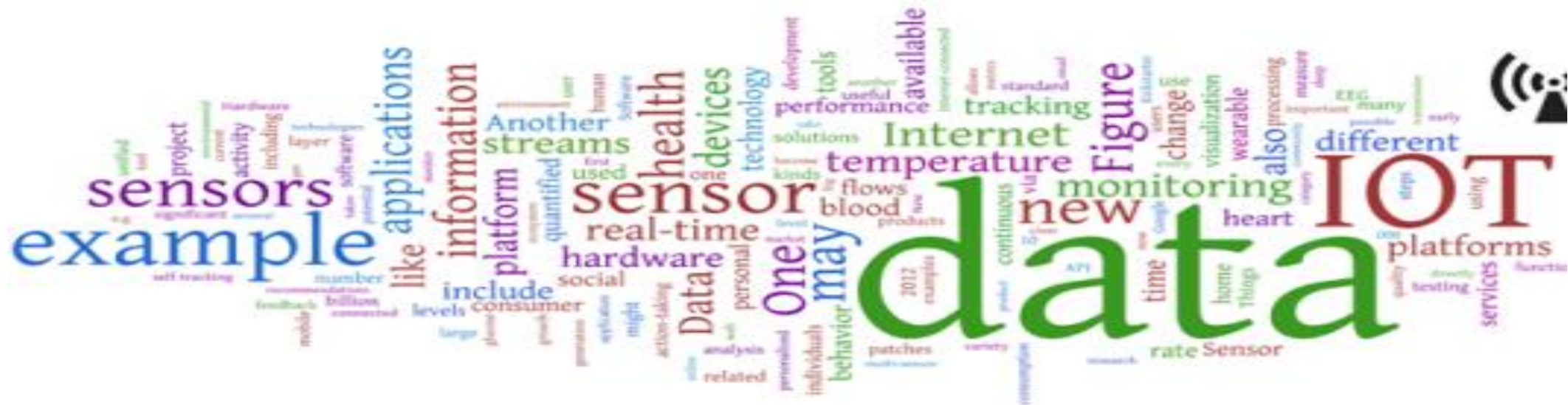# Ontology Summit 2015

Internet of Things: Toward Smart Networked Systems and Societies
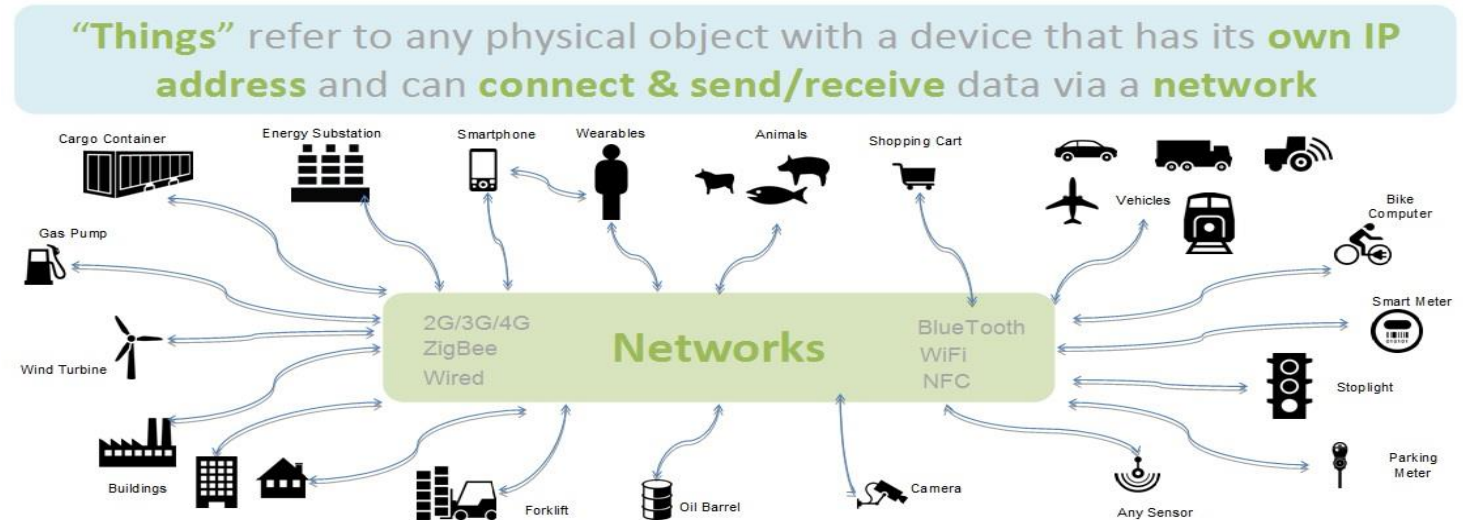

