

An explicit OWL representation of ISO/OGC Observations and Measurements

Comparison with SSN ontology

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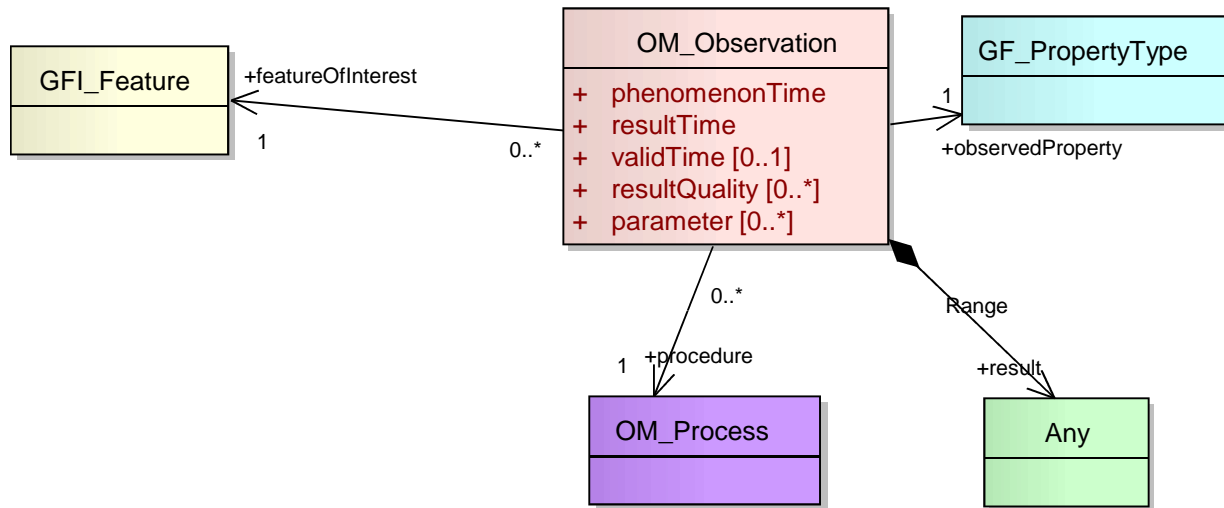


Outline

- Methodology for O&M in OWL
- Challenges in converting from UML
- Expressivity
- Alignment

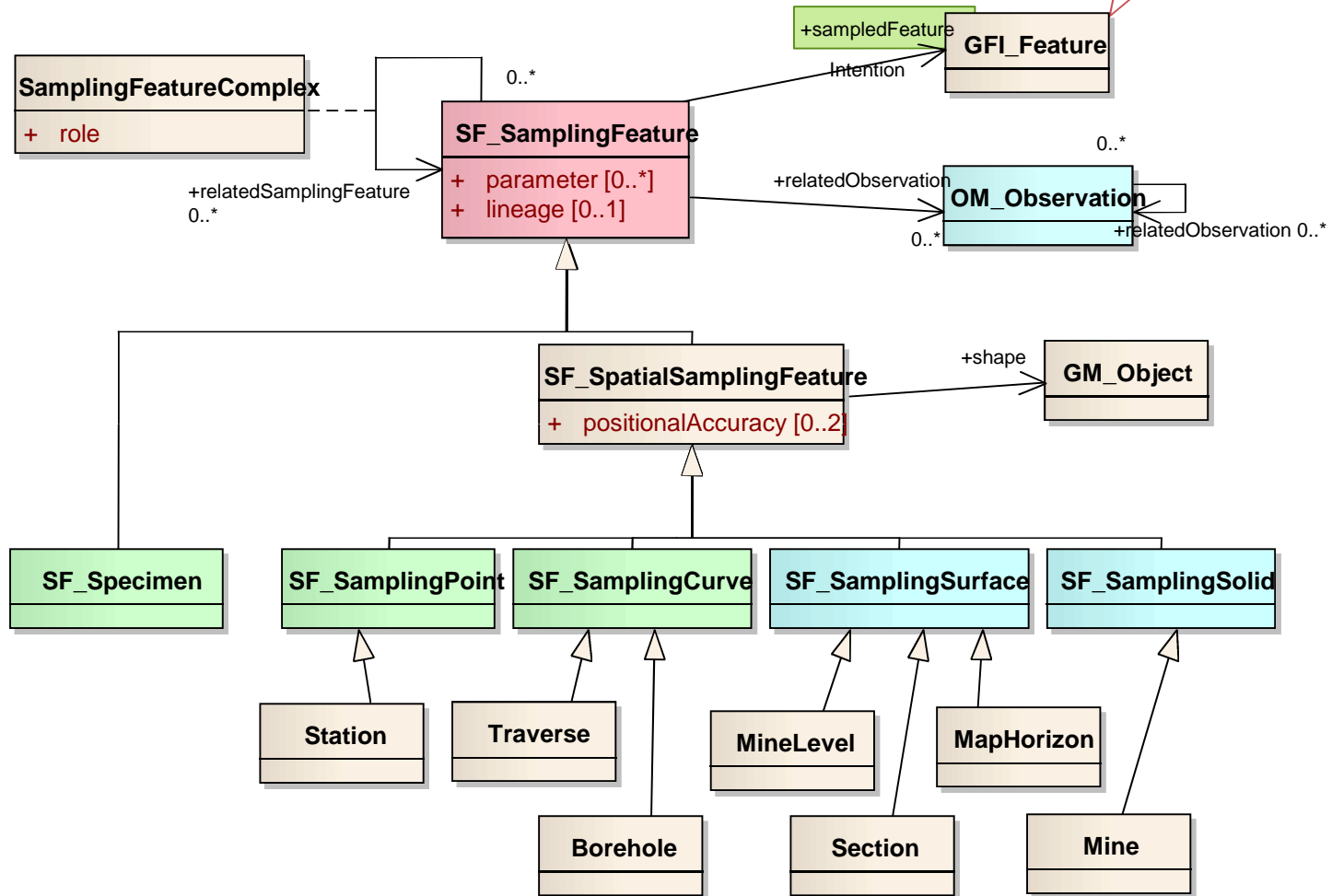
OBSERVATIONS AND MEASUREMENTS

ISO 19156 Observations and Measurements



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**

ISO 19156 Sampling features

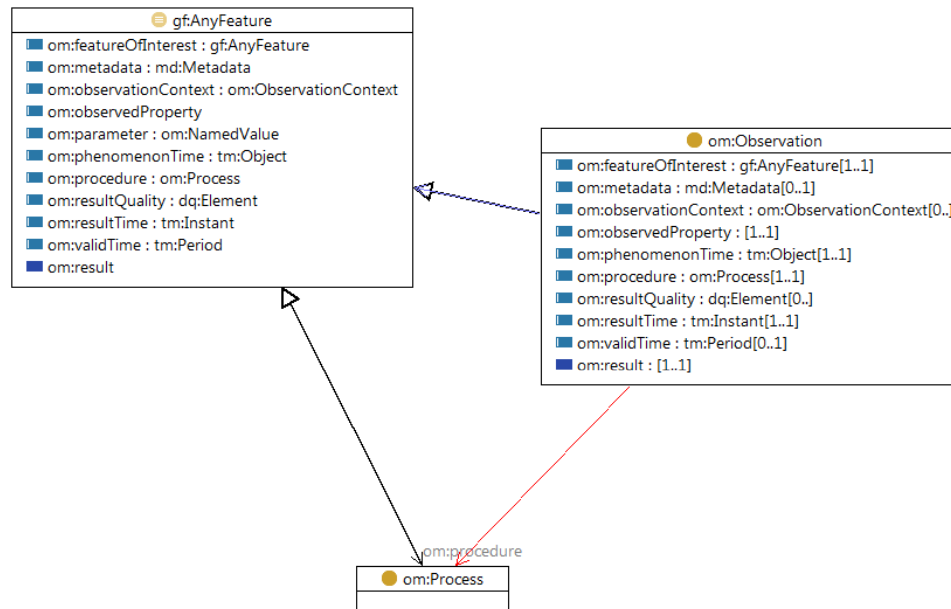


UML → OWL CONVERSION RULES

ISO 19150-2 (2015?)

- UML Package → OWL Ontology
- UML Class → OWL Class
- UML Attribute/Association role → RDF Property
- UML Stereotype → OWL Class

om:Observation class



(TopBraid diagram view)

UML-OWL mismatches

UML is frame-based

- Attributes owned by classes
- Association-roles owned by classes
- property redefinition/refinement uncommon and complicated

RDF is open-world

- *Properties scoped to Ontology (namespace)*
- *Property re-use expected*
- *rdfs:subPropertyOf easy, commonly used*

Options for defining properties

Frame-based

- Name scoped to class
- Narrow rdfs:domain
- Narrow rdfs:range
- Strict cardinality constraints

```
om:Observation.resultTime
```

```
    a owl:ObjectProperty ;  
    rdfs:label "Result time"@en ;  
    rdfs:domain om:Observation ;  
    rdfs:range tm:Instant .
```

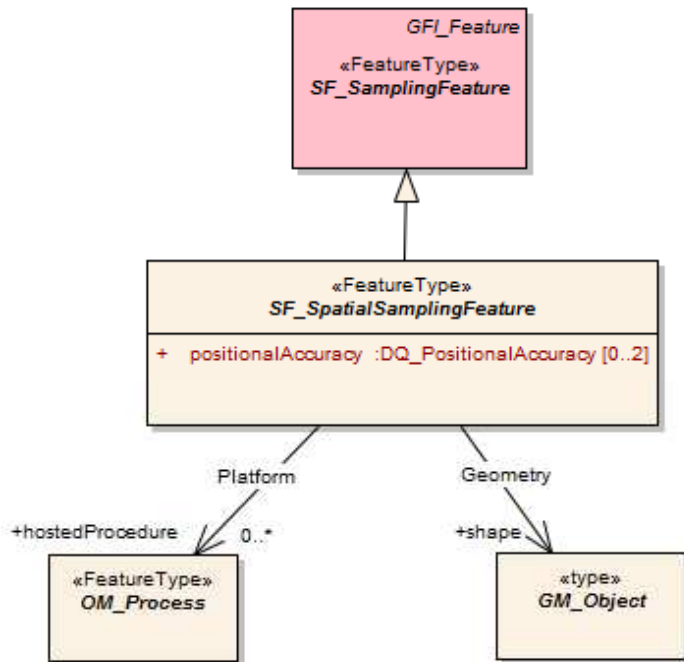
Open-world

- Name scoped to namespace
- Generic rdfs:domain
- Narrow rdfs:range
- Loose cardinality constraints

```
om:resultTime
```

