Technical Note

Analysis of the extension of the EO product metadata

April 2010
EXECUTIVE SUMMARY

This technical note describes the evolutions to the GML 3.1.1 Application Schema for EO Products that are proposed within the HMA FO Task 1 project.

This document firstly contains an analysis on how to align this HMA product metadata standard with the evolutions that the underlying standards have been undergoing. Notably the migration to GML 3.2.1 with or without Model Driven Approach and the adoption of the Observation and Measurements model are discussed.

Secondly it contains a set of proposals for metadata schema extensions for three new thematic product types: radar altimeter, limb looking products and systematic and synthesis products. During the analysis of the input of different stakeholders, some potential improvements and additions to the base eop schemas were also noted and are discussed within this document.

This technical note is submitted by a consortium consisting of ERDAS, GIM and STFC in the frame of HMA Follow On Task 1 project.

The current version of this document is submitted for validation of the approach by the different stakeholders involved in the HMA-FO project. It is accompanied by a questionnaire to solicit structured feedback on the proposals.
SIGNATURES

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DOCUMENT STATUS SHEET

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APPLICABLE DOCUMENTS


[AD03] OGC 06-080r4 GML 3.1.1 Application schema for Earth Observation products, Version 1.0.0, 2010-02-25 (OGC standard)

[AD04] OGC06-080r5 GML 3.1.1 Application schema for Earth Observation products, Version 1.0.0, 2010-01-25, (Best Practices)

REFERENCE DOCUMENTS


[RD03] OGC 06-080r2 GML 3.1.1 Application Schema for EO Products, Version 0.9.0, OGC Best practice: http://portal.opengeospatial.org/files/?artifact_id=22161

[RD05] ISO 19115:2003 Geographic information -- Metadata


[RD07] ISO 19139:2007 Geographic information -- Metadata -- XML schema implementation


[RD09] ISO 19109:2005 Geographic information -- Rules for application schema


[RD11] ISO/DIS 19142: Geographic information -- Web Feature Service

[RD12] OGC 06-131r6, EO Products Extension Package for ebRIM Profile of CSW 2.0.2, Version 0.2.5.


[RD16] OGC 08-114, GML Change Request – deprecate various components

[RD17] OGC07-063r1: Web Map services, Application Profile for EO Products

[RD18] OGC 06-121r8, OGC Web Services Common 1.2 Implementation Standard


[RD20] Generic metadata guidelines on atmospheric and oceanographic datasets for the Envisat Calibration and Validation Project, Version 01R001 pre-print April 24, 2002


[RD22] OGC 09-110, WCS 2.0 Core Interface Standard, 2009-11-09

[RD23] OGC 09-146, GML 3.2 Application Schema for WCS 2.0, 2009-11-09


[RD26] HMA FO Task 3 Online Data Access EO Metadata Requirements, HMA-FO-ODA-EOMR_SPOT, Issue 1 - 01/03/2010

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<td>CSMF</td>
<td>Conceptual Schema Modelling Facilities</td>
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<td>CSML</td>
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1 INTRODUCTION

1.1 PAST APPROACH

In the frame of the initial Heterogeneous Missions Accessibility -Interoperability (HMA-I) project, ESA together with other GMES participating agencies as ASI, CNES, CSA-MDA, and DLR decided to model the metadata of Earth Observation products as geographic features encoded in the OGC Geographic Markup Language.

The reasoning for adopting gml instead of a more traditional approach using the ISO19115 Geographic Information Metadata model was the fact that the ISO 19115 elements are more suited for describing the metadata of collections of EO Products rather than for describing individual EO products themselves:

- Typical mandatory ISO 19115 metadata elements like contactInformation (gmd:Contact), citation and abstract (MD_dataIdentification) constitute information that will be identical for each individual product in the collection. It does not make a lot of sense to repeat these elements in every product metadata record. The complexity of the overall ISO19115 model with deep nesting of elements leads to a less efficient data structure for web access.

- On the other hand specific metadata elements like for instance cloud cover are required to allow for efficient discovery of EO products. In case ISO19115 would have been selected, such elements would have needed to be added to a non-comprehensive profile extension of ISO19115 which would anyway have been specific to the HMA community.

Instead of choosing this clearly sub-optimal ISO19115 approach, it was agreed to model EO Product metadata as a geographic feature characterised by a footprint and a set of attributes. As the specification document [AD01] states: “From an end user point of view, an EO data product can be naturally described by a spatial extent (e.g. the geographic footprint of a satellite acquisition) and several attributes describing the metadata (e.g. date of acquisition, etc.).” The encoding language for describing geographic features is the Geography Markup Language as standardised by the OGC and further adopted as ISO19136.

The GML application schema for Earth Observation Products was developed during a consensus process in which a mapping was done between metadata elements from the different partners on to a harmonised set of elements. Where possible, the element names were taken from corresponding element names within the ISO19115 [RD05] and ISO19115 Part 2 [RD06] standards.

The metadata was initially modelled as features (extending <gml:AbstractFeature>) and later on refined as gml:observations.

All metadata elements common to all Earth Observation products were defined within an Earth Observation Product (eop) GML application schema (formerly known as hma schema). Specific metadata elements for optical radar and atmospheric products, were assigned to three specific application schemas deriving (respectively opt, sar and atm) from the base eop schema. For products of specific missions requiring further metadata elements for their descriptions, it is possible to define a specific application schema deriving from one of the thematic application schemas.

The Pleiades HR schema (phr) is an example of such a mission specific schema that extends the thematic optical schema.

The advantages of this hierarchical set of schemas which is graphically depicted in the figure below are

- to create an efficient schema set that describes EO Products concentrating on the core metadata containing the key characteristics that differentiate products within a collection of a specific product type.
• to profit from the increasingly wider adoption of GML so that the product metadata can be displayed by a variety of GML viewers. A generic GML Viewer, will be able to recognise and display EO Product metadata as features with a footprint and with “unknown” metadata. On the other hand, specifically developed Viewers for EO Products (or specific thematic or mission schemas) will be able to understand the semantic of these metadata.

Figure 1 EO Product Metadata Stack copied from [AD01]

1.2 CURRENT STATE OF THE STANDARD

The latest publicly available version of the GML 3.1.1 Application schema for Earth Observation products is OGC 06-080r4 [AD01]. It is this version that is stated as the current baseline version in the HMA Specification Configuration Management table on the HMA WIKI [RD01].

According to the HMA WIKI Page on mapping of the interface specifications onto project and Ground Segment [RD02], it is this version that currently is used on all projects/Ground Segments.

This document (with minor edits) has been approved as OGC standard in its Version 1.0.0 version dated 25/02/2010 [AD03].

Note that there has been a more recent version (r5) available on the OGC Pending documents list [RD04] since 12/03/2009. This includes the resolution for a number of issues that were discovered during the HMA-T Project. It is however OGC06-080r4 (on which OGC06-131 is based) that has now been promoted to OGC Standard (formerly Implementation Specification) status.
2 PROPOSED EVOLUTIONS OF THE STANDARDS BASELINE

2.1 INTRODUCTION

Before defining the schema extensions for the new product types, it is beneficial to evaluate the underlying standards baseline.

The current GML application schema for EO Products is based on GML 3.1.1 which has been superseded since almost 3 years by GML 3.2.1. During the OGC adoption process of OGC06-080 comments were already raised on the fact that an application schema of a deprecated standard was being voted. Upgrade to a higher version of GML 3.2.1 was then listed as one of the future work items stating that this can only be done when the CS-W ebRIM application profile would be based on a future evolution of the OGC Filter specification that in turn would be based on GML 3.2.1.

The newer version of the EO EP of ebRIM CSW (OGC06-131) that is being developed in the frame of this project will be based on CSW 3.0 to make use of its new features that allow to carry the RepositoryItem GML as payload in the response to the GetRecords operation. This CSW 3.0 will be aligned with OWSCommon 2.0 and will use the OGC Filter encoding with GML 3.2.1. As a consequence of this and for the reasons laid out below, there should be an upgrade of the GML schemas to 3.2.1.

Several approaches are possible for this technical update of the EO schemas. These range from a direct 'translation' of the existing schemas to GML 3.2.1, through to extensive refactoring (e.g. taking into account new EO models in ISO 19115-2 and exploiting fully the O&M model in linking to a data access service). These various approaches are outlined in the sections below.

2.2 ADOPTION OF GML 3.2.1

Since the initial work on the GML Application Schema for EO Products in 2006, the base GML 3.1.1 specification of which [AD01] is an application schema has been superseded by a newer version. GML 3.2.1 [AD02] is now the official OGC GML Implementation Specification since July 2007.

2.2.1 Reasons for changing to GML 3.2.1

There are a number of reasons for changing the version of GML within this revision of the EO Product metadata schema:

- Facilitate the adoption process of the revised specification at the OGC. During the voting process on [AD01] in the Standards Working Group at OGC, comments were already received relating to the appropriateness of publishing an application schema of a deprecated specification;
- GML 3.2.1 fixes a number of schema issues in GML3.1.1 which makes it impossible to generate classes on the basis of the xsds using software like for instance JAXB and gives parsing errors in commonly used XML parsers;
- GML 3.2.1 has been aligned with ISO 19XXX series of standards and has hence a more solid conceptual foundation;
- GML 3.2.1 is an approved ISO standard: ISO19136:2007;
- GML3.2.1 is the baseline for developing the encodings for the INSPIRE Data Specifications;
- GML3.2.1 is a prerequisite for the model driven approach described in 2.3;
- GML 3.2.1 is the version that WCS 2.0 will align itself to for its coverage encoding;
- GML 3.2.1 required for CSW 3.0.
An overview of the changes from GML 3.1.1 to GML 3.2.1 are documented in an OGC Revision Notes document [RD08].

### 2.2.2 Schema-level implications of change to GML 3.2.1

One “conceptual change” that particularly impacts the EO GML AS is the clarification “that the observation types specified in GML are primarily intended for "simple" observations. Schemas for scientific, technical and engineering observations and measurements will typically require the development of a GML Application Schema for such observations. See, for example, the draft Observations and Measurements specification.” The effects of the potential adoption of O&M are further discussed in section 2.4.

In order to estimate the impact of a migration to GML3.2.1, not following the Model Driven Approach (see section 2.3), the GML3.1.1 eop schema was ported manually to GML3.2.1. By following this straightforward approach one obtains a set of schemas that validate against GML3.2.1. However they do not necessarily follow all the rules for the creation of GML Application Schemas and subtle constraints like the fact that one should avoid as much as possible XML attributes.

The following changes need to be done in order to get the eop schema to validate against GML3.2.1 and to retain the full information model:

<table>
<thead>
<tr>
<th>Change</th>
<th>Section in RD08</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Change gml namespace definition to xmlns:gml=&quot;<a href="http://www.opengis.net/gml/3.2">http://www.opengis.net/gml/3.2</a>&quot;</td>
<td>5.3</td>
</tr>
<tr>
<td>2 Change import statement to point to gml 3.2 schemas and adapt namespace:</td>
<td>5.2</td>
</tr>
<tr>
<td>&lt;xs:import namespace=&quot;<a href="http://www.opengis.net/gml/3.2">http://www.opengis.net/gml/3.2</a>&quot;</td>
<td></td>
</tr>
<tr>
<td>schemaLocation=&quot;gml/3.2.1/gml.xsd&quot;/&gt;</td>
<td></td>
</tr>
<tr>
<td>3 Remove the gml:_Metadata substitutiongroup for the EarthObservationMetaData element in view of the deprecation of the gml:_MetaData</td>
<td>5.12</td>
</tr>
<tr>
<td>4 Replace the=&quot;gml:_Object&quot; by &quot;gml:AbstractObject&quot; substitutionGroup for the</td>
<td>5.9</td>
</tr>
<tr>
<td>&lt;Histogram&gt; element in view of the fact that all underscores in element</td>
<td></td>
</tr>
<tr>
<td>names to indicate abstractness have been replaced by &quot;Abstract&quot; as used in type names.</td>
<td></td>
</tr>
<tr>
<td>5 Replace the=&quot;gml:_Feature&quot; by &quot;gml:AbstractFeature&quot; substitutionGroup for the</td>
<td>5.9</td>
</tr>
<tr>
<td>&lt;EarthObservationResult&gt;, &lt;EarthObservationEquipment&gt;, &lt;MaskFeature&gt;, &lt;Footprint&gt;, &lt;Mask&gt; element in view of the fact that all underscores in element names to indicate abstractness have been replaced by &quot;Abstract&quot; as used in type names.</td>
<td></td>
</tr>
<tr>
<td>6 Instead of using the MetadataProperty Type which has been deprecated, one</td>
<td>5.12</td>
</tr>
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<td>must define an eop specific EarthObservationMetadataPropertyType in the</td>
<td></td>
</tr>
<tr>
<td>eop schema and add such a property to the EarthObservation element</td>
<td></td>
</tr>
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<td>&lt;xs:complexType name=&quot;EarthObservationMetadataPropertyType&quot;&gt;</td>
<td></td>
</tr>
<tr>
<td><a href="">xs:complexContent</a></td>
<td></td>
</tr>
<tr>
<td>&lt;xs:extension base=&quot;gml:AbstractMetadataPropertyType&quot;&gt;</td>
<td></td>
</tr>
<tr>
<td><a href="">xs:sequence</a></td>
<td></td>
</tr>
<tr>
<td>&lt;xs:element ref=&quot;eop:EarthObservationMetaData&quot;/&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/xs:sequence&gt;</td>
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</tr>
<tr>
<td>&lt;/xs:extension&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/xs:complexContent&gt;</td>
<td></td>
</tr>
<tr>
<td>7 Also multiExtentOf and centerOf have been deprecated and are taken up into</td>
<td>5.8</td>
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<td>the deprecatedTypes.xsd. These should hence be replaced by explicitly-</td>
<td></td>
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defined elements (note that eop schema still validates)

Table 1 Changes to eop.xsd when migrating from GML 3.1.1 to GML 3.2.1 without applying MDA

<table>
<thead>
<tr>
<th>Change</th>
<th>Section in RD08</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Change gml namespace definition to xmlns:gml=&quot;<a href="http://www.opengis.net/gml/3.2">http://www.opengis.net/gml/3.2</a>&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Add gml:id attributes on all “GML Objects” whereby a “GML object is an XML element of a type derived directly or indirectly from gml:AbstractGMLType” (as per [AD02]). Examples are: gml:TimePeriod, eop:EarthObservationEquipment, eop:Footprint, gml:Polygon, gml:Point, eop:EarthObservationResult</td>
</tr>
<tr>
<td>3</td>
<td>Replace gml:metadataProperty with eop:metadataProperty</td>
</tr>
<tr>
<td>4</td>
<td>Since the eop:EarthObservationMetadataProperty has been added to the definition of eop:EarthObservation by extending gml:observation with a sequence, the eop:EarthObservationMetadataProperty now occurs at the end of the document.</td>
</tr>
</tbody>
</table>

Table 2 Summary of changes to GML instance documents when migrating to GML 3.2.1

An example modified instance document can be found in Annex A.

