Practical ISO 15926, interoperability with RDF/OWL

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Fluor Corporation

Semantic Days, Stavanger – May 31, 2010

Topics

- ISO 15926 short introduction
  - Who is ISO 15926
  - What is ISO 15926
  - Support of ISO 15926
  - Relation to Semantic Web
  - Methodology for interoperability
  - Templates
- Compliancy
- The Engineering contractor and the supply chain company.
- Software development projects

ISO 15926 short introduction

ISO 15926

What is it ??

- Interoperability standard

  Interoperability: the ability of different types of computers, networks, operating systems, and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner.
- Neutral layer used for data integration

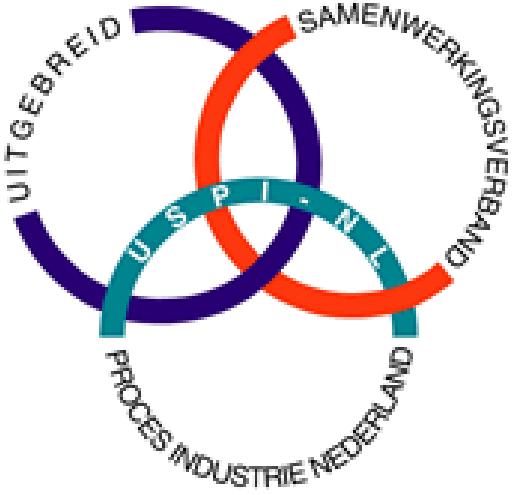
ISO 15926 – The Whole Standard

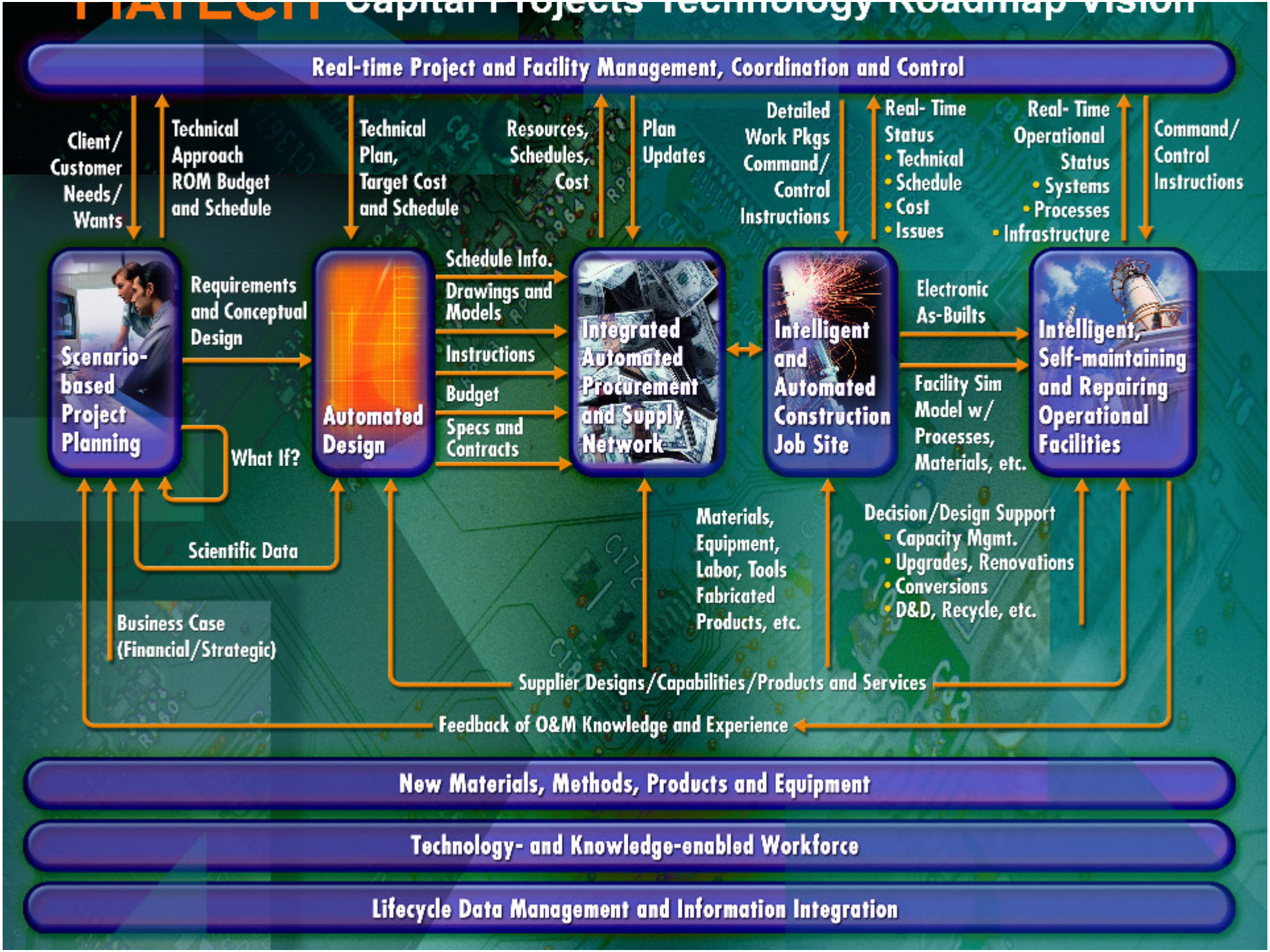
Integration of life-cycle data for process plants *including* oil and gas production facilities.

- **ISO 15926 - 1 Overview and fundamentals** (Approved IS June 2004)
- **ISO 15926 - 2 Data model** (Approved IS December 2003)
- **ISO 15926 - 3 Geometry** (Approved TS April 2009)
  (ISO - 10303 - 42 Represented in RDS/WIP according to Parts 2 & 4)
- **ISO 15926 - 4 Initial reference data**. (Approved TS October 2007)
  (RDL included in the RDS/WIP and extended from there according to Parts 5 & 6)
- **ISO 15926 - 5 RDL Maintenance Procedures** (***Superseded*** by **ISO-TC184/SC4 RDL Database procedure** with 15926-specific annex – issued for ballot January 2010)
- **ISO 15926 - 6 Scope and methodology for developing additional reference data**
  (NWI/CD submitted to ISO Q3 2007, planned ballot in 2010)
- **ISO 15926 - 7 Template Implementation Methodology** (TS submission 2010)
- **ISO 15926 - 8 OWL/RDF (W3C) Representation** (TS submission 2010)
- **ISO 15926 - 9 Façade (Semantic Web Interface) Implementation** (TS planned 2011)
- **ISO 15926 - 10 Abstract Test Methods** (TS planned 2011)
- **ISO 15926 - 11 Simplified Industrial Usage** (New Work Item)
- **ISO 15926 - 12**
- **ISO 15926 - 13**

Who is ISO 15926

Who is ISO 15926 ??




Real-time Project and Facility Management, Coordination and Control
Client/ Customer Needs/ Wants
Technical Approach ROM Budget and Schedule
Technical Plan, Target Cost and Schedule
Resources, Schedules, Cost
Plan Updates
Detailed Work Pkgs Command/ Control Instructions
Real- Time Status • Technical • Schedule • Cost • Issues
Real- Time Operational Status • Systems • Processes • Infrastructure
Command/ Control Instructions
Scenario-based Project Planning
Requirements and Conceptual Design
What If?
Automated Design
Schedule Info.
Drawings and Models
Instructions
Budget
Specs and Contracts
Integrated Automated Procurement and Supply Network
Intelligent and Automated Construction Job Site
Electronic As-Builts
Facility Sim Model w/ Processes, Materials, etc.
Intelligent, Self-maintaining and Repairing Operational Facilities
Scientific Data
Business Case (Financial/Strategic)
Materials, Equipment, Labor, Tools Fabricated Products, etc.
Decision/Design Support
• Capacity Mgmt.
• Upgrades, Renovations
• Conversions
• D&D, Recycle, etc.
Supplier Designs/Capabilities/Products and Services
Feedback of O&M Knowledge and Experience
New Materials, Methods, Products and Equipment
Technology- and Knowledge-enabled Workforce
Lifecycle Data Management and Information Integration


AVEVA
BENTLEY
DASSAULT SYSTEMES
INTERGRAPH
IBM
aspentech
Adobe
e-Builder
Meridian SYSTEMS
Autodesk
NRX
ORACLE
PRIMAVERA
Skire
SIEMENS
metegrity
ENGINEERING LTD
CADE
ENGINEERING SOFTWARE

US Army Corps
of Engineers

MANAGING RISK

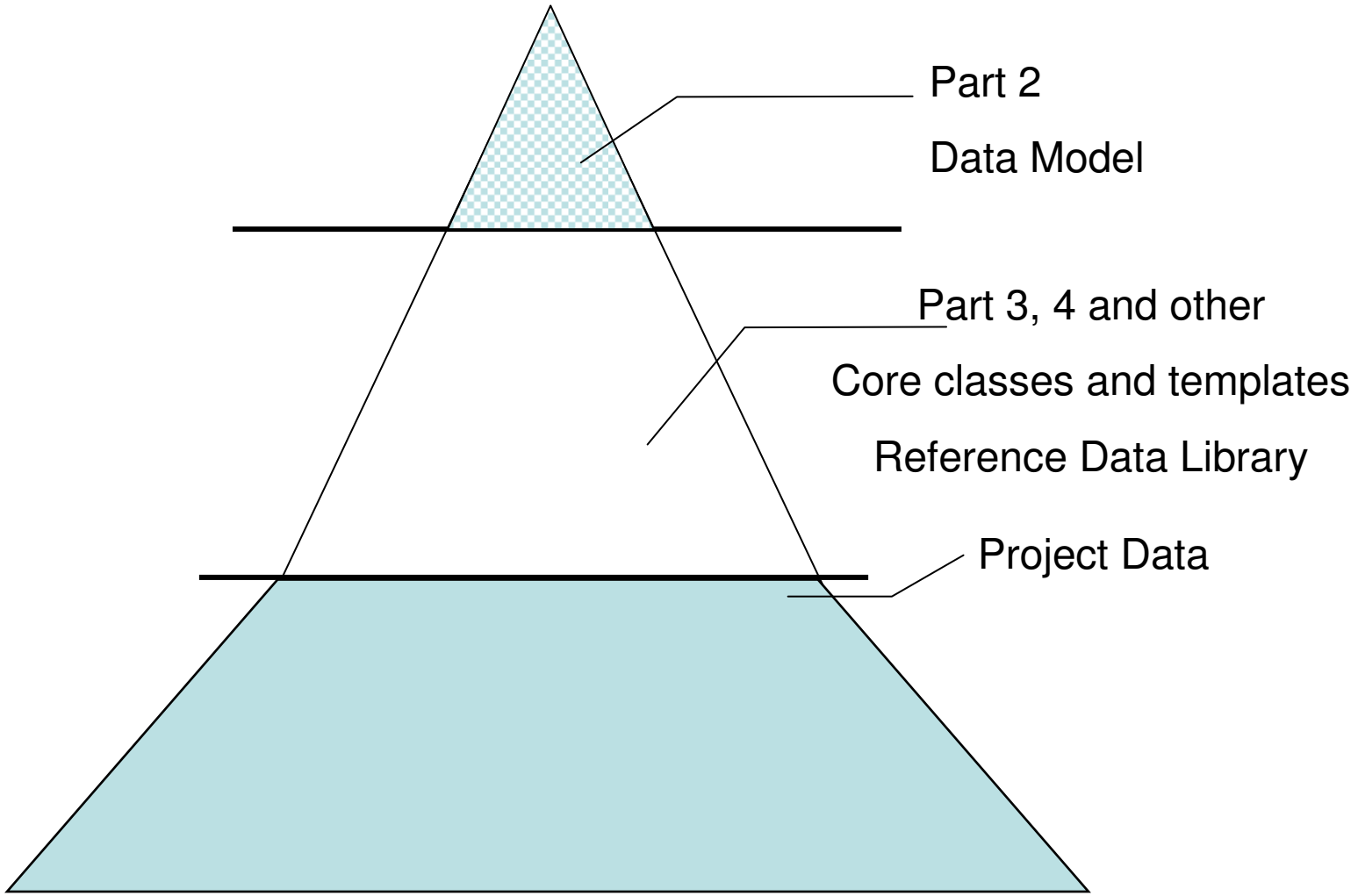
What is ISO 15926

What is in ISO 15926 ??

