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# From UML To VOTable

A End-to-End Trip in the VO-DML World

# Test Baselines

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## 1. Operating a VO-DML workflow on server side

- a. Are both modeling and mapping consistent to each other?
- b. Which tool are available or missing?
- c. Which human skill is required

## 2. Target

- a. Replacing <COOSYS> with VO-DML annotations
- b. Annotating Healpix tessellation

## 3. Procedure

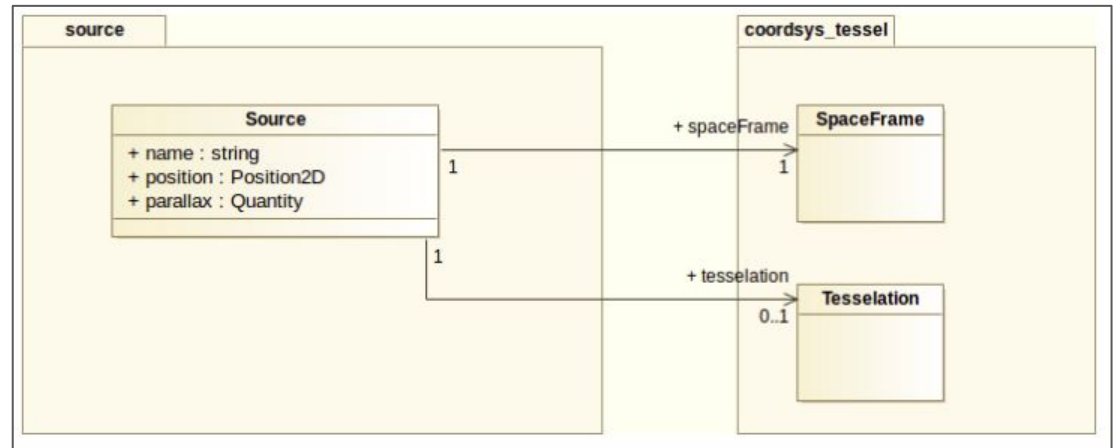
- a. Designing a simple model
- b. Building a VO-DML representation of this model
- c. Annotating real data with this model
- d. Validating the result
- e. Consume the result with a (the) client

# The model

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- **lmsource: A basic Model describing a source**

