

## **A NOTE ON A POSSIBLE EXTENSION TO SIAP TO INCLUDE MORE STRUCTURE.**

**Pedro Osuna and Jesus Salgado, VILSPA 06 Apr 2004.**

The modelling of the whole structure of any project or astronomical object is a gigantic work which is being handled by the Data Modelling group (and others). However, we believe that adding functionality to the SIAP in order to be able to display “Structured Output” is a much easier task that could be handled with a couple of modifications to already existing protocols and tools.

In order to try and make things clear since the very beginning, we will work with a specific example from our XMM-Newton archive data and will give some general indications at the end.

Our XMM-Newton database CDM (Conceptual Data Model) contains the following tables:

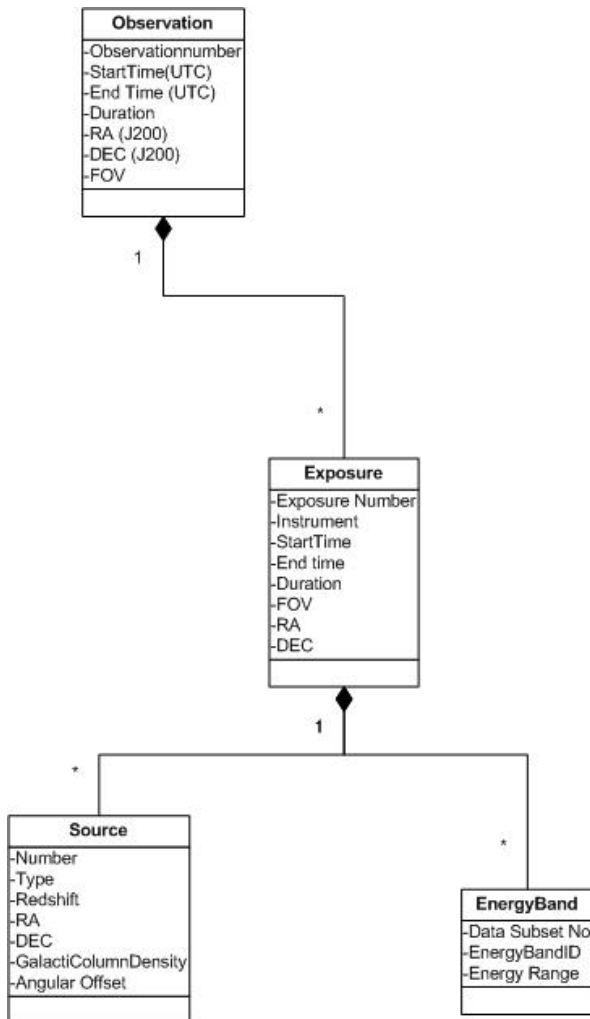
- Observation
- Exposures
- Sources
- Pointing

Plus many other tables related to specific settings of the satellite.

The fields in the tables can be very complex. For example, in the database there might not be such thing as a Field Of View (FOV henceforth) for an exposure, as this might depend on the distance of the Boresight to the center of the detector, the boresight being recalculated from time to time to allow for more precision in the measurements.

It is not this whole data model what we want to be able to display in our “structured” display.

Rather, we would like to map this XMM-Newton specific Data Model to the “Display Data Model” that we want to give in our SIAP-like answer to a client requesting data from our service. In this Display Data Model, we DO want to have a FOV. The way we calculate it internally is of no interest to the client. Therefore, the model we would give back in a SIAP query would correspond to something like the following:



Of course, this model would not be a fixed one: we could change it to include whichever attributes we need.

Now, the question would be: how do we insert this “Display Data Model” in the SIAP response”.

We believe this would be very easy if the VOTable would be extended to include hierarchical structure inside. Maybe this proposal has already been done and has been rejected in the past, but the simplicity of the model we propose and the possibilities it offers might make it worth to reconsider the inclusion of certain flexibility in the VOTable.

To allow for any Display Data Model to be included in a VOTable, the only thing to do would be to allow for TABLES inside TABLES. Only a couple of lines of the DTD would have to be modified in the FIELD definitions.

