



RÉPUBLIQUE
FRANÇAISE

*Liberté
Égalité
Fraternité*



Géosciences pour une Terre durable

brgm

PUTTING ALL THIS TOGETHER IN A PROJECT



Sylvain Grellet – BRGM
ENSG – mastère GDM – 2023-01-20

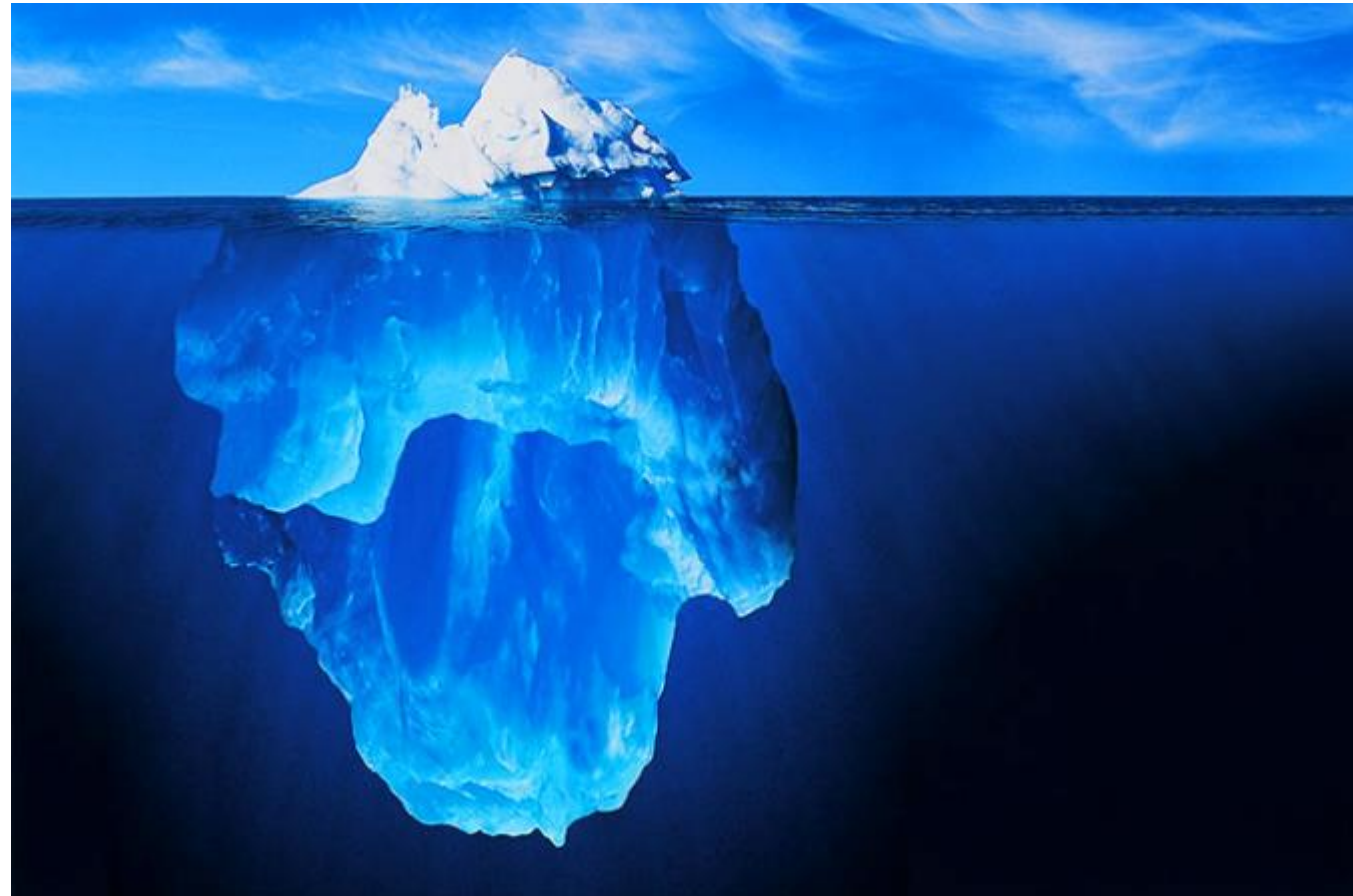




Interoperable / FAIR data in a project – How ?

What not to do

- Consider the “Data” Portal / GUI (@fr 'IHM') of a project to be the only target



A GUI

Interoperable APIs

Interoperable Semantics

Data Architecture

System Architecture

Disclaimer : not willing to standardize scientists brains, rather give them time for their real work

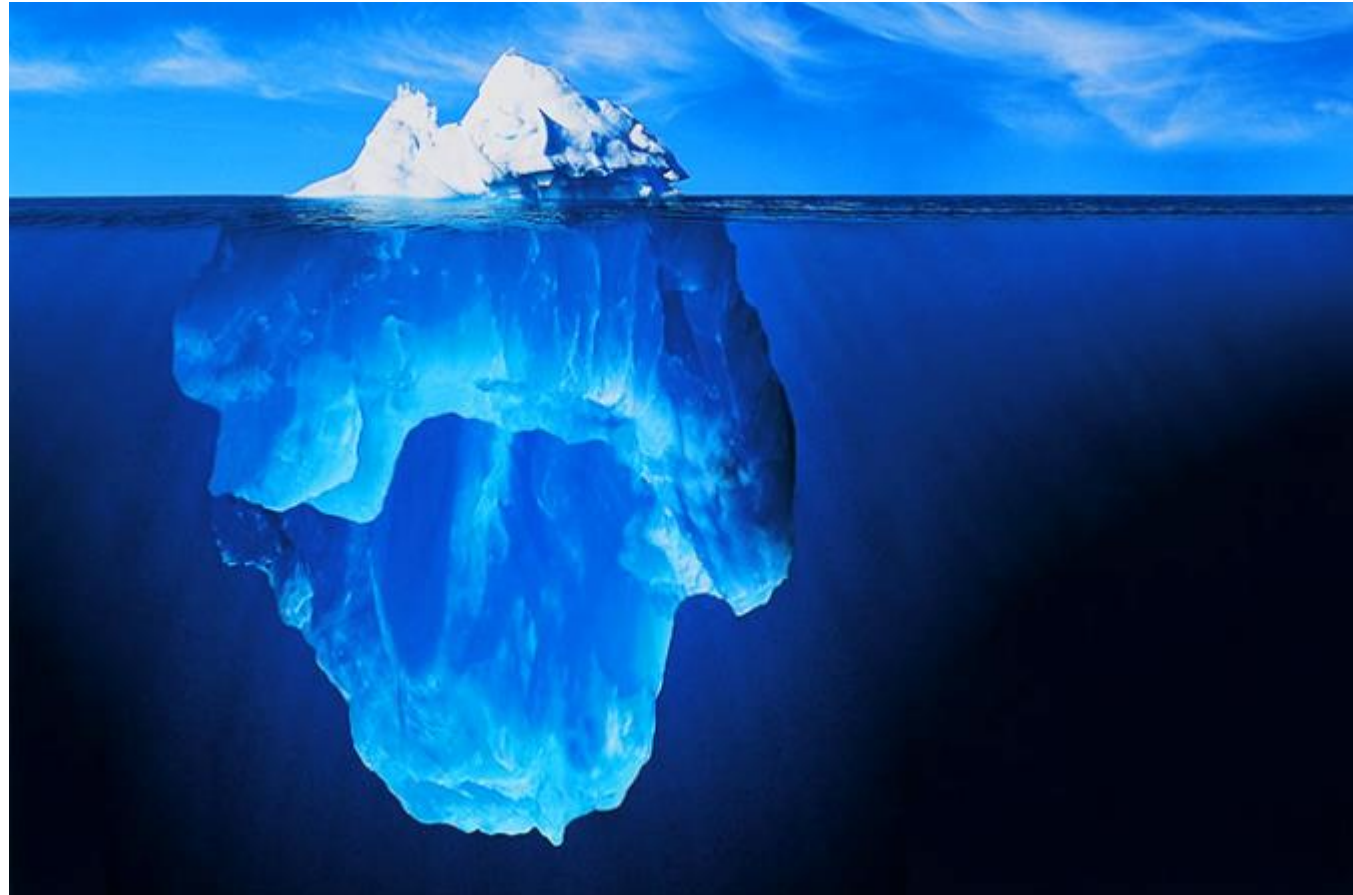


Interoperable / FAIR data in a project – How ?



What to do

- Have a holistic approach, taking all the facets of the iceberg into consideration





The FAIR ecosystem

Relies on 3 core elements

Semantic and technical
interoperability standards
/ best practices



Open-source
implementations

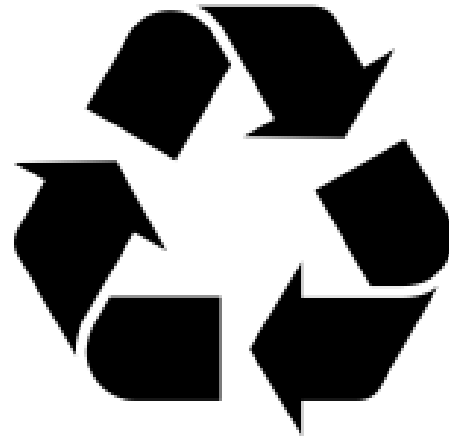
International domains
communities building
on FAIR



The FAIR ecosystem

Relies on 3 core elements linked altogether by a virtuous cycle

Semantic and technical
interoperability standards
/ best practices



Open-source
implementations

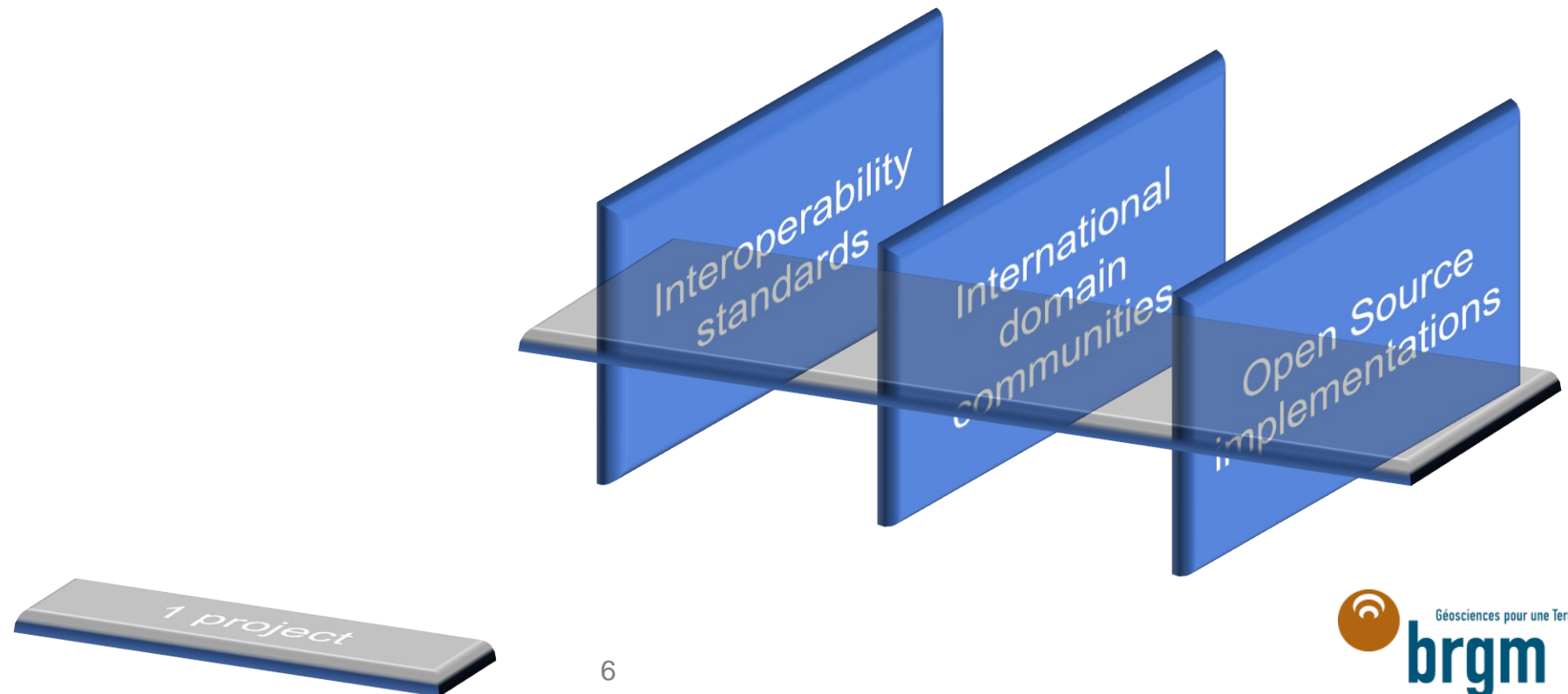
International domains
communities building
on FAIR



Interoperable / FAIR data in a project – How ?

The challenge is to have that ecosystem implemented in the project

- It shall be the DNA of every project to build on it
 - And not add / shoehorn interoperability / FAIR principles at the end to expose content. Interoperability principles are not only for exposing data to the outside. They are crucial within the system itself.



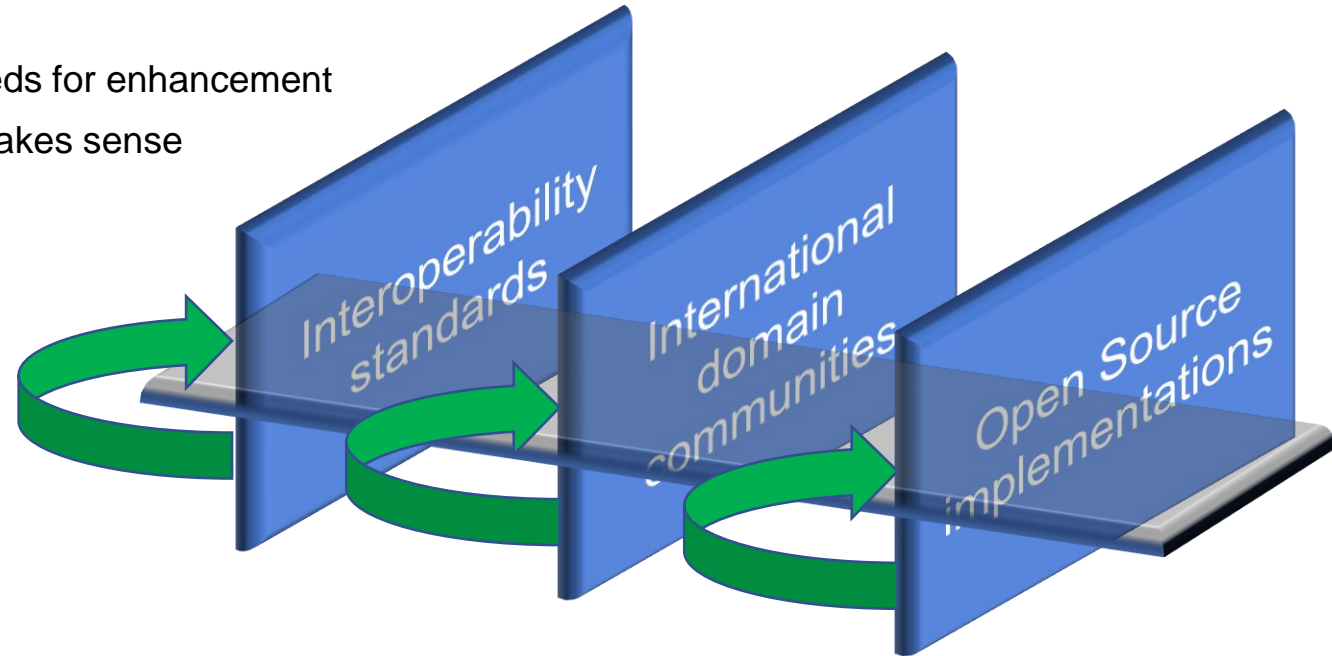


Interoperable / FAIR data in a project – How ?



and make the project implementation part of the ecosystem

- If the project meets limitations / needs for enhancement
 - It feedbacks to the group that makes sense



- Examples:
 - OGC API for Observations (OGC SensorThings API) test : CSV was not part of the output formats. BRGM worked with Fraunhofer / DataCove to specify it. Now it's part of an extension and also one of the reference implementation.
 - BRGM in Observations & Measurements -> Change Requests -> Co-Lead of the OGC/ISO standard revision -> many systems ask us for Guidelines on how to implement it
- Positive “side effect”
 - Contributions to those core elements are visible : this also lead to publications or visible contributions to the communities. It also help those doing core IT work in the tools to have their contribution visible.

Disclaimer : not willing to standardize scientists brains, rather give them time for their real work



Integration in a project

Work sequence

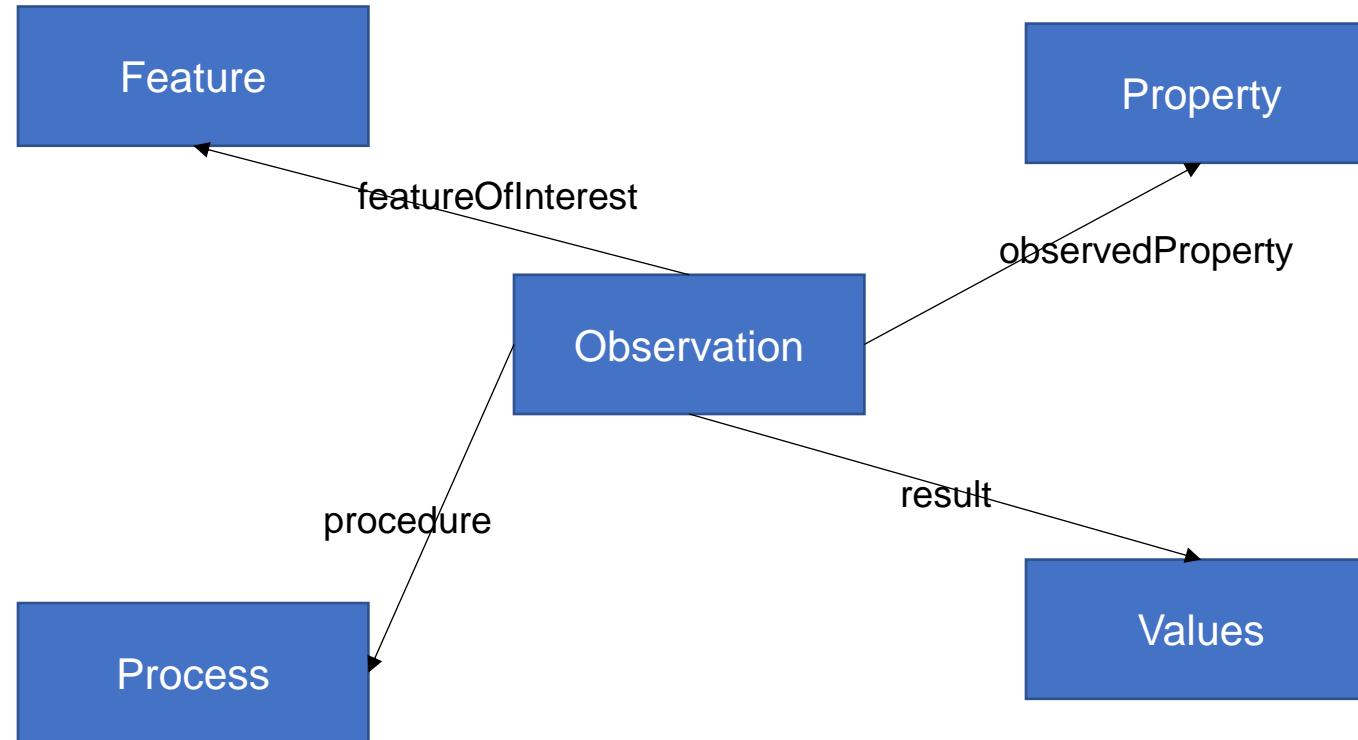
- 0°/ Use Case
 - IT 101, Best Practices => no Use Case, no project ☺
- 1°/ clarify data considerations with domain experts
 - Semantics, provider, transformations etc...
 - Don't only follow the GUI mermaids
 - UX/UI limited to GUI is nice but only looking at this leads to forgetting data semantics. Good data semantics & semiology leads to a better UX/UI.
- 2°/ identify which API to ingest/expose what
 - Knowing what data the projects handles and what are the expected UseCase will help identify the API
- GUI
 - Could work alongside the others, provided a proper feedback loop exists with steps 1 and 2

