Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the EU:

2x10MHz in 700MHz in 10 European Countries

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Foreword

This report extends the research originally undertaken to estimate the socioeconomic benefits for the use of enhanced mobile broadband by public protection and disaster relief (PPDR) agencies for the November 2013 report, *Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the UK: 2x10MHz in 700MHz*, into 10 European Countries. The same methodology underpins both reports, but the lacuna in available data has required the extrapolation of some UK ratios and metrics to bridge these. In addition, a lack of information exists assessing the potential contribution that a harmonised utilisation of spectrum for mobile broadband by emergency services can make both within European countries and in a consolidated manner across the Continent: the 'socioeconomic impact'. With the impending auction of the 700MHz spectrum in the UK and other European countries, this research has assessed a number of potential contributing areas to socioeconomic benefit that pivot on *intervention*, with a core focus on Police..

The socioeconomic benefit estimation accruing from intervention-driven changes in policing and other emergency services focuses on four major areas of socioeconomic contribution arising from enhanced use of mobile broadband in 2x10MHz in 700MHz: intervention benefits; efficiency from intervention; operational efficiency and benefits from Traffic Police utilisation. The intervention-driven socioeconomic benefit estimated for Police represents the core contributory block of this research. Recognition exists that a greater degree of analysis could strengthen the results gained from these further. The difficulties of capturing some EU capital city crime data have resulted in less emphasis on this section than for the UK Report.

The consolidation of estimates on the utilisation of 700MHz for mobile broadband on a more dedicated basis by emergency services indicates that they outweigh the opportunity cost of the 'one-off' sale of spectrum to commercial operators. The degree to which these potential benefits are realised depends on a range of factors including regulatory and license conditions; the network mode of delivery; the speed of mobile broadband adoption; the nature of the services that are provided, and others. This research is a starting point that amongst other approaches, consolidates existing information; extrapolates methodology from relevant research to additional areas; extends primary research in crime intervention from a UK-wide to a European context. These assess the socioeconomic benefits that potentially can ensue from the enhanced use of mobile broadband by public protection and disaster agencies, also referred to as the Emergency Services.

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Executive Summary

European emergency services have to date primarily relied on TETRA for their communication in the field with mobile data utilised to a significantly lower degree.[1] This has seen a step-change recently as austerity overlapped with a changing social and crime milieu to usher in a new operating paradigm for some public safety agencies such as the Police.[2] Concomitant to, or perhaps as a result of these changes, efficiency-enhancing tools such as mobile data have been increasingly used by these agencies to obtain productivity benefits, enhance the performance of fewer resources and potentially confer wider socioeconomic benefits.

A lacuna exists in the quantification of these benefits with a lack of research that adequately peels the organisational and social fabric. The enclosed research attempts to bridge this by assessing the socioeconomic benefits of mission critical mobile broadband in public safety in the five categories of *safety, efficiency from enhanced safety, operational efficiency, the use by traffic police,* and a *reduction of mortality by Ambulance Services* in a 2x10MHz portion of the 700MHz spectrum in 10 European countries from three regions: (1) *Northern Europe:* Denmark, Norway, Finland; (2) *Central Europe:* UK Germany, France; (3) *Southern Europe:* Spain, Portugal, Greece. These countries are utilised as a proxy for a wider European region with a four staged process that: (1) estimates the socioeconomic benefits of mission critical mobile broadband in public safety in a 2x10MHz portion of the 700MHz spectrum in Europe across the categories of safety, efficiency, macroeconomic growth, and service disruption; (2) estimates the opportunity cost of the alternative use of this portion of spectrum as defined by its potential auction value; (3) compares the potential auction value with the estimated benefits value; (4) provided the qualitative and quantitative context for PPDR in the Europe that frames the analysis in a topical context. This process estimated an annual consolidated socioeconomic value of around €20.9 billion. The population of these countries is approximately 300 million people, which represents 60 per cent of the EU28 population of around 500 million people. If this benefit was extrapolated across EU28 countries, a value of approximately €34 billion is derived. This approximation does not necessarily reflect the variations that exist between individual countries' mobile networks, license costs, coverage, and other variables.

