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Observations and Measurements – Part 1 - Observation schema

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i. Preface

This Specification was produced as part of the OGC's Sensor Web Enablement (SWE) activity.

Suggested additions, changes, and comments on this report are welcome and encouraged. Such suggestions may be submitted by OGC portal message, email message, or by making suggested changes in an edited copy of this document.

The changes made in this document version, relative to the previous version, are tracked by Microsoft Word, and can be viewed if desired. If you choose to submit suggested changes by editing this document, please first accept all the current changes, and then make your suggested changes with change tracking on.

ii. Submitting organizations

The following organizations submitted this document to the Open Geospatial Consortium Inc.

Commonwealth Scientific and Industrial Research Organisation (Australia) (CSIRO).

Geoscience Australia.

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iii. Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Contact	Company
Simon Cox (Editor)	CSIRO Exploration and Mining
Mike Botts	University of Alabama in Huntsville
Alexandre Robin	University of Alabama in Huntsville
John Davidson	Image Matters, LLC
Stefan Falke	Washington University
Andrew Woolf	NERC UK
Nick Ardlie	Geoscience Australia
Jim Greenwood	SEI Corp
Hans Shoebach	Galdos Systems Inc.
Ingo Simonis	Geosptial Research, Germany
Ganael Jatteau	PCI Geomatics Inc.
Gerry Creager	Texas A&M University

iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
2003-02-11	0.9.2	Simon Cox	Baseline version	OGC Recommendation Paper arising from OWS-1.2
2005-10-07	0.10	Simon Cox	All	New version of model emerging from OWS3 Model converted to ISO conformant UML Document simplified, much discursive discussion material removed Systematic gradation of instance examples NOTE: Reference and bibliography still need cleaning up
2005-10-07	0.11	Simon Cox	v., vi., 1, 3, 6 (minor), 6.6.2, 7 (minor), 7.3.3.5, 8	
2006-01-30	0.12	Simon Cox, Alex Robin	7, Annexes	Added generic “xml encoding” for arrays and tables, added CommonObservation examples; replaced metaLite with ISO19139 GMD schema
2006-02-24	0.13	Simon Cox	6, 7, 8, Annexes	Minor wording clarifications; inserted discussion of time-series/feature-of-interest, etc; inserted better introduction to three result

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				encoding variants; added discussion of observation vs interpretation; move detailed RecordSchema model to Annex.
2006-08-23	0.14	Simon Cox		Major revision Add discussion of constant vs coverage properties/results Add normative clause on SamplingFeatures Clarify Feature/Coverage/Obs relationships Move XML examples clause to Annex, remove compact encoding variants Add Annex providing terminology mapping Numerous editorial changes Stubs for conformance rules
2007-06-15	0.15	Simon Cox, O&M RWG	Throughout	Major revision in response to RFC. See OGC 07-044r1
2007-06-26	0.15.5	Simon Cox, Nick Ardlie	2.2, 6.2, Annex A	Complete conformance classes, add package dependencies diagram, add abstract test suite
2007-12-08	0.15.6	Kevin Stegemoller	Annex D, Annex E	Update dependency versions and schema

v. Changes to the OpenGIS® Specification

The OpenGIS® Standard requires changes to accommodate the technical contents of this document. The following is a list of the required changes:

a) Observations and Measurements to be added to the OGC Abstract Specification as a new topic.

b) O&M describes a property-value provider model, linked to the ISO 19109 GFM, under which *features* are the generic carriers of properties. However, ISO 19123 provides a model for describing properties that vary with spatio-temporal location. For consistency between the GFM and the Coverage model, it appears that every coverage must be related to one or more “features” of some type that may logically carry the property whose variation is described. This may be trivial – e.g. the “medium” whose extent matches the domain-extent of the coverage (e.g. atmosphere, ocean, earth) – and may merely be described in the coverage “metadata”.   But it is nonetheless required to add a notion of "the feature carrying the coverage" to ISO 19123 in order to make it consistent with the GFM, or else to explicitly introduce the possibility of coverage-typed feature-properties to ISO 19109 to acknowledge this important viewpoint.

c) Introduce new stereotype <<estimatedProperty>> to the UML profile, to be used on attributes and association-roles to mark those properties whose value is

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amenable to determination by application of an observation procedure and is there for an estimate, in contrast to those properties whose value is assigned by an authority and therefore exact. This may flow through in implementation to a mechanism to resolve the "Observation" that provided the value-estimate (i.e. a property-metadata syntax).

Alternatively, a stereotype (e.g. <<assertedProperty>>) could be introduced to mark those properties whose values are assigned by some authority, and hence whose values are not amenable to observation and have no error associated.

vi. Future work

Some unresolved issues are indicated in the text formatted as follows:

Issue: Discussion text

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Foreword

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. Open Geospatial Consortium Inc. shall not be held responsible for identifying any or all such patent rights. However, to date, no such rights have been claimed or identified.

Observations and Measurements consists of the following parts:

- *Part 1 - Observation schema (OGC 07-022) (this document)*
- *Part 2 - Sampling features (OGC 07-002)*

Part 1 replaces the OGC Recommendation Paper 05-087r4 *Observations and Measurements* clauses 1-6, 8 and Annexes. The changes that have been made relative to the previous version are documented in the O&M RFC Comments and Responses document OGC 07-044r1.

A set of XML schemas implementing the model as a GML Application Schema is provided in ANNEX D.

Clauses 1-6 and Annex A are normative. The other sections are informative.

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Introduction

OGC's Sensor Web Enablement (SWE) activity, which is being executed through the OGC Web Services (OWS) initiatives (under the Interoperability Program) and the SWE Working Group (under the Specification Program), is establishing the interfaces and protocols that will enable a "Sensor Web" through which applications and services will be able to access sensors of all types over the Web. These initiatives have defined, prototyped and tested several components needed for a Sensor Web, namely:

1. **Sensor Model Language (SensorML)**.
2. **Transducer Markup Language (TML)**
3. **Observations & Measurements (O&M)**
4. **Sensor Observation Service (SOS)**.
5. **Sensor Planning Service (SPS)**.
6. **Sensor Alert Service (SAS)**.

This document specifies the core Observations and Measurements model. A Sampling Features model is described in the document named Observations and Measurements - Part 2. This refactors elements originally all described as part of the Observations and Measurements best practice paper. The other components are specified under separate cover.

Herein we describe a framework and encoding for measurements and observations. This is required specifically for the Sensor Observation Service and related components of an OGC Sensor Web Enablement capability, and also for general support for OGC compliant systems dealing in technical measurements in science and engineering.

The aim is to define a number of terms used for measurements, and the relationships between them. This proposal discusses **observation, measurement, result, procedure, feature of interest, observed property, property type, coverage** and related terms, presented using UML class diagrams and in equivalent GML conformant XML serialisations. The scope covers observations and measurements whose results may be quantities, categories, temporal and geometry values, coverages, and composites and arrays of any of these.

This work was supported by OGC through OWS Interoperability Projects, by the Water Resources Observation Network activity based at CSIRO Australia, and by Geoscience Australia.

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OGC Abstract Specification — Observations and Measurements – Part 1 - Observation schema

1 Scope

We describe a conceptual model and encoding for observations and measurements. This is formalized as an Application Schema, but is applicable across a wide variety of application domains.

An Observation is an action with a result which has a value describing some phenomenon. The observation is modelled as a Feature within the context of the General Feature Model [ISO 19101, ISO 19109]. An observation feature binds a result to a feature of interest, upon which the observation was made. The observed property is a property of the feature of interest. An observation uses a procedure to determine the value of the result, which may involve a sensor or observer, analytical procedure, simulation or other numerical process. The observation pattern and feature is primarily useful for capturing metadata associated with the estimation of feature properties, which is important particularly when error in this estimate is of interest.

An observation results in an estimate of the value of a property of the feature of interest. Observation values 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 is the feature. In a physical realisation, the result will typically be sampled on the domain, and hence represented as a discrete coverage.

Additional components that are used, but not described, in this report include:

- Sensor Model Language (SensorML) & Sensor Instance/Sensor Type registries,
- Reference System definitions (CRS, frames, units of measure, dictionaries & category lists),
- Semantic definition of phenomena, and
- Geometry and temporal objects
- Data-types provided by various standards.

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2 Conformance

2.1 Overview

Clause 6 and ANNEX C of this Specification use the Unified Modeling Language (UML) to present conceptual schemas for describing Observations. These schemas define conceptual classes that (i) may be considered to comprise a cross-domain application schema, or (ii) may be used in application schemas, profiles and implementation specifications. The document 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.

ANNEX D of this Specification specifies XML Schema components, in the form of GML Application Schemas that implement the conceptual model in accordance with ISO DIS 19136.

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

This flexibility is controlled by a set of UML types that can be implemented in a variety of manners. Common names for "metaphorically identical" but technically different entities are acceptable. The UML model in this Specification defines conceptual classes, various software systems define implementation classes or data structures, and the XML following the encoding standard (ISO 19136) defines entity tags. All of these reference the same information content. There is no difficulty in allowing the use of the same name to represent the same information content even though at a deeper level there are significant technical differences in the digital entities being implemented. This allows types defined in the UML model to be used directly in application schemas.

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. Application Schemas also claiming conformance to this Specification shall also conform to the rules specified in Clauses 6 and pass all relevant test cases of the Abstract Test Suite in ANNEX A. Depending on the characteristics of an Application Schema, NN conformance classes are distinguished. Table 1 lists these classes and the corresponding Subclause of the AbstractTest Suite.

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

Conformance class	Subclause of the Abstract Test Suite
Generic observation interface	A 1.1
Specialized observation interface	A 1.2
Generic observation interchange	A 2.1
Specialized observation interchange	A 2.2

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TBC

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

IETF RFC 2396, *Uniform Resource Identifiers (URI): Generic Syntax. (August 1998)*

ISO 1000:1994, *SI units and recommendations for the use of their multiples and of certain other units.*

ISO 8601:2004, *Data elements and interchange formats — Information interchange Representation of dates and times*

ISO/IEC 11404:1996, Information technology — Programming languages, their environments and system software interfaces – Language-independent datatypes

ISO 19101:2003, *Geographic Information--ReferenceModel*

ISO/TS 19103:2006, *Geographic Information — Conceptual schema language*

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

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

ISO 19109:2006, *Geographic Information — Rules for application schemas*

ISO 19110:2006 , Geographic Information – Feature cataloguing methodology

ISO 19115:2003, *Geographic Information — Metadata*

ISO 19118:2005, *Geographic Information — Encoding*

ISO 19123:2005, *Geographic Information — Coverages*

ISO DIS 19136:2006, *Geographic Information — Geography Markup Language*

ISO/FDTS 19139:2006, *Geographic Information — Metadata — XML schema implementation*

ISO/IEC 19757-3:2006, *Information technology -- Document Schema Definition Language (DSDL) -- Part 3: Rule-based validation -- Schematron*

OpenGIS® Discussion Paper *GML Encoding of Discrete Coverages (interleaved pattern), OGC document 06-188.*

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OpenGIS® Engineering Specification *Observations and Measurements – Part 2: Sampling Features, OGC document 07-002.*

OpenGIS® Engineering Specification *Sensor Model Language, OGC document 07-001.*

OpenGIS® Engineering Specification *Sensor Observation Service, OGC document 06-009.*

OpenGIS® Engineering Specification *Transducer Markup Language, OGC document 06-010.*

OpenGIS® Interoperability Program Report *SWE Common, OGC document 07-003.*

UCUM, Unified Code for Units of Measure, Schadow, G. and McDonald, C. J. (eds.), <http://aurora.rg.iupui.edu/UCUM>

W3C XLink, *XML Linking Language (XLink) Version 1.0. W3C Recommendation (27 June 2001)*

W3C XML, *Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation (6 October 2000)*

W3C XML Namespaces, *Namespaces in XML. W3C Recommendation (14 January 1999)*

W3C XML Schema Part 1, *XML Schema Part 1: Structures. W3C Recommendation (2 May 2001)*

W3C XML Schema Part 2, *XML Schema Part 2: Datatypes. W3C Recommendation (2 May 2001)*

4 Terms and definitions

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

4.1
analyte
species whose concentration is subject to **observation.** Specialization of observable **property-type**.

4.2
application schema
conceptual schema for data required by one or more applications

[ISO 19101]

4.3
codespace
rule or authority for a code, name, term or category label

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Example: Codespaces may include dictionaries, authorities, codelists, patterns, etc.

4.4
coordinate reference system
coordinate system that is related to the real world by a datum [ISO 19111]

4.5
coverage
feature that acts as a function to return values from its range for any direct position within its spatiotemporal domain

[ISO 19123]

4.6
data type
specification of a value domain with operations allowed on values in this domain

[ISO/TS 19103]

Example: Integer, Real, Boolean, String, Date (conversion of a data into a series of codes).

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

4.7
determinand
parameter or a characteristic of a phenomenon subject to **observation.** Synonym for observable **propertyType.**

4.8
feature
abstraction of real world phenomena

[ISO 19101]

NOTE: A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.

4.9
GML application schema
application schema implemented according to ISO 19136

4.10
measure (noun)
value described using a numeric amount with a scale or using a scalar reference system

[ISO/TS 19103]

NOTE: When used as a noun, measure is a synonym for physical quantity.

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4.11
measurement (noun)
an observation whose result is a measure

4.12
measurand
physical parameter or a characteristic of a phenomenon subject to a **measurement,** whose value is described using a Measure (ISO 19103). Specialization of observable **property-type**.

4.13
namespace <XML>
collection of names, identified by a URI reference, which are used in XML documents as element names and attribute names [W3C XML Namespaces]

4.14
observation (noun)
an act of observing a property or phenomenon, with the goal of producing an estimate of the value of the property. A specialized event whose result is a data value.

4.15
phenomenon
concept that is a characteristic of one or more feature types, the value for which may be estimated by application of some procedure in an observation. Synonym for property-type in this specification.

4.16
procedure
method, algorithm or instrument, or system of these

4.17
property <General Feature Model>
characteristic of a feature type, including attribute, association role, defined behaviour, feature association, specialization and generalization relationship, constraints

[ISO 19109]

4.18
property <GML>
a **child element** of a GML object

NOTE: It corresponds to feature attribute and feature association role in ISO 19109. If a GML property of a feature has an xlink:href attribute that references a feature, the property represents a feature association role.

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4.19
property-type
concept that is a characteristic of one or more feature types, the value for which may be estimated by application of some procedure in an observation. Synonym for phenomenon in this specification.

4.20
result
an estimate of the value of some property generated by a known procedure

4.21
scale
a particular way of assigning numbers or symbols to measure something is called a scale of measurement [SAR1995].

4.22
semantic type
category of objects that share some common characteristics and are thus given an identifying type name in a particular domain of discourse

4.23
UML application schema
application schema written in UML according to ISO 19109

4.24
Uniform Resource Identifier (URI)
unique identifier for a resource, structured in conformance with IETF RFC 2396

NOTE: The general syntax is <scheme>::<scheme-specific-part>. The hierarchical syntax with a namespace is <scheme>://<authority><path>?<query> - see [RFC 2396].

4.25
value
member of the value-space of a datatype. A value may use one of a variety of scales including nominal, ordinal, ratio and interval, spatial and temporal. Primitive datatypes may be combined to form aggregate datatypes with aggregate values, including vectors, tensors and images [ISO11404].

5 Conventions

5.1 Symbols (and abbreviated terms)

GFM	General Feature Model
GML	Geography Markup Language
ISO	International Organization for Standardization
O&M	Observations and Measurements

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OGC	Open Geospatial Consortium
OWS	OGC Web Services
SensorML	Sensor Model Language
SAS	Sensor Alert Service
SOS	Sensor Observation Service
SPS	Sensor Planning Service
SWE	Sensor Web Enablement
TML	Transducer Markup Language
UML	Unified Modeling Language
WXS	W3C XML Schema Definition Language
XML	Extensible Markup Language
1D	One Dimensional
2D	Two Dimensional
3D	Three Dimensional

5.2 UML notation

Most diagrams that appear in this specification are presented using the Unified Modeling Language (UML) static structure diagram, as described in Subclause 5.2 of the OGC Web Services Common Implementation Specification [OGC 04-016r2].

Many of the models refer to classes from various models in the ISO 19100 series of international standards. In this document these components have been imported from the ISO Harmonized Model as of 2006-06-14.

The UML is conformant with the profile described in ISO 19103 and ISO 19136 (GML) Annex E. Use of this restricted idiom supports direct transformation into a GML Application Schema.

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.

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5.3 Document terms and definitions

This document uses the specification terms defined in Subclause 5.3 of [OGC 04-016r2].

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6 A model for Observations and Measurements

6.1 Introduction

In this Clause, we describe a model for observations and associated components. The analysis is presented using UML static structure diagrams.

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 [FOW1998]. The phenomenon is a *property* of an identifiable object, which is the *feature of interest* of the observation. The observation uses a *procedure*, which is often an instrument or sensor [NRC1995] 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.

In conventional measurement theory [e.g. KRALST, SAR1995, VIM] the term "measurement" is used. However, Fowler's distinction between measurement and category-observation [FOW1998] has been adopted in more recent work [NIE2001, YOD] so the term "observation" is used here for the general concept. "Measurement" may be reserved for cases where the result is a numeric quantity (sub-clause 6.3.3). The result-type or level may be used as a basis for defining specialized observation types.

The Observation model takes a 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 provider-centric viewpoint.

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 discussed in detail in sub-clause 6.3.1, in sub-clause 6.3.3, and in *Observations and Measurements – Part 2 – Sampling Features*.

6.2 Basic observation model

The observation schema is organized in a package stereotyped <<ApplicationSchema>>. The observation schema has dependencies on a number of packages from the OGC Sensor Web Enablement suite, and on the ISO 19100 Harmonized Model, as shown in Figure 1.

