Meaningful Data

Making possible a scalable and reasoning-enabled digital asset model

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A single element of data is not meaningful

160

No reasoning is possible

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When context is added, meaning increases

Minimum meaning for humans to do Process Engineering

	TAG #	B	Range[Bar]	D	E	F
1						
2						
3						
4	PT/TT-003		160			
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

Ark1

Limited processing only, such as syntax and range validity checking

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When more context is added, meaning increases further

Just enough meaning for humans to perform Procurement

	TAG #	Rating	Range	Accuracy	Material
1					
2					
3					
4	PT/TT-003	240	160	0.025%	SS316
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Ark1

Limited processing only, such as property value validity checking

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When more context is added, meaning increases further

Just enough meaning for representing a ‘thing’ during live operation

	TAG #	Rating	Range	Accuracy	Material	Measures	Document
1							
2							
3							
4	PT/TT-003	240	160	0.025	SS316	83.55	DS-003
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Ark1

Limited processing only, such as property value validity checking

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For every new property, a column/field must be added

	TAG #	Rating	Range	Accuracy	Material	Measures	Document
1							
2							
3							
4	PT/TT-003	240	160	0.025	SS316	83.55	DS-003
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Ark1

SCALABLE?

Adding unforeseen property types requires changing the system configuration

Adding relations further increases the context and meaning

Just enough meaning for basic Digital Twin representation

TAG #	Rating	Size	Trim	Body
Choke-003	240	6	Carbide	SS316

RELATION

TAG #	Rating	Range	Accuracy	Material	Measures	Document
PT/TT-003	240	160	0.025	SS316	83.55	DS-003

RELATION

RELATION

Some level of reasoning is possible, such as checking inherited requirements

Holding many relations as links between tables increases complexity

Approaching the level of meaning for a full Digital Twin representation

TAG #	Rating	Size	Trim	Body
Choke-003	240	6	Carbide	SS316

TAG #	Rating	Range	Accuracy	Material	Measures	Document
PT/TT-003	240	160	0.025	SS316	83.55	DS-003

NOT SCALABLE

Reasoning requires complexity in SW

NOT SCALABLE

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A Digital Twin data model will grow in both contents and structure

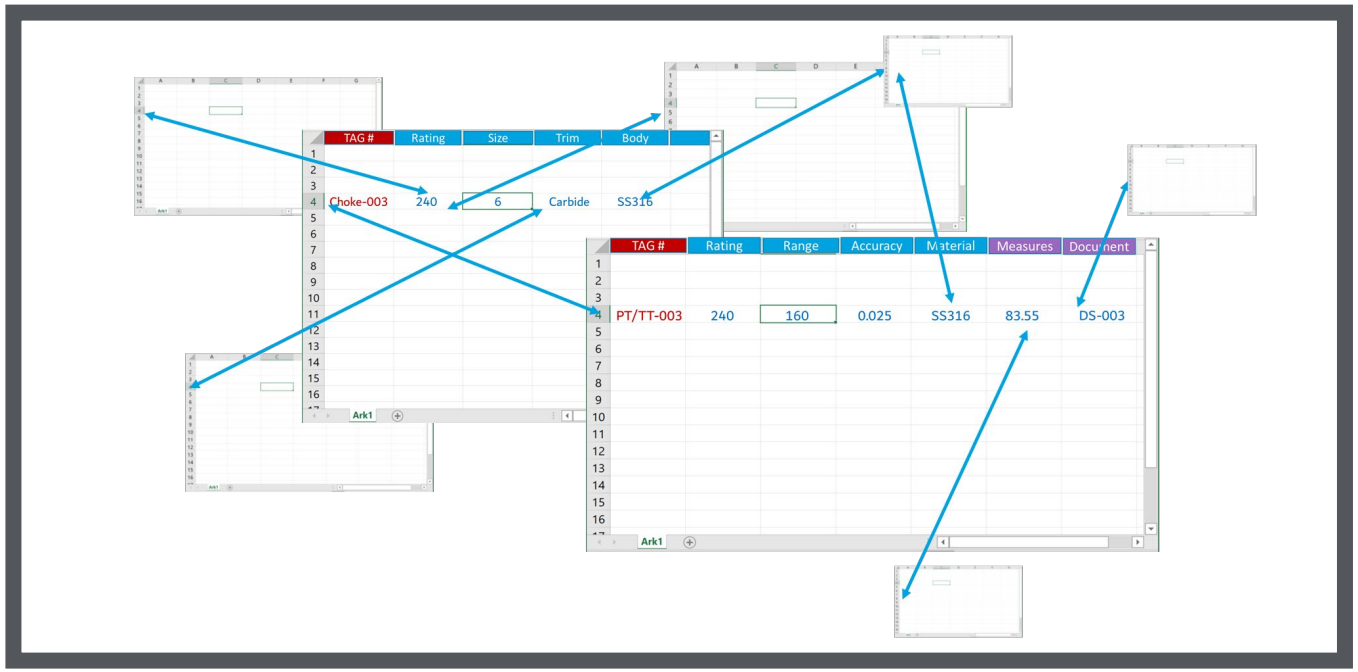
Data + context is the single source of truth throughout the whole life cycle

