Modeling methodology

1 ISO 15926

Information concerning engineering, construction and operation of production facilities is created, used and modified by many different organizations throughout a facility's lifetime. The purpose of ISO 15926 is to facilitate integration of data to support the life-cycle activities and processes of production facilities.

The data model and the initial reference data are suitable for shared databases or data warehouse computer systems in development project and in operation and maintenance. Furthermore, as well as, for defining the terms used in product catalogues in e-commerce. Another used of the standard is as a reference classification for shared databases and product catalogues not based on ISO 15926.

1.1 ISO 15926 parts

ISO 15926 consists of several parts, and new parts are under development or will be developed in the future. The ISO published parts, currently parts 1, 2 and 4, can be bought from ISO:
http://www.iso.org/iso/search.htm?qt=15926&published=on&active_tab=standards
Parts of ISO 15926 are available for PCA members on the Members Area on the PCA Trac
https://www.posccaesar.org/wiki/PCA/Internal/Index

1.1.1 part 1 Overview and fundamental principles

ISO 15926-1:2003 specifies a representation of information associated with engineering, construction and operation of process plants. This representation supports the information requirements of the process industries in all phases of a plant's life-cycle and the sharing and integration of information amongst all parties involved in the plant's life cycle.

1.1.2 Part 2 Data Model

ISO 15926-2:2003 is a part of ISO 15926, an International Standard for the representation of process plant life-cycle information. This representation is specified by a generic, conceptual data model designed to be used in conjunction with reference data: standard instances that represent information common to a number of users, process plants, or both. The use and definition of reference data for process plants is the subject of Parts 4 and 6 of ISO 15926. (ISO)

Conceptual data model

The model can support all disciplines and life-cycle stages, and it can support information about functional requirements, physical solutions, types of objects and individual objects as well as activities.

Section 4 of part 2 is recommended to read.

Resources:

- Online version of ISO 15926-2 http://www.tc184-sc4.org/wg3ndocs/wg3n1328/lifecycle_integration_schema.html
- POSC Caesar's OWL serialization of ISO 15926-2. http://rds.posccaesar.org/2008/02/OWL/ISO-15926-2_2003
- See also ISO 15926 in OWL for more information on how ISO 15926 may be represented in OWL (Web Ontology language) https://www.posccaesar.org/wiki/ISO15926inOWL
- EXPRESS listing of ISO 15926-2 http://www.steptools.com/sc4/archive/oil-and-gas/15926-0002-lifecycle_integration.exp?rev=1.1&content-type=text/vnd.viewcvs-markup

1.1.3 part 3 Ontology for geometry and topology

ISO 15926–3 will make the concepts defined by ISO 10303-42 and ISO 10303-104, including concepts in Earth models and the GIS standards ISO 19107 and ISO 1911, available within the ISO 15926 environment. The ontology defined by ISO 15926-3 will be equally valid for CAD, GIS and Earth models.

Resources:

- ISO TS 15926-3 (2007) REFERENCE DATA CLASS. This is the reference data item classifying all reference data items defined in ISO 15926-3 as represented in the POSC Caesar Reference Data Library of Feb. 2008

1.1.4 Part 4 Initial reference data

ISO/TS 15926-4:2007 defines the initial set of reference data for use with the ISO 15926 and ISO 10303-221 industrial data standards. (ISO)

Resources

- Reference data sets as Excel spreadsheets. The reference data items defined in ISO 15926-4 are published on the Internet at this address http://www.tc184-sc4.org/ts/15926/-4/ed-1/tech/rdl/
- Web "browsable" version of the ISO 15926-4:2007 reference data items http://rds.posccaesar.org/2008/05/XML/ISO-15926-4_2007/

1.1.5 Part 6 Methodology for the development and validation of reference data

A combined NWI proposal and CD/TS proposal has been prepared for ISO 15926 Part 6.

1.1.6 Part 7 Implementation methods for the integration of distributed systems
ISO/CD-TS 15926-7
Technical specification

Part 7 ISO 15926-7 is defining and testing implementation methodologies. Through the IDS project a short cut implementation strategy for using Part 4 reference data as a dictionary of standard terms has been developed.

This Part is a specification for data exchange and lifecycle and based on the data model of ISO 15926-2.

