



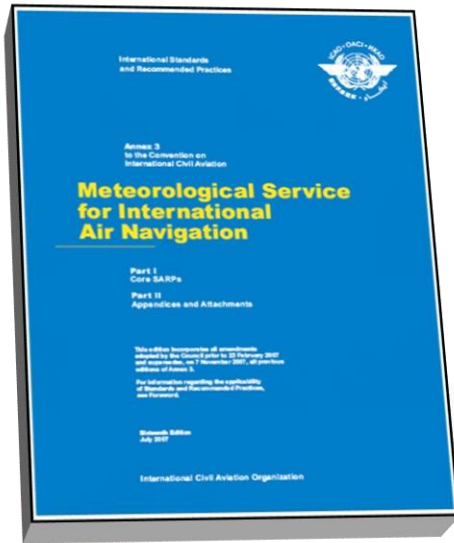
World Meteorological Organization  
Weather • Climate • Water



WMO Codes Registry:  
<http://codes.wmo.int>

web-based publication of the Manual on Codes

# Motivation: XML-encoded data exchange standards



**ICAO Annex 3 / WMO No. 49 II**

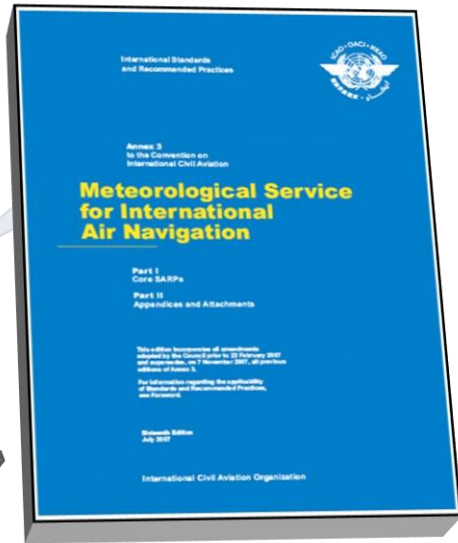
***Meteorological Service for International Air Navigation***


***Amendment 76 (2013) to ICAO Annex 3 shall, for states in a position to do so to, permit bilateral exchange of OPMET data via XML***

**TAF  
METAR/SPECI  
SIGMET**



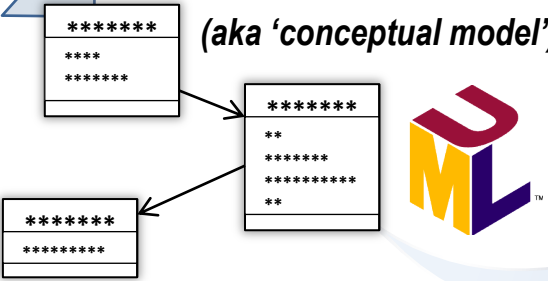
# Model-driven approach to data exchange standards



Geographic Information  
[ISO 19100-series] 

« formalised as »

Application Schema  
(aka 'conceptual model')



« validated against »

