

Model driven integration architecture for IO G2 information

Reference Semantic Model alignment to ISO 15926

Integrated Operations in the High North – Joint Industry Project



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Content



- Background
 - Owner / operator requirements
- Reference Architecture
 - Conceptual Reference Architecture for IO G2
 - The IBM Integrated Information Framework
- Reference Semantic Model
 - Integrating information model for the oil&gas industry
- RSM alignment to ISO15926
 - RSM as a Reference Data Library module
 - Providing ISO15926 data from the IIF/RSM



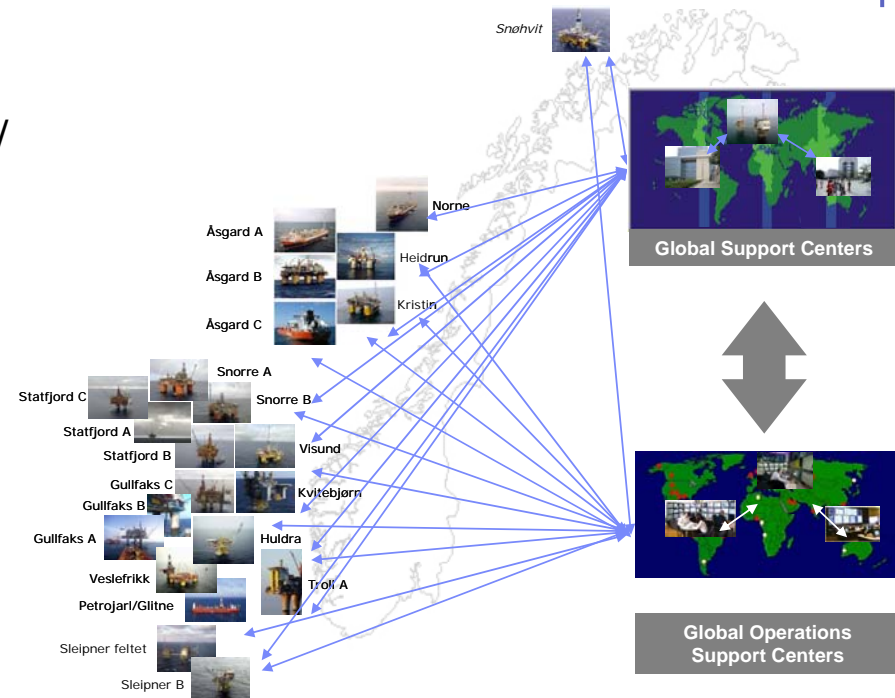
StatoilHydro TAIL-IO R&D Programme

- Operational reality

- Large number of different applications. Each instance with own unique reference and data model. Example:
 - Real Time historians / IMS Systems - One for each asset
 - Hydro Carbon Accounting systems - One for each asset / license
- Complex views spanning divisions/plants/process areas requires new “one-off” application developments.

Challenges

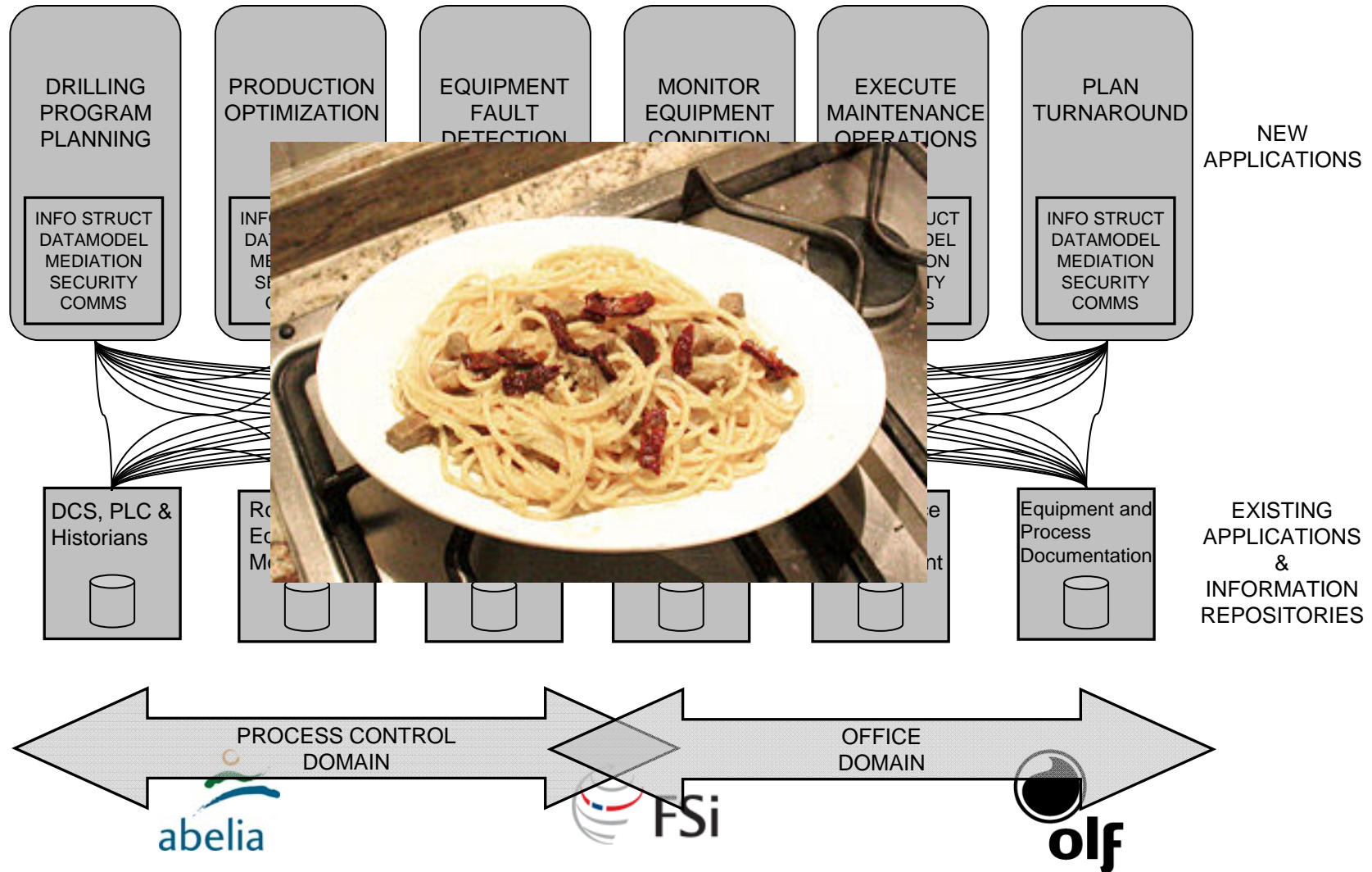
- Lost volumes
- Inefficient operation & maintenance
- Incidents
- Reduced IT ROI



The current situation

– complexity is increasing

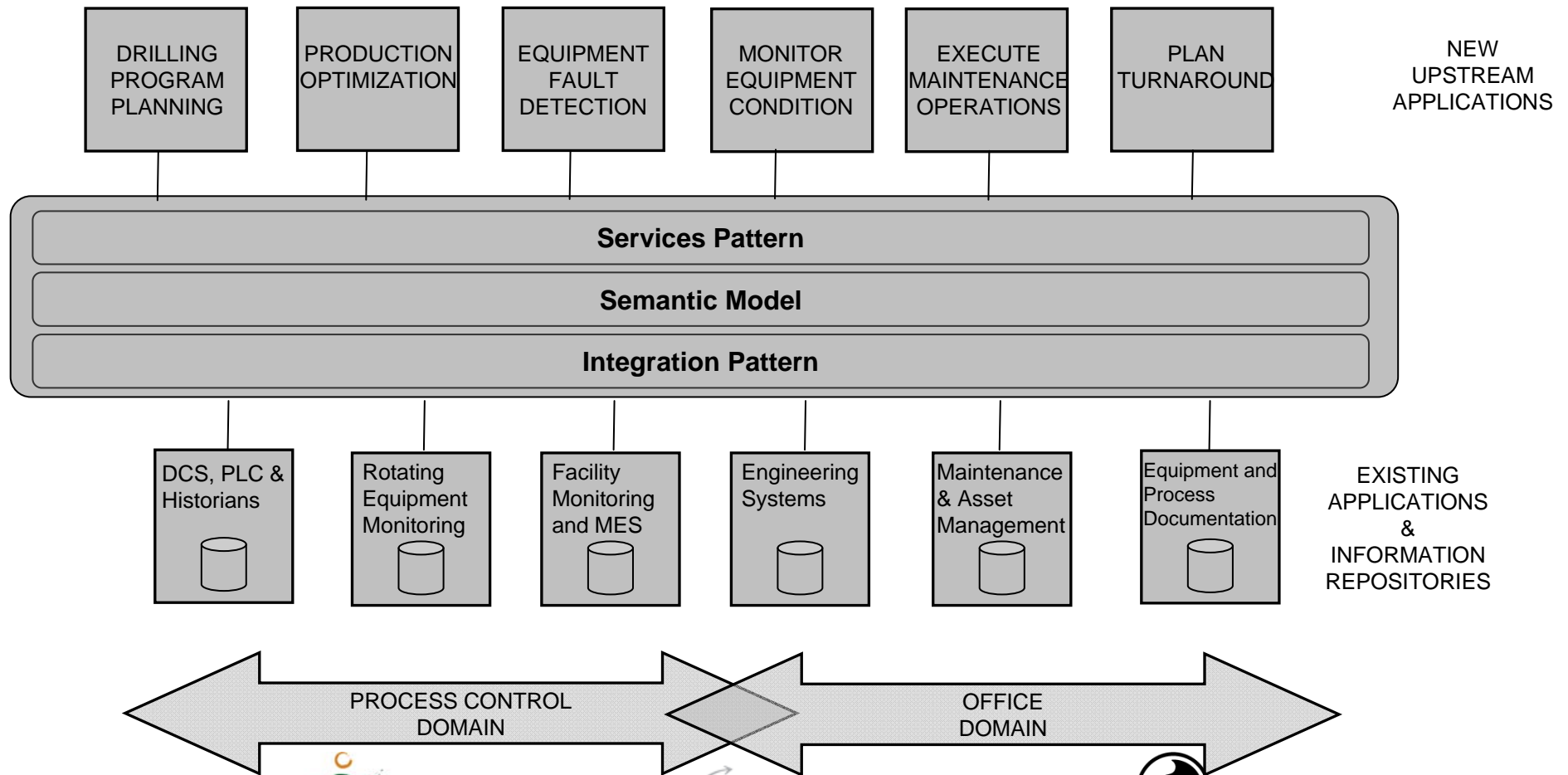
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Draft Reference Architecture for OLF Integrated Operations Generation 2 Version 1.0 *)



- Current EAI/ESB technologies are inadequate

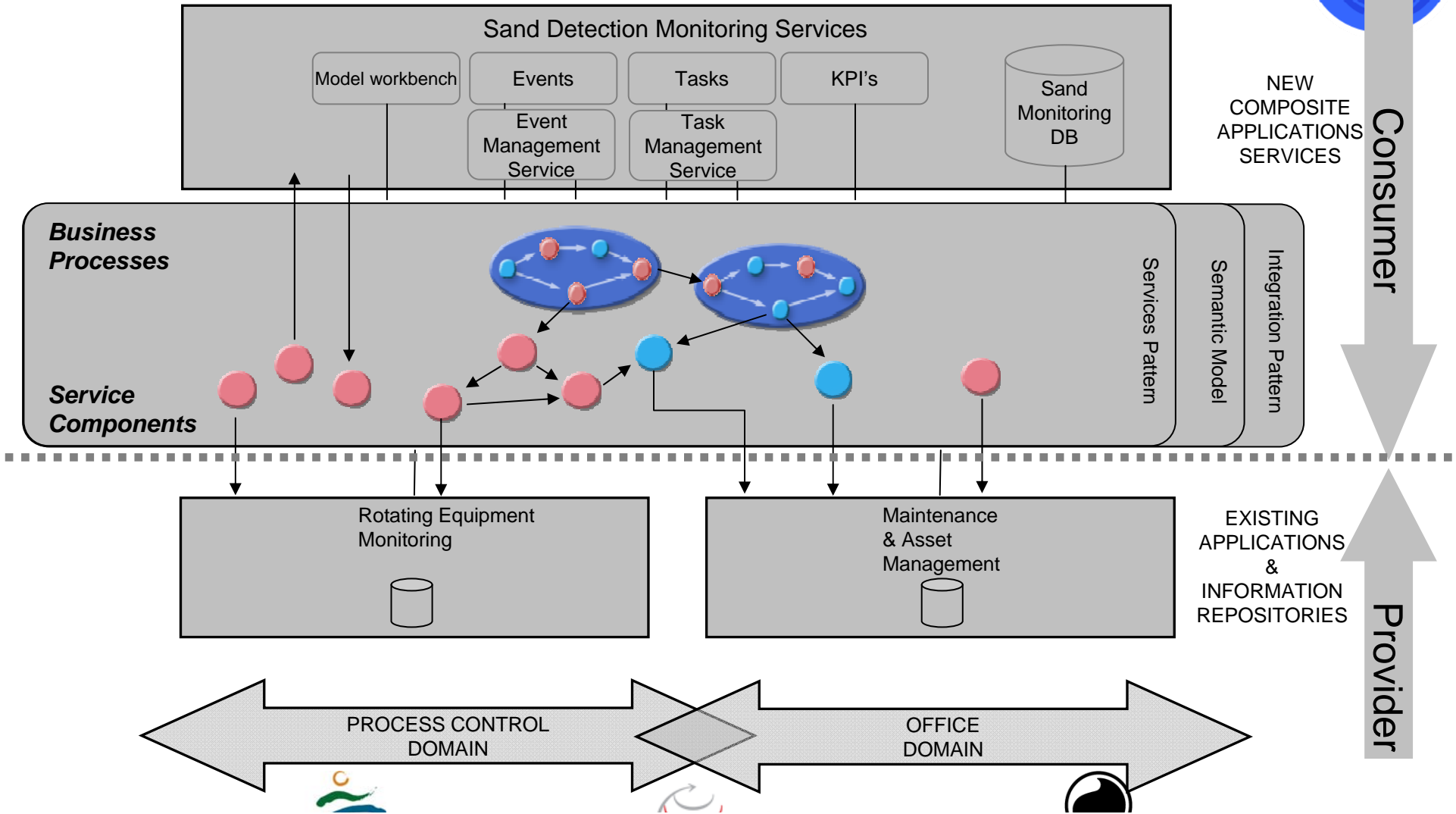


*)Svein G. Johnsen (SINTEF), Einar Landre, Knut Sebastian Tungland (StatoilHydro), Frode Myren (LUM), Paul Carr (CapGemini)



The Service patterns

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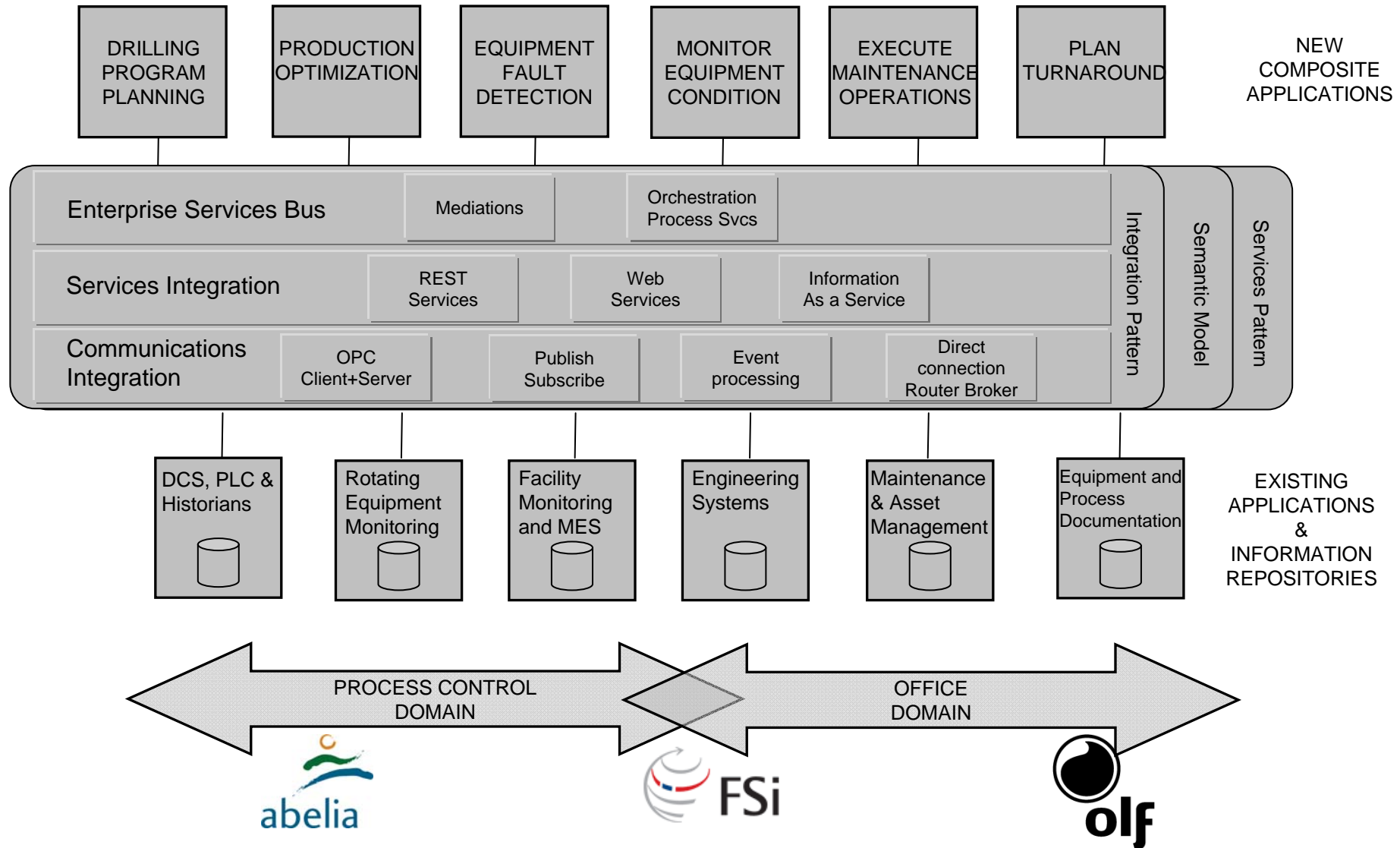
http://www.computer.org/portal/cms_docs_itpro/itpro/homepage/2007/may_june/f3010.pdf

IEEE S3: A Service-Oriented Reference Architecture, Arsanjani et al.