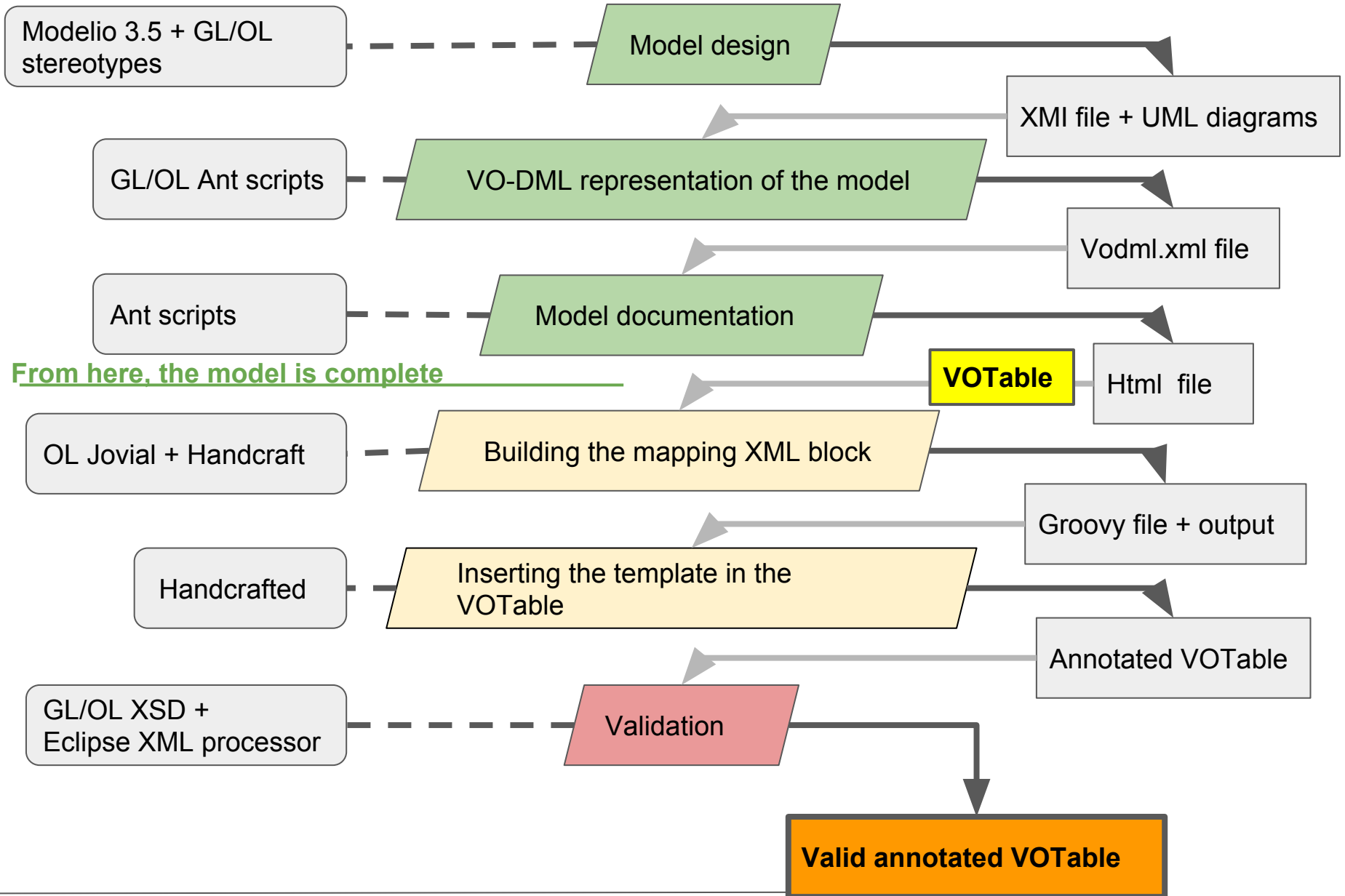
- Name
  - also used as primary key
- Sky coordinates
  - 2 axis: RA/DEC
  - One space frame
  - An elliptical error
- Healpix tessellation
  - Another space frame
  - A numbering schema
  - The healpix order
  - A pixel value
- Parallax



- **Saving reinventing the wheel**

- Let's start from the STC2 space coordinate pattern (Arnold & Mark)

# The Workflow

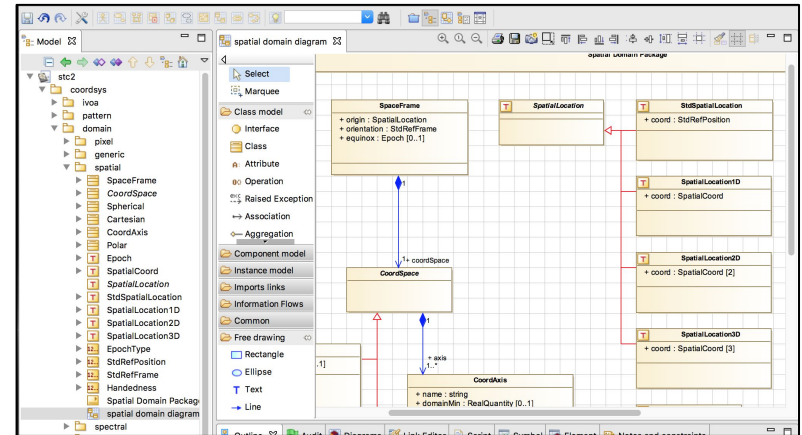




# Model Design

## 1. Updating STC to support tessellation

- a. Load STC2 patterns in Modelio 3.5
  - i. CoordSys and Coord
  - ii. Available on Volute
- b. Update and rename the models
  - i. tessell\_XXX
- c. Export it as XMI
- d. Generate VO-DML files
  - i. XML, HTML



