4 - Towards Semantic IoT, oneM2M Base Ontology

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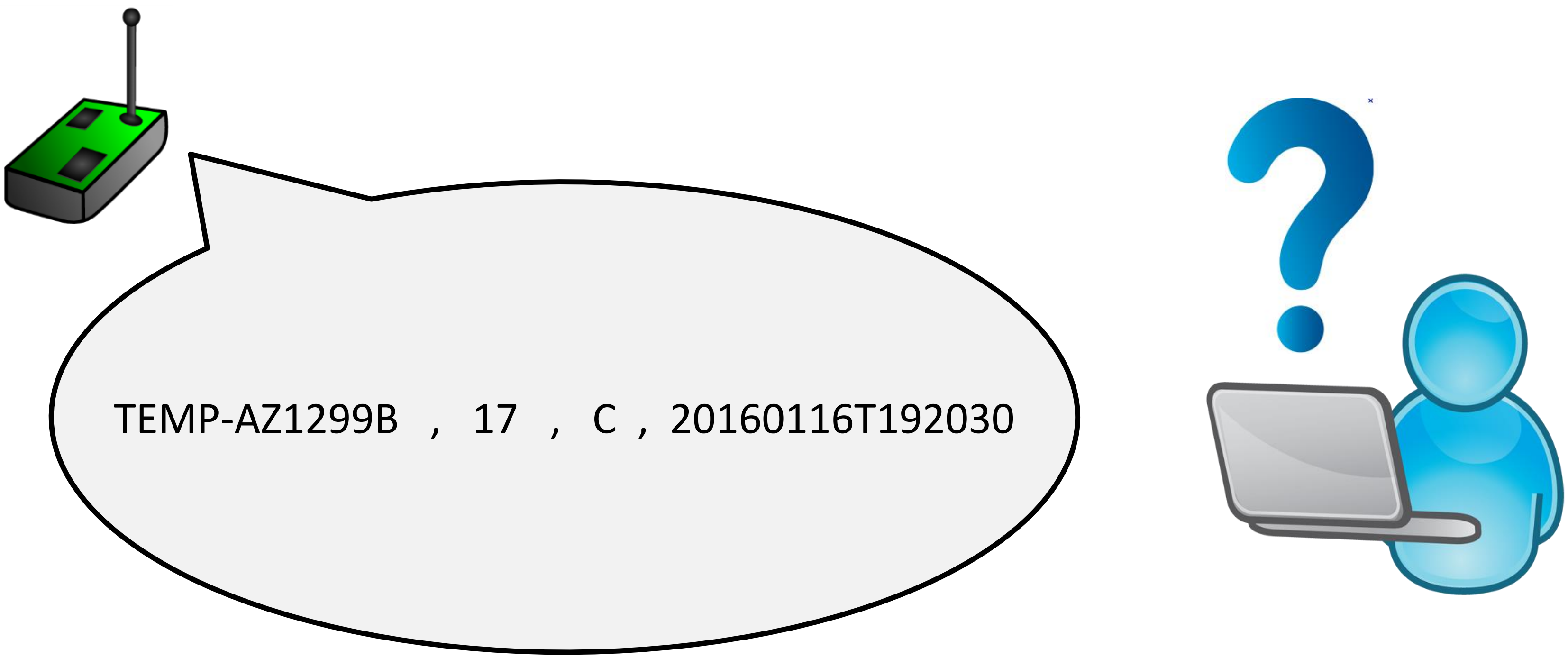
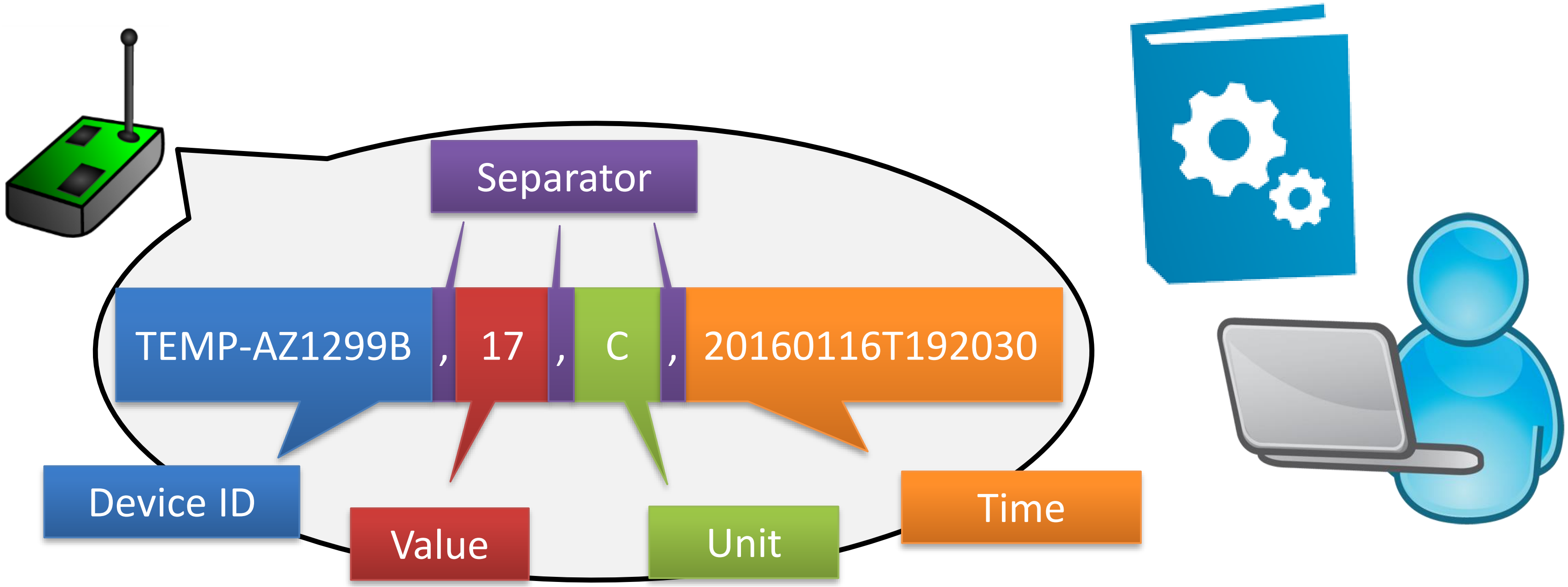
Do we really need semantic ?

- oneM2M Release-1 ensure interoperability at the level of communications.
- Data is treated as black boxes. The content is opaque and applications have to a-priori know how to interpret the data.
- The consumer is programmed or configured for certain consumers. No data interoperability.



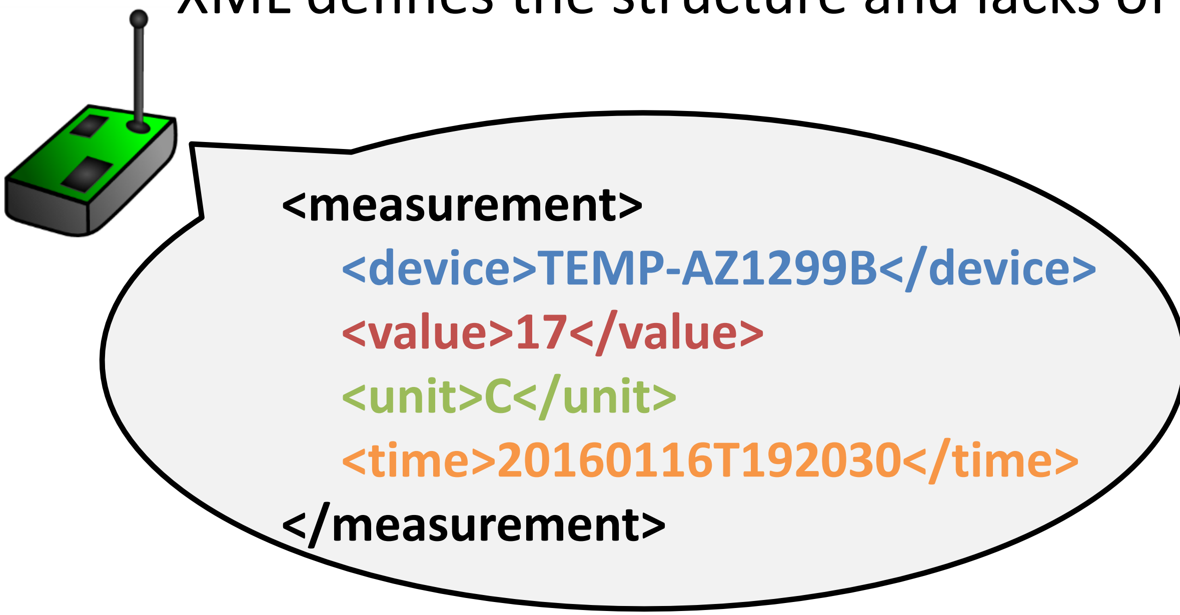
Beforehand agreement required

- It is required to learn information model of each device before using it.
- Beforehand agreement on the data representation is needed between applications and devices.
- Hard to integrate and deal with existing legacy devices.
- Can work in small and closed environnent. But does not scale!



