Institut Mines-Télécom

Choosing your ontologies for sensor data applications

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http://maxime-lefrancois.info/

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Une école de l'IMT

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OGC® Making location count.

W3C®

ETSI

1. Who we are

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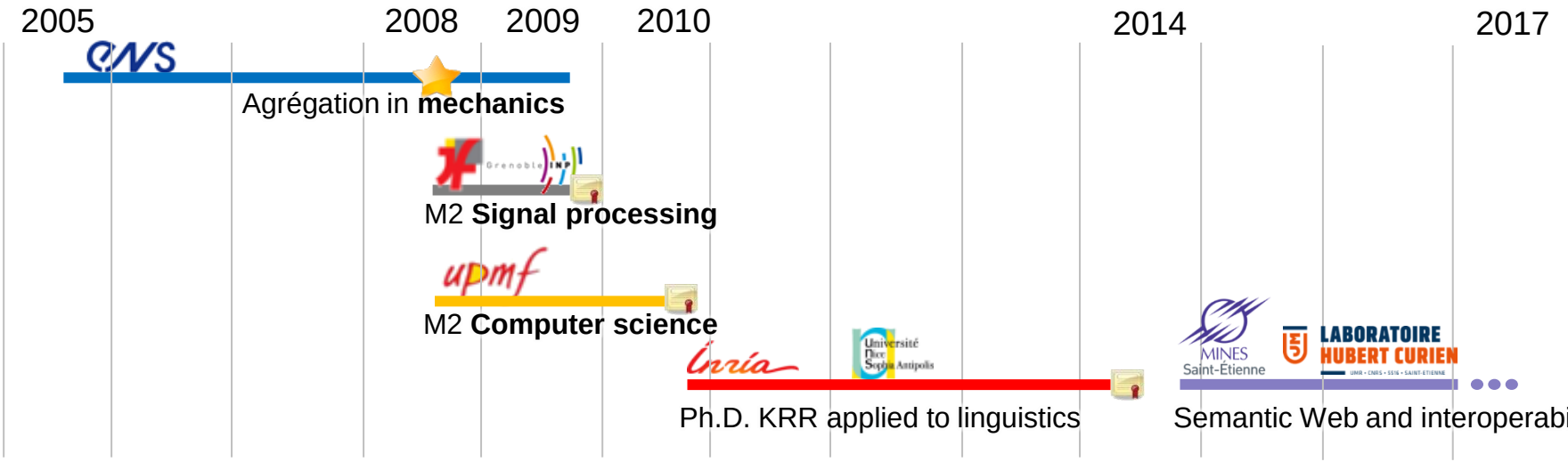

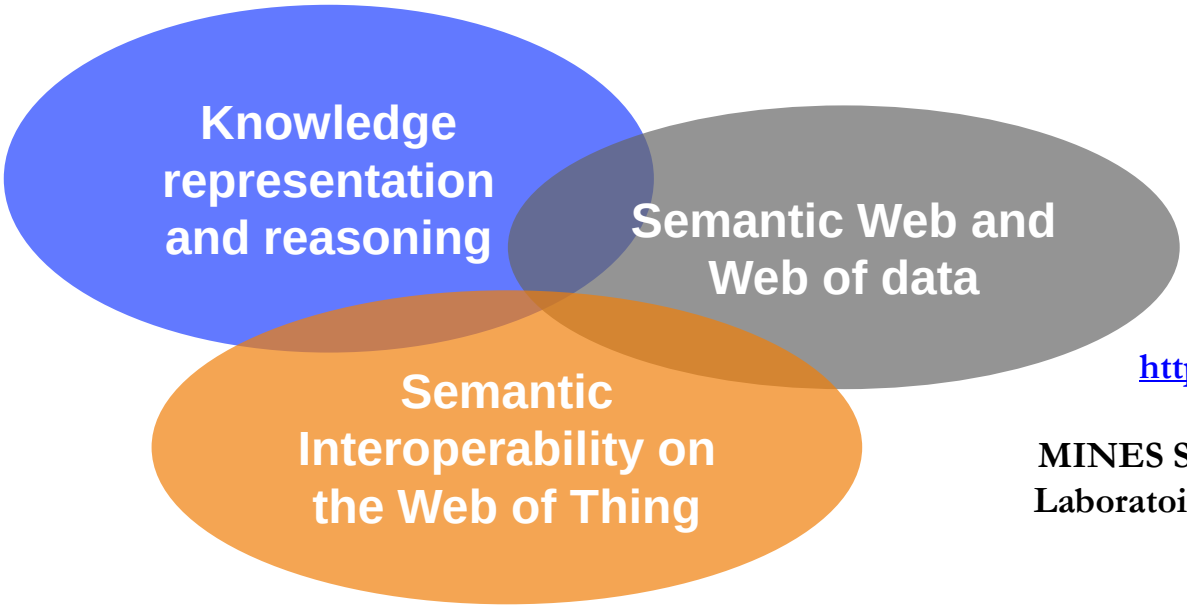

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Connected Intelligence Team
Hubert Curien Laboratory

https://connected-intelligence.univ-st-etienne.fr/

CONNECTED INTELLIGENCE

13 permanent staff members – 14 Ph.D. students – 2 postdoc

Contact: Olivier.Boissier@emse.fr

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UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

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INSTITUT d'OPTIQUE GRADUATE SCHOOL ParisTech

Collaborative actions

Smart Home, Smart City

ANR OpenSensingCity

Smart Home

Smart Utilities

Smart Energy ITEA3 SEAS

Smart Energy

Smart Water ITEA 3 WATERM

Intelligent Transport

Smart Territory platform

Taxi on-demand allocation

GROUPE RENAULT

Web of Data Communities, Recommandations

ANR C3PO

ITEA3 MoocTab

1DLab

ITN WDAqua

Ethics of autonomous agents

ANR eThicAa

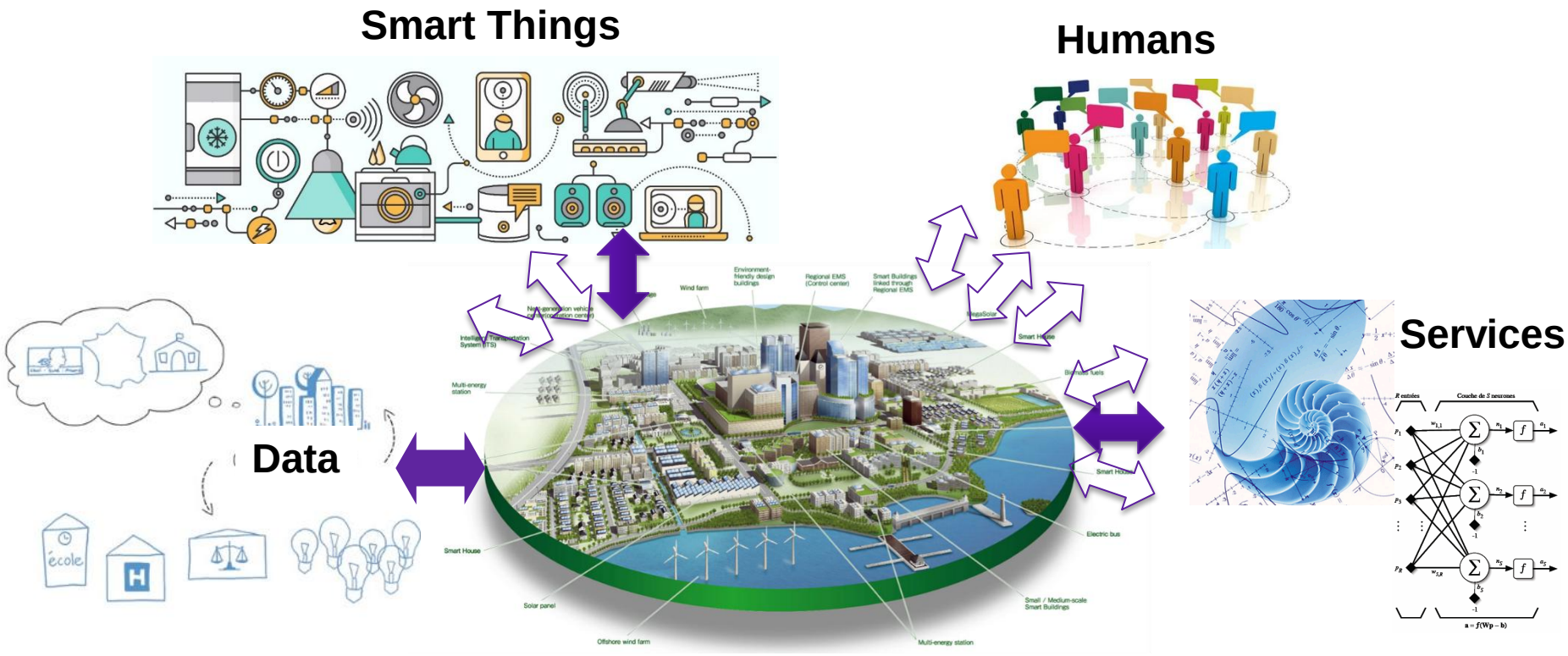
éthique & Agents autonomes

Ontology Standardization

Semantic Sensor Networks Ontology

Consolidation of SAREF Ontology & ecosystem of users

Scientific challenges



- Automation and delegation of repetitive cognitive activities
- Understanding/interoperability between heterogeneous things and services
- Cooperation between services, things and human activities

Objective

- **Definition of models, algorithms and software architectures to support the inter-connection of data, services, things & people**

- **Requirements:**
  - Cooperation, Distribution, Decentralization, Openness, Scalability
  - Evolution / Agility / Robustness
  - Interoperability of contents, services, things & machines

- **Scientific Domains:**
  - Artificial Intelligence, Knowledge Representation, Semantic Web
  - Multi-Agent Systems, Services, Web of Things
  - Social Networks, Virtual Communities, Recommendation

Scientific Directions

Challenges of the increasing automation of cognitive human tasks in the digital transformation of the society

- Processing, Representation and Reasoning on **dynamic and heterogeneous amounts of data**, distributed on the Web, on social media, in the Internet of things

- Deployment in these complex environments of new services, able to **autonomously** process, **reason** and **decide** on these distributed data and knowledge sources but also to **cooperate** with each other in an efficient and flexible way

- Implication of these services in innovative **user-centric** applications supporting **individual** and/or **collective** activities

Scientific Directions

- **Knowledge Representation & Reasoning**
  - How to process, represent and reason on knowledge in distributed and open environments such as, in particular, the Web?

- **Multi-Agent & Services**
  - How to coordinate and adapt agents and services deployed in open, decentralized, dynamic and large scale systems?

Transversal issues:

- **Trust, Privacy & Ethics,**
- **Individual and collective dimensions**

2. the Web of Things and Semantic Interoperability

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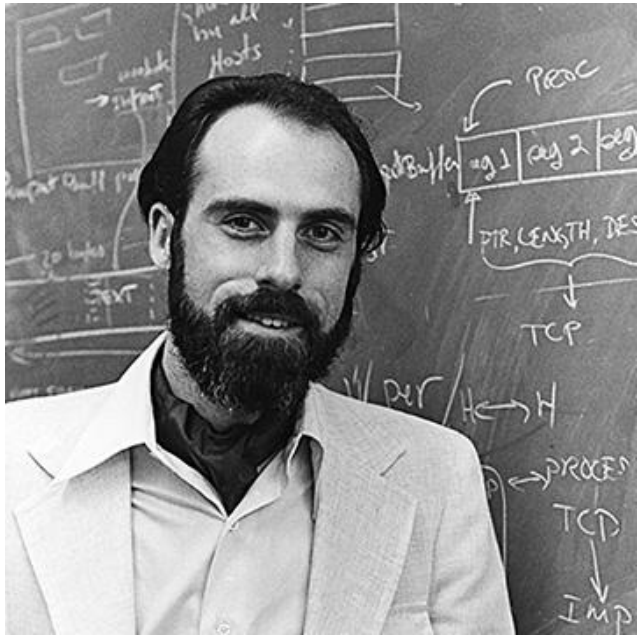
Internet vs Web ?



The Internet – the network (TCP/IP, 1973)

Vinton Cerf, Robert Elliot Kahn, Louis Pouzin

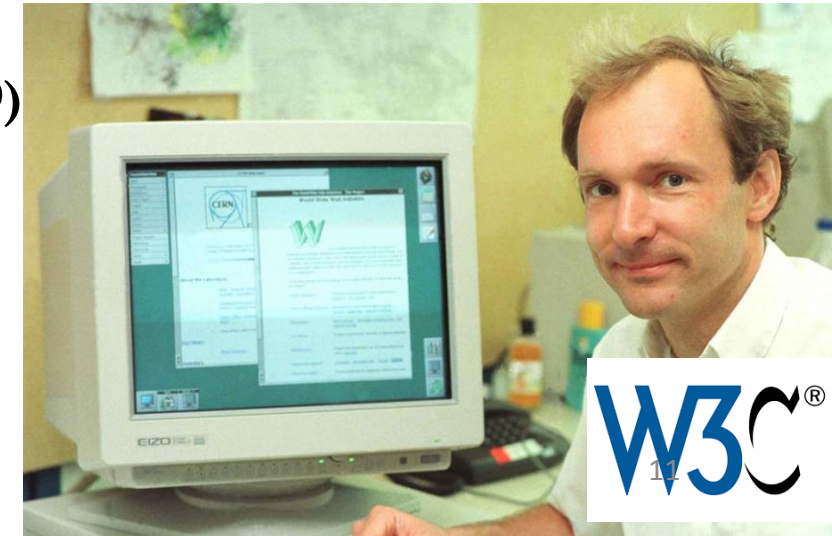
The Web – the information space (HTTP, 1989)

→ 1.0 - Documentary web, e-commerce

→ 2.0 – Social and Collaborative Web

→ 3.0 – Semantic Web

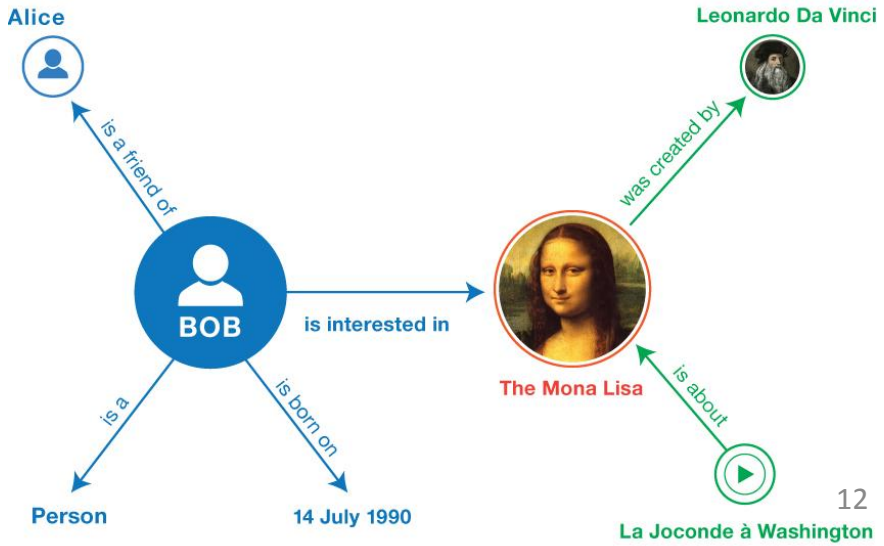
- Web services, API, …



Recent innovation vectors on the Web

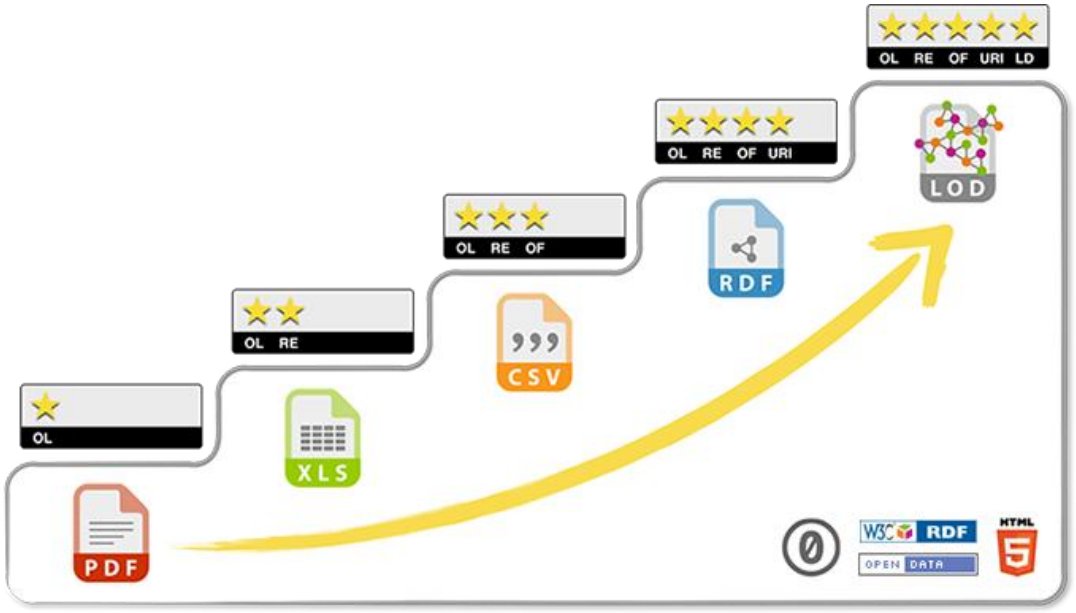
→ Developpement of Open Data

→ Development of Semantic Web formalisms



Recent innovation vectors on the Web

→ Development of the Web of Linked Data
→ Development of the Web of Linked Open Data



https://5stardata.info/en/

50 B communicating devices by 2020

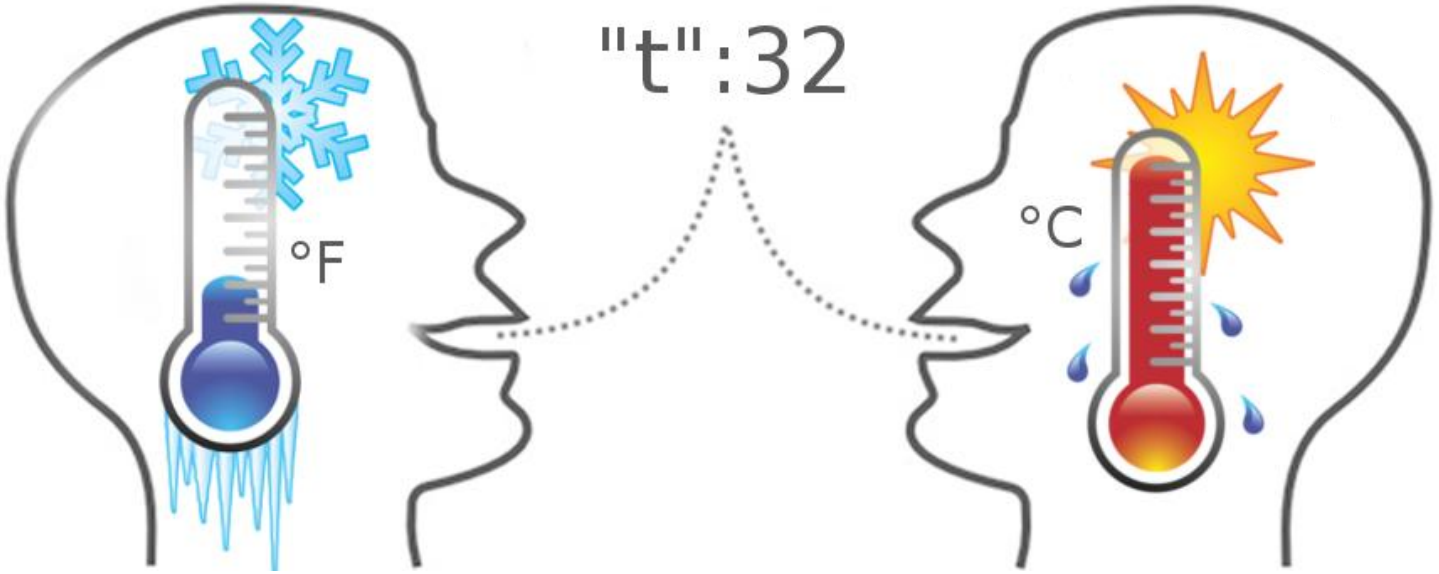
For now: the Internet of Things

Annual turnover generated on the Web by e-commerce BtoC in 2016 ?

Annual turnover estimated for the Internet of Things in 2020 ?

Tomorrow, the Web of Things will be the new innovation vector

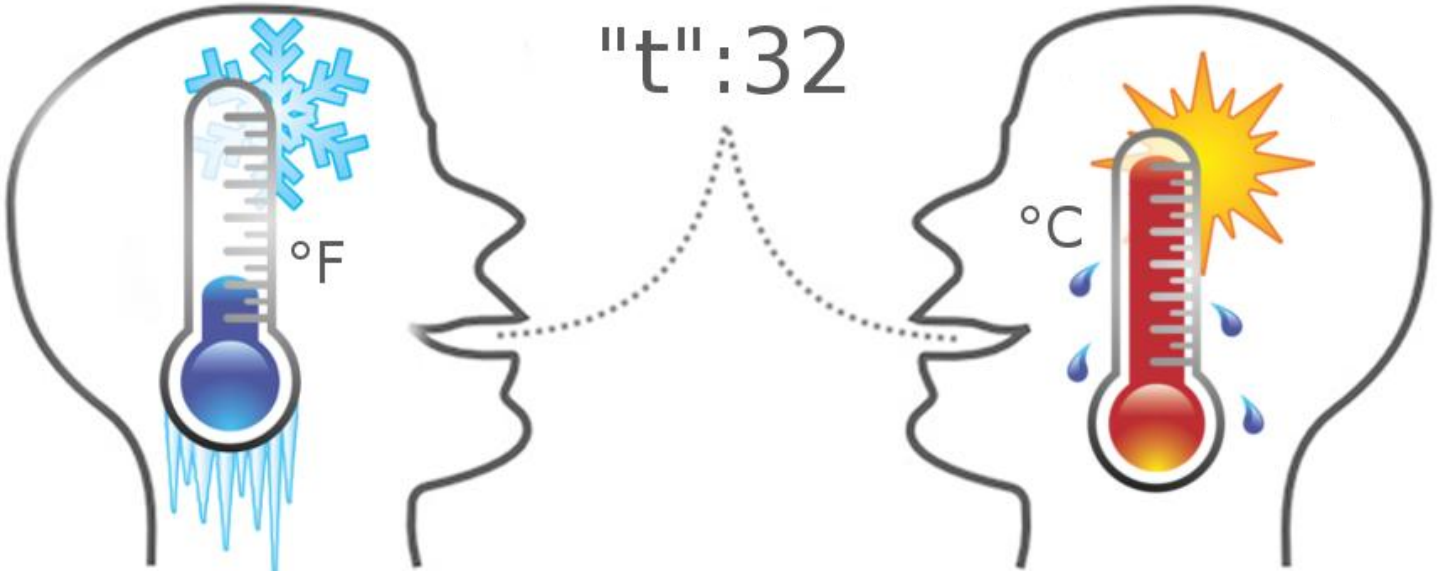
50 B communicating devices by 2020
… and interoperable?



Semantic Interoperability ?

- ✓ 50 billion sensors, actuators, simple robots, connected by 2020
- ✓ $11.1 trillion a year in economic value by 2025
- ✓ 40% - 60% enabled only thanks to interoperability

« the sensors send messages in different formats (JSON, XML, …)»
« the message structures are different »
« some messages are text, other are binary »
« different unit »
« different agregation operation »



Semantic Interoperability

Today, we focus on solutions that rely on Sem Web Vocabularies/Ontologies

3. There exists many vocabularies/ontologies

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Several ontologies exist

LOV

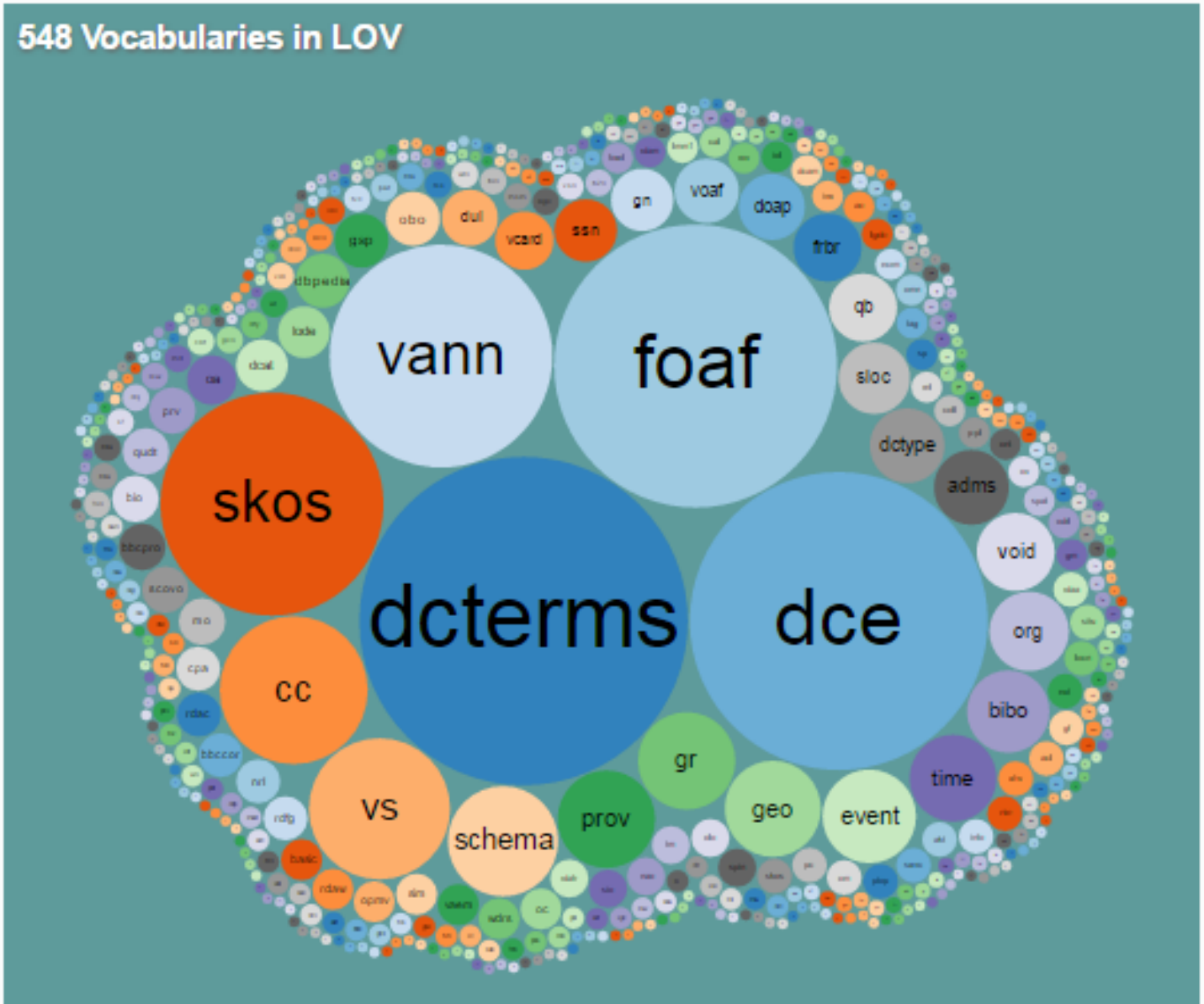
600+ ontologies

350+ ontologies

They have heterogenities

- In adoption,
- In institutional statuses,
- In structure/content/publication/metadata quality
- In maintenance
- In extensibility
- In availability

Linked Open Vocabularies (LOV)



Some vocabularies/ontologies

- vCard: describe contacts
  - IETF RFC6350 standard
  - As ontology: W3C Interest Group Note 22 May 2014

```
<http://purl.org/NET/cnr#Siège%20Social%20de%20Lyon>
  vcard:organization-name "Siège Social de Lyon" ;
  vcard:hasEmail <mailto:cnr.lyon@cnr.tm.fr> ;
  vcard:hasAddress [
    vcard:street-address "2, rue André Bonin" ;
    vcard:postal-code "69004" ;
    vcard:locality "Lyon" ;
    vcard:country-name "France" ] ;
  vcard:hasTelephone [ a vcard:Voice ; vcard:hasValue "tel:+33472006969" ] ;
  vcard:hasTelephone [ a vcard:Fax ; vcard:hasValue "tel:+33472106666" ] ;
  vcard:hasGeo <geo:45.775005,4.813461> .
```

Some vocabularies/ontologies

- SKOS: Simple Knowledge Organization System
  - W3C Recommendation 18 August 2009
- at least labels… + note on semantics…

```
cnr:DBT
  skos:prefLabel "Douaisienne de Basse Tension" ;
  skos:altLabel "DBT" ;
```

```
cnr:FR:CN1:P:10002
  skos:prefLabel "DRB-Bureaux 2" ;
  skos:hiddenLabel "FR*CN1*P*10002" ;
```

Some vocabularies/ontologies

- GEO: Basic Geo (WGS84 lat/long) Vocabulary

```
cnr:FR:CN1:P:00011
  geo:location [ geo:lat 45.775005 ; geo:long 4.813461 ] ;
```

Some vocabularies/ontologies

- Gr: Good Relations (ontology for the e-commerce)
  - Used by big players (amazon, google, …)

  - BusinessEntity, Offering, PriceSpecification, ProductOrServiceModel,…
  - Description of products
  - Description of offers

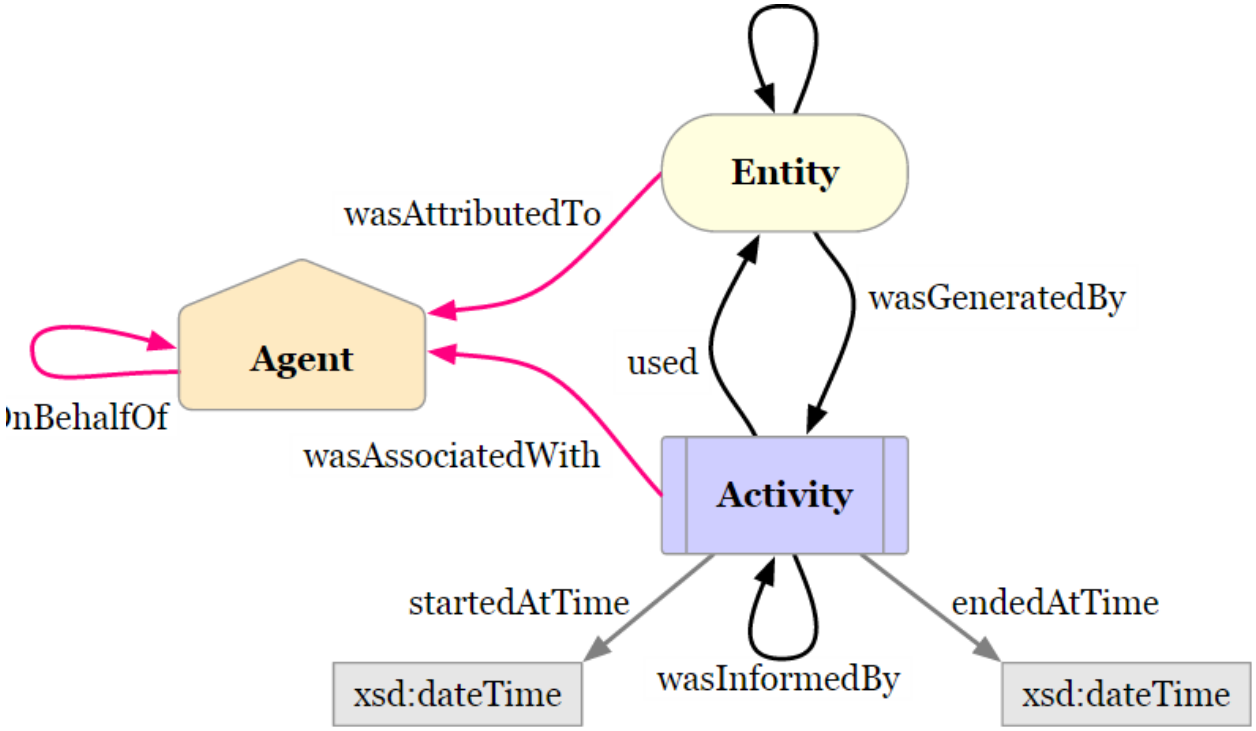
```
cnr:DBT_GNS a gr:ProductOrServiceModel ;
  gr:hasManufacturer cnr:DBT .
```

```
cnr:Compagnie%20Nationale%20du%20Rhône a gr:BusinessEntity ;
   gr:offers <chargings> .

<chargings> gr:availableAtOrFrom cnr:FR:CN1:P:10002
```

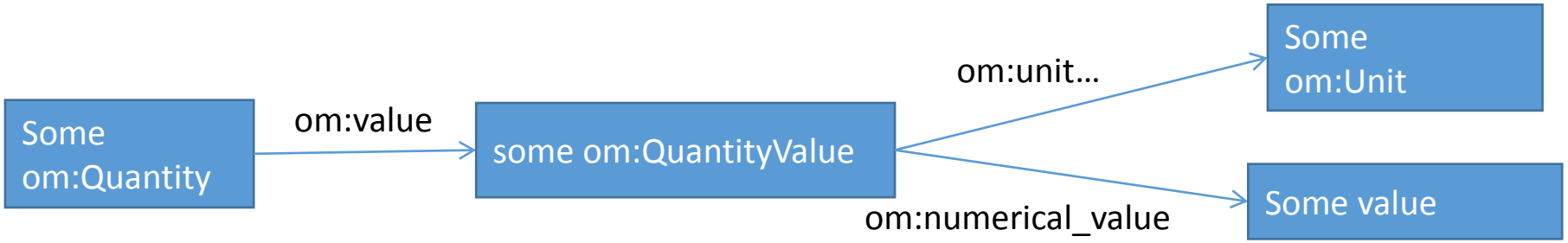
Some vocabularies/ontologies

- PROV: The Provenance Ontology
  - prov:Agent (organization, person, software, **sensor**, **actuator**…)
  - prov:Activity (translate a document, **predict**, **measure**…)
  - prov:Entity (observation, prediction, aggregated or obfuscated…)



Some vocabularies/ontologies

- OM: Ontology of Units of Measure
- Values of physical quantities, units of measure, precision, …




```
cnr:FR:CN1:C:10002
  seas:maximalCurrent [
    om:value [
      om:unit_of_measure_or_measurement_scale om:ampere ;
      om:numerical_value 32.0 ] ] .
```

Some vocabularies/ontologies

- CDT: Custom Datatypes
  - Easier to represent quantity values

@prefix cdt: <http://w3id.org/lindt/custom_datatypes#>.

