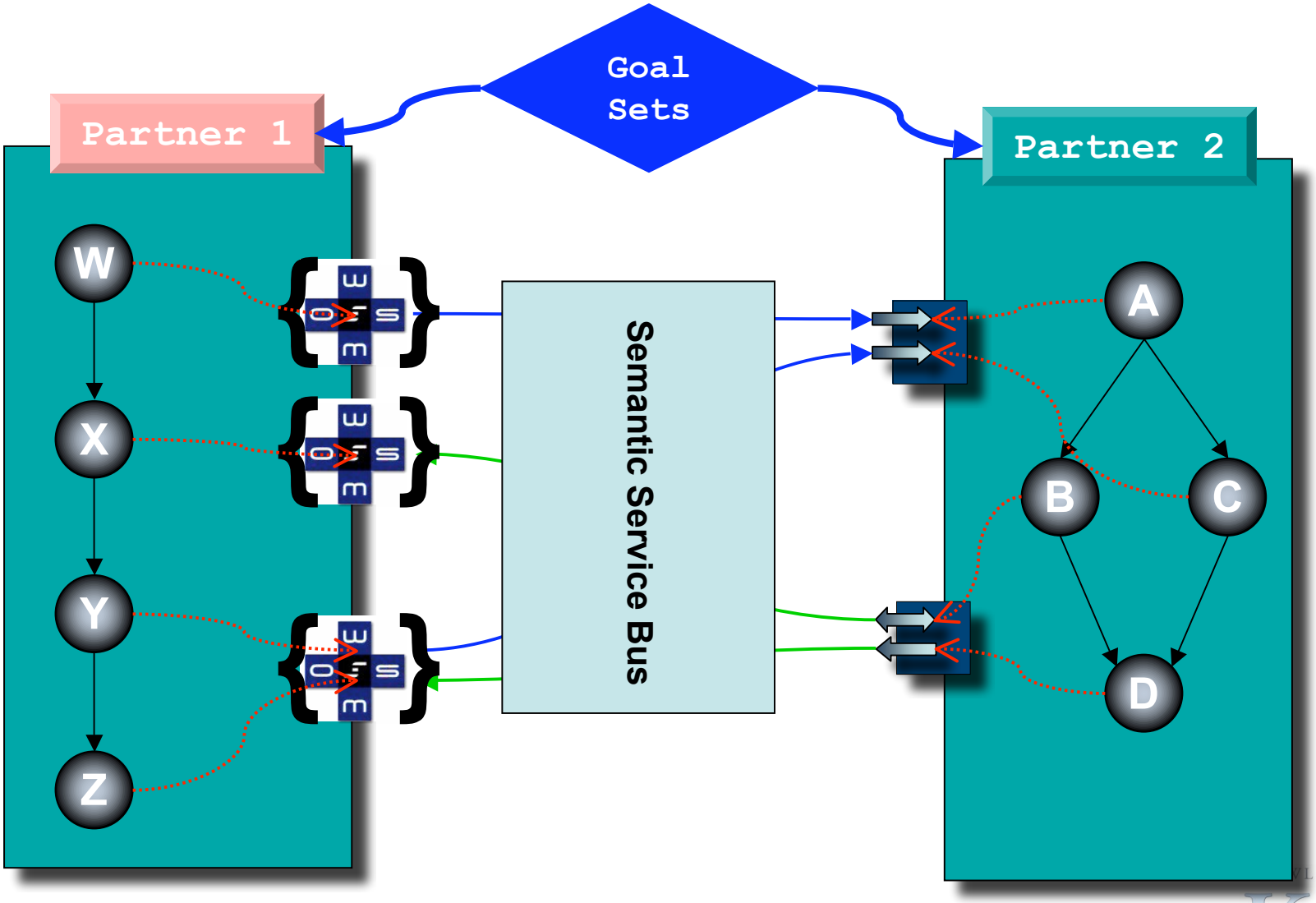
Business Protocols



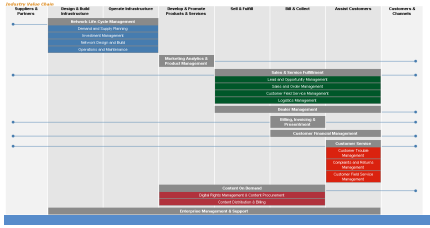


Business Protocols



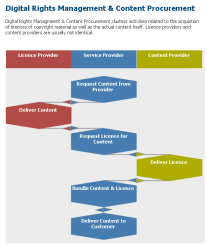


Modelling Stack



- Making sense of a domain \problem
- Communication tool
- What is it all about ?

- Solution maps
- Mind maps
- Ad-hoc modelling techniques
- …

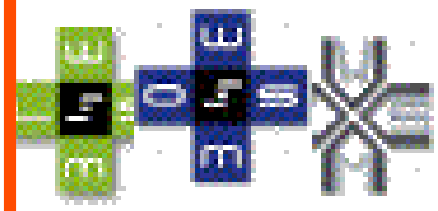


- Visualizing \specifying business process
- Focus : Business Problem
- Who does what , when , how and why ?
- Usually multiple layers

- Business Scenario Maps
- Event - driven process chains
- Flowchart techniques
- BPMN
- …

- Process execution specification
- Formal , clearly specified grammar
- Focus : Implementation
- Which component is called when , how, by whom with which data ?

- BPEL
- …



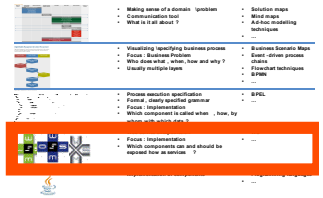
- Web service encapsulation
- Focus : Implementation
- Which components can and should be exposed how as services ?

- WS*
- …

- Implementation of components

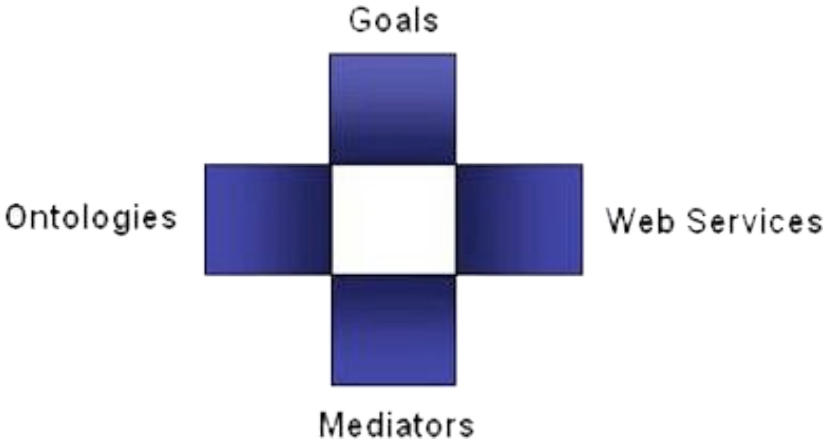
- Programming languages
- …

WSMO Top Level Notions



Objectives that a client wants to achieve by using Web Services

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

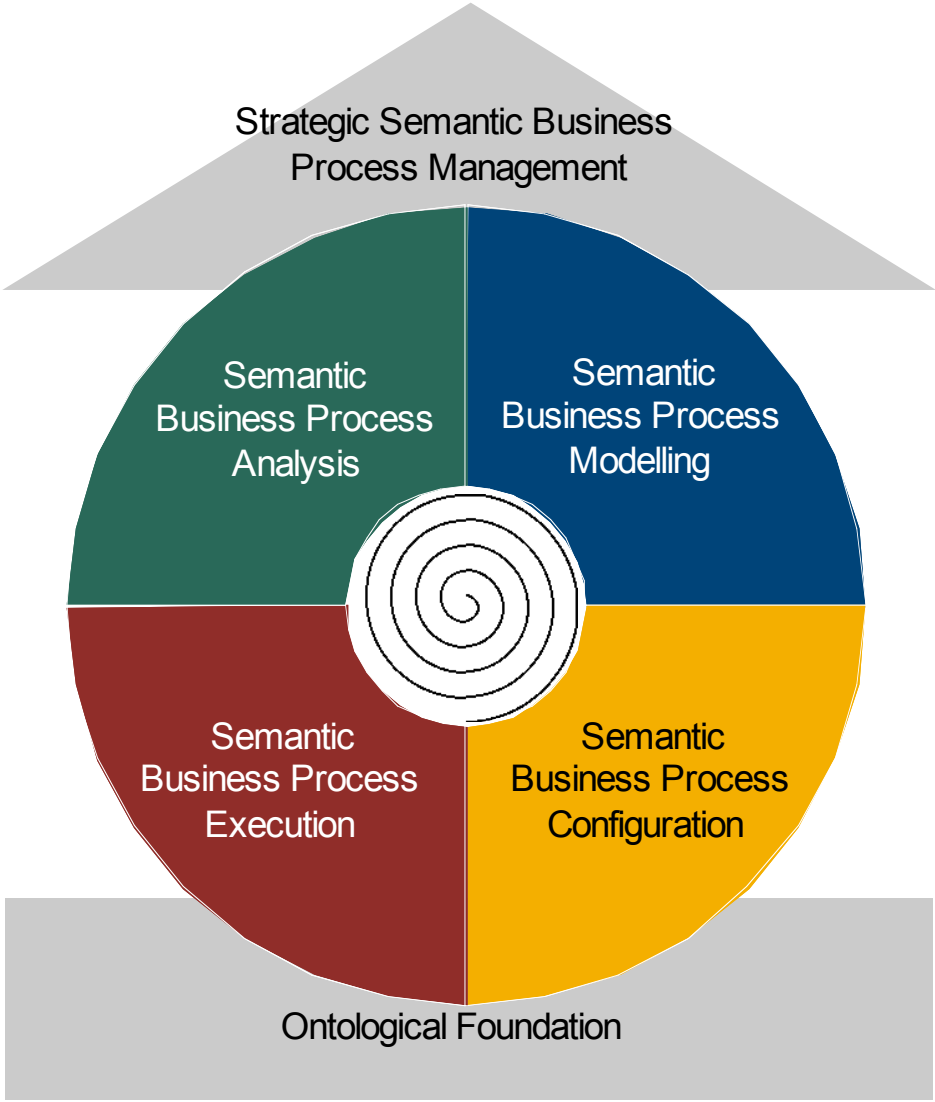


Semantic description of Web Services:
- **Capability *(functional)***
- **Interfaces *(usage)***

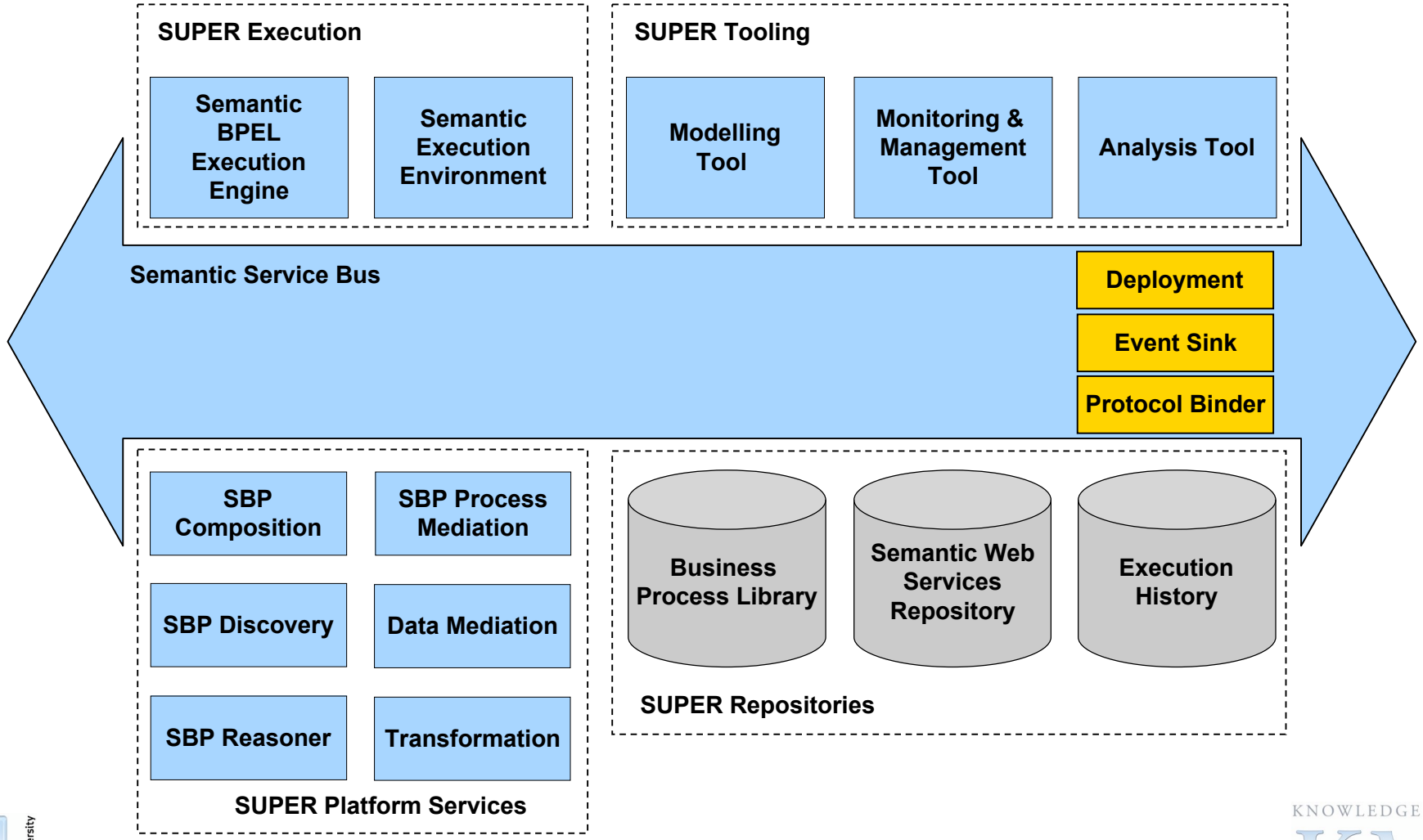
Connectors between components with mediation facilities for handling heterogeneities

