WIGOS METADATA REPRESENTATION – SPECIFICATION OF DATA MODEL AND XML SCHEMA 1.0

Revision history

Date	Author	Comment
	Dominic Lowe	Initial version
2017-06-27	J. Klausen	documenting 1.0RC6
2017-07-05	J. Klausen	documenting attributes newly added to 1.0RC6
2017-08-23	J. Klausen	documenting in 6.1.5 the link between OM_Observation, Deployment and Equipment, as well as the grouping of OM_Observation in ObservingCapability
2017-09-25	J. Klausen	updated Figure 1; correction in 4.2.2; correction to section 8.7 Codelist 5-14
2017-10-23	J. Klausen	updated URLs in section 8.6
2017-12-06	J. Klausen	updated URL to 1.0RC7; included Frequencies; included element internationalExchange; re-formatted document to use multi-level numbering
2017-12-28	T. Kralidis	schema/editorial updates
2018-01-17	T. Kralidis	editorial updates
2018-06-06	J. Klausen	Updates for 1.0RC9, editorial changes
2018-10-03	T. Kralidis	editorial updates, schema referencing updates
2018-10-18	J. Klausen	Review and update of chapters 1-5
2018-10-19	J. Klausen	Review and update of chapters 6-9, references to schematron replaced with reference to OSCAR/Surface, because schematron is no longer maintained.
2018-10-25	J. Klausen	Handling of contact information and supervising organization in OSCAR/Surface described.
2018-10-29	J. Klausen	Cardinality of AbstractEnvironmentalMonitoringFacility/responsibleParty changed to 0..*
2018-10-30	J. Klausen	Cardinality of diurnalBaseTime changed to 0..1, TOC updated
2018-11-07	J. Klausen	Further refinement of 4.2.3.1 and 6.2.6 specification
2018-11-08	J. Klausen	Final correction of 4.2.3.1 (Contacts have no history in OSCAR/Surface), also correct Figure 1 inserted.
2018-12-07	J. Klausen	Cardinalities of several elements relaxed from 1 or 1..* to 0..1 or 0..*. Addition of a number of attributes that either are in the WMDS, are supported already by OSCAR/Surface, or were recommended by TT-WMD. Reference to the "Phases" 1, 2, 3 removed. Version 1.0 for approval.
2018-12-11	J. Klausen	Typo corrected

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1 OVERVIEW

1.1 Scope

1.1.1 This document provides guidance on how to use the WIGOS Metadata Data Representation (WMDR) XML Schema to create WIGOS metadata. The XML schema is generated from a UML model which builds on ISO TC211 conceptual models. Sections 2-7 of this document give an overview of the core concepts in the model. Section 8 gives an overview of the XML schema which is derived from the model.

1.1.2 WMDR implements concepts in the WIGOS Metadata Standard (WMO-No. 1192). Since WMDR re-uses defined types from existing ISO and OGC schemas there are some terminology differences between the WIGOS Metadata Standard and the WMDR.

1.1.3 For implementation purposes this document should be used in conjunction with the XML Schema at http://schemas.wmo.int/wmdr/1.0/wmdr.xsd, which defines the implementation of the WMDR. In the event of any discrepancy between this document and the schema, the schema should be assumed to be correct.

1.1.4 An HTML version of the data model in UML is available at http://schemas.wmo.int/wmdr/1.0/html.

1.1.5 WMDR describes observing facilities, observing equipment and observations made using these facilities and equipment. Observations in the WMDR model are conceptually based around the ISO 19156 Observations & Measurements (O&M) standard version 2.0, while bespoke types are used to describe observing facilities and equipment with sufficient detail to satisfy the WIGOS metadata standard. Bespoke types are also defined to describe the observing process in detail including aspects of deployment configuration, sampling, processing and reporting.

1.2 Normative Reference

1.2.1 In case this document differs from the documentation of the XML schema, the formal schema documentation takes precedence.

2 MODEL CONCEPTS – INTRODUCTION

2.1 Modelling approach

2.1.1 The WMDR model has been defined in UML (Unified Modelling Language) and defines 'classes' (either modeled as 'FeatureType' or 'DataType') for particular concepts in the WIGOS Metadata Standard.

2.1.2 A class-based approach is used to compartmentalise metadata about different aspects of the WIGOS Metadata Standard. For example, an observing facility is defined as a separate class to an observation from that facility.

2.1.3 The model is defined according to ISO 19109 Rules for Application Schema. The WMO Guide to Data Modelling (cf. http://wis.wmo.int/metce-uml) contains more information on this topic.

2.1.4 An XML Schema is auto-generated as a Geography Mark-up Language (GML) application schema from the UML model. This schema is the basis for implementation and data exchange.

3 MODEL CONCEPTS – WIGOS METADATA RECORD

3.1 WIGOSMetadataRecord

3.1.1 The WIGOSMetadataRecord is a container for WIGOS information for the purposes of packaging the information for delivery to, or transfer between, systems.

3.1.2 WIGOSMetadataRecord has the following properties:

Property	Cardinality	Type[1]	Property Description
headerInformation	1..1	Header	A header section must be included with every WIGOS MetadataRecord.
facilitySet	0..*	FacilitySet	A FacilitySet instance in this metadata record. The FacilitySet will simply consist of links to ObservingFacilities belonging to the set.
facility	0..*	ObservingFacility	An ObservingFacility instance in this metadata record.
observation	0..*	ObservingCapability	An ObservingCapability instance in this metadata record. An ObservingCapability is a container to group instances of OM_Observation.
deployment	0..*	Deployment	A Deployment instance in this record. Note that Deployments may also be encoded inline with the OM_Observation (as part of the Process).
equipment	0..*	Equipment	An Equipment instance in this metadata record.
facilityLog	0..*	FacilityLog	A FacilityLog instance in this metadata record. Note that an FacilityLog may also be encoded inline with the ObservingFacility instance.
equipmentLog	0..*	EquipmentLog	An EquipmentLog instance in this metadata record. Note that an EquipmentLog may also be encoded inline with the Equipment instance.
extension	0..*	Any	This extension point is to facilitate the encoding of any other information for complimentary or local purposes such as complying with legislative frameworks. However, it should not be expected that any extension information will be appropriately processed, stored or made retrievable from any WIGOS systems or services.

Table 1 Properties of WIGOSMetadataRecord

[1] For the XML schema implementation these model types are mapped to appropriate XML schema types. The schema should be examined to confirm the exact schema type used.

3.2 Header

3.2.1 Header contains meta information about a WIGOSMetadataRecord. This is metadata about the record used to facilitate transport or ingestion into a system such as OSCAR. The header does not contain any metadata about observations, only about the XML record.

3.2.2 Header has the following properties:

Property	Cardinality	Type	Property Description
fileDateTime	0..1	xs:dateTime	Date and time this file was last updated.
recordOwner	0..1	gmd:CI_Responsible Party	The organisation responsible for the metadata.
version	0..1	xs:int	The version of the XSD.

Table 2 Properties of Header

4 MODEL CONCEPTS – EQUIPMENT AND OBSERVING FACILITIES

4.1 Overview of Equipment and Observing Facilities

4.1.1 In WMDR the Equipment class describes any piece of equipment used for making observations – common terms for this are instrument, sensor, measuring device etc. WMDR uses Equipment as a generic name.

4.1.2 An ObservingFacility is a platform or station at (or from) which Equipment may be used or deployed. This may be a mobile or fixed platform.

4.1.3 It is important to note that Equipment and ObservingFacility are specified in WMDR independently of any observations that may be made using these things.

4.1.4 In WMDR the Equipment and ObservingFacility classes are both derived from the superclass 'AbstractEnvironmentalMonitoringFacility'.

4.1.5 Records of activity or events (e.g. maintenance, calibration, change events etc.) are captured using logs for the Equipment or ObservingFacility. Logs are defined using a separate class. See Section 5.2 on logs and log entries.

4.1.6 The diagram in Figure 1 shows the ObservingFacility and Equipment classes and the relationships between them. It can be seen that both classes inherit from the same base class AbstractEnvironmentalMonitoringFacility and thus inherit all the properties of AbstractEnvironmentalMonitoringFacility.