[1] Stavroulakis, P. (2007). Terrestrial Trunked Radio - Tetra: A Global Security Tool. Springer.
[2] Evans, D (2013) IHS Report: Vertical Insights – Public Safety and Security Mobile Radio – World – 2013'

The opportunity cost of the alternative sale of this spectrum at auction could yield a one-off economic gain for the Governments of these countries totaling €3.7 billion based on a per MHz cost per POP benchmarked from international auctions of 700MHz and 800MHz and from UK results. This is lower than the annual estimated socioeconomic benefit, as depicted in Table 1. If this figure was extrapolated across the EU28 countries, it increases to around €6 billion. This remains lower than the estimated extrapolated socioeconomic benefit of €34 billion. Amortised over a 15 year license, the annual socioeconomic benefit of the 10 countries assessed equates to €1.9 billion, versus €246 million for the amortised potential alternative sale of the spectrum at auction. These estimates indicate that the socioeconomic benefits of the use of this portion of spectrum by PPDR agencies exceed the opportunity cost for its alternative sale at auction.

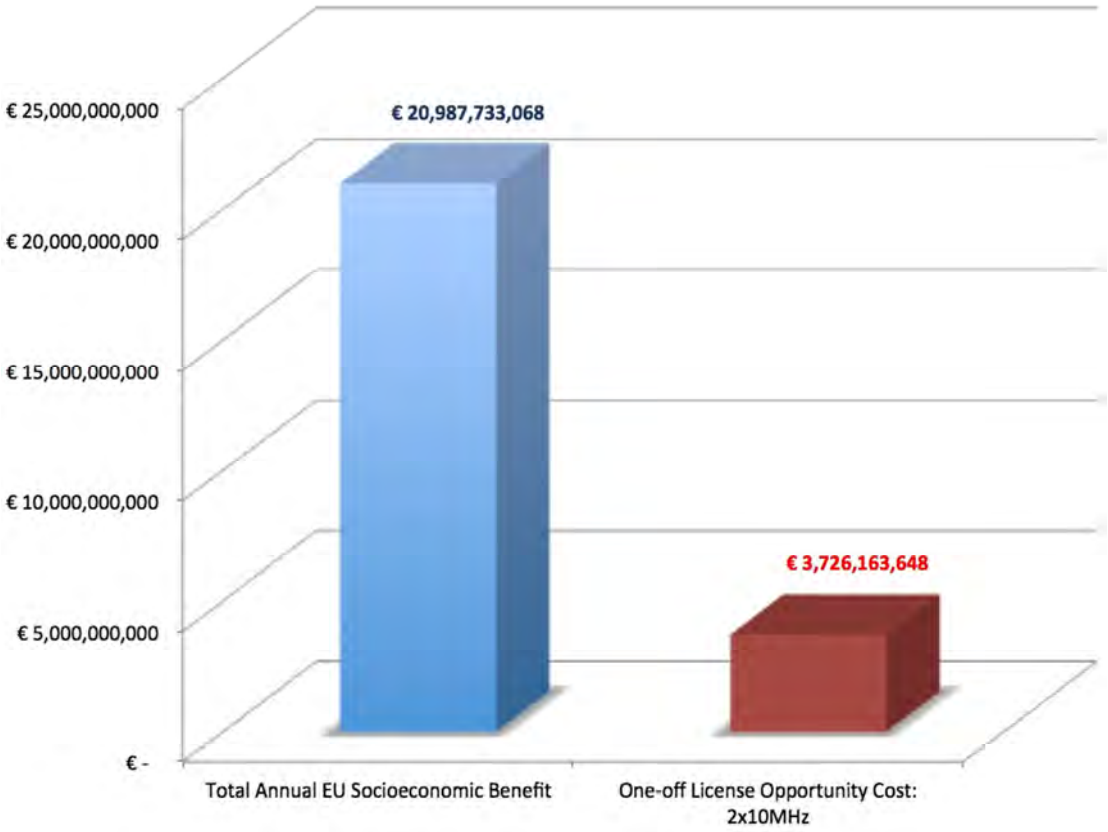

Table 1: Socioeconomic benefit versus cost in Europe from PPDR use of 2x10MHz in 700MHz versus its commercial sale at auction

Maximising the value of this 20MHz block of the 700MHz band requires congruence with an appropriate implementation model in order to fulfill key mission critical broadband and voice requirements for public safety. By aligning a number of these critical parameters, socioeconomic benefits can ensue and continue to be achieved.

