

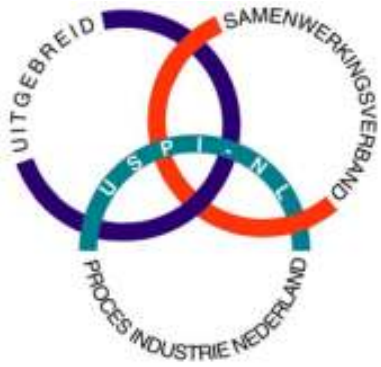
Practical use of a Reference Data Library (RDL)
like ISO 15926-4
combined with the Gellish language

Implemented within D&C projects based on
System Engineering, for example tunnel projects

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2007 EPEDC

European Plant Engineering & Design Conference



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TBI techniek

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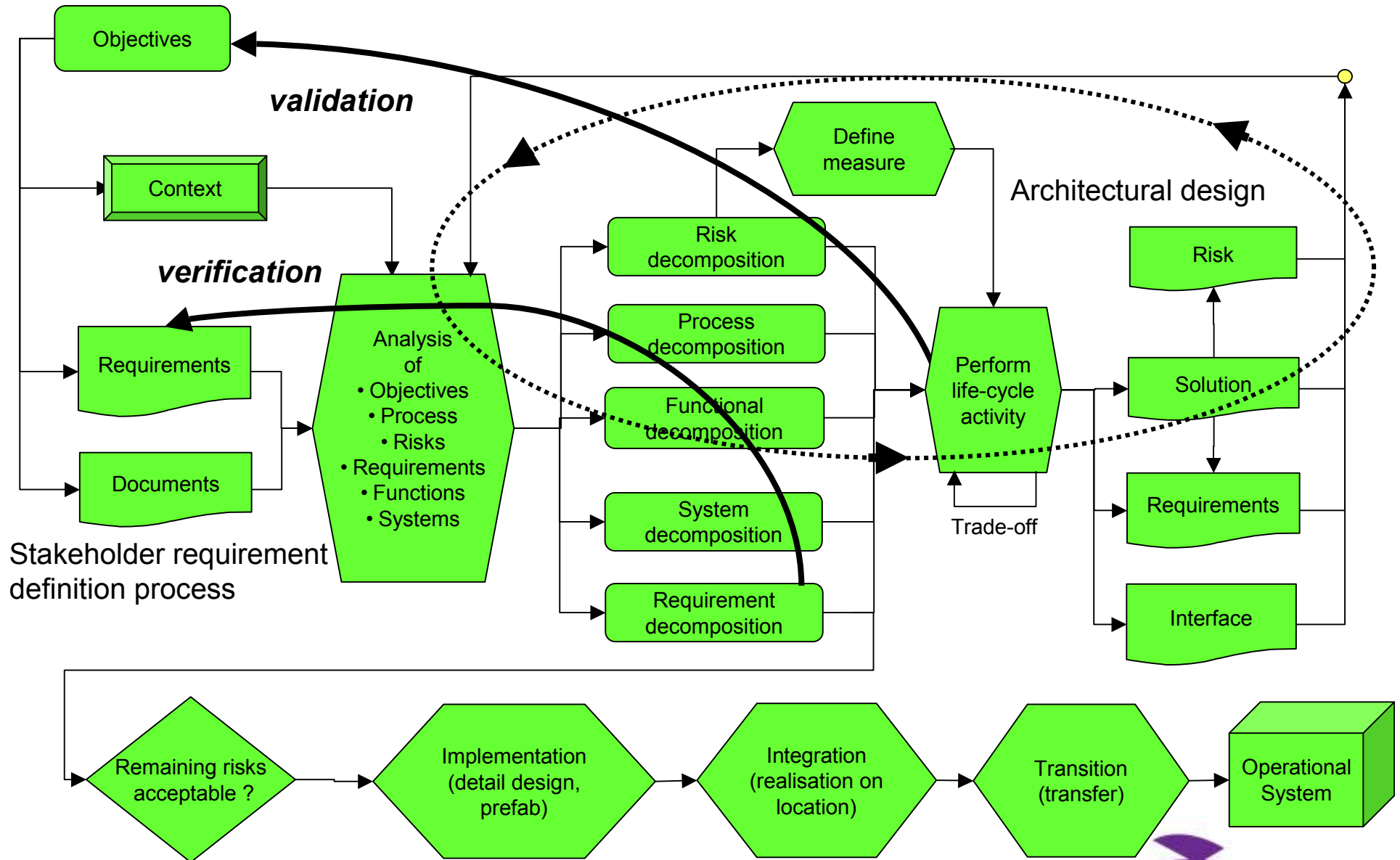
- System Engineering (SE) as used within infrastructure projects
- Breaking down complexity of SE
- Object Information Models (OIM) using a Reference Data Library (RDL) and the Gellish language
- View on a Systems Engineering information system, based on use of a RDL, OIM's and Gellish

Projects: Things you always wanted to know but were afraid to ask

- What requirements have lead to this solution and what is the background of these requirements?
- If this requirement were to change, what should be revised?
- Is everything documented and are all documents traceable?
- Are all project activities connected, assigned and registered, including interfaces?
- Are we compliant with all requirements?
- Does our product contribute effectively to the objectives of our client ?
- Etc...

SE offers a framework that gives answers to these questions.

SE according to ISO 15288 (verifiable controlled process)



Systems Engineering complexity

In real terms, applying SE is often seen as a project risk because of its reputation to be complex

Statement:

“Complexity can be managed if the information is managed”

*Information management in the context of SE requires a methodology;
For this, ISO 15926 offers a framework (explicit, unambiguous, traceable)*



Integration of SE lifecycle data (based on ISO 15926)

Objective of ISO 15926:

“Supporting life-cycle processes and activities”

Some characteristics of ISO 15926:

- Multiple views on data (design, engineering, operation, maintenance)
- Supports concurrent engineering
- Is meant for using standardized product data
- No duplication of data
- Based on system and function approach
- Time labelling of changes

Principle of life-cycle data integration

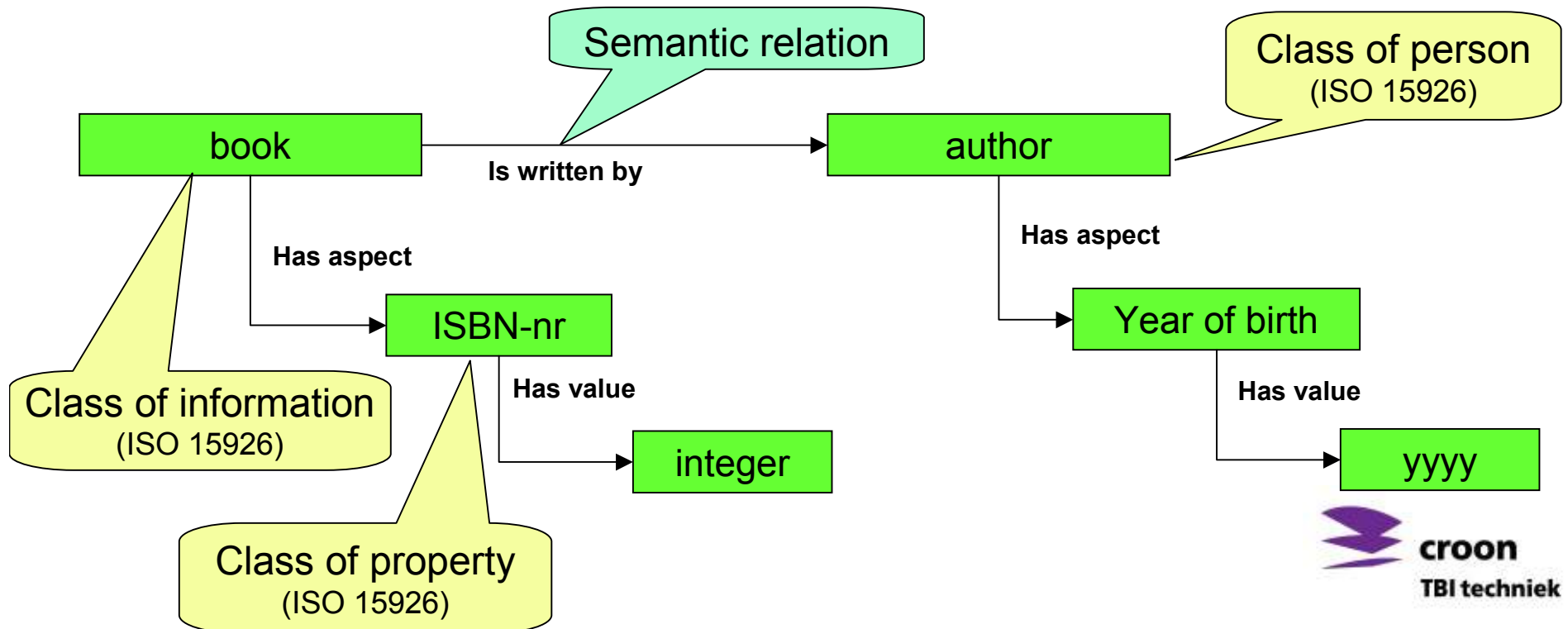
(in accordance with ISO 15926)

