Open Geospatial Consortium Inc.

Date: 2006-02-24

Reference number of this OGC® document: **OGC 05-087r3**

Version: 0.13.0

Category: OpenGIS® Discussion Paper

Editor: Simon Cox

Observations and Measurements

Document type: OpenGIS® Discussion Paper
Document subtype: if applicable
Document stage: Approved
Document language: English

Contents

Figures

Code Listings

i. Preface

This draft specification is produced under OGC's Sensor Web Enablement (SWE) activity, which is being executed under OGC's Interoperability Program. This latest version was produced under the OGC Web Services (OWS) 3 Initiative, conducted April - October 2005.

Suggested additions, changes, and comments on this draft 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).

iii. Document contributor contact points

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

Contact	Company	Address
Simon Cox (Editor)	CSIRO Exploration and Mining	ARRC PO Box 1130 Bentley WA 6102 Australia
Mike Botts	University of Alabama in Huntsville	ESSC / NSSTC Huntsville, AL 35899
Alexandre Robin	University of Alabama in Huntsville	ESSC / NSSTC Huntsville, AL 35899
Mark Priest	3eti	
Ingo Simonis	IFGI Uni. Muenster	
Alexander Walkowski	IFGI Uni. Muenster	
Jeff Ricker	Distributed Instruments	33 West Shore Drive Putnam Valley, NY 10579
John Davidson	Image Matters, LLC	214 South King St. Leesburg VA 20175 USA
Steve Liang	York Uni., Toronto	

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 1. Model converted to ISO conformant UML 2. Document simplified, much discursive discussion material removed 3. 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 encoding variants; added discussion of observation vs interpretation; move detailed RecordSchema model to Annex.

v. Changes to the OpenGIS® Specification

The OpenGIS© Specification 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) The gml:Observation feature type within GML (observation.xsd) should either be be modified to harmonize with the model and terminology used here, or removed from GML and the schema presented here used instead

c) The Record and SWE_CompactRecord/RecordSchema components provide a systematic replacement for the GML valueObjects schema, used in GML observation and GML coverage schemas. The GML valueObjects schema should be deprecated and the schema presented here used instead

NOTE: These recommendations imply a move to a more modular approach for GML, with the scope of GML core reduced, moving components for coverages and observations into separate specifications and namespaces.

vi. Future work

Improvements in this document are desirable to

1. Correct numbering of Annex sections
2. Clarify relationship between (OM) Record/RecordSchema, (SML) Data
3. Possibly spin out Records & Grids clauses into a separate document

4. Move Clause 7 to an Annex.

5. The Event model introduced as parent to Observation is likely to be of more general applicability, and may merit a separate specification in due course

Foreword

This report replaces the OGC Recommendation Paper 03-022r4 *Observations and Measurements*. The following changes have been made to the model presented earlier:

1. O&M is now expressed in a rigorous UML model following the profile described in ISO TS 19103 and ISO 19136. ISO 19115 components are used where appropriate

2. The XML schema implementation is based on GML version 3.1.1. Metadata components are based on a version of ISO DTS 19139 GMD schema adapted to GML 3.1.1

3. An Event class has been introduced as the parent of AbstractObservation and ObservationCollection.

4. The target or subject of an observation is now referred to as the "featureOfInterest", and is required to be a feature.

5. The association with the sensor or procedure used for the observation is now referred to as "procedure".

6. The observable or measurand is now referred to as "observedProperty", whose value is the definition of a Phenomenon. The Phenomenon model has been refined.

7. The generic Observation has a result whose content model is "Any". The set of "value objects" defined in earlier versions of the specification (and included in GML in the valueObjects.xsd schema) may be used but is no longer required. Any available content model may be used, as defined in any schema indicated in the instance document.

8. A small set of specialized observation types are provided, each having a strongly-typed result property, including measures, categories.

9. A schema is provided for the definition of the structure of simple records, particularly tuples and grids

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

This specification was developed under the OWS 3 initiative as part of the Sensor Web Enablement thread. It provides the primary information model for requests to and responses from the Sensor Observation Service interface (OGC 05-088). It is compatible with a number of additional resources: descriptions of measurement procedures or

sensors, which may use Sensor Model Language (OGC 05-086); a source for definitions of reference systems, such as units of measure and codelists, definitions of phenomena and related information.

Introduction

OGC's Sensor Web Enablement (SWE) activity, which is being executed through the OGC Web Services (OWS) initiatives (under the Interoperability 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 foundational components needed for a Sensor Web, namely:

1. **Sensor Model Language (SensorML) –** The general models and XML encodings for sensors. SensorML originated under OWS 1.1, was significantly enhanced under OWS 1.2 and OWS 3 and is now available as an OGC Recommendation Paper.

2. **Transducer Markup Language (TML)** – A model and XML encodings for primitive transducer data. TML originated external to OWS, but was significantly enhanced under OWS 3.

3. **Observations & Measurements (O&M) -** The general models and XML encodings for observations and measurements, including but not restricted to those using sensors. O&M originated under OWS 1.1 and was significantly enhanced under OWS 1.2 and OWS 3

4. **Sensor Observation Service (SOS) –** A service by which a client can obtain observations from one or more sensors/platforms (can be of mixed sensor/platform types). Clients can also obtain information that describes the associated sensors and platforms. This service originated as Sensor Collection Service under OWS 1.1 and OWS 1.2, and was renamed and significantly enhanced in OWS 3.

5. **Sensor Planning Service (SPS) –** A service by which a client can determine collection feasibility for a desired set of collection requests for one or more mobile sensors/platforms, or a client may submit collection requests directly to these sensors/platforms. This service was defined under OWS 1.2 and significantly enhanced under OWS 3.

6. **Sensor Alert Service (SAS) –** A service providing active (push-based) access to sensor data.

7. **Web Notification Service (WNS) –** A service by which a client may conduct asynchronous dialogues (message interchanges) with one or more other services. This service is useful when many collaborating services are required to satisfy a client request, and/or when significant delays are involved is satisfying the request.

This document specifies Observations and Measurements. 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, phenomenon, record schema,** 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, and composites and arrays of these.

A discussion regarding how the observation and measurement model is used in the context of SensorWeb Enablement is included. The discussion notes how different parts of the information model would be provided by different services. However, the details remain to be resolved and might depend on specific use-cases.

This report is a major revision of reports prepared during the OGC Web Services 1.1 and 1.2 initiatives.

This work was supported by OGC through the OWS-3 Interoperability project, and by the SEE Grid activity based at CSIRO Australia.

Observations and Measurements: an information model and implementation specification

1 Scope

We describe a conceptual model and encoding for observations and measurements.

An Observation is an event with a result which has a value describing some phenomenon. The observation is modelled as a Feature within the context of the ISO/OGC Feature Model. An observation feature binds the result to the feature of interest, upon which it was made. An observation uses a procedure to determine the value, 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 data capture.

An observation results in an estimate of the value of a property or phenomenon related to the feature of interest. The 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 is compound and requires multiple components for its encoding. Furthermore, if the subject of the observation (feature of interest, observation time) has multiple components, then the result may have a value corresponding to each element of the subject. In this latter case the observation feature encapsulates the metadata related to the capture of data corresponding to a discrete coverage.

The value normally requires a scale or reference system to provide the context for its interpretation and valid operations on it. These include the scale or unit of measure for a quantity, a dictionary or "code space" for a category, a spatial reference system for location and geometry, and a temporal reference system for time values. A value may be constructed by aggregating primitive values, to build tuples, arrays and lists, and compound values such as vectors and tensors, in which case the structure of the result is described by a record schema. An observed value may be semantically typed according to the phenomenon being observed or observable, sometimes called measurand. Observed values may have other properties, such as quality indicators.

We discuss how the observation and measurement model is used in the context of SensorWeb, noting that different parts of the information model may be provided by different services.

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.

2 Conformance

Not required for an IP IPR, DIPR, or Discussion Paper.

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.

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/TS 19103:—[1], *Geographic Information — Conceptual schema language*

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

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

ISO 19109:—[1], *Geographic Information — Rules for application schemas*

ISO 19110: , Geographic Information – Feature cataloguing methodology

ISO 19115:2003, *Geographic Information — Metadata*

ISO 19118:—[1], *Geographic Information — Encoding*

ISO 19123:—[1], *Geographic Information — Coverages*

ISO 19136:—[1], *Geographic Information — Geography Markup Language*

---

[1] To be published.

ISO/TS 19139:—[1], *Geographic Information — Metadata — XML schema implementation*

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

OpenGIS® Abstract Specification *Topic 0: Overview, OGC document 99-100r1* http://www.opengeospatial.org/

OpenGIS® Implementation Specification *Filter Encoding version 1.1. OGC Document 04-095* http://www.opengeospatial.org/

OpenGIS® Implementation Specification *Geography Markup Language, version 3.1.1. OGC Document 03-105r1* http://www.opengeospatial.org/

OpenGIS® Implementation Specification *Web Coverage Service. OGC Document 02-024* http://www.opengeospatial.org/

OpenGIS® Implementation Specification *Web Feature Service, version 1.1. OGC Document 04-094* http://www.opengeospatial.org/

OpenGIS® Interoperability Program Report *Sensor Model Language, OGC document 05-086.*

OpenGIS® Interoperability Program Report *Sensor Observation Service, OGC document 05-088.*

OpenGIS® Interoperability Program Report *Transducer Markup Language, OGC document 05-085.*

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)*

W3C XPointer Framework (XPointer Framework), *W3C Recommendation (25 March 2003)*

W3C XPointer element() Scheme (XPointer element()), *W3C Recommendation (25 March 2003)*

W3C XPointer xmlns() Scheme (XPointer xmlns()), *W3C Recommendation (25 March 2003)*

W3C XPointer xpointer() Scheme (XPointer xpointer()), *W3C Working Draft (19 December 2002)*

OGC 05-008c1, OWS Common Implementation Specification, May 2005

4 Terms and definitions

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

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

[ISO 19101]

4.2
GML application schema
application schema written in XML Schema according to the rules specified in ISO 19136

[ISO 19136]

4.3
association
semantic relationship between two or more classifiers that specifies connections among their instances

[ISO 19501-1]

NOTE: A binary association is an association among exactly two classifiers (including the possibility of an association from a classifier to itself).

4.4
attribute <UML>
feature within a classifier that describes a range of values that instances of the classifier may hold

NOTE: An attribute is semantically equivalent to a composition association; however, the intent and usage is normally different.

4.5
attribute <XML>
name-value pair contained in an **element**

4.6
child element <XML>
immediate descendant **element** of an **element**

4.7
codespace
rule or authority for a code, name, term or category

EXAMPLE Examples of codespaces include dictionaries, authorities, codelists, patterns, etc.

4.8
coordinate reference system
coordinate system that is related to the real world by a datum [ISO 19111]

4.9
coverage
feature that acts as a function to return values from its range for any direct position within its spatiotemporal domain

[ISO 19123]

4.10
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.

NOTE:

4.11
determinand
parameter or a characteristic of a phenomenon subject to **observation.** Synonym for **observable.**

4.12
domain
well-defined **set**

[ISO/TS 19103]

NOTE: 1 A mathematical **function** may be defined on this set, i.e. in a function f:A→B A is the domain of the function f.

NOTE: 2 A domain as in domain of discourse refers to a subject or area of interest.

4.13
element <XML>
basic information item of an XML document containing **child elements**, **attributes** and character data

NOTE: From the XML Information Set: "Each XML document contains one or more elements, the boundaries of which are either delimited by start-tags and end-tags, or, for empty elements, by an empty-element tag. Each element has a type, identified by name, sometimes called its 'generic identifier' (GI), and may have a set of attribute specifications. Each attribute specification has a name and a value."

4.14
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.

4.15
feature association
relationship that links instances of one feature type with instances of the same or different feature type

[ISO 19110]

4.16
grid
network composed of two or more sets of **curves** in which the members of each set intersect the members of the other sets in an algorithmic way

[ISO 19123]

NOTE: The curves partition a space into grid cells.

4.17
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.

4.18
measurement (noun)
an observation whose result is a measure

4.19
measurand
physical parameter or a characteristic of a phenomenon subject to a measurement

4.20
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]

4.21
observable (noun)
parameter or a characteristic of a phenomenon subject to **observation**

4.22
observation (noun)
an act of observing a property or phenomenon, with the goal of producing an estimate of the value of the property

4.23
property <General Feature Model>
characteristic of a feature type, including attribute, association role, defined behaviour, feature association, specialization and generalization relationship, constraints

[ISO 19109]

4.24
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.

4.25
range
set of all values a function f can take as its arguments vary over its domain

4.26
result
an estimate of the value of some property

4.27
scale
a particular way of assigning numbers or symbols to measure something is called a *scale* of measurement [SAR1995].

4.28
schema
formal description of a model

[ISO 19101]

NOTE: In general, a schema is an abstract representation of an object's characteristics and relationship to other objects. An XML schema represents the relationship between the attributes and elements of an XML object (for example, a document or a portion of a document)

4.29
schema <XML Schema>
collection of schema components within the same target **namespace**

EXAMPLE Schema components of W3C XML Schema are types, elements, attributes, groups, etc.

4.30
schema document <XML Schema>
XML document containing schema component definitions and declarations

NOTE: The W3C XML Schema provides an XML interchange format for schema information. A single schema document provides descriptions of components associated with a single XML namespace, but several documents may describe components in the same schema, i.e. the same target namespace.

4.31
semantic type
category of objects that share some common characteristics and are thus given an identifying type name in a particular domain of discourse

4.32
sequence
finite, ordered collection of related items (objects or values) that may be repeated

[ISO 19107]

4.33
set
unordered collection of related items (**objects** or values) with no repetition

[ISO 19107]

4.34
tag <XML>
markup in an XML document delimiting the content of an **element**

EXAMPLE <Road>

NOTE: A tag with no forward slash (e.g. <Road>) is called a start-tag (also opening tag), and one with a forward slash (e.g. </Road> is called an end-tag (also closing tag).

4.35
tuple
ordered list of values

4.36
UML application schema
application schema written in UML according to ISO 19109

4.37
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].

4.38
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)

GML	OGC Geography Markup Language
ISO	International Organization for Standardization
O&M	Observations and Measurements
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
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 2004-05-11.

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 are sometimes used as natural language words where this assists in constructing a readable text.

5.3 Document terms and definitions

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

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.

6.2 Observation event

We follow Fowler [FOW1998] and consider an observation to be an act through which a number, term or other symbol is assigned to a phenomenon. An observation is a kind of *event* and thus is associated with a discrete time. The phenomenon is associated with 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, 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 and interpretation of the result.

In conventional measurement theory [e.g. KRALST, SAR1995, VIM] the term "measurement" is used for the concept. However, Fowler's distinction between measurement and category-observation 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.

6.3 Basic observation model

The basic observation model is presented in Figure 1.

Event is a feature type [OGC AS Topic 0] characterized by a **time** whose value is a temporal object (TM_Object), a **location** whose value is either a spatial object described using coordinates (GM_Object) or a named place (EX_GeographicDescription). Persons or organisations (CI_ResponsibleParty) may be identified as **responsible** for the Event. Note that TM_Object includes both temporal primitives and aggregates. The latter may be applicable for recurring events and time-series. Associations with other events may be indicated as either a **precedingEvent** or **followingEvent**.

Observations are specialized events. All observations have a **result** and (optionally) an indication of its event-specific **quality**. Other properties characterizing all observations are shown as associations, with the following roleNames:

- the value of the **featureOfInterest** is a representation of the real-world object regarding which the observation is made

- the value of the **observedProperty** identifies or describes the Phenomenon for which the observation result provides an estimate of its value

– the value of the **procedure** is the description of a generic process used to generate the observation

A set of general parameters describe other aspects of the observation event.

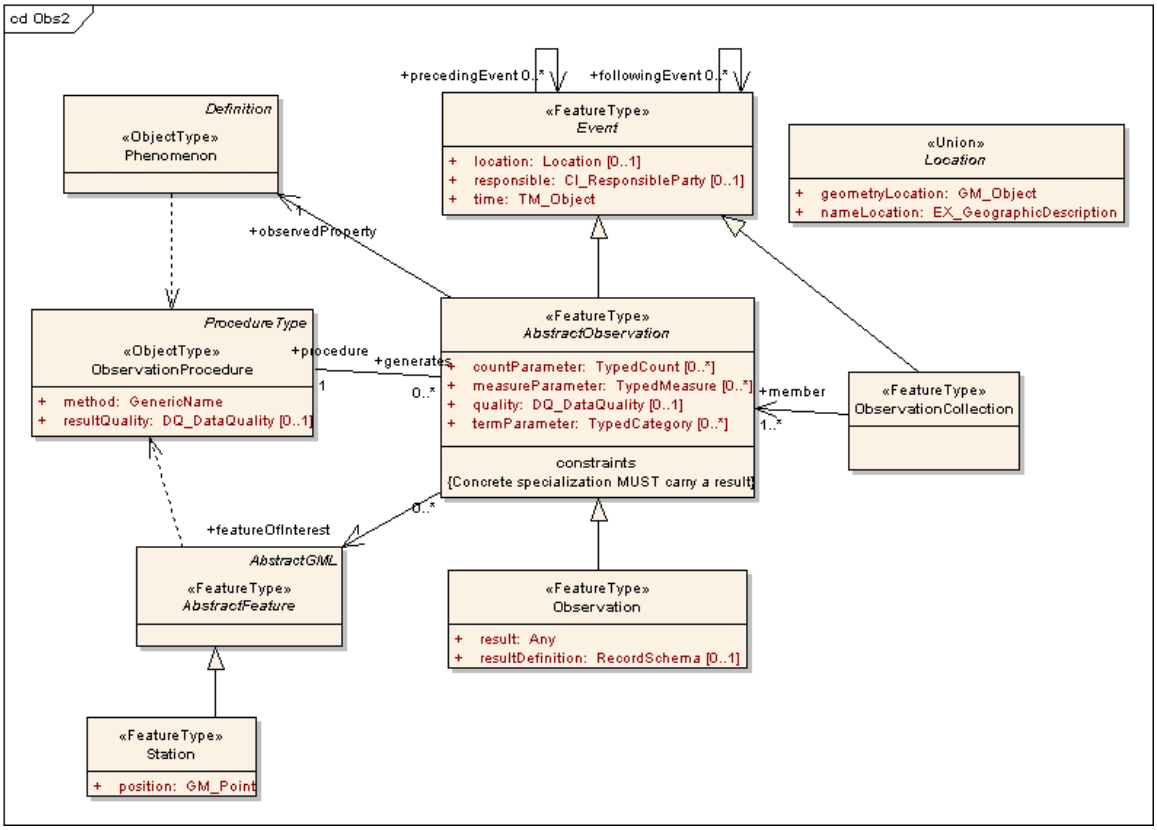

Figure 1. The basic Event and Observation feature types

The separation of the *feature of interest* and the *location* of the observation (inherited from the Event class) is notable. In the context of an observation event, the location will normally refer to the location of the instrument or observer at the time of the observation. For in-situ observations, this will correspond with the location of the feature of interest. But for remote sensing, they are quite different. Thus, the model clearly supports the required distinction and allows both to be described.

Note that the feature instance that is the target of the featureOfInterest association represents the *proximate* subject of the observation event, i.e. the object to which the immediate observation result applies. In some cases, often where the immediate observation concerns a more primitive phenomenon, this may not be the *ultimate* feature of interest. The latter may rather be associated with a project or campaign that the immediate observation is associated with.

The spatio-temporal domain of an observation is embodied in the description of its feature of interest. While this may be a “natural” feature recognised from some application domain (river, road, person, mountain, etc), the target of an observation is often an artefact generated by a sampling regime (specimen, station, traverse, pixel,

swath etc). Observations of time-dependent phenomena will often use a sampling regime characterised by time as well as space, so this will normally be accommodated in the description of the feature of interest.

The value of the procedure property is the description of a procedure type with its standard parameters and settings. Event-specific parameters associated with the use of the procedure for the specific observation (e.g. instrument settings) may be recorded in **countParameter**, **measureParameter** or **termParameter** properties.

There may also be dependencies between the procedure and other observation properties as follows:

- The procedure, perhaps with event-specific parameters, may provide key parts of the intrinsic description of the feature of interest; this is particularly the case in remote sensing observations

- The procedure must be appropriate for the observedProperty; conversely, the specific details of the observedProperty are constrained by the procedure used; e.g. an observed radiance wavelength is determined by the response characteristics of the sensor.

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

The type of the result is variable, and in this model we follow Fowler [FOW1998] and distinguish certain observation types according to the result type (see clause 6.6).

NOTE: In order to avoid the use of constraints and technical difficulties associated with classes derived by restriction, the result attribute does not appear directly on the abstract superclass **AbstractObservation**, but all concrete observation classes derived from AbstractObservation MUST add an attribute called result, having an appropriate type.

6.4 Concrete observations

Observation is a generic concrete class for observations where the result type is shown as *Any*. The implication is that the result type must be indicated at the data instance level.

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

NOTE: The GML schema document valueObjects.xsd describes general purpose value structures that may be used.

The optional **resultDefinition** property provides a slot where details of the result structure maybe provided, where this is necessary to augment the type of the result. For example, when the result is a generic “Record”, the resultDefinition defines the components and their order. This is effectively a local instance-level schema for the result.

ObservationCollection is specialized from Event, being a collection of member observations. There are no constraints on the relationships between member observations.

6.5 Associated components

6.5.1 Result types

The Observation class allows for a result whose type is specified in the instance. Any datatype known to the application may be used, including the basic type libraries provided in ISO 19103 and implemented in part in GML [ISO 19136]. Two additional basic type classes are defined in this specification to support some common use cases (Figure 2).

ResultMeasure is a variation of the standard Measure, which is a number with a scale [ISO 19103]. The additional attribute **relativeMeasure** supports inexact and missing values, with a default of "equals". The semantics of the nil values are as given in GML [ISO 19136].

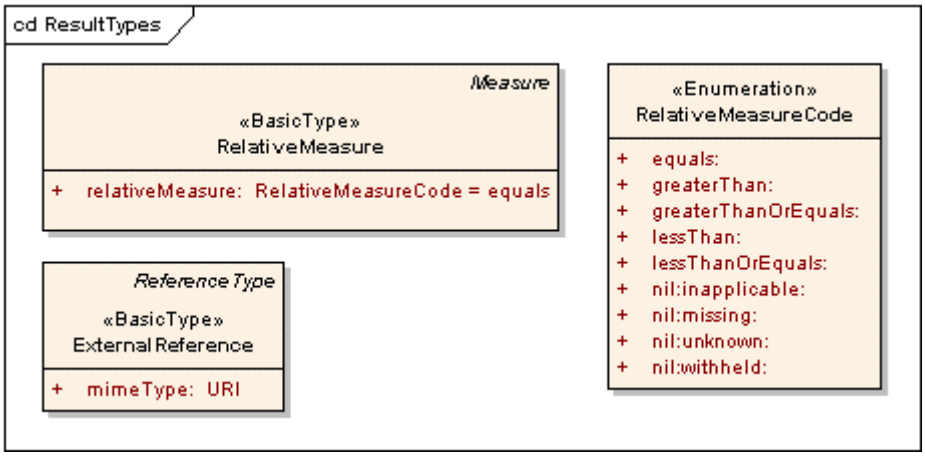

Figure 2. Types used for encoding an observation result

ExternalReference is a variation of the standard GML ReferenceType [ISO 19136], which carries an identifier for an external source for the information (typically a URI). The additional attribute **mimeType** allows the encoding of the externally supplied data to be indicated. This datatype is intended to support cases where the representation of an Observation instance includes all details of the observation event, but points to an external source for the result. This is particularly useful for service interfaces to high-volume and streaming data, where it may be convenient to deliver the result via a separate service.

6.5.2 Feature of interest

The feature of interest may be any feature regarding which observations may be made and reported. Thus, in general, the value of the feature of interest will be a feature instance of a type from catalogue representing the application domain [ISO 19109, ISO 19110].

Nevertheless, certain feature types are only associated with sampling, and have no significant function outside the observation process. These include stations, profiles, swaths, scenes, specimens, and various specializations of these.

NOTE: A non-normative schema describing a selection of these types is provided in Annex B.

A simple **Station** feature type is shown in Figure 1 and included in the normative observation schema for convenience purposes (Annex A).

6.5.3 Observed property (phenomenon schema)

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. This is referred to in this specification as a Phenomenon, the estimate of whose value is the primary result of the observation. A schema for semantic definitions is beyond the scope of this specification: ultimately this rests on shared concepts that can only be 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 phenomena must be available.

NOTE: The term “Phenomenon” is sometimes used to refer to transient features, such as lightning or storms. Here it is used as an umbrella term to encompass definitions of any kind of feature property whose value is amenable to observation or estimation, including physical properties, classification axes, existence and occurrence assessments, etc.

Formal notations for knowledge representation are available (e.g. OWL [OWL]) and prototype ontologies for phenomena 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 OWL’s known weakness in numerics.

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

In order to support common uses in natural sciences and engineering, we provide a schema which supports the description of “derived” phenomena definitions. This requires a pre-existing set of definitions of “fundamental” phenomena to be used as the base phenomena, and for the semantics of axes of constraint for derived phenomena. There is, however, no canonical set of base phenomena or system for determining these.

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 schema for derived phenomena definitions is shown in Figure 3, and a sample phenomenon dictionary in Annex C.

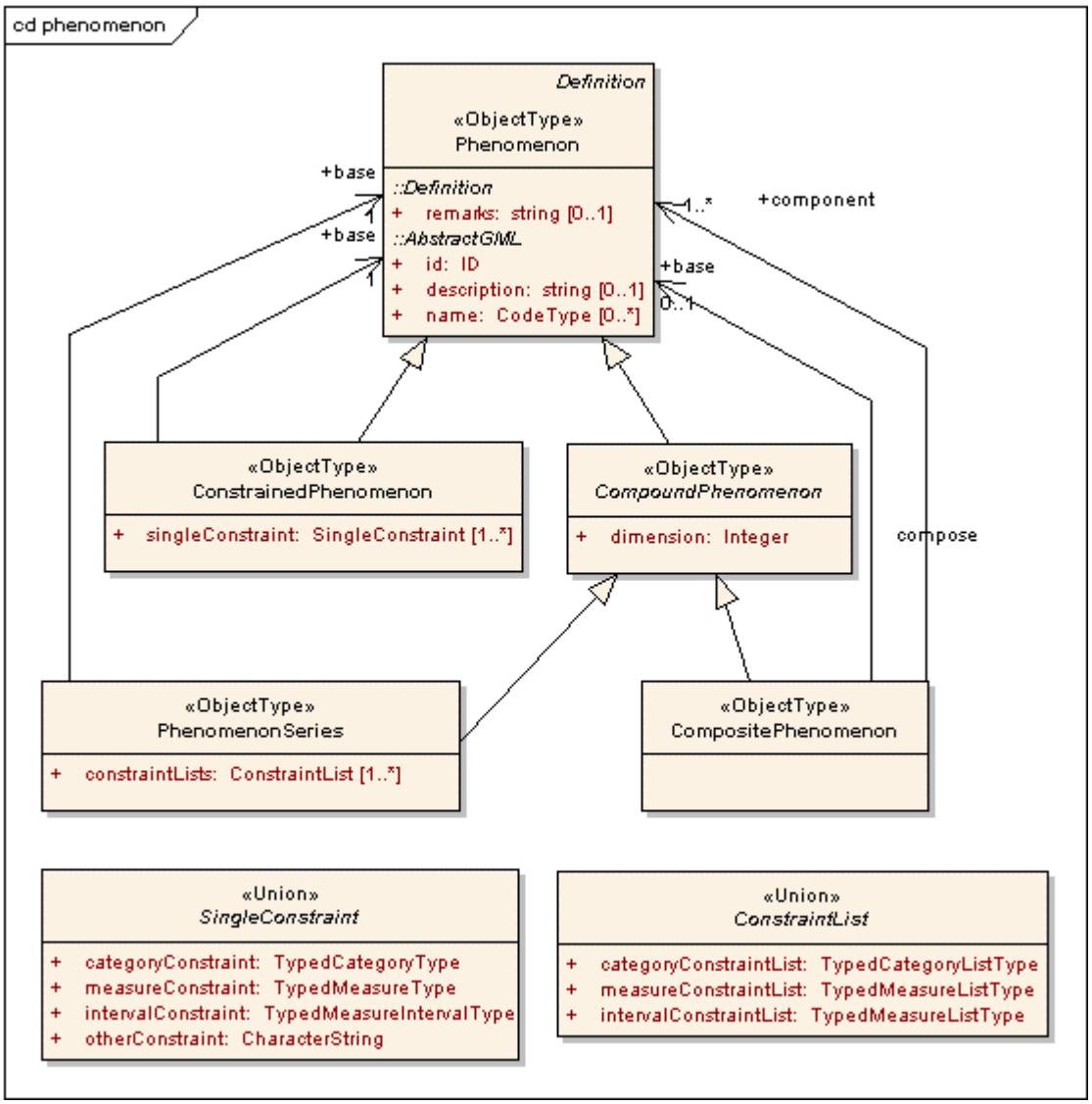

Figure 3. A taxonomy of phenomenon definitions

The basic **Phenomenon** class is a definition with an identifier. In the model shown here it is based on the GML Definition class. The **description** property may be used to hold a textual definition, or to carry a pointer to a more authoritative source.

Two kinds of specializations are supported: constraints and compounding.

A **ConstrainedPhenomenon** modifies a **base** phenomenon by adding **singleConstraint**s, each specifying a value on some secondary axis.

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

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

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

A **PhenomenonSeries** applies one or more **constraintLists** to the base phenomenon, 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.

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

6.5.4 Procedure

The value of the procedure property is the description of a procedure. This may be quite elaborate, and may involve the description of multiple processing steps or activities, with various inputs, calibrations, etc used in particular stages. SensorML provides a model and encoding suitable for many classes of sensors, particularly focussing on process models associated with remote sensing.

In the context of the model described here, event-specific parameters are considered to be properties of the observation. The description of the Procedure should only include generic parameters that apply to all observations generated by it.

The description of procedures in general is beyond the scope of this specification. However, a basic framework for defining generic procedures is shown in Figure 4.