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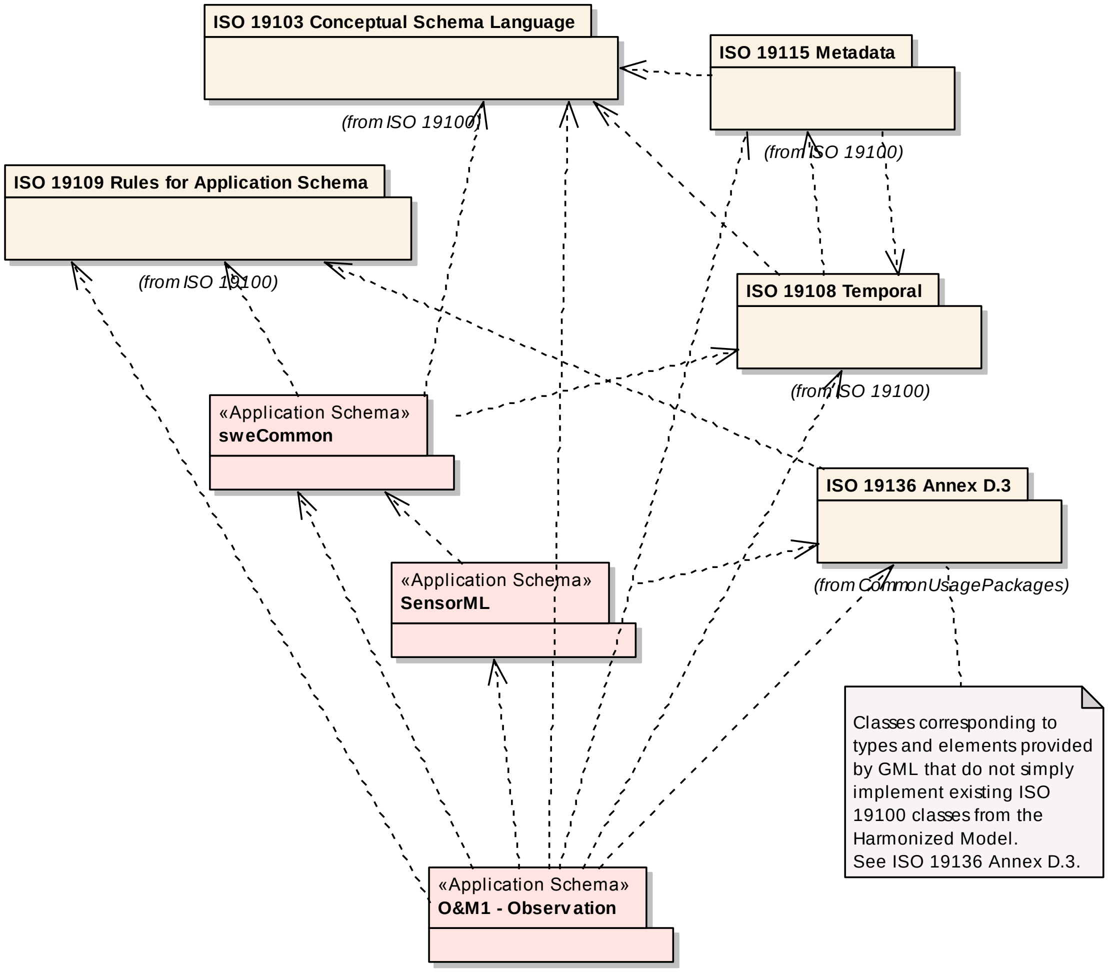

Figure 1. Observation schema dependencies on packages from OGC Sensor Web Enablement and the ISO 19100 Harmonized model

The basic observation model is shown in Figure 2 and summarized in this sub-clause. Sub-clause 6.3 provides more detail for some properties of observations.

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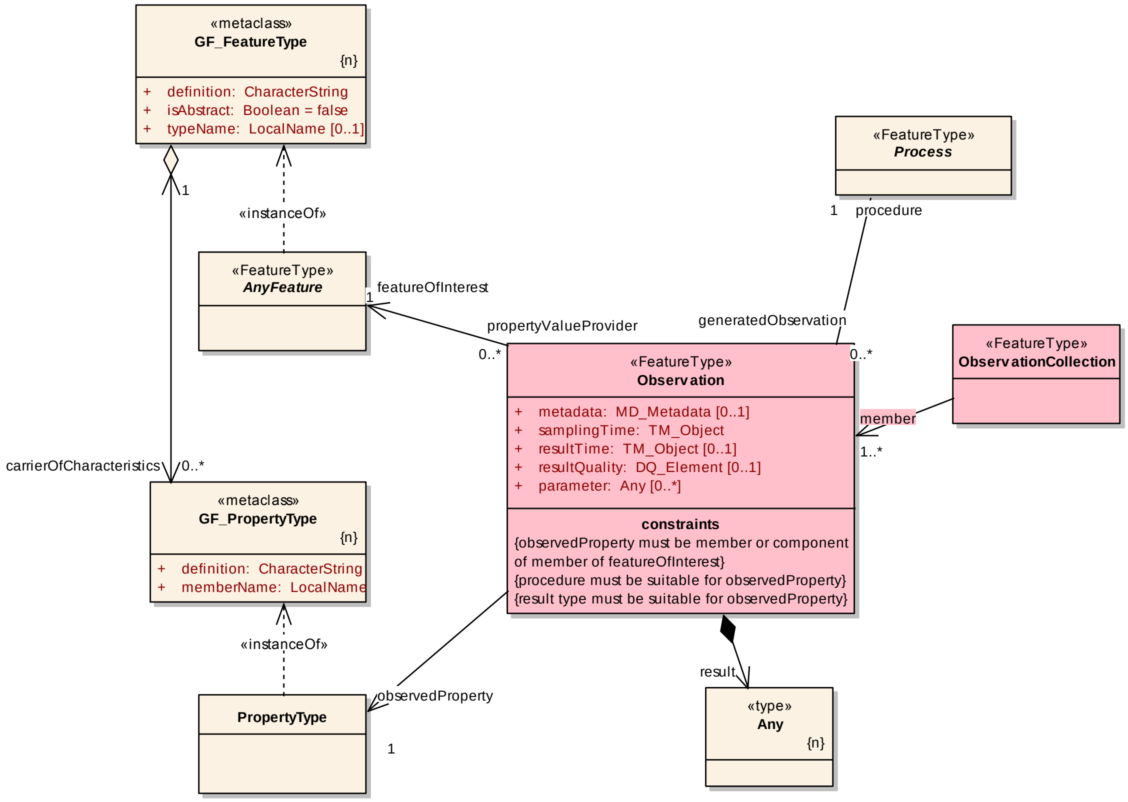

Figure 2. The basic Observation type

NOTE: The class named “AnyFeature” represents the set of all classes with the stereotype <<FeatureType>>. In an implementation this abstract class will be substituted by a concrete class representing a feature type from a domain of discourse. This class is implemented in GML by the element gml:AbstractFeature.

The key properties of an Observation are its featureOfInterest, the observedProperty, the procedure and the result.

The **featureOfInterest** is a feature of any type (ISO 19109, ISO 19101), which is a representation of the observation target, being the real-world object regarding which the observation is made.

The **observedProperty** identifies or describes the phenomenon for which the observation result provides an estimate of its value. It must be a property associated with the type of the feature of interest.

NOTE: A model and ontology for phenomena definitions is presented in ANNEX C clause 2

The **procedure** is the description of a process used to generate the result. It must be suitable for the observed property.

NOTE: At this level we do not distinguish between sensor-observations, estimations made by an observer, or algorithms, simulations, computations and complex processing chains.

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The **result** contains the value generated by the procedure. The *type* of the observation result must be consistent with the observed property, and the scale or scope for the value must be consistent with the quantity or category type.

NOTE: In some contexts, particularly in earth and environmental sciences, the term "observation" is used to refer to the *result*.

NOTE: In the XML implementation, an element may be declared in the schema to have type="anyType", and the type may be indicated within a data instance (a) using the xsi:type attribute on the result element, or (b) through schema declarations for namespace qualified components appearing within the element content.

An observation may involve a complex process over an extended period. For a generic observation this is summarized in two time-related properties. The **samplingTime** is the time that the result applies to the feature-of-interest. This is the time usually required for geospatial analysis of the result. The **resultTime** is the time when the procedure associated with the observation act was applied. For some observations these are identical, in which case the resultTime may be omitted. However, there are important cases where they differ.

Example: Where a measurement is made on a specimen in a laboratory, the samplingTime should record the time the specimen was retrieved from its host, while the resultTime should record the time the laboratory procedure was applied.

Example: Where sensor observation results are post-processed, the resultTime is the post-processing time, while the samplingTime preserves the time of initial interaction with the world.

Example: Simulations are often used to estimate the values for phenomena in the future or past. The samplingTime is the real-world time that the result applies to, while the resultTime is the time that the simulation process was executed.

An Observation **parameter** is a general event-specific parameter. This will typically be used to record environmental parameters, or event-specific sampling parameters that are not tightly bound to either the feature-of-interest or the procedure.

NOTE: Parameters that are tightly bound to the procedure should be recorded as part of the procedure description. For example, the SensorML model associates parameters with specific process elements or stages.

NOTE: The semantics of the parameter must be provided as part of its value.

In some applications it is convenient to use a generic or standard procedure, or feature-of-interest, rather than define an event-specific process or feature. In this context, event-specific parameters are bound to the Observation act.

Example: A time sequence of observations of water quality in a well may be made at variable depths within the well. While a comprehensive model may identify a specimen from the well taken at this depth as the feature-of-interest, a more common approach is to identify the well itself as the feature-of-interest, and add a "samplingDepth" parameter to the observation. The sampling depth is of secondary interest relative to the temporal variation of water quality at the site.

An observation may have **metadata**, and an indication of the event-specific **resultQuality**.

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6.3 Details of key observation properties

6.3.1 Feature of interest and observed property

An observation serves as 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, which complements the dataset-level and feature-level metadata that have been conventionally considered (e.g. ISO 19115).

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 Sampling Features (Part 2 of this specification). The feature type defines its set of properties, which for the current purposes may be divided into those properties whose value is assigned by some rule or assertion (e.g. name, ownership), and those properties whose value is determined by observation. Hence, the feature-of-interest must carry the observed property as part of the definition of its type.

Example: A feature type "PhysicalSpecimen" may be defined as having the attribute "mass" of type "Measure". An observation providing the value of this property must have observedProperty="mass", the result must be of type "Measure" and the scale (unit of measure) must be suitable for mass measurements.

In the case of a feature property with structure (e.g. feature associations) the observed property may be of one component, or a subset of elements, of the complete feature property. Hence, the observed property might not appear directly as a first order property in the type definition for the feature of interest, but must appear within the structure of the feature type definition at some level.

Issue: For some feature types there may be multiple property components with the same name or type, distinguished by context. Hence, mapping the result of an observation to a slot associated with a feature instance requires a complete path to the slot. Should this be called out explicitly in the model? And in the XML encoding? Can this be made consistent with the notion that multiple representations of the feature of interest may be available?

Note that the property-type was originally conceived as providing a semantic or thematic classification, useful for discovery and potential data fusion.

The description of the property-type may be persisted in a dictionary (e.g. an ISO 19135 Register) and its identifier or designator used as the value of a reference within the observation instance. The description instantiates GF_PropertyType (ISO 19109).

NOTE: Treating the property as a first-class object is an important characteristic of knowledge-representation technologies, such as [RDF]. In the semantic web context, either an object or property may be identified by a URI.

NOTE: The detailed definition of property types is beyond the scope of O&M. In ANNEX C clause 2 we provide the requirements for a Property Type ontology in the form of a UML schema.

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The ultimate feature of interest of an investigation is usually of a type defined in a domain-specific application schema. However, an observation processing chain may involve a series of transformations of the result coupled to transformation of the observed property. This may imply a change in the feature of interest between steps. When considering the different stages of processing, the proximate feature of interest must be consistent with the result, carrying the observed property as part of the definition of its type, i.e. a feature of the correct type must be identified as the feature of interest.

Example: elements of an optical sensor system may measure photon intensity (feature of interest: sensor focus or ambiguity space), then different sensor bands combined to get a colour spectrum or radiance (feature of interest: pixel or scene), then an algorithm used to obtain a vegetation index (feature of interest: landcover tract).

If realised explicitly, the observations associated with the primitive, intermediate and final results comprise a temporal sequence of observations.

While the ultimate feature of interest may be a "natural" feature recognised from the application domain (e.g. river, road, person, vehicle, building, mountain, aquifer, etc), the proximate or intermediate target of an observation is often an artefact of sampling (e.g. specimen, station, traverse, pixel, swath etc). A schema for feature types corresponding to sampling artefacts is presented in O&M – Part 2.

6.3.2 Observation procedure

The procedure provides a description of the **Process** used to obtain the result. This is often an instrument or sensor, but may be a human observer, a simulator, or a process or algorithm applied to more primitive results used as inputs.

There are dependencies between the procedure and other observation properties as follows:

- the procedure must be appropriate for the observed property;
- as a corollary, details of the observed property are constrained by the procedure used;

Example: Example: an observed radiance wavelength is determined by the response characteristics of the sensor.

- the procedure, perhaps with event-specific parameters, may provide key parts of the intrinsic description of the feature of interest;

Example: Examples: sampling depth within an observation well; ground location of a target (remote sensing observations)

Notwithstanding the dependencies, it is useful to separate procedure, observed property and feature of interest and represent them as primary properties of an observation. This is because they support *classification* of the observation in a way that is useful for discovery and retrieval.

NOTE: The detailed description of observation processes is the topic of SensorML. In ANNEX C clause 3 we provide an overview of the SensorML process hierarchy, and some possible specializations for observation.

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6.3.3 Result and observation specializations

6.3.3.1 General

The observation result type must be suitable for the observed property.

6.3.3.2 Constant properties

If a property of the feature of interest is single-valued, the corresponding observation result is a scalar (e.g. mass, length, temperature), or a record whose components correspond to a thematic decomposition of the observed property (e.g. bands of a spectrum, components of a wind-velocity vector, components of a stress tensor). Where a standard model for the observed property is available, this may be used for the result (e.g. observations of position, shape, or time should use GM_Object and TM_Object, as appropriate).

NOTE: Specialized observation types may be defined in which the generic result property is constrained to be a specific type (e.g. Figure 3). In the ComplexObservation the result is a **Record** (ISO 19103), where details of the result structure are provided by its **RecordType** (ISO 19103), which defines the components and their order,.

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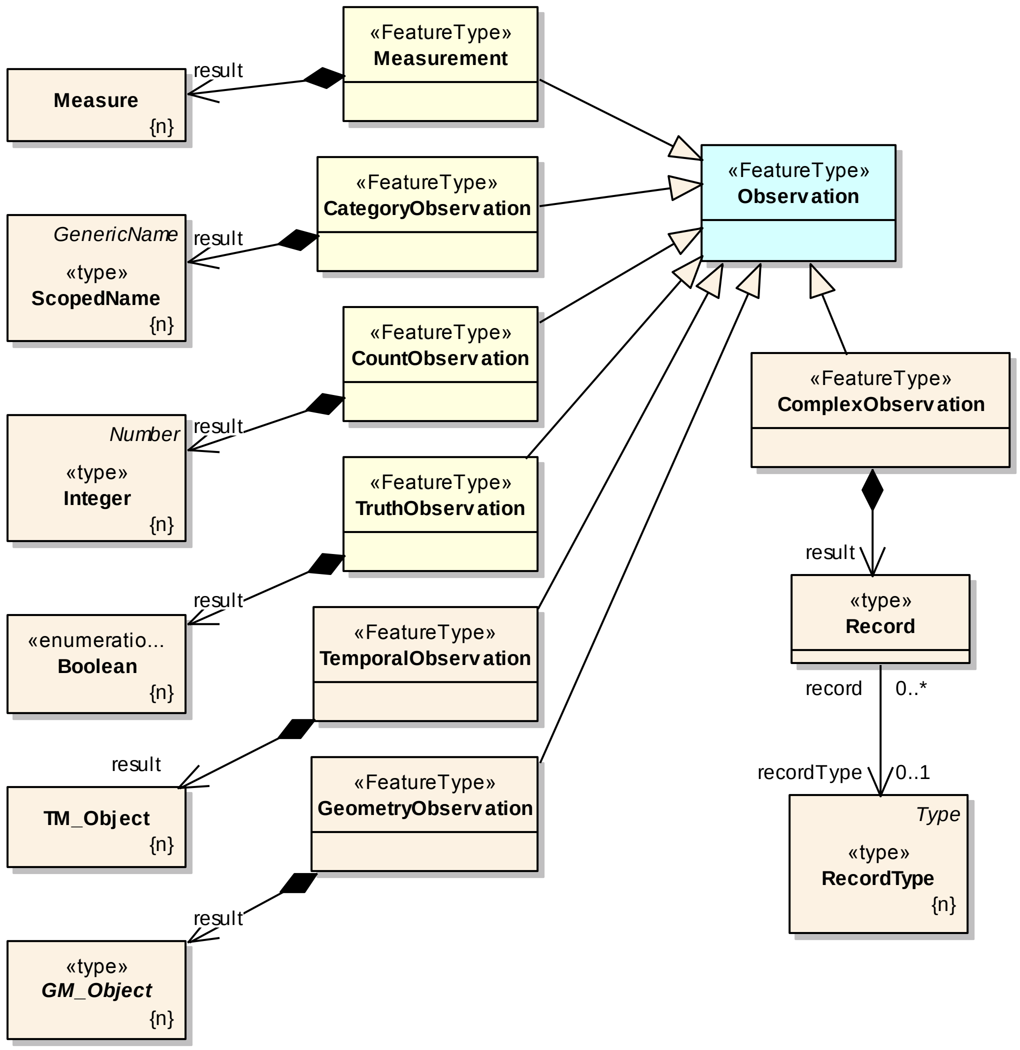

Figure 3. (Informative) Specializations of observation by result type

6.3.3.3 Varying properties

If the type of a feature allows for a property that is dependent on some parameter, then the value of the property is a *function* of this parameter. If the variation is temporal or spatial, then the function is a *coverage* (CV_Coverage—ISO 19123) whose domain is the spatio-temporal extent of the feature. The value of a corresponding observation result must also be a function or coverage, respectively. In practice, the observation will *sample* the relevant axis of the target feature, resulting in a *discrete* function or coverage (CV_DiscreteCoverage).

NOTE: ISO 19123 describes a discrete coverage as being composed of a set of CV_DomainObjects with the role of domainElements and a set of CV_AttributeValues with the role of rangeElements. The domain elements and range elements provide values for the geometry and value attributes (respectively) of a collection of CV_GeometryValuePair elements of a discrete coverage. These two viewpoints correspond with "map" and "interleaved" encodings.

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The target feature may have many observations made on it using different sampling regimes, so it is common for the latter to be associated with the observation, rather than the feature of interest. This is accommodated by making the decomposition of the domain geometry (i.e. the CV_DomainObject elements) explicit in the observation result. A discrete coverage result structure also provides a description of the map between domain and range elements.

Example: The colour of a scene varies with position.The result of an observation of the property”colour”of the scene is a coverage. Each domain element is a pixel whose index allows the spatial location within the scene to be obtained.

