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# Background

This technical note contains comments on the IoT-A initial Architecture Reference Model [1]. The ARM document was developed by the Internet of Things – Architecture (IoT-A) - a European Commission FP7 Project. The comments below are from the OGC Chief Architect and do not necessarily represent a consensus of the OGC members. Further discussions between IoT-A and the OGC are encouraged.

# References

[1] “[Initial Architectural Reference Model for IoT](http://www.iot-a.eu/public/public-documents/project-deliverables/1/1/D1%202_Initial_architectural_reference_model_for_IoT.pdf/at_download/file),” IoT-A Project Deliverable D1.2, V6, 2011-06-16.

[2] “[OGC Reference Model](http://www.opengeospatial.org/standards/orm),” OGC Document 08-062r4, 2008-11-11

[3] “[Sensor Web Enablement Architecture](http://portal.opengeospatial.org/files/?artifact_id=29405),” OGC Document 06-021r4, 2008-08-20

[4] “[Observations and Measurements](http://portal.opengeospatial.org/files/?artifact_id=41579),” OGC Document 10-004r3, 2010-11-10

[5] “[Sensor Model Language - SensorML](http://portal.opengeospatial.org/files/?artifact_id=21273),” OGC Document 07-000, 2007-07-17

[6] “[Web Processing Service](http://portal.opengeospatial.org/files/?artifact_id=24151),” OGC Document 05-007r7, 2007-06-08

[7] “[Supply Chain sensor support by integrating the OGC Sensor Web Enablement and the EPC Network architectures](http://www.autoidlabs.org/uploads/media/AUTOIDLABS-WP-SWNET-028.pdf)”, Auto-ID Lab White Paper SWNET-028, March 2010

[8] [SANY](http://sany-ip.eu/) – A project of the European Commission 6th Framework Programme

[9] [ISTIMES](http://www.istimes.eu/) – A project of the European Commission 7th Framework Programme

# Comments on the initial IoT-A Architecture Reference Model

1. **ARM Viewpoints**

ARM Location: Section 1.3 **Architecture methodology**

Comment severity: Low

The IoT-A approach of using viewpoints for the Reference Model and Architectures is consistent with most standard approaches for architecture – although there is little agreement on the specific viewpoints. OGC typically uses the viewpoints of RM-ODP (ISO/IEC 10746, Reference Model for Open Distributed Processing) for many reasons including: 1) RM-ODP is an international standard, and 2) the five viewpoints defined by RM-ODP are manageable versus approaches using a larger number of viewpoints. For example, the OGC Reference Model [2] uses the RM-ODP viewpoints. The IoT-A approach of distinguishing between Reference Model and Architectures is similar to discussions in OGC, except OGC uses the RM-ODP viewpoints for both with differing levels of detail.

1. **Environmental Sensing**

ARM Location: Section 1.4. **Business scenarios**

Comment severity: High

The last “Field of application” in the table is “Environment” for which the description in nearly all about Smart Grids. Smart Grids are important and might be listed as their own field of application. What is missing is sensing of the environment. A major element of IoT will be sensors that measure environmental parameters (temperature, pressure, chemical, radiation, etc.) The use of these measurements will apply to many environmental applications ranging from security to climate change. The OGC Sensor Web Enablement (SWE) standards [2] have been applied extensively to the environmental monitoring field of application, examples include SANY and ISTIMES projects, OGC Testbeds, and other implementations.

1. **Location**

ARM Location: Figure 6: **IoT Domain Model.**

Comment severity: High

Location should appear as a primary element of the IoT Domain Model. Location is of primary importance to most IoT use cases. For example the Augmented Reality association in Figure 6 is typically based on spatial registration of Physical and Virtual entities. Requirements later in the document (IR4.2, IR4.3, IR4.4) declare the need for location. These requirements are marked as “Medium,” but given the criticality of location to IoT, it seems they might be marked as “High” priority. Location could be modeled as a separate class, which is an attribute of multiple Entities.

Location is a complex concept that includes location by coordinates (geographic coordinates, local coordinates, etc.), location by identifiers (codes, addresses), and relative location. The definition for “address” in Section 2.2.3 appears to be regarding “network address” which is confusing respect to say “physical address”. Approaches to including Location in the IoT-A domain model could be a basis of interaction with OGC.

1. **O&M and SensorML**

ARM Location: Figure 6: **IoT Domain Model.**

Comment severity: Medium

Figure 6 models the relationship between Physical Entities and Sensors. The OGC Observations and Measurements (O&M) standard ([4], also available as ISO 19156) defines a model for the semantics of observations suitable to sensors. An act of *observation* measures the value of a *property* of a *feature* of the environment. A *sensor* is an entity capable of observing and returning a *property* value. A shared understanding of *property* *types* is important to understanding the fitness for use of an Observation to a user. Understanding the properties and process of sensors in an distributed computing environment was a motivation for OGC SensorML [5].