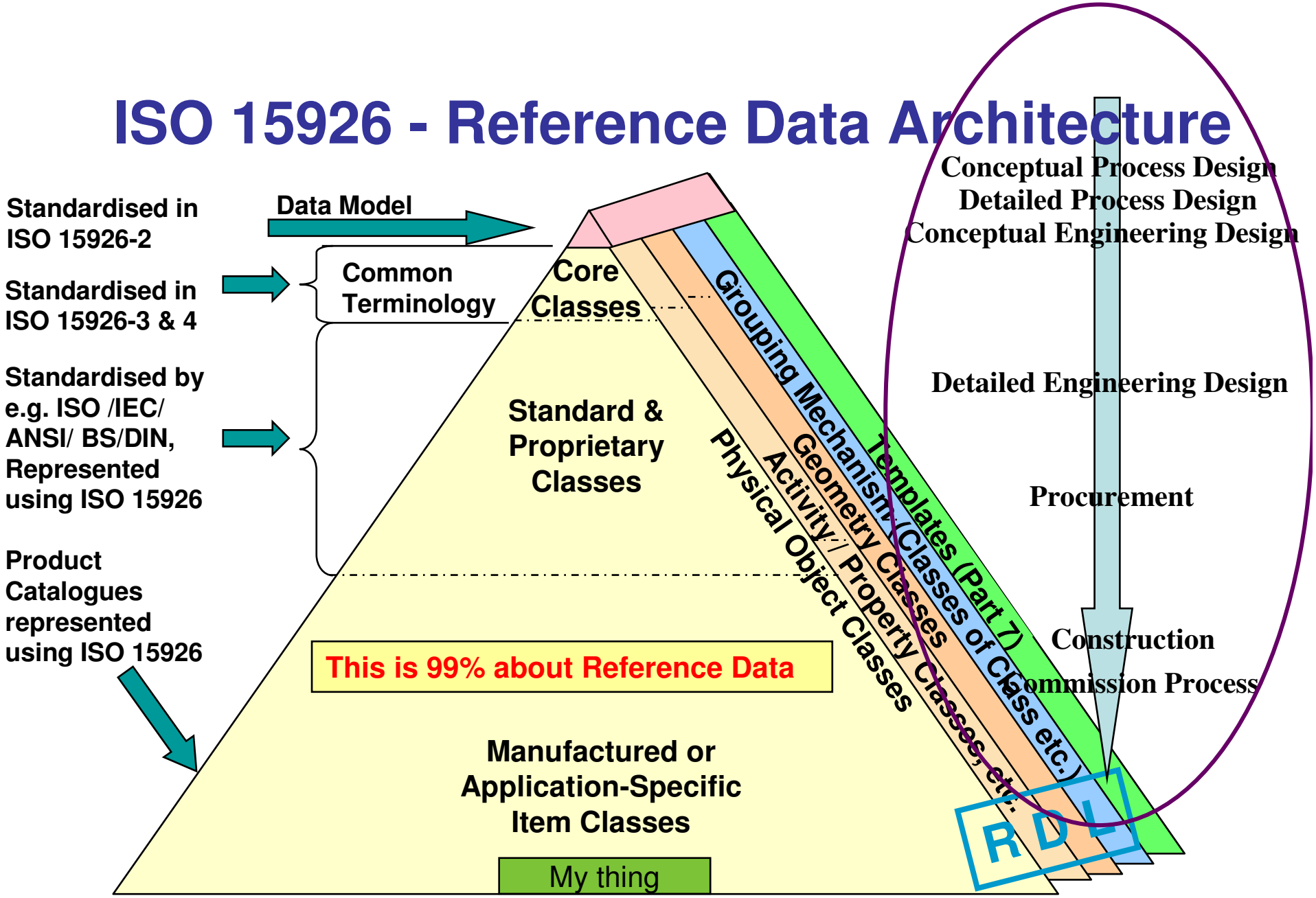
- **Reference data library** (RDL)
  - It is part of the WIP –
    an online triple store / facade
    http://rdl.rdlfacade.org/
  - JORD project

- **Data integration and interoperability methodology**
  - IRING Tools

Class Hierarchy in RDL



ISO 15926 - Reference Data Architecture



ISO 15926 part 4 spreadsheets

Spreadsheet	count		Spreadsheet	count	
basics.xls	**108**		**valves.xls**	**553**	
core.xls	**17**		**connection_ material.xls**	**226**	
uom.xls	**1087**		**mathematical_ objects.xls**		
information.xls	**313**		**rotating_equipment**	**1150**	
properties.xls	**1667**		**activities.xls**	**1829**	
class_of_class.xls	**488**		**functions.xls**	**80**	
heat_transfer.xls	**268**		**solid_handling.xls**	**67**	
encoded_ information.xls	**38**		**protection.xls**	**103**	
electrical.xls	**1465**		**static_equipment.xls**	**637**	
instrumentation.xls	**724**		**transport.xls**	**100**	
piping.xls	**704**		Total	11624	

Levels of Precision

Text

ISO 15926-4 Dictionary

ISO 15926-4 Thesaurus

ISO 15926-4 Ontology

Model
(Integration)

1. **Nomenclature (List of names of concepts)**

English	667 447 900	centrifugal pump
English	667 492 900	dynamic pump
English	667 501 900	impulse pump

2. **Dictionary (List of concepts with definitions)**

English	570 200	centrifugal pump	A (dynamic) pump utilizing impellers provided with vanes generating centrifugal force to achieve the required pressure head.

3. **Taxonomy (Structure of like concepts with definitions)**

English	570 200	centrifugal pump	is a specialization of	632 100	dynamic pump
English	632 100	dynamic pump	is a specialization of	570 100	pump

4. **Compound classes (Knowledge models with implicit product structure)**

English	570 200	centrifugal pump	class_of_indirect_property	139999	impeller diameter

5. **Ontology (Knowledge models with explicit product structure)**

English	570 200	centrifugal pump	class_of_assembly_of_individual	130207	pump impeller
English	130207	pump impeller	class_of_indirect_property	139999	impeller diameter

6. **Extended Ontology (Knowledge models including relations between products)**

English	570 200	centrifugal pump	can be performer of a	192512	pumping process
English	400143	batch of liquid	can be subject in a	192512	pumping process

7. **Individual product models**

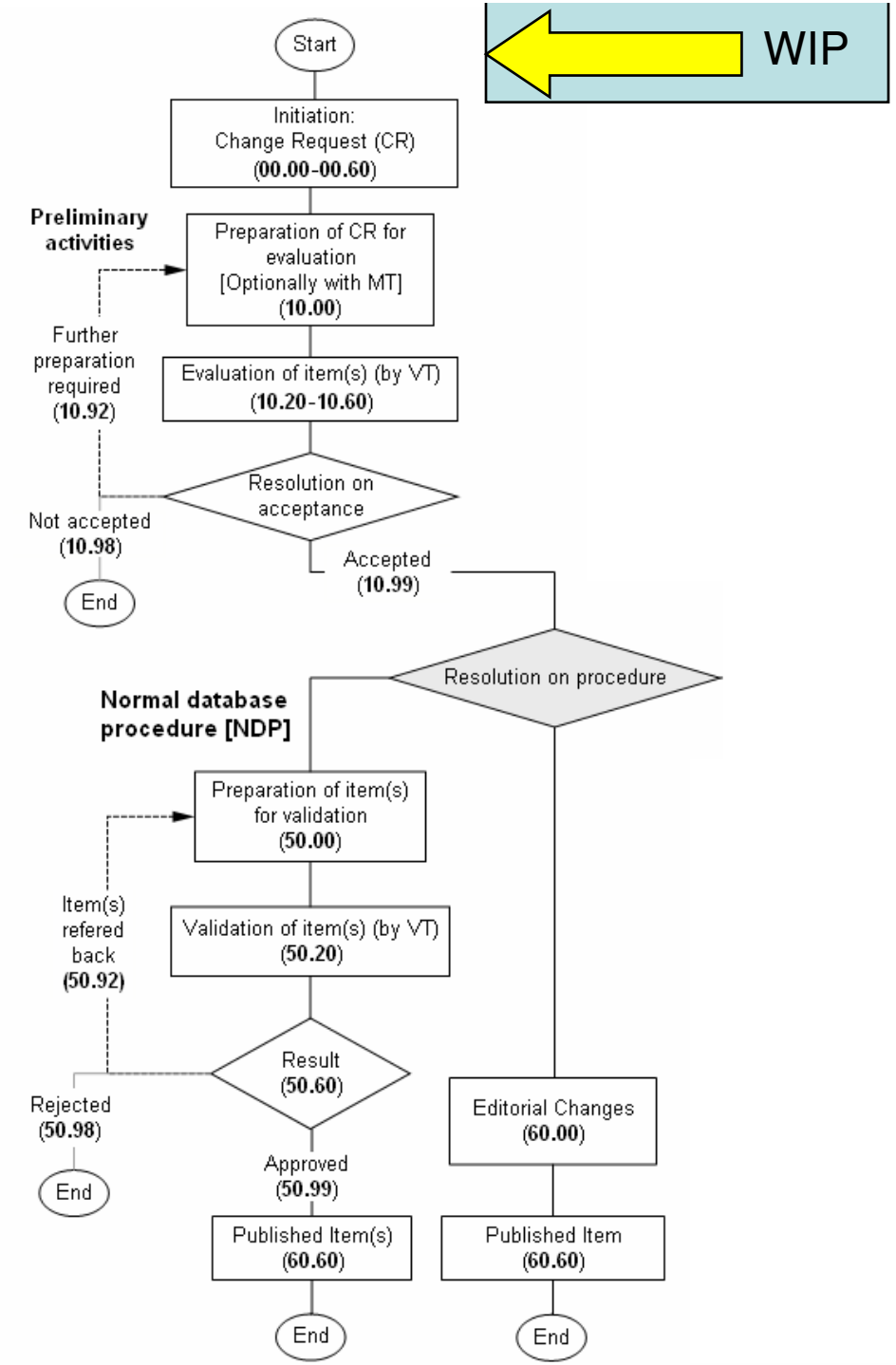
English	1000001	P-1301	is classified as a	570200	centrifugal pump
English	1000001	P-1301	is part of	1000002	Unit 1300

Domain experts

RDL/Domain experts

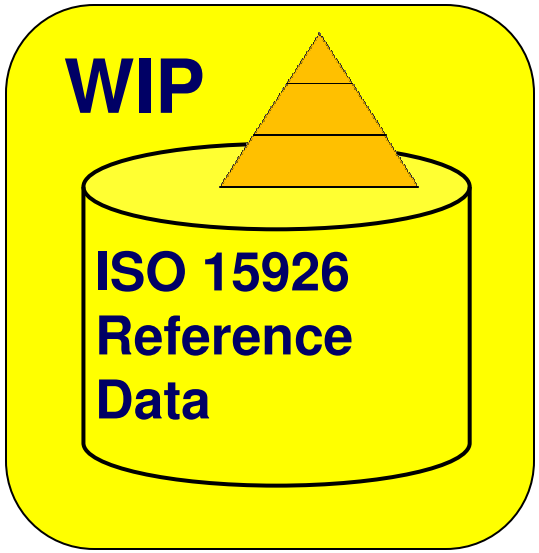
Support of ISO 15926

ISO Normal process for the maintenance of existing standards as databases



ISO 15926 RDS/WIP

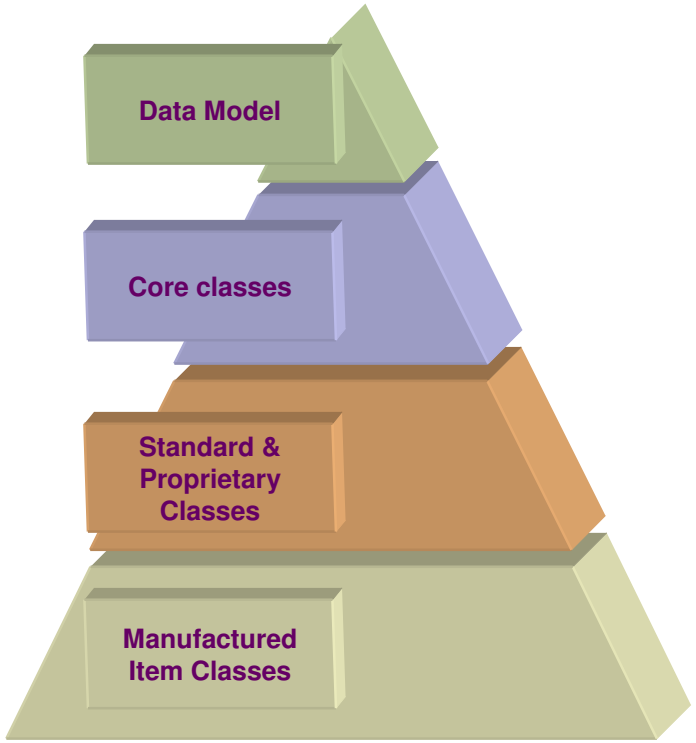
- Single global source for reference data
- Contains standardized product models
- Extensible
- The “inbox” for ISO
- Anybody can browse
- Certified user can extend
- All entries are permanent
- Includes browser and SOA interfaces