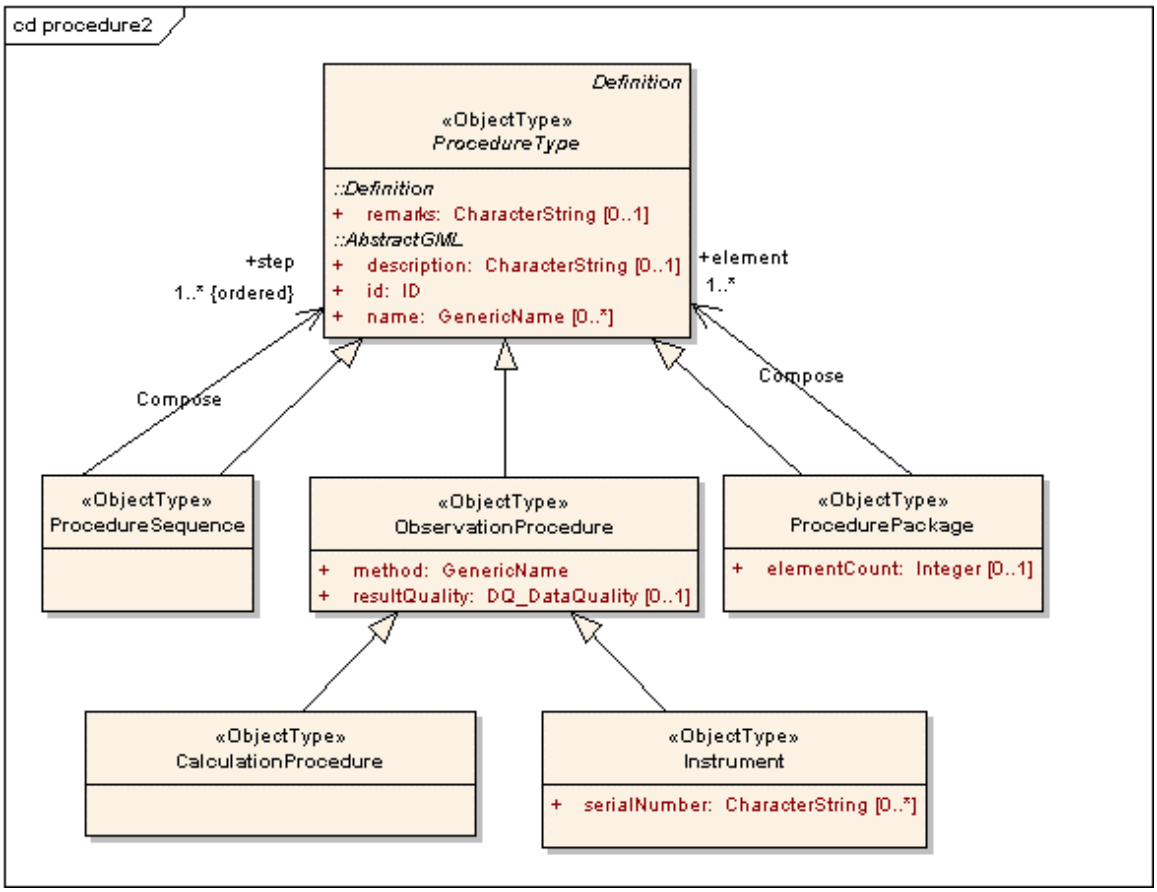

Figure 4. Basic Procedures that might be used for observations.

A “procedure” is generally an abstraction, for which the description or catalogue entry provides the canonical object. Hence, the abstract superclass **ProcedureType** is stereotyped <<ObjectType>>, and in the model shown here is derived from the GML Definition class.

An **ObservationProcedure** is characterized by a **method**, and a **resultQuality** that is associated systematically with the results of observation made using this procedure. The “method” will typically be a code from some catalogue.

A **ProcedureSequence** is a single procedure composed of an ordered set of **steps**, the value of each being a Procedure. A ProcedureSequence generates a simple result.

A **ProcedurePackage** is a single procedure composed of **elements** each responsible for a different observed property. A ProcedurePackage generates a complex result representing the value of a compound phenomenon.

For illustrative purposes, two specializations of ObservationProcedure are shown. An **Instrument** is a physical artefact used for generating observations; the model adds a **serialNumber** denoting the instrument instance. A **CalculationProcedure** is a data-processing or simulation procedure; in the model here it uses the inherited description, remarks and method properties to give details.

6.6 Specialized observation types

6.6.1 Simple observations

A set of specialized observation types are shown in Figure 5. These are distinguished by having a fixed result type.

The result of a **CategoryObservation** is a **ScopedName**, which is a term scoped by a vocabulary or authority.

The result of a **CountObservation** is an **Integer**.

The result of a **Measurement** is a **RelativeMeasure**.

The result of a **TruthObservation** is a **Boolean**.

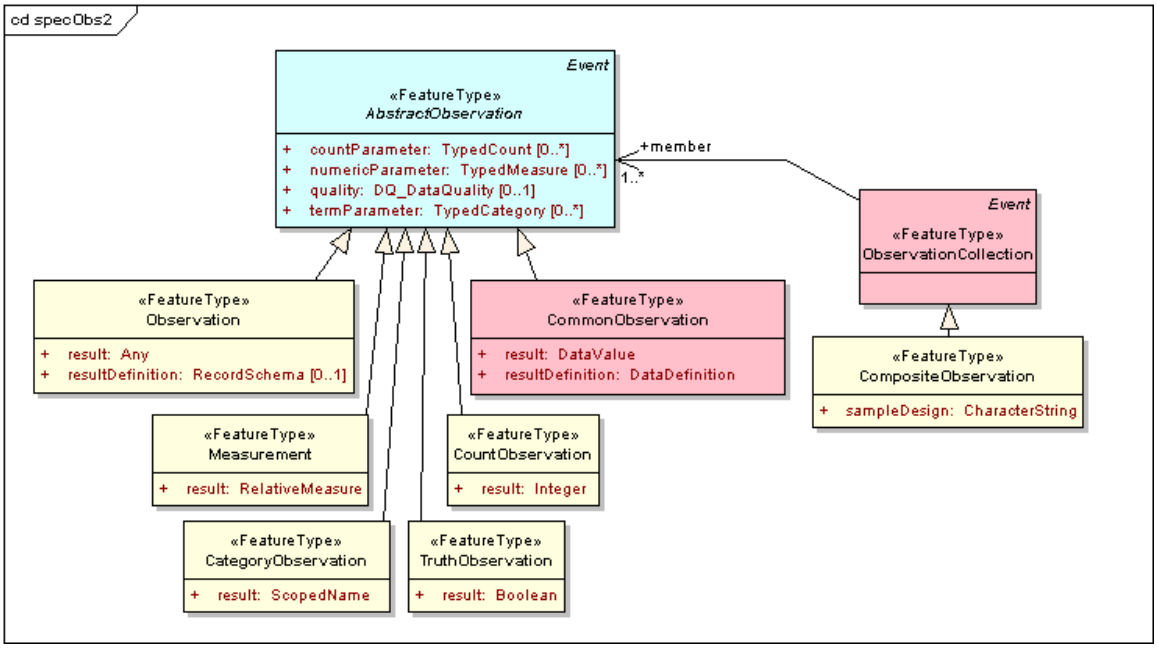

Figure 5. Observation types specialized by result type

6.6.2 Compound observations

6.6.2.1 The need to represent compound results

Observation events may yield results that must be expressed in multiple components. This may be because one or more of the following apply:

a) the observedProperty is complex.

NOTE: Clause 6.5.3 contains descriptions of models for describing such phenomena

Examples: a multi-band spectral radiance; a compound observable like “weather”; a tensor property like earthquake moment.

b) the feature of interest is decomposed into several elements and there are separate results for each element

NOTE: Observations of this type describe the acquisition of data corresponding to a coverage [ISO 19136] whose domain is the set of feature elements, and whose range is the observation result

Example: an array of stations, which may be on a grid.

c) observations are made at several times, with a separate result at each time.

NOTE: Observations of this type describe the acquisition of data corresponding to a coverage [ISO 19136] whose domain is the set of time elements, and whose range is the observation result

Comment: In principle all aspects of the spatio-temporal domain of the observation should be embodied in the description of the feature of interest. However, this conflicts with common usage, in which (for example) a "Station" is the static feature of interest, upon which observations are made at various times (events). Best practice in relation to the use of either the Event/time property or temporal properties of the feature of interest is unclear, and probably depends on the extent to which the description of the feature of interest concerns a sampling regime, or a feature-type with significance in another domain. This issue partially mirrors the discussion of the spatial properties Event/location vs feature-of-interest given in 6.3 above.

6.6.2.2 Representation using generic observation classes

The most general way to combine observations is through an **ObservationCollection** [Clause 6.4] where the result is split between component observations. Each component of the result is modelled as a separate observation.

A **CompositeObservation** is a specialization of ObservationCollection, with the constraint that at least one of (featureOfInterest, time, phenomenon) is constant across all members.

The generic concrete **Observation** [Clause 6.4] may be used, with the result type specified as some kind of Record. When using the Observation feature type to encode complex observations, the **resultDefinition** property provides a slot where the **RecordSchema** may be given explicitly. The RecordSchema must provide the meaning (name) of elements in the record, their order, and scale (for numbers) or scope (for terms). This provides an additional layer of semantics essential to augment the structural types of a generic record.

Example: an Observation/result may use the SWE_CompactRecordType or SWE_CompactNumericRecordType [A 1.1], or Data type [Clause 6.6.2.3, SensorML].

6.6.2.3 Common Observation

A **CommonObservation** is a strongly-typed alternative for complex observations, using the "**Data**" components from the SWECommon schema [SensorML] for its result type and resultDefinition. This is a specific implementation of a record/recordSchema encoding, in which the result is a list of tuples representing values of the components of an observedProperty, and then ordered according to capture time. The ordering often corresponds (ultimately) to component elements of the feature of interest, such as pixels within a swath or scene. Time-ordering of the observation result is typically used

relatively early in the processing chain, prior to the assignment of values more explicitly to the intended feature of interest, through rectification, etc.

6.6.3 Result Definition (Record schema)

Some specialized compound result types are used for observations whose result is complex.

A record instance should provide a means of obtaining a description of its structure (see ISO 19103). In the context of an Observation instance, this may be provided locally as the value of the resultDefinition property.

NOTE: XML Schema definitions of types for a compact representation (i.e. a list of space separated items encoded as the value of a single XML element) and "XML Encoded" representation (i.e. items recorded in separate XML elements in a scalable Array-Record-Item structure) are provided in SWE_basicTypes.xsd and record.xsd in Annex A.

The separate items in a record generally iterate through a combination of components of (i) the observed property, (ii) the feature of interest, and (iii) the observation time. The resultDefinition must disambiguate the order of items in the list. Because of the importance of this issue, a model for basic record schemas is provided in Annex A 1.1.4. This model is sufficient to accommodate the requirements of the observation types described here and illustrated in Clause 7.3.

NOTE: It is often convenient to provide such information at run time, i.e. in the data instance. In an XML implementation, the schema definition for the element and attribute names or a specifically identified type may provide sufficient information. However, while a run-time XML schema definition may be used, in the context of observations, a more constrained language has some benefits.

NOTE: There are a number of appropriate alternatives to the schema shown here, including the data definition components from Sensor Model Language and Transducer Markup Language.

7 XML implementation

7.1 Implementation strategies

The O&M model presented here has been designed with implementation as a GML Application Schema as a key output. This is to allow O&M objects to be represented in a form that conforms with requirements for service interfaces specified by OGC, in particular WFS [WFS] and profiles of WFS. Direct GML implementation requires that the UML model conforms to a subset of the UML profile specified in ISO 19103, as described in ISO 19136. The patterns and use of data types in this specification reflects this.

However, it is important to note that the O&M model was not designed solely, or even primarily, for a GML implementation, but is rather intended to provide a basic output- or user-oriented information model for sensor web and related applications.

Furthermore, the direct GML implementation [Annex A] is not exclusive. It is an explicit implementation, in which the properties of observations and measurements identified in the analysis presented in clause 6 appear literally. Nevertheless, alternative XML implementations and other serializations may conform to the model, provided that slots in the implementation can be associated with properties of the O&M model presented here.

For example, 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 ultimate feature-of-interest, and even observed property, being assembled and assigned to the result in a way that carries the key semantics to end users of observation data, as represented in the O&M model. In particular, part of a TML or SensorML datastream may include information that must be further processed to determine the position of the real target or feature-of-interest, or may indicate the actual observation time. At the early processing stage, positional and timing information may also 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 CompositePhenomenon which may include components representing the observation timing and position and attitude of the sensor, and which 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 CompositePhenomenon, etc.

7.2 GML Application Schema

The procedure for implementing a model designed in UML as a GML Application Schema is described in Annex F of GML 3.1. For the implementation many of the data types and parent classes indicated in the UML diagrams in clause 6 are mapped to specific XML Schema type definitions and element declarations, as specified in the table of mappings given in Annex E of ISO 19136. An XML Schema that follows these rules is presented in Annex A.

The details of the GML implementation are most easily explained using instance examples. Since the GML implementation is an explicit mapping from the model, largely using names from the model as element and attribute names, inspection of sample data is also an effective way to assess the effectiveness of the model in capturing the required information. In the remainder of this clause, we present a graduated series of examples to illustrate the model and encoding.

As indicated in sub-clauses 6.3, 6.5.1 and 6.6, the result of an observation may have many types. Furthermore, as foreshadowed in sub-clause 6.6, various encodings of some types are available. 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 several of the examples below [7.3.3] up to three alternative encodings with different advantages are shown for “complex” results. These include:

1. a compact record contained within a single XML element, composed of space-separated items, corresponding to the W3C XML Schema “list” type. This means that the items are addressable using standard XML processing technology (XPointer)

2. 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 different. Results encoded using this structure are more human readble, but this microformat requires a specific writer and reader to augment standard XML processing

3. a record in which the items are encoded in separate XML elements, and composed into generic multidimensional record and array structures. This is verbose, but has the advantage of using the basic XML structuring components that are accessible in all XML processing environments, making applications for both writing and reading easier to implement.

In all three cases, the semantics of the record structure are indicated separately, in the recordDefinition.

7.3 Examples of GML implementation (informative)

7.3.1 Simple Observations with scalar results

These examples shows basic observations where the result is a scalar with the value embedded in the document.

The document shown in Listing 1 describes a simple observation to determine the mass of a specific banana.

Listing 1. observation1.xml

```
<om:Observation gml:id="obsTest1"
xmlns:om="http://www.opengis.net/om"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
 xmlns:gml="http://www.opengis.net/gml"
            xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
      <gml:description>Observation test instance</gml:description>
      <gml:name>Observation test 1</gml:name>
      <om:time>
            <gml:TimeInstant gml:id="ot1t">
                  <gml:timePosition>2005-01-11T16:22:25.00</gml:timePosition>
            </gml:TimeInstant>
      </om:time>
      <om:location>
            <gmd:EX_GeographicDescription>
                  <gmd:geographicIdentifier>
                        <gmd:MD_Identifier>
                              <gmd:code>
                                    <gco:CharacterString>Subiaco Markets</gco:CharacterString>
                              </gmd:code>
                        </gmd:MD_Identifier>
                  </gmd:geographicIdentifier>
            </gmd:EX_GeographicDescription>
      </om:location>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:OGC:scales"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:mass"/>
      <om:featureOfInterest xlink:href="http://some.interested.org/vegetables/instances/banana1"/>
      <om:result xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:kg">0.28</om:result>
</om:Observation>
```

The location of the observation is given as a geographicDescription, whose value is text. The value of the procedure (“scales”), the observedProperty (“mass”), and the featureOfInterest (a banana) 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 04-013r5 and 05-010, modified according to OGC 05-091 and 05-092], 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.

The document shown in Listing 2 describes the same observation using the specialized observation type Measurement.

Listing 2. observation1m.xml

```
<om:Measurement gml:id="obsTest1m"
xmlns:om="http://www.opengis.net/om"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
```

```
xmlns:gml="http://www.opengis.net/gml"
        xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
    <gml:description>Observation test instance</gml:description>
    <gml:name>Observation test 1m</gml:name>
    <om:time>
        <gml:TimeInstant gml:id="ot1t">
            <gml:timePosition>2005-01-11T16:22:25.00</gml:timePosition>
        </gml:TimeInstant>
    </om:time>
    <om:location>
        <gmd:EX_GeographicDescription>
            <gmd:geographicIdentifier>
                <gmd:MD_Identifier>
                    <gmd:code>
                        <gco:CharacterString>Subiaco Markets</gco:CharacterString>
                    </gmd:code>
                </gmd:MD_Identifier>
            </gmd:geographicIdentifier>
        </gmd:EX_GeographicDescription>
    </om:location>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:OGC:scales"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:mass"/>
    <om:featureOfInterest xlink:href="http://some.interested.org/vegetables/instances/banana1"/>
    <om:result uom="urn:x-ogc:def:uom:OGC:kg" relativeMeasure="greaterThanOrEquals">0.28</om:result>
</om:Measurement>
```

The result type is fixed so the xsi:type attribute is not needed. An additional variation is that the optional relativeMeasure attribute appears, and here indicates that the value given is a lower bound estimate rather than exact.

The document shown in Listing 3 describes a simple observation to determine the species of an item of market produce.

Listing 3. observation2.xml

```
<om:Observation gml:id="obsTest2"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
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 ../om.xsd">
    <gml:description>Observation test instance</gml:description>
    <gml:name>Observation test 2</gml:name>
    <om:time>
        <gml:TimeInstant gml:id="ot2t">
            <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
        </gml:TimeInstant>
    </om:time>
    <om:location xlink:href="#ot2p"/>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Observer:SEEGrid:cox075"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Species"/>
    <om:featureOfInterest>
        <om:Station gml:id="ot2s">
            <gml:name>8903</gml:name>
            <om:position>
                <gml:Point gml:id="ot2p">
                    <gml:pos srsName="urn:x-ogc:def:crs:EPSG:6.3:62836405">-30.7025065
134.1997256</gml:pos>
                </gml:Point>
            </om:position>
            <om:procedureHosted xlink:href="urn:seegrid:definition:procedure:person:cox075"/>
        </om:Station>
    </om:featureOfInterest>
```

```
        <om:result xsi:type="swe:ScopedNameType"
codeSpace="http://en.wikipedia.org/wiki/List_of_fruits">Banana</om:result>
</om:Observation>
```

The value of the location, procedure (a human observer), and observedProperty ("species") are given as references, following the standard GML pattern using xlink:href attributes. These references are all given as URIs: the location is given using a local fragment identifier [XPointer] acting as a cross-reference to a node within the same document; the other two use the OGC URN scheme. The featureOfInterest in this example is an observation station, which is a simple point-located feature used for observations (see Figure 1 and clause 6.5.2).

The type of the result is indicated in the instance using the standard xsi:type attribute [W3C XML Schema]. In this example it is om: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.

The document shown in Listing 4 describes the same observation using the specialized observation type CategoryObservation. The result type is fixed so the xsi:type attribute is not needed.

Listing 4. observation2c.xml

```
<om:CategoryObservation gml:id="obsTest2"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
        <gml:description>Observation test instance</gml:description>
        <gml:name>Observation test 2</gml:name>
        <om:time>
                <gml:TimeInstant gml:id="ot2t">
                        <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
                </gml:TimeInstant>
        </om:time>
        <om:location xlink:href="foi.xml#ot2p"/>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Observer:SEEGrid:cox075"/>
        <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Species"/>
        <om:featureOfInterest xlink:href="foi.xml#ot2s"/>
        <om:result codeSpace="http://en.wikipedia.org/wiki/List_of_fruits">Banana</om:result>
</om:CategoryObservation>
```

7.3.2 Observations acting as metadata for 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 5 describes an observation of Relative Humidity at an observation station.

Listing 5. Pointer1.xml

```
<om:Observation gml:id="OPTest1"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
      <gml:description>Observation instance with remote result</gml:description>
      <gml:name>Observation Pointer 1</gml:name>
      <om:time>
            <gml:TimePeriod gml:id="op1t">
                  <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
                  <gml:endPosition indeterminatePosition="after">2005-01-11T17:22:25.00</gml:endPosition>
            </gml:TimePeriod>
      </om:time>
      <om:location>
            <gml:Point gml:id="op1p">
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836413">-30.7025065 134.1997256 -50.2</gml:pos>
            </gml:Point>
      </om:location>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:3eti:abc45"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
      <om:featureOfInterest xlink:href="http://my.modest.org/wfs%26request=getFeature%26id=789002"
xlink:role="urn:seegrid:definition:featuretype:station"/>
      <om:result xlink:href="http://my.modest.org/results%3f798002%26property=RH" xlink:role="application/xmpp"
xsi:type="gml:ReferenceType"/>
</om:Observation>
```

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 value of the location is given explicitly, as a gml:Point. 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.

The document shown in Listing 6 describes an observation of “Stress” in a shallow borehole.

Listing 6. Pointer2.xml

```
<om:Observation gml:id="OPTest2"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
      <gml:description>Observation instance with remote result</gml:description>
      <gml:name>Observation Pointer 2</gml:name>
      <om:time>
            <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:time>
        <om:location>
            <gml:Point gml:id="op2p">
                <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836413">-30.7025065 134.1997256 -50.2</gml:pos>
            </gml:Point>
        </om:location>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:SEEGrid:overcoring"/>
        <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:SEEGrid:stress"/>
            <om:featureOfInterest xlink:href="http://some.datasupplying.org/wfs%26request=getFeature%26id=789002"
        xlink:role="urn:seegrid:definition:featuretype:borehole"/>
        <om:result xlink:href="http://some.datasupplying.org/results%3f798002%26property=stress"
        mimeType="application/xml" xsi:type="om:ExternalReferenceType"/>
</om:Observation>
```

Most of the properties are expressed as a variation of the patterns described in the previous example. The type of the result in this example is om:ExternalReferenceType, so the required mimeType attribute is also present. The result value is indicated by the value of the xlink:href attribute. The value of the mimeType describes the nature of the external resource.

7.3.3 Compound Observations and Measurements

7.3.3.1 Observation Collection

Various forms of observation compounding may be described. The first example shows a basic collection of simple observations.

The document shown in Listing 7 describes a collection of two observations.

Listing 7. Collection1.xml

```
<om:ObservationCollection gml:id="coll1"
xmlns:om="http://www.opengis.net/om"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
        <gml:description>Collection of observations</gml:description>
        <gml:name>Observation Collection 1</gml:name>
        <om:time>
            <gml:TimePeriod gml:id="oc1t">
                <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
                <gml:endPosition>2005-01-11T17:24:25.00</gml:endPosition>
            </gml:TimePeriod>
        </om:time>
        <om:location>
            <gmd:EX_GeographicDescription>
                <gmd:geographicIdentifier>
                    <gmd:MD_Identifier>
                        <gmd:code>
                            <gco:CharacterString>Subiaco Markets</gco:CharacterString>
                        </gmd:code>
                    </gmd:MD_Identifier>
                </gmd:geographicIdentifier>
            </gmd:EX_GeographicDescription>
        </om:location>
        <om:member>
            <om:Observation gml:id="o1">
```

```
            <om:time>
                <gml:TimeInstant gml:id="ot1t">
                    <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
                </gml:TimeInstant>
            </om:time>
            <om:location>
                <gmd:EX_GeographicDescription>
                    <gmd:geographicIdentifier>
                        <gmd:MD_Identifier>
                            <gmd:code>
                                <gco:CharacterString>Subiaco Markets</gco:CharacterString>
                            </gmd:code>
                        </gmd:MD_Identifier>
                    </gmd:geographicIdentifier>
                </gmd:EX_GeographicDescription>
            </om:location>
            <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:OGC:scales"/>
            <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:mass"/>
            <om:featureOfInterest xlink:href="http://some.interested.org/vegetables/instances/banana1"/>
            <om:result xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:kg">0.28</om:result>
        </om:Observation>
    </om:member>
    <om:member>
        <om:Observation gml:id="o2">
            <om:time>
                <gml:TimeInstant gml:id="ot2t">
                    <gml:timePosition>2005-01-11T17:24:25.00</gml:timePosition>
                </gml:TimeInstant>
            </om:time>
            <om:location>
                <gmd:EX_GeographicDescription>
                    <gmd:geographicIdentifier>
                        <gmd:MD_Identifier>
                            <gmd:code>
                                <gco:CharacterString>Subiaco Markets</gco:CharacterString>
                            </gmd:code>
                        </gmd:MD_Identifier>
                    </gmd:geographicIdentifier>
                </gmd:EX_GeographicDescription>
            </om:location>
            <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:OGC:scales"/>
            <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:mass"/>
            <om:featureOfInterest xlink:href="http://some.interested.org/vegetables/instances/banana2"/>
            <om:result xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:kg">0.27</om:result>
        </om:Observation>
    </om:member>
</om:ObservationCollection>
```

The member observations should be consistent with the values or ranges of time and location of the ObservationCollection, but there are no other constraints on the relationships between them. In this case the observations have the same location, and the times of each fall within the time period indicated on the collection.

7.3.3.2 Compound observed property

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

The document shown in Listing 8 describes an observation of the shape of a banana.

Listing 8. observation2shape.xml

```
<om:Observation gml:id="shapeTest2"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
        <gml:description>Observation test instance</gml:description>
        <gml:name>Shape observation test</gml:name>
        <om:time>
                <gml:TimeInstant gml:id="st2t">
                        <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
                </gml:TimeInstant>
        </om:time>
        <om:location xlink:href="foi.xml#ot2p"/>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Observer:SEEGrid:cox075"/>
        <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Shape"/>
        <om:featureOfInterest xlink:href="foi.xml#ot2s"/>
        <om:result>
                <gml:Solid gml:id="bs">
                        <gml:description>An explicit description of a solid.
The succeeding "gml:exterior" property ommitted here for brevity.</gml:description>
                </gml:Solid>
        </om:result>
</om:Observation>
```

Most of the document follows Listing 3. However, the observed property is “Shape” and 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. Note that since the result is an XML encoded data structure, the result is contained a sub-element whose name is explicit, so the xsi:type attribute on the result element is not needed.

The documents shown in Listing 9, Listing 10 and Listing 13 describe an observation of weather conditions at a locality.

In Listing 9 the result is given as a swe:SWE_CompactRecordType (Listing 30), in which the components are embedded in a space-separated XML Schema list.

Listing 9. complexObservation2.xml

```
<om:Observation gml:id="COTest1"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
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 ../om.xsd">
        <gml:description>Complex Observation test instance</gml:description>
        <gml:name>Complex Observation test 1</gml:name>
        <om:time>
                <gml:TimeInstant gml:id="ot1t">
                        <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
                </gml:TimeInstant>
        </om:time>
        <om:location xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604"/>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:SEEGrid:weatherStation1"/>
        <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:SEEGrid:weather1"/>
```

```
    <om:featureOfInterest xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604" xlink:role="urn:x-
seegrid:definition:featuretype:locality"/>
    <om:resultDefinition xlink:href="weatherRecordDefinition.xml"/>
    <om:result xsi:type="swe:SWE_CompactRecordType" RS="weatherRecordDefinition.xml">35.1 6.5 085.0 950. 32.0
clear</om:result>
</om:Observation>
```

In Listing 10 the result is given as a swe:Record (Listing 31), which separates the components into XML elements.

Listing 10. complexObservation3.xml

```
<om:Observation gml:id="COTest3" xmlns:om="http://www.opengis.net/om" xmlns:swe="http://www.opengis.net/swe"
xmlns:xst="http://www.seegrid.csiro.au/xml/st" 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 ../om.xsd">
    <gml:description>Complex Observation test instance</gml:description>
    <gml:name>Complex Observation test 3</gml:name>
    <om:time>
        <gml:TimeInstant gml:id="ot1t">
            <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
        </gml:TimeInstant>
    </om:time>
    <om:location xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604"/>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:SEEGrid:weatherStation1"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:SEEGrid:weather1"/>
    <om:featureOfInterest xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604" xlink:role="urn:x-
seegrid:definition:featuretype:locality"/>
    <om:resultDefinition xlink:href="weatherRecordDefinition.xml"/>
    <om:result>
        <swe:Record>
            <swe:item>35.1</swe:item>
            <swe:item>6.5</swe:item>
            <swe:item>085.0</swe:item>
            <swe:item>950.</swe:item>
            <swe:item>32.0</swe:item>
            <swe:item>clear</swe:item>
        </swe:Record>
    </om:result>
</om:Observation>
```

The location of the observation and the feature of interest are 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 phenomenon definitions, shown in Listing 11. In both Listing 9 and Listing 10 the resultDefinition gives a link to a RecordDefinition, shown in Listing 12.

The document fragment shown in Listing 11 shows a phenomenon description composed of six elements, given as links to definitions identified by URN. The base phenomenon ("Weather") allows this specialized definition ("weather1") to be related to its parent, which may be used by some interfaces to allow discovery of related offerings.

Listing 11. Phenonena.xml#weather1

```
<swe:CompositePhenomenon gml:id="weather1" dimension="6">
    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)"
        >urn:x-ogc:def:phenomenon:SEEGrid:weather1</gml:name>
    <swe:base xlink:href="urn:x-ogc:def:phenomenon:OGC:Weather"/>
    <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:AirTemperature"/>
    <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:WindSpeed"/>
```

```
        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:WindDirection"/>
        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:AtmosphericPressure"/>
        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:Visibility"/>
</swe:CompositePhenomenon>
```

The document fragment shown in Listing 12 shows a record schema that defines the structure of the record in the observation result in Listing 9 and Listing 10.