TAF  
METAR/SPECI  
SIGMET 



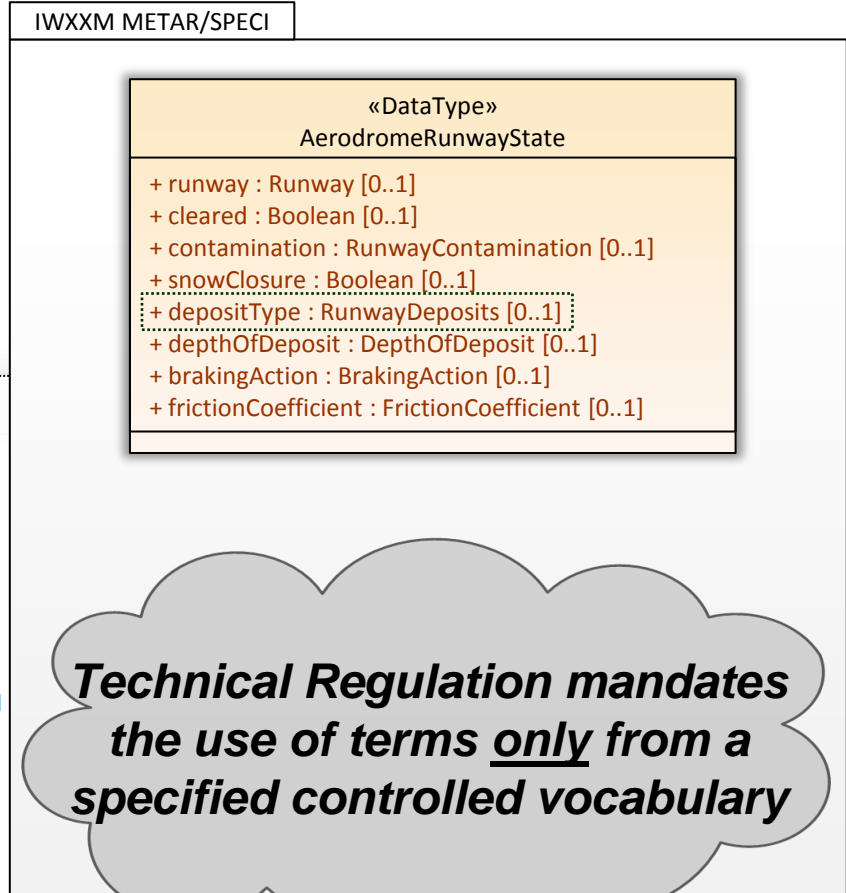
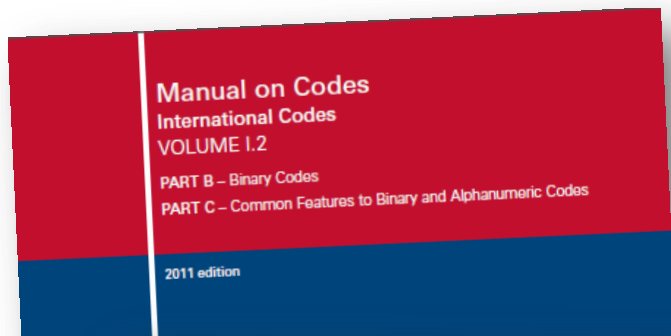
Conformance to  
Technical Regulation  
requires strong  
validation

« serialized as »

