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Towards a Knowledge-Based Secure Healthcare Resource Balancing System

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ABSTRACT

This paper describes the collaborative partnership between European regions with the objective of developing a secure information network for the advancement of healthcare and humanitarian aid work. The basis for the project is the EU i2010 Initiative (European Information Society for Growth and Employment (June 2005)). The aims and objectives of EU i2010 are to ensure that European business, governments and citizens make the best use of ICT in order to improve industrial competitiveness, support growth and the creation of jobs, as well as aiming to address key societal challenges including geographic and social exclusion. The combination of a widely dispersed population, healthcare provision in remote environments, and an overall shortage of medical professionals, are key issues in the delivery of services. The objective is therefore to establish a system to overcome a lack of qualified medical professionals and establish cross-border data transmission to improve patient treatment and optimize existing healthcare resources. The intent is develop a platform application which can then be transferred for the benefit of other healthcare services.

Keywords (Required)

Medical Informatics, Secure Networking, Medical Imaging , Cross boarder patient data transmission, GRID technology

INTRODUCTION

Information technology has enabled new possibilities in providing and distributing public services, which includes the renewal of processes in the healthcare sector. Consideration of patient requirements remains of the highest importance when improving the quality and cost effectiveness of healthcare services. State-of-the art eHealth applications, electronic patient records and secure broadband networks will improve the quality of delivered healthcare services equally regardless of distance between the healthcare provider and the patient [1]. The regions in the consortium described in this paper have become robust in this specific area of health informatics, combining challenging research and educational activities with active development work involving Small to Medium sized Enterprises (SMEs) and healthcare professionals. This consortium has the ability to generate new, innovative, and user-friendly eHealth applications, monitoring and diagnostic devices to support the distribution of healthcare in a new holistic way.

One of the specific regional characteristics of the Finnish partners in this consortium is the sparsely population in a large geographical area. This aspect, in conjunction with increasing healthcare costs and the growing problem of healthcare professionals emigrating, creates a conflict between the legislation which defines equal healthcare services to all citizens [2]. It has led to a situation, where healthcare policy makers, researchers and healthcare professionals have been compelled to deliver healthcare services in new, even radical, methods.

The primary aim of these facts led us to postulate the efficacy of a secure, usable and effective clinical information network for the advancement development of a suitable grid methodology to support humanitarian aid work. The basis for the work are open standards, interoperability and reliability with the aim of the wide exploitation of grid networking technology to ensure that industry, governments and citizens make the best use of ICT in order to improve industrial competitiveness, support growth and the creation of jobs, as well as aiming to address key societal challenges.

The hypothesis of the work is based on the conception that special healthcare services can be provided equally to developing countries alike in industrial countries. By utilizing new information and communication technology it is possible to distribute and deliver the best knowledge available provided by different specialists acting in the healthcare sector**.** This proposed approach can be seen as a generic model for the existing phenomena to provide humanitarian aid. Medical imaging has been chosen as a specific special healthcare sector in order to validate the new service model. The work aims to provide proven evidence of the best ways for humanitarian aid organisations to utilise grid methods to support the operative work. This work for humanitarian organisations, beside its high necessity for mankind, will prefigure what could be deployed in Europe for daily clinical practice.

This research aims to generate well defined and theoretically proven methods and guidelines to utilise GRID method in supporting humanitarian aid work. The conclusion will mainly deal with the following issues: impact, feasibility and validation of the new service model. The research will face the upcoming challenges of interoperability from the service oriented architecture point of view.

The outcomes of the work will generate research results to support a new clinical services model based on the knowledge generated out of the interface layer, application layer, security layer and GRID layer. These outcomes will be measured by technical and usability studies in order to provide evidence of the efficacy and effectiveness of resource balancing of medical experts, information sharing as well as sharing archiving capacity to support humanitarian aid. Humanitarian aid organisations can utilise a new holistic way of providing healthcare service to areas most in need which will fabricate a new organisation models in the context of grid and data-based infrastructure This strives to produce added value, quality and cost-efficiency for the healthcare sector.

