



Observational and Measurement data in INSPIRE

Status and Outlook



Overview

Section 1 : Legislative aspects and guidance documents

Observational data and the EU

Section 2 : it works !


Seriously :)

Section 3 : Alternative encodings and RESTful provision options

Future options

Section 4 : Next steps and discussion

Please speak now!



Section 1 : Legislative aspects and guidance documents

Observational data and the EU



The European Data Economy

- Part of the Digital Single Market (DSM) strategy
- Extension of the success of the Single Market in the digital realm
- The value of the EU data economy
 - estimated at EUR 300 billion in 2016, or 1.99% of EU GDP
 - will increase to EUR 739 billion by 2020, representing 4.00% (Source: European Data Market Study SMART 2013/0063)
 - EU countries defense budget – 1.4% of EU GDP. Source: European Defense Agency

Observations and the EU policy agenda

- "Building a European Data Economy"
 - COM(2017) 9 final & SWD(2017) 2 final
 - The role of INSPIRE is acknowledged
 - Goes beyond the public sector and considers
 - Raw machine-generated (IoT) content
 - Private data
 - Industrial data platforms
 - Citizens

Machine generated data are 'spatial data' as sensors usually also transmit their direct or indirect position (location) together with their measurement. (page 16)

- INSPIRE is recognised as a best practice

Observations and the EU policy agenda

High level objectives (to be addressed on EU level):

- The **free flow of data** to be adopted as a guiding principle

Challenges:

- **Data protection** to be retained for personal data
 - General Data Protection Regulation (Into force as of May 2018)
- **Avoid unnecessary localisation** of storage and processing
- Address issues related to possible **liability** (failure of sensors, software defects, others)
- Ensure **portability, interoperability and standards**

INSPIRE Guidance Documents on O&M and SOS

- 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
- Now 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>

INSPIRE Guidance Documents on O&M and SOS

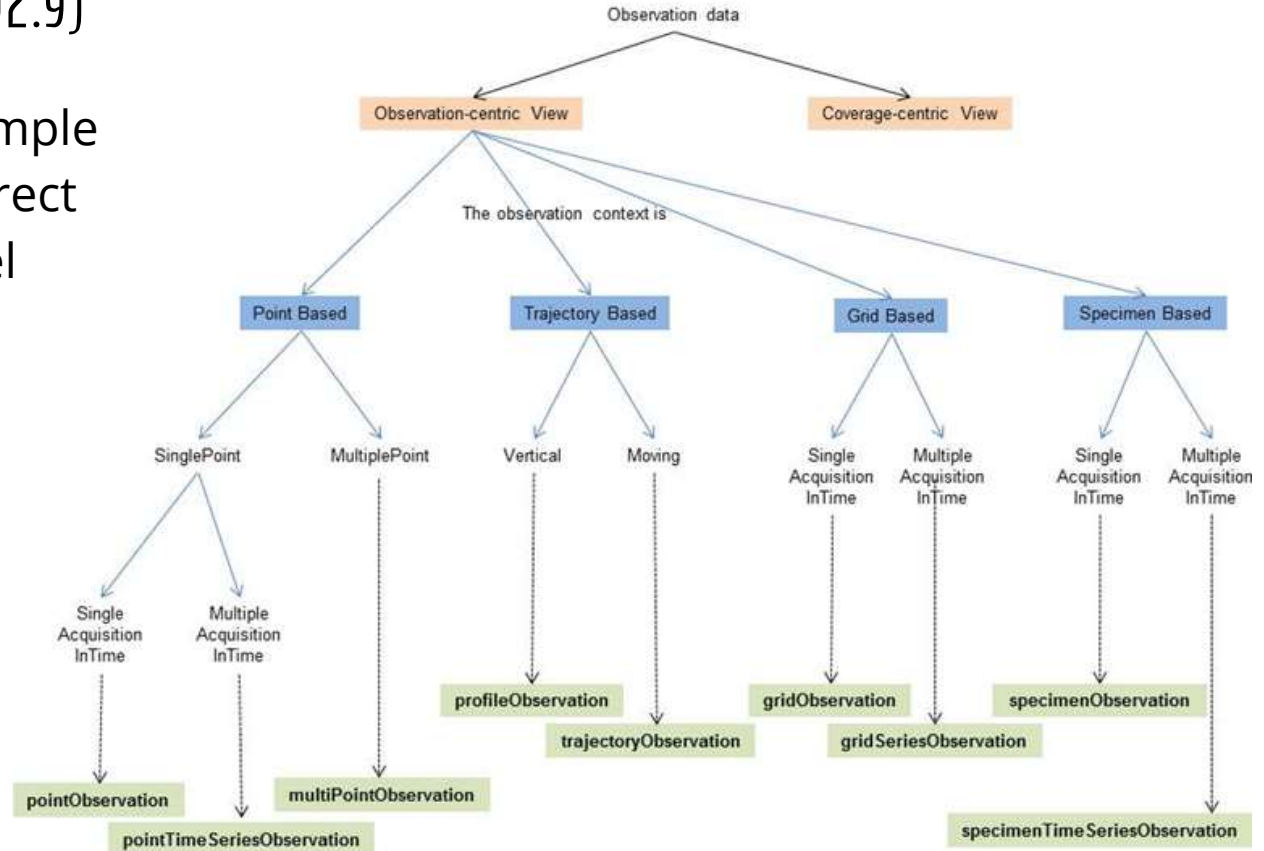
Guidelines for O&M (D2.9)

- O&M Design patterns
- Specialised INSPIRE observation types
- O&M INSPIRE profile
- Service Layer

INSPIRE Guidance Documents on O&M and SOS

Guidelines for O&M (D2.9)

Decision Tree for simple identification of correct observational model



INSPIRE Guidance Documents on O&M and SOS

Guidelines for O&M (D2.9)

- Core Observation profile
 - FeatureOfInterest:
 - SF_SamplingFeature
 - Provision of sampledFeature: either domain feature or Nasa SWEET ontology entry
 - Procedure
 - Sensor type not instance (as defined in SOS 2.0 Hydrology profile)
 - Dedicated Process specialisation in Inspire (xsd)
 - Link to monitoringFacility or monitoringNetwork generating the observation:
 - Pattern defined using om:parameter; value pointing to URI of the facility/network

INSPIRE Guidance Documents on O&M and SOS

Guidelines for O&M (D2.9)

- Service Layer
 - Link to INSPIRE SOS technical guidance document
 - GetDataAvailability as additional operation for determining the data sets offered by an SOS server
 - Hierarchical offerings

INSPIRE Guidance Documents on O&M and SOS

Technical Guidance SOS as a download service

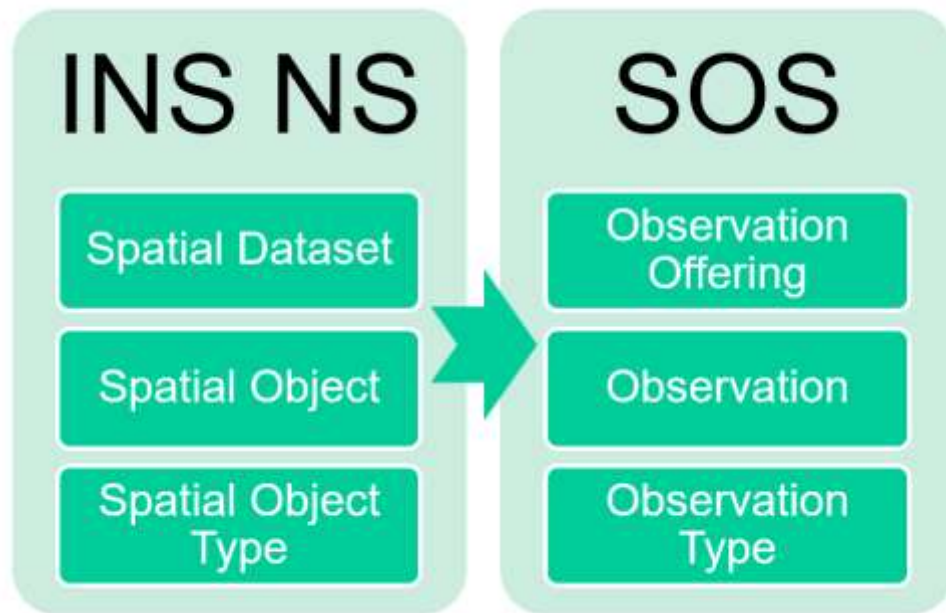
- Defines

- Extended capabilities for metadata
- Mapping INSPIRE terminology to SOS operations
- DescribeSensor operation
 - Behaviour linked back to D2.9 recommendations
- Observation identifier handling
 - getObservationById should reuse gml:identifier. Inspire 'identifier' is a dedicated type that is not gml:identifier...

INSPIRE Guidance Documents on O&M and SOS

Technical Guidance SOS as a download service

- Mapping INSPIRE terminology to the SOS standard



INSPIRE Guidance Documents on O&M and SOS

Technical Guidance SOS as a download service

- Mapping INSPIRE requirements to SOS operations

- Pre-defined Access Download:

- Get Download Service Metadata → SOS::GetCapabilities

- Get Spatial Data Set → SOS::GetObservation

- Describe Spatial Dataset → SOS::GetCapabilities

- Link Download Service → CSW

- Direct Access Download:

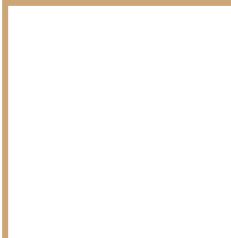
- Get Spatial Object → SOS::GetObservation

- Describe Spatial Object Type → SOS::GetCapabilities

INSPIRE Guidance Documents on O&M and SOS

Technical Guidance SOS as a download service

- SOS Extensions
 - INSPIRE Metadata
 - CRS
 - Metadata about supported CRS
 - Request parameters
 - Multilinguality
 - Metadata about supported languages
 - Request different CRS



Section 2 : it works!

Seriously :)



Integration Observations & Spatial Features

- Integration with WFS and WPS
- Data relationships and information flows
- Implementing these URI based interlinkages
- Examples illustrating entire chain provision, processing, visualization
- Available software solutions

Flash Presentations

National Network

- French Ground Information Network - GIN

Clients

- Postprocessing of observation data with R and shiny
- Jupyter Notebook
- QGIS GML Application Schema
- iNaturalist2SOS adapter

Sensor Metadata

- GET-IT - EDI metadata editor
- NeXOS and FixO3: smle

Flash Presentations

National Network

- **French Ground Information Network - GIN**

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Example 1 : French Ground Information Network

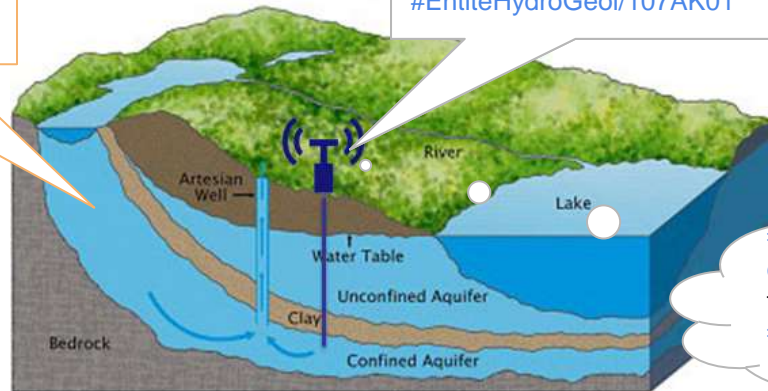
- Objectives

- To provide stable and resolvable links to resources
- To allow reference / data citation

I am
[#EntiteHydroGeol/107AK01](#)
monitored by
[#Piezometre/00634X0147/PZ1.2](#)

underlying technologie:

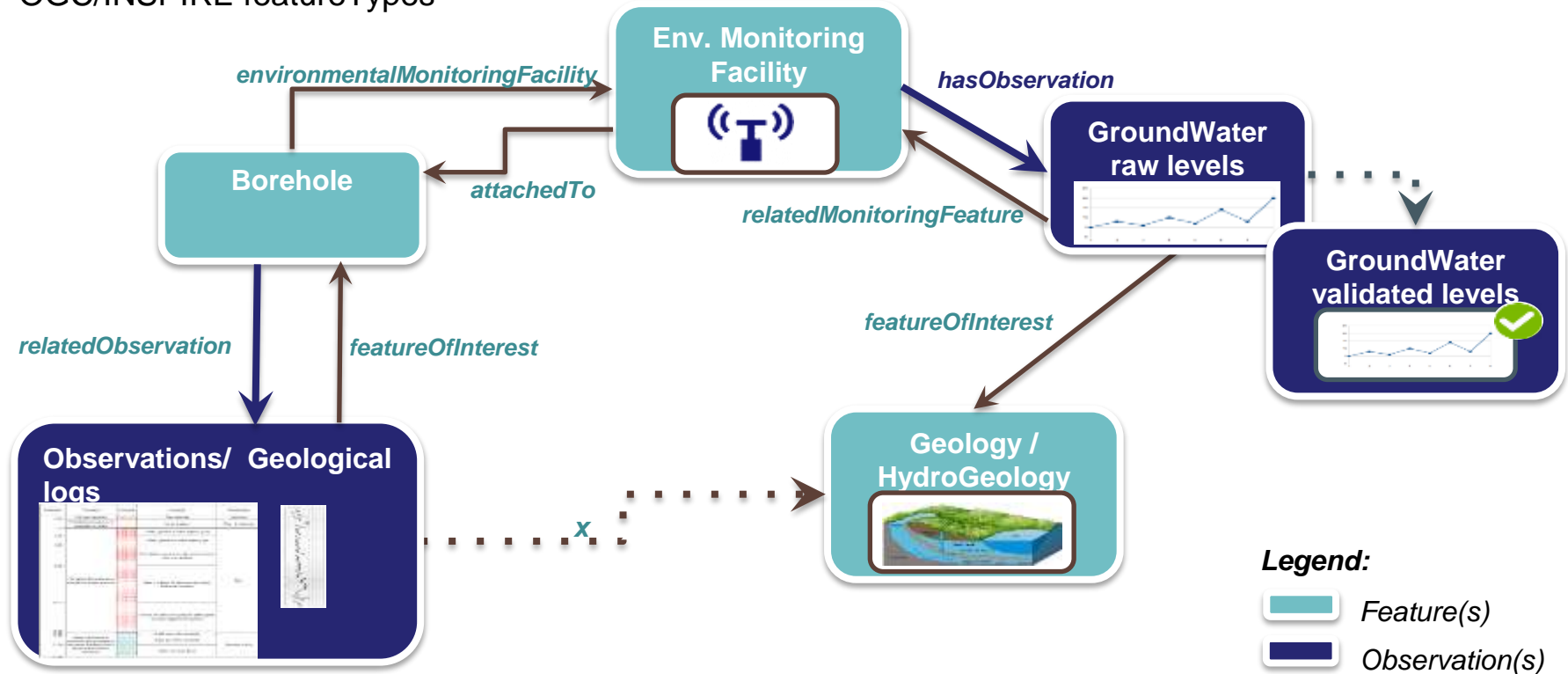
I have [#GroundWater Levels observations](#)
regarding
[#EntiteHydroGeol/107AK01](#)