Some vocabularies/ontologies

- dcterms, dc elements: Dublin Core
- foaf: Friend of a Friend
- OWL-time: OWL Time ontology
- SOSA/SSN: Semantic Sensor Networks (OGC, W3C)
- SAREF: Smart Appliances REFerence ontology (ETSI)
- dogont: an ontology for intelligent environments

4. The OGC and W3C Semantic Sensor Networks Ontology

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Origins of SSN

2002 OGC's Sensor Web Enablement initiative

→ Sensor Model Language (SensorML)

'provider-centric': sensor + raw data

Sensor Observation Service - API REST Specification

→ Observations and Measurements (O&M)

'user-centric': feature of interest and observed property

2005 W3C Semantic Sensor Network Incubator Group

References and compares several existing proposed ontologies

First version of SSN published in 2011

Widely used, but juged too complicated and not well documented

TITRE	CITÉE PAR	ANNÉE
The ssn ontology of the w3c semantic sensor network incubator group M Compton, P Barnaghi, L Bermudez, R Garcia-Castro, O Corcho, S Cox, ... Web Semantics: Science, Services and Agents on the World Wide Web	800	2012
A survey of the semantic specification of sensors M Compton, C Henson, L Lefort, H Neuhaus, A Sheth Proceedings of the 2nd International Conference on Semantic Sensor Networks ...	214	2009
The stimulus-sensor-observation ontology design pattern and its integration into the semantic sensor network ontology K Janowicz, M Compton Proceedings of the 3rd International Conference on Semantic Sensor Networks ...	114	2010
Sensor search techniques for sensing as a service architecture for the internet of things C Perera, A Zaslavsky, CH Liu, M Compton, P Christen, ... IEEE Sensors Journal 14 (2), 406-420	106	2014
Semantic Sensor Network XG Final Report, W3C Incubator Group Report (2011) L Lefort, C Henson, K Taylor, P Barnaghi, M Compton, O Corcho, ...	104 *	

Origins of SSN

2015 OGC/W3C Spatial Data on the Web Working Group

Use Cases and Requirements (Working Group Note)
Spatial Data on the Web Best practices (Working Group Note)
Time ontology (Recommendation)
Semantic Sensor Network ontology (Recommendation)
3 other Working Group Note

Origins of SSN

Semantic Sensor Network ontology subgroup

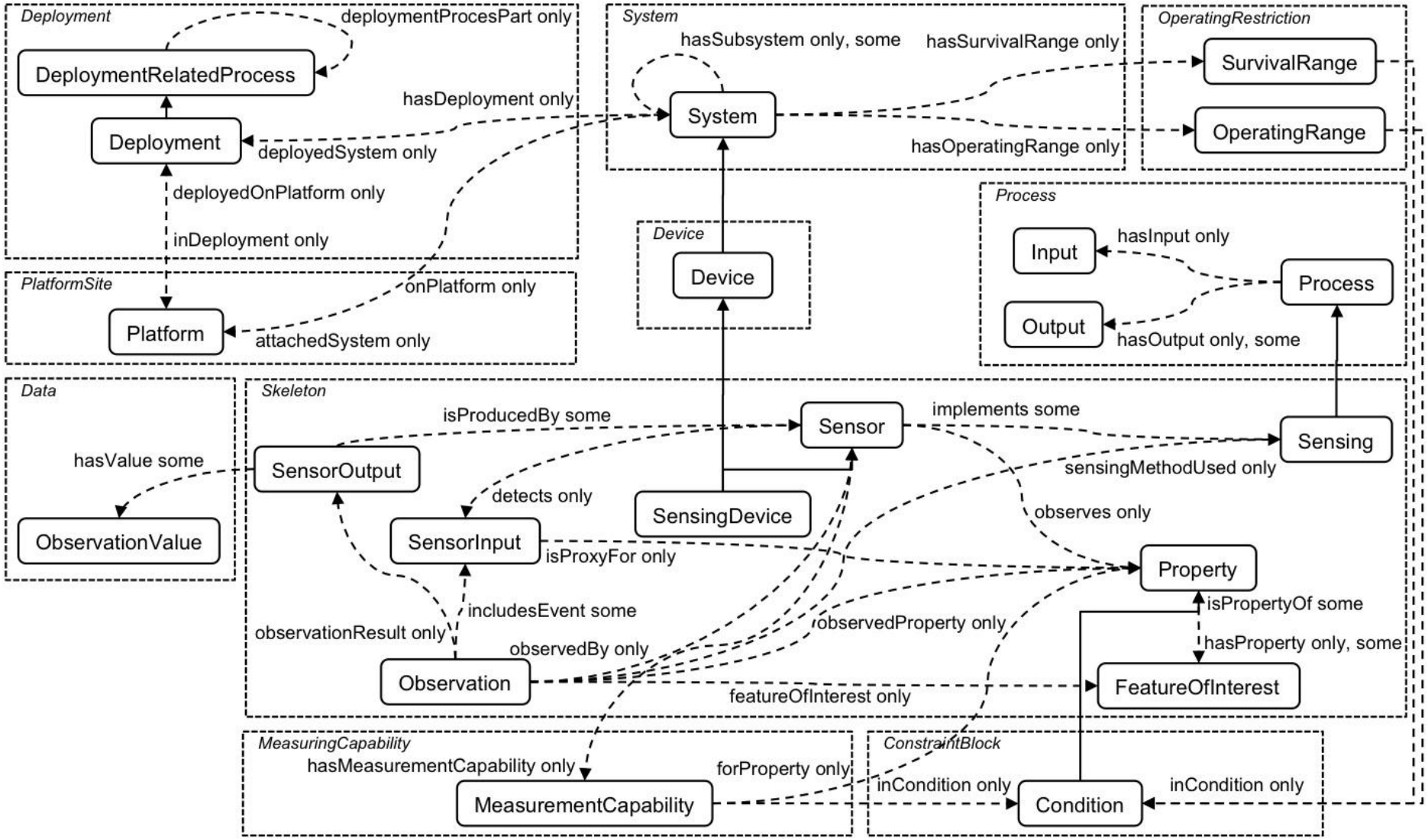
Objectives:

- better document and exemplify
- weaken dependency to Dolce Ultralite ontology
- modularize
- clean
- extend to cover new use cases

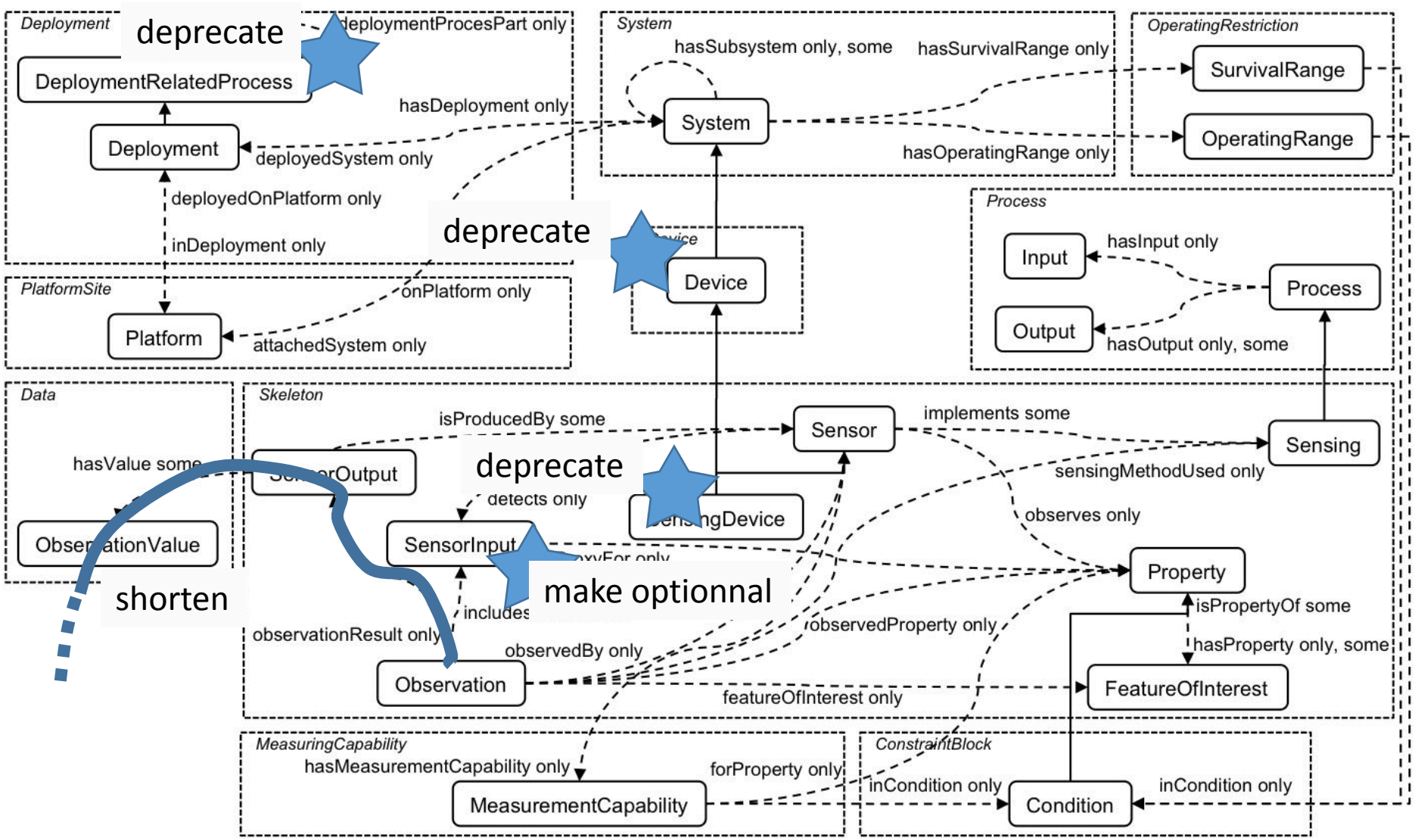
Samplers – Sampling – Samples

Actuator – Actuating

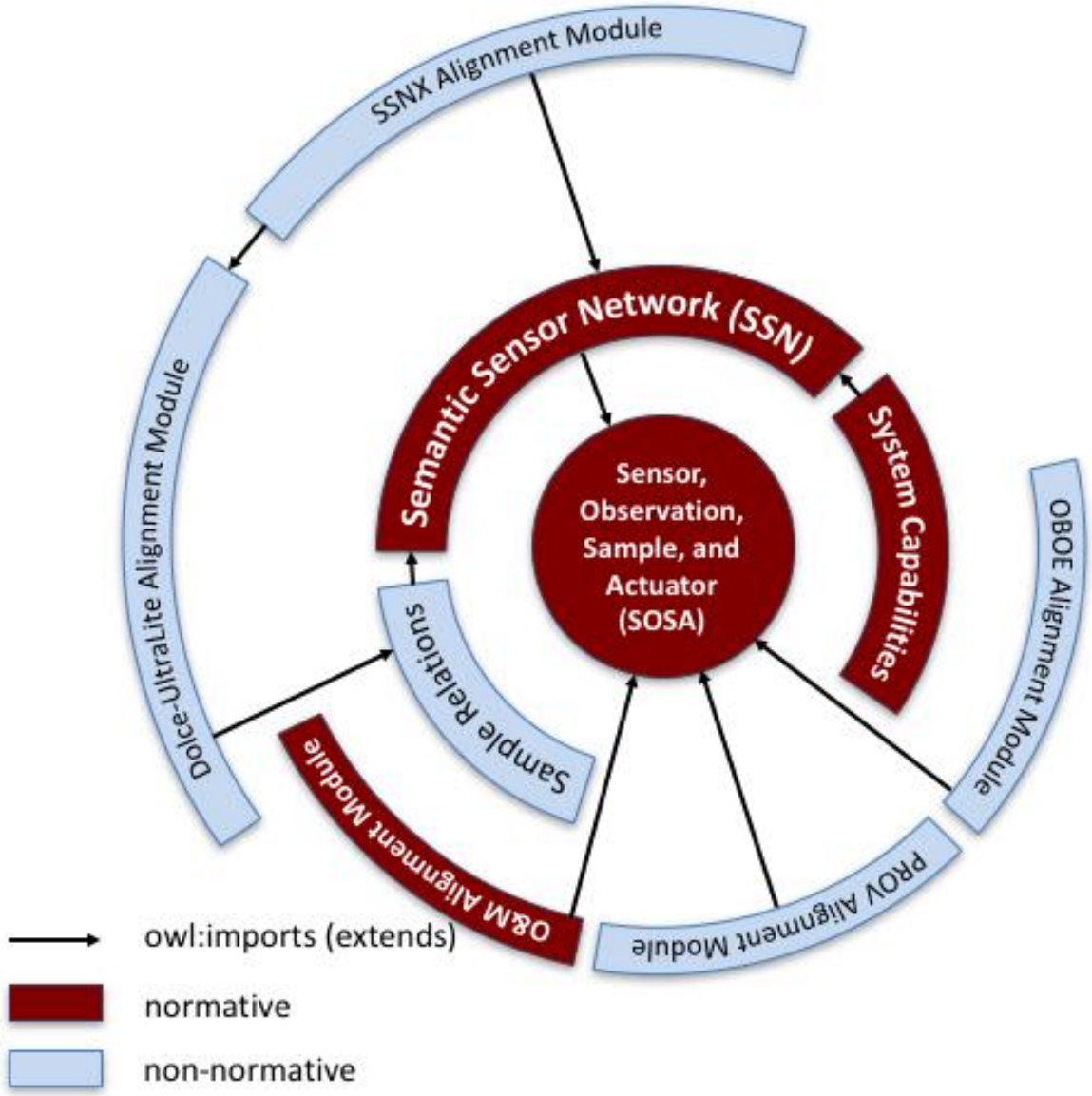
W3C Semantic Sensor Network



W3C Semantic Sensor Network



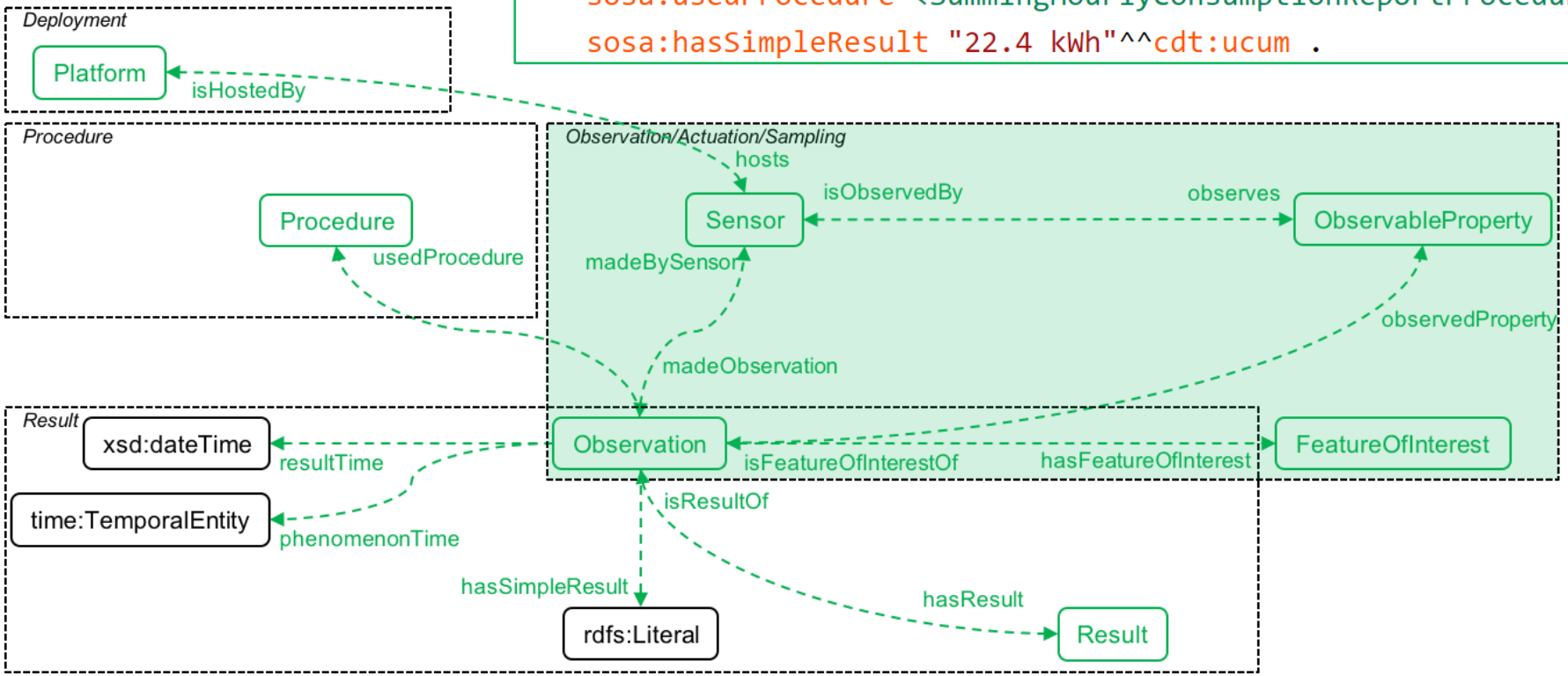
A modular ontology



SOSA: simple core module

SOSA = Sensor, Observation, Sample, Actuator

```
<Observation/235714> a sosa:Observation ;
    sosa:hasFeatureOfInterest <Apartment/134> ;
    sosa:observedProperty <Apartment/134#electricConsumption>;
    sosa:madeBySensor <Sensor/926>;
    sosa:usedProcedure <SummingHourlyConsumptionReportProcedure>;
    sosa:hasSimpleResult "22.4 kWh"^^cdt:ucum .
```



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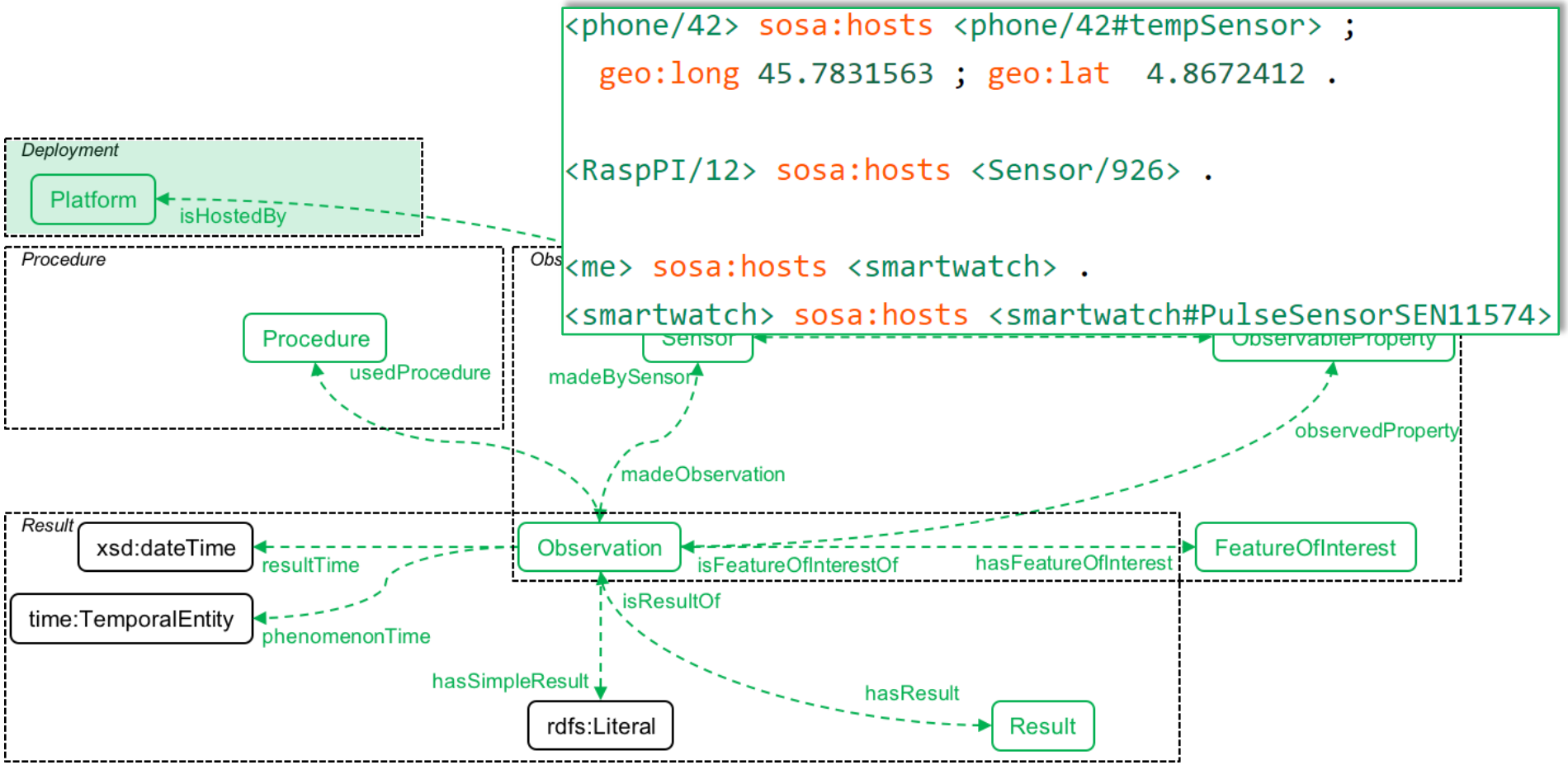


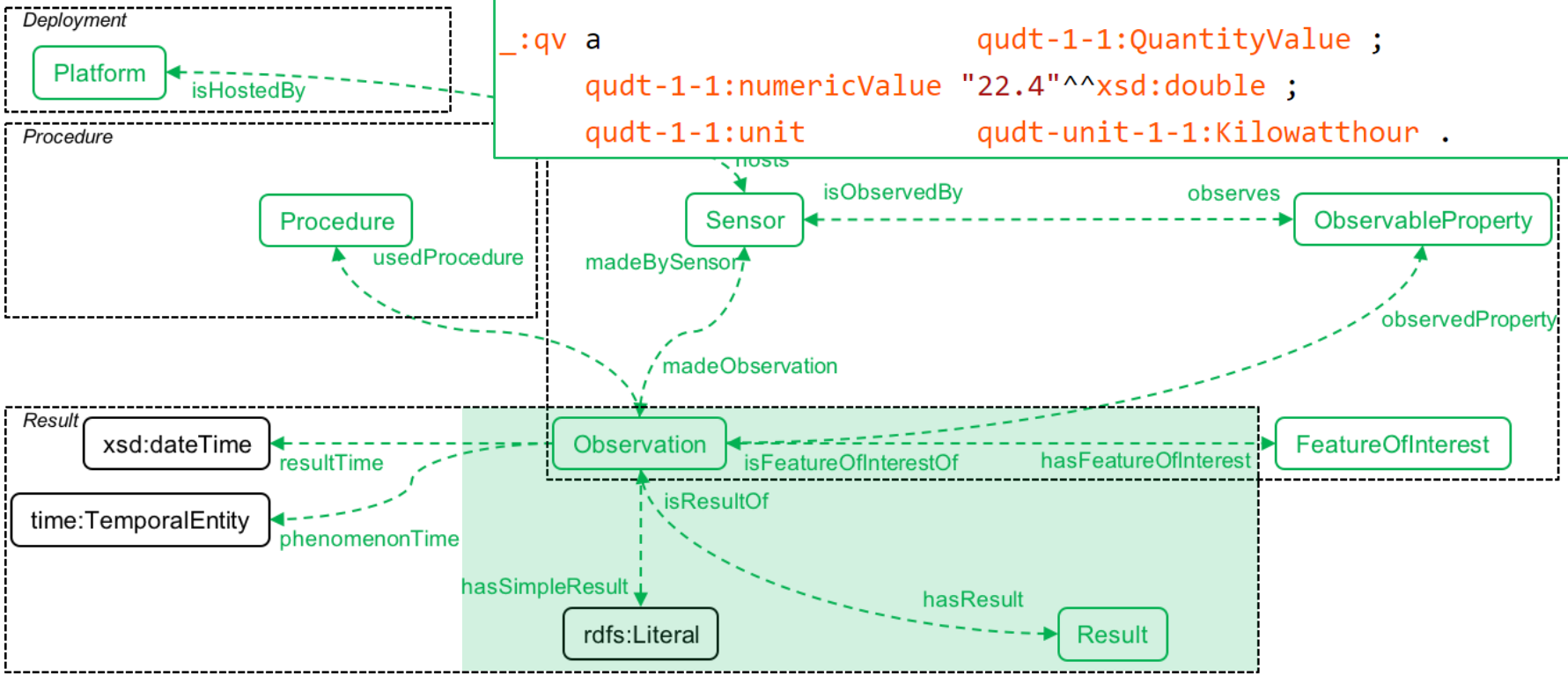
SOSA: simple core module

SOSA = Sensor, Observation, Sample, Actuator

```
<Observation/235714> sosa:hasSimpleResult "22.4 kWh"^^cdt:ucum .

<Observation/235714> sosa:hasResult _:qv .

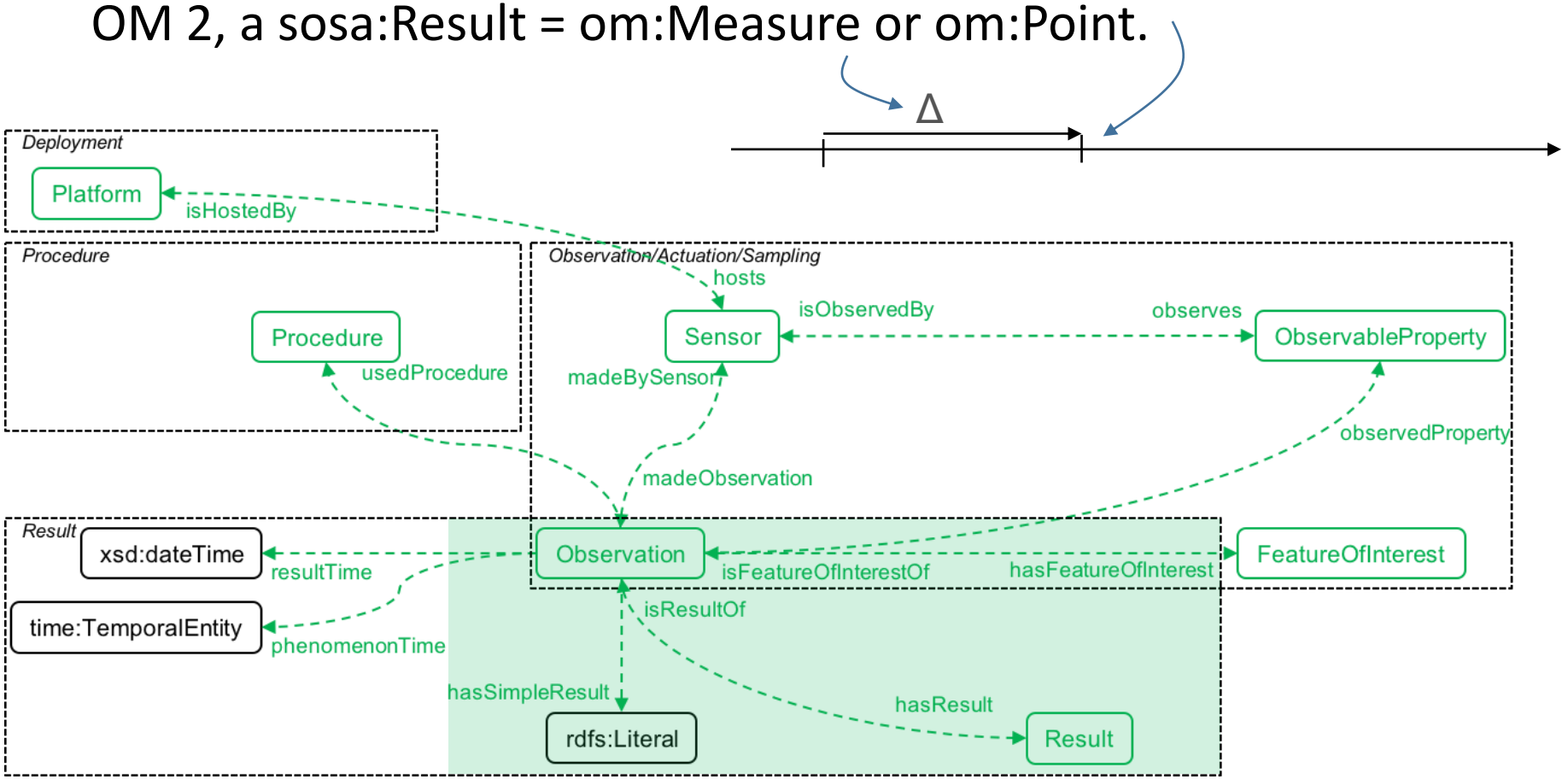
_:qv a                          qudt-1-1:QuantityValue ;
     qudt-1-1:numericValue "22.4"^^xsd:double ;
     qudt-1-1:unit              qudt-unit-1-1:Kilowatthour .
```