Building blocks for defining a system (including projects):

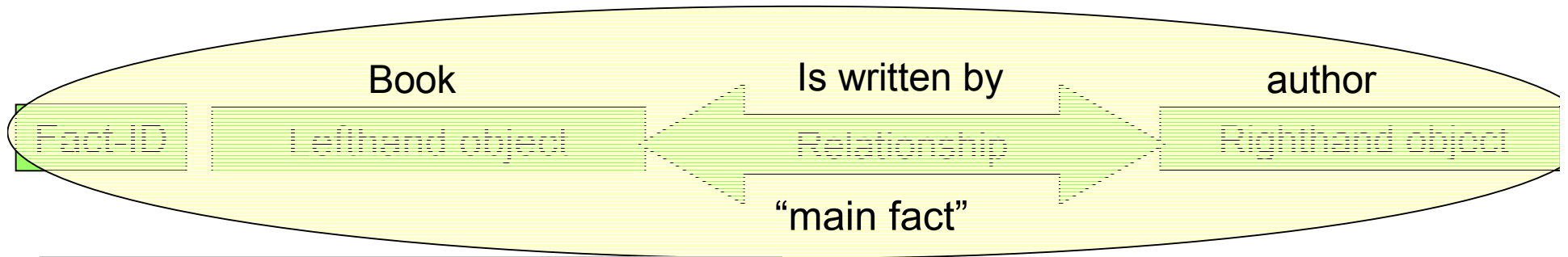
Objects: Physical things, activities, functions, people, documents etc.

Properties: Characterises objects

Relations: Meaningful, semantical relationships between objects



Data Integration by defining relationships between objects (the Gellish language, presented in a Gellish Table)



relation between individual things	
is related to	
	is associated with
	is approver of
	is a component of
	is arranged in
	occurs after
	is connected with
	is logically connected to
	is physically connected to
	is using as connection material
	refers to
	has as effect
	is the cause of begin of
	is the cause of end of
	is represented by
	is location of

- Meta data of a main fact:**
- Unique identifiers lefthand, righthand
 - Definition of lefthand object
 - Context of the fact
 - Status of the fact
 - Source of the fact
 - Language
 - Begin of life date of the fact
 - Modify date of the fact

Part of hierarchie structure of relations

Basic set of 15926 entities and Gellish semantic relationships:

Entry for 15926 part 4 (15926 part 2 entities)	Example applicable Gellish relation	Inverse Gellish relation
Class Of Individual	has aspect	Is an aspect of
Class Of Physical Object	is physically connected to	is physically connected with
Class Of Property	Is quantified as	Is a quantification of
Class Of FunctionalObject	Is logically connected to	Is logically connected with
Class Of Activity	has as subject	Is subject of
Class Of Event	cause of event is	event is caused by
Class Of Person	Is author of	Has as author
Class Of Organisation	is responsible for	is responsibility of
Class Of InformationObject	is description of	Is described by
Class Of Compound	is made of material	Is material for
Class Of Feature	is a part of	Is whole for
Role	is approved by	Is approver for
SpatialLocation	is located at	Is location for

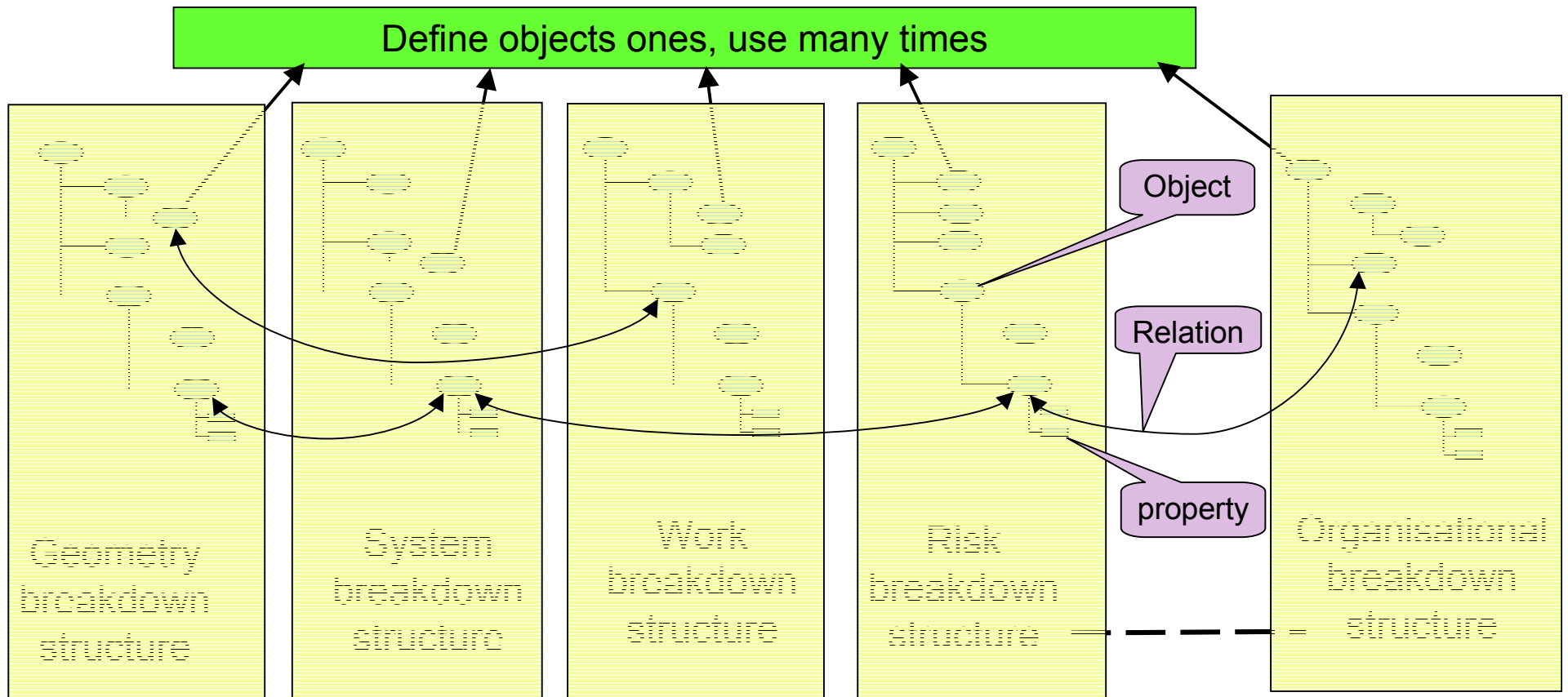
Examples of ISO 15926-4 Reference Data Library

- ! radiant exitance
- ! radiant intensity
- ! radioactivity
- ! rate **Class of Property: (specialization hierarchie)**
 - ! absorbed dose rate
 - ! energy fluence rate
 - ! exposure rate
 - ! flow rate
 - ! flow rate mole basis
 - ! flow rate per area mass basis
 - ! flow rate per area mole basis
 - ! flow rate per area volume basis
 - ! flow rate per length mass basis
 - ! flow rate per length volume basis
 - ! heat flow rate
 - ! mass flow rate
 - ! radiant flux
 - ! shear rate
- ! ratio
 - ! absorption factor
 - ! activity coefficient
 - ! activity coefficient
 - ! activity of solvent
 - ! attenuation
 - ! binding fraction
 - ! break down torque multiplier
 - ! breakdown torque multiplier
 - ! charge number of ion
 - ! coupling factor
 - ! directional spectral emissivity
 - ! dissipation factor