[#GroundWater Levels observations](#)
from
[#Piezometre/00634X0147/PZ1.2](#)

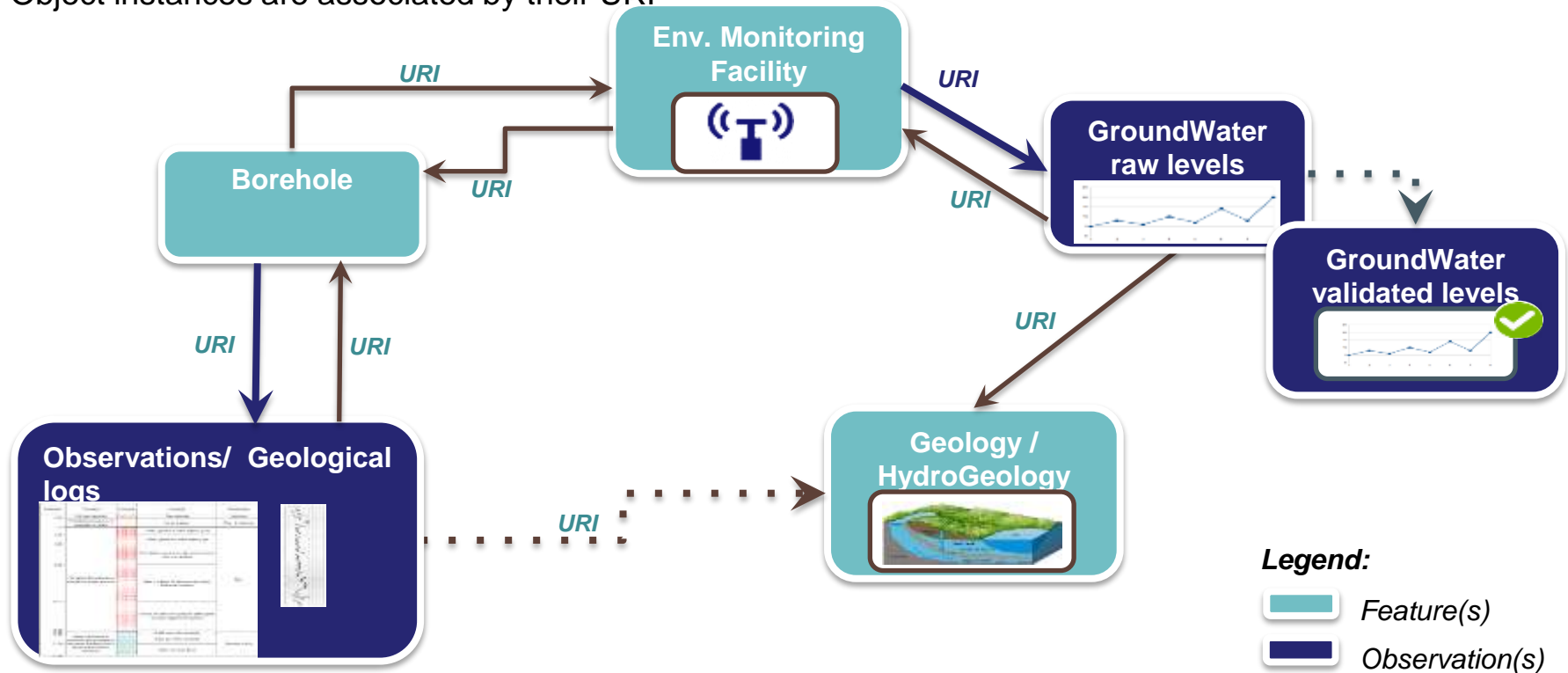
Example 1 : French GIN – linked data use case

OGC/INSPIRE featureTypes



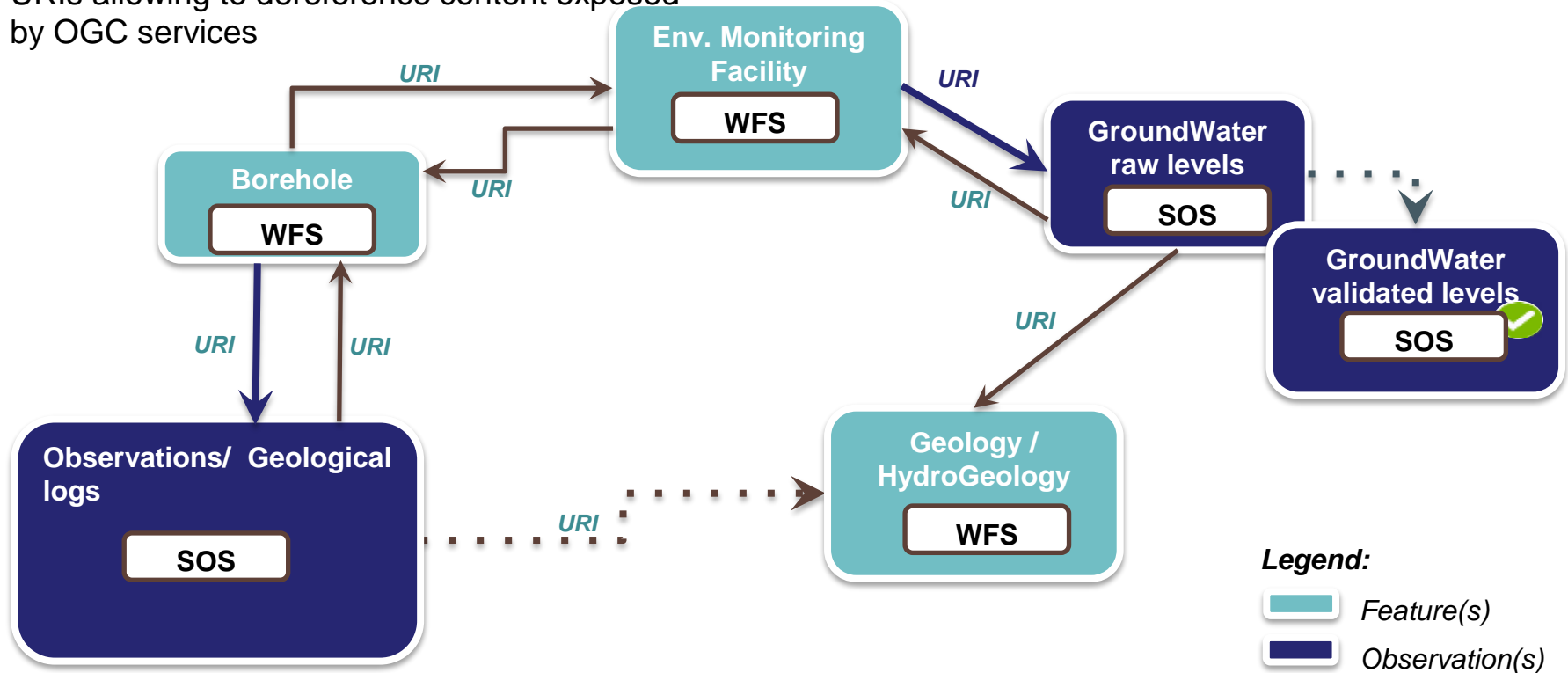
Example 1 : French GIN – linked data use case

Object instances are associated by their URI



Example 1 : French GIN – linked data use case

URIs allowing to dereference content exposed by OGC services



Flash Presentations

National Network

- French Ground Information Network - GIN

Clients

- **Postprocessing of observation data with R and shiny**
- **Jupyter Notebook**
- **QGIS GML Application Schema**
- **iNaturalist2SOS adapter**

Sensor Metadata

- GET-IT - EDI metadata editor
- NeXOS and FixO3: smle



About AirSensEUR

JRC & partners are working on the AirSensEUR project since end 2014

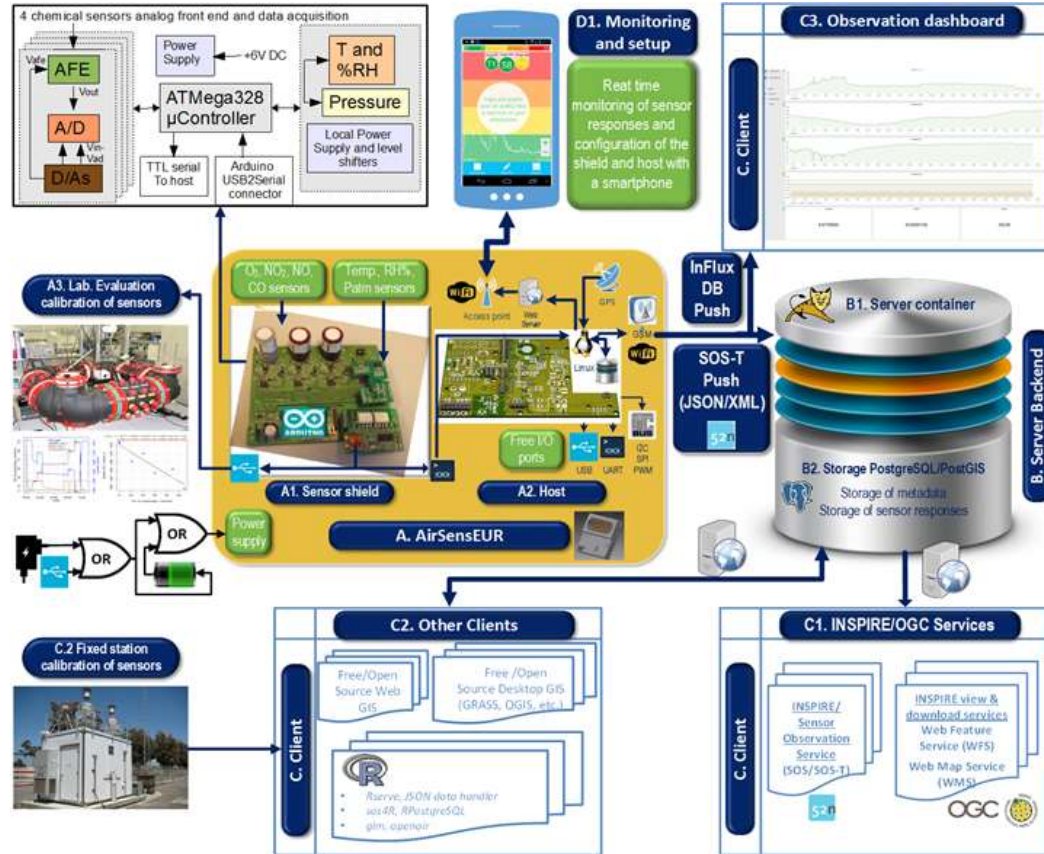
- **Objective:** “Create open and interoperable sensor nodes which provide observation data”, and meet the requirements of

- A) European Air Quality Directive

- B) European INSPIRE Directive (SOS as download service)

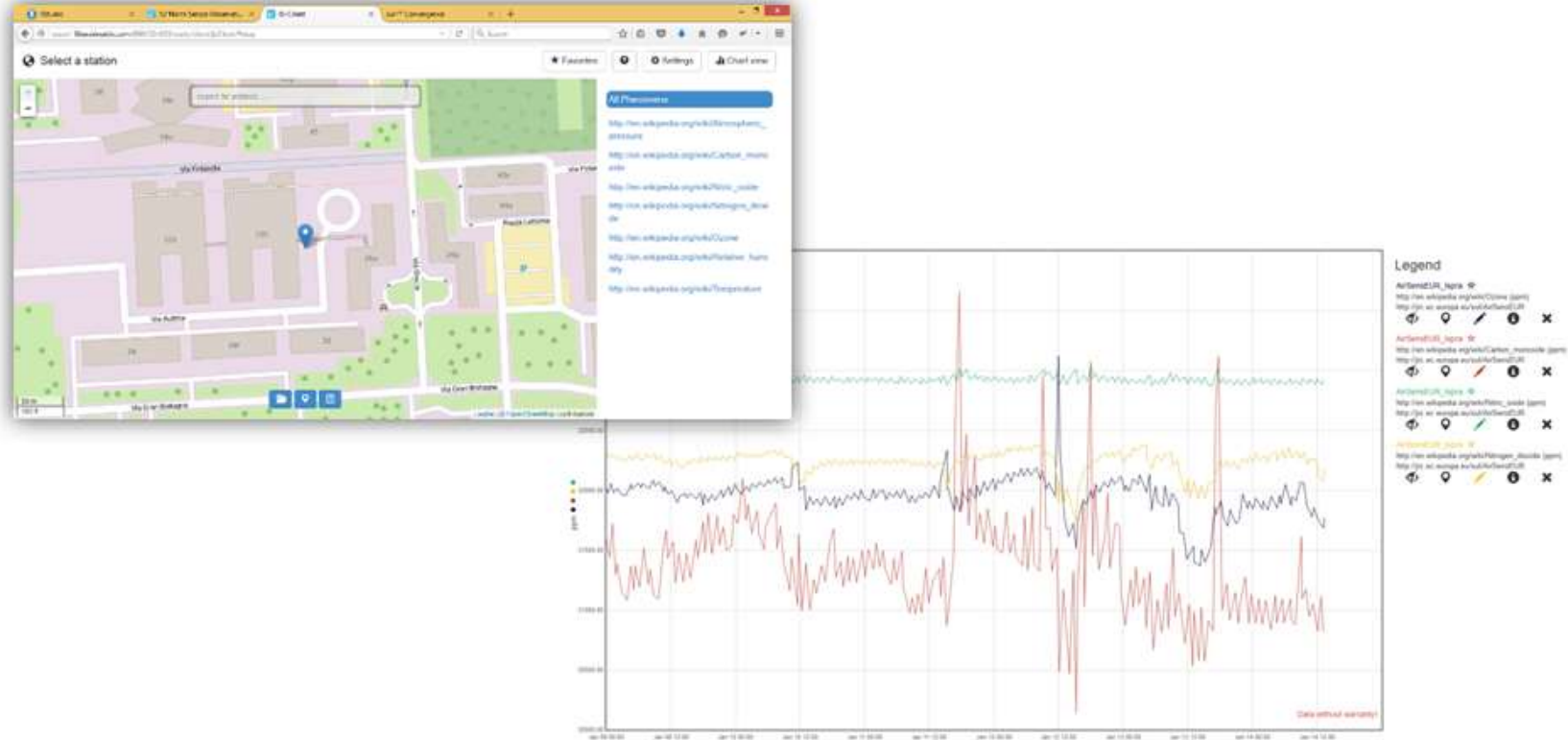
- **Specifications, data quality and calibration:** JRC Air and Climate Unit (ERLAP, Michel Gerboles, Laurent Spinelle)
- **Data management:** JRC Digital Economy Unit (Alex Kotsev, Sven Schade, Max Craglia)
- **Platform design and software:** Liberaintentio srl (Marco Signorini)
- **Growing community of sensor testers:** RIVM-NL, NILU-NO, AIRPARIF-FR ...