The main substantive change that results is the requirement to include a mandatory ‘id’ attribute on all GML objects. The conceptual basis for this is that all GML objects have identity in principle. I.e. it is possible that one might wish to refer just to an eop:Footprint, or eop:EarthObservationResult, within a document instance; then these need to have identities. The addition of mandatory ‘id’ also opens the possibility to use the GML ‘by-reference’ pattern to reduce redundancy. For instance, if a common eop:EarthObservationEquipment were shared between multiple instance EO Product instances, then it could be cross-referenced (using xlink and the gml:id) instead of reproducing it everywhere inline, if that were desired.

The semantics of the ‘id’ attribute are that it should provide an identifier for each ‘GML object’ element, unique within an EO Product Metadata document. Beyond this, there is no restriction on how a provider chooses to construct the identifier. However, it is recommended to adopt best practice, e.g. not overloading the identifier structure with additional semantics. The lexical scope of the ‘id’ attribute is equal to the XML Schema ‘ID’ type, based on the XML NCName type, but unique within a document.

Afterwards, only changes 1 and 2 need to be repeated within the derived opt, sar and atm schemas to make them validate.

The eop GML 3.2.1 schema can be found in Annex A.

2.2.3 Instance-level implications of change to GML 3.2.1

More important to evaluate the impact of moving to GML3.2.1 are the changes that need to be done to a GML3.1.1 instance document to have it validate against the newly created GML3.2.1 schema.
2.3 MODEL-DRIVEN APPROACH

It is proposed, for extending the ‘GML Application Schema for EO Products’ to adopt the model-driven approach of ISO TC211, illustrated in Figure 2 below.

In this approach, a *universe of discourse* is modelled formally as a *conceptual model* in a *UML application schema* using the General Feature Model of ISO 19109 [RD09]. *Feature types* may be registered in a *feature catalogue* specified within ISO 19110 [RD10] for re-use (e.g. as part of other application schemas, through association or generalisation), thus aiding interoperability.

From the UML model, a canonical XML *encoding* may be generated automatically, providing a *GML application schema* as per ISO19136 [AD02]. Exchange datasets containing feature instances may then be transformed from existing (legacy) database or other storage into an XML document conforming to the GML application schema.

Usually these GML instances are accessed through a Web Feature Service as specified in ISO 19142 [RD11].

In the case of the ‘GML Application Schema for EO Products’, the GML dataset contains product-level metadata and is instead accessed through the CSW ebRIM profile (OGC 07-110[RD12]) using the EO Products ebRIM Extension Package (OGC 06-131[RD13]).

**Figure 2: Model-driven approach of ISO TC211**

The term ‘model-driven’ refers to the fact that the primary artefact is the UML conceptual model – the GML application schema (and other artefacts, e.g. model documentation) are generated automatically from the UML model.

The motivation for a model-driven approach follows naturally from the theoretical principles underlying the conceptual modelling framework adopted by ISO TC211, the Conceptual Schema Modelling Facilities (CSMF) [RD14].

Without dwelling on the details of this, CSMF defines a number of important principles for conceptual modelling. Chief among them are:

- the “100% principle”: everything significant in the universe of discourse should be described in the conceptual model
- the “conceptualisation principle”: the conceptual model should contain only aspects of the universe of discourse (it should not include aspects related to implementation details, e.g. data representation or storage)
- the “Helsinki principle”: any meaningful exchange should follow agreed syntax and semantics related to the conceptual model.
In particular, the Helsinki principle implies a direct relationship between the UML conceptual model and the GML application schema, and that the latter should in principle be generated from the former.

By now, there are sufficient examples of the use of this approach to suggest its maturity for adoption in HMA-FO. For instance, the recently-published GML application schemas for INSPIRE Annex I themes1 were generated in this manner. There are at least two well-known open-source tools available for generating GML application schemas from a UML conceptual model:

- ShapeChange (Interactive Instruments): adopted by INSPIRE for Annex I work
- FullMoon (CSIRO): http://projects.arc.org.au/trac/fullmoon/wiki/FullMoon

For the HMA-FO work we use ShapeChange for maximum compliance with the INSPIRE framework.

An additional benefit of the model-driven approach is that application schemas for different versions of GML may be generated by a simple software configuration.

### 2.3.1 Testing the model-driven approach

The model-driven approach has been tested successfully by reverse-engineering a UML model for the existing ‘GML Application Schema for EO Products’ and applying automated schema generation. The results are provided in the document HMAFOT1-TN-0003-STFC-10.doc.

An almost 100% correspondence was achieved at the level of instance documents between the existing application schema and the ‘reverse-engineered’ model-driven version. The main differences are:

1. Elements (e.g. imageQualityDegradation) with attribute ‘uom=”%”’ fail to validate against the imported GML 3.1 schemas. This is actually a bug in the existing schemas. The existing EOP schemas don’t import the normative GML 3.1.1 schemas directly (from http://schemas.opengis.net/gml/3.1.1/base/gml.xsd), but instead use a file ‘gmlSubset.xsd’. This is an incorrect subset of the relevant GML 3.1 schemas, in particular gml:MeasureType is based on GML 3.2, rather than GML 3.1. (For GML 3.2 schema generation, this is not a problem.)

2. The metaDataProperty attribute is ordered differently, coming at the end of the document, rather than at the start. This is a GML3.2.1 issue (see section 2.2.3 above) that results from inheriting the attribute from the base EarthObservation feature type.

3. The eop namespace is used instead of gml for the following elements: metaDataProperty, multiExtentOf, centerOf (the latter two are attributes of Footprint). This is also a GML3.2.1 issue – these are all elements that have been deprecated in GML3.2.1, relying instead on application schema specific property names.

4. All objects in GML3.2.1 have a mandatory gml:id attribute.

To note from this test is that the Model Driven Approach does not imply any additional change within the GML instances as compared to the mere evolution to GML3.2.1. Given the fact that the decision was taken to move towards GML3.2.1 in the HMA FO Preliminary Review Meeting, it would seem logical to also apply the Model Driven Approach as it improves consistency of the XML schema with the documentation and it ensures that the GML schemas are compliant with the rules for GML schema generation.

### 2.4 Observations and Measurements

#### 2.4.1 GML: Observation

The current GML Application Schema for EO Products adopts the GML Observation as its basis. This is defined in GML 3.2.1 as listed in Figure 3 below.

---

1 http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2
The content model is a straightforward extension of gml:AbstractFeatureType; it automatically has the gml:identifier, gml:description, gml:descriptionReference, gml:name, and gml:boundedBy properties.
The gml:validTime element describes the time of the observation. Note that this may be a time instant or a time period.
The gml:using property contains or references a description of a sensor, instrument or procedure used for the observation.
The gml:target property contains or references the specimen, region or station which is the object of the observation. This property is particularly useful for remote observations, such as photographs, where a generic location property might apply to the location of the camera or the location of the field of view, and thus may be ambiguous.
The gml:subject element is provided as a convenient synonym for gml:target. This is the term commonly used in photograpy.
The gml:resultOf property indicates the result of the observation. The value may be inline, or a reference to a value elsewhere.

```xml
<element name="Observation" type="gml:ObservationType" substitutionGroup="gml:AbstractFeature">
  <annotation>
    <documentation>
The content model is a straightforward extension of gml:AbstractFeatureType; it automatically has the gml:identifier, gml:description, gml:descriptionReference, gml:name, and gml:boundedBy properties.
The gml:validTime element describes the time of the observation. Note that this may be a time instant or a time period.
The gml:using property contains or references a description of a sensor, instrument or procedure used for the observation.
The gml:target property contains or references the specimen, region or station which is the object of the observation. This property is particularly useful for remote observations, such as photographs, where a generic location property might apply to the location of the camera or the location of the field of view, and thus may be ambiguous.
The gml:subject element is provided as a convenient synonym for gml:target. This is the term commonly used in photograpy.
The gml:resultOf property indicates the result of the observation. The value may be inline, or a reference to a value elsewhere.
    </documentation>
  </annotation>
</element>

<complexType name="ObservationType">
  <complexContent>
    <extension base="gml:AbstractFeatureType">
      <sequence>
        <element ref="gml:validTime"/>
        <element ref="gml:using" minOccurs="0"/>
        <element ref="gml:target" minOccurs="0"/>
        <element ref="gml:resultOf"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<element name="using" type="gml:ProcedurePropertyType"/>
<complexType name="ProcedurePropertyType">
  <sequence minOccurs="0">
    <element ref="gml:AbstractFeature"/>
  </sequence>
  <attributeGroup ref="gml:OwnershipAttributeGroup"/>
  <attributeGroup ref="gml:AssociationAttributeGroup"/>
</complexType>

<element name="target" type="gml:TargetPropertyType"/>
<complexType name="TargetPropertyType">
  <choice minOccurs="0">
    <element ref="gml:AbstractFeature"/>
    <element ref="gml:AbstractGeometry"/>
  </choice>
  <attributeGroup ref="gml:OwnershipAttributeGroup"/>
  <attributeGroup ref="gml:AssociationAttributeGroup"/>
</complexType>

<element name="resultOf" type="gml:ResultType"/>
<complexType name="ResultType">
  <sequence minOccurs="0"/>
</complexType>
```
Figure 3: GML 3.2 Observation schema

A GML Observation has the following key attributes (for current purposes):

- **metaDataProperty** (inherited from gml:AbstractFeatureType): for observation metadata
- **validTime**: an abstract time primitive giving the time of the observation
- **using**: references a description of the procedure used for the observation; can be an instance of any valid feature type (i.e. inheriting from gml:AbstractFeature)
- **target**: references the specimen, region or station which is the object of the observation; can be an instance of any valid feature type or geometry
- **resultOf**: indicates the result of the observation (either inline or by reference); an open content model is defined (with the xsd:any element)

### 2.4.2 Use of GML observation by 06-080r4

Table 3 illustrates how the existing GML application schema for EO products uses the properties of GML observation.

<table>
<thead>
<tr>
<th>GML observation property</th>
<th>06-080r4</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>metaDataProperty</td>
<td>eop:EarthObservationMetadata</td>
<td>General properties such as the data identifier, the downlink and archiving information</td>
</tr>
<tr>
<td>validTime</td>
<td>gml:TimePeriod</td>
<td>The acquisition duration</td>
</tr>
<tr>
<td>using</td>
<td>eop:EarthObservationEquipment</td>
<td>The Platform/Instrument/Sensor used for the acquisition and the acquisition parameters (i.e. pointing angles, etc.)</td>
</tr>
<tr>
<td>target</td>
<td>eop:Footprint</td>
<td>The observed area on ground i.e. the footprint of acquisition</td>
</tr>
<tr>
<td>resultOf</td>
<td>eop:EarthObservationResult</td>
<td>The Earth Observation result composed of the browse, mask and product description</td>
</tr>
</tbody>
</table>

**Table 3: Use of GML observation by 06-080r4**

### 2.4.3 ISO 19156: OM_Observation

Over almost ten years, OGC has been developing a richer conceptual model for observations and measurements. This work is nearing completion and in the final stages of publication as ISO standard 19156 “Geographic Information – Observations and Measurements” [RD15] of which the document has been posted on the OGC pending documents list in January 2010. The UML model for the core Observation package is shown in Figure 4 below.
Figure 4: Core Observation model from draft ISO 19156 (Observations and Measurements)

In natural language, the model states:

An **observation** is an event that estimates an **observed property** of some **feature of interest** using a specified **procedure** and generates a **result**.

The major elements of the model are indicated in bold and modelled through associations in the UML model. In addition, an observation has the following attributes and associations:

- **parameter** (optional): for arbitrary event-specific parameters, e.g. instrument settings
- **phenomenonTime** (mandatory): the time that the result applies to the feature of interest
- **resultQuality** (optional): the quality of the result
- **resultTime** (mandatory): the time when the result becomes available (e.g. if postprocessing or laboratory analysis is required, it might be different to the phenomenonTime)
- **validTime** (optional): the time period during which the result is intended to be used (e.g. if a meteorological forecast is modelled as an observation, then it is intended to be used during a specific period of time)
- **relatedObservation** (optional): related observations providing important context for understanding the result
- **metadata** (optional): descriptive metadata
2.4.4 Differences between GML Observation and ISO 19156 OM_Observation

The first point to note is that the OGC GML Standards Working Group is considering a Change Request [RD16] to deprecate the existing gml:Observation and replace it with the ISO model.

The differences between the two models are not major, with the ISO model adding the following mandatory properties to the GML model (see correspondences in Table 4):

- the observed property
- the result time (which in general may be different to the phenomenonTime)

<table>
<thead>
<tr>
<th>GML</th>
<th>ISO 19156</th>
</tr>
</thead>
<tbody>
<tr>
<td>validTime</td>
<td>phenomenonTime</td>
</tr>
<tr>
<td>using</td>
<td>procedure</td>
</tr>
<tr>
<td>target</td>
<td>featureOfInterest</td>
</tr>
<tr>
<td>resultOf</td>
<td>result</td>
</tr>
<tr>
<td>-</td>
<td>observedProperty</td>
</tr>
<tr>
<td>-</td>
<td>parameter</td>
</tr>
<tr>
<td>-</td>
<td>resultQuality</td>
</tr>
<tr>
<td>-</td>
<td>resultTime</td>
</tr>
<tr>
<td>-</td>
<td>validTime</td>
</tr>
<tr>
<td>-</td>
<td>relatedObservation</td>
</tr>
<tr>
<td>-</td>
<td>metadata</td>
</tr>
</tbody>
</table>

Table 4: GML vs. ISO 19156 observation properties (optional properties in italics)

2.4.5 Approach to using OM_Observation

In considering a move towards the ISO 19156 observation model from GML, a range of possibilities present themselves – from a minimal change to a radical refactoring.

However, the latter would most profitably be undertaken jointly with explicit adoption of elements of ISO 19115-2 (which includes models for instrument, platform, etc.).

