

# IHE based Interoperability for Service Oriented Architectures

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**Abstract:** Introduction: Optimized workflows and communication between institutions involved in a patient's treatment process can lead to improved quality and efficiency in the healthcare sector. Electronic Health Records (EHRs) provide a patient-centered access to clinical data across institutional boundaries supporting the above mentioned aspects. Interoperability is regarded as vital success factor. However a clear definition of interoperability does not exist. The aim of this work is to define and to assess interoperability criteria as required for EHRs. Methods: The definition and assessment of interoperability criteria is supported by the analysis of existing literature and personal experience as well as by discussions with several domain experts. Results: Criteria for interoperability addresses the following aspects: Interfaces, Semantics, Legal and organizational aspects and Security. The Integrating the Healthcare Enterprises initiative (IHE) profiles make a major contribution to these aspects, but they also arise new problems. Flexibility for adoption to different organizational/regional or other specific conditions is missing. Regional or national initiatives should get a possibility to realize their specific needs within the boundaries of IHE profiles. Security so far is an optional element which is one of IHE greatest omissions. An integrated security approach seems to be preferable. Discussion: Irrespective of the so far practical significance of the IHE profiles it appears to be of great importance, that the profiles are constantly checked against practical experiences and are continuously adapted.

## 1 Introduction

Optimized workflows and communication between institutions involved in a patient's treatment process can lead to improved quality and efficiency in the healthcare sector.

Availability of relevant information can furthermore lead to significant cost reduction and increased patient safety [Co70, BD02, Ma02]. Electronic Health Records (EHRs) provide a patient-centered access to clinical data across institutional boundaries supporting the above mentioned aspects [WN02].

Those benefits can however only be exploited if involved systems are able to share required data amongst each other. In distributed environments a applications can be provided as services leading to a Service Oriented Architecture (SOA). Driven by the expected benefits in security, scalability and availability a variety of distributed, service-oriented architectures (SOAs) has been developed for Electronic Health Records.

As the majority of those systems is provided by different manufacturers a vendor-independent interoperability is seen as vital aspect. Integrating the Healthcare Enterprise (IHE) is a non-profit initiative founded in 1998 with working groups in North America and Europe with the aim to stimulate integration of health information systems [Ei05, IH06]. The IHE is not a standardization organization but rather defines so called Integration Profiles which cover most common clinical workflows by using and further constraining existing technical communication and data standards.

The IHE proposes in their Integration Profiles several distributed architectures which incorporate the SOA paradigm as each actor (system in the IHE terminology) provides clearly defined services which can be independently consumed by various other actors. The loose coupling and the clearly defined interfaces (mostly Web Services) allow IHE-based systems to be classified as Service Oriented Architectures, for that reason the SOA paradigm is implicitly presumed for all IHE-based systems discussed in this work.

**Problem Context:** Interoperability is regarded as vital success factor for shared electronic healthcare applications; however a clear definition of interoperability does not exist so far. It is unknown if currently available IHE Integration Profiles sufficiently support interoperability as required for EHRs. It is furthermore unknown if and to which degree extensions have to be applied to existing IHE Integration Profiles to support the desired degree of interoperability.

**Objectives:** Based on the previously described deficiencies the following goals have been identified:

1. Definition of interoperability as required for EHRs and extraction of assessment criteria.
2. Assessment to which extent the desired degree of interoperability can be achieved by existing IHE profiles

## 2 Methods

In an initial step a literature analysis [Ro04] has been carried out to find interoperability requirements for EHR systems. Findings of the literature analysis form the basis for

further considerations and are therefore outlined as the first part of the results of this work.

Based on the expertise in the field of Shared Electronic Health Records gained in the health@net project [Sc06] criteria have been elaborated to measure interoperability for EHR systems. Personal experience acquired in the process of integrating IHE compatibility in an EHR system including successful interoperability testing at the 2007 connect-a-thon in Berlin, Germany has been incorporated in the measurement criteria. The interoperability assessment described as objectives is supported by the analysis of existing literature and personal experience. In order to obtain reproducible and valid results those findings have been discussed and aligned with domain experts in the fields of HER standardization and security as well as with clinical experts which are involved in the requirements definition process.

### 3 Results

#### 3.1 Definition of Interoperability

Interoperability is required to support trans-institutional clinical data exchange in the context of EHRs [Ka06]. Therefore common criteria are necessary which implies a common understanding of the term interoperability. The IEEE for example defines interoperability as the:

“Ability of a system or a product to work with other systems or products without special effort on the part of the customer” [IE07].

#### 3.2 Criteria for Interoperability Assessment

This definition however addresses the interoperability problem on a very generic level which does not allow the extraction of the desired criteria. A different approach applied in this work is to derive a common set of interoperability criteria from requirements for EHR systems which have been published in literature. In order to fully support trans-institutional exchange of clinical data, basically the same requirements which apply for EHR systems can also be mapped as criteria for their interoperability. In the following enumeration the most relevant interoperability criteria are listed:

**Interfaces:** Has a common structure of interfaces been agreed on?

**Semantics:** Are data interpreted identically on systems of different vendors?

**Legal and organizational aspects:** Are local legal and organizational requirements correctly considered?

**Security:** Must the security level of a system to be decreased for the sake of interoperability?

The list above has been extracted from requirements for EHRs independently analyzed by [Ka06] and [Sc05]. Interoperable EHR applications must at least support those requirements in order to exploit the above mentioned benefits of trans-institutional clinical data exchange.

