Paper for Consideration by S100WG TSM

Realtime data handling way forward proposal

Submitted by:	IIC Technologies
Executive Summary:	Proposals for handling of realtime data in S-100.
Related Documents:	S-100WG5 papers, OGC Sensor API
Related Projects:	GML Revision to Part 10b

Introduction / Background

A previous submission to S-100WG5 looked at the task of including realtime data handling within S-100. As the proposed version 5.0.0 of S-100 is drafted some specific revisions to certain parts are required in order to provide compatibility with, and facilities for, modelling and promulgating these datatypes. Subsequent to S-100WG5 a number of discussions have taken place and an approach to the problems is articulated in this paper.

Distribution of realtime data is by no means novel, nor innovative and the previous paper noted that the issue is more one of aligning S-100 to the architecture and content structure required to enable its use within different data streaming frameworks. The previous paper described the current dataset nature of S-100 through aggregations of individual features (for defined encodings) and the characterising elements of the marine domain which S-100 data addresses, namely:

1. Restricted bandwidth
2. Data integrity
3. Global reach
4. Specific encodings
5. Regulatory requirements.

In order to address these requirements a set of proposed amendments to S-100 are described in this paper.

Analysis/Discussion

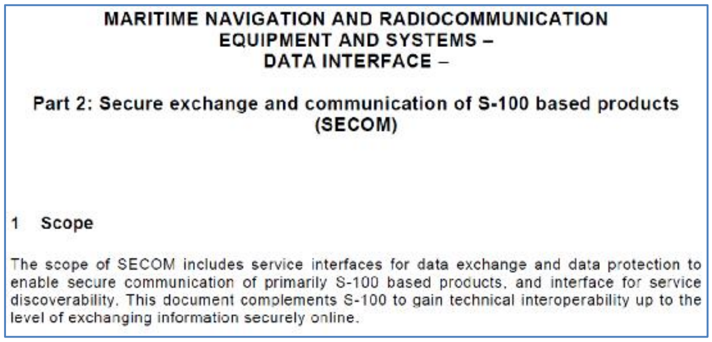
Realtime data is, as stated, by no means a novel concept. The Open Geospatial Consortium, within its Sensor Web enablement framework (SWE) characterises realtime data by focusing on “Observations”, “…an act that produces a result whose value is an estimate of a property of the observation target or Feature Of Interest…”

In order to distribute realtime data, access is generally through API and web services. OGC includes an entire model (replicated in Annex 1) for SWE which provides many useful definitions in how to describe (through domain-specific modelling such as the S-100 framework provides) realtime data observations and measurements including the construction of web services for their transport. OGC provides two relevant models for the description and encoding of realtime phenomena:

1. The Sensor Web Enablement Common data model encoding
2. The Observation and Measurement XML Implementation
3. Timeseries Profile of Observations and Measurement.

The timeseries Profile also includes timeseries of coverage data compatible with S-100’s coverage dataset and HDF5 encoding. The OGC framework has many implementations based on GML data content and has been implemented by many vendors and IoT service providers. The SWE framework encompasses a large number of different standards covering discoverability, access and data use, only those relating to data modelling and interoperability are considered here. The vessel use case is likely to be implemented by the SECOM standard.

The other notable framework is the IEC-63173 SECOM standard, currently under development, which emerged from the STM project within the e-Navigation community. This standard specifically references S-100 and is focused on transmission and distribution of data to (and within) SOLAS vessels.



MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –
DATA INTERFACE –

Part 2: Secure exchange and communication of S-100 based products (SECOM)

1 Scope

The scope of SECOM includes service interfaces for data exchange and data protection to enable secure communication of primarily S-100 based products, and interface for service discoverability. This document complements S-100 to gain technical interoperability up to the level of exchanging information securely online.