The Integration pattern within the architecture

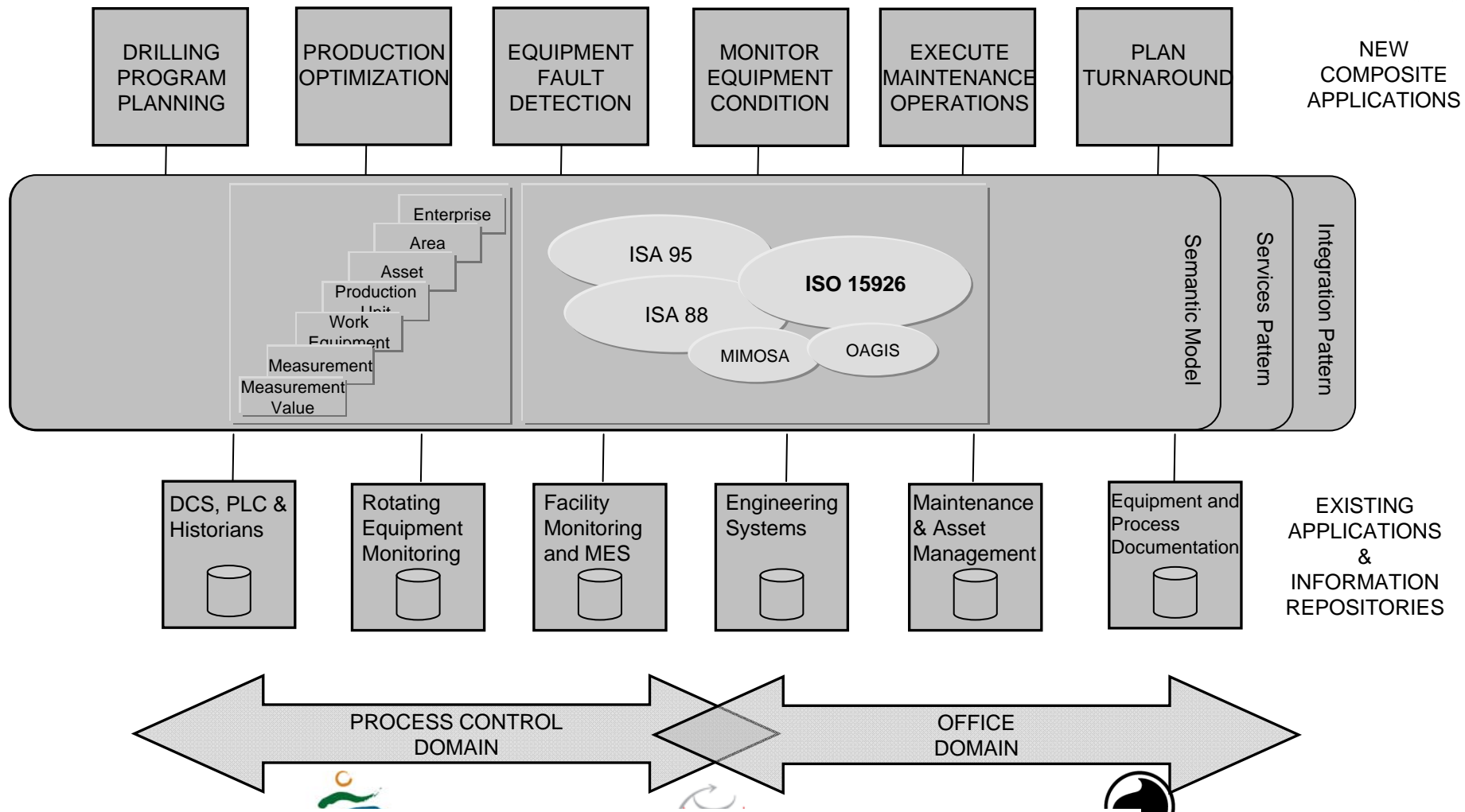


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The Role of the Semantic Model within the integration architecture

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RSM: Part of real time transactional integration platform

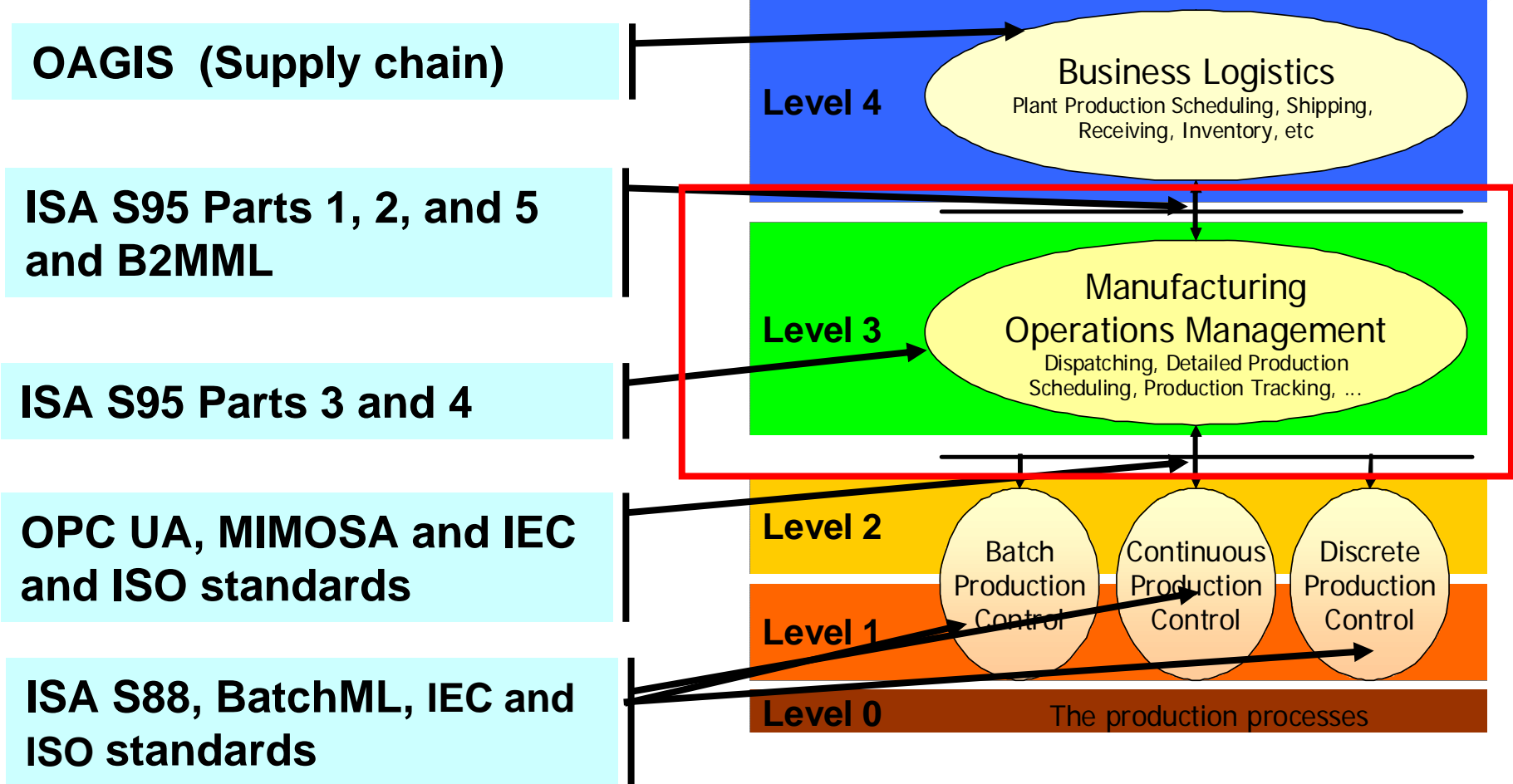
ISO15926: Master data definitions and structures



The Purdue Reference Model – Enterprise – Operation – Control

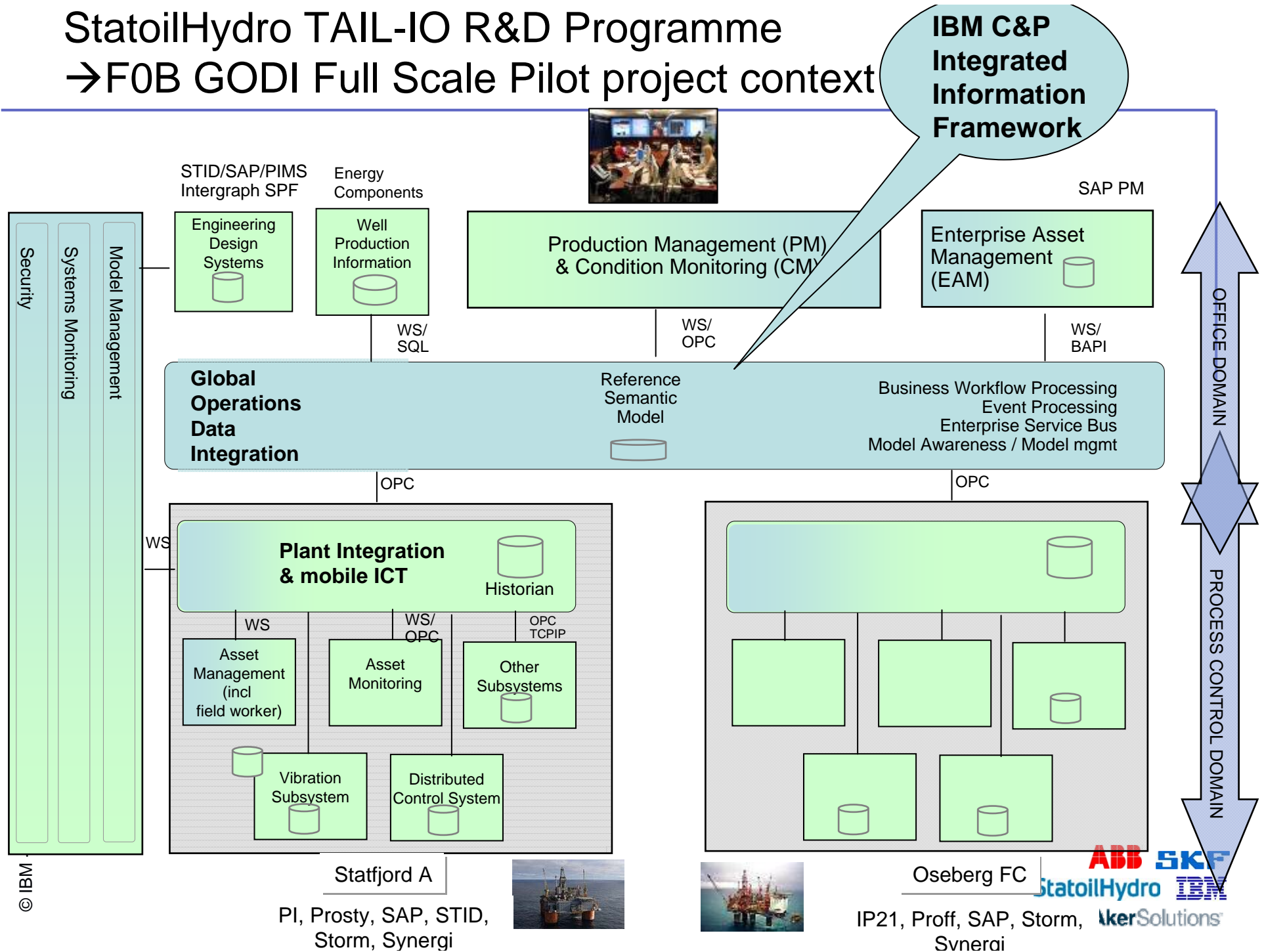
Applicable standards for integration

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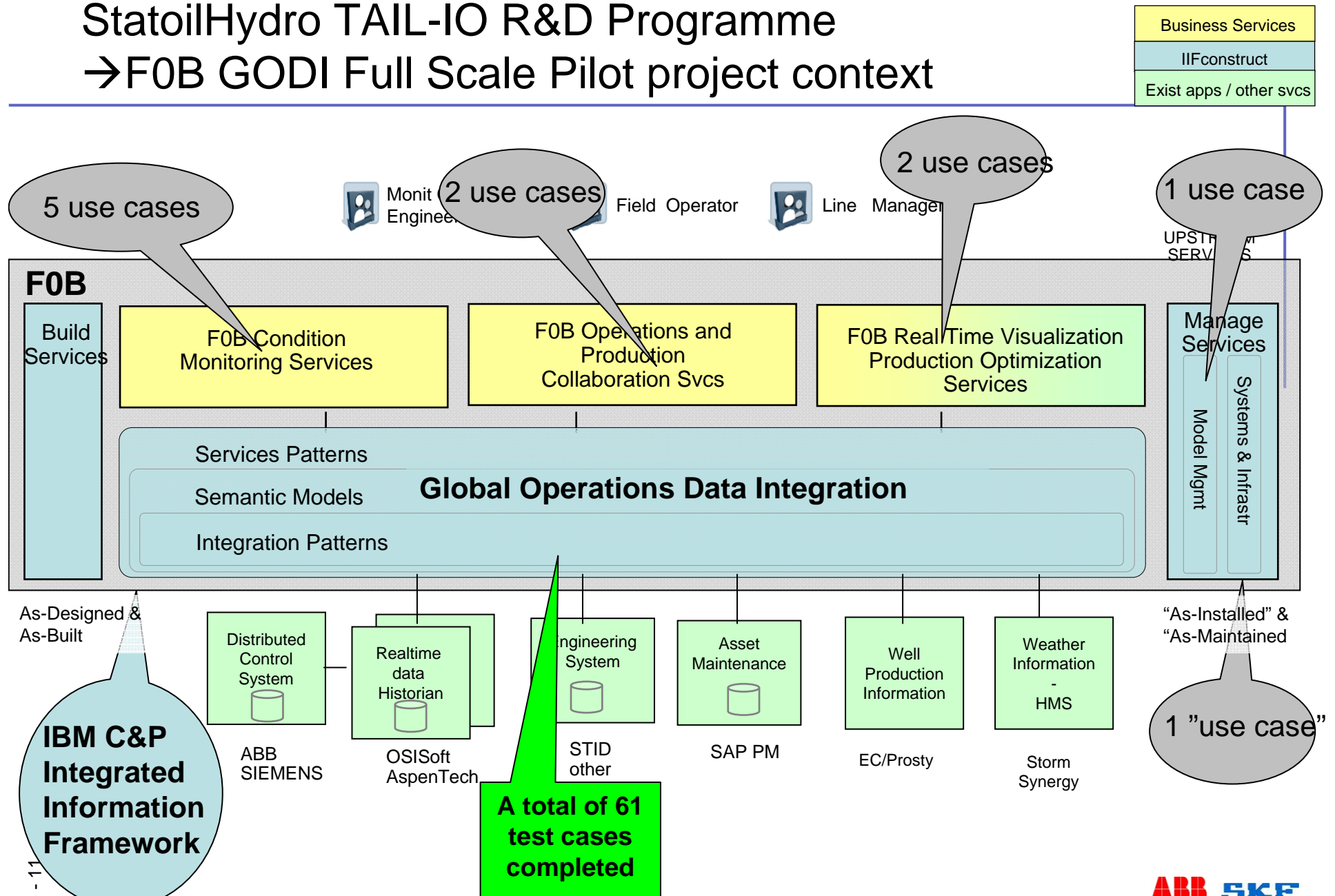
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→ F0B GODI Full Scale Pilot project context



StatoilHydro TAIL-IO R&D Programme

→ F0B GODI Full Scale Pilot project context



- Verification of flexibility & scalability wrt work processes and data access
- Verification of performance, availability, security, usability



IBM C&P Integrated Information Framework, extending IBM WebSphere

Users and applications

- Maintenance Supervisor/Engineer
- Platform Engineer



- Production Supervisor
- Operator
- HSE Engineer
- Field, Asset Owner



Human alerts
mail/ terminal
/SMS



Integration with other
systems (ERP, EAM,
Oil accounting)

Built in IIF Extensions

Production and performance reporting



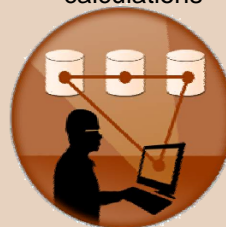
Condition based monitoring



Intelligent alerts & event management



KPIs and production calculations



Collaboration for decision making



IIF (Middleware)



Reference semantic model



Global standards



Smart SOA with collaboration



Configurable event rules engine



Visualization in context of process

Accessed via Model aware adapters

Facility monitoring, HSE apps. & legacy appl.

Rotating equipment monitoring

DCS, PLC, & historians

Drilling & Production Acc. systems

Maintenance & Asset mgt

Equipment & process documentation



IIF Solution Studio

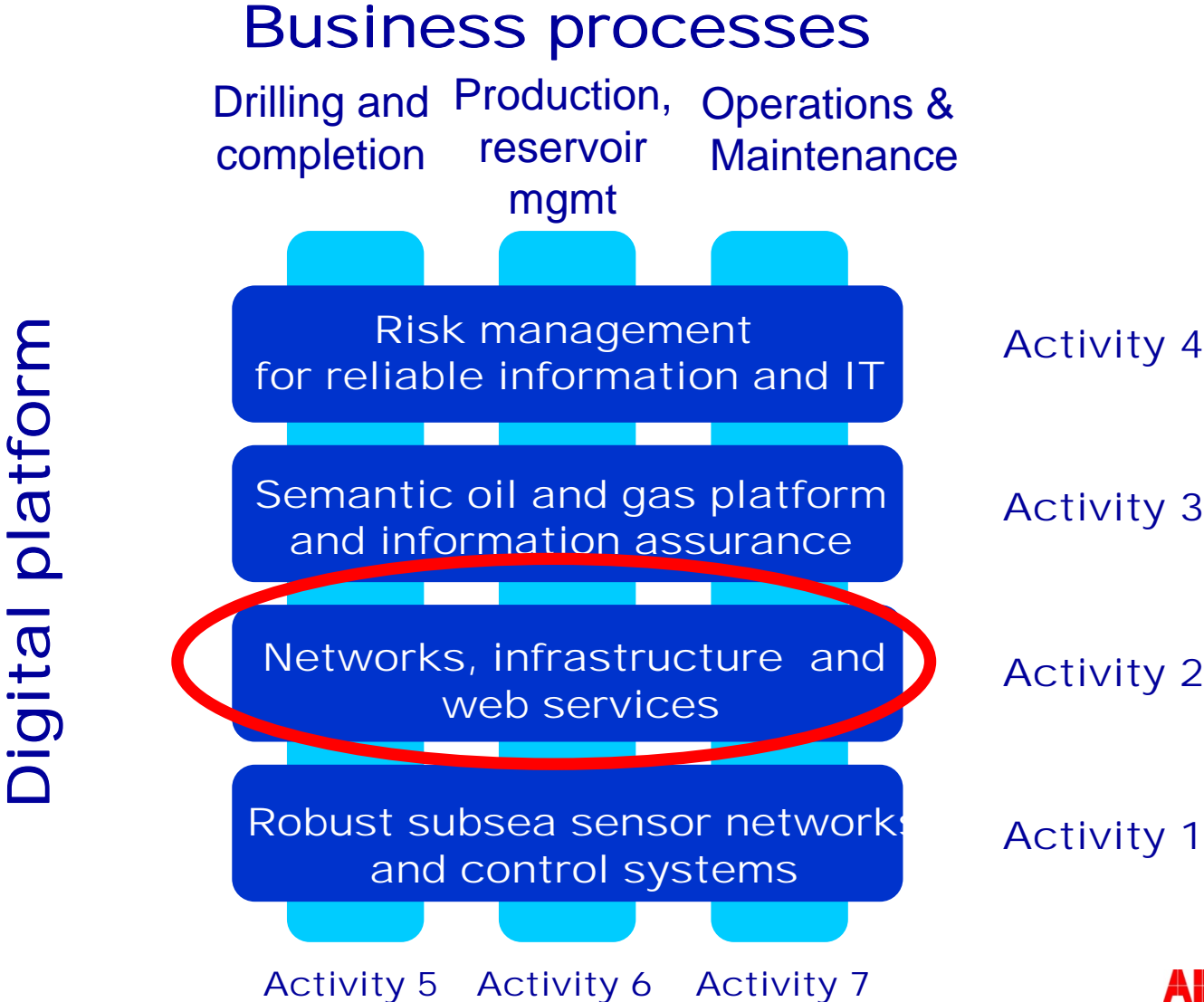
Facilitates exchange of measurements, equipment, planning information, federated across applications, across facilities

The screenshot displays the IIF Workbench software interface. The main window is titled "Field Instrumentation Diagram Editor" and shows a process flow diagram with various components like valves (HV1160, ESV1162, ESV1161, DQ-PT-A7), transmitters (PI1163, AT1161A, PT1161), and tanks (LZ1016). A red circle highlights the left-hand navigation tree, which includes a "My Diagrams" folder and a tree structure for "Gulf of Mexico" and "Tabasco II" systems. A tooltip for item "13-XX0" lists several transmitters and valves. A line chart in the bottom right shows "Measurement" over "Last 10 readings" with a current reading of 16.0. The bottom of the screen shows a Windows taskbar with the Start button and several open applications.