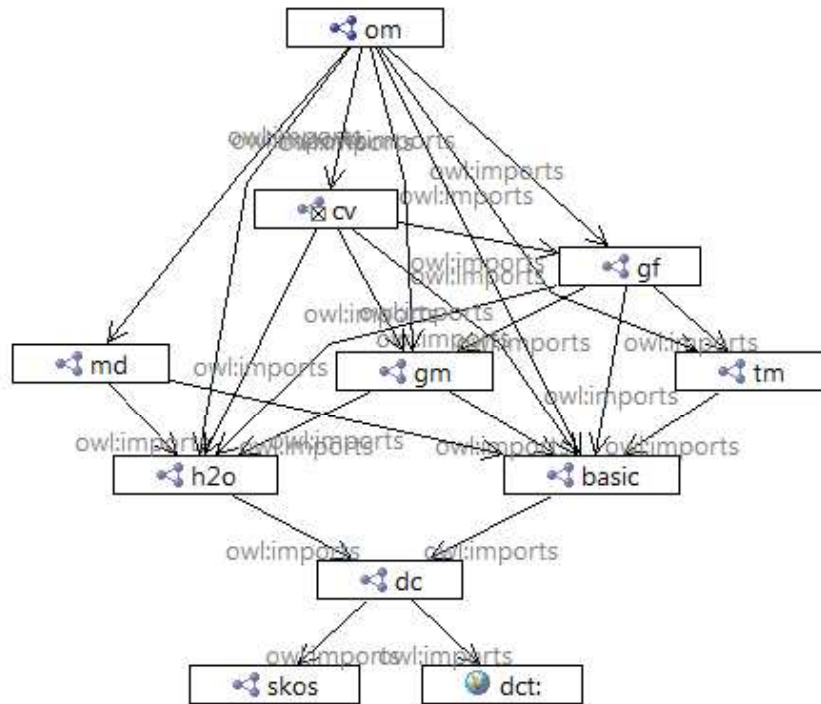
```
    a owl:ObjectProperty ;  
    rdfs:label "Result time"@en ;  
    rdfs:domain gf:AnyFeature ;  
    rdfs:range tm:Instant .
```

Complete example – lax form



```
sam:SF_SpatialSamplingFeature
a owl:Class ;
rdfs:label "Spatial sampling feature"@en ;
rdfs:subClassOf gf:AnyFeature , sam:SF_SamplingFeature ;
rdfs:subClassOf
[ a owl:Restriction ;
  owl:cardinality "1"^^xsd:nonNegativeInteger ;
  owl:onProperty sam:shape ] ;
rdfs:subClassOf
[ a owl:Restriction ;
  owl:minCardinality "0"^^xsd:nonNegativeInteger ;
  owl:onProperty sam:positionalAccuracy ] ;
rdfs:subClassOf
[ a owl:Restriction ;
  owl:maxCardinality "2"^^xsd:nonNegativeInteger ;
  owl:onProperty sam:positionalAccuracy ] ;
rdfs:subClassOf
[ a owl:Restriction ;
  owl:minCardinality "0"^^xsd:nonNegativeInteger ;
  owl:onProperty sam:hostedProcedure ] ;
skos:notation
  "SF_SpatialSamplingFeature"^^h2o:ISOCClassName .
```

O&M integrated into ISO framework

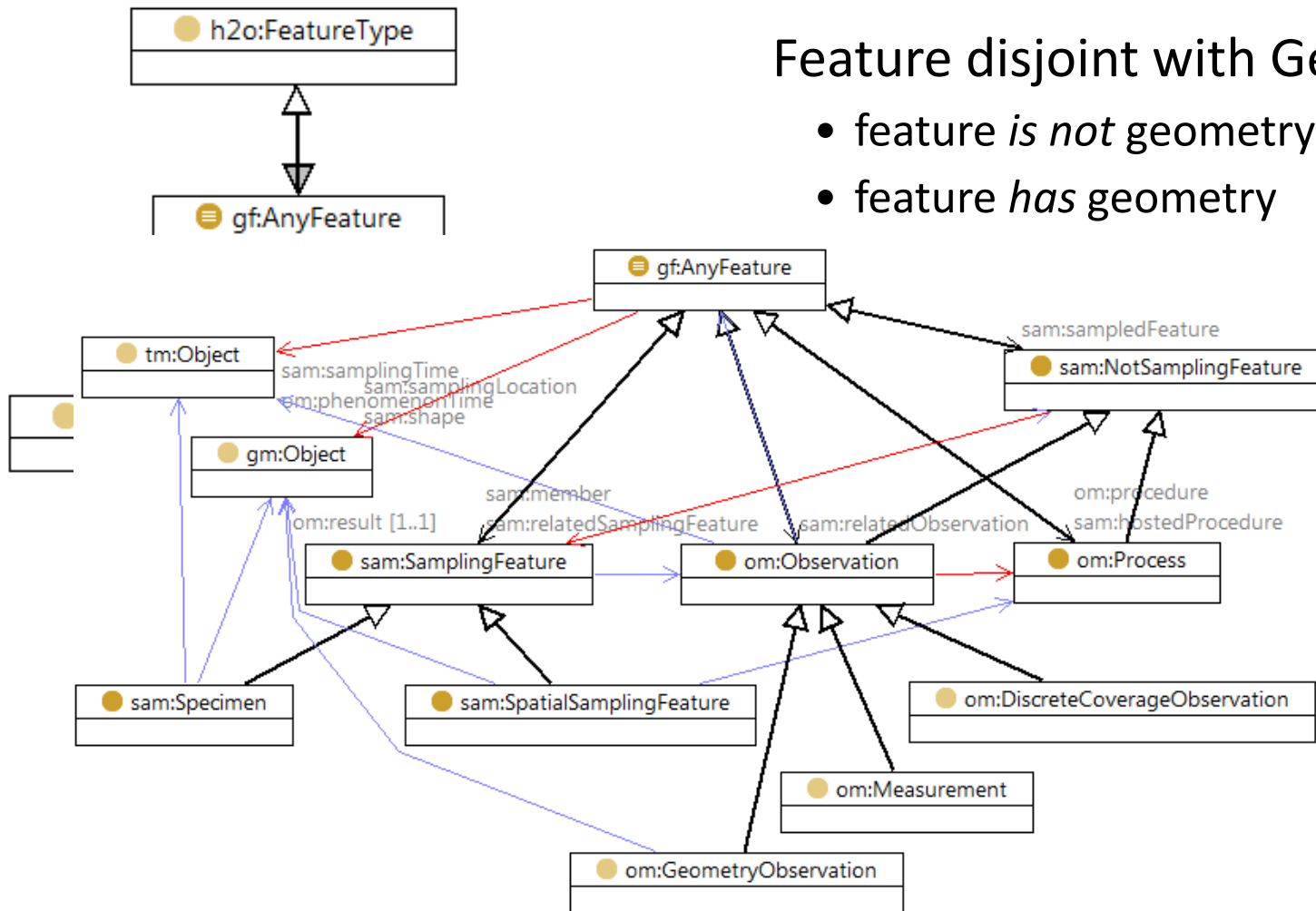


Direct dependencies

- Feature ISO 19109
- Geometry ISO 19107
- Temporal ISO 19108
- Coverage (fields) ISO 19123
- Metadata (!) ISO 19115
- Meta-model ISO 19150-2
- Basic datatypes ISO 19103

