

DIN EN ISO 19156



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Entwurf

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Vorgesehen als Ersatz für
DIN EN ISO 19156:2013-10

**Geoinformation –
Erdbeobachtung und Erdmessung (ISO/DIS 19156:2022);
Englische Fassung prEN ISO 19156:2022**

Geographic information –
Observations, measurements and samples (ISO/DIS 19156:2022);
English version prEN ISO 19156:2022

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2022-01-14 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

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Nationales Vorwort

Dieses Dokument (prEN ISO 1956:2022) wurde vom Technischen Komitee ISO/TC 211 „Geographic information/Geomatics“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 287 „Geoinformation“ erarbeitet, dessen Sekretariat von BSI (Vereinigtes Königreich) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 005-03-03 AA „Geoinformation (SpA zu CEN/TC 287+ISO/TC 211)“ im DIN-Normenausschuss Bauwesen (NABau).

Dieses Dokument enthält unter Berücksichtigung des Präsidialbeschlusses 1/2004 nur die englische Originalfassung von prEN ISO 19115-3:2022.

Der Bedarf für eine Deutsche Fassung wird derzeit beraten.

Für die in diesem Dokument zitierten Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 19101-1:2014	siehe	DIN EN ISO 19101-1:2015-03
ISO 19107:2019	siehe	DIN EN ISO 19107:2020-09
ISO 19108:2002	siehe	DIN EN ISO 19108:2005-05
ISO 19109:2015	siehe	DIN EN ISO 19109:2016-05
ISO 19115-1:2014/Amd 2:2020	siehe	DIN EN ISO 19115-1/A2:2021-03
ISO 19136-1:2020	siehe	DIN EN ISO 19136-1:2020-12
ISO 19157:2013	siehe	DIN EN ISO 19157:2014-04
ISO 19157:2013/Amd 1:2018	siehe	DIN EN ISO 19157/A1:2018-05

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Änderungen

Gegenüber DIN EN ISO 19156:2013-10 wurden folgende Änderungen vorgenommen:

- a) Anpassung an den aktuellen Stand der Technik;
- b) Erweiterung der Begriffsdefinitionen;
- c) redaktionelle Überarbeitung.

Nationaler Anhang NA (informativ)

Begriffe

Die Benennungen der folgenden Begriffe sind identisch mit den Benennungen in der englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

— ISO Online Browsing Platform: verfügbar unter <https://www.iso.org/obp>

— IEC Electropedia: verfügbar unter <http://www.electropedia.org/>

3.1

Anwendungsschema

en application schema

konzeptuelles Schema für Daten, die für eine oder mehrere Anwendungen erforderlich sind

[QUELLE: ISO 19101-1:2014, 4.1.2]

3.2

Coverage

en coverage

Feature, das als Funktion zur Rückgabe von Werten aus seinem Wertebereich für jede direkte Position innerhalb seines Bereichs dient

[QUELLE: ISO/DIS 19123-1, 3.1.8]

3.3

Datentyp

en data type

Festlegung eines Bereichs von Werten mit auf den Werten in diesem Bereich zulässigen Operationen

BEISPIEL Ganz, real, boolesch, Zeichenkette, Datum und SG-Punkt (Umwandlung eines Datums in eine Reihe von Codes).

Anmerkung 1 zum Begriff: Zu Datentypen gehören primitive vordefinierte Typen und benutzerdefinierte Typen.

[QUELLE: ISO 19103:2015, 4.14]

3.4

Bereich

en domain

wohldefiniertes (Fach-)Gebiet oder bestimmter Wertebereich

Anmerkung 1 zum Begriff: Alle Elemente eines Bereichs sind von einem vorgegebenem Typ.

[QUELLE: ISO 19109:2015, 4.8, modifiziert — Ursprüngliche Anmerkung 1 zum Begriff wurde durch eine neue Anmerkung zum Begriff ersetzt.]

3.5

Fachobjekt

en domain feature

Feature einer Klasse, die innerhalb eines bestimmten Anwendungsbereichs festgelegt ist

Anmerkung 1 zum Begriff: Dies steht Beobachtungen und Abtastfeatures gegenüber, die zu Typen gehören, die zu bereichsübergreifenden Zwecken festgelegt werden.

3.6

Ex-situ

en ex-situ

extern

bezogen auf die Untersuchung, Erhaltung oder Konservierung einer Probe oder Population außerhalb der natürlichen Umgebung

Anmerkung 1 zum Begriff: Gegenteil von In-situ (intern).

3.7

Feature

en feature

Abstraktion eines realen Phänomens

Anmerkung 1 zum Begriff: Ein Feature kann als Typ oder Instanz auftreten. In diesem Dokument bezieht sich Feature auf eine Instanz, soweit nichts anderes angegeben ist.

[QUELLE: ISO 19101-1:2014, 4.1.11, modifiziert — Anmerkung 1 zum Begriff wurde geändert.]

3.8

relevantes Feature

en feature-of-interest

Objekt der Beobachtung

3.9

Featureklasse (Objektart)

en feature type

Klasse von Features mit gemeinsamen Merkmalen

3.10

Messgröße

en measurand

Größe, die gemessen werden soll

3.11

Maß

en measure

<GML>-Wert, der unter Verwendung einer numerischen Menge mit einer Skala oder mithilfe eines skalaren Bezugssystems beschrieben wird

Anmerkung 1 zum Begriff: Bei der Anwendung als Substantiv ist Maß ein Synonym für eine physikalische Größe.

[QUELLE: ISO 19136-1:2020, 3.1.41]

3.12

Messung

en measurement

Reihe von Operationen mit dem Ziel, den Wert einer Größe zu bestimmen

[QUELLE: ISO 19101-2:2018, 3.21]

3.13

Beobachtung

en observation

Tätigkeit, die von einem Beobachter ausgeführt wird, um mithilfe eines Verfahrens den Wert einer beobachtbaren Eigenschaft eines Objekts (relevanten Features) zu bestimmen, bei der der Wert als Ergebnis geliefert wird

3.14

Beobachter

en observer

Identifizierbare Entität, die mithilfe eines Verfahrens Beobachtungen über eine beobachtbare Eigenschaft generieren kann

Anmerkung 1 zum Begriff: Ein Beobachter ist eine Instanz eines Sensors, eines Instruments, die Implementierung eines Algorithmus oder ein Wesen wie eine Person.

3.15

Verfahren

en procedure

festgelegte Art und Weise, eine Tätigkeit oder einen Prozess auszuführen

[QUELLE: ISO 9000:2015, 3.4.5, modifiziert — Anmerkung 1 zum Begriff wurde gestrichen.]

3.16

Prozess

en process

Satz zusammenhängender oder sich gegenseitig beeinflussender Tätigkeiten, der Eingaben zum Erzielen eines vorgesehenen Ergebnisses verwendet

[QUELLE: ISO 9000:2015, 3.4.1, modifiziert — Anmerkungen 1-6 zum Begriff wurden gestrichen.]

3.17

Eigenschaft

en property

benannter Aspekt oder benanntes Attribut eines Objekts

BEISPIEL Abbys Auto hat die Farbe rot, wobei „Farbe rot“ eine Eigenschaft des Autos ist.

[QUELLE: ISO 19143:2010, 4.21, modifiziert — Beispiel wurde dem Begriff hinzugefügt.]

3.18

Eigenschaftstyp

en property type

Merkmal einer Featureklasse

Anmerkung 1 zum Begriff: Der Wert für eine Instanz eines beobachtbaren Eigenschaftstyps kann durch den Vorgang einer Beobachtung geschätzt werden.

BEISPIEL Jedes Auto (eine Featureklasse) hat eine charakteristische Farbe, wobei „Farbe“ ein Eigenschaftstyp ist.

Anmerkung 2 zum Begriff: Bei Anwendungen in der Chemie werden häufig die Bezeichnungen „Determinand“ oder „Analyt“ verwendet.

Anmerkung 3 zum Begriff: Übernommen aus ISO 19109:2005.

3.19

unmittelbar relevantes Feature

en proximate feature-of-interest

Entität, die von direktem Interesse bei der Tätigkeit der Beobachtung ist

Anmerkung 1 zum Begriff: Dies ist eine spezialisierte Form des relevanten Features.

3.20

Wertebereich

en range

<Coverage>-Menge von Werten von Feature-Attributen, die durch eine Funktion, der Coverage, mit den Elementen des Bereichs einer Coverage verbunden ist

Anmerkung 1 zum Begriff: Dies stimmt mit der allgemeineren Definition des Wertebereichs in ISO 19107:2019 überein.

[QUELLE: ISO/DIS 19123-1, 3.1.47]

3.21

Probe

en sample

Objekt, das repräsentativ für ein Konzept, ein Objekt der realen Welt oder ein Phänomen ist

3.22

Probenehmer

en sampler

Vorrichtung oder Entität (einschließlich Menschen), die ein Probenahmeverfahren implementiert oder für ein Probenahmeverfahren genutzt wird, um eine oder mehrere Probe(n) zu nehmen oder zu transformieren

3.23

Sensor

en sensor

Element eines Messsystems, das direkt von einem Phänomen, einem Körper oder einer Substanz beeinflusst wird, die eine zu messende Menge tragen

[QUELLE: ISO/IEC Guide 99:2007, 3.8, modifiziert —Beispiel und Anmerkung 1 zum Begriff wurden gestrichen.]

3.24

endgültig relevantes Feature

en ultimate feature-of-interest

Entität, die von endgültigem Interesse bei der Tätigkeit der Beobachtung ist

Anmerkung 1 zum Begriff: Dies ist eine spezialisierte Form des relevanten Features.

3.25

Maßeinheit

en unit of measure

aus einer Einheitenäquivalenzgruppe gewählte Größe

Anmerkung 1 zum Begriff: Übliche Maßeinheiten in der Positionierung sind Winkleinheiten oder lineare Einheiten. Die Implementierung von Positionierungen muss klar zwischen SI- und Nicht-SI-Einheiten unterscheiden. Wenn Nicht-SI-Einheiten verwendet werden, muss ihre Beziehung zu SI-Einheiten angegeben werden.

[QUELLE: ISO 19116:2019, 3.29]

3.26

Wert

en value

Element aus einem Bereich

Anmerkung 1 zum Begriff: Ein Wert betrachtet den möglichen Zustand eines Objekts innerhalb einer Klasse.

Anmerkung 2 zum Begriff: Ein Datenwert ist eine Instanz eines Datentyps, ein Wert ohne Identität.

Anmerkung 3 zum Begriff: Ein Wert kann eine von vielen Skalen verwenden, einschließlich der Nominalskala, Ordinalskala, Ratioskala und Intervallskala, Raumskala und Zeitskala. Primitive Datentypen können kombiniert werden, um aggregierte Datentypen mit aggregierten Werten, einschließlich Vektoren, Tensoren und Bildern, zu bilden.

[QUELLE: ISO/IEC 19501:2005, 0000_5, modifiziert — Anmerkung 3 zum Begriff wurde hinzugefügt.]

