Interoperable Provision of Research Vessel Tracking Data via OGC SensorThings API and Sensor Observation Service

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Within the last year, many applications of Sensor Web technologies to share marine observation data have emerged. This comprises not only data standards for encoding observation data but also the provision of metadata and data access interfaces. Many of these applications have focused on the provision of stationary in-situ data (e.g. data collected by fixed buyos or stations).

Within this paper, we introduce how the Sensor Web Enablement (SWE) standards of the Open Geospatial Consortium (OGC) can be applied to handle near real-time flows of research vessel data. Specific challenges addressed in this paper are the efficient transmission of the data into a Sensor Web infrastructure as well as the subsequent provision via Web applications.

As a starting point of the developments of the project, several requirements were identified that guided the design of the system:

- Integration of different research vessels of different operators
- Achieve an integration beween the EARS (Eurofleets Automatic Reporting System) software system which is running on each of the considered research vessels
- Ensure a timely and lightweight flow of information
- Rely on internaltional interoperability standards to ensure extensibility and sustainable re-use
- Facilitate the visualisation of historic as well as live data

The resulting system architecture is outlined in Figure 1. Each of the research vessels is running an instance of the EARS (Eurofleets Automatic Reporting System) software system. This software collects the generated observation data. From there on, different approaches such as UDP/Iridium but also manual data transfer via USB storage are used to transfer the collected data to the on-shore vessel operator for further storage and archival. Subsequently, the research vessel operators provide access to the available current near-live data via HTTP endpoints.

The HTTP endpoints offering the latest ship data are the basis for enabling the feeding of the data into a Sensor Web infrastructure. For this purpose, a feeder application continuously checks the HTTP endpoints for new ship data. If new data is available, it is downloaded and forwarded via a lightweight MQTT stream to an OGC SensorThings API server.

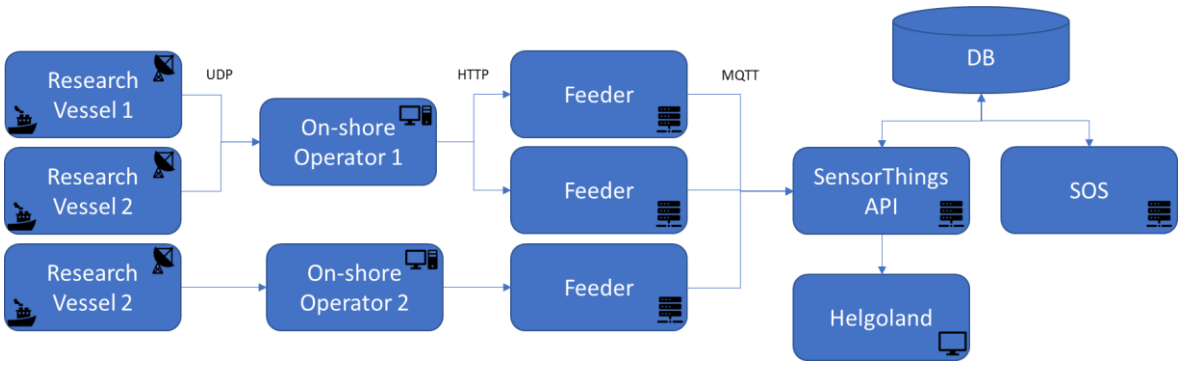

Figure 1: Architecture Overview

The SensorThings API server acts as a sink for the MQTT streams delivering the different types of ship data and metadata. In details the following types of information are handled:

- Navigation data: longitude/latitude, heading, speed, depth, course over ground, speed over ground
- Meteorological data: wind mean velocity, wind gust, wind direction, air temperature, humidity, solar radiation, atomospheric pressure
- Thermosalinity data: salinity, water temperature, raw fluorometry, density (Sigma-t)

After receiving new data via MQTT, the SensorThings API server takes care of ingesting the collected vessel data into a central Sensor Web database (in this case a relational PostgreSQL database). From there on, the data is made available via interoperable interfaces (OGC Sensor Observation Service and OGC SensorThings API).

On top of the SensorThings API, a Web viewer application is deployed. This Web viewer, based on the 52°North Helgoland Sensor Web viewer, allows users to view the current positions and data of the included research vessels. In addition, also historic data of the ships (e.g. trajectories of past journeys) can be discovered and visualised.

Besides establishing the necessary data flows and visualisation tools based on technologies previously developed and enhanced in projects such as SeaDataCloud, the modelling of the research vessel data was a second major task during the design process. In this case, a consistent mapping of the different entity types to the OGC Sensor Observation Service and SensorThings API data models had to be established. Core elements of this model include:

- The collected data is modelled as so called SpatialFilteringProfile measurements as defined by the OGC Sensor Observation Service standard. This means that the latest navigation data is merged with the corresponding thematic observation data into individual observations.
- The tracks of the research vessel are considered as so-called Features of Interest which are dynamically updated with each new message containing ship navigation data.
- The Thing concept of the OGC SensorThings API is mapped to the research vessels (in case of the SOS, the vessels are mapped to the concept of “procedures”)

Furthermore, to ensure semantic interoperability, the terms used for referring to the observed properties and to the units of measurements are taken from the NERC Vocabulary Server.

The validation of the developed approach is carried out in close cooperation with Eurofleets. Data delivered by the vessels “Belgica” (Royal Belgian Institute of Natural Sciences) and “Sarmiento de Gamboa” as well as “García del Cid” (both CSIC).

In summary we present an approach how live streams of research vessel data can be collected via interoperable Sensor Web standards. This comprises not only the encoding of the data and metadata, but also lightweight data transmission technologies, semantic as well as syntactic data interoperability as well as Web-based visualisation tools.

Credits

The work presented in this paper was performed as part of the EMODnet Ingestion 2 project in cooperation witht Eurofleets.