No other alignment attempted
at this time

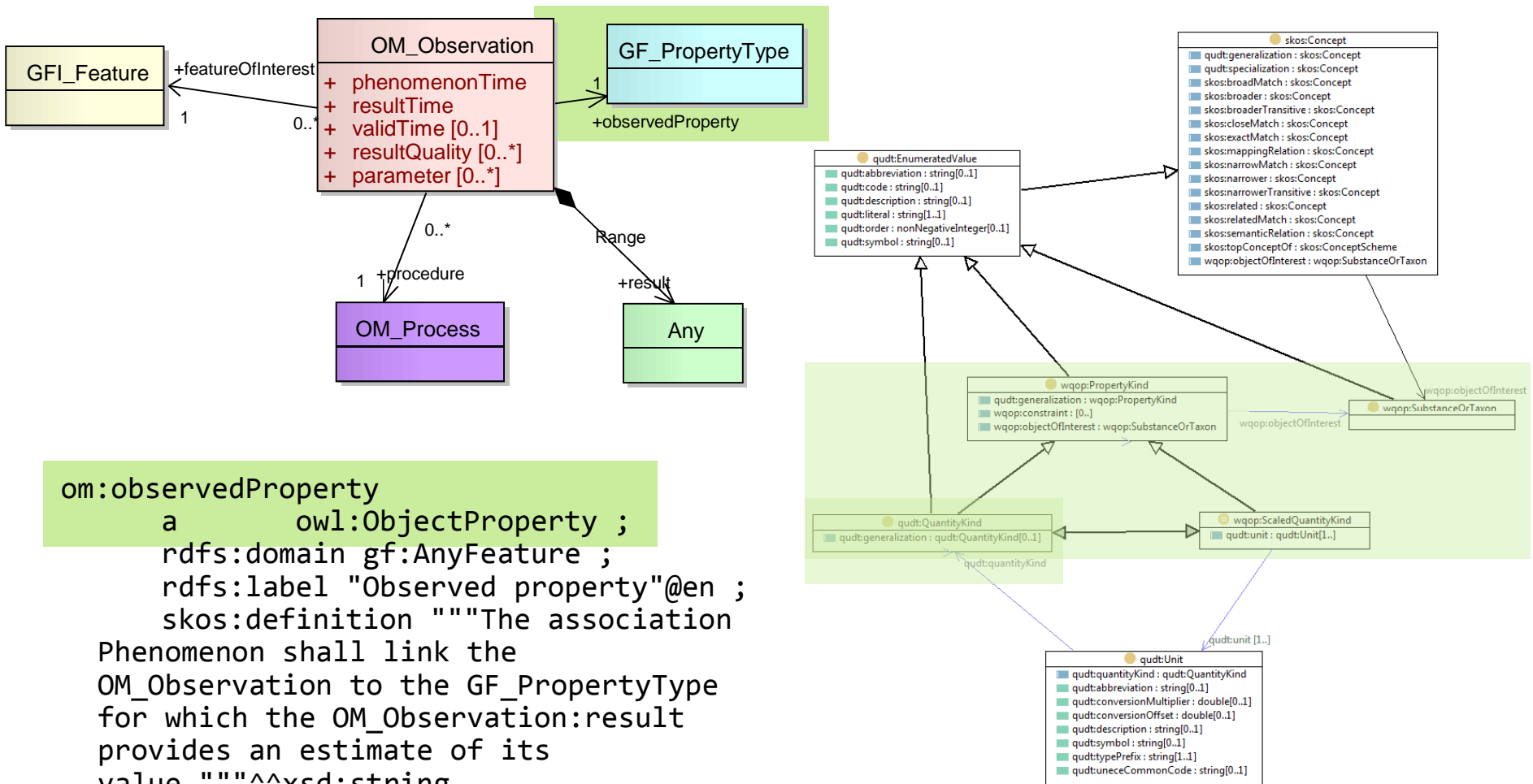
ISO/OGC Feature Model



Feature disjoint with Geometry

- feature *is not* geometry
- feature *has* geometry

O&M linked to QUDT



```

om:observedProperty
    a      owl:ObjectProperty ;
    rdfs:domain gf:AnyFeature ;
    rdfs:label "Observed property"@en ;
    skos:definition ""The association
    Phenomenon shall link the
    OM_Observation to the GF_PropertyType
    for which the OM_Observation:result
    provides an estimate of its
    value.""^^xsd:string .
    
```

COMPARE WITH SSN

Side by side instances

```
p1:obsTest1
  rdf:type om:Measurement ;
  om:featureOfInterest <http://wfs...&featureid=fruit37f> ;
  om:observedProperty
    <http://sweet.jpl.nasa.gov/2.0/phys.owl#Mass> ;
  om:phenomenonTime p1:ot1t ;
  om:procedure p1:Scales1 ;
  om:result
  [ rdf:type basic:Measure ;
    basic:uom <http://www.opengis.net/def/uom/UCUM/0/kg> ;
    basic:value "0.28"^^basic:Number ] ;
  om:resultTime p1:ot1t ;
  om:parameter
  [ rdf:type om:NamedValue ;
    om:name
      <http://sweet.jpl.nasa.gov/2.0/physThermo.owl#Temperature> ;
    om:value
    [ rdf:type basic:Measure ;
      basic:uom <http://www.opengis.net/def/uom/UCUM/0/Cel> ;
      basic:value "22.3"^^basic:Number ] ] .
```

```
p1:Scales1
  rdf:type om:Process ;
  rdfs:label "Salter scales"^^xsd:string .
```

```
p1:ot1t
  rdf:type tm:Instant ;
  tm:dateTimePosition "2005-01-11T16:22:25.00"^^xsd:dateTime .
```

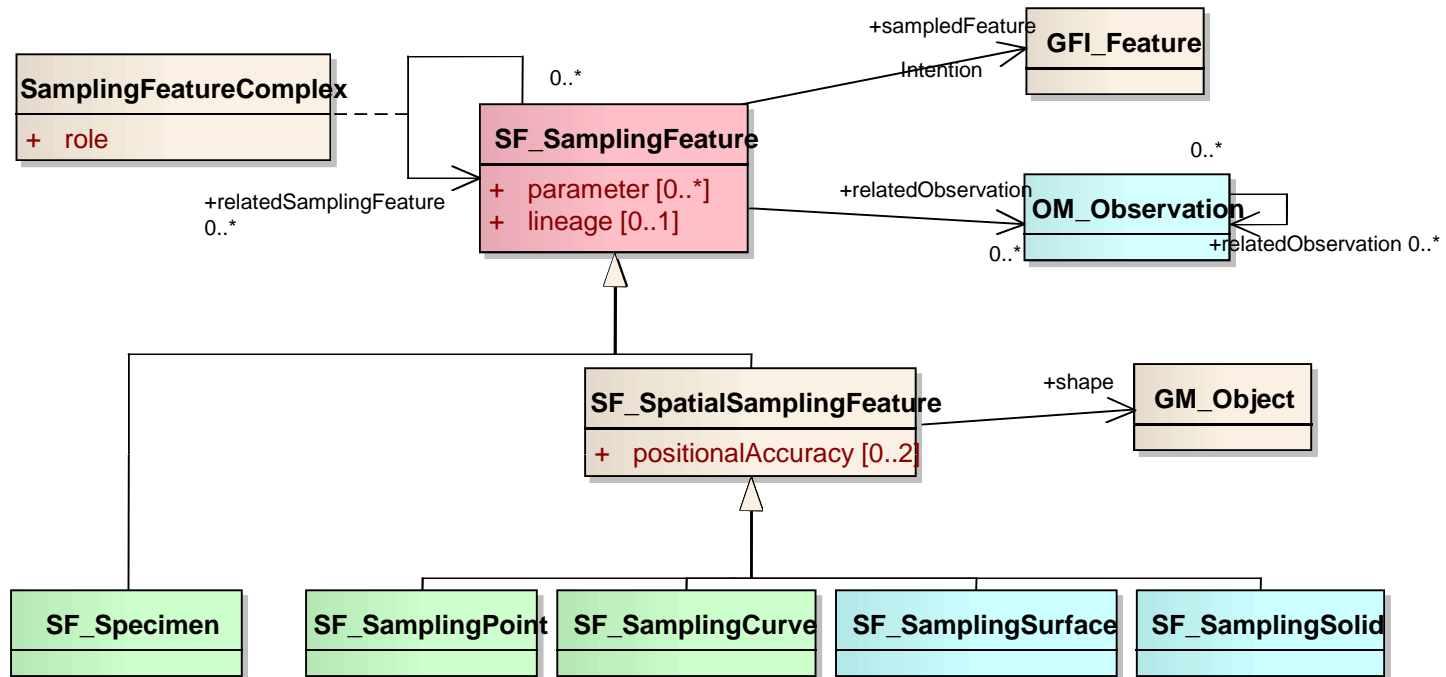
```
p1:obsTest1
  rdf:type ssn:Observation ;
  ssn:featureOfInterest <http://wfs...&featureid=fruit37f> ;
  ssn:observedProperty <http://qudt.org/vocab/quantity#Mass> ;
  ssn:observationSamplingTime p1:ot1t ;
  ssn:observedBy p1:Scales1 ;
  ssn:observationResult
  [ rdf:type ssn:SensorOutput ;
    ssn:hasValue
    [ rdf:type DUL:Amount , ssn:ObservationValue ;
      DUL:hasDataValue "0.28"^^xsd:float ;
      DUL:isClassifiedBy <http://qudt.org/vocab/unit#Kilogram> ] ;
    ssn:isProducedBy p1:Scales1 ] ;
  ssn:observationResultTime p1:ot1t ;
  DUL:hasSetting p1:tempObsTest1 .
```

```
p1:tempObsTest1
  a ssn:Observation ;
  rdfs:comment "Observation of temperature context for
  measurement of fruit mass"^^xsd:string ;
  ...
  DUL:isSettingFor p1:obsTest1 .
```

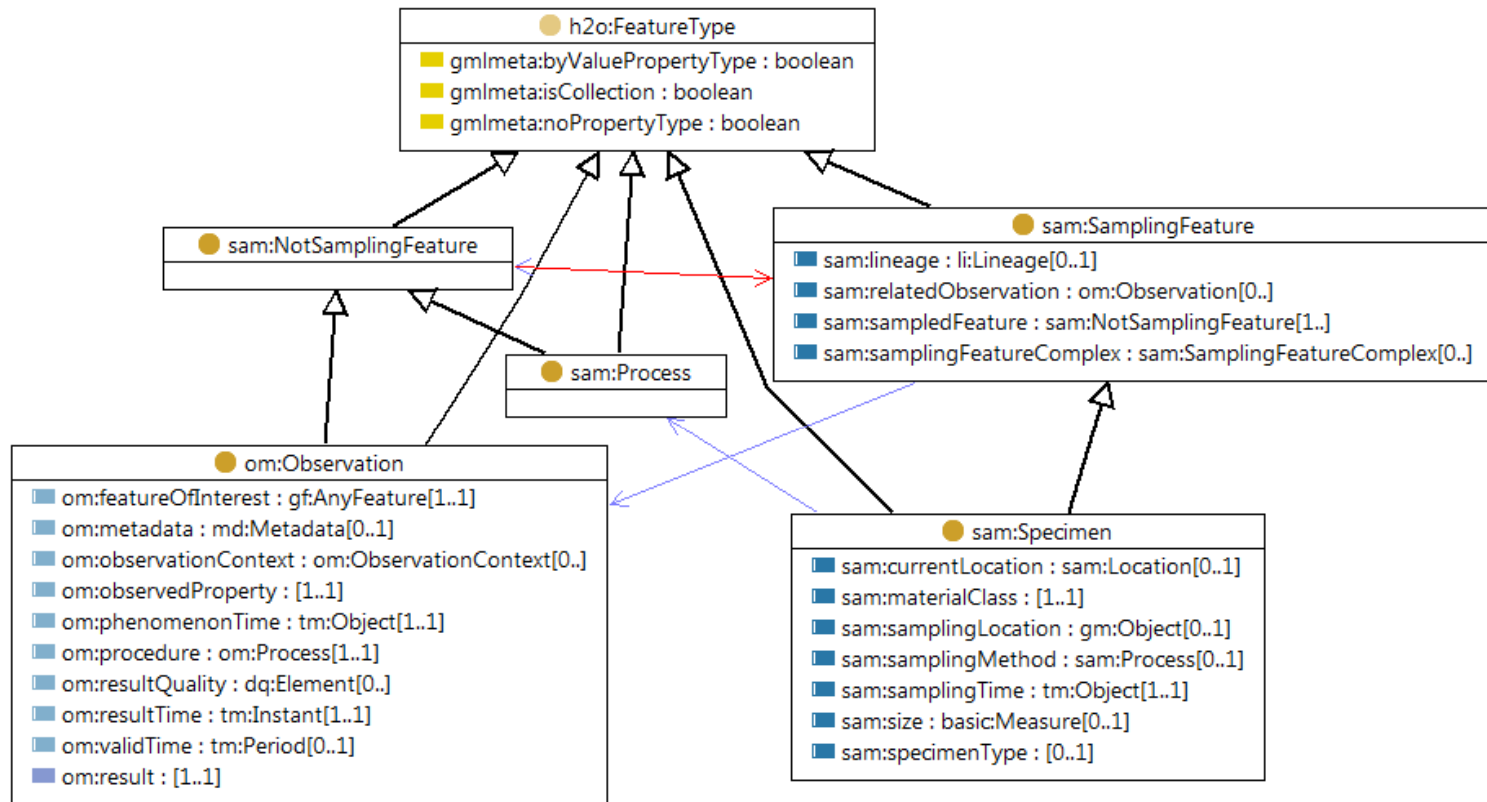
```
p1:Scales1
  rdf:type ssn:SensingDevice ;
  rdfs:label "Salter scales"^^xsd:string .
```

```
p1:ot1t
  rdf:type DUL:Amount ;
  DUL:hasDataValue "2005-01-11T16:22:25.00"^^xsd:dateTime .
```