1.1.7 Part 8
ISO/CD-TS 15926-8
Implementation methods for the integration of distributed systems — OWL implementation

This Part is a specification for data exchange and lifecycle information integration using RDF+OWL and based on the data model of ISO 15926-2.

1.1.8 part 11

2 Modeling
Modelling refers to the process of generating a model as a conceptual representation of some phenomenon. During such a process the end result should be a model, which is a simplified abstract view of the complex reality.

3 Modeling in ISO 15926

3.1 Classes and Individuals
An ISO 15926 Class is defined by its membership. Whether an individual is a member of a class or not is based on its characteristics. In this way, a class is bunch of individuals that corresponds the characteristics of that class. The things that define the group of individuals are considered a class. More concrete, a class is a category or type of things with one or several criteria for inclusion and exclusion. These criteria for inclusion and exclusion define a set of rules with the basis from set theory.

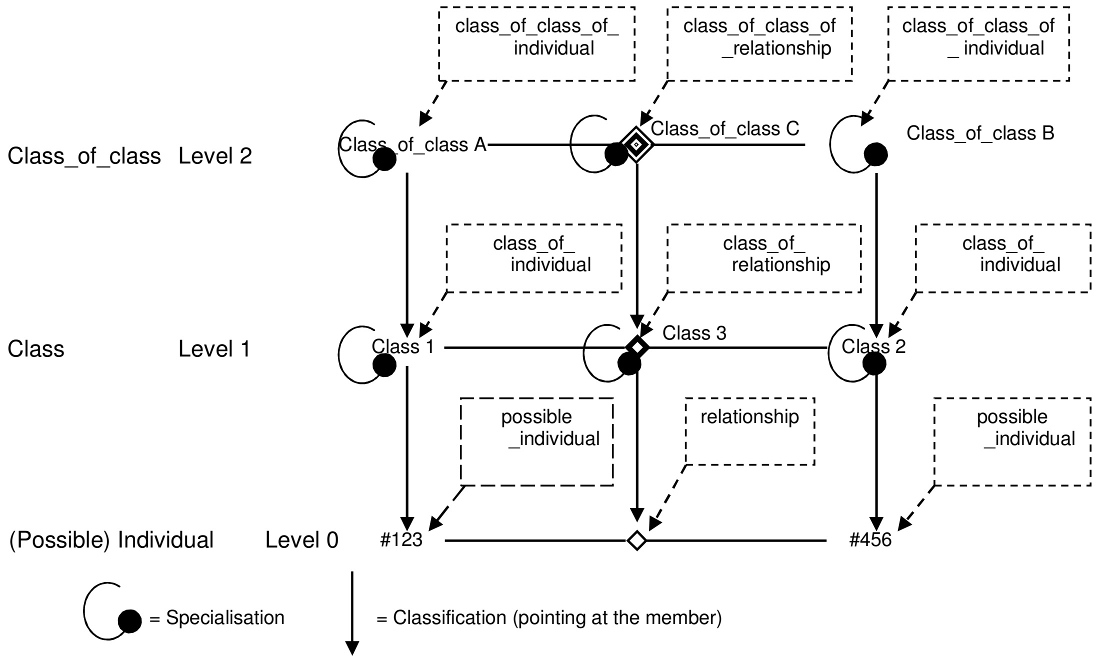
Is it a class or an individual?
Depends on what we are talking about

Note that for programmers, an object oriented class does not have the same interpretation as an ISO 15926 class. In programming, classes are defined first Programmeringsmessig definerer man klassen først, og så legge på properties

For all classes or concepts in the RDL, each separate concept has a unique id (PCA ID), which implies that an id can appear one or more times. If a concept is a specialization of two or more general concepts, the same id is used for all entries for that particular concept.