**IWXXM: ICAO Weather Information Exchange Model** 



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



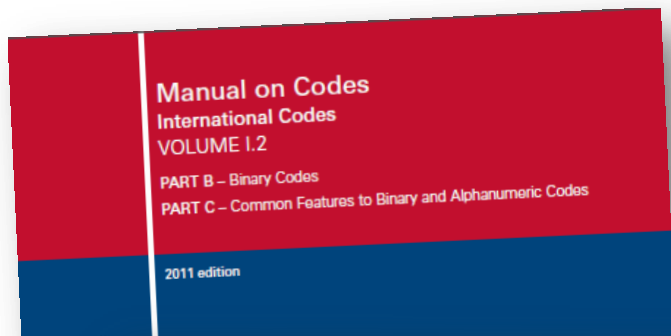
0 20 086  
Runway deposits

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

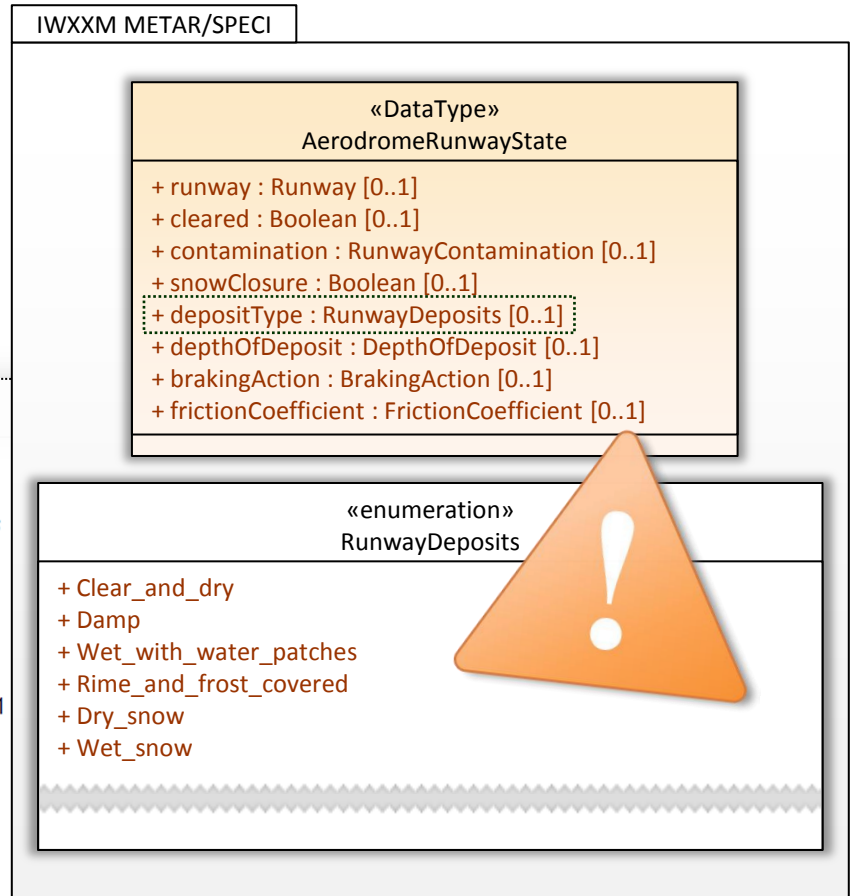


# Design choice: avoid use of «enumeration» entities (*fragile*)



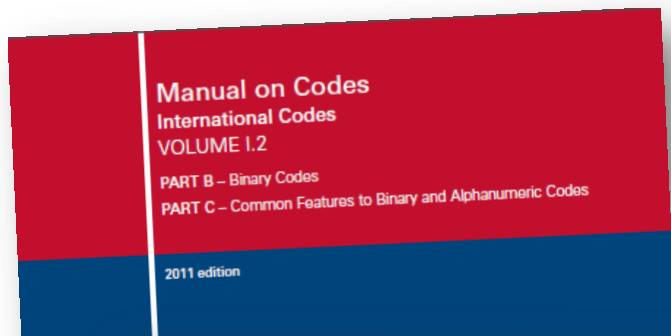
## 0 20 086 Runway deposits

Code figure	Description	Operational
0	Clear and dry	
1	Damp	
2	Wet with water patches	
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

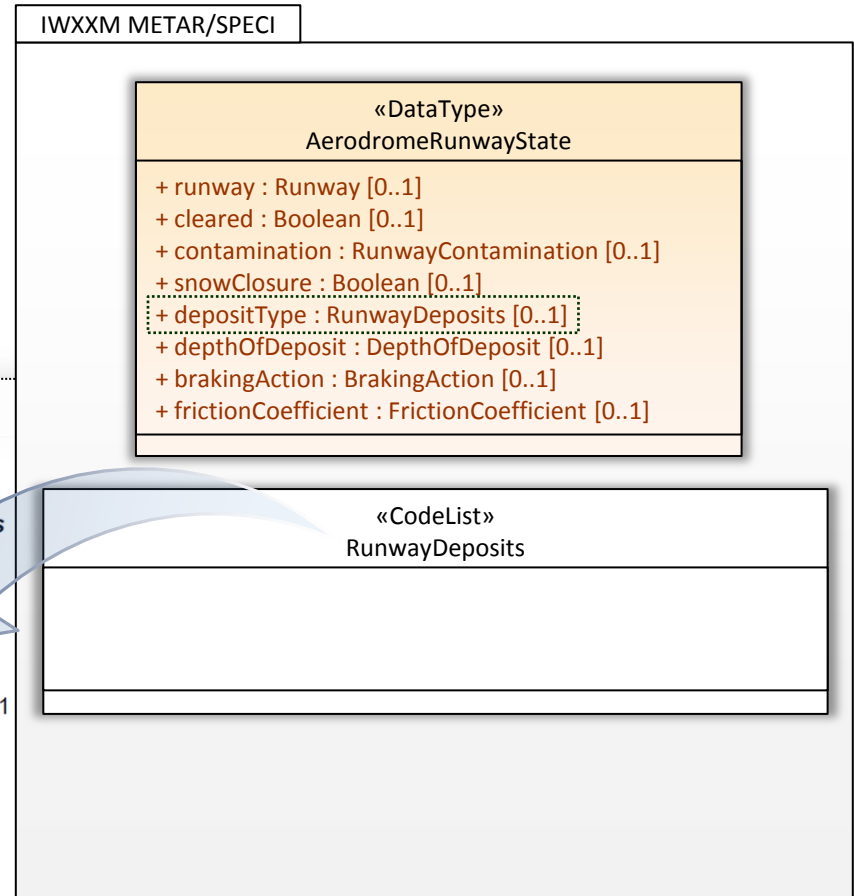
# Best practice: use «CodeList» class (*external reference*)