Item	Value
width	206
height	211
xAxisLabel	Last 10 readings
yAxisLabel	Measurement
xMin	1
xMax	10

IOHN Activity 2 has the architecture focus

To establish a digital platform infrastructure across domains



IOHN Activity 3 focus for this effort

To establish a semantic platform

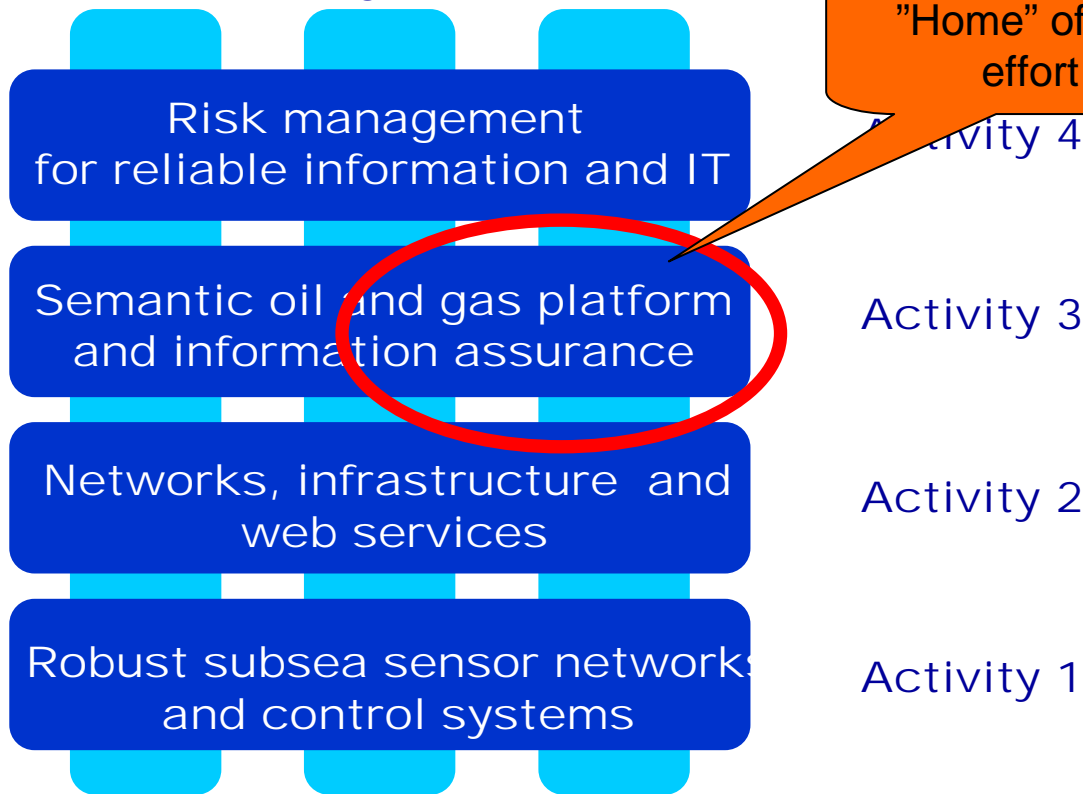
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Business processes

Drilling and completion
Production reservoir mgmt
Operations & Maintenance

Digital platform



"Home" of this effort



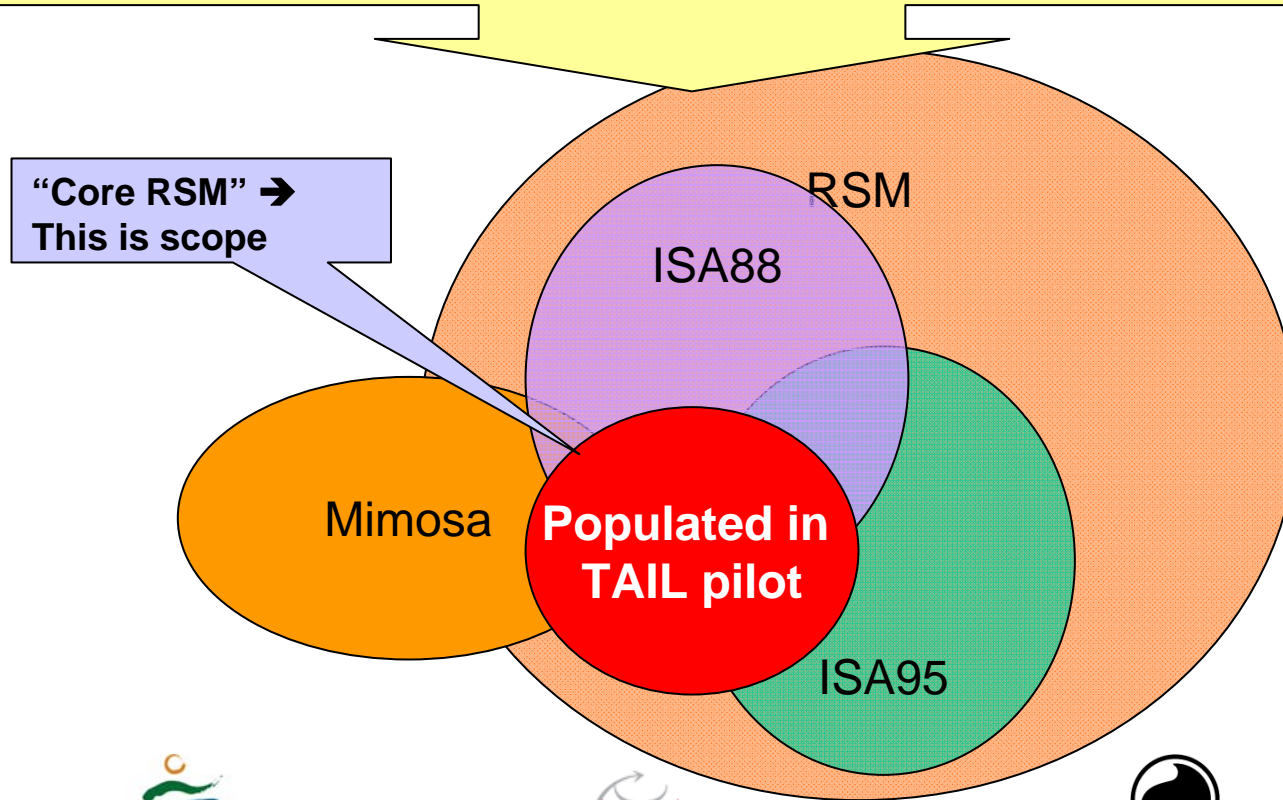
Activity 5 Activity 6 Activity 7



Mission and scope

Represent the Reference Semantic Model (RSM) in ISO15926

This scope: Represent in ISO15926 the scope of the Reference Semantic Model (RSM) currently exploited by the FOB/GODI (TAIL) project

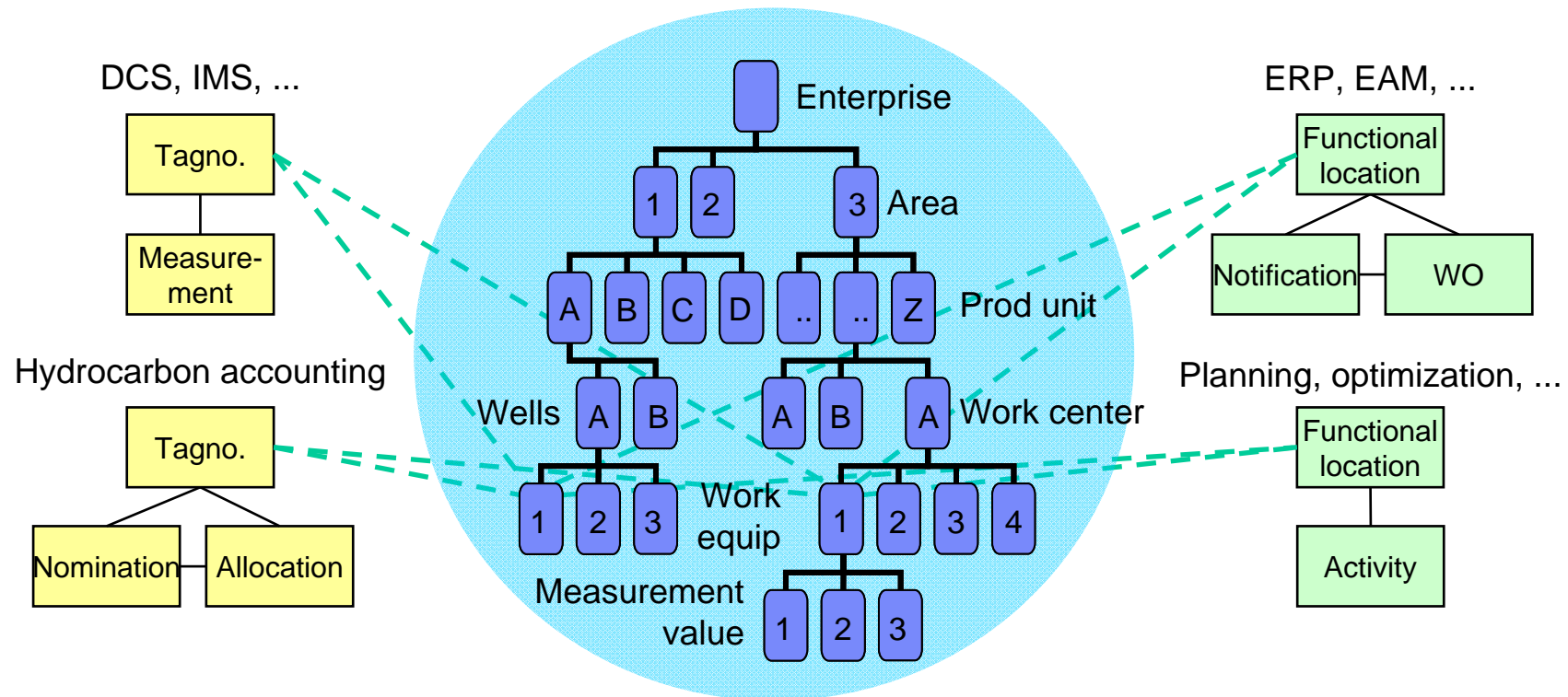


Examples of challenges targeted by the RSM and the IIF framework



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- Part of real time transactional integration platform
- Access to information concerning the same object(s) even if the information is dispersed across many facilities and many applications
- An instance model providing a naming context for measurements across facilities



Reference Semantic Model

- An integrating information model for the oil & gas industry

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Overview

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- **Why the Reference Semantic Model**
- Main elements of Reference Semantic Model
- Summary



Main aspects of the Reference Semantic Model

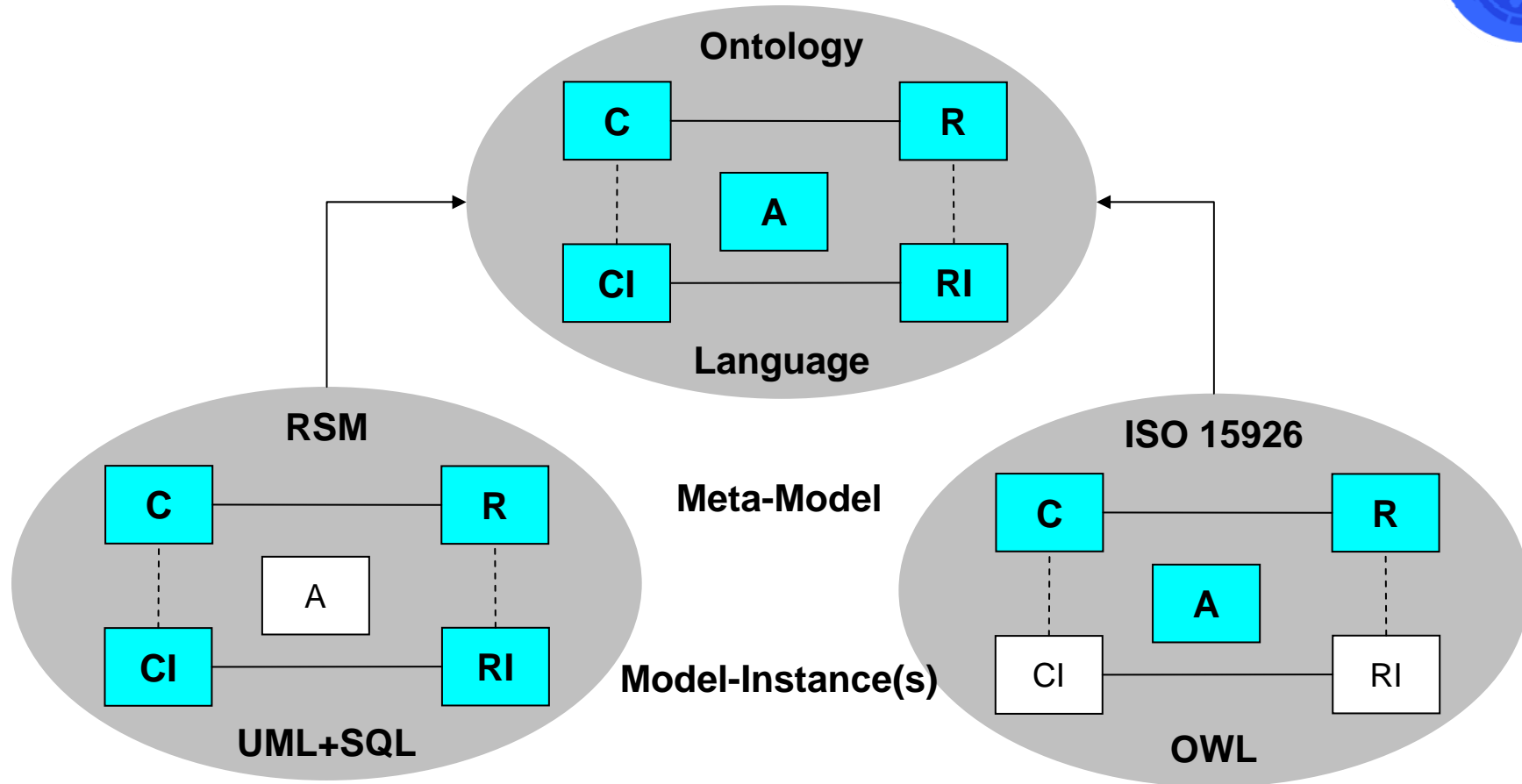
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- Uniform representation of data/information flowing through the IIF
- Supports information needs of different applications
- Is a blend of different information model standards like ISA S88, S95, MIMOSA, ISO 15926
- The RSM is
 - defined as a UML meta-model
 - implemented as a relational database for storing model instance data



Clarifying terms and how they are used in RSM and ISO 15926

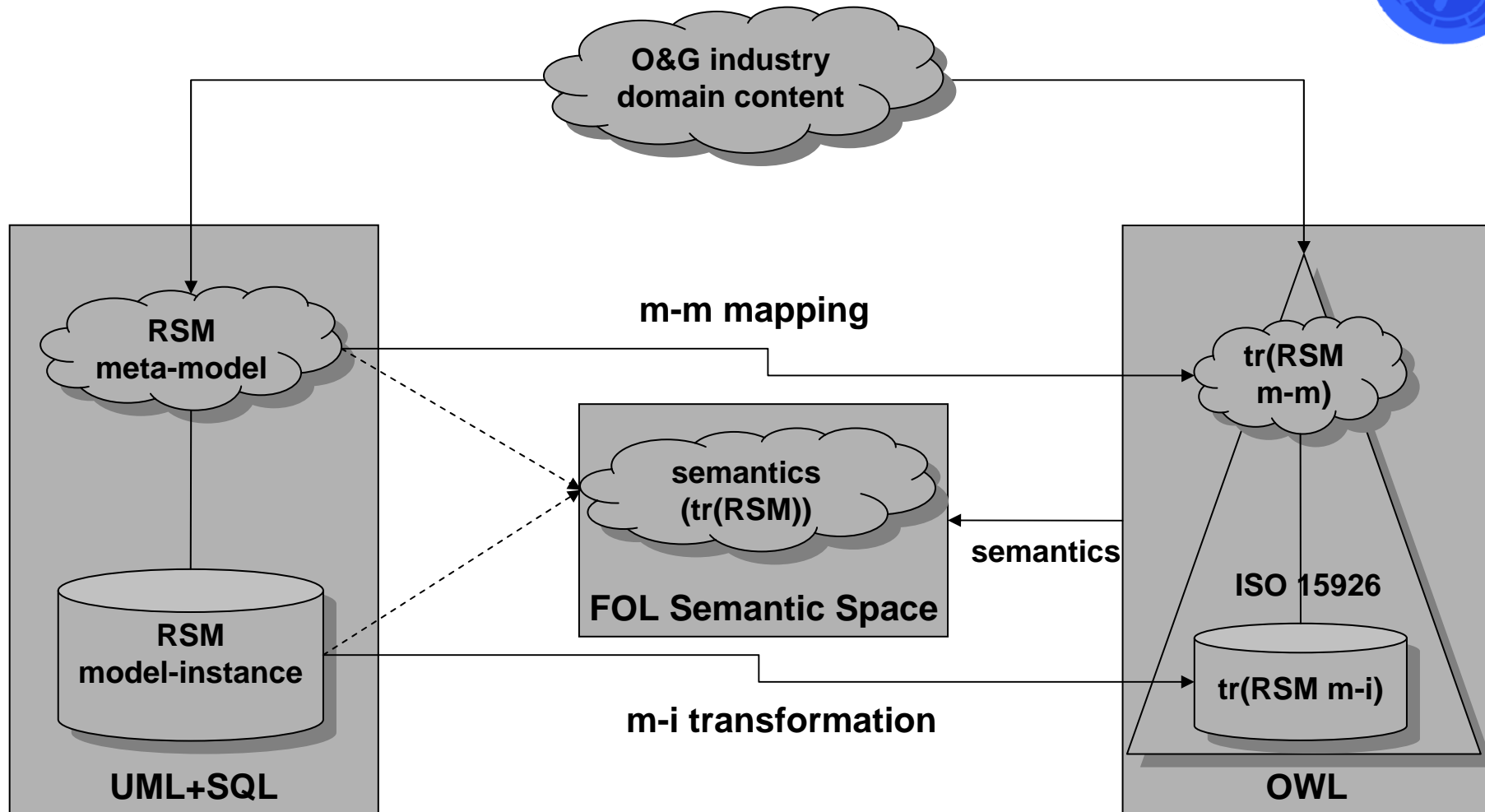


C = class, R = relation, A = axiom, CI = class instance, RI = relation instance



Semantics for RSM: by translation into ISO 15926

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Why the term ,Reference Semantic Model‘?

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- Reference Semantic Model aims at
 - **richer content quantity** \neq higher content quality through
 - expanding the industry domain modeling scope
 - unification of relevant information models like S95, S88, MIMOSA
 - richer content quantity \neq **higher content quality** through
 - Reviews of UML master model
 - (semantics-defining) transformation to ISO 15926
 - exploiting semantics of OWL used as modeling language for ISO 15926



Overview

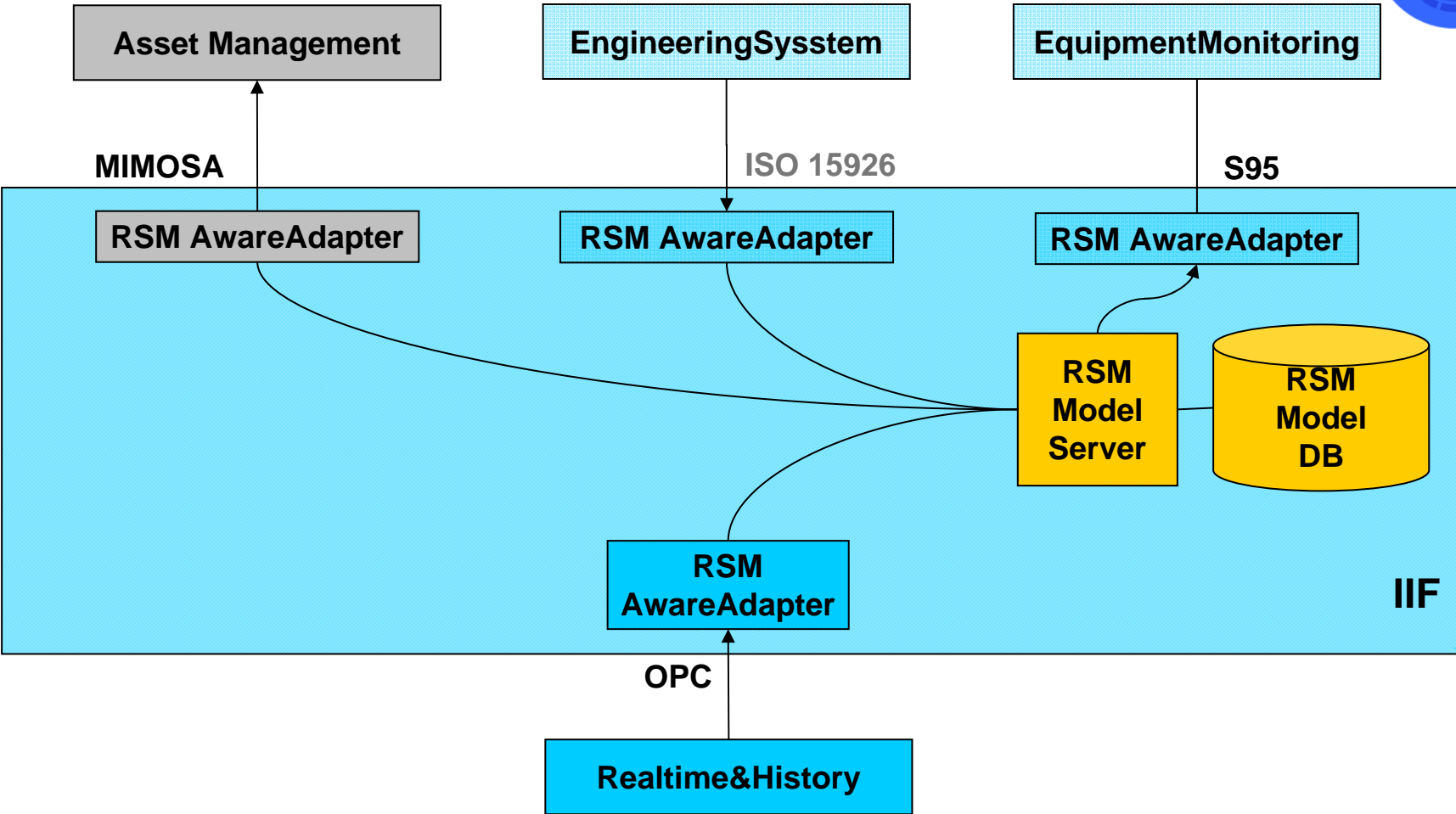
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- Why a Reference Model
- **Main elements of Reference Semantic Model**
- Summary



