

Combining two approaches for ontology building

**W3C workshop on Semantic Web in Oil & Gas
Houston, December 8-9, 2008**

Jan Rogier, Sr. System Architect

Jennifer Sampson, Sr. Ontology Engineer

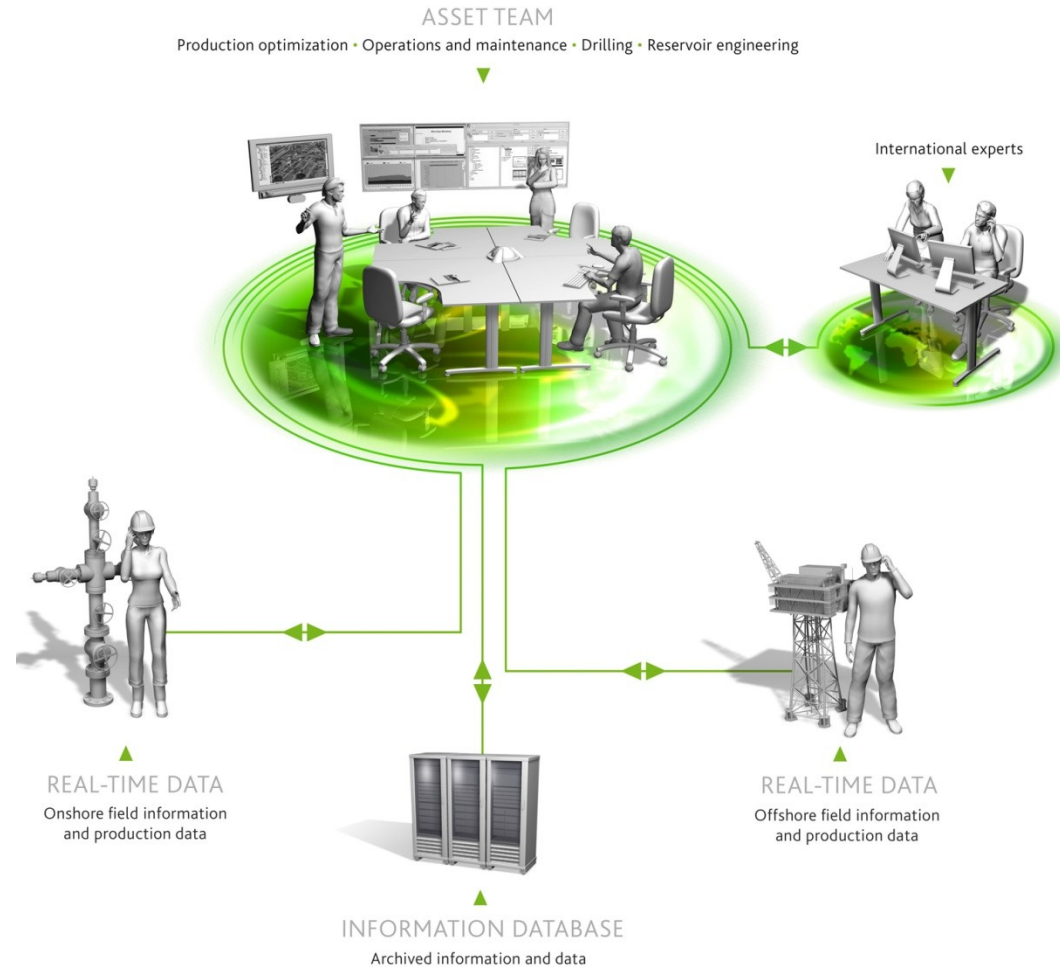
Frédéric Verhelst, VP Real-time Decision Support

Outline

- About Epsis
- About Integrated Operations
- Informed decision making
- Top-down and bottom-up ontology development
- Examples
- Conclusions

About Epsis

- Solely focused on Integrated Operations
- Based in Bergen, Norway
 - Office downtown Houston
- Established in 2002
- Currently 45 employees
- Solutions:
 - Business consultancy
 - Collaborative solutions
- Technology lines:
 - Collaboration and Visualization Technologies
 - Real-time Decision Support Technologies



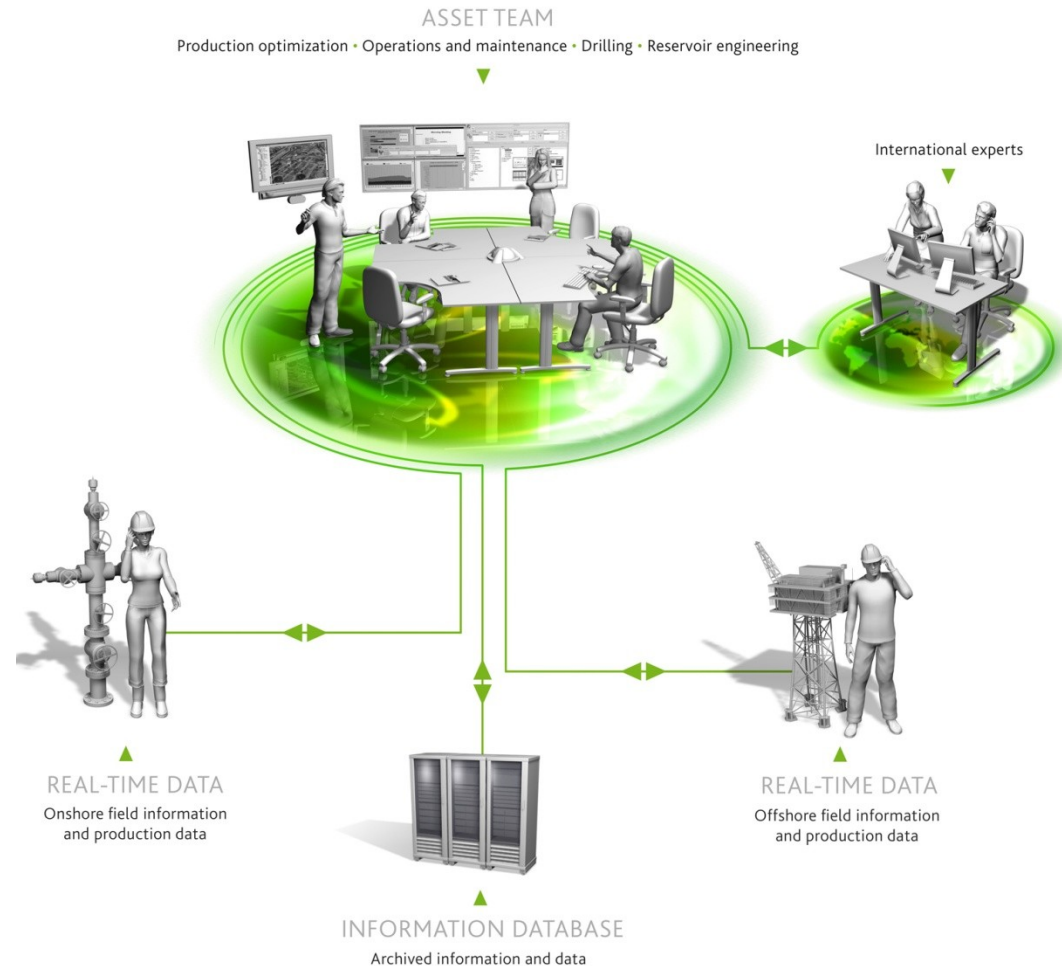
Semantic technologies and projects at EPSIS