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

**0 20 086**  
*Runway deposits*

**«CodeList»**  
**RunwayDeposits**



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*

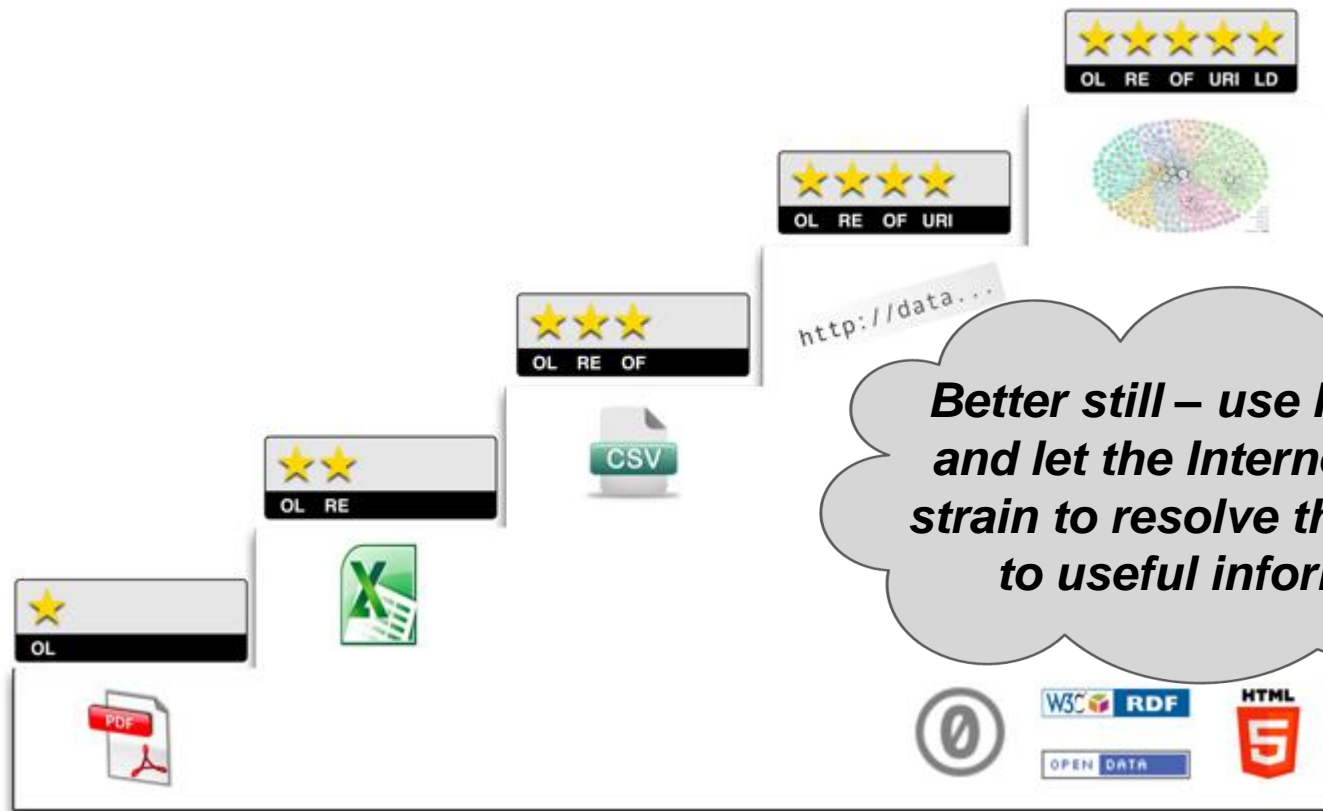
*GML requires use of XLINK for «CodeList» references; the Locator Attribute “href” must be a URI*



# 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





# HTTP URI – it's just an identifier!

404

This is not the  
web page you  
are looking for.



