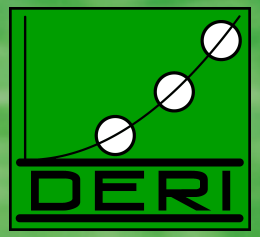

Linked Data meet Sensor Networks

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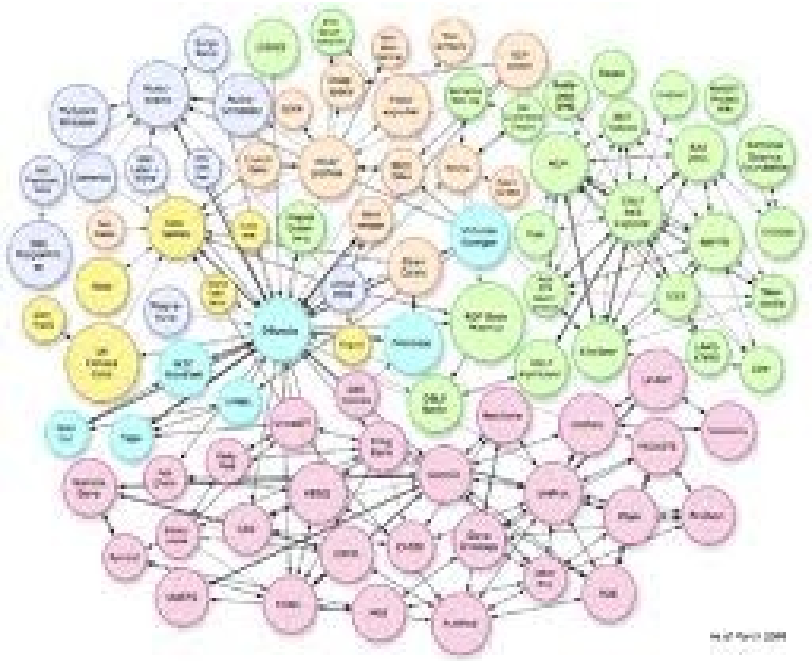
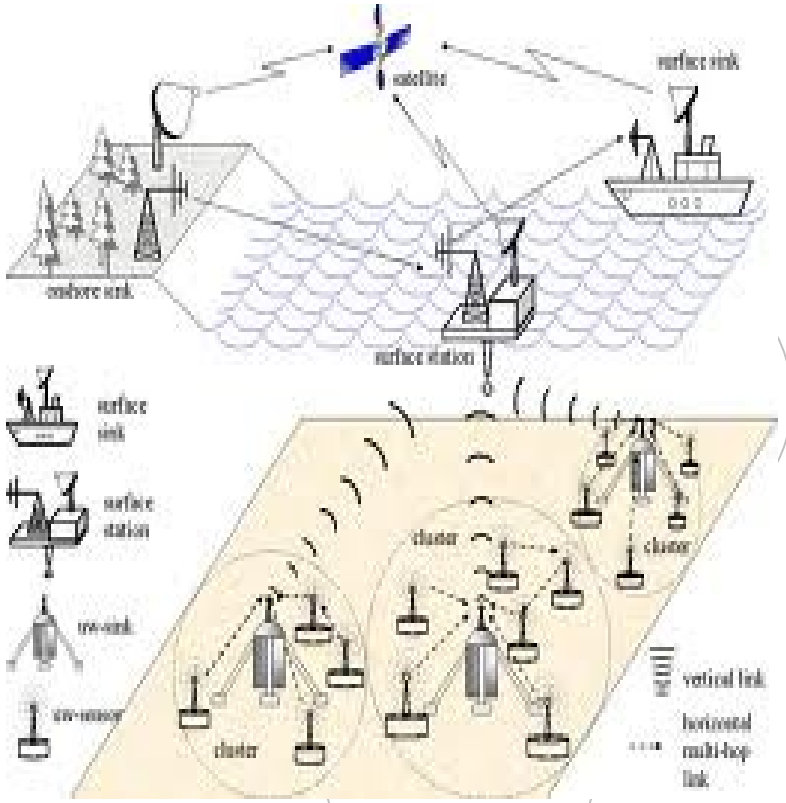
Linked Data meet Sensor Networks



?



Linked Data meet Sensor Networks

- What's a Sensor Network without Semantics ?

How is the ocean like at Cancùn right now?

That's Semantics for sensors!

- How can all the sensors that are acquiring oceanographic data in Cancùn be found?
- Self-awareness
  - SN expose their own machine-understandable description
- Several data representations are used. How can I understand these measurements?

That's Semantics for sensor data!

- Observations and measurements machine-understandable description

Linked Data meet Sensor Networks

- What's a Semantic Sensor Network without Linked Data ?

How is the ocean like at Cancùn right now?

- Two different SN located on the coastline detect a calm ocean.

… at the same time ...

- Another SN detect a movement of earth plates

1)How can we check if this movement is generally associated with storm surges?
2)If it's so, how can we link this hazard warning to the user answer?

1.1 Search the LoD cloud to eventually create proper links with similar data regarding earth plates.

That's Linked Data!

That's Linked Data benefit!

