INTERNATIONAL STANDARD

ISO 19156

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Geographic information — Observations and measurements

Information géographique — Observations et mesures

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 19156 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the Open Geospatial Consortium, Inc. (OGC).

Introduction

This International Standard arises from work originally undertaken through the Open Geospatial Consortium's Sensor Web Enablement (SWE) activity. SWE is concerned with establishing interfaces and protocols that will enable a "Sensor Web" through which applications and services will be able to access sensors of all types, and observations generated by them, over the Web. SWE has defined, prototyped and tested several components needed for a Sensor Web, namely:

— Sensor Model Language (SensorML).

— Observations & Measurements (O&M).

— Sensor Observation Service (SOS).

— Sensor Planning Service (SPS).

— Sensor Alert Service (SAS).

This International Standard specifies the Observations and Measurements schema, including a schema for sampling features.

The content presented here derives from an earlier version published by Open Geospatial Consortium as OGC 07-022r1, *Observations and Measurements — Part 1 — Observation schema* and OGC 07-002r3, *Observations and Measurements — Part 2 — Sampling Features*. A technical note describing the changes from the earlier version is available from the Open Geospatial Consortium (see http://www.opengeospatial.org/standards/om).

Geographic information — Observations and measurements

1 Scope

This International Standard defines a conceptual schema for observations, 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 sampling feature types classified primarily by topological dimension, as well as samples for ex-situ observations. The schema includes relationships between sampling 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 Conformance

2.1 Overview

Clauses 7 to 11 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.

2.2 Conformance classes related to Application Schemas including Observations and Measurements

The conformance rules for Application Schemas in general are described in ISO 19109:2005. Application Schemas also claiming conformance to this International Standard shall also conform to the rules specified in Clauses 7 to 11 and pass all relevant test cases of the Abstract Test Suite in Annex A.

Depending on the characteristics of an Application Schema, 18 conformance classes are distinguished. Table 1 lists these classes and the corresponding subclause of the Abstract Test Suite.

Table 1 — Conformance classes related to Application Schemas including Observations and Measurements

Conformance class	Subclause
Generic observation interchange	A.1.1
Measurement interchange	A.1.1, A.1.2
Category observation interchange	A.1.1, A.1.3
Count observation interchange	A.1.1, A.1.4
Truth observation interchange	A.1.1, A.1.5
Temporal observation interchange	A.1.1, A.1.6
Geometry observation interchange	A.1.1, A.1.7
Complex observation interchange	A.1.1, A.1.8
Discrete coverage observation interchange	A.1.1, A.1.9
Point coverage observation interchange	A.1.1, A.1.10
Time series observation interchange	A.1.1, A.1.11
Sampling feature interchange	A.2.1, A.2.2
Spatial sampling feature interchange	A.2.1 to A.2.3
Sampling point interchange	A.2.1 to A.2.4
Sampling curve interchange	A.2.1 to A.2.3, A.2.5
Sampling surface interchange	A.2.1 to A.2.3, A.2.6
Sampling solid interchange	A.2.1 to A.2.3, A.2.7
Specimen interchange	A.2.1 to A.2.3, A.2.8

3 Normative references

The following referenced documents are indispensable for the application 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 19101:2002, *Geographic information — Reference model*

ISO/TS 19103:2005, *Geographic information — Conceptual schema language*

ISO 19107:2003, *Geographic information — Spatial schema*

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

ISO 19109:2005, *Geographic information — Rules for application schema*

ISO 19111:2007, *Geographic information — Spatial referencing by coordinates*

ISO 19115:2003, *Geographic information — Metadata*

ISO 19115:2003/Cor.1:2006, *Geographic information — Metadata — Technical Corrigendum 1*

ISO 19123:2005, *Geographic information — Schema for coverage geometry and functions*

ISO 19136:2007, *Geographic information — Geography Markup Language (GML)*

ISO/IEC 19501:2005, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

ISO 19157:—[1], *Geographic information — Data quality*

1) To be published.

4 Terms and definitions

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

4.1
application schema
conceptual schema for data required by one or more applications

[ISO 19101:2002, definition 4.2]

4.2
coverage
feature that acts as a function to return **values** from its range for any direct position within its spatial, temporal or spatiotemporal domain

[ISO 19123:2005, definition 4.17]

4.3
data type
specification of a **value** domain with operations allowed on values in this domain

[ISO/TS 19103:2005, definition 4.1.5]

EXAMPLE Integer, Real, Boolean, String, Date (conversion of a date into a series of codes).

NOTE Data types include primitive predefined types and user-definable types. All instances of a data type lack identity.

4.4
domain feature
feature of a type defined within a particular application domain

NOTE This may be contrasted with **observations** and **sampling features**, which are features of types defined for cross-domain purposes.

4.5
ex-situ
referring to the study, maintenance or conservation of a specimen or population away from its natural surroundings

NOTE Opposite of *in-situ*.