Figure 1: IEC63171 Introductory scope

A schematic of the intended operation of systems using the SECOM standard (accessed via the Maritime Connectivity Platform) is shown in the image below:

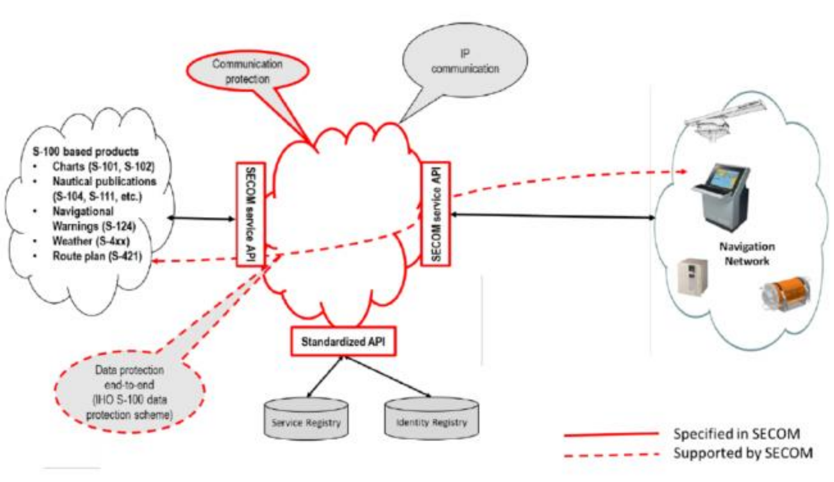


Figure 2: The SECOM operating model

S-100 edition 4.0.0 contains a comprehensive ISO conformant data modelling environment, together with multiple encodings which can be used, in conjunction with the IHO geospatial registry, to produce data “content” aggregated into datasets. S-100 also contains a flexible GML Profile (Part 10b) and a (mostly informative) data streaming implementation (Part 14). S-100 has no interest in creating its own web services framework and the established OGC and SECOM frameworks provide sufficient facilities to allow data to be defined and distributed using web services.

OGC’s SWE framework, although mature, is likely to undergo revision as part of the API-based redevelopment of all web services which will result in a more content-neutral and self-describing framework. SECOM is still under development but is specific to both S-100 and the Marine domain.

Conclusions

The task, therefore, for the upcoming edition of S-100 is to:

1. Recognise that the OGC and SECOM frameworks have the capacity to deliver data appropriately without requiring an additional framework for web services embedded within S-100 itself.
2. The IHO has an existing (advanced) registry structure and data modelling/representation methodology embedded in S-100 which comprehensively deals with hydrographic data and which is already implemented in core product specifications focused on ECDIS and ancillary uses.
3. The S-100 encodings (GML, ISO8211 and HDF5) are interoperable in theory with both SECOM and OGC. Developing this into a normative interoperability can be achieved in the next edition of S-100.
4. Although no established methodology exists for integrating S-100 data “content” with external frameworks for distribution via web services this could be achieved with some editing of the existing S-100 parts. There is no need for a new part to S-100.
5. The exact mechanism for interoperability is likely to at least partially be defined in the relevant product specification and will be dependent on the nature of the data itself, e.g. point water level observations vs

coverage surfaces and meteorological observations. The inclusion in the product specification of elements which promote interoperability can be usefully embedded in S-100's informative Part 14.

The proposed review and update to S-100 should accommodate the following:

S-100 Part 10b:

1. Ensure clear distinction between the dataset aggregation elements of the GML Profile and the data content itself.
2. Enable the ability to define dataset aggregations from external frameworks, effectively to allow S-100 data to be "carried" within collections defined by OGC and SECOM
3. Ensure the S-100 fields within the SECOM web services are defined in the GML profile metadata.
4. Ensure type compatibility between the S-100 core types and both OGC/SECOM frameworks.
5. Ensure the GML profile is flexible enough to ensure realtime elements defined within a product specification's model will be carried through into its application schema.

