



9 April 2014
Athens - Greece

“An industry perspective on deployed semantic interoperability solutions”

Ralph Hodgson, CTO, TopQuadrant

SEMIC Conference, Athens, April 9, 2014

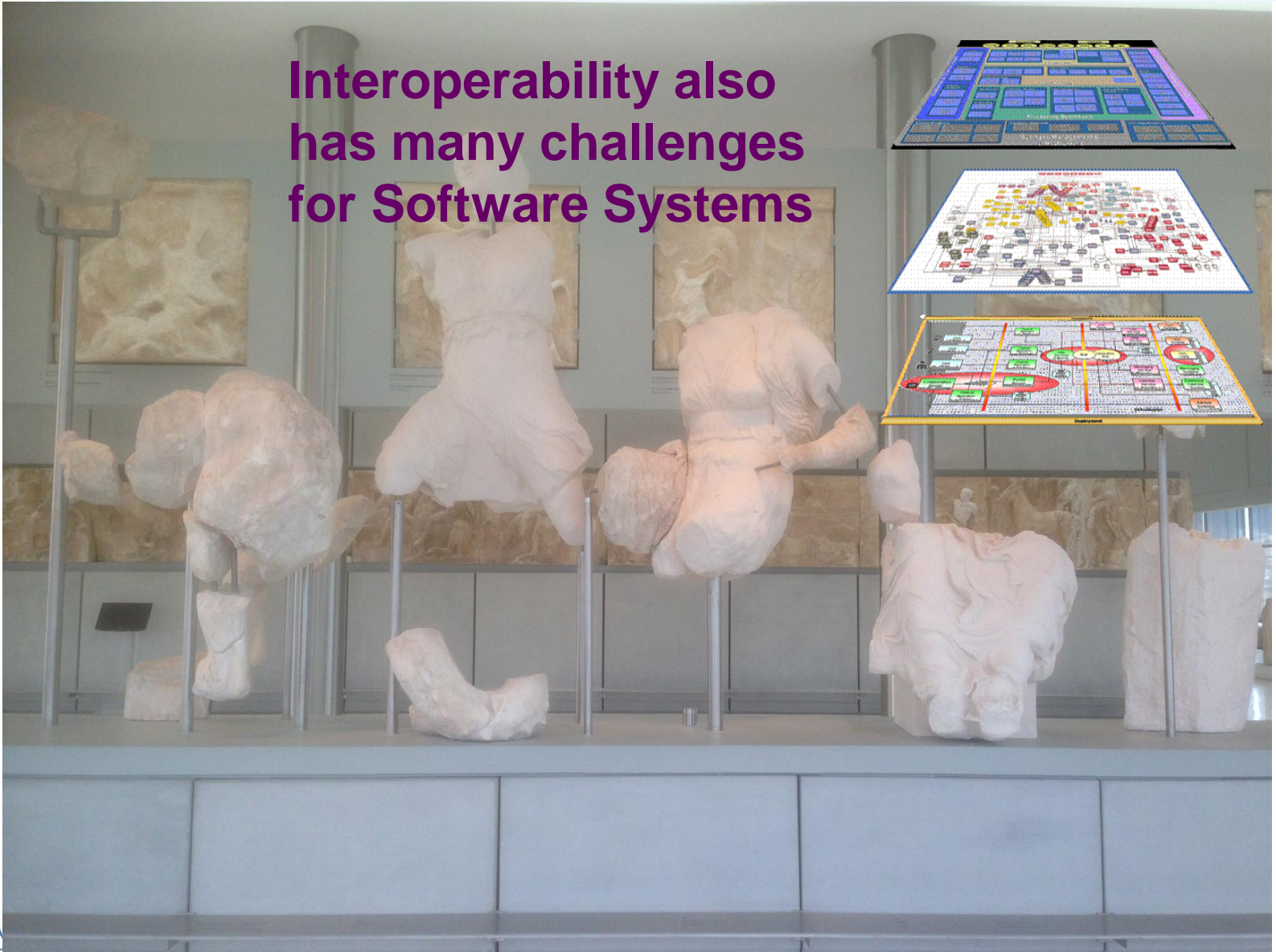
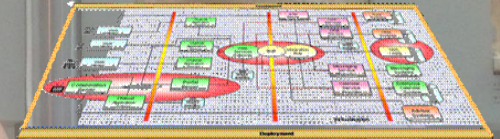
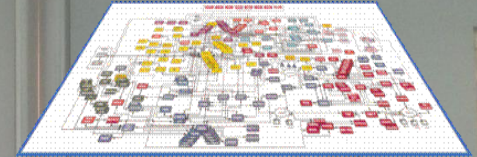
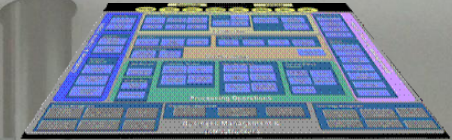


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<https://joinup.ec.europa.eu/community/semic/event/semic-2014-semantic-interoperability-conference>

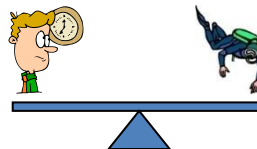
Interoperability has many Dimensions

Interoperability also has many challenges for Software Systems



Content

- Introductions
- Defining Interoperability
- Linked Data and Putting Ontologies to Work
- Semantic Interoperability Support with TopBraid Technologies
- Case Studies
- Deeper Dive on One Case Study: EPIM
- Concluding Remarks
- Other Work



*Little time to dive deep:
“Take-Away” Slide*



Me - Ralph Hodgson

- ❖ *Co-founder and CTO of TopQuadrant, Inc., a US-headquartered company that specializes in semantic solutions, consulting, training, and platforms;*
- ❖ *NASA QUDT Ontologies and Handbook Lead*
- ❖ *EPIM Lead Semantic Applications Architect and Ontology Modeler*

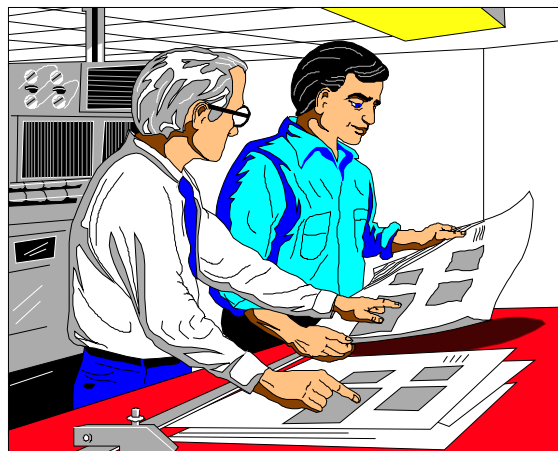
TopQuadrant

- ❖ *Started in in the US in 2001*
- ❖ *Innovator of SPARQL-based technologies: SPARQL Inferencing Notation ([SPIN](#)), [SPARQLMotion](#), SPARQL Web Pages ([SWP](#)), SPARQL Web Applications ([SWA](#))*
- ❖ *Vendor of:*
 - ❖ *Semantic Technology Solutions,*
 - ❖ *TopBraid Products,*
 - ❖ *TopBraid Platform,*
 - ❖ *IDE Tools,*
 - ❖ *Training and Consulting*



Two Meanings of Interoperability

- Interoperable information:
 - The ability of two or more systems or components to exchange information and to use the information that has been exchanged. [IEEE]
- Interoperable components:
 - "interoperable" means to be functionally equivalent or interchangeable components of the system or process in which they are used. [IETF RFC 2026, section 4.1.2]



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February 14 -16, 2006

What can go wrong with Data drives the requirements for Semantic Interoperability

Failure Mode	Cause
Data Type	<i>Different primitive or abstract types for same information</i>
Naming and Coding	<i>Synonyms/antonyms have different text labels. Enumerations have different coding schemes</i>
Aggregation: Structure and - Cardinality	<i>Different notions about relationships among concepts in similar data sets. Collections or constraints modeled differently for same information</i>
Generalization	<i>Different abstractions to model same domain</i>
Value Representation	<i>Different choices about what to made explicit</i>
Impedance Mismatch	<i>Fundamentally different data representations</i>
Naming	<i>Synonyms/antonyms exist in same/similar concept instance values</i>
Scaling and Units	<i>Different units of measures - incompatible scales</i>
Confounding	<i>Similar concepts with different definitions</i>
Domain	<i>Fundamental incompatibilities in domains</i>

February 14 -16, 2006



The Linked Data World (circa-2009)