Can XML/JSON do the job ?

- Human can understand XML-Documents.
  - Intuitively clear for human.
  - Tag names provide semantic meaning since they are domain-terms.
- Machines do not have intuition.
  - Tag names do not provide semantics for machines.
  - XML defines the structure and lacks of semantic model.



Semantic gap between machines

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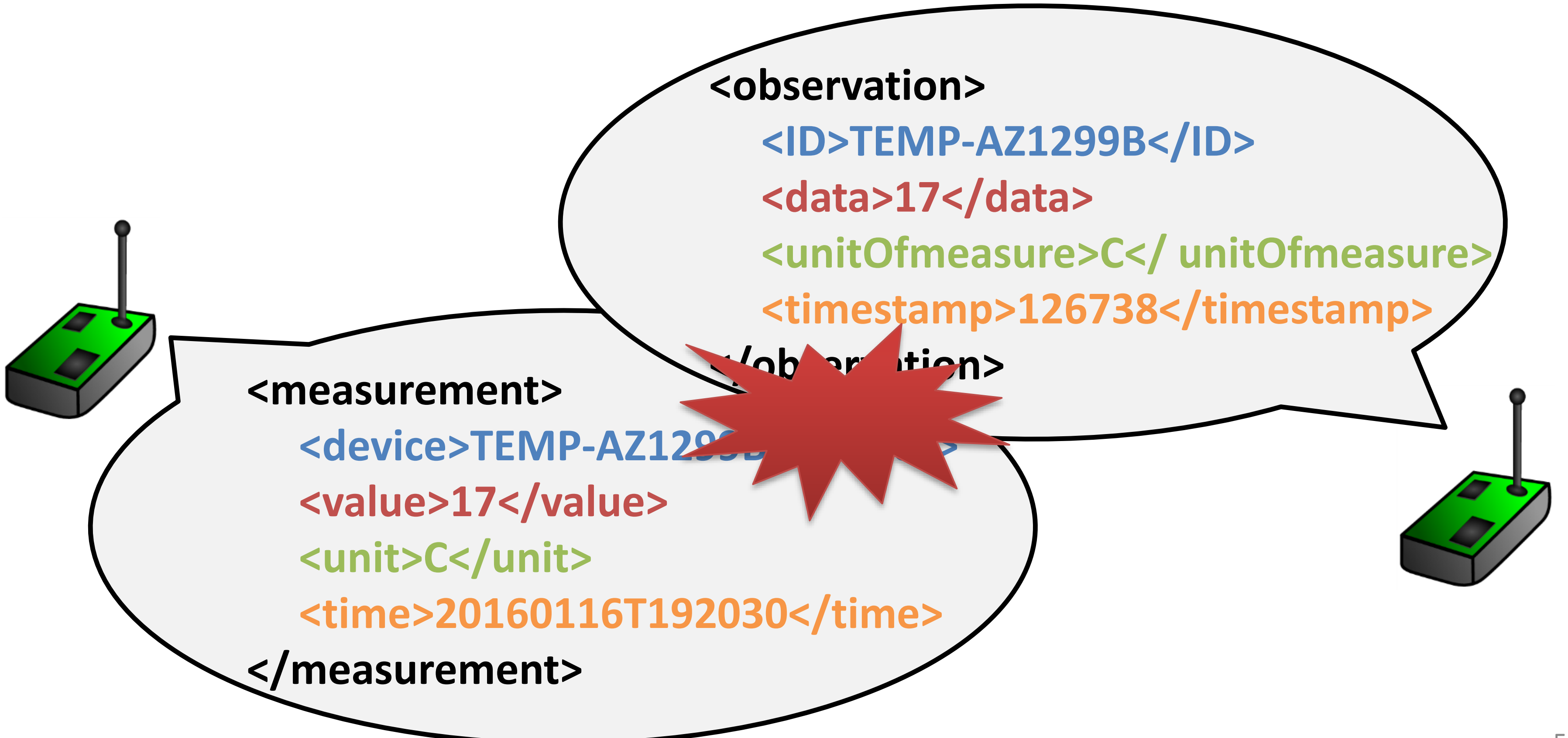
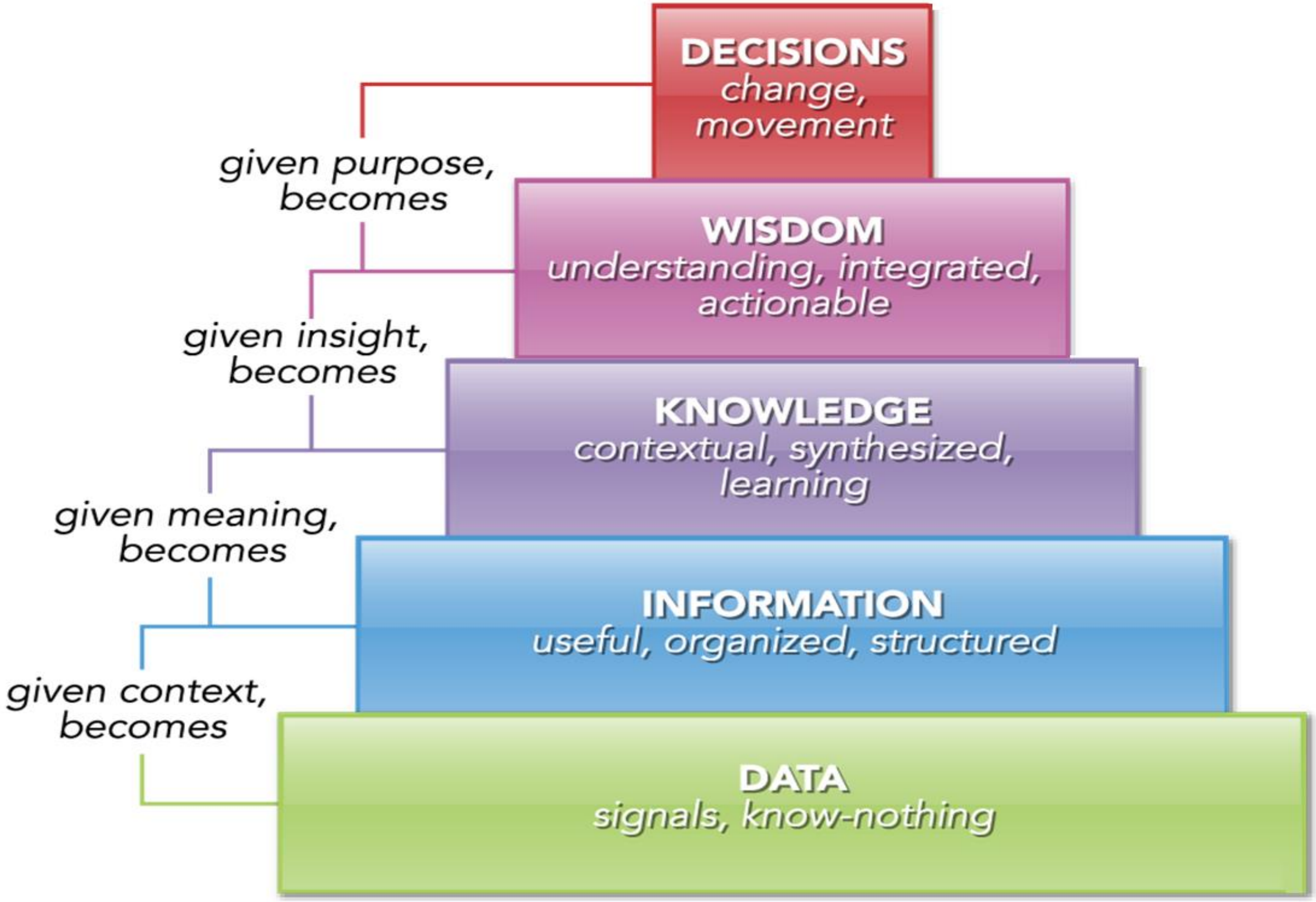
- Which words shall we use to describe a given set of concepts?
- A common vocabulary is required for IoT to bridge the semantic gap between machines.
- Semantic technologies must be used to solve these issues.