4.6
feature
abstraction of real-world phenomena

[ISO 19101:2002, definition 4.11]

NOTE A feature may occur as a type or an instance. In this International Standard, feature instance is meant unless otherwise specified.

4.7
feature type
class of **features** having common characteristics

4.8
measurand
particular quantity subject to **measurement**

[ISO/TS 19138:2006, definition 4.5]

NOTE Specialization of observable **property type**.

4.9
measure
value described using a numeric amount with a scale or using a scalar reference system

[ISO 19136:2007, definition 4.1.41]

4.10
measurement
set of operations having the object of determining the **value** of a quantity

[ISO/TS 19101-2:2008, definition 4.20]

4.11
observation
act of measuring or otherwise determining the **value** of a **property**

4.12
observation procedure
method, algorithm or instrument, or system of these, which may be used in making an **observation**

4.13
observation protocol
combination of a sampling strategy and an **observation procedure** used in making an **observation**

4.14
observation result
estimate of the **value** of a **property** determined through a known **observation procedure**

4.15
property
facet or attribute of an object referenced by a name

[ISO 19143:2010, definition 4.21]

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

4.16
property type
characteristic of a **feature type**

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

NOTE 1 The **value** for an instance of an observable property type can be estimated through an act of **observation**.

NOTE 2 In chemistry-related applications, the term "determinand" or "analyte" is often used.

NOTE 3 Adapted from ISO 19109:2005.

4.17
sampling feature
feature which is involved in making **observations** concerning a **domain feature**

EXAMPLE Station, transect, section or specimen.

NOTE A sampling feature is an artefact of the observational strategy, and has no significance independent of the observational campaign.

4.18
value
element of a type domain

[ISO/IEC 19501:2005]

NOTE 1 A value considers a possible state of an object within a class or type (domain).

NOTE 2 A data value is an instance of a **datatype**, a value without identity.

NOTE 3 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.

5 Abbreviated terms and notation

5.1 Abbreviated terms

GFM	General Feature Model
GML	Geography Markup Language
O&M	Observations and Measurements
OGC	Open Geospatial Consortium
SensorML	Sensor Model Language
SOS	Sensor Observation Service
SWE	Sensor Web Enablement
UML	Unified Modeling Language
XML	Extensible Markup Language
1-D	One Dimensional
2-D	Two Dimensional
3-D	Three Dimensional

5.2 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/TS 19103.

The UML is conformant with the profile described in ISO 19136:2007, 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.

5.3 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 implementors, a mapping from the element names specified in this International Standard to common terminology in some application domains is provided in Annex B.

6 Dependencies

Some model elements used in the schema described in Clauses 7 to 11 are defined in other International Standards. By convention within ISO/TC 211, names of UML classes, with the exception of basic data type classes, include a two or three letter prefix that identifies the International Standard and the UML package in which the class is defined. Table 2 lists the standards and packages in which UML classes used in this International Standard have been defined. UML classes defined in this International Standard have the prefix of CVT, GFI, OM and SF. The prefix GFI is used for classes defined in this International Standard, but which are associated with the GF package in ISO 19109. The prefix CVT is used for classes defined in this International Standard, but which are associated with the CV package in ISO 19123:2005.

Table 2 — Sources of UML classes

Prefix	International Standard	Package
CVT	This International Standard (Annex C)	Temporal coverage
CV	ISO 19123:2005	Coverage
GFI	This International Standard (Annex C)	General Feature Model general instance
DQ	ISO 19115:2003	Data Quality
GF	ISO 19109:2005	General Feature Model
GM	ISO 19107:2003	Geometry
LI	ISO 19115:2003, ISO 19115:2003/Cor.1:2006	Data Quality
MD	ISO 19115:2003/Cor.1:2006	Metadata Entity
OM	This International Standard	Observations and Measurements
SC	ISO 19111:2007	Coordinate reference systems
SF	This International Standard	Sampling features
TM	ISO 19108:2002	Temporal Schema

7 Fundamental characteristics of observations

7.1 The context for observations

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 phenomenon [2]. It 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. Use of a common model allows observation data using different procedures to be combined unambiguously.

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 that have been conventionally considered (e.g. ISO 19115).

NOTE ISO 19115-2:2009 provides MI_Event, which plays a similar role to OM_Observation in the context of image capture.

7.1.3 Observation properties

An observation results in a value being assigned to a phenomenon. The phenomenon is a property of a feature, the latter being the feature-of-interest of the observation. The observation uses a procedure, which is often an instrument or sensor [1][2], 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 property of the feature-of-interest, and the other observation properties provide context or metadata to support evaluation, interpretation and use of the result.

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

7.1.4 Observation location

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

However, the location of the feature-of-interest may not be trivially 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.

Other locations appear 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 (e.g. remote sensing; or where specimens are removed from their sampling location and observations made *ex-situ*). 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, 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 (7.2.2.2; 7.2.2.3). This is a consequence of 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 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 a physical realization, the result will typically be sampled discretely on the domain, and may be represented as a discrete coverage.