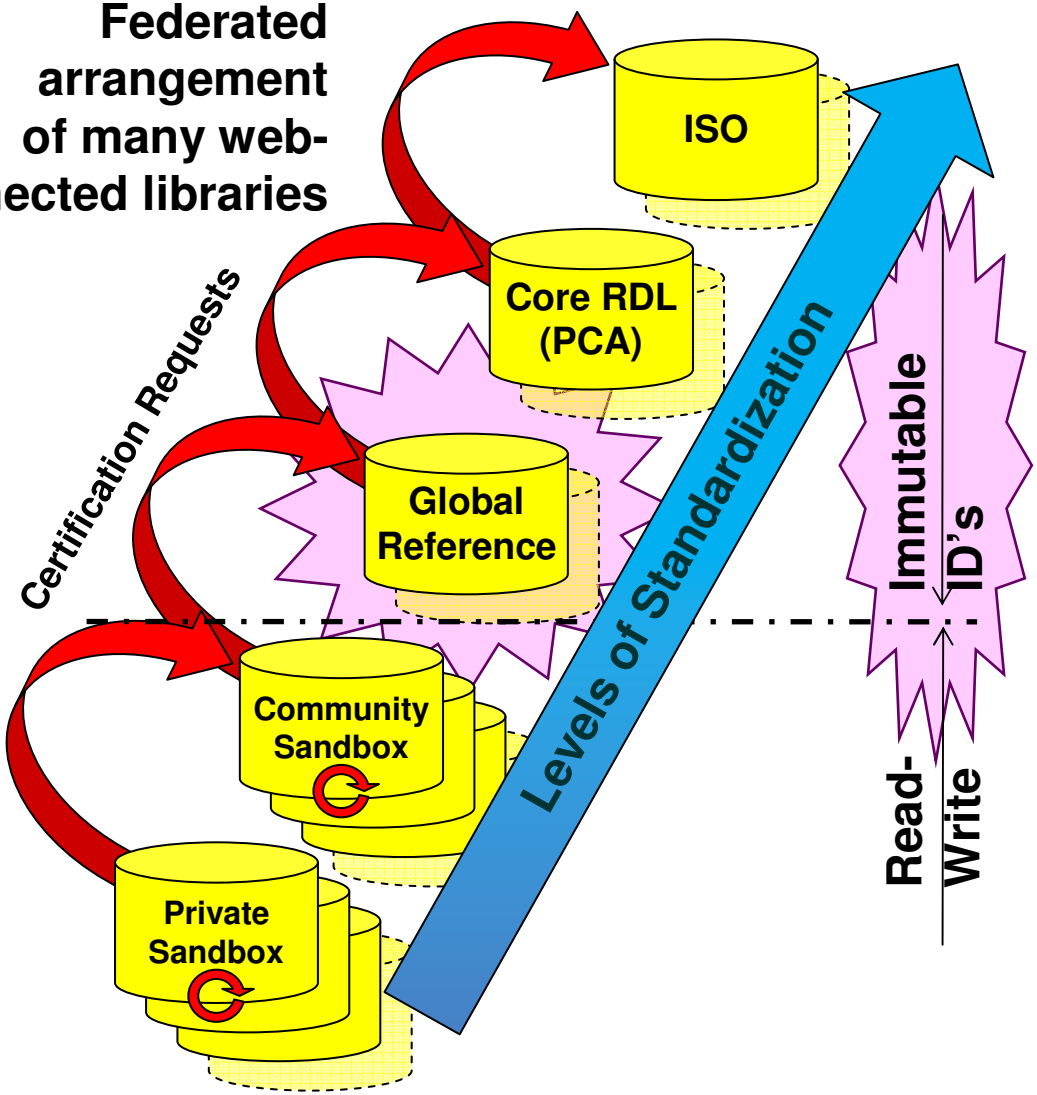


15926 & Federated Reference Data

Logical organization of reference data

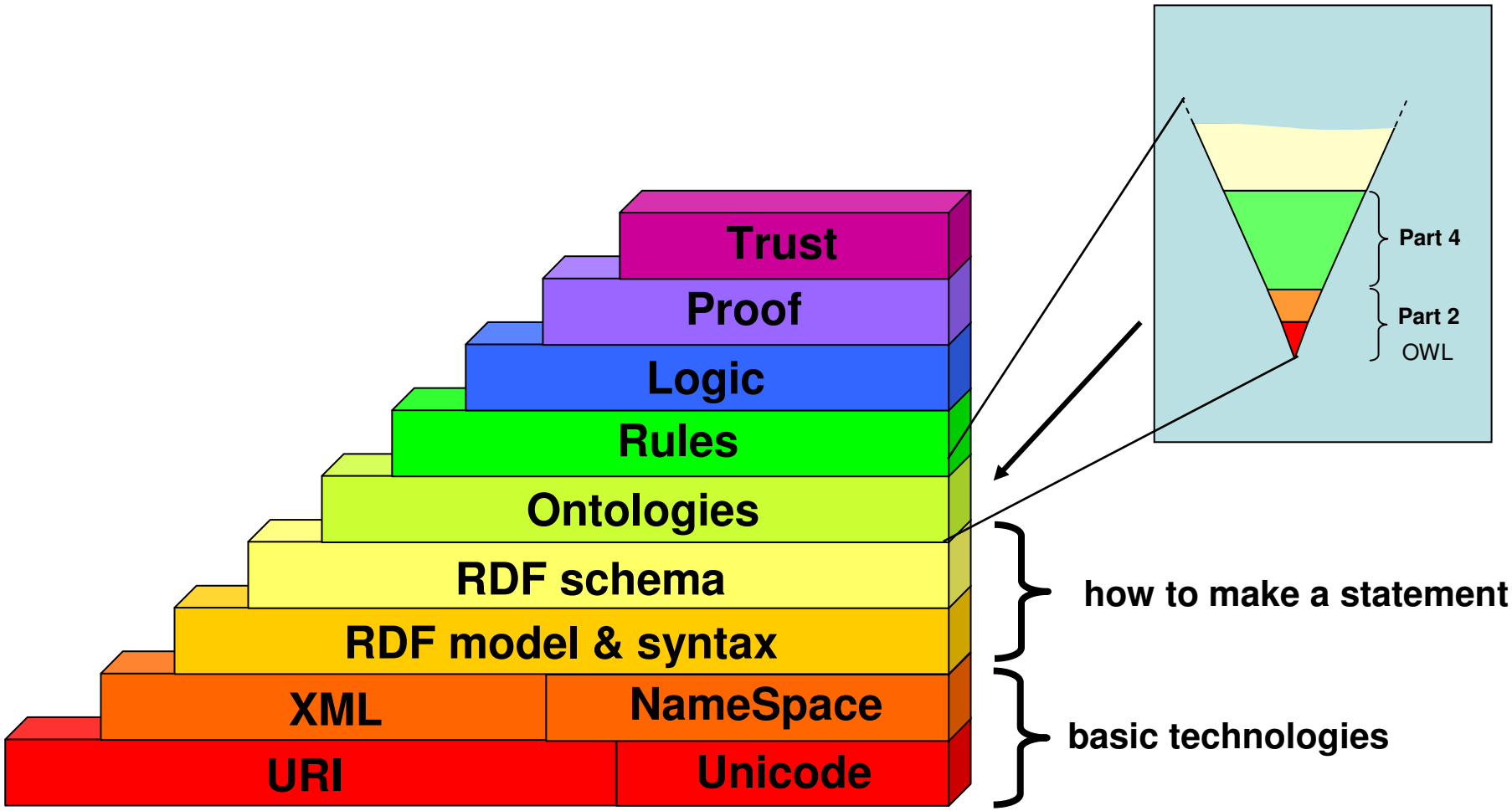
Federated arrangement of many web-connected libraries





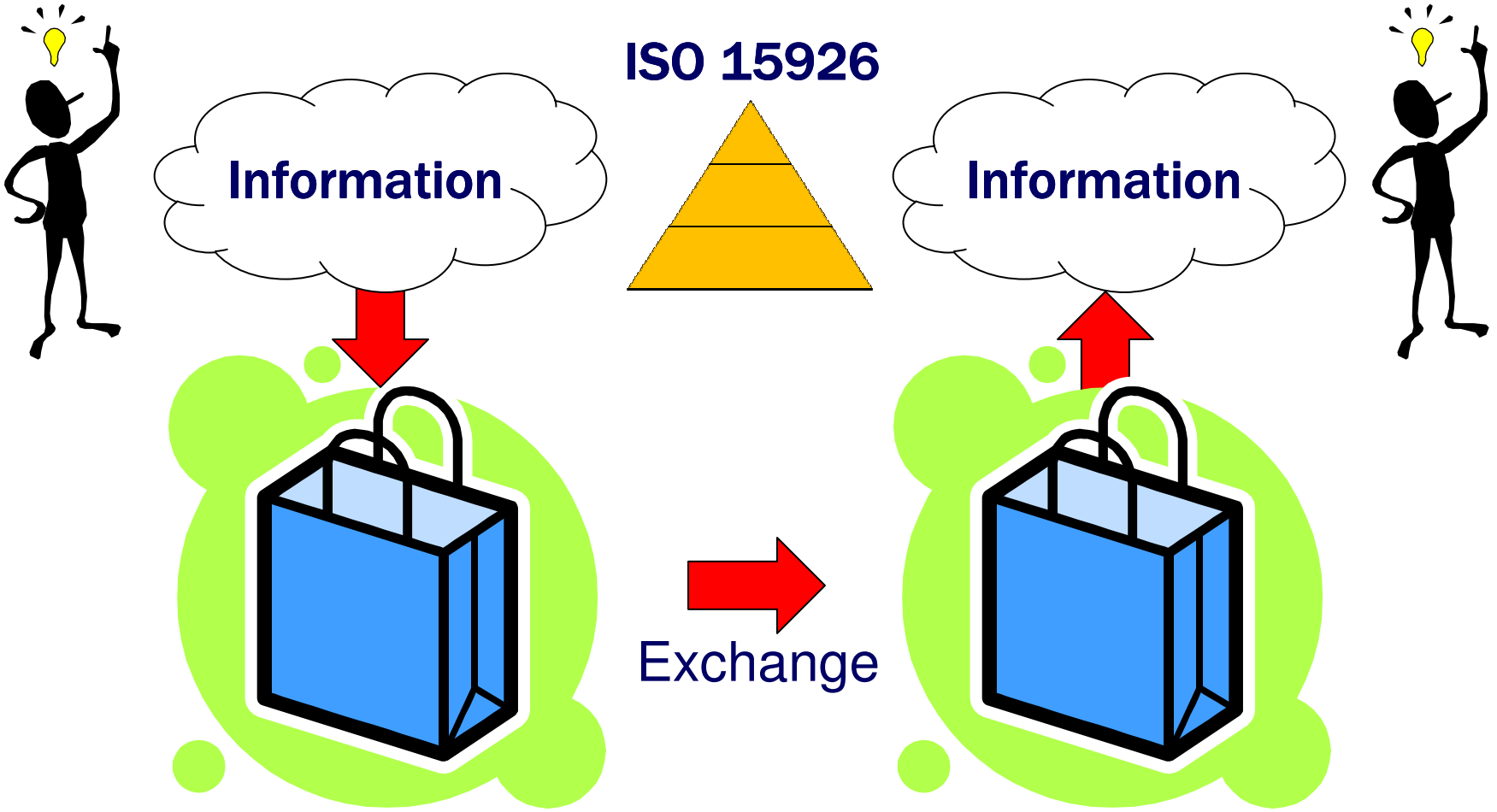
Relation to Semantic Web

ISO 15926 map to the Semantic Web



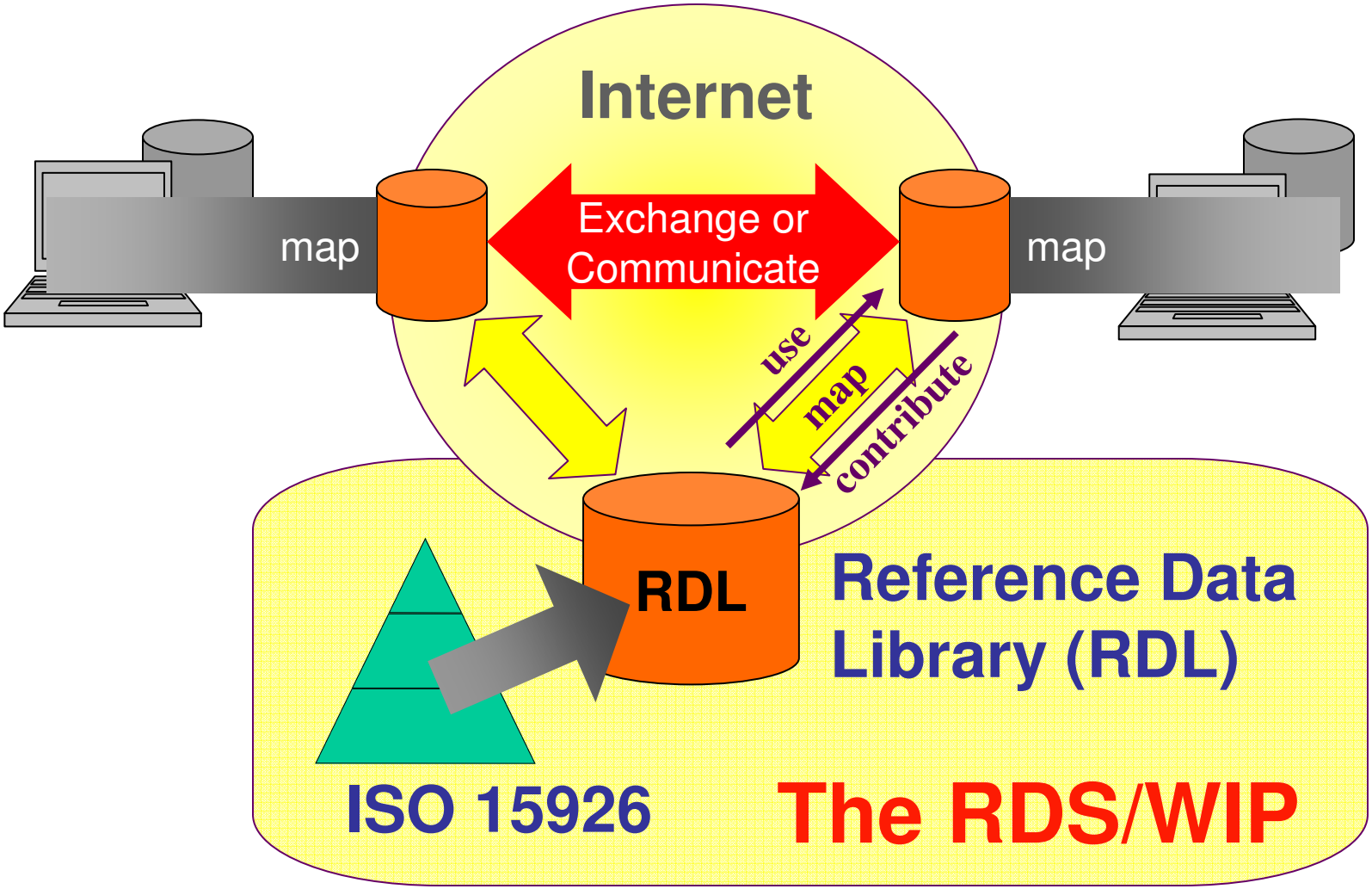
Methodology for interoperability

RDL: reference data library



The ISO 15926 provides the ability to build common data models

ISO 15926: interoperability



Confederation of Participating Façades (CPF)