SOSA: simple core module

SOSA = Sensor, Observation, Sample, Actuator

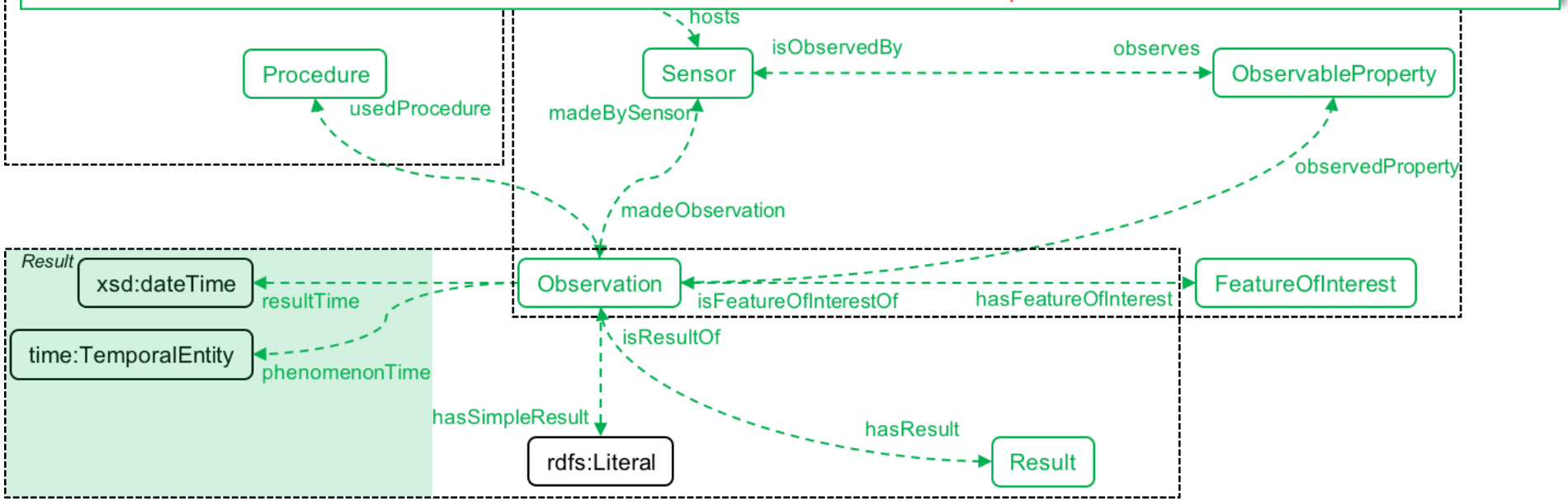
QUDT 1.1, a sosa:Result = qudt:QuantityValue.
OM 2, a sosa:Result = om:Measure or om:Point.



SOSA: simple core module

SOSA = Sensor, Observation, Sample, Actuator

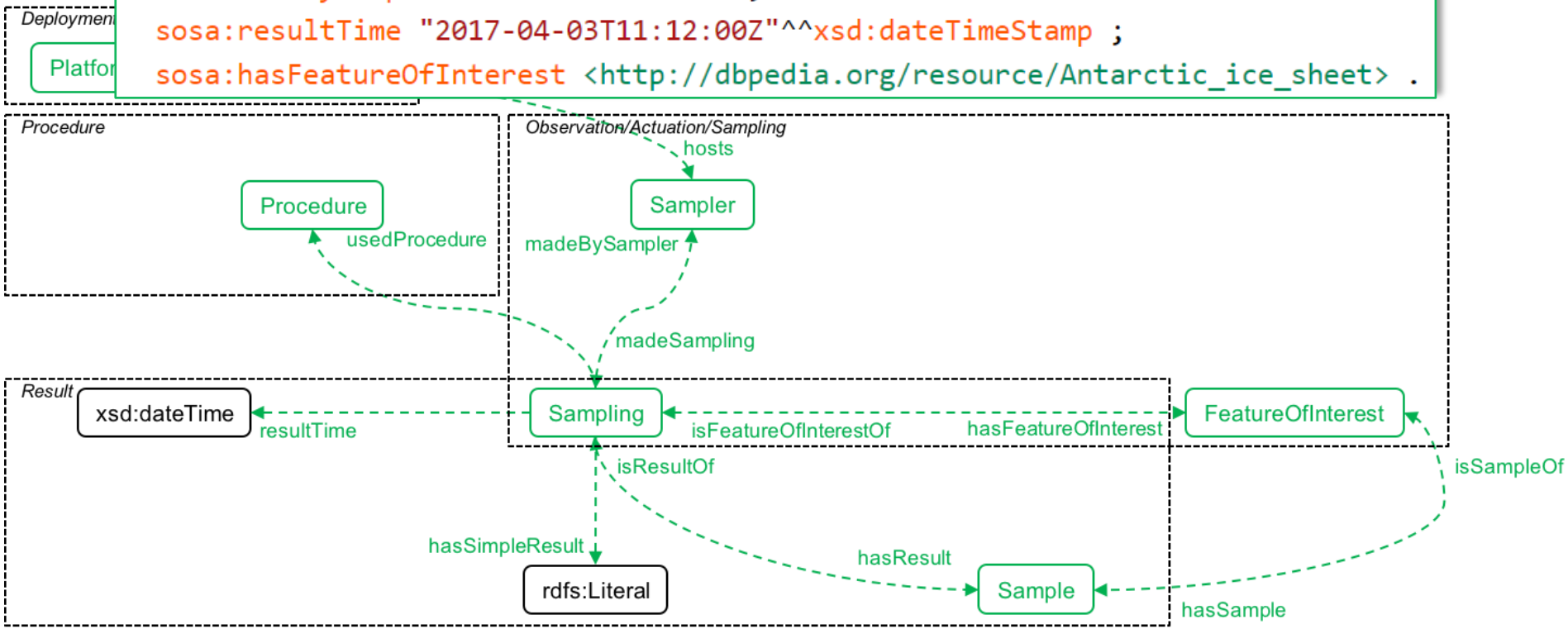
```
<Observation/235714> rdf:type sosa:Observation ;
  sosa:observedProperty  <apartment/134/electricConsumption> ;
  sosa:hasSimpleResult "22.4 kWh"^^cdt:ucum ;
  sosa:phenomenonTime [ a time:Interval ;
    time:hasBeginning [ time:inXSDDateTimeStamp "2017-04-15T00:00:00+00:00"^^xsd:dateTimeStamp ] ;
    time:hasEnd [ time:inXSDDateTimeStamp "2017-04-16T00:00:00+00:00"^^xsd:dateTimeStamp ]
  ] ;
  sosa:resultTime "2017-04-16T00:00:12+00:00"^^xsd:dateTimeStamp .
```



SOSA: simple core module

SOSA = Sensor, Observation, Sample, Actuator

```
<WellDrilling/4578> a sosa:Sampling ;
  geo:lat -73.35 ;
  geo:long 9.32 ;
  sosa:hasResult <iceCore/12> ;
  sosa:madeBySampler <thermalDrill/2> ;
  sosa:resultTime "2017-04-03T11:12:00Z"^^xsd:dateTimeStamp ;
  sosa:hasFeatureOfInterest <http://dbpedia.org/resource/Antarctic_ice_sheet> .
```



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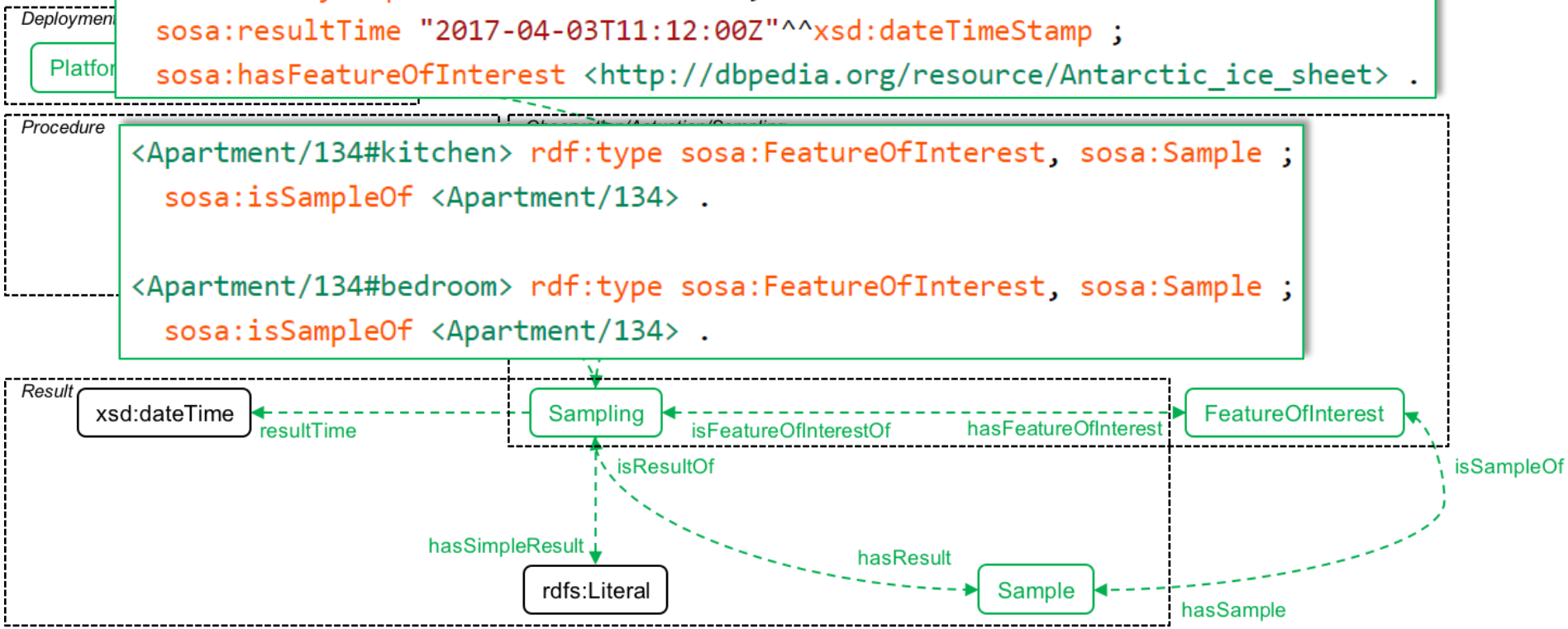
<WellDrilling/4578> a sosa:Sampling ;
  geo:lat -73.35 ;
  geo:long 9.32 ;
  sosa:hasResult <iceCore/12> ;
  sosa:madeBySampler <thermalDrill/2> ;
  sosa:resultTime "2017-04-03T11:12:00Z"^^xsd:dateTimeStamp ;
  sosa:hasFeatureOfInterest <http://dbpedia.org/resource/Antarctic_ice_sheet> .
```

```
<Apartment/134#kitchen> rdf:type sosa:FeatureOfInterest, sosa:Sample ;
  sosa:isSampleOf <Apartment/134> .

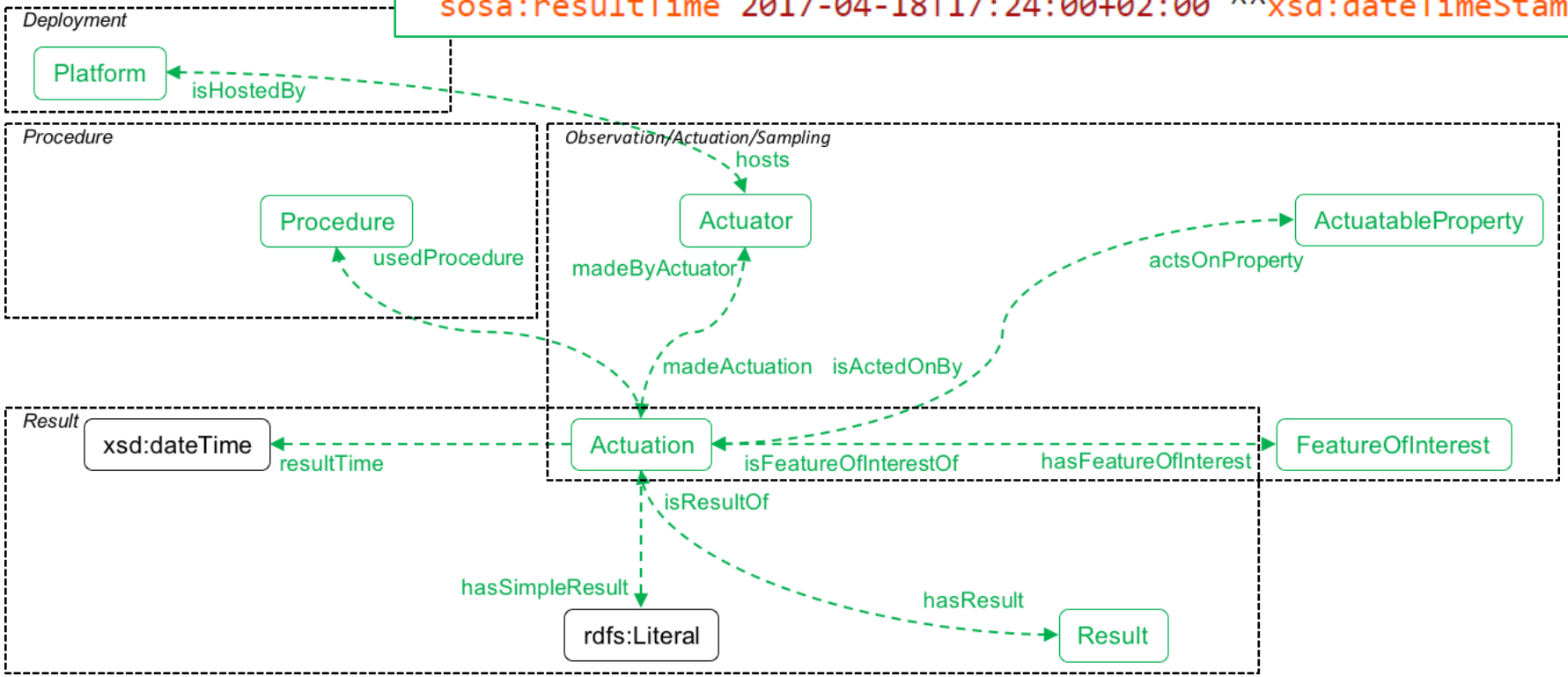
<Apartment/134#bedroom> rdf:type sosa:FeatureOfInterest, sosa:Sample ;
  sosa:isSampleOf <Apartment/134> .
```



SOSA: simple core module

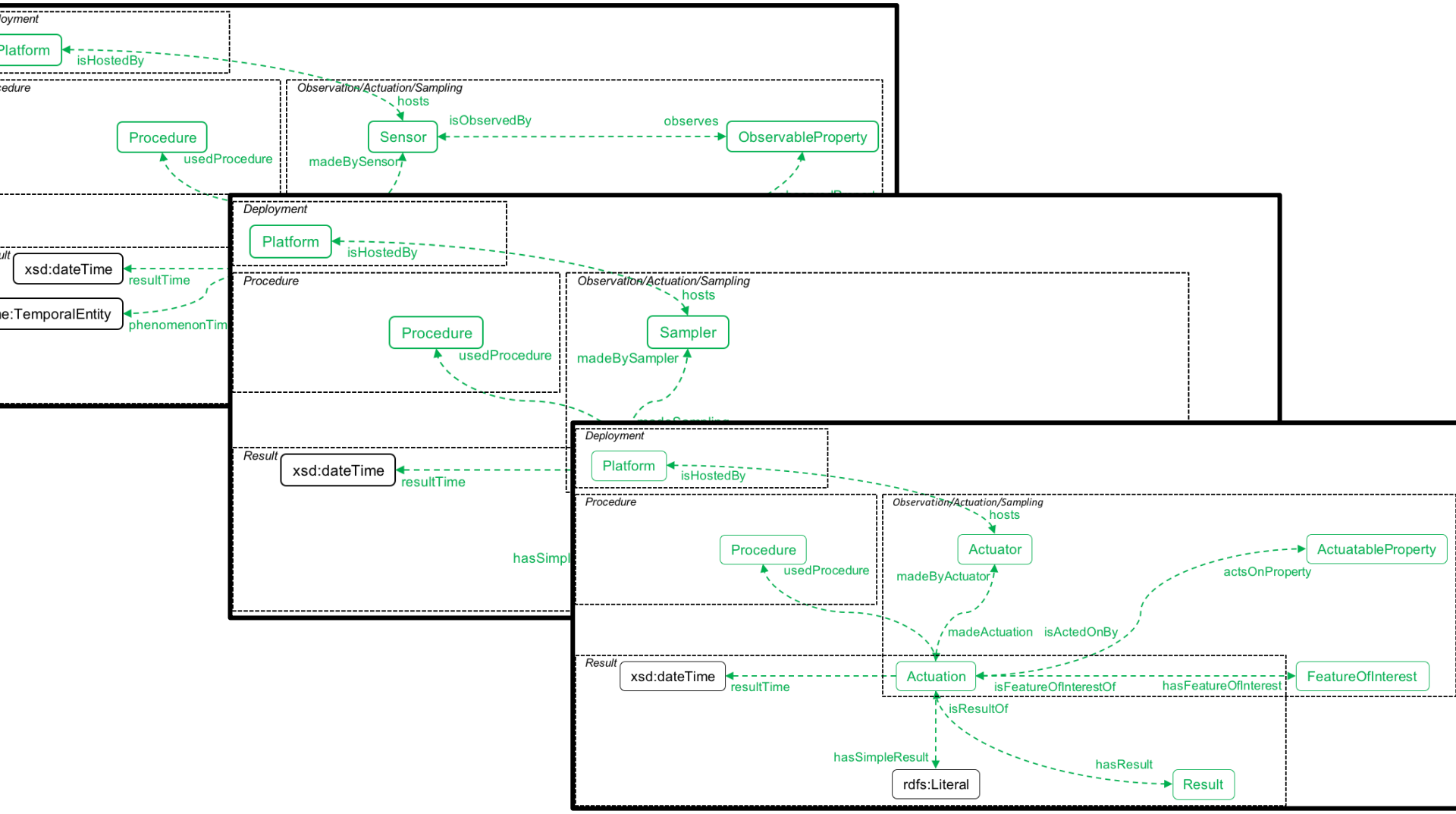
SOSA = Sensor, Observation, Sample, Actuator

