Application Research of Dimensional Engineering in XBRL Taxonomy

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Abstract.

XBRL is the latest technology used in processing accounting information. As a special case of software engineering, XBRL dimensional engineering is a relatively new solution for XBRL modeling. The lack of a common modeling direction is a major drawback. This paper sets out the applications status of dimension technology and the principle of dimensional engineering. With analysis of typical applications in China domestic taxonomy, some practical approaches of dimension modeling are proposed for the taxonomy creators to improve the accuracy and efficiency.

Keywords: XBRL, taxonomy, dimensional engineering, dimension specification

Introduction

XBRL (eXtensible Business Reporting Language) is a language for the electronic communication of business and financial data which is a revolutionary technology on business reporting around the world. It provides major benefits in the preparation, analysis and communication of business information. It offers cost savings, greater efficiency and improved accuracy to all those involved in supplying or using financial data. Up to now, dozens of government departments and organizations promulgated their XBRL projects.

Multidimensionality in XBRL is a relatively new solution for taxonomy modeling in environments when disclosure of information is in cubes. These cubes have two or more vectors to analyze and break down the information into subsets of interest to the end-users. It supports end-users querying and displaying information according to defined breakdowns. This may be for some combination by regions, by products, by clients, etc. However, the processes of multidimensional modeling in taxonomies are different from one another. The application of dimension urgently needs engineering methods and strong direction.

This paper begins with the statistics of some projects, which shows that the application of dimension is popular. In the description of the XBRL dimensional engineering, there are some complex constructs including dimension defaults and

empty hypercubes and dimensions, etc. Typical practical applications in the CAS (China Accounting Standards) taxonomy released by the Chinese Ministry of Finance are analyzed extensively to provide some proposals for the taxonomy creators.

Application Status of Dimension Technology

Before the XBRL dimension technology, tuples are commonly used to express tables with known headings with an unknown number of rows. Because of the lack of ability of expression on multidimensional information and flexibility on taxonomy extension, the tuple technology is replaced by the dimension technology.

Because of released earlier some taxonomies only use tuples. Tuple is a good choice before the XBRL Dimensions Specification 1.0 [1] promulgated. Because there is no need to use more sophisticated dimensional structures, some taxonomies, which are smaller, contains fewer elements and less than five documents, released in recent years only use tuples.

In the special case, tuples and dimensions exist at the same time. Both of them are selected to use in different places. The tuples are used to express two-dimensional information, i. e. address containing country, city, postcode, etc. The dimensions are used to express more sophisticated information, i. e. balance sheet.

In theory, most of the financial tables can be described using ether tuples or dimensions. However, dimensions can describe multidimensional information whereas tuples can only describe two-dimensional information. Besides, most of the dimensional structures can be reused whereas tuples must be redefined every time in the taxonomy extension. In a word, dimensions can totally replace tuples in technical aspect. The taxonomies only use tuples without dimensions are out of date.

XBRL Dimensional Engineering

XBRL technology architecture consists of three parts: technical specifications, taxonomies and instance documents. Any taxonomy is based on XBRL technical specifications which defined the working mechanism and syntax rules. The developer of taxonomies and instance documents must compliance with these specifications. With the practical application of XBRL to business reporting projects around the word, it quickly became apparent that the existing XBRL 2.1 specification did not completely support the need for exchanging multidimensional information. The requirements caused incorporation of dimensions into XBRL specifications and heavily influenced the approaches and solutions applied in XBRL Dimensions Specification 1.0, which is promulgated as a recommendation on September 18, 2006. This specification defines syntax and logic of the underlying technology to support dimensions. There are a lot of syntax rules in the XBRL Dimensions Specification 1.0. There is a hierarchical structure

of dimension technology, containing most basic and important items and relationships among them.

A primary item is an abstract element, which may have several members. The primary item can be connected with hypercubes, which may have several breakdowns, named dimensions. A dimension only has one domain, which may have several domain members [2].

For example, a profit statement divided by different regions can be defined by this hierarchical structure [3]. “Profit statement” element can be defined as a primary item, with the member “profit” element. The hypercube should have a “Region” dimension, which contains an “AllRegion” domain. The domain may have several domain members, i. e. “Beijing”, “Shanghai”, “Tianjin”, etc.

The XBRL Dimensions Specification 1.0 suggests the modularization structure of the dimensional engineering separated into three parts, showed in Fig. 1.