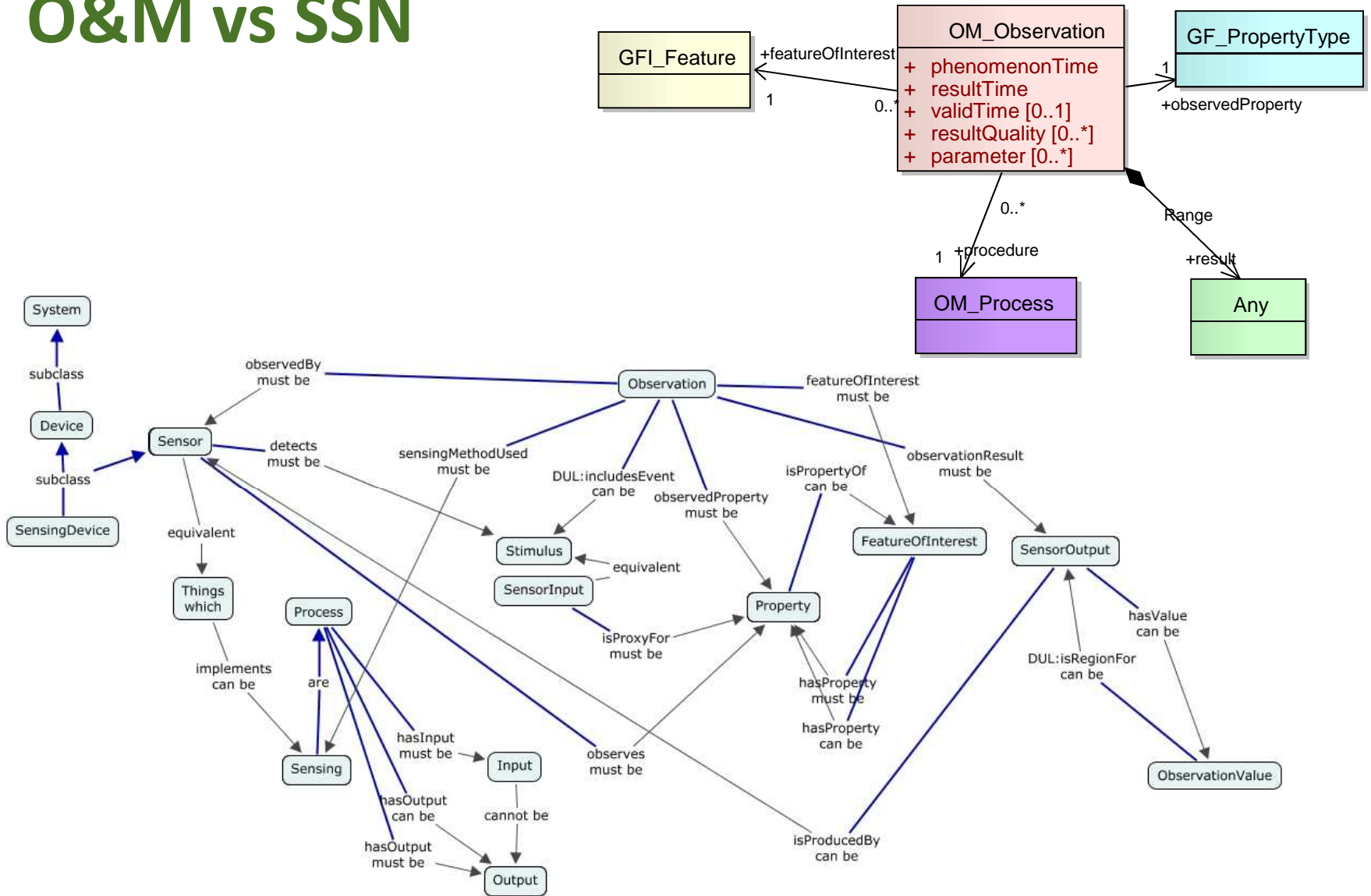

ISO 19156 Sampling features



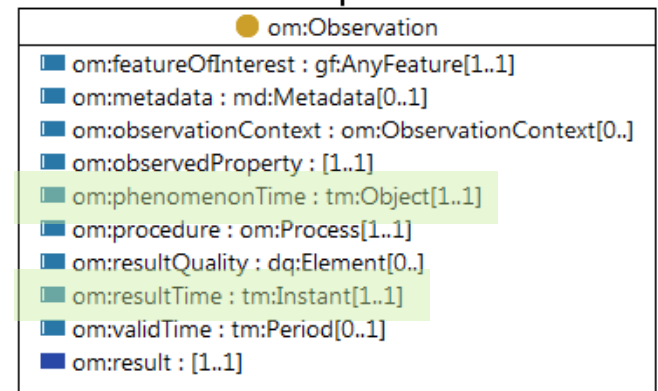
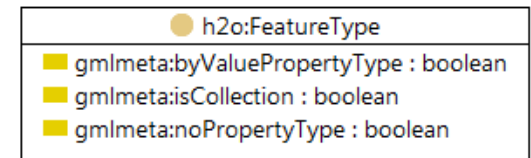
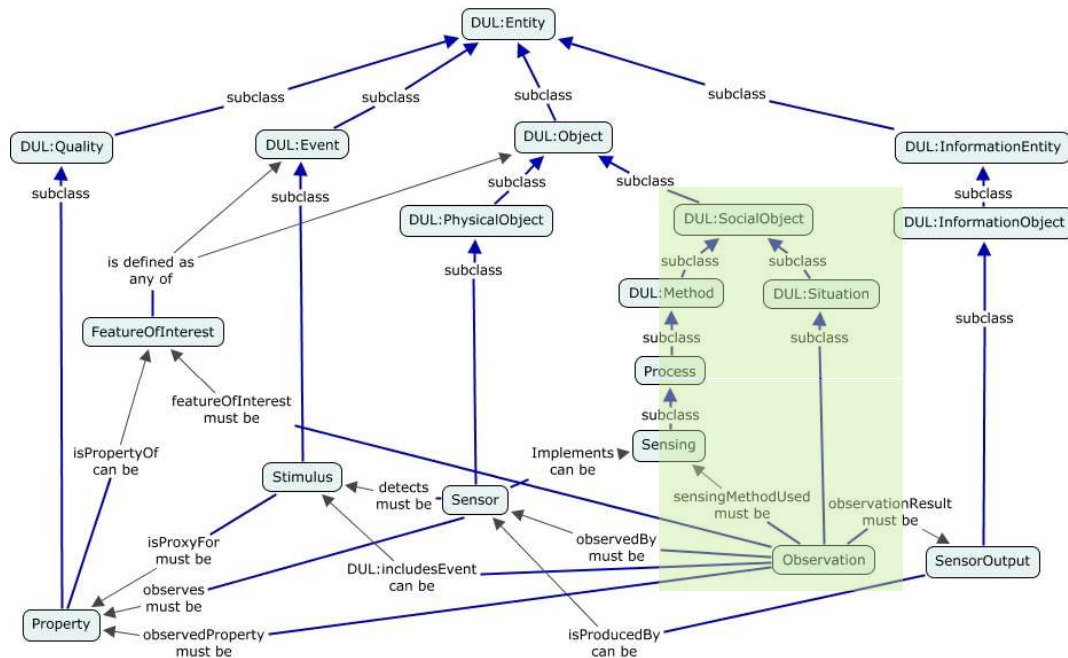
sam:Specimen



O&M vs SSN



SSN alignment



Alignment strategy

SSN

- Syntactic/semantic alignment (UML→OWL/RDF+DUL) in one step
- Conflates concerns?

OM

- UML→OWL 'syntactic' alignment first
- Semantic alignment (various) in later steps, separate graphs

`rdfs:subClassOf`

`owl:equivalentClass`

`rdfs:subPropertyOf`

SUMMARY

Summary

- Model
 - Rule-based transformation from UML to OWL
 - Dependencies on other ISO 19100 models
- Expressivity
 - SSN & O&M comparable
- Alignment
 - O&M 2.0 Observation is an Event
 - SSN Observation is a DUL:SocialObject
 - Separate syntactic and semantic alignment?