The SUPER Trinity

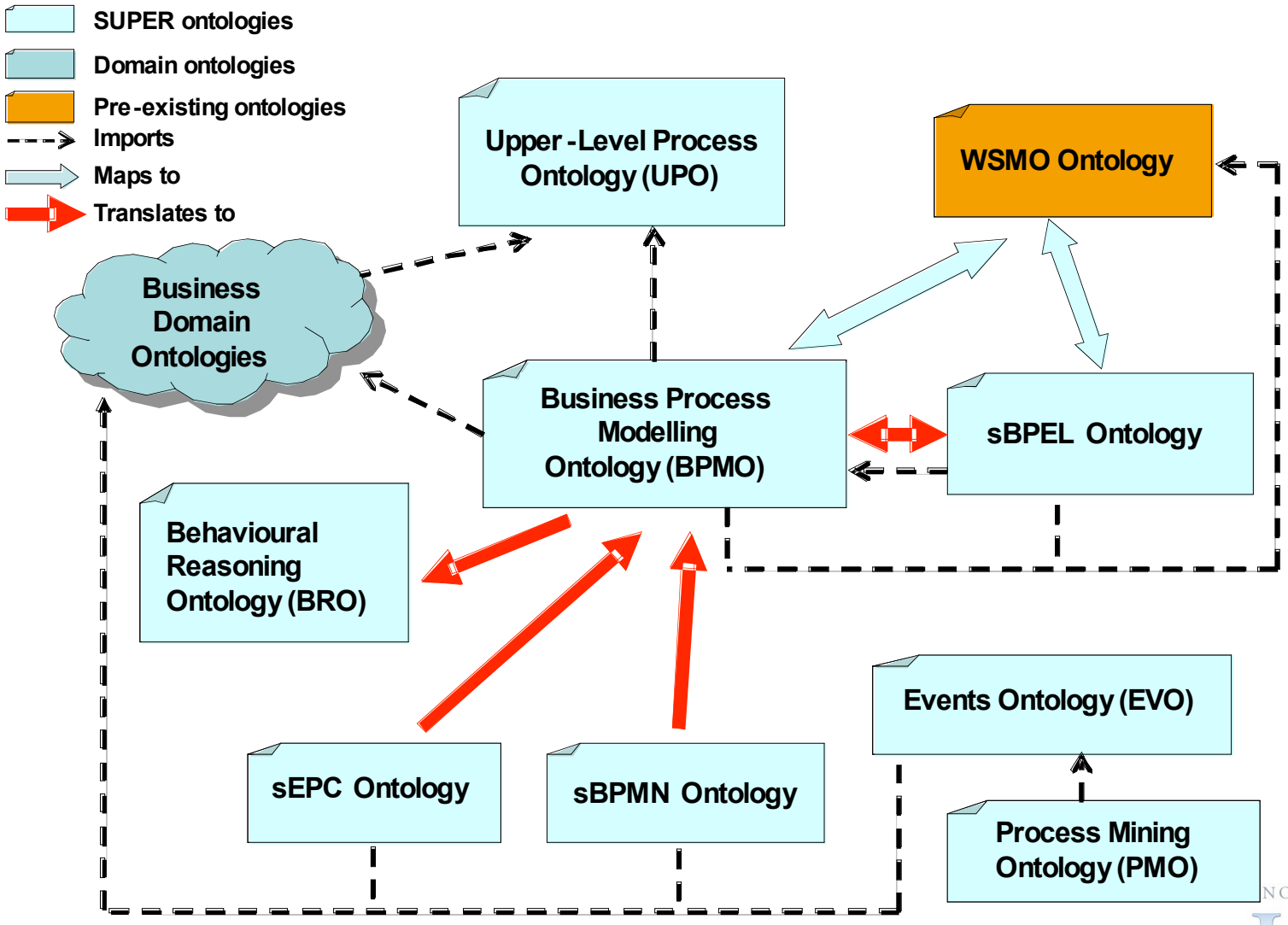
SUPER Methodology



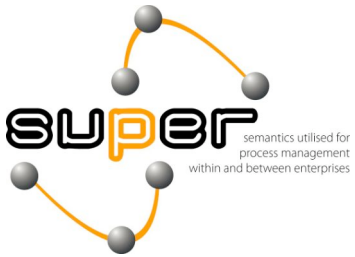
SUPER Architecture



SUPER Ontology Stack



Super Demo Context



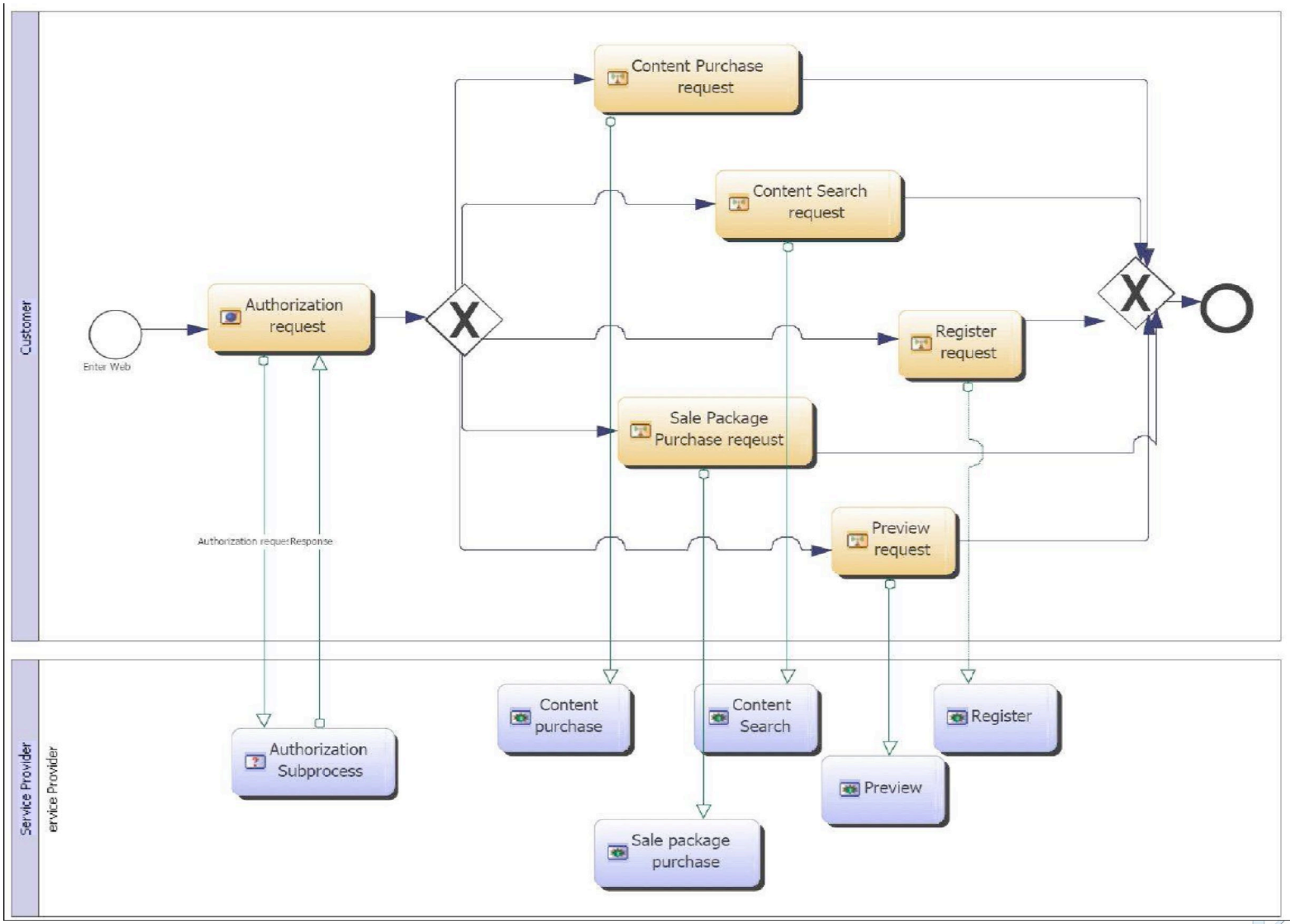
Prototype Scenario

Digital Asset Management

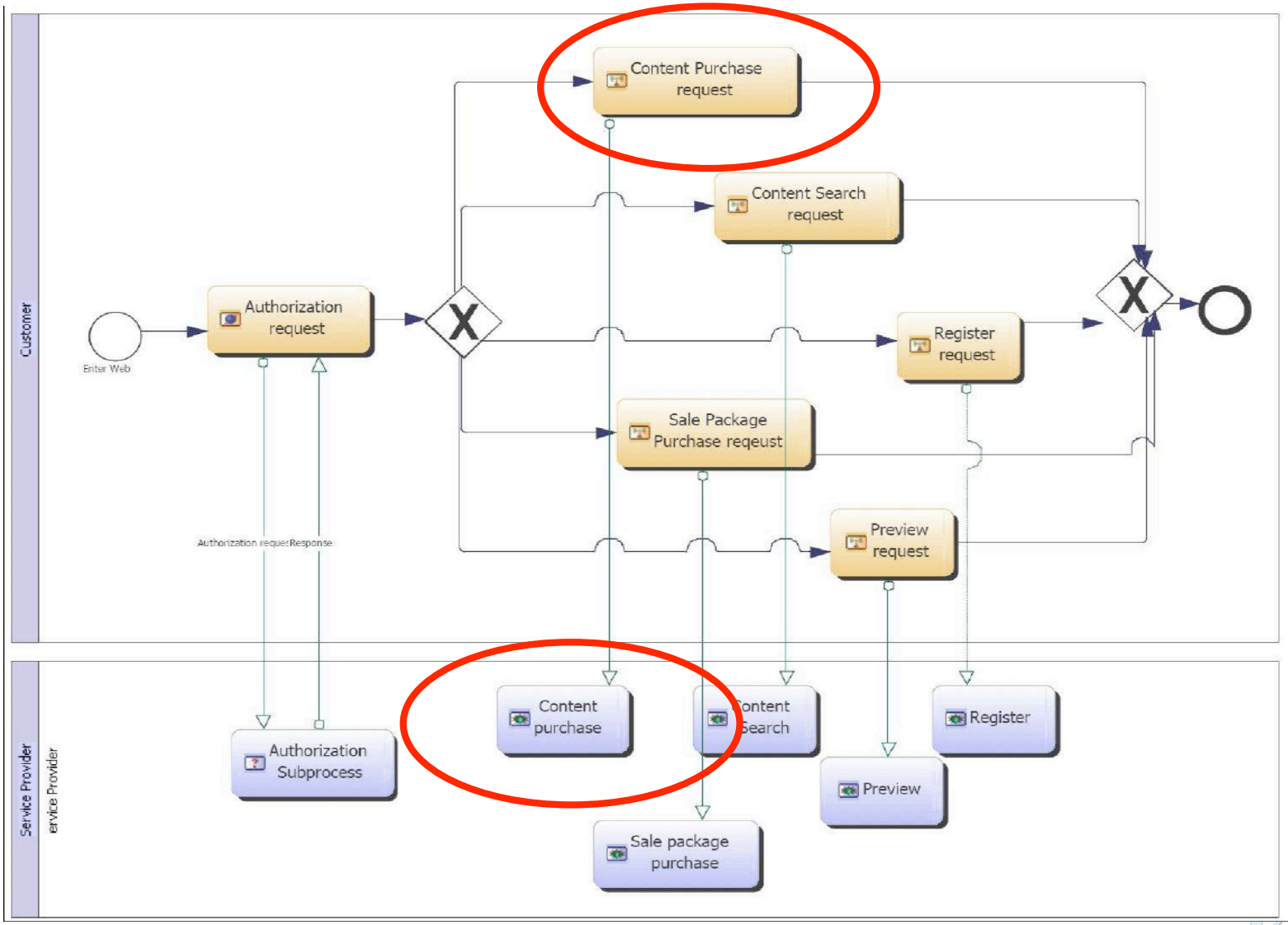
Digital Content Downloading

Content Purchase

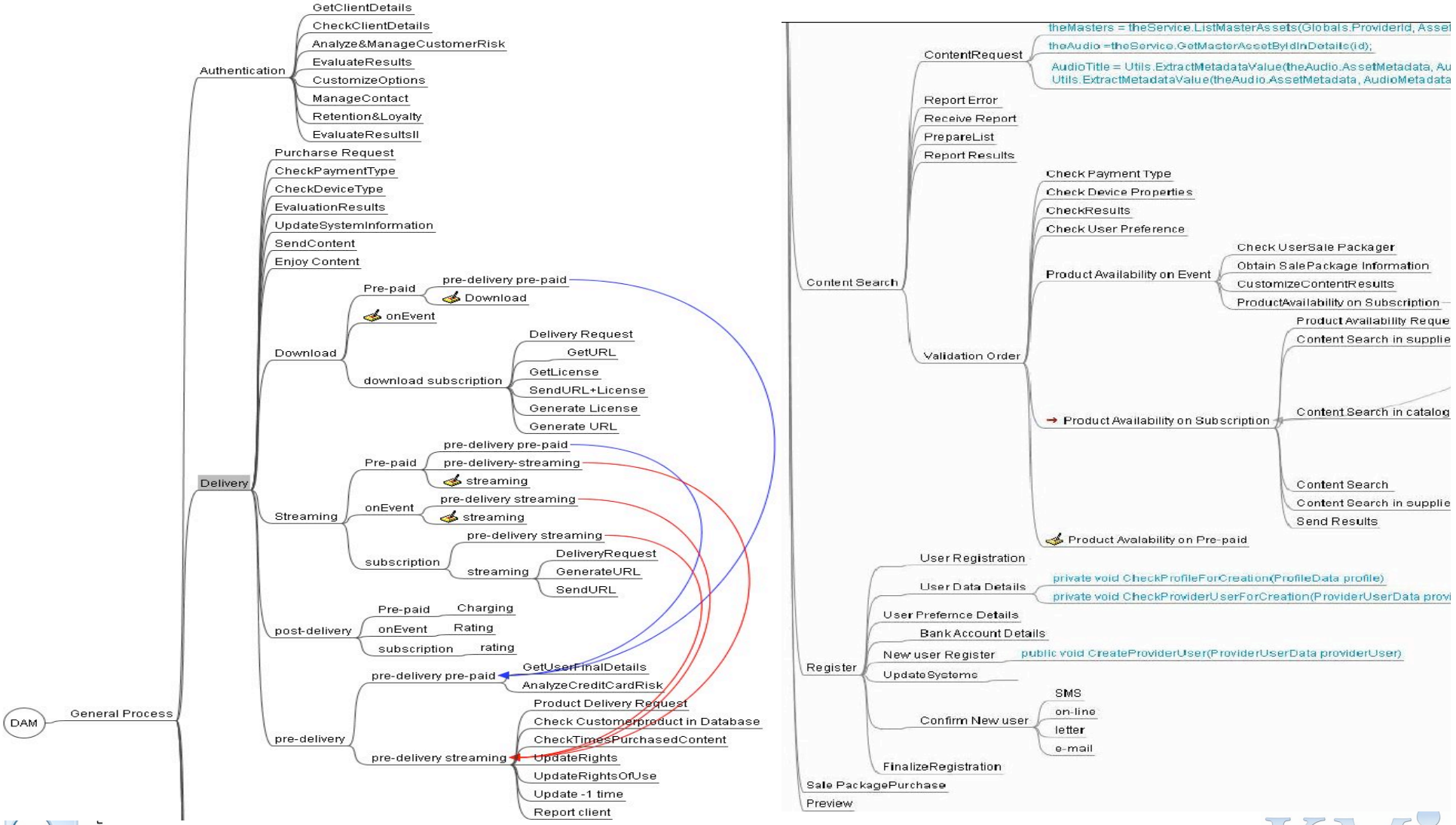
Digital Asset Management BPMN



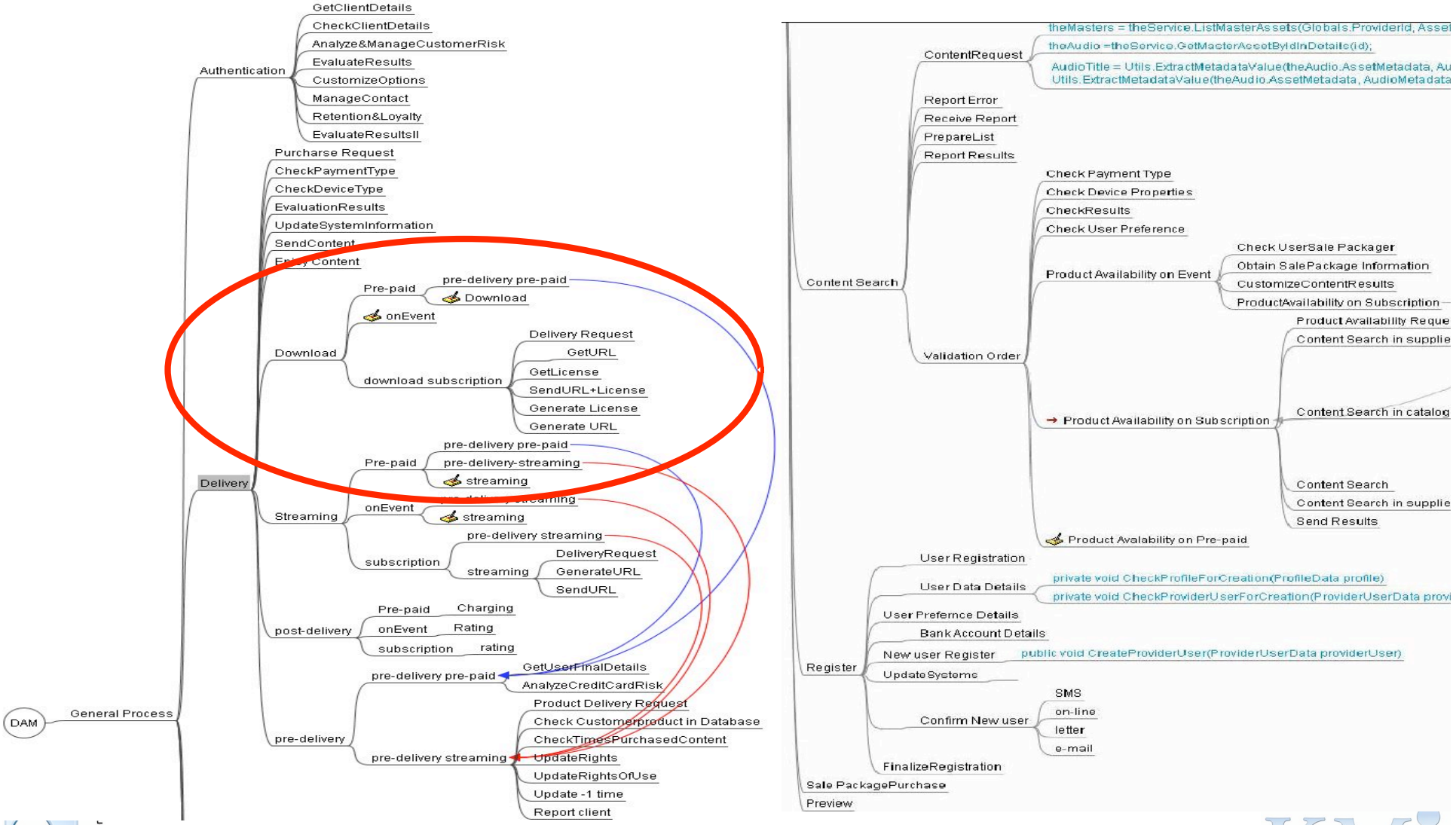
Digital Asset Management BPMN



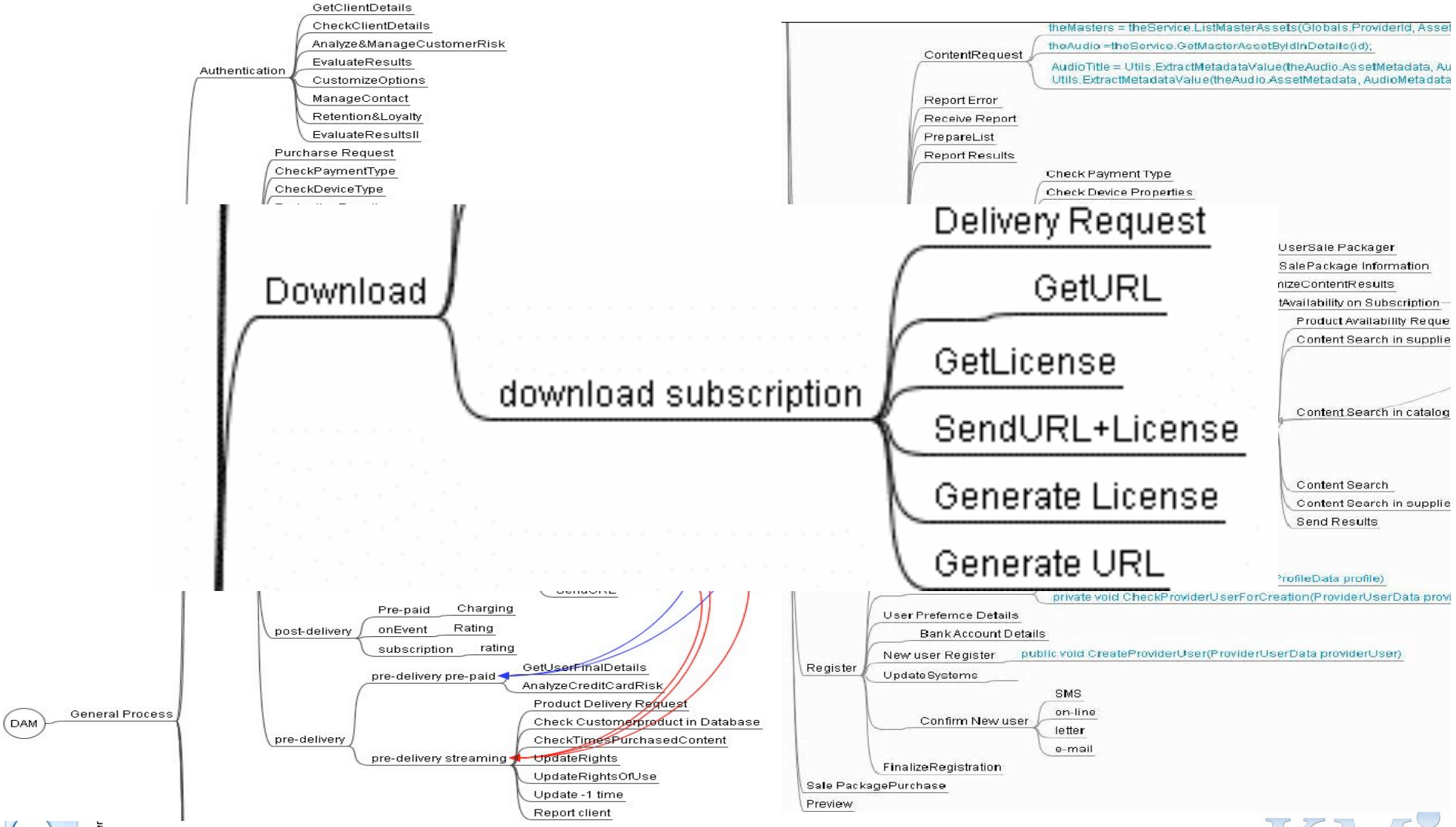
Service/Process Catalogue



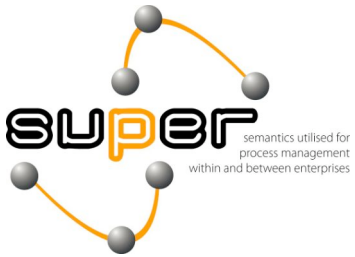
Service/Process Catalogue



Service/Process Catalogue



Super Demo Video



Semantic Web Services and eLearning

LUISA Project

- 30 Month 4.2M Euro project
  - Duration: 30 Months
  - Start: March 2006

LUISA Consortium

- 7 Partners:
  - **Atos Origin (ATOS) - Spain**
  - KMi, the Open University (OU) - UK
  - University of Alcalá de Henares (UAH) - Spain
  - University of Uppsala (ULL) - Sweden
  - Giunti Interactive Labs (GIUNTI) - Italy
  - University Henri Pointcaré (UHP) - France
  - EADS Corporate Research Centre (EADS) - France

LUISA Goal (1/2)

- LUISA addresses one essential problem: the location of (the appropriate) **learning resources** for some **given needs** (of learners, instructors or groups).
- Two main approaches are available as of today:
  - General Purpose Search Engine *(Google*!)
  - Specialized “learning object repositories” (LOR) that provide search based on “specialized” metadata.
- But:
  - The first one does not exploit information specific to learning/instruction.
  - The second one does (to some extent), but without exploiting domain/commonsense/specialized knowledge

LUISA Goal (2/2)

- Proposes a **framework for developing specialized systems or brokers for other systems**.
  - It does not replace but extends existing investment.
- And provides several key innovations:
  1. Enables the expression of queries in terms of **ontologies**.
  2. Locates the **best sources/providers for given queries** (learning needs).
  3. Suggests tentative **compositions** based on learning needs.
  4. Is able of getting **back to the user** for more relevant info (negotiation).
  5. Enables **different query resolution/composition strategies**, including educational knowledge.