Some examples

- Generic Observations & Measurements (OM) example : Environmental observation use case
- OM with domain model (river) : OMS level 1 example : surface water quantity (height gage)
- OM with domain model (river) + looooot of related observations : OMS level 2 example : surface water quality (samples)
- EPOS : Multi-standards integration in an Enterprise Architect project

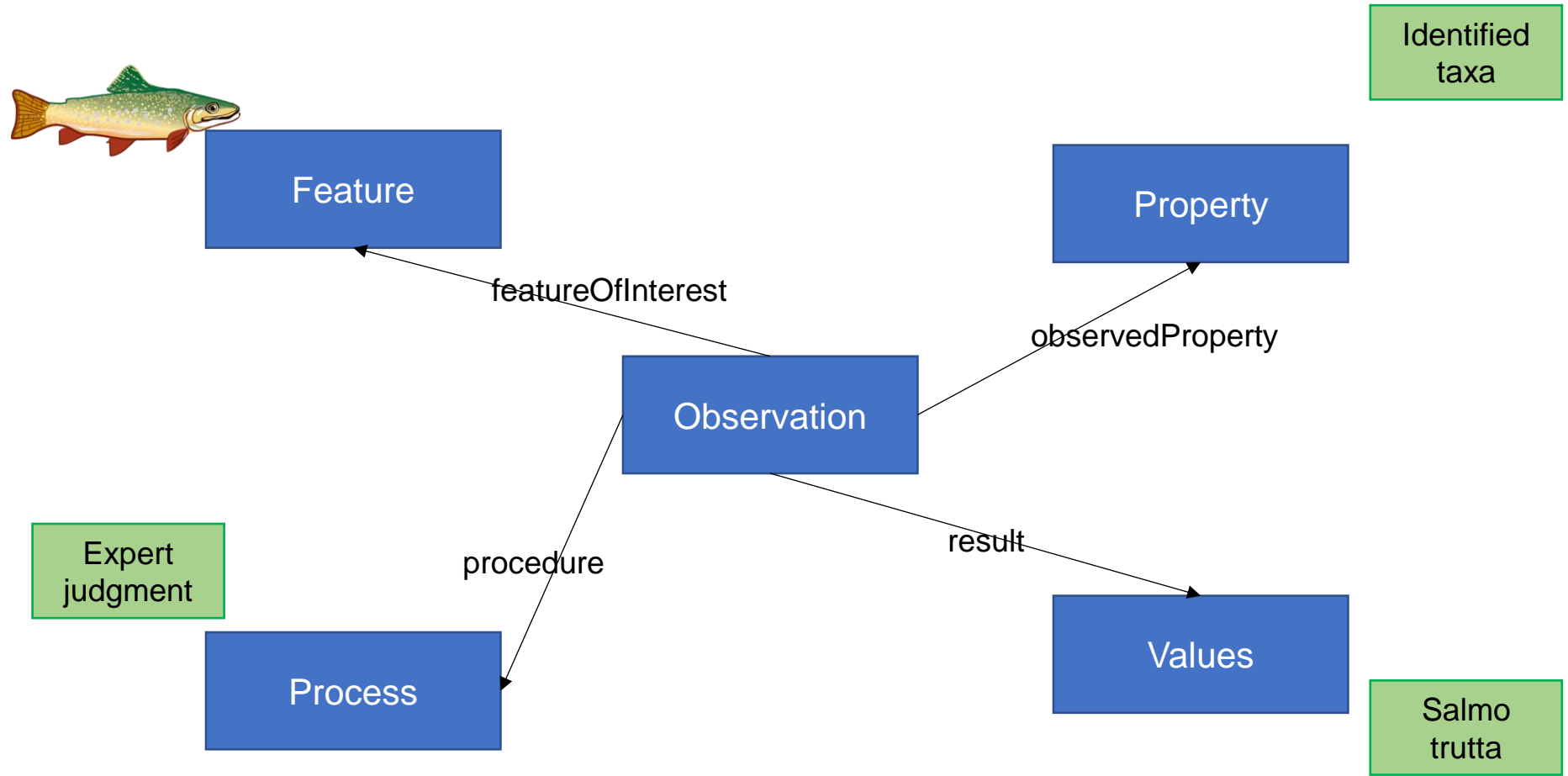
Environmental observation use case - overview

The reference point : Observations & Measurements (O&M)



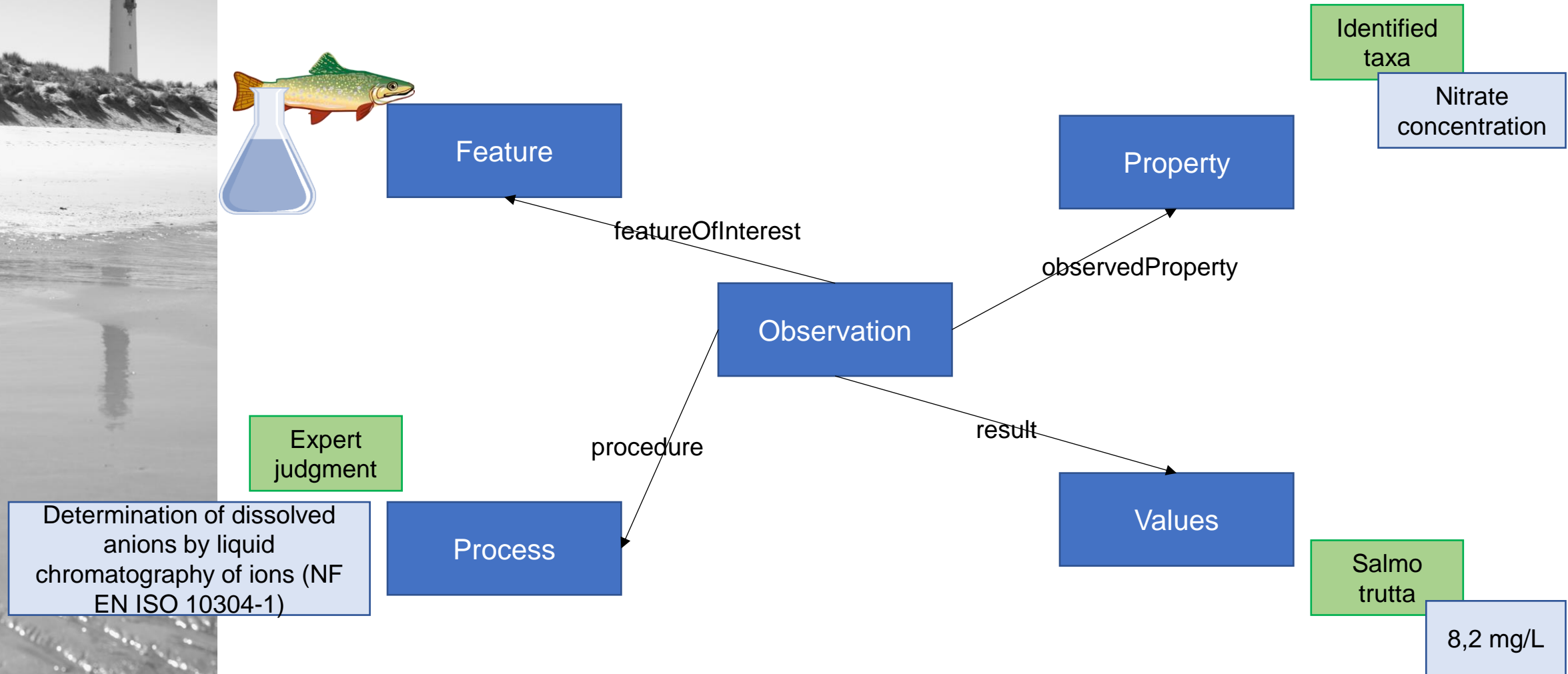
Environmental observation use case - overview

The reference point : Observations & Measurements (O&M)



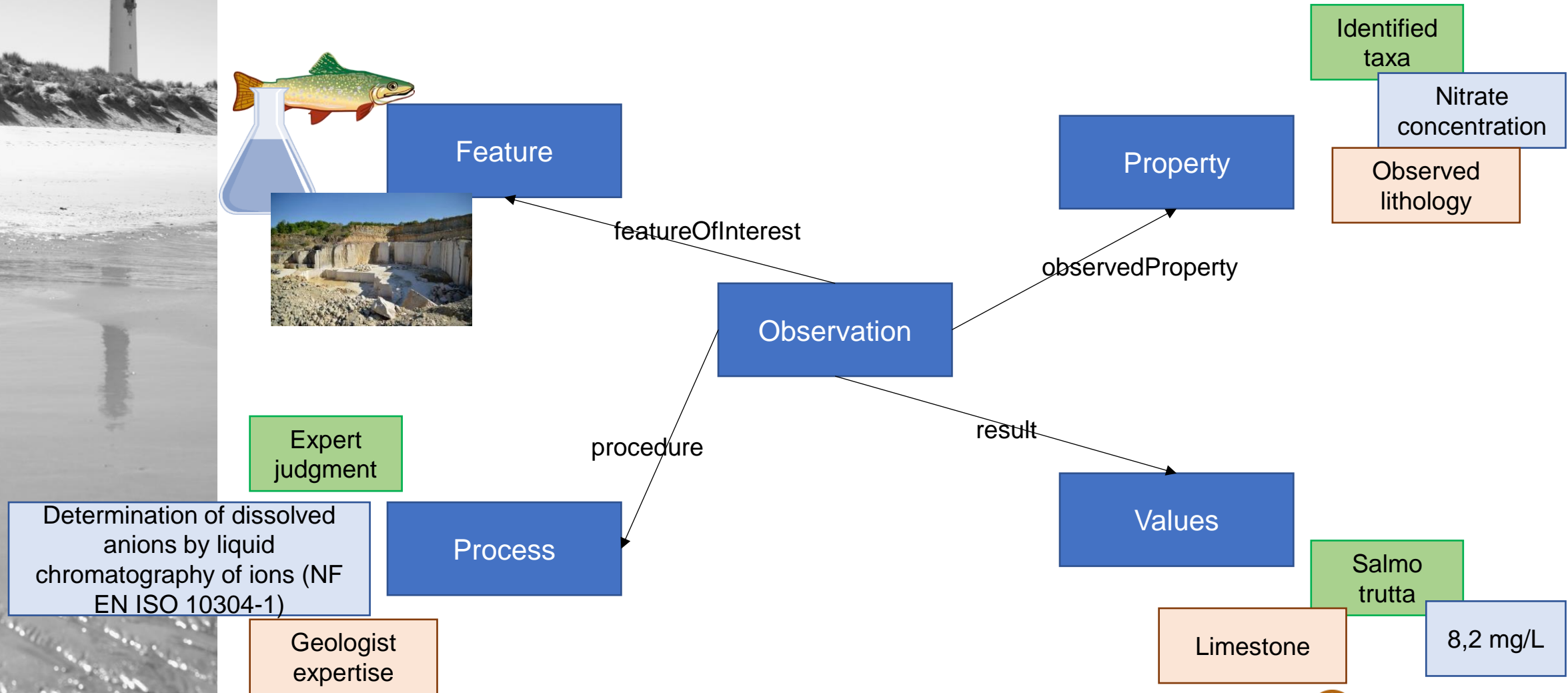
Environmental observation use case - overview

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Environmental observation use case - overview

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Environmental observation use case - overview