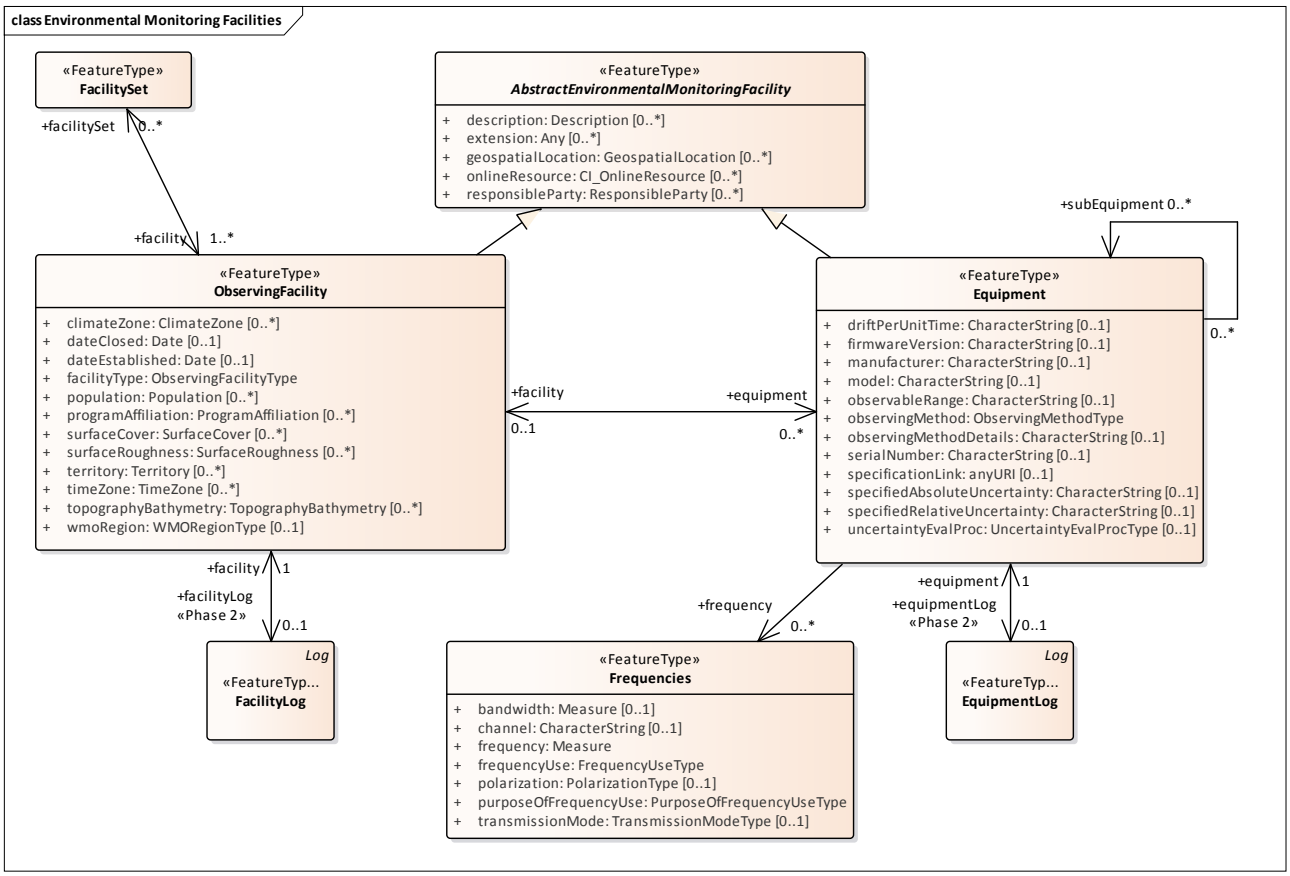

Figure 1 ObservingFacility and Equipment

4.2 AbstractEnvironmentalMonitoringFacility

4.2.1 An abstract class for environmental monitoring facilities. An environmental monitoring facility may be a station, a platform (moving or stationary), or it may be a sensor or an instrument. WIGOS defines two concrete specialisations: ObservingFacility (to represent stations/platforms) and Equipment (to represent sensors/instruments). NOTE: The WIGOS specialisations of AbstractEnvironmentalMonitoringFacility (ObservingFacility, Equipment) can both be mapped conceptually to the INSPIRE EF EnvironmentalMonitoringFacility

4.2.2 AbstractEnvironmentalMonitoringFacility has the following properties:

Property	Cardinality	Type	Property Description
responsibleParty	0..*	ResponsibleParty	9-01 Name of organization who owns the observation. [Phase 2] Cf. 4.2.3.1 <DataType> ResponsibleParty
geospatialLocation	0..*	GeospatialLocation	3-07 Position in space defining the location of the environmental monitoring station/platform at the time of observation. [Phase 1] 5-12 Geospatial location of instrument/sensor [Phase 2] Cf. 4.2.3.2 <DataType> GeospatialLocation
onlineResource	0..*	gmd:CI_OnlineResource	An online resource containing additional information about the facility or equipment.
description	0..1	Description	Further descriptive information [Phase 1].

Property	Cardinality	Type	Property Description
			Cf. 4.2.3.3 <DataType> Description
extension	0..*	Any	This extension point is to facilitate the encoding of any other information for complimentary or local purposes such as complying with legislative frameworks. However it should not be expected that any extension information will be appropriately processed, stored or made retrievable from any WIGOS systems or services. [Phase 1]

Table 3 Properties of AbstractEnvironmentalMonitoringFacility

4.2.3 The properties of AbstractEnvironmentalMonitoringFacility use the following DataTypes:

4.2.3.1 <DataType> ResponsibleParty

Property	Cardinality	Type	Property Description
responsibleParty	1..1	gmd:CI_ResponsibleParty	9-01 Supervising Organization. NB: In the current implementation of the OSCAR/Surface API, the element CI_ResponsibleParty is used to specify both, the Supervising Organization and any station contacts. If the corresponding role code of a CI_ResponsibleParty is “owner”, only the element CI_ResponsibleParty/organisationName will be considered and will be used to identify the Supervising Organization. Several instances can exist if the validPeriod is specified and if validPeriods are not overlapping, otherwise only the first occurrence will be used. If the corresponding role code of a CI_ResponsibleParty is “principalInvestigator”, all elements of CI_ResponsibleParty will be evaluated and used to identify and register or update a station contact as “Station Manager”. If more than one instance exists with this role code, they will all be rejected. If the corresponding role code of a CI_ResponsibleParty is “pointOfContact” or is not specified at all, all elements of CI_ResponsibleParty will be evaluated and used to identify and register or update a station contact without a specific station function. If such a station contact should be labeled as “Measurement Leader” for a specific observation, this function must be specified under om:metadata/MD_Metadata/contact (cf. 6.2.6). The element CI_ResponsibleParty/name must be specified as a comma-separated character string of [familyname], [firstname] [title], where at least [familyname] is required.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated responsibleParty. If omitted, the dateEstablished of the facility will be assumed.

Table 4. Properties of Description

4.2.3.2 <DataType> GeospatialLocation

4.2.3.2.1 A GeospatialLocation is a geospatial location accompanied by a timestamp and a geopositioningMethod indicating the time from which that location is considered to be valid. If known, an end time may also be provided. In WIGOS, an ObservingFacility or Equipment may carry multiple locations which are valid over different periods of time.

4.2.3.2.2 GeospatialLocation has the following properties:

Property	Cardinality	Type	Property Description
coordinateReferenceSystem	0..1	CoordinateReferenceSystemType	11-02 The WMDS support only one entry here at present, namely WSG84 EGM96 (2004)
geoLocation	1..1	GM_Object	3-07 Representative or conventional geospatial location of observing facility, the reference location. This will always be a point location, but this location can change with time. 5-12 Geospatial location of instrument or observing equipment, typically the location of the sensing element or sample inlet. This will always be a point location, but this location can change with time.
geopositioningMethod	0..1	GeopositioningMethodType	11-01 The method used to establish the specified geoLocation.
validPeriod	0..1	gml:TimePeriod	The time period for which this location is known to be valid. Normally, this will be specified as a "from" date, implying that the validity extends but does not include the next location on record.

Table 5 Properties of TimeStampedLocation

4.2.3.3 <DataType> Description

Property	Cardinality	Type	Property Description
description	1..1	CharacterString	Defined in ISO19103 Edition 1
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated description. If omitted, the dateEstablished of the facility will be assumed.

Table 6. Properties of Description

4.3 ObservingFacility

4.3.1 An ObservingFacility (station/platform) can be anything that supports making observations, e.g., a fixed station, a moving platform or a remote sensing platform. In abstract terms, an observing facility groups a near colocation of observing equipment managed by a single entity or several entities.

4.3.2 ObservingFacility has the following properties:

Property	Cardinality	Type	Property Description
facilitySet	0..*	gml:ReferenceType	4.3.2.1 Cf. 4.3.3.8 <DataType> TimeZone Property | Cardinality | Type | Prope timeZone | 1..1 | TimeZoneType | Time z codeli

Property	Cardinality	Type	Property Description
			validPeriod | 0..1 | gml:TimePeriod | Specifies at least the be omitted, the dateEstab

Table 15 Properties of TimeZone

4.3.2.2 <DataType> Population

Property	Cardinality	Type	Prope
population10km	0..1	Integer	Popul
population50km	0..1	Integer	Popul
validPeriod	0..1	gml:TimePeriod	Specif omitte

Table 16 Properties of Population

			FacilitySet
facilityType	1..1	ObservingFacilityTyp e	3-04 The type of the observing facility from the ObservingFacilityType codelist.
dateEstablished	0..1	Date	Date at which the observingFacility was established. Normally considered to be the date the first observations were made, but it can be some other, administrative date.
dateClosed	0..1	Date	Declares the date when the ObservingFacility was closed.
wmoRegion	0..1	WMORegionType	3-01 The WMO region the observing facility is located in, from the WMORegionType codelist.
timeZone	0..1	TimeZoneType	The time zone of an ObservingFacility, from the TimeZoneType codelist.
Territory	0..*	Territory	3-02 The territory the observing facility is located in, from the TerritoryType codelist. Cf. 4.3.3.1
programAffiliation	0..*	ProgramAffiliation	2-02 The global, regional or national program/network(s) that the station/platform is associated with. Cf. 4.3.3.2 <DataType> ProgramAffiliation
climateZone	0..1	ClimateZone	4-07 type of climate zone at the facility. From the ClimateZoneType codelist. Cf. 4.3.3.3 <DataType> ClimateZone
surfaceCover	0..1	SurfaceCover	4-01 The (bio)physical cover on the earth's surface in the vicinity of the observations from the LandCoverType codelist . NOTE: Only applies for surface-based (fixed) observing facilities. Cf. 4.3.3.4 <DataType> SurfaceCover
surfaceRoughness	0..1	SurfaceRoughness	4-06 surface roughness at the facility. From the SurfaceRoughnessType codelist.
facilityLog	0..1	FacilityLog	Cf. 5 MODEL CONCEPTS – LOGS AND LOG ENTRIES
topographyBathymetry	0..*	TopographyBathymetry	Cf. 4.3.3.6 <DataType> TopographyBathymetry
population	0..*	Population	Population within a radius of 10 km and 50 km around the ObservingFacility
observation	0..*	ObservingCapability	Container to group presumably homogenous time series of observations modelled as OM_Observation. Characterized by

Property	Cardinality	Type	Property Description
			observingFacility and observedProperty.
equipment	0..*	Equipment	Cf. 4.5 Equipment

Table 7 Properties of ObservingFacility

4.3.3 The properties of ObservingFacility use the following complex DataTypes:

4.3.3.1 <DataType> Territory

Property	Cardinality	Type	Property Description
territoryName	1..1	TerritoryType	3-02 The territory the observing facility is located in, from the TerritoryType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated territory. If omitted, the dateEstablished of the facility will be assumed.

Table 8 Properties of Territory

4.3.3.2 <DataType> ProgramAffiliation

Property	Cardinality	Type	Property Description
programAffiliation	1..1	ProgramAffiliationType	2-02 The global, regional or national program/network(s) that the station/platform is associated with.
programSpecificFacilityID	0..1	CharacterString	The identifier of the observing facility as used by the program/network.
reportingStatus	0..*	ReportingStatus	Cf. 4.3.3.7 ReportingStatus

Table 9 Properties of ProgramAffiliation

4.3.3.3 <DataType> ClimateZone

Property	Cardinality	Type	Property Description
climateZone	0..1	ClimateZoneType	4-07 type of climate zone at the facility. From the ClimateZoneType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated climateZone. If omitted, the dateEstablished of the facility will be assumed.

