The MOBI project: Common Mobile Digital Services for all Public Protection and Disaster Relief (PPDR) Vehicles

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Abstract: - The MOBI project results that all public protection and disaster relief (PPDR) actors have many similar applications in their vehicles such as a navigation system, patrol tracking, target maps, activity logs, alarms and remote access to central databases as well as controlling of blue lights and sirens, power supply systems, communications equipment, and need of inventory of equipment. The study shows that information and communication technology (ICT) systems should be designed as modular system where individual modules could be replaced without the need to change other parts of the whole system. The modules are 1) a vehicle infrastructure and power management layer, 2) a communications layer, 3) a service platform and common services layer, and 4) an actor-specific services layer. Some aspects, such as security, power efficiency and product safety regulations run through all the layers. According to our approach, although police patrol cars, fire trucks and ambulances are different their communications layer as well as their service platform and common services layer could be identical. This enables interoperability between PPDR organisations and first responders, at least at technical level.

Key-Words: - Ambulance**,** Digital services, Fire truck, First responder, Police patrol vehicle, Public safety, Public protection and disaster relief, PPDR

1 Introduction

In field operations, first responders (FRs) most important tool is their vehicle. The Finnish approach to provide digital services to field for of public protection and disaster relief (PPDR) is via their Vehicles. In Finland, Border Patrol, Custom and Police Cars are already quite similar - except their colour, because these all are equipped by The Police Technical Center. Also other emergency response vehicles (ERVs) such as fire trucks and ambulances have similar needs for navigation system, patrol tracking, target maps, activity logs, alarms and remote access to central databases as well as the control of blue lights and sirens, power supply systems and communications equipment. Also, the inventory of ERVs' equipment means a weekly basis the number of hours used in the examination of goods, all of which are out of from field work. The development of a common ERV concept for all FRs is the background for the MOBI project [1].

2 Research Problem and Methodology

Our research and experiment case is focusing on the developing of a new ERV concept. New digital technical solutions are facing challenges of current business problem. If we put innovative artifacts into the action and analyse how they are used and how they performed, we will see things that cannot be seen in the laboratory [2]. Management information systems (MIS) involve three primary resources: people, technology, and information. According to the "going the last mile" approach [2], the starting point of research should be a real problem for real people. In this paper, the real problem comes from PPDR organisations and FRs who are experiencing challenges. This paper gathers results together from several Finnish research and development (R&D) projects.

The grounded theory based research of end-user requirements results in layered approach. According to this approach, ERVs' electrical, electronic and ICT systems are divided into four layers that have standardized interfaces, as shown in Fig.1. These layers are 1) a vehicle infrastructure and power

