Observations to Information

2013 Leptoukh Lecture

Simon Cox | Research Scientist | Environmental Information Systems

12 December 2013

LAND AND WATER
www.csiro.au

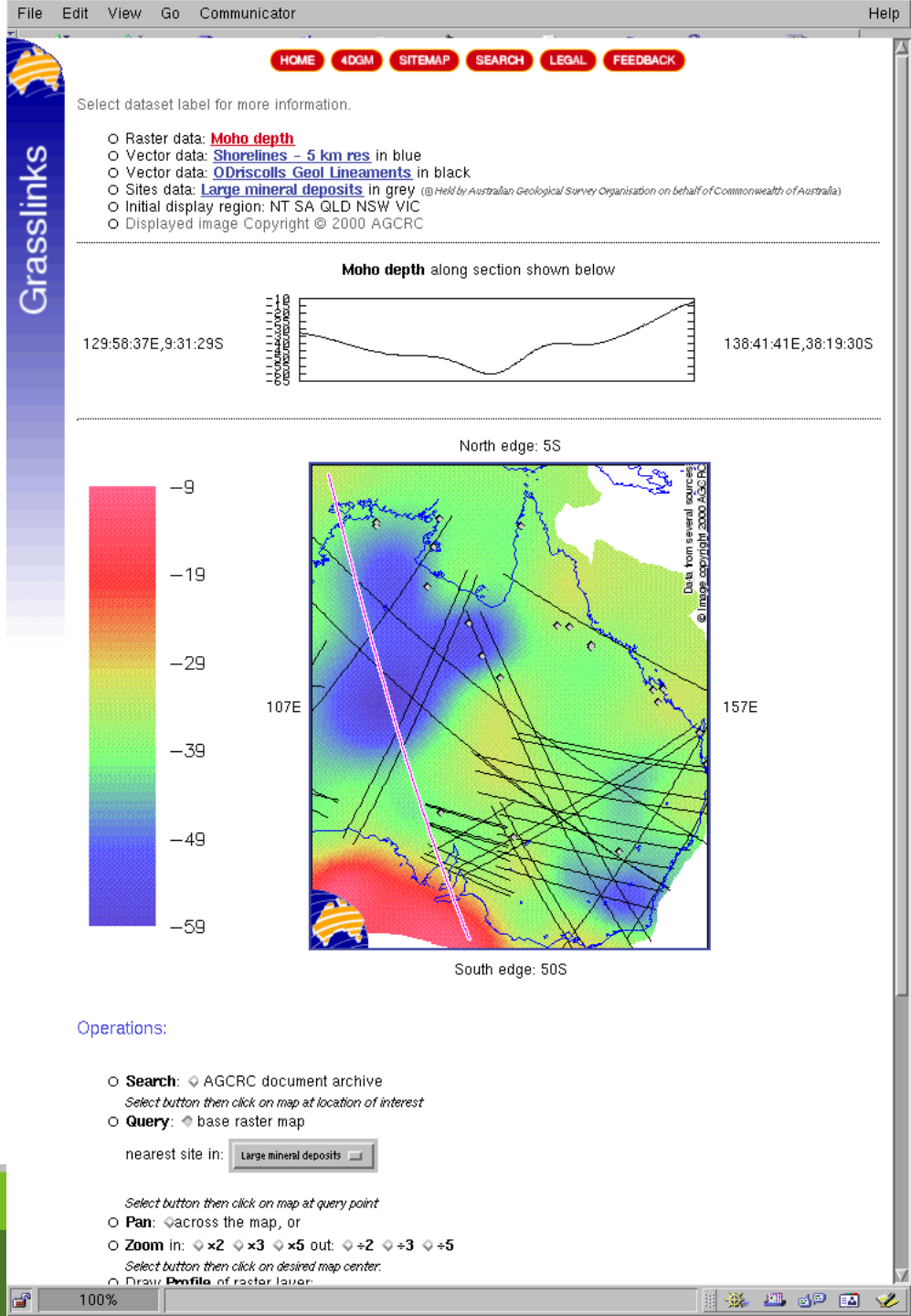
Standards for observation data

- Motivation and development
- Earth-science and environmental applications
- Renewal

Origins

A bit of history

- 1993-2000 AGCRC
  - Web-mapping
  - Reporting research online
- 1995



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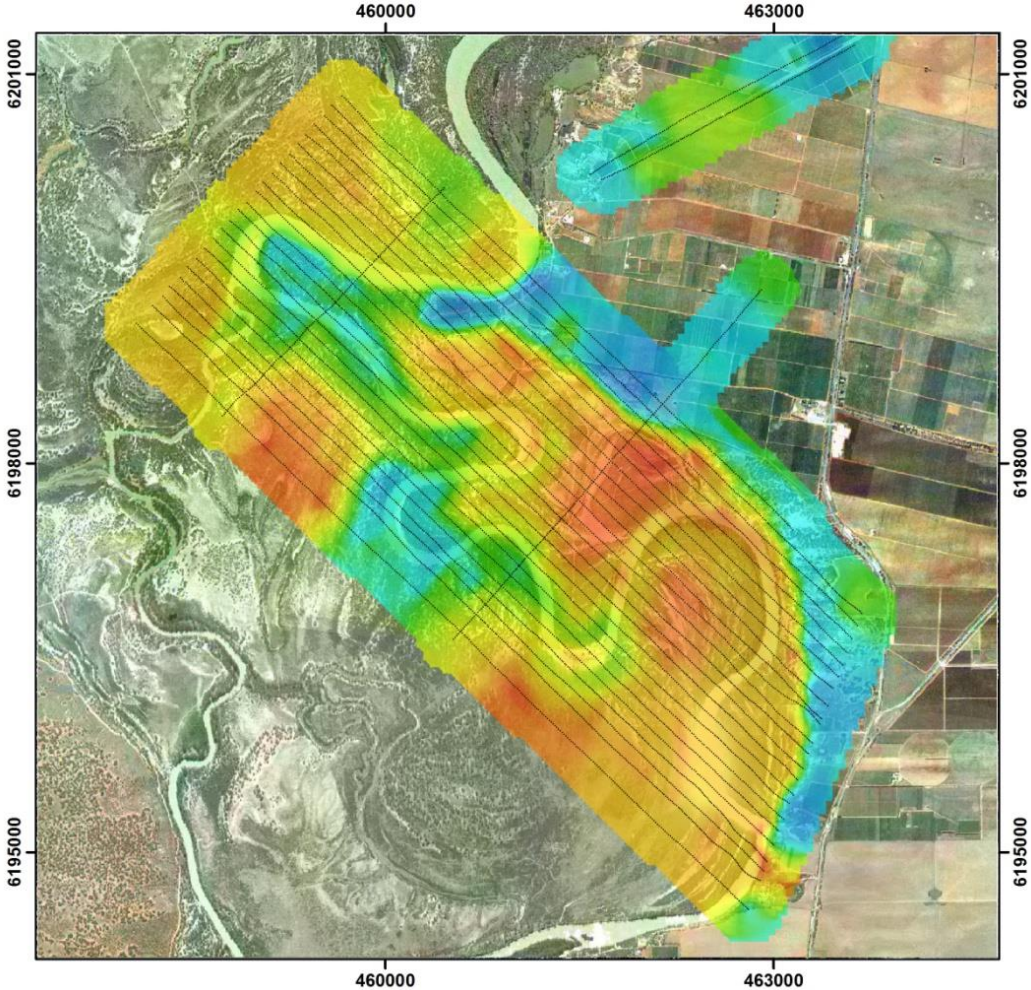
  - Exploration data standards



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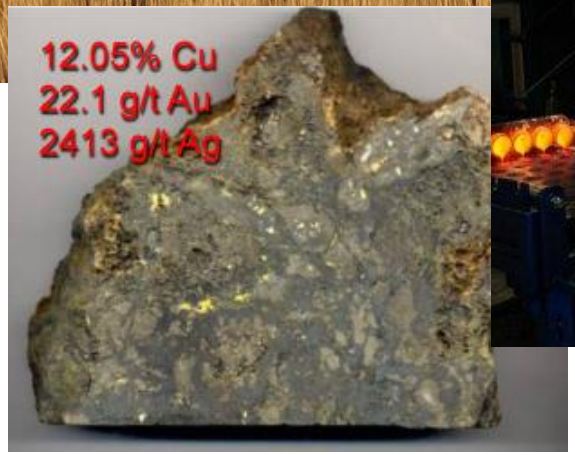

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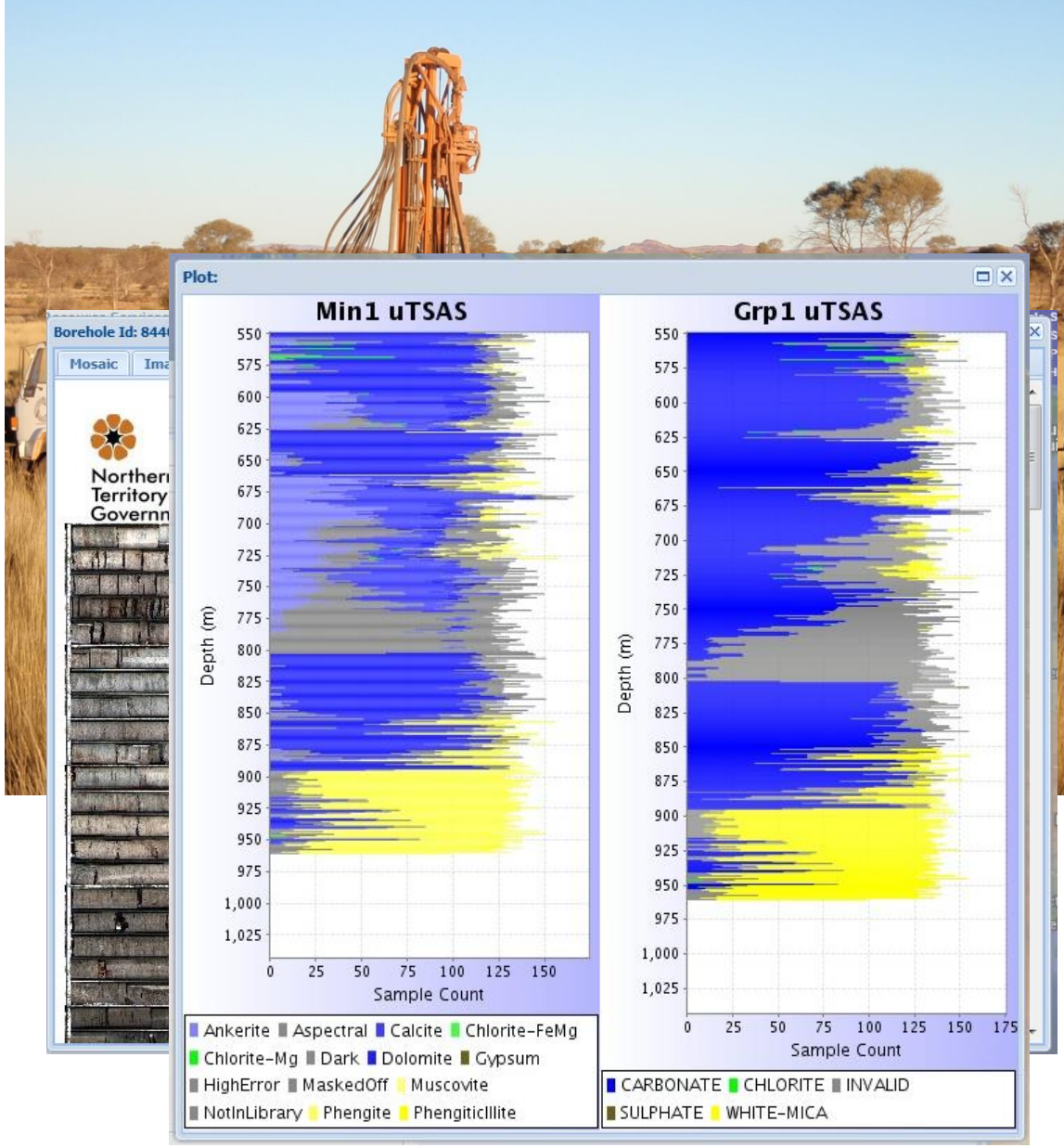

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- 2002-2005 OGC SWE
  - Sensors anywhere

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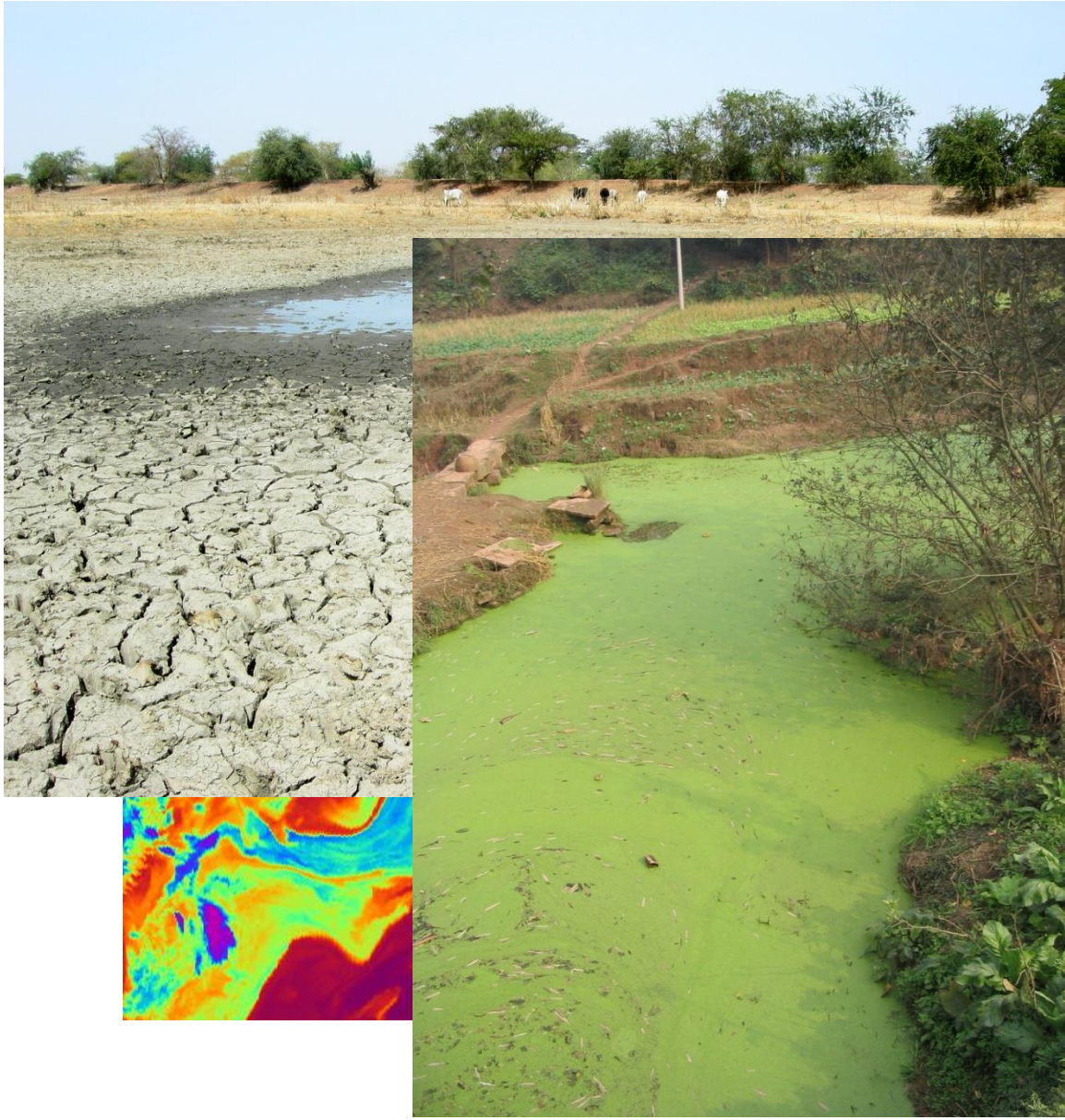
- 2005-2013 Fluid Earth
  - Water informatics



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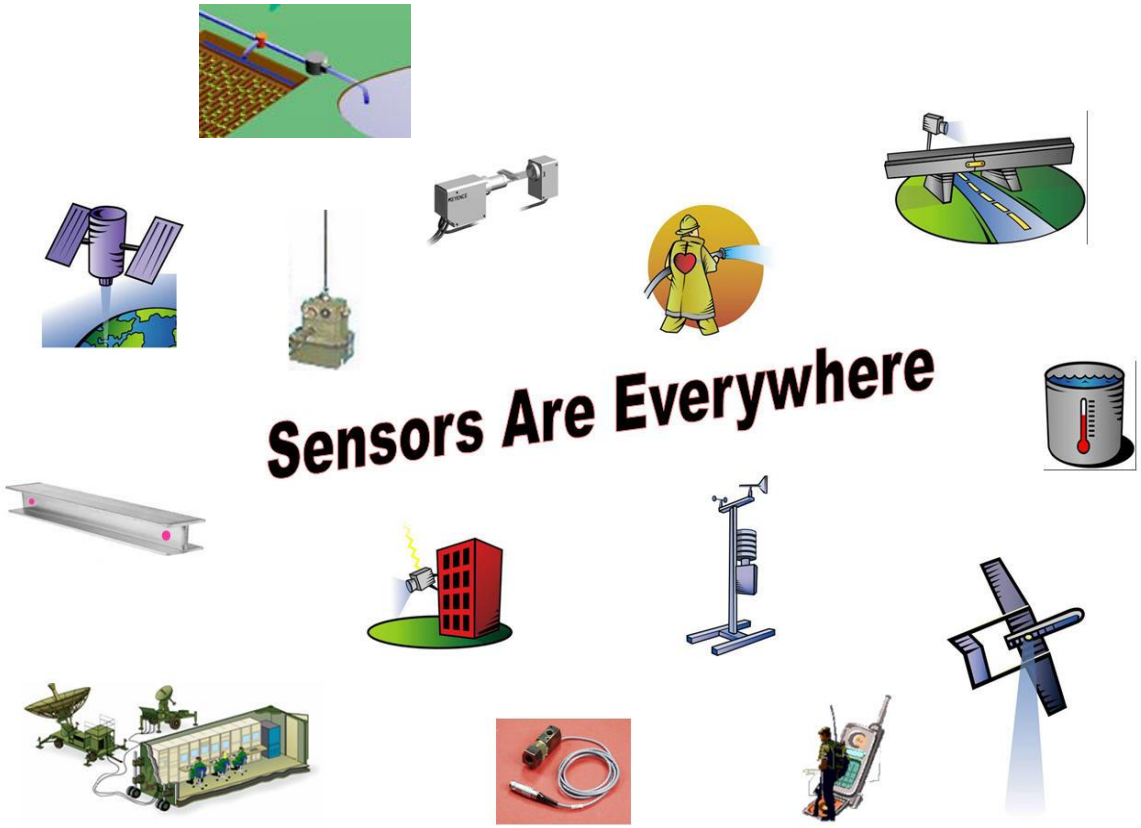


