Achieving Semantic Interoperability in the Internet of Things

IoT Interoperability workshop
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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/

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W3C SSN Ontology