- Begins as requirements input to the design and grows in details until delivery
- Is continuously updated during operation and until decommissioning
- Data-centric design means documents are results of data, and are no longer sources of data

The (IT) technology must enable such continuous information growth

• Adding data values	e.g.	Range=	0-160 barg
• Adding new properties	e.g.	CO2 footprint=	60 kg
• Adding new relations	e.g.	Is_retrieved_with	FCM
• Adding new classifications	e.g.	Parent Class:	Inline equipment

Scaling up the context – i.e. adding meaning - requires altering the (IT) configuration such as table columns, links, as well as software applications



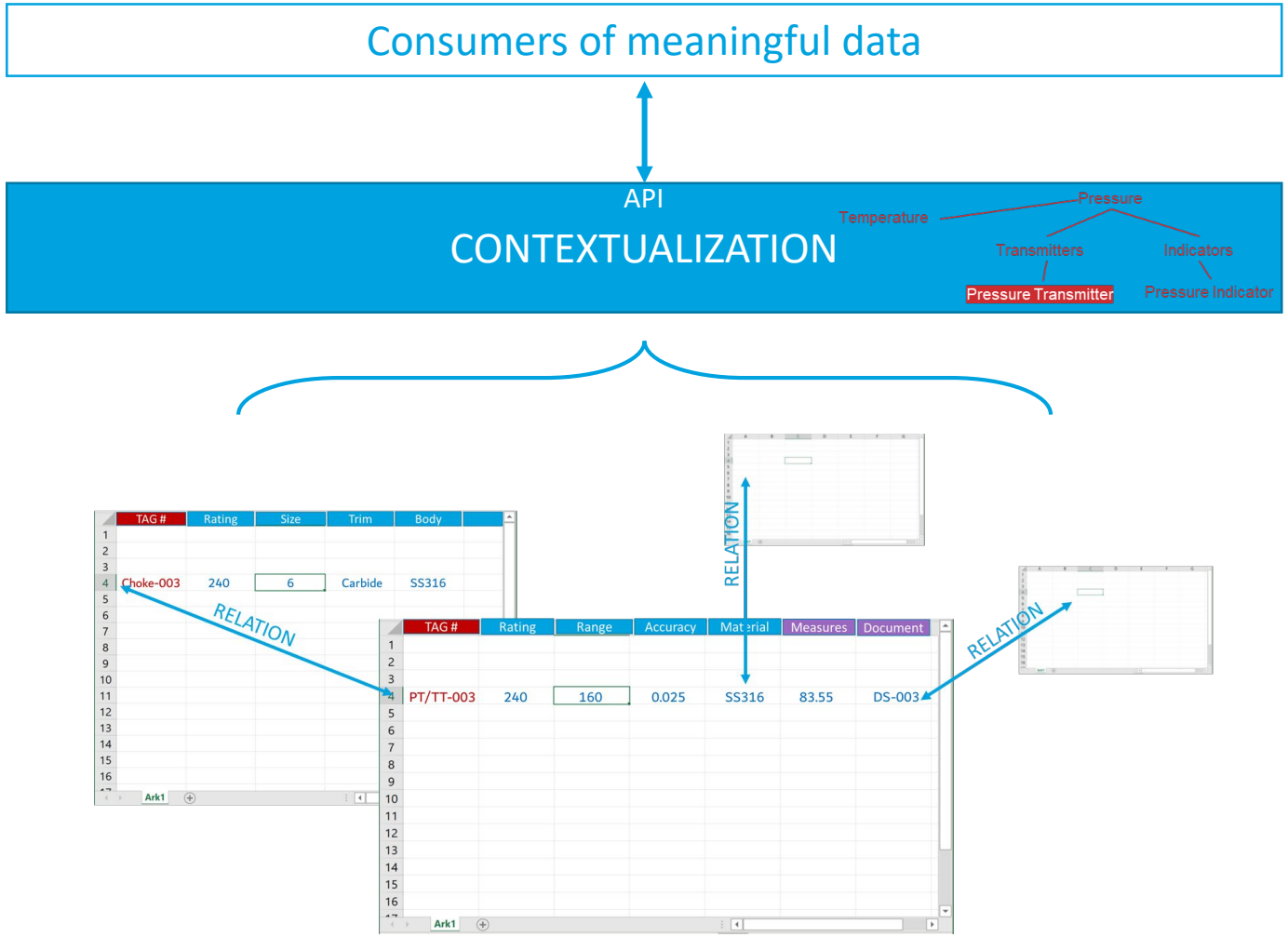
CLOSED SYSTEM

i.e. does not easily scale

Context is today coded/configured into the information system - this is by principle not continuous/open