RESTful API implementing O&M : SensorThings API

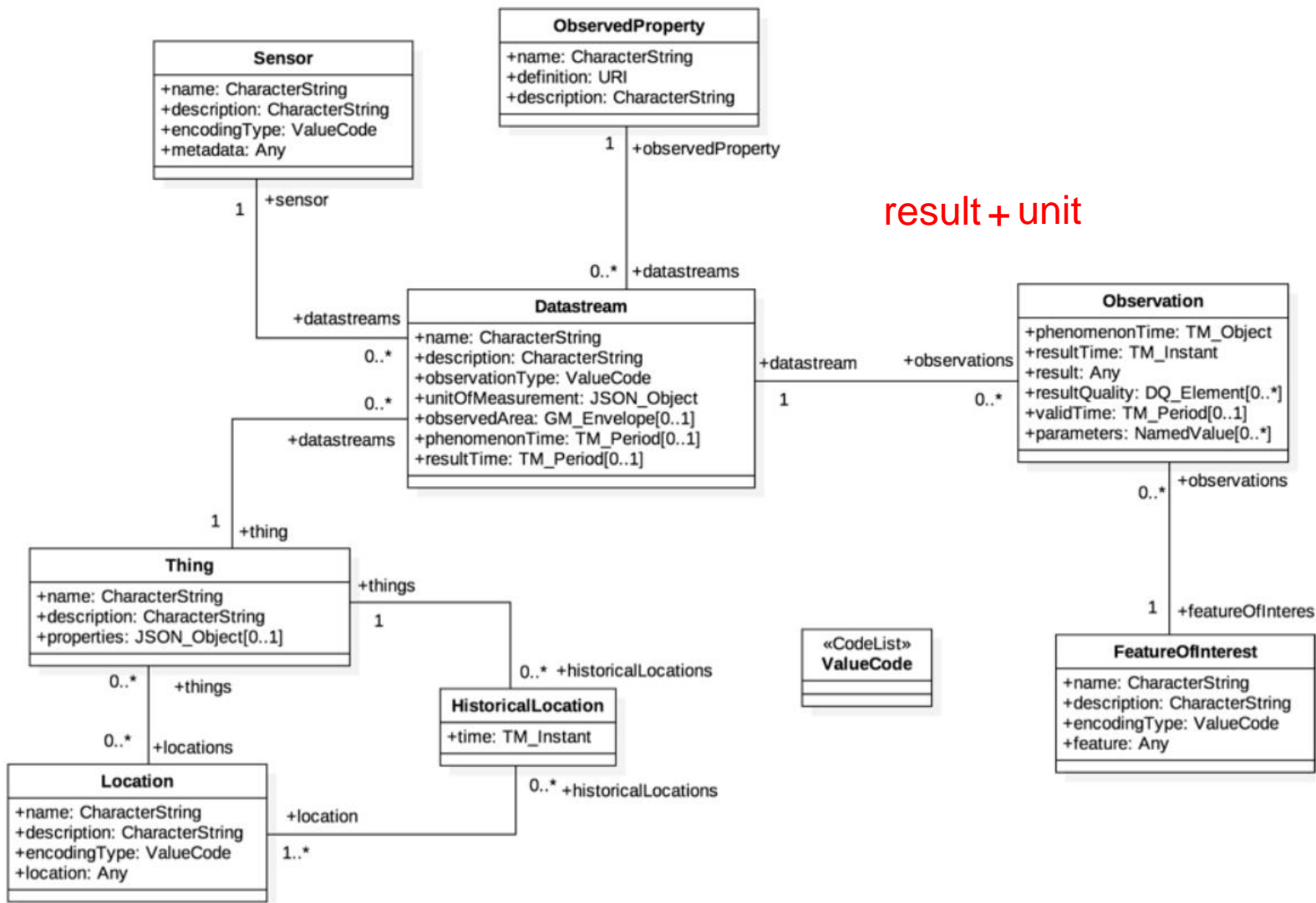


Figure: 2: Sensing Entities



Environmental observation use case - overview

RESTful API implementing O&M : SensorThings API

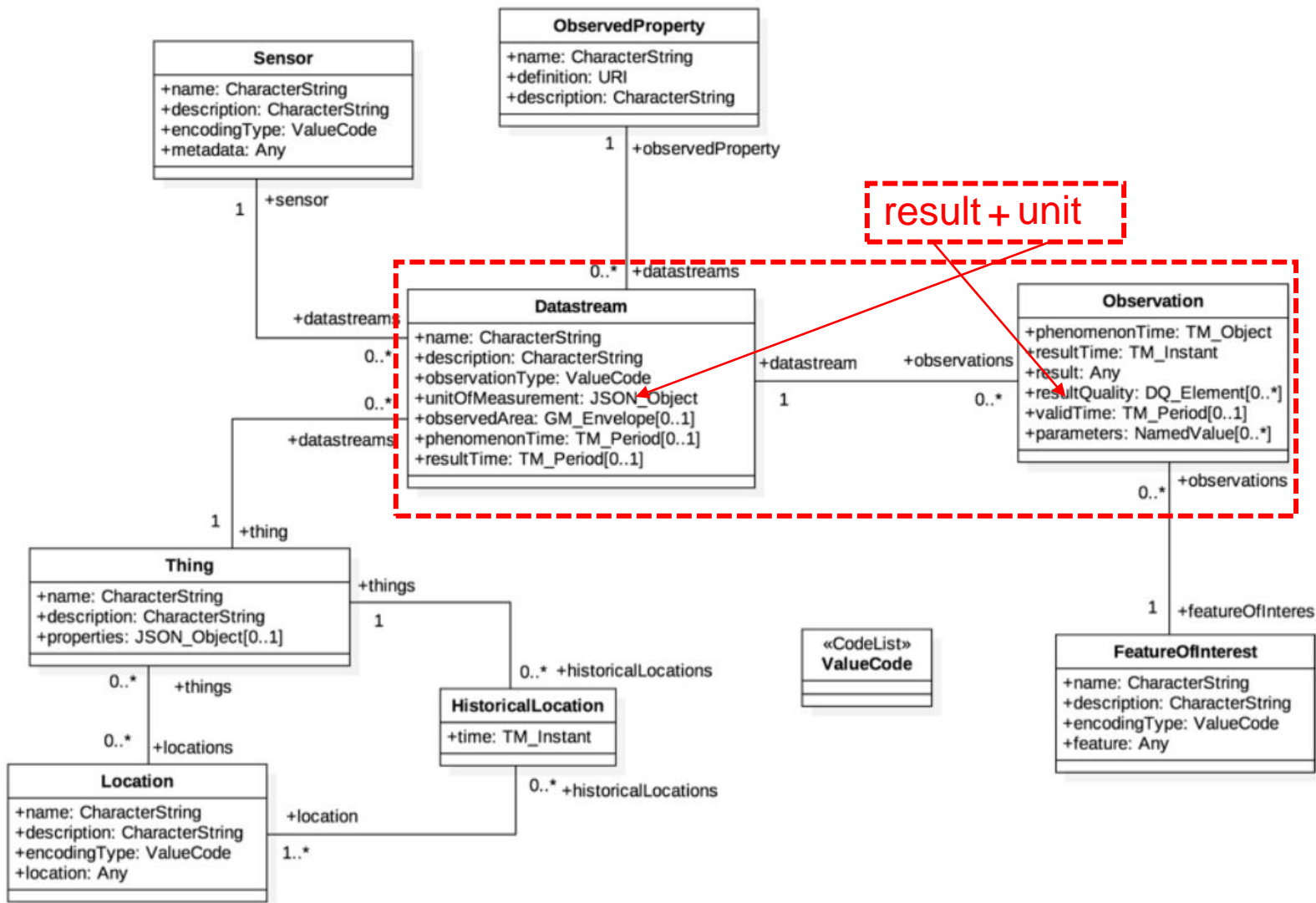


Figure: 2: Sensing Entities



Environmental observation use case - overview

RESTful API implementing O&M : SensorThings API

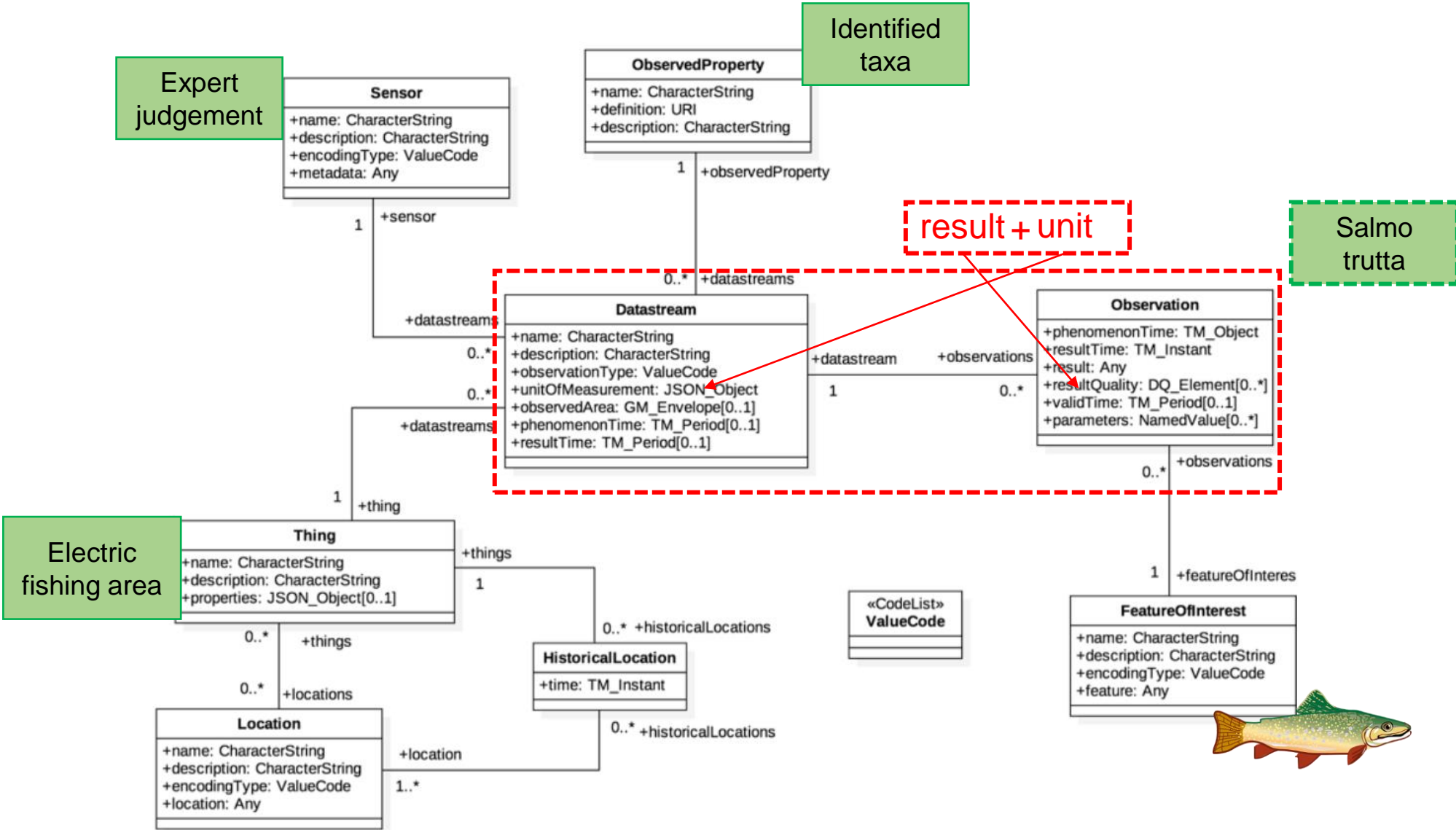


Figure: 2: Sensing Entities

Environmental observation use case - overview

RESTful API implementing O&M : SensorThings API

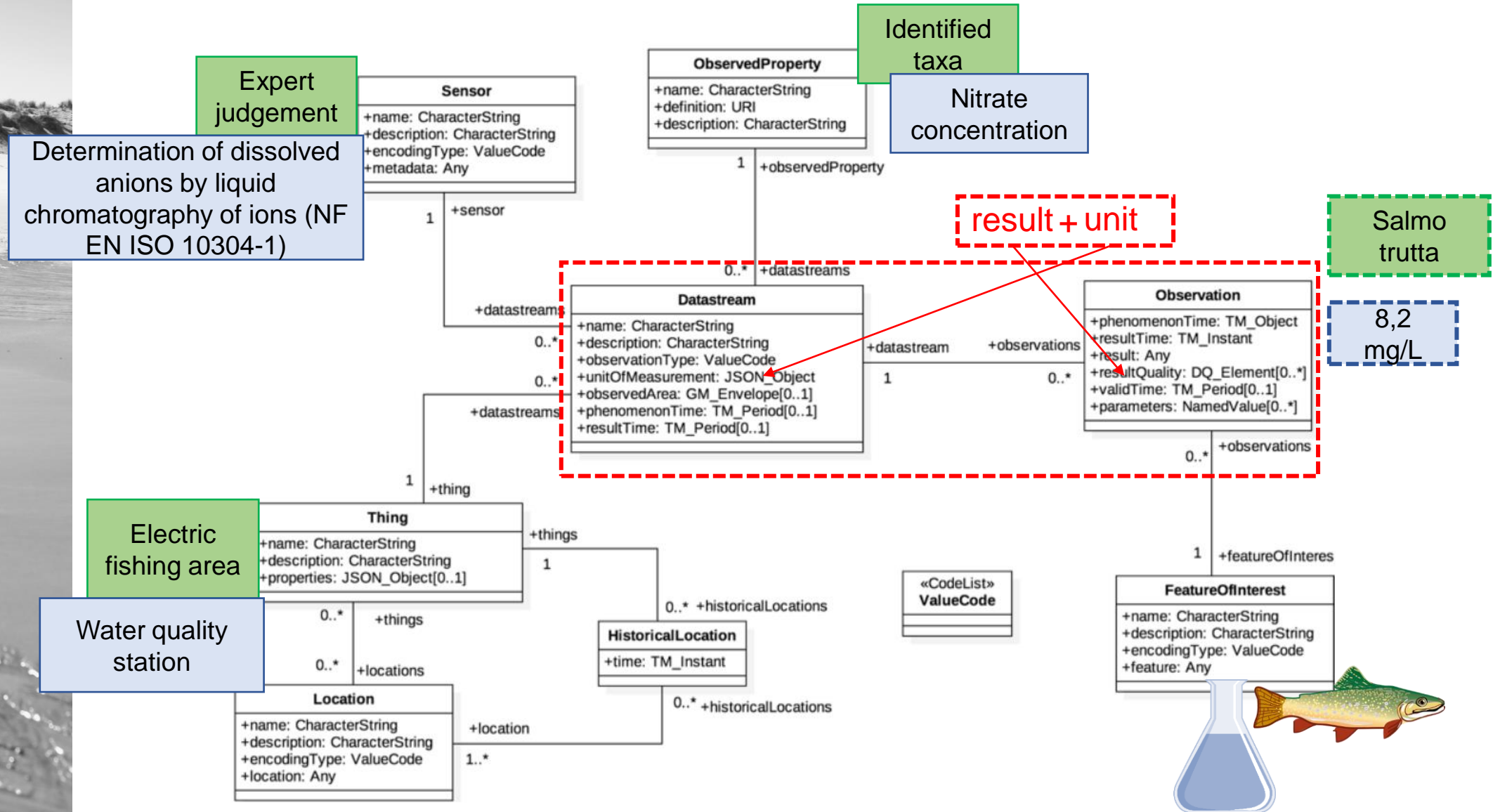


Figure: 2: Sensing Entities

Environmental observation use case - overview

RESTful API implementing O&M : SensorThings API

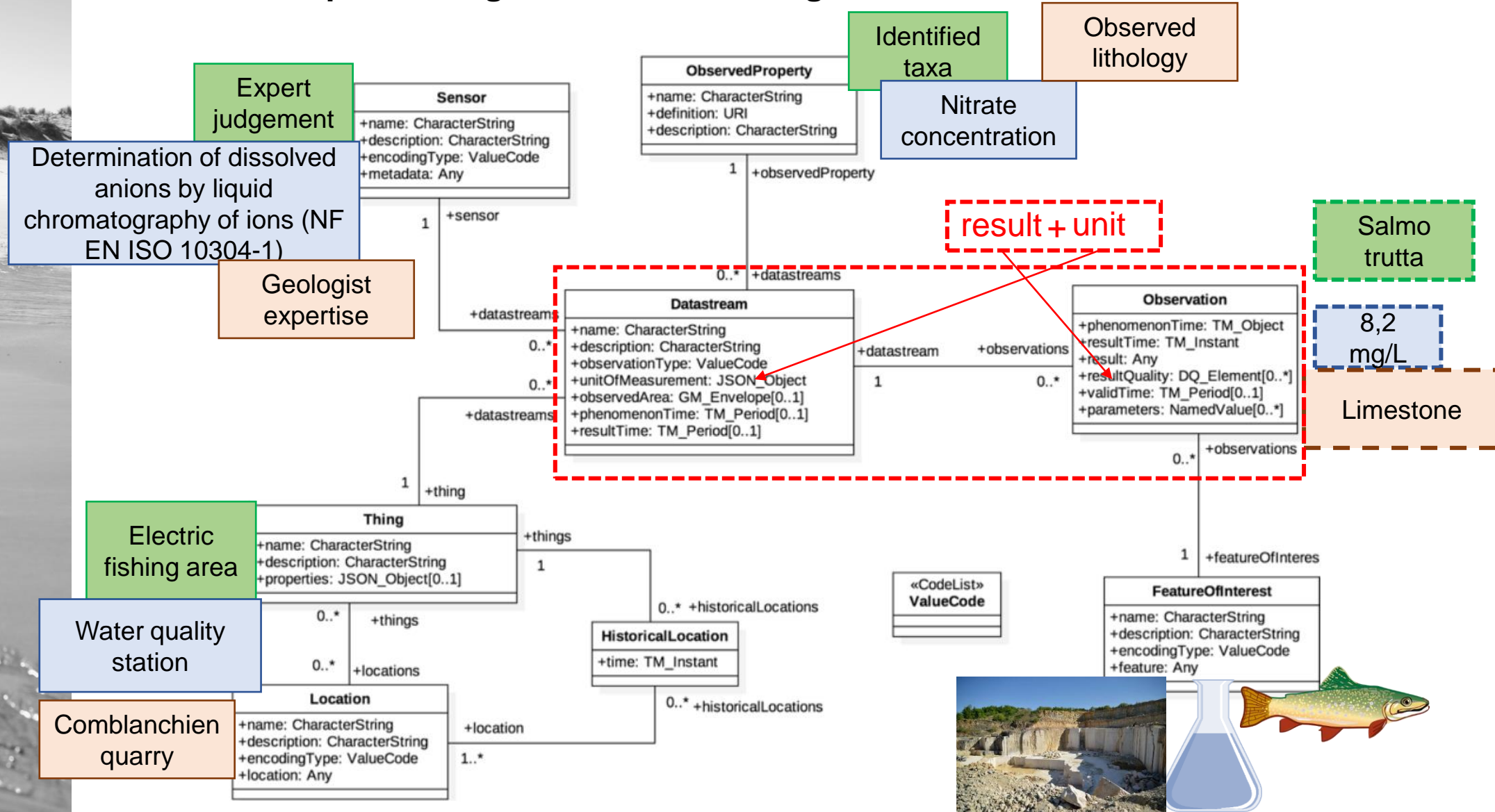
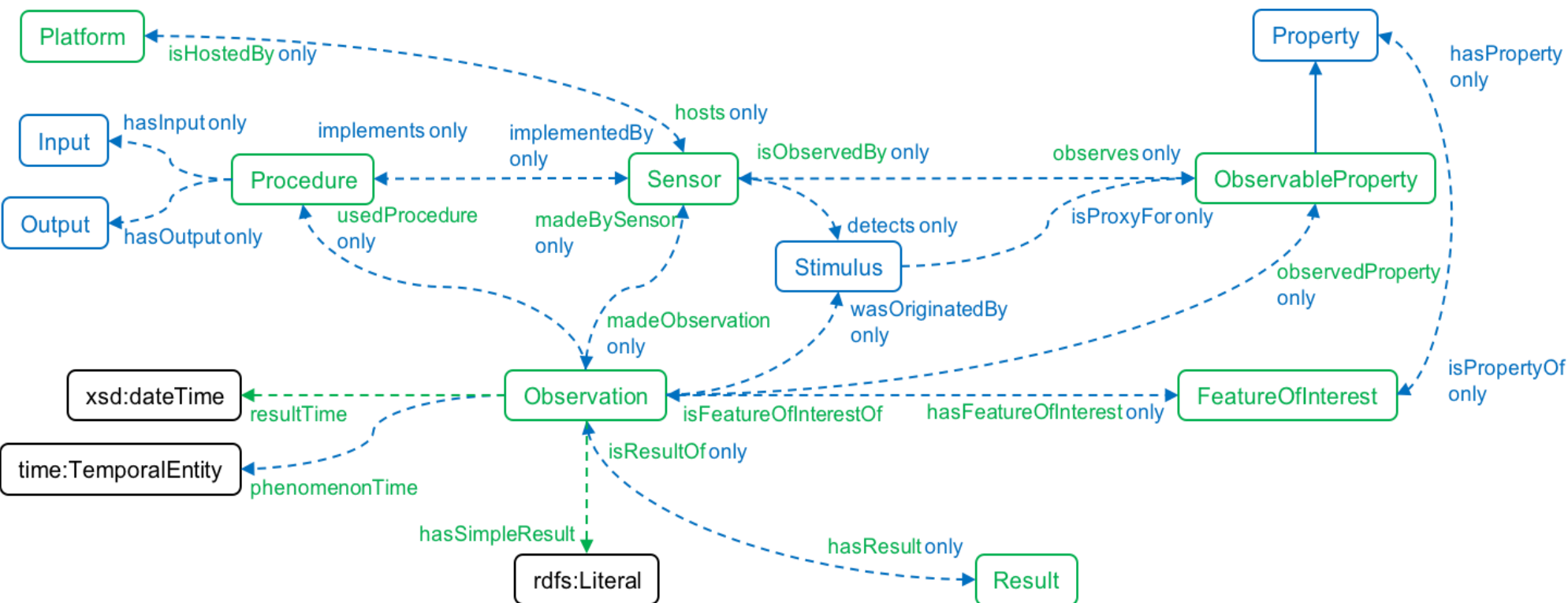


Figure 2: Sensing Entities



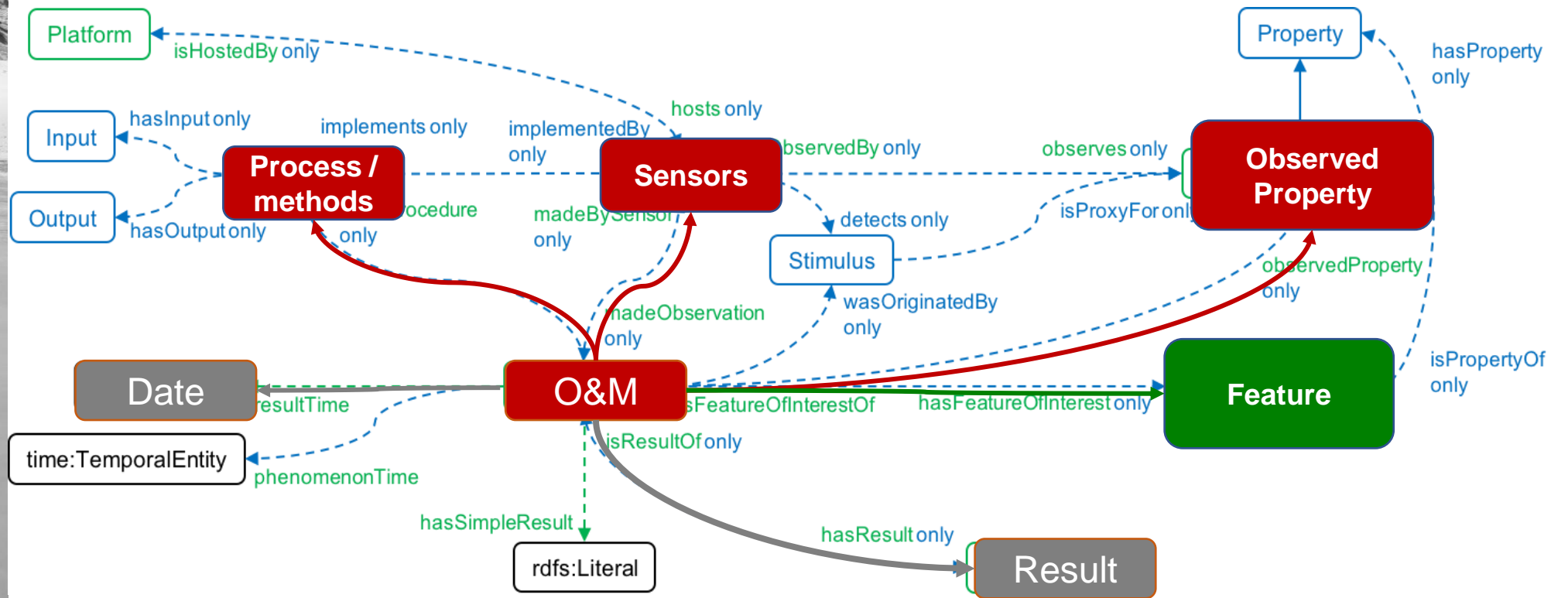
Environmental observation use case - overview