```
<Actuation/188> rdf:type sosa:Actuation ;
  sosa:actsOnProperty <window/104#state> ;
  sosa:actuationMadeBy <windowCloser/987> ;
  sosa:hasSimpleResult true ;
  sosa:resultTime"2017-04-18T17:24:00+02:00"^^xsd:dateTimeStamp .
```

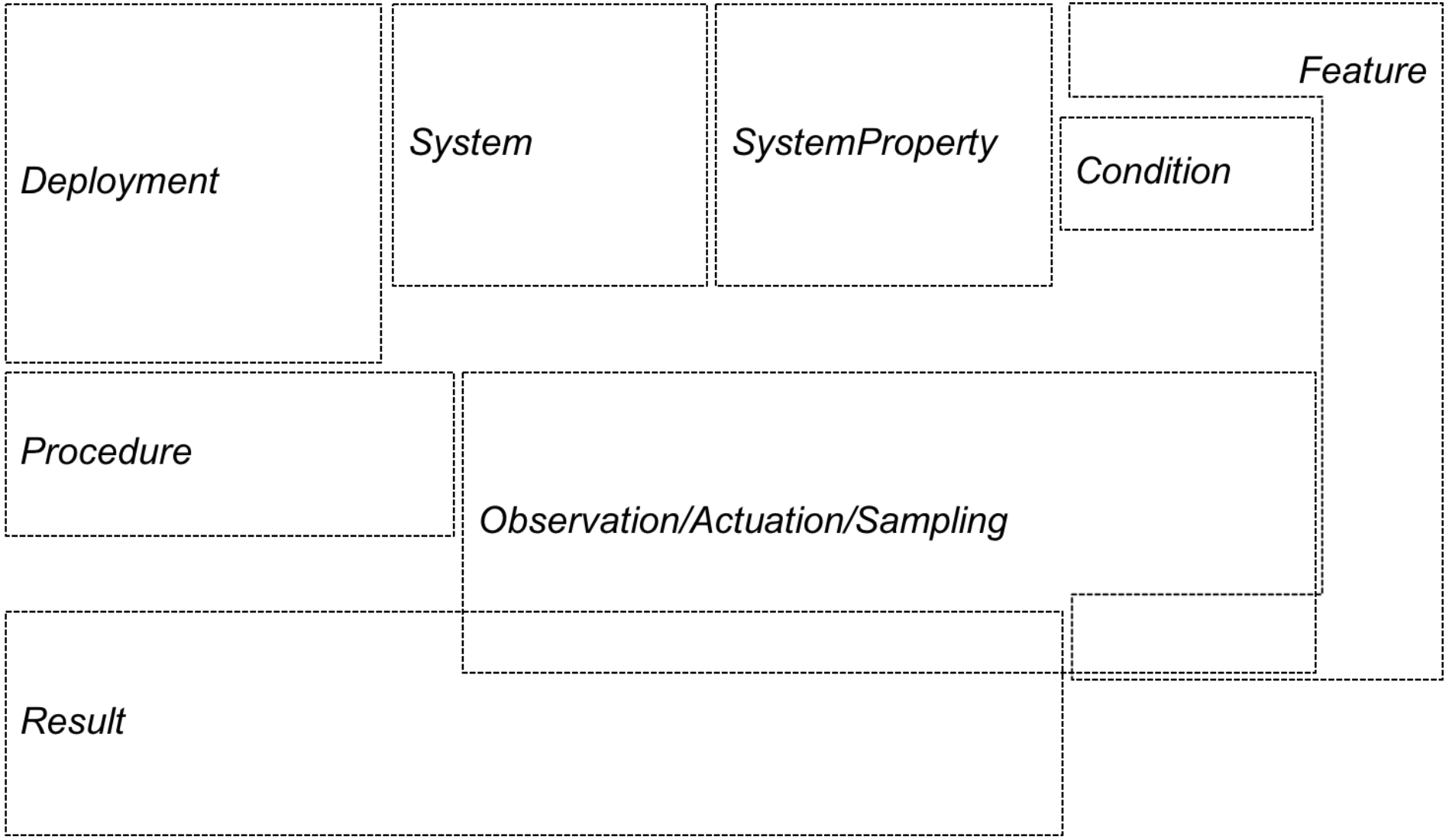


SOSA: module noyau simple

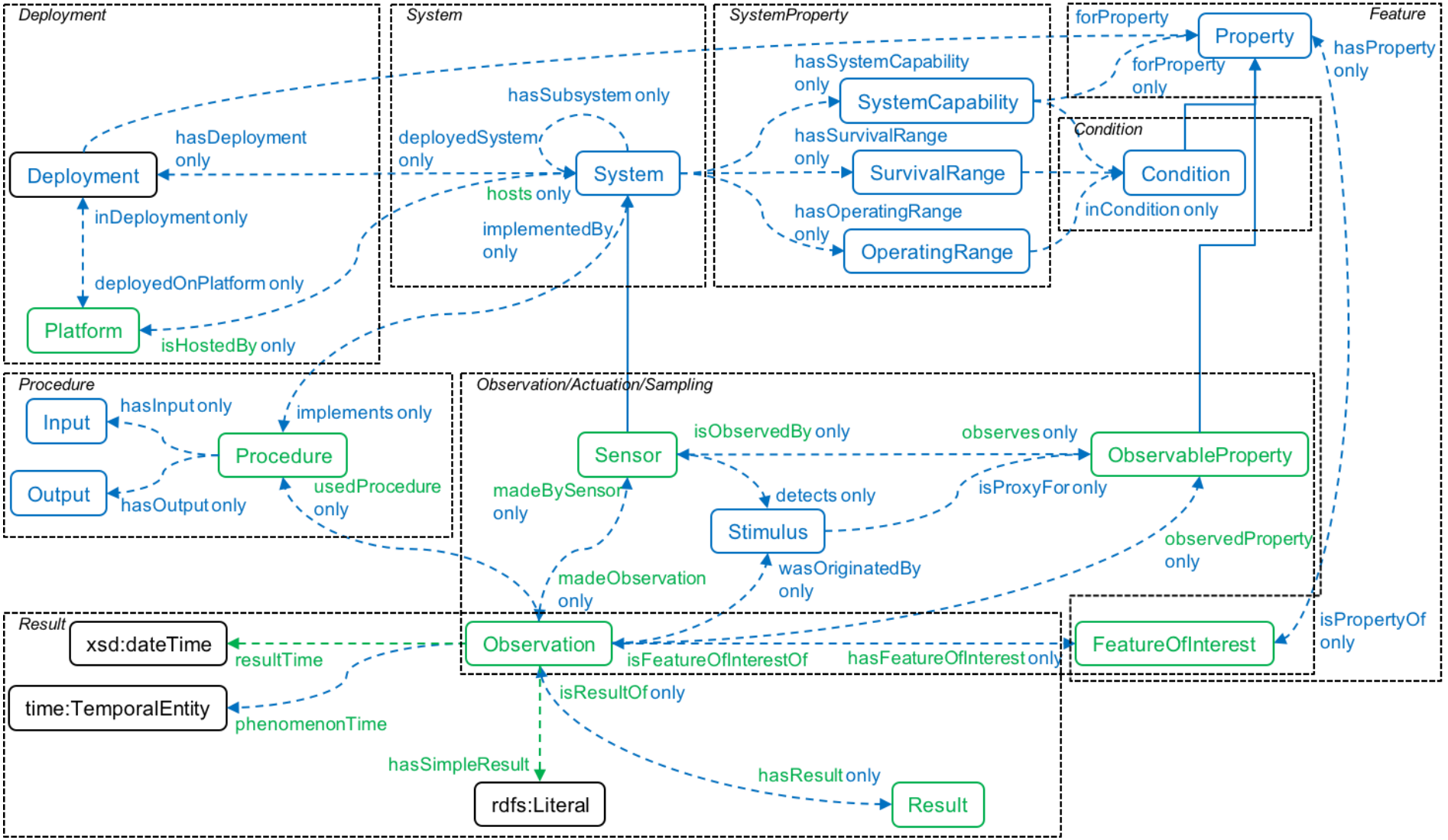
SOSA = Sensor, Observation, Sample, Actuator



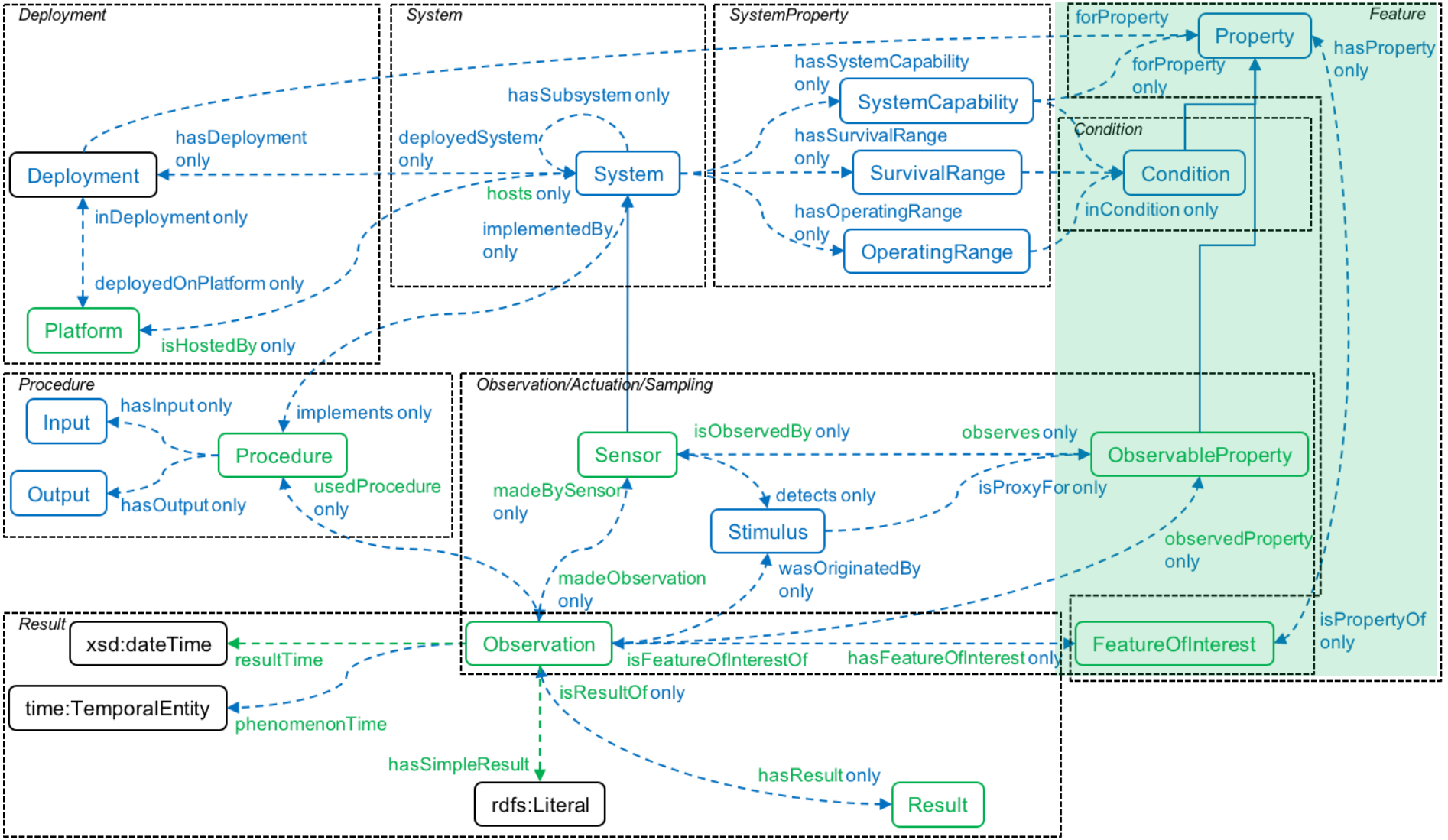
W3C Semantic Sensor Network



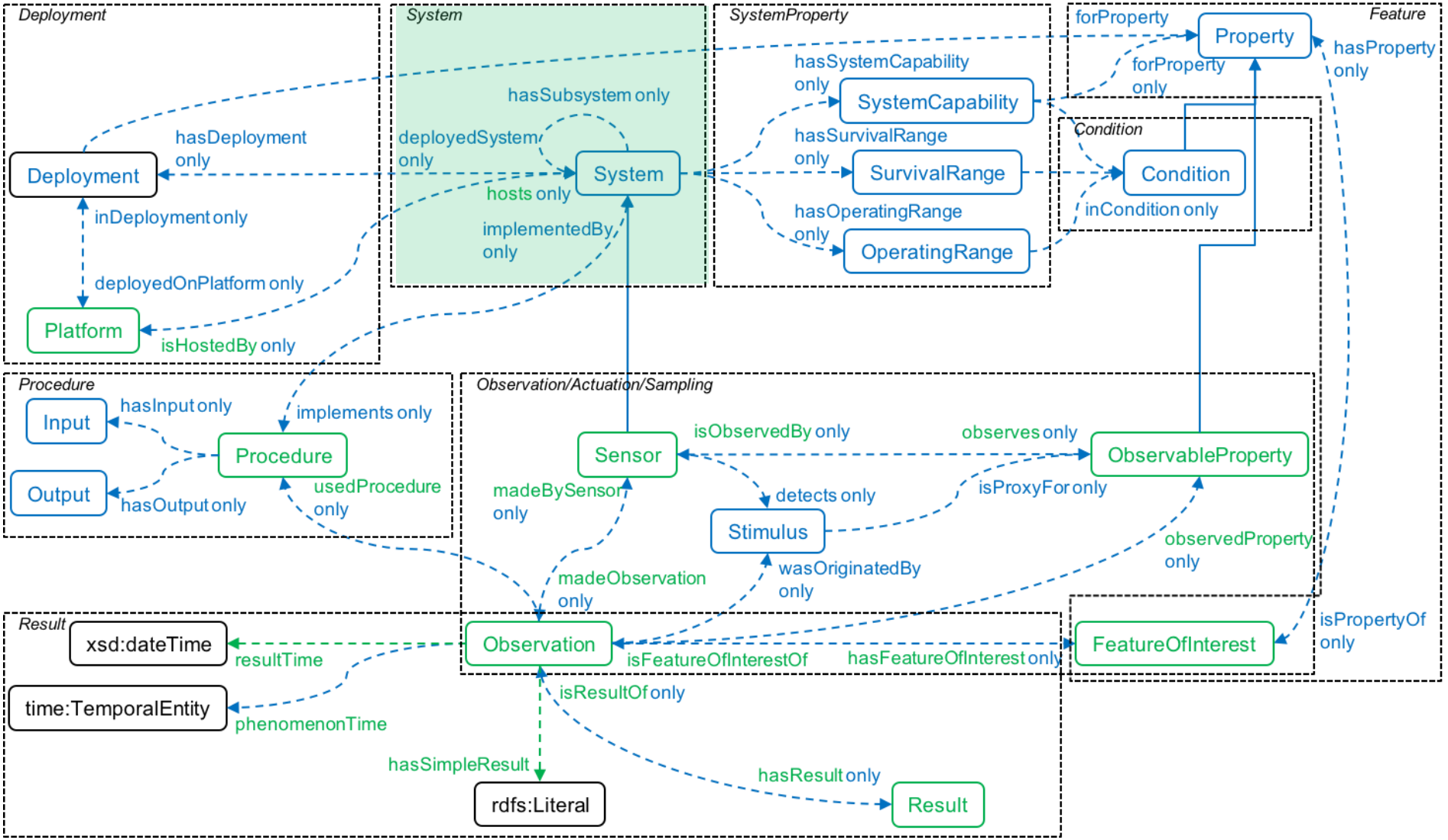
W3C Semantic Sensor Network



W3C Semantic Sensor Network

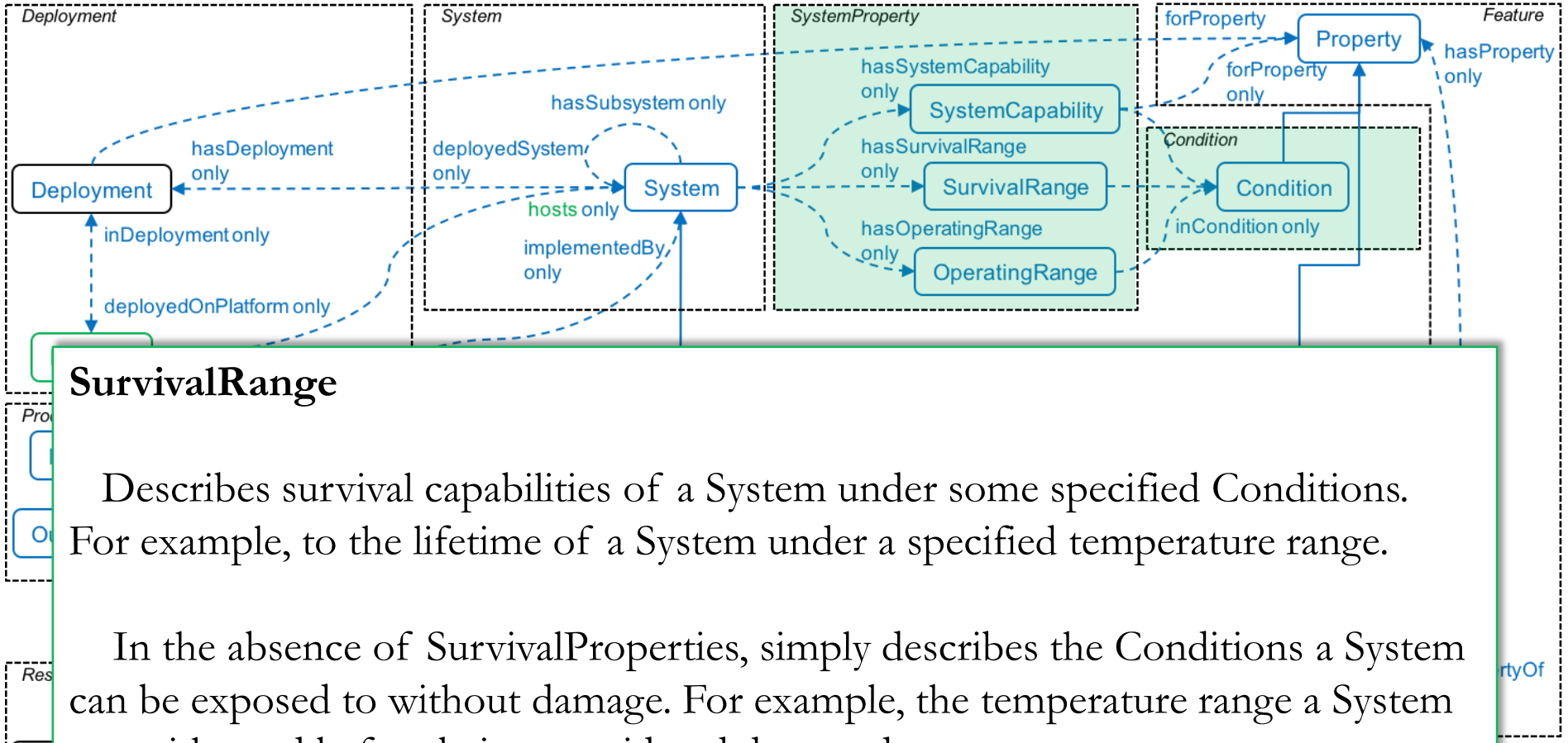


W3C Semantic Sensor Network



SSN-systems Separate Module

Non normative http://www.w3.org/ns/ssn/systems/



SurvivalRange

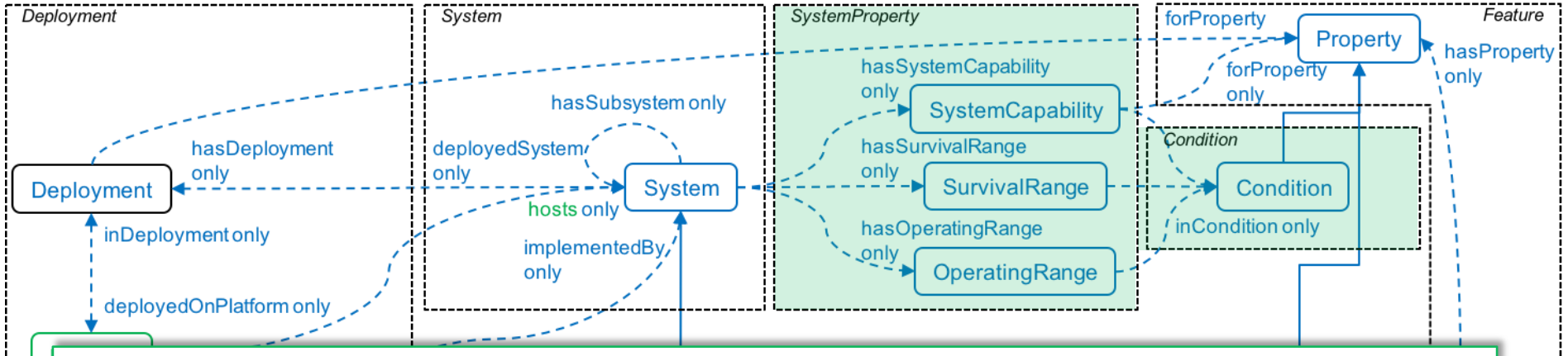
Describes survival capabilities of a System under some specified Conditions. For example, to the lifetime of a System under a specified temperature range.

In the absence of SurvivalProperties, simply describes the Conditions a System can be exposed to without damage. For example, the temperature range a System can withstand before being considered damaged.

Violation → 'damaged'

SSN-systems Separate Module

Non normative http://www.w3.org/ns/ssn/systems/



OperatingRange

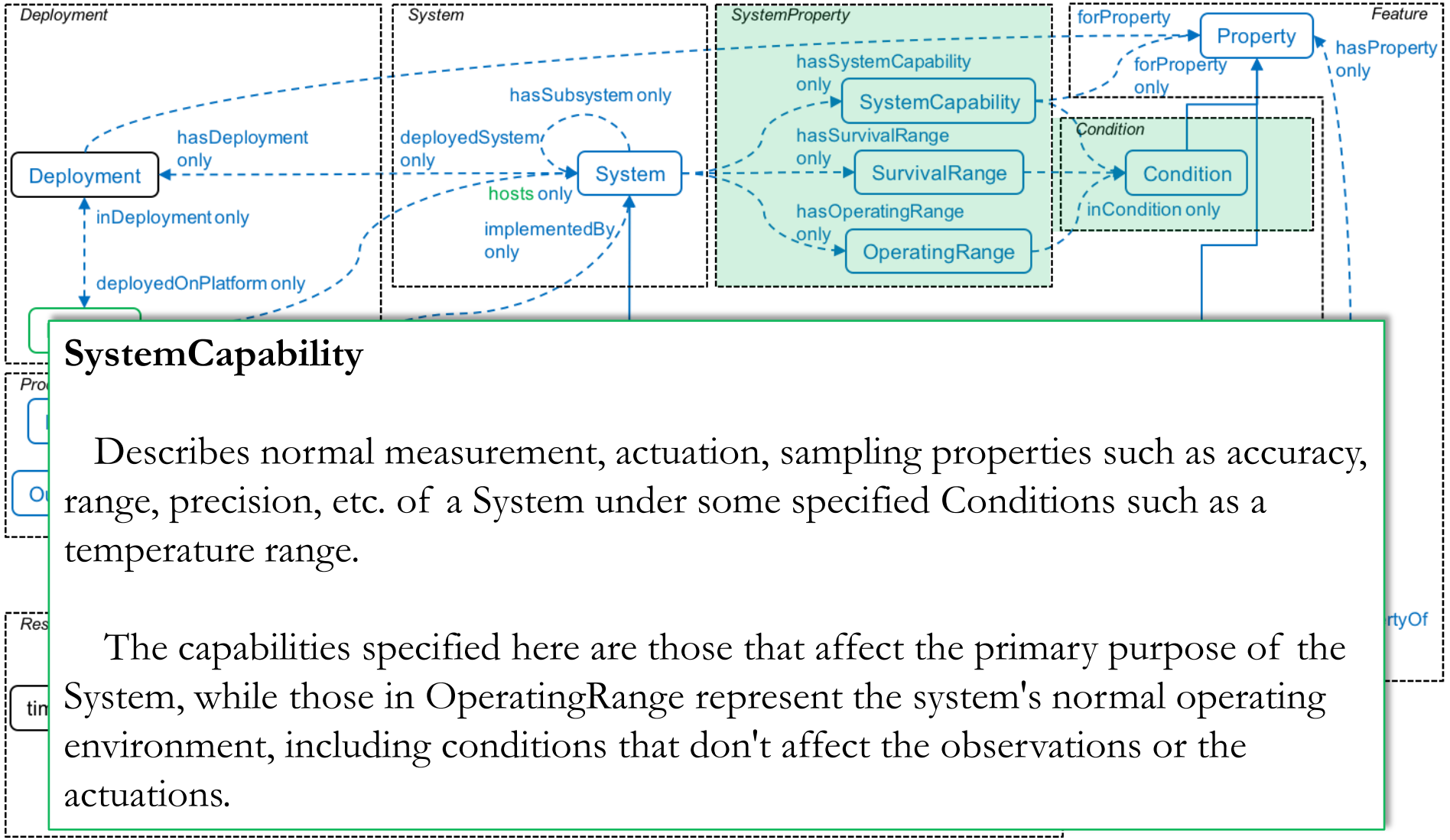
Describes normal OperatingProperties of a System under some specified Conditions. For example, to the power requirement or maintenance schedule of a System under a specified temperature range.

In the absence of OperatingProperties, it simply describes the Conditions in which a System is expected to operate.

Violation → 'out of operating range'

SSN-systems Separate Module

Non normative http://www.w3.org/ns/ssn/systems/



SystemCapability

Describes normal measurement, actuation, sampling properties such as accuracy, range, precision, etc. of a System under some specified Conditions such as a temperature range.

The capabilities specified here are those that affect the primary purpose of the System, while those in OperatingRange represent the system's normal operating environment, including conditions that don't affect the observations or the actuations.

Standardization Process

1. Totally transparent

Public mailing list https://lists.w3.org/Archives/Public/public-sdw-wg/

Wiki https://lists.w3.org/Archives/Public/public-sdw-wg/

Tracker system https://www.w3.org/2015/spatial/track/issues

Public Git repo https://github.com/w3c/sdw/

Confcalls
on average 1h30 every week

Standardization Process

2. Very strict process to reach reco status

2a Public Working Draft
Public Working Draft
…

2b Candidate Recommendation – vote by the group, under control of W3C

2c Last Call Working draft –
prove there was a month-long wide review phase,
and questions/comments have been answered/addressed

2d Proposed Recommendation –
Vote by the Advisory Committee (1 representative per member)
Prove there are **sufficient implementation evidence**

2e Recommendation – decision of the 'Director'

Standardization Process

2d. Implementation report

Criterion: Every term produced in at least two datasets, and used by at least two application

On the usage of the SSN ontology

W3C Document 22 November 2017

Latest editor's draft:
https://w3c.github.io/sdw/ssn-usage/

Editors:
Raúl García-Castro, Ontology Engineering Group, Universidad Politécnica de Madrid
Armin Haller, Australian National University
Nandana Mihindukulasooriya, Ontology Engineering Group, Universidad Politécnica de Madrid

Term in SSN	Equivalent term in SSN-XG	Datasets	Total	Comment
sosa:actsOnProperty		D14	1	entailed by sosa:isActedOnBy
sosa:ActuatableProperty		D14, D18	2	
sosa:Actuation		D14, D18	2	
sosa:Actuator		D14, D18	2	
ssn:deployedOnPlatform	oldssn:deployedOnPlatform	D2, D11, D16, D20	4	
ssn:deployedSystem	oldssn:deployedSystem	D11, D20	2	entailed by ssn:hasDeployment
ssn:Deployment	oldssn:Deployment	D2, D16	2	
ssn:detects	oldssn:detects	D11, D15	2	
sosa:FeatureOfInterest	oldssn:FeatureOfInterest	D1, D5, D11, D12, D14, D15, D17, D20, D21	8	