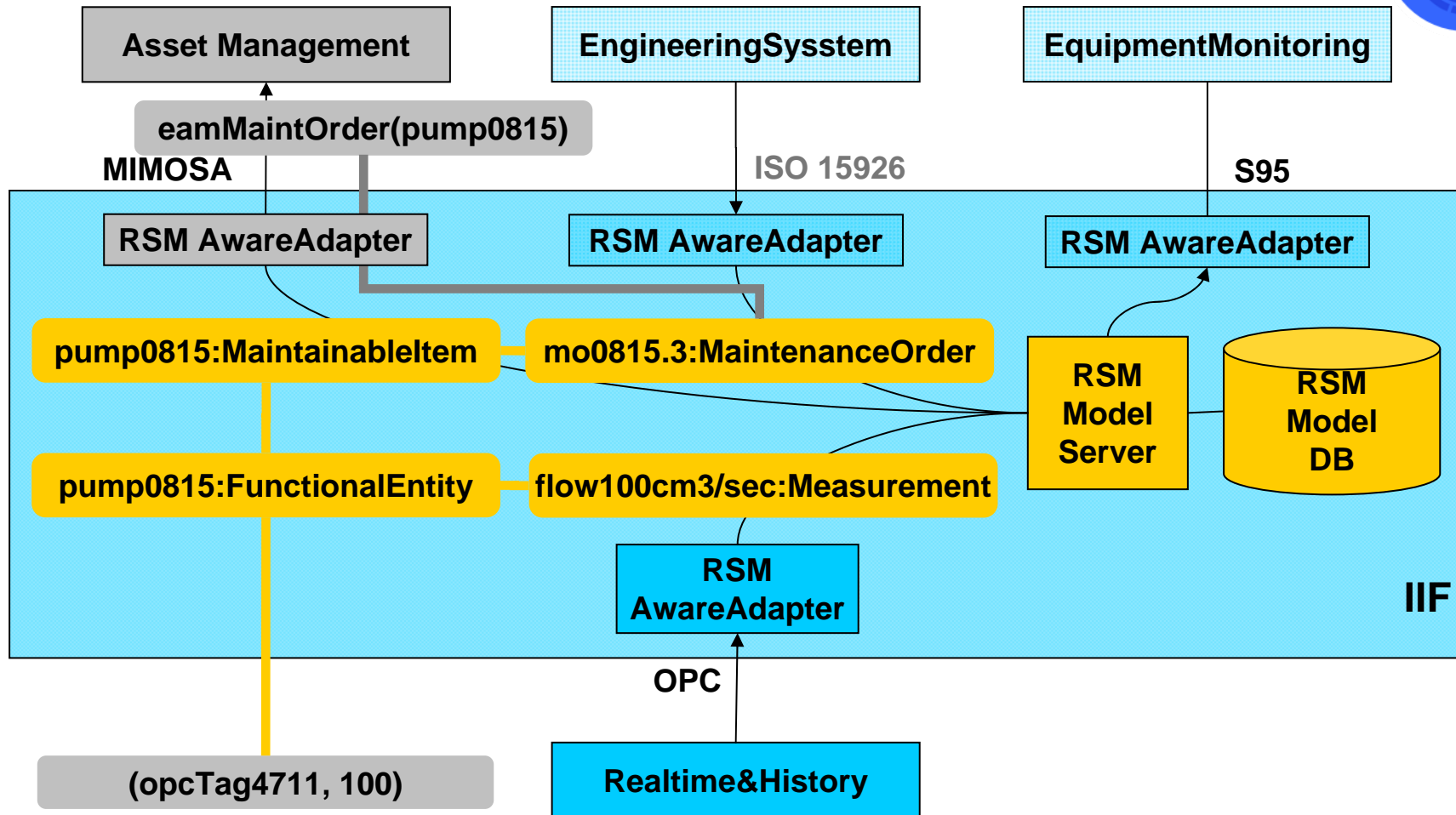
Standards around RSM and IIF



Standards around RSM and IIF



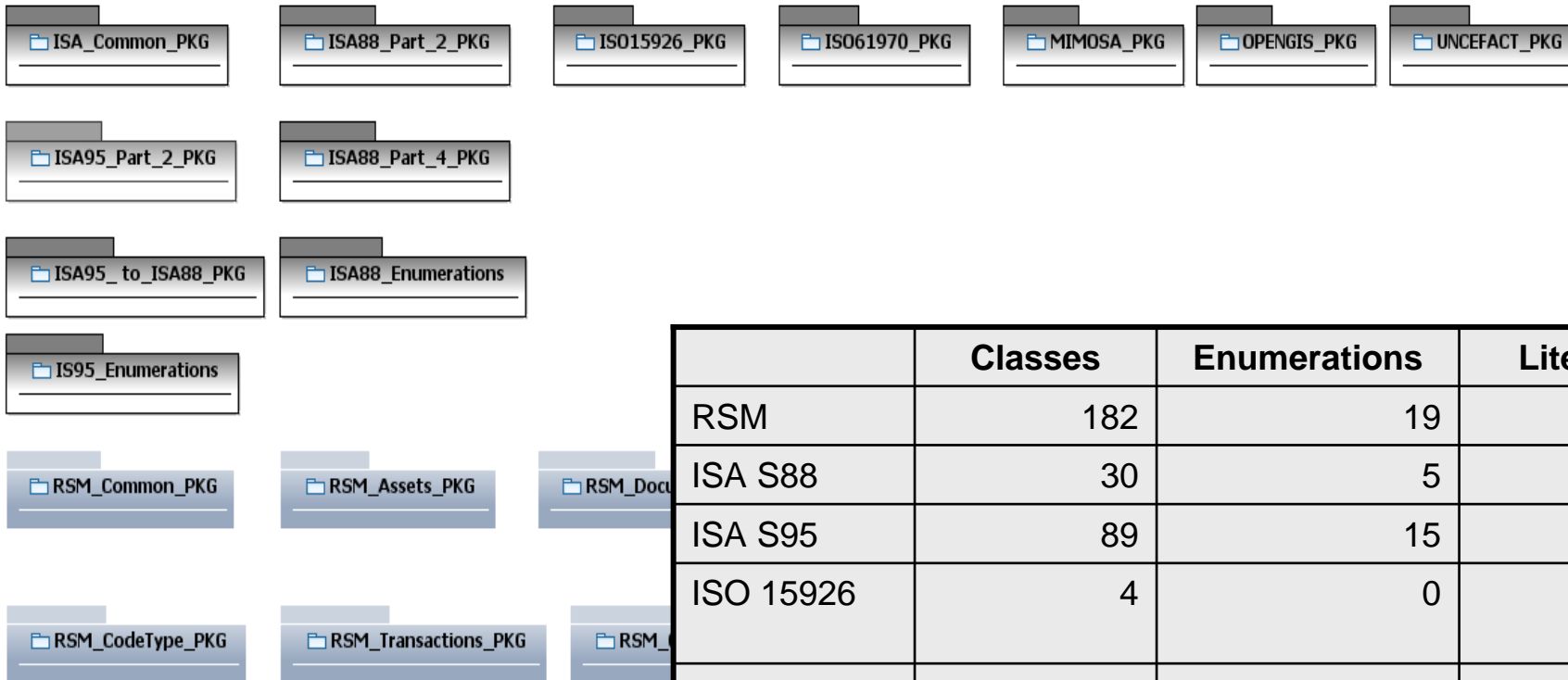
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RSM main package collection



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	Classes	Enumerations	Literals
RSM	182	19	~ 100
ISA S88	30	5	~ 100
ISA S95	89	15	~ 100
ISO 15926	4	0	0
MIMOSA	20	1	3
OPENGIS	38	6	~ 50
UNCEFACT	2	3	~ 800
Total	365	49	1208



Key aspects of O&M for oil & gas enterprises in RSM

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- Currently most exploited parts of RSM
- Main areas of RSM subject for ISO 15926 alignment
- Alignment means
 - Position RSM more precisely in the ISO 15926 ontology
 - RSM classes as subclasses of ISO 15926 classes
 - Import equipment classifications from ISO 15926 into RSM
 - ISO 15926 classes as subclasss of RSM classes
 - ISO 15926 classes as instances of RSM classes

Enterprise & Site
Structure

Equipment
Hierarchies

Measurements



Functional enterprise structure

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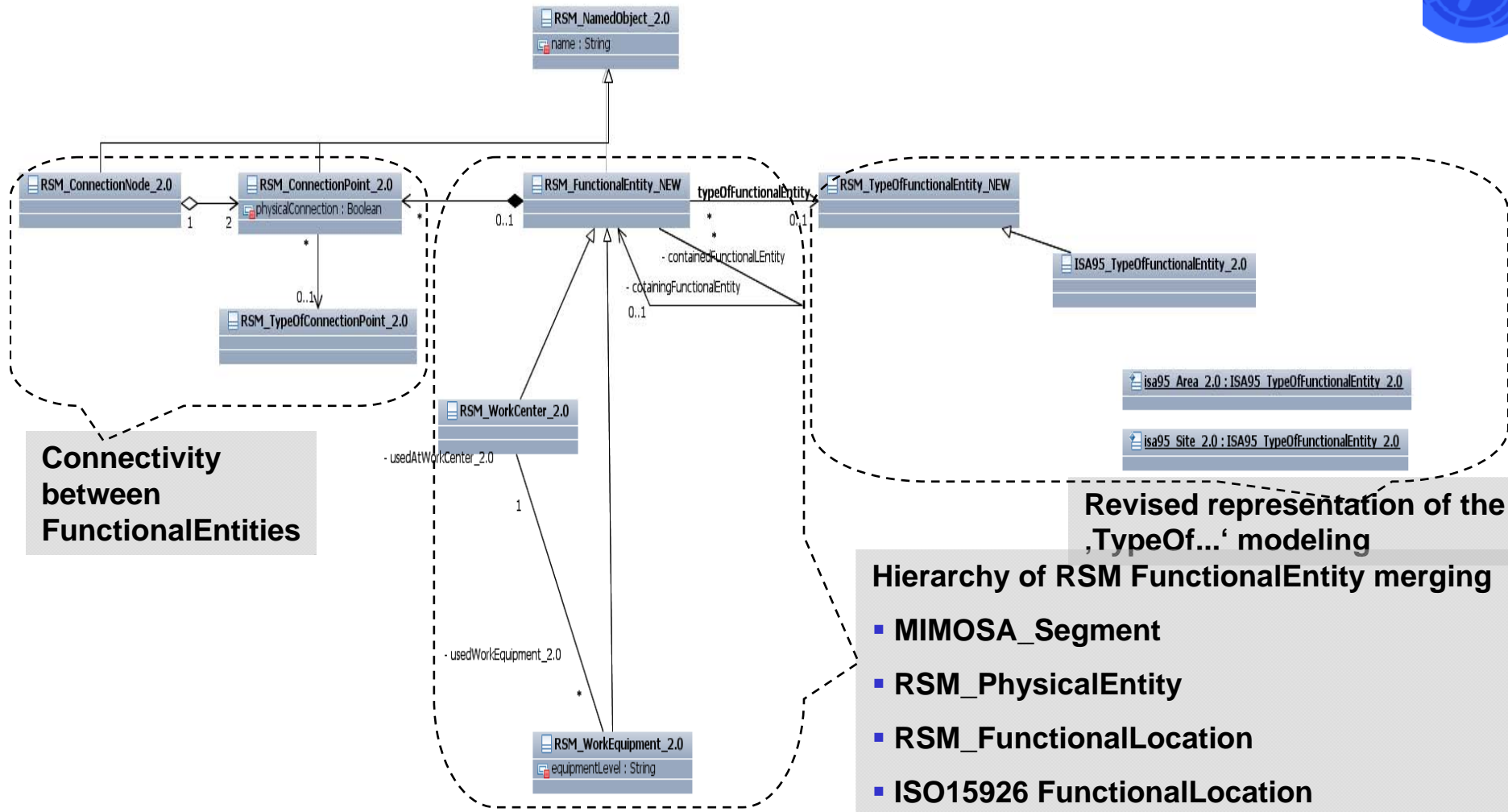
- Objectives of the RSM and ISO 15926 alignment effort
 - The intended representation aimed at capturing
 - the functional entities in an enterprise
 - the accountable assets – including a view of the physical specimen
 - Unify RSM, ISA, ISO 15926, and MIMOSA terminology
 - Capture a notion of connectivity between functional entities
 - Simplify RSM modeling to eliminate redundancies
 - Adapt the ‚TypeOf...‘ representations for better alignment with ISO 15926



Functional enterprise structure



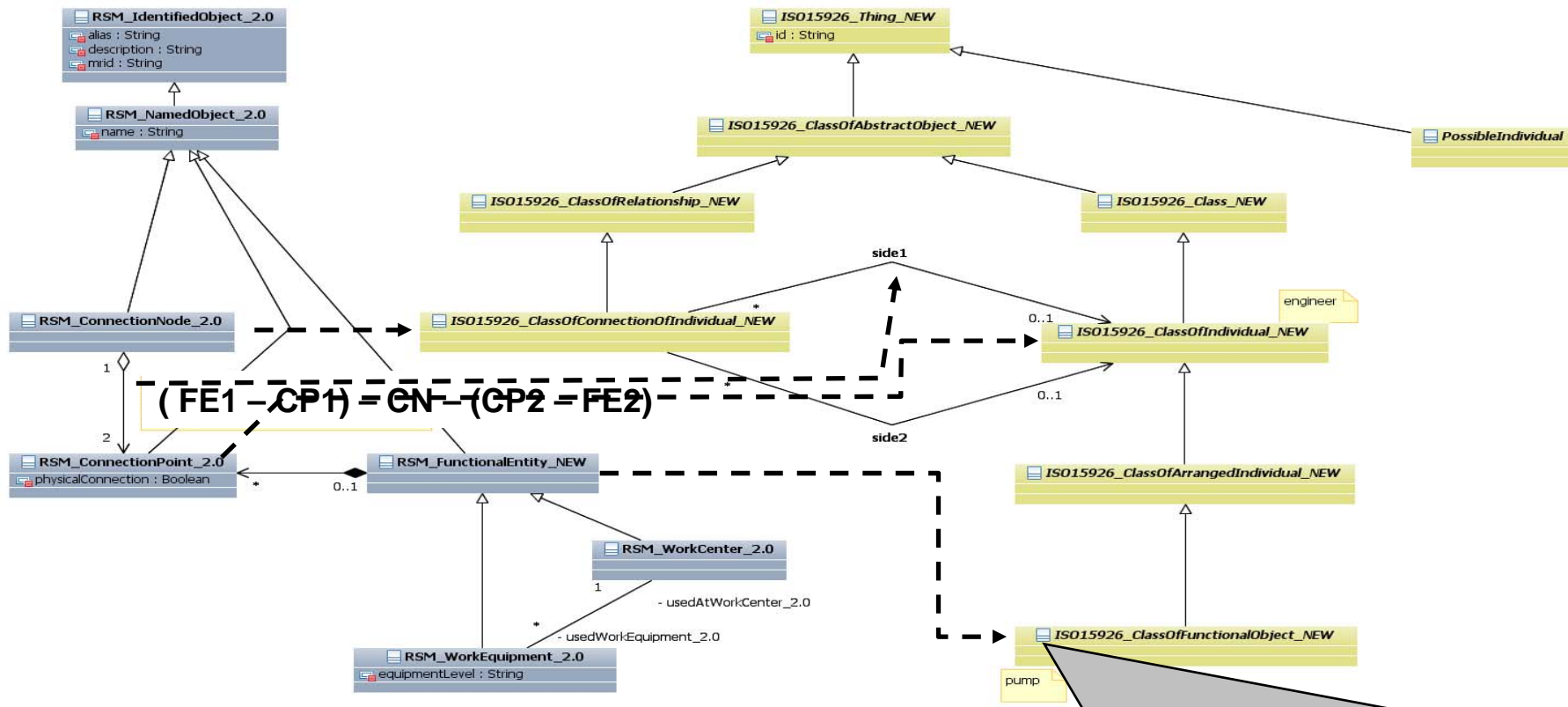
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ISO 15926-to-RSM alignment for functional entities



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Both models have detailed model elements for functional structure
 → close links are possible → better mechanical translations



The ‚TypeOf...‘ construction - I



- In the RSM there are many different types of
 - OrganizationalEntity
 - **FunctionalEntity**
 - Asset
 - ...
- In ISO 15926 those types of ... are represented as classes in the meta-model
- Adopting this approach for RSM
 - is highly highly interesting, since it allows for exploiting ISO 15926 equipment classification
 - has to be done with care, because, e.g.,
 - ISO 15926 has 10.000+ equipment types represented as OWL classes
 - Representing each such OWL class per equipment type as a UML class in RSM would lead to 10.000+ sparsely populated DB tables



Equipment type modeling: - instances vs subclasses – original RSM approach



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Meta-model

Equipment
tOE : TypeOfEquipment

TypeOfEquipment
rdlURL : String

motor:TypeOfEquipment

pump:TypeOfEquipment

valve:TypeOfEquipment

instances

Database

Equipment		
name	desc	type
motor1		motor
...		motor
m10000		motor
pump1		pump
...		pump
p10000		pump
valve1		valve

One big table:
many queries run against
large amounts of data

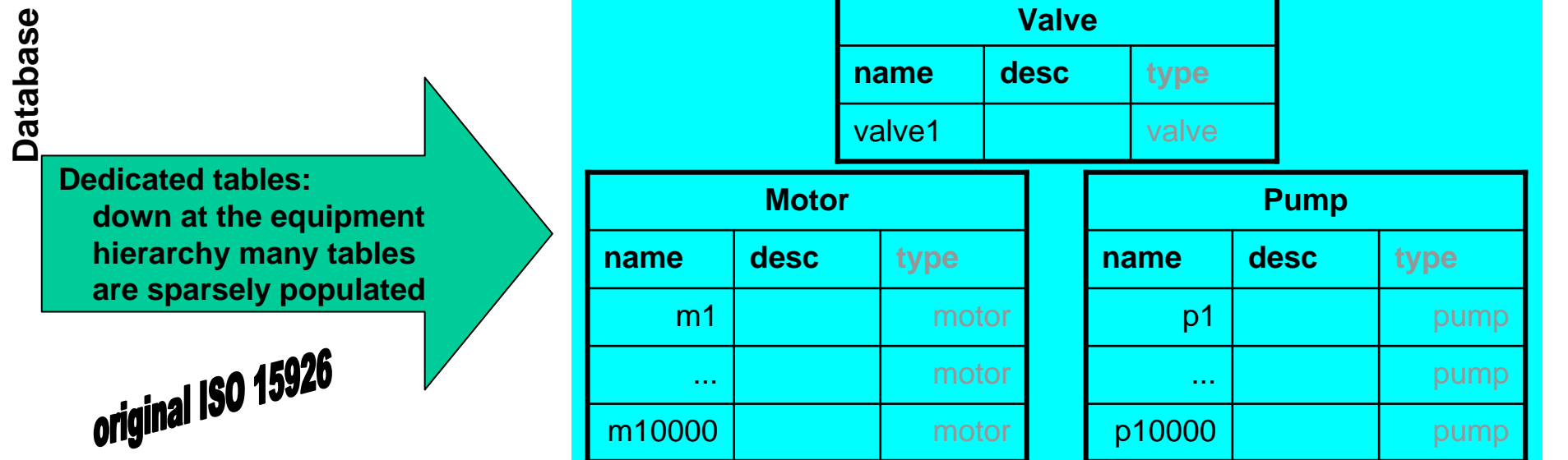
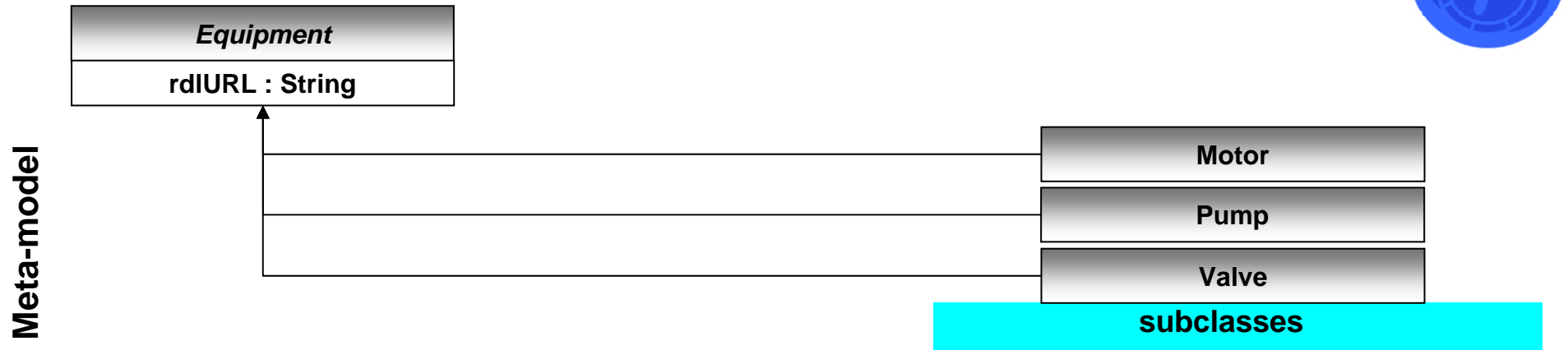
original RSM