Listing 12. weatherRecordDefinition.xml

```
<swe:RecordDefinition gml:id="weather1" recordLength="6"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
xmlns:swe="http://www.opengis.net/swe"
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/swe ../recordSchema.xsd">
        <gml:name>Weather 1</gml:name>
        <swe:component>
                <swe:ItemDefinition gml:id="at1">
                        <gml:name>Air Temperature</gml:name>
                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:AirTemperature"/>
                        <swe:representation>
                                <swe:SimpleType>
                                        <xst:restriction base="xst:decimal"/>
                                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:degC"/>
                                </swe:SimpleType>
                        </swe:representation>
                </swe:ItemDefinition>
        </swe:component>
        <swe:component>
                <swe:ItemDefinition gml:id="ws1">
                        <gml:name>Wind Speed</gml:name>
                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:WindSpeed"/>
                        <swe:representation>
                                <swe:SimpleType>
                                        <xst:restriction base="xst:decimal">
                                                <xst:minInclusive value="0.0"/>
                                        </xst:restriction>
                                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:m_s"/>
                                </swe:SimpleType>
                        </swe:representation>
                </swe:ItemDefinition>
        </swe:component>
        <swe:component>
                <swe:ItemDefinition gml:id="wd1">
                        <gml:name>Wind Direction</gml:name>
                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:WindDirection"/>
                        <swe:representation>
                                <swe:SimpleType>
                                        <xst:restriction base="xst:decimal">
                                                <xst:minInclusive value="0.0"/>
                                                <xst:maxExclusive value="360.0"/>
                                        </xst:restriction>
                                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:deg"/>
                                        <swe:frame xlink:href="http://sweet.jpl.nasa.gov/ontology/space.owl#North"/>
                                </swe:SimpleType>
                        </swe:representation>
                </swe:ItemDefinition>
        </swe:component>
        <swe:component>
                <swe:ItemDefinition gml:id="ap1">
                        <gml:name>Atmospheric Pressure</gml:name>
                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:AtmosphericPressure"/>
                        <swe:representation>
```

```
                    <swe:SimpleType>
                        <xst:restriction base="xst:decimal">
                            <xst:minInclusive value="0.0"/>
                        </xst:restriction>
                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:hPa"/>
                    </swe:SimpleType>
                </swe:representation>
            </swe:ItemDefinition>
        </swe:component>
        <swe:component>
            <swe:ItemDefinition gml:id="rh1">
                <gml:name>Relative Humidity</gml:name>
                <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
                <swe:representation>
                    <swe:SimpleType>
                        <xst:restriction base="xst:decimal">
                            <xst:minInclusive value="0.0"/>
                            <xst:maxExclusive value="100.0"/>
                        </xst:restriction>
                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:percent"/>
                    </swe:SimpleType>
                </swe:representation>
            </swe:ItemDefinition>
        </swe:component>
        <swe:component>
            <swe:ItemDefinition gml:id="vi1">
                <gml:name>Visibility</gml:name>
                <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:Visibility"/>
                <swe:representation>
                    <swe:SimpleType>
                        <xst:restriction base="xst:string">
                            <xst:enumeration value="poor"/>
                            <xst:enumeration value="moderate"/>
                            <xst:enumeration value="good"/>
                        </xst:restriction>
                        <swe:classification xlink:href="urn:x-seegrid:definition:vocabulary:visibility"/>
                    </swe:SimpleType>
                </swe:representation>
            </swe:ItemDefinition>
        </swe:component>
    </swe:RecordDefinition>
```

In this example the schema is a RecordDefinition composed of six ordered components, each being an ItemDefinition. Each item binds a property definition to its representation. The representation binds an elementary data-type and a reference system, such as units of measure, frame or classification scheme. The syntax for describing the elementary datatype is taken from the W3C XML Schema representation of “simpleType” definitions, which includes the ability to constrain the value space with *facets* such as length, minimum and maximum values, patterns, encodings etc [W3C XML Schema, Part 2].

Finally, the commonObservation version of the encoding mandates use of an inline swe:DataDefinition [SensorML] as the record schema, as an alternative to the (inline or by-reference) swe:RecordDefinition shown in the previous examples. The example shown in Listing 13 is essentially the same as Listing 9 with this change.

Listing 13. commonObservation2.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CommonObservation gml:id="COMTest3"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
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/om ../om.xsd">
  <gml:description>Common Observation test instance</gml:description>
  <gml:name>Commmon Observation test 2</gml:name>
  <om:time>
    <gml:TimeInstant>
      <gml:timePosition>2005-01-11T17:22:25.00</gml:timePosition>
    </gml:TimeInstant>
  </om:time>
  <om:location xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604"/>
  <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:SEEGrid:weatherStation1"/>
  <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:SEEGrid:weather1"/>
  <om:featureOfInterest xlink:href="http://www.ga.gov.au/bin/gazd01?rec=293604" xlink:role="urn:x-
seegrid:definition:featuretype:locality"/>
  <om:resultDefinition>
    <swe:DataDefinition>
      <swe:dataComponents name="WeatherData">
        <swe:DataGroup>
          <swe:component name="AirTemperature">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:AirTemperature" uom="urn:x-
ogc:def:uom:OGC:degC"/>
          </swe:component>
          <swe:component name="WindSpeed">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:WindSpeed" uom="urn:x-
ogc:def:uom:OGC:m_s"/>
          </swe:component>
          <swe:component name="WindDirection">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:WindDirectionToNorth" uom="urn:x-
ogc:def:uom:OGC:deg"/>
          </swe:component>
          <swe:component name="AtmosphericPressure">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:AtmosphericPressure" uom="urn:x-
ogc:def:uom:OGC:hPa"/>
          </swe:component>
          <swe:component name="RelativeHumidity">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity" uom="urn:x-
ogc:def:uom:OGC:percent"/>
          </swe:component>
          <swe:component name="Visibility">
            <swe:Category definition="urn:x-ogc:def:phenomenon:OGC:Visibility"/>
          </swe:component>
        </swe:DataGroup>
      </swe:dataComponents>
      <swe:encoding>
        <swe:AsciiBlock tokenSeparator="&#x20;" tupleSeparator="&#x20;" decimalSeparator="."/>
      </swe:encoding>
    </swe:DataDefinition>
  </om:resultDefinition>
  <om:result>35.1 6.5 085.0 950.0 32.0 clear</om:result>
</om:CommonObservation>
```

The DataDefinition within Listing 13 accomplishes the same outcome as the RecordDefinition shown in Listing 12, binding semantics (the value of the *definition* attribute) to a representation (the name of the component child element – i.e. *Quantity*, *Category*) and a scale (the value of the *uom* attribute).

7.3.3.3 Compound feature of interest

In this example, the result of the observation is complex because the feature of interest is composed of multiple elements.

NOTE: Observations in this group describe the acquisition of data corresponding to a *coverage* [ISO 19136] whose domain is the set of feature elements, and whose range is the observation result

The documents shown in Listing 14, Listing 15 and Listing 16 describe an observation of panchromatic radiance where the feature of interest is a SiteCollection composed of four Stations. The value of the event location indicates that the sensor was being carried on a low altitude aircraft. The feature of interest is identified using a link to a description provided external to this document, shown in Listing 17.

In Listing 14 and Listing 15 the observation is encoded using the generic Observation. In Listing 14 the type of the result is indicated by the value of the xsi:type attribute. Here this is gml:MeasureListType [ISO 19136] which is a white-space separated list of numbers all sharing the same units of measure, as indicated by the value of the uom attribute.

Listing 14. multiElement1.xml

```
<om:Observation gml:id="obsTest4"
xmlns:om="http://www.opengis.net/om"
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:gmd="http://www.isotc211.org/2005/gmd"
xmlns:gco="http://www.isotc211.org/2005/gco"
        xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
    <gml:description>Observation test instance - multi-element featureOfInterest
    This is the "observation" view including what is normally encoded as a "coverage"
     * coverage domain == observation featureOfInterest
     * coverage range == observation result
    </gml:description>
    <gml:name>Multi-element 1</gml:name>
    <om:time>
        <gml:TimeInstant gml:id="ots1t">
            <gml:timePosition>2005-06-17</gml:timePosition>
        </gml:TimeInstant>
    </om:time>
    <om:location>
        <gmd:EX_GeographicDescription>
            <gmd:geographicIdentifier>
                <gmd:MD_Identifier>
                    <gmd:code>
                        <gco:CharacterString>Low altitude aircraft</gco:CharacterString>
                    </gmd:code>
                </gmd:MD_Identifier>
            </gmd:geographicIdentifier>
        </gmd:EX_GeographicDescription>
    </om:location>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:xyz345"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Radiance"/>
    <om:featureOfInterest xlink:href="foi.xml#stc1"/>
    <om:result xsi:type="gml:MeasureListType" uom="urn:x-ogc:def:uom:OGC:uV">10.1 15.7 20.2 27.5</om:result>
</om:Observation>
```

In Listing 15 the same data is shown with the result XML encoded using the swe:Record structure (Listing 31).

Listing 15. multiElement2.xml

```
<om:Observation gml:id="multi2"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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:gmd="http://www.isotc211.org/2005/gmd"
xmlns:gco="http://www.isotc211.org/2005/gco"
            xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
      <gml:description>Observation test instance - multi-element featureOfInterest
      This is the "observation" view including what is normally encoded as a "coverage"
       * coverage domain == observation featureOfInterest
       * coverage range == observation result</gml:description>
      <gml:name>Multi-element 2</gml:name>
      <om:time>
            <gml:TimeInstant gml:id="ots1t">
                  <gml:timePosition>2005-06-17</gml:timePosition>
            </gml:TimeInstant>
      </om:time>
      <om:location>
            <gmd:EX_GeographicDescription>
                  <gmd:geographicIdentifier>
                        <gmd:MD_Identifier>
                              <gmd:code>
                                    <gco:CharacterString>Low altitude aircraft</gco:CharacterString>
                              </gmd:code>
                        </gmd:MD_Identifier>
                  </gmd:geographicIdentifier>
            </gmd:EX_GeographicDescription>
      </om:location>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:xyz345"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Radiance"/>
      <om:featureOfInterest xlink:href="foi.xml#stc1"/>
      <om:result>
            <swe:Record>
                  <swe:item xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:uV">10.1</swe:item>
                  <swe:item xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:uV">15.7</swe:item>
                  <swe:item xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:uV">20.2</swe:item>
                  <swe:item xsi:type="gml:MeasureType" uom="urn:x-ogc:def:uom:OGC:uV">27.5</swe:item>
            </swe:Record>
      </om:result>
</om:Observation>
```

In Listing 16 the same information is encoded as a CommonObservation, and the result is an array of 4 StationID/Radiance pairs. Values are given in a sequence following the data structure read from the inside. The sequence in this case will be:
[[StationID Radiance] [StationID Radiance] … x4]

Listing 16. commonObservation3.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CommonObservation gml:id="COMTest3"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
xmlns:gml="http://www.opengis.net/gml"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/om ../om.xsd">
      <gml:description>Common Observation Version of multiElement2.xml</gml:description>
      <gml:name>Multi-element 2</gml:name>
      <om:time>
            <gml:TimeInstant gml:id="ots1t">
                  <gml:timePosition>2005-06-17</gml:timePosition>
            </gml:TimeInstant>
      </om:time>
      <om:location>
            <gmd:EX_GeographicDescription>
                  <gmd:geographicIdentifier>
                        <gmd:MD_Identifier>
```

```
                        <gmd:code>
                            <gco:CharacterString>Low altitude aircraft</gco:CharacterString>
                        </gmd:code>
                    </gmd:MD_Identifier>
                </gmd:geographicIdentifier>
            </gmd:EX_GeographicDescription>
        </om:location>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:xyz345"/>
        <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Radiance"/>
        <om:featureOfInterest xlink:href="foi.xml#stc1"/>
        <om:resultDefinition>
            <swe:DataDefinition>
                <swe:dataComponents name="RadianceData">
                    <swe:DataArray arraySize="4">
                        <swe:component>
                            <swe:DataGroup>
                                <swe:component name="StationID">
                                    <swe:Category definition="foi.xml#stc1"/>
                                </swe:component>
                                <swe:component name="Radiance">
                                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:Radiance"
uom="urn:x-ogc:def:uom:OGC:uV"/>
                                </swe:component>
                            </swe:DataGroup>
                        </swe:component>
                    </swe:DataArray>
                </swe:dataComponents>
                <swe:encoding>
                    <swe:AsciiBlock tokenSeparator=" " tupleSeparator=" " decimalSeparator="."/>
                </swe:encoding>
            </swe:DataDefinition>
        </om:resultDefinition>
        <om:result>st1 10.1 st2 15.7 st3 20.2 st4 27.5</om:result>
</om:CommonObservation>
```

Note that it is also possible to remove the StationID from the data and assume that radiance values are given in the same order as individual stations in the station collection. The explicit version is though preferred.

The document fragment shown in Listing 17 describes the SamplingFeatureCollection which acts as the feature of interest for the observation shown in Listing 14.

Listing 17. foi.xml#stc1

```
<sa:SamplingFeatureCollection gml:id="stc1">
    <gml:boundedBy>
        <gml:Envelope srsName="urn:x-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:member>
        <sa:Station gml:id="st1">
            <sa:surveyDetails xlink:href="urn:x-ogc:def:nil:OGC:unknown"/>
            <sa:position>
                <gml:Point gml:id="st1p">
                    <gml:pos>-30.702 134.199</gml:pos>
                </gml:Point>
            </sa:position>
        </sa:Station>
    </sa:member>
    <sa:member>
        <sa:Station gml:id="st2">
            <sa:surveyDetails xlink:href="urn:x-ogc:def:nil:OGC:unknown"/>
            <sa:position>
```

```
                        <gml:Point gml:id="st2p">
                            <gml:pos>-30.692 134.199</gml:pos>
                        </gml:Point>
                    </sa:position>
                </sa:Station>
            </sa:member>
            <sa:member>
                <sa:Station gml:id="st3">
                    <sa:surveyDetails xlink:href="urn:x-ogc:def:nil:OGC:unknown"/>
                    <sa:position>
                        <gml:Point gml:id="st3p">
                            <gml:pos>-30.702 134.209</gml:pos>
                        </gml:Point>
                    </sa:position>
                </sa:Station>
            </sa:member>
            <sa:member>
                <sa:Station gml:id="st4">
                    <sa:surveyDetails xlink:href="urn:x-ogc:def:nil:OGC:unknown"/>
                    <sa:position>
                        <gml:Point gml:id="st4p">
                            <gml:pos>-30.692 134.209</gml:pos>
                        </gml:Point>
                    </sa:position>
                </sa:Station>
            </sa:member>
            <sa:surveyDetails xlink:href="urn:x-ogc:def:nil:OGC:unknown"/>
        </sa:SamplingFeatureCollection>
```

This feature type is from the namespace identified http://www.seegrid.csiro.au/xml/sampling, the model and schema for which is described in Annex 0. The details of that model are not important here, except for the essential feature that the collection is composed of four Station elements. The result of the compound observation supplies a value for each of these elements.

7.3.3.4 Time Series

In these examples, the result of the observation is a complex value because observations were made at multiple times.

NOTE: Observations in this group describe the acquisition of data corresponding to a *coverage* [ISO 19136] whose domain is the set of time elements, and whose range is the observation result

The documents shown in Listing 18, Listing 19, Listing 20 and Listing 21 describe an observation of rainfall at a station.

In Listing 18 and Listing 19 he observation time is a TimeAggregate, as defined in the model and schema shown in Annex A. This includes five TimePeriod members. The location of the observation and the feature of interest are each indicated through links to elements in the site collection shown in Listing 17. The observation is encoded using the generic Observation, so the type of the result is indicated by the value of the xsi:type attribute.

In Listing 18 this is gml:MeasureListType [ISO 19136] which is a white-space separated list of numbers all sharing the same units of measure, as indicated by the value of the uom attribute.

Listing 18. timeSeries2.xml

```
<om:Observation gml:id="timeSeries2"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
      <gml:description>Observation test instance - time series</gml:description>
      <gml:name>Time series 2</gml:name>
      <om:time>
            <swe:TimeAggregate gml:id="ta1">
                  <swe:member>
                        <gml:TimePeriod gml:id="tp1">
                              <gml:beginPosition>2005-06-17T09:00+08:00</gml:beginPosition>
                              <gml:endPosition>2005-06-18T09:00+08:00</gml:endPosition>
                              <gml:duration>PT24H</gml:duration>
                        </gml:TimePeriod>
                  </swe:member>
                  <swe:member>
                        <gml:TimePeriod gml:id="tp2">
                              <gml:beginPosition>2005-06-18T09:00+08:00</gml:beginPosition>
                              <gml:endPosition>2005-06-19T09:00+08:00</gml:endPosition>
                              <gml:duration>PT24H</gml:duration>
                        </gml:TimePeriod>
                  </swe:member>
                  <swe:member>
                        <gml:TimePeriod gml:id="tp3">
                              <gml:beginPosition>2005-06-19T09:00+08:00</gml:beginPosition>
                              <gml:endPosition>2005-06-20T09:00+08:00</gml:endPosition>
                              <gml:duration>PT24H</gml:duration>
                        </gml:TimePeriod>
                  </swe:member>
                  <swe:member>
                        <gml:TimePeriod gml:id="tp4">
                              <gml:beginPosition>2005-06-20T09:00+08:00</gml:beginPosition>
                              <gml:endPosition>2005-06-21T09:00+08:00</gml:endPosition>
                              <gml:duration>PT24H</gml:duration>
                        </gml:TimePeriod>
                  </swe:member>
                  <swe:member>
                        <gml:TimePeriod gml:id="tp5">
                              <gml:beginPosition>2005-06-21T09:00+08:00</gml:beginPosition>
                              <gml:endPosition>2005-06-22T09:00+08:00</gml:endPosition>
                              <gml:duration>PT24H</gml:duration>
                        </gml:TimePeriod>
                  </swe:member>
            </swe:TimeAggregate>
      </om:time>
      <om:location xlink:href="foi.xml#st1p"/>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:BOM:rg23"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Precipitation"/>
      <om:featureOfInterest xlink:href="foi.xml#st1"/>
      <om:result xsi:type="gml:MeasureListType" uom="mm">10.1 15.7 20.2 27.5 45.2</om:result>
</om:Observation>
```

In Listing 19 the same information is shown with the result XML encoded using the swe:Record structure (Listing 31).

Listing 19. timeSeries5.xml

```
<om:Observation gml:id="timeSeries2" xmlns:swe="http://www.opengis.net/swe" xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
      <gml:description>Observation test instance - time series</gml:description>
```

```
    <gml:name>Time series 2</gml:name>
    <om:time xlink:href="timeSeries2.xml#ta1"/>
    <om:location xlink:href="foi.xml#st1p"/>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:BOM:rg23"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Precipitation"/>
    <om:featureOfInterest xlink:href="foi.xml#st1"/>
    <om:result>
        <swe:Record>
            <swe:item xsi:type="gml:MeasureType" uom="mm">10.1</swe:item>
            <swe:item xsi:type="gml:MeasureType" uom="mm">15.7</swe:item>
            <swe:item xsi:type="gml:MeasureType" uom="mm">20.2</swe:item>
            <swe:item xsi:type="gml:MeasureType" uom="mm">27.5</swe:item>
            <swe:item xsi:type="gml:MeasureType" uom="mm">45.2</swe:item>
        </swe:Record>
    </om:result>
</om:Observation>
```

The document shown in Listing 20 shows the same information, except that the observation time is a TimeIntervalGrid, as defined in the model and schema shown in Annex A 1.1.5 and Listing 34. This schema follows the pattern for the definition of a spatial grid described in ISO 19123.

Listing 20. timeSeries1.xml

```
<om:Observation gml:id="timeSeries1"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
    <gml:description>Observation test instance - time series</gml:description>
    <gml:name>Time series 1</gml:name>
    <om:time>
        <swe:TimeIntervalGrid gml:id="ots1t">
            <swe:extent>
                <swe:SeriesEnvelope>
                    <swe:low>0</swe:low>
                    <swe:high>4</swe:high>
                </swe:SeriesEnvelope>
            </swe:extent>
            <swe:originPos>2005-06-17T09:00+08:00</swe:originPos>
            <swe:offsetDuration>PT24H</swe:offsetDuration>
            <swe:windowDuration>PT24H</swe:windowDuration>
        </swe:TimeIntervalGrid>
    </om:time>
    <om:location xlink:href="foi.xml#st1p"/>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:BOM:rg23"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Precipitation"/>
    <om:featureOfInterest xlink:href="http://my.big.org/feature?type=station%26name=st1"/>
    <om:result xsi:type="gml:MeasureListType" uom="mm">10.1 15.7 20.2 27.5 45.2</om:result>
</om:Observation>
```

In Listing 21 the same information is shown encoded as a CommonObservation. The result here includes time range values, so only the overall time period is given in the om:time. The data structure is now a list of begin time, end time and precipitation value. An extra DataGroup is used for the TimeRange in order to strictly define it using the URN “urn:x-ogc:def:phenomenon:OGC:TimePeriod”. A software is then able to understand that those two time values correspond to a time range. Data is encoded in an ASCII tuple of space separated values. The sequence of values:
[BeginTime EndTime Precipitation] [BeginTime EndTime Precipitation] … x5

Listing 21. commonObservation4.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CommonObservation gml:id="COMTest3"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
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/om ../om.xsd">
  <gml:description>Common Observation Version of multiElement2.xml</gml:description>
  <gml:name>Multi-element 2</gml:name>
  <om:time>
    <gml:TimePeriod gml:id="overallTp">
      <gml:beginPosition>2005-06-17T09:00+08:00</gml:beginPosition>
      <gml:endPosition>2005-06-22T09:00+08:00</gml:endPosition>
      <gml:duration>PT120H</gml:duration>
    </gml:TimePeriod>
  </om:time>
  <om:location xlink:href="foi.xml#st1p"/>
  <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:BOM:rg23"/>
  <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:Precipitation"/>
  <om:featureOfInterest xlink:href="foi.xml#st1"/>
  <om:resultDefinition>
    <swe:DataDefinition>
      <swe:dataComponents name="PrecipitationData">
        <swe:DataGroup>
          <swe:component name="TimeRange">
            <swe:DataGroup definition="urn:x-ogc:def:phenomenon:OGC:TimePeriod">
              <swe:component name="Begin">
                <swe:Time definition="urn:x-ogc:def:phenomenon:OGC:time:iso8601"/>
              </swe:component>
              <swe:component name="End">
                <swe:Time definition="urn:x-ogc:def:phenomenon:OGC:time:iso8601"/>
              </swe:component>
            </swe:DataGroup>
          </swe:component>
          <swe:component name="Precipitation">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:Precipitation" uom="urn:x-
ogc:def:uom:OGC:mm"/>
          </swe:component>
        </swe:DataGroup>
      </swe:dataComponents>
      <swe:encoding>
        <swe:AsciiBlock tokenSeparator="&#x20;" tupleSeparator="&#x20;" decimalSeparator="."/>
      </swe:encoding>
    </swe:DataDefinition>
  </om:resultDefinition>
  <om:result>
    2005-06-17T09:00+08:00 2005-06-18T09:00+08:00 10.1
    2005-06-18T09:00+08:00 2005-06-19T09:00+08:00 15.7
    2005-06-19T09:00+08:00 2005-06-20T09:00+08:00 20.2
    2005-06-20T09:00+08:00 2005-06-21T09:00+08:00 27.5
    2005-06-21T09:00+08:00 2005-06-22T09:00+08:00 45.2
  </om:result>
</om:CommonObservation>
```

7.3.3.5 Multiple compounding axes

In these examples, the result of the observation is a grid because observations were made at a sequence of times, on elements of a compound feature of interest, and concerning a compound phenomenon.

NOTE: Observations in this group describe the acquisition of data corresponding to a *coverage* [ISO 19136] whose domain is the set of feature elements over the set of time elements, and whose range is the observation result

The documents shown in Listing 22, Listing 23, Listing 25 and Listing 26 describe an observation of a (raw) radiance spectrum corresponding to the LandsatTM bands, made on four stations at three time instants.

I in Listing 22, Listing 23 and Listing 25 the observation is encoded as a ComplexMeasurement. The observation time is a TimeAggregate similar to that described in Listing 18 but composed of TimeInstants. The feature of interest is the SiteCollection described in Listing 17.

In Listing 22 the result is a list of items each corresponding to one atom of the result grid. As with the previous compound results, the items in the list are separated by white-space [W3C XML Schema].

Listing 22. spectrumSeries1.xml

```
<om:Observation gml:id="multiAxis1"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
xmlns:sa="http://www.seegrid.csiro.au/xml/sampling"
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 ../om.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:time xlink:href="toi.xml#ta1"/>
      <om:location xlink:href="foi.xml#stc1"/>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:Landsat7"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:DiscreteSpectrumTM"/>
      <om:featureOfInterest xlink:href="foi.xml#stc1"/>
      <om:resultDefinition>
            <swe:GridDefinition gml:id="ssd1" dimension="3">
                  <gml:description>This describes how to unpack an array and assign the atomic values to components of
a set of map vectors
      A Landsat TM spectrum is observed on 4 stations at 5 time instants</gml:description>
                  <gml:name>Spectrum Series Definition</gml:name>
                  <swe:map>
                        <swe:ObjectArray gml:id="et" arrayLength="3">
                              <gml:name>time</gml:name>
                              <swe:member xlink:href="toi.xml#ti1"/>
                              <swe:member xlink:href="toi.xml#ti3"/>
                              <swe:member xlink:href="toi.xml#ti5"/>
                        </swe:ObjectArray>
                  </swe:map>
                  <swe:map>
                        <swe:ObjectArray gml:id="tl" arrayLength="4">
                              <gml:name>location</gml:name>
                              <swe:member xlink:href="foi.xml#st11"/>
                              <swe:member xlink:href="foi.xml#st13"/>
                              <swe:member xlink:href="foi.xml#st12"/>
                              <swe:member xlink:href="foi.xml#st14"/>
                        </swe:ObjectArray>
                  </swe:map>
                  <swe:tupleMap xlink:href="tm7.xml#tm7"/>
            </swe:GridDefinition>
      </om:resultDefinition>
      <om:result xsi:type="swe:SWE_CompactNumericRecordType" RS="#ssd1">9 8 7 6 5 4 3
      1 2 3 4 5 6 7
```

```
      1 9 2 8 3 7 4
      5 6 3 7 2 8 1

      9 8 7 6 5 4 3
      1 2 3 4 5 6 7
      1 9 2 8 3 7 4
      5 6 3 7 2 8 1

      9 8 7 6 5 4 3
      1 2 3 4 5 6 7
      1 9 2 8 3 7 4
      5 6 3 7 2 8 1</om:result>
</om:Observation>
```

In Listing 23 the same data is shown with the result XML encoded using the swe:Array structure (Listing 31).

Listing 23. spectrumSeries3.xml

```
<om:Observation
gml:id="specSeries3"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.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:time xlink:href="toi.xml#ta1"/>
      <om:location xlink:href="foi.xml#stc1"/>
      <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:Landsat7"/>
      <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:DiscreteSpectrumTM"/>
      <om:featureOfInterest xlink:href="foi.xml#stc1"/>
      <om:resultDefinition xlink:href="specSeriesDef.xml#ssd1"/>
      <om:result>
            <swe:Array>
                  <swe:Array>
      <swe:Record><swe:item>9</swe:item><swe:item>8</swe:item><swe:item>7</swe:item><swe:item>6</swe:item><
swe:item>5</swe:item><swe:item>4</swe:item><swe:item>3</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>2</swe:item><swe:item>3</swe:item><swe:item>4</swe:item><
swe:item>5</swe:item><swe:item>6</swe:item><swe:item>7</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>9</swe:item><swe:item>2</swe:item><swe:item>8</swe:item><
swe:item>3</swe:item><swe:item>7</swe:item><swe:item>4</swe:item></swe:Record>
      <swe:Record><swe:item>5</swe:item><swe:item>6</swe:item><swe:item>3</swe:item><swe:item>7</swe:item><
swe:item>2</swe:item><swe:item>8</swe:item><swe:item>1</swe:item></swe:Record>
                  </swe:Array>
                  <swe:Array>
      <swe:Record><swe:item>9</swe:item><swe:item>8</swe:item><swe:item>7</swe:item><swe:item>6</swe:item><
swe:item>5</swe:item><swe:item>4</swe:item><swe:item>3</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>2</swe:item><swe:item>3</swe:item><swe:item>4</swe:item><
swe:item>5</swe:item><swe:item>6</swe:item><swe:item>7</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>9</swe:item><swe:item>2</swe:item><swe:item>8</swe:item><
swe:item>3</swe:item><swe:item>7</swe:item><swe:item>4</swe:item></swe:Record>
      <swe:Record><swe:item>5</swe:item><swe:item>6</swe:item><swe:item>3</swe:item><swe:item>7</swe:item><
swe:item>2</swe:item><swe:item>8</swe:item><swe:item>1</swe:item></swe:Record>
                  </swe:Array>
                  <swe:Array>
      <swe:Record><swe:item>9</swe:item><swe:item>8</swe:item><swe:item>7</swe:item><swe:item>6</swe:item><
swe:item>5</swe:item><swe:item>4</swe:item><swe:item>3</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>2</swe:item><swe:item>3</swe:item><swe:item>4</swe:item><
swe:item>5</swe:item><swe:item>6</swe:item><swe:item>7</swe:item></swe:Record>
      <swe:Record><swe:item>1</swe:item><swe:item>9</swe:item><swe:item>2</swe:item><swe:item>8</swe:item><
swe:item>3</swe:item><swe:item>7</swe:item><swe:item>4</swe:item></swe:Record>
```

```
        <swe:Record><swe:item>5</swe:item><swe:item>6</swe:item><swe:item>3</swe:item><swe:item>7</swe:item><
swe:item>2</swe:item><swe:item>8</swe:item><swe:item>1</swe:item></swe:Record>
                    </swe:Array>
                </swe:Array>
        </om:result>
</om:Observation>
```

However, in order to associate each item in the list with the correct observation time, feature-of-interest element, and property component, the record schema must provide a mapping that describes the sequence iteration order.

Within a ComplexObservation, the record schema is described or identified by the resultDefinition. The resultDefinition appears above the observation result to assist streaming processors to parse the result as it arrives. In the case of multiple compounding axes, the record schema should be a GridDefinition or equivalent. This describes the order of the items in the result as an ordered set of maps, each describing an axis.

The values of the first two maps are each an ObjectArray containing an ordered list of members, each carrying a link to an object defined elsewhere. The first array ("time") selects three times from a TimeAggregate. The second array ("location") selects the four Stations from the site collection shown in Listing 17. Note, however, that this time the station order is modified from the sequence in the original site collection. Finally, the value of the tupleMap is simply a link to the record schema shown in Listing 24.

NOTE: This model for the description of a grid in terms a set of maps is inspired by the OPeNDAP XML implementation – see http://www.opendap.org/support/docs.html.

To clarify the mapping of the result to the observation domain, additional linefeeds appear within the result in Listing 22. These break the result into three blocks of four rows of seven items, mapping to the time, location, and property-components, respectively, as indicated in the GridDefinition. For example, the 24th item in the list is the radiance value in the 3rd band on the 1st station at the 2nd sampling instant.

The document shown in Listing 24 describes the details of the representation of the value of the observed property, as a RecordDefinition. This data structure was described in conjunction with Listing 12.

Listing 24. tm7.xml

```
<swe:RecordDefinition gml:id="tm7" recordLength="7"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
xmlns:swe="http://www.opengis.net/swe"
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/swe ../recordSchema.xsd">
    <gml:name>Thematic mapper raw counts</gml:name>
    <swe:component>
        <swe:ItemDefinition gml:id="TM1">
            <gml:name>Thematic Mapper band 1</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand1"/>
            <swe:representation>
                <swe:SimpleType>
                    <xst:restriction base="xst:integer">
                        <xst:minInclusive value="0"/>
                        <xst:maxInclusive value="255"/>
```