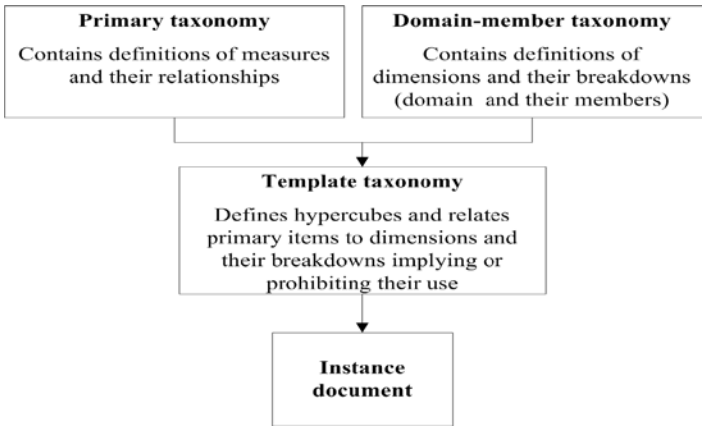

Fig. 1. The modularization structure of dimensional taxonomy

Taxonomies developed under the XBRL 2.1 specification consist only of primary items and make use of no dimensional elements or relationships. These taxonomies are assumes as the primary taxonomies. Domain-member taxonomies define dimension items and their domains (members and their hierarchical structures). They may also indicate default members for each of the dimensions. Best practice suggests that the definition of each dimension is in a separate taxonomy (XBRL Schema file with corresponding linkbases). This separate taxonomy can be applied for primary items where and when required.

This modular structure guarantees a flexible maintenance of an extensible model that can be reused in other places. Furthermore, the modular structure eases the national adaptation of an international taxonomy. Elements with the same meaning were identified by business experts and extracted in separate primary taxonomies for each template group. It is needed to know the elements with the same meaning used in different templates. The maintenance of these elements can be reduced and the relations between templates can be identified easily.

There are four difficulties in the XBRL dimensional engineering, including positive and negative hypercubes, dimension defaults, empty hypercubes and empty dimensions.

Some taxonomy creators may have a policy about hypercube restriction that whenever possible the users should use positive hypercubes. For example, there are a range of facts are reported across 4 different domain members (A, B, C and D). However, facts 1 and 2 are only relevant to domain members A and B, fact 5 are only relevant to domain members C and D, and fact 3 and 4 are relevant to all 4 domain members (these are represented by the grey cells).

Fig. 2 shows all 5 facts in one single grid, therefore requiring 2 negative hypercubes to negate domain members C and D for facts 1 and 2, and domain members A and B for fact 5. Fig. 3 shows the facts in 3 distinct grids implemented by 3 separate positive hypercubes.

	Domain member A	Domain member B	Domain member C	Domain member D
Fact 1				
Fact 2				
Fact 3				
Fact 4				
Fact 5				

Fig. 2. Using 1 single grid with 2 negative hypercubes

The implementation described in Fig. 3 has been deemed more appropriate and will be used whenever possible. The exception to this rule is when it is fundamental for making business sense of the data that all facts are combined in one single grid as shown in Fig. 2.

	Domain member A	Domain member B
Fact 1		
Fact 2		

	Domain member A	Domain member B	Domain member C	Domain member D
Fact 3				
Fact 4				

	Domain member C	Domain member D
Fact 5		

Fig. 3. Using the positive hypercube approach

Dimensions can be assigned default values from the set of their domain members. Usually, the dimension default is used when a breakdown has a logical top-level element being simultaneously an aggregator of all enumerations of a breakdown (a total of all domain members). According to the XBRL Dimensions Specification 1.0, each dimension can have only one default member which is set globally. For some dimensions an element of a default value is not applicable. It happens in particular when a dimension breakdown consists of alternatives such as solo/consolidated, audited/unaudited.

The use of empty hypercubes and empty dimensions can improve XBRL validation of instance documents against dimensional taxonomies [4]. These constructs apply especially in closed reporting by disallowing redundant data. The typically closed reporting is in a variety of regulatory environments, where the regulators wish to receive data with a high degree of reliability and may not need a great deal of extensibility from the organizations submitting fillings.

One of the problems that taxonomy creators must deal with when constructing extension or modularized taxonomies are elements that are in the schema files but that do not participate in relationship linkbases. In some reporting environments, this may allow reported facts in instance documents that the developer does not desire to see reported. Under that condition, the empty dimensions can be used to prevent these redundant elements from being reported.