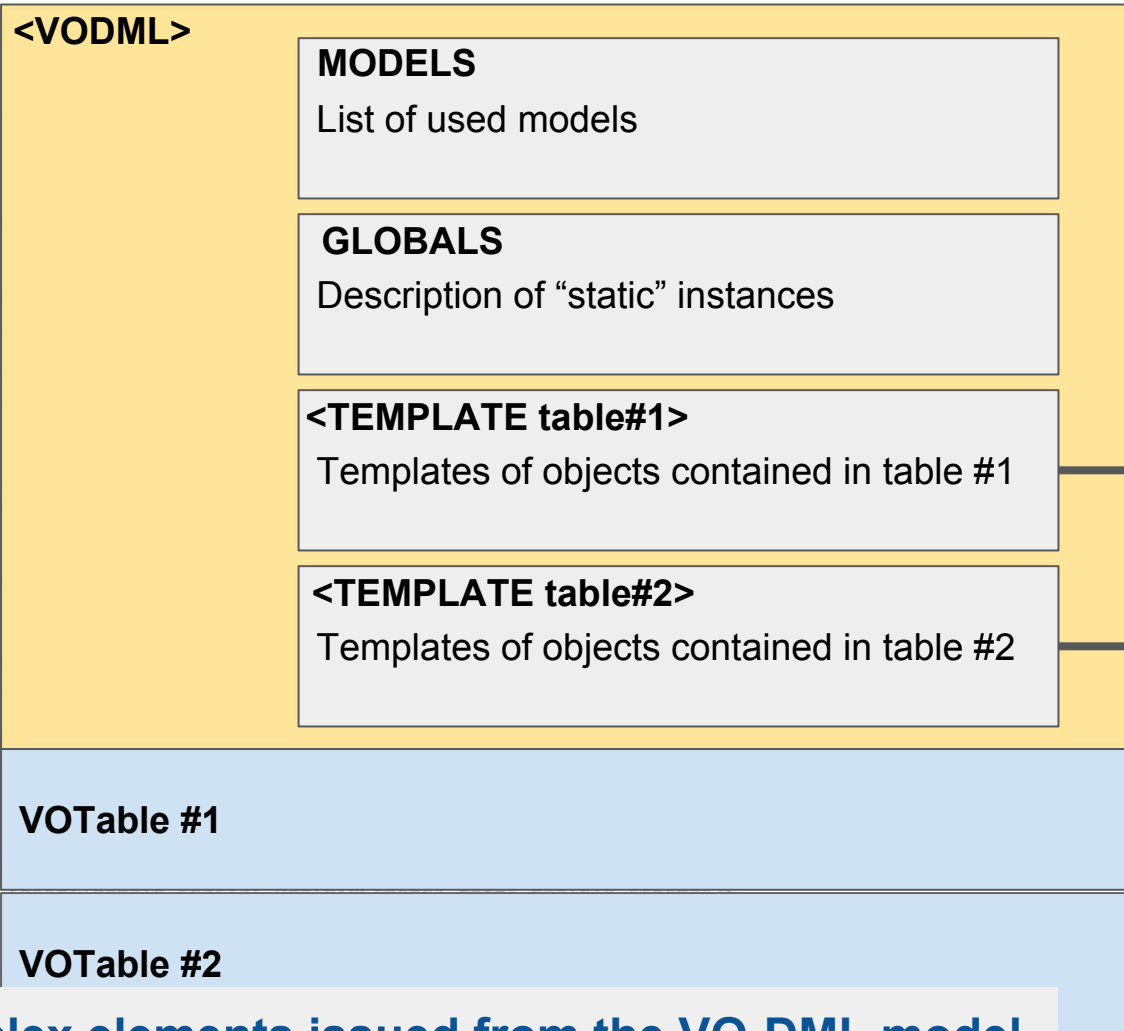
## 2. Creating the source model

- a. New project on Modelio
  - i. See beginners guide
- b. Write proxy classes matching the imported STC2 classes
  - i. See the import guide on Volute
- c. Export as XMI
- d. Generate VO-DML files (XML, HTML)

# Building the VO-DML mapping block

```

<MODEL>
  <NAME>lmsource</NAME>
  <URL>http://volute.g-vo.org/sv
  <IDENTIFIER>ivo://ivoa.org/dm/
</MODEL>
<GLOBALS ID=" MyFirstGlobal">
  <INSTANCE dmtpe="coordsys tes
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="TOPOCENTER
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="ICRS" dmtyp
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="2015" dmtyp
    </ATTRIBUTE>
  </INSTANCE>
  <INSTANCE dmtpe="coordsys tes
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="TOPOCENTER
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="ICRS" dmtyp
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="coordsys _
      <LITERAL value="2000" dmtyp
    </ATTRIBUTE>
    <REFERENCE dmrole="coordsys
      <IDREF> healpixframe</IDREF
    </REFERENCE>
  </INSTANCE>
  <INSTANCE dmtpe="coordsys tes
    <ATTRIBUTE dmrole="coordsys
      <CONSTANT dmtpe="coordsys
        <!-- generated by Jovial <
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="coordsys
  </INSTANCE>
</GL
<TEP
  