From data to decision

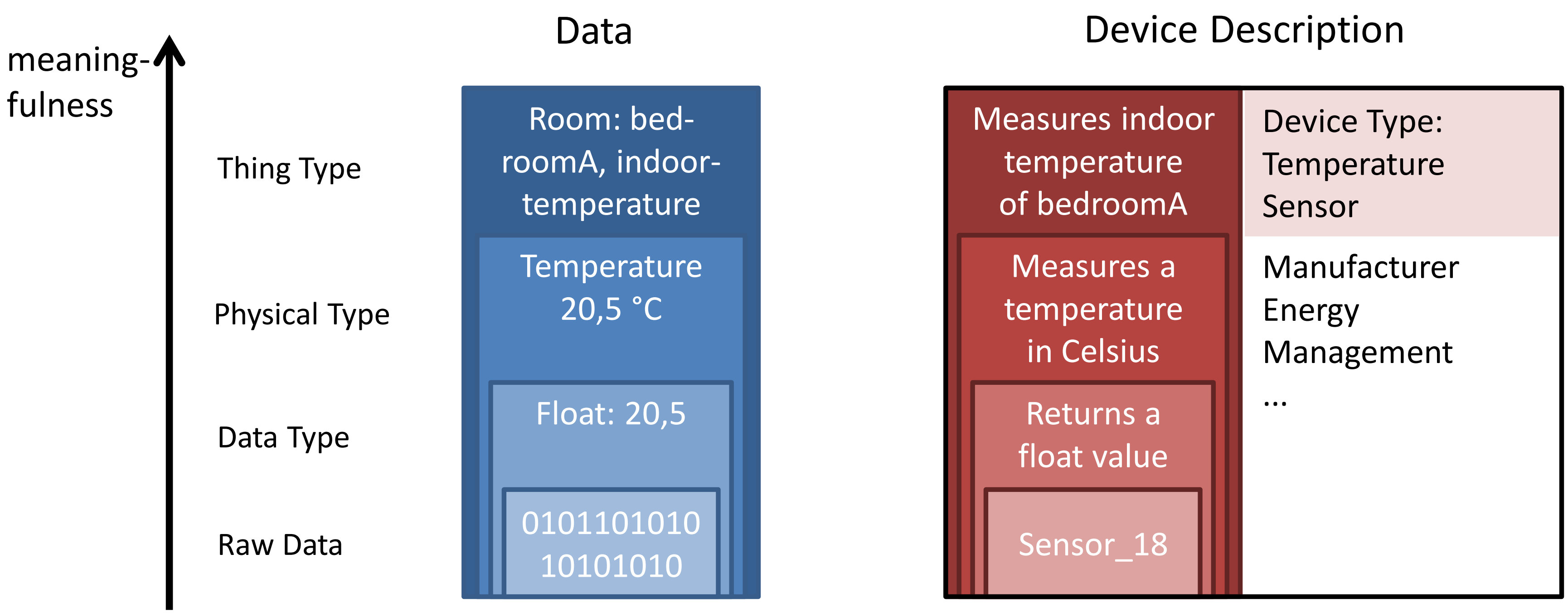
- Collecting data is not sufficient, only your ability to convert data into decisions that gives you the edge.



Source: Curt Swindoll , Persuant 2011

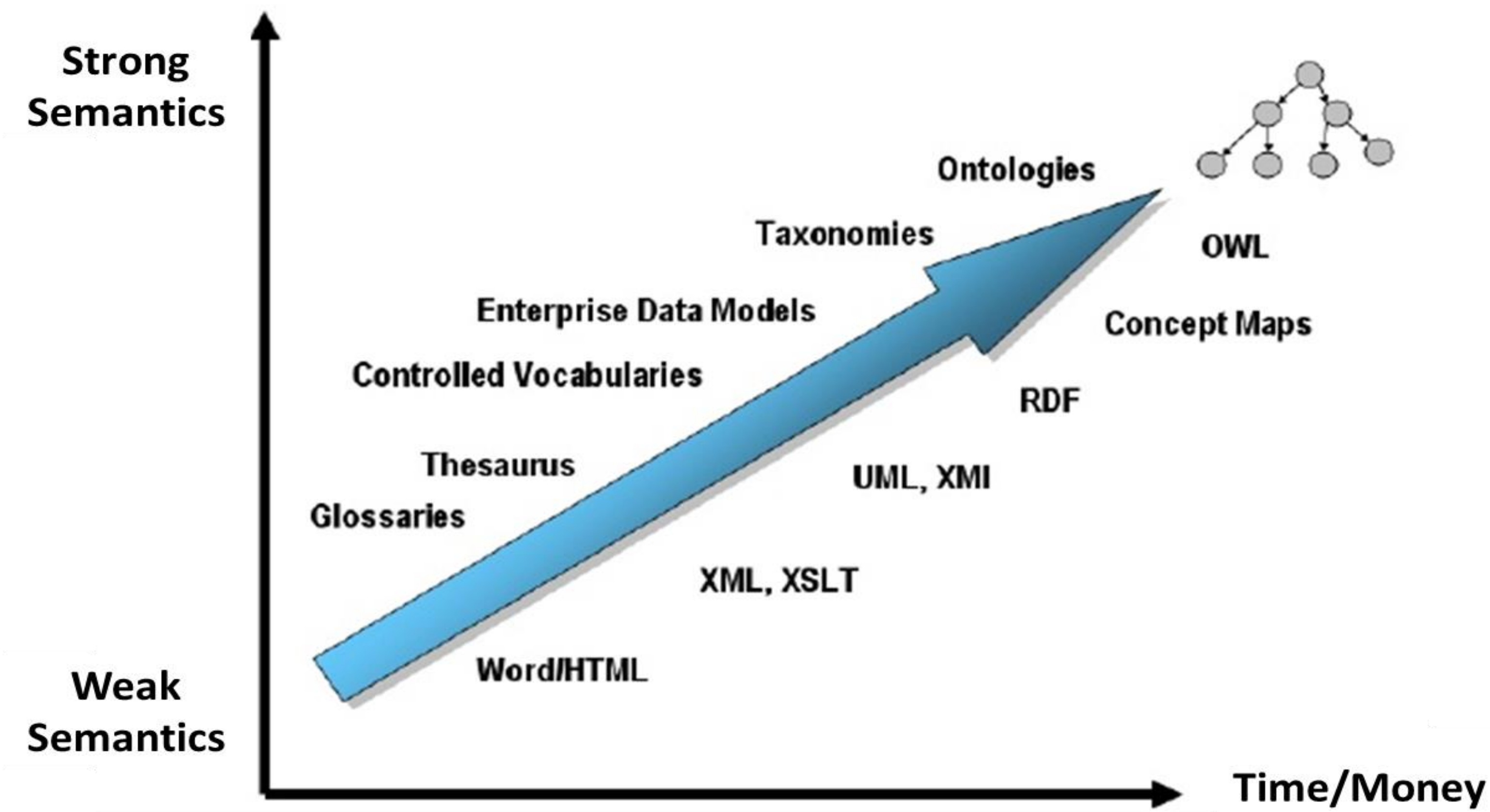
Levels of meaningfullness

- There is not just one single level of semantics that could be attached to a raw data element.
- Different levels of meaningfulness can be identified to describe data and device descriptions.