Example: Many properties of an observation-well vary along its length, including rock-type, orientation, permeability etc. These are conventionally encoded as “logs”, with different sampling regimes. Each well-log is a coverage whose domain is the curve describing the shape of the well. The domain is sampled with elements whose location is described in terms of 1-D position measured along the well axis.

A familiar simple case concerns sampling a property at points on an extensive feature. The observation result is a set of point-value pairs (CV_PointValuePair—ISO 19123).

Example: Temperature may be sampled using an array of weather stations. The temperature field of the region covered by the array may be represented as a discrete point coverage, whose domain-elements correspond to the station locations.

An important and common special case concerns monitoring a time-varying property of a persistent feature by sampling at discrete points in time. The observation result is a set of time-value pairs (either CV_PointValuePair, in which the point geometry uses a temporal reference system, or CV_TimeInstantValuePair—OGC 06-188r1).

Example: An air- or water-quality monitoring station observes properties such as ozone, turbidity, etc. The instantaneous value is a scalar concentration or index value. However, the value is time-dependant. The value may be expressed as a coverage whose domain is the period of interest. This is usually described as a time series, which is a discrete time coverage.

The feature of interest may be naturally structured into elements, such as a road network composed of road-segments, or a state composed of administrative areas at a finer scale, or a farm composed of fields. Observation of a property of these features may capture its variation as a function of the sub-features. In these cases the standard members of the target feature are responsible for the decomposition of the domain geometry. The result of an observation on such a compound feature is a set of element-value pairs (CV_ElementValuePair—OGC 06-188r1), in which the domain object refers to a feature, which must be a member of the compound feature that is the feature of interest of the complete observation.

NOTE: ISO 19123 allows for a domain object to be parameterized by space and time. The use of a feature as the domain object is thus a variation on the standard coverage model. In this usage the feature is playing a similar role as an index from a grid domain – it is a designator that supports the relevant spatio-temporal position being obtained indirectly.

NOTE: Specialized observations with coverage results may be defined (Figure 4).

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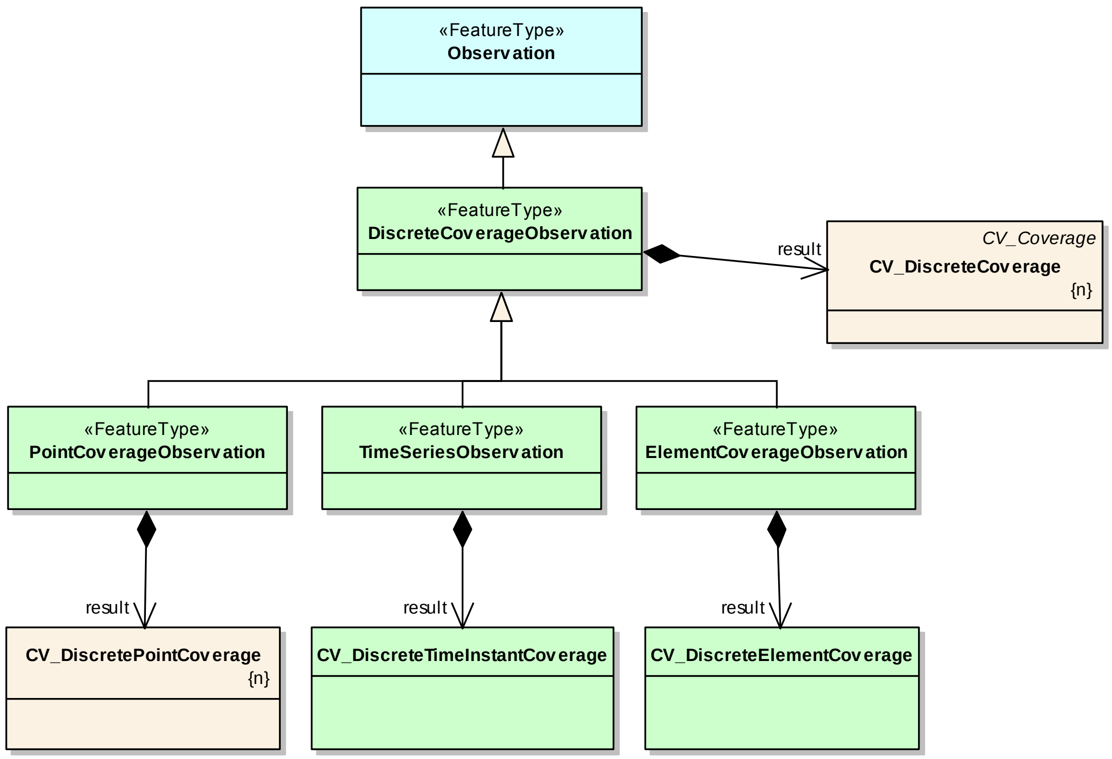

Figure 4. (Informative) Specialization of observations with coverage-valued results

6.4 Location

Observations may be associated with a geospatial location. The primary location of interest is usually associated with the ultimate feature-of-interest, so this is a principle classifier of an observation and its result, used in indexing and discovery.

However, the location 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 detected entity, 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 (see sub-clauses 6.3.1 and O&M-Part 2).

Other locations appear in various scenarios. Sub-sampling at locations within the feature-of-interest may occur (see sub-clause 6.3.3.3). The procedure may involve a sensor located remotely from the ultimate feature of interest (e.g. remote sensing; specimens removed from their sampling location and observed ex-situ). Furthermore, the location of the feature of interest may be time-dependent.

Finally, the O&M 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).

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For these reasons, the 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.

6.5 Collections of observations

An **ObservationCollection** is composed of a set of member observations (Figure 2).

Under certain conditions of homogeneity, the information in an observation collection may be captured in a compound observation type, as described in sub-clause 6.3.3.

If the member observations have

– the same feature of interest

– the same sampling time

– different observed properties

this may be represented as a ComplexObservation (sub-clause 6.3.3.2) whose observed property compounds the individual properties.

Example: A multi-band spectral radiance; a compound observable like "weather"; a tensor property like earthquake moment.

If the member observations have

– the same feature of interest

– the same observed property

– different sampling times

this may be transformed into a TimeSeriesObservation (sub-clause 6.3.3.3) whose sampling time is the period encompassing all the member times.

Example: Air-temperature at a weather station; water quality observations at a water monitoring station.

If the member observations have

– the same observed property

– the same sampling time

– features of interest that comprise elements of a larger feature

this may be represented as a DiscreteCoverageObservation (sub-clause 6.3.3.3) whose feature of interest is the larger feature, and within which the result elements' geometry describe its spatio-temporal decomposition.

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Example: The feature of interest is an array of stations, which may be on a grid; or an array of pixels, which comprise a scene

6.6 Implementation

6.6.1 XML encoding rule

The model is presented using the UML profile described in ISO 19103 and ISO DIS 19136. This allows a GML Application Schema to be generated by following the encoding rules in ISO DIS 19136. Such an XML implementation represents the model explicitly, with elements that carry the names that appear in the model.

Alternative GML Application Schema implementations are possible, and may be considered conformant provided they accommodate the information items identified in the model (see ANNEX A). The model may also be used to design or analyse implementations using other platforms, such as tables, spreadsheets, etc.

Note that a GML implementation is necessary to allow O&M objects to be represented in a form that conforms with requirements for service interfaces specified by OGC, in particular WFS and profiles of WFS.

6.6.2 Basic observation

The schema for the Observation model shown in Figure 2 is presented in ANNEX D Clause 2.3.

6.6.3 Specialized observation types

The specialized observation types shown in Figure 3 and Figure 4 each have a result property of a specific type. These are implemented in the schema shown in ANNEX D Clause 2.4.

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7 Discussion

7.1 Domain specialization

Specialization of the observation model for an application domain is accomplished primarily through the domain application schema and its feature-type catalogue. For example, an instance of a feature-type in the domain feature-type catalogue will provide the ultimate feature of interest for the investigation of which the observation is a part, and the characteristic properties of the feature-type provide potential observed properties. A description of a sensor or process familiar within the application domain is the value of the observation procedure.

The observation model encourages encapsulation of domain specialization in the associated classes, and the observation class itself rarely needs specialization.

Nevertheless, other choices could be made in partitioning information between the classes in the model. For some applications it may be convenient for information that is strictly associated with a second-layer object (procedure, feature of interest) to be associated with a specialized observation type.

For example, when measuring chemistry or contamination, the process often involves retrieving *specimens* from a sampling station, which are then sent to a laboratory for analysis. The specimen is a very tangible feature instance, with identity. For some applications it may be important to recognize the existence of the specimen, and retain a separate description of it. However, in other applications, particularly when the focus is on monitoring the change in a property at a sampling station, the existence of a series of distinct specimens is of minor or no interest. In this case creating a series of objects and identifiers is superfluous to the user's requirements.

Nevertheless, some properties that might be strictly associated with such a specimen must still be recorded, such as "sampling elevation" in a water or atmospheric column. A number of choices may be made. For example, the elevation could be

(a) a property of each distinct specimen on which atomic observations are actually made,

(b) a property of the sampling station (which would require distinct stations for all elevations at which observations are made),

(c) a parameter of the observation procedure, (which makes the procedure specific to this observation series only) or

(d) a parameter of the observation event, either using the soft-typed procedureParameter, or through specialization of the observation type.

Any of these is a legitimate approach. The optimum one will be dependent on the application.

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All of the classes in the models presented here for observations and procedures may be further specialized for domain-specific purposes. Additional attributes and associations may be added as necessary.

Example: "Assay" may be derived from Measurement, fixing the observedProperty to be "ChemicalConcentration" and adding an additional attribute "analyte".

7.2 Comparison with provider-oriented models

The O&M model is intended to provide a basic output- or user-oriented information model for sensor web and related applications. The goal is to provide a common language for discourse regarding sensor and observation systems.

In comparison, TML and SensorML have process- or provider-oriented data models. These are usually used to describe data at an early stage in the data processing and value-adding chain. This may be prior to the details of the feature-of-interest and observed property being assembled and assigned to the result in a way that carries the key semantics to end-users of observation data. In particular, part of a TML or SensorML datastream may include information that must be processed to determine the position of the target or feature-of-interest. At the early processing stage such positional and timing information may be embedded within the result.

Nevertheless, even within these low-level models the O&M formalization may be applied. The proximate feature-of-interest is the vicinity of the sensor. The observed property is a composite type including components representing observation timing, and position and attitude of a sensor, etc. This must be processed to obtain the details of the ultimate feature of interest. The procedure is a sensor package including elements that capture all of the elements of the composite phenomenon or property-type, etc.

7.3 Observation discovery and use

The Observation and Measurements model presented here offers a user-oriented viewpoint. The information object is characterized by a small set of properties, which are likely to be of interest to a user for discovery and request of observation data. The user will typically be interested primarily in a feature of interest, or the variation of a phenomenon. The model provides these items as first order elements. An interface to observation information should expose these properties explicitly.

Sensor Observation Service [SOS] leverages the O&M model directly, with *featureOfInterest* and *observedProperty* being (1) explicit classifiers for an observationOffering in the capabilities description, used for discovery, and (2) explicit parameters in the GetObservation request. From a user point of view, the sensor or procedure description is primarily *metadata*, which is only of interest to specialists during discovery, and then to assist evaluation or processing of individual results.

Each of these associated objects (sensor or procedure, target feature, phenomenon) may require a complex description. Hence they are modelled as distinct classes, which may be as simple or complex as necessary. In the XML serialized representation following the GML pattern, they may appear inline, perhaps described using one of the models

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presented here, or they may be indicated by reference using a URI. The URI identifier may be a URL link or service call, which should resolve immediately to yield a complete resource. Or it may be a canonical identifier, such as a URN, which the user and provider are preconfigured to recognise and understand.

On the other hand, TML and SensorML take a process- or provider-oriented viewpoint. Discovery and request is based primarily on the user having knowledge of specific sensor systems and their application. While this is a reasonable assumption within technical communities, specialist knowledge of sensor systems would not be routinely available within a broader set of potential users of sensor data, particularly as this is made widely available through interfaces like SOS.

7.4 Observations vs. Interpretations

Some conceptual frameworks make a fundamental distinction between *observations* and *interpretations* as the basis for their information modelling approach. This supports a pattern in which observations are given precedence and archived, while interpretations are more transient, being the result of applying the current algorithms and paradigms to the currently available observations.

An alternative view is that the distinction is not absolute, but is one of degree. Even the most trivial "observations" are mediated by some theory or procedure. For example, the primary measurement when using a mercury-in-glass thermometer is the position of the meniscus relative to graduations. This allows the length of the column to be estimated. A theory of thermal expansion plus a calibration for the physical realization of the instrument allows conversion to an inferred temperature. Other observations and measurements all involve some kind of processing from the primary observable. For modern instruments the primary observable is almost always voltage or resistance or frequency from some kind of sensing element, so the "procedure" typically involves calibrations, etc, built on a theory of operation for the sensor. But the same high-level information model - that every "value" is an estimate of the value of a property, generated using a procedure and inputs - applies to both "observations" and "interpretations". It is just that the higher the semantic value of the estimate, the more theory and processing is involved.

In some cases it may be useful to explicitly describe the processing chain instance that has taken a more primitive observations (e.g. an image) and retrieved a higher level observation (e.g. the presence of a certain type of feature instance) through the application of one or more processing steps.

7.5 Features, coverages and observations – different views of information

ISO 19109 describes the *feature* as a “fundamental unit of geographic information”. The “General Feature Model” (GFM) presented in ISO 19101 and 19109 defines a feature type in terms of its characteristic set of properties, including attributes, association roles, and behaviours, as well as generalization and specialization relationships, and constraints.

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Typical concrete feature types have names like "road", "watercourse", "mine", "atmosphere", etc. For a road the set of properties may include its name, its classification, the curve describing its centreline, the number of lanes, the surface material, etc. The complete description of a road instance, therefore, is the set of values for the set of properties that define a road type. This use of the feature model is object-centric, and supports a viewpoint of the world in terms of the set of discrete identifiable objects that occupy it.

The principle alternative model for geographic information is the *coverage*, described in ISO 19123. This viewpoint focuses on the variation of a property within the (spatio-temporal) domain of interest. The domain may be a grid, a transportation network, a volume, a set of sampling stations, etc. The range of the coverage may be any property, such as reflectance, material-type, concentration of some pollutant, number of lanes etc. But the key to the coverage viewpoint is that it is property-centric, concerning the distribution of the values of a property within its domain space.

These viewpoints are not exclusive, and both are used in analysis and modelling. For example, a feature may be detected from analysis of variation of a property in a region of interest (e.g. an ore-body from a distribution of assay values). And for some feature types, the value of one or more properties may vary across the feature, in which case the shape of the feature provides the coverage domain (e.g. ore-grade within a mine).

Observations focus on the data collection event. An act of Observation serves to assign a value to a property of a feature. If the property is non-constant, the value may be a function or coverage. The results of a set of observations of different properties on the same feature of interest may provide a complete description of the feature instance. Alternatively, the results of a set of observations of the same property on a set of different features provide a discrete coverage of that property over a domain composed of the geometry of the feature set. The other properties of the Observation are metadata concerning the estimation of the value(s) of a property on a feature of interest.

In particular, Observations concern properties (e.g. shape, color) whose values are determined using an identifiable procedure, in which there is a finite uncertainty in the result. This may be contrasted with properties whose values are specified by assertion (e.g. name, owner) and are therefore exact. The observation instance provides "metadata" for the property value-estimation process.

An observation event is clearly a "feature" in its own right, according to the GFM definition. An observation instance is a useful unit of information, therefore observation is a feature type.

In sub-clause 6.5 we discussed equivalences of certain observation collections with complex observations, and with observations whose result is a coverage. Transformation between viewpoints is frequently required. OGC AS Topic 6 comments: "we should be comfortable moving back and forth between any of the [different representations of the same information] whenever it makes sense to do so". Some of the observation specializations provide an explicit demonstration of the transformation.

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This is illustrated in Figure 5, which schematically shows a dataset comprising values of a set of properties at a set of locations. A row of the table provides the complete description of the properties at a single location. This is a representation of a potential feature description. A column of the table describes the variation of a single property across the set of locations. This is a representation of a discrete coverage. A single cell in the table provides the value of a single property on a single feature. This may be the result of an observation.

Observations, Coverage and Feature representations may be associated with different phases of the data-processing cycle or value-chain:

– The observation view is associated with data collection, when an observation event causes values for a property of a feature to be determined, and during data entry when the data-store is updated by inserting values into fields in the datastore;

– A coverage view may be assembled from results of observations of a specific property, and represents data assembled for analysis, when the objective is to find signals in the variation of a property over a domain;

– A discrete feature description is a "summary" viewpoint, assembled from results of observation on the same target, or an "inferred" viewpoint, by extraction of a signal from a coverage.

Location	**Properties**			
	Property 1	Property 2	…	Property m
(x_1, y_1)	$Value_1^1$	$Value_1^2$	…	$Value_1^m$
(x_2, y_2)	$Value_2^1$	$Value_2^2$	…	$Value_2^m$
(x_3, y_3)	$Value_3^1$	$Value_3^2$	…	$Value_3^m$
(x_n, y_n)	$Value_n^1$	$Value_n^2$	…	$Value_n^m$

Feature 3

Coverage 2

Figure 5. Tabular representation of information associated with a set of locations.

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ANNEX A
(normative)

Abstract test suite for Observation schemas

1 Abstract tests for observation interfaces

1.1 Generic observation interface

Test Purpose: Verify that an application schema involving observations or measurements instantiates the Observation class with the properties *samplingTime*, *procedure*, *observedProperty*, *featureOfInterest*, and *result*.

Test Method: Inspect the application schema.

Reference: Clause 6.2

Test Type: Capability Test

1.2 Specialized observation interface

Test Purpose: Verify that an application schema involving specialized observations instantiates a class that specializes the Observation class, by (i) adding new properties or (ii) by overriding the definition of one or more of *procedure*, *observedProperty*, *featureOfInterest*, and *result* by restricting its type to a specialized process, to a member of a limited set of property-types, to a member of a specific feature type catalogue, or to specific data-types, respectively.

Test Method: Inspect the application schema

Reference: Clause 6.2

Test Type: Capability Test

2 Abstract tests for observation interchange

2.1 Generic observation interchange

Test Purpose: Verify that an interchange schema involving observations or measurements implements the mandatory attributes and associations of the Observation class.

Test Method: Inspect the documentation of the interchange schema

Reference: Clause 6.2

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Test Type: Capability Test

2.2 Specialized observation interchange

Test Purpose: Verify that an interchange schema involving specialized observations implements the mandatory attributes and associations of a class that specializes the Observation class.

