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DEVELOPING M-SERVICES: LESSONS LEARNED FROM THE DEVELOPERS PERSPECTIVE

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ABSTRACT

In recent years the Swedish Police Force (SPF) have encountered greater demands on availability and 24/7 services when dealing with errands that are regarded as low priority compared to regular police work, e.g. collecting tips from the public. One attempt to meet these increasing demands was the development of a mobile communications platform that allowed the public to communicate easily with the SPF using their own mobile phones by sending SMS and MMS. The focus of this paper is on the early phases of development of this m-service, in particular, on the specific technical issues such as interoperability and standards used by the actors on the scene affecting the development of mobile information systems. The learning experiences are as follows: First, mobile communication platforms have a large potential for contributing to the field of emergency management information systems since they can be based on open and nationally accepted standards. Second, global and national standards for sending multimedia messages are not always truly standardized. Operators and mobile phone manufacturers make minor alterations and interpretations of the standard and thereby some of the benefits found in standards disappear. Third, when developing mobile information systems we suggest and recommend that the analysis phase should be enhanced compared to traditional system development, and it should address the interoperability between mobile phones on one hand and operators on the other hand.

Keywords: mobile communication platform, m-service, information systems development, SMS, MMS

I. INTRODUCTION

In recent years the Swedish Police Force (SPF) have encountered greater demands on availability and 24/7 services when dealing with errands that are regarded as low priority compared to regular police work, e.g. collecting tips from the public. One attempt to meet these increasing demands was the development of a mobile communications platform that allowed the public to communicate easily with the SPF using their own mobile phones. The idea was to build a system that allowed the public to send in tips with SMS (short message service) and MMS (multi media message service) messages to local police offices. The idea originated from a system that was discussed, but never implemented, to administrate Appointed Security Guards (detailed description in a following section). Discussions with a system development firm were initiated and the firm initiated a project that was later named Public-Communication-Central

(PCC). Two of the rationales behind the project were the possibility of asynchronous communication that could ease the pressure on the police, and the use of pictures (delivered through MMS) to aid the police in determining which action to take in a certain scenario. The large number of mobile telephone users and the widespread adoption of mobile amusement services in Sweden [Post- och telestyrelsen 2006] was an important parameter. During the development of the system a number of problems were encountered that even the very experienced members of the development team had not previously come across, for example, incompatibilities between mobile phones, operators, and file formats. The mobile operators were unaware of several problems even though their own platforms caused most of the issues.

II. OBJECTIVES

This paper presents the learning experiences drawn from the development of a prototype of a communications platform designed to enhance the SPF's capabilities to communicate with the public and non-police personnel (read "Appointed Security Guards"). The focus of this paper is on the early phases of the development cycle of a mobile information communications platform. One important aspect to consider is that this paper concerns a field that needs a systematic exploration [Lyytinen 2001; Lyytinen and Yoo 2002; Fransman 2002], namely the development of a mobile system used by organizations in their business processes. The paper is organized as follows: the next section addresses the research approach; the following section presents the case which includes background, development, problems, and solutions; and the final section presents the main learning experiences drawn from the development of the platform.

III. RESEARCH APPROACH

The study can be considered a case study [Yin 2003] in which the object was the development of a mobile communication platform. The focus was on the technical issues related to the development of the system and the unique aspects of developing mobile information systems. The study was mainly done from the perspective of the developing firm. The main method used was participating in the development process and in the communication process between the developers and the mobile operators' technical staffs. Other methods included interviewing the developers, analyzing internal documents, and analyzing system interface documents published by the mobile operator. In relation to the development, we asked respondents from the developing firm how they perceived the development, what the issues (mostly of a technical nature) of the development process were, the pros and cons, and the way they managed the development. We conducted a total of 12 interviews, of which eight were with representatives of the developing firm and four with members the mobile operators' technical staffs. The interviews were semi-structured, including some closed questions and some open questions to ensure exploration. Two researchers shared the interviewing process which lasted on average between 30 and 120 minutes. The interviewees were selected specifically in order to provide a deep knowledge of the topic of interest, i.e. the development process. We used a grounded method, where the empirical observations provided the basis for writing the case. Thus, the case description is not influenced by existing theories. In accordance with the grounded approach, the structure of the presentation of the empirical findings below is based on observations instead of being based on preexisting theory [Yin 2003].

IV. HE PCC SETTINGS

In this section we describe the context, the background, and the process of developing the PCC.

CONTEXT AND BACKGROUND

The members of the SPF raised some concerns about the intended users and their willingness to adopt new technologies in a case where the benefits seemed low to the citizens. It was therefore decided that only previously implemented standardised technology in mobile phones should be

used. The team of developers was familiar with the problems associated with JAVA applications and the mobile phone manufacturers' habit of altering the JAVA standards to fit the specific mobile phone making it very costly to develop JAVA applications that work on a broad range of devices. A consequence of this is that each JAVA application has to be certified for each mobile phone, which is both a time-consuming and costly process. Another aspect is that if a JAVA application was chosen, the end user would be forced to install a JAVA-application in order to communicate with the SPF. This was not considered an easy way to communicate and therefore was not an option.

