EXECUTIVE SUMMARY

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

This document first contains an analysis on how to align this HMA product metadata standard with the evolutions that the underlying standard have been undergoing notably the adoption of GML 3.2.1 and the Observation and Measurements Specification and following the model driven approach. It also pays attention to the inclusion of more exploitation oriented metadata to ensure compatibility with the forthcoming EO extension of OGC WCS.

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.

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 draft version of this document will be updated after discussions with the different stakeholders involved in the HMA-FO project.
SIGNATURES

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<tr>
<td>Steven Smolders (GIM)</td>
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DOCUMENT STATUS SHEET

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APPLICABLE DOCUMENTS


[AD03] GML 3.1.1 Application schema for Earth Observation products, Version 1.0.0, 2010-01-25

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
[RD19] NetCDF Climate forecast Convention Standard name table, Version 12, 06/07/2009,
[RD20] Generic metadata guidelines on atmospheric and oceanographic datasets for the Envisat Calibration and Validation Project, Version 01R001 pre-print April 24, 2002
[RD21] Maintaining and Advancing the CF Standard for Earth System Science Community Data
[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

**ACRONYMS**

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<td>Conceptual Schema Modelling Facilities</td>
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<td>Catalogue Service For the Web</td>
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<td>ebRIM</td>
<td>e-Business Registry Information Model</td>
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<td>EO</td>
<td>Earth Observation</td>
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<td>World Wide Web Consortium</td>
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<td>XML</td>
<td>extensible Markup Language</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 specification mapping onto project and Ground Segment, it is this version that currently is used [RD02] on all projects/Ground Segments. The voting process to approve this document as an official OGC standard officially ended on 13/01/2010.

To note is that at the moment one can only find the r2 version (or 0.9.0) of this standard [RD03] as a best practice paper on the OGC public website. This version should however be replaced by the OGC with version r4.

A more recent version (r5) is available on the OGC Pending documents list [RD04] since 12/03/2009. It includes the resolution for a number of issues that were discovered during the HMA-T Project.

With some minor edits related to the publication of the document as an OGC standard, this document is now available in its 1.0.0 version from the OGC Public Web Site [AD03] since late January 2010.
2 PROPOSED EVOLUTIONS OF THE STANDARDS BASELINE

2.1 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.

There are a number of reasons for changing the version of GML with 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 2.2

An overview of the changes from 3.1.1 to 3.2.1 are documented in an OGC Revision Notes document [RD08].

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 2.3.

In order to estimate the impact of a migration to GML3.2.1, not following the model-driven approach as explained in section 2.2, the GML3.1.1 eop schema was ported 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</td>
<td>5.3</td>
</tr>
</tbody>
</table>
Change the gml namespace definition to `xmlns:gml=http://www.opengis.net/gml/3.2`.

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

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

More important to evaluate the impact of moving to GML 3.2.1 are the changes that need to be done to a GML 3.1.1 instance document to have it validate against the newly created GML 3.2.1 schema.

### 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>
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<tr>
<td>Change gml namespace definition to <code>xmlns:gml=http://www.opengis.net/gml/3.2</code></td>
<td>5.3</td>
</tr>
</tbody>
</table>
2  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
5.11

3  Replace gml:metadataProperty with eop:metadataProperty
5.12

4  Since the eop:EarthObservationMetadataProperty has been defined by ourself and added to the definition of eop:EarthObservation by extending gml:observation with a sequence, the eop:EarthObservationMetadataProperty now occurs a the end of the document.
5.12

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.

2.2 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]).
versions of GML may be generated by a simple software configuration. An additional benefit of the model-driven approach is that application schemas for different frameworks.

open-source tools available for generating GML application schemas from a UML conceptual modelling. Chief among them are:

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 themes\(^1\) 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

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.

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\(^1\) [http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2](http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2)
2.2.1 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 results from inheriting the attribute from the base EarthObservation feature type and could perhaps be fixed with some additional changes to the ‘sequenceNumber’ tagged value (i.e. ensuring that the sequence number of attributes in specialised classes is sufficiently high to be larger than the sequence numbers in any base classes).

3. The eop namespace is used instead of gml for the following elements: metaDataProperty, multiExtentOf, centerOf (the latter two are attributes of Footprint). These are all elements that have been deprecated in GML 3.2, relying instead on application schema specific property names.