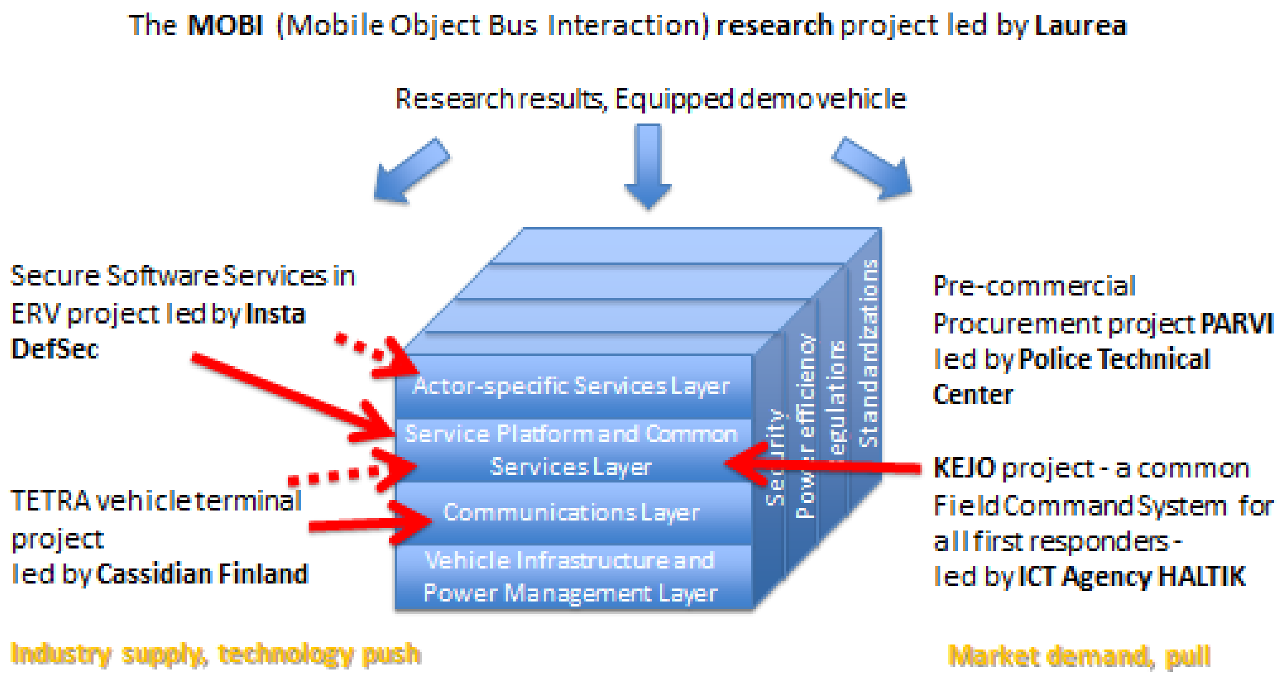

Fig.1 Finnish ERV projects

management layer, 2) a communications layer, 3) a service platform and common services layer, and 4) an actor-specific services layer. Some aspects, such as security, power efficiency and product safety regulations run through all the layers [3].

Fig.1 also shows what kings of research and development activities in this filed are ongoing in Finland. When looking technology push side, the MOBI coalition includes two enterprise projects. An enterprise project, led by Insta DefSec Ltd., developed secured software services. The project utilized the results of the related research project and aimed to develop product concepts which have potentials in both domestic and export markets. Additionally, Insta DefSec Ltd. will further develop its business model in order to be able to utilize growth potential of the product concepts. The project started June 2010 and ended December 2012 [4].

Another enterprise project, led by Cassidian Finland Ltd., implements a vehicle-installed professional mobile radio (PMR) concept for law enforcement, and fire and rescue operations. The project started January 2010 and will end May 2013 [5].

When looking market pull, end-user and customer side, the Police Technical Center is leading a pre-commercial procurement project (the PARVI project) for a new type of a law enforcement patrol car [6].

Ministry of the Interior's ICT Agency HALTIK and the National Police Board are developing a common Field Command System for all public safety actors. This KEJO project has started January 2013 and will end December 2016 [7].

The Mobile Object Bus Interaction (MOBI) research project generates research data for enterprise and governmental projects by researching and documenting the needs and requirements of the users, power generation and supply and specifying the existing solutions. We are also equipping a demo vehicle. The project started September 2010 and will end March 2014 [8].

3 Standardization Aspects

3.1 Vehicle Infrastructure and Power Management

With regard to the vehicle infrastructure and power management layer, there are two main areas to standardize: 1) what services will be adapted from a standard vehicle system and 2) how to make the car body modifications and new installation in a standardized way. The services adopted from standard vehicle include, for example, power generation when the engine is on and information applied from the vehicle's controller area network (CAN). The standardised ERV installations include vehicle body modifications, emergency lights and

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alarms, intelligent power management (power generation, storage and distribution systems) as well as cable and antenna installations (electromagnetic compatibility issues).

A modern ERV carries a lot of equipment and it is extremely important to be sure that all needed tools are available in field operations. All ERVs should be ready to service on 24/7 basis. Preventive maintenance acts vital role to guarantee ERV operation preparedness but maintenance procedures during and after working sift are important too. The inventory of an ERV means a weekly basis the number of hours used in the examination of goods, all of which are out of from normal work. By applying, for example, RFID technology the inventory of tools could be automatized [9].

3.2 Communications

ERVs' communication layer is a part of the nation-wide public safety communications (PSC) system. The enhanced performances of the technologies in the private sector grow faster than in PSC as shown in Fig.2. Current communication standards, such as 802.11n and Long Term Evolution (LTE)-Advanced are providing data rates up to 100 Mbit/s with a roadmap up to 1 Gbit/s [10]. This enables users to rely on mobile data services and mobile Internet access in many situations. The overall performance of TETRA is on the degree in which commercial mobile networks were two decades ago. This situation prevents the use of high-data services such as live video broadcasting. Although some enhancements are planned to the TETRA standard – e.g. TETRA Enhanced Data Services (TEDS) – the gap between the technologies applied in PSC and private sector is getting wider over the time [10].

