Creating a service oriented architectural model for emergency vehicles

Jyri Rajamäki and Timo Villemson

***Abstract*—**E.g. Finnish police cars have about 40 different user interfaces (radio, navigation, command and control systems, radar, alarm lights, etc.) on the deck beyond the cars' standard user interfaces. In cold weather conditions, not all police vehicles are creating enough electricity for intensive operations. Also, wiring and ergonomics are problematic. The annual delivery amount of emergency vehicles is, however, so low that traditional business models, where devices and systems are sold to the end-user, do not motivate suppliers to do invest significantly in system development. Therefore, other business models, such as digital service concepts, are needed for security services. In this paper, the concept vehicle is a Volkswagen transporter used by the Finnish police, but the possibility of extending this concept to other emergency vehicles is also discussed. A new mobile platform for police cars is proposed, and the digital service design parameters of the ICT integration solution are defined. Further research subjects are also presented.

***Keywords*—**Digital service design, Emergency vehicle, Emergency vehicle ICT systems, Police ICT systems.

I. Introduction

EMERGENCY vehicles used by police, customs, frontier guards, as well as fire and rescue services, are increasingly dependent on ICT systems, especially wireless and mobile communications. In the past decade, an increasing number of new technical devices and systems have been installed in these vehicles, and it is necessary to ensure that information and "on-demand" services provided by these technologies are delivered reliably and securely through one or more of the recently deveopled wireless architectures.

There are, however, serious challenges to overcome. As the number of ICT systems has increased, the number of user interfaces of emergency vehicles has increased considerably. This has resulted in functionality problems; for example, the space for airbags to function has decreased. Also, technical problems with regard to electric supply and cabling arrangements have occurred. In addition, the documentation of applied solutions is not always adequate.

Another issue is that the longed-for standardization in the field has not taken place. This may be due to the large variety of equipment suppliers or because the annual delivery amount of emergency vehicles is so low that the standardization has not been given priority by experts in the field.

In global communications, service providers are moving from a network-centric to service-centric environment to meet consumer and enterprise demand for innovative multimedia applications and services. Meeting this demand, while increasing focus on the end-user, requires advanced network deployment, but in the current cash-strapped environment how can this be accomplished, while at the same time achieving reduction in total cost of ownership? Through creative partnering and innovative risk sharing options, new managed services and outsourcing business models must be developed. Such models should provide the framework for creating a portfolio of affordable next-generation services for consumers and enterprises without compromising network performance, service quality and security.

In this situation, the challenge is to use infrastructure-based communications and ad hoc networks to provide on-demand services in a highly-volatile, complex environment; smooth interoperability of architectures with regard to emergency vehicles should be studied. Chapter II of this paper illustrates this operating environment: communication networks of public authorities, emergency vehicles, as well as the ongoing change towards service business. Chapter III describes the main ICT systems of an emergency vehicle with emphasis on the police car. Chapter IV presents the research method applied in this study: the digital design service approach. Chapter V presents the findings of this study. A new mobile platform for a police car is proposed, as well as the digital services and the design parameters of the ICT integration solution. Chapter VI outlines a new service model that could be outsourced to 3rd party vendors and the methods that could be used refine these models. Chapter VII presents the needs for further research and conclusions.

II. Environment

A. Critical Network Environments

In a society considered as an information society, the different network and information system services must be optimized for the purpose in question and they must complement each other. According to [1] it is increasingly important to protect advanced critical infrastructure under exceptional circumstances and also during serious disruptive situations in normal circumstances. This is due to the following factors: society has become more information-intensive; foreign ownership has increased; functions are

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outsourced; ICT systems are more integrated and interdependent; usage of freely accessible information networks has increased; and dependence on electricity has strengthened. [1]

According to [1], the state should ensure that it always has sufficient ownership and control authority concerning at least those elements of the fixed telecommunications networks most critical to the functioning of society. This objective should be implemented in such a way that, to guarantee security, the amount of the state's capital tied up in the ownership of telecommunications companies is as little as possible; the state's actions should clearly convey the pursuit of a communications policy that is independent of state ownership. Ref. [1] continues that the Government should set up a standing committee of public servants, composed of representatives of the main ministries and other authorities, for the purpose of supporting and coordinating official tasks concerning the regulation of communications markets, the availability of electronic networks for public authorities, and the ownership policy with regard to communications companies. Also, the high-security national information infrastructure produced by the security network (TUVE) project for the government sector should be utilised wherever possible. [1]

Fig. 1 shows the interrelationships of different Finnish critical communication networks. The world's first nationwide TErrestrial TRunked RAdio (TETRA) network - the "Viranomaisradioverkko" or VIRVE network - is commonly used by Finnish authorities. The VIRVE network is used by the emergency and fire and rescue services, the police, the Finnish Defence Forces, the Frontier Guard, social and health services, the Finnish Maritime Administration and different government departments.

