## GMDM IOP Serialization

### 61970-552 data exchange serialization

Version 3 of the 61970-552 standard allows ‘meta’ information about the organization of grid data – which previously was supported by the -552 header - to be supplied by means of a UML-described class model. It also contains updates to the use of RDF in CIM serialization (some of which were apparently introduced in the not-so-widely implemented version 2, but are understood by WG13 to be best practice).

The serialization approach taken by the GMDM CIM IOP includes the following:

* Data exchanges in the form of a zipped or unzipped collection of .xml files made up of:
  + One manifest file, which must be called Manifest.xml
  + One or more .xml files containing CIM 61970 Meta objects
  + Zero or more .xml files containing CIM 61970 Grid objects
* Use of a Meta UML information model including the following classes:
  + Frame
  + Boundary
  + Model
  + ModelSpec
  + Assembly
* Use of an Exchange UML information model including the following classes:
  + Manifest
  + InstanceSet
* A set of miscellaneous choices related to how .mRID is serialized, the use of rdf:about, how UUID is encoded, and the exchange of CIMDatatypes

### Manifest.xml

The purpose of the Manifest.xml file is twofold: to provide a single, universally understood starting point for software reading a CIM -552 data exchange and to identify those .xml files in the exchange that contain CIM 61970 Meta objects.

The Manifest.xml file contains only a Manifest object. Here is an example of the contents of a Manifest.xml file:

<?xml version="1.0" encoding="UTF-8"?>

<?iec61970-552 version="3.0" method=”DataSet”?>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"

xmlns:exch="http://ucaiug.org/GMDM/Exchange#">

<exch:Manifest rdf:about="urn:uuid:0a66f3bf-883a-43bf-93cc-e798098d611f">

<exch:Manifest.name>Manifest for Planning Golden Assembly Exchange</exch:Manifest.name>

<exch:Manifest.profile>http://ucaiug.org/GMDM/Meta\_Profile</exch:Manifest.profile>

<exch:Manifest.InstanceSet rdf:resource="urn:uuid:a84ffc15-6994-4758-9f36-7430d6b0421e"/>

</exch:Manifest>

</rdf:RDF>

The Manifest object:

* Is an instance of the Manifest class described in the IEC61970GMDMExchange package of the CIM
* Has a string attribute of .profile, which, by convention, must be a Meta profile
* Has an association to one or more InstanceSets of Meta objects (each of which is contained in a separate .xml file)

### .xml file containing Meta objects

The purpose of the one or more .xml files containing Meta objects (abbreviated here as <Meta>.xml) which are present in a 61970 data exchange is to supply information describing the context and purpose of instances of grid data exchanges. <Meta>.xml files supply the sort of information that the version 1 and 2 -552 header previously supplied, with the advantage of having that information flexibly and concisely defined by means of a UML information model, instead of defined in a fixed manner for all data exchanges.

There must be at least one <Meta>.xml file for a meaningful exchange of 61970 data. In the GMDM CIM IOP, the choice was made to have only a single <Meta>.xml file for any exchange.

A <Meta>.xml file contains a single InstanceSet object, followed by Meta objects. Here is an example excerpt of the contents of a <Meta>.xml file:

<?xml version="1.0" encoding="UTF-8"?>

<?iec61970-552 version="3.0" method=”DataSet”?>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"

xmlns:meta="http://ucaiug.org/GMDM/Meta#"

xmlns:exch="http://ucaiug.org/GMDM/Exchange#">

<exch:InstanceSet rdf:about="urn:uuid:a84ffc15-6994-4758-9f36-7430d6b0421e">

<exch:InstanceSet.name>Planning Golden Assembly</exch:InstanceSet.name>

</exch:InstanceSet>

<meta:Frame rdf:about="urn:uuid:9e734578-d840-4a7e-9f94-78ecd1787bd6">

<meta:IdentifiedMetaObject.name>T</meta:IdentifiedMetaObject.name>

<meta:IdentifiedMetaObject.description>Transmission Frame</meta:IdentifiedMetaObject.description>

