Valuation of Mobile Broadband PSE Network for Society

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Abstract

We calculate the added value for society of Public Safety and Emergency (PSE) agencies when they have a dedicated mobile wideband/broadband network to complement the offering of the existing PSE mobile networks. The principles of benefit valuation are demonstrated. The basic PSE operational processes are divided into operations. The operations of an organization can be modelled and the sub-tasks of operations utilizing improved communication tools and applications can be redefined. The modelling and the definition of the costs of every operation can be done using the System Dynamic analysis and Three Viewpoint Model analysis (Martikainen and Halonen, 2011) tools. After that the costs of the new mobile network service are estimated; the alternatives analysed include the dedicated TEDS (TETRA Enhanced Data System) and LTE (Long Term Evolution) networks.

The proposed approach gives answers to the three following questions: (1) is there any benefit in building a new high speed mobile data network for PSE agencies; (2) what is the Net Present Value (NPV) of the business case including the costs of the new PSE wideband/broadband mobile network and what are the social benefits that the new network makes possible, and; (3) how can the benefits of mobile broadband/wideband communication be correlated to population density in order to create additional value for society.

Keywords: TETRA, TEDS, PSE mobile networks, social benefits.

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1 Introduction

Many working in the field of public safety and security feel strongly that PSE (Public Safety and Emergency) agencies will, in future, need mobile wideband/broadband (WB/BB) communication services, like TEDS (TETRA Enhanced Data System) and LTE (Long Term Evolution) (Steppler, 2011; Motorola, 2009). There remain, however, many obstacles to implementing these networks, including shortage of available spectrum (TETRA, 2010) and problems related to financing. Nonetheless, there remain calls for improved performance of PSE agencies. With regard to the problems of financing, the same question has arisen recently in many European countries: how can the value of PSE services be demonstrated to government decision makers? That's why business case studies have been examined to show the value of the new investments that are required. Studies have already been done to demonstrate, which functionalities are needed to improve the performance of the PSE agencies (Borgonjen, 2012). Studies have also been conducted to understand the best roadmap to implement high speed mobile data communication for PSE (Peltola, 2011).

The paper presents the process for calculating the value of the PSE network. The approach used is based on activity-based costing (Back et. al., 2000) and on business process redesign (BPR) (Jarvenpaa and Stoddard, 1998), which can be used for process improvement evaluations. The basic PSE operations are divided into sub-tasks using System Dynamic analysis (Sterman, 2000). The operations of an organization can be modelled and the sub-tasks utilizing improved communication tools can be redefined. With the help of mobile broadband communication the costs of some sub-tasks can be lowered and also the structure of the operation can be modified slightly to lower the costs and to improve performance. We calculate the performance improvement enabled by process change using the 3VPM (Three Viewpoint Model). The social benefit realized can be then measured against the additional costs arising from the new mobile network service. Finally, the paper presents a valuation estimate of an example PSE network created for demonstration purposes.

2 Background

The first roll-outs of digital PSE networks came at the end of the 1990s and the process still continues in many European countries today - some of the biggest ongoing roll-outs being the networks in Germany and Norway. The lifetime of TETRA systems can be thought to last until the end of the 2020s – i.e.

the TETRA networks will be up and running in many countries until the years 2025. . . 2030. The future alternatives to PSE networks have been studied and the usefulness of these new high speed mobile networks appears obvious. However, the financing of new networks is an issue at this time when everywhere in Europe there is strong pressure to make savings in all public purchases. The utilization of commercial networks might provide answers to the financing question. The commercial networks indeed have many advantages, i.e. the networks already exist and the coverage is excellent. Nevertheless, the commercial mobile networks seem to have some fundamental problems if these networks are to be used for PSE mobile communication (Peltola, 2011), one of the most critical problems being that the networks become jammed in disaster situations (Swan & Taylor, 2003). For this reason, it has been concluded that the utilization of the commercial mobile networks as a media for PSE mobile communication is possible for non-critical communication. For mission critical communication, however, a dedicated network is required.

There are two clear candidates to fulfil the high speed data mobile communication needs of PSE mobile networks, TEDS and LTE. TEDS can utilize existing TETRA platforms and it works also in TETRA frequencies (400MHz area). LTE needs more spectrum, but it is a real BB technology and it seems to have a de facto position in US PSE markets - therefore it is a strong candidate within TETRA operators and may have an impact on the future PSE BB technology selections in Europe. It should be possible to acquire the additional spectrum for PSE mobile communication in Europe sometime between 2015 and 2020 – most probably in the 700MHz area, meaning that at that time it will be possible to roll-out PSE-specific BB mobile networks (TETRA, 2010).

