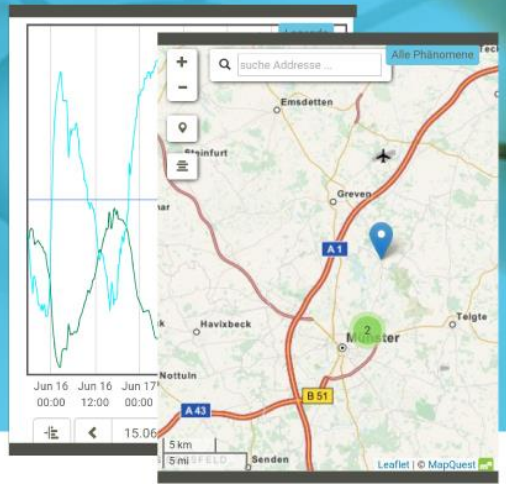
September 3 – 5, 2018 Muenster, Germany

Geospatial Sensor Webs Conference 2018



Introduction into Sensor Web Technologies

Dr. Simon Jirka, jirka@52north.org

52north exploring horizons

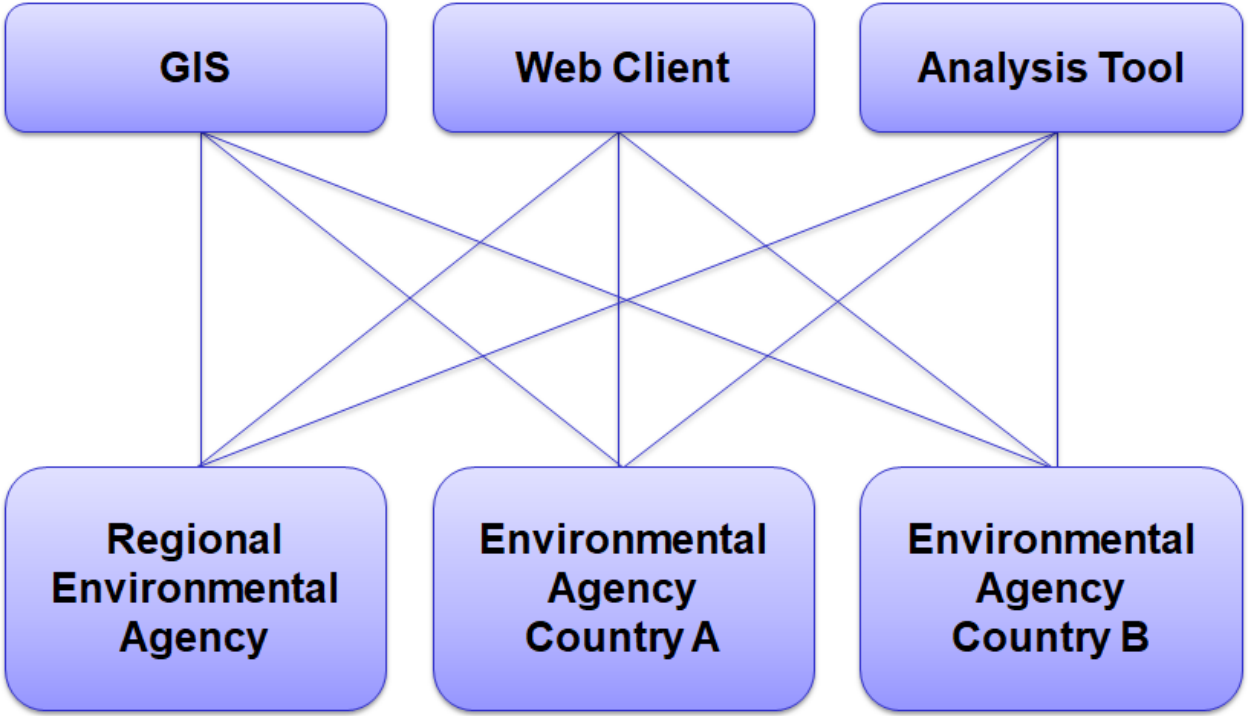
Agenda

- Motivation
- OGC Sensor Web Enablement
  - Data Models: ISO/OGC Observations and Measurements
  - Metadata: OGC Sensor Model Language
  - Data Access: OGC SensorThings API
  - Data Access: OGC Sensor Observation Service
- OGC Sensor Web Enablement and INSPIRE Download Services
- Deployment Strategies
- Application Examples
  - Wupperverband
  - IRCEL-CELINE
- Questions and Discussion

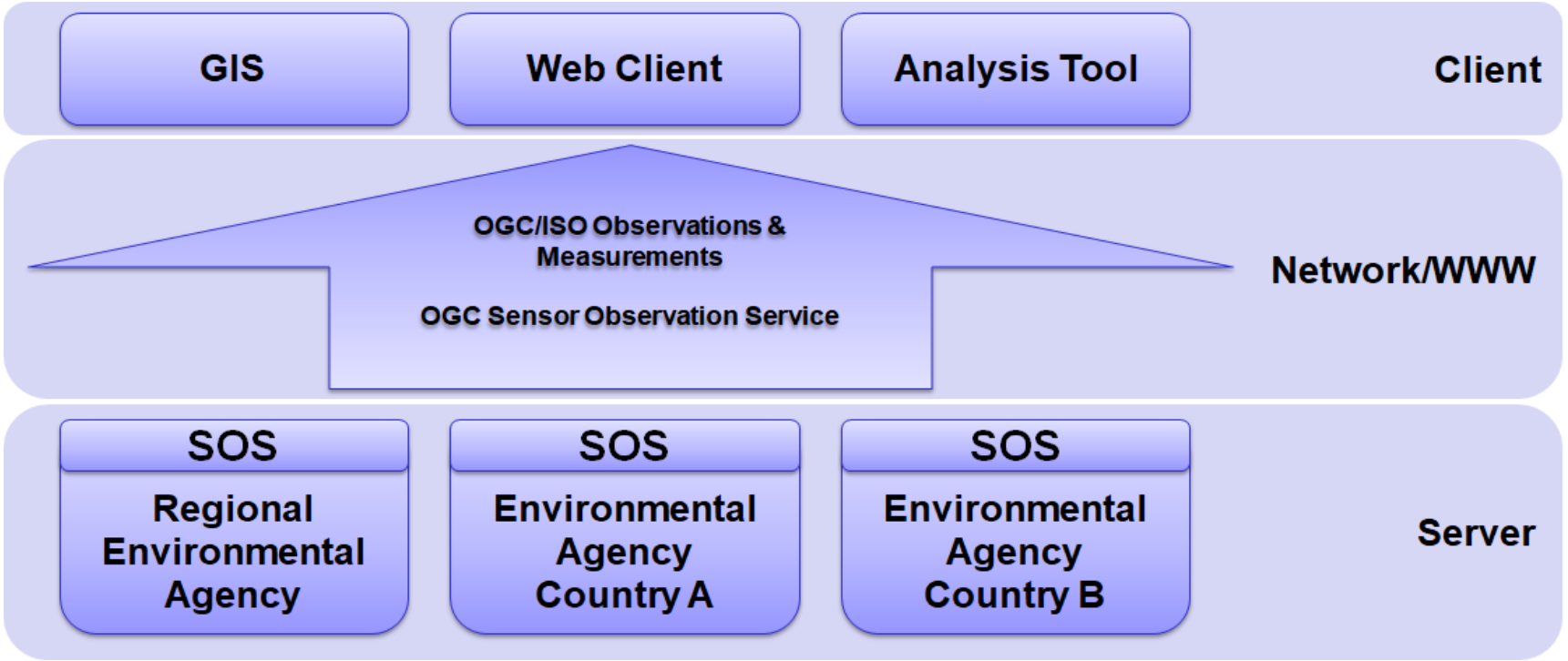
Motivation

- More and more sensors are deployed
- Human observations
- Lots of different phenomena
  - Weather
  - Pollution
  - Biodiversity
  - Hydrological Data
  - Traffic
  - ...
- Different structures and elements of observations
- Sensor interfaces are very heterogeneous
- Need for harmonisation → interoperability

