Service oriented architecture as an enabler of ICT integration and optimization in public protection and disaster relief services: case study of medical emergency services in Finland

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Abstract—Current global initiative is geared towards improving health care services using service oriented architecture (SOA) and Web Services or REST. The decision support systems so far introduced have been based on software development approaches and architectural philosophies that have inherent limitations and therefore do not adequately tackle the growing pressure on the health care services such as the emergency medical services and the integration of systems that support such services. These systems are to a large extent not interoperable and do not support agility, reusability and integration owing to the approaches that gave birth to them. Since health services are moving towards the adoption of SOA and Web Services, this paper proposes a SOA model for use in medical emergency vehicles and their control centres together with a conceptual innovative service blue print for the domain. The primary idea is to address issues of ICT integration, interoperability and support for information inter-change within the domain. The paper also presents the outcome of a survey which sought to test the popularity and viability of SOA as a technology for adoption including its implementation using Web services or REST. Issues that affect the adoption and implementation of SOA and suggested ways through which they can be addressed are also presented. The research findings suggest that, a SOA solution is feasible in the problem domain and standards-based interoperability and integration can be achieved.

Keywords—Data communications, Fire and rescue services, ICT, Health services, Service oriented architecture, Systems integration, Web services, Database.

I. INTRODUCTION

THE health care sector remains a very vital sector in every locality, region and a nation in general. This cannot be overemphasized as the growth of localities, regions and nations is a function of a healthy citizenry. The provision of a sustainable and effective healthcare system is therefore paramount. The health sector has witnessed the introduction of computer decision support systems and technologies to enable the attainment of an effective healthcare system in the past. Due to growth, these systems do not match current demands with respect to service delivery and integrated administration across different health domains. The Emergency Medical Services (EMS) is a domain in the health sector of which services are always pressurized when an emergency occurs as this often warrant calls for desperate ICT systems and services to function efficiently and effectively in order to manage the emergency. First emergency responders such as Medical Emergency Vehicles (MEVs) need to be effectively supported ICT-wise. An inter-sectorial and intra-sectorial integration strategy is necessary to achieve efficient EMS [1], [18] and [24]. There is therefore the need to explore emerging technologies and software development paradigms with the aim of utilizing them to support ICT systems and services that are used in MEVs and their control centres.

However, the interoperation of computerized systems and software applications poses a major problem for present day public and private enterprises including the health sector. Apart from the gains of return on investment, automatic data and information exchange between partners or branches of the same organization is often difficult to achieve. This is owing to the fact that, data and information models are different and the software application methods that are also employed are largely incompatible [3] and [12]. The MOBI project [35], [36] and [37] partly aims to tackle systems interoperability and integration between emergency vehicles in European countries and of which this research aims to make a contribution to. Towards achieving standards-based interoperability between ICT systems and services in MEVs and the control centre, this research considers the Service Oriented Architecture (SOA). Its main goal therefore is to design a future emergency medical vehicle.

SOA has become one of the most visible and emerging software development paradigms in the field of computing in recent years. In [31], SOA is an architectural paradigm which enables the organization and the utilization of capabilities which are in a distributed platform and which may have different proprietary domains. It is an architecture which provides for a set of loosely coupled services and interfaces. The access to these interfaces does not require any knowledge

of their implementation platform. These interfaces can be published over the World Wide Web, discovered and invoked by various service users. According to [47] and [48], Web services are the most common form of SOA implementation framework and the service interfaces they provide are described via Web Service Definition Language (WSDL) while the Simple Object Access Protocol (SOAP) is also commonly used to transfer data over HTTP. However, it is well acknowledged that, SOA provides for a technology platform which takes cognizance of the changes that are inherent in a business climate and is able to effectively and quickly react to such business changes when compared to earlier architectures.

II. RELATED WORK

There are however several approaches and technologies surrounding the SOA paradigm. Current research proposal towards resolving systems interoperability and integration is the merging of the SOA and the model driven Architecture (MDA) paradigms [16]. In [33], the approaches and technologies which enable the unification of SOA principles and concepts with those of event driven programming were reviewed. These technologies which we would later consider in more detail include the Enterprise Service Bus (ESB) and Web Services. Since SOA enables loose-coupling and interoperability between heterogeneous platforms, their paper focused on the ESB and a description of an array of functions which are produced to provide a controllable and standards-based backbone which in turn extends middleware functionality via the connection of heterogeneous platforms. The integration of services is enabled in the process. They went further to propose an extension of the traditional SOA through the provision of some vital requirements of the ESB which includes service orchestration, service management, smart routing, provisioning, integrity and security of messages. The outcome of their research would help us resolve our research question as we apply the reviewed approaches and technologies in the creation of an SOA model for medical emergency vehicles and the control centre.

However, [7] proposed a framework that is based on the service oriented architecture for a community-based referral information system. Their work shows a way of achieving systems integration, sustainability and stability through the adoption of SOA. While SOA is the main software development approach that the research adopted, a relational database model and concepts such as an Ontology which makes use of the Extended Markup Language (XML) together with Resource Description Framework (RDF) were incorporated into their framework to enable the delivery of data to the user. Whereas their work is based on a community referral system, the current study seeks to explore SOA with the aim of applying it in the area of medical emergency vehicles. The problem space is therefore different but the result of their research provides useful insights to enable the current study.

Also, [13] in their paper titled "A Cross-Functional Service-Oriented Architecture to Support Real-Time Information Exchange in Emergency Medical Response"

adopted SOA which utilizes shared data models of medical emergency incidents to enable the exchange of data between heterogeneous systems. Their work is closely related to our proposed study though it stresses the need for real-time information exchange between desperate heterogeneous platforms in a disaster scenario. It also drives home the point that the SOA paradigm provides support for tackling interoperability issues between different software systems. SOA was used in the development of the Washington DC Metropolitan region's Advanced Health and Disaster Aid Network (AID-N) system. The system serves as a test-bed for the investigation of technologies which aim to improve the interoperability between numerous emergency response organizations. The application of SOA enabled the research team to provide real-time data exchange between different and separately deployed systems which includes a pre-hospital patient care reporting system used in medical ambulances, a syndromic surveillance system used by public health departments and a hazardous material reference system. Their research work provides useful details which can be used in our proposed study. Our case study would later adopt this shared data model in part of our design. Their messaging model is rather typical of the usual SOAP messaging framework already in use.

In [46], a SOA model for medical image processing has been proposed. This model consists of a programming model, service model and a messaging model. In our attempt to create a SOA model for MEVs and the control centre, this research found their contributions very useful as their proposed model is generic enough to be applied to our problem case study. We would modify this model to suit the needs of our case study during our design. We would particularly be interested in the programming model where we would be proposing the core use of Object Oriented Programming rather than Component Development Programming as proposed by their paper.

A. State of SOA and Web Services Research in Finnish Health Services

There is a known national development effort to revitalize the Finnish health services (FHS).To this end, a lot of research has been going on in Finland with the aim of re-designing and improving upon the current FHS IT-wise as can be seen in [23], [26], [27], [28], [44], etc.. The research which cuts across various facets of the FHS has been undertaken by independent researchers in one hand and the Finnish government in partnership with the academia and private companies. One of the key issues identified for research is how to achieve systems integration and interoperability which is caused by the existence of different technologies and organizational operating environments coupled with increasing growth in the health care services. Towards the goal of achieving systems integration, interoperability and generally improving upon the health services, several systems development approaches were explored and standards proposed.