The PSE mobile communication networks will consist in future of a set of technologies (Ittner, 2006), i.e. narrowband (TETRA), wideband (TEDS), broadband (LTE) and local area (WLAN) - with appropriate coverage and capacity. The wireless landscape will be more heterogeneous than earlier being base on a multi-technology solution. Because the hybrid technology solution allows defining the optimum price per value ratio, it is important to understand how the value of the PSE network can be calculated (Saijonmaa, 2009; Omnibus, 2012). In this study the assumption has been made that the new WB network is based on TEDS 400MHz technology and that the new BB network is based on LTE 750MHz technology. This is also in accordance with earlier papers (TETRA, 2010).

The costs of the new network are based on the information from the vendors (Telecom, 2012). The costs shown are additional costs to the existing network situation with an assumption that TETRA operator already exists and necessary supporting services are available. The usefulness, or social benefit, of the network is formed out of many separate issues: (1) direct savings in the costs of PSE administration operations, saving work hours; (2) the savings of lives, health or savings of the property because of the improved performance of PSE operations; (3) the improved performance of society, e.g. the saving of a citizen's time; (4) savings resulting from preventive PSE administrative operations and; (5) the value, the effect that improved PSE performance can have on society, e.g. the improved feeling of safety.

3 Valuation Process

The proposed valuation process is based on the utilization of Causality and System Dynamics analysis (Sterman, 2000) - when describing the process - and utilizing the Three Viewpoint Model analysis tool (Martikainen and Halonen, 2011) when modelling the operations of the process. The key financing indicators are presented as Net Present Values (NPV).

Framework

The overall causal diagram analysis (Figure 1) shows the causalities, how the operations of the PSE agencies (police, rescue) are linked with the benefits to society and how those operations are dependent on the applications which are available via the mobile PSE network.

The value of the PSE broadband network is, on the one hand, dependent on the benefits that new operations can create and, on the other hand, on the investment and operational costs changes in the new network, new applications and operation changes. The overall valuation process is presented in Figure 2: (1) the coverage and the capacity of the high speed mobile network is defined; (2) the existing operation processes are defined; (3) operations with sub-tasks are modelled by the Three Viewpoint Model (3VPM) analysis tool; (4) new applications working in the network are defined - the new applications set the frame for what kind of sub-tasks are possible and what the structure of these sub-tasks is; (5) new operations are formed of sub-tasks and can be modelled with the 3VPM; (6) new operations may cause social benefits to society and (7) the costs of the new network, applications and possibly more costly operations can be calculated. Only after all these factors have been taken into consideration, can the final value of the PSE network be summarized taking the new social benefits and subtracting from them the costs found.