2.1 Search the LoD cloud to eventually create proper links
2.2 Linkable SD about earth plates detected. Their representation already is linked to the storm surge hazard

Linked Data meet Sensor Networks : State Of the Art - standards

- Definition of Standards
  - For transducers: IEEE1451, Radiation detection standards : ANSI N42
  - Open Geospatial Consortium's Sensor Web Enablement (OGC's SWE)
    - Sensor-centric : sensor Model Language (sensorML)
    - User-centric : Observations & Measurements (O&M)
- Removal of interface heterogeneity among networks
  - Concept incompatibilites not solved yet

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies

SSN ontologies describe different aspects:

- Sensor / Device
  - System, component, types of sensors
- Capabilities
  - Condition, resolution, latency
- Process
  - Input, output, effect
- Physical Properties
  - Location, platform, deployment, power supply
- Observation
  - Quantity, feature, Unit of Measurement
- Networks
  - Energy efficiency, hierarchy, routing algorithm

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies

- Issue: absence of 'standard' ontologies for each domain
- Example:
  - *Domain*: Computer Science ontologies onto1; onto2
  - *Concepts:* onto1:monitor and onto2:rotinom
  - Both refer to 'computer screen' but there's no triple as *<onto1:monitor owl:sameAs onto2:rotinom>*

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies

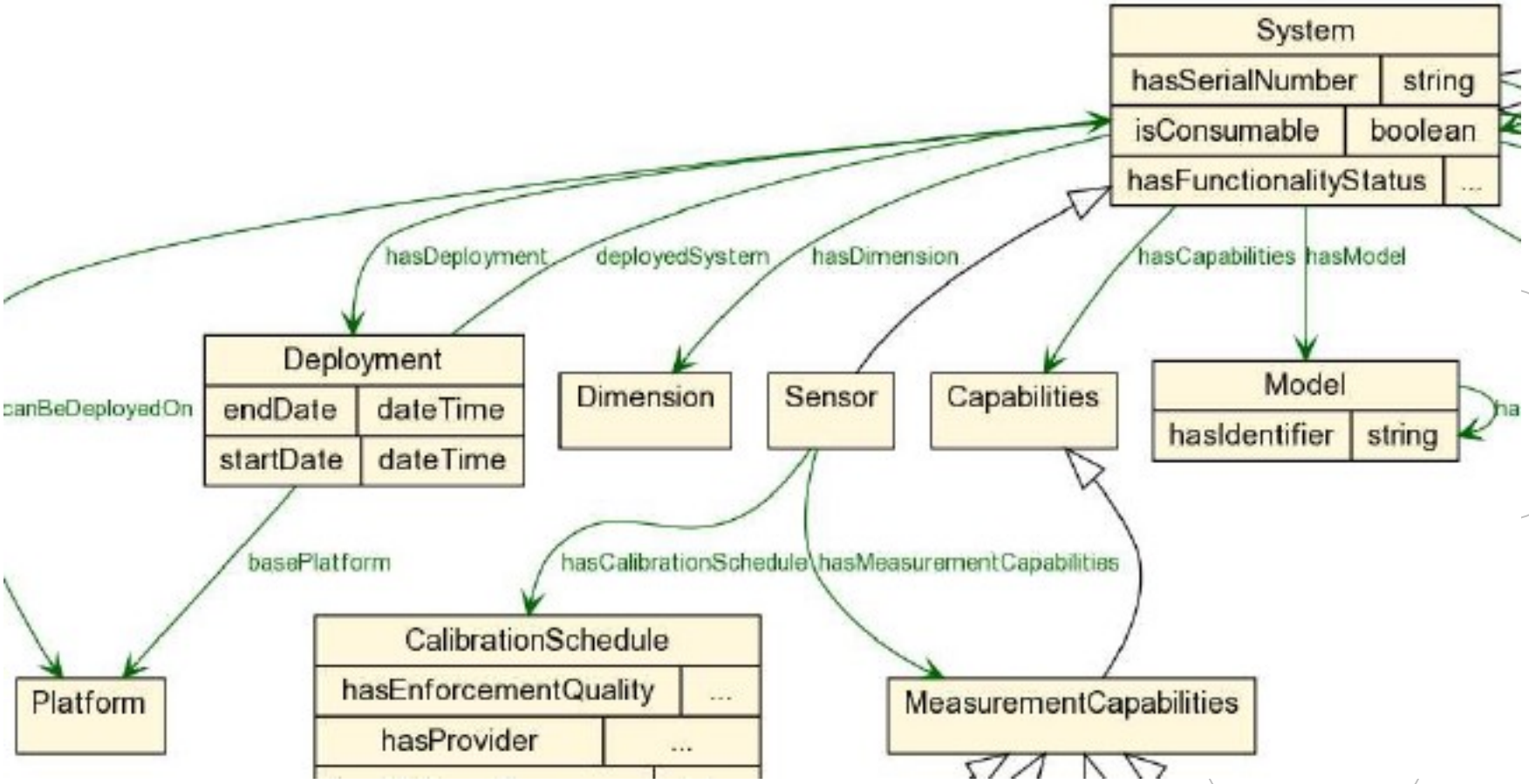
- Solution: Alignment with Upper-Level (Foundational) ontologies
  - i.e. DOLCE, SUMO
  - General cross-domain concepts from natural philosophy
- Alignment with a foundational ontology allow more interoperability
  - Easily happens onto1 and onto2 don't know each other, in contrast Foundationals are all known
  - onto1 and onto2 aligned both to DOLCE

→ monitor and rotinom are now related

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies

- MMI Device ontology ; CSIRO sensor ontology
  - Focused on system and capabilities, Process composition, Operational and Response model
- OOSTethys Model ; CESN Ontology
  - Sensor System: aggregation of sensors mounted on the same platform
  - Sensor Network : spatially distributed communicating sensors or sensor systems.
  - Instrument: several sensors container