ssn:forProperty	oldssn:forProperty	D14, D18, D20	3	entailed by sosa:observes
ssn:hasDeployment	oldssn:hasDeployment	D16	1	entailed by

Term in SSN	Equivalent term in SSN-XG	AEMET	aws	BCI	CF	DogOnt	Energy	iot-lite	IoT-O	M3 Lite	OpenIoT	PEP-SSN Alignment	RAMI	SAN	SAO	SPITFIRE	VITAL	Geologic timescale	IoT	SAN	FIxO3	SEAS-SSN Alignment	LSO	Trajectory	Total	Comment
sosa:actsOnProperty																					X	X			2	entailed by sosa:isActedOnBy
sosa:ActuatableProperty				X																X	X	X			4	
sosa:Actuation				X								X							X	X	X	X			6	
sosa:Actuator				X								X							X	X	X	X			6	
ssn:deployedOnPlatform	oldssn:deployedOnPlatform																				X				1	
ssn:deployedSystem	oldssn:deployedSystem																				X				1	entailed by ssn:hasDeployment
ssn:Deployment	oldssn:Deployment																				X				1	
ssn:detects	oldssn:detects			X																	X				2	
sosa:FeatureOfInterest	oldssn:FeatureOfInterest	X		X	X		X		X					X					X		X	X		X	10	
ssn:forProperty	oldssn:forProperty			X					X					X						X	X	X	X		7	entailed by sosa:observes
ssn:hasDeployment	oldssn:hasDeployment																				X				1	entailed by ssn:deployedSystem
sosa:hasFeatureOfInterest	oldssn:featureOfInterest	X		X			X												X		X	X			6	entailed by isFeatureOfInterestOf
ssn:hasInput	oldssn:hasInput											X									X	X			3	
ssn:hasOutput	oldssn:hasOutput											X									X	X			2	
ssn:hasProperty	oldssn:hasProperty			X	X									X						X	X	X			6	entailed by ssn:isPropertyOf
sosa:hasSample																						X			1	entailed by sosa:isSampleOf
sosa:hasSimpleResult	oldssn:hasSimpleResult											X									X	X			3	
ssn:hasSubSystem	oldssn:hasSubSystem							X									X				X	X			4	
sosa:hasResult	oldssn:hasValue oldssn:observationResult			X			X		X			X		X							X	X	X		8	
sosa:hosts	oldssn:attachedSystem										X										X				2	entailed by sosa:isHostedBy
ssn:implementedBy	oldssn:implementedBy																				X				1	entailed by

First integration in schema.org

Actuator

Canonical URL: http://iotschema.org/Actuator

Device > Actuator

Actuator – A device that is used to change the state of the world.

Property	Expected Type	Description
Properties from Actuator		
Made Actuation	PropertyValue	Relation linking a PropertyValue to the Actuator that made that Actuation.
For Property	Property or Action	Relation between an Actuator and either a Property or an Action that it is capable of actuation.

Instances of Actuator may appear as values for the following properties

Property	On Types	Description
Is Acted On By	Property or Action	Relation between an Action or a Property of a FeatureOfInterest and an Actuator changing its state.

5. Other ontologies of interest under development at the W3C ?

5a. The Thing Description ontology

Choosing your ontologies for sensor data applications

Institut Mines-Télécom

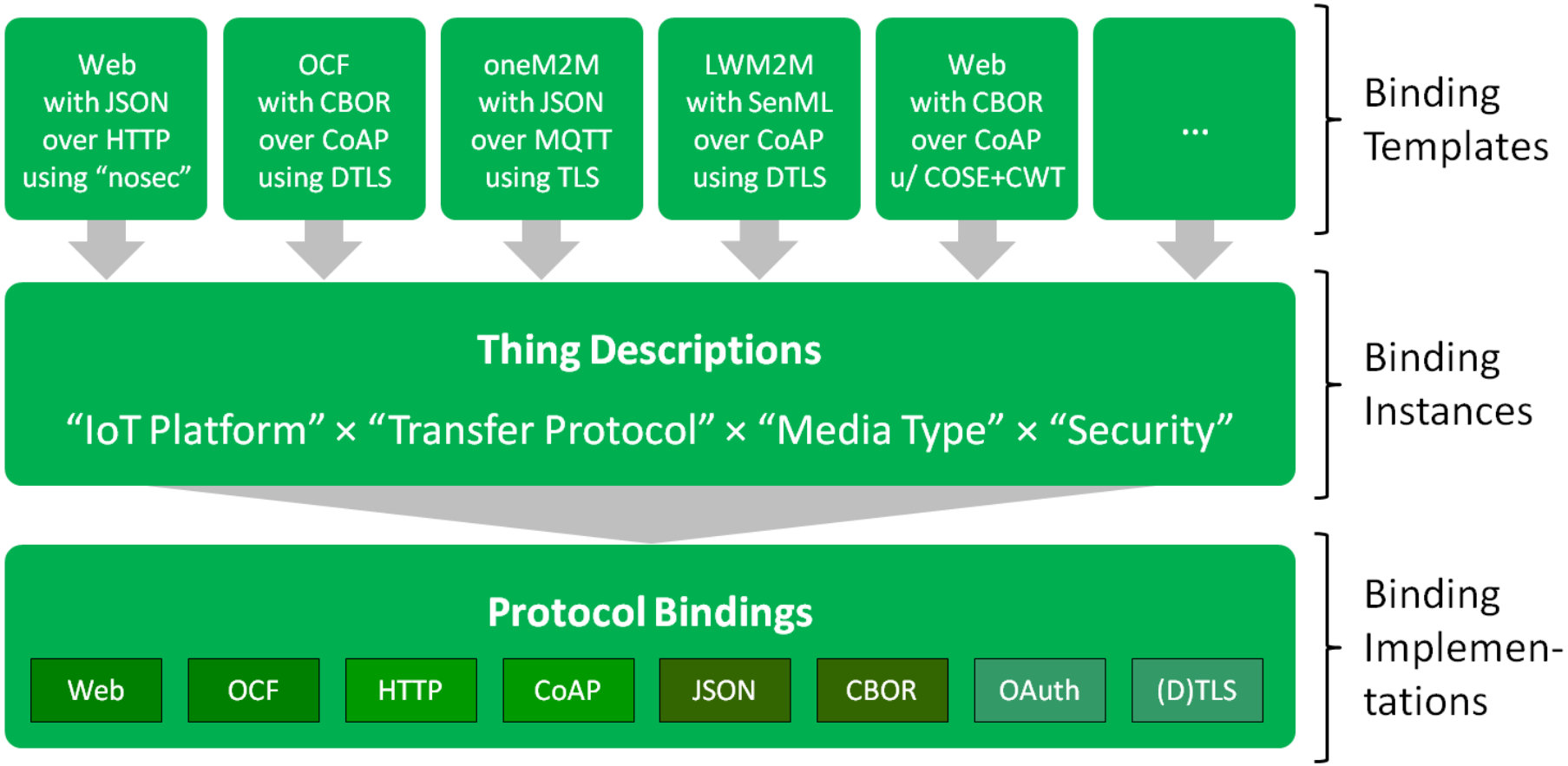
Next group to watch ? (1/2)

W3C Web of Things 2016 - 2019

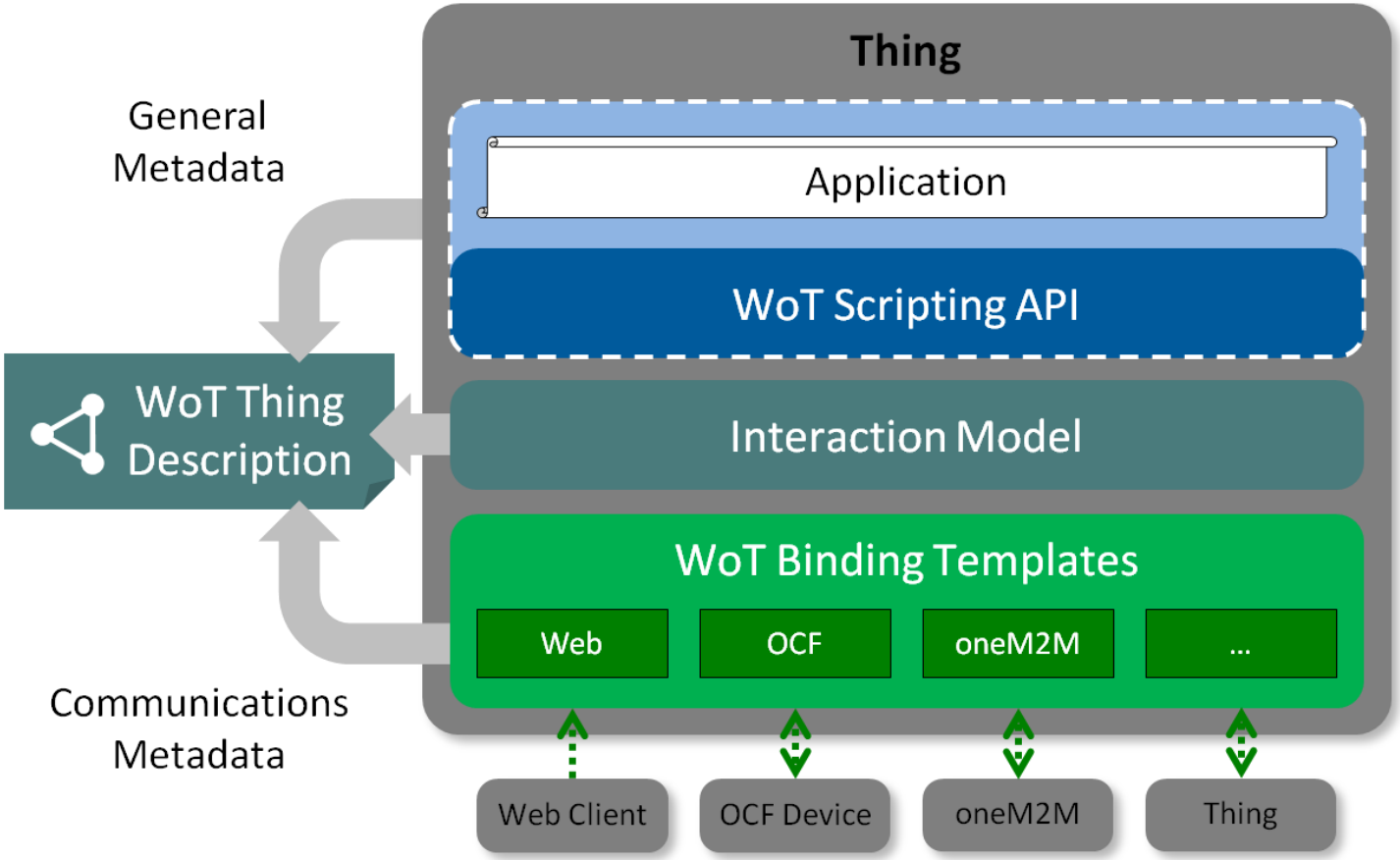
Member organization	# contributors
(Public) Invited Experts	3
W3C Invited Experts	2
ACCESS CO., LTD.	2
Alibaba Group	2
AT&T	1
Avaya Communications	3
Blockstream	3
British Broadcasting Corporation	1
Cable Television Laboratories Inc	1
China Electronic Technology Group Corporation Information Science Academy	7
China Mobile Communications Corporation	2
China Unicom	2
Consiglio Nazionale delle Ricerche (CNR)	1
Copper Horse Solutions Ltd	1
DATUMIZE,S.L.	1
Deutsche Telekom AG	2
Electronics and Telecommunications Research Institute (ETRI)	4
Ericsson	4
EVRYTHNG	4
Forschungszentrum Informatik (FZI)	2
Fraunhofer Gesellschaft	4
Fujitsu Limited	5
Fundacion CTIC	2
German Research Center for Artificial Intelligence (DFKI) Gmbh	2
Google, Inc.	1
HARTING KGaA	1
Hewlett Packard Enterprise	1
Hitachi, Ltd.	3
Huawei	3
INSIGHT - The Centre for Data Analytics	9
Institut National de Recherche en Informatique et en Automatique (INRIA)	4
INSTITUT TELECOM	5
Inswave Systems Co., Ltd.	1