Equipment type modeling:

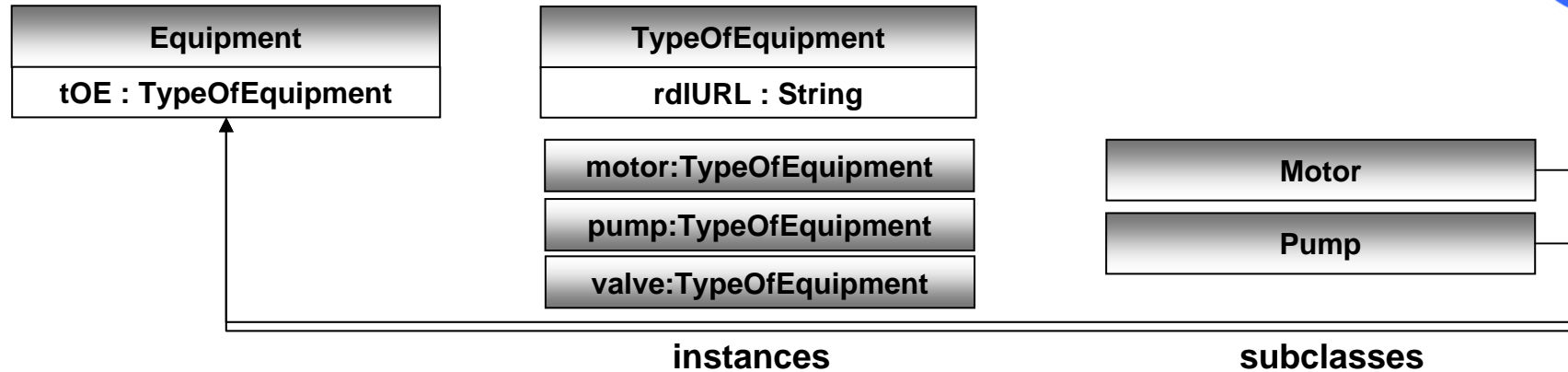
- instances vs subclasses – original ISO 15926 approach

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Equipment type modeling: - instances vs subclasses recommendation

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ISO 15926 and RSM alignment allows for a combined ,TypeOf...' modeling approach

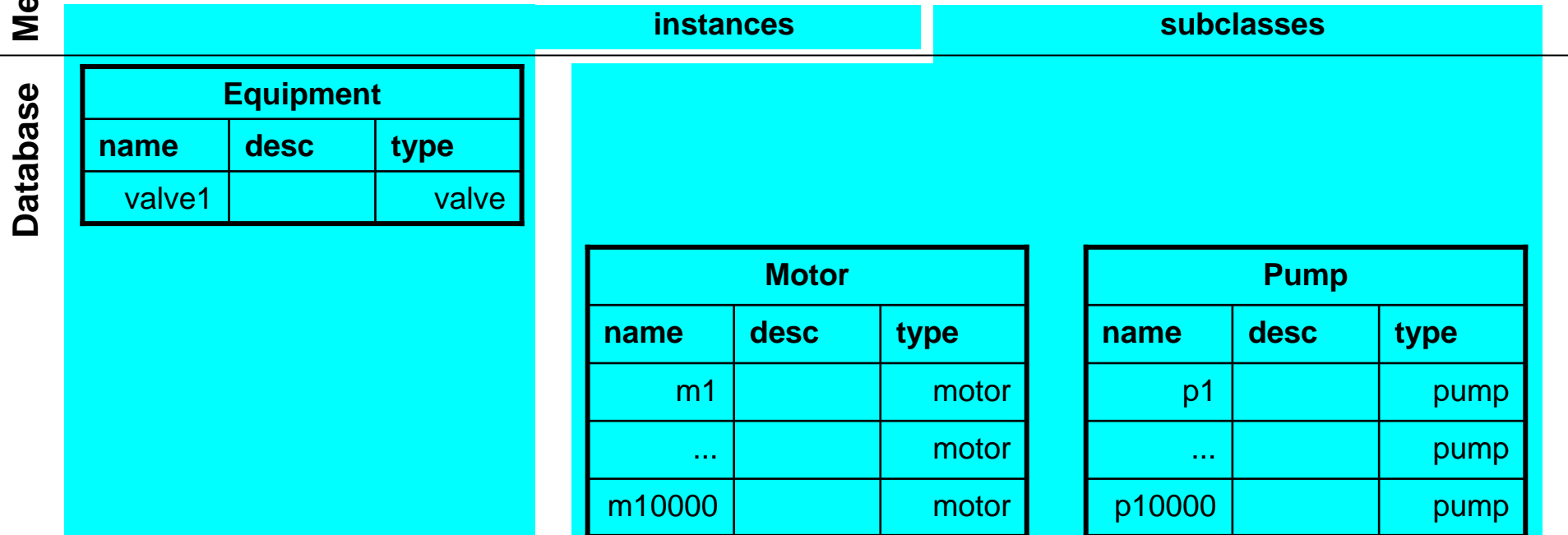
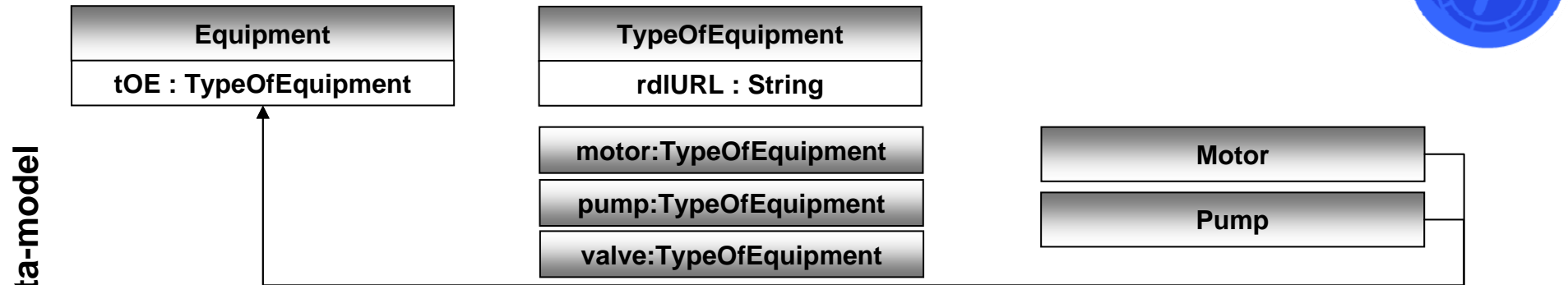
- subclasses for equipment types with high population
- just type instances for equipment types with low population



Equipment type modeling: - instances vs subclasses as recommended



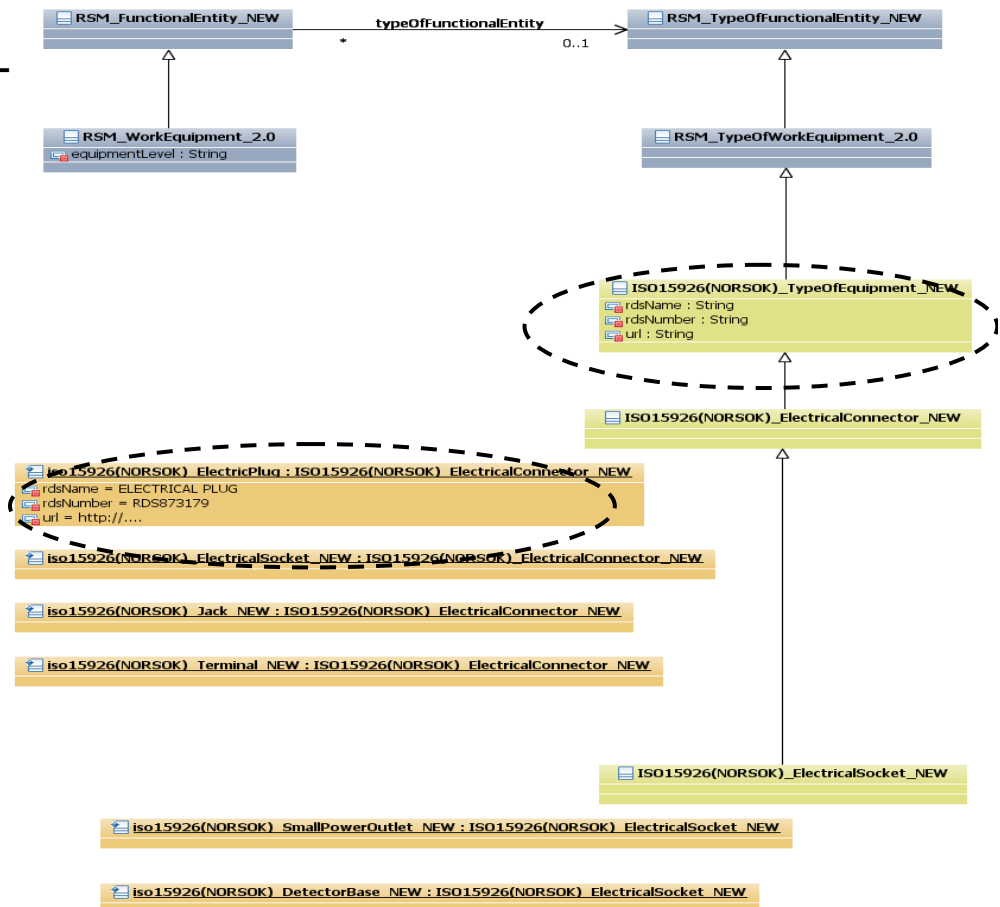
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The ,TypeOf...' construction - II



- Adopting the ISO 15926 modeling approach strictly for RSM, the equipment types are subclasses of RSM_WorkEquipment
- The chosen approach for RSM 2.0 is more flexible in the sense of
 - Modeling the ISO 15926 equipment type hierarchy through RSM classes ,down to a reasonable' level of detail
 - ➔ if large numbers of certain equipments suggest separate tables per equipment type
 - Modeling ISO 15926 equipment types as instances of class RSM_TypeOfWorkEquipment
 - ➔ if small numbers of certain equipment types suggest a single table for equipment of different types



Detailed UML diagram view



Overview

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- Why a Reference Model
- Background Reference Semantic Model
- Main elements of the Reference Semantic Model

- **Summary**



Two interesting threads to bring RSM forward

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- Gain acceptance for RSM through established standardization bodies
 - The standards integration approach of RSM considered meaningful
- Expand the scope of RSM to provide improved integration support through IIF
 - Understand integration and information model alignment needs along the processing chain

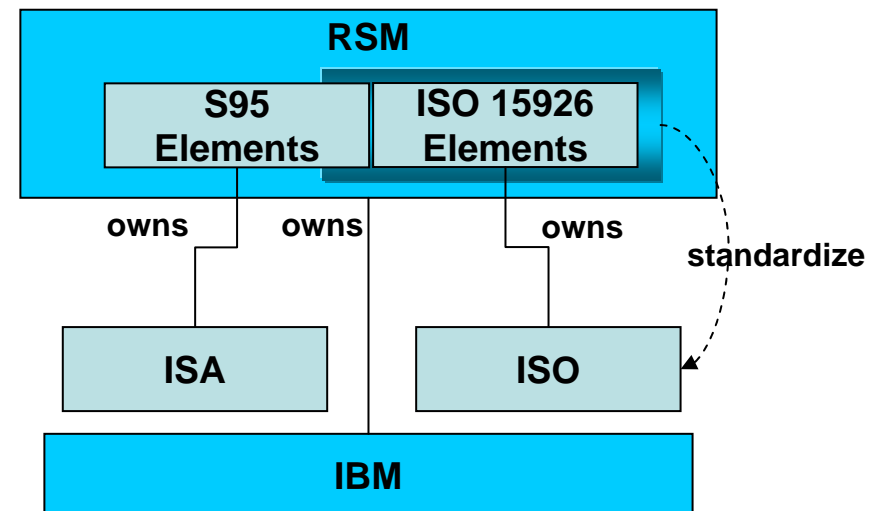


RSM and its parent standards



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- Parent standards are established as industry standards
- RSM is not yet standardized
- Its nature as a mesh-model combining other standards implies
 - **Portions of RSM ,close enough‘ to parent standard could be standardized by the organization owning the parent standard**
 - Standardizing RSM may also trigger parent organizations cross-accepting other standard’s models



Standardize RSM

- to obtain acceptance of RSM based applications by POSC Caesar and ISO
- to assure better interoperability with systems based on RSM parent standards



Number of existing standards prohibitively high to incorporate all of them into RSM

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ISO Standards for use in the oil & gas industry

ISO 10418 Basic surface safety systems
ISO 10423 Wellhead & christmas tree equipment
ISO 13533 Drill-through equipment (DTE)
ISO 13534 Hoisting equipment - care/maint
ISO 13535 Hoisting equipment - specification
ISO 13626 Drilling and well-servicing structures
ISO 13702 Control & mitigation of fire & explosion
ISO 13703 Offshore piping systems
ISO 14224 Reliability/maintenance data
ISO 14692 CRP piping, Parts 1-4
ISO 14693 Drilling equipment

ISO 15136-1 Selection of cracking resistant materials for use in H₂S environments
ISO 15136-2 Cracking-resistant steels and cast irons for use in H₂S environments
ISO 15136-3 Cracking-resistant alloys for use in H₂S environments
ISO 15138 H₂AC (Rev)
ISO 15544 Emergency response
ISO 15663 Life cycle costing, Parts 1-3
ISO 17774 Assessment of hazardous situations
ISO 20815 Production assurance and reliability management (Rev)
ISO/TS 27469 Method of test for offshore fire dampers (New)
ISO/TS 29001 Sector-specific quality management systems (Rev)

ISO 19900 Offshore structures - general requirements
ISO 19901-1 Metocean design and operating considerations
ISO 19901-2 Seismic design
ISO 19901-3 Geotechnical and foundation design
ISO 19901-4 Weight control
ISO 19901-5 Marine operations (New)
ISO 19901-6 Marine operations (New)
ISO 19902 Fixed steel offshore structures (Rev of ISO 13819-2)
ISO 19903 Fixed concrete offshore structures
ISO 19904-1 Floating offshore structures

ISO 2977-5 Gas turbines - procurement
ISO 10420 Sucker rods
ISO 10451 Pumping units (Rev)
ISO 10454 Bolted bonnet steel gate valves
ISO 10457 Special-purpose steam turbines
ISO 10458 Lubrication, shaft-sealing and control-oil systems, Parts 1-4 (Rev)
ISO 10459 Centrifugal compressors
ISO 10460 Rotary-type positive-displacement process compressors (oil-free) (Rev)
ISO 10440-2 Rotary PD packaged air compressors
ISO 10441 Flexible couplings - special (Rev)
ISO 10442 Integrally geared air compressors
ISO 13621 Reciprocating gas compressors
ISO 13691 High speed enclosed gear units
ISO 13704 Calculation of heater tube thickness (Rev)
ISO 13705 Fired heaters for general service
ISO 13706 Air-cooled heat exchangers

ISO 13707 Reciprocating compressors
ISO 13709 Centrifugal pumps (Rev)
ISO 13710 Reciprocating positive displacement pumps
ISO 14691 Flexible couplings - general
ISO 15547-1 Plate & frame type heat exchangers
ISO 15649 Brazed aluminum platefin type heat exchangers
ISO 15649 Piping
ISO 15761 Steel valves DN 100 and smaller
ISO 16812 Steel & tube heat exchangers (Rev)
ISO 17292 Metal ball valves
ISO 21049 Centrifugal and rotary pumps shaft sealing
ISO 22951 Pressure-relieving and surge-arresting systems (Rev)
ISO/TS 24817 Composite repair of pipework
ISO 25457 Flare details (New)
ISO 28300 Venting of storage tanks (New)

ISO 13624-1 Marine drilling riser systems (New)
ISO/TR 13624-2 Marine drilling riser systems analysis (New)
ISO 13625 Marine drilling riser couplings
ISO 19901-7 Statickeeping systems

ISO 13628-1 Subsea production systems
ISO 13628-2 Subsea flexible pipe systems
ISO 13628-3 Subsea TFL pumpdown systems
ISO 13628-4 Subsea wellhead and tree equipment
ISO 13628-5 Subsea control umbilicals (Rev)
ISO 13628-6 Subsea production control

ISO 13628-7 Completion/workover riser systems
ISO 13628-8 ROV interfaces
ISO 13628-9 ROV intervention systems
ISO 13628-10 Bonded flexible pipe
ISO 13628-11 Flexible pipe systems for subsea and marine applications (New)

ISO/TR 10400 Calculations for OTC performance properties (Rev)
ISO 10405 Care/use of casing/tubing
ISO 10407-1 Drill stem design
ISO 10407-2 Inspection and classification of drill stem elements (New)
ISO 10414-1 Field testing of water-based fluids (Rev)
ISO 10414-2 Field testing of oil-based fluids
ISO 10416 Drilling fluids - lab testing (Rev)
ISO 10417 Subsurface safety valve systems
ISO 10424-1 Rotary drill stem elements
ISO 10424-2 Threading and gauging of connections (New)
ISO 10426-1 Well cementing
ISO 10426-2 Testing of well cements

ISO 10426-3 Testing of dispersement well cement
ISO 10426-4 Preparation and testing of atmospheric foamed cement slurries
ISO 10426-5 Shrinkage and expansion of well cement
ISO 10426-6 Static gel strength of cement formulations (New)
ISO 10427-1 Blow spring casing centralizers
ISO 10427-2 Centralizer placement and stop-collar testing
ISO 10427-3 Performance testing of cement float equipment
ISO 10432 Subsurface safety valves
ISO 11960 Casing and tubing
ISO 11961 Drill pipe (Rev)
ISO 12580 Drilling fluids
ISO 13581 Drilling fluids - processing systems evaluation

ISO 12503-1 Measurement of viscous properties of completion fluids
ISO 13503-2 Measurement of properties of preproppants
ISO 13503-3 Testing of heavy brines
ISO 13503-4 Measurement of stimulation & gravel-pack fluid leakage
ISO 13503-5 Measurement of long term conductivity of preproppants
ISO 13678 Thread compounds
ISO 13679 Connection testing
ISO 13680 OCA sealers tubes for casing and tubing (Rev)
ISO 14310 Packers and bridge plugs (Rev)
ISO 15136-1 Progressing cavity pump systems
ISO 15136-2 Progressing cavity pump systems - drive heads
ISO 15463 Field inspection of new casing, tubing and plain end drill pipe

ISO/TR 15464 Gauging and inspection of casing, tubing and line pipe threads (New)
ISO 15546 Aluminum alloy drill pipe (Rev)
ISO 14680 Lock mandrels and landing nipples
ISO 17078-1 Side-pocket mandrels
ISO 17078-2 Flow control devices for side-pocket mandrels (New)

ISO 3103 Steel pipe for pipeline transportation systems (Rev)
ISO 13623 Pipeline transportation systems (Rev)
ISO 13847 Pipeline welding
ISO 14313 Pipeline valves (Rev)
ISO 14723 Subsea pipeline valves
ISO 15509-1 Cathodic protection for on-land pipelines
ISO 15509-2 Cathodic protection for offshore pipelines
ISO 15509-3 Pipeline induction bends
ISO 15509-4 Pipeline fittings
ISO 15509-5 Pipeline flanges
ISO 16708 Pipeline reliability-based limit state design
ISO 21329 Test procedures for pipeline mechanical connection