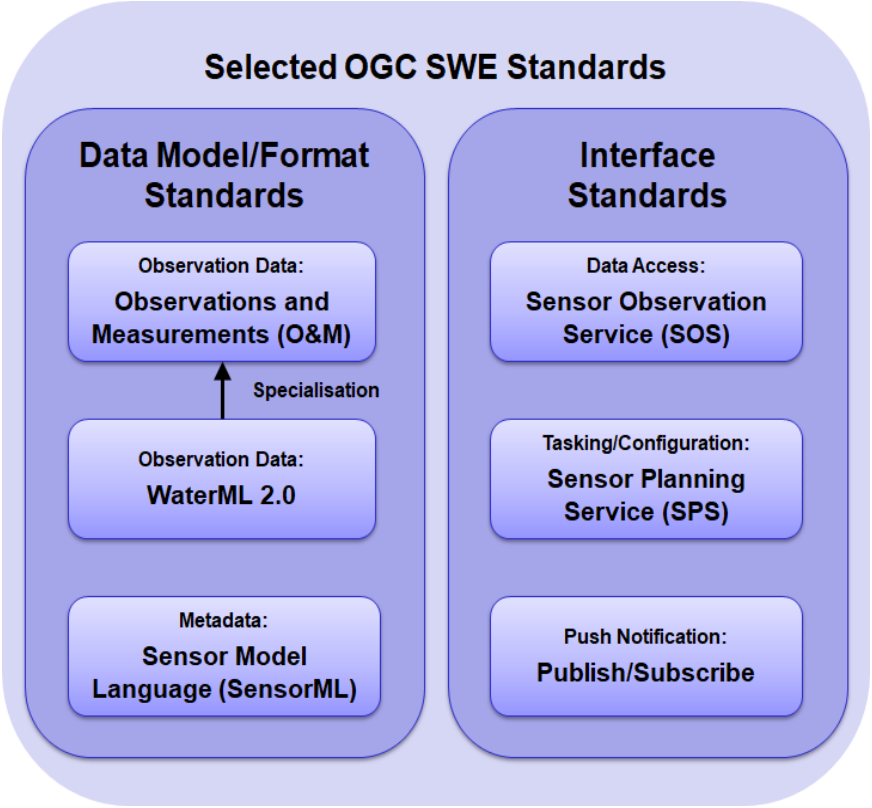
OGC Sensor Web Enablement



OGC Sensor Web Enablement



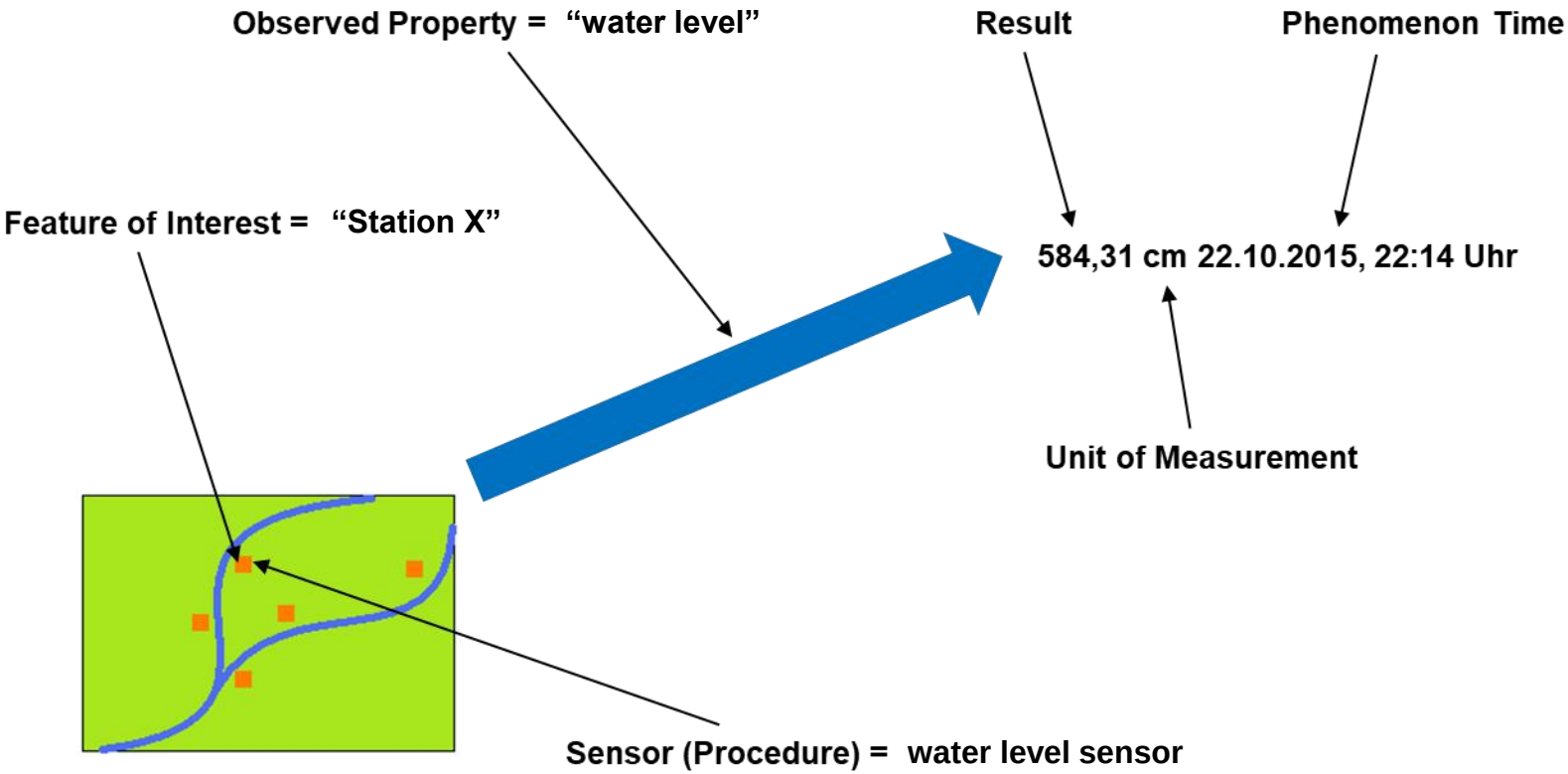
OGC Sensor Web Enablement



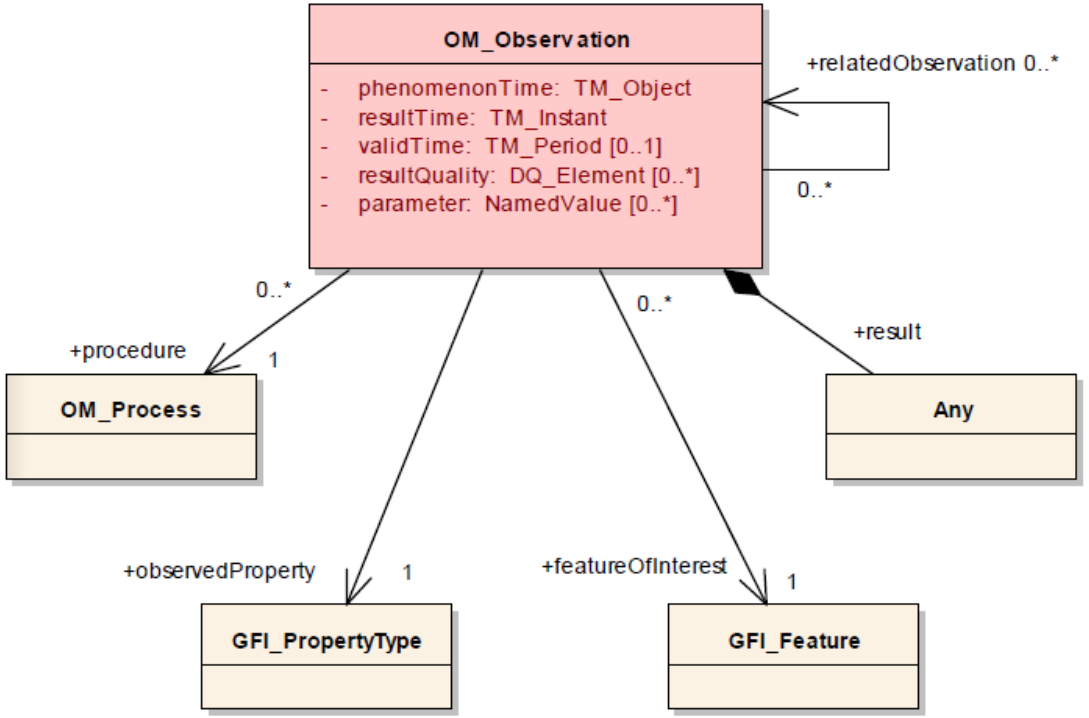
Data Models: ISO/OGC Observations and Measurements

- Conceptual model for
  - Representing observations
  - Exchanging observations
- Implementation as application schema
- XML schemata extending the Geography Markup Language (GML)
- Primary use: Encode SOS GetObservation response documents
- Current version: O&M 2.0 (OGC and ISO standard)

Data Models: ISO/OGC Observations and Measurements



Data Models: ISO/OGC Observations and Measurements



Source: OGC

Data Models: ISO/OGC Observations and Measurements

```
<om:OM_Observation gml:id="o_75AD0C99DAC8E06F6AE24B9F2402A81F9AEAA0FF">
  <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement"/>
  <om:phenomenonTime>
    <gml:TimeInstant gml:id="phenomenonTime_74">
      <gml:timePosition>2012-11-19T13:06:00.000Z</gml:timePosition>
    </gml:TimeInstant>
  </om:phenomenonTime>
  <om:resultTime xlink:href="#phenomenonTime_74"/>
  <om:procedure xlink:href="http://www.52north.org/test/procedure/6"/>
  <om:observedProperty xlink:href="http://www.52north.org/test/observableProperty/6"/>
  <om:featureOfInterest xlink:href="http://www.52north.org/test/featureOfInterest/6"/>
  <om:result xmlns:ns="http://www.opengis.net/gml/3.2" uom="test_unit_6" xsi:type="ns:MeasureType">2.6</om:result>
</om:OM_Observation>
```

Data Models: ISO/OGC Observations and Measurements


```
"observations" : [
  {
    "type" : "http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement",
    "procedure" : "http://www.52north.org/test/procedure/6",
    "offering" : "http://www.52north.org/test/offering/6",
    "observableProperty" : "http://www.52north.org/test/observableProperty/6",
    "featureOfInterest" : {
      "identifier" : {
        "codespace" : "http://www.opengis.net/def/nil/OGC/0/unknown",
        "value" : "http://www.52north.org/test/featureOfInterest/6"
      },
      "sampledFeature" : "http://www.52north.org/test/featureOfInterest/world",
      "geometry" : {
        "type" : "Point",
        "coordinates" : [
          51.447722,
          7.270806
        ]
      }
    },
    "phenomenonTime" : "2012-11-19T13:02:00.000Z",
    "resultTime" : "2012-11-19T13:02:00.000Z",
    "result" : {
      "uom" : "test_unit_6",
      "value" : 2.2
    }
```

Metadata: OGC Sensor Model Language

- General sensor information → discovery
- Facilitate processing and analysis of sensor measurements
- Geolocation of observed values
- Description of the process by which an observation was obtained
- Current version: SensorML 2.0

Metadata: OGC Sensor Model Language

- Steps and elements of a data acquisition and processing chain are modelled as so called “Processes”
- Typical metadata
  - Common metadata (ID, classification, textual description, contact information)
  - Constraints (e.g. temporal validity of document)
  - Capabilities and characteristics of the sensor
  - Inputs and Outputs
  - Parameters
  - Processing methods
  - Geo-locations
  - References to further documentation
  - History (e.g. events in the lifetime of a sensor)
  - ...