Table 10 Properties of ClimateZone

4.3.3.4 <DataType> SurfaceCover

Property	Cardinality	Type	Property Description
surfaceCover	1..1	SurfaceCoverType	4-01 The observed (bio)physical cover on the Earth's surface in the vicinity of the observation. From the SurfaceCoverType codelist.
surfaceCoverClassification	1..1	SurfaceCoverClassificationType	4-02 Name and reference or link to document describing the classification scheme. From the SurfaceCoverClassificationType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated surfaceCover. If omitted, the dateEstablished of the facility will be assumed.

Table 11 Properties of SurfaceCover

4.3.3.5 <DataType> SurfaceRoughness

Property	Cardinality	Type	Property Description

Property	Cardinality	Type	Property Description
surfaceRoughness	1..1	SurfaceRoughnessType	4-06 surface roughness at the facility. From the SurfaceRoughnessType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated surfaceRoughness. If omitted, the dateEstablished of the facility will be assumed.

Table 12 Properties of SurfaceRoughness

4.3.3.6 <DataType> TopographyBathymetry

Property	Cardinality	Type	Property Description
localTopography	0..1	LocalTopographyType	4-03 The local topography from the LocalTopographyType codelist.
relativeElevation	0..1	RelativeElevationType	4-03 The relative elevation from the RelativeElevationType codelist.
topographicContext	0..1	TopographicContextType	4-03 The topographic context from the TopographicContextType codelist.
altitudeOrDepth	0..1	AltitudeOrDepthType	4-03 The altitude/depth with respect to mean sea level from the AltitudeOrDepthTypeCodelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated surfaceRoughness. If omitted, the dateEstablished of the facility will be assumed.

Table 13 Properties of TopographyBathymetry

4.3.3.7 <DataType> ReportingStatus

Property	Cardinality	Type	Property Description
reportingStatus	1..1	ReportingStatusType	3-09 Declared reporting status of an observing facility with respect to a certain program/network affiliation. From the ReportingStatusType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated ReportingStatus. If omitted, the dateEstablished of the facility will be assumed.

Table 14 Properties of ReportingStatus

4.3.3.8 <DataType> TimeZone

Property	Cardinality	Type	Property Description
timeZone	1..1	TimeZoneType	Time zone of the ObservingFacility, from the TimeZoneType codelist.
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated TimeZone. If omitted, the dateEstablished of the facility will be assumed.

Table 15 Properties of TimeZone

4.3.3.9 <DataType> Population

Property	Cardinality	Type	Property Description
population10km	0..1	Integer	Population within a 10 km radius of the ObservingFacility
population50km	0..1	Integer	Population within a 10 km radius of the ObservingFacility
validPeriod	0..1	gml:TimePeriod	Specifies at least the begin date of the indicated Population. If omitted, the dateEstablished of the facility will be assumed.

Table 16 Properties of Population

4.4 FacilitySet

4.4.1 A set of observing facilities may be defined as a set by using a FacilitySet. Association (grouping) criteria can vary and maybe program/network specific. Examples: In GAW, some Global stations consist of several distinct observing facilities; The NASA A-Train may be considered a FacilitySet comprised of several individual satellites.

4.4.2 FacilitySet has the following properties:

Property	Cardinality	Type	Property Description
facility	1..*	ObservingFacility	An ObservingFacility that belongs to this set. Cf. 4.3 ObservingFacility

Table 17 Properties of FacilitySet

4.5 Equipment

4.5.1 The Equipment class describes the equipment used to make observations. Since WIGOS is broad in scope Equipment may be anything from a single sensor to a complex multi-sensor device. Equipment may also have sub-equipment.

4.5.2 Equipment has the following properties:

Property	Cardinality	Type	Property Description
facility	1..*	ObservingFacility	An ObservingFacility to which Equipment belongs. Cf. 4.3 ObservingFacility
manufacturer	0..1	CharacterString	5-09 Manufacturer of the equipment
model	0..1	CharacterString	5-09 Model number of the equipment
firmwareVersion	0..1	CharacterString	5-09 Firmware version of the equipment
serialNumber	0..1	CharacterString	5-09 Serial number of the equipment
observingMethod	1..1	ObservingMethodType	5-02 The method of measurement/observation used from the ObservingMethodType codelist.
observingMethodDetails	0..1	CharacterString	5-02 A description of the method of measurement/observation used from the ObservingMethodType codelist.
observableRange	0..1	CharacterString	5-03 Intrinsic capability of the measurement/observing method - range
specifiedAbsoluteUncertainty	0..1	CharacterString	5-03 Intrinsic capability of the measurement/observing method - specified absolute uncertainty e.g. 0.2 deg C (k=2).
specifiedRelativeUncertainty	0..1	CharacterString	5-03 Intrinsic capability of the measurement/observing method - specified relative uncertainty. Typically a percentage.
uncertaintyEvalProc	0..1	UncertaintyEvalProcType	8-02 Procedure used to establish the specified uncertainties.
driftPerUnitTime	0..1	CharacterString	5-03 Intrinsic capability of the measurement/observing method – drift per unit time. Typically a percentage per unit time but could be absolute e.g. 1 degree per year.
specificationLink	0..1	URI	5-03 Link to manufacturers (or other) specification describing the equipment.

Property	Cardinality	Type	Property Description
Frequency	0..*	Frequencies	Cf. 4.6 Frequencies
equipmentLog	0..*	EquipmentLog	Cf. 5.2 Log
subEquipment	0..*	Equipment	Used to describe subEquipment of Equipment, e.g. coupled instruments can be described as subEquipment of the whole.

Table 18 Properties of Equipment

4.6 Frequencies

4.6.1 The Frequencies class describes the frequencies that may be used by a piece of equipment. It is an optional FeatureType that can be considered to be part of WIGOS Metadata Standard category 5-03 Instrument specifications. This is a proxy for several more specific elements as detailed in the table below.

4.6.2 Equipment may use frequencies to make observations or to transmit data using an over-the-air link. For observations, equipment may use frequencies actively (transmit) or passively (receive).

4.6.3 Frequencies has the following properties:

Property	Cardinality	Type	Property Description
frequency	1	gml:Measure	The nominal frequency used by equipment. The attribute uom is expected to provide one of Hz, kHz, MHz, GHz, THz
bandwidth	0..1	Decimal	The difference of the highest and the lowest frequency, or more specifically, the full-width at half-maximum (FWHM). The attribute uom is expected to provide one of Hz, kHz, MHz, GHz, THz
purposeOfFrequencyUse	1	PurposeOfFrequencyUseType	PurposeOfFrequencyUseType uses values (observation, telecomms).
frequencyUse	1	FrequencyUseType	Expected values are: Transmit, Receive, TransmitReceive
transmissionMode	0..1	TransmissionModeType	Expected values are: pulsed, continuous-wave Use conditional on frequencyUse = Transmit

Table 19 Properties of Equipment

5 MODEL CONCEPTS – LOGS AND LOG ENTRIES

5.1.1 The FacilityLog and EquipmentLog classes are both derived from an abstract Log class as shown in the following diagram. Each log contains log entries recording details about the changes (like a real-world log). There are different types of log entries for different purposes. These log entries are also derived from a common base class, LogEntry.

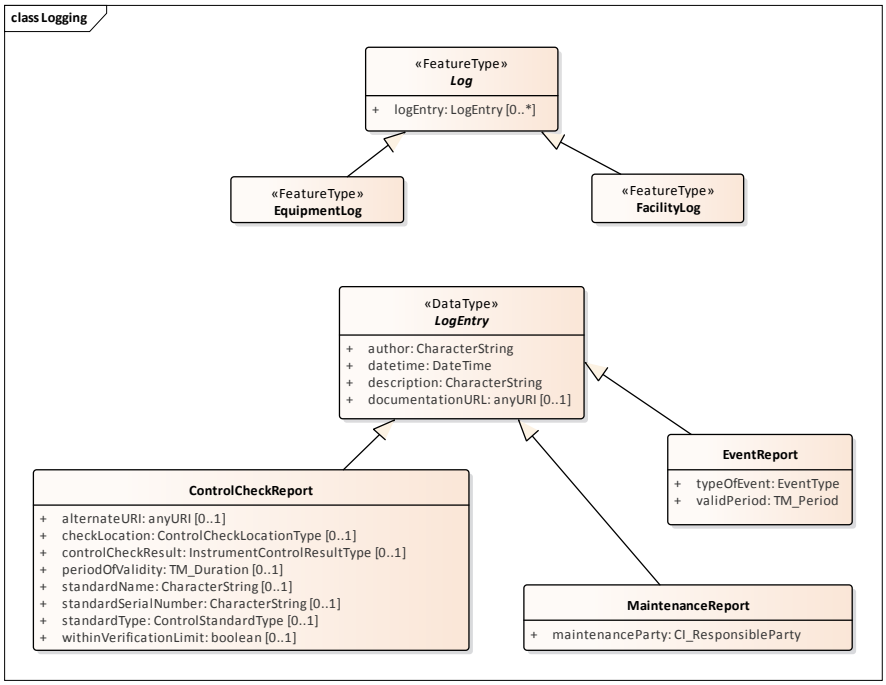

Figure 2 Log and LogEntry model

5.1.2 A ControlCheckReport describes a log entry for a calibration check. A ControlCheckReport is related to a particular Equipment instance.

5.1.3 A MaintenanceReport describes a log entry for a maintenance activity. A MaintenanceReport is related to a particular Equipment instance.

5.1.4 An EventReport describes a log entry for an event at a station/facility. An EventReport is related to a particular ObservingFacility instance.

5.2 Log

5.2.1 Conceptually a log is simply a record of log entries. The requirements for a log may depend on the type of log. Therefore specialized logs exist for specific types of log (such as ControlCheckReports, MaintenanceReports and EventReports).

5.2.2 Log has the following properties:

Property	Cardinality	Type	Property Description
logEntry	0..*	LogEntry [abstract]	An entry in a Log.