Additional credits

O&M: Fowler & O'Dea, OGC, ISO/TC 211,
Rob Atkinson (CLW), Rob Woodcock (CESRE)

OM Ontology: David Ratcliffe, Michael Compton,
Laurent Lefort (CCI), Jonathan Yu (CLW)

Projects: XMML, pmd*²CRC, AuScope, WIRADA, IPBA, eREEFS

Thank you

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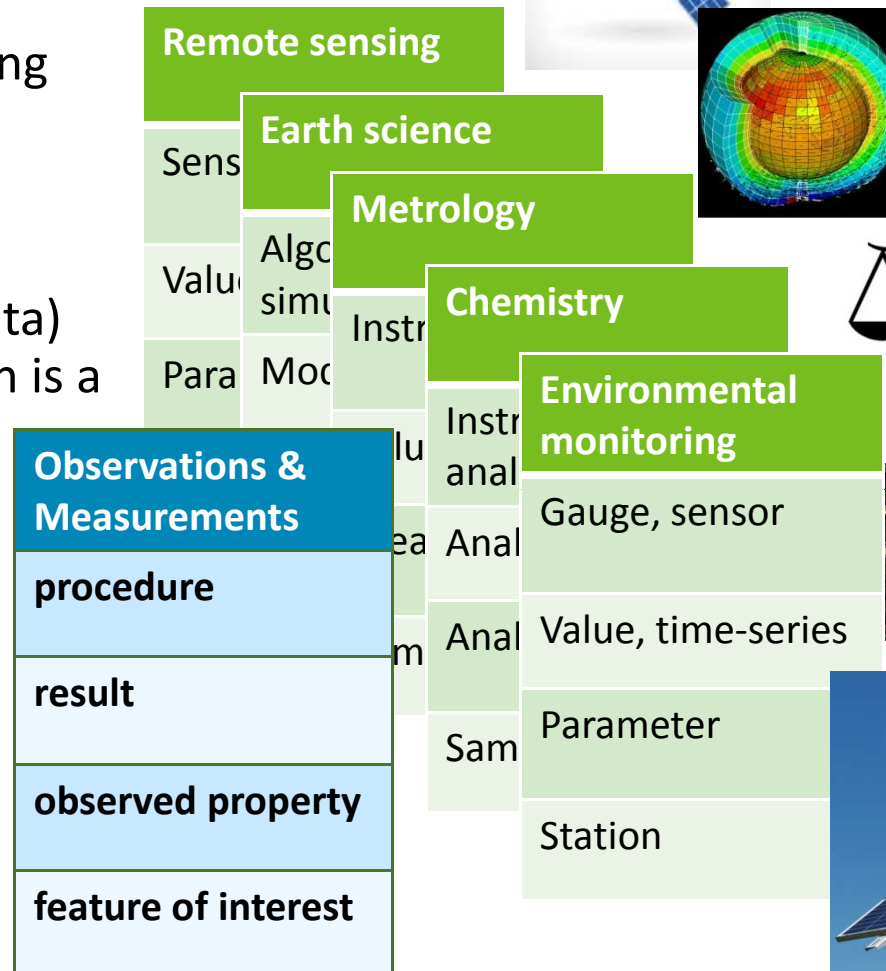
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The need for standardisation

- Integrated modelling is becoming the norm
 - bioregional assessment
 - eReefs
- When using heterogeneous (data) sources, discovery & integration is a major challenge
- **Standards make this easier**
 - Many private contracts
 - one public agreement

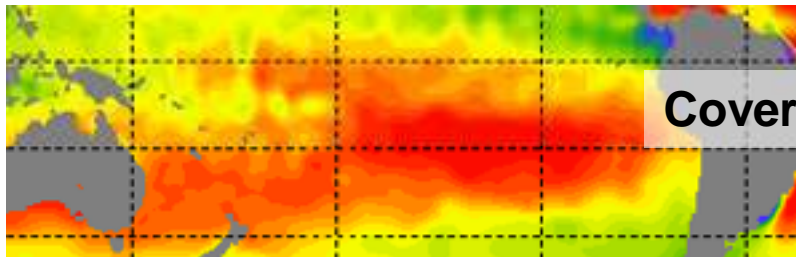


Views of data



Features

Features exist, have attributes and can be spatially described – ‘discrete’ or ‘vector’



Coverages

Continuous phenomena, varying in space and time – ‘raster’.

A function: spatial, temporal or spatio-temporal domain to attribute range

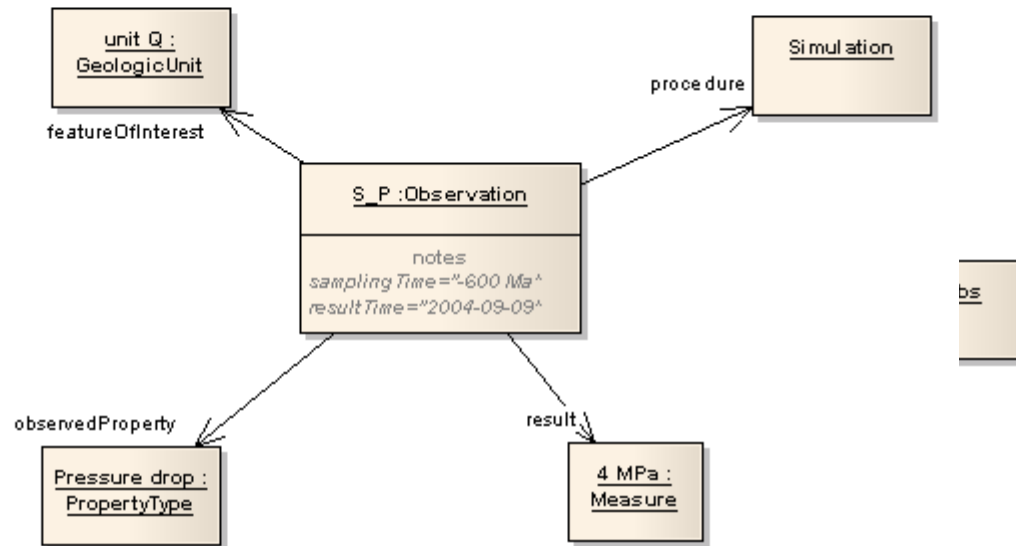


Observations

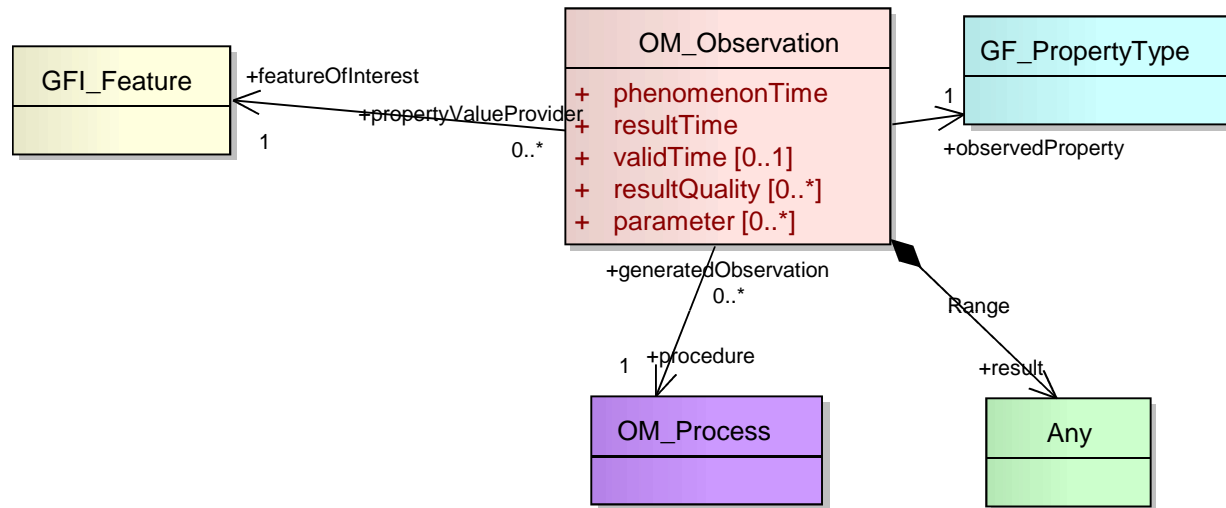
An act that results in the estimation of the value of a feature property, and involves application of a specified procedure, such as a sensor, instrument, algorithm or process chain

In “pictures”

Name: UnitQ
Package: Examples
Version: 1.0
Author: Simon Cox



ISO 19156 Observations and Measurements



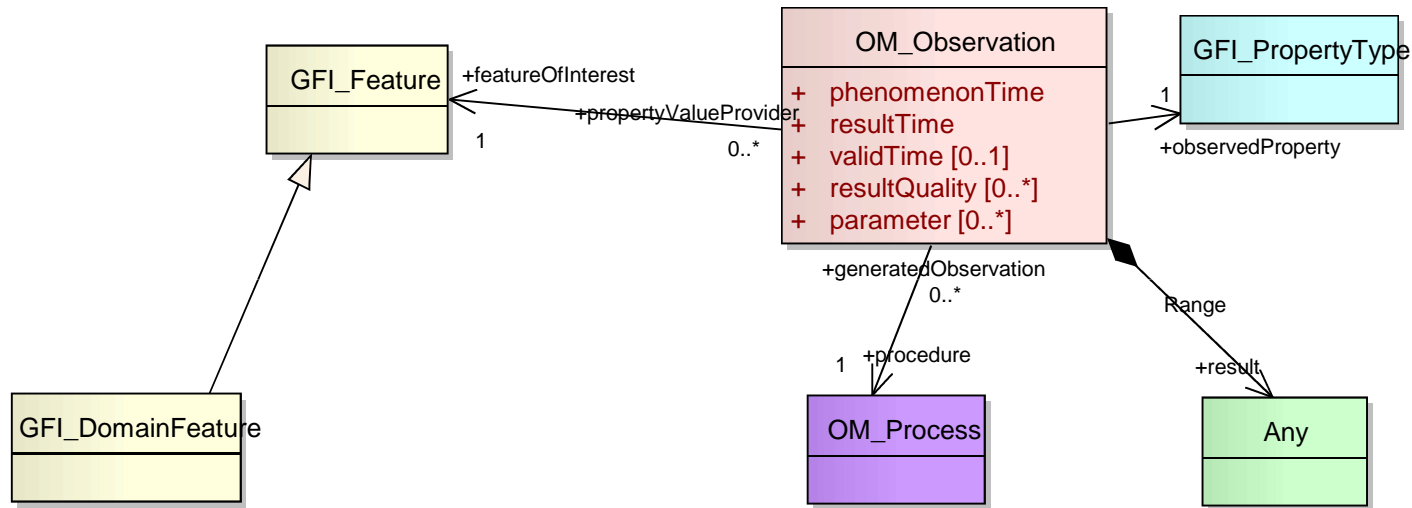
An **Observation** is an action whose **result** is an estimate of the value of some **property** of the **feature-of-interest**, obtained using a specified **procedure**

