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Towards Semantic Asset Information Models

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Outline

- What is an Asset Information Model?
- Open issues with Asset Information Models
- A long road ahead (from industry standards to Semantic Asset Information Models)
- Machine interpretable information
- Ontologies (aka Knowledge Graphs)
- Industry Standards and Recommendations for machine interpretable (semantic) AIMs
- Towards Semantic Asset Information Models (SAIMs)



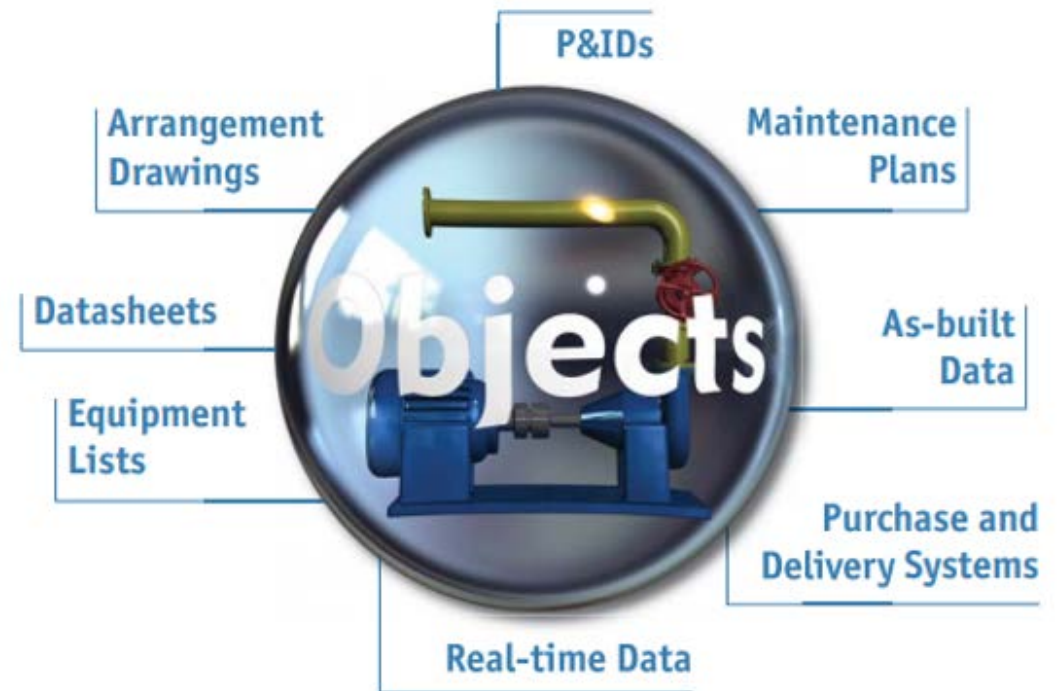
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What is an Asset Information Model?

Asset information models (AIMs) are software artefacts that provide a trusted and harmonised single information source that enables management of real assets.

AIMs might include:

- asset (or system) breakdowns
- real time data
- simulated data
- product definitions
- technical documentation
- more ...



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What is an Asset Information Model?

The screenshot displays the AVEVA NET Dashboard interface. On the left is a navigation tree under 'IPE' with categories like Assets, Functional Facility, Document Types, 3D Models, Arrangement Drawings, Cad, Data Sheets, Instrument Datasheets, Mechanical Datasheets, Diagrams, Hook Ups, IP - Isolation Procedures, Isometrics, Location Drawings, Master Equipment Lists, P&IDs, Photographs, Plot Plans, Purchase Orders, Purchase status, PW - Permits to Work, and Reports. A tooltip is visible over the 'Ball_Valves' folder in the Photographs section, showing details: 'Class: PHOTOGRAPH', 'ID: IPEBall_Valves', and 'Name: Photograph Ball Valve'. The main area shows the 'Equipment Form (QUERY FORM)' in 'Table View'. The table has columns: Tag ID, State, CommSys, Name, Prepared by, and Resp. Department. The table contains 20 rows of equipment data, with several rows highlighted in blue. At the bottom, it shows 'Page 1 of 1'.