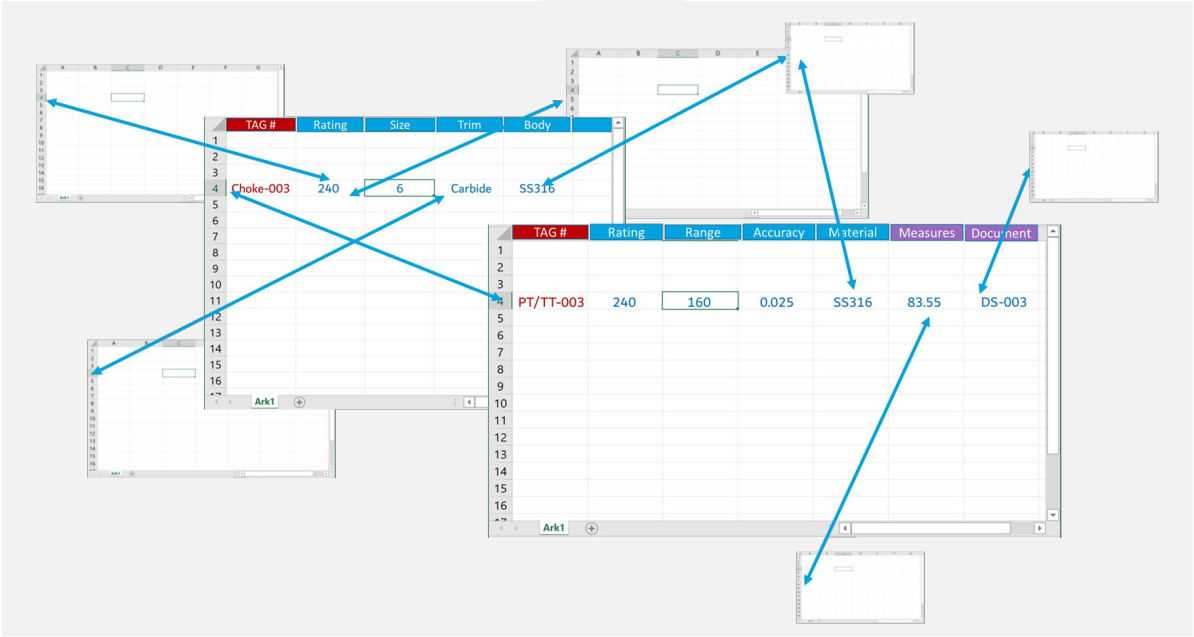
A scalable technology is needed to support Digital Twin data

Adding contextualization as a new layer – a short-term solution



- A contextualization layer needs to be built for each time/project
- The process is manual, or can be semi-automatic if tagging is informative and consistent
- Pro: The underlying data/structure does not need to be changed
- Pro: Consumers of meaningful data relate to common APIs
- Con: The resulting data model is proprietary and not portable
- Con: Must be tailored to the underlying data/system
- Con: Does not scale efficiently

Reasoning-enabled data – a semantic (meaningful) format:



PT/TT-003	is_of_class	PT
PT/TT-003	has_rating	240 barg
PT/TT-003	is_part_of	Choke-003
Choke-003	is_subclass_of	Valves
Choke-003	is_connected_to	XT-01A
etc		

Data / context can be given for several aspects of a thing (As per ISO/IEC 81346)

- Physical/product, e.g. it is a valve
- Location, e.g. located at X, Y, Z
- Functional, e.g. flow control
- Type, e.g. is model FTI-314A

Data is openly scalable in scope and aspects

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The power of reasoning-enabled data