Different types of classes exist. For the types of classes described below, examples are "physical object" classes. The classes are grouped in the following categories for management and responsibility purposes:

- **Core Classes**
    - Classes where the specifications of conditions for membership is expressed without reference to any Standard and/or proprietary specification. (Commonly understood terms)
    - Example: Elbow, Elbow 90 Degree Long Radius
- **Standard Classes**
    - Classes where the proprietary rights to the specifications of conditions for membership is owned/controlled by a standardisation body. (E.g. ISO, IEC, ANSI, ASME, CEN, BS, SAE, API)
    - Example: Elbow 90 Deg. LR ASME B16.9 BE 3" Sch. 80
- **Proprietary Classes**
    - Classes where the proprietary rights to specifications of conditions for membership is owned/controlled by a proprietary company/body non-standardisation body.
    - Example: Sandvik SteelXYZ, Graylock type ABC
- **Commodity Classes**
    - Types of Things which can be specified by reference to Standards and/or publicly available Proprietary Specifications, and where several types of manufactured items may meet the requirements.
    - Example: Elbow Type X (ELL 90-DEG BE, ASME B16.9 LR, 3" SCH 80,CS ASTM A234 GR WPB/NACE MR-01-75, BS-EN-10204:3.1B)
- **Manufactured Item Classes**
    - Example: Manufacturer A's Type X



- **Level 0** (Possible_Individual/Relationship)
    - As a general individuals will not have designations or definitions, except from Reference Individuals (e.g. Paris, London, DNV, ISO TC184/SC4), that at least will have Designation.
    - Relationships will not have Designations, only PCA Identifiers and classifications stating the class membership.
- **Level 1** (Class_of_Individual/Class_of_relationship)
    - Designation in singular form
    - Definition in singular form, i.e. as if we are describing a member of the class.
    - See ISO TS 15926-6, Section 5.3, Reference data item designation, and
    - See ISO TS 15926-6, Section 6, Reference data item definition by explanatory text
- **Level 2** (Class_of_class/Class_of_class_of_relationship)
    - Designation in singular form, reflecting that the member is a class. Hence the designation shall end with the word 'class'.
    - Definition in singular form, i.e. as if we are describing a member of the class.
    - See ISO TS 15926-6, Section 5.3, Reference data item designation, and
    - See ISO TS 15926-6, Section 6, Reference data item definition by explanatory text

For each entity type in ISO 15926-2 there is a corresponding RDL class (the universal class). These classes shall have a designation starting with 'ISO 15926-4 ' (for now) followed by a string derived from their entity type as follows:

- **Level 1** (class)

    - Name of entity type excluding ‘class_of’, e.g. the universal class of ‘class_of_arranged_individual’ is ‘ISO 15926-4 ARRANGED INDIVIDUAL’, instance of ‘class_of_arranged_individual’.
- **Level 2** (class_of_class)
    - Name of entity type excluding ‘class_of_class_of’, and appended by ‘class’, e.g. the universal class of ‘class_of_class_of_individual’ is ‘ISO 15926-4 INDIVIDUAL CLASS’, instance of ‘class_of_class_of_individual’.

3.2 Specialization and generalization

Specialisation or Classification

In a generalization-specialization relationship, the specialization by definition has the same properties, behaviours, and constraints as the generalization plus one or more additional properties, behaviours, or constraints. For example, car is a specialization of vehicle. So any car is also a vehicle, but not every vehicle is a car. Therefore, a type needs to satisfy more constraints to be a car than to be a vehicle.

An specialization-generalization relationship always has to be true –
Subclass of -> this is a specialisation of – ALWAYS
Specialization of a class involved added constraints on the subclass, but the class still complies with the constraints from the superclass, and is therefore a member of the superclass too – everything that is true for the superclass is always true for the subclass.
More rules for the subclass than for the superclass

Specialization – for useful purposes in our community – a subclass should have at least one member, but anything could be defined. More information can always be added to the class.

You can never specialize an individual! Tools need to incorporate this.

Inheritance in programming should not be confused with specialization. Because inheritance can be overridden, and specialisation cannot, the term inheritance should not be used in relation to ISO 15926.