Metadata: OGC Sensor Model Language

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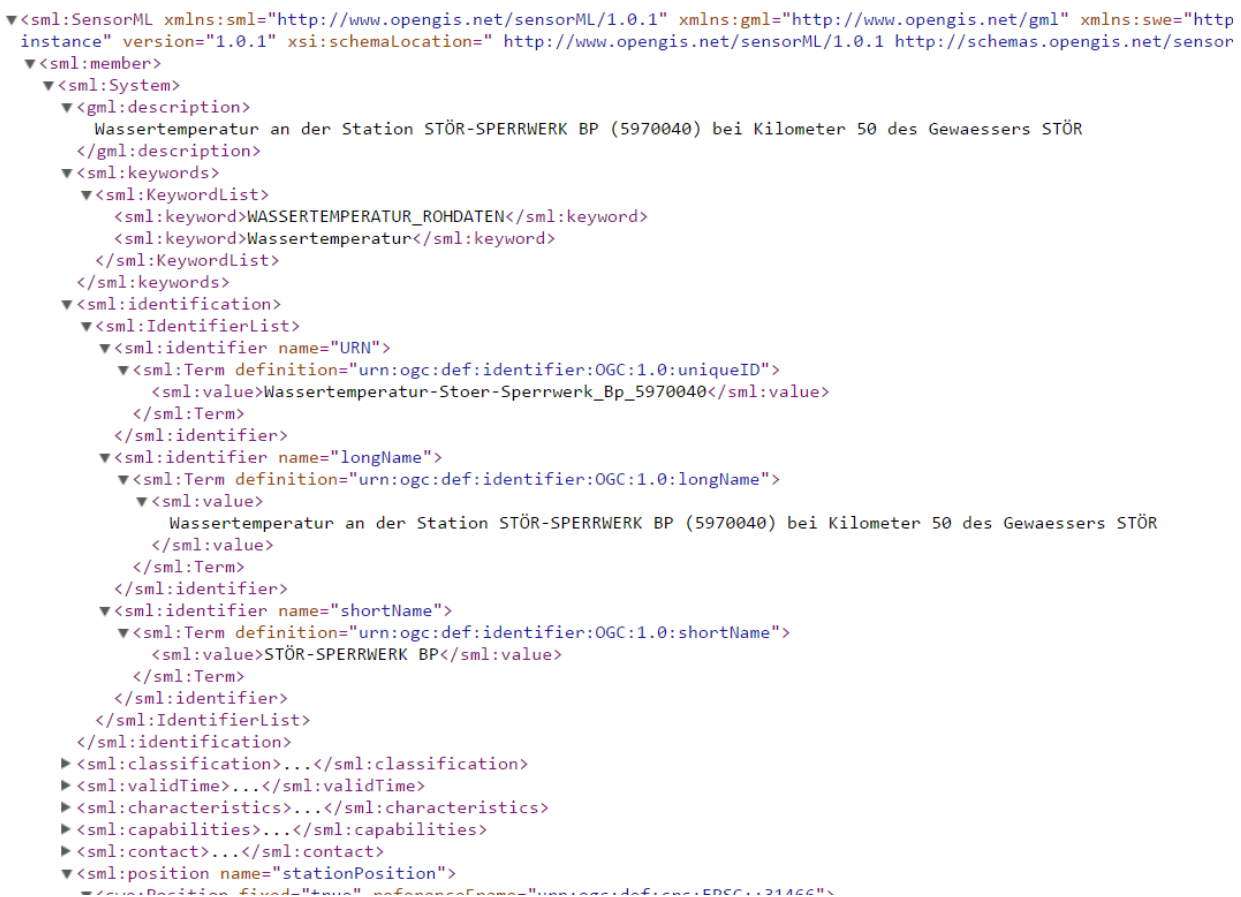

Metadata: OGC Sensor Model Language

smle - SensorML editor

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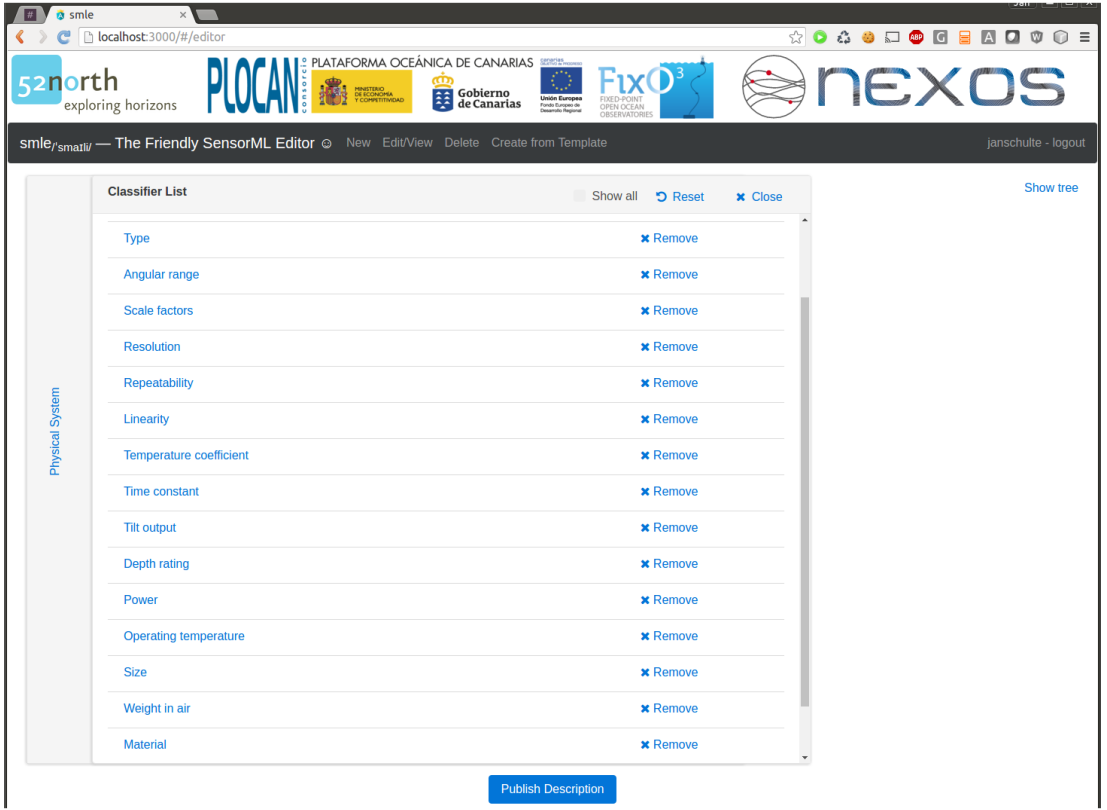
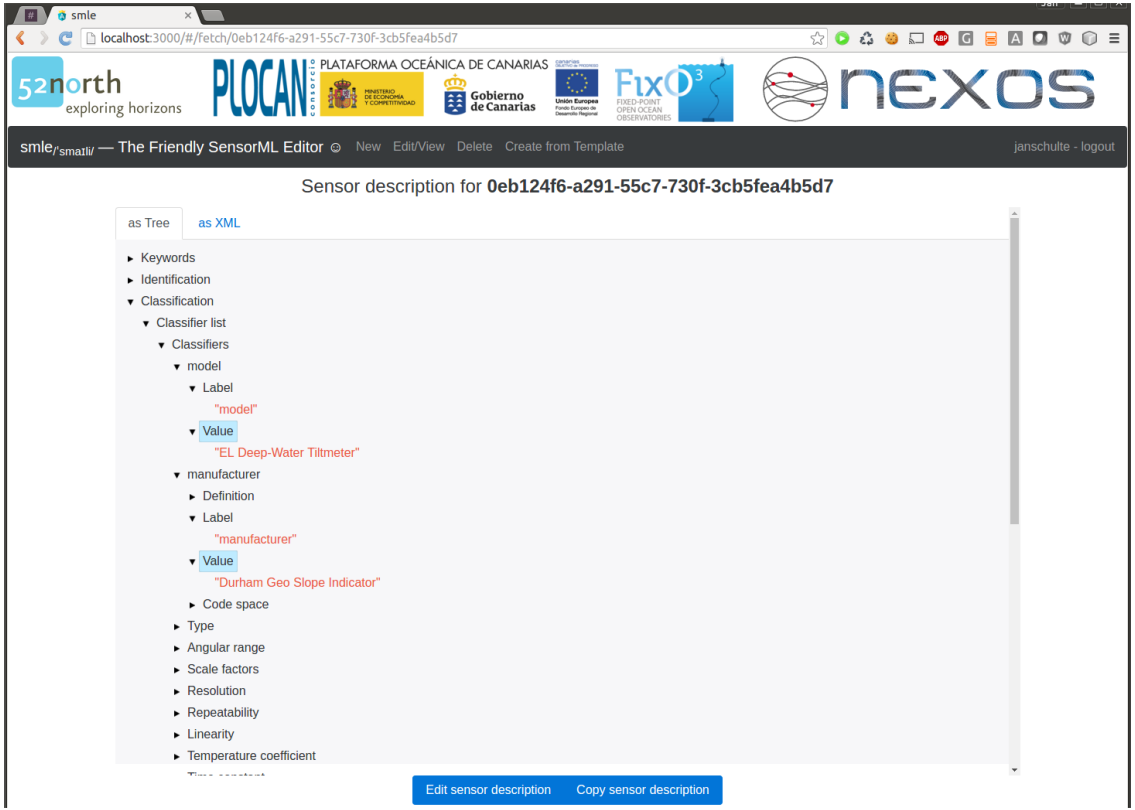