However, the ISO 19156 project leader (Simon Cox) has noted that the relationship between ISO 19156 (O&M) and ISO 19115-2 is not entirely clear – for instance the O&M observation, procedure and feature of interest correspond very closely to ISO 19115-2 MI_Event, MI_Instrument and MI_Objective, respectively.

In any case, deeper adoption of ISO 19115-2 is probably out of scope for the HMA-FO work, since the primary focus is on extending the schema to new product types (altimetry, limb-sounding, systematic/synthesis).

In addition, there is a general desire to maximise backwards-compatibility. Finally, the current implementation of the application schema – within the ebRIM profile CSW – requires significant work to accommodate application schema changes.

For all of these reasons, the approach proposed here for adoption of ISO 19156 is conservative; a minimal change is introduced to integrate OM_Observation. More radical possibilities that might be considered in future are discussed briefly in section 2.5.

Thus, our proposed approach adopts OM_Observation as the basis of the GML application schema, replacing GML observation properties with their equivalent (Table 5). Several aspects of this are discussed below.

<table>
<thead>
<tr>
<th>OM_Observation property</th>
<th>HMA-FO 06-080</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>metadata</td>
<td>eop:EarthObservationMetadata</td>
<td>see section 2.4.5.1 (new element 'metaDataProperty' added to EOP)</td>
</tr>
</tbody>
</table>
Table 5: HMA-FO adoption of ISO 19156 OM_Observation (compare Table 3)

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>contact/</td>
<td>Contact individual, organisation or position for this product</td>
<td>0..1 (one at least is required)</td>
</tr>
<tr>
<td>CI_ResponsibleParty/individualName (or organisationName or positionName)</td>
<td>Fixed value from CI_RoleCode, recommended to be ‘pointOfContact’</td>
<td>1</td>
</tr>
<tr>
<td>dateStamp(*)</td>
<td>Date of creation or update of</td>
<td>1</td>
</tr>
</tbody>
</table>

2.4.5.1 OM_Observation.metadata

OM_Observation adopts the ISO 19115 model for attached metadata. While most of the current EarthObservationMetadata structure could, in principle, be adopted unchanged, the following additions would be required:

- **Property**: Contact individual, organisation or position for this product
  - **Description**: Contact individual, organisation or position for this product
  - **Cardinality**: 0..1 (one at least is required)

- **Property**: Fixed value from CI_RoleCode, recommended to be ‘pointOfContact’
  - **Description**: Fixed value from CI_RoleCode, recommended to be ‘pointOfContact’
  - **Cardinality**: 1

- **Property**: Date of creation or update of
  - **Description**: Date of creation or update of
  - **Cardinality**: 1
**Table 6: Metadata additions required for EarthObservationMetadata to conform to MD_Metadata**

<table>
<thead>
<tr>
<th>identificationInfo/</th>
<th>MD_DataIdentification/abstract</th>
<th>Brief narrative summary of product</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>identificationInfo/</td>
<td>MD_DataIdentification/citation/CI_Citation/title (***)</td>
<td>Recommended citation title to be used for product</td>
<td>1</td>
</tr>
<tr>
<td>identificationInfo/</td>
<td>MD_DataIdentification/citation/CI_Citation/date (***)</td>
<td>Recommended citation date to be used for the product</td>
<td>1</td>
</tr>
<tr>
<td>identificationInfo/identificationInfo/</td>
<td>MD_DataIdentification/language</td>
<td>Language(s) used within the product</td>
<td>1</td>
</tr>
</tbody>
</table>

(*) To note is that the datestamp is a useful feature in a harvesting (metadata replication) use case as it allows selective harvesting of recently modified metadata records.

(**) A number of the parameters listed here are also required within the OGC CSW Core output schemas.

(***) A number of elements are also listed in the HMA FO Task 3 document on EO Metadata Requirements in the frame of online data access [RD26]. The objective of that document is to “collect metadata elements required for accessing satellite imagery data through an Online Data Access (ODA) service. The metadata identified is to be attached to a georeferenced imagery product and should allow online data access for visualization, downloading and processing of these products. It is restricted to georeferenced products (i.e. imagery has been re-projected in a geographic projection) and thus does not include information about the sensor model which would be needed to process raw imagery product. The metadata items summarized are focusing on products attached to the service rather than the service itself.”

**At the HMA-FO Preliminary Review meeting it was agreed that this ISO 19115 metadata for O&M Observation would not be used for EarthObservationMetadata, and that an additional metadata property would be added instead.** The O&M metadata could however be used to store ISO19115 metadata like requested within [RD26] if deemed necessary.

### 2.4.5.2 Observed property

The ‘observed property’ is mandatory for OM_Observation. For maximum interoperability, it should take a value from a defined codelist. For instance, the values shown in Table 7 could be used for various EO product types.

Additional work is required to determine the best approach to implementing the observed property, and constraining the valid values, and also for determining its relationship to: (1) the ATM DataLayer.specy attribute, and (2) the proposed new EarthObservationResult.parameter attribute (see discussion in sections 3.2 and 6.2). A discussion on possible code lists to use can also be found in section 6.2.

<table>
<thead>
<tr>
<th>Product type</th>
<th>OM_Observation.observedProperty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAR</td>
<td>“Dominant wave direction”, “Snow status (wet/dry)” etc.</td>
<td>geophysical parameter observed by SAR instrument</td>
</tr>
<tr>
<td>OPT</td>
<td>“Vegetation type”, “Glacier cover”, etc.</td>
<td>geophysical parameter observed by optical imager</td>
</tr>
</tbody>
</table>
ATM equivalent to DataLayer.specy

Altimetry
"Ocean dynamic topography", "Significant wave height", etc.
geophysical parameter observed by radar altimeter

Limb-sounding
"O₃ profile", "Atmospheric temperature profile", etc.
geophysical parameter observed by limb-scanning instrument

Systematic/synthesis
See discussion within section 6

Table 7 Example use of observed property (see section 6.2 and Annex D for more detail)

2.4.5.3 Result time
The OM_Observation ‘resultTime’ is the time at which the result became available. In general, this may be different to the ‘phenomenonTime’, which is the geophysically relevant time at which the final product applies. The times may be different when additional processing is performed to retrieve geophysical parameters.

2.4.6 O&M adoption – summary

2.4.6.1 Current status
The current status of O&M is that it has been approved (2 March 2010, ISO document 211n2878) through vote for publication as Draft International Standard, with only editorial comments. There will be no substantive changes to the model that would impact any adoption in the EO Product Metadata schema.

It is highly likely that O&M will be adopted by INSPIRE for numerous Annex II/III themes, including orthoimagery which will have some overlap with EO Product Metadata. See, for example, the recommendations arising from the FP7 GIGAS project (the table headed ‘Observation and Measurements’ at http://www.theigasforum.eu/forum/recommendations.html). O&M-based schemas are already in use for geology (GeoSciML) and climate science (CSML).

2.4.6.2 XML schemas
Candidate XML schemas have been developed for O&M and currently under discussion within OGC (http://portal.opengeospatial.org/files/?artifact_id=37915); the author of these (Simon Cox) currently sits on the HMA AWG. There is every expectation that final stable schemas will be available on a timescale compatible with HMA-FO.

See Annex E for example XML instance documents using the current draft schema. It can be seen that the changes from GML3.2.1 are very minor.

2.4.6.3 Adoption pros and cons
Some additional pros and cons are summarised below:

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Futureproofing with respect to very likely deprecation of gml:Observation.</td>
<td></td>
</tr>
<tr>
<td>Will facilitate approval process through OGC.</td>
<td></td>
</tr>
<tr>
<td>Compatibility with other data-sharing initiatives (e.g. INSPIRE), cf. recommendations of GIGAS project.</td>
<td></td>
</tr>
<tr>
<td>Opportunity for deeper integration in future between EO Product Metadata and Download Service (e.g. using the O&amp;M SamplingCoverageObservation).</td>
<td></td>
</tr>
<tr>
<td>Provides built-in ability to describe physical observable – crucial especially for atmospheric, limb-sounding and systematic/synthesis products.</td>
<td></td>
</tr>
</tbody>
</table>
Some minor changes required for providers: addition of ‘observedProperty’ and ‘resultTime’, some element name changes (‘validTime’ → ‘phenomenonTime’, ‘using’ → ‘procedure’, ‘target’ → ‘featureOfInterest’, ‘resultOf’ → ‘result’)

Need to follow schema evolution (although in practice this is trivial since support will be built-in to the tools used for the model-driven approach)

Based on a more conceptual view of missions and overall HMA architecture – could be considered a disadvantage when focussed on detailed engineering aspects.

When compared to the existing EO GML we do not feel that the adoption of O&M would bring additional complexity for adopters. The revised EO GML document would be self-descriptive and there would hence not be the need to study the O&M base document and schemas.

When considering compatibility of the GML instance documents with non–HMA GML clients we distinguish the following types of clients:

- Client applications that are using proper XML parsers. For these applications, the move to GML 3.2.1 will facilitate adoption from the non-standard GML 3.1.1 schema constructs.
- GIS Clients (like for instance ArcGIS, MapInfo, …): the GML support in these is typically limited to Simple Features GML (Level 0 Compliance) that allow only one type of geometry per feature and a set of simple attributes. As the current EO GML schemas are non-simple, we do not think that introduction of O&M will hinder interoperability. On the contrary if the INSPIRE data models get more and more introduced, the support for O&M based models in those tools will likely increase.

### 2.5 MORE RADICAL REFACTORING

It is to be noted that the approach listed in the previous section is based on the adoption of O&M hereby moving entire eop GML metadata blocks from the gml:observation properties to the associated OM_Observation properties. One could however as well imagine a more radical refactoring whereby one would critically evaluate each metadata element in view of the O&M schemas and other models, and decide on its most appropriate place, e.g. taking into account ISO19115 Part 2 through the use of MI_Metadata, and also SensorML.

*From the feedback received during and after the Preliminary Review it was clear that this extensive refactoring is not desired by the HMA stakeholders and will hence not be further elaborated.*

### 2.6 CONCLUSION

On the basis of the analysis before we would strongly recommend adopting the Model-driven approach when upgrading to GML 3.2.1 as it improves consistency and facilitates maintenance whilst not introducing any additional change at GML instance level.

In view of mainly the deprecation of gml:Observation and alignment with INSPIRE, and the minor additional changes it introduces, we also recommend to adopt O&M with minimal refactoring of the original schemas.
3 BASE APPLICATION SCHEMA CHANGES

3.1 IDENTIFIED CHANGES WITHIN HMA-T

3.1.1 Incorporated in OGC06-080r5

Within the HMA-T Phase 2 project, a number of inconsistencies were discovered between the text of the OGC06-080r4 specification and the schemas. Also for the more flexible description of synthesis products, a different definition of the compositeType was requested.

These change requests were discussed in the Standards working group and were adopted in OGC06-080r5 which was posted to the OGC pending documents list.

These changes need to be retained within the newer version of the specification that will be the outcome of the HMA-FO Task 1 project.

<table>
<thead>
<tr>
<th>OGC Issue tracker no</th>
<th>Comment</th>
<th>Proposed Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 170</td>
<td>productType element of EarthObservationMetadata is as per the OGC06-080r4 text an element with cardinality of 0..1 intended to describe the product type &quot;in case that mixed types are available within a single collection, this is ground segment specific definition.&quot; According to the schema eop.xsd this element is however mandatory.</td>
<td>As not all collections have mixed types, we propose to make this optional in the schema. Schema change: &lt;xs:element ref=&quot;eop:productType&quot; minOccurs=&quot;0&quot; /&gt;</td>
</tr>
<tr>
<td>2 171</td>
<td>There appears to be an inconsistency between the text of the document and the xsd with respect to the cardinality of the ProcessingInformation child elements. The text suggests that elements like processing/ProcessingInformation/method should have a cardinality of 0..n. The schema implies a cardinality of 0..1 for these elements and for the parents ProcessingInformation and processing so that one can only describe one processing step which is too limitative.</td>
<td>One could solve this by adjusting the cardinality at any of the three levels: processing, ProcessingInformation or ProcessingInformation children. It is proposed to change the cardinality of the &quot;middle&quot; ProcessingInformation element to 1..n as this would allow to group the information that belongs to one processing step together within one ProcessingInformation element. Schema change: &lt;xs:element ref=&quot;eop:ProcessingInformation&quot; /&gt;</td>
</tr>
</tbody>
</table>
### 3.1.2 Additional proposed changes

In addition to these “approved changes”, there also is a change request that was created to be able to fulfill the use cases specified for the EO Application Profile of WMS [RD17] and to be able to use the filename element for online access to browse images (WMS) or full products (WCS) when a SOAP Binding is used:

Within the eop:EarthObservationResult there is the product/ProductInformation/filename element that is to contain the "Path to the actual product data if available online". OGC06-080r4 clarifies that the contents of the filename element “could be any type of URL: direct link to the image or WMS/WCS interface), it is assumed that if a client is prepared to "manage" a product delivered by e.g. WCS they would parse the URL to identify that it contains the OGC standard SERVICE=WCS. Same principle applies for the browseInformation.

Issues:

1) The semantics of the element are ill defined. The client application needs to discover the appropriate use of the URL by parsing it.

2) The filename element is expected to contain a URL with in case of WCS, the appropriate KeyValuePair Parameters to constitute a valid GetCoverage Request. This however assumes that only the HTTP GET binding is used. In case the HTTP POST or SOAP bindings would be used, it would be more convenient to have separate elements to specify the endpoint and the POST/SOAP XML message and Header.

<table>
<thead>
<tr>
<th>3</th>
<th>172</th>
<th>The processing /ProcessingInformation/compositeType element expects values that come from the enumeration that contains values Weekly, Daily, Monthly. This does not allow describing all possible composites as for instance SPOT VGT 10-daily synthesis products or the MODIS NDVI 16 day composites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>To have a more generic approach we would propose to use the ISO8601 format for time intervals as is for instance used in the OGC WMS Specification to express the time interval between available maps. This gives: Weekly P7D Daily: P1D Monthly: P1M 10 Daily: P10D 16 Daily: P16D Xsd Type: duration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;xs:element name=&quot;compositeType&quot; minOccurs=&quot;0&quot; maxOccurs=&quot;unbounded&quot;/&gt;</td>
</tr>
</tbody>
</table>

Table 8 Changes in OGC06-080r5
3) The “Web Map Service Application Profile for EO Products” proposes a different use for this element. It is to contain a URL to a Web Map Context document to allow passing the online reference to a group of layers (base product and mask layers and/or derived geophysical products with their appropriate styles).