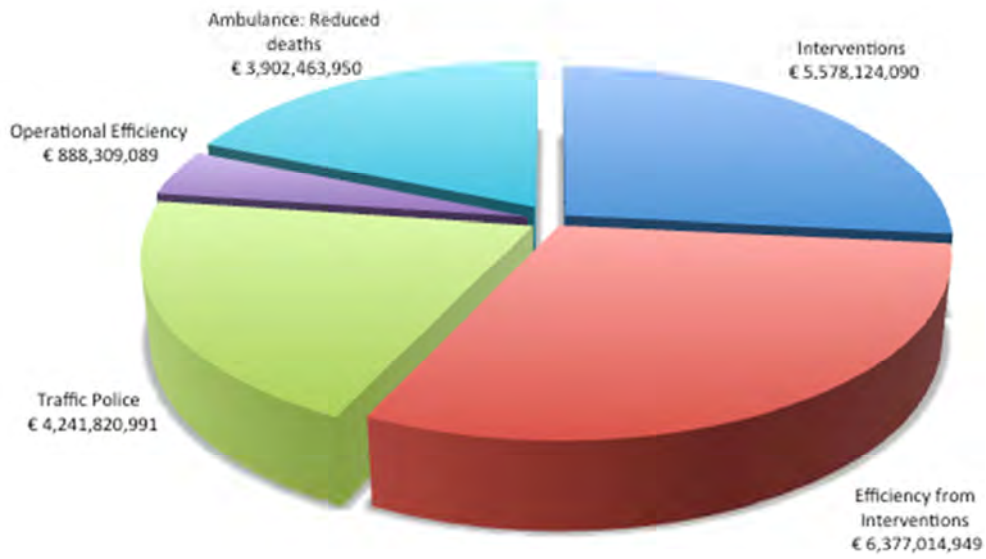

Figure 1: Consolidated socioeconomic benefit in the EU from PPDR use of 2x10MHz in 700MHz

The benefits from Police intervention to reduce crime and its commensurate social costs represent the majority of safety benefits estimated, with the utilisation of technology to assist patrolling police yielding social benefits that are likely to increase over time as adoption of mobile broadband increases. This extends to emergency services, with the potential existing for the Ambulance Service to adopt greater mobile broadband to assist teams reach coronary arrest victims in particular in less than 8 minutes, and save a greater proportion of the 1,000 people a day who die from out of hospital cardiac arrests deaths in Europe[3], with only a 7 per cent survival rate for the remainder.[4] The collective socioeconomic value generated through the utilisation of mission critical mobile applications by Public Safety Agencies for these and other areas can be juxtaposed against the opportunity cost of alternative commercial use of the 2x10MHz spectrum. The estimated socioeconomic benefits for the utilisation of this spectrum by Public Safety Agencies is estimated to be significantly greater than the commercial value of the sale of this segment of spectrum to commercial operators.

The core potential socioeconomic benefits estimated for Europe in this study are segmented into the following categories:

[3] http://www.restartaheart.eu
[4] European Society of Cardiology (2013, September 1). *ScienceDaily*. Retrieved November 24, 2013, from http://www.sciencedaily.com- /releases/2013/09/130901154147.htm

Safety:

- €5.57 billion annual socioeconomic benefit could result from an estimated 12 per cent of current homicide, serious wounding and sexual assault crime costs benefitting from mobile broadband to derive a favourable outcome.[5]

- €3.98 billion annual socioeconomic benefit could result from mobile broadband being utilised to assist ambulance crews saving an additional 1,858 out-of-hospital cardiac arrest victims faster[6], especially within the 8 minute target that is even more critical for 'Type A' life threatening responses, and for the crews to be better informed. [7]

- €4.20 billion potential socioeconomic benefit per annum could result if European Traffic Police achieved comparable results as US Highway Patrols in increasing their efficiency by reducing traffic stop times due to the enhanced and integrated use of mobile broadband. [8] The potential socioeconomic benefits are derived from avoiding an estimated total annual 9,800 major serious injuries and some fatalities that could occur otherwise occur if an officer is engaged on an existing stop, instead of maximising the period of mobility due to enhanced operational efficiency in the field.