B. *Emergency Vehicles in Finland*

The authorities have to operate in a variety of different conditions in Finland. They must be able to get about in narrow city streets, country roads, fells, coastal and inland waters, etc. Great seasonal differences increase the demands on police vehicles. The means of transport used by the police are passenger car, van, bicycle, boat, Jet Ski, motorcycle, motor scooter, snowmobile and horseback. In Finland, the police have approximately 1,500 cars and vans. The Volkswagen (VW) Transporter is the most common vehicle, and at present, they account for almost a third of all the vehicles in stock. Police vehicles are used for an average of 7 years, after which they are sold at Police Technical Centre auctions. [2]

The interior of the VW Transporter can be converted into, for example, an office, a dog-handling vehicle or a vehicle weighing unit. The police identifiers and other equipment for the cars are installed at the Police Technical Centre, which is a support services unit of the Finnish Police. The responsibilities of the Police Technical Centre include the supply of police vehicles, uniforms, service weapons, and the acquisition, storage and sale of the material needed by the police. The purpose of their development work is to ensure that police receive equipment and supplies that are thoroughly tested and suited to Nordic conditions. The customers of the Police Technical Centre include Finnish Police and other security and emergency management bodies of the central and local government. [2]

C. *Digital Services*

The annual delivery amount of emergency vehicles is very low in Finland. Therefore, a traditional product-based economy, where devices and systems are sold to the end-user, does not motivate suppliers to do invest significantly in system development. Therefore, other business models, such as digital service concepts, are needed for security services.

A service is defined as "any activity or benefit that one party can give to another that is, essentially intangible and does not result in the ownership of anything. Its production

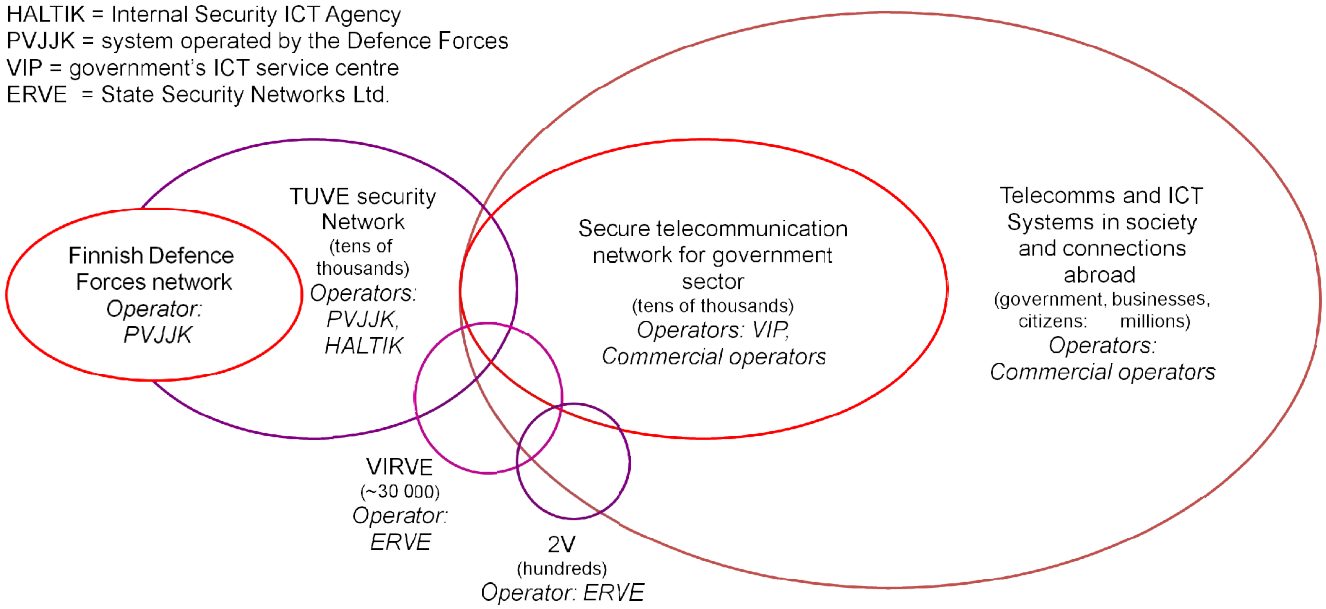

Fig. 1 Finnish critical communication networks [1]

Fig. 2 Vehicle installations of the POKE system [8]

may or may not be tied to a physical product" [3]. According to [4], 'digital services' means services which are obtained and/or arranged through a digital transaction (information, software modules, or consumer goods) over Internet Protocol (IP). A difference between digital and non-digital services is the idea of ownership, which indicates possession. For a digital artefact, the physical possession might not be the same as having full control; often digital rights and ownership rights are non-specific, which makes it difficult to know who owns what, and where the rights of one party stops and the other's begin. 'Digital rights' is an area where the provider of a digital service might represent a large number of digital owners in their interactions with other parties. [5]