Nationaler Anhang NB (informativ)

Literaturhinweise

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Contents

Page

Foreword.....	ix
Introduction.....	x
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Document conventions.....	4
4.1 Abbreviated terms and acronyms.....	4
4.2 Schema language.....	5
4.3 Model element names.....	5
4.4 Requirements and recommendations.....	5
4.5 Requirements classes.....	6
4.6 Conformance classes.....	7
4.7 Identifiers.....	7
5 Conformance.....	8
5.1 Overview.....	8
5.2 Conformance classes related to models including Observations, Measurements and Samples.....	8
6 Packaging, requirements and dependencies.....	10
6.1 Requirements.....	10
6.2 UML.....	11
6.2.1 UML package structure.....	11
6.2.2 UML package dependencies.....	12
6.3 Note on the use of Any.....	13
7 Fundamental characteristics of observations and samples (informative).....	14
7.1 Observation schema.....	14
7.1.1 Property evaluation.....	14
7.1.2 Observation.....	14
7.1.3 Properties of an Observation.....	14
7.1.4 Observation location.....	15
7.1.5 Result types.....	16
7.1.6 Use of the observation model.....	16
7.2 Sample schema.....	16
7.2.1 Role of sample features.....	16
7.2.2 Proximate vs. ultimate feature-of-interest.....	16
7.2.3 Role of Sample.....	18
7.2.4 Sampling process.....	18
7.2.5 Classification of samples.....	19
7.3 Alignment between Observation, Sample and domain models.....	19
7.3.1 Model consistency.....	19
7.3.2 Relationship between Sample and domain features.....	21
8 Conceptual Observation schema.....	24
8.1 General.....	24
8.1.1 Conceptual Observation model.....	24
8.1.2 Conceptual Observation schema package Requirements Class.....	25
8.1.3 Association relatedObservation.....	25
8.2 Observation.....	25
8.2.1 Observation Requirements Class.....	25
8.2.2 Interface Observation.....	26
8.2.3 Attribute phenomenonTime.....	26
8.2.4 Attribute resultTime.....	27
8.2.5 Attribute validTime.....	27

8.2.6	Association featureOfInterest.....	28
8.2.7	Association observedProperty.....	28
8.2.8	Association result.....	28
8.2.9	Association observingProcedure.....	29
8.2.10	Association observer.....	29
8.2.11	Association host.....	29
8.2.12	Constraint Observer or Host.....	29
8.2.13	Constraint ObservableProperty characteristic associated with featureOfInterest.....	29
8.2.14	Constraint suitable ObservableProperty.....	29
8.2.15	Constraint suitable result type.....	29
8.2.16	Constraint unit of measure.....	30
8.3	ObservableProperty.....	30
8.3.1	ObservableProperty Requirements Class.....	30
8.3.2	Interface ObservableProperty.....	30
8.3.3	Association observer.....	30
8.4	Procedure.....	31
8.4.1	Procedure Requirements Class.....	31
8.4.2	Interface Procedure.....	31
8.5	ObservingProcedure.....	31
8.5.1	ObservingProcedure Requirements Class.....	31
8.5.2	Interface ObservingProcedure.....	31
8.5.3	Association observer.....	32
8.6	Observer.....	32
8.6.1	Observer Requirements Class.....	32
8.6.2	Interface Observer.....	32
8.6.3	Association observableProperty.....	33
8.6.4	Association observingProcedure.....	33
8.6.5	Association deployment.....	33
8.7	Host.....	33
8.7.1	Host Requirements Class.....	33
8.7.2	Interface Host.....	33
8.7.3	Association deployment.....	34
8.7.4	Association relatedHost.....	34
8.8	Deployment.....	34
8.8.1	Deployment Requirements Class.....	34
8.8.2	Interface Deployment.....	34
8.8.3	Association observer.....	34
8.8.4	Association host.....	34
9	Abstract Observation Core.....	35
9.1	General.....	35
9.1.1	Abstract Observation Core Package Requirements Class.....	35
9.1.2	Association metadata.....	35
9.2	AbstractObservationCharacteristics.....	35
9.2.1	AbstractObservationCharacteristics Requirements Class.....	35
9.2.2	Feature type AbstractObservationCharacteristics.....	37
9.2.3	Attribute observationType.....	37
9.2.4	Attribute parameter.....	37
9.2.5	Attribute resultQuality.....	37
9.2.6	Association proximateFeatureOfInterest.....	38
9.2.7	Association ultimateFeatureOfInterest.....	38
9.3	AbstractObservation.....	39
9.3.1	AbstractObservation Requirements Class.....	39
9.3.2	Constraint observationType.....	39
9.3.3	Constraint resultTime instant.....	39
9.3.4	Constraint parameter unique name.....	40
9.3.5	Constraint proximate or ultimate featureOfInterest.....	40
9.3.6	Constraint Observer or Host.....	40

	9.3.7	Constraint ObservableProperty characteristic associated with featureOfInterest.....	40
	9.3.8	Constraint suitable ObservableProperty	40
	9.3.9	Constraint suitable result type.....	40
9.4		AbstractObservableProperty.....	40
	9.4.1	AbstractObservableProperty Requirements Class.....	40
9.5		AbstractObservingProcedure.....	41
	9.5.1	AbstractObservingProcedure Requirements Class.....	41
9.6		AbstractObserver.....	42
	9.6.1	AbstractObserver Requirements Class.....	42
9.7		AbstractHost.....	43
	9.7.1	AbstractHost Requirements Class.....	43
9.8		AbstractDeployment.....	44
	9.8.1	AbstractDeployment Requirements Class.....	44
	9.8.2	Attribute deploymentReason.....	44
	9.8.3	Attribute deploymentTime.....	45
9.9		NamedValue.....	45
	9.9.1	NamedValue Requirements Class.....	45
	9.9.2	Data type NamedValue	45
	9.9.3	Attribute name.....	45
	9.9.4	Attribute value	45
9.10		Codelists.....	46
	9.10.1	AbstractObservationType.....	46
10		Basic Observations	46
10.1		General.....	46
	10.1.1	Basic Observations Package Requirements Class.....	46
	10.1.2	Attribute link.....	46
	10.1.3	Attribute location	46
10.2		Observation.....	47
	10.2.1	Observation Requirements Class	47
10.3		ObservationCharacteristics.....	48
	10.3.1	ObservationCharacteristics Requirements Class	48
	10.3.2	Association collection.....	48
10.4		ObservationCollection	48
	10.4.1	ObservationCollection Requirements Class.....	48
	10.4.2	Feature type ObservationCollection.....	48
	10.4.3	Attribute collectionType.....	48
	10.4.4	Association member.....	49
	10.4.5	Association memberCharacteristics	49
	10.4.6	Association relatedCollection.....	49
10.5		ObservingCapability.....	49
	10.5.1	ObservingCapability Requirements Class	49
	10.5.2	Feature type ObservingCapability	50
10.6		ObservableProperty	51
	10.6.1	ObservableProperty Requirements Class.....	51
10.7		ObservingProcedure	52
	10.7.1	ObservingProcedure Requirements Class	52
10.8		Observer.....	53
	10.8.1	Observer Requirements Class	53
10.9		Host.....	54
	10.9.1	Host Requirements Class	54
10.10		Deployment.....	55
	10.10.1	Deployment Requirements Class.....	55
10.11		GenericDomainFeature.....	56
	10.11.1	GenericDomainFeature Requirements Class	56
	10.11.2		
		Feature type GenericDomainFeature	57
10.12		Codelists.....	

10.12.1	AbstractObservationCollectionType	57
10.12.2	ObservationCollectionType	58
10.12.3	ObservationTypeByResultType	60
11	Conceptual Sample schema	61
11.1	General	61
11.1.1	Conceptual Sample schema model	61
11.1.2	Conceptual Sample Schema Package Requirements Class	62
11.2	Sample	62
11.2.1	Sample Requirements Class	62
11.2.2	Interface Sample	62
11.2.3	Association sampling	63
11.2.4	Association preparationStep	63
11.2.5	Association sampledFeature	63
11.2.6	Association relatedSample	63
11.3	Sampling	63
11.3.1	Sampling Requirements Class	63
11.3.2	Interface Sampling	64
11.3.3	Association sample	64
11.3.4	Association featureOfInterest	64
11.3.5	Association sampler	64
11.3.6	Association samplingProcedure	65
11.3.7	Association relatedSampling	65
11.4	Sampler	65
11.4.1	Sampler Requirements Class	65
11.4.2	Interface Sampler	65
11.4.3	Association sampling	66
11.4.4	Association implementedProcedure	66
11.5	PreparationStep	66
11.5.1	PreparationStep Requirements Class	66
11.5.2	Interface PreparationStep	66
11.5.3	Association processingDetails	66
11.5.4	Association preparedSample	66
11.6	PreparationProcedure	66
11.6.1	PreparationProcedure Requirements Class	66
11.6.2	Interface PreparationProcedure	67
11.6.3	Association samplePreparationStep	67
11.7	SamplingProcedure	67
11.7.1	SamplingProcedure Requirements Class	67
11.7.2	Interface SamplingProcedure	67
11.7.3	Association sampling	67
11.7.4	Association sampler	67
12	Abstract Sample Core	68
12.1	General	68
12.1.1	Abstract Sample Core Package Requirements	68
12.2	AbstractSample	68
12.2.1	AbstractSample Requirements Class	68
12.2.2	Attribute sampleType	69
12.2.3	Attribute parameter	69
12.3	AbstractSampling	69
12.3.1	AbstractSampling Requirements Class	69
12.3.2	Attribute samplingLocation	70
12.3.3	Attribute time	71
12.3.4	Attribute parameter	71
12.4	AbstractSampler	71

	12.4.1	AbstractSampler Requirements Class	71
	12.4.2	Attribute samplerType	72
12.5		AbstractSamplingProcedure	72
	12.5.1	AbstractSamplingProcedure Requirements Class	72
12.6		AbstractPreparationProcedure	73
	12.6.1	AbstractPreparationProcedure Requirements Class	73
12.7		AbstractPreparationStep	74
	12.7.1	AbstractPreparationStep Requirements Class	74
	12.7.2	Attribute description	74
	12.7.3	Attribute time	75
12.8		Codelists	75
	12.8.1	AbstractSampleType	75
	12.8.2	AbstractSamplerType	75
13		Basic Samples	75
	13.1	General	75
	13.1.1	Basic Samples Package Requirements Class	75
	13.2	Sample	76
	13.2.1	Sample Requirements Class	76
	13.3	SpatialSample	77
	13.3.1	SpatialSample Requirements Class	77
	13.3.2	Feature type SpatialSample	77
	13.3.3	Attribute shape	77
	13.3.4	Attribute horizontalPositionalAccuracy	77
	13.3.5	Attribute verticalPositionalAccuracy	78
	13.4	MaterialSample	78
	13.4.1	MaterialSample Requirements Class	78
	13.4.2	Feature type MaterialSample	78
	13.4.3	Attribute size	78
	13.4.4	Attribute storageLocation	79
	13.4.5	Attribute sourceLocation	79
	13.5	StatisticalSample	79
	13.5.1	StatisticalSample Requirements Class	79
	13.5.2	Feature type StatisticalSample	79
	13.5.3	Attribute classification	80
	13.6	Sampling	80
	13.6.1	Sampling Requirements Class	80
	13.7	Sampler	81
	13.7.1	Sampler Requirements Class	81
	13.8	SamplingProcedure	81
	13.8.1	SamplingProcedure Requirements Class	81
	13.9	PreparationProcedure	82
	13.9.1	PreparationProcedure Requirements Class	82
	13.10	PreparationStep	83
	13.10.1	PreparationStep Requirements Class	83
	13.11	SampleCollection	84
	13.11.1		
		SampleCollection Requirements Class	84
	13.11.2		
		Feature type SampleCollection	85
	13.11.3		
		Association member	85
	13.11.4		
		Association relatedCollection	85
	13.12	PhysicalDimension	85
	13.12.1		
		PhysicalDimension Requirements Class	85
	13.12.2		
		Data type PhysicalDimension	85

13.12.3.....	86
Attribute dimension.....	86
13.12.4.....	86
Attribute value.....	86
13.13 NamedLocation.....	86
13.13.1.....	86
NamedLocation Requirements Class.....	86
13.13.2.....	86
Data type NamedLocation.....	86
13.13.3.....	87
Attribute address.....	87
13.13.4.....	87
Attribute name.....	87
13.13.5.....	87
Attribute representativeGeometry.....	87
13.14 StatisticalClassification.....	87
13.14.1StatisticalClassification Requirements Class.....	87
13.14.2.....	87
Data type StatisticalClassification.....	87
13.14.3.....	87
Attribute concept.....	87
13.14.4Attribute classification.....	88
13.15 Codelists.....	88
13.15.1.....	88
SampleTypeByGeometryType.....	88
Annex A (normative) Abstract Test Suite.....	89
Annex B (informative) Common usage of OMS concepts.....	99
Annex C (informative) Changes in the Observation and Sample modelsbetween ISO 19156:2011, edition 1 and ISO 19156:2021, edition 2.....	103
Annex D (informative) Best practices in use of the Observation and Sampling models.....	121
Bibliography.....	129

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the Open Geospatial Consortium, Inc. (OGC).

This second edition cancels and replaces the first edition (ISO 19156:2011), which has been technically revised. The UML model as well as the requirements/conformance class structure has been completely redesigned to address the contemporary modelling and observation data provision use cases. The fundamental Observation model has remained largely the same as in the previous version, with carefully designed improvements and clarifications for the intended use. The Sample model has also been refined. Given the integral nature of the Sample model, it has been decided to include that term in the name of the standard.

Special care has been taken to ensure smooth migration from the ISO 19156:2011 to this version.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This International Standard arises from work originally undertaken through the Open Geospatial Consortium's Sensor Web Enablement (SWE) activity. A set of interfaces and protocols was standardized through which applications and services are able to access sensors of all types, and observations generated by them, over the Web.