Reference Data Library

Plant Owner/ Operator - HQ

Plant Owner/ Operator - Plant

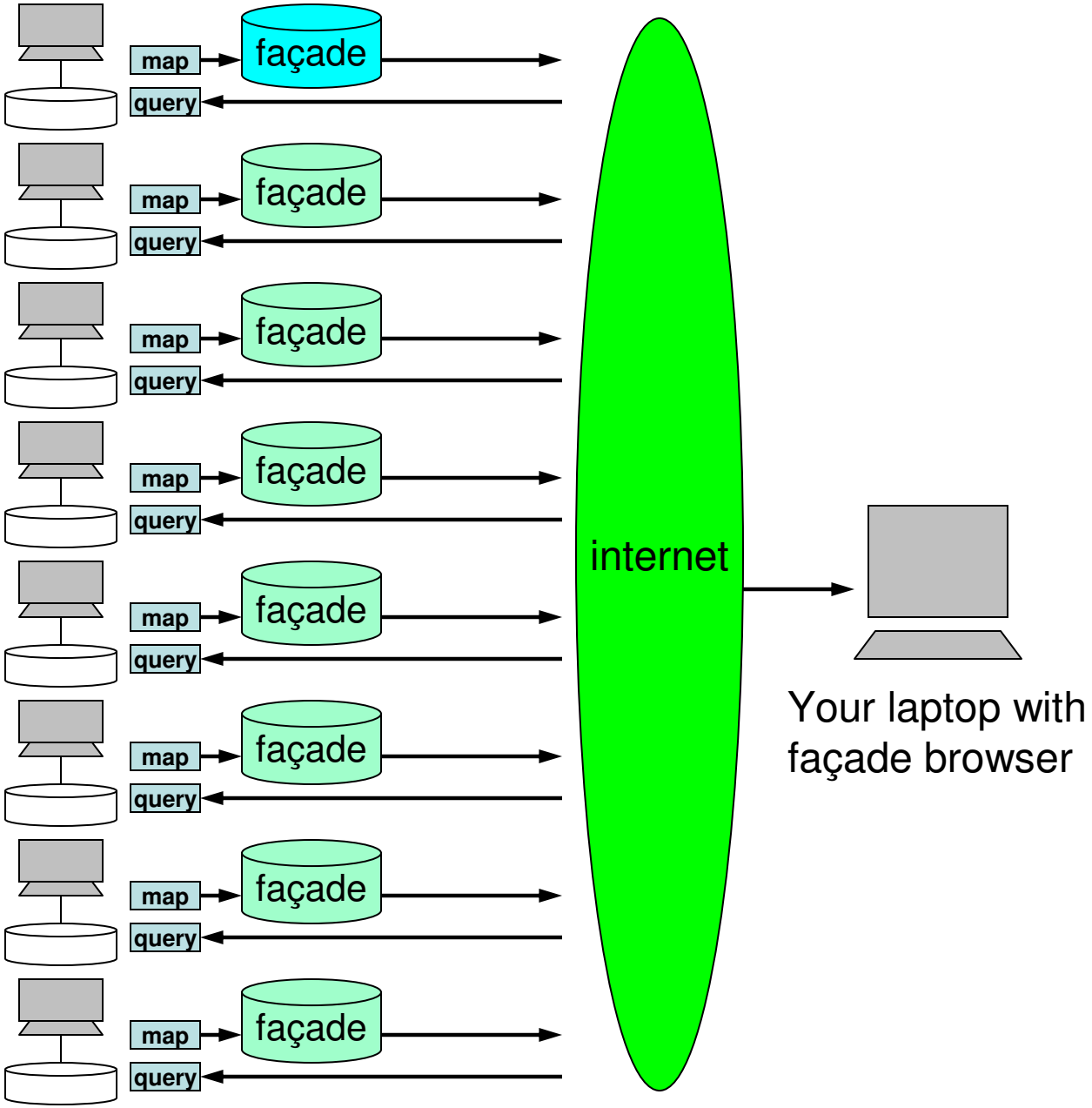
EPC contractor – A

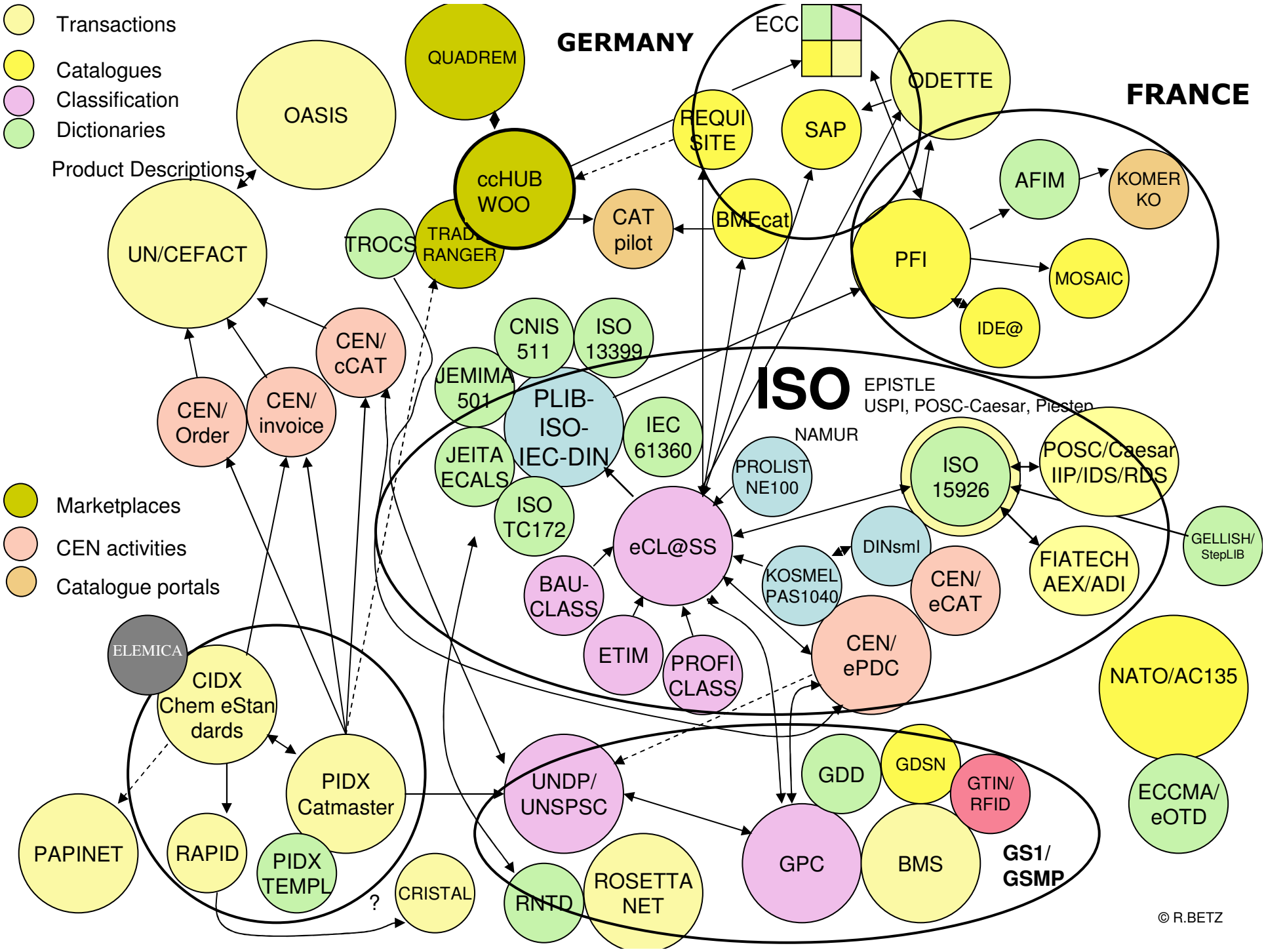
EPC contractor – B

Supplier Catalog – e.g. PLib

Supplier – project data

RDL of standards organization

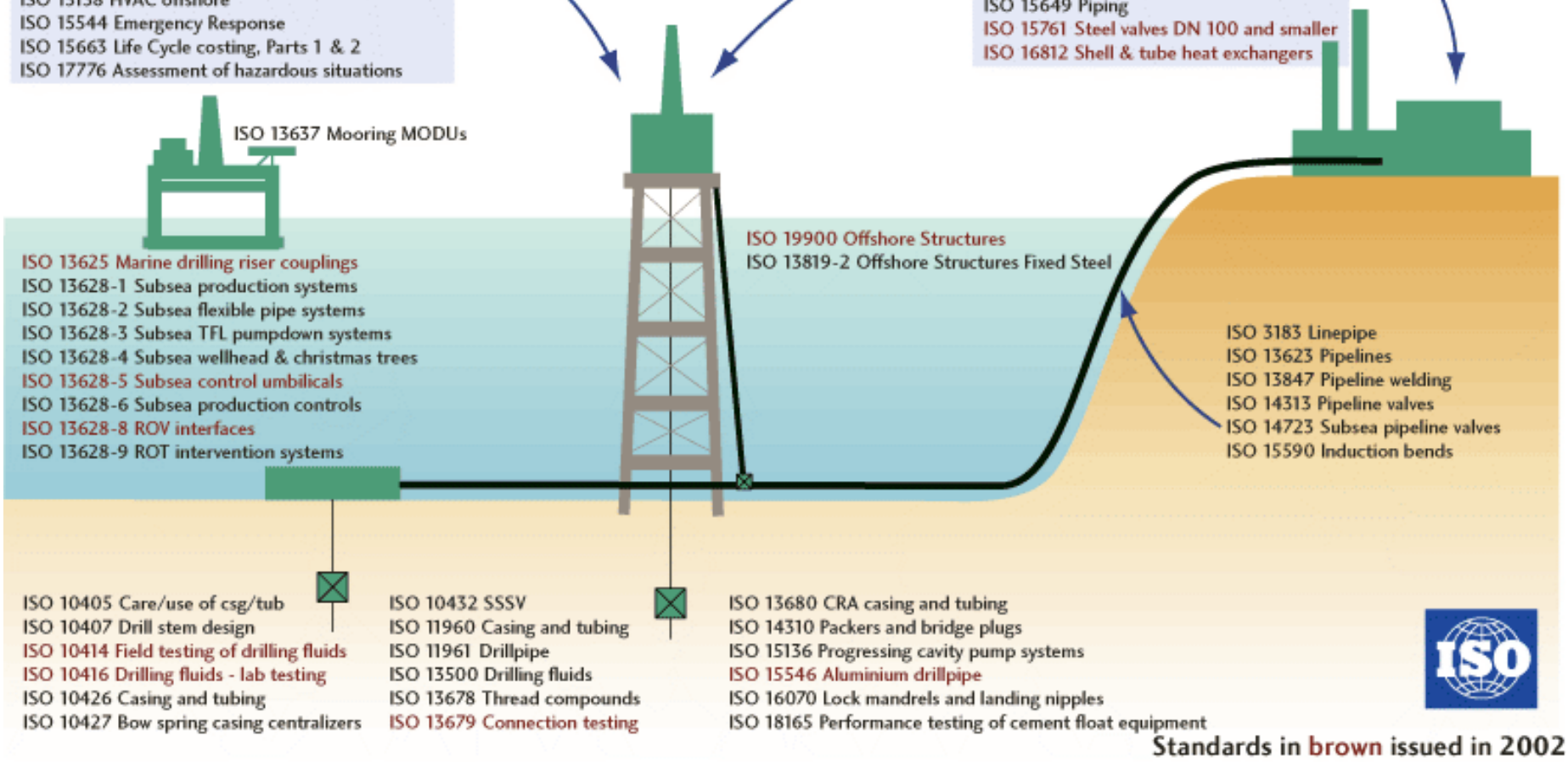



Transactions
Catalogues
Classification
Dictionaries
Product Descriptions
Marketplaces
CEN activities
Catalogue portals
GERMANY
FRANCE
ISO
EPISTLE
USPI, POSC-Caesar, Piesten
NAMUR
QUADREM
OASIS
ECC
ODETTE
REQUI SITE
SAP
ccHUB WOO
CAT pilot
BMEcat
TROCS
TRADE RANGER
UN/CEFACT
AFIM
KOMER KO
PFI
MOSAIC
IDE@
CEN/ cCAT
CEN/ Order
CEN/ invoice
CNIS 511
ISO 13399
JEMIMA 501
PLIB-ISO-IEC-DIN
IEC 61360
JEITA ECALS
ISO TC172
PROLIST NE100
ISO 15926
POSC/Caesar IIP/IDS/RDS
GELLISH/ StepLIB
eCL@SS
DINsml
KOSMEL PAS1040
CEN/ eCAT
FIATECH AEX/ADI
BAU-CLASS
ETIM
PROFI CLASS
CEN/ ePDC
ELEMICA
CIDX Chem eStan dards
PIDX Catmaster
NATO/AC135
ECCMA/ eOTD
UNDP/ UNSPSC
GDD
GDSN
GTIN/ RFID
PAPINET
RAPID
PIDX TEMPL
?
CRISTAL
RNTD
ROSETTA NET
GPC
BMS
GS1/ GSMP
© R.BETZ

