Applying ISO 15926 to drilling control systems

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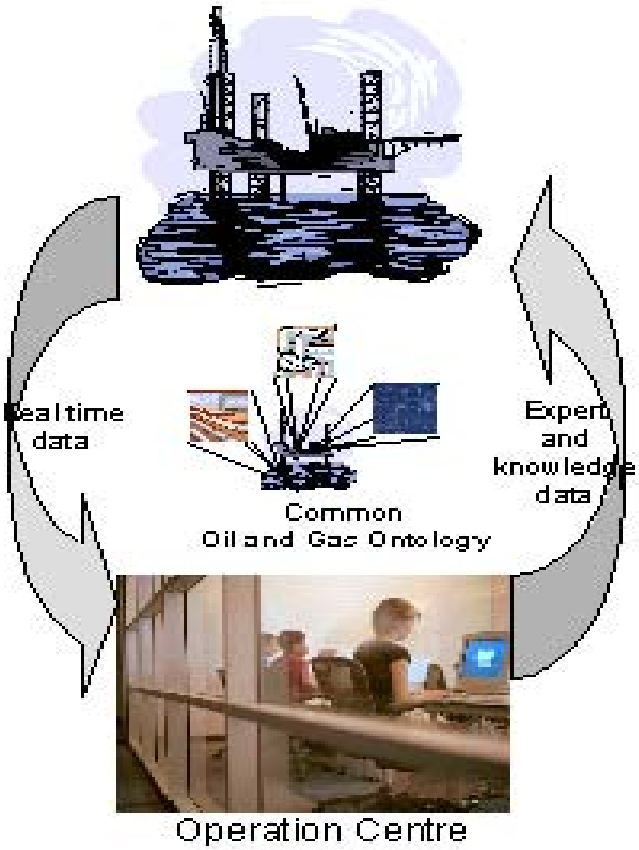
Integrated Operations

- Support operational decisions about offshore installations by onshore control centres
- Use ISO 15926 as the instrument for integrating data
- Estimated to increase the value of the petroleum resources on NCS with > 30 billions Euro NPV
- Generation 1 (IO G1)
  - Integrate processes and people offshore and onshore
  - Currently being implemented
- Generation 2 (IO G2)
  - Utilize vendors' competences and services more efficiently
  - Impose high demands on technology and data integration
  - High degree of autonomous systems



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Background

- Vast amount of data exist for decades
- Large and expensive systems
  - Need solutions that work in association with existing systems
- Segregated data
  - Demands human interpretation to see relations
- Integrate data from diverse sources:
  - Need to see data in relation to reach a conclusion.
- Handle large amounts of data
  - To ease human data processing
  - Enable autonomous operations
- Need data that can be interpreted and processed by applications
- Share information based on meaning (Semantic Interoperability)
- Need an unified understanding of concepts and how they are related
- Demands high level of domain knowledge

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Example XML-files

```
<Order>
   <Date> Jan 1, 2004, 14:29</Date>
   <Customer>
      <Name>John Public</Name>
      <Address>
         <Street>123 Somewhere Ave</Street>
         <City>Some Town</City>
         <State>TA</State>
         <Zip>00000123</Zip>
      </Address>
   </Customer>
   <Products>
      <Product>
         <Model>X965</Model>
         <Price>129.95</Price>
         <Quantity>250</Quantity>
      </Product>
      <Product>…….</Product>
   </Products>
</Order>
```

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<wellboreInfo>
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      06T13:15:00.000</dTimSpud>
  <dTimPreSpud>1982-06-
      06T13:15:00.000</dTimPreSpud>
  <:operator>Statoil</operator>−
  <rigAlias>
    <name>Statfjord C</name>
    <namingSystem>NPD Name</namingSystem>
  </rigAlias>
</wellboreInfo>
<statusInfo>
  <dTim>2002-01-01T12:00:00</dTim>
  <md uom="m">6898<md>
  <tvd uom="m">4561</tvd>
  <mdPlugTop uom="m">3564.22</mdPlugTop>
  <diaHole uom="in">43.33</diaHole>
  <diaPilot uom="in"> 45.55</diaPilot>
  <mdKickoff uom="m">1233.22</mdKickoff>
  <diaCsgLast uom="in">16.6</diaCsgLast>
  <mdCsgLast uom="m">1234.56</mdCsgLast>
  <mdPlanned uom="m">78.9</mdPlanned>
</statusInfo>
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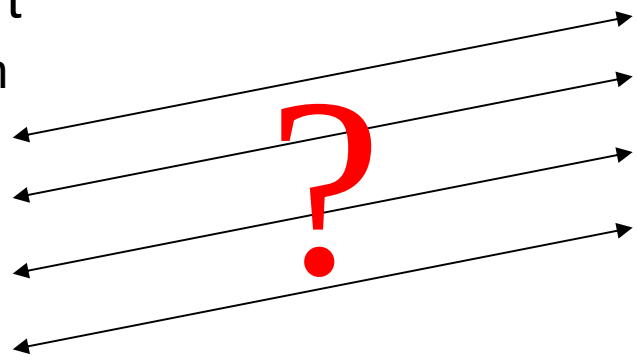
An example