- + ! switchgear and controlgear compartment
- ! switchgear and controlgear **Class of Physical object (specialization hierarchie)**
 - ! control station
 - + ! distribution board
 - + ! enclosed switchgear and controlgear
 - ! factory-built switchgear and controlgear
 - ! indoor switchgear and controlgear
 - ! motor control centre
 - ! outdoor switchgear and controlgear
 - + ! switchboard
 - ! switching device
 - ! mechanical switching device
 - ! auxiliary switch of a mechanical switching device
 - ! circuit-breaker
 - ! air circuit-breaker
 - + ! earth leakage circuit-breaker
 - ! miniature circuit-breaker
 - ! moulded-case circuit-breaker
 - ! circuit-breaker with lock-out preventing closing
 - ! current-limiting circuit-breaker
 - ! dead tank circuit-breaker
 - ! gas-blast circuit-breaker
 - ! air-blast circuit-breaker
 - ! integrally fused circuit-breaker
 - ! live tank circuit-breaker
 - ! oil circuit-breaker
 - ! sf6 circuit-breaker
 - ! vacuum circuit-breaker
 - ! contactor
 - ! air contactor
 - ! contactor relay

“A circuit-breaker in which the contacts open and close in air at atmospheric pressure.”

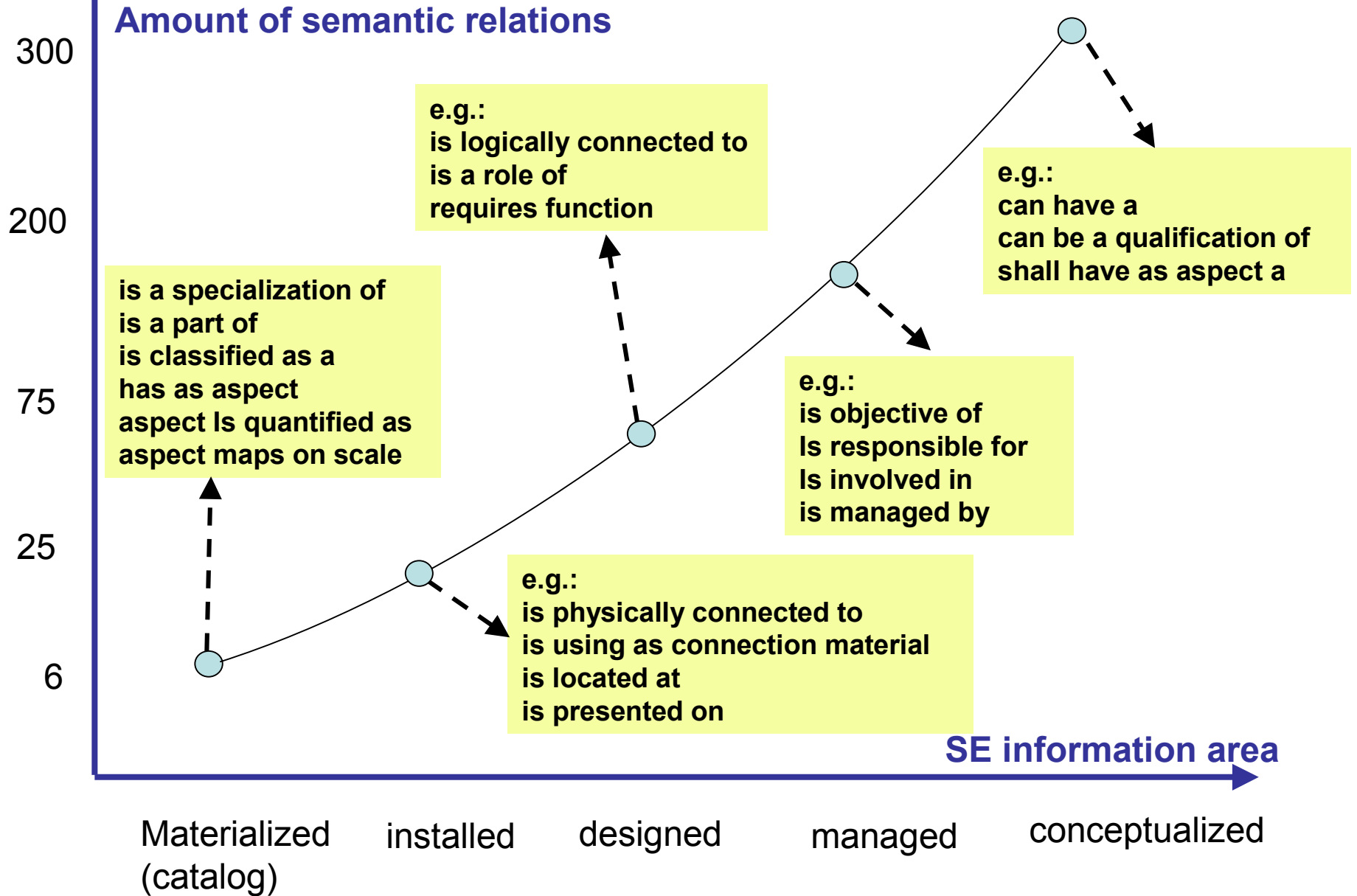
Breakdown of SE complexity: project decomposition



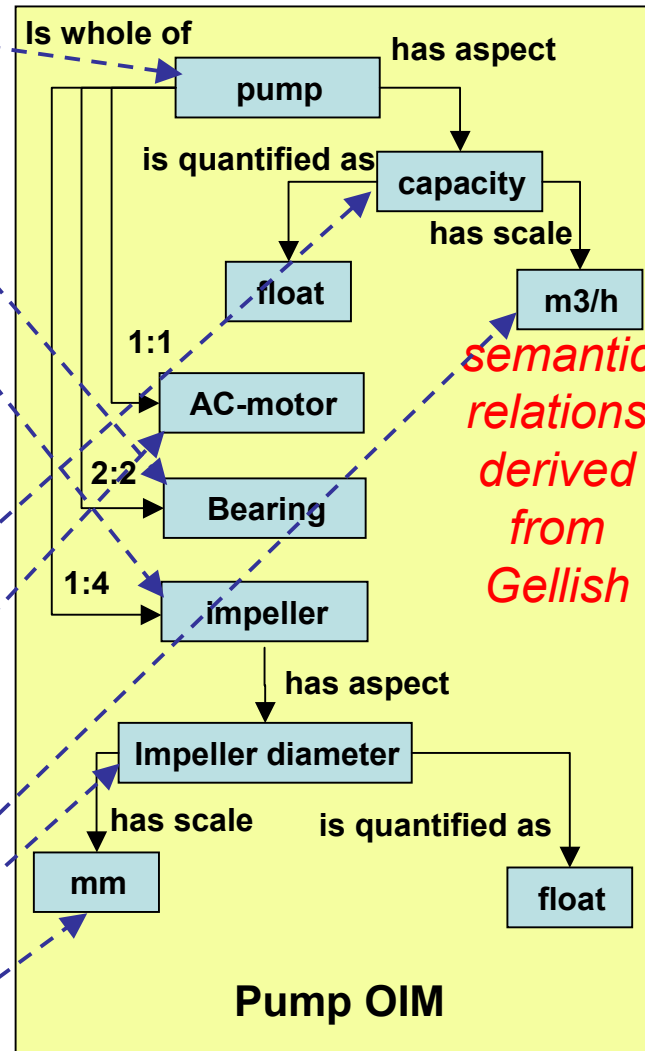
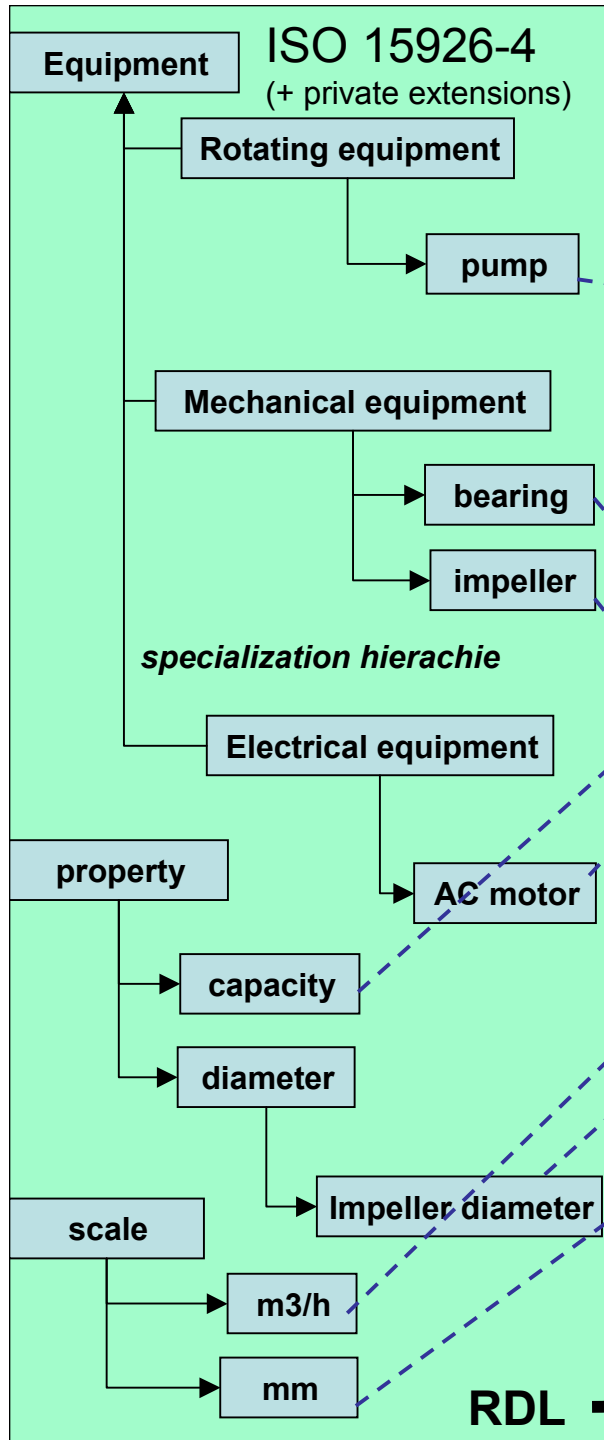
Each object has several properties and relationships with other objects;

