Integration of Standardized and Non-Standardized Product Data

Wolfgang Maass[1], Matthias Lampe[2]

[1]Digital Media
Hochschule Furtwangen University
Robert-Gerwig-Platz 1
78120 Furtwangen
wolfgang.maass@hs-furtwangen.de

[2]Institute for Pervasive Computing
ETH Zurich
CH-8092 Zurich, Switzerland
lampe@inf.ethz.ch

Abstract: Smart products adapt to environments, process contexts, users and other products. Standardized product data such as BMECat, eCl@ss, and EPC global formats are designed to support the *exploitation* of product data and therefore contribute to more efficient supply chains. Non-standardized product data mainly target soft benefits which targets the *exploration* of product data [Su04]. We present an extended product data model (SPDO) that integrates standardized and non-standardized product data. The SPDO model consists of five product information types that receive product data and, if available, associated explicit semantics. Explicit semantics are used for advanced services, such as compatibility testing or product bundling. Exemplified by the GS1 approach, we present how standardized product data is retrieved via RFID-based Electronic Product Codes (EPC) and stored in SPDO instantiations.

1 Introduction

Product data in supply processes is designed for supporting transportation of products through value chains with clearly defined benefits, such as cost reduction, process consistency and process efficiency [Su04]. But beside *exploitation* of product data, supply processes can also support *exploration* with "[s]oft benefits that are difficult to evaluate in advance", such as analysis of point-of-sale data to understand patterns in customer preferences [Su04] or direct communication between products and customers [FD03]. Benefits derived from exploitation require standardized product data which results in the idea of "real-time business" [AO04]. For instance, real-time tracking of tangible products and processing of standardized product data is supported by cheap wireless object identification technologies, such as RFID [Fi06]. Benefits derived from exploration require flexible and semantically rich product descriptions that can be used along the whole supply chain, for instance, for natural language communication in support situations, contract negotiation in non-standardized environments and adaptation to domains and contexts [FD03, MJ07]. In summary, product data serve supply processes that are based on standardized as well as non-standardized semantics. Products that efficiently support exploitation needs and also leverage product data for exploration purposes are called *smart products* [MF06]. Smart products interact with other products and users and adapt to situations. In this article, we present a tentative version of an integrated product data model for both data types. As an example for standardized product data, we discuss how the EPC network model is used as a data feed for real-time tracking data.

2 Product Data

Product master data as used in eCl@ss, BMECat, ebXML focus on data that is used by standardized supply chain applications to gain exploitation benefits [Su04]. The semantics of product data standards for supply chain applications are generally implicit to data representations, i.e., organisations that use standards in their applications are required to comply with the semantics at design time. Therefore additional product data has to be negotiated between partners that share this data which results in high data integration costs [OFA00]. This problem is increased by data that is gathered by sensor technologies attached to tangible products and by object identification (OI) technologies, such as RFID [Fi06]. The Auto-ID centers and now GS1 (www.gs1.org) aim at the development of standards for real-time identification of product instances (EPCglobal) and of standards for associated services. It is assumed that in particular the Global Data Synchronization Network, GSDN, will reduce inefficiencies in sharing standardized product data that hinder electronic supply chains, electronic markets and e-collaboration [NCZ06, Lo05].

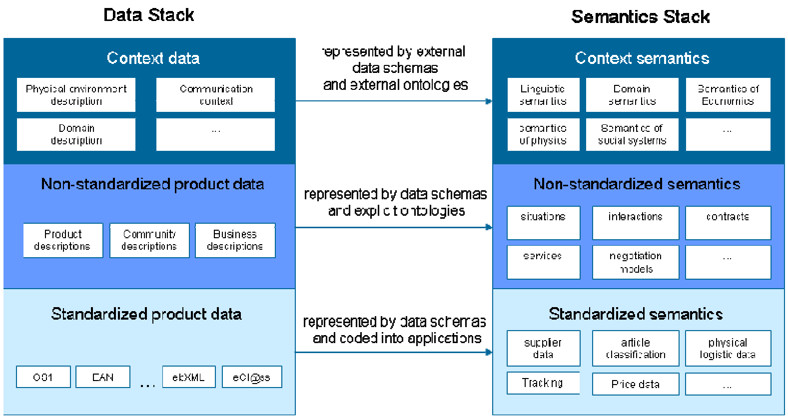

Figure 1: product data and semantics stack

But these standards are not sufficient for application environments that intend to leverage product data along the exploration dimension by value-added services [Su04]. For instance, products can become interactive and adaptive to local contexts by embedding information technologies into tangible products [BHW07, FD03].