4. All objects in GML 3.2 have a mandatory gml:id attribute.

2.3 Observations and Measurements

2.3.1 GML: Observation

The current GML Application Schema for EO Products adopts the GML Observation as its basis. This is defined in GML 3.2 as listed in Figure 3 below.

```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 photographt.
    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>
```
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)

### 2.3.2 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>
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</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

### 2.3.3 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.
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

2.3.4 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>
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<tbody>
<tr>
<td>validTime</td>
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<td>relatedObservation</td>
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<td>-</td>
<td>metadata</td>
</tr>
</tbody>
</table>

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

2.3.5 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 likely to be 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 in section 8.

Thus, our 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.
property

Metadata eop:EarthObservationMetadata see section 2.3.5.1

phenomenonTime gml:TimePeriod

procedure eop:EarthObservationEquipment

featureOfInterest eop:Footprint

result eop:EarthObservationResult

observedProperty code list see section 0

resultTime gml:TimeInstant see section 0

Table 5: HMA-FO adoption of ISO 19156 OM_Observation (compare Table 3)

Figure 5: Relationship of EarthObservation and EarthObservationMetadata to O&M

2.3.5.1 OM_Observation.metadata

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Cardinality</th>
</tr>
</thead>
</table>

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Table 6: Metadata additions required for EarthObservationMetadata to conform to MD_Metadata

(*) 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.

2.3.5.2 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 the various EO product types.

Additional work is required to determine the best approach to implementing the observed property, and constraining the valid values. A discussion on possible code lists to use can 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>&quot;radarEcho&quot;</td>
<td>fixed value</td>
</tr>
<tr>
<td>OPT</td>
<td>&quot;radiance&quot;</td>
<td>fixed value</td>
</tr>
<tr>
<td>ATM</td>
<td>equivalent to specy</td>
<td></td>
</tr>
<tr>
<td>Altimetry</td>
<td>&quot;seaSurfaceHeight&quot;</td>
<td>fixed value</td>
</tr>
<tr>
<td>Limb-sounding</td>
<td>equivalent to specy</td>
<td></td>
</tr>
<tr>
<td>systematic/synthesis</td>
<td>See discussion within section 6</td>
<td></td>
</tr>
</tbody>
</table>

Table 7 Proposed use of observed property
2.3.5.3 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.
3 BASE APPLICATION SCHEMA CHANGES

3.1 IDENTIFIED CHANGES OF 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.

To note is that OGC06-080r5 (V1.0.0) has meanwhile been made available via the publicly available OGC standards pages.

<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.</td>
</tr>
</tbody>
</table>
HMA-FO Task 1 – TN Analysis of the extension of the EO product metadata

Doc. Id: HMAFOT1-TN-0002-ERDAS-11

Issue: 1.1

Date: 2010-01-28

### Table 8 Changes in OGC06-080r5

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>172</td>
<td>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</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>
</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 which 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.

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.

Proposed solution allow 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 have been proposed by EUMETSAT in email communication. In the table below only the most interesting elements that are important to include as indicated by EUMETSAT are listed here. The complete list with a first analysis of the Task 1 consortium can be found in Annex C.

<table>
<thead>
<tr>
<th>ShortName</th>
<th>Full name</th>
<th>Comments EUMETSAT</th>
<th>Comments HMA FO Task 1</th>
</tr>
</thead>
<tbody>
<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>Information on spectral bands is also a request for the “systematic product category” from EMSA and ESA GECA. Overlaps to some extent with the exploitation metadata.</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>To be checked if the product/ProductInformation/Size element cannot be used</td>
</tr>
<tr>
<td>QQOV</td>
<td>Overall quality Flag</td>
<td>OK, NOK or NULL</td>
<td>Additional optional element to be added to EarthObservationMetadata</td>
</tr>
</tbody>
</table>