Track B: "Beyond Semantic Sensor Network Ontologies"

Session 1 Jan. 29, 2015

Co-champions: Torsten Hahmann (U. of Maine) & Gary Berg-Cross (SoCoP)

Rationale and Mission Statement

- Sensors are a big part of IoT and result in Big Data challenges (heterogeneity etc.)

- Misunderstanding the data can result in invalid or misrepresented analyses

  - Semantic technologies, such as the Semantic Sensor Network ontology (SSN) ontology and associated reasoning, play a major role in the IoT

  - Being applied to help process and understand sensor information

  - A source of good work useful for starting work and some lessons learned relevant to IoT.

- Understand challenges in utilizing semantic technologies for the IoT in the context of Sensor Networks

  - Sensor "Things" are inherent part of the IoT **heterogeneity** with:
    Multiple Techs, Standards, Information Sources

"**Things**" refer to any physical object with a device that has its **own IP address** and can **connect & send/receive** data via a **network**

Cargo Container, Energy Substation, Smartphone, Wearables, Animals, Shopping Cart, Vehicles, Bike Computer, Gas Pump, Wind Turbine, Buildings, Forklift, Oil Barrel, Camera, Any Sensor, Smart Meter, Stoplight, Parking Meter

2G/3G/4G ZigBee Wired — **Networks** — BlueTooth WiFi NFC

Loose IoT talk – "Semantic Interfaces" or "Machine Learning"

• Talk about Semantic interoperability between heterogeneous information systems (service providers and service requestors)
  ◦ "just develop comprehensive shared information models among the participant applications and businesses" (like we always do)

• Usual problems
  ◦ Differing standards & language about concepts which are rigid and inflexible when it comes to IoT data or processes
  ◦ Hard to build semantic mediators (translators) to facilitate the needed conversion and conversations
  ◦ Explosive complexity
  ◦ What IoT devices have enough knowledge and smarts for what is needed?

Examples of Research Issues and Questions

General issues:

- How do we use ontologies to smartly aggregate, filter, find, process, access, and respond to sensor data?
- We want to achieve common semantics and reuse in a timely manner with manageable resources.
- These are key ingredients for practical development of quality and interoperable ontologies as needed in IoT.

- What degree of community agreement have we reached on the major classes, relations etc.?

- Has this reduced the burden of creating new ontologies from scratch and helps avoiding data and ontology silos?

- How do we leverage and build on common standards such as SSNO?

- Wider application of SSNO+ raises challenges:

  - Even using and extending existing standard raise issues of how to assembly, specialize, integrate, and align different efforts

Two fundamentally different approaches:

1. Centralized processing of spatially distributed and heterogeneous sensor data vs.
2. Intelligent (geo-)sensor networks with Distributed/In-place computation

Today's Session (Jan. 29th, 2015)

◦ Introduction to the Session

◦ Gary Berg-Cross (SOCoP): Beyond SSNO Overview

Speakers:

  ◦ Jeff Voas (NIST): **'Networks of Things' Pieces, Parts, and Data**

  ◦ Cory Henson (Bosch Research and Technology Center): **Semantic Sensor Network Ontology: Past, Present, and Future**

◦ Discussion

2nd Session March 5th, 2015 Plans

◦ Try and bring together the possible approaches and problem documentation

◦ Will focus more on applications

Speakers

◦ Barry Smith: **Ontology of Sensors**

◦ Jean-Paul Calbimonte: **Ontology-based Access to Sensor Data Stream**

◦ Konstantinos Kostis: **Managing unknown IoT entities by uncovering and aligning their semantics**

◦ Charles Vardeman, II: **Computational Observations**

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

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_Ontology.pdf

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 et al. (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