We would allow the FIELD element to include a TABLE, i.e., where it says:

```

<!-- FIELD is the definition of what is in a column of the table -->
<!-- A field may have 2 sets of VALUES: "legfal" and "actual" -->
<!ELEMENT FIELD (DESCRIPTION?, VALUES*, LINK*)>
<!ATTLIST FIELD
    ID ID #IMPLIED
    unit CDATA #IMPLIED
    datatype (boolean | bit | unsignedByte | short | int | long | char
| unicodeChar | float | double | floatComplex | doubleComplex) #IMPLIED
    precision CDATA #IMPLIED
    width CDATA #IMPLIED
    ref IDREF #IMPLIED
    name CDATA #IMPLIED
    ucd CDATA #IMPLIED
    arraysize CDATA #IMPLIED
    type (hidden | no_query | trigger) #IMPLIED>

```

it would say something like

```

<!ELEMENT FIELD (DESCRIPTION?, TABLE?, VALUES*, LINK*)>
<!ATTLIST FIELD
    ID ID #IMPLIED
    unit CDATA #IMPLIED
    datatype (boolean | bit | unsignedByte | short | int | long | char
| unicodeChar | float | double | floatComplex | doubleComplex | table) #IMPLIED
    precision CDATA #IMPLIED
    width CDATA #IMPLIED
    ref IDREF #IMPLIED
    name CDATA #IMPLIED
    ucd CDATA #IMPLIED
    arraysize CDATA #IMPLIED
    type (hidden | no_query | trigger) #IMPLIED>

```

i.e., we have added the possibility to have 0 or more TABLE elements inside a FIELD element.

Doing this, a “flat” SIAP result from our XMM-Newton service, like the following:

<http://xsa01.vilspa.esa.es:8080/aio/jsp/siap.jsp?POS=23.45,30.66&size=0.1>

(only the first result pointer (observation) is displayed)

```

<?xml version="1.0" ?>
<!DOCTYPE VOTABLE (View Source for full doctype...)>
<VOTABLE version="1.0">
<RESOURCE type="results">
  <DESCRIPTION>XMM-Newton Simple Image Access Protocol (SIAP) Service</DESCRIPTION>
  <INFO name="QUERY_STATUS" value="OK" />
<TABLE>
  <FIELD ID="ObsId" ucd="OBS_ID" datatype="char" arraysize="*" />
  <FIELD ID="Reference" ucd="DATA_LINK" datatype="char" arraysize="*" />
  <FIELD ID="Target_Name" ucd="VOX:Image_Title" datatype="char" arraysize="*" />
  <FIELD ID="Start_Time" ucd="VOX:OBS_START_TIME" datatype="char" arraysize="*" />
  <FIELD ID="End_Time" ucd="VOX:OBS_END_TIME" datatype="char" arraysize="*" />
  <FIELD ID="On_Time" ucd="VOX:OBS_DURATION" datatype="int" />
  <FIELD ID="RA" ucd="POS_EQ_RA_MAIN" datatype="char" arraysize="*" />
  <FIELD ID="DEC" ucd="POS_EQ_DEC_MAIN" datatype="char" arraysize="*" />
  <FIELD ID="NAXES" ucd="VOX:Image_Naxes" datatype="int" />
  <FIELD ID="NAXIS" ucd="VOX:Image_Naxis" datatype="double" arraysize="*" />
  <FIELD ID="SCALE" ucd="VOX:Image_Scale" datatype="double" arraysize="*" />
  <FIELD ID="FORMAT" ucd="VOX:Image_Format" datatype="char" arraysize="*" />
  <FIELD ID="Proprietary Date" ucd="VOX:PROP_DATE" datatype="char" arraysize="*" />
<DATA>
<TABLEDATA>
<TR>
<TD>0102640101</TD>
<TD>
  <![CDATA[http://xsa.vilspa.esa.es:8080/aio/jsp/product.jsp?obsno=0102640101&name=OIMAGE&level=PPS&extension=FTZ&protocol=HTTP]]>
</TD>
<TD>XMM EPIC Image. Target: M33_1</TD>
<TD>2000-08-04 05:16:00.0</TD>
<TD>2000-08-04 10:27:12.0</TD>
<TD>18672</TD>
<TD>23.458305</TD>
<TD>30.66414</TD>
<TD>2</TD>
<TD>650 650</TD>
<TD>-1.1111111111111111E-03 1.1111111111111111E-03</TD>
<TD>image/fits</TD>
<TD>Dec 15 2002</TD>
</TR>
.
.
.
</TABLEDATA>
</DATA>
</TABLE>
</RESOURCE>
</VOTABLE>