Design
Verify
Operate
Automate

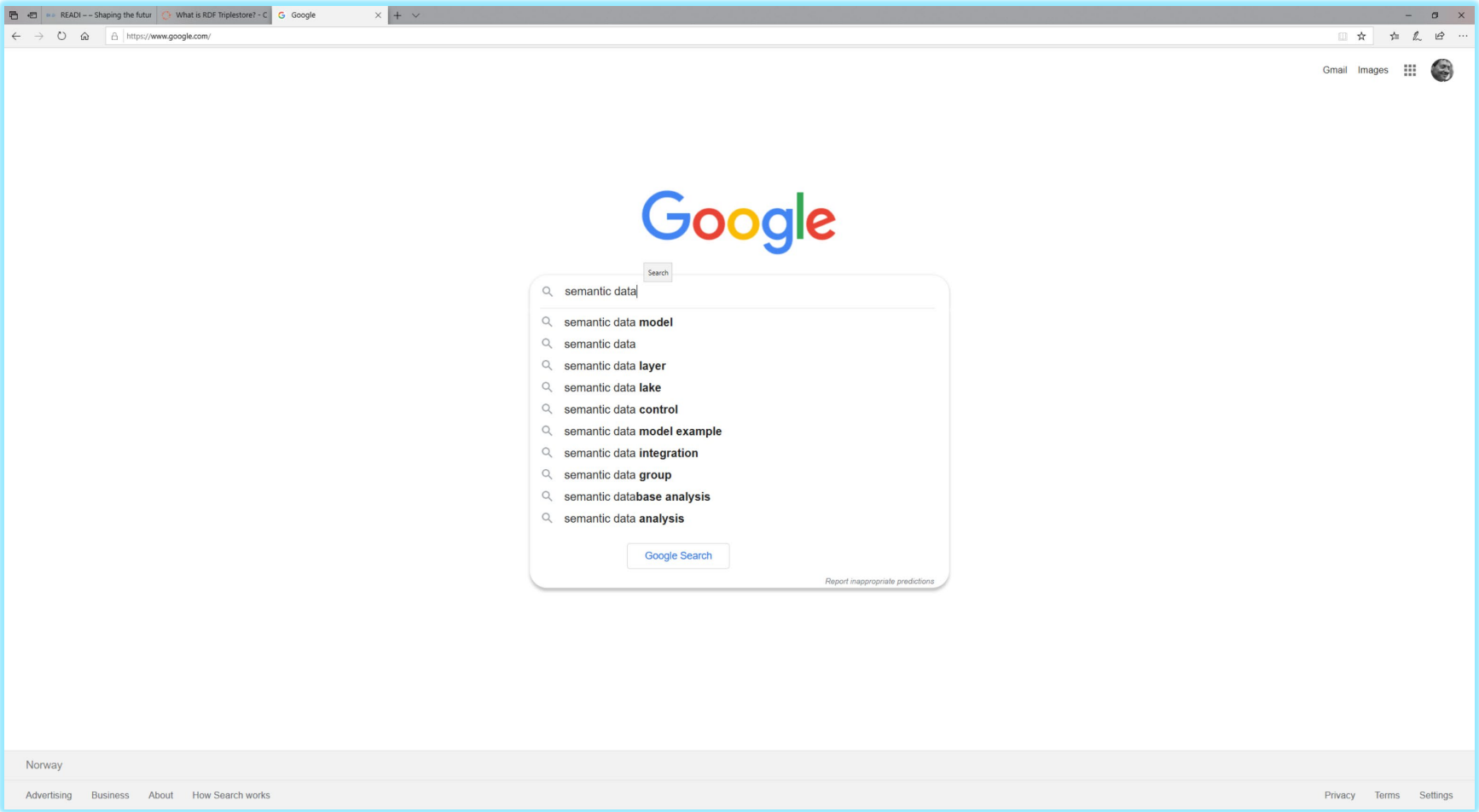
Choke-003 is_subclass_of Valves

Design Model

Reasoning

- To achieve a scalable, reasoning-enabled format, the context of the data is included as an inherent part of the data element
- This allows *any* computer to traverse the data and perform reasoning, needing no proprietary database structures – it is implementation independent
- A Digital Twin formulated such will enable full interoperability across platforms
- AI/ML will not be limited by having to build on context hidden in volumes of raw data; reasoning-enabled data dramatically increases its power

The arrival of web technologies



Reasoning: Requirements data ⟷ Design data

Requirements on a digital format (SCD)

Scope	Condition	Demand
PT/TT Sensors	Op.temp.> 60C	Shall be Titanium

R

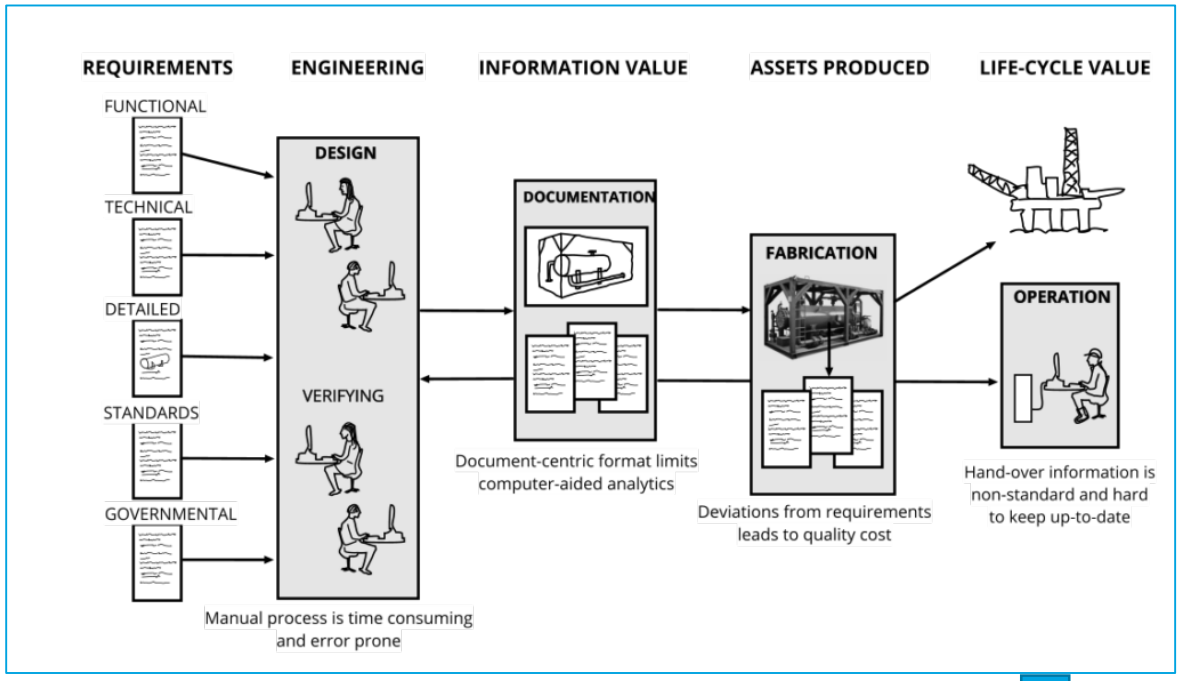
Design on a digital format (RDF triples)

