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Abstract

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Keywords

Ontology, mapping, between, HL7, versions, OpenEHR, for, observations, messages

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Ontology Mapping between HL7 Versions 2 and 3 and OpenEHR for Observations Messages

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Abstract: Interoperability between health informatics standards enables new best-of-breed solutions to evolve from legacy health information systems, and enables a healthcare data model to evolve and be enriched. In this paper we show that a lightweight XSLT framework can be used to achieve interoperability between HL7 versions 2 and 3 and HL7 version 3 and OpenEHR. We present the necessary transformations between terminology and structure in these standards as an exercise in ontology mapping. We discuss our experience with respect to clinical observation messaging.

Introduction

Our claim is that Semantic Interoperability in healthcare can be achieved by using complementary health informatics standards. By using each standard for its purpose, an enriched semantic model can be achieved for communicating and storing health information.

In order for standards to interoperate effectively, ontology mapping is required between them. Previous papers have discussed mapping SNOMED CT and HL7 [1][2]. This paper continues that work mapping HL7v2 and HL7v3, and then mapping HL7v3 to OpenEHR, using observations messages as an example.

Ontology Mapping

Ontology mapping is the process where two ontologies with overlapping content are related at the conceptual level to create a semantic correspondence between the two [4] [5], or to put it another way, the two ontologies are mapped to each other so that the source ontology instances can be transformed into the target ontology instances according to mapping rules. The problem is well studied in artificial intelligence researchers and finds practical application in the health informatics context. Ehrig and Staab [3] define ontology mapping:

> "Given two ontologies O_1 and O_2, mapping one ontology onto another means that for each entity (concept *C*, relation *R*, or instance *I*) in ontology O_1, we try to find a corresponding entity, which has the same intended meaning, in ontology O_2."

This definition is non-reflexive but can be made reflexive by completing the inverse mapping, i.e., to use the earlier definition, the target instances are transformed back into the source instances. In this paper, the inverse mapping is required to interoperate in both directions (i.e. map O_1 to O_2 and then map O_2 to O_1).

Mapping between HL7 Versions 2 and 3

Translation between XML representations of HL7 versions 2 and 3 is achievable because the two cover the same semantic content but with different structures and syntax [6]. Mapping in both directions is required in this case (v2 to v3 and then v3 to v2), i.e. for each entity in HL7 v2, a corresponding entity is found in HL7 v3, and then for each entity in HL7 v3, a corresponding entity found in HL7 v2. This is to allow interoperability in both directions, for communication between legacy systems using v2 and new systems using v3.

Bicer, et al achieved this transform using *Web Ontology Language* (OWL) [7] by creating an OWL mapping tool called *OWLmt* [4] and have used it in the *Artemis Message Exchange Framework* (AMEF) [8]. As part of their work, they used the HAPI (HL7 API) [9] and Assembler/Disassembler tool to perform an EDI to XML conversion to handle HL7 v2 messages in its old format. The EDI-format messages are first converted to XML, which then allows the OWL mapping between HL7 v2 XML and HL7 v3 XML. To achieve the XML mapping, Bicer et al., make use of various tools, including XPath, JavaScript and OWL-QL [10] within OWLmt.

The system that Bicer, et al have created for translation is an excellent solution to general mappings between the two HL7 versions. However, in our work we did not need such a heavy-weight solution, as we concentrated on the one type of data – observations. As such, the simpler lightweight solution taken in this work was to translate between HL7 v2 and v3 XML by creating XSLT stylesheets based on mapping rules between the two models. The HL7 v2 and v3 datatypes were mapped first, as they are quite similar and provide a foundation for information representation in both models. As an example, the mapping between the v3 datatype AD (postal Address) and the v2 datatype XAD (extended address) is shown in Table 1.

Table 1. Mapping between HL7 v3 datatype "Postal Address (AD)" and HL7 v2 datatype "Extended Address (XAD)".