Daily drilling report

- Survey Station complex element
  - dTim
  - md
  - tvd
  - incl
  - azi



- OPC-UA
- 4 fields
  - MDEPTH
  - TVDEPTH
  - INCL_V_DEG
  - AZMH_TN_DEG

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Metadata

- Data about data
- Essential to discover and understand the content of data
- Vital in interoperability
  - Adds meaning to the communicated data
- Need to assure consistent metadata interpretation
- Crosswalk

	OPC UA	**WITSML**
Measure dept	MDEPTH	md
True vertical depth	TVDEPTH	tvd
Hole inclination	INCL_V_DEG	incl
Hole azimuth	AZMH_TN_DEG	azi

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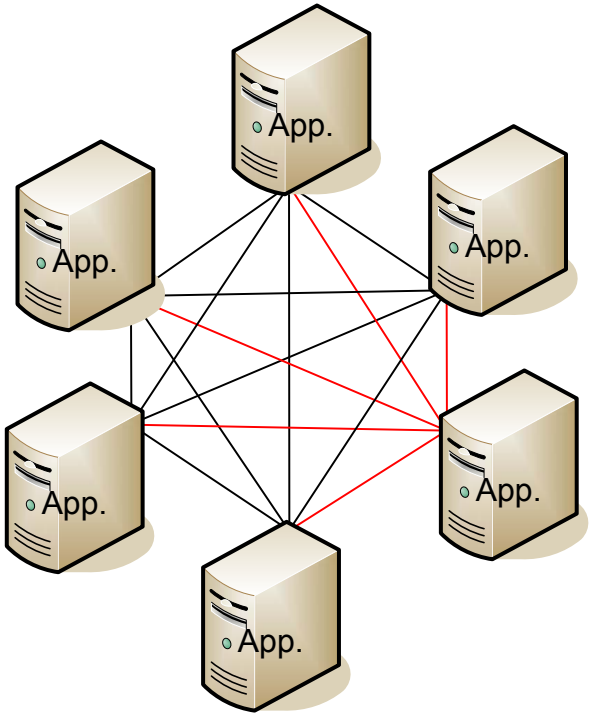
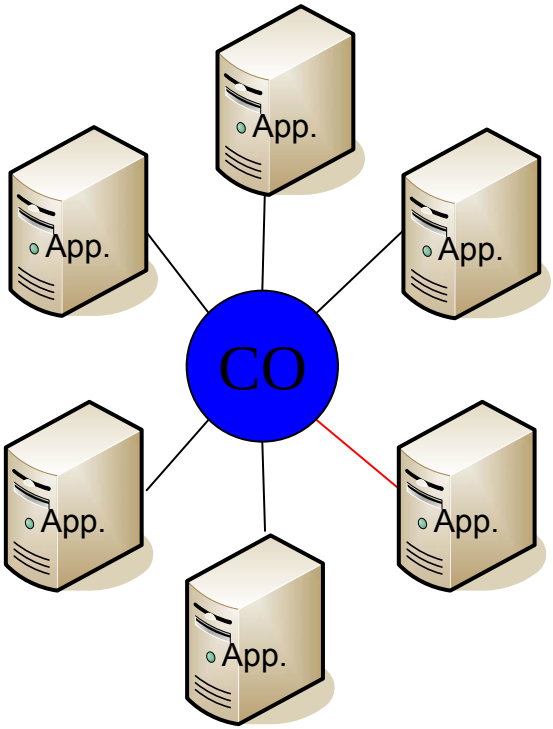
Data integration - Vision



