



World Meteorological Organization

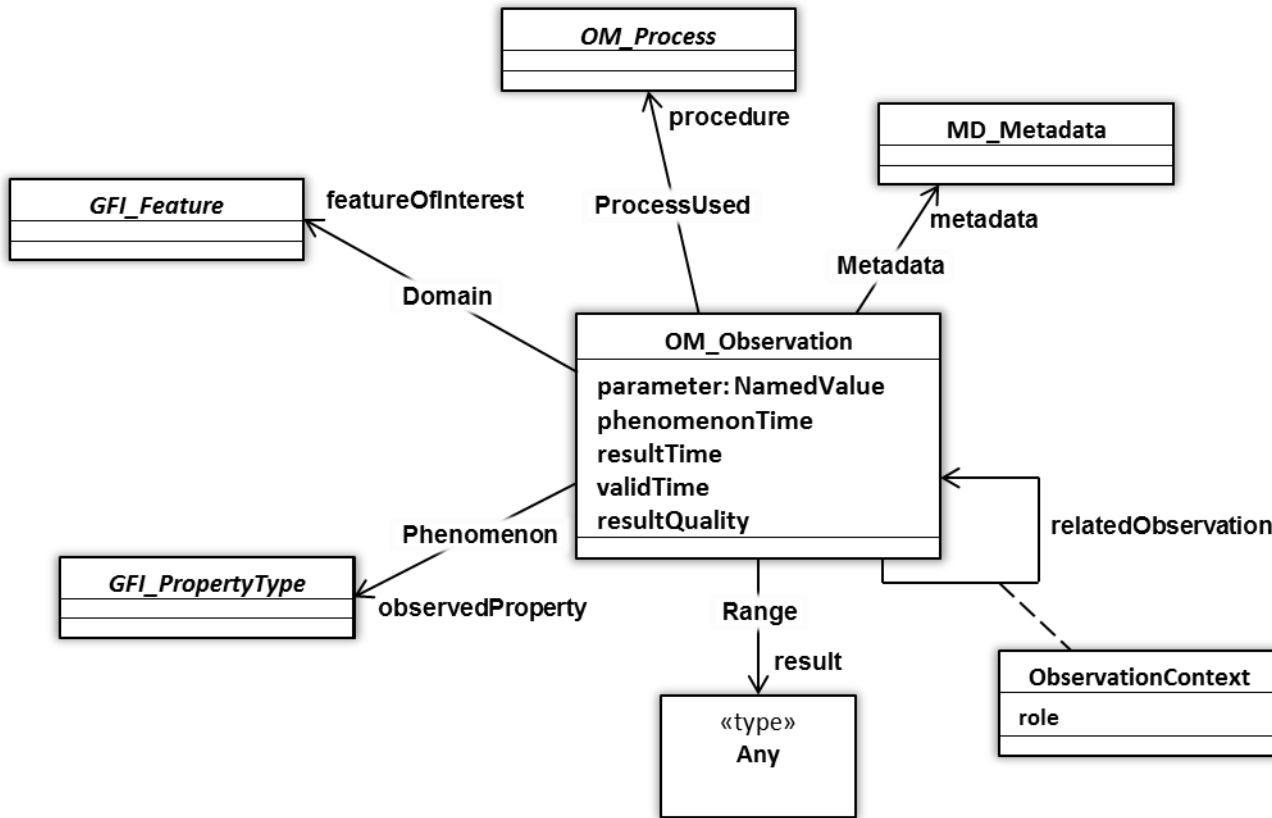
Weather • Climate • Water

Emerging trends in information architecture

ET-CDMS, 4-7 November 2014

Jeremy Tandy, Met Office & chair IPET-MDRD

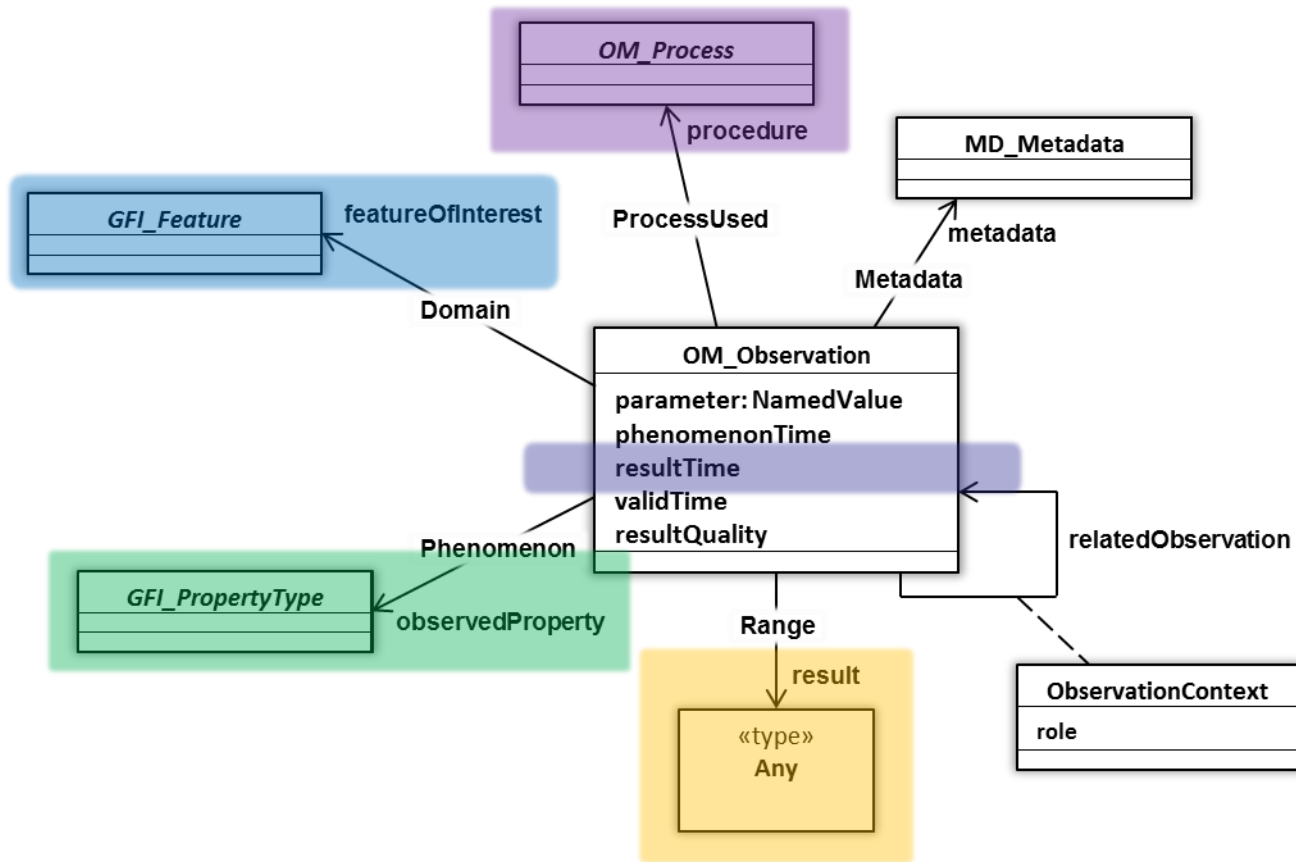
Observations and measurements



ISO 19156:2011 'Geographic information – Observations and measurements' provides a metamodel for describing the context required to interpret the results of an observation.



Observations and measurements



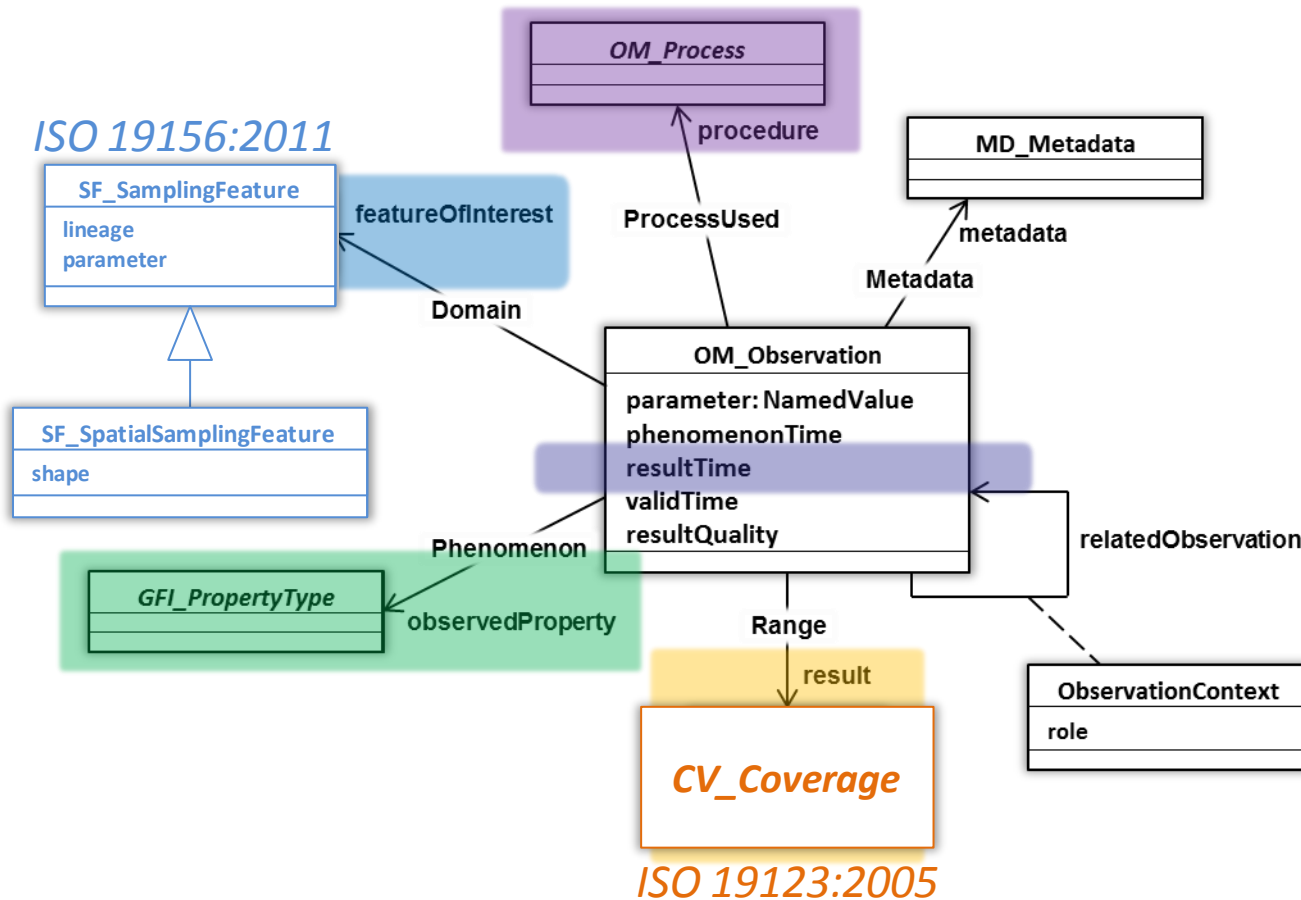
OM_Observation:

- an **EVENT** whose
- **RESULT** is an *estimate* of a value of some
- **PROPERTY** of some
- **THING** obtained using a specified
- **PROCEDURE** ...