ISO/TC67 standards published

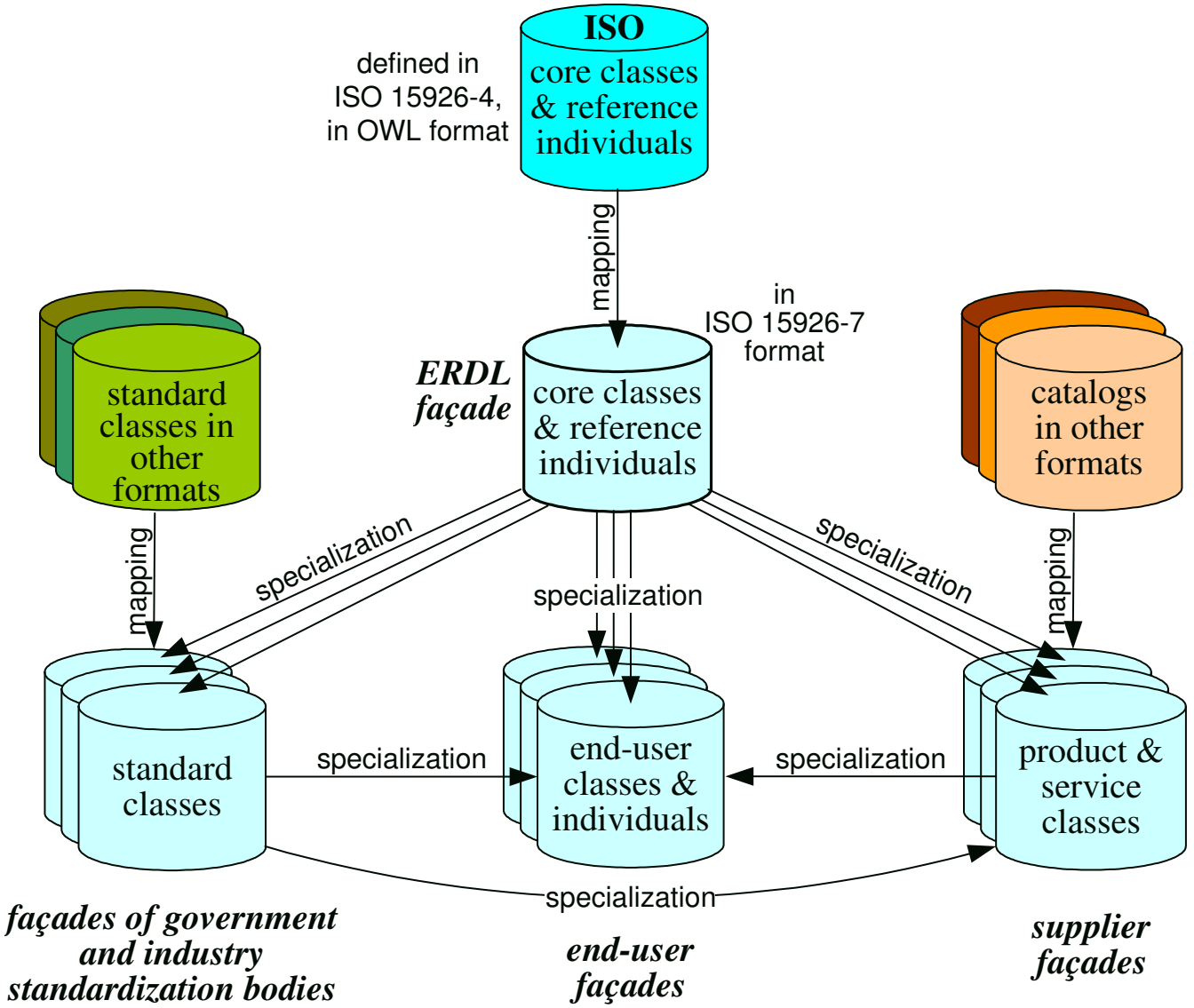
ISO 10418 Surface safety systems
ISO 10423 Wellhead & christmas tree equipment
ISO 13533 Drill-through equipment
ISO 13534 Hoisting equipment - care/maint RP
ISO 13535 Hoisting equipment - specification
ISO 13702 Control & mitigation of fire & explosion
ISO 13703 Offshore piping systems
ISO 14224 Reliability/maintenance data
ISO 14692 GRP piping
ISO 15156 Materials for H_2S environments
ISO 15138 HVAC offshore
ISO 15544 Emergency Response
ISO 15663 Life Cycle costing, Parts 1 & 2
ISO 17776 Assessment of hazardous situations

ISO 3977-5 Gas turbines – procurement
ISO 10434 Steel gate valves
ISO 10437 Steam turbines
ISO 10440 P D rotary compressors
ISO 10441 Flexible couplings – special
ISO 10442 Integrally geared air compressors
ISO 13631 Reciprocating gas compressors
ISO 13691 High speed enclosed gear units
ISO 13704 Calculation heat tube thickness
ISO 13705 Fired heaters for general service
ISO 13706 Air-cooled heat exchangers
ISO 13707 Reciprocating compressors
ISO 14961 Flexible couplings – general
ISO 15547 Plate heat exchangers
ISO 15649 Piping
ISO 15761 Steel valves DN 100 and smaller
ISO 16812 Shell & tube heat exchangers



Standards in brown issued in 2002

Locations by information ownership



Templates

They are n-ary relationships

Building domain ontologies with *templates*

- An ontology is used to record *statements.* That's semantics.
- To build the RDL, we need to represent facts about a given domain using the language of ISO 15926
- Ideally, a domain expert states the facts, and the machine interprets the facts automatically

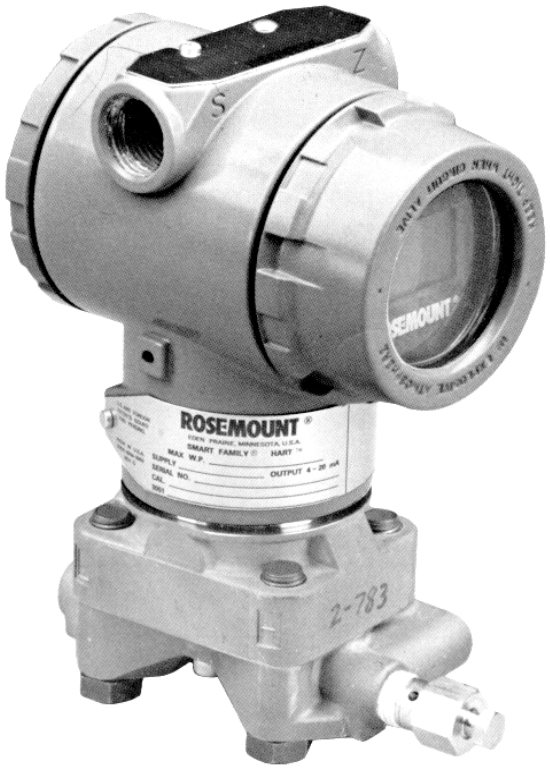
A template is a pattern for stating facts

- A Template for ISO 15926 is a *predicate*, a *statement form*, a *pattern for facts*
- A template has a *signature* defining the form of a statement
  - What arguments need to be given
  - What are their types
- Each template has an *interpretation rule* that interprets facts that fit the pattern
  - Reducing a complex statement into simpler ones
  - Eventually, to atomic statements in ISO 15926
  - Yielding an expression of the fact in the ontology language
- Logical methodology is rigorously defined in ISO 15926-7

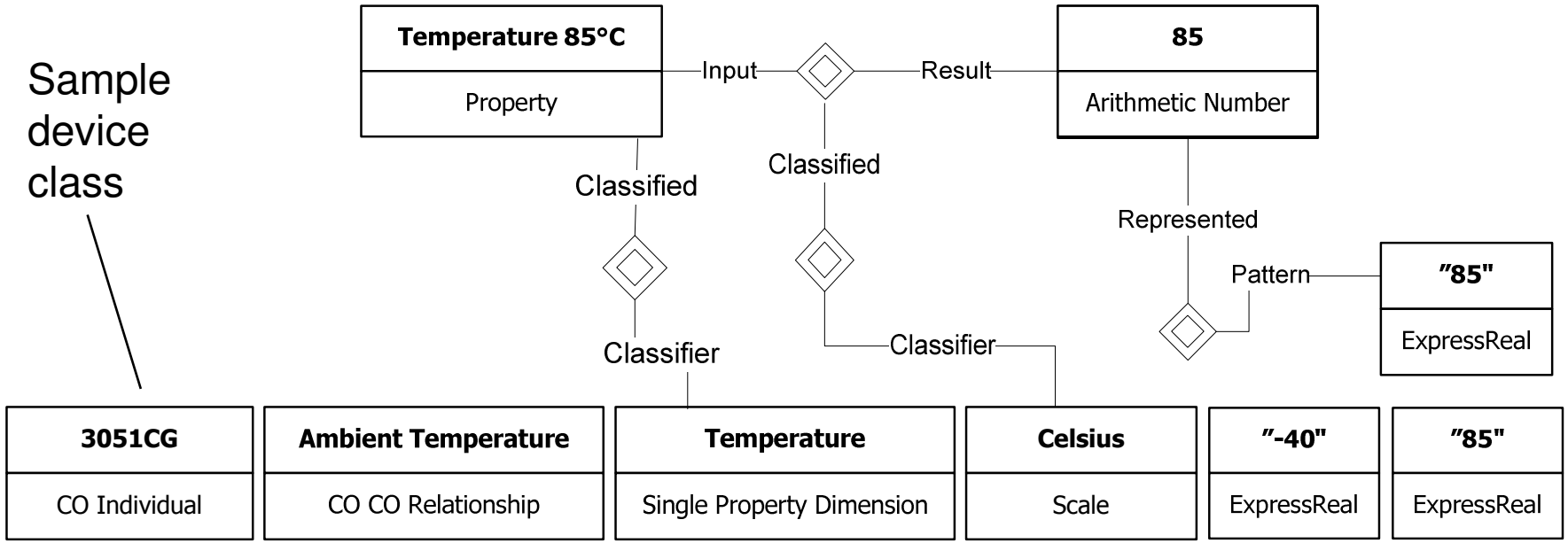
Interoperability: templates
an example

A fairly complex claim

> “The ambient temperature during operation of a 3051CG pressure transmitter should be within -40 and 85 degrees Celsius.”

