A Critical Assessment of ISO 13584 Adoption by B2B Data Exchange Specifications

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Abstract. Recently, the ISO 13584 standard for parts libraries (PLIB) has been widely discussed as a reference model for developing product ontologies, such as product classification systems and standardized property lists. For instance, major industry consortia have announced their intention to incorporate this standard into their product dictionaries and related data exchange specifications. Implementing these PLIB-compliant dictionaries is often regarded as an important step for overcoming heterogeneity in product descriptions and enabling automated cross-industry communication centered on product information. While many industries are aware of PLIB's potential contribution to semantic interoperability (and some have already started providing PLIB-compliant content), the actual degree of support by B2B data exchange specifications may be a limiting factor to wider diffusion. In this paper, we (1) analyze the current degree of ISO 13584 adoption in such specifications, (2) determine how this adoption has changed over time, and (3) identify existing gaps between ISO 13584 and XML-based specifications.

Keywords. Product Data Management, PLIB, ISO 13584, Ontologies, XML, Standards

1. Introduction

Many important business processes, such as procurement, distribution, engineering, and fulfillment, refer to or process information about products (and services). In order to increase market transparency, and to enable product comparison and automated process execution between multiple, often independent business entities in open and increasingly flexible business environments requires a consensual representation for categorizing and describing products [1] [2]. Both functions, the categorization of products by providing a hierarchy of product categories as well as the description of products by defining category-specific product properties, are being addressed by the ISO 13584 standard (PLIB) [3]. Basically, PLIB standardizes a comprehensive data model for product categories and properties. It can be used by business partners as well as industry consortia and standardization bodies for defining respective content; in the latter case, content standards such as product classification systems (e.g., UNSPSC, eCl@ss, and the RosettaNet Technical Dictionary) can be based on ISO 13584 [4] [5].

Bringing ISO 13584 into real-world business applications is only possible if it is widely adopted by decision makers, content creators, solution providers, and related B2B integration technology, such as data converters and data exchange specifications. The latter is especially of importance for most of the current B2B scenarios, which were driven by the emergence of e-procurement and e-marketplaces systems in the late 1990s. This first wave of B2B e-commerce had resulted in a great number of XML-based data exchange specifications and underlying data models for product data and related business transactions. These were either inspired by existing EDIFACT specifications or developed completely from scratch [6]. In recent years, many industries have identified PLIB as an essential tool for reducing heterogeneities in product categorization and description on the conceptual level. However, actual support by B2B data exchange specifications may remain a substantial barrier to wider acceptance and industry-wide diffusion, since PLIB itself lacks an XML-based exchange format.

The contribution of our paper is as follows: We (1) critically assess the current degree of ISO 13584 adoption by B2B data exchange specifications, (2) determine if and how this adoption has changed over the past five years, and (3) analyze existing gaps between the ISO 13584 model and current XML-based specifications. The remainder of our paper is structured as follows: In Section 2, we describe and discuss related work and explain the missing link between ISO 13584 and its adoption in B2B e-commerce. In Section 3, we define a comprehensive set of criteria that allow us to assess ISO 13584 adoption. In Section 4, we apply these criteria to the most relevant B2B data exchange specifications and provide an in-depth analysis of their PLIB adoption. In Section 5, we discuss our findings. Finally, Section 6 draws conclusions from our findings and points to future research and development.

2. Related Work

Related work to product classification and description and its respective standards and technologies can be found in diverse fields such as product data management, interorganizational information systems, and ontology engineering. Next we describe only work that addresses the role of standardization explicitly.

Research on ISO 13584 emphasizes the ontological aspect and its contribution to semantic integration. In this context, all data exchange is assigned to PLIB's own exchange format that is specified in the EXPRESS language of STEP and results in non-XML data files; e.g. [7] [8].

In 2002, Leukel et al. described the process of developing an XML-based exchange format being capable of transferring the classification schemes eCl@ss, ETIM, proficl@ss and UNSPSC/EGAS without loss of information [9]. However, this early work did not consider ISO 13584 at all.

A CEN workshop on e-cataloguing has resulted in a broad survey of data exchange formats for e-catalogs [10]. The respective project report contains a comparative analysis of 14 formats (11 being XML-based), though the product classification and description part is very shallow with only checking whether it is possible to define this content (but not how to do it). The workshop concludes that ISO 13584 adoption is insufficient and further standardization work should be undertaken.