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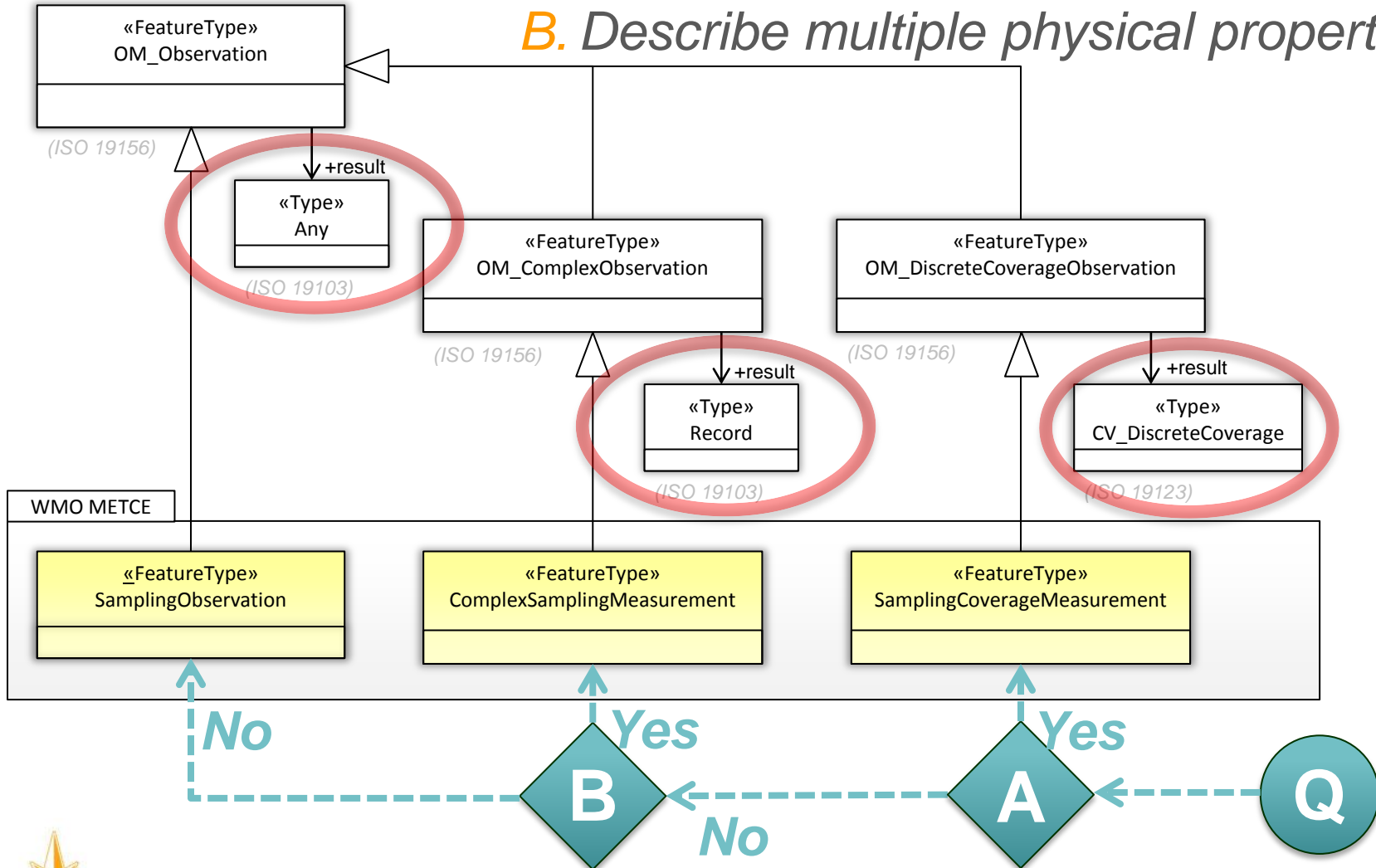


METCE: a *profile* of Observations and Measurements

Does the data collected (e.g. the 'result') from the Observation event:

A. Vary in space and or time?

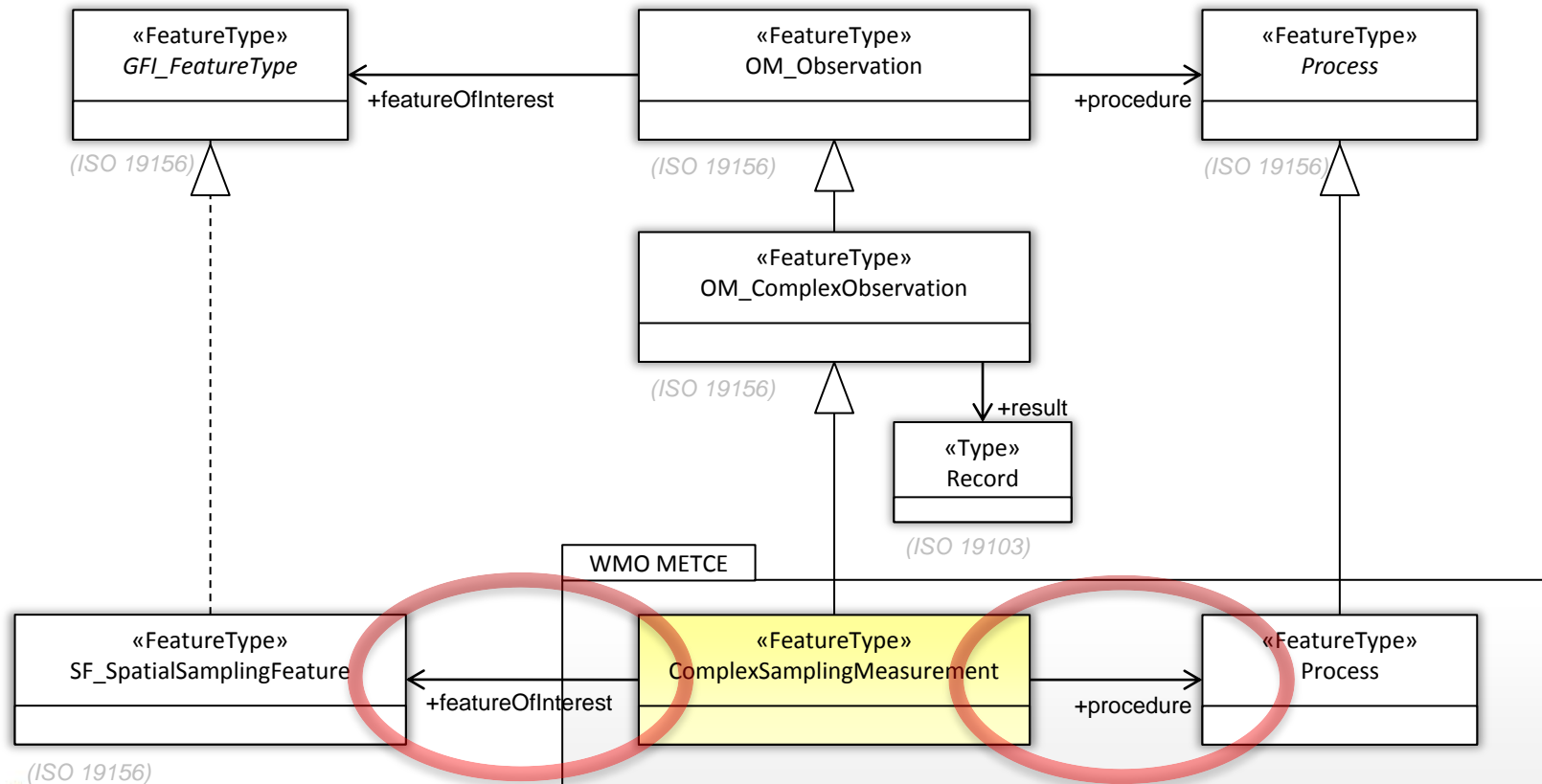
B. Describe multiple physical properties?