In [18] the HL7-OMG health care services framework is a framework for the application of SOA and standardized structured information model based on XML to enable

semantic interoperability among systems used in the health care services. Their research shows that, the health care sector stands to make significant accomplishments if the adoption of SOA is considered based on the HL7 specification and standards. HL7 identifies services for standardization and defines service functional models (SFMs). These SFMs helps to specify the capability and conformability criteria for the services so identified. According to [43], SOA and the HL7 CDA R2 standards is a recognized tool which easily enables the storage and sharing of medical information in a uniformed way that supports semantic interoperability. This tool according to Suna was commissioned for use in the project implementation of the Finnish national health record archive by the Finnish Ministry of Social Affairs and Health. The national health archive known as KanTa is expected to be operational starting from this year.

The idea of exploring SOA and Web Services with the aim of using it to tackle system integration and interoperability problems is not new to the Finnish health care sector. It is however, a global initiative to generally improve health care provision. The specification by HL7-OMG triggered a lot of research in the area of service oriented computing and its applicability in the Finnish health care services. Towards resolving systems integration in the health care and also generally, it has been acknowledged that singular technological solutions are not enough to tackle integration hence in [28], different integration models were proposed for health information systems (HIS) with the hope that project teams can identify, combine and apply these models together with appropriate set of standards to enable their solutions.

The health care sector is a large sector with multi-faceted departments having heterogeneous software systems and different levels of organization. Research that seeks to apply SOA and Web Services to specific health domains as in [7], [13], [23], [25], [41] and [46] is needed given the nature of health services. Most of the research that has been carried out so far has provided frameworks, guidelines and standards for the application of SOA and Web Services aimed at the whole health sector. However, given the size and complexity of the health services sector there is need to consider specific health domains where SOA and Web Services can be applied. This research has been able to identify few health care domains in Finland that have been targeted for a possible adoption of SOA and Web Service including [23], [26], [34] and [44].

The aim of our study is to apply the results of the aforementioned research works in a targeted health care domain which is the EMS services with particular consideration of medical emergency vehicles like the ambulances. This would make it possible for various emergency vehicles ranging from medical, rescue services and the police to interoperate. As already explained in [26], the Finnish health system is organized and managed on local, regional and national basis so also the ICT systems and services hence the need to tackle integration and interoperability problems across such a heterogeneous environment. We consider the possibility of achieving same in medical emergency vehicles in an outside-hospital scenario where the vehicle's operations and management are segmented

across Finland. The idea is to have emergency vehicles share common services in a way that supports integration and interoperability and more importantly boost the efficient delivery of emergency health service.

More recently, ([37] undertook a preliminary investigation of the possibility of integrating information technologies that are on-board public protection and emergency vehicles under the MOBI project. The benefits of SOA were however considered in their preliminary investigation.

B. Research Motivation

As previously stated and again recapitulated here, the health care sector remains a very vital sector in every community, region and a nation in general. This cannot be overemphasized as the growth of communities, regions and nations is a function of a healthy citizenry. The provision of a sustainable and effective healthcare system is therefore paramount. The health sector has witnessed the introduction of computer decision support systems and technologies to enable the attainment of an effective healthcare system in the past. Due to growth, these systems do not match current demands with respect to service delivery and integrated administration across different health domains. The Emergency Medical Services (EMS) is a domain in the health sector whose services are always pressurised when an emergency occurs as this would warrant calls for desperate ICT systems and services to function efficiently and effectively in order to manage the emergency. First emergency responders such as Medical Emergency Vehicles (MEVs) need to be effectively supported ICT-wise. An inter-sectorial and intra-sectorial integration strategy is necessary to achieve efficient EMS [1], [18] and [24]. There is therefore the need to explore emerging technologies and software development paradigms with the aim of utilizing them to support ICT systems and services that are used in MEVs and their control centres.

However, the decision support systems so far introduced have been based on software development approaches and architectural philosophies whose inherent limitations do not adequately tackle the growing pressure on the health care services such as the emergency services and the integration of systems that support such services. These systems are to a large extent not interoperable and do not support agility, reusability and integration owing to the approaches that gave birth to them.

This research is inspired by earlier published research by [35], [13] and [46] among others. It focuses on studying the current ICT systems and services used by medical emergency vehicles (MEVs) and their control centres with the view to finding a new software development approach that supports the alignment of business goals with emerging ICT technologies. It goes further to propose a service oriented architectural model for use in medical emergency vehicles and the control centre. It aims therefore to create a model which is based on innovative services which are in turn reusable, agile, flexible, and can easily be integrated and interoperable.

Software systems development has witnessed several software development approaches in recent times. These varying approaches are all aimed at providing software systems that meets user's set goals. Though these approaches

have this goal in common, the software development projects they are targeted at remain different. Therefore, one software development approach may not be viable for a particular software project while another approach could suffice. The software development approach chosen for the EMS should be one that supports integration, interoperability based on standards and the alignment of medical emergency services with appropriate technologies.

The EMS unit is a unit which is responsible for responding and handling all medical emergencies that may occur in any given location and at any given time. In the event of any medical emergency, desperate systems that are hosted by the EMS unit are called to play in tackling the emergency. These desperate systems include database systems, computer applications, network systems, communication systems, external devices such as PDAs, and a host of other systems that maybe supported by the unit. These systems which exist in an EMS unit would as the case maybe, need to communicate with the systems of other external departments such as the police, fire services or rescue services. Given this scenario, a problem could arise as a result of bottlenecks in communication between these systems thereby hindering the efficient delivery of service.

Due to how rapid software technology and development approaches have evolved and continuously evolving, there is a need to undertake an analysis of current medical emergency services with the hope of taking advantage of the benefits these new technologies promise. However, given the array of factors in terms of ICT services that are called to play in an emergency scenario, an SOA based solution would no doubt be probable as an emerging flexible architectural paradigm which targets to address the interoperability, reusability, and cost effectiveness of building and deploying software systems. The main idea is to create reusable services that can easily be integrated and flexible to manage. What this research sets out to achieve is finding how medical emergency services can be better supported for efficient service delivery in all emergency scenarios. The main objective of this research was divided into three phases; the first phase concerned itself with the motivations for adoption of SOA, the second phase proposed a service oriented architectural model for ICT systems in MEVs and MEV control centre while the third phase proposed an innovative service blue print for ICT systems in medical emergency vehicles and their control centre.

In order to justify the research idea, the research attempted to carry out an implementation of the proposed service model and sought expert opinions through interviews and questionnaire. The questionnaire was targeted at IT experts in the industry and in the academia and medical personnel knowledgeable in IT systems. The answers to the questionnaire were analysed and the information used to draw research conclusions.

III. CURRENT STATE OF THE ART

A. The EMS System (Helsinki Region, Finland)

The Helsinki region has an EMS Dispatching Centre (DC) which serves a population of about 567,000 within and around the Helsinki capital city. Medical calls to the DC are prioritized based on four (4) emergency groupings. The table below shows the groupings and the units to be dispatched.