W3C Ontology « inspired from » O&M » : SSN / SOSA



Environmental observation use case - overview

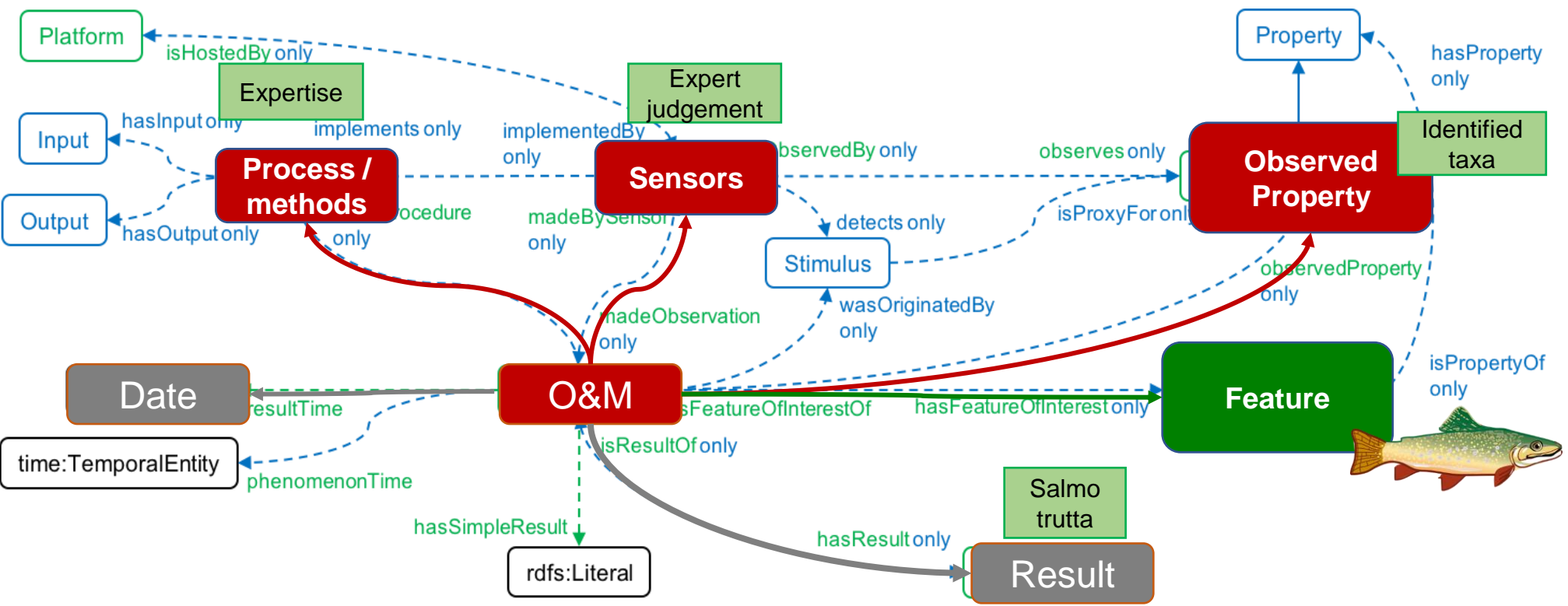
W3C Ontology « inspired from » O&M » : SSN / SOSA





Environmental observation use case - overview

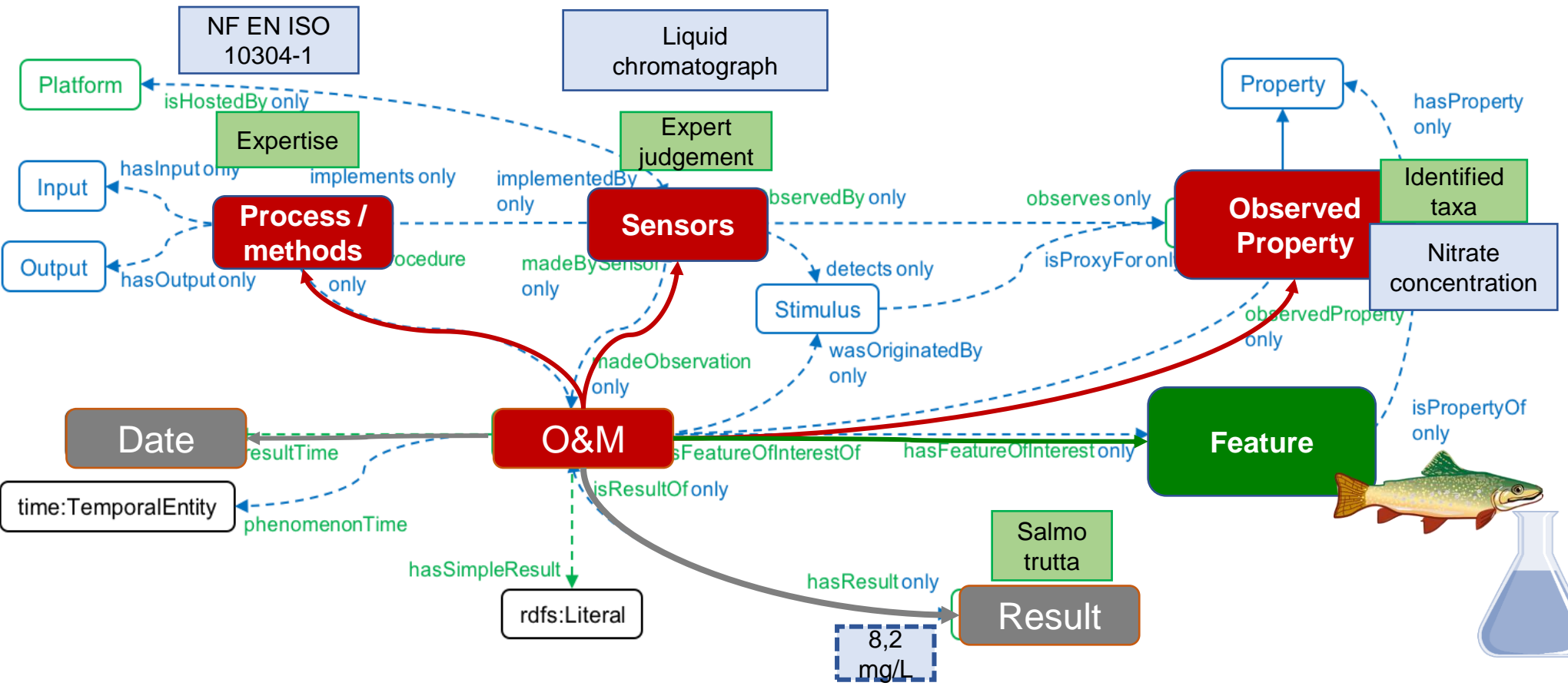
W3C Ontology « inspired from » O&M » : SSN / SOSA





Environmental observation use case - overview

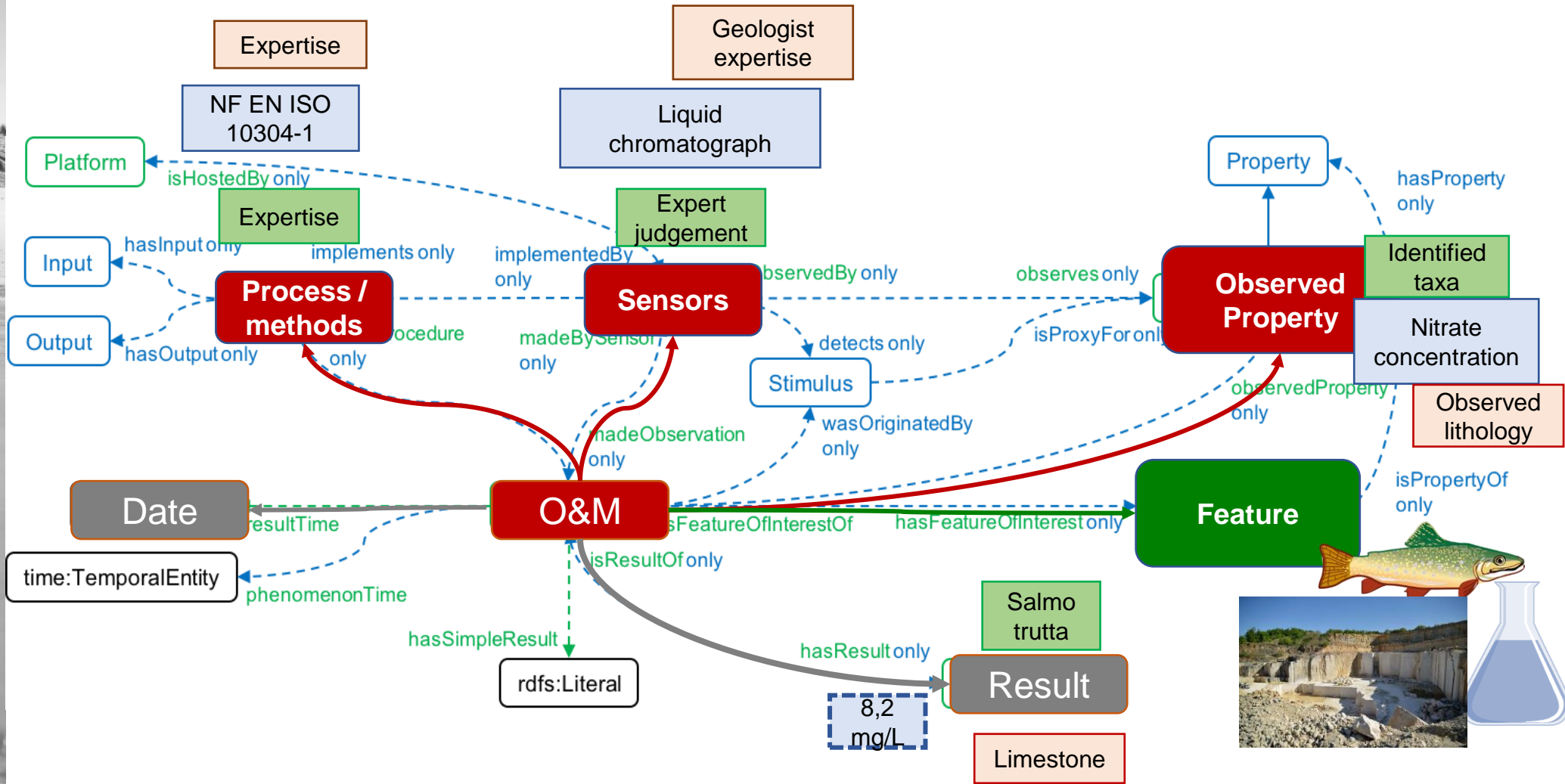
W3C Ontology « inspired from » O&M » : SSN / SOSA





Environmental observation use case - overview

W3C Ontology « inspired from » O&M » : SSN / SOSA



Environmental observation use case – with vocabularies

Features described in a domain model outside O&M



Feature

Observed properties
<https://data.geoscience.fr/ncl/ObsProp>

Property

Identified taxa

Nitrate concentration

Observed lithology

featureOfInterest

observedProperty

Observation

result

Values

Expert judgement

Determination of dissolved anions by liquid chromatography of ions (NF EN ISO 10304-1)

Process

Geologist expertise

Methods / process :
<https://data.geoscience.fr/ncl/Proc>

Salmo trutta

8,2 mg/L

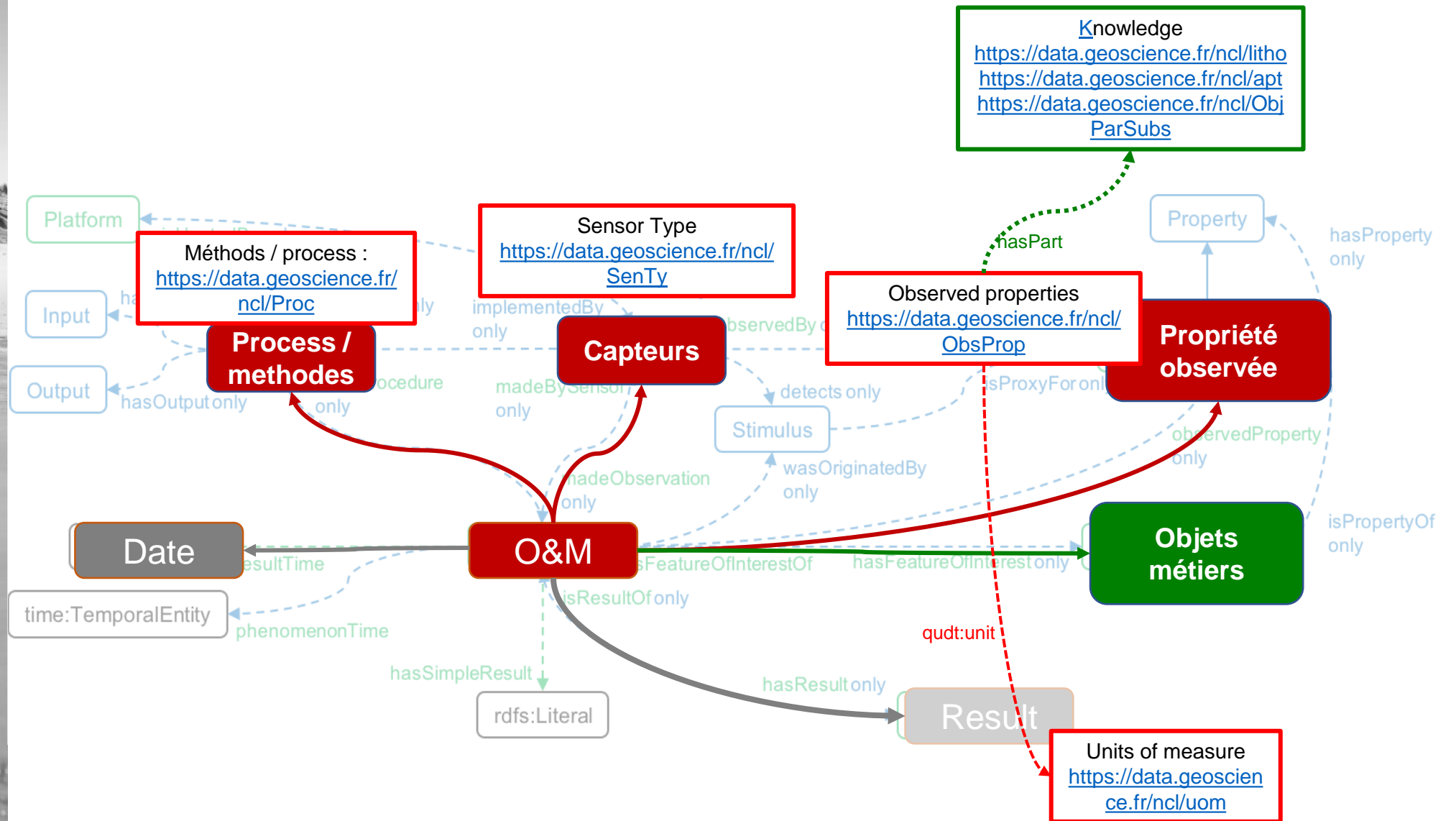
Unit of measures
<https://data.geoscience.fr/ncl/uom>

Limestone

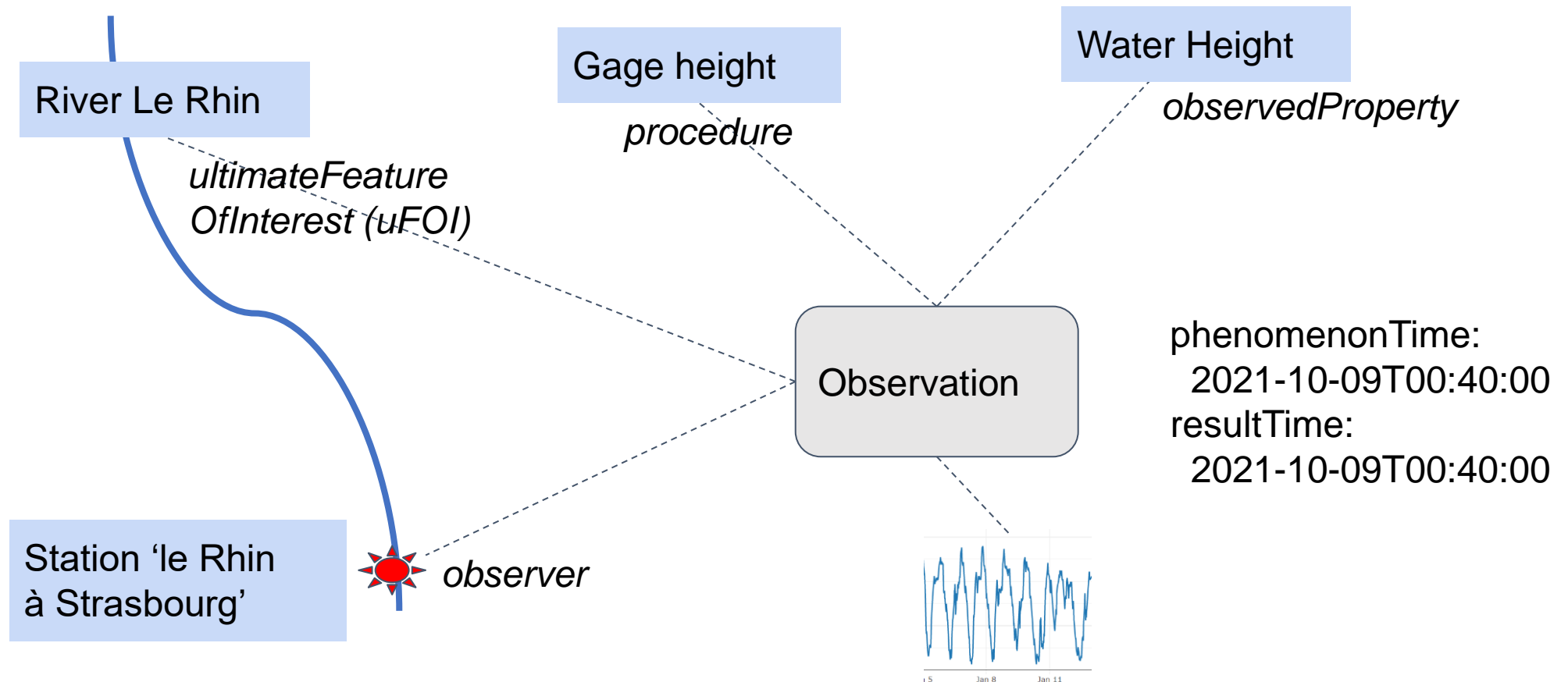
Knowledge
<https://data.geoscience.fr/ncl/litho>
<https://iddata.eaufrance.fr/ncl/apt>
<https://data.geoscience.fr/ncl/ObjParSubs>



Environmental observation use case – with vocabularies

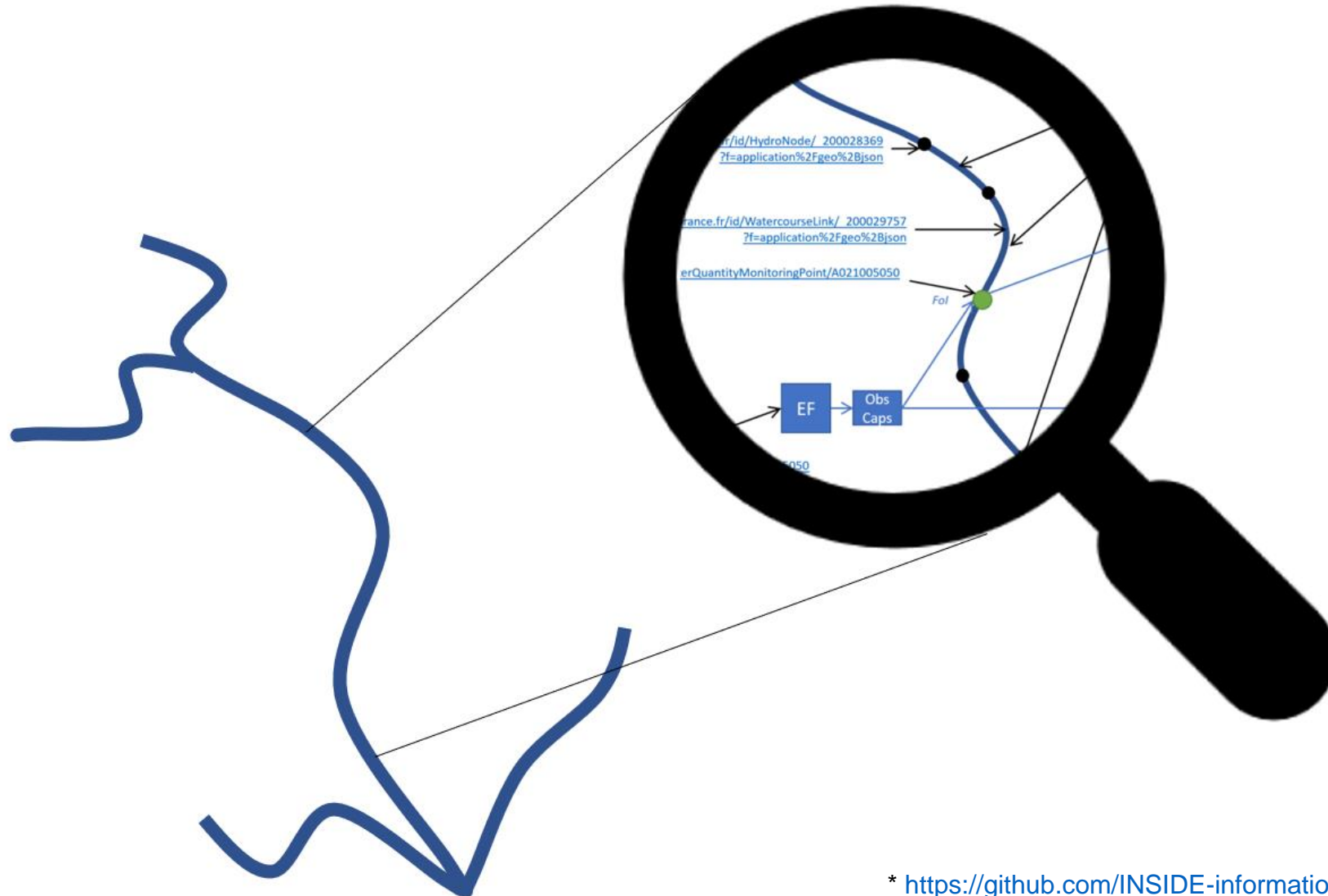


OMS level 1 example : surface water quantity (height gage)