```
                    </xst:restriction>
                    <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                </swe:SimpleType>
            </swe:representation>
        </swe:ItemDefinition>
    </swe:component>
    <swe:component>
        <swe:ItemDefinition gml:id="TM2">
            <gml:name>Thematic Mapper band 2</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand2"/>
            <swe:representation>
                <swe:SimpleType>
                    <xst:restriction base="xst:integer">
                        <xst:minInclusive value="0"/>
                        <xst:maxInclusive value="255"/>
                    </xst:restriction>
                    <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                </swe:SimpleType>
            </swe:representation>
        </swe:ItemDefinition>
    </swe:component>
    <swe:component>
        <swe:ItemDefinition gml:id="TM3">
            <gml:name>Thematic Mapper band 3</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand3"/>
            <swe:representation>
                <swe:SimpleType>
                    <xst:restriction base="xst:integer">
                        <xst:minInclusive value="0"/>
                        <xst:maxInclusive value="255"/>
                    </xst:restriction>
                    <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                </swe:SimpleType>
            </swe:representation>
        </swe:ItemDefinition>
    </swe:component>
    <swe:component>
        <swe:ItemDefinition gml:id="TM4">
            <gml:name>Thematic Mapper band 4</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand4"/>
            <swe:representation>
                <swe:SimpleType>
                    <xst:restriction base="xst:integer">
                        <xst:minInclusive value="0"/>
                        <xst:maxInclusive value="255"/>
                    </xst:restriction>
                    <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                </swe:SimpleType>
            </swe:representation>
        </swe:ItemDefinition>
    </swe:component>
    <swe:component>
        <swe:ItemDefinition gml:id="TM5">
            <gml:name>Thematic Mapper band 5</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand5"/>
            <swe:representation>
                <swe:SimpleType>
                    <xst:restriction base="xst:integer">
                        <xst:minInclusive value="0"/>
                        <xst:maxInclusive value="255"/>
                    </xst:restriction>
                    <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                </swe:SimpleType>
            </swe:representation>
        </swe:ItemDefinition>
    </swe:component>
    <swe:component>
        <swe:ItemDefinition gml:id="TM6">
            <gml:name>Thematic Mapper band 6</gml:name>
            <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand6"/>
            <swe:representation>
```

```
                        <swe:SimpleType>
                            <xst:restriction base="xst:integer">
                                <xst:minInclusive value="0"/>
                                <xst:maxInclusive value="255"/>
                            </xst:restriction>
                            <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                        </swe:SimpleType>
                    </swe:representation>
                </swe:ItemDefinition>
            </swe:component>
            <swe:component>
                <swe:ItemDefinition gml:id="TM7">
                    <gml:name>Thematic Mapper band 7</gml:name>
                    <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TMBand7"/>
                    <swe:representation>
                        <swe:SimpleType>
                            <xst:restriction base="xst:integer">
                                <xst:minInclusive value="0"/>
                                <xst:maxInclusive value="255"/>
                            </xst:restriction>
                            <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:count"/>
                        </swe:SimpleType>
                    </swe:representation>
                </swe:ItemDefinition>
            </swe:component>
        </swe:RecordDefinition>
```

The document shown in Listing 25 is essentially the same as shown in Listing 22, this time with the link to the record schema given as the value of the RS attribute on the result element.

Listing 25. spectrumSeries2.xml.xml

```
<om:Observation gml:id="multiAxis2"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.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:time xlink:href="toi.xml#ta1"/>
    <om:location xlink:href="foi.xml#stc1"/>
    <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:Landsat7"/>
    <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:DiscreteSpectrumTM"/>
    <om:featureOfInterest xlink:href="foi.xml#stc1"/>
    <om:result xsi:type="swe:SWE_CompactNumericRecordType" RS="specSeriesDef.xml#ssd1">9 8 7 6 5 4 3
    1 2 3 4 5 6 7
    1 9 2 8 3 7 4
    5 6 3 7 2 8 1

    9 8 7 6 5 4 3
    1 2 3 4 5 6 7
    1 9 2 8 3 7 4
    5 6 3 7 2 8 1

    9 8 7 6 5 4 3
    1 2 3 4 5 6 7
    1 9 2 8 3 7 4
    5 6 3 7 2 8 1</om:result>
</om:Observation>
```

In Listing 26 the same information is shown encoded as a CommonObservation. In this more complex example, results need to be related to both a feature of interest (indicated by a StationID) and a time of interest. The data structure shown is a tuple of this form:
[Time [StationID TM1 TM2 TM3 TM4 TM5 TM6 TM7]
[StationID TM1 TM2 TM3 TM4 TM5 TM6 TM7] … x4]

This is specified in the resultDefinition using a DataGroup containing a time value and an array of size 4. The array itself contains a group of 8 components: the Station ID and 7 TM measurements. The data contains values of 3 tuples of the type specified above.

Listing 26. commonObservation5.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CommonObservation gml:id="COMTest3"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
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/om ../om.xsd">
  <gml:description>Observation test instance - Multiple compounding axes
    A Landsat TM spectrum is observed on 4 stations at 3 time instants</gml:description>
  <gml:name>Spectrum Series</gml:name>
  <om:time xlink:href="toi.xml#ta1"/>
  <om:location xlink:href="foi.xml#stc1"/>
  <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:NASA:Landsat7"/>
  <om:observedProperty xlink:href="urn:x-ogc:def:phenomenon:OGC:DiscreteSpectrumTM"/>
  <om:featureOfInterest xlink:href="foi.xml#stc1"/>
  <om:resultDefinition>
    <swe:DataDefinition>
      <swe:dataComponents name="LandsatData">
        <swe:DataGroup>
          <swe:component name="Time">
            <swe:Time definition="urn:x-ogc:def:phenomenon:OGC:time:iso8601"/>
          </swe:component>
          <swe:component name="MeasurementSeries">
            <swe:DataArray arraySize="4">
              <swe:component>
                <swe:DataGroup>
                  <swe:component name="StationID">
                    <swe:Category definition="foi.xml#stc1"/>
                  </swe:component>
                  <swe:component name="TMBand1">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand1" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                  </swe:component>
                  <swe:component name="TMBand2">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand2" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                  </swe:component>
                  <swe:component name="TMBand3">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand3" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                  </swe:component>
                  <swe:component name="TMBand4">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand4" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                  </swe:component>
                  <swe:component name="TMBand5">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand5" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                  </swe:component>
                  <swe:component name="TMBand6">
                    <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand6" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
```

```
                    </swe:component>
                    <swe:component name="TMBand7">
                      <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:TMBand7" uom="urn:x-
ogc:def:uom:OGC:count" min="0" max="255"/>
                    </swe:component>
                  </swe:DataGroup>
                </swe:component>
              </swe:DataArray>
            </swe:component>
          </swe:DataGroup>
        </swe:dataComponents>
        <swe:encoding>
          <swe:AsciiBlock tokenSeparator="&#x20;" tupleSeparator="&#x20;" decimalSeparator="."/>
        </swe:encoding>
      </swe:DataDefinition>
    </om:resultDefinition>
    <om:result>
      2005-06-17T09:00+08:00
      st1 9 8 7 6 5 4 3
      st2 1 2 3 4 5 6 7
      st3 1 9 2 8 3 7 4
      st4 5 6 3 7 2 8 1
      2005-06-18T09:00+08:00
      st1 9 8 7 6 5 4 3
      st2 1 2 3 4 5 6 7
      st3 1 9 2 8 3 7 4
      st4 5 6 3 7 2 8 1
      2005-06-19T09:00+08:00
      st1 9 8 7 6 5 4 3
      st2 1 2 3 4 5 6 7
      st3 1 9 2 8 3 7 4
      st4 5 6 3 7 2 8 1
    </om:result>
</om:CommonObservation>
```

The documents shown in Listing 27, Listing 28 and Listing 29 describe an observation of Relative Humidity at an observation station, at a series of time instants, shown in this example as part of the result stream. These examples follow Listing 5 in part, but with the result inline rather than as an out-of-band link. Furthermore, the observation time is an explicit component of each result, so the observed property is a CompositePhenomenon whose components are time position and RH.

In Listing 27 and Listing 28 the value of the resultDefinition is a GridDefinition. This has two maps: the IndexMap has arrayLength=“unbounded” indicating that the result is composed of an unspecified number of “rows” (not tied to real objects), then the RecordDefinition describes the details of the result tuple structure, following the pattern described for Listing 12 and Listing 24.

In Listing 27 the result is a list in which the first 14 items are shown, interleaving observed time and observed RH as specified by the GridDefinition.

Listing 27. timeSeries3.xml

```
<om:Observation gml:id="TStest3"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
      <gml:description>Time Series with explicit times</gml:description>
```

```
        <gml:name>Time Series 3</gml:name>
        <om:time>
                <gml:TimePeriod gml:id="op1t">
                        <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
                        <gml:endPosition indeterminatePosition="after">2005-01-11T17:22:25.00</gml:endPosition>
                </gml:TimePeriod>
        </om:time>
        <om:location>
                <gml:Point gml:id="op1p">
                        <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836413">-30.7025065 134.1997256 -50.2</gml:pos>
                </gml:Point>
        </om:location>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:3eti:abc45"/>
        <om:observedProperty>
                <swe:CompositePhenomenon gml:id="t_rh" dimension="2">
                        <gml:name>time and RH</gml:name>
                        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:TimePosition"/>
                        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
                </swe:CompositePhenomenon>
        </om:observedProperty>
        <om:featureOfInterest xlink:href="http://my.modest.org/wfs%26request=getFeature%26id=789002"
xlink:role="urn:seegrid:definition:featuretype:station"/>
        <om:resultDefinition>
                <swe:GridDefinition gml:id="ts3g" dimension="2">
                        <gml:description>This describes how to unpack an array and assign the atomic values to components of
a set of map vectors
        A RH measurement at a series of time instants</gml:description>
                        <gml:name>RH Series Definition</gml:name>
                        <swe:map>
                                <swe:IndexArray gml:id="ti" arrayLength="unbounded">
                                        <gml:name>observation time</gml:name>
                                </swe:IndexArray>
                        </swe:map>
                        <swe:tupleMap>
                                <swe:RecordDefinition gml:id="t_rh_record" recordLength="2">
                                        <gml:name>time and RH</gml:name>
                                        <swe:component>
                                                <swe:ItemDefinition gml:id="time">
                                                        <gml:name>Time Position</gml:name>
                                                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:TimePosition"/>
                                                        <swe:representation>
                                                                <swe:SimpleType>
                                                                        <xst:restriction base="xst:dateTime"/>
                                                                        <swe:frame xlink:href="ISO:8601"/>
                                                                </swe:SimpleType>
                                                        </swe:representation>
                                                </swe:ItemDefinition>
                                        </swe:component>
                                        <swe:component>
                                                <swe:ItemDefinition gml:id="RH">
                                                        <gml:name>Relative Humidity</gml:name>
                                                        <swe:property xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
                                                        <swe:representation>
                                                                <swe:SimpleType>
                                                                        <xst:restriction base="xst:decimal">
                                                                                <xst:minInclusive value="0.0"/>
                                                                                <xst:maxInclusive value="100.0"/>
                                                                        </xst:restriction>
                                                                        <gml:unitOfMeasure uom="urn:x-ogc:def:uom:OGC:percent"/>
                                                                </swe:SimpleType>
                                                        </swe:representation>
                                                </swe:ItemDefinition>
                                        </swe:component>
                                </swe:RecordDefinition>
                        </swe:tupleMap>
                </swe:GridDefinition>
        </om:resultDefinition>
        <om:result xsi:type="swe:SWE_CompactRecordType" RS="#ts3g">2005-01-11T17:22:25.00 15.5
        2005-01-11T17:30:15.00 17.0
        2005-01-11T17:43:10.00 30.1
        2005-01-11T17:54:35.00 45.0
```

```
        2005-01-11T18:07:25.00 70.0
        2005-01-11T18:11:05.00 65.0
        2005-01-11T18:22:25.00 60.3
        ...
        </om:result>
</om:Observation>
```

In Listing 28 the result is shown XML encoded as a swe:Array (Listing 31).

Listing 28. timeSeries4.xml

```
<om:Observation gml:id="TStest4"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
xmlns:swe="http://www.opengis.net/swe"
xmlns:om="http://www.opengis.net/om"
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 ../om.xsd">
        <gml:description>Time Series with explicit times</gml:description>
        <gml:name>Time Series 4</gml:name>
        <om:time>
                <gml:TimePeriod gml:id="op1t">
                        <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
                        <gml:endPosition indeterminatePosition="after">2005-01-11T17:22:25.00</gml:endPosition>
                </gml:TimePeriod>
        </om:time>
        <om:location>
                <gml:Point gml:id="op1p">
                        <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836413">-30.7025065 134.1997256 -50.2</gml:pos>
                </gml:Point>
        </om:location>
        <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:3eti:abc45"/>
        <om:observedProperty>
                <swe:CompositePhenomenon gml:id="t_rh" dimension="2">
                        <gml:name>time and RH</gml:name>
                        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:TimePosition"/>
                        <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
                </swe:CompositePhenomenon>
        </om:observedProperty>
        <om:featureOfInterest xlink:href="http://my.modest.org/wfs%26request=getFeature%26id=789002"
xlink:role="urn:seegrid:definition:featuretype:station"/>
        <om:resultDefinition xlink:href="timeSeries3.xml#ts3g"/>
        <om:result>
                <swe:Array>
                <swe:Record><swe:item>2005-01-11T17:22:25.00</swe:item><swe:item>15.5</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T17:30:15.00</swe:item><swe:item>17.0</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T17:43:10.00</swe:item><swe:item>30.1</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T17:54:35.00</swe:item><swe:item>45.0</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T18:07:25.00</swe:item><swe:item>70.0</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T18:11:05.00</swe:item><swe:item>65.0</swe:item></swe:Record>
                <swe:Record><swe:item>2005-01-11T18:22:25.00</swe:item><swe:item>60.3</swe:item></swe:Record>
                </swe:Array>
        </om:result>
</om:Observation>
```

Listing 29 follows Listing 27 but with the resultDefinition containing a swe:DataDefinition. Note that in a CommonObservation, time is conventionally embedded in the result. The data structure of this example is simple: it is just a list of Time / RelativeHumidity pairs. The encoding is an ASCIIBlock with space separated values.

Listing 29. commonObservation6.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<om:CommonObservation gml:id="COMTest3"
xmlns:om="http://www.opengis.net/om"
xmlns:swe="http://www.opengis.net/swe"
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/om ../om.xsd">
  <gml:description>Time Series with explicit times</gml:description>
  <gml:name>Time Series 3</gml:name>
  <om:time>
    <gml:TimePeriod gml:id="op1t">
      <gml:beginPosition>2005-01-11T17:22:25.00</gml:beginPosition>
      <gml:endPosition indeterminatePosition="after">2005-01-11T17:22:25.00</gml:endPosition>
    </gml:TimePeriod>
  </om:time>
  <om:location>
    <gml:Point gml:id="op1p">
      <gml:pos srsName="urn:ogc:def:crs:EPSG:6.3:62836413">-30.7025065 134.1997256 -50.2</gml:pos>
    </gml:Point>
  </om:location>
  <om:procedure xlink:href="urn:x-ogc:object:feature:Sensor:3eti:abc45"/>
  <om:observedProperty>
    <swe:CompositePhenomenon gml:id="t_rh" dimension="2">
      <gml:name>time and RH</gml:name>
      <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:TimePosition"/>
      <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
    </swe:CompositePhenomenon>
  </om:observedProperty>
  <om:featureOfInterest xlink:href="http://my.modest.org/wfs%26request=getFeature%26id=789002"
xlink:role="urn:seegrid:definition:featuretype:station"/>
  <om:resultDefinition>
    <swe:DataDefinition>
      <swe:dataComponents name="HumidityData">
        <swe:DataGroup>
          <swe:component name="Time">
            <swe:Time definition="urn:x-ogc:def:phenomenon:time:iso8601"/>
          </swe:component>
          <swe:component name="RelativeHumidity">
            <swe:Quantity definition="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity" uom="urn:x-
ogc:def:uom:OGC:percent"/>
          </swe:component>
        </swe:DataGroup>
      </swe:dataComponents>
      <swe:encoding>
        <swe:AsciiBlock tokenSeparator="&#x20;" tupleSeparator="&#x20;" decimalSeparator="."/>
      </swe:encoding>
    </swe:DataDefinition>
  </om:resultDefinition>
  <om:result>
    2005-01-11T17:30:15.00 17.0
    2005-01-11T17:43:10.00 30.1
    2005-01-11T17:54:35.00 45.0
    2005-01-11T18:07:25.00 70.0
    2005-01-11T18:11:05.00 65.0
    2005-01-11T18:22:25.00 60.3
  </om:result>
</om:CommonObservation>
```

8 Discussion

8.1 Features, coverages and observations – different views of information

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

Typical concrete feature types have names like "road", "watercourse", "mine", "specimen", etc. The properties of these types usually have single values, which are constant on the feature. For a road this may include its name, its classification, the curve describing its centreline, the number of lanes, etc. The complete description of a road, 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 concern of the coverage viewpoint is the distribution of the values of a property within the 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). Hence, the coverage might be considered the general case, with classic single-valued properties being the special case.

Observations provide a third viewpoint, which focusses on the data collection event. An Observation event serves to assign a value to a property of a feature, or to elements of a domain. 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 feature set. The other properties of the Observation are effectively metadata concerning the assignment 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, so the value may be thought of as an "estimate". 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.

In the model presented here, observations are modelled as a specialization of event, which is a kind of feature. Similarly, the model in ISO 19123 shows coverage as an instantiation of feature type. So the generalization "feature" strictly includes both observations and coverages. Nevertheless, in the remainder of the discussion here the terms feature and feature type will refer to the "object-centric" viewpoint, in which feature instances are discrete objects described using a set of properties with constant values. Coverages provide the "property-centric" viewpoint. Observations provide the "event-centric" viewpoint.

This is illustrated in Figure 6, 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 potential representation of a 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 often be the result of an observation.

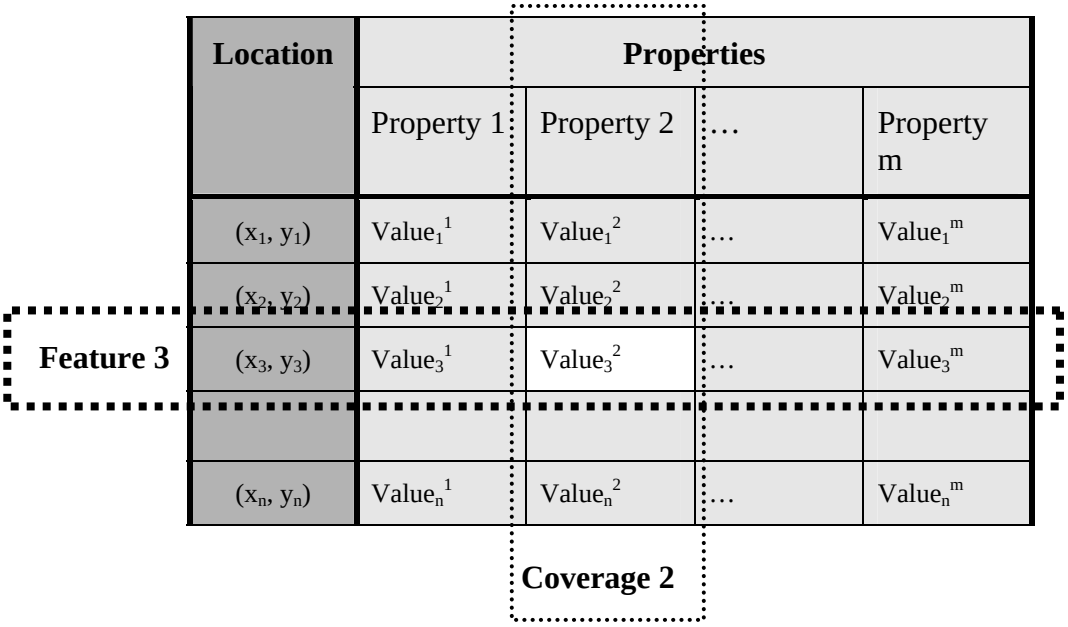

Figure 6. Tabular representation of information associated with a set of locations.

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.

For example, a composite phenomenon may be defined that includes the complete set of properties characterizing a feature type. In which case the result of a complex observation

will essentially provide the description of the corresponding *feature* instance, the other observation properties adding the metadata describing its capture (follow the patterns shown in clause 7.3.3.2 and Listing 9).

The result of an observation made on a compound features, or at multiple times, corresponds with a *coverage* describing the variation of the observed property over a domain defined by the spatio-temporal characteristics of those feature and time elements (clauses Listing 13, 7.3.3.4, 7.3.3.5). The GridDefinition structure shown in 7.3.3.5 includes both the range description and an explicit representation of the mapping or sequence rule from the domain to the range value.

Observations, Coverage and Feature representations are often associated with different phases of the data-processing cycle:

- 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;

- The coverage view is 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.

8.2 Semantics vs process

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 *property* being (1) explicit classifiers for an observationOffering in the capabilities description (for discovery), and (2) explicit parameters in the GetObservation request. From a user point of view, the sensor or procedure description is primarily *metadata*, of lower importance than the primary classifiers, providing the processing model and parameters, information related to quality assessment, and refinement of the semantics of the observed property definition.

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 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 narrow technical communities, specialist knowledge of sensor systems cannot be assumed to be routinely available within the broader set of potential users of sensor data, particularly as this is made more widely available through interfaces like SOS.

8.3 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 more 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 provides the length of the column, and a theory of thermal expansion plus a calibration etc 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 - 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.

8.4 Further specialization

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”. “AssayProcedure” may be derived from ObservationProcedure by constraining the vocabulary from which the “method” may be taken.

Annex A
(normative)

XML Schemas for Observations

A 1 Utility Schemas

A 1.1 SWE Common schemas

A set of schemas describe components used in several SWE encodings. These are in the namespace http://www.opengis.net/swe

A 1.1.1 Basic types

Listing 30. SWE_basicTypes.xsd

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

Some basic types (simpleContent) required in various places in OWS Sensor Web application schemas

Copyright © 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</documentation>
	</annotation>
	<!-- ========================================================================== -->
	<!-- ===== SimpleContent types ====== -->
	<!-- ========================================================================== -->
	<!-- ========================================================================== -->
	<!-- ===== some basic list types ====== -->
	<!-- ========================================================================== -->
	<simpleType name="refList">
		<list itemType="anyURI"/>
	</simpleType>
	<!-- ========================================================================== -->
	<simpleType name="nonNegativeIntegerList">
		<list itemType="nonNegativeInteger"/>
	</simpleType>
	<!-- ========================================================================== -->
	<simpleType name="doubleList">
		<list itemType="double"/>
	</simpleType>
	<!-- ========================================================================== -->
	<simpleType name="stringList">
		<annotation>
			<documentation>When appearing in a list context, internal whitespace is interpreted as an item
separator.
Strings may be represented in a list by escaping spaces as a (non-breaking space) entity.</documentation>
		</annotation>
		<list itemType="string"/>
	</simpleType>
	<!-- ========================================================================== -->
	<!-- ========================================================================== -->
	<simpleType name="UomIdentifier">
		<union memberTypes="swe:UomSymbol swe:UomURI"/>
	</simpleType>
```

```
    <simpleType name="UomSymbol">
        <restriction base="string">
            <pattern value="[^: \n\r\t]+"/>
        </restriction>
    </simpleType>
    <simpleType name="UomURI">
        <restriction base="anyURI">
            <pattern value="([a-zA-Z][a-zA-Z0-9\-\+\.]*:|\.\./|\./|#).*"/>
        </restriction>
    </simpleType>
    <!-- ========================================================================== -->
    <!-- ===== Numeric Records and tables ====== -->
    <!-- ========================================================================== -->
    <complexType name="SWE_CompactNumericRecordType">
        <annotation>
            <documentation>A set of numeric values, representing a list of Records or a table.
            A single record is a list with just one member.
    Generalises the approach used for gml:DirectPositionType, replacing "srsName" with "RS" (record schema).
    This allows a table of values to be recorded in compact form, as a whitespace-separated list of doubles.

        In general, Record components increment fastest, followed by Record instances, so if you think of this as a table in
which the rows are Records, then the representation is left-to-right followed by down the table.

    To assist direct inspection of the data, good practice is to use
      * linefeed between Records, and
      * tab between components in a Record.
    However any whitespace character sequence is a valid separator between items.</documentation>
        </annotation>
        <simpleContent>
            <extension base="swe:doubleList">
                <attribute name="RS" type="anyURI" use="optional">
                    <annotation>
                        <documentation>Pointer to record definition or schema.
        The RS description should indicate the semantics/label and units of measure for each component,
        and the order in which the components appear in the Record.
        RS may be omitted, in which case it is the same as the previous value in the current context or
document.</documentation>
                    </annotation>
                </attribute>
                <attribute name="recordLength" type="positiveInteger" use="optional">
                    <annotation>
                        <documentation>The number of components in the Record. Should this be
mandatory?</documentation>
                    </annotation>
                </attribute>
                <attribute name="recordCount" type="nonNegativeInteger" use="optional" default="1">
                    <annotation>
                        <documentation>The number of Records in the list.</documentation>
                    </annotation>
                </attribute>
            </extension>
            <!--
                <attributeGroup ref="gml:SRSInformationGroup">
                    <annotation>
                        <documentation>Optionally include the axis-names and axis-labels as
lists</documentation>
                    </annotation>
                </attributeGroup>
                -->
        </simpleContent>
    </complexType>
    <!-- ========================================================================== -->
    <!-- ========================================================================== -->
    <!-- ===== General Records and tables ====== -->
    <!-- ========================================================================== -->
    <complexType name="SWE_CompactRecordType">
        <annotation>
            <documentation>A set of values, representing a Record.
    Generalises the approach used for swe:NumericRecordType.
    This allows a Record to be recorded in compact form, as a list of tokens.
```

```
    Note that XML "token" may contain embedded single spaces, so item separators should be tabs, linefeeds, or two or more consecutive spaces.</documentation>
                </annotation>
                <simpleContent>
                    <extension base="swe:stringList">
                        <attribute name="RS" type="anyURI" use="optional">
                            <annotation>
                                <documentation>Pointer to definition of the reference system for the Record.
        The RS description should indicate the semantics/label and
        units of measure or value-space (if appropriate) for each component,
        and the order in which the components appear in the Record.
        RS may be omitted, in which case it is the same as the previous value in the current context or document.</documentation>
                            </annotation>
                        </attribute>
                        <attribute name="recordLength" type="positiveInteger" use="optional">
                            <annotation>
                                <documentation>The number of components in the Record. Should this be mandatory?</documentation>
                            </annotation>
                        </attribute>
                        <attribute name="recordCount" type="nonNegativeInteger" use="optional" default="1">
                            <annotation>
                                <documentation>The number of Records in the list.</documentation>
                            </annotation>
                        </attribute>
                    </extension>
                    <!--
                        <attributeGroup ref="gml:SRSInformationGroup">
                            <annotation>
                                <documentation>Optionally include the axis-names and axis-labels as lists</documentation>
                            </annotation>
                        </attributeGroup>
                        -->
                </simpleContent>
            </complexType>
            <!-- ========================================================================== -->
            <!-- ========================================================================== -->
            <!-- ===== Types used for observation results ====== -->
            <!-- ========================================================================== -->
            <complexType name="ScopedNameType">
                <annotation>
                    <documentation>Extension of string which also carries a codeSpace attribute.</documentation>
                </annotation>
                <simpleContent>
                    <extension base="string">
                        <attribute name="codeSpace" type="anyURI" use="required"/>
                    </extension>
                </simpleContent>
            </complexType>
            <!-- ========================================================================== -->
            <complexType name="ScopedNameListType">
                <annotation>
                    <documentation>Extension of stringList which also carries a codeSpace attribute.</documentation>
                </annotation>
                <simpleContent>
                    <extension base="swe:stringList">
                        <attribute name="codeSpace" type="anyURI" use="required"/>
                        <attribute name="count" type="nonNegativeInteger" use="optional"/>
                    </extension>
                </simpleContent>
            </complexType>
            <!-- ========================================================================== -->
            <complexType name="RelativeMeasureType">
                <simpleContent>
                    <extension base="double">
                        <attribute name="uom" type="swe:UomIdentifier" use="required"/>
                        <attribute name="relativeMeasure" type="swe:RelativeMeasureCode" default="equals"/>
                    </extension>
                </simpleContent>
```

```
	</complexType>
	<!-- ..... -->
	<simpleType name="RelativeMeasureCode">
		<annotation>
			<documentation xml:lang="en">This enumerated data type specifies values for relative
measures.</documentation>
		</annotation>
		<restriction base="string">
			<enumeration value="lessThan"/>
			<enumeration value="lessThanOrEquals"/>
			<enumeration value="equals"/>
			<enumeration value="greaterThanOrEquals"/>
			<enumeration value="greaterThan"/>
			<enumeration value="nil:inapplicable"/>
			<enumeration value="nil:missing"/>
			<enumeration value="nil:unknown"/>
			<enumeration value="nil:withheld"/>
	</restriction>
	</simpleType>
	<!-- ========================================================================  -->
	<!-- ========================================================================= -->
	<!-- ===== Soft-typed values and lists ====== -->
	<!-- ========================================================================= -->
	<!-- ========================================================================= -->
	<complexType name="TypedCategoryType">
		<annotation>
			<documentation>A text value,
			taken from a value space identified by the value of the codeSpace attribute,
			and representing a description of the phenomenon identified by the property attribute.</documentation>
		</annotation>
		<simpleContent>
			<extension base="string">
				<attribute name="codeSpace" type="anyURI" use="required"/>
				<attribute name="property" type="anyURI" use="required">
					<annotation>
						<documentation>This attribute holds a reference to or label for the property being
described.
	This will usually refer to a classification or phenomenon described on a nominal scale,
	such as lithology type, material colour.</documentation>
					</annotation>
				</attribute>
			</extension>
		</simpleContent>
	</complexType>
	<!-- ========================================================================= -->
	<complexType name="TypedCategoryListType">
		<annotation>
			<documentation>A list of text values,
			taken from a value space identified by the value of the codeSpace attribute,
			and representing a set of descriptions of the phenomenon identified by the property
attribute.</documentation>
		</annotation>
		<simpleContent>
			<extension base="swe:stringList">
				<attribute name="codeSpace" type="anyURI" use="required"/>
				<attribute name="property" type="anyURI" use="required">
					<annotation>
						<documentation>This attribute holds a reference to or label for the property being
described.  </documentation>
					</annotation>
				</attribute>
				<attribute name="count" type="nonNegativeInteger" use="optional"/>
			</extension>
		</simpleContent>
	</complexType>
	<!-- ========================================================================= -->
	<complexType name="TypedCategoryIntervalType">
		<annotation>
			<documentation>A pair of text values, representing an interval of the phenomenon identified by the
property attribute.</documentation>
		</annotation>
```

```
            <simpleContent>
                <restriction base="swe:TypedCategoryListType">
                    <length value="2"/>
                    <attribute name="count" type="nonNegativeInteger" use="prohibited" fixed="2"/>
                </restriction>
            </simpleContent>
        </complexType>
        <!-- ========================================================================== -->
        <!-- ========================================================================== -->
        <complexType name="TypedMeasureType">
            <annotation>
                <documentation>A numeric value,
                expressed using the scale indicated by the value of the (mandatory) uom attribute, attribute,
                and representing a description of the phenomenon identified by the property attribute.</documentation>
            </annotation>
            <simpleContent>
                <extension base="double">
                    <attribute name="uom" type="swe:UomIdentifier" use="required"/>
                    <attribute name="property" type="anyURI" use="required">
                        <annotation>
                            <documentation>This attribute holds a reference to or label for the property being
described.
        This will usually refer to a measure described on a ratio or interval scale,
        such as temperature, wavelength, concentration.</documentation>
                        </annotation>
                    </attribute>
                </extension>
            </simpleContent>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="TypedMeasureListType">
            <annotation>
                <documentation>A list of numeric values,
                expressed using the scale indicated by the value of the (mandatory) uom attribute, attribute,
                and representing a set of descriptions of the phenomenon identified by the property
attribute.</documentation>
            </annotation>
            <simpleContent>
                <extension base="swe:doubleList">
                    <attribute name="uom" type="swe:UomIdentifier" use="required"/>
                    <attribute name="property" type="anyURI" use="required">
                        <annotation>
                            <documentation>This attribute holds a reference to or label for the property being
described.  </documentation>
                        </annotation>
                    </attribute>
                    <attribute name="count" type="nonNegativeInteger" use="optional"/>
                </extension>
            </simpleContent>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="TypedMeasureIntervalType">
            <annotation>
                <documentation>A pair of numeric values,
                expressed using the scale indicated by the value of the (mandatory) uom attribute, attribute,
                and representing an interval of the phenomenon identified by the property attribute.</documentation>
            </annotation>
            <simpleContent>
                <restriction base="swe:TypedMeasureListType">
                    <length value="2"/>
                    <attribute name="count" type="nonNegativeInteger" use="prohibited" fixed="2"/>
                </restriction>
            </simpleContent>
        </complexType>
        <!-- ========================================================================== -->
        <!-- ========================================================================== -->
        <complexType name="TypedCountType">
            <annotation>
                <documentation>A numeric value, representing a count of the phenomenon identified by the property
attribute.</documentation>
            </annotation>
```

```
            <simpleContent>
                  <extension base="nonNegativeInteger">
                        <attribute name="property" type="anyURI" use="required">
                              <annotation>
                                    <documentation>This attribute holds a reference to or label for the property being
described.  </documentation>
                              </annotation>
                        </attribute>
                  </extension>
            </simpleContent>
      </complexType>
      <!-- ========================================================================== -->
      <complexType name="TypedCountListType">
            <annotation>
                  <documentation>A pair of numeric values, representing a set of counts of the phenomenon identified by
the property attribute.</documentation>
            </annotation>
            <simpleContent>
                  <extension base="swe:nonNegativeIntegerList">
                        <attribute name="property" type="anyURI" use="required">
                              <annotation>
                                    <documentation>This attribute holds a reference to or label for the property being
described.  </documentation>
                              </annotation>
                        </attribute>
                        <attribute name="count" type="nonNegativeInteger" use="optional"/>
                  </extension>
            </simpleContent>
      </complexType>
      <!-- ========================================================================== -->
      <complexType name="TypedCountIntervalType">
            <annotation>
                  <documentation>A pair of numeric values, representing an interval of the phenomenon identified by the
property attribute.</documentation>
            </annotation>
            <simpleContent>
                  <restriction base="swe:TypedCountListType">
                        <length value="2"/>
                        <attribute name="count" type="nonNegativeInteger" use="prohibited" fixed="2"/>
                  </restriction>
            </simpleContent>
      </complexType>
      <!-- ========================================================================== -->
      <!-- ================================================== -->
</schema>
```