Sharing today



Sharing tomorrow

An example

Daily drilling report

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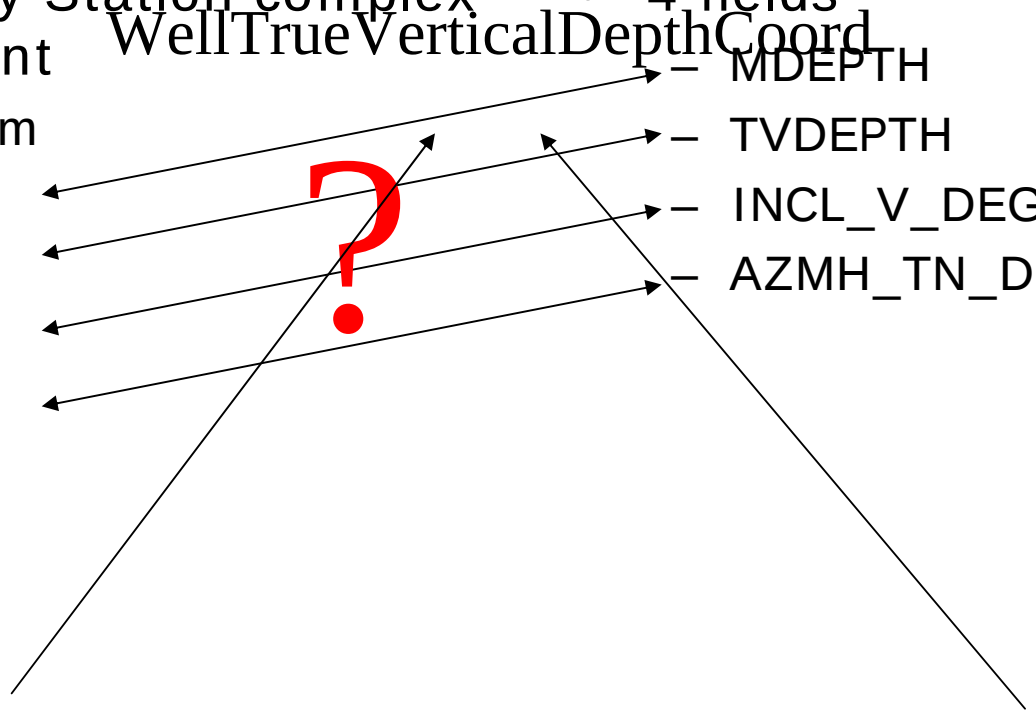

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- 4 fields
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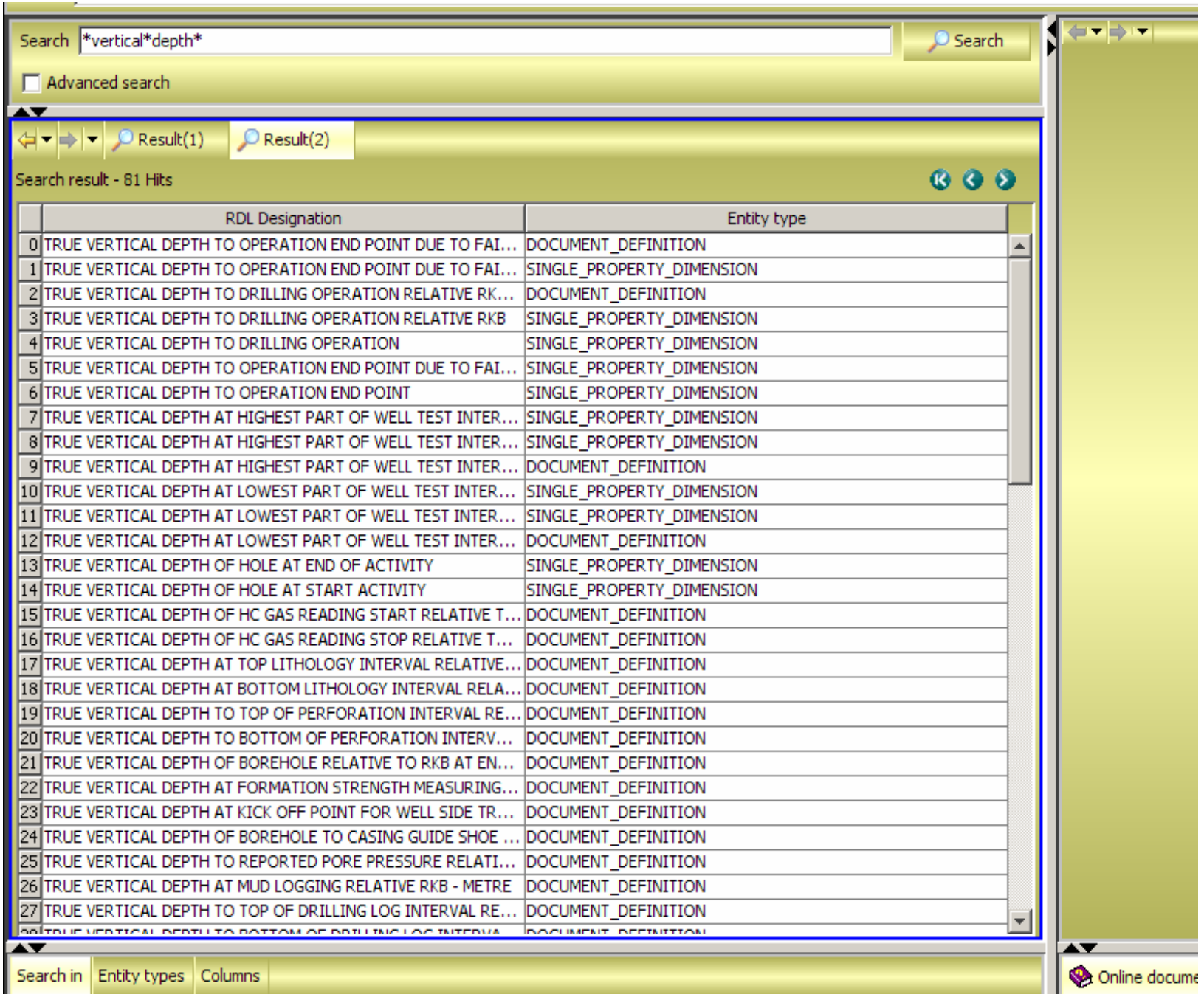

