Multi-Level Healthcare Information Modeling Vision

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DRAFT!

Introduction

The Multi-Level Healthcare Information Modeling (MLHIM) approach follows on several years of research and development work to overcome semantic interoperability in complex information environements and especially in healthcare. This work has been carried on across continents and projects but always with the foundation that the proof is in the implementation.

History

Origins of openEHR

The text below was extracted from the openEHR.org website and reprinted here according to the license.[1]

It was edited and reformatted to present it in alignment with this document.

David Ingram October 2002 Some ten years after the GEHR project was established in 1989, partners in that project have come together again to review experience gained over the intervening years. It is especially encouraging that a forthcoming ISO standard will elevate formally defined clinical requirements to the highest level in the standards process for electronic healthcare records.

Introduction - the AIM Initiative in Europe In 1988, the European Union established the Advanced Informatics in Medicine (AIM) initiative, within the wide-ranging Framework Programme for Research and Technology Development in Europe.

The rationale for the Framework Programme was:

o To strengthen the economic and social cohesion of the Community

o To offer obvious benefits through the collaboration of several States

o To apply significant and complementary results across the whole Community

o To contribute to a common market and to scientific and technical unification

It succeeded in catalysing a wave of new partnerships across all sectors of the European economy.

In relation to health, the Framework Programme objectives set out in 1988 were:

o To unify European activities by providing the means for efficient communication of medical records and knowledge so that these may be understood and compatible, thereby permitting the integration of health information systems

o To strengthen competitiveness by advancing the technical basis of products and services and commercialising European inventiveness in all scales of enterprise

[1] http://www.openehr.org/about/origins.html

o To improve the quality of life through improving diagnosis and treatment, increasing public awareness and knowledge of health care and widening access to improved services

Thus, from the earliest stages of the Programme, the harmonisation of electronic health care records was seen as of the highest strategic importance for health care development in Europe.

Under the outstanding leadership of Dr Niels Rossing, the AIM Programme was developed in key phases, as follows:

o 1988 - 1990 Exploratory phase, 20 million ECU, 43 projects

o 1990 - 1994 110 million ECU, 38 projects; 12 concerted actions

o 1994 - 1998 135 million ECU, ~60 projects

The first major Call for Proposals under the AIM Workplan was issued in 1989.

The Good European Health Record (GEHR) Project Proposal A Consortium was drawn together by Dr Alain Maskens and Dr Sam Heard to bid to work within AIM on electronic health record architecture.

The Consortium comprised seven professional, industrial and academic partners: St Bartholomew's Medical College (co-ordinating partner); HDMP; The French Red Cross Hospitals; The Association of Doctors and Dentists of Luxembourg; The General Practice Institute of Oporto, Portugal; France Telecom; Smithkline Beecham.

The project proposal was put together in three months in early 1991 and was given the title The Good European Health Record (GEHR). The project commenced in January 1992.

The Accomplishments of the GEHR Project The work of the GEHR project is well documented in its many widely communicated project reports, publications and software, and described on the CHIME.ucl.ac.uk web site. The final AIM Conference Paper concluded the first stage of the story of GEHR. All public deliverables of the Project may be downloaded from the UCL, CHIME web site.

Key attributes of the project approach and accomplishment were:

- Development of an original, formal approach to electronic health record architecture, based on object modelling methods and founded on a comprehensive and systematic review of patient and clinical professional roles and requirements, across Europe, in relation to records.
- An empirical and iterative prototyping approach to the evolution of the architecture, emphasising implementation and testing of concepts at each stage.
- The decision of the partners, in the interests of effective dissemination of the work, to publish the project results openly, within the public do-

main. The EU Contract in principle vested IPR for the work with the Consortium.

At about the same time that the AIM Programme was initiated, CEN established a standards initiative for medical informatics through its Technical Committee TC/251.

During the course of the GEHR Project, a Project Team was established under TC/251 of CEN, to propose a pre-standard health record architecture. The team published the first CEN pre standard, ENV 12265.

The GEHR Project came to an end in 1994.