A 1.1.2 XML-encoded generic record

Listing 31. record.xsd

```
<?xml version="1.0"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema" xmlns:swe="http://www.opengis.net/swe"
targetNamespace="http://www.opengis.net/swe" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="pre-release">
	<annotation>
		<documentation>A basic schema for data stored in arrays and grids.
		All items are XML encoded
		(contrast with swe:SWE_CompactRecordType where items are encoded compactly in a space separated list
within a single XML element)
		The description of the grid or array is given in recordSchema.xsd</documentation>
	</annotation>
	<!-- ================ -->
	<element name="item" type="anyType">
		<annotation>
			<documentation>An item is an item of data of any type</documentation>
		</annotation>
	</element>
	<!-- ================ -->
	<element name="Record">
		<annotation>
			<documentation>A record is an ordered list of items</documentation>
		</annotation>
		<complexType>
			<sequence>
				<element ref="swe:item" maxOccurs="unbounded"/>
			</sequence>
		</complexType>
	</element>
	<!-- ================ -->
	<element name="Array">
		<annotation>
			<documentation>An array is an ordered list of records or of other arrays.
			arrays must be homogeneous in the sense that they may not mix arrays and records</documentation>
		</annotation>
		<complexType>
			<sequence>
				<choice>
					<element ref="swe:Record" maxOccurs="unbounded"/>
					<element ref="swe:Array" maxOccurs="unbounded"/>
				</choice>
			</sequence>
		</complexType>
	</element>
	<!-- ================ -->
</schema>
```

A 1.1.3 Phenomenon

Listing 32. phenomenon.xsd

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

A GML conformant schema
for definitions of phenomena
used for soft-typing of property elements

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr
</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"/>
	<include schemaLocation="./SWE_basicTypes.xsd"/>
	<!-- ============================================================================ -->
	<complexType name="PhenomenonType">
		<complexContent>
			<extension base="gml:DefinitionType"/>
		</complexContent>
	</complexType>
	<!-- ......... -->
	<element name="Phenomenon" type="swe:PhenomenonType" substitutionGroup="gml:Definition">
		<annotation>
			<documentation>Use the generic gml:DefinitionType for basic Phenomenon definitions,
			gml:description may be used for a more extensive description of the semantics, with a link to a definitive
version (if available).
			gml:name should be used for the "short name" or label.
</documentation>
		</annotation>
	</element>
	<!-- ......... -->
	<complexType name="PhenomenonPropertyType">
		<sequence minOccurs="0">
			<element ref="swe:Phenomenon"/>
		</sequence>
		<attributeGroup ref="gml:AssociationAttributeGroup"/>
	</complexType>
	<!-- ============================================================================ -->
	<complexType name="ConstrainedPhenomenonType">
		<annotation>
			<documentation>A scalar Phenomenon defined by adding constraints to an existing property.
    </documentation>
		</annotation>
		<complexContent>
			<extension base="swe:PhenomenonType">
				<sequence>
					<element name="base" type="swe:PhenomenonPropertyType">
						<annotation>
							<documentation>Property that forms the basis for generating a set of more refined
Phenomena; e.g. Chemical Composition, Radiance</documentation>
						</annotation>
					</element>
					<group ref="swe:singleConstraint" maxOccurs="unbounded"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................................... -->
```

```
        <element name="ConstrainedPhenomenon" type="swe:ConstrainedPhenomenonType"
substitutionGroup="swe:Phenomenon">
                <annotation>
                        <documentation>Description of a scalar Phenomenon defined by adding constraints to a property
previously defined elsewhere.</documentation>
                </annotation>
        </element>
        <!-- ========================================================================== -->
        <group name="singleConstraint">
                <annotation>
                        <documentation>Constraints expressed in fully explicit form.
        The base Phenomenon is associated with each value or interval in turn</documentation>
                </annotation>
                <choice>
                        <element name="categoryConstraint" type="swe:TypedCategoryType">
                                <annotation>
                                        <documentation>A value from a classification that constrains the base Phenomenon; e.g.
Chemical Species</documentation>
                                </annotation>
                        </element>
                        <element name="measureConstraint" type="swe:TypedMeasureType">
                                <annotation>
                                        <documentation>A numeric value of some property that constrains the base Phenomenon;
e.g. Wavelength</documentation>
                                </annotation>
                        </element>
                        <element name="intervalConstraint" type="swe:TypedMeasureIntervalType">
                                <annotation>
                                        <documentation>An interval or range of some property that constrains the base
Phenomenon; e.g. Wavelength band</documentation>
                                </annotation>
                        </element>
                        <element name="otherConstraint" type="gml:StringOrRefType"/>
                </choice>
        </group>
        <!-- ========================================================================== -->
        <!-- ========================================================================== -->
        <complexType name="CompoundPhenomenonType" abstract="true">
                <annotation>
                        <documentation>Description of a set of Phenomena.
    A Phenomenon set may defined as either
    1. a set of explicitly enumerated components which may or may not be related to one another
    2. a base property convolved with a set of constraints
    The set of  constraints may be either
    * an explicit set of soft-typed measures, intervals and categories
    * one or more lists of soft-typed measures, intervals and categories
    * one or more sequences of soft-typed measures and intervals
</documentation>
                </annotation>
                <complexContent>
                        <extension base="swe:PhenomenonType">
                                <attribute name="dimension" type="positiveInteger" use="required">
                                        <annotation>
                                                <documentation>The number of components in the tuple</documentation>
                                        </annotation>
                                </attribute>
                        </extension>
                </complexContent>
        </complexType>
        <!-- ........................................ -->
        <element name="CompoundPhenomenon" type="swe:CompoundPhenomenonType" abstract="true"
substitutionGroup="swe:Phenomenon">
                <annotation>
                        <documentation>Description of a set of properties or a compound Phenomenon,
    that are the subject of a measurement, observation or assignment.   </documentation>
                </annotation>
        </element>
        <!-- ========================================================================== -->
        <complexType name="CompositePhenomenonType">
                <complexContent>
                        <extension base="swe:CompoundPhenomenonType">
```

```
                    <sequence>
                        <element name="base" type="swe:PhenomenonPropertyType" minOccurs="0" >
                            <annotation>
                                <documentation>Phenomenon that forms the basis for generating more
specialized composite Phenomenon by adding more components</documentation>
                            </annotation>
                        </element>
                        <element name="component" type="swe:PhenomenonPropertyType"
maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................................... -->
        <element name="CompositePhenomenon" type="swe:CompositePhenomenonType"
substitutionGroup="swe:CompoundPhenomenon">
            <annotation>
                <documentation>A Composite Phenomenon Definition is composed from arbitrary base Phenomena.
</documentation>
            </annotation>
        </element>
        <!-- ========================================================================== -->
        <complexType name="PhenomenonSeriesType">
            <complexContent>
                <extension base="swe:CompoundPhenomenonType">
                    <sequence>
                        <element name="base" type="swe:PhenomenonPropertyType">
                            <annotation>
                                <documentation>Phenomenon that forms the basis for generating a set of more
refined Phenomena; e.g. Chemical Composition, Radiance</documentation>
                            </annotation>
                        </element>
                        <group ref="swe:constraintLists" maxOccurs="unbounded">
                            <annotation>
                                <documentation>A set of values of some secondary property that constraints the
basePhenomenon to generate a Phenomenon set.
                                    If more than one set of constraints are possible, then these are applied
simultaneously to generate </documentation>
                            </annotation>
                        </group>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................................... -->
        <element name="PhenomenonSeries" type="swe:PhenomenonSeriesType"
substitutionGroup="swe:CompoundPhenomenon">
            <annotation>
                <documentation>A Series is derived from a common basePhenomenon (e.g. Chemical Concentration)
with one or more constraint lists (e.g. Chemical Species). </documentation>
            </annotation>
        </element>
        <!-- ========================================================================== -->
        <group name="constraintLists">
            <choice>
                <annotation>
                    <documentation>Constraint sets expressed in compact form.
      The base property is associated with each value or interval in turn</documentation>
                </annotation>
                <element name="categoryConstraintList" type="swe:TypedCategoryListType">
                    <annotation>
                        <documentation>A list of values from a classification ; e.g. Chemical
Species</documentation>
                    </annotation>
                </element>
                <element name="measureConstraintList" type="swe:TypedMeasureListType">
                    <annotation>
                        <documentation>A list of numeric values of some property; e.g.
Wavelength</documentation>
                    </annotation>
                </element>
```

```
                <element name="intervalConstraintList" type="swe:TypedMeasureListType">
                    <annotation>
                        <documentation>A list of *pairs* of numeric values each defining an interval of some
property; e.g. Wavelength band</documentation>
                    </annotation>
                </element>
                <!--
                <element name="measureConstraintSequence" type="string">
                    <annotation>
                        <documentation>A set of numeric values of some property; e.g. Wavelength, expressed as a
regular sequence (incomplete)</documentation>
                    </annotation>
                </element>
                <element name="intervalConstraintSequence" type="string">
                    <annotation>
                        <documentation>A set of *pairs* of numeric values of some property; e.g. Wavelength band,
expressed as a regular sequence (incomplete)</documentation>
                    </annotation>
                </element>
                -->
            </choice>
        </group>
        <!-- ========================================================================== -->
</schema>
```

A 1.1.4 Result Definition (Record schema)

A model for basic record schemas is shown in Figure 7.

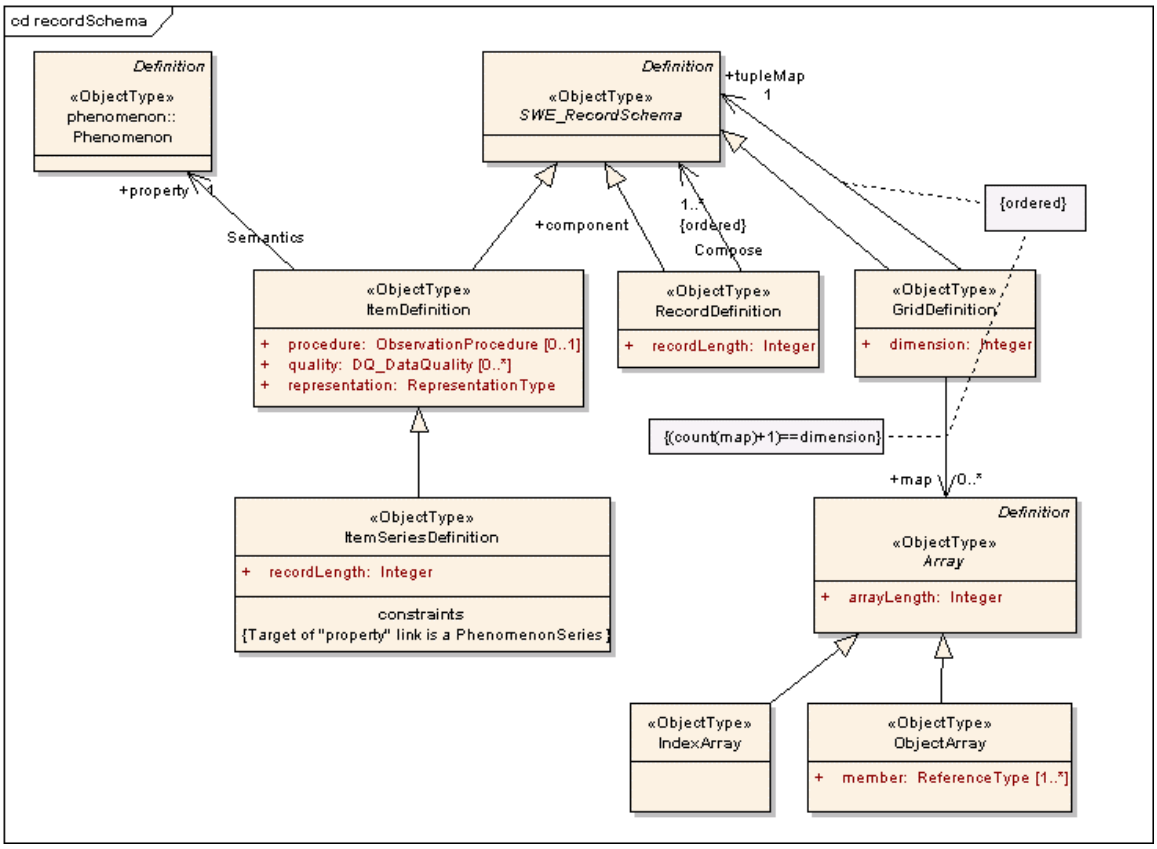

Figure 7. Basic record and grid schema

SWE_RecordSchema is the abstract superclass. Four concrete specializations are provided.

ItemDefinition describes a single item in a record. It is characterized as follows:

- the **property** described by the record item is indicated by an association with a Phenomenon
- the item **representation** specifies how the item is encoded, as a character string, real, etc
- optional **quality** and **procedure** properties allow item-specific metadata to be provided.

The next two specializations describe a record representing a “tuple” of information, by describing the items in the tuple in a single ordered sequence.

RecordDefinition describes a record of the specified **recordLength**, in terms of an explicit set of ordered **components**. Typically each component will be an ItemDefinition,

but other SWE_RecordSchema classes may in principle be nested as components of a RecordDefinition.

ItemSeriesDefinition describes a record of the specified **recordLength**, in which all items share the same representation, quality and procedure. The items within the record refer to a series of properties as specified in the associated PhenomenonSeries (clause 6.5.3).

Finally, **GridDefinition** supports the description of the axes of an array of the specified **dimension**. These are provided as an ordered set of records, including one labelled **tupleMap** and others labelled **map**. The tupleMap association is to a record schema which allows the items in a record to be defined. The map association is to an **Array** composed of **arrayLength member** elements. Two specializations of Array are provided. Each member of an **ObjectArray** is (a pointer to) an object described elsewhere, such as elements of a station array, or elements of a temporal aggregate. The members of an **IndexArray** are not tied to a conceptual object.

When used as the value of a resultDefinition, the order of the maps and their members within a GridDefinition describes the iteration sequence for the items in a result encoded as a serialized record that corresponds with a grid.

The XML Schema implementation of the model is shown in Listing 33.

Listing 33. recordSchema.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:swe="http://www.opengis.net/swe" xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml"
xmlns:xst="http://www.seegrid.csiro.au/xml/st"
      targetNamespace="http://www.opengis.net/swe" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="pre-release">
      <annotation>
            <documentation>recordSchema.xsd

A GML conformant schema
for definitions of properties and property sets
used for soft-typing of property elements

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</documentation>
      </annotation>
      <!-- ============================================================== -->
      <!-- bring in other schemas -->
      <import namespace="http://www.seegrid.csiro.au/xml/st" schemaLocation="./simpleTypeDerivation.xsd">
            <annotation>
                  <documentation>SimpleType derivation components from W3C XML Schema specification, loaded into a
new namespace.</documentation>
            </annotation>
      </import>
      <import namespace="http://www.opengis.net/gml"
schemaLocation="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"/>
      <import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
      <include schemaLocation="./phenomenon.xsd"/>
      <!-- ============================================================== -->
      <!-- ============================================================== -->
      <complexType name="SWE_RecordSchemaType">
            <complexContent>
                  <extension base="gml:DefinitionType"/>
            </complexContent>
```

```
        </complexType>
        <!-- ......... -->
        <element name="SWE_RecordSchema" type="swe:SWE_RecordSchemaType" abstract="true"
substitutionGroup="gml:Definition">
                <annotation>
                        <documentation>Abstract element used as head of a substitution group for axis and record
definitions</documentation>
                </annotation>
        </element>
        <!-- ..................................... -->
        <complexType name="SWE_RecordSchemaPropertyType">
                <sequence minOccurs="0">
                        <element ref="swe:SWE_RecordSchema"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="ItemDefinitionType">
                <annotation>
                        <documentation>Description of a scalar property with its representation and scale and (optional) quality
indicators.</documentation>
                </annotation>
                <complexContent>
                        <extension base="swe:SWE_RecordSchemaType">
                                <sequence>
                                        <element name="property" type="swe:PhenomenonPropertyType"/>
                                        <element name="representation" type="swe:RepresentationType"/>
                                        <element name="procedure" type="gml:ReferenceType" minOccurs="0"/>
                                        <element name="quality" type="gmd:DQ_DataQuality_PropertyType" minOccurs="0"
maxOccurs="unbounded">
                                                <annotation>
                                                        <documentation>One or more quality elements record systematic measure of
reliability</documentation>
                                                </annotation>
                                        </element>
                                </sequence>
                        </extension>
                </complexContent>
        </complexType>
        <!-- ..................................... -->
        <element name="ItemDefinition" type="swe:ItemDefinitionType" substitutionGroup="swe:SWE_RecordSchema">
                <annotation>
                        <documentation>Description of a scalar property with its representation and scale and (optional) quality
indicators</documentation>
                </annotation>
        </element>
        <!-- ..................................... -->
        <complexType name="ItemDefinitionPropertyType">
                <sequence minOccurs="0">
                        <element ref="swe:ItemDefinition"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="ItemSeriesDefinitionType">
                <annotation>
                        <documentation>Description of a series of scalar properties with a common representation and scale
and (optional) quality indicators.</documentation>
                </annotation>
                <complexContent>
                        <extension base="swe:ItemDefinitionType">
                                <attribute name="recordLength" type="positiveInteger" use="required">
                                        <annotation>
                                                <documentation>The number of components in the tuple</documentation>
                                        </annotation>
                                </attribute>
                        </extension>
                </complexContent>
        </complexType>
        <!-- ..................................... -->
```

```
	<element name="ItemSeriesDefinition" type="swe:ItemSeriesDefinitionType"
substitutionGroup="swe:ItemDefinition">
		<annotation>
			<documentation>Description of a series of scalar properties with a common representation and scale
and (optional) quality indicators.</documentation>
		</annotation>
	</element>
	<!-- ..................................... -->
	<complexType name="ItemSeriesDefinitionPropertyType">
		<sequence minOccurs="0">
			<element ref="swe:ItemSeriesDefinition"/>
		</sequence>
		<attributeGroup ref="gml:AssociationAttributeGroup"/>
	</complexType>
	<!-- ========================================================================= -->
	<complexType name="RecordDefinitionType">
		<complexContent>
			<extension base="swe:SWE_RecordSchemaType">
				<sequence>
					<element name="component" type="swe:SWE_RecordSchemaPropertyType"
maxOccurs="unbounded"/>
				</sequence>
				<attribute name="recordLength" type="positiveInteger" use="required">
					<annotation>
						<documentation>The number of components in the tuple</documentation>
					</annotation>
				</attribute>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................................... -->
	<element name="RecordDefinition" type="swe:RecordDefinitionType"
substitutionGroup="swe:SWE_RecordSchema">
		<annotation>
			<documentation>A Record Definition is composed from arbitrary base axes, which may be
records.</documentation>
		</annotation>
	</element>
	<!-- ..................................... -->
	<complexType name="RecordDefinitionPropertyType">
		<sequence minOccurs="0">
			<element ref="swe:RecordDefinition"/>
		</sequence>
		<attributeGroup ref="gml:AssociationAttributeGroup"/>
	</complexType>
	<!-- ========================================================================= -->
	<!-- ========================================================================= -->
	<complexType name="GridDefinitionType">
		<annotation>
			<documentation>definition of how to unpack an array and assign atomic values to components of map
vectors.
			The array must correspond with an N-dimensional grid.
			Each map describes the values of the independent variable for one axis of the grid.
			The order of maps defines the iteration sequence within the grid, i.e. the rule for assigning the control
variables to the items in an ordered list corresponding with a grid.</documentation>
		</annotation>
		<complexContent>
			<extension base="swe:SWE_RecordSchemaType">
				<sequence>
					<element name="map" type="swe:ItemArrayPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
					<element name="tupleMap" type="swe:SWE_RecordSchemaPropertyType"/>
					<element name="map" type="swe:ItemArrayPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
				</sequence>
				<attribute name="dimension" type="positiveInteger" use="required">
					<annotation>
						<documentation>The number of axes in the grid</documentation>
					</annotation>
				</attribute>
			</extension>
```

```
        </complexContent>
    </complexType>
    <!-- ..................................... -->
    <element name="GridDefinition" type="swe:GridDefinitionType" substitutionGroup="swe:SWE_RecordSchema"/>
    <!-- ..................................... -->
    <complexType name="GridDefinitionPropertyType">
        <sequence minOccurs="0">
            <element ref="swe:GridDefinition"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ========================================================================== -->
    <!-- ========================================================================== -->
    <complexType name="ItemArrayType">
        <annotation>
            <documentation>Basic ordered array type</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:DefinitionType">
                <attribute name="arrayLength" type="swe:count" use="required"/>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................................... -->
    <simpleType name="count">
        <union memberTypes="positiveInteger swe:unbounded"/>
    </simpleType>
    <!-- ..................................... -->
    <simpleType name="unbounded">
        <restriction base="string">
            <enumeration value="unbounded"/>
        </restriction>
    </simpleType>
    <!-- ..................................... -->
    <element name="ItemArray" type="swe:ItemArrayType" abstract="true"/>
    <!-- ..................................... -->
    <complexType name="ItemArrayPropertyType">
        <sequence minOccurs="0">
            <element ref="swe:ItemArray"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ========================================================================== -->
    <complexType name="ObjectArrayType">
        <annotation>
            <documentation>Ordered array whose members are references to items defined
elsewhere</documentation>
        </annotation>
        <complexContent>
            <extension base="swe:ItemArrayType">
                <sequence>
                    <element name="member" type="gml:ReferenceType" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................................... -->
    <element name="ObjectArray" type="swe:ObjectArrayType" substitutionGroup="swe:ItemArray"/>
    <!-- ========================================================================== -->
    <complexType name="IndexArrayType">
        <annotation>
            <documentation>Ordered array whose members are simply index numbers</documentation>
        </annotation>
        <complexContent>
            <extension base="swe:ItemArrayType"></extension>
        </complexContent>
    </complexType>
    <!-- ..................................... -->
    <element name="IndexArray" type="swe:IndexArrayType" substitutionGroup="swe:ItemArray"/>
    <!-- ========================================================================== -->
    <!-- === Type designed to allow the specification of simpleContent types in-line === -->
```

```
<!-- ================================================================== -->
<complexType name="RepresentationType">
    <annotation>
        <documentation>this uses components copied from XML Schema to describe the "value-space" in terms
of
        a base type and facets, or a composite such as a union.

    For numeric types this will normally indicate integer, double etc and (optionally) facets
    to describe one or more intervals or a precision.
    For textual types this will normally indicate string, token etc and (optionally) facets
    will indicate a pattern, enumeration, length etc.</documentation>
    </annotation>
    <choice>
        <element name="SimpleType">
            <complexType>
                <complexContent>
                    <extension base="xst:localSimpleType">
                        <sequence>
                            <group ref="swe:scale"/>
                        </sequence>
                    </extension>
                </complexContent>
            </complexType>
        </element>
        <element name="Number">
            <complexType>
                <sequence>
                    <element name="restriction" minOccurs="0">
                        <complexType>
                            <sequence>
                                <element ref="xst:minInclusive" minOccurs="0"/>
                                <element ref="xst:minExclusive" minOccurs="0"/>
                                <element ref="xst:maxInclusive" minOccurs="0"/>
                                <element ref="xst:maxExclusive" minOccurs="0"/>
                            </sequence>
                        </complexType>
                    </element>
                    <sequence>
                        <element ref="gml:unitOfMeasure">
                            <annotation>
                                <documentation>Use this element to indicate an unit of measure for
numeric values on a ratio scale.</documentation>
                            </annotation>
                        </element>
                        <element name="frame" type="gml:ReferenceType" minOccurs="0">
                            <annotation>
                                <documentation>Use this element to indicate the description of a
reference system for numeric values on an interval scale.</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </sequence>
            </complexType>
        </element>
        <element name="Word">
            <complexType>
                <sequence>
                    <element name="restriction" minOccurs="0">
                        <complexType>
                            <choice>
                                <element ref="xst:pattern"/>
                                <element ref="xst:enumeration" maxOccurs="unbounded"/>
                            </choice>
                        </complexType>
                    </element>
                    <element name="classification" type="gml:StringOrRefType"/>
                </sequence>
            </complexType>
        </element>
        <element name="Boolean">
            <complexType>
```

```
                        <sequence>
                            <element name="restriction">
                                <complexType>
                                    <sequence>
                                        <element ref="xst:enumeration" minOccurs="2" maxOccurs="2"/>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </complexType>
                </element>
            </choice>
        </complexType>
        <!-- ......  ...... -->
        <group name="scale">
            <choice>
                <sequence>
                    <element ref="gml:unitOfMeasure">
                        <annotation>
                            <documentation>Use this element to indicate an unit of measure for numeric values on
a ratio scale.</documentation>
                        </annotation>
                    </element>
                    <element name="frame" type="gml:ReferenceType" minOccurs="0">
                        <annotation>
                            <documentation>Use this element to indicate the description of a reference system for
numeric values on an interval scale.</documentation>
                        </annotation>
                    </element>
                </sequence>
                <element name="frame" type="gml:ReferenceType">
                    <annotation>
                        <documentation>Use this element to indicate the description of a reference system for
numeric values on an interval scale.</documentation>
                    </annotation>
                </element>
                <element name="classification" type="gml:StringOrRefType">
                    <annotation>
                        <documentation>Use this element to indicate an informally or externally described
classification scheme for values on an Ordinal or Nominal scale.</documentation>
                    </annotation>
                </element>
                <element name="noScale" type="boolean" fixed="true"/>
            </choice>
        </group>
        <!-- ========================================================================== -->
</schema>
```