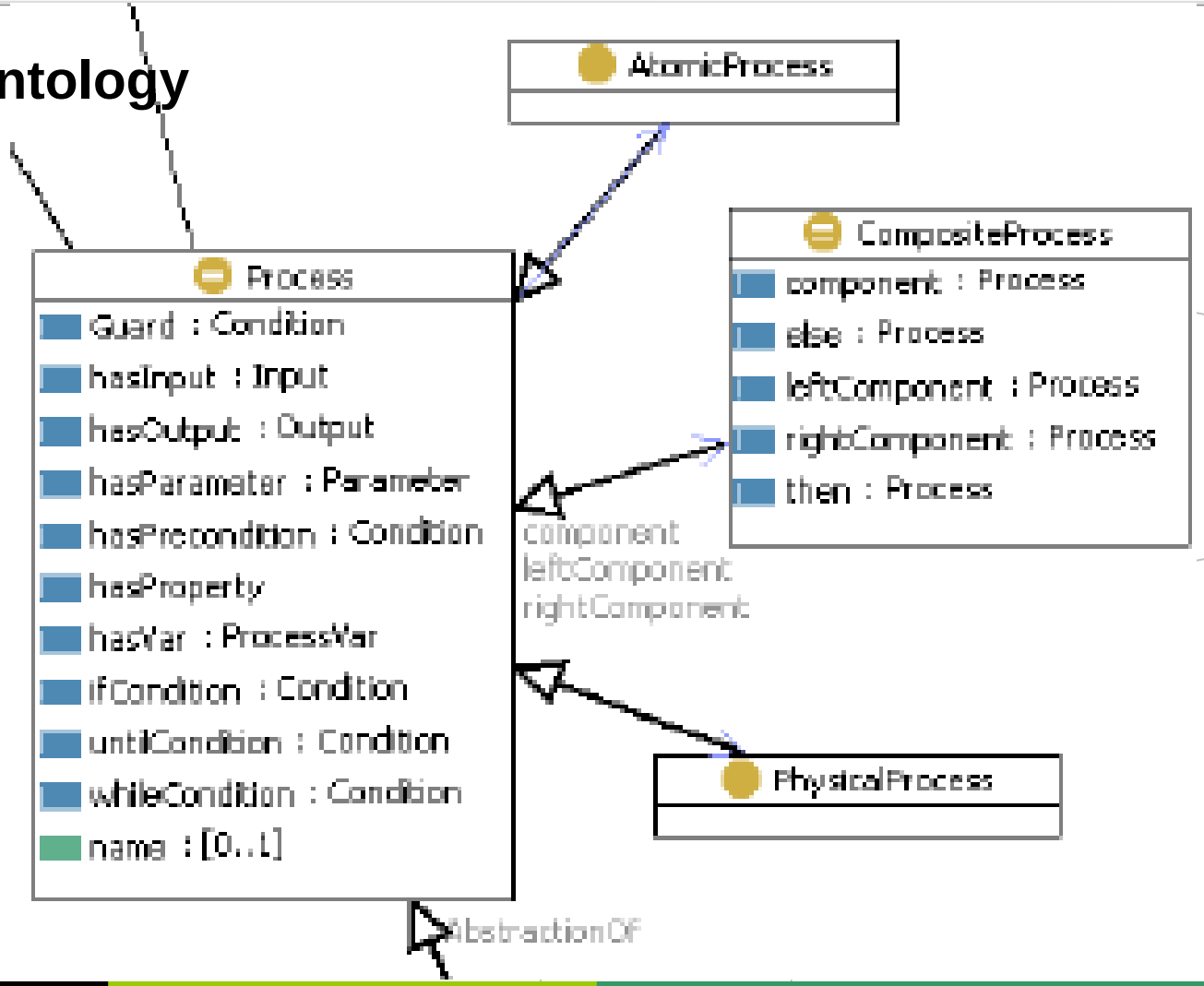
Linked Data meet Sensor Networks : State Of the Art – sensor ontologies example