Another aspect that affected the system was the demand that abbreviated numbers should be used. It was assumed that the use of a short number (a five-digit abbreviated number) instead of an ordinary long number (a 10-digit number) would make it easier for the end users to remember the number. The fact that abbreviated numbers are operator specific (to local operators) presented a problem. For example, if a mobile phone used a SIM card (i.e. subscription) from Vodafone then the abbreviated number (ex. 71234) must be registered at Vodafone and a receiving component that listened to calls from Vodafone had to be implemented. If the mobile phone used a SIM-card from the operator TeliaSonera, the transmission of the message would fail because Vodafone was the "owner" of that specific abbreviated number (71234). This forced the developers to design and develop a system that used all of the existing operators in Sweden. The same abbreviated number was registered at each operator with a physical network in Sweden and accounts were administrated for each operator. So, the system had to check and keep track of which operator a specific number was linked to. Number linkage is controlled by an operator jointly owned company called SNPAC (http://www.snpac.se/indexEN.htm).

The Second Actor on the Scene, the Appointed Security Guards

The previously mentioned Appointed Security Guards (ASGs) were also an important actor in this case. The police had discussed a solution where the communication between the ASGs and the police and between the police and the public would be handled by a single system. A short description of the ASGs and why they were a concern is presented as follows.

In Sweden, ASGs have a rather unique working condition: they have limited police authority, but only when on duty. Otherwise, an ASG has the same authority as a private citizen. An important restriction is that the ASG must send a report indicating that they are on duty precisely when their shift begins; the ASGs are not allowed to announce in advance when they are on duty or afterward when they were on duty. ASG are often employees of a security company and work at their company's client's facilities either on a regular basis or at a specific event. On an average weekend about 2,500 ASGs and 600 policemen are on duty in Sweden. Thus, ASGs constitute a large and important part of the legal force that maintains law and order in Sweden. The main tasks and work areas for ASGs are to maintain law and order at specific locations, such as concerts, soccer games, or restaurants, and to protect private property. The ASGs' work assignments are in part stipulated by Swedish authorities. If anyone arranges a large event they must hire ASGs to ensure a certain degree of security for the participants or they will not receive permission to organize the event.

PRESENT SITUATION FOR THE CITIZENS

Currently a citizen calls 112 for emergency calls or a local number if the need is less urgent. When calling a local number the citizen is likely to face long telephone queues. In addition to this, the offices are often only open during office hours in the larger cities in Sweden. In smaller cities they may only be open one or two days a week. There is a need to enhance the citizens' possibility to communicate with the police in errands other than emergencies.

PRESENT SITUATION FOR THE ASG

The alleged workflow is as follows: when an ASG starts his or her work shift a report is filed to the local police force (LPF) via a fax message which includes the time, the surveillance location, and

the ASG's identification number. When the work shift is over a similar routine is followed: the name, place, and ID number of the ASG are sent to the LPF via fax at the exact time when their shift ends. The rationale behind this law is to ensure that an ASG could be contacted if a situation arose that required enforcement by an ASG. Another purpose was to ensure that an organizer of an event really had enough ASGs as stipulated by the event permission from the local authority. The method of reporting duty through fax messages resulted in several problems for both the ASG and the LPF. The ASGs found it cumbersome to send a fax message every time their shifts began or ended, since many of them travelled directly from their home to their workplace and did not always have access to a fax machine. The result of this was that they often neglected to send in the required fax message. Furthermore, if all of the ASGs actually were to submit their reports, it would amount to at least 10,000 faxes per week that the LPF simply did not have the resources to administer. The LPF conducted some random checks to ensure that the ASGs sent in their reports, but this control mechanism proved to be an ineffective method. Finally, a fax-based reporting system does not enable any collaborative between the SPF and the ASGs; it represents a one-way communication link from the ASG to the LPF. In sum, we have an inefficient and ineffective system, which calls for an innovation.

PROPOSED SOLUTION

Functions

The proposed system was of a rather simple design: opt-in opt-out, sending and receiving SMS/MMS, and some storage of data. Abbreviated numbers should be used but no JAVA applications or complicated WAP services.

Table 1. List of Functions and Actors in the PCC Case

Actor → Function ↓	Police	Public (end user)	ASG	System
Send in a SMS		X	X	
Send in a MMS		X	X	
Send out a SMS	X			
Reply to specific SMS	X			
Send out a MMS	X			
Reply to a specific MMS	X			
Register start of duty, opt-in			X	
Add to send list				X
Receipt on opt-in to ASG				X
Register end of duty, opt-out			X	
Add to send list				X
Receipt on opt-in to ASG				X

Infrastructure

A crucial issue when designing the infrastructure of the system was whether or not to connect it to all Swedish operators or only to one. If merely one operator was to be used, a solution involving an abbreviated number would not be possible since the number has to be registered with each operator in order to work. Furthermore, delivery reports for MMS would not be available because the operators cannot send these to other networks, i.e. if an MMS is interconnected no delivery report would be sent back to the system. Infrastructure with one operator and interconnect is shown in Figure 1.