this “cloud of information”, surrounding an object, can be captured and standardised by an “Object Information Model” (OIM)

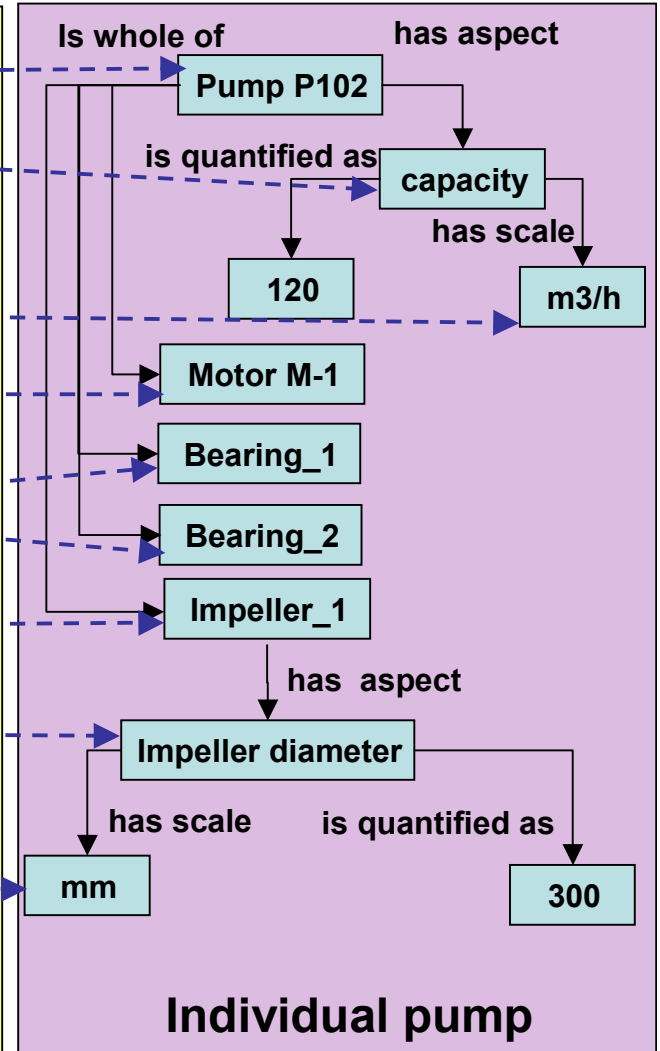
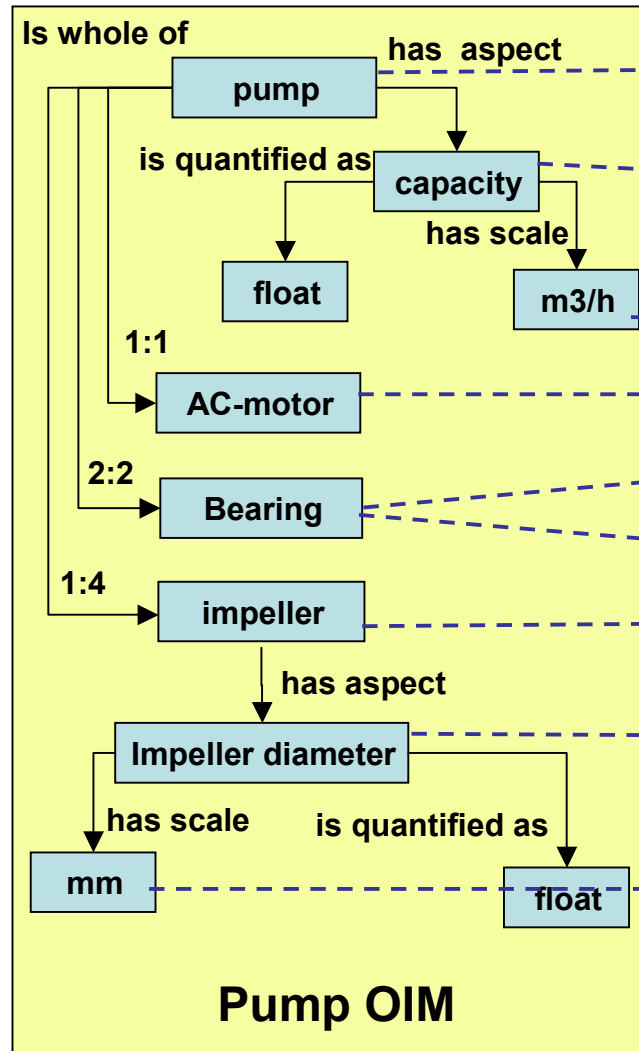
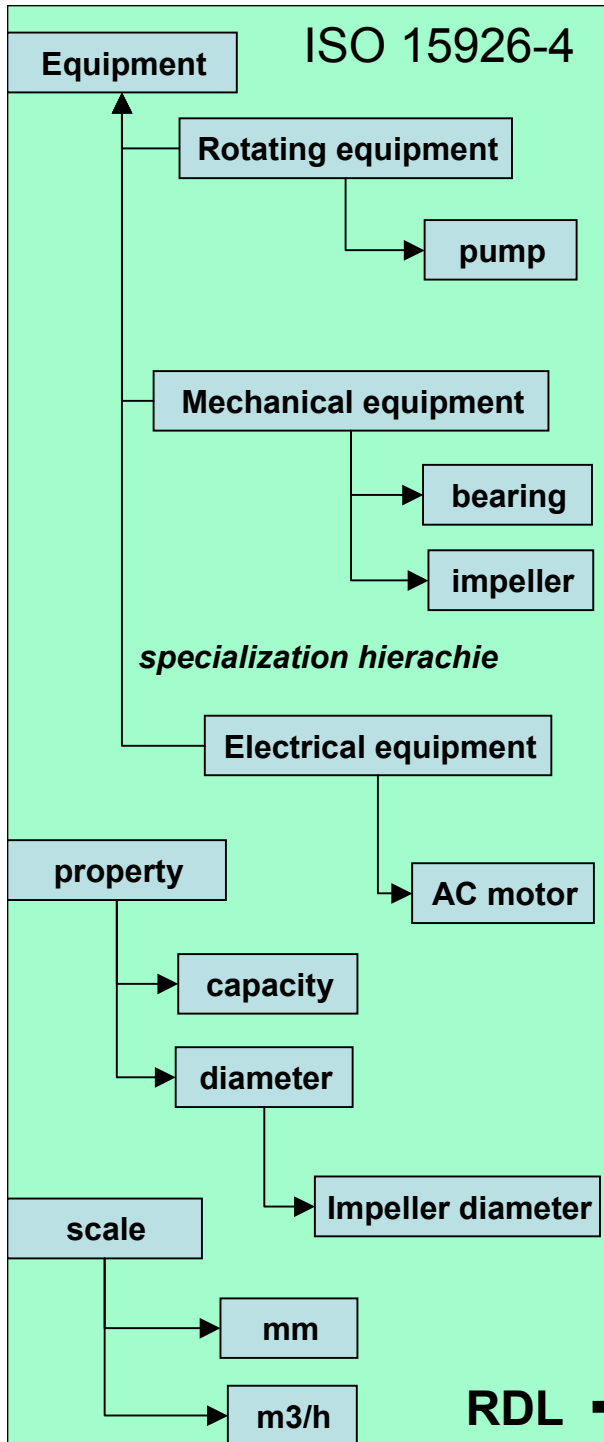
Making SE Object Information more explicit