Information Architecture

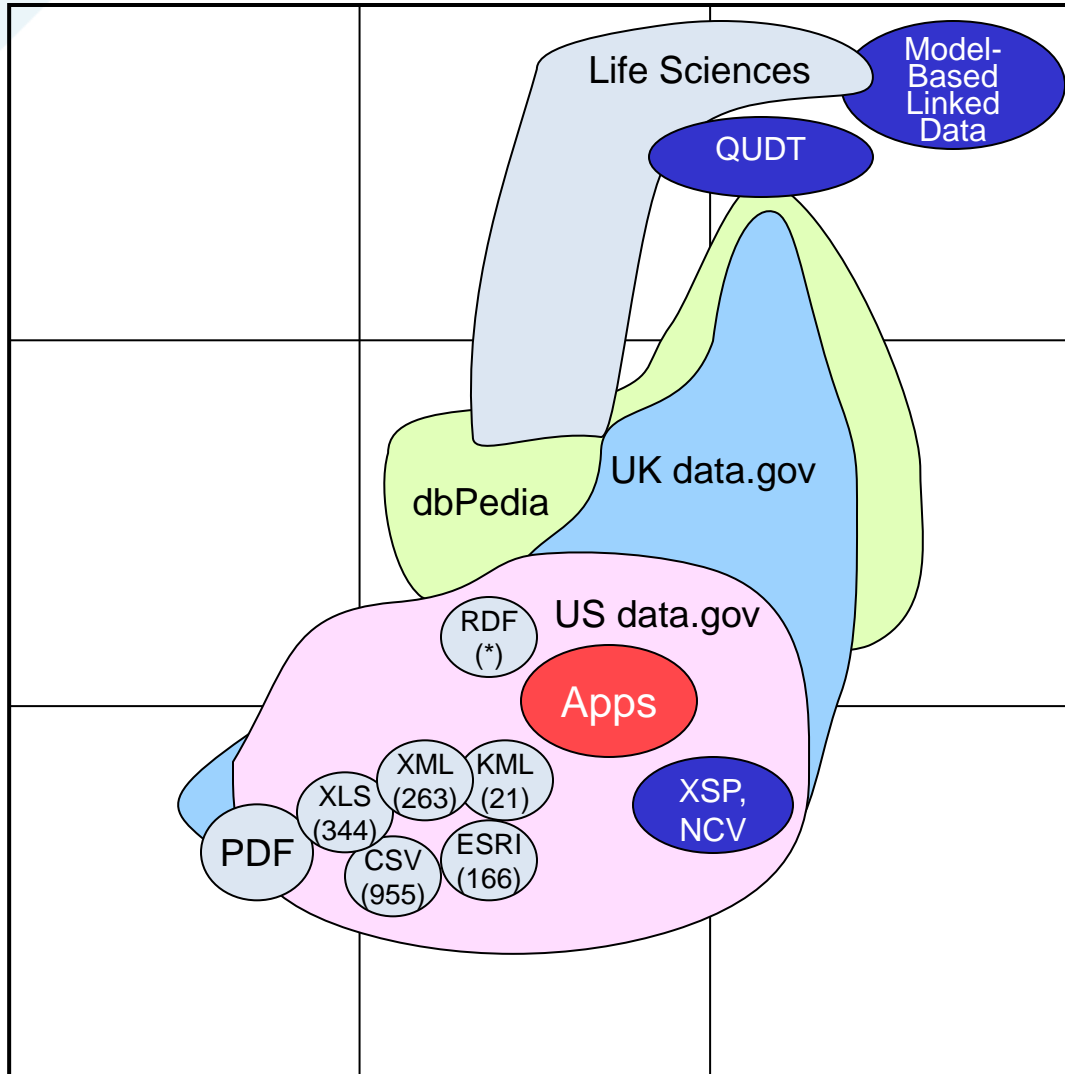
Strong
RDF/OWL + Controlled
Vocabularies

Medium
RDF/OWL

Weak
Non RDF/OWL

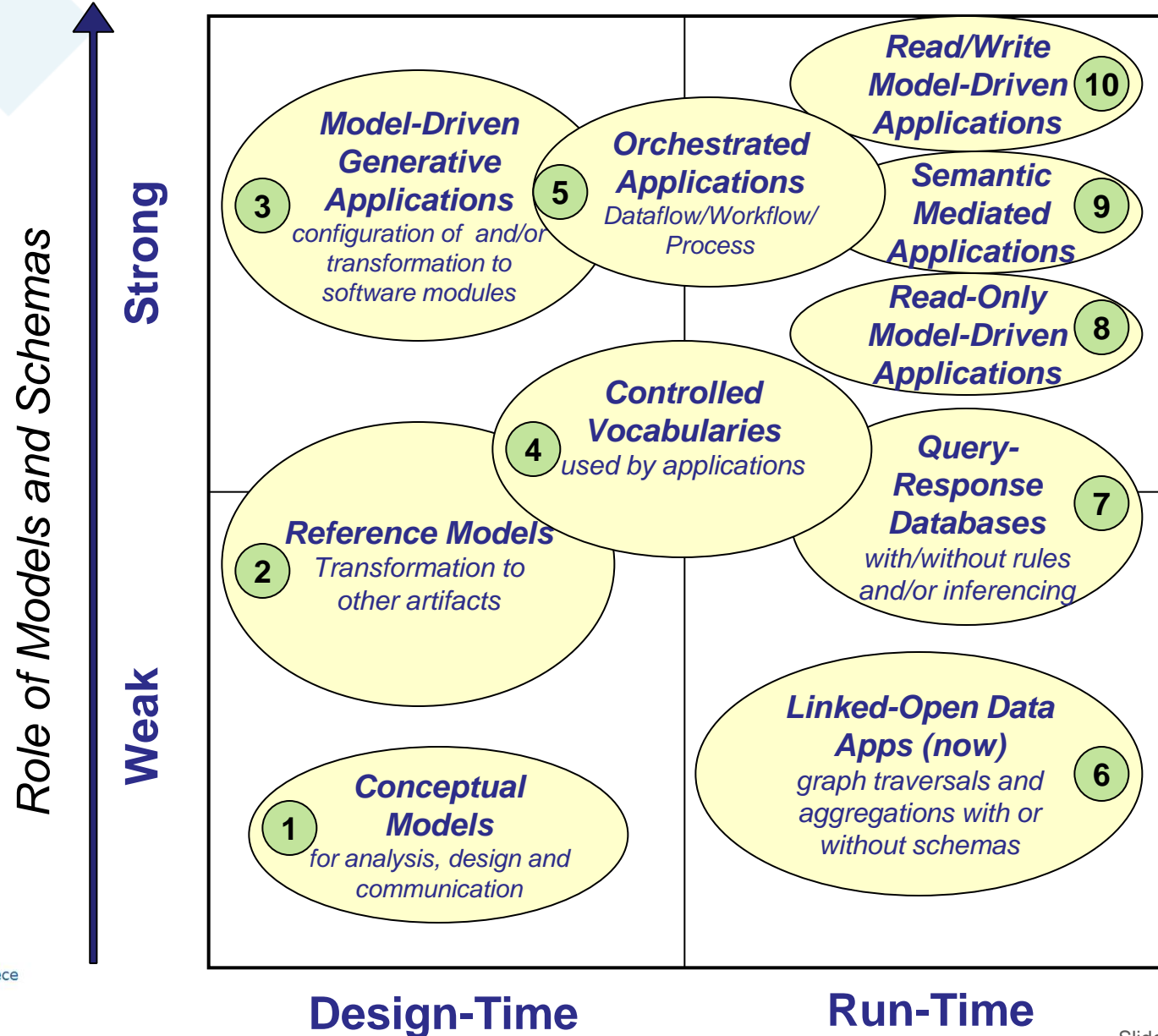
None "ETL/Code/SPARQL"-Based Intrinsic

"Link-ability"

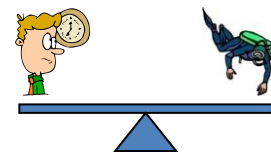
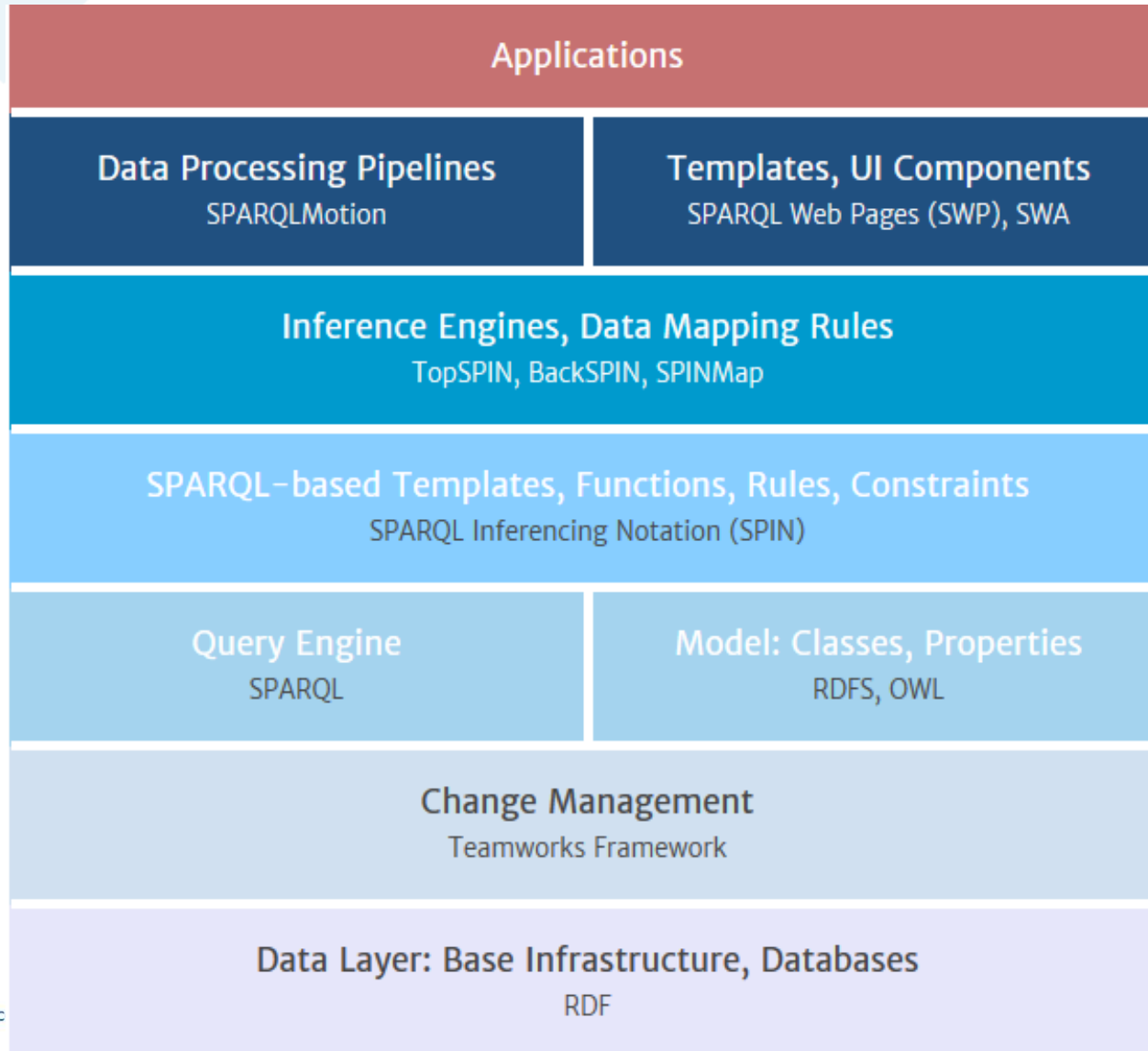


