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Geospatial Sensor Webs Conference 2018



Introduction into Sensor Web Technologies

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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
 - 0 ...
- Different structures and elements of observations
- Sensor interfaces are very heterogeneous
- Need for harmonisation \rightarrow interoperability



OGC Sensor Web Enablement



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OGC Sensor Web Enablement



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OGC Sensor Web Enablement





- 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)





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```
"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
```

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- General sensor information \rightarrow 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



- 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
 - \circ Geo-locations
 - References to further documentation
 - History (e.g. events in the lifetime of a sensor)
 - 0 ...



<sml:SensorML xmlns:sml="http://www.opengis.net/sensorML/1.0.1" xmlns:gml="http://www.opengis.net/gml" xr instance" version="1.0.1" xsi:schemaLocation=" http://www.opengis.net/sensorML/1.0.1 http://schemas.open <sml:member>

▼<sml:System>

▼<gml:description>

Wassertemperatur an der Station STÖR-SPERRWERK BP (5970040) bei Kilometer 50 des Gewaessers STÖR </gml:description>

- \$\sml:keywords>...</sml:keywords>
- ▶ <sml:identification>...</sml:identification>
- ><sml:classification>...</sml:classification>
- ▶<sml:validTime>...</sml:validTime>
- ▶<sml:characteristics>...</sml:characteristics>
- ▶ <sml:capabilities>...</sml:capabilities>
- ▶ <sml:contact>...</sml:contact>
- \sml:position name="stationPosition">
 - ▼<swe:Position fixed="true" referenceFrame="urn:ogc:def:crs:EPSG::31466">
 - ▼<swe:location>
 - ▼<swe:Vector gml:id="SYSTEM_LOCATION">
 - ▼<swe:coordinate name="easting">
 - ▼<swe:Quantity axisID="y">
 - <swe:uom code="degree"/>
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 - </swe:Quantity>
 - </swe:coordinate>
 </swe:coordinate name="northing">
 - v<swe:coordinate name="northing">
 v<swe:Ouantity axisID="x">

 - <swe:value>5971455.607148565</swe:value>
 - </swe:Quantity>
 - </swe:coordinate>
 - </swe:Vector>
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 - </sml:position>
- > <sml:inputs>...</sml:inputs>
- ▼<sml:outputs>
- ▼<sml:OutputList>
- ▼<sml:output name="Wassertemperatur"> ▼<swe:Quantity definition="Wassertemperatur"> <swe:uom code="°C"/>
 - </swe:Quantity>
- </sml:output>
- </sml:OutputList>
- </sml:outputs> </sml:System>
- </sml:System> </sml:member>
- </sml:SensorML>





- <sml:SensorML xmlns:sml="http://www.opengis.net/sensorML/1.0.1" xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http instance" version="1.0.1" xsi:schemaLocation=" http://www.opengis.net/sensorML/1.0.1 http://schemas.opengis.net/sensor <sml:member> <sml:System> <sml:description>
 - Wassertemperatur an der Station STÖR-SPERRWERK BP (5970040) bei Kilometer 50 des Gewaessers STÖR
 - </gml:description>
 - ▼<sml:keywords>
 - ▼<sml:KeywordList>
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 - <sml:keyword>Wassertemperatur</sml:keyword>
 - </sml:KeywordList>
 - </sml:keywords>
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 - ▼<sml:IdentifierList>
 - ▼<sml:identifier name="URN">
 - w<sml:Term definition="urn:ogc:def:identifier:OGC:1.0:uniqueID">
 - <sml:value>Wassertemperatur-Stoer-Sperrwerk_Bp_5970040</sml:value>
 - </sml:Term>
 - </sml:identifier>
 - ▼<sml:identifier name="longName">
 - w<sml:Term definition="urn:ogc:def:identifier:OGC:1.0:longName">
 - ▼<sml:value>
 - Wassertemperatur an der Station STÖR-SPERRWERK BP (5970040) bei Kilometer 50 des Gewaessers STÖR </sml:value>
 - </sml:Term>
 - </sml:identifier>
 - ▼<sml:identifier name="shortName">
 - v<sml:Term definition="urn:ogc:def:identifier:OGC:1.0:shortName">
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 - </sml:Term>
 - </sml:identifier>
 - </sml:IdentifierList>
 - </sml:identification>
 - \$\landstation\$\landstation\$\landstation\$
 - ▶ <sml:validTime>...</sml:validTime>
 - ▶<sml:characteristics>...</sml:characteristics>
 - ▶ <sml:capabilities>...</sml:capabilities>
 - ▶ <sml:contact>...</sml:contact>
 - \sml:position name="stationPosition">
 - > = / cup. Docition fixed="true" nofononcoEnomo="unrioge: dof: cre: EDCC: 21/66">



smle - SensorML editor

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smle - SensorML editor

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	Temperature coefficient	×R	emove	
	Time constant	×R	emove	
	Tilt output	×R	emove	
	Depth rating	×R	emove	
	Power	×R	emove	
	Operating temperature	×R	emove	
	Size	×R	emove	
	Weight in air	×R	emove	
	Material	×R	emove	
		Publish Description		



smle - SensorML editor



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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)



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Data Access: SensorThings API



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- 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

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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: <u>https://live.osgeo.org/de/index.html</u>



The 52°North Helgoland Sensor Web Viewer





The 52°North Helgoland Sensor Web Viewer



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The 52°North Helgoland Sensor Web Viewer





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: <u>http://inspire.ec.europa.eu/id/document/tg/download-sos</u>



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	\rightarrow CSW
Direct Access Download:	
Get Spatial Object	\rightarrow SOS::GetObservation

→ 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

Describe Spatial Object Type

• Metadata and request parameter for supporting multiple languages



Custom database access implementation



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Database views to emulate the default SOS data model





Dedicated SOS database replicating a source database



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Default database with transactional feeding





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- 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



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Application Examples: IRCEL-CELINE

Wähle eine Station aus 0 CEinstellungen * Favoriten Station: 41R002 - Ixelles Sulphur dioxide 6613 - AF-21M (Environnement) sedert 94 - procedure (Sulphur dioxide) \$\prime\$ 23.5 ug/m3 (02.07.18 21:00 h) Nitrogen dioxide 6615 - AC-31M (Environnement) sedert 96 - procedure (Nitrogen dioxide) \$\procedure\$ 7.5 ug/m3 (02.07.18 21:00 h) Carbon Monoxide 6611 - ENVIRONNEMEMT CO-11M sedert 9802 - procedure (Carbon Monoxide) * 0.125 mg/m3 (02.07.18 21:00 h) Nitrogen monoxide 6614 - AC-31M (Environnement) sedert 96 - procedure (Nitrogen monoxide) 1/2 3 ug/m3 (02.07.18 21:00 h) Carbon Dioxide 6612 - This model 41H - procedure (Carbon Dioxide) \$\$ 404.5 ppm (02.07.18 21:00 h) Black Carbon 6609 - Aethalometer - procedure (Black Carbon) 🛠 0.475 ug/m3 (02.07.18 21:00 h) wähle alle Zeitreihen

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Application Examples: IRCEL-CELINE

Diagramm

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02:00



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06:00

08:00

10:00

12:00

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14:00

16:00

18:00

20:00

22:00

04:00



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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