III. ICT Solutions of Emergency Vehicles

A. Network Operator

The operations of the Internal Security ICT Agency (HALTIK) were initiated in 2008, and it produces information and communication technological services to the administrative branches of the Ministry of the Interior relating to home land security and immigration. HALTIK is responsible for providing basic information technology services, expert services related to information technology, as well as the implementation of security cluster services on the basis of a service contract that adheres to the orderer-producer principle. HALTIK has about 320 employees. HALTIK services are used by approximately 18,000 customers from the various public branches of the Ministry of the Interior. About half of these customers are police officers. [6]

B. Police Data Systems and Information Services

1) POKE Field Command Systems

Today the most important data system of Finnish police cars is the POKE Field Command System, whose real-time data communication such as text and status message services are enabled by the VIRVE network. VPN tunneling techniques in IP enables Security. Also, TETRA-IP low bandwidth is available, and public mobile operator networks are in use for high bandwidth. A GPS module enables low-price position data. GPS is attached to all police mobile radio, which in Finland means 1500 handheld radios with GPS. The POKE system dispatches 2 million AVL messages per day. [7], [8]

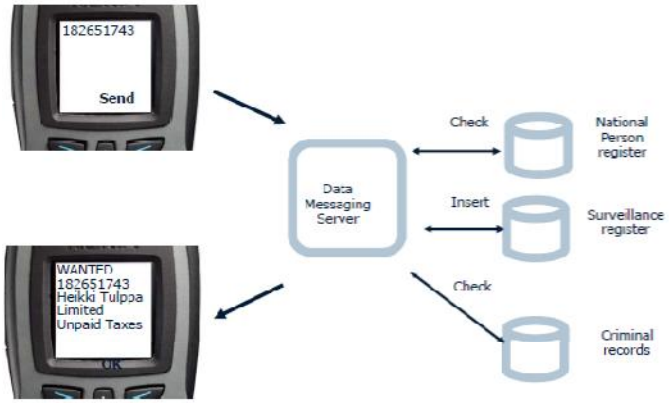

Fig. 3 POKE system text services [8]

Vehicle installations of the POKE system are shown in Fig. 2 with van installation on the left and passenger car on the right. Fig. 3 represents POKE's text services. POKE Field Commander (Fig. 4) includes a touch screen, a TETRA modem and a huge map and chart application.

2) Police Affairs Information System

The police affairs information system is a nationwide police information system in Finland, which stores the practical work-related information of the police. The different parts of the police affairs information system are: 1) crime report index, 2) investigation and post-assistance system, 3) investigation and post-assistance system archive records, 4) the warrant register, 5) identification registry, 6) the property register, 7), arrest registry, 8) characteristic registry, 9) crime execution way registry, 10) the registry of sought after motor vehicles, and 11) message dispatch registry. Police officers are allowed to collect information for entry into the police affairs information system database about individuals for joint use according to the Finnish police law.

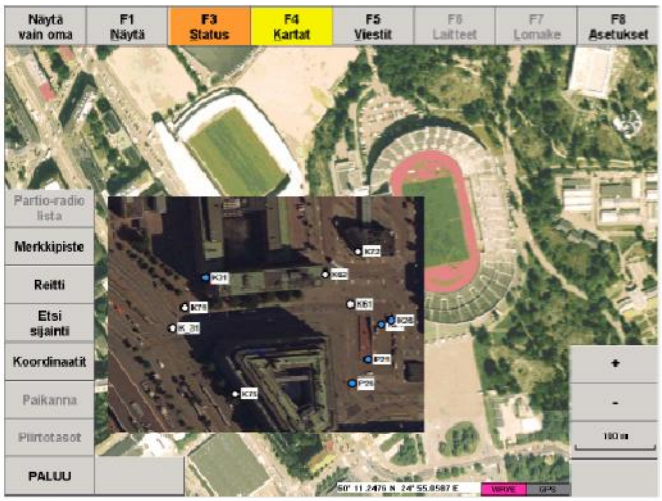

Fig. 4 POKE Field Commander [8]

3) Schengen Information System

The Schengen Information System (SIS) is a secure governmental database used by several European countries to maintain and distribute information on individuals and pieces of property of interest. The intended uses of this system is for national security, border control and law enforcement purposes. Information in the SIS is shared among institutions of the 27 participating countries in the Schengen Agreement Application Convention (SAAC). [9]

4) Permit register

The permit register information system stores, for example, the information of all the gun permit owners in Finland. All the queries made to the database are logged, and the legality of the register is frequently checked by the police information management center.

5) Workstations

The Workstations service offered by HALTIK includes equipment procurement, installation and commissioning, maintenance and servicing arrangements, and the safe disposal of information. Operating systems and application programs for the service include installation, maintenance, and necessary updates. The service also includes a customer-specific IT support in problem situations, as well as expert advice for IT and IT-security matters.