*A URI doesn't have to resolve  
to anything – but it's helpful if  
it does ...*

*Don't confuse a URI with a  
URL; operational systems not  
connected to the Internet can  
still use URIs as identifiers*



# 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 Firefox browser window displaying the WMO Codes Registry page for the entity 'Damp'. The browser 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 displays the following information:

- Entity: **Damp**
- URI: `http://codes.wmo.int/bufr4/codeflag/0-20-086/1`
- Type: `runwayDeposits`
- Description: *no description supplied*

A green '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' with the following details:

- submitted on: 25 Sep 2013 12:56:34.668
- submitted by: bootstrap

At the bottom right of the page, it says 'Developed by Epimorphics Ltd'.



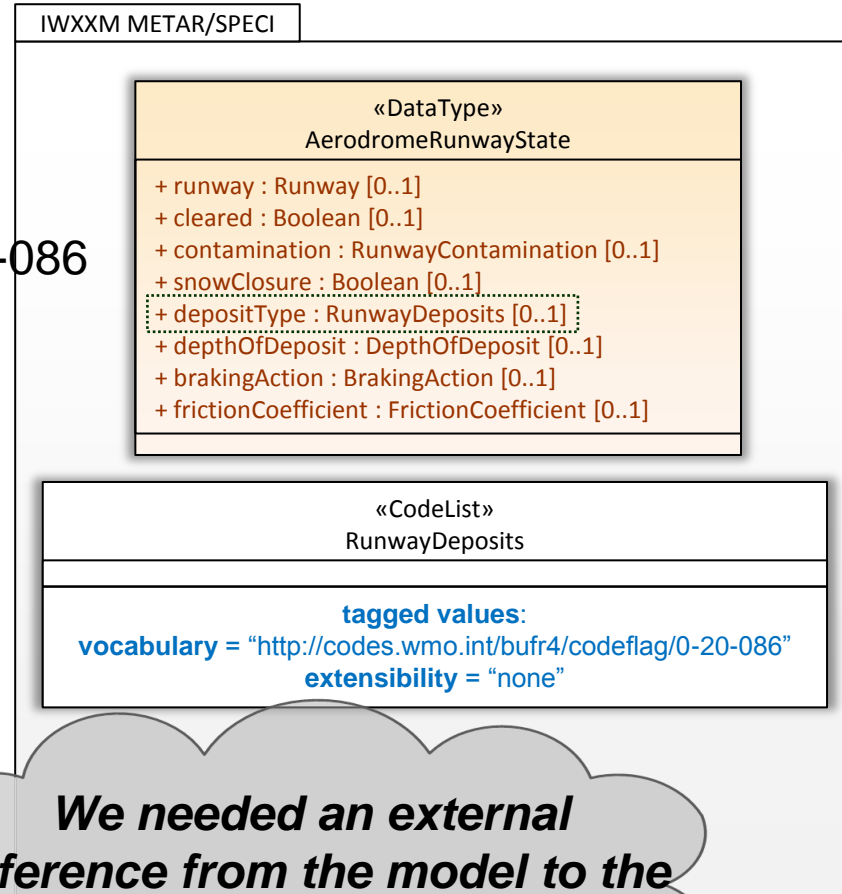
# Overview of WMO Codes Registry

- [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 ...