LUISA Objectives

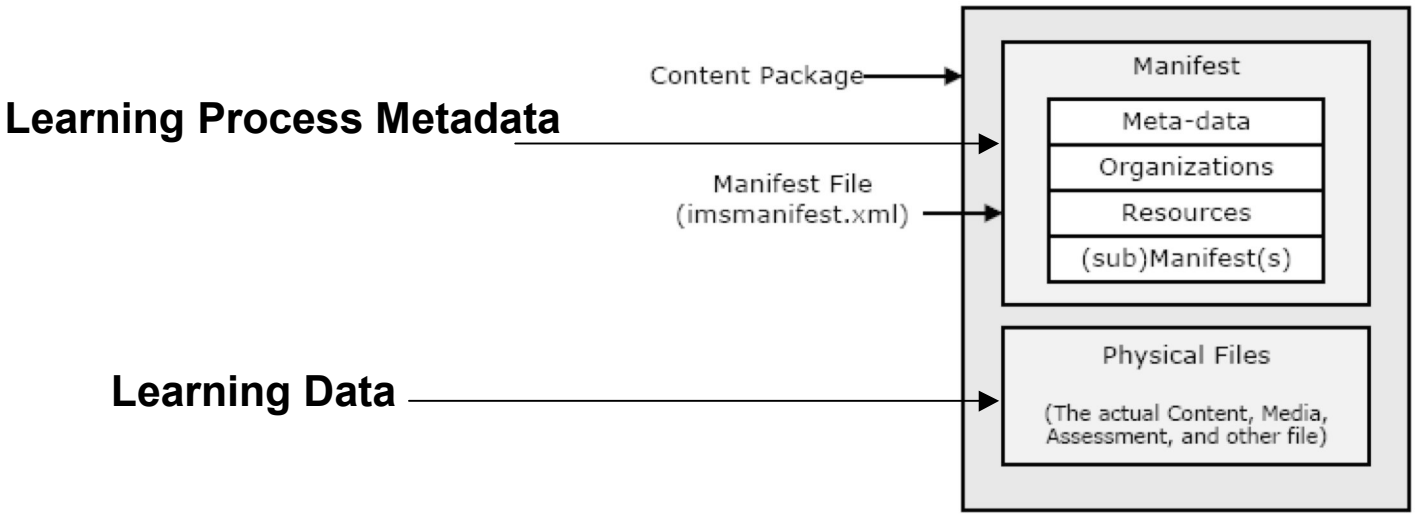
- **(O1) Developing a Semantic Web Service-based Infrastructure for Learning Object Discovery, Selection, Negotiation and Composition**
- **(O2) Developing Semantic Learning Object Annotation Techniques**
- **(O3) Annotation Tool development**
- **(O4) Integration of the architecture into existing LCMS**
- **(O5) Case study reports**
  - **Academic Learning** (UHP)
  - **Industrial Training** (EADS)

SWS-based Infrastructure

E-Learning Technologies: **State of the Art**

Currently, supporting learning objectives means:

- Providing learners with manually created composite learning contents: Learning Objects (LO)
  - Ideally based on metadata standards (e. g. IEEE LOM, ADL SCORM, IMS Learning Design)
- Accesing to Learning Object Metadata Repositories (LOMR)
- Using learning (content) management systems (LMS-LCMS) (e. g. Moodle)

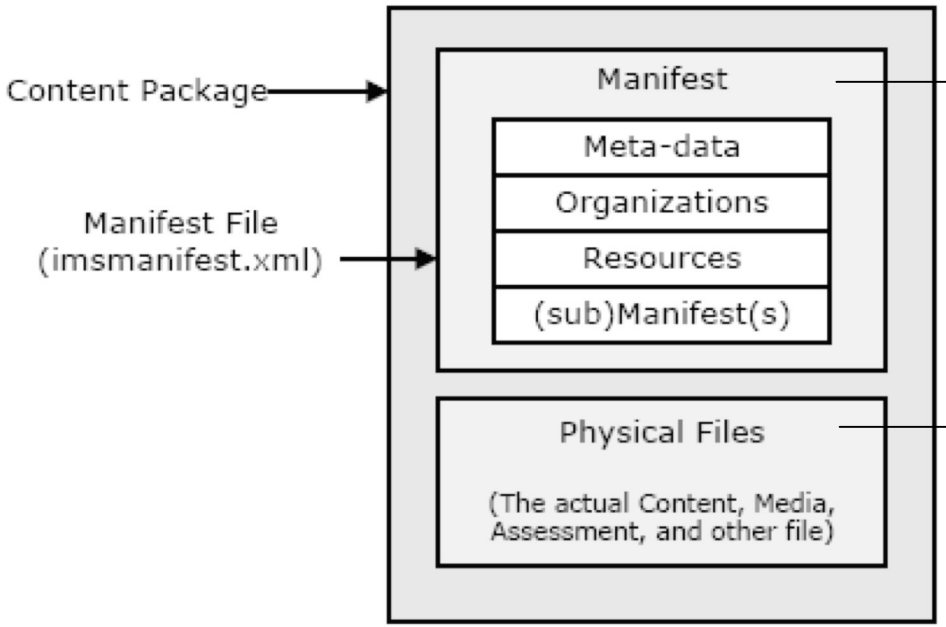


E-Learning Technologies: **State of the Art**

Neil

(learner)

- **Specific requirements and preferences:**
  - Skill Level (learning prerequisites)
  - Language
  - Platform
  - Cost
  - …



Learning Process Metadata

Learning Data

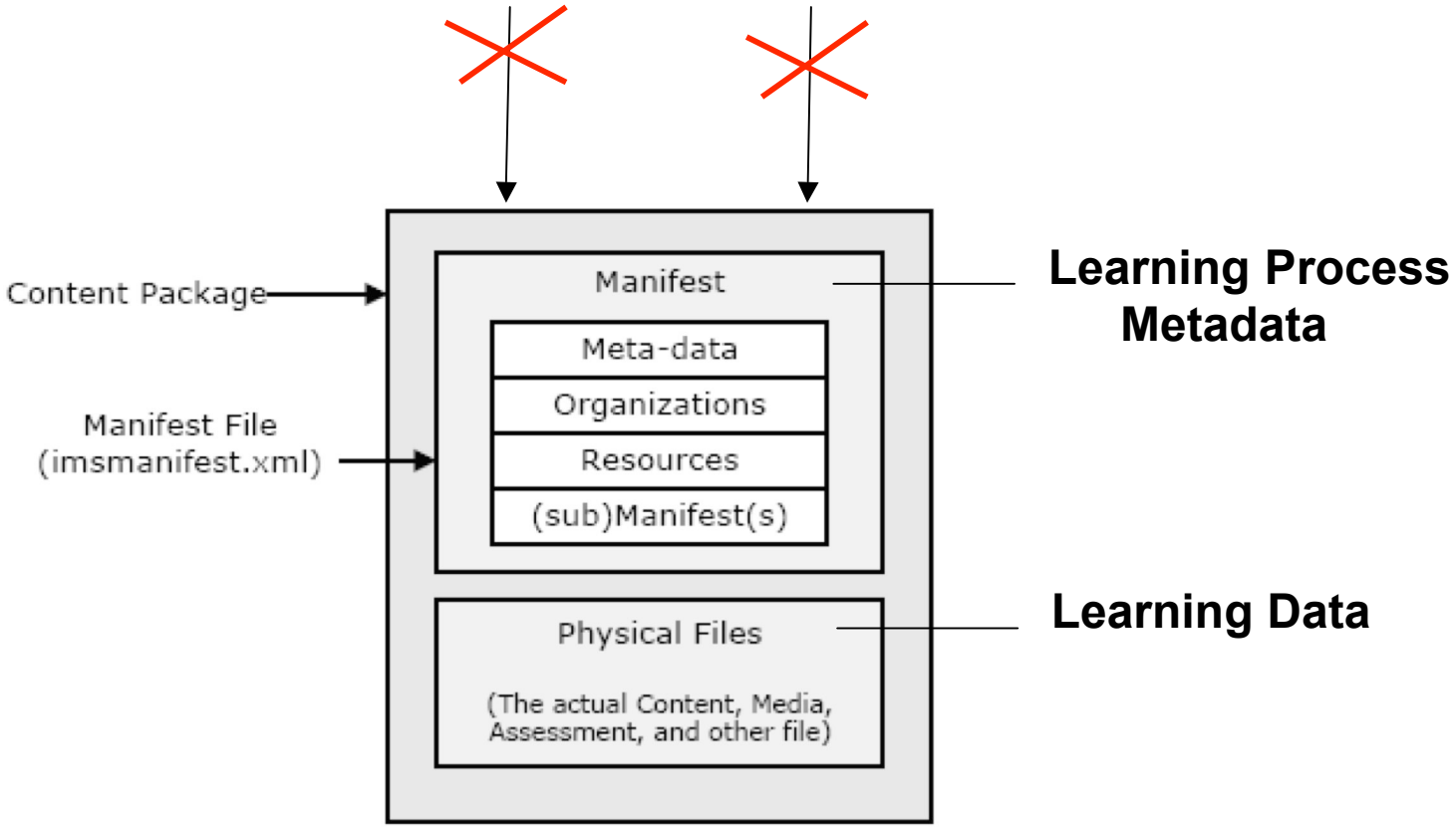
John

(teacher)

E-Learning Technologies: **Issues**

Alessio
(learner)

Stefan
(learner)



E-Learning Technologies: **Issues**

Issues:

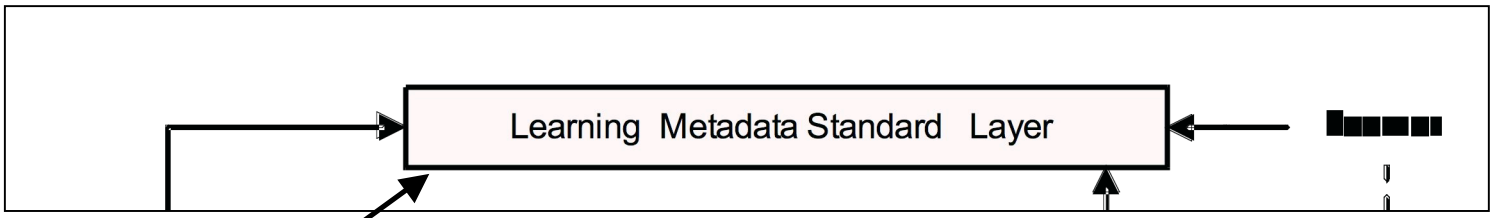
- Limited reusability across different context (learner needs) and metadata standards.
- Limited appropriateness and dynamic adaptability to actual process contexts.
- Limited use of available sources (repositories)
- High development costs

- **Main Reasons:**
  - Learning support is mainly based on content delivery
  - Content is stored within the learning package
  - Learning package is composed at design-time when the actual learning context cannot be considered
  - Learning package is manually created based on the subjective decision of individual learning designers

Vision: **Dynamic Adaptation at Runtime**

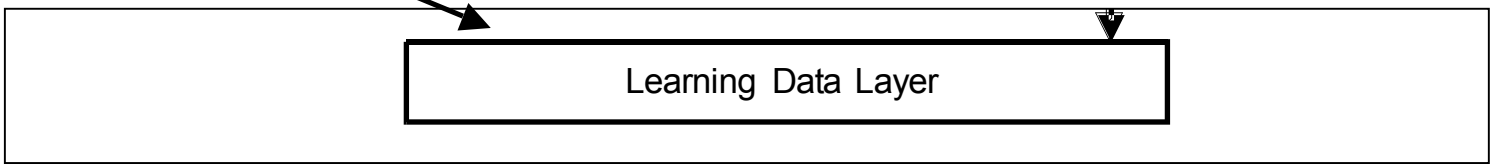
- **Move**
  - from a **manual design-time composition of learning contents**
  - to an **automatic run-time adaptation to learning contexts**
- **By introducing a paradigm-shift**
  - from the current **data and metadata-centric** approach
  - to a **dynamic functional-oriented** approach based on Semantic Web Services technology

Approach: **Dynamic use of Learning (Meta) Data ?**



(e. g. IMS LD, ADL SCORM, …)

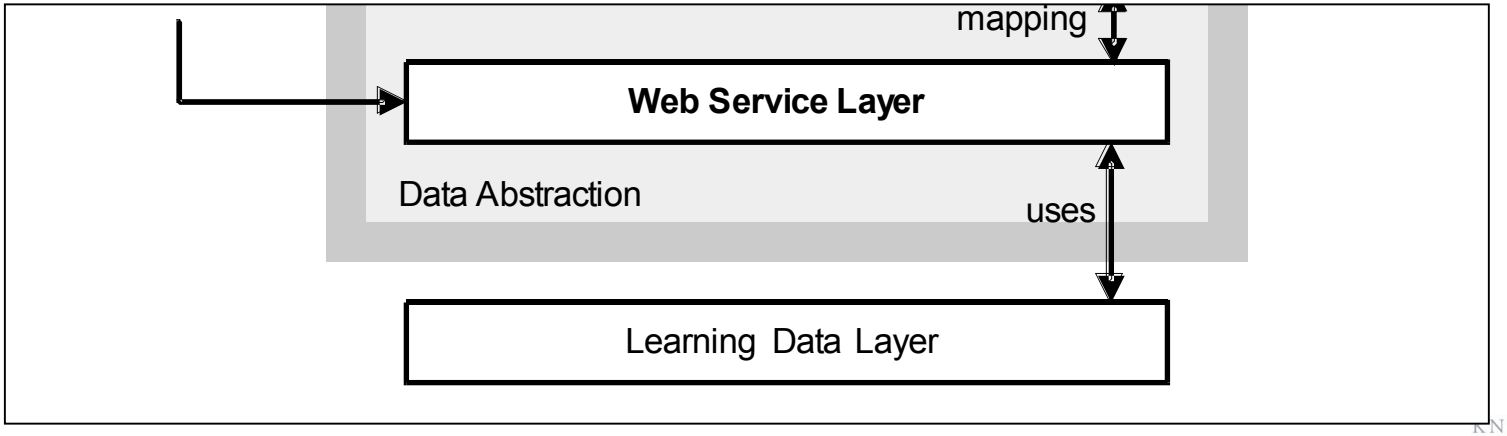
(multiple repositories. e. g. LUISA LOMR, Open Learn,…)



Approach: **Services (dynamic) instead of Data (static)**

1st Step - Abstracting from learning resources …

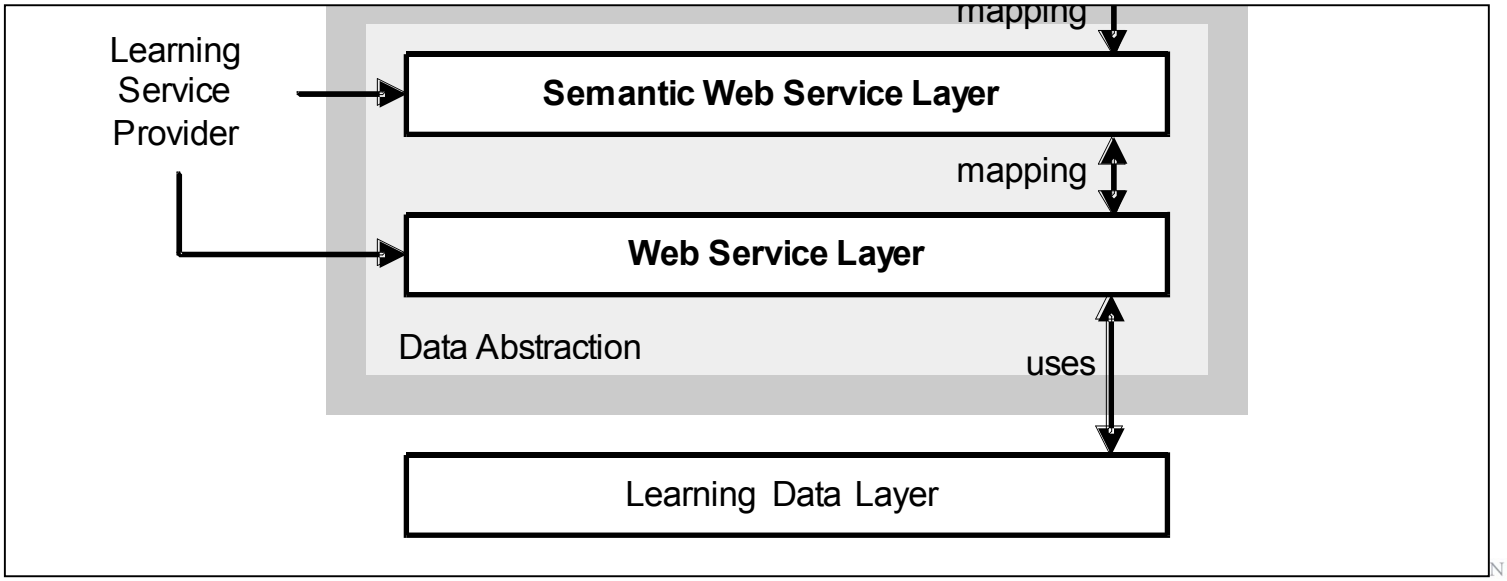
- Providing functionalities (**Web services**) supporting learning, instead of static data
- Enables dymanic adaptation to specific learning context, based on **dynamic delivery of appropriate data**
- Enables **dynamic integration of several content sources**
- Describing Web services is **more efficient** than describing data



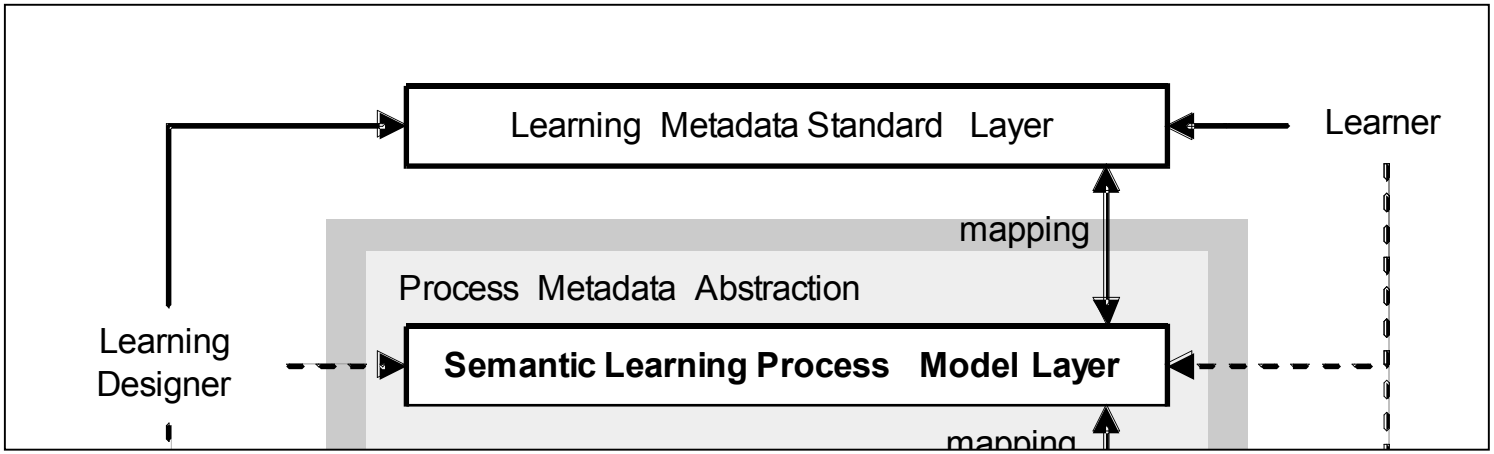
Approach: **SWS (dynamic²) instead of Data (static)**

... 2nd Step - Abstracting from services …

- Adopting **Semantic Web Service** technology (**WSMO**)
- Enables **dynamic selection and invocation of functionalities** (Web services) appropriate to achieve a specific **learning goal (objective)**
- Enables dynamic adaptation to different learning contexts based on **dynamic delivery of appropriate functionalities**



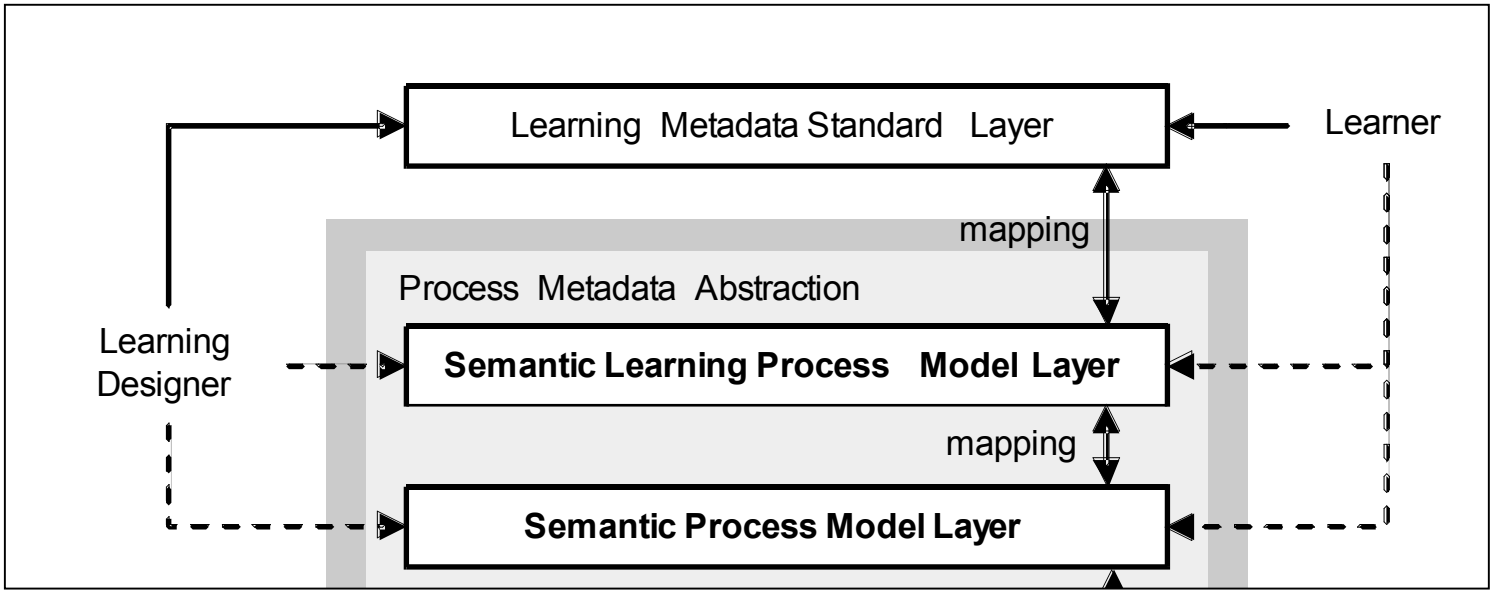
Approach: **Learning Processes**



… 3rd Step - Abstracting from specific learning process metadata standards ...

