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Interface Map as a User-Driven and Activity-Driven Interoperability Standards Portfolio

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Abstract

Use of interoperability specifications such as standards and their implementation guides is currently hindered by lack of systematic directories. It is difficult for potential users of standards to locate potential specifications which could be useful for their specific development needs. We introduce a multi-directory interface map approach which supports systematic description of healthcare interoperability specifications through consistent metadata and complementary classifications. The approach is built on basic premises of standards portfolios in enterprise architectures as well as activity-driven and interoperability paradigm-based classifications. We illustrate the approach through a case project in Finland.

Keywords

Standards, Usability, Portfolio, Directories, Interoperability.

Introduction

Elaboration of patient-centered health information system architectures within and beyond health care institutions and related information management strategies are a central research direction in health informatics to support well-organized health care [1]. Interoperability specifications are increasingly central in this pursuit, supporting the continuously evolving needs in healthcare. System developers and their clients, however, need to be able to locate and assess those standards and specifications which could be used to support interoperability requirements in their respective projects and systems. These projects usually have detailed integration needs, focusing on limited interoperability needs on an organizational or inter-organizational level. Standards portfolios and catalogues are used in enterprise architectures and national development programmes, as well as in standards development organizations (SDOs). These catalogues typically list numerous specifications for highly varying purposes, and offer very limited metadata or directory support for potential users who are looking for concrete support for their work.

In this paper, we introduce the *interface map approach* which has been developed to support the search, selection and evaluation of healthcare interoperability specifications. The interface map is a user-driven approach to provide metadata and several parallel directories complementary to standards portfolios and catalogues. Base classifications of the directories of the portfolio are based on integration needs in healthcare activities (through activity analysis), interoperability paradigms of standards development organizations, and functional classifications of health information systems. We illustrate the approach through a case study in which a concrete web-based interface map was built for a national HL7 affiliate in Finland. This approach can be used to improve the accessibility of interoperability specifications in standards portfolios.

Motivation, Materials and Methods

There are various eHealth standards portfolios and catalogues available. In standards development organizations, the directories of standards typically reflect the organizational committee setup of standards development. The metadata of each standard in these catalogues are often inconsistent or scarce. For example, the existing national inventories of eHealth interoperability specifications (in the national eHealth KanTa initiative and HL7 Finland association) consist merely of the main captions of specifications. In addition, the authors are not aware of standards portfolios, which are based on multiple directories, each of which focuses on distinct user-driven classification.

The authors had previously participated in the development of national public administration standards portfolio recommendation (JHS 181) [2], national recommendations for eHealth standardization [3], standards portfolio for social care informatics national programme [4], and research projects on enterprise architecture artefacts [5] as well as application integration [6]. Each of these efforts included production of standards catalogues or portfolios, but their usability by developers or other potential users of specification was perceived as poor. In addition, previous work on evaluation and selection framework of interoperability standards [7] suggested that there were many improvement needs in early phases of identification of potential specifications for users of standards. In some cases, even web authoring tools limited the possibility of utilizing key metadata elements, which would have supported easy location and initial evaluation of specifications.

Standard portfolios in enterprise and reference architectures are typically used to: (1) list, (2) support the location and access of, (3) communicate the official status of, or (4) communicate the binding status of standards or specifications in a certain domain [2]. In the two previous instances of HL7 interface catalogue and other similar standards catalogue implementations [8][9], the “listing” functionality can be found, as they are storages for the documentation produced by different organizations and projects. "Support for location and access," including searchability was not implemented on a satisfactory level on any catalogue, as the catalogues lacked necessary metadata on each standard or seldom provided consistent directories to support needs-based location of specifications. Some catalog listings are publicly available on the Internet and can therefore be indexed by search engines, but this does not provide a reliable and consistent classification of different types of needs or functionalities, relying only on expertise to find suitable keywords and phrases.

