Mapping between the formulas XBRL and the Multidimensional Data Model.

Academic Track @ XBRL Week, Frankfurt (Germany). June, 1st – 2nd 2016
European Central Bank.
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Summary

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Introduction I

This presentation is based in:


This presentation focuses on research into the mapping between the XBRL data model (XBRLDM) and the multidimensional data model (MDM), as well as its automation.

The MDM is a straightforward model that combines objects, dimensions (hierarchies), measures and attributes for representing real work business problems. In addition, this model is the heart of On-Line Analytical Processing (OLAP), which requires complex queries that can be solved by the MDM in real time.

Conversion between the aforementioned models will be made using the Model Driven Architecture (MDA) paradigm, which ensures interoperability and solves the problem of heterogeneity between systems.

UML/MDA (OMG, 2015) is a powerful tool that has helped in different areas of Information Technology (IT) to model structured and robust systems. However, the techniques of verification and validation of the software is not supported in the standard MDA.
**XBRL Data Model and Calculations I**

- XBRL semantic information, separated from application software, uses and extends the XML standard.
- A report or XBRL instance document references a set of XML or XBRL Schemas. This set of schemas in the XBRLDM, called a **Discoverable Taxonomy Set (DTS)** specifies the concepts, rules and constraints.
- The role, *Calculation* provides simple calculation relationships between different elements (basic concepts, dimensions and dimension attributes), but does not allow formulas or complex expressions.
- The previous version, XBRL 1.0, was based on hierarchies with a tree structure, since XML, the language on which it was based, is hierarchical.
- An example of a XBRL instance document generated under these limitations is presented in *next slide* (XBRL International and Novartis International AG, consisting of a set of basic concepts with a set of dimension-dimension attribute pairs.)
## Consolidated Balance Sheet
(at December 31, 2001 and 2000)

<table>
<thead>
<tr>
<th>Assets</th>
<th>Notes</th>
<th>2001 CHF millions</th>
<th>2000 CHF millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>8</td>
<td>9060</td>
<td>9030</td>
</tr>
<tr>
<td>Intangible assets</td>
<td>9</td>
<td>6548</td>
<td>5830</td>
</tr>
<tr>
<td>Investment in associated companies</td>
<td>11</td>
<td>6715</td>
<td>1531</td>
</tr>
<tr>
<td></td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Deferred taxes</td>
<td>12</td>
<td>3235</td>
<td>3265</td>
</tr>
<tr>
<td>Other financial assets</td>
<td>13</td>
<td>7027</td>
<td>5601</td>
</tr>
<tr>
<td><strong>Total long-term assets</strong></td>
<td></td>
<td><strong>32585</strong></td>
<td><strong>25257</strong></td>
</tr>
<tr>
<td>Current assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total current assets</strong></td>
<td></td>
<td><strong>34200</strong></td>
<td><strong>32939</strong></td>
</tr>
<tr>
<td><strong>TOTAL ASSETS</strong></td>
<td></td>
<td><strong>66785</strong></td>
<td><strong>58196</strong></td>
</tr>
</tbody>
</table>
XBRL Data Model and Calculations III

Summary
Introduction
XBRLDM & Calculation
XBRL Formula
Specification & the MDM
Semantic Questions
POC
Validations
Conclusions
Future works
Questions
**Summary**

Introduction

**XBRL Data Model and Calculation**

**XBRL Formula Specification & the MDM**

Semantic Questions

POC

Validations

Conclusions

Future works

Questions

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**Consolidated Balance Sheet (December 31, 2001 and 2000)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Tangible assets</th>
<th>Intangible assets</th>
<th>Investment in associated companies</th>
<th>Deferred taxes</th>
<th>Other financial assets</th>
<th>Total long-term assets</th>
<th>Total current assets</th>
<th>TOTAL ASSETS</th>
<th>Basic Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Jan 2001</td>
<td>9060</td>
<td>6548</td>
<td>6715</td>
<td>3235</td>
<td>7027</td>
<td>32585</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 Dec 2001</td>
<td>9030</td>
<td>5830</td>
<td>1531</td>
<td>3265</td>
<td>5601</td>
<td>25257</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 Dec 2000</td>
<td>32930</td>
<td>58196</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Entity**
XBRL formula Specification & the MDM I
The CIM model in this research work is the set of XBRL instance documents, the taxonomies and XBRL Formula Specification.

The rules and definitions from the CIM are obtained, through XBRL Formula Specification.

The PIM used in this proposal is based on UML, which is a star model, the MDM.

The set of constrains, dimensions and dimension attributes are collected in an automatic way from a taxonomy and its algorithm is shown.

The PSM is a set of stored procedures or programmes in Cobol, C++, etc. The algorithm will show the mapping from the PIM to the PSM.

The process of validation is divided in two phases.