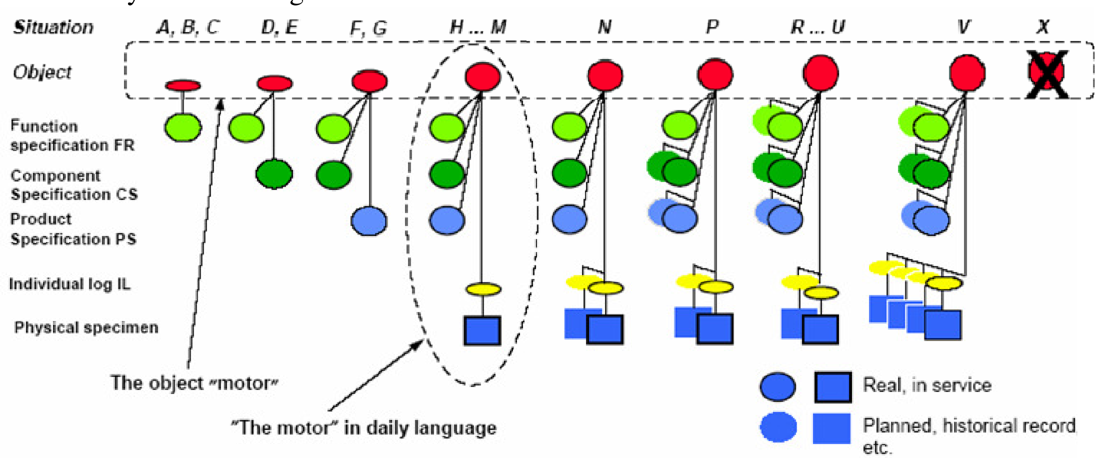
3.3 modeling principles

- Attributes should be defined as entities referred to by relationships
- Attributes cannot be referred to and are very inflexible to change
- attributes do not allow history
- information about attributes cannot be held
    - e.g. Units of a number
    - e.g. language of a description
- attributes do not allow different values
- many descriptions

- many names
- changing values
- attribution cannot be described
- What if an entity in one model is an attribute in another models
- what is an entity and what is an attribute depend on your start point
- does not support integration very well

What something always is
Roles are transient and not underlying nature
Example
Customer and supplier are roles
The underlying nature is organisation
Enables information about the same thing to be recognised
Model underlying nature
composition of organisation, not of customer and of supplier
person assignment to organisation, not to customer or supplier
Roles identify populations
find all organisations that are my customers

The Life Cycle According to IEC 61346-4



There are some already proposed in the discussion thread.
(Many of the rules are also already in the methodology.)
A MANDATORY relation for an individual is to ***classify*** it.
(To say using a Classification relation which Class it is a member of.)
(That Class should be as specialized as possible / appropriate)
A MANDATORY relation for a Class is to ***specialize*** it.
(To say using a Specialization relation which Class it is a subtype of.)

A MANDATORY relation for a Class of Class is to ***specialize*** it. (To say using a Specialization relation which Class of Class it is a subtype of.)
An OPTIONAL relation for a Class is to ***classify*** it. (To say using classification which Class or Class it is a member of.)
A MANDATORY relation for any object is to ***identify*** it ... Etc ...
When we get to the OWL/RDF (general ontological) world –
Classify corresponds to Type (transfers entity type and entity-type-related rules & behaviour to the members.)
Specialize corresponds to SubClassOf (inherits all aspects of the parent class except for specialization of the constraining aspect.)

3.4 exchange

You can expose some of you model (e.g. in your product catalogue), can expose more if more information is needed. Model in a consistent way and agree on what you want to publish. But the model needs to be the same

e.g to display a view for people level 4 hiding details in level 5 could be useful. Hide what they do not need to see.

Three text strings having (e.g. some product catalogue) joint together points to the class RDL
Mapping between internal representation to RDL
Make implicit information explicit

3.5 implicit and explicit information

What things are! The underlying nature of the object.

How to handle imprecise information?
Eg. in early phases
How to record options
When we do not want to specialise too early

Different labels – do they mean the same thing?

Interpretation of data sheets

Mapping user interface – betyr fargene I tabaellen noe?

Preliminary analysis of datasheets – what is actually being represented? Look out for implicit information.

Knowledge pt 2 and 4 helps – in though processes – what do I need to make explicit?
Get closer to the desired end result by this knowledge.