Efficiency:

- €6.37 billion socioeconomic benefit could result from a 10 per cent improvement in productivity by Police Forces across Europe, as has already occurred in some Constabularies in the UK and the US from the adoption of mobile data [9] and the efficiency benefits in policing. An improvement in intervention rates could result in an additional 1.6 million interventions per annum occurring if these interventions were distributed in the same ratio as they crimes currently occur.

- €888 million of efficiency savings could result per annum if the current operational efficiency benefits being obtained by some UK Police Forces[10] in

[5] Intervention estimates obtained from: Johur, J. (2013). Evaluating the Benefits of Mission-Critical Mobile Broadband to the UK Police Service. MBA Thesis. Henley Business School. Additional primary and secondary research undertaken.
[6] LSE Research.
[7] Price, L. (2006). Treating the clock and not the patient: ambulance response times and risk. Quality and Safety in Health Care; 15: pp127–130.
[8] University of Cincinnati Policing Institute. Traffic Stop Data Analysis Study: Year 3 Final Report. November 2009.
[9] http://www.straighttalkonline.com/cio-articles/going-mobile-wiltshire
[10] British APCO Journal. January 31, 2012.

undertaking integrated operational duties between the frontline and back-office were realised across Europe's Police Forces.

Dedicated versus sharing spectrum with the general public

- A socioeconomic cost of €5.4 billion could result if a 1 per cent reduction in service availability occurred across the 10 sample countries, due to spectrum not being available in a dedicated manner for public safety in times of mission critical dependency, particularly acute for large-scale emergencies.[11] A 5 per cent degradation of service is estimated to potentially result in a socioeconomic cost of over €27 billion. Service outages in individual countries will result in differing figures, with the highest impact estimated to occur from Central European countries of the UK, Germany and France, where a 1 per cent reduction could result in a socio economic cost of €1.3 billion, €1.1 billion and €1 billion respectively.

GDP

- Crime has a significant impact on society, with criminal activity facilitating the consumption of illegal goods and services, whilst concomitantly levying costs through stolen and damaged goods, greater insurance premiums, spending on safety, pain suffering, loss of life and other factors.[12] These impact both the private and public sector with total crime cost accounting for 7.7 per cent of GDP in England and Wales (€124 billion), 11.9 per cent in the US[13], whilst In Colombia, crime is estimated to hinder economic growth by 2 per cent per annum.[14] Inherent difficulties exist in establishing causality between crime and GDP however.

- This research has not factored a socioeconomic benefit for crime reduction due to house price growth that was driven by enhanced crime intervention and reduction. This was due to a lack of available data at a more granular level, combined with the heterogeneous changes in crime across countries. Property related crime such as domestic burglary increased by 62 per cent in some countries such as Greece between 2007-2012, whilst decreasing by

[11] Sampling estimates obtained from: Johur, J. (2013). Evaluating the Benefits of Mission-Critical Mobile Broadband to the UK Police Service. MBA Thesis. Henley Business School. Additional primary and secondary research undertaken.
[12] Detotto, C., and Otranto, E. (2010). Does Crime Affect Economic Growth? KYKLOS, Vol. 63. August; No. 3; pp: 330–345.
[13] Ibid.
[14] Cárdenas , M., and Rozo, S. (2008). Does Crime Lower Growth? Evidence from Colombia. World Bank. Commission on Growth and Development. Working Paper No 30.

20-30 per cent in others such as Austria and Luxembourg.[15] Motor vehicle theft also reduced between 2007-2010 across EU member states by almost 25 per cent. Overall, recorded crime reduced by 10 per cent between 2005 and 2010 in the EU.[16] US research estimates that a 10 and 25 per cent reduction in violent crime could increase housing prices in 8 major US cities by 0.83 and 2.1 per cent respectively in the following year.[17] This would equate to US$16 billion and US$41 billion respectively in the case of the major US cities assessed. Although the UK has experienced over a 15 per cent reduction in violent crime between 2007-2012, which could equate to over £1billion in property value increase, many EU countries have not achieved a comparable property-and-person related crime reduction.[18] Although a more granular degree of analysis could occur in this area, such crime reduction could result in a net increase in property values of at least the UK figure. This area represents an opportunity for crime reduction that enhances neighborhoods to be factored into socioeconomic benefits that could be accelerated due to enhanced broadband access and police being retained on their rounds for longer.