Table 1: EMS Medical Calls Prioritization and Groupings

Urgency	Dispatched Unit
A	Nearest ambulance + MICU or medical supervisor + FRU if required
B	Nearest ambulance + FRU if required
C	Appropriate ambulance
D	Private ambulance

The criteria for realizing this prioritization and groupings are given in a dispatching guidebook which accompanies the team. The seriousness of the patient's main ailment such as chest pain, haemorrhage, fall etc. together with his current condition such as breathing conditions, being-awake or not etc. are considered during call prioritization. As shown in the preceding table, calls are divided into 4 units namely, A, B, C and D. The Rescue Department is responsible for providing medical services for call groups A, B and C while private ambulance companies are responsible for category D medical calls which are deemed to be non-emergency calls. Category A calls are calls from situations that could be life threatening. Its priority is therefore high while category B calls are calls from situations in which the risk involve could be manageable or sometimes unknown. Calls which fall in category C are usually calls with non-life threatening risks.

The EMS system that is used in Helsinki follows a three-tiered architecture. The first tier is comprised of eight Basic Life Support (BLS) ambulances and eight fire engines which are used as First Respondent Units (FRUs). They are controlled by the Emergency Medical Technicians (EMTs). The second tier is made up of three Advanced Life Support (ALS) ambulances which are operated by the paramedics and a medical supervisory unit while the third tier is the Mobile Intensive Care Unit (MICU) which comprises of physicians. These ambulances are positioned in eight fire and ambulance stations and the EMS is not responsible for providing inter-patient transfers.

B. ICT systems and Services provided in the EMS System

The Merlot system is one of four systems that are currently in use by the Finnish EMS. The other field management systems also currently in use include: Vaahtotykki, Merlot Mobile and PEKE. Vaahtotykki is a communications system and aiding system used in managing take-offs and Fire Brigade alarms. PEKE on the other hand is a field commanding system for emergency vehicles. It has been refined and built over the Finnish Police field management system.. This paper focuses on the Merlot system. The Merlot system is a diverse field command system that combines multiple techniques into one, i.e., job dispatching, radio terminals, internet and positioning are all managed through one system. The Merlot Mobile is the same system put into a mobile operating environment and communicates with the Merlot main system interface, also creating an effective inter-communication network in the field

operations. The Merlot system was developed and maintained by Logica, a software development company. The functionalities of the Merlot Medi can be grouped into the following categories namely: Operational control, online consulting, electronic patient reporting system (EPR), reception alarms and SURO major incident application. This research would place more emphasis on the EPR system which is used in the ambulances.

Operational Control is used in the monitoring station and provides an interface for the monitoring of the reservation status of ambulance units and their location displayed on a map. This helps to deploy units and resources from an area of lower demand to other areas that need more units. It therefore helps to plan the distribution of resources.

Online Consulting enables an emergency consulting doctor to see the status of all ambulance units and he or she is able to open and emergency care record for consulting purposes. The support provided by the doctor is communicated in writing thereby reducing any misunderstandings. He can also view the patient's previous records for study purposes.

The Electronic Reporting (EPR) system from Logica was introduced by the Helsinki EMS in 2007 for clinical use. The system was made for use in ambulances and other out-of-hospital use. It consists of four different components namely: (1) electronic medical record module which replaces the paper chart initially used; (2) control management module for physician and the medical supervisor on duty; (3) disaster and major incident module; (4) administration module which includes reporting and invoicing features.

This research would pay more emphasis on the electronic medical record module and the administration module when considering possible service candidates.

The ambulances and the FRUs are equipped with touch screen laptops (Xplore Technologies 104C3 Tablet Computers, Austin, TX) and small printers (Pentax PocketJet 3 Plus, Golden, CO). The EPR client and server is run on the laptop computer and connections to the DC server is achieved either via wireless, LAN or packet radio service. The printers in the ambulances are used to print a patient's copy of the report and discharge instructions in cases where he or she is not transported to the emergency department (ED). The DC issues the alarm and dispatch instructions to the laptop in the ambulance. In every case, the necessary details to be filled in the ERP include: cause of call, time of symptoms or injury, information about the caller, current medication and other chronic diseases. After duly getting answers to these questions, the ambulance team can decide to choose answering predefined symptoms or injury-specific questions or in the alternative type free text. The data about the patient's vital signs such as heart rate, blood pressure, oxygen saturation, end-tidal CO_2, and 12-lead electrocardiogram are transmitted through Bluetooth from monitors (Lifepack 12, Physiocontrol, Minneapolis, Minn) to the laptop and then to the EPR server. The EPR consist of all EMS protocols and patient referral instructions. Upon fulfilment of the criteria for contacting online medical direction, the system throws up a red alert on the screen as a reminder for the EMTs or paramedic team. The

report is then electronically sent to a printer at the ED while the ambulance is still in transit.

The EMS system presents a distributed environment where the ERP system running on the ambulance laptop collaborates with the dispatching centre (or control centre) and the hospital system (includes emergency medical records, disaster applications etc.). One of the main processes in this distributed platform is the generation and submission of the patient's pre-hospital admission record before arriving at the hospital. However, following the medical call groupings in Table 1 above, there is an involvement of private ambulances which expands the EMS network. These private ambulances have their own ICT systems which are different from the systems on the government owned ambulances. The private and public ambulances are operated and managed on regional basis. This peculiarity makes the application of SOA suitable since common medical emergency services are provided by different organizations. This commonality in service provision coupled with the different types of ICT systems used by both private and public ambulances can take advantage of SOA reusability and integration goals.

IV. REQUIREMENT ELICITATION

In this section we summarize the main requirements that inspired this research:

1) The need to achieve standardization, integration and interoperability between ICT systems used by collaborating disaster management agencies which includes the emergency medical services and the fire and rescue services.

2) The need to enable effective and efficient information inter-change between collaborating agencies in order to manage a medical emergency.

3) The need to enable ICT systems and services provided by emergency vehicles to be ready in order to fit into the SOA vision of the Finnish health care services and support local, regional and national management of medical emergency services in a unified and transparent manner.

V. RESEARCH SURVEY ANALYSIS

` In this section, we analyse the responses from the questionnaire that was administered to Information Technology (IT) experts in the industry and in the academia. Based on this analysis together with our primary and secondary research, some conclusions and recommendations were drawn. This survey and its results further provided the motivation to continue with the research.

A. Survey Objectives

In order to understand the current trend and motivations for SOA in addition to also help inform the decisions of the MOBI project team concerning the adoption of SOA via Web services, the research undertook a survey. The survey questions can be found in appendix A. The survey was initially administered using E-lomake (A Finnish tool for administering surveys) which was subscribed to by Laurea University. Eight responses were obtained while using this tool but its continuous use was hindered by the fact that my contract with Laurea ended and access was revoked. The responses were

retrieved and manually entered into Survey Monkey, another online survey tool which I personally subscribed to and thereafter continued with administering the survey. In addition to the analysis functionalities that are provided in Survey Monkey, Microsoft Excel was also used for the analysis. The objectives of the questionnaire are summarized as follows:

1) To understand the current and future trend of SOA and Web services

2) To understand the motivation for SOA, its adoption and which health domains have already adopted it.

3) To know the extent to which SOA and Web Services can be applied in the health services and which domains could benefit from it.

4) To seek knowledge about which SOA implementation style (REST or SOAP) is suitable for our case study and the attitude of developers towards these implementation styles.