Metadata: OGC Sensor Model Language

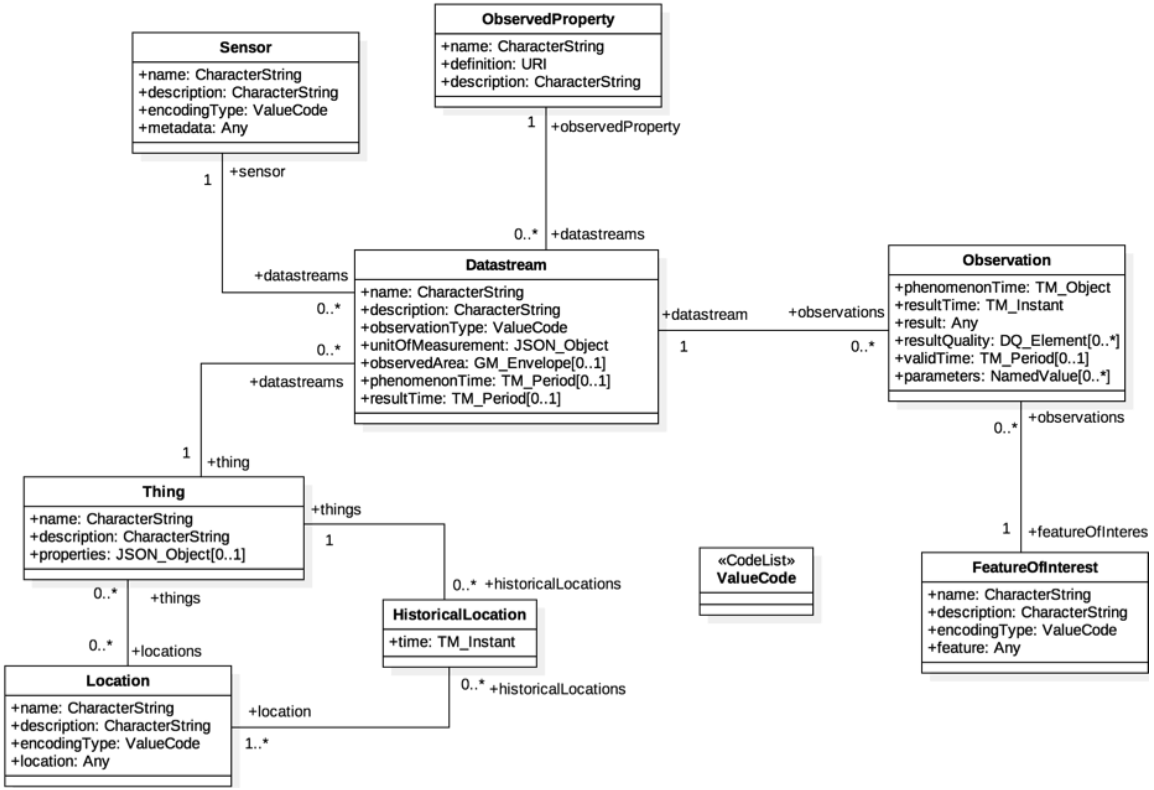
smle - SensorML editor



Data Access: SensorThings API

- Complementary specification to enhance the OGC SWE framework for Internet of Things applications
- Simplified approach
- Based on REST and JSON
- REST binding for SOS functionalities
- JSON binding for the O&M model
- Two parts
  - Data access (available as adopted standard)
  - Sensor tasking (in the final steps of the standardization process)

Data Access: SensorThings API

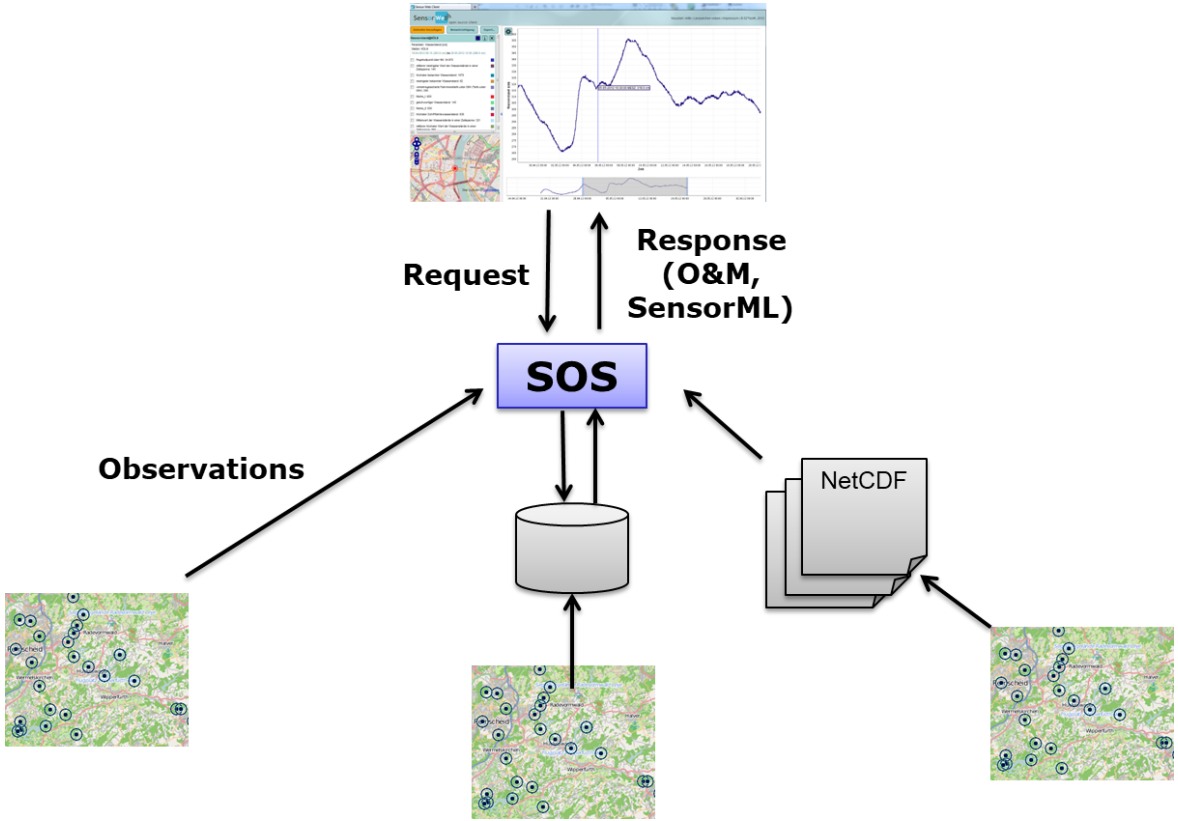


Source: OGC

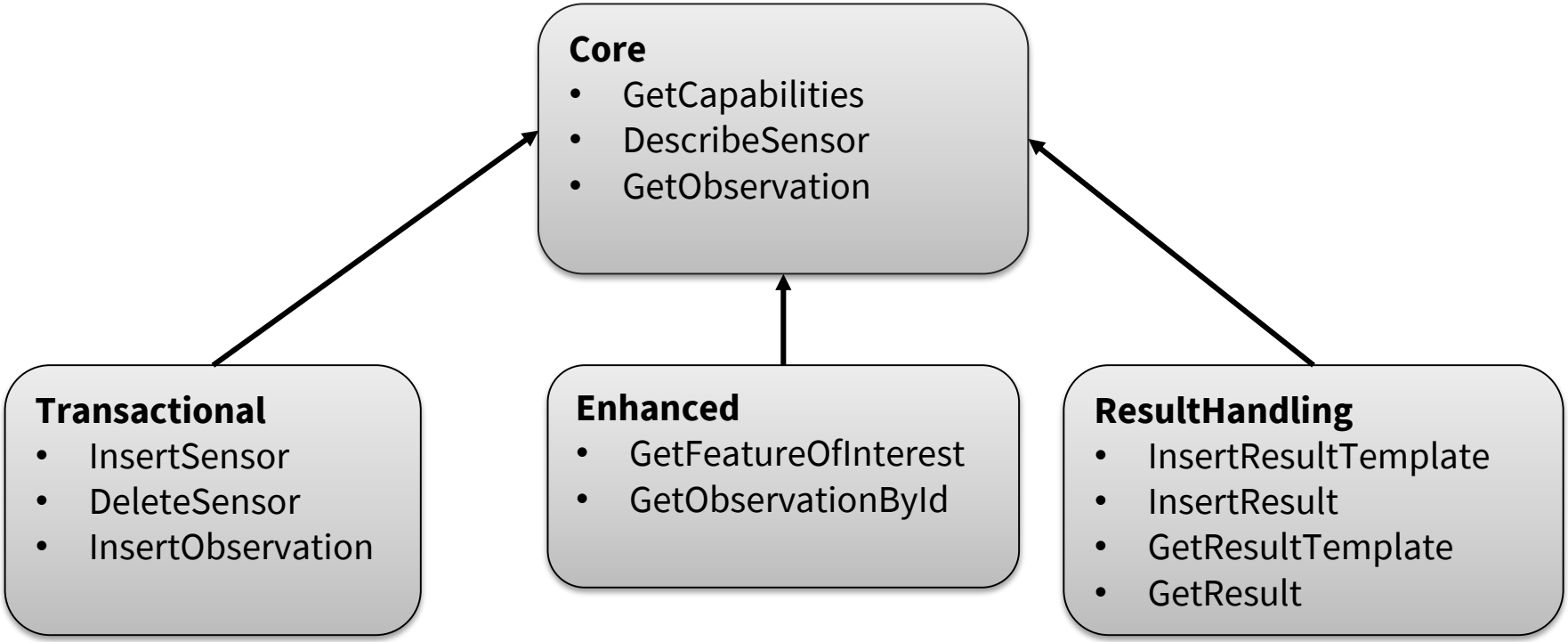
Data Access: OGC Sensor Observation Service