Common constraints applicable to all METCE types

All specialisations of *OM_Observation* defined in WMO METCE require:

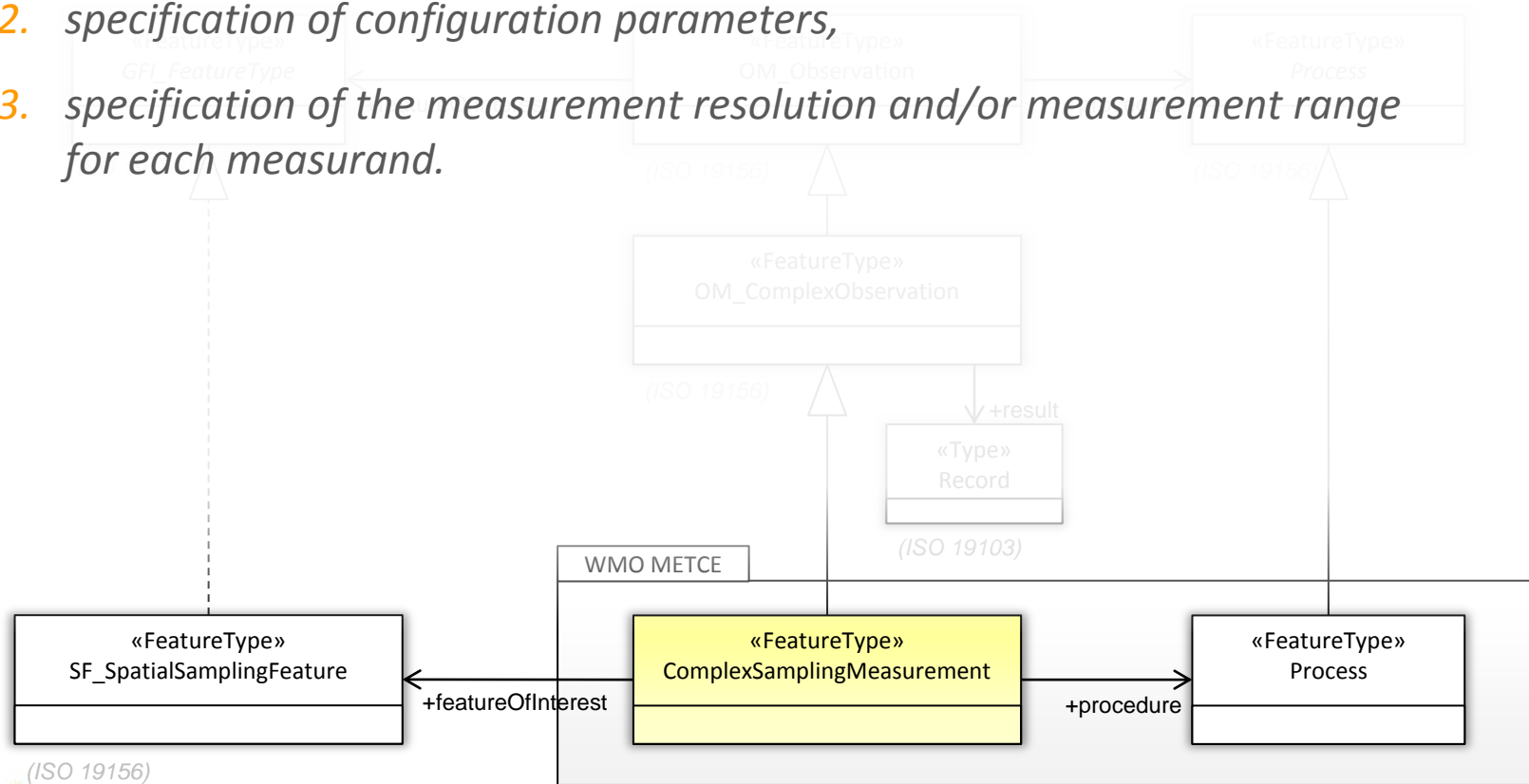
- association role 'featureOfInterest' shall be of type *SF_SpatialSamplingFeature*
- association role 'procedure' shall be of type *Process* (from WMO METCE)



METCE Process

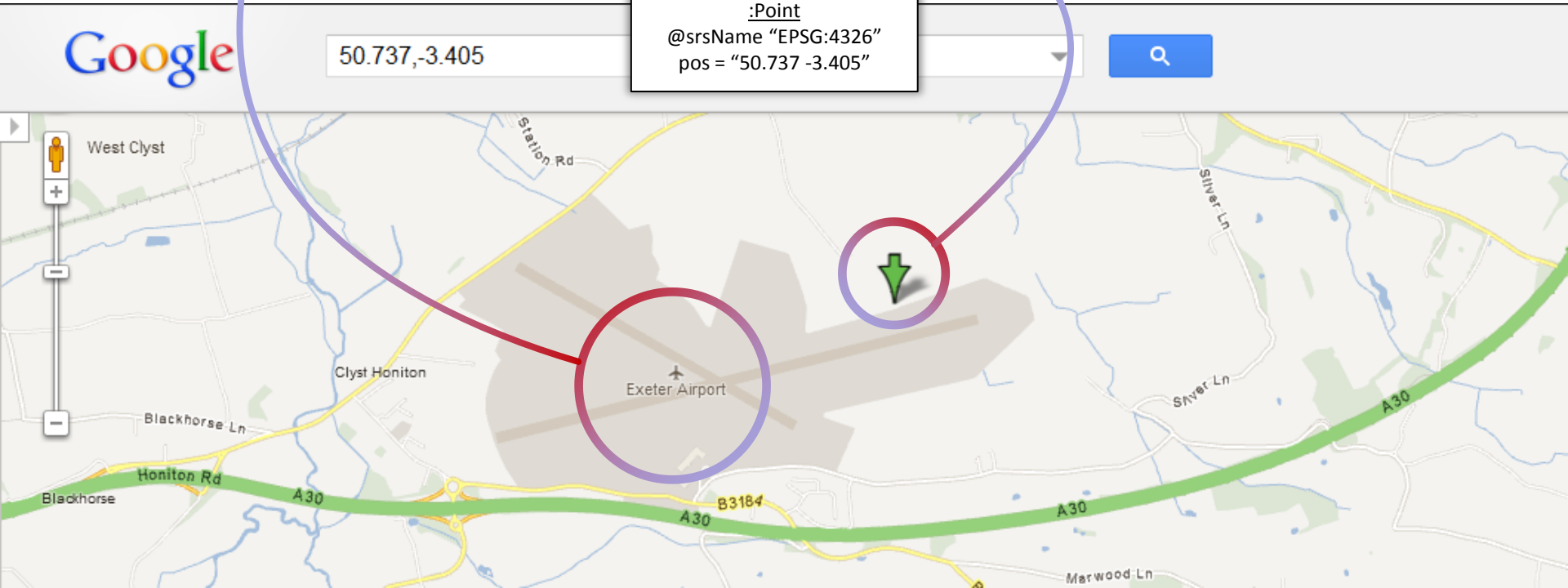
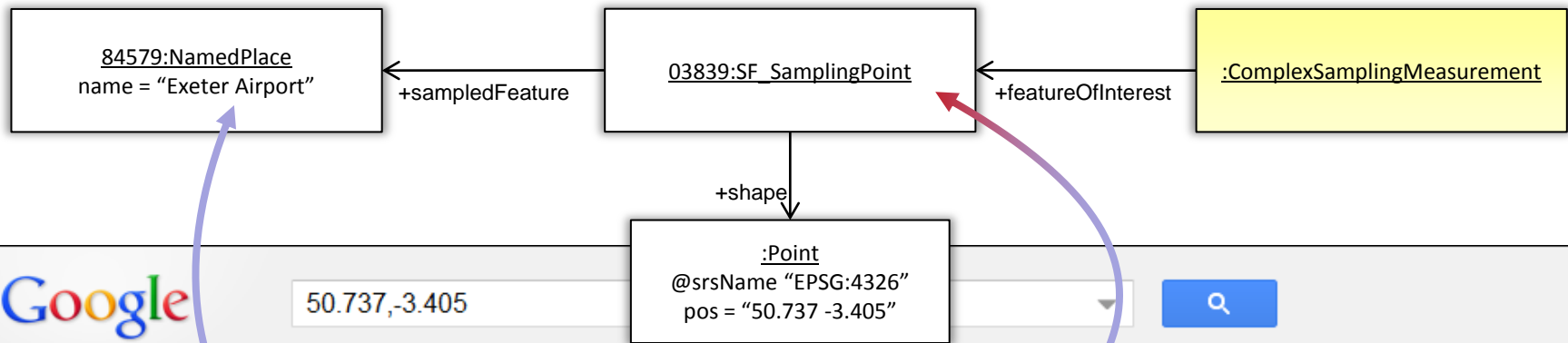
Process (from WMO METCE) provides a concrete implementation of the abstract OM_Process supporting the following requirements:

1. reference to supporting documentation,
2. specification of configuration parameters,
3. specification of the measurement resolution and/or measurement range for each measurand.



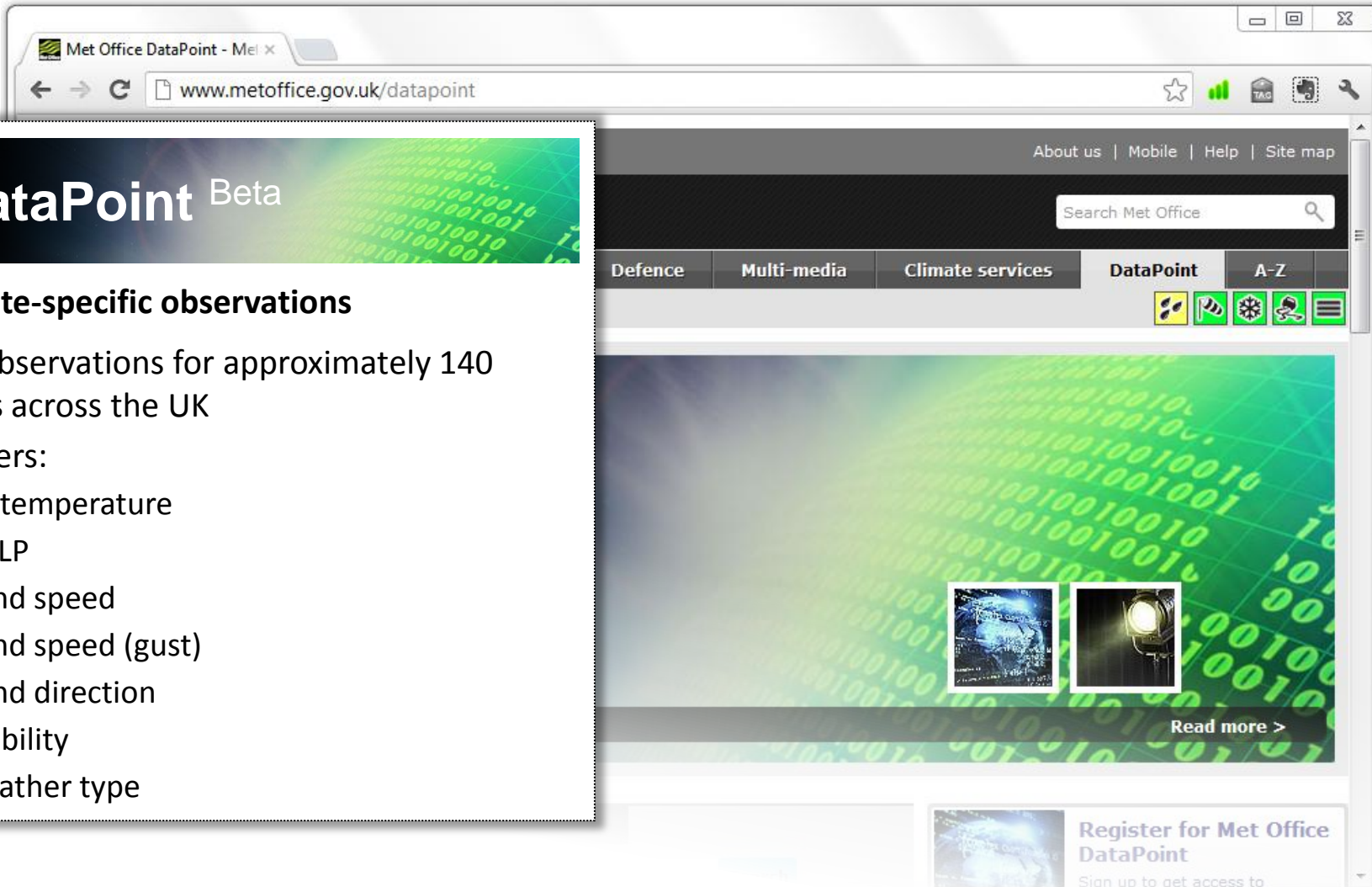
SamplingFeature as OM_Observation.featureOfInterest

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.



