OGC SensorThings API: Communicating "Where" in the Web of Things

The real potential of the Internet of Things (IoT) and the Web of Thing (WoT), like the potential of the Internet itself, lies in richly connected “systems of systems”. IoT systems that operate in isolated technology or vendor specific silos inhibit use, value, and interoperability. Massively scalable and widely distributed networks of heterogeneous devices, sensors and services in the growing Internet of Things will support countless different simultaneous applications. The IoT will be like an orchestra capable of playing multiple musical compositions simultaneously. Sensors and “smart” devices have more value if they can be accessed by multiple applications, which may come and go over time. Because sensors and sensor systems will be connected in so many different ways and accessed by so many different applications, standards are critical to the continued evolution of the IoT.

The First Law of Geography

Geographer Waldo Tobler's idea that "Everything is related to everything else, but near things are more related to each other" is referred to as the "first law of geography," and it applies to the IoT. The significance of the location of a smart object often depends on the locations of “near things,” and information about those “near things” usually comes from other sources. Smart cars, for example, need to communicate with other smart cars as well as traffic advisories, traffic signals, and routing applications. Using consistent models, such as the OGC Sensor Web Enablement standards, allows sensor feeds from multiple sources to be integrated/aggregated and used more effectively for analytics, modeling, simulations, and so forth. Spatial interoperability – communicating location information and/or integrating it with location information from other sources – is thus an important requirement.

Spatial data – information about locations, boundaries, routes, connectivities, attributes and relationships of features and phenomena on the Earth’s surface or in a building – takes many different forms. Different instances of digital representations of physical world networks (roads, pipes, wires etc.), 2/3/4/5D images, vector outlines, point clouds, points of interest, in-building locations, civil engineering data, facility maps etc. can have different data models, data structures, coordinate reference systems, and encodings. Even simple lat/lon coordinate pairs can be structured and encoded in different ways. Existing standards enable, and emerging standards will further enable, IoT/WoT applications to address this complexity.

For more than twenty years, the OGC and ISO TC/211 have been the primary geospatial standards organization focused on communicating and integrating spatial information. Since location is important in many different domains, the OGC works with a growing number of other standards organizations to provide a consistent location standards framework across the information technology industry.

The OGC SensorThings API Standard

The OGC SensorThings API standard is a standardized open data model and application programming interface for accessing sensors in the WoT and IoT. The core of the SensorThings API is the ISO/OGC Observation and Measurement (O&M) model (ISO 19156:2011). O&M defines “an Observation is an act that results in the estimation of the value of a feature property, and

involves application of a specified procedure, such as a sensor, instrument, algorithm or process chain." Use of a common model allows observation data using different procedures to be combined unambiguously. Figure 1 illustrate the concept of the O&M and relationship between the entities involved in observations. SensorThings "Thing"'s definition follows the ITU-T definition: "an object of the physical world (a physical thing) or the information world (a virtual thing) that is capable of being identified and integrated into communication networks" (ITU-T Y.2060). The SensorThings model and API also support locations change over time (e.g., moving features). A Thing can also have multiple Datastreams, and a Datastream is a collection of Observations of the same kind.

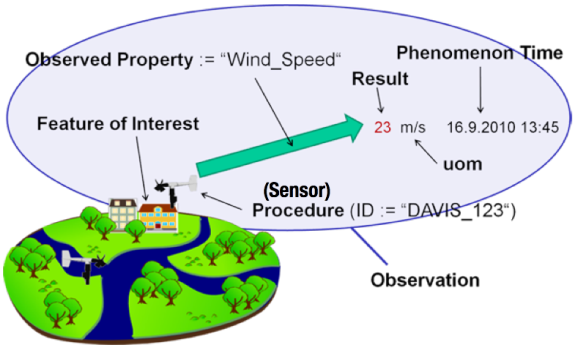

Figure 1 Relationships between the entities of the OGC/ISO Observation and Measurement Data Model

Application developers can use the OGC SensorThings API to connect to various IoT devices over the Web and develop innovative applications without worrying about the heterogeneous protocols used by different IoT devices, gateways and services. IoT device manufacturers can embed the SensorThings API in IoT hardware and software platforms so that the various IoT devices in their offerings can have a common interface and can effortlessly connect with spatial data servers around the world that implement the full array of OGC Sensor Web Enablement (SWE) standards.

SensorThings API is being developed to provide IoT data interoperability, or semantic interoperability, as shown in the IoT standards stack diagram below.

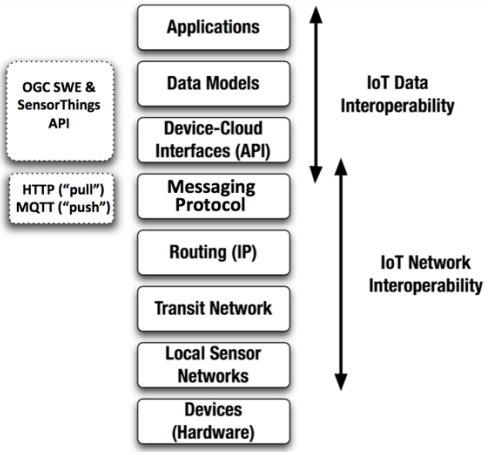

Figure 2 A Layer Diagram of the IoT Interoperability Layers

The SensorThings API builds on Web protocols and the OGC Sensor Web Enablement standards. The model and API are designed specifically for resource-constrained IoT devices and the Web developer community. Developers can download the free SensorThings API standard to build WoT applications using standard IT and Web infrastructure. The API employs an efficient and easy-to-use REST-like style based on HTTP REST, a JSON encoding, and the MQTT messaging transport. The URL pattern and query options are based on the OASIS OData 4.0.

SensorThings API is part of the OGC Sensor Web Enablement (SWE) suite of open international standards. OGC SWE standards are a mature and integrated suite of web service interface and data encoding standards (v.2.0 now, v.1.0 published in 2005). SWE standards enable developers to make all types of sensors, transducers and sensor data repositories discoverable, accessible and useable via the Web. SWE standards are in use by countless large organizations such as NASA, NOAA, USGS, Natural Resources Canada, the World Meteorological Organization (WMO) and many other organizations, including many private sector companies.

The SensorThings API's alignment with the OGC/ISO O&M Model enables developers to easily establish interoperability between lightweight SensorThing API applications and a vast number of data servers that serve data and processing capabilities based not only on the OGC SWE standards but also on other OGC standards. The international population of servers supporting OGC standards is growing rapidly. The universe of OGC standards includes standards that are 16 years old and also new standards that reflect the IT industry's rapid and ongoing change. Newer OGC standards include:

- **The OGC OpenGeoSMS Standard**, now also officially published by the ITU, provides an easy and standard way to include GPS coordinates in a text message.
- **The OGC Moving Feature Encoding Standard** provides overlay and integration of moving feature data (from IoT devices on pedestrians, vehicles, etc.)
- **IndoorGML** is an OGC standard defining an open data model and XML schema (OGC GML) for indoor spatial information, particularly for navigation and providing spatial reference of features in indoor space.
- **buildingSMART** International is cooperating with OGC to harmonize built environment standards and geospatial standards, including the OGC CityGML standard (3D modelling) and the LandInfra Conceptual Model (for land parcels and the built environment). This collaborative work will ultimately relate to indoor sensor location, sensor location in structural components of bridges, and mobile sensors on campuses such as hospital complexes, etc.