Ben Ridge Road Weather Station, South Esk River Catchment, Tasmania

The Semantic Sensor Network Ontology

A Generic Language to Describe Sensor Assets

Holger Neuhaus

Michael Compton

Commonwealth Scientific and Industrial Research Organisation, Australia

www.csiro.au

CSIRO

Overview

- Motivation
- Ways to go
- Current state
- Constituent parts
- Geospatial data harmonisation
- Future work

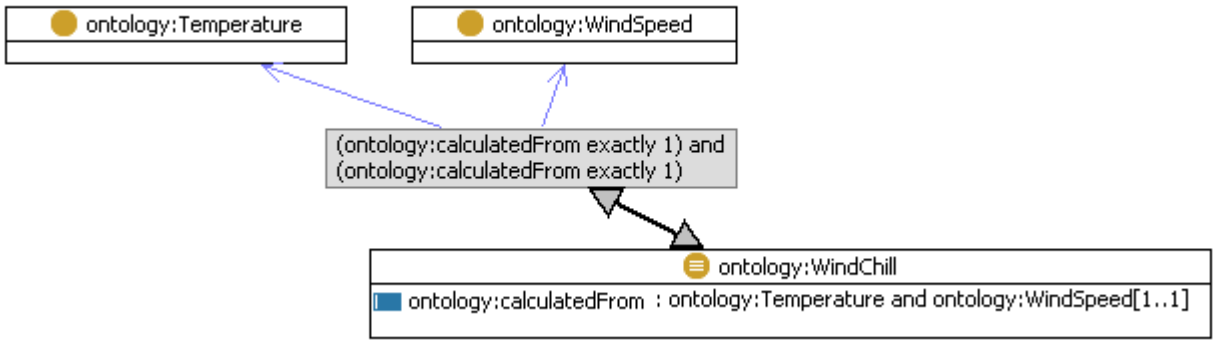
Semantic Interoperability

- "The ability of communicating entities to share unambiguous meaning" [Wikipedia]
- Syntactic interoperability provided by the OGC standards is a pre-requisite to semantic interoperability
- Legislative drivers: *e.g.* INSPIRE, AWRIS
- At the GEOSS Sensor Web Workshop in May 2008 a number of shortcomings of the OGC's Sensor Web Enablement standards were identified

  "A big issue is the lack of **semantically rich discovery mechanisms** in SWE services based infrastructures. […]. At the moment, **related concepts, subgroups of sensor types, or other dependencies can hardly be explored**. Eventually, the integration of domain ontologies […], **semantic queries** and **semantic transformations** in Sensor Web infrastructure have to be addressed." [Ingo Simonis and Johannes Echterhoff, "*GEOSS and the Sensor Web*," Final report, WS Geneva, 2008.]

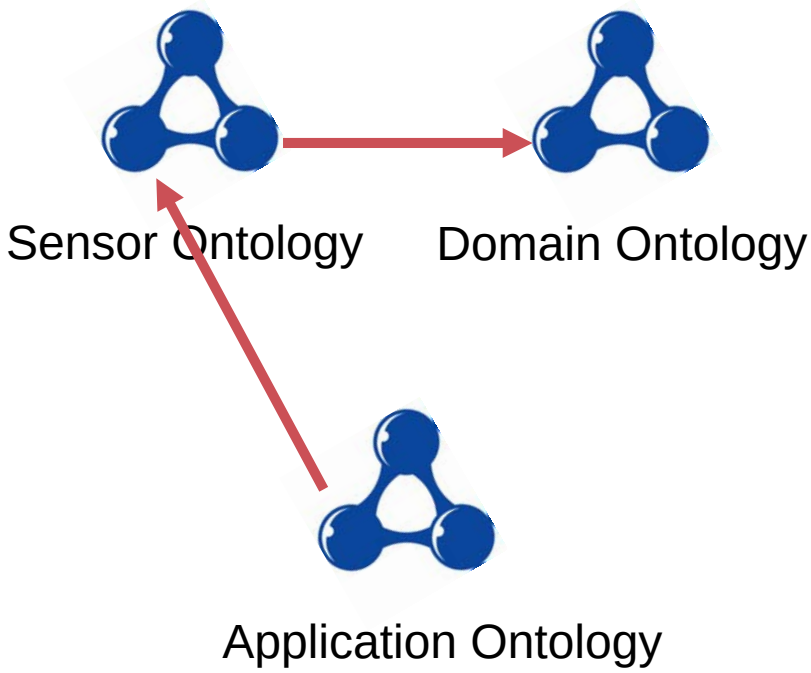
Domain Ontology Example: Wind Chill

$$W = 13.12 + 0.6215 \times T_{air} - 11.37 \times V_{10m}^{0.16} + 0.3965 \times T_{air} \times V_{10m}^{0.16}$$



Advantage of Ontology-based discovery

- Wind chill sensor
  - NIL
- Wind speed sensor
  - WM30_001
  - WM30_002
- Temperature sensor
  - WM30_001
  - WM30_002
- Result
  - "Wind chill measurement available"
    - WM30_001
    - WM30_002



Semantic Sensor Network Ontology

- Two possible approaches
  - an ontology about sensing - all the concepts to do with sensing, all the types of sensing and what is sensed - like an upper ontology of sensing, or
  - an ontology in which to describe particular instances, or classes, of sensors - the functional, physical and measurement aspects - partly what's on the data sheet.