- Chairing POSC Caesar Association's (PCA) Special Interest Group for Reservoir and Production
- Extension of Oil and Gas ontology (ISO 15926)
 - Reservoir and Production
 - Include Daily & Monthly Production Reporting (done)
 - Extension for production optimization (on going)
 - Refinement for automatic reasoning using Smart Agents
 - Health, Safety and Environment
 - EnvironmentWeb terminology in PCA's RDL (current)
 - Operations and Maintenance
 - Assist DNV with extending ISO 15926 (current)
- Pilot for Reservoir and Production for Integrated Operations in the High North JIP

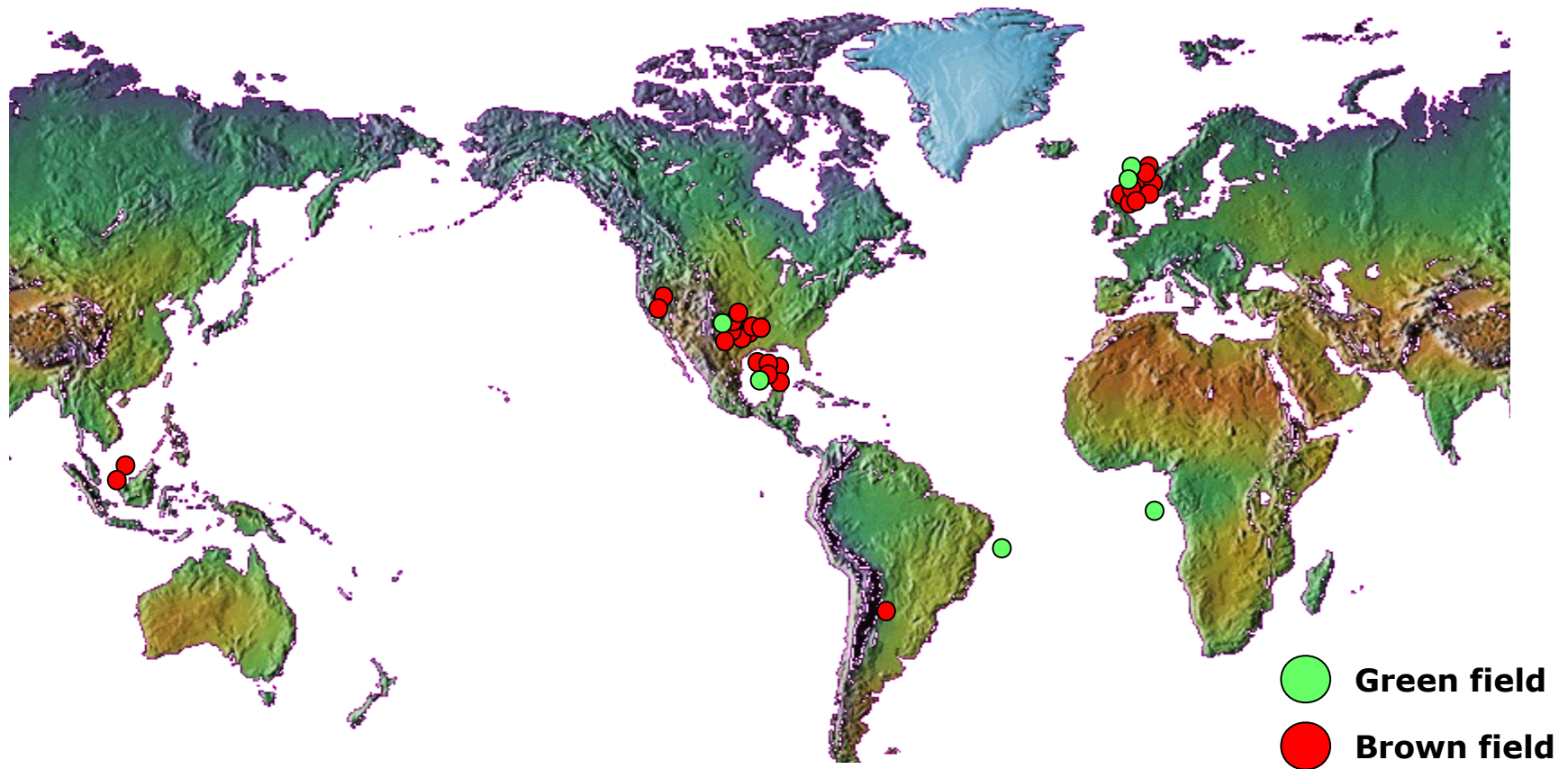
Integrated Operations: what is it?

Integrated Operations (IO) is the integration of people, processes, and technology to make and execute better decisions faster. It is enabled by the use of real time data, collaborative technologies, and multi-disciplinary work flows.