In addition 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" /> </choice> <element ref="gml:posList" /> <element ref="gml:coordinates" /> </choice> <element name="radius" type="gml:LengthType" /> </sequence> </restriction> </complexContent> </complexType>
```
3.3 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 ° to +180 ° 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)

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 criterion). 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.

![Figure 9: Dateline issue display of METOP footprints with dateline correction](image)

### 3.3.1 Alternative solutions

#### 3.3.1.1 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.

#### 3.3.1.2 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.
3.3.1.3 *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 criterium, but does not help solving the complete ambiguity.

3.3.1.4 *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.”*
3.3.1.5 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.

3.3.1.6 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 followed if one wants to be strictly conformant to the OGC/ISO Specification stack.
## 4 APPLICATION SCHEMA EXTENSION FOR ALTIMETRY PRODUCTS

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product type</td>
<td>Whether along-track or gridded(mapped) (determined by processing level?)</td>
</tr>
<tr>
<td>Reference level</td>
<td>Absolute dynamic heights, anomalies (referenced to geoid, longterm mean, monthly mean, etc.), mean dynamic topography</td>
</tr>
<tr>
<td>Geophysical parameter</td>
<td>Sea-level, geostrophic velocity, mapping error,</td>
</tr>
<tr>
<td>Cycle number</td>
<td>Full-orbit cycle number since inception</td>
</tr>
<tr>
<td>Relative pass number</td>
<td>Pass number within a cycle</td>
</tr>
<tr>
<td>Absolute pass number</td>
<td>Pass number since beginning of mission</td>
</tr>
<tr>
<td>Pass direction</td>
<td>Ascending, descending</td>
</tr>
</tbody>
</table>

### Orbital Characteristics

a. Semi-major axis  
b. Eccentricity  
c. Inclination  
d. Argument of periapsis  
e. Inertial longitude of the ascending node  
f. Mean anomaly  
g. Reference (Equatorial) altitude  
h. Nodal period  
i. Repeat period  
j. Number of revolutions within a cycle  
k. Equatorial cross-track separation  
l. Ground track control band + 1 km (at equator)  
m. Acute angle at Equator crossings  
n. Longitude of Equator crossing of pass  
o. Inertial nodal rate  
p. Orbital speed  
q. Ground track speed

**NOTES:**

1. These have been based primarily on an analysis of JASON-2, and applicability to other missions/products is being investigated.
2. May want some/all/none of these?

In addition, the eop:Footprint needs to handle along-track altimetry products. It must be determined whether is best placed in the eop schemas or in the altimetry extension.
5 APPLICATION SCHEMA EXTENSION FOR LIMB LOOKING PRODUCTS

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geophysical parameter (for L2)</td>
<td>Temperature, ozone, water vapour, methane, etc.</td>
</tr>
<tr>
<td>Units of measure (L1 / L2)**</td>
<td>Units used</td>
</tr>
<tr>
<td>Processing algorithm (L2)**</td>
<td>Processing algorithm</td>
</tr>
<tr>
<td>Spectral range (for L1) &amp; spectral resolution</td>
<td>Range of wavelengths observed</td>
</tr>
<tr>
<td>Measurement type (L1)</td>
<td>“Absorption” or “Emission”</td>
</tr>
<tr>
<td>Geolocation information for each Profile†</td>
<td>{start-,mid-,end-}scan lat/lon/altitude</td>
</tr>
<tr>
<td>Pointing direction‡</td>
<td>Rear, sideways</td>
</tr>
<tr>
<td>Observation mode§</td>
<td>Nominal, polar winter chemistry, Tropospheric-stratospheric exchange, upper atmosphere, dynamics, diurnal changes, impact of aircraft</td>
</tr>
<tr>
<td>Altitude range</td>
<td>Range of altitude sampled</td>
</tr>
<tr>
<td>Vertical grid</td>
<td>Spacing between consecutive vertical measurements. Or, may be irregular.</td>
</tr>
<tr>
<td>Horizontal spacing§</td>
<td>Distance between single measurements horizontally (if regular)</td>
</tr>
</tbody>
</table>

NOTES:

1. These are based primarily on analysis of MIPAS products, but applicability to other mission/products is being investigated.
2. Similar to the GML-EO ‘atmosphere’ products.
3. Most files contain a whole orbit, therefore it is important to know the lat/lon/altitude ranges of specific profiles to locate relevant data - e.g. Studying a volcano plume requires very specific geo-location metadata.
4. Not strictly necessary at “discovery” level.
5. These modes will vary from instrument to instrument (examples here are from MIPAS). Each mode implies a measurement scenario with specific altitude range/vertical spacing so as long as these are well described it may not be necessary to name the observation mode.
6. Horizontal spacing probably not needed – should be covered by geolocation of scans/profiles.

In addition, the eop:Footprint may need to handle the vertical profile geometry.
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).