Tag ID	State	CommSys	Name	Prepared by	Resp. Department
<input checked="" type="checkbox"/> HR-51	REVISED	0-82-80-C0		TTR	RAS
<input type="checkbox"/> HR-52	RELEASED	1-83-A0-C0		TTR	RAS
<input checked="" type="checkbox"/> HR-53	REVISED	1-83-A0-P0		TTR	RAS
<input checked="" type="checkbox"/> J-8001A	REVISED	1-83-A0-R0		HER	TYW
<input type="checkbox"/> J-8001B	RELEASED			HER	TYW
<input type="checkbox"/> J-8002A	REVISED	1-83-A0-S0		FRE	TYW
<input checked="" type="checkbox"/> J-8002B	REVISED	1-83-80-AC0		HER	TYW
<input type="checkbox"/> J-8003	RELEASED	1-83-80-AD0		HER	TYW
<input type="checkbox"/> J-8004A	RELEASED	1-83-80-AE0		HER	TYW
<input checked="" type="checkbox"/> J-8004B	REVISED	1-83-80-AG0		FRE	TYW
<input checked="" type="checkbox"/> J-8013A	REVISED	1-83-A0-P0		HER	TYW
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<input type="checkbox"/> J-8518	RELEASED	0-71-A0-D0		HER	TYW
<input checked="" type="checkbox"/> J-9002A	REVISED	0-71-A0-D0	VERTICAL PUMP	SAR	TYW
<input checked="" type="checkbox"/> J-9002B	REVISED	0-71-A0-D0	VERTICAL PUMP	HER	TYW
<input checked="" type="checkbox"/> J-9005A	REVISED	0-71-A0-D0	VERTICAL PUMP	SAR	TYW
<input type="checkbox"/> J-9005B	RELEASED	0-71-A0-D0	VERTICAL PUMP	FRE	TYW
<input checked="" type="checkbox"/> L-8001	REVISED	0-71-A0-J0		TTR	RAS

What is an Asset Information Model?

Asset Information Models (AIMs) are instrumental for the realisation of Digital Twins.



© Image downloaded from DNV



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Open issues with Asset Information Models

- No general consensus about how AIMs should be implemented
- No standard representations that facilitate use, exchange and access to AIMs
- AIMs are very expensive to build and maintain
- Not clear how AIMs should be integrated with Digital Twins



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A long road ahead ...

To *machine interpretable* Asset Information Models (AIMs)
(*semantic*)

From Industrial Standards and Recommendations



Machine interpretable information

- Machine interpretable information is defined using formal languages that machines can understand (interpret) without human support
- Machine interpretable information is encoded in digital representation artefacts known as ontologies (aka knowledge graphs)



Are Excel files machine interpretable information?

oC?



=CONVERT(B3,"C","F")							
	A	B	C	D	E	F	G
1		Generator 1		Generator 2		Generator 3	
2	Temperature (oC) ?	Min	Max	Min	Max	Min	Max
3	Temperature for Sep 1, 2017	37.3	85.2	38.2	85.4	36.1	85.4
4	Temperature for Sep 2, 2017	39.3	84.2	36.2	84.0	38.6	84.6
5	Temperature for Sep 3, 2017	39.1	84.6	36.3	84.0	38.8	84.8
6	Temperature for Sep 4, 2017	39.7	84.8	39.7	85.0	36.6	84.6
7							
8	Temperature (oF) ?						
9	Temperature for Sep 1, 2017	99.1	185.4	100.8	185.7	97.0	185.7
10	Temperature for Sep 2, 2017	102.7	183.6	97.2	183.2	101.5	184.3
11	Temperature for Sep 3, 2017	102.4	184.3	97.3	183.2	101.8	184.6
12	Temperature for Sep 4, 2017	103.5	184.6	103.5	185.0	97.9	184.3
13							
14							



Are Excel files machine interpretable information?

oC?



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14							

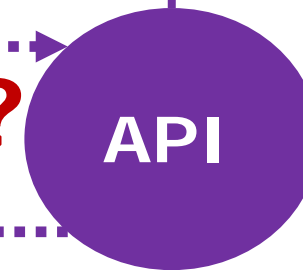
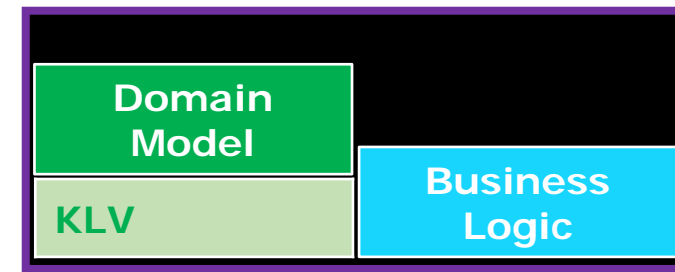
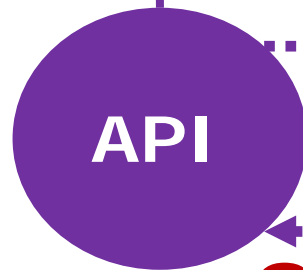
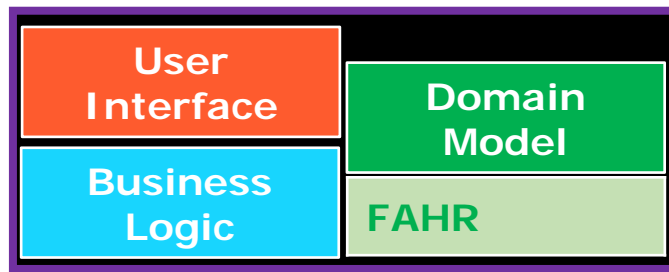
Celsius