MarineMetadataInteroperability (MMI) Device Ontology

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies example

CSIRO Sensor Ontology

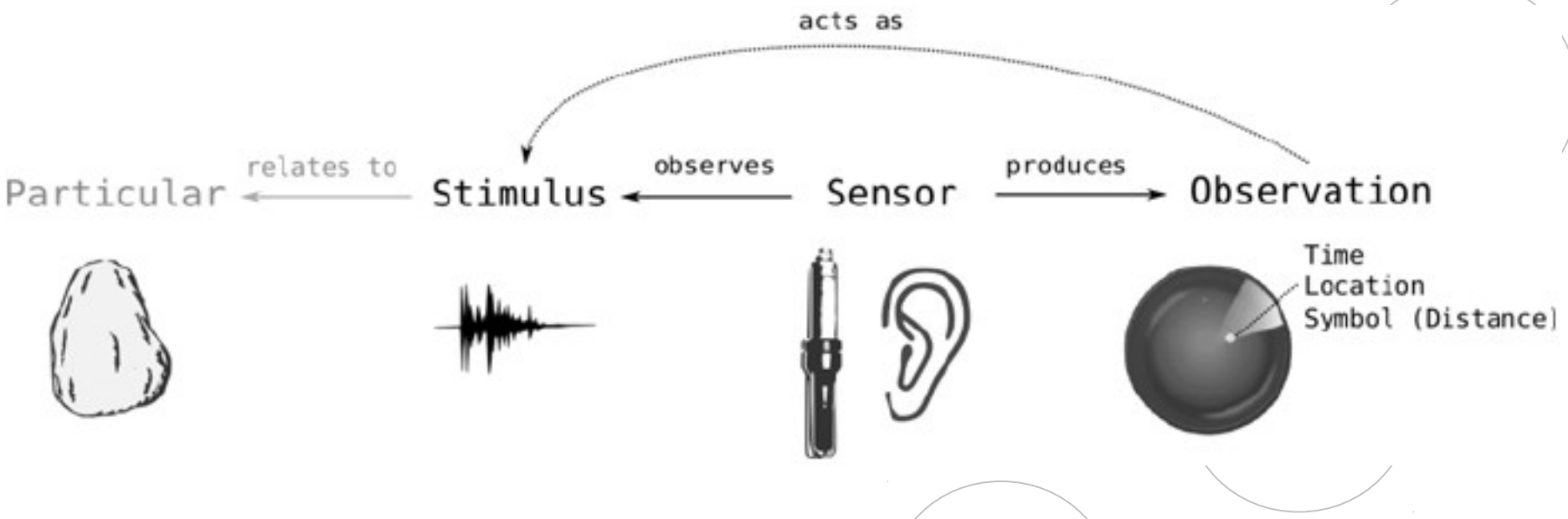


Linked Data meet Sensor Networks : State Of the Art – sensor ontologies

- SWAMO
  - Dynamic and composable interoperability between SensorWeb products and services
- A3m3
  - Self-discovery, Self-description, Classification of devices and their capabilities
- Sensors and Compositions
  - Query not satisfied by any existing sensor → Composition of a satisfying « virtual sensor » from the existing ones

Linked Data meet Sensor Networks : State Of the Art – sensor ontologies - Observations

- Kuhn
  - Bridge together sensorML and O&M by focusing on Stimuli



Linked Data meet Sensor Networks : State Of the Art – sensor ontologies - Observations

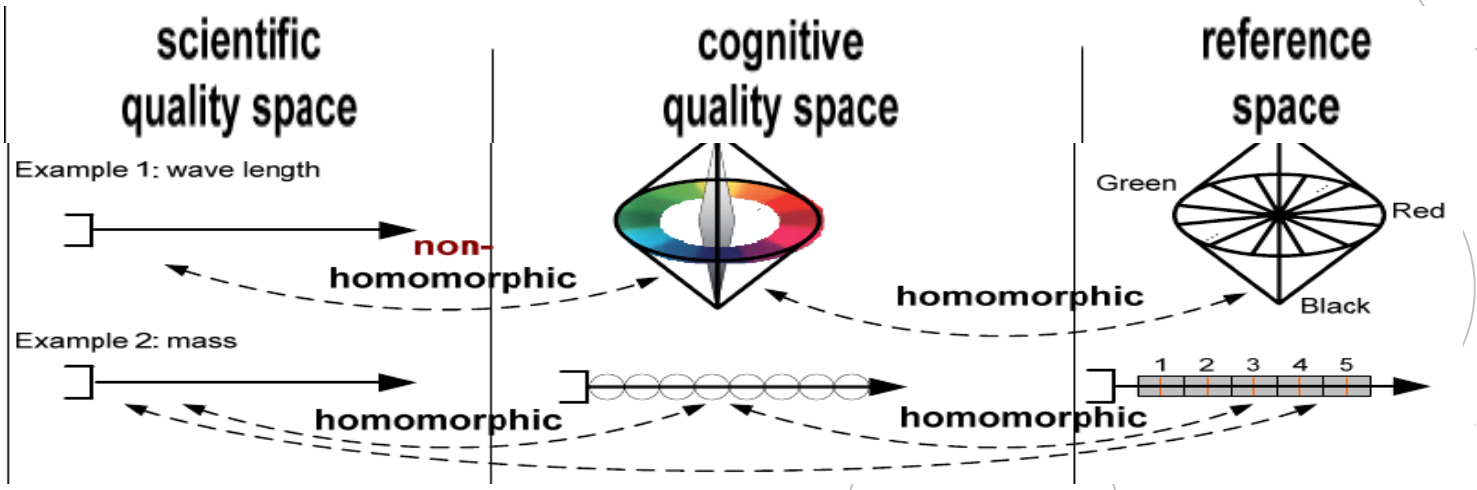
- Probst 2007
  - Reference region

    maps to

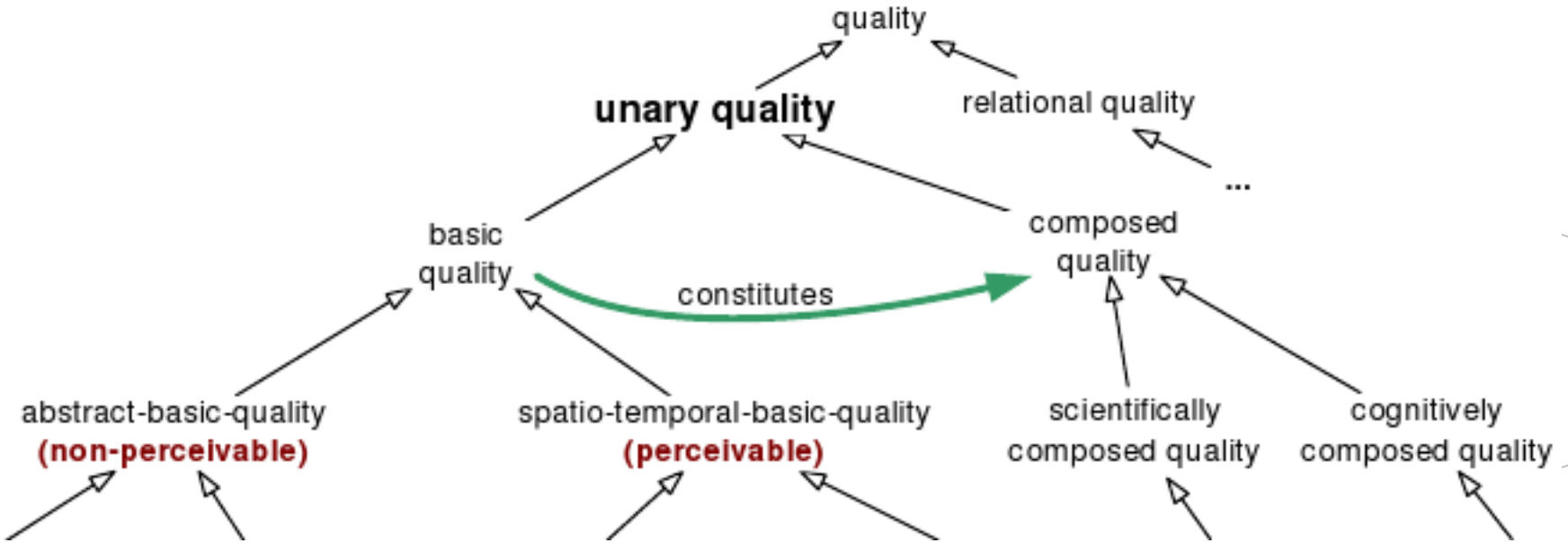
    Quality region (magnitude of the observed quality)
  - Quality regions