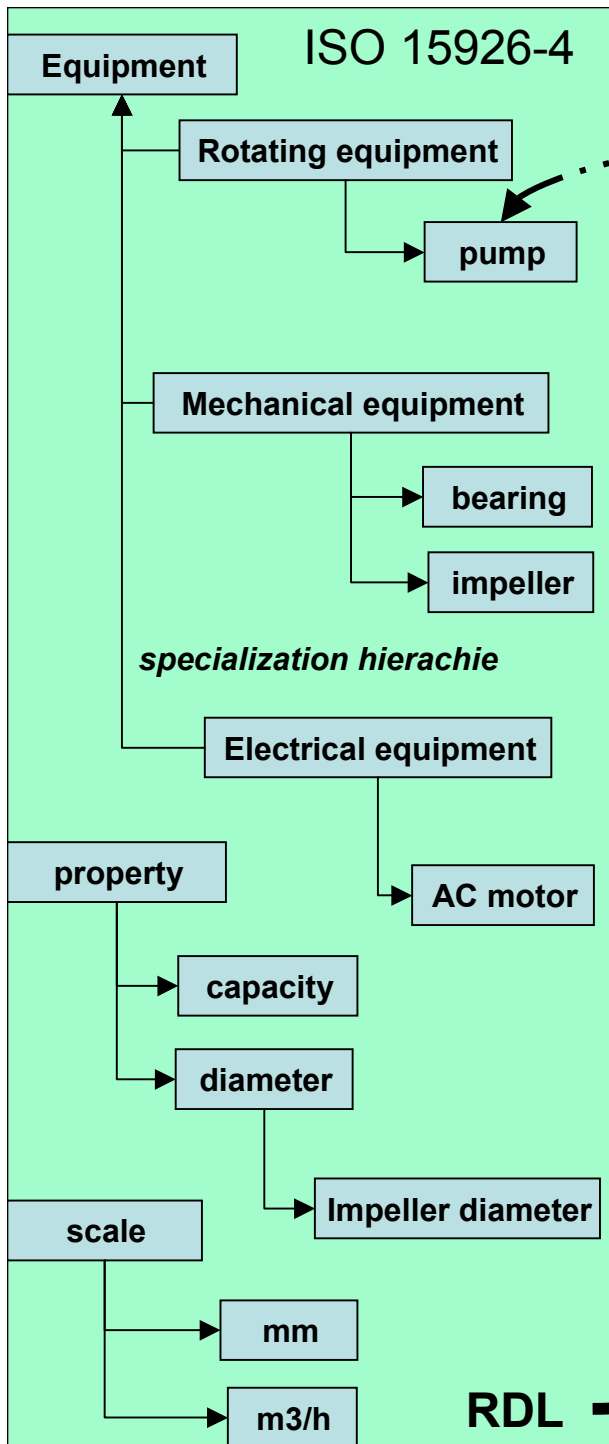
Breakdown of SE complexity: Object Information Models based on a RDL



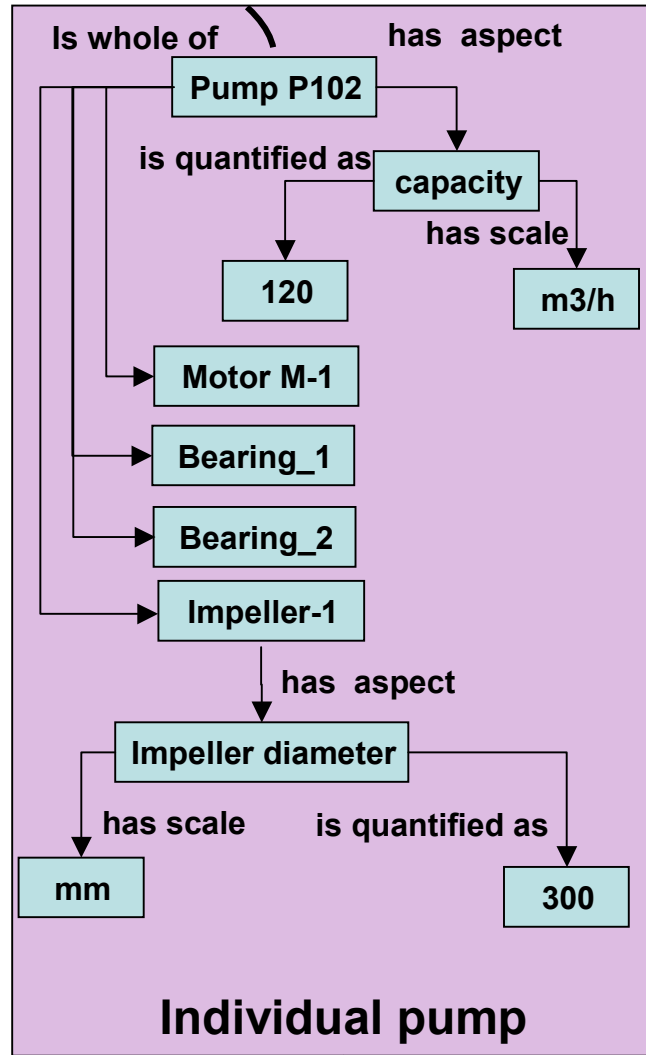
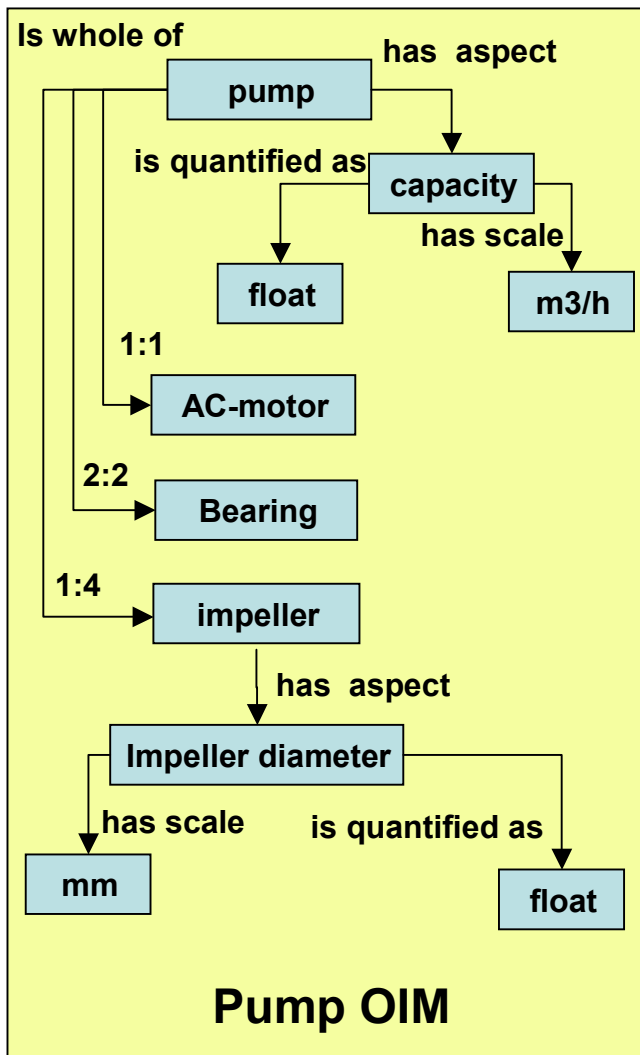
Building OIM's and individuals using a RDL