More recently, CEN has set up a project on developing the aforementioned specification in order to submit it to ISO TC 184 for approval [11]. The result is called

OntoML, an UML view on the complex PLIB model complemented by an XML schema for data exchange.

Several representations of product classification schemes for the Semantic Web have been proposed. In consequence, respective specifications apply formal languages, such as RDF and OWL [12] [13]. For instance, Hepp has presented a methodology for deriving OWL ontologies from existing schemes and converted eCl@ss into such an ontology [14]. Again, ISO 13584 is not considered here, since all this work takes existing, non PLIB-compliant content as the starting point and aims at "ontologizing" it.

The brief discussion of related work points to the fact that either (1) PLIB itself is widely neglected (i.e., [9] [14]) or (2) the data exchange issues are limited to the PLIB world, thus the prevailing commercial B2B specifications are neither considered nor integrated (i.e., [8] [11]). Therefore, the need for a closer investigation of the complementary relations between PLIB as the conceptual data model on one side and exchange specifications on the other side becomes clearly evident.

3. Criteria for Assessing ISO 13584 Adoption

In this section, we define a comprehensive set of criteria that allow us to assess ISO 13584 adoption. In our context, adoption is an abstract term describing any kind of guidance, support, and implementation, may it be either complete or not. PLIB adoption can be assessed primarily by comparing its schema with the respective data exchange specifications. This approach also requires identifying whether PLIB's basic concepts for representing categories, properties, and their relationships to each other are followed. In B2B scenarios, dictionary content can be exchanged between organizations developing classifications, buyers, intermediaries, and suppliers; 9 specific exchange relationships are being described in [4]. In addition to transferring dictionaries, we will have to consider the *usage* of dictionary entries in various business transactions, such as manufacture-to-order processes.

3.1. Terminology and Basic Concepts

Since the scope of PLIB has been extended towards e-procurement and e-sales, we replace in the following the original term 'family of parts' by the more abstract 'product category' or 'category'. Note that both in literature and practice, many other terms are frequently used (e.g., class, group, and concept). Therefore, we incorporate terminological aspects into our analysis in order to unfold the existing diversity with regard to the most essential terms.

PLIB implements a number of basic concepts that help building consistent dictionaries containing unambiguous definitions of reusable dictionary entries. Here, we briefly describe only those concepts (1) that have to be adopted by data exchange specifications and (2) that can not be assessed by analyzing the models for categories and properties isolated:

<u>Separation of property definition and property application:</u> This concept requires two steps. First, each property has to be defined as far as possible independently from the categorization; that means independently from its application in a specific context. However, often the definition on the top level is not feasible because properties can be interpreted differently in the context of different categories (e.g., the measurement of height might differ between a table and a valve) [8]. This information is called

definition scope. Second, these well-defined properties can be used in multiple property lists; hence they are mapped to more detailed categories [11, p.37].

Property inheritance: Considering that properties are assigned to categories forming a classification hierarchy, property inheritance says that properties are inherited to all lower categories [11, p.38]. Moreover, an inherited property can be modified on subsequent lower levels. For data exchange, this concept can be implemented by allowing properties being mapped to intermediate categories (nodes) of the classification tree. It has to be emphasized that this procedure is only feasible if the classification tree is truly based on is-a-relationships; currently, these relationships can rarely be found in most existing product classification schemes [14].

Domain restriction by values: Properties have at least a data type assigned, such as string, integer or float. However, very often product characteristics need to be expressed by selecting a value from a list of allowed, predefined values (enumerative type). In PLIB, this concept is being represented by a tertiary relation between category, property and value [11, p.39]. Domain restrictions by value lists have to be mentioned here, since single values are not dictionary entries, though they can be defined by a value code (as identifier), the value itself, and a reference to a document defining the value and its meaning.

3.2. Definition of Dictionary Entries

The definition of dictionary entries is the main subject of PLIB: it provides a data model (or schema). Data exchange specifications are nothing but schemas for the same subject, though they specify how to serialize the dictionary content by using an XML schema language such as XSDL or XML DTD. Comparing these schemes requires raising XML schemes to the conceptual level; thus we need to identify if dictionary entries can be fully represented respectively transferred by these specifications. Therefore, we abstract from the actual serialization and XML document structure; instead we look at the attributes describing the two main types of dictionary entries.