The cost of semantic clarity

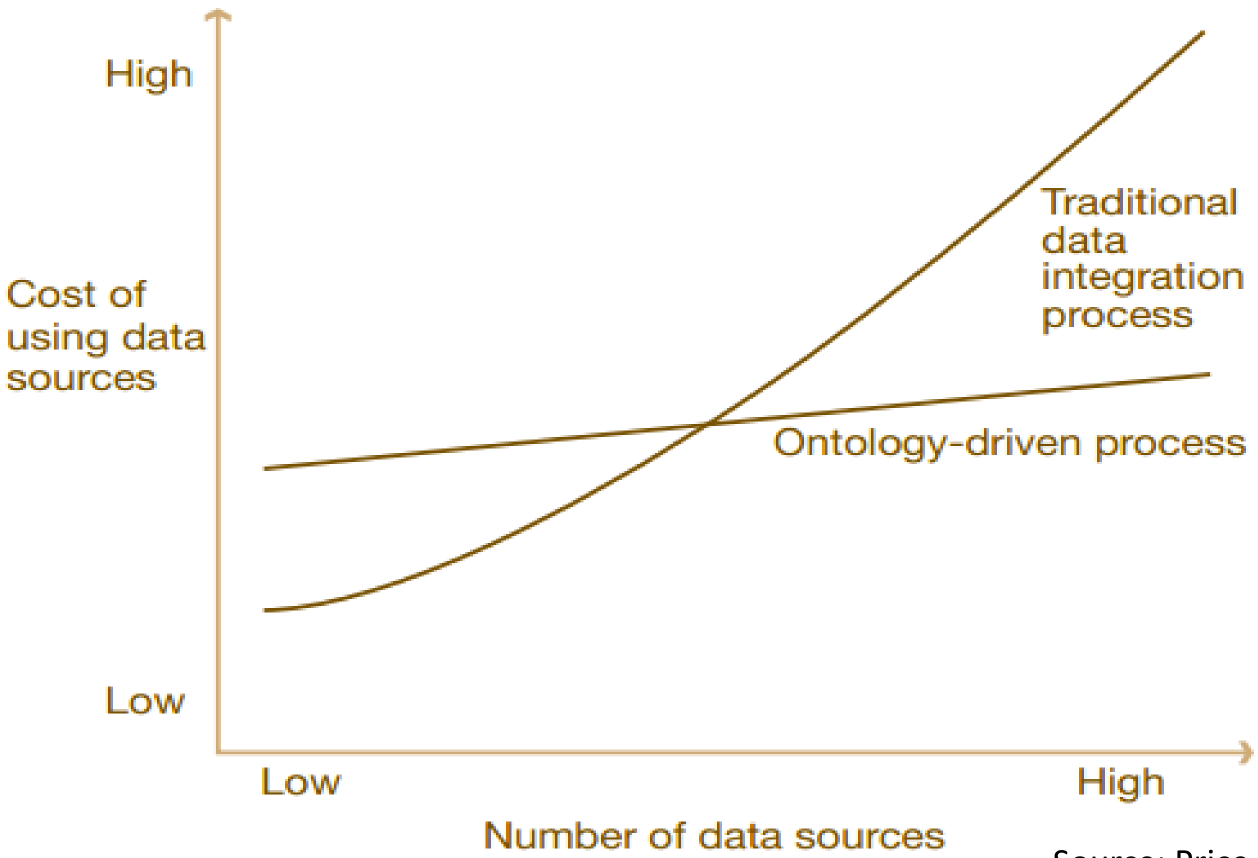
- Ontologies provides the highest level of semantic clarity however they are costly in terms of time and money.
- Is it reasonable to use ontologies ?



Source: Mike Pergman

The cost of data integration

- Ontology-driven approaches provides a lower costs when dealing with high number of data sources.
- It ensure interoperability for open and big environments.



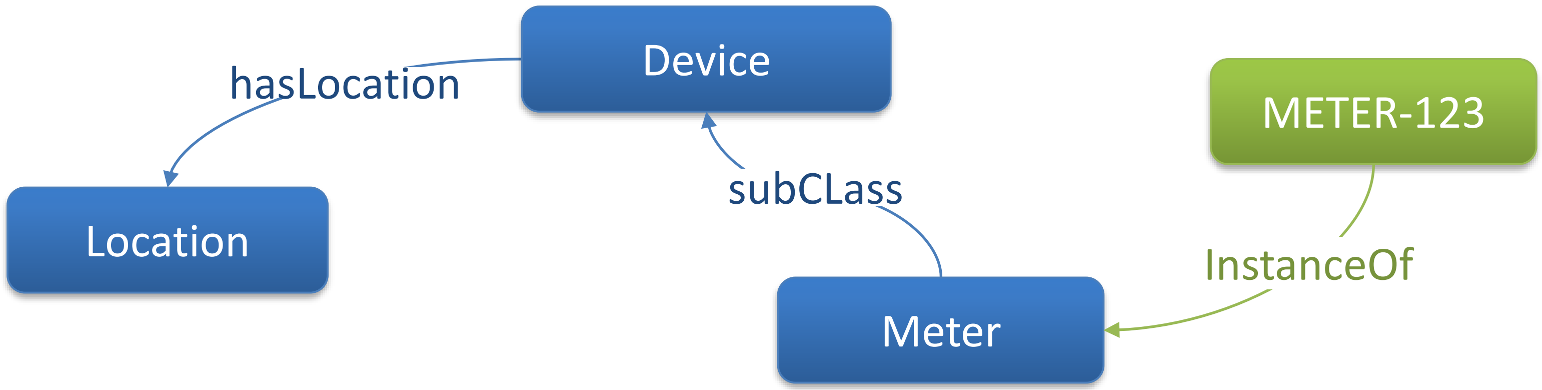
Source: Price Waterhouse Cooper

Semantic web and ontologies

- *"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in co-operation."*

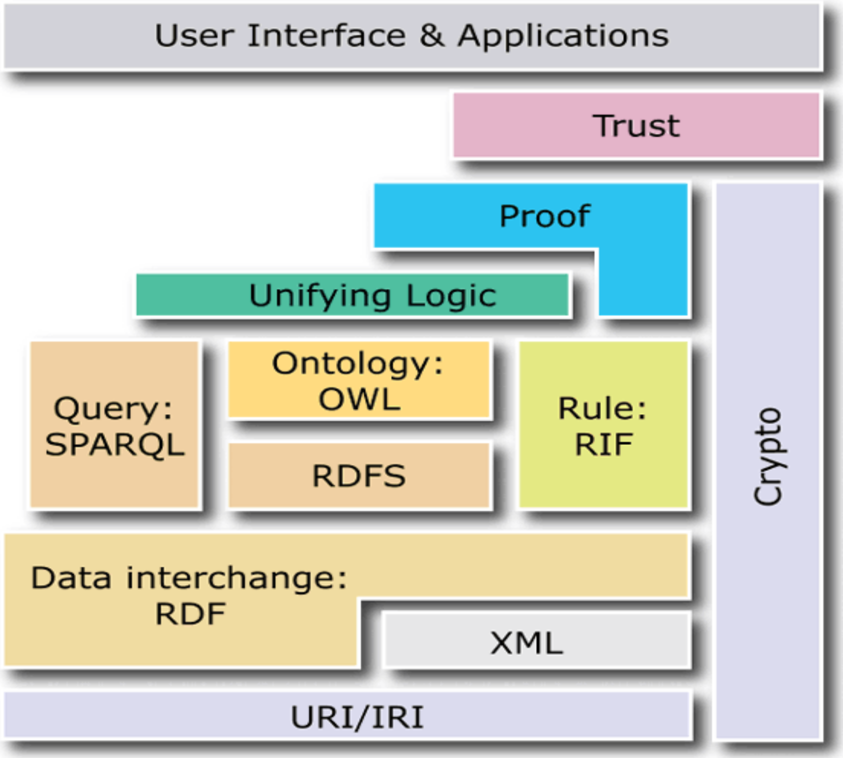
  -Tim Berners-Lee et al, 2001

- The term ontology is originated from philosophy. It is a formal specification of a domain including concepts and their relationships, attributes and some logical restrictions.
- Example:



Semantic web building blocs

- URI/IRI: Almost everyting is a URI.
- RDF/XML: Facts and relations organized in triples. mimic natural language sentences. Directed graph
- RDFS/OWL: Describe taxonomies and classification networks.
- SPARQL: Ontology querying: Select, Update, Construct, etc.)



Semantic IoT vs Semantic Web

- Semantic Web:
  - Relatively static content.
  - E.g. Semantic Wikipedia (dbpedia), annotated pages, etc.

- Seamantic IoT
  - Highly dynamic environment.
  - the meaning of data and the annotations can change frequently over time/space.
  - E.g. fleet tracking, patient monitoring, etc.

- The semantic IoT is more complex to manage than semantic web. It requires continuous monitoring, pre-processing, filtering, aggregation, annotation and integration.

Semantic IoT goals

- Effective data interoperability between devices and applications. Communication without any prior agreement.
- Generic interworking and automated management of resources.
- Semantic discovery and data querying.
- Semantic matching and binding of devices and applications.
- Semantic reasoning to infer new knowledge from a set of asserted facts.
- Better monitoring and understanding of the surrounding environment.
- Make smart decisions and dynamically adapt to environments changes.

