Ontology Summit 2015: Internet of Things: Toward Smart Networked Systems and Societies
Track 2: "Beyond Semantic Sensor Network Ontologies"

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Motivation

- **Context:** Internet of Things: Connects Active Physical things with the Processing of an Information Network
- **Perception:** Semantic Sensor Net ontology, soon an OGC standard, has been a source of good work useful for this area
- **Motivation:** bring together the different groups using SSO and going beyond it for such things as multi-modal sensing and various applications

– How has SSO been enhanced and expanded for use?

- E.g. Smart objects, services, datastreams etc.

– What issues of reuse have been noted?

– What new standards might be expected?

Semantic Issues in Sensor Data

- **Centralized processing of spatially distributed and heterogeneous sensor data or data streams**
  - Data collected in different settings by various kinds of sensors/things/persons
  - Processed in an offline or semi-offline fashion
  - Issues: Describing sensors and other devices correctly to enable semantic integration and interoperability
    - Work on Units of Measurements, Prov-O, etc. is relevant
  - Issues: Understanding sensor data using ontologies
- **Intelligent (geo-)sensor networks**
  - Distributed processing: In-network (on sensor) computing
  - Issues: Use ontologies to make sensor network operation smarter
    - Smartly aggregate, filter, process, access, and react to sensor data

General issues

- Other relevant aspects: real-time processing vs. post-mortem processing of sensor data streams based on ontologies
- **Interoperability issues** that arise from inherent heterogeneity implies that providing interoperability among the “Things” on the IoT is one of the most fundamental requirements to support object addressing, tracking, and discovery as well as information representation, storage, and exchange.
  - What does “interoperability” mean in the dynamic situation of IoT?
- **Bridging** raw, low-level **sensor data** and aggregated, higher-level representations of **knowledge** as captured in ontologies

Mission Statement (condensed)

The track will discuss the major challenges in utilizing semantic technologies for the IoT, and current efforts on developing the next generation of semantic technology for integrating, processing and understanding sensor information and for developing smart sensor networks.

Working with various researchers this track will discuss the use of the SSNO and its various extensions, look at issues and explore possible solutions.

We will work to make the results of our discussions useful to both the ontology and IoT communities.

Mission (contd.)

- Semantic technologies, such as the SSN ontology and associated reasoning, play a major role in the IoT and are increasingly being applied to help process and understand sensor information.
- One challenge in these efforts is to build and leverage common standards such as SSNO.
- This reduces the burden of creating new ontologies from scratch and helps avoiding data and ontology silos.
- But its wider application raises challenges: Even using and extending existing standard raise issues of how to assembly, specialize, integrate, and align different efforts
- Achieving commonality and reuse in a timely manner and with manageable resources remain key ingredients for practical development of quality and interoperable ontologies as needed in IoT.

Approach / Track Plan

- We are in the process of enlisting a variety of practitioners and the community to discuss ontological and application issues and problems, and present their efforts and experiences that address.
- The goal, in cooperation with other tracks, is to have a diverse set of speakers from both the research and application arenas, to stimulate forum discussion within the broader Ontology Summit community.
- Reference and possibly build on past Ontology Summits (for example, last year's Big Data discussions), Ontolog mini series (e.g. The O&M ontology), as well as connect to other tracks as part of the Summit.
- Promote discussion of track session topics on the Ontolog/Summit forum both before and after sessions and leading up to the face-to-face meeting
- Work with our speakers and the attending community to distil the virtual meeting topics to a useful integration and set up material for the face-to-face Symposium and Communique.
- Help draft material for the final communique.

Sessions Plan

- Session 1 – 29th January 2015
  - **Review SSO and recent developments**
  - **Take a look at the ontology problem space and the possible approaches**
  - **Get some examples of applications and related ontology and challenges in practice**
- Forum/Email conversations
  - **Flesh out the possible approaches**
  - **Get some alternative viewpoints on the table**

Sessions Plan

- Session 2 – 5th March 2015
  - **Try and bring together the possible approaches and problem documentation**
  - **Will focus more on applications**

Sessions: Proposed Speakers

- Session 1
  - Cory Henson: SSNO
- Proposed Speakers for Fundamentals:
  - Sara Hachem: Ontologies for the IoT
  - (Kerry Taylor)
- Proposed Speakers for Application Smart Cities
  - Gregor Schiele
  - Steve Ray
  - Manfred Hauswirth

- Session 2
  - Jean-Paul Calbimonte: Ontology-based Access to Sensor Data Stream
  - Charles Vardeman, II: Observations and Measurements
  - Torsten Hahmann, Silvia Nittel: Understanding Group Activities from Movement Sensor Data
- Proposed Speakers:
  - Markus Stocker: Making Sense of Sensor Data Using Ontology

Contributions

- Track champions will develop and carry out the above plan as well as contribute their experience in this area, recruit speakers, facilitate running of the track session and help to promote useful discussions.
- Track champions will look for prior statements of the problem and possible solutions, both from earlier Ontology Summits and in the literature.
- In addition we will look for synergies with other Tracks such as Ontology Integration.

References: Foundations

Sara Hachem, Thiago Teixeira, Valerie Issarny: “Ontologies for the Internet of Things”: http://thiagot.com/papers/hachem_middleware11.pdf

Barnaghi, Payam, Wei Wang, Cory Henson Kerry Taylor: “Semantics for the Internet of Things: early progress and back to the future." International Journal on Semantic Web and Information Systems (IJSWIS) 8.1 (2012): 1-21: http://knoesis.org/library/download/IJSWIS_SemIoT.pdf

Holger Neuhaus, Amit Sheth: Semantic Sensor Network Ontology (SSNO) http://www.esdi-humboldt.eu/files/agile2009/Neuhaus2009_Semantic_Sensor_Network_

References: Using Ontologies for Understanding & Processing Sensor Data

Jean-Paul Calbimonte: Ontology-based Access to Sensor Data Streams
http://oa.upm.es/15320/1/JEAN_PAUL_CALBIMONTE.pdf

Markus Stocker, Mikko Kolehmainen: Making Sense of Sensor Data Using Ontology: A Discussion for Residential Building Monitoring:
http://link.springer.com/chapter/10.1007/978-3-642-33412-2_35#page-1

Silvia Nittel, Torsten Hahmann: Understanding Group Activities from Movement Sensor Data

Marco Ortolani: Extracting Structured Knowledge From Sensor Data for Hybrid Simulation

References: Applications

Gregor Schiele: VITAL project -- Moving Towards Interoperable Internet-of-Things Deployments in Smart Cities: http://vital-iot.eu/project

Andrew Crapo (GE): The Smart Grid as a Semantically Enabled Internet of Things http://www.pointview.com/data/files/3/2433/2137.pdf

A. Devaraju and K. Janowicz: Combining Process and Sensor Ontologies to Support Geo-Sensor Data Retrieval

Amelie Gyrard, Christian Bonnet, and Karima Boudaoud: Helping IoT Application Developers with Sensor-based Linked Open Rules