Cross-domain model for observations

- Standard terminology for cross-domain/interdisciplinary use
- Broadly applicable
 - In-situ observations, monitoring
 - Remote sensing
 - Sampling and ex-situ (lab) observations
 - Simulations and forecasts
- Adoption
 - GeoSciML, AIXM, INSPIRE, D&I
 - WMO, WaterML, ODIP, ANZSoilML,

Domain specific vocabularies required

observed property
Related to feature-of-interest



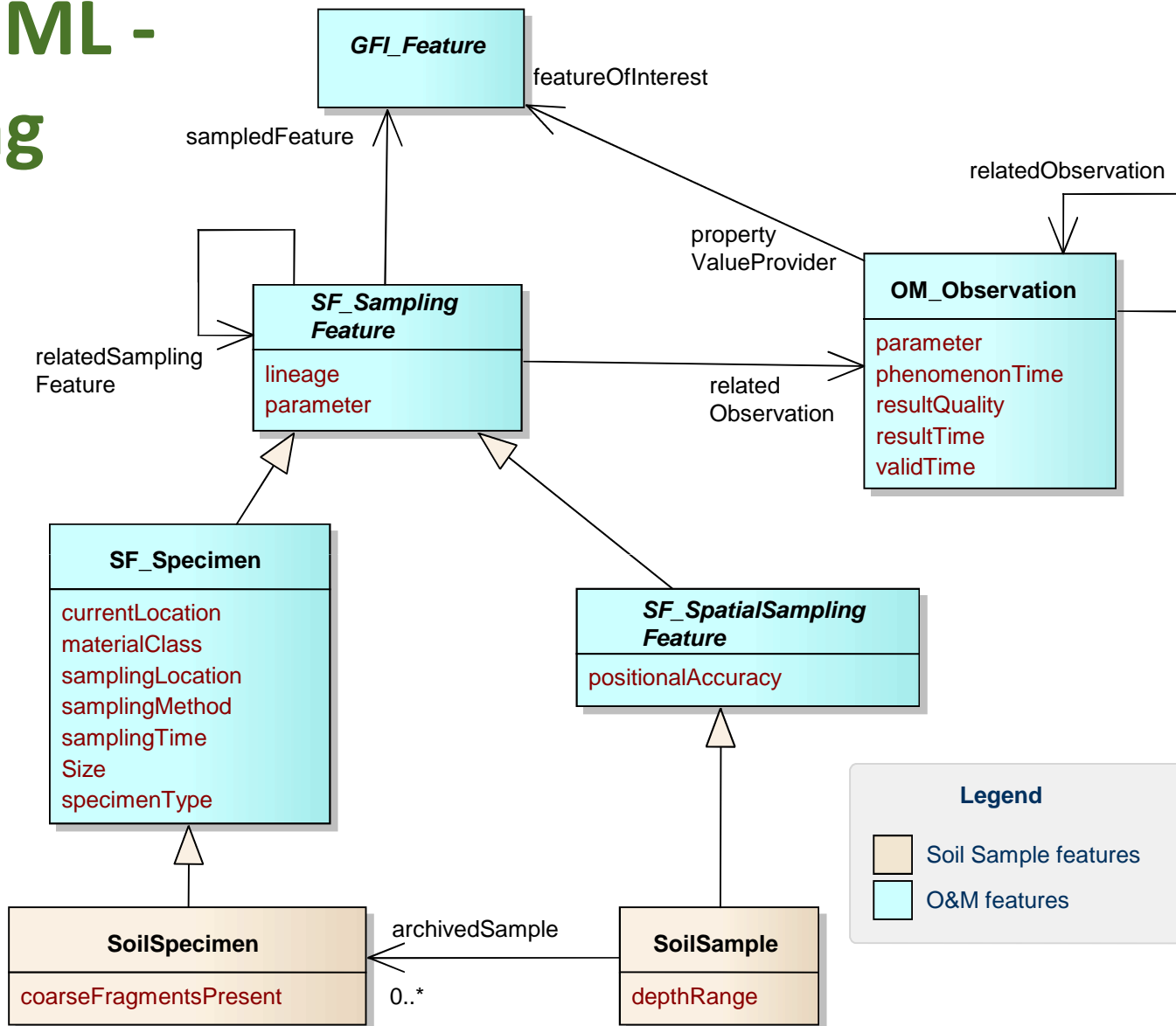
feature of interest
Feature-type
Feature instances