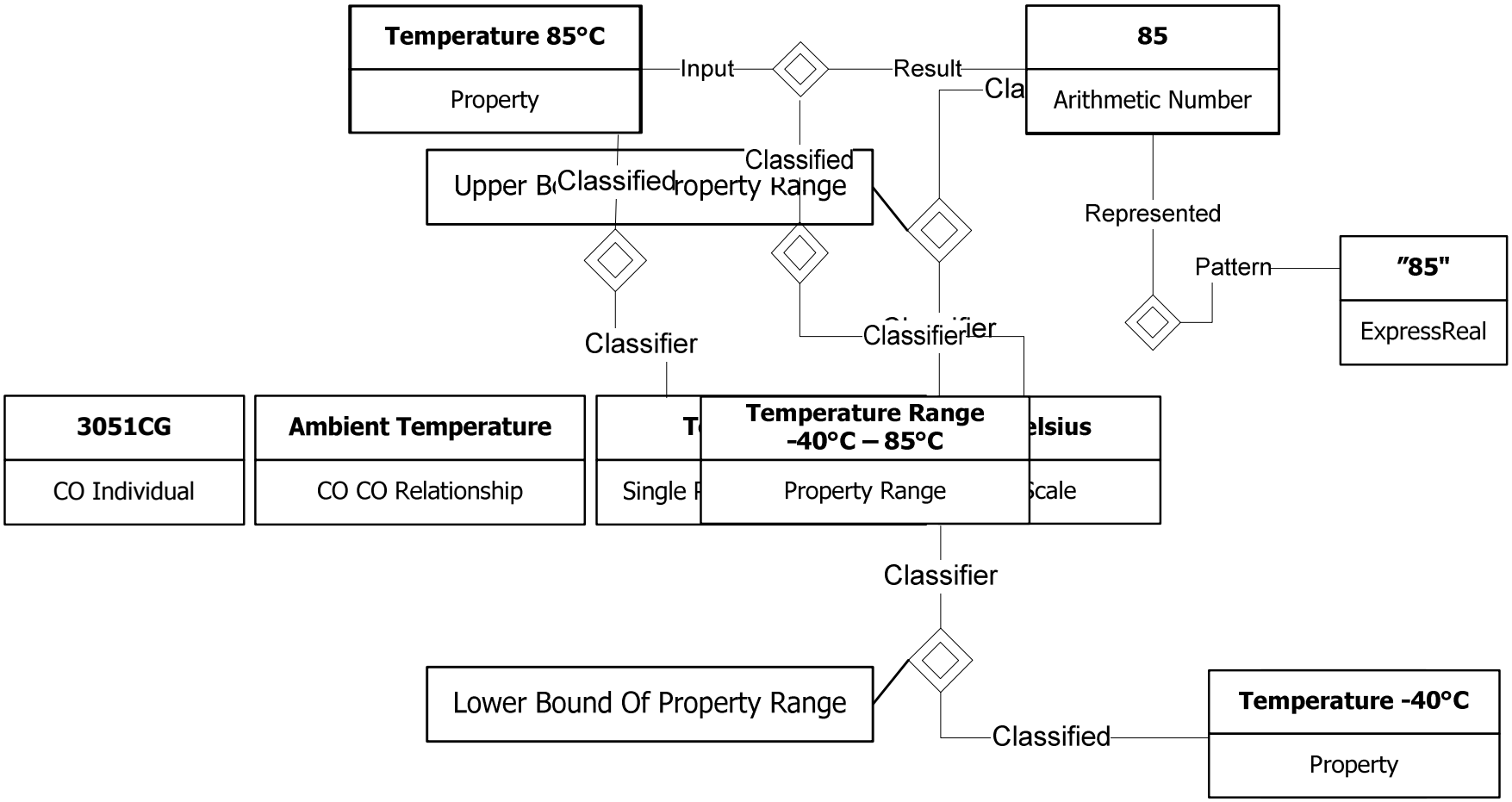


Property with Scale and Quantification

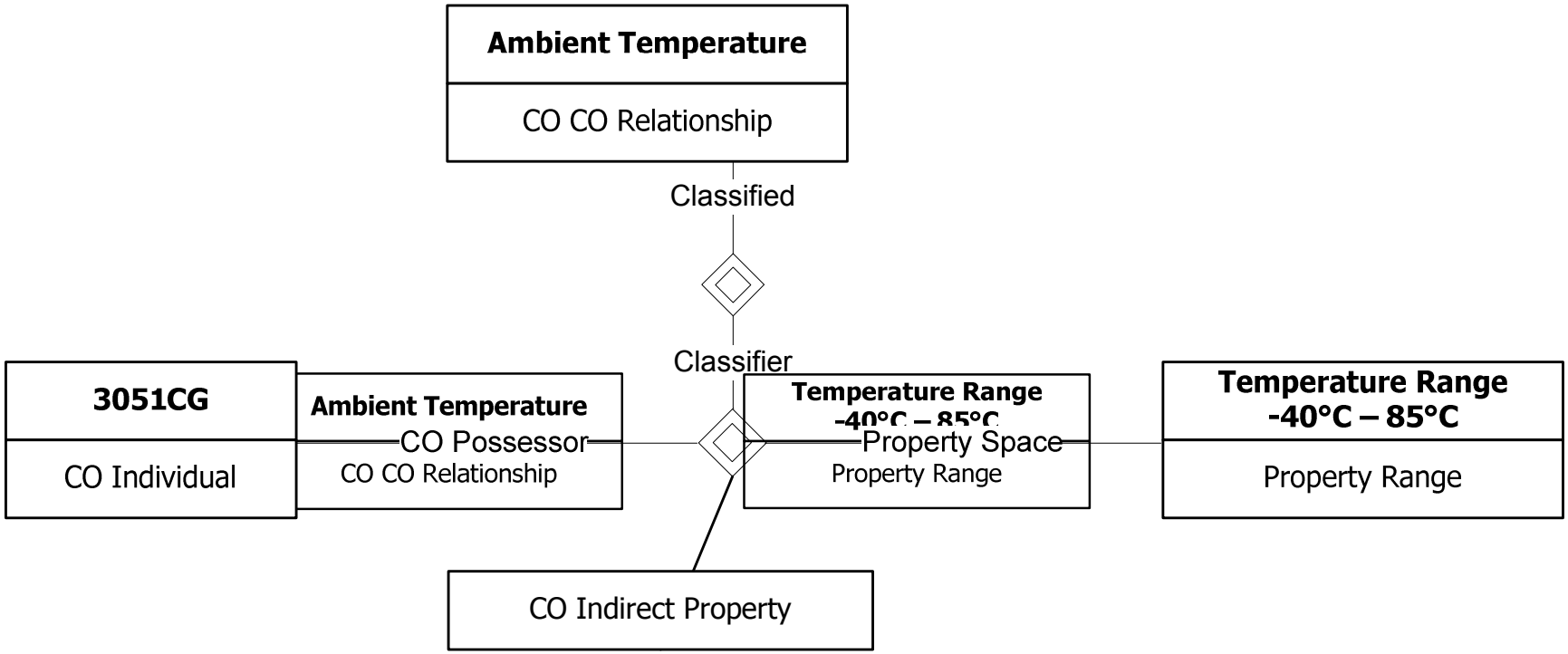


"The ambient temperature during operation of a 3051CG pressure transmitter should be within -40 and 85 degrees Celsius."

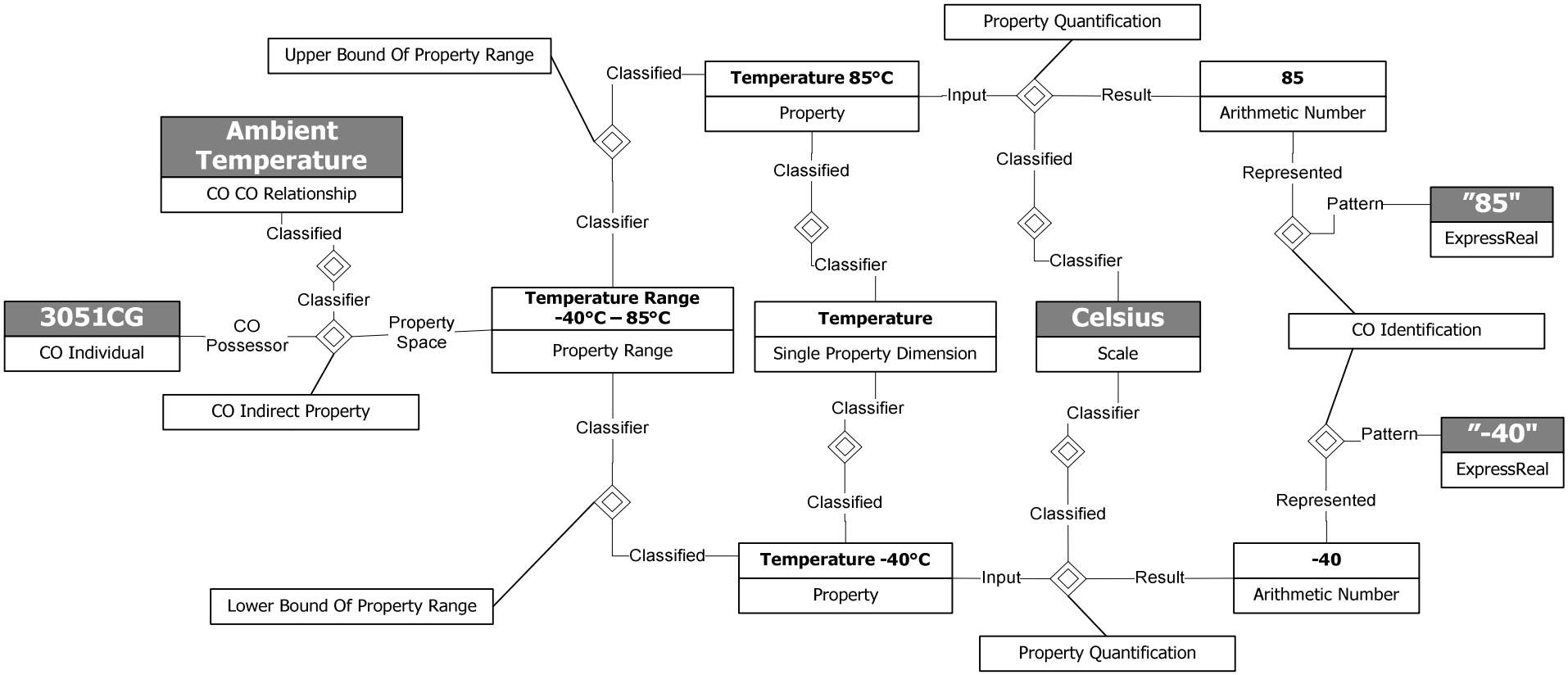
Property Range



Property Range Restriction



Model: Ambient Temperature Range



3051CG ambient temperature: -40°C – 85°C

Template instance showing temperature range restriction

RDF notation:

```
<rdl:PropertyRangeMagnitudeRestrictionOfClass rdf:ID="T593292">
   <rosm:hasRestrictedClass rdf:resource="#PT-3051CG"/>
   <rosm:hasProperty rdf:resource="http://rdl.rdlfacade.org/data#AmbientTemperature"/>
   <rosm:hasScale rdf:resource="http://rdl.rdlfacade.org/data#DegreesCelcius"/>
   <rosm:valUpperReal rdf:datatype="&xsd;real">-40</rosm:valUpperReal>
   <rosm:valLowerReal rdf:datatype="&xsd;real">85</rosm:valLowerReal>
</rdl:PropertyRangeMagnitudeRestrictionOfClass>
```

Manchester syntax notation:

```
Individual: rosm:T593292

   Types:
      rosm:PropertyRangeMagnitudeRestrictionOfClass

   Facts:
      rosm:hasProperty  <http://rdl.rdlfacade.org/data#AmbientTemperature>,
      rosm:hasRestrictedClass  rosm:PT-3051CG,
      rosm:hasScale  <http://rdl.rdlfacade.org/data#DegreesCelcius>,
      rosm:valLowerReal  "85"^^xsd:real,
      rosm:valUpperReal  "-40"^^xsd:real

Individual: rosm:PT-3051CG
```

First Order Logic – “lifted data”

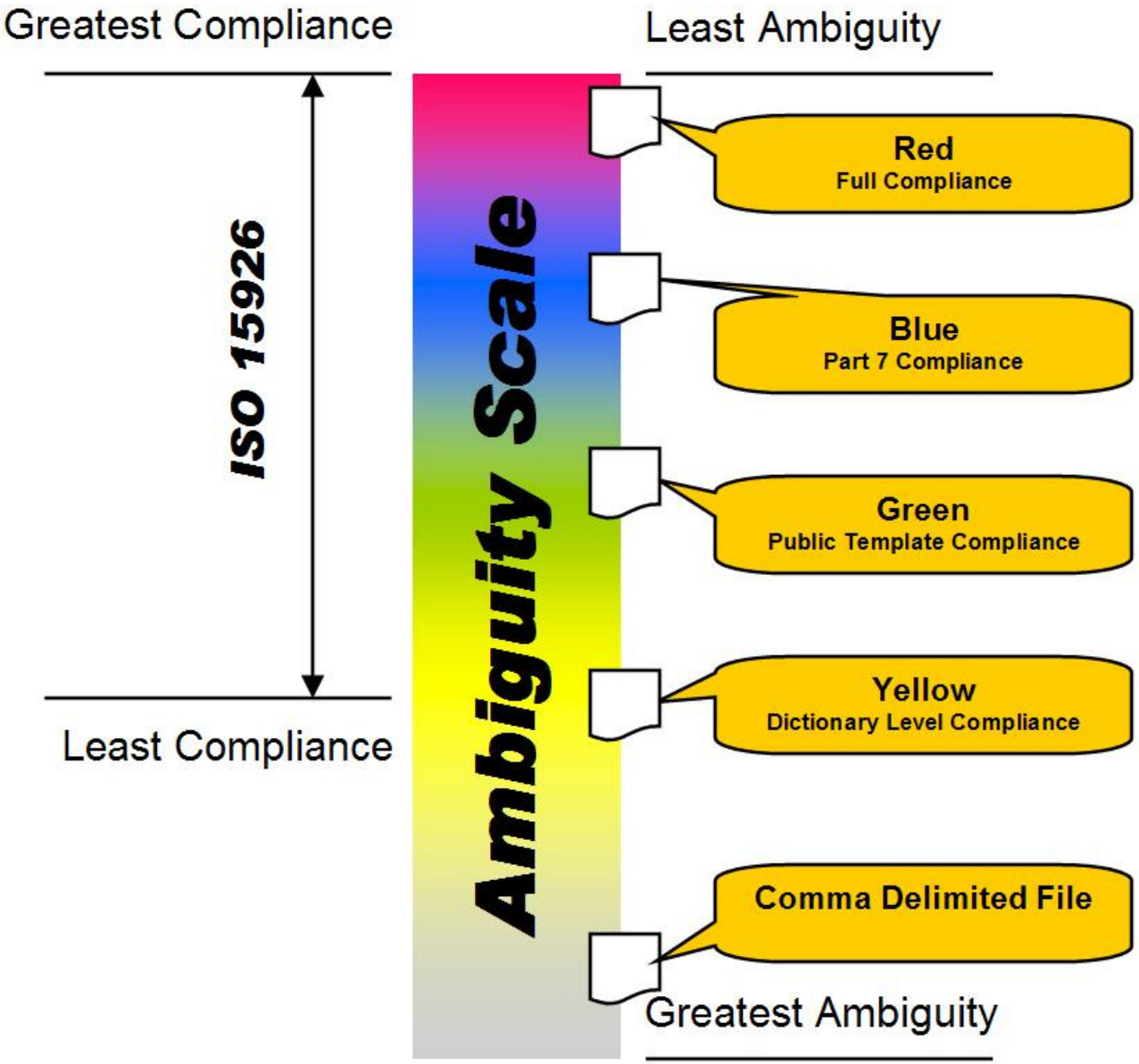
PropertyRangeMagnitudeRestrictionOfClass(n330A3874, AmbientTemeperature, DegrCentigrade, n40, n80)

```
 ClassOfIndividual(n330A3874)
& ClassOfIndirectProperty(AmbientTemeperature)
& Scale(DegrCentigrade)
& ExpressReal(n40)
& ExpressReal(n80)
& exists u
    (  (  ClassOfIndividual(n330A3874)
       & ClassOfIndirectProperty(AmbientTemeperature)
       & PropertyRange(u)
       & exists u0
           (  (  ClassOfIndirectProperty(u0)
              & hasClassOfPossessor(u0, n330A3874)
              & hasPropertySpace(u0, u))
           & ClassOfRelationship(u0)
           & ClassOfRelationship(AmbientTemeperature)
           & exists y
               (  (  Specialization(y)
                  & hasSubclass(y, u0)
                  & hasSuperclass(y, AmbientTemeperature))
               & exists z
                   (  Classification(z)
                    & hasClassified(z, y)
                    & hasClassifier(z, End2UniversalRestriction)))))
    & exists y1
        exists y2
          (  (  ExpressReal(n40)
             & Thing(y1)
             & exists z
                 (  ClassOfIdentification(z)
                  & hasPattern(z, n40)
                  & hasRepresented(z, y1)))
          & (  ExpressReal(n80)
             & Thing(y2)
             & exists z
                 (  ClassOfIdentification(z)
                  & hasPattern(z, n80)
                  & hasRepresented(z, y2)))
& PropertyRange(u)
          & Scale(DegrCentigrade)
          & ArithmeticNumber(y1)
          & ArithmeticNumber(y2)
          & exists y10
              exists y20
                (  (  PropertyRange(u)
                   & Property(y10)
                   & Property(y20)
                   & exists z
                       (  LowerBoundOfPropertyRange(z)
                        & hasClassified(z, y10)
                        & hasClassifier(z, u))
                   & exists z
                       (  UpperBoundOfPropertyRange(z)
                        & hasClassified(z, y20)
                        & hasClassifier(z, u)))
                & (  Property(y10)
                   & ArithmeticNumber(y1)
                   & Scale(DegrCentigrade)
                   & exists u
                       (  (  PropertyQuantification(u)
                          & hasInput(u, y10)
                          & hasResult(u, y1))
                        & exists z
                            (  Classification(z)
                             & hasClassified(z, u)
                             & hasClassifier(z, DegrCentigrade))))
                & Property(y20)
                & ArithmeticNumber(y2)
                & Scale(DegrCentigrade)
                & exists u
                    (  (  PropertyQuantification(u)
                       & hasInput(u, y20)
                       & hasResult(u, y2))
                     & exists z
                         (  Classification(z)
                          & hasClassified(z, u)
                          & hasClassifier(z, DegrCentigrade))))))
```