A 1.1.5 Temporal aggregates

Listing 34. temporalAggregates.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:swe="http://www.opengis.net/swe"
targetNamespace="http://www.opengis.net/swe" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="pre-release">
	<annotation>
		<documentation>
temporal.xsd

time geometric complex and time grids

2005-06-27

Copyright (c) 2005 CSIRO - see https://www.seegrid.csiro.au/twiki/bin/view/Xmml/LegalNotices#Software_Notice
</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"/>
	<!-- ================================================================== -->
	<!-- ========================================================== -->
	<!-- ========================================================== -->
	<simpleType name="TimeValueList">
		<list itemType="gml:TimePositionUnion"/>
	</simpleType>
	<!-- ================================================================== -->
	<complexType name="TimePositionListType">
		<annotation>
			<documentation>TimePositionList instances hold a sequence of time positions within the same
frame.</documentation>
		</annotation>
		<simpleContent>
			<extension base="swe:TimeValueList">
				<attribute name="frame" type="anyURI" use="optional" default="#ISO-8601"/>
				<attribute name="calendarEraName" type="string" use="optional"/>
				<attribute name="indeterminatePosition" type="gml:TimeIndeterminateValueType" use="optional"/>
				<attribute name="count" type="positiveInteger" use="optional">
					<annotation>
						<documentation>"count" allows to specify the number of direct positions in the list.
</documentation>
					</annotation>
				</attribute>
			</extension>
		</simpleContent>
	</complexType>
	<!-- ========================================================== -->
	<!-- ===== Time geometric complexes ====== -->
	<!-- ================================================================== -->
	<complexType name="TimeGeometricComplexType">
		<complexContent>
			<extension base="gml:AbstractTimeComplexType">
				<sequence>
					<element name="primitive" type="gml:TimeGeometricPrimitivePropertyType"
maxOccurs="unbounded">
						<annotation>
							<documentation>Reference to an identified time
primitive</documentation>
						</annotation>
					</element>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
```

```
        <element name="TimeGeometricComplex" type="swe:TimeGeometricComplexType"
substitutionGroup="gml:_TimeComplex">
                <annotation>
                        <documentation>a self-consistent set of TimeInstants and TimePeriods</documentation>
                </annotation>
        </element>
        <!-- ..... -->
        <complexType name="TimeGeometricComplexPropertyType">
                <sequence minOccurs="0">
                        <element ref="swe:TimeGeometricComplex"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ================================== -->
        <!-- ===== Time aggregates ====== -->
        <!-- ================================================================== -->
        <!-- ===== Explicit time aggregates ====== -->
        <!-- ================================================================== -->
        <complexType name="TimeObjectPropertyType">
                <sequence minOccurs="0">
                        <element ref="gml:_TimeObject"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ================================================================== -->
        <complexType name="TimeAggregateType">
                <complexContent>
                        <extension base="gml:AbstractTimeObjectType">
                                <sequence>
                                        <element name="member" type="swe:TimeObjectPropertyType" maxOccurs="unbounded"/>
                                </sequence>
                        </extension>
                </complexContent>
        </complexType>
        <!-- ..... -->
        <element name="TimeAggregate" type="swe:TimeAggregateType" substitutionGroup="gml:_TimeObject">
                <annotation>
                        <documentation>a set of TimeObjects, often TimeInstants and TimePeriods</documentation>
                </annotation>
        </element>
        <!-- ..... -->
        <complexType name="TimeAggregatePropertyType">
                <sequence minOccurs="0">
                        <element ref="swe:TimeAggregate"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ================================== -->
        <!-- ===== Implicit time aggregates ====== -->
        <!-- ================================================================== -->
        <complexType name="TimeInstantGridType">
                <annotation>
                        <documentation>Regular "grid" of time-points.
    Follow pattern of (ISO 19123) spatial grids:
 these have (dimension,axisName,extent(,origin,offsetVector))
 For temporal case, dimension is fixed (1), axisName is fixed ("time")</documentation>
                </annotation>
                <complexContent>
                        <extension base="gml:AbstractTimeComplexType">
                                <sequence>
                                        <element name="extent" type="swe:TimeGridExtentType"/>
                                        <choice>
                                                <element name="originPos" type="gml:TimePositionType">
                                                        <annotation>
                                                                <documentation>Simple-content time position</documentation>
                                                        </annotation>
                                                </element>
                                                <element name="origin" type="gml:TimeInstantPropertyType">
                                                        <annotation>
                                                                <documentation>Reference to an identified time instant</documentation>
                                                        </annotation>
```

```
                        </element>
                    </choice>
                    <choice>
                        <element name="offsetDuration" type="duration">
                            <annotation>
                                <documentation>XML Schema built-in simple type for duration: e.g.
        P1Y (1 year)
        P1M (1 month)
        P1DT12H (1 day 12 hours)
        PT5M (5 minutes)
        PT0.007S (7 milliseconds)</documentation>
                            </annotation>
                        </element>
                        <element name="offsetInterval" type="gml:TimeIntervalLengthType">
                            <annotation>
                                <documentation>representation of the ISO 11404 model of a time interval
length: e.g.
        value=1, unit="year"
        value=1, unit="other:month" (or see next)
        value=1, unit="year" radix="12" factor="1" (1/12 year)
        value=1.5, unit="day"
        value=36, unit="hour"
        value=5, unit="minute"
        value=7, unit="second" radix="10" factor="3" (7 milliseconds)</documentation>
                            </annotation>
                        </element>
                    </choice>
                    <element name="duration" type="duration" minOccurs="0"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................... -->
    <element name="TimeInstantGrid" type="swe:TimeInstantGridType" substitutionGroup="gml:_TimeComplex">
        <annotation>
            <documentation>A set of uniformly spaced time instants described using an implicit
notation</documentation>
        </annotation>
    </element>
    <!-- ..................... -->
    <complexType name="TimeInstantGridPropertyType">
        <sequence minOccurs="0">
            <element ref="swe:TimeInstantGrid"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ========================================================== -->
    <complexType name="TimeGridExtentType">
        <sequence>
            <element name="SeriesEnvelope">
                <annotation>
                    <documentation>Grid extent specified in grid coordinates - i.e. 2 integers</documentation>
                </annotation>
                <complexType>
                    <sequence>
                        <element name="low" type="integer"/>
                        <element name="high" type="integer"/>
                    </sequence>
                </complexType>
            </element>
        </sequence>
    </complexType>
    <!-- ================================================================ -->
    <complexType name="TimeIntervalGridType">
        <annotation>
            <documentation>Extend time instant grid with window size property</documentation>
        </annotation>
        <complexContent>
            <extension base="swe:TimeInstantGridType">
                <sequence>
                    <choice>
```

```
                                    <element name="windowDuration" type="duration">
                                        <annotation>
                                            <documentation>XML Schema built-in simple type for
duration</documentation>
                                        </annotation>
                                    </element>
                                    <element name="windowInterval" type="gml:TimeIntervalLengthType">
                                        <annotation>
                                            <documentation>representation of the ISO 11404 model of a time interval
length</documentation>
                                        </annotation>
                                    </element>
                                </choice>
                            </sequence>
                        </extension>
                    </complexContent>
                </complexType>
                <!-- ..................... -->
                <element name="TimeIntervalGrid" type="swe:TimeIntervalGridType" substitutionGroup="gml:_TimeComplex">
                    <annotation>
                        <documentation>A set of uniformly spaced time intervals described using an implicit
notation</documentation>
                    </annotation>
                </element>
                <!-- ..................... -->
                <complexType name="TimeIntervalGridPropertyType">
                    <sequence minOccurs="0">
                        <element ref="swe:TimeIntervalGrid"/>
                    </sequence>
                    <attributeGroup ref="gml:AssociationAttributeGroup"/>
                </complexType>
                <!-- ================================================================== -->
</schema>
```

A 1.1.6 SWE wrapper schema

Listing 35. swe.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.opengis.net/swe" xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified">
	<xs:annotation>
		<xs:documentation>Stub schema for swe</xs:documentation>
	</xs:annotation>
	<!--======================-->
	<xs:include schemaLocation="./positionData.xsd"/><!-- transitively includes paramaters -->
	<xs:include schemaLocation="./data.xsd"/>
	<xs:include schemaLocation="./recordSchema.xsd"/><!-- transitively includes phenomenon -->
	<xs:include schemaLocation="./record.xsd"/>
	<xs:include schemaLocation="./temporalAggregates.xsd"/>
</xs:schema>
```

A 1.2 External Utility Schemas

A 1.2.1 Simple type representation

The W3C XML “Schema for Schemas” is used as the basis for describing the representation of simple content types within record-schema instances. However, due to difficulties in validation resulting from importing schema components that are already assumed to exist by the XML processors, these components have been declared in a new namespace for the present purposes. This namespace is http://www.seegrid.csiro.au/xml/st

Listing 36. simpleTypeDerivation.xsd

```
<?xml version="1.0"?>
<!-- Derived from XML Schema schema for XML Schemas: Part 2: Datatypes -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:st="http://www.seegrid.csiro.au/xml/st"
xmlns:hfp="http://www.w3.org/2001/XMLSchema-hasFacetAndProperty"
targetNamespace="http://www.seegrid.csiro.au/xml/st" elementFormDefault="qualified" xml:lang="en">
      <xs:annotation>
            <xs:documentation>
This schema is based on the W3C XML Schema schema for XML Schemas: Part 2: Datatypes

The definitions of the "magic" built-in datatypes have been removed
The components for defining derived simpleTypes are retained, but defined in a new namespace.
  </xs:documentation>
      </xs:annotation>
      <!-- these next six components from XMLSchema.xsd -->
      <xs:import namespace="http://www.w3.org/XML/1998/namespace"
schemaLocation="http://www.w3.org/2001/xml.xsd">
            <xs:annotation>
                  <xs:documentation>
    Get access to the xml: attribute groups for xml:lang
    as declared on 'schema' and 'documentation' below
  </xs:documentation>
            </xs:annotation>
      </xs:import>
      <xs:complexType name="openAttrs">
            <xs:annotation>
                  <xs:documentation>
    This type is extended by almost all schema types
    to allow attributes from other namespaces to be
    added to user schemas.
  </xs:documentation>
            </xs:annotation>
            <xs:complexContent>
                  <xs:restriction base="xs:anyType">
                        <xs:anyAttribute namespace="##other" processContents="lax"/>
                  </xs:restriction>
            </xs:complexContent>
      </xs:complexType>
      <xs:complexType name="annotated">
            <xs:annotation>
                  <xs:documentation>
    This type is extended by all types which allow annotation
    other than &lt;schema&gt; itself
  </xs:documentation>
            </xs:annotation>
            <xs:complexContent>
                  <xs:extension base="st:openAttrs">
                        <xs:sequence>
                              <xs:element ref="st:annotation" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="id" type="xs:ID"/>
                  </xs:extension>
            </xs:complexContent>
```

```
    </xs:complexType>
    <xs:element name="appinfo" id="appinfo">
        <xs:annotation>
            <xs:documentation source="./#element-appinfo"/>
        </xs:annotation>
        <xs:complexType mixed="true">
            <xs:sequence minOccurs="0" maxOccurs="unbounded">
                <xs:any processContents="lax"/>
            </xs:sequence>
            <xs:attribute name="source" type="xs:anyURI"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="documentation" id="documentation">
        <xs:annotation>
            <xs:documentation source="./#element-documentation"/>
        </xs:annotation>
        <xs:complexType mixed="true">
            <xs:sequence minOccurs="0" maxOccurs="unbounded">
                <xs:any processContents="lax"/>
            </xs:sequence>
            <xs:attribute name="source" type="xs:anyURI"/>
            <xs:attribute ref="xml:lang"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="annotation" id="annotation">
        <xs:annotation>
            <xs:documentation source="./#element-annotation"/>
        </xs:annotation>
        <xs:complexType>
            <xs:complexContent>
                <xs:extension base="st:openAttrs">
                    <xs:choice minOccurs="0" maxOccurs="unbounded">
                        <xs:element ref="st:appinfo"/>
                        <xs:element ref="st:documentation"/>
                    </xs:choice>
                    <xs:attribute name="id" type="xs:ID"/>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
    </xs:element>
    <!-- from here to end of document from datatypes.xsd -->
    <xs:simpleType name="derivationControl">
        <xs:annotation>
            <xs:documentation>
A utility type, not for public use</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:NMTOKEN">
            <xs:enumeration value="substitution"/>
            <xs:enumeration value="extension"/>
            <xs:enumeration value="restriction"/>
            <xs:enumeration value="list"/>
            <xs:enumeration value="union"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:group name="simpleDerivation">
        <xs:choice>
            <xs:element ref="st:restriction"/>
            <xs:element ref="st:list"/>
            <xs:element ref="st:union"/>
        </xs:choice>
    </xs:group>
    <xs:simpleType name="simpleDerivationSet">
        <xs:annotation>
            <xs:documentation>
#all or (possibly empty) subset of {restriction, union, list}
</xs:documentation>
            <xs:documentation>
A utility type, not for public use</xs:documentation>
        </xs:annotation>
        <xs:union>
            <xs:simpleType>
```

```
                        <xs:restriction base="xs:token">
                            <xs:enumeration value="#all"/>
                        </xs:restriction>
                    </xs:simpleType>
                    <xs:simpleType>
                        <xs:restriction base="st:derivationControl">
                            <xs:enumeration value="list"/>
                            <xs:enumeration value="union"/>
                            <xs:enumeration value="restriction"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:union>
            </xs:simpleType>
            <xs:complexType name="simpleType" abstract="true">
                <xs:complexContent>
                    <xs:extension base="st:annotated">
                        <xs:group ref="st:simpleDerivation"/>
                        <xs:attribute name="final" type="st:simpleDerivationSet"/>
                        <xs:attribute name="name" type="xs:NCName">
                            <xs:annotation>
                                <xs:documentation>
      Can be restricted to required or forbidden
    </xs:documentation>
                            </xs:annotation>
                        </xs:attribute>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="topLevelSimpleType">
                <xs:complexContent>
                    <xs:restriction base="st:simpleType">
                        <xs:sequence>
                            <xs:element ref="st:annotation" minOccurs="0"/>
                            <xs:group ref="st:simpleDerivation"/>
                        </xs:sequence>
                        <xs:attribute name="name" type="xs:NCName" use="required">
                            <xs:annotation>
                                <xs:documentation>
      Required at the top level
    </xs:documentation>
                            </xs:annotation>
                        </xs:attribute>
                    </xs:restriction>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="localSimpleType">
                <xs:complexContent>
                    <xs:restriction base="st:simpleType">
                        <xs:sequence>
                            <xs:element ref="st:annotation" minOccurs="0"/>
                            <xs:group ref="st:simpleDerivation"/>
                        </xs:sequence>
                        <xs:attribute name="name" type="xs:NCName" use="prohibited">
                            <xs:annotation>
                                <xs:documentation>
      Forbidden when nested
    </xs:documentation>
                            </xs:annotation>
                        </xs:attribute>
                        <xs:attribute name="final" type="st:simpleDerivationSet" use="prohibited"/>
                    </xs:restriction>
                </xs:complexContent>
            </xs:complexType>
            <xs:element name="simpleType" type="st:topLevelSimpleType" id="simpleType">
                <xs:annotation>
                    <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
simpleType"</xs:documentation>
                </xs:annotation>
            </xs:element>
            <xs:group name="facets">
                <xs:annotation>
```

```
                <xs:documentation>
    We should use a substitution group for facets, but
    that's ruled out because it would allow users to
    add their own, which we're not ready for yet.
  </xs:documentation>
            </xs:annotation>
            <xs:choice>
                <xs:element ref="st:minExclusive"/>
                <xs:element ref="st:minInclusive"/>
                <xs:element ref="st:maxExclusive"/>
                <xs:element ref="st:maxInclusive"/>
                <xs:element ref="st:totalDigits"/>
                <xs:element ref="st:fractionDigits"/>
                <xs:element ref="st:length"/>
                <xs:element ref="st:minLength"/>
                <xs:element ref="st:maxLength"/>
                <xs:element ref="st:enumeration"/>
                <xs:element ref="st:whiteSpace"/>
                <xs:element ref="st:pattern"/>
            </xs:choice>
        </xs:group>
        <xs:group name="simpleRestrictionModel">
            <xs:sequence>
                <xs:element name="simpleType" type="st:localSimpleType" minOccurs="0"/>
                <xs:group ref="st:facets" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:group>
        <xs:element name="restriction" id="restriction">
            <xs:complexType>
                <xs:annotation>
                    <xs:documentation>source="./XML Schema Part 2 Datatypes.htm#element-restriction"
     base attribute and simpleType child are mutually
     exclusive, but one or other is required
    </xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="st:annotated">
                        <xs:group ref="st:simpleRestrictionModel"/>
                        <xs:attribute name="base" type="xs:QName" use="optional"/>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
        </xs:element>
        <xs:element name="list" id="list">
            <xs:complexType>
                <xs:annotation>
                    <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-list"
     itemType attribute and simpleType child are mutually
     exclusive, but one or other is required
    </xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="st:annotated">
                        <xs:sequence>
                            <xs:element name="simpleType" type="st:localSimpleType" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="itemType" type="xs:QName" use="optional"/>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
        </xs:element>
        <xs:element name="union" id="union">
            <xs:complexType>
                <xs:annotation>
                    <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-union"
     memberTypes attribute must be non-empty or there must be
     at least one simpleType child
    </xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="st:annotated">
```

```
                        <xs:sequence>
                            <xs:element name="simpleType" type="st:localSimpleType" minOccurs="0"
maxOccurs="unbounded"/>
                        </xs:sequence>
                        <xs:attribute name="memberTypes" use="optional">
                            <xs:simpleType>
                                <xs:list itemType="xs:QName"/>
                            </xs:simpleType>
                        </xs:attribute>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
        </xs:element>
        <xs:complexType name="facet">
            <xs:complexContent>
                <xs:extension base="st:annotated">
                    <xs:attribute name="value" use="required"/>
                    <xs:attribute name="fixed" type="xs:boolean" use="optional" default="false"/>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="noFixedFacet">
            <xs:complexContent>
                <xs:restriction base="st:facet">
                    <xs:sequence>
                        <xs:element ref="st:annotation" minOccurs="0"/>
                    </xs:sequence>
                    <xs:attribute name="fixed" type="xs:boolean" use="prohibited"/>
                </xs:restriction>
            </xs:complexContent>
        </xs:complexType>
        <xs:element name="minExclusive" type="st:facet" id="minExclusive">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
minExclusive"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minInclusive" type="st:facet" id="minInclusive">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
minInclusive"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maxExclusive" type="st:facet" id="maxExclusive">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
maxExclusive"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maxInclusive" type="st:facet" id="maxInclusive">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
maxInclusive"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:complexType name="numFacet">
            <xs:complexContent>
                <xs:restriction base="st:facet">
                    <xs:sequence>
                        <xs:element ref="st:annotation" minOccurs="0"/>
                    </xs:sequence>
                    <xs:attribute name="value" type="xs:nonNegativeInteger" use="required"/>
                </xs:restriction>
            </xs:complexContent>
        </xs:complexType>
        <xs:element name="totalDigits" id="totalDigits">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
totalDigits"</xs:documentation>
            </xs:annotation>
            <xs:complexType>
```

```
                <xs:complexContent>
                    <xs:restriction base="st:numFacet">
                        <xs:sequence>
                            <xs:element ref="st:annotation" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="value" type="xs:positiveInteger" use="required"/>
                    </xs:restriction>
                </xs:complexContent>
            </xs:complexType>
        </xs:element>
        <xs:element name="fractionDigits" type="st:numFacet" id="fractionDigits">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
fractionDigits"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="length" type="st:numFacet" id="length">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-length"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minLength" type="st:numFacet" id="minLength">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
minLength"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maxLength" type="st:numFacet" id="maxLength">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
maxLength"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="enumeration" type="st:noFixedFacet" id="enumeration">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
enumeration"</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="whiteSpace" id="whiteSpace">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
whiteSpace"</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:complexContent>
                    <xs:restriction base="st:facet">
                        <xs:sequence>
                            <xs:element ref="st:annotation" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="value" use="required">
                            <xs:simpleType>
                                <xs:restriction base="xs:NMTOKEN">
                                    <xs:enumeration value="preserve"/>
                                    <xs:enumeration value="replace"/>
                                    <xs:enumeration value="collapse"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:attribute>
                    </xs:restriction>
                </xs:complexContent>
            </xs:complexType>
        </xs:element>
        <xs:element name="pattern" type="st:noFixedFacet" id="pattern">
            <xs:annotation>
                <xs:documentation> source="./XML Schema Part 2 Datatypes.htm#element-
pattern"</xs:documentation>
            </xs:annotation>
        </xs:element>
</xs:schema>
```

A 2 Observation Schemas

A 2.1 O&M schemas

A set of schemas describe the Observation feature types. These are in the namespace http://www.opengis.net/om

A 1.2.2 Event

Listing 37. event.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema 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"
      targetNamespace="http://www.opengis.net/om" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="pre-release">
      <annotation>
            <documentation>event.xsd

Components required to establish the top-level of the om:Event substitution group

Copyright © 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</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"/>
      <import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
      <!-- ================================================================== -->
      <!-- ================================================== -->
      <complexType name="TimeObjectPropertyType">
            <sequence minOccurs="0">
                  <element ref="gml:_TimeObject"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
      </complexType>
      <!-- ================================================== -->
      <complexType name="LocationPropertyType">
            <sequence minOccurs="0">
                  <choice>
                        <element ref="gml:_Geometry"/>
                        <element ref="gmd:EX_GeographicDescription"/>
                  </choice>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
            <attribute name="unionSemantics">
                  <simpleType>
                        <restriction base="string">
                              <enumeration value="geometryLocation"/>
                              <enumeration value="nameLocation"/>
                        </restriction>
                  </simpleType>
            </attribute>
      </complexType>
      <!-- ================================================================== -->
      <complexType name="EventType">
            <annotation>
                  <documentation>Description of an event, particularly that causes transformation, creation or destruction
of a feature.
    The event may be transport or administrative.
    Use gml:description to describe the nature of the event or action, or to point to a description of it.
    Specialised event types may be derived from this type.</documentation>
            </annotation>
            <complexContent>
```

```
                <extension base="gml:AbstractFeatureType">
                    <sequence>
                        <element name="time" type="om:TimeObjectPropertyType">
                            <annotation>
                                <documentation>
                                    The Time when the event occurred (mandatory).
                This may be given
            * in absolute terms as a TimeInstant or TimePeriod
            * in approximate terms or relative to an absolute position using the indeterminatePosition attribute
            * or using a TimeTopology element (TimeEdge or TimeNode), which provides the option of giving a time relative
to other edges or nodes, either directly (gml) or indirectly (xmml)
            * as a TimeGeometricComplex if it is a recurring or repeating event</documentation>
                            </annotation>
                        </element>
                        <element name="location" type="om:LocationPropertyType" minOccurs="0" >
                            <annotation>
                                <documentation>
                            Location where the event took place (optional)</documentation>
                            </annotation>
                        </element>
                        <element name="precedingEvent" type="gml:StringOrRefType" minOccurs="0"
maxOccurs="unbounded">
                            <annotation>
                                <documentation>Description of, or pointer to, preceding
event(s)</documentation>
                            </annotation>
                        </element>
                        <element name="followingEvent" type="gml:StringOrRefType" minOccurs="0"
maxOccurs="unbounded">
                            <annotation>
                                <documentation>Description of, or pointer to, following event(s)</documentation>
                            </annotation>
                        </element>
                        <element name="responsible" type="gmd:CI_ResponsibleParty_PropertyType"
minOccurs="0">
                            <annotation>
                                <documentation>Person or organisation responsible for the event, if applicable.
                            The nature of the responsibility (i.e. the role of the party with respect to the event) may be
indicated using the xlink:arcrole attribute.
                            Examples of roles are operator, sponsor, requestor, provider, processor,
etc.</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="Event" type="om:EventType" substitutionGroup="gml:_Feature"/>
        <!-- ..................... -->
        <complexType name="EventPropertyType">
            <sequence minOccurs="0">
                <element ref="om:Event"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
</schema>
```

A 1.2.3 Procedure

Listing 38. procedure.xsd

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

Components to describe procedures used in observations and measurements, and other events.

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</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"/>
      <import namespace="http://www.opengis.net/swe" schemaLocation="../../sweCommon/1.0.30/swe.xsd"/>
      <include schemaLocation="./event.xsd"/>
      <!-- ============================================================================ -->
      <!-- ============================================================================ -->
      <!-- === Generic Procedure type === -->
      <complexType name="ProcedureTypeType">
            <annotation>
                  <documentation>Use gml:description element to describe the procedure or link to a definitive
description.</documentation>
            </annotation>
            <complexContent>
                  <extension base="gml:DefinitionType"/>
            </complexContent>
      </complexType>
      <!-- ..................... -->
      <element name="ProcedureType" type="om:ProcedureTypeType" abstract="true"
substitutionGroup="gml:Definition">
            <annotation>
                  <documentation>Abstract Head of substitution group.
                  Procedures may be listed in a Dictionary (i.e. lightweight registry)</documentation>
            </annotation>
      </element>
      <!-- ..................... -->
      <complexType name="ProcedureTypePropertyType">
            <sequence minOccurs="0">
                  <element ref="om:ProcedureType"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
      </complexType>
      <!-- ============================================================================ -->
      <complexType name="ProcedureSequenceType">
            <annotation>
                  <documentation>
                  </documentation>
            </annotation>
            <complexContent>
                  <extension base="om:ProcedureTypeType">
                        <sequence>
                              <element name="step" type="om:ProcedurePropertyType" maxOccurs="unbounded"/>
                        </sequence>
                  </extension>
            </complexContent>
      </complexType>
      <!-- ..................... -->
      <element name="ProcedureSequence" type="om:ProcedureSequenceType"
substitutionGroup="om:ProcedureType">
            <annotation>
                  <documentation>
                  </documentation>
```

```
            </annotation>
        </element>
        <!-- ..................... -->
        <complexType name="ProcedureSequencePropertyType">
            <sequence minOccurs="0">
                <element ref="om:ProcedureSequence"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="ProcedurePackageType">
            <annotation>
                <documentation>
                </documentation>
            </annotation>
            <complexContent>
                <extension base="om:ProcedureTypeType">
                    <sequence>
                        <element name="element" type="gml:ReferenceType" maxOccurs="unbounded"/>
                    </sequence>
                    <attribute name="count" type="positiveInteger"/>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="ProcedurePackage" type="om:ProcedurePackageType" substitutionGroup="om:ProcedureType">
            <annotation>
                <documentation>
                </documentation>
            </annotation>
        </element>
        <!-- ..................... -->
        <complexType name="ProcedurePackagePropertyType">
            <sequence minOccurs="0">
                <element ref="om:ProcedurePackage"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <!-- ========================================================================== -->
        <!-- ========================================================================== -->
        <complexType name="ProcedureEventType">
            <annotation>
                <documentation>Description of an event involving a procedure.</documentation>
            </annotation>
            <complexContent>
                <extension base="om:EventType">
                    <sequence>
                        <element name="procedureUsed" type="om:ProcedureTypePropertyType"/>
                        <element name="termParameter" type="swe:TypedCategoryType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="countParameter" type="swe:TypedCountType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="measureParameter" type="swe:TypedMeasureType" minOccurs="0"
maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="ProcedureEvent" type="om:ProcedureEventType" substitutionGroup="om:Event">
            <annotation>
                <documentation>Description of an event involving a procedure.</documentation>
            </annotation>
        </element>
        <!-- ..................... -->
        <complexType name="ProcedureEventPropertyType">
            <sequence minOccurs="0">
                <element ref="om:ProcedureEvent"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
```

```
    </complexType>
    <!-- ========================================================================== -->
    <complexType name="ProcedureHistoryType">
        <annotation>
            <documentation>An ordered sequence of ProcedureEvents.</documentation>
        </annotation>
        <complexContent>
            <extension base="om:ProcedureEventType">
                <sequence>
                    <element name="step" type="om:ProcedureEventPropertyType" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ........................ -->
    <element name="ProcedureHistory" type="om:ProcedureHistoryType" substitutionGroup="om:ProcedureEvent">
        <annotation>
            <documentation>
            </documentation>
        </annotation>
    </element>
    <!-- ........................ -->
    <complexType name="ProcedureHistoryPropertyType">
        <sequence minOccurs="0">
            <element ref="om:ProcedureHistory"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ========================================================================== -->
    <complexType name="ProcedurePropertyType">
        <sequence minOccurs="0">
            <choice>
                <element ref="om:ProcedureType"/>
                <element ref="om:ProcedureEvent"/>
            </choice>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
        <attribute name="unionSemantics">
            <simpleType>
                <restriction base="string">
                    <enumeration value="genericProcedure"/>
                    <enumeration value="procedureInstance"/>
                </restriction>
            </simpleType>
        </attribute>
    </complexType>
    <!-- ========================================================================== -->
</schema>
```

A 1.2.4 Specialized procedures

Listing 39. procedureSpecializations.xsd

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

Components to describe procedures used in observations and measurements, and other events.