	RDL Designation	Entity type
0	TRUE VERTICAL DEPTH TO OPERATION END POINT DUE TO FAI...	DOCUMENT_DEFINITION
1	TRUE VERTICAL DEPTH TO OPERATION END POINT DUE TO FAI...	SINGLE_PROPERTY_DIMENSION
2	TRUE VERTICAL DEPTH TO DRILLING OPERATION RELATIVE RK...	DOCUMENT_DEFINITION
3	TRUE VERTICAL DEPTH TO DRILLING OPERATION RELATIVE RKB	SINGLE_PROPERTY_DIMENSION
4	TRUE VERTICAL DEPTH TO DRILLING OPERATION	SINGLE_PROPERTY_DIMENSION
5	TRUE VERTICAL DEPTH TO OPERATION END POINT DUE TO FAI...	SINGLE_PROPERTY_DIMENSION
6	TRUE VERTICAL DEPTH TO OPERATION END POINT	SINGLE_PROPERTY_DIMENSION
7	TRUE VERTICAL DEPTH AT HIGHEST PART OF WELL TEST INTER...	SINGLE_PROPERTY_DIMENSION
8	TRUE VERTICAL DEPTH AT HIGHEST PART OF WELL TEST INTER...	SINGLE_PROPERTY_DIMENSION
9	TRUE VERTICAL DEPTH AT HIGHEST PART OF WELL TEST INTER...	DOCUMENT_DEFINITION
10	TRUE VERTICAL DEPTH AT LOWEST PART OF WELL TEST INTER...	SINGLE_PROPERTY_DIMENSION
11	TRUE VERTICAL DEPTH AT LOWEST PART OF WELL TEST INTER...	SINGLE_PROPERTY_DIMENSION
12	TRUE VERTICAL DEPTH AT LOWEST PART OF WELL TEST INTER...	DOCUMENT_DEFINITION
13	TRUE VERTICAL DEPTH OF HOLE AT END OF ACTIVITY	SINGLE_PROPERTY_DIMENSION
14	TRUE VERTICAL DEPTH OF HOLE AT START ACTIVITY	SINGLE_PROPERTY_DIMENSION
15	TRUE VERTICAL DEPTH OF HC GAS READING START RELATIVE T...	DOCUMENT_DEFINITION
16	TRUE VERTICAL DEPTH OF HC GAS READING STOP RELATIVE T...	DOCUMENT_DEFINITION
17	TRUE VERTICAL DEPTH AT TOP LITHOLOGY INTERVAL RELATIVE...	DOCUMENT_DEFINITION
18	TRUE VERTICAL DEPTH AT BOTTOM LITHOLOGY INTERVAL RELA...	DOCUMENT_DEFINITION
19	TRUE VERTICAL DEPTH TO TOP OF PERFORATION INTERVAL RE...	DOCUMENT_DEFINITION
20	TRUE VERTICAL DEPTH TO BOTTOM OF PERFORATION INTERV...	DOCUMENT_DEFINITION
21	TRUE VERTICAL DEPTH OF BOREHOLE RELATIVE TO RKB AT EN...	DOCUMENT_DEFINITION
22	TRUE VERTICAL DEPTH AT FORMATION STRENGTH MEASURING...	DOCUMENT_DEFINITION
23	TRUE VERTICAL DEPTH AT KICK OFF POINT FOR WELL SIDE TR...	DOCUMENT_DEFINITION
24	TRUE VERTICAL DEPTH OF BOREHOLE TO CASING GUIDE SHOE ...	DOCUMENT_DEFINITION
25	TRUE VERTICAL DEPTH TO REPORTED PORE PRESSURE RELATI...	DOCUMENT_DEFINITION
26	TRUE VERTICAL DEPTH AT MUD LOGGING RELATIVE RKB - METRE	DOCUMENT_DEFINITION
27	TRUE VERTICAL DEPTH TO TOP OF DRILLING LOG INTERVAL RE...	DOCUMENT_DEFINITION