Test Method: Inspect the documentation of the interchange schema

Reference: Clause 6.2

Test Type: Capability Test

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ANNEX B
(informative)

Mapping O&M terminology to usage in some common domains

1 Introduction

This document describes use of terminology in support of a generic, cross-domain model for observations and measurements. This includes terms taken from a variety of disciplines. The terms are used within the model in a consistent manner, but in order to achieve internal consistency, this varies from how the same terms are used in some application domains. In order to assist in the correct application of the model across domains, this Annex provides a mapping from O&M terminology to some domain vocabularies.

2 Earth Observations (EO)

O&M	**EO**
Observation::result	observation value, measurement value
Observation::procedure	method, sensor
Observation::observedProperty	parameter, variable
Observation::featureOfInterest	media (air, water, …), Global Change Master Directory "Topic"

2.1 EO Examples

2.1.1 Air Quality

O&M	**Particulate Matter 2.5 Concentrations**
Observation::result	35 ug/m^3
Observation::procedure	U.S. EPA Federal Reference Method for $PM_{2.5}$
Observation::observedProperty	Particulate Matter 2.5
Observation::featureOfInterest	troposphere

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3 Metrology

O&M	Metrology
Observation::procedure	instrument
Observation::observedProperty	measurand
Observation::result	value

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ANNEX C
(informative)

The O&M second layer

1 Introduction

O&M describes a generic model for metadata associated with property-value estimation. However, much of the detail in specific observations is associated with classes in the "second layer" – i.e. the features of interest, phenomena, and procedures. As described in sub-clause 7.1, detailed schemas for the second-layer objects are generally the concern of domain-specific application schemas that utilise O&M. However, some general patterns apply, which are discussed in this clause through models for Property-type and Process.

The models in this Annex describe some requirements and are non-normative. In the context of encoding Observation instances, both Property-type and Process are often indicated by reference, rather than represented by a complete description "inline". That pattern requires that each instance of these classes has an unambiguous identifier, which is then used in the reference. The reference may also be to a description encoded in another form, including offline. Provided the semantics are correct, then this is consistent with the model. A common pattern, however, is that identifiers for Property-type and Process are more immediately important to users than the full description of these concepts.

2 Requirements for a property-type schema

2.1 Scope

The observed property is a feature characteristic, the estimation of which is the purpose of the observation. This may be a physical property (such as temperature, length, etc), a classification (such as species), frequency or count, or an existence indication.

A schema for semantic definitions of property-types is beyond the scope of this specification. Ultimately this rests on shared concepts described in natural language. However, the value of the observed property is a key classifier for the information reported in an observation. Thus, in order to support such classification, for use in discovery and requests, an ontology of observable property-types must be available.

Formal notations for knowledge representation are available (e.g. OWL [OWL]) and prototype ontologies for property-types have been constructed using such technology (e.g. SWEET - see http://sweet.jpl.nasa.gov/ontology/property.owl).

NOTE: SWEET is the most well known ontology for physical properties. However, SWEET is incomplete, and furthermore has limitations in the description of phenomena derived from more basic or atomic components, partly related to the limitations that OWL's identity-focussed approach introduces when dealing with continuous values (numerics).

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NOTE: EDCS “Attributes” [ISO/IEC 18025] is another formal dictionary of observable property-types.

2.2 Derived property-types

In order to support common uses in natural sciences and engineering, we require a schema which supports the description of “derived” property-type definitions. This uses a pre-existing set of definitions of “fundamental” property-types as base property-types, and for the semantics of axes of constraint.

NOTE: The set of “quantity types” used in the definition of units of measure (e.g. SI) may be used as basic physical properties, but this does not exhaust the base phenomena required to characterize observations.

A model for such derived property-type definitions is shown in Figure 6.

The description of the property-type will often be persisted in a dictionary (e.g. an ISO 19135 Register) and its identifier or designator used as the value in the observation instance. The PropertyType class effectively instantiates GF_PropertyType (ISO 19109).

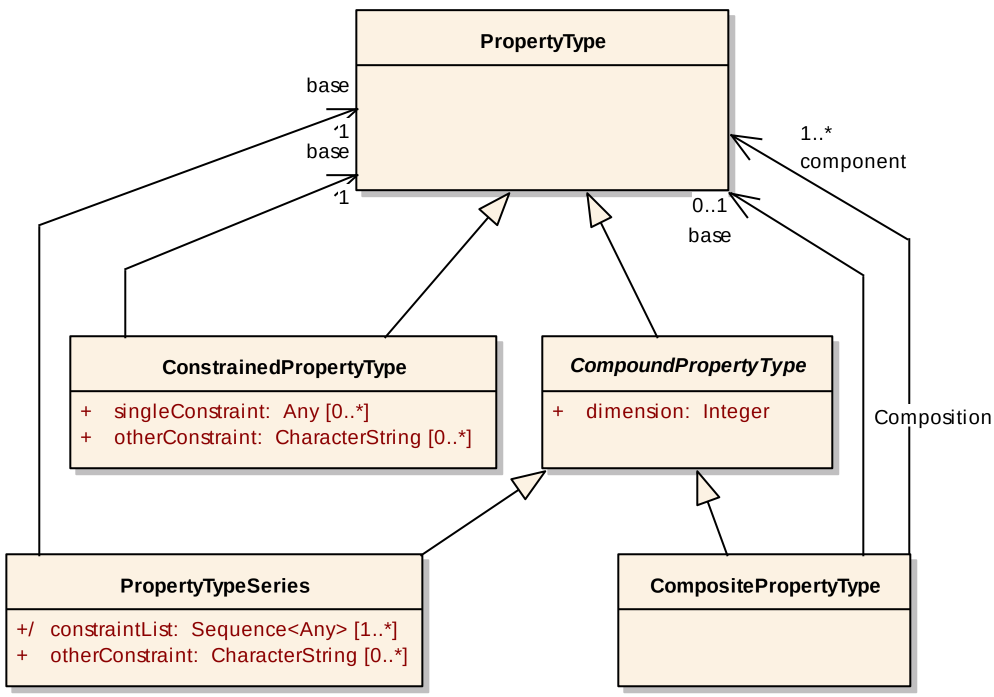

Figure 6. A model for derived property-type definitions

The basic **PropertyType** class carries a definition, with an identifier and an optional set of aliases.

Two kinds of specializations are supported: constraints and compounding.

A **ConstrainedPropertyType** modifies a **base** property-type by adding **singleConstraint**s, each specifying a value on some secondary axis.

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Example: "water temperature" has the base "temperature" (i.e. it is a kind of temperature) constrained so that the property "substance" has the value "water". "Surface water temperature" might add another constraint that "depth" is "between 0 - 0.3m".

A **CompoundPropertyType** has several components, whose count is indicated by the **dimension**. CompoundPropertyType is an abstract class. Two concrete specializations are provided.

A **CompositePropertyType** is composed of a set of **component** property-types. The components may not be related to each other, though useful compound property-types would usually have some semantic coherence. The optional **base** property-types allows for the CompositePropertyType to be generated by adding components to a base.

A **PropertyTypeSeries** applies one or more **constraintList**s to the base property-types, each providing a set of values for a single secondary axis.

Example: A "radiance spectrum" may be based on "radiance" with a list of "wavelength" intervals specified.

The "base" association indicates a conceptual relationship, which may be useful in classification of observation types. The value of a specialised property-type must be described using a scale (units of measure, vocabulary) that could also be used for the base.

Example: an application may choose to include observations of "WaterTemperature" when the subject of interest is observations of "Temperature".

2.3 XML Implementation

An explicit XML implementation of the PropertyType model as a GML Application Schema is presented in Swe Common OGC 07-003 (as the "Phenomenon" schema).

3 Model for observation Process

3.1 Scope

The description of Observation procedures is beyond the scope of this document. Figure 7 shows a basic taxonomy of processes introduced by SensorML.

NOTE: It is expected that standard process model descriptions will be published in a standard location (e.g. ISO 19135 register) enabling them to be used by-reference.

The following types of concrete process are identified:

- a **ProcessModel** is an atomic procedure.
- a **ProcessSystem** aggregates sub-processes, which may apply either in parallel (as a process package) or sequentially (in a processing chain) or a mixture (i.e. a process-graph).

Example: In the set of instruments at a weather station there are separate elements to measure temperature, wind-speed, pressure, etc, providing a complete description of the weather as a compound phenomenon. Multi-component seismometers, and multi-spectral imaging sensors are other examples.

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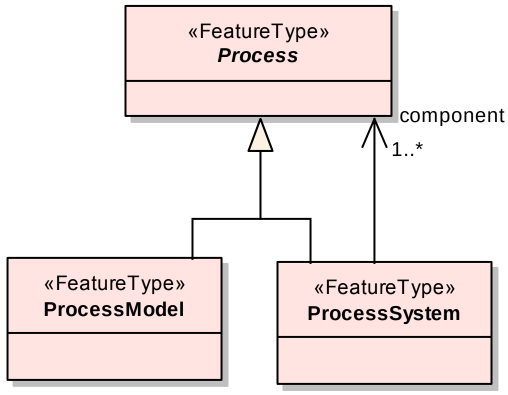

Figure 7. Simple model of Processes (from SensorML).

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ANNEX D
(informative)

XML Schema implementation

1 GML Application Schema

The models presented in this specification use the UML profile described in ISO 19103 and ISO DIS 19136. This allows a GML Application Schema to be generated by following the encoding rules in ISO DIS 19136. This implementation provides an explicit representation of the model, with XML elements carrying the literal names that appear in the model.

NOTE: The gml:Observation element provided in ISO 19136 implements a closely related concept. However, gml:Observation does not conform to the model described in this specification in the following ways: (a) the observation target is not constrained to be a feature; (b) the “using” property (corresponding to “procedure”) is optional; (c) the observedProperty is not provided.

Note that the XML Schema presented in this Annex uses GML 3.1.1. This is the GML version used by SensorML v1.0 and by the SWE Common v1.0 components described therein, which are used by the O&M encoding. Schema validity of a set of dependent XML schemas requires that they use common versions.

2 Observations and measurements schema

2.1 Namespace

The schema for Observations and Measurements v1.0 is in the namespace http://www.opengis.net/om/1.0

2.2 Dependencies

The O&M schema v1.0 has direct dependencies on the following externally governed schemas:

Schema	Version	XML namespace	Location of imported schema document
GML	3.1.1	http://www.opengis.net/gml	http://schemas.opengis.net/gml/3.1.1/base/gml.xsd
Swe Common	1.0.1	http://www.opengis.net.swe/1.0.1	http://schemas.opengis.net/swe/1.0.1/swe.xsd
SensorML	1.0.1	http://www.opengis.net/sensorML/1.0.1	http://schemas.opengis.net/sensorML/1.0.1/base/sensorML.xsd

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Issue: The ISO 19115 Metadata XML Implementation described in ISO 19139 is bound to GML 3.2, so cannot be used with this version. Placeholder types and elements have been used in place of the ISO components in this version of the schema. The upgrade path is indicated at relevant points in the schema documents.

Issue: It has been suggested that the concrete observation feature-type provided as part of GML (viz. gml:Observation) might be replaced by om:Observation. Since om:Observation has dependencies on SWE Common and on SensorML, this would require either (i) that those dependencies were also introduced into GML, (ii) that the content-model be relaxed to take a wild-card (<any> or type="xs:anyType") in place of SWE Common or SensorML components, or (iii) that the observation feature-type be removed from GML, and application developers directed to O&M as a standard cross-domain application schema for Observations, but not in the GML namespace.

2.3 Observation

This document implements the basic Observation and ObservationCollection classes described in sub-clause 6.2 and shown in Figure 2.

Listing 1. observation.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:om="http://www.opengis.net/om/1.0"
    xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:sml="http://www.opengis.net/sensorML/1.0.1"
targetNamespace="http://www.opengis.net/om/1.0" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="1.0.0">
	<annotation>
		<documentation>observation.xsd

An XML implementation of the OandM model from OGC 07-022

Copyright (c) 2007 Open Geospatial Consortium - see http://www.opengeospatial.org/ogc/software</documentation>
	</annotation>
	<!-- ====================================================================== -->
	<!-- bring in other schemas -->
	<import namespace="http://www.opengis.net/gml"
schemaLocation="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"/>
	<!-- can't use ISO Metadata schema with GML 3.1.1
	<import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../../../gml/trunk/gml/3.1.1/gmd/gmd.xsd"/>
	-->
	<import namespace="http://www.opengis.net/swe/1.0.1"
schemaLocation="http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd"/>
	<import namespace="http://www.opengis.net/sensorML/1.0.1"
schemaLocation="http://schemas.opengis.net/sensorML/1.0.1/sensorML.xsd"/>
	<!-- ====================================================================== -->
	<!-- ====================================================================== -->
	<!-- ===== Object types for Observations ====== -->
	<!-- ====================================================================== -->
	<complexType name="ObservationType">
		<annotation>
			<documentation>Base type for Observations.
      Observation is an act ("event"), whose result is an estimate of the value of a property of the feature of interest.
      The observed property may be any property associated with the type of the feature of interest.

                              The following properties are inherited from AbstractFeatureType:
                                   <!--    from AbstractGMLType
```

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```
<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
<element ref="gml:description" minOccurs="0"/>
<element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/> -->
<!--	from AbstractFeatureType
<element ref="gml:boundedBy" minOccurs="0"/> --></documentation>
</annotation>
<complexContent>
<extension base="gml:AbstractFeatureType">
<sequence>
<element name="metadata" type="om:AnyOrReferenceType" minOccurs="0">
<!--				<element name="observationMetadata"
type="gmd:MD_Metadata_PropertyType" minOccurs="0"> -->
<annotation>
<documentation>Replace with reference to ISO Metadata entity when GML
version 3.2.X has been formally adopted.</documentation>
</annotation>
</element>
<element name="samplingTime" type="swe:TimeObjectPropertyType">
<annotation>
<documentation>The samplingTime is the time that the result applies to the
feature-of-interest.
This is the time usually required for geospatial analysis of the result.</documentation>
</annotation>
</element>
<element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0">
<annotation>
<documentation>The resultTime is the time when the procedure associated with
the observation act was applied.
For some observations this is identical to samplingTime, in which case the resultTime may be
omitted.

Example:	Where a measurement is made on a specimen in a laboratory, the samplingTime
should record the time the specimen was retrieved from its host, while the resultTime should record the time the
laboratory procedure was applied.
Example:	Where sensor observation results are post-processed, the resultTime is the post-
processing time, while the samplingTime preserves the time of initial interaction with the world.
Example:	Simulations are often used to estimate the values for phenomena in the future or
past. The samplingTime is the real-world time that the result applies to, while the resultTime is the time that the simulation
process was executed.</documentation>
</annotation>
</element>
<element name="procedure" type="om:ProcessPropertyType">
<annotation>
<documentation>The procedure is the description of a process used to generate
the result.
It must be suitable for the observed property.
NOTE:	At this level we do not distinguish between sensor-observations,
estimations made by an observer, or algorithms, simulations, computations and
complex processing chains.</documentation>
</annotation>
</element>
<element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0">
<!--				<element name="resultQuality"
type="gmd:DQ_Element_PropertyType" minOccurs="0"> -->
<annotation>
<documentation>Instance-specific quality assessment or measure.
Allow multiple quality measures if required.

Replace with reference to ISO Metadata entity when GML version 3.2.X has been formally
adopted.</documentation>
</annotation>
</element>
<element name="observedProperty" type="swe:PhenomenonPropertyType">
<annotation>
<documentation>Property-type or phenomenon for which the observation result
provides an estimate of its value.
for example "wavelength", "grass-species", "power", "intensity in the waveband x-
y", etc.
It must be a property associated with the type of the feature of interest.
This feature-property that provides the (semantic) type of the observation.
The description of the phenomenon may be quite specific and constrained.
```

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```
                                        The description of the property-type may be presented using various alternative
encodings.
                                        If shown inline, the swe:Phenomenon schema is required.
                                        If provided using another encoding (e.g. OWL or SWEET) then the description
must be in a remote repository and xlink reference used.</documentation>
                                </annotation>
                        </element>
                        <element name="featureOfInterest" type="gml:FeaturePropertyType">
                                <annotation>
                                        <documentation>The featureOfInterest is a feature of any type (ISO 19109, ISO
19101), which is a representation of the observation target, being the real-world object regarding which the observation is
made.
                                        such as a specimen, station, tract, mountain, pixel, etc.
                                        The spatial properties (location) of this feature of interest are typically of most
interest for spatial analysis of the observation result.</documentation>
                                </annotation>
                        </element>
                        <element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded">
                                <annotation>
                                        <documentation>An Observation parameter is a general event-specific parameter.
                                        This will typically be used to record environmental parameters, or event-specific
sampling parameters that are not tightly bound to either the feature-of-interest or the procedure.
                                        NOTE:   Parameters that are tightly bound to the procedure should be recorded
as part of the procedure description. For example, the SensorML model associates parameters with specific process
elements or stages.
                                        NOTE:   The semantics of the parameter must be provided as part of its value.

                                        In some applications it is convenient to use a generic or standard procedure, or
feature-of-interest, rather than define an event-specific process or feature.
                                        In this context, event-specific parameters are bound to the Observation
act.</documentation>
                                </annotation>
                        </element>
                        <element name="result" type="anyType">
                                <annotation>
                                        <documentation>The result contains the value generated by the procedure.
                                        The type of the observation result must be consistent with the observed property,
and the scale or scope for the value must be consistent with the quantity or category type.
                                        Application profiles may choose to constrain the type of the
result.</documentation>
                                </annotation>
                        </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ......................... -->
    <element name="Observation" type="om:ObservationType" substitutionGroup="gml:_Feature">
        <annotation>
            <documentation>Observation is an act ("event"), whose result is an estimate of the value of a property of
the feature of interest.
    The observed property may be any property associated with the type of the feature of interest.</documentation>
        </annotation>
    </element>
    <!-- ...................... -->
    <complexType name="ObservationPropertyType">
        <sequence minOccurs="0">
            <element ref="om:Observation"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ==================================================================== -->
    <!-- ===== Observation Collection ======= -->
    <!-- ==================================================================== -->
    <complexType name="ObservationCollectionType">
        <annotation>
            <documentation>Collection of arbitrary observations</documentation>
        </annotation>
        <complexContent>
```

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```
                <extension base="gml:AbstractFeatureType">
                    <sequence>
                        <element name="member" type="om:ObservationPropertyType" maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ...................... -->
        <element name="ObservationCollection" type="om:ObservationCollectionType" substitutionGroup="gml:_Feature">
            <annotation>
                <documentation>Collection of arbitrary observations</documentation>
            </annotation>
        </element>
        <!-- ====================================================================== -->
        <!-- ====================================================================== -->
        <complexType name="ProcessPropertyType">
            <annotation>
                <documentation>This property type allows the Observation/procedure property to  either
            * contain a SensorML Process,
            * contain a description of a process described using another model, wrapped inside a om:Process element
            * point to a Process either elsewhere in the document or identified by a URI</documentation>
            </annotation>
            <sequence minOccurs="0">
                <choice>
                    <element ref="sml:_Process">
                        <annotation>
                            <documentation>Top of  SensorML Process hierarchy</documentation>
                        </annotation>
                    </element>
                    <element name="Process">
                        <annotation>
                            <documentation>This element is xs:anyType so may contain a description of a process
provided in any well-formed XML.
                    If the process description is namespace qualified, then the namespace must be identified in the
instance document.</documentation>
                        </annotation>
                    </element>
                </choice>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ====================================================================== -->
        <!-- ====================================================================== -->
        <complexType name="AnyOrReferenceType">
            <annotation>
                <documentation>Placeholder type
                Used in a few places where ISO 19139 metadata classes are used, which will become available with
GML 3.2</documentation>
            </annotation>
            <sequence minOccurs="0">
                <any/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ====================================================================== -->
        <!-- ====================================================================== -->
</schema>
```

2.4 Specialized observation

These documents implement the specialized Observation classes described in sub-clause 6.3.3.2, and shown in Figure 3.