3.6 Different roles

Domain experts together with modellers
Then software to test it as you model it

Start: I want to make a statement about something
Well defined classes
Semantic precision

Indirect properties are statements that we make about things
It has a pressure, but we want to say it has a specific range
-> therefore pressure range
I am designing this to operate under these conditions

3.7 Decisions

Be aware of pros and cons of each step, e.g. using signatures without lifting

RDI = Reference Data Items
Different level of details (e.g. Katalogtittere og designere har ulikt behov for detaljnivå av utstyret
Standardised symbols should be modelled as reference data
Four types of objects
Functional
Product specification (for the thing that is going to
Manufacturer's model
Physical
Need a nomenclature
Notations
what do you think you are talking about?
Specialisation and classification
Classification goes between levels
Specialisation within level 1 and specialisation within level 2
What does it take to bee one?
Is it always true?
Activity – everything that involves a change in condition (e.g. explosion, corrosion, fire, calibration)
General + the four levels -> starting point for modelling
Standardised symbols should be modelled as reference data
Rated – means under a predefined set of conditions
Instance of entity type can be on class of class level too
Reuse of signatures – between domains

Instance in 15926 context –> record in a database that can represent a class or an individual - ALWAYS
‘
Start use – search – get familiar with RDL

Resources
RD modeller
Creating and maintaining shared RD
Domain experience
Current RDL
One or more persons
Mapper

EPISTLE principles
(entity = class)
Attributes should be defined as entities referred to by relationship
Avoid the disadvantages mentioned on slide
Attribute = property = characteristics

Enter once and refer to it

Relationships is between individuals level 0
Class of relationships between classes level 1
Class of class of relationships

Processes and resources are necessary in the Process of mapping – different roles
Domain experts and application experts – 2 different roles
Modelling role – 3rd role

4 Mapping

Mapping
When people come and have a set of template signatures, how do I represent this with signatures and reference data?

Mapping of internal representations in internal applications
Reference data neutral in the middle

NORSOK | INSTRUMENT DATASHEET P01
PRESSURE / DIFF. PRESSURE INSTRUMENT ELECTRIC

Tag number	:	Scale Range	:
Service description	:	Set/Alarm Point	:
P&ID	:	Area	:
Line/equipment no.	:	P. O. Number	:

1 GENERAL
1.01 Type :
1.02 Manufacturer :
1.03 Manufacturer model no :
1.04 Operating Temp. Limits :
1.05 Mounting :
1.06 Weight :
1.07 Other :

2 INSTRUMENT CHARACTERISTICS
2.01 Calibrated input range :
2.02 Characteristic :
2.03 Accuracy :
2.04 Repeatability :
2.05 Lower / upper range limits :
2.06 Min / max span :
2.07 Zero adjustment :
2.08 Overpressure protect. to :
2.09 Max static pressure :
2.10 Other :

3 ELEMENT / SENSOR
3.01 Type :
3.02 Material, element (sensor) :
3.03 Material, socket (inlet port) :
3.04 Material, sensor bolts/nuts :
3.05 Process conn. size/type :
3.06 Sour service spec. :
3.07 Other :

4 HOUSING
4.01 Dimension :
4.02 Material :
4.03 Cable connection :
4.04 Cable entry :
4.05 Enclosure protection :
4.06 Ex. classification :
4.07 Protective coating :
4.08 Other :

5 TRANSMITTER
5.01 Indicator :
5.02 Output signal :
5.03 Communication :
5.04 Supply voltage :
5.05 Consumption :
5.06 Load limitation :
5.07 Other :

6 SWITCH
6.01 Reset; automatic or manual :
6.02 Deadband or differential :
6.03 Alarm at increase/decrease :
6.04 Contact configuration :
6.05 Contact material :
6.06 Contact rating :
6.07 Contact action on alarm :
6.08 Other :

7 CHEMICAL SEAL
7.01 Type :
7.02 Material, upper/lower part :
7.03 Material, bolts / nuts :
7.04 Material, diaphragm :
7.05 Fill fluid :
7.06 Capillary length/diameter :
7.07 Material, capillary/armour :
7.08 Process conn. size/type :
7.09 Other :

8 ACCESSORIES
8.01 Mounting bracket :
8.02 Material, mounting bracket :
8.03 Overpr. protection valve :
8.04 Material, overpr. prot. valve :
8.05 Pulsation damper :
8.06 Material, pulsation damper :
8.07 Other :