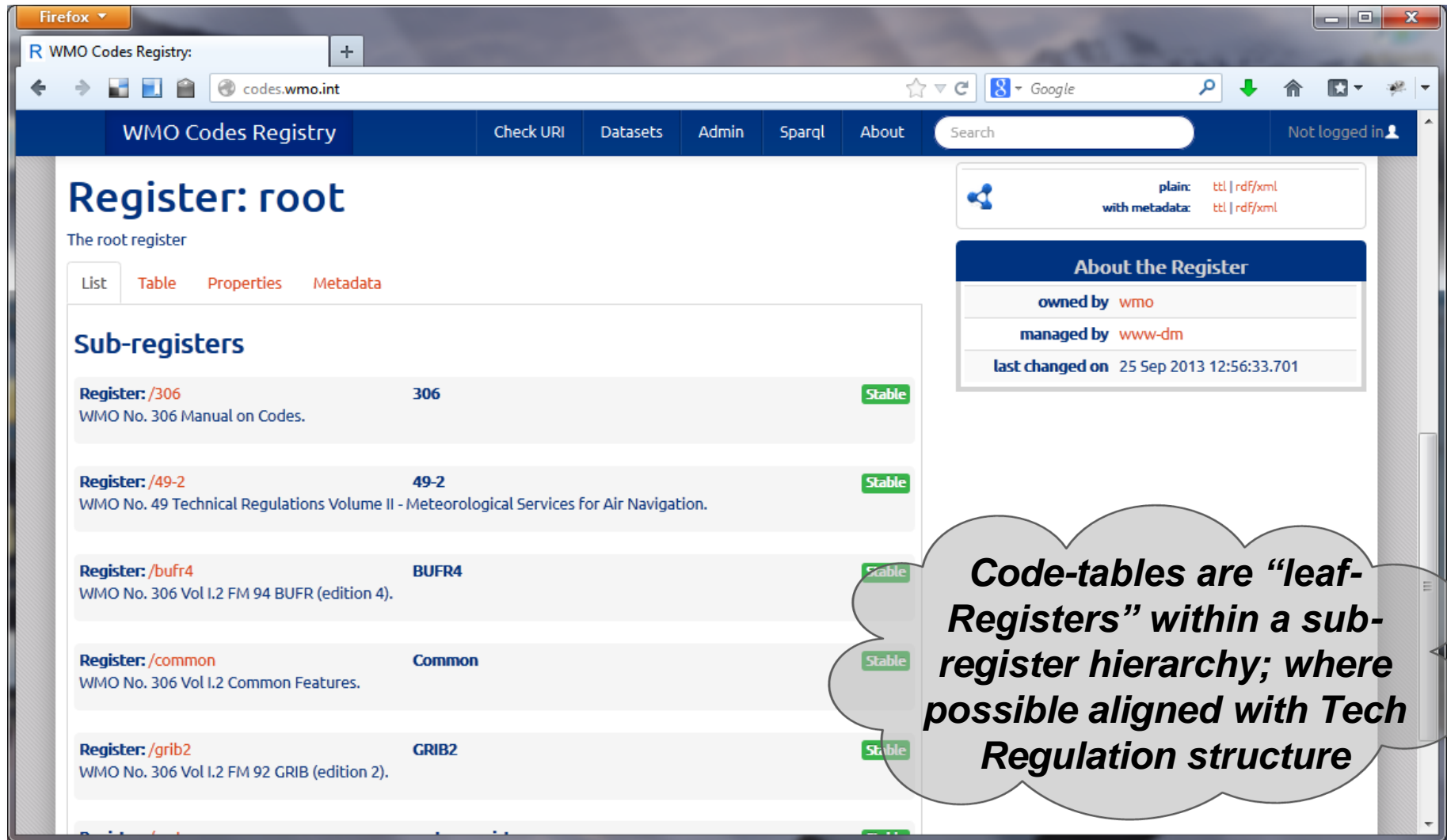
The screenshot shows a web browser window displaying the WMO Codes Registry page for 'Runway deposits'. The URL is `codes.wmo.int/bufr4/codeflag/0-20-086`. The page title is 'Register: Runway deposits' and it includes a 'Stable' badge. The main content is a table of items:

Item	Type	Stability
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

A callout bubble on the right side of the page contains the text: **Each code-table is published as a "Register"**



# Register hierarchy aligned with WMO Technical Regulation



The screenshot shows the WMO Codes Registry website in a Firefox browser. The page title is "Register: root" and it describes "The root register". There are tabs for "List", "Table", "Properties", and "Metadata". A list of sub-registers is displayed, each with a "Stable" status indicator. The sub-registers are:

Register ID	Code	Status
Register: /306	306	Stable
Register: /49-2	49-2	Stable
Register: /bufr4	BUFR4	Stable
Register: /common	Common	Stable
Register: /grib2	GRIB2	Stable

Additional information on the right side of the page includes:

- plain: ttl | rdf/xml
- with metadata: ttl | rdf/xml
- owned by: wmo
- managed by: www-dm
- last changed on: 25 Sep 2013 12:56:33.701

A callout bubble contains the text: **Code-tables are "leaf-Registers" within a sub-register hierarchy; where possible aligned with Tech Regulation structure**



# Answering the “membership” question: *is this a valid term?*

WMO Codes Registry

Check URI Datasets Admin Sparql About Search Not logged in

## Check whether a URI is registered

URI is registered:

Item	Register	Status
Damp	0-20-086	Stable

Developed by Epimorphics Ltd

*The Registry service provides a validation API (web browser-based & programmatic) to assess whether a specified term is a valid member of the code-table*