Issue: The XML schema for specialized observation types presented in Listing 2, Listing 3 and Listing 4 are implementations of the non-normative models given in Figure 3. They are provided as illustrations of XML Schema mechanisms for specialization. However, they are not included in the stub schema om.xsd that is recommended for use in domain schemas.

Listing 2 shows one formulation of the specialization, where the specialized types use Schematron [ISO/IEC 19737-3] constraints to enforce the result type.

Listing 2. observationSpecialization_constraint.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:sch="http://purl.oclc.org/dsdl/schematron"
	targetNamespace="http://www.opengis.net/om/1.0"
elementFormDefault="qualified" attributeFormDefault="unqualified" version="1.0.0">
	<annotation>
		<appinfo source="urn:x-iso:std:ISO:fts:19139:2006">
			<sch:title>Schematron validation</sch:title>
			<sch:ns prefix="gml" uri="http://www.opengis.net/gml"/>
			<sch:ns prefix="om" uri="http://www.opengis.net/om/1.0"/>
			<sch:ns prefix="swe" uri="http://www.opengis.net/swe/1.0"/>
			<sch:ns prefix="xlink" uri="http://www.w3.org/1999/xlink"/>
			<sch:ns prefix="xs" uri="http://www.w3.org/2001/XMLSchema"/>
			<sch:ns prefix="xsi" uri="http://www.w3.org/2001/XMLSchema-instance"/>
		</appinfo>

		<documentation>observationSpecialization_constraint.xsd

An implementation of the OandM model for SWE
This document contains various specializations of the basic observation pattern, by fixing the type of the result.
In this version, the specialization is achieved by using Schematron to constrain the type of the result element from
om:ObservationType

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	</annotation>
	<!-- ====================================================================== -->
	<!-- bring in other schemas -->
	<import namespace="http://www.opengis.net/gml"
schemaLocation="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"/>
	<import namespace="http://www.opengis.net/swe/1.0.1"
schemaLocation="http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd"/>
	<include schemaLocation="../observation.xsd"/>
	<!-- ====================================================================== -->
	<!-- ====================================================================== -->
	<!-- ===== Scalar Observations ====== -->
	<!-- ====================================================================== -->
	<element name="Measurement" type="om:ObservationType" substitutionGroup="om:Observation">
		<annotation>
			<appinfo>
				<sch:pattern name="result type must be gml:MeasureType">
					<sch:rule context="//om:Measurement">
						<sch:assert test="om:result/@xsi:type='gml:MeasureType' ">xsi:Type must be
gml:MeasureType</sch:assert>
					</sch:rule>
				</sch:pattern>
			</appinfo>
			<documentation>Specialized Observation in which the result is a Measure</documentation>
		</annotation>
	</element>
	<!-- ====================================================================== -->
	<element name="CategoryObservation" type="om:ObservationType" substitutionGroup="om:Observation">
		<annotation>
			<appinfo>
				<sch:pattern name="result type must be gml:CodeType">
```

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```
                    <sch:rule context="//om:CategoryObservation">
                        <sch:assert test="om:result/@xsi:type='gml:CodeType' ">xsi:Type must be
gml:CodeType</sch:assert>
                    </sch:rule>
                </sch:pattern>
            </appinfo>
            <documentation>Specialized Observation, in which the result is a textual value from a controlled
vocabulary</documentation>
        </annotation>
    </element>
    <!-- ====================================================================== -->
    <element name="CountObservation" type="om:ObservationType" substitutionGroup="om:Observation">
        <annotation>
            <appinfo>
                <sch:pattern name="result type must be xs:integer">
                    <sch:rule context="//om:CountObservation">
                        <sch:assert test="om:result/@xsi:type='xs:integer' ">xsi:Type must be
xs:integer</sch:assert>
                    </sch:rule>
                </sch:pattern>
            </appinfo>
            <documentation>Specialized Observation, in which the result is an integer representing the count of the
observed property</documentation>
        </annotation>
    </element>
    <!-- ====================================================================== -->
    <element name="TruthObservation" type="om:ObservationType" substitutionGroup="om:Observation">
        <annotation>
            <appinfo>
                <sch:pattern name="result type must be xs:boolean">
                    <sch:rule context="//om:TruthObservation">
                        <sch:assert test="om:result/@xsi:type='xs:boolean' ">xsi:Type must be
xs:boolean</sch:assert>
                    </sch:rule>
                </sch:pattern>
            </appinfo>
            <documentation>Specialized Observation, in which the result is a boolean value representing the truth
value (usually existence) of the observed property</documentation>
        </annotation>
    </element>
    <!-- ====================================================================== -->
    <element name="GeometryObservation" type="om:ObservationType" substitutionGroup="om:Observation">
        <annotation>
            <appinfo>
                <sch:pattern name="result must contain a gml:_Geometry and nothing else">
                    <sch:rule context="//om:GeometryObservation">
                        <sch:assert test="om:result/gml:_Geometry">gml:_Geometry must be present as child
of om:result</sch:assert>
                        <sch:assert test="count(om:result/*) = 1">only one child may be present</sch:assert>
                </sch:rule>
                </sch:pattern>
            </appinfo>
            <documentation>Specialized Observation, in which the result is a geometry</documentation>
        </annotation>
    </element>
    <!-- ====================================================================== -->
    <element name="TemporalObservation" type="om:ObservationType" substitutionGroup="om:Observation">
        <annotation>
            <appinfo>
                <sch:pattern name="result must contain a gml:_TimeObject and nothing else">
                    <sch:rule context="//om:TemporalObservation">
                        <sch:assert test="om:result/gml:_TimeObject">gml:_TimeObject must be present as
child of om:result</sch:assert>
                        <sch:assert test="count(om:result/*) = 1">only one child may be present</sch:assert>
                </sch:rule>
                </sch:pattern>
            </appinfo>
            <documentation>Specialized Observation, in which the result is a temporal object</documentation>
        </annotation>
    </element>
    <!-- ====================================================================== -->
```

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```
	<!-- ===== Observation with constant complex result ====== -->
	<!-- ====================================================================== -->
	<element name="ComplexObservation" type="om:ObservationType" substitutionGroup="om:Observation">
		<annotation>
			<appinfo>
				<sch:pattern name="result must contain a swe:Record and nothing else">
					<sch:rule context="//om:ComplexObservation">
						<sch:assert test="om:result/swe:DataRecord">swe:DataRecord must be present as
child of om:result</sch:assert>
						<sch:assert test="count(om:result/*) = 1">only one child may be present</sch:assert>
				</sch:rule>
				</sch:pattern>
			</appinfo>
			<documentation>Specialized Observation, in which the result is a record representing a multi-component
phenomenon</documentation>
		</annotation>
	</element>
	<!-- ====================================================================== -->
</schema>
```

Listing 3 shows an alternative formulation of the specialization, using XML Schema "restriction" to ensure that the result has the appropriate type. Note that, since the parent types contain locally-scoped element declarations the restriction mechanism may only be used for schemas with the same targetNamespace.

Listing 3. observationSpecialization_override.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:swe="http://www.opengis.net/swe/1.0.1"
	targetNamespace="http://www.opengis.net/om/1.0"
		elementFormDefault="qualified" attributeFormDefault="unqualified" version="1.0.0">
	<annotation>
		<documentation>observationSpecialization_override.xsd

An implementation of the OandM model for SWE
This document contains various specializations of the basic observation pattern, by fixing the type of the result.
In this version, the specialization is achieved by restricting om:ObservationType to have a result of the correct type

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	</annotation>
	<!-- ====================================================================== -->
	<!-- bring in other schemas -->
	<import namespace="http://www.opengis.net/gml"
schemaLocation="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"/>
	<import namespace="http://www.opengis.net/swe/1.0.1"
schemaLocation="http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd"/>
	<include schemaLocation="../observation.xsd"/>
	<!-- ====================================================================== -->
	<!-- ====================================================================== -->
	<!-- ===== Scalar Observations ====== -->
	<!-- ====================================================================== -->
	<complexType name="MeasurementType">
		<annotation>
			<documentation>Specialized Observation in which the result is a Measure</documentation>
		</annotation>
		<complexContent>
			<restriction base="om:ObservationType">
				<sequence>
					<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
					<element ref="gml:description" minOccurs="0"/>
					<element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
```


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```
						<element ref="gml:boundedBy" minOccurs="0"/>
						<element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="samplingTime" type="swe:TimeObjectPropertyType"/>
						<element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
						<element name="procedure" type="om:ProcessPropertyType"/>
						<element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="observedProperty" type="swe:PhenomenonPropertyType"/>
						<element name="featureOfInterest" type="gml:FeaturePropertyType"/>
						<element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
						<element name="result" type="gml:MeasureType"/>
					</sequence>
				</restriction>
			</complexContent>
		</complexType>
		<!-- ...................... -->
		<element name="Measurement" type="om:MeasurementType" substitutionGroup="om:Observation">
			<annotation>
				<documentation>Specialized Observation in which the result is a Measure</documentation>
			</annotation>
		</element>
		<!-- ==================================================================== -->
		<complexType name="CategoryObservationType">
			<annotation>
				<documentation>Specialized Observation, in which the result is a textual value from a controlled
vocabulary</documentation>
			</annotation>
			<complexContent>
				<restriction base="om:ObservationType">
					<sequence>
						<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
						<element ref="gml:description" minOccurs="0"/>
						<element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
						<element ref="gml:boundedBy" minOccurs="0"/>
						<element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="samplingTime" type="swe:TimeObjectPropertyType"/>
						<element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
						<element name="procedure" type="om:ProcessPropertyType"/>
						<element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="observedProperty" type="swe:PhenomenonPropertyType"/>
						<element name="featureOfInterest" type="gml:FeaturePropertyType"/>
						<element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
						<element name="result" type="swe:ScopedNameType">
							<annotation>
								<documentation>A Scoped Name is a term with a mandatory codeSpace
attribute</documentation>
							</annotation>
						</element>
					</sequence>
				</restriction>
			</complexContent>
		</complexType>
		<!-- ...................... -->
		<element name="CategoryObservation" type="om:CategoryObservationType"
substitutionGroup="om:Observation">
			<annotation>
				<documentation>Specialized Observation, in which the result is a textual value from a controlled
vocabulary</documentation>
			</annotation>
		</element>
		<!-- ==================================================================== -->
		<complexType name="CountObservationType">
			<annotation>
				<documentation>Specialized Observation, in which the result is an integer representing the count of the
observed property</documentation>
			</annotation>
			<complexContent>
				<restriction base="om:ObservationType">
					<sequence>
						<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
```

```
                    <element ref="gml:description" minOccurs="0"/>
                    <element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
                    <element ref="gml:boundedBy" minOccurs="0"/>
                    <element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
                    <element name="samplingTime" type="swe:TimeObjectPropertyType"/>
                    <element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
                    <element name="procedure" type="om:ProcessPropertyType"/>
                    <element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
                    <element name="observedProperty" type="swe:PhenomenonPropertyType"/>
                    <element name="featureOfInterest" type="gml:FeaturePropertyType"/>
                    <element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                    <element name="result" type="integer">
                        <annotation>
                            <documentation>count of the observed property</documentation>
                        </annotation>
                    </element>
                </sequence>
            </restriction>
        </complexContent>
    </complexType>
    <!-- ...................... -->
    <element name="CountObservation" type="om:CountObservationType" substitutionGroup="om:Observation">
        <annotation>
            <documentation>Specialized Observation, in which the result is an integer representing the count of the
observed property</documentation>
        </annotation>
    </element>
    <!-- =================================================================== -->
    <complexType name="TruthObservationType">
        <annotation>
            <documentation>Specialized Observation, in which the result is a boolean value representing the truth
value (e.g. existence) of the observed property</documentation>
        </annotation>
        <complexContent>
            <restriction base="om:ObservationType">
                <sequence>
                    <element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
                    <element ref="gml:description" minOccurs="0"/>
                    <element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
                    <element ref="gml:boundedBy" minOccurs="0"/>
                    <element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
                    <element name="samplingTime" type="swe:TimeObjectPropertyType"/>
                    <element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
                    <element name="procedure" type="om:ProcessPropertyType"/>
                    <element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
                    <element name="observedProperty" type="swe:PhenomenonPropertyType"/>
                    <element name="featureOfInterest" type="gml:FeaturePropertyType"/>
                    <element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                    <element name="result" type="boolean">
                        <annotation>
                            <documentation>truth value (e.g. existence) of the observed
property</documentation>
                        </annotation>
                    </element>
                </sequence>
            </restriction>
        </complexContent>
    </complexType>
    <!-- ...................... -->
    <element name="TruthObservation" type="om:TruthObservationType" substitutionGroup="om:Observation">
        <annotation>
            <documentation>Specialized Observation, in which the result is a boolean value representing the truth
value (usually existence) of the observed property</documentation>
        </annotation>
    </element>
    <!-- =================================================================== -->
    <complexType name="GeometryObservationType">
        <annotation>
            <documentation>Specialized Observation, in which the result is a Geometry </documentation>
```

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```
            </annotation>
            <complexContent>
                <restriction base="om:ObservationType">
                    <sequence>
                        <element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
                        <element ref="gml:description" minOccurs="0"/>
                        <element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
                        <element ref="gml:boundedBy" minOccurs="0"/>
                        <element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
                        <element name="samplingTime" type="swe:TimeObjectPropertyType"/>
                        <element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
                        <element name="procedure" type="om:ProcessPropertyType"/>
                        <element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
                        <element name="observedProperty" type="swe:PhenomenonPropertyType"/>
                        <element name="featureOfInterest" type="gml:FeaturePropertyType"/>
                        <element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="result" type="gml:GeometryPropertyType">
                            <annotation>
                                <documentation>Geometry of the observed property</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </restriction>
            </complexContent>
        </complexType>
        <!-- ...................... -->
        <element name="GeometryObservation" type="om:GeometryObservationType"
substitutionGroup="om:Observation">
            <annotation>
                <documentation>Specialized Observation, in which the result is a Geometry</documentation>
            </annotation>
        </element>
        <!-- ================================================================= -->
        <complexType name="TemporalObservationType">
            <annotation>
                <documentation>Specialized Observation, in which the result is a Temporal object</documentation>
            </annotation>
            <complexContent>
                <restriction base="om:ObservationType">
                    <sequence>
                        <element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
                        <element ref="gml:description" minOccurs="0"/>
                        <element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
                        <element ref="gml:boundedBy" minOccurs="0"/>
                        <element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
                        <element name="samplingTime" type="swe:TimeObjectPropertyType"/>
                        <element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
                        <element name="procedure" type="om:ProcessPropertyType"/>
                        <element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
                        <element name="observedProperty" type="swe:PhenomenonPropertyType"/>
                        <element name="featureOfInterest" type="gml:FeaturePropertyType"/>
                        <element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="result" type="swe:TimeObjectPropertyType">
                            <annotation>
                                <documentation>Temporal value of the observed property</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </restriction>
            </complexContent>
        </complexType>
        <!-- ...................... -->
        <element name="TemporalObservation" type="om:TemporalObservationType"
substitutionGroup="om:Observation">
            <annotation>
                <documentation>Specialized Observation, in which the result is a Temporal object</documentation>
            </annotation>
        </element>
        <!-- ================================================================= -->
```

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```
	<!-- ===== Observation with constant complex result ====== -->
	<!-- ====================================================================== -->
	<complexType name="ComplexObservationType">
		<annotation>
			<documentation>Specialized Observation, in which the result is a record representing a description of a
multi-component phenomenon.</documentation>
		</annotation>
		<complexContent>
			<restriction base="om:ObservationType">
				<sequence>
					<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
					<element ref="gml:description" minOccurs="0"/>
					<element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
					<element ref="gml:boundedBy" minOccurs="0"/>
					<element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
					<element name="samplingTime" type="swe:TimeObjectPropertyType"/>
					<element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
					<element name="procedure" type="om:ProcessPropertyType"/>
					<element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
					<element name="observedProperty" type="swe:PhenomenonPropertyType"/>
					<element name="featureOfInterest" type="gml:FeaturePropertyType"/>
					<element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
					<element name="result" type="swe:DataRecordPropertyType">
						<annotation>
							<documentation>result is a Record - i.e. a heterogeneous list of fields (ISO/IEC
11404) - describing a multi-component phenomenon</documentation>
						</annotation>
					</element>
				</sequence>
			</restriction>
		</complexContent>
	</complexType>
	<!-- ...................... -->
	<element name="ComplexObservation" type="om:ComplexObservationType" substitutionGroup="om:Observation">
		<annotation>
			<documentation>Specialized Observation, in which the result is a record representing a multi-component
phenomenon</documentation>
		</annotation>
	</element>
	<!-- ====================================================================== -->
</schema>
```

Listing 4 shows another alternative formulation of the specialization, using XML Schema “redefine” to restrict the result type without changing the name of the element representing the observation class. .

Listing 4. redefineObservation.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:om="http://www.opengis.net/om/1.0"
	xmlns:swe="http://www.opengis.net/swe/1.0.1" targetNamespace="http://www.opengis.net/om/1.0"
elementFormDefault="qualified" attributeFormDefault="unqualified" version="1.0.0">
	<annotation>
		<documentation>observation.xsd

An example of how to "redefine" ObservationType to restrict the result-type

Copyright (c) 2007 Open Geospatial Consortium - see http://www.opengeospatial.org/ogc/software</documentation>
	</annotation>
	<!-- ====================================================================== -->
	<!-- bring in other schemas -->
	<import namespace="http://www.opengis.net/gml"
schemaLocation="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"/>
```