6) Telecommunications

HALTIK manages the Interior Ministry's core network and communication links. It also develops and analyzes the development of these networks. One of these networks is called TUVE, Government Security Network, which is scheduled to be in operation in the beginning of 2011.

7) HelpDesk

HALTIK implements a centralized helpdesk for the entire police administration staff 24 / 7. The support service aims to provide the police administration staff one contact point through which all service requests are received and directed to appropriate specialists. Support services are received through telephone, e-mail and web-site.

8) Special Systems in Vehicles

The emergency vehicles supplied by the Police Technical Centre of Finland have many electrical, electronic and ICT devices and system, such as intelligent electric supply systems, radio, video and radar equipment, average speed measurement system, alarm devices, PC, printer, weighing appliance, biometric systems, automated recognition systems for registration plates, GPS and Alco meter. Mobile communication equipment includes devices for both TETRA networks and public mobile operator networks, such as GPRS, Edge, 3G, @450, WLAN and WiMAX.

IV. Digital Service Design Research

A gigantic shift from a product-based economy to one based on services, specifically digital services, is ongoing. The subject of this study is to design new digital services for public security services. Today digital services are being designed for and offered to users. However, very little is known about the design process that goes behind these developments. Is there a science behind designing digital services? [3] The framework of this study is the design of emerging digital services, applying guidelines described in [3] and [4].

It has been argued that innovation is more a result of iterative emergence than design [10]. According to [3], there are some important differences between digital services, existing software products, and non-digital services. While these differences vary from service to service, there are similarities that are useful to the field of design science [3].

The party that gives the service or activity is the digital service provider, and the party receiving the activity or benefit is the digital service user. A single transaction is sufficient to provide a digital service, however, these transactions are usually provided in groups or continuous transactions. Two organizations with exactly the same digital artifacts can behave totally differently in the market. [3]

Two dimensions that emerged from [4] included 1) fundamental design dimensions and 2) fundamental service provider objectives. The fundamental design dimensions include the ideas of service delivery, service maturity, malleability, and pricing, but are not necessarily exhaustive. The fundamental service provider objectives include how the digital service is designed to meet the objectives of business success, technological success, and success of interactions. [4]

A. Fundamental Design Dimensions

According to [3], four fundamental design dimensions distinguish one service from the other: 1) Service delivery, 2) Service maturity, 3) Malleability (provider and user), and 4) Pricing and funding.

The service delivery describes how the service is provided and the range of requirements for the consumer of the service to participate at different levels [3]. Table I shows service delivery requirements - what is required to use the digital service?

TABLE I
SERVICE DELIVERY REQUIREMENTS [3]

Level	Description
High	Specialized hardware or software required (latest version or certified hardware/software)
Medium	Standard computers with late (past 2 or 3 years) operating system sufficient
Low	Older computers (3+ years) and operating systems work fine, but specified
None	Minimum hardware/software requirements not specified

The four digital service maturity levels used in this study and described in Table II are as follows: 1) Enthusiast - designers available to assist; 2) Professional - professional customer service; 3) Consumer phase - help accessible within product; and 4) Embedded - automatic, help not required [3].

TABLE II
STAGES OF DIGITAL SERVICE MATURITY [3]

Development Phase	When Problem Arise	Technical skills required by system users:	Overriding Goals of Phase
Enthusiast	Technical users solve the problems themselves or check with other technical experts or with the system designers	High	Innovation and creativity
Professional / Business	Formal customer service delivery system with occasional interaction with the systems designer	Medium	Value and reliability
Consumer	Eliminated need for interaction with systems designers and best practices are built into the system and the customer service delivery systems	Low	Simplicity and trust
Embedded Systems	Eliminated the need for interactions with customer service delivery systems. System failures are handled as artefacts of failures of related systems	None	Automation and dependence

According to [3], a most desirable quality of digital services is the ability to be malleable or to be able to adapt to changing market needs or requirements. Digital services have an advantage if they can be dynamically and incrementally changed without the need for the users to upgrade their software, since the functionality of the latest code is deployed from the service provider upon use. Tables III and IV shows service malleability levels with regard to the providers' and users' point of view.

The value proposition is an important component in digital services, where users pay for the perceived value. Generic approaches to revenue logic in the open source software business are identified as follows [11]:

- *Licensing*, that is, license sales and royalties as the main source of revenue.
- *Revenue sharing* with distribution partners or profit sharing with users.
- *Loss-leader pricing*, meaning giving something for less than its value. This is done, for example, in order to increase the customer base for later revenue, or, to support sales of some other part of the product/service offering.
- *Media model*, where the revenue is based on advertisement sales either through advertisement in the user interfaces of software or by selling user information for advertisers.
- *Effort-, cost- or value-based pricing*, which is a common approach in customized or tailor-made software solutions and made-to-order software projects.
- *Hybrid models* as various combinations of the above.