Compliancy

…how to eat the elephant

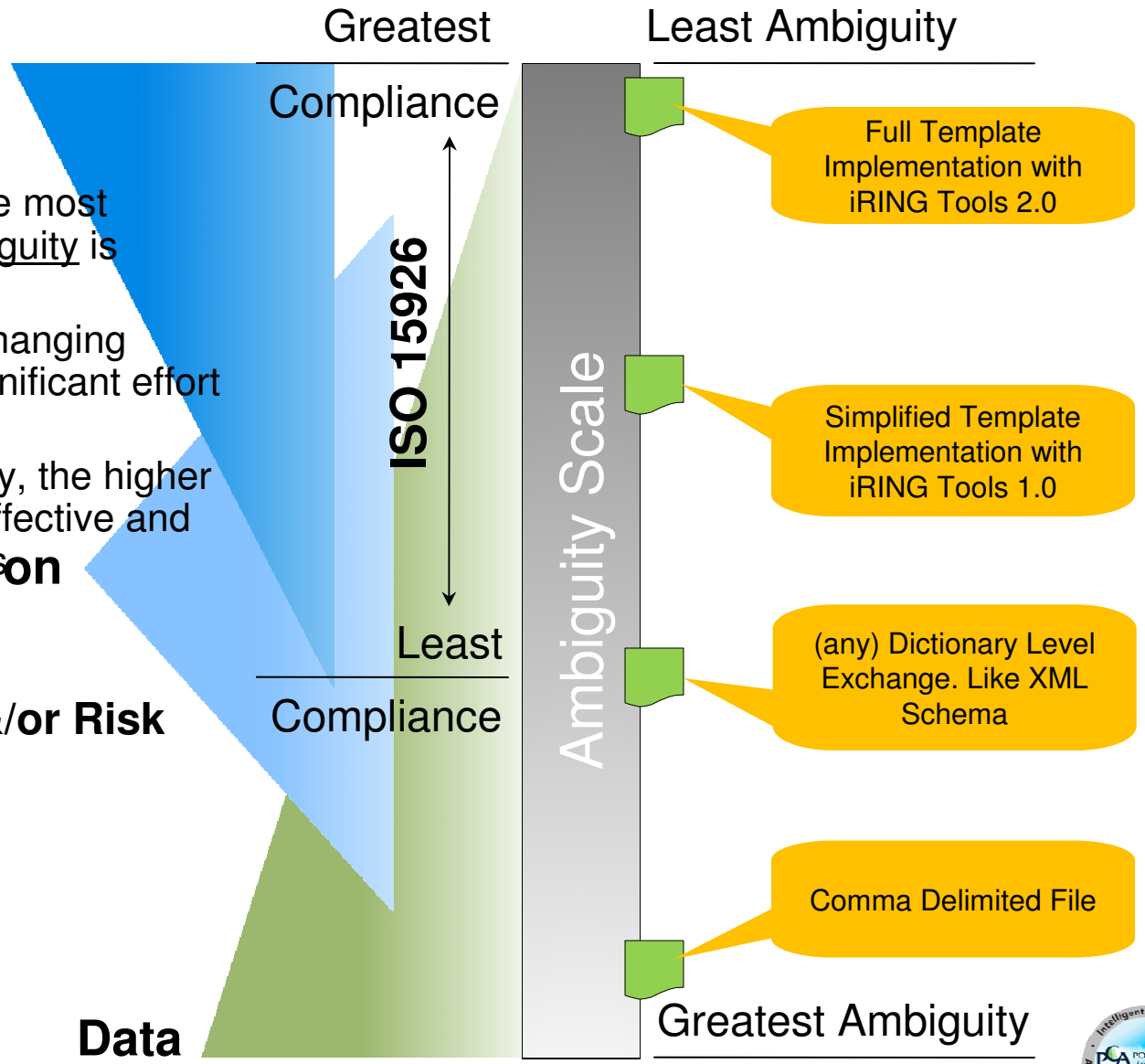
Compliancy to the standard



Information Ambiguity

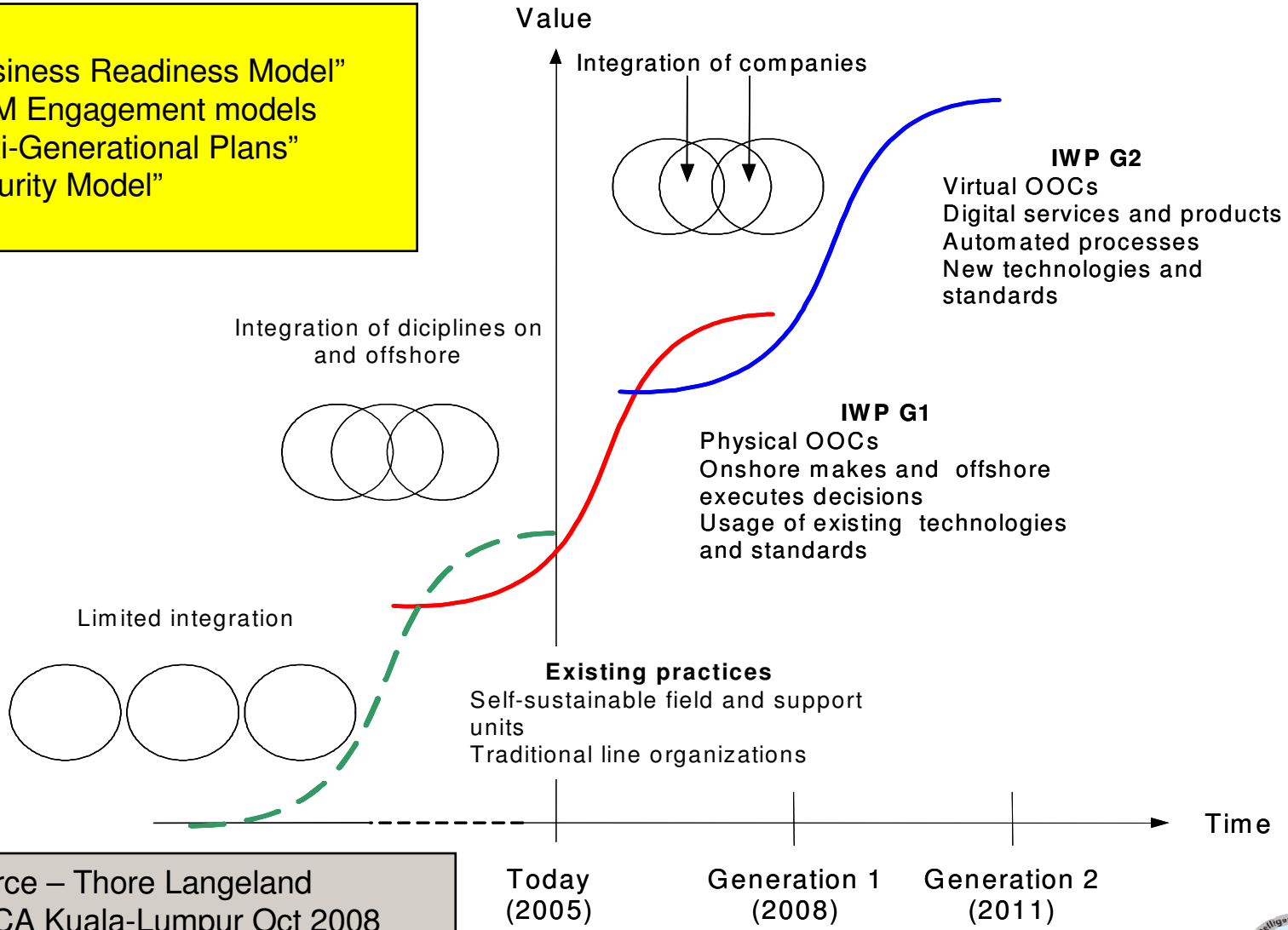
- Data exchanges operate most successfully when ambiguity is eliminated
- Ambiguity between exchanging partners can require significant effort (labor) to remove
- The higher the ambiguity, the higher the cost to implement effective and efficient data exchanges

Ambiguity = Cost &/or Risk



Example - The OLF view

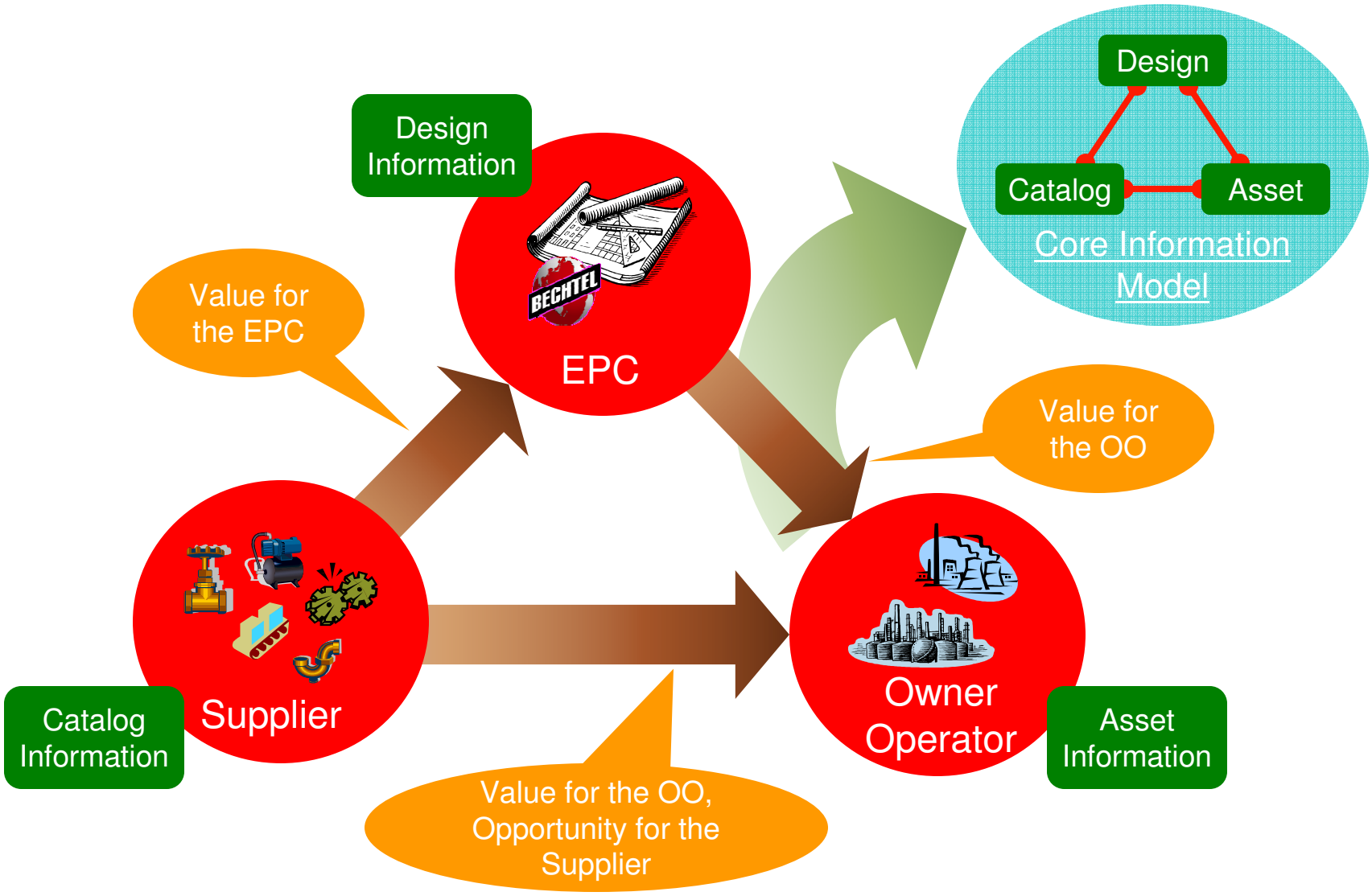
See also :
- USPI "Business Readiness Model"
- SAP & IBM Engagement models
- Dow "Multi-Generational Plans"
- DNV "Maturity Model"
- ... Etc.



