Ontology Summit 2015:
Internet of Things: Toward Smart Networked Systems and Societies
Synthesis I – February 19, 2015

Track A: Ontology Integration in the Internet of Things: Synthesis I

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Track A: Ontology Integration in the Internet of Things: **Goal** & **Mission**

- ***Goal of Track:***
  - To discuss the various approaches being taken to address the integration and interoperability issues
- ***Mission:***
  - Present case studies of IoT
  - Discuss current approaches in integration and interoperability
  - Discuss gaps in current approaches
  - Discuss issues of vertical integration and interoperability across layers of the IoT, including granularity
  - Propose methods for achieving integration and interoperability through ontologies
  - Propose a unified framework for integration and interoperability for multimodal (audio, text, video, etc.) interfaces

Track A – Session I, Feb. 5, 2015 Speakers

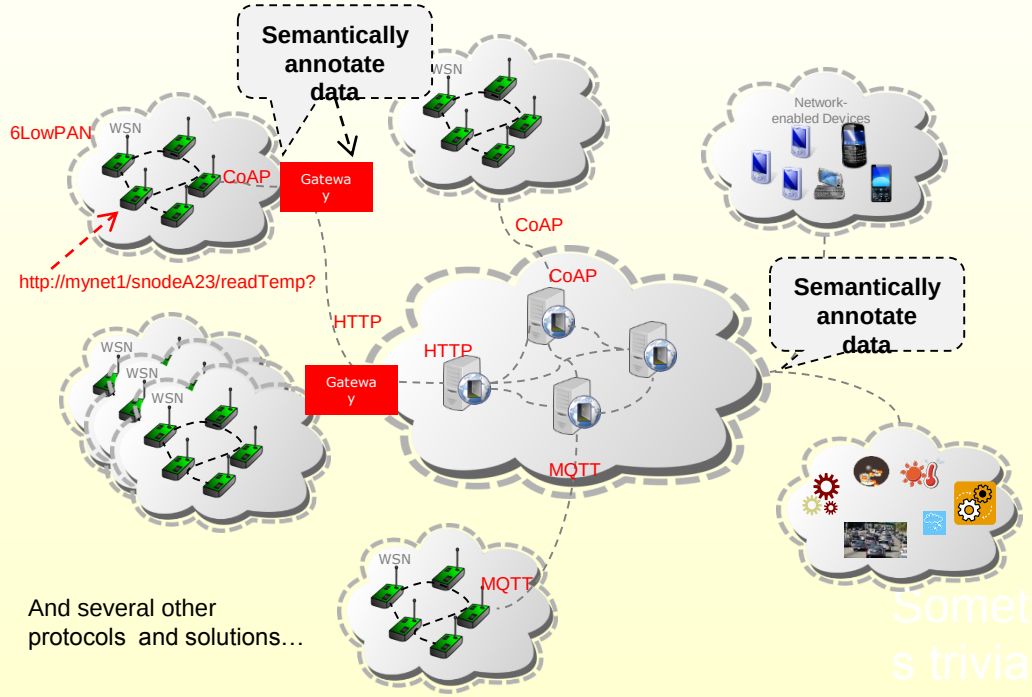
- **Dr. Steve Ray (Carnegie Mellon University, USA): An Ontology-Driven Integration Framework for Smart Communities**
  - Describes a neutral, abstract ontology and framework that supports the vision and diverse contexts of a smart community, supporting IoT and ontology mapping
- **Dr. Payam Barnaghi (University of Surrey, UK): Dynamic Semantics for the Internet of Things**
  - Provides an overview of the use-case and requirements for semantic interoperability in the IoT with a focus on annotation, processing and information extraction and dynamicity in the IoT environment
- **Dr. Jack Hodges (Web of Things (WOT) Research Group, Siemens Berkeley Laboratory, USA): Semantic Integration Prototype for Wearable Devices in Health Care**
  - Describes a prototype using curated biomedical ontologies to assist health care professionals in selecting appropriate wearable devices to monitor diagnosed disorders

Case Studies

- Sensor Integration (Steve Ray)
- Smart Grid (Steve Ray)
- Smart Healthcare – Decision making for device selection (Jack Hodges)
- Web of Things/Internet of Things Framework (Payam Barnaghi)

Some approaches for Integration and Interoperability (1)

- Simple approaches (e.g., Hyper/CAT, slides 14, 17, Payam Barnaghi) to Semantic approaches:

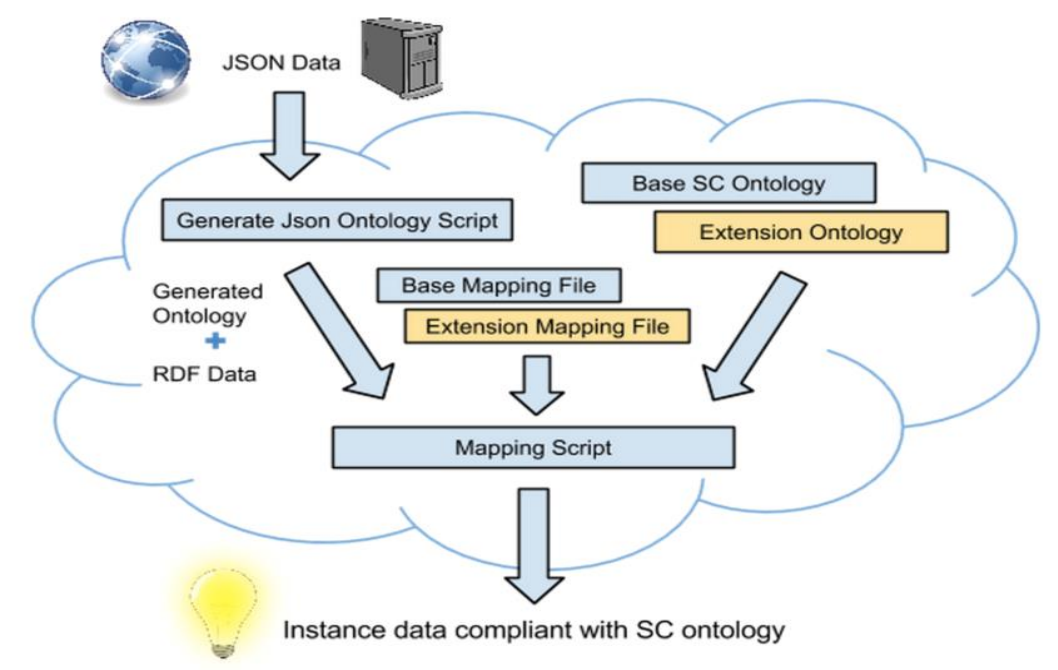


  - Servers provide catalogues of resources to clients.
  - A catalogue is an array of URIs.
  - Each resource in the catalogue is annotated with metadata (RDF-like triples).

Some approaches for Integration and Interoperability (2)

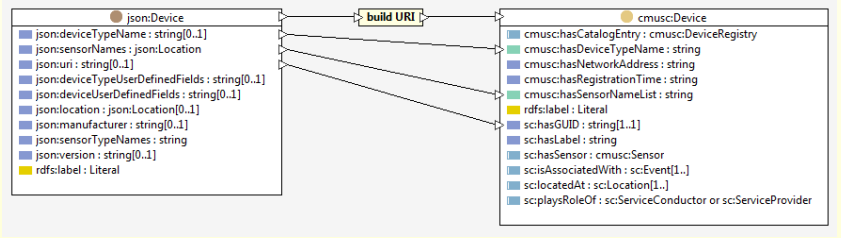
- Simple manual mapping to inference-based ontology mapping (see Steve Ray, slides 3, but 8-9)

High-Level System Design

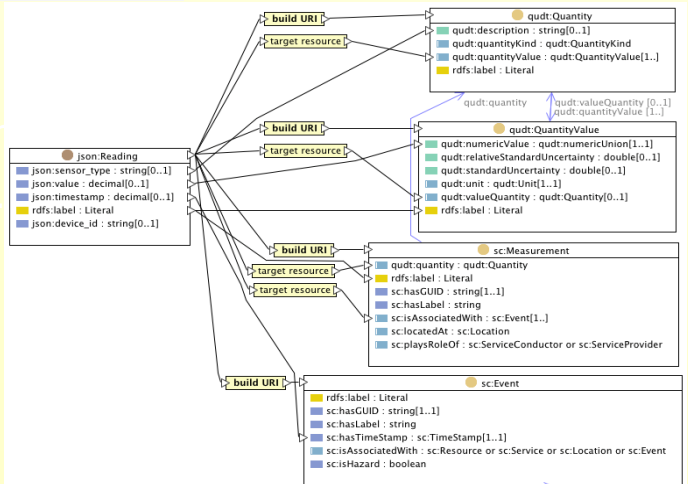


Manually Map JSON Entities to Target Ontology (the one manual step)

