OpenNCP: a novel framework to foster cross-border e-Health services

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Abstract. The continuity of cross-border health care in the European Union depends on the ability to set up shared practices with respect to patient data exchange across Member States. This flow of data must comply with demanding security, legal and interoperability requirements, as defined by the epSOS project specifications. In this paper, we describe the OpenNCP framework that offers a comprehensive set of interoperability services to enable national and regional e-Health platforms to set up cross-border health information networks compliant with epSOS, with minimal adaptation of the existing infrastructure. The OpenNCP, available as open source software, has been adopted in 10 Member States, allowing them to securely interconnect their eHealth infrastructures.

Keywords. Health Information Systems, Delivery of Health Care, Electronic Health Records, Electronic Prescribing, Semantics, Standards.

Introduction

The political goal of cross-border healthcare provisioning in the European Union (EU), clearly stated in the EC Directive 2011/24 on patient rights in cross border healthcare [2], raised the awareness to the need for interoperable eHealth and motivated the development of support initiatives [4], such as the set-up of the EU e-Health Interoperability Framework [1] and the funding of pilots for health data exchange. One of the most relevant efforts was the epSOS Project, aiming at designing, building and evaluating an e-Health framework and ICT infrastructure for patient data to be securely exchanged among different European healthcare systems [5].

The epSOS project selected a set of cross-border use-cases aligned with the EC e-Health Framework study [1], including the exchange of Patient summaries, (remote) access to the (domestic) prescriptions data, dispensation of drugs in the visiting country for domestic prescriptions, the Patient access to his/her information kept in different Member States, as well as the possibility to return a Healthcare Encounter Report (HCER) to the country of origin. The implementation of these use cases represents a major breakthrough in eHealth in Europe and has been the driver for a multitude of other initiatives, e.g.: the Antilope project dealing with certification and labelling processes (http://www.antilope-project.eu/), or the European/USA Trillium Bridge project (http://www.trilliumbridge.eu/) on cross-continental interoperability.

Figure 1 provides a representative example of the epSOS services usage for...
healthcare provision while the patient is abroad: the Patient receives care in a foreign country (country B) from a Health Care Professional (HCP). The HCP uses his usual point-of-care system and requests access to the Patient’s health record, stored in the eHealth infrastructure of country of origin (Country A). At this point, the epSOS services ensures that the HCP (authenticated by the Country-B infrastructure) gets the patient clinical summary, in a language s/he can understand, while having the patient consent. Information produced in the context of the encounter may be forwarded back to the Patient’s record in his home country. The cross border services are handled by clinical gateways called National Contact Points (NCP).

epSOS introduced a full set of specifications, including technical, legal, semantic and operational aspects to define an interoperability framework that builds on widely accepted standards, such as Health Level 7 (HL7) and Integrating the Healthcare Enterprise (IHE). epSOS also provided a reference implementation [5] that, later in the project, was changed to an open-source community implementation: the OpenNCP suite discussed in this paper.

OpenNCP solves the problem of securely exchange documents for care provision abroad, translated in the Health professional language, maintaining the clinical/legal value of the original documents. It delivers a comprehensive set of services (e.g., security, auditing, clinical documents generation, consent enforcement) to facilitate the integration of heterogeneous e-Health infrastructures, with different levels of standardization, in cross-border workflows [7]. More information and abbreviations lists exist in references [3], [19], [20], [21].

1. Methods

In the context of the epSOS framework, the legal grounds for the exchange of patient data are supported by a formal agreement between Member States, which sets the responsibilities of the participants in a peer-to-peer model, forming the concept of a Circle of Trust. Under this model, Member States set collaborations with each other and agree to ensure the required terms of service. This circle of trust is in fact the cornerstone of the OpenNCP Interoperability Architecture.

Figure 2 depicts the OpenNCP high level architecture, based on the defined epSOS specifications [7][8]. The NCPs act as gateways that process and enable the transfer of clinical documents between two countries. NCP major logic components are [8]:

![Figure 1. Sequence diagram illustrating the use of epSOS services for care provision abroad.](image-url)
• **Data Discovery Exchange Services**: establishes the communication, in order to allow patients to be identified and clinical information to be retrieved;

• **Trust Services**: ensures the circle-of-trust, i.e. the validation, verification, signing and mapping of messages/information as well as the patient consent mechanism;

• **Transformation Services**: used in the transformation of the involved clinical documents, in what concerns to the translation and mapping of taxonomy;

• **Audit Services**: assures the system traceability and operation auditing;

• **Support Services**: ensures service availability, response time, guaranteed delivery and session.