- Interface standard for accessing observation data and metadata
- Pull-based communication
- Core operations
  - GetCapabilities
  - DescribeSensor
  - GetObservation
- Additional functionality
  - Transactional operations
  - Result handling
  - Spatial filtering
- Relies on
  - ISO/OGC Observations and Measurements (O&M) for encoding measurement data
  - OGC Sensor Model Language (SensorML) for encoding metadata
- Current version: OGC SOS 2.0

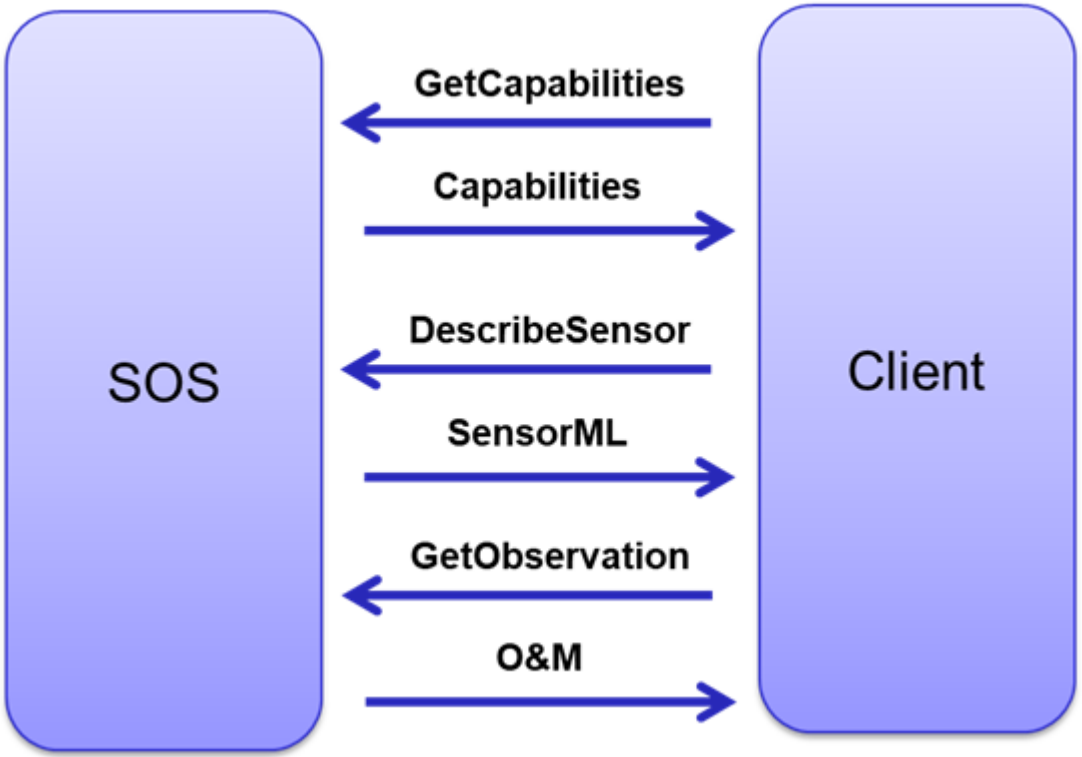
Data Access: OGC Sensor Observation Service



Data Access: OGC Sensor Observation Service



Data Access: OGC Sensor Observation Service



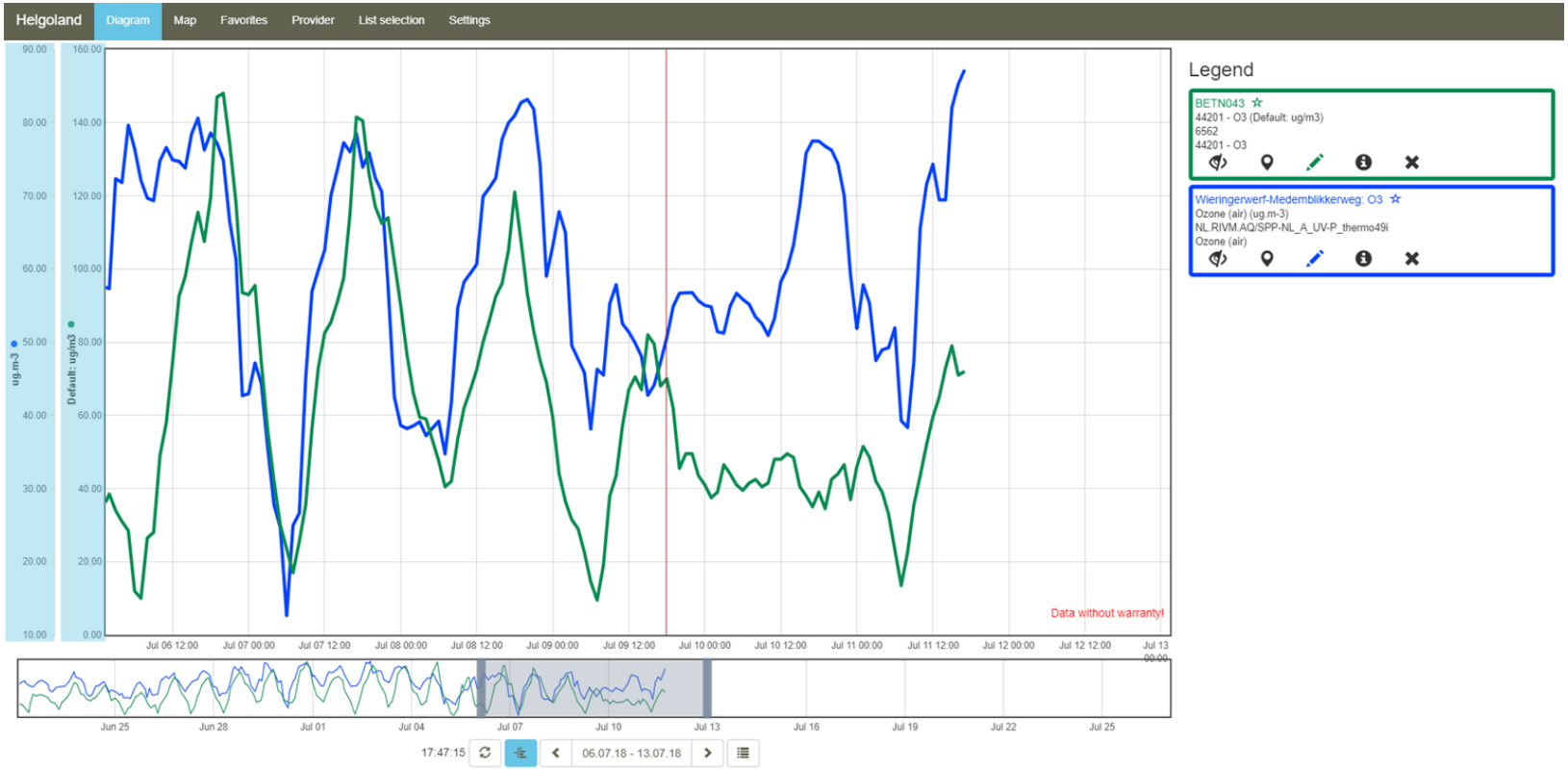
The 52°North Implementation: SOS Server

- Full implementation of the OGC Sensor Observation Service 2.0 standard
- Additional functionality
  - Extensions for different thematic domains (e.g. air quality (e-Reporting), hydrology (WaterML 2.0 and SOS 2.0 Hydrology Profile)
  - Support of different observation types (e.g. time series, trajectories, profiles)
  - Result filtering
  - Hierarchical management of procedures, offerings, etc.
  - Comprehensive graphical user interface for managing the SOS server
  - Complementary REST API for facilitating client development
  - OGC SensorThings API module currently in development