Similar to i-Field, Smart Field, Field of the Future, Digital Oil Field of the Future,...



Epsis has been part of about 50 assessments of opportunities within Integrated Operations worldwide



Business Case for Integrated Operations:

The assessment on the Norwegian Continental Shelf

- Value creation potential of Integrated Operations on Norwegian Continental Shelf (NCS) estimated at: **42 billion USD**
- Focused elements:
 - Increased reserves
 - Accelerated Production
 - Reduced Operation costs
 - Reduced Drilling costs

News

You are here: [Frontpage](#) > [News](#) > [English Summary](#)



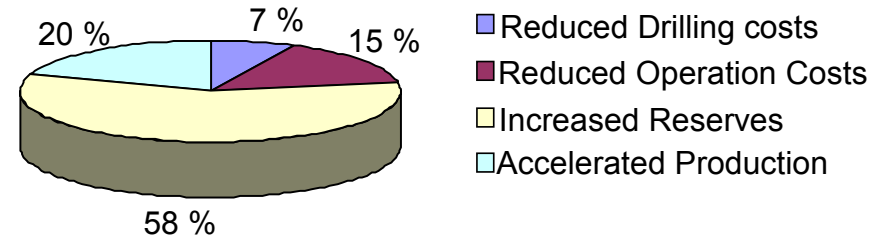
News 23.11.2007 11:17

Potential value creation of 300 billion NOK

"In 2005, the value creation potential in integrated operations was estimated at NOK 250 billion. New estimates this autumn have raised the potential to NOK 300 billion - values on a par with finding another major oil field on the Norwegian Shelf. The new OLF report also emphasises the importance of the industry getting into top gear in its work for integrated operations (IO). Too little effort made in this area may cut value creation in half. IO is a combination of new modes of cooperation and new technology. The oil companies as well as the supplier industry have invested heavily in this issue over the last few year, and there is no doubt such investments are profitable: since 2005 the industry has taken out 24 billion in additional value on account of IO. According to the 2005 OLF report, the potential for the period amounted to 37 billion," writes OLFs Director General Per Terje Vold in the editorial.

Study from the Norwegian Oil Industry Association (OLF, www.olf.no).
 Oil prices used: 50 USD/bbl (2008) to 30 USD/bbl (2015)
 Net Present Value over the next 10 years (7% discount rate)

Value distribution



Integrated Operations: Generations

**Focus:
Optimization**

GENERATION 2:
Data-to-Information
Intelligent Prediction
Smart agents
Integrated scheduling

era
decide



**Focus:
Collaboration**

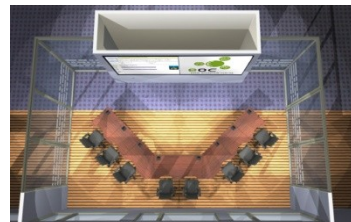
GENERATION 1:
Work process mgmt.
Collaboration
Visualization



era
connect

era
visual

GENERATION 0:
Collaboration Centers
Data infrastructure
Change management



**Focus:
Infrastructure**

Integrated Operations: Current status

Generalized – regional differences may occur

**Focus:
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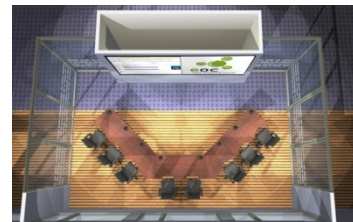


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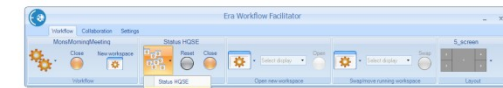
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decide



**Focus:
Collaboration**

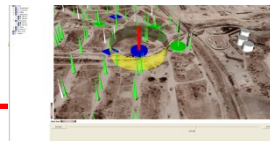


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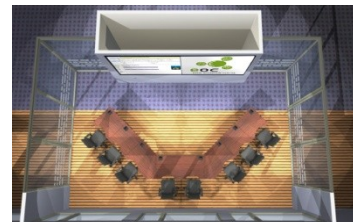


era
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GENERATION 0:
Collaboration Centers
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**Focus:
Infrastructure**

Biggest gain yet to come!



**Focus:
Optimization**

GENERATION 2:

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Integrated scheduling

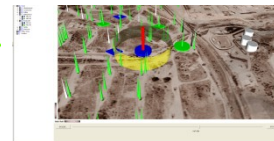
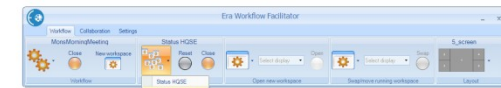


**Focus:
Collaboration**



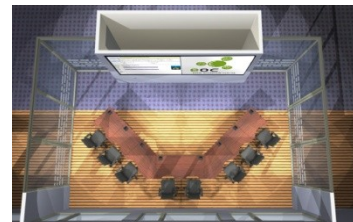
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GENERATION 0:

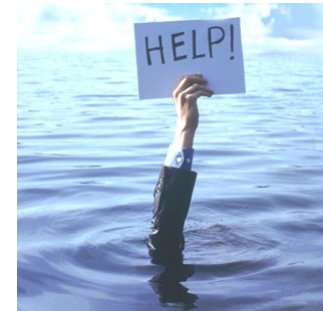
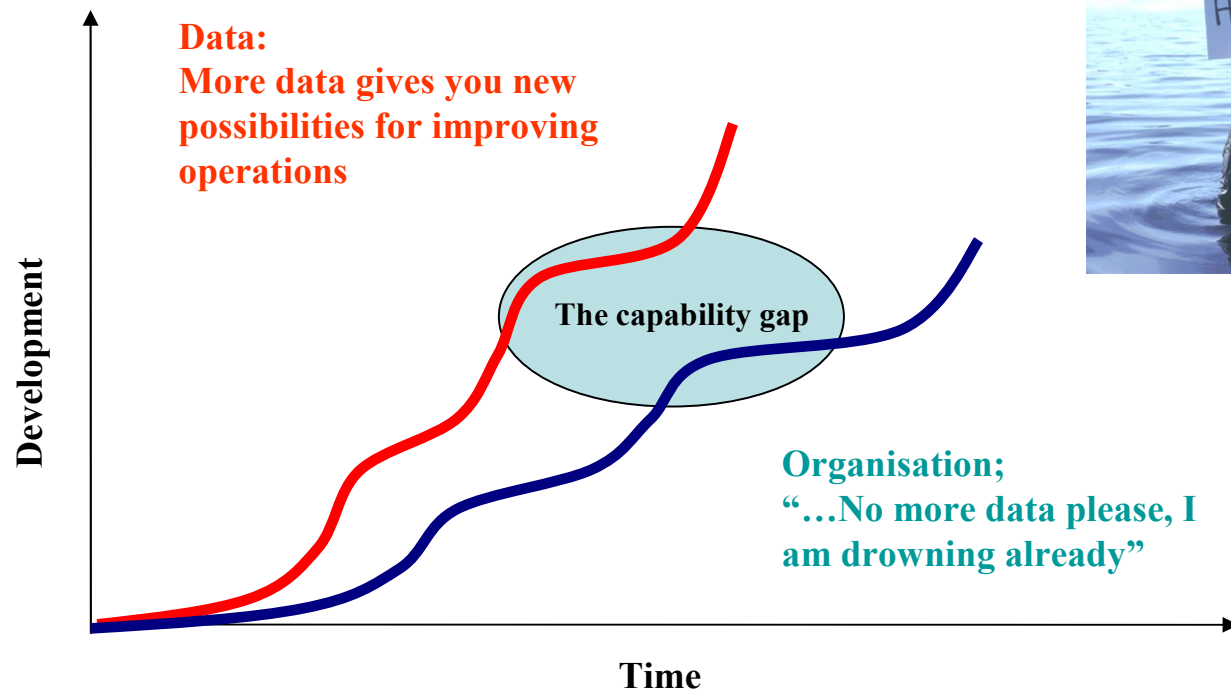
Collaboration Centers
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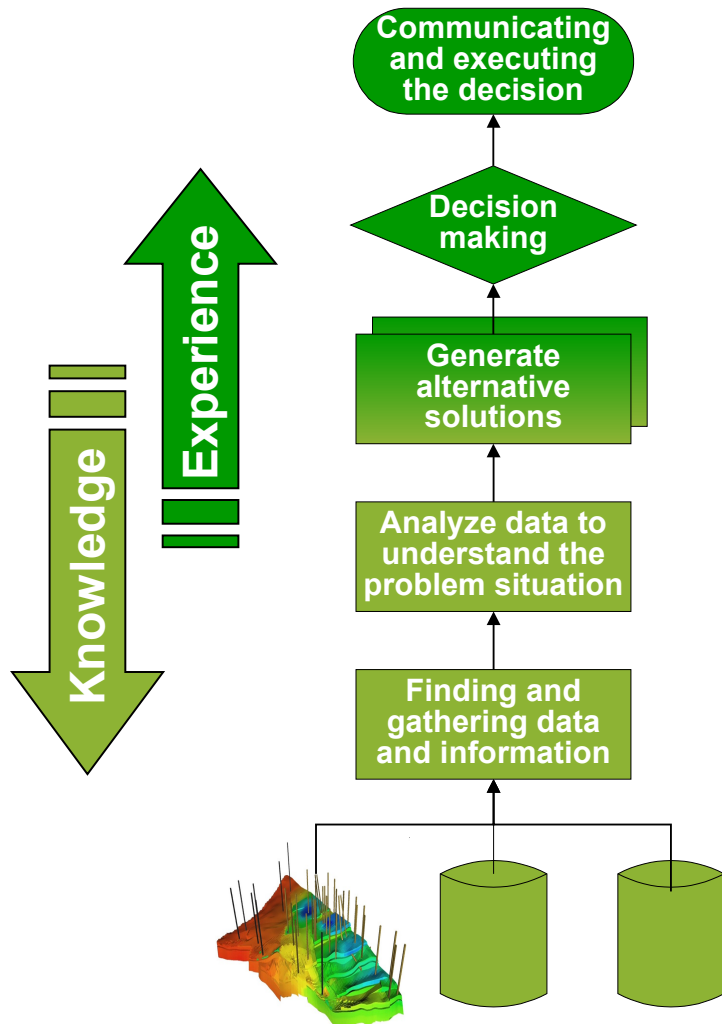
**Focus:
Infrastructure**

One of the main challenges is “data overload”

- Terabytes / Petabytes of data are available!
- Processing capabilities (tools/resources) have not seen a proportional increase



Solution: better informed decision making



- Typical decision making for science-based professions
- Specialists apply both **knowledge** and **experience** for informed decisions making
- First part mainly knowledge gathering
- Second part more based on experience
- Both parts important for efficient decision making

Typical questions to be answered

Knowledge

Experience

Where is the data coming from?

Didn't we have this problem last time?

What other information is relevant?