The proposed solution is to allow the definition of the “filename” using the "service reference" that is proposed in OWS Common 1.2 specification (table 55) [RD18].

### 3.2 NEW METADATA ELEMENTS

The following additional metadata elements that are of relevance for more than one of the new product types as well as to the existing product types have been proposed by the different stakeholders. These elements (or relaxations of content for certain elements) are hence proposed as optional elements within the base EOP schema.

<table>
<thead>
<tr>
<th>EOP Extension Point</th>
<th>Additional element</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>wavelengthInformation</td>
<td>Information about the wavelengths used in the product</td>
<td>0…*</td>
</tr>
<tr>
<td></td>
<td>(property)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition</td>
<td>WavelengthInformation</td>
<td>Class containing about the wavelengths observed in the product</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>(class)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>startWavelength</td>
<td>Start of the observed wavelengths (for level 1 data).</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td>(property)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>endWavelength</td>
<td>End of the observed wavelengths (for level 1 data).</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td>(property)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>wavelengthResolution</td>
<td>Spacing between consecutive wavelengths.</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Must be a gml Measure</td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>discreteWavelength</td>
<td>A list of discrete wavelengths observed in the product.</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Must be a gml MeasureList</td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>spectralRange</td>
<td>The observed spectral range.</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td>(property)</td>
<td>Values must be taken from enumeration SpectralRangeValue</td>
<td></td>
</tr>
<tr>
<td>Acquisition/WavelengthInfor mation</td>
<td>SpectralRangeValue</td>
<td>Enumeration of spectral ranges:</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>(enumeration)</td>
<td>• VISIBLE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• INFRARED</td>
<td></td>
</tr>
<tr>
<td><strong>ProductInformation</strong></td>
<td><strong>qualityFlag</strong> (property)</td>
<td>Flag to indicate the overall quality OK or NOK</td>
<td>0..1</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td><strong>EarthObservationResult</strong></td>
<td><strong>parameter</strong> (property)</td>
<td>Information about the geophysical or biophysical measurements available in the product.</td>
<td>0...*</td>
</tr>
<tr>
<td><strong>EarthObservationResult</strong></td>
<td><strong>ParameterInformation</strong> (class)</td>
<td>Class used to model Parameter information</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>EarthObservationResult/ParameterInformation</strong></td>
<td><strong>name</strong> (property)</td>
<td>Name for geophysical or biophysical measurements available in the product referenced from a codelist. E.g. Sea Surface Heights, Significant Wave Heights, Ozone concentration, NDVI, … Possible values are governed by an extensible codelist as discussed in section 6.2.</td>
<td>1</td>
</tr>
<tr>
<td><strong>EarthObservationResult/ParameterInformation</strong></td>
<td><strong>uom</strong> (attribute)</td>
<td>Units of measure in which the geo or biophysical parameter is expressed</td>
<td>0...1</td>
</tr>
<tr>
<td><strong>ProcessingInformation</strong></td>
<td><strong>auxiliaryDataSetFileName</strong> (property)</td>
<td>Name of auxiliary datasets used within the processing step</td>
<td>0...*</td>
</tr>
<tr>
<td><strong>Footprint</strong></td>
<td><strong>Orientation</strong> (property)</td>
<td>Determines the orientation of the polygon coordinates for the exterior boundary. Possible values are CW (clockwise), counterclockwise (CCW) or unspecified. Default value is counter clockwise. Element is only to be provided for products that do not follow the OGC simple features convention. More information can be found in section 3.2.2.</td>
<td>0..1</td>
</tr>
</tbody>
</table>

### 3.2.1 Circular geometries
In addition to the changes mentioned above, it would be beneficial to allow encoding of circular geometries by defining the centrepoint and the radius. The proposed geometry construct is circleByCentrePoint that allows the encoding of the centrepoint position, and the radius as defined in the schema fragment given below:

```xml
<complexType name="CircleByCenterPointType"> <complexContent> <restriction base="gml:ArcByCenterPointType"> <sequence> <choice> <choice> <element ref="gml:pos" /> <element ref="gml:pointProperty" /> <element ref="gml:pointRep" /> <element ref="gml:posList" /> <element ref="gml:coordinates" /> <element name="radius" type="gml:LengthType" /> </choice> </choice> </sequence> </restriction> </complexContent> </complexType>
```

Note that this does not entail a new element in the schema only a change to the schematron rules to also allow this type of geometry as exterior boundary of the Polygon within the Footprint.

### 3.2.2 Encoding rules for geometries to avoid dateline Issue

The current EO GML specification states that the coordinates should be encoded in the CRS:WGS84 (formerly known as EPS:4326 with longitude/latitude ordering) Coordinate Reference System. This is the de facto standard Coordinate reference systems used within the OGC world. It refers to the Geographical Coordinate system that use the WGS84 datum. It is in fact the "plate carree" projected form that is understood by OGC as being EPSG:4326.

In such a planar coordinate space going from $-180^\circ$ to $+180^\circ$ in the X direction and from $-90$ to $+90$ in the Y direction, polygonal features that cross the dateline, cannot be correctly drawn as single polygons.

If one just takes the list of coordinates describing the polygon and one does not take into account the orientation of the nodes within this list of coordinates, there are in fact two polygons that can be drawn on the ellipsoid that represents the world. The first one following the polygon vertices in clockwise direction, the other polygon in counter-clockwise direction.

The following figure illustrates this showing the 2 possible polygons that could be drawn for a single polygon description with coordinates (expressed as X,Y pairs): -30, -30 -30, 30 30,30, 30, -30.

![Figure 6: Dateline issue: showing 2 polygons defined by identical coordinates (3D View)](image)

Polygon A and (multi)-polygon B are both polygons that are defined using the same coordinates.
There is hence a certain ambiguity in determining which polygons (described by 4 corner points) do cross the dateline and which do not. This is not specific to the CRS in use as such coordinate discontinuity will always occur when wanting to project a sphere on a planer surface when the entire sphere needs to be represented.

If one needs to present such a polygon on a flat surface, the most logical polygon to draw is in fact the one that does not cross the coordinate discontinuity at the dateline which is what most softwares will do resulting in a set of near horizontal lines being drawn going from -180 to 180.

Within the SSE Portals’ WebMapViewer logic was built in to detect if a polygon crosses the dateline (based on a minimum distance criterium). And if the polygon was detected to cross the dateline, the geometry was changed in order to not draw the East-West lines at each dateline crossing. The transformation algorithm used is quite complex and differs in function of the number of poles that are
crossed (none, one or both). Such revised geometries are shown in the following picture that gives the same footprints as in the previous figure.

![Dateline issue display of METOP footprints with dateline correction](image)

**Figure 9: Dateline issue display of METOP footprints with dateline correction**

### 3.2.2.1 Alternative solutions

#### 3.2.2.1.1 Forbid dateline crossing polygons

State in the EO GML Specification the condition that polygons should not cross the dateline. Each Ground Segment should cut footprint polygons into multipolygons when they cross the dateline. This is however not a very satisfying solution as this means first of all that each Ground Segment needs to implement this logic. Secondly, if dateline crossing polygons would be viewed in software that is capable of reprojecting the features into another CRS, the footprint polygons would be displayed with a linestring following the dateline. From a clients perspective this is obviously the most simple approach.

#### 3.2.2.1.2 Represent such polygons only in another CRS

This corresponds to solution a) that the OpenGIS Web Services Common Specification proposes for handling Bounding Boxes that span the value discontinuity in an angular coordinate axis. For example use a coordinate reference system with its prime meridian near the centre of the polygon. In case of world covering polygons, this is however not a solution. It also limits the CRSses a client application can use and hence hinders interoperability.

#### 3.2.2.1.3 Include Bounding Box with Lower corner as most western edge

This corresponds to solution b) that the OpenGIS Web Services Common Specification [RD18] proposes for handling Bounding Boxes that span the value discontinuity in an angular coordinate axis. For a circular coordinate, specify that the LowerCorner shall define the box edge furthest toward decreasing values, and the UpperCorner shall define the box edge furthest toward larger values. For longitude, the LowerCorner longitude would define the West-most box edge, and the UpperCorner longitude would define the East-most box edge. (The LowerCorner would no longer always use the minimum value, and the UpperCorner would no longer always use the maximum value. The value at the LowerCorner can be greater than at the UpperCorner when this bounding box crosses the value discontinuity.).
If such Bounding Boxes were included in addition to the footprint geometry, this would allow the client application to assess whether the polygon included within the Bounding Box crosses the dateline or not. This would however not work for footprints that are “wider than 360°”. It also only helps detecting whether or not the polygons cross the dateline and is such somewhat equivalent to the minimum distance criterion, but does not help solving the complete ambiguity.

3.2.2.1.4 Specify coordinates outside the normal value range

This corresponds to solution c) that the OpenGIS Web Services Common Specification [RD18] proposes for handling Bounding Boxes that span the value discontinuity in an angular coordinate axis.

Allow a circular coordinate value to lie outside the normal value range, so this value can be the minimum or maximum and also define a bounding box that crosses the value discontinuity. For example, allow the LowerCorner longitude to range from -540 to +180 degrees (allowing a bounding box from -538 degrees on the West to +179 degrees on the East).

Using this approach one would need to encode a footprint polygon as going from 179° to 181° instead of (-179). This appears to be similar to what is done in the PHR specific application schema.

This solution would solve ambiguity but would create problems in a lot of software packages that do not accept coordinates to go outside the normal value range of a Coordinate Reference System.

To note is that a similar solution is indicated in the phr.xsd schema of CNES included in previous versions of the OGC06-080 specification where an element antimeridianLongitudeConvention" is present when specifying the location models that are used to map the Album image in its geographical footprint.

"Used only if Features crosses the antimeridian line. The Location Model is continuous and ignores the antimeridian discontinuity : longitudes may be greater than +180 or lower than -180. This tag gives the sign of the longitude used by the location model. If POSITIVE, longitudes are extended beyond +180 (example : -177 is expressed as +183). If NEGATIVE, longitudes are extended below -180."

3.2.2.1.5 Minimum worldline distance and coordinate orientation convention

This would consist in applying two conventions to the polygon footprints:

1. The first criterion is to specify that the logic interpretation of a polygon is to take the interpretation that involves the smallest worldline distance between two vertices, the distance that is smaller than 180°. As such the logic interpretation of a linestring specified by coordinates lon -30.0 to lon 30.0 would be considered as not to cross the dateline as the smallest distance linking the 2 points is 60 degrees does not cross the dateline. Alternatively a linestring going from -150 to +150 would be considered as crossing the dateline as the smallest distance linking the 2 points goes over the dateline.

2. In addition, there would be the obligation to encode the polygons of the exterior boundary of the polygon in counter clockwise direction. Previously there was some ambiguity about whether a certain orientation was prescribed. It has been clarified at OGC in the latest Simple Features Access Common Architecture Specification that the coordinates should be ordered following this convention.

"A Polygon is a planar Surface defined by 1 exterior boundary and 0 or more interior boundaries. Each interior boundary defines a hole in the Polygon. The exterior boundary LinearRing defines the “top” of the surface which is the side of the surface from which the exterior boundary appears to traverse the boundary in a counter clockwise direction. The interior LinearRings will have the opposite orientation, and appear as clockwise when viewed from the “top”.

When applying these two criteria, client applications have enough information to properly represent the polygons.

Note that a consequence of the first criteria is that if one wants to present a polygon that goes from for instance -100 to +100 and does not cross the dateline, one needs to add vertices in the middle.
One exception that could be foreseen is for footprints with a Bounding Box that covers the world like common for L3/L4 based products. Such products go from -180 to +180° and the minimum distance is hence 0. As this is a commonly occurring case, one could fix the interpretation of such polygons as always be world covering instead or the unlogical interpretation of having a footprint with 0 surface area.

This solution appears to be most inline with the specifications and with current industry practice.

### 3.2.2.1.6 Minimum worldline distance and additional centrepoint

As alternative to the above one could consider adding a mandatory centrepoint to all footprints instead of the coordinate ordering convention. This is equivalent to option g in [RD18].

This is however considered complex and less elegant than the coordinate order convention that anyway needs to folowed if one wants to be strictly conformant to the OGC/ISO Specification stack.

### 3.2.2.2 Conclusion

In order to solve the dateline ambiguity, there is a need to capture more precise information with respect to the shape of the polygons. Industry practice is to use the conventions about minimum worldline distance and counterclockwise orientation of the coordinates.

- Applying the minimum worldline distance criterion is expected to have no effect on existing implementations. This criterion means that in order to determine how to link 2 vertices, that one will follow the smallest worldline distance between the two vertices: the distance that is smaller than 180°. This only affects footprints that are “wider” than 180 degrees and for which there would be a polygon “side” specified by only 2 points. For such polygons one would need to encode additional vertices in between the 2 points that are 180 degrees apart to avoid them to be misinterpreted. In our experience we have not encountered polygons that would require changing when this criterium would get applied. The only cases where this happens are the “Worldcovering” synthesis products for which we would introduce the exeption described above.

- Applying the counter clockwise orientation of exterior boundaries will have more effect as it is known that some of the agencies use the opposite convention. As counterclockwise orientation of exterior boundaries now appears to be a requirement of ISO/OGC simple features we would recommend using this convention for all new developments. One solution would be to add a new optional element `<orientation>` under `<FootPrint>` that would need to get the value “clockwise”, “counterclockwise” or “unspecified”. The default value would be counterclockwise and this element can hence be omitted for polygons that do follow the simple features “counterclockwise” convention.
4 APPLICATION SCHEMA EXTENSION FOR ALTIMETRY PRODUCTS

4.1 NEW METADATA ELEMENTS

Preliminary analysis indicates the following properties probably need to be included in the altimetry products application schema:

<table>
<thead>
<tr>
<th>EOP Extension Point</th>
<th>ALT Extension</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>EarthObservationEquipment</td>
<td>auxiliaryInstrument (property)</td>
<td>Must be of type AuxiliaryInstrument. Auxiliary instruments are a class of instruments that are not the primary instrument. It is desirable to identify them for discovery purposes. e.g. DORIS-DIODE is an auxiliary instrument used in altimetry.</td>
<td>0…n</td>
</tr>
<tr>
<td>Instrument</td>
<td>AuxiliaryInstrument (class)</td>
<td>Extends InstrumentType with properties: ‘instrumentType’ ‘description’</td>
<td>n/a</td>
</tr>
<tr>
<td>Instrument</td>
<td>AuxiliaryInstrument/instrumentType (property)</td>
<td>See above</td>
<td>0…1</td>
</tr>
<tr>
<td>Instrument</td>
<td>AuxiliaryInstrument/description (property)</td>
<td>See above</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationEquipment</td>
<td>instrument (property)</td>
<td>Cardinality of instrument attribute in base schema is 0..1. For combined products (made with multiple altimeters) there may be more than one primary instrument. Cardinality is therefore modified to 0..n</td>
<td>0…n</td>
</tr>
</tbody>
</table>
(Note this is separate from the requirement for Auxiliary Instruments).