The list of attributes describing categories and properties can be extracted directly from the PLIB model; these are contained in ISO 13584-42 in sections 8.2 and 7.2 [15] [16]. However, it is not sufficient to look for the existence of these attributes or its equivalents only, since PLIB follows a strict, sophisticated data typing, similar to precisely defined data exchange specifications formally described in XSDL. Therefore, we check for each attribute the data type and possible domain restrictions.

3.3. Usage of Dictionary Entries

Once dictionary entries have been defined, they can be used in actual business transactions. Due to global unique identifiers (GUID) for all entries, the usage requires only referencing these entries. In the Semantic Web world, this procedure is called annotating content. For instance, actual products in catalogs can be mapped to a category and described by category-specific properties. The latter adds a value by adhering to the defined domain or picking a value from the list of allowed ones.

Here, PLIB adoption can be assessed by looking for message types that allow references to dictionary entries. The range of message types and respective business processes is not limited to exchanging master data, such as catalogs. The reason is that a product's category and its property values determine many business processes. This information adds value to supply chain management and automated business process execution; hence it should be included in respective inter-organizational information systems and message specifications [17].

4. Analysis of B2B Data Exchange Specifications

In this section, we apply our assessment criteria to the most relevant B2B data exchange specifications and provide an in-depth analysis of their PLIB adoption. The first step of our analysis is the selection of relevant specifications. We take the CEN study on e-catalog data exchange as a starting point (for details on each specification see [10]). Of the 11 XML-based specifications described there, we chose all but two (which have become obsolete in the meantime). Conducting the analysis incorporates (1) accessing the most recent versions from the respective websites, (2) studying both documentations and XML schemes, (3) documenting the findings in detailed mapping tables, and (4) summarizing the results as presented in the following four tables.

The first table lists the various terms used for naming the two essential objects, categories and properties. In addition, it shows which of the three basic concepts are actually adopted by the respective specification (yes/no).

Table 1. Terminology and basic concepts.

ISO 13584	BMEcat 1.2	BMEcat 2005	CIDX 4.0	cXML 1.2.014	eCX 3.6	GS1 BMS 2.0	OAGIS 9.0	Rosetta Net	xCBL 4.0
Date of publication	Mar. 2001	Nov. 2005	2004	Oct. 2005	Nov. 2003	Nov. 2004	Apr. 2005	Dec. 2003	Jun. 2003
Terminology: Family of parts	Classi-fication group	Classi-fication group	Product classifi-cation	Classi-fication	Catego-ry	Classi-fication catego-ry	Classi-fication, Comm-odity	Classi-fica-tions	Catego-ry
Terminology: Properties of parts	Feature	Feature	Product specifi-cation	Type-Attribu-te	Attribu-te	-	Proper-ty, Specifi-cation	Charac-teristics, Attribu-te	Attribu-te
Separation of property definition and application	No	Yes	No	No	Yes	No	Yes	No	Yes
Property inheritance	Not ex-plicitly	Yes	No	Yes	No	No	Not ex-plicitly	No	Yes
Domain restrictions by values	Yes	Yes	No	Yes	No	No	No	No	Yes

The next two tables show which of the 15 respectively 21 attributes that describe categories respectively properties are actually supported by each specification. PLIB's mandatory attributes are marked with 'M', its optional attributes with 'O'.

Table 2. Attributes that describe categories.

ISO 13584		BMEcat 1.2	BMEcat 2005	CIDX 4.0	cXML 1.2.014	eCX 3.6	GS1 BMS 2.0	OAGIS 9.0	Rosetta Net	xCBL 4.0
Code	M	Yes	Yes	No	No	Yes	No	Yes	No	Yes
Superclass	O	Yes	Yes	No	No	Yes	No	Yes	No	Yes
Preferred name	M	Yes	Yes	No	No	Yes	No	Yes	No	Yes
Short name	O	No	Yes	No	No	No	No	No	No	No
Synonymous name	O	Yes	Yes	No	No	No	No	No	No	No
Definition	M	Yes	Yes	No	No	No	No	No	No	Yes
Source document of def.	O	No	Yes	No	No	No	No	No	No	Yes
Note	O	No	Yes	No	No	No	No	Yes	No	Yes
Remark	O	No	Yes	No	No	Yes	No	No	No	No
Simplified drawing	O	No	Yes	No	No	No	No	No	No	No
Date of original def.	M	No	Yes	No	No	No	No	No	No	No
Date of current version	M	No	Yes	No	No	No	No	No	No	No
Date of current revision	M	No	Yes	No	No	No	No	No	No	No
Version number	M	No	Yes	No	No	No	No	No	No	No
Revision number	M	No	Yes	No	No	No	No	No	No	No

Table 3. Attributes that describe properties.