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The AutoConRig project

- Founded by The Research Council of Norway
- Part of the IOHN project
- The main objective is to analyse, develop and test an autonomous and semi-automated drilling control system
- Enable real plug-and-play control connection between any approved control party – and a drilling rigs drilling machine
- Deliverables
  - Standard for communicating with the drilling machineries
  - Ontology for Integrated Drilling Control
  - Agent-oriented architecture for semi-autonomous control systems

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Some definitions

- Agent
  - A computer system that is situated in some environment, and that is capable of autonomous actions in this environment in order to meet its designed objectives
  - An intelligent agent has flexible, autonomous behaviour, in which it reacts to its environment appropriately and may take initiatives to meet its goals
- Autonomous
  - having autonomy; not subject to control from outside*

**Dictionary.com*

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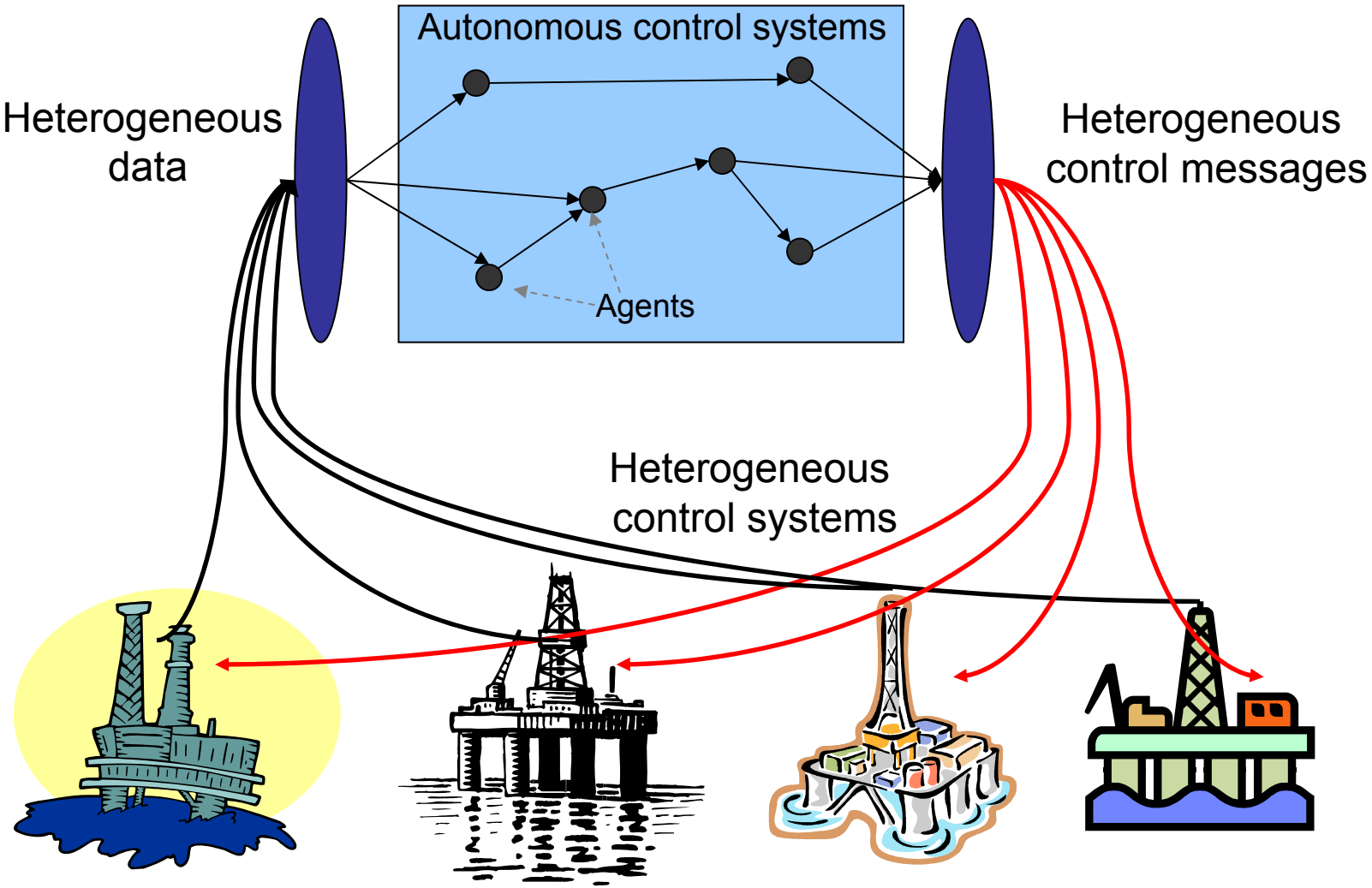
Autonomous Drilling Control Systems in an heterogenous environment