9 NOTES

Rev	Date	Issue/description	Prepared	Checked	Approved	Datasheet no.	Page

SHARECAT | Datasheet
Transmitter, Pressure, Electric

Document Number	:	**28-1A-KOG-I54-27500-0012**	Revision	:	**1**
Plant/Platform	:	**Test Installation 2**	Process Datash. No.	:	**N/A**
Tag number	:	**PT -42-0304**	System	:	**N/A**
SerialNo	:	**N/A**	Range From	:	**0**
SetPoint Low	:	**10 barG**	Range To	:	**110**
SetPoint Hight	:	**71 barG**	Range Unit	:	**barG**
P & ID	:	**28-1A-KOG-C78-00275-0002**	Area	:	**N/A**
Line/Equipment no.	:	**XX-42-0002**	PO:	:	**TI2-M022-ME-01**
Service description	:	**SCALE INHIBITOR. PUMP OUTLET**			

Unique no.	**TEK-00018117**
Manufacturer	**EMERSON PROCESS MANAGEMENT**
Type	**3051CG**
Manuf. Partno.	**3051CG-5-A-2-2-A-1-K-B4-I1-L4-M6-Q4**
Class	**Transmitter, Pressure, Electric**

1. Accepted
2. Accepted with comments incorporated
3. Not accepted, revise and resubmit
4. Issued for information
5. Interface information as clouded is accepted and frozen

	1	2	3	4	5
Date:					
Sign:					

Area

Explosion protection	:	**EEx ia**
Gas-group	:	**IIC**
Temperature class	:	**T5**
Approval authority	:	**BASEEFA**
Certificate	:	**BAS 97ATEX1089X**
IP-Class	:	**IP66**
ATEX group	:	**II**
ATEX category	:	**1**
ATEX explosive atmosphere	:	**G**
Ambient temperature	:	**-40 - 85 °C**

Dimensions and Weight

Weight	:	**4.7 kg**

Function

Range	:	**0 - 13800 kPa**
Span limit minimum, Pressure	:	**138 kPa**
Span limit maximum, Pressure	:	**13800 kPa**
Alternative Range	:	**0 - 138 bar**
Alternative span limit minimum, Pressure	:	**1.38 bar**
Alternative span limit maximum, Pressure	:	**138 bar**
Output signal	:	**4 - 20 mA**
Accuracy	:	**+/- 0.075 %**
Display type	:	**LCD**
Static working pressure	:	**3626 psi**

General

Description	:	**Gauge**
Description	:	**Smart, hart protocol**
Supply	:	**10.5 - 55 V DC**
Mounting	:	**Coplanar flange bracket for pipe or panel**

Material

Body material	:	**Stainless steel**
Filling fluid	:	**Silicone oil**
Seal material	:	**Glass filled TFE**
Process connection material	:	**Stainless steel**
Non process cover material	:	**316**
Flange bolt material	:	**316 AUSTENITIC**
Drain/vent material	:	**Stainless steel**
Diaphragm material low pressure connection	:	**316L**
Diaphragm material high pressure connection	:	**316L**
Bracket material	:	**Stainless steel**
Bracket bolt material	:	**Stainless steel**
Adapter bolt material	:	**316 AUSTENITIC**

Process Connection

Connection design	:	**NPT**
Size	:	**1/4"**
Thread pitch	:	**18 thr/in**

Supply Connection

Supply connection design	:	**Metric threaded**
Supply connection size	:	**20 mm**
Thread pitch supply	:	**1.5 mm/thr**

Comment
Accuracy for span greater than 10:1 of URL. Power consumption 18-36 mW. Load limitation: 587 Ohm. Static pressure value valid within transmitter temperature spec. Output: Digital signal based on hart protocol. Coplanar flange Intrinsic Safety and Dust approval. Calibration data sheet (5 points calibration at 0%, 25%, 50%, 75%, and 100% of range)

Rev.	Date	Issue/description	Prepared	Cheked	Disc. Appr.	Client. Appr.	Page 1 of 1
1	09.11.2006 14:44	Generated by SHARECAT	P.M.				