If the system was to be able to offer delivery reports for MMS and use an abbreviated number then it would necessary to establish a connection with every mobile operator, illustrated in figure 2.
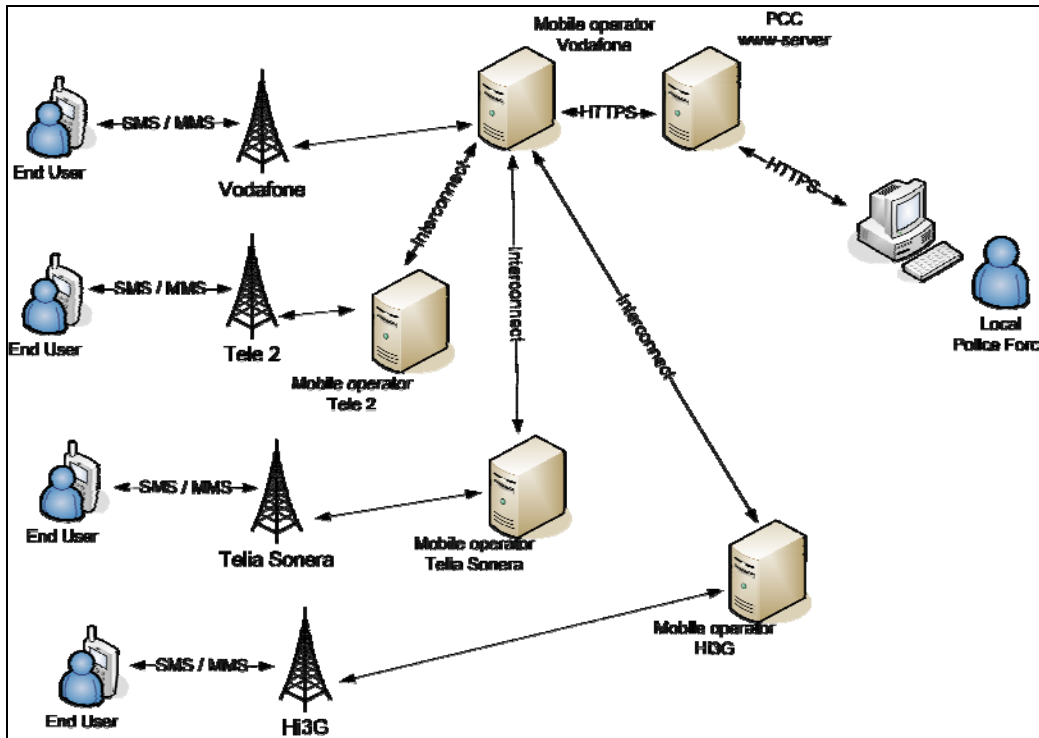
Figure1. Messages to and from recipients have to be relayed between the operators if only one operator is used in the system, i.e. interconnect is performed to route the messages. Two serious problems arise with this solution: it is not possible to use an abbreviated number, and delivered reports for MMS are not available.
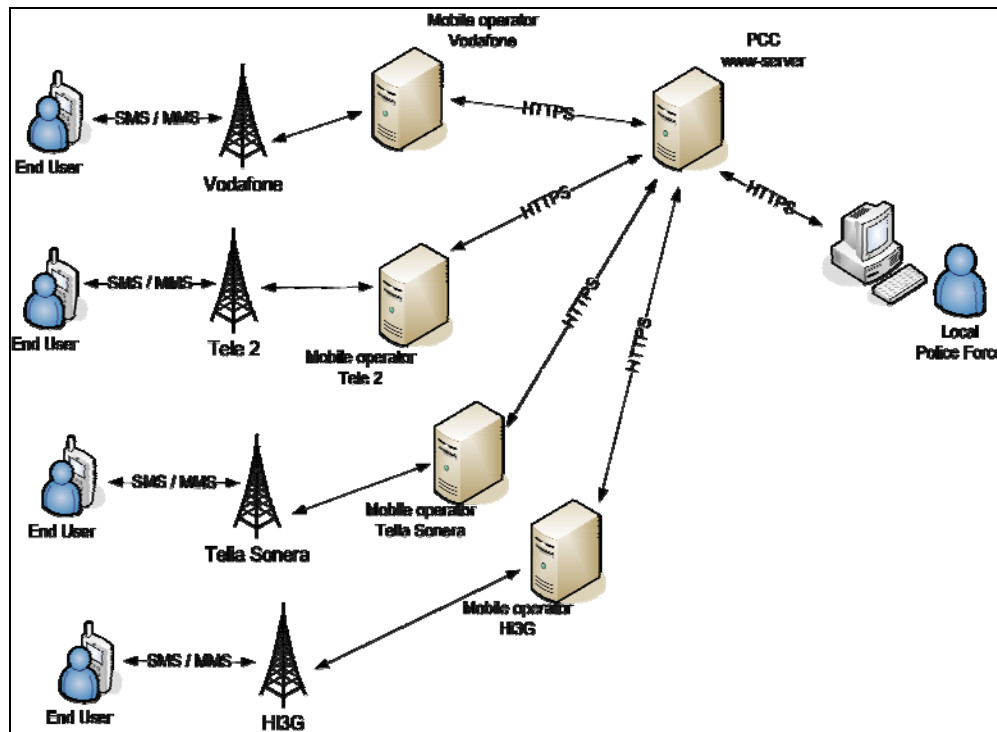

Figure 2. The communication structure of the implemented prototype: An SMS/MMS sent from the PCC server is transmitted to the same mobile operator that the end user uses. All messages

(SMS/MMS) sent to the LPF from end users are stored on the PCC server and can be read by a police officer at any time.

THE DEVELOPMENT PHASE

Issues Discussed But Neglected

There were some discussions about security issues with the SPF. Since this was in the first iteration of the RAD (Rapid Application Development) cycle the most interesting discussion was if the system would work at all. The SPF accepted that many security aspects would be addressed during later development cycles.

Data reliability: Is the data safely stored? The normal police-related data were stored in at least six different locations to ensure protection against data loss. The PCC system would use a single server with RAID discs to ensure some degree of protection against data loss.