This requirement is for the case when a gridded product for example is the result of more than one instrument.

**EarthObservationEquipment**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>platform (property)</td>
<td>Cardinality of platform attribute in base schema is 0..1</td>
<td>0…n</td>
</tr>
<tr>
<td></td>
<td>For combined products (made with multiple altimeters) there may be more than one primary platform.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cardinality is therefore modified to 0..n</td>
<td></td>
</tr>
</tbody>
</table>

**Acquisition**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>cycleNumber (property)</td>
<td>Number of Cycle</td>
<td>0…1</td>
</tr>
<tr>
<td>absolutePassNumber (property)</td>
<td>Pass number since start of operation</td>
<td>0…1</td>
</tr>
<tr>
<td>relativePassNumber (property)</td>
<td>Pass number since start of cycle</td>
<td>0…1</td>
</tr>
<tr>
<td>isSegment (property)</td>
<td>Acquisition may not be a pass but may be a segment characterised by a start and end time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In this case the isSegment flag should be set to ‘True’</td>
<td>0…1</td>
</tr>
<tr>
<td></td>
<td>The default value (or the assumed value if not present) is ‘False’</td>
<td></td>
</tr>
<tr>
<td>segmentStartTime (property)</td>
<td>Start time of the segment acquisition</td>
<td>0…1</td>
</tr>
<tr>
<td>segmentEndTime (property)</td>
<td>End time of the segment acquisition</td>
<td>0…1</td>
</tr>
</tbody>
</table>

**ProcessingInformation**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>groundTrackUncertainty (property)</td>
<td>Measure of the uncertainty of the ground track. Sometimes known as deadband e.g. 1Km deadband.</td>
<td>0…1</td>
</tr>
<tr>
<td>productContentsType (property)</td>
<td>Classification of product according to ground type covered. Value of this</td>
<td>0…*</td>
</tr>
<tr>
<td>Property</td>
<td>Type</td>
<td>Value (enumeration)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ProductContentsTypeValue</td>
<td>ProcessingInformation</td>
<td>Enumeration of ProductContentTypes: COASTAL, CONTINENTAL, HYDROLOGY, ICE, OPEN_OCEAN, OTHER</td>
</tr>
<tr>
<td>processingMode</td>
<td>ProcessingInformation</td>
<td>Whether the mode is Near real time, real time etc (or OGDR/IGDR/GDR. As these semantics differ between missions, the value of processingMode must be restricted to one of the generic terms in the enumeration ProcessingModeValue</td>
</tr>
<tr>
<td>ProcessingModeValue</td>
<td>ProcessingInformation</td>
<td>Enumeration of processing modes: DATA_DRIVEN_PER_ACQUISITION, DATA_DRIVEN_DAILY, OFFLINE, OTHER</td>
</tr>
<tr>
<td>samplingRate</td>
<td>ProcessingInformation</td>
<td>Rate at which samples are provided in product. Some products may contain more than one sampling rate, e.g. 1kHz and 20kHz. Cardinality is therefore zero to many.</td>
</tr>
<tr>
<td>nominalTrack</td>
<td>Footprint</td>
<td>A geometry of type GM_Multicurve used to define the nominal track on the earths surface. This</td>
</tr>
</tbody>
</table>
track is essentially a line that is representative of the product but does not include points for every value.
The use of GM_MultiCurve allows for multiple lines and breaks in lines.
In future wide-swath altimetry cases (e.g. SWOT) where the track will be a swath, the multiExtentOf property in the base schema may be used (as it is for other EO products).

4.2 DISCUSSION

Some of the metadata elements in Section 4.1 warrant further discussion beyond what is in the Description field in the table.

AuxiliaryInstrument: The auxiliary instrument describes secondary instruments that do not return the ultimate data of interest but are perhaps of importance for calibration. For example, a Microwave Radiometer is used to enable more accurate altimeter measurements.

AuxiliaryInstrument as modelled here contains information not found in the eop:Instrument, specifically, instrumentType and ‘description’ attributes. Since these are likely to be useful for generic Instruments it may actually be preferable to add these attributes to the “Instrument” class in the EOP base schema rather than be the ALT extension. The ALT extension could then use a code list to constrain the suitable InstrumentTypes to those appropriate for Altimetry such as:

- MICROWAVE_RADIOMETER
- DOPPLER
- LASER
- GPS
- OTHER

Cardinality of Instruments/Platforms/Sensors: It was noted in separate discussions with both CNES and NCEO (regarding limb-looking products) that there is an increased trend towards composite products that do not fit the 1 platform/instrument/sensor model inherent in the EOP base schema. For example, the ESA EarthWatch Programme Element on Global Monitoring of Essential Climate Variables will use data from multiple platforms/instruments to create sets of new products. In limb-sounding the Premier mission has two limb-sounding instruments, one microwave, one infrared.

Footprint: The along-track Altimetry footprint can be represented on a map as a line. This line can be generated using some of the real measurement points or otherwise generated using an algorithm to calculate suitable representative points. We call this the nominalTrack.

For the most flexibility in how this line is defined the nominalTrack is modelled as a GM_MultiCurve.

Feedback from GECA was that the spatial error, i.e. the distance between a real measurement point and its nearest line segment, is an order less than the spatial collocation criterium that will be used within altimetry (or an orderless than the distance between two measurement points). This can be put...
in as a guidance note in the schema, but it will be difficult to enforce this using schematron or other mechanisms.

For wide-band swath altimeters (such as SWOT), then the multiExtentOf property may be used as for other EO products.

4.3 SOURCE OF REQUIREMENTS

Input into these requirements came from:

- CNES
- CLS (MyOcean)
- EUMETSAT
- ESA GECA

A face to face meeting was held at CNES (04 March 2010) where these requirements were reviewed in detail. CLS were also present and EUMETSAT were invited. While they could not attend they did provide input to the meeting via email.

The document “Application des schémas OGC EOP à l’altimétrie - cas des produits Jason” by CNES also informed this draft.

Further input on this draft is welcomed and will be sought from other agencies and users.
## 5 APPLICATION SCHEMA EXTENSION FOR LIMB LOOKING PRODUCTS

### 5.1 NEW METADATA ELEMENTS

Preliminary analysis indicates the following properties probably need to be included in the limb-looking products application schema:

<table>
<thead>
<tr>
<th>EOP Extension Point</th>
<th>LMB Extension</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>measurementType (property)</td>
<td>Whether the measurement is absorption or emission. Must be from the enumeration of MeasurementTypeValues</td>
<td>0..1</td>
</tr>
</tbody>
</table>
| Acquisition         | MeasurementTypeValues (enumeration) | Enumeration of measurement types:  
  • ABSORPTION  
  • EMISSION | n/a |
| Acquisition         | observationMode (property) | Observation mode used in acquisition. E.g. ‘UTLS-1’ is one of the seven MIPAS observation modes which determine the sampling regime. Not constrained at the limb-looking schema level as these modes are instrument specific. | 0..1 |
| Footprint           | maximumAltitude (property) | Upper bound of measurements in vertical dimension. Must be gml Measure | 0..1 |
| Footprint           | minimumAltitude (property) | Lower bound of measurements in vertical dimension. Must be gml Measure | 0..1 |
| Footprint           | nominalTrack (property) | A geometry of type GM_Multicurve used to define the nominal track on the earth's surface. This track is essentially a line that is representative of the product but does not include points for every value. | 0..1 |
5.2 DISCUSSION

Some of the metadata elements in Section 5.1 warrant further discussion beyond what is in the Description field in the table.

**Resolution:** It is accepted that not all products are regularly spaced in the vertical, therefore the resolution property will only be applicable in some cases.

**Observation Modes:** As mentioned in the notes these vary instrument by instrument. For example MIPAS has seven observation modes, which determine the horizontal and vertical sampling regimes at different altitudes. If the limb-looking schema was further specialized for a specific instrument then it would be desirable to explicitly enumerate the available modes for that instrument in the specialization. The observation modes are well known and useful discovery metadata.

**Footprint:** As for altimetry metadata, representing the nominal track with a GM_MultiCurve should provide enough flexibility for data providers to provide a ‘map’ image of the track. Again accuracy guidance should be provided along side the model as per the altimetry footprint.

The vertical ‘footprint’ must also be considered. A single limb-sounding product is made up of many vertical profiles through the atmosphere, each of which has a (potentially) different maximum and minimum altitude. While the ideal solution would be to make the details of each individual profile available for discovery, in practice encoding this level of detail may become very verbose and beyond the level of detail in other GML-EO products. So for discovery purposes an approximation to the maximum and minimum for the whole product is a pragmatic solution. The maximum and minimum altitudes can then be used in conjunction with the nominalTrack to create a 3-Dimensional surface for use on maps or other visual interfaces.

An alternative solution would be to provide a series of maximum and minimum altitudes that correlate with the lon/lat ground points in the nominalTrack representation. However there are some problems with this solution. Firstly, the nominalTrack may not use real measurement points (it may have been generated from an algorithm to get a best fit line) therefore there will be no ‘real’ altitude measurements – although the nearest/best fit could be used. Secondly, by only using a subset of vertical values we risk excluding points of extreme measurement from the approximation – or in otherwords, a nominalTrack that is sufficient for approximating the ground track may not be the best choice of values for approximating the vertical measurements.

Taking into account these issues, it is felt that for discovery purposes it is more important to accurately capture the extremes of the vertical measurements (the maximumAltitude, minimumAltitude properties) in a concise manner than to attempt to encode a more complex altitude pattern.
5.3 SOURCES OF REQUIREMENTS

NCEO (NERC Centre for Earth Observation) and STFC Atmospheric Science Division have been the sources of requirements for limb-looking products so far. They are end users of the products so are actively engaged with the discovery use case.

Clearly further input on this draft will be welcomed and will be sought from other agencies and users.
6 APPLICATION SCHEMA EXTENSION FOR SYNTHESIS AND SYSTEMATIC PRODUCTS

6.1 SYNTHESIS PRODUCTS

Synthesis (or composite) products are products that are generated by combining information from multiple EO Products that are acquired over a certain period of time.

Examples of synthesis products are

- For SPOT VGT the products that are being generated by VITO on the basis of the individual VGT Segment (VGT-P – Physical Values):
  - VGT S1: Daily Mean Value Composite synthesis
  - VGT S10: 10-Daily Mean Value Composite synthesis
  - VGT D10: 10-Daily BiDirectional Composite syntheses
- MODIS/Terra 16 day Maximum Value Composite

For describing Synthesis products the following metadata elements are taken into account:

- Information on the averaging period over which the synthesis product is created. Examples of typical averaging periods are 1 day, 10 days, 16 days, one month, one year. This information can in the existing eop schemas already be captured within the eop:CompositeType element. In [AD01] this is formulated as a restriction on string allowing only the enumeration of DAILY, WEEKLY, MONTHLY. A change request originating from HMA-T caused the type of the element to change to xs:duration in [RD04] so that one can now specify periods of arbitrary duration like P1D: 1 day, P10D: 10 days, P1M: 1 month, P1Y: 1 year, ... . To be discussed whether this element stays at eop level or could be moved to a new schema.

- Information on the base products that were taken into account within the composition process. To note is that within the eop base schemas there already exist an element called composedOf. [AD01] states that this association "is used to define structural links to extended metadata. For instance a "phr:Datastrip" is logically split into one or more "phr:Scene". Thus, each Scene in the "phr:Datastrip" schema is referenced with the "eop:composedOf" property. Despite the name of the element, the description of its contents does not fit with the relationship between a synthesis product and its constituting products. It is therefore proposed to add an additional element derivedFrom that could be used to capture the links. It is to be noted that the composedOf property takes as value an eop:EarthObservation object either by enclosing the GML Content of the GML content of an EarthObservationProduct or by urn (xlink attribute).

\[
\begin{align*}
\text{<xs:element name="composedOf" type="eop:EarthObservationPropertyType"/>} \\
\text{<xs:complexType name="EarthObservationPropertyType">} \\
\text{\hspace{1cm}<xs:sequence>} \\
\text{\hspace{2cm}<xs:element ref="eop:EarthObservation" minOccurs="0"/>} \\
\text{\hspace{2cm}</xs:sequence>} \\
\text{\hspace{1cm}</xs:complexType}> \\
\end{align*}
\]

- The NominalDate that is assigned to the synthesis product for uniquely identifying it. The nominal date can be expressed as an xs:datetime.
The first two elements would be very useful for the description of synthesis products. The third one is a nice-to-have. It does not seem worthwhile to create an additional application schema just for synthesis products. Certainly not when considering the fact that the compositeType element is currently already present at eop level. It seems more logical to include these elements within the systematic product category.

### 6.2 Systematic Products

For systematic products the following additional elements have been defined on the basis of information received from EMSA, VITO, MyOcean, EUMETSAT (see Annex C for full analysis) and the ESA GECA project.

- **Physical Quantity**: the physical property that is being measured with its units of measure and optionally its symbol. This element should have a cardinality of 1:n to allow the presence of multiple physical quantities in the different bands of a product type. *It is to be noted that in case the O&M Schemas will be adopted then the ObservedProperty is intended to capture this information.* After discussions it was decided to move this parameter to the eop level (as it was shared by all new product types) and rename it “parameter”. The allowed values for this “parameter” element should be based on a well-established code list. Three possible codelists are known:

  - The codelist that is provided by the netCDF-CF convention in the so-called standard name table [RD19]. This provides a set of standardised terms for quantities within the following categories: Atmospheric Chemistry, Atmosphere Dynamics, Ocean Dynamics, Radiation, Carbon Cycle, Sea Ice, Cloud and Hydrology. There also are guidelines for constructing new names. The guidelines for creation of names have drawn on the ECMWF and NCEP GRIB tables, the PCMDI standard variable names, and the NASA Global Change Master Directory. The netCDF- CF standards are maintained by the netCDF-CF community as described in [RD21] consisting mainly of scientists involved in atmospheric science and oceanography.