Intel Corporation	11
Jaguar Land Rover	4
KDDI CORPORATION	7
Knowbility, Inc	1
Konica Minolta Inc.	1
LG Electronics	1
MITRE Corporation	2
Mitsubishi Electric Corporation	2
Monohm Inc.	1
NIC.br - Brazilian Network Information Center	1
Nippon Telegraph & Telephone Corp. (NTT)	2
Nokia Corporation	4
Nominet	1
NRU ITMO	1
Open Geospatial Consortium	1
Oracle Corporation	4
Orange	3
Pacific Northwest National Laboratory	1
Panasonic Corporation	10
Plantronics, Inc.	3
PTC	1
RWE AG	5
Siemens AG	9
SMARTRAC TECHNOLOGY Fletcher, Inc.	1
SoftBank Corp.	1
Sony Corporation	1
Target	1
Telecom Italia SpA	1
Tencent	2
The Boeing Company	1
The Paciello Group, LLC	4
TNO	1
Toshiba Corporation	2
UNI K.K.	3
Universidad Politécnica de Madrid	1
Universidade de Sao Paulo	4
Université de Lyon	5
University of Southampton	3
University of Surrey	1
Viacom	1
W3C Staff	10
WU (Wirschaftsuniversitat Wien) - Vienna University of Economics and Business	1

Total : 73 organizations, 210 group participants, 5 invited experts

W3C Web of Things



W3C Web of Things



W3C Web of Things

Thing Description representation (semantic ~ ?) of:

- the Thing,
- the interaction capabilities it exposes
  - Properties (observable ?, writable ?)
  - Action (an object is generated to monitor, cancel, …)
  - Event (type pub/sub)
- how to sollicitate it (URL, media type and in/out datamodel)

WoT Binding Templates

- every interaction type with every protocol or existing standard

  ex. OCF light and motion sensor using CoAP on LAN

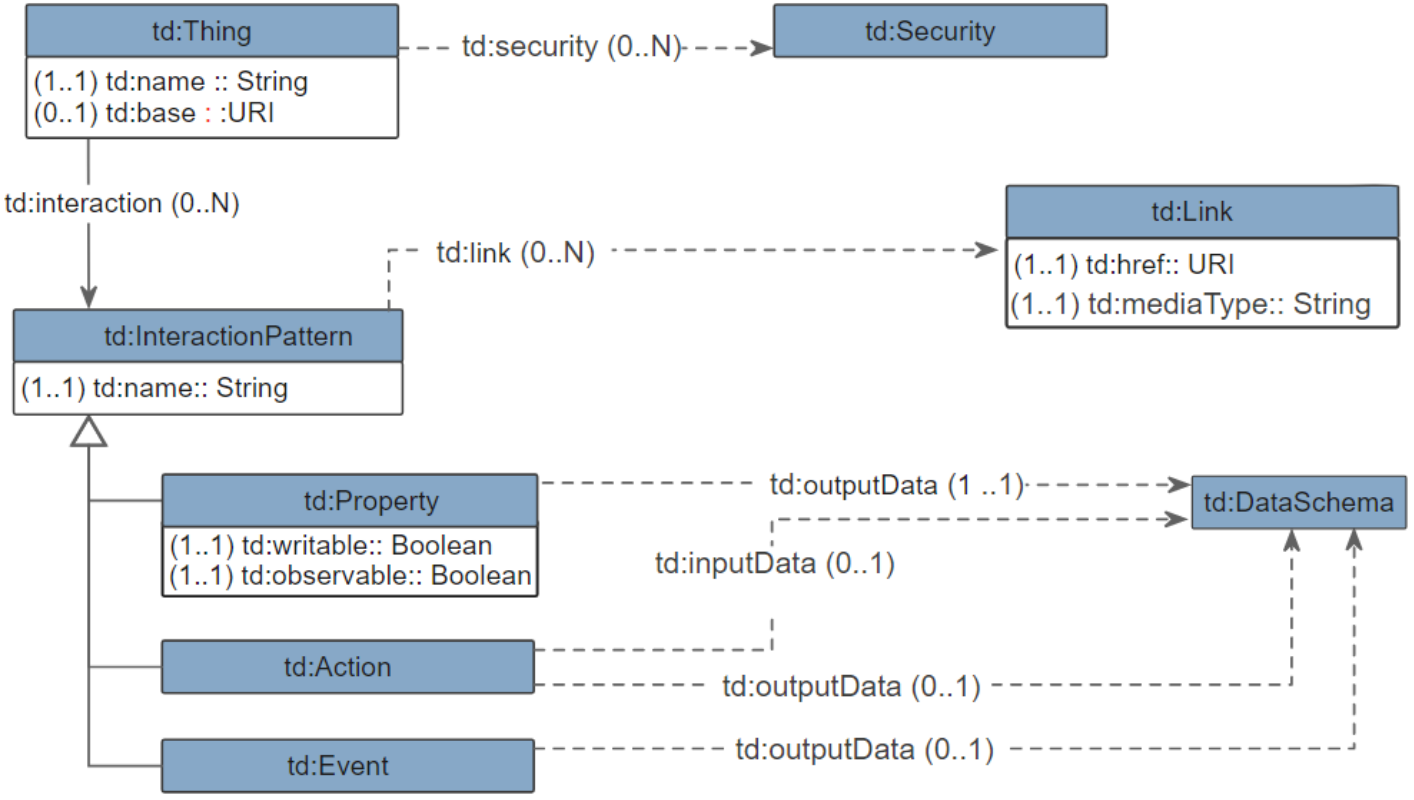
  ex. LWM2M+IPSO environmental sensor from MQTT brokers, LAN and cloud

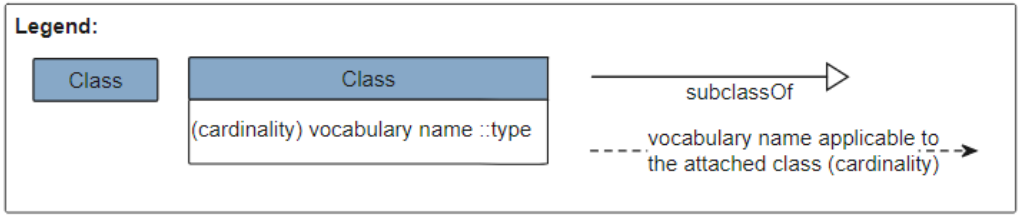
  ex SmartThings Endpoint API using HTTP cloud-to-cloud

Scripting API

- javacript API to search / discover / sollicitate things

W3C Web of Things





@prefix td: <http://www.w3.org/ns/td#>.

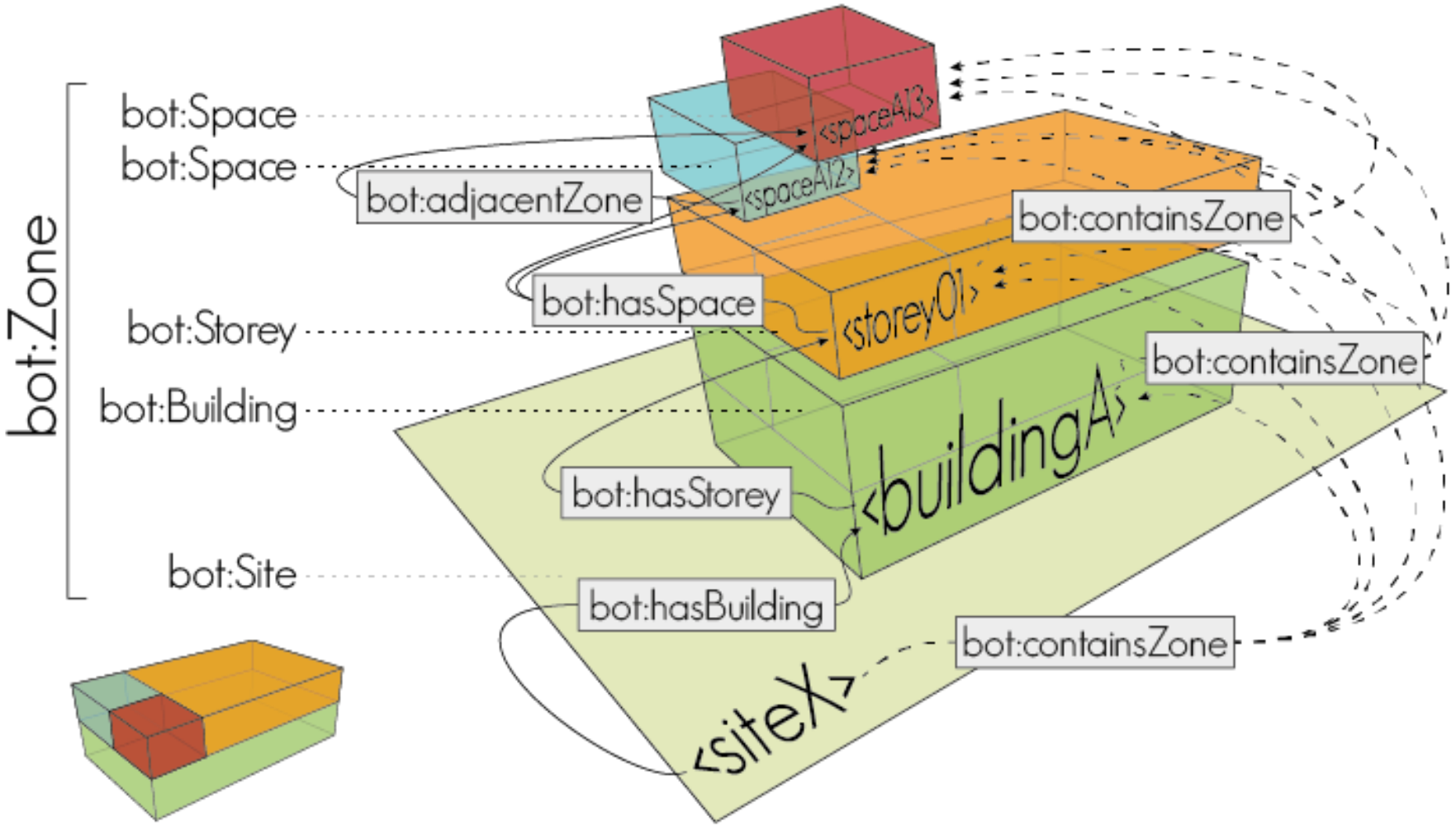
5. Other ontologies of interest under development at the W3C ?

5b. The Building Topology Ontology

Choosing your ontologies for sensor data applications

Institut Mines-Télécom

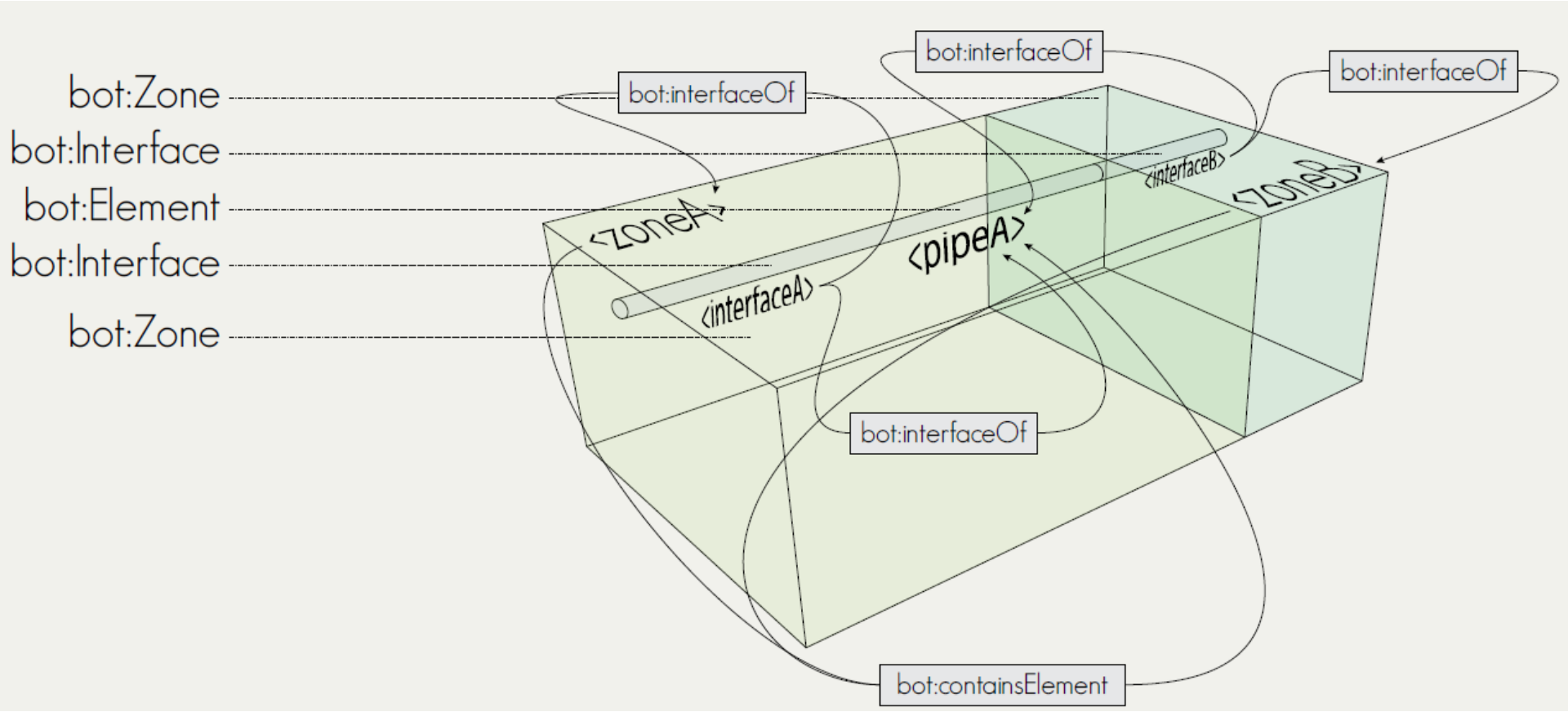
W3C Linked Building Data community group



credit: Mads Holten Rasmussen, Alectia

@prefix bot: <https://w3id.org/bot#>.

W3C Linked Building Data community group



credit: Mads Holten Rasmussen, Alectia

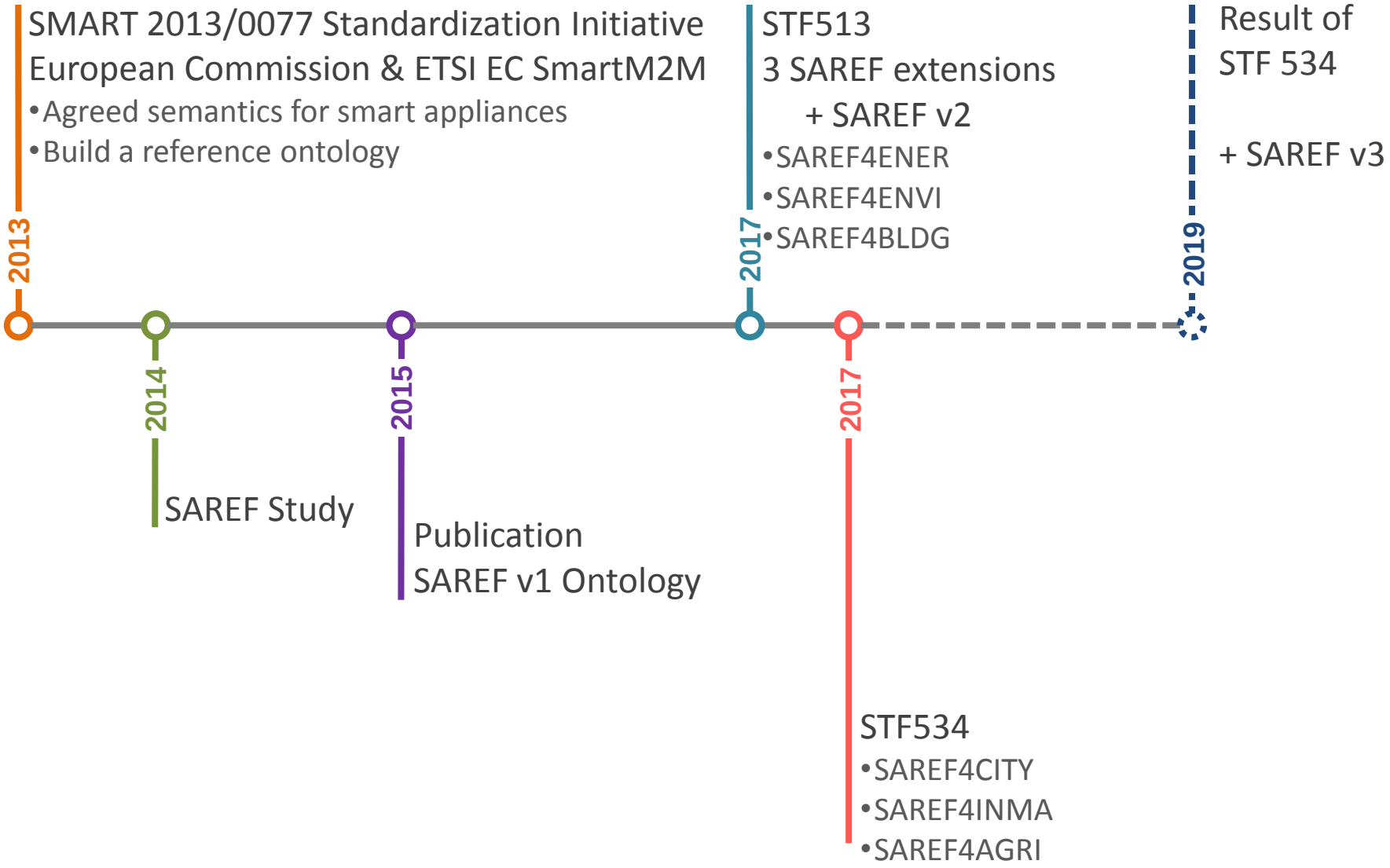
@prefix bot: <https://w3id.org/bot#>.

5. Other ontologies of interest under development in other standard development organizations ?

Choosing your ontologies for sensor data applications

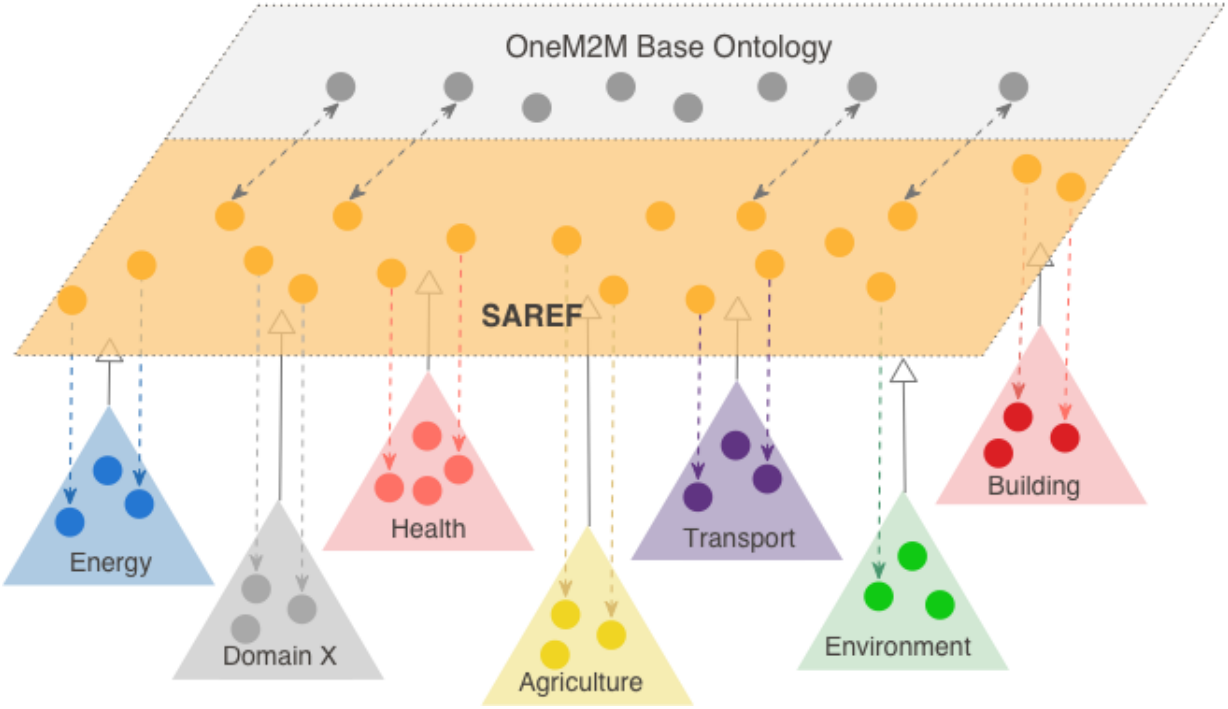
Institut Mines-Télécom

The SAREF ontology context

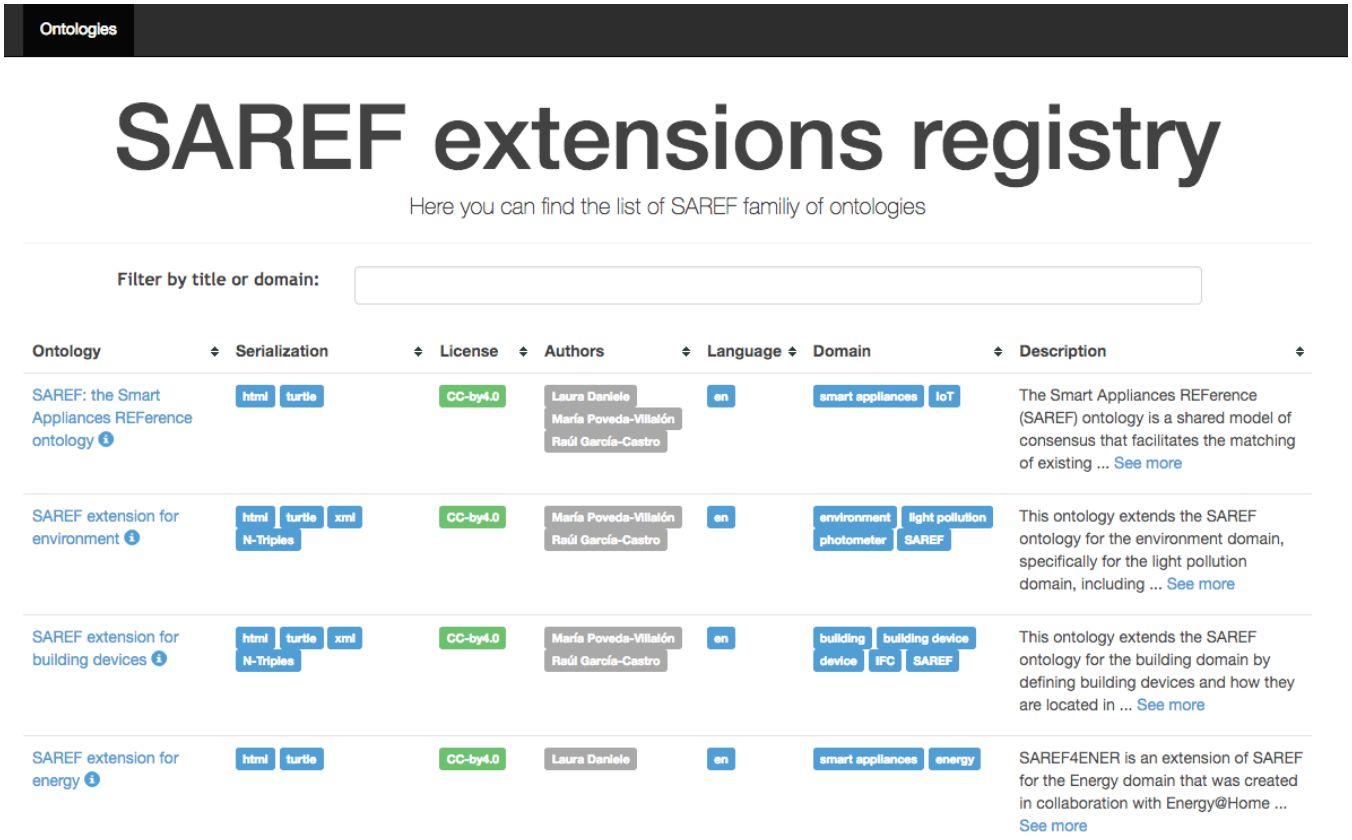


The SAREF ontology context

- SAREF is not intended to replace existing standards, its intention is to **link** information coming from **different** smart **appliances**, based on different **standards**
- SAREF is the **core model** to **connect** smart **appliances** from all domains
- As **different domains** have different information needs, **extensions** of SAREF will be defined to tune the standard for a domain



http://saref.linkeddata.es/ Catalogue (UPM's site, not official)



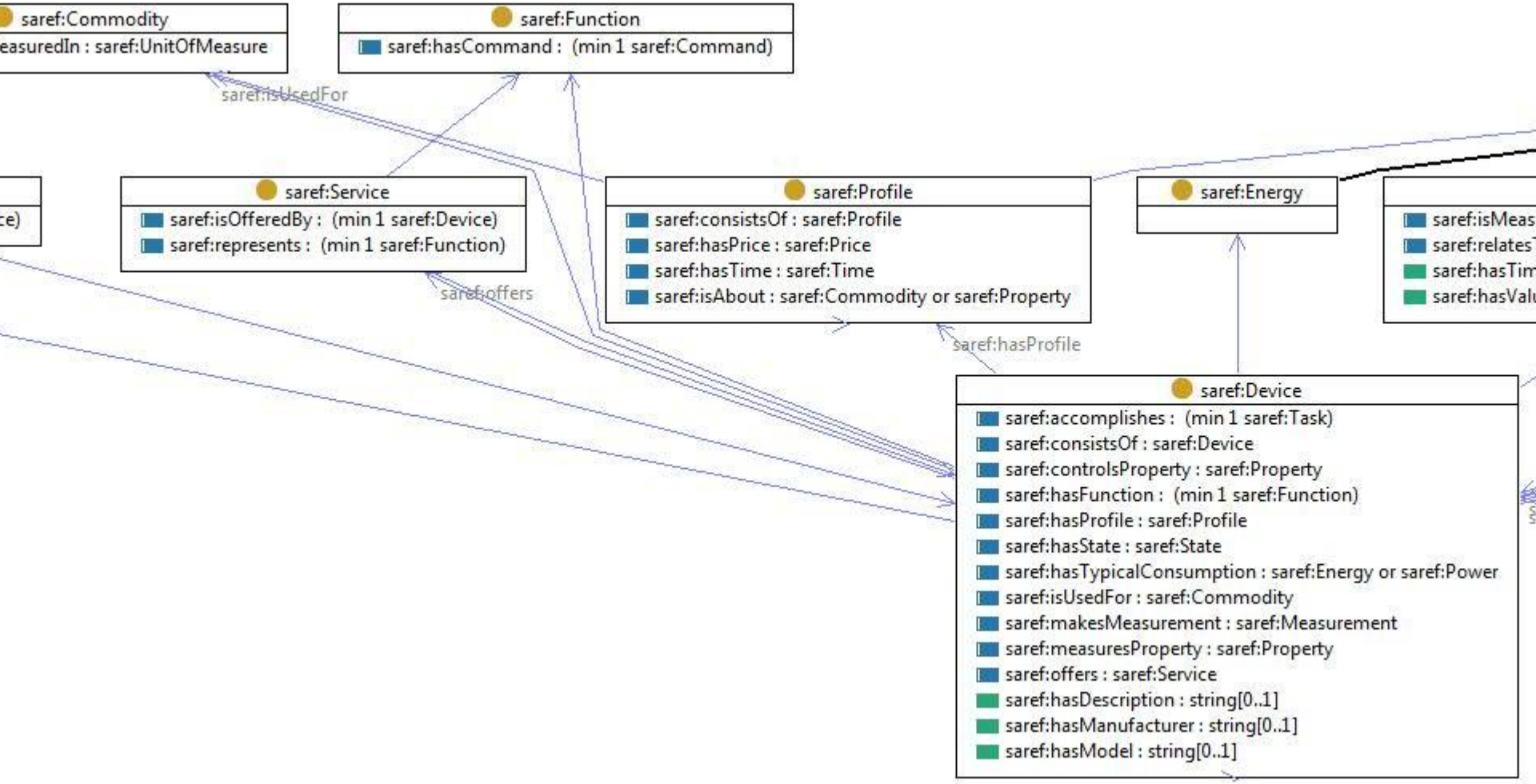
Includes:

- SAREF ontology
- SAREF4ENVI
- SAREF4BLDG
- SAREF4ENER

To be included (when available):

- SAREF4CITY
- SAREF4INMA
- SAREF4AGRI

Powered by


saref:Commodity
easuredIn : saref:UnitOfMeasure
saref:Function
saref:hasCommand : (min 1 saref:Command)
saref:isUsedFor
saref:Service
saref:isOfferedBy : (min 1 saref:Device)
saref:represents : (min 1 saref:Function)
saref:offers
saref:Profile
saref:consistsOf : saref:Profile
saref:hasPrice : saref:Price
saref:hasTime : saref:Time
saref:isAbout : saref:Commodity or saref:Property
saref:hasProfile
saref:Energy
saref:Device
saref:accomplishes : (min 1 saref:Task)
saref:consistsOf : saref:Device
saref:controlsProperty : saref:Property
saref:hasFunction : (min 1 saref:Function)
saref:hasProfile : saref:Profile
saref:hasState : saref:State
