Metamodelling of Domain-Specific Standards for Semantic Interoperability

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Abstract. The IEEE defines interoperability as the ability of two or more systems or components to exchange information and to *use* the information that has been exchanged. Semantic interoperability problems arise in various business domains [1]. Exemplary, we take a look at the healthcare domain. Connecting heterogeneous information sources in healthcare usually implies problems of semantic interoperability. A typical problem of semantic interoperability in this domain is that the same terms are often used for different concepts (homonyms) and that the same concepts are denoted by different terms (synonyms). Many standardization efforts aim at solving these problems [2]. Standards play an important role for ensuring a common understanding of transferred data among heterogeneous application systems [3]. To achieve effective communication, not only technical interfaces are required, but also common semantics for exchanged data. This paper focuses on problems of interoperability on the level of the application architecture, viz. Enterprise Application Integration [4]. Various health care standards were analyzed, uniformly structured and put into the context of a metamodel that enables interoperability based on domain-specific standards.

1 Metamodelling

Metamodels are models of models, e.g., a UML metamodel describes a model. An example of a metamodel is the UML metamodel, which is an integral part of a layered architecture that also deals with other abstraction levels, such as the meta-meta level. The classes at the meta-meta level are specified by the Meta Object Facility (MOF) and serve as the basic building blocks for classes at the meta UML level. The semantics of UML are defined by instantiating the MOF classes at the meta-meta level. Metamodels may be applied to concisely specify and reason about the semantics of modelling languages. Figure 1 illustrates our metamodel architecture.

2 Domain-specific standards in healthcare

Cooperation of health care providers is required to enable shared care. Well-known problems for interoperability with respect to correct communication among heterogeneous software systems of dissimilar health care providers emerge.

A classification of domain-independent and domain-dependent standards for achieving interoperability may be found in [5]. In the domain of health care there exist various

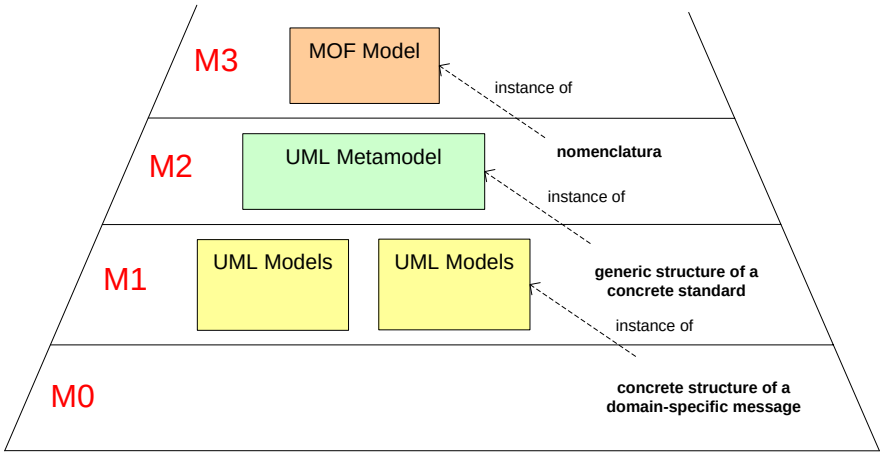

Fig. 1. Metamodel levels

standards for communication and documentation. We integrate these standards into a common metamodel. HL-7 (Health Level Seven), for instance, is a standard, which is used mainly for communication within hospitals [6]. An accepted standard for exchanging digital images is DICOM (Digital Imaging and Communications in Medicine) [7]. Communication among general practitioners in Germany is supported by the BDT (Behandlungsdatenträger) standard [8]. We modelled the relationships among these standards by means of the standardized modeling language UML (Unified Modeling Language). Figure 2 illustrates in its lower box the resulting structure of communication standards in health care as a UML class diagram. The upper box of Figure 2 contains the corresponding metamodel on the M2 level. We follow the multilevel metamodeling approach of [9].