Example use of METCE: Met Office DataPoint

*Illustrative example demonstrating how METCE provides a foundation to domain specific **Application Schema** ...*



The screenshot shows a web browser window with the URL www.metoffice.gov.uk/datapoint. The page features a dark header with the Met Office logo and the text "DataPoint Beta". A search bar is present with the placeholder text "Search Met Office". Below the header is a navigation menu with links for "Defence", "Multi-media", "Climate services", "DataPoint", and "A-Z". The main content area has a green background with binary code and two small images: a satellite view of the Earth and a close-up of a light fixture. A "Read more >" link is visible below the images. At the bottom right, there is a registration prompt: "Register for Met Office DataPoint" with the subtext "Sign up to get access to".

UK hourly site-specific observations

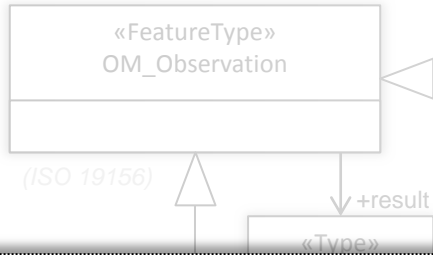
- Hourly observations for approximately 140 locations across the UK
- Parameters:
 - Air temperature
 - MSLP
 - Wind speed
 - Wind speed (gust)
 - Wind direction
 - Visibility
 - Weather type

Which type of OM_Observation?

Does the data collected (e.g. the 'result') from the Observation event:

A. Vary in space and or time?

B. Describe multiple physical properties?

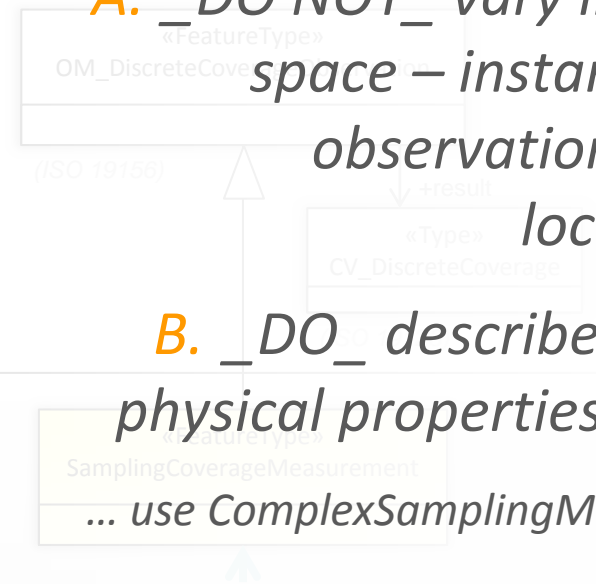


DataPoint observation results:

A. DO NOT vary in time or space – instantaneous observation at fixed location; and

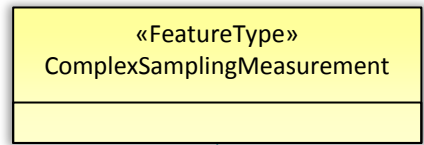
B. DO describe multiple physical properties (count = 7)

... use ComplexSamplingMeasurement



UK hourly site-specific observations

- Hourly observations for approximately 140 locations across the UK
- Parameters:
 - Air temperature
 - MSLP
 - Wind speed
 - Wind speed (gust)
 - Wind direction
 - Visibility
 - Weather type



Validatable data products: bespoke Records class

The Record class (from ISO 19103) provides a set of name-value pairs.

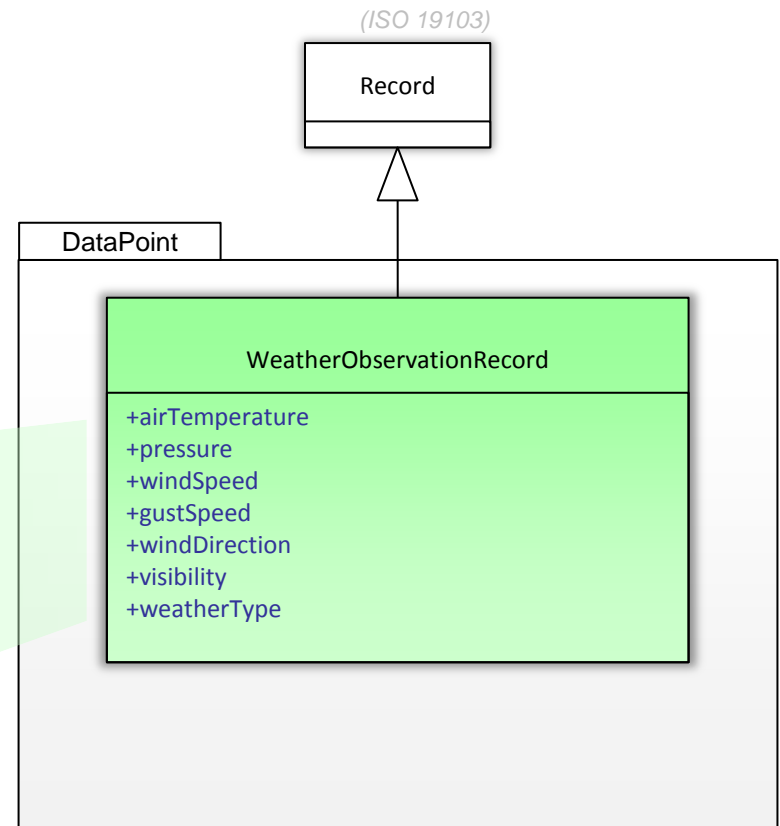
In GML, this can be implemented using SWE DataRecord ...

However, in this example, we require validatable data products. Therefore, we need to generate an XML Type for the Record – which is derived from our Application Schema:



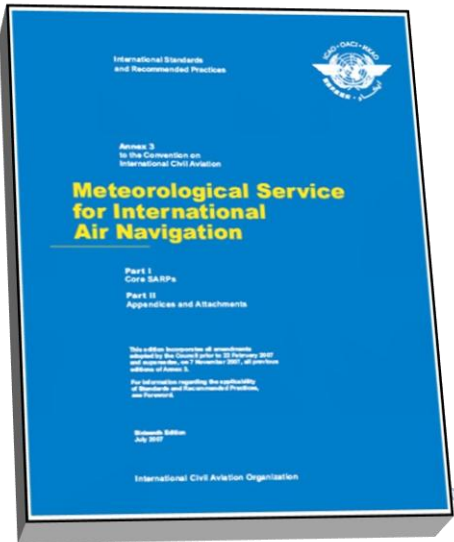
UK hourly site-specific observations

- Hourly observations for approximately 140 locations across the UK
- Parameters:
 - Air temperature
 - MSLP
 - Wind speed
 - Wind speed (gust)
 - Wind direction
 - Visibility
 - Weather type

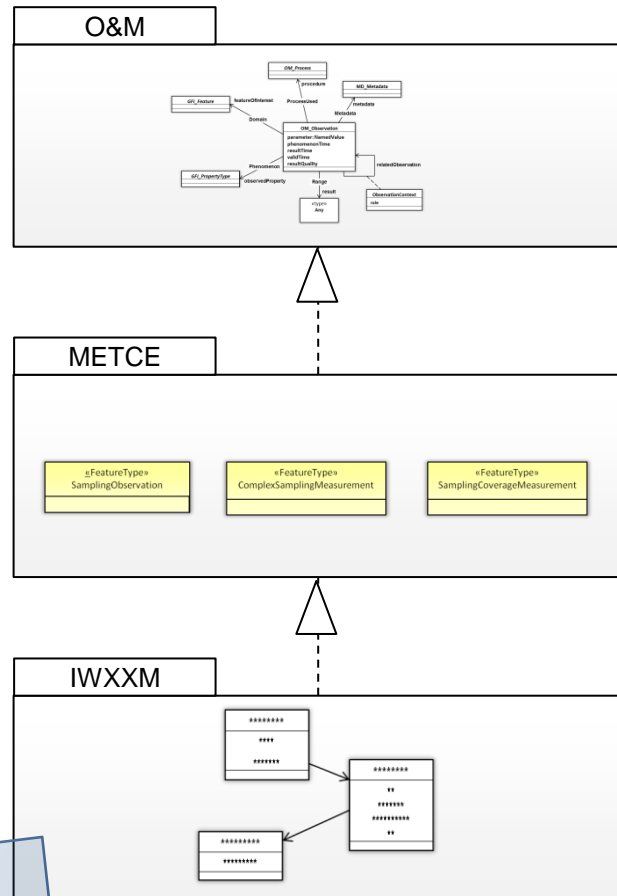


ICAO Weather eXchange Model (IWXXM)