procedure
Standard procedures,

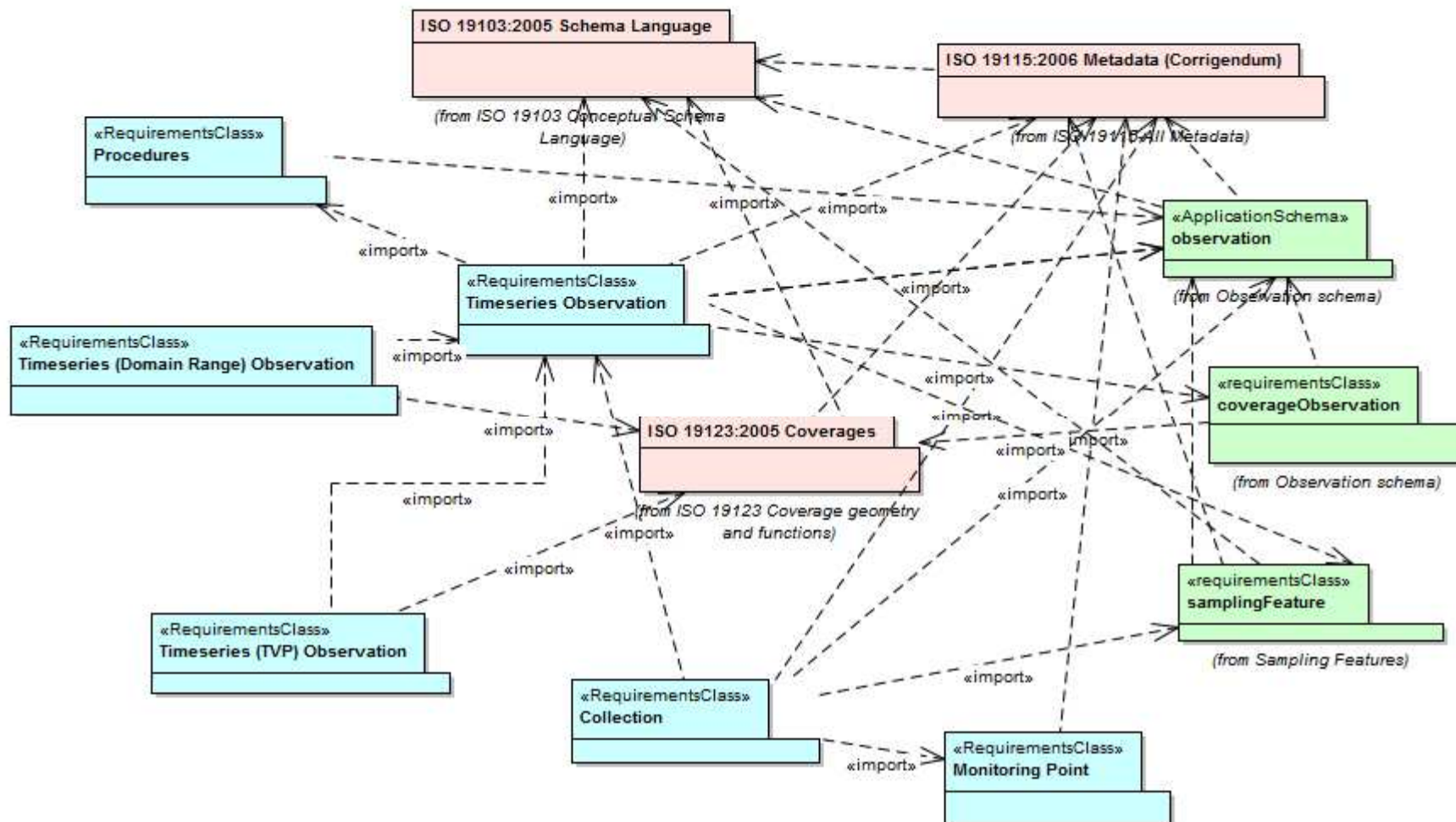
result
GML, SWE, netCDF

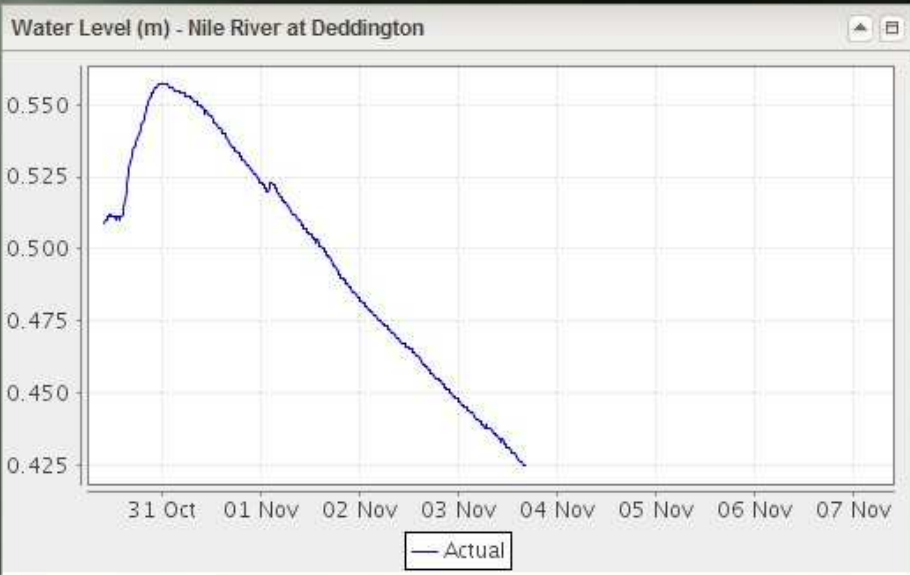
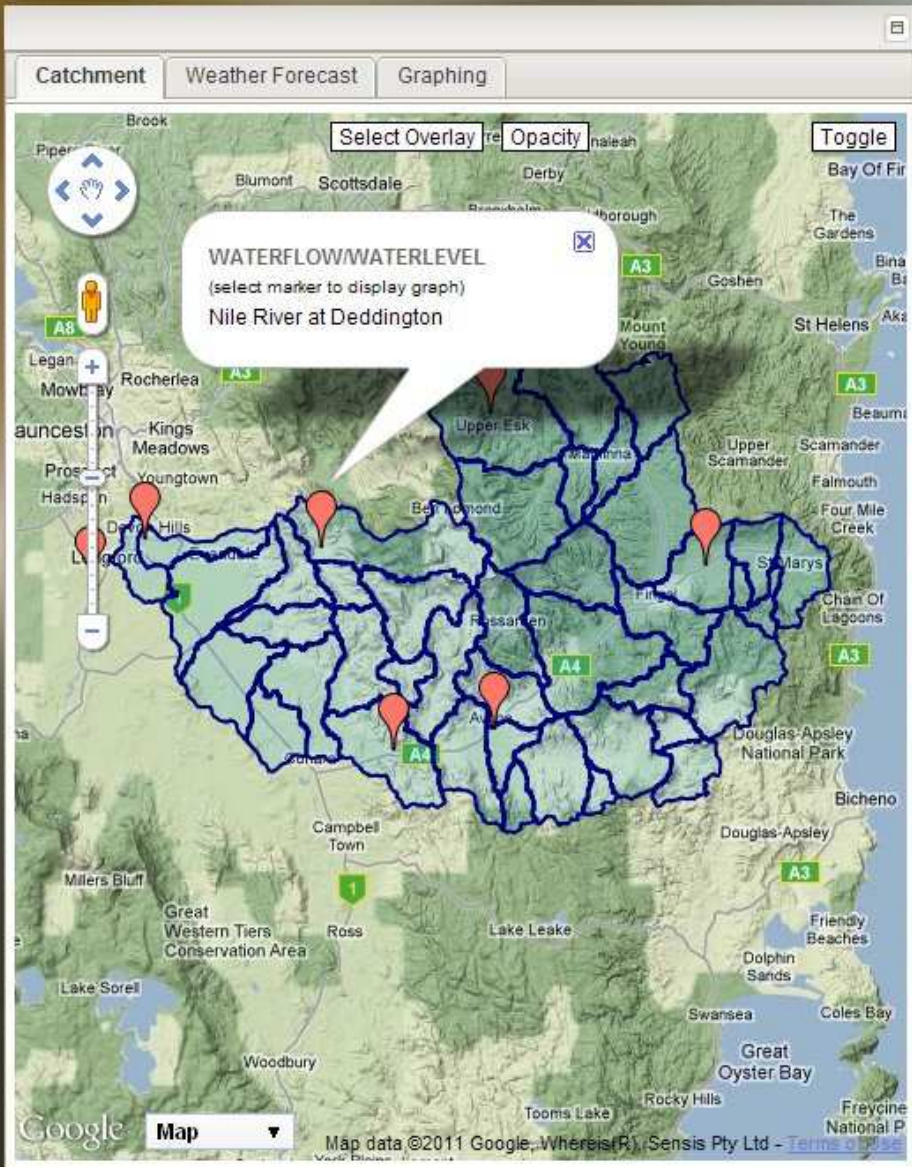
APPLICATIONS

ANZSoilML - sampling



WaterML 2.0







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:

Begin Date:

End Date:

Plot Begins:

2012-07-25

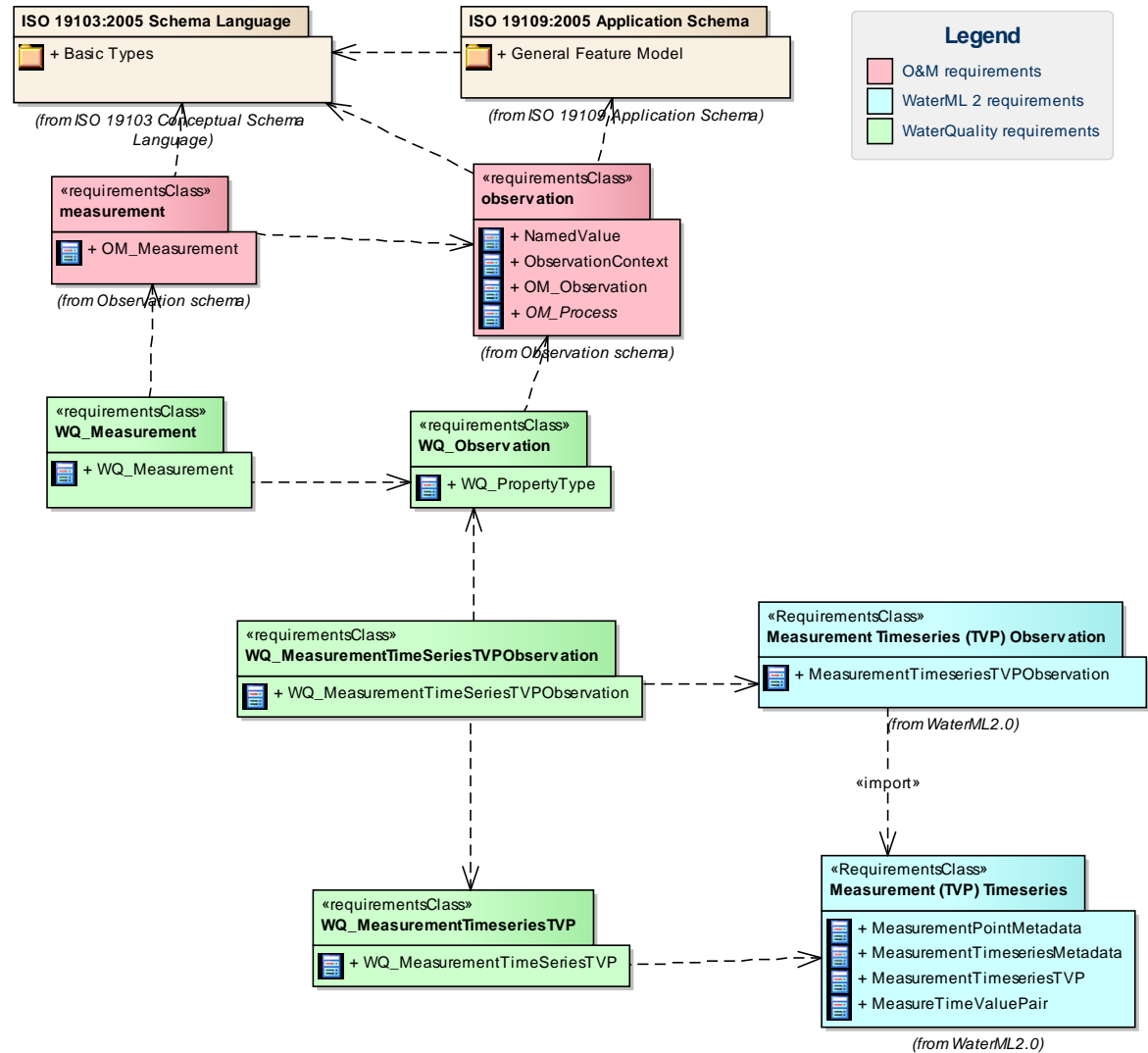
Plot Ends:

2013-07-25

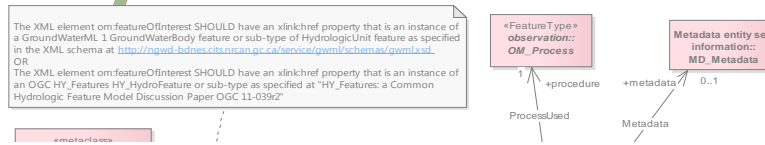
Available Data (choose up to 3 properties to plot):

	Property	Begin date	End date
<input type="checkbox"/>	Temperature, water (deg C) Continuous	2007-10-01	2013-07-25
<input checked="" type="checkbox"/>	Temperature, water (deg C) Daily Maximum	1966-07-15	1966-09-30
<input type="checkbox"/>	Temperature, water (deg C) Daily Minimum	1966-07-15	1966-09-30
<input type="checkbox"/>	Temperature, water (deg C) Daily Mean	2007-03-31	2013-07-24
<input type="checkbox"/>	Temperature, water (deg C) Daily Am	1956-10-02	1958-09-30
<input type="checkbox"/>	Temperature, water (deg C) Daily Instantaneous	1958-10-01	1973-09-30
<input type="checkbox"/>	Discharge (cfs) Continuous	2007-	2013-