5) To draw knowledge which would to some extent validate and strengthen our research investigation concerning the use of SOA via Web services to support ICT integration, interoperability, optimization and information inter-change in our domain and other similar domains.

B. Questionnaire Design

The questionnaire was divided into three sections A, B and C. Section A sought to identify and place a respondent using his job role and level of knowledge in SOA and Web services. Section B concentrated on SOA and Web services and their promise while section C mainly considered the motivations for choice of implementation styles and future trends of these styles.

Though the Likert scale is 1-5, this research used a scale of 1-4. The option of neutrality was not employed for reasons we would explain next. Because we have targeted professionals who have the know-how of this matter, we did not include neutral answers but did well to create space for comments where necessary. Only two questions that sought to identify and place the participant where mandatory while the rest were not mandatory so a participant can still afford not to answer any question he or she chooses not to answer because of inadequate knowledge. By so doing, participants were not coerced to fall in any of the divides.

It is worth noting that, due to the complex nature of SOA as an emerging architecture that is yet to be widely accepted, it is was really difficult to access a large number of SOA professionals responding to our survey as we would have loved to access since expertise is currently very limited. This notwithstanding, we were still able to access quite a reasonable sample size drawn from IBM, Oracle, independent professionals, very few respondents from the academia. Apart from mass mailing targeted professionals, the questionnaire was posted on notable SOA forums such as SitePoint, OTN, IBM forum, Stackoverflow etc.

The questionnaire was analysed on question by question basis. Simple percentages were used and where necessary we applied mean and standard deviations. Graphs were not employed since percentages sufficed and graphs not necessarily needed.

C. Results

Twenty five (25) IT professionals completed the survey. Of this number, 2 participants (8.0%) were Software Developers, 1 participant (4.0%) was a System Analyst, 6 participants (24.0%) were SOA Architects, 4 participants (16.0%) were IT Specialists, 3 participants (12.0%) were CIOs. 9 participants (36.0%) fell under the "others " job specification. Of this number, 3 participants (12.0%) were high level students, 4 participants (16.0%) were high level members of the academia and 2 participants (8.0%) were Principal Solution Architect and Chief Architect-Open Source Technologies respectively.

The majority of the participants (64.0%) rated their knowledge of Service Oriented Architecture (SOA) and Web Services as high and 9 participants (36.0%) rated their knowledge as medium. All respondents supported the transition of Health Services to SOA.

The respondent's replies to two key questions that seek to find out whether SOA provides good support for achieving integration and interoperability seems very interesting and positive. With regards to integration, 44.0% were in strong support while 48.0% simply agree to the use of SOA for integration and the remaining 8.0% do not think that SOA provides good support. When it comes to interoperability, 54.2% support the use of SOA in tackling interoperability while 41.7% just agree to its use. 4.2% do not support the use of SOA in this regard.

Participants were again asked the question of what Health Services domains they thought could benefit from the adoption of SOA. Table 5.2 shows the rankings of the most popular responses to this question.

From Table 2, one could see that Emergency services followed by Accounts, Laboratory and Radiology units gained more support than other domains. There is therefore a general acceptance of the application of SOA in these healthcare domains that top the table while some could still be possibly considered.

Majority (60.0%) of the respondents agree that a SOA solution is feasible in a situation where a headquarters needs to communicate with local hospitals and where there is need for inter-hospital collaborations and most importantly need for

Table 2: Ranking of the most popular domains that could benefit from SOA adoption

Health Service Domain	Number (N)	Percentage (%)
Emergency Medical Unit including ambulances	21	91.3%
Accounts Units	19	82.6%
Laboratory Unit	17	73.9%
Radiology Unit	15	65.2%
Surgical Unit	13	56.5%
Maternity Unit	11	47.8%
Paediatric Unit	11	47.8%
Orthopaedic Unit	11	47.8%
Neurology Unit	11	47.8%
ENT (Ear, Nose and Throat) Unit	11	47.8%

information inter-change among collaborators during an emergency. The remaining 40.0% strongly agree that a SOA solution is very feasible in this circumstance.

Apart from Web services which are commonly used for implementing SOA, there are yet other approaches for achieving same. 40.0% of participants strongly agreed that the Web services option is more viable and 52.0% simply agreed to Web services viability while 8.0% disagreed with the proposition. It would not be out of place to put that, Web services are more viable than other approaches and would continue to gain support in the future based on the result of the sampling.

However, while some people still consider SOA as a buzz paradigm and unnecessarily hyped, it is interesting to find that this thinking could be seen to reflect in the number of adoptions SOA has witnessed. A majority (76.0%) of the participants do not know any domain in the health services that has adopted SOA while 24.0% claimed knowledge of its adoption in certain health domains. The domains mentioned include, HIS (Hospital Information System) for Apollo Hospitals, Paras Hospitals by Akhil Systems Pvt. Ltd, New Delhi, New South Wales State Emergency Service, patient monitoring system, medical records and HL7 uses it to support information interchange.

Participants were asked to rate some of the reasons for the adoption of REST. Table 5.3 shows the rankings of the possible motivations based on questions 12, 13, 14, 15 and 16. Their responses were analysed using the Likert scale of 4 denoting strongly agree, 3 for agree, 2 for disagree and 1 denoting strongly disagree.

Table 3: Rankings of the reasons for the adoption of REST

Motivation	Mean	SD
REST is a true representation of the Web hence more suitable for building Web services	2.83	0.78
RESTful services now witnesses more adoptions than SOAP-WSDL services	2.79	0.76
REST supports better systems integration than SOAP	2.75	0.66
Majority of RESTful services available today do not	-	-
really adhere to the four cardinal principles of REST which would have brought more benefits	2.63	0.81

However, from the point of view of percentages concerning participant's motivations and starting with the first motivation in the above table, 16.7% strongly agree to the proposition while 50.0% somehow agreed to it and 29.2% someway disagreed while 4.2% strongly disagreed. We could therefore see the "agree" and "strongly agree" proponents having quite the upper hand. Meanwhile, in the second motivation still in the above table, we see the motivation dropping as 22.7% strongly agreed and 31.38% somehow agreeing while 45.5% simply disagreed with the proposition. It drops quite a little further in the third possible motivation where 16.7% strongly

agree and 33.3% somehow agree while 45.8%, 4.2% someway disagree and strongly disagree with the motivation.   In the fourth motivation which perhaps does not really seem to be a motivation, a majority (50.0%) agree to the motivation and12.5% strongly agree to the proposition while 37.5% somehow disagree with the proposition. This no doubt informs that, generally, some adoptions of REST are far from what REST actually specify. Again in the fifth and final motivation, there is a sharp contrast on both divides as the mean also tells us. A majority (47.8%) somehow feels comfortable programming REST services and 4.3% strongly feel comfortable programming REST while 39.1% some do not feel comfortable programming REST and 8.74% strongly do not like programming REST services.

The realization of SOA via Web services presents the choice of either REST or SOAP as possible implementation styles. 11 participants (44.0%) strongly agreed that, the choice of which implementation style to adopt should be based on the needs of the software systems to be developed or integrated and the domain while 13 participants (52.0%) simply agreed and 4.0% disagreed. It is interesting to find that, when asked which of REST or SOAP best suits our case study, 6 participants (24.0%) supported SOAP and another 24.0% supported REST while 60.0% spoke in favour of both. This can however be seen as a reflection of the on-going debate over which implementation style is better.