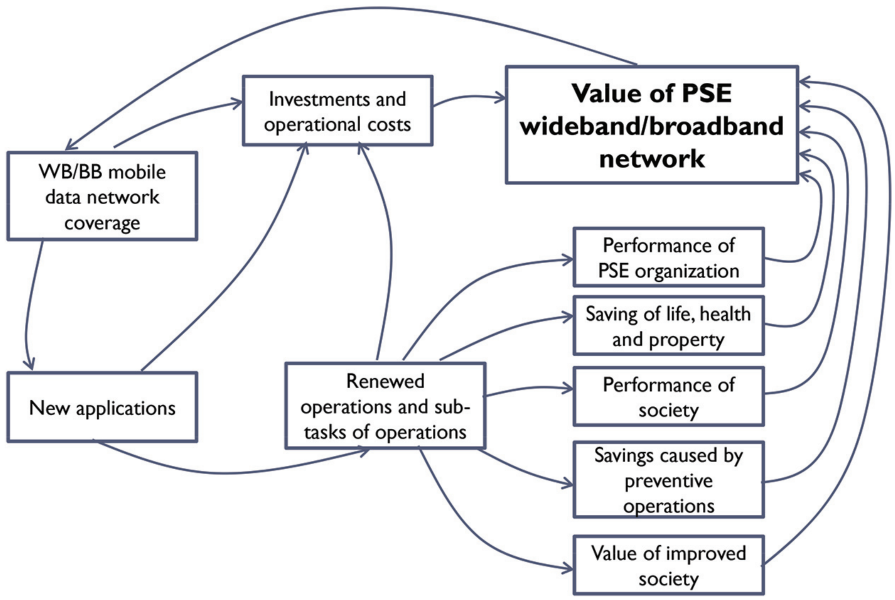

Figure 1 Valuation of the broadband PSE network for the society

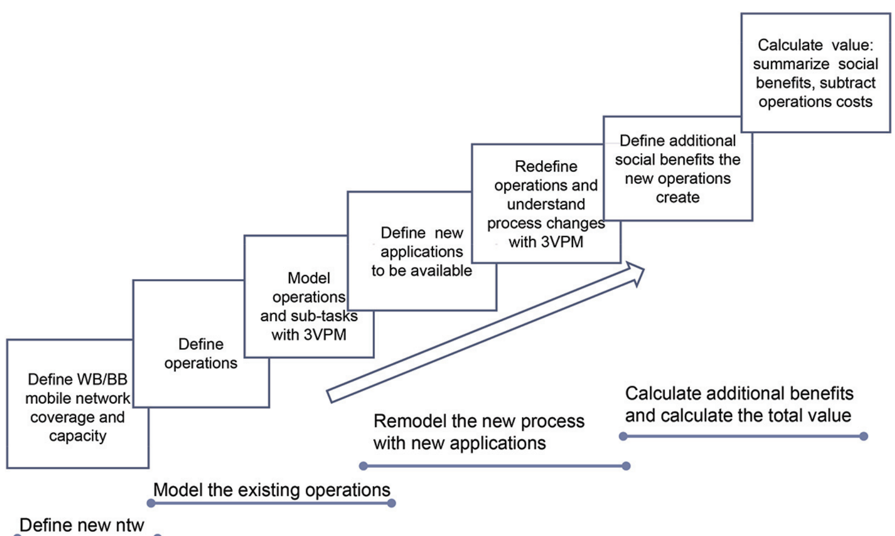

Figure 2 Valuation process

Operations and Subtasks

After the network coverage and capacity has been defined the next step in the process is to define operations. As an example, the operation types of the Finnish police organization are listed in Table 1, which also shows the statistics of various operations (Police of Finland, 2012). These are all potential sources of additional benefits for society.

The operations are formed of sub-tasks. The main sub-tasks can be identified for the operation types using the causal diagram and System Dynamic analysis (Sterman, 2000). The understanding of sub-tasks is important, because then beneficial applications can be identified. As an example, the sub-tasks for police operations are listed below in Table 2.

Table 1 Operation types of finnish police activities and the annual statistics of the operations

Type of Operation	Number of Operations Per Year
Life or health protection	51 457
Property protection	121 101
Traffic, traffic accident	242 445
Single person protection	314 353
Accident, dangerous situation, fire	45 900
Specific task	183 859
Basic supervision	103 313
Patient transportation or First Aid task	294
Social sector task	1 300
Total	1 064 022

Table 2 List of main sub-tasks of operations in police activities

Sub-task Type
Monitor or supervise "the situation"
Know "the location" and circumstances there beforehand
Be situation aware at "the location"
Find and drive as quickly as possible to "the right location"
Find and detect a person or a car
Arrest and transport a person
Find/search information about the person, the crime or the event
Make crime research using storing and analysing it-tools
Research and report the crime or the crime place for the courts
Write a fine, a remark or a report in the field
Traffic monitoring (speed, behaviour, etc.)
Verify the person/driver/car (identification, drugs, alcohol)
Give first aid

Table 3 List of main police applications based on WB/BB mobile network support

Application	Importance of Application	Needed Network
1. Mobile office(internet, email, Word, Excel)	medium	LTE or commercial 3G
2. Emergency centre communication, AVLS	high	TEDS
3. Mobile Command and Control	high	TEDS/LTE
4. License plate tracking	medium	TEDS
5. Information Database (maps, drawings)	medium	LTE or commercial 3G
6. Mobile video	high	LTE
7. Video – SW recognition analysis	medium	LTE
8. Patient monitoring (EKG, ECC)	high	TEDS/LTE

Applications

With the help of new applications which are available via mobile broadband communication, the costs of some sub-tasks/operations can be lowered and also partly the structure of the operation process can be changed to both lower the costs and to improve the performance. The application table (Table 3) lists the main network supported applications which the WB/BB (TEDS/LTE) PSE mobile network can make available (Borgonjen, 2012).

Modelling Operations

The micro-level analysis of a system of processes applies the following four steps: (1) drawing the logical process model diagrams of the original and transformed processes; (2) calculating the process performance of the obtained models; (3) calculating the activity based costs of the models and; (4) comparing the results of the original and transformed models. The modelling and the definition of the costs of the operation can be carried out using the Three Viewpoint Model analysis (Martikainen and Halonen, 2011) tools shown in Figure 3.

In the Three Viewpoint Model (3VPM) (Martikainen and Halonen, 2011) the three viewpoints: 1) diagram models, 2) performance and 3) cost are related to each other with common variables. In the process diagram the activities (A_i), related resources (R_k), tasks or customers (E) served and the corresponding task arrival intensities (λ_i), routing probabilities (ρ_{ij}), service times in activities (T_i), population sizes (N_i) and costs of resources (C_{Rk}) are given for the model M. The results are calculated in the 3VPM analysis using the queuing network solution denoted by G and the cost analysis solution denoted by F. The used analysis methodology is described in detail in ETLAs discussion papers (Naumov and Martikainen, 2011a; Naumov and Martikainen 2011b;