- Semantic models of learning processes **independent from any specific standard**
- Describing learning processes in terms of **learning goals**
- **Mapping** to and between several metadata standards as well as WSMO goals

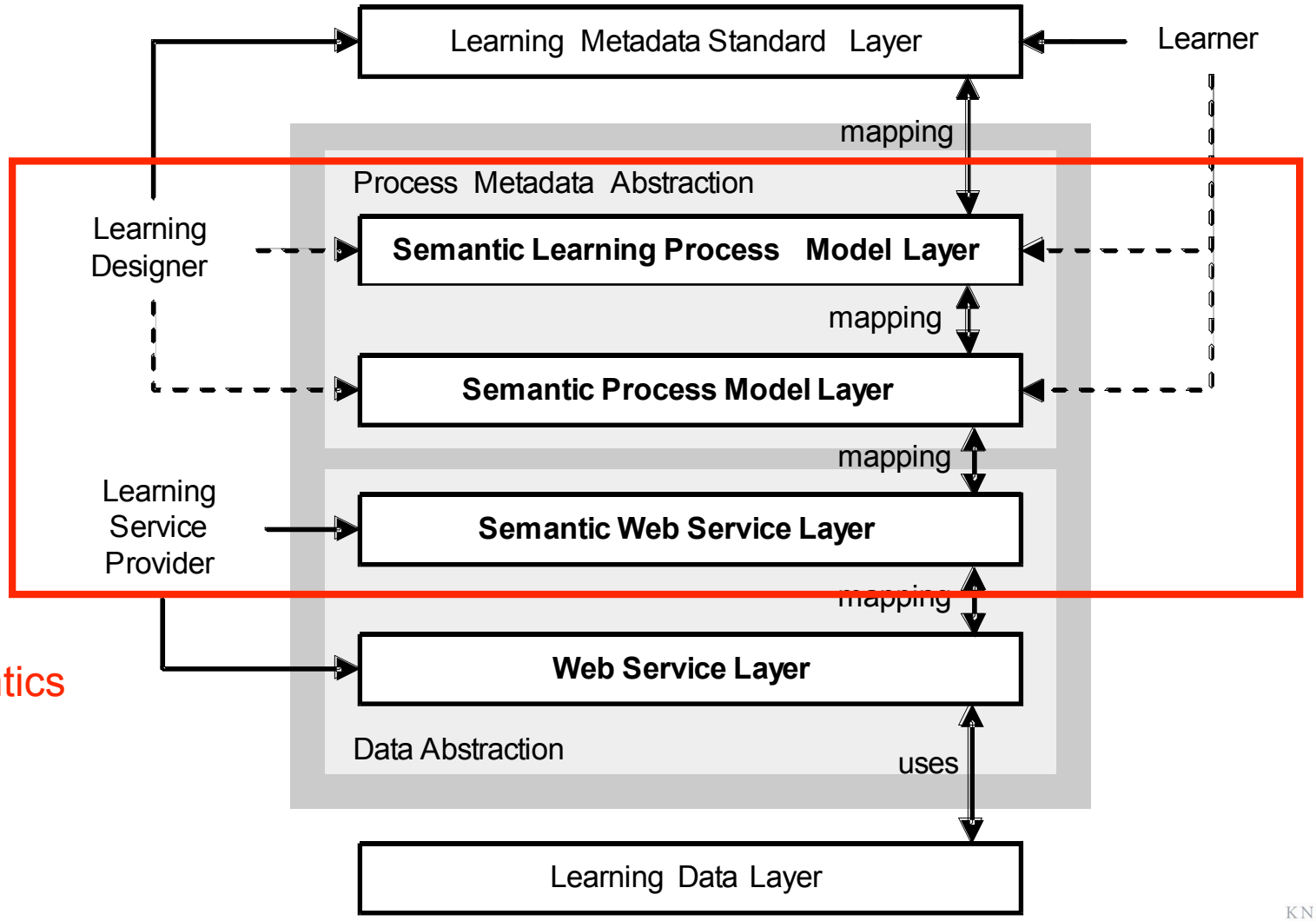
Approach: **Generic Processes**



… 4th Step - Abstract from learning process domain.

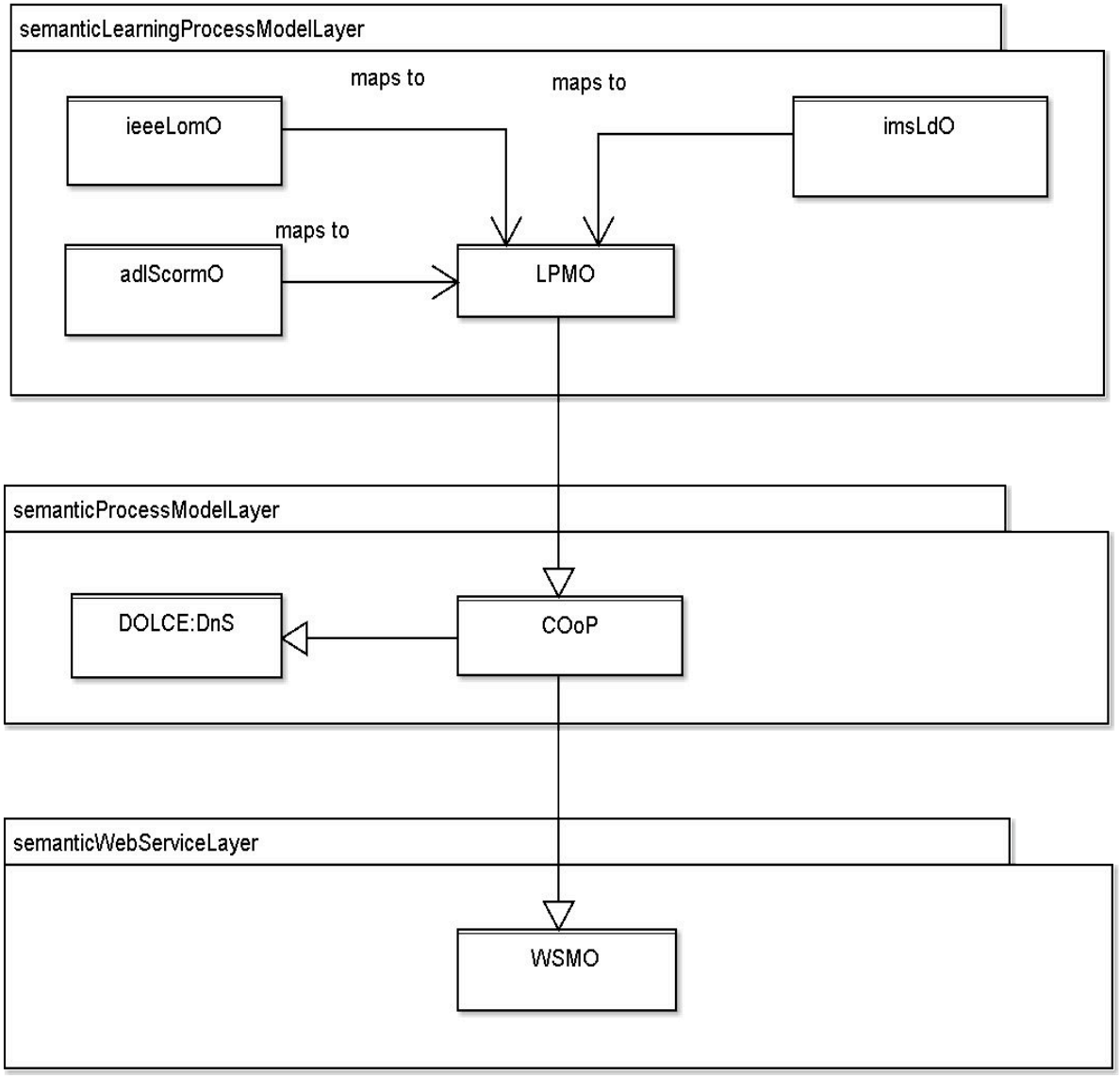
- Semantic models of processes **independent from specific kind of process**, e. g. learning process, business process
- Enables mapping between different kind of domain processes