Unauthorized system use: Can the system be accessed by unauthorized individuals? This problem was considered to be a minor one since the system was at this time viewed as a noncritical service by the SPF. The JAVA EE2 role-based security features and encrypted transmission were thought to provide adequate protection against unauthorized use.

System capacity: When would the SMS/MMS traffic reach levels that blocked the channel? The system could deliver 13-53 SMS per second depending on differing operator specifications. Field studies had been performed which displayed that the SMS channel was reliable compared to ordinary voice communication via GSM even under heavy use.

Several of the security issues were considered important, but the conceivable advantages of the system were regarded to be of greater value than the possible consequences of misuse or security-related problems. All this is in comparison to the present situation. If implemented to full scale the SPF Data Centre would assume responsibility of the operation of the system which would resolve most of the security issues.
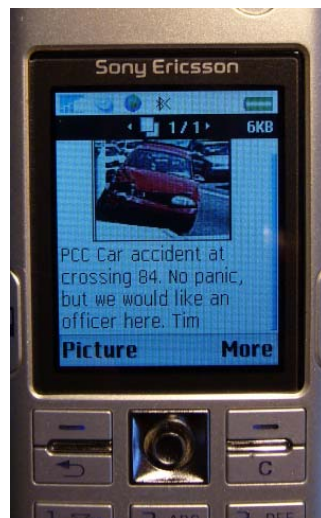
Figure 3. Photo of the screen on the mobile phone sending the MMS: The built-in camera in the mobile phone was used to take the picture.

IMPLEMENTED PROTOTYPE

The system implemented for testing used the previously described infrastructure with known problems.

Example of Workflow for Citizens

Imagine a car accident. The police in Sweden are instructed only to attend to a car accident if there are personal injuries or risk for people's safety. At the site of a car accident a participant can take a photo with an ordinary mobile phone and compose an MMS message with a short description of the need for the assistance of a police officer (Figure 3).
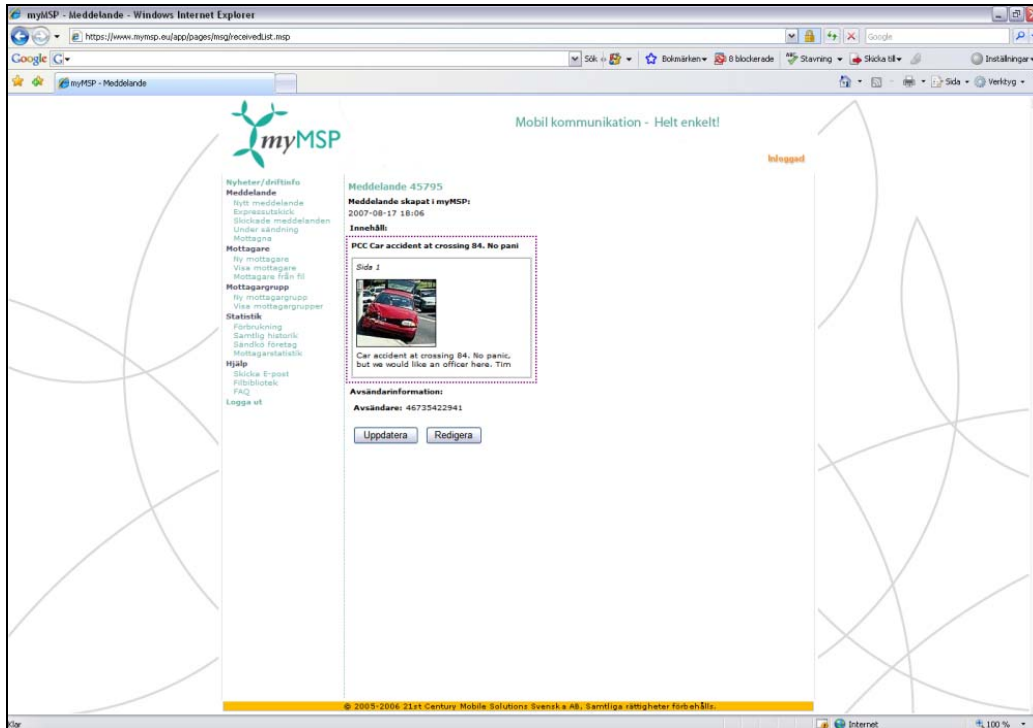

Figure 4. Screen shoot of the entire Web interface: On the left, the menu is displayed and on the right the selected option is displayed.
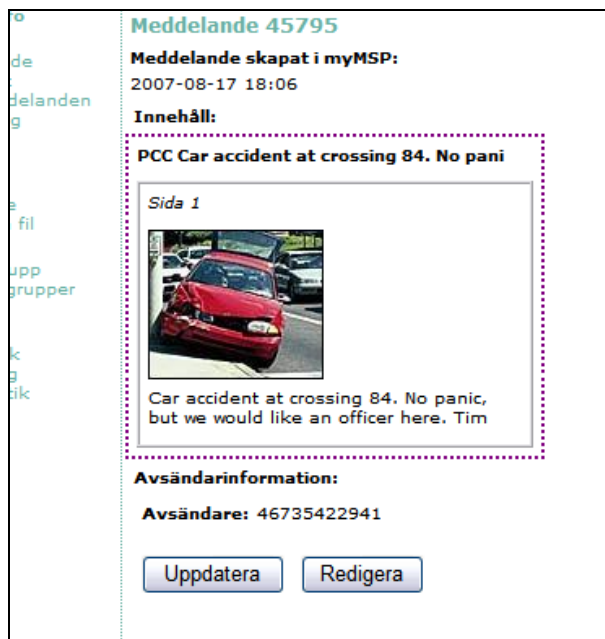
Figure 5. Previous picture enlarged, focusing on the incoming MMS: Information regarding which phone number sent the MMS, and the actual receiving time is also displayed with the message.