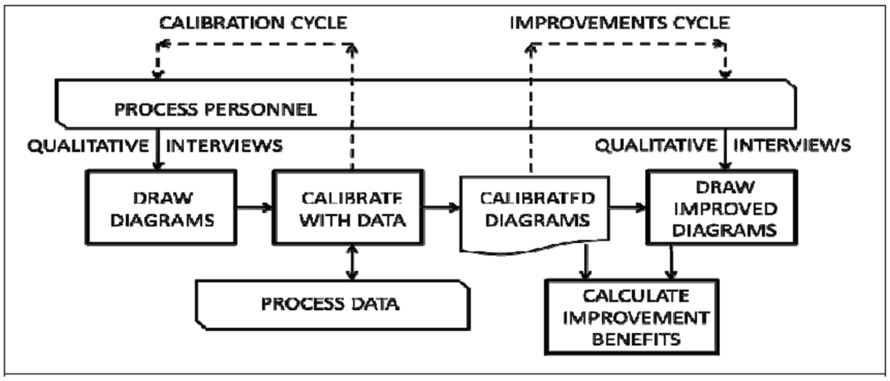

Figure 3 The four analysis steps of 3VPM to evaluate service benefits (Martikainen and Halonen, 2011)

Naumov and Martikainen, 2012). The variables used as input and results obtained as output are displayed in Table 4 and they are related as shown in Equations 1, 2 and 3.

The model M includes the process components and the graphical description. The function G is the solution of the open or closed queuing network representing the process. Usually G is an algorithm that cannot be given in a closed form. The function F simply calculates the costs based on the resource utilizations and customer delays that are obtained from G. In the 3VPM analysis the input parameters of the original process model M_1 and the transformed process model M_2 are collected and the benefits of the transformation from M_1 to M_2 is analysed by comparing the calculated output parameters (times, queue lengths, resource utilizations and costs) of the models M_1 and M_2.

Table 4 Input and output parameters in the 3VPM analysis

Inputs		Outputs	
Activities	A_i	Customer time in activity ...	W_i
Task classes	E_p	Customers p in activity i	N_{pi}
Routing probability	ρ_{ij}	Utilization of activity	ρ_i
Service time in activity	T_i	Utilization of resource k in activity i	$\rho_{ki,}$
Arrival intensity	λ_i	Fixed costs	C_f
Customers p in system	N_p	Variable costs	C_v
Resource	R_k		
Resource time in activity	$R_{ki,}$		
Resource k cost in time	C_{Rk}		
Activity I other costs	C_{Aj}		

$$\mathrm{M} = (\mathrm{A_i}, \mathrm{T_i}, \mathrm{r_{ij}}, \mathrm{E_p}, \mathrm{C_{Rk}}, \mathrm{C_{aj}}) \tag{1}$$

$$(\rho_{\mathrm{i}}, \rho_{\mathrm{ki}}, \mathrm{W_i}) = \mathrm{G}(\lambda_{\mathrm{ij}}, \mathrm{N_i}, \mathrm{R_{ki}}, \mathrm{M}) \tag{2}$$

$$(\mathrm{C_F}, \mathrm{C_V}) = \mathrm{F}(\rho_{\mathrm{i}}, \rho_{\mathrm{ki}}, \mathrm{W_i}, \mathrm{M}) \tag{3}$$

Defining Social Benefits

With the described process the PSE operations can be modelled and the sub-tasks utilizing improved communication tools can be redefined. With the help of mobile broadband communication the costs of some sub-tasks may be lowered and also the structure of the operation may be changed to lower the costs and to improve the performance.

The social benefits that the new operations (based on new PSE Mobile network) may create are formed of many parts: (1) direct savings in the costs of administration operations, i.e. improved organizational performance; (2)

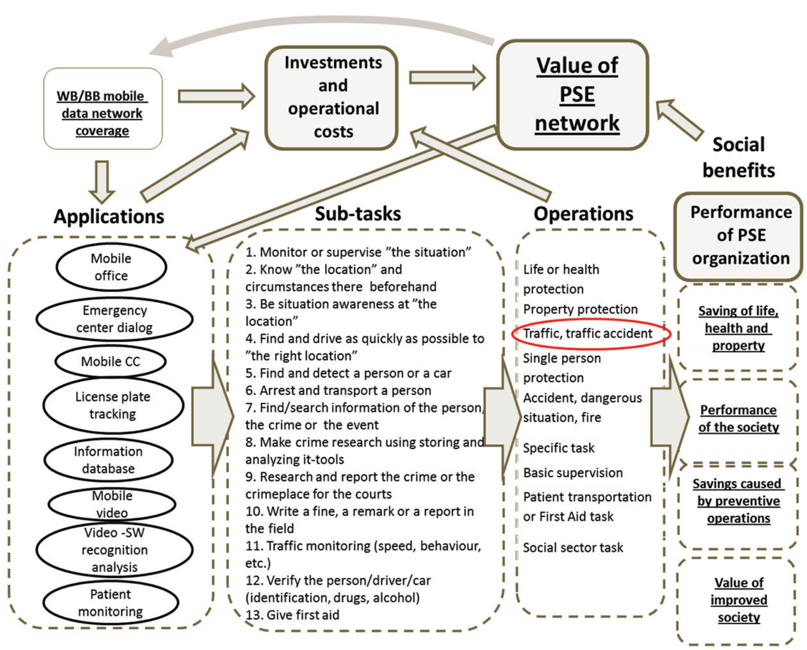

Figure 4 Police operations: causalities of WB/BB network, applications, subtasks, operations, social benefits, new costs and the total value of PSE network.

savings of lives, health and the safety of private property because of the improved performance of operations; (3) the improved performance of society, e.g. the saving of people's time; (4) savings that can result from the preventive operations and; (5) the value that the improved performance can have on society, e.g. the increased feeling of public safety.