OBJECTIVES

The objective is to coordinate and support research activities in order to establish a secure infrastructure-based service. This service would ultimately aim to:

- overcome the lack of qualified healthcare specialists
- establish trustworthy cross-border data transmission
- improve patient treatment and optimise existing healthcare resources
- use existing healthcare resources for humanitarian aid purposes
- provide a powerful tool for the development of expert databases relating to specific disease areas particularly for rare disorders, where clinical data sharing will expand and enhance knowledge relating to diagnosis and treatment

This research will further investigate grid techniques to enable the effective management of resources across different time zones, and the availability of healthcare personnel for rapid diagnosis in large scale incidences. The combination of increased critical mass of clinical data in particular disease areas, and the use of new intelligent prognostic techniques will potentially lead to improved diagnosis and increased quality of care.

The chief outcome from research will be an increase in the quality and efficiency of humanitarian healthcare delivery through the secure outsourcing of clinical data. Other outcomes include the definition and dissemination of the necessary organisational and technological changes required to deliver these improvements, with a view to continually extending the technology to include an increasing range of clinical applications. These outcomes are envisaged in order to provide a high profile focus that can bring together the various multidisciplinary aspects of work. The results would also raise the profile of new ways of working for organisations in the field of providing humanitarian aid and inform the end users of issues concerning secure, cross-border and cross-cultural, transfer of clinical knowledge (and bring interdisciplinary expertise to bear upon key and fundamental issues) as well as developing a deeper understanding of the efficacy of using ICTs in clinical and healthcare environments and to learn from previous experiences.

The study would also enable the provision of evidence for a high-quality and equitable method of clinical knowledge exchange supported by ICT. Additionally the outcomes would include the production of a summary of relevant technical

standards within a legal and ethical framework with due consideration to privacy and confidentiality issues as well as develop organisational standards and protocols for the clinical sector.

KNOWLEDGE CREATION AND SHARING
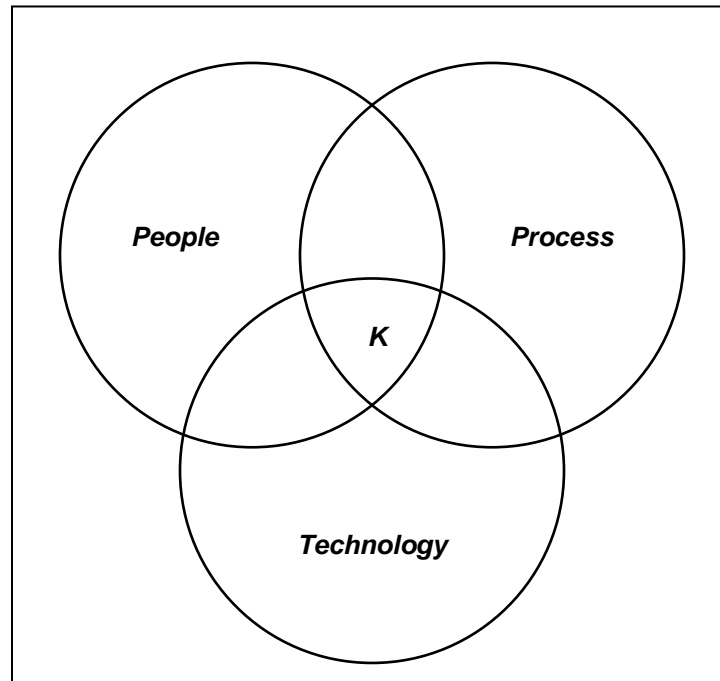
The diagram above shows the inter-relationship between people, process and technology. The intersection between the three aspects provides us with Knowledge. The work will fully support this schematic in order to achieve value-added knowledge, enabling us to achieve the following project aims and objectives:

THE TECHNOLOGIES

The research will adopt a four pillar research and governance strategy: (1) interoperability, (2) legal and ethical issues, (3) research and knowledge management and (4) service-oriented architecture. This strategy will be underpinned by four project instruments: (1) interface layer, (2) security layer and (3) applications layer and (4) grid layer. The combined output of these instruments generates knowledge. Monitoring and evaluation will be carried out by 3 metrics: (1) impact, (2) feasibility and (3) validation.

By creating a secure information society, the development of eHealth and the usability of health informatics will be increased. The aim is to provide higher quality of healthcare in a more efficient way. The objective is to follow the initiative mentioned in the i2010 [3] and provide a demonstration and testing environment to:

   – Improve the quality of life
   – Ensure interoperable digital rights
   – Ensure management of patient data in a secure information society
   – Introduce actions to overcome the geographic and social digital divide among all citizens.