The result type may be used as a basis for defining specialized observation types.

7.1.6 Measurements

In conventional measurement theory (e.g. [1][5][10][11][19]) the term “measurement” is used. However, a distinction between measurement and category-observation has been adopted in more recent work [2][12][21] so the term “observation” is used here for the general concept. “Measurement” may be reserved for cases where the result is a numerical quantity.

7.2 Observation schema

7.2.1 Packaging

The observation schema is organized in one package containing eleven leaf packages corresponding to the conformance classes defined in 2.2, with dependencies on several other packages from International Standards covering geographic information, on the General Feature Instance package (C.2) and the Temporal Coverage package (C.3). The inter-package dependencies are shown in Figure 1. The core observation package is documented in this subclause. The specialized observations are documented in Clause 8.

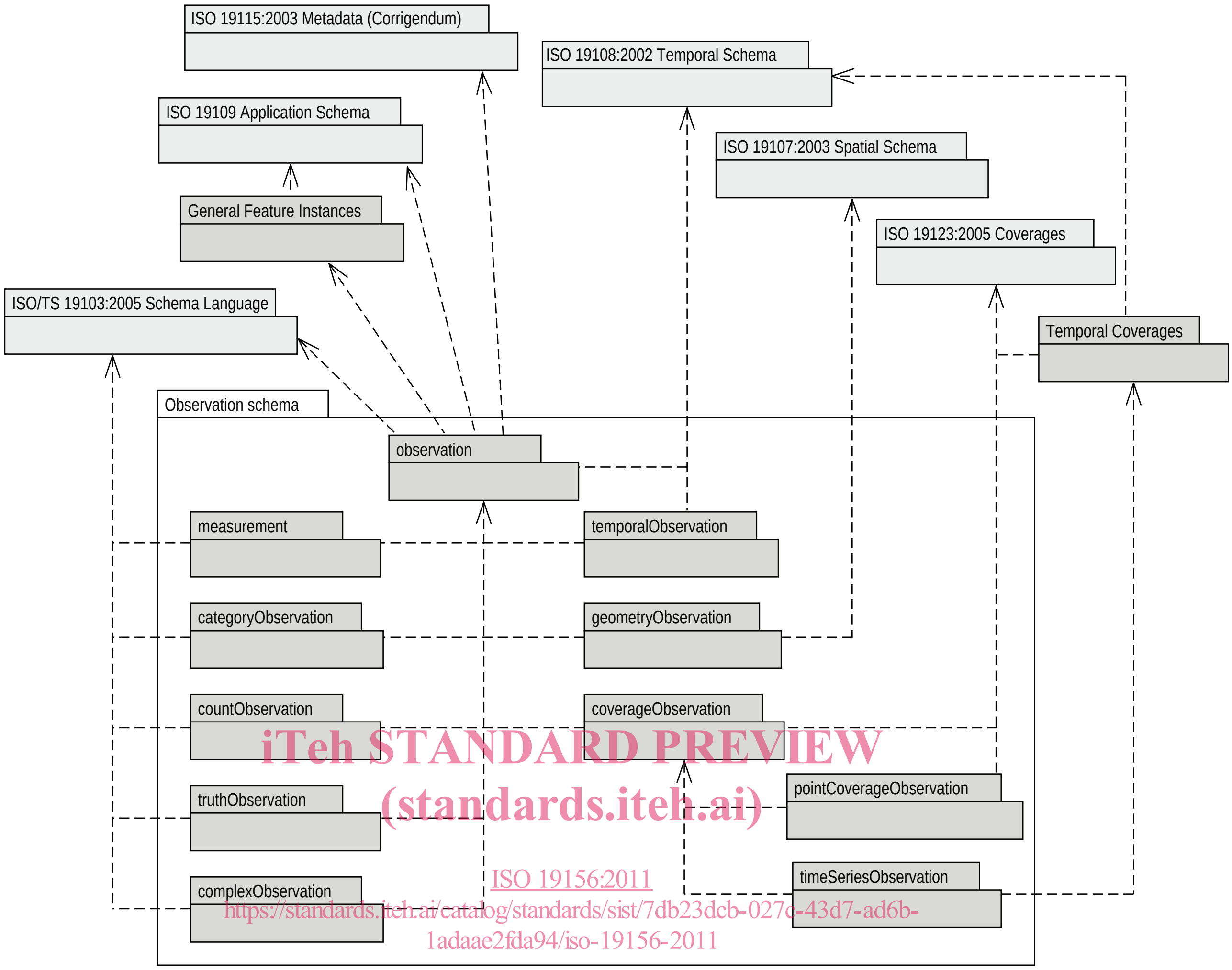

Figure 1 — Package dependencies of the observation schema

7.2.2 OM_Observation

7.2.2.1 General

The class *OM_Observation* (Figure 2) is an instance of the «metaclass» GF_FeatureType (ISO 19109), which therefore represents a feature type. OM_Observation shall support five attributes and six associations, and shall be subject to four constraints.