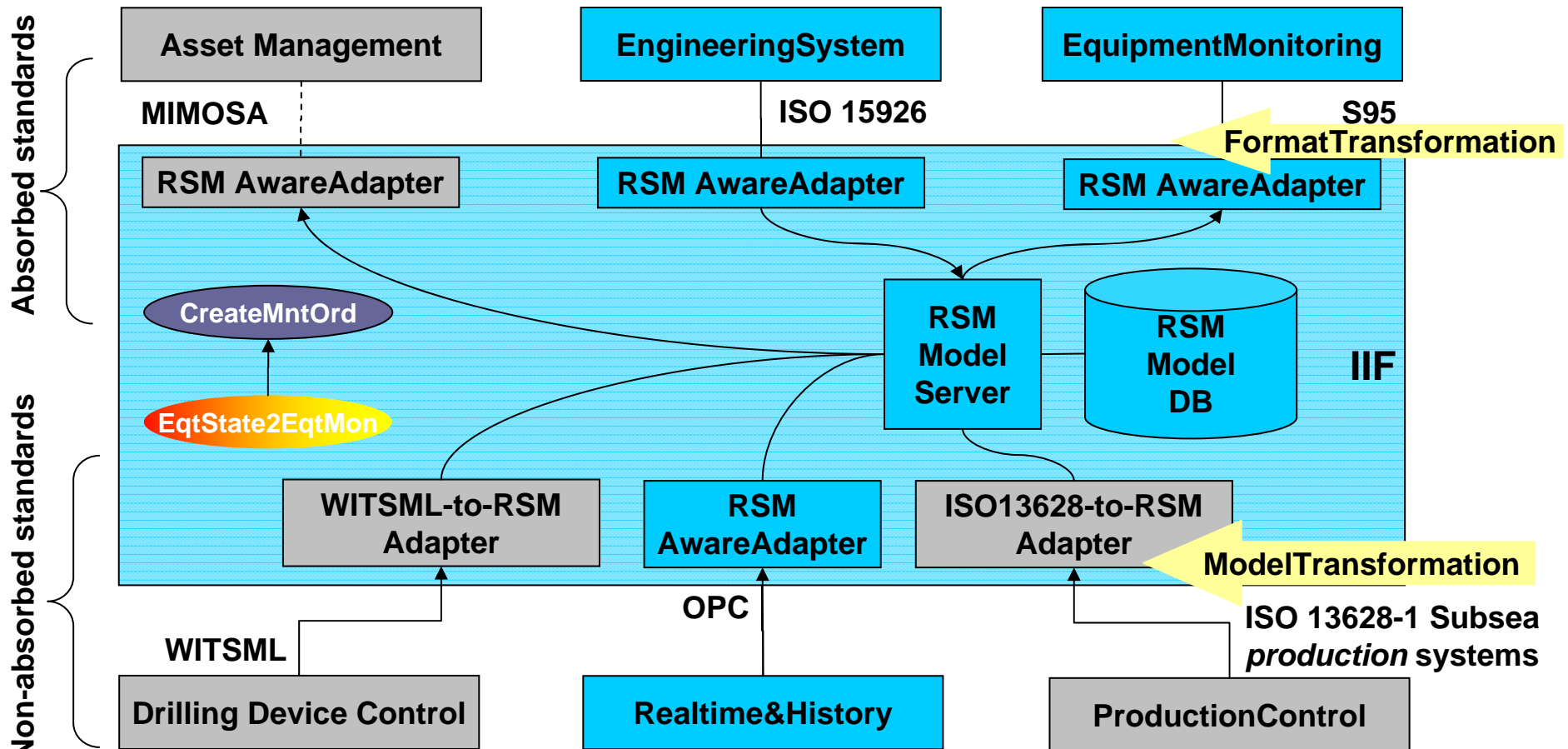
ISO 21009-1 Extended polyolefin coatings for pipelines (New)
ISO 21009-2 Fusion-bonded epoxy coatings (New)
ISO 21009-3 Field joint coatings for pipelines (New)



Standards in brown issued in 2007
 Standards in green are a priority for 2008 issue
 Many of these standards are adopted by API, CEN and other recognised standards bodies



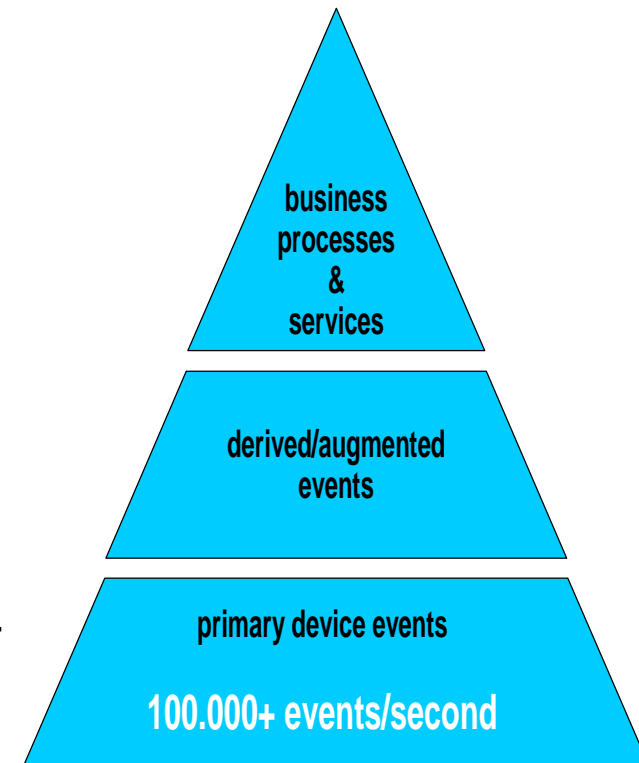
Standards around RSM and IIF



„To absorb‘ or ‚Not to absorb‘?



- (Partially) absorbed parent standards
 - Allow for simpler transformation between IIF and applications relying on parent standard
→ format transformation in adapters
 - ‚Absorption‘ means static model alignment
- Non-absorbed (further) parent standards
 - Require more complex transformations
→ model transformation inside adapters
 - ‚Non-absorption‘ requires dynamic model transformation
- Expand parents standard integration for applications that exchange information with IIF at the bottom of the event processing pyramid
 - good candidates are PRODML/WITSML



Exploitation and evolution of RSM

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- StatoilHydro TAIL project
 - Gain practical experience and prove applicability
- Streamline RSM content and align with ISO 15926
 - Gain acceptance through established standardization bodies
- Absorb elements from further standards
 - Assure wider scope of usage



Alignment to ISO 15926

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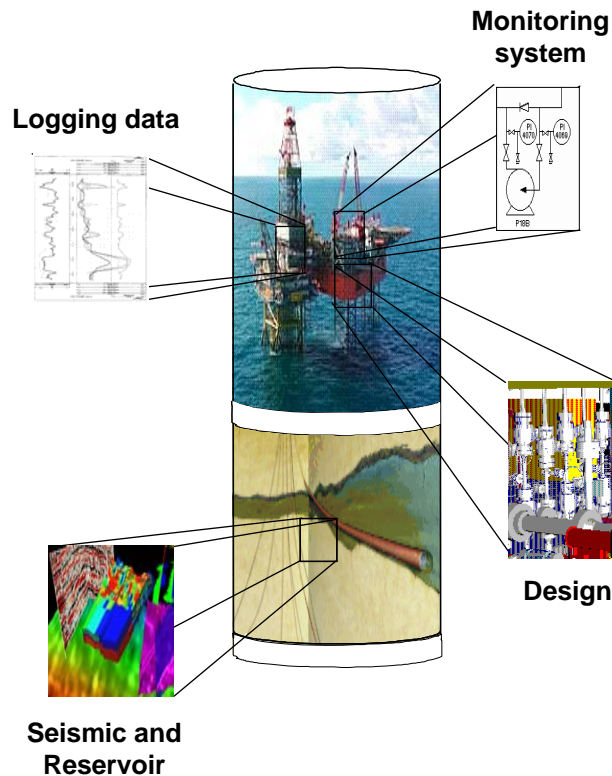


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IOHN Activity 3 overall objective

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Based on requirements from the pilot projects and project participants:

- Extend and improve the content and quality of the ISO 15926 Reference Data Library (RDL)
- Develop a prototype information validation service

ISO 15926 – *Integration of life-cycle data for process plants including oil and gas production facilities.*

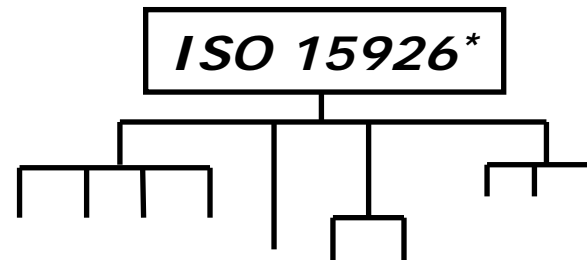
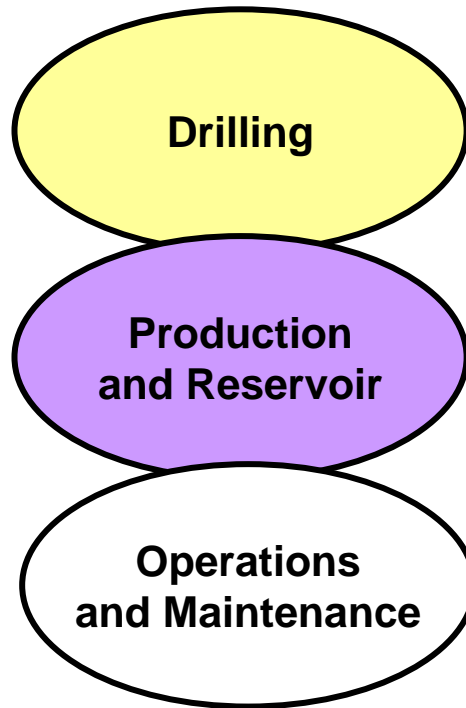


Domain specific reference data

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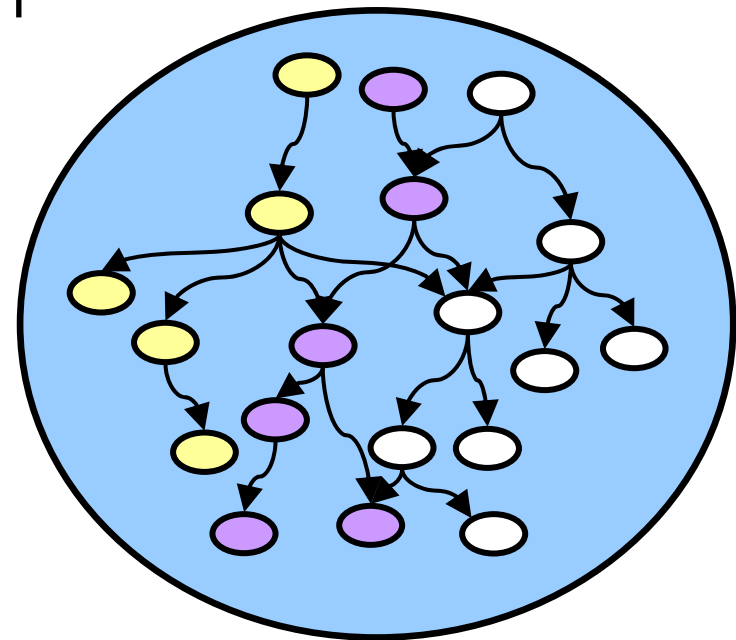


Domain specific nomenclatures



Structure and add to ISO 15926 Reference Data Library (RDL)

Oil and gas ontology (Reference Data)



'RSM in ISO 15926' means two things



- The RSM UML model in ISO 15926 Reference Data Library
 - Represented as an ISO 15926 ontology
 - RSM classes are mainly specializations of O&M, P&R classes
- Export/import data between IIF/RSM systems and ISO 15926 format
 - RSM content provided with RDL classification
 - On demand production of exchange-friendly instance data

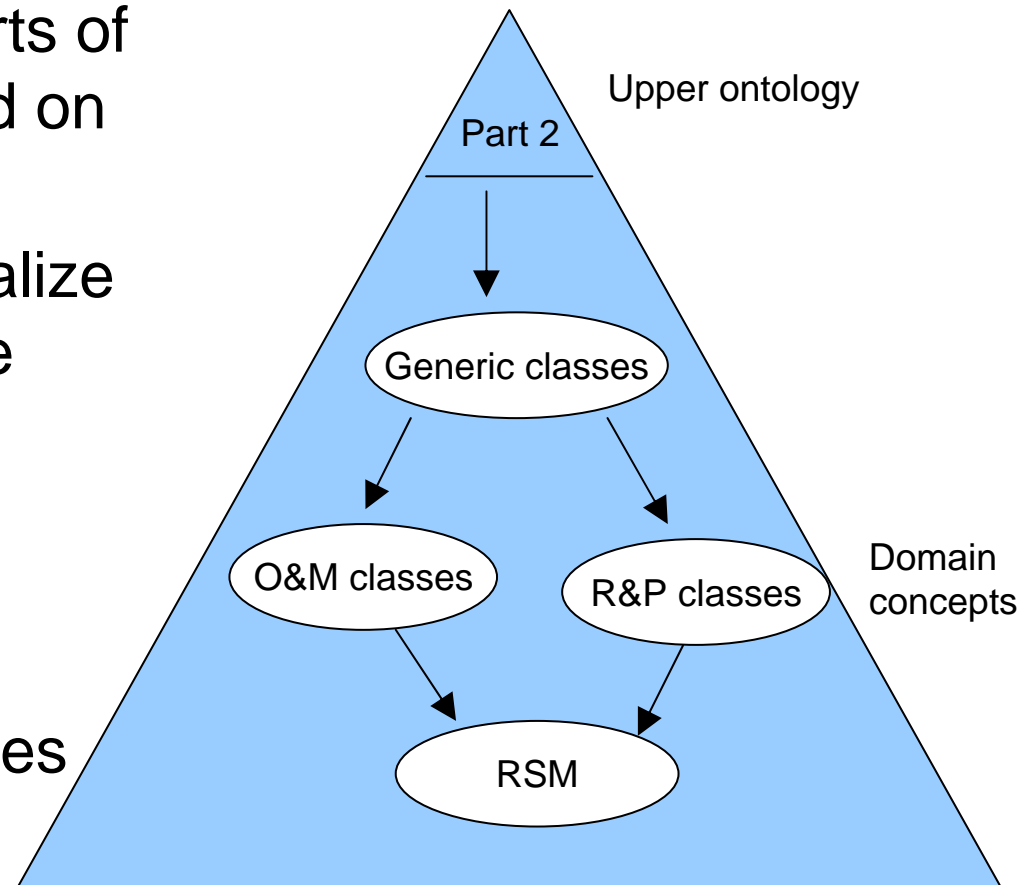


RSM *model* in the ISO 15926 RDL hierarchy

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- Domain-specific parts of the PCA RDL depend on generic parts
- RSM classes specialize RDL classes from the IOHN Activity 3 information scope
- The RSM model representation effort introduced new classes to the RDL



Work carried out in IOHN Activity 3

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- Modelling using Protégé OWL workbench and Rational Software Architect
- RSM UML model entities represented as RDL classes and relations
- Complex mappings expressed in ISO 15926-7 templates
- Mappings tested using Template Expander tool
- The RSM classes uploaded to the RDL



Three generic levels of *data* alignment

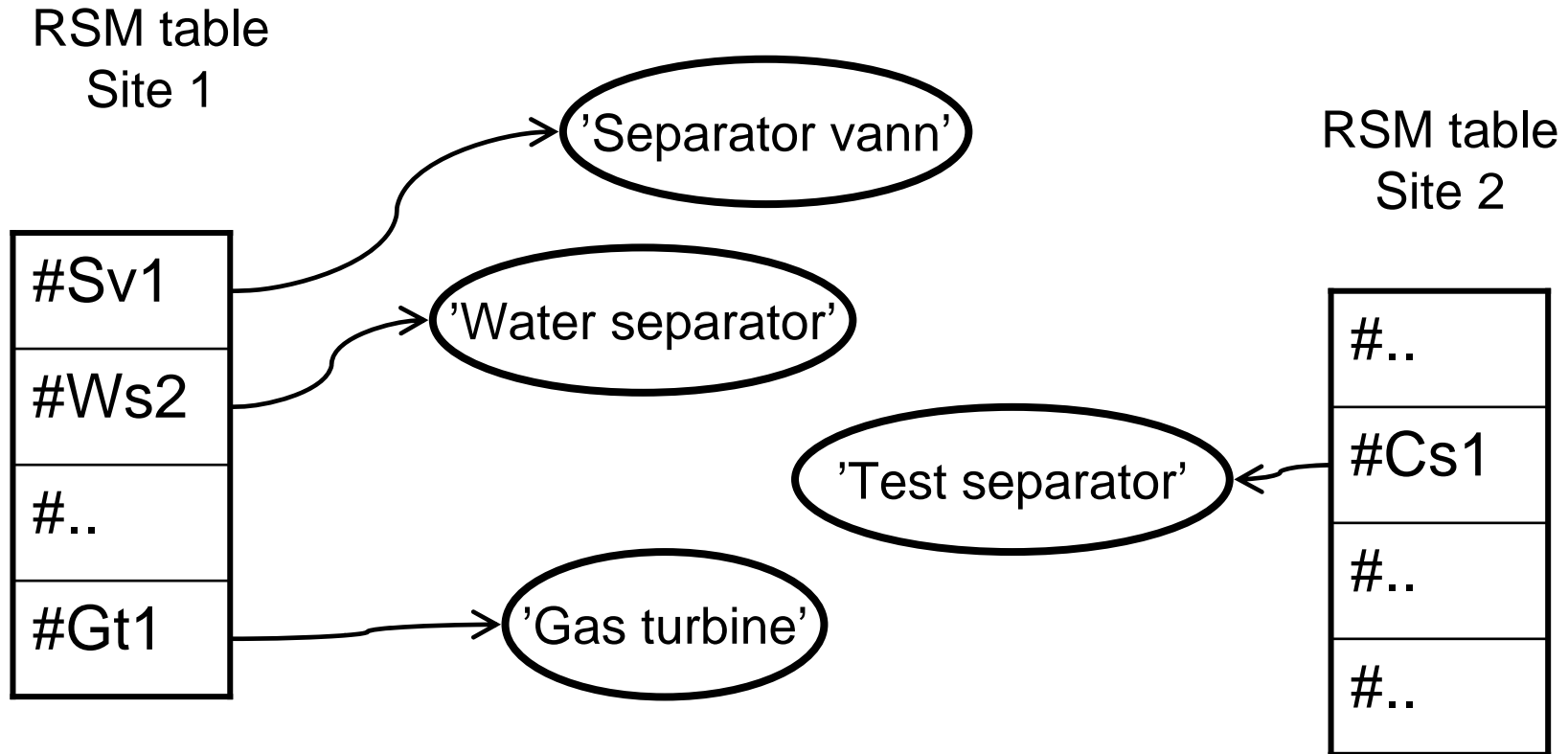
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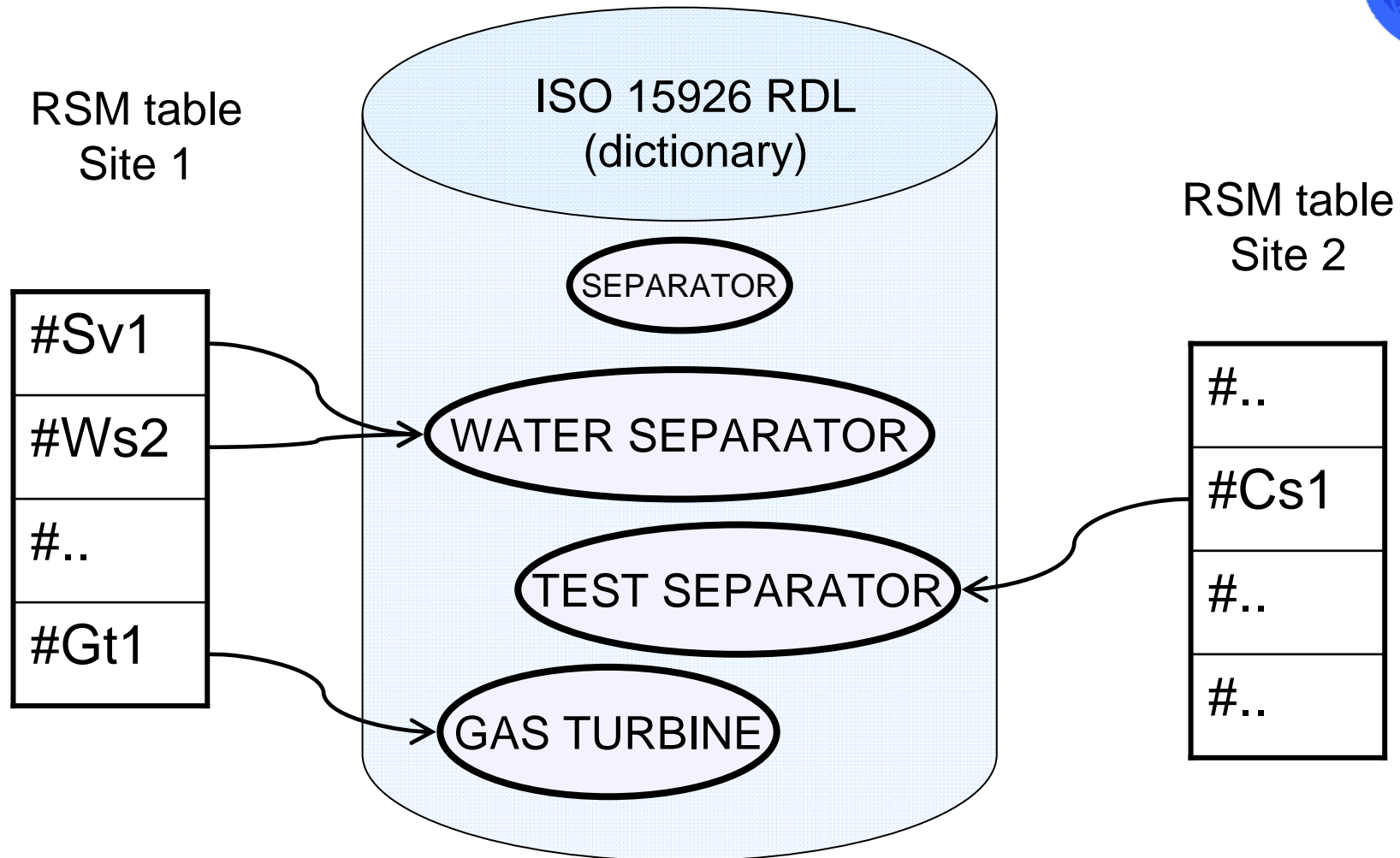
- Dictionary: Explanation
 - *apply reference definition to things*
- Taxonomy: Aggregation
 - *generic/specific categories of things*
- Ontology: Relation
 - *identify things that are related in various ways*