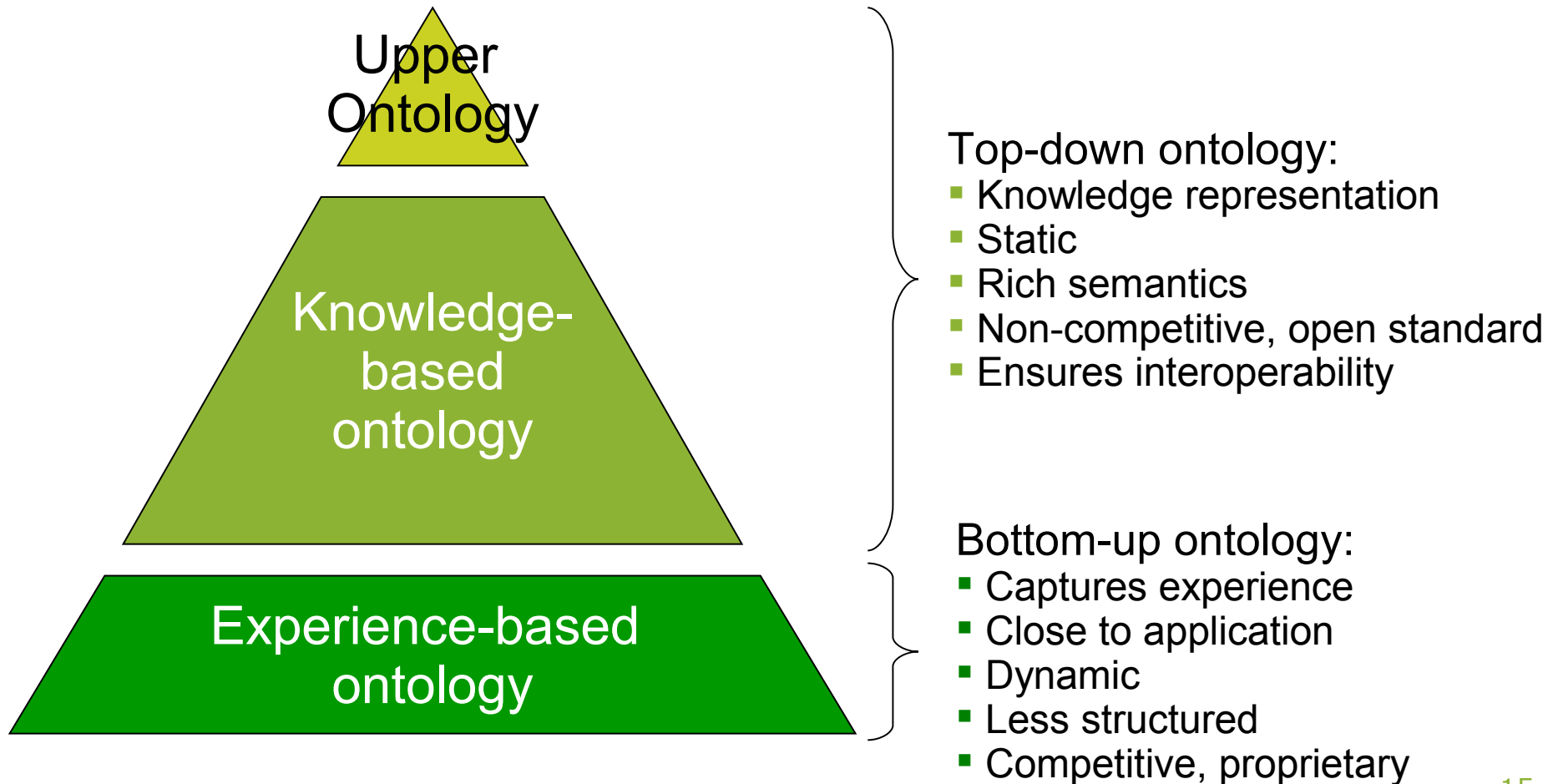
What are the possible solutions?

What is the relationship with this problem?

What is the best option?

