

## Standardized EHR Interoperability – Preliminary Results of a German Pilot Project using the Archetype Methodology

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**Abstract.** The mobility of doctors and patients asks for multilingualism of electronic health record (EHR) systems: Doctors might face language problems using foreign medical information systems; people working abroad ask for continuous care which requires the treating physician to consult and understand the patient's health record. To address these linguistic and interoperability issues a solution is being developed that is based on widely acclaimed standards. Medical concepts that are derived from ASTM CCR define an interface model (based on ISO 13606). A server manages the data exchange between heterogeneous systems based on the interface model. It provides web services (automatic) and web forms (manual) and performs a transformation from the legacy scheme to the common structure. Furthermore, the server provides rich visualization capabilities (e. g. language-switch, custom charts etc.) which are useful for those EHR systems that don't provide these features.

**Keywords.** EHR, semantic interoperability, standardization, ISO 13606, CCR

### Introduction

In Germany there are over 150,000 resident doctors [1] having over 100 heterogeneous EHR systems [2]. There is no common infrastructure for exchanging this medical data, therefore semantic interoperability of electronic health records (EHR) remains a major challenge in medical informatics [3] and requires, among others [4], lingual and technical interoperability. Doctors face language problems using foreign medical information systems; people working abroad ask for continuous care which requires the treating physician to consult the patient's health record. Also doctors and patients ask for EHR systems which are able to handle heterogeneous medical data e.g. data from different (multi-linguistic) sources, etc.

To achieve semantic interoperability within heterogeneous environment different standards must be combined into a holistic solution [5]. The ISO/EN 13606 [6] (EHR data exchange) archetype model provides a means to define medical content and knowledge for the electronic exchange of health records [7]. The ASTM CCR (Continuity of Care Record) [8] focuses on the definition of medical information for

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US purposes and is rather inflexible when it comes to adaptations. Though ISO/EN 13606 provides a modeling toolset it still has to be defined what information can be extracted from one legacy system and imported into another and how this exchange must be implemented. The ByMedConnect project aims at implementing a data exchange solution in a physicians' network in Germany and the evaluation of the ISO 13606 standard. An ISO 13606 information model was defined by deriving the medical content from the ASTM CCR standard (e.g. Functional status, Problems, Alerts, Medications, Immunizations, Vital signs) and adopting it to the regional (German) needs to achieve a common understanding on the data to be exchanged.

## **1. Methods**

EHR systems were classified according to their interoperability potential to provide the solution that enables data exchange among all the heterogeneous systems that are used within the regional health care network. A communication solution based on a web-service oriented architecture was developed to manage the data exchange between heterogeneous systems and to make the solution scalable.

Successful exchange of data requires a common dataset that all the parties agree on. The analysis of the doctors' requirements on the dataset and data exchange scenarios resulted in the development of a dataset that is based on the CCR specification adapted to German requirements. The dataset is defined as a set of archetypes that confirm the ISO 13606 data model. This allows re-usability of the dataset and flexibility for the doctors when they have to change the dataset at a later point of time. The data set was defined as a set of ISO 13606 archetypes. The top level of the ByMedConnect dataset corresponds to the CCR but does not include US specific administrative data (Encounters, Payer, HealthCare Providers).

For data transformation a canonical approach was applied [9]. Participating parties transform the data from their local domain model (EHR scheme) to the common/canonical schema; a set of information which defines the information set that is to be exchanged and which all participants are committed to. The canonical schema itself acts as an interface model (based on the archetype model of ISO 13606 [10]) of the (medical) data that is bound to be exchanged.

To overcome language barriers the ISO 13606 multilingualism features can be leveraged. When retrieving uploaded (sent) data the solution was enabled to generate a report of the data in different languages.

## **2. Solution**

The developed solution models standard-based medical concepts (ASTM CCR) as a set of archetypes (ISO 13606). The archetypes were developed in a strong cooperation with the doctors of the GO IN regional network in Ingolstadt (Germany).

Data exchange in the regional network is complicated due to the fact that different practices operate different EHR systems having different interfaces and information models and/or have no data export facilities and/or cannot provide (state of the art) functionality that satisfies the requirements of future proof systems and support e.g. pre XML EHR systems. The concept of free choice of doctors is mandatory in Germany and makes it also impossible for a sender to know the recipient in advance.



The ByMedConnect system was implemented based on service-oriented architecture, where web-services apply data transformation. The solution provides a central server which stores encrypted data in a temporary repository until it is retrieved by a recipient while being authorized by the patient. The introduced interoperability matrix (Table 1) classifies EHRs according to their interoperability potential. To achieve a high percentage of participation in the data exchange solution of ByMedConnect services provide data export tools for L2 systems and web-forms for a manual data entry for L1 systems.