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```
	<!-- can't use ISO Metadata schema with GML 3.1.1
	<import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../../../gml/trunk/gml/3.1.1/gmd/gmd.xsd"/>
	-->
	<import namespace="http://www.opengis.net/swe/1.0.1"
schemaLocation="http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd"/>
	<import namespace="http://www.opengis.net/sensorML/1.0.1"
schemaLocation="http://schemas.opengis.net/sensorML/1.0.1/sensorML.xsd"/>
	<redefine schemaLocation="../observation.xsd">
		<!-- ====================================================================== -->
		<!-- ====================================================================== -->
		<!-- ===== Object types for Observations ====== -->
		<!-- ====================================================================== -->
		<complexType name="ObservationType">
			<annotation>
				<documentation>Redefines observation type, restricting the result to be a
measure.</documentation>
			</annotation>
			<complexContent>
				<restriction base="om:ObservationType">
					<sequence>
						<element ref="gml:metaDataProperty" minOccurs="0" maxOccurs="unbounded"/>
						<element ref="gml:description" minOccurs="0"/>
						<element ref="gml:name" minOccurs="0" maxOccurs="unbounded"/>
						<element ref="gml:boundedBy" minOccurs="0"/>
						<element name="metadata" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="samplingTime" type="swe:TimeObjectPropertyType"/>
						<element name="resultTime" type="swe:TimeObjectPropertyType" minOccurs="0"/>
						<element name="procedure" type="om:ProcessPropertyType"/>
						<element name="resultQuality" type="om:AnyOrReferenceType" minOccurs="0"/>
						<element name="observedProperty" type="swe:PhenomenonPropertyType"/>
						<element name="featureOfInterest" type="gml:FeaturePropertyType"/>
						<element name="parameter" type="swe:AnyDataPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
						<element name="result" type="gml:MeasureType">
							<annotation>
								<documentation>restrict result to "measure"</documentation>
							</annotation>
						</element>
					</sequence>
				</restriction>
			</complexContent>
		</complexType>
		<!-- ====================================================================== -->
	</redefine>
	<!-- ====================================================================== -->
</schema>
```

2.5 Coverage observation types

Specialized observation types with coverage results may be implemented following the patterns given in sub-clause 2.4, setting the value of the result to a suitable coverage representation such as gml:Coverage or cv:CV_DiscreteCoverage (see OGC 06-188r1).

2.6 Schema for import

Listing 5 is a stub schema document that collects Observations and Measurements components for use in external domain schemas. Use of this document for external references to the O&M package ensures that all components are included, and reduces the risk of conflicting <import> statements.

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Listing 5. om.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema" xmlns:om="http://www.opengis.net/om/1.0"
targetNamespace="http://www.opengis.net/om/1.0" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="1.0.0">
	<annotation>
		<documentation>om.xsd

The Observations and Measurements schema
This document contains only the normative elements described in the OGC standard

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	</annotation>
	<!-- ====================================================================== -->
	<include schemaLocation="./observation.xsd"/>
	<!-- ====================================================================== -->
</schema>
```

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ANNEX E
(informative)

XML implementation - examples

1 Introduction

The details of the XML implementation may be explored using instance examples. Using the GML implementation rules results in an explicit mapping from the model, using names from the model as element and attribute names. Inspection of sample data is an effective way to assess the effectiveness of the model in capturing the required information. In this clause we present a graduated series of examples to illustrate the model and encoding.

Observations may have many result types. It may also be convenient to provide the result value out-of-band. The details of how the result is encoded is not important to the model, though practical interoperability in data transfer is best served by agreement on the form.

In some examples below alternative encodings with different advantages are shown for “complex” results. These include:

1. a compact record contained within a single XML element, composed of a list of records each corresponding to a set of parameter values whose structure is then repeated. The syntax is taken from SensorML [SensorML]. Item and record separators are explicit, and may be changed. This microformat requires a specific writer and reader to augment standard XML processing

2. a record or discrete coverage in which the items are encoded in separate XML elements. This is verbose, but has the advantage of using the basic XML structuring components that are accessible in all XML processing environments. This makes applications for both writing and reading easier to implement.

In all cases, the record structure is indicated separately.

2 Coding standards

2.1 Dependencies

The instance examples in this clause depend on the following externally governed schemas:

Schema	Version	XML namespace	Location of imported schema document

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GML	3.1.1	http://www.opengis.net/gml	http://schemas.opengis.net/gml/3.1.1/base/gml.xsd
Swe Common	1.0.1	http://www.opengis.net.swe/1.0.1	http://schemas.opengis.net/swe/1.0.1/swe.xsd
SensorML	1.0.1	http://www.opengis.net/sensorML/1.0.1	http://schemas.opengis.net/sensorML/1.0.1/base/sensorML.xsd
Discrete Coverages	0.2.1	http://www.opengis.net/cv/0.2.1	http://bp.schemas.opengis.net/06-188r1/cv/0.2.1/cv.xsd

3 Simple Observations with scalar results

3.1 Measurements

The document shown in Listing 6 describes a simple observation to determine the mass of a specific banana.

The value of the procedure (“scales”), the observedProperty (“mass”), and the featureOfInterest (a fruit) are all given as references to external objects, using xlink:href attributes following the standard GML pattern. These references are all given as URIs: the first two use the (proposed) OGC URN scheme [OGC 06-023r1], and the third is a (notional) URL.

The type of the result is indicated in the instance using the standard xsi:type attribute [W3C XML Schema]. In this example it is gml:MeasureType, so the required **uom** attribute is also present. The value of the uom is also given as a URN according to the OGC scheme.

NOTE: In GML 3.2/ISO DIS 19136 the type of the uom attribute is extended to allow unit symbols from the UCUM scheme, allowing the more familiar short symbols like “kg” to appear instead of a URI.

Listing 6. observation1.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="obsTest1" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
        xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
    <gml:description>Observation test instance: fruit mass</gml:description>
    <gml:name>Observation test 1</gml:name>
    <om:samplingTime>
        <gml:TimeInstant gml:id="ot1t">
            <gml:timePosition>2005-01-11T16:22:25.00</gml:timePosition>
        </gml:TimeInstant>
    </om:samplingTime>
    <om:procedure xlink:href="http://www.flakey.org/register/process/scales34.xml"/>
    <!-- a notional URL identifying a  procedure ... -->
    <om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:mass"/>
    <!-- a notional URN identifying the observed property -->
    <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=fruit37f "/>
    <!-- a notional WFS call identifying the object regarding which the observation was made -->
```


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```
	<om:parameter>
		<swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#Temperature">
			<swe:uom xlink:href="urn:ogc:def:uom:UCUM:Cel"/>
			<swe:value>22.3</swe:value>
		</swe:Quantity>
		<!-- example of optional soft-typed parameter -->
	</om:parameter>
	<om:result xsi:type="gml:MeasureType" uom="urn:ogc:def:uom:OGC:kg">0.28</om:result>
	<!-- The XML Schema type of the result is indicated using the value of the xsi:type attribute -->
</om:Observation>
```

3.2 Category observations

The document shown in Listing 7 describes a simple observation to determine the species of an item of market produce.

The observedProperty ("species") and feature of interest are given as references, following the standard GML pattern using xlink:href attributes. These references are all given as URIs, using the OGC URN scheme.

The description of the procedure is encapsulated using SensorML.

The type of the result is indicated in the instance using the standard xsi:type attribute [W3C XML Schema]. In this example it is swe:ScopedNameType, so the required **codeSpace** attribute is also present. The value of the codeSpace is a reference to a vocabulary from which the value of the result was taken.

Listing 7. observation2.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="obsTest2" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:sml="http://www.opengis.net/sensorML/1.0.1" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
	xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd http://www.opengis.net/sensorML/1.0.1
http://schemas.opengis.net/sensorML/1.0.1/sensorML.xsd">
	<gml:description>Observation test instance: fruit identification</gml:description>
	<gml:name>Observation test 2</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ot2t">
			<gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
	<om:procedure>
		<sml:ProcessModel>
			<sml:method xlink:href="http://www.flakey.org/register/party/abc99"/>
		</sml:ProcessModel>
	</om:procedure>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Species"/>
	<om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=fruit37f "/>
	<om:result xsi:type="swe:ScopedNameType"
codeSpace="http://en.wikipedia.org/wiki/List_of_fruits">Banana</om:result>
</om:Observation>
```

The document shown in Listing 8 describes the same observation except that this time the description of the procedure is encapsulated in the om:Process element, which provides a generic container for components from any namespace, thus allowing re-use of a pre-existing schema for observation methods.

Listing 8. observation2b.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="obsTest2b" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:sml="http://www.opengis.net/sensorML/1.0.1" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
	xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd http://www.opengis.net/sensorML/1.0.1
http://schemas.opengis.net/sensorML/1.0.1/sensorML.xsd">
	<gml:description>Observation test instance: fruit identification</gml:description>
	<gml:name>Observation test 2b</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ot2t">
			<gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
	<om:procedure>
		<om:Process>
			<gml:description>Field worker</gml:description>
			<gml:name>Abby Bachrach-Cox</gml:name>
		</om:Process>
	</om:procedure>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Species"/>
	<om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=fruit37f "/>
	<om:result xsi:type="swe:ScopedNameType"
codeSpace="http://en.wikipedia.org/wiki/List_of_fruits">Banana</om:result>
</om:Observation>
```

The document shown in Listing 9 describes the same observation using the specialized observation type CategoryObservation taken from one of the schema documents shown in ANNEX D sub-clause 2.4. The result type is fixed so the xsi:type attribute is not needed.

Listing 9. observation2c.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CategoryObservation gml:id="obsTest2c"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../extensions/observationSpecialization_override.xsd">
	<gml:description>Observation test instance: fruit identification</gml:description>
	<gml:name>Observation test 2c</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ot2t">
			<gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
   <om:procedure xlink:href="http://www.flakey.org/register/party/abc99"/>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Species"/>
   <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=fruit37f "/>
	<om:result codeSpace="http://en.wikipedia.org/wiki/List_of_fruits">Banana</om:result>
</om:CategoryObservation>
```


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3.3 Observation of a complex property

The document shown in Listing 10 describes an observation of the shape of a banana.

This has the following differences compared to the previous examples: (a) the procedure is identified as “triangulation987” (b) a resultTime is also given, indicating the time when the triangulation procedure was applied, which in this case was the day following when the item of fruit was actually obtained (c) the observed property is “Shape” and (d) the result is expressed as a gml:Solid (details suppressed for brevity).

This example illustrates the benefit of being able to use any available type in the result of a generic observation. The result is an XML encoded data structure, using a sub-element whose name is explicit, so no xsi:type attribute is required.

Listing 10. observation2shape.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="shapeTest2"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
	<gml:description>Observation test instance</gml:description>
	<gml:name>Shape observation test</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ot2t">
			<gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
	<om:resultTime>
		<gml:TimeInstant gml:id="ot2ts">
			<gml:timePosition>2005-01-12T09:25:00.00</gml:timePosition>
		</gml:TimeInstant>
	</om:resultTime>
	<om:procedure xlink:href=" http://www.flakey.org/register/process/triangulation987"/>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Shape"/>
   <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=fruit37f "/>
	<om:result>
		<gml:Solid gml:id="bs">
			<gml:description>An explicit description of a solid. The details of the description of the exterior surface
omitted here for brevity.</gml:description>
			<gml:exterior>
				<gml:Surface gml:id="be">
					<gml:patches>
					</gml:patches>
				</gml:Surface>
			</gml:exterior>
		</gml:Solid>
	</om:result>
</om:Observation>
```

4 Observations pointing to results provided out-of-band

These examples shows basic observations where the result is provided external to the observation instance document, and identified using a URI.

The document shown in Listing 11 describes an observation of Relative Humidity at an observation station.

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The observation event time is a **gml:TimePeriod**, so the result is likely to be a time-series, potentially with many values. For this reason, it may be convenient to provide the result as a data stream out-of-band from the document describing the observation.

The values of the procedure (an instrument), observedProperty ("Relative Humidity"), and feature of interest (an observation station) are given as references, following the standard GML pattern using xlink:href attributes. These references are all given as URIs: the first two use the OGC URN scheme; the featureOfInterest in this example is obtained via a service call to a WFS service.

The type of the result in this example is gml:ReferenceType. The result value is indicated by the value of the xlink:href attribute. The value of the (optional) xlink:role attribute describes the nature of the external resource, here given as a MIME type.

Listing 11. pointer1.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="OPTest1"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
	<gml:description>Observation instance with remote result</gml:description>
	<gml:name>Observation Pointer 1</gml:name>
	<om:samplingTime>
		<gml:TimePeriod gml:id="op1t">
			<gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
			<gml:endPosition>2005-01-11T18:22:25.00</gml:endPosition>
		</gml:TimePeriod>
	</om:samplingTime>
	<om:procedure xlink:href="urn:ogc:object:feature:Sensor:3eti:abc45"/>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:RelativeHumidity"/>
	<om:featureOfInterest xlink:href="http://my.modest.org/wfs%26request=getFeature%26;featureid=789002"
xlink:role="urn:ogc:def:featureType:NWS:station"/>
	<om:result xlink:href="http://my.modest.org/results%3f798002%26property=RH" xlink:role="application/xmpp"
xsi:type="gml:ReferenceType"/>
</om:Observation>
```

The document shown in Listing 12 describes an observation of "Stress" in a shallow borehole.

The type of the result in this example is gml:ReferenceType. The result value is indicated by the value of the xlink:href attribute, and the mimeType is indicated using the xlink:role attribute.

Listing 12. pointer2.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="OPTest2"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
	<gml:description>Observation instance with remote result</gml:description>
```

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```xml
        <gml:name>Observation Pointer 2</gml:name>
        <om:samplingTime>
                <gml:TimePeriod gml:id="op1t">
                        <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
                        <gml:endPosition>2005-01-11T18:22:25.00</gml:endPosition>
                </gml:TimePeriod>
        </om:samplingTime>
        <om:procedure xlink:href="urn:ogc:object:feature:Sensor:SEEGrid:overcoring"/>
        <om:observedProperty xlink:href="urn:ogc:def:phenomenon:SEEGrid:stress"/>
        <om:featureOfInterest xlink:href="http://some.datasupplying.org/wfs%26request=getFeature%26id=789002"
xlink:role="urn:ogc:def:featureType:SEEGRID:borehole"/>
        <om:result xlink:href="http://some.datasupplying.org/results%3f798002%26property=stress"
xlink:role="application/xml" xsi:type="gml:ReferenceType"/>
</om:Observation>
```

5 Compound observations

5.1 Observation Collection

The document shown in Listing 13 describes a collection of two observations.

Listing 13. Collection1.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:ObservationCollection gml:id="coll1"
xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
        <gml:description>Collection of observations</gml:description>
        <gml:name>Observation Collection 1</gml:name>
        <om:member>
                <om:Observation gml:id="o1">
                        <om:samplingTime>
                                <gml:TimeInstant gml:id="ot1t">
                                        <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
                                </gml:TimeInstant>
                        </om:samplingTime>
    <om:procedure xlink:href="http://www.flakey.org/register/process/scales34.xml"/>
                        <om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:mass"/>
    <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=fruit37f "/>
                        <om:result xsi:type="gml:MeasureType" uom="urn:ogc:def:uom:OGC:kg">0.28</om:result>
                </om:Observation>
        </om:member>
        <om:member>
                <om:Observation gml:id="o2">
                        <om:samplingTime>
                                <gml:TimeInstant gml:id="ot2t">
                                        <gml:timePosition>2005-01-11T17:24:25.00</gml:timePosition>
                                </gml:TimeInstant>
                        </om:samplingTime>
    <om:procedure xlink:href="http://www.flakey.org/register/process/scales34.xml"/>
                        <om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:mass"/>
    <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=fruit35d "/>
                        <om:result xsi:type="gml:MeasureType" uom="urn:ogc:def:uom:OGC:kg">0.27</om:result>
                </om:Observation>
        </om:member>
</om:ObservationCollection>
```

5.2 Compound observed property

In these examples, the result of the observation is a complex value because the observed property (weather) requires multiple components.

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In Listing 14 the result is given as a swe:Record, which separates the components fields encoded in generic XML elements. The feature of interest is indicated through a link to an entry in an online gazetteer. The observedProperty is given as a link to an entry in a dictionary of property type definitions, the content of which is shown in Listing 15. The RS gives a link to a description of the result structure, shown as a swe:DataRecord in Listing 16.

Listing 14. complexObservation3.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="COTest3" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
        xmlns:gml="http://www.opengis.net/gml" xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
    <gml:description>Complex Observation test instance</gml:description>
    <gml:name>Complex Observation test 3</gml:name>
    <om:samplingTime>
        <gml:TimeInstant gml:id="ot1t">
            <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
        </gml:TimeInstant>
    </om:samplingTime>
    <om:procedure xlink:href="http://www.flakey.org/register/process/weatherStation3"/>
    <om:observedProperty xlink:href="urn:ogc:def:phenomenon:SEEGrid:weather1"/>
    <om:featureOfInterest xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604"
xlink:role="urn:cgi:featureType:SEEGRID:framework:locality"/>
    <om:result>
        <swe:Record RS="weatherRecordDefinition.xml">
            <swe:field><swe:Item>35.1</swe:Item></swe:field>
            <swe:field><swe:Item>6.5</swe:Item></swe:field>
            <swe:field><swe:Item>085.0</swe:Item></swe:field>
            <swe:field><swe:Item>950.</swe:Item></swe:field>
            <swe:field><swe:Item>32.0</swe:Item></swe:field>
            <swe:field><swe:Item>clear</swe:Item></swe:field>
        </swe:Record>
    </om:result>
</om:Observation>
```

The document shown in Listing 15 shows a property type description composed of six elements, given as links to concepts identified by URN. The base property type (“Weather”) allows this specialized definition (“weather1”) to be related to its parent. The parent property type may be used by some interfaces to allow discovery of related offerings.

Listing 15. weather1.xml

```
<?xml version="1.0"?>
<swe:CompositePhenomenon
xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/swe/1.0.1 http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd"
gml:id="weather1" dimension="6">
    <gml:name codeSpace="urn:ietf:rfc:2141"
                    >urn:ogc:def:phenomenon:SEEGrid:weather1</gml:name>
    <swe:base xlink:href="urn:ogc:def:phenomenon:OGC:Weather"/>
    <swe:component xlink:href="urn:ogc:def:phenomenon:OGC:AirTemperature"/>
    <swe:component xlink:href="urn:ogc:def:phenomenon:OGC:WindSpeed"/>
    <swe:component xlink:href="urn:ogc:def:phenomenon:OGC:WindDirection"/>
  <swe:component xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#AtmosphericPressure"/>
```


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```
  <swe:component xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#RelativeHumidity"/>
  <swe:component xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Visibility"/>
</swe:CompositePhenomenon>
```

The document shown in Listing 16 shows a record-type description composed of six elements, matching the property type description given above. Each field description binds a definition to a representation (the name of the component child element – i.e. *Quantity*, *Category*) and a scale (the value of the *uom* attribute).

