Journal of Biomedical Informatics 57 (2015) 415–424

Contents lists available at ScienceDirect

Journal of Biomedical Informatics

journal homepage: www.elsevier.com/locate/yjbin

Working with the HL7 metamodel in a Model Driven Engineering context

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ARTICLE INFO

Article history:
Received 6 April 2015
Revised 23 June 2015
Accepted 1 September 2015
Available online 5 September 2015

Keywords:
HL7
Metamodel
Model Interchange Format
Model Driven Engineering
UML

ABSTRACT

HL7 (Health Level 7) International is an organization that defines health information standards. Most HL7 domain information models have been designed according to a proprietary graphic language whose domain models are based on the HL7 metamodel. Many researchers have considered using HL7 in the MDE (Model-Driven Engineering) context. A limitation has been identified: all MDE tools support UML (Unified Modeling Language), which is a standard model language, but most do not support the HL7 proprietary model language. We want to support software engineers without HL7 experience, thus real-world problems would be modeled by them by defining system requirements in UML that are compliant with HL7 domain models transparently. The objective of the present research is to connect HL7 with software analysis using a generic model-based approach. This paper introduces a first approach to an HL7 MDE solution that considers the MIF (Model Interchange Format) metamodel proposed by HL7 by making use of a plug-in developed in the EA (Enterprise Architect) tool.

1. Introduction

HL7 (Health Level 7) International [1] is a non-profit organization that promotes and defines standards associated with health information systems. HL7 International members develop standards related to the exchange and model of Health information, with the objective of supporting clinical practice, management, development, and evaluation in Health services. This set of standards is known as HL7 standards, or simply, HL7.

A domain model is a conceptual model that describes concepts related to the problem domain [2,3]. It copes with concepts linked to the problem itself, instead of describing software system concepts. MDE (Model Driven Engineering) is a new paradigm that centers on creating and exploiting models [2,3]. Using MDE, productivity is increased because compatibility among systems is maximized (thanks to reutilization), thus simplifying the design process. Models act as system bases. This way, the conceptual definition of applications can be separated from the technology where they are executed. For this purpose, metamodel is a fundamental concept because it describes the concepts used in a specific model. There are many accepted notations to represent metamodels. In this case, we use UML (Unified Modeling Language)-class diagrams because they are the notations applied to both HL7 and UML.

HL7 has a metamodel called MIF (Model Interchange Format) [4]. This metamodel is not compliant with UML. In addition, HL7 International has developed its own graphic language to design the elements that compose its models. Considering the wide range of entities that MIF needs to cover in order to collect all the concepts necessary in a general health system, we must argue that MIF is very extensive and is presented in such an abstract way that, although it seems very interesting from the conceptual perspective, it can be difficult to manage.

HL7 International defines different domain models to explain each working problem or scenario that has been identified throughout the process. These conceptual schemes cover all areas that range from the information necessary to define system messages to the clinical documents themselves. All HL7 domain models can be modeled from MIF.

Considering that HL7 models are built in their own graphic language, and regarding the extension they present to cover all the entities necessary in a health system, we conclude that designing

Abbreviations: HL7, Health Level 7; MDE, Model Driven Engineering; UML, Unified Modeling Language; MIF, Model Interchange Format; NDT, Navigational Development Techniques; CDA, Clinical Document Architecture; OMG, Object Management Group; EA, Enterprise Architect; M2M, model-to-model transformations; ADL, Archetype Definition Language; AML, Archetype Modeling Language; RIM, Reference Information Model; HDF, HL7 Development Framework.

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http://dx.doi.org/10.1016/j.jbi.2015.09.001
1532-0464/

a software solution that can fulfill an HL7 standard is not an easy task for a software engineer. The fact that HL7 has a metamodel in a proprietary format produces much impact in the industry because lack of a commercial tooling support is identified, and a smaller knowledge field is produced simply because this notation is not a typical subject taught to software engineers at the university. In contrast, software engineers generally know UML and can design solutions through this standard. In addition, many MDE tools exist that perform a series of actions automatically, such as generating code or documentation, through a UML model.

Therefore, working to connect HL7 with software analysis has been relevant for us. Our long-term objective is for software engineers to design their solutions using the UML metamodel and the HL7 metamodel automatically. Consequently, we offer the capability of using standard MDE tools that need the problem to be modeled with UML modeling, apart from simplifying the solutions design.