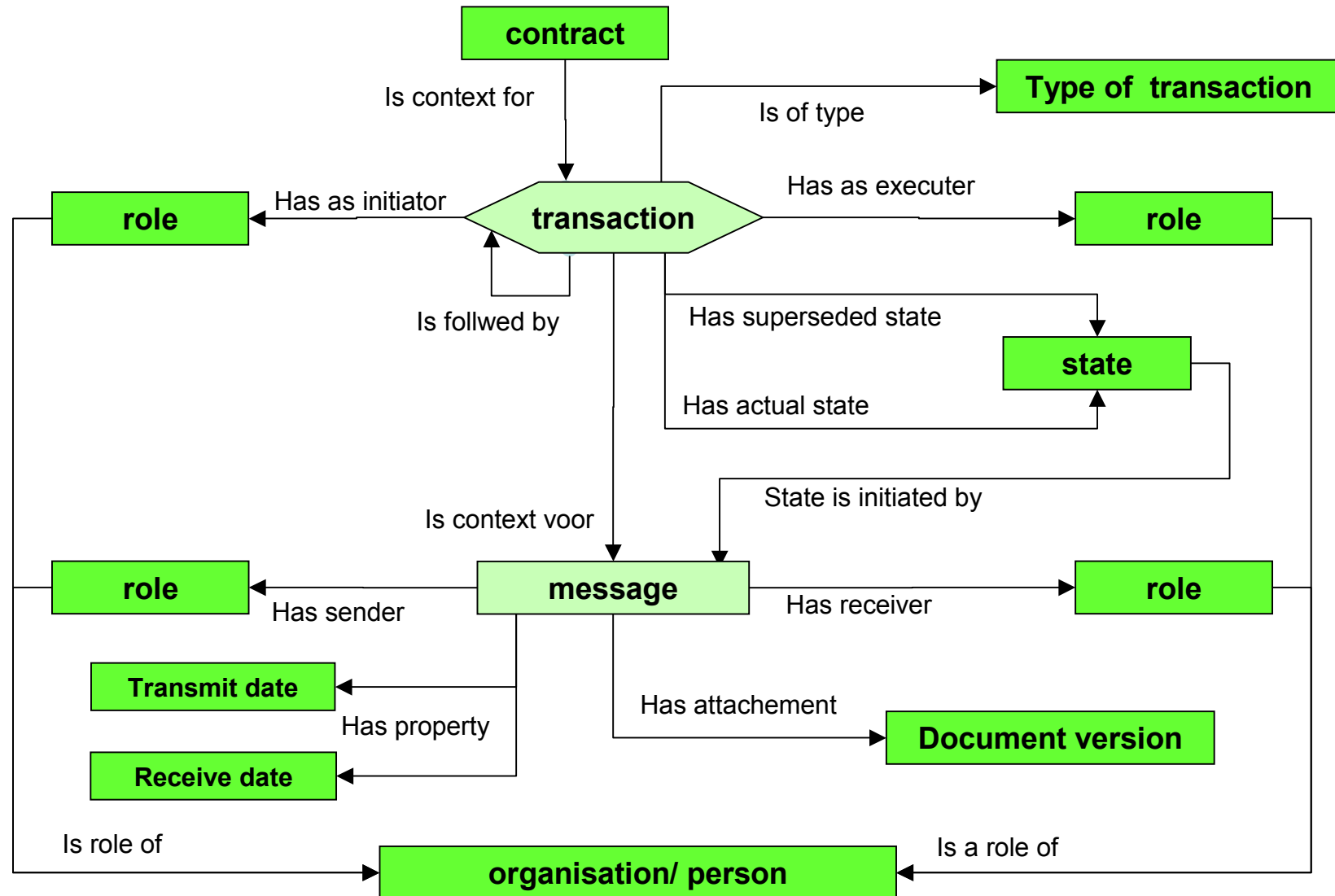
Building OIM's and individuals using a RDL



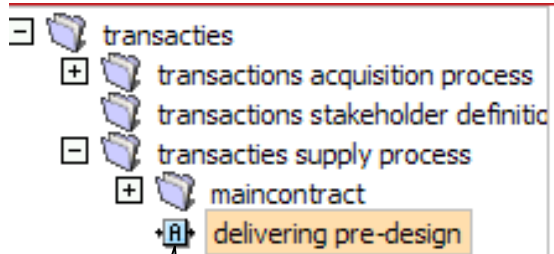
"Is classified as" relation



SE-Object Information Model: Transaction and message



Implementatie OIM “transactie”:



OIM object

object

Gellish relation

OIM object

General Subjects Message

attributen

name	delivering pre-design
description	

transaction has actual state

Name	
! executing	

transaction has superseded state

Name	
! promised	
! started	

has property

name	value	
start date [jjjjmmdd]	2007-03-08	

is a transaction in the context of

Name	
! maincontract	

has as executer <1:1>

Name	
! specification executer	

has as initiator <1:1>

Name	
! specification initiator	

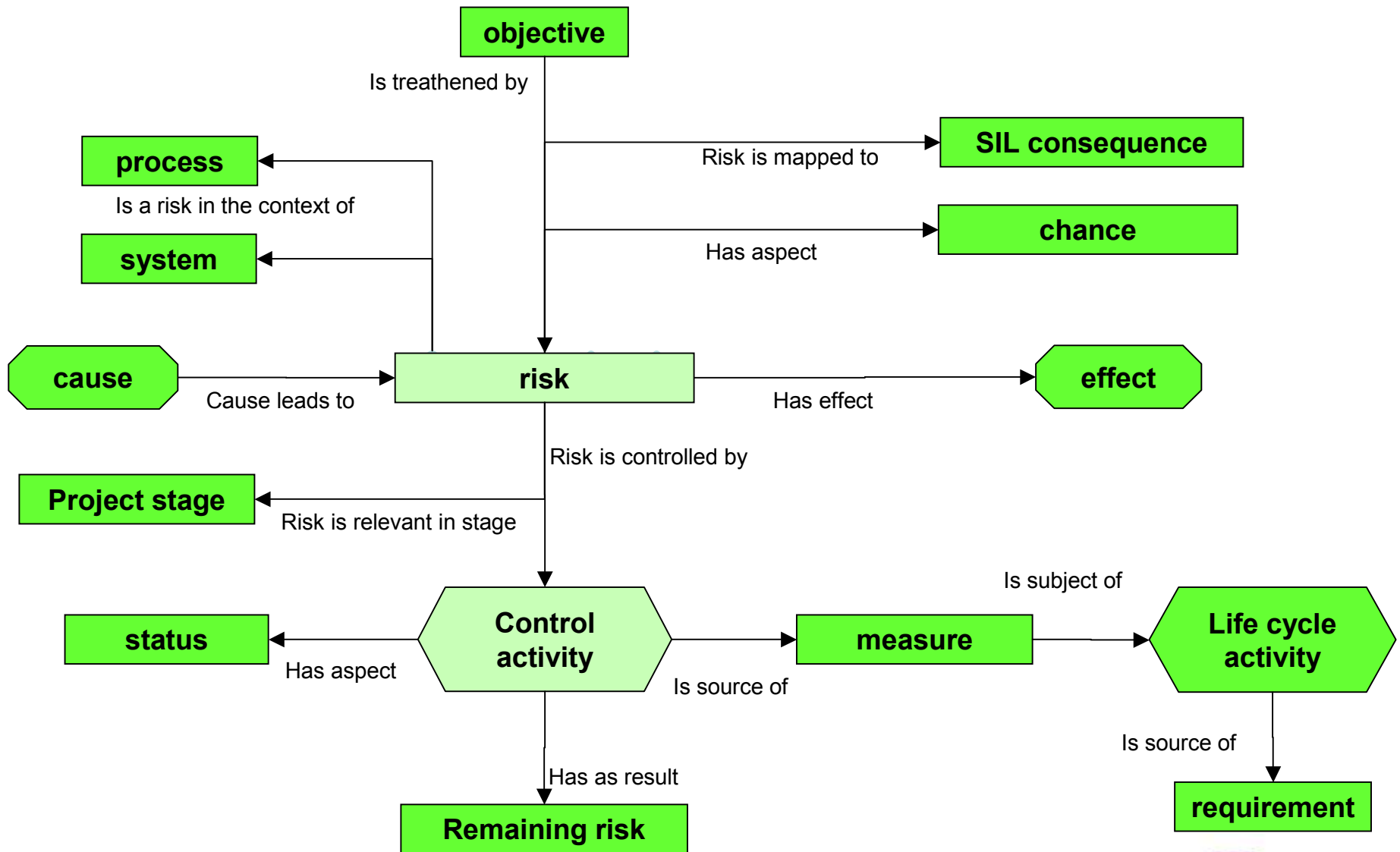
is an occurrence of (OIM)