Table 20 Properties of Log

5.2.3 It should be noted that the LogEntry type is abstract. Therefore only concrete sub-classes of LogEntry can be used to satisfy the logEntry property.

5.3 LogEntry

5.3.1 At the abstract level a LogEntry contains the time, author and descriptions of the activity or event being logged. This class is specialized further to provide more specific log entry types where needed.

5.3.2 LogEntry has the following properties:

Property	Cardinality	Type	Property Description
datetime	1..1	DateTime	Date and time of the event being logged
author	1..1	CharacterString	Author of the log entry.
description	1..1	CharacterString	Description of the log entry
documentationURL	0..*	URI	Link to additional documents, photos etc. about the event being logged.

Table 21 Properties of LogEntry

5.4 EquipmentLog

5.4.1 The EquipmentLog is a log used to capture notable events and extra information about the equipment used to obtain the observations, such as actual maintenance performed on the instrument

5.4.2 EquipmentLog has no properties beyond those defined in Log. It merely implements Log as a concrete class.

5.4.3 The logEntry properties of a EquipmentLog are described using ControlCheckReport and/or MaintenanceReport.

5.5 ControlCheckReport

5.5.1 A ControlCheckReport is a log entry in an EquipmentLog describing a calibration type event. E.g. an instrument was re-calibrated.

5.5.2 ControlCheckReport has the following properties, in addition to the properties of LogEntry:

Property	Cardinality	Type	Property Description
checkLocation	0..1	ControlCheckLocationType	5-08 Location of sensor when check was performed (e.g. in-situ, offsite etc.) From codelist ControlCheckLocationType.
periodOfValidity	0..1	TM_Duration	5-08 period of validity of the control check (e.g. 4 years)
controlCheckResult	0..1	InstrumentControlResultType	5-08 Result of the control check, from InstrumentControlResultType codelist
standardType	0..1	ControlStandardType	5-08 Type of the Standard used. From the StandardType code list.
standardName	0..1	CharacterString	5-08 Nameof the Standard used.
standardSerialNumb	0..1	CharacterString	5-08 Serial Number of the standard used.

er			
withinVerificationLimit	0..1	boolean	5-08 Was the instrument found to be within verification limits (True if yes, False if no)
alternateURI	0..1	URI	5-08 Alternatively the summary of the control check may be provided via a URI that resolves to a document containing this information.

Table 22 Properties of ControlCheckReport

5.6 MaintenanceReport

5.6.1 A MaintenanceReport is a log entry in an EquipmentLog describing maintenance (actual, not a schedule) performed on Equipment.

5.6.2 MaintenanceReport has the following properties, in addition to the properties of LogEntry:

Property	Cardinality	Type	Property Description
maintenanceParty	1..1	CI_ResponsibleParty	5-11 Details of who performed the maintenance.

Table 23 Properties of MaintenanceReport

5.7 FacilityLog

5.7.1 The FacilityLog is used to capture notable events and extra information about the observing facility or its surroundings such as facility maintenance (e.g. tree removal) or other events that might impact the observations.

5.7.2 FacilityLog has no properties beyond those defined in Log. It merely implements Log as a concrete class.

5.7.3 The logEntry properties of a FacilityLog are described using EventReport.

5.8 EventReport

5.8.1 An EventReport is a logEntry in a FacilityLog used to describe events at a facility.

5.8.2 EventReport has the following properties, in addition to the properties of LogEntry:

Property	Cardinality	Type	Property Description
typeOfEvent	1..1	EventType	The type of event, taken from the EventType codelist (e.g. tree removal, storm damage etc).
validPeriod	1..1	gml:TimePeriod	Specifies the üeriod of the event described.

Table 24 Properties of EventReport

6 MODEL CONCEPTS – OBSERVATIONS

6.1 Application of ISO 19156 Observations and Measurements to describe Observations

6.1.1 ISO 19156 Observations and Measurements is a conceptual model commonly known as *O&M*. The O&M standard is also freely available from the Open Geospatial Consortium where it is known as "OGC Abstract Specification – Topic 20" (http://portal.opengeospatial.org/files/?artifact_id=41579).

6.1.2 In addition to the conceptual model there is a companion OGC specification describing an XML implementation of O&M that is provided in the OGC specification "Observations & Measurements – XML Implementation" (http://portal.opengeospatial.org/files/?artifact_id=41510). This is referred to as OMXML. The XML schema for this implementation is here: http://schemas.opengis.net/om/2.0/

6.1.3 An understanding of O&M will help greatly in understanding the WMDR specification. Some detail is given in this document but it is recommended to read the specification. There is also a useful overview here (https://www.seegrid.csiro.au/wiki/AppSchemas/ObservationsAndSampling, retrieved January 2017)

6.1.4 The core of the O&M model is the OM_Observation class. An OM_Observation describes an event using a procedure, the result of which is an estimation of a value of some feature of interest. This framework is applied here to document WIGOS metadata.

6.1.5 In the context of WIGOS we assume that the OM_Observation event is the monitoring of some meteorological property using a Deployment of some Equipment. This will normally take place over a time period (possibly a very long time period), and the result of this event will be a time series of (ideally homogenous) data. One or several instances of OM_Observation may be grouped into an ObservingCapability used to describe the record of observations of a particular quantity from an observing facility. This is an important point as one common meteorological use of the term 'observation' applies to a single observation at an instant (or very short period) of time, so this semantic difference should be understood.

6.1.6 As another point of semantics: WIGOS metadata is not the same metadata as ISO19115 or WIS metadata. WIGOS metadata is detailed metadata about observations while WIS metadata is metadata about products.

6.1.7 OM_Observation is essentially a framework around which WIGOS metadata can be attached.

6.2 OM_Observation

6.2.1 *The following text is taken verbatim from the ISO 19156 standard:* "An observation is 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. The procedure may be applied in-situ, remotely, or ex-situ with respect to the sampling location. Use of a common model allows observation data using different procedures to be combined unambiguously. Observation details are also important for data discovery and for data quality estimation. Observation feature types are defined by the properties that support these applications."

6.2.2 *The following text is taken verbatim from the ISO 19156 standard: "*An observation is an act associated with a discrete time instant or period through which a number, term or other symbol is assigned to a phenomenon. The result of an observation is an estimate of the value of a property of some feature, so the details of the observation are metadata concerning the value of the feature property. The observation itself is also a feature, since it has properties and identity."

6.2.3 The following table shows the properties of OM_Observation as defined in OGC and ISO 19156:2011(E). References in parentheses refer to that document.

Property	Cardinality	Type	Property Description
phenomenonTime	1..1	TM_Object	The attribute phenomenonTime:TM_Object shall describe the time that the result (7.2.2.9) applies to the property of the feature-of-interest (7.2.2.7). This is often the time of interaction by a sampling procedure (9.1.3) or observation procedure (7.2.2.10) with a real-world feature. NOTE 1 The phenomenon time is the temporal parameter normally used in geospatial analysis of the result. NOTE 2 If the observedProperty of an observation is 'occurrence time' then the result should be the same as the phenomenonTime
resultTime	1..1	TM_Instant	The attribute resultTime:TM_Instant shall describe the time when the result became available, typically when the procedure (7.2.2.10) associated with the observation was completed For some observations this is identical to the phenomenonTime. However, there are important cases where they differ. EXAMPLE 1 Where a measurement is made on a specimen in a laboratory, the phenomenonTime is the time the specimen was retrieved from its host, while the resultTime is the time the laboratory procedure was applied. EXAMPLE 2 The resultTime also supports disambiguation of repeat measurements made of the same property of a feature using the same procedure. EXAMPLE 3 Where sensor observation results are post-processed, the resultTime is the post-processing time, while the phenomenonTime is the time of initial interaction with the world. EXAMPLE 4 Simulations may be used to estimate the values for phenomena in the future or past. The phenomenonTime is the time that the result applies to, while the resultTime is the time that the simulation was executed.
validTime	0..1	TM_Period	If present, the attribute validTime:TM_Period shall describe the time period during which the result is intended to be used. NOTE This attribute is commonly required in forecasting applications.
resultQuality	0..*	DQ_Element	If present, the attribute resultQuality:DQ_Element shall describe

Property	Cardinality	Type	Property Description
			the quality of the result (7.2.2.9). This instance-specific description complements the description of the observation procedure (7.2.2.10), which provides information concerning the quality of all observations using this procedure. Quality of a result may be assessed following the procedures in ISO 19114:2003. Multiple measures may be provided (ISO/TS 19138:2006).
parameter	0..*	NamedValue	If present, the attributes parameter:NamedValue shall describe an arbitrary event-specific parameter. This might be an environmental parameter, an instrument setting or input, or an event-specific sampling parameter that is not tightly bound to either the feature-of-interest (7.2.2.7) or to the observation procedure (7.2.2.10). To avoid ambiguity, there shall be no more than one parameter with the same name. NOTE Parameters that are tightly bound to the procedure may be recorded as part of the procedure description. In some contexts the Observation::procedure (7.2.2.10) is a generic or standard procedure, rather than an event-specific process. In this context, parameters bound to the observation act, such as instrument settings, calibrations or inputs, local position, detection limits, asset identifier, operator, may augment the description of a standard procedure. EXAMPLE A time sequence of observations of water quality in a well may be made at variable depths within the well. While these may be associated with specimens taken from the well at this depth as the features-of-interest, a more common approach is to identify the well itself as the feature-of-interest, and add a “samplingDepth” parameter to the observation (Figure 3). The sampling depth is of secondary interest compared to the temporal variation of water quality at the site.
Procedure	1..1	OM_Process	The association ProcessUsed shall link the OM_Observation to the OM_Process (7.2.3) used to generate the result. The process has the role procedure with respect to the observation. A process might be responsible for more than one generatedObservation. The OM_Process shall be suitable for the observed property. As a corollary, details of the observed property are constrained by the procedure used. EXAMPLE Observed radiance wavelength is determined by the response characteristics of the sensor. A description of the observation procedure provides or implies an indication of the reliability or quality of the observation result.
featureOfInterest	1..1	GFI_Feature	The association Domain shall link the OM_Observation to the GFI_Feature (B.2.1) that is the subject of the observation and carries the observed property. This feature has the role featureOfInterest with respect to the observation. This feature is the real-world object whose properties are under observation, or is a feature intended to sample the real-world object, as described in Clause 8 of this standard. An observation instance serves as a propertyValueProvider for its feature of interest.
Result	1..1	Any	The association Range shall link the OM_Observation to the value generated by the procedure.The value has the role result with respect to the observation. The type of the result is shown as Any, since it may represent the value of any feature property. NOTE OGC SWE Common provides a model suitable for describing many kinds of observation results.