Motivation for a standard

All of society's grand challenges require data to be shared and integrated across cultures, scales and technologies

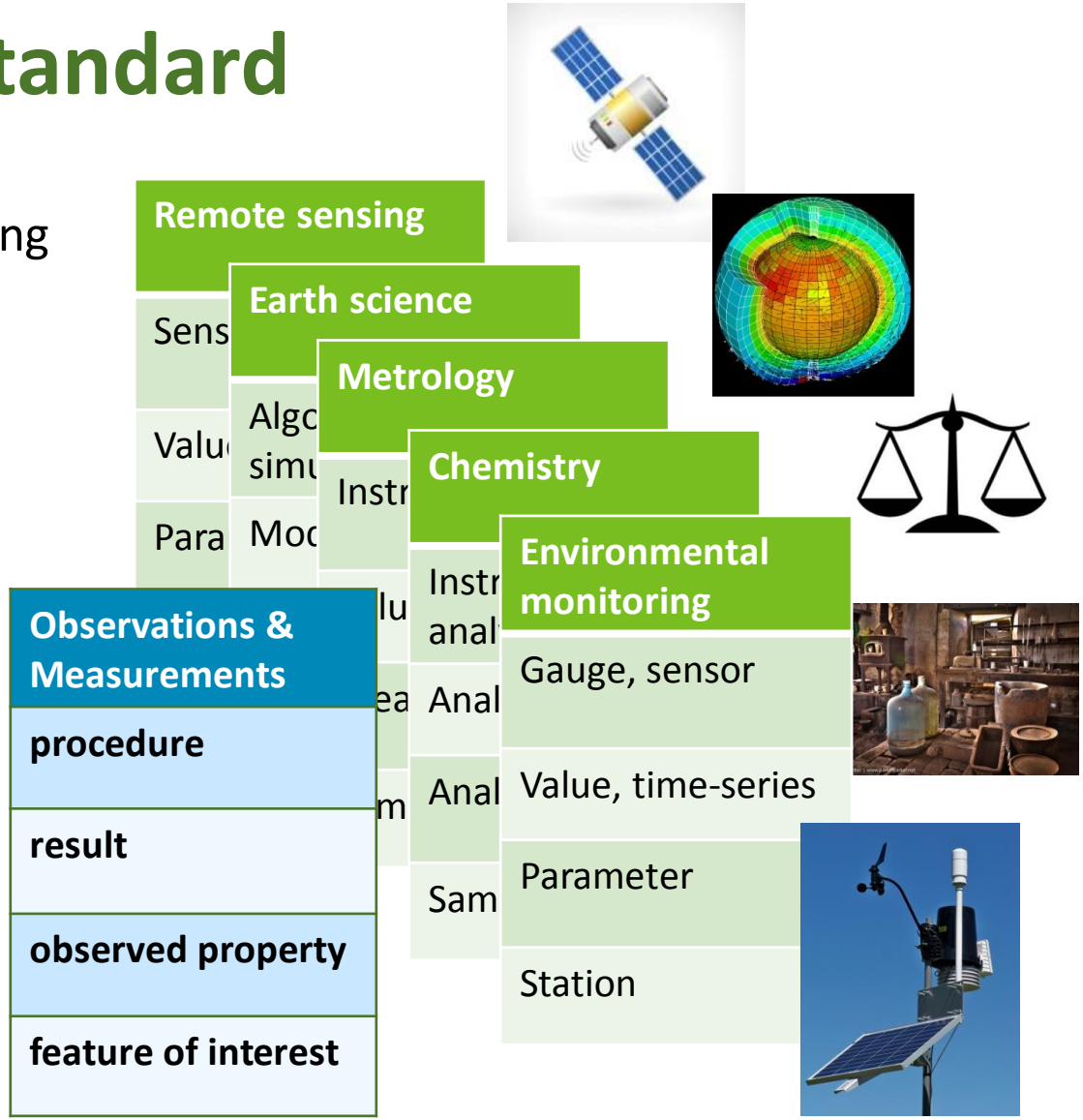
RDA
RESEARCH DATA ALLIANCE
Research Data Sharing without barriers

CSIRO

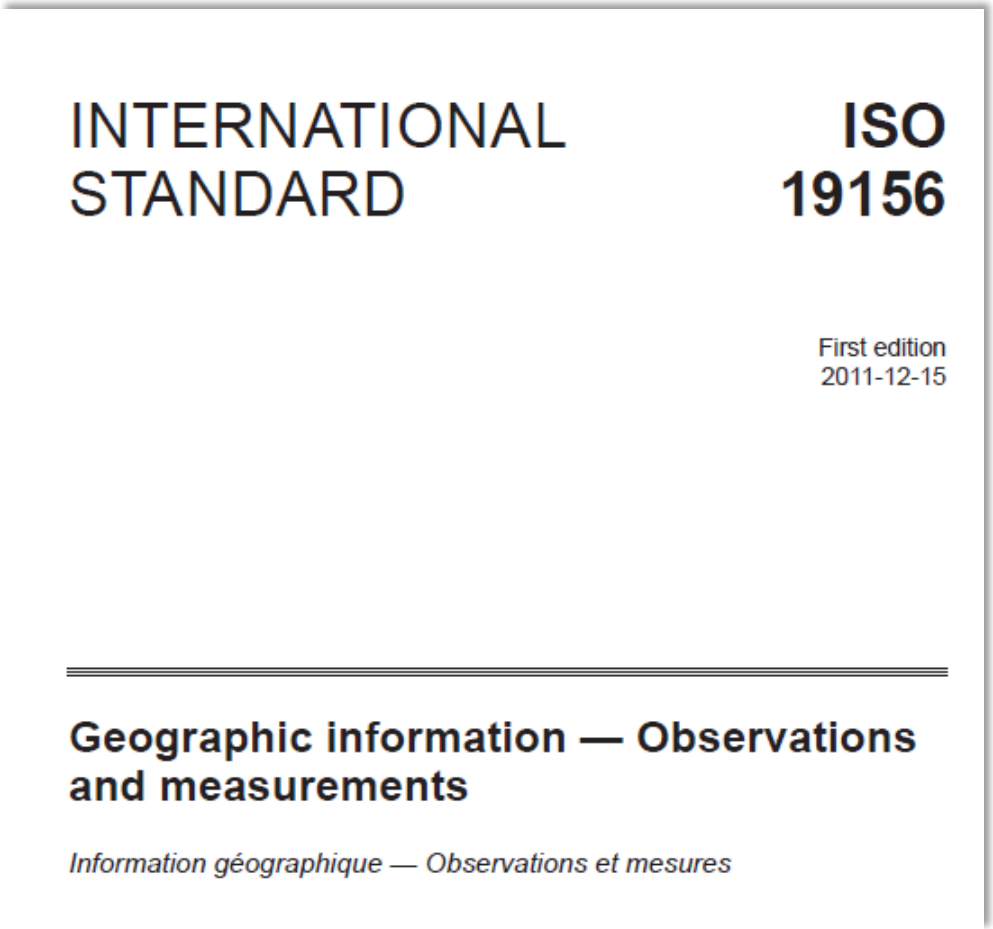
Motivation for a standard

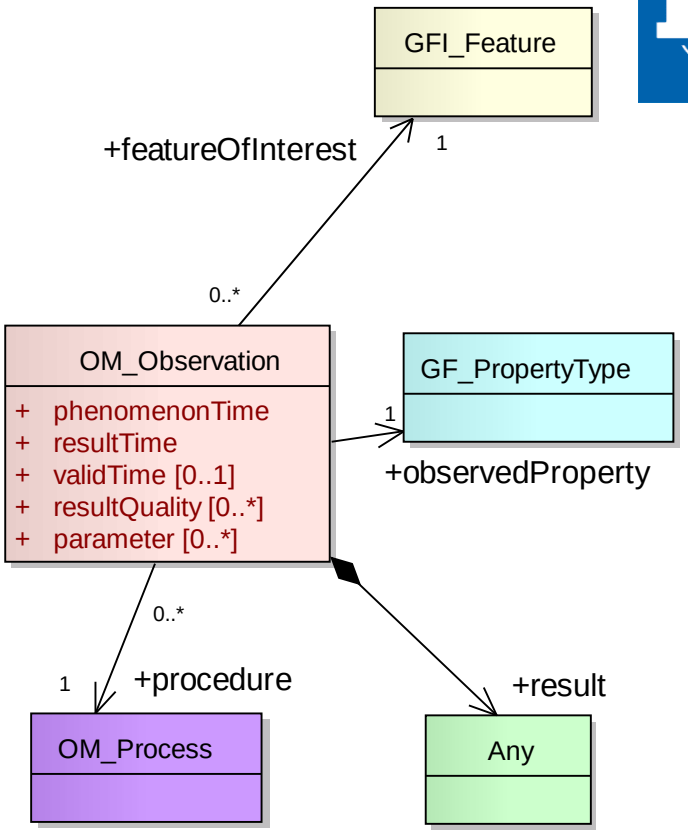
- Integrated analysis and modelling
- Discovery & data integration a significant challenge
- **Standard vocabulary**

  ~~Many private contracts~~
  one public agreement!



SWE/O&M





An Observation is an action whose result is an estimate of the value of some property of the feature-of-interest, obtained using a specified procedure

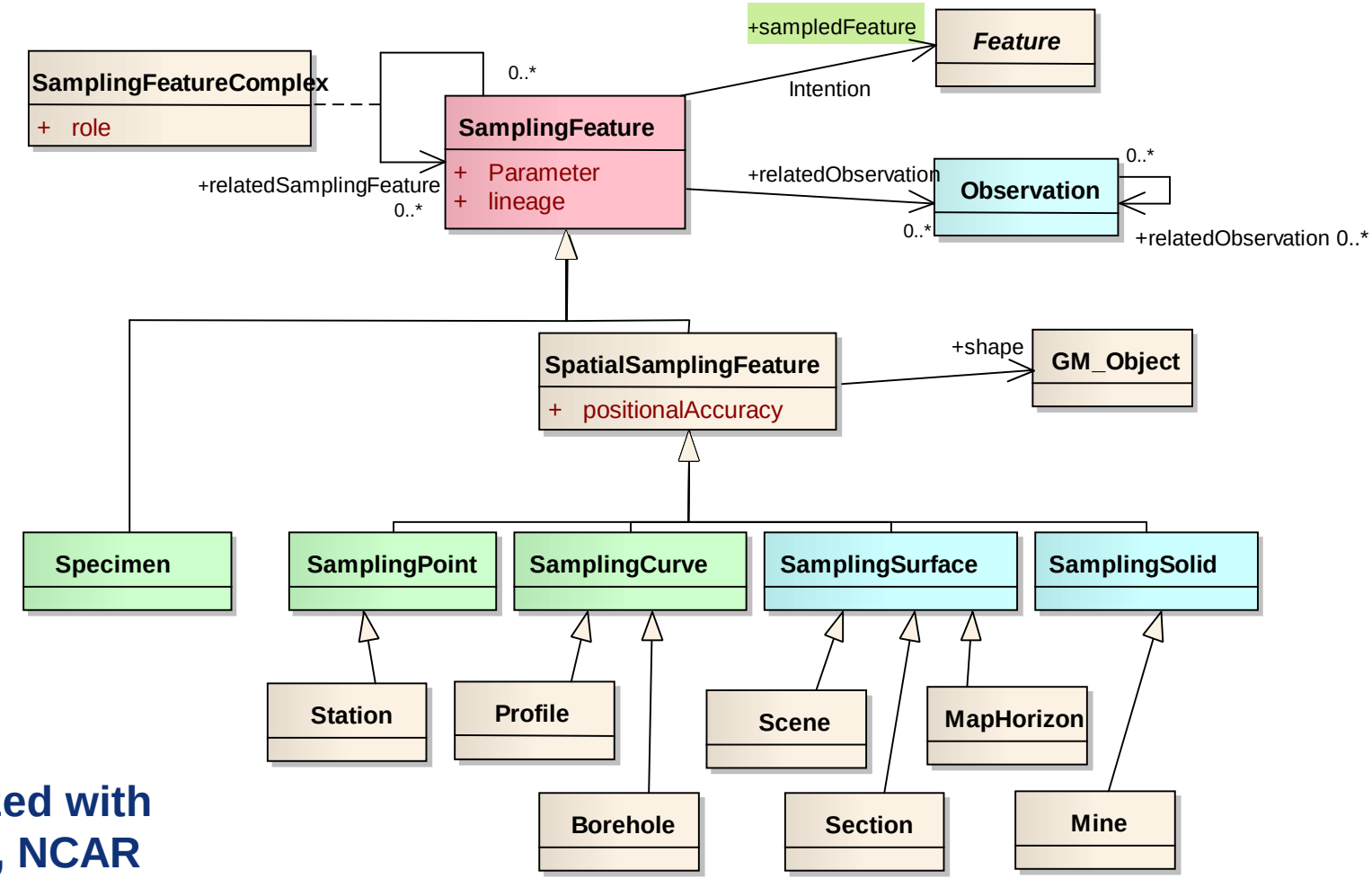
Cox, OGC Abstract Specification – Topic 20: Observations and Measurements 2.0
ISO 19156:2011 Geographic Information – Observations and measurements

Scope

- In situ observations
- Remote sensing
- Ex-situ observations
- Numerical models/simulations
- Forecasts

Any action whose result is an *estimate* of a property value

Sampling features



Harmonized with CSML, NCAR

Cox, OGC Abstract Specification – Topic 20: Observations and Measurements 2.0
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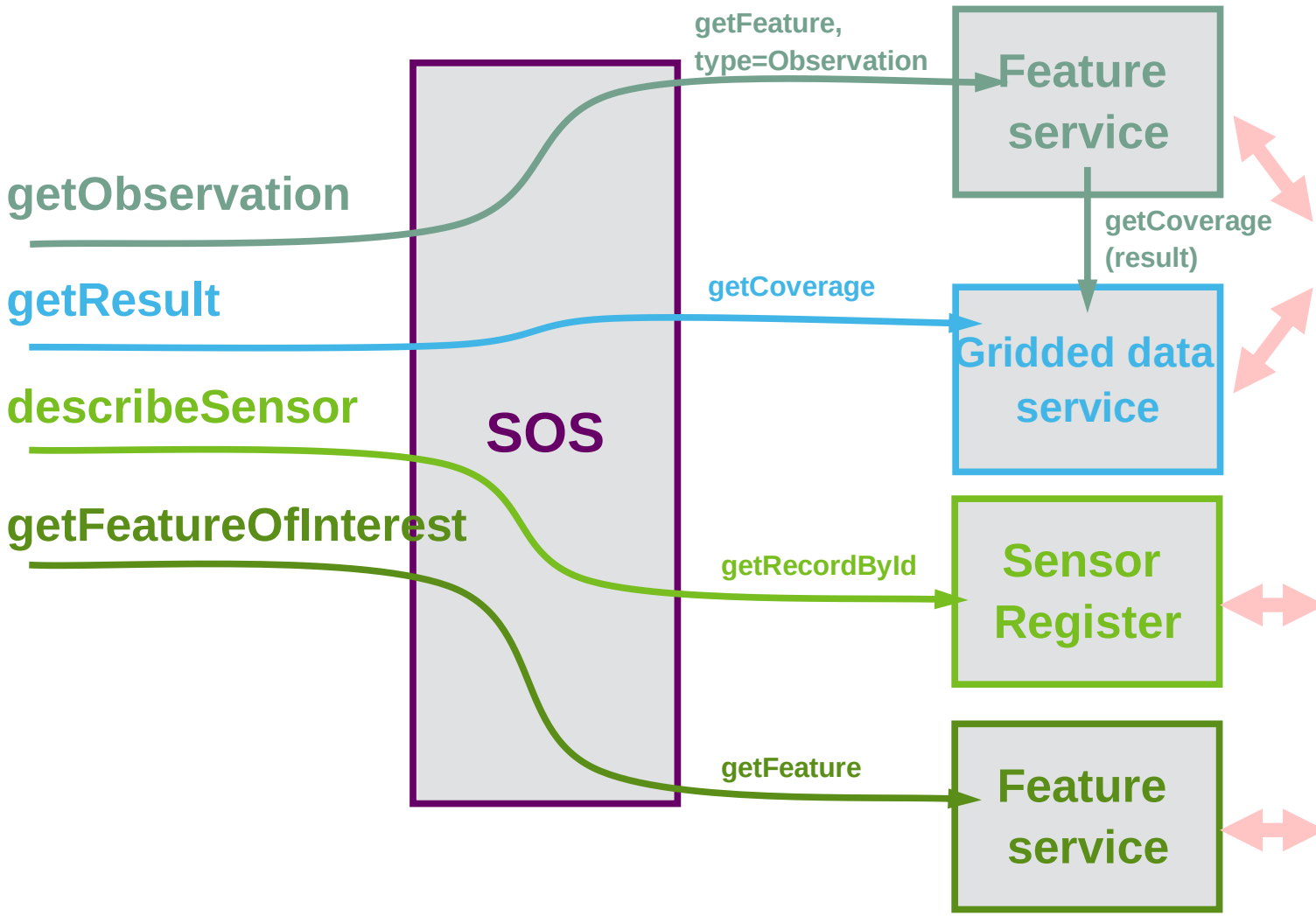
OGC Sensor Web Enablement