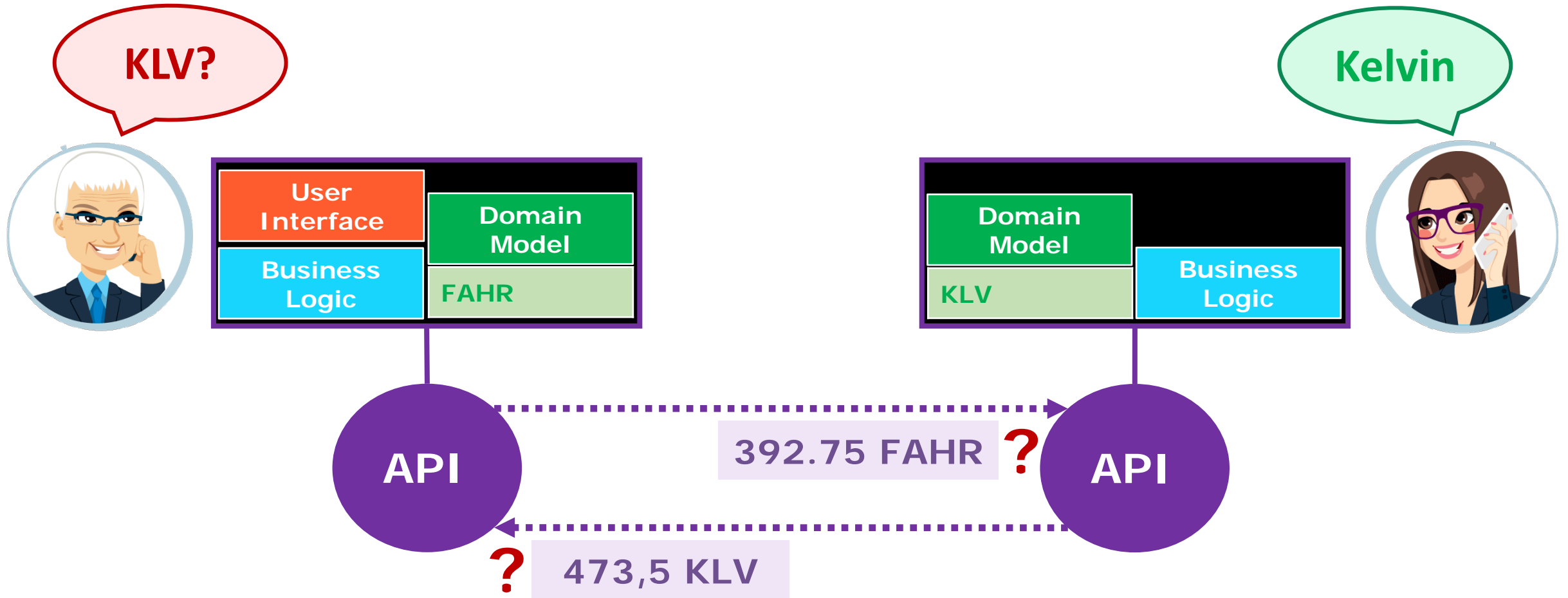
Do APIs define machine interpretable information?

KLV?





Do APIs define machine interpretable information?





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Ontologies (aka Knowledge Graphs)

An **ontology** is a formal, explicit specification of a shared conceptualization.

Ontologies (aka Knowledge Graphs)

Machine interpretable (unambiguous, implicit knowledge can be inferred)

An **ontology** is a formal, explicit specification of a shared conceptualization.