Note that this element plays a different but complementary role: the property type description is primarily concerned with semantics, and would be used for *discovery*; the record description is primarily concerned with data structure, and would be used for *exploitation*.

Listing 16. weatherRecord1.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<swe:DataRecord xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
        xsi:schemaLocation="http://www.opengis.net/swe/1.0.1
http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd">
    <swe:field name="AirTemperature">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:AirTemperature">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:degC"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="WindSpeed">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:WindSpeed">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:m_s"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="WindDirection">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:WindDirectionToNorth">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:deg"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="AtmosphericPressure">
        <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#AtmosphericPressure">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:hPa"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="RelativeHumidity">
        <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#RelativeHumidity">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:percent"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="Visibility">
        <swe:Category definition="http://sweet.jpl.nasa.gov/ontology/property.owl#Visibility">
        </swe:Category>
    </swe:field>
</swe:DataRecord>
```

5.3 Complex feature of interest

In these examples, the result of the observation varies on a feature of interest that is decomposed into multiple elements.

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The documents in this sub-clause describe observations of radiance where the feature of interest is a SiteCollection composed of four Stations. The feature of interest is identified using a link to a description provided external to the document.

In Listing 17 and Listing 18 the observation is encoded using the generic Observation, with the result being a swe:CV_DiscreteCoverage. Listing 17 shows a panchromatic radiance observation. The type of the value element in each geometry-value pair is gml:MeasureType, as indicated using the xsi:type attribute.

Listing 17. multiElement1.xml


```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="obsTest4" xmlns:cv="http://www.opengis.net/cv/0.2.1"
xmlns:swe="http://www.opengis.net/swe/0" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
 xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd http://www.opengis.net/cv/0.2.1
http://bp.schemas.opengis.net/06-188r1/cv/0.2.1/cv.xsd">
	<gml:description>Observation test instance - multi-element featureOfInterest	</gml:description>
	<gml:name>Multi-element 1</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ots1t">
			<gml:timePosition>2005-06-17</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
	<om:procedure xlink:href="urn:ogc:object:feature:Sensor:NASA:xyz345"/>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Radiance"/>
	<om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1"/>
	<om:result>
		<cv:CV_DiscreteCoverage>
			<cv:domainExtent
xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1#xpointer(./boundedBy)"/>
			<cv:rangeType xlink:href="urn:ogc:def:phenomenon:OGC:Radiance"/>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel1"/>
					<cv:value xsi:type="gml:MeasureType" uom="uV">10.1</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel2"/>
					<cv:value xsi:type="gml:MeasureType" uom="uV">15.7</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel3"/>
					<cv:value xsi:type="gml:MeasureType" uom="uV">20.2</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel4"/>
					<cv:value xsi:type="gml:MeasureType" uom="uV">27.5</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
		</cv:CV_DiscreteCoverage>
	</om:result>
</om:Observation>
```


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Listing 18 shows a two-band radiance observation. The type of the value element in each geometry-value pair is a swe:Record, each containing two items whose type is gml:MeasureType.

Listing 18. multiElement2.xml


```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="multi2"  xmlns:cv="http://www.opengis.net/cv/0.2.1"
xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd http://www.opengis.net/cv/0.2.1
http://bp.schemas.opengis.net/06-188r1/cv/0.2.1/cv.xsd">
	<gml:description>Observation test instance - multi-element featureOfInterest</gml:description>
	<gml:name>Multi-element 2</gml:name>
	<om:samplingTime>
		<gml:TimeInstant gml:id="ots1t">
			<gml:timePosition>2005-06-17</gml:timePosition>
		</gml:TimeInstant>
	</om:samplingTime>
	<om:procedure xlink:href="urn:ogc:object:feature:Sensor:NASA:xyz345"/>
	<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Radiance45"/>
	<om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1"/>
	<om:result>
		<cv:CV_DiscreteCoverage>
			<cv:domainExtent
xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1#xpointer(./boundedBy)"/>
			<cv:rangeType xlink:href="urn:ogc:def:phenomenon:OGC:Radiance45"/>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel1"/>
					<cv:value>
						<swe:Record>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">10.1</swe:Item></swe:field>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">9.1</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel2"/>
					<cv:value>
						<swe:Record>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">15.7</swe:Item></swe:field>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">8.5</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry xlink:href="pixel3"/>
					<cv:value>
						<swe:Record>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">20.2</swe:Item></swe:field>
							<swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">5.2</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
```


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```
                    <cv:CV_GeometryValuePair>
                         <cv:geometry xlink:href="pixel4"/>
                         <cv:value>
                              <swe:Record>
                                   <swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">27.5</swe:Item></swe:field>
                                   <swe:field><swe:Item xsi:type="gml:MeasureType"
uom="uV">6.5</swe:Item></swe:field>
                              </swe:Record>
                         </cv:value>
                    </cv:CV_GeometryValuePair>
               </cv:element>
          </cv:CV_DiscreteCoverage>
     </om:result>
</om:Observation>
```

The document fragment shown in Listing 19 describes a SamplingFeature which acts as the feature of interest for the observation shown in the previous listings. This feature type is from the sampling features schema described in O&M Part 2. The feature is composed of four Station members. The result of the observation supplies a value for each of these elements.

Listing 19. foi.xml#stc1

```
<?xml version="1.0"?>
<sa:SamplingFeatureCollection gml:id="foi" xmlns:sa="http://www.opengis.net/sampling/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
                    xsi:schemaLocation="http://www.opengis.net/sampling/1.0
http://schemas.opengis.net/sampling/1.0.0/sampling.xsd">
     <gml:description>This SamplingFeature serves as a container for a collection composed of a single Station and
another SamplingFeature containing a collection of Stations</gml:description>
     <gml:boundedBy>
          <gml:Envelope srsName="urn:ogc:def:crs:EPSG:6.3:62836405">
               <gml:lowerCorner>-90 -180</gml:lowerCorner>
               <gml:upperCorner>90 180</gml:upperCorner>
          </gml:Envelope>
     </gml:boundedBy>
     <sa:sampledFeature xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
     <sa:surveyDetails xlink:href="urn:ogc:def:nil:OGC:unknown"/>
     <sa:member>
          <sa:SamplingPoint gml:id="ot2s">
               <gml:name>8903</gml:name>
               <sa:sampledFeature xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
               <sa:position>
                    <gml:Point gml:id="ot2p">
                         <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836405">-30.7025065
134.1997256</gml:pos>
                    </gml:Point>
               </sa:position>
          </sa:SamplingPoint>
     </sa:member>
     <sa:member>
          <sa:SamplingFeatureCollection gml:id="stc1">
               <gml:description>This  serves as a container for a set of Stations</gml:description>
               <gml:boundedBy>
                    <gml:Envelope srsName="urn:ogc:def:crs:EPSG:6.3:62836405">
                         <gml:lowerCorner>-30.702 134.199</gml:lowerCorner>
                         <gml:upperCorner>-30.692 134.209</gml:upperCorner>
                    </gml:Envelope>
               </gml:boundedBy>
               <sa:sampledFeature xlink:href="urn:ogc:def:nil:OGC:unknown"/>
               <sa:member>
                    <sa:SamplingPoint gml:id="st1">
```

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```
                        <sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
                        <sa:position>
                            <gml:Point gml:id="st1p">
                                <gml:pos>-30.702 134.199</gml:pos>
                            </gml:Point>
                        </sa:position>
                    </sa:SamplingPoint>
                </sa:member>
                <sa:member>
                    <sa:SamplingPoint gml:id="st2">
                        <sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
                        <sa:position>
                            <gml:Point gml:id="st2p">
                                <gml:pos>-30.692 134.199</gml:pos>
                            </gml:Point>
                        </sa:position>
                    </sa:SamplingPoint>
                </sa:member>
                <sa:member>
                    <sa:SamplingPoint gml:id="st3">
                        <sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
                        <sa:position>
                            <gml:Point gml:id="st3p">
                                <gml:pos>-30.702 134.209</gml:pos>
                            </gml:Point>
                        </sa:position>
                    </sa:SamplingPoint>
                </sa:member>
                <sa:member>
                    <sa:SamplingPoint gml:id="st4">
                        <sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
                        <sa:position>
                            <gml:Point gml:id="st4p">
                                <gml:pos>-30.692 134.209</gml:pos>
                            </gml:Point>
                        </sa:position>
                    </sa:SamplingPoint>
                </sa:member>
            </sa:SamplingFeatureCollection>
        </sa:member>
</sa:SamplingFeatureCollection>
```


5.4 Time Series

In these examples, the observation samples the phenomenon over a time period.

The documents in this sub-clause describe an observation of a weather property at a station.

In Listing 20 rainfall is observed in a series of TimePeriods. The feature of interest is again indicated through links to elements in the site collection shown in Listing 19. The observation is encoded using the generic Observation.

In Listing 20 the result is given as CV_DiscreteCoverage. The domain is composed of TimePeriods, each covering a 24-hour period. The range values are measures.

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Listing 20. timeSeries2.xml

```
<?xml version="1.0"?>
<sa:SamplingFeatureCollection gml:id="foi" xmlns:sa="http://www.opengis.net/sampling/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
			xsi:schemaLocation="http://www.opengis.net/sampling/1.0
http://schemas.opengis.net/sampling/1.0.0/sampling.xsd">
	<gml:description>This SamplingFeature serves as a container for a collection composed of a single Station and
another SamplingFeature containing a collection of Stations</gml:description>
	<gml:boundedBy>
		<gml:Envelope srsName="urn:ogc:def:crs:EPSG:6.3:62836405">
			<gml:lowerCorner>-90 -180</gml:lowerCorner>
			<gml:upperCorner>90 180</gml:upperCorner>
		</gml:Envelope>
	</gml:boundedBy>
	<sa:sampledFeature xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
	<sa:surveyDetails xlink:href="urn:ogc:def:nil:OGC:unknown"/>
	<sa:member>
		<sa:SamplingPoint gml:id="ot2s">
			<gml:name>8903</gml:name>
			<sa:sampledFeature xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
			<sa:position>
				<gml:Point gml:id="ot2p">
					<gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836405">-30.7025065
134.1997256</gml:pos>
				</gml:Point>
			</sa:position>
		</sa:SamplingPoint>
	</sa:member>
	<sa:member>
		<sa:SamplingFeatureCollection gml:id="stc1">
			<gml:description>This  serves as a container for a set of Stations</gml:description>
			<gml:boundedBy>
				<gml:Envelope srsName="urn:ogc:def:crs:EPSG:6.3:62836405">
					<gml:lowerCorner>-30.702 134.199</gml:lowerCorner>
					<gml:upperCorner>-30.692 134.209</gml:upperCorner>
				</gml:Envelope>
			</gml:boundedBy>
			<sa:sampledFeature xlink:href="urn:ogc:def:nil:OGC:unknown"/>
			<sa:member>
				<sa:SamplingPoint gml:id="st1">
					<sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
					<sa:position>
						<gml:Point gml:id="st1p">
							<gml:pos>-30.702 134.199</gml:pos>
						</gml:Point>
					</sa:position>
				</sa:SamplingPoint>
			</sa:member>
			<sa:member>
				<sa:SamplingPoint gml:id="st2">
					<sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
					<sa:position>
						<gml:Point gml:id="st2p">
							<gml:pos>-30.692 134.199</gml:pos>
						</gml:Point>
					</sa:position>
				</sa:SamplingPoint>
			</sa:member>
			<sa:member>
				<sa:SamplingPoint gml:id="st3">
					<sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
					<sa:position>
						<gml:Point gml:id="st3p">
							<gml:pos>-30.702 134.209</gml:pos>
						</gml:Point>
					</sa:position>
```


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```
                    </sa:SamplingPoint>
                </sa:member>
                <sa:member>
                    <sa:SamplingPoint gml:id="st4">
                        <sa:sampledFeature
xlink:href="http://wfs.flakey.org?request=getFeature&amp;featureid=tract470"/>
                        <sa:position>
                            <gml:Point gml:id="st4p">
                                <gml:pos>-30.692 134.209</gml:pos>
                            </gml:Point>
                        </sa:position>
                    </sa:SamplingPoint>
                </sa:member>
            </sa:SamplingFeatureCollection>
        </sa:member>
</sa:SamplingFeatureCollection>
```

In Listing 21 air-temperature is observed at a series of time instants. The result is given as CompactDiscreteTimeCoverage. The domain objects are simple time positions. The range values are measures. An om:parameter is used to indicate that the actual sampling point is 3.5m above the station.

Listing 21. timeSeries1.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="timeSeries1" xmlns:cv="http://www.opengis.net/cv/0.2.1"
xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd  http://www.opengis.net/cv/0.2.1
http://bp.schemas.opengis.net/06-188r1/cv/0.2.1/cv.xsd">
    <gml:description>Observation test instance - time series</gml:description>
    <gml:name>Time series 1</gml:name>
    <om:samplingTime>
        <gml:TimePeriod gml:id="ts1t">
            <gml:beginPosition>2005-06-17T09:00:00+08:00</gml:beginPosition>
            <gml:endPosition>2005-06-21T09:00:00+08:00</gml:endPosition>
        </gml:TimePeriod>
    </om:samplingTime>
    <om:procedure xlink:href="urn:ogc:object:feature:Sensor:BOM:t_2a"/>
    <om:observedProperty xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Temperature"/>
    <om:featureOfInterest xlink:role="urn:ogc:def:featureType:OGC:Station"
xlink:href="http://my.big.org/feature?type=station%26name=st1"/>
    <om:parameter>
        <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#Elevation">
            <swe:uom xlink:href="urn:ogc:def:uom:UCUM:m"/>
            <swe:value>3.45</swe:value>
        </swe:Quantity>
    </om:parameter>
    <om:result>
        <cv:CompactDiscreteTimeCoverage>
            <cv:domainExtent
xlink:href="http://my.big.org/feature?type=station%26name=st1#xpointer(./boundedBy)"/>
            <cv:rangeType xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Temperature"/>
            <cv:element>
                <cv:CompactTimeValuePair>
                    <cv:geometry>2005-06-17T09:00:00+08:00</cv:geometry>
                    <cv:value xsi:type="gml:MeasureType" uom="Cel">19.3</cv:value>
                </cv:CompactTimeValuePair>
            </cv:element>
            <cv:element>
                <cv:CompactTimeValuePair>
                    <cv:geometry>2005-06-18T09:00:00+08:00</cv:geometry>
                    <cv:value xsi:type="gml:MeasureType" uom="Cel">17.1</cv:value>
                </cv:CompactTimeValuePair>
            </cv:element>
            <cv:element>
```

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```
                <cv:CompactTimeValuePair>
                    <cv:geometry>2005-06-19T09:00:00+08:00</cv:geometry>
                    <cv:value xsi:type="gml:MeasureType" uom="Cel">16.5</cv:value>
                </cv:CompactTimeValuePair>
            </cv:element>
            <cv:element>
                <cv:CompactTimeValuePair>
                    <cv:geometry>2005-06-20T09:00:00+08:00</cv:geometry>
                    <cv:value xsi:type="gml:MeasureType" uom="Cel">25.8</cv:value>
                </cv:CompactTimeValuePair>
            </cv:element>
            <cv:element>
                <cv:CompactTimeValuePair>
                    <cv:geometry>2005-06-21T09:00:00+08:00</cv:geometry>
                    <cv:value xsi:type="gml:MeasureType" uom="Cel">29.2</cv:value>
                </cv:CompactTimeValuePair>
            </cv:element>
        </cv:CompactDiscreteTimeCoverage>
    </om:result>
</om:Observation>
```

In Listing 22 the same information is shown with the value of the result provided out-of-band, using the xlink pattern shown earlier.