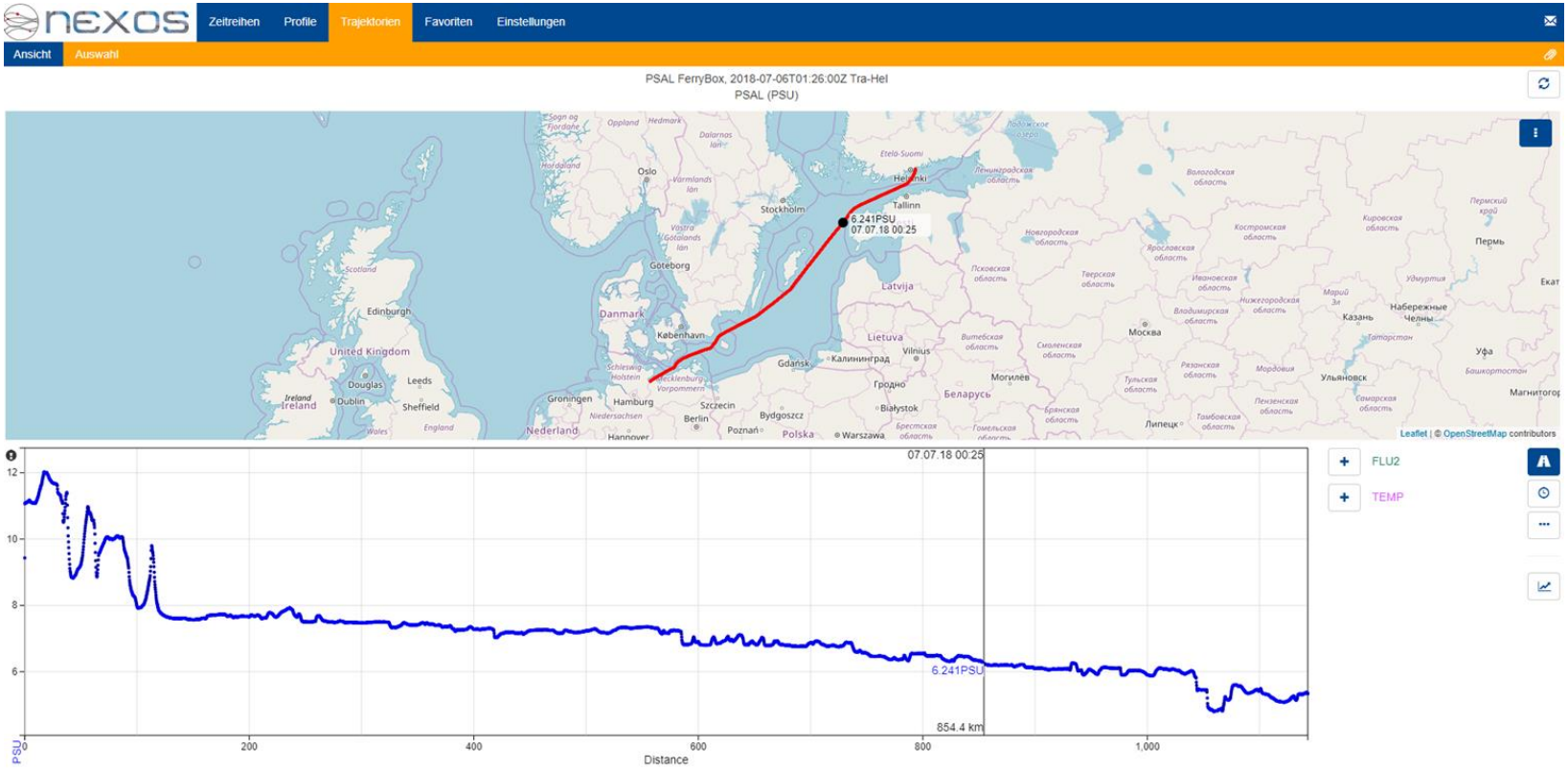
The 52°North Implementation: SOS Server

- Flexible Integration into existing IT infrastructures
- Can be connected to different database management systems
  - Oracle
  - PostgreSQL
  - MySQL
  - Microsoft SQL Server
- Object-relational mappings may be used for configuring the SOS to a specific database model (Hibernate)
- Different approaches for database integration are supported and used in operational environments
- Open source
- Demonstration available as part of the OSGeo Live project: https://live.osgeo.org/de/index.html

The 52°North Helgoland Sensor Web Viewer



The 52°North Helgoland Sensor Web Viewer



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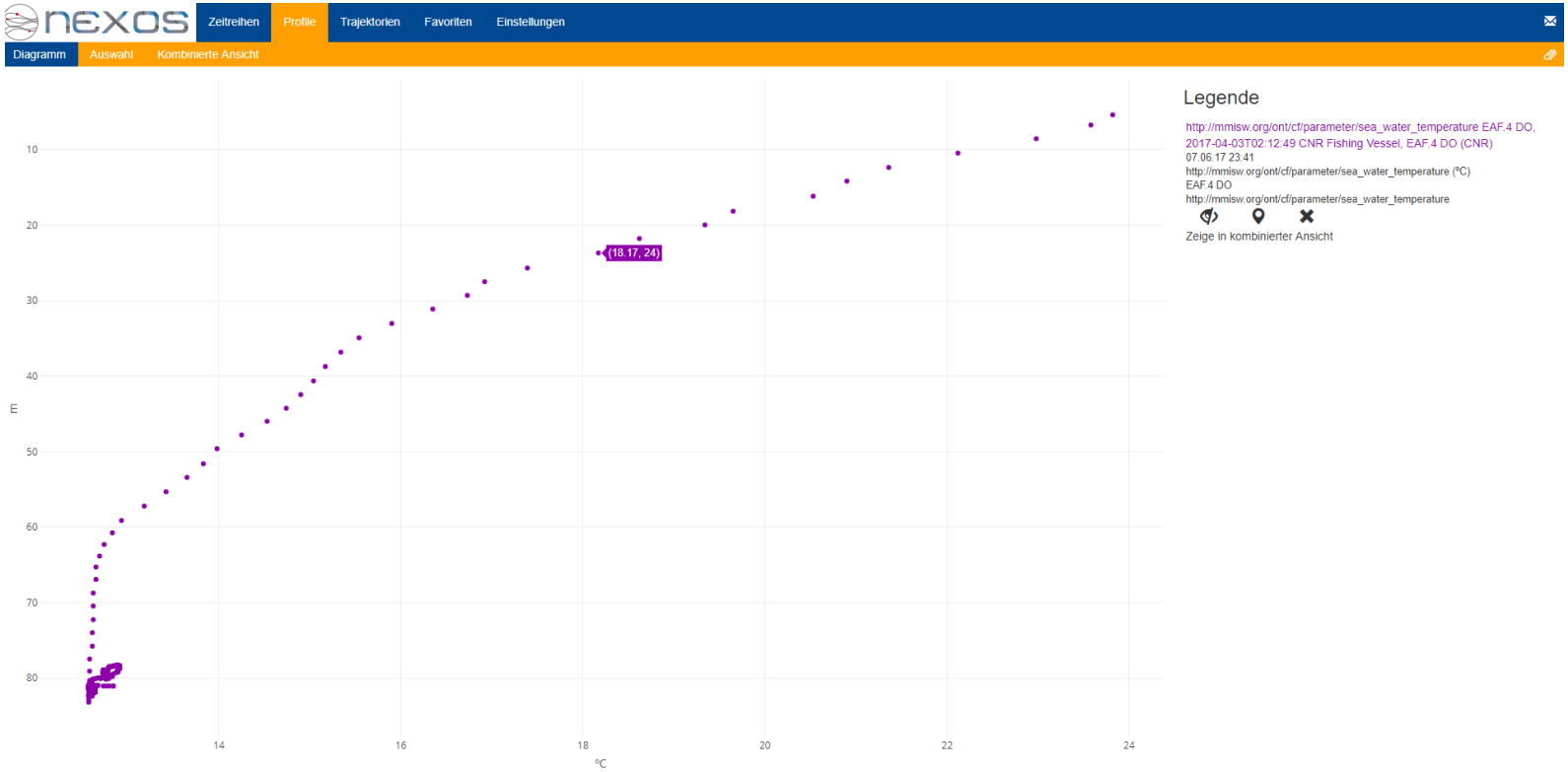
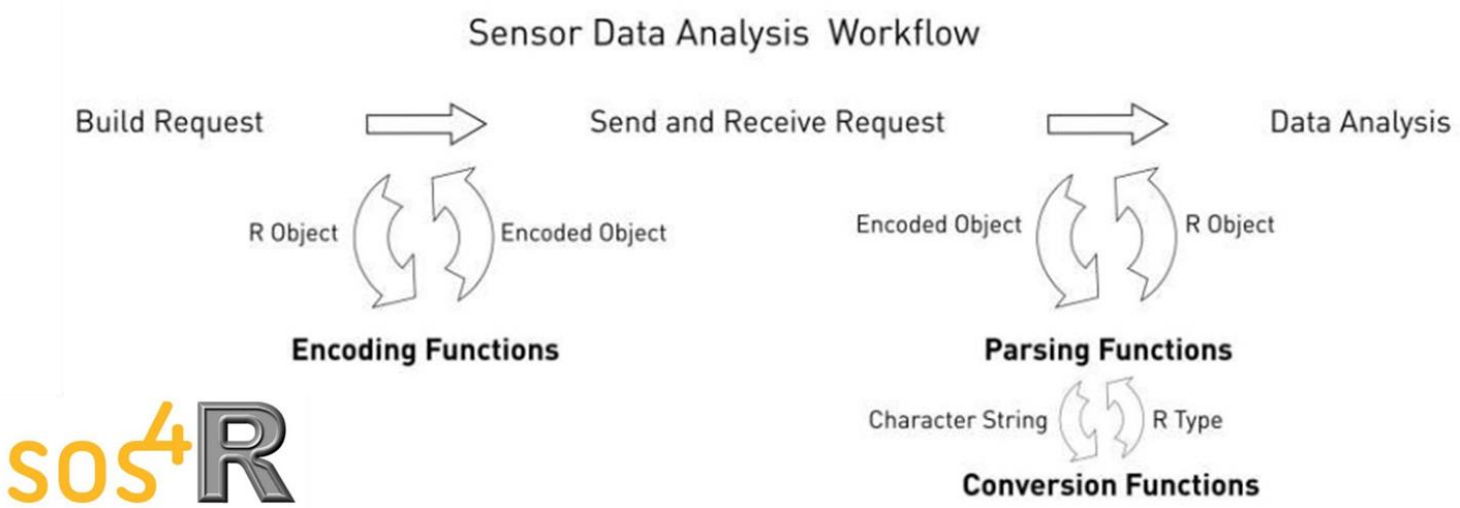


sos4R

- Use R for analysing different types of (in-situ) observation data
- sos4R offers an adaptor to integrate data from SOS servers



OGC Sensor Web Enablement and INSPIRE Download Services

- Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE (D2.9)
- Technical Guidance for implementing download services using the OGC Sensor Observation Service and ISO 19143 Filter Encoding
- Officially endorsed as INSPIRE Technical Guidance documents:
  - Guidelines for O&M (D2.9): http://inspire.ec.europa.eu/id/document/tg/d2.9-o&m-swe
  - Technical Guidance SOS as a download service: http://inspire.ec.europa.eu/id/document/tg/download-sos

OGC Sensor Web Enablement and INSPIRE Download Services

- How to map the INSPIRE Download Service functionality to the SOS standard?

