

Challenges and experiences

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- Project introduction
- Data sources and complexity
- System ideal design
- Which web services?
- Challenges with standards
- Current architecture
- Future plans

Project objective :

"Support sustainable and cost-efficient exploitation of satellite sensors for water quality monitoring of inland, transitional and coastal waters."

Challenges for satellite services:

- optically complex water bodies
- adjacent land and continental aerosols

Part of **solution**: sustained in situ observations to calibrate / validate operational satellite services in near real-time

- adequate spatial coverage
- sufficient and traceable quality

Specific challenge: existing observatories lack parameters to:

- separate atmospheric and water optical properties from satellite obs
- derive water column properties from near-surface observations



MONOCLE – brief summary











Improved in situ components of the GEOSS and Copernicus programmes in optically complex waters

- Sensor and sensor-network innovation
- Innovative deployment strategies

Cost-effectiveness of in situ observation services

- coupled measurement of water-leaving reflectance and atmospheric transmissivity
- high-end reference sensors in a spatially sparse configuration and complementary low cost sensors for smartphones and unmanned aerial vehicles
- support for existing sensors
- In-field calibration, towards a self-calibrating network

Sustainable networks and services

- support exchange and downstream data usage
- anomaly and drift detection
- configure for information providers in data-poor regions
- training materials and active capacity building

MONOCLE – Data sources

7-7



Cost of acquisition

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Diversity of data collection

The project collects data from a very diverse suite of sensors

- Citizen science
- In-situ sensors
- Platforms that move (Ferries)
- Existing databases of data

This leads to a great variety of data *types* that need to be transferred, stored and re-used



MONOCLE – Initial design



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Suite of OGC services used so far

In making our proposed system a reality we have utilised several OGC web services

Web Map Service – used to quickly display satellite imagery and drone imagery

Web Coverage Service – used to access satellite data for analysis Sensor Observation Service – used as the primary data transfer and access service for all in-situ data



Suite of OGC services Planned for future use

For the more complex interactions between sensors and sensor controllers we have started to look into some less commonly used services.

Sensor Planning Service – for initiating sensing or requesting changes in sensing frequency/resolution

Sensor Event Service – initially planned to use for trigger based sensing changes. This looks like it will be changed to utilise the OGC Pub/Sub emerging standard

Sensor Observation Service – initial challenges

- Working with a very diverse set of sensors we had to take a deep dive into SensorML
- Simply put SensorML is hard....
- Coming from the relatively fixed metadata world of coverages & WCS, the sheer number of optional ways to represent metadata was daunting
- The complex naming conventions are also relatively challenging for developers coming at SensorML.

But these were just basic challenges of documentation and learning

Sensor Observation Service

To make the required learning as easy as possible we chose the 52North SOS. This was due to the extensive documentation provided due to its reference implementation status. With our basic needs met we now faced some interesting Challenges specific to our needs

- Variable number of sensors in a particular category that could be deployed in any campaign
- New sensors are being added/tested going forward

These two challenges basically break down into a single problem : **Allowing transactional access dynamically**



Dynamic transactional access

- The 52North SOS allows access to be restricted to a list of IP addresses
- Sensors being deployed in the field with GPRS/LTE connections cannot guarantee IP address will not change over time
- To account for this we need a proxy mechanism that the service will allow transactional requests from

Solving the transactional inserts is only part of the problem as we still need to be able to register the device

Dynamic transactional access – Adding sensors

- To allow sensors to be added as needed the proxy acts as as a thin access control layer.
- Minting a token based on credentials that can then be used for future requests from the sensor



Dynamic transactional access – SOS proxy

- The SOS proxy is written in Node/Express as this should cope with many quick connections efficiently (first test event was successful)
- For the access control database we use our central operational Postgres instance (the reason for this will become clear)
- Quick deployment to any architecture is facilitated by wrapping the proxy in a docker container

So getting data into the service in a secure manner is currently solved by the proxy. This still leaves the thorny issue of securing data going out from the service.



Not all data are "open"

The data collected in the project is primarily open, following the FAIR principles. However in trying to capture as much data as possible some comes with access constraints :

- Time based embargo
- User based restrictions
- Specific licensing restrictions on use
- Data prior to QA/QC may need to be restricted to limit misinterpretation

OGC services are open

- The OGC services used within the MONOCLE system do not have access control *built-in* especially for data output.
- Focusing on SOS we decided that as we are proxying requests we can use this system to collect an data that requires access constraints
- A completely separate storage mechanism was discussed but the benefits of using the standardised SOS for all data storage allows us to re-use code an utilities.
- This led to the following design

MONOCLE – Data Challenges

Securing MONOCLE data

- Proxy stored data access restrictions in database keyed to the token for a given sensor
- Data are linked to these restrictions by metadata
- This allows control per data point, e.g. if the requirements change a new token can be minted so future data will have updated rules
- Data are copied over to the public instance by a utility script



Enhancing MONOCLE data

The current design allows for storage of *any* metadata that can then be linked to an individual measurement/sensor. Currently these are :

- Simple quality flag a generic flag normally used for marking test data
- Battery warning some sensors error increases with varying power supply
- The embargo length for a given data point
- Restricted to project partners (again for a given time)

Currently these metadata are queried separately from the SOS data. On the future we are looking at adding these data as parameters on the sensor when the data are pushed to the public SOS.



MONOCLE – Field Test

Taking the system into the environment

In July this year MONOCLE had its first trial campaign. Based around Lake Balaton in Hungary.

The testing aim for this part of the project was testing the data flow into the system and the ability of devices to register in the field.



MONOCLE – Field Test

Successes

- Devices successfully registered in the field
- We tested auto registration on one device (on start-up)
- Data flow was considerable, with some sensors recording data at 10hz
- The 52North SOS combined with proxy managed this with no issue
- A test device with python script was able to request data back from the system





MONOCLE – Field Test

Challenges & Quirks

- A misunderstanding of how the feature of interest was recorded resulted in a ship based sensor creating a new feature of interest for each data point, at 10Hz
- Drops in connection are frequent. Local storage is a must
- Over all the test went well and generated some of the ideas i've presented here.





Current architecture allows

- Sensor manufacturers can register the sensor with the SOS directly from the sensor in the field
- Data that are inserted are controlled via our access control proxy
- Each data point can have metadata associated with via the token used to insert the data
- Data out flow can be controlled via several mechanisms, e.g time embargo
- Data can be requested by a sensor from the controlled SOS
- The main data archive is accessible via a public facing SOS



MONOCLE – final summary



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Future work in the project

- Sensor provisioning (SPS)
 - Using our database of sensors we can create an interface to allow activation/deactivation
 - This could help to reduce the energy requirements of a remote deployment of a sensor network
- Sensor configuration changes based on triggers (SES/pubsub)
 - Main use case: increasing sensing rate when a satellite is passing over
 - This will allow better validation of remote sensed data

The use of the proxy will make adding the features simpler as we have more fine grain control of the data flow and metadata storage.



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Thank you for your time

Any Questions?

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