V3: AD		**V2: XAD**	
attribute	*datatype*	*attribute*	*datatype*
use	SET<CS>	XAD-7 address type	ID
		XAD-44 address usage	ID
useablePeriod	GTS	XAD-13 effective date	DTM
		XAD-14 expiration date	DTM
isNotOrdered	BL	n/a	n/a
streetAddressLine	ST	XAD-1 street address	SAD
city	ST	XAD-3 city	ST
state	ST	XAD-4 state or province	ST
postalCode	ST	XAD-5 zip or postal code	ST
houseNumber	ST	XAD-2 other designation	ST
direction	ST		
country	ST	XAD-6 country	ID

From the table, some single v3 attributes map to multiple v2 attributes, while multiple v3 attributes map to a single v2 attribute. For example, use is a set of codes in v3 (SET<CS> means 'set of Coded Strings'), which maps to two different ID (code) fields in v2 (the first line of Table 1). V3 attributes such as houseNumber and direction both map to the v2 attribute XAD-2, which is 'other designation'. As a general rule we can infer from the table that anything that is GTS (General Time Specification) datatype in v3 can be represented as DTM (Date Time) datatype in v2, and vice versa. Other general rules can be derived such as v3 STs (Character Strings) can be converted to v2 STs (Strings).

Observations Messages Mapping

As clinical observation messages had been researched in-depth as part of a previous project discussed in [2], observations messages were continued as a case study. The HL7 v3 RMIM (message model) used for observations can be seen in Figure 1, shown mapped to the HL7 v2 ORU_R30 message structure. The ORU message refers to 'point-of-care observations message' and R30 refers to the trigger event 'place an order'.

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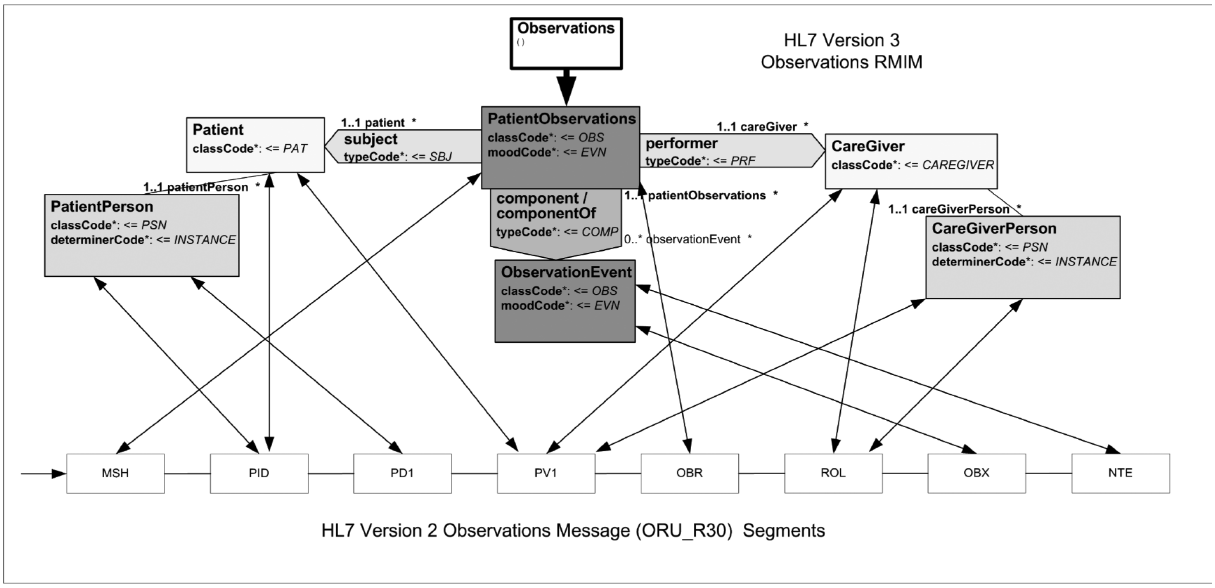

Figure 1. Mapping between HL7 V2 and V3 Observation messages.

Table 2 shows the mapping of actual v2 fields to v3 attributes for patient data. For example, it shows the v2 fields for the Patient Identification Segment (PID) and their mappings to v3 in the form of class::attribute. From Table 2 (and Figure 1), the v2 segment PID maps to the v3 classes patient and patientPerson. XSLT transforms were created for translating between HL7 v2 and v3 observations messages based on these mappings.

Table 2. Mapping of HL7 version 2 PID segment fields to HL7 version 3.