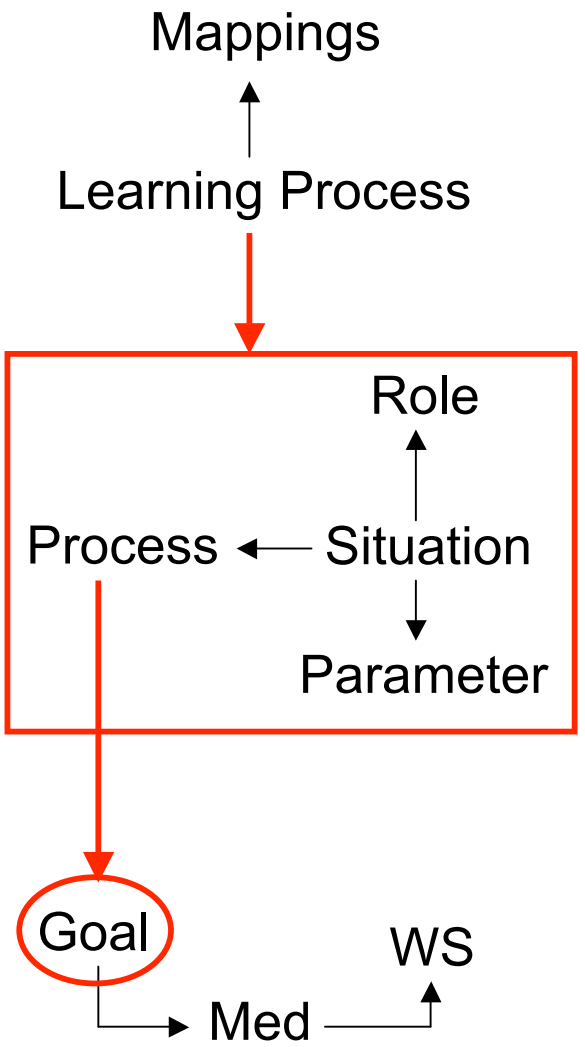
Approach: **Conceptual Architecture**



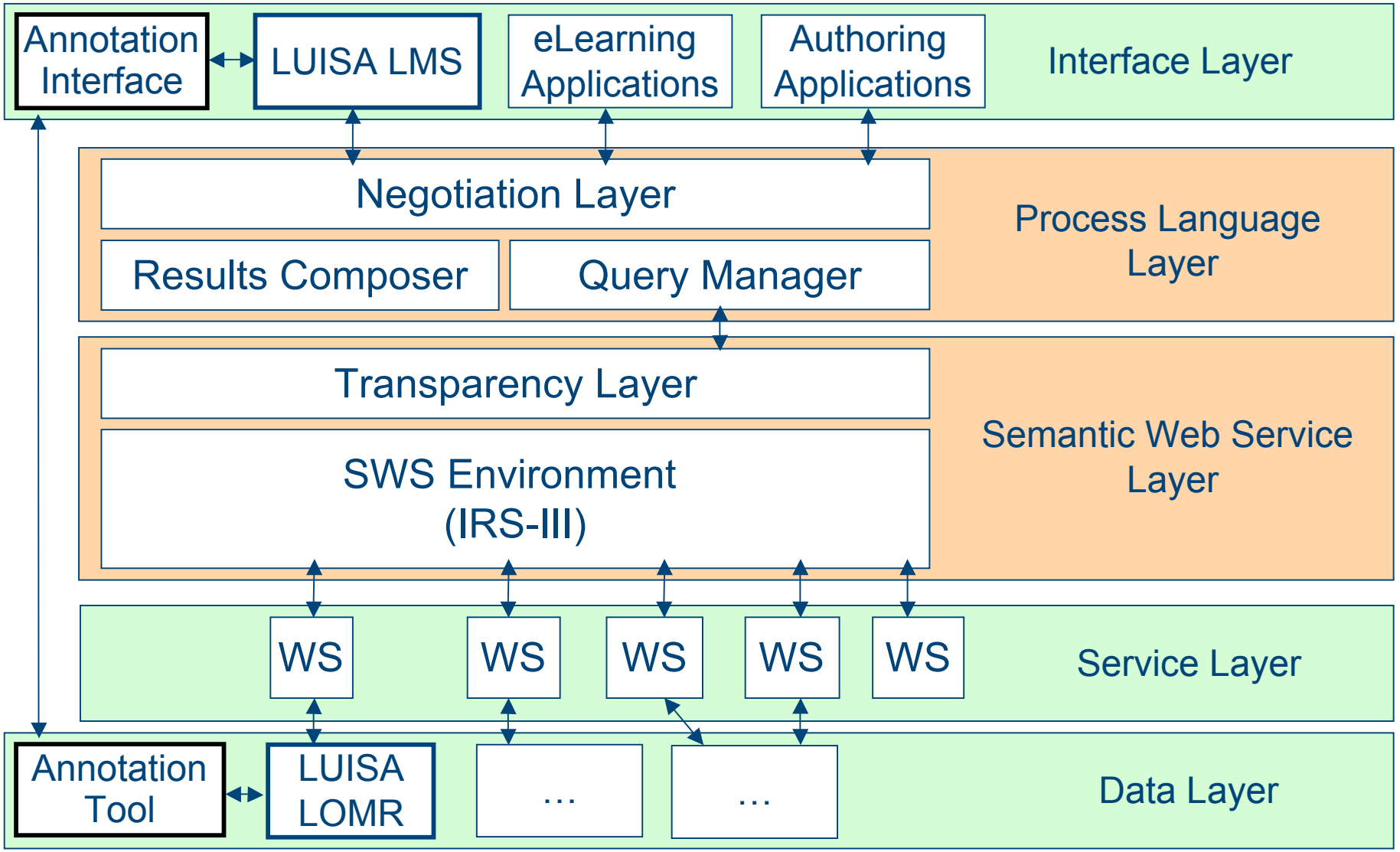
Use of Semantics

Use of semantics: **Ontology Stack**

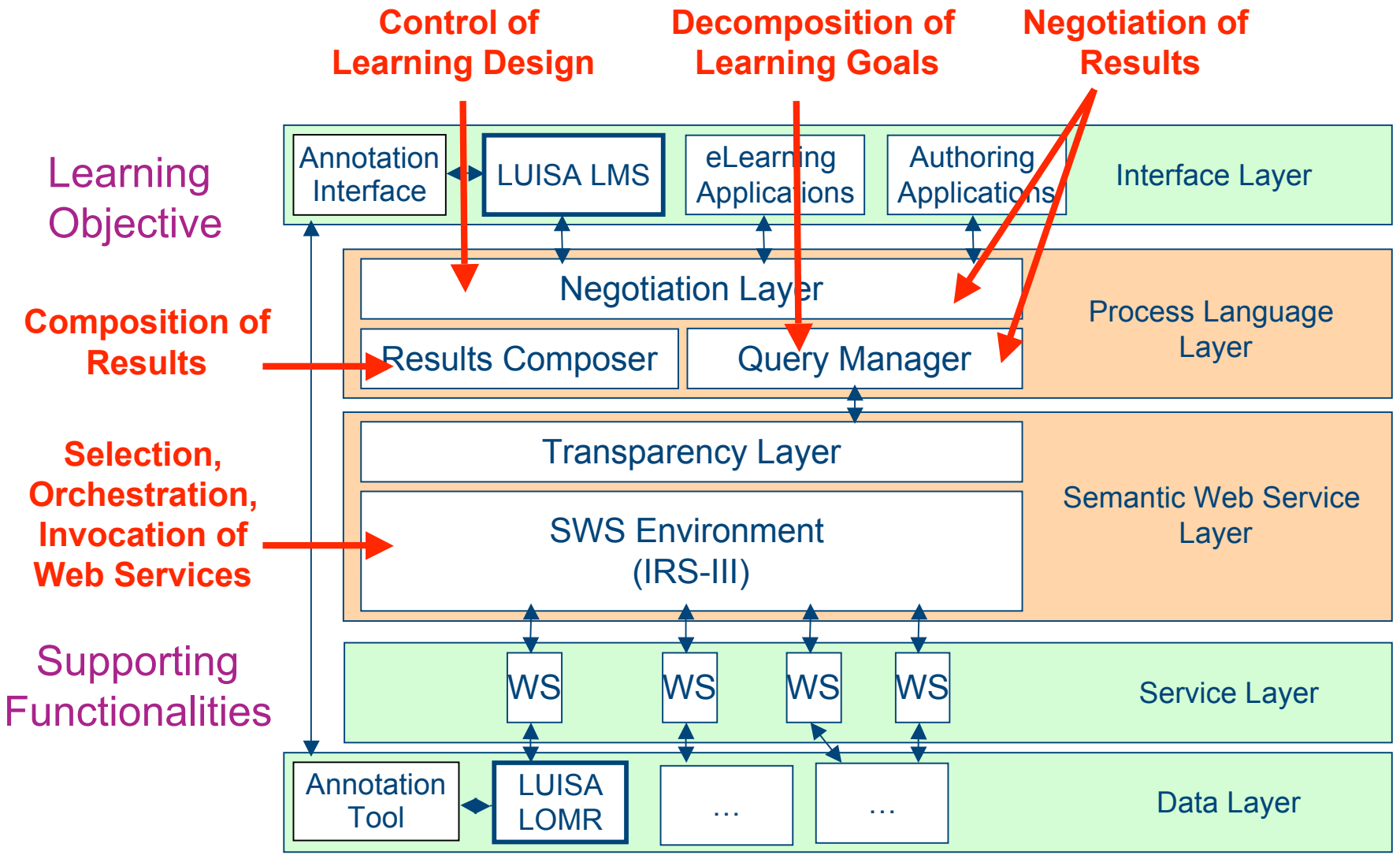




Luisa SWS Infrastructure: **Architecture**



SWS Infrastructure: **Role**



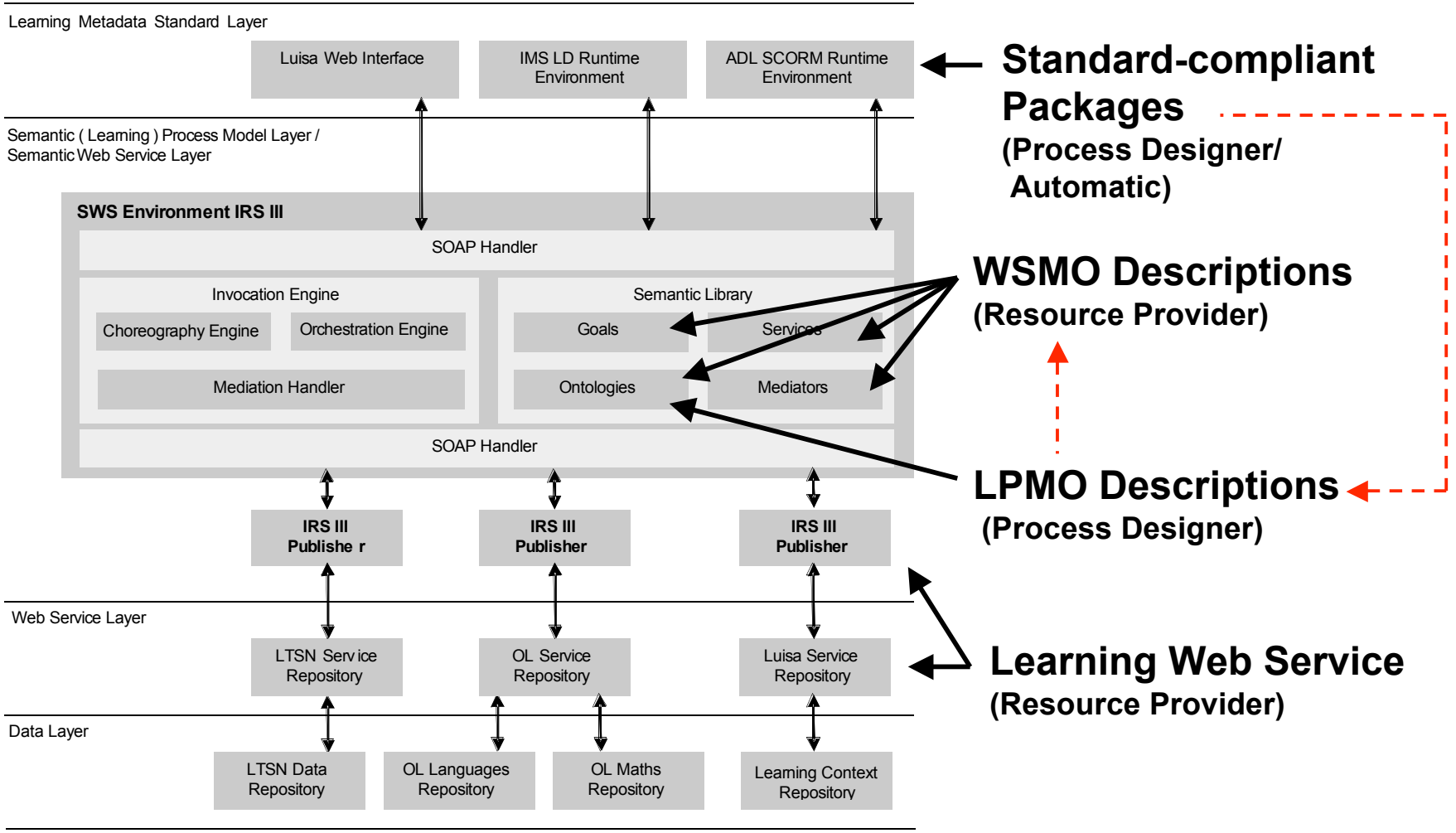
Use Case

Use Case: **Scenario**

Highly adaptive and standard-compliant learning packages:

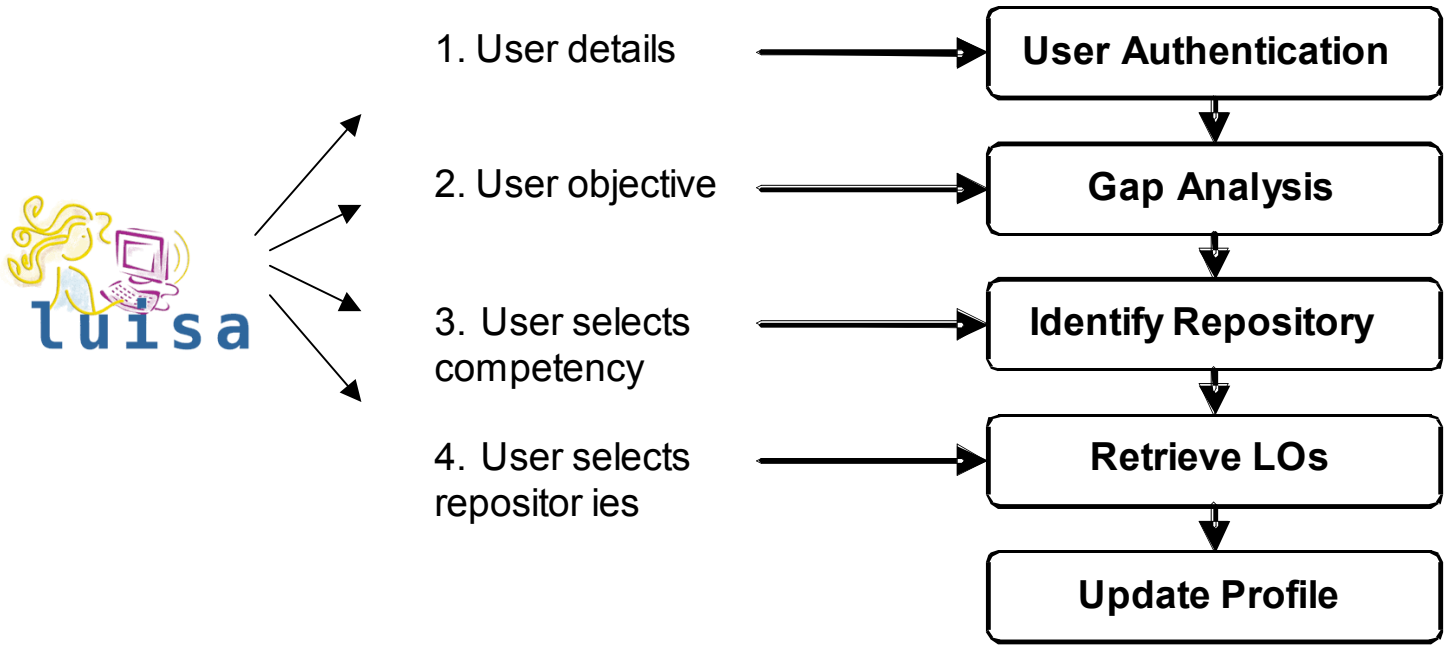
- One unique IMS Content Package (IMS LD) reused across different learning contexts
- Different learners supported by achieving his/her different objectives
  (e. g. “Learn German”, “Learn Italian” …)
- Individual learner preferences (e. g. native language) are considered at runtime for the dynamic service selection
  (e. g. french learners get french learning content…)

Use Case: **IRS-III**



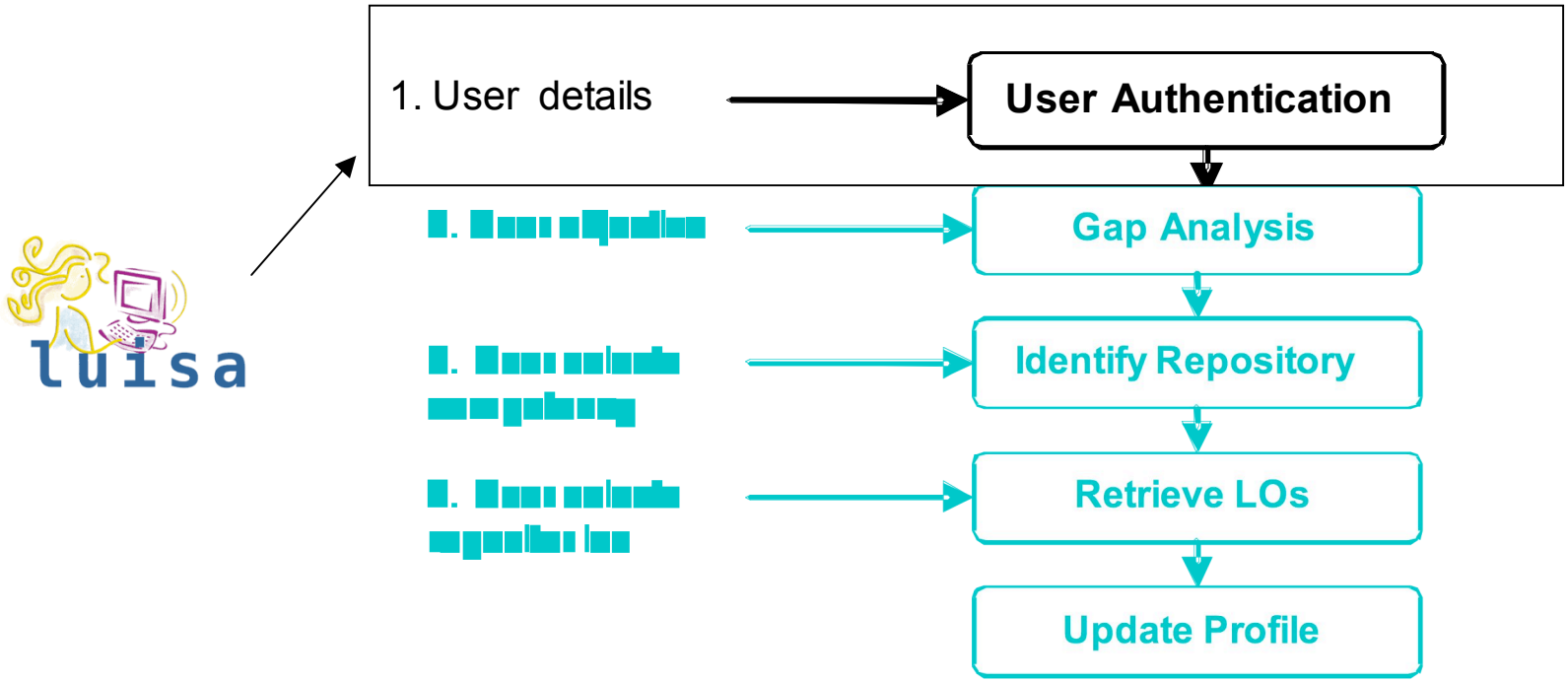
Use Case: **Dynamic Context-Adaptation**

- **Context-adaptive delivery** of …
- … **distributed learning resources** based on semantic matchmaking



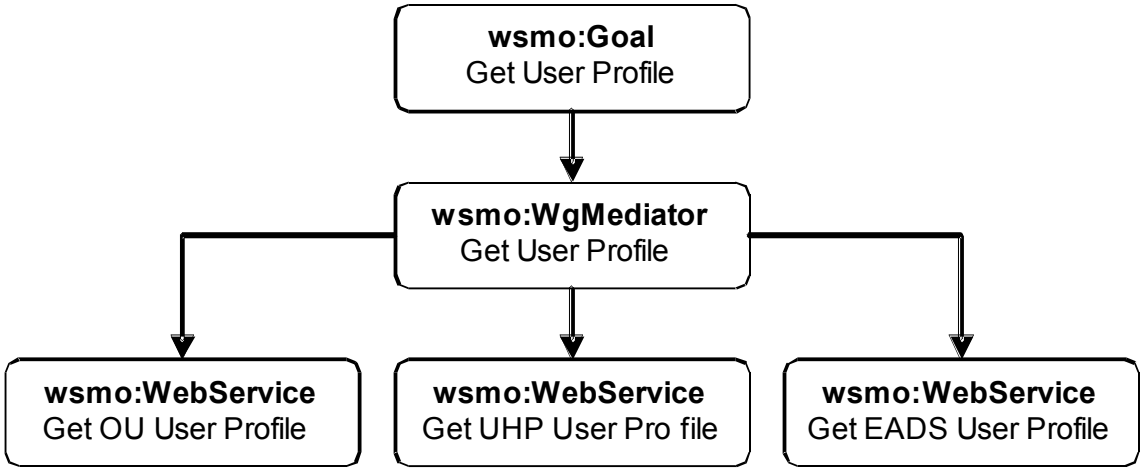
Use Case: **Dynamic Context-Adaptation**

- **Context-adaptive delivery** of …
- … **distributed learning resources** based on semantic matchmaking



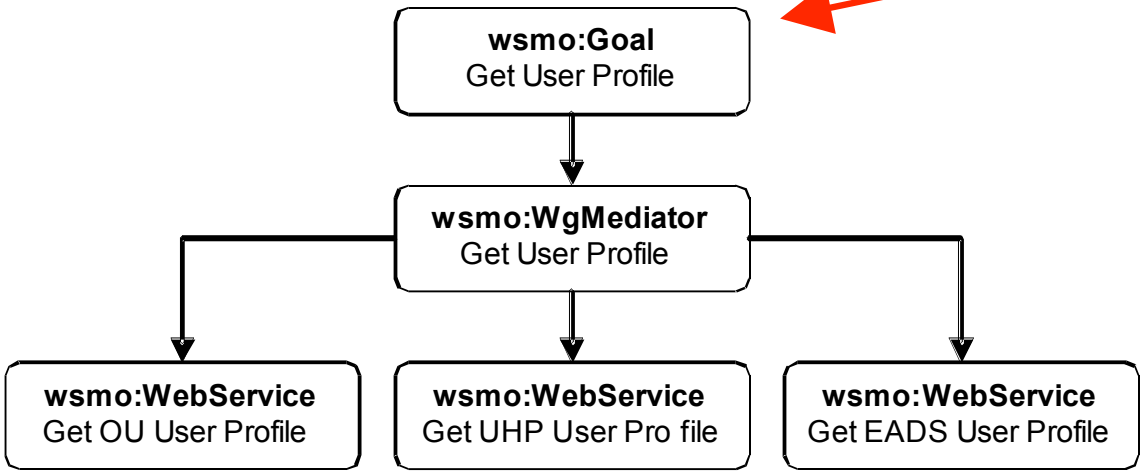
Prototype Application: **User Authentication**

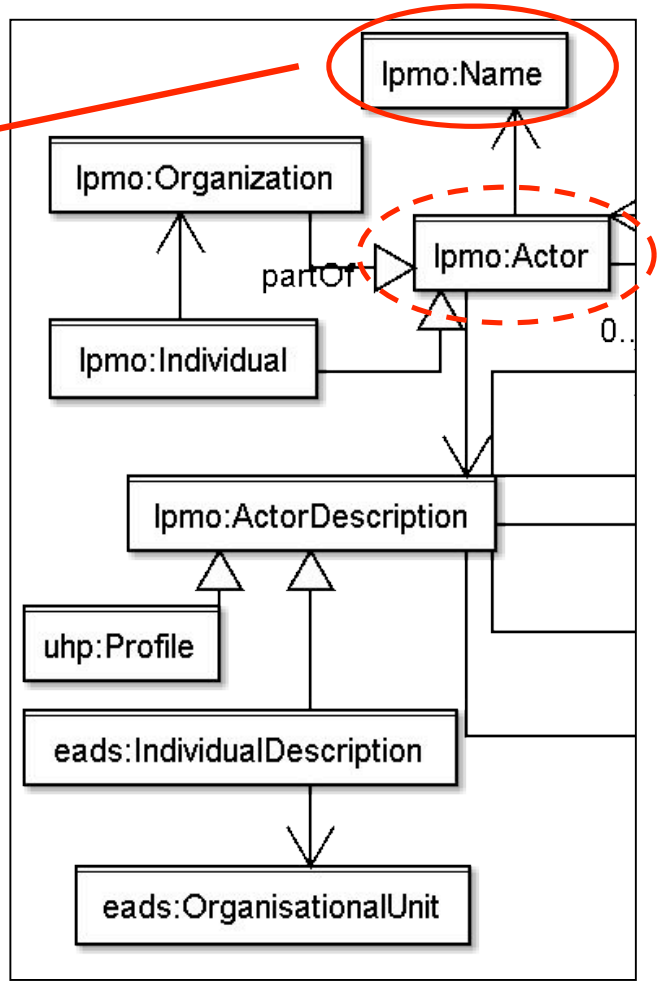
Involved **Semantic Web Services** …



Prototype Application: **User Authentication**

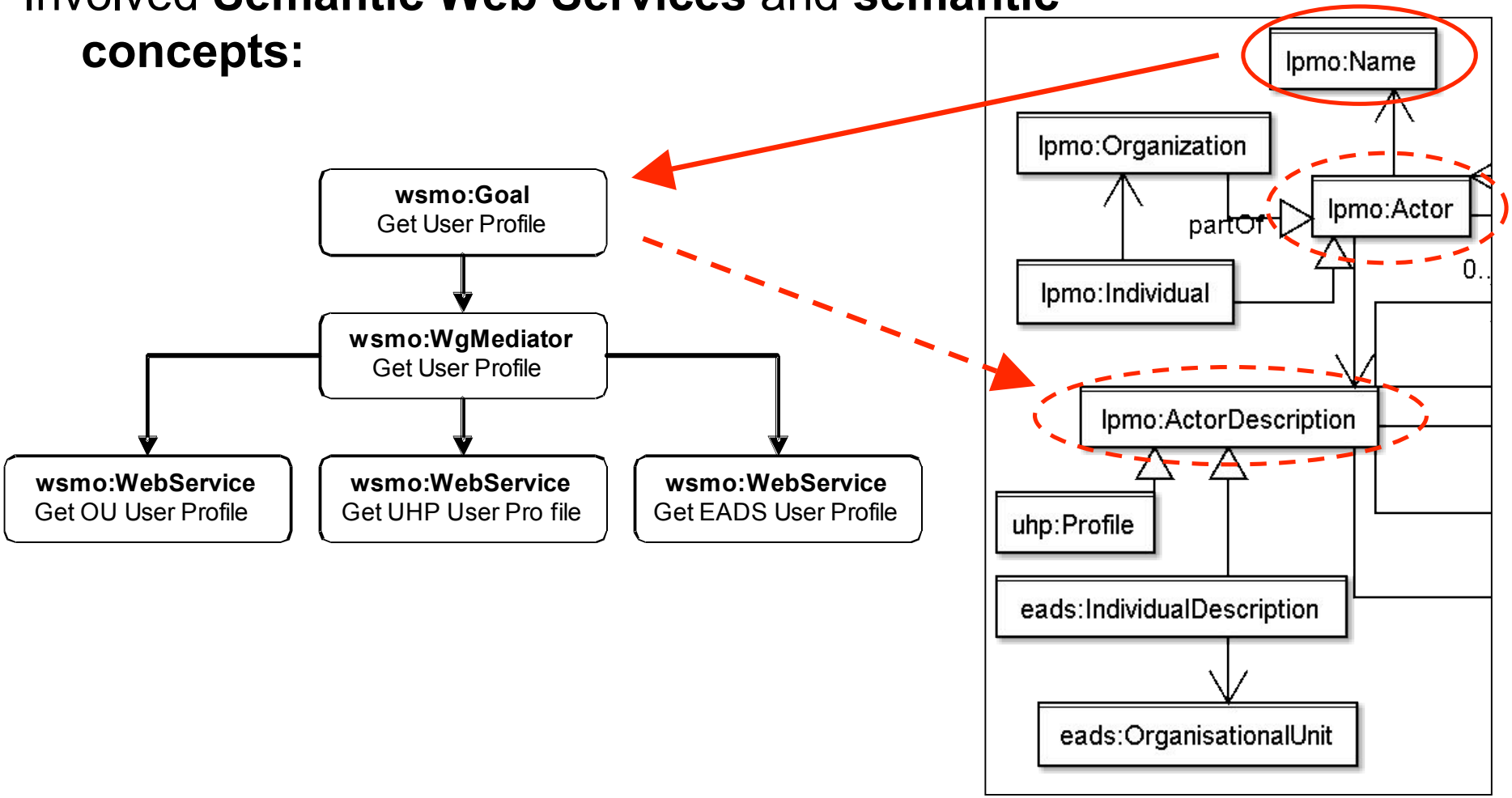
Involved **Semantic Web Services** and **semantic concepts:**