Listing 22. timeSeries1r.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="timeSeries1" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
    <gml:description>Observation test instance - time series</gml:description>
    <gml:name>Time series 1</gml:name>
    <om:samplingTime>
        <gml:TimePeriod gml:id="ts1t">
            <gml:beginPosition>2005-06-17T09:00:00+08:00</gml:beginPosition>
            <gml:endPosition>2005-06-21T09:00:00+08:00</gml:endPosition>
        </gml:TimePeriod>
    </om:samplingTime>
    <om:procedure xlink:href="urn:ogc:object:feature:Sensor:BOM:t_2a"/>
    <om:observedProperty xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Temperature"/>
    <om:featureOfInterest xlink:role="urn:ogc:def:featureType:OGC:Station"
xlink:href="http://my.big.org/feature?type=station%26name=st1"/>
    <om:parameter>
        <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#Elevation">
            <swe:uom xlink:href="urn:ogc:def:uom:UCUM:m"/>
            <swe:value>3.45</swe:value>
        </swe:Quantity>
    </om:parameter>
    <om:result xlink:href="http://www.flakey.org/opendap/378.cdf"/>
</om:Observation>
```

Error! Reference source not found. presents an observation whose result is a time-series of weather observations. The result is shown in compact form in a SWE Common “TextBlock”. The observed property definition was given earlier in Listing 15. In contrast to the previous examples, the result is not specifically tagged as a “coverage”. As the items in the swe:values element are not XML-tagged, use of the result requires that this be separately parsed, using the item separators indicated in the swe:encoding.

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Listing 23. weatherObservation.xml


```xml
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation xmlns="http://www.opengis.net/om/1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns:om="http://www.opengis.net/om/1.0" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd">
  <gml:name>Weather Data</gml:name>
  <om:samplingTime>
    <gml:TimePeriod>
      <gml:beginPosition>2007-04-01T00:00:00.000-06:00</gml:beginPosition>
      <gml:endPosition>2007-04-01T03:40:00.000-06:00</gml:endPosition>
    </gml:TimePeriod>
  </om:samplingTime>
  <om:procedure xlink:href="urn:vast:sensor:weatherStation"/>
  <om:observedProperty xlink:href="weather1.xml"/>
     <om:featureOfInterest xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604"
xlink:role="urn:ogc:def:featuretype:SEEGRID:locality"/>
  <om:result>
    <swe:DataArray>
      <swe:elementCount>
        <swe:Count>
                  <swe:value>23</swe:value>
             </swe:Count>
      </swe:elementCount>
      <swe:elementType name="WeatherRecordType" xlink:href="weatherRecord1_t.xml"/>
      <swe:encoding>
        <swe:TextBlock decimalSeparator="." tokenSeparator="," blockSeparator=" "/>
      </swe:encoding>
      <swe:values>
2007-04-01T00:00:00.000-06:00,30.4,28.8,155.8,1055.32,55,haze
2007-04-01T00:00:10.000-06:00,30.4,28.8,155.8,1055.4,59,haze
2007-04-01T00:00:20.000-06:00,30.4,28.8,155.7,1055.47,65,haze
2007-04-01T00:00:30.000-06:00,30.3,28.9,155.7,1055.55,66,haze
2007-04-01T00:00:40.000-06:00,30.3,28.9,155.6,1055.62,61,haze
2007-04-01T00:00:50.000-06:00,30.3,28.9,155.6,1055.69,55,haze
2007-04-01T00:01:00.000-06:00,30.3,28.9,155.5,1055.77,51,haze
2007-04-01T00:01:10.000-06:00,30.2,28.9,155.5,1055.84,48,haze
2007-04-01T00:01:20.000-06:00,30.2,28.9,155.4,1055.91,43,haze
2007-04-01T00:01:30.000-06:00,30.2,28.9,155.4,1055.99,44,haze
2007-04-01T00:01:40.000-06:00,30.2,29,155.3,1056.06,46,haze
2007-04-01T00:01:50.000-06:00,30.1,29,155.3,1056.13,48,haze
2007-04-01T00:02:00.000-06:00,30.1,29,155.2,1056.2,44,haze
2007-04-01T00:02:10.000-06:00,30.1,29,155.2,1056.27,41,haze
2007-04-01T00:02:20.000-06:00,30.1,29,155.1,1056.34,40,haze
2007-04-01T00:02:30.000-06:00,30,29,155.1,1056.41,36,clear
2007-04-01T00:02:40.000-06:00,30,29,155,1056.48,39,clear
2007-04-01T00:02:50.000-06:00,30,29.1,155,1056.55,50,haze
2007-04-01T00:03:00.000-06:00,30,29.1,155,1056.62,65,haze
2007-04-01T00:03:10.000-06:00,30,29.1,154.9,1056.69,70,haze
2007-04-01T00:03:20.000-06:00,29.9,29.1,154.9,1056.76,71,haze
2007-04-01T00:03:30.000-06:00,29.9,29.1,154.8,1056.83,75,haze
2007-04-01T00:03:40.000-06:00,29.9,29.1,154.8,1056.89,75,haze
      </swe:values>
    </swe:DataArray>
  </om:result>
</om:Observation>
```


As the time of each element in the result array is embedded in the result, the record definition shown in Listing 24 has an explicit “time” element.

Listing 24. weatherRecord1_t.xml


```xml
<?xml version="1.0" encoding="UTF-8"?>
<swe:DataRecord xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
```


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```
            xsi:schemaLocation="http://www.opengis.net/swe/1.0.1
http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd">
        <swe:field name="time">
                <swe:Time definition="urn:ogc:def:phenomenon:time:iso8601"/>
        </swe:field>
        <swe:field name="AirTemperature">
                <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:AirTemperature">
                        <swe:uom xlink:href="urn:ogc:def:uom:OGC:degC"/>
                </swe:Quantity>
        </swe:field>
        <swe:field name="WindSpeed">
                <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:WindSpeed">
                        <swe:uom xlink:href="urn:ogc:def:uom:OGC:m_s"/>
                </swe:Quantity>
        </swe:field>
        <swe:field name="WindDirection">
                <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:WindDirectionToNorth">
                        <swe:uom xlink:href="urn:ogc:def:uom:OGC:deg"/>
                </swe:Quantity>
        </swe:field>
        <swe:field name="AtmosphericPressure">
                <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#AtmosphericPressure">
                        <swe:uom xlink:href="urn:ogc:def:uom:OGC:hPa"/>
                </swe:Quantity>
        </swe:field>
        <swe:field name="RelativeHumidity">
                <swe:Quantity definition="http://sweet.jpl.nasa.gov/ontology/property.owl#RelativeHumidity">
                        <swe:uom xlink:href="urn:ogc:def:uom:OGC:percent"/>
                </swe:Quantity>
        </swe:field>
        <swe:field name="Visibility">
                <swe:Category definition="http://sweet.jpl.nasa.gov/ontology/property.owl#Visibility">
                </swe:Category>
        </swe:field>
</swe:DataRecord>
```

5.5 Multiple compounding axes

In these examples, observations were made at a sequence of times, on elements of a compound feature of interest, and concerning a compound phenomenon.

The documents shown in Listing 25 describe an observation of a (raw) radiance spectrum corresponding to the LandsatTM bands, made on four stations at three time instants. The result is encoded as a CV_DiscreteCoverage. The domain objects iterate over time and space explicitly, and the range value is a Record composed of seven items.

Listing 25. spectrumSeries3.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:Observation gml:id="specSeries3" xmlns:cv="http://www.opengis.net/cv/0.2.1"
xmlns:swe="http://www.opengis.net/swe/1.0.1" xmlns:om="http://www.opengis.net/om/1.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om/1.0 ../om.xsd  http://www.opengis.net/cv/0.2.1
http://bp.schemas.opengis.net/06-188r1/cv/0.2.1/cv.xsd">
        <gml:description>Observation test instance - Multiple compounding axes
        A Landsat TM spectrum is observed on 4 stations at 5 time instants</gml:description>
        <gml:name>Spectrum Series</gml:name>
        <om:samplingTime>
                <gml:TimePeriod gml:id="tpss1">
                        <gml:beginPosition>2005-06-17</gml:beginPosition>
                        <gml:endPosition>2005-06-21</gml:endPosition>
                </gml:TimePeriod>
```

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```
    </om:samplingTime>
    <om:procedure xlink:href="urn:ogc:object:feature:Sensor:NASA:Landsat7"/>
    <om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:DiscreteSpectrumTM"/>
    <om:featureOfInterest xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1"/>
    <om:result>
        <cv:CV_DiscreteCoverage>
            <cv:domainExtent
xlink:href="http://wfs.flakey.org?request=getFeature&#38;featureid=stc1#xpointer(./boundedBy)"/>
            <cv:rangeType xlink:href="tm7.xml#tm7"/>
            <cv:element>
                <cv:CV_GeometryValuePair>
                    <cv:geometry>
                        <cv:CV_DomainObject>
                            <cv:spatialElement xlink:href="./foi.xml#st1"/>
                            <cv:temporalElement xlink:href="./toi.xml#ti1"/>
                        </cv:CV_DomainObject>
                    </cv:geometry>
                    <cv:value>
                        <swe:Record>
                            <swe:field><swe:Item>9</swe:Item></swe:field>
                            <swe:field><swe:Item>8</swe:Item></swe:field>
                            <swe:field><swe:Item>7</swe:Item></swe:field>
                            <swe:field><swe:Item>6</swe:Item></swe:field>
                            <swe:field><swe:Item>5</swe:Item></swe:field>
                            <swe:field><swe:Item>4</swe:Item></swe:field>
                            <swe:field><swe:Item>3</swe:Item></swe:field>
                        </swe:Record>
                    </cv:value>
                </cv:CV_GeometryValuePair>
            </cv:element>
            <cv:element>
                <cv:CV_GeometryValuePair>
                    <cv:geometry>
                        <cv:CV_DomainObject>
                            <cv:spatialElement xlink:href="./foi.xml#st3"/>
                            <cv:temporalElement xlink:href="./toi.xml#ti1"/>
                        </cv:CV_DomainObject>
                    </cv:geometry>
                    <cv:value>
                        <swe:Record>
                            <swe:field><swe:Item>1</swe:Item></swe:field>
                            <swe:field><swe:Item>2</swe:Item></swe:field>
                            <swe:field><swe:Item>3</swe:Item></swe:field>
                            <swe:field><swe:Item>4</swe:Item></swe:field>
                            <swe:field><swe:Item>5</swe:Item></swe:field>
                            <swe:field><swe:Item>6</swe:Item></swe:field>
                            <swe:field><swe:Item>7</swe:Item></swe:field>
                        </swe:Record>
                    </cv:value>
                </cv:CV_GeometryValuePair>
            </cv:element>
            <cv:element>
                <cv:CV_GeometryValuePair>
                    <cv:geometry>
                        <cv:CV_DomainObject>
                            <cv:spatialElement xlink:href="./foi.xml#st2"/>
                            <cv:temporalElement xlink:href="./toi.xml#ti1"/>
                        </cv:CV_DomainObject>
                    </cv:geometry>
                    <cv:value>
                        <swe:Record>
                            <swe:field><swe:Item>1</swe:Item></swe:field>
                            <swe:field><swe:Item>9</swe:Item></swe:field>
                            <swe:field><swe:Item>2</swe:Item></swe:field>
                            <swe:field><swe:Item>8</swe:Item></swe:field>
                            <swe:field><swe:Item>3</swe:Item></swe:field>
                            <swe:field><swe:Item>7</swe:Item></swe:field>
                            <swe:field><swe:Item>4</swe:Item></swe:field>
                        </swe:Record>
                    </cv:value>
                </cv:CV_GeometryValuePair>
```


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```xml
</cv:element>
<cv:element>
	<cv:CV_GeometryValuePair>
		<cv:geometry>
			<cv:CV_DomainObject>
				<cv:spatialElement xlink:href="./foi.xml#st4"/>
				<cv:temporalElement xlink:href="./toi.xml#ti1"/>
			</cv:CV_DomainObject>
		</cv:geometry>
		<cv:value>
			<swe:Record>
				<swe:field><swe:Item>5</swe:Item></swe:field>
				<swe:field><swe:Item>6</swe:Item></swe:field>
				<swe:field><swe:Item>3</swe:Item></swe:field>
				<swe:field><swe:Item>7</swe:Item></swe:field>
				<swe:field><swe:Item>2</swe:Item></swe:field>
				<swe:field><swe:Item>8</swe:Item></swe:field>
				<swe:field><swe:Item>1</swe:Item></swe:field>
			</swe:Record>
		</cv:value>
	</cv:CV_GeometryValuePair>
</cv:element>
<cv:element>
	<cv:CV_GeometryValuePair>
		<cv:geometry>
			<cv:CV_DomainObject>
				<cv:spatialElement xlink:href="./foi.xml#st1"/>
				<cv:temporalElement xlink:href="./toi.xml#ti3"/>
			</cv:CV_DomainObject>
		</cv:geometry>
		<cv:value>
			<swe:Record>
				<swe:field><swe:Item>9</swe:Item></swe:field>
				<swe:field><swe:Item>8</swe:Item></swe:field>
				<swe:field><swe:Item>7</swe:Item></swe:field>
				<swe:field><swe:Item>6</swe:Item></swe:field>
				<swe:field><swe:Item>5</swe:Item></swe:field>
				<swe:field><swe:Item>4</swe:Item></swe:field>
				<swe:field><swe:Item>3</swe:Item></swe:field>
			</swe:Record>
		</cv:value>
	</cv:CV_GeometryValuePair>
</cv:element>
<cv:element>
	<cv:CV_GeometryValuePair>
		<cv:geometry>
			<cv:CV_DomainObject>
				<cv:spatialElement xlink:href="./foi.xml#st3"/>
				<cv:temporalElement xlink:href="./toi.xml#ti3"/>
			</cv:CV_DomainObject>
		</cv:geometry>
		<cv:value>
			<swe:Record>
				<swe:field><swe:Item>1</swe:Item></swe:field>
				<swe:field><swe:Item>2</swe:Item></swe:field>
				<swe:field><swe:Item>3</swe:Item></swe:field>
				<swe:field><swe:Item>4</swe:Item></swe:field>
				<swe:field><swe:Item>5</swe:Item></swe:field>
				<swe:field><swe:Item>6</swe:Item></swe:field>
				<swe:field><swe:Item>7</swe:Item></swe:field>
			</swe:Record>
		</cv:value>
	</cv:CV_GeometryValuePair>
</cv:element>
<cv:element>
	<cv:CV_GeometryValuePair>
		<cv:geometry>
			<cv:CV_DomainObject>
				<cv:spatialElement xlink:href="./foi.xml#st2"/>
				<cv:temporalElement xlink:href="./toi.xml#ti3"/>
			</cv:CV_DomainObject>
```


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```xml
				</cv:geometry>
				<cv:value>
					<swe:Record>
						<swe:field><swe:Item>1</swe:Item></swe:field>
						<swe:field><swe:Item>9</swe:Item></swe:field>
						<swe:field><swe:Item>2</swe:Item></swe:field>
						<swe:field><swe:Item>8</swe:Item></swe:field>
						<swe:field><swe:Item>3</swe:Item></swe:field>
						<swe:field><swe:Item>7</swe:Item></swe:field>
						<swe:field><swe:Item>4</swe:Item></swe:field>
					</swe:Record>
				</cv:value>
			</cv:CV_GeometryValuePair>
		</cv:element>
		<cv:element>
			<cv:CV_GeometryValuePair>
				<cv:geometry>
					<cv:CV_DomainObject>
						<cv:spatialElement xlink:href="./foi.xml#st4"/>
						<cv:temporalElement xlink:href="./toi.xml#ti3"/>
					</cv:CV_DomainObject>
				</cv:geometry>
				<cv:value>
					<swe:Record>
						<swe:field><swe:Item>5</swe:Item></swe:field>
						<swe:field><swe:Item>6</swe:Item></swe:field>
						<swe:field><swe:Item>3</swe:Item></swe:field>
						<swe:field><swe:Item>7</swe:Item></swe:field>
						<swe:field><swe:Item>2</swe:Item></swe:field>
						<swe:field><swe:Item>8</swe:Item></swe:field>
						<swe:field><swe:Item>1</swe:Item></swe:field>
					</swe:Record>
				</cv:value>
			</cv:CV_GeometryValuePair>
		</cv:element>
		<cv:element>
			<cv:CV_GeometryValuePair>
				<cv:geometry>
					<cv:CV_DomainObject>
						<cv:spatialElement xlink:href="./foi.xml#st1"/>
						<cv:temporalElement xlink:href="./toi.xml#ti5"/>
					</cv:CV_DomainObject>
				</cv:geometry>
				<cv:value>
					<swe:Record>
						<swe:field><swe:Item>9</swe:Item></swe:field>
						<swe:field><swe:Item>8</swe:Item></swe:field>
						<swe:field><swe:Item>7</swe:Item></swe:field>
						<swe:field><swe:Item>6</swe:Item></swe:field>
						<swe:field><swe:Item>5</swe:Item></swe:field>
						<swe:field><swe:Item>4</swe:Item></swe:field>
						<swe:field><swe:Item>3</swe:Item></swe:field>
					</swe:Record>
				</cv:value>
			</cv:CV_GeometryValuePair>
		</cv:element>
		<cv:element>
			<cv:CV_GeometryValuePair>
				<cv:geometry>
					<cv:CV_DomainObject>
						<cv:spatialElement xlink:href="./foi.xml#st3"/>
						<cv:temporalElement xlink:href="./toi.xml#ti5"/>
					</cv:CV_DomainObject>
				</cv:geometry>
				<cv:value>
					<swe:Record>
						<swe:field><swe:Item>1</swe:Item></swe:field>
						<swe:field><swe:Item>2</swe:Item></swe:field>
						<swe:field><swe:Item>3</swe:Item></swe:field>
						<swe:field><swe:Item>4</swe:Item></swe:field>
						<swe:field><swe:Item>5</swe:Item></swe:field>
```


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```xml
							<swe:field><swe:Item>6</swe:Item></swe:field>
							<swe:field><swe:Item>7</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry>
						<cv:CV_DomainObject>
							<cv:spatialElement xlink:href="./foi.xml#st2"/>
							<cv:temporalElement xlink:href="./toi.xml#ti5"/>
						</cv:CV_DomainObject>
					</cv:geometry>
					<cv:value>
						<swe:Record>
							<swe:field><swe:Item>1</swe:Item></swe:field>
							<swe:field><swe:Item>9</swe:Item></swe:field>
							<swe:field><swe:Item>2</swe:Item></swe:field>
							<swe:field><swe:Item>8</swe:Item></swe:field>
							<swe:field><swe:Item>3</swe:Item></swe:field>
							<swe:field><swe:Item>7</swe:Item></swe:field>
							<swe:field><swe:Item>4</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
			<cv:element>
				<cv:CV_GeometryValuePair>
					<cv:geometry>
						<cv:CV_DomainObject>
							<cv:spatialElement xlink:href="./foi.xml#st4"/>
							<cv:temporalElement xlink:href="./toi.xml#ti5"/>
						</cv:CV_DomainObject>
					</cv:geometry>
					<cv:value>
						<swe:Record>
							<swe:field><swe:Item>5</swe:Item></swe:field>
							<swe:field><swe:Item>6</swe:Item></swe:field>
							<swe:field><swe:Item>3</swe:Item></swe:field>
							<swe:field><swe:Item>7</swe:Item></swe:field>
							<swe:field><swe:Item>2</swe:Item></swe:field>
							<swe:field><swe:Item>8</swe:Item></swe:field>
							<swe:field><swe:Item>1</swe:Item></swe:field>
						</swe:Record>
					</cv:value>
				</cv:CV_GeometryValuePair>
			</cv:element>
		</cv:CV_DiscreteCoverage>
	</om:result>
</om:Observation>
```


The document shown in Listing 26 describes the details of the representation of the value of the observed property, as a swe:DataRecord.

Listing 26. tm7c.xml


```xml
<?xml version="1.0" encoding="UTF-8"?>
<swe:DataRecord gml:id="TM7c"
xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/swe/1.0.1 http://schemas.opengis.net/sweCommon/1.0.1/swe.xsd">
	<swe:field name="TMBand1">
		<swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand1">
			<swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
			<swe:constraint>
```


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```
                <swe:AllowedValues id="SINGLE_BYTE">
                    <swe:interval>0 255</swe:interval>
                </swe:AllowedValues>
            </swe:constraint>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand2">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand2">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand3">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand3">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand4">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand4">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand5">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand5">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand6">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand6">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
    <swe:field name="TMBand7">
        <swe:Quantity definition="urn:ogc:def:phenomenon:OGC:TMBand7">
            <swe:uom xlink:href="urn:ogc:def:uom:OGC:count"/>
            <swe:constraint xlink:href="#SINGLE_BYTE"/>
        </swe:Quantity>
    </swe:field>
</swe:DataRecord>
```


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