Name	
! transaction	

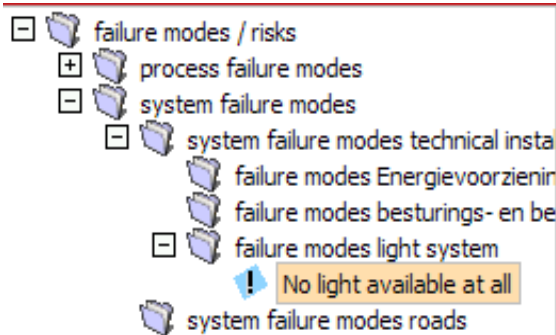
is classified as (RDL element)

Name	
! delivering architectural design	

SE Object Information Model: Risk



Implementation of OIM “Risk” (1):



General Cause and effect Remaining risk

has attributes

name	No light available at all
description	total breakdown of all lighting inside the tunnel, including emergency light(ing)

has properties

property	value
category	not compliant with the contract
identifier	1567
risk priority number	45
status	definitief

is a treath for objective

name
safe travel for system user

is a failure mode in the context of

name
tunnel lighting system

is relevant within in project stage

name
exploitation phase

failure mode is subject of control activity

naam
Risk analysis activity 1567

failure mode has chance

type	class	percentage	frequency
unlikely	1	0 tot 1%	

failure mode has as detection mechanism

naam	Description
detection by control and SCADA system	

is classified as (RDL element)

name
risk

Implementation of OIM “Risk” (2):

failure modes risks

- process failure modes
- system failure modes
 - system failure modes technical installa
 - failure modes Energievoorziening
 - failure modes besturings- en bedi
 - failure modes light system
 - No light available at whole
 - system failure modes roads

General Cause and effect Remaining risk

cause of failure mode is

Name
breakdown of public energy network

failure mode has effect

Name
No traffic possible through the tunnel

risk is represented by SIL graph

Name	Description
SIL graph risk	Safety Integrity Levels (SILs) are determined using a risk graph. This has been developed for use based on the example given in IEC-61508 Part 5: Annex D

Relation to another OIM: “SIL graph”

attributes

name	SIL graph risk
description	Safety Integrity Levels (SILs) are determined using a risk graph. This has been developed for use based on the example given in IEC-61508 Part 5: Annex D
remark	

risk graph has consequence class

Name
Minor Injury, recoverable

risk graph has frequency class

Name
Persons present in the danger area > 10% of the time (over a 24-Hour period)

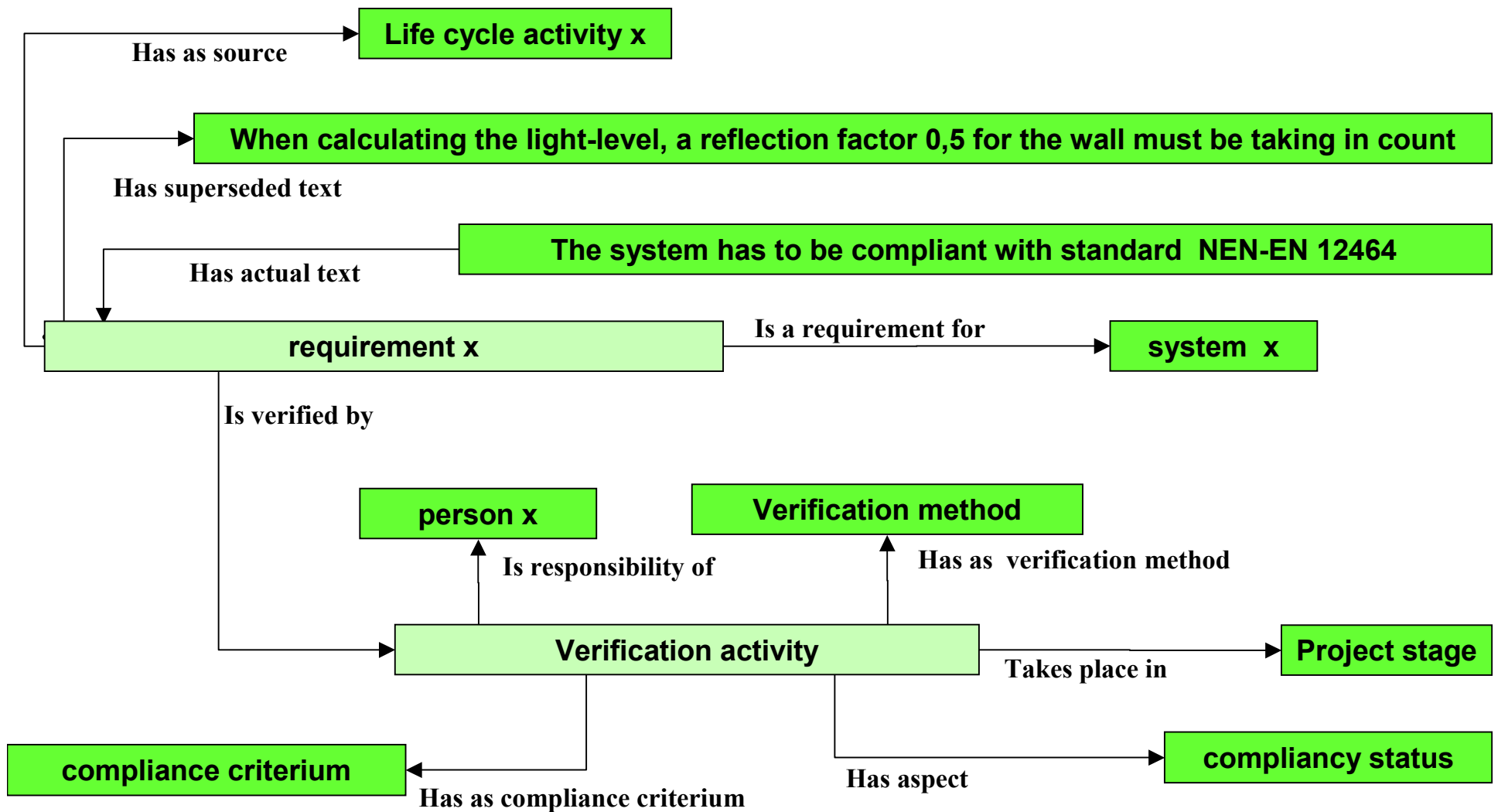
risk graph has possibility class

Name
possible to avoid danger (conditions to be noted)

risk graph has probability class

Name
> once per year

SE Object Information Model: requirement and verification



Implementation OIM “requirement”:

Navigation icons: Home, Add, Delete, Refresh, Print, etc.