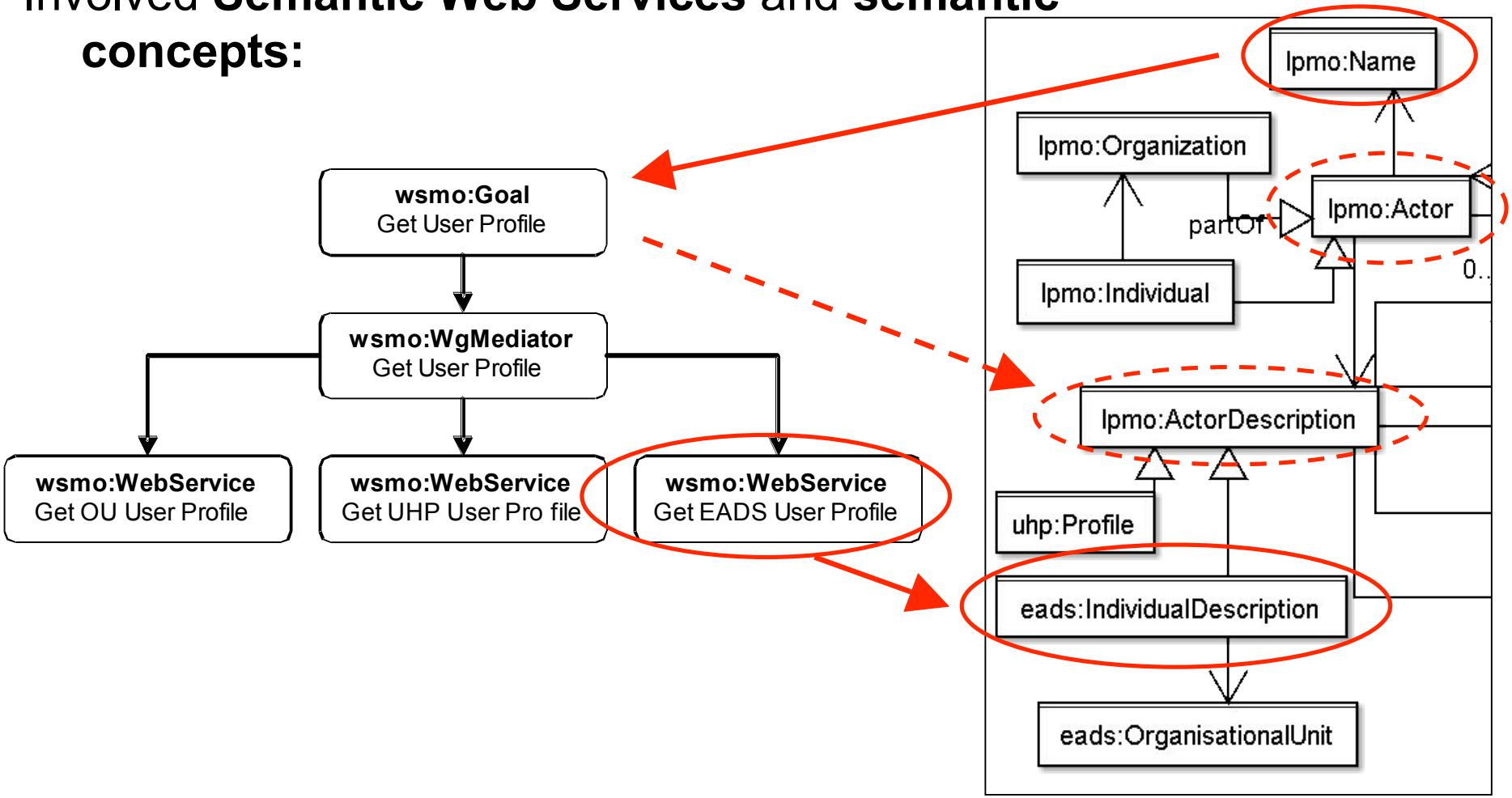
Prototype Application: **User Authentication**

Involved **Semantic Web Services** and **semantic concepts:**



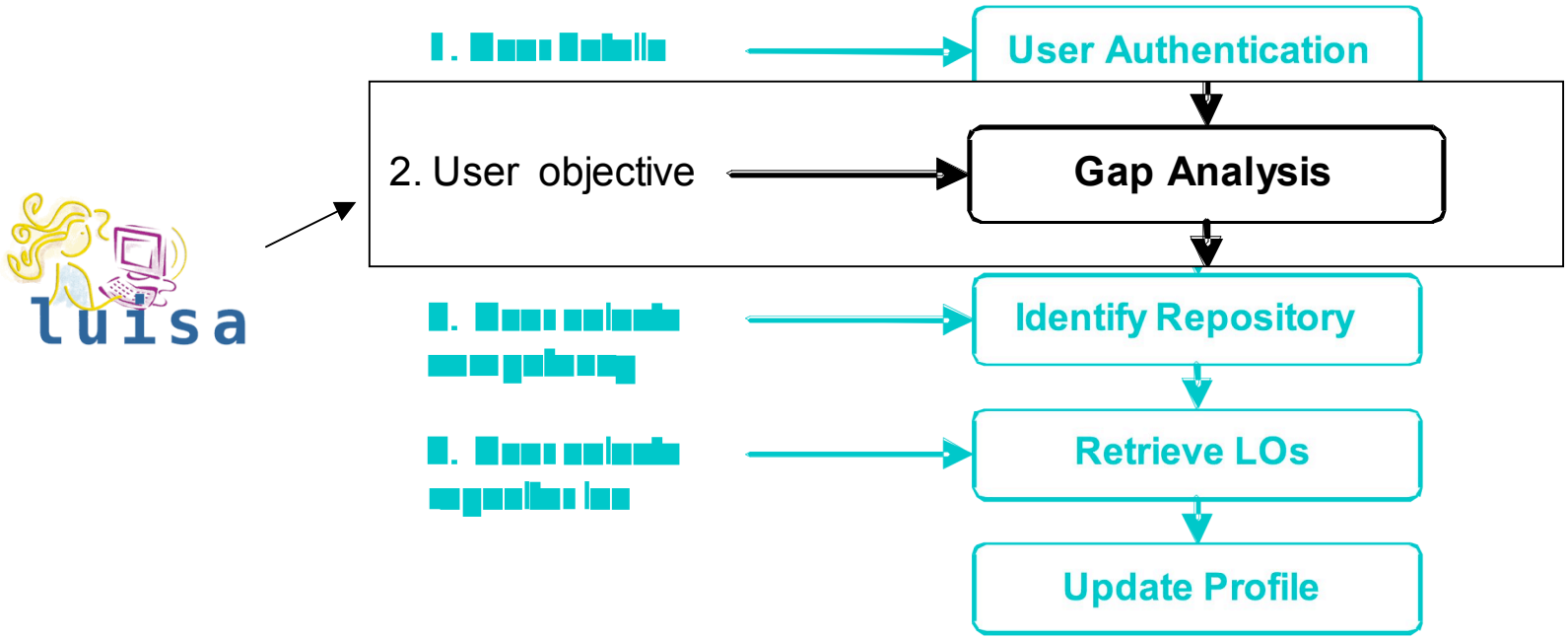
Prototype Application: **User Authentication**

Involved **Semantic Web Services** and **semantic concepts:**



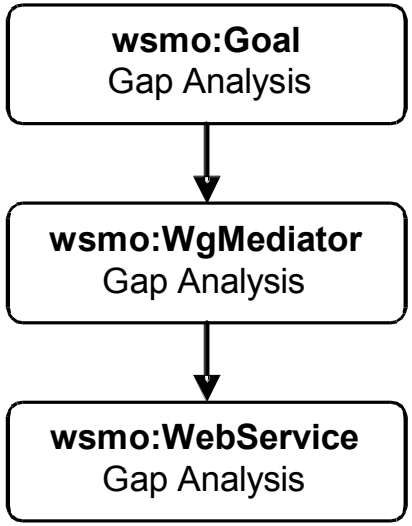
Use Case: **Dynamic Context-Adaptation**

- **Context-adaptive delivery** of …
- … **distributed learning resources** based on semantic matchmaking



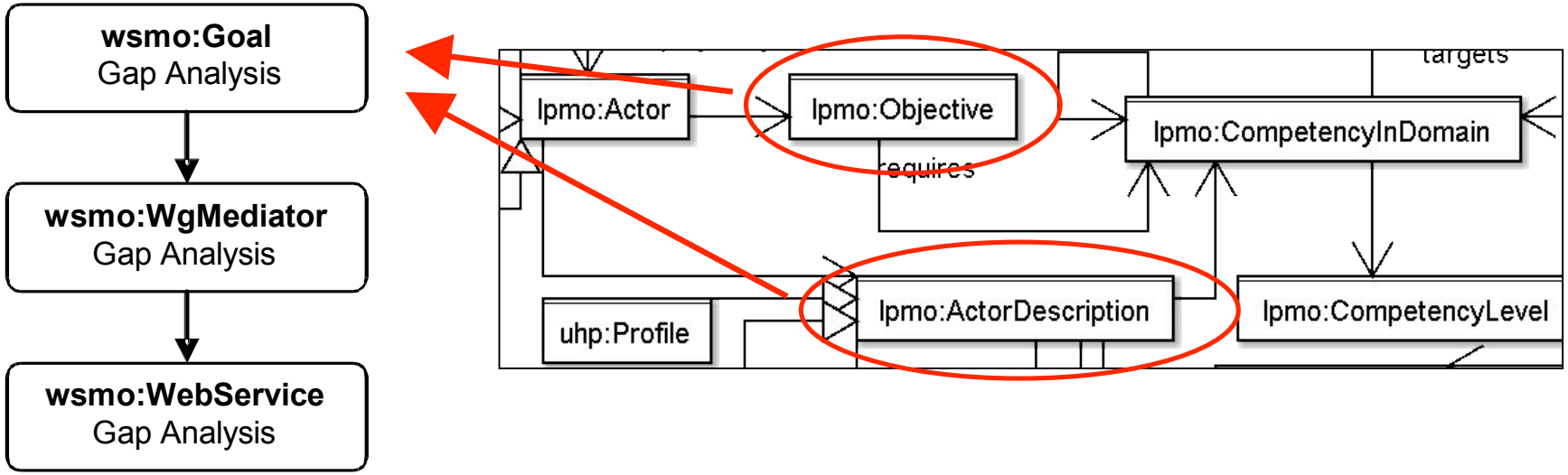
Prototype Application: **Gap Analysis**

Involved **Semantic Web Services** …



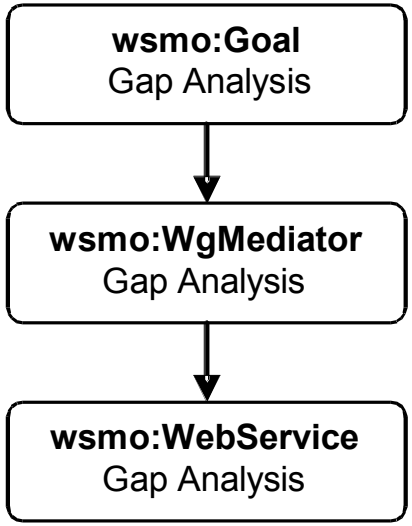
Prototype Application: **Gap Analysis**

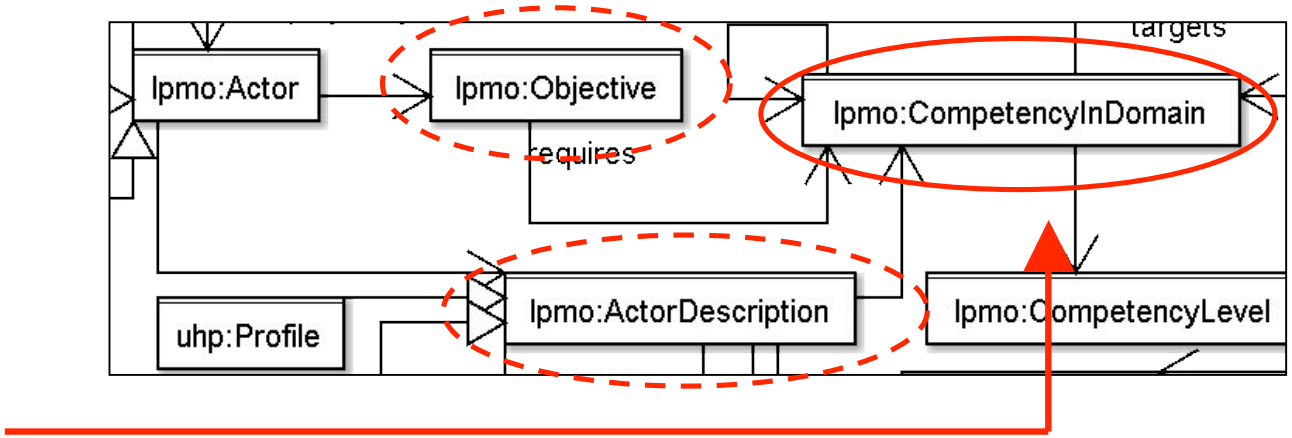
Involved **Semantic Web Services** and **semantic concepts:**



Prototype Application: **Gap Analysis**

Involved **Semantic Web Services** and **semantic concepts:**

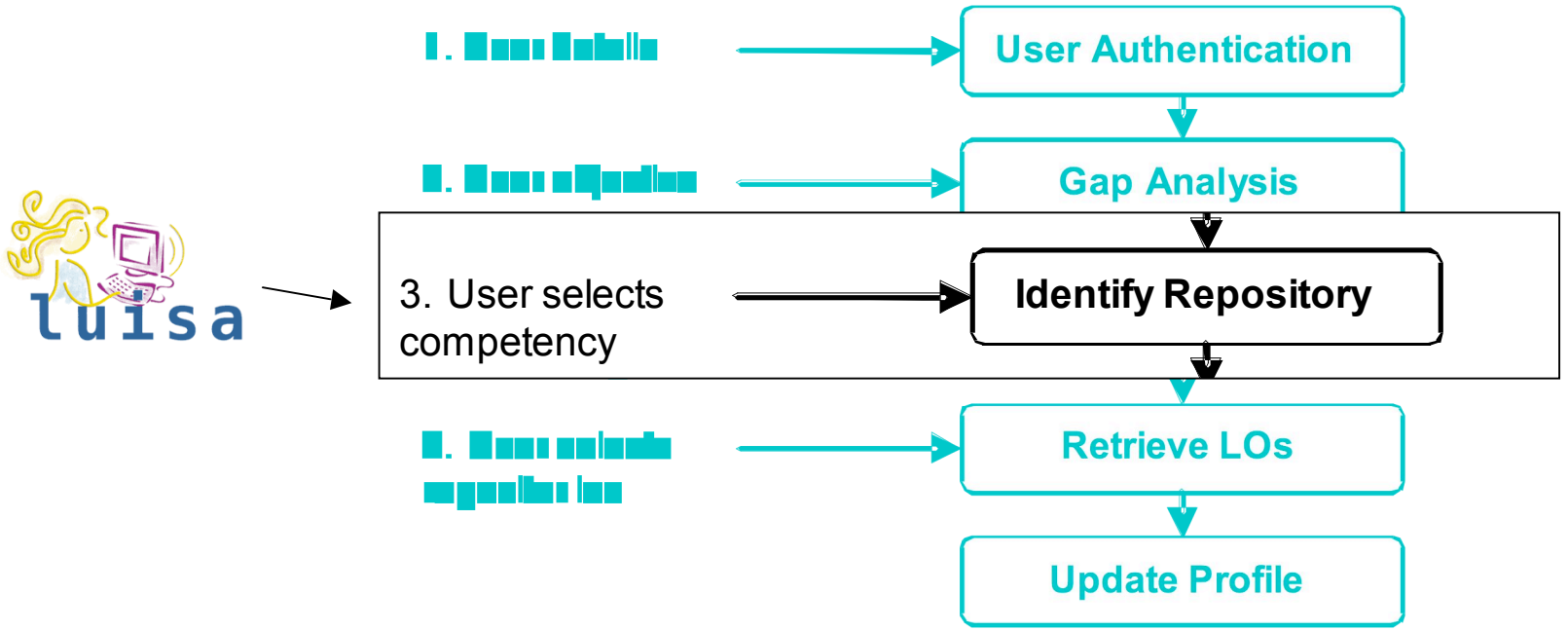




computed competency gap
(list of competencies)

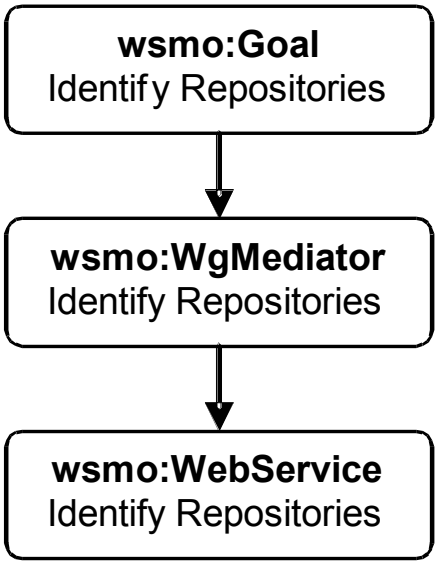
Use Case: **Dynamic Context-Adaptation**

- **Context-adaptive delivery** of …
- … **distributed learning resources** based on semantic matchmaking



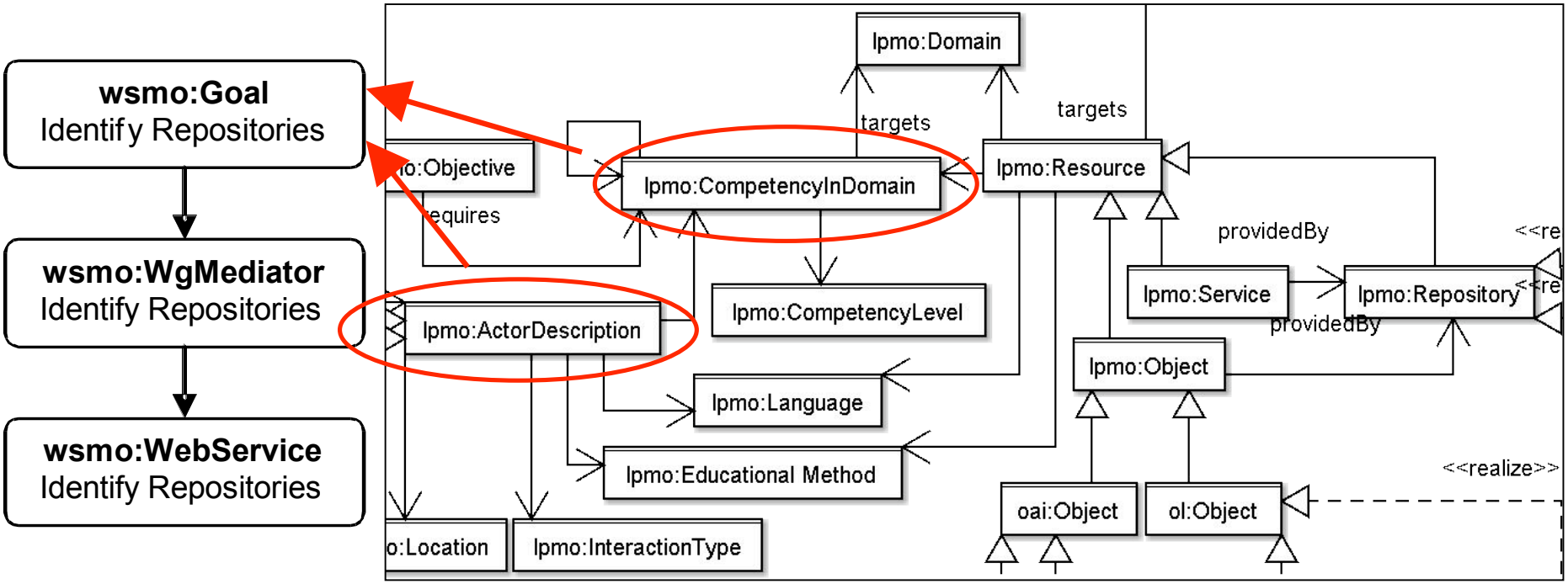
Prototype Application: **Identify Repositories**