```xml
<xs:element name="composedOf" type="eop:EarthObservationPropertyType"/>
<xs:complexType name="EarthObservationPropertyType">
  <xs:sequence>
    <xs:element ref="eop:EarthObservation" minOccurs="0"/>
  </xs:sequence>
  <xs:attributeGroup ref="gml:AssociationAttributeGroup"/>
</xs:complexType>
```

- 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 or store the 2 new elements at eop level and make them optional.

### 6.2 **SYSTEMATIC PRODUCTS**

For systematic products the following additional elements have been defined on the basis of information received from EMSA, VITO, MyOcean and ESA GECA

- **Physical Quantity**: the physical property that is being measured with its units of measure and 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 that the ObservedProperty is intended to capture this information, however, the cardinality of this property is limited to 1.

The values should be based on a well-established code list. Two possible codelist 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 (kg/m3)`
- `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 with support of the ESA GECA project. Examples of “variable names” are:
  - `O3.CONCENTRATION`
  - `ALBEDO`

- Information on the wavelengths. Either wavelength range(s) or a list of discrete values should be possible.
- **Bands/Channels**: list of discrete values of xs:string type
- **Additional ProcessingInformation like type of algorithm**: Type (regression, empirical, etc.) – convention: most likely to be included in existing extended processingInformation element.

To add is the requirement to group EO and derived products in a single “virtual product” (e.g. SAR Image together with detected oil spill).
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 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 incorporated 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 hold an instansion of a gmlwcs:abstractCoverage (like for instance a RectifiedGridCoverage). To note is that it should have the gml:AssociationAttributeGroup, since the general usage will be to provide just the identifier of the coverage.
8 MORE RADICAL REFACTORIZATION

- comprehensive adoption of 19115-2 through MI_Metadata (NB: CSW is for metadata, so right that we adopt a metadata record together with OM_Obs). NB: platform, instrument, sensor stuff.
- FoI=SF
- coverage result with application schema following 19156::\\u201cSamplingCoverageObservation\\u201d pattern
- mask=quality info? browse=metadata browseGraphic? product=link to service/file?
Annex A: STRAIGHTFORWARD MIGRATION TO GML3.2.1

Changes to GML 3.2.1 EOP Schema Document