    ---Scientific

    --- Cognitive (human personal perception of magnitudes)



Linked Data meet Sensor Networks : State Of the Art – sensor ontologies - Observations



Particular of the taxonomy of Qualities proposed by Probst

Linked Data meet Sensor Networks : State Of the Art – W3C SSN-XG

- W3C SemanticSensorNetwork-XG Incubator Group
- Main motivation
  - No existing SSN ontology included all the basic concepts
- Main tasks :

1) Add semantic annotations to existing standards

2) Semantic Sensor Network Ontology (avoiding to reinvent any wheel)

Linked Data meet Sensor Networks : State Of the Art – W3C SSN-XG

1) Semantic annotation added to the OGC standards

- XLink used to encode Semantic Annotations
- RDF interpretation of Xlink annotations

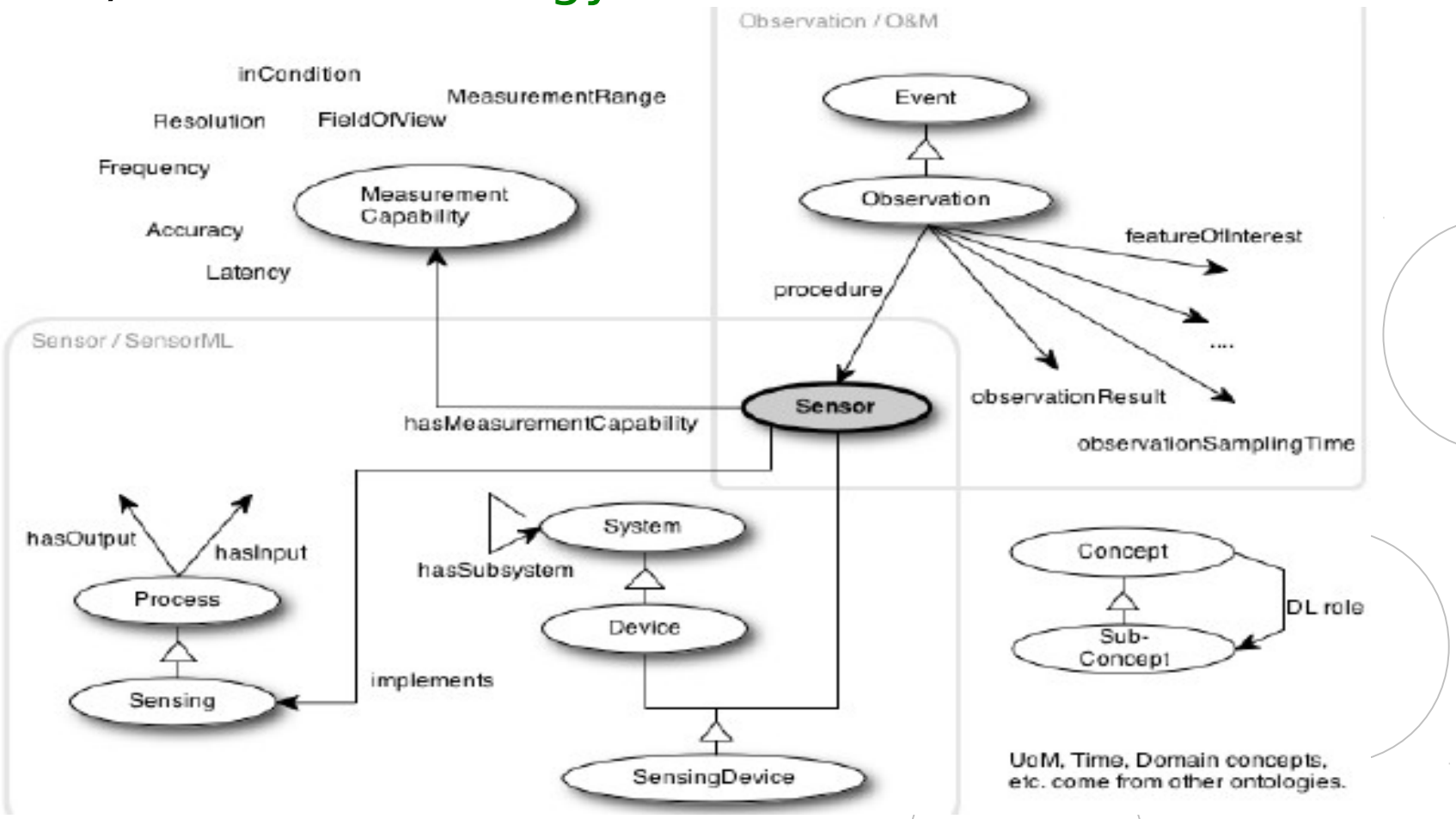
Example :