About AirSensEUR



www.airsenseur.org

SOS/REST API implementation (52N)



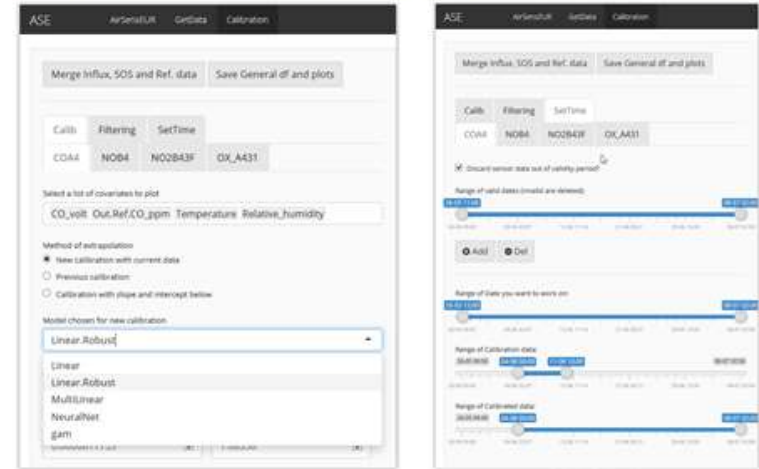
Simplified data treatment with R and Shiny

Simplify data treatment with R and shiny

- Develop R scripts for data transfer and data treatment
- Develop a Web shiny application for configuration of the scripts



Calibration – Selection of method and dates

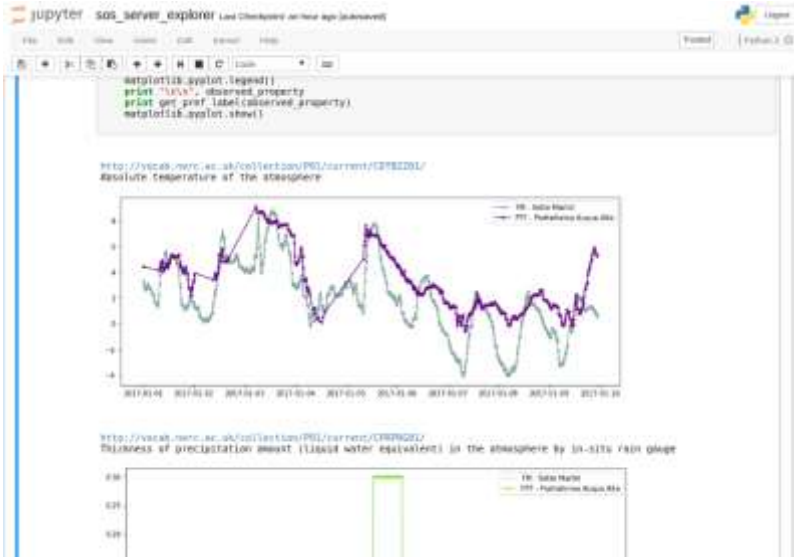


29



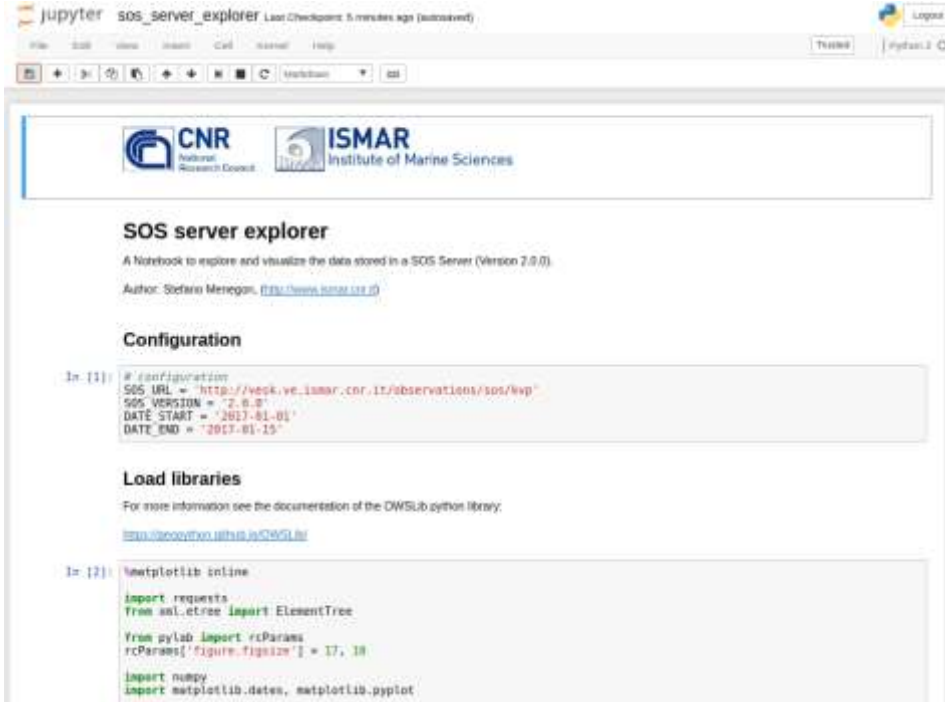
Author: Michel Gerboles, ERLAP, JRC

Jupyter Notebook



- Interactive computational environment, in which you can combine code execution, rich text, mathematics, plots and rich media
- It evolved to support interactive data science and scientific computing

Jupyter Notebook - SOS Server Explorer



The screenshot shows a Jupyter Notebook titled 'sos_server_explorer' with a toolbar and a 'Logout' button. The notebook content includes the CNR and ISMAR logos, a title 'SOS server explorer', a description 'A Notebook to explore and visualize the data stored in a SOS Server (Version 2.0.0)', and the author 'Stefano Menegon'. It features two code cells: 'Configuration' and 'Load libraries'. The 'Configuration' cell sets variables for the SOS URL, version, and date range. The 'Load libraries' cell imports necessary Python libraries like requests, ElementTree, matplotlib, and numpy.

jupyter sos_server_explorer Last Checkpoint: 5 minutes ago (autosaved)

File Edit View Insert Cell Help Trusted JupyterLab 2

CNR National Research Council ISMAR Institute of Marine Sciences

SOS server explorer

A Notebook to explore and visualize the data stored in a SOS Server (Version 2.0.0).

Author: Stefano Menegon, stefano.menegon@ismar.cnr.it

Configuration

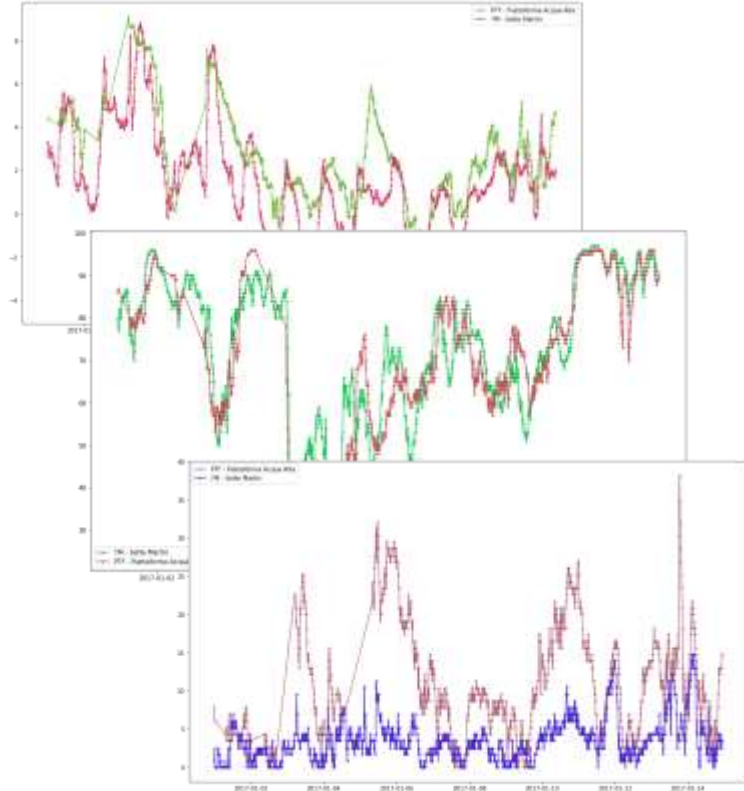
```
In [1]: # configuration
SOS_URL = "http://veek.ve.ismar.cnr.it/observations/sos/vep"
SOS_VERSION = "2.0.0"
DATE_START = "2017-01-01"
DATE_END = "2017-01-15"
```

Load libraries

For more information see the documentation of the OWSLib python library:
<http://geopython.github.io/OWSLib/>

```
In [2]: %matplotlib inline
import requests
from xml.etree import ElementTree
from pylab import rcParams
rcParams['figure.figsize'] = 17, 10
import numpy
import matplotlib.dates, matplotlib.pyplot
```

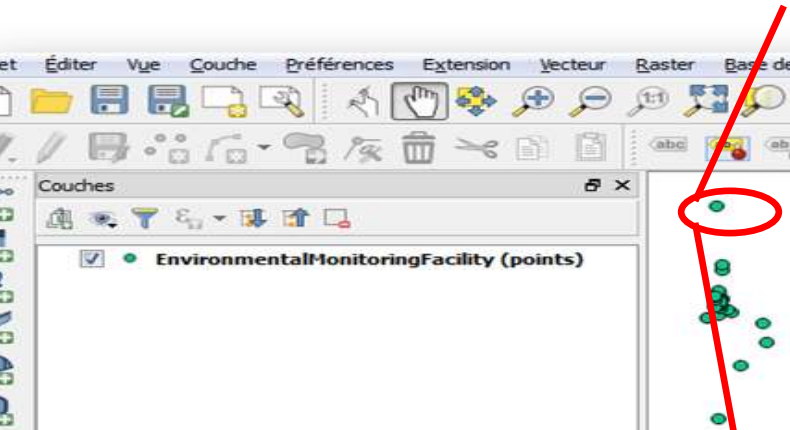
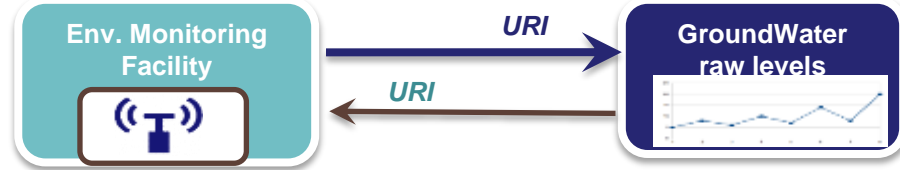
Example: <https://github.com/CNR-ISMAR/SOS-Server-Explorer>



Clients - QGIS GML Application Schema Toolbox

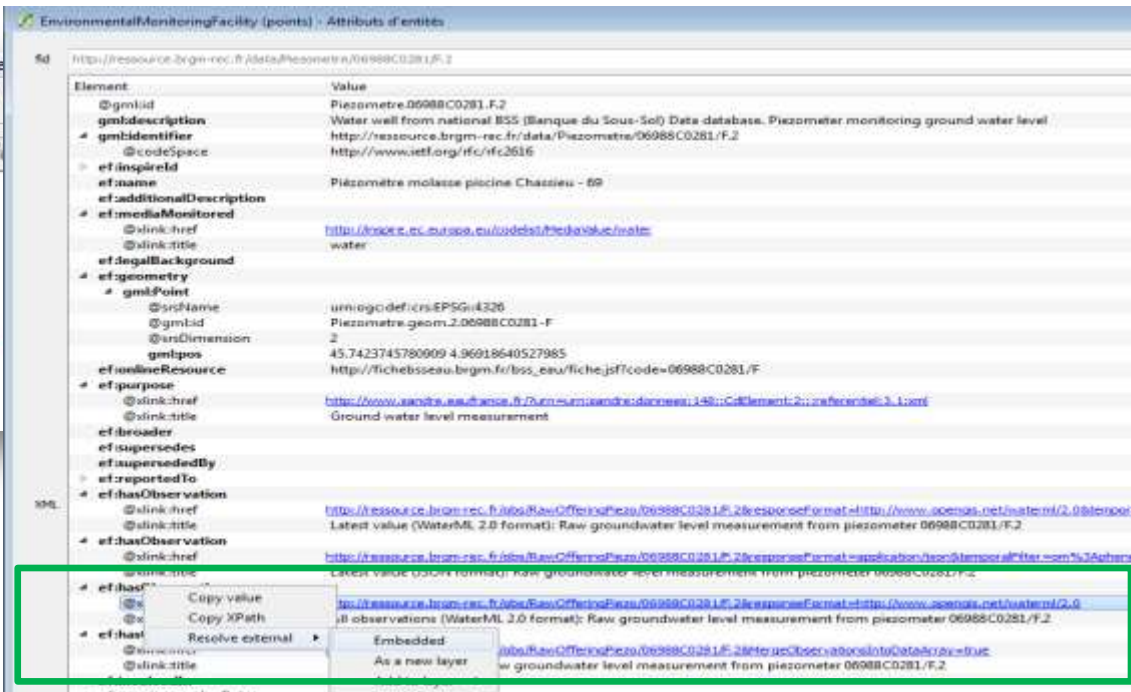
- Extract from workshop this afternoon 'GML application compliant complex features in QGIS and beyond'
- github : https://github.com/BRGM/gml_application_schema_toolbox