TABLE III
DIMENSIONS OF SERVICE PROVIDER MALLEABILITY [4]

Melleability Level	Description
High	Changes are easily made to the digital service offerings by the service provider and require no testing
Medium	Changes require changes to more than a few parts of the service and limited testing
Low	Changes are difficult or expensive to implement and require extensive scenario testing
None	Changes require a complete re-write or complete new implementation

TABLE IV
DIMENSIONS OF SERVICE USER MALLEABILITY [4]

Melleability Level	Description
High	The service user is either not impacted by the changes or is positive towards them
Medium	The service user is impacted in their use of the digital service and must make some changes to their user behavior.
Low	Changes are difficult or expensive for the service user to consume and may interfere with their continued use of the product, unless there are other incentives to remain as a service user.
None	The digital service is like a completely new offering and could have been provided by another service provider.

B. Fundamental Service Provider Objectives

Digital services are offered to users for the benefit of the users, but the service provider is doing so to achieve certain objectives. Three service provider objectives described in [3] are: 1) Business objectives, 2) Technological objectives, and 3) Interaction objectives.

Business objectives are not just about making money, but also about building a successful business, which includes brand establishment, customer loyalty and offering superior customer service. Business objectives are determined from the following questions: Can design impact customer acquisition and retention, and if so how? How does the provider of the system make money to keep their service online? How important are service enhancements to their growth and sustenance as a going concern? How does the provider of the system differentiate their service from that of competitors? [4]

Technological objectives describe the level of importance of the choice of technological solutions. They are studying questions, such as: How much control does the service provider exercise over all components of their technology? Where is the product in the lifecycle? [4]

In this context, interaction means the human-computer interaction and the experience a user gets while using the service. Interaction objectives can be reviewed with the following questions: How is loyalty encouraged? Can customers distinguish between one brand and another? Is the digital service easy to learn? How does the service provider

meet the custom or individual needs of their customers? [4]

While all of these objectives are important, often there is a ranking that executes a controlling effect on the design of digital services [3].

C. Fundamental Digital Service Design Taxonomy

Fig. 5 shows the four design dimensions, which dictate how best to improve the service, and three service provider objectives. There are dependencies between design objectives and design dimensions, e.g. business objectives are likely going to impact choices of service delivery and pricing functions. Similarly, technological objectives could stipulate how malleable a service is.

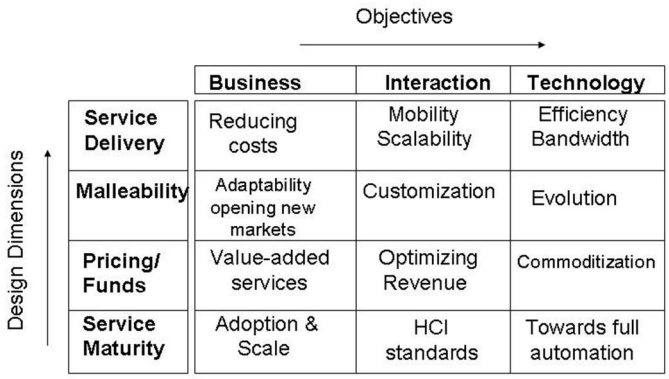

Fig. 5 Digital service design taxonomy [4]

The taxonomy can be applied for digital service design to think about non-functional and functional aspects of design. It provides a holistic framework for developing new methods and forces one to think about non-technical aspects of the services. [4]

V. Design Taxonomy of Police Car ICT Systems

The design of large and complex ICT integration solutions is a difficult task. ICT system integration could be seen as a journey that an organization undertakes to interconnect its "siloed" business functions and work practices to streamline organizational processes. It can require solutions that are unique because of constraints from the current set of legacy applications. Enterprise integration, sometimes referred to as systems integration, is an example of ICT integration which is widely researched. However, design knowledge for enterprise integration solutions is difficult to articulate and reuse [12]. The solutions often take the form of connecting stovepipe legacy applications (referred to as EAI – enterprise application integration [13]) or imposing and customizing enterprise systems packages (referred to as ERP – enterprise resource planning software [14]). Regardless of the solution chosen, bottom-up EAI or top-down ERP, the integrated solutions are intended to support and facilitate cross-functional business processes [15]. Because of the unique nature of each ICT integration project and the significant organizational change burden associated with the deployment of integration solutions, much research related to the design of integration solutions is dominated by either 1) a technology perspective, e.g. devising more efficient middleware implementations, or 2) investigation of organizational concerns such as transformation and change management. [12]

A. Design Dimensions

Table V examines some of the current devices, systems and protocols used in a police car with regard to the different aspects of the digital service design dimensions. When considering the devices, the main perspective is in the malleability of the system. Is it closed or open for changes and in what level, hardware, software or both? When studying the systems, we must consider the platform where the system is run on, as well as the level of input the user is allowed to the system. When examining the protocols we must consider how the value is added there, because with some protocols a simple software update at the service provider's end is sufficient, and in the worst case scenario the service provider has to renew a massive amount of hardware and software and also include an extensive amount of testing. The same aspects apply for the service's user. For example, the newest WLAN devices have a hardware-level support for the coming n-class, and when the standard is finalized, the new service can be taken into use with a simple software patch.