- Location (as a Feature)

```
<sos:featureOfInterest
      xlink:href="http://sws.geonames.org/5248611/"
      xlink:role="http://www.w3.org/2009/SSN-XG/Ontologies/SensorBasis.owl#Location"
      xlink:arcrole="http://www.w3.org/ns/sawsdl#modelReference"/>
```

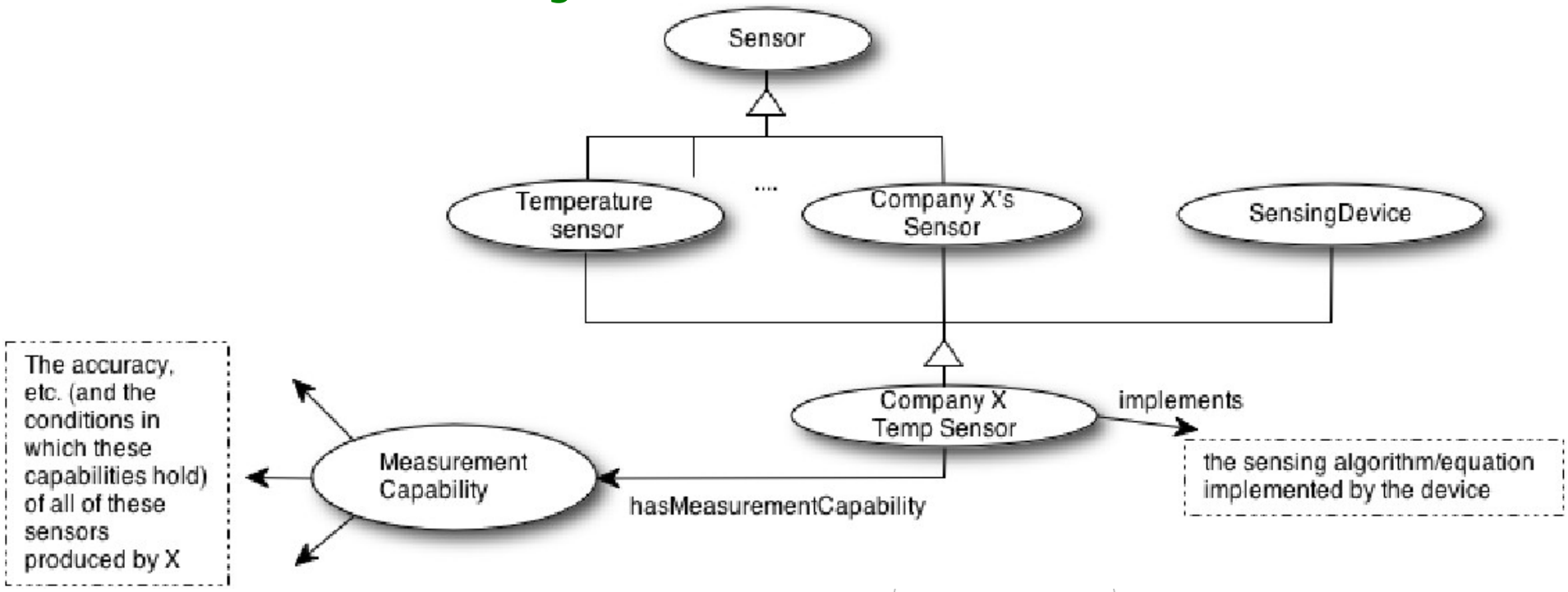
Linked Data meet Sensor Networks : State Of the Art – W3C SSN-XG