```

would become something like:

```

<?xml version="1.0" ?>
<!DOCTYPE VOTABLE (View Source for full doctype...)>
<VOTABLE version="1.0">
<RESOURCE type="results">
  <DESCRIPTION>XMM-Newton Simple Image Access Protocol (SIAP) Service</DESCRIPTION>
  <INFO name="QUERY_STATUS" value="OK" />
  <TABLE>
    <FIELD ID="ObsId" ucd="OBS_ID" datatype="char" arraysize="*" />
    <FIELD ID="Target_Name" ucd="VOX: Image_Title" datatype="char" arraysize="*" />
    <FIELD ID="Start_Time" ucd="VOX: OBS_START_TIME" datatype="char" arraysize="*" />
    <FIELD ID="End_Time" ucd="VOX: OBS_END_TIME" datatype="char" arraysize="*" />
    <FIELD ID="On_Time" ucd="VOX: OBS_DURATION" datatype="int" />
    <FIELD ID="RA" ucd="POS_EQ_RA_MAIN" datatype="char" arraysize="*" />
    <FIELD ID="DEC" ucd="POS_EQ_DEC_MAIN" datatype="char" arraysize="*" />
    <FIELD ID="FOV" ucd="VOX: Field_Of_View" datatype="char" arraysize="*" />
    <FIELD ID="FORMAT" ucd="VOX: Image_Format" datatype="char" arraysize="*" />
    <FIELD ID="Reference" ucd="DATA_LINK" datatype="char" arraysize="*" />
    <FIELD ID="Exposure_Table" datatype="table" />
  <DATA>
    <TABLEDATA>
      <TR>
        <TD>0102640101 </TD>
        <TD>XMM EPIC Image. Target: M33_1 </TD>
        <TD>2000-08-04 05:16:00.0 </TD>
        <TD>2000-08-04 10:27:12.0 </TD>
        <TD>18672 </TD>
        <TD>23.458305 </TD>
        <TD>30.66414 </TD>
        <TD>0.72x0.72 </TD>
        <TD>Dec 15 2002 </TD>
        <TD>image/fits </TD>
      <TD>
        <![CDATA[http://xsa.vilspa.esa.es:8080/aio/jsp/product.jsp?obsno=0102640101&name=OIMAGE&level=PPS&extension=FTZ&protocol=HTTP]]>
      </TD>
    <TD>
      <TABLE>
        <FIELD ID="ExposureNumber" ucd="EXP_ID" datatype="char" arraysize="*" />
        <FIELD ID="Image_Name" ucd="VOX: Image_Title" datatype="char" arraysize="*" />
        <FIELD ID="Instrument" ucd="INST_ID" datatype="char" arraysize="*" />
        <FIELD ID="Start_Time" ucd="VOX: OBS_START_TIME" datatype="char" arraysize="*" />
        <FIELD ID="End_Time" ucd="VOX: OBS_END_TIME" datatype="char" arraysize="*" />
        <FIELD ID="Duration" ucd="VOX: OBS_DURATION" datatype="int" />
        <FIELD ID="FOV" ucd="VOX: Field_Of_View" datatype="char" arraysize="*" />
        <FIELD ID="RA" ucd="POS_EQ_RA_MAIN" datatype="char" arraysize="*" />
        <FIELD ID="DEC" ucd="POS_EQ_DEC_MAIN" datatype="char" arraysize="*" />
        <FIELD ID="FORMAT" ucd="VOX: Image_Format" datatype="char" arraysize="*" />
        <FIELD ID="Reference" ucd="DATA_LINK" datatype="char" arraysize="*" />
        <FIELD ID="Source_Table" datatype="table" />
        <FIELD ID="Energy_Band_Table" datatype="table" />
      <DATA>
        <TABLEDATA>
          <TR>
            <TD>S001 </TD>
            <TD>XMM EPIC EPN Image. Target: M31Core. Exposure S001 </TD>
            <TD>EPN </TD>
            <TD>2000-08-04 06:06:43.0 </TD>
            <TD>2000-08-04 09:51:52.0 </TD>
            <TD>13509 </TD>
            <TD>0.72x0.72 </TD>
            <TD>23.458305 </TD>
            <TD>30.66414 </TD>
            <TD>image/fits </TD>
          <TD>
            <![CDATA[http://xsa.vilspa.esa.es:8080/aio/jsp/product.jsp?obsno=0102640101&instname=PN&datasubsetno=8&name=IMAGE&level=PPS&extension=FTZ&protocol=HTTP]]>
          </TD>
        <TD>
          <TABLE>
            <FIELD ID="SourceId" ucd="SRC_ID" datatype="char" arraysize="*" />