F (#) Based on data.gov June 2009

There are a number of ways of using Ontologies for Interoperability



Semantic Interoperability with the TopBraid Technology Stack



TopBraid EVN: Viewing and editing

Switching between reference data (terms) and schema (classes, properties) editing

Each item has an audit trail

TopBraid Enterprise Vocabulary | Geography Vocabulary | Show History | User: Administrator (log out)

Concept Hierarchy

- Geography
 - Africa
 - Asia
 - Atlantic Ocean
 - Europe
 - Indian Ocean
 - Latin America
 - North America
 - Canada
 - Mexico
 - United States**
 - Alabama
 - Alaska
 - Arizona
 - Arkansas
 - California
 - Colorado
 - Connecticut
 - Delaware
 - Florida
 - Georgia
 - Hawaii
 - Idaho
 - Illinois
 - Indiana
 - Iowa
 - Kansas
 - Kentucky

United States (Country) <http://topquadrant.com/ns/examples/ge>

Labels and Definition

preferred label: United States
 alternative label: America, USA, United States of America
 type: [Country](#)

Standard Relationships

has broader: [North America](#)

Custom Properties

calling code: 1
 capital: [Washington D.C.](#)
 latitude: 38.88333511352539
 longitude: -77.01667022705078

Search Concepts

Search for Type:

has broader:

has narrower:

has related:

Custom Properties

altitude: -

area (KM): -

calling code: -

capital:

language:

latitude: -

longitude: -

Search Results

Resource	Capital	Language
Afghanistan	Kabul	Dari Persian
Albania	Tirana	Albanian
Algeria	Algiers	Arabic
Andorra	Andorra la Vella	Catalan

Comments (0)

Achieving UI component interoperability through TopBraid SWA (SPARQL Web Applications)

TopBraid Default Application - Geography Vocabulary

Class Hierarchy

- Thing
 - Collection
 - Concept
 - Geo concept
 - City
 - **Continent**
 - Country
 - Island
 - Province
 - State
 - Territory
- Concept Scheme
- Spatial thing

Continent (Class)

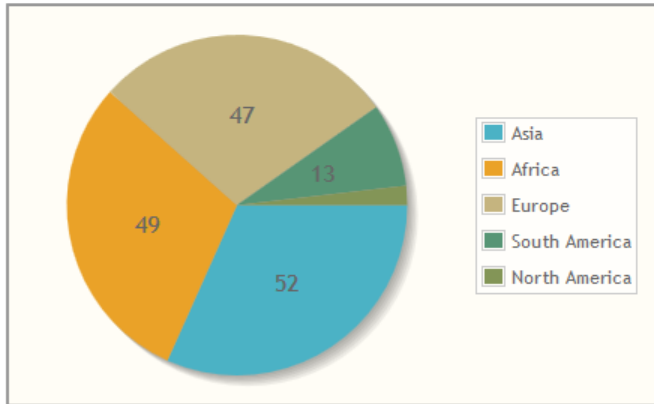
Annotations
label: Continent

Class Axioms
subClassOf: Geo concept

Albania

Chart Builder

Chart Type: Pie chart Edit Query...



Continent	Count
Asia	52
Africa	49
Europe	47
South America	13
North America	3

Search for Continent

Search Text Properties

Labels and Definition

preferred label:

alternative label:

hidden label:

notation:

type:

definition:

Standard Relationships

has broader:

has narrower:

Search Results

Resource	#[inv] Has Broader
Africa	49
Asia	52
Europe	47
North America	3
South America	13

Page 1 of 1 | 10 | View 1 - 5

Instances of Continent

Resource
Africa
Asia
Europe
North America

Illustrative Enterprise Customers

Digital Media



Life Sciences



Other



These companies are using TopBraid to:

- ❖ **Mayo Clinic:** “re-integrate and enhance access to knowledge across research, education and clinical practice”
- ❖ **Syngenta:** “help scientists to develop insights into research data using databases and information sources – both internal and external”
- ❖ **EPIM:** “establish a standards-based knowledge platform for data exchange –receiving, validating, storing, analyzing and transmitting reports”
- ❖ **OTPP:** “enable data to be searched without a PhD in SQL”



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Case Study #1: Mayo Clinic

Went Live 5 January 2014 with over 5.6 million page views per day!

Enhance Value of Mayo's Knowledge

Initiative: Knowledge Content Management System (KCMS)

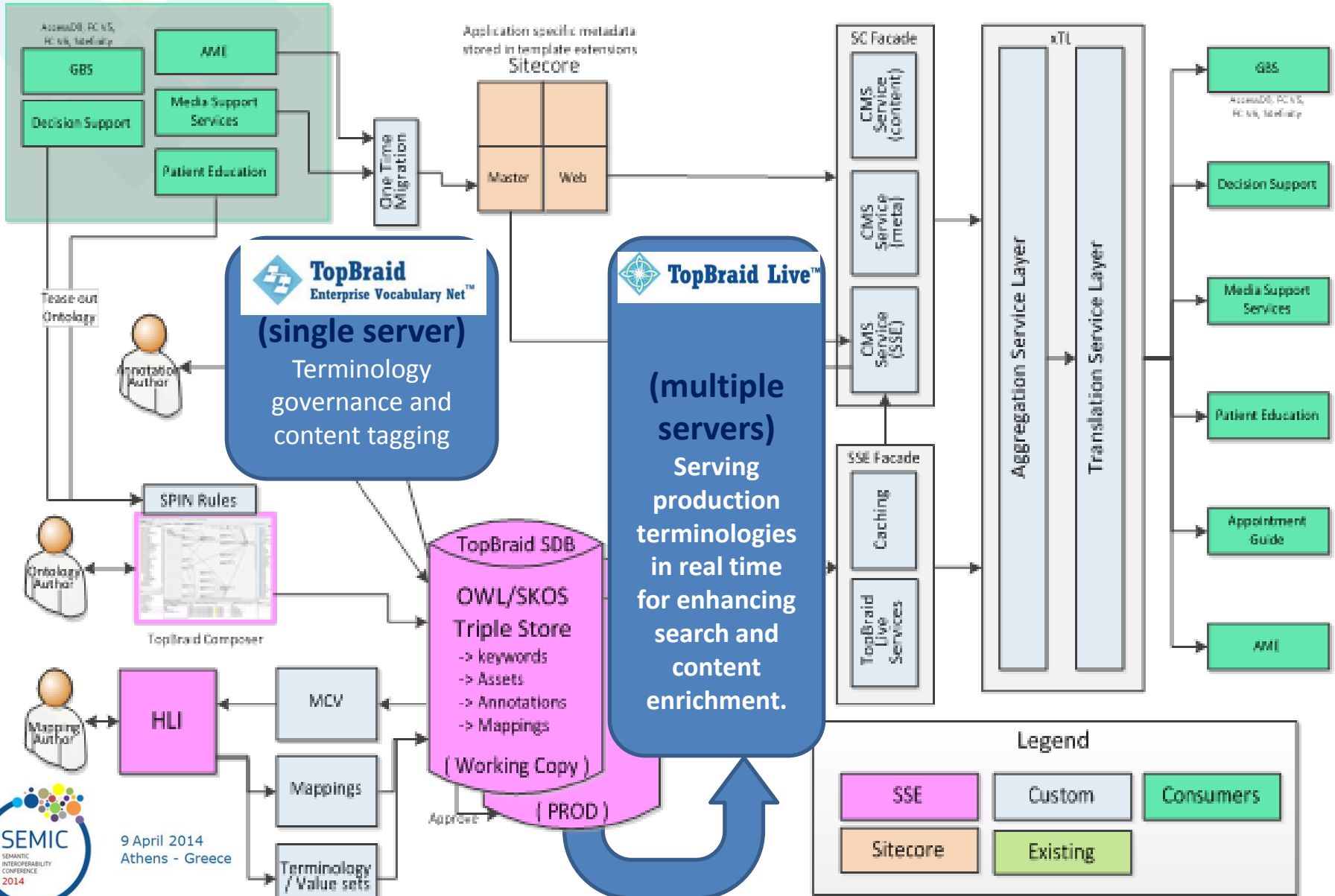
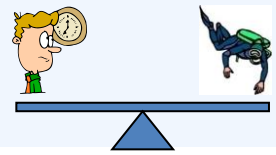
- Enhanced Search
- Taxonomy management
- Run-time terminology services



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Interoperability through terminologies for content and data aggregation, meta-data management and governance

Conceptual Architecture



EVN enables service-based interoperability using template SPARQL queries

skostemplate:ConceptsAndBroaderConceptsForResourceAndProperty (spin:SelectTemplate)

Given a resource and a property, return all vocabulary concepts, and all concepts broader than the matched concepts, referenced by the resource/property pair.