A new generation of geospatial standards is now emerging, based on general Web standards, architecture, and current practice, as described in <https://www.w3.org/TR/sdw-bp/>. This includes several new standards for describing and publishing sensors and observations, such as the OGC SensorThings API^[23] and the W3C/OGC Semantic Sensor Network Ontology^[29]. This new version of the Observations and Measurements Standard (now named "Observations, Measurements and Samples", OMS for short) is informed by these recent developments. The focus of this revision is aimed at enabling the publication of observation data as part of the Web of data, while also supporting other means of data exchange.

The content presented here derives from the previous version published by Open Geospatial Consortium as OGC 10-004r3, OGC Abstract Specification Geographic information — Observations and measurements (ISO 19156:2011). A technical note describing the changes from the earlier version is available as Annex C.

Geographic information — Observations, measurements and samples

1 Scope

This International Standard defines a conceptual schema for observations, for features involved in the observation process, and for features involved in sampling when making observations. These provide models for the exchange of information describing observation acts and their results, both within and between different scientific and technical communities.

Observations commonly involve sampling of an ultimate feature-of-interest. This International Standard defines a common set of sample types according to their spatial, material (for ex-situ observations), or statistical nature. The schema includes relationships between sample features (sub-sampling, derived samples).

This International Standard concerns only externally visible interfaces and places no restriction on the underlying implementations other than what is needed to satisfy the interface specifications in the actual situation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19103:2015, *Geographic information — Conceptual schema language*

ISO 19107:2019, *Geographic information — Spatial schema*

ISO 19108:2002, *Geographic information — Temporal schema*

ISO 19109:2015, *Geographic information — Rules for application schema*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

application schema

conceptual schema for data required by one or more applications

[SOURCE: ISO 19101-1:2014, 4.1.2]

3.2

coverage

feature that acts as a function to return values from its range for any direct position within its domain

[SOURCE: ISO/DIS 19123-1, 3.1.8]

3.3

data type

specification of a value domain with operations allowed on values in this domain

EXAMPLE Integer, Real, Boolean, String, Date and SG Point (conversion of data into a series of codes).

Note 1 to entry: Data types include primitive predefined types and user-definable types.

[SOURCE: ISO 19103:2015, 4.14]

3.4

domain

well-defined set

Note 1 to entry: All elements within a domain (set) are of a given type.

[SOURCE: ISO 19109:2015, 4.8, modified — Original Note 1 to entry has been replaced with a new note to entry.]

3.5

domain feature

feature of a type defined within a particular application domain

Note 1 to entry: This may be contrasted with observations and sampling features, which are features of types defined for cross-domain purposes.

3.6

ex-situ

off-site

referring to the study, maintenance or conservation of a specimen or population away from its natural surroundings

Note 1 to entry: Opposite of in-situ (on-site).

3.7

feature

abstraction of real-world phenomena

Note 1 to entry: A feature may occur as a type or an instance. In this document, feature instance is meant unless otherwise specified.

[SOURCE: ISO 19101-1:2014, 4.1.11, modified — Note 1 to entry has been modified.]

3.8

feature-of-interest

subject of the observation

3.9

feature type

class of features having common characteristics

3.10

measurand

quantity intended to be measured

3.11

measure

<GML> value described using a numeric amount with a scale or using a scalar reference system

Note 1 to entry: When used as a noun, measure is a synonym for physical quantity.

[SOURCE: ISO 19136-1:2020, 3.1.41]

3.12

measurement

set of operations having the object of determining the value of a quantity

[SOURCE: ISO 19101-2:2018, 3.21]

3.13

observation

act carried out by an observer to determine the value of an observable property of an object (feature-of-interest) by using a procedure, with the value is provided as the result

3.14

observer

identifiable entity that can generate observations pertaining to an observable property by implementing a procedure

Note 1 to entry: An observer is an instance of a sensor, instrument, implementation of an algorithm or a being such as a person.

3.15

procedure

specified way to carry out an activity or a process

[SOURCE: ISO 9000:2015, 3.4.5, modified — Note 1 to entry has been deleted.]

3.16

process

set of interrelated or interacting activities that use inputs to deliver an intended result

[SOURCE: ISO 9000:2015, 3.4.1, modified — Notes 1-6 have been deleted.]

3.17

property

facet or attribute of an object referenced by a name

EXAMPLE Abby's car has the colour red, where "colour red" is a property of the car.

[SOURCE: ISO 19143:2010, 4.21, modified — Example has been added to the entry.]

3.18

property type

characteristic of a feature type

Note 1 to entry: The value for an instance of an observable property type can be estimated through an act of observation.

EXAMPLE Cars (a feature type) all have a characteristic colour, where "colour" is a property type.

Note 2 to entry: In chemistry-related applications, the term "determinand" or "analyte" is often used.

Note 3 to entry: Adapted from ISO 19109:2005.

3.19

proximate feature-of-interest

entity that is directly of interest in the act of observing

Note 1 to entry: This is a specialized form of the feature-of-interest

3.20

range

<coverage> set of feature attribute values associated by a function, the coverage, with the elements of the domain of a coverage

Note 1 to entry: This is consistent with the more generic definition of range in ISO 19107:2019.

[SOURCE: ISO/DIS 19123-1, 3.1.47]

3.21

sample

object that is representative of a concept, real-world object or phenomenon

3.22

sampler

device or entity (including humans) that is used by, or implements, a sampling procedure to create or transform one or more sample(s)

3.23

sensor

element of a measuring system that is directly affected by a phenomenon, body, or substance carrying a quantity to be measured

[SOURCE: ISO/IEC Guide 99:2007, 3.8, modified — Example and Note 1 to entry were deleted.]

3.24

ultimate feature-of-interest

entity that is ultimately of interest in the act of observing

Note 1 to entry: This is a specialized form of the feature-of-interest.

3.25

unit of measure

reference quantity chosen from a unit equivalence group

Note 1 to entry: In positioning services, the usual units of measurement are either angular units or linear units. Implementations of positioning services must clearly distinguish between SI units and non-SI units. When non-SI units are employed, it is required that their relation to SI units be specified.

[SOURCE: ISO 19116:2019, 3.29]

3.26

value

element of a type domain

Note 1 to entry: A value considers a possible state of an object within a class or type (domain).

Note 2 to entry: A data value is an instance of a datatype, a value without identity.

Note 3 to entry: A value can use one of a variety of scales including nominal, ordinal, ratio and interval, spatial and temporal. Primitive datatypes can be combined to form aggregate datatypes with aggregate values, including vectors, tensors and images.

[SOURCE: ISO/IEC 19501:2005, 0000_5, modified — Note 3 to entry has been added.]

4 Document conventions

4.1 Abbreviated terms and acronyms

GFM General Feature Model

GML	Geography Markup Language
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
O&M	Observations and Measurements (ISO 19156:2011)
OMS	Observations, Measurements and Samples (this current version of ISO 19156)
OGC	Open Geospatial Consortium
SensorML	OGC Sensor Model Language
SOS	OGC Sensor Observation Service
STA	OGC SensorThings API
SWE	OGC Sensor Web Enablement
UML	Unified Modeling Language
XML	Extensible Markup Language
2-D	Two Dimensional
3-D	Three Dimensional

4.2 Schema language

The conceptual schema specified in this International Standard is in accordance with the Unified Modelling Language (UML) ISO/IEC 19501, following the guidance of ISO 19103:2015.

The UML in Abstract Core and Basic packages is conformant with the profile described in ISO 19136-1:2020, Annex E. Use of this restricted idiom supports direct transformation into a GML Application Schema. ISO 19136 introduces some additional stereotypes. In particular «FeatureType» implies that a class is an instance of the «metaclass» GF_FeatureType (ISO 19109), and therefore represents a feature type.

The prose explanation of the model uses the term “property” to refer to both class attributes and association roles. This is consistent with the General Feature Model described in ISO 19109. In the context of properties, the term “value” refers to either a literal (for attributes whose type is simple), or to an instance of the class providing the type of the attribute or target of the association. Within the explanation, the property names (property types) are sometimes used as natural language words where this assists in constructing a readable text.

4.3 Model element names

This International Standard specifies a model for observations using terminology that is based on current practice in a variety of scientific and technical disciplines. It is designed to apply across disciplines, so the best or “most neutral” term has been used in naming the classes, attributes and associations provided. The terminology does not, however, correspond precisely with any single discipline. As an aid to implementers, a mapping from the element names specified in this International Standard to common terminology in some application domains is provided in Annex B.

4.4 Requirements and recommendations

All requirements are **normative**, and each is presented with the following template:

Requirement /req/{pkg}/{classM}/{reqN}	[Normative statement]
---	-----------------------

where **/req/{pkg}/{classM}/{reqN}** identifies the requirement. The use of this layout convention allows the normative provisions of this standard to be easily located by implementers.

All defined classes, attributes and associations mentioned within requirements or recommendations are shown in **bold** correspond to references to the definition of the referenced element.

The following base (**/req/{pkg}/**) has been used per package:

- a) **/req/obs-cpt**: Conceptual Observation schema;
- b) **/req/obs-core**: Abstract Observation Core;
- c) **/req/obs-basic**: Basic Observations;
- d) **/req/sam-cpt**: Conceptual Sample schema;
- e) **/req/sam-core**: Abstract Sample core;
- f) **/req/sam-basic**: Basic Samples.

In the lines below, the base (**/req/{pkg}/**) has been left out for better readability.

For naming of individual requirements pertaining to classes, the following syntax is used:

— **{Class Name}-sem**: The semantic definition of the concept, together with the naming of the Class.

For naming of individual requirements pertaining to attribute or associations, the following syntax is used:

- **{Attribute/Association Name}-sem**: The semantic definition of the concept, together with the naming of the attribute or association role. Except for cases where concepts are mandatory within all packages, these statements are phrased to be cardinality neutral, e.g. they also apply to cardinality 0..*;
- **{Attribute/Association Name}-type**: Type information pertaining to the attribute or association when the type is constrained within one model package;
- **{Attribute/Association Name}-card**: Cardinality information pertaining to the attribute or association;
- **{Attribute/Association Name}-con**: Additional constraints. As these sometimes pertain to multiple attributes or associations, this part of the name may become more complex.

Please note that the individual requirements are case sensitive, following UML naming conventions. Requirements pertaining to classes contain the class name in UpperCamelCase, requirements pertaining to associations utilize the association role name in lowerCamelCase.

All recommendations are **informative**, and each is presented with the following template:

Recommendation /rec/{pkg}/{classM}/{recO}	[Informative statement]
--	-------------------------

where **/rec/{pkg}/{classM}/{recO}** identifies the recommendation. The use of this layout convention allows the informative provisions of this standard to be easily located by implementers.

4.5 Requirements classes

Each statement (requirement or recommendation) in this standard is a member of a requirements class.

All requirement classes are normative.

Each requirements class is described in a discrete clause, and summarized using the following template:

Requirements class	/req/{pkg}/{classM}
Target type	[artefact or technology type]
Name	Name of the requirements class
Imports	/req/{pkg}/{classZ}
Requirement	/req/{pkg}/{classM}/{reqN}
Recommendation	/rec/{pkg}/{classM}/{recO}
Requirement	/req/{pkg}/{classM}/{reqP}
Requirement /Recommendation	[repeat as necessary]

All requirements in a class must be satisfied. Hence, the requirements class is the unit of re-use and dependency.

Dependency to another requirement class (and the requirements and recommendations defined in it) is done using the “Imports” keyword. All requirements in a dependency SHALL also be satisfied by a conforming implementation.

A requirements class may consist only of dependencies and introduce no new requirements.

4.6 Conformance classes

Conformance to this standard is possible at a number of levels, specified by conformance classes (Annex A). Each conformance class is summarized using the following template:

Conformance Class	/conf/{pkg}/{classM}
Requirements	[identifier for the requirements class]
Test purpose	[Reason for test]
Test method	[Method to determine if test fulfilled]
Test Type	[Type of test]

All tests in a class must be passed. Each conformance class tests conformance to a set of requirements packaged in a requirements class.

4.7 Identifiers

Each requirements class, requirement and recommendation is identified by a unique identifier. This allows cross-referencing of class membership, dependencies, and links from each conformance test to the requirements tested. Appended to a base URI that identifies the specification as a whole, it enables the construction of a complete URI for identification in an external context.

The entire Requirements and Conformance Structure, consisting of the individual requirements and definitions together with the information on how these are linked together for the creation of Requirements and Conformance classes, will be exposed in a machine actionable format (such as the one provided by the OGC Definitions Server).