Figure 4 describes the whole structure and causalities in the case when new police operations create new social benefits: (1) the availability of new applications is dependent on the coverage of the high speed data mobile network; (2) new subtasks are based on new applications; (3) operations are formed of subtasks; (4) new operations may bring benefits to society as a whole; (5) the costs of the new network, new applications and sometimes more costly operations which may cause additional unforeseen costs and; (6) the final value of the PSE network is a summary of the costs found and new benefits identified.

4 Example

Case Definition

In the case study analysed, two hypothetical dedicated LTE or TEDS networks in Finland are evaluated and social benefits are calculated of police operations. The first network is inside the Ring Road IV covering the metropolitan area of Helsinki and its surrounding suburban called here as *Ring IV network.* The second network is in the northern part of Finland (Figure 5), referred to *Kainuu network.* The area of the Ring IV network is about 6,000 km^2, the number of the population about 1.5 million, meaning a population density of 250 persons per square kilometre. This first area is currently covered by approximately 100 TETRA base stations. In the Kainuu network case, the size of the area is about 21500 km^2 and the number of people living in that area is about 82,000, meaning a population density of 4 persons per square kilometre. The second area is now covered by approximately 60 TETRA base stations. In Figure 5 the population density of Finland is also represented - only 20% of the area covers almost 80% of the citizens (Suomen kuntaliitto, 2012).

The number of LTE base stations has been estimated based on the assumption that: (1) an LTE network works in the 750MHz area; (2) the minimum offered service is 1 Mbit/s (PPDR, 2012) and (3) the inside coverage is guaranteed in the rooms which are on the outer bounds of the houses. Because the typical use case of the listed applications is that the vehicle radio is used, then the number of LTE base stations is expected to be twice the number of TETRA base stations in the same area. In the TEDS use case, the

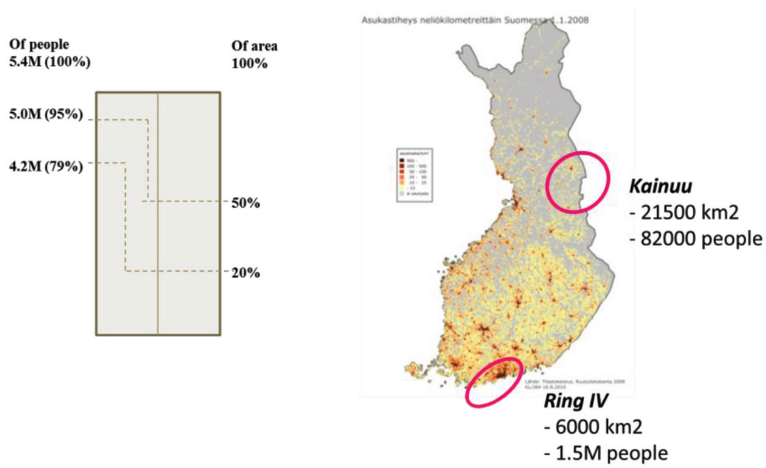

Figure 5 Example networks and the population density in Finland

number of base stations is same as with TETRA, because the used frequencies are the same.

Network Investments and Operational Costs

The total costs of the Ring IV and Kainuu networks are shown in Table 5, including the costs of both TEDS and LTE networks. The utilization of new applications will require new investment and operational costs. The daily amount of police patrols in the Ring IV area is roughly 100 patrols and in Kainuu area roughly 10 patrols (Sisäasiainministeriö, 2012, pp. 88). The applications investment costs are estimated to be 75k€ per patrol for the LTE case and 56k€ per patrol (i.e. 25% less) for the TEDS case; the annual application operating costs are 10% of the investment (shown in Table 5). In the Ring IV area (1.5M people/6000km^2), the estimated LTE and TEDS network *annual discounted costs* (including the new application infra) is in the LTE case 6100k€/6000km^2 = 1.02k€/km^2 and in the TEDS case 0.45k€/km^2; in the Kainuu area the corresponding figures are 2950k€/21500km^2 = 0.14k€/km^2 (LTE case) and 0.04k€/km^2 (TEDS case).