Towards semantic IoT model

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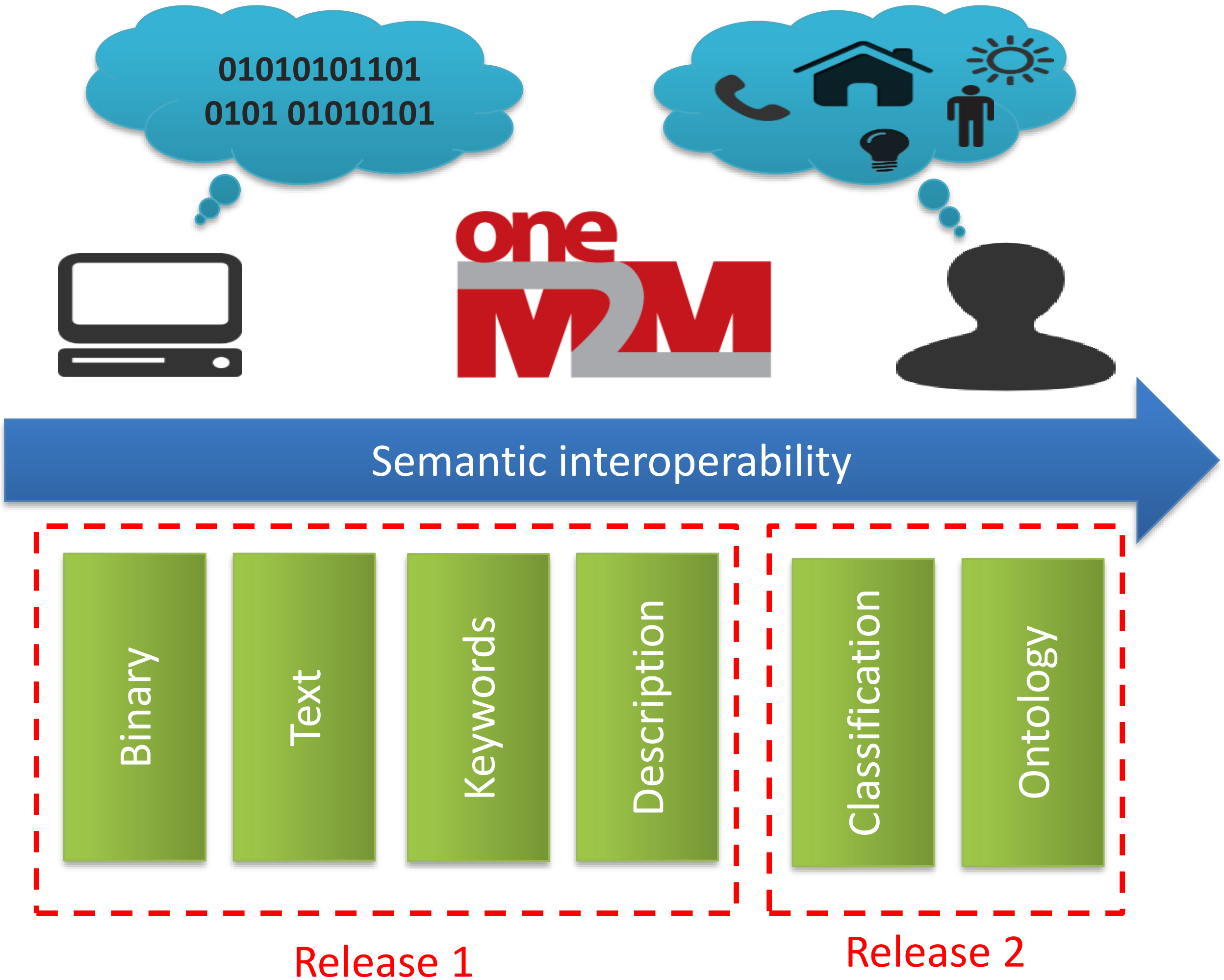
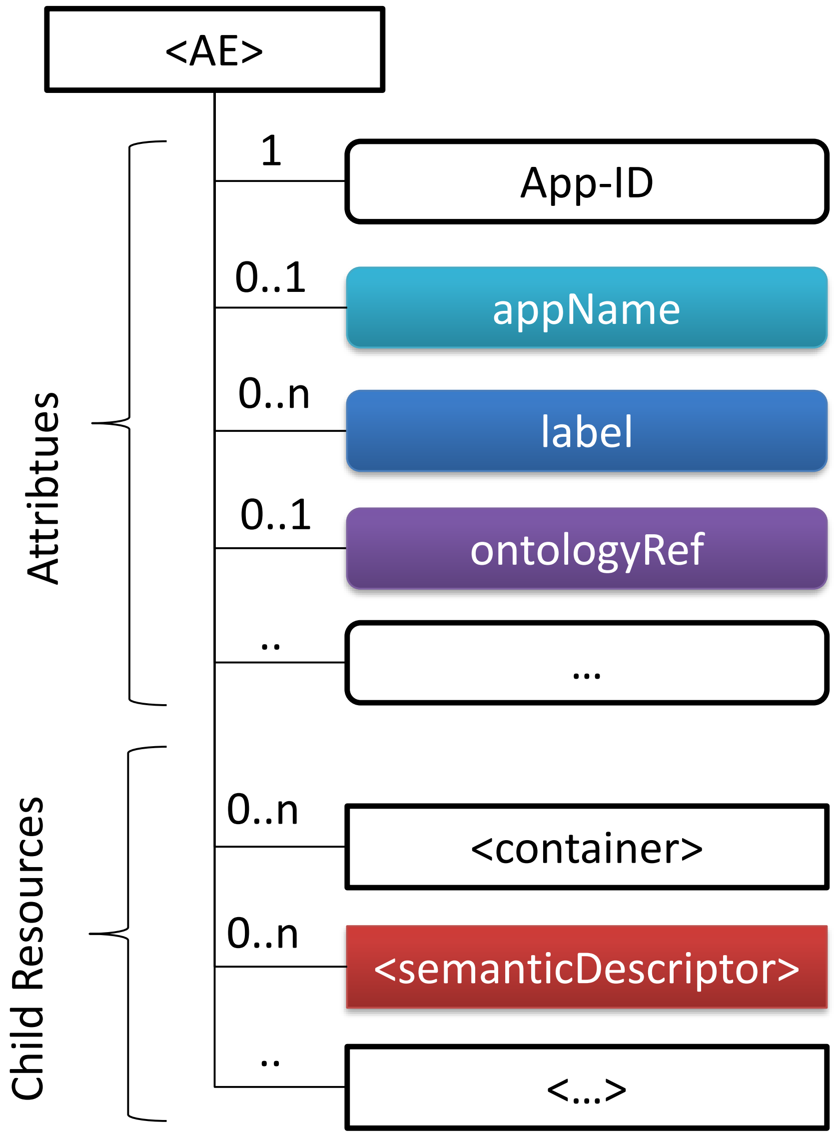
- We have good models and description frameworks. RDF, OWL, SPARQL
- Having good models and developing ontologies is not enough.
- Think of the applications and use-cases before starting to annotate the data.
- Semantic descriptions are intermediary solutions, not the end product.
- We should provide machine-interpretable but not machine-untreatable. Think of constrained devices in IoT.
- We should accept the fact that sometimes we do not need full semantic descriptions.

Semantic in oneM2M

- oneM2M offered minor semantic enhancement in release-1 and aims to provide full semantic support in the next releases.