Synapses: The Synapses project from 1995-1998 succeeded in implementing several pilot record servers, built according to the Synom/Synod principle, across Europe (see CHIME and TCD web sites).

Synapses reached a compromise to extend the fundamental concepts of Env 12265, with new aggregation structures to accommodate the requirements analysed and provided for within the GEHR Object Model (GOM) in the later stages of the GEHR project.

- from GEHR and Synapses to Synex, Medicate and 6-winit in CHIME and UCL In developing its ideas, post GEHR, the team started a prolonged period of intensive software implementation and evaluation of the record architecture and object dictionary. This work was conducted throughout the EU Synapses project, then in the EU Synex, Medicate and now the 6-WINIT and CLEF projects. In the Synex Project a wider grouping of record architecture, terminology (GALEN) and protocols (Proforma) formalisms were drawn into the Consortium.

In 1998, at the conclusion of the Synapses Project, David Ingram circulated a paper about the need for a clinically focused Foundation to own the content domain around standards for clinical information management. It attracted interested comment and it was left with UCL to take it forward. In late 1999, a joint meeting of the Australian and UCL teams, in London, considered the forward pathway for the work of their two teams, in this context. The name openEHR, proposed by David Ingram, was adopted. Membership, it was felt, should be open to all signing up to a set of principles guiding the Foundation's activities, which emphasised constructive, inclusive and empirically based evolution of rigorously defined software and systems, organised around the two level strategy of the UCL object dictionary and the Australian archetype methodology.

openEHR directs its efforts towards:

- well-formulated clinical requirements, offered as a contribution towards international consensus
- rigorous development, implemention and evaluation methodology for systems

- common information model for the record, where clinical requirements dictate that this is necessary and where the relationship between model and requirements is made explicit
- diversity of information models and implementations, where these will enrich experience of a variety of approaches and systems and thereby promote the evolution towards high quality and cost-effective EHR solutions offered
- empirical evaluation of systems performance against clinical requirements

In pursuing its aims, openEHR will: * be open to all who sign up to its objectives and methods of work

* have free individual membership

* charge membership fees for official bodies, on a not-for-profit basis

* help to define and support a common process of specification of clinical requirements, specification and implementation of systems and evaluation of the electronic healthcare records provided

* publish the work of projects and systems conducted within the openEHR community and adopting the GEHR methodology.

* offer the sources of such GEHR-based systems, in which IPR will be assigned to openEHR, under an open-source license within the community. Individuals or companies assigning IPR to the Foundation may where necessary and appropriate be remunerated under contract or through license fees.

* offer all its work openly in a spirit of a public enterprise, believing that this is the best and perhaps only way that appropriate high quality and interoperable systems are likely to emerge, worldwide.

* seek constructive relationships with groups and communities focusing on other aspects of clinical information management such as messages, terminology, knowledge-management and decision-support.

openEHR will not: * campaign against or obstruct others working on electronic healthcare records.

Origins of MLHIM

In late 1997 the author of this document, Timothy Cook, embarked on a project to create an open source practice management application. That project lead to an open source electronic medical record with practice management capabilities. The journey wasn't without trials. Within the first year I realized that creating an electronic medical record that could be maintained for a long period of time by a community of open source advocates had some unique data modeling challenges. The eventual product named FreePM was taken on by investors and the company Free Practice Management, Inc. was formed to support it.

FreePM used a multi-level modeling approach to solve some of the interoperability and data modeling issues. Based on an object oriented information

model, FreePM included an integrated template designer that allowed users or teams to create purpose specific information containers. Still baffled that this problem had not already been addressed, I met Dr. Sam Heard in November 2001. Upon discovering the work that had gone on in the "Origins of openEHR"above. I quickly decided to work with this group. I continued collaborating with them and in 2004 the openEHR Architecture Review Board was created and I was asked and accepted to become an initial member. I continued in this capacity and in other collaborative work with the openEHR Foundation until March 2009.