Clients - QGIS GML Application Schema Toolbox

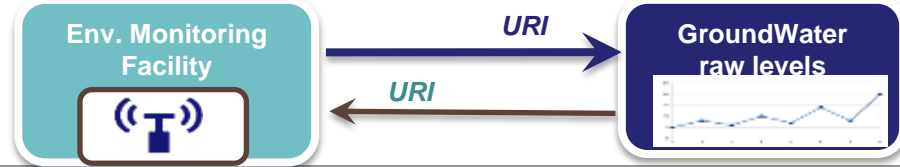


1

2



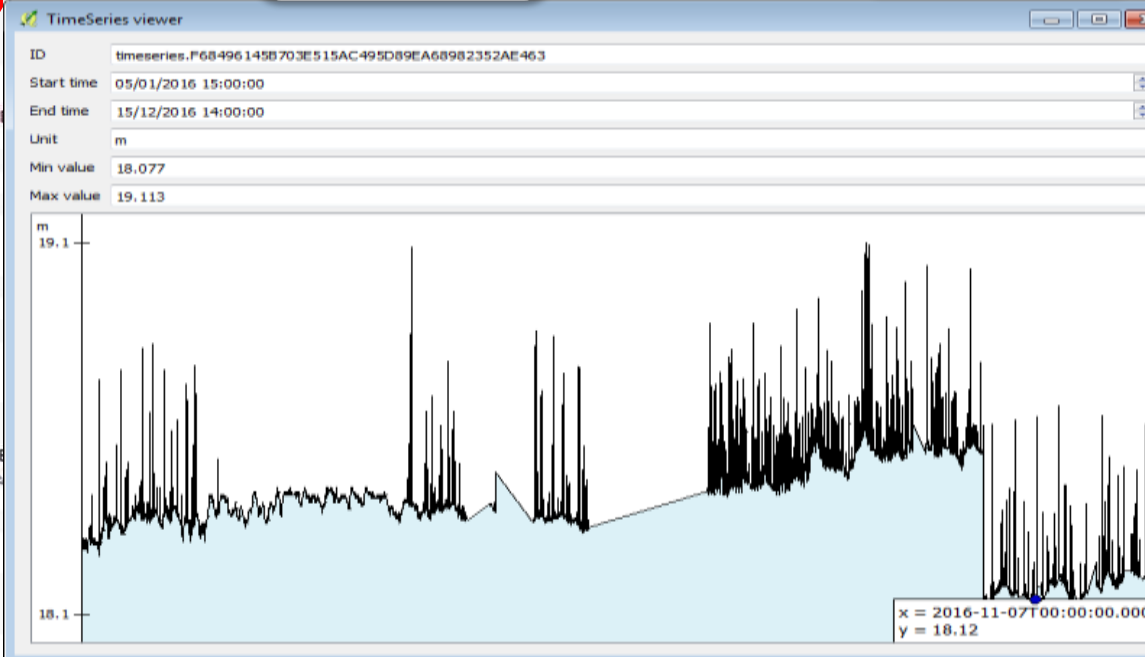
Clients - QGIS GML Application Schema Toolbox



XML Schema snippet showing GML elements:

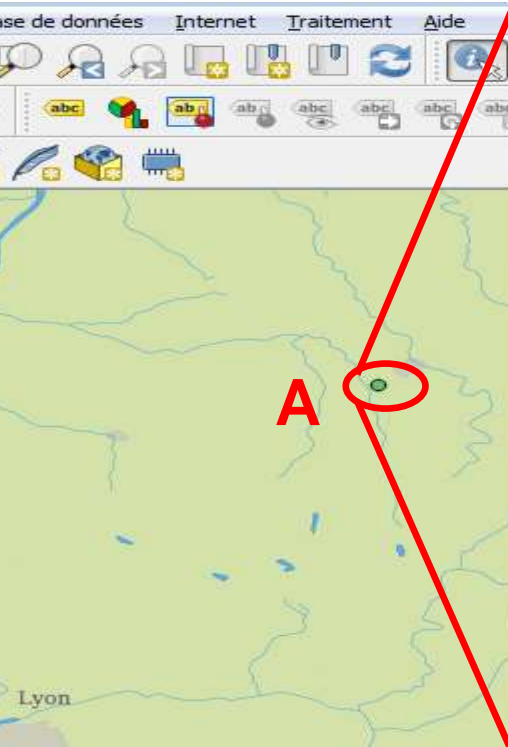
```
<om:resultTime>
  <gml:TimeInstant>
    @gml:id="ti_A5B605235028277DAC699731065C3965E0F1"
    gml:timePosition="2016-12-15T14:00:00.000Z"
  </gml:TimeInstant>
  <om:procedure>
    @xlink:href="http://id.eaufrance.fr/met/403.xml"
    @xlink:title="Electronic piezometric probe"
  </om:procedure>
  <om:parameter>
    <om:observedProperty>
      @xlink:href="http://id.eaufrance.fr/par/1649.xml"
      @xlink:title="GroundWaterLevel"
    </om:observedProperty>
    <om:featureOfInterest>
      <wml2:MonitoringPoint>
        @gml:id="mp_4C6129829FFC1C2DE4A2FB853F56C5B1A8"
        gml:identifier="http://ressources.brgm-rec.fr/data/Piezometrie"
        gml:name="Piezo 06988C0281/F.2"
        sf:sampledFeature="..."
        sams:shape="..."
      </wml2:MonitoringPoint>
    </om:featureOfInterest>
  </om:parameter>
</om:resultTime>
```

A red box highlights the "wml2:MonitoringPoint" element, with a red line connecting it to the "TimeSeries viewer" window.



Clients - QGIS GML Application Schema Toolbox

Borehole



BoreholeView (points) - Attributs d'entités

fid <http://ressource.brgm-rec.fr/data/BoreholeView/BSS001REWW>

Element	Value
@gml:id	BSS001REWW
gml:description	Borehole description
✦ gml:identifier	http://ressource.brgm-rec.fr/data/BoreholeView/BSS001REWW
@codeSpace	http://www.ietf.org/rfc/rfc2616
gml:name	Forage BSS001REWW
gsmlp:identifier	http://ressource.brgm-rec.fr/data/Borehole/BSS001REWW
✦ gsmlp:purpose	http://inspire.ec.europa.eu/codelist/BoreholePurposeValue/hydrogeologicalSurvey
@xlink:href	levÃ© hydrogÃ©ologique, gestion de lâ€™eau
@xlink:title	
✦ gsmlp:status	http://resource.europe-geology.eu/vocabs/BoreholeStatus/drillingCompleted
@xlink:href	drilling completed
@xlink:title	
✦ gsmlp:drillingMethod	http://resource.europe-geology.eu/vocabs/DrillingMethod/hydraulic_rotary_drilling
@xlink:href	hydraulic rotary drilling
@xlink:title	
gsmlp:operator	BRGM (PIEZOMETRIE)
gsmlp:driller	INTRAFOR-COFOR
gsmlp:drillEndDate	1974-11-30Z
✦ gsmlp:startPoint	http://resource.europe-geology.eu/vocabs/BoreholeStartPoint/naturalLandSurface
@xlink:href	natural land surface
@xlink:title	
✦ gsmlp:inclinationType	http://resource.europe-geology.eu/vocabs/BoreholeInclinationType/vertical
@xlink:href	vertical
@xlink:title	
gsmlp:boreholeMaterialCustodian	unknown
✦ gsmlp:boreholeLength_m	23.0
@uom	http://qudt.org/vocab/unit/M

XML

Clients - QGIS GML Application Schema Toolbox

Borehole

http://ressource.brgm-rec.fr/data/BoreholeView/BSS001REWW

Element	Value
gsmlp:drillEndDate	1974-11-30Z
gsmlp:startPoint	
@xlink:href	http://resource.europe-geology.eu/vocabs/BoreholeStartPoint/naturalLandSurface
@xlink:title	natural land surface
gsmlp:inclinationType	
@xlink:href	http://resource.europe-geology.eu/vocabs/BoreholeInclinationType/vertical
@xlink:title	vertical
gsmlp:boreholeMaterialCustodian	unknown
gsmlp:boreholeLength_m	23.0
@uom	http://qudt.org/vocab/unit/M
gsmlp:elevation_m	223.87
@uom	http://qudt.org/vocab/unit/M
gsmlp:elevation_srs	http://www.opengis.net/def/crs/EPSSG/0/5720
gsmlp:source	http://ficheinfoterre.brgm.fr/InfoterreFiche/ficheBss.action?id=06512X0037/STREMY
gsmlp:metadata_uri	http://www.geocatalogue.fr/Detail.do?fileIdentifier=BR_BSS_BAA
gsmlp:genericSymbolizer	Not provided
gsmlp:shape	
gml:Point	
@srsDimension	2
@srsName	urn:ogc:def:crs:EPSG:::4326
@gml:id	gsmlp.shape.BSS001REWW
gml:pos	46.1909541655103 5.18713262971692
gsmlp:cored	false
gsmlp:accessToPhysicalDrillCore	false
gsmlp:boreholeUse	
@xlink:href	http://inspire.ec.europa.eu/codelist/BoreholePurposeValue/groundwaterLevelMonitoring
@xlink:title	surveillance du niveau de la nappe phrÃ©atique
gsmlp:detailedDescription	
@xlink:href	http://www.opengis.net/def/nil/OGC/0/template
@xlink:title	template
gsmlp:geophysicalLogs	
@xlink:href	http://www.opengis.net/def/nil/OGC/0/unknown
@xlink:title	unknown
gsmlp:geologicalDescription	
@xlink:href	http://ressource.brgm-rec.fr/obs/RawGeologicLogs/BSS001REWW
@xlink:title	Borehole BSS001REWW geologic log available.
gsmlp:groundWaterLevel	
@xlink:href	http://ressource.brgm-rec.fr/data/Piezometre/06512X0037/STREMY.2
@xlink:title	Description of Piezometer attached to BSS001REWW. Provides link to SensorObservationService offering

Clients - QGIS GML Application Schema Toolbox

B

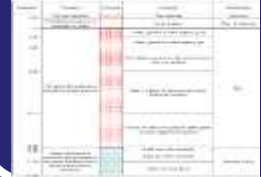
gsmlp:shape		
gml:Point		
@srsDimension	2	
@srsName	urn:ogc:def:crs:EPSG::4326	
@gml:id	gsmlp.shape.BSS001REWW	
gml:pos	46.1909541655103 5.18713262971692	
gsmlp:cored	false	
gsmlp:accessToPhysicalDrillCore	false	
gsmlp:boreholeUse		
@xlink:href	http://inspire.ec.europa.eu/codelist/BoreholePurposeValue/groundwaterLevelMonitoring	
@xlink:title	surveillance du niveau de la nappe phrÃ©atique	
gsmlp:detailedDescription		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/template	
@xlink:title	template	
gsmlp:geophysicalLogs		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/unknown	
@xlink:title	unknown	
gsmlp:geologicLog		
@xlink:href	http://ressource.brgm-rec.fr/obs/RawGeologicLogs/BSS001REWW	
@xlink:title	hole BSS001REWW geologic log available.	
gsmlp:groundWaterChemistry		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/unknown	
@xlink:title	unknown	
gsmlp:rockGeochemistry		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/unknown	
@xlink:title	unknown	
gsmlp:poreGasChemistry		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/inapplicable	
@xlink:title	inapplicable	
gsmlp:geoTechnicalInfo		
@xlink:href	http://www.openqgis.net/def/nil/OGC/0/unknown	
@xlink:title	unknown	