Evolution of semantic in oneM2M



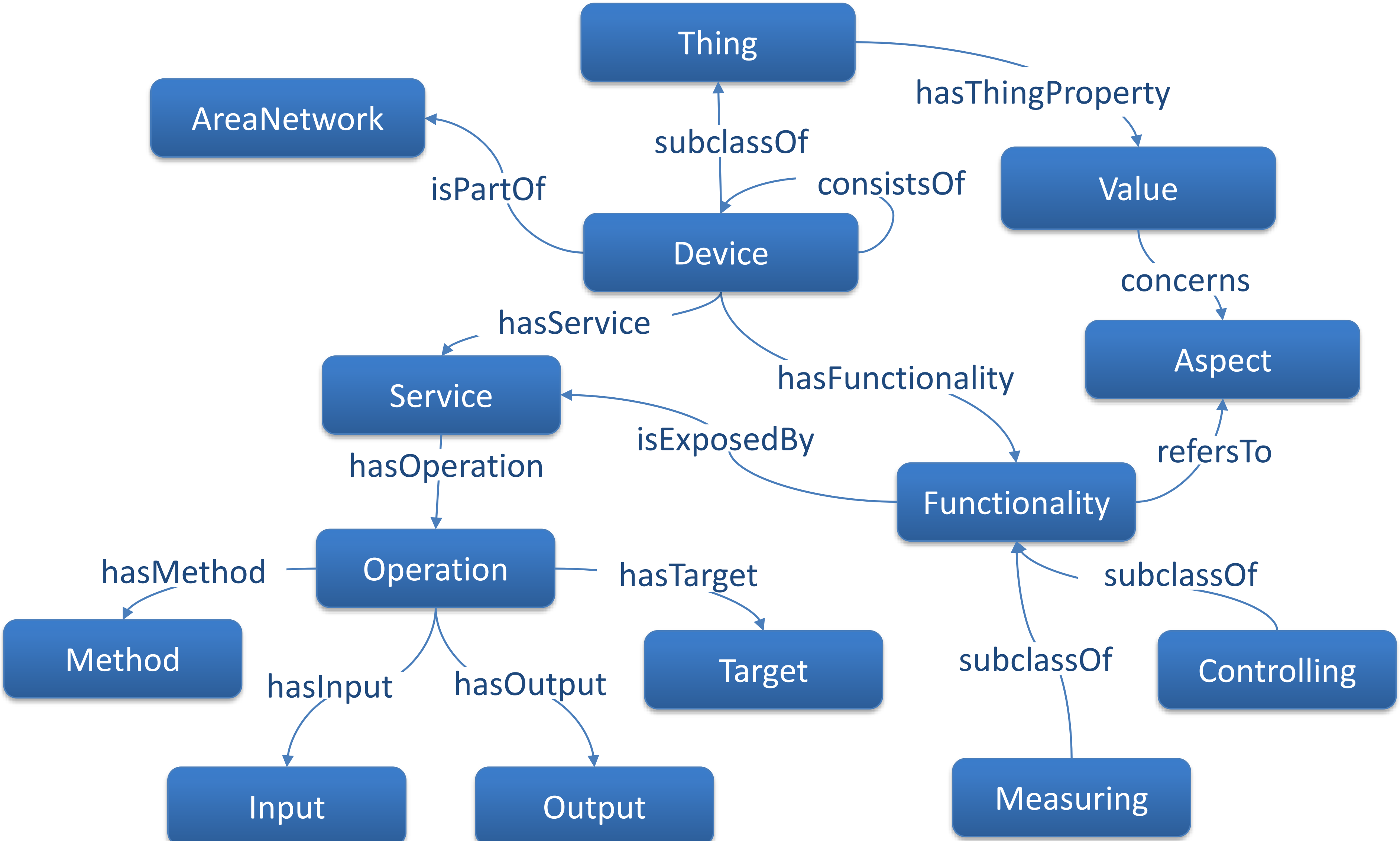
Release-1: Resource Names (Text) can be defined by the client and so have some meaning. E.g. « Temperature-AE »

Release-1: A set of labels (keywords) can be defined for each resorce. E.g. « temperature », « luminosity »

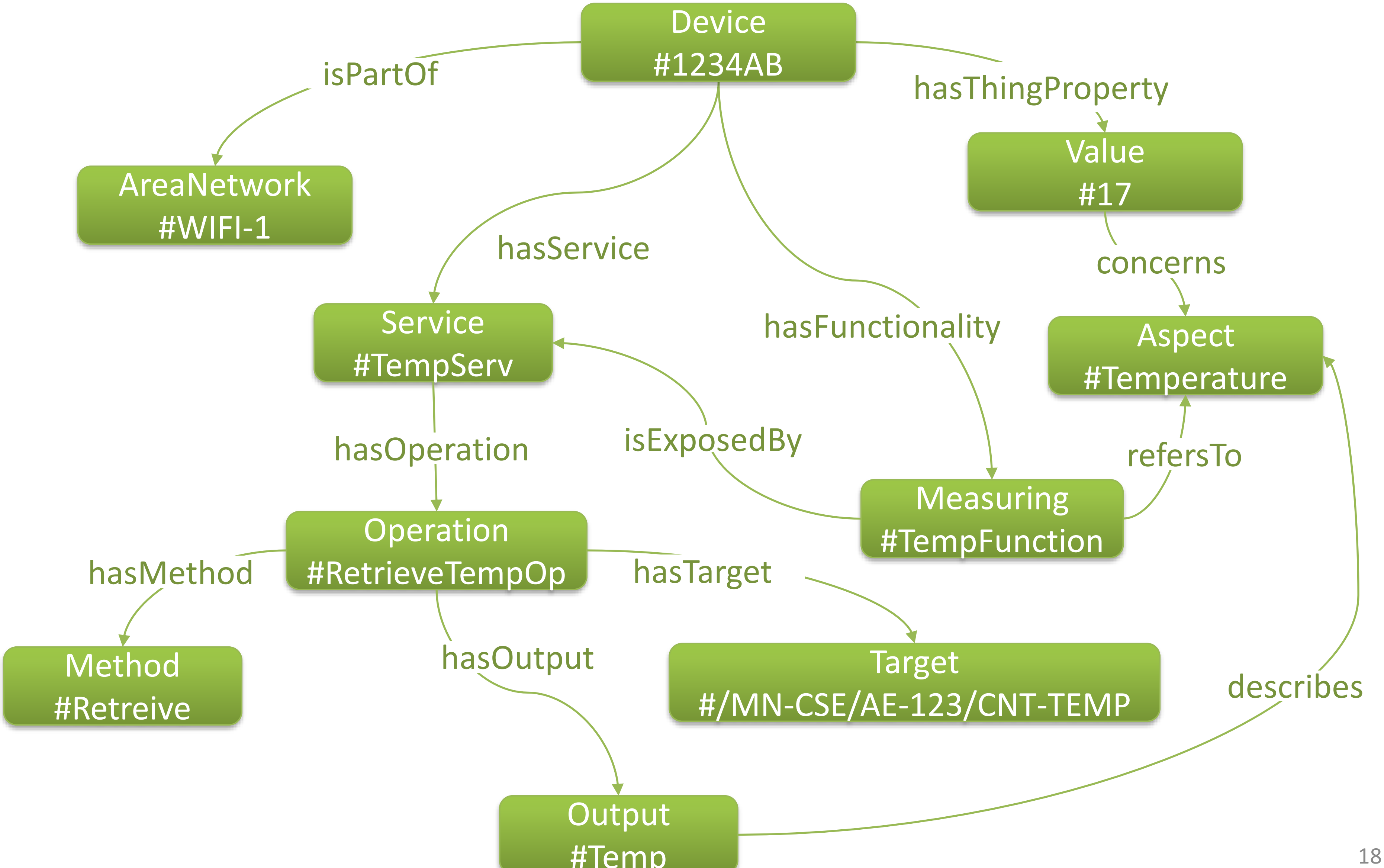
Release-1: Each resource can be linked to an ontology reference (description). E.g. « http://ontology.tno.nl/saref#Device »

Release-2: A complete semantic description can be added to a resource (Ontology). E.g.<RDF>…</RDF>