The communications concept of the Finnish Government consists of many different networks that can be roughly divided into four different levels of preparedness, as shown in Fig.3. The Defence Forces' strategic communications have the highest level of preparedness. The second level is the secure data network for state officials (TUVE network)

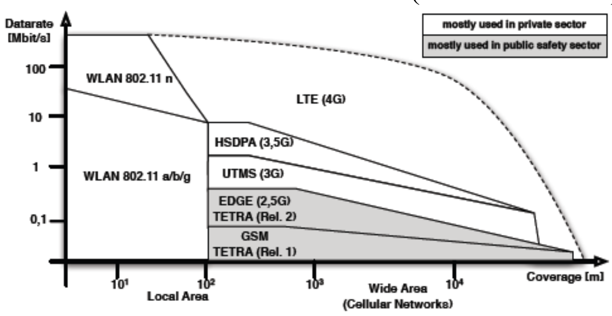

Fig.2 Coverage and data rates of wireless network technologies [10]

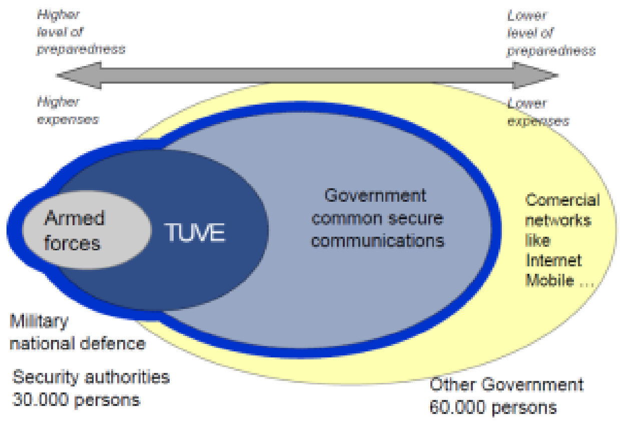

Fig.3 Communication concept of Finnish Government [11]

having about 30.000 users [11, 12]. The third level consists of the Government's common secure communications requirements. This level is realized by public-private-partnership (PPP); together with the State IT Service Centre and commercial telecommunication operators [13]. The fourth level has normal business requirements and it is realised by commercial networks.

Finnish TETRA-based PPDR network VIRVE has been operative since 2002 with full domestic interoperability. Every week, VIRVE transmits 800,000 group calls and 32 million short data service (SDS) messages [14]. The Finnish experience shows that GSM networks were overloaded during emergency situations (e.g. high school massacres in 2007 and 2008 and summer storms in 2010) whereas the VIRVE network was operating normally.

The main challenges in public safety communications are (1) lack of broadband connectivity and (2) lack of interoperability. In the field, wireless communications' role is to support the mobility of first responders by providing continuous connectivity among responders and with the headquarters [15]. The support includes: maintenance of voice communication to coordinate the relief efforts for the resolution of the crisis; creation and distribution of a common operational picture among all the responsible parties; collect and distribute data in the operational context or the environment from sensors; retrieve data from central repositories (e.g. building plans, inventory data) to support their activity; support the tracking and tracing of the supply chain of goods and materials needed for the response and recovery phases of a crisis. The lack of interoperability limits the effectiveness of PPDR practitioners in actual operations, and an evident lack of understanding as to whether these limitations arose from technology, operational procedures, and gaps in procurement or research [15].

All PPDR actors have the same basic needs for the system and data communication. However, they also have own distinct requirements. Data communication needs can be classified according to the data rates required as shown in Table I.