The exploitation and exploration views together anticipate a rich information sphere around tangible products that support more efficient supply chain processes but also value-added services, such as customer-oriented communication services and support services. Bringing both views together, the data stack for processing product data can be classified into three categories (cf. Figure 1): (1) standardized product data (SPD) used by services, such as for efficient tracking and transportation of products, (2) non-standardized product data (N-SPD), i.e. proprietary and negotiated data models used by value-added services, such as product bundling services, and (3) context data that provides descriptions of general knowledge, such as on physics and natural language communication. Each category has associated semantics by which product data can be interpreted. For instance, standardized semantics of product data are used if a customer wants to know the type of a photo camera while N-SPD is needed if he wants to know whether video clips captured with this camera can be processed with *Avid Liquid 7*. While SPD generally rests on semantics expressed by data schema and application level, semantics of N-SPD and context data are either negotiated at design time or made explicit at run-time.

2.1 Smart product data model

We propose a data model called *Smart Product Description Object* (SPDO) that integrates both product data categories [MF06]. By analysis of various product types and business models, we have identified five information types (facets) that shall be supported by the SPDO data model [MF06]:

(1) *product description* (PD): functional and structural information about the product itself as given, for instance, by the GS1 Business Message Standard (BMS) format.

(2) *presentation description* (PRD): communication of smart products requires adaptation to communication interfaces, such as graphical displays, sound devices or mobile phones.

(3) *community description* (CD): behavior of a smart product is related to its context consisting of different social actors, such as consumers and sales personnel, user groups, other smart products, and additional contextual factors.

(4) *business description* (BD): description of contractual, pricing and legal information that governs how a smart product can be used.

(5) *trust&security description* (TS): control information that governs the access to other information types

Each facet can be associated with formal ontologies [Gu95] that allow automatic interpretation of N-SPD. SPD, such as defined by GS1, is merged into the product description facet which can then be used as a proxy. In other settings applications can leverage N-SPD for value-added services. For instance, we have implemented a prototype that uses non-standardized business descriptions for automatic derivation of product bundles [MFS07]. Without loss of generality, N-SPD and semantics are represented by formal logic descriptions based on web-based semantic representation languages, i.e. *OWL Lite* [Be04] while SPD is simply based on XML schema. By using *OWL Lite*, N-SPD and attached semantic representations (ontologies) can be transferred via Internet protocols so that this product data can be processed anywhere and anytime.

This approach distinguishes between data that describe the facets and ontologies that explicitly describe the intended meaning of the concepts used in the data [Gu95]. SPDO data is evaluated by a DL reasoner (here Fact++) for logical consistency which means that the model is valid relative to the underlying ontology.

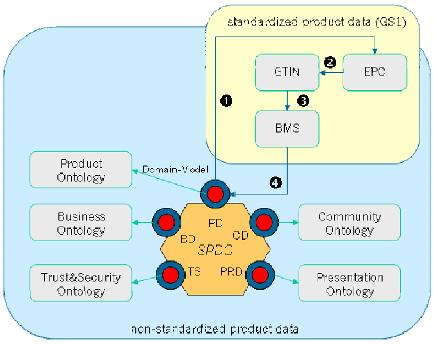

Figure 2: SPDO model – integration of standardized and non-standardized product data