```



- XML complex elements issued from the VO-DML model
  - <VODML> block located just below <VOTABLE>

# Building the VO-DML mapping block

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- **No automated way to proceed**

- Depends on the data to be annotated
- Instance values can be picked out from different places
  - Hardcoded in <GLOBALS>
  - From <PARAM> or <FIELD>
- Possible use of cross references
  - Filter definition e.g.
- Data possibly spread over multiple tables

- **Options**

- Writing by hand
- Using a DSL (Jovial, O.L)
- Both used here
- ...



# Groovy Snapshot

```
/*
 * Pseudo table necessarily to generatea VODML annotation
 */
resource(id: "table_objects") {
  table(id: "_table1") {
    def nameesaada = []
    def pos_ra_csa = []
    def pos_dec_csa = []
    def error_maj_csa = []
    def healpix_csa = []
    def parallax_csa = []
  }
  /*
   * One Source instance per data row
   */
  instance(type: "lmsource:source.Source", id: "_source") {
    // taking the name as primary key (works for this example)
    pk() {
      column(role: "lmsource:source.Source.name", id: "namesaada_100", data: nameesaada)
    }
    column(role: "lmsource:source.Source.name", id: "namesaada_100", data: nameesaada)
    // Position2D component: RA/DEC + error
    instance(role: "lmsource:source.Source.position", type: "coords_tessel:domain.spatial.Position2D") {
      instance(role: "coords_tessel:domain.spatial.Position.tile", type: "coords_tessel:domain.spatial.Tile"){
        instance(role: "coord_tessel:domain.spatial.Tile.skyindex", type: "coordsys_tessel:domain.spatial.Tile.skyindex"){
          column(role: "coord_tessel:domain.spatial.SkyIndex.loc", id: "healpix_csa_100", data: healpix_csa)
        }
      }
    }
    instance(role: "lmsource:source.Source.position", type: "coords_tessel:domain.spatial.Position2D") {
      // Position2D.coord is an attribute with a multiplicity of 2
      instance(role: "coords_tessel:domain.spatial.Position2D.coord", type: "coordsys_tessel:domain.spatial.SpatialCoord") {
        column(role: "coordsys_tessel:domain.spatial.SpatialCoord.loc", id: "pos_ra_csa_100", data: pos_ra_csa)
        instance(role: "coordsys_tessel:domain.spatial.SpatialCoord.axis", type: "coordsys_tessel:domain.spatial.CoordAxis"){
          instance(type: "ivoa:String", role: "name", value: "ra")
        }
      }
    }
  }
}
```