Involved **Semantic Web Services** …



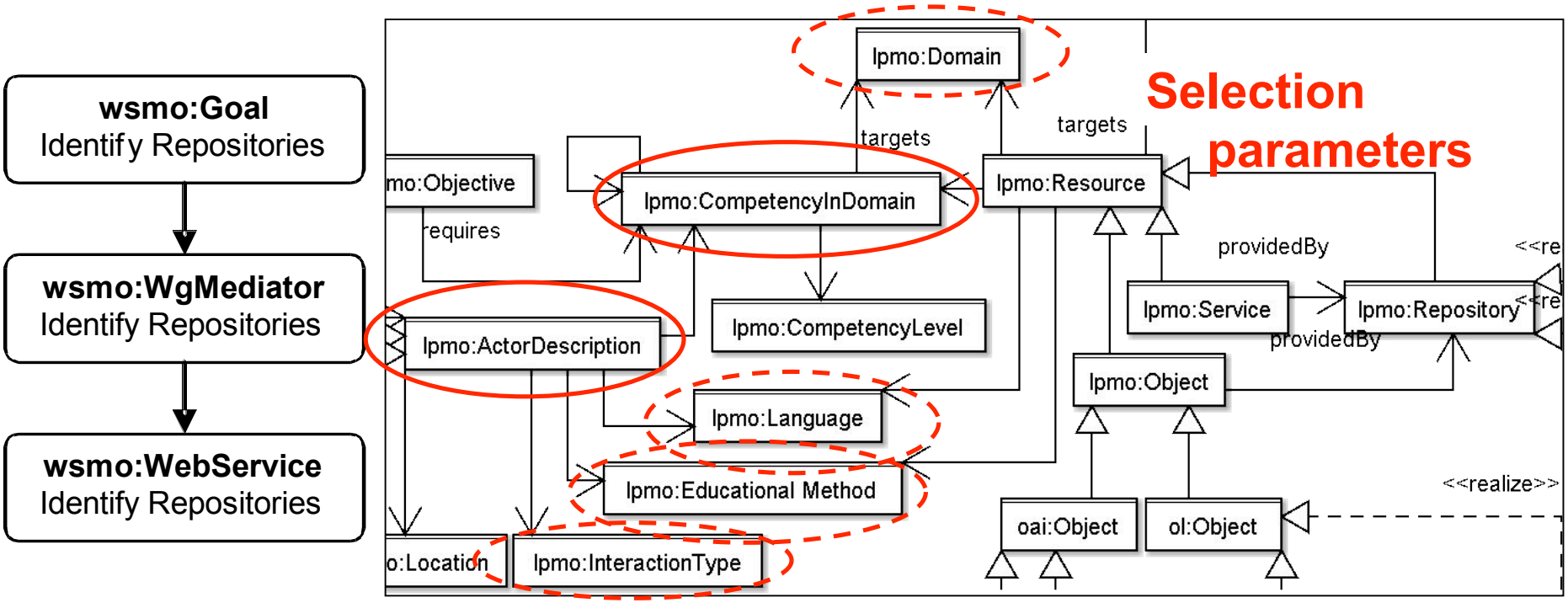
Prototype Application: **Identify Repositories**

Involved **Semantic Web Services** and **semantic concepts:**



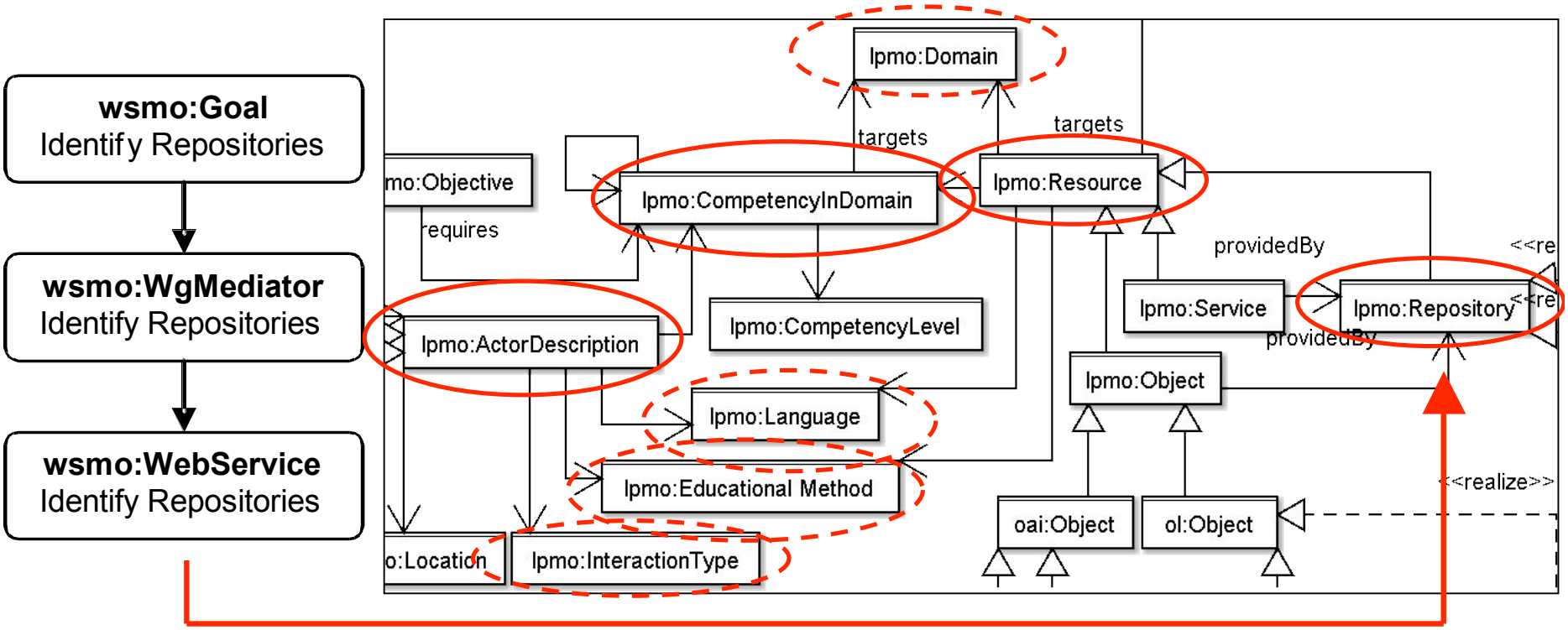
Prototype Application: **Identify Repositories**

Involved **Semantic Web Services** and **semantic concepts:**



Prototype Application: **Identify Repositories**

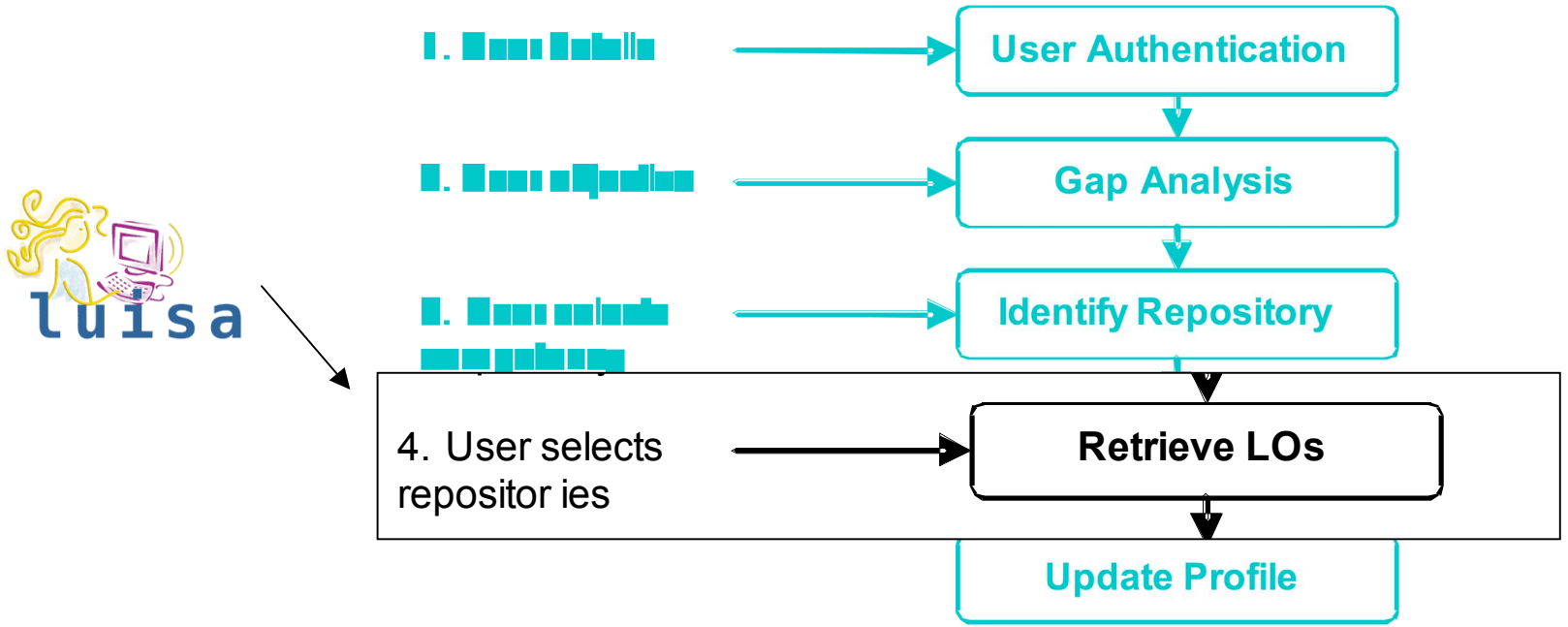
Involved **Semantic Web Services** and **semantic concepts:**



Matching repositories (list)

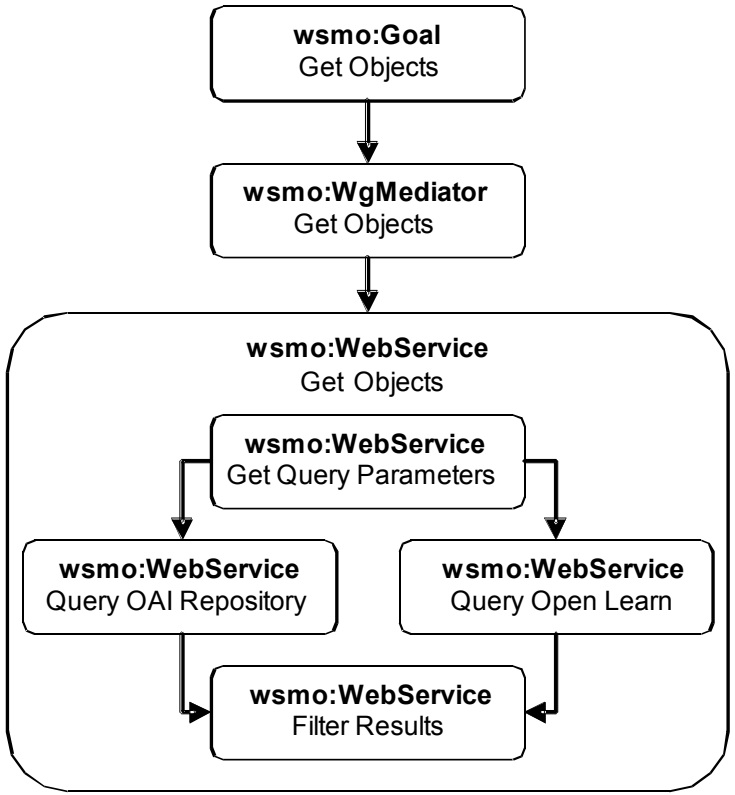
Use Case: **Dynamic Context-Adaptation**

- **Context-adaptive delivery** of …
- … **distributed learning resources** based on semantic matchmaking



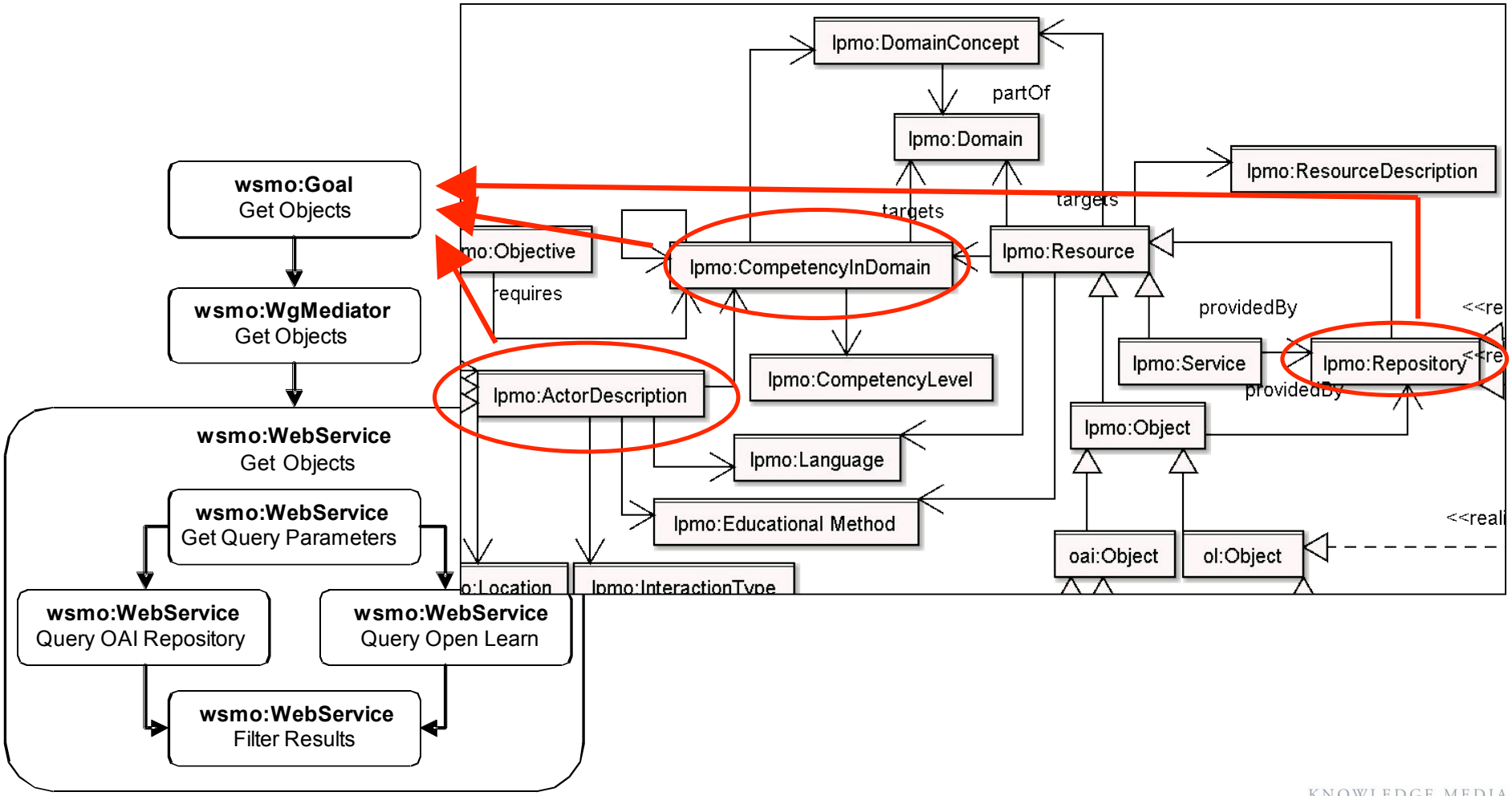
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** …



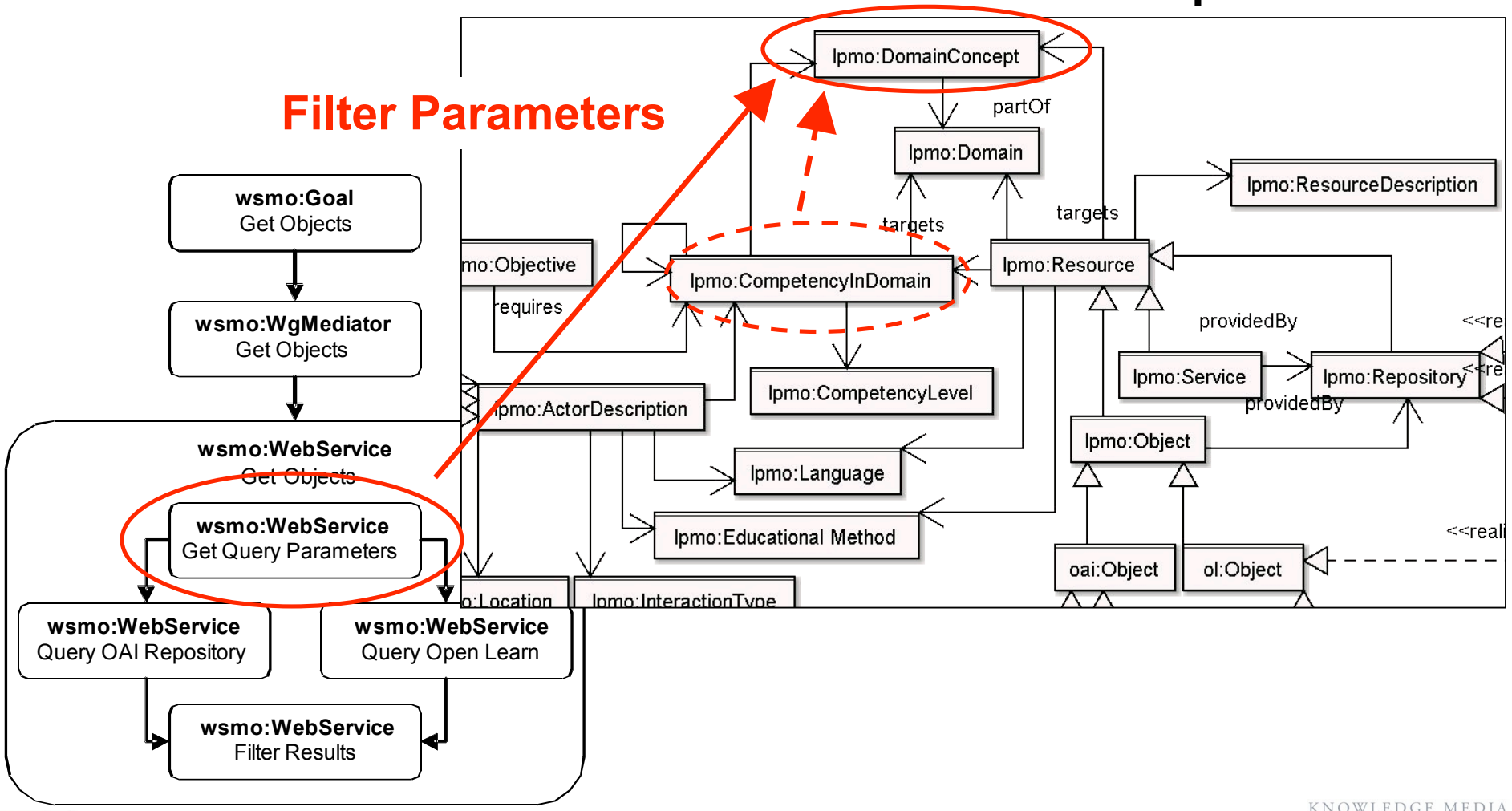
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