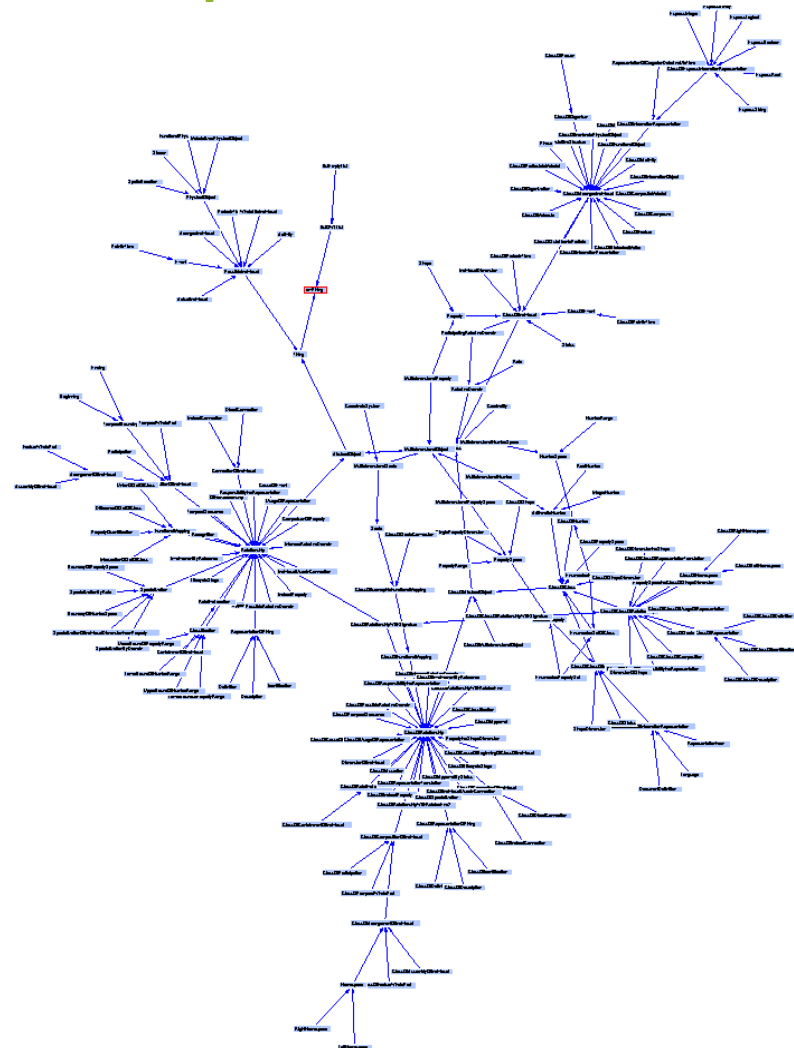


Two approaches for ontology building: Top-down and Bottom-up approach



Top Down Approach Example

- Environment Web Ontology development



Environment Web Project Background

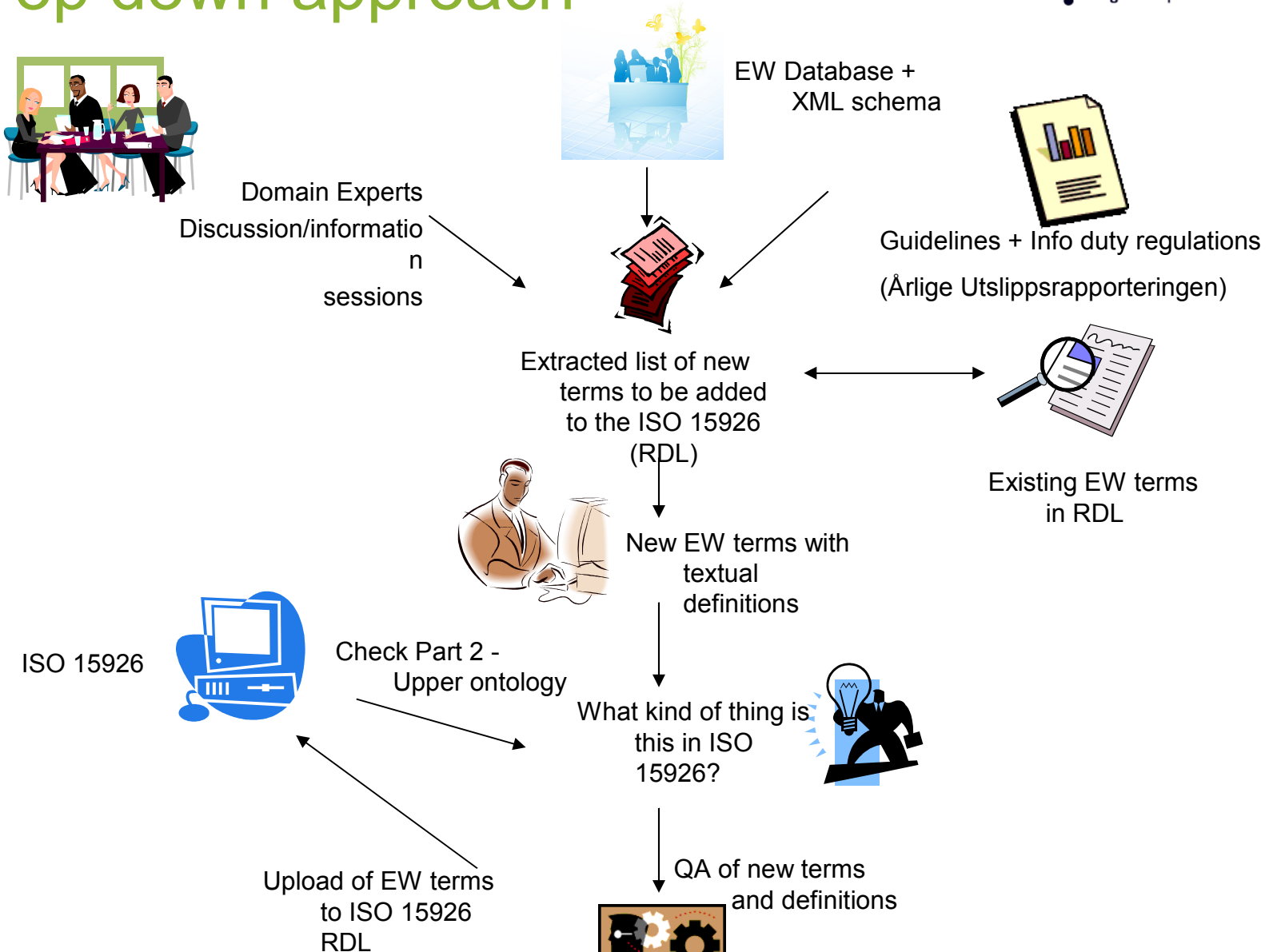
- Official database for emissions and discharges from the offshore oil and gas industry
- Operated by EPIM and OLF (Norwegian Oil Industry Association)
- Used by the authorities and industry
- The purpose of the project is to include terms and definitions from the EW database and EW reporting systems in the [ISO 15926 \(RDL\)](#)



EW to ISO 15926 – Top down approach

- We create an EW ontology which, after a QA process, is uploaded to part 4 of the ISO 15926 standard
- The new EW terms in part 4 are linked to the upper ontology (part 2 of the ISO 15926).
 - EW terms in the RDS can be used as a reference point for all systems using EW terms
 - Interoperability with other reporting systems
 - Annotate EW reports using ISO 15926 definitions

Top down approach



Example set of new concepts

ACUTE POLLUTION	class_of_compound	An environmentally hazardous compound, such as chemicals, oil or gas, that is accidentally discharged to the environment, and that must be reported
ACUTE POLLUTION TO SEA	class_of_compound	An environmentally hazardous compound, such as chemicals, oil or gas, that is accidentally discharged to sea and that must be reported according to
ACUTE OIL POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of oil.
ACUTE DIESEL OIL POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of diesel oil.
ACUTE CRUDE OIL POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of crude oil.
ACUTE FUEL OIL POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of fuel oil.
ACUTE WASTE OIL POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of waste oil.
ACUTE OIL POLLUTION TO SEA OTHER THAN DIESEL OR CRUDE OIL OR WASTE OIL	class_of_compound	An ACUTE POLLUTION TO SEA that consists of oil, other than diesel, crude oil, fuel oil, or waste oil.
ACUTE CHEMICALS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of chemicals.
ACUTE CORROSIVE CHEMICALS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of corrosive chemicals.
ACUTE ENVIROTOXINS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of environmental toxins.
ACUTE CHEMICAL POLLUTION TO SEA OTHER THAN CORROSIVE CHEMICALS OR ENVIROTOXINS	class_of_compound	An ACUTE POLLUTION TO SEA that consists of chemicals, where the discharged chemicals can not be classified as corrosive chemicals, envirotoxins
ACUTE OIL BASED DRILLING FLUIDS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of oil based drilling fluids.
ACUTE WATER BASED DRILLING FLUIDS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of water based drilling fluids.
ACUTE SYNTHETIC DRILLING FLUIDS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of synthetic drilling fluids.
ACUTE NON OIL BASED DRILLING FLUIDS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of non-oil based drilling fluids.
ACUTE FLAMMABLE CHEMICALS POLLUTION TO SEA	class_of_compound	An ACUTE POLLUTION TO SEA that consists of flammable chemicals.
ACUTE POLLUTION TO AIR	class_of_compound	Gas that is accidentally discharged to the environment and that must be reported according to relevant environmental regulations.
ENVIRONMENTAL TOXIN	class_of_compound	Environmental toxins are any chemical or substance that are toxic, slowly degradable and/or accumulates in living organ