What is to be represented
Format
From a particular format determine which template signatures and classes to use to represent the types of statements represented by each label
This involves amongst other inspecting the source to identify the "implicit" object types
Identify shortcuts one might want to use to avoid representation "overkill"
For potential new template signatures, define its corresponding expansion to full Part 2/3/4 representation.
Which options are involved for types of objects represented using the format?
Content
To define the actual relationships that a particular "object" represented using a datasheet format involves, e.g. which particular relationships applies for "3051CG-5-A-2-2-A-1-K-I1-M6"
How to implement
Template signatures for data exchange or "format compliant" storage
Full expansion to Part 2/4/RDL compliant data store

(Need this also for 1. for verification)

None of the involved strings are necessarily unique outside their context
In order to resolve this, a neutral, system independent representation that is unique and that can map to any proprietary representation is required.
Need to recognise which representation is used by which proprietary representation

5 Templates

Proto template
Core template

Can have two signatures for the same expansion

Specialised template for simplifying mapping + limit set of possible role fillers

Pros and cons for different approaches
There is no way or the other

Generic vs specialised template signatures
Elaborate on pros and cons, there is no perfect way.
generic template signature –
+ fewer templates to manage
- move specialise decision to protect, multiple times
- lesser constraints

Specialised template signature
- RDL extensive expansion
+ increased precision
+ ease of use
- may become redundant if class specialisation covers