Estimation of Social Benefits

As said earlier, social benefits are formed of many parts: (1) direct savings in the costs of administration operations; (2) the saving of lives, health, property, among other things because of the improved performance; (3) the

Table 5 Network investment and operating costs of Example networ

	Ring IV Network		Kainuu Network	
Example Network	Dedicated TEDS	Dedicated LTE	Dedicated TEDS	Dedicated LTE
Investments (k€)				
Number of base stations	100	200	60	120
Base station network	–2300	–7300	–1480	–4660
Core network	–	–1000	–	–1000
Network management	–	–650	–	–650
Applications	–5625	–7500	–563	–750
Terminal costs	–500	–500	–50	–50
Annual operating costs (k€)				
OPEX of base station network	–850	–2700	–510	–1632
OPEX of core network	–30	–170	–30	–170
OPEX of terminals	–	–	–	–
Application costs	–563	–750	–56	–75
Net Present Value	–19300	–43655	–6581	–21084
Total annual (k€) discounted costs	–2700	–6100	–910	–2950

better performance of society; (4) the preventive operations and; (5) value of improved society. Part of the existing costs in Finland is shown in Table 6 (Police of Finland, 2012; Pelastusopisto, 2010; Tiehallinto, 2009; Hinkkanen, 2009; Kuntatietolehti, 2009). In Finland the costs related to (2), (3) and (4) are together more than 6000M€ annually. The fifth item, the value of improved society, is difficult to estimate – however, it is an important issue in society and its value might be very high. As an example, in the Ring IV area the population is about 28% of all Finnish people, meaning that the share of the mentioned costs is in this area more than 1650M€ . A saving less than 0.4% of the costs in items (2), (3) and (4) in Table 6 would cover the annual discounted LTE network investments and operations costs.

Estimation of Performance Improvements of PSE Organizations

More concrete savings – savings resulting in an immediate positive cash flow to the administration - can be seen, when savings in the area of “Performance of PSE organizations”, in Table 6, will be analysed. The potential savings can be counted in the area of *“Performance of PSE organizations”* by using the 3VPM tool (Martikainen and Halonen, 2011).

Table 6 In Finland the existing cost level in the area of potential social benefits and example of applications to improve performance

Area of Potential Social Benefits	Some Existing Annual Cost Elements in Finland	Applications to Improve Performance
1. Performance of PSE organizations	- police operations costs 773M€ 1) - costs of rescue services 344M€ 2)	- all applications in Table 3
2. Saving of life, health and property	- human costs of traffic accidents in 2008 >2500M€ - dead persons = 600M€ 3) - injured people = 1900M€ 3) - vehicle damages > 500M€ 5) - costs of house fires (property)130M€ 2)	- Mobile video monitoring - License plate tracking - Information Database - Improved AVLS systems
3. Performance of society	- costs of crimes >2000 M€ 4)	- Mobile video, SW basedrecognition analysis-Information Database
4. Savings caused bypreventive operations	- crimes preventive activities >840M€ 4)	- Mobile video, SW based recognition analysis - Information Database
5. Value of improved society	- not defined	

1) Police of Finland, 2012
2) Pelastusopisto, 2010
3) Tiehallinto, 2009
4) Hinkkanen, 2009
5) Kuntatietolehti, 2009

This tool makes it possible to define improved operations in the administration processes. As an example the Police Traffic Accident operation is modelled (Figure 6 Ring IV area, Figure 7 Kainuu area) to understand the saving potentials caused by the new applications supported by WB/BB networks. Some examples of applications affecting to the operations are listed in Table 7.

Social Benefits in Ring IV and in Kainuu Areas

The hourly cost of the police patrol is defined to be 141€ /h and the medium costs of a police traffic accident operation 400€ (Tiehallinto, 2006). The usage of 3VPM tool to model the present and remodelled police accident operation gives the costs and benefits values, which are presented in Table 8. The simulation of the new model shows that the time used for an accident could be close to 50% less than with the existing operation model.