Once an environment of trust [4] has been created, cross-border patient data transmission will allow consultation from one region to the other. This will enable the balancing of medical recourses, and could be applied, for example in the consultation of MRI images.

THE ACTORS

As bounding parties, *Helsinki University of Technology* (Finland), together with their partners, and *Coventry University* (UK), together with their partners, play a major role in turning the multidisciplinary research and development work into success stories. Resource balancing in medical imaging has been chosen as one of the focus areas as studies clearly indicate that the arising challenges in healthcare, especially in remote areas, can be matched, at least partly, with eHealth applications and the endorsing technology [5]. The goal is to provide scientific evidence for best practice in healthcare. In addition, the latest technology i.e. secure broadband, videoconferencing [6] and eLearning [7] methods will be implemented in everyday use in the region.

Helsinki University of Technology (TKK)

The University is the oldest university of technology in Finland and a pioneer in the field of technology in the country; its fields of education and research cover all areas of technology that are of importance to the Finnish economy (including architecture). The University is involved in nine national Centres of Excellence in Research. Nominated by the Academy of Finland, the Centres of Excellence carry out research on topics ranging from nanotechnology and radio technology to bioadaptive materials and brain activity.

Coventry University

Coventry University is a forward-looking, modern University with a proud tradition as a provider of high quality education and a focus on multidisciplinary research. The University is an established academic presence regionally, nationally and internationally, occupying a purpose-built 33-acre campus in the heart of Coventry City centre. The Biomedical Computing and Engineering Technologies (BIOCORE) Applied Research Group at Coventry University undertakes research relating to the development and application of computational methods, biomedical engineering and healthcare systems for the analysis, interpretation, prediction, as well as for the design of biological, clinical and health-related processes.

MEDICAL IMAGING AND RESOURCE BALANCING

The objective of the research is to foster the possibilities of a new GRID-based service model to support the distribution of healthcare services more efficiently and more equally than before. The goal is to combine GRID methods, Information Security Management Systems, medical applications and a network of experts to become one holistic entity. The model will support distribution of healthcare services in a new way, supporting and consolidating humanitarian work.

The target and objectives is to study the usability and effectiveness of GRID technology within the global healthcare service. The objective of the research is to study the usability and effectiveness of the theoretical model as well as validate the state-of-the-art technology from the humanitarian aid point of view. The research will be carried out by using the existing networks, ensuring that the model will match up with existing standards and guidelines and by end-users rating the model. From the Information Security Management Systems point of view in medical applications, the goal is to understand the demands of privacy and fulfil confidentiality (by way of authorisation, strong authentication, role-based access controls and identity management).

The core of the method is the GRID resource broker with the real-time balancing and allocation of resources, which will knit together the separate partners into a network of trust. This model will enable more effective management of resources across different time zones. At the same time, the expectation is that the data collected from the field will be archived in a structured manner in order to get the maximum benefits out of the information from the research and educational point of view. The sharing of resources is not primarily file exchanges but rather direct access to databases, software, professional resources, as required by a range of emerging collaborative problem-solving and resource brokering strategies. This sharing is necessarily highly controlled, with resource providers and rules defining clearly and carefully what is shared, who is allowed to share, and the conditions under which sharing occurs.

The second goal examines the imbalance between clinical demands and available resources in a crisis situation. Historically, the healthcare sector has been unable to effectively address the imbalance; however, with modern ICT (Information and Communication Technologies) systems, it is possible to share expert knowledge, use sophisticated data manipulation software, archive data in servers, and share information (and storage capacity) across geographical borders in a secure internet environment. Within future initiatives, we will be seeking to investigate other areas of healthcare where this model may be applied.

FUTURE WORK

The future initiatives will seek to investigate other potential areas of healthcare where this model may be applied. One option under consideration is the use of digital pen and PDA technology to encourage increased reporting of clinical/anaesthetic outcomes and adverse incidents. Project objectives include improving healthcare risk management and achieving consistent clinical outcomes based on improved reporting methods. A successful pilot has been conducted in Australia, creating an opportunity for technology transfer to the UK & Finland to evaluate and improve the product. This involvement would expose the technology to a wider professional audience and different healthcare systems; with a strong emphasis on usability and effectiveness. Other potential application areas include the mapping of drug trial patients, and development of healthcare search engines.

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