OMS level 1 example : surface water quantity *

@fr 'Le Rhin', @en "The Rhine" river



* <https://github.com/INSIDE-information-systems/API4INSPIRE>

OMS level 1 example : surface water quantity

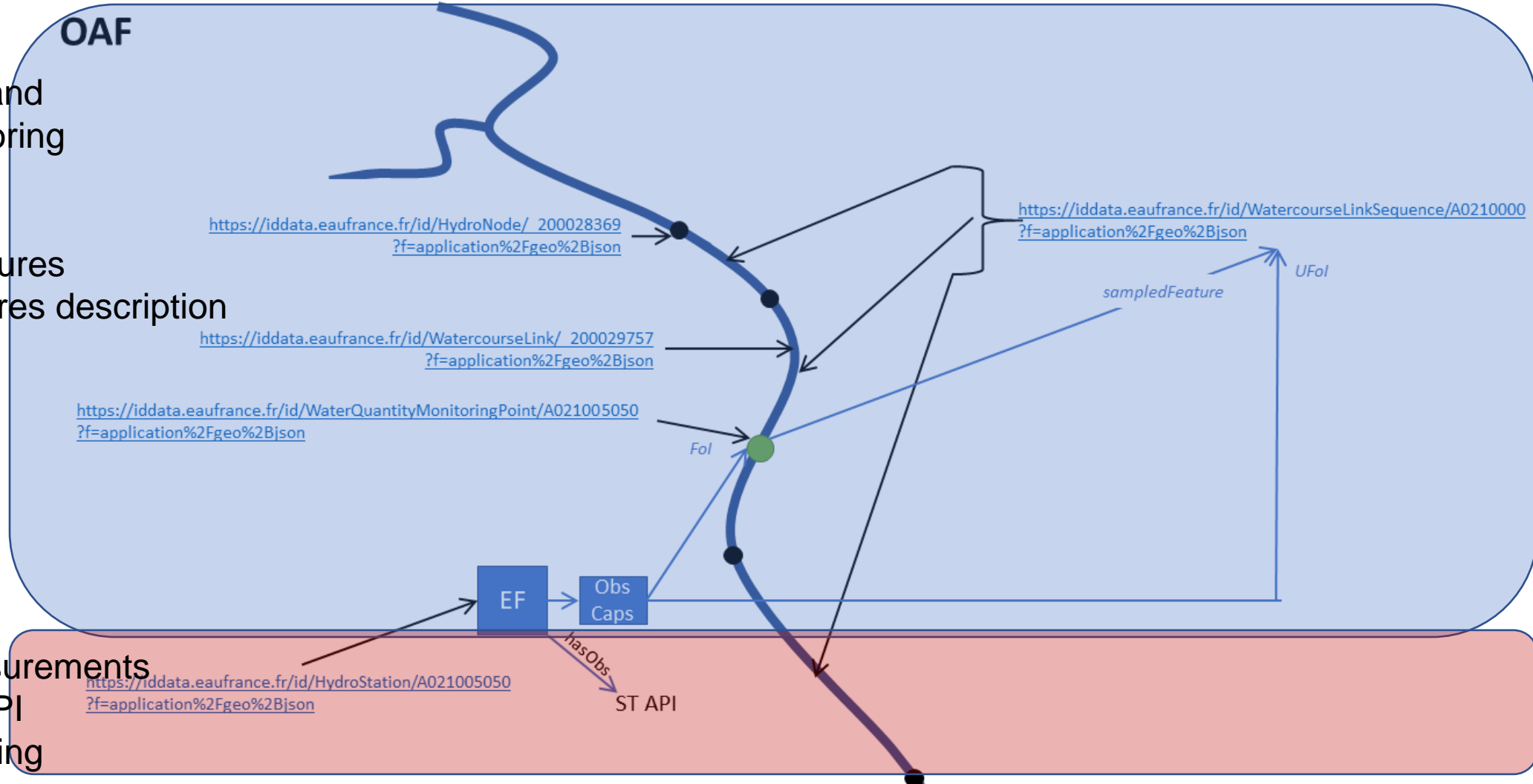
Which standard for which type of information

<https://iddata.eaufrance.fr/api/hydroFAPI/ogc/features/collections/>

Semantics:
INSPIRE Hydrology and
Environmental Monitoring
Facility themes

API: OGC API – Features
For Geospatial Features description

Semantics
Observations & Measurements
API: SensorThings API
For Observation sharing



Station

le : surface water quantity

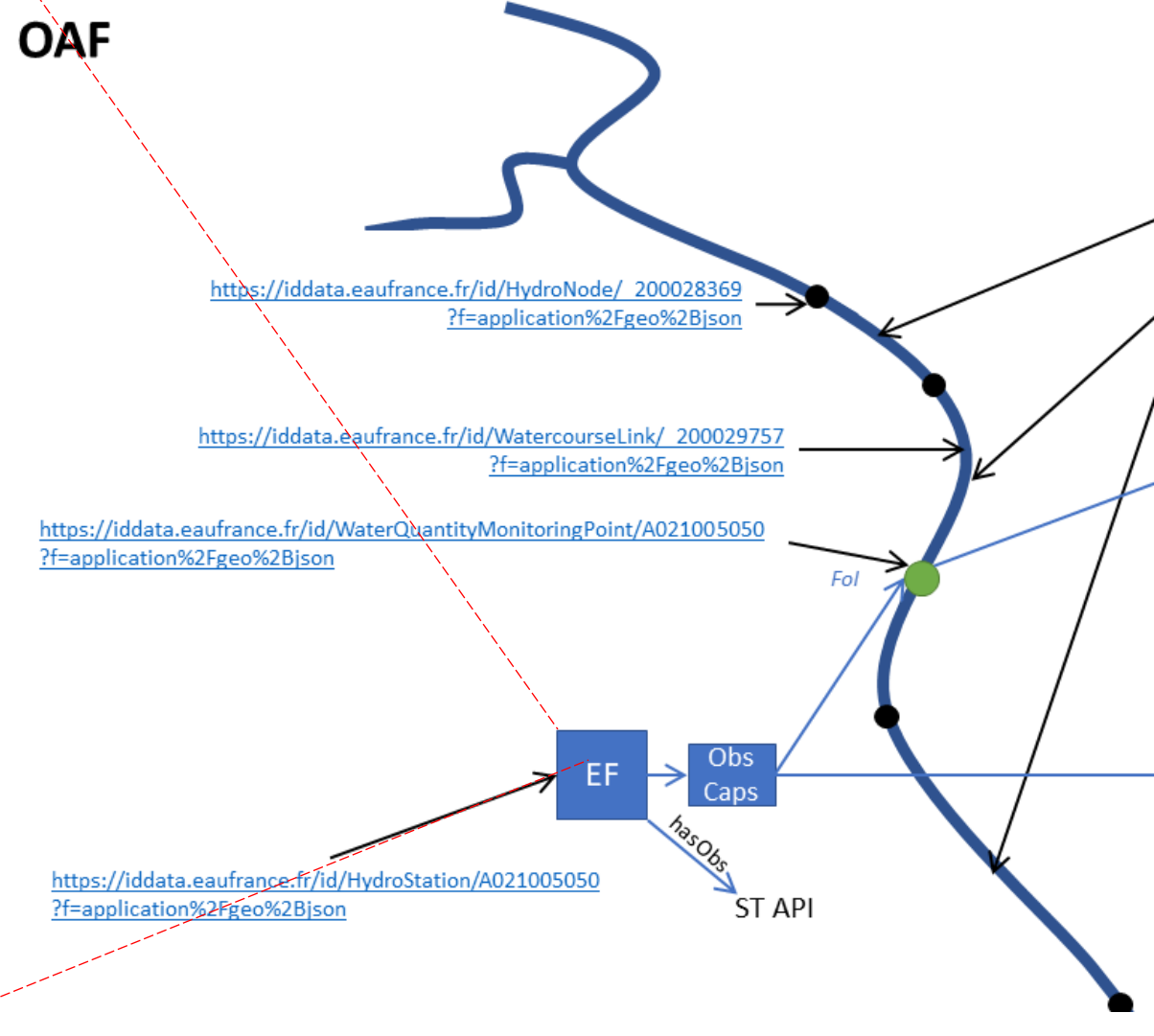
```

{
  "type": "Feature",
  "id": "A021005050",
  "geometry": { ... }, // 2 items
  "properties": {
    "@featureType": "EnvironmentalMonitoringFacility",
    "identifiier": {
      "value": "https://iddata.eaufrance.fr/id/HydroStation/A021005050",
      "@codeSpace": "http://www.ietf.org/rfc/rfc2616"
    },
    "inspireId": { ... }, // 3 items
    "name": "Le Rhin en Suisse [Rheinhalle]",
    "mediaMonitored": [
      {
        "@href": "http://inspire.ec.europa.eu/codelist/MediaValue/water"
      }
    ],
    "observingCapability": [
      {
        "observingTime": {
          "@dataType": "observingTime",
          "TimePeriod": { ... } // 3 items
        },
        "processType": {
          "@href": "https://inspire.ec.europa.eu/codelist/ProcessTypeValue/process"
        },
        "resultNature": {
          "@href": "https://inspire.ec.europa.eu/codelist/ResultNatureValue/primary"
        },
        "procedure": {
          "@href": "http://id.eaufrance.fr/nsa/512#0",
          "@title": "MeasuredBySensor"
        },
        "featureOfInterest": { ... }, // 1 item
        "ultimateFeatureOfInterest": [
          {
            "@href": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A0210000"
          }
        ],
        "observedProperty": {
          "@href": "http://id.eaufrance.fr/nsa/509#H",
          "@title": "WaterLevel"
        }
      }
    ],
    "hasObservation": [
      {
        "@href": "https://iddata.eaufrance.fr/id/ObservationCollection/SurfacewaterQuantity/A021005050",
        "@title": "A021005050 surfacewater quantity observation collection."
      }
    ]
  }
}

```

<https://iddata.eaufrance.fr/api/hydroFAPI/ogc/features/collections/>

OAF



Station

le : surface water quantity

```
{
  "type": "Feature",
  "id": "A021005050",
  "geometry": { ... }, // 2 items
  "properties": {
    "@featureType": "EnvironmentalMonitoringFacility",
    "identifier": {
      "value": "https://iddata.eaufrance.fr/id/HydroStation/A021005050",
      "@codeSpace": "http://www.ietf.org/rfc/rfc2616"
    },
    "inspireId": { ... }, // 3 items
    "name": "Le Rhin en Suisse [Rheinhalle]",
    "mediaMonitored": [
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        "@href": "http://inspire.ec.europa.eu/codelist/MediaValue/water"
      }
    ],
    "observingCapability": [
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        "observingTime": {
          "@dataType": "observingTime",
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        },
        "processType": {
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        "resultNature": {
          "@href": "https://inspire.ec.europa.eu/codelist/ResultNatureValue/primary"
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        "procedure": {
          "@href": "http://id.eaufrance.fr/nsa/512#0",
          "@title": "MeasuredBySensor"
        },
        "featureOfInterest": { ... }, // 1 item
        "ultimateFeatureOfInterest": [
          {
            "@href": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A02100000"
          }
        ],
        "observedProperty": {
          "@href": "http://id.eaufrance.fr/nsa/509#H",
          "@title": "WaterLevel"
        }
      }
    ],
    "hasObservation": [
      {
        "@href": "https://iddata.eaufrance.fr/id/ObservationCollection/SurfaceWaterQuantity/A021005050",
        "@title": "A021005050 surfacewater quantity observation collection."
      }
    ]
  }
}
```

Reference to part of the river network

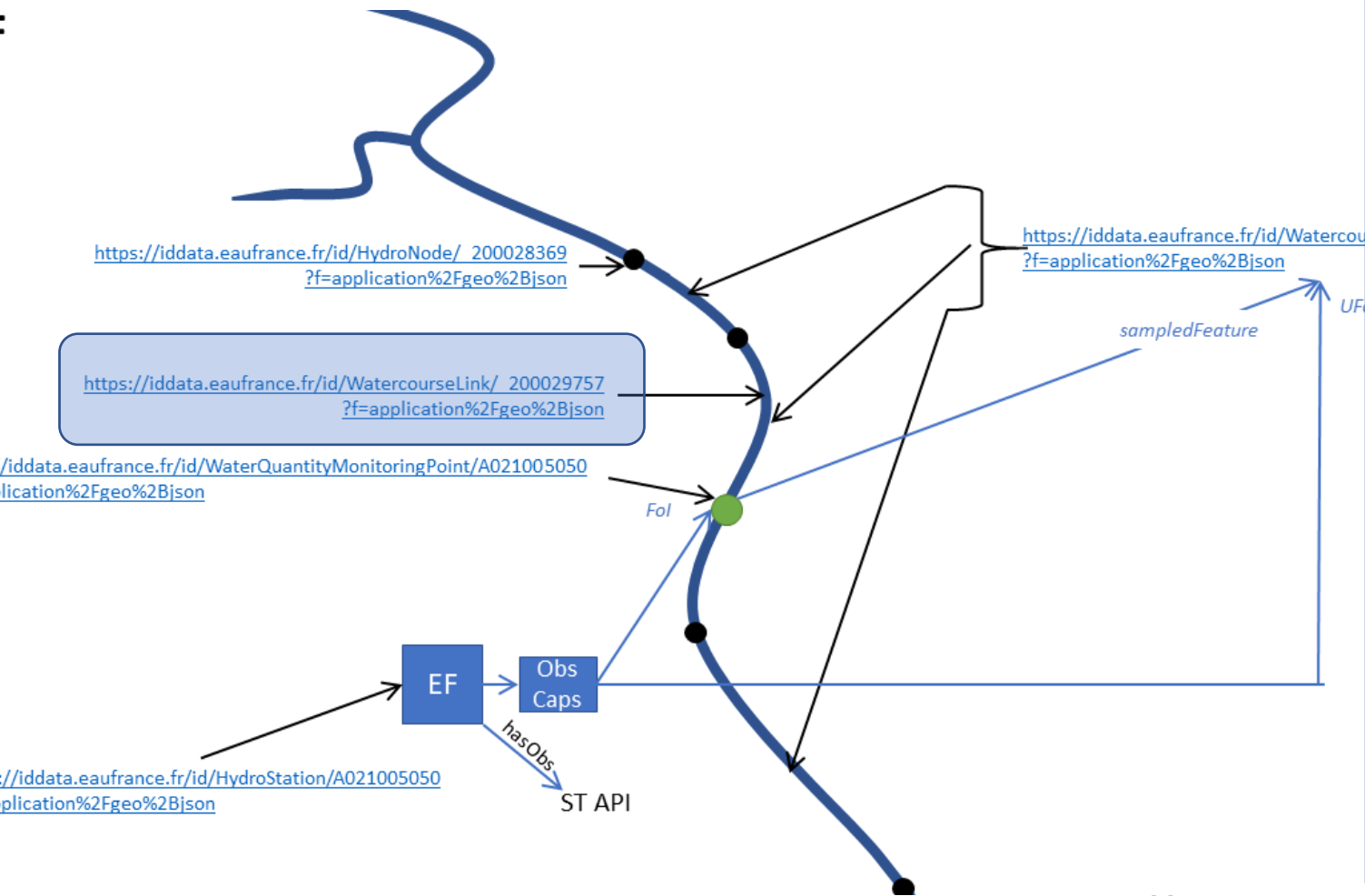
Station example : surface water quantity

```
"type": "Feature",
"id": "A021005050",
"geometry": { ... }, // 2 items
"properties": {
  "@featureType": "EnvironmentalMonitoringFacility",
  "identifiant": {
    "value": "https://iddata.eaufrance.fr/id/HydroStation/A021005050",
    "@codeSpace": "http://www.ietf.org/rfc/rfc2616"
  },
  "inspireId": { ... }, // 3 items
  "name": "Le Rhin en Suisse [Rheinhalle]",
  "mediaMonitored": [
    {
      "@href": "http://inspire.ec.europa.eu/codelist/MediaValue/water"
    }
  ],
  "observingCapability": [
    {
      "observingTime": {
        "@dataType": "observingTime",
        "TimePeriod": { ... } // 3 items
      },
      "processType": {
        "@href": "https://inspire.ec.europa.eu/codelist/ProcessTypeValue/process"
      },
      "resultNature": {
        "@href": "https://inspire.ec.europa.eu/codelist/ResultNatureValue/primary"
      },
      "procedure": {
        "@href": "http://id.eaufrance.fr/nsa/512#0",
        "@title": "MeasuredBySensor"
      },
      "featureOfInterest": { ... }, // 1 item
      "ultimateFeatureOfInterest": [
        {
          "@href": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A02100000"
        }
      ],
      "observedProperty": {
        "@href": "http://id.eaufrance.fr/nsa/509#H",
        "@title": "WaterLevel"
      }
    }
  ],
  "hasObservation": [
    {
      "@href": "https://iddata.eaufrance.fr/id/ObservationCollection/SurfacewaterQuantity/A021005050",
      "@title": "A021005050 surfacewater quantity observation collection."
    }
  ]
}
```

Watercourse Link Sequence

```
{
  "type": "Feature",
  "id": "A02100000",
  "geometry": {
    "type": "LineString",
    "coordinates": [ ... ] // 91 items
  },
  "properties": {
    "@featureType": "WatercourseLinkSequence",
    "metaDataProperty": [ ... ], // 1 item
    "identifiant": {
      "value": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A02100000",
      "@codeSpace": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/"
    },
    "inspireId": { ... }, // 4 items
    "beginLifespanVersion": "2020-03-17T20:00:00Z",
    "inNetwork": [
      {
        "@href": "https://iddata.eaufrance.fr/id/Watercourse/A---0000",
        "@title": "fleuve le rhin"
      }
    ],
    "link": [
      {
        "link": {
          "@href": "https://iddata.eaufrance.fr/id/WatercourseLink/_200029757"
        }
      },
      {
        "link": {
          "@href": "https://iddata.eaufrance.fr/id/WatercourseLink/_200029799"
        }
      }
    ]
  }
}
```