The URI for each requirements class has the form:

<http://www.opengis.net/spec/om/3.0/req/pkg/classM>

The URI for each requirement has the form:

<http://www.opengis.net/spec/om/3.0/req/pkg/classM/reqN>

The URI for each recommendation has the form:

<http://www.opengis.net/spec/om/3.0/rec/pkg/classM/recO>

The URI for each conformance class has the form:

<http://www.opengis.net/spec/om/3.0/conf/pkg/classM>

5 Conformance

5.1 Overview

Clauses 7 to 13 of this International Standard use the Unified Modeling Language (UML) to present conceptual schemas for describing Observations. These schemas define conceptual classes that:

- a) may be considered to comprise a cross-domain application schema, or;
- b) may be used in application schemas, profiles and implementation specifications.

This flexibility is controlled by a set of UML types that can be implemented in a variety of manners. Use of alternative names that are more familiar in a particular application is acceptable, provided that there is a one-to-one mapping to classes and properties in this International Standard.

The UML model in this International Standard defines conceptual classes. Various software systems define implementation classes or data structures. All of these reference the same information content. The same name may be used in implementations as in the model, so that types defined in the UML model may be used directly in application schemas.

Annex A defines a set of conformance tests that will support applications whose requirements range from the minimum necessary to define data structures to full object implementation.

5.2 Conformance classes related to models including Observations, Measurements and Samples

The conformance rules for Models in general are described in ISO 19109:2015. Application Schemas also claiming conformance to this International Standard shall also conform to the rules specified in Clauses 7 to 13 and pass all relevant test cases of the Abstract Test Suite in Annex A.

Depending on the characteristics of the implementing model application, schema or profile, one or more of the declared conformance classes can be chosen for fine-grained Observations, Measurements and Samples conformance. Table 1, Table 2, Table 3, Table 4, Table 5, and Table 6 list all of these the classes by package, their relative identifiers and the corresponding subclauses of the Abstract Test Suite. The full URIs of the conformance classes is formed by prefixing the relative URI path as described in Clause 4.7.

Table 1 — Conceptual Observation schema conformance classes

Conformance class	Identifier	Annex A clause
Conceptual Observation schema package	/conf/obs-cpt	A.1.1
Conceptual Observation - Deployment	/conf/obs-cpt/Deployment	A.1.2
Conceptual Observation - Host	/conf/obs-cpt/Host	A.1.3
Conceptual Observation - ObservableProperty	/conf/obs-cpt/ObservableProperty	A.1.4
Conceptual Observation - Observation	/conf/obs-cpt/Observation	A.1.5
Conceptual Observation - Observer	/conf/obs-cpt/Observer	A.1.6
Conceptual Observation - ObservingProcedure	/conf/obs-cpt/ObservingProcedure	A.1.7
Conceptual Observation - Procedure	/conf/obs-cpt/Procedure	A.1.8

Table 2 — Abstract Observation core conformance classes

Conformance class	Identifier	Annex A clause
Abstract Observation core package	/conf/obs-core	A.2.1
Abstract Observation core - AbstractDeployment	/conf/obs-core/AbstractDeployment	A.2.2
Abstract Observation core - AbstractHost	/conf/obs-core/AbstractHost	A.2.3
Abstract Observation core - AbstractObservableProperty	/conf/obs-core/AbstractObservableProperty	A.2.4
Abstract Observation core - AbstractObservation	/conf/obs-core/AbstractObservation	A.2.5
Abstract Observation core - AbstractObservationCharacteristics	/conf/obs-core/AbstractObservationCharacteristics	A.2.6
Abstract Observation core - AbstractObserver	/conf/obs-core/AbstractObserver	A.2.7
Abstract Observation core - AbstractObservingProcedure	/conf/obs-core/AbstractObservingProcedure	A.2.8
Abstract Observation core - NamedValue	/conf/obs-core/NamedValue	A.2.9

Table 3 — Basic Observations conformance classes

Conformance class	Identifier	Annex A clause
Basic Observations package	/conf/obs-basic	A.3.1
Basic Observations - Deployment	/conf/obs-basic/Deployment	A.3.2
Basic Observations - GenericDomainFeature	/conf/obs-basic/GenericDomainFeature	A.3.3
Basic Observations - Host	/conf/obs-basic/Host	A.3.4
Basic Observations - ObservableProperty	/conf/obs-basic/ObservableProperty	A.3.5
Basic Observations - Observation	/conf/obs-basic/Observation	A.3.6
Basic Observations - ObservationCharacteristics	/conf/obs-basic/ObservationCharacteristics	A.3.7
Basic Observations - ObservationCollection	/conf/obs-basic/ObservationCollection	A.3.8
Basic Observations - Observer	/conf/obs-basic/Observer	A.3.9
Basic Observations - ObservingCapability	/conf/obs-basic/ObservingCapability	A.3.10
Basic Observations - ObservingProcedure	/conf/obs-basic/ObservingProcedure	A.3.11

Table 4 — Conceptual Sample schema conformance classes

Conformance class	Identifier	Annex A clause
Conceptual Sample schema package	/conf/sam-cpt	A.4.1
Conceptual Sample - PreparationProcedure	/conf/sam-cpt/PreparationProcedure	A.4.2
Conceptual Sample - PreparationStep	/conf/sam-cpt/PreparationStep	A.4.3
Conceptual Sample - Sample	/conf/sam-cpt/Sample	A.4.4
Conceptual Sample - Sampler	/conf/sam-cpt/Sampler	A.4.5
Conceptual Sample - Sampling	/conf/sam-cpt/Sampling	A.4.6
Conceptual Sample - SamplingProcedure	/conf/sam-cpt/SamplingProcedure	A.4.7

Table 5 — Abstract Sample core conformance classes

Conformance class	Identifier	Annex A clause
Abstract Sample core package	/conf/sam-core	A.5.1
Abstract Sample core - AbstractPreparation-Procedure	/conf/sam-core/AbstractPreparation-Procedure	A.5.2
Abstract Sample core - AbstractPreparation-Step	/conf/sam-core/AbstractPreparation-Step	A.5.3
Abstract Sample core - AbstractSample	/conf/sam-core/AbstractSample	A.5.4
Abstract Sample core - AbstractSampler	/conf/sam-core/AbstractSampler	A.5.5
Abstract Sample core - AbstractSampling	/conf/sam-core/AbstractSampling	A.5.6
Abstract Sample core - AbstractSamplingPro- cedure	/conf/sam-core/AbstractSamplingPro- cedure	A.5.7

Table 6 — Basic Samples conformance classes

Conformance class	Identifier	Annex A clause
Basic Samples package	/conf/sam-basic	A.6.1
Basic Samples - MaterialSample	/conf/sam-basic/MaterialSample	A.6.2
Basic Samples - NamedLocation	/conf/sam-basic/NamedLocation	A.6.3
Basic Samples - PhysicalDimension	/conf/sam-basic/PhysicalDimension	A.6.4
Basic Samples - Sample	/conf/sam-basic/Sample	A.6.5
Basic Samples - SampleCollection	/conf/sam-basic/SampleCollection	A.6.6
Basic Samples - Sampler	/conf/sam-basic/Sampler	A.6.7
Basic Samples - Sampling	/conf/sam-basic/Sampling	A.6.8
Basic Samples - SpatialSample	/conf/sam-basic/SpatialSample	A.6.9
Basic Samples - StatisticalClassification	/conf/sam-basic/StatisticalClassification	A.6.10
Basic Samples - StatisticalSample	/conf/sam-basic/StatisticalSample	A.6.11

6 Packaging, requirements and dependencies

6.1 Requirements

As OMS implementations often seamlessly integrate with existing data ecosystems, a very flexible requirements and conformance structure is defined. This structure enables users to selectively mix and match elements as required for their purposes from the OMS data model without the necessity of achieving compliance with the entire data model.

Such flexibility is becoming increasingly relevant with the shift to Linked Data practices, where different organizations maintain and expose only certain aspects of a larger distributed dataset.

EXAMPLE A provider may only serve information on Observable Properties or Monitoring Facilities, while relying on other partners to provide information on measurement procedures. These could claim compliance to those parts falling under their responsibility, while letting other data providers link to these resources.

For this purpose, a fine grained structure for requirements and recommendations, requirements classes and conformance classes has been defined. As far as possible, patterns from the OGC Modular Specification^[26] have been taken into account. However, pertaining to the alignment between UML

Packages and Conformance Classes, a relaxation of the requirement on one-to-one alignment between UML Package and Conformance Class has been proposed as follows:

- a) For each UML Package, both a Requirements Class as well as a Conformance Class have been defined;
- b) Additional Requirements Classes have been created for each Class appearing in the data model, Conformance Classes are added accordingly to enable grouping of the formers and support references to either a group or an individual Requirement Class depending on the need;
- c) Thematic Domains may create additional Requirements and Conformance Classes reflecting their domain profiles by reference to existing Requirements and Requirements Classes.

As mentioned, as data provision paradigms increasingly shift towards distributed and linked approaches, stipulating that all aspects of an information system conform explicitly to the same underlying standards becomes increasingly difficult. Simultaneously, as distributed data provision becomes increasingly ubiquitous, ever more communities are emerging dedicated to individual aspects of the wider data provision landscape.

One example of such external definition and hosting pertains to the provision of observable properties. In previous versions of the O&M Model, the observable properties concept was only included as a metaclass, with the assumption that a reference to an existing code list will be provided. Within the current OMS Model, the observable property has been upgraded to a featureType. This is because emerging requirements show the need for a more detailed model for this concept. Simultaneously, other communities, such as the Research Data Alliance (RDA), are also working on observable property models (I-ADOPT). The same rationale can be applied to most concepts from the OMS Model.

In order to expose this flexibility beyond the package structure described above, a fine grained hierarchical requirements class structure was created. A modular requirements class is provided for each concept at all three levels of the model. In addition, a further requirements class that imports all the modular classes provided for the individual concepts has been provided for each package.

6.2 UML

6.2.1 UML package structure

OMS provides the relevant concepts for the structured description of observations, including the sampling structure often essential for true understanding of the nature of the observations being provided. As data provision mechanisms are transitioning towards highly distributed linked approaches, the model structure and packaging has been significantly abstracted. This approach allows implementers to explicitly select the concepts to be supported based on their requirements, while clearly stating to which requirements and Conformance Classes their implementation complies. Both the Observation and Sample sections of this model have been structured using the following layering of packages:

- a) **Conceptual:** Within the Conceptual Model Packages, only Interfaces are provided. These models provide a very abstract view of the individual concepts they contain without reference to specific implementations. This approach allows for the inclusion of semantically aligned objects from external sources, that while not having been created under the Observations, Measurements and Samples Model, do provide concepts sharing the same semantic meaning as the concepts from the Conceptual Models;
- b) **Abstract Core:** Within the Abstract Core Model Packages, only abstract featureTypes are provided following the semantic structure of the Conceptual model (i.e: realizing the interfaces provided by the Conceptual Model Packages). A consistent approach to metadata provision is introduced. All associations from the abstract featureTypes reference the conceptual Interfaces for greater implementation flexibility. The Abstract Core Model Packages are foreseen for the creation of domain models providing an Abstract Core ready for Extension;

- c) **Basic:** Within the Basic Packages, simple concrete featureTypes (specializing the abstract ones from the Abstract Core model) have been defined with some basic utility attributes added for rapid out-of-the-box deployment. A few additional concepts pertaining to collections and potential observations are introduced at this level.

6.2.2 UML package dependencies

Some model elements used in the schema are defined in other International Standards. The Table 7 lists the dependencies between the UML packages defined in this International Standard and other International Standards, and the Figure 1 show the dependencies of the entire OMS UML model package to the other International Standards in a graphical form.