- SensorML
- O&M

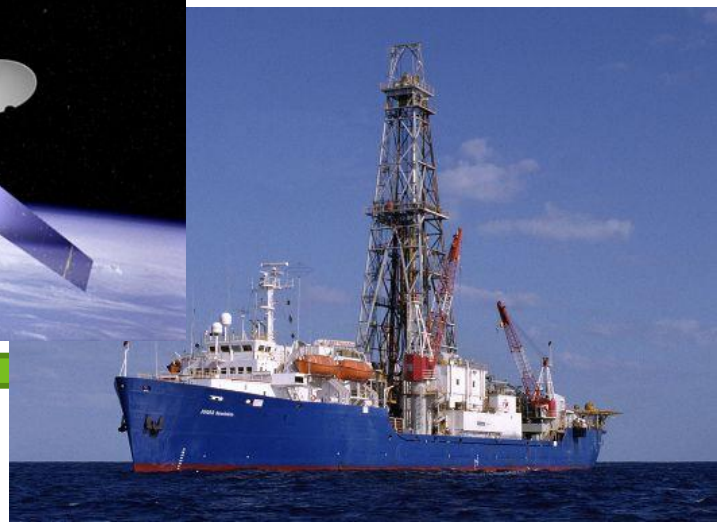
- Sensor Observation Service
- Sensor Planning Service

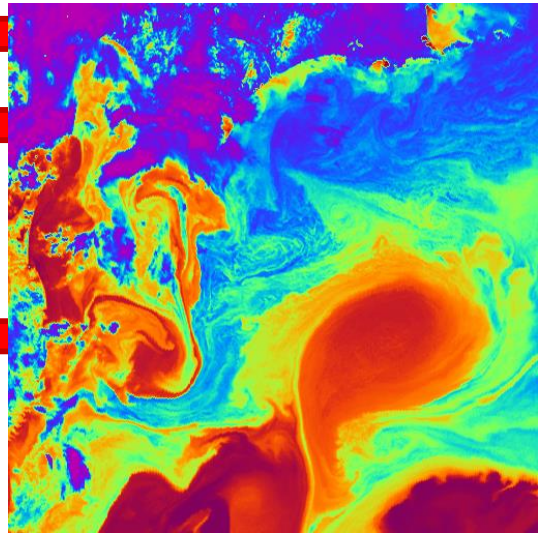
Sensor Observation Service



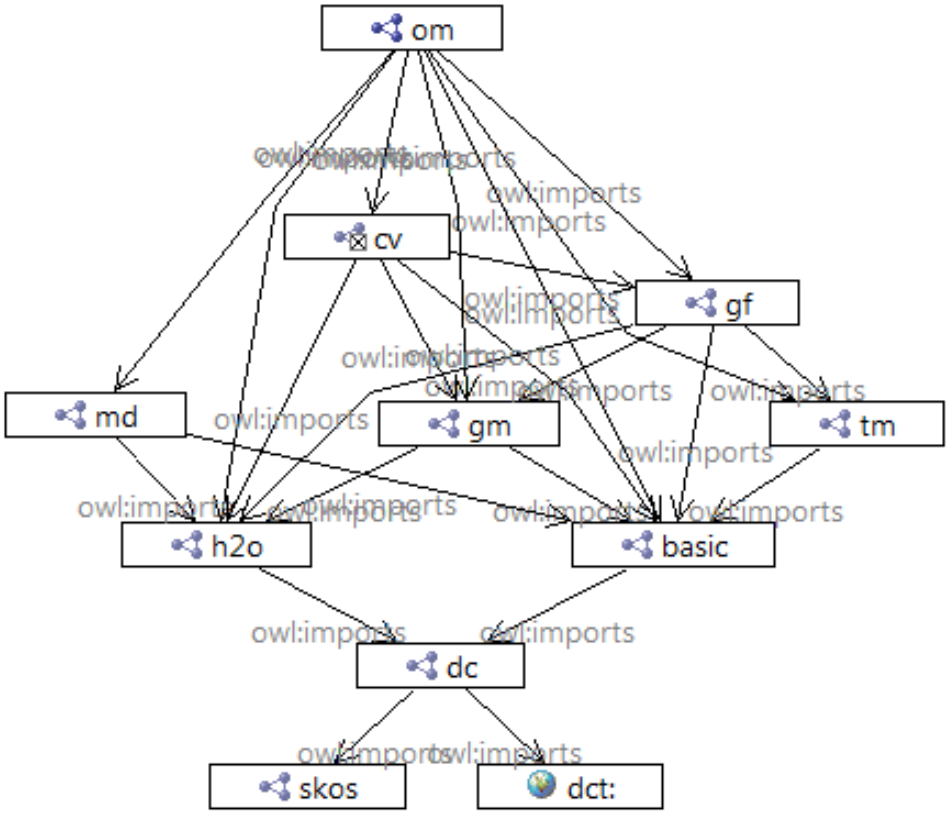
Provider or consumer?

Observations & Measurements
procedure
result
observed property
feature of interest
result time
phenomenon time
valid time





Integrated into ISO 19100 framework



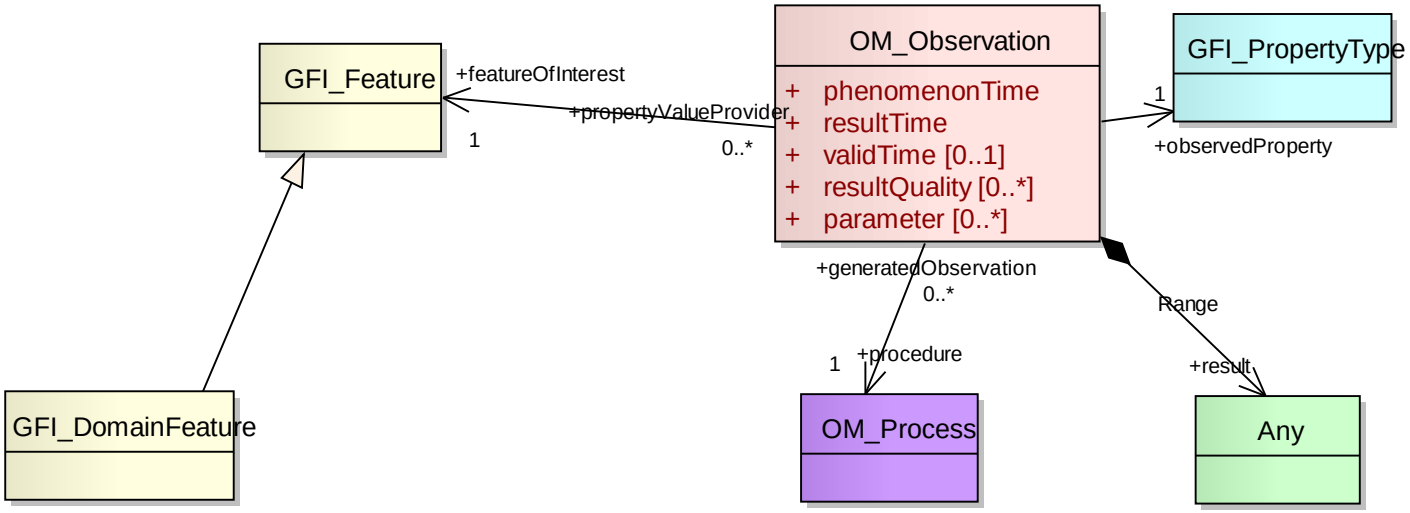
ISO dependencies

- gf - Feature ISO 19109
- cv - Coverage (fields) ISO 19123
- md - Metadata ISO 19115
- gm - Geometry ISO 19107
- tm - Temporal ISO 19108
- basic - Datatypes ISO 19103

Domain specialization

observed property

Parameter dictionary



feature of interest

Feature-type catalogue

Feature service

procedure

Register of sensors, processes & algorithms

result format:

GML, SWE, netCDF, JSON, SQLite ...

Linked vocabularies can be shared and re-used

NERC Vocabulary Serv

vocab.nerc.ac.uk/collection/P07/

This XML file does not appear to have any style inform

```
▼<rdf:RDF xmlns:rdf="http://www.w3.org/19
 xmlns:dc="http://purl.org/dc/elements/1.
 xmlns:grg="http://www.isotc211.org/schem
 ▼<skos:Collection rdf:about="http://voca
    <skos:prefLabel>Climate and Forecast
    <dc:title>Climate and Forecast Standa
    <skos:altLabel>CF Standard Names</sko
```

SISSVoc Search Client

sissvoc.ereefs.info/search#

SISSVoc Search

Climate and Forecast Standard

Service URL: http://auscope-services-test.arrc.csiro.au/elda-demo/n

Results for **Climate and Forecast Standard**. Showing page 1, result 1 to 10 (0.655 secs)

Climate and Forecast Standard Names Committee

http://vocab.nerc.ac.uk/collection/C30/current/CF/

altLabel: CF Standard Names
definition: Formal vocabulary specialist group within the governance of the Climate and Forecast Community Metada
notation: SDN:C30::CF
date: 2010-08-10 14:40:40.0
deprecated: false
identifier: SDN:C30::CF
note: accepted
versionInfo: 1
Type (1)

Climate and Forecast Standard Names Committee

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Linked Data - Object

auscope-services-test.arrc.csiro.au/elda-demo/nerc/resource?_view=skos&uri=http://vocab.r

SISSVoc

Powered

NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC-SISSVoc Test

html | json | rdf

Climate and Forecast Standard Names

http://vocab.nerc.ac.uk/collection/P07/current/

alt label	CF Standard Names
comment	Formal vocabulary specialist group within the governance of the Climate and Forecast Community Metadata Standard.
description	Terms used for definitive but not necessarily comprehensive descriptions of measured phenomena in the CF conventions (a content standard for data stored in NetCDF).
member	aerosol_angstrom_exponent
	age_of_sea_ice
	age_of_stratospheric_air
	age_of_surface_snow
	air_density
	air_potential_temperature
	air_pressure
	air_pressure_anomaly
	air_pressure_at_cloud_base
	air_pressure_at_cloud_top
	air_pressure_at_convective_cloud_base
	air_pressure_at_convective_cloud_top
	air_pressure_at_freezing_level
	air_pressure_at_sea_level
	air_temperature
	air_temperature_anomaly
	air_temperature_at_cloud_top
	air_temperature_lapse_rate
	air_temperature_threshold
	altimeter_range
	altimeter_range_correction_due_to_dry_troposphere

Find Concepts

Exact label

Text within label

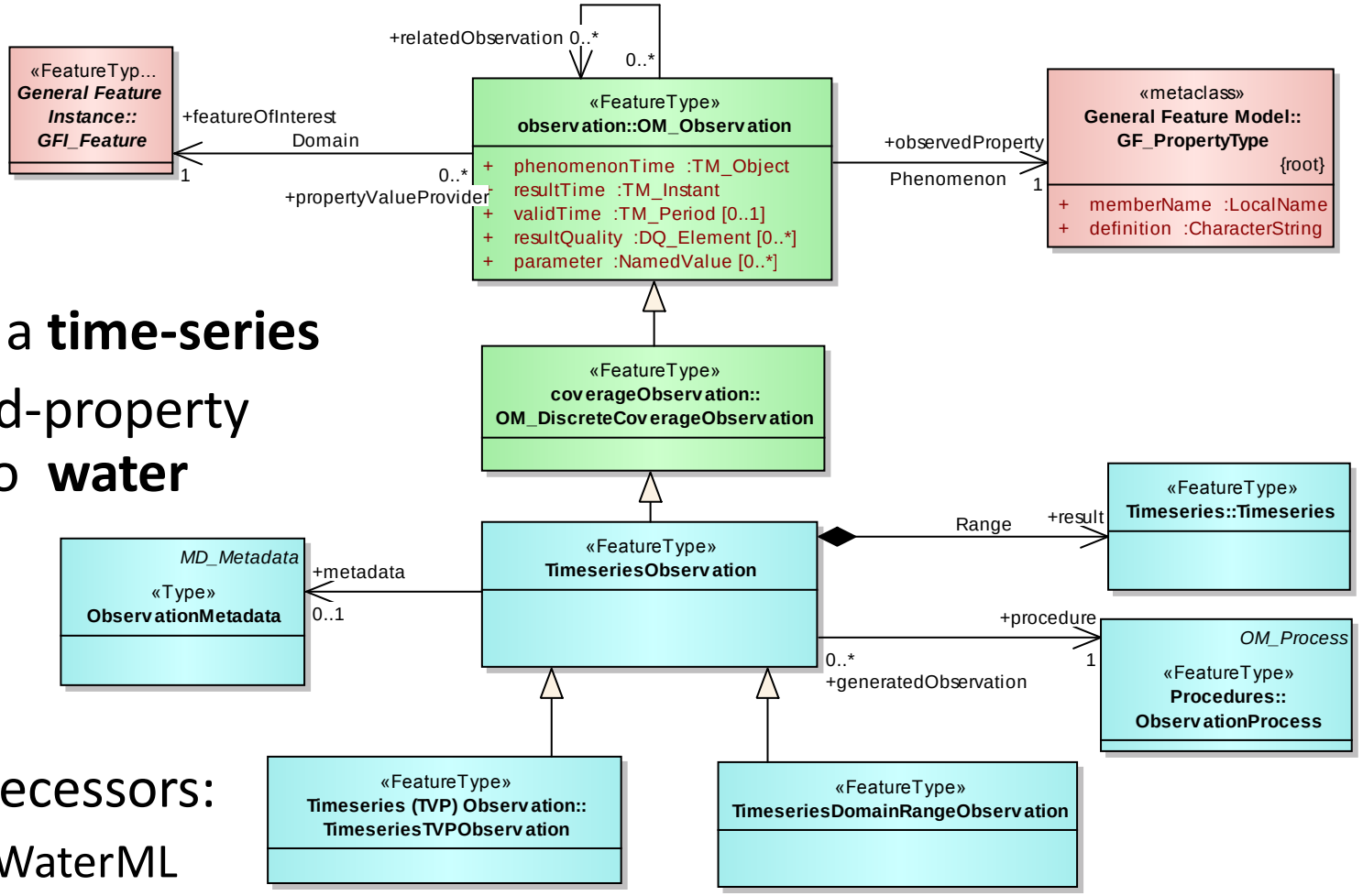
View

» skosbasic » default
» description » basic

pref label
alt label
comment
description
member
type
is primary topic of

Applications

WaterML2 specializes O&M

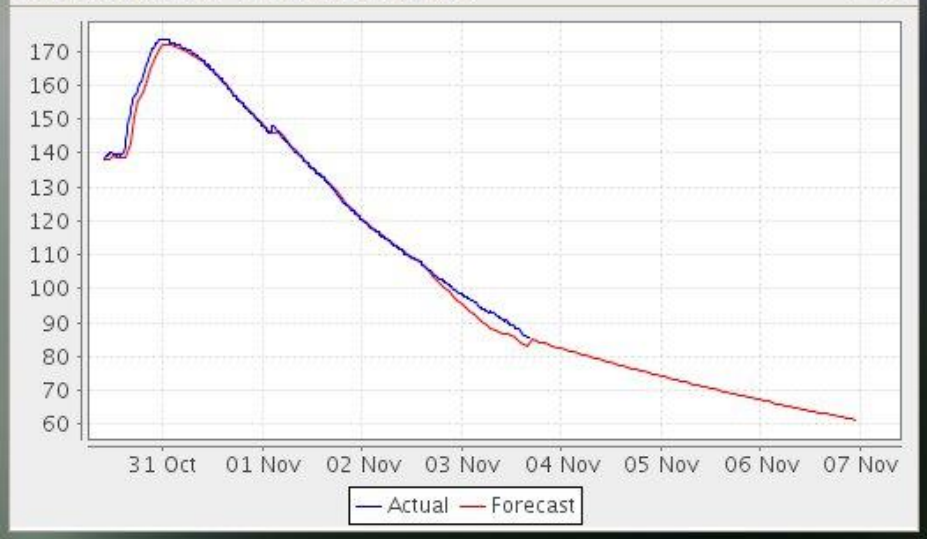


- Result is a **time-series**
- Observed-property relates to **water**

- Key predecessors:
  - CUAHSI WaterML
  - WDTF

Catchment | Weather Forecast | Graphing

Water Flow (ML/day) - Nile River at Deddington



Water Level (m) - Nile River at Deddington

General Graph

Environmental Data Discovery and Transformation - Beta Service Version

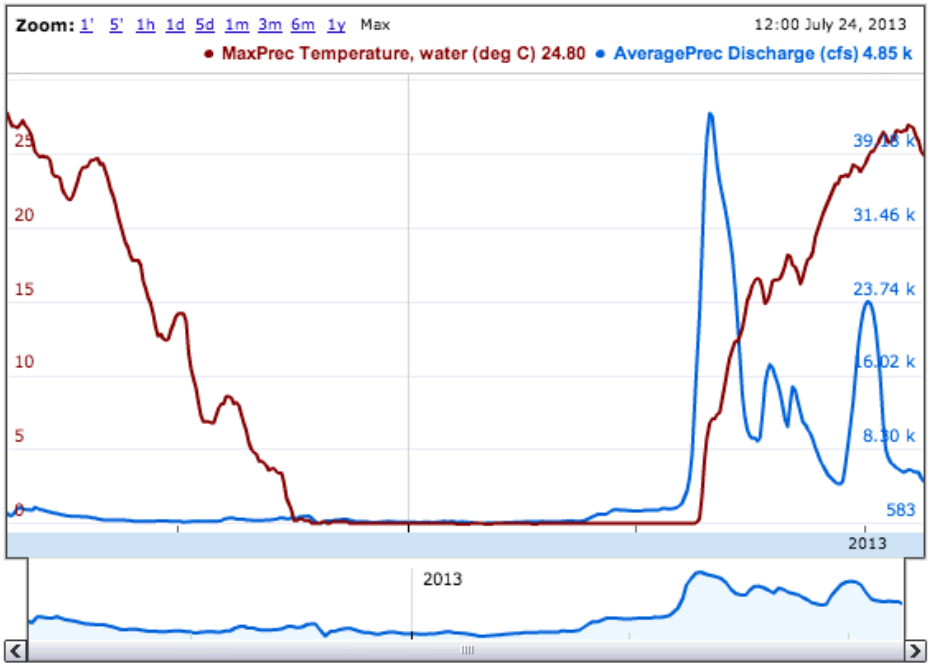
Forecasting Interoperability Experiment USGS Timeseries Observations

Navigation

- OGC Services
- Interactive Map
- Timeseries Plot

RED RIVER OF THE NORTH AT GRAND FORKS, ND : 05082500

Note: Data loading performs best in **Firefox, Chrome, Safari, or IE9**.