Arguments

arg:property (rdf:Property): The property.

arg:resource (rdfs:Resource): The URI of the content object.

Service Syntax

template/skostemplate/ConceptsAndBroaderConceptsForResourceAndProperty?property=...&resource=...

OR

template?_template=skostemplate:ConceptsAndBroaderConceptsForResourceAndProperty&property=...&resource=...

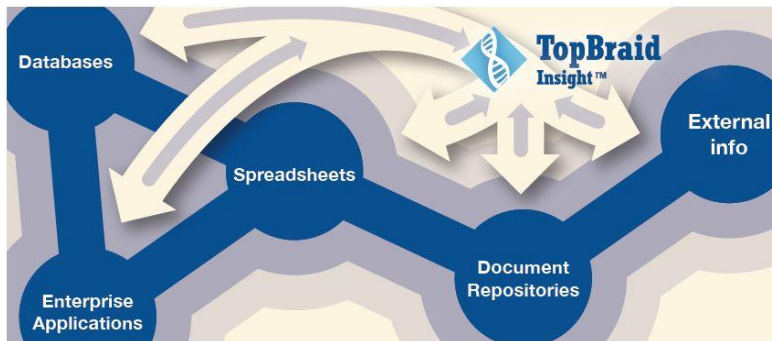
Template Body

```
SELECT DISTINCT ?concept
WHERE {
  ?resource ?property ?broaderConcepts .
  ?broaderConcepts (skos:broader)+ ?concept .
  ?concept a ?type .
  ?type (rdfs:subClassOf)+ skos:Concept .
}
```

- ❖ TopBraid EVN ships with over 30 template services.
- ❖ Customers implement their own services based on SPARQL templates.

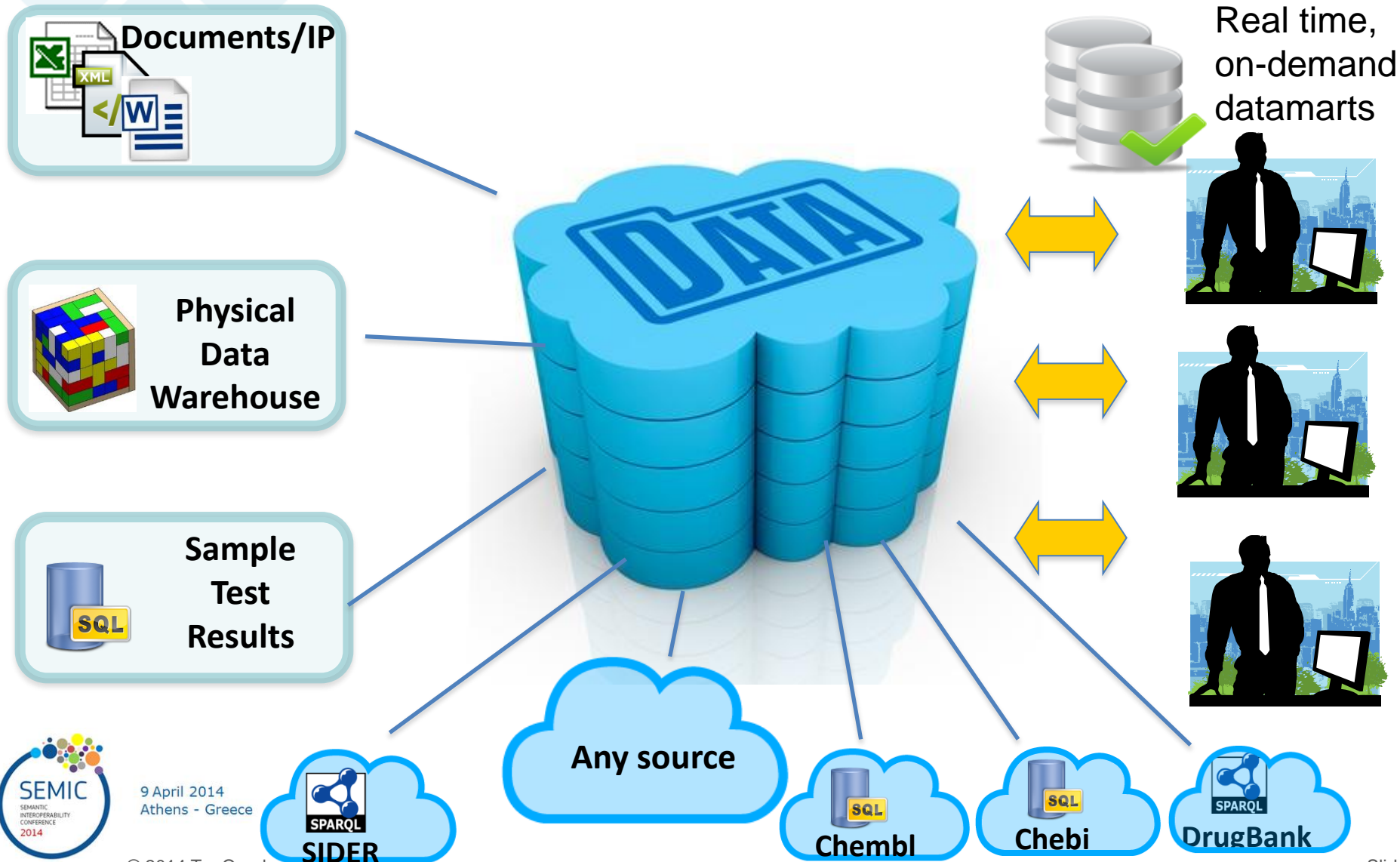
Case Study #2: Syngenta

- ❖ Many disconnected and diverse data sources
- ❖ Need to gain insights by aggregating, aligning and exploring data as if it were from one data source

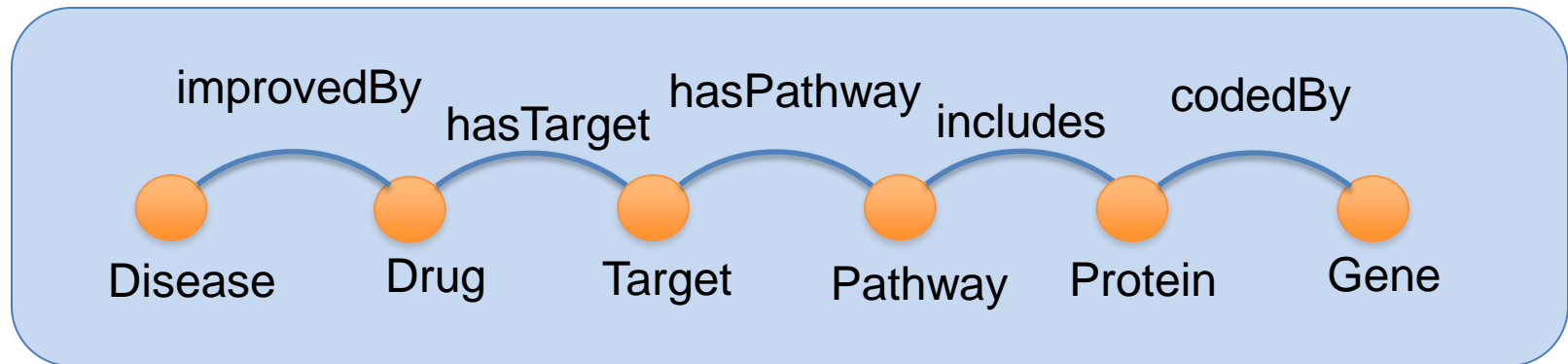


Interoperability through model-driven mappings and a unified way of interpreting data from different data sources

TopBraid Insight provides a layer of connection and meaning to the user and insulates them from the tedious mechanics of data access.



With TopBraid Insight, interoperability means that data sources with different schemas to participate in queries that are written using a unified model representation



- Multiple queries may be involved by exploring links
- Federated data sources are often relational
 - some may be SPARQL endpoints and other sources

Case Study #3: EPIM – the Norwegian E & P Information Management Association

EPIM

E&P Information Management Association

EPIM is the instrument for the operators on the Norwegian Continental Shelf to secure efficient information sharing among all relevant stakeholders by providing cost effective and user friendly common digital solutions based on international standards

- EPIM ReportingHub (ERH)
- License2Share (L2S)
- EqHub
- EnvironmentWeb



EPIM E&P Information Management Association

Interoperability through semantic transformation of XML data translated to instances of ISO15926 ontologies and alignment with NPD Facts, government registry of the exploration and production operators on the Norwegian continental shelf.

EPIM's Vision for Oil & Gas Solutions

- ❖ Build a shared suite of knowledge based-applications using Semantic technology and industry-standard domain concepts
 - i.e. a **Semantic Ecosystem** for the Oil and Gas Industry on the Norwegian Continental Shelf



The screenshot shows the EPIM website with a navigation bar (Home, About, Services, Contact, Career, Member area login) and a search bar. Below the navigation are five main categories, each with a list of sub-items:

- JOINT VENTURE MANAGEMENT**
 - ▶ License2Share
 - ▶ Gas Sales Tax
 - ▶ Reporting
- HEALTH, SAFETY & ENVIRONMENT**
 - ▶ EnvironmentWeb
 - ▶ General Safety
 - ▶ Training
- EXPLORATION & PRODUCTION**
 - ▶ ReportingHub
 - ▶ Outcrop
 - ▶ Norwegian Deepwater Programme
 - ▶ Reporting Formats
 - ▶ SAM-X
- SUPPLY CHAIN MANAGEMENT**
 - ▶ EqHub
 - ▶ LogisticsHub
- INFRASTRUCTURE & TECHNOLOGY**

At the bottom of the page, the slogan "By the industry, for the industry" is displayed.