Pre-defined Dataset Download:

Get Download Service Metadata	→ SOS::GetCapabilities
Get Spatial Data Set	→ SOS::GetObservation (for Offering)
Describe Spatial Dataset	→ SOS::GetCapabilities
Link Download Service	→ CSW

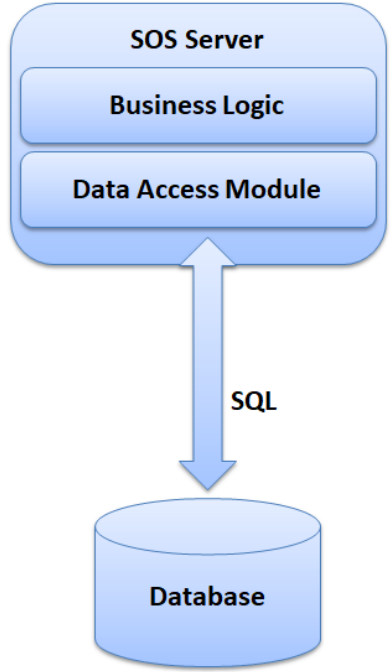
Direct Access Download:

Get Spatial Object	→ SOS::GetObservation
Describe Spatial Object Type	→ SOS::GetCapabilities

- Additional aspects:
  - INSPIRE metadata (e.g. title, metadata point of contact, spatial data service type)
  - Metadata and request parameter for supporting multiple CRS
  - Metadata and request parameter for supporting multiple languages

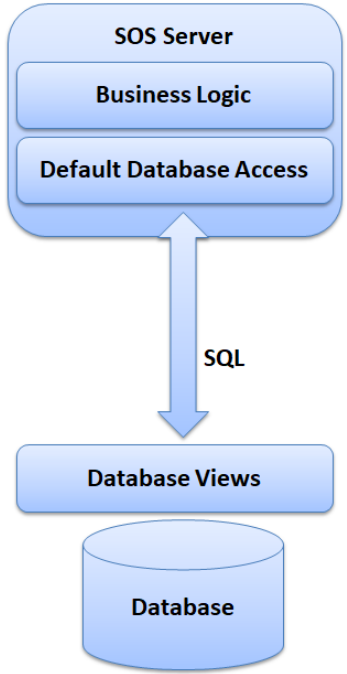
Deployment Strategies

Custom database access implementation



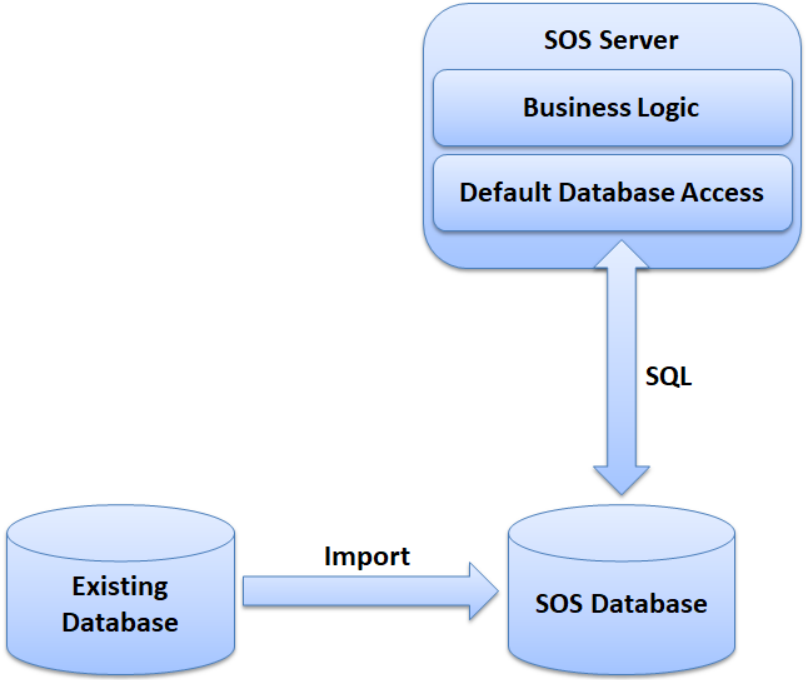
Deployment Strategies

Database views to emulate the default SOS data model



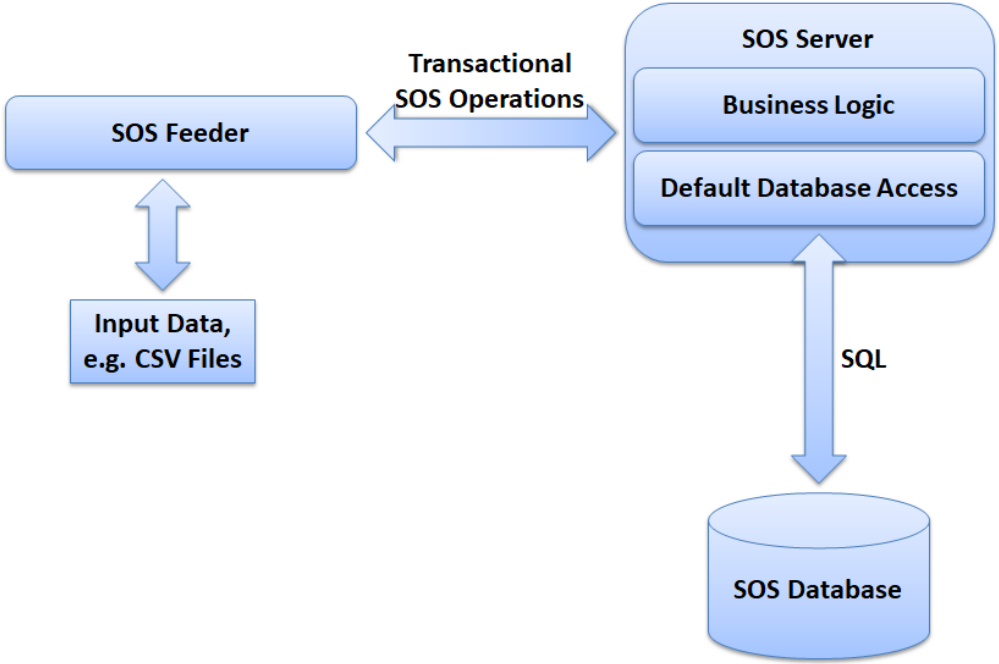
Deployment Strategies

Dedicated SOS database replicating a source database



Deployment Strategies

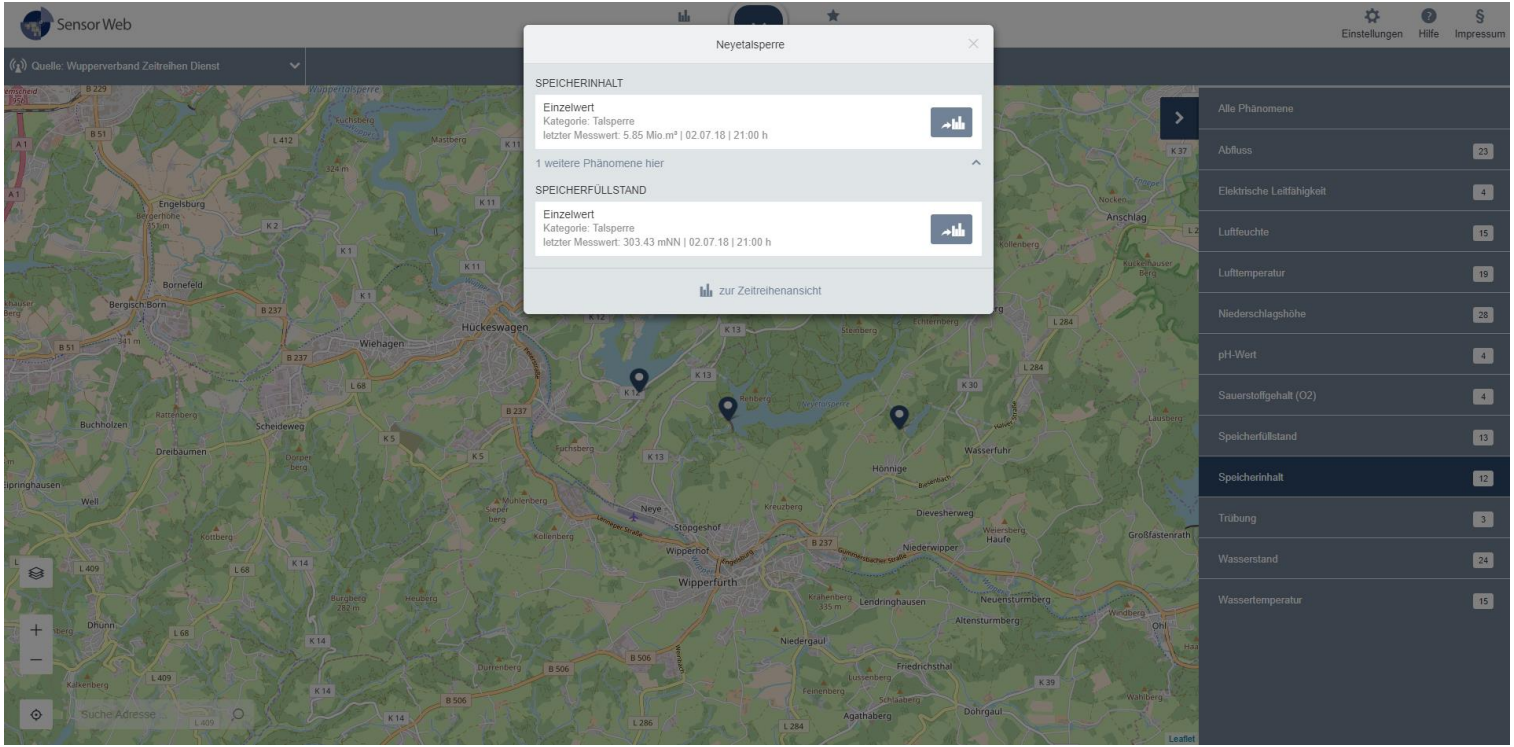
Default database with transactional feeding