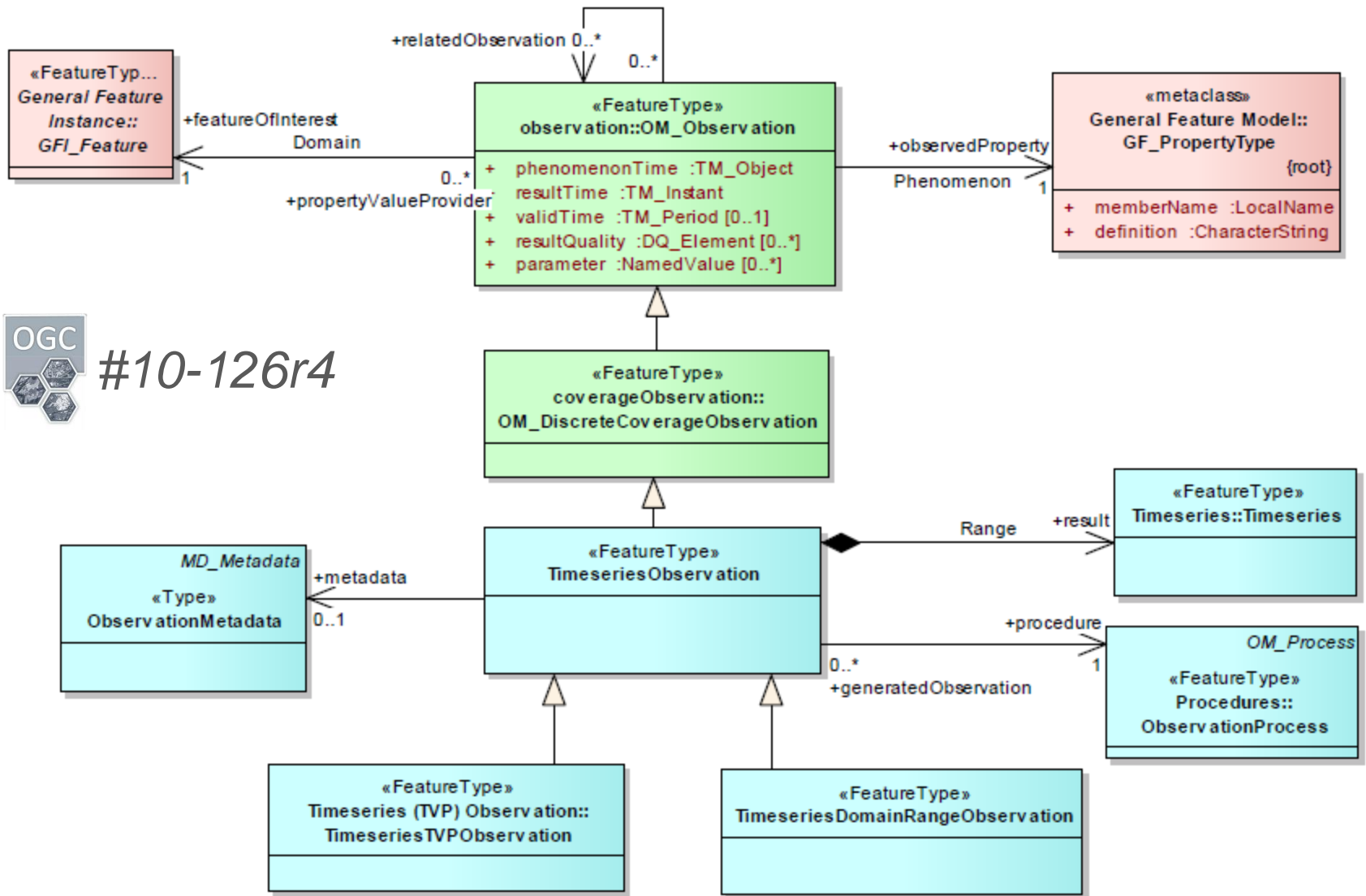
ICAO Annex 3 / WMO No. 49 II
Meteorological Service for
International Air Navigation



« formalised as »



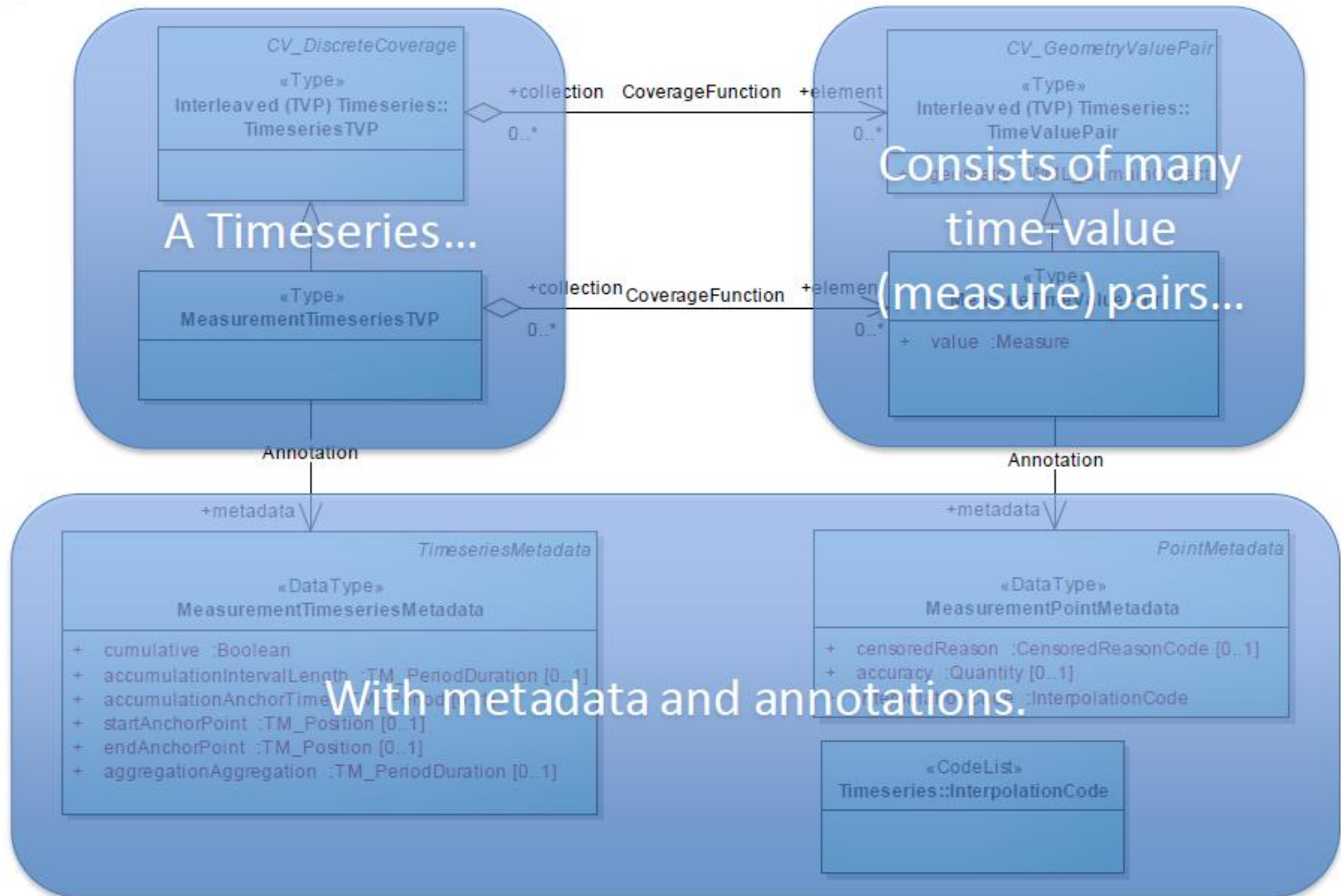
WaterML2 Part 1 – Timeseries; another OM profile



OGC #10-126r4

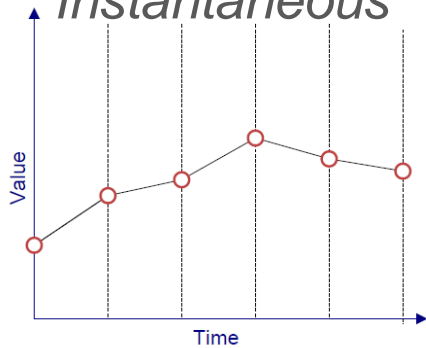


WaterML2: Specialised Result type (TimeSeries)

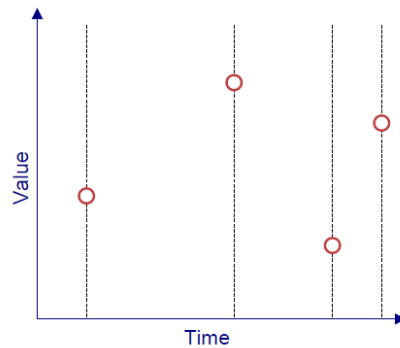


WaterML2: Time series structures (and more)