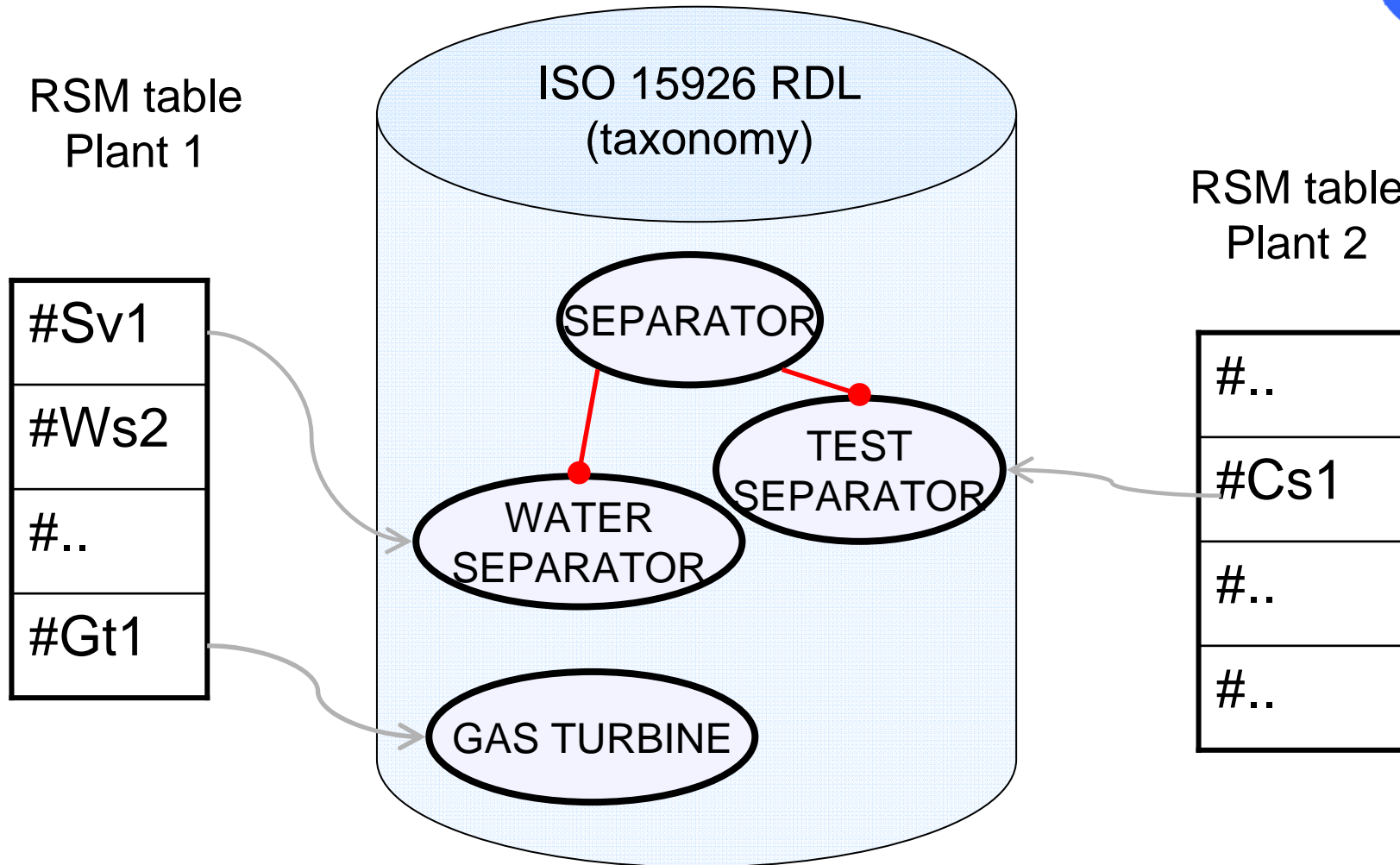
Current classification isn't uniform



Dictionary alignment: *Apply common terminology*



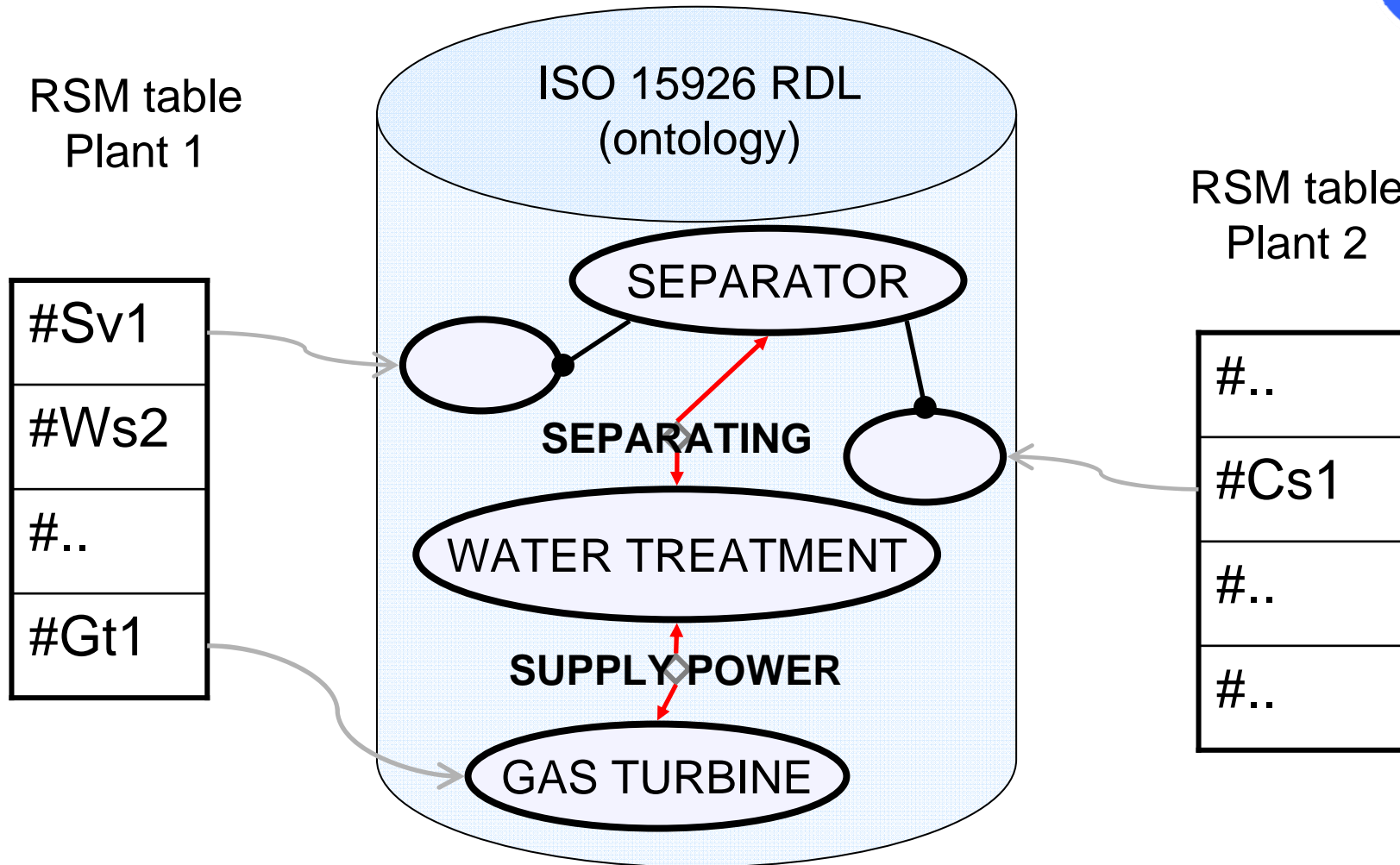
Taxonomy alignment: *Discover additional knowledge*



Ontology alignment

Knowledge discovery along arbitrary dimensions

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Mapping complex patterns



- Several constructions in the RSM scope require information assemblies of more than one element
 - *E.g. Connections, measurements, properties*
 - For a meaningful interpretation, several pieces of information have to be considered together.
 - The *dictionary, taxonomy, ontology* alignment levels apply also to patterns of information
- RSM and ISO 15926 represent things differently



ISO 15926 Templates

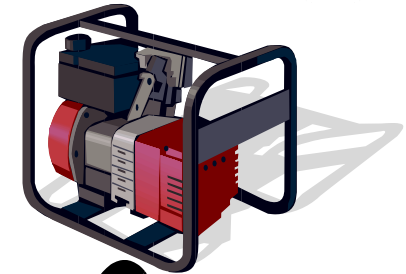


- *Part 7* is a new addition to ISO 15926
- A template captures a pattern for stating facts
- Signature – Rule (Axiom):
 - The template signature specifies the input arguments
 - The template rule specifies what statement is made, expanding to explicit ISO 15926 format
 - Template rules allow for interpretation as first-order logic axioms



Example: Connections

- *Typical information in an RSM database: A generator is connected to power a fan.*
- *The general case is: Pieces of equipment are connected.*
- *We want to present such connection information in the ISO 15926 space as well.*

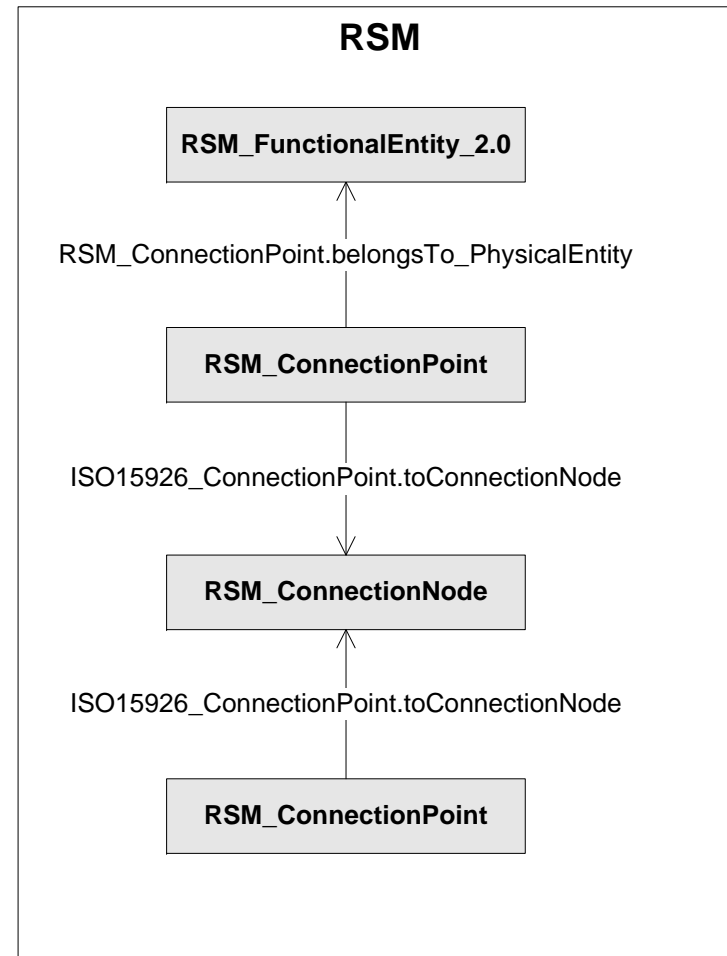


Connections in RSM

We need to consider the RSM classes

- Functional Entity
- Connection Point
- Connection Node

and relations between them.

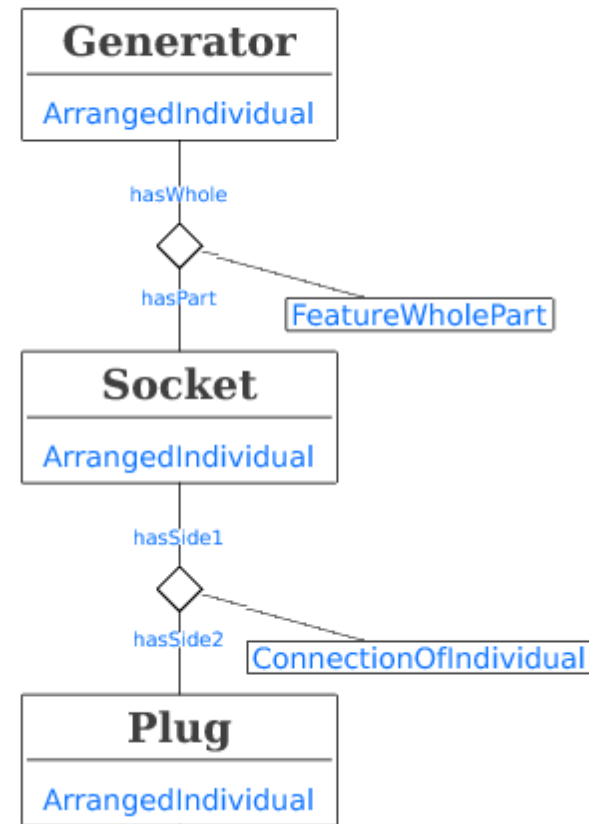


Connections in ISO 15926

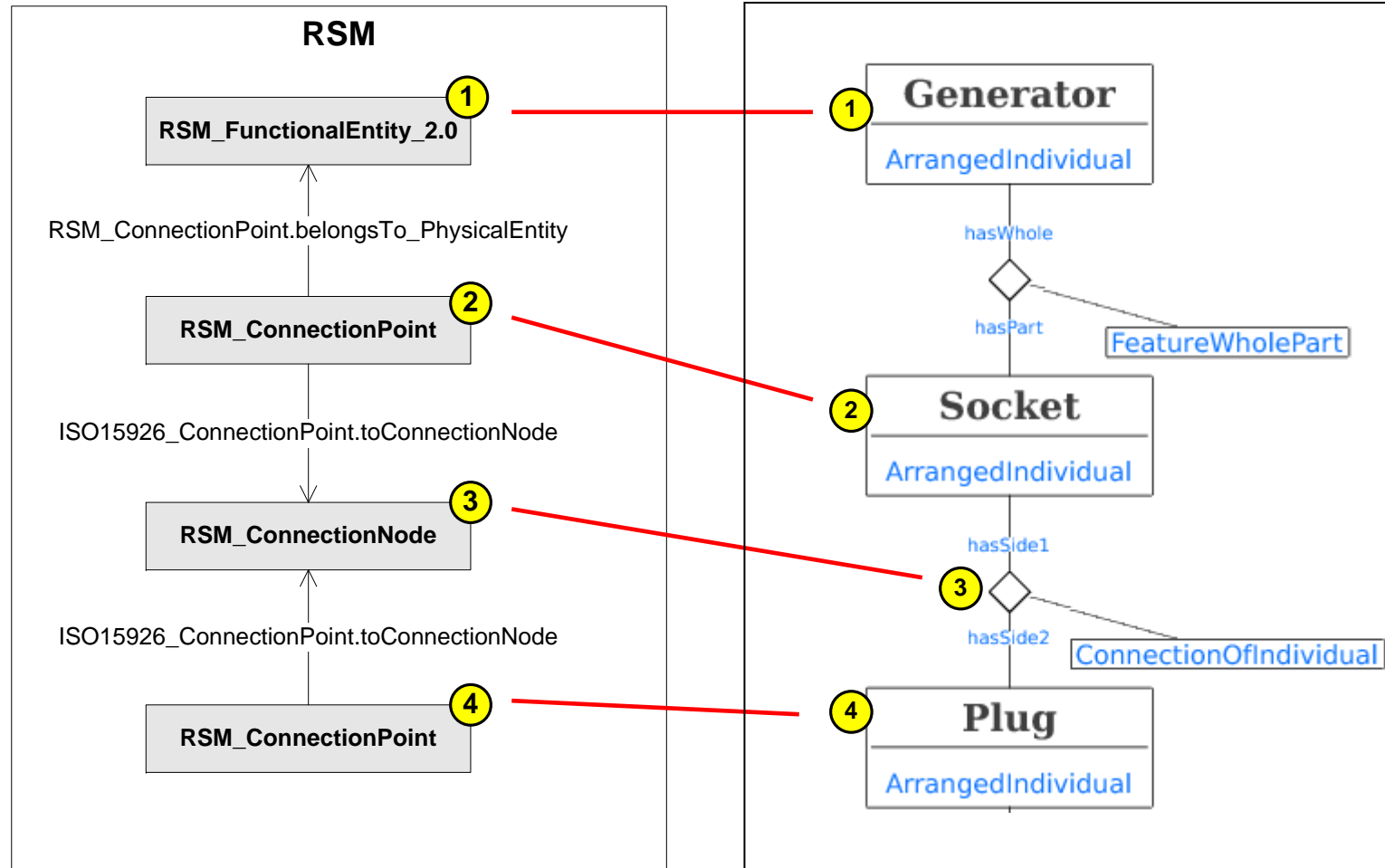
We need to consider the ISO 15926 entity types

- ArrangedIndividual
- FeatureWholePart
- ConnectionOfIndividual

and relations.