Subject	Predicate	Object
PT/TT 003	Is of class	PT/TT Sensor
PT/TT 003	has max op. temp	120C
PT/TT 003	has body material	SS316

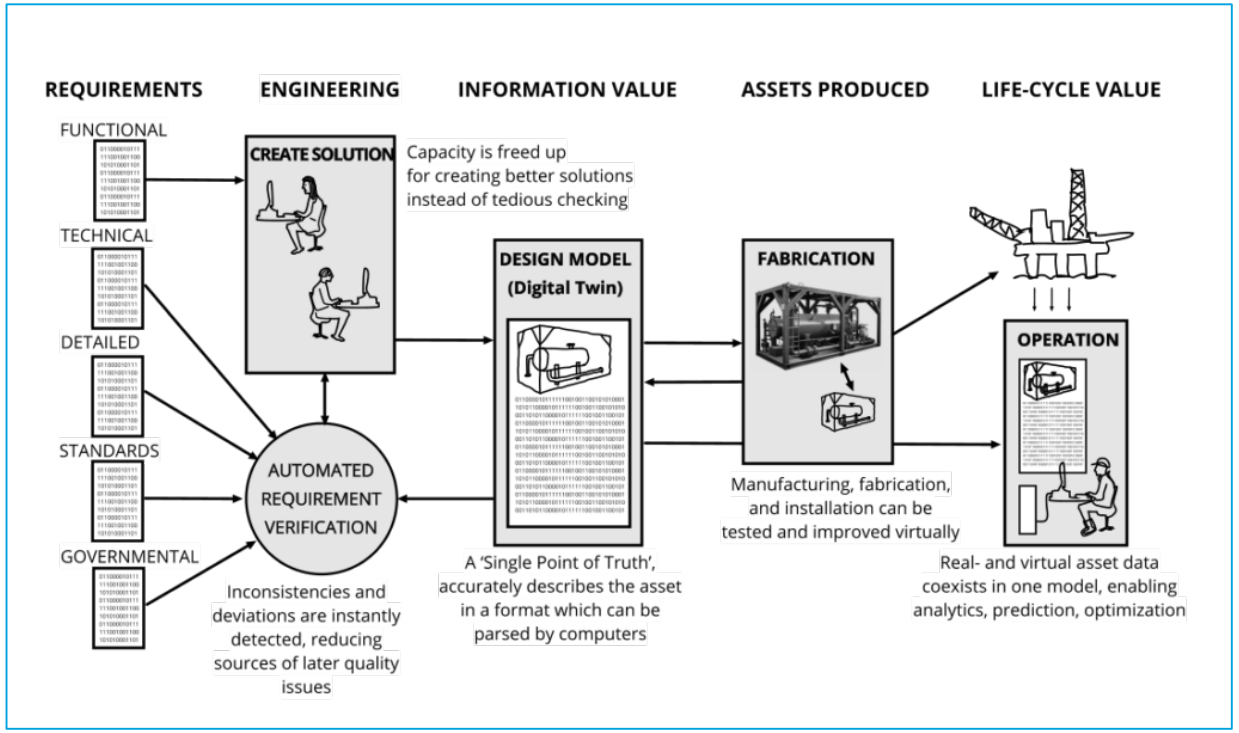
Reasoning to identify non-compliance between material requirement and material as designed

Note: wording has been simplified for educational purpose – this is not formal semantic syntax