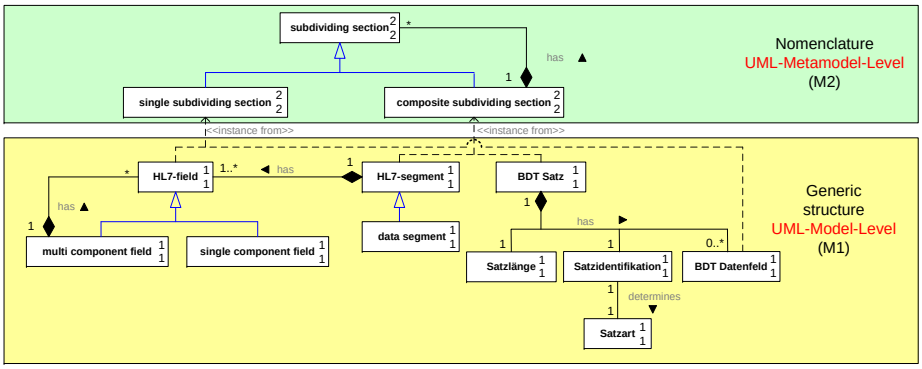

Fig. 2. Top-down structural analysis from the metamodel for communication standards towards the models for HL7 and BDT

3 Summary

Domain-specific standards play an important role for achieving semantic interoperability among federated information systems. In the present paper, we discuss our efforts for uniform structuring of these relevant standards on the metamodel level. The proposed approach is evaluated within the context of an epidemiologic cancer registry system. Our goal is to develop a flexible and scalable software architecture, which enables interoperability among the various institutions in health care. This architecture is based on the presented metamodels for health care standards. Because of our uniform specification of relevant standards for communication and documentation by means of the standardised UML, appropriate metadata for a transformation among heterogeneous models is provided for achieving interoperability among federated information systems of the various institutions in health care.

Top-down integration, based on domain-specific standards, can result in scalable and flexible software architectures for federated information systems [10, 11]. In the domain of health care there exist various standards for communication and documentation, which are integrated into a common metamodel. Various health care standards are analysed, uniformly structured on the metamodel level to enable interoperability based on domain-specific standards.

References

1. Hasselbring, W., Weigand, H.: Languages for electronic business communication: State of the art. Industrial Management & Data Systems **101** (2001) 217 bis 227
2. Pedersen, S., Hasselbring, W.: Interoperabilitt für Informationssysteme im Gesundheitswesen. Informatik Forschung und Entwicklung **18** (2004) 174–188
3. Hasselbring, W.: The role of standards for interoperating information systems. In Jakobs, K., ed.: Information Technology Standards and Standardization: A Global Perspective. Idea Group Publishing, Hershey, PA (2000) 116–130
4. Hasselbring, W.: Information system integration. Communications of the ACM **43** (2000) 32–36
5. Chari, K., Seshadri, S.: Desmystifying integration. Communications of the ACM **47** (2004) 58–63
6. Dolin, R.H., et al.: The HL7 clinical document architecture. AMIA The Practice of Informatics (2004)
7. Bidgood, W.D., et al.: Understanding and using DICOM, the data interchange standard for biomedical imaging. AMIA Medical Imaging Informatics (2002)
8. KBV: xDT - Synonym für elektronischen Datenaustausch in der Arztpraxis. http://www.kbv.de/it/xdtinfo.htm (2005)
9. Atkinson, C., Kühne, T.: The essence of multilevel metamodeling. In Gogolla, M., Kobryn, C., eds.: Proc. UML 2001. Volume 2185 of Lecture Notes in Computer Science., Springer-Verlag (2003) 19–33
10. Hasselbring, W.: Web data integration for e-commerce applications. IEEE Multimedia **9** (2002) 16–25
11. Hasselbring, W., van den Heuvel, W.J., Papazoglou, M.: Top-down enterprise application integration with reference models. Australian Journal of Information Systems **8** (2000) 126–136