Provisional data subject to revision

Link to plot data: offering=00001&observedProperty=00010

Link to plot data: offering=00003&observedProperty=00060

Return home

Get New Station: 05082500

Begin Date: 2012-07-25

Plot Begins: 2012-07-25

End Date: 2013-07-25

Plot Ends: 2013-07-25

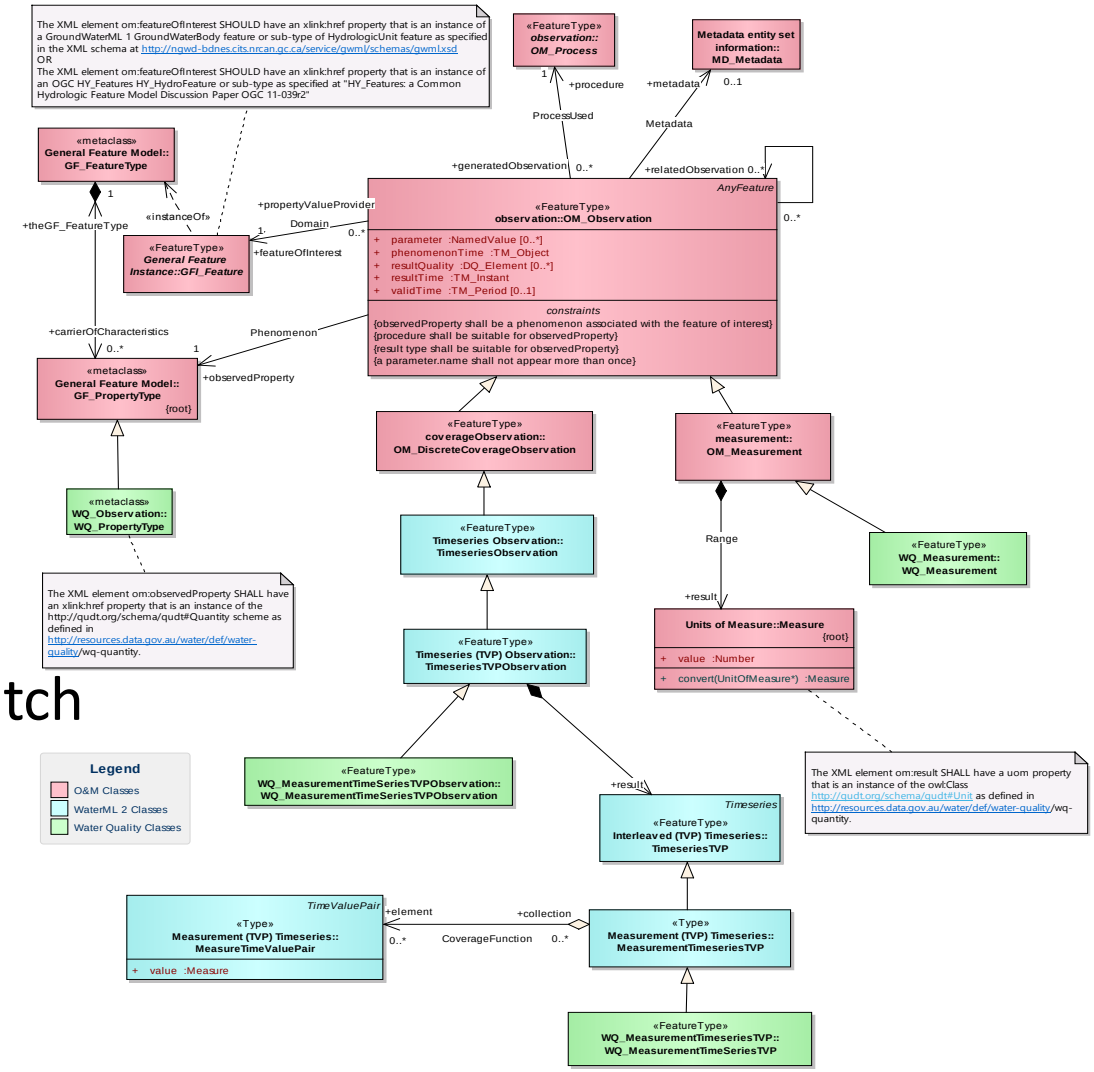
Available Data (choose up to 3 properties to plot):

	Property	Begin date	End date
☐	Temperature, water (deg C) Continuous	2007-10-01	2013-07-25
☑	Temperature, water (deg C) Daily Maximum	1966-07-15	1966-09-30
☐	Temperature, water (deg C) Daily Minimum	1966-07-15	1966-09-30
☐	Temperature, water (deg C) Daily Mean	2007-03-31	2013-07-24
☐	Temperature, water (deg C) Daily Am	1956-10-02	1958-09-30
☐	Temperature, water (deg C) Daily Instantaneous	1958-10-01	1973-09-30
☐	Discharge (cfs) Continuous	2007-	2013-

Submit

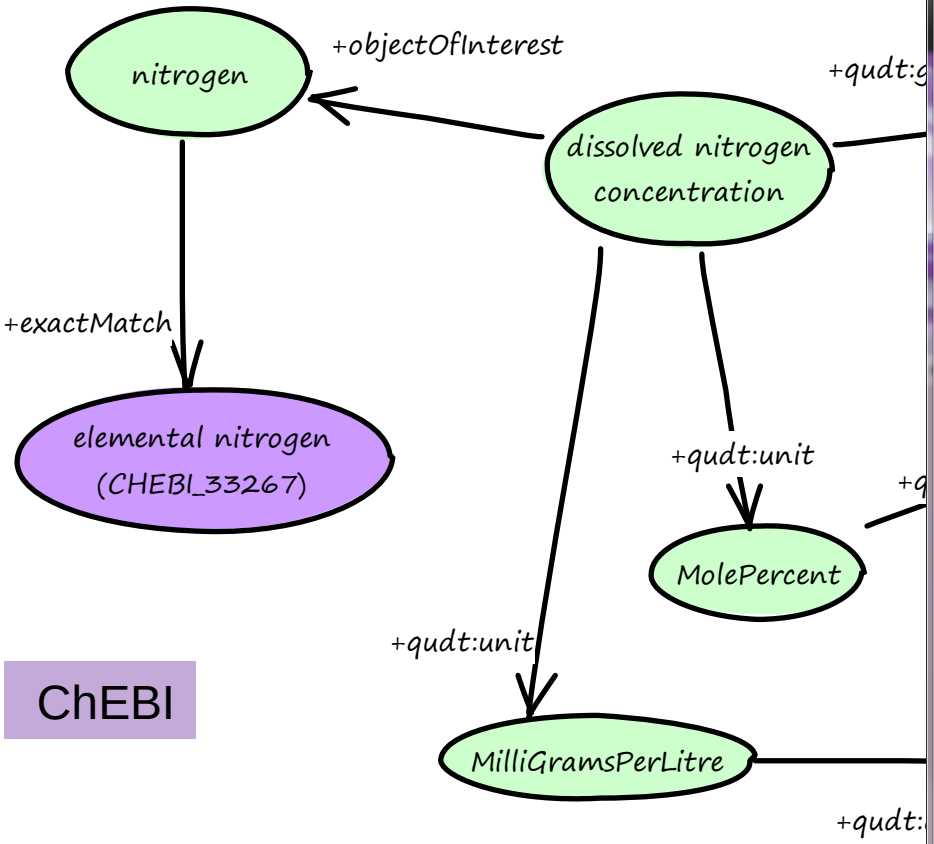
WaterML-WQ constrains O&M and WaterML

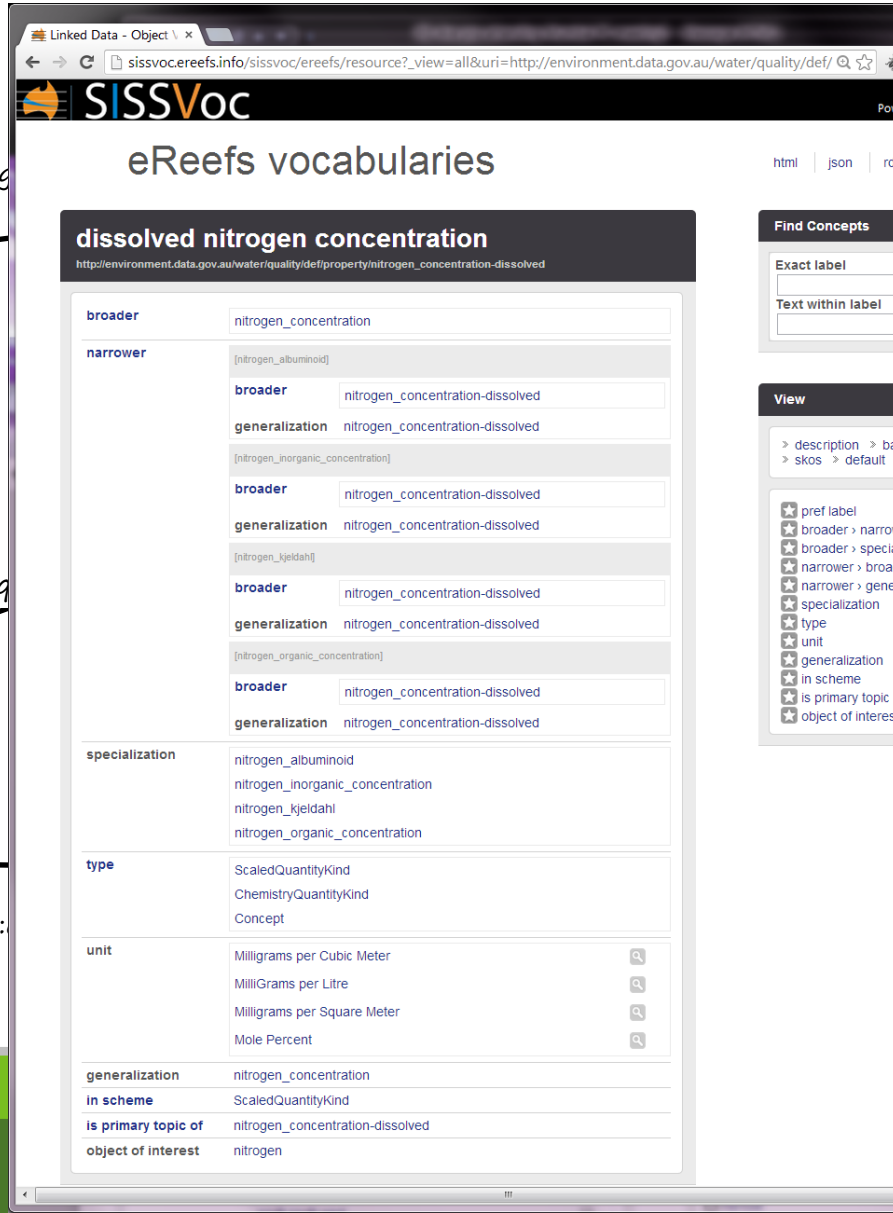
- Subject is a **groundwater** or **geofabric** feature
- observed property is **water-quality** property
- **units of measure** must match