Vocabulary for Sensing *vs.* Device Ontology

- Following the second option to
  - Encode sensors, reason, task, plan, query, enable provenance, *etc.*
  - Enable linking in domain specific concepts, processing concepts, services, *etc.*

- Thus, the ontology needs to be
  - Generic
  - Extensible
  - ‘pluggable’
  - Reusable
  - *etc.*

“A language to describe sensors”

- Not realistically possible encoding concepts for every aspect of every possible sensor
- Build a core framework to plug in
  - suitable domain ontology
  - suitable location ontology
  - suitable UoM ontology, *etc.*
- Places for *e.g.* MathML when going beyond OWL space
- Potential to capture multiple levels of detail or abstractions

Current state:

  - sensor, feature
  - physical properties, metadata links, power
  - operation, result, process (simple and composite), input and output, accuracy, resolution, abstract properties

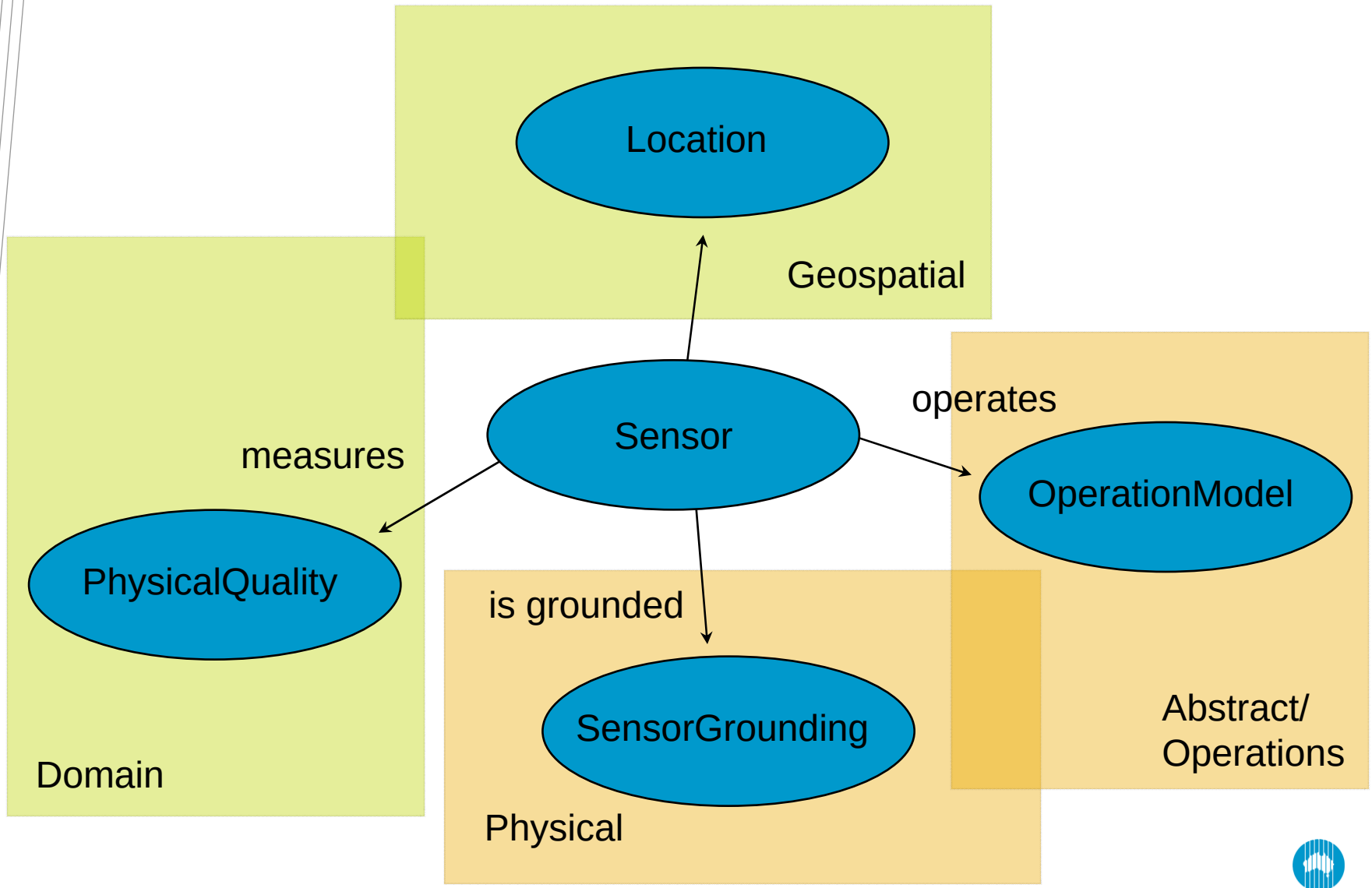
Grounding - Physical Aspects

- SensorGrounding: everything physical for “the box” that is the sensor and everything implementation/deployment-specific for its operations
  - location, mobility
  - platform
  - dimensions, materials, wires and connectors
  - calibrations, range/field of sensing
  - reference documentation and other metadata
  - power-source, consumption, batteries
  - how to access – network, radio, directly
- Separating the implementation details from the specification