XML technologies has advanced tremendously over this period and has gained wide acceptance on a global basis. The MLHIM team[2] believes that it is time to re-think previous efforts and modernize the approach to embrace XML technologies. We are therefore working to produce similar but not necessarily inter-operable specifications, tools and application development platforms independent of the openEHR Foundation.

[2] http://www.mlhim.org

Concepts

MLHIM embraces some general concepts in order to provide for semantic information interoperability across conforming healthcare applications. The most basic concept is one of a common information reference model constrained by components that express domain knowledge in artifacts known as Concept Constraint Definitions (CCDs) and Template Constraint Definitions (TCDs).

Persistence

While the MLHIM specifications do not specify a certain persistence model. There are some basic concepts that implementers should be aware of when creating their applications.

MLHIM based information is document oriented. Therefore storage in a SQL database means that the developers will not only need to implement ORM but also querying the information is more difficult. The NoSQL [3] family of persistence solutions is growing in popularity and capability. Many such as Riak[4] are highly scalable, highly available and have multiple APIs.

[3] http://nosql-database.org/
[4] http://wiki.basho.com/display/RIAK/Riak

User Interfaces

Certainly every user interface to every application is different. However, there are some specific things that can be done to generate some consistency. In OSHIP (oship/cuiwidgets directory) we have planned to embraced the Microsoft Common User Interface (MS-CUI) concepts. This has been a collaborative work between Microsoft and the National Health Service (NHS) in the UK[5]. The basic concept here is to create a library of widgets using CSS, AJAX, etc. technologies so that they can be reused across applications.

[5]Dr. Mike Bainbridge, one of the leaders of the UK-NHS effort will be a keynote speaker at the INCT-MACC event June 28,2010.

Programming Language

The MLHIM specifications are programming language agnostic. The exception being that it must be an Object Oriented language. Please see the Reference Implementations section below.

XML Technologies

In order to convert the concepts of multi-level modeling into practical application using XML[6] we will begin with a list and a short description of each XML component and how they can be used in MLHIM. A thorough foundation of XML will provide for ease of interoperability, especially in Web Services usage of Terminology Servers and other Service Oriented Architecture requirements. This also provides for easier construction and / or adaptation of applications for use on mobile devices.

XHTML (Extensible HTML)

A stricter and cleaner XML based version of HTML. In MLHIM used as UI output.

XML DOM (XML Document Object Model)

A standard document model for accessing and manipulating XML. Forms the basis for all information in MLHIM compliant applications.

XSL (Extensible Style Sheet Language)

XSL consists of three parts:

1. XSLT (XSL Transform) - transforms XML into other formats, like HTML
2. XSL-FO (XSL Formatting Objects)- for formatting XML to screen, paper, etc
3. XPath - a language for navigating XML documents

XQuery (XML Query Language)

An XML based language for querying XML data.

[6] http://www.w3schools.com/xml/xml_technologies.asp

XSD (XML Schema)

An XML-based structure description. Used for all reference model and constraint definitions.

XLink (XML Linking Language)

A language for creating hyperlinks in XML documents.

XPointer (XML Pointer Language)

Allows the XLink hyperlinks to point to more specific parts in the XML document.

XForms (XML Forms)

Uses XML to define form data.

SOAP (Simple Object Access Protocol)

An XML-based protocol to let applications exchange information over HTTP.

WSDL (Web Services Description Language)

An XML-based language for describing web services.

RDF (Resource Description Framework)

An XML-based language for describing web resources.

RSS (Really Simple Syndication)

A format for syndicating news and the content of news-like sites. Can be used in MLHIM to push update information to subscribers.

WAP (Wireless Application Protocol)

A XML based language for displaying content on wireless clients, like mobile phones.

SMIL (Synchronized Multimedia Integration Language)

A language for describing audiovisual presentations. Used in MLHIM for radiology and other multimedia requirements.

SVG (Scalable Vector Graphics)

Defines graphics in XML format. Radiology, etc.

Tools

Constraint Definition Designer (CDD)

https://launchpad.net/cdd

Healthcare Knowledge Component Repository (HKCR)

https://launchpad.net/hkcr

Reference Implementations

Open Source Health Information Platform (OSHIP)