When further examining the design dimensions of police car ICT systems, some basic presumptions could be made. With regard to service delivery requirements, all of the classifications are made by considering the platforms where the device, system or protocol can be used. For example, is it a closed system or a system that is run from a browser windows, and is the protocol moved through a tower, cable or perhaps ad hoc? With regard to the stages of digital service maturity, we look at the freedoms a user is given with the service and

TABLE V
DESIGN DIMENSIONS OF POLICE CAR ICT SYSTEMS [16]

	Service delivery requirements	Stages of digital service maturity	Dimensions of service provider malleability	Dimensions of service user malleability
Device				
PC	Medium	Low	Medium	Medium
Printer	Low	Low	None	High
GPS	High	None	Medium	Trust
Alco meter	None	None	None	None
HC SCALE	None	None	None	None
Laser speed gun	None	None	None	None
ANPR	Medium	None	None	Medium
System				
POKE	Medium	Low	Medium	High
VIRVE	High	Low	Low	Medium
Police affairs information system	None	Medium	High	High
RANKKURI PRO	Low	Low	Low	Medium
Protocol				
2G	Low	Low	Low	Medium
3G	Medium	Low	Medium	Medium
FM	Low	None	High	High
WLAN	Medium	Medium	Medium	Medium
@450	Medium	Low	Medium	Medium
WiMAX	Medium	Low	Medium	Medium
GPS	Medium	Low	Medium	Medium
TETRA	Medium	Medium	Medium	Medium

also the skills required to interact with the system. With regard to the dimensions of service provider and user malleability, we look at services at points where the service is updated or given added functionality.

Table V is a preliminary one, as we have not yet received or produced an extensive list of devices, systems and protocols used in the different police vehicles. Also, the values given in the tables are estimates based on the scarce and scattered information collected from varied sources. However, there are a lot of similarities in the services that are viewed in Table V. The services are mostly based on technologies that are closed; they have extensively been researched and, also, wield a wide variety of support. This is a good sign because people working in the field of public security or emergency services should not operate as beta testers, and should only use services that are well-tested and preferably standardized. Another good observation is that the services needed in police cars are services that can and mostly are used in all kinds of emergency vehicles, like ambulances and fire trucks. Our digital service design goal is that most of the services can be applied in different emergency vehicles. That calls for modularity in the designs for the core services. Also, the use of level 'medium' and level 'none' systems should be increased, because level 'high' services might prove too hard to use in the field, and in some situations level 'low' systems could be too rigid.

B. *Digital Service Design Taxonomy*

As [3] describes, platforms that offer digital services are emerging to be an important area of research and study. Fig. 6 proposes a new, integrated mobile platform for digital services of a police car. Fig. 7 summarizes the current state of services used in police cars. On the other hand, Fig. 8 lists the goals of our integration project and how we are planning on refining the taxonomy in it.

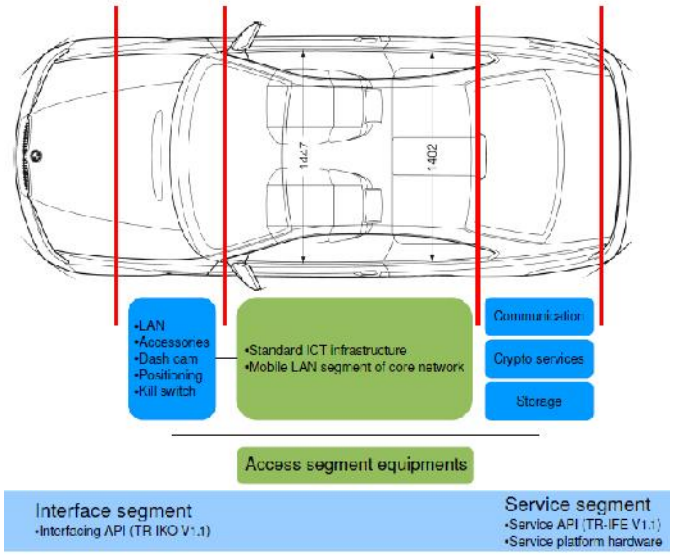

Fig. 6 New mobile platform for police car

One of the main objectives for this research is to find a suitable third-party supplier to take over most of the development for the emergency vehicles and to motivate the

	Business	Interaction	Technology
Service Delivery	Mostly savings are earned through competitive tendering.	Systems are build straight into the car. For that reason, most of the services are unmovable.	Systems operate mostly in a low bandwidth, high latency networks.
Malleability	Different services are constructed through multiple providers. System integrator is missing.	Customization is acquired through added hardware and is usually rigid and hard.	Systems are delivered by different providers using different interfaces giving minimal interaction with other systems.
Pricing / Funds	Service providers are too scattered to achieve new service designs.	Optimization through competitive tendering.	At its current state commoditization is not a realistic option.
Service Maturity	The scattered nature of the services makes it impossible to evaluate their adoption rate.	The provided interfaces are intended for a larger market so they are mostly standardizes.	Most of the systems have a high level of automation and do not require a lot of user interaction.