1) SSN-XG ontology

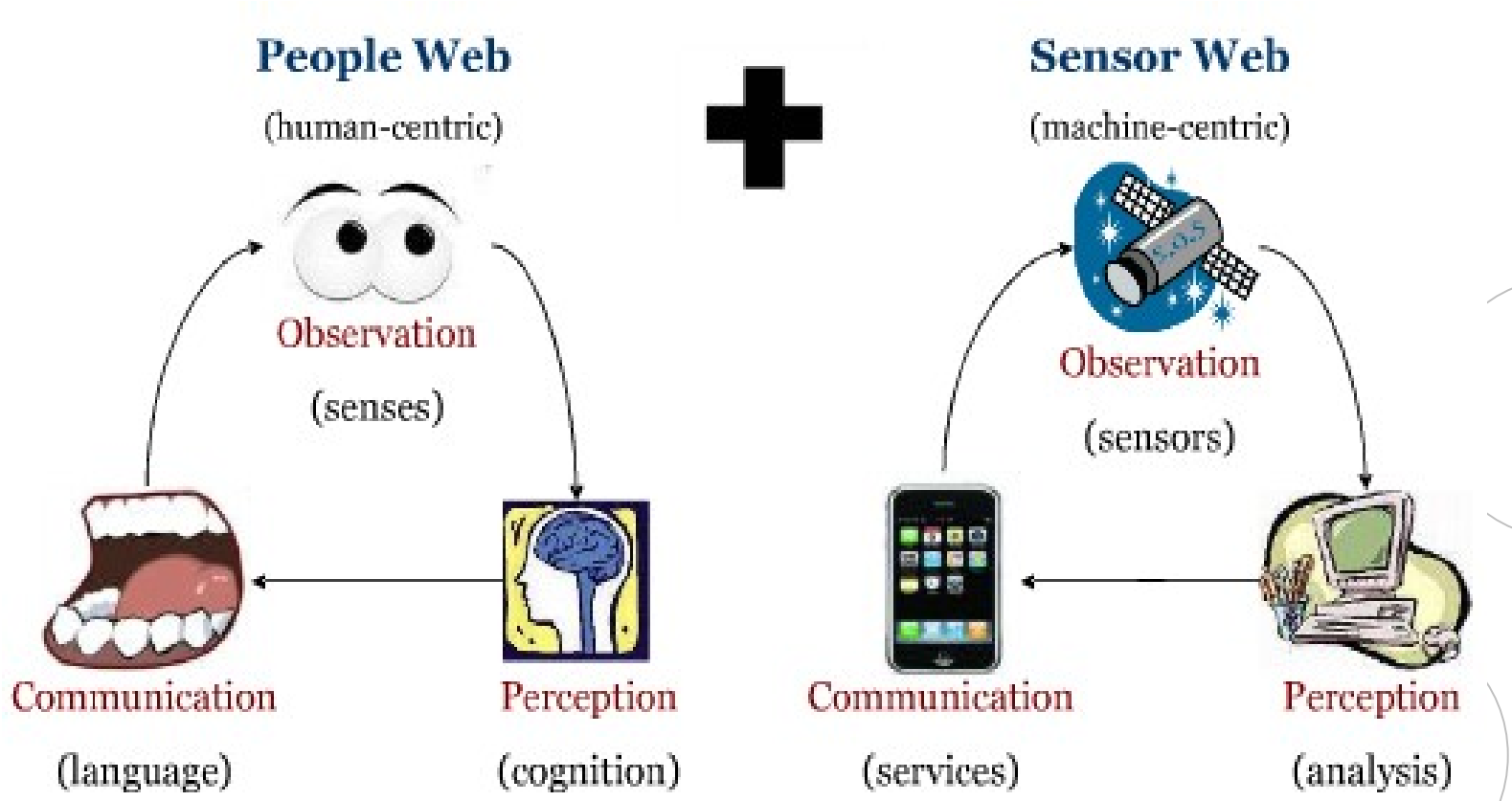


Linked Data meet Sensor Networks : State Of the Art – W3C SSN-XG

- Allow to express :
  - sensor concepts, types, instances
- DescriptionLogic (DL) reasoner can classify concepts and instances considering those other data



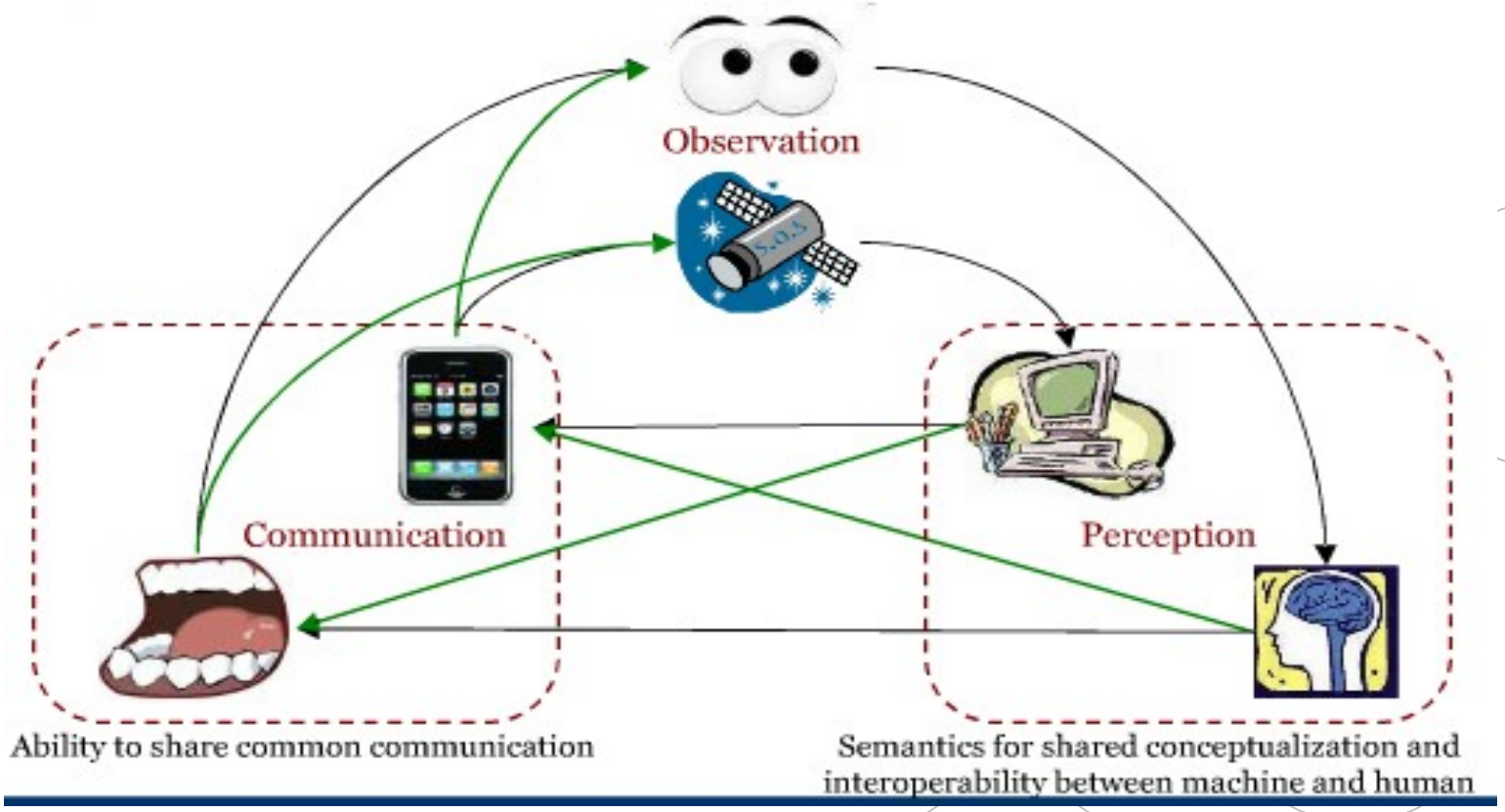
Linked Data meet Sensor Networks : Not yet done