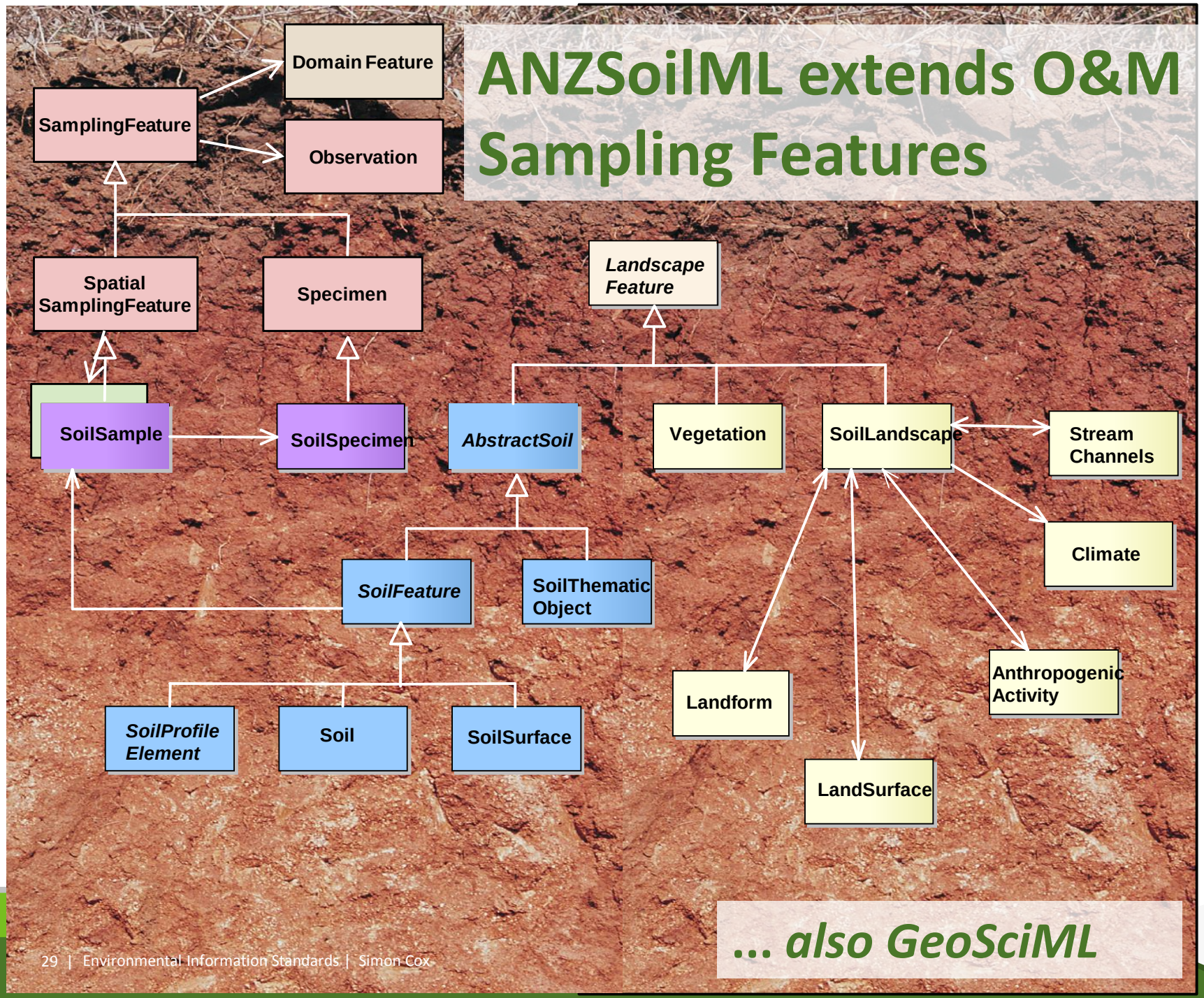
Observables vocabulary

GREAT BARRIER REEF foundation





ANZSoilML extends O&M Sampling Features

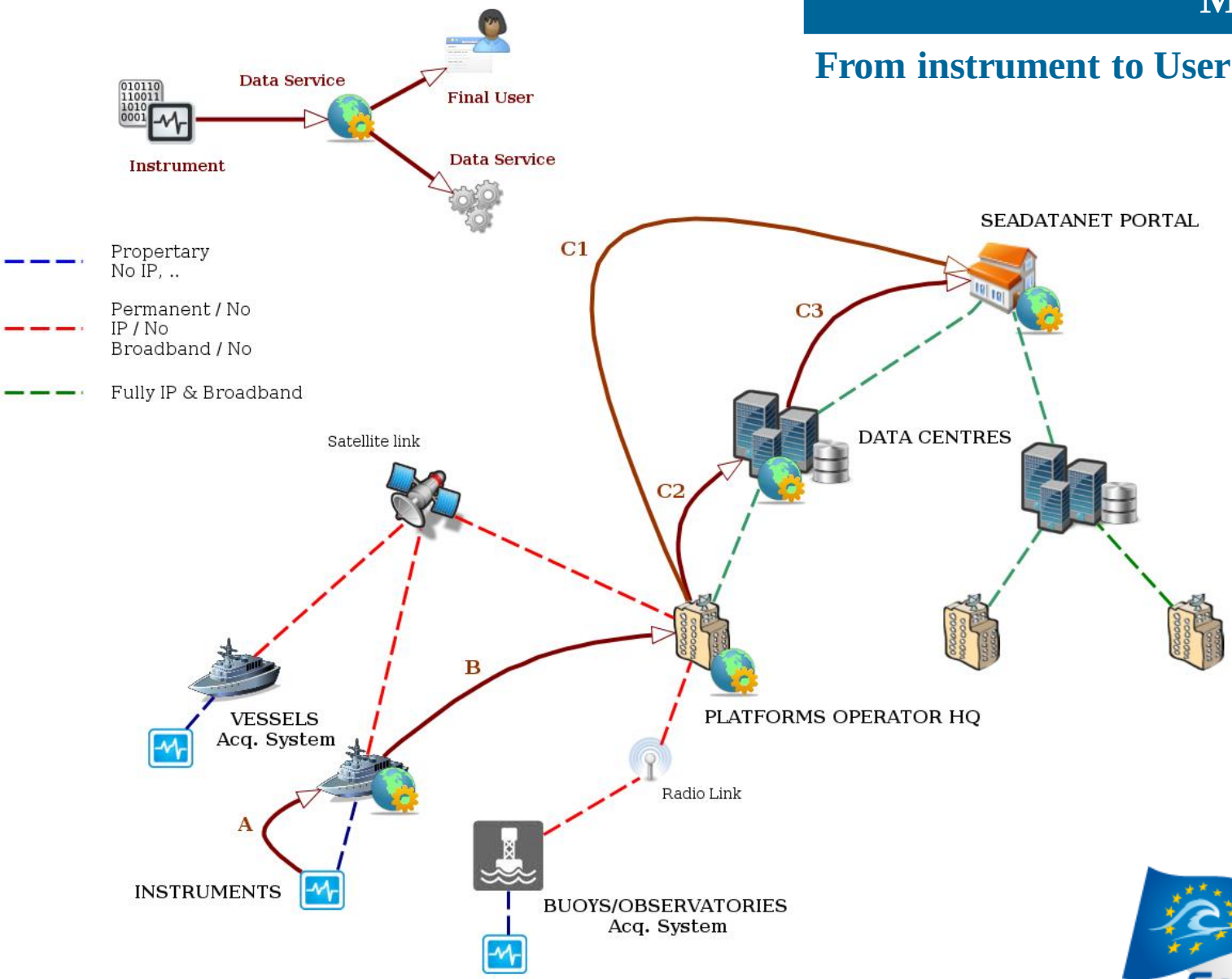


... also GeoSciML

Existing Activity

Motivation

From instrument to User



Existing Activity

SWE Adoption

Seismic Profile O&M

```
<sa:relatedObservation>
    <om:Observation gml:id="IT89AP103_part_1">
        <gml:description>
                ....
        </gml:description>
        <om:samplingTime>
            <gml:TimeInstant>
                <gml:timePosition>2007-06-06T17:20:30.00+08:00</gml:timePosition>
            </gml:TimeInstant>
        </om:samplingTime>
        <om:procedure xlink:href="http://sismica.ogs.trieste.it/sensor/IT89AP103_sml.xml" />
        <om:observedProperty xlink:href="http://bodc.somewhere/definitions/reflectivity" />
        <om:featureOfInterest xlink:href="http://bodc.somewhere/definitions/earthVolume" />
```

D=IT89AP103_part_1

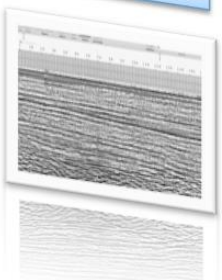
Domain specific parameters

Another SensorML doc

```
<sa:relatedObservation>
    <om:Observation gml:id="IT89AP103_part_1">
        <gml:description>
                ....
        </gml:description>
        <om:samplingTime>
            <gml:TimeInstant>
                <gml:timePosition>2007-06-06T17:20:30.00+08:00</gml:timePosition>
            </gml:TimeInstant>
        </om:samplingTime>
        <om:procedure xlink:href="http://sismica.ogs.trieste.it/sensor/IT89AP103_sml.xml" />
        <om:observedProperty xlink:href="http://bodc.somewhere/definitions/reflectivity" />
        <om:featureOfInterest xlink:href="http://bodc.somewhere/definitions/earthVolume" />
        <om:result>
            xlink:href=http://seisviewer.ogs.trieste.it/viewer?CDI_ID=..SEZ_ID=IT89AP103_part_1
            xlink:role="application/sgy"  xsi:type="gml:ReferenceType"
        </om:result>
    </om:Observation>
</sa:relatedObservation>
```

Link to visualization services

HR visualization

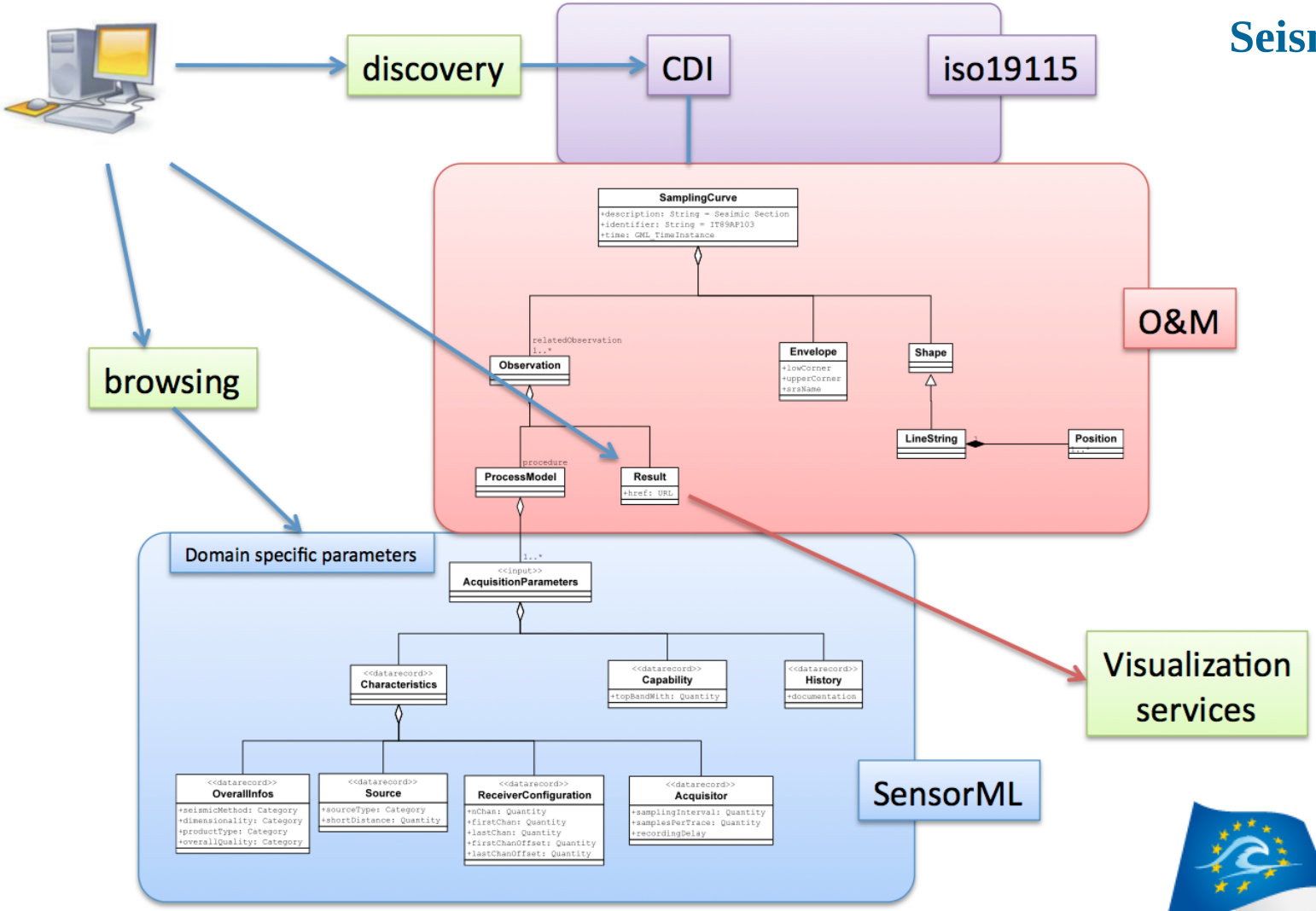


Diviacco, P. et al. 2011 Marine Seismic Metadata for an Integrated European Scale Data Infrastructure

SWE Adoption

Integration with existing SeaDataNet Standards

Seismic



EU Air Quality Directive

11.6.2008 EN Official Journal of the European Union

(Acts adopted under the EC T

DIRECTIVE 2008/50/EC OF THE

on ambient ai

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF TH
PEAN UNION,

Having regard to the Treaty establishing the European C
nity, and in particular Article 175 thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Econor
Social Committee ([1]),

Having regard to the opinion of the Committee of the Reg

L 335/86 EN Official Journal of the European Union 17.12.2011

COMMISSION IMPLEMENTING DECISION

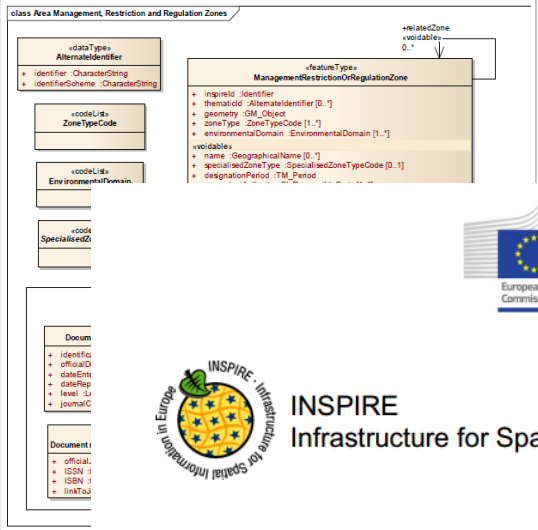
of 12 December 2011

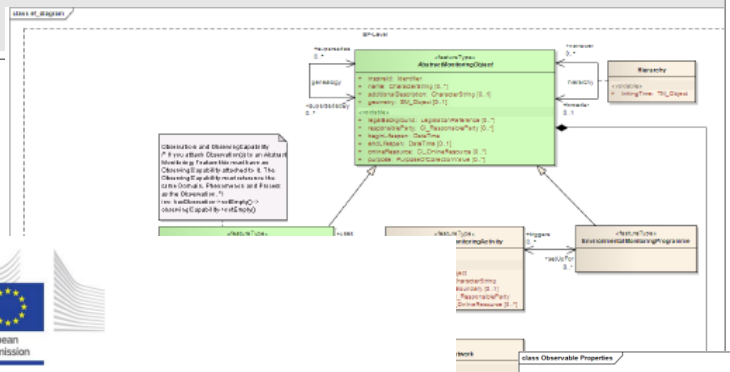
laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air quality

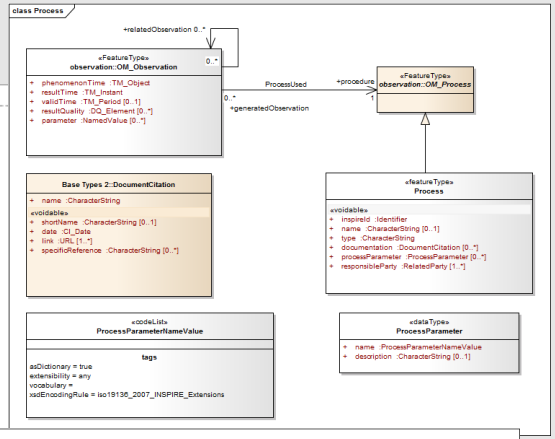
IPR Nr.	Reference	Element	Specification	Description	Requirement	Cardinality
	D.5	*The dataset describing Fixed and Indicative Measurements comprises meta-information on three hierarchical levels:* • *Measurement Configuration* • *Station* • *Network*			*M*	*1..**
	D.5.1	*Information concerning measurement configuration by pollutant (sampling point), to be provided for each measurement configuration for which data is to be reported.* *According to Art. 2 (3), a 'Measurement Configuration' means the technical facilities used for the measurement of one pollutant or one of its compounds at a specific station. For a pollutant, more than one Measurement Configurations at a single station can be in operation.*			*M*	*1..**
1	D.5.1.1	Measurement configuration ID	Identifier	Unique identifier for this measurement configuration. In case of existing measurement configuration the localID should be the Existing code. In case of new measurement configuration the localID is to be defined by data provider, comprising station code, pollutant AirBase code and a number.	M	1
2	D.5.1.2	European station ID	Link	Selection only from existing codes that identify stations for which metadata is provided. *Link to D.5.2*	M	1
3	D.5.1.3	Network ID	Link	Network which manages the sampling point. *Link to D.5.3*	M	1
	D.5.1.4	Measurement time references			M	1
7	D.5.1.4.1	Measurement start date	Timestamp	Start of the measurement configuration (measurement of a pollutant at a monitoring station)	M	1
7	D.5.1.4.2	Measurement end date	Timestamp	End of the measurement configuration (measurement of a pollutant at a monitoring station)	C M if the measurement configuration is closed	0..1
	D.5.1.5	*Emissions with predominant influence: For each measurement configuration, the type of source is to be given which is responsible for the largest (relative) contribution to the observed concentration.* *Describes emissions influencing the monitoring station for the specific pollutant. This information is relevant for the interpretation of the measured data and the assessment of the representativeness of the site.*			*M*	*1*
22	D.5.1.5.1	Classification of station in relation to major emission sources relevant for the measurement configuration	Menu	See codelist *Station Classification* "Classification of station" represents the "Type of station in relation to dominant emission sources" defined in the Exchange of Information (97/101/EC): • traffic • industrial • background Further guidance is provided in chapter 19.	M	1
23	D.5.1.5.2	Main emission sources	Menu	See codelist *Main emission sources* The main emission source(s) (D.5.1.5.2) can be selected from the Codelist Main Emission Sources. In addition to the CRF emission categories, two "source" types have been introduced which represent contributions not originating from identifiable sources: "Secondary" and "Long-range	C M if available	0..1

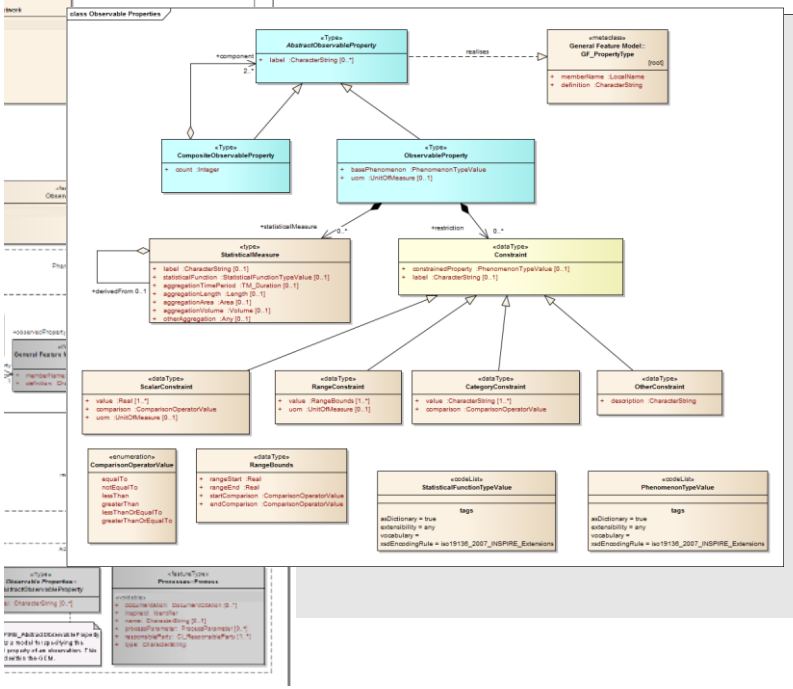
EN 2 EN

INSPIRE – OM









European Commission

INSPIRE
Infrastructure for Spatial Information in Europe

D2.9 Draft Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development

Title	D2.9 Draft Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development
Creator	INSPIRE Cross Thematic Working Group on Observations & Measurements
Date	2013-02-22
Subject	Use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE
Publisher	INSPIRE Cross Thematic Working Group on Observations & Measurements
Type	Text
Description	This document describes the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE data specification development. This version (version 2, release candidate 3) reflects the content of the draft amendment to Commission Regulation (EU) No 1089/2010 for the Annex II+III spatial data themes as submitted to the INSPIRE Committee.