EnvironmentHub

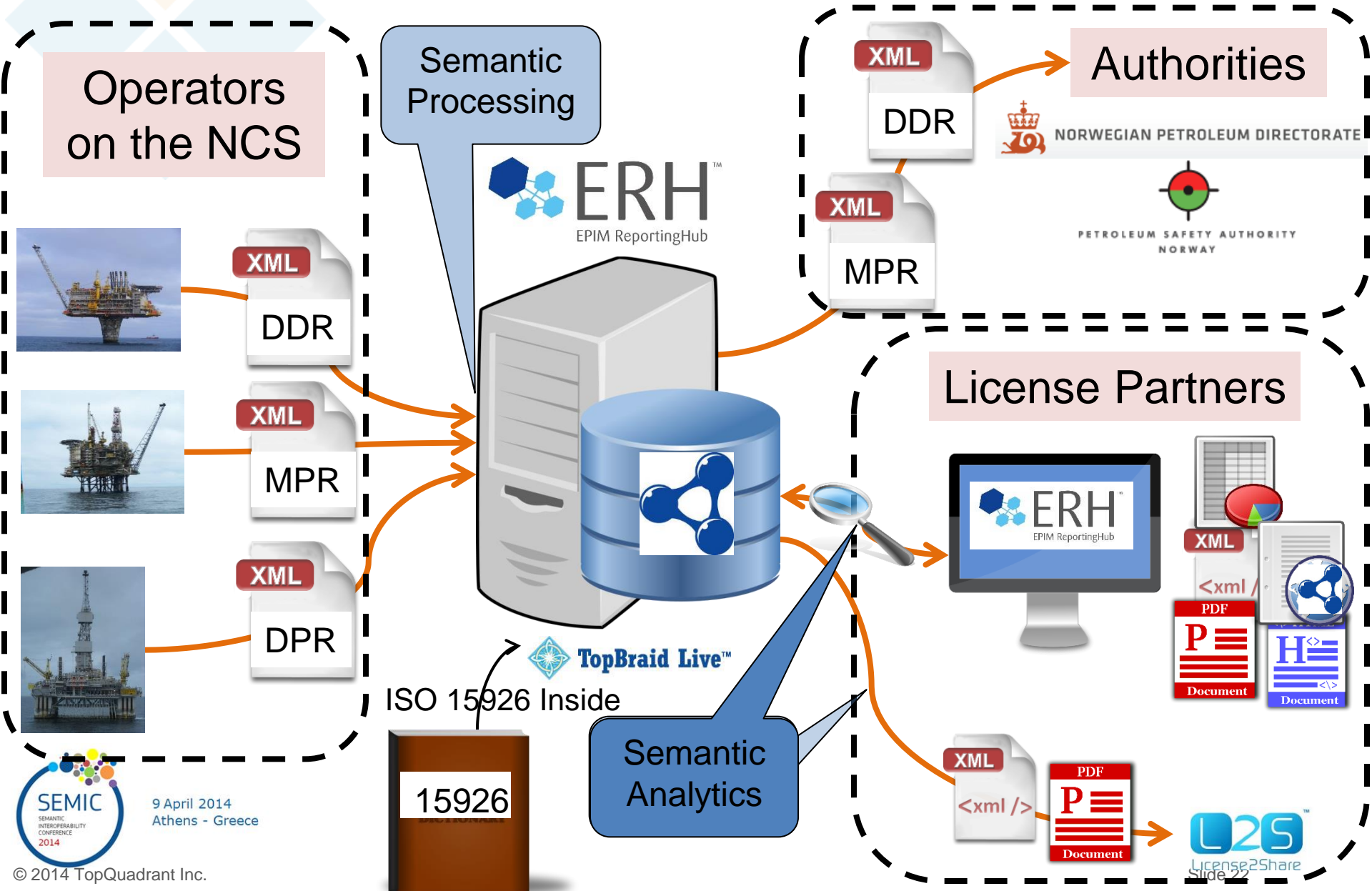
ReportingHub

LogisticsHub

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EPIM ReportingHub (ERH) Architecture – in production for nearly two years now



Operators on the NCS

Semantic Processing

ERH
EPIM ReportingHub

Authorities



NORWEGIAN PETROLEUM DIRECTORATE



PETROLEUM SAFETY AUTHORITY NORWAY

License Partners



Semantic Analytics

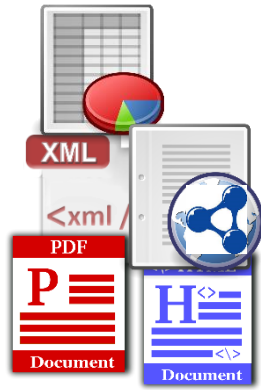
TopBraid Live™

ISO 15926 Inside

15926



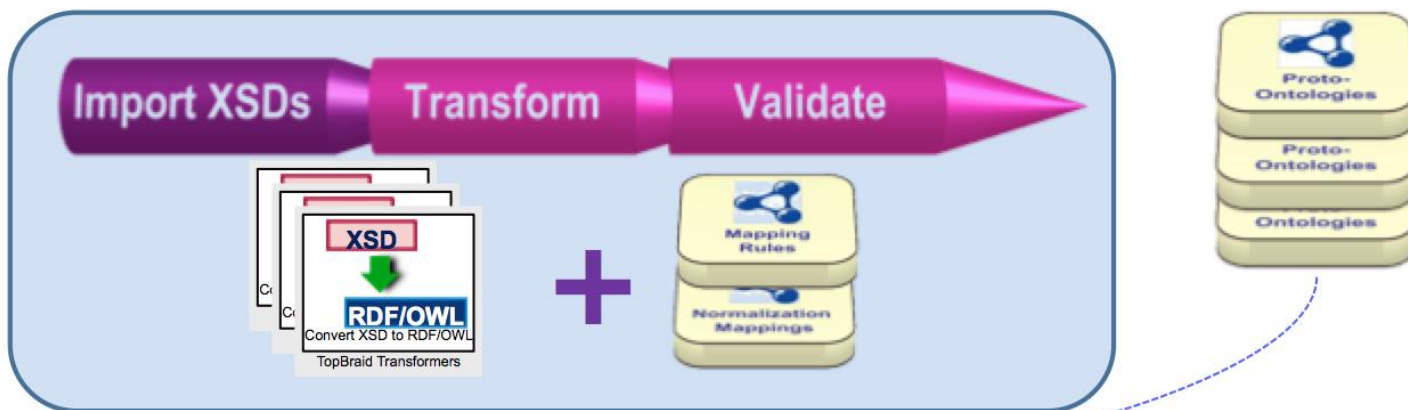
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Interoperability by Co-existing in the XML World

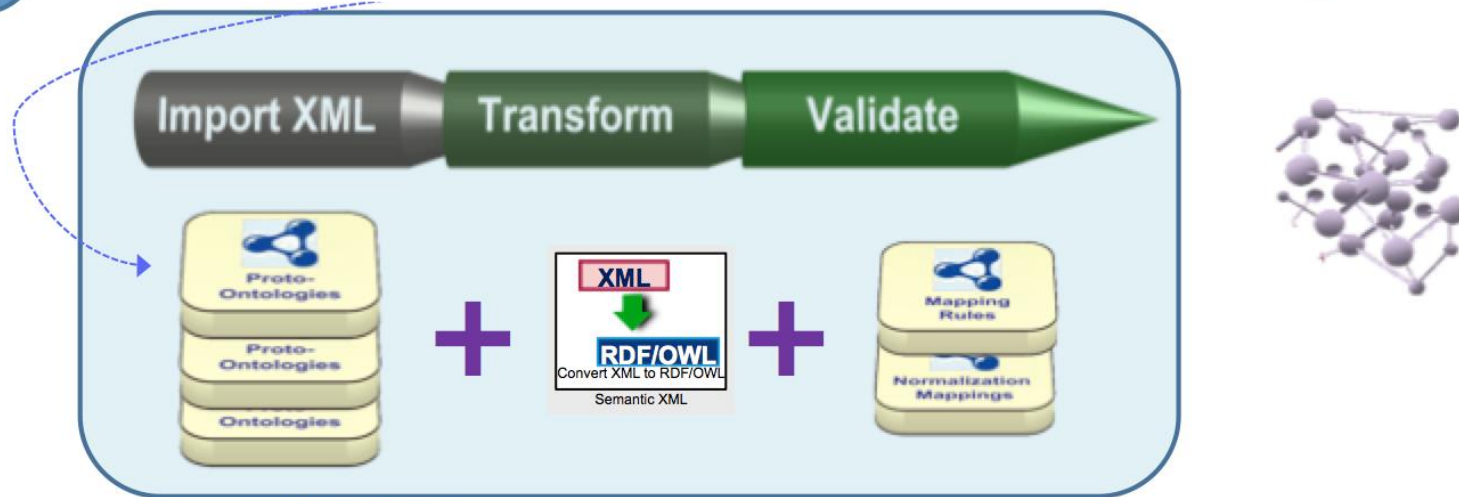
1

Make OWL Schemas from XSD Schemas



2

Use the OWL Schemas to make RDF from XML Messages



EPIM Environment Hub (EEH)