If Public Safety Agencies were required to use the spectrum commercial operators have acquired through auctions, a greater degree of risk and operational challenges could ensue through the required fulfillment of communication attributes required including those related to safety; quality of service; network redundancy; security and other areas. Governments and policy makers in some countries are reviewing existing mobile network delivery modes in order to assess the optimal mode for accommodating multiple mobile operators in a 21st Century milieu including public safety and commercial operators to optimise investment and social efficiency. The impending 700MHz auction in the UK represents an opportunity for Government to review spectrum allocation and a delivery model for PPDR in this band.

[15] Eurostat, 2012. Trends in Crime and Criminal Justice: 18/2013. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-13-018/EN/KS-SF-13-018-EN.PDF
[16] Ibid.
[17] Shapiro, R. J., and Hassett, K. A. (2012). The Economic Benefits of Reducing Violent Crime: A Case Study of 8 American Cities. Centre for American Progress.
[18] Eurostat, 2012. Op cit.

"Technology has transformed the way we live our lives, but it has not yet transformed the way the police do their jobs. In five years time we need to look back and see this was the beginning of a technological revolution in policing. We could see pen and notebook replaced with voice recognition technology or manually sorting paper files replaced by automatic uploading to cloud storage." [19]

UK Home Office Minister, July 8, 2013.

[19] Speech given by Home Office Minister Damian Green on the need for police reform - 8 July 2013. https://www.gov.uk/government/speeches/damian-green-speech-on-police-reform

1. Public Safety and Spectrum in the EU

1.1 A close 'mission critical' relationship

> *"Spectrum is a valuable resource that enables growth and innovation. Without it wireless communications such as mobile phones, or Wi-Fi or satellite TV are not possible. It is also a critical input to enable delivery of essential services provided, and supported, by the public sector."*[20]
>
> DCMS, March 2011.

Radio networks continue to be recognised as a fundamental component of public safety operation for professional mobile radio (PMR) that includes emergency services.[21] A key distinction between PMR services and commercial consumer-driven communication is the mission-critical nature of public safety. The TETRA and Critical Communications Association (TCCA) defines the term 'mission critical' as: *"A function whose failure leads to catastrophic degradation of service that places public order or public safety and security at immediate risk. These systems are paramount to the operation of a nation's public safety and critical infrastructure services and are therefore specified to have particular and adequate inbuilt functionality, availability, security and interoperability."* This definition encompasses the wide role of Emergency Services in public protection and disaster relief (PPDR) across a range of activities: protection of the public, property, business, key national infrastructure and government; accident management; crime prevention; natural and man-made disasters, and terrorism.[22] The International Telecommunications Union defines the two terms as[23]:

Public protection (PP) radio communication: Radio communications used by responsible agencies and organisations dealing with maintenance of law and order, protection of life and property, and emergency situations.

Disaster relief (DR) radio communication: Radio communications used by agencies and organisations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes. US public safety

[20] Department for Culture Sport and Media (DCMS). March 2011. Enabling UK growth – Releasing public spectrum. Making 500 MHz of spectrum available by 2020; p5. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/77429/Spectrum_Release.pdf
[21] Parliamentary Joint Committee on Law Enforcement. Spectrum for public safety mobile broadband. July, 2013.
[22] TTCA, Public Protection and Disaster Relief (PPDR). TETRA + Critical Communications Association. www.tandcca.com/assoc/page/12329
[23] Report ITU-R M.2033 . Radiocommunication objectives and requirements for public protection and disaster relief: 2003.

users have four to ten times the spectrum available in Europe,[24] whilst the former has 31 people per square kilometer versus 114 for the latter. This indicates that EU public safety utilisation of spectrum is either efficient, or under-resourced:[25] additional research posits that spectrum is utilised efficiently by public safety agencies, with the public sector, including defence, transport and public safety, utilising around half of the spectrum between 108MHz and 6GHz, and public safety accounting for 0.2 per cent of this in any member state.[26] This contrasts with a figure of 0.9 per cent from earlier research[27] and indicates that public safety operates in a very small proportion of EU spectrum. In the UK, half of the spectrum is utilised by the public sector, including defence, emergency services and others[28], with this located below 15 GHz, and with technical characteristics that support a wide variety of applications including mobile communications and increasingly, mobile broadband.[29] Emergency and Safety Services possess 5 per cent of UK spectrum, and account for two per cent of its use.[30]