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Autonomous Drilling Control Systems

- Need
  - Standard for communication with the drilling machineries
- Existing Drilling-specific standards:
  - WITSML
  - AKSIO
  - ISO 13628
  - IADC
  - TRAC-ID
  - Control systems (OPC & ISA88)

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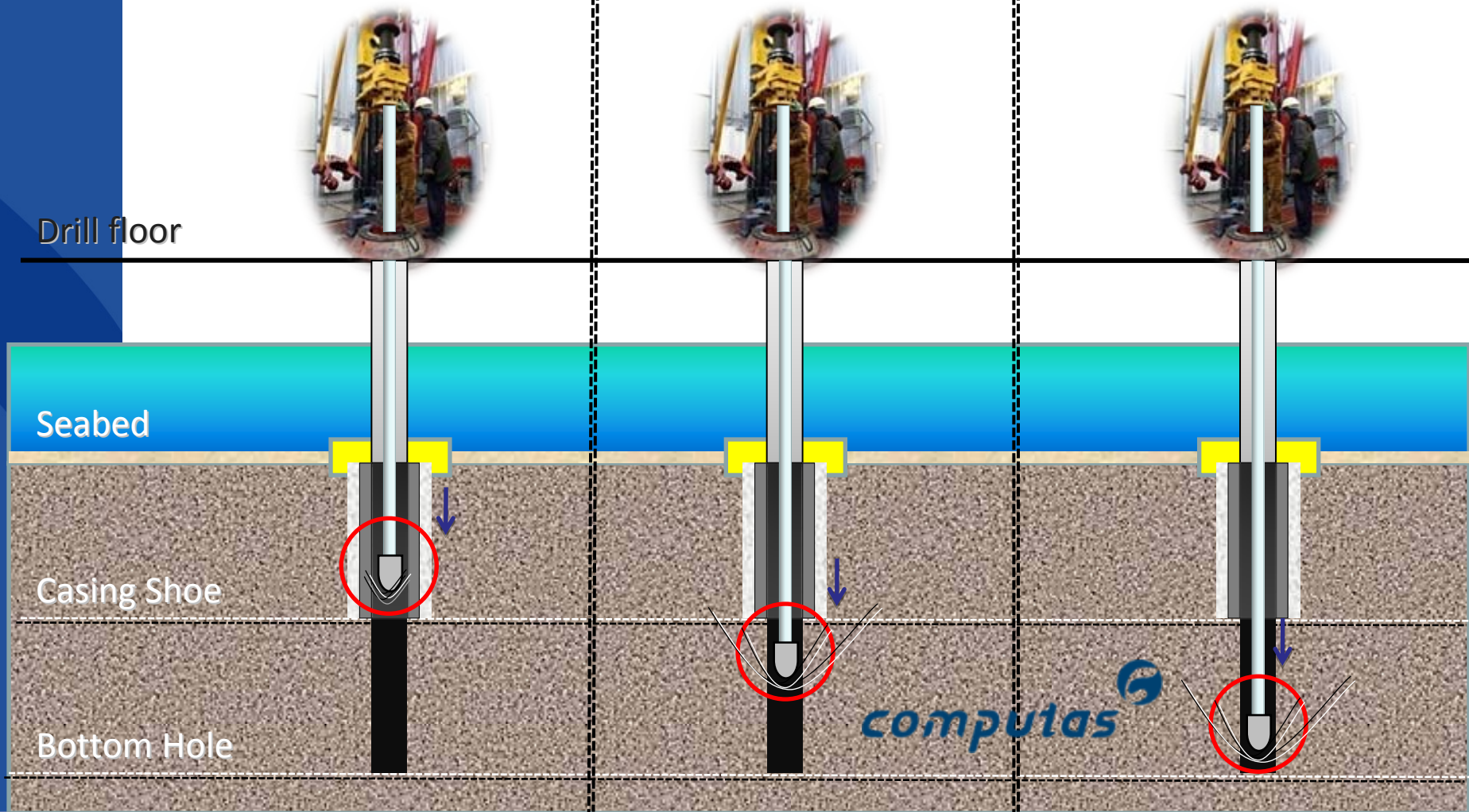
Scenarios