saref:hasTypicalConsumption : saref:Energy or saref:Power
saref:isUsedFor : saref:Commodity
saref:makesMeasurement : saref:Measurement
saref:measuresProperty : saref:Property
saref:offers : saref:Service
saref:hasDescription : string[0..1]
saref:hasManufacturer : string[0..1]
saref:hasModel : string[0..1]

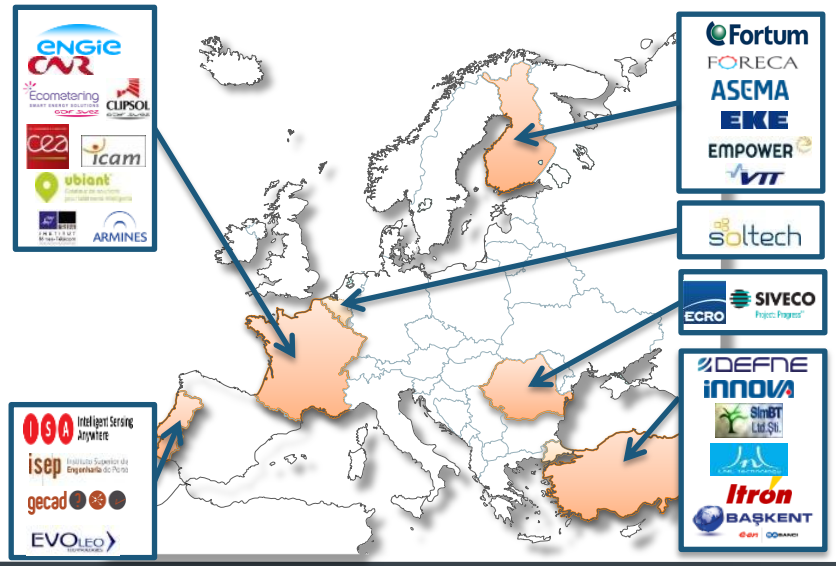
6. The SEAS ontology network

Choosing your ontologies for sensor data applications

Institut Mines-Télécom

Smart Energy-Aware Systems

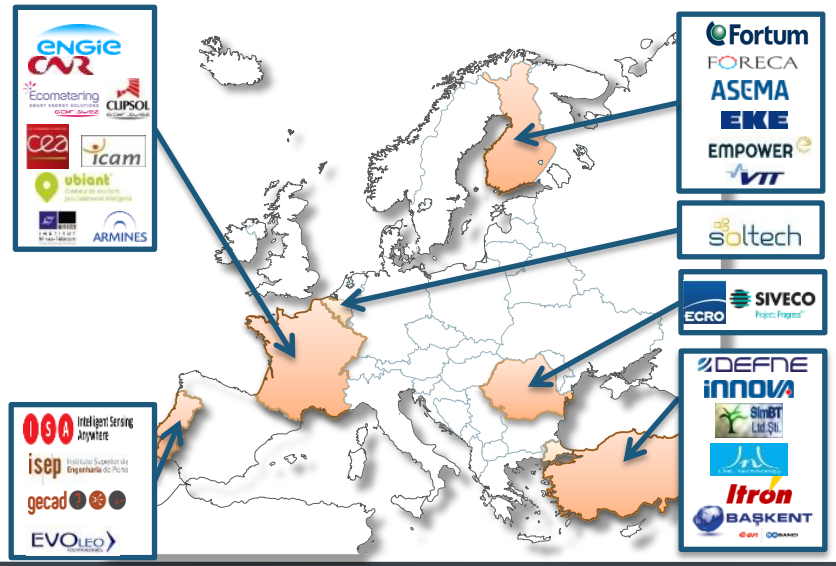
Feb 2014 - Dec 2016 - 3 yrs, 6 countries, 34 partners, 16 M€, 160 man-year



Smart Energy-Aware Systems

« Design and develop a global ecosystem of services and smart things collectively capable of ensure the stability and the energy efficiency in the future energy grid »

Feb 2014 - Dec 2016 - 3 yrs, 6 countries, 34 partners, 16 M€, 160 man-year



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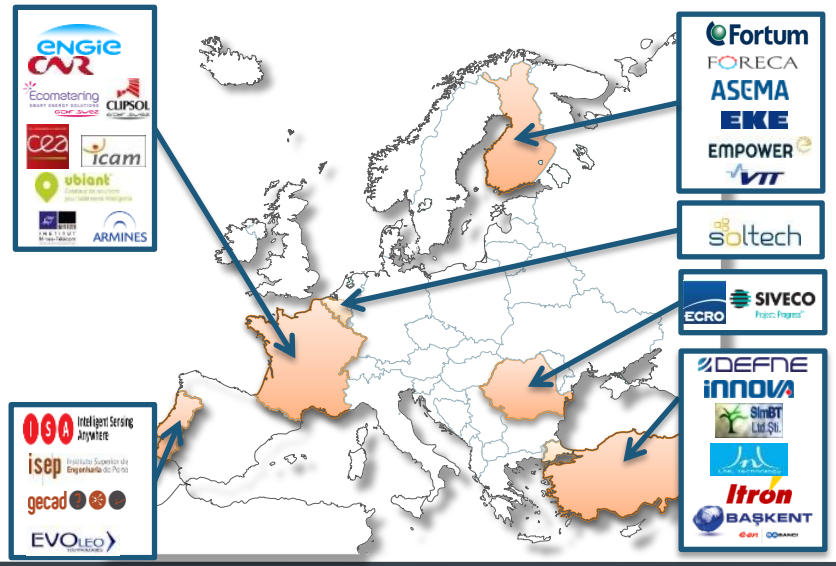


WP 1 - Use cases, business models, requirements, architecture
WP 2 - Knowledge model, knowledge based services
WP 3 - Smart Building
WP 4 - Microgrids, and Electric Vehicles
WP 5 - Simulations
WP 6 - Prototypes and Pilots
WP 7 - Standardization

Domains to be modelled

Describing very light messages sent to/from sensor/actuators
Describing SEAS service and their interfaces to ease their registration and discovery
Time series: history, observations, forecast
Data privacy and access control – contracts
The infrastructures characteristics and limitations
Energy generation/load/storage/transfer
Smart Building zones and environmental factors
Smart Building and its interaction with the environment
Controllable and non-controllable appliances / loads
Controllable and non-controllable energy generators
electric vehicles and charging equipment
Characteristics specific to batteries
Demands, offers, transactions
Contracts for demand-response or aggregators

SEAS – Design goals

- Conform to the publication and metadata best practices
  - Detect violations as soon as possible
  - Leave little work for the ontology maintainers

- Open source development projects quality criterias:
  - Modular,
  - Semantic Versioning,
  - Open source (allow for contributions)

- Short learning curve
  - Simple core
  - Consistent extensions ot various domains
  - internal structure

Design requirements

REQ1: Best practices for IRIs

Cool URIs [for the Sem Web], Linked Data design principles

REQ2: Best practices for the ontology and the terms metadata

REQ3: Modular as specified in OWL2 REC

REQ4: Versioning mechanism as specified in OWL2 REC

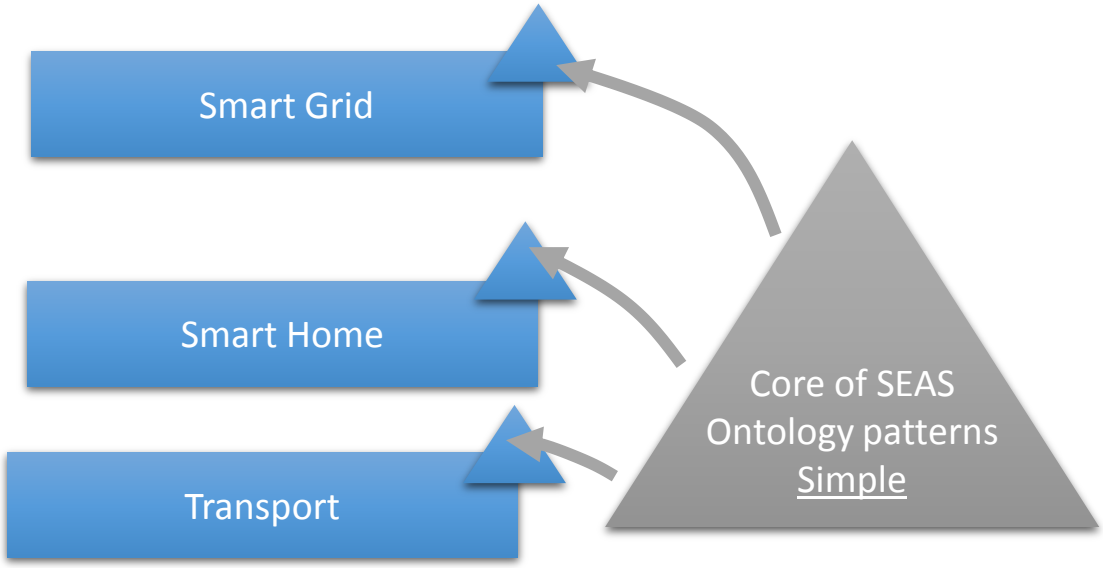
REQ5: Semantic Versioning adapted to the linked vocabularies

REQ6: All the resources IRIs must be in the same namespace

Prefix seas: <https://w3id.org/seas/> .

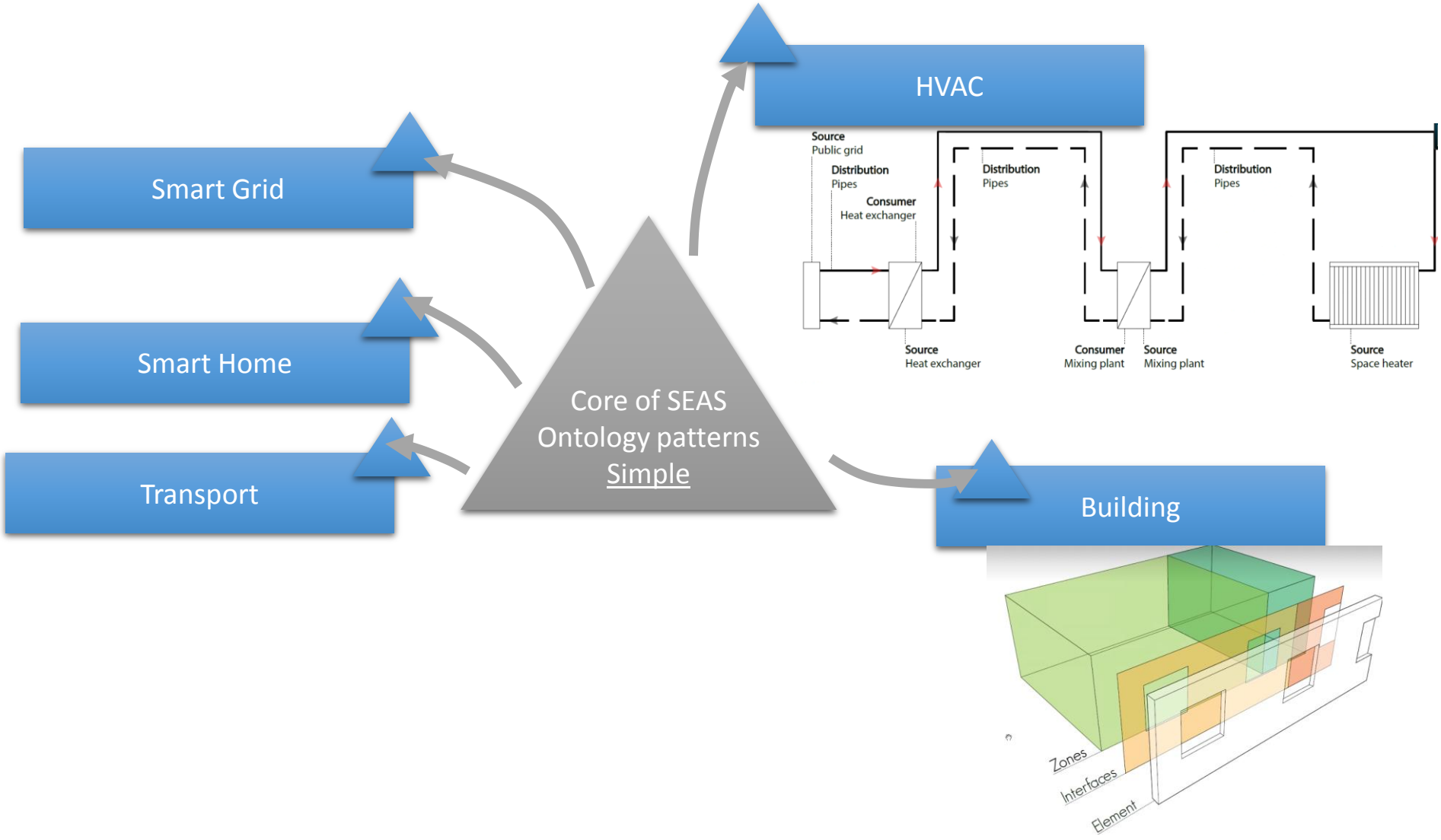
Ease their extension to other domains ?

simple core + extensible + open-source

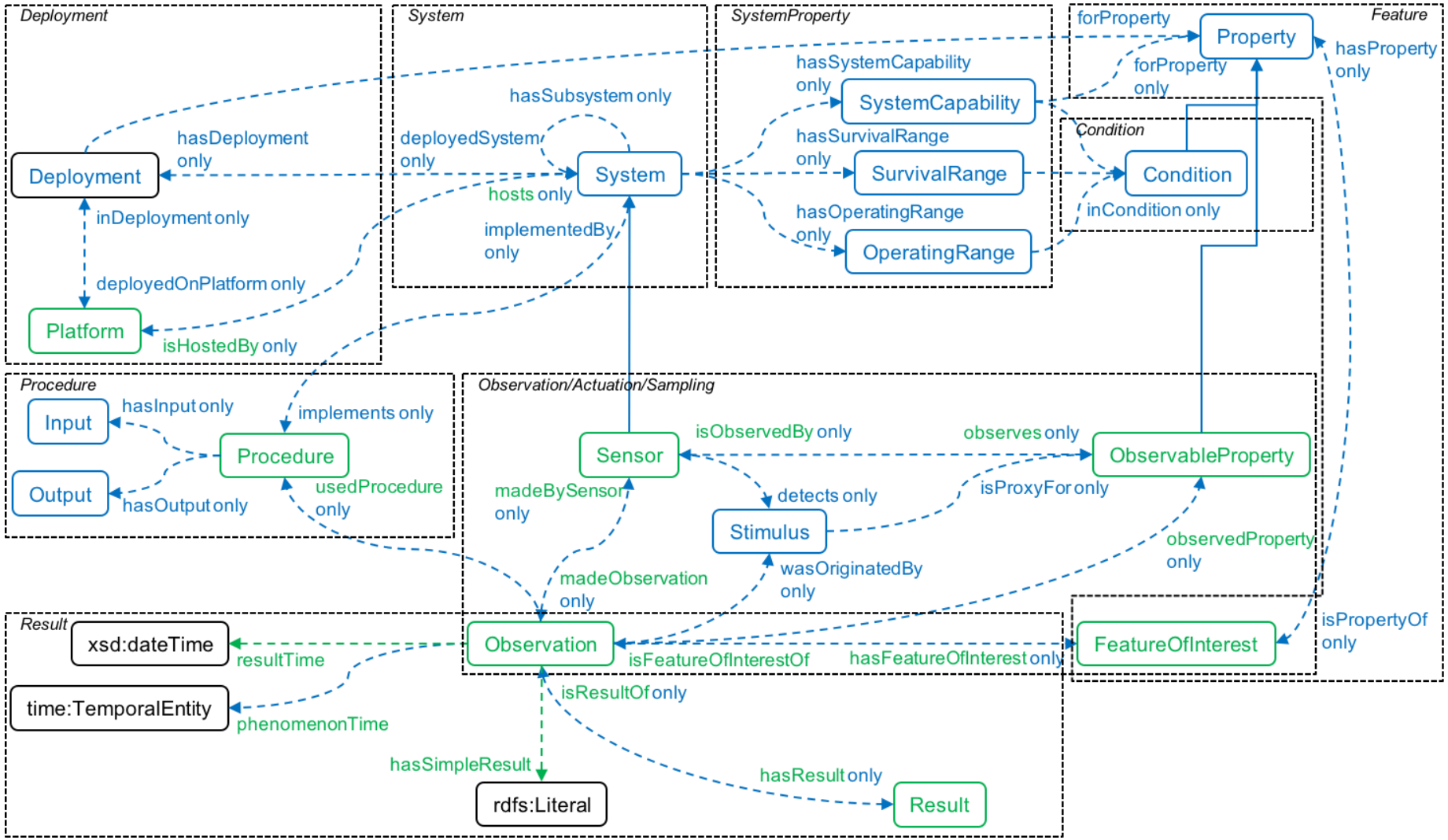


Ease their extension to other domains ?

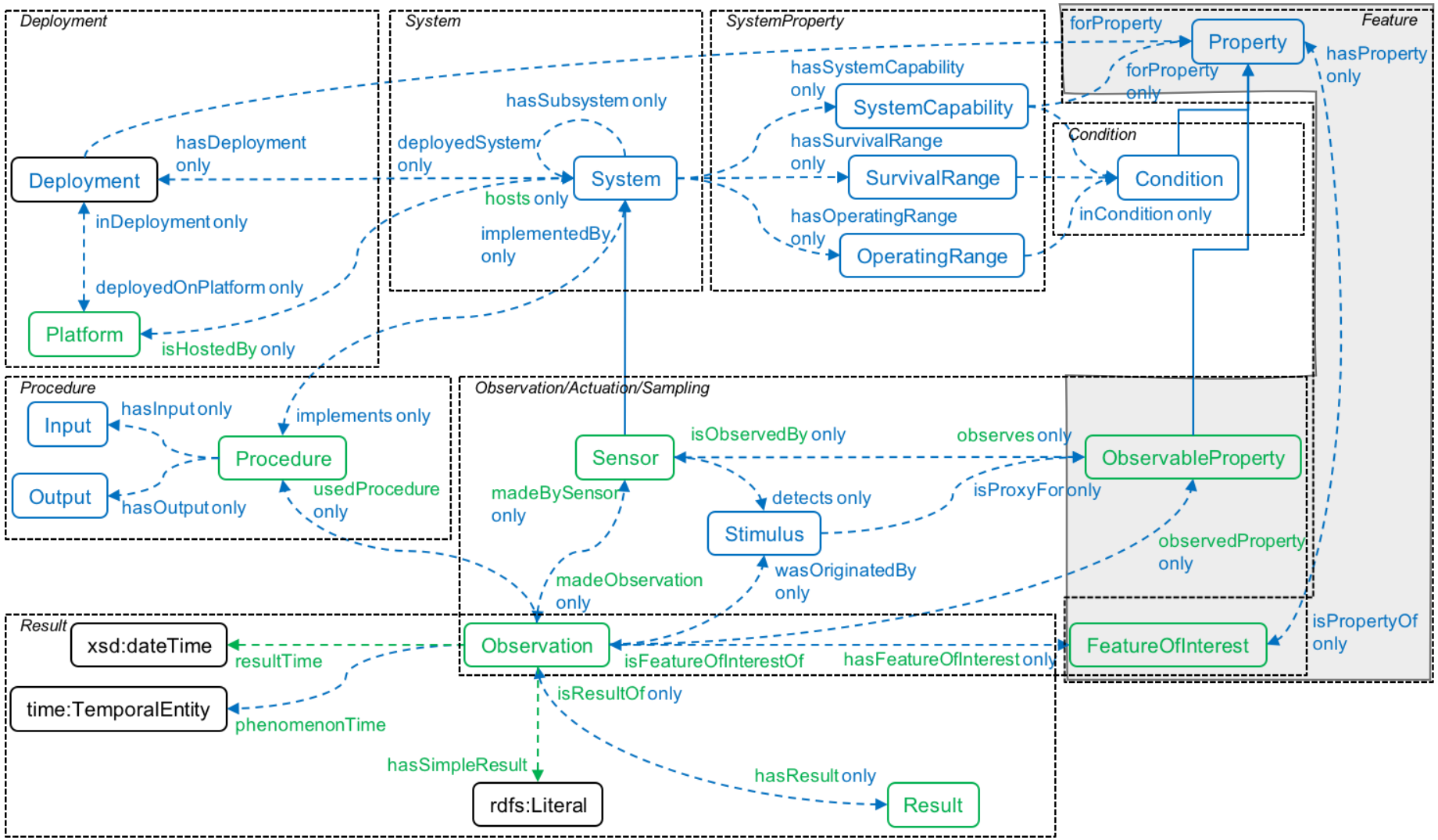
simple core + extensible + open-source



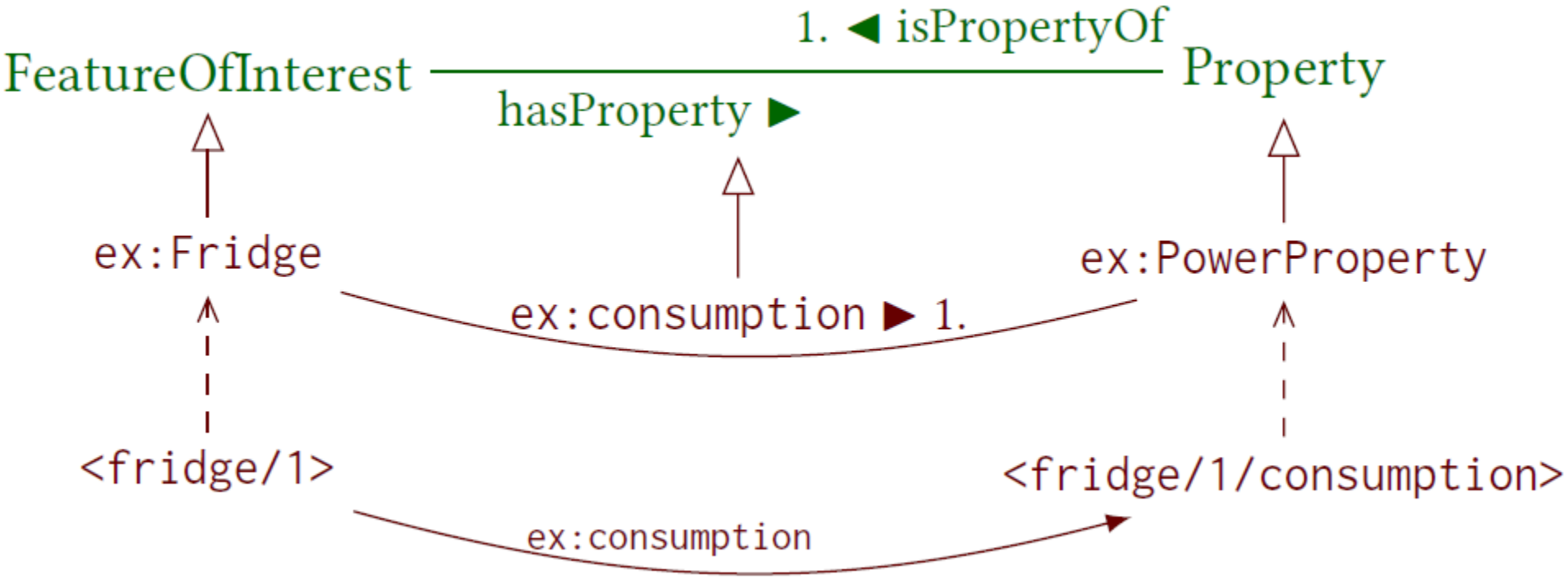
The W3C&OGC SOSA/SSN ontology



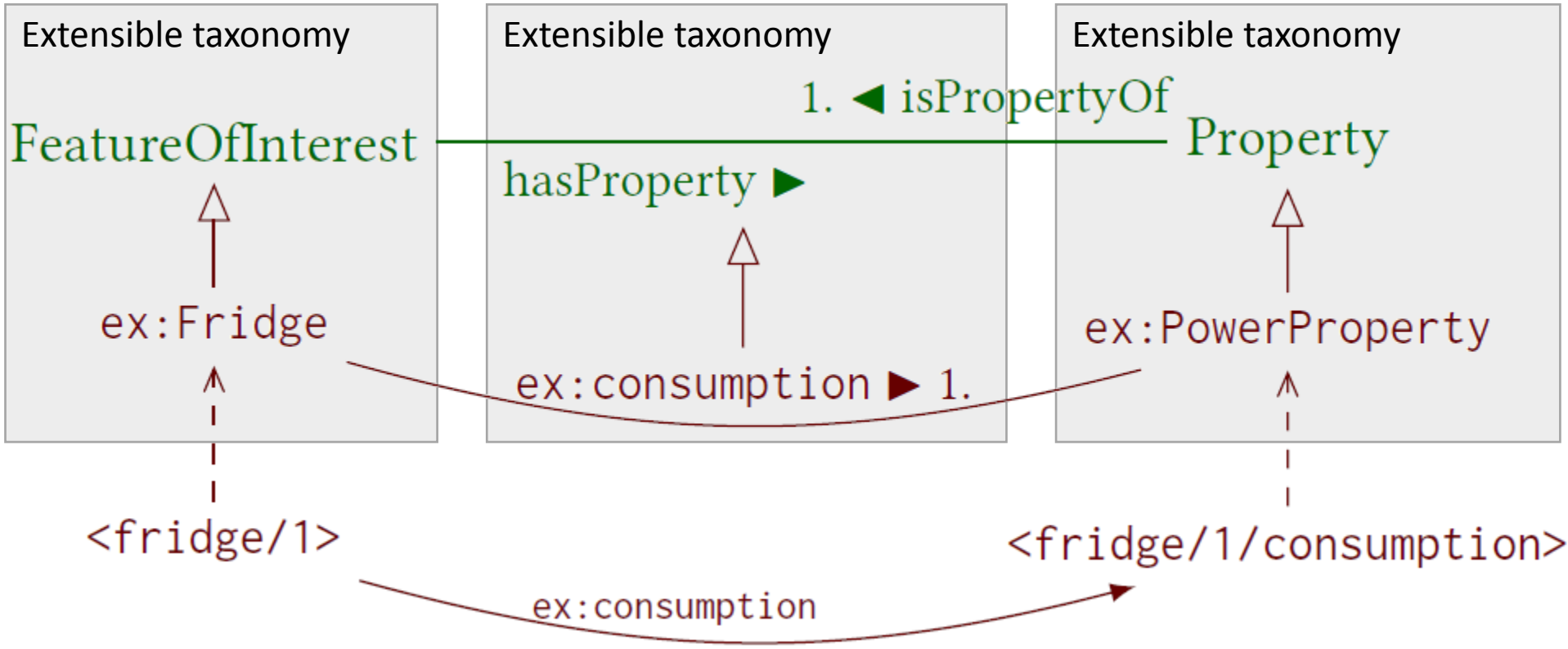
The W3C&OGC SOSA/SSN ontology



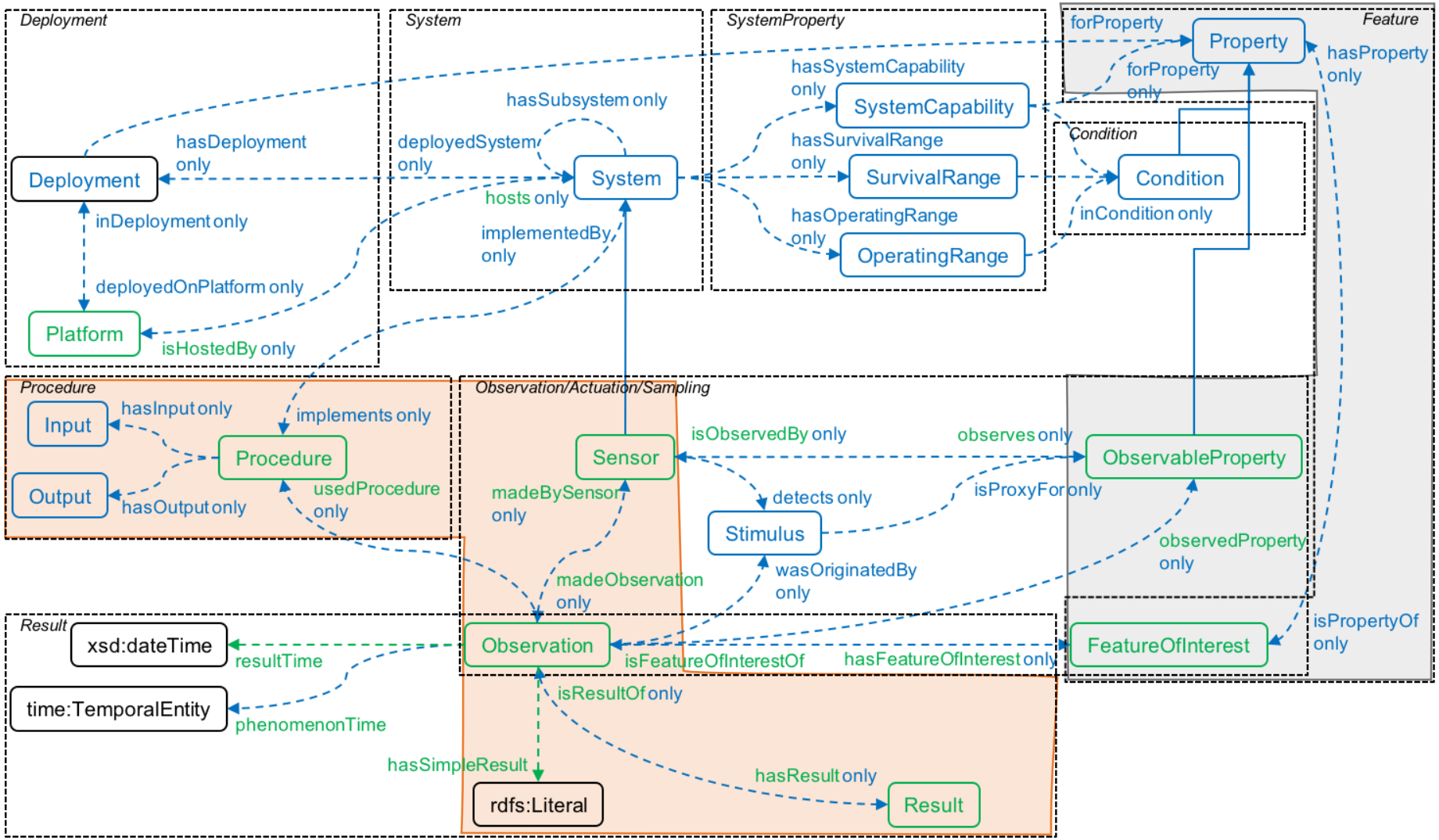
the **Property** ontology pattern



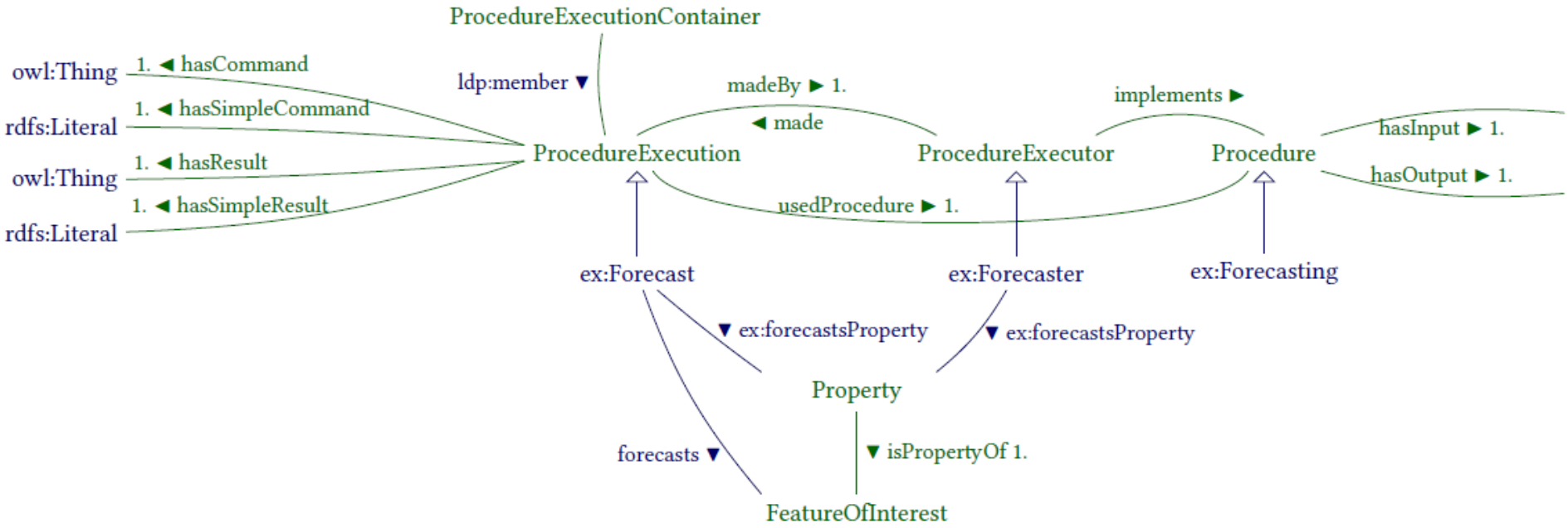
the **Property** ontology pattern



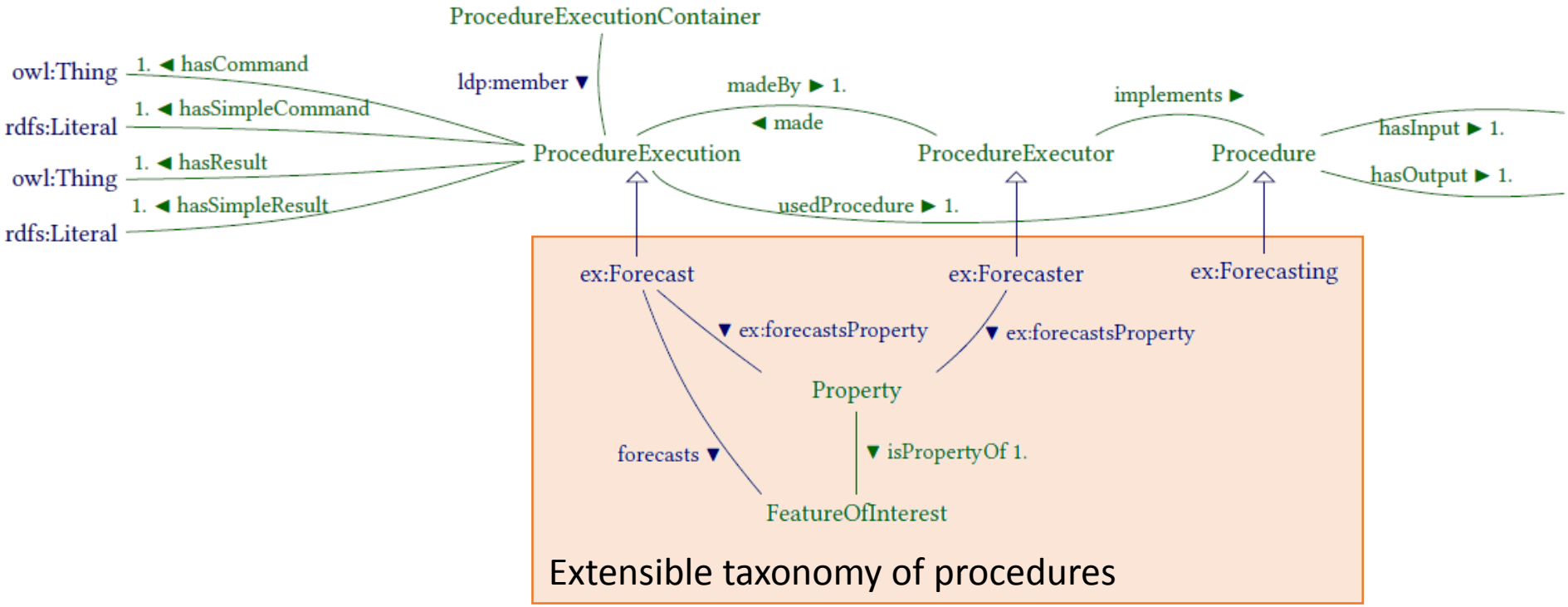
The W3C&OGC SOSA/SSN ontology



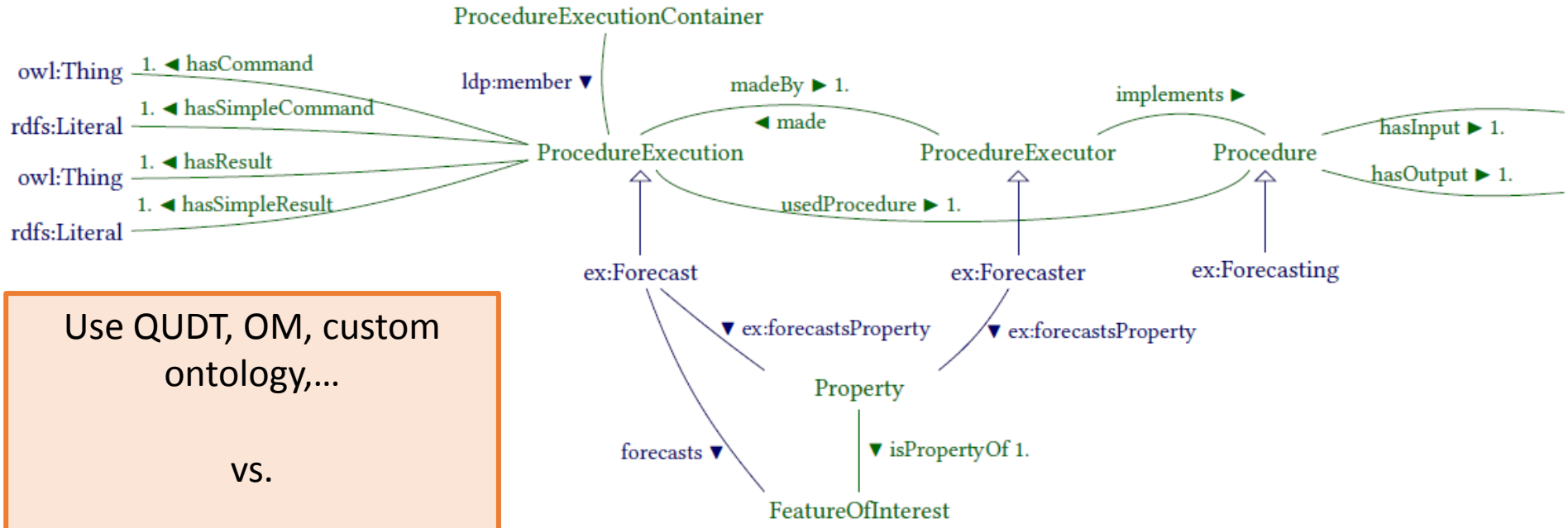
the **Procedure Execution** ontology pattern



the **Procedure Execution** ontology pattern



the **Procedure Execution** ontology pattern

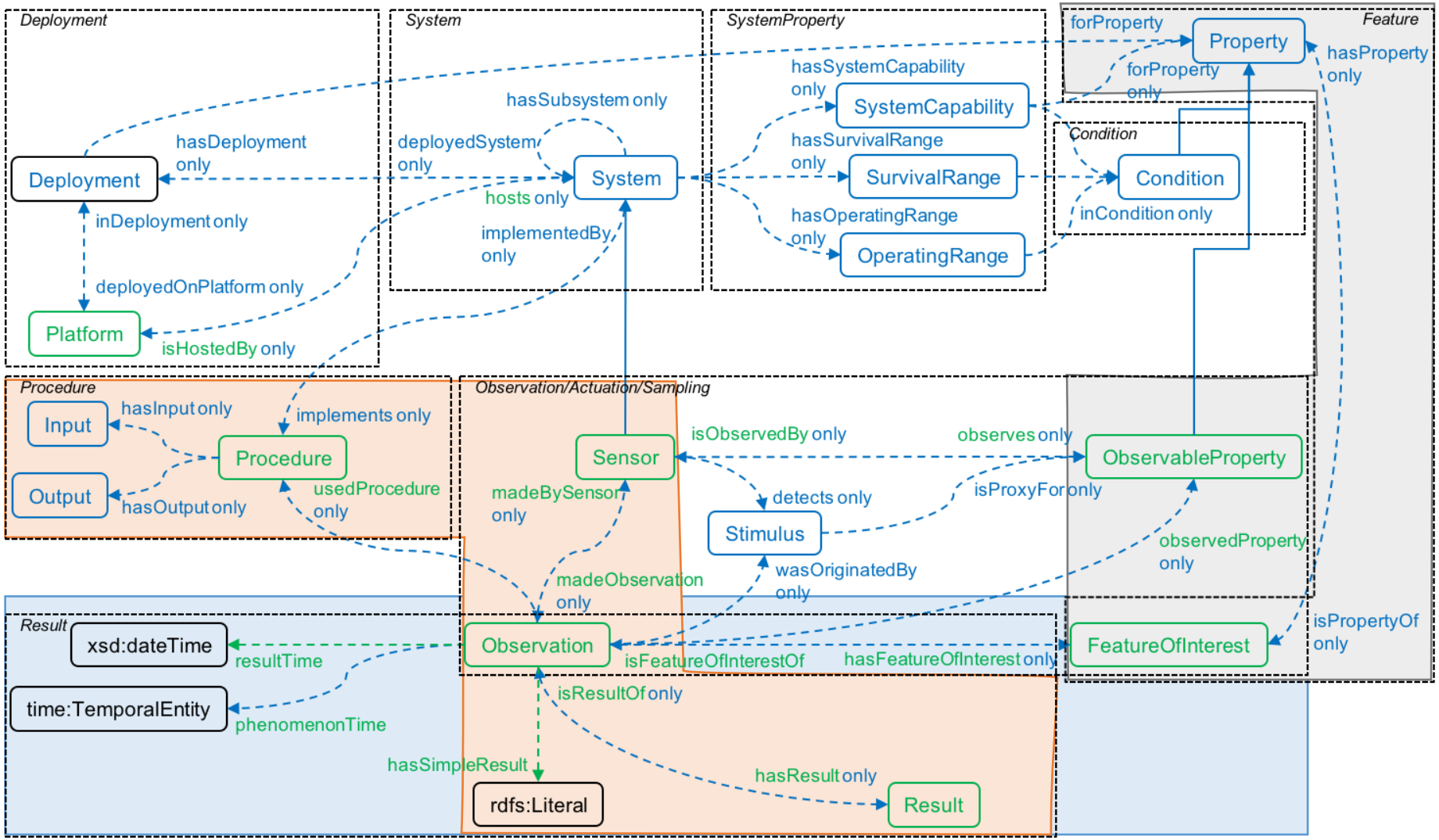


Use QUDT, OM, custom ontology,…

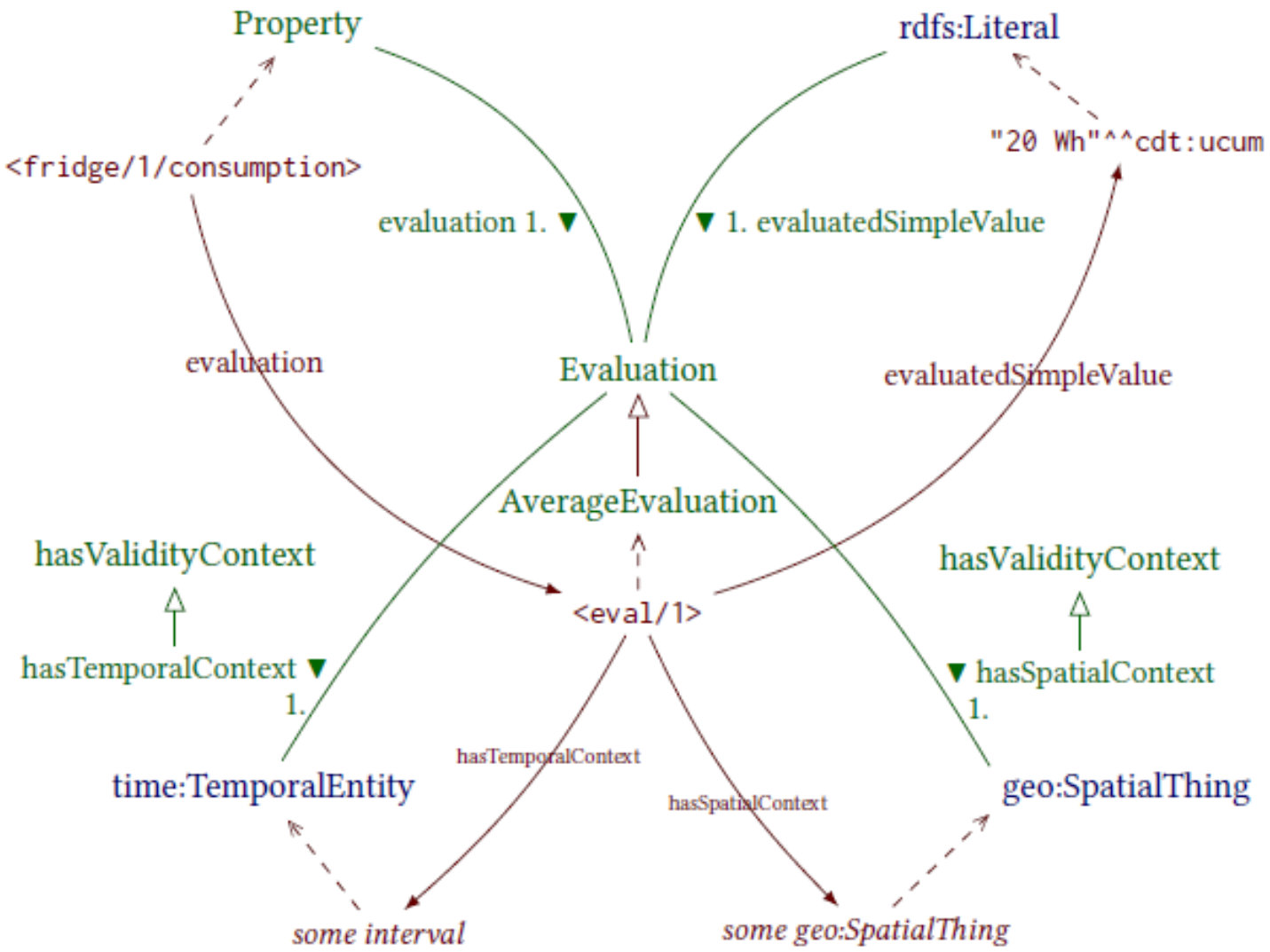
vs.

Use literals, custom literals, "42.7 km/h"^^cdt:ucum…

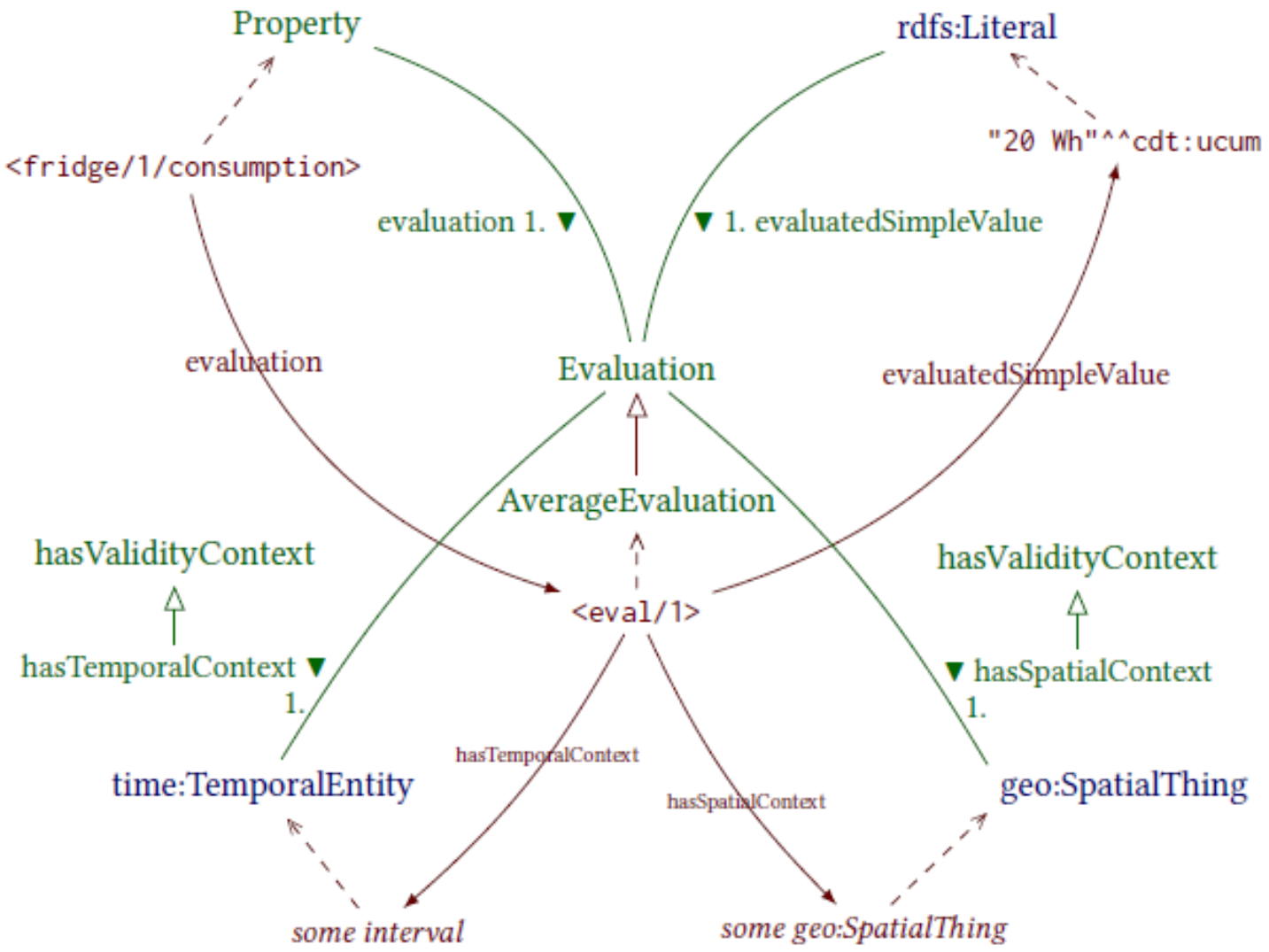
The W3C&OGC SOSA/SSN ontology



the **Evaluation** ontology pattern



the **Evaluation** ontology pattern