RDL - explorer

Address <http://193.212.132.108/rds/> Log out Guest

Search

Advanced search

Result(1) Result(2) Result(3) Result(4)

Search result - 15 Hits

	RDL Designation	Entity type
0	Diesel__REFERS_TO__DIESEL FUEL	CLASS_OF_IDENTIFICATION
1	DIESEL OIL ACUTE POLLUTION TO SEA VOLUME	SINGLE_PROPERTY_DIMENSION
2	DIESEL OIL MASS BURNT FROM WELL TESTING - TO...	SINGLE_PROPERTY_DIMENSION
3	DIESEL OIL MASS BURNT FROM WELL TESTING	SINGLE_PROPERTY_DIMENSION
4	DIESEL OIL MASS BURNT	SINGLE_PROPERTY_DIMENSION
5	DIESEL OIL MASS	SINGLE_PROPERTY_DIMENSION
6	DIESEL OIL IMPORT VOLUME	SINGLE_PROPERTY_DIMENSION
7	DIESEL OIL FUEL SYSTEM	CLASS_OF_INANIMATE_PHYSICAL...
8	DIESEL OIL PUMP	CLASS_OF_INANIMATE_PHYSICAL...
9	DIESEL-ELECTRIC PROPULSION ENGINE	CLASS_OF_INANIMATE_PHYSICAL...
10	DIESEL OIL VOLUME	SINGLE_PROPERTY_DIMENSION
11	DIESEL ENGINE BVM-12	CLASS_OF_INANIMATE_PHYSICAL...
12	DIESEL ENGINE	CLASS_OF_INANIMATE_PHYSICAL...
13	DIESEL ENGINE CATERPILLAR 3512	CLASS_OF_INANIMATE_PHYSICAL...
14	DIESEL FUEL	CLASS_OF_COMPOUND

Search in Entity types Columns

	Entity types	#
9	PARTICIPATING_ROLE_AND_DOMAIN	268
10	CLASS_OF_INDIVIDUAL	100
11	CLASS_OF_EVENT	106
12	CLASS_OF_POINT_IN_TIME	2
13	STATUS	22
14	CLASS_OF_PERIOD_IN_TIME	16
15	PROPERTY	614
16	MULTIDIMENSIONAL_PROPERTY	1
17	CLASS_OF_ARRANGED_INDIVIDUAL	101
18	CLASS_OF_FEATURE	2940
19	CLASS_OF_COMPOUND	1777
20	CLASS_OF_COMPOSITE_MATERIAL	13
21	CLASS_OF_BIOLOGICAL_MATTER	5
22	CLASS_OF_ATOM	183
23	CLASS_OF_PARTICULATE_MATERIAL	6
24	CLASS_OF_ORGANIZATION	25

CLASS OF COMPOUND External references Search global

RDL Designation : DIESEL FUEL
PCA ID : RDS418648421
Creation Date : 2007.03.19
Creator : jorsk
Registration status : Candidate

RDL Definition : A mineral oil that is a specific fractional distillate of fuel oil (mostly petroleum) that is used as fuel in a diesel engine invented by German engineer Rudolf Diesel.

First relation

- DIESEL FUEL (2)
 - CLASSIFICATION.classified (1)
 - MONTHLY PRODUCTION REPORT PROD...
 - SPECIALIZATION.subclass (1)
 - MINERAL OIL (2)
 - OIL (1)
 - LIQUID COMPOUND (1)
 - PETROLEUM (2)
 - HYDROCARBON COMPOUND (1)
 - ISO 15926-4 COMPOUND (1)
 - LIQUID COMPOUND (1)
 - FLUID COMPOUND (1)

Second relation

- DIESEL FUEL (1)
 - CLASS_OF_IDENTIFICATION.represented (2)
 - DIESEL OIL (0)
 - diesel (0)

RDL Explorer 1.6.2 Memory (Available/Total) 10.74 Mb / 25.17 Mb

Examples

- “Hazardous waste is not Acute Pollution,
...it consists of various waste streams collected onboard platforms with hazardous environmental properties which make them illegal to discharge.”
 - e.g. drainage water from the platforms containing oil is collected onboard and sent to land for further treatment. Another example is drilling cuttings with drilling mud.

But...

- *“If Hazardous waste is accidentally discharged to sea, it is reported as an Acute pollution in EW.”*
 - e.g. oily drill cuttings which were injected into the seafloor at Visund was reported as Acute Pollution in 2007, when it was discovered that the storage in the ground leaked to the sea floor surface.

TopBraid - TopBraid/EW_ISO15926/ew2.owl - Eclipse Platform

File Edit Navigate Project Model Scripts Inference Resource Window Help

AcutePollutionToSea

Classes

- rdfs:Resource (1042)
- owl:DataRange (98)
- owl:Thing
 - AcutePollution
 - AcutePollutionToAir
 - AcutePollutionToSea
 - AcuteChemicalsPollutionToSea
 - AcuteChemicalsPollutionToSeaOther
 - AcuteCorrosiveChemicalsPollutionToSea
 - AcuteEnvirottoxinsPollutionToSea
 - AcuteFlammableChemicalsPollutionToSea
 - AcuteNonOilBasedDrillingFluidsPollutionToSea
 - AcuteOilBasedDrillingFluidsPollutionToSea
 - AcuteCrudeOilPollutionToSea
 - AcuteDieselOilPollutionToSea
 - AcuteOilOtherPollutionToSea
 - AcutePollutionToSeaOld
 - AcuteWasteOilPollutionToSea
 - AcutePollutionToSeaProperties
 - ChemicalComponent
 - ChemicalContaminant
 - ChemicalProduct
 - Combustion
 - CombustionHeatingValue

geotravel.owl ew2.owl

StructureType

- rdfs:subClassOf
 - hasField all Field
 - owl:allValuesFrom
 - Field
 - rdfs:subClassOf
 - hasFacility all Facility
 - owl:allValuesFrom
 - Facility
 - rdfs:subClassOf
 - hasAcutePollutionToSea all AcutePollutionToSea