Borehole

URI

URI

Observations/ Geological logs



Clients - QGIS GML Application Schema Toolbox

sos:GetObservationResponse

- @xlink:href <http://ressource.brgm-rec.fr/obs/RawGeologicLog/Borehole%20BSS001REWW.gml>
- @xlink:title Borehole BSS001REWW geologic log available.
- @xsi:schemaLocation http://www.opengis.net/sos/2.0 http://schemas.opengis.net/sos/2.0

sos:observationData

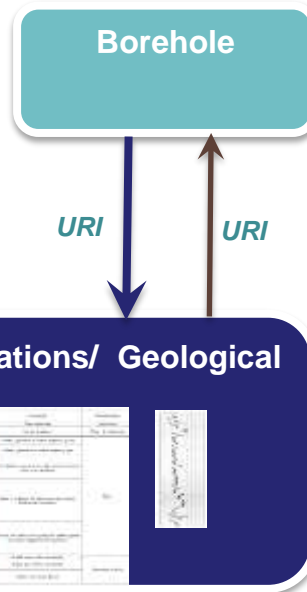
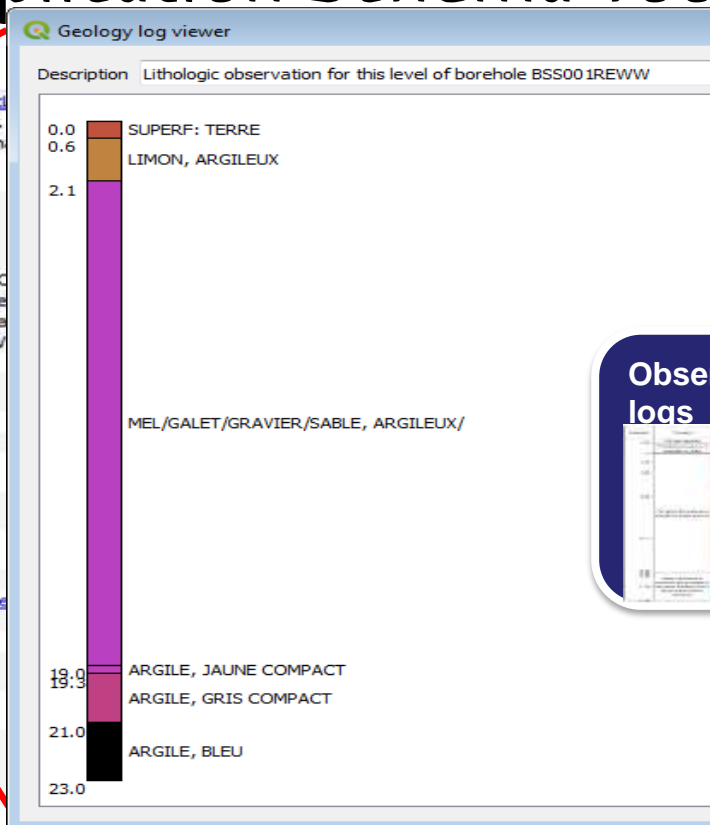
- om:OM_Observation**
 - @gml:id o_B8A579CD13F439A702FBAD713F09AA17FC
 - gml:description Lithologic observation for this level of borehole
 - gml:identifier http://ressource.brgm-rec.fr/obs/RawEarthMaterialLogObservation/BSS001REWW.gml
 - gml:name RawEarthMaterialLogObservation BSS001REWW
 - om:type
 - om:phenomenonTime
 - om:resultTime
 - om:procedure
 - om:parameter
 - om:parameter
 - om:parameter
 - om:observedProperty
 - @xlink:href <http://www.opengis.net/def/qgis/2.0/observation/EarthMaterial>
 - @xlink:title Earth Material
 - om:featureOfInterest
 - om:result

sos:observationData

- om:OM_Observation

gsmip:groundWaterLevel

- @xlink:href <http://ressource.brgm-rec.fr/data/Piezometre/06512X0037/STREMY.2>
- @xlink:title Description of Piezometer attached to BSS001REWW. Provides link to SensorObservationService offering



Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Context:

- management of citizen-collected data is a major barrier to the reusability and integration of these contribution across borders;
- the provision of results in the long-term is a particular open issue;
- Citizen Science projects are extremely diverse in topics and approaches, so are their data management practices;

(Cfr. Data management practices in Citizen Science projects – results from a survey Sven Schade & Chrisa Tsinaraki ECSA2016)

Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Aims:

- preserve community practices;
- maximise interoperability among existing systems;
- increase usefulness and mutual exchanges between the citizen science and the scientific community.

Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Proposal: applying the
ADAPTER PATTERN,
from CS project API to
O&M and SWE
Standards.

Proof of concept:

iNaturalist → SOS



Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



HOW?



SOS [GetObservation](#) and [getFeatureOfInterest](#) are translated to [iNaturalist API](#)

[iNaturalist data](#) are re-modeled according to [O&M](#).



API

ADAPTER



Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Test client: post SOS requests to iNaturalist adapter service

<http://inat2sos.get-it.it/service/>

```
1 <!-- write some xml below -->
2 <sos:observationData>
3   <om:OM_Observation gml:id="o_103037">
4     <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CategoryObservation"/>
5     <om:phenomenonTime>
6       <gml:TimeInstant gml:id="phenomenonTime_103037">
```

iNaturalist obs UID

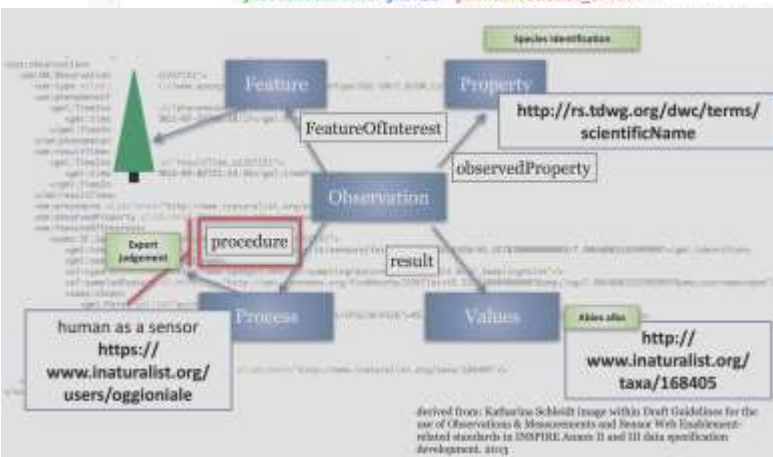
iNaturalist user

observedProperty

FOI of observation

value of observation

```
<scientificName>
  <gml:Text value="http://rs.tdwg.org/dwc/terms/scientificName" type="text"/>
</scientificName>
<observedProperty>
  <gml:Text value="http://www.inaturalist.org/taxa/168405" xsi:type="ns:Ref" type="text"/>
</observedProperty>
```



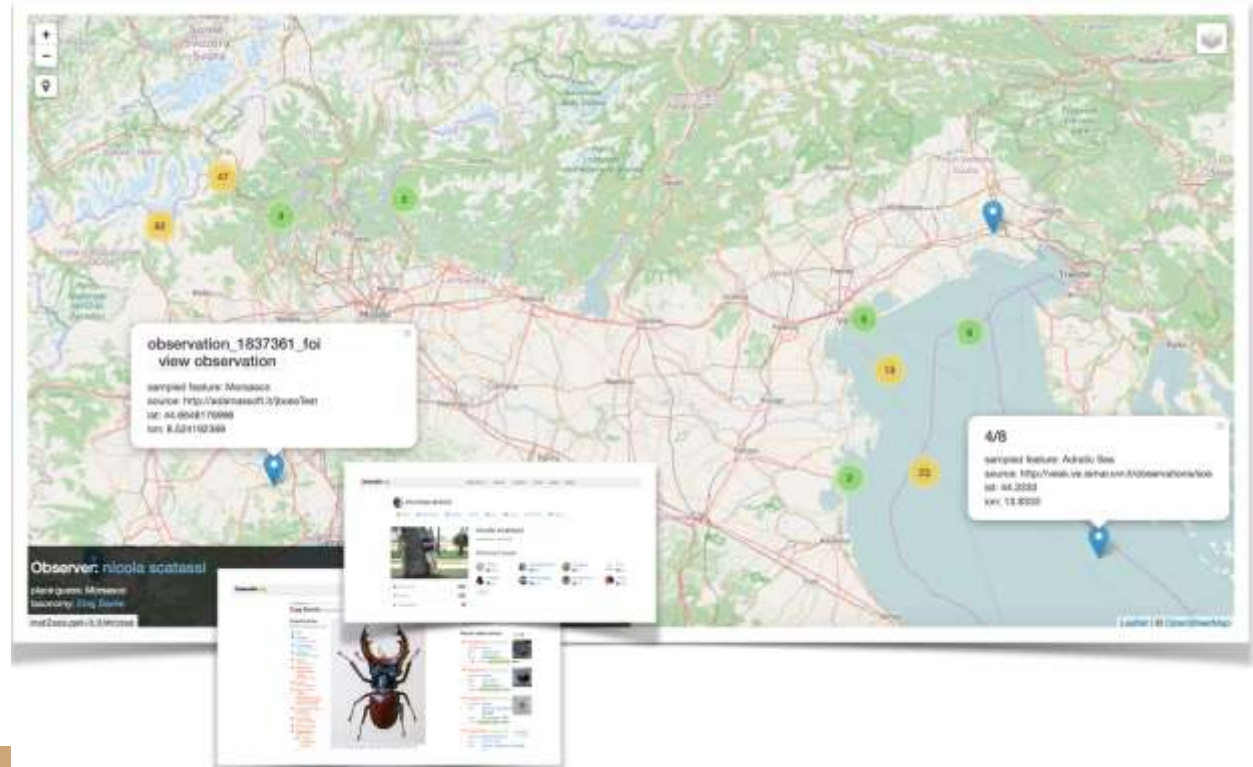
Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Map Client (pure SOS requests): visualize observations from iNaturalist (via the adapter) and other SOS servers

<http://inat2sos.get-it.it/>



Clients - Bringing Citizen Science to interoperability

iNaturalist2SOS adapter



Key Points:

- O&M is a good candidate for representing CS data;
- adapter approach allow to maintain the data management practices breaking the barrier of reusability and integration.

Next steps:

- propose the solution as a best practice within LifeWatch and LTER;
- adapt other CS framework.

<http://inat2sos.get-it.it/>

REFERENCE

A. Oggioni, P. Tagliolato, and F. Pavesi. Ready, steady, go! bringing CS observations to interoperability standards. the adapter approach (and inaturalist). In *Book of Abstract of the First ECSA Conference 2016, Berlin, May, 19-21 2016*, p. 37. European Citizen Science Association. url: http://www.ecsa2016.eu/assets/book_of_abstracts_ecsa2016.pdf

Flash Presentations

National Network

- French Ground Information Network - GIN

Clients

- Postprocessing of observation data with R and shiny
- Jupyter Notebook
- QGIS GML Application Schema
- iNaturalist2SOS adapter

Sensor Metadata

- **GET-IT - EDI metadata editor**
- **NeXOS and FixO3: smle**

Metadata for sensors

RITMARE: GET-IT - EDI metadata editor



- Original context: RITMARE flagship project.
- Collaboration with Long Term Ecological Research Network and LifeWatch-ITA
- Development of distributed SDI - enabling solutions for participants
- Needs:
 - to **ease metadata authoring** activities also for unskilled users
 - to **support multiple metadata formats** and **profiles**
 - to natively support **semantically enriched metadata**

Metadata for sensors

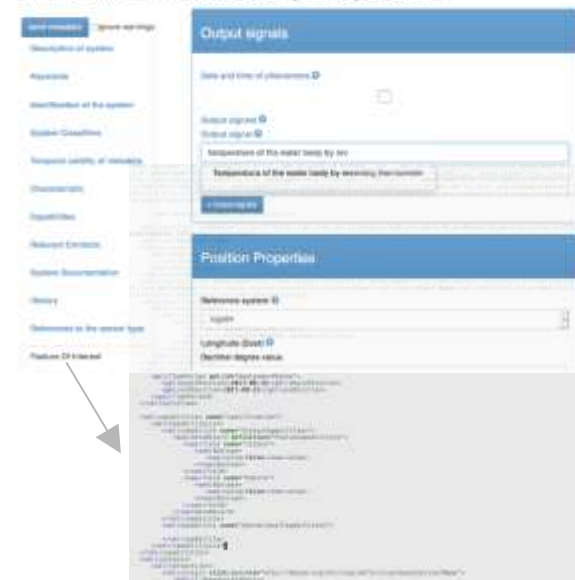
RITMARE: GET-IT - EDI metadata editor



Features:

- Web based: **user friendly web-form**
- **Template driven**: instructed (make aware of a specific format/profile) and customized (to specific workgroups, institutes, or projects by changing sources of additional information) by a "template"
- **specifically tailored to support semantics aware profiles**: **EDI is linked to triple stores through runtime SPARQL queries** on endpoints with authoritativeness acknowledged by the specific profile - e.g. NVS in the marine community
- **semantic enrichment is transparent to the user**: user chooses labels, the system stores URIs and automatically completes whole metadata chunks according to SPARQL logics and semantics in selected endpoints (e.g. given the name of manufacturer, all information on address, contacts, etc. is composed by the software)

EDI - SensorML v2.0.0 SOS lightweight profile

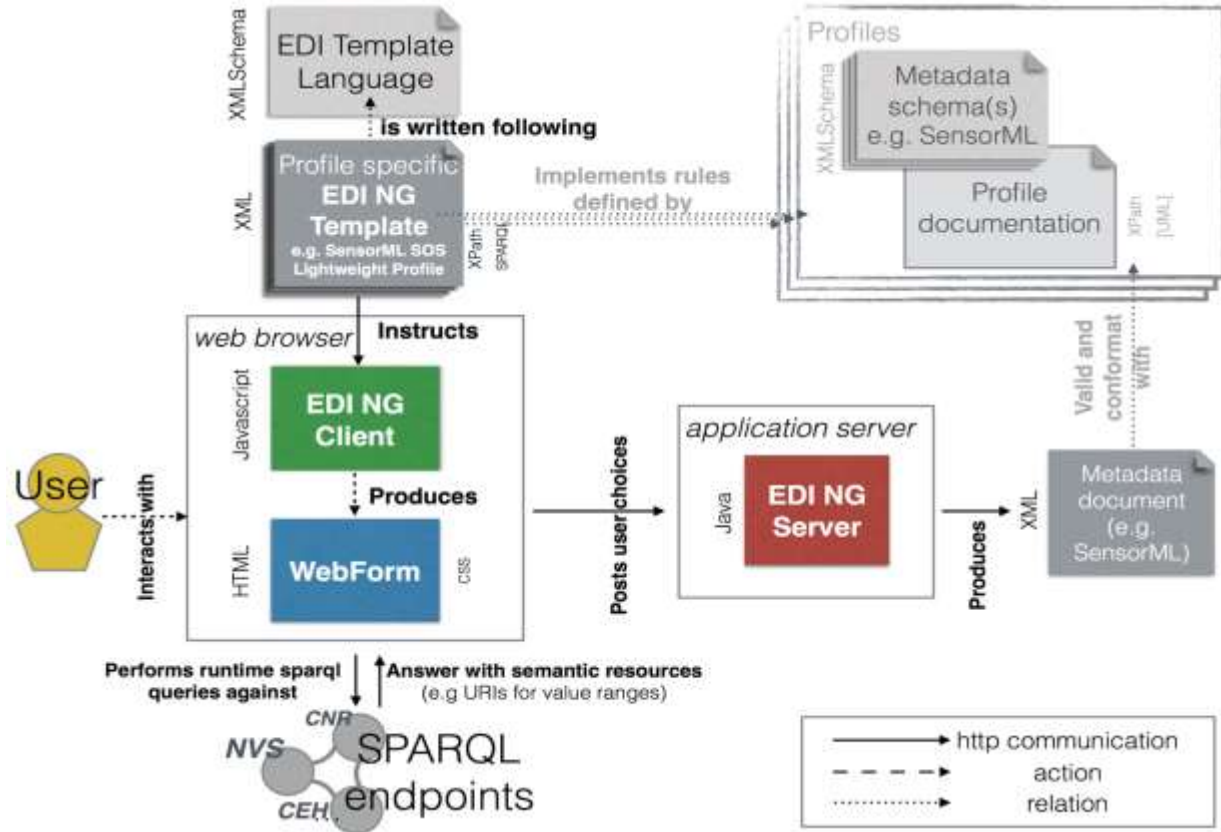
The screenshot shows a web-based form for editing sensor metadata. On the left is a vertical sidebar with a list of categories: General metadata, Output signals, Position Properties, and others. The main area is divided into two panels. The top panel, titled "Output signals", contains fields for "Date and time of phenomenon", "Sensor output", and "Temperature of the water body by sea". The bottom panel, titled "Position Properties", contains fields for "Reference system", "Longitude (WGS)", and "Reference degree value". Below these panels is a large text area containing SPARQL queries. An arrow points from the "Position Properties" section to the SPARQL queries.