V2 field	description	mapping to V3 (class::attribute)
PID.3	Patient Identifier List	*patient::id*
PID.5	Patient Name	*patientPerson::name*
PID.7	Date/Time of Birth	*patientPerson::birthTime*
PID.8	Administrative Sex	*patientPerson::administrativeGenderCode*
PID.10	Race	*patientPerson::raceCode*
PID.11	Patient Address	*patient::addr*
PID.13	Phone Number - home	*patient::telecom*
PID.14	Phone Number - business	*patient::telecom*

Table 3. OpenEHR Archetypes used for Clinical Observations.

SNOMED CT Concept	OpenEHR Archetype
core body temperature (276885007)	openEHR-EHR-OBSERVATION. body_temperature.v1
pulse rate (78564009)	openEHR-EHR-OBSERVATION. heart_rate.v1
rate of spontaneous respiration (271625008)	openEHR-EHR-OBSERVATION. respiration.v1
blood pressure (75367002)	openEHR-EHR-OBSERVATION. blood_pressure.v1
haemoglobin saturation with oxygen (103228002)	openEHR-EHR-OBSERVATION. oximetry.v1
body weight (27113001)	openEHR-EHR-OBSERVATION. body_weight.v1
blood glucose level (365812005)	openEHR-EHR-OBSERVATION. bm_glucose.v1
contents of urine (249299009)	openEHR-EHR-OBSERVATION. urinalysis.v1draft

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OpenEHR Clinical Observations Messages

The OpenEHR archetypes in Table 3 were grouped together using the archetype for Clinical Findings (openEHR-EHR-SECTION.findings.v1.adl [11]) – which comprises an OpenEHR SECTION containing OBSERVATIONS (the archetypes in the table). This maps to the HL7 Observations RMIM directly in that the SECTION corresponds to a container ObservationEvent (referring to the patient visit) with component ObservationEvents corresponding to blood pressure, pulse, etc. Figure 2 (left) shows the HL7 message structure taken from the RMIM for patient observations. Figure 2 (right) shows the Clinical Findings SECTION of an EHR. It can be seen that the structure of the Patient Observations part of the HL7 message is the same as the OpenEHR Clinical Findings section. This means that the HL7 XML for this section can simply be transformed to OpenEHR XML using XSLT based on mappings between the fields and then stored permanently as part of a patient's EHR.