Table 7 — UML package level dependencies

Dependency from package	to package	in an International Standard	Notes
Conceptual Observation schema	Any type	ISO 19103:2015 (Edition 1)	Any
Conceptual Observation schema	Temporal Objects	ISO 19108:2002 (Edition 1)	TM_Object
Conceptual Observation schema	Name types	ISO 19103:2015 (Edition 1)	GenericName
Abstract Observation core	Conceptual Observation schema	This International Standard	TM_Instant, TM_Period via the Temporal Objects dependency
Abstract Observation core	General Feature Model	ISO 19109:2015 (Edition 2)	Feature concepts
Abstract Observation core	Text	ISO 19103:2015 (Edition 1)	CharacterString
Basic Observations	Abstract Observation core	This International Standard	
Basic Observations	Web environment	ISO 19103:2015 (Edition 1)	URI
Basic Observations	Geometry	ISO 19107:2019 (Edition 2)	Geometry
Conceptual Sample schema	Any type	ISO 19103:2015 (Edition 1)	Any
Conceptual Sample schema	Temporal Objects	ISO 19108:2002 (Edition 1)	TM_Object
Conceptual Sample schema	Name types	ISO 19103:2015 (Edition 1)	GenericName
Conceptual Sample schema	Conceptual Observation schema	This International Standard	Observation, Procedure
Abstract Sample core	Conceptual Sample schema	This International Standard	
Abstract Sample core	General Feature Model	ISO 19109:2015 (Edition 2)	Feature concepts
Abstract Sample core	Geometry	ISO 19107:2019 (Edition 2)	Geometry
Abstract Sample core	Text	ISO 19103:2015 (Edition 1)	CharacterString
Abstract Sample core	Abstract Observation core	This International Standard	NamedValue
Basic Samples	Abstract Sample core	This International Standard	
Basic Samples	Web environment	ISO 19103:2015 (Edition 1)	URI
Basic Samples	Measure types	ISO 19103:2015 (Edition 1)	Measure

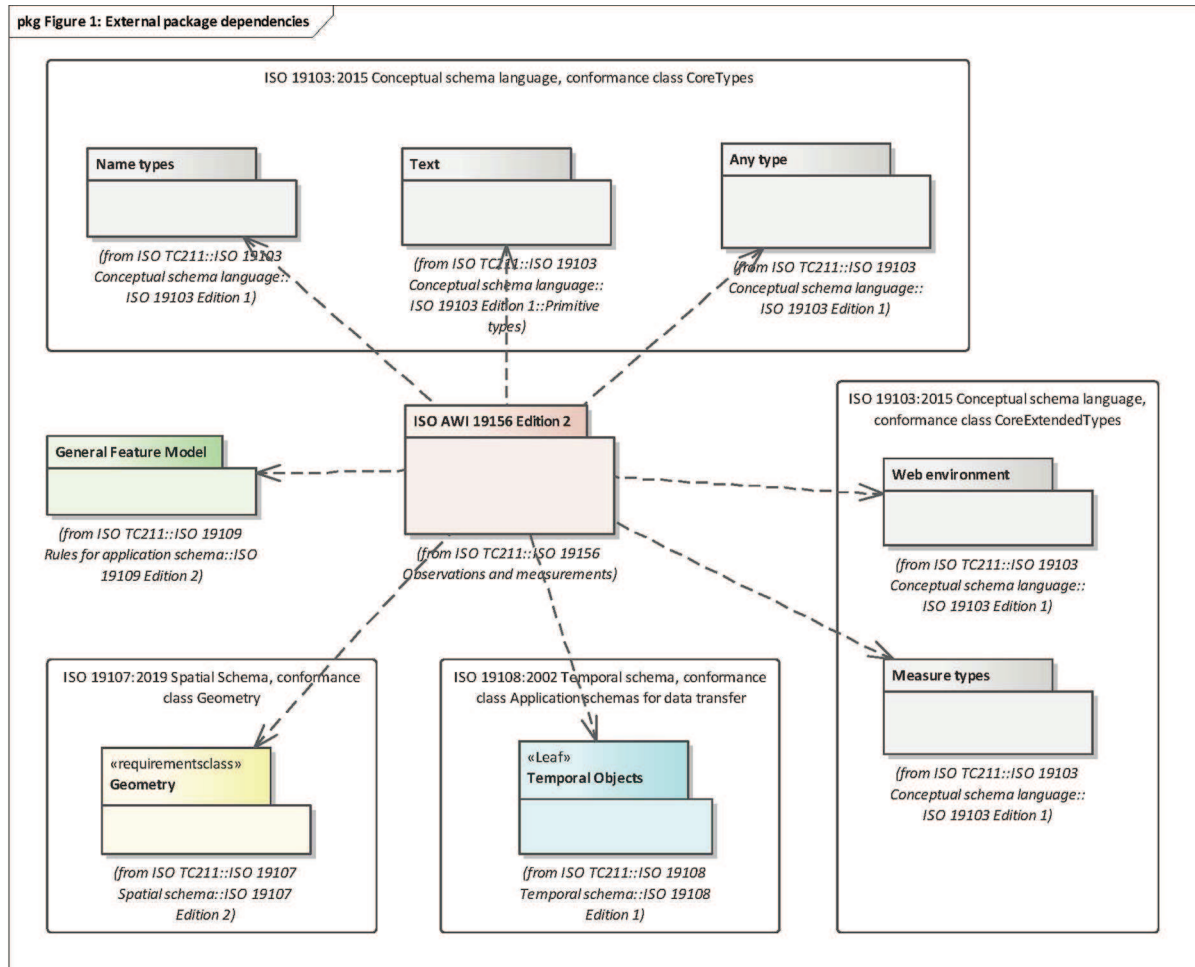


Figure 1 — External UML package dependencies

6.3 Note on the use of Any

The UML models defined in this International Standard make extensive use of the Any interface defined in ISO 19103:2015 Any type package. The realized Any values of the associations with role names **proximateFeatureOfInterest**, **ultimateFeatureOfInterest**, **result**, **metadata**, **featureOfInterest** and **sampledFeature** MAY be of any type or a reference to an digital representation of an appropriate concept. In the case they are of feature type, the values are not owned by the instances of referring classes, they may have an independent life span from the referring classes, and they may be associated with more than one instance of referring classes.

NOTE Any type can be owl:Thing, featureType, dataType

EXAMPLES

- Reference to SWEET Ontology: <http://sweetontology.net/realmAtmoBoundaryLayer#planetaryboundarylayer>
- Reference to SensorThings deployment: [https://lubw-frost.docker01.ilt-dmz.iosb.fraunhofer.de/v1.1/Locations\(269\)](https://lubw-frost.docker01.ilt-dmz.iosb.fraunhofer.de/v1.1/Locations(269))
- Reference to 19115 Metadata: https://inspire-geoportal.ec.europa.eu/resources/INSPIRE-61494ff5-6fad-11e8-b649-52540023a883_20210415-080302/services/1/PullResults/701-750/43.iso19139.xml
- Reference to an instance of Borehole : <https://data.geoscience.fr/id/borehole/BSS001REWW>
- Reference to an hydro station : <https://iddata.eaufrance.fr/id/HydroStation/Y251002001>

- Reference to a river segment : <https://iddata.eaufrance.fr/id/WatercourseLinkSequence/A0080300>
- An (embedded) Boolean value as Result
- An (embedded) SWE DataRecord
- Elevation Coverage from an external WCS as an observation Result: [https://inspire.rasdaman.org/rasdaman/ows?service=WCS&version=2.0.1&request=GetCoverage&coverageId=INSPIRE_EL&subset=E\(494500,496000\)&subset=N\(4654300,4655000\)&format=image/jpeg](https://inspire.rasdaman.org/rasdaman/ows?service=WCS&version=2.0.1&request=GetCoverage&coverageId=INSPIRE_EL&subset=E(494500,496000)&subset=N(4654300,4655000)&format=image/jpeg)
- OMS MaterialSample -> Reference to a rock sample : https://www.geodata.rocks/Samples/SD-5054_1_A_564_7WR_20-40

7 Fundamental characteristics of observations and samples (informative)

7.1 Observation schema

7.1.1 Property evaluation

Properties of a feature fall into two basic categories:

- a) Value (e.g. name, price, legal boundary) assigned by some authority. These are exact;
- b) Value (e.g. height, classification, colour) determined by application of an observation procedure.

These are estimates, with a finite error associated with the value.

The observation error typically has a systematic component, which is similar for all estimates made using the same procedure, and a random component, associated with the particular application instance of the observation procedure. If potential errors in a property value are important in the context of a data analysis or processing application, then the details of the act of observation which provided the estimate of the value are required.

7.1.2 Observation

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 characteristic. This act 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. The result of an observation is an estimate of the value of a property of some feature; an observation is a property-value-provider for a feature-of-interest. Use of a common model allows observation data using different procedures to be combined unambiguously.

In conventional measurement theory (e.g. [12], [15], [16], [17], [19], [24]) the term “measurement” is used. However, a distinction between measurement and category-observation has been adopted in more recent work [13], [18], [25] so the term “observation” is used here for the general concept. “Measurement” may be reserved for cases where the result is a numerical quantity.

The observation itself is also a feature, since it has properties and identity.

Observation details are important for data discovery and for data quality estimation.

The observation could be considered to carry “property-level” instance metadata, which complements the dataset-level and feature-level metadata commonly provided via catalogue services (e.g. ISO 19115 or other community agreed one).

7.1.3 Properties of an Observation

An observation results in a value being assigned to a characteristic. The characteristic is a property of a feature, the latter being the feature-of-interest of the observation. The observation uses a specified

procedure performed by an observer, which is often an instrument or sensor^{[12], [13]} but may be a process chain, human observer, an algorithm, a computation or simulator. The key idea is that the observation result is an estimate of the value of some quality (property, characteristic) of the feature-of-interest, and the other properties of the observation provide context or metadata to support evaluation, interpretation and use of the result. The diagram below (based on representation work done under INSPIRE^[30]) provides a visual overview of this.

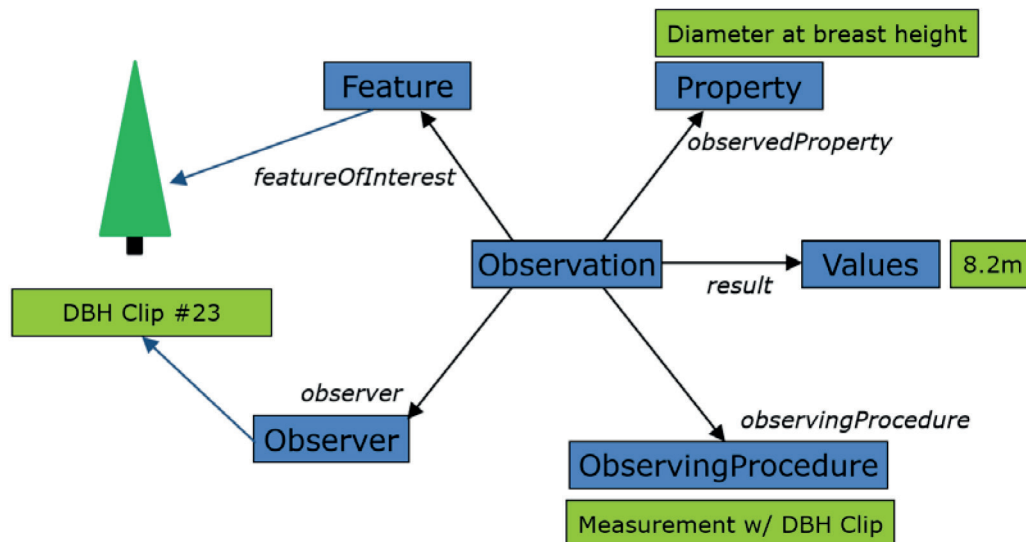


Figure 2 — Properties of an Observation

The relationship between the properties of an observation and those of its feature-of-interest is key to the semantics of the data model elaborated in this standard. This is further elaborated in Annex D.3.

7.1.4 Observation location

The principal location of interest of an observation is usually associated with the ultimate feature-of-interest.

However, the location of the feature-of-interest may not be readily available. For example, in remote sensing applications, a complex processing chain is required to geolocate the scene or swath. In feature-detection applications the initial observation may be made on a scene, but the entity to be detected, which is the ultimate feature-of-interest, occupies some location within it. The distinction between the proximate and ultimate feature-of-interest is a key consideration in these cases. The proximate feature-of-interest is the object upon which the measurement is directly performed, whereas the ultimate feature-of-interest is the object for which this measurement is ultimately seen as representative of.

Other locations may be relevant in various scenarios. Sub-sampling at locations within the feature-of-interest may occur. The procedure may involve a sensor located remotely from the ultimate feature-of-interest such as in remote sensing, or where specimens are removed from their sampling location and observations made ex-situ (the sampling schema description below elaborates on this). Furthermore, the location of the feature-of-interest may be time-dependent.

The model is generic. The geospatial location of the feature-of-interest may be of little or no interest for some observations (e.g. live specimens, observations made on non-located things like chemical species).

For these reasons, a generic Observation class does not have an inherent location property. Relevant location information should be provided by the feature-of-interest, by the sampling procedure, or by the observation procedure, according to the specific scenario.

NOTE In contrast to spatial properties, some temporal properties are associated directly with an observation (Clauses 8.2.3; 8.2.4). This is due to the fact that an observation is a kind of ‘event’ so its temporal characteristics are fundamental, rather than incidental.