ISO 13584		BMEcat 1.2	BMEcat 2005	CIDX 4.0	cXML 1.2.014	eCX 3.6	GS1 BMS 2.0	OAGIS 9.0	Rosetta Net	xCBL 4.0
Code	M	Yes	Yes	No	No	Yes	No	Yes	No	Yes
Data type	M	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Preferred name	M	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Short name	O	No	Yes	No	Yes	No	No	No	No	No
Preferred letter symbol	O	No	Yes	No	No	No	No	No	No	No
Synonymous letter symb.	O	No	No	No	No	No	No	No	No	No
Synonymous name	O	No	Yes	No	No	No	No	No	No	No
Property type classific.	O	No	Yes	No	No	No	No	No	No	No
Definition	M	No	Yes	No	Yes	No	No	No	No	No
Source document of def.	O	No	Yes	No	No	No	No	No	No	No
Note	O	No	Yes	No	No	No	No	Yes	No	No
Remark	O	No	Yes	No	No	Yes	No	No	No	No
Unit	M	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Condition	O	No	Yes	No	No	No	No	No	No	No
Formula	O	No	No	No	No	No	No	No	No	No
Value format	M	No	Yes	No	Yes	No	No	No	No	No
Date of original def.	M	No	Yes	No	No	No	No	No	No	No
Date of current version	M	No	Yes	No	No	No	No	Yes	No	No
Date of current revision	M	No	Yes	No	No	No	No	No	No	No
Version number	M	No	Yes	No	No	No	No	No	No	No
Revision number	M	No	Yes	No	No	No	No	No	No	No

In the final table, we present the results for the usage of dictionary entries. These are (1) the way how to reference a category or property and (2) the list of message types allowing such references, if any. For our analysis, we chose the catalog message plus five message types representing the most relevant interactions between business partners in pre-order and order management processes.

Table 4. Usage of dictionary entries.

	BMEcat 1.2	BMEcat 2005	CIDX 4.0	cXML 1.2.014	eCX 3.6	GS1 BMS 2.0	OAGIS 9.0	Rosetta Net	xCBL 4.0
Reference of Categories	Yes	Yes	By name	Yes	Inter-nal only	Yes	Yes	UN-SPSC+ RNTD	Yes
Reference of Properties	By name	Yes	By name	No	No	No	By name	No	Yes
Message types (C=category reference; P=Property reference; '-'=no such message type)									
Catalog	C+P	C+P	C+P	C	No	C	C+P	No	C+P
Request for quotation	No	No	C	-	-	-	C+P	No	No
Quotation	No	No	-	-	-	-	C+P	No	No
Order	No	No	C	No	-	No	C+P	No	P
Order change	No	No	C	-	-	-	C+P	-	P
Order response	No	No	C	-	-	No	C+P	No	P

5. Discussion

In this section, we discuss our findings and relate them to the goal of our analysis. The first question concerns the current degree of ISO 13584 adoption. Obviously, none of the message specifications is fully compliant with PLIB. Reviewing the detailed data models and attributes for categories, we can make the following statements:

- 4 out of 9 specifications do not at all support the definition of categories.
- 4 specifications provide a rudimentary data model for categories, with only basic attributes, such as code, superclass and preferred name. Only BMEcat and xCBL contain PLIB's mandatory attribute for a human-language category definition.
- Only BMEcat 2005 covers all requirements expressed by the set of PLIB attributes.

Regarding properties, there is a similar situation as with categories:

- 3 out of 9 specifications do not contain a respective data model.
- 5 specifications have a sparse data model covering only basic information, such as code, name, and data type. The specifications differ in coverage with regard to the other attributes, though none shows a significant higher degree of coverage. cXML ignores the code attribute.
- Again, BMEcat 2005 has the most detailed data model, very similar to PLIB. However, it is not complete (two attributes are missing) and does not follow all of PLIB's attribute domains (i.e., definition of value formats and data types).