Annotations

Foo VOTable

# Here We Are

```
<VOTABLE
  xmlns="http://www.ivoa.net/xml/VOTable/v1.4_vodml"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.4_vodml https://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/xsd/ext

  <VODML>
    <MODEL>
      <NAME>ivoa</NAME>
      <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/ivoa/IVOA.vo-dml.xml</URL>
    </MODEL>
    <MODEL>
      <NAME>coordsys_tessel</NAME>
      <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/coordsys_tessel.vo-dml.xml</URL>
      <IDENTIFIER>ivo://ivoa.org/dm/sample/CoordSysTessel/0.1</IDENTIFIER>
    </MODEL>
    <MODEL>
      <NAME>coords_tessel</NAME>
      <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/coords_tessel.vo-dml.xml</URL>
      <IDENTIFIER>ivo://ivoa.org/dm/sample/CoordsTessel/0.1</IDENTIFIER>
    </MODEL>
    <MODEL>
      <NAME>lmsource</NAME>
      <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/lmsource.vo-dml.xml</URL>
      <IDENTIFIER>ivo://ivoa.org/dm/sample/LMSource/0.1</IDENTIFIER>
    </MODEL>
    <GLOBALS ID="MyFirstGlobal">
      <INSTANCE dmtpe="coordsys_tessel:domain.spatial.SpaceFrame" ID="_coordspaceframe">
        <ATTRIBUTE drole="coordsys_tessel:domain.spatial.SpaceFrame.origin">
          <LITERAL value="TOPOCENTER" dmtpe="coordsys_tessel:domain.spatial.SpatialLocation"/>
        </ATTRIBUTE>
        <ATTRIBUTE drole="coordsys_tessel:domain.spatial.SpaceFrame.orientation">
          <LITERAL value="ICRS" dmtpe="coordsys_tessel:domain.spatial.StdRefFrame"/>
        </ATTRIBUTE>
        <ATTRIBUTE drole="coordsys_tessel:domain.spatial.SpaceFrame.equinox">
          <LITERAL value="2015" dmtpe="coordsys_tessel:domain.spatial.Epoch"/>
        </ATTRIBUTE>
      </INSTANCE>
    </TEMPLATES>
  </VODML>
  <DESCRIPTION><![CDATA[
  iaadaDB:
    name : ThreeXMMdr6
    url  : http://xcatdb.unistra.fr/3xmmdr6
    date : Mon Apr 10 17:18:07 CEST 2017
  ]>
  Query parameters:
  query: SELECT TOP 5 CATALOGUE_ENTRY.CATALOGUE_ENTRY.namesaada, CATALOGUE_ENTRY.pos_ra_csa, CATALOGUE_ENTRY.pos_dec_csa, CATALOGUE_ENTRY.healpix_order
  FROM CATALOGUE_ENTRY

  limit: -1
  archive generated by SAADA: http://saada.u-strasbg.fr
  ]>
  </DESCRIPTION>
  <RESOURCE type="results"><DESCRIPTION>TAP1.0</DESCRIPTION>
  <INFO name="QUERY_STATUS" value="OK"/>
  <INFO name="LANGUAGE" value="ADQL"/>
  <INFO name="QUERY" value="Query"><![CDATA[SELECT "CATALOGUE_ENTRY.namesaada", "CATALOGUE_ENTRY.pos_ra_csa", "
  FROM CATALOGUE_ENTRY AS CATALOGUE_ENTRY]]></INFO>
  <TABLE name="Results" ID="_table1">
    <GROUP ID="_healpix">
      <PARAM datatype="char" arraysize="*" name="healpix_schema" ID="_healpix_schema" value="NESTED"/>
      <PARAM datatype="int" name="healpix_order" ID="_healpix_order" value="13"/>
    </GROUP>
    <FIELD ID="namesaada_100" name="namesaada" datatype="char" ucd="meta.id" arraysize="*">
      <DESCRIPTION>Attribute managed by Saada</DESCRIPTION>
    </FIELD>
    <FIELD ID="pos_ra_csa_100" name="pos_ra_csa" datatype="double" ucd="pos.eq.ra;meta.main" unit="deg">
      <DESCRIPTION>Attribute managed by Saada</DESCRIPTION>
    </FIELD>
    <FIELD ID="pos_dec_csa_100" name="pos_dec_csa" datatype="double" ucd="pos.eq.dec;meta.main" unit="deg">
      <DESCRIPTION>Attribute managed by Saada</DESCRIPTION>
    </FIELD>
    <FIELD ID="healpix_order_100" name="healpix_order" datatype="int" ucd="meta.id">
      <DESCRIPTION>Attribute managed by Saada</DESCRIPTION>
    </FIELD>
  </TABLE>
  </RESOURCE>
  </RESULTS>
</VOTABLE>
```

## Mapping Block

## Resource

# XML Validation

- **VOTable and VO-DML schemas in different files**

- VOTable-1.4: Ignore the <VODML> block
- VODML-mapping: Ignore everything but the <VODML> block
- Schemas can evolve regardless from each other
  - At least while XML elements keep different in both contexts

- **XSD <include> mechanism**

- VO-DML is included into VOTable 1.4

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
  xmlns="http://www.ivoa.net/xml/VOTable/v1.4_vodml" targetNamespace="http://www.ivoa.net/xml/VOTable/v1.4_vodml">
  <!--
    Include the VOML mapping within a unique namespace (workaround for validator issues) (LM)
  -->
  <xs:include schemaLocation="VODML-mapping.xsd" />
```

- Only one XSF file to invoke