As it is with humans, technologies evolve and we sort to know what could become of SOAP or REST in the future. Our findings indicate a very sharp contrast between the future and dominance of REST and SOAP. 12.5% of our participants strongly agree that REST would be a dominant approach to realizing Web services in the near future, 37.5% just agree to it, 45.8% disagreed while 4.2% strongly disagreed. If one should create two divides, we would have 50.0% agreeing to the proposition while 50% disagreeing with the proposition. This again reflects the reason for the debate and why it could be a win-win situation.

In order to create a balance between SOAP and REST in terms of the above proposition, participants were again asked if they believe SOAP would in the other way round be the dominant implementation style in the future. 8.3% strongly agreed to this proposition, 29.2% just agreed while 62.5% simply disagreed with the proposition If we again create two divides, we would have 37.5% agreeing to the proposition while 62.5% disagreeing to the proposition. The two divides in both the REST and SOAP propositions concerning the dominance of each other in the future indicates that, a majority of the participants do not believe that SOAP would be a future dominant approach for implementing Web services. When it comes to rest, it appeared to be a tug of war as the equal percentages show and it is yet another reflection on the state of the raging debate.

D. Summarized Facts Drawn from Survey

The issues of integration, interoperability and optimization of ICT systems and services used in MEVs and their control centres together with support for information interchange among collaborating agencies during an emergency can be addressed by SOA through the use of Web services. This is

due to "loose-coupling", a key characteristic which underlies SOA. The domain of our study is one of the key domains that SOA can be applied as the survey has indicated. The motivation for a possible SOA via Web services adoption for our case study stems from the advantages it brings. These advantages however cannot be obtained on platter of gold if SOA is not thoroughly considered and successfully adopted. The integration of proprietary systems belonging to certain collaborating domains that are involved in emergency management is necessary if information must be shared in real-time. It also makes the administration of emergency services unified and transparent since systems are linked to the headquarters or control centres. Standardization and system agility can also be achieved across the domain in consideration.

Web services and all the standards it provides are a very viable approach to realising an SOA. This would remain so since Web services have always been there and are commonly used coupled with the fact that Web services are continuing to evolve as first choice approach. More so, REST and SOAP are very common approaches to in turn implement Web services. While REST is more of a style, SOAP is rather a protocol specification. Both of these are suitable for our domain but where we are most concerned with realising high level security, we would be considering the adoption of SOAP as opposed to REST. This research is of the opinion that, neither REST nor SOAP can overtake each other in the future. Both would continue to evolve and by so doing tackle the weaknesses that are prone to each. The use of either of them should be based on the needs of the projects. Project teams would have to consider the trade-offs each carries with it and the strengths the project team seeks to incorporate into their SOA solution. SOA is gradually moving from the level of being perceived as a "buzz word" and mere technology hype to a real architecture that is witnessing many adoptions in other domains but less in the healthcare domain. We see the adoption of SOA in health services gaining more momentum in the future.

VI. SOA MODEL FOR MEVs AND THE CONTROL CENTRE

A. SOA Programming Model

The Fig. 1 below is a modified SOA programming model originally proposed in [46] as part of their SOA model for medical image processing. The motivation for this research to adopt and modify the original model stems from the fact that, our model is more generic. This new model has been created to suite our case study and is majorly based on the application of Object Oriented Programming (OOP) instead of Component Based Development (CBD) approach as originally proposed. OOP enables more flexibility than CBD. The idea is that, Web Services can be generated from existing OOP classes in a scenario where existing legacy systems are a product of OOP. It also implies that, the functions or methods existent in program modules or legacy applications can be exposed easily as Web services where necessary for instance in our case study.
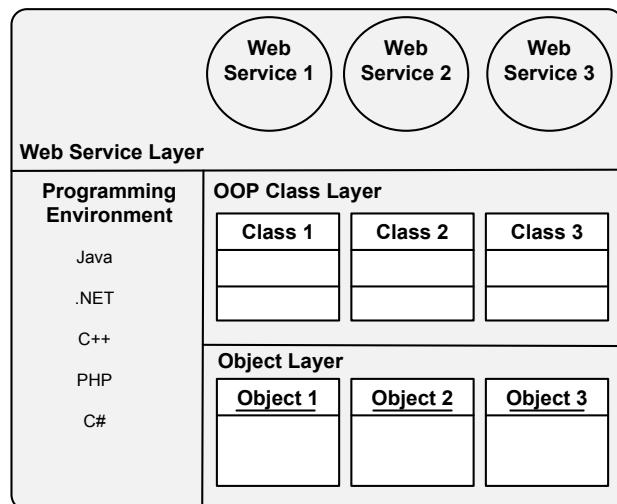

Fig. 1: SOA Programming Model

The programing model above contains three main layers which are: the Web Services Layer, OOP Class Layer and the Object Layer. The Web services which constitute the Web service layer are generated from OOP classes which are in turn derived from OOP objects. The Web Service Layer represents the functional part of the SOA stack depicted in Fig.1 above which is the service element. At the lower level of Object Orientation, classes are composed from objects and the programming environment could be any of Java, .NET, C++ or PHP. Web Services are programming-platform independent hence any platform of choice could suffice. In actuality, it does not matter whether systems in private ambulances are .Net or Java based same also in public ambulances operated by the government. The model as it is can help generate new web services in scenarios where they are non-existent and even more so facilitate integration of legacy applications as we would explain shortly in the following section which presents the service model.

B. The SOA Service Model

Having created our Web services based on the programming model above, we can now consider how these services can be integrated based on the service layer in the SOA stack which is still given in Figure 2.1 of chapter 2. In this case, we adopt and apply the service model in [46].

A Web Service Interface Layer which would majorly consist of the Web Service Contract in the form of WSDL document would provide support to Web Service Clients that would need to consume the Web services. The Web service clients could be located in the MEVs in the case where patient records during an emergency need to be transmitted to the hospital which may be hosting the web services. The service contract which serves as the interface between the service provider and the client exposes the services and provides all the necessary details needed for the client to be able to consume the service.

Since our problem domain is not extensive and complex we would leave out the Business Façade which could be part of

the Web Service Interface Layer as originally proposed. The operations or methods that are exposed in the service contract are implemented by the Business services which are composed from Application services. These Business services are the actual functional components of the model based on the SOA stack

There is also the Resource Layer which is made up of non-functional components. These different non-functional components enable the Web services to interact with external resources. In order for our Web services to interact with external resources we would employ common resources such as those that provide data access for database systems, a service gateway for accessing other web services and an adapter which would act as a wrapper for accessing legacy application systems. Through this resource layer, integration with external resources that are useful to our domain can be realized.

C. The SOA Messaging Platform

The Web services clients in the MEVs need a way to consume the Web services which are published in a UDDI and hosted by the controlling centre which in this case could be the hospital or the fire and rescue department. Service consumption is by way of communication between the client and the service provider using well defined SOAP or REST messages as specified by a chosen messaging framework. SOAP and REST as we have explained earlier are standards for implementing Web services and which help in defining and sending of messages on the internet. The Java Message Service is also a standard which could be used in the alternative. The messaging platform would normally comprise of a Service Interface which as stated earlier exposes the methods or operations present in the service in the form of a WSDL document. This WSDL document would define the types of messages that are required by the exposed operations. The use of WSDL only applies where SOAP messaging is adopted since REST does not support WSDL. The defined messages are made up of data types that describe any attribute of the service. The data types are serialized in XML documents and are then sent via SOAP or REST depending on the messaging framework chosen.