Agreed among several people

Abstract and simplified view of the world







Ontologies (aka Knowledge Graphs)

- An **ontology** is a digital representation artefact that can be interpreted by humans and machines
- It defines a "**digital lingua franca**" agreed among several people for information exchange
- It defines (unambiguously) a collection of terms (including classes, relations and entities) and restrictions about how to apply these terms
- It is usually encoded using a graph data model



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W3C (& IETF) standards for building ontologies

STANDARD	PURPOSE
	Modelling language for the implementation of ontologies
	Query language for retrieving specific content of ontologies
	Graph data model for storing and exchange ontologies
	A string of characters that unambiguously identifies a particular term (e.g. class, relation and individual)

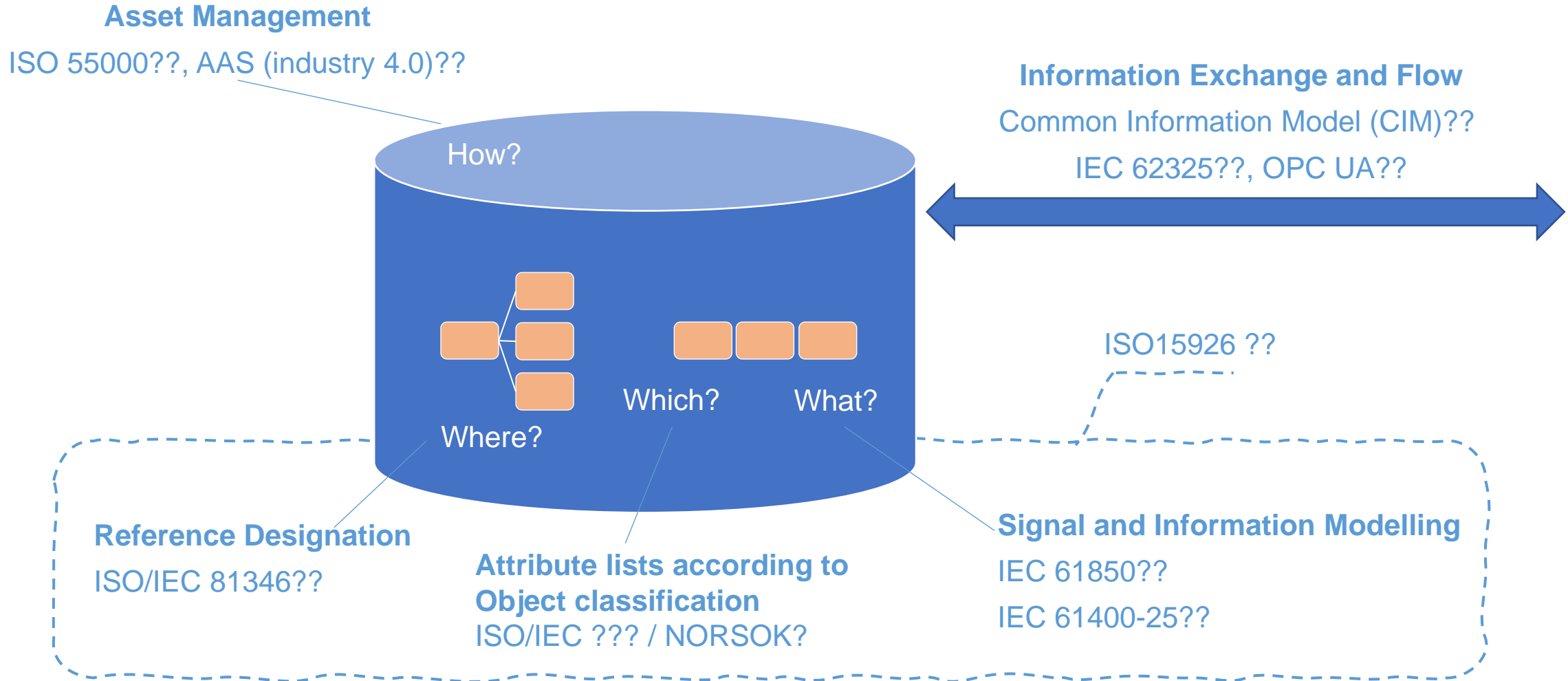
Industry Standards and Recommendations for machine interpretable (semantic) AIMs

- Many industry standards and recommendations are published as PDF reports enriched with tabular data (e.g., Excel files)
 - Not a suitable representation for applying these standards in digitalization initiatives
- Many industry standards and recommendations are developed by different working groups
 - Integration between related standards and recommendations are not properly addressed
- Many industry standards must be adapted (extended) to be suitable to build machine interpretable (semantic) AIMs
- Not a general consensus in the industry about which standards and recommendations and how to apply them to build machine interpretable (semantic) AIMs



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Industry Standards and Recommendations for machine interpretable (semantic) AIMs





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Towards Semantic Asset Information Models (SAIMs)

4. Define how to integrate and deploy SAIMs in Digital Twins

3. Define methods and tools for building SAIMs

2. Digitize selected standards and recommendations as ontologies

1. Select, adapt and integrate industry standards and recommendations



Technology for a better society

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