OMS level 1 example : surface water quantity



Watercourse Link Sequence

```

{
  "type": "Feature",
  "id": "A0210000",
  "geometry": {
    "type": "LineString",
    "coordinates": [ ... ] // 91 items
  },
  "properties": {
    "@featureType": "WatercourseLinkSequence",
    "metaDataProperty": [ ... ], // 1 item
    "identifier": {
      "value": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A0210000",
      "@codeSpace": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/"
    },
    "inspireId": { ... }, // 4 items
    "beginLifespanVersion": "2020-03-17T20:00:00Z",
    "inNetwork": [
      {
        "@href": "https://iddata.eaufrance.fr/id/Watercourse/A---0000",
        "@title": "fleuve le rhin"
      }
    ],
    "link": [
      {
        "link": {
          "@href": "https://iddata.eaufrance.fr/id/WatercourseLink/_200029757"
        }
      },
      {
        "link": {
          "@href": "https://iddata.eaufrance.fr/id/WatercourseLink/_200029799"
        }
      }
    ]
  }
}

```

Reference to the entire network 'le Rhin'

Or to a specific WatercourseLink

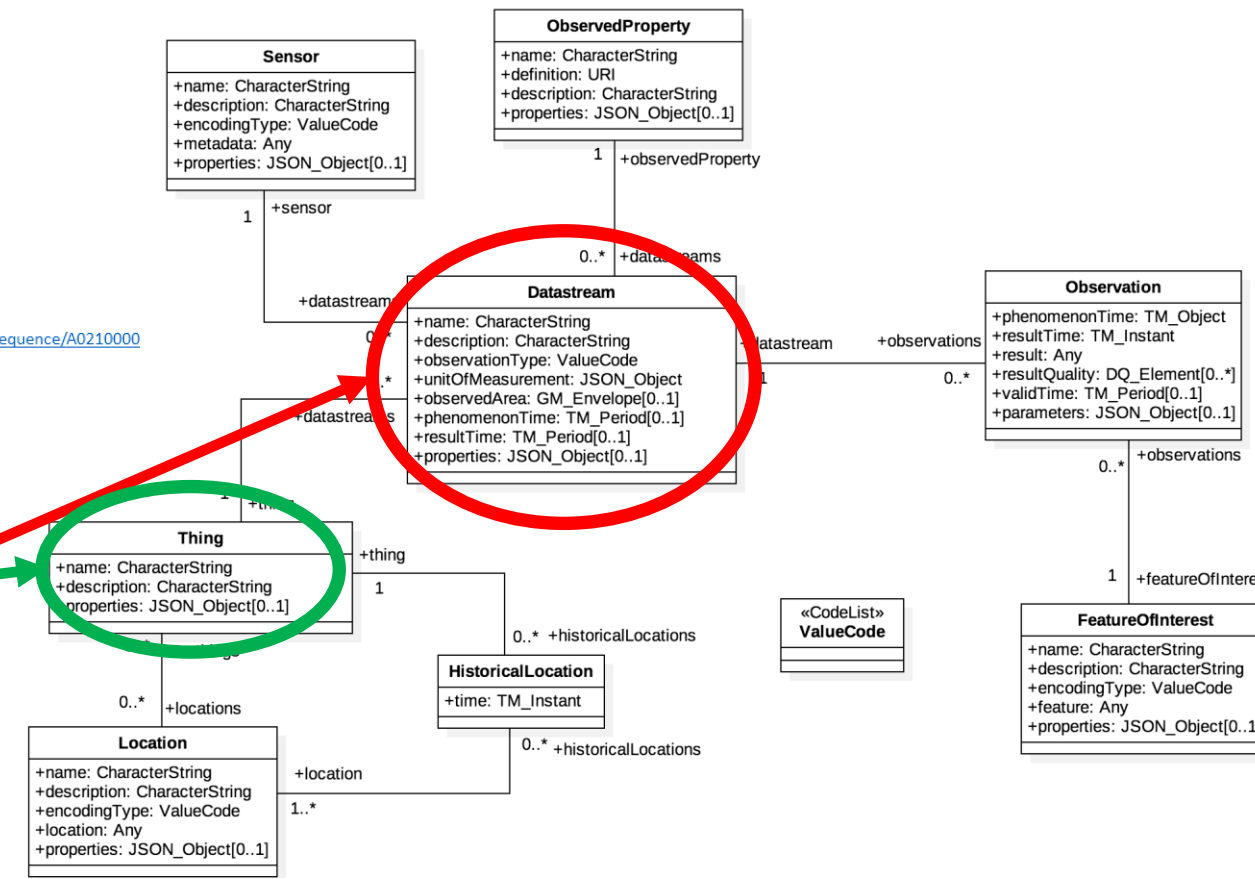
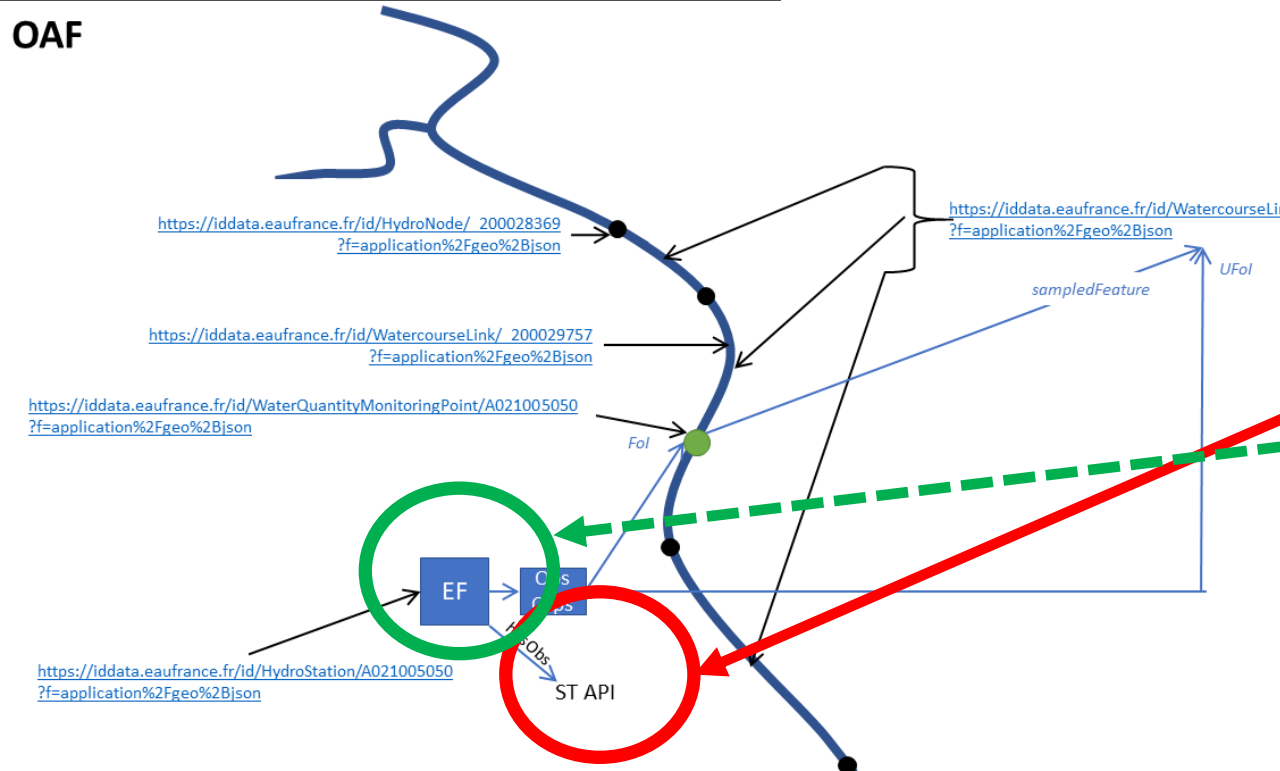
OMS level 1 example : surface water quantity

Crosswalk between APIs

<https://iddata.eaufrance.fr/api/hydroFAPI/ogc/features/collections/>

OAF

SensorThings API



Station

le : surface water quantity

```
{
  "type": "Feature",
  "id": "A021005050",
  "geometry": { ... }, // 2 items
  "properties": {
    "@featureType": "EnvironmentalMonitoringFacility",
    "identifier": {
      "value": "https://iddata.eaufrance.fr/id/HydroStation/A021005050",
      "@codeSpace": "http://www.ietf.org/rfc/rfc2616"
    },
    "inspireId": { ... }, // 3 items
    "name": "Le Rhin en Suisse [Rheinhalle]",
    "mediaMonitored": [
      {
        "@href": "http://inspire.ec.europa.eu/codelist/MediaValue/water"
      }
    ],
    "observingCapability": [
      {
        "observingTime": {
          "@dataType": "observingTime",
          "TimePeriod": { ... } // 3 items
        },
        "processType": {
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        "resultNature": {
          "@href": "https://inspire.ec.europa.eu/codelist/ResultNatureValue/primary"
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          "@href": "http://id.eaufrance.fr/nsa/512#0",
          "@title": "MeasuredBySensor"
        },
        "featureOfInterest": { ... }, // 1 item
        "ultimateFeatureOfInterest": [
          {
            "@href": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A0210000"
          }
        ],
        "observedProperty": {
          "@href": "http://id.eaufrance.fr/nsa/509#H",
          "@title": "WaterLevel"
        }
      }
    ],
    "hasObservation": [
      {
        "@href": "https://iddata.eaufrance.fr/id/ObservationCollection/SurfacewaterQuantity/A021005050",
        "@title": "A021005050 surfacewater quantity observation collection."
      }
    ]
  }
}
```

Station

le : surface water quantity

```
"type": "Feature",
"id": "A021005050",
"geometry": { ... }, // 2 items
"properties": {
  "@featureType": "EnvironmentalMonitoringFacility",
  "identifiant": {
    "value": "https://iddata.eaufrance.fr/id/HydroStation/A021005050",
    "@codeSpace": "http://www.ietf.org/rfc/rfc2616"
  },
  "inspireId": { ... }, // 3 items
  "name": "Le Rhin en Suisse [Rheinhalle]",
  "mediaMonitored": [
    {
      "@href": "http://inspire.ec.europa.eu/codelist/MediaValue/water"
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  ],
  "observingCapability": [
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      "observingTime": {
        "@dataType": "observingTime",
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      "resultNature": {
        "@href": "https://inspire.ec.europa.eu/codelist/ResultNatureValue/primary"
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        "@title": "MeasuredBySensor"
      },
      "featureOfInterest": { ... }, // 1 item
      "ultimateFeatureOfInterest": [
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          "@href": "https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A0210000"
        }
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        "@title": "WaterLevel"
      }
    }
  ],
  "hasObservation": [
    {
      "@href": "https://iddata.eaufrance.fr/id/ObservationCollection/SurfaceWaterQuantity/A021005050",
      "@title": "A021005050 surfacewater quantity observation collection."
    }
  ]
}
```

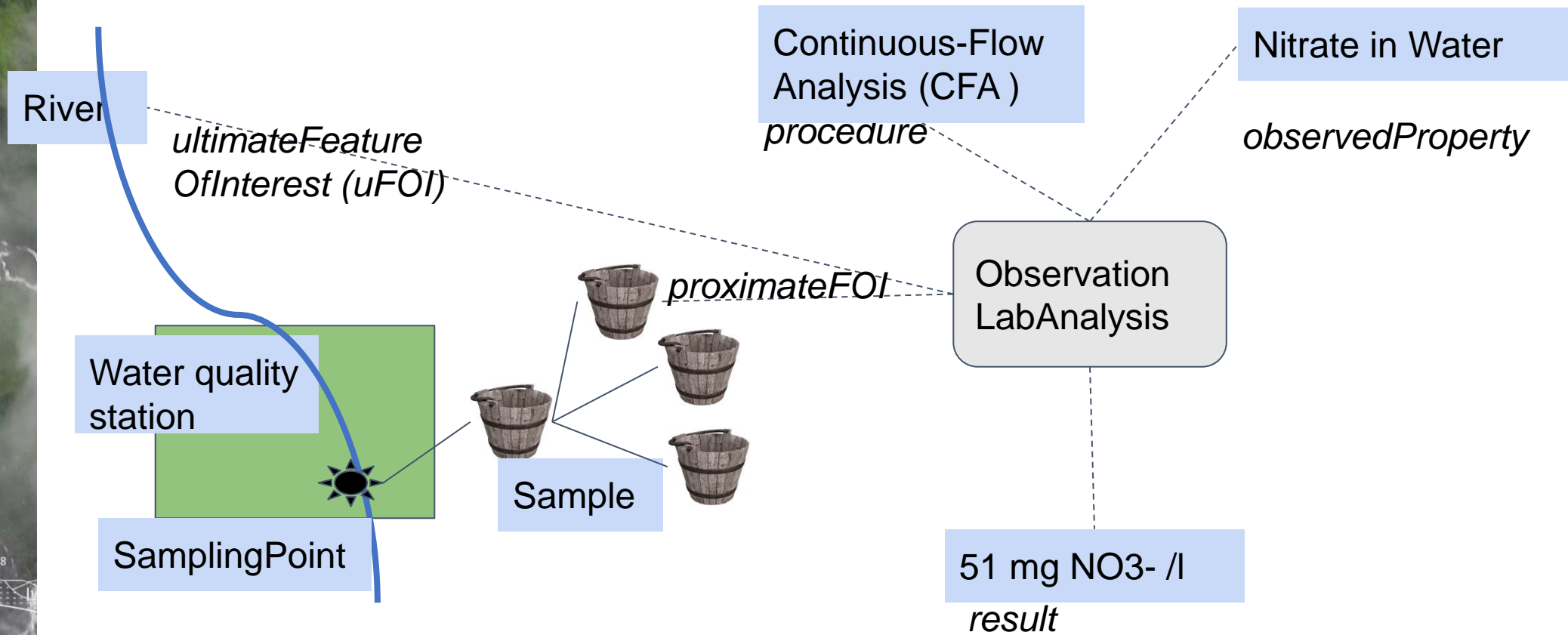
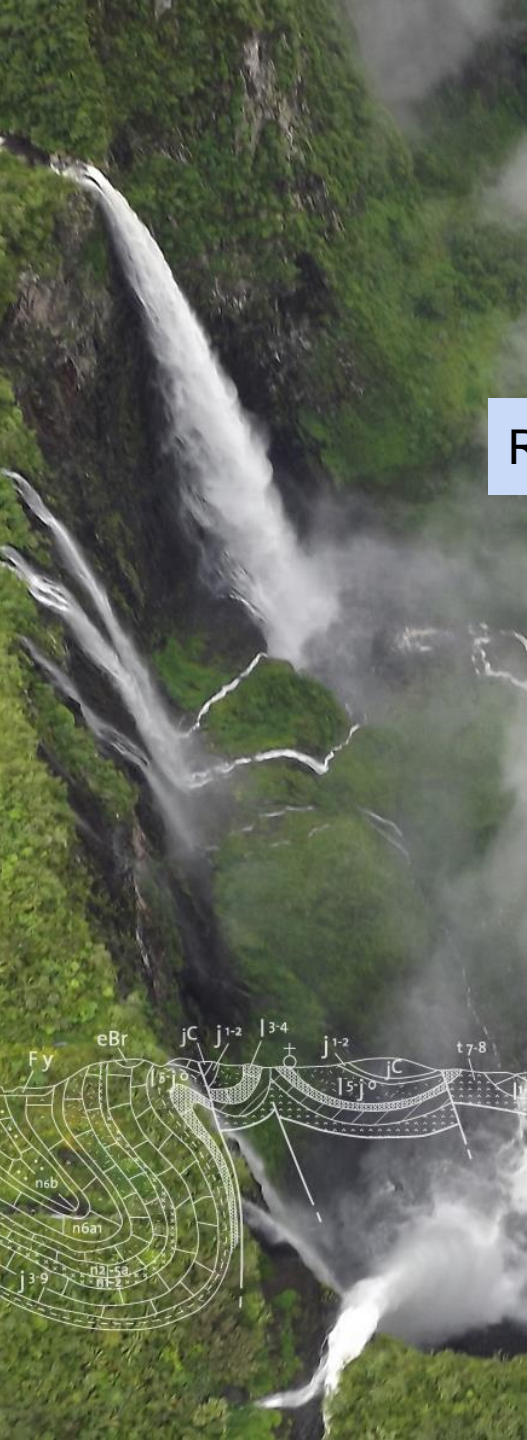
SensorThings API DataStreams available

```
{
  "value": [
    {
      "@iot.selfLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(347)",
      "@iot.id": 347,
      "name": "Hydrometry depth at Le Rhin en Suisse [Rheinhalle] with method Hydrometry depth measurement by electronic probe",
      "description": "Hydrometry depth at Le Rhin en Suisse [Rheinhalle] with method Hydrometry depth measurement by electronic probe",
      "observationType": "http://www.opengis.net/def/observationType/OGC-01/2.0/OM_Measurement",
      "unitOfMeasurement": {
        "name": "millimeters",
        "symbol": "mm",
        "definition": "https://data.geoscience.fr/ncl/uom/491"
      },
      "observedArea": { ... }, // 2 items
      "phenomenonTime": "2020-09-16T03:45:00Z/2021-08-09T15:00:00Z",
      "properties": {
        "relatedTo.FeaturesOfInterest@iot.id": 347
      },
      "resultTime": "2020-09-16T03:45:00Z/2021-08-09T15:00:00Z",
      "ObservedProperty@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(347)/ObservedProperty",
      "Sensor@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(347)/Sensor",
      "Thing@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(347)/Thing",
      "Observations@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(347)/Observations"
    },
    {
      "@iot.selfLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(348)",
      "@iot.id": 348,
      "name": "Water flow at Le Rhin en Suisse [Rheinhalle] with method Water flow measurement by electronic probe",
      "description": "Water flow at Le Rhin en Suisse [Rheinhalle] with method Water flow measurement by electronic probe",
      "observationType": "http://www.opengis.net/def/observationType/OGC-01/2.0/OM_Measurement",
      "unitOfMeasurement": {
        "name": "Liter Per second",
        "symbol": "l/s",
        "definition": "https://data.geoscience.fr/ncl/uom/541"
      },
      "observedArea": { ... }, // 2 items
      "phenomenonTime": "2020-09-16T03:15:00Z/2021-08-09T15:00:00Z",
      "properties": {
        "relatedTo.FeaturesOfInterest@iot.id": 348
      },
      "resultTime": "2020-09-16T03:15:00Z/2021-08-09T15:00:00Z",
      "ObservedProperty@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(348)/ObservedProperty",
      "Sensor@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(348)/Sensor",
      "Thing@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(348)/Thing",
      "Observations@iot.navigationLink": "https://sta4hydrometry.brgm-rec.fr/FROST-Server/v1.1/Datastreams(348)/Observations"
    }
  ]
}
```