The MMS are routed to the PCC Web site and via a Web interface the police staff can log on to the system and read the incoming MMS (Figure 4). The communication runs via HTTPS.

The extended information that the photo can offer can make a difference in judging if a police officer is needed at the scene of the accident. The police can easily reply to the sender and even check if the message has arrived to the recipients' mobile phone.
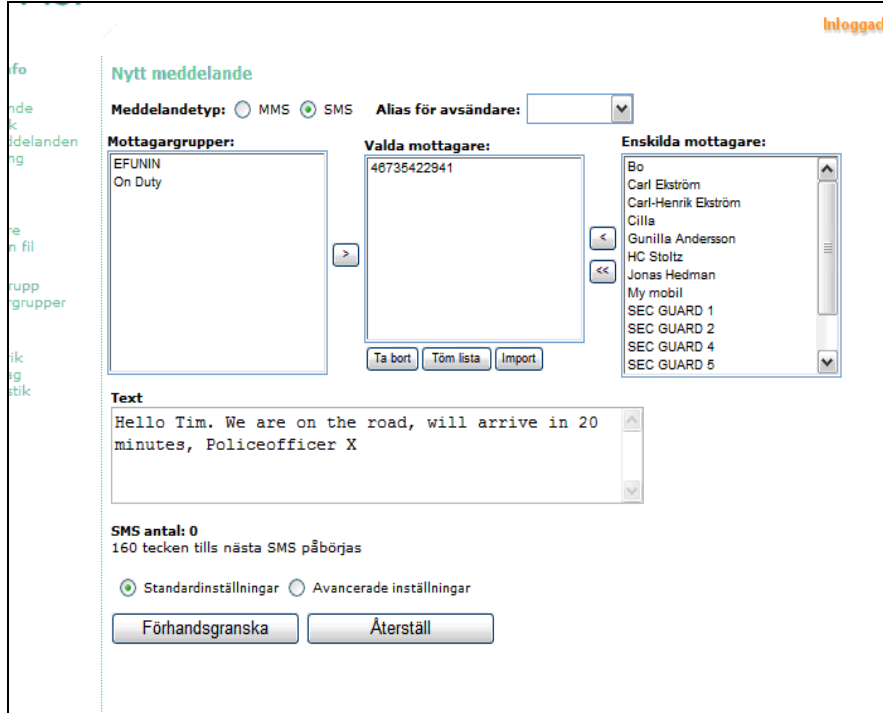
Figure 6. The Web interface displaying the environment where the police create the reply to the participant at the car accident

Figure 7. After sending the reply, the police can check sent messages if it has arrived to the participants' mobile phone; in this example it is delivered 2007-03-02 16:12.

Figure 8. Photo of the screen on the mobile phone receiving the SMS

Example of Workflow for ASG

When an ASG begins his or her shift, he or she sends an SMS to a specific number. The message contains information about where the ASG is located, whom the ASG is, and what the ASG is doing (starting or finishing a shift). For example, the information can be sent in following format: LOC4, ASG2, START ([Location], [ASG id-number], [Status]) using Opt-in to register on the "On Duty" list. Notifying the end of a work shift would be done in the same manner, Optout: LOC4, ASG2, END (Figure 9).

Figure 9. Photo of the screen on the mobile phone sending the SMS

When the SMS is received by the PCC server the actual date, time, and the phone number of the mobile phone that the ASG used is registered along with the other information contained in the SMS (Figure 10).
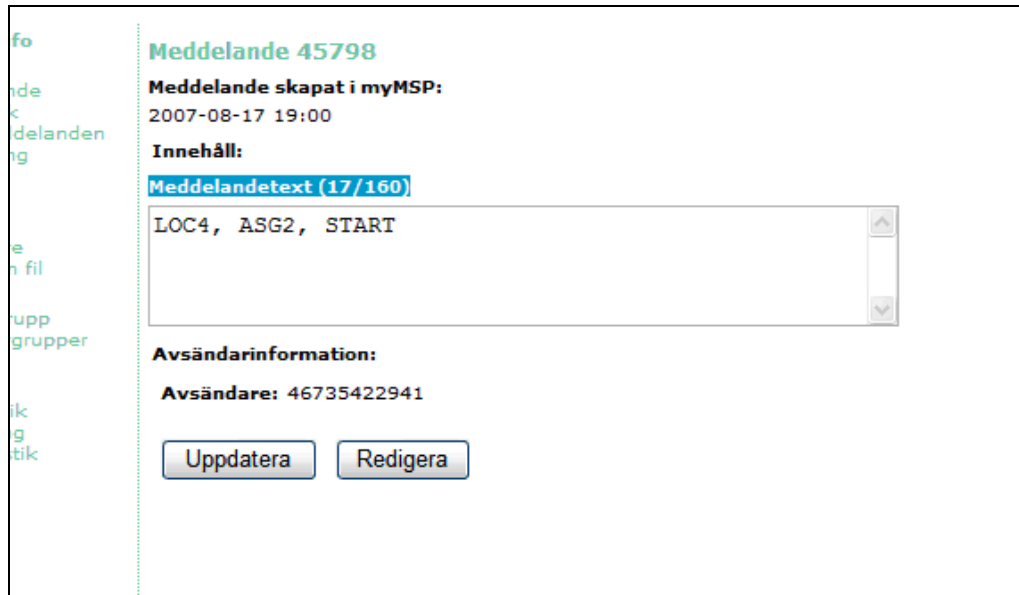
Figure 10. Screen shoot of the Web interface displaying an incoming Opt-In SMS from an ASG

The security guard receives an opt-in receipt (Figure 11).