Reporting of emissions and contaminants to sea and air

EEH English Norsk Operator: Engsoil User: Sjur Enge

Home **Reporting** Standard Reports Analytics Edit Historical Data Administration

1 Start Reporting 2 Edit 3 Prepare report 4 Submit Reporting year: 2013

Reporting status

Reporting status	Field	Error	Structure types (inactive wellbores not included)				Inactive Wellbores reported	Status	
			Field	Facilities	Active Wellbore	Total			
View Reporting status	Alve	0	1/1	119/119	147/147	267/267	1	Reopened	
	Brage	2	0/1	112/119	137/147	249/267	2	In progress	
Field	Facilities not complete								
Drilling	Applicable Structure types								
Mud Cuttings Disposal	Brage A	Oily Water Discharge Jetting						Upload missing Structure types	
	Brage B	Oily Water Discharge Jetting Accute pollution to Sea							
Facility	Brage C	Oily Water Discharge Jetting Combustion							
Oily Water	Brage D	Oily Water Discharge Jetting							
Oily Water Discharge Prod Dr Dis	Brage E	Oily Water Discharge Jetting							
Oily Water Discharge Jetting	Fram	3	0/1	17/119	7/98	24/218	0	Submitted	
Produced Water Analysis	Glitne	0	1/1	85/85	105/105	191/191	0	Submitted	
Pollution to air	Grane	0	1/1	85/85	140/140	226/226	0	In progress	
Combustion	Gullfaks	-	0/1	0/85	0/140	0/226		No started	
Loading	Heidrun	-	0/1	0/85	0/140	0/226		No started	
Fugitive emissions and venting	Heimdal	0	1/1	119/119	147/147	267/267	0	In progress	
GasTracer	Huldra	0	1/1	85/85	105/105	191/191	3	In progress	
Accute pollution	Hyme	0	1/1	85/85	105/105	191/191	5	In progress	
Accute pollution to Sea	Kristin	0	1/1	85/85	140/140	226/226	2	In progress	
Accute pollution to Sea Propertie	Kvitebjørn	4	0/1	68/85	140/140	208/226	0	In progress	
Accute pollution to air									
Waste									
Hazardous Waste Other									

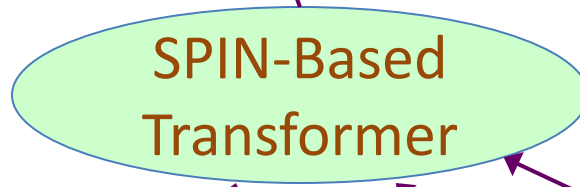
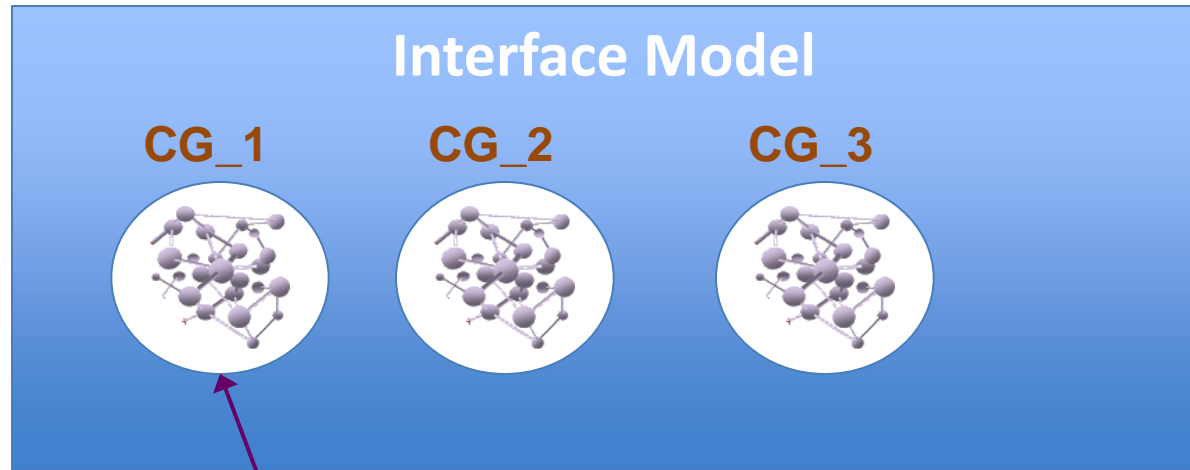
Interoperability through semantic transformation of XML data translated to instances of ISO15926 ontologies and alignment with NPD Facts, government registry of the exploration and production operators on the Norwegian continental shelf.

Interoperability Using Transformations based on “Magic Graphs”

Simple View Ontologies for UI, reporting and analytics

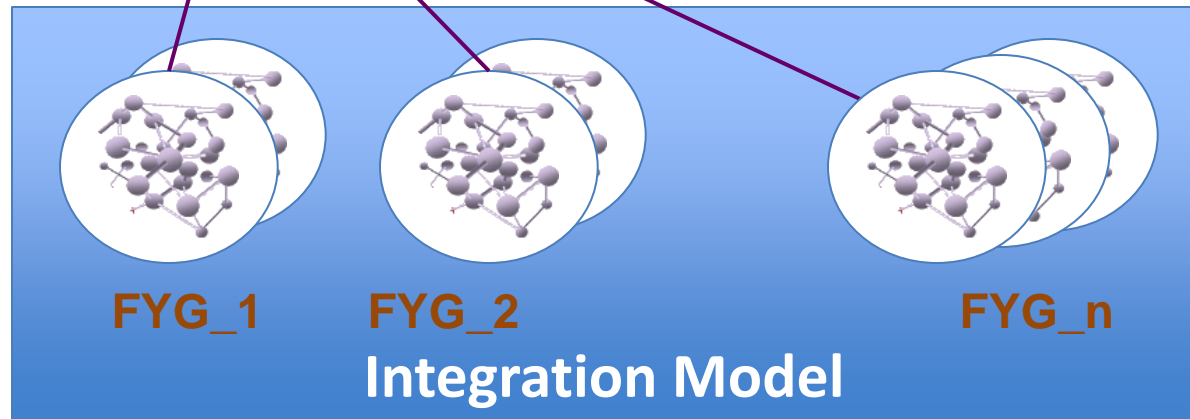
SPARQL Query-View Transformation

ISO-15926 4D Ontologies



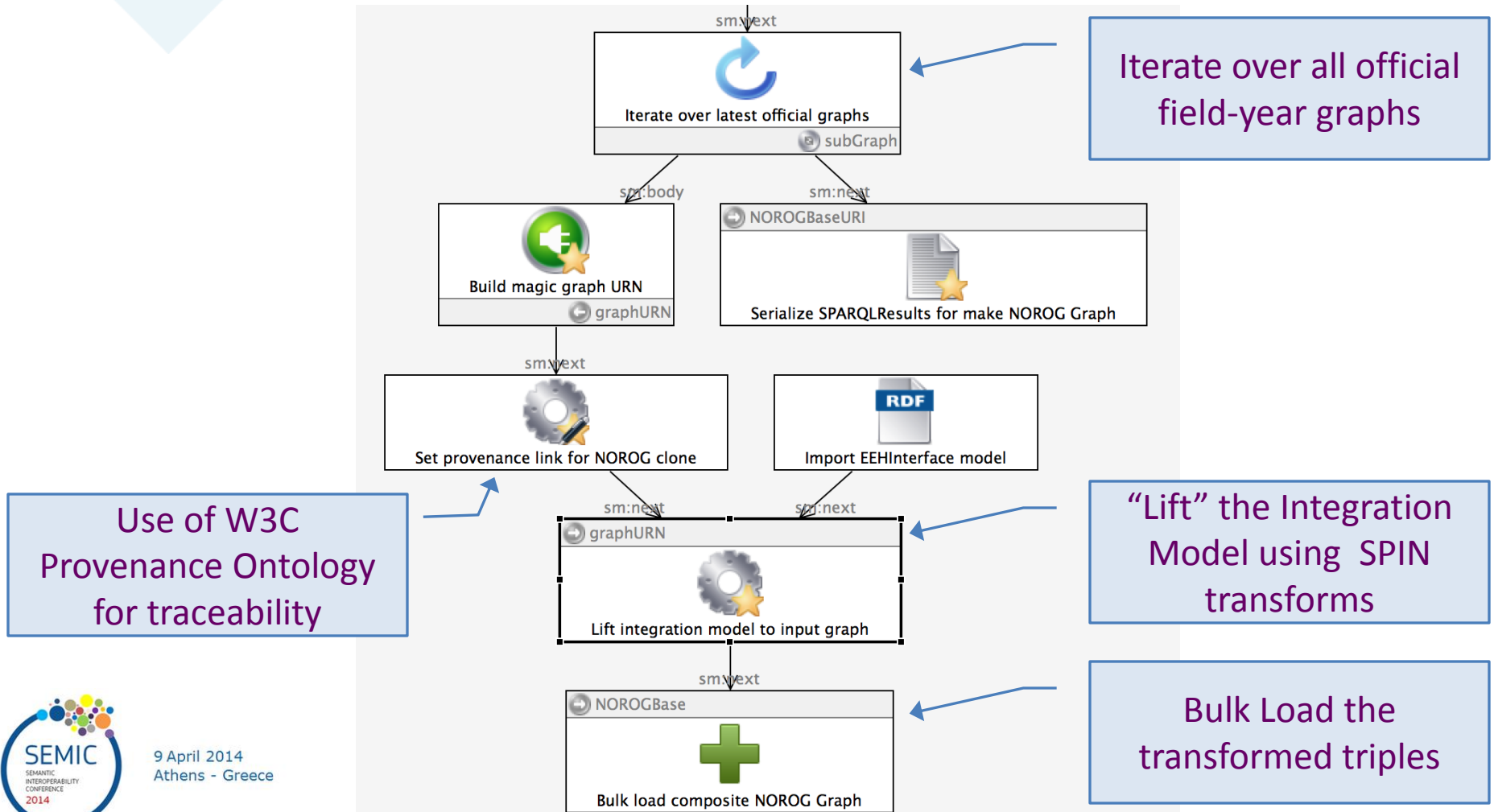
Uses “Magic Graphs”