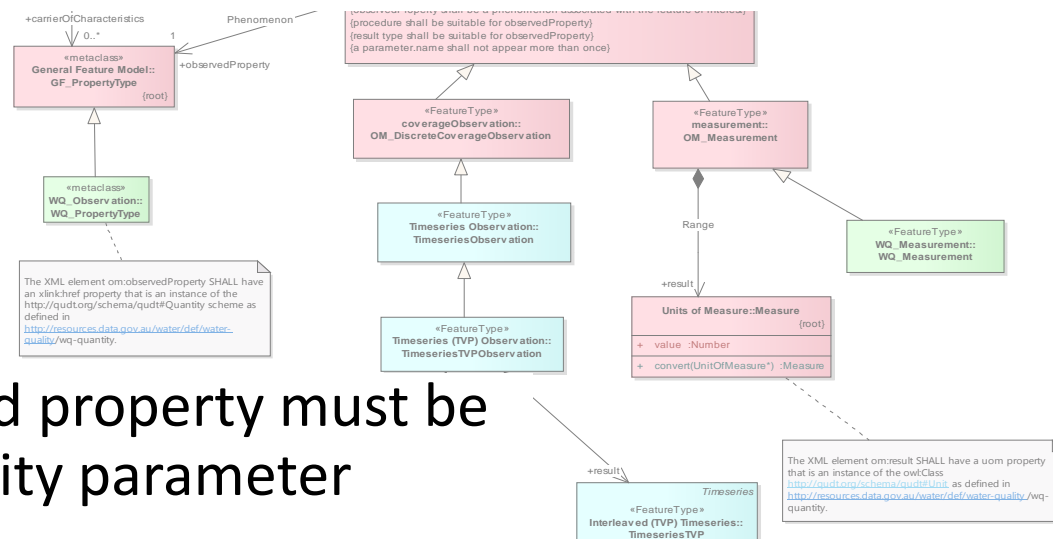
WQML



Water quality observations model

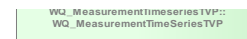
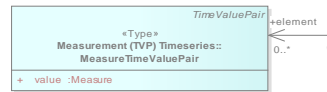


- The observation feature of interest must be either a groundwater or geofabric feature

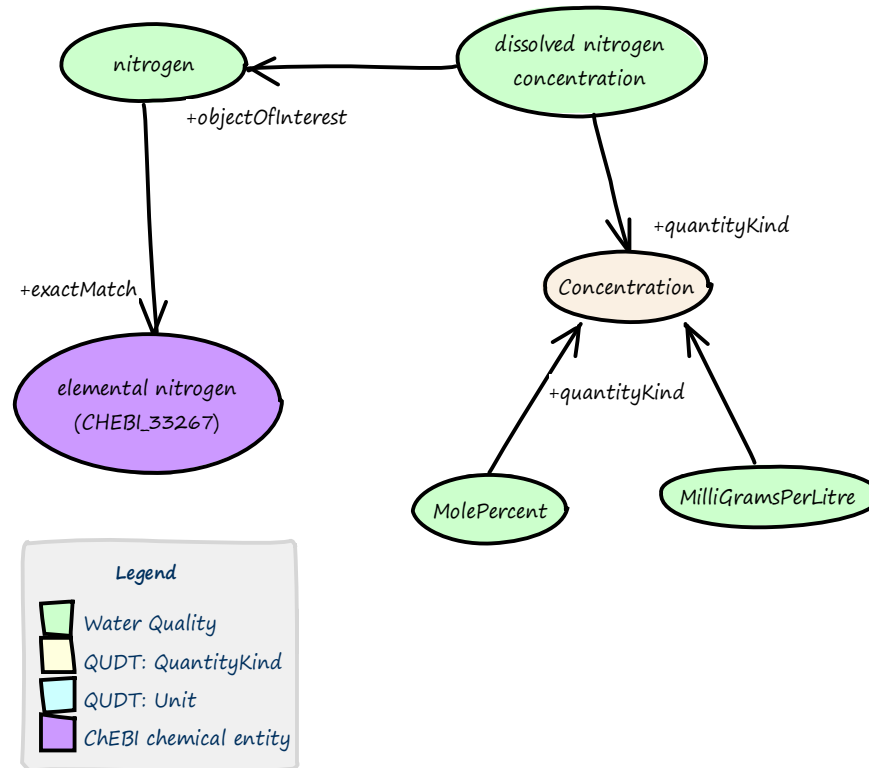


- The observed property must be a water-quality parameter

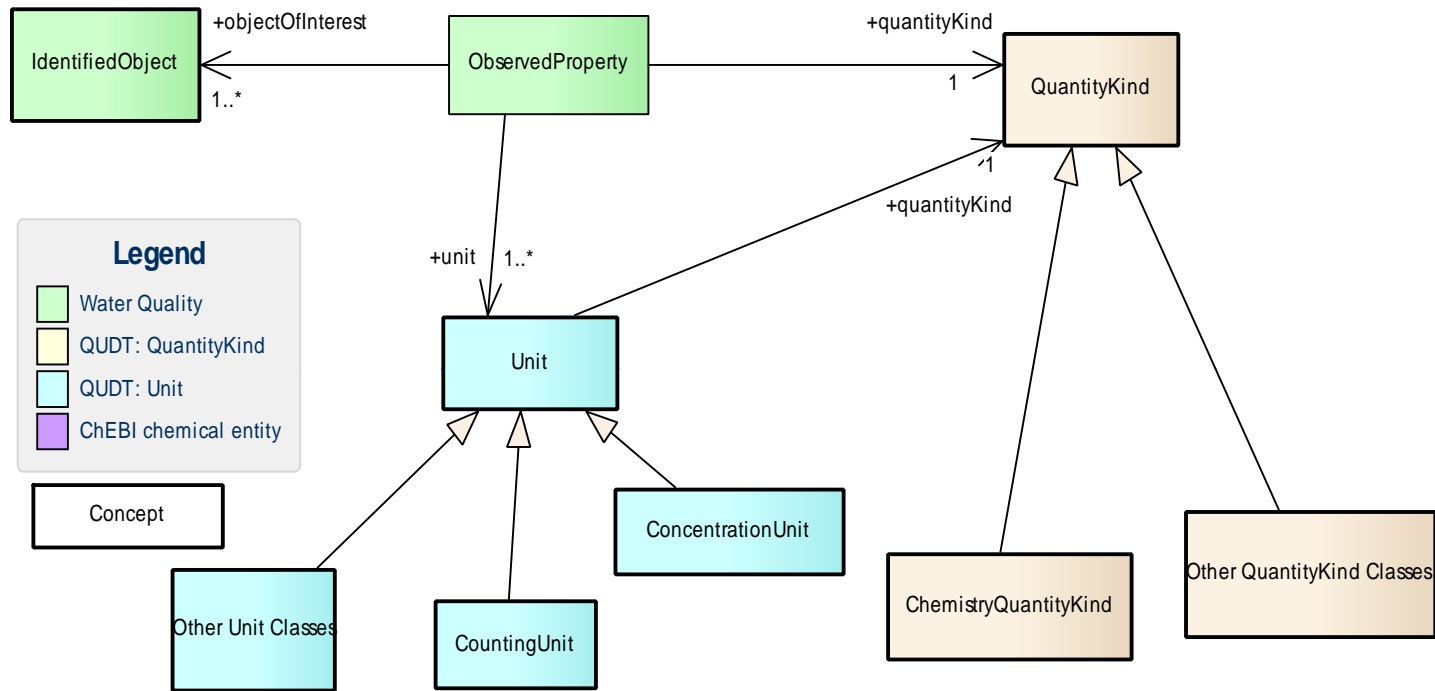
- The units of measure must match the water-quality parameter



Observed properties – water quality



WQ Properties model



wq-quantity.ttl

Resource Form

URI:

- Annotations
- alternative label
 -
 - preferred label
 -
- Incoming Referenc...
- ← has narrower
 - non-metal con...
 - organic compo...
 - organochlorine

http://purl.obolibrary.org/obo/CHEBI_17194

organic compound co

non

Linked Data - Object View

auscope-services-test.rrc.csiro.au/elda-demo/wq/resource?uri=http://def.seegrid.csiro.:

Personal GovDex My Google groups tools RDF CSIRO OSP-FSDF ISO OGC TND/WaterML2 Other bookmarks

SISSVoc Powered by ELDA

SISSvoc Water Quality Service

html json rdf text ttl xml

bromochloromethane concentration

http://def.seegrid.csiro.au/resources/water/water-quality/wq-quantity-instance/bromochloromethane_concentration

alt label	<input type="text" value="methylene bromochloride concentration"/>
skos_broader	<input type="text" value="[chlorinated_volatile_organic_compound_concentration]"/>
	<input type="text" value="[non-metal_concentration]"/>
skos_narrower	<input type="text" value="bromochloromethane_concentration"/>
	<input type="text" value="[organic_compound_concentration]"/>
skos_narrower	<input type="text" value="bromochloromethane_concentration"/>
	<input type="text" value="[organochlorine_concentration]"/>
skos_narrower	<input type="text" value="bromochloromethane_concentration"/>
type	Quantity Concept
in scheme	<input type="text" value="Water Quality Quantities"/>
is primary topic of	<input type="text" value="bromochloromethane_concentration"/>
qudt_quantity kind	<input type="text" value="AmountOfSubstancePerUnitVolume"/>
qudt_unit	<input type="text" value="MilliGrams per Litre"/>
wqp_object of interest	<input type="text" value="bromochloromethane"/>

Find Concepts

Exact label

Text within label

View

> basic > description > all

- pref label
- alt label
- skos_broader · skos_narrower
- type
- in scheme
- is primary topic of
- qudt_quantity kind
- qudt_unit
- wqp_object of interest

WQ Ontology

- Immediate requirements
 - IPBA, eReefs partners, BoM
- Harmonization and alignment
 - CUAHSI, EPA, USGS
 - ChEBI - Chemical Entities of Biological Interest
 - QUDT – NASA/TopBraid
- Formalization
 - Semantic Web technologies – RDF/OWL/SKOS
- Publication
 - SISSvoc