Sometimes trivial…



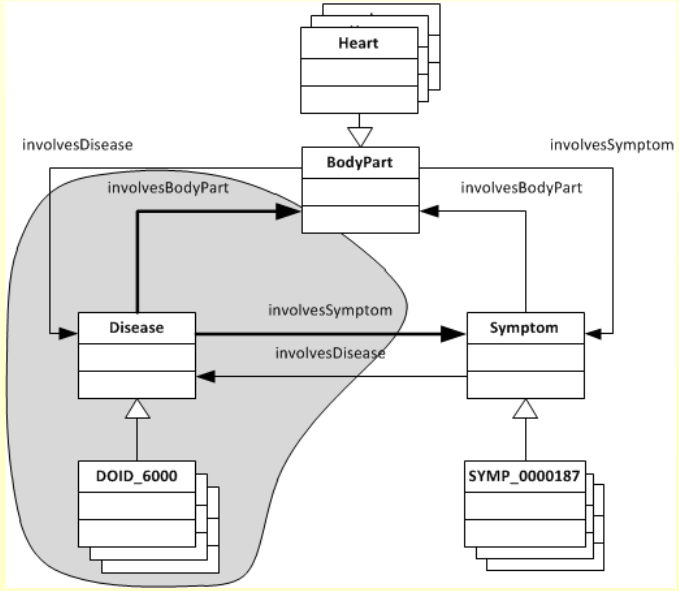
…sometimes more complex

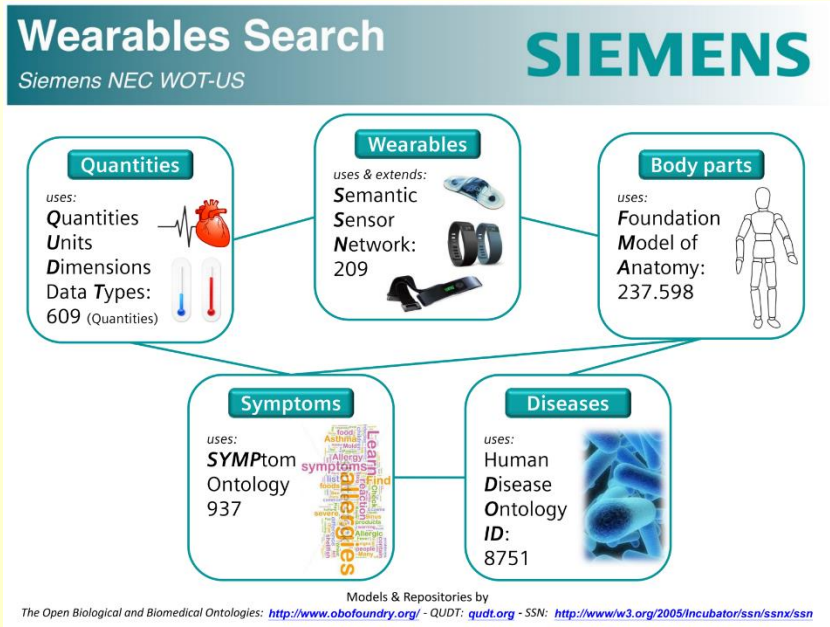


Some approaches for Integration and Interoperability (3)

- Combine existing ontologies (Jack Hodges, slide 11):
  - Automatic ontology matching/mapping not attempted
    - No existing/proposed approach is 100%
    - For usefulness generated mappings would have to be checked manually by SMEs anyway
  - So, bridge ontologies and mappings (slides 13, 15):

DOID ←→ SYMP ←→ FMA bridge ontologies





Gaps

- Most systems in prototype stage
- Lack of semantic annotation tools
- Lack of tools for validation of ontologies
- Need more work on representing events
- IoT ontologies need to deal with dynamic time varying data vs. the often static Semantic Web
- Mostly manual methods for integration

Prospective Insights

- See Payam Barnaghi's slides 35-38:

#1: Design for large-scale and provide tools and APIs.
#2: Think of who will use the semantics and how when you design your models.
#3: Provide means to update and change the semantic annotations.
#4: Create tools for validation and interoperability testing.
#5: Create taxonomies and vocabularies.
#6: Of course you can always create a better model, but try to re-use existing ones as much as you can.
#7: Link your data and descriptions to other existing resources.
#8: Define rules and/or best practices for providing the values for each attribute.
#9: Remember the widely used semantic descriptions on the Web are simple ones like FOAF.
#10: Semantics are only one part of the solution and often not the end-product so the focus of the design should be on creating effective methods, tools and APIs to handle and process the semantics.

Query methods, machine learning, reasoning and data analysis techniques and methods should be able to effectively use these semantics.