However, different Messaging Exchange Patterns (MEP) such as Request/Response or Publish/Subscribe etc. can be used to exchange messages between collaborating partners. The Request/Response MEP also known as Request/Reply is the most commonly used MEP. As the name implies, a service requester sends a request and the service provider sends a reply to it. In addition, the Web service client can choose to use synchronous or asynchronous communication mechanisms. In a synchronous mode, the service requester waits for a reply before other processes can start. This would be required in our problem domain since for instance the submission of pre-hospital patient information is critical. In asynchronous mode, replies to messages are not instantaneous. It is only recommended when communications are expensive and the network is quite unpredictable.

VII. SUMMARY OF POTENTIAL SERVICE CANDIDATES

A preliminary service oriented analysis and design gave the following potential service candidates (due to space limitation, this paper did not present the rigorous processes undertaken to arrive at the candidates):

1) A Patient Referral Service
2) A Patient Referral Fulfilment Service
3) A Patient Invoicing Service
4) A Patient Invoicing Fulfilment Service
5) A Fleet Resource Management Service
6) A Doctor Online Consulting Service
7) A Personnel Management Service
8) Navigational Service
9) MEV Provider Service
10) Patient Management Service.

The first four services were derived earlier but the remaining services were arrived at in a black-box approach hence the SOA analysis procedures that gave rise to them like the other services are not described here. We have only demonstrated how these potential services can be derived with the incorporation of service orientation during the analysis and design stages.

In order to realize information inter-change between collaborating agencies who are involve in managing an emergency, there is need to have a common database where all categories of data relating to the incident can be stored, updated and retrieved by parties who are interested in such data. To this end, we would also employ a shared data model proposed by [13] in our design and implementation. This shared data model is SOA based and it simplifies data sharing since the data to be supplied by field agents such as ambulances in this case can write to the database through their Web service clients while hospitals via their Web service clients can consume the same data. Having this shared data model in place implies that, critical information which is shared in an emergency situation can be accurate and reliable.

The Fig. 2 below is a representation of the SOA scheme and the Web services as proposed and can be seen to be incorporated in this representation. The abstract business services that we have proposed and which would be resident in the UDDI would serve as the basis for integration. This approach is known as Service Integration. The business services are such that they are not coupled to a single database or a legacy application. This in fact is where SOA comes in handy since the business service interfaces are separated from implementations that lie beneath them. This approach can be used to realize integration within an organization but where there is need to achieve collaboration between organizations involve with dealing with an emergency like in our case, a B2B integration approach would be appropriate. The ambulance business processes and the business services that have been derived would be integrated with the hospital business processes and applications already in use.

From the Fig. 2 below, all the potential Web services that have been derived are created and published in a UDDI which could be a private or semi-private service registry that can be managed by either the EMS unit at the hospital or the fire and rescue control centre. In our domain, the management of the

UDDI would most likely be under the fire and rescue department since the ambulances and the fire vehicles are under the same control. The emergency shared database which is based on SOA incorporates all the published services and utilizes them to manage any given emergency. An emergency call is prioritized and forwarded to ambulance units via the shared database system. Web service clients on the ambulances send details of patient conditions and other information obtained from the vital signs equipment to the database while the hospital Web service clients retrieve the information they require from the same database. The hospital via its clients is able to utilize the online doctor consulting service to assess patient's condition and offer assistance as required. Other services such as the personnel management service, fleet resource management etc. enables the development of client applications that are able utilize them in providing further services.

VIII.   IMPLEMENTING A SOA SOLUTION

In the preceding section, we were able to identify and propose a service oriented architectural model which can be used to transition the problem domain to a SOA. It is specifically suited for integration of software systems in our chosen application domain and the creation of new Web services. We were also able produce a service blue print which is composed of potential Web services that can support the application domain and fit into the SOA adoption vision. In this section we focus on real issues concerning the implementation of the SOA model in our problem domain.

A. Important Issues with Realizing the Implementation of the Proposed SOA Model

As we have stated earlier on, the software system used by ambulances in Finland is provided by Logica an IT company contracted by the Finnish government. Some versions of this software are used by the Finnish fire and rescue services and the police. In order to implement the proposed model, this research identified some major bottlenecks which must be dealt with in order to realize the much needed integration which would enable information inter-change between agencies taking part in emergency management. These major bottlenecks include:

1)   Non-existence of a formal cooperation

There is no existent or known formal cooperation between agencies of which ICT systems are to be integrated ICT-wise. This is even more evident as the provision of emergency services and its management is not centralized but rather on local, regional and national basis.

There is no existent or known formal cooperation between agencies of which ICT systems are to be integrated ICT-wise. This is even more evident as the provision of emergency services and its management is not centralized but rather on local, regional and national basis.

2)   Security

There are security and management concerns to be addressed while trying to gain access to the ICT systems to be integrated. This problem arises partly as a consequence of 1

above. The agencies whose systems are to be integrated are concerned that their systems would be compromised and disruptions in service provision would arise.
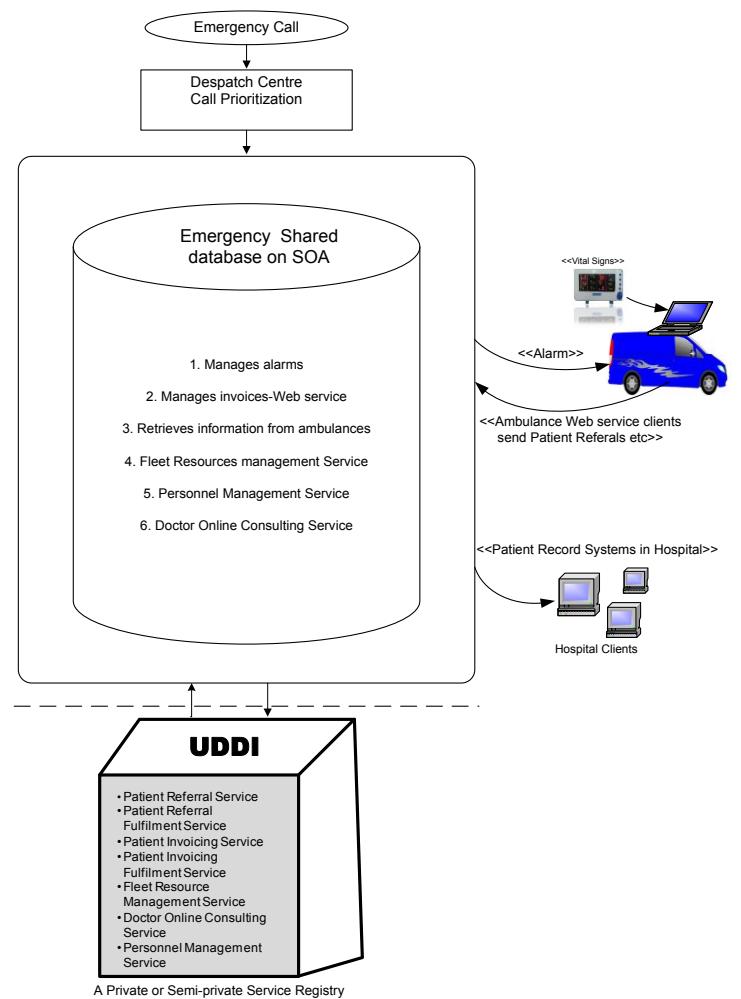

Fig. 2: Processes and Information Transmission from a SOA Perspective

3)   Business consultant (middle man) unwillingness to share information

The third issue is the inability to acquire the necessary details and adequate access to the current ICT systems in consideration because of an existing agreement between our middle man and the vendor who currently provides the software that is used by the Finnish ambulances. What this research do know and to which the business analyst agrees to is that, the ICT systems as they currently exist are not supported by the SOA paradigm and the problem this brings is that, agencies which should normally exchange information during an emergency cannot afford to achieve such a goal. This is one of the motivations for this research in addition to integrating various ICT systems of various units.