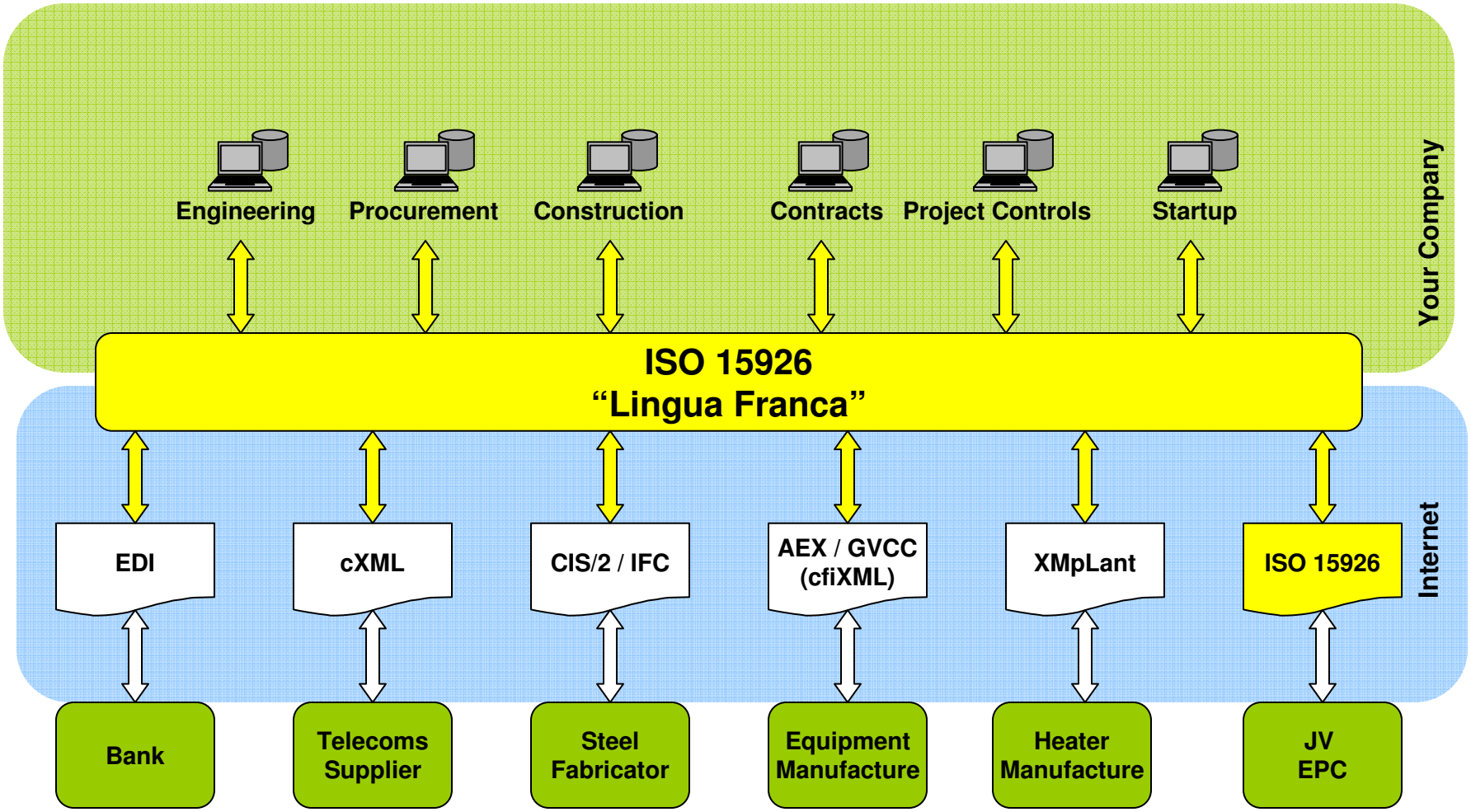
Source – Thore Langeland
PCA Kuala-Lumpur Oct 2008

The Engineering contractor and the supply chain company.

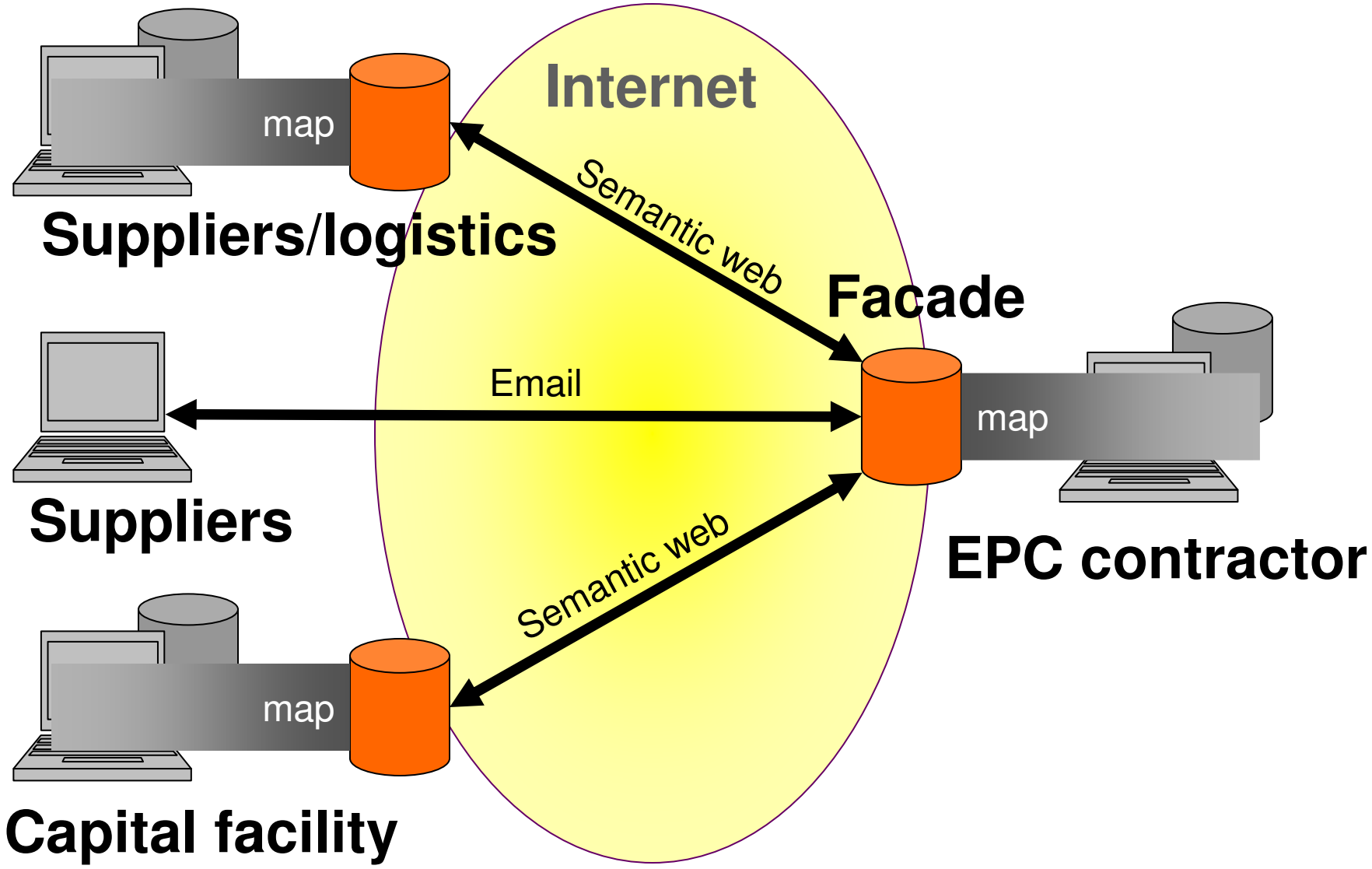
Integration and Interoperability Value



Data integration

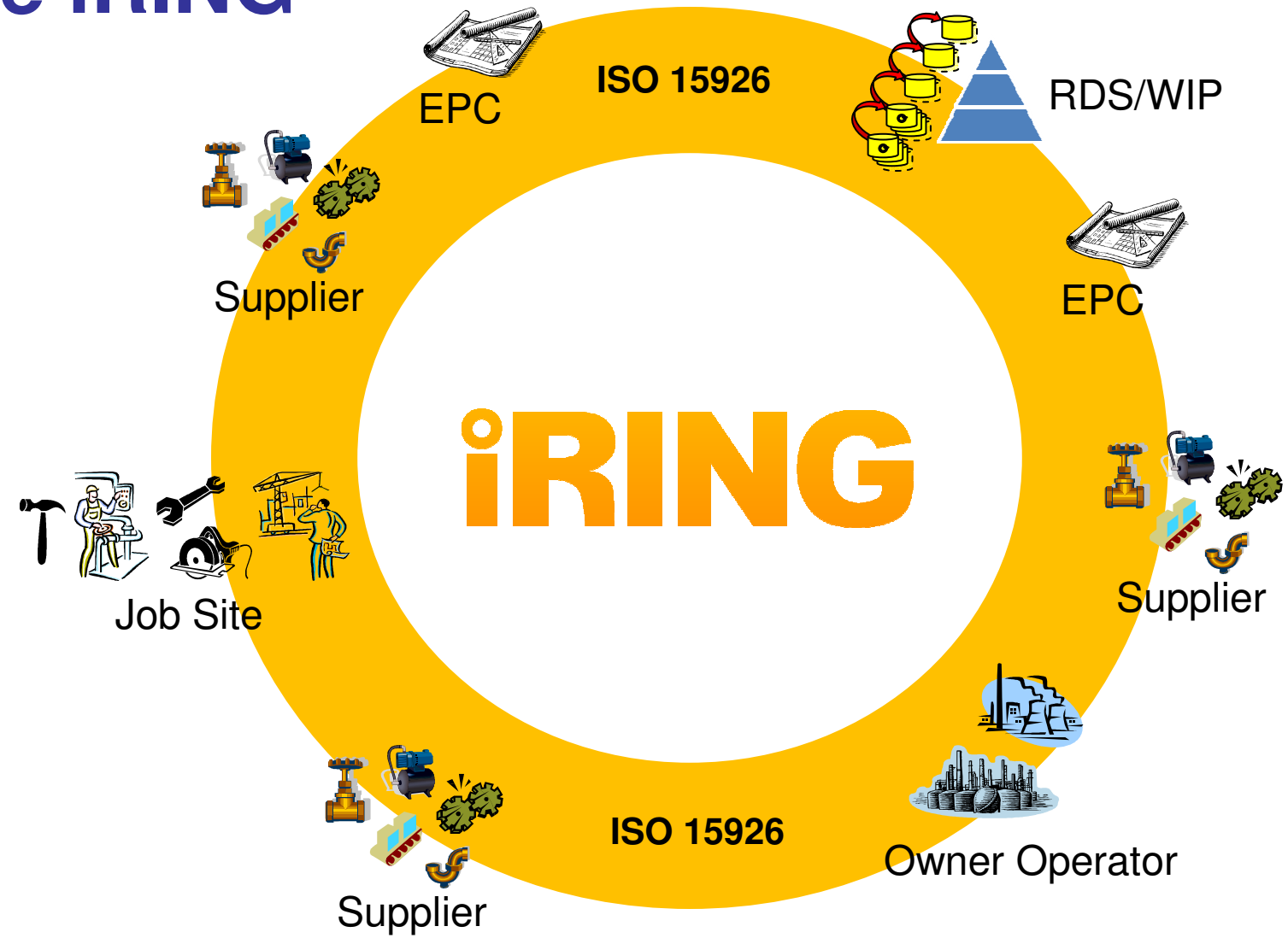


10,000 suppliers/logistics, 80% don't use technical software suites



Software development projects

The iRING



ISO 15926 Realtime Interoperability Network Grid

Linked resources.

- Note / Beware ... This is (*mostly*) open wiki-style collaboration ... it's no-one's "job" to keep all the pages up-to-date / consistent !!! (Formal Documents have publishing version control.)
- ***IDS-ADI*** project page - www.ids-adi.org currently resolves to ... https://www.posccaesar.org/wiki/IdsAdiProject
- ***ISO 15926 Structure & Parts*** (see earlier slides)
  https://www.posccaesar.org/wiki/IdsAdiStandardStructure
- ***Primer*** - What 15926 is about, why would / should business care up to "getting started" (so far) *We could and should develop getting started scenarios for different starting points and domains of interest. We could and should incorporate the intent of this presentation into the Primer too.* https://www.posccaesar.org/wiki/ISO15926Primer
- ***Tutorial*** – Background and explanation of the ISO15926 modelling approach (*Good, but incomplete in terms of Template usage*).
  - https://www.posccaesar.org/svn/projects/IDS-ADI/ComplianceSpecification/15926Tutorial_module1.pdf
  - https://www.posccaesar.org/svn/projects/IDS-ADI/ComplianceSpecification/15926Tutorial_module2_part1.pdf
  - https://www.posccaesar.org/svn/projects/IDS-ADI/ComplianceSpecification/15926Tutorial-lecture-notes.pdf
- ***iRING Tools Technology***
  - http://iring.ids-adi.org/repository/org/ids-adi/camelot/index.html
  - http://www.iringug.org/
- ***PCA RDS*** (reference data services & resources) ...
  - https://www.posccaesar.org/wiki/Rds
    (*Note also links to Camelot & Avalon for iRING and OWL RDF Endpoints, Avalon / PCA aim is to fix RDLFACADE endpoints sustainably)*
- Mapping & Characterization ***Methodology*** Guideline (***Industrial Usage*** - Proposed Part 11 harmonization with Gellish)
  - How do I relate my industrial data to 15926 Reference Data ?
  - https://www.posccaesar.org/svn/projects/IDS-ADI/Part7/Part7SpecificationsMethodologies
  - https://www.posccaesar.org/svn/projects/IDS-ADI/Part7/Part7SpecificationsMethodologies/ISO15926_Dataset_Template_Characterization.doc
  - https://www.posccaesar.org/svn/projects/IDS-ADI/Part7/Part7SpecificationsMethodologies/P7M_Characterization_Methodology.xls
- ***Compliance*** Guideline
  – How do I comply with ISO15926 ?
  - https://www.posccaesar.org/wiki/IdsAdiComplianceSpecification
  - https://www.posccaesar.org/svn/projects/IDS-ADI/ComplianceSpecification/ISO_15926_Compliance_Specification.doc