Specification (operation, process and results)

- A sensor may have a number of operations (described by OperationModel). Each can be described at an appropriate (or multiple) level of detail.
  - Result - specification in terms of inputs and conditions, accuracy, latency, resolution, effect (mathematical specification)
  - ResponseModel - the behavior of the sensor in terms of physical stimulus and response
  - Process - description of process flow
    - more important when combining a number of sensors into a single sensing unit than for a single transducer
    - important for provenance
- Specifications of processes, not individual measurements
- Not just single sensors included by the definition of “Sensor”
- Can be extended to include larger macro instruments or models

Structure


Location
Geospatial
Sensor
operates
measures
OperationModel
PhysicalQuality
is grounded
SensorGrounding
Abstract/
Operations
Domain
Physical

Context of Geospatial Data Harmonisation

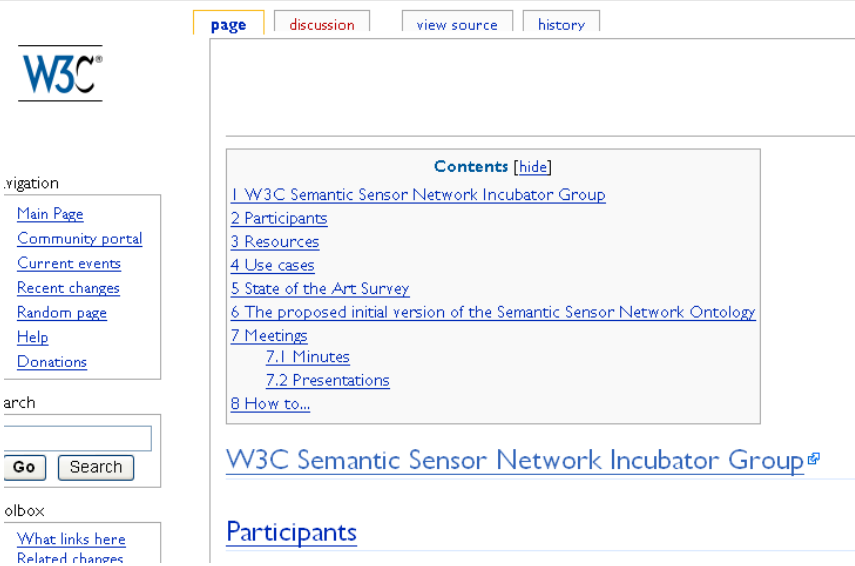
- Ontological models for
  - Geospatial data
  - Domains of Interest
  - Workflow composition, SOA, *etc*.
- Sensor is the ‘integration point’
  - Utilise above ontologies
  - Discover data sources
  - Acquire data to fit current needs (re-purposing of Sensor Web)
- Research challenges in the upcoming years
  - Ontology development
  - Integration of those ontologies
  - INSPIRE, ARWIS, *etc.*

Future work

- Some important aspects of sensors are covered
  - still more to do, *e.g.*:
- Accuracy
  - depends, for example, on magnitude of measurement and other environmental influences like temperature
  - not always simply ±3%; often a function of influencing factors
  - So, is it enough to simply leave space for XML encoding the function
    - This doesn't then include any of the influencing factors in the ontology
  - Same for response model, ranges, input/output, power
- Units of Measurement
  - need to decide on a system to record units against measurements
  - keep the UoM ontology separate

W3C Semantic Sensor Network XG

- Initiated by Amit Parashar (CSIRO)
- Co-chaired with
  - Kerry Taylor
  - Amit Sheth (Kno.e.sis Centre)
- From the charter:
  - “begin the formal process of producing ontologies that define the capabilities of sensors and sensor networks”
  - “develop semantic annotations of a key language used by services based sensor networks”



http://www.w3.org/2005/Incubator/ssn/wiki/

Tasmanian ICT Centre
Dr. Holger Neuhaus
Post-Doctoral Research Fellow

Phone: 03 6232 5547
Email: holger.neuhaus@csiro.au
Web: www.csiro.au/science/TasICTCentre.html

www.csiro.au

Thank you

Contact Us
Phone: 1300 363 400 or +61 3 9545 2176
Email: enquiries@csiro.au Web: www.csiro.au

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