Property	Cardinality	Type	Property Description
			The type of the observation result shall be consistent with the observed property, and the scale or scope for the value shall be consistent with the quantity or category type. If the observed property (7.2.2.8) is a spatial operation or function, the type of the result may be a coverage, NOTE In some contexts, particularly in earth and environmental sciences, the term "observation" is used to refer to the result itself.
observedProperty	1..1	GF_PropertyType	The association Phenomenon shall link the OM_Observation to the GFI_PropertyType (B.2.2) for which the OM_Observation:result (7.2.2.9) provides an estimate of its value. The property type has the role observedProperty with respect to the observation. The observed property shall be a phenomenon associated with the type of the featureOfInterest. NOTE An observed property may, but need not be modelled as a property (in the sense of the General Feature Model) in a formal application schema that defines the type of the feature of interest The observed property supports semantic or thematic classification of observations, which is useful for discovery and data fusion.
Metadata	0..1	MD_Metadata	If present, the association Metadata shall link the OM_Observation to descriptive metadata.
relatedObservation	0..*	OM_Observation	Some observations depend on other observations to provide context which is important, sometimes essential, in understanding the result. These dependencies are stronger than mere spatio-temporal coincidences, requiring explicit representation. If present, the association class class ObservationContext (Figure 2) shall link a OM_Observation to another OM_Observation, with the role name relatedObservation for the target. It shall support one attribute. EXAMPLES Some examples include the conditions associated with experimental replicates (e.g., experimental plots and treatments used), biotic factors (e.g., ecological community), interactions among features (e.g., predator-prey), or other temporary relationships occurring at the time of observation that are are not inherent to the observed features themselves (i.e., they change over time), or the related observation may provide input to a process that generates a new result. This association complements the Intention association which describes relationships between a sampling feature and domain features.

Table 25 Properties of OM_Observation (from OGC and ISO 19156:2011(E))

6.2.4 It can be seen from the definitions in Table 25 that the O&M model is a very general model which seeks to be useful for many different applications. In order to apply O&M to WIGOS metadata we need to consider how to use it in this context and to define concrete types where there are none in O&M. E.g. for the O&M procedure the value type OM_Process is an abstract class so requires a concrete implementation.

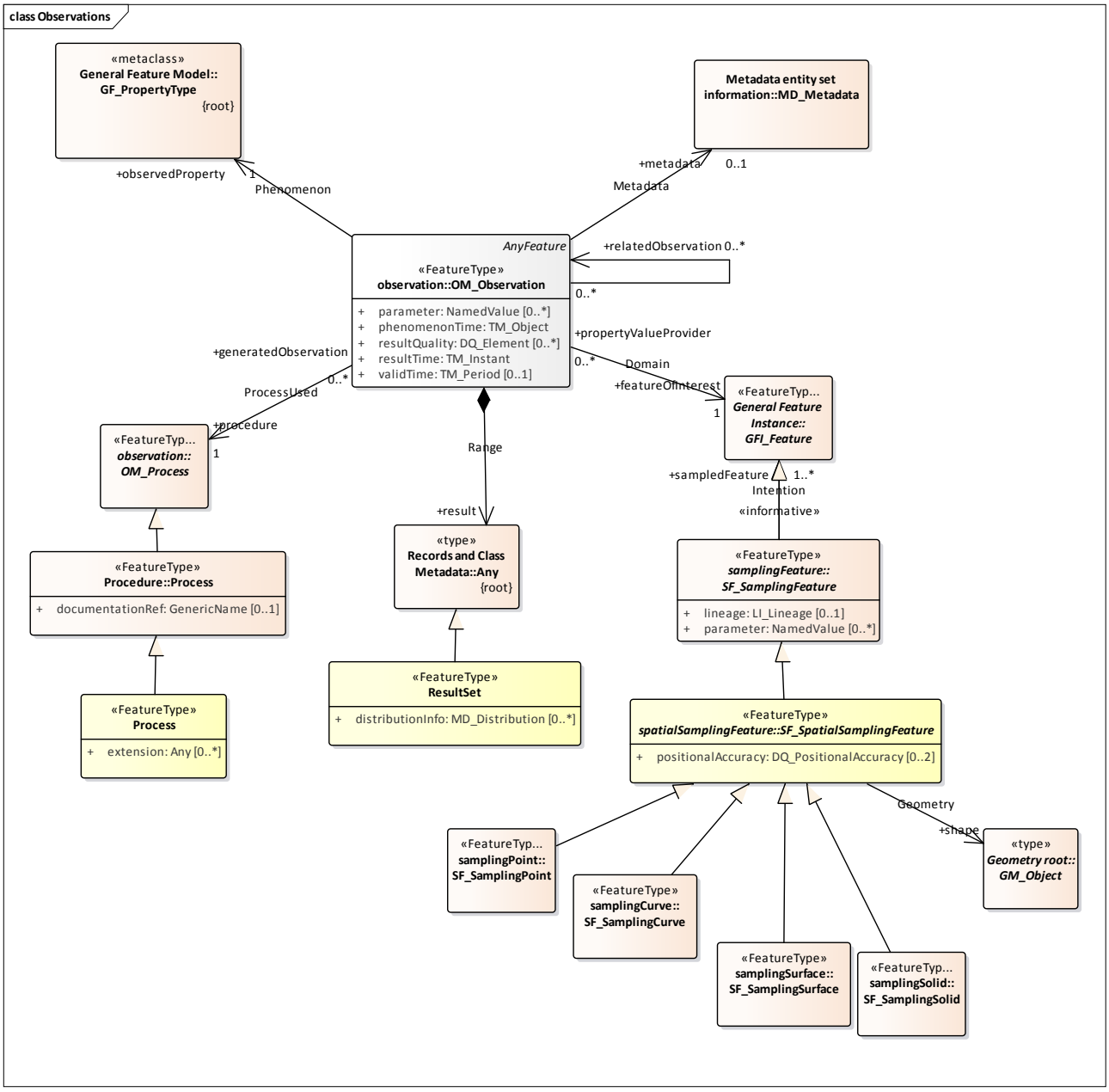

Figure 3 The profiling of O&M in WMDR

6.2.5 The figure above and the table below describe a pattern for how WMDR types fit into the O&M model. Not all O&M properties are used.

OM_Observation properties	Purpose	Expected WMDR content	Notes
om:metadata	A reference to a 19115 metadata record	Shall be an xlink:href attribute where the value is a link to an appropriate WIS record. e.g. <om:metadata xlink:href=http://link.to.wis.record/ >	This provides an important link from observations to the WIS.
om:phenomenonTime	The time period over which the property is observed.	Shall be a gml:TimePeriod element describing the start and end date/time of the observation event.	This time period may be many days, months or years in the case of long term observation records.
om:procedure	The wmdr Process describes the procedure used in observing and carries the additional concepts of Deployment, Sampling, Processing and Reporting	Shall be a wmdr:Process element, containing sub-elements for Deployment, Sampling, Processing and Reporting as per the WMDR schema.	A great number of the WIGOS metadata elements are contained in the Process class and the associated classes of Deployment, Sampling, Processing, Reporting. [See also the section in this document on wmdr:Process]
om:featureOfInterest	The thing being observed. In WMDR we use Spatial Sampling Features (ISO 19156) as proxy features for real world features.[2]	sams:SF_SpatialSamplingFeature	A spatial sampling feature shall be used to describe the geographic extent of the observation. The 'shape' property of the spatial sampling feature describes the geographic extent of the feature. The 'role' property shall point to the appropriate WMO geometry definition.
om:result	The final result (output) of the observation.	A WMDR ResultSet which contains one or more links to data resources	Links shall be provided to the most relevant data resource for this observation (may be to a data service)
om:observedProperty	The property being observed (e.g. air temperature)	This shall be a link to a value from the controlled list at http://codes.wmo.int	1-01 Observed Variable
om:resultTime	The time at which the observation became available	gml:TimeInstant	This describes when the information was made available, not when the observation occurs.

Table 26 O&M Properties as applied in WMDR

[2] For example: to measure atmospheric temperature, we do not measure the entire atmosphere (the ultimate feature of interest) but we sample the temperature at a sampling point or sampling profile. These sampling features (point locations, profiles) are known as Spatial Sampling Features in 19156. The spatial sampling feature may be at the same location as the equipment or it may be remote from the equipment.

6.2.6 The om:metadata link to MD_Metadata is intended to assign a single contact to the OSCAR/Surface function “Measurement Leader”. For this, the role code “principalInvestigator” must be specified. The contact must already exist and will be identified by element contact/…/CI_Address/electronicMailAddress or by element CI_ResponsibleParty/name, specified as a comma-separated character string of [familyname], [firstname] [title], where at least [familyname] is required. If the contact does not yet exist, it can be specified as a station contact under ObservingFacility/responsibleParty (cf. 4.2.3.1 <DataType> ResponsibleParty).

7 MODEL CONCEPTS – PROCESS

7.1 Process

7.1.1 The Process contains details of the observing process used in the observation and forms a major part of the WMDR. The Process class is the entry point to several related classes, including Deployment, Sampling, Processing and Reporting all of which can be collectively considered to describe the process used to make observations.

7.1.2 Process has the following properties:

Property	Cardinality	Type	Property Description
extension	0..*	Any	This extension point is to facilitate the encoding of any other information for complimentary or local purposes such as complying with legislative frameworks. However it should not be expected that any extension information will be appropriately processed, stored or made retrievable from any WIGOS systems or services.
Deployment	1..1	Deployment	The deployment(s) describe which equipment is deployed, during which time period, and in which configuration.