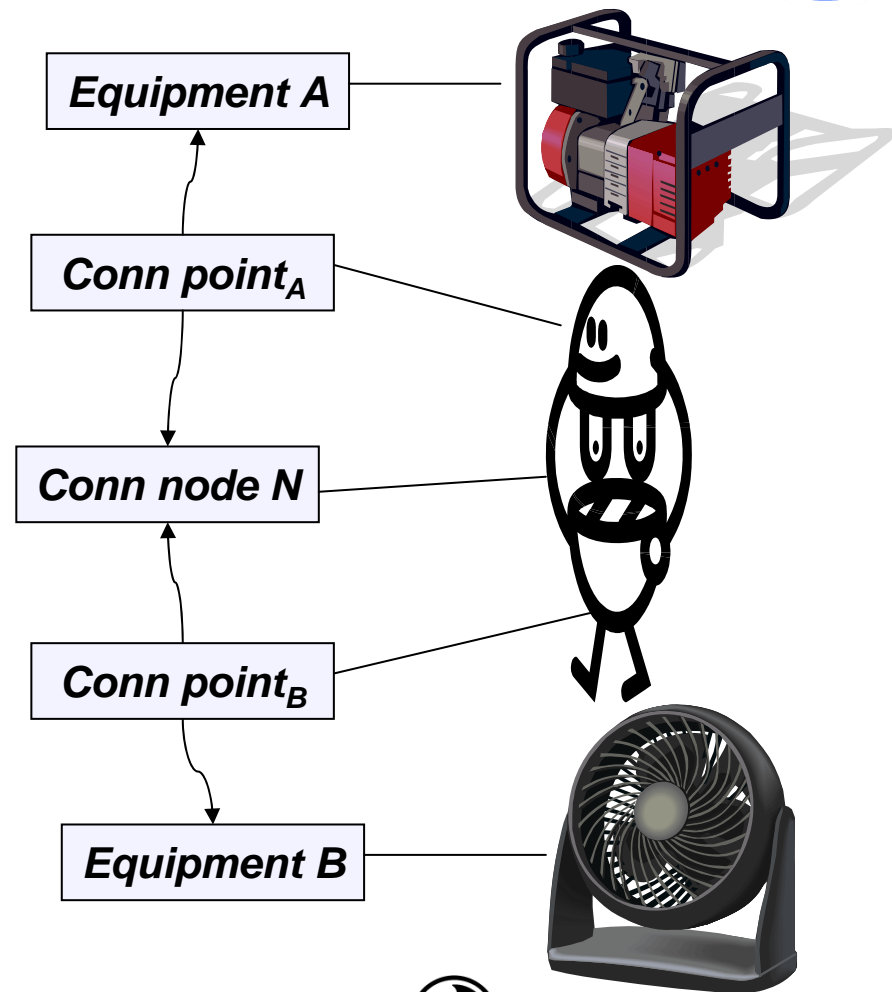


Alignment: Connections



Connections: RSM representation

- There are two pieces of equipment, *A* and *B*.
- There is a connection *N* between *A* and *B*.
- Connection points *CA*, *CB* represent equipment parts that participate in the connection
- *N* is the connection itself

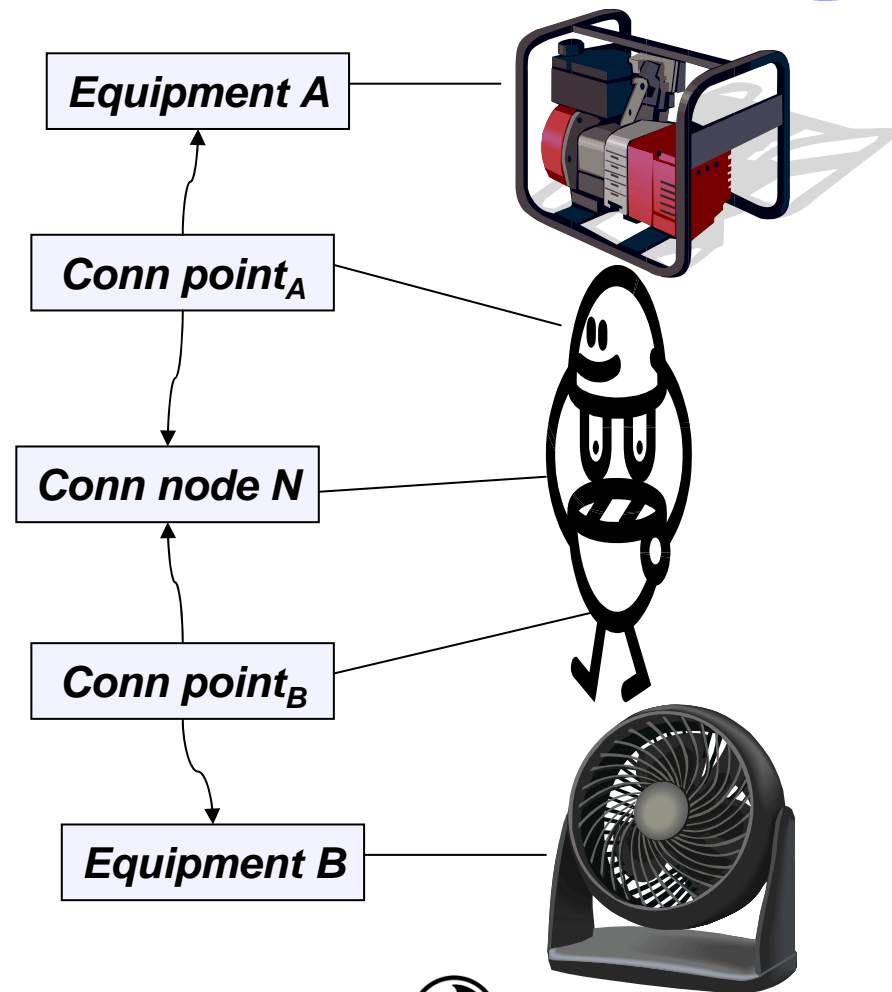


Template signature: Input arguments

RSMFunctionalEntityConnection

#	Role	Type
1	Entity 1	ArrangedIndividual
2	Entity 2	ArrangedIndividual
3	Conn. pt. 1	ArrangedIndividual
4	Conn. pt. 2	ArrangedIndividual
5	Connection	ConnectionOfIndividual

This signature defines a table for recording RSM connections.



Rule: The ISO 15926 representation pattern



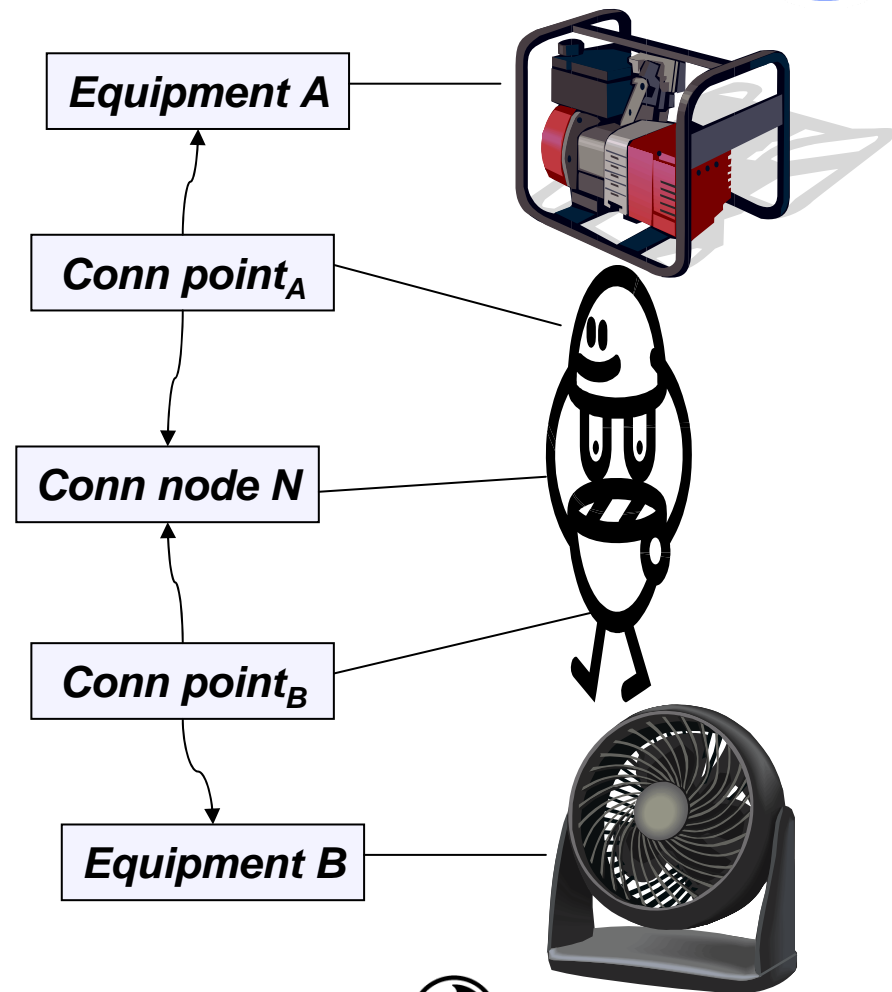
ISO 15926-7 template signature:

<i>RSMFunctionalEntityConnection</i>		
1	Entity 1	ArrangedIndividual
2	Entity 2	ArrangedIndividual
3	Conn. pt. 1	ArrangedIndividual
4	Conn. pt. 2	ArrangedIndividual
5	Connection	ConnectionOfIndividual

ISO 15926-7 template rule:

```

RSMFunctionalEntityConnection
    (x1, x2, x3, x4, x5) <->
    ArrangedIndividual(x1) &
    ArrangedIndividual(x2) &
    ArrangedIndividual(x3) &
    ArrangedIndividual(x4) &
    ConnectionOfIndividual(x5) &
    FeatureWholePartTemplate(x3, x1) &
    FeatureWholePartTemplate(x4, x2) &
    DirectConnectionTriple(x5, x3, x4) .
    
```

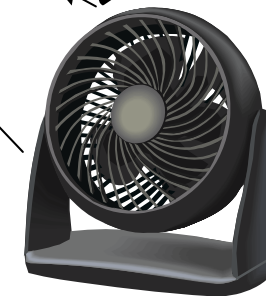
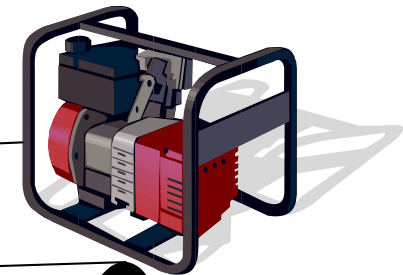


Template expansion

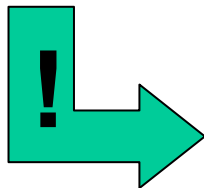


ISO 15926-7 template instance

<i>RSMFunctionalEntityConnection</i>		
1	Entity 1	Equipment A
2	Entity 2	Equipment B
3	Conn. pt. 1	Conn point_A
4	Conn. pt. 2	Conn point_B
5	Connection	Conn node N



Expanded to explicit ISO 15926-2



ArrangedIndividual(A)
 & ArrangedIndividual(B)
 & ArrangedIndividual(CA)
 & ArrangedIndividual(CB)
 & ConnectionOfIndividual(N)

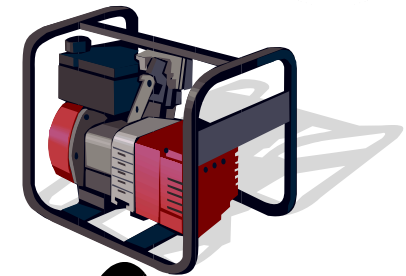
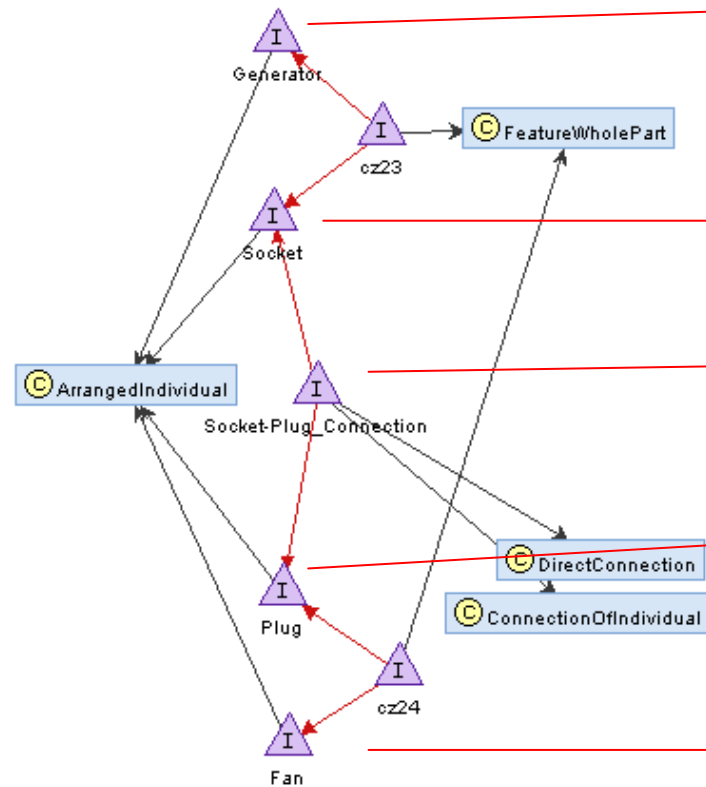
This illustrates RSM to ISO 15926 model interchange for equipment connectivity.



The connection in ISO 15926-2



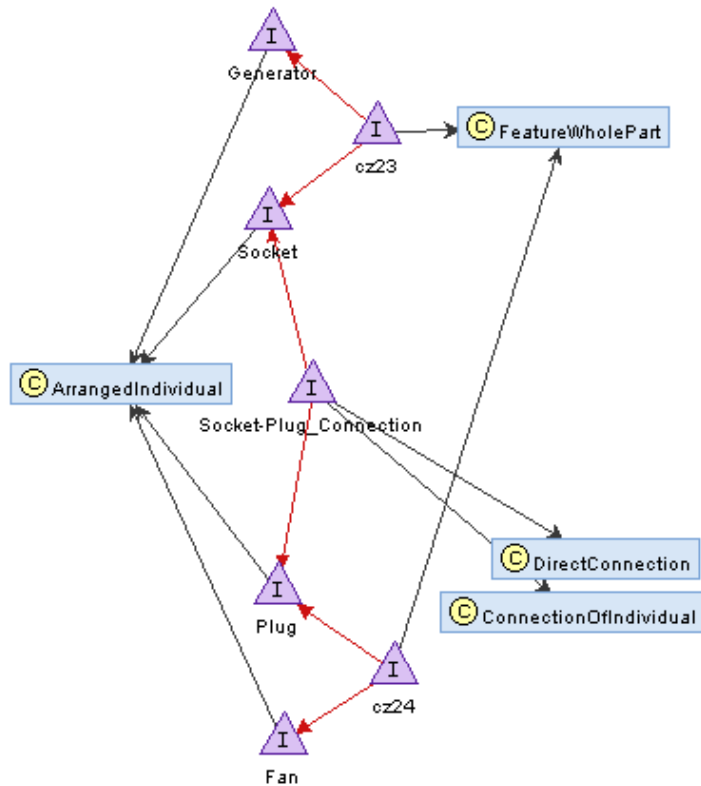
OWL representation



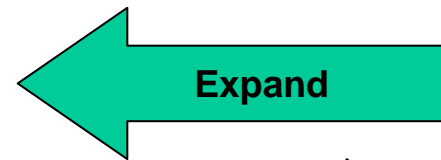
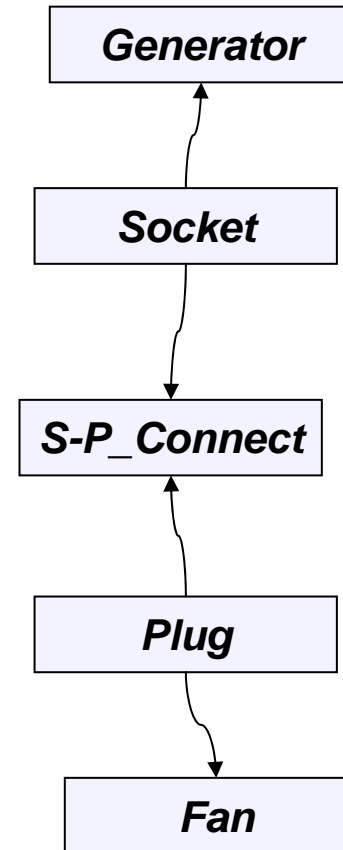
Translation in two directions



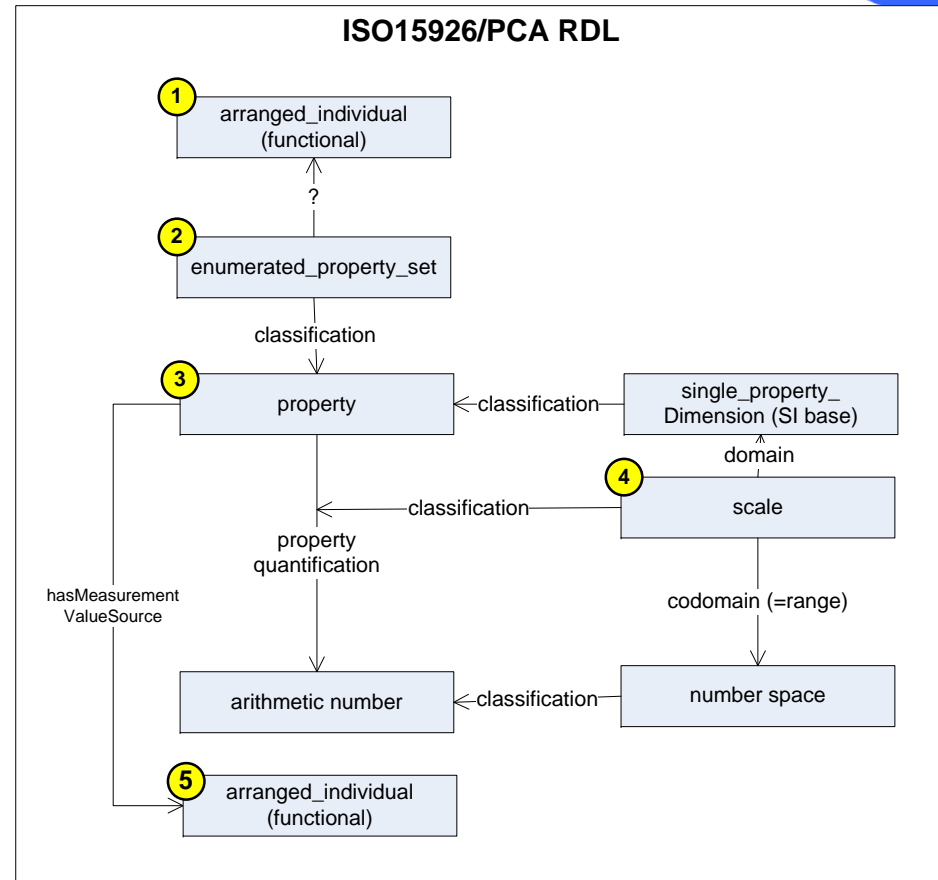
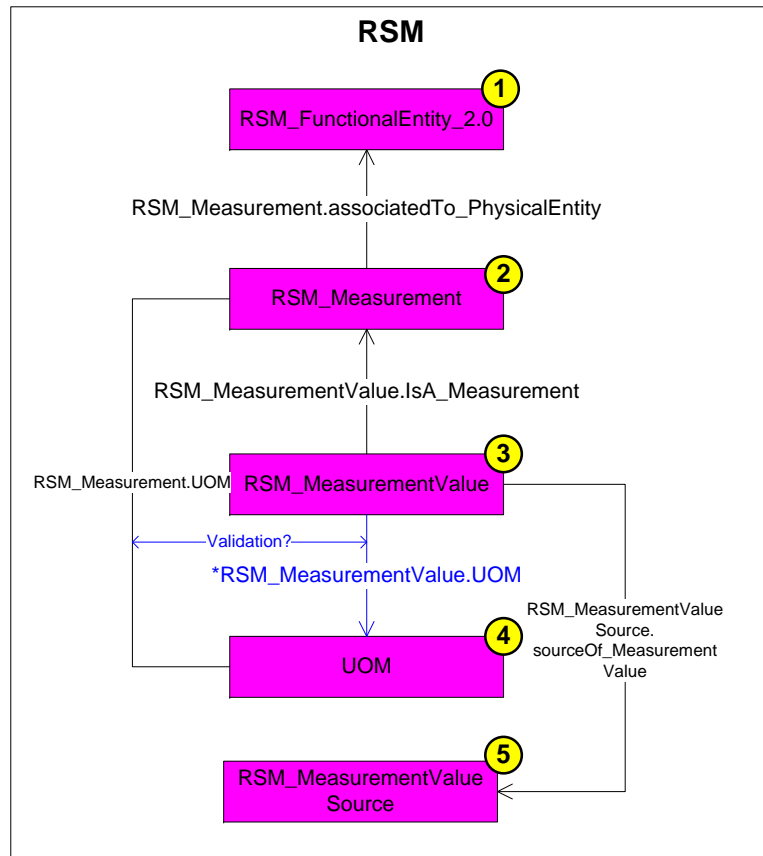
ISO 15926 data set



RSM data set



Another complex mapping: Measurements



RSM model in RDL: Advantages

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- We obtain a standardized representation of the model
- Documentation of the system structure is openly available
- Users and independent software vendors can investigate the model for alignment and integration



RSM data in ISO 15926: Advantages

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- Dictionary alignment. *Apply common terminology*
- Taxonomy/ontology alignment. *Discover additional knowledge*
- Data quality. Content from various OPC sources is given a standard classification
- Integration. ISO 15926/reference data content is suitable for exchange
- Applications. The OWL/RDF format makes content available for semantic tools



Thank you!

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Questions?