Figure 11. Photo of the screen on the mobile phone receiving the Opt-In SMS

The LPF logs on to the Web server and easily determines which ASG are currently on duty (Figure 12).
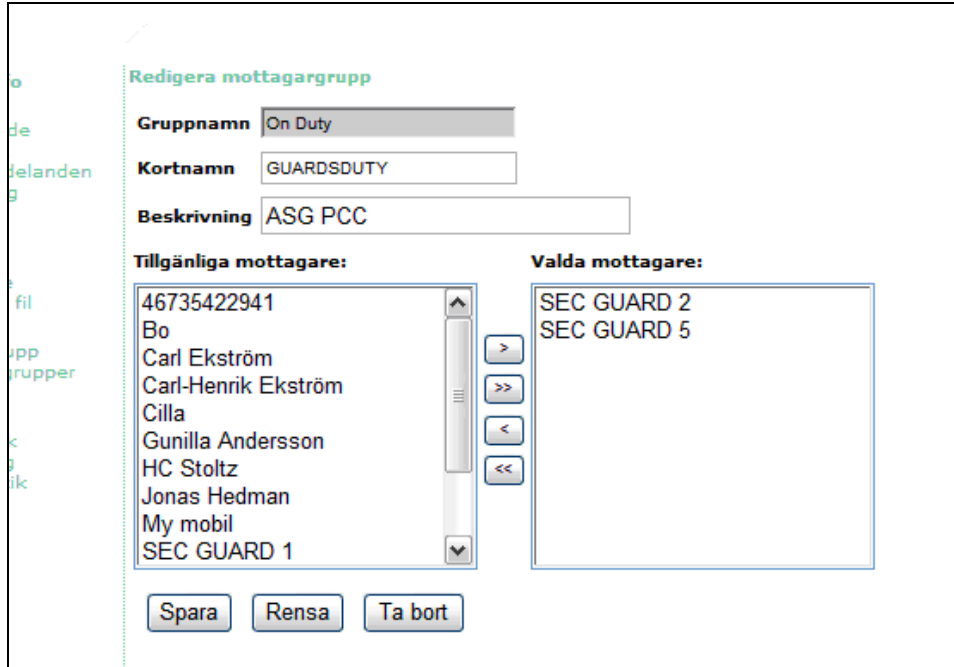
Figure 12. Screenshot of the Web interface displaying the members of the send list "On Duty"

If an incident occurs, the LPF could create an SMS or MMS via the Web interface, choose a recipient from a list of ASG on duty, create a message, and send the message directly to the selected ASG (Figure 13).
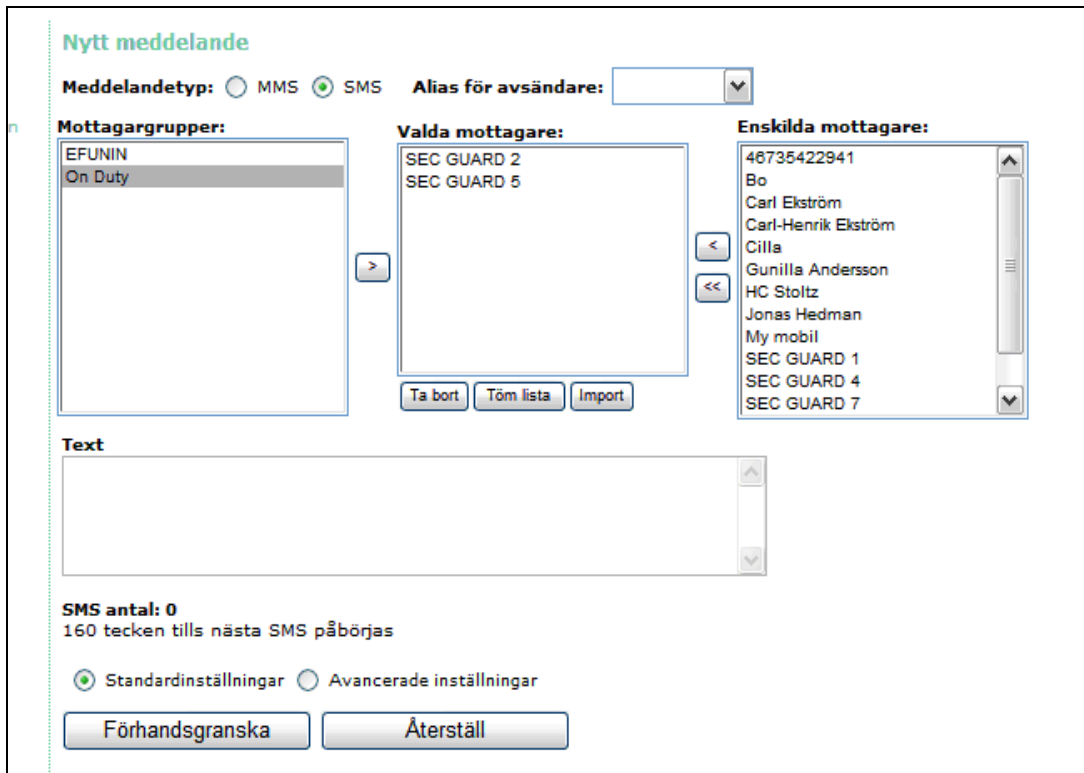
Figure 13. Screenshot of the Web interface: The "On Duty" is selected and the two members "SECGUARD 2" and "SECGUARD 5" are shown in the recipient list (Valda mottagare).