When developing taxonomies where some items come with dimensional information and some do not, there is a strong need to indicate those elements that should build from a base context. The empty hypercubes can be used to keep the primary items from any dimensional information.

The Suggestions for Improvement of the CAS Taxonomy

On October 19, 2010, the Chinese Ministry of Finance released the CAS General Purpose taxonomy [5]. The CAS taxonomy uses a single schema to define of all reporting elements and does not use tuples, but items and dimensions are used instead. There are a total of 2,845 elements in the CAS taxonomy.

Dimensions in the CAS taxonomies relates to treating business concepts such as Changes of inventories, Construction materials, Capital surplus items, etc. as primary items and the breakdowns in which they may be reported as dimensions. The CAS taxonomy uses three kinds of element type defined by XBRL Specifications - item, hypercube and dimension. There are a total of 2,633 items, 108 hypercubes and 104 dimensions in the CAS taxonomy.

Although the CAS taxonomy follows the Dimensions Specification 1.0, it does not use modularization structure shown in Fig. 1. The CAS taxonomy, as the IFRS (International Financial Reporting Standards) taxonomy extension, has the architecture similar to the IFRS taxonomy. In the CAS taxonomy architecture, all the elements are defined in one schema and all the linkbases are organized and viewed by China Generally Accepted Accounting Principles.

There are two important attributes used in the arc between a primary item and a hypercube. One is the context Element attribute, which indicates whether the dimensions are reported in the scenario or in the segment element of the context of an XBRL instance document. In the CAS taxonomy, the value of this attribute is always “scenario”. The other is closed attribute. It indicates whether the assigned hypercube is closed, which means it is not allowed to add further dimensions in an instance document. Since this ought to be not allowed by the CAS taxonomy and since the default value of the closed attribute is “false”, this attribute is explicitly set to “true”.

Due to its detailed business structure divided by roles, the CAS taxonomy does not use negative hypercubes. The number of dimensions attached to one hypercube is one or two in the CAS taxonomy, so the use of positive hypercubes can meet the needs of applications.

The CAS taxonomy makes extensive use of the dimension default. All dimensions contain such a default value which is usually the total of all the dimension domain members. Since the Dimension Specification states that dimension default members must not be used in the context, but are inferred when not present, this gives the capability of reporting total values for primary items which have dimensions, along with values of elements that do not have dimensions.

The CAS taxonomies does not use advanced dimensional constructs such as empty hypercubes and empty dimensions. These can be improved in the next version of the CAS taxonomy.

The CAS taxonomy contains a schema which imports all the elements of the IFRS taxonomy and adds all the required additional primary items. However, it imports none linkbase from the IFRS taxonomy. All presentation, definition, and calculation relationships have been recreated. So there are a number of elements imported from the IFRS taxonomy which are not included in either the presentation, definition or calculation linkbases. It is true that these unused elements could be reported in an instance document without the validation raising any error.

This case should be considered by the taxonomy creators in the next version with an improved approach. One mechanism to avoid these elements from being reported is to assign a hypercube which is always invalid – a hypercube with an

empty dimension. It is also can be done at the application level, e.g. if any company extension wishes to use validation to prevent these elements from being reported, it should attach these elements to a hypercube with an empty dimension in the definition linkbase.

The second advanced dimensional construct not used in the CAS taxonomy is a hypercube without none dimension – an empty hypercube. The empty hypercube can be assigned to the primary items which ought to be reported without dimensions. The empty hypercube can be considered using in the next version of the CAS taxonomy. The mechanism is that in a definition linkbase with dimensionless primary items, an abstract placeholder is on top of the domain member network of those dimensionless elements and an empty hypercube should be assigned to the placeholder.

Conclusions

As a new solution for XBRL modeling, XBRL dimension engineering is only in the preliminary stage. Although the Dimension Specification 1.0 is a comprehensive standard and most government departments and organizations used dimension technology, the processes of dimension engineering are different from one another. The application of dimension technology urgently needs project management and strong direction. The development of these dimensional taxonomies, just as in any other large scale software development process, requires careful planning, constant discipline, and sound management to ensure a quality product.

The CAS taxonomy is analyzed as a typical application. Many dimensional applications can be found as use cases in the CAS taxonomy. However, some advanced dimensional constructs are not involved. This paper provides some approaches to practical application of dimension technology for the CAS taxonomy creators.

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