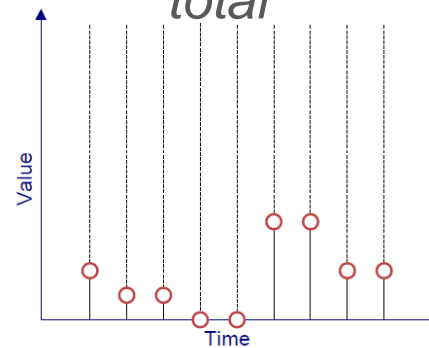
*Continuous/
Instantaneous*



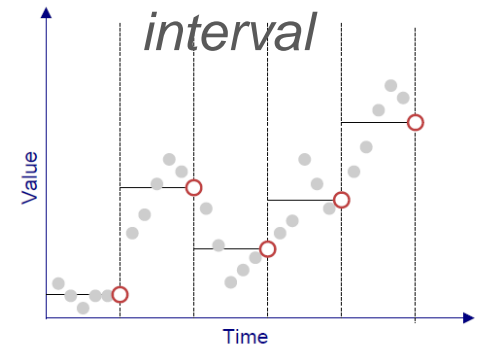
Discontinuous



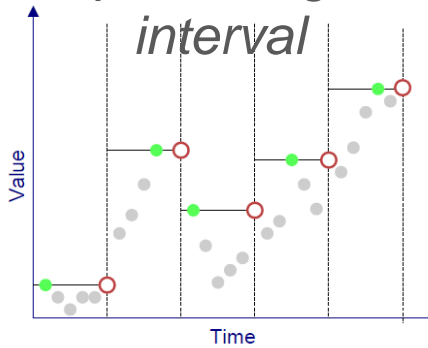
*Instantaneous
total*



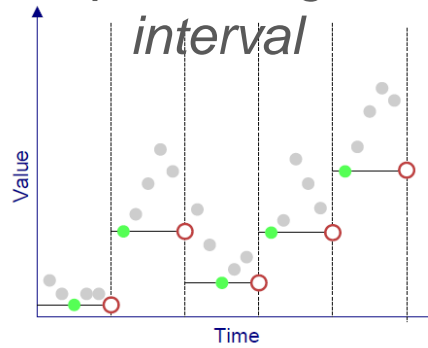
*Average in
preceding
interval*



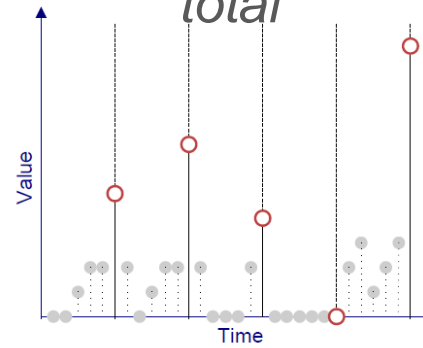
*Maximum in
preceding
interval*



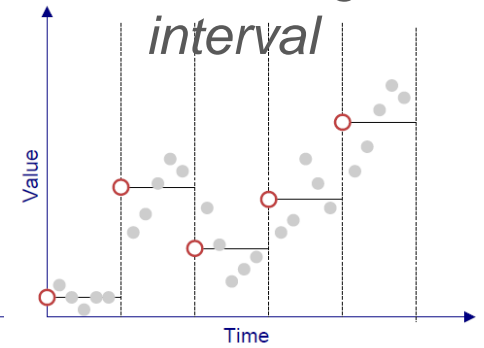
*Minimum in
preceding
interval*



*Preceding
total*



*Average in
succeeding
interval*



OGC Change Request #13-123: TimeSeriesML

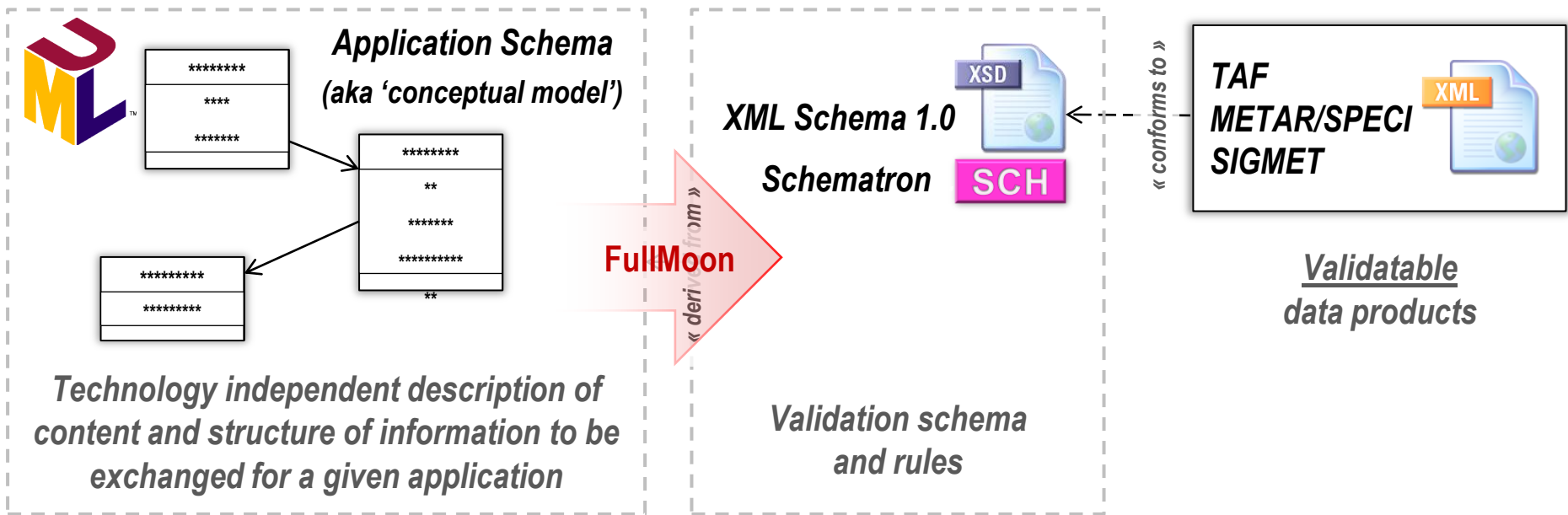
To repackage WaterML 2.0: Part 1 as TimeSeriesML and place its stewardship and further evolution under the guidance of a broader-based working group.

Other than some of the examples, there is nothing hydrology-specific in the Part 1 specification. Rather it complements O&M and SWE Common Data Model to provide a very functional advance in OGC support for the management and distribution of time series data across multiple domains.

TimeSeriesML SWG Charter established Nov 2014

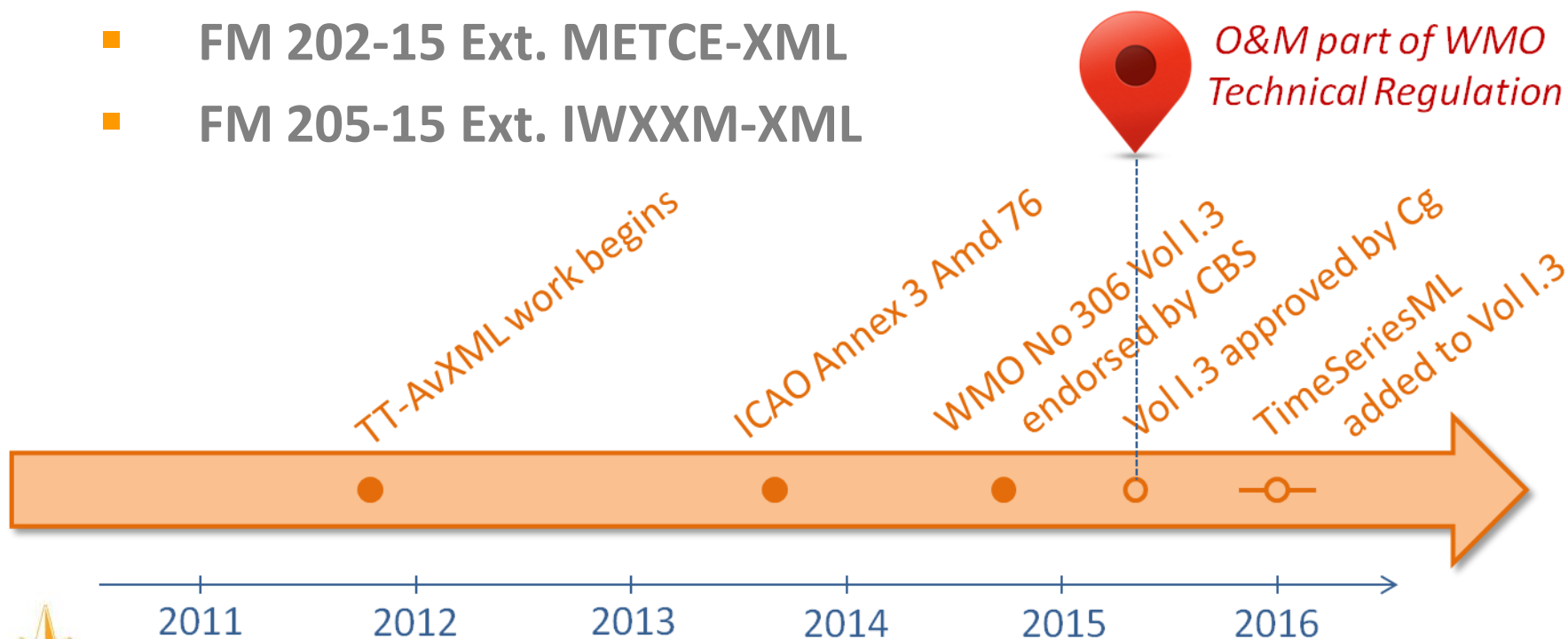


Model-driven data exchange standards; XML encoding

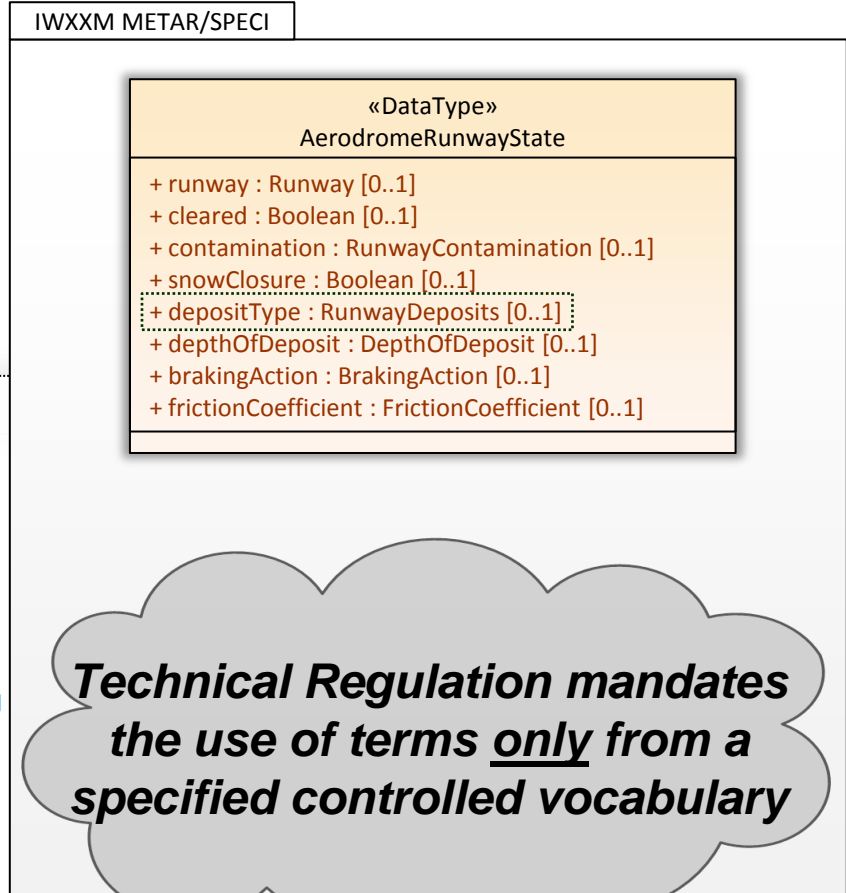
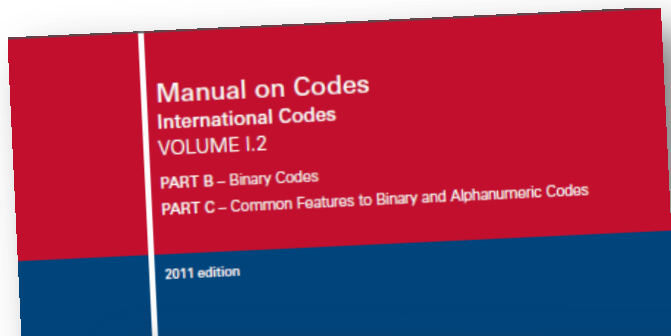