S-100 Part 14

1. Part 14 can remain predominantly informative but should provide guidance and examples for the integration of S-100 data content within external frameworks, specifically referencing SECOM and the OGC architectures. Some substantial revisions to Part 14 should be drafted to enable this.
2. Provide modelling guidance to ensure existing product specifications can be modified to be interoperable with the existing frameworks and new product specifications are designed to be similarly interoperable.
3. Where product specifications are likely to be distributed either using realtime web services, references to Part 14 should be included. This should clearly define required fields, metadata, types and any elements required.
4. Forward compatibility with OGC Features API should be investigated. S-100 is providing the content modelling for realtime data and this should continue to be interoperable as the new OGC architecture is more content-neutral. Although the OGC community is moving more towards JSON encodings in API services the ability to support S-100's GML encoding will continue.

The proposed S-100WG TSM proposal to revise the S-100 GML Profile should complement the activities here by clearly separating the dataset content from the S-100 modelled data.

Recommendations

1. Contribute to the revision to Part 10b to ensure realtime data and interoperability with existing frameworks is added
2. Revise Part 14, modernising the content in line with this paper and providing informative guidance for implementers of external frameworks with S-100 data content
3. Ensure guidance for developers of product specifications is contained within S-100 to ensure interoperability.

Action Required of S-100TSM

The S-100TSM is invited to:

a. endorse the way forward proposed in this paper
b. note continued participation and communication with both IALA and OGC communities in the continued development of this interoperability.

Annex 1 – the OGC Sensor Web Enablement API Architecture:

A sensor network is a computer accessible network of many, spatially distributed devices using sensors to monitor conditions at different locations, such as temperature, sound, vibration, pressure, motion or pollutants. A Sensor Web refers to web accessible sensor networks and archived sensor data that can be discovered and accessed using standard protocols and application program interfaces (APIs).

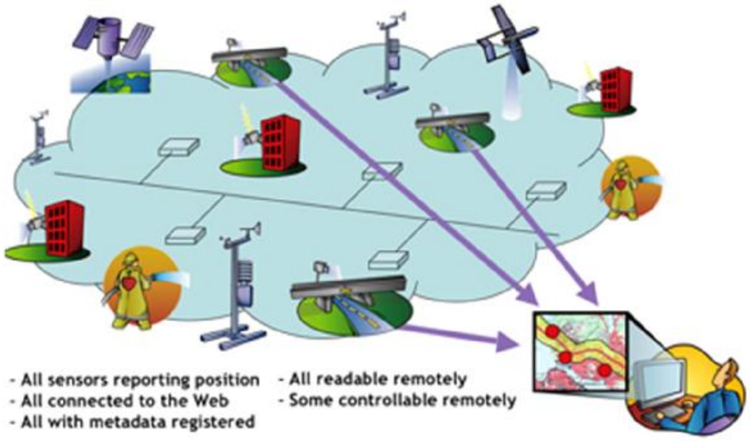


Figure 1: Sensor Web Concept

In an Open Geospatial Consortium (OGC)[2] initiative called Sensor Web Enablement (SWE), members of the OGC have defined and documented a unique and revolutionary framework of open standards for exploiting Web-connected sensors and sensor systems of all types: flood gauges, air pollution monitors, stress gauges on bridges, mobile heart monitors, Webcams, airborne and satellite-borne earth imaging devices and countless other sensors and sensor systems.

SWE presents many opportunities for adding a real-time sensor dimension to the Internet and the Web. This has a high level of significance for disaster management, environmental monitoring, transportation management, public safety, facility security, utilities' Supervisory Control And Data Acquisition (SCADA) operations, industrial controls, science, facilities management and many other domains of activity.

The sections below describe the high level SWE architecture, SWE standards, harmonization with other standards such as IEEE 1451, and several use cases.