Deployment Strategies

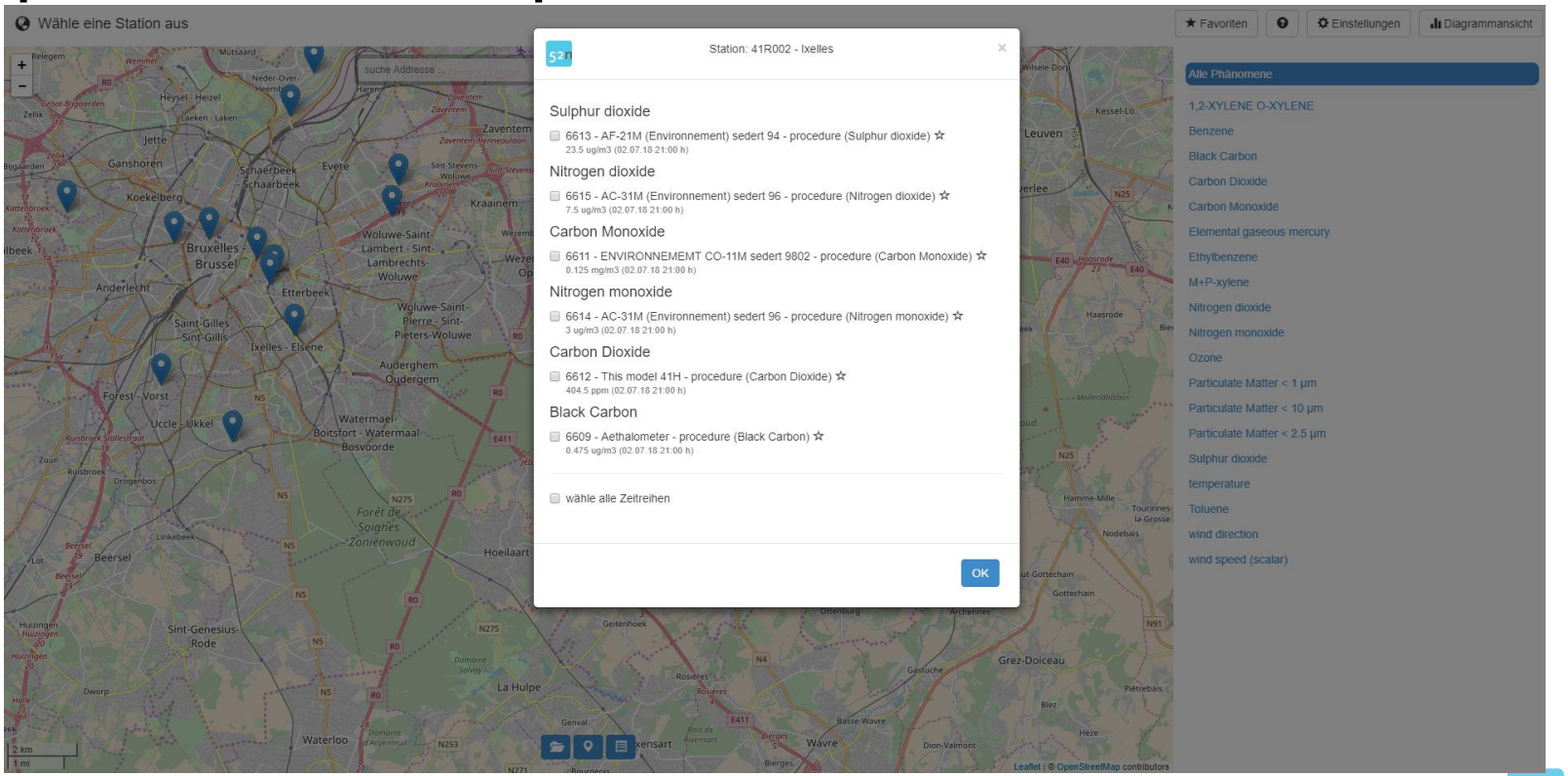
- Selecting the right strategy depends on multiple factors
  - Is there already an existing database?
  - Complexity of an existing database
  - Performance requirements
  - Working on the database vs. programming

Application Examples: Wupperverband



Application Examples: Wupperverband

Application Examples: IRCEL-CELINE



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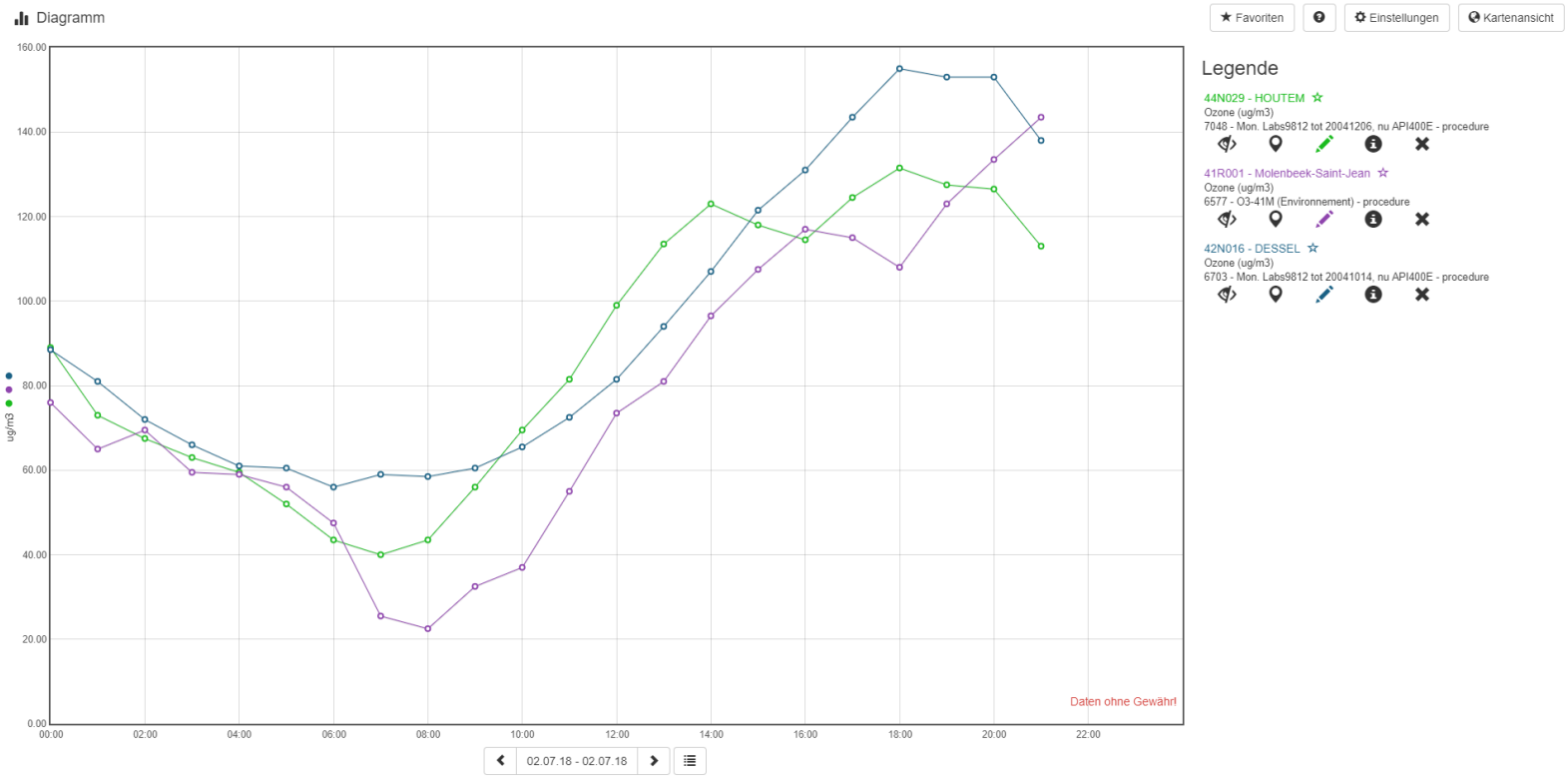

Summary

- OGC Sensor Web Enablement allows the interoperable integration of observation data
- Standards for data access
  - OGC Sensor Observation Service
  - OGC SensorThings API
- Standards for data and metadata
  - ISO/OGC Observation and Measurements
  - OGC Sensor Model Language
- Sensor Web standards can be used for providing INSPIRE Download Services
- Several implementations and operational deployments

Questions and Discussion

https://52north.github.io/sensor-web-tutorial/

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