PROBLEMS ENCOUNTERED DURING THE DEVELOPMENT PHASE

The PCC system was developed using RAD [Martin 1991; Mathiassen et al. 2001] with the goal of creating a quick and functional solution for evaluation. A mistake that was made in the analysis phase was to underestimate the complexity in regards to the heterogeneity between services offered by the mobile operators and mobile phone technology. Even though this domain was supposedly fairly standardised it was still cumbersome to investigate and deal with the heterogeneity.

Three main problem areas where encountered during the development of the system: different SMIL- and MIME-file interpretation, asymmetric services from the operators, and lack of media-file standardisation. Figure 14 summarizes the different interoperability problems faced during the development. Each major interoperability problem is described in more detail as follows.
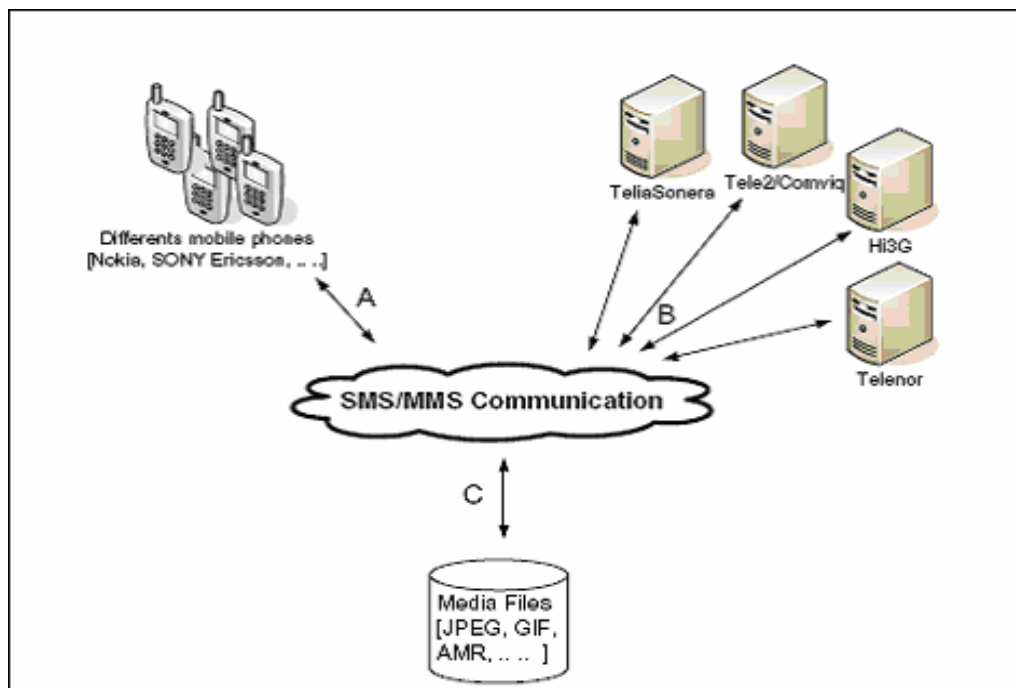
Figure 14. Three areas of problems were identified during the development phase, A: different mobile phones interpretation of SMIL/MIME files, B: asymmetric services offered by the operators, C: mobile phones capability to read ordinary media files.

SMIL/MIME-File Interpretation

When receiving a simple SMS (yes, SMS can also be complex) on a mobile phone there were no problems, but when an MMS was sent the results differed depending on the type of mobile phone that was used. Often different mobile phones interpreted the MMS/SMIL file in different ways resulting in a wide range of errors. This problem was even present on different models from the same manufacturer! The result was that it was impossible to design a SMIL file that could be correctly interpreted by all mobile phones on the market.

Asymmetric Services from Operators

Developing a send component that sends an SMS from a platform like the PCC using one operator was a straightforward task. However, problems arose when trying to integrate the system interfaces of four operators into one service for the end users. Even a simple service such as SMS was handled in a different way by each operator. One example was how the operators dealt with long SMS (more than 160 characters). One operator accepted long SMS; two operators

split the SMS into several short SMS but with varying length (part 1: 154 char, part 2: 148 char and so on); one operator did not accept long SMS at all. Another function that the operators handled differently was sender aliases, i.e. the possibility to replace a phone number with a text string. Two operators accepted that a sender alias was attached to a message; one operator demanded that the sender alias should be reported to them in advance, and one operator did not allow sender aliases under any conditions. The fact that the SPF wanted to use both long SMS and sender aliases presented the development team with some serious problems. The complete list of services offered by the operators is shown in Appendix 1.

Moving on from SMS to MMS, similar problems occurred. When receiving MMS the problems with functionality in the operator's platforms effectively stopped the work. Even after one year, one of the operators has still not solved basic problems in their platform, and this has prevented end users from using that operator's network to use this service.