This article lays the foundation for this research that we have recently started, and is motivated by our previous experiences, such as Diraya Specialized Attention project [5,6] and the eHealth project [7]. On the one hand, we performed a practical experience in the MDE context in the first project, which consisted in applying NDT (Navigational Development Techniques) Web Engineering methodology [8] when performing the Requirements and Analysis phases in a large-scale Web system focused on supporting Health information systems in Andalusia. On the other hand, the second project aimed to adapt the eHealth platform of the Virgen del Rocío University Hospital of Seville to a process-based SOA (Service-Oriented Architecture) to allow greater modularity, independence, maintainability, and usability for the development of functional modules that provide support to the clinical services of this hospital. For this purpose, we defined a model-driven proposal supported by automatic software tools.

These experiences concluded that MDE can reduce development time and identify possible errors or inconsistencies in early phases.

The main target of the research presented in this paper is to use the HL7 metamodel in the MDE context.

Fig. 1 illustrates the general process we aim to reach with this study.

Our secondary goals are as follows:

- To provide software engineers involved in the healthcare area with a solution that employs the benefits of the UML general proposed standard, standards recommended by HL7 International, and MDE existing tools.
- To take advantage of the potential of the existing tools that work with the new domain models exploitation paradigm: MDE.

This paper is structured as follows: After this introduction, Section 2 reviews and presents previous experiences. Then, Sections 3 and 4 explain the methodology used and the results obtained, respectively. Finally, Section 5 provides further discussion, and Section 6 states final conclusions.

2. Previous experiences

Some members of the HL7 International community have experienced the need of using a modeling standard instead of the modeling language that defines the domain models generated from MIF.

Previous experiences have studied the connection between HL7 v2.X and UML structures [9]. One of the first steps to use HL7 in the MDE context consists in implementing MIF in a computer-workable language. There are cases related to implementing computer-workable languages of a specific domain model, for example HL7 v3, but they do not cover the HL7 metamodel completely [10].

Researchers from the Polytechnic University of Catalonia have conducted an experiment in this domain. They identified some weaknesses while using the HL7 modeling language, and proposed a translation of the HL7 domain models to UML nomenclature in order to overcome such weaknesses. The researchers even implemented a translation from the HL7 v3 domain model to UML models [11]. Finally, they concluded that the HL7 International community could not find the UML model sufficiently suitable to replace the original MIF, and therefore, they could reject its adoption.

Since 2012, Sparx Systems has sponsored the HL7 Tooling Challenge, a yearly contest aiming to encourage the development of

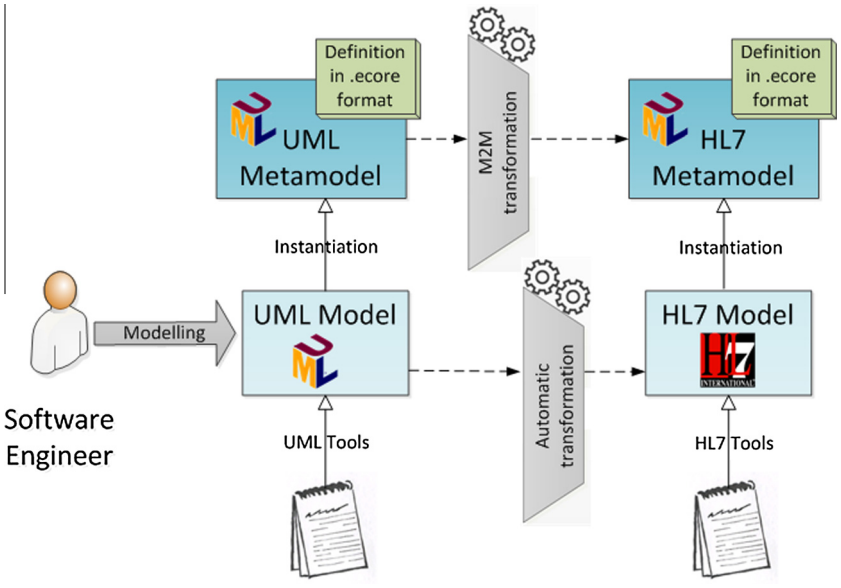

Fig. 1. Solution using the HL7 metamodel in the MDE context.