`<urn:x-magic:
TheSchemaMapGraph:
TheFieldYearSubGraph:
TheTargetSchema>`



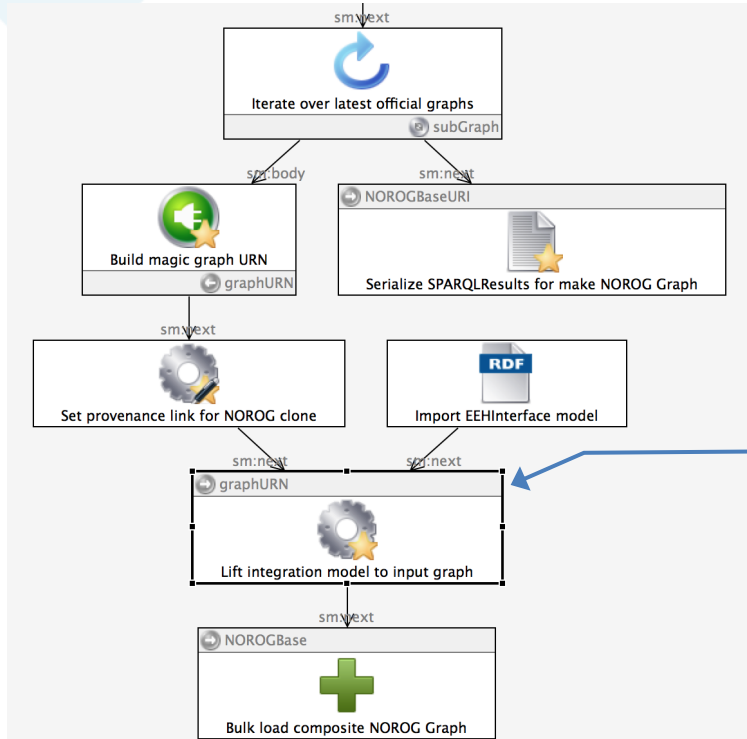
Transforming is controlled by a SPARQLMotion Web Service (1 of 2)

SPARQL Views: Lifting the ISO 15926 Data Graphs into the Interface Model Representation.



Transforming is controlled by a SPARQLMotion Web Service (2 of 2)

SPARQL Views: Lifting the ISO 15926 Data Graphs into the Interface Model Representation.



SERVICES_EEH-WorkflowServices-v1.1.sms.ttl

Resource Form

Name: eeh-wfs:LiftIntegrationModelToInputGraph

Annotations

rdfs:label
Lift integration model to input graph

Other Properties

sm:next
eeh-wfs:BulkLoadCompositeNOROGGraph

sml:constructQuery

```

CONSTRUCT {
  ?instance a ?class .
  ?instance ?property ?o .
}
WHERE {
  rdf:nil eeh-rsrv:classesOfInterfaceModel ( ?class ) .
  ( ?class ) eeh-rsrv:propertiesOfClassesOfInterfaceModel ( ?property ) .
  GRAPH ?graphURN {
    ?instance a ?class .
    ?instance ?property ?o .
  } .
}
    
```

sml:replace
true

rdf:type
sml:ApplyConstruct

Incoming References

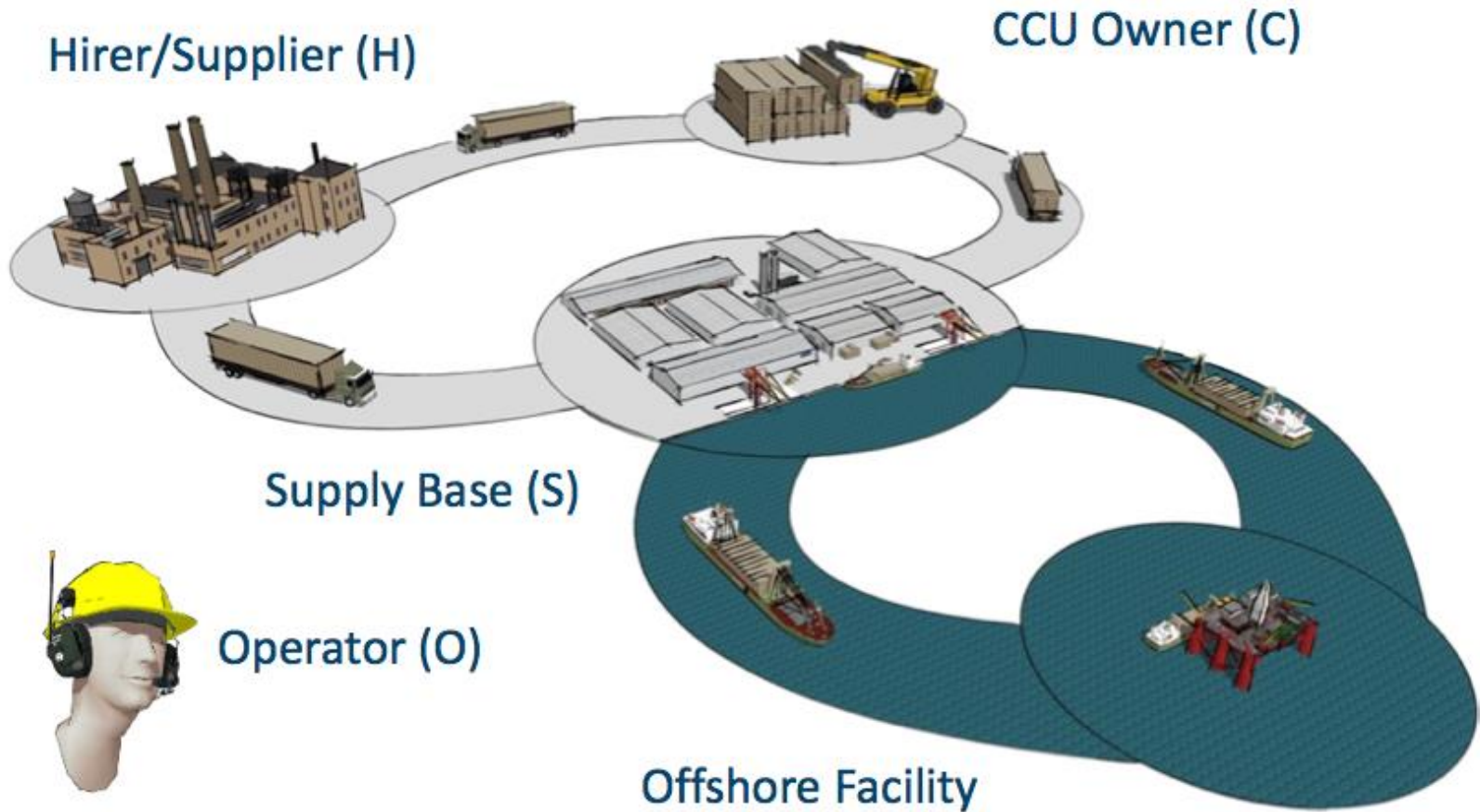
← sm:next

- eeh-wfs:CopyGraphIntoCompositeGraph
- eeh-wfs:ImportEEHInterfaceModel

- ❑ Total triples in the Integration Model (ISO-15926 Ontologies): ~ 4,000,000
- ❑ Total triples in the Interface Model: ~400,000

EPIM Logistics Hub (ELH)

Offshore Supply Chain: CCU Tracking



Concluding Remarks

- ❖ The focus given was addressing the data variety and veracity challenges in interoperability
- ❖ Interoperability has different solution types
- ❖ Model-driven applications exploit the real power of semantic web technologies for interoperability
 - SPARQL is more than a query language
 - Customers use SPARQL and Semantic Web Technologies for rules, constraint checking, transformations, dataflow orchestration, user interfaces, authorization checking, ...

Other Relevant Work (1)

<p>NASA TECHNICAL HANDBOOK</p> <p>National Aeronautics and Space Administration Washington, DC 20546-0001</p>	<p>HDBK-1003R</p>
	<p>Approved: MM-DD-YYYY Superseding NASA-HDBK-1003R</p>
<p>NASA QUDT Handbook</p> <p>Quantities, Units, Dimensions and Types</p>	
<p>DRAFT v0.96 - April 30, 2013</p> <p>This official draft has not been approved and is subject to modification. DO NOT USE PRIOR TO APPROVAL.</p>	

Collaboration & INTEROPERABILITY
Congress - May 21-23, 2013

www.3DCIC.com

NASA QUDT Handbook

Ontology-based Specification of Quantities, Units, Dimensions and Types

The 15th NASA-ESA Workshop on Product Data Exchange
Colorado Springs, USA, 21-23 May 2013

Ralph Hodgson
TopQuadrant CTO and NASA QUDT Ontologies Lead

Jack Spivak
TopQuadrant Associate

Logos: DE, MCAD Café.com, AIAG, DASSAULT SYSTEMES, AUTODESK, capvidia, PART SOLUTIONS, Theorem Solutions, KUBOTEK, TenLinks Daily, SPATIAL, TRANSMAGIC, PDS, Inc., cenit, ConnectPress Ltd, 3D PDF CONSORTIUM, ITI TranscenData, Microsoft, PROTOTYPE TODAY.