Automated reasoning can dramatically reduce cost & time



Document-centric regime



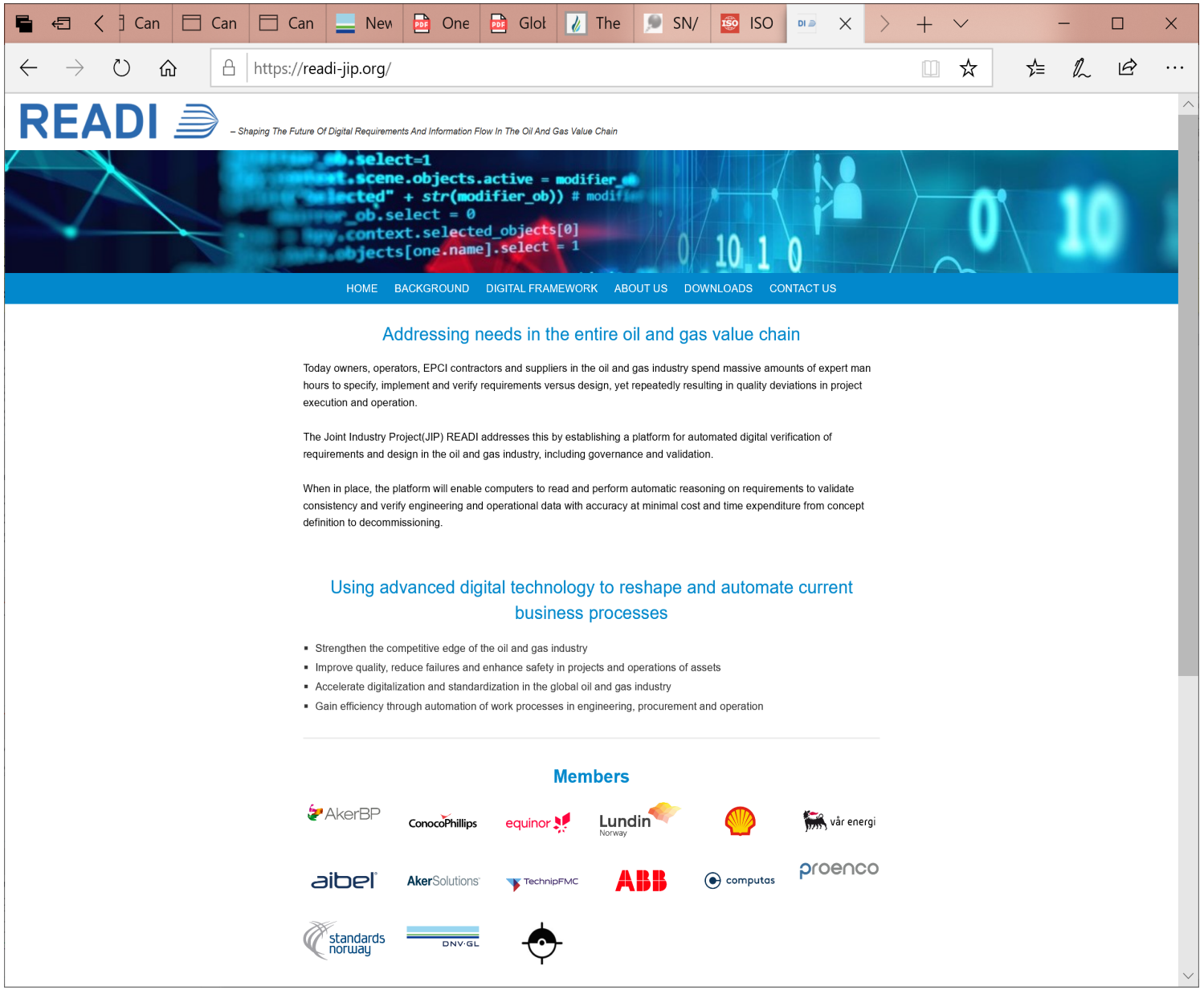
Semantic data-centric regime

Joint Industry Project

READI

Administrated by DNV GL

- Joint industry effort driven by the need for reducing cost and improving quality
- First target is to digitalize the processing of Requirements
- Achieve a standard structure, vocabulary and language for contextualized data
- Accomodate the need of Digital Twin market for a scalable and interoperable data model



A common standardized structure – ISO/IEC 81346

The Reference Designation System (RDS)

Aspect

How the system is viewed

Structure

How system elements are related

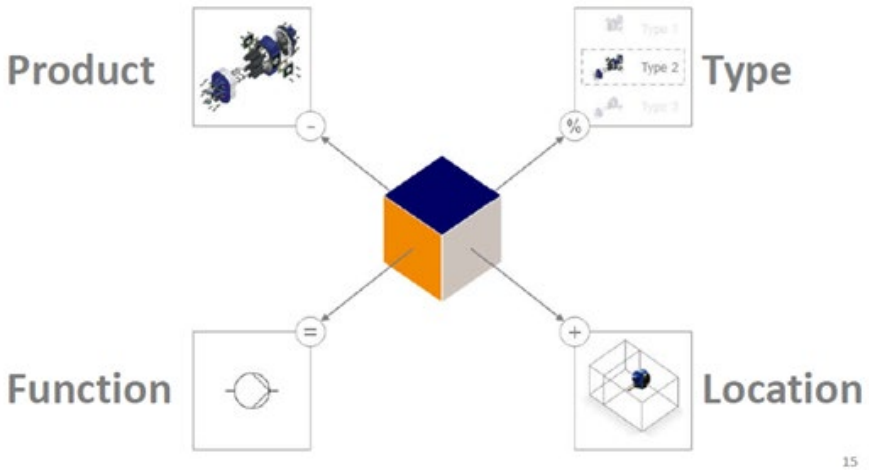
(part-of relations)