WMO and O&M convergence

- WMO tasked by ICAO to deliver GML application schema for aeronautical meteorology data exchange
- WMO (TT-AvXML) adopt model-driven approach based on O&M; new code forms include
 - FM 202-15 Ext. METCE-XML
 - FM 205-15 Ext. IWXXM-XML



Nominal value-types; regulated set of terms (code-table)



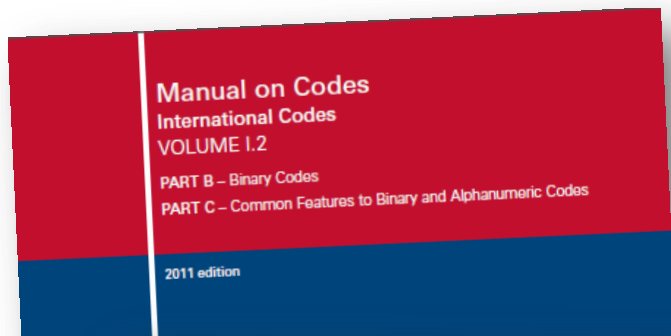
0 20 086
Runway deposits

Code figure		
0	Clear and dry	
1	Damp	
2	Wet with water patches	
3	Rime and frost covered (depth normally less than 1	
4	Dry snow	
5	Wet snow	
6	Slush	
7	Ice	
8	Compacted or rolled snow	
9	Frozen ruts or ridges	
10-14	Reserved	Operational
15	Missing or not reported (e.g. due to runway clearance in progress)	Operational

Excerpt from BUFR edition 4 Code- and Flag-tables

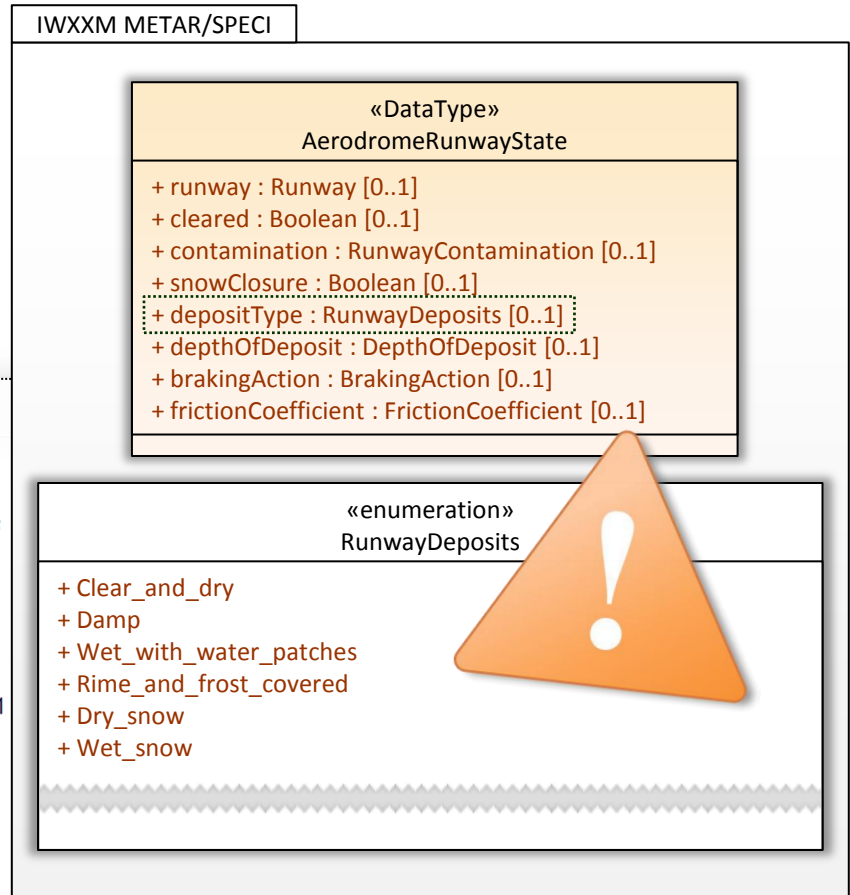


Design choice: avoid use of «enumeration» entities (*fragile*)



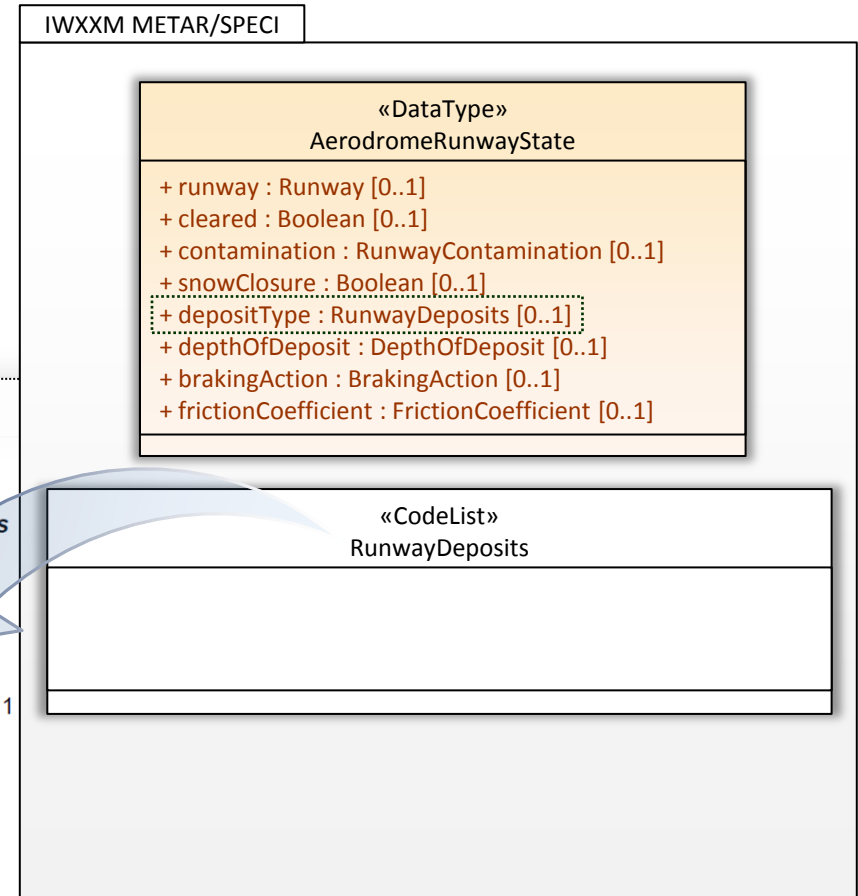
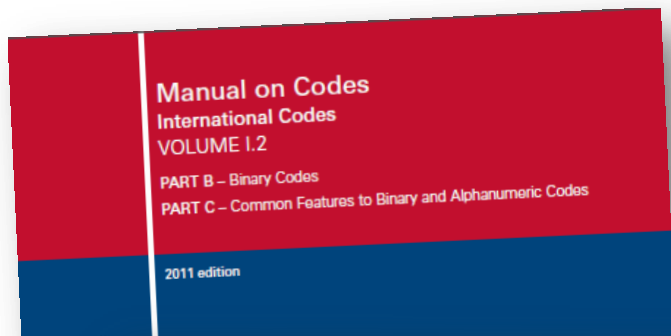
0 20 086 Runway deposits

Code figure	Description	Operational
0	Clear and dry	
1	Damp	
2	Wet with water patches	
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6	Slush	
7	Ice	
8	Compacted or rolled snow	
9	Frozen ruts or ridges	
10-14	Reserved	Operational
15	Missing or not reported (e.g. due to runway clearance in progress)	Operational



Excerpt from BUFR edition 4 Code- and Flag-tables

Best practice: use «CodeList» class (*external reference*)



0 20 086
Runway deposits

Code figure	Description	Operational
0	Clear and dry	
1	Damp	
2	Wet with water patches	
3	Rime and frost covered (depth normally less than 1	
4	Dry snow	
5	Wet snow	
6	Slush	
7	Ice	
8	Compacted or rolled snow	
9	Frozen ruts or ridges	Operational
10-14	Reserved	Operational
15	Missing or not reported (e.g. due to runway clearance in progress)	Operational

Excerpt from BUFR edition 4 Code- and Flag-tables



Referencing terms using canonical labels

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      Damp  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

«DataType» AerodromeRunwayState
+ runway : Runway [0..1]
+ cleared : Boolean [0..1]
+ contamination : RunwayContamination [0..1]
+ snowClosure : Boolean [0..1]
+ depositType : RunwayDeposits [0..1]
+ depthOfDeposit : DepthOfDeposit [0..1]
+ brakingAction : BrakingAction [0..1]
+ frictionCoefficient : FrictionCoefficient [0..1]

Canonical labels don't work well as identifiers as their use is error prone ...



Referencing terms using canonical labels

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      DAMP  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

CAPITALISATION?



Referencing terms using canonical labels

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      Damp  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

Typographic errors?



Referencing terms using canonical labels

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      влажный  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

Multilingual content?



Referencing terms using local identifiers; “code-figure”

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      1  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

“1” what? Because XML is a generalised exchange format, there are no implied semantics like for BUFR and GRIB



Referencing terms using local identifiers; “code-figure”

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      0-20-086/1  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

Qualifying the code-figure with the code-table identifier is still fairly meaningless unless you're a BUFR expert!



Referencing terms using local identifiers; “code-figure”

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      bufr4/codeflag/0-20-086/1  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

Adding context (e.g. BUFR edition 4, code- and flag-tables) helps – but who’s the publishing authority?