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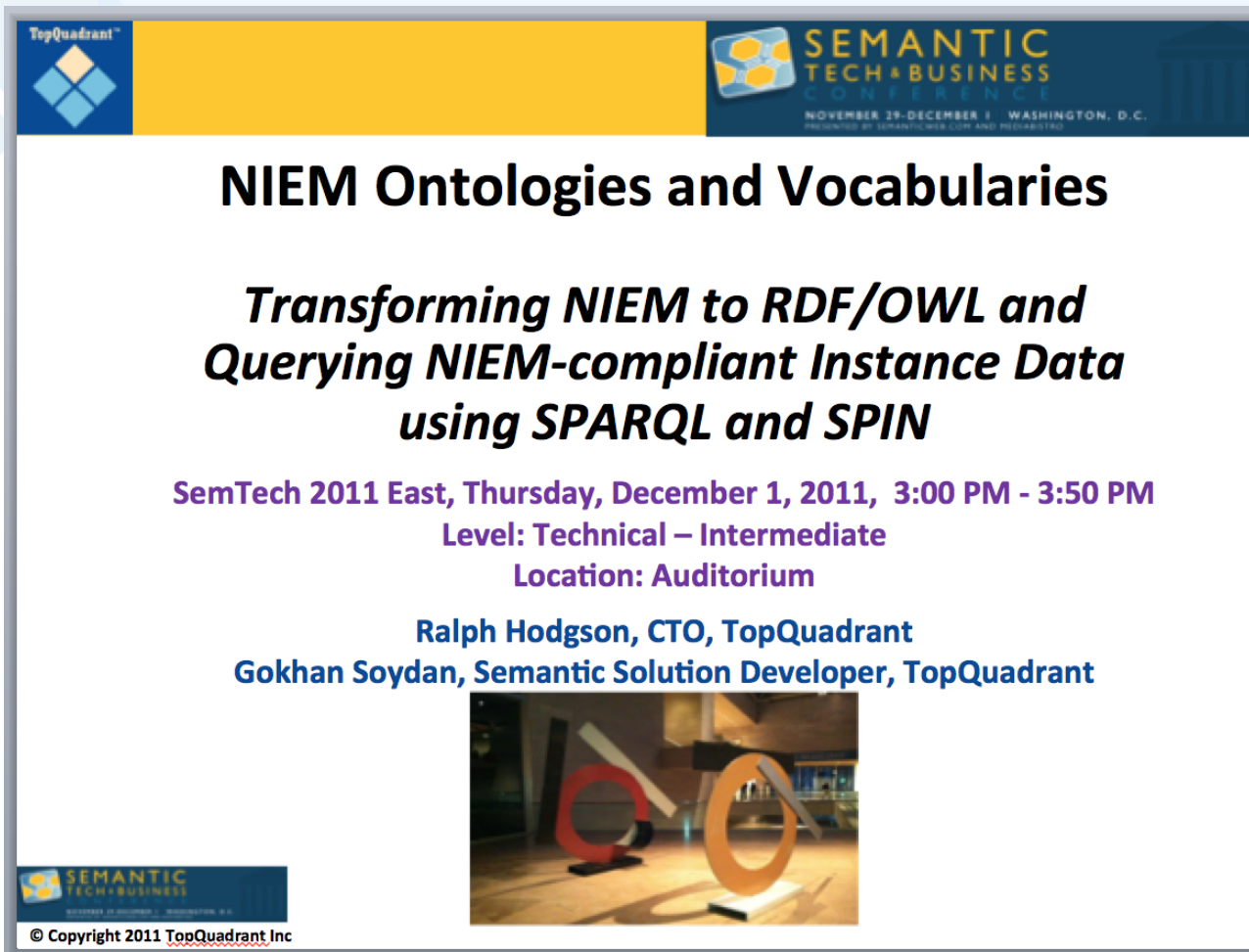
<http://qudt.org>



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<http://tinyurl.com/om9u6o5>

Other Relevant Work (2)




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NOVEMBER 29-DECEMBER 1, WASHINGTON, D.C.
HOSTED BY SEMANTICWEB.COM AND METAORBIT

NIEM Ontologies and Vocabularies

Transforming NIEM to RDF/OWL and Querying NIEM-compliant Instance Data using SPARQL and SPIN

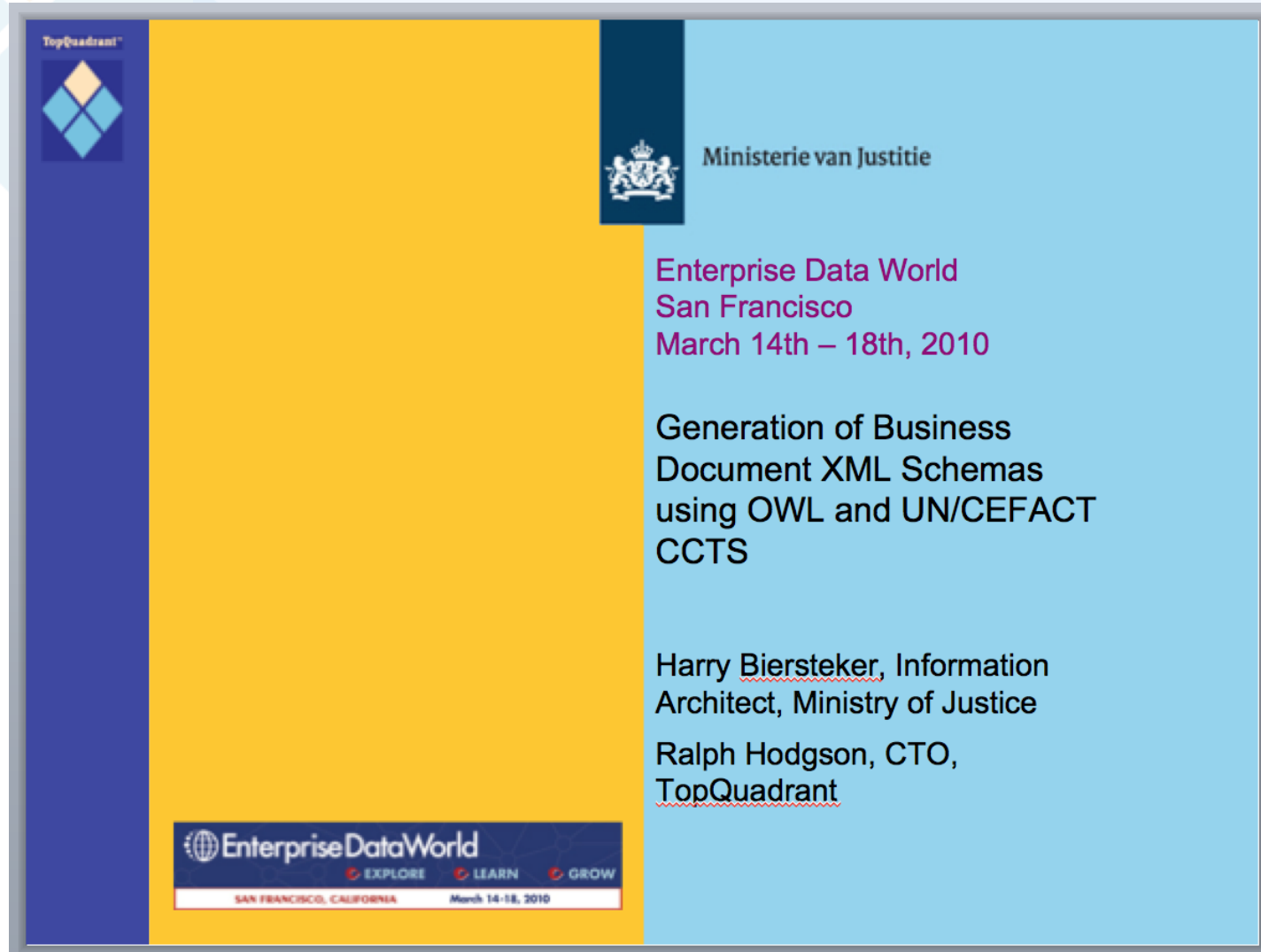
SemTech 2011 East, Thursday, December 1, 2011, 3:00 PM - 3:50 PM
Level: Technical – Intermediate
Location: Auditorium

Ralph Hodgson, CTO, TopQuadrant
Gokhan Soydan, Semantic Solution Developer, TopQuadrant




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NOVEMBER 29-DECEMBER 1, WASHINGTON, D.C.
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Other Relevant Work (3)



The screenshot shows a presentation slide with a blue and yellow background. On the left, there is a vertical blue bar with the TopQuadrant logo. The main content area is yellow and contains the following text:

 Ministerie van Justitie

Enterprise Data World
San Francisco
March 14th – 18th, 2010

Generation of Business
Document XML Schemas
using OWL and UN/CEFACT
CCTS

Harry Biersteker, Information
Architect, Ministry of Justice

Ralph Hodgson, CTO,
TopQuadrant

Enterprise Data World
EXPLORE LEARN GROW
SAN FRANCISCO, CALIFORNIA March 14-18, 2010

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<http://www.scribd.com/doc/29565138/The-Netherlands-MoJ-and-TQ-Presentation-at-EDW2010>

Thank You

- ❖ rhodgson AT [topquadrant.com](mailto:rhodgson@topquadrant.com)
- ❖ Twitter @ralphtq, @topquadrant
- ❖ www.scribd.com/ralphtq
- ❖ www.linkedmodel.org



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