For finding common solutions and operation models, system integration is needed. This also enables coherent system design including improved activities, cost savings and improved multi-authority co-operation at the scene. The roles of complementary wireless PSC technologies in the future are as follow:

- 2G/GPRS technologies are reaching the end of their life cycle.
- 3G technology has good coverage with U900. However, problems exist on the availability/capacity of commercial networks during major accidents in crowded areas.
- 4G/LTE networks are at 2.6 GHz, which is not suitable for rural coverage. In future, 800MHz LTE systems are anticipated.
- Wireless local area network (WLAN) technology has at least three scenarios for data transfer: (1) from a vehicle to a station garage, (2) a local wireless AdHoc network around the vehicle at the scene, and (3) from a vehicle to a public WLAN; ”WLAN fire plug”.
- Satellite technology has a complementary role when a lack of coverage of available terrestrial communications network. It includes long term usage when no other systems are available and communication required for temporary sites.

3.3 Service Platform and Common Services

The standardized communication layer for all PPDR organizations enables cooperation between authorities, e.g., by setting up a common talk group for incident communications. The next pitch of harmonizing is the service platform and common services layer, in which the design principles of service-oriented architecture (SOA) could be applied. All ERVs have many similar applications such as a navigation system, patrol tracking, target maps, activity logs, alarms and remote access to central databases as well as controlling of blue lights and sirens, power supply systems, communications equipment. Roughly the common needs of the service platform and common services layer could

Table I Classification of data communication needs [16]

Class	Information carried	Service used	Rata needed
Narrow band	Alarm, status, location info	Status message, SDS[a], LIP[b]	< 100 kbit/s
Wide band	Still picture, query, announcement, low-resolution video, Internet access	File transfer, email, IP data	100-1000 kbit/s
Broad band	High-resolution video	Multi-media, streaming	> 1 Mbit/s

[a] TETRA Short Data Services
[b] ETSI Location Information Protocol

be divided into two main areas: decrease in the number of physical Human-Machine Interfaces (HMIs), and a common field command system for all PPDR actors that also improves interoperability between different FR actors. However, several physical HMIs are needed for different modes of operation. For example, the HMIs when driving at full speed should be totally different than those in mobile office mode where ergonomics act an important role. Applying design principles of service oriented architecture, from end-users point of view, different existing systems seem as a one part of the field command system [17].

3.4 Actor-specific Services

By ‘actor-specific services’ we mean these digital services that differ substantially from other FRs’ needs. For example, medical information systems and databases have developed rapidly in recent years. Progress in mobile technologies has generated a demand to take these functionalities into account on mobile work in ambulances. The ambition to make the most out of the medical information systems in these mobile environments is to take advantage of the capabilities in mobile technologies to make use of the systems remotely. The primary functions for these mobile technologies and systems are to substitute the paperwork, provide interface to search for information and to enter information to the medical information systems while on mobile emergency. Benefits that will be gained from real time patient information updates are the increased quality of the care and more accurate information about the patient's condition during the mobile emergency care.

4 Discussions

The benefits of our approach to the development of ERVs are similar to those that the Open Systems Interconnection (OSI) reference model brought to the field of data communications. The layered approach breaks ERVs' electrical, electronic, information and communication technologies into smaller and simpler parts, as well as smaller and simpler components, thus aiding component development, design and troubleshooting. The standardized interfaces allow modular engineering, meaning that different types of hardware and software components communicate with each other. Interoperability between vendors allows multiple-vendor development through the standardization of ERV components. It defines the process for connecting two layers together, promoting interoperability between vendors. It allows vendors to compartmentalize their design efforts in order to fit a modular design that eases implementation and simplifies troubleshooting. The layered approach ensures the interoperability of technologies, preventing the changes in one layer affecting other layers, allowing quicker development and accelerating evolution. It provides effective updates and improvements to individual components without affecting other components. All these aspects have already been found to be very valuable in the field of data communications after the OSI model has been applied.

The problems within the public safety branch are similar within all countries; for example the constant increments in ICT devices of ERVs. Different public safety actors need different kinds of ERV; since an ambulance differs from a border patrol vehicle. The current ERV-related standards specify the majority of construction and design details, including voice radio installation requirements. However these standards offer no information about field command systems and interoperability requirements between different first responders. According to our approach, although ERVs are different their communications layer as well as their service platform and common services layer could be identical. This enables interoperability between first responders, at least at a technical level.

All PPDR organisations main need is to maintain their core services with a significantly reduced budgets. Traditionally PPDR organisations suffer from intensive human involvement. The only realizable solution is the better piggybacking of ICT and digital services. In field operations, the first responders' most important tool is their vehicle. This paper presents a layered approach for standardizing the electrical, electronic and ICT devices of ERVs. On the basis of this infrastructure, the mobile digital services needed for first responders could be supplied [17].