Metadata for sensors



RITMARE: GET-IT - EDI metadata editor

- Architecture



Metadata for sensors

RITMARE: GET-IT - EDI metadata editor



Current applications of EDI - several SensorML profiles/community of practices:

Profile	semantic sources (through SPARQL endpoint)	community
SensorML v.1.0 - RITMARE	<p>[Source: NERC Vocabulary Server - NVS2.0] Parameters: P01 (BODC Parameter Usage Vocabulary) and P02 (SeaDataNet Parameter Discovery Vocabulary) Units of measure: P06 (BODC data storage units) Sensor types: P10 (Global Change Master Directory Instrument Keywords)</p> <p>[Source: RITMARE infrastructure - Get-it triple store] Manufacturers: FOAF (Friends Of A Friend) graph version of Esonet Yellow Pages. Operators, and owners: FOAF (Friends Of A Friend) graph of RITMARE participants</p>	RITMARE community
SensorML v2.0.0 SOS lightweight profile - (RITMARE subprofile)		

Metadata for sensors

RITMARE: GET-IT - EDI metadata editor



Profile	semantic sources (through SPARQL endpoint)	community
SensorML v2.0.0 Vessel Profile	<p>[Source: NERC Vocabulary Server - NVS2.0]</p> <p>Vessels and platform collection: C17</p> <p>Device category: L05</p> <p>Platform category: L06</p> <p>SensorML type vocabulary: W01</p> <p>Parameters: P01 (BODC Parameter Usage Vocabulary)</p> <p>Units of measure: P06 (BODC data storage units)</p> <p>[Source: RITMARE infrastructure - Get-it triple store]</p> <p>Manufacturers: FOAF (Friends Of A Friend) graph version of Esonet Yellow Pages.</p> <p>Operators, and owners (demo): FOAF (Friends Of A Friend) graph.</p>	SeaDataNet - EuroFleets (EDI templates developed in collaboration with CSIC, Spain)
SensorML v2.0.0 Vessel Components History	<p>Parameters: P01 (BODC Parameter Usage Vocabulary)</p> <p>Instruments: L22 (SeaVoX Device Catalogue) NVS</p>	
SensorML v2.0.0 Vessel Event History		

Metadata for sensors

RITMARE: GET-IT - EDI metadata editor



Some more (INSPIREd) EDI applications

Profile	semantic sources (through SPARQL endpoint)	community
INSPIRE MD (profile of ISO 19139)	Languages, data types, reference system codes, responsible party roles, and INSPIRE themes: INSPIRE codelists Keywords: Global Change Master Directory Science Keyword variables , P02 NERC vocabulary and EUROVOC	RITMARE and Ermes FP7 Project
RNDT (Repertorio Nazionale Dati Territoriali) - Italian profile of INSPIRE ISO 19139	Responsible parties, points of contact, etc.: FOAF (RITMARE infrastructure triple store)	RITMARE

Metadata for sensors

RITMARE: GET-IT - EDI metadata editor



EDI Metadata Editor is a Free Open Source Software project (under GPL3 licence)

Try the software:

<http://edidemo.get-it.it>

Get the source code:

https://github.com/SP7-Ritmare/EDI-NG_client

Get more info:

<http://www.get-it.it>

Metadata for sensors

NeXOS and FixO³: smle



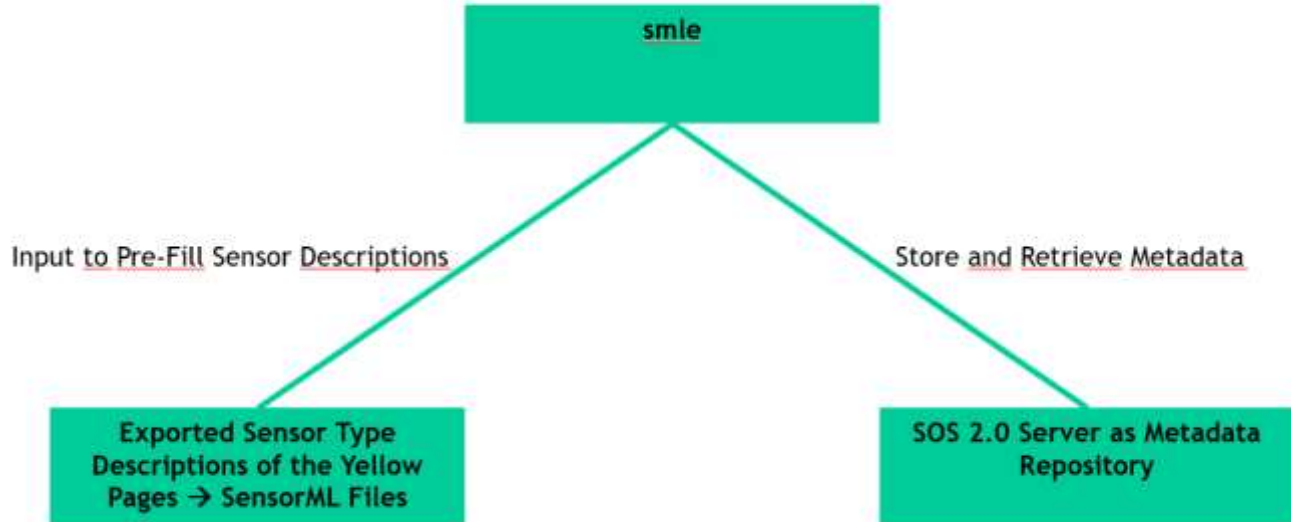
- Needed: A tool for facilitating the creation of sensor and sensor platform descriptions
- Approach
 - OGC SensorML 2.0 is an OGC standard for providing metadata about sensors and sensor systems
 - Currently in development: Marine Sensor Web Profile define which elements of SensorML are relevant for marine sensors
 - Idea: Build an editor for SensorML smle
 - Graphical user interface
 - Ensure that the users provide valid inputs
 - Couple the editor to a metadata repository for storing the created sensor descriptions
 - Make use of the Esonet/FixO3 Yellow Pages use as input to provide common metadata for sensor types

Metadata for sensors

NeXOS and FixO³: smle



- Architecture



Metadata for sensors

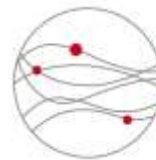
NeXOS and FixO³: smle



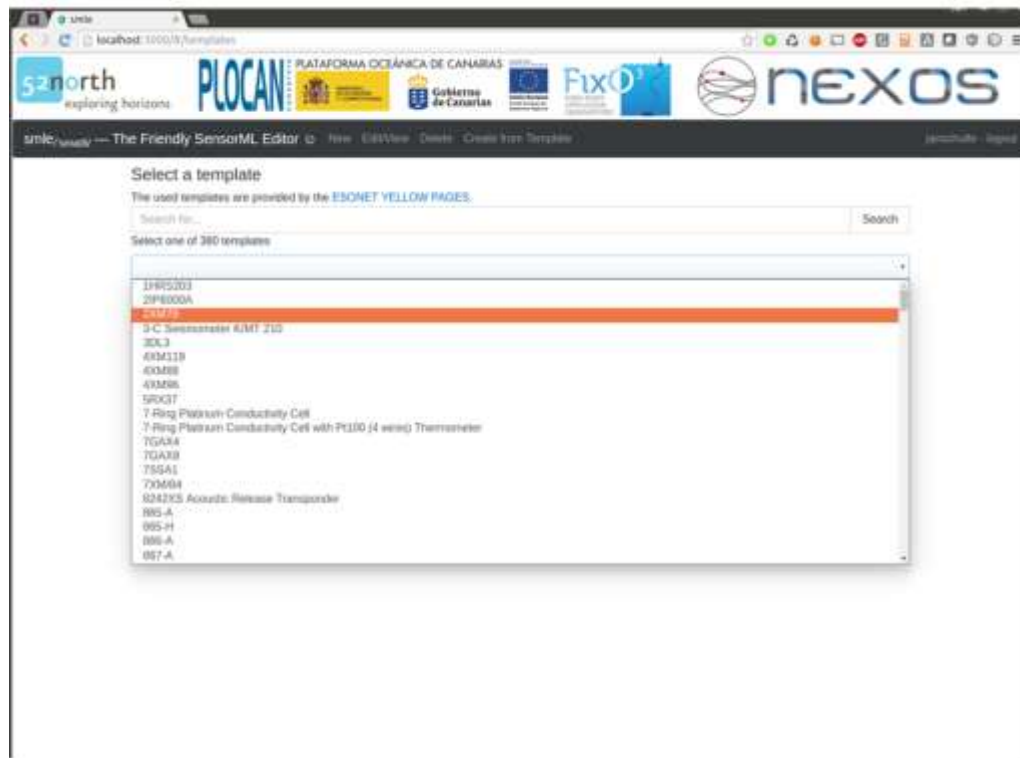
- smle has been completed in a first full version
- Developed in cooperation of FixO3 and NeXOS
- Available as open source software: <https://github.com/52North/sml>
- Future work
 - Link to vocabularies (e.g. NERC)
 - Couple with ongoing work on Marine SWE Profiles
 - Add enhanced discovery capabilities (e.g. different search options for finding sensors)
 - Link with Sensor Web clients for discover sensor data sets

Metadata for sensors

NeXOS and FixO³: smle

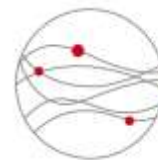


nEXOS



Metadata for sensors

NeXOS and FixO³: smle

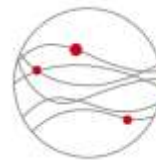


nEXOS

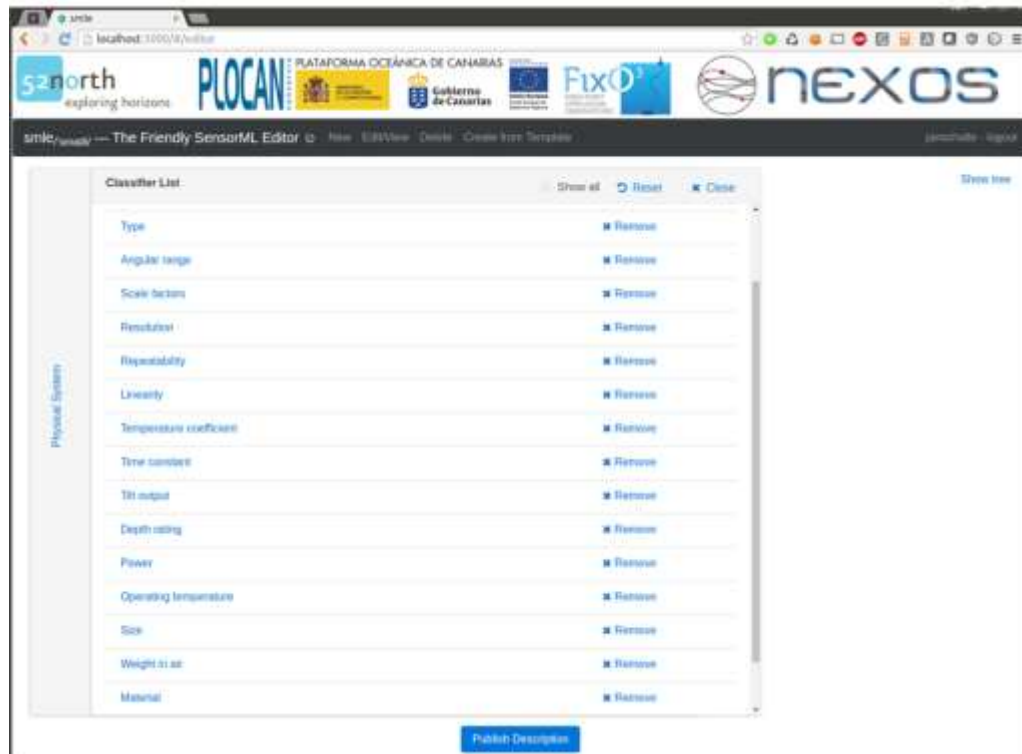
A screenshot of a web browser displaying the NeXOS metadata editor. The browser's address bar shows "localhost:10000/...". The page header includes logos for "s2north", "PLOCAN", "Gobierno de Canarias", "FixO³", and "nEXOS". Below the header is a dark navigation bar with the text "The Friendly SensorML Editor" and links for "Home", "Edit View", "Delete", "Create from Template", "JavaScript", and "Logout". The main content area is a form titled "Contact" with a "Show all" button and "Reset" and "Close" icons. The form contains fields for "Phone", "Address", "Online resource", "Contact instructions", and "Hours of service". On the left side of the form, there are three vertical tabs labeled "Physical Component", "Contact List", and "Responsible Party". At the bottom of the form is a blue button labeled "Publish Description".