- The first phase is to test the UML star model / MDM (the PIM), from the XBRL taxonomies and the XBRL reports.
- The second one is to validate the set of stored procedures using ROLAP technology.
### Summary

Introduction

**XBRLDM & Calculation**

**XBRL Formula Specification & the MDM**

Semantic Questions

POC

Validations

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# XBRL Formula Specification & the MDM III

<table>
<thead>
<tr>
<th>Def</th>
<th>XBRLDM, the CIM</th>
<th>MDM or star model (the PIM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fact</td>
<td>Fact</td>
</tr>
<tr>
<td>2</td>
<td>Assertion</td>
<td>Constraint</td>
</tr>
<tr>
<td>3</td>
<td>Filter</td>
<td>Set of pairs &lt;dimension/attribute of dimension&gt;</td>
</tr>
<tr>
<td>4</td>
<td>Implicit filter</td>
<td>Set of pairs &lt;dimension/attribute of dimension&gt;</td>
</tr>
<tr>
<td>5</td>
<td>Explicit filter</td>
<td>Set of pairs &lt;dimension/attribute of dimension&gt;</td>
</tr>
<tr>
<td>6</td>
<td>Basic concept</td>
<td>Pair &lt;Dimension/attribute of dimension&gt;</td>
</tr>
<tr>
<td>7</td>
<td>Constant</td>
<td>Constraint</td>
</tr>
<tr>
<td>8</td>
<td>Variable</td>
<td>Set of pairs &lt;dimension/attribute of dimension&gt;</td>
</tr>
<tr>
<td>9</td>
<td>FallbackValue</td>
<td>Constraint</td>
</tr>
<tr>
<td>10</td>
<td>Precondition</td>
<td>Constraint</td>
</tr>
<tr>
<td>11</td>
<td>Filter group</td>
<td>Set of pairs &lt;dimension/attribute of dimension&gt;</td>
</tr>
</tbody>
</table>

---

*From the CIM to the PIM*
Example using the Bank of Spain’s consolidated public sector balance sheet 6610.

```
assertionSet
  valueAssertion
    (((creditInstitutions + InsuranceEntities + otherEntities + settlementAdjustments) eq TotalGroupEntities) and (TotalGroupEntities eq 0))
  conceptName ifrs-gp:InvestmentsInSubsidiariesAtCost
  factVariable creditInstitutions fallbackValue 0
  explicitDimension CreditInstitutionConsolidatedGroup
  sp-bs-d-FR-dist:DistributionDimension
  factVariable InsuranceEntities fallbackValue 0
  explicitDimension InsuranceEntities
  sp-bs-d-FR-dist:DistributionDimension

  factVariable otherEntities fallbackValue 0
  explicitDimension otherEntities
  sp-bs-d-FR-dist:DistributionDimension

  factVariable settlementAdjustments fallbackValue 0
  explicitDimension settlementAdjustments
  sp-bs-d-FR-dist:DistributionDimension

  factVariable TotalGroupEntities
  explicitDimension TotalSectorial
  sp-bs-d-FR-dist:DistributionDimension
```
Example of assertion presented graphically
One particular problem arises when the instance document uses implicit filters and a fact is null.

The XBRL processor or DBMS must validate:

1. \( FA1 = FB1 + FC1 \)
2. \( FA2 = FB2 + FC2 \)

Since \( FA2 \) is null according to the assertion \( FA2 = FB2 + FC2 \) is not validated.
Another potentially problematic case is when the instance document uses implicit filters and a variable has two facts, since it contains an additional dimension (i.e., explicit filter) compared to the other variables.

If \( C_1 \cup E_2 \cup T_1 \) is \( FA_2 \) and \( FA_2' \), then it is necessary to decide amongst:

1. \( FA_2 = FB_2 + FC_2 \) \( y \ FA_2' = FB_2 + FC_2 \)
2. \( FA_2 = FB_2 + FC_2 \) \( o \ FA_2' = FB_2 + FC_2 \)
3. None
Proof of Concept I

Obtaining the validation API
Proof of Concept II

Validation process
Assertion process of validation-process-generating algorithm
Proof of Concept IV

Start
    begin
        if there are preconditions
            then if there are variables
                then if explicit filter has basic concepts and not dimensions
                    then template SQL V
                    else if explicit filter does not have basic concepts and has dimensions
                        then template SQL VI
                        else template SQL VII
                else template SQL IV
            else if explicit filter has basic concepts and not dimensions
                then template SQL I
                else if explicit filter does not have basic concepts
                    then template SQL II
                    else template SQL III
        end
    End

Creation of SQL templates
Diagram with the context in the star model.
Conclusions

- The development of the entire metadata model's life cycle using a robust architecture technology as the MDA, non-existent to date.

- The establishment of a data model design life cycle ensures fewer errors in the design, since it has been proven in concept testing and validation, and gives the possibility of making a set of test cases for analysing anomalies and other semantic questions.

- This paper has validated the interoperability of this technology by studying its design. Moreover, it shows how this model can be implemented in different databases of different vendors and even enables mapping to other platforms.
Future works

- Comparing the complexity of both types of algorithms, based on a star model with or without context, as well as the performance of both.

- Checking the performance of formula validation through stored procedures and comparing it with the performance using XML validation.

- Expand the use of this specification to other environments that are not Supervision and Regulation.

- Incorporate into this research the Data Point Model (DPM), and its implementation in XBRL.

- Through this development life cycle, facilitate the creation of public test games.

- Not only generate templates for SQL stored procedures, but also in other languages such as COBOL, .NET, Java, etc.
Questions
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