```
<VOTABLE
  xmlns="http://www.ivoa.net/xml/VOTable/v1.4_vodml"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.4_vodml ../../xsd/ext/VOTable-1.4_extvodml.xsd">
```

- Not name-space issue in the VOTable

- **Validation processed by XMLExpresso (Eclipse)**

# VOTable Parsing

- **MAST prototype**

- Developed by T.D
- Still in development

- **Features**

- Fine grain VOTable validation
- Multi-facet data display
  - Tabular
  - Hierarchical
- Available as a Web Service
  - Run with `curl`
- Doc on Volute
  - `./vo-dml/mapping/`

```
0 ( _source )
├── _dmtype_ : lmsource:source.Source
├── _id_ : _source
├── _primarykey_ : 3XMM J172607.5+022156
├── _attributes_
│   ├── lmsource:source.Source.name: 3XMM J172607.5+022156
│   └── lmsource:source.Source.position
│       ├── _dmtype_ : coords_tessel:domain.spatial.Position2D
│       ├── _attributes_
│       │   ├── coords_tessel:domain.spatial.Position2D.error
│       │   │   ├── _dmtype_ : coords_tessel:domain.spatial.StatisticalError2D
│       │   │   ├── _attributes_
│       │   │   │   ├── coords_tessel:domain.spatial.StatisticalError2D.statError
│       │   │   │   │   ├── _dmtype_ : coords_tessel:dtypes.dtypes.Ellipse
│       │   │   │   │   ├── _attributes_
│       │   │   │   │   │   ├── coords_tessel:dtypes.Ellipse.posAngle: 0
│       │   │   │   │   │   └── coords_tessel:dtypes.Ellipse.semiAxis: 0.000216155833333333
│       │   │   └── _compositions_
│       │   │       ├── coords_tessel:domain.spatial.Position2D.coord
│       │   │       │   ├── _dmtype_ : coordsys_tessel:domain.spatial.CoordAxis
│       │   │       │   ├── _attributes_
│       │   │       │   │   ├── coordsys_tessel:domain.spatial.Axis.name: ra
│       │   │       │   │   └── coordsys_tessel:domain.spatial.SpatialCoord.loc: 261.53145000675
│       │   └── lmsource:source.Source.parallax
│       └── coords_tessel:domain.spatial.Position.tile
│           ├── _dmtype_ : coords_tessel:domain.spatial.Tile
│           ├── _attributes_
│           │   ├── coord_tessel:domain.spatial.Tile.skyindex
│           │   │   ├── _dmtype_ : coordsys_tessel:domain.spatial.Tile.skyindex
│           │   │   ├── _attributes_
│           │   │   │   └── coord_tessel:domain.spatial.SkyIndex.loc: 8171902023
│           └── .spaceFrame
│               └── _idref_ : _coordspaceframe
```

<https://masttest.stsci.edu/vodml/Mashup/Clients/Mast/Portal.html>

# Conclusions

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- **Model Design with Modelio**

- + Rather easy with a little training
- + Possibility of editing diagram
- + Import supported
- - No way back from VO-DML to modeler
- - Risk of deprecation for the XML resources in a future version
  - XMI format change implies to adapt the XSLT sheets

- **Annotation**

- + Comprehensive syntax
- + VOTable elements distinct from Mapping elements
- + VO-DML elements grouped on the top of the VOTable
  - Makes easier to automate the annotation process
  - Makes easier the extraction of the annotation
  - Allow streaming
- - No automated process right now
- - Loose coupling between VO-DML/XML and VOTable mapping
  - VO-DML IDs picked out from an HTML page regardless to the VO-DML serialization
- A bit talkative, maybe? :=)

# Conclusion

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- **Everything is working**

- With more or less pain, but it's working

- **Documentation**

- Job rather difficult without cookbook

- **Validation**

- Needed because of the complexity of the annotation
- The current validation just checks the syntax not the model semantic
- The VO-DML/XML serialisation is a very convenient reference
  - Although it has been under-utilised here

- **For the future ...**

- A framework helping to automate the annotation generation for existing data (Vizier e.g.) would be welcome.
- Agreement on minimal (sub)models necessarily for actual clients?
  - Coosys/healpix...

# Do it Yourself

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- **All stuff available on Volute**

- <https://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/>
- Models
- Operating mode
- Output
- Registry record

- **Enjoy...**

- **Next trip**

- Including the client side?