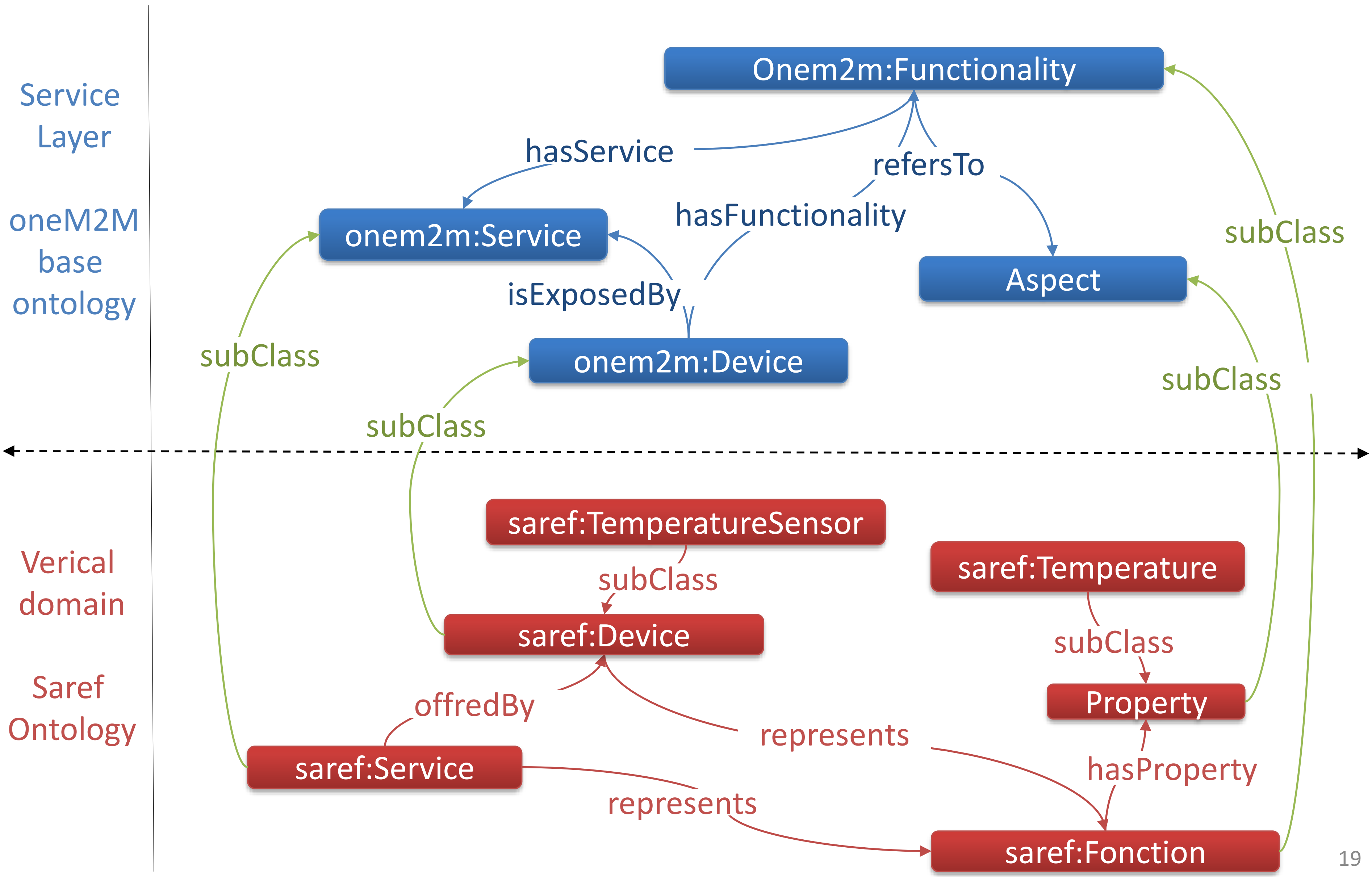
oneM2M base ontology model



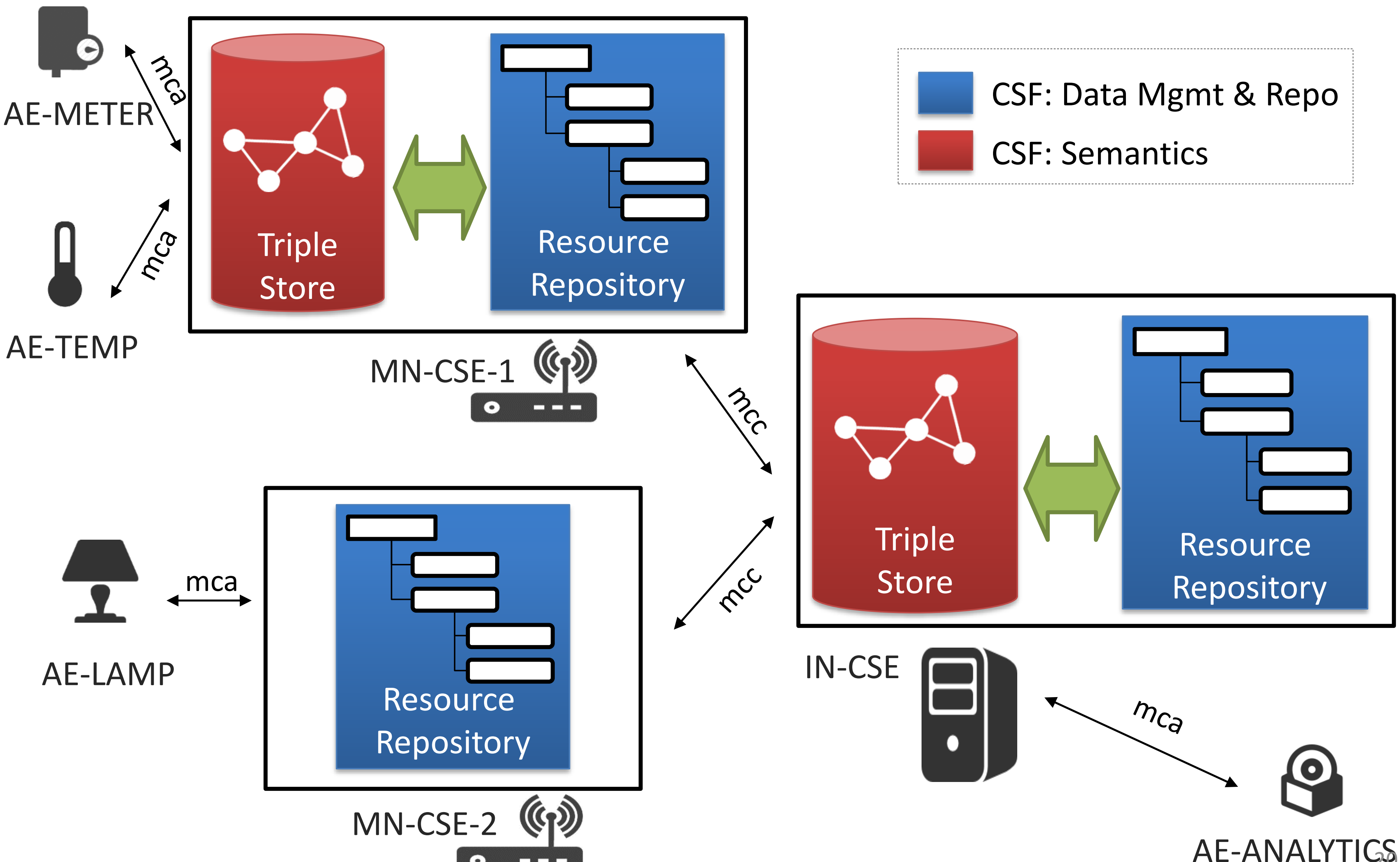
oneM2M base ontology instance



Mapping to vertical ontologies

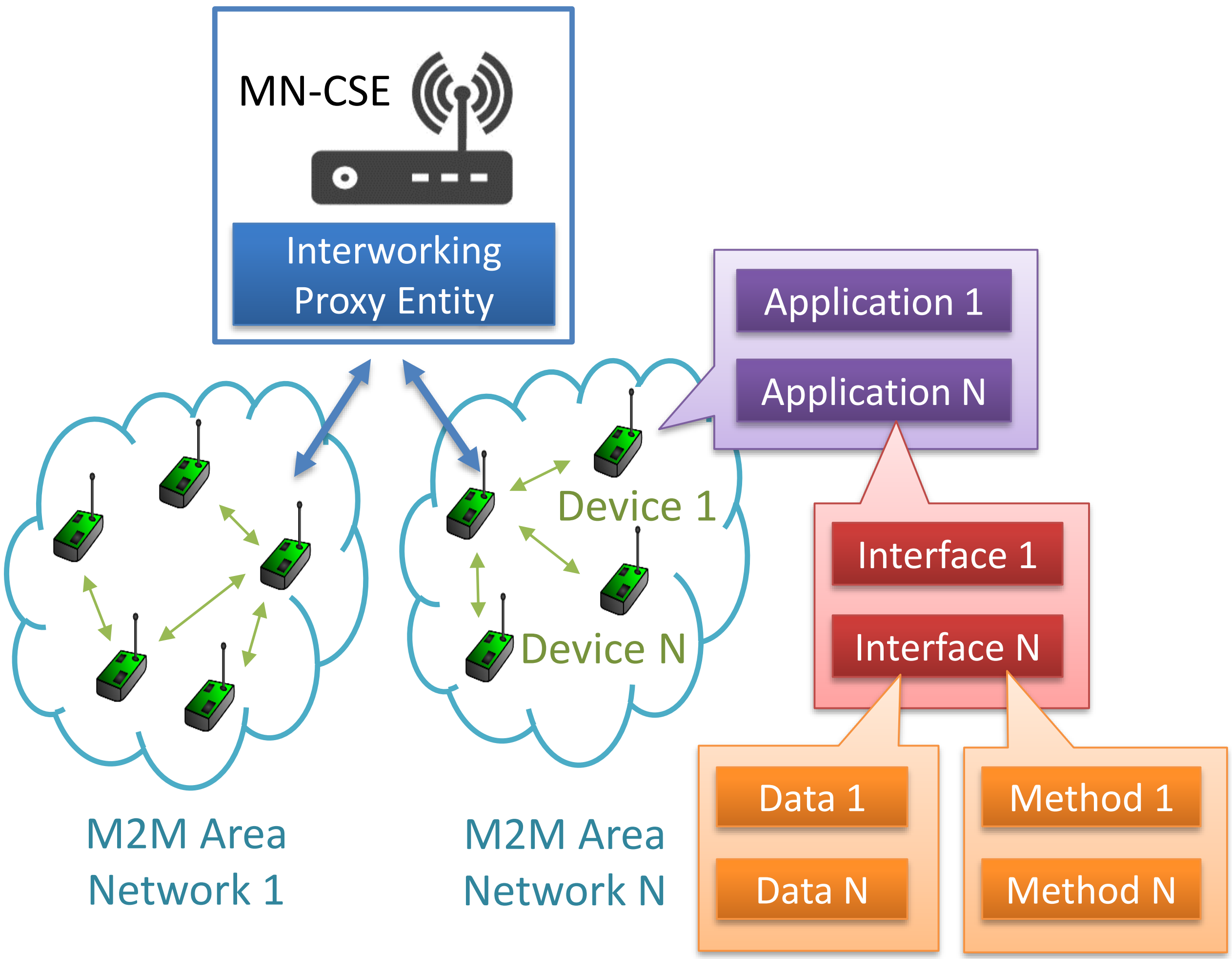


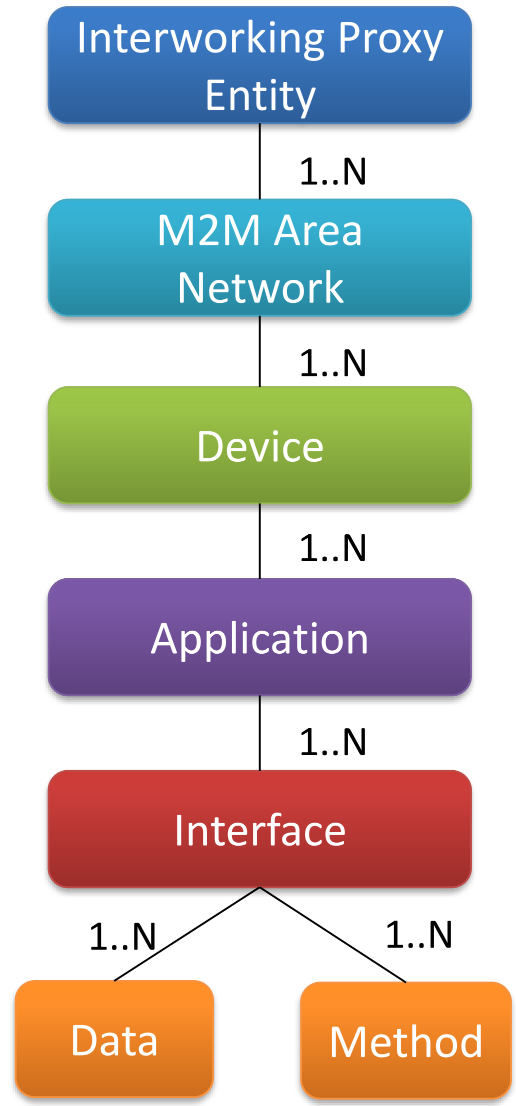
Semantic oneM2M archtiecture



Generic data modeling for interworking

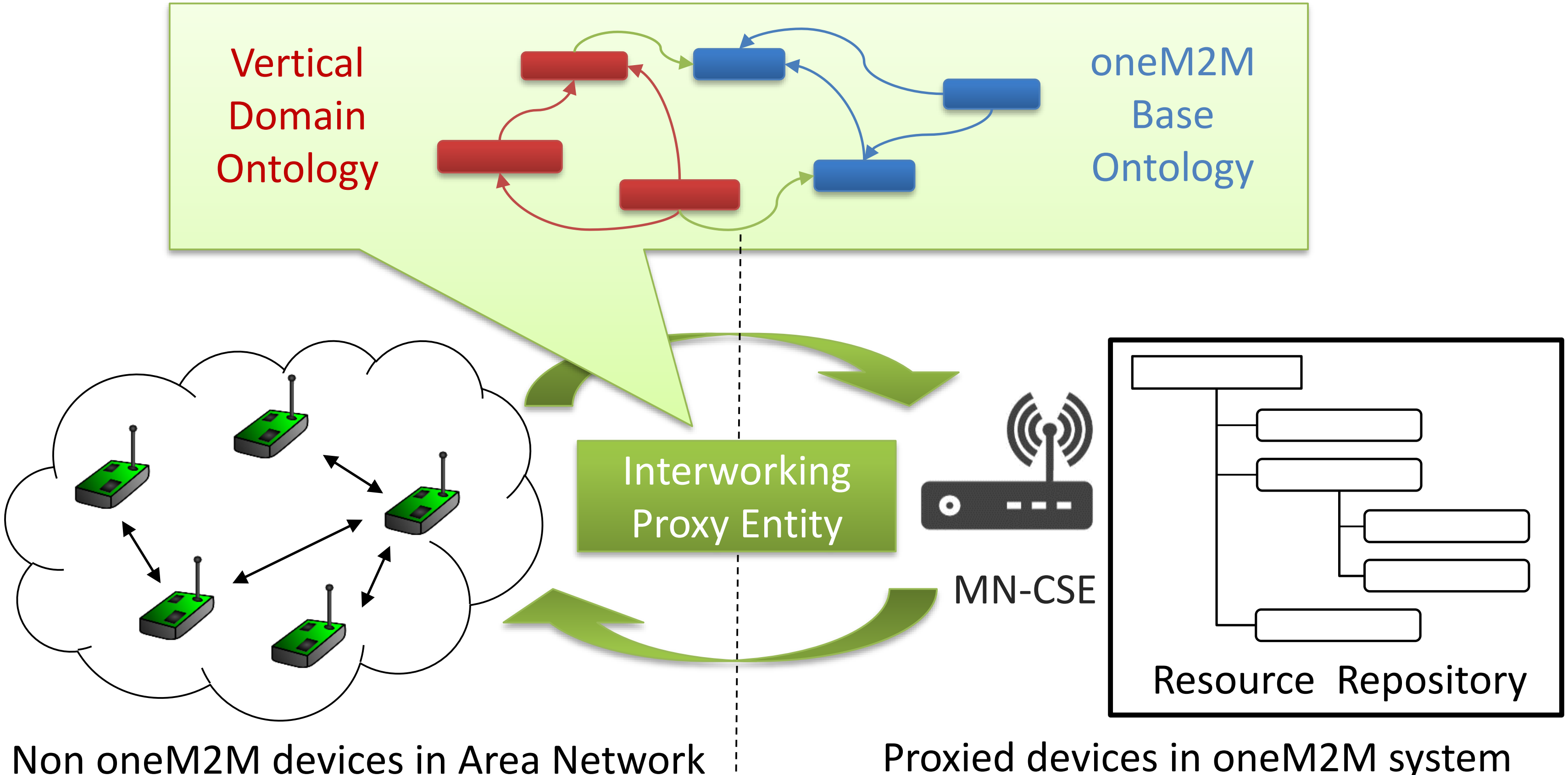
- Common abstract data model for non oneM2M devices.





Generic interworking using semantic

- Non oneM2M devices are described using the oneM2M base ontology + domain specific extensions.
- The Interworking Proxy Entity translates the ontology instance to resources on the CSE based on pre-defined instantiation rules.



oneM2M semantic challenges

- Access Rights management of semantic data
  - How to protect non open data in oneM2M ?
  - Include Access Control Policy in the oneM2M base ontology ?
- Semantic querying and discovery
  - SPARQL through « mca » interface ?
- Semantic reasoning
  - infer new knowledge for dynamic reconfiguration.
- Distributed triple store
  - How to connect remote triple store together. Via « mcc » oneM2M interface ?
- Performance and support of constrained environments

Thank you for your Attention

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