Mobile broadband growth continues to be fuelled by the consumer and commercial markets, with mobile subscriptions now over 800 million in Europe, representing almost 130 per cent penetration.[31] Around 60 per cent of the European population owns a smartphone with internet access.[32] Globally, over one billion smartphones are in circulation from a total use base of 5 billion mobile phones, with the average data consumption reaching over 500 MB/month.[33] Demand for mobile capacity is estimated to increase by 80 per cent by 2030 in many European countries, with auctions of radio spectrum such as 4G expected to assist in meeting mobile broadband demand.[34] In contrast, the global PMR market has an estimated installed base of around 40 million[35], and is served by narrowband digital systems that offer limited data capability.[36] In contrast, as commercial consumer-led mobility has increasingly permitted greater data capability, the growth in mobile subscribers has had a complementary impact on applications developed ('apps') across a broad spectrum encompassing entertainment, productivity, music, social networking and

[24] http://www.tandcca.com/Library/Documents/Files/Documents/Efficiencyuse.pdf
[25] Ibid.
[26] Ibid.
[27] European Commission, 2009. Final RSPG Opinion: 09-258. DG INFSO/B4/RSPG Secretariat. http://rspg-spectrum.eu/_documents/documents/opinions/rspg09_258_rspgopinion_pus_final.pdf
[28] DCMS, (2011). Op cit.
[29] Ibid
[30] Ibid.
[31] http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats/a#subscribers
[32] https://www.gov.uk/government/news/speeding-up-mobile-broadband-roll-out
[33] http://www.go-gulf.com/blog/smartphone/
[34] Ibid.
[35] Analysis Mason. DMR Market Report. December 2011.
[36] TCCA. Critical Communications Broadband Group (CCBG). White Paper. *Mission Critical Mobile Broadband: Practical standardisation & roadmap considerations.* February 2013.

others.[37] Over 1.2 billion people were using mobile apps at the end of 2012, with forecasts that by 2017, over 200 billion apps will be downloaded annually globally.[38]

In this increasingly data-centric mobile communication milieu, PPDR organisations are assessing and adopting new technology for data communications from the commercial sector across 2.5G, 3G and 4G, and relying on these mobile network operators for the delivery of those services.[39] The mission critical and safety nature of PPDR often result in a longer and more 'cautious' process occurring before new technology is adopted, and a high degree of confidence that it is 'fit for purpose' and effective in maintaining or improving safety levels.[40]

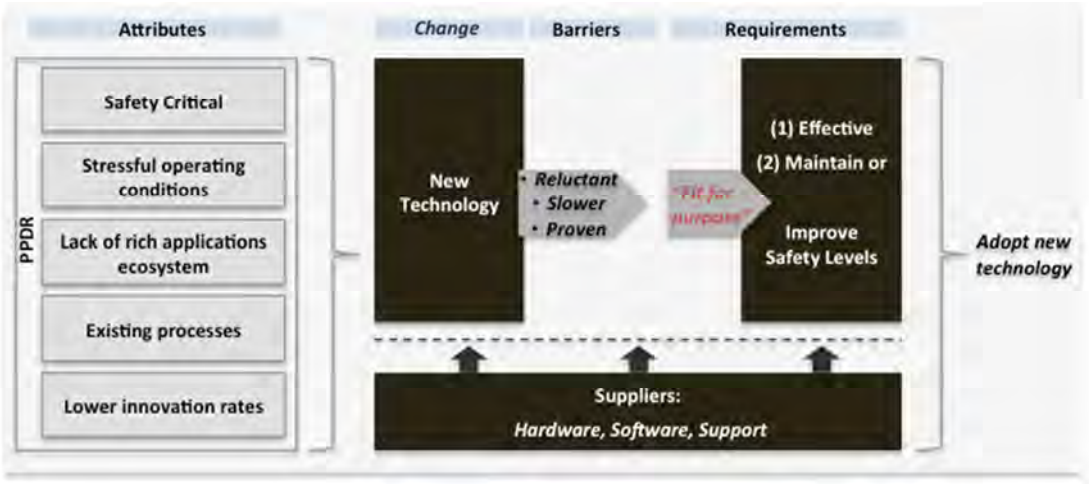

Figure 2: New Technology Adoption by PPDR Organisations

Figure