In addition, fear shrouds the implementation or our proposed model. There is the fear that, our study would make some proposals which may not be in the interest of the vendor who currently provides the software systems in various

versions for the ambulances, police and fire and rescue services.

B. Resolving Issues with SOA Implementation

In order to realize the integration of ICT systems used by the various emergency respondents through a SOA implementation, the following steps are proposed.

1) Legislation

There is need for the relevant body such as the Finnish parliament to enact a legislation which would enable agencies to cooperate in order to achieve integration via a SOA implementation based on the proposed model. This legislation should be able to provide a framework which would define how the cooperation can be realized and the core areas that would be targeted. The motivation to drive the legislation would mainly be information sharing or information interchange together with effective resource management during an emergency. It is expected that proprietary systems that are managed by the different agencies and which are ideal for integration in order to support information sharing would be identified and specified as part of the framework.

However, having the legislation in place implies that, there would be no barriers arising from claims of ownership of jurisdiction of the ICT systems that need to be integrated or affected. This is because, provisions would have been made and all issues addressed in the legislative framework. The issue of achieving this cooperation is peculiar to the scenario we are investigating where ICT systems and services are provided and managed by different agencies. The case is different for private companies who are seeking to integrate their ICT systems and services across their entire enterprise scope. In any case where integration is being considered, there is need to have in place legislation or a common framework that would enable a SOA transition since many parties are called to play.

Since security concerns are a consequence of not having a legislation or framework in place that fosters cooperation between the parties whose systems are to be integrated, the provision of such a framework eventually addresses the security issues that are raised.

2) Handling Middlemen and Vendor Apprehensiveness

There is an unavoidable apprehension on several fronts whenever the idea to introduce or propose a software system transition is considered. The vendor front is one where this is obvious especially when the vendor is not included in the scheme of things. A vendor who may not be a party to a SOA transitioning project would think that the recommendations that would emanate from such a project are a real threat to the continuous supply of their software. They would therefore aim not to supply any required information to aid the project as the case is in the MOBI project.

One possible way of tackling this is to call in the vendor who supplied the current software systems as a formal partner to the project which is considering the adoption of SOA. The MOBI project has a list of partners who are interested in considering a SOA transition of the domain. Unfortunately, Logica, the vendor whose software systems are currently used in this domain is not a project partner. The result is the bottleneck the project has to deal with. This research would propose that, Logica be called in to partner with the project if it is possible. This scenario comes to the fore when all major stakeholders in a project are not formally involved in the project. This research encourages the involvement of all stakeholders in any SOA implementation project if the goals of the projects are to be realized.

There is also an administrative front within the organizations where the SOA solution is targeted. This is most times due to political reasons or the disposition of management towards such a transition. As it was learned during this research, some persons heading the affairs of the fire and rescue services and some of the heads in the medical emergency unit have in the past not been in support of a SOA transition for reasons that are not best known but simply revolved around their disposition towards accepting technological changes. To this group, the status quo may always be preferable.

C. Way Forward with Implementation

Given the circumstances this research has experienced, this section focuses on presenting alternative steps a project team can adopt to realize a SOA implementation that seeks to achieve systems integration and interoperability in order to bring about an effective and efficient medical emergency management still using our case study. As we have stated earlier, having a legislation which fosters cooperation between agencies of which systems are to be affected and also having the vendor as a partner to the integration project would be worthy elements to have in place from the initial stage. In a case where these are not in place like in our case for example, something still has to be done to achieve the same goal and that is what we would proceed to present.

It is necessary to have at least one representative of each unit of which ICT systems and services would be affected as part of the project team. In our case, it is obvious that the dispatching centre controlled by the fire and rescue department and the hospitals would be units whose systems would be affected. The fire and rescue department is responsible for the medical ambulances and these ambulances are stationed at designated fire and rescue departments across the Helsinki region. The representative's duty would be to liaise with the technical experts in order to define and establish the processes and services that would be created or integrated. We are therefore considering a scenario where the vendor who supplied the current ICT systems for the domain in question is not in the picture of things due to the reason stated earlier on and the services of another vendor contracted by the project team. The representative must be part of the SOA analysis and design stages.

D. Beyond the Case Study

This research has focused mainly on emergency services provided by the Finnish ambulance services. The Finnish domain under consideration has certain characteristics which distinguish it from other European countries such as Britain, Germany, and France etc. These characteristics include population size and complexity of the domain due to the size of population. Finland has a population of about 5 million compared to the large populations of the aforementioned

countries. One would therefore expect to deal with extensive and complex emergency management systems in those countries. In any event that a major catastrophe such as the September 11 attack that took place in the U.S occurs in either of France or UK or even Germany, the impact would be far greater than it would be witnessed in Finland which is not densely populated.

The requirements we have earlier mentioned which chiefly includes providing support for real-time information interchange between collaborating agencies during an emergency and tackling integration and interoperability which would in turn enable a unified and transparent management of emergency services across all units are not only peculiar to the Finnish domain in consideration but also applicable to other emergency domains within the EU. They would even be more applicable given the size of their populations and the complexity envisaged. We expect to see various collaborating units having different proprietary systems that would need to be integrated in order to share information during an emergency.

One major characteristic of SOA is its promotion of loose-coupling in software systems. The Web services we have proposed and which have this SOA characteristic incorporated are applicable to other emergency domains outside Finland. SOA as an integrating architecture also promotes standards-based interoperability. The SOA programming model we have presented can be used to implement these new Web services. The SOA service and messaging models can also be adopted to realize integration goals especially where legacy systems are existent like in our domain. Web services that are peculiar to our domain can be hosted in a public UDDI which can be commercialized and utilized by EU countries.

IX. SUMMARY

In order to benefit from the promise of SOA and Web services, a SOA model and a shared SOA-based database have been proposed for medical emergency vehicles and their control centre. The SOA model has a programming model which enables the creation of new Web services based on the Object Oriented paradigm. A conceptual service blue print which contains potential Web services that can be physically implemented using this model was also proposed. The service model enables the integration of these Web services and also provides for interfacing them with external software applications, legacy applications or other resources. The model also provides for a messaging platform which is based on the SOAP messaging framework. Web services clients can exchange SOAP messages between themselves and with the control centre in a request/response pattern.