Fig. 7 Current state of police car's ICT services

supplier on this path. One of the best ways to do this is to present the supplier and client with different options that they can use to set up a lucrative partnership. First we will take a look at some of the techniques and protocols that can be used to enhance the operative strength of the Finnish police force. In this paper we will look at routing protocol Quality of Service – Ad-hoc On-demand Distance Vector (QoS – AODV), a protocol used to enhance performance in Ad hoc networks, [17] the Requirement Centric Operational Data Store Model (ReCODS-M), that can be used to enhance data integration and processing [18], and we will also look at research that looks at system engineering with the human factor [19]. These techniques, protocols and models give excellent pointers on how to develop new service models, but we will also add some product ideas that can be used with the protocols and techniques that were introduced prior. These product ideas will include the IP-RFID-based management system [20] and EUHARMONIC, a universal multi-sensory space recorder. [21] We will also take a look at two developments and make product suggestions for both of them. One development concerns information security in satellite tracking systems, [22] and the other research deals with the advantages of Multi Input Multi Output (MIMO) in Ad hoc networks. [23]

	Business	Interaction	Technology
Service Delivery	Savings are acquired through modular packages and more efficient processes.	The amount of devices has decreased and most of the interfaces and services are integrated into more easily movable ensemble.	Most of the data link interfaces are made into a bigger whole with enough intelligence to switch modes on the fly.
Malleability	All services are acquired through a single provider who takes care of all the aspects of the service.	Customization is acquired through easily manageable modules.	The R&D is acquired through the service provider, universities and the service user.
Pricing / Funds	The adding of value is more easily done as the whole package is handled by a single provider.	New and improved funding models can be implemented more easily because of the nature of the service.	Commoditization can be acquired when the service is taken into the global markets.
Service Maturity	The modular design of the service makes it easily adaptable into different environments.	The core design will be made according to the HCI standards but the modular design will also allow redesigning.	The automation level will be made modular and adjustable for different modules, situations and users.

Fig. 8 Designing goals emergency vehicle ICT integration

This is where the research on QoS-AODV comes in. This protocol can be used as one of the links to improve WLAN technology reliability in the field and in Ad hoc networks. The basic principal behind the QoS-AODV is that the protocol actively maps all of the nodes within the Ad hoc network and keeps some basic information on the nodes. The information collected tells all of the other nodes basic routing information and the amount of free bandwidth. This information can then be used to calculate the best possible route for the data stream, thus decreasing packet loss significantly. [17]

With these added functionalities the problem may not be the low availability of information but the overflow of it. In these kinds of situations efficient data management is needed. This is where the ReCODS-model comes in. ReCODS is a requirement centric operational data store model that consist of three parts: Operational Data Store (ODS), Data Warehouse (DW) and Data Mart (DM), and these parts are a combination of operational data and analytical tools. [18] It should also be considered if this kind of a system should be used as an add-on to existing systems like POKE, or should it be used as an independent tactical database. The successful implementation of a system like this can really improve the field efficiency of any emergency personnel, especially if the system can be used between different officials (police, fire department, paramedic) to exchange information.

If the presented material is ever supposed to be refined into a more usable form, then a rational method is needed. In this paper we will be looking at a research called “Beyond Human Factors.” The paper talks about requirements engineering and the importance of the human factor in it. The paper also talks about the problems with current methods that have left the human factor out of the development process. [19] So when the refining process for the services starts, it is important to make sure that the services are produced for humans by humans. This will greatly increase the usability and malleability of the system. Also, involving the end-user in the development of the system greatly increases the motivation of the user to use and learn the system efficiently. If the requirement gathering part of the process is done thoroughly and the requirements are categorized according to the research into three categories, normal requirements, expected requirements and exiting requirements, then the output of the information gathering process can be used as a future reference to develop new systems, and also decrease the time used in the development phase drastically.

C. Product development of material research

All of the immaterial services that were presented can be integrated with material products, and some of them even need them to reach their full potential. One of the most promising ideas presented was the EUHARMONIC multi-sensor personal space recorder. The EUHARMONIC is a collection of devices and sensors that together collect visual and audio data from the surroundings of its bearer. The devices are integrated into the users’ clothing or persona and collect data. [21] Some of the devices used are useful to this project, some can be integrated into existing equipment and some parts are irrelevant to this project. The SenseCam is a wearable digital camera that takes photographs passively without user intervention. The camera is equipped with a fish-eye lens to maximize the field-of-view, and it can also be fitted with subsystems like: light-intensity and light-color sensors, or even a temperature sensor. If this camera could be upgraded into a video camera that sends data to the central part of the system (PDA), then the video stream could be sent via WLAN to a tactical center or a tactical database for evidence or for some other use. This system could also be integrated into the daily use of the police, where the camera could stream video to a black box located in the police car, or if it is out of reach of the cars’ WLAN network, it could use a small (30-60min) memory of its own. This part of the system could be a great asset in law suits against the police.