In summary, the shortcomings of existing catalogues and portfolios in relation to most main requirements were evident based on short analysis of existing catalogues and portfolios:

- lack of usability, searchability, and browseability using different classifications;
- lack of consistent descriptive data to make better informed selections, exclusions, and comparisons;
- ambiguity in validity of information, dependencies, or responsibilities in updating the catalogues.

Consequently, to improve usability of standards catalogues, a systematic metadata specification and a multi-directory approach was developed. Different classifications would be used to support *several* directories which could be used in locating and selecting specifications. An activity-driven "landscape view" of health services (see Figure 1) according to the ActAD (Activity-based Analysis and Design) model [10] was the basis for one of the classifications. Other directories consisted of functional (clinical and administrative) and "interoperability style" classifications.

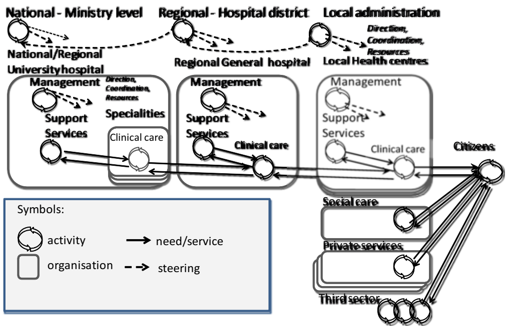

Figure 1-Simplified activity system of Finnish healthcare.

The primary user groups of the interface map were defined as system users, system vendors, system implementers, and decision makers in health information exchange environments. In addition, the interface map was used by specification developers in communicating the outcomes and status of specification efforts. The experience and criticism of previous models, as well as intended usage by recognized user groups, were used as guidance in the implementation project.

Results

The interface map is a multi-directory standards portfolio structure which aims to support systematic and usable inventory of interoperability specifications in health care. The usability of interface map is based on two main features: *consistent core metadata* and *complementary classification-based directories*.

Metadata

There are various metadata templates for standard catalogues, such as HL7 product brief templates or Finnish public administration JHS 179 standard portfolio templates. These are simple worksheet listings of standards and their key attributes. These metadata typically include administrative and intended use data of specifications. The metadata attributes may also contain classifications. Consistent metadata promotes comparability and consistency within the standards catalogue. Searching and browsing operations on such catalogue metadata, however, can be burdensome, if no additional directories are provided.

Only those metadata items which are the most useful for describing the specification or supporting the user in initial evaluation should be included in standards portfolios. The selected metadata in interface map (see Table 1) were a small subset of metadata of standards from an evaluation and selection model [7] which includes 54 metadata items, and JHS [9] and HL7 [11] product brief models were also used as basis for elements. Only those items which were deemed most central for communicating the users the scope and core properties of the specifications were selected.

Table 1-Metadata of interface map specifications.

Data item	Meaning
Name	Complete name of the specification
Version	Version information included in repository
Identifier	Universal identifier of the specification e.g. OID, URI, official abbreviation or id
Date	Year or timestamp of publications
Link	Location of the specification (e.g. URL)
Status	Level of official acceptance, e.g. normative, draft, etc.
Scope	Scope statement as stated in specification
Organization	Organization responsible for maintenance of the specification.
Functional class	(see section "Functional classification")
Organizational class	(see section "Organizational activity system classification")
Interoperability paradigm class	(see section "Interoperability paradigm classification")
Summary	Brief free format description of the main contents of the specification
Relationships	Key relationships to other specifications such as base standards, dependencies, etc.
Additional information	Other relevant key information about the specification.
Version history	Previous versions of the specification (including links if applicable)

The name of the standard often gives some information about the intended use of the standard. The "scope" item of metadata list, however, is the primary key element in describing the intended purpose of the specification. Indeed, each specification should include a clear scope statement. However, scope statements are not always adequate to communicate the boundaries of the specification or its context in organizational settings. In addition, browsing and making sense of large number of scope statements may be a slow and tedious process, especially if the catalogue contains many specifications. This was one of the reasons several complementary classifications were specified to support the use of the interface map.