```xml
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:gml="http://www.opengis.net/gml/3.2" 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:annotation>
        <xs:documentation>Earth Observation Product description</xs:documentation>
      </xs:annotation>
      <xs:complexContent>
        <xs:extension base="gml:ObservationType">
          <xs:sequence>
            <xs:element name="metaDataProperty" type="eop:EarthObservationMetadataPropertyType"/>
          </xs:sequence>
          <xs:attribute name="version" type="xs:string" use="required" fixed="NA">
            <xs:annotation>
              <xs:documentation>Reference to the schema version number used to validate the instance</xs:documentation>
            </xs:annotation>
          </xs:attribute>
        </xs:extension>
      </xs:complexContent>
    </xs:complexType>
  </xs:element>
  <xs:element name="EarthObservationMetaData" type="eop:EarthObservationMetaDataType"/>
  <xs:complexType name="EarthObservationMetaDataType" mixed="true">
    <xs:complexContent mixed="true">
      <xs:extension base="gml:AbstractMetaDataType">
        <xs:sequence>
          <xs:element ref="eop:identifier"/>
          <xs:element ref="eop:doi" minOccurs="0"/>
          <xs:element ref="eop:parentIdentifier" minOccurs="0"/>
          <xs:element ref="eop:processing" minOccurs="0"/>
          <xs:element ref="eop:vendorSpecific" minOccurs="0"/>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
  <xs:complexType name="EarthObservationMetadataPropertyType">
    <xs:complexContent>
      <xs:extension base="gml:AbstractMetadataPropertyType">
        <xs:sequence>
          <xs:element ref="eop:EarthObservationMetaData"/>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
  <xs:element name="processing" type="eop:ProcessingInformationPropertyType" minOccurs="0"/>
  <xs:element name="vendorSpecific" type="eop:SpecificInformationArrayPropertyType" minOccurs="0"/>
  <xs:element name="EarthObservationMetadataPropertyType"/>
</xs:element>
</xs:schema>
```

EO GML Instance Document
<gml:resultOf>
  <eop:EarthObservationResult gml:id="ID0007">
    <eop:browse>
      <eop:BrowseInformation>
        <eop:type>QUICKLOOK</eop:type>
        <eop:referenceSystemIdentifier codeSpace="EPSG">epsg:4326</eop:referenceSystemIdentifier>
      </eop:BrowseInformation>
    </eop:browse>
    <eop:mask>
      <eop:MaskInformation>
        <eop:type>CLOUD</eop:type>
      </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:archivingDate>2001-08-22T11:02:47.999</eop:archivingDate>
        </eop:ArchivingInformation>
      </eop:archivedIn>
      <eop:processing>
        <eop:ProcessingInformation/>
      </eop:processing>
    </eop:EarthObservationMetaData>
  </eop:metaDataProperty>
</gml:resultOf>
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](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


- 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...’:
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-twgc.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
B.7.3 Import model into EA

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):

6. 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.
4. Import the profile by clicking the ‘Import’ button. The INSPIRE profile is added to the ‘UML Profiles’ folder within the ‘Resources’ tab.

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 he 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 U-MARF METADATA ELEMENTS

<table>
<thead>
<tr>
<th>Short Name</th>
<th>Full Name</th>
<th>Description of the field/Comment</th>
<th>HMA FO Task 1 Comments/Questions</th>
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<tbody>
<tr>
<td>GranuleID</td>
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<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' Under EarthObservationMetadata/processing/ProcessingInformation the elements method and methodVersion exist. Is there a reason for not using these to describing the base Algorithm and Algorithm Version?</td>
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</tr>
<tr>
<td>Miscellaneous Metadata</td>
<td></td>
<td>Fields part of the MiscellaneousMetadataStruct which provides additional information on the granule to be archived</td>
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</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>Will be proposed - FYI - Information on (spectral) bands has been requested by more stakeholders</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>Under EarthObservationResult/ProductInformation there exist an element &quot;size&quot;. Is there a reason for not using this?</td>
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<tr>
<td>Processing Metadata</td>
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<td>Fields which provides the information on the Production process</td>
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<tr>
<td>GDMD</td>
<td>EPS Disposition Mode</td>
<td>C','O','P','T' The EUMETSAT Generic Product Format Specification (EPS.GGS.SPE.96167 v7D) gives the following meanings: Commisioning, Operational, Testing and E for EARS processing environment. (P appears not to be listed?) Can this perhaps be stored in the EarthObservationMetadata/acquisitionSubType element</td>
<td></td>
</tr>
<tr>
<td>GPMD</td>
<td>EPS Processing Mode</td>
<td>Processing mode applied for generation of the product. ('N','B','R','V') The EUMETSAT Generic Product Format Specification (EPS.GGS.SPE.96167 v7D) gives the following meanings: Nominal, Backlog Processing, Reprocessing and validation. This can perhaps be described in the productType element?</td>
<td></td>
</tr>
<tr>
<td>APPN</td>
<td>Parent Product Name</td>
<td>Name of the parent product, upon which the product is</td>
<td>Would you see this element at eop level or at the newly</td>
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HMAFO-T1-TN-ERDAS-11(2010-01-28)
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<th>Quality Metadata</th>
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<td>Fields which provides the information concerning the quality of the product to be archived</td>
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<td></td>
</tr>
<tr>
<td>QQOV</td>
<td>Overall quality Flag</td>
<td>OK, NOK or NULL</td>
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<tr>
<td>QDLC</td>
<td>Dropped line count</td>
<td>For MSG products, dropped line count. For EPS products, missing data time.</td>
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<tr>
<td>QDRP</td>
<td>Degraded Record Percentage</td>
<td>Percentage of degraded and incomplete EPS MDRs.</td>
</tr>
<tr>
<td>QDRC</td>
<td>Degraded Record Count</td>
<td>Number of degraded and incomplete EPS MDRs.</td>
</tr>
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<td>QCCV</td>
<td>Cloud Coverage</td>
<td>Only SAF products</td>
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<td></td>
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<td>XADF</td>
<td>Auxiliary Dataset Presence Indicator</td>
<td>Indicates the number of Auxiliary Datasets referenced in the product</td>
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<td>XADP</td>
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<td>Name of the external auxiliary data referenced in the product.</td>
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<table>
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<tr>
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<td>Multi Satellite ID</td>
<td>Proposed to allow multiple EarthObservationEquipment for systematic products.</td>
</tr>
<tr>
<td>MIID</td>
<td>Multi Instrument ID</td>
<td>Proposed to allow multiple EarthObservationEquipment for systematic products.</td>
</tr>
</tbody>
</table>

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</thead>
<tbody>
<tr>
<td>Fields which provide specific Geographic area information concerning only some SAF products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAST</td>
<td>Statistic Type</td>
<td>Provides Statistic type information for CLIMATE SAF products</td>
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</table>
### Occultation Metadata

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

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<th>AAAR</th>
<th>Geographic Area</th>
<th>Can you clarify what this element contains?</th>
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</thead>
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</table>

<table>
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<th>LOLA</th>
<th>Occultation Latitude</th>
<th>Provides the Latitude of the n-occultation point</th>
<th>Proposed in limb looking products extension</th>
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<tbody>
<tr>
<td>LOLO</td>
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<td>Proposed in limb looking products extension</td>
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