

# Achieving Semantic Interoperability in the Internet of Things

*IoT Interoperability workshop  
26th March 2012, Paris*

Payam Barnaghi  
Centre for Communication Systems Research  
University of Surrey  
Guildford, UK

# Semantic Interoperability

- *“Meaning of data can be comprehended unambiguously by humans and computer programs.”*

*Mei Selvage et al, IBM.*

# IoT data: current status

- The current IoT data communications often rely on binary or syntactic data models which lack of providing machine interpretable meanings to the data.
  - Syntactic representation or in some cases XML-based data
  - Often no general agreement on annotating the data
    - requires a pre-agreement between different parties to be able to process and interpret the data
  - Limited reasoning based on the content and context data
  - Limited interoperability in data level
  - Data integration and fusion issues

# What is expected in service/application level?

- Unified access to data
  - unified descriptions and at the same time an open frameworks
- Deriving additional knowledge (data mining)
- Reasoning support and association to other entities and resources
- Self-descriptive data an re-usable knowledge
  
- In general: Large-scale platforms to support discovery and access to the resources, to enable autonomous interactions with the resources, to provide self-descriptive data and association mechanisms to reason the emerging data and to integrate it into the existing applications and services.

# Possible solutions?

- The semantic Web has faced this problem earlier.
  - Proposed solution: using **machine-readable** and **machine-interpretable** meta-data
    - Important not: **machine-interpretable** but not **machine-untreatable**!
    - Well defined standards and description frameworks: RDF, OWL, SPARQL
    - Variety of open-source, commercial tools for creating/managing/querying and accessing semantic data
      - Jena, Sesame, Protégé, ...
- An Ontology defines conceptualisation of a domain.
  - Terms and concepts
  - A common vocabulary
  - Relationships between the concepts
- There are several existing and emerging ontologies in the IoT domain.
  - IOT-A information model and ontologies
  - SENSEI information model
  - W3C SSN ontology
  - And many more

# Myth and reality

- **#1:** If we create an Ontology our data is interoperable
  - **Reality:** there are/could be a number of ontologies for a domain
    - Ontology mapping
    - Reference ontologies
    - **Standardisation efforts**
- **#2:** Semantic data will make my data machine-understandable and my system will be intelligent.
  - **Reality:** it is still met-data, machine don't understand it but can interpret it. It still does need intelligent processing, reasoning mechanism to process and interpret the data.
- **#3:** It's a Hype! Ontologies and semantic data are too much overhead; we deal with tiny devices in IoT.
  - **Reality:** Ontologies are a way to share and agree on a common vocabulary and knowledge; at the same time there are machine-interpretable and represented in interoperable and re-usable forms;
  - You don't necessarily need to add semantic metadata in the source- it could be added to the data at a later stage (e.g. in a gateway);
  - Legacy applications can ignore it or to be extended to work with it.

# What are the main requirements?

- Creating ontologies and defining data models are not enough
  - tools to create and annotate data
  - data handling components
- Complex models and ontologies look good, but
  - design lightweight versions for constrained environments
  - think of practical issues
  - make it as much as possible compatible and/or link it to the other existing ontologies
- Domain knowledge and instances
  - Common terms and vocabularies
    - Location, unit of measurement, type, theme, ...
- Link it to other resource
  - Linked-data
  - URIs and naming

IoT.est project: Internet of Things Environment for Service Creation and Testing

<http://ict-iotest.eu/iotest/>



Payam Barnaghi  
Centre for Communication Systems Research  
Faculty of Engineering and Physical Sciences  
University of Surrey  
p.barnaghi@surrey.ac.uk

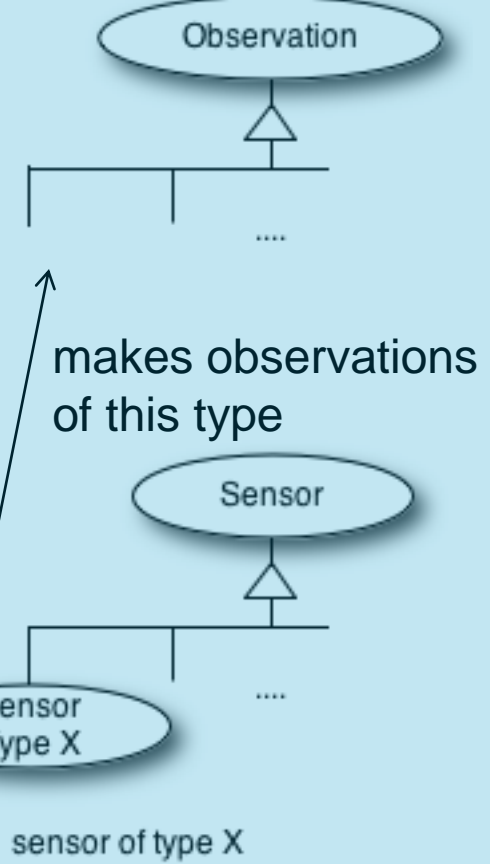


# W3C SSN Ontology

## SSN-XG annotations

```
<om:Observation>  
  <om:samplintTime><gml:TimeInstant>...</gml:TimeIn: </om:samplintTime>  
  <om:procedure xlink:role="http://www.w3.org/2009/I  
    xlink:href="http://www.w3.org/2009/I  
  <om:observedProperty xlink:href="http://www.w3.org  
  <featureOfInterest xlink:href="http://sws.geoname  
  <om:result uom="http://www.w3.org/2009/Incubator/s  
</om:Observation>
```

## SSN-XG Ontology Scope



## SSN-XG ontologies