    Examples of netCDF terms are
    - mass_concentration_of_ozone_in_air
    - surface_albedo

  - The codelist that is provided in the ENVISAT-AURA Validation data centre metadata guidelines [RD20] that is targeted at collecting auxiliary data used in EO Measurement calibration and validation activities. This list is maintained by ESA, NASA and a number of correlative data providers. A new version of this standard is currently being developed by NASA and NILU with support of the ESA GECA project and is coined “GeoMS”. Examples of “variable names” are:

    - O3.CONCENTRATION
    - ALBEDO

  - The list of geophysical parameters provided in the ‘WMO/CEOS Database of Operational Requirements’ [RD27] contains a list of instrument types from a number of missions, and their associated geophysical parameters. Examples include:

    - O₃ profile
    - Earth’s surface albedo

An analysis of these code lists for a set of “Parameters” for radar altimeter and systematic and synthesis products is given in Annex D. This partial analysis shows that most of the “Parameters” can be described using these lists. GEOMS offers more flexibility in describing
atmospheric “species” variables whereas NetCDF CF Standard Names is broader and allows a finer granularity for describing for instance “vegetation” parameters. The CEOS/WMO Database is oriented to geophysical parameters at Level-2 processing.

- **Information on the wavelengths.** Either wavelength range(s) or a list of discrete values should be possible. After discussions it was decided to move this parameter to the eop level as it was shared by most new product types.
- **Additional Processing Information** like type of algorithm (regression, empirical, etc.). After discussions it was decided to be included in the existing extended processingInformation element that can appear multiple times as per the previously discussed changes.
- **Geographical Name:** indication for the area that is covered by a product e.g. World, Europe, Arctic, Africa…. For generality reasons this will not be linked to a code list (or gazetteer) (modelled using SI_LocationInstance)
- **Allow multiple platforms and instruments** to be referenced
- **Add snowcover and cloudcover information**

### 6.3 SSP NEW METADATA ELEMENTS

The following table lists the proposed new metadata elements to be taken up in the “Synthesis & Systematic Products” GML Application Schema for which the namespace prefix “ssp” is proposed.

<table>
<thead>
<tr>
<th>EOP Extension Point</th>
<th>SSP Extension</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
<tbody>
<tr>
<td>EarthObservationMetadata</td>
<td>nominalDate</td>
<td>Nominal date assigned to the synthesis product</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationMetadata</td>
<td>derivedFrom</td>
<td>Link to an EO Product that was used in the generation of the ssp product</td>
<td>0…*</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>cloudCoverPercentage</td>
<td>Cloud Cover Percentage (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>cloudCoverPercentageAssesmentConf</td>
<td>Cloud Cover Percentage Assessment Confidence (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>cloudCoverPercentageQuotationMode</td>
<td>Cloud Cover Percentage Quotation Mode (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>snowCoverPercentage</td>
<td>Snow Cover Percentage (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>snowCoverPercentageQuotationMode</td>
<td>Snow Cover Percentage Quotation Mode (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationResult</td>
<td>snowCoverPercentage (property)</td>
<td>Snow Cover Percentage (cfr optical products)</td>
<td>0…1</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Footprint</td>
<td>geographicalName (property)</td>
<td>Name (string) to indicate the area that is covered e.g. “World”, “Africa”, …</td>
<td>0…1</td>
</tr>
<tr>
<td>EarthObservationEquipment</td>
<td>platform (property)</td>
<td>platform (ssp are generated on the basis of products resulting from instruments onboard of more than one satellite)</td>
<td>0…n (as compared to 0..1 for eop)</td>
</tr>
<tr>
<td>EarthObservationEquipment</td>
<td>Instrument (property)</td>
<td>Instrument (ssp are generated on the basis of products resulting from more than one sensor)</td>
<td>0…n (as compared to 0..1 for eop)</td>
</tr>
</tbody>
</table>
7 INCLUSION OF EXPLOITATION METADATA

The metadata that is currently defined within the EO GML is targeted at Cataloguing of products and is hence limited to so-called discovery metadata.

When working with EO Products one also has additional metadata information that must be known in order to usefully exploit the products in image processing software.

The information that is required consists of

- The spatial domain: typically the number of rows/columns and their affine transformation to the coordinates of an external CRS using the coordinates of the origin and offset vectors.
- The ranges: bands/channels with their datatype and their minima and maxima
- Mask values

Typically a file with such exploitation metadata is shipped with each data product to facilitate its interpretation. In the HMA Context, it would only be logical that this exploitation metadata is encoded using an optional structure inside the GML Application schema.

This exploitation metadata becomes also very relevant when considering the online data access. Within HMA FO task 3, work is ongoing to define an EO extension to the WCS 2.0 core [RD22] which is currently out for voting in the OGC Working group. For this new version of the WCS the entire coverage metadata is now encoded using GML. Originally the intent was to use the gml coverage definition. However in the course of developing WCS 2.0 it has turned out that the coverage definition of GML 3.2.1 does not contain sufficient and suitable information about the range data structure of a coverage. To remedy this, a GML 3.2.1 Application Schema for use in conjunction with the WCS 2.0 suite of specifications was defined [RD23]. This is a strict extension: no existing part of the GML 3.2.1 AbstractCoverage is changed in syntax nor semantics. It is expected that the changes described in this Application Profile eventually will be incorporated in a future version of the GML standard, such as 3.3 or 4.0

The gmlwcs coverage definition perfectly addresses all the needs for exploitation metadata and should hence be encorporated in the EO GML as optional information.

It is therefore proposed to extend the eop:EarthObservationResult by including of an additional property named coverage that is to reference an instantiation of a gmlwcs:abstractCoverage (like for instance a RectifiedGridCoverage) using xlink. To note is that it should have the gml:AssociationAttributeGroup, since the general usage will be to provide just the identifier of the coverage.
Annex A: STRAIGHTFORWARD MIGRATION TO GML3.2.1

Changes within EOP Schema Document

```xml
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:eop="http://earth.esa.int/eop" xmlns:xs="http://www.w3.org/2001/XMLSchema"
  targetNamespace="http://earth.esa.int/eop"
  elementFormDefault="qualified" attributeFormDefault="unqualified" version="2.0.0">
  <xs:import namespace="http://www.opengis.net/gml/3.2" schemaLocation="gml/3.2.1/gml.xsd"/>
  <xs:import namespace="http://www.w3.org/1999/xlink" schemaLocation="xlink/1.0.0/xlinks.xsd"/>
  <xs:element name="EarthObservation" type="eop:EarthObservationType" substitutionGroup="gml:Observation">
    <xs:annotation>
      <xs:documentation>eop root element for generic Earth Observation Product description</xs:documentation>
    </xs:annotation>
    <xs:complexType name="EarthObservationType">...
      <xs:element name="EarthObservationMetaData" type="eop:EarthObservationMetaDataType"/>
      <xs:complexType name="EarthObservationMetaDataType" mixed="true">...
        <xs:complexType name="EarthObservationMetadataPropertyType">...
          <xs:element name="metaDataProperty" type="eop:EarthObservationMetadataPropertyType"/>
        </xs:complexType>
      </xs:complexType>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

<--- Omitted --->

<xs:element name="EarthObservationMetaInformation" type="eop:EarthObservationMetaInformationType"/>
<xs:complexType name="EarthObservationMetaInformationType">...
<xs:element name="metaDataProperty" type="eop:EarthObservationMetadataPropertyType"/>
</xs:complexType>
```
Changes within EO GML Instance Document

```xml
<eop:EarthObservation version="NA" gml:id="DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234"
xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:eop="http://earth.esa.int/eop"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmllns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://earth.esa.int/eop /
.../eop.xsd">
  <gml:validTime>
    <gml:TimePeriod gml:id="ID00001">
      <gml:beginPosition>2001-08-22T11:02:47.000</gml:beginPosition>
      <gml:endPosition>2001-08-22T11:02:47.999</gml:endPosition>
    </gml:TimePeriod>
  </gml:validTime>
  <gml:using>
    <eop:EarthObservationEquipment gml:id="ID00002">
      <eop:platform>
        <eop:Platform>
          <eop:shortName>PHR</eop:shortName>
          <eop:serialIdentifier>1A</eop:serialIdentifier>
        </eop:Platform>
      </eop:platform>
      <eop:instrument>
        <eop:Instrument>
          <eop:shortName>PHR</eop:shortName>
        </eop:Instrument>
      </eop:instrument>
      <eop:sensor>
        <eop:Sensor>
          <eop:sensorType>OPTICAL</eop:sensorType>
          <eop:operationalMode codeSpace="urn:eop:PHR:sensorMode">PX</eop:operationalMode>
          <eop:resolution uom="m">0.7</eop:resolution>
        </eop:Sensor>
      </eop:sensor>
    </eop:EarthObservationEquipment>
    <gml:target>
      <eop:Footprint gml:id="ID00003">
        <eop:multiExtentOf>
          <gml:MultiSurface srsName="EPSG:4326" gml:id="ID0004">
            <gml:surfaceMembers>
              <gml:Polygon gml:id="ID0005">
                <gml:exterior>
                  <gml:LinearRing>
                    <gml:posList>2.1025 43.516667 2.861667 43.381667 2.65 42.862778 1.896944 42.996389 2.1025 43.516667</gml:posList>
                  </gml:LinearRing>
                </gml:exterior>
              </gml:Polygon>
            </gml:surfaceMembers>
          </gml:MultiSurface>
        </eop:multiExtentOf>
      </eop:Footprint>
    </gml:target>
  </gml:using>
</eop:EarthObservation>
```

43.51667
<eop:EarthObservationResult gml:id="ID0007">
  <eop:Browse>
    <eop:BrowseInformation>
      <eop:type>QUICKLOOK</eop:type>
      <eop:referenceSystemIdentifier codeSpace="EPSG">epsg:4326</eop:referenceSystemIdentifier>
      <eop:fileName>http://eop.cnes.fr/catalog/DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234.jpg</eop:fileName>
    </eop:BrowseInformation>
  </eop:Browse>
  <eop:Mask>
    <eop:MaskInformation>
      <eop:type>CLOUD</eop:type>
      <eop:format>VECTOR</eop:format>
      <eop:fileName>http://eop.cnes.fr/catalog/DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234.gml</eop:fileName>
    </eop:MaskInformation>
  </eop:Mask>
</eop:EarthObservationResult>

<eop:metaDataProperty>
  <eop:EarthObservationMetaData>
    <eop:identifier>DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234</eop:identifier>
    <eop:acquisitionType>NOMINAL</eop:acquisitionType>
    <eop:productType>TBD</eop:productType>
    <eop:status>ACQUIRED</eop:status>
    <eop:downlinkedTo>
      <eop:DownlinkInformation>
        <eop:acquisitionStation codeSpace="urn:eop:PHR:stationCode">TLS</eop:acquisitionStation>
      </eop:DownlinkInformation>
    </eop:downlinkedTo>
    <eop:archivedIn>
      <eop:ArchivingInformation>
        <eop:archivingCenter codeSpace="urn:eop:PHR:stationCode">TLS</eop:archivingCenter>
      </eop:ArchivingInformation>
    </eop:archivedIn>
  </eop:EarthObservationMetaData>
</eop:metaDataProperty>
</eop:EarthObservation>
Annex B: MDA Using Enterprise Architect Instructions

B.1 Introduction

It is proposed in Task One of HMA-FO to adopt the model-driven approach of ISO TC211 for developing GML application schemas. This uses a UML conceptual model of the application schema as the primary artefact, with other artefacts (GML application schema, documentation, etc.) derived or generated from it semi-automatically.

This approach has been adopted by INSPIRE, and represents current best practice for interoperable geospatial data modelling.

Moreover, it is proposed (like INSPIRE) to adopt the Enterprise Architect (EA) UML CASE tool for developing the conceptual model. EA is inexpensive and offers rich functionality for geospatial data modelling, and is being widely adopted by the geospatial community as the conceptual modelling tool of choice. The ISO TC211 Harmonised Model Maintenance Group (HMMG) has recently abandoned Rational Rose in favour of EA for maintaining the normative version of its UML models.

This document describes how to set up the modelling environment for HMA-FO conceptual modelling in Task One.

B.2 Install Enterprise Architect

A recent version of Enterprise Architect should be installed. It is available to purchase, or in a 30-day trial version, from:


This document does not provide an EA tutorial, but the software comes with documentation. Basic familiarity with UML modelling is assumed.

B.3 Create HMA-FO project in EA

An initial EA project file for HMA-FO should be created:

1. Use the EA menu to create a new project file (File|New Project...).

2. The project should be created in any suitable local directory, and with any filename (‘hma-fo.eap’ is logical).

3. Click ‘Cancel’ in the ‘Select model(s)’ dialogue box – the HMA-FO model will be imported, not created.
B.4 Obtain access to HMA svn

The Open Geospatial Consortium has established a private subversion repository for ESA HMA activity. Development of GML Application schema extensions under HMA-FO is using the repository at the following URL:


Two steps are required in order to obtain access to this repository:

1. First obtain access to the HMA project within the OGC portal: OGC members should send an email to the portal administrator (gbuehler@opengeospatial.org) requesting access to the HMA Project. (Non OGC members should discuss their access requirements with the HMA project or Task One lead.)

2. Having obtained access to the OGC HMA Project, a browser should navigate to the HMA project page at: http://portal.opengeospatial.org/?m=projects&a=view&project_id=309. A link is available under ‘Project Information Resources’ to register for access to the svn repository.

B.5 Install subversion client software

Free svn client software for Windows includes:


It is recommended to install both of these – the first is useful for initial checkout of svn repositories, the second is needed for EA. Alternatively EA may use any other command-line svn client that may already be installed.
To note is that the commandline svn tool that will be used by Enterprise Architect needs to be preconfigured with the authentication information to access the OGC SVN since EA does not provide the means for entering username and password.

One way to do this is to run from the command prompt the following command in which XXXX needs to be replaced by OGC Portal login credentials:

```
```

Afterwards the authentication details will be cached in the Collabnet svn tool. The testsvn directory that was created, can be removed.

This document does not provide an svn tutorial, but detailed documentation is available at http://svnbook.red-bean.com, or else with the installed client svn software.