Classification

What kind of system elements

(type-of relations)

The four RDS aspects



A common standardized vocabulary – ISO 15926

The Reference Data Library (RDL)

Is exended to support direct semantics

- Classes, e.g. ‘Valve’
- Object properties, e.g. ‘partOf’
- Data properties, e.g. ‘massInKilograms’

Is being incorporated as ISO/IEC15926-14

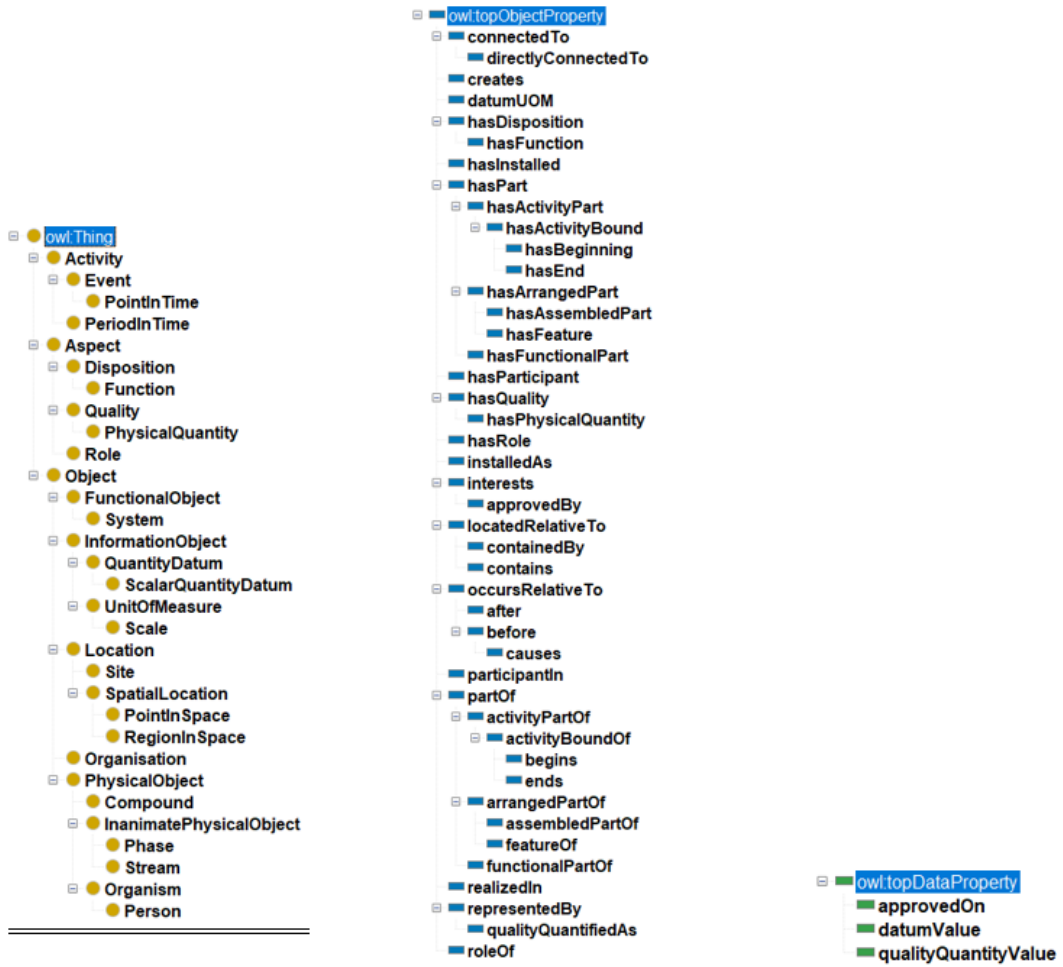
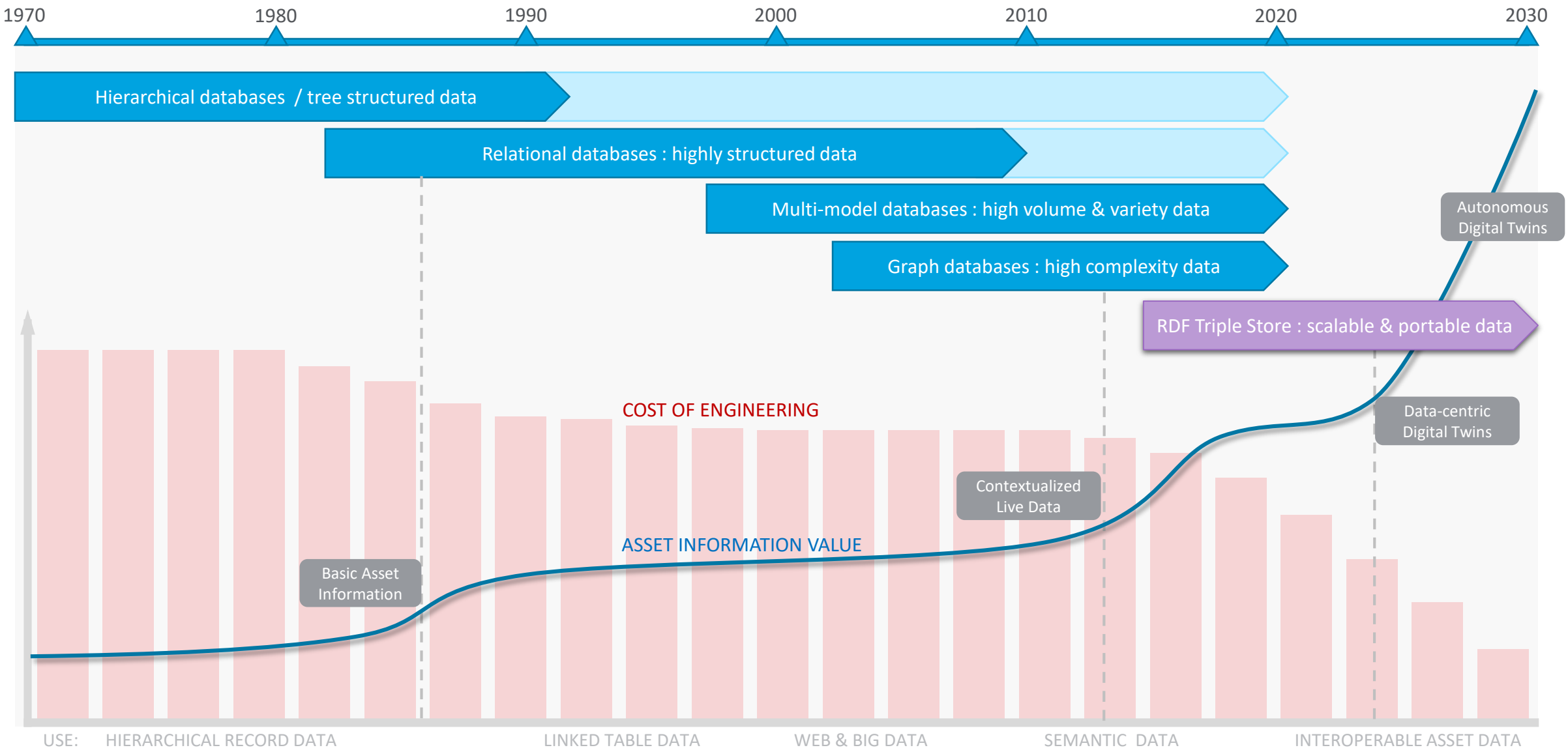