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</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"/>
	<import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
	<include schemaLocation="./procedure.xsd"/>
	<!-- ============================================================================ -->
	<!-- ============================================================================ -->
	<!-- === Specialised Procedure types === -->
	<!-- ============================================================================ -->
	<complexType name="ObservationProcedureType">
		<annotation>
			<documentation>Use gml:description element to describe the procedure or link to a definitive description.
</documentation>
		</annotation>
		<complexContent>
			<extension base="om:ProcedureTypeType">
				<sequence>
					<element name="method" type="string">
						<annotation>
							<documentation>Code for the particular procedure type.  Usually an item from a
list or registry of procedures, methods, instrument-types, etc.</documentation>
						</annotation>
					</element>
					<element name="resultQuality" type="gmd:DQ_DataQuality_PropertyType" minOccurs="0">
						<annotation>
							<documentation>Quality associated systematically with observations made using
this procedure.</documentation>
						</annotation>
					</element>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="ObservationProcedure" type="om:ObservationProcedureType"
substitutionGroup="om:ProcedureType">
		<annotation>
			<documentation>Procedures may be listed in a Dictionary (i.e. lightweight registry)</documentation>
		</annotation>
	</element>
	<!-- ..................... -->
	<complexType name="ObservationProcedurePropertyType">
		<sequence minOccurs="0">
			<element ref="om:ObservationProcedure"/>
		</sequence>
		<attributeGroup ref="gml:AssociationAttributeGroup"/>
	</complexType>
	<!-- ============================================================================ -->
	<!-- ============================================================================ -->
	<complexType name="InstrumentType">
		<annotation>
```

```
                <documentation>Add one or more instrument serial numbers, in order to identify specific instances or
stations</documentation>
            </annotation>
            <complexContent>
                <extension base="om:ObservationProcedureType">
                    <sequence>
                        <element name="serialNumber" type="string" minOccurs="0" maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="Instrument" type="om:InstrumentType" substitutionGroup="om:ObservationProcedure"/>
        <!-- ..................... -->
        <complexType name="InstrumentPropertyType">
            <sequence minOccurs="0">
                <element ref="om:Instrument"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================= -->
        <complexType name="CalculationProcedureType">
            <annotation>
                <documentation>Use the "description" property to record the details of the calculation</documentation>
            </annotation>
            <complexContent>
                <extension base="om:ProcedureTypeType"/>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="CalculationProcedure" type="om:CalculationProcedureType"
substitutionGroup="om:ProcedureType"/>
        <!-- ..................... -->
        <complexType name="CalculationProcedurePropertyType">
            <sequence minOccurs="0">
                <element ref="om:CalculationProcedure"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================= -->
</schema>
```

A 1.2.5 Observation

Listing 40. 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" xmlns:swe="http://www.opengis.net/swe"
targetNamespace="http://www.opengis.net/om" elementFormDefault="qualified" attributeFormDefault="unqualified"
version="pre-release">
    <annotation>
        <documentation>observation.xsd

An implementation of the OandM model for SWE

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</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"/>
    <import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
    <import namespace="http://www.opengis.net/swe" schemaLocation="../../sweCommon/1.0.30/swe.xsd"/>
    <include schemaLocation="./procedureSpecializations.xsd"/>
    <!-- ============================================================== -->
    <!-- ============================================================== -->
    <!-- ===== Object types for Observations ====== -->
    <!-- ============================================================== -->
    <complexType name="AbstractObservationType">
        <annotation>
            <documentation>Base type for Observations.

                Concrete Observation types must extend this type with a "result" of the appropriate type.

                The following properties are inherited from EventType:
                    <!--   from AbstractGMLType
                    <group ref="gml:StandardObjectProperties"/> -->
                    <!-- or
                    <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"/> -->
                    <!--   from EventType
                    <element name="time" type="om:TimeObjectPropertyType" nillable="true"/>
                    <element name="location" type="om:LocationPropertyType" nillable="true"/>
                    <element name="precedingEvent" type="gml:StringOrRefType" minOccurs="0"
maxOccurs="unbounded"/>
                    <element name="followingEvent" type="gml:StringOrRefType" minOccurs="0"
maxOccurs="unbounded"/>
                    <element name="responsible" type="meta:PartyPropertyType" minOccurs="0"
maxOccurs="unbounded"/> -->

                In the context of an Observation, the interpretation of some of the properties shall be refined as
follows:
                time - the date/Time at which the procedure was executed
                location - the location of the procedure (sensor, intrument, computational engine) at the time of the
observation event

                For "in situ" procedures the value of the location will usually be the same as the location of the
featureOfInterest.
                For "remote" procedures the location will normally be removed from the location of the
featureOfInterest</documentation>
        </annotation>
        <complexContent>
            <extension base="om:EventType">
                <sequence>
                    <element name="procedure" type="om:ObservationProcedurePropertyType"/>
```

```
                        <element name="countParameter" type="swe:TypedCountType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="measureParameter" type="swe:TypedMeasureType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="termParameter" type="swe:TypedCategoryType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="observedProperty" type="swe:PhenomenonPropertyType">
                            <annotation>
                                <documentation>Link to a description of the property or phenomenon whose value
is being described or estimated through observation
                                for example "wavelength", "grass-species", "power", "intensity in the waveband x-
y", etc.
                                It is this feature-property that provides the (semantic) type of the observation.
                                Note that the description of the phenomenon may be quite specific and
constrained.
                                In general the precise details of the constraints describing the observe properties
require attention to the procedure used in making the observation:
                                e.g. an optical sensor typically has a wavelength-dependent response.
                                This property may be provided for client convenience, to allow comparison
between and aggregation of observations of the same property made using different procedures.</documentation>
                            </annotation>
                        </element>
                        <element name="quality" type="gmd:DQ_DataQuality_PropertyType" minOccurs="0"
maxOccurs="unbounded">
                            <annotation>
                                <documentation>Allow multiple quality measures if required.</documentation>
                            </annotation>
                        </element>
                        <element name="featureOfInterest" type="gml:FeaturePropertyType">
                            <annotation>
                                <documentation>the Feature regarding which the observations are being made,
            sometimes called the target or subject of the observation, such as a specimen, station, tract, mountain,
pixel, etc.

            The spatial properties (location) of the feature of interest are typically of most interest for spatial analysis
of the observation result.

            If any of the properties are time dependent, then the values at the Observation/eventTime should
appear.</documentation>
                            </annotation>
                        </element>
                        <!--
                        <element name="result" type="anyType">
                            <annotation>
                                <documentation>This is a placeholder - concrete types must replace (restrict) this
with a "result" property of the correct type. </documentation>
                            </annotation>
                        </element>
                        -->
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..... -->
        <element name="AbstractObservation" type="om:AbstractObservationType" abstract="true"
substitutionGroup="om:Event">
            <annotation>
                <documentation>Head of Observation substitution group</documentation>
            </annotation>
        </element>
        <!-- ..... -->
        <complexType name="AbstractObservationPropertyType">
            <sequence minOccurs="0">
                <element ref="om:AbstractObservation"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================== -->
        <complexType name="ObservationType">
            <annotation>
                <documentation>Observation event.
```

```
                carries a generic  "result" properties of type "anyType".</documentation>
            </annotation>
            <complexContent>
                <extension base="om:AbstractObservationType">
                    <sequence>
                        <element name="resultDefinition" type="swe:SWE_RecordSchemaPropertyType"
minOccurs="0">
                            <annotation>
                                <documentation>Allows additional soft-typing information concerning the result
structure to be recorded locally.
Typically this will be a "schema" for the result-tuple, needed to complete the description of the result structure where its
type is Record or NumericRecord. </documentation>
                            </annotation>
                        </element>
                        <element name="result" type="anyType" nillable="true">
                            <annotation>
                                <documentation>an xsi:type attribute may appear in the instance to indicate the
type of the result</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="Observation" type="om:ObservationType" substitutionGroup="om:AbstractObservation">
            <annotation>
                <documentation>Generic Observation event</documentation>
            </annotation>
        </element>
        <!-- ========================================================================= -->
        <!-- ===== Observation Collection ======= -->
        <!-- ========================================================================= -->
        <complexType name="ObservationCollectionType">
            <complexContent>
                <extension base="om:EventType">
                    <sequence>
                        <element name="member" type="om:AbstractObservationPropertyType"
maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="ObservationCollection" type="om:ObservationCollectionType" substitutionGroup="om:Event">
            <annotation>
                <documentation>Observation collection, using the "Composite" pattern</documentation>
            </annotation>
        </element>
        <!-- ========================================================================= -->
        <!-- === Convenience type to serve as value of feature-of-interest when no other feature type catalogue is available
=== -->
        <!-- ========================================================================  -->
        <complexType name="StationType">
            <annotation>
                <documentation>A "Station" is an identified position (0-D geospatial feature).
                It may be revisited for various purposes, in particular to retrieve multiple specimens or make repeated or
complementary observations.
                The position property of the station provides the value of the position property of observations an specimens
associated with the station.
                The procedureHosted property allows the user to point to one or more sensors or other procedures that are
relevant to this station.

                By using the Station feature, this position information and any metadata associated with it may be encoded in
one place,
                i.e. normalised, and then re-used _by reference_ on other feature instances associated with
it.</documentation>
            </annotation>
            <complexContent>
                <extension base="gml:AbstractFeatureType">
                    <sequence>
```

```
                        <element name="position" type="gml:PointPropertyType"/>
                        <element name="procedureHosted" type="gml:ReferenceType" maxOccurs="unbounded"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="Station" type="om:StationType" substitutionGroup="gml:_Feature"/>
        <!-- ..................... -->
        <complexType name="StationPropertyType">
            <sequence minOccurs="0">
                <element ref="om:Station"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ============================================================================ -->
        <complexType name="ExternalReferenceType">
            <complexContent>
                <extension base="gml:ReferenceType">
                    <attribute name="mimeType" type="anyURI" use="required"/>
                </extension>
            </complexContent>
        </complexType>
        <!-- ============================================================================ -->
</schema>
```

A 1.2.6 Specialized observations

Listing 41. observationSpecializations.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"
xmlns:swe="http://www.opengis.net/swe" targetNamespace="http://www.opengis.net/om" elementFormDefault="qualified"
attributeFormDefault="unqualified" version="pre-release">
	<annotation>
		<documentation>observationSpecializations.xsd

An implementation of the OandM model for SWE
This document contains various specializations of the basic observation pattern, primarily by fixing the type of the result.

Copyright (c) 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</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"/>
	<import namespace="http://www.opengis.net/swe" schemaLocation="../../sweCommon/1.0.30/swe.xsd"/>
	<include schemaLocation="./observation.xsd"/>
	<!-- ================================================================== -->
	<!-- ================================================================== -->
	<!-- ===== Object types for Observations ====== -->
	<!-- ================================================================== -->
	<complexType name="MeasurementType">
		<annotation>
			<documentation>Measurement event.
			carries one "result" properties of type "ResultMeasureType".</documentation>
		</annotation>
		<complexContent>
			<extension base="om:AbstractObservationType">
				<sequence>
					<element name="result" type="swe:RelativeMeasureType" nillable="true"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="Measurement" type="om:MeasurementType" substitutionGroup="om:AbstractObservation">
		<annotation>
			<documentation>Measurement event</documentation>
		</annotation>
	</element>
	<!-- ================================================================== -->
	<complexType name="CategoryObservationType">
		<annotation>
			<documentation>Observation, in which the result is a textual value from a controlled
vocabulary</documentation>
		</annotation>
		<complexContent>
			<extension base="om:AbstractObservationType">
				<sequence>
					<element name="result" type="swe:ScopedNameType"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="CategoryObservation" type="om:CategoryObservationType"
substitutionGroup="om:AbstractObservation">
		<annotation>
			<documentation>Observation, in which the result is a textual value from a controlled
vocabulary</documentation>
		</annotation>
	</element>
	<!-- ================================================================== -->
```

```
	<complexType name="CountObservationType">
		<annotation>
			<documentation>Observation, in which the result is an integer representing the count of the observed
property</documentation>
		</annotation>
		<complexContent>
			<extension base="om:AbstractObservationType">
				<sequence>
					<element name="result" type="integer"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="CountObservation" type="om:CountObservationType"
substitutionGroup="om:AbstractObservation">
		<annotation>
			<documentation>Observation, in which the result is an integer representing the count of the observed
property</documentation>
		</annotation>
	</element>
	<!-- ========================================================================= -->
	<complexType name="TruthObservationType">
		<annotation>
			<documentation>Observation, in which the result is a boolean value representing the truth value (usually
existence) of the observed property</documentation>
		</annotation>
		<complexContent>
			<extension base="om:AbstractObservationType">
				<sequence>
					<element name="result" type="boolean"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="TruthObservation" type="om:TruthObservationType"
substitutionGroup="om:AbstractObservation">
		<annotation>
			<documentation>Observation, in which the result is a boolean value representing the truth value (usually
existence) of the observed property</documentation>
		</annotation>
	</element>
	<!-- ========================================================================= -->
	<!-- ========================================================================= -->
	<complexType name="CommonObservationType">
		<annotation>
			<documentation>Observation event.
			"result" property contains an sml:DataValue
			resultDefinition property contains value record schema, used to parse value, and an indication of the
encoding</documentation>
		</annotation>
		<complexContent>
			<extension base="om:AbstractObservationType">
				<sequence>
					<element name="resultDefinition" type="swe:DataDefinitionPropertyType"/>
					<element name="result" type="swe:DataValueType" nillable="true"/>
				</sequence>
			</extension>
		</complexContent>
	</complexType>
	<!-- ..................... -->
	<element name="CommonObservation" type="om:CommonObservationType"
substitutionGroup="om:AbstractObservation">
		<annotation>
			<documentation>Observation event</documentation>
		</annotation>
	</element>
	<!-- ========================================================================= -->
	<!-- ===== Composite Observation ======= -->
	<!-- ========================================================================= -->
```

```
    <complexType name="CompositeObservationType">
        <complexContent>
            <extension base="om:ObservationCollectionType">
                <sequence>
                    <element name="sampleDesign" type="string"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................... -->
    <element name="CompositeObservation" type="om:CompositeObservationType"
substitutionGroup="om:ObservationCollection">
        <annotation>
            <documentation>Specialization of ObservationCollection, in which the members of the collection refer to
a consistent target, time etc. Functionally equivalent to ComplexObservation</documentation>
        </annotation>
    </element>
    <!-- ================================================================== -->
</schema>
```

NOTE: CommonObservation is a specialized observation type in which the value of the result property is a DataValue from the SWE Common components. DataDefinition and DataValue are fully documented in the SensorML specification (OGC document 05-086).

A 1.2.7 O&M wrapper schema

Listing 42. om.xsd

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

The complete Observations and Measurements schema

Copyright © 2005 Open Geospatial Consortium - see http://www.opengeospatial.org/about/?page=ipr</documentation>
	</annotation>
	<!-- ========================================================================== -->
	<include schemaLocation="./observationSpecializations.xsd"/>
	<include schemaLocation="./procedureSpecializations.xsd"/>
	<!-- ========================================================================== -->
</schema>
```

Annex B
(informative)

Additional XML Schemas

B.1 Sampling

B.1.1 Sampling Features

A key property of an Observation is the “featureOfInterest”. Since observations may be made on more-or-less any real-world object, the feature of interest may be defined in any application schema, which will generally be domain-specific. Nevertheless, there is a set of feature-types that exist primarily to support observations. These include stations, profiles, sections, area-of-interest, etc, and physical specimens. A set of schemas describing these components has been developed by the SEE Grid community, and is provided here as a utility schema, for use directly, or by extension, for observation applications. These are in the namespace http://www.seegrid.csiro.au/xml/sampling

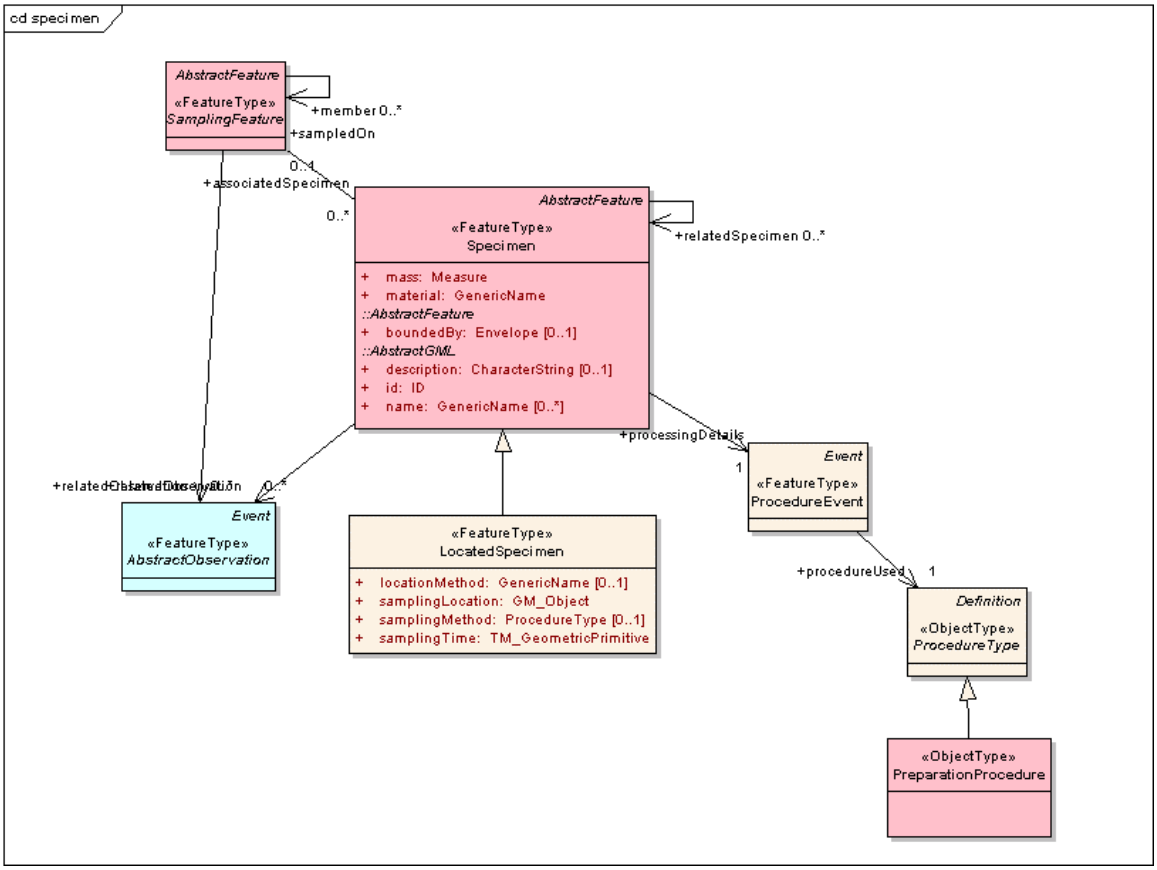

Figure 8. Feature types that exist primarily to support observation sampling

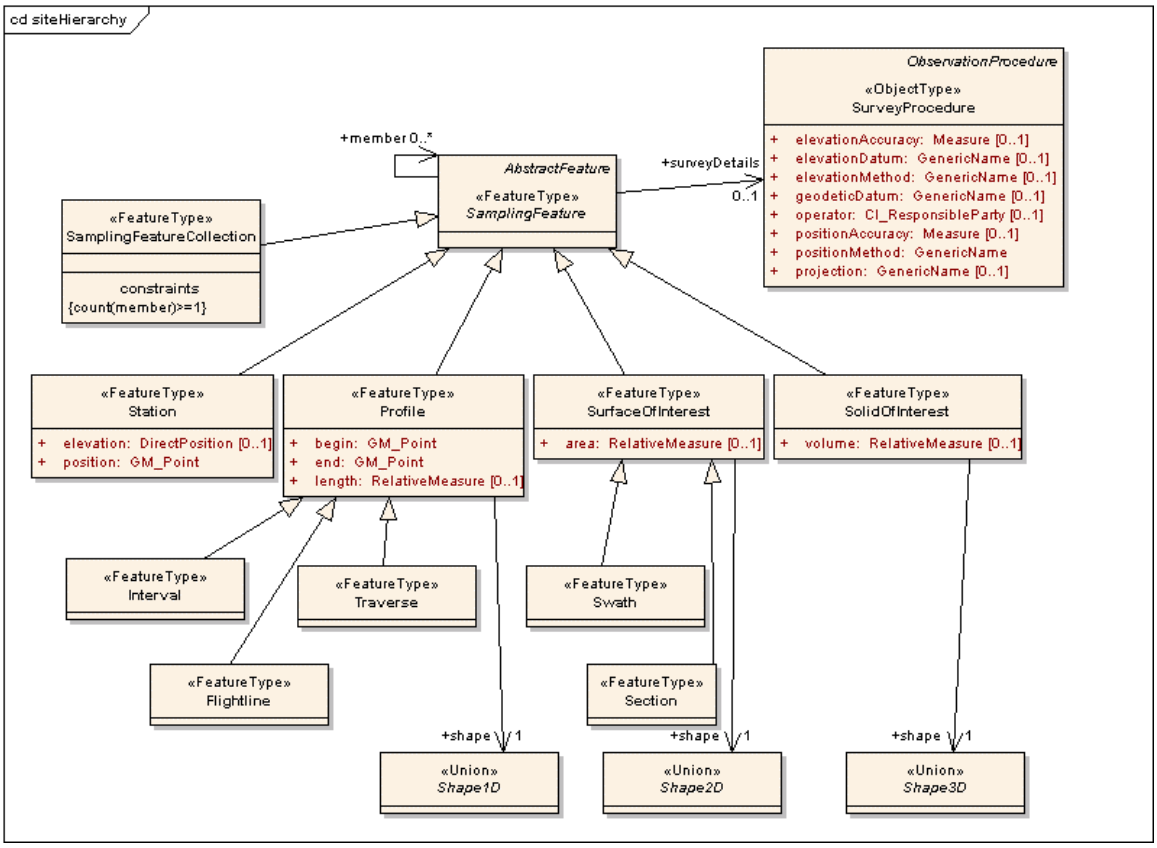

Figure 9. A hierarchy of site types used for observation sampling. Note that the Union classes Shape1D, Shape2D, Shape3D are sets of curve, surface and solid classes provided for convenience.

A 1.2.8 Survey Procedure

Listing 43. surveyProcedure.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:sa="http://www.seegrid.csiro.au/xml/sampling" xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml" xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:om="http://www.opengis.net/om" targetNamespace="http://www.seegrid.csiro.au/xml/sampling"
elementFormDefault="qualified" attributeFormDefault="unqualified" version="pre-release">
    <annotation>
        <documentation>procedures.xsd

Components to describe procedures used in sampling.

Copyright (c) 2005 CSIRO - see
https://www.seegrid.csiro.au/twiki/bin/view/Xmml/LegalNotices#Software_Notice</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"/>
    <import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
    <import namespace="http://www.opengis.net/om" schemaLocation="../../om/1.0.30/om.xsd"/>
    <include schemaLocation="./LUTgeodesy.xsd"/>
    <!-- ================================================================== -->
    <!-- ================================================================== -->
    <complexType name="SurveyProcedureType">
        <annotation>
            <documentation/>
        </annotation>
        <complexContent>
            <extension base="om:ProcedureTypeType">
                <sequence>
                    <element name="positionMethod" type="sa:positionMethodType" minOccurs="0"/>
                    <element name="positionAccuracy" type="gml:MeasureType" minOccurs="0"/>
                    <element name="elevationMethod" type="sa:elevationMethodType" minOccurs="0"/>
                    <element name="elevationAccuracy" type="gml:MeasureType" minOccurs="0"/>
                    <element name="projection" type="sa:projections" minOccurs="0"/>
                    <element name="geodeticDatum" type="sa:gDatums" minOccurs="0"/>
                    <element name="elevationDatum" type="sa:vDatums" minOccurs="0"/>
                    <element name="operator" type="gmd:CI_ResponsibleParty_PropertyType" minOccurs="0">
                        <annotation>
                            <documentation>Note than in other contexts the "operator" is not embedded in the
procedure description. Maybe needs a tweak later?</documentation>
                        </annotation>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................... -->
    <element name="SurveyProcedure" type="sa:SurveyProcedureType" substitutionGroup="om:ProcedureType"/>
    <!-- ..................... -->
    <complexType name="SurveyProcedurePropertyType">
        <sequence minOccurs="0">
            <element ref="sa:SurveyProcedure"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ================================================================== -->
</schema>
```

A 1.2.9 Site/Sampling feature

Listing 44. site.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema
xmlns:gml="http://www.opengis.net/gml"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:om="http://www.opengis.net/om"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:sa="http://www.seegrid.csiro.au/xml/sampling"
targetNamespace="http://www.seegrid.csiro.au/xml/sampling"
elementFormDefault="qualified" attributeFormDefault="unqualified" version="pre-release">
	<annotation>
		<documentation>site.xsd

Sites are feature types that are used primarily for making observations:
Site, Station (0-D, and collections are described in this schema document

Profile, Interval, Traverse, Flightline, Borehole (1-D)
SurfaceOfInterest, Swath (2-D)
SolidOfInterest (3-D) are described in extensiveSite.xsd

Copyright (c) 2005 CSIRO - see
https://www.seegrid.csiro.au/twiki/bin/view/Xmml/LegalNotices#Software_Notice</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"/>
	<import namespace="http://www.isotc211.org/2005/gmd"
schemaLocation="../../iso19139/gml3.1.1version/gmd/gmd.xsd"/>
	<import namespace="http://www.opengis.net/om" schemaLocation="../../om/1.0.30/om.xsd"/>
	<include schemaLocation="./surveyProcedure.xsd"/>
	<include schemaLocation="./specimen.xsd"/>
	<!--
	<include schemaLocation="../enumerations/LUTgeography.xsd"/>
	-->
	<!-- ================================================================== -->
	<!-- ===== Feature types in Site hierarchy ====== -->
	<!-- ================================================================== -->
	<complexType name="SamplingFeatureType">
		<annotation>
			<documentation>A "SamplingFeature" is a feature used primarily for taking
observations.</documentation>
		</annotation>
		<complexContent>
			<extension base="gml:AbstractFeatureType">
				<sequence>
					<element name="member" type="sa:SamplingFeaturePropertyType" minOccurs="0"
maxOccurs="unbounded">
						<annotation>
							<documentation>A site is often associated with a set of member sites: e.g.
stations on a traverse, intervals in a borehole or section, boreholes within an area of interest.</documentation>
						</annotation>
					</element>
					<element name="surveyDetails" type="sa:SurveyProcedurePropertyType" nillable="true">
						<annotation>
							<documentation>Description of, or link to, the procedure used in determining the
position of the site.
		For complex procedures, such as when elevation and position are determined separately, may be
disaggregated.</documentation>
						</annotation>
					</element>
					<element name="associatedSpecimen" type="sa:SpecimenPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
					<element name="relatedObservation" type="om:AbstractObservationPropertyType"
minOccurs="0" maxOccurs="unbounded"/>
				</sequence>
```

```
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="SamplingFeature" type="sa:SamplingFeatureType" abstract="true"
substitutionGroup="gml:_Feature"/>
        <!-- ..................... -->
        <complexType name="SamplingFeaturePropertyType">
            <sequence minOccurs="0">
                <element ref="sa:SamplingFeature"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="SamplingFeatureCollectionType">
            <complexContent>
                <restriction base="sa:SamplingFeatureType">
                    <sequence>
                        <group ref="gml:StandardObjectProperties"/>
                        <element ref="gml:boundedBy">
                            <annotation>
                                <documentation>The bounds of a SiteCollection must be
provided</documentation>
                            </annotation>
                        </element>
                        <element name="member" type="sa:SamplingFeaturePropertyType" minOccurs="1"
maxOccurs="unbounded">
                            <annotation>
                                <documentation>A SiteCollection must have at least one member
site</documentation>
                            </annotation>
                        </element>
                        <element name="surveyDetails" type="sa:SurveyProcedurePropertyType" nillable="true"/>
                        <element name="associatedSpecimen" type="sa:SpecimenPropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                        <element name="relatedObservation" type="om:AbstractObservationPropertyType"
minOccurs="0" maxOccurs="unbounded"/>
                    </sequence>
                </restriction>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="SamplingFeatureCollection" type="sa:SamplingFeatureCollectionType"
substitutionGroup="sa:SamplingFeature"/>
        <!-- ..................... -->
        <complexType name="SamplingFeatureCollectionPropertyType">
            <sequence minOccurs="0">
                <element ref="sa:SamplingFeatureCollection"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <complexType name="StationType">
            <annotation>
                <documentation>A "Station" is an identified position (0-D geospatial feature).
            It may be revisited for various purposes, in particular to retrieve multiple specimens or make repeated or
complementary observations.
            The position property of the station provides the value of the position property of observations an specimens
associated with the station.
            By using the Station feature, this position information and any metadata associated with it may be encoded in
one place, i.e. normalised, and then re-used _by reference_ on other feature instances associated with
it.</documentation>
            </annotation>
            <complexContent>
                <extension base="sa:SamplingFeatureType">
                    <sequence>
                        <element name="position" type="gml:PointPropertyType"/>
                        <element name="elevation" type="gml:DirectPositionType" minOccurs="0">
                            <annotation>
                                <documentation>Use the srsName attribute to record the elevation
datum</documentation>
```

```
                                    </annotation>
                                </element>
                            </sequence>
                        </extension>
                    </complexContent>
                </complexType>
                <!-- ..................... -->
                <element name="Station" type="sa:StationType" substitutionGroup="sa:SamplingFeature"/>
                <!-- ..................... -->
                <complexType name="StationPropertyType">
                    <sequence minOccurs="0">
                        <element ref="sa:Station"/>
                    </sequence>
                    <attributeGroup ref="gml:AssociationAttributeGroup"/>
                </complexType>
                <!-- ========================================================================== -->
                <!-- ========================================================================== -->
</schema>
```

A 1.2.10 Extensive sites

Listing 45. extensiveSite.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:gml="http://www.opengis.net/gml" xmlns:geo="http://www.seegrid.csiro.au/xml/geometry"
xmlns:swe="http://www.opengis.net/swe" xmlns:om="http://www.opengis.net/om"
xmlns="http://www.w3.org/2001/XMLSchema" xmlns:sa="http://www.seegrid.csiro.au/xml/sampling"
targetNamespace="http://www.seegrid.csiro.au/xml/sampling" elementFormDefault="qualified"
attributeFormDefault="unqualified" version="pre-release">
    <annotation>
        <documentation>extensiveSite.xsd

Sites are feature types that are used primarily for making observations:
Site, Station (0-D), and collections are described in site.xsd

Profile, Interval, Traverse, Flightline, Borehole (1-D)
SurfaceOfInterest, Swath (2-D)
SolidOfInterest (3-D) are described in this schema document

In many cases the properties of interest vary within the site, so may be represented as a coverage associated with the
site.