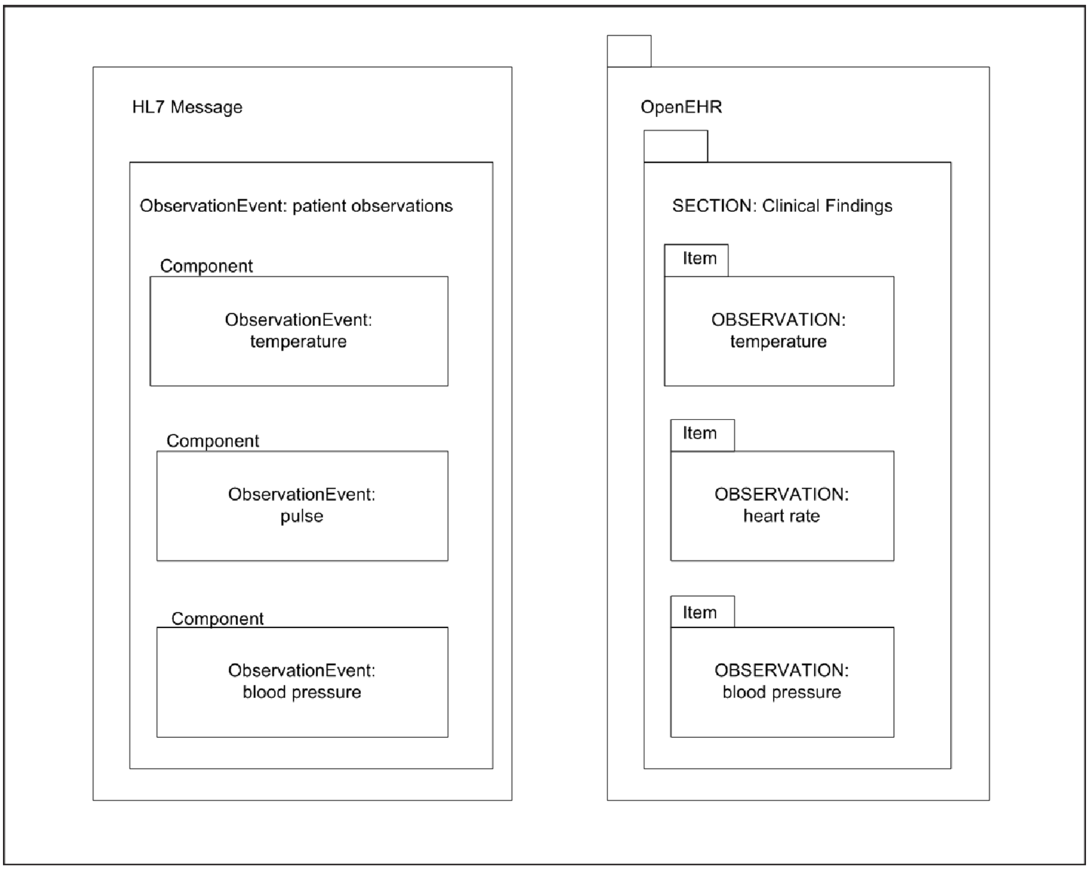

Figure 2. Mapping HL7 message structure to OpenEHR structure for Observations.

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Mapping between HL7 v3 and OpenEHR

Instances of archetypes can be represented as XML using the OpenEHR XML Implementable Technology Specification (ITS), so the mapping between HL7 and OpenEHR was performed in the same way as the mapping between the two versions of HL7 – using XSLT. Bi-directional mapping was also needed in this case, to ensure that meaning was preserved in translating in both directions (from HL7 to OpenEHR, and from OpenEHR to HL7).

Mapping between HL7 and OpenEHR was first employed so that systems using different health standards could communicate with each other using translation services, but was later expanded to an EHR XML database containing OpenEHR instances for use in a messaging framework called the Health Service Bus (HSB). In this system, translation between HL7 and OpenEHR is used to translate clinical observations instances in HL7 messages into persistent EHR representations of observations to be stored in a patient's lifelong record in the database. XML instances conforming to the OpenEHR archetypes in Table 3 were mapped to HL7 XML instances for clinical observations.

The structure of the HL7 observation message models is very similar to the OpenEHR archetype for clinical findings (openEHR-EHR-SECTION.findings.v1.adl), so mapping in this case is basically a translation of XML element and attribute names, rather than a complete restructure of information – less restructuring than between HL7 v2 and v3. For example, the XML instance of an OpenEHR ELEMENT is shown in Figure 2 (a), followed by the matching XML instance of a HL7 observationEvent component in Figure 2 (b).

The SNOMED CT code and the value of the observation are represented in each, surrounded by the OpenEHR tags or HL7 tags respectively. As with the mappings between HL7 v2 and v3, XSLT transforms were created for translating HL7 v3 and OpenEHR Observations.

a. OpenEHR XML

```
<ELEMENT archetype_node_id=”at0004”>
  <name>
    <value>systolic blood pressure</value>
      <mappings>
        <match>at0004</match>
        <target>
          <terminology_id>
            <value>SNOMED-CT(2007)</value>
          </terminology_id>
          <code_string>163030003</code_string>
        </target>
      </mappings>
  </name>
  <value>
    <magnitude>130</magnitude>
    <units>mm[Hg]</units>
  </value>
</ELEMENT>
```

b. HL7 XML

```
<component typeCode=”COMP”>
  <code code=”163030003”
       codeSystem=”2.16.840.1.113883.19.6.96”
       codeSystemName=”SNOMED CT(2007)”
       displayName=”systolic blood pressure” />
  <observationEven classCode=”OBS”
                    moodCode=”EVN”>
    <effectiveTime value=”200805201800+10” />
    <value>130 mm[hg]</value>
  </observationEvent>
</component>
```

Figure 2. (a) OpenEHR ELEMENT XML. (b) HL7 observationEvent component XML.

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Conclusions

There are many standards and terminologies used in Health Informatics for different purposes. Mapping different information models and terminology structures can enable semantic interoperability in several ways. First, communication may be achieved between systems using differing standards. Second, exploiting the strong points of each and using standards harmoniously enriches the expressiveness of the healthcare data model. A complete lifetime EHR can be obtained by grouping representations of instances-of-care (messages) in the one OpenEHR record. By mapping HL7 to OpenEHR, continuing exact semantic meaning into the EHR can be assured. Restricting the use of terminology in the EHR to match the HL7 models ensures this. We have also shown that heavy-weight systems are not always needed to translate between health standards – a working knowledge of the standards and some XML is all that is needed in simple cases to create a practical translation solution.

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