Figure 1- ISO/TR 15926-14 upper ontology: DL version

Asset modelling step-changes – enabled by technology



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Thank you!

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Backup slides

READI scope

READI Vision

- Automated digital verification of requirements, design and interoperability in the oil and gas industry
- Used globally, based on international standards
- Standardized breakdown of assets and identification of components in all project life cycles and operation across facilities - based on ISO/IEC 81346, Reference Designation System – RDS O&G.

Industry ambition

READI framework

Governance
Manage and maintain RDS and Reference Data Libraries (RDLs)
Host validation service (e.g. EPIM, IOGP, ?)
READI: Specify framework

W3C standards
OWL 2, semantics, ontologies, logical reasoning, HTML 5,

Methodology and tools
Requirement syntax (SCD), READI tool suite, reference data architecture and INCOSE guidelines

Information model

Upper ontology, ISO 15926
Part 14: Oil & Gas OWL vocabulary (reasoning)

ISO/IEC 81346
Functional naming and breakdown structure (own part for Oil & Gas)

Standard RDLs and vocabularies
ISO 14224: Maintenance and reliability
IEC 61355: Document designations
ISO 15926 Part 4: Reference Data Library (no reasoning)

Applications and use cases

Norsok Z-Ti harmonization and digitalization
Z-001, Z-DP-002, Z-CR-002, Z-003 (replaced), Z-018/TIRC

Digital design basis
OLGA, Hysys, Unisim integration through common vocabulary (-14)

Piping commodity codes
ISO15926-14, TR2000 etc.

IOGP JIP 33/36
ISO15926-14, RDS

Other

Current scope

Ongoing dialogue

READI ambition