High Level Architecture

The models, encodings, and services of the SWE architecture enable implementation of interoperable and scalable service-oriented networks of heterogeneous sensor systems and client applications. In much the same way that Hyper Text Markup Language (HTML) and Hypertext Transfer Protocol (HTTP) standards enabled the exchange of any type of information on the Web, the OGC's SWE initiative is focused on developing standards to enable the discovery, exchange, and processing of sensor observations, as well as the tasking of sensor systems. The functionality that OCG has targeted within a sensor web includes:

- Discovery of sensor systems, observations, and observation processes that meet an application's or user's immediate needs;
- Determination of a sensor's capabilities and quality of measurements;
- Access to sensor parameters that automatically allow software to process and geo-locate observations;
- Retrieval of real-time or time-series observations and coverages in standard encodings
- Tasking of sensors to acquire observations of interest;
- Subscription to and publishing of alerts to be issued by sensors or sensor services based upon certain criteria.

Within the SWE initiative, the enablement of such sensor webs and networks is being pursued through the establishment of several encodings for describing sensors and sensor observations, and through several standard interface definitions for web services. Sensor Web Enablement standards that have been built and prototyped by members of the OGC include the following OGC standards:

1. Observations & Measurements Schema (O&M) – An OGC adopted standard that defines conceptual models for encoding observations and measurements from a sensor, both archived and real-time.

2. Observations and Measurements XML (OMXML) – XML encoding of the O&M conceptual model.

3. Sensor Model Language (SensorML) – An OGC adopted standard that defines standard models and XML Schema for describing sensors systems and processes; provides information needed for discovery of sensors, location of sensor observations, processing of low-level sensor observations, and listing of taskable properties.

4. Sensor Observations Service (SOS)- An OGC adopted standard that specifies a standard web service interface for requesting, filtering, and retrieving observations and sensor system information. This is the intermediary between a client and an observation repository or near real-time sensor channel.

5. Sensor Planning Service (SPS) – An OGC adopted standard that specifies standard web service interface for requesting user-driven acquisitions and observations. This is the intermediary between a client and a sensor collection management environment.

6. SWE Common Data Model -The Sensor Web Enablement (SWE) Common Data Model Encoding Standard defines low level data models for exchanging sensor related data between nodes of the OGC® Sensor Web Enablement (SWE) framework. These models allow applications and/or servers to structure, encode and transmit sensor datasets in a self-describing and semantically enabled way.

7. SWE Services Common – This standard currently defines eight packages with data types for common use across OGC Sensor Web Enablement (SWE) services. Five of these packages define operation request and response types. These packages use data types specified in other standards.

8. PUCK Protocol Standard- This standard defines a protocol for RS232 and Ethernet connected instruments. PUCK addresses installation and configuration challenges for sensors by defining a standard instrument protocol to store and automatically retrieve metadata and other information from the instrument device itself. PUCK is the newest addition to the SWE standards suite.

9. Sensor Alert Service (SAS) – An OGC Discussion paper describing a web service interface for publishing and subscribing to alerts from sensors. This is not an OGC standard.

10. Web Notification Services (WNS) – Standard web service interface for asynchronous delivery of messages or alerts from SAS and SPS web services and other elements of service workflows. This is not an OGC standard.

The goal of SWE is to enable all types of Web and/or Internet-accessible sensors, instruments, and imaging devices to be accessible and, where applicable, controllable via the Web. The vision is to provide a standards foundation for “plug-and-play” Web-based sensor networks. Sensor location is usually a critical parameter for sensors on the Web, and OGC is the world’s leading geospatial industry standards organization. Therefore, SWE standards have been harmonized with other OGC standards for geospatial processing. The SWE standards foundation also references other relevant sensor and alerting standards such as the IEEE 1451 “smart transducer” family of standards (see page 8) and the OASIS Common Alerting Protocol (CAP), Web Services Notification (WS-N) and Asynchronous Service Access Protocol (ASAP) specifications. OGC works with the groups responsible for these standards to harmonize them with the SWE specifications.

Advances in digital technology are making it practical to enable virtually any type of sensor or locally networked sensor system with wired or wireless connections. Such connections support remote access to the devices’ control inputs and data outputs as well as their identification and location information. For both fixed and mobile sensors, sensor location is often a vital sensor parameter. A variety of location technologies such as GPS and Cell-ID with triangulation make mobile sensing devices capable of reporting their geographic location along with their sensor-collected data.