</meta:Frame>

<meta:Frame rdf:about="urn:uuid:160b38bc-a280-4844-94f3-165b19760c44">

<meta:IdentifiedMetaObject.name>D</meta:IdentifiedMetaObject.name>

<meta:IdentifiedMetaObject.description>Distribution Frame</meta:IdentifiedMetaObject.description>

</meta:Frame>

<meta:Boundary rdf:about="urn:uuid:f79692f9-40ca-4ab4-80b7-89a18b276294">

<meta:IdentifiedMetaObject.name>TD</meta:IdentifiedMetaObject.name>

<meta:IdentifiedMetaObject.description>Trans/Dist Boundary</meta:IdentifiedMetaObject.description>

<meta:Boundary.Frame rdf:resource="urn:uuid:9e734578-d840-4a7e-9f94-78ecd1787bd6"/>

<meta:Boundary.Frame rdf:resource="urn:uuid:160b38bc-a280-4844-94f3-165b19760c44"/>

</meta:Boundary>

…

…

…

<meta:Assembly rdf:about="urn:uuid:64e5340b-5610-4cd5-889e-c223ab436ef3">

<meta:IdentifiedMetaObject.name>Plan Golden Assembly</meta:IdentifiedMetaObject.name>

<meta:Assembly.dateTimeCreated>2022-06-13T09:32:12-04:00</meta:Assembly.dateTimeCreated>

<meta:Assembly.dateTimeRepresented>2022-06-15T02:00:00-04:00</meta:Assembly.dateTimeRepresented>

<meta:Assembly.producingAuthority>EPRI</meta:Assembly.producingAuthority>

<meta:Assembly.AssemblySpec rdf:resource="urn:uuid:3333abab-9807-4f05-8b88-cedebf444444"/> <meta:Assembly.Model rdf:resource="urn:uuid:c20add7e-01c1-4918-991e-ad90f46d825c"/>

<meta:Assembly.Model rdf:resource="urn:uuid:a3b89ffc-bf5c-4139-8ff8-753f09ac71ce"/>

<meta:Assembly.Model rdf:resource="urn:uuid:d4d2701f-110f-418b-9452-eed59383ecac"/>

<meta:Assembly.Model rdf:resource="urn:uuid:62070765-fcc3-432c-ab4e-0c9c380f7399"/>

<meta:Assembly.Model rdf:resource="urn:uuid:9bd3a4df-ce5d-4b43-9e9e-94f88f63e0d8"/>

</meta:Assembly>

</rdf:RDF>

A Meta object:

* Is an instance of a concrete class described in the IEC61970GMDMMeta package of the CIM
* May have associations to one or more other Meta objects in either its own InstanceSet or a different InstanceSet of Meta objects
* If a Model object, must refer to one InstanceSet of Grid objects
* If a ChangeModel object, must refer to one ChangeSet describing changes to Grid objects

### .xml file containing Grid objects

The purpose of an .xml file containing Grid objects (abbreviated here as <Grid>.xml) is to supply information describing some aspect of the grid (its physical components, its real or simulated state, its presentation on diagrams, etc.). <Grid>.xml files contain information whose context is supplied by the content of one or more <Meta>.xml files.

A <Grid>.xml file must be accompanied by a <Meta>.xml file that references the <Grid>.xml file’s InstanceSet.

A <Grid>.xml file contains a single InstanceSet object, followed by Grid objects. Here is an example excerpt of the contents of a Grid.xml file:

<?xml version="1.0" encoding="UTF-8"?>

<?iec61970-552 version="3.0" method=”DataSet”?>

<rdf:RDF

xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"

xmlns:cim="http://ucaiug.org/61970cim18v02\_61968cim14v00#"

xmlns:gmdm="http://ucaiug.org/GMDM#"

xmlns:exch="http://ucaiug.org/GMDM/Exchange#">

<exch:InstanceSet rdf:about="urn:uuid:e5ffc257-98f6-4a8a-ba22-d7091ed016fc">

<exch:InstanceSet.name>Distribution Planning Basic Golden Model InstanceSet</exch:InstanceSet.name>