From Amit Sheth's “Computing for Human Experience: Sensors, Perception, Semantics, Social Computing, Web N.0, and beyond”

Linked Data meet Sensor Networks : Not yet done

- = Human and Machine working in harmony



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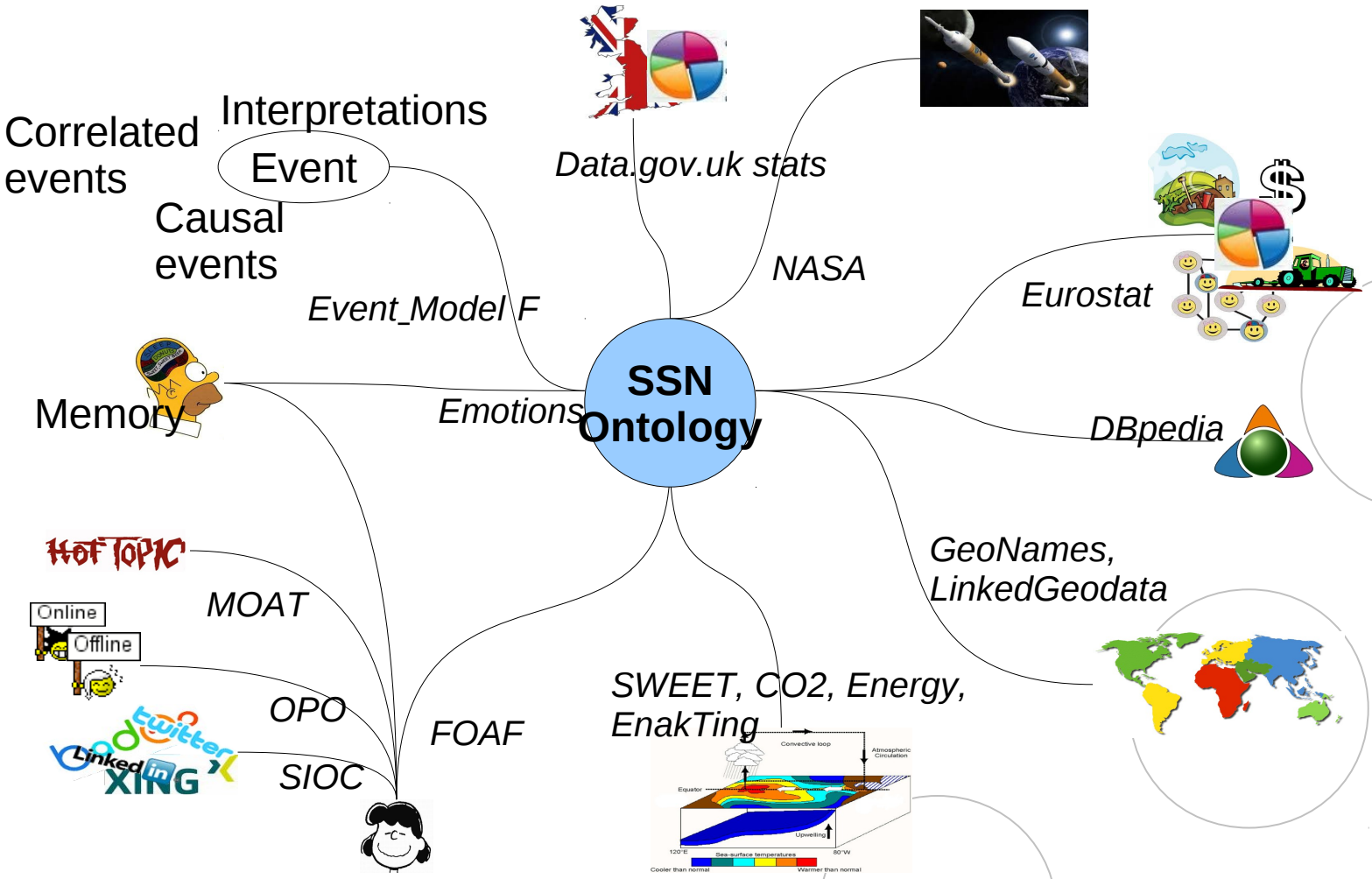
Linked Data meet Sensor Networks : Not yet done

- Linked Sensor Data are not yet completely implemented
  - Meta description of dataset
  - Main Issues : Web of Data Discovery
  - Good hint : voID (vocabulary of Interlinked Dataset) plus concept from ontologies aligned with Upper level ones
- No spread usage of rich expressivity by OWL or RDFS
- Query SPARQL : exactly correct ontology terms need to be inserted in the query

Linked Data meet Sensor Networks : Not yet done



References

- Five challenges for the Semantic Social Web - O. Corcho, R. Castro
- Computing for Human Experience - A. Sheth
- Review by W3C SSN-XG

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