Copyright (c) 2005 CSIRO - see
https://www.seegrid.csiro.au/twiki/bin/view/Xmml/LegalNotices#Software_Notice</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"/>
    <import namespace="http://www.opengis.net/om" schemaLocation="../../om/1.0.30/om.xsd"/>
    <import namespace="http://www.seegrid.csiro.au/xml/geometry" schemaLocation="../../geo/0.1.0/geo.xsd"/>
    <import namespace="http://www.opengis.net/swe" schemaLocation="../../sweCommon/1.0.30/swe.xsd"/>
    <include schemaLocation="./site.xsd"/>
    <!-- ============================================================== -->
    <!-- 1-D sites and sampling regimes -->
    <!-- ============================================================== -->
    <element name="Profile" type="sa:ProfileType" substitutionGroup="sa:SamplingFeature"/>
    <!-- ..................... -->
    <complexType name="ProfileType">
        <annotation>
            <documentation>A "Profile" is an identified 1-D spatial feature.
        It may be revisited for various purposes, in particular to retrieve multiple specimens or make repeated or
complementary observations.</documentation>
        </annotation>
        <complexContent>
            <extension base="sa:SamplingFeatureType">
                <sequence>
                    <element name="begin" type="gml:PointPropertyType"/>
                    <element name="end" type="gml:PointPropertyType"/>
                    <element name="length" type="swe:RelativeMeasureType"/>
                    <element name="shape" type="geo:Shape1DPropertyType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ..................... -->
    <complexType name="ProfilePropertyType">
        <sequence minOccurs="0">
            <element ref="sa:Profile"/>
        </sequence>
        <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </complexType>
    <!-- ============================================================== -->
    <!-- 2-D sites and sampling regimes -->
    <!-- ============================================================== -->
    <element name="SurfaceOfInterest" type="sa:SurfaceOfInterestType" substitutionGroup="sa:SamplingFeature"/>
    <!-- ..................... -->
    <complexType name="SurfaceOfInterestType">
```

```
            <annotation>
                <documentation>A "SurfaceOfInterest" is an identified 2-D spatial feature.
            It may be used for various purposes, in particular for observations of cross sections through
features.</documentation>
            </annotation>
            <complexContent>
                <extension base="sa:SamplingFeatureType">
                    <sequence>
                        <element name="area" type="swe:RelativeMeasureType"/>
                        <element name="shape" type="geo:Shape2DPropertyType"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <complexType name="SurfaceOfInterestPropertyType">
            <sequence minOccurs="0">
                <element ref="sa:SurfaceOfInterest"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
        <element name="Swath" type="sa:SwathType" substitutionGroup="sa:SurfaceOfInterest"/>
        <!-- ..................... -->
        <complexType name="SwathType">
            <annotation>
                <documentation> </documentation>
            </annotation>
            <complexContent>
                <extension base="sa:SurfaceOfInterestType"/>
            </complexContent>
        </complexType>
        <!-- ========================================================================== -->
        <element name="Section" type="sa:SectionType" substitutionGroup="sa:SurfaceOfInterest"/>
        <!-- ..................... -->
        <complexType name="SectionType">
            <annotation>
                <documentation> </documentation>
            </annotation>
            <complexContent>
                <extension base="sa:SurfaceOfInterestType"/>
            </complexContent>
        </complexType>
        <!-- ========================================================================== -->
        <!-- 3-D sites and sampling regimes -->
        <!-- ========================================================================== -->
        <element name="SolidOfInterest" type="sa:SolidOfInterestType" substitutionGroup="sa:SamplingFeature"/>
        <!-- ..................... -->
        <complexType name="SolidOfInterestType">
            <annotation>
                <documentation>A "SolidOfInterest" is an identified 3-D spatial feature used in sampling.
</documentation>
            </annotation>
            <complexContent>
                <extension base="sa:SamplingFeatureType">
                    <sequence>
                        <element name="volume" type="swe:RelativeMeasureType"/>
                        <element name="shape" type="geo:Shape3DPropertyType"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <complexType name="SolidOfInterestPropertyType">
            <sequence minOccurs="0">
                <element ref="sa:SolidOfInterest"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================== -->
</schema>
```

A 1.2.11 Specimens

Listing 46. specimen.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns:gml="http://www.opengis.net/gml" xmlns:om="http://www.opengis.net/om"
xmlns="http://www.w3.org/2001/XMLSchema" xmlns:sa="http://www.seegrid.csiro.au/xml/sampling"
      targetNamespace="http://www.seegrid.csiro.au/xml/sampling" elementFormDefault="qualified"
attributeFormDefault="unqualified" version="pre-release">
      <annotation>
            <documentation>specimen.xsd

feature types that are used primarily for making observations:

Copyright (c) 2005 CSIRO - see
https://www.seegrid.csiro.au/twiki/bin/view/Xmml/LegalNotices#Software_Notice</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"/>
      <import namespace="http://www.opengis.net/om" schemaLocation="../../om/1.0.30/om.xsd"/>
      <include schemaLocation="./surveyProcedure.xsd"/>
      <!--
      <include schemaLocation="../enumerations/LUTgeography.xsd"/>
      -->
      <!-- ================================================================== -->
      <!-- ================================================================== -->
      <complexType name="SpecimenType">
            <annotation>
                  <documentation>A located object on which measurements may be made.

                  A "Station" from where the specimen was obtained may be recorded using the samplingStation property.

                  A basic material classification is provided using the "material" property.
                  Its value may be relatively generic (rock, pulp) or may reflect a detailed classification (calcrete,
adamellite, biotite-schist).
                  In the latter case it is wise to use the codeSpace attribute to provide a link to the classification
scheme/vocabulary used.

                  Note that if this specimen is a "processed" version of another (e.g. by grinding, seiving, etc) then
                  the predecessor (if known) may be recorded as a relatedFeature

                  If this specimen has been processed from an "original" specimen,
                  as collected in the field or as supplied to the lab,
                  but results should be reported regarding the original,
                  then the original may be indicated using the reportingSpecimen property.

                  Related observations may also be recorded using the relatedFeature property.</documentation>
            </annotation>
            <complexContent>
                  <extension base="gml:AbstractFeatureType">
                        <sequence>
                              <element name="sampledOn" type="gml:ReferenceType" minOccurs="0">
                                    <annotation>
                                          <documentation>Pointer to the station, section, etc from which the specimen was
obtained</documentation>
                                    </annotation>
                              </element>
                              <element name="material" type="gml:CodeType">
                                    <annotation>
                                          <documentation>Material type, usually taken from a controlled vocabulary
                              Specialised domains may choose to fix the vocabulary to be used</documentation>
                                    </annotation>
                              </element>
                              <element name="mass" type="gml:MeasureType" nillable="true">
                                    <annotation>
                                          <documentation>The mass of the specimen</documentation>
                                    </annotation>
```

```
                        </element>
                        <element name="processingDetails" type="om:ProcedureEventPropertyType">
                            <annotation>
                                <documentation>One or more procedures may have been applied to a specimen.
        May contain collection, sampling and preparation procedures</documentation>
                            </annotation>
                        </element>
                        <element name="relatedSpecimen" type="gml:ReferenceType" minOccurs="0">
                            <annotation>
                                <documentation>A related specimen for which results may be
available.</documentation>
                            </annotation>
                        </element>
                        <element name="relatedObservation" type="om:AbstractObservationPropertyType"
minOccurs="0" maxOccurs="unbounded">
                            <annotation>
                                <documentation>An observation on the specimen</documentation>
                            </annotation>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="Specimen" type="sa:SpecimenType" substitutionGroup="gml:_Feature"/>
        <!-- ..................... -->
        <complexType name="SpecimenPropertyType">
            <sequence minOccurs="0">
                <element ref="sa:Specimen"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================= -->
        <complexType name="LocatedSpecimenType">
            <annotation>
                <documentation/>
            </annotation>
            <complexContent>
                <extension base="sa:SpecimenType">
                    <sequence>
                        <element name="samplingLocation" type="gml:GeometryPropertyType" nillable="true"/>
                        <element name="locationMethod" type="gml:StringOrRefType" minOccurs="0"/>
                        <element name="samplingTime" type="gml:TimePrimitivePropertyType" nillable="true">
                            <annotation>
                                <documentation>Time and date when the specimen was initially
retrieved</documentation>
                            </annotation>
                        </element>
                        <element name="samplingMethod" type="om:ProcedureTypePropertyType" minOccurs="0"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <!-- ..................... -->
        <element name="LocatedSpecimen" type="sa:LocatedSpecimenType" substitutionGroup="sa:Specimen"/>
        <!-- ..................... -->
        <complexType name="LocatedSpecimenPropertyType">
            <sequence minOccurs="0">
                <element ref="sa:LocatedSpecimen"/>
            </sequence>
            <attributeGroup ref="gml:AssociationAttributeGroup"/>
        </complexType>
        <!-- ========================================================================= -->
        <!-- ========================================================================= -->
</schema>
```

Annex C
(informative)

Additional XML Instances

C.1 Phenomenon dictionary

The document shown in Listing 47 shows a dictionary of phenomenon definitions used in many of the examples.

Listing 47. phenomena.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<gml:Dictionary xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
            xsi:schemaLocation="http://www.opengis.net/swe ../../sweCommon/1.0.30/phenomenon.xsd"
gml:id="phenomena1_0_30">
      <gml:description>A dictionary of phenomena, compiled through OWS-1, OWS-1.2 OWS-3.
SJDC 2005-10-03
</gml:description>
      <gml:name>OWS Phenomena</gml:name>
      <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="_19V">
                  <gml:description>19 GHz Radiation Vertical Polarisation</gml:description>
                  <gml:name>19V</gml:name>
                  <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:19V</gml:name>
                  <swe:base xlink:href="#Radiation"/>
                  <swe:measureConstraint property="#PeakWavelength"
uom="./units.xml#GHz">19.35</swe:measureConstraint>
                  <swe:categoryConstraint
property="http://www.opengis.net/componentPhenomenonType#PolarisationDirection"
codeSpace="http://www.opengis.net/sensorGlossary">V</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
      </gml:dictionaryEntry>
      <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="_19H">
                  <gml:description>19 GHz Radiation Horizontal Polarisation</gml:description>
                  <gml:name>19H</gml:name>
                  <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:19H</gml:name>
                  <swe:base xlink:href="#Radiation"/>
                  <swe:measureConstraint
property="http://www.opengis.net/componentPhenomenonType#peakWavelength"
uom="#GHz">19.35</swe:measureConstraint>
                  <swe:categoryConstraint
property="http://www.opengis.net/componentPhenomenonType#PolarisationDirection"
codeSpace="http://www.opengis.net/sensorGlossary">H</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
      </gml:dictionaryEntry>
      <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Age">
                  <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/time.owl#Age">Time duration since
creation</gml:description>
                  <gml:name>Age</gml:name>
                  <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Age</gml:name>
            </swe:Phenomenon>
      </gml:dictionaryEntry>
      <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="AtmosphericPressure">
```

```
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#AtmosphericPressure">fluid
pressure exerted due to the gravitational effect on the column of atmosphere above the position of
interest</gml:description>
                <gml:name>Atmospheric Pressure</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:AtmosphericPressure</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="CloudCover">
                <gml:description>fraction of sky occupied by visible cloud</gml:description>
                <gml:name>Cloud Cover</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:CloudCover</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Concentration">
                <gml:description
xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#MassConcentration">Amount of substance as a fraction of host
medium</gml:description>
                <gml:name>Concentration</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Concentration</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Density">
                <gml:description/>
                <gml:name>Density</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Density</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Depth">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Depth">Linear distance
measured vertically downwards from a reference surface</gml:description>
                <gml:name>Depth</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Depth</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="DewPointTemperature">
                <gml:description
xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#DewPointTemperature">Temperature at which water
condensation occurs, providing an indirect measure of humidity</gml:description>
                <gml:name>Dew Point Temperature</gml:name>
                <gml:name>Dew Point</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:DewPointTemperature</gml:name>
                <swe:base xlink:href="#Humidity"/>
                <swe:otherConstraint>Condensation temperature</swe:otherConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Direction">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/space.owl#Direction">Orientation of a
vector relative to a reference frame.</gml:description>
                <gml:name>Direction</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Direction</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="DissolvedSolids">
                <gml:description
xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#DissolvedConcentration">Amount of solids remaining after
evaporation</gml:description>
                <gml:name>Dissolved Solids</gml:name>
```

```
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:DissolvedSolids</gml:name>
                <swe:base xlink:href="Concentration"/>
                <swe:categoryConstraint property="#Material" codeSpace="http://www.opengis.net/ows/material">total
solute</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="DOX">
                <gml:name>Dissolved Oxygen</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:DOX</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:CompositePhenomenon gml:id="EarthquakeParameters" dimension="2">
                <gml:name>Earthquake Parameters</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:EarthquakeParameters</gml:name>
                <swe:component>
                    <swe:CompositePhenomenon gml:id="EarthquakeLocation" dimension="3">
                        <gml:name>Earthquake Location</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:EarthquakeLocation</gml:name>
                        <swe:component xlink:href="#Epicentre"/>
                        <swe:component xlink:href="#Depth"/>
                        <swe:component xlink:href="#OriginTime"/>
                    </swe:CompositePhenomenon>
                </swe:component>
                <swe:component>
                    <swe:CompositePhenomenon gml:id="MomentTensor" dimension="6">
                        <gml:name>Earthquake Moment Tensor</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MomentTensor</gml:name>
                        <swe:component xlink:href="#Mrr"/>
                        <swe:component xlink:href="#Mtt"/>
                        <swe:component xlink:href="#Mff"/>
                        <swe:component xlink:href="#Mrt"/>
                        <swe:component xlink:href="#Mrf"/>
                        <swe:component xlink:href="#Mtf"/>
                    </swe:CompositePhenomenon>
                </swe:component>
            </swe:CompositePhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Elevation">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Elevation">Linear distance
measured vertically upwards from a reference surface</gml:description>
                <gml:name>Elevation</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Elevation</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Epicentre">
                <gml:description>The location on the surface of the earth directly above the position of the origin of an
earthquake</gml:description>
                <gml:name>Epicentre</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Epicentre</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="Humidity">
                <gml:description  xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Humidity">Concentration of
water</gml:description>
                <gml:name>Humidity</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Humidity</gml:name>
                <swe:base xlink:href="Concentration"/>
```

```
                    <swe:categoryConstraint property="#Material"
codeSpace="http://www.opengis.net/ows/material">Water</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Medium">
                    <gml:description>Material of which an object is constructed or within which a phenomenon
occurs</gml:description>
                    <gml:name>Medium</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Medium</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mrr">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mrr"/>
                    <gml:name>Earthquake Moment Tensor component Mrr</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:"Mrr</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mtt">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mtt"/>
                    <gml:name>Earthquake Moment Tensor component Mtt</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Mtt</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mff">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mff"/>
                    <gml:name>Earthquake Moment Tensor component Mff</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Mff</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mrt">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mrt"/>
                    <gml:name>Earthquake Moment Tensor component Mrt</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Mrt</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mrf">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mrf"/>
                    <gml:name>Earthquake Moment Tensor component Mrf</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Mrf</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="Mtf">
                    <gml:description xlink:href="http://biggeophysicsdictionary.org/parameters/earthquakes/moment/Mtf"/>
                    <gml:name>Earthquake Moment Tensor component Mtf</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Mtf</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="MolWt">
                    <gml:description/>
                    <gml:name>Molecular weight</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MolWt</gml:name>
                </swe:Phenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:Phenomenon gml:id="MolVol">
```

```
                <gml:description/>
                <gml:name>Molecular volume</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MolVol</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="OrganismCount">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Population">Number of
organisms</gml:description>
                <gml:name>Organism count</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:OrganismCount</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="OriginTime">
                <gml:description>The time instant corresponding to the initiation of the event.</gml:description>
                <gml:name>Origin Time</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:OriginTime</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="PeakWavelength">
                <gml:description>Centre of wavelength sensitivity band</gml:description>
                <gml:name>Peak Wavelength</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:PeakWavelength</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Precipitation">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Rainfall"></gml:description>
                <gml:name>Precipitation</gml:name>
                <gml:name>Rainfall</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Precipitation</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="Precipitation1Hour">
                <gml:description>Percipitation - over 1 hour</gml:description>
                <gml:name>Precipitation1Hour</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Precipitation1Hour</gml:name>
                <swe:base xlink:href="#Precipitation"/>
                <!-- trying to represent the averaging period in secconds -->
                <swe:measureConstraint property="#TimeAverage"
uom="./units.xml#s">3600</swe:measureConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="Precipitation24Hour">
                <gml:description>Percipitation - over 24 hours</gml:description>
                <gml:name>Precipitation24Hour</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Precipitation24Hour</gml:name>
                <swe:base xlink:href="#Precipitation"/>
                <!-- trying to represent the averaging period in secconds -->
                <swe:measureConstraint property="#TimeAverage"
uom="./units.xml#s">86400</swe:measureConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Radiation">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#RadiantEnergy"/>
                <gml:name>Radiation</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Radiation</gml:name>
            </swe:Phenomenon>
```

```
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="Radiance">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Radiance"/>
                <gml:name>Radiance</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Radiance</gml:name>
                <swe:base xlink:href="#Radiation"/>
                <swe:categoryConstraint property="mode" codeSpace="urn:x-
ogc:def:nil:OGC:unknown">passive</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="RelativeHumidity">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Humidity">Amount of water
vapour in a gas measured as a fraction of full saturation</gml:description>
                <gml:name>Relative Humidity</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:RelativeHumidity</gml:name>
                <swe:base xlink:href="#Humidity"/>
                <swe:otherConstraint>Normalised</swe:otherConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Shape">
                <gml:description>The geometry of the boundary of the object of interest</gml:description>
                <gml:name>Shape</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Shape</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Species">
                <gml:description>The kind of thing</gml:description>
                <gml:name>Species</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Species</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Speed">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Speed">Scalar rate of
movement</gml:description>
                <gml:name>Speed</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Speed</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:CompositePhenomenon gml:id="DiscreteSpectrumTM" dimension="7">
                <gml:name>Landsat Thematic Mapper spectrum</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:DiscreteSpectrumTM</gml:name>
                <swe:base xlink:href="#Radiance"/>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand1">
                        <gml:name>Landsat TM band 1</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand1</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">0.45
0.52</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand2">
                        <gml:name>Landsat TM band 2</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand2</gml:name>
                        <swe:base xlink:href="#Radiance"/>
```

```
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">0.52
0.60</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand3">
                        <gml:name>Landsat TM band 3</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand3</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">0.63
0.69</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand4">
                        <gml:name>Landsat TM band 4</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand4</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">0.76
0.90</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand5">
                        <gml:name>Landsat TM band 5</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand5</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">1.55
1.75</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand6">
                        <gml:name>Landsat TM band 6</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand6</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">10.4
12.5</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
                <swe:component>
                    <swe:ConstrainedPhenomenon gml:id="TMBand7">
                        <gml:name>Landsat TM band 7</gml:name>
                        <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TMBand7</gml:name>
                        <swe:base xlink:href="#Radiance"/>
                        <swe:intervalConstraint property="#Wavelength" uom="./units.xml#um">2.08
2.35</swe:intervalConstraint>
                    </swe:ConstrainedPhenomenon>
                </swe:component>
            </swe:CompositePhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="SurfaceWaterTemperature2">
                <gml:name>Surface Water Temperature 2</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:SurfaceWaterTemperature2</gml:name>
                <swe:base xlink:href="#Temperature"/>
                <swe:categoryConstraint property="#Medium"
codeSpace="http://www.opengis.net/ows/material">water</swe:categoryConstraint>
                <swe:intervalConstraint property="#Depth" uom="./units.xml#m">0.0 1.5</swe:intervalConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="SurfaceWaterTemperature">
                <gml:name>Surface Water Temperature</gml:name>
```

```
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:SurfaceWaterTemperature</gml:name>
                <swe:base xlink:href="#WaterTemperature"/>
                <swe:intervalConstraint property="#Depth" uom="./units.xml#m">0.0 1.5</swe:intervalConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Temperature">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Temperature"/>
                <gml:name>Temperature</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Temperature</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="TimePosition">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/time.owl#Instant">A position on a time
scale</gml:description>
                <gml:name>Time Position</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:TimePosition</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:PhenomenonSeries gml:id="uSpectrum" dimension="17">
                <gml:description>Simple spectrum with uniform spacing of bands</gml:description>
                <gml:name>UniformSpectrum</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:uSpectrum</gml:name>
                <swe:base xlink:href="#Radiance"/>
                <swe:measureConstraintList property="http://www.opengis.net/componentPhenomena#Wavelength"
uom="./units.xml#um">0.300 0.304 0.308 0.312 0.316 0.320 0.324 0.328 0.332 0.336 0.340 0.344 0.348 0.352 0.356
0.360 0.364</swe:measureConstraintList>
            </swe:PhenomenonSeries>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:PhenomenonSeries dimension="12" gml:id="Radiance12cA">
                <gml:description>12-Channel Radiance for NNNNNNNNN</gml:description>
                <gml:name>12-Channel_Radiance</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Radiance12cA</gml:name>
                <swe:base xlink:href="#Radiance"/>
                <swe:intervalConstraintList property="#Wavelength" uom="./units.xml#um">
            0.42 0.45
        0.45 0.52
        0.52 0.60
        0.60 0.62
        0.63 0.69
        0.69 0.75
        0.76 0.90
        0.91 1.05
        1.55 1.75
        2.08 2.35
        3.60 3.79
        10.26 11.26
            </swe:intervalConstraintList>
            </swe:PhenomenonSeries>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:CompositePhenomenon gml:id="Velocity" dimension="2">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Velocity">Vector rate of
movement relative to a reference frame</gml:description>
                <gml:name>Velocity</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Velocity</gml:name>
                <swe:component xlink:href="#Speed"/>
                <swe:component xlink:href="#Direction"/>
            </swe:CompositePhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="WaterTemperature">
```

```
                <gml:name>Water Temperature</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:WaterTemperature</gml:name>
                <swe:base xlink:href="#Temperature"/>
                <swe:categoryConstraint property="#Medium"
codeSpace="http://www.opengis.net/ows/material">water</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Visibility">
                <gml:description>Atmospheric visibility</gml:description>
                <gml:name>Visibility</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Visibility</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Wavelength">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#Wavelength">Distance
between peak values of a wave</gml:description>
                <gml:name>Wavelength</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Wavelength</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="WindChill">
                <gml:description xlink:href="http://sweet.jpl.nasa.gov/ontology/property.owl#WindChill"/>
                <gml:name>Wind Chill</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:WindChill</gml:name>
                <swe:base xlink:href="#Temperature"/>
                <swe:otherConstraint>Corrected for wind speed</swe:otherConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="WindDirection">
                <gml:name>Wind Direction</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:WindDirection</gml:name>
                <swe:base xlink:href="#Direction"/>
                <swe:categoryConstraint codeSpace="urn:x-ogc:def:phenomenon:SWE:1.0.30"
property="#Medium">Wind</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="WindSpeed">
                <gml:name>Wind Speed</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:WindSpeed</gml:name>
                <swe:base xlink:href="#Speed"/>
                <swe:categoryConstraint codeSpace="urn:x-ogc:def:phenomenon:SWE:1.0.30"
property="#Medium">Air</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="WindVelocity">
                <gml:name>Wind Velocity</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:WindVelocity</gml:name>
                <swe:base xlink:href="#Velocity"/>
                <swe:categoryConstraint codeSpace="urn:x-ogc:def:phenomenon:SWE:1.0.30"
property="#Medium">Air</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <!-- ================== -->
        <!-- Added by Mark Priest for OWS3-SWE - comments by Simon Cox -->
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="TimeAverage">
                <gml:description>Statistical mean value in a time series of data</gml:description>
                <gml:name>Average</gml:name>
```

```
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Average</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="TimeMax">
                <gml:description>Statistical maximum value in a time series of data</gml:description>
                <gml:name>Max</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Max</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="TimeMin">
                <gml:description>Statistical minimum value in a time series of data</gml:description>
                <gml:name>Min</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Min</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Chemical">
                <gml:description>Chemical compound - ********** should this be formulated as
ConstrainedPhenomenon species(chemical) ? **********</gml:description>
                <gml:name>Chemical</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Chemical</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <!-- the following series are clearly all related so should be formulated as a set of related ConstrainedPhenomenon
definitions -->
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAir">
                <gml:name>Chemical presence (as apposed to absence)</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresence</gml:name>
                <swe:base xlink:href="#Chemical"/>
                <swe:categoryConstraint property="#Medium"
codeSpace="http://www.opengis.net/ows/material">Air</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirDPM">
                <gml:name>DPM chemical presence</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirDPM</gml:name>
                <swe:base xlink:href="#ChemicalPresenceInAir"/>
                <swe:categoryConstraint property="#Chemical" codeSpace="./">DPM</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirMS">
                <gml:name>MS chemical presence</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirMS</gml:name>
                <swe:base xlink:href="#ChemicalPresenceInAir"/>
                <swe:categoryConstraint property="#Chemical" codeSpace="./">MS</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirGA">
                <gml:name>GA chemical presence</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirGA</gml:name>
                <swe:base xlink:href="#ChemicalPresenceInAir"/>
                <swe:categoryConstraint property="#Chemical" codeSpace="./">GA</swe:categoryConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirGB">
                <gml:name>GB chemical presence</gml:name>
```

```
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirGB</gml:name>
                    <swe:base xlink:href="#ChemicalPresenceInAir"/>
                    <swe:categoryConstraint property="#Chemical" codeSpace="./">GB</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirGD_GF">
                    <gml:name>GD_GF chemical presence</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirGD_GF</gml:name>
                    <swe:base xlink:href="#ChemicalPresenceInAir"/>
                    <swe:categoryConstraint property="#Chemical" codeSpace="./">GD_GF</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirVX">
                    <gml:name>VX chemical presence</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirVX</gml:name>
                    <swe:base xlink:href="#ChemicalPresenceInAir"/>
                    <swe:categoryConstraint property="#Chemical" codeSpace="./">VX</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="ChemicalPresenceInAirHD">
                    <gml:name>HD chemical presence</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:ChemicalPresenceInAirHD</gml:name>
                    <swe:base xlink:href="#ChemicalPresenceInAir"/>
                    <swe:categoryConstraint property="#Chemical" codeSpace="./">HD</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <!-- ============== -->
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="AirTemperature">
                    <gml:name>Air Temperature</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:AirTemperature</gml:name>
                    <swe:base xlink:href="#Temperature"/>
                    <swe:categoryConstraint property="#Medium"
codeSpace="http://www.opengis.net/ows/material">Air</swe:categoryConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="AverageWindSpeed15Minute">
                    <gml:description>Average wind speed - 15 minutes</gml:description>
                    <gml:name>AverageWindSpeed15Minute</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:AverageWindSpeed15Minute</gml:name>
                    <swe:base xlink:href="#WindSpeed"/>
                    <!-- trying to represent the averaging period in secconds -->
                    <swe:measureConstraint property="#TimeAverage" uom="./units.xml#s">900</swe:measureConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="AverageAirTemperature15Minute">
                    <gml:description>Average air temperature - 15 minutes</gml:description>
                    <gml:name>AverageAirTemperature15Minute</gml:name>
                    <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:AverageAirTemperature15Minute</gml:name>
                    <swe:base xlink:href="#AirTemperature"/>
                    <!-- trying to represent the averaging period in secconds -->
                    <swe:measureConstraint property="#TimeAverage" uom="./units.xml#s">900</swe:measureConstraint>
                </swe:ConstrainedPhenomenon>
            </gml:dictionaryEntry>
            <gml:dictionaryEntry>
                <swe:ConstrainedPhenomenon gml:id="MaximumWindSpeed15Minute">
                    <gml:description>Maximum wind speed - 15 minutes</gml:description>
                    <gml:name>MaximumWindSpeed15Minute</gml:name>
```

```
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MaximumWindSpeed15Minute</gml:name>
                <swe:base xlink:href="#WindSpeed"/>
                <!-- trying to represent the averaging period in secconds -->
                <swe:measureConstraint property="#Max" uom="./units.xml#s">900</swe:measureConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="MinimumWindSpeed15Minute">
                <gml:description>Minimum wind speed - 15 minutes</gml:description>
                <gml:name>MinimumWindSpeed15Minute</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MinimumWindSpeed15Minute</gml:name>
                <swe:base xlink:href="#WindSpeed"/>
                <!-- trying to represent the averaging period in secconds -->
                <swe:measureConstraint property="#Min" uom="./units.xml#s">900</swe:measureConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:ConstrainedPhenomenon gml:id="MaximumRelativeHumidity15Minute">
                <gml:description>Maximum relative humidity - 15 minutes</gml:description>
                <gml:name>MaximumRelativeHumidity15Minute</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:MaximumRelativeHumidity15Minute</gml:name>
                <swe:base xlink:href="#RelativeHumidity"/>
                <!-- trying to represent the averaging period in secconds -->
                <swe:measureConstraint property="#Max" uom="./units.xml#s">900</swe:measureConstraint>
            </swe:ConstrainedPhenomenon>
        </gml:dictionaryEntry>
        <!-- Some odds and sods for illustrative purposes -->
        <gml:dictionaryEntry>
            <swe:Phenomenon gml:id="Weather">
                <gml:description>Generic weather type. This may be used directly, typically for cases where the
observation has a textual result. Or it may serve as the basis for more specific weather types by extension - see
below.</gml:description>
                <gml:name>Weather</gml:name>
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:OGC:Weather</gml:name>
            </swe:Phenomenon>
        </gml:dictionaryEntry>
        <gml:dictionaryEntry>
            <swe:CompositePhenomenon gml:id="weather1" dimension="6">
                <gml:name codeSpace="urn:x-ogc:tc:arch:doc-rp(05-010)">urn:x-
ogc:def:phenomenon:SEEGrid:weather1</gml:name>
                <swe:base xlink:href="urn:x-ogc:def:phenomenon:OGC:Weather"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:AirTemperature"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:WindSpeed"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:WindDirection"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:AtmosphericPressure"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:RelativeHumidity"/>
                <swe:component xlink:href="urn:x-ogc:def:phenomenon:OGC:Visibility"/>
            </swe:CompositePhenomenon>
        </gml:dictionaryEntry>
</gml:Dictionary>
```

Bibliography

[EDCS] ISO/IEC 18025:2003 *Information technology -- Computer graphics and image processing -- Environmental Data Coding Specification (EDCS).*

[FOW1998] Fowler, M. *Analysis Patterns: reusable object models*. Addison Wesley Longman, Menlo Park, CA. 1998.

[KRALST] Krantz, D. H., Luce, R. D., Suppes, P., and Tversky, A. (1971), *Foundations of measurement, Vol. I: Additive and polynomial representations*, New York: Academic Press. ; Suppes, P., Krantz, D. H., Luce, R. D., and Tversky, A. (1989), *Foundations of measurement, Vol. II: Geometrical, threshold, and probabilistic respresentations*, New York: Academic Press. ; Luce, R. D., Krantz, D. H., Suppes, P., and Tversky, A. (1990), *Foundations of measurement, Vol. III: Representation, axiomatization, and invariance*, New York: Academic Press.

[NIE2001] Nieva, T. *Remote data acquisition* of embedded systems using internet technologies: a role-based generic system specification. Thesis, Ecole Polytech. Fed. Lausanne 2001. available http://icawww.epfl.ch/nieva/thesis/Report/PhD.pdf.

[NRC1995] National Research Council. *Expanding the Vision of Sensor Materials*. Committee on New Sensor Technologies: Materials and Applications. National Academy Press. http://books.nap.edu/books/0309051754/html/index.html 1995.

[OWL] W3C OWL Web Ontology Language, W3C Recommendation (10 February 2004)

[PAT1995] Gamma, E., Helm, R., Johnson, R., Vlissides, J. Design Patterns: *Elements of Reusable Object-Oriented Software*. 395pp. Addison Wesley, 1995.

[SAR1995] Sarle, W.S., *Measurement theory: frequently asked questions*. Originally published in the Disseminations of the International Statistical Applications Institute, 4th edition, 1995, Wichita: ACG Press, pp. 61-66. Revised 1996, 1997. Available at ftp://ftp.sas.com/pub/neural/measurement.html

[VIM] *International Vocabulary of Basic and General Terms in Metrology*. BIPM/ISO 1993.

[YOD] Yoder, J. W., Balaguer, F. and Johnson, R. *From analysis to design of the observation pattern*. http://www.joeyoder.com/Research/metadata/Observation/ObservationModel.pdf