Table 27 Properties of Process

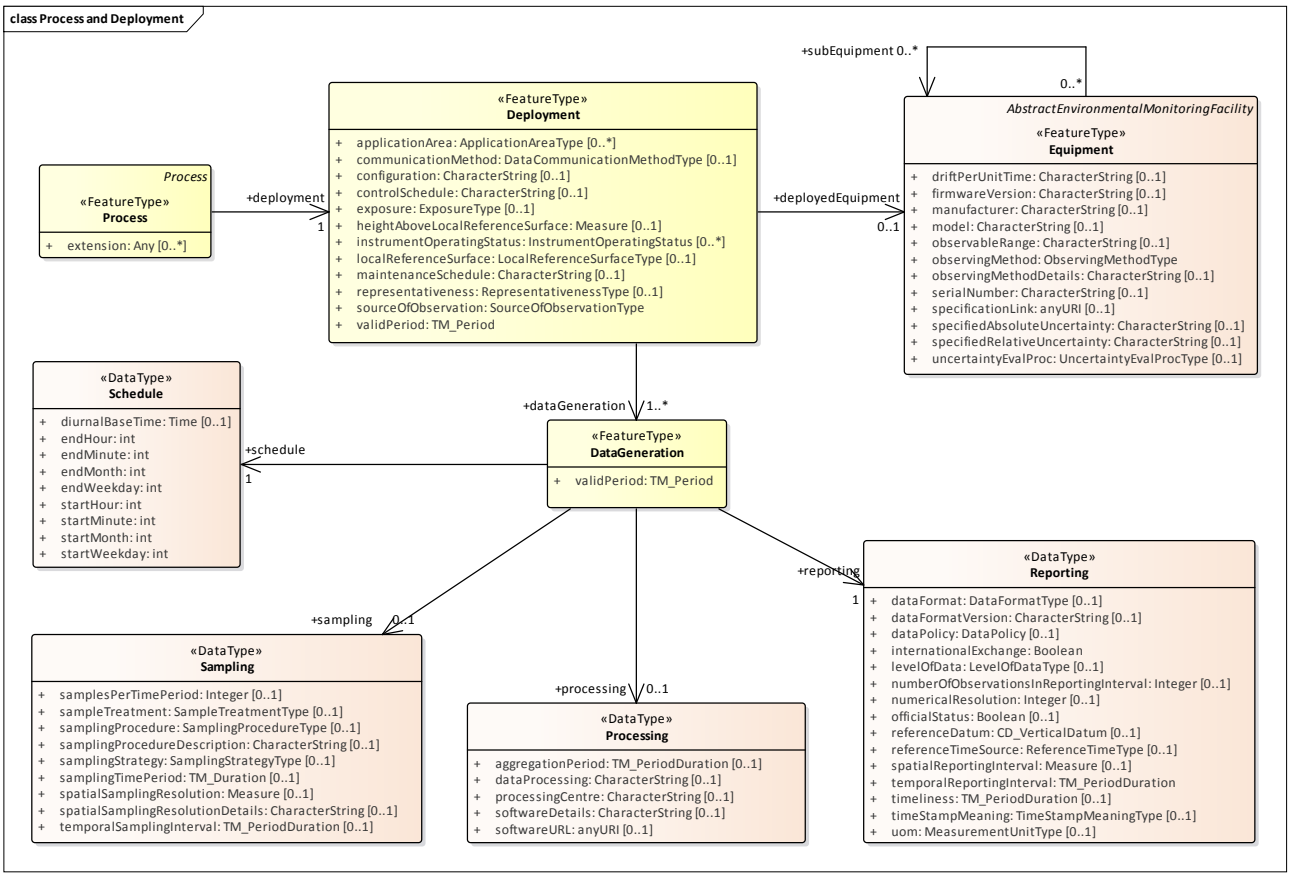

Figure 4 Showing the Process, Deployment and relationships

7.2 Deployment

7.2.1 The Deployment describes which equipment is deployed, during which time period, and in which configuration in the course of generating observations. A Deployment can describe any period of time (equipment could be deployed for less than a day, e.g. a mobile sensor deployed in the field, or it could be deployed for many years.) A defining characteristic of the Deployment is that the configuration described in the Deployment remains, by-and-large, unchanged for the duration of the deployment. If the configuration changes, then a new Deployment must be recorded.

7.2.2 Deployment has the following properties:

Property	Cardinality	Type	Property Description
deployedEquipment	0..1	Equipment	The Equipment which is used for the duration of the Deployment.
dataGeneration	1..*	DataGeneration	Description of sampling, processing, reporting and schedule used for making the observation(s).
validPeriod	1..1	TM_Period	The period of time for which this deployment configuration was/is in place. (Note: this time period must fall within the time period specified in the OM_Observation phenomenonTime)
heightAboveLocalReferenceSurface	0..1	Measure	5-05 Vertical distance of sensor from specified reference surface, in the direction away from the earth's center. Positive values indicate above reference surface, negative values indicate below references surface (e.g., below ocean surface).
localReferenceSurface	0..1	LocalReferenceSurfaceType	5-05 Description of the specified reference surface taken from the codelist LocalReferenceSurfaceType
applicationArea	0..*	ApplicationAreaType	2-01 The context within, or intended application(s) for which the observation is primarily made or which has/have the most stringent requirements.
sourceOfObservation	1..1	SourceOfObservationType	5-01 The source of the observation (manual, automatic, visual etc.) from the SourceOfObservationType codelist.
communicationMethod	0..1	DataCommunicationMethodType	3-08 The primary data communication method, from the DataCommunicationMethodType codelist.
exposure	0..1	ExposureType	5-15 The degree to which an instrument is affected by external influences according to the CIMO classification. Value from ExposureType codelist.
representativeness	0..1	RepresentativenessType	1-05 An assessment of the representativeness of the observations from the RepresentativenessType codelist.
configuration	0..1	CharacterString	5-06 Description of any shielding or configuration/setup of the instrumentation.
maintenanceSchedule	0..1	CharacterString	5-10 A description (and schedule) of maintenance that is routinely performed on an instrument.
controlSchedule	0..1	CharacterString	5-07 Description of schedule for calibrations or verification of instrument.
instrumentOperatingStatus	0..1	InstrumentOperatingStatusType	5-04 The operational status of the instrument when deployed (Operational, testing etc.).

Table 28 Properties of Deployment

7.2.3 The properties of Deployment use a variety of complex DataTypes.

7.3 DataGeneration

7.3.1 The DataGeneration class is a container to group the classes that describe the sampling, processing and reporting characteristics, as well as the schedule (temporal coverage) that applies.

7.3.2 DataGeneration has the following properties:

Property	Cardinality	Type	Property Description
validPeriod	1..1	TM_Period	The period of time for which this DataGeneration arrangement was/is in place. (Note: this time period must fall within the time period specified in the Deployment).
schedule	1..1	Schedule	6-08 Description of the schedule of observation.
sampling	0..1	Sampling	Sampling details
processing	0..1	Processing	Processing details
reporting	1..1	Reporting	Reporting details

Table 29 Properties of DataGeneration

7.4 Schedule

7.4.1 Schedule contains a description of the temporal coverage of observation. Schedules are defined in terms of months covered, weekdays covered, hours and minutes covered during each day. At present, schedules within the minute are not supported. A complete definition of a schedule requires specification of the temporalReportingInterval, and may require the specification of diurnalBaseTime.

7.4.2 Schedule has the following properties:

Property	Cardinality	Type	Property Description
startMonth	1..1	int	Start month of schedule (January = 1, December = 12)
endMonth	1..1	int	End month of schedule (January = 1, December = 12)
startWeekday	1..1	int	Start day of schedule (Monday = 1, Sunday = 7)
endWeekday	1..1	int	End day of schedule (Monday = 1, Sunday = 7)
startHour	1..1	int	Start hour of schedule (0 to 23)
endHour	1..1	int	End hour of schedule (0 to 23)
startMinute	1..1	int	Start minute of schedule (0 to 59)
endMinute	1..1	int	End minute of schedule (0 to 59)
diurnalBaseTime	0..1	TM_ClockTime	6-07 Time (of day) to which diurnal statistics are referenced. For example, a 24 h accumulated total precipitation might refer to 0700z as the diurnal base time. [Phase 1]

Table 30 Properties of Schedule

7.5 Sampling

7.5.1 The Sampling class describes the procedure(s) involved in obtaining a sample/making an observation.

7.5.2 Sampling has the following properties:

Property	Cardinality	Type	Property Description
samplingStrategy	0..1	SamplingStrategyType	6-03 The strategy used to generate the observed variable. [Phase 1]
samplingProcedure	0..1	SamplingProcedureType	6-01 The procedure(s) involved in obtaining a sample/making an observation. Taken from the SamplingProcedureType codelist [Phase 3]
samplingProcedureDescription	0..1	CharacterString	6-01 Description of the procedure(s) involved in obtaining a sample/making an observation. [Phase 3]
sampleTreatment	0..1	SampleTreatmentType	6-02 Description of chemical or physical treatment of the sample prior to analysis from the SampleTreatmentType codelist. [Phase 3]
temporalSamplingInterval	0..1	TM_PeriodDuration	6-06 Time period (as a duration) between the beginning of consecutive sampling periods. [Phase 3]
samplingTimePeriod	0..1	TM_Duration	6-04 The period of time over which a measurement is taken. This value is a duration, e.g. 1 hour, not specific times and dates. [Phase 3]
spatialSamplingResolutionDetails	0..1	CharacterString	6-05 Explanatory information about the exact meaning of the value of samplingResolution. Note: not currently supported. [Phase 2]
spatialSamplingResolution	0..1	Measure	6-05 The spatial sampling resolution is the size of the smallest observable object. The value of this property may be supported by explanatory information in spatialSamplingResolutionDescription.
samplesPerTimePeriod	0..1	Integer	Number of samples taken during specified time period, normally 1.