Table 1. Interoperability Level Assessment Matrix.

Requirements  Degree of requirements fulfillment (Levels of interoperability)		Can export data	Can transform data	Can communicate via web services
No conventional participation possible	L0			
Participation is possible	L1	X		
Requirements are partially fulfilled	L2a	X	X	
	L2b	X		X
All requirements are fulfilled	L3	X	X	X

According to the canonical approach the sender exports and transforms the data from its native scheme to the canonical model and subsequently the receiver transforms the data from the canonical model (ByMedConnect dataset) into the local scheme and imports it to its system (similar to [11]). The canonical schema provides the core of the solution and contains a model of the data that is bound to be exchanged.

The ByMedConnect infrastructure (Fig. 1.) offers the following functionality (in chronological order):

1. **Data submission**
  - a. via web service interface (automatically)
  - b. via a web upload form (manually; acting as a proxy to the web service; uploading an XML file)
  - c. via a (web) form (a manual entry of data and its transformation to the schema of the canonical information model; acting as a proxy to the web service)
2. **(Local-to-canonical) data transformation** (in case of 1a, 1b) to transform the submitted data from the local to the canonical schema (ByMedConnect dataset); a web service performs data transformation on demand by applying a previously defined transformation script (which is stored on the server).
3. **Data validation** of the data (to ensure that the submitted data is formally correct and valid) by applying **XML Schemas** that were derived from the ByMedConnect dataset<sup>2</sup>.
4. **Data retrieval** (including a **canonical-to-local data transformation** before the download, if necessary; as described in 2.).
  - a. via web service interface (automatically)

<sup>2</sup> Due to the fact that the ISO 13606 archetypes are modeled in the ADL syntax validation routines (XML Schemas derived according to the UML based ISO 13606 Reference Model) were derived manually.

- b. via a web download form (manually; acting as a proxy to the web service; downloading an XML file)
5. (and/or) **Data visualization** to provide language-switch functionalities and to enable different views on the retrievable data (e.g. charts, tables, graphics) for those EHR systems that do not provide these features.

The solution defines a common information model that can be adapted to the changing requirements. Some practice management systems can by now match the canonical model only partially but can still participate in the exchange network meanwhile adapting the system towards full compatibility and the defined information model can serve as a reference for EHR systems that are being developed.

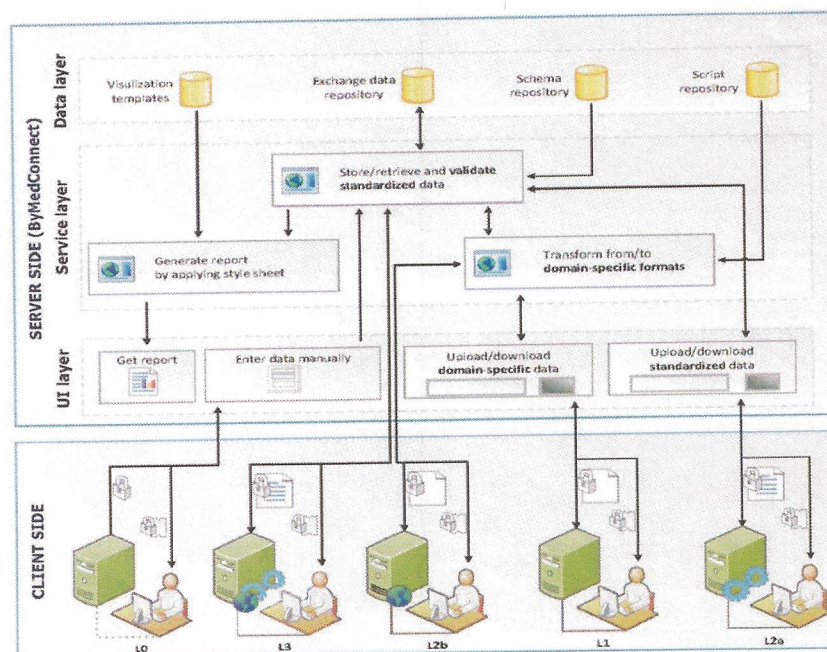


Figure 1. ByMedConnect Server architecture.

The server offers rich visualization capabilities which can improve the quality of care by providing an easy to recognize model of the underlying (text-based) data for the practitioners and patients; as the same time it helps overcoming lingual barriers.

### 3. Preliminary findings

In the presented solution, where a server acts as a temporary repository, validation is crucial. The ISO 13606 provides a powerful toolset for EHR data modeling and exchange but does not introduce formal rules regarding the representation of data.

The introduced interoperability potential matrix can be useful for other data exchange projects, too. It can serve to assess the interoperability of systems in a tangible way and where other Enterprise Application Integration (EAI) approaches are applied it can be adapted to project specific requirements. Cross-border eHealth