Observations from DataStream 1

Observations from DataStream 2

OMS level 2 example : surface water quality (samples)*

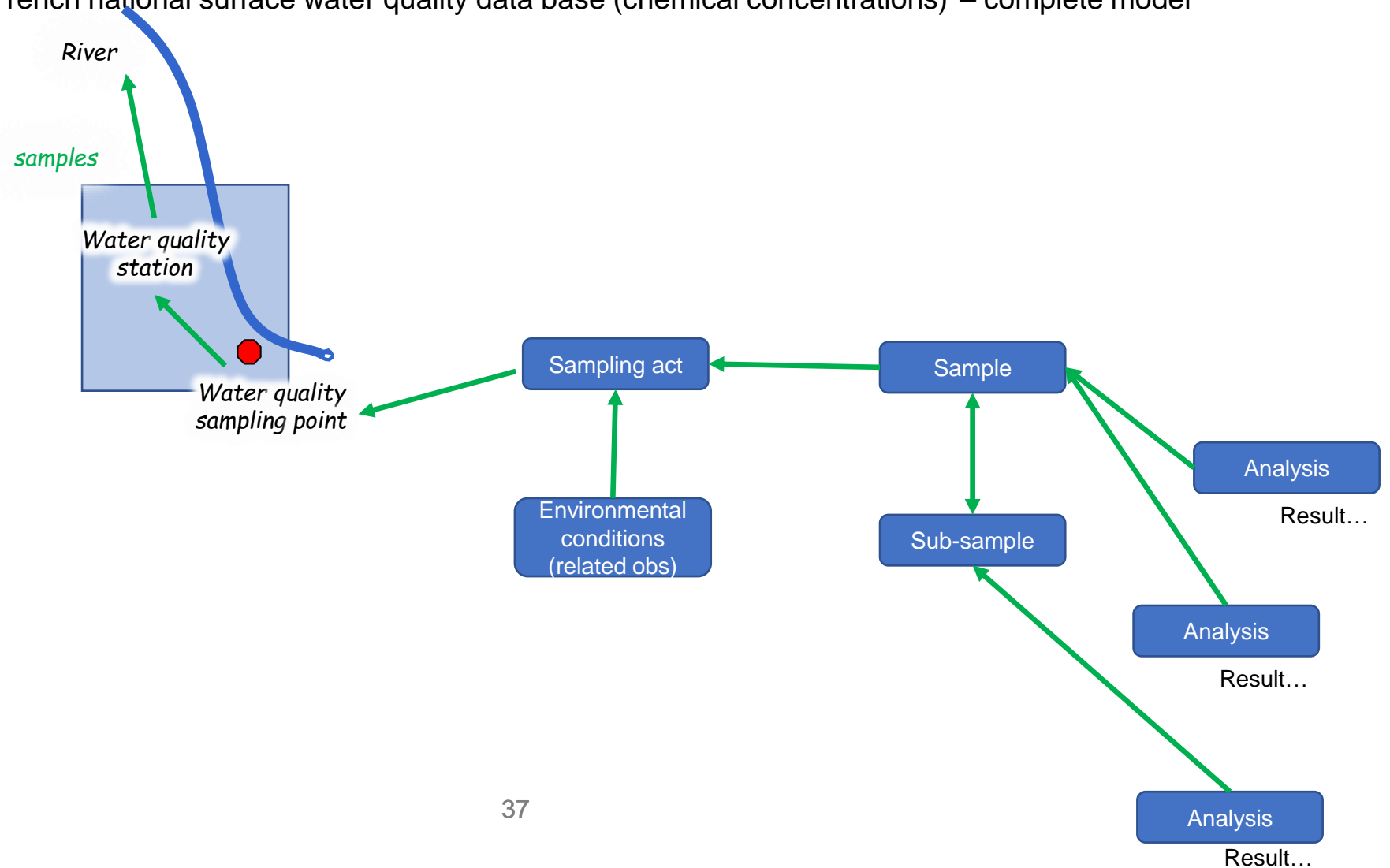




OMS level 2 example : surface water quality (samples)

Semantics

- French national surface water quality data base (chemical concentrations)* – complete model

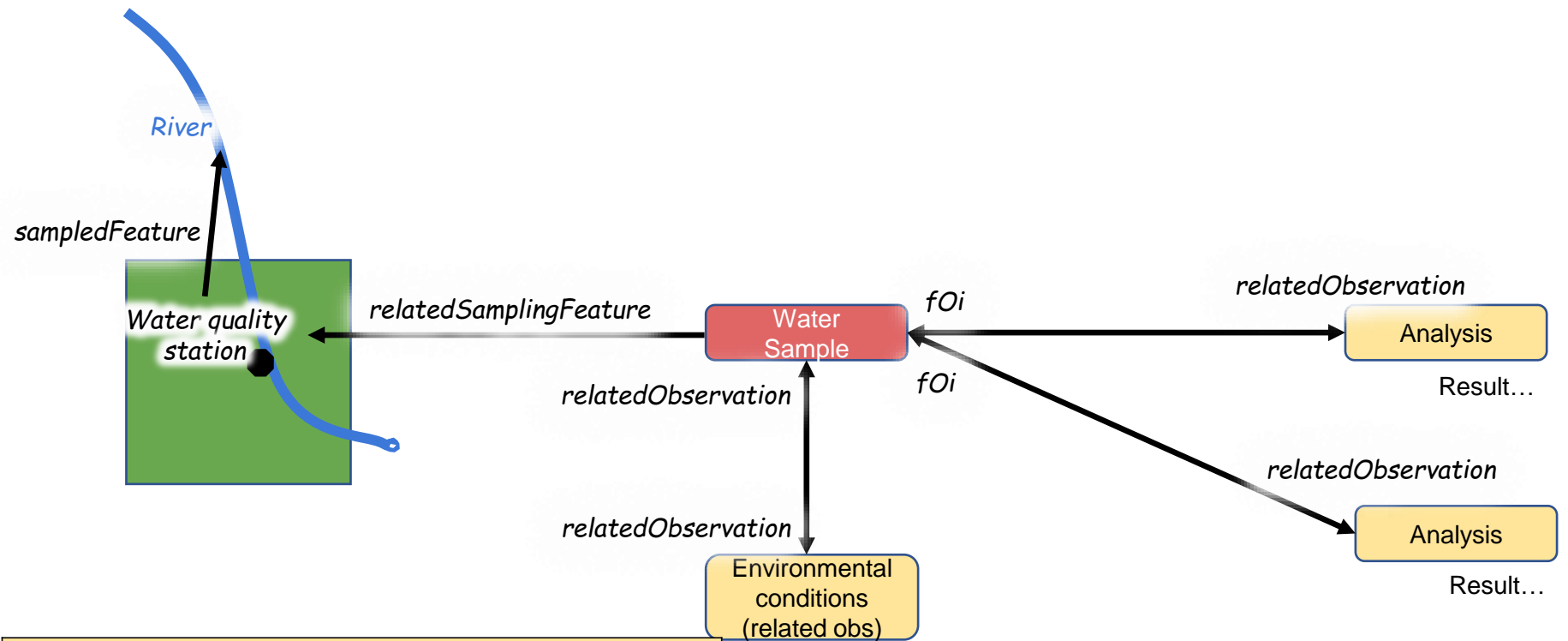




OMS level 2 example : surface water quality (samples)

Semantics

- Simplified (implemented) model => mapped to O&M and existing standards

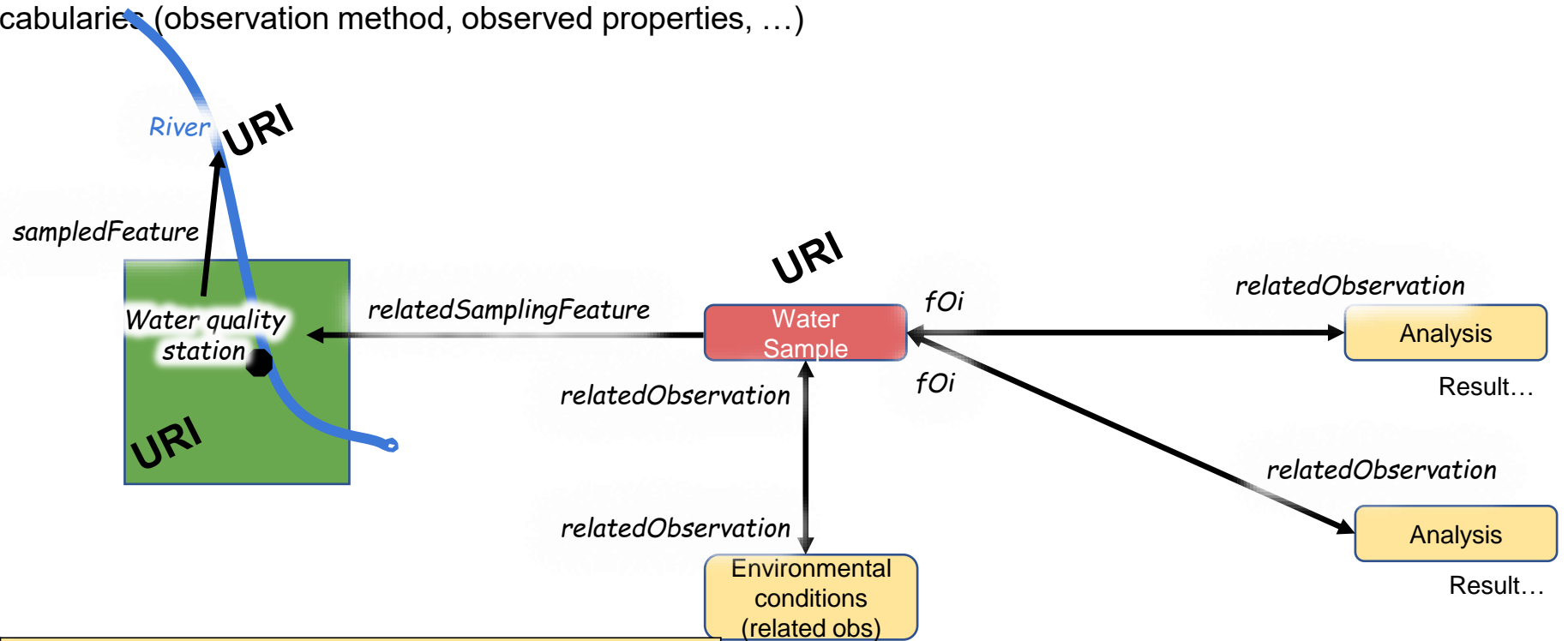


Observation
Observation result
Water Sample (SF_Specimen)
River (ultimate fOI) : HY_Features
Other fOIs on the side (ex : river pertains to river basin) : HY_Features
OMS Observer VS INSPIRE Environmental Monitoring Facility (EF)
OMS Observer / INSPIRE:EF associated information

OMS level 2 example : surface water quality (samples)

Linked Data

- As much as possible : URIs on FeatureInstance (and ?ObservationCollection / Observation?) AND controlled vocabularies (observation method, observed properties, ...)

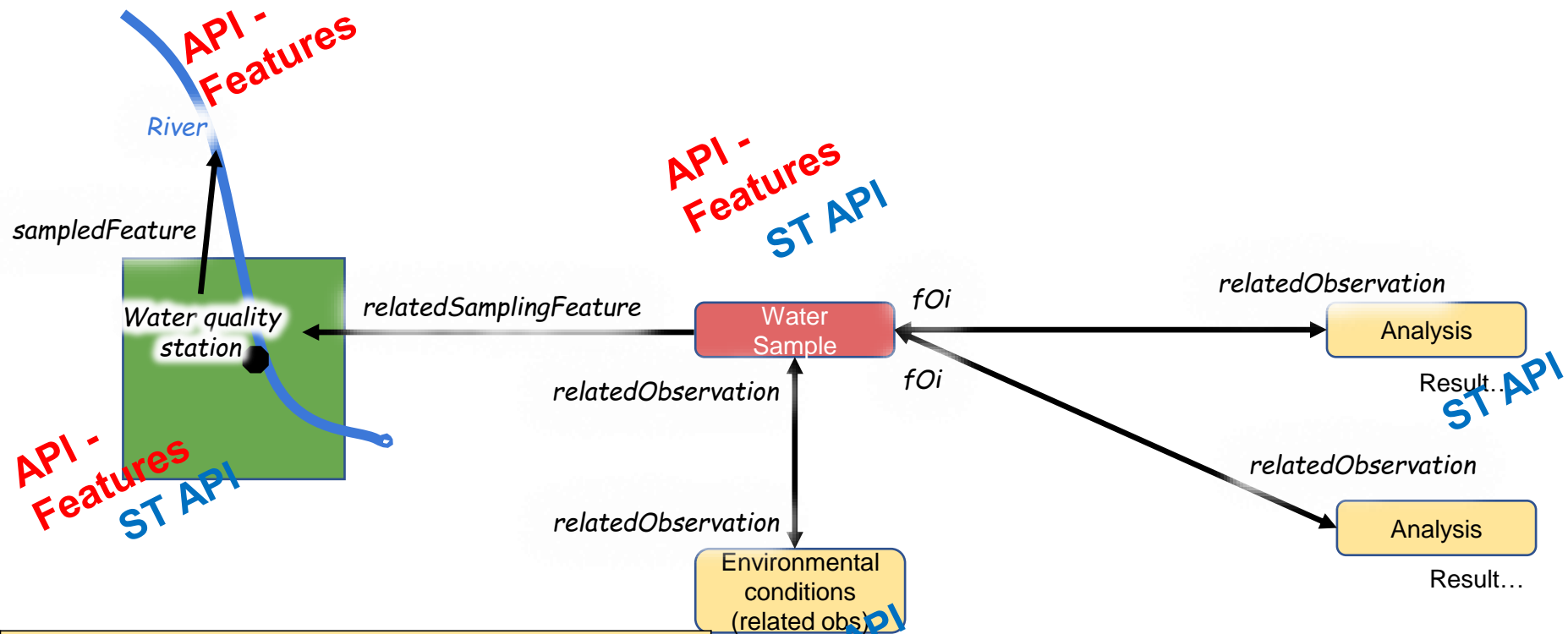


Observation
Observation result
Water Sample (SF_Specimen)
River (ultimate fOI) : HY_Features
Other fOIs on the side (ex : river pertains to river basin) : HY_Features
OMS Observer VS INSPIRE Environmental Monitoring Facility (EF)
OMS Observer / INSPIRE:EF associated information

OMS level 2 example : surface water quality (samples)

OGC APIs

- Simplified (implemented) model => mapped to OGC API + ST API (other not done because of time)



Observation
Observation result
Water Sample (SF_Specimen)
River (ultimate fOI) : HY_Features
Other fOIs on the side (ex : river pertains to river basin) : HY_Features
OMS Observer VS INSPIRE Environmental Monitoring Facility (EF)
OMS Observer / INSPIRE:EF associated information

OGC API - Features

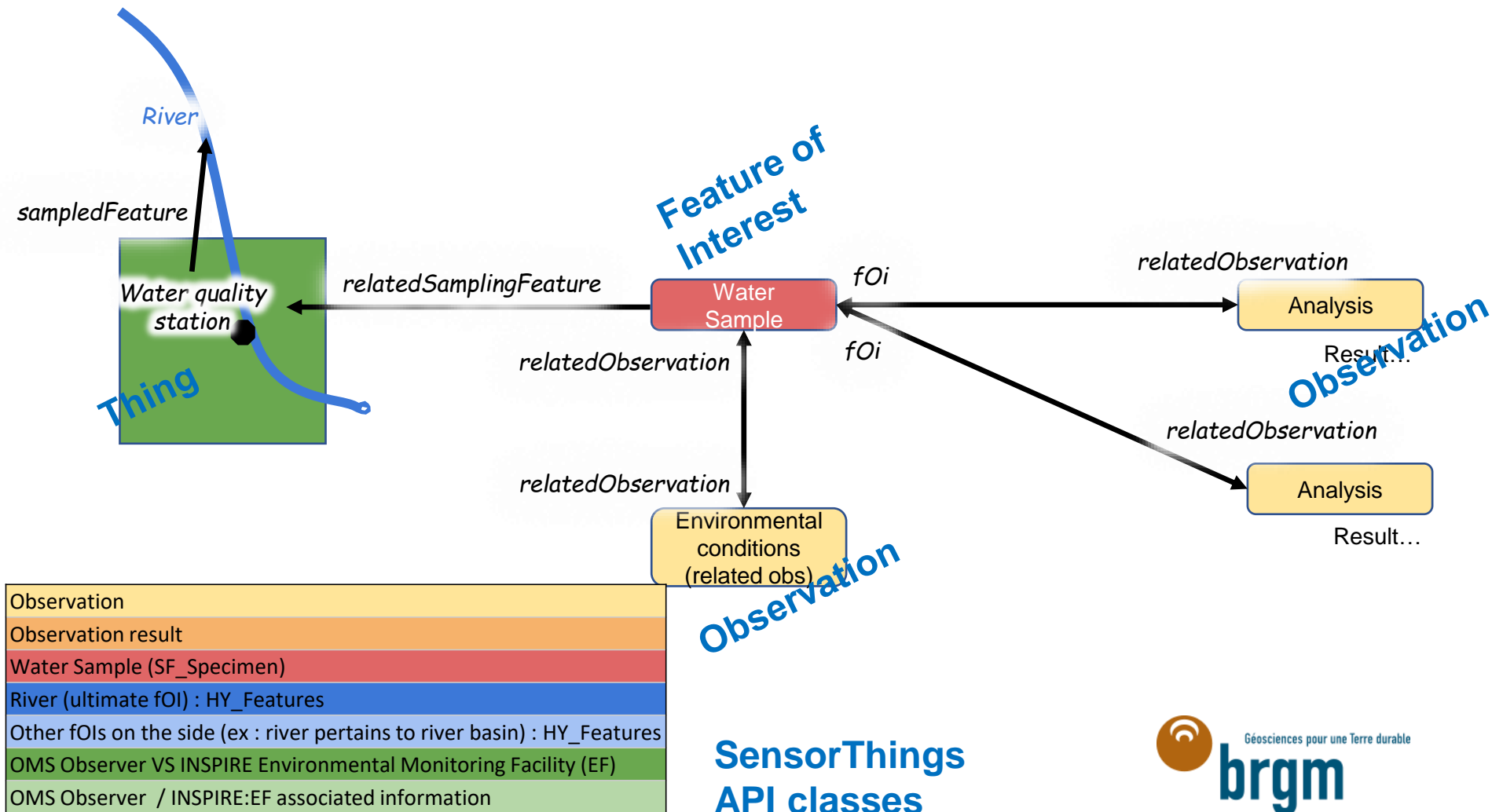
OGC SensorThings API



OMS level 2 example : surface water quality (samples)

OGC APIs

- Simplified (implemented) model => mapped to O&M and existing standards then ST API