Also the neck or throat microphone can be useful because it is attached to the user’s neck where it detects bone vibration from the vocal cords so outside interference is minimal. This decreases the amount of volume the user needs to use to get himself heard thus being able to give mission critical updates to the tactical command even in situations where silence is required, also the lower need for bandwidth enables the use of the VIRVE network in the communications.

The main body of the system could be a PDA device with a large internal encrypted memory and WLAN, Bluetooth and GPS capabilities. This central device will work as an interface for all of the other devices. The PDA will then send its data to the central black box located in the police car which can then either save the information for later processing or in critical situations send the data onwards to the police's Ad hoc network. The PDA could also attach positioning data from the GPS to the audio and video feeds.

The other physical product that could be provided to the Finnish police force by a 3rd party vendor is an IP-RFID-based management system. This technology adds IP functionalities into the already existing RFID technology. This enables direct access to the RFID tag through an IP-network. This technology is also cost effective and easy to install. [20] The IP-RFID technology could be implemented into an emergency vehicle as an authentication device. This would greatly decrease the time needed to form and to authenticate an Ad hoc network during time-critical missions. The IP properties in the RFID also enable more secure keys to be used and traded through the IP network.

When there is a lot of mission-critical GPS data moving, it is also important to discuss security. The research "Information security in satellite tracking systems" digs into this subject. The most important thing is to protect the data streams with adequate encryption. IPSEC is one of the most widely-used protocols. The benefits for this protocol are that it is widely used, supported and well researched. The IPSEC protocol will be used to secure the tracking systems data path. [22]

D. Product overviews

This chapter offered an insight on how to offer different kinds of services to a 3rd party vendor that would take over the research and development of Police Technical Center, a.k.a. PTK's services. These services would guarantee a steady monetary flow to the vendor and adequate motivation.

This chapter presented a collection of services and products that were entwined together in several ways and supported each other's actions and usability. Much of the features were also built around different kinds of wireless technologies like WLAN, Bluetooth and TETRA. It should also be considered that the options presented in this paper are only a small fraction of the possibilities that can be offered to outside vendors.

The main ideas revolved around WLAN and thus much consideration was put on how to offer reliable services with this technology. The answer provided in this paper revolved around the QoS-AODV and MIMO that should offer reliable operations to the high-speed traffic that is planed for these Ad hoc networks. This network could then offer real-time audio and video streams to tactical centers inside our outside the formed Ad hoc networks, giving rescue personnel a real tactical advantage in all situations that they are located in.

These services still require a lot of work and thought so that the problems with them can be addressed. For example, the weight of the EUHARMONICS system can not be too excessive because it could then harm performance. The battery life could also be an issue. There should be research that clearly states minimum operational times for the devices, and lastly integration with other interfaces should be considered. What protocols should the devices support? Also, there should be consideration on who will host the data services. Should they be brought under the same jurisdiction as POKE and other existing databases, or can they also be outsourced to a 3rd party, and if yes, what kind of legislative issues should be considered? These questions will be addressed in parallel works at a different time.

VI. Discussions and Conclusions

In the public safety and security field, applied business models are needed with regard to promoting *de facto* and *de jure* standardization for systems and services. The market in the field has to be studied and the minimum volumes of needed services should be defined. In addition to this, the interrelationship between national and international regulations,, as well as public-private partnership legislation should be detected. The nature of the service design solution is generic; the user requirements of the police, border guards and customs have great similarities, and the new services should serve them all. An example of these services is a gateway that provides all of the essential data services, authenticates the user to the service, manages the protocol versions, and acts as a server for key services, providing a gateway to external servers. Also, an essential question is the synergy with the fire and rescue department; should the service also be usable to this user segment, and if, how should common services be treated?

Design is moving towards incremental and prototyping-based approaches. Experience and service flow design gain importance as we develop for customers even with regard to public security services. In this paper, we apply the taxonomy approach proposed in [3] and [4]. We illustrate essential design features that apply to digital services for public security authorities. This is the first such study as per our knowledge. In this preliminary attempt, we have identified several key design dimensions and service provider objectives that play an important role in both the success of the mobile service platform for emergency vehicles, as well as the business models in the safety and security field.

Also the idea of outsourcing most of the research and development to a 3rd party vendor is something that should be given a lot more thought. This would free the Police Technical Center a.k.a. PTK's resources to more important tasks like quality control and making sure that everything provided is up to date with different legislations and regulations.

It is clear that this research is part of a much larger whole and will spawn a vast amount of parallel research on this subject.

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