5 Conclusions

It is vital that different PPDR organisations will develop the common ERV concept together. This enables new mobile digital services for first responders to their field operations. The MOBI research project has been an essential feasibility study finding out the requirements of all PPDR organisations and FRs in the field. However, more multidisciplinary research is needed.

Within the duration of the MOBI project, the society has changed radically; applying of social media has exploded, and the authorities from the advanced countries have taken these matters into account when developing their digital services for public safety. For example with these advanced systems, people being first at the scene of the accident (involved and/or eyewitness) can communicate with PPDR authorities who are able to receive social media and multimedia messages into their operative systems. Unfortunately, many PPDR organisations see the Internet and social media only as an extra resource in which they can collect and transpose "material" to analyse it in their own systems. In practice, too strict data security regulations may rule out the mobile utilising of digital services in the field. However, most often the biggest cyber threat is so-called "insider threat" like Snowden and Manning cases indicate. When taken into account the Finnish cultural-ethnic environment, it could be invested in towards this security originated from end-users, rather than the strict technical data security by which the last 0.02% of confidence can be achieved.

References:

[1] (2013, Dec. 3). MOBI wiki [online]. Available: http://mobi.laurea.fi.

[2] R. Winter, "Interview with Jay F. Nunamaker, Jr. on "Toward a broader vision of IS research"," Business & Information Systems Engineering, vol. 2, pp. 321-329, 2010.

[3] J. Rajamaki, "The MOBI Project: Designing the Future Emergency Service Vehicle," *Vehicular*

Technology Magazine, IEEE, vol. 8, pp. 92-99, 2013.
[4] (2013, Dec. 3). Secure software services [online]. Available: http://www.tekes.fi/programmes/Turvallisuus/Projects?id=10210602.
[5] (2013, Dec. 3). Vehicle installed professional mobile radio concept for law enforcement and fire & rescue operations. [Online] . Available: http://www.tekes.fi/programmes/Turvallisuus/Projects?id=10201742.
[6] H. Riippa, "Procurement at the finnish police," in Tekes Safety and Security Programme's Annu. Seminar, 2012, .
[7] (2013, Dec. 3). Projektipäällikkö – Kejo-hanke (Project Manager – Kejo Project). [Online]. Available: http://www.poliisi.fi/poliisi/bulletin.nsf/PFC/6FA46AF5EF825F98C2257AF3002E83A8.
[8] (2013, Dec. 3). Mobile Object Bus Interaction. [Online] . Available: http://www.tekes.fi/programmes/Turvallisuus/Projects?id=10199203.
[9] T. Timonen and J. Rajamäki, "RFID technology as an inventory tool for future emergency service vehicles," in *Recent Advances in Computer Science and Networking: Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN'13)*, 2013, pp. 142-145.
[10] S. Subik and C. Wietfeld, "Integrated PMR-broadband-IP network for secure realtime multimedia information sharing," in *Technologies for Homeland Security (HST)*, 2011 IEEE International Conference On, 2011, pp. 20-25.
[11] Y. Benson, "Authority IT serving national security, " in VIRVE Day -Seminar, Helsinki, 2011, .
[12] K. Manni, "Security communications – possibilities and challenges," in VIRVE Day -Seminar, Helsinki, 2011, .
[13] M. Lehti, H. Pursiainen, R. Volanen, R. Luoma, P. Timonen, R. Hagman and I. Kanane, "Promoting the availability of secure telecommunications networks," The Ministry of Transport and Communications Publication, Helsinki, 2009.
[14] H. Riippa, "The future of PPDR networks in Finland – Requirements and options," Presentation in the EU Workshop on the Future of PPDR Services in Europe, March 30, 2011.
[15] G. Baldini, "Report of the workshop on “Interoperable communications for Safety and Security”," Publications Office of the European Union, 2010.
[16] M. Rantama, "Mapping the future for Finland’s rescue services," *TetraToday*, vol. Issue 3, pp. 32-35, 2011.
[17] J. Rajamaki, "Mobile digital services for border protection: Standardization of emergency response vehicles," in *Intelligence and Security Informatics Conference (EISIC)*, 2013 European, 2013, pp. 256-261.