### B.6 Install HMA-FO model

There are several steps involved:

1. Obtaining a local working copy of the svn repository
2. Configuring version control settings in the EA project
3. Importing the version-controlled model into EA

#### B.6.1 Check-out local working copy of HMA-FO svn repository

First, a local working copy of the HMA-FO svn repository (https://svn.opengeospatial.org/ogc-projects/public/hma/OGC-06-080 (GML EO App Schema)) should be checked out with subversion:

- using tortoisesvn, the ‘Right-click|SVN Checkout...’ dialogue within Windows Explorer may be used
- using a command-line client, the following command may be issued:

```
```

#### B.6.2 Configure version control settings in EA project

Next, version control settings need to be configured within the EA project created in section B.3 above:

1. Select version control configuration from the EA menu (Project|Version Control|Version Control Settings...). This will display a dialogue box (Figure 10).
2. Set the project to be a ‘private model’ (i.e. the local working EAP file is local) by selecting the checkbox ‘This model is private’.
3. Set a new configuration:
   a. Unique Id: hma-fo (NB: it is important that this identifier is used exactly as-is)
   b. Type: Subversion
   c. Working Copy path: the base directory of the HMA-FO local working copy checked out in section B.6.1.
   d. Subversion Exe Path: file path to subversion command line client
4. Save the configuration using the ‘Save’ button
B.6.3 **Import model into EA**

An EA model is version controlled through its representation as an XMI (XML Metadata Interchange) file. This HMA-FO model XMI file needs to be imported into the EA project:

1. Within the EA ‘Project Browser’ (View|Project Browser), right-click on the model root (Model) and select ‘Package Control|Get Package...’:

![Figure 10: EA project version control configuration dialogue](image)
2. This will display the ‘Get Shared File’ dialogue. Select the ‘hma-fo’ version control configuration created in section ‘Configure version control settings in EA project’ above.

3. Select the version-controlled XMI file ‘HMA-FO.xml’.

4. Click the ‘OK’ button to perform the import.
B.7 Install ISO TC211 models

The same three-step process is followed to import the version-controlled ISO TC211 models into the EA project.

B.7.1 Check-out local working copy of ISO TC211 svn repository

Check out a local working copy of the ISO TC211 svn repository into any suitable location. The official svn repository is now based at the JRC in Ispra (https://inspire-twg.jrc.it/svn/iso/), but is not publicly accessible. However, a mirror is maintained at: https://www.seegrid.csiro.au/mirrors/iso-harmonized-model:

- using tortoisesvn, the ‘Right-click|SVN Checkout...’ dialogue may be used
- using a command-line client, the following command may be issued: `svn co https://www.seegrid.csiro.au/mirrors/iso-harmonized-model`

B.7.2 Configure version control settings in EA project

Version control settings need to be configured within the EA project:

1. Select version control configuration from the EA menu (Project|Version Control|Version Control Settings...). This will display the ‘Version Control Settings’ dialogue box.

2. Set a new configuration:
   a. Unique Id: isotc211 (NB: it is important that this identifier is used exactly as-is)
   b. Type: Subversion
   c. Working Copy path: the base directory of the ISO TC211 local working copy checked out in section B.7.1.
   d. Subversion Exe Path: file path to subversion command line client

3. Save the configuration using the ‘Save’ button
Finally, the ISO TC211 model XMI files need to be imported into the EA project:

1. Within the EA 'Project Browser' (View|Project Browser), right-click on the model root (Model) and select 'Package Control|Get Package...'.

2. This will display the 'Get Shared File' dialogue (Figure 11). Select the 'isotc211’ version control configuration created in section B.7.2:
3. Select the version-controlled XML file 'isotc211\ISO TC211.xml'.

4. Click 'OK' to perform the import. Note that this imports only a template for the full set of ISO TC211 XMI model files, all of which are separately version-controlled. One further step is required actually to import all of the individual ISO TC211 models (an alternative would be to import all of these models manually without using the 'ISO TC211.xml' template):

5. Right-click on any version-controlled package within the Project Browser and select 'Package Control|Get All Latest'. Click 'OK' in the 'Get All Latest' dialogue (Figure 14). This may take some time, and it is recommended not to attempt the step unless a high-bandwidth internet connection is available – the entire hierarchy of ISO TC211 models is imported into the EA project. Future updates are much quicker since only differential svn changes are applied.

Following HMA-FO and ISO TC211 model installation, they both should be displayed within the Project Browser, Figure 15.
B.8 Install INSPIRE UML profile

The INSPIRE Generic Conceptual Model [D2.5] describes (in section “9.6.3 UML profile”) a UML profile to be used for conceptual modelling. It defines various stereotypes and tagged values that should be used. An XML template implementing this profile for EA is available in the subversion repository, filename ‘INSPIRE_UMLProfile_D2.5_v3.0.xml’.

This template should be imported into EA:

1. Open the ‘Resources’ tab (View|Resources).
2. Right-click on the ‘UML Profiles’ node and select ‘Import Profile’, this will display the ‘Import UML Profile’ dialogue box.
3. Select the INSPIRE UML profile file (‘INSPIRE_UMLProfile_D2.5_v3.0.xml’). The default Import option checkbox settings are fine.
B.9 Subversion interaction through EA

Now that the version-controlled ESA HMA-FO model has been fully imported into a local EA project file, all version-control interactions should proceed via EA. It is strongly advised not to independently update the local working copies of HMA-FO or ISO TC211 except through EA. The main operations that are necessary through EA are:

1. Checking out the HMA-FO model for editing: Right-click the HMA-FO model (‘EO App Schema’) within the Project Browser, and select ‘Package Control|Check Out…’. The model is then available for local editing.

2. Checking in a modified HMA-FO model: ‘Package Control|Check In…’. The ‘Add Comment’ dialogue will display allowing informative comments to be added to the svn revision history for this update of the HMA-FO model.

3. Updating packages from svn: Right-click on any version-controlled package within the Project Browser and select ‘Package Control|Get All Latest’.

Additional instructions for using subversion in EA are available in the EA help documentation (also available online: http://www.sparxsystems.com/uml_tool_guide/uml_model_management/versioncontrol.html).

B.10 Schema generation with ShapeChange

The open-source tool, ShapeChange, is used to automatically generate a GML application schema from a conformant EA UML model, following the rules of ISO 19136:2007 Annex E ‘UML-to-GML
application schema encoding rules’. The tool has been adopted by INSPIRE for generating the
normative INSPIRE schemas from the theme-specific INSPIRE UML models.
Currently, ShapeChange is not publicly available in the INSPIRE-conformant version, however this is
expected to change very shortly. Meanwhile, export of a GML Application Schema from the EA HMA-
FO UML model can be performed as required (with permission of ShapeChange owner Interactive
Instruments) by project partner STFC.

B.11 Model documentation export

An EA template is available on the HMA-FO svn (in the directory ‘OGC-06-080 (GML EO App
Schema)/EA documentation templates’) to generate model documentation in a human-readable form.
It uses a ‘feature catalogue’ format consistent with ISO 19110 and ISO 19131. This has been
developed by INSPIRE and kindly made available to the HMA-FO project. The following steps are
required

B.11.1 Import the RTF template into EA

The template file should be imported into EA to provide a template that can be used to export an RTF
documentation file:

- Open the template import dialogue (‘Project|Documentation|Rich Text Format (RTF)
  Report...|Templates|Import From Reference File’)

- Click ‘Import from Reference File’ to display the ‘Import Reference Data’ dialogue. Select the
template file ‘RTFReportTemplate_xml.xml’ from the directory ‘EA documentation templates’.
Click ‘Import’ and a new template (featureTypes_xml) should be displayed available for use.

B.11.2 Export model documentation

- Click once in the Project Browser to select the package for which documentation is required (e.g. the ‘EO App Schema’ package)
- Select the report-generation dialogue ‘Project|Documentation|Rich Text Format (RTF) Report...|Generate’
- Select the template ‘featureTypes_xml’ (this was imported in section 0). This template will export model documentation as XML format text within an RTF file.

- Select a location for the output file (‘Output to File’)
- Generate documentation by clicking ‘Generate’

B.11.3 Transform documentation to HTML form using XSLT

The documentation now needs to be rendered for human reading:
• Open the RTF document created above.
• Copy and paste the contents into a new XML file.
• This file should validate against the schema ‘package.xsd’ available in the svn subdirectory ‘EA documentation templates’.
• Transform the XML document using the XSLT file ‘featureCatalogue_xml2html.xslt’ also available in svn. This will generate HTML that can be copied and pasted into a Word document.
## Annex C: ADDITIONAL PROPOSED METADATA ELEMENTS (U-MARF)

<table>
<thead>
<tr>
<th>Short Name</th>
<th>Full Name</th>
<th>Description of the field/Comment</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>GranuleID</td>
<td></td>
<td>Other fields that uniquely defines each granule archived in U-MARF</td>
<td></td>
</tr>
<tr>
<td>AVBA</td>
<td>Base Algorithm Version</td>
<td>Values likes ‘0001’… or ‘NA’</td>
<td>Can be included by allowing multiple processingInformation elements (as per changes in OGC06-080r5.)</td>
</tr>
<tr>
<td>ABID</td>
<td>Spectral Band Ids</td>
<td>List of the spectral bands actually present in the product. (values like xxxx)</td>
<td>To be proposed at eop level (as parameter and/or wavelength information)</td>
</tr>
<tr>
<td>APAS</td>
<td>Product Actual Size</td>
<td>Actual size of the product in Byte (EPS products only). MSG/MTP could be estimated.</td>
<td>Already present (EarthObservationResult/ProductInformation/size) No action</td>
</tr>
<tr>
<td>GDMD</td>
<td>EPS Disposition Mode</td>
<td>C’, ‘O’, ‘P’, ‘T’</td>
<td>productType can be used for this element - no action</td>
</tr>
<tr>
<td>GPMD</td>
<td>EPS Processing Mode</td>
<td>Processing mode applied for generation of the product. (‘N’, ‘B’, ‘R’, ‘V’)</td>
<td>AcquisitionSubtype can be used for this element – no action</td>
</tr>
<tr>
<td>APPN</td>
<td>Parent Product Name</td>
<td>Name of the parent product, upon which the product is based.</td>
<td>Element DerivedFrom proposed at ssp level</td>
</tr>
</tbody>
</table>

### Miscellaneous Metadata
Fields part of the MiscellaneousMetadataStruct which provides additional information on the granule to be archived:

### Processing Metadata
Fields which provides the information on the Production process:

### Quality Metadata
Fields which provides the information concerning the quality:
<table>
<thead>
<tr>
<th><strong>QQOV</strong></th>
<th>Overall quality Flag</th>
<th>OK, NOK or NULL</th>
<th>Proposed at eop level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QDLC</strong></td>
<td>Dropped line count</td>
<td>For MSG products, dropped line count. For EPS products, missing data time.</td>
<td>Proposed to use the Vendor Specific elements mechanism (*)</td>
</tr>
<tr>
<td><strong>QDRP</strong></td>
<td>Degraded Record Percentage</td>
<td>Percentage of degraded and incomplete EPS MDRs.</td>
<td>Proposed to use the Vendor Specific elements mechanism (*)</td>
</tr>
<tr>
<td><strong>QDRC</strong></td>
<td>Degraded Record Count</td>
<td>Number of degraded and incomplete EPS MDRs.</td>
<td>Proposed to use the Vendor Specific elements mechanism (*)</td>
</tr>
<tr>
<td><strong>QCCV</strong></td>
<td>Cloud Coverage</td>
<td>Only SAF products</td>
<td>Cloud cover proposed for Systematic product extension</td>
</tr>
</tbody>
</table>

**Auxiliary Metadata**

Fields which provides information concerning the external auxiliary data referenced in the product

<table>
<thead>
<tr>
<th><strong>XADF</strong></th>
<th>Auxiliary Dataset Presence Indicator</th>
<th>Indicates the number of Auxiliary Datasets referenced in the product</th>
<th>auxiliaryDataSetFileName to be added to eop schemas with a cardinality of 1..n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>XADP</strong></td>
<td>External Auxiliary Data Name</td>
<td>Name of the external auxiliary data referenced in the product.</td>
<td>auxiliaryDataSetFileName to be added to eop schemas with a cardinality of 1..n</td>
</tr>
</tbody>
</table>

**Specific SAF Metadata**

<table>
<thead>
<tr>
<th><strong>MSID</strong></th>
<th>Multi Satellite ID</th>
<th>Systematic products should be allowed to have more than one eop:EarthObservationEquipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIID</strong></td>
<td>Multi Instrument ID</td>
<td>Systematic products should be allowed to have more than one eop:EarthObservationEquipment</td>
</tr>
</tbody>
</table>

**Geographic Area Metadata**

Fields which provide specific Geographic area information
**Concerning only some SAF products**

<table>
<thead>
<tr>
<th>Statistic Type</th>
<th>Provides Statistic type information for CLIMATE SAF products</th>
<th>processingInformation/method will be used: no action</th>
</tr>
</thead>
</table>

| Geographic Area | geographicalName to be proposed at systematic level as string field (no code list as harmonisation will be difficult) |

**Occultation Metadata**

Fields which provide localisation information for the 70 occultations composing a GRAS SAF product

<table>
<thead>
<tr>
<th>Occultation Latitude</th>
<th>Provides the Latitude of the n-occultation point</th>
<th>Multipoint geometry to be added for limb looking schemas.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Occultation Longitude</th>
<th>Provides the Longitude of the n-occultation point</th>
<th>Multipoint geometry to be added for limb looking schemas.</th>
</tr>
</thead>
</table>

(*) These elements could also be included in an EUMETSAT or UMARF specific “mission” schema.
Annex D: COMPARISON NETCDF-CF STANDARD NAMES VERSUS GEOMS VARIABLE NAMES

The following table contains a comparison of “Parameter names” as defined in the NetCDF-CF Standard Name Table (Version 12 of 06/07/2009), the GEOMS standard for correlative EO Products, and the CEOS/WMO Database of Observational Requirements. A number of parameters have been selected at random for the analysis below from the different inputs received.