The directories of interface map are based on classifications. Each specification is usually primarily intended for one or more use contexts in clinical or administrative activities (*functional* viewpoint), one or more integration contexts in relation to organizational and activity boundaries (*organizational activity system* viewpoint), and often based on one primary "interoperability mode" in a systems implementation context (*interoperability paradigm* viewpoint). These viewpoints were selected as bases for directories in the interface map, as they provide support for quick screening, grouping, and location of specification from viewpoints of the identified user groups. They also provided a simple, comprehensive, and adequately extensible mechanism for practical directories in the hyperlink-based web implementation of the interface map.

Functional classification

Functional classifications are based on different functional areas of health care activities. The main division used in the interface map is between administrative and clinical domains, and both of these main classes can be further classified according to different administrative or clinical areas of activity. In addition, there are specifications which do not distinguish between whether they are used in clinical or administrative activities (generic domain). Examples of interoperability specifications under different classes include:

- Administrative interfaces
  - Patient admission and discharge specifications
  - Patient and organization billing interfaces
  - Diagnosis-related group (DRG) grouping service interfaces
  - Appointment scheduling specifications
  - etc.
- Clinical interfaces
  - Electronic Patient Record Documents
  - Laboratory Orders and Results
  - Clinical and Radiology Imaging interfaces
  - Clinical Decision Support interfaces
  - etc.
- Generic
  - Generic messaging specifications
  - etc.

The classification was based on previous research on locating and classifying interoperability needs and solutions on the hospital, regional, and national level [12] as well as classification of domains in HL7 version 3 standard packages. Both of these earlier models were based on classifications of health information systems and specialties. Subclasses could also be based on classifications such as content-based technical frameworks (TFs) of IHE (Integrating the Healthcare Enterprise), including domains such as radiology, laboratory, oncology, eye care etc. The interface map classification hierarchy, however, was kept low for case implementation, and specialties could also be described using keywords as part of the specification metadata.

Organizational activity system classification

Organizational activity system classification is driven by distinction between different types of integration needs. It especially focuses on *boundaries of activities in organizational context*. Interoperability needs and solutions are observed in terms of what kind of organizational or activity boundaries are faced in the integration effort in relation to the activity system, as depicted in Figure 1 [13]. These aspects often have very profound effects on the architecture, security requirements, availability of shared infrastructure, and the level of detail of needed agreements for interoperability. The categories and examples of interoperability specifications in each category are as follows:

1. Interoperability internal to one activity: support for work of an *individual user or group*. Examples include synchronization of applications using clinical context integration solutions such as those based on HL7 CCOW standard (e.g. selection of a patient in one application and communication of patient context to other simultaneously used applications), portal integration, user-based integration between scheduling or ePrescription system with EPR application, single sign-on, etc. This category also includes interfaces between devices and professional systems within an activity.
2. Interoperability between *activities within an organization*, typically between core clinical care activities or units and supporting activities and services. Examples include request-reply interactions between clinics and laboratories or between wards and radiology departments.

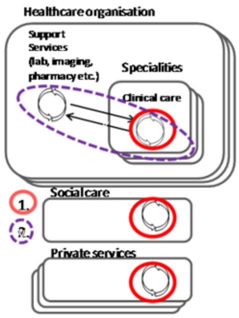

Figure 2-Interoperability within an organization, within one activity and between activities (classes 1 and 2).

3. Interoperability between *activities along the service chain or inter-organizational care pathway*. Examples include electronic referral and discharge messages, support for ePrescription processes between care providers and pharmacies, or disease-specific system integrations, support the care pathway of diabetes patients, for example.