When the network connection is layered with Internet and Web protocols, eXtensible Markup Language (XML) schemas can be used to publish formal descriptions of the sensor's capabilities, location, and interfaces. Then Web brokers, clients and servers can parse and interpret the XML data, enabling automated Web-based discovery of the existence of sensors and evaluation of their characteristics based on their published descriptions. The information provided also enables applications to geolocate and process sensor data without requiring a priori knowledge of the sensor system.

Figure 2: The role of the Sensor Web Enablement framework

Information in the XML schema about a sensor's control interface enables automated communication with the sensor system for various purposes: to determine, for example, its state and location; to issue commands to the sensor or its platform; and, to access its stored or real-time data. A Web-based application might communicate with the sensor system through a proprietary or custom interface or through an interface that implements the IEEE 1451 standard. An object-oriented approach to sensor and data description also provides a very efficient way to generate comprehensive standard-schema metadata for data produced by sensors, facilitating the discovery and interpretation of data in distributed archives.

The Observation and Measurements Data Model.

- The key to the model is that an Observation is modeled as an act that produces a result whose value is an estimate of a property of the observation target or FeatureOfInterest.

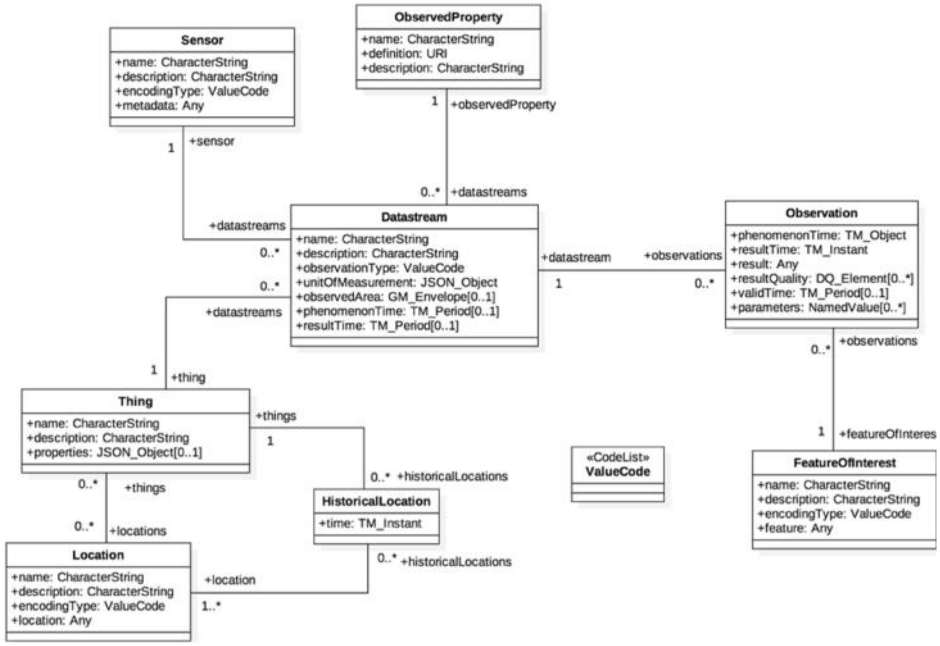
- An Observation instance is classified by its event time (e.g., resultTime and phenonmenonTime), FeatureOfInterest, ObservedProperty, and the procedure used (often a Sensor).

- Moreover, Things are also modeled in the SensorThings API, and its definition follows the ITU-T definition: "an object of the physical world (physical things) or the information world (virtual things) that is capable of being identified and integrated into communication networks" [ITU-T Y.2060].

- The geographical Locations of Things are useful in almost every application and as a result are included as well. For the Things whose location changed, the HistoricalLocations entities offer the history of the Thing's locations.

- A Thing also can have multiple Datastreams. A Datastream is a collection of Observations grouped by the same ObservedProperty and Sensor.

- An Observation is an event performed by a Sensor that produces a result whose value is an estimate of an Observed Property of the FeatureOfInterest.



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