2.2 Integration of EPC product data into the SPDO model

Bridging the gap between the physical and virtual world by means of object identification and sensing technologies is the basis for smart products. Among others, RFID technology represents a suitable means for automatic object identification [Wa99]. For RFID-based infrastructures, the EPC Network is the most prominent specification for RFID-based object environments. EPC Network consists of the following modules: reader, filtering and collecting middleware, and the EPC information service (EPCIS) (www.epcglobalinc.org). The reader module provides low-level management service, such as reading RFID data but also for event recognition, such as entry and exit events, and space aggregation that allows grouping of multiple RFID antennas to a single logical entity [FLR07]. Since in supply chain management, many readers capture RFID data that need to be disseminated to higher layers, there is the need for software systems that manage readers and filter and aggregate captured RFID data. The reader module of the Accada platform [FLR07] implements the EPCglobal Reader Protocol [Ep06]. The Auto-ID object model is based on a symbolic location model, in which physical objects also define locations. The term object stands for the entity in the model that represents physical objects in the real world. *Objects* can have *properties* and *functions*. *Auto-ID readers* that identify objects can also act as *property sources* that set the values of object properties. A reference management mechanism recognises and keeps track of products as they enter and leave a location, e.g. a factory or a warehouse, and how products are related to one another in a certain geo-physical context. This is provided by mechanisms specified by *EPC Network* [Ch04]. In our prototype SPDO initially contains a reference to an EPC (cf. Figure 1, step 1). The EPC is used to extract the Global Trade Item Identification (GTIN) (step 2) which is used retrieve product data in XML Business Message Standards (BMS) format according to the Global Data Dictionary (GDD) (step 3). This, in turn, is stored in the product description facet of the SPDO model (step 4).

4 Related Work

The concept of a smart product enriches tangible products with a behavioral component, i.e. smart products adapt to situations and are communicative. Therefore the concept of a smart product has resemblances with more generic approaches such as *adaptive user interfaces* [Li98], *tangible user interfaces* [IU97], *augmented realities* [FMS93] and *ambient computing* [JFW02]. A more closely related approach is the Mobile ShoppingAssistent (MSA) that focuses on multimodal communications between a single product and individual users [WSK03]. Earlier systems, such as MyGrocer [Ko02] and [Fo00], venture the integration of tangible objects and digital representations. Tip ‘n Tell extends these approaches by using web-based semantic representation technologies with distributed knowledge sources.

5 Conclusion and future work

Smart products leverage standardized and N-SPD for exploitation and exploration purposes. In exploitation scenarios they support efficient exchanges of product data in interorganizational settings [Su04]. Differentiation potential is given by product data that is used for exploration purposes, such as sales communication, self-activated operations in emergency situations, self-replenishment and bundling with third-party products. Those applications require explicit semantic representations that can be used for reasoning at run-time. With SPDO we have presented an extended plug-and-play model that integrates standardized and N-SPD by a set of five product information types. SPD are stored as part of the product description facet. Exemplified by the GS1 approach, we have shown how SPD is retrieved via EPC information and stored in a SPDO instantiation.

In our future work, we develop exploration services for large sets of SPDOs in realistic retail environments. We are working on services for product bundling, pricing and user-product natural language communication [MJ07]. It is an open issue how product data referring to incompatible semantics can be merged and used together. Our final goal is the development of a semantically rich “product language” with well-defined operations on product data that support a wide range of exploration scenarios.

References

[AO04] Alt, R., Österle, H.: Real-time Business: Lösungen, Bausteine und Potenziale des Business Networking. Springer, New York, 2004.

[Be04] Bechhofer, S., van Harmelen, F., Hendler, J., Horrocks, I., McGuinness, D., Patel-Schneider, P., Stein, L.A.: OWL Web Ontology Language Reference. In: Dean, M., Schreiber, G. (eds.), 2004.

[BHW07] Botterweck, G., Hampe, F., Westenberg, S.: Mobile RFID Management – An Application Scenario on the Handling of Industrial Liquid Containers, 20th Bled eConference, Bled, Slovenia, 2007.

[Ch04] Chawathe, S., Krishnamurthyy, V., Ramachandrany, S., Sarma, S.: Managing RFID Data. 30st international conference on very large data bases (VLDB), p. 1189–1195, Toronto, Canada, 2004.