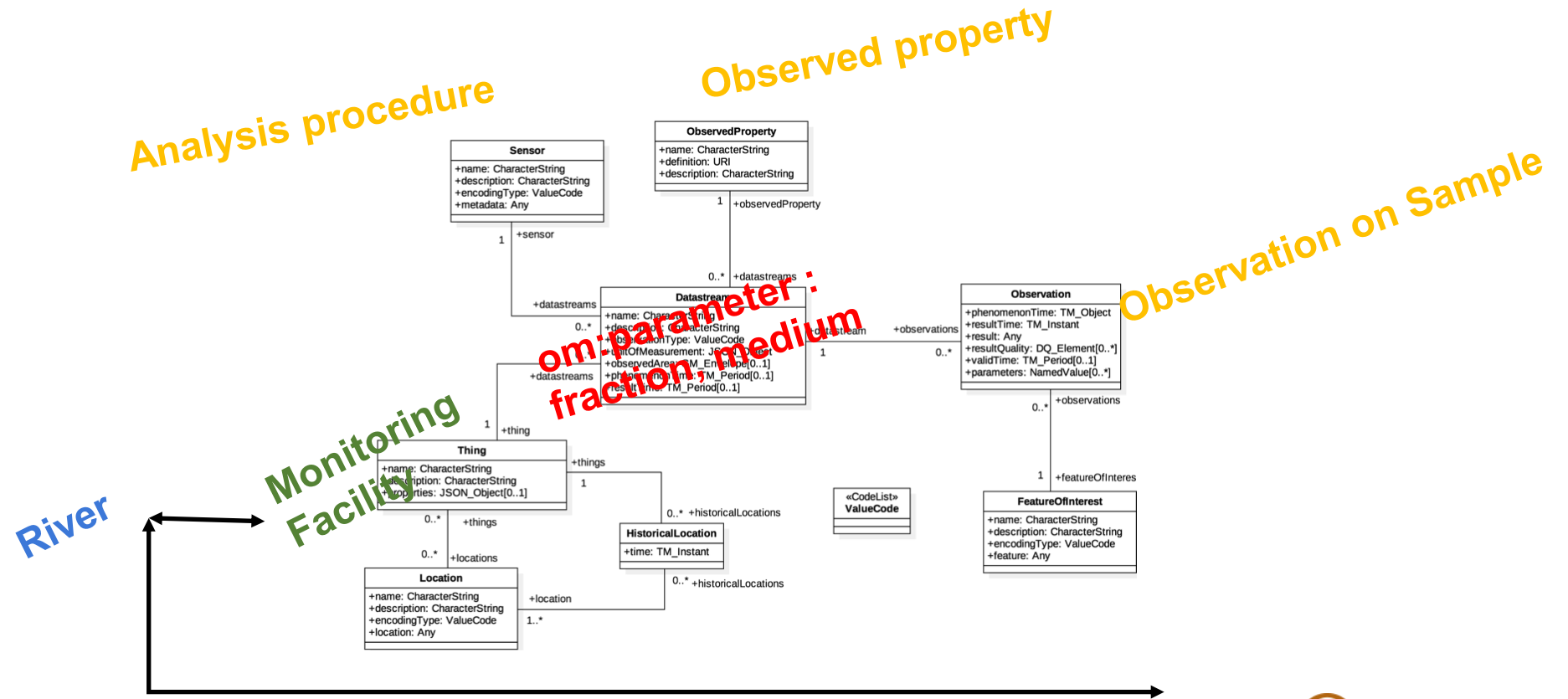




OMS level 2 example : surface water quality (samples)

OGC APIs

- Chemical concentration - Simplified (implemented) model => mapped to ST API



EPOS : Multi-standards integration in an Enterprise Architect (EA) project

1/ Conceptual Model

Class : Segment

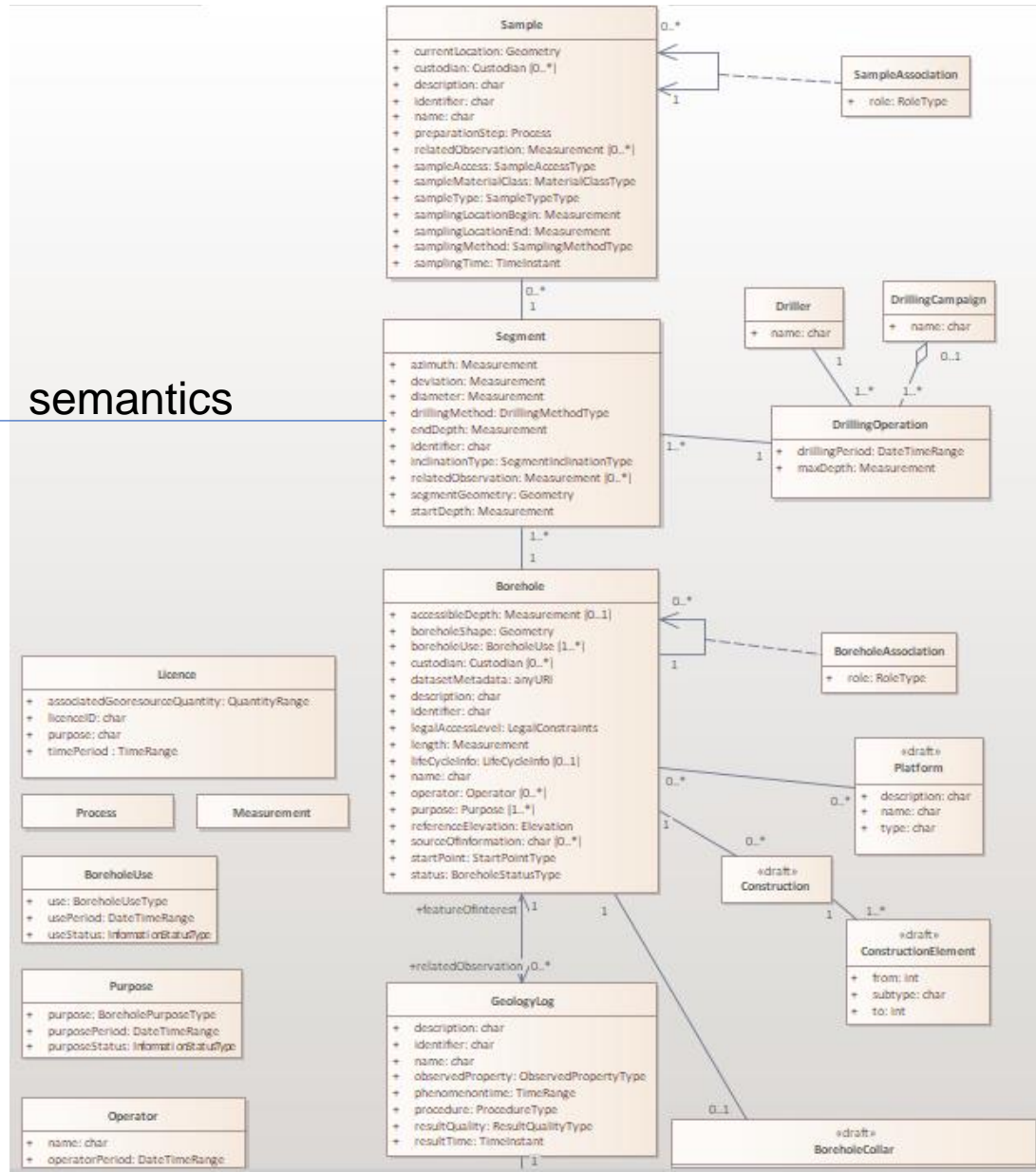
Properties

- General
- Responsibilities
- Requirements
- Constraints
- Scenarios
- Files
- Related Links

Name: Segment

Coherent set of diameter and drillingMethod. Each time one of those two elements changes it's a new segment.

semantics

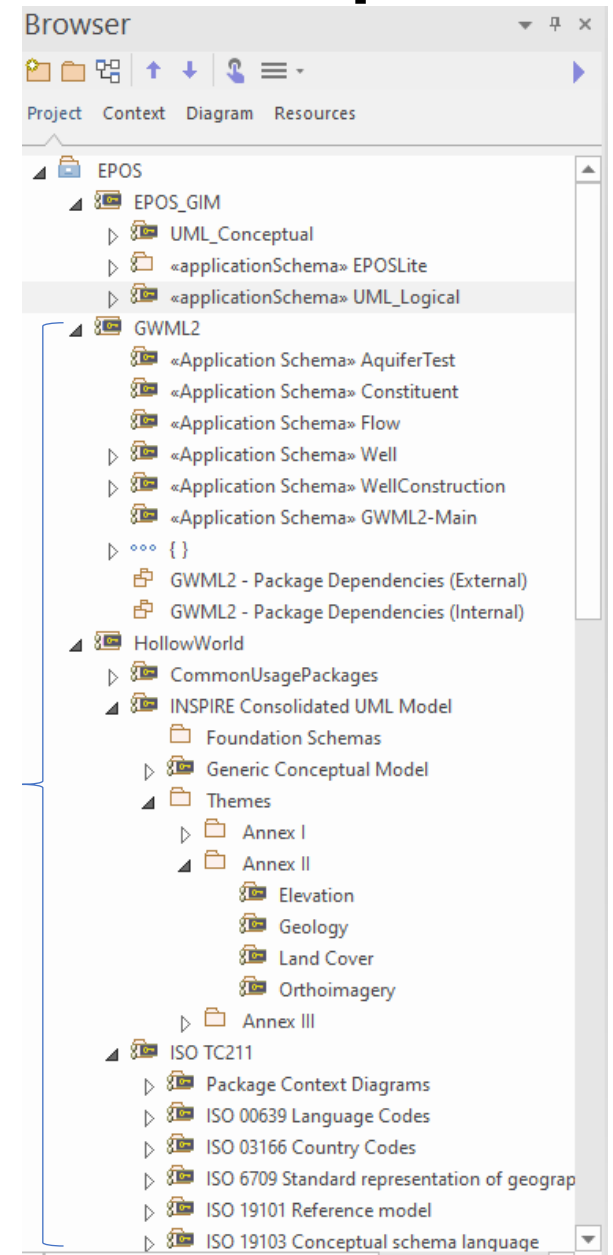


EPOS : Multi-standards integration in an Enterprise Architect (EA) project

2°/ Logical Model built on standards

- Note : This example uses the previous EA-SVN connexion
 - Now we use EA “Reusable Assets”

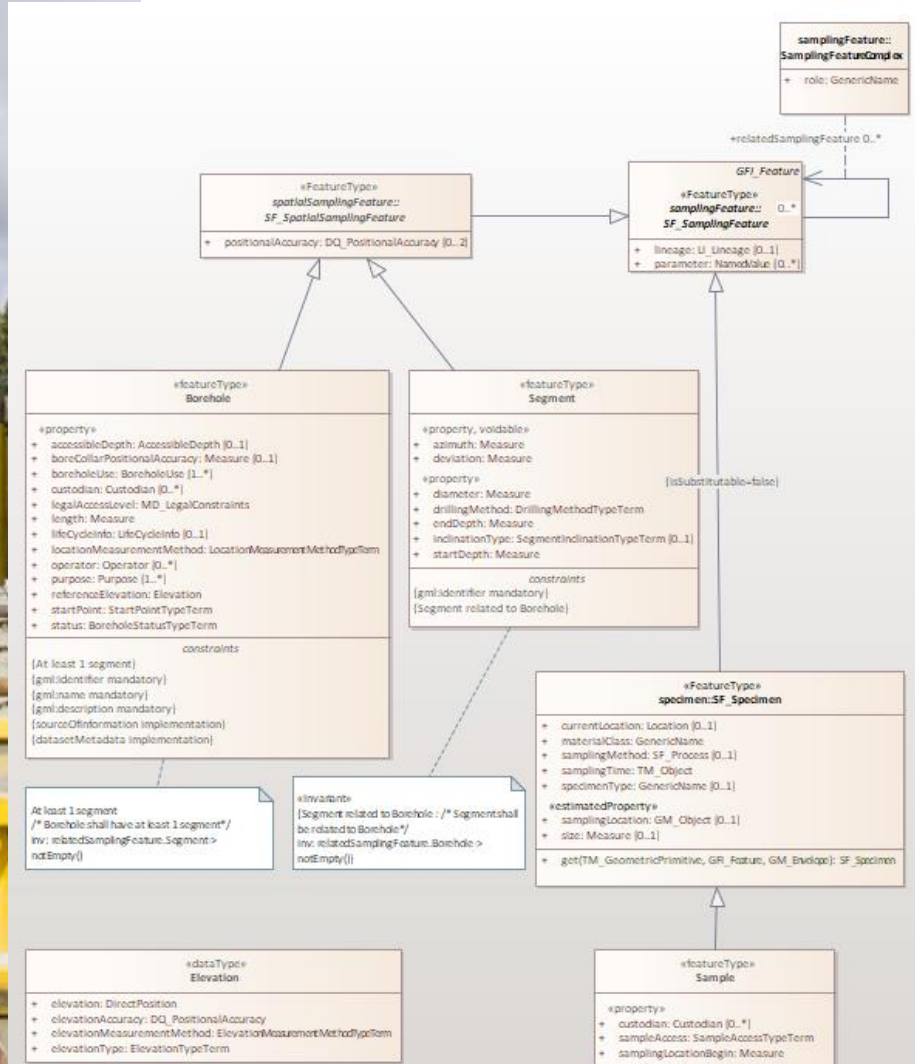
Standards introduced in the « 3_Interoperability_toolbox » presentation



EPOS : Multi-standards integration in an Enterprise Architect (EA) project

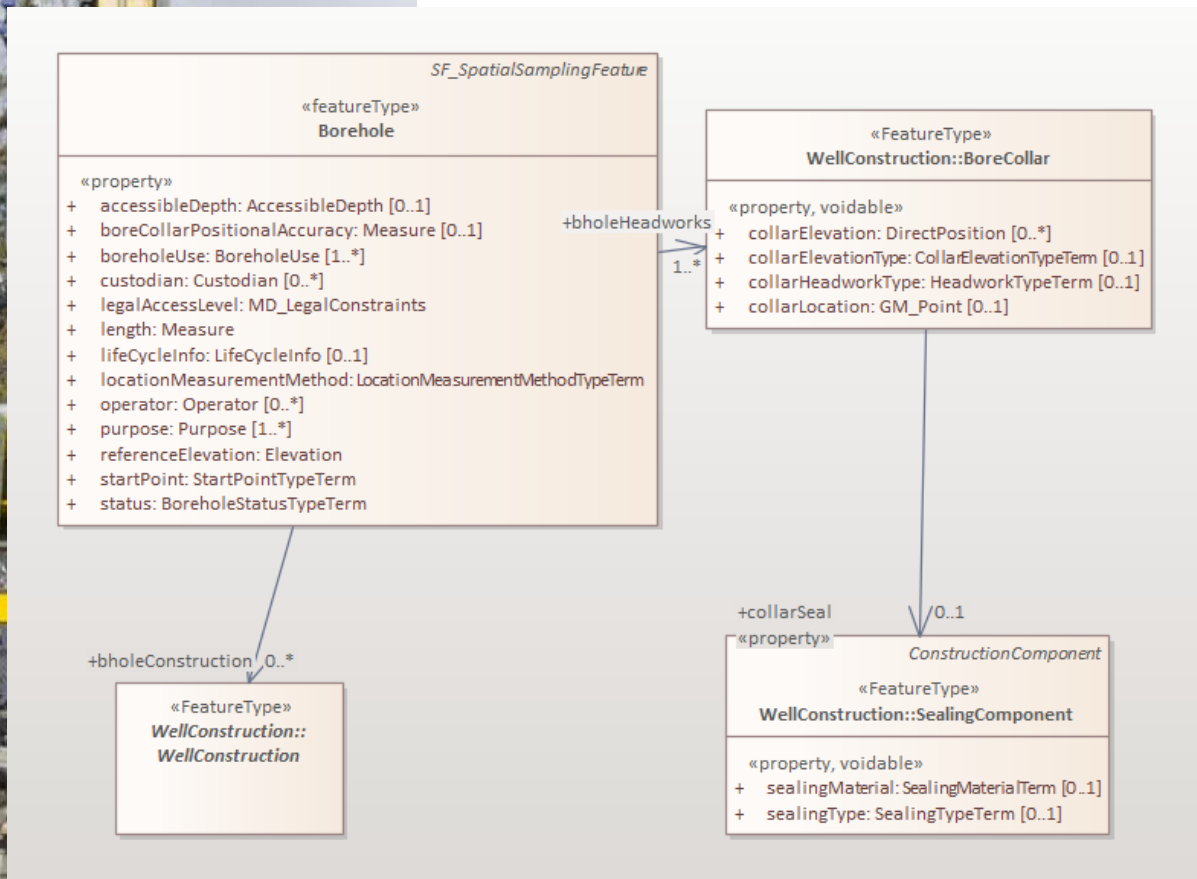
2°/ Logical Model built on standards

In the logical model, the Borehole, Segment, Sample cascade from step 1° is modelled building on classes from Observations & Measurements



EPOS : Multi-standards integration in an Enterprise Architect (EA) project

2°/ Logical Model built on standards



In the logical model, Borehole is a subtype of SF_SpatialSamplingFeature from Observations & Measurements ...

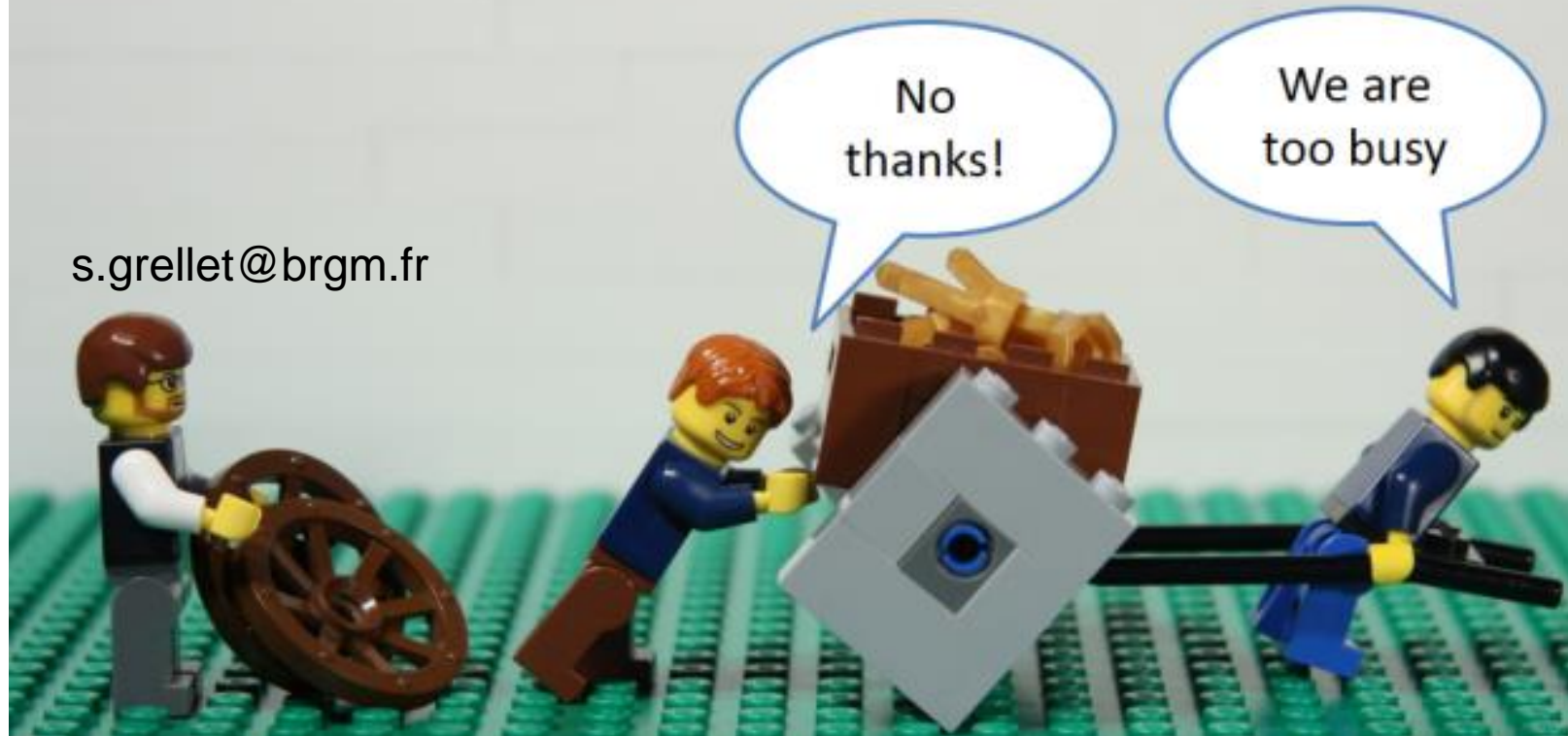
... and Borehole constructions elements from step 1° are reusing classes defined in GroundWaterML2.0

Thank you



Are you too busy to improve?

s.grellet@brgm.fr



Håkan Forss @hakanforss <http://hakanforss.wordpress.com>

This illustration is inspired by and in part derived from the work by Scott Simmerman, "The Square Wheels Guy" <http://www.performancecompany.com/>

Thanks to

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