Air Quality Station

AQ_Station :EnvironmentalMonitoringFacility

inspireId = AT/ST_123
name = AQ_Station
geometry = [48.204541, 16.367455]
additionalDescription = A test air quality station
legalBackground = http://eur-lex.europa.eu/...2008/50/EC
beginLifespan = 20120217
measurementRegime = continuous data collection
mediaMonitored = air
mobile = False
resultAcquisitionSource = in-situ

+operationalActivityPeriod

AQ_Station_Operation : OperationalActivityPeriod

activityTime = [20020321 -]

+broader

hierarchy

LinkingTime :Hierarchy

linkingTime = [20030524 -]

+narrower

O3_Sensor :EnvironmentalMonitoringFacility

inspireId = AT/O3_456
name = O3_01
additionalDescription = O3 Sensor
geometry = [48.204541, 16.367455]
beginLifespan = 20120217
measurementRegime = continuous data collection
mediaMonitored = air
mobile = False
resultAcquisitionSource = in-situ

+operationalActivityPeriod

O3_Sensor_Operation : OperationalActivityPeriod

activityTime = [20030524 -]

+observingCapability

O3_Capabilities :ObservingCapability

observingTime = [20030524 -]
processType = INSPIRE_OM_Process
reportedTo = 2008/50/EC
resultNature = primary

+featureOfInterest

Domain

O3_FoI :My_FoI_Type

geometry = [48.204541, 16.367455]

ProcessUsed

+procedure

O3_Process :INSPIRE_OM_Process

inspireId = AT/O3_Process
onlineDocumentation = http://doc.somewhere.com

Phenomenon

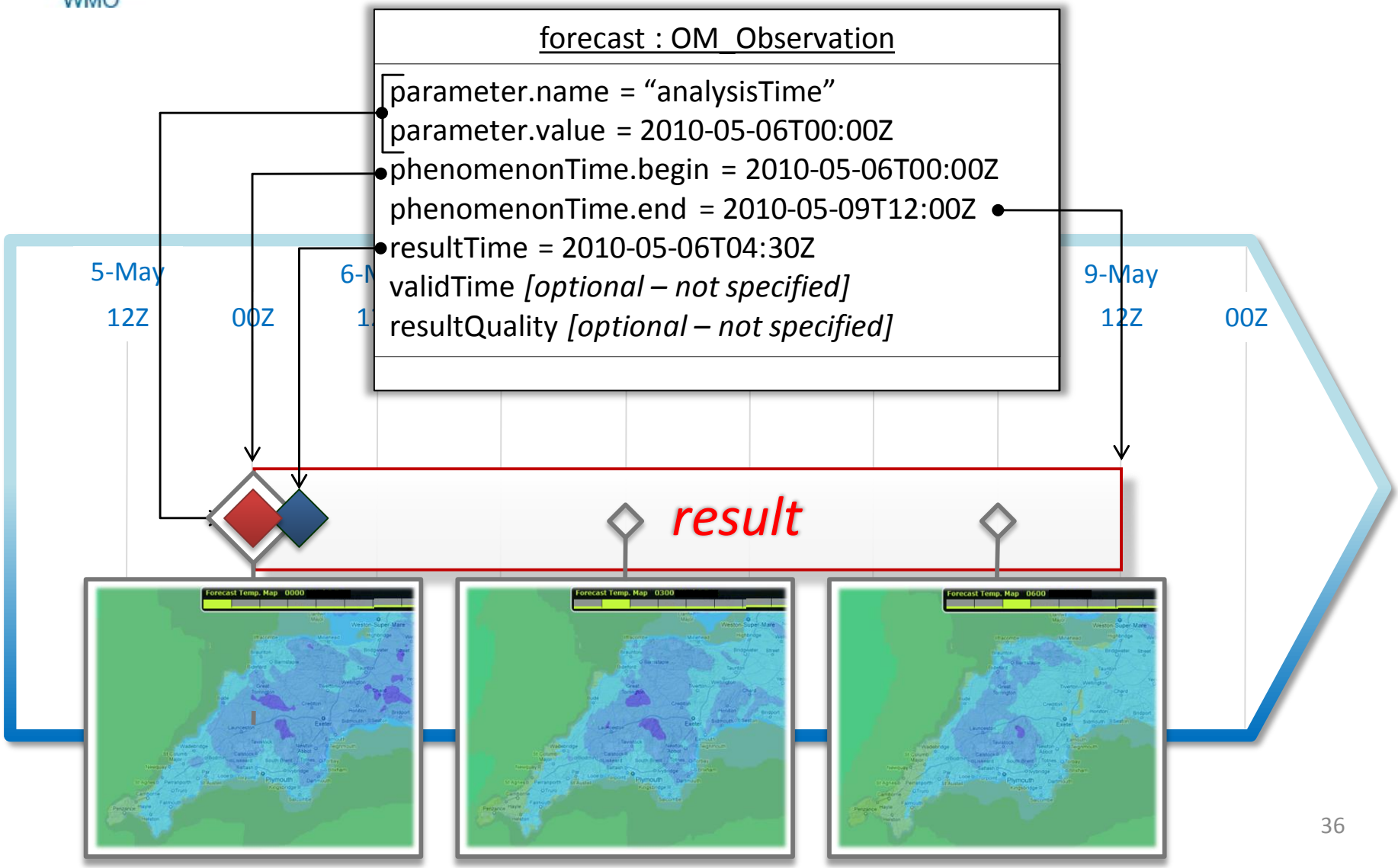
+observedProperty

O3_Property :StatisticalMeasure

basePhenomenon = O3
uom = ppm
aggregationTimePeriod = [TM_Duration.hour=1]

ISO19156 Observations and measurements:

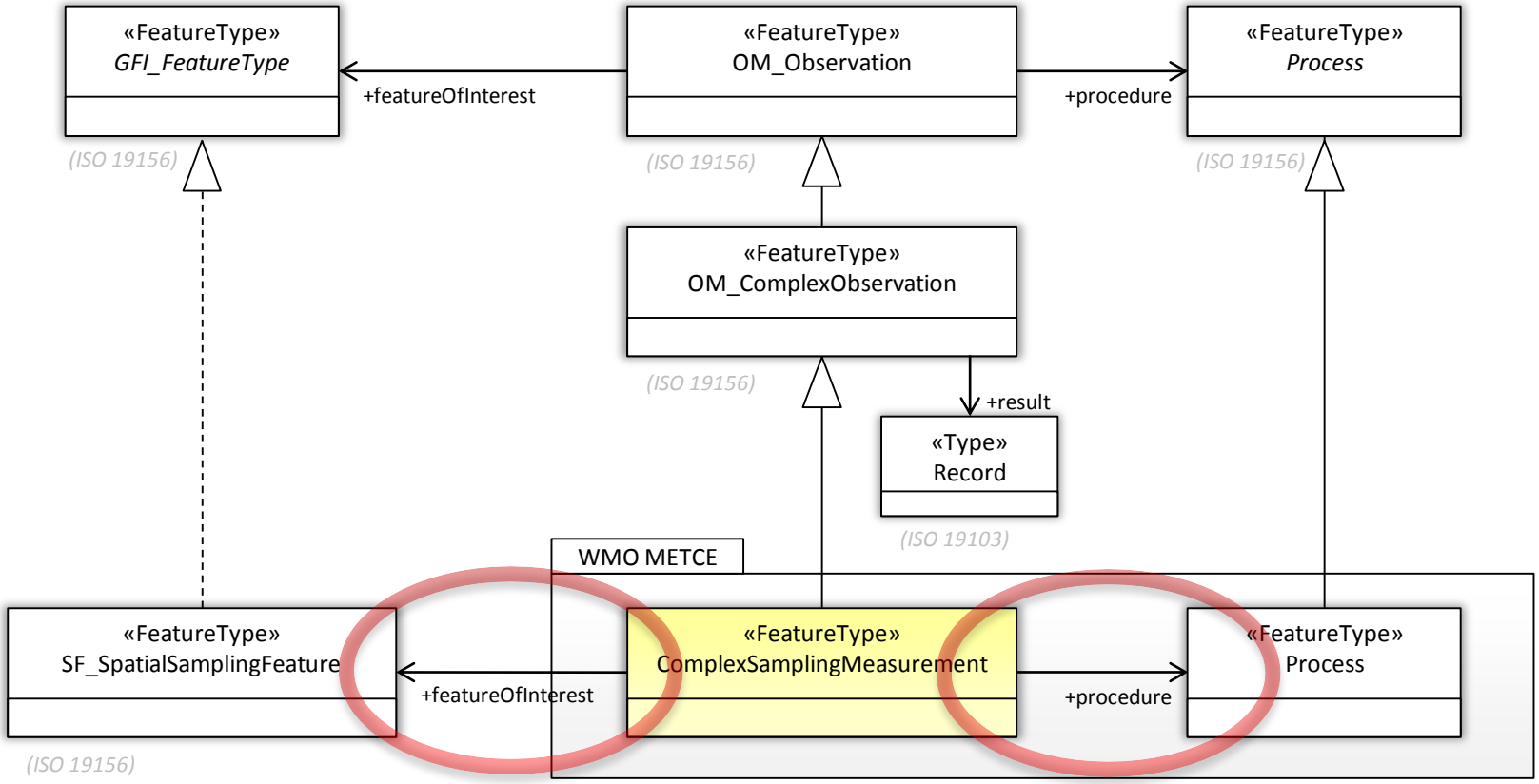
also suitable for numerical simulations – including forecasts



Common constraints applicable to all WMO METCE Observation types

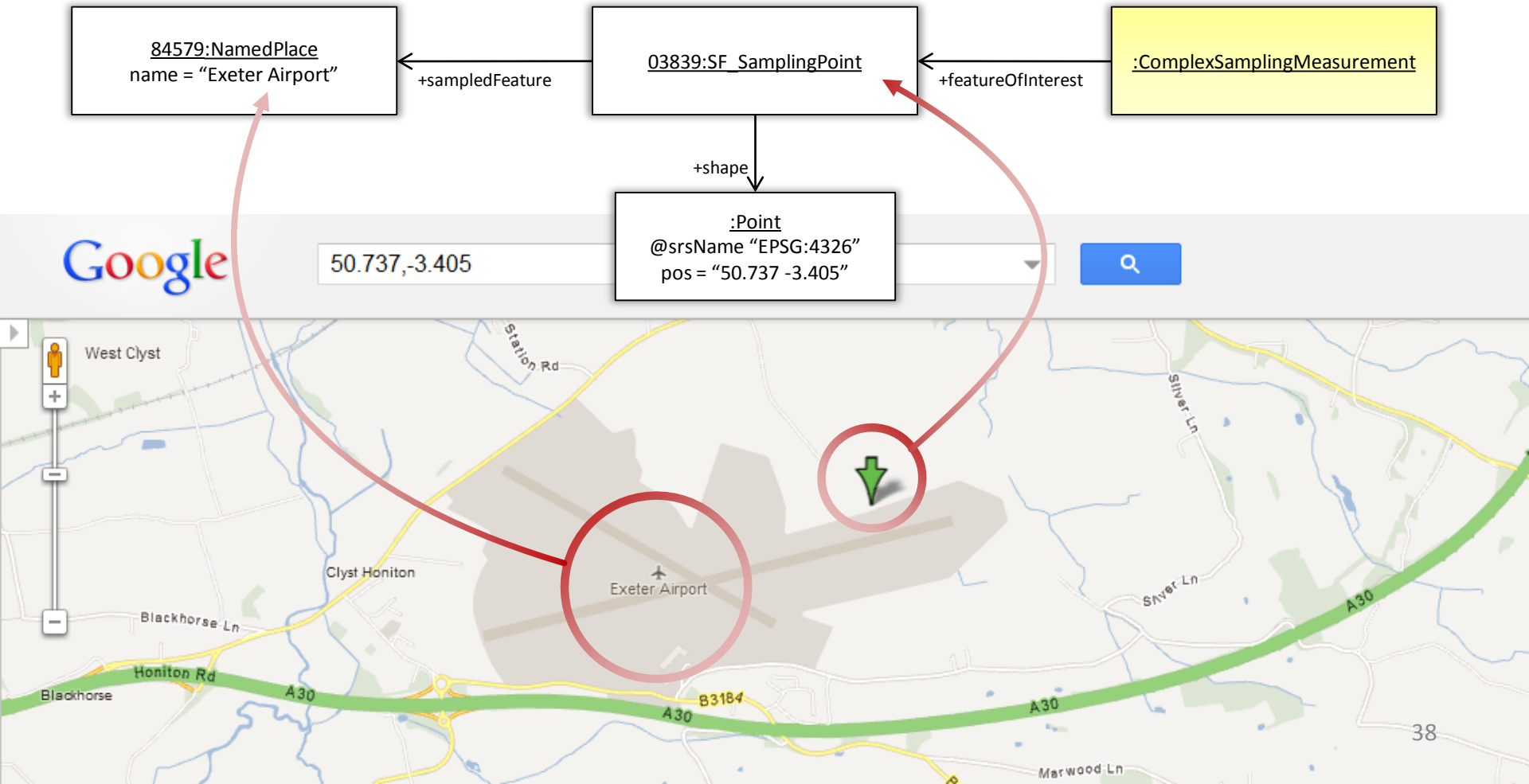
All specialisations of OM_Observation defined in WMO METCE require:

- *association role 'featureOfInterest' shall be of type SF_SpatialSamplingFeature*
- *association role 'procedure' shall be of type Process (from WMO METCE)*

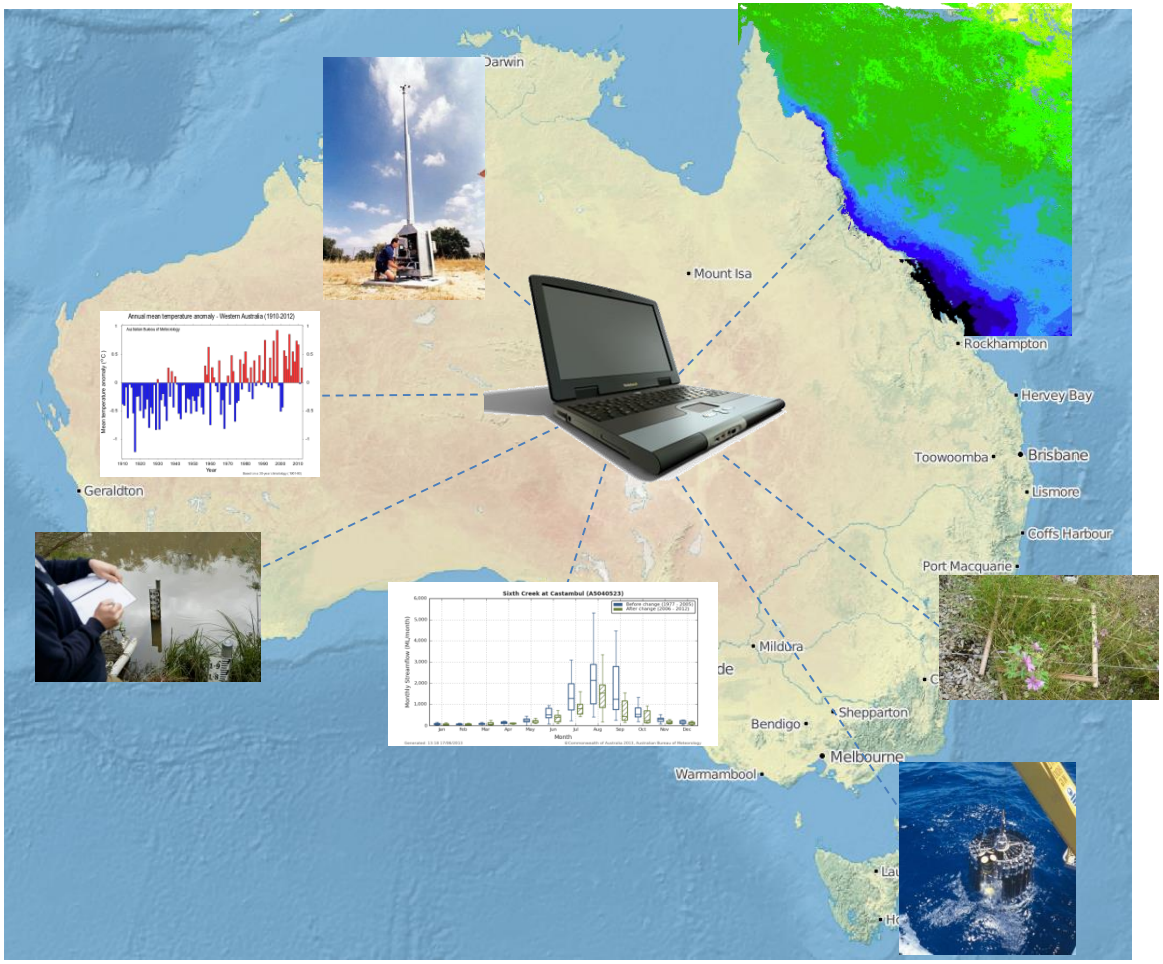


SamplingFeature as OM_Observation.featureOfInterest

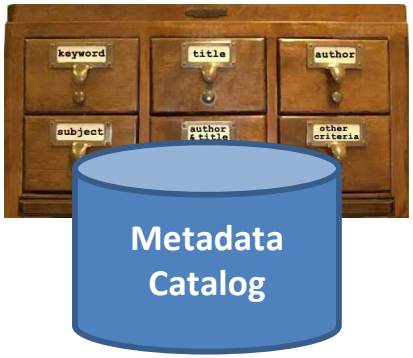
In meteorology, we define a sampling regime that enables us to observe, measure or simulate the real-world. Sampling Features (from ISO 19156 'Observations and measurements') provide a way to characterise this sampling regime and the relationship to the real-world.