1) Above Casing Shoe (CS)

2) <1 stand below CS

3) >1 stand below CS



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Applying ISO 15926 to AutoConRig

- Have to design a vocabulary for the standard
- ISO 15926
  - "Integration lifecycle data for process plants including oil and gas production facilities
  - Methodology for building ontologies for the offshore industry (Part 2)
  - Reference data library (RDL) – (Part 2 and Part 4)
  - Templates – information triples (Part 7)
- Semantic technologies
  - Semantics: Study of meaning in language
  - Technologies, software standards, and methodologies aiming at providing explicit meaning of data
- The need for semantic technologies
  - Differences in data format and interpretation of terms
  - Extract domain knowledge from IT systems
  - Automatic interpretation of data

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Ontologies vs. Terminologies

- Terminologies (reference data libraries)
  - Just static structures used for knowledge references
  - Describe the kinds of entities in the world
  - Excellent starting point for ontology structuring
- Ontologies
  - Describe, in addition, how the entities are related
  - Allow knowledge inference and reasoning
  - Can also be used as a reference data library
  - Represent content rather than just data
  - Capture a shared understanding of a domain of interest
  - Contain no ambiguities
  - (Provide a formal and machine manipulability model of the domain)
- Upper ontologies:
  - Important for integration
  - How can one integrate different ontologies and maintain consistency?