The following URLs provide access respectively to the CF Standard Names table and the CEOS/WMO database list:
- CEOS/WMO: [http://192.91.247.60/sat2/aspscripts/SelectParam.asp](http://192.91.247.60/sat2/aspscripts/SelectParam.asp)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Product Type</th>
<th>NetCDF CF Standard Names</th>
<th>GeoMS</th>
<th>WMO/CEOS Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Surface Height</td>
<td>Radar altimeter</td>
<td>sea_surface_height_above_sea_level</td>
<td>SEA.SURFACE.HEIGHT</td>
<td>Sea level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(alias: sea_surface_height)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altimeter range</td>
<td>Radar altimeter</td>
<td>altimeter_range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backscatter coefficient</td>
<td>Radar altimeter</td>
<td></td>
<td>BACKSCATTERING.COEFFICIENT</td>
<td></td>
</tr>
<tr>
<td>Wind speed</td>
<td>Radar altimeter</td>
<td>wind_speed</td>
<td>WIND SPEED</td>
<td>Wind speed over sea surface</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>Radar altimeter</td>
<td>sea_floor_depth_below_sea_level</td>
<td>DEPTH.SEA.FLOOR</td>
<td>Bathimetry (sic)</td>
</tr>
<tr>
<td>Significant wave height</td>
<td>Radar altimeter</td>
<td>sea_surface_wave_significant_height</td>
<td>SEA.SURFACE.WAVEHEIGHT.SIGNIFICANT</td>
<td>Significant wave height</td>
</tr>
<tr>
<td>NDVI</td>
<td>Synthesis &amp; systematic</td>
<td>normalized_difference_vegetation_index</td>
<td>VEGETATION.INDEX (extension)</td>
<td>Normalized Differential Vegetation Index (NDVI)</td>
</tr>
<tr>
<td>products</td>
<td>parameter</td>
<td>system</td>
<td>description</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Surface Albedo Synthesis &amp; systematic products</td>
<td>surface_albedo</td>
<td>ALBEDO.SURFACE</td>
<td>Earth's surface albedo²</td>
<td></td>
</tr>
<tr>
<td>Aerosol Optical Depth Synthesis &amp; systematic products</td>
<td>Atmosphere_optical_thickness_due_to_aerosol</td>
<td>AEROSOL.OPTICAL.DEPTH</td>
<td>Aerosol absorption optical depth (column)²</td>
<td></td>
</tr>
<tr>
<td>Fractional Cloud Cover Synthesis &amp; systematic products</td>
<td>cloud_area_fraction</td>
<td>CLOUD.FRACTION (under Review)</td>
<td>Cloud cover profile</td>
<td></td>
</tr>
<tr>
<td>Cloud Top Temperature Synthesis &amp; systematic products</td>
<td>air_temperature_at_cloud_top</td>
<td></td>
<td>Cloud top temperature</td>
<td></td>
</tr>
<tr>
<td>Cloud Top Height Synthesis &amp; systematic products</td>
<td>cloud_top_altitude</td>
<td>CLOUD.TOP.HEIGHT</td>
<td>Cloud top height</td>
<td></td>
</tr>
<tr>
<td>Cloud Top Pressure Synthesis &amp; systematic products</td>
<td>air_pressure_at_cloud_top</td>
<td>CLOUD.TOP.PRESSURE (under Review)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud Optical Thickness Synthesis &amp; systematic products</td>
<td>atmosphere_optical_thickness_due_to_cloud</td>
<td>CLOUD.LAYER.THICKNESS (?)</td>
<td>Cloud optical thickness</td>
<td></td>
</tr>
<tr>
<td>Ozone concentration Synthesis &amp; systematic products</td>
<td>mass_concentration_of_ozone_in_air</td>
<td>O3.XXXX</td>
<td>O₃ profile</td>
<td></td>
</tr>
<tr>
<td>Land Surface Temperature Synthesis &amp; systematic products</td>
<td>surface_temperature</td>
<td>SURFACE.TEMPERATURE</td>
<td>Land surface temperature</td>
<td></td>
</tr>
</tbody>
</table>

² Appears in some versions of the list (e.g. http://www.database.eohandbook.com/timeline/timeline.aspx?measurementParameterID=218)
<table>
<thead>
<tr>
<th>products</th>
<th>leaf_area_index</th>
<th>LEAF.AREA_INDEX</th>
<th>Leaf Area Index (LAI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf Area Index Synthesis &amp; systematic products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fractional Vegetation Cover</td>
<td>vegetation_area_fraction</td>
<td></td>
<td>Fraction of vegetated land</td>
</tr>
<tr>
<td>Fraction of Absorbed Photosynthetic Active Radiation</td>
<td></td>
<td></td>
<td>Fraction of Absorbed PAR (FAPAR)</td>
</tr>
<tr>
<td>Transpiration Synthesis &amp; systematic products</td>
<td>transpiration_amount</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Moisture Synthesis &amp; systematic products</td>
<td>soil_moisture_content</td>
<td></td>
<td>Soil moisture at surface</td>
</tr>
<tr>
<td>NO2 Concentration Synthesis &amp; systematic products</td>
<td>mass_fraction_of_nitrogen_dioxide_in_air</td>
<td>NO2.XXXX (Per species like NO2, GeoMS supports multiple variables like NO2.PARTIAL.COLUMN, ...)</td>
<td>NO₂ profile</td>
</tr>
</tbody>
</table>
Annex E: XML INSTANCE EXAMPLES ADOPTING O&M

E.1 Schema-valid O&M Instance Document (eop)

Here, the current version of the O&M draft schemas are applied. The main incremental differences compared with the GML 3.2.1 version in Annex A are highlighted (XML comments ignored).

NOTES:

1. The element ‘om:phenomenonTime’ replaces ‘gml:validTime’

2. The new element ‘om:resultTime’ is added. This represents the time when the result became available – e.g. it could be equivalent to the eop:archivingDate, or eop:processingDate, or it could hold new information not currently populated within EOP. Although it is mandatory, it is nillable with the gml:NilReasonType used to indicate the reason (this is done in the example below).

3. This requires the procedure to be included by-reference (using om:parameter), rather than inline.

4. The new element ‘om:observedProperty’ is added. This represents the property of the feature-of-interest that is being observed. We described earlier in the TN (section 2.4.5.2) how this element could be used for existing and new products, e.g.:
   - SAR: “Dominant wave direction”, “Snow status (wet/dry)” etc.
   - OPT: “Vegetation type”, “Glacier cover”, etc.
   - ATM: equivalent to DataLayer.specy

   But see also the discussion in the TN (section 6.2) on codelists for physical parameters.

   The element is nillable with the gml:NilReasonType used to indicate the reason (this is done in the example below).

5. The element ‘om:featureOfInterest’ replaces ‘gml:target’.


```xml
<?xml version="1.0" encoding="utf-8"?>
<eop:EarthObservation
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://earth.esa.int/eop OMSchemas/xsd/eop_3.2_om.xsd"
    xmlns:xlink="http://www.w3.org/1999/xlink"
    xmlns:gml="http://www.opengis.net/gml/3.2"
    xmlns:eop="http://earth.esa.int/eop"
    xmlns:om="http://www.opengis.net/om/2.0"
    gml:id="DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234">
  <!-- Replaces gml:validTime -->
  <om:phenomenonTime>
    <gml:TimePeriod gml:id="ID00001">
      <gml:beginPosition>2001-08-22T11:02:47.000</gml:beginPosition>
      <gml:endPosition>2001-08-22T11:02:47.999</gml:endPosition>
    </gml:TimePeriod>
  </om:phenomenonTime>
  <!-- This is the time at which the result became available - could reuse archivingDate, processingDate, or be a new information item altogether -->
  <om:resultTime nilReason="unknown"/>
  <om:procedure xlink:href="#ID00002"/>
  <om:parameter>
    <om:NamedValue>
```

For now, need instead to use xlink to reference EarthObservationEquipment as an Observation-specific 'parameter' (see below) -->

```xml
  <om:procedure xlink:href="#ID00002"/>
  <om:parameter>
    <om:NamedValue>
```
<!-- Need referenceable identifier for EarthObservationEquipment metadata element -->
<om:value>
<eop:EarthObservationEquipment gml:id="ID00002">
  <eop:Platform>
    <eop:Platform>
      <eop:shortName>PHR</eop:shortName>
      <eop:serialIdentifier>1A</eop:serialIdentifier>
    </eop:Platform>
  </eop:Platform>
  <eop:Instrument>
    <eop:shortName>PHR</eop:shortName>
  </eop:Instrument>
  <eop:Sensor>
    <eop:Sensor>
      <eop:shortName>PHR</eop:shortName>
    </eop:Sensor>
    <eop:operationalMode codeSpace="urn:op:PHR:sensorMode">PX</eop:operationalMode>
    <eop:resolution uom="m">0.7</eop:resolution>
    <eop:Sensor>
      <eop:acquisitionParameters>
        <eop:Acquisition>
          <eop:orbitNumber>12</eop:orbitNumber>
          <eop:lastOrbitNumber>12</eop:lastOrbitNumber>
          <eop:orbitDirection>ASCENDING</eop:orbitDirection>
          <eop:wrsLatitudeGrid>12</eop:wrsLatitudeGrid>
          <eop:acrossTrackIncidenceAngle uom="deg">14.0</eop:acrossTrackIncidenceAngle>
          <eop:alongTrackIncidenceAngle uom="deg">13.9</eop:alongTrackIncidenceAngle>
          <eop:pitch uom="deg">0</eop:pitch>
          <eop:roll uom="deg">0</eop:roll>
          <eop:yaw uom="deg">0</eop:yaw>
        </eop:Acquisition>
      </eop:acquisitionParameters>
    </eop:Sensor>
  </eop:Sensor>
</eop:EarthObservationEquipment>
</om:value>
</om:NamedValue>
</om:parameter>

<!-- For relevant products, the observed property could refer to the physical parameter (see discussion in TN) -->
<om:observedProperty nilReason="inapplicable"/>

<!-- Replaces gml:target -->
<om:featureOfInterest>
  <eop:Footprint gml:id="ID00003">
    <gml:MultiSurface gml:id="ID0004" srsName="EPSG:4326">
      <gml:surfaceMembers>
        <gml:Polygon gml:id="ID0005">
          <gml:exterior>
            <gml:LinearRing>
              <gml:posList>2.1025 43.516667 2.861667 43.381667 2.65 42.862778 1.896944 42.996389 2.1025 43.516667 2.861667 43.381667 2.65 42.862778 1.896944 42.996389 2.1025 43.516667</gml:posList>
            </gml:LinearRing>
          </gml:exterior>
          <gml:Polygon gml:id="ID0005">
            <gml:exterior>
              <gml:LinearRing>
                <gml:posList>2.374167 43.190833</gml:posList>
                </gml:LinearRing>
              </gml:exterior>
            </gml:Polygon>
          </gml:Polygon>
        </gml:MultiSurface>
      </gml:MultiSurface>
    </gml:MultiSurface>
    <gml:MultiSurface>
      <gml:exterior>
        <gml:LinearRing>
          <gml:posList>2.374167 43.190833</gml:posList>
          </gml:LinearRing>
        </gml:exterior>
      </gml:MultiSurface>
    </gml:MultiSurface>
  </eop:Footprint>
</om:featureOfInterest>

<!-- Replaces gml:resultOf -->
<om:result>
  <eop:EarthObservationResult gml:id="ID0007">
    <eop:BrowseInformation>
      <eop:type>QUICKLOOK</eop:type>
      <eop:referenceSystemIdentifier codeSpace="EPSG">epsg:4326</eop:referenceSystemIdentifier>
    </eop:BrowseInformation>
  </eop:EarthObservationResult>
</om:result>
E.2 O&M Instance document with inline Procedure (eop)

Here, the draft O&M schemas are used, but placing the procedure in-line (consistent with the current EOP encoding). While this is not currently schema-valid, discussion with Simon Cox suggests this schema change will be adopted.

The main incremental differences compared with the GML 3.2.1 version are highlighted (XML comments ignored).

NOTE: The changes compared to GML 3.2.1 are minimal.

```xml
<?xml version="1.0" encoding="utf-8"?>
<eop:EarthObservation
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://earth.esa.int/eop OMSchemas/xsd/eop_3.2_om.xsd"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:eop="http://earth.esa.int/eop"
 xmlns:om="http://www.opengis.net/om/2.0"
 gml:id="DS_PHR1A_20010822110247_TLS_PX_E123N45_0101_01234">
  <!-- Replaces gml:validTime -->
  <om:phenomenonTime>
    <gml:TimePeriod gml:id="ID00001">
      <gml:beginPosition>2001-08-22T11:02:47.000</gml:beginPosition>
      <gml:endPosition>2001-08-22T11:02:47.999</gml:endPosition>
    </gml:TimePeriod>
  </om:phenomenonTime>
  <!-- This is the time at which the result became available - could reuse archivingDate, processingDate, or be a new information item altogether -->
  <om:resultTime nilReason="unknown"/>
  <!-- Replaces gml:using -->
  <om:procedure>
    <eop:EarthObservationEquipment gml:id="ID00002">
      <eop:platform>
        <eop:Platform>
          <eop:shortName>PHR</eop:shortName>
          <eop:serialIdentifier>1A</eop:serialIdentifier>
        </eop:Platform>
      </eop:platform>
      <eop:instrument>
        <eop:Instrument>
          <eop:shortName>PHR</eop:shortName>
        </eop:Instrument>
      </eop:instrument>
      <eop:sensor>
        <eop:Sensor>
          <eop:sensorType>OPTICAL</eop:sensorType>
          <eop:operationalMode codeSpace="urn:eop:PHR:sensorMode">PX</eop:operationalMode>
          <eop:resolution uom="m">0.7</eop:resolution>
        </eop:Sensor>
      </eop:sensor>
      <eop:acquisitionParameters>
        <eop:Acquisition>
          <eop:orbitNumber>12</eop:orbitNumber>
          <eop:lastOrbitNumber>12</eop:lastOrbitNumber>
          <eop:orbitDirection>ASCENDING</eop:orbitDirection>
          <eop:wrsLatitudeGrid>12</eop:wrsLatitudeGrid>
          <eop:acrossTrackIncidenceAngle uom="deg">14.0</eop:acrossTrackIncidenceAngle>
          <eop:alongTrackIncidenceAngle uom="deg">13.9</eop:alongTrackIncidenceAngle>
          <eop:pitch uom="deg">0</eop:pitch>
          <eop:roll uom="deg">0</eop:roll>
          <eop:yaw uom="deg">0</eop:yaw>
        </eop:Acquisition>
      </eop:acquisitionParameters>
    </eop:EarthObservationEquipment>
  </om:procedure>
</eop:EarthObservation>
```

<!-- For relevant products, the observedProperty could refer to the physical parameter (see discussion in TN) -->