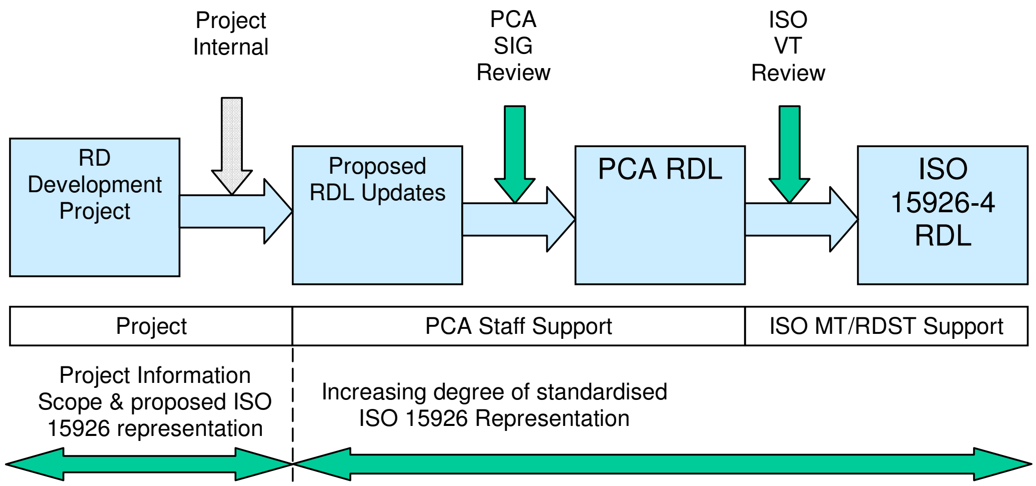
Comment [LH1]: Create table

Signatures will limit on the role fillers, but expansion will be the same

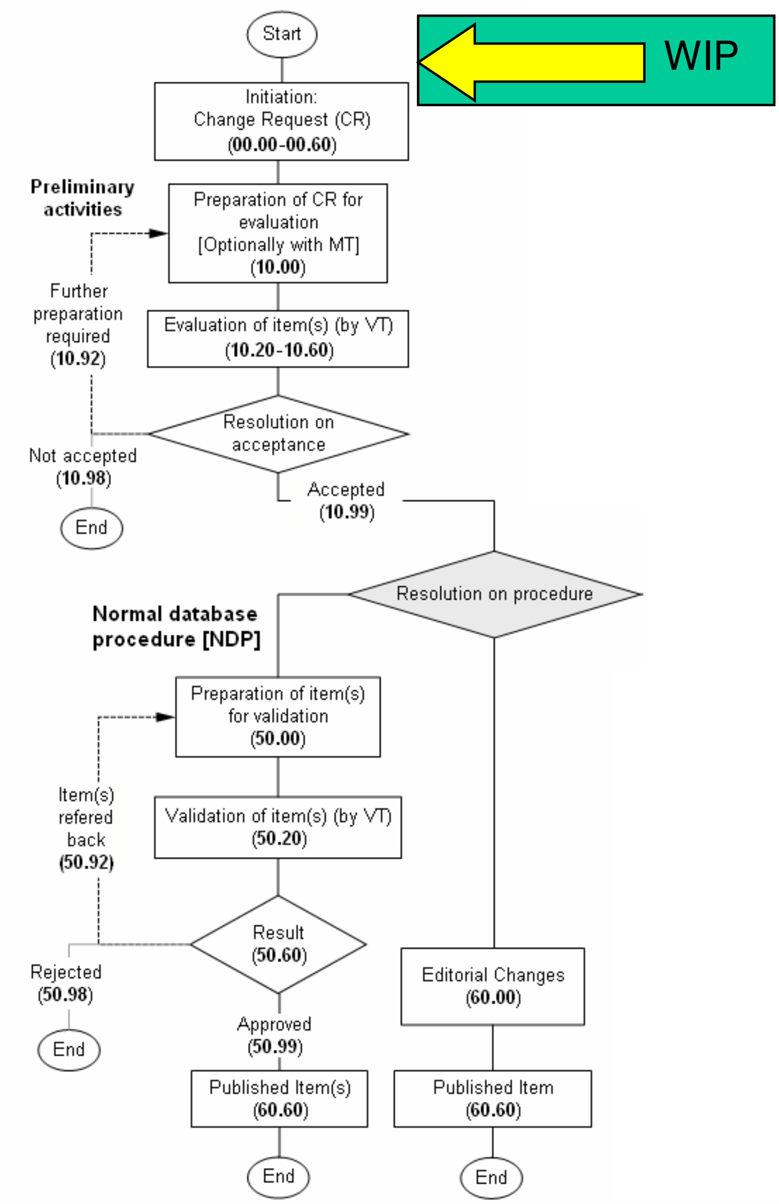
With good templates, it's easy to speak the language of the ontology
The template signature is all the end user needs to know
A rigorous rule takes care of interpretation in terms of the ontology language
Signatures and rules have implementation-agnostic definitions
You can implement in a variety of systems
There's a precise definition of what a template instance means
The structures of the ontology determine whether the outcome of applying the rules is consistent with the standard
We can test definitions using (automated) reasoning
Templates hide complexity and secure correctness

6 The standardization process

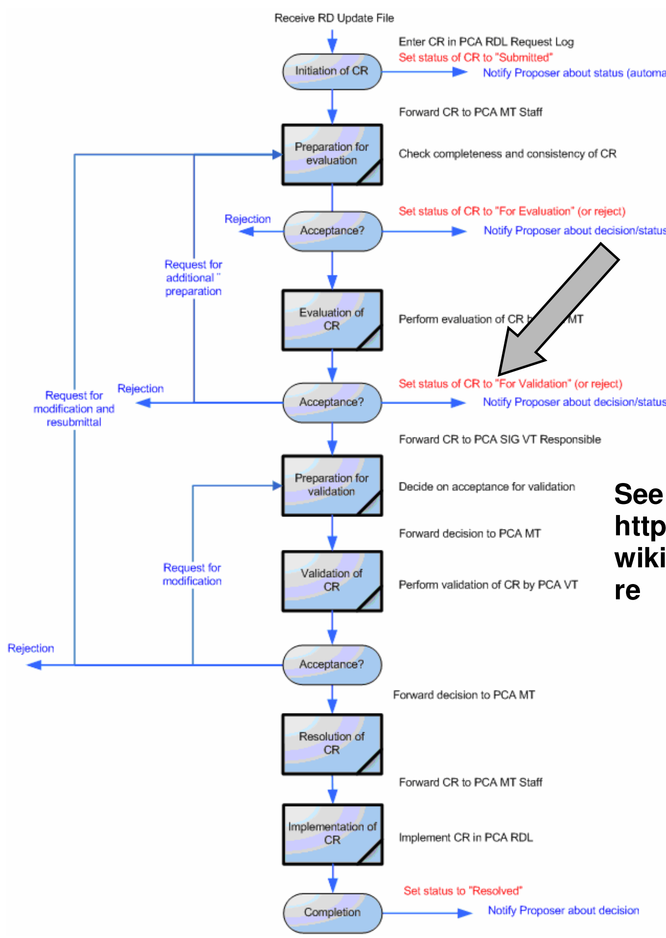
Separation between PCA and ISO standardization process.



SC4 Normal process for the maintenance of existing standards as databases



PCA Process for the Development of PCA RDL and submissions of proposals to ISO



PCA has developed a procedure that mirrors the SC4 process and corresponding status codes.
Needs minor updates (including status codes) as the SC4 procedure has been updated.

See https://www.posccaesar.org/wiki/RdsMaintenanceProcedure