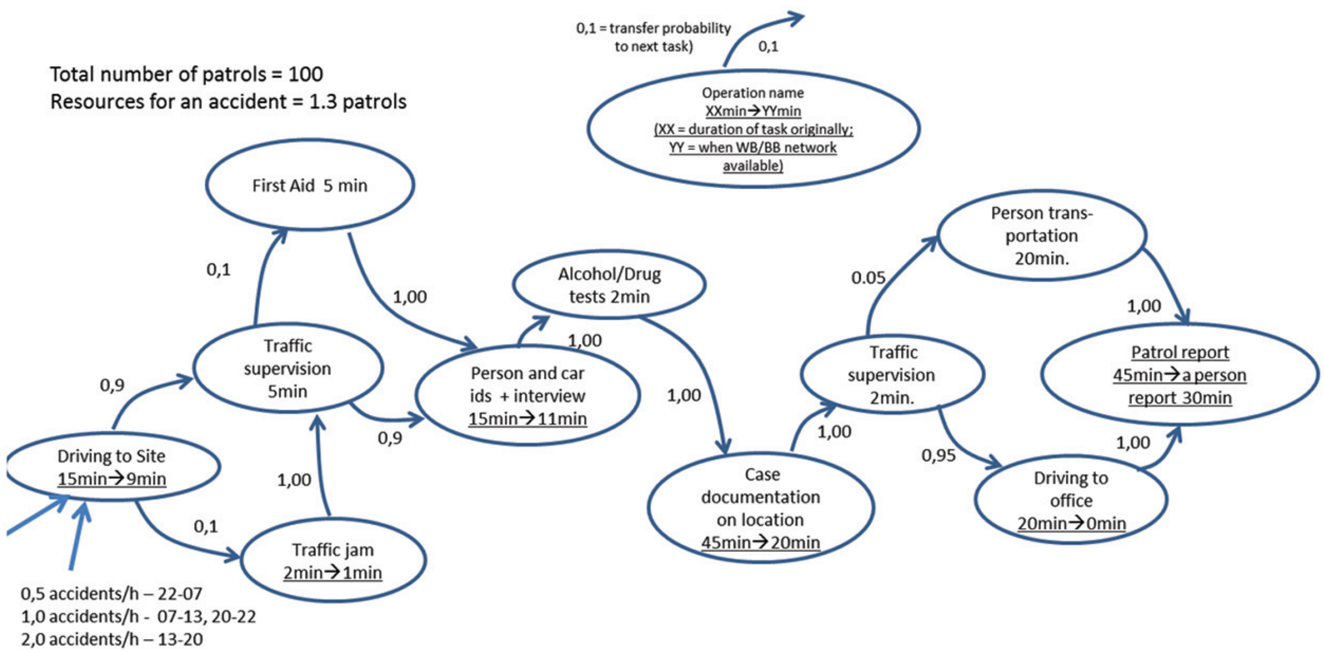

Figure 6 Model of police traffic accident operation in ring iv area; original and remodelled version

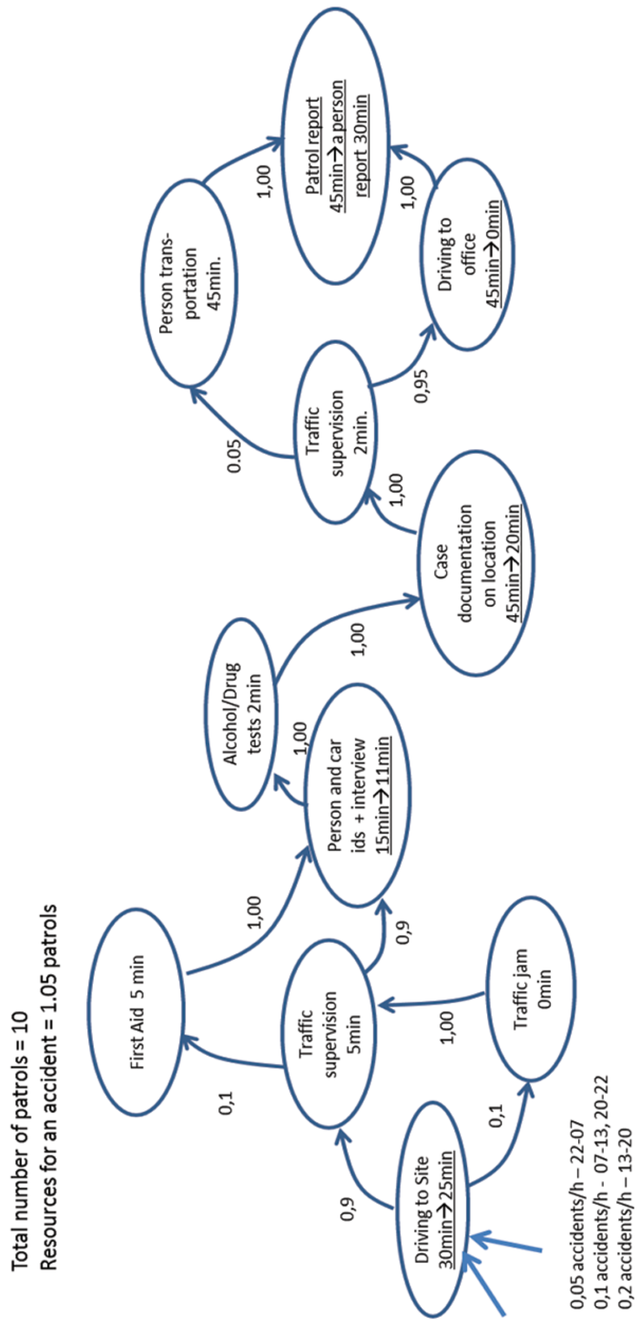

Figure 7 Model of police traffic accident operation in kainuu area; original and remodelled version