Another aspect was that the operators were continuously modifying their platforms, which forced the developers to constantly reconfigure the PCC platform in order to accommodate the changes.

Media File Standardisation

Mobile phones interpret media files, e.g. JPG files, in different ways depending on the model of the phone. This problem was even encountered when dealing with low resolution images in the standard JPEG and GIF formats. This is a result of the "hidden" properties of JPEG and GIF images, e.g. interlacing, exif-formats and compression levels. As a consequence of this there was a risk that a picture attached to an MMS would be either incorrectly displayed or not displayed at all.

SOLVING THE PROBLEMS

SMIL/MIME File Interpretation

The SMIL/MIME issues were never completely resolved, but by using a simple form of SMIL the problem was at least minimized. The chosen SMIL format did not allow collections of images or more complex data types. The drawback of this solution was that the system could not take advantage of the more advanced features that other SMIL formats provide.

Asymmetric Services from Operators

A strategy of "smallest common service" was used in order to handle the problems associated with asymmetric services, i.e. only services that were supported by all operators would be available to the end users. The high rate of change that the operator platforms exhibited favoured an architecture that allowed fast and easy reconfiguration of the system. Many of these problems were solved by utilizing autonomous business objects and a parameter-driven structure.

Media File Standardisation

The media-file issues were alleviated by installing an automatic converter on the server that transcoded all pictures to a JPEG format with no "hidden" properties. This increased the chance that a picture would be displayed correctly.

V. LEARNING EXPERIENCES

In this final section, we summarize some of our learning experiences from the case and present some ideas on future research endeavours.

Learning experience one: When developing a system that includes standard mobile phones such as MT (Mobile Terminated) and MO (Mobile Originated), the "workload" in the system development phases should be slightly altered. The analysis phase ought to be more comprehensive because of the interoperability in the mobile operators' systems and the

interoperability among mobile phones. The architecture of a system like the PCC must to as great of an extent as economically possible, be component oriented, have a high degree of scalability, and be designed for reconfiguration in order to deal with the changing technical interfaces of the operators and the rapid development and deployment of mobile phones.

Learning experience two: Developing information systems in an emerging technical area with many stakeholders (such as phone manufacturers, mobile system providers, and operators) creates new and unforeseen problems and issues that are difficult (bordering on impossible) for a single development firm to handle. To manage this situation there is an increasing need for standardisation on both a national and on a global level. Even though standards such as MM7 exist, stakeholders still seem intent on making their own small alterations which contribute to a world of non-interoperability. One can also come to the conclusion that this stakeholder behaviour leads to sub-optimization and a slower growth of advanced mobile services.

Learning experiences three: Mobile-based communication platforms have a large potential in enhancing the field of business applications, since they can be based on existing "open" standards, which rapidly increases the speed of development – even though there are still some issues to resolve.

VI. FINAL REFLEXIONS

If the presented prototype (PPC) will be implemented several savings would be made, both in cost savings (i.e. enhanced administration of ASGs would finance the running costs) and in increased level of service. The development and enhancement of the PCC and related m-services on this platform will be a continuous process over the next few years. In our future research we will focus on two major issues. The first issue is related to interoperability and internationalization. Can these services be offered across several countries and with even more operators connected to PCC? Preliminary findings from a study of mobile operators in Spain displays the problem with asymmetric services is almost identical to the Swedish operators. The second area is aimed at addressing the use of the PCC from both organizational and individual perspectives. Does the implemented technology alter the users' work situation? As a final remark, the developer of the system compared developing PCC with shooting at three flying ducks at the same time (the operators, the mobile phones, and the media files).

ACKNOWLEDGEMENTS

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APPENDIX

Table 2. Description of Services Offered by Operators in Sweden (Unknown means that the technical staff were unable to answer the question.)

Question	Operator 1	Op. 2	Op. 3	Op. 4
Can Content Providers access the operators' network via API (Content Provider Agreement CPA)?	Yes	Yes	Yes	Yes
Do the CPA accounts support long numbers (10 digits)?	Yes	Yes	Unknown	No
Do the CPA accounts support short numbers (abbreviated) (5 digits)?	Yes	Yes	Yes	Yes
Do the CPS account support sending of SMS (MT)?	Yes	Yes	Yes	Yes
Do the CPA account support receiving of SMS (MO)?	Yes	Yes	Yes	Yes
Maximum sending capacity offered to CPA account (SMS/sec)	5/sec	1-400/sec	Unknown	1/sec
Do the CPA account allow distribution (receiving) of SMS to other Swedish operators (interconnect)?	Yes	Yes	No	Yes
Do the CPA account allow distribution (sending) of SMS to other Swedish operators (interconnect)?	Yes	Yes	No	No
Used protocol for CPA account access?	CIMD + SMPP	SMPP	SMPP + UCP	UCP
Which version of protocol?	CIMD 2.1 + SMPP 3.4	3.3 + 3.4	Unknown	Unknown
Which character set I used?	GSM Standard	Unknown	Unknown	Unknown
Do the CPA account support long SMS (more than 160 characters)?	Yes	Unknown	Yes	No
Do the CPA account support alphanumeric senderalias sender aliases?	Yes	Yes	Yes	No
If the CPA account support alphanumeric sender aliases, max number of characters (max length)?	11 char	Unknown	Unknown	Unknown
Are their any restrictions in using sender alias sender aliases?	Yes	Unknown	Unknown	Unknown
Do the CPA account support delayed deliverance of SMS?	Yes	No	Yes	No

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