Medical Virtual Public Services

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The healthcare enterprises are very disconnected. This paper intends to propose a solution that will provide citizens, businesses and medical enterprises with improved access to medical virtual public services. Referred medical services are based on existing national medical Web services and which support medically required services provided by physicians and supplementary health care practitioners, laboratory services and diagnostic procedures, clinics and hospitals' services. Requirements and specific rules of these medical services are considered, and personalization of user preferences will to be supported.
The architecture is based on adaptable process management technologies, allowing for virtual services which are dynamically combined from existing national medical services. In this way, a comprehensive workflow process is set up, allowing for service-level agreements, an audit trail and explanation of the process to the end user. The process engine operates on top of a virtual repository, providing a high-level semantic view of information retrieved from heterogeneous information sources, such as national sources of medical services.
The system relies on a security framework to ensure all high-level security requirements are met. System's architecture is business oriented: it focuses on Service Oriented Architecture - SOA concepts, asynchronously combining Web services, Business Process Management – BPM rules and BPEL standards.
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1 Introduction

The overall project objective is to research, design and develop technology innovations, which will create and support a software environment that provides user-friendly, advanced interfaces to support medical services for citizens and businesses – administration interactions involving many different health care organizations within the European Union.
As the healthcare market is very global, patients as customers contact US, European, Japanese and other Asia Pacific countries health institutions, context which shows that several recent advances in e-Health must be oriented to a much more ubiquitous and pervasive infrastructure around Electronic Patient Records, given a patient a much more important role in managing his or her own health.
The past few years offered systems that perceive emergencies for patient lives. In this situation can be created and used electronic devices in order to try to contact the corresponding patient, recognize his status and ultimately if they decide that the patient runs an urgent situation, to give phone calls and messages to the emergency center so as the patient will be medical attended immediately. Just like the previously mentioned system, the Health Information Service Bus will offer fast and sure medical solutions because of an easy access to any patient information, medical background and diagnosis notes. Furthermore, e-Health includes use of the internet or other electronic media to disseminate health related information or services, accurate, easy to find, according to client needs and up to date.
Key challenges in Healthcare are:
- improved quality of life - save lives, reduce patient discomfort, reduce medical errors, improve patient outcomes by earlier diagnosis and thus lowering costs of subsequent treatments;
- cost control - demographics (aging popula-

tion), increasing fraction of GDP, healthcare growth in developing countries.

A very important concept to be mentioned here is telemedicine, technology that assures a totally integrated system, the best possible care for patients no matter their location and/or other time and spacewalk means.

Business solution's specific *objectives:*

- to create adaptable process management technologies by enabling virtual services to be combined dynamically from the available set of existing functions;
- to improve effective usage of advanced medical services by information technologies by means of service-level agreements, an audit trail, semantic representations, better availability and better performance;
- to organize currently available Web services according to the specific life-event requirements, creating a comprehensive workflow process that provides clear instructions for end users and allows them to personalize services as required;
- to support a virtual repository of data sources required by medical processes, including meta-data, declarative rules, and procedural knowledge about medical services categories.

Generally, citizens and businesses will profit from more public services that are accessible. The following concrete *benefits* will be achieved:

- improved public medical services for citizens and businesses (free for service patients, medical clients or companies with benefit plans, medical employees);
- easier access to cross-border services and therefore a closer European Union that offers unified services for its citizens, no matter the location, language or social status;
- improved quality communication, through an integrated system for all user types: medical employees, patients, companies as medical clients;
- increase in productivity by a reduced red tape.

2. Lifecycle Stages

To accomplish these challenging objectives, Health System researches advances in business process and Web service technologies. Virtual repositories provide data abstraction, and a security service framework ensures adequate levels of data protection and information security. Multi-channel interfaces allow users easy access using their preferred interface. Based on the project goals, research is being conducted in seven *main directions*:

- Design - Scenarios and Requirement Analysis
- Modeling and Architecture
- Process Execution and Web Services
- Virtual Repository Management
- Security Framework and Qualified Signature
- Prototype Implementation
- Process Monitoring and Process Optimization

2.1. Requirement Analysis

The main objective of the project is to deliver a set of tools which both enable and facilitate the construction of an application which integrates various medical IT systems built locally by public administration bodies at the European level. The major constraints for this kind of solutions have been stated in the document on European Interoperability Framework - EIF for pan-European e-Government Services - PEGS. EIF emphasizes several principles: accessibility, multilingualism, security, privacy, etc. all of which need to be considered during development of any supranational solution.