Table 7 Applications offering in the case examples

PSE BB Network Applications Offering	Affects to the Operation	Available in LTE	Available in TEDS
Mobile office	No main office visit, fast reporting	yes	(UMTS)
Emergency Centre communication, GPS	Faster location arrival	yes	yes
Mobile Command and Control	Closest patrol found	yes	yes
License plate video tracking	Automatic plate checking, runaway identification	yes	yes
Information database of maps and building drawings	Fast location documentation	yes	partly yes
Mobile video	Fast and exact location documentation	yes	
Video, SW recognition analysis	Person identification	yes	
Patient monitoring	First aid possibility	yes	yes

Table 8 Achieved benefits when WB/BB mobile network available

	Ring IV Area	Kainuu Area
area/km2	6,000	21,500
population	1.5M	82000
Number of accidents in a year [6)]	8361	643
Cost per accident, original	350€	470€
LTE case: Cost per accident	180€	235€
Benefits per accident in LTE/BB case	170€	235€
Total benefits in a year (LTE)	6200k€	660k€
TEDS case:		
Benefits per accident in a TEDS/WB case (75% of LTE benefit)	130€	175€
Total benefits in a year (TEDS)	4700k€	500k€

6) Tilastokeskus, 2012

The calculated operational savings were achieved in one class of operations, i.e. a police traffic operations (Table 1), where all traffic class operations (242445 operations) are 23% of the total annual police operations (1 064 022 operations). The Police Traffic Accident operation represents 3% all of police operations because the number of police traffic accident operations is roughly 30 000 (Tilastokeskus, 2012). By utilizing the 3VPM analysing tool all operation cases can be analysed and real savings resulting from better operational performance can be estimated.

Table 9 Calculation of the social benefits in various network cases

	Ring IV Network		Kainuu Network	
	Dedicated TEDS	Dedicated LTE	Dedicated TEDS	Dedicated LTE
area/km2	6000	6000	21500	21500
population	1.5M	1.5M	82000	82000
number of base stations	100	200	60	120
Capital expenditures				
- network	2.3M€	9.0M€	1.5M€	6.3M€
- applications	6.1M€	8.0M€	0.6M€	0.8M€
Annual operational expenditures				
- network	0.88M€	2.9M€	0.54M€	1.8M€
- applications	0.56M€	0.8M€	0.06M€	0.08M€
Annual social benefits	4.7M€	6.2M€	0.5M€	0.7M€
Discounting rate (%)	8%	8%	8%	8%
PSE WB/BB network Net Present Value (NPV)	14M€	0.9M€	–3M€	–16M€
Internal Rate of Return	59%	9%		

We make a conservative estimation and say that the found savings represent of 23% (not 3%) of all the savings which are possible to achieve. In that case achieved annual social benefits from all police operations would be in the Ring IV area with new applications and LTE technology 6.2M€ of and 0.7M€ in the Kainuu area. It is important to notice that the mentioned 6.2M€/0.7M€ of social benefits are argued to come from only one source – from the item *"Performance of PSE organizations"* in Table 6 – the other items (2), (3), (4) and (5) have not been considered. In the TEDS wideband network case some applications are not available, for instance mobile video. This has been taken into account by decreasing the social benefit by 25%, meaning a total of 4.7M€ social benefits annually in the Ring IV area and 0.5M€ in the Kainuu area.

Table 9 summarizes the key figures of the four cases which have been analysed. When the population density is high, then the LTE-based dedicated PSE mobile network seems to be a profitable investment. If the population density is low, then the TEDS type of network solution looks more economical from society's point of view.

5 Conclusions

The paper presents the process for calculating the added value for society – social benefits - of PSE agencies having a wideband/broadband network to complement the offering of the existing PSE mobile networks. Two Finnish network area cases are analysed: the first is a network in the southern part of Finland, around the capital; the second is in the northern part of Finland where the population density is much lower. In both cases two implementation alternatives are studied: firstly, a 750MHz LTE network and, secondly, a TEDS network working in the 400MHz area. If we compare the additional, annual discounted network costs of two technologies, the LTE alternative seems to have twice the costs what TEDS has, in the rural areas triple costs.

When the potential social benefits – based on the improved operational processes-are estimated, the indirect savings, like the saving of lives, the prevention of crimes or improving the feeling of public safety are not taken into account. The social benefits which have been counted are based on savings in operational costs, typically meaning the saving of working hours in operations. The calculated social benefits are based on the improvements in one type of operation, the traffic accident police operation. From the results a conservative approximation is made to estimate the total savings in police operations. The potential social benefits based on improved operations in other user organizations (rescue, border guard or customs), with the help of the better mobile PSE network, are not taken into account.

The results show that, in the southern part of Finland – in the high population density area – the investment for the dedicated WB or BB PSE network can be proofed to be profitable to the society, even all social benefits are not taken into account in the business case calculation.

In that part of the country, where population density is low - the investment for the dedicated WB PSE network is probably profitable from the society's point of view, but the business case of the BB PSE network looks questionable because of the low number of operations which could utilize the high capacity network.

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