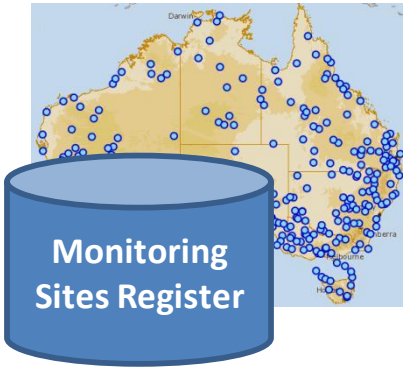


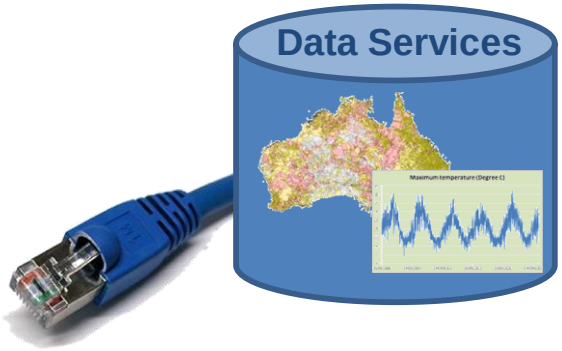
National Environmental Information Infrastructure



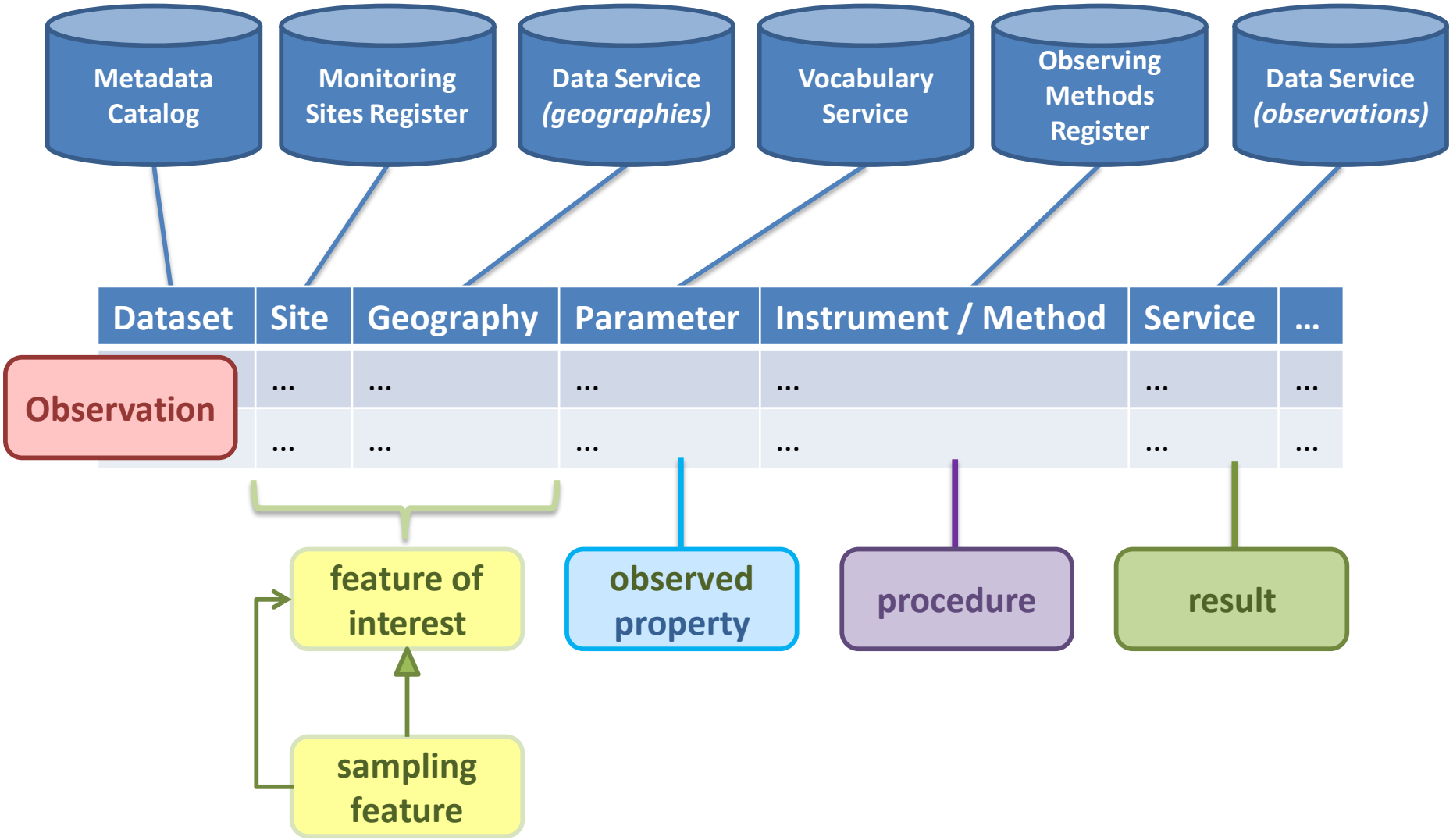
NEII components



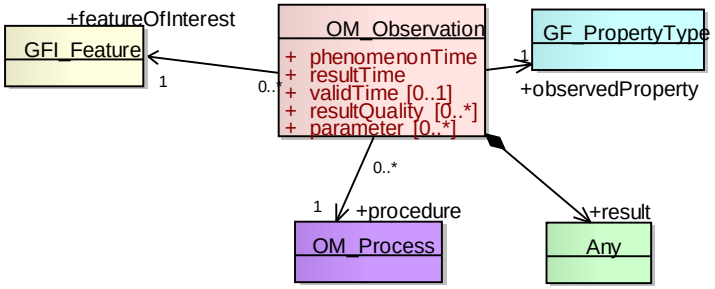


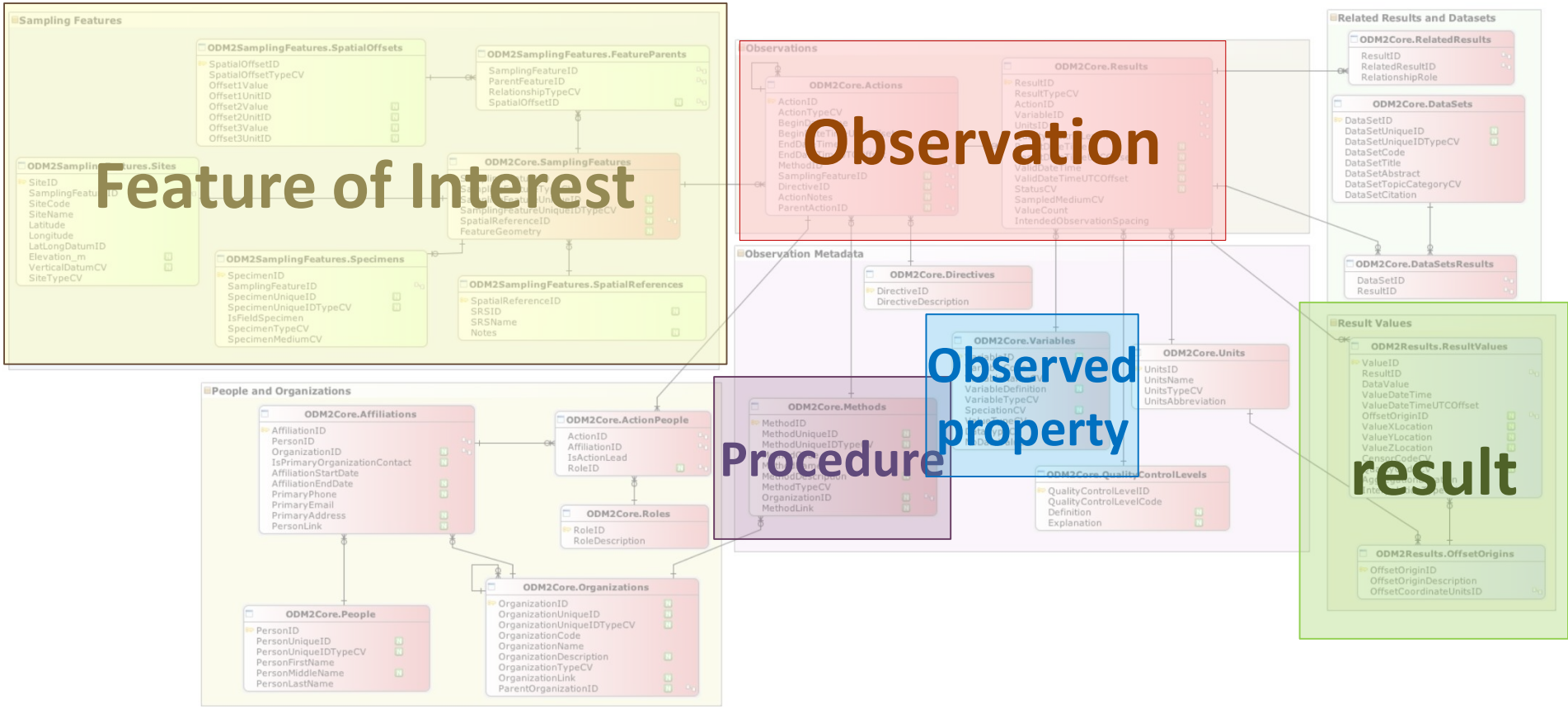


Integration through linking table



ODM2


+featureOfInterest
GFI_Feature
1
0..*
OM_Observation
+ phenomenonTime
+ resultTime
+ validTime [0..1]
+ resultQuality [0..*]
+ parameter [0..*]
1
GF_PropertyType
+observedProperty
0..*
1
+procedure
OM_Process
+result
Any


Feature of Interest
Observation
Observed property
Procedure
result
Sampling Features
ODM2SamplingFeatures.SpatialOffsets
ODM2SamplingFeatures.FeatureParents
ODM2Core.SamplingFeatures
ODM2SamplingFeatures.Specimens
ODM2SamplingFeatures.SpatialReferences
Observations
ODM2Core.Actions
ODM2Core.Results
Related Results and Datasets
ODM2Core.RelatedResults
ODM2Core.DataSets
ODM2Core.DataSetsResults
Observation Metadata
ODM2Core.Directives
ODM2Core.Variables
ODM2Core.Units
ODM2Core.Methods
ODM2Core.QualityControlLevels
Result Values
ODM2Results.ResultValues
ODM2Results.OffsetOrigins
People and Organizations
ODM2Core.Affiliations
ODM2Core.ActionPeople
ODM2Core.Roles
ODM2Core.People
ODM2Core.Organizations

IGSN Sample Metadata

IGSN e.v.

IGSN Registry

- IGSN
- ResourceURI
- Registrant ID
- timeStamp
- status

ISO & OGC O&M compliant

IGSN:	GMY00007W
Sample Name:	TN182_47_002
Other Name(s):	
Sample Type:	Individual Sample
Parent IGSN:	GMY00001B

Description	
Material:	Rock
Classification:	Igneous>Plutonic>Mafic
Field Name:	gabbro, hornblende gabbro
Description:	mafic plutonic rock
Age (min):	2 Ma
Age (max):	50 Ma
Collection Method:	Dredging
Collection Method Description:	Not Provided
Size:	0.5 kg
Geological Age:	Cenozoic
Geological Unit:	Not Provided
Comment:	Not Provided
Purpose:	Not Provided

Geolocation	
Latitude:	51.6298
Longitude:	179.8611
Elevation:	-1460
Nav Type:	Not Provided
Physiographic Feature:	fault scarp
Name Of Physiographic Feature:	Sunday Basin
Location Description:	north wall of Sunday Basin depression

ating Agent Catalog

SN
mpleEvent
mplePhysicalSize
latedResource
mplingMethodDetails
ocessingHistory
rationHistory
ore local detail...

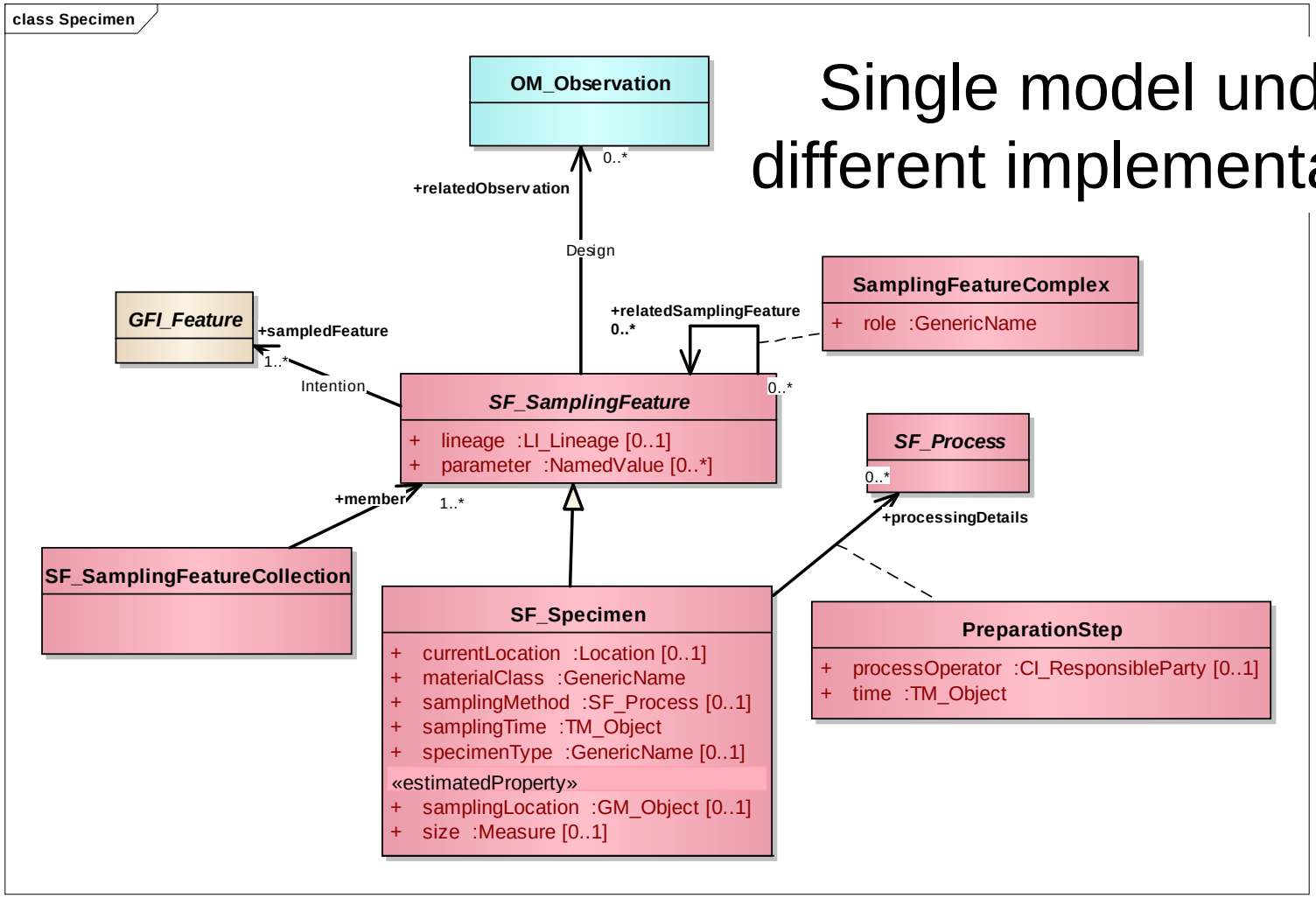
IGSN Sample in OMXML

```
<spec:SF_Specimen gml:id="abc123">
    <gml:identifier codeSpace="http://igsn.org">IGSN.SIOabc123</gml:identifier>
    <sa:sampledFeature xlink:href="http://example.org/midAtlanticRidge"/>
    <sa:relatedSamplingFeature>
        <sa:SamplingFeatureComplex>
            <sa:role xlink:href="http://example.org/parent"/>
            <sa:relatedSamplingFeature xlink:href="http://handle.net/10273/IGSN.SIOxyz456"/>
        </sa:SamplingFeatureComplex>
    </sa:relatedSamplingFeature>
    <spec:materialClass xlink:href="http://example.org/rock"/>
    <spec:samplingTime>
        <gml:TimeInstant gml:id="tim123">
            <gml:timePosition>2009-06-30T08:00:00.00-02:00</gml:timePosition>
        </gml:TimeInstant>
    </spec:samplingTime>
    <spec:samplingMethod xlink:href="http://example.org/ghostbuster"/>
    <spec:samplingLocation>
        <gml:Point gml:id="loc123" srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
            <gml:pos>45.12 -81.78</gml:pos>
        </gml:Point>
    </spec:samplingLocation>
    <spec:size uom="kg">0.46</spec:size>
    <spec:currentLocation xlink:href="http://example.org/Warehouse3/shelf9/box67"/>
    <spec:specimenType xlink:href="http://example.org/splitCore"/>
</spec:SF_Specimen>
```

IGSN Sample in RDF

```
<http://handle.net/10273/IGSN.SIOabc123>
      a       sam:Specimen ;
      rdfs:label "SIO specimen abc123"^^xsd:string ;
      sam:currentLocation <http://example.org/various/Warehouse3/shelf9/box67> ;
      sam:materialClass p1:rock ;
      sam:preparationStep
              [ sam:processOperator p1:JohnDoe ;
                sam:processingDetails
                        <http://example.org/various/sf-process/jkl987> ;
                sam:time <http://handle.net/10273/IGSN.SIOabc123/tim2> ] ;
      sam:sampledFeature p1:midAtlanticRidge ;
      sam:samplingFeatureComplex
              [ sam:relatedSamplingFeature <igsn:SIOxyz456> ;
                sam:role p1:parent ] ;
      sam:samplingLocation
              p1:loc123 ;
      sam:samplingMethod <http://ldeo.columbia.edu/sampling/ghostbuster> ;
      sam:samplingTime "2013-06-12T09:25:00.00+11:00"^^xsd:dateTime
      sam:size [ basic:uom unit:kg ;
                 basic:value "0.46"^^basic:Number ] ;
      sam:specimenType p1:splitCore .
```

O&M Specimen model



Single model underlies different implementations

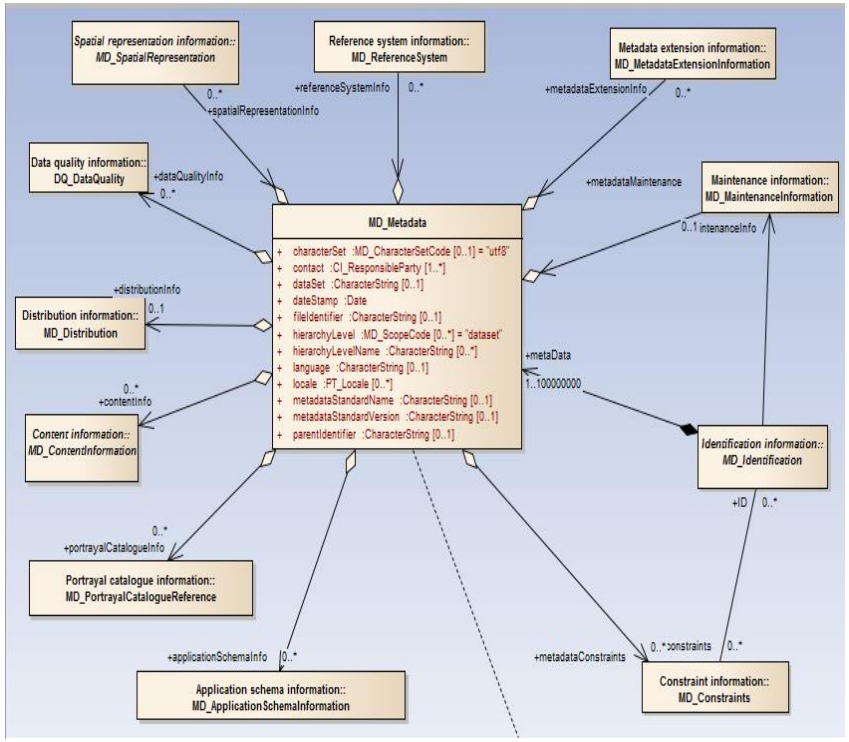
Application of O&M

- Direct
  - SOS + OMXML
    - [Metadata for values from] data services
  - Specializations
    - WaterML2, WaterML-WQ, SoilML, SeaDataNet, INSPIRE, WMO ...
- Bridging vocabulary for integration
  - TERENO (GFZ), NEII, ODM2, IGSN/SESAR, OBOE ...
- Checklist ...
  - Slots for implicit → explicit for x-domain use

Modernizing

~~XSD~~ OWL from UML

UML Model



Output in OWL

iso19115MetadataEntitySetInformation.txt - Bloc-notes

Fichier Edition Format Affichage ?