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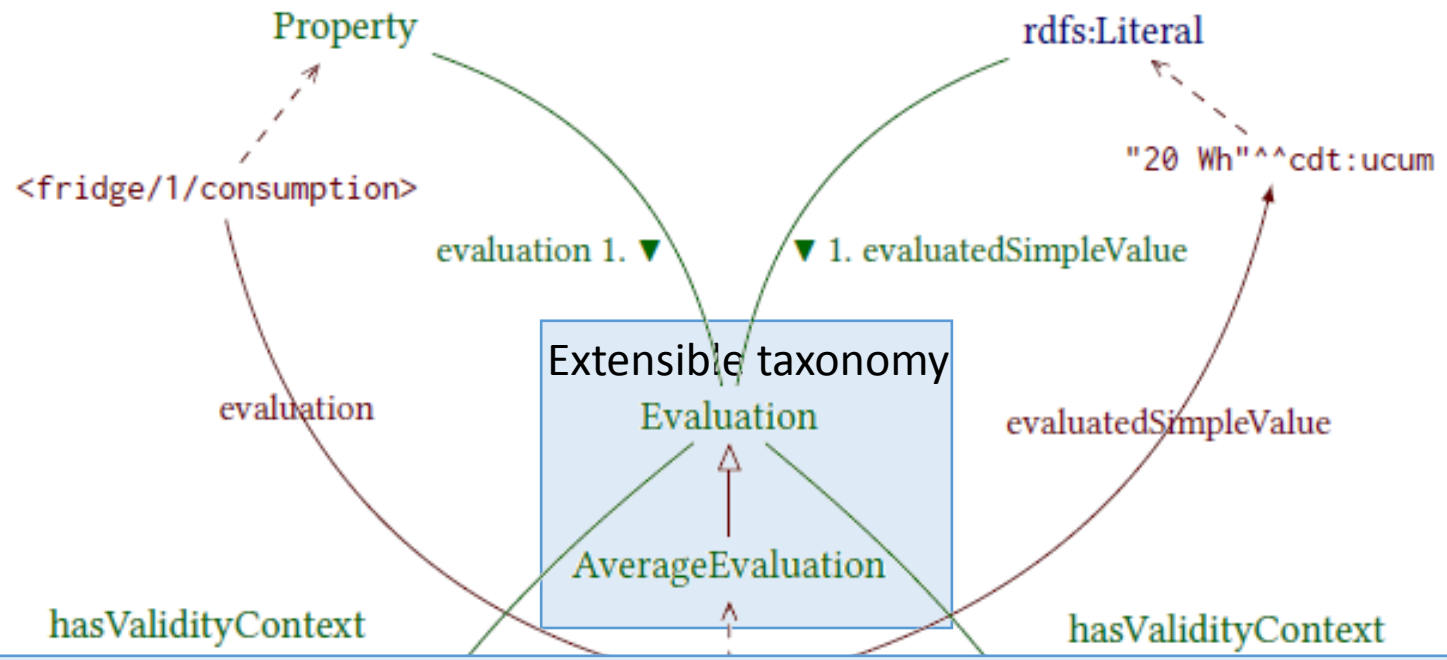
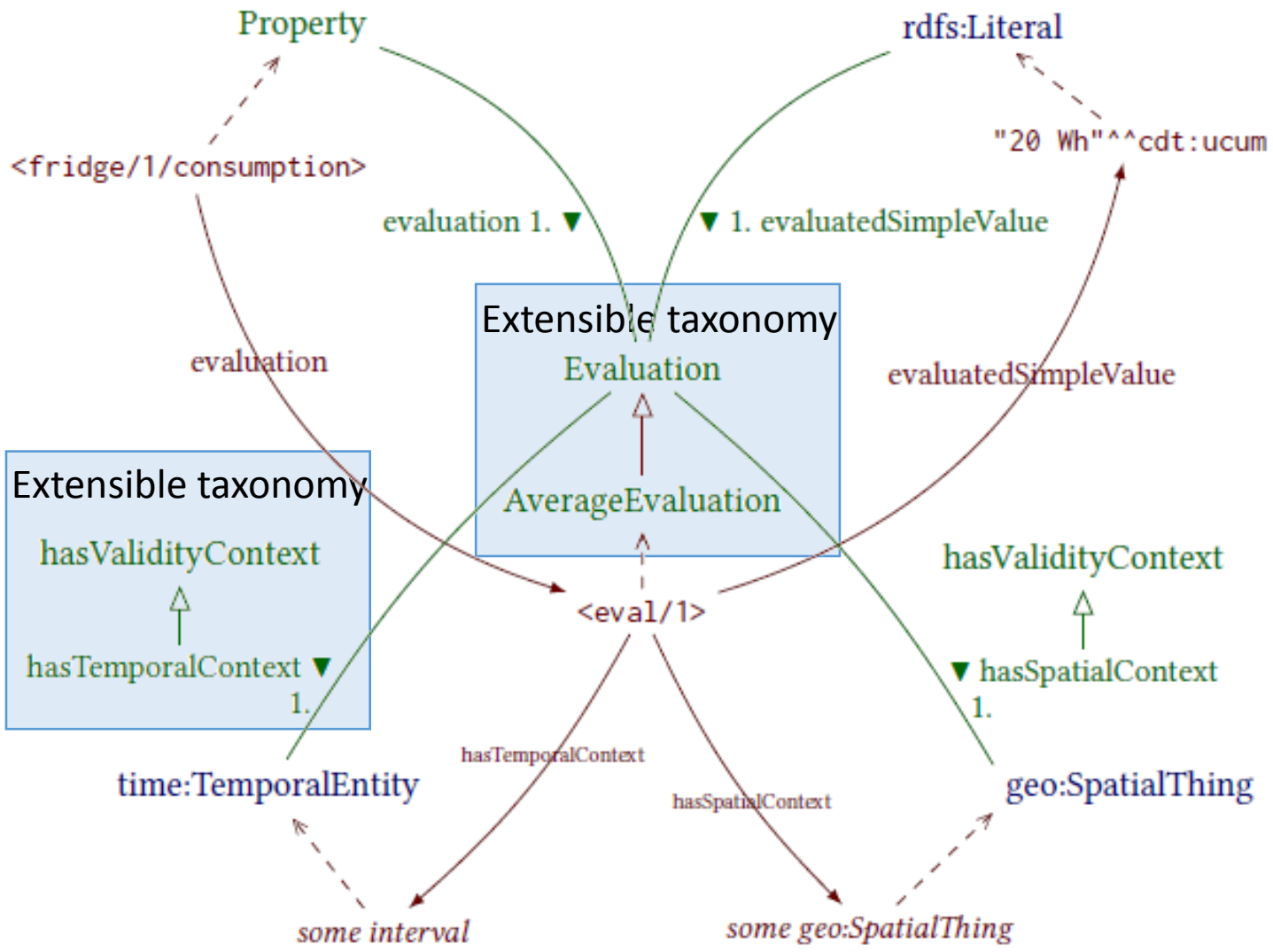


Instead of duplicating « hasProperty » sub-properties,

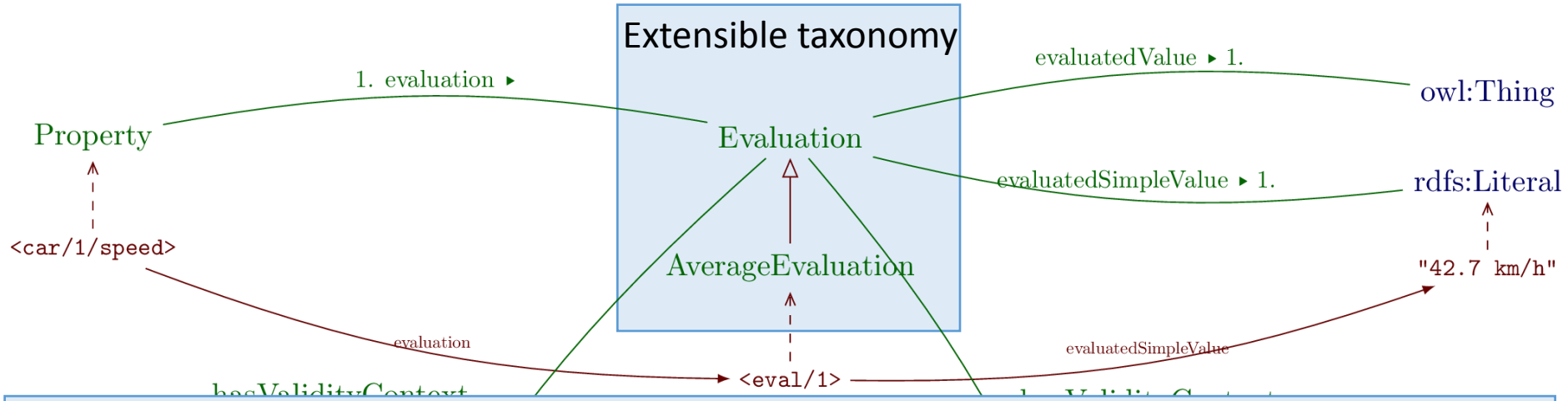
-> us a single « hasProperty » sub-property, and one or more sub-classes of Evaluation

-> <fridge/1/consumption> + AverageEvaluation;
<fridge/1/consumption> + NominalOperatingEvaluation;
<fridge/1/consumption> + ReductionFlexibilityEvaluation;
<fridge/1/consumption> + …

the **Evaluation** ontology pattern



the **Evaluation** ontology pattern



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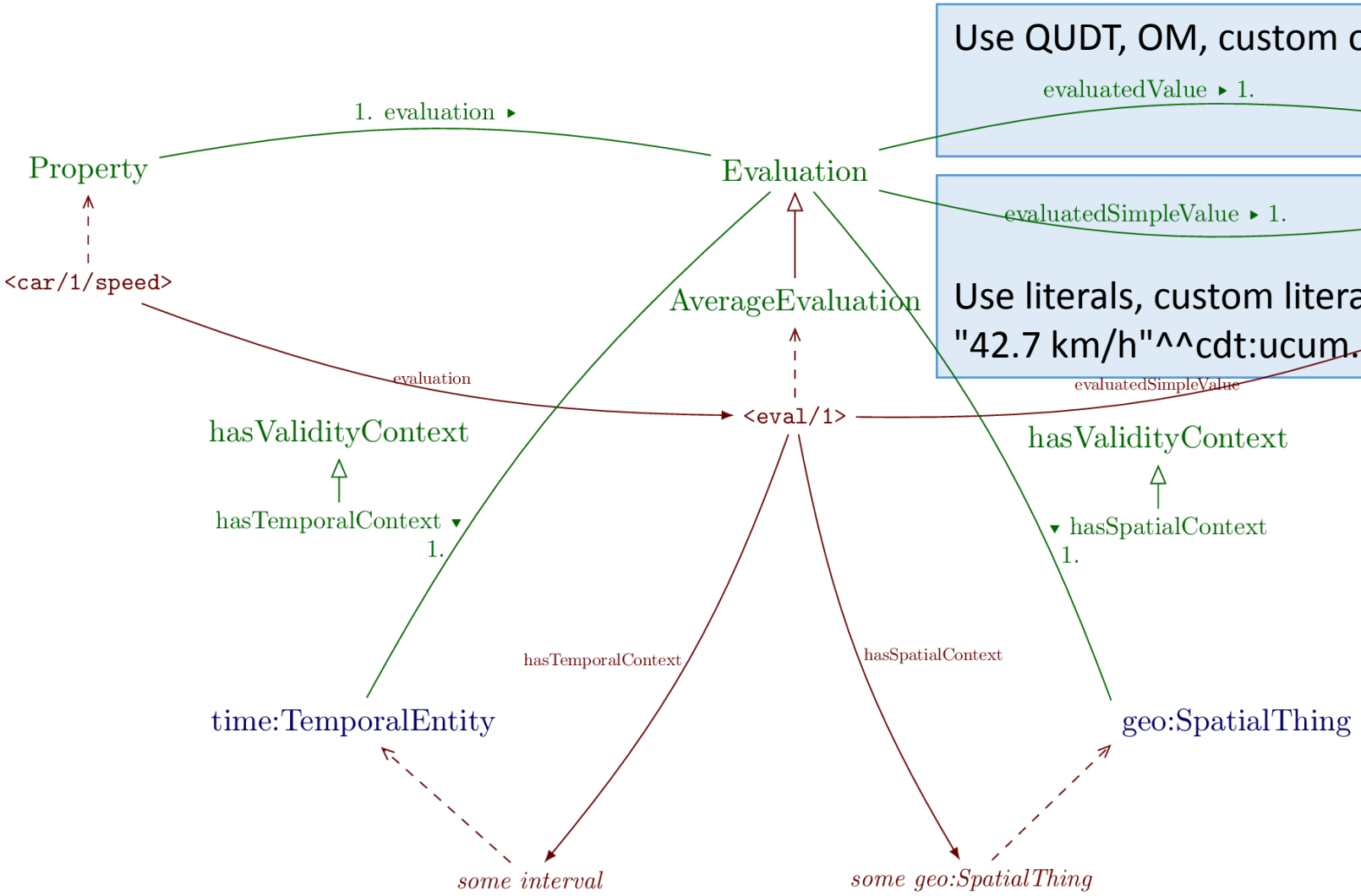
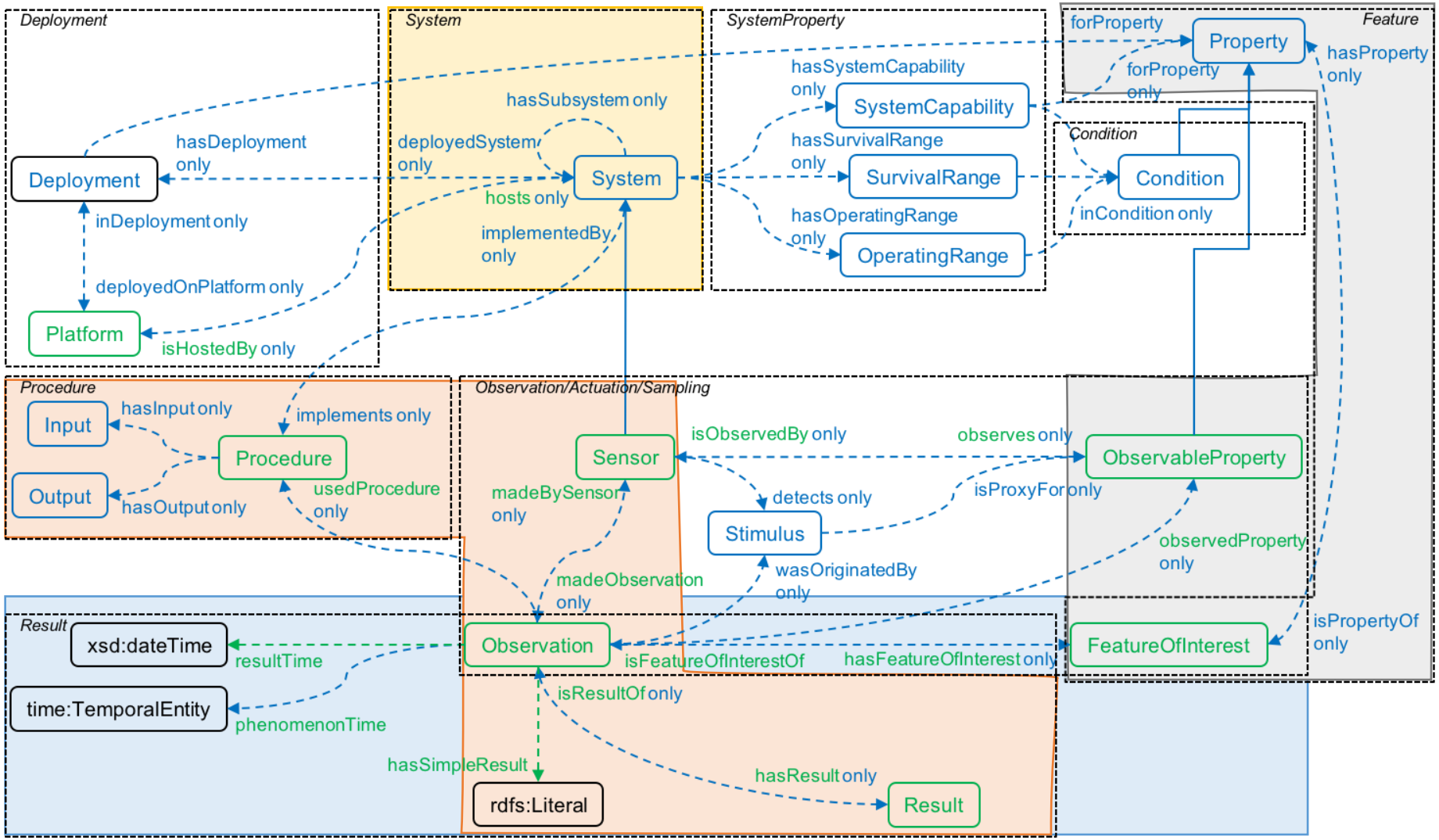
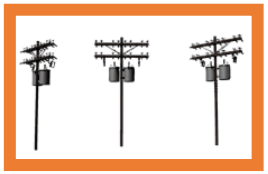


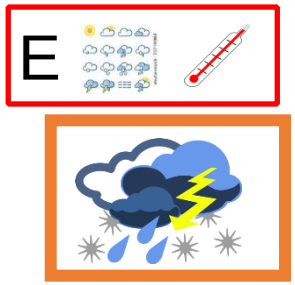
The W3C&OGC SOSA/SSN ontology

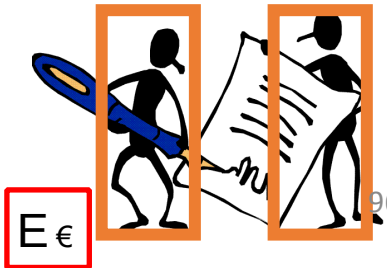


the **System** ontology pattern

- Qualify **systems**
  - The environment in a specific place
  - A building, a room
  - An appliance
  - A set of appliances
  - A business partner







the **System** ontology pattern

- Qualify **systems**
  - The environment in a specific place
  - A building, a room
  - An appliance
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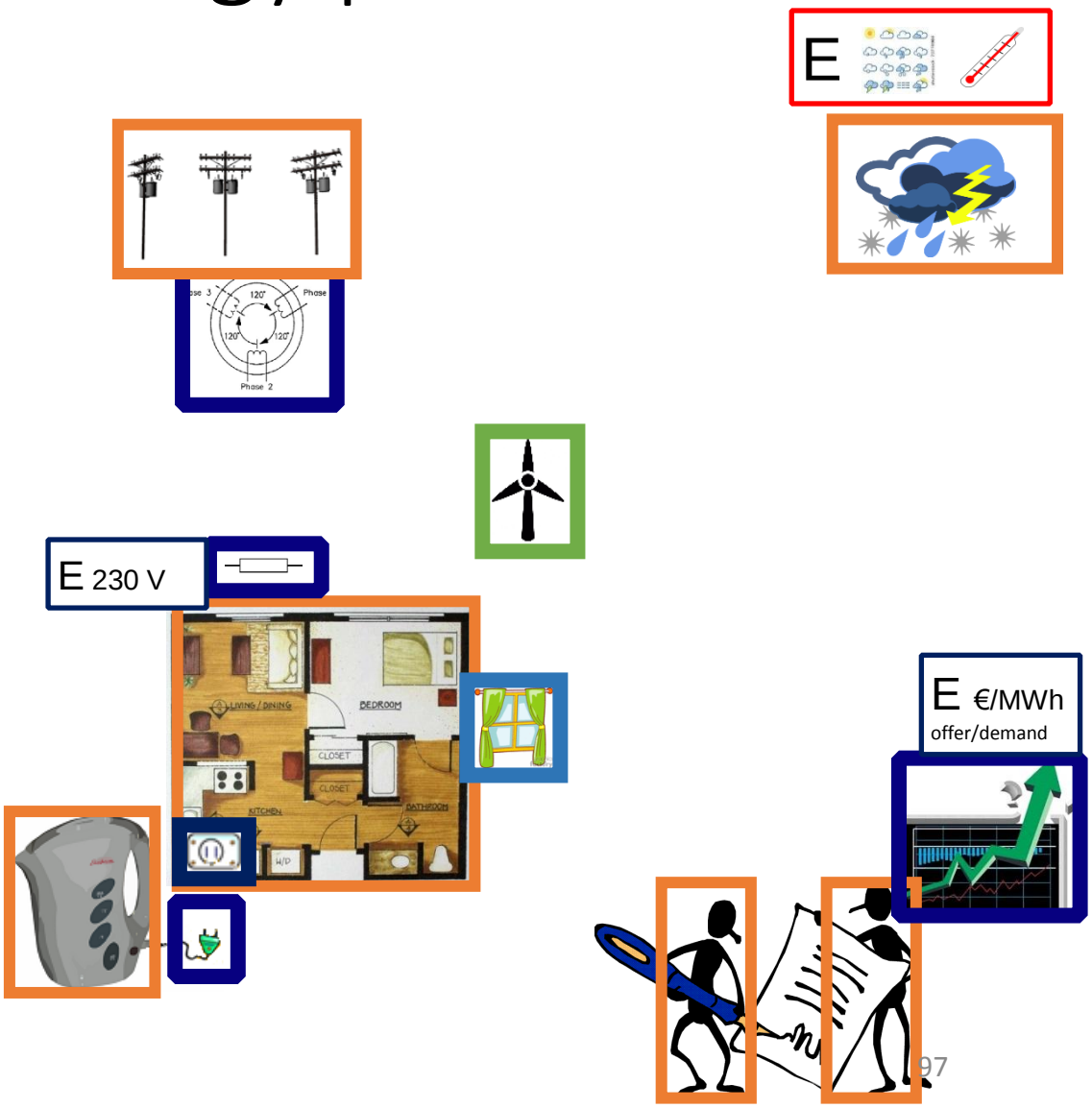
- Qualify their **connection points**
  - Wall, window, ceiling
  - Plug, Socket
  - Offer, demand



the **System** ontology pattern

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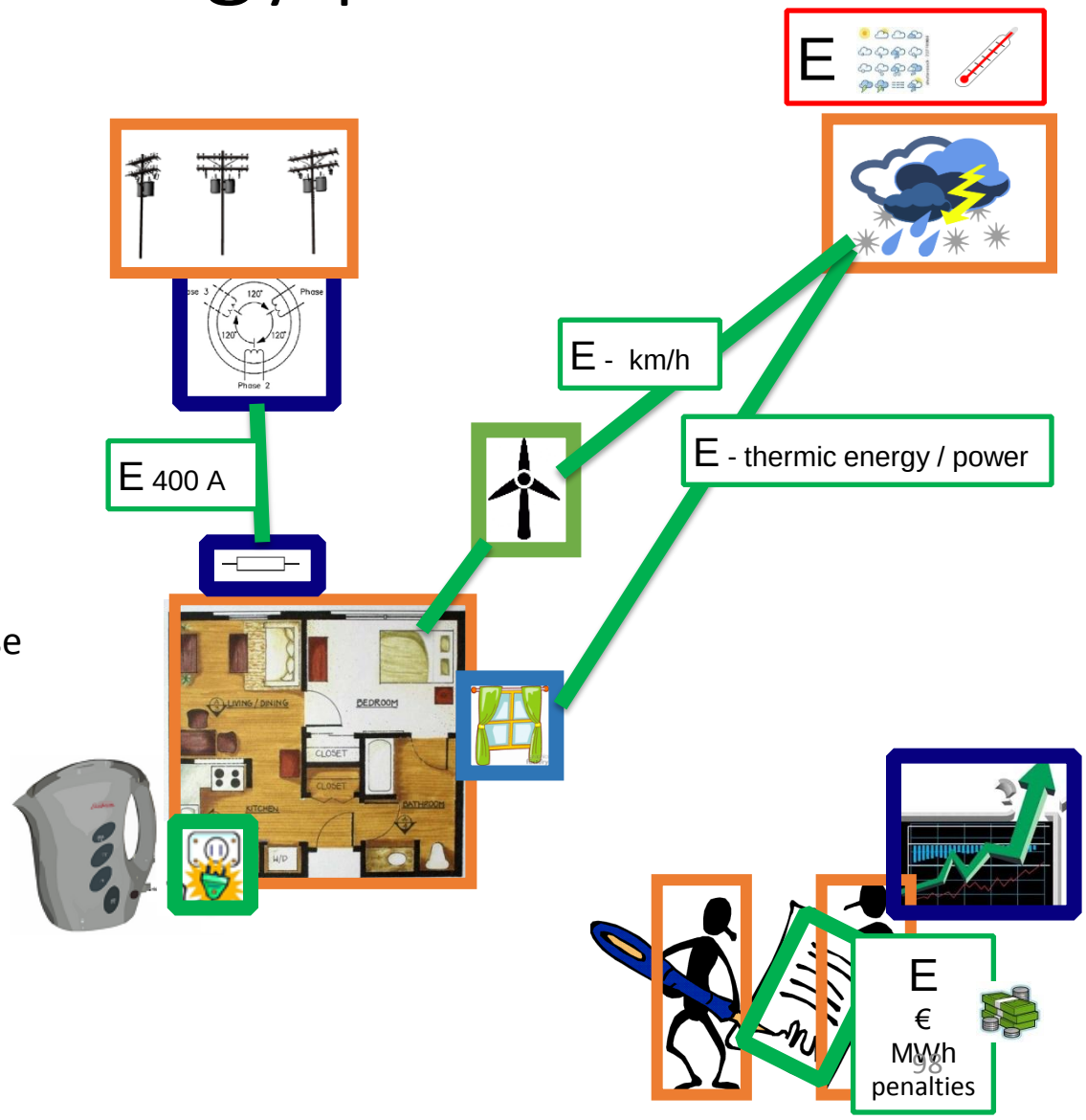
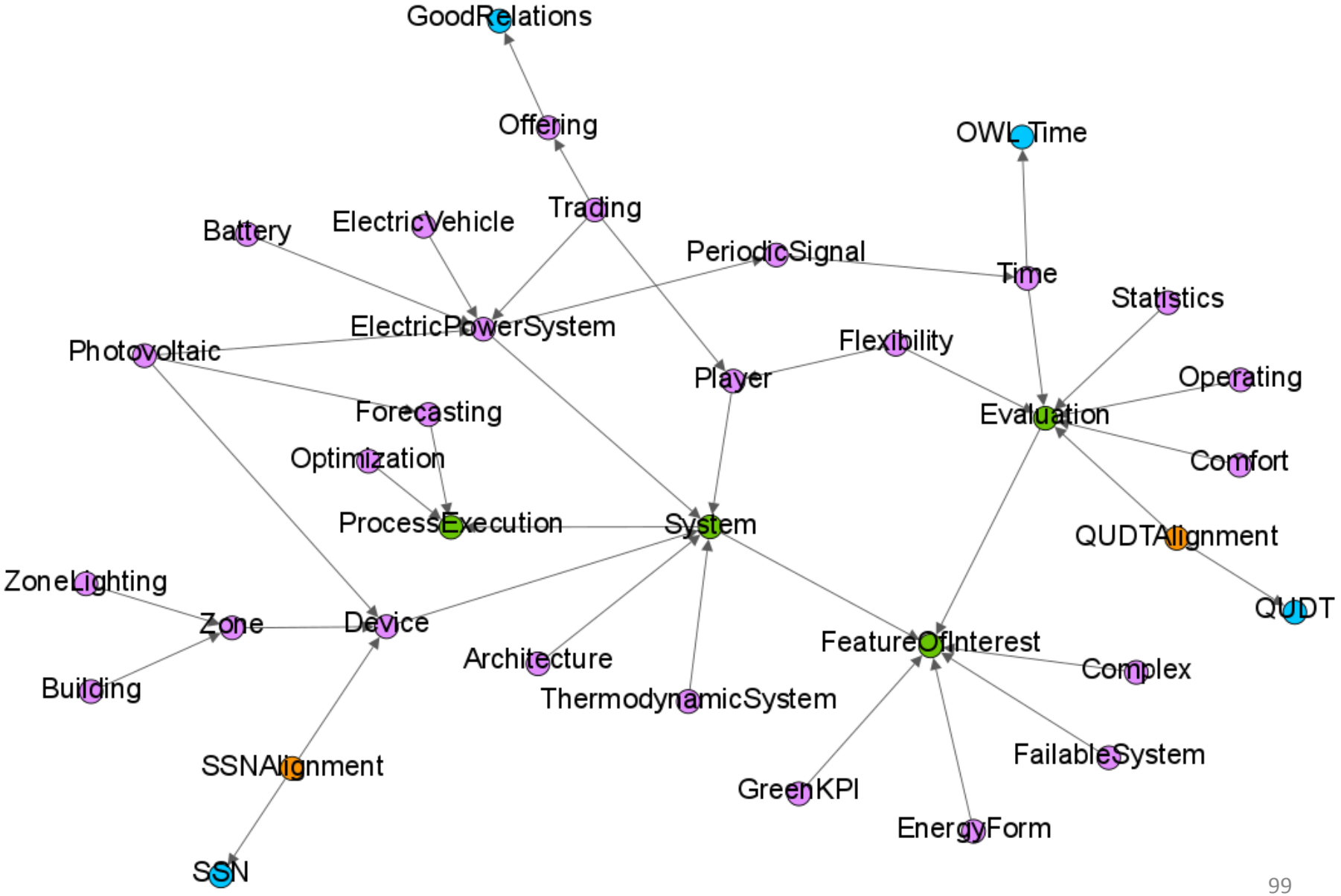
  - A set of appliances
  - A business partner
- Qualify their **connection points**
  - Wall, window, ceiling
  - Plug, Socket
  - Offer, demand
- Qualify the **connections** between these systems (flows)
  - Electric energy flows
  - Water volume/ thermic energy / light flows
  - …



Current modules



Recent additions

Smart Meter ontology
→ Metering, various instantiations of the Process Execution ontolog pattern

Pricing ontology
→ price (gross, nett), selling, buying, recommended retail, cost, market, penetration

Generic property ontology
→ geometry, speed, noise, pollution,…

Communication ontology
→ Various IT communication protocols

Electric light source ontology
→ Taxonomy of lamp types, and their properties

Flow system ontology
→ Describe HVAC systems and reason on their properties

SEAS + SAREF = **SAREF v3**

Brings new competency questions

Brings new ontology patterns

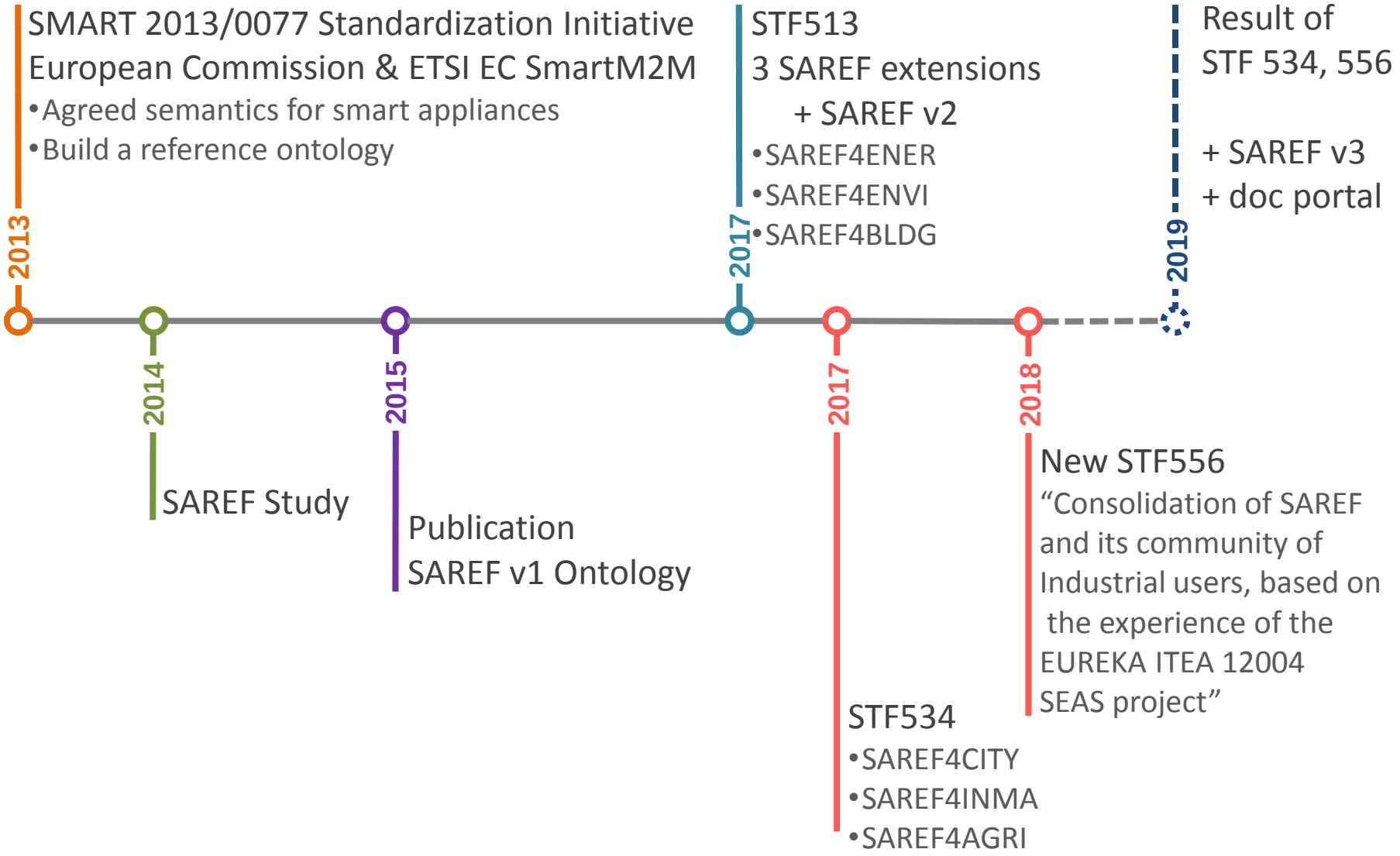
Brings new modules

Suggests new design choices

Suggests new publication choices

Suggests new development process

SEAS + SAREF = **SAREF v3**

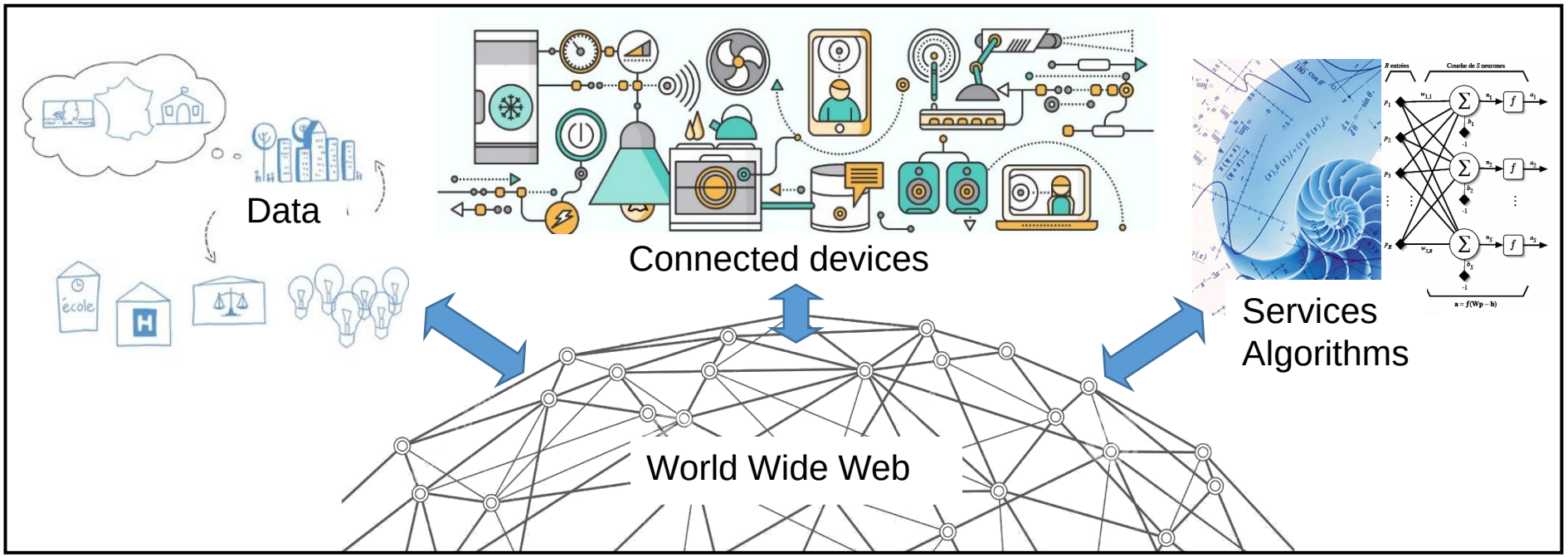


7. Great, ontologies, now what ?

Choosing your ontologies for sensor data applications

Institut Mines-Télécom

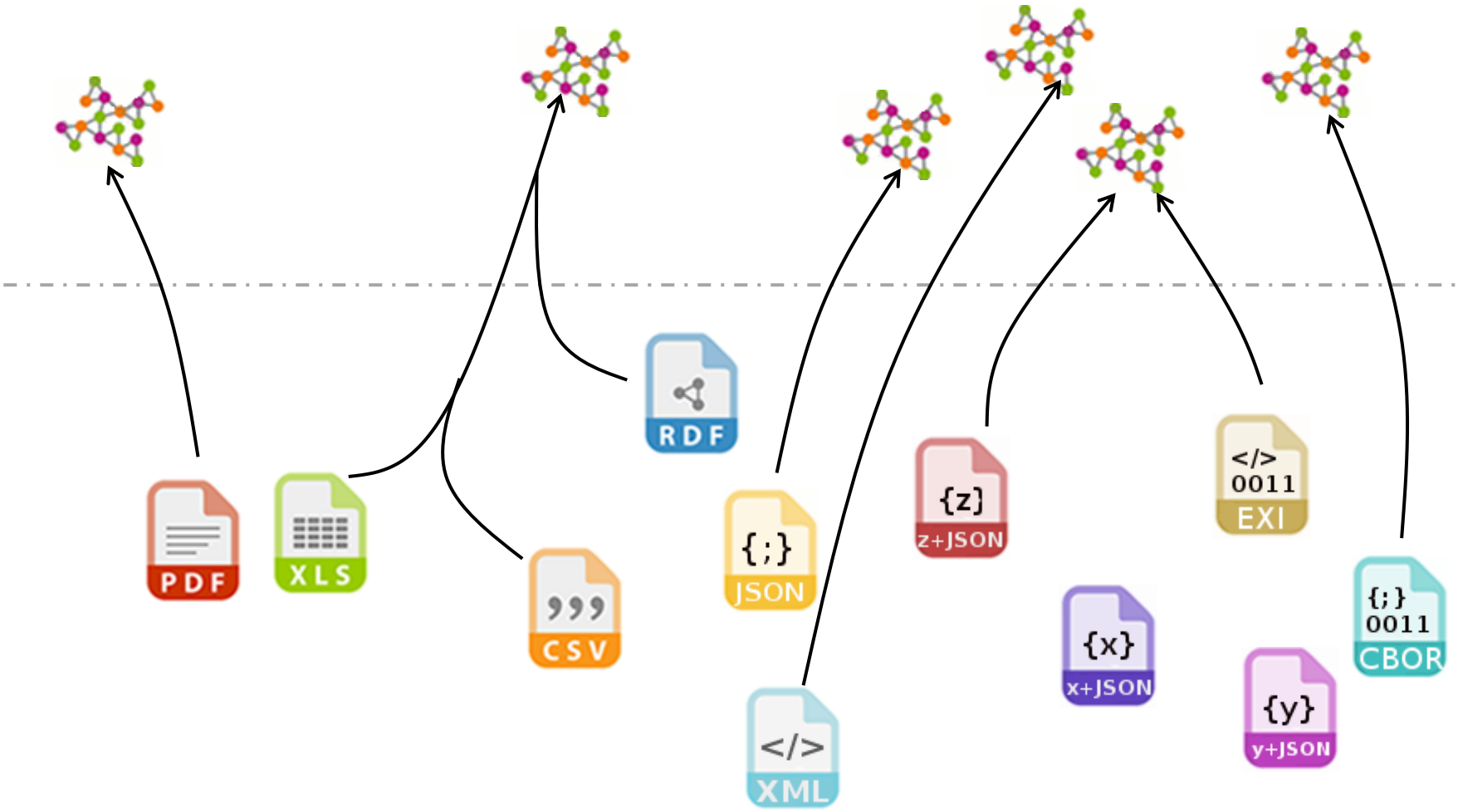
Semantic Web Adoption Challenges



« OK to use ontologies and Semantic Web to reach semantic interoperability, but…

- I use legacy devices that consume and produce messages in various formats!
- I can't recode everything with RDF!
- RDF formats are too verbose and not adapted to my device/network constraints! »

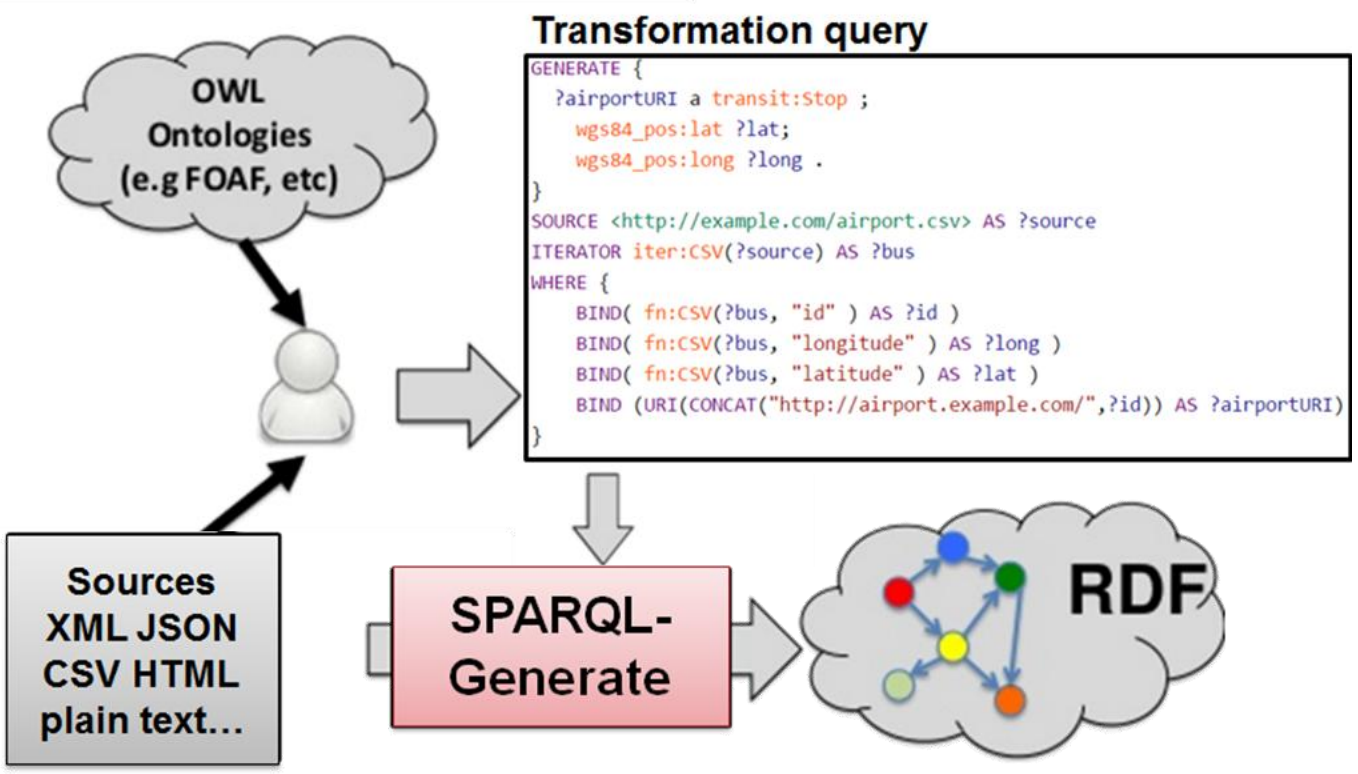
Uniform RDF model



Heterogeneous formats

SPARQL-Generate

Flexibility + extensibility = fast prototyping = save time = save



- open-source implementation over a well known library
- Supports XML JSON CBOR CSV TSV HTML plain text
- Demonstration and documentation Web site http://ci.emse.fr/sparql-generate/

Some vocabularies/ontologies

- CDT: Custom Datatypes
  - Easier to represent quantity values

@prefix cdt: <http://w3id.org/lindt/custom_datatypes#>.

Institut Mines-Télécom

Choosing your ontologies for sensor data applications

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http://maxime-lefrancois.info/

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MINES Saint-Étienne
Une école de l'IMT

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