Table 31 Properties of Sampling

7.6 Processing

7.6.1 The Processing class contains details of the processing procedures including analysis and post-processing.

7.6.2 Processing has the following properties:

Property	Cardinality	Type	Property Description
processingCentre	0..1	CharacterString	7-02 Center at which the observation is processed.[Phase 2]. Although this is a free text string, it is expected that in practice this value should be from a controlled list of known centers.
aggregationPeriod	0..1	TM_PeriodDuration	7-09 Time period over which individual samples/observations are aggregated [Phase 2]
dataProcessing	0..1	CharacterString	7-01 A description of the data processing used to generate observations including, if relevant, algorithms used to derive the result. [Phase 3]
softwareDetails	0..1	CharacterString	7-05 Name and version of the software or processor used to derive the values [Phase 3]

softwareURL	0..1	URI	7-05 URL for the software or processor used to derive the values [Phase 3]

Table 32 Properties of Processing

7.7 Reporting

7.7.1 The Reporting class contains details of the reporting procedures for observations.

7.7.2 Reporting has the following properties:

Property	Cardinality	Type	Property Description
internationalExchange	1..1	Boolean	7-14 Specifies if the observations described using dataGeneration, in particular through the temporalReportingInterval, are intended for international exchange.
uom	0..1	MeasurementUnitType	1-02 Measurement Unit (unit of measure)
spatialReportingInterval	0..1	Measure	7-03 Spatial interval over which the observed variable is reported. Note that this is expressed as length, without geo-referencing.
temporalReportingInterval	1..1	TM_PeriodDuration	7-03 Time interval over which the observed variable is reported. Note that this is a duration, e.g., (every) 1 hour.
timeStampMeaning	0..1	TimeStampMeaningType	7-03 Meaning of the time stamp in the temporalReportingInterval taken from the TimeStampMeaning codelist.
referenceDatum	0..1	CD_VerticalDatum	7-11 Reference datum used to convert observed quantity to reported quantity.
dataPolicy	0..1	DataPolicyType	9-02 Details relating to the use and limitations surrounding data imposed by the supervising organization.
numberOfObservationsInReportingInterval	0..1	Integer	Specifies how many aggregated observations are reported on average in each temporal reporting interval. For full temporal coverage, the number of observations reported = temporal reporting interval / aggregation period.
referenceTimeSource	0..1	ReferenceTimeType	7-10 Time reference used for observations
levelOfData	0..1	LevelOfDataType	7-06 Level of data processing
dataFormat	0..1	DataFormatType	7-07 Description of the format in which the observed variable is primarily being provided, from the DataFormatType codelist.
officialStatus	0..1	Boolean	5-14 Official status of observation
dataFormatVersion	0..1	CharacterString	7-08 Version of the data format
timeliness	0..1	TM_PeriodDuration	7-13 Timeliness of reporting is the typical time taken between completion of the observation and when it becomes available to users
numericalResolution	0..1	Integer	7-12 Numerical resolution is a measure of the detail to which a numerical quantity is expressed. This is synonymous to numerical precision of the reporting, but can be different than the numerical precision of the observed value. [Phase 3]

Table 33 Properties of Reporting

7.8 ResultSet

7.8.1 The ResultSet contains distribution information for the observation result(s). It is used for the O&M 'result' property. This may contain direct links to the data or to services or websites where the data can be sourced. Each MD_Distribution shall use CI_OnlineResource to point to URLs where data can be found. In order to distinguish the different URLs in a ResultSet, the description property of each MD_Distribution shall be used to describe what the URL resolves to (near real time data, archive etc.)

7.8.2 ResultSet has the following properties:

Property	Cardinality	Type	Property Description
distributionInfo	0..*	MD_Distribution	The distributionInfo provides information about how to source the data, described using MD_Distribution from ISO 19115. Specifically, a URL to the data should be specified using CI_OnlineResource, viz. <gmd:distributionInfo> <gmd:MD_Distribution> <gmd: MD DigitalTransferOptions> <gmd:onLine> <gmd:CI_OnlineResource> <gmd:linkage>URL pointing to data </gmd:linkage> <gmd:function>download </gmd:function> </gmd:CI_OnlineResource> </gmd:onLine> </gmd: MD DigitalTransferOptions> </gmd:MD_Distribution> </gmd:distributionInfo>

Table 34 Properties of ResultSet

8 WMDR XML SCHEMA IMPLEMENTATION

8.1 Schema location

8.1.1 The WMDR XML format (WMDR-XML) is defined by an XML Schema available at http://schemas.wmo.int/wmdr/1.0/wmdr.xsd.

8.1.2 Detailed schema-level technical documentation is available at: http://schemas.wmo.int/wmdr/1.0/documentation/schemadoc/.

8.1.3 The schema documentation is extensive as it includes documentation for many OGC and ISO schemas that are referenced from the WMDR schema. To focus on the WMDR documentation select the WMDR namespace (http://def.wmo.int/wmdr/1.0) on the left hand side of the schema documentation.

8.1.4 Many other XML schema-aware tools can also show the schema in a way that makes it readable. E.g. Oxygen XML and XMLSpy both have visual schema representations. In addition, many programming languages and frameworks support XML in support of automated workflows; some examples include (but are not limited to) libxml2 (C) and lxml (Python), JAXB (Java).

8.1.5 The WMDR XML schema is a GML application schema and it also imports the OGC Observations & Measurements XML schema (OMXML) and uses OMXML schema types. The WMDR XML Schema provides additional schema types that are appropriate for use in different parts of the O&M model. For example, OMXML provides an abstract 'process' class called OM_Process. The WMDR schema specialises this class to capture WIGOS metadata relating to observing processes.

8.2 Validation of XML instance documents against the schema.

8.2.1 XML instance documents can be validated against the WIGOS Schema by using any XML Schema aware validator such as that included in XMLSpy, OxygenXML or in various software libraries. It should be noted that not all XML validators adequately validate 'substitution groups' which are used throughout GML. The free software Notepad++ has an XML plugin that provides appropriate validation.

8.2.2 The WIGOS XML Schema contains all the necessary import statements for the various schemas it uses (such as O&M, GML). Therefore it is only necessary to validate WIGOS XML instance documents against the WIGOS XSD schema (cf. 8.1.1).

8.2.3 To enable validation, in the header section of an XML instance document the schema location should appear in the header of an instance document as follows:

```
<wmdr:WIGOSMetadataRecord

        gml:id="examplerecord1"

        xmlns:wmdr="http://def.wmo.int/wmdr/1.0"
```

xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gmd="http://www.isotc211.org/2005/gmd"

xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:om="http://www.opengis.net/om/2.0"

xmlns:gml="http://www.opengis.net/gml/3.3" xmlns:sam="http://www.opengis.net/sampling/2.0"

xmlns:sams="http://www.opengis.net/samplingSpatial/2.0"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://def.wmo.int.wmdr/1.0 http://schemas.wmo.int/wmdr/1.0/wmdr.xsd">

8.2.4 The other namespaces in the header (xlink, gco, gml etc.) are all used by WMDR and should also be present in the header.

8.2.5 The version attribute for this version is required as a fixed value of "1.0".

8.3 Further Validation of Instance Documents Using OSCAR/Surface

8.3.1 OSCAR/Surface (https://oscar.wmo.int/surface) implements certain rules to check the content an instance document. These rules complement the syntactic checking done by XML Schema validation.

8.3.2 These rules are implemented to test for appropriate use of codelists, correct application of O&M and several XML encoding details.

8.3.3 Access to the parser of OSCAR/Surface for validation of instance documents is granted to registered users.

8.4 Structure of Instance Documents

8.4.1 The structure of a WIGOS metadata record is as follows:

- WIGOSMetadataRecord - Root Element
    - Header Section – contains 'meta' information about the record itself
    - Extensions Section – may be used to add additional content not defined in WMDR e.g. for local purposes.
    - Content Sections – contains instances of the various WIGOS types such as Equipment, OM_Observation etc.

8.4.2 The element WIGOSMetadataRecord acts as the root element for the XML document. All other content should be contained as sub-elements within WIGOSMetadataRecord.

8.4.3 The Header section contains 'meta' information about the record. It includes:

- Information about the record owner
- An identifier for the observing facility this record relates to.

8.4.4 The Header section is optional, but strongly recommended to facilitate traceability.

8.4.5 Content sections are used, as appropriate to define other WMDR types.

8.4.6 A WIGOS metadata record can be used to define:

- Observations metadata about the observations made (using OM_Observation)
- Real world things i.e. Equipment or ObservingFacilities.
- Deployments or components of deployments such as 'Sampling'
- Logs

8.4.7 The named content sections are named equipment, facility, observation. Other named sections are also supported in the schema but are not expected to be widely used initially as content (such as Deployment) and can be provided inline with an OM_Observation.

```
<wmdr:WIGOSMetadataRecord>
<wmdr:headerInformation>
    <!—file header -->
<wmdr:Header>…</wmdr:Header>
</wmdr:headerInformation>
<wmdr:equipment>
    <!-- an Equipment instance -->
    <wmdr:Equipment> … </wmdr:Equipment>
</wmdr:equipment>
<wmdr:equipment>
<!-- another Equipment instance -->
    <wmdr:Equipment> … </wmdr:Equipment>
</wmdr:equipment>
<wmdr:facility>
    <!-- an ObservingFacility instance -->
<wmdr:ObservingFacilty> … </wmdr:ObservingFacilty>
</wmdr:facility>
<wmdr:observation>
    <!-- an ObservingCapability instance -->
    <wmdr:ObservingCapability gml:id="…">
        <om:OM_Observation> … </om:OM_Observation>
        <!-- another OM_Observation instance -->
        <om:OM_Observation> … </om:OM_Observation>
    </wmdr:ObservingCapability>
    <!-- another ObservingCapability instance -->
    <wmdr:ObservingCapability gml:id="…">
        <om:OM_Observation> … </om:OM_Observation>
    </wmdr:ObservingCapability>
    <!—a third ObservingCapability instance -->
    <wmdr:ObservingCapability gml:id="…">
        <om:OM_Observation> … </om:OM_Observation>
    </wmdr:ObservingCapability>
</wmdr:observation>
```

8.4.8 The content of the extensions section is not constrained by the WMDR and this section may contain any valid XML. However good practice would recommend that XML content which is valid against a known XML Schema is used. This may be a local schema or some other public schema.

8.4.9 Content in the extensions section is not likely to be managed or processed in any way by WMO systems and is purely there for the convenience of data providers who may wish to maintain some of their own information in a WMDR document.

8.5 GML properties

8.5.1 Most of the WMDR classes are defined as GML FeatureTypes.

8.5.2 GML FeatureTypes carry additional properties from GML, namely:

```
gml:name
gml:identifier
gml:description
```

8.5.3 Of these, gml:name, gml:identifier and gml:description are used in WMDR.

8.5.4 GML identifier is the most critical and is used to assign identifiers. For further detail on the use of identifiers please see the following section 'Use of Identifiers'.