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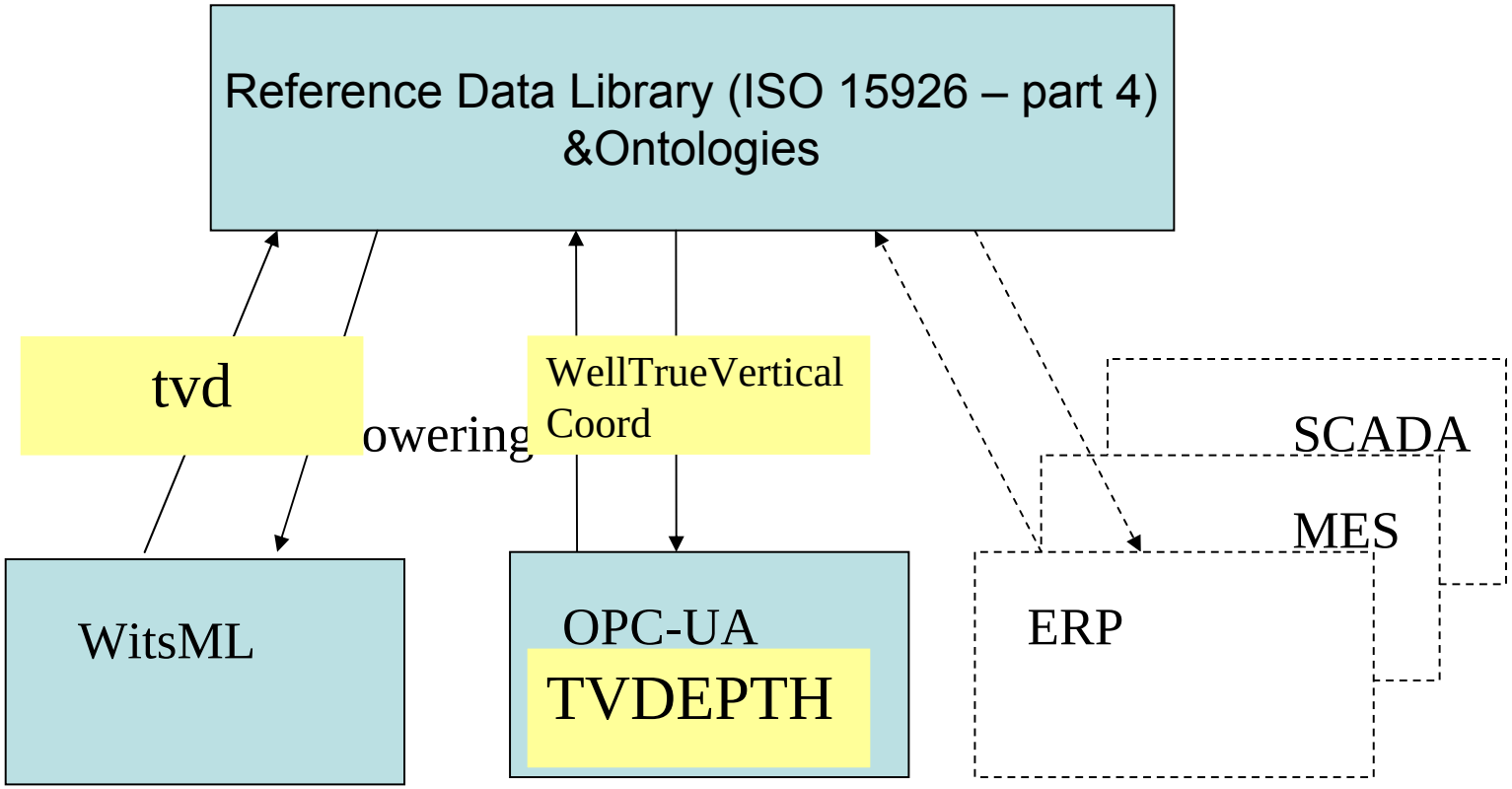
ISO 15926 as an intermediary



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Reasoning

- The art of science of drawing conclusions
- Logic: the study of systems of reasoning
- Different reasoning mechanisms
  - Case-based reasoning
  - Model-based reasoning
  - Rule-based reasoning
  - Fuzzy logic
- Agents use rules and reasoning mechanisms to:
  - Make decisions
  - Infer new information
  - Update plans and goals
  - Learning
- Semantic and logic can be extracted from the systems
  - Ontologies describe the world of interest
  - Rules form the knowledge base

Where should the domain ontology end, and the business specific rules begin?

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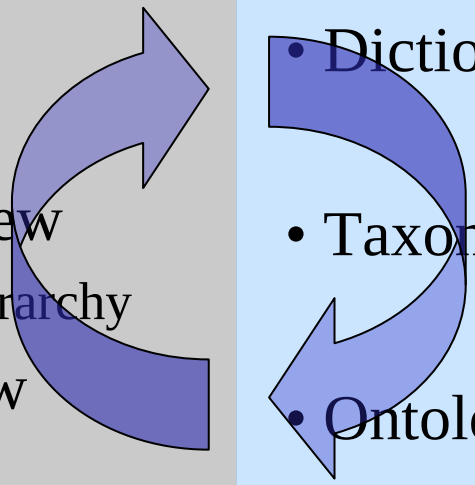
PCA SIG vs. Project (IOHN)

SIG

- Dictionary review
  - Naming
  - Definition
- Taxonomy review
  - Position in hierarchy
- Ontology review
  - Constraints
  - Relations



Project (IOHN)

- Review relevant information sources
- Dictionary modeling
- Taxonomy modeling
- Ontology modeling
- ISO 15926-2/7 compliant ontology modeling

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Thank you for your attention!

Contact information

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More information can be found at:

IOHN wiki: http://www.posccaesar.org/wiki/IOHN

SIG D&C wiki: http://www.posccaesar.org/wiki/SigDc