AcutePollutionToSea

- rdfs:subClassOf
 - AcuteChemicalsPollutionToSea
 - AcuteCrudeOilPollutionToSea
 - AcuteDieselOilPollutionToSea
 - AcuteOilOtherPollutionToSea
 - AcutePollutionToSeaOld
 - AcuteWasteOilPollutionToSea
- rdfs:subClassOf
 - AcutePollutionToSeaProperties
- rdfs:subClassOf
 - ChemicalComponent
 - ChemicalContaminant
 - ChemicalProduct
 - Combustion
 - CombustionHeatingValue

hasTotalVolume max 1

- owl:Restriction
- xsd:string
- Type

Properties

- hasVolume
- hasVolumeLarge
- hasVolumeMedium
- hasVolumeSmall
- hasWaterExported
- hasWaterImported
- hasWaterInjected
- hasWaterInOilExported
- hasWaterToSea
- hasWellbore
- hasWellTest
- BOD
- Casno
- Category
- CHEMSTradeName
- Comments
- Component
- ComponentContaminantGroup
- composite:index
- ContaminantType
- Contingency
- Description
- EALCode
- FacilityID
- FieldID
- Fuel
- FunctionGroup
- GasType
- HasRenplaced

Form Diagram Graph Form Layout Source Code

Imports Instances SPARQL Rules Domain Relevant Properties Inferences

Query Editor Query Library

```
SELECT ?subject ?object
WHERE { ?subject rdfs:subClassOf ?object }
```

Basket

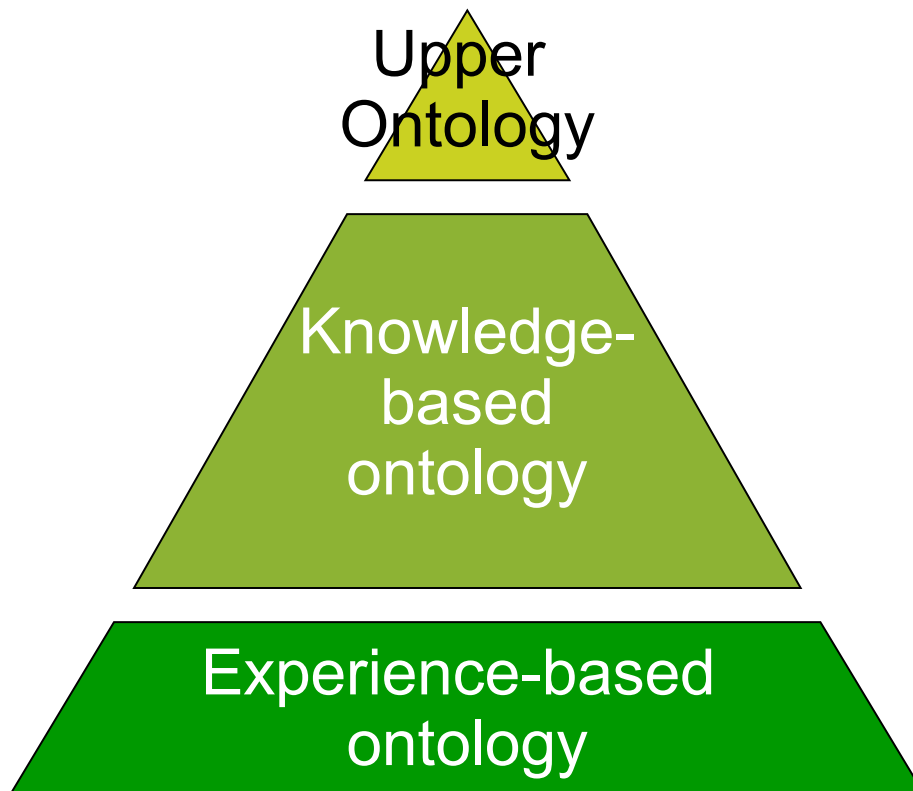
Bottom-up approach: Crime investigation tool for Dutch police

- Domain issues
 - Aspects: 2 ontologies: crime and law
 - Scope: crime scene scenarios on 5 distinguished levels of organizational detail
- Vocabulary issues
 - Concepts and properties
 - Offenders, victims, goods, resources
 - Concepts and relations
 - Scenarios
 - Heuristics and pattern comparison; serial behavior
- Modeling issues; building the ontology interactively
 - BRAINS system for crime investigation
 - Completing a model by (i.e. finding missing components/property values)
 - Text mining
 - Semantic pattern recognition



Crime investigation

Advantages of combined approach



- Two complementary approaches
- Top-down approach:
 - Knowledge representation
 - Rich Semantics
 - Open standard
 - Interoperability
- Bottom-up approach:
 - Captures experience
 - Close to application
 - Dynamic

Conclusions

- Integrated Operations status:
 - IT infrastructure in place
 - Collaborative workflows currently being implemented
 - Next step: solving data overload challenge
- Informed decision making is based on knowledge and experience
- Two approaches to ontology building:
 - Top-down approach:
 - Suitable for knowledge representation in a specific domain
 - Bottom-up approach:
 - Suitable for capturing experience from a group of individuals

Questions / comments



Bottom-Up approach: Methodology

- Domain issues
 - Aspects: Which viewpoints do I need to distinguish?
 - Scope: What level of detail/specialisation do I need to consider?
- Vocabulary issues
 - Concepts and properties
 - What (concepts and propositions) are we talking about?
 - Concepts and relations
 - What kind of topologies of concepts are allowed?
 - What kind of dependencies exist between properties? (mathematical, statistical, heuristics, ...)
- Modeling issues; building the ontology interactively
 - Building a model by instantiating concepts in components
 - Interactively building the model by:
 - Applying property dependencies
 - Comparing model structures