[Ep06] EPCglobal, "Reader Protocol Standard, Version 1.1," Jun 2006.

[FD03] Fleisch, E., Dierkes, M.: Betriebswirtschaftliche Anwendungen des Ubiquitous Computing - Beispiele, Auswirkungen und Visionen. Springer Verlag, 2003.

[Fi06] Finkenzeller, K.: RFID Handbuch. Hanser, 2006.

[FLR07] Floerkemeier, C., Lampe, M., Roduner, C.: Facilitating RFID Development with the Accada Prototyping Platform.: PerWare Workshop 2007 at IEEE International Conference on Pervasive Computing and Communications, New York, 2007.

[FMS93] Feiner, S., MacIntyre, B., Seligmann, D.: Knowledge-based augmented reality. Communications of the ACM 36, 1993; p. 52-62.

[Fo00] Fox, A., Johanson, B., Hanrahan, P., Winograd, T.: Integrating information appliances into an interactive workspace. IEEE Computer Graphics and Applications 20, 2000; p. 54-65.

[Gu95] Guarino, N.: Formal Ontology, Conceptual Analysis and Knowledge Representation. Journal of Human-Computer Studies 43, 1995; p. 625-640.

[IU97] Ishii, H., Ullmer, B.: Tangible Bits: Towards Seamless Interfaces between People, Bits, and Atoms. Computer-Human Interaction, CHI’97, 1997; p. 234-241.

[JFW02] Johanson, B., Fox, A., Winograd, T.: The Interactive Workspaces project: Experiences with ubiquitous computing rooms. Pervasive Computing 1, 2002; p. 67-74.

[Ko02] Kourouthanassis, P., Spinellis, D., Roussos, G., Giaglis, G.M.: Intelligent Cokes and Diapers: MyGROCER Ubiquitous Computing Environment. First International Mobile Business Conference, 2002; p.150-172.

[Li98] Lieberman, H.: Integrating user interface agents with conventional applications. Int. Conf. on Intelligent User Interfaces, San Francisco, CA, 1998; p. 39-46.

[Lo05] Loebbecke, C.: RFID Technology and Applications in the Retail Supply Chain: The Early Metro Group Pilot. 18th Bled eConference, Bled, Slovenia, 2005.

[MF06] Maass, W., Filler, A.: Towards an Infrastructure for Semantically Annotated Physical Products. In: Hochberger, C., Liskowsky, R. (eds.): Informatik 2006, Vol. P-94. Springer, Berlin, 2006; S. 544-549.

[MFS07] Maass, W., Filler, A., Seeburger, J.: Product-centered mobile reasoning support for physical shopping situations (submitted). TaMoCo 2007: Techniques and Applications for Mobile Commerce, University of Paisley, Glasgow, Scotland, UK, 2007.

[MJ07] Maass, W., Janzen, S.: Dynamic Product Interfaces: A Key Element for Ambient Shopping Environments. 20th Bled eConference, Bled, Slovenia, 2007.

[NCZ06] Nakatani, K., Chuang, T., Zhou, D.: Data Synchronization Technology: Standards, Business Values and Implications. Communications of the Association for Information Systems 17, 2006; p. 962-994.

[OFA00] Österle, H., Fleisch, E., Alt, R.: Business Networking: Shaping Enterprise Relationships on the Internet. Springer, Berlin, 2000.

[Su04] Subramani, M.: How do suppliers benefit from information technology use in supply chain relationships? MIS Quarterly 28, 2004; p. 45-73.

[Wa99] Want, R., Fishkin, K.P., Gujar, A., Harrison, B.L.: Bridging physical and virtual worlds with electronic tags. CHI '99: Proceedings of the SIGCHI conference on Human factors in computing systems. ACM Press, New York, NY, USA, 1999; p. 370-377.

[WSK03] Wasinger, R., Stahl, C., Krüger, A.: Robust speech interaction in a mobile environment through the use of multiple and different media input types. 8th European Conference on Speech Communication and Technology, 2003; p. 1049-1052.