Metadata for sensors

NeXOS and FixO³: smle

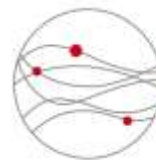


nEXOS




Metadata for sensors

NeXOS and FixO³: smle



nEXOS

The screenshot shows a web browser window with the URL "localhost:3000/smler/0eb124f6-a291-55c7-730f-3cb5fea4b5d7". The page header includes logos for "52north", "PLOCAN", "Gobierno de Canarias", "FixO³", and "nEXOS". The main content area is titled "Sensor description for 0eb124f6-a291-55c7-730f-3cb5fea4b5d7". It features a tree view on the left with expandable sections: "Keywords", "Identification", "Classification", "Classifier Info", "Classifiers", "model", "Label", "Value", "manufacturer", "Definition", "Label", "manufacturer", "Value", "Code space", "Type", "Angular range", "Scale factors", "Resolution", "Repeatability", "Uncertainty", and "Temperature coefficient". The "Value" section is currently expanded, showing the text "EL Deep-Water Tiltmeter". At the bottom of the page, there are two buttons: "Edit sensor description" and "Copy sensor description".



Section 3 : Alternative encodings and RESTful provision options

Future options



Serving Observation with API/JSON

Background documents on alternative encodings

Some examples:

- Hub'Eau
- 52°North Sensor Web REST API
- Sensor Things
- ELFIE: OGC Environmental Linked Features Interoperability Experiment
- CNR-ISMAR In Situ Observation Network

Some relevant documents on alternative encodings

OGC Observations and Measurements – JSON implementation:

<https://portal.opengeospatial.org/files/64910>

Testbed 11 Implementing JSON/GeoJSON in an OGC:

https://portal.opengeospatial.org/files/?artifact_id=64595

Testbed-12 Javascript-JSON-JSON-LD Engineering Report:

<http://docs.opengeospatial.org/per/16-051.html>

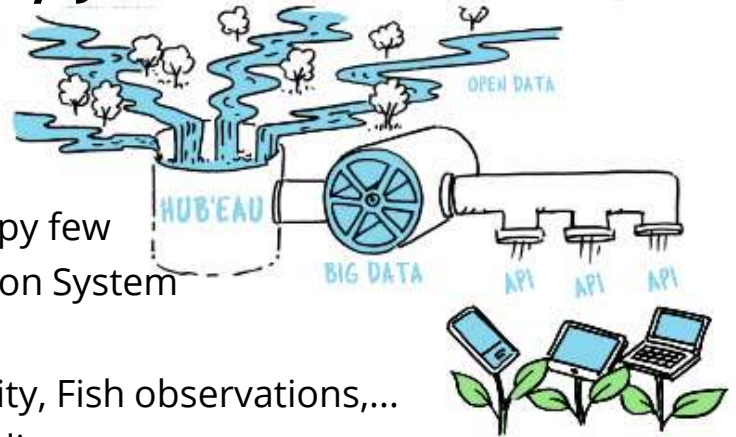
Guidelines for the RDF encoding of spatial data: http://inspire-eu-rdf.github.io/inspire-rdf-guidelines/#_namespace_conventions

Serving Observation with API/JSON - Hub'Eau

<http://hubeau.eaufrance.fr/>

- Rationale :

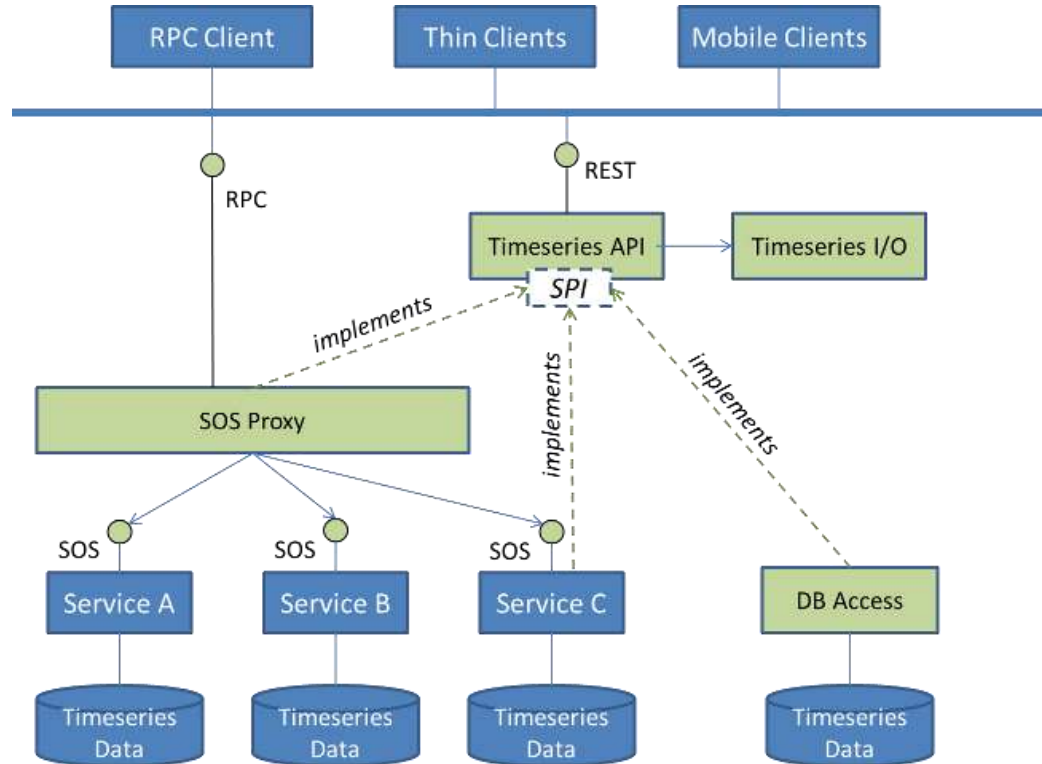
- access to complex XML flows reserved to happy few
- deploy APIs on top of French Water Information System
 - source : databases and webservice
 - GroundWater Level, Surface Water quality, Fish observations,...
 - Coming : water temp, GroundWater quality
 - -> millions of analysis
- API
 - using swagger
 - serving JSON, GeoJSON and others
 - goal is to apply Observations & Measurements semantics



52°North Sensor Web REST API

- Interaction with SOAP/XML services is rather heavyweight compared to REST/JSON
- Gathering all metadata from SOS servers for building client applications may require complex sequences of SOS requests
- Idea: Provide simple interface to
 - Discover sensor data sets
 - Download sensor data and metadata
 - Provide additional functionality for client/Web developers
 - Pre-rendered diagrams
 - Data conversion (e.g. CSV files)
 - Accessing first/last observed values
 - Generalisation
 - PDF outputs

52°North Sensor Web REST API



52°North Sensor Web REST API

- Used in several projects to build client application such as 52°North Helgoland



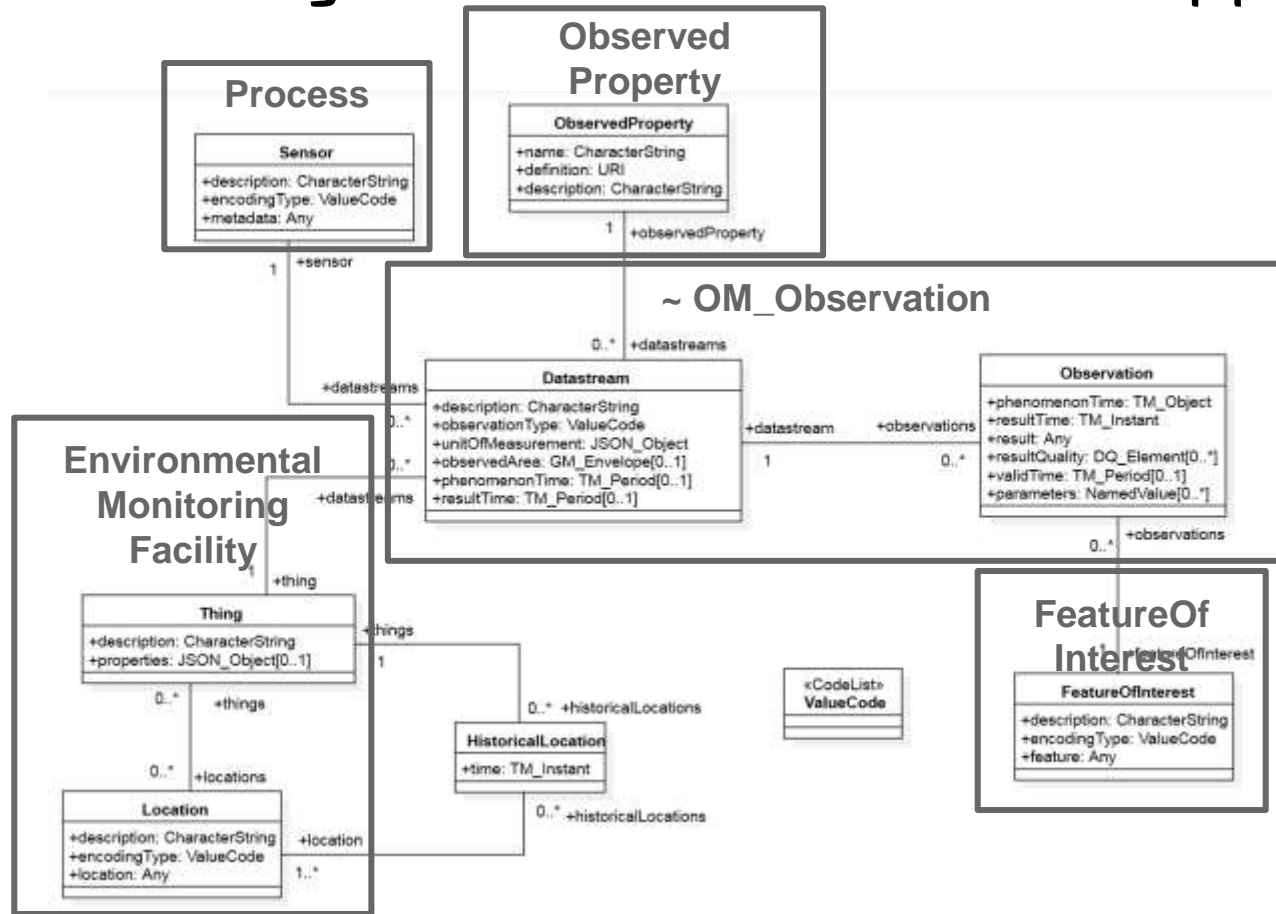
52°North Sensor Web REST API

- Implementation available as open source software
 - <https://github.com/52North/series-rest-api>
- Outlook
 - sensorweb4R: R extension for consuming data from Sensor Web REST API endpoints
 - Further modules
 - Event processing
 - Subscriptions
 - Notifications
 - Geo-processing
 - Publish as OGC Discussion Paper

SensorThings API

- New OGC standard for provision of observational data
- Provides:
 - open and unified way to interconnect Internet of Things (IoT) devices over the Web
 - interfaces to interact with and analyze their observations
- Data model similar to O&M data model
- Restful service provision based on oData Model
- Data provision in JSON
- Possible INSPIRE Extension

SensorThings API - INSPIRE O&M (approximate)



SensorThings API - RESTful Services

Base URIs for different object types:

- <http://.../SensorThingsServer-1.0/v1.0/Datastreams>
- <http://.../SensorThingsServer-1.0/v1.0/MultiDatastreams>
- <http://.../SensorThingsServer-1.0/v1.0/FeaturesOfInterest>
- <http://.../SensorThingsServer-1.0/v1.0/HistoricalLocations>
- <http://.../SensorThingsServer-1.0/v1.0/Locations>
- <http://.../SensorThingsServer-1.0/v1.0/Observations>
- <http://.../SensorThingsServer-1.0/v1.0/ObservedProperties>
- <http://.../SensorThingsServer-1.0/v1.0/Sensors>
- <http://.../SensorThingsServer-1.0/v1.0/Things>

SensorThings API - RESTful Services

URIs follow data model graph:

<http://.../v1.0/Things>: all Things

[http://.../v1.0/Things\(1\)](http://.../v1.0/Things(1)): Thing with the id 1

[http://.../v1.0/Things\(1\)/Locations](http://.../v1.0/Things(1)/Locations): all Locations associated with Thing 1

[http://.../v1.0/Things\(1\)/Locations\(3\)](http://.../v1.0/Things(1)/Locations(3)): Location 3 associated with Thing 1

Use expand to include nested classes:

[http://.../v1.0/Thing?\\$expand=Datastreams/ObservedProperty](http://.../v1.0/Thing?$expand=Datastreams/ObservedProperty)

SensorThings API - RESTful Services

Filter functions:

- Observations of Datastream 2, with result < 10:
`/v1.0/Datastreams(2)/Observations?$filter=result lt 10`
- all Observations before the specified time:
`/v1.0/Observations?$filter=phenomenonTime lt '2016-11-24T14:37:01.000Z'`
- Locations with location [-79.407,43.661]:
`/v1.0/Locations?$filter=st_equals(location,geography'POINT(-79.407 43.661)')`

OGC Environmental Linked Features Interoperability Experiment (ELFIE)

Objectives:

- Demonstrate integration of environmental observation data with domain features (ReSTful and Linked Data principles)
- Prepare OGC engineering report on interlinkages identified between observation data and domain features
- Provide draft linked data encodings to relevant standards working groups