**[POST]** `http://codes.wmo.int/bufr4?`

`validate=http://codes.wmo.int/bufr4/codeflag/0-20-086/1`

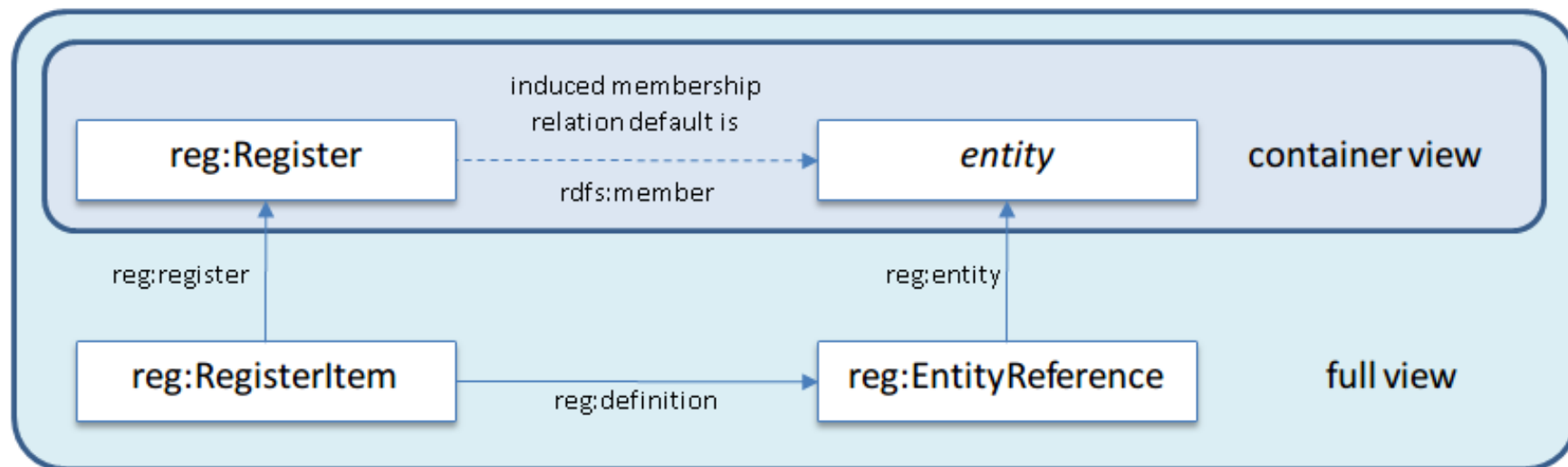
**[HTTP 200 OK]** `http://codes.wmo.int/bufr4/codeflag/0-20-086/1` is

`http://codes.wmo.int/bufr4/codeflag/0-20-086/_1`





# Sophisticated underpinning data model & simple views



- Data model derived from [ISO 19135 Procedures for item registration](#)
- RegisterItem: relates an *entity* to a specific Register – like the index-card in a library ...
- RegisterItem identifiers use a underscore “\_” syntax
- RegisterItem defines the status of an *entity* with respect to the Register
- Life cycle management of terms built in
- RegisterItems are versioned – enabling traversal through historical changes



## Current status and future plans

- [WMO Codes Registry](#) is available now!
- Web-application and RESTful API – both for READ and UPDATE operations
- Authentication via OpenID (Google); self-registration permitted – *only members of WMO Expert Team will be authorized to make changes*
- Current coverage of WMO No. 306 is sparse as initial objective is support for [IWXXM](#); commitment from WMO to expand coverage and add multilingual content
- Planned enhancements include:
  - support for offline operational systems (export & validation)
  - improvements to User Interface (less technical)
  - addition of 'back-catalogue' terms from previous versions of TDCF



## And finally ...

- We set out to support IWXXM ...
- But along the way, we have unlocked one of the best kept secrets of WMO – the code-tables which provide a definitive shared language for talking about weather, water and climate ...
- Although previously these were tightly bound into complex data format specifications, the concepts and terms defined in the code-tables can now be used by the everyone interested in meteorology – not just WMO members.
- We've made it easy for everyone to talk about the weather using consistent and unambiguous semantics.



**World  
Meteorological  
Organization**

Weather • Climate • Water

Thank you for your attention  
For further information please refer to the [User  
Guide](#), [FAQ](#) and [technical documentation](#)