</exch:InstanceSet>

<cim:CoordinateSystem rdf:about="urn:uuid:dbdbe344-254b-4b4f-9aca-a7b62165a4dd">

<cim:IdentifiedObject.name>EPSG 4236 (WPS 84)</cim:IdentifiedObject.name>

<cim:CoordinateSystem.crsUrn>urn:ogc:def:crs:EPSG::4326</cim:CoordinateSystem.crsUrn>

</cim:CoordinateSystem>

<cim:BaseVoltage rdf:about="urn:uuid:7576ea67-2cd4-4e6e-882f-1e5806aafde3">

<cim:IdentifiedObject.name>12.47 kV</cim:IdentifiedObject.name>

<cim:BaseVoltage.nominalVoltage>12.470000267028809</cim:BaseVoltage.nominalVoltage>

</cim:BaseVoltage>

<cim:ConnectivityNode rdf:about="urn:uuid:c4ac9fcf-f894-49ba-8276-a1ed127046c7">

<cim:IdentifiedObject.name>g</cim:IdentifiedObject.name>

</cim:ConnectivityNode>

…

…

…

<gmdm:PointOfCommonCoupling rdf:about="urn:uuid:aac94c20-1f2e-4209-885c-9ec0745e51da">

<cim:IdentifiedObject.name>PCC 010</cim:IdentifiedObject.name>

<gmdm:PointOfCommonCoupling.Terminal rdf:resource="urn:uuid:c9b5658c-db69-45c9-8e43-e84e26dcb6f2"/>

</gmdm:PointOfCommonCoupling>

</rdf:RDF>

A Grid object:

* Is an instance of a class described in the IEC61970 package as well as select classes from the packages of other CIM standards. In the GMDM IOP, a Grid object may also be an instance of a class described in the GMDMCIMExtension package.
* May have associations to one or more other Grid objects in either its own InstanceSet or a different InstanceSet of Grid objects
* Does not have an association to an InstanceSet.

### .xml file example

The diagram below illustrates how seven (7) .xml files might be used to convey 3 sets of Meta objects and 3 sets of Grid objects.

Note that:

* The Manifest object can ‘point’ to many InstanceSets, but they must all be InstanceSets of Meta objects
* A Meta object can ‘point’ to one or more Meta objects in its own InstanceSet or in other InstanceSets of Meta objects
* A Grid object cannot ‘point’ to an InstanceSet (although a Grid object in one InstanceSet can point to a Grid object in another InstanceSet of Grid objects)

The example is intended to illustrate both how the generic instance set approach described in version 3 of -552 could be used and that rules specific to the use of the approach for network model data exchanges will likely be needed.



### Other serialization decisions

**Use of rdf:about**

All exchange objects are expressed as resources using rdf:about, not rdf:ID. (This aligns with the both the proposed 61970-552 version 3 and with the future direction articulated in 61970-600-1.)

**No .mRID attribute explicitly specified**

The UUID specified by the rdf:about statement for the resource is assumed to be the .mRID attribute for any exchanged object for which an .mRID is defined according to the governing profile. (This aligns with what the proposed 61970-552 appears to suggest in its examples, but this topic is a subject of ongoing discussions within WG13.)

**No xml: base in CIM XML files**

There is no declaration of xml:base in the RDF header of the CIM XML files and each individual identifier is prefaced with urn:uuid:. (This aligns with both the proposed 61970-552 version 3 and with the future direction articulated in 61970-600-1.)

**CIMDatatypes**

All CIM Datatypes have their .unit and .multipler attributes pre-defined in the profile. (Some come from the canonical UML itself and others are part of the profile specification, but the net effect is that the profile definition addresses both.) (This aligns with one of two options outlined in 61970-401 Edition 2 for profiling and exchange of CIMDatatypes.)