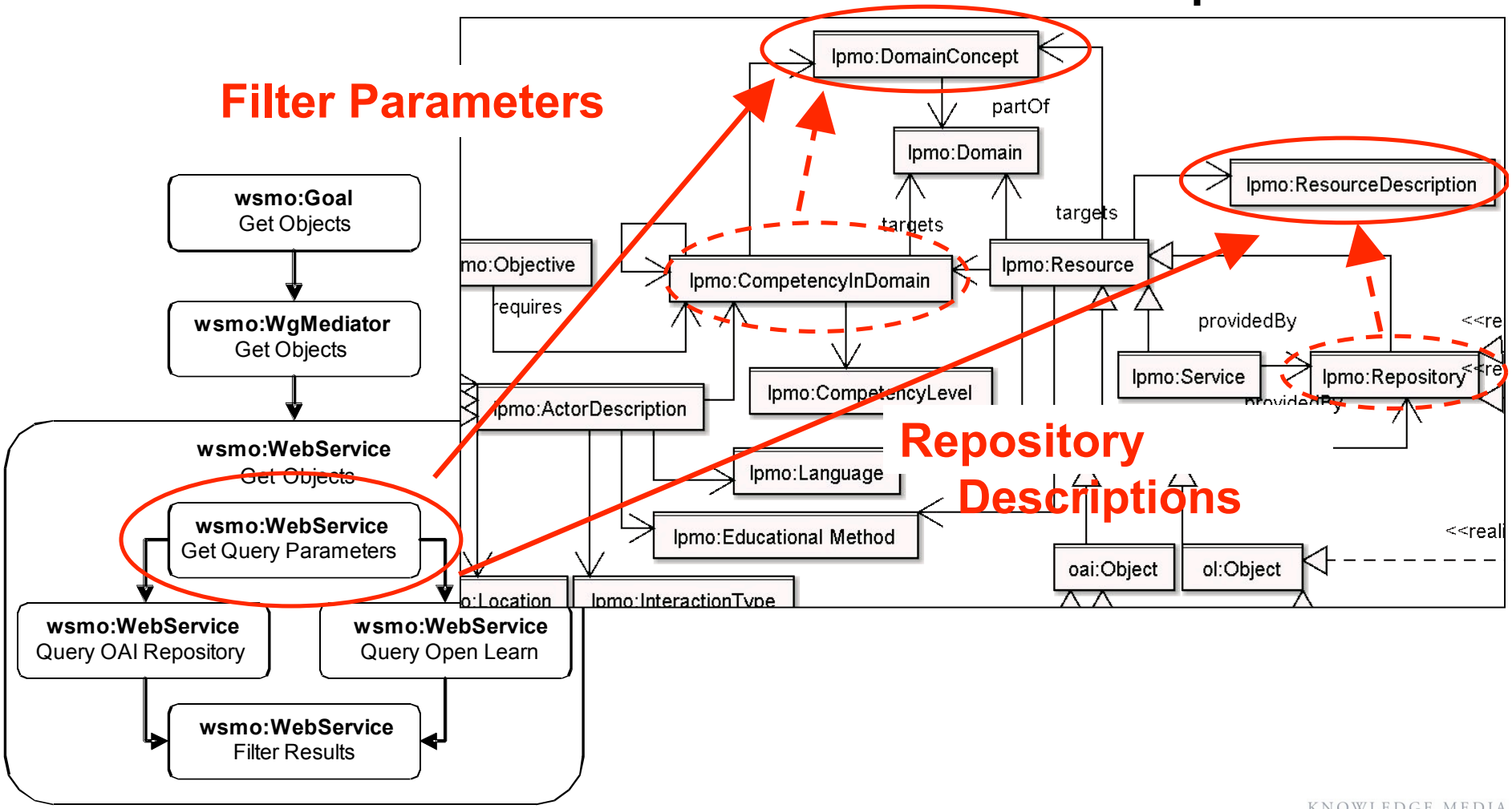
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



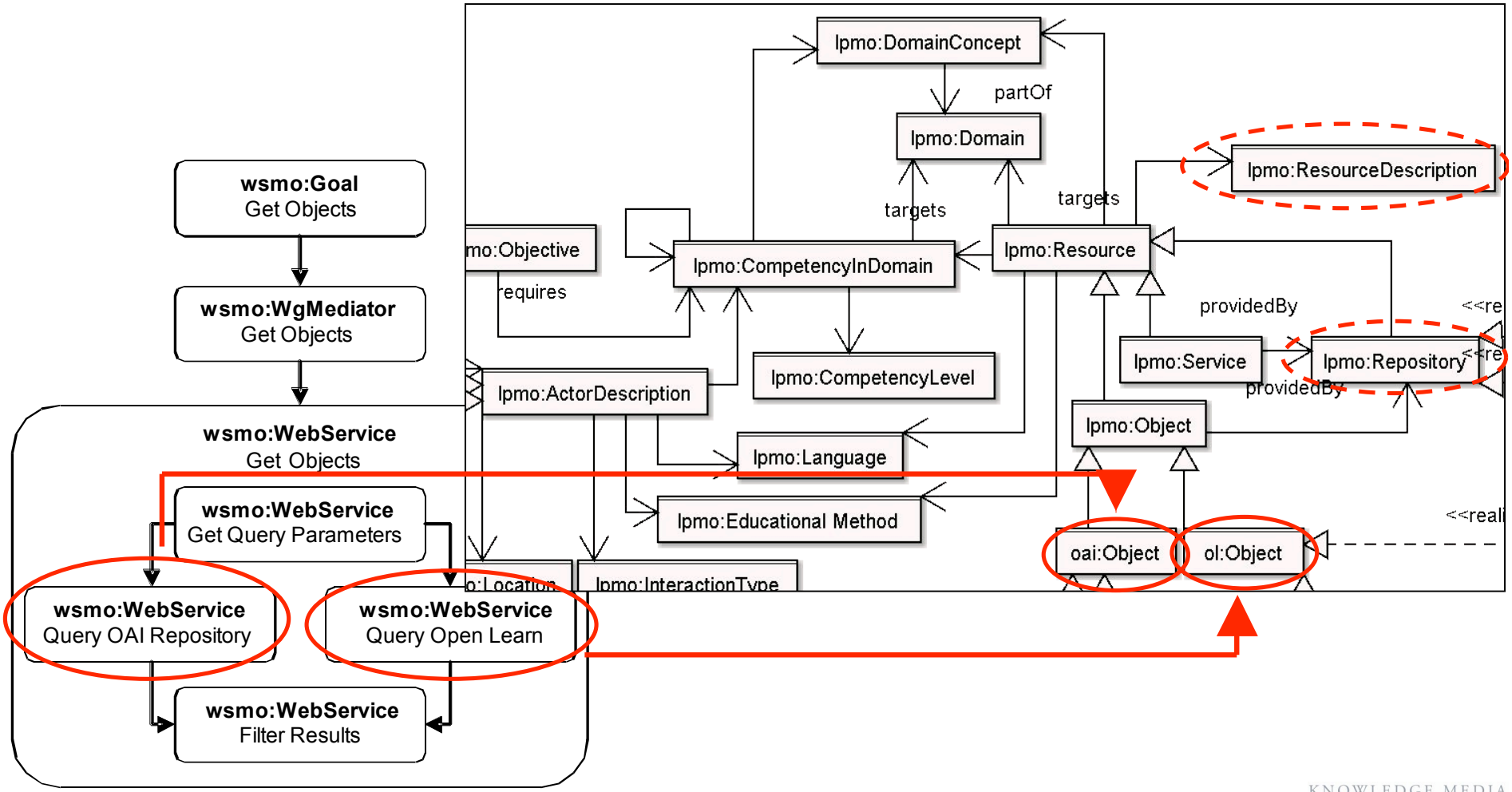
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



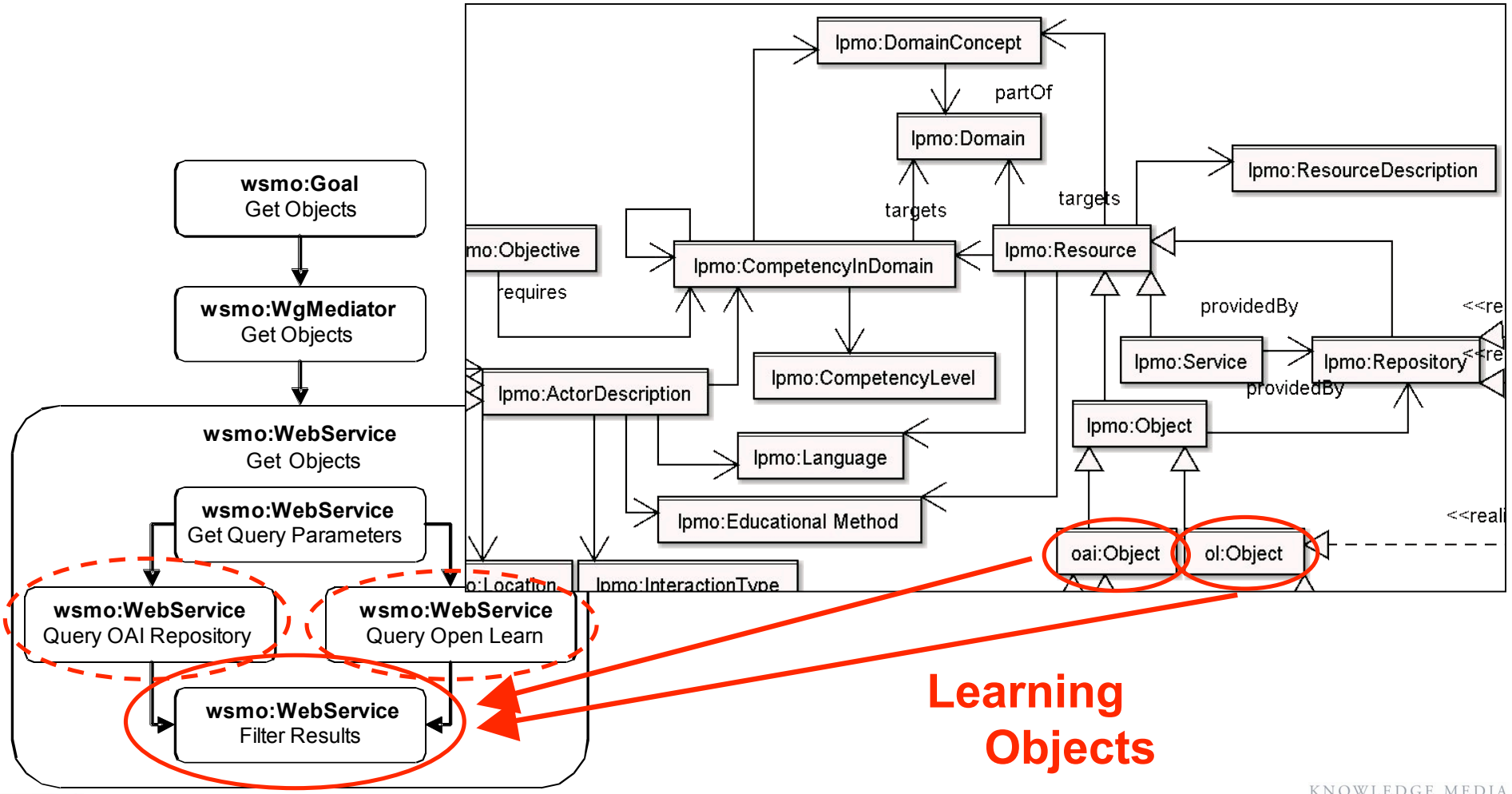
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



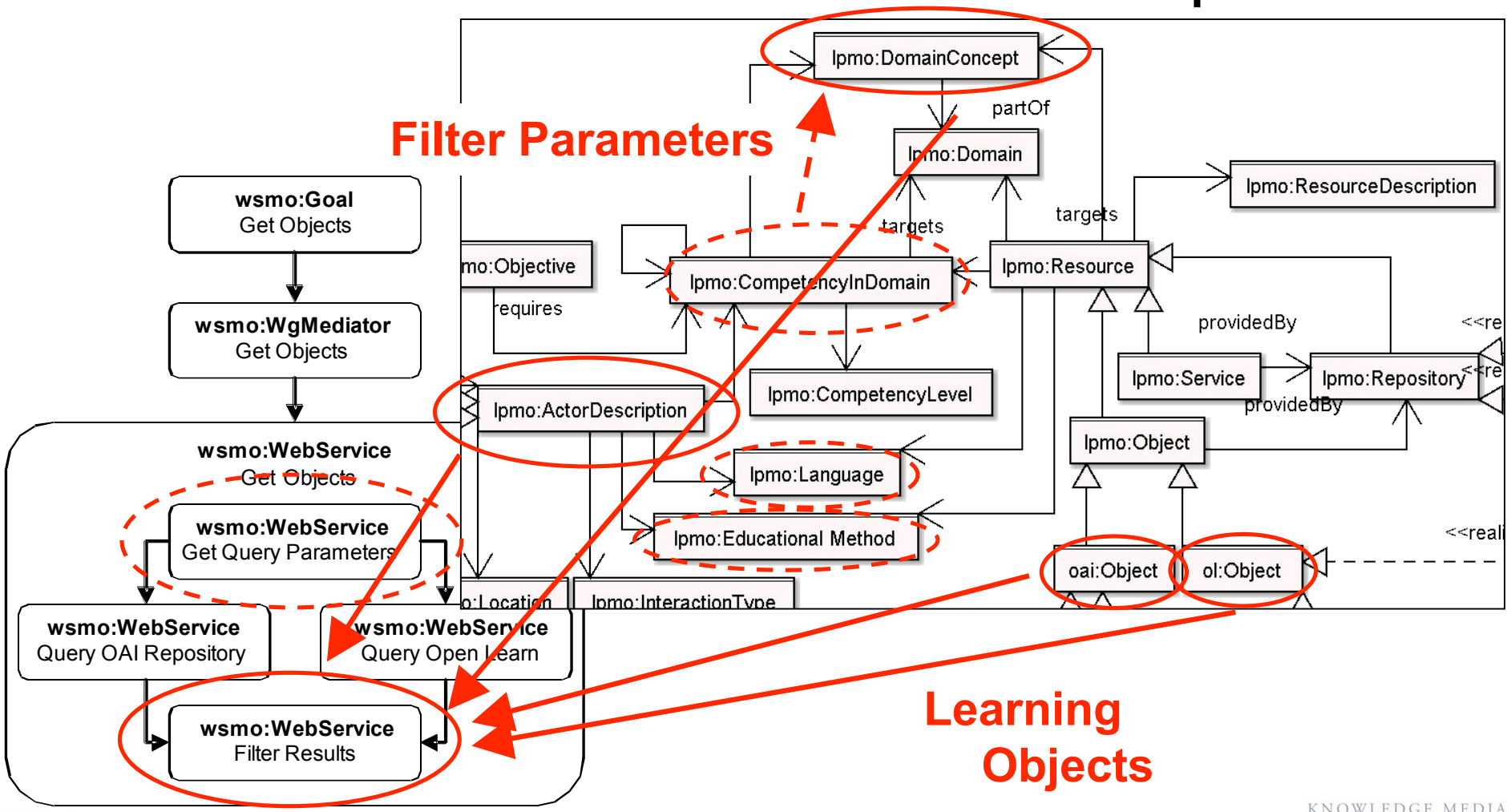
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



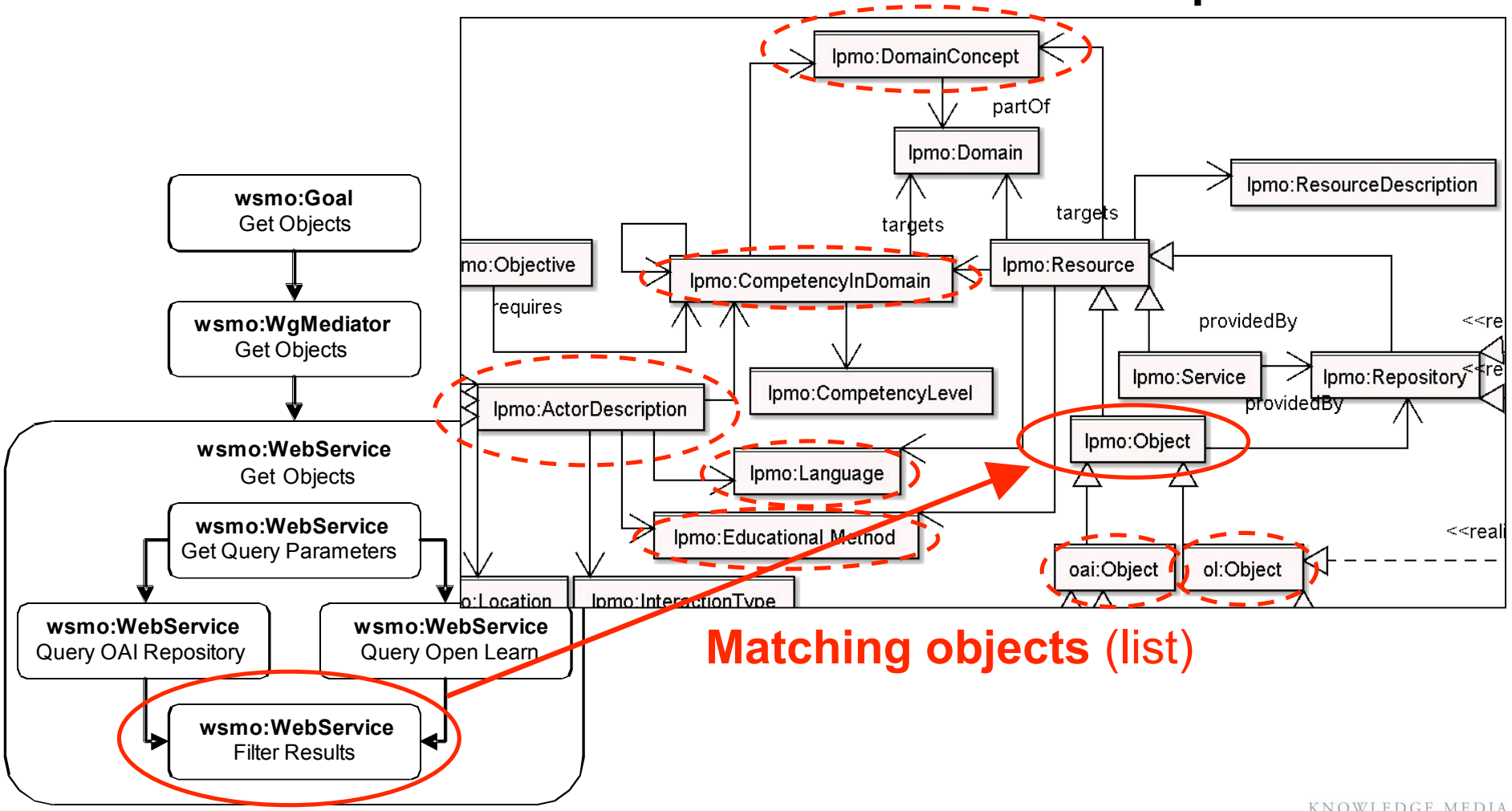
Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



Prototype Application: **Retrieve Objects**

Involved **Semantic Web Services** and **semantic concepts:**



Luisa Demo Video

Summary

- Applying SWS to support emergency planning
  - Integration of IRS-III and Google Maps
- Applying SWS to business process modelling
  - Ontology stack related to BPM notations and BPEL
- Applying SWS to eLearning in the Luisa project
  - Moving from learning objects to learning services

Acknowledgements

- Liliana Cabral
- Vlad Tanasescu
- Alessio Gugliotta
- Stefan Dietze
- Mary Rowlatt
- Leticia Gutierrez
- Christian Brelage
- DIP project
- SUPER project
- Luisa project

Thanks

KNOWLEDGE MEDIA

KMi

INSTITUTE