**Figure 2.** OpenNCP high-level architecture diagram

With this interoperability architecture, each NCP instance talks to its peers, mapping the concept of the Circle of Trust; there is no central coordinator node. NCP components heavily rely on IHE profiles and HL7 CDA, to which additional services are added (**Figure 3**). The technical interoperability is assured by **IHE Profiles** for defining the services (XCPD [10], XCA [11] and XDR [10]) and HL7 CDA V3 R2 [13] for information transport at clinical document level. The OpenNCP architecture does not imply changes in the National Infrastructures operations. Developers of national installations are only required to extend the base implementation of well-defined Connector components (e.g. PatienServiceInterface, DocumentSearchinterface).

**Figure 3.** OpenNCP components and main interactions.

The semantic interoperability builds on commonly agreed **Master Value** and **Master Translation/Transcoding Catalogues** (MVC, MTC) that define the set of terminologies and their representations in different languages. MVC is the main catalogue containing the agreed set of used concepts; the MTC is the catalogue instance, mapping the shared translation and transcoding to the each national representation. They are based on widely accepted standards (e.g., ICD-10 is used to code diagnosis, ATC-5 for medicinal active ingredients, etc.). Since all fields in the
exchanged clinical documents are bound to a well-defined coding system, it is safe to translate and transcode clinical documents between different languages and coding systems, to support different health systems and cultures.

The OpenNCP security components implement the security/privacy foreseen by the Circle of Trust legal agreement, including end-to-end secure communications (IPSec + SSL) and PKI infrastructure. IHE Profile XUA+ is used to communicate claims about the identity of an authenticated actor (e.g. Healthcare professional) [14]. Key transactions are audited through IHE Profile ATNA [15]. The patient consent is also considered and secured by the IHE Profile BPPC [16], which allows consent to travel from one country to another as well as to be given on-the-fly, if needed.

2. Results

The open licensing scheme and the decoupled component-based architecture (allowing them to be integrated piece by piece or as a bundle), facilitates the integration of already established National Infrastructures. OpenNCP deals with all the “plumbing” (security, IHE compliance, document formatting and parsing, etc.) and offers a high level API of services for Infrastructures to use. OpenNCP has an associated web graphical user interface (Gnomon Portal B) that incorporates a specific CDA display tools, enabling visualization of information for the end users.

OpenNCP has been adopted by 10 Member states (+3 testing), which already validated their systems in integration testing events [18]. Table 1, shows the overall adoption as in June 30, 2014 (additional initiatives in progress). The movement from testing towards production is expected to flourish in the context of the European Interoperability Framework uptake.

<table>
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<tr>
<th>Country</th>
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3. Discussion

As for related work, the FET Solution was the first to be delivered by the epSOS project [6]. It was built upon several industry closed-source, licensed core components, complemented with other very specific open-source components. OpenNCP was introduced to reduce operational costs and directly focus on the epSOS specificities. For non-epSOS scenarios, it is worth noting that the Open Health Tools initiative (http://www.openhealthtools.org/) delivers a set of commercially-free IHE profiles.
implementation. Open Health Tools do not provide the semantic and security services addressed by OpenNCP, and required for the EU cross-border scenarios.

OpenNCP is being used to enable cross-border e-Health information exchange, still in a piloting stage in several countries. The OpenNCP builds on industry standards, for technical interoperability (e.g.: IHE, HL7, SAML, etc) and clinical data representation (e.g.: SNOMED); none, however, cover per se the requirements defined for the epSOS cross-border use cases. OpenNCP adds services to provide enhanced security and data alignment requirements, while facilitating the integration of the existing national e-Health platforms [17].

OpenNCP provides a novel and verified framework to build “National gateways” to foster an e-Health ecosystem across Europe [18]. Its adoption by the Member States has raised expectations about the enhancement of the interoperability services that are now being handed to new projects for expansion and market developments (e.g.: EXPAND, STORK and Trillium Bridge). OpenNCP has been acknowledged as an interoperability asset to be reused under the Connected Europe Facility to create the information highways of tomorrow in a pan-European scale.

Acknowledgments

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References