ELFIE Methodology

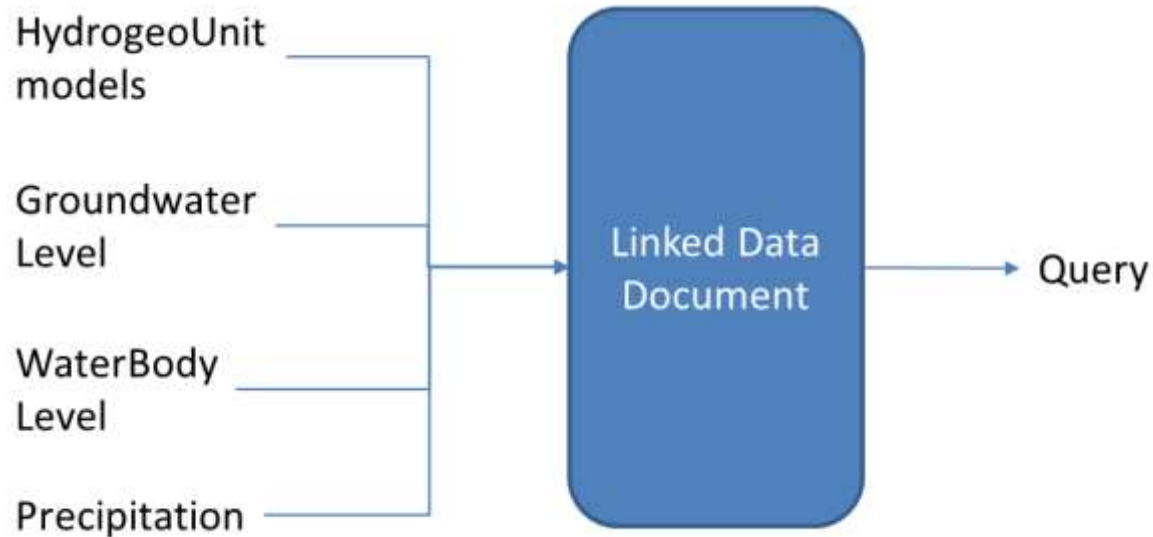
- Define specific technical criteria to test hypothesis
- Refine use cases and select source data
- Select and/or draft linked data encodings to be used
- Encode documents for each use case
- Evaluate documents against predefined criteria
- Write engineering report

ELFIE Use Cases

- River Monitoring and Flooding
- Irrigation
- Ground Water / Surface Water Impacts
- Hydrologic Drought
- Water Quality

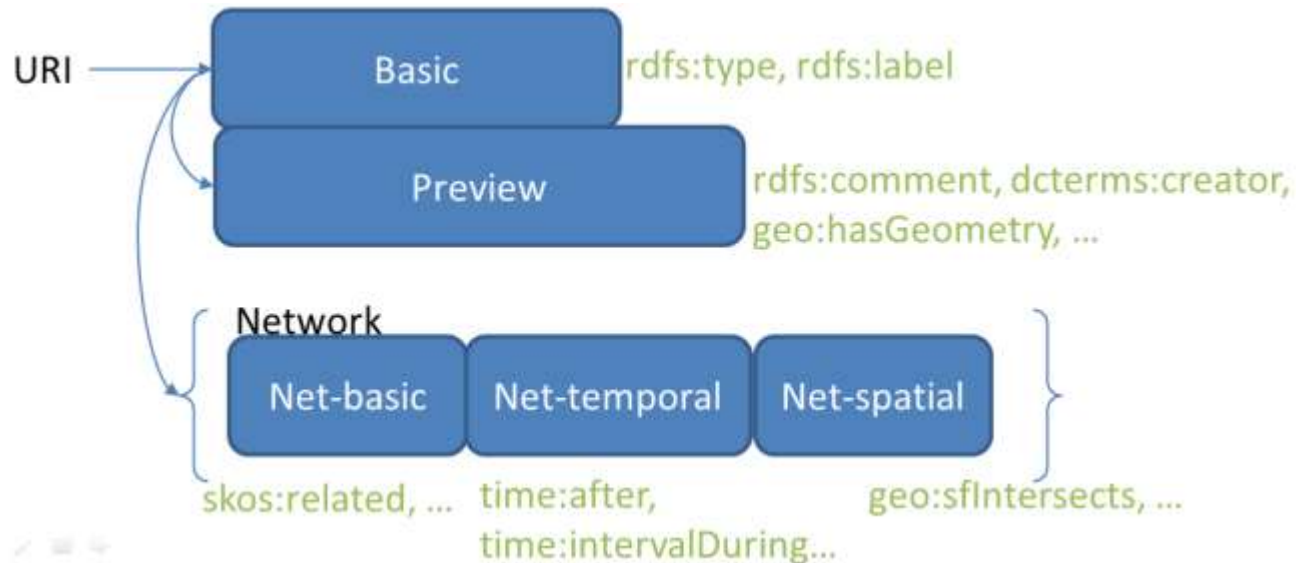
ELFIE Use Case Example

Hydrologic Drought



ELFIE View approach

- Rest operations or graph views
- Default encoding will be JSON-LD
- Draft predicates to be provided in responses:



ELFIE Relevance to INSPIRE

Links from Domain Features to Observations

- EF: EMF hasObservation
- OF/SR: PointObservationCollection; MarineContour sourceObservations
- SD: SpeciesDistributionUnit observations
- AC/MF: Purely Observations
- AQD: Air quality attainment/exceedance

Links from Observations to Domain Features

- D2.9 defines linking to monitoring facility / network

Further relevant Domain Features

- GE : (especially for hydrogeology) and AM (Area Management), HY (we'll expose EF monitoring rivers)

CNR-ISMAR In Situ Observation Network



Goals

Unique visible access point for the ISMAR observational network

**SOS Endpoint +
JSON HTTP API Endpoint for reading and
writing data**

Archiving and storing historical data

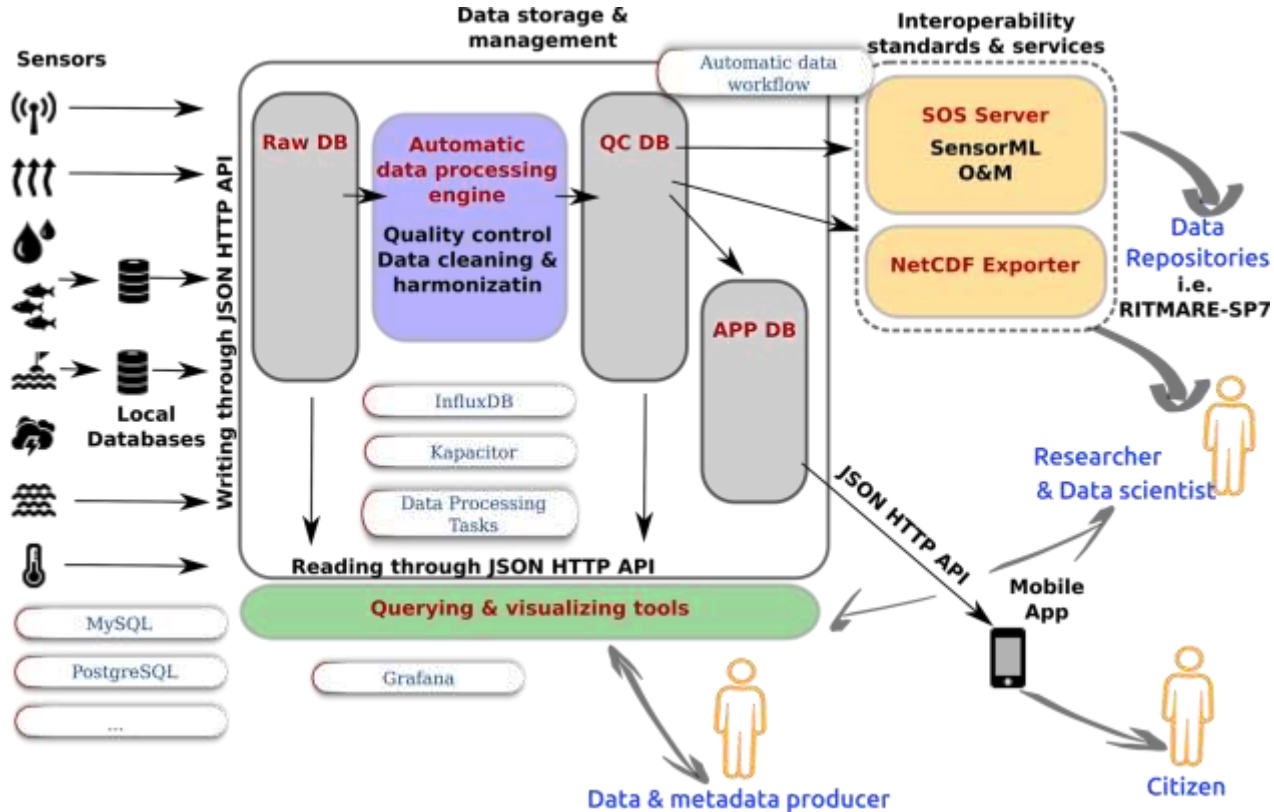
Real-time data streams for efficient operational
model

Interactive and efficient system

Interoperability

Open data

CNR-ISMAR Observation Network: architecture



CNR-ISMAR In Situ Observation Network



Interactive dashboards through JSON
HTTP API
InfluxDB + Grafana

CNR-ISMAR Observation Network: Data App



ISMAR Data

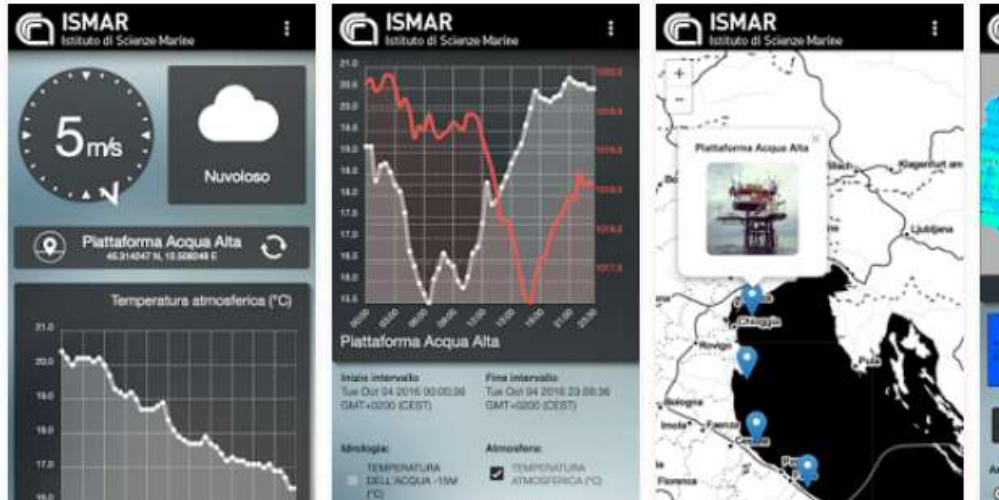
CNR-ISMAR Istituto di Scienze Marine Education



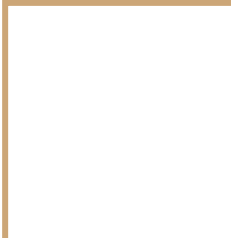
PEGI 3

This app is compatible with some of your devices.

Installed



Mobile APP Android, iOS
Reading through JSON HTTP API



Section 4 : Next steps and discussion

Please speak now!



Known deficits in OGC standards - next steps

getObservationById – not clear what id references pertaining to time series:

- Entire Timeseries
- Predefined temporal subsample

getDataAvailability V2 vs. Offering vs. ObsCaps:

- Partially parallel developments with overlaps
- Alignment would be beneficial

Use of SWE data arrays with sos:GetObservationResponse:

- further standardization required

(If you're interested in these and related topics, please join the cluster meeting as well as our various beery-breakout-evenings)

Next steps in Guidance Documentation

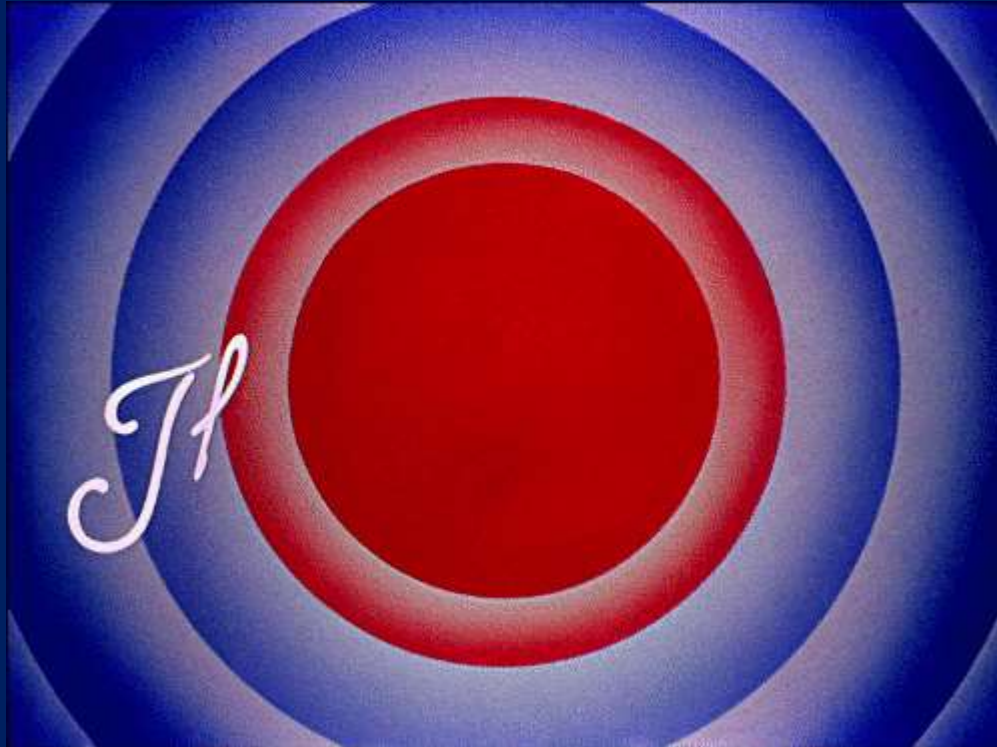
(D2.9 and SOS)

- SensorML 2.0 handling
- Integration with OGC TimeSeriesML 1.0 standard
- JSON Encoding and RESTful architecture for INSPIRE observation data
- Event handling and asynchronous transactions
- Potential usage of OGC SensorThings API as an INSPIRE download service
- Pub/Sub and event-based architectures
 - MQTT
 - SensorThingsAPI
- Alignment of data citation with Research Data Alliance activities
- Semantic integration

Discussion...



Thanks for your attention



© Disney

Providing INSPIRE measurement data

Thanks for your attention!



Cast: (alphabetic order)

- Alessandro Oggioni
- Alessandro Sarretta
- Alexander Kotsev
- Kathi Schleidt
- Mickael Beaufils
- Paolo Tagliolato
- Simon Jirka
- Sylvain Grellet