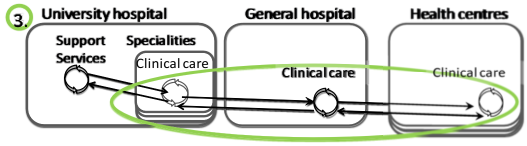

Figure 3-Interoperability between activities along the service chain (class 3).

4. Interoperability solutions for *information sharing between organizations* participating in the service spectrum, without tying the integration points to any particular processes or pathways. For example, regional or national document sharing infrastructures or shared EPR repositories are included in this class.
5. Interoperability for *electronic services and self-management* for patients and clients. These kinds of solutions include integrated or provider-tethered PHRs, patient / provider shared care and communication systems and integration between home measurements and professional care provision systems, for example.
6. Interoperability for *management, public health and statistics* which is not directly related to client-facing services. Such interoperability solutions include public health and disease registry reporting. Interoperability for clinical research has many similar integration needs.

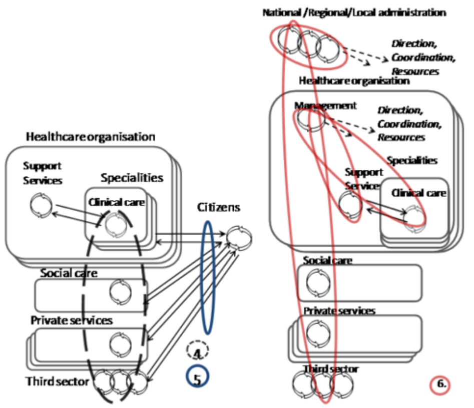

Figure 4-Interoperability for information sharing between organizations (class 4, left), for electronic services and self management (class 5, left) and for management, public health and statistics (class 6, right).

Many interoperability specifications have one or two primary contexts in relation to organizational activity systems, but it may also be possible to utilize them for other purposes.

Interoperability paradigm classification

The third classification of the interface map deals with a basic architectural approach to the implementation of the interoperability solutions. In this classification, the realization of interoperability solutions can be roughly categorized into message-based, document-based, or service-based interoperability interfaces. Such classifications are used in standards organizations' product lists [11] and also more recently in the SAIF (Services Aware Interoperability Framework) [14] [15] from HL7. In the interface map, this classification provides metadata and a directory to help users determine the interoperability style and infrastructure considerations of the interfaces as one basis of standards evaluation. The four classes of the interoperability paradigm classification are:

- *Messages*: transient messages such as HL7 versions 2 and message interfaces and other similar messaging protocols including various SOAP/XML transport standards. Message interfaces traditionally support information transfer between systems and organizations through defined transfer formats, information elements and syntactic structures.
- *Documents*: persistent information collections which may have legal status, often containing both displayable and machine-processable information. Document interfaces and types are often based on ISO/HL7 Clinical document architecture (CDA) release 1 or release 2 standards.
- *Services:* interfaces which focus on functional capabilities exposed by service providers and used by service consumers, often also specifying the related information content of service operations. Such specifications include various service functional model and interface specification standards for local or distributed service interfaces, including HL7 CTS (Common Terminology Service) versions 1 and 2 and other code service interfaces, DRG grouping interfaces, and interfaces for clinical decision support service operations.
- *Foundation:* Specifications which are not tied to any of the above interoperability classes but provide shared foundations for interoperability, including data types, security techniques such as digital signatures, unique identifiers such as ISO OID (object identifiers) or shared reference models.

Classes within each of the three classifications are non-exclusive as such. Some messaging specifications may be well used both within one organization and between several organizations. On the other hand, a service-oriented functional model specification may be implemented using message-oriented technical implementation guides. In addition, the same functional integration needs may fall under different categories in different organizational settings. For example, a laboratory integration interface may be first introduced inside a hospital (organizational class 2) and, after an organizational change to use of regional laboratories, turn into regional workflow or information sharing (organizational class 3 or 4). As an example, CDA R2 Laboratory specification (2009) in HL7 Finland catalogue was built to support inter-organizational care pathways and information sharing, using document-oriented interoperability paradigm, whereas earlier laboratory messaging specifications (circa 2000) were intended for intra-hospital use and utilized a message-based paradigm.

Discussion

The interface map was implemented by the authors in a case project, which was put out to public tender by the HL7 Finland association in 2012. The concrete goals were to create and update the inventory of implementation guides, specifications, and documentation released by the association, to publish it on the web, and to improve its usability. The project developed a draft interface map document including directory structures which was sent for comments to approximately 70 member organizations of the association and discussed in several committee meetings and seminars. The final interface map was implemented as a set of public web pages in HL7 Finland website [16] and published in October 2012.

The published interface map consists of 41 instances of metadata tables for interoperability specifications related to HL7 Finland (starting from 77 specifications many of which were re-grouped and moved to archive of outdated versions) four directories (classifications of the Results section and an alphabetical index), direct links to all specifications, and instructions for interface map maintenance. Maintenance comprises both guidance for classifications and acceptance of specifications according to the policies of the association, as well as technical tips and hints for web implementation of the interface map. For example, instructions were released to guarantee periodic updates of the map and to include all new specifications and versions as metadata instances in the map.

In relation to the requirements for improved support for standards utilization, the interface map approach and its realization provide the following achievements and improvements in comparison to earlier practices:

- Searchability and browseability: uniform metadata set and multi-directory approach support improved usability of standards catalogues or portfolios; in addition, the web-based implementation of the map supports use of site-specific or generic search engines.
- Consistent descriptive data: the metadata set of the interface map was selected based on experience and models from a number of existing approaches and previous research. It includes comprehensive administrative data, and most importantly scope and description data to support easy first assessment of standards. In addition, comparisons for different functional and organizational needs and project contexts are eased by the classifications.

- Clarity, validity, and responsibility assignments are supported by metadata on dependencies and version history of specifications, and instructions including recommendation for periodic updates and checks of the interface map.

Many generic EA classifications have limited use in terms of interoperability-specific considerations. The health informatics profiling framework (HIPF) [17], for example, is based on Zachman's enterprise architecture framework. We decided not to include its "level of specificity" and enterprise architecture "perspectives" in interface map metadata, because in practice, many interoperability specifications focus on conceptual or logical levels of HIPF and cover several perspectives, and most of the other information is not the primary interest of system implementation or acquisition efforts.

The interface map, as its name implies, focuses on an interface-based approach to interoperability and rather a pragmatic support for implementations. It is not aimed at realization of comprehensive or universal EHR interoperability; rather, it supports concrete integration needs for specific activities in an environment with multiple systems for specific purposes. Its classifications limit its use for specific areas of interoperability such as detailed collections for fine-grained semantic templates or archetypes, although parts of the classification can be extended to support such repositories. The maintenance work requires knowledge of each classification in addition to the understanding on each specification. All classification-related aspects are not always explicit in the specifications.

The interface map could also be useful for organizations such as standards bodies which need to support users of standards in locating relevant specifications among hundreds of documents. The classifications can also be used for analyzing standards catalogues and portfolios.

Conclusions and future work

In addition to development and harmonization of interoperability standards, support is needed for the use of standards and interoperability specifications. The interface map approach focuses on this support, providing complementary directories as well as consistent and concise metadata to support more efficient identification of relevant specifications for different user needs.

In addition to evaluation of content of each specification, the implementation base is one of the key factors affecting the adoption of specifications. For this purpose, a survey of implementations of different specifications in Finland was also planned but was not realized due to low response rate to a rather lengthy questionnaire. Feedback to the published interface map, however, has been positive, and systematic feedback gathering from the users of the map has been planned. Improvement ideas have thus far focused on keyword metadata, more detailed functional classification and full-fledged database or enterprise architecture tool repository implementation of the map. Even at this stage, the approach can be used both in organizational and standards development settings to ease the uptake and use of interoperability specifications.

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