More so, when considering a SOA implementation, issues such as non-existent formal cooperation between collaborating agencies of which systems are to be integrated and which leads to security concerns together with vendor concerns arise. There should be a formal cooperation by way of legislation between the agencies that manage emergencies and of which ICT systems need to be integrated. Vendors who supplied the software systems that would be affected should be a part of the project that wishes to transition the domain to SOA. SOA

adoption is a complex and extensive exercise which requires high level expertise, sufficient skills from users and reasonable budget to acquire the necessary infrastructure. Time, cost and benefits of investing in a SOA solution must be duly considered before SOA can be adopted.

X. RECOMMENDATIONS

Service Oriented Architecture should be seen to be a long term investment which would not pay off in the short-run. The implementation of a SOA solution which among other things seeks to address issues of integration, interoperability and real-time information interchange by any project team should first address issues of legislation which fosters formal cooperation between collaborating agencies dealing with medical emergency services. The legislative framework should be able to address security concerns that could also arise. Vendors who supplied existing legacy systems or applications that are to be affected by SOA should if possible be part of any SOA project team that is considering SOA adoption. This removes bottlenecks with regards to accessing copyrighted software components in the existing system. Since true interoperability is still far reachable, standards-based interoperability is and organizations should encourage their software vendor suppliers to incorporate service standards in order to benefit from any future SOA implementation.

XI. CONCLUSION

Based on the SOA paradigm and the Web services implementation style, this research was able to propose a SOA model which can be used in medical emergency vehicles and their control centre. This model enables the creation of new Web services and the integration of ICT systems and services which belong to different collaborating agencies and which need to exchange information in real-time during an emergency. The real-time information interchange is made possible by the application of a shared SOA-based database which can be updated and the information therein consumed by interested parties. A conceptual and innovative service blue print which consists of potential Web services for implementation was also proposed. The paper also considered some practical issues that must be resolved for a SOA implementation to take-off.

Apart from providing support for real-time information interchange during an emergency, SOA through Web services can enable a unified and transparent layer of administering emergency services across local, regional and national boundaries and across organizations. The software systems which are SOA-based are easily integrated within and across the medical emergency management domain. In the future when these services expand, further integration would become more feasible since the existing systems are already SOA enabled. The research outcomes are not only applicable to our case study but also adoptable by other countries but with due consideration given to their peculiarities such as population, medical emergency domain and other peculiar requirements as they may deem necessary. The adoption of SOA via Web services is only a strategic long term investment and organizations wishing to adopt it should be able to take due

steps in considering its adoption. The thought of adopting SOA in order to reap from its promises in the short-term often leads to failure since it is sometimes not successfully adopted. Given its drawbacks, SOA would not be an ideal architecture for use in scenarios where the environment is non-distributed and loose coupling not necessarily desired hence, other architectural styles should therefore be adopted.

Being a practical and not a fictitious or imaginative research, its real implementation was hindered by the problems already highlighted above but the research did well to offer possible solutions to overcome the problems in order for any SOA project team to fulfil its objective. This research relied on proven approaches, expert opinions and a survey; the outcome of which helped to justify our findings to a very reasonable extent. With the outcome of the research findings, a project team can be well-informed about certain key decisions that they would have to make in order to successfully consider and finally adopt a SOA solution.

APPENDIX

A. *Research Questionnaire*

Mobile Object Bus Interaction Research

Exit   this   survey

A research questionnaire concerning Service Oriented Architecture and Web services

	100%

Researcher under MOBI Project, Laurea University of Applied Sciences, Finland.

This questionnaire supports Mobile Object Bus Interaction (MOBI), a Tekes funded project undertaken by Laurea University of Applied Sciences. The purpose of this questionnaire is to assess the applicability of Service Oriented Architecture (SOA) and Web Services in Medical Emergency Vehicles (MEVs) and the Control Centre. This would enable us to know to what extent SOA and Web Services standards can be employed in the development of software systems to fulfil the software application requirements of MEVs and the Control Centre and reduce the challenges of integration and interoperability. We would appreciate the resources and time you take out to complete this questionnaire. We aim to contribute towards improving health care delivery. It is hoped that your feedback would help inform decision makers about the choice of software development paradigm to use in the development of software applications for MEVs and the Control Centre since there is a global trend towards the adoption of SOA in the health sector.

Section A: This section only seeks to know your role in the organization you are part of.
1. What position do you occupy in your organization?

2. Please rate your knowledge about Service Oriented Architecture and Web Services

○   Please rate your knowledge about Service Oriented Architecture and Web Services Low

○   Medium

○   High

Section B: This section boarder on SOA and its pplication in health services
3. Do you believe that SOA can provide support for software systems integration more than other architectures would do?

○   Strongly agree   ○   Agree   ○   Disagree   ○   Strongly disagree

4. Do you also think SOA can support software systems interoperability more than other architectures would do?

○   Strongly agree   ○   Agree   ○   Disagree   ○   Strongly disagree

5. SOA can enable software systems reusability, availability and discoverability in an enterprise system where information interchange and control is critical?

○   Strongly agree   ○   Agree   ○   Disagree   ○   Strongly disagree

Additional Comments(Optional)

6. Do you support the transition of Health Services to SOA?

○   Yes   ○   No

Additional Comments(Optional)

7. Which of the following Health Services domains do you think can benefit from the adoption of SOA? You can choose more than one option

☐   Surgical Unit   ☐   ENT (Ear, Nose and Throat) Unit

☐   Maternity Unit

☐   Paediatric Unit   ☐   Emergency Medical Unit including ambulances

☐   Orthopaedic Unit   ☐   Radiology Unit

☐   Neurology Unit   ☐   Laboratory Unit

☐   Accounts Units

8. Given any national, regional or district setup where the headquarters needs to communicate with local hospitals or need for inter-hospital collaborations, SOA solution can be feasible

○   Strongly agree   ○   Agree   ○   Disagree   ○   Strongly

agree   disagree

Additional Comments(Optional)

[ ]

9. The implementation of SOA using Web services is the most viable choice to provide mobile and internet support for medical emergency vehicles, mobile doctors, patients and the main emergency unit at the hospital as information can easily be shared.

○ The   ○ Agree   ○ Disagree   ○ Strongly
Strongly agree   disagree

Additional Comments(Optional)

[ ]

10. Do you know any domain (e.g. emergency services) in the health services that is currently being supported by SOA?

⦿ Yes   ○ No

11. If Yes, please name the domain(s) and the service provided

[ ]

If Yes, please name the domain(s) and the service provided
Section C: This section explores the attitude of developers towards SOAP and REST as web service implementations of SOA

12. RESTful services now witnesses more adoptions than SOAP-WSDL services

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

13. REST is a true representation of the Web hence more suitable for building Web services

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

14. REST supports better systems integration than SOAP

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

15. Majority of RESTful services available today do not really adhere to the four cardinal principles of REST which would have brought more benefits

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

16. I feel more comfortable designing and programming RESTful services than SOAP web services

⦿ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

17. The choice of either SOAP or REST should be based on the major needs of the software systems to be developed or integrated and the domain.

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

Additional Comments(Optional)

[ ]

18. Which of either SOAP or REST would you recommend for use in health services?

☐ SOAP   ☐ REST   ☐ Both

19. REST would be the dominant approach to realizing Web services in the near future

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

20. SOAP would be the dominant approach to realizing Web services in the near future

○ Strongly ○ Agree   ○ Disagree   ○ Strongly
agree   disagree

21. Further Comments (If you have additional comments please fill free to write)

[ ]

[Done]

Create your own free online survey now!

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