```

```
<FIELD ID="Image_Name" ucd="VOX: Image_Title" datatype="char" arraysize="*" />
<FIELD ID="Type" ucd="SRC_ID" datatype="char" arraysize="*" />
<FIELD ID="Redshift" ucd="REDSHIFT_PHOT" datatype="char" arraysize="*" />
<FIELD ID="RA" ucd="POS_EQ_RA_MAIN" datatype="char" arraysize="*" />
<FIELD ID="DEC" ucd="POS_EQ_DEC_MAIN" datatype="char" arraysize="*" />
<FIELD ID="GalacticColumnDensity" ucd="VOX: Galactic_Column_Density" datatype="char"
arraysize="*" />
<FIELD ID="AngularOffset" ucd="INST_ANG_OFFAXIS" datatype="char" arraysize="*" />
<FIELD ID="FORMAT" ucd="VOX: Image_Format" datatype="char" arraysize="*" />
<FIELD ID="Reference" ucd="DATA_LINK" datatype="char" arraysize="*" />
<DATA >
<TABLEDATA >
<TR>
<TD>1XMM J013342.1+303030 </TD>
<TD>XMM PN Source 1XMM J013342.1+303030 </TD>
<TD>null </TD>
<TD>null </TD>
<TD>23.41 </TD>
<TD>30.50 </TD>
<TD>8.4E+20 </TD>
<TD>570.37 </TD>
<TD>image/pdf </TD>
<TD>
<![CDATA[http://xsa.vilspa.esa.es:8080/aio/jsp/product.jsp?obsno=0102640101&sourceName=J013342.1+303030&instname=PN
&name=IMAGE_&level=PPS_SRC&extension=PDF&protocol=HTTP]]>
</TD>
</TR>
</TABLEDATA >
</DATA >
</TABLE >
</TD >
<TD >
<TABLE >
<FIELD ID="EnergyBandId" ucd="ENERGY_BAND_ID" datatype="char" arraysize="*" />
<FIELD ID="Image_Name" ucd="VOX: Image_Title" datatype="char" arraysize="*" />
<FIELD ID="EnergyRange" ucd="VOX: Phys_Energy_Range" datatype="char" arraysize="*" />
<FIELD ID="FORMAT" ucd="VOX: Image_Format" datatype="char" arraysize="*" />
<FIELD ID="Reference" ucd="DATA_LINK" datatype="char" arraysize="*" />
<DATA >
<TABLEDATA >
<TR>
<TD>4 </TD>
<TD>XMM EPIC EPN Image. Target: M33_6/4.5 -7.5keV </TD>
<TD>4.5 -7.5 </TD>
<TD>image/fits </TD>
<TD>
<![CDATA[http://xsa.vilspa.esa.es:8080/aio/jsp/product.jsp?obsno=0102640601&instname=PN&expno=S001&
datasubsetno=4&sourceno=000&name=IMAGE_&level=PPS&extension=FTZ&protocol=HTTP]]>
</TD>
</TR>
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</TABLEDATA >
</DATA >
</TABLE >
</TD >
</TR >
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</TABLEDATA >
</DATA >
</TABLE >
</TD >
</TR >
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</TABLEDATA >
</DATA >
```

```
</TABLE>  
</RESOURCE>  
</VOTABLE>
```

It is worth noting in this model, that both the Sources and the EnergyBands are aggregations of the same exposure class. This does not pose any problem in this model, as the TABLE data properly declared in the FIELDS table header, put them both at the same level.

Clients would only have to traverse the hierarchy and display it appropriately (e.g., by implementing a DOM-like parsing of the VOTable structure and passing the object directly to something like a JTree in Java).

## Summary of the model

- It does not pretend to define a model of any existing project or any existing physical quantity. It only pretends to allow for structure display in SIAP-like queries.
- It allows the display of any type of structure in a tree like form. The aspect of the tree is defined by the “Display” Data Model that the Data Provider wants to include in its SIAP response.
- It allows for multiple aggregation. In the example above, both the Source object and the EnergyBand object are aggregates of the same Exposure object. Both will appear in the SIAP response as TABLEs each one with its own ID. It will then be up to the client to display them in the same branch. There is no possible confusion.
- It does not reflect any database join problem, as this model does not pretend – already stated- to model any data provider repository or physical quantity, and thus does not have to care about how the real data (in the database or whatever) is organized: it will only care about the structure given in the SIAP response, which should reflect a specific “Display” Data Model.
- It respects the UCD paradigm. Any object in the display data model would have to find an equivalent UCD to describe the “TYPE” of object it represents, not WHAT the object is with precision. We believe that the knowledge of what the object is might be crucial for a global Data Model representing the whole astrophysical quantities in the Universe, but not in allowing structured display for SIAP.
- It does not impose any restriction on the display data model names (for the objects). The clients do not care about the names of the different hierarchical structures inside a response: they only care about what the display data model name is for a specific object and what the pointer to the data product is. The rest is up to the data provider. In our example, the first object in the hierarchy is called Observation for obvious reasons in Space based observatories. However, in the same display there could be a project whose first object in the hierarchy could be called “Pointing” or “Plaque” or whatever. It is not important what the thing exactly is, but of what type it is and where the pointer to the real image (in the case of SIAP; spectrum in the case of SSA) is.