Referencing terms using global identifiers

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType>  
      wmo.int/bufr4/codeflag/0-20-086/1  
    </iwxxm:depositType>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

We want to be sure that this is the authoritative version from WMO; prefix identifier with WMO's Internet domain name



Referencing terms using global identifiers; xlink & URN

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType  
      xlink:href="urn:foo:wmo.int/bufr4/codeflag/0-20-086/1"  
      xlink:title="Damp"/>  
  </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

A URN may be used – but then one needs additional knowledge to determine how to resolve the identifier

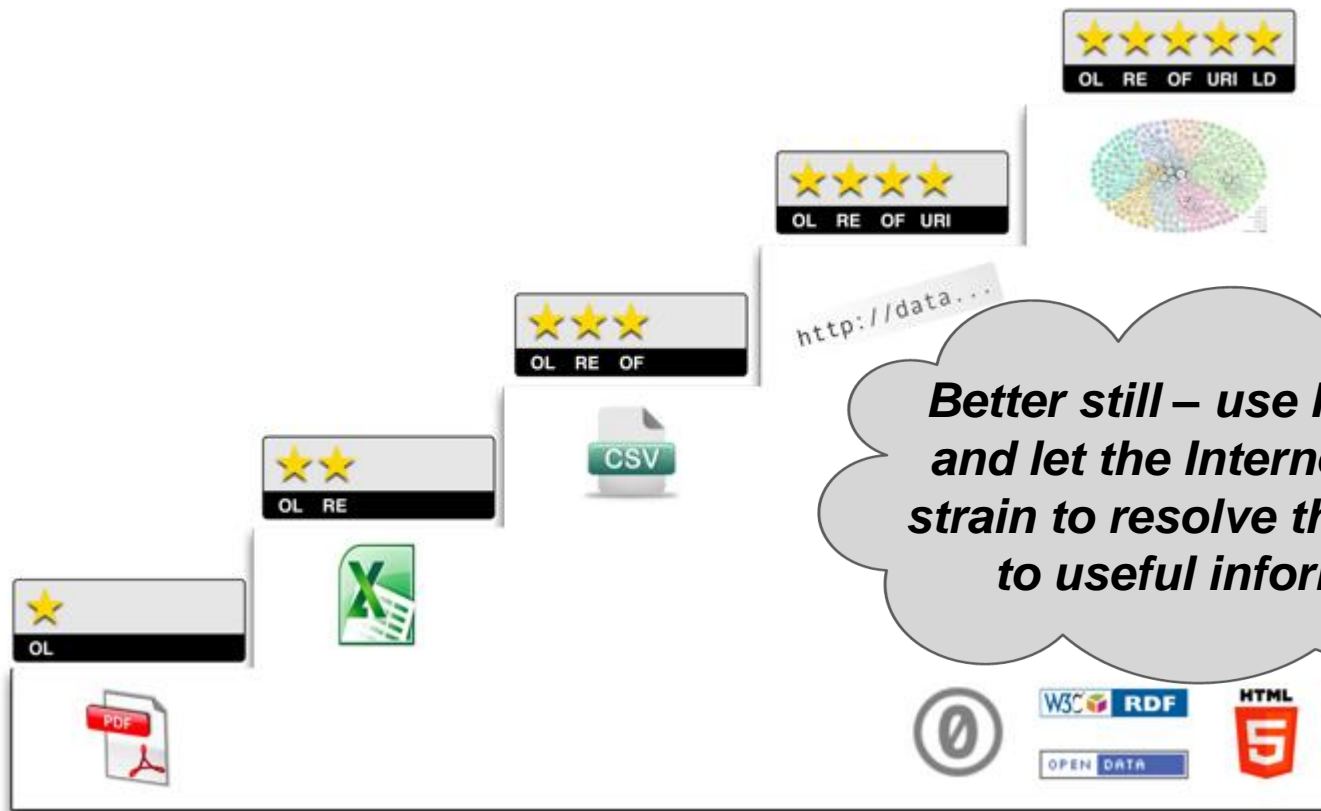
GML requires use of XLINK for «CodeList» references; the Locator Attribute “href” must be a URI



Referencing terms using URIs; an Open Data approach

5 ★ Open Data scheme: the degree to which data is (re-)usable

★ ★ ★ ★ use URIs to denote things – so that people can point to your stuff



The WMO Codes Registry service: resolving identifiers

```
<iwxxm:runwayState>  
  <iwxxm:AerodromeRunwayState>  
    <iwxxm:depositType  
      xlink:href="http://codes.wmo.int/bufr4/codeflag/0-20-086/1"  
      xlink:title="Damp"/>  
    </iwxxm:AerodromeRunwayState>  
</iwxxm:runwayState>
```

***“codes” sub-domain prefix
added to wmo.int Internet
domain name to enable
redirection using DNS ...***



The WMO Codes Registry service: resolving identifiers

The screenshot shows a web browser window displaying the WMO Codes Registry page for the entity 'Damp'. The browser's address bar shows the URL `codes.wmo.int/bufr4/codeflag/0-20-086/1`. The page header includes navigation links for 'Check URI', 'Datasets', 'Admin', 'Sparql', and 'About', along with a search bar and a 'Not logged in' status. The main content area features the title 'Entity: Damp' and its URI: `http://codes.wmo.int/bufr4/codeflag/0-20-086/1`. The entity is identified as a 'runwayDeposits' type, with no description supplied. A 'Stable' badge is visible next to the URI. Below the main information, there are tabs for 'Properties', 'Metadata', and 'History'. The 'Properties' tab is active, showing a table with the following data:

label	Damp
type	runwayDeposits

On the right side of the page, there is a section for 'About the Item' which includes the submission date '25 Sep 2013 12:56:34.668' and the submitter 'bootstrap'. Above this section, there are links for 'plain: ttl | rdf/xml' and 'with metadata: ttl | rdf/xml'. The footer of the page indicates it was developed by Epimorphics Ltd.



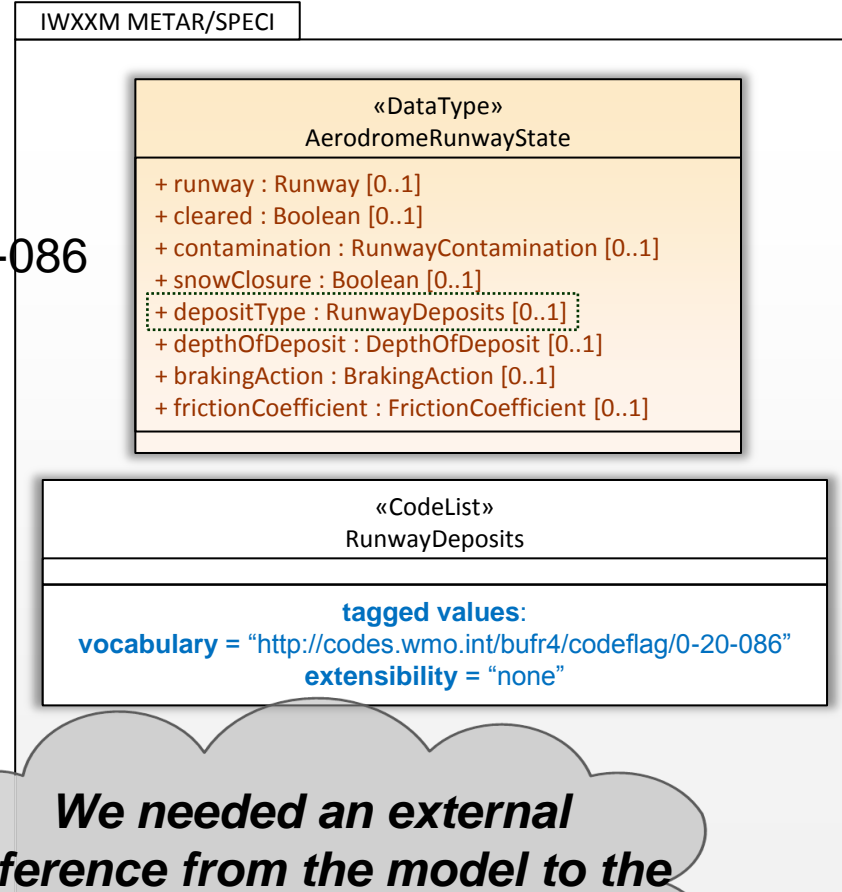
Overview of WMO Codes Registry

- [WMO Codes Registry](#) is the Service that resolves these HTTP URIs
- Provides *useful* information about each identified resource or concept (as determined by WMO) – using [content negotiation](#) to render both human- and machine-readable content ([HTML](#), [RDF/XML](#), [Turtle](#) & [JSON-LD](#))
- Newly deployed: September 2013
- Operated by Met Office on behalf of WMO
- Founded on Linked Data principles and RDF
- Built using [open-source Registry software](#) developed by UK Government



HTTP URIs assigned to code-tables too ...

```
<complexType name="RunwayDepositsType">
  <annotation>
    <appinfo>
      <vocabulary>
        http://codes.wmo.int/bufr4/codeflag/0-20-086
      </vocabulary>
      <extensibility>none</extensibility>
    </appinfo>
    <documentation>
      Type of deposit on a runway [..snip..]
    </documentation>
  </annotation>
  <complexContent>
    <extension base="gml:ReferenceType"/>
  </complexContent>
</complexType>
```



We needed an external reference from the model to the code-table; "vocabulary" tagged value is code-table URI



HTTP URIs assigned to code-tables too ...

The screenshot shows the WMO Codes Registry website. The browser address bar displays `codes.wmo.int/bufr4/codeflag/0-20-086`. The page title is "Register: Runway deposits". Below the title, it says "WMO No. 306 Vol I.2 FM 94 BUFR (edition 4) Code-table 0 20 086 'Runway deposits'". There are tabs for "List", "Table", "Properties", and "Metadata". The "List" tab is active, showing a table of items. Each item has a "Stable" status indicator. A callout bubble points to the "Stable" status of Item 0.

Item	Description	Type	Status
Item: 0	Clear and dry	runwayDeposits	Stable
Item: 1	Damp	runwayDeposits	Stable
Item: 2	Wet with water patches	runwayDeposits	Stable
Item: 3	Rime and frost covered (depth normally less than 1mm)	runwayDeposits	Stable
Item: 4	Dry snow	runwayDeposits	Stable
Item: 5	Wet snow	runwayDeposits	Stable
Item: 6	Slush	runwayDeposits	Stable

Each code-table is published as a "Register"



Next: Linked Data

QUESTIONS?