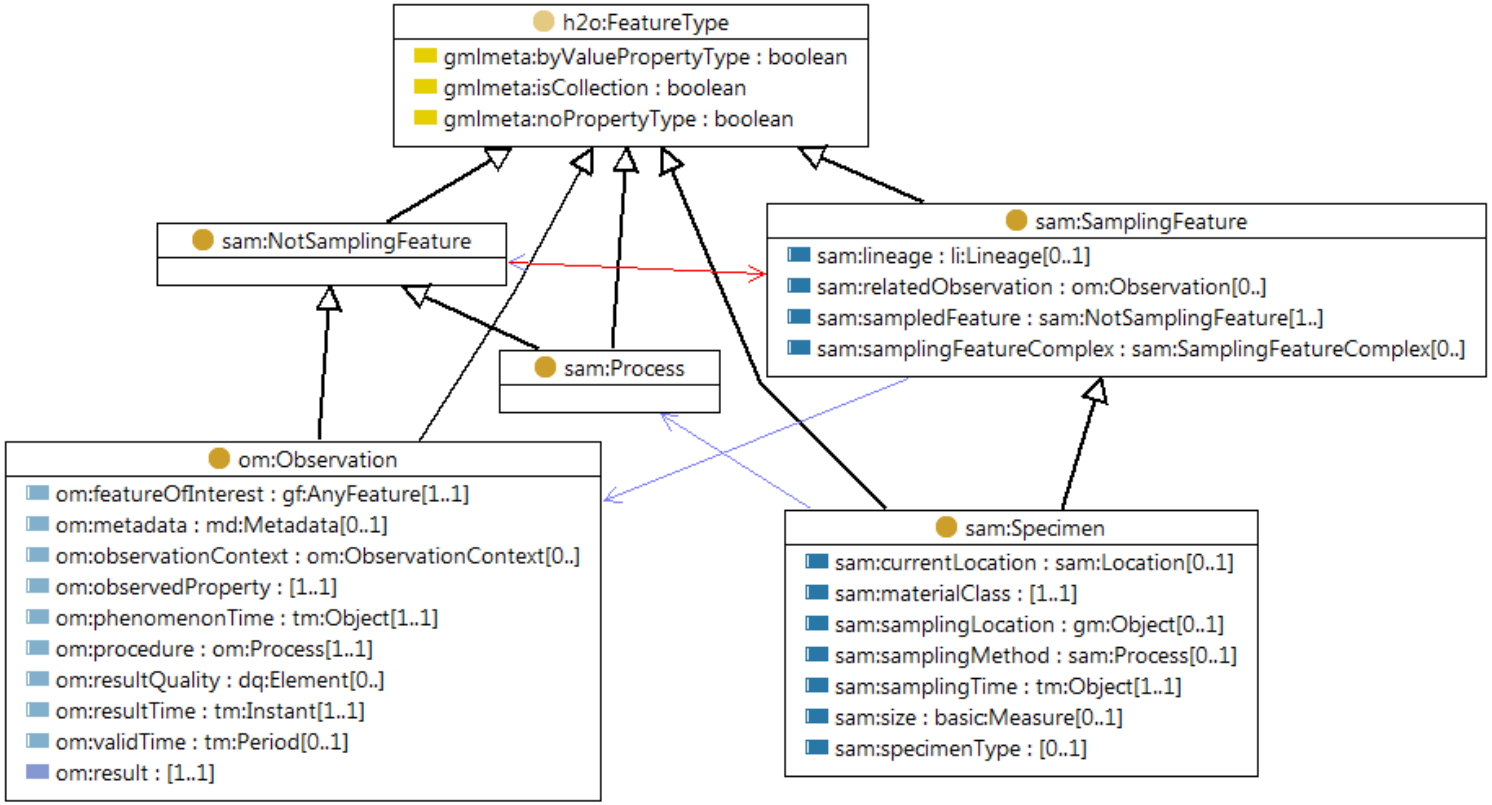
```
<rdf:RDF xmlns="http://def.isotc211.org/iso19115/2006/MetadataEntitySetInformation#"
  xml:base="http://def.isotc211.org/iso19115/2006/MetadataEntitySetInformation"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns:skos="http://www.w3.org/2004/02/skos/core#"
  xmlns:iso19115="http://def.isotc211.org/iso19115/2006/MetadataEntitySetInformation#">
  <owl:Ontology rdf:about="http://def.isotc211.org/iso19115/2006/MetadataEntitySetInformation">
    <rdfs:label>ISO 19115:2006 MetadataEntitySetInformation</rdfs:label>
    <dc:source>http://standards.iso.org/iso/19115/ed-2/en/</dc:source>
    <owl:versionInfo>2006-07-01</owl:versionInfo>
  </owl:Ontology>
  <owl:Class rdf:about="&iso19115;MD_Metadata">
    <skos:prefLabel>MD_Metadata</skos:prefLabel>
    <skos:definition>Information about the metadata</skos:definition>
    <dc:source>http://standards.iso.org/iso/19115/ed-2/en/</dc:source>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.fileIdentifier"/>
        <owl:maxCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:maxCardinality>
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.fileIdentifier"/>
        <owl:allValuesFrom rdf:resource="xsd;string">
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.language"/>
        <owl:maxCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:maxCardinality>
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.language"/>
        <owl:allValuesFrom rdf:resource="xsd;string">
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.characterSet"/>
        <owl:maxCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:maxCardinality>
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="&iso19115;MD_Metadata.characterSet"/>
```

O&M in OWL2

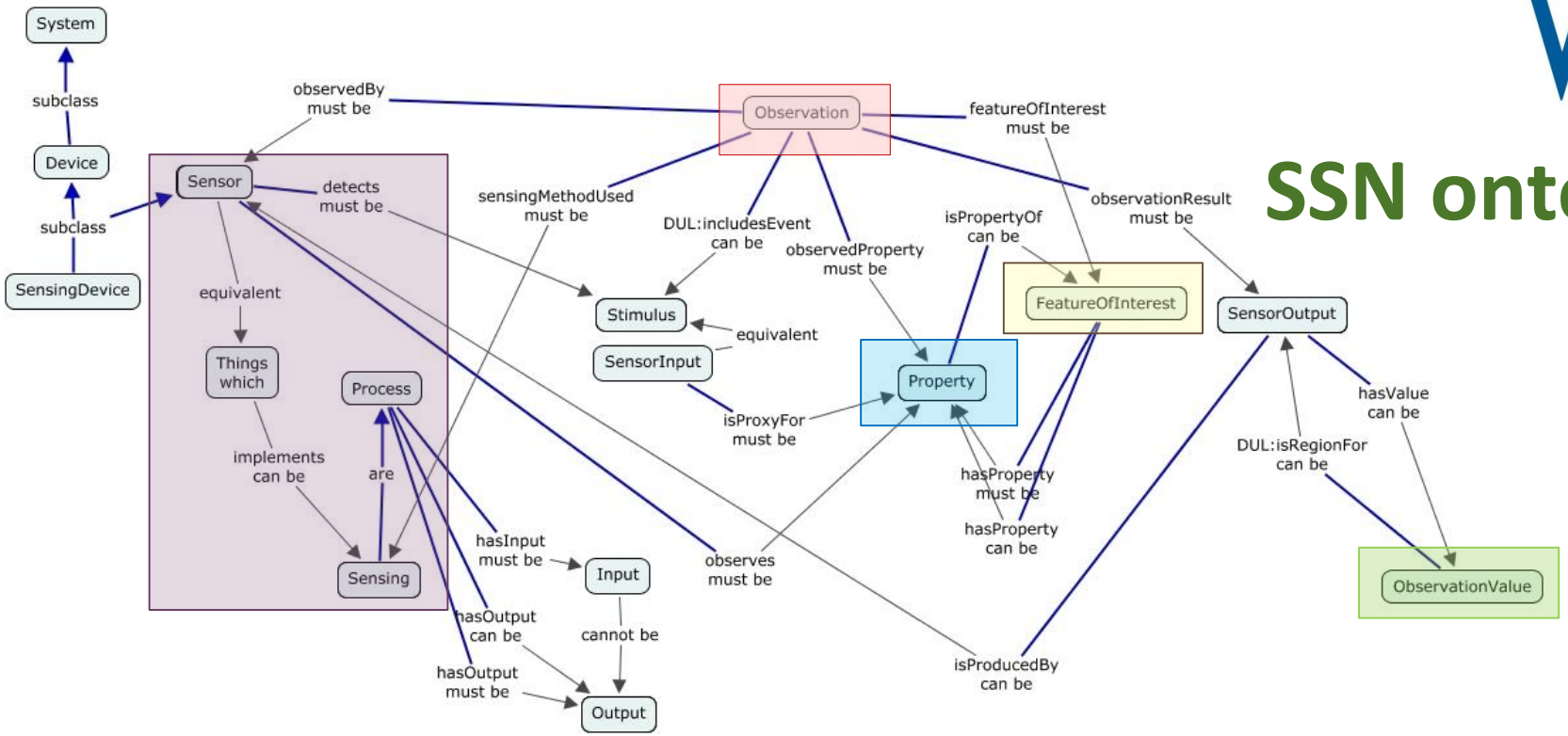
```
om:Observation
    a                   :Class ;
    rdfs:label          "Observation"@en ;
    rdfs:subClassOf     gf:AnyFeature , h2o:FeatureType ;
    :disjointWith       om:Process ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:result                ] ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:observedProperty      ] ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:featureOfInterest     ] ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:phenomenonTime        ] ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:procedure             ] ;
    rdfs:subClassOf [ a  :Restriction ;  :cardinality "1";  :onProperty   om:resultTime            ] .
```

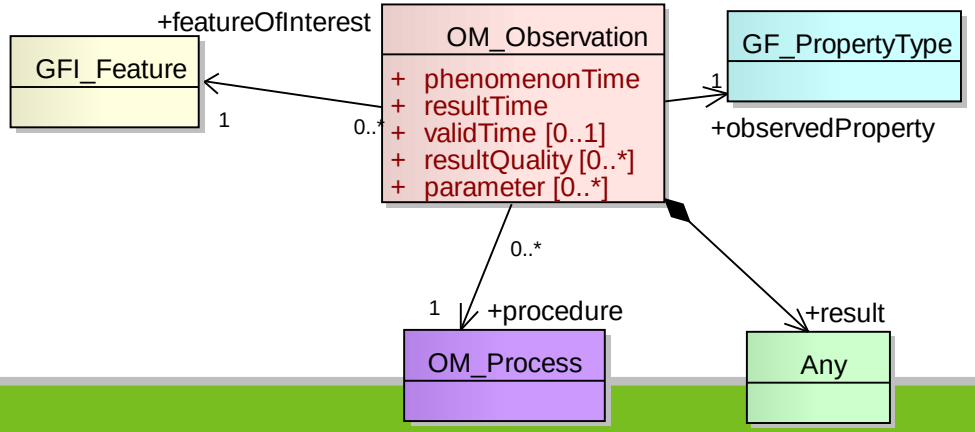
http://def.seegrid.csiro.au/isotc211/iso19156/2011/observation

sam:Specimen

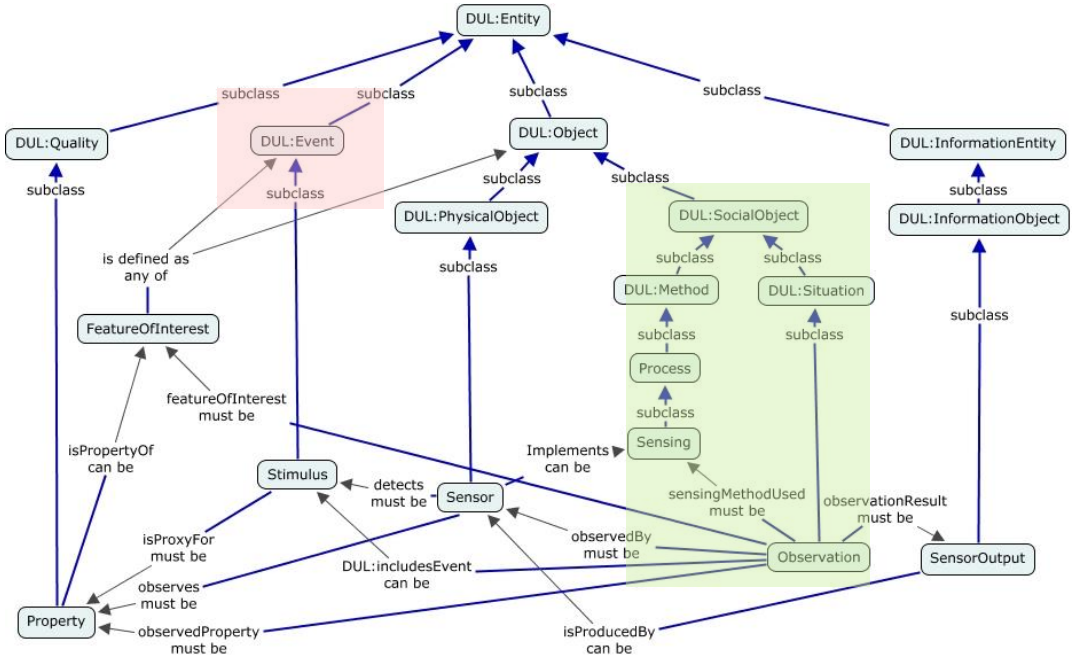


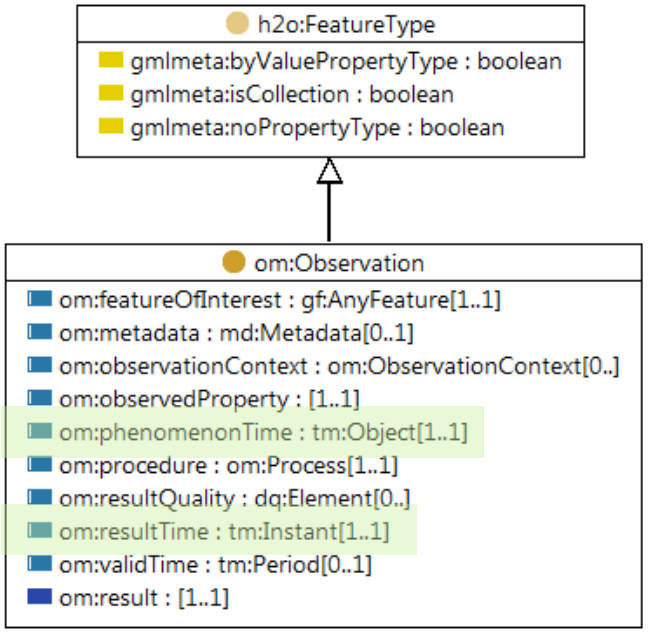
SSN ontology





Alignment





Is Observation a Social Object, or an Event?

Lessons

Lessons

- Ontology for observations, models and forecasts
  - X-domain interoperability
  - Extensible, specialize with vocabularies, link to other ontologies
- Standards
  - A generic model can provide a checklist for design, and a basis for harmonization and incremental design
  - Consensus introduces an overhead
- Change
  - Common conceptual model supports multiple implementations
- Widely used

Additional credits

O&M: Fowler & Odell; GeoSciML team; OGC; ISO/TC 211; Rob Atkinson, Rob Woodcock(CSIRO)

WaterML: CUAHSI; Gavin Walker, **Pete Taylor**, Laurent Lefort (CSIRO); Paul Sheahan (BOM)

Soil, WQ: **Bruce Simons**, Peter Wilson, Jonathan Yu (CSIRO); Alistair Ritchie (Landcare NZ)

SeaDataNet: **Jordi Sorribas**, Paolo Diviacco

AQD: Michael Lutz, Ale Sarretta (JRC); **Kathi Schleidt** (Env. Agency Austria)

WMO: **Jeremy Tandy** (UK Met Office); Aaron Braeckel (UCAR)

NEII: **Andrew Woolf**, Dom Lowe (BOM)

ODM2: **Jeff Horsburgh**

IGSN: **Kerstin Lehnert** (LDEO), Jens Klump (GFZ)

Vocabulary services: Stuart Williams (Epimorphics), Roy Lowry, Adam Leadbetter (BODC)

Thank you

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