- Eisen afgeleid uit Normen en Richtlijnen
- Eisen contract klant
- NHK-77007-050000 DBFM Overeenkomst
- NHK-77007-050001 Systeemdefinities
- NHK-77007-050002 Raakvlakdefinitie Westrandweg
- NHK-77007-050003 Raakvlakdefinitie EM-installaties V
- NHK-77007-050004 Structuur Outputspecificaties Nie
- NHK-77007-050005 Technische begrippen en afkorting
- NHK-77007-050006 Overzicht bindende Normen en Ri
- NHK-77007-050007 Systeemspecificatie
- NHK-77007-050008 Subsysteemspecificatie Weg
- NHK-77007-050009 Subsysteemspecificatie Kruisinge
- NHK-77007-050010 Subsysteemspecificatie Kruising e
- NHK-77007-050011 Subsysteemspecificatie Kruising T
- NHK-77007-050012 Subsysteemspecificatie Ecologisch
- NHK-77007-050013 Subsysteemspecificatie Geluidbe
- NHK-77007-050014 Subsysteemspecificatie Waterhui
- NHK-77007-050015 Subsysteemspecificatie Overige ir
- NHK-77007-050016 Subsysteemspecificatie Verkeer
- NHK-77007-050016 1 Functionele eisen
 - NHK-77007-050016 1.1 Algemeen
 - NHK-77007-050016 1.2 Verkeer en veiligheic
 - VMS/NZKkr-ctt-0259**
 - VMS/NZKkr-ctt-0260
 - VMS/NZKkr-ctt-0261
 - VMS/NZKkr-ctt-0262
 - VMS/NZKkr-ctt-0263
 - VMS/NZKkr-ctt-0264
 - VMS/NZKkr-ctt-0265
 - VMS/NZKkr-ctt-0266
 - VMS/NZKkr-ctt-0277
- NHK-77007-050016 2 Externe raakvlakeisen
- NHK-77007-050016 3 Productspecificaties

Attributes		
name	VMS/NZKkr-ctt-0259	
remark		
reference		

properties	
Name	Value
context	contract requirement
discipline	onbepaald

is actual presented on text			
Name	Description	relation type	reference
VMS/NZKkr-ctt-0259 Toevoer toerit.	De toevoer van verkeer binnen het Nieuwe Systeem vanaf de opritten naar de hoofdrijbaan, moet worden gereguleerd.	actual	

will be verified by activity		
Verificatie		
Verificatie VMS/NZKkr-ctt-0259 Toevoer toerit.		

requirement is relevant in the context of ISO 152 process	
Name	
integration process	

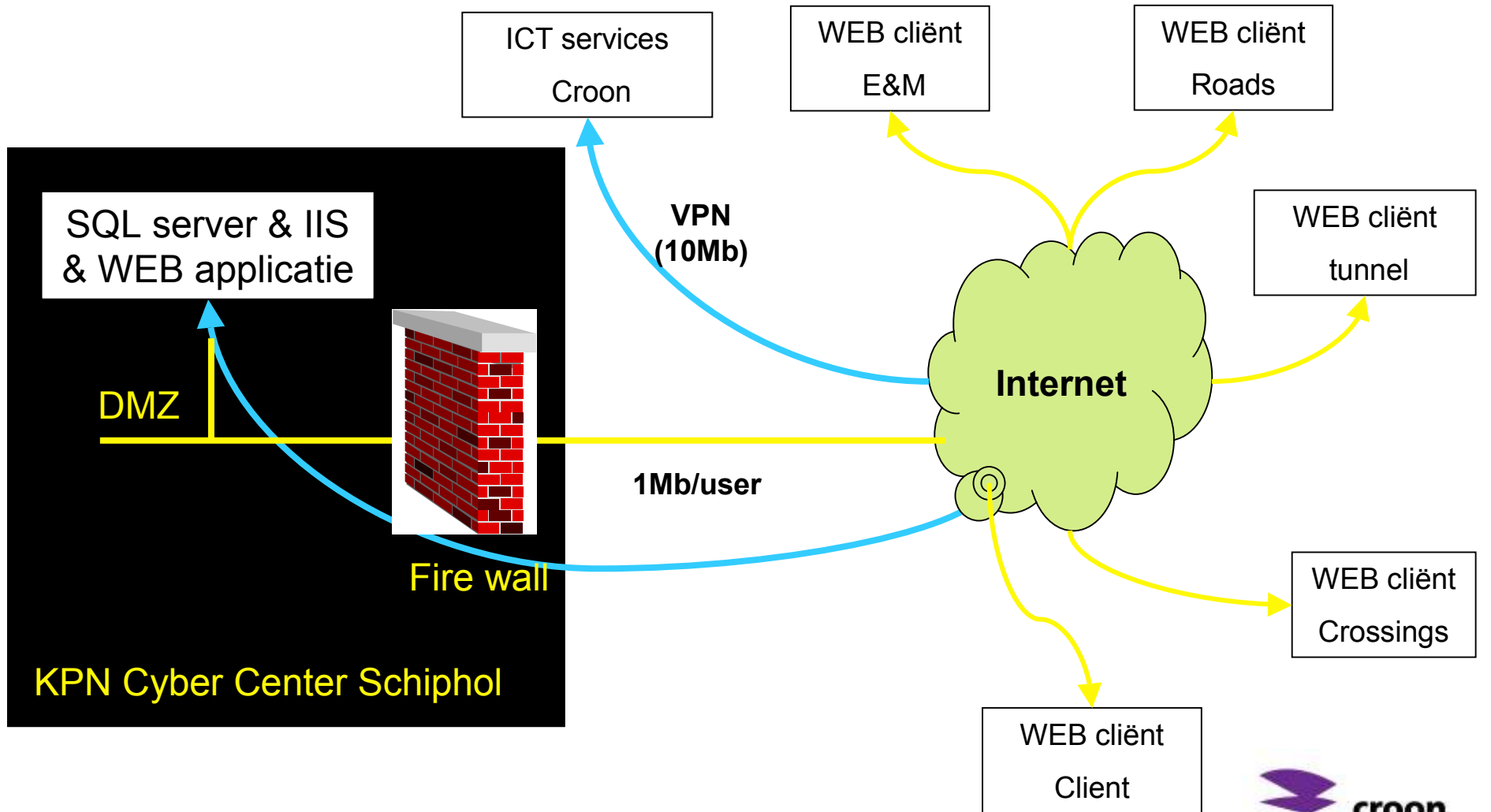
has severity (impact of non-compliance) <1:1>	
Name	
kritisch	

requirement is about aspect	
Name	Description
safety	

has higher level requirements	
Eis naam	text
cttSYS2260	Het Nieuwe Systeem dient voorzieningen te bevatten waarmee, afhankelijk van de actuele situatie op het betreffende wegvak, de afwikkeling van de hoeveelheid verkeer te maximaliseren is.
cttSYS2272	Het Nieuwe Systeem dient het mogelijk te maken de hoeveelheid voertuigen op het Nieuwe Systeem te beïnvloeden, gebaseerd op de actuele situatie op het betreffende wegvak, conform de prioritering van verkeersstromen zoals beschreven in de "Netwerkvisie Noord-Holland".

has lower level requirements	
Eis naam	text
VMS-TDT-0067	De toerit doseerinstallatie moet de functionaliteit bieden voor het aansturen van een roodlicht camera.

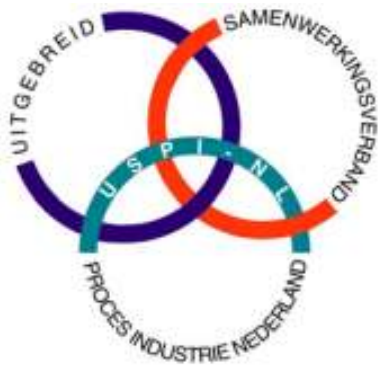
ICT infrastructure consortium tunnel project



Summary of managing information in the context of SE

- **Start SE with identifying relevant Object Information Models.**
- **Structure the information needs of SE based upon these OIMs.**
- **Work up to reusable, generic OIMs.**
- **Make use of relevant standards.**
- **Draw up multidisciplinary project decompositions.**
- **Define your terms and definitions, make use of an existing RDL (CROW dutch civil object library, ISO 15926-4, Lexicon).**
- **Distinguish types of things and individual things.**
- **Select an adequate “OO” information management tool.**

- Thanks for your attention !



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