ARM Section 2.2.3 defines *Sensor as “*A *device* identifying or recording features of a given *physical entity*.” A quick comparison with O&M and SensorML suggests changing “feature” to “property” in the IOT-A definition of sensor. Further discussions about O&M and SensorML could result in a robust model for use by IoT-A. For example a profile of SensorML for the broad set of sensors in IoT might be in order.

1. **Data processor (DP) and WPS**

ARM Location: Section 2.4.4IoT Communication model as seen from the application level

Comment severity: Medium

This Section and the associated Figure 17 define a **Data processor that** receives data directly from sensors and performing operations like filtering or aggregation. OGC has a similar distributed processing model that has been implemented using the OGC Web Processing Service [6]. The WPS serves the role in OGC architecture to allow loosely coupled services that host algorithms to be performed on remote data. WPS has been used extensively in the OGC Interoperability Program to perform processing on sensor data. Multiple implementations of WPS have been made based on existing algorithms. The current emphasis in OGC is to define profiles of WPS for general classes of algorithms.

1. **Location Determination**

ARM Location: Section 3.1.1 **Functionality groups**

Comment severity: High

This section and the associated Figure 19 are silent on the topic of location determination functionality. Location of devices may be determined by a function in “IoT service & resource” or in “Device connectivity and communication.” Use of a cellular networks location service is an example of the former, where a GPS on-board the device would an example of the latter. Perhaps the appearance of a location determination function in Figure 19 should be preceded by a discussion of the need for the function earlier in section 3.1.

1. **Use Case – Discovery by Location.**

ARM Location: Annex B – **System use cases**

Comment severity: High

A primary use case of IoT will be the discovery of *services*, *devices*, and possibly *resources* that are “near” a location. The location of interest might be the current location of the user or it might a location remote from the user. Such an IoT discovery use case could be rapidly developed based on use cases previously developed by OGC.

1. **Use Case – Sensors and RFID.**

ARM Location: Annex B – **System use cases**

Comment severity: High

An important use case will be the coordinated use of RFID and Sensors. An AutoID report applies this use case to for supply train tracking [7]. The objective of the AutoID scenario is to judge if the proposed merging of the OGC SWE framework and the EPC Network would provide sufficient functionality to enable real-life condition monitoring and tracking. This scenario assumes that for each item to be monitored, RFID data is read and stored, and sensor data is read and stored. This means that, as a principle, we assume that the sensor readings can be unequivocally and automatically matched with a specific item. The functionality of this scenario may warrant one or more use cases.

1. **SANY - FP6 Project**

ARM Location: (Generally applicable to IoT-A ARM)

Comment severity: Low

The SANY integrated project focused on interoperability of in-situ sensors and sensor networks, and assuring the sensor data can be easily processed and used as a basis for decision making [8]. SANY allows for quick and cost-efficient reuse of data and services from currently incompatible sources in future environmental risk management applications.

The SANY Sensor Service Architecture (SensorSA) is an application OGC SWE. The specification of the SensorSA is structured around the concept of architectural viewpoints of RM-ODP.

SANY was implemented in several pilots: Marine Risk, GeoHazards, Air Quality. The SANY pilots highlight benefits of being able to task and query sensors through interoperable networking, rather than having to rely largely on proprietary arrangements. Being able to use sensors as well as services in an interchangeable and interoperable fashion boasts a whole range of new opportunities for information collection, research and subsequent business development.

1. **ISTIMES - FP7 Project**

ARM Location: (Generally applicable to IoT-A ARM)

Comment severity: Low

The FP7 Project “Integrated System for Transport Infrastructures surveillance and Monitoring by Electromagnetic Sensing (ISTIMES)” [9] is relevant to the application of IoT to infrastructure monitoring. The aim of the ISTIMES project is to design, assess and promote an ICT-based system, exploiting distributed and local sensors, for non-destructive electromagnetic monitoring in order to make critical transport infrastructures more reliable and safe. This has the overall aim to developing high situation awareness in order to provide real time and detailed information and images of the infrastructure status to improve decision support for emergency and disasters stakeholders.

The system exploits an open networked architecture that can accommodate a wide range of sensors, static and mobile, and can easily scale up to allow the integration of additional sensors and to interface with other networks. The System Architecture document - ISTIMES Deliverable 2.1 – has been drafted but not yet publically posted. The ISTIMES System Architecture applies the OGC SWE standards to provide Internet access to sensors that measure infrastructure things.