The second result of our analysis addresses the question whether PLIB adoption has changed over time. This question was based on the assumption that recent developments in product classification pointed out that PLIB could become a widely-accepted standard for the definition of product ontologies [8]. Interestingly, the empirical results show that almost all relevant specifications have not yet adopted PLIB in their most recent releases. For instance, both CDIX and OAGIS have been subject of major revisions over the past three years, though the data models for categories and properties were only slightly improved. Other specifications, such as eCX, RosettaNet and xCBL, are nearly static. Therefore, we did not include multiple versions of the same specification in the tables of Section 4. The only exception is BMEcat 2005, which has not only been substantially extended regarding its data models in comparison to the preceding version BMEcat 1.2; still, it is the only specification that explicitly mentions ISO 13584 in its documentation. BMEcat 2005 claims that it 'is oriented to a large extent at ISO 13584'. While this is a first step into the right direction, we have to stress that 'orientation' is a weak form of adoption. For instance, BMEcat 2005 follows a proprietary approach for naming attributes and defining data types and value formats respectively.

The third question addresses existing gaps in PLIB adoption towards the support of business processes and related transactions. At first sight, we observed that the way of referencing dictionary entries differs with from PLIB's fundamental concept of GUID. CIDX references categories by their name only and thus fails to support multi-lingual content delivery and respective applications. Two more specifications are confined to a specific dictionary (e.g., UNSPSC). For properties, the situation is even worse, with only BMEcat 2005 and xCBL 4.0 allowing references by identifiers.

The closer look at message types unveils that using dictionary entries is hardly possible. Only the catalog transaction, thus the transfer of master product data, shows a high coverage with 7 out of 9 specifications supporting category references. Speaking of the more frequent business process transactions, only three specifications support any form of usage: (1) CIDX allows category references in 4 out of 5 message types, (2) OAGIS allows both references in all 5 message types, and (3) xCBL allows property references for order management, but not for pre-order management. Combining these observations with the previously assessed way how to give such references, both CIDX and OAGIS fall behind due to ignoring the GUID concept, which is necessary for multi-lingual dictionaries. All other specifications fail to provide any form of referencing, if respective message types are available. The overall situation shows a huge gap in PLIB adoption with regard to its applicability in actual electronic business processes.

6. Conclusions

In this paper, we have critically assessed the current degree of ISO 13584 adoption by B2B data exchange specifications. We determined if and how this adoption has changed over the past five years. This allowed us to identify a number of existing gaps between the ISO 13584 model and current XML-based specifications.

Specifically, we (1) have shown that the majority of the analyzed specifications fails to support PLIB and its basic concepts. Even the most comprehensive specification BMEcat 2005 is not fully compatible. However, it should be noted that it explicitly mentions ISO 13584. In other words, PLIB has found its way into at least one current B2B XML format. Another issue that complements our data model analysis and its apparent results is the domain of terminology and basic concepts. In there, we see significant differences, which also prevent a common understanding of the domain and its problems (i.e., various names for properties, e.g., attribute, feature). In addition, (2) nearly all specifications are quite static concerning attributes describing categories and properties (with BMEcat 2005 being the only exception). Finally, (3) we identified a huge gap in PLIB adoption with regard to inter-organizational business processes in pre-order and order management. Thus, besides our detailed data model analysis regarding the definition of dictionary entries, a major obstacle to a wider proliferation of PLIB-compliant dictionaries is formed by missing and/or insufficient specifications regarding the *usage* of dictionary entries.

While the current degree of ISO 13584 adoption is low, other developments exist that either aim at brining PLIB to the real-world or could help improving XML-based specifications. A major effort is undertaken by many consortia in defining PLIB-compliant dictionaries, thus creating dictionary entries. These projects follow a ‘push logic’, thus if PLIB content is emerging, the need for compliant message specifications will increase. Moreover, recently two standardization bodies have started working on new exchange specifications for catalogs: However, both the Universal Business Language 2.0 [18] and the CEN/ISSS EEG1 Project Team cCatalogue [19] avoided the subject of specifying models for the definition of PLIB dictionaries; though they do implement the GUID concept, thus allow giving ID-based references to entries.

Our findings and conclusions stress the importance of being able to use PLIB dictionary entries in critical, value-adding business processes. In that sense, we regard future developments in ISO TC184/SC4 on standardizing an XML-based exchange format for dictionaries as a meaningful step; this will, however, not address the issue of using PLIB-compliant content in transactional business processes.

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