### **3.2.1 Coverage of Interoperability Criteria by IHE Integrating Profiles**

In the following section, a discussion of each criterion defined above is given with regard to which extent it can be covered by existing IHE Integration Profiles. The assessment is primarily based on our experience in the field of designing and implementing IHE compliant EHR architectures as well as existing literature.

### **3.2.2 Interoperability on Interface Level by IHE Integrating Profiles**

The core competence of IHE is to analyze common clinical use cases and describe a set of actors and transactions based on existing standards to support those use cases. Systems implemented and tested according to the IHE specifications basically support interoperability on interface level to interconnect EHR applications of different vendors.

However, based on our experience, Integration Profiles leave details open for implementation, which is, from the economic point of view, expected to support the market. Technically this might lead to slightly different interpretation of the specification, which may prevent successful communication between different systems as experienced in the 2007 connect-a-thon. The concept of IHE is interoperability testing and not certification. This means that systems attested conformity to an Integration Profile can be further developed. This “snapshot” approach allows vendors to further modify and improve their systems even after conformity has been attested, which furthermore allows modifications carried out during the connect-a-thon to be stabilized to a mature system. We however would like create awareness that changes to a successfully tested system might lead to side effects that can, in the worst case, break interoperability.

### **3.2.3 Interoperability on Semantic Level by IHE Integrating Profiles**

Semantic interoperability is a vital aspect to guarantee that data are interpreted identically in trans-institutional EHR applications. IHE has recognized the importance of semantic interoperability and aligned their Integration Profiles with internationally accepted standards for semantic interoperability such as the Clinical Document Architecture (CDA) and common medical dictionaries such as LOINC and SNOMED.

The common data format increases the likelihood that identical meaning of data can be preserved in trans-institutional EHR applications on a technical level. With currently available technology such as CDA, a very fine-grained structure can be applied to clinical data which allows even a language-independent identical interpretation. We however have identified two main challenges which are to be solved in order to profit

from those theoretic benefits: (1) As long as there is no strict requirement for producers to apply a fine-grained structure to their data, there will be large amounts of completely unstructured data which are expected to be interpreted anything else then identically. (2) Structuring of clinical data is expected to entirely change the workflow of data capturing. This is an organizational rather than a technical problem as health professionals must be motivated to switch from flexible free text to a rigid framework for data capturing.

### **3.2.4 Interoperability on Legal and Organizational Level by IHE Integrating Profiles**

One of the greatest challenges of the IHE-integration-profiles is the demand to be so specific that it could work, but also to have the corresponding range to fit the legal and organizational requirements of the different nations. The medico legal and organizational scenarios for different areas like Europe, USA or Australia for various actors of healthcare providers differs in many parts, so it's hard for a user group like IHE to develop integration profiles for different actors which meets all requirements worldwide. Therefore the possibility for development of national extensions is a very important precondition.

### **3.2.5 Interoperability on Security Level by IHE Integrating Profiles**

Security is a very complex topic as different institutions with distinct security requirements are involved. The IHE tries to solve security issues by a modular approach which is the definition of additional Integration Profiles such as the Audit Trail and Node Authentication (ATNA) and the Cross Enterprise User Assertion (XUA) which should provide security for existing profiles.

This approach simplifies the implementation process as security can be plugged in at a later time. In our opinion security should however be an integral part of each Profile and not an optional add on. If security becomes an integral part of each application, the concept of application layer security can be implemented which allows authentication and other relevant security features to be handled directly by the communicating applications and not as currently described in the ATNA Profile on network level between communicating nodes.

## **4 Discussion**

So far we have looked at the IHEs potential to solve the problem of interoperability from four different viewpoints. As we figured out the IHE profiles certainly make a major contribution to this problem, but they also arise new problems or do not solve the initial problems completely. Conformity with IHE profiles is not checked continuously by the IHE organization which can lead to interoperability problems itself as systems are constantly enhanced. It seems appropriate to implement a mechanism that deals with this problem. Another problem that is closely associated with IHE profiles is their missing

flexibility for adoption to different organizational or other specific conditions. Regional or national initiatives should get a possibility to realize their specific needs within the boundaries of IHE profiles without violation of interoperability. One of IHEs greatest omissions is the lack of security integration in its different profiles. Security so far is an optional element and can only be implemented on network level within the IHE profiles. An integrated security approach seems to be preferable.

Irrespective of the so far practical significance of the IHE profiles it appears to be of great importance, that the profiles are constantly checked against practical experiences and are continuously adapted. Local initiatives like the health@net project [Sc05] are able to provide an important contribution to the enhancement of IHE profiles with their practical experience.

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