To sum up, the *state of the art* consists of:

- interoperability constraints – heterogeneous applications behave as an integrated system;
- requirements – potential areas of interest for PEGS (with regard to requested functionality) based on various published survey reports;
- existing technology – the latest technology platforms;
- legal issues – personal data protection, handling of sensitive data.

Requirements to move the vision from e-Health to an integrated service bus are:

- portability of electronic patient records information;

- technical and political issues need to be resolved;
- different health systems throughout the EU must be brought to a common sense;
- the system should be the way to document the complete history of a patient from birth to death:
  - will require a unique patient number: privacy and security concerns;
  - who will have access to the information (DNA or other);
  - economies of scale need to be reached;
  - will link many systems together: technology will not be the issue, but the definition of standards and processes;
  - will also allow patients and doctor's access to the relevant information;
  - in order to make the many examples of e-Health activities successful all information about the patient needs to be available;
  - the data explosion will not allow to have all information stored in a single system, but to consider repositories to offer a organized and transparent way of storing, localizing, accessing and monitoring data.

Project implementation will require teamwork between all industry actors (manufacturers, health systems, doctors, insurers) and the public sector.

The lack of homogeneity in the healthcare organizations requires a suitable implementation of Workflow automation tools to create and manage the execution of the care giving processes, customizing them to local ward needs. Solutions for this problem, as well as the integration of the workflow organizers to be used by individual health professional during daily activity, are to be discussed.

2.2. BPM Architecture

As the project is situated at the European level, the main technical requirements are scalability and modularity (as the European community can grow, any new European country may be able to join the bus without changing the system's architecture), non-intrusive access to data. The use of existing or slightly modified standards is another requirement. The functional requirement is to allow any European citizen to access the public medical services no matter his localization or language. Since the system will potentially be processing private data, an implied requirement is that the whole process must be entirely secure.

2.3 Web Services

Business Process Management - BPM support, Service Level Agreement - SLA enforcement, asynchronous behavior of the Web services are provided by combining various Web services additional standards. The implementation of a Service Oriented Architecture - SOA ensures business orientation according to a distributed computing paradigm.

There are four *possible scenarios* for accessing services based on existing e-Medical services:

- direct service access for services which don't need to be enhanced;
- direct service access via enhancements for existing Web services which are compliant;
- access to services via Web services relay that encapsulate existing Web services which are not compliant;
- access to services via a service abstraction layer which exposes legacy application functionality as compliant Web services.

2.4. Virtual Repository Management

Technically, a virtual repository (Fig.1) is a mechanism that supports transparent access to distributed, heterogeneous, fragmented and redundant resources. There are many forms of transparency, in particular location, concurrency, implementation, scaling, fragmentation, heterogeneity, replication, indexing, security, connecting/ disconnecting and failure transparency. Due to transparency implemented on the middleware level, some complex features of a distributed and heterogeneous data/service environment do not need to be included in the code of client applications. Moreover, a virtual repository supplies relevant data in the volume and shape tailored to the particular use. Thus, a virtual repository much amplifies the application programmers' productivity and greatly supports flexibility, maintainability and security of software. A central part of the architecture consists of ODRA (Object Database for Rapid Application development), an ob-

ject-oriented DBMS (DataBase Management System). Existing resources are extended by wrappers and contributory views (or importers/exporters) that convert data/services proprietary to particular existing applications into the format acceptable for ODRA. The application developers can install as many ODRA servers as necessary, addressing the same distributed sources. The integration view on an ODRA server allows for the virtual integration of data and services supplied by distributed sources, supporting many of the transparencies mentioned above.

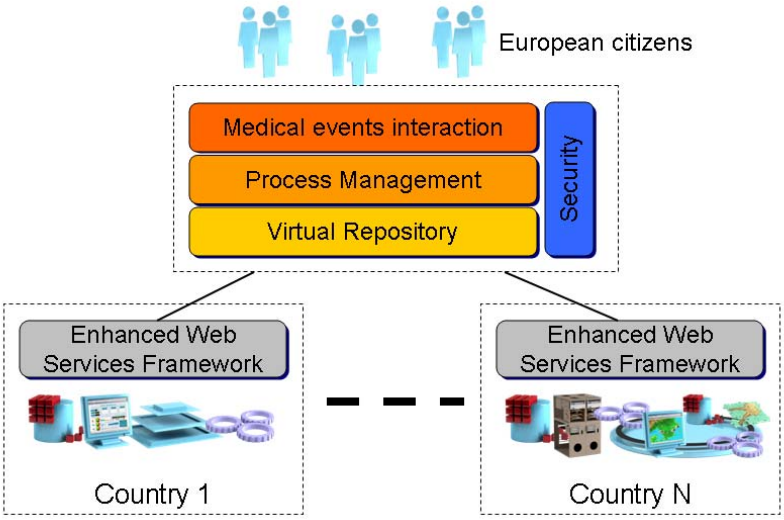

Fig.1. Architectural overview

As for *advantages* of the solution, the following could be mentioned:

- most obvious solution for the situations where there are already web services implemented;
- will require minimal but strict modifications on the existing web services;
- transforms regular service input and output into a web service;
- least intrusion when implementing.

Possible *disadvantages* are:

- not all medical services fulfill framework requirements;
- requires implementation effort to cope with unsupported standards;
- message processing overhead due to protocol encapsulation for non-supported standards;
- custom connectors have to be written for each of the existing applications in order to be fully integrated with the whole system.

2.5. Security Framework

In order to develop solutions that are capable of seamlessly in national corporations, legacy identification and authentication solutions, which includes national ID cards, qualified electronic signatures or new approaches, such as Microsoft Cardspace, the system's services rely on standard Web service security mechanisms. These mechanisms are: the OASIS standard specifications Web Service Security, SOAP Message Security (WS-Security) and the Security Assertion Markup Language - SAML, modular security services, implemented as SOAP/WSDL based Web services, which provide qualified signatures, encryption, authentication, secure timestamps or secure auditing.

System's architecture chooses as a security solution on the client side the usage of smart cards. The purpose of adopting a programmable smart card will be to ensure the highest levels of security and users' privacy. Each client could utilize a personal smart card to securely hold information for multiple usages to include, for example, different medical consultations. Whenever medical record information from different clinics/hospitals for the same client is needed to be linked together, the client can dynamically release the necessary identifier information from his smart card. The smart card can also provide a secure platform for hosting and execution of

different software "agents" from different parties. Utilizing a patient-centric approach, sensitive medical information can be collected from distributed medical databases in different clinic/hospitals and linked together on demand dynamically without revealing the patient's identity. While this pseudo-anonymity preserves user privacy, the architecture design allows the anonymity to be revocable under well-defined policies with legal-compliance. Thus, the new system can inherit the advantages in centralized management and access to distributed medical databases and repositories while protecting patient privacy. Although constrained by its limited computing power and resources, a smart card can operate as an effective secure token for dynamic identity management in e-Health system.

2.6. Prototype Implementation

During the implementation phase of the project, we have to take several points into consideration:

- that the functional requirements are all meet;
- that the issued programs meet the technical requirements;
- that there is no security gap between the modules.

The implementation step should begin with analyzing system's requirements and studying the possibility of accomplishing them according to the available resources. A detailed report that will be validating the project's implementation by figures should become available.

First step is identifying medical application that will be integrated in order to work together as a complete and integrated system. Available web services must be wrapped using the virtualization engine to ensure compatibility of data, business functions and secure a full duplex communication between heterogeneous parts.

The following step is one of a great importance and it gives to the proposed solution the opportunity of being useful and used in production, not only as a theory. It consists in the approving of the project by important players of medical market who must sustain and cooperate for the project implementation and offer all legal and material resources required in order to have a functional system.

2.7. Process monitoring and optimization

Process monitoring and process optimization phases will begin as lifecycles once the system enters its production state through software implementation, functional testing and usage by the targeted actors. Following the stages as described, the development process will becomes an iterative one, being analyzed, reconsidered and designed as a result of its performance and productivity. Users are active participants to these stages of the process, contributing to the future evolution of the system, once given to usage.

3. Conclusions

As European medical services are very heterogeneous and healthcare enterprises disconnected, the architecture proposed by this paper comes as a lien between medical system's actors: individual patients, business clients and medical employees in the context of their affiliated medical institutions. The combination of information technologies and concepts such as Web Services, Service Oriented Architecture, Business Process Architecture, in the way presented, leads to the integration of all those services in order to provide European citizens with easier and efficient access to a unified healthcare system, no matter the position from which they use system's services. The healthcare information system is meant to support the clinical and administrative information management needs of the various stockholders in today's world of contracted healthcare services – from insurer to provider organization, from patient to clinician. The solution intends to be a multinational complete suite for healthcare planning and service delivery management, situated at the European level.

References

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