8.5.5 The following feature types implement in the WMDR schema carry standard GML properties.

```
AbstractMonitoringFeature
AbstractEnvironmentalMonitoringFeature
Deployment
Equipment
EquipmentLog
FacilityLog
FacilitySet
Log
ObservingFacility
Process
ResultSet
WIGOSMetadataRecord
```

8.6 Use of Identifiers

8.6.1 It is important to note that Equipment and ObservingFacility instances are defined independently and are identifiable objects in their own right. These identifiers are used to refer to these Equipment and ObservingFacility instances from within OM_Observation instances.

8.6.2 For example, a meteorological agency has 10 stations and 100 instruments. The agency may upload 10 ObservingFacility definitions, each with unique identifiers and 100 Equipment definitions, each with unique identifiers.

8.6.3 Then the agency may upload OM_Observations about the various observations made. This observations metadata will *refer to* the already-defined Equipment and ObservingFacilities used in the capture of the observation.

8.6.4 WMDR records shall use WIGOS Station Identifiers for the gml:identifier property of ObservingFacility.

8.6.5 Identifiers used to identify items referred to by WIGOS metadata records must have the form a-b-c-d. The URI http://data.wmo.int/wigos/a-b-c-d always identifies the entity unambiguously.

8.6.6 The identifier is intended to be used as a label only, and there is no inherent meaning in its components. The sub-divisions are intended to allow a systematic approach of delegating the construction of an identifier in a way that retains a guarantee of global uniqueness.

8.6.7 The sub-components of the identifier should be created as follows.

8.6.7.1 First element: **a**. The first component following http://data.wmo.int/wigos/ (***a***) is the *WIGOS Identifier Series*. The values permitted for WIGOS identifiers supporting WIGOS metadata are in Table 35.

WIGOS Identifier Series	Type of item
0	Observing facility, station/platform. Denotes the identifier to be a WIGOS station identifier.
1	Item of Equipment (such as an instrument)
2	OM_Observation (a concept of the data representation for WIGOS metadata taken from ISO 19156)
3	Deployment (a concept of the data representation for WIGOS metadata)
4	Contact information for the person or team responsible for an element of WIGOS metadata (a means of referring to contact information without having to repeat it in all metadata records, and so avoiding the maintenance issues of having to update every impacted metadata record whenever there is a change in contact information). This is modelled as CI_ResponsibleParty in WMDR.

Table 35. WIGOS Identifier Series used to define types of WIGOS metadata identifier

8.6.7.2 Second element: **b**. The second component following http://data.wmo.int/wigos/
(***b***) is the *Issuer of Identifier*. The value to be used is defined in the documentation for the WIGOS station identifier.
Every identifier issued by a Member should use the *Issuer of Identifier* allocated to that Member. Following the principle that no type of WIGOS identifier may refer to more than one instance of an item, if responsibility for maintaining an item of metadata passes to another body, then the body responsible for identifiers issued with that *Issuer of identifier* value must ensure that the identifiers associated with that item are not re-issued. In the event that responsibility for an item is transferred to another Member. It follows that the *Issuer of Identifier* cannot be used to determine the body responsible for the item.
This element should not have leading zeroes.
The range is the same as for the Issuer of Identifier in the WIGOS station identifier.

8.6.7.3 Third element: **c**. The third component following http://data.wmo.int/wigos/
(***c***) is the *Issue number* and enables Members to delegate the issue of identifiers within their area of responsibility (and is similar to the *Issue Number* in the WIGOS station identifier). Noting that a Member may have several pre-existing methods for allocating identifiers to items (for example, an asset management identifier for an instrument), each method for allocating national identifiers could be allocated an *Issue number*. Members may choose how they wish to use the *Issue number* to ensure uniqueness of its identifiers. This element should not have leading zeroes.
The range of permitted values is the same as for the Issue Number of the WIGOS station identifier.

8.6.7.4 Fourth element: **d**. The fourth component following http://data.wmo.int/wigos
(**d**) corresponds to the *Local Identifier* of an item (and is analogous to the local identifier of the WIGOS Station Identifier). It is used in combination with the other elements to ensure global uniqueness of the identifier. It should not contain blanks, and shall contain only characters that are permitted in URLs. Further constraints may apply.
If a Member generates this component from a national system that uses characters not permitted in URLs, those characters should be substituted by others in a systematic manner that ensures uniqueness of the resulting identifier. To simplify maintenance of records, Members that derive their identifiers from national systems may wish to ensure that the national identifier can be extracted from the WIGOS identifier.
This component of the WIGOS identifier should be short enough that the total length of the WIGOS identifier http://data.wmo.int/wigos/a-b-c-d does not exceed 255 characters.

9 CODE LISTS

9.1.1 Codelists are published at http://codes.wmo.int/wmdr. These codelists and the entries in the lists are managed separately from the XML Schema.

9.1.2 The following table shows how the published codelists relate to the numbered definitions in the WIGOS metadata standard. Individual terms in these lists will be identified using individual URIs of the form http://codes.wmo.int/wmdr/{codetable}/{label}, where label is the label of the individual terms.

WIGOS table reference	Description	Location of code table
1-01-01	Observed variable – measurand, Atmosphere	http://codes.wmo.int/wmdr/ObservedVariableAtmosphere
1-01-02	Observed variable – measurand, Earth	http://codes.wmo.int/wmdr/ObservedVariableEarth
1-01-03	Observed variable – measurand, Ocean	http://codes.wmo.int/wmdr/ObservedVariableOcean
1-01-04	Observed variable – measurand, Outer Space	http://codes.wmo.int/wmdr/ObservedVariableOuterSpace
1-01-05	Observed variable – measurand, Terrestrial	http://codes.wmo.int/wmdr/ObservedVariableTerrestrial
1-02	Measurement unit	http://codes.wmo.int/common/unit
1-04	Geometry of observation	http://codes.wmo.int/wmdr/Geometry
1-05	Representativeness	http://codes.wmo.int/wmdr/Representativeness
2-01	Application areas	http://codes.wmo.int/wmdr/ApplicationArea
2-02	Programme/Network affiliation	http://codes.wmo.int/wmdr/ProgramAffiliation
3-01	Region of origin of data	http://codes.wmo.int/wmdr/WMORegion
3-02	Territory of origin of data	http://codes.wmo.int/wmdr/TerritoryName
3-04	Station/platform type	http://codes.wmo.int/wmdr/FacilityType
3-08	Data communication method	http://codes.wmo.int/wmdr/DataCommunicationMethod
3-09	Station/Platform operating status	http://codes.wmo.int/wmdr/ReportingStatus
4-01-01	Surface cover types (IGBP)	http://codes.wmo.int/wmdr/SurfaceCoverIGBP
4-01-02	Surface cover types (UMD)	http://codes.wmo.int/wmdr/SurfaceCoverUMD
4-01-03	Surface cover types (LAI/fPAR)	http://codes.wmo.int/wmdr/SurfaceCoverLAI
4-01-04	Surface cover types (NPP)	http://codes.wmo.int/wmdr/SurfaceCoverNPP
4-01-05	Surface cover types (PFT)	http://codes.wmo.int/wmdr/SurfaceCoverPFT
4-01-06	Surface cover types (LCCS)	http://codes.wmo.int/wmdr/SurfaceCoverLCCS
4-02	Surface cover classification scheme	http://codes.wmo.int/wmdr/SurfaceCoverClassification
4-03-01	Local topography	http://codes.wmo.int/wmdr/LocalTopography

WIGOS table reference	Description	Location of code table
4-03-02	Relative elevation	http://codes.wmo.int/wmdr/RelativeElevation
4-03-03	Topographic context	http://codes.wmo.int/wmdr/TopographicContext
4-03-04	Altitude/depth	http://codes.wmo.int/wmdr/AltitudeOrDepth
4-04	Events at station/platform	http://codes.wmo.int/wmdr/EventAtFacility
4-06	Surface Roughness (Davenport roughness classification)	http://codes.wmo.int/wmdr/SurfaceRoughnessDavenport
4-07	Climate Zone	http://codes.wmo.int/wmdr/ClimateZone
5-01	Source of observation	http://codes.wmo.int/wmdr/SourceOfObservation
5-02-01	Measurement/observing method, Atmosphere	http://codes.wmo.int/wmdr/ObservingMethodAtmosphere
5-02-02	Measurement/observing method, Earth	http://codes.wmo.int/wmdr/ObservingMethodEarth
5-02-03	Measurement/observing method, Ocean	http://codes.wmo.int/wmdr/ObservingMethodOcean
5-02-04	Measurement/observing method, Outer Space	http://codes.wmo.int/wmdr/ObservingMethodOuterSpace
5-02-05	Measurement/observing method, Terrestrial	http://codes.wmo.int/wmdr/ObservingMethodTerrestrial
5-04	Instrument operating status	http://codes.wmo.int/wmdr/InstrumentOperatingStatus
5-08-01	Control standard type	http://codes.wmo.int/wmdr/ControlStandardType
5-08-02	Control location	http://codes.wmo.int/wmdr/ControlLocation
5-08-03	Instrument control result	http://codes.wmo.int/wmdr/InstrumentControlResult
5-14	Status of observation	http://codes.wmo.int/wmdr/ObservationStatus
5-15	Exposure of instrument	http://codes.wmo.int/wmdr/Exposure
6-03	Sampling strategy	http://codes.wmo.int/wmdr/SamplingStrategy
7-06	Level of data	http://codes.wmo.int/wmdr/LevelOfData
7-07	Data format	http://codes.wmo.int/wmdr/DataFormat
7-10	Reference time	http://codes.wmo.int/wmdr/ReferenceTime
8-03-01	Quality Flag (BUFR derived from CIMO guide)	http://codes.wmo.int/wmdr/QualityFlagCIMO
8-03-02	Quality Flag (From WaterML2)	http://codes.wmo.int/wmdr/QualityFlagOGC
8-03-04	Quality Flag System	http://codes.wmo.int/wmdr/QualityFlagSystem
8-05	Traceability	http://codes.wmo.int/wmdr/Traceability
9-02	Data policy/use constraints	http://codes.wmo.int/wmdr/DataPolicy
11-01	Coordinates source/service	http://codes.wmo.int/wmdr/GeopositioningMethod
11-02	Coordinates reference	http://codes.wmo.int/wmdr/CoordinateReferenceSystem
11-03	Meaning of time stamp	http://codes.wmo.int/wmdr/TimeStampMeaning