7.1.5 Result types

Observation results may have many datatypes, including primitive types like category or measure, but also may have more complex types such as time, location and geometry. Complex results are obtained when the observed property requires multiple components for its encoding. Furthermore, if the property varies on the feature-of-interest, then the result is a coverage, whose domain extent is the extent of the feature. In reality, the result will typically be sampled discretely on the domain, and may be represented as a discrete coverage.

Building on this, specialized observation types can be defined by communities to describe the type of result provided, expressed using a terminology common to that community.

7.1.6 Use of the observation model

The observation model takes a data-user-centric viewpoint, emphasizing the semantics of the feature-of-interest and its properties. This contrasts with sensor-oriented models, which take a process- and thus a provider-centric viewpoint.

The digital representation of an observation is a property-value-provider for a feature-of-interest. Aside from the result, the details of the observation event are primarily of interest in applications where an evaluation of errors in the estimate of the value of a property is of concern. The observation could be considered to carry “property-level” instance metadata, complementing the dataset-level and feature-level metadata that have been conventionally considered (e.g. ISO 19115-1:2014).

Additional discussion of the application of the observation and sample models, and nuances within these, is provided in Annex D.

7.2 Sample schema

7.2.1 Role of sample features

A sample may act as a proxy for the ultimate feature-of-interest of an observation, and be associated with this observation by the role feature-of-interest. In this case the sampled-feature association of sample would point upwards in the chain of sampled features leading to ultimate feature-of-interest of the observation. The sample may also be associated with observations, both those being made directly on the sample as well as observations on other samples.

7.2.2 Proximate vs. ultimate feature-of-interest

7.2.2.1 Introduction

The observation model maps the result of the application of a procedure to a subject, which plays the role of feature-of-interest of the observation. However, the proximate feature-of-interest of an observation may not be the ultimate domain-specific feature whose properties are of interest in the investigation of which the observation is a part. There are three circumstances that can lead to this:

- a) The observation does not obtain values for the whole of a domain feature;
- b) The observation is performed on a proxy that is not part of the domain feature;

- c) The observation procedure obtains values for properties that are not characteristic of the type of the ultimate feature.

Furthermore, in some practical situations, multiple differences apply.

7.2.2.2 Proximate feature-of-interest embodies a sample design

For various reasons, the domain feature may not be fully accessible. In such circumstances, the procedure for estimating the value of a property of the domain feature involves sampling in representative locations. Then the procedure for transforming a property value observed on the sample to an estimate of the property on the ultimate feature-of-interest depends on the sample design.

EXAMPLE 1 The chemistry of water in an underground aquifer is sampled at one or more positions in a well or bore.

EXAMPLE 2 The magnetic field of the earth is sampled at positions along a flight-line. In contrast to the well in the example above, the flight-line does not represent a real-world object.

EXAMPLE 3 The structure of a rock mass is observed on a cross-section exposed in a river bank.

EXAMPLE 4 The bubble of air around the intake of an air quality monitoring station is taken as representative for the wider air around the station. Again, a virtual feature serves as proximate feature-of-interest.

In other cases, where direct observation of the domain feature is not possible, the observation may be performed on a proxy.

EXAMPLE 5 In order to measure the intensity of the sun's light, the reflectance on a white sheet of paper may be utilized as a proxy for the sun's intensity.

In some cases, the observation procedure obtains values for properties that are not characteristic of the type of the ultimate feature

EXAMPLE 6 The salinity of water in a well is measured, the feature-of-interest of this well is an aquifer. However, the final target of the observation is the fluid body contained within the aquifer (see Figure 8).

7.2.2.3 Observed property is a proxy

The procedure for obtaining values of the property of interest may be indirect, relying on direct observation of a more convenient parameter which is a proxy for the property of interest. Application of an algorithm or processing chain obtains an estimate of the ultimate property of interest.

The observation model requires that the feature-of-interest of the initial observation be of a type that carries the observed property within its properties. Thus, if the proxy property is not a member of the ultimate feature-of-interest, a proxy feature with a suitable model shall be involved.

EXAMPLE 1 A remote sensing observation might obtain the reflectance colour, when the investigation is actually interested in vegetation type and quality. The feature which contains reflectance colour is a scene or swath, while the feature carrying vegetation properties is a parcel or tract.

EXAMPLE 2 The direct value coming from a sensor may be quantified as a voltage, whereas the observed property represented by this voltage is the physiochemical value being observed by the sensor (ex: pH).

7.2.2.4 Combination

These variations may be combined if exhaustive observation of the domain feature is impractical, and direct measurement is of a proxy property.

EXAMPLE For certain styles of mineralization, the gold concentration of rocks in a region might be estimated through measurement of a related element (e.g. copper), in a specimen of gravel collected from a stream that drains part of the region. The gravel samples the rocks in the catchment of the stream, i.e. in the stream bed and upslope.

7.2.3 Role of Sample

Samples are artefacts of an observational strategy, and have no significant function outside of their role in the observation process. The physical characteristics of the samples themselves are of little interest, except perhaps to the manager of a sampling campaign.

EXAMPLE 1 In various countries/domains, terms like “site” and “station” are encountered. These usually correspond to an identifiable locality where a monitoring facility (host, platform, ...) has been established, sensors, or other measurement devices (observers) have been deployed to acquire observations on a given observable property applying a specific procedure. In the context of the observation model, the spatial sample (both proximate and ultimate) connotes the “world in the vicinity of the observer/sampler”, so the observed properties relate to the physical medium at the observer/sampler described by the sample, and not to any physical artefact such as a mooring, buoy, benchmark, monument, well, and so forth that may be described by Host.

EXAMPLE 2 In some domains, elements are taken from their natural environment (ex-situ) curated and preserved for the purpose of keeping a trace of their existence. Examples are biodiversity studies, crop seed preservation, and so forth. In those cases, the material samples considered are called specimen. That's why the class named SF_Specimen in the previous version of the standard is renamed into MaterialSample in this updated version.

EXAMPLE 3 Statistical samples usually apply to populations or other sets, of which certain subset may be of specific interest.

NOTE A transient spatial sample, such as a ships-track or flight-line, might be identified and described, but is unlikely to be revisited exactly.

A sample is intended to sample some object in an application domain. However, in some cases the identity, and even the exact type, of the sampled object may not be known when observations are made using the sample.

7.2.4 Sampling process

Understanding the process by which samples are obtained is often essential to understanding the context of subsequent measurements on this object (feature-of-interest). Different sampling strategies can provide vastly different samples, in turn leading to different result values in observations pertaining to these samples.

A sample is created through the act of sampling, whereby a sampler follows a defined procedure in order to identify and/or extract representative samples from the ultimate feature-of-interest.

The nature of the sampler varies by sampling strategy; at one end of the spectrum the sampler can be a sensor or other automated measurement device; at the other end of the spectrum the sampler can be a human being providing observations or taking part in a biodiversity survey campaign.

As a dependence on the sampling strategy, a sampling procedure appropriate to the sampling act to be performed must be selected and defined. For the provision of fine-grained information pertaining to the sampling process, multiple sampling procedures can be applied to one sampling act. Multiple sampling procedures may also be required for the case where one sampling process classifies samples in accordance with multiple criteria.

EXAMPLE 1 When performing observations on populations, these may first be sampled by gender and age. Sampling Procedures describing the criteria utilized for gender and age classification can be provided individually.

A sampling event may involve very different samples, whereby some of these samples may serve purely to provide contextual information pertaining to the sampling event.

EXAMPLE 2 When sampling water from a river, information on the meteorology at the time of sampling may be relevant for the interpretation of measurements obtained on the water sample.

7.2.5 Classification of samples

A small number of common sampling patterns, similar across domains, provide a basis for processing and portrayal tools, and depend particularly on the geometry of the sample design. These provide a basis for processing and portrayal tools which are similar across domains, and depend particularly on the geometry of the sample design. Common names for sampling features include specimen, sample, site, profile, transect, path, swath and scene.

Spatial sampling is classified primarily by the topological dimension. Material samples may provide information on their original source location, but are more often characterized by their size and storage location.

In addition, various preparation steps may be performed on samples both before and after observations are performed on the sample.

Additional information on provenance, curation and methods of archiving a sample has been delegated to external standards that may be referenced via the ‘metadata’ association that can be provided for all types contained within the Sampling model.

7.3 Alignment between Observation, Sample and domain models

7.3.1 Model consistency

The type of the feature-of-interest is defined in an application schema (ISO 19109). This may be part of a domain model, or may be from a cross-domain model, such as Sample (Clause 11). The feature type defines its set of characteristics as properties. For consistency, the feature-of-interest shall carry the observed property as part of the definition of its type (e.g. Figure 4).

EXAMPLE A pallet with the characteristic mass is to be described via a feature model. In the simplest form, an interface “Pallet” may be defined as having the attribute “mass” of type “Measure” describing the mass characteristic of the pallet being described (Figure 3). However, when using this direct approach, no further measurement metadata is available, only the numeric mass is provided together with the unit of measurement.

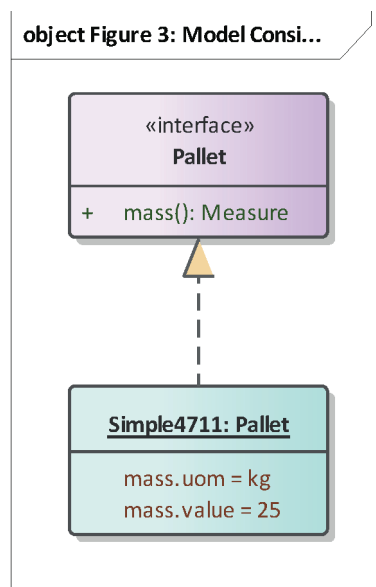


Figure 3 — (Example) Pallet interface, simple example for model consistency

Alternatively, through utilization of the OMS model, an observation providing the value of this property for the feature being investigated may be utilized to fulfil the data requirements ensuing from the Pallet Interface. This approach makes it possible for the information system to ‘describe’ how the result (here mass value) was obtained together with the relevant value.

For this purpose, the observation shall have observedProperty “mass”, the result shall be of the type “Measure” and the scale (unit of measure) shall be suitable for mass measurements. Thus, the requirements ensuing from the Pallet Interface are fulfilled, while additional relevant measurement meta-information is also provided; model consistency has been ensured. This approach is illustrated in Figure 4.

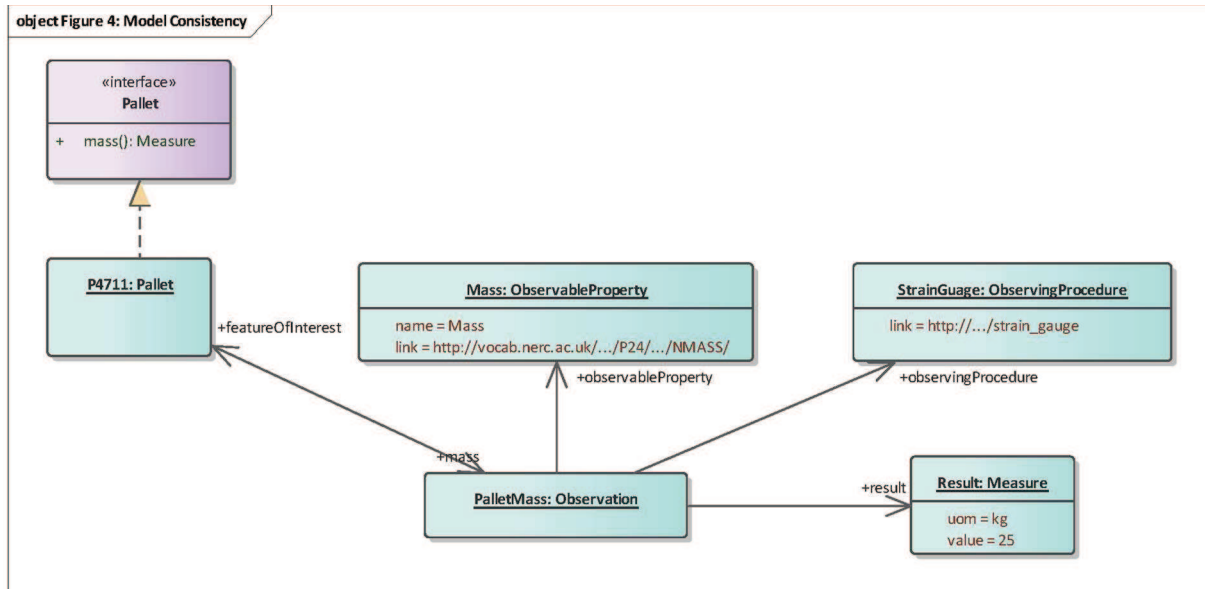


Figure 4 — (Example) An observation with consistent properties: the observed property (mass) is a characteristic associated with the type of the feature-of-interest (Pallet) and the procedure and result type are also suitable

The figure below shows a complete representation of a mass observation. In addition to the basic information provided with the observation in the preceding diagram, information on the specific measurement device used is provided together with information on where this device was deployed as the observation was performed.

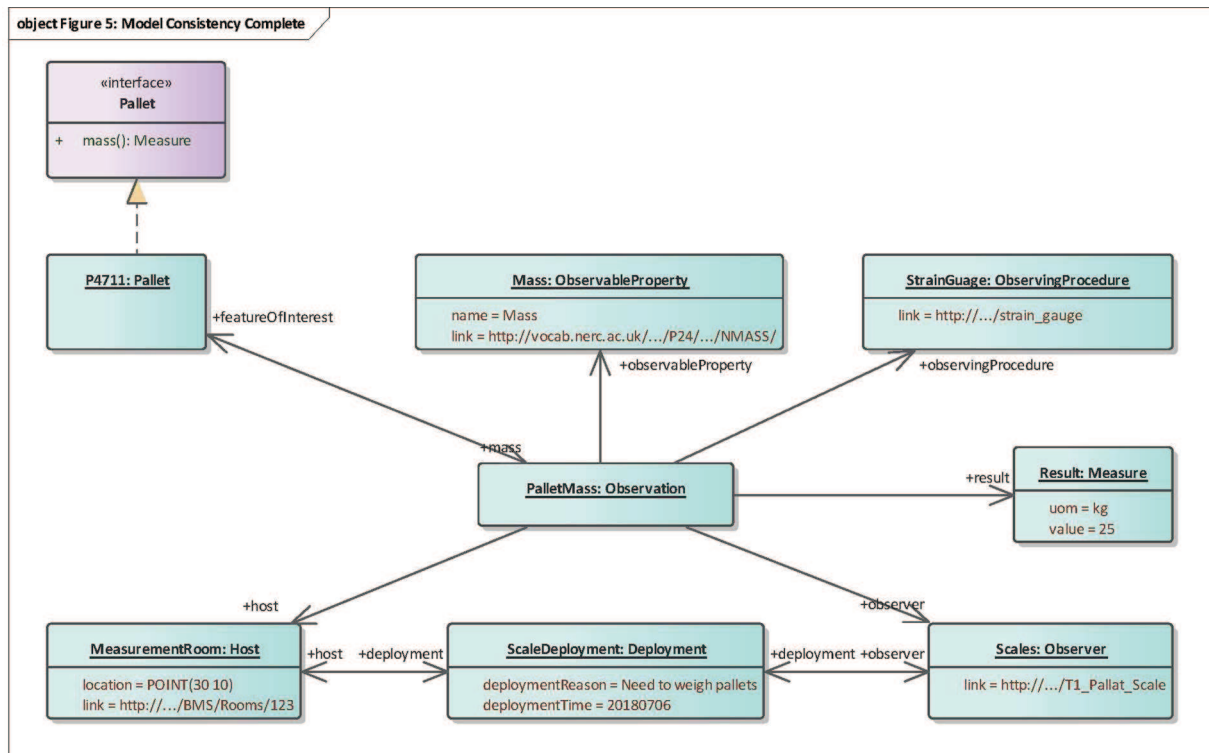


Figure 5 — (Example) An observation with complete properties: for additional context, the Observer, Host and Deployment have been added

An attribute from within the conceptual model can be instantiated as an Observation in the concrete realization. The attributes that have been defined for the domain feature within the interface, in the example “mass” and “uom”, can be realized through the association of an observation carrying this information. Formally, these two representations both realize the defined interface.

Based on the use case, when modelling one must decide whether solely providing information of type ‘Measure’ with uom is sufficient for the domain considered. In some cases, the full OMS model is required to actually discover, exchange and reuse data properly. For example, a single attribute ‘lake surface’ will be sufficient for most mapping agency needs whereas a more thorough observation description of how that surface was measured and when (e.g.: dam empty/full, rainfall observation...) is important for water management needs.

7.3.2 Relationship between Sample and domain features

A sample feature is established in order to make observations concerning some domain feature. The association “sampledFeature” links the sample feature to the feature which the sampling feature was designed to sample. The target of this association is usually a real-world feature from an application domain (see Figure 6).

EXAMPLE A profile typically samples a water- or atmospheric-column; a well samples the water in an aquifer; a tissue specimen samples a part of an organism.

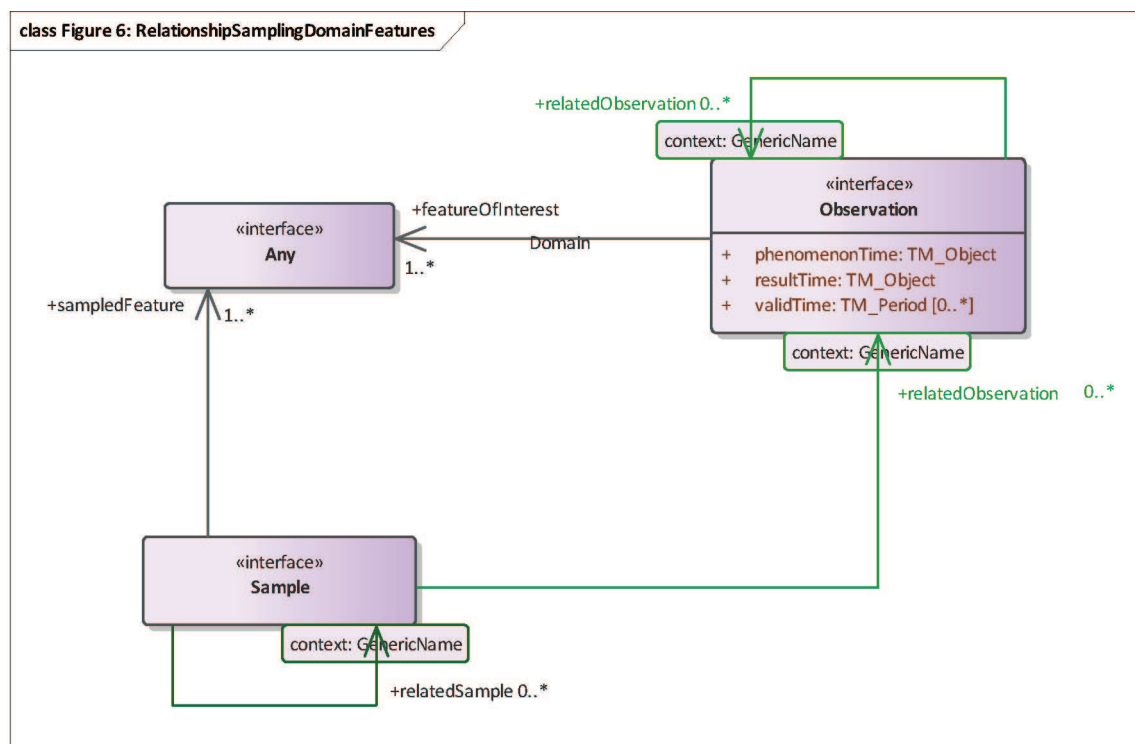


Figure 6 — (Informative) Relationship between Sample and domain features

Both the Sample and the Domain feature may appear as the feature-of-interest. If a Sample feature is involved, it samples a feature of a type defined in a domain model.

Any Domain object can be a featureOfInterest of an Observation.

The more refined example described in Figure 7 further explains how both Sample and Observation from the OMS model can interact with a domain model.

In this example, Well, Aquifer and FluidBody are modelled outside the OMS model but:

- The Well also conforms to the Sample requirements;
- Instances from the domain model are the proximate and ultimate features of interest of the WaterSalinity Observation.

The Well that samples the Aquifer acts as a proxy to the Aquifer in the observation act. The Well is thus considered as the proximateFeatureOfInterest of the Observation. The sampledFeature (the Aquifer) of the Well being the ultimateFeatureOfInterest.

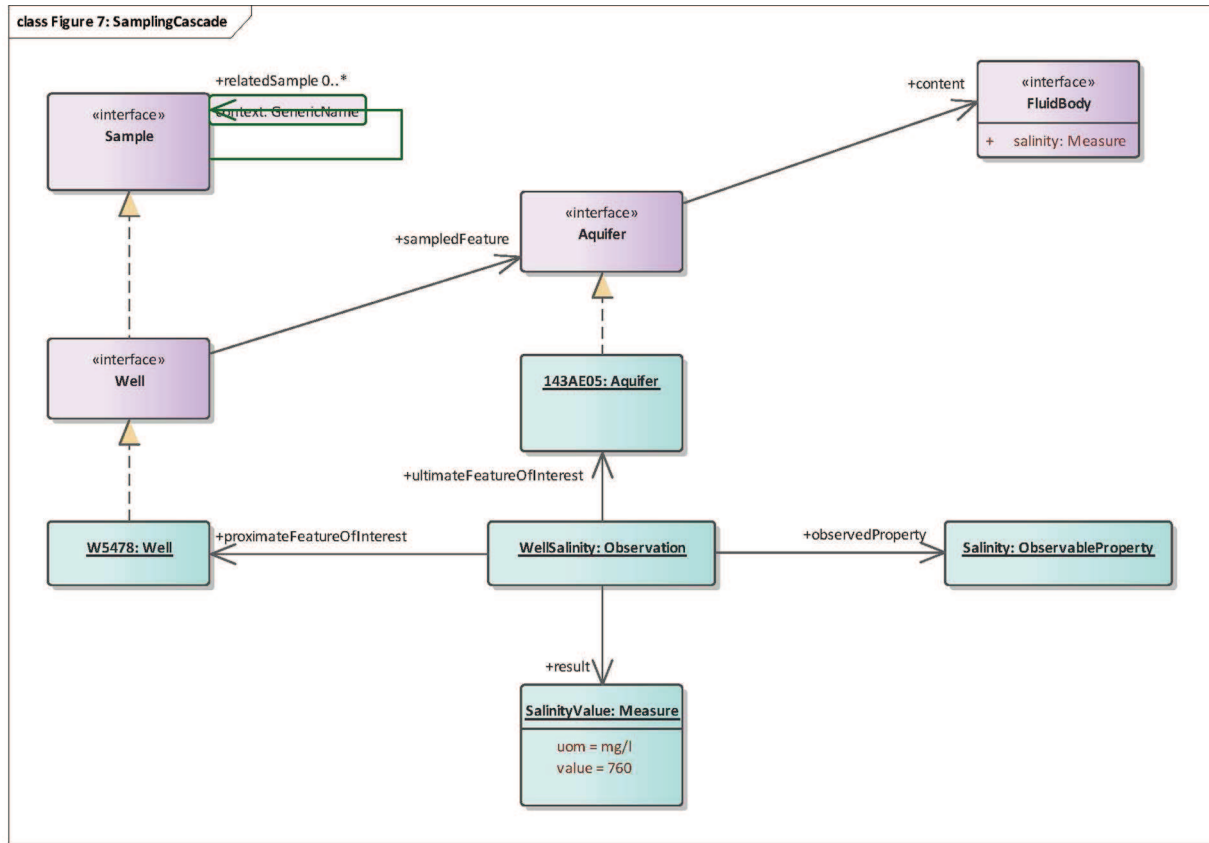


Figure 7 — (Example) Sampling Cascade example including domain features

Depending on the use case, one might want to push the modelling choice a step further and instantiate a FluidBody in the system according to the semantic of the domain model (Well, Aquifer, FluidBody). That example is further refined in Figure 8. Then depending on the viewpoint considered, either the instance of the Aquifer and/or the instance of the FluidBody can be considered as the ultimateFeatureOfInterest of the Observation. The Well remains the proximateFeatureOfInterest.

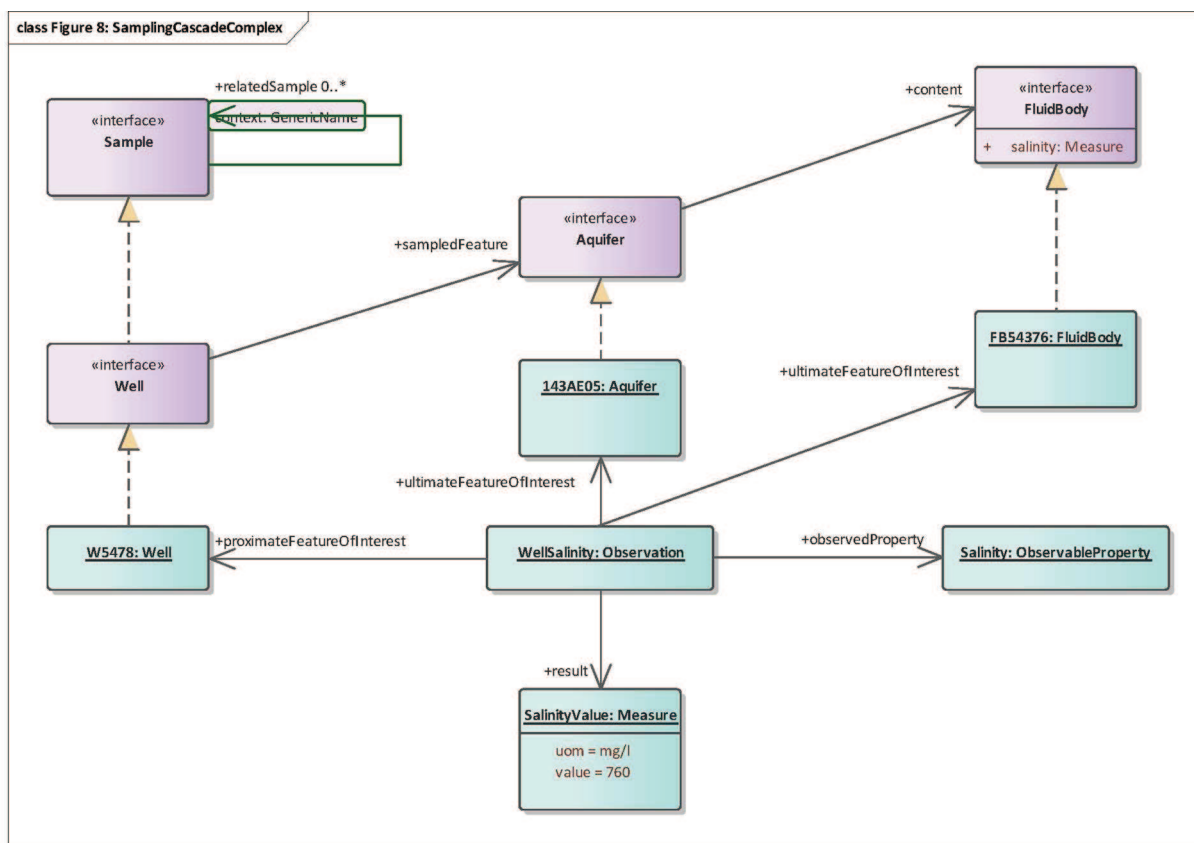


Figure 8 — (Example) Complex Sampling Cascade example referencing external domain feature

8 Conceptual Observation schema

8.1 General

8.1.1 Conceptual Observation model

The Conceptual Observation schema is described as a class diagram in Figure 9. The schema is fully described in the Clause 8.1.2.

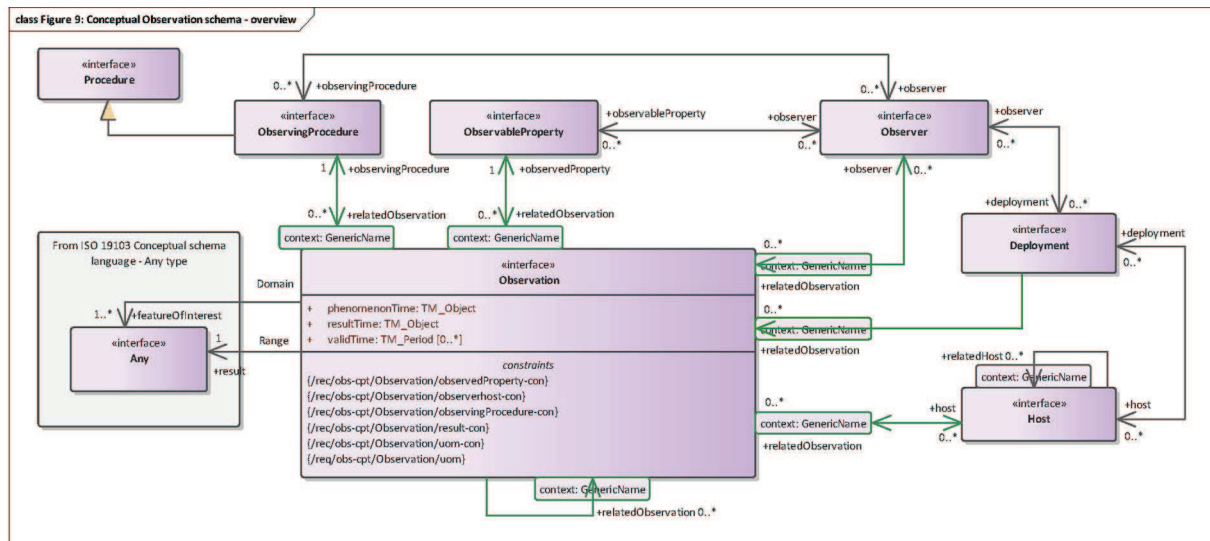


Figure 9 — Conceptual Observation schema overview

8.1.2 Conceptual Observation schema package Requirements Class

Requirements Class	/req/obs-cpt
Target type	Conceptual model
Name	Conceptual Observation schema package
Dependency	ISO 19103:2015 Geographic information – Conceptual schema language, UML2 conformance class
Imports	/req/obs-cpt/Observation
Imports	/req/obs-cpt/ObservableProperty
Imports	/req/obs-cpt/Procedure
Imports	/req/obs-cpt/ObservingProcedure
Imports	/req/obs-cpt/Observer
Imports	/req/obs-cpt/Host
Imports	/req/obs-cpt/Deployment

8.1.3 Association relatedObservation

Requirement /req/obs-cpt/gen/relatedObservation-sem	An Observation the object is related to. If a reference to a related Observation is provided, the association with role relatedObservation SHALL be used. The context:GenericName qualifier of this association may be used to provide further information as to the nature of the relation.
---	---

8.2 Observation

8.2.1 Observation Requirements Class

Requirements Class	/req/obs-cpt/Observation
Target type	Conceptual model
Name	Conceptual Observation - Observation

Requirements Class	/req/obs-cpt/Observation
Dependency	ISO 19103:2015 Geographic information – Conceptual schema language, UML2 conformance class
Dependency	ISO 19103:2015 Geographic information – Conceptual schema language, CoreTypes conformance class
Dependency	ISO 19108:2002 Geographic information – Temporal schema, Application schemas for data transfer conformance class
Requirement	/req/obs-cpt/Observation/Observation-sem
Requirement	/req/obs-cpt/Observation/phenomenonTime-sem
Requirement	/req/obs-cpt/Observation/phenomenonTime-card
Requirement	/req/obs-cpt/Observation/resultTime-sem
Requirement	/req/obs-cpt/Observation/resultTime-card
Requirement	/req/obs-cpt/Observation/validTime-sem
Requirement	/req/obs-cpt/Observation/featureOfInterest-sem
Requirement	/req/obs-cpt/Observation/featureOfInterest-card
Requirement	/req/obs-cpt/Observation/observedProperty-sem
Requirement	/req/obs-cpt/Observation/observedProperty-card
Requirement	/req/obs-cpt/Observation/result-sem
Requirement	/req/obs-cpt/Observation/result-card
Requirement	/req/obs-cpt/Observation/observingProcedure-sem
Requirement	/req/obs-cpt/Observation/observingProcedure-card
Requirement	/req/obs-cpt/Observation/observer-sem
Requirement	/req/obs-cpt/Observation/host-sem
Recommendation	/rec/obs-cpt/Observation/observerhost-con
Recommendation	/rec/obs-cpt/Observation/observedProperty-con
Recommendation	/rec/obs-cpt/Observation/observingProcedure-con
Recommendation	/rec/obs-cpt/Observation/result-con
Recommendation	/rec/obs-cpt/Observation/phenomenonTimeResult-con
Requirement	/req/obs-cpt/gen/relatedObservation-sem
Requirement	/req/obs-cpt/Observation/uom
Recommendation	/rec/obs-cpt/Observation/uom-con

8.2.2 Interface Observation

Requirement /req/obs-cpt/Observation/Observation-sem	An observation is an act carried out by an Observer to determine the value of an ObservableProperty of an object (featureOfInterest) by using an ObservingProcedure ; the value is provided as the result .
--	--

NOTE It is important to note that the terms ‘observation’, ‘interpretation’, ‘forecast’, ‘simulation’ do correspond to this definition. This aspect is further clarified in Clause 7 “Fundamental characteristics of observations and samples (informative)”.

8.2.3 Attribute phenomenonTime

Requirement /req/obs-cpt/Observation/phenomenonTime-sem	The time that the result applies to the characteristic of the FeatureOfInterest being observed. If the phenomenonTime is described, this SHALL be provided by the attribute phenomenonTime:TM_Object
---	---

NOTE 1 The phenomenonTime is often the time the Sample has been taken.

NOTE 2 This is often the time of interaction by a sampling Procedure or observation Procedure with a real-world feature.

NOTE 3 If the result is the average of multiple samples taken at different times, then the phenomenonTime is the time interval over which these measurements were taken.

Requirement /req/obs-cpt/Observation/phenomenonTime-card	An Observation SHALL have exactly 1 phenomenonTime .
Recommendation /rec/obs-cpt/Observation/phenomenonTimeResult-con	If the observedProperty of an Observation is 'occurrence time' then the result SHOULD be the same as the phenomenonTime .

8.2.4 Attribute resultTime

Requirement /req/obs-cpt/Observation/resultTime-sem	The instant of time when the result of the Observation became available. If the resultTime is described, this SHALL be provided by the attribute resultTime:TM_Object
---	--

EXAMPLE 1 The resultTime typically corresponds to when the Procedure associated with the Observation was completed. For some observations this is identical to the phenomenonTime. However, there are important cases where they differ.

EXAMPLE 2 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 3 The resultTime also supports disambiguation of repeat measurements made of the same property of a feature using the same procedure.

EXAMPLE 4 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 5 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.

Requirement /req/obs-cpt/Observation/resultTime-card	An Observation SHALL have exactly 1 resultTime .
--	--

8.2.5 Attribute validTime

Requirement /req/obs-cpt/Observation/validTime-sem	The time interval during which the result is assumed to be applicable for use. If validTime(s) are described they SHALL be provided by the attribute validTime:TM_Period
--	--

NOTE This attribute is commonly required in forecasting applications.

8.2.6 Association featureOfInterest

Requirement /req/obs-cpt/Observation/featureOfInterest-sem	The subject of the Observation . The reference(s) to featureOfInterest(s) SHALL be provided using the association Domain with the role featureOfInterest .
--	---

NOTE 1 The featureOfInterest can be of Any type

EXAMPLE 1 An instance of a feature modelled in a specific domain model (Borehole according to OGC GeoSciML).

EXAMPLE 2 The bubble of air around the intake of an air quality monitoring station.

EXAMPLE 3 An existing well being used for water quality measurements.

NOTE 2 This object is the real-world object whose properties are under observation, or is an object created with the intention to sample the real-world object, as described in the Sampling part of section 7. An observation instance serves as a propertyValueProvider for its feature-of-interest.

Requirement /req/obs-cpt/Observation/featureOfInterest-card	An Observation SHALL have at least 1 featureOfInterest and MAY have more than 1 in cases objects are created with the intention to sample the real-world object The cardinality of the featureOfInterest association SHALL be 1 at minimum.
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8.2.7 Association observedProperty

Requirement /req/obs-cpt/Observation/observedProperty-sem	The ObservableProperty that is the subject of the Observation . If a reference to an ObservableProperty is provided, the association with the role observedProperty SHALL be used.
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Requirement /req/obs-cpt/Observation/observedProperty-card	An Observation SHALL have exactly 1 observedProperty .
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8.2.8 Association result

Requirement /req/obs-cpt/Observation/result-sem	The result of the Observation . If a reference to a result is provided, the association Range with the role result SHALL be used.
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NOTE 1 The result can be of Any type as it may represent the value of any feature property.

NOTE 2 If the observed property is a spatial operation or function, the type of the result may be a coverage.

NOTE 3 In some contexts, particularly in earth and environmental sciences, the term “observation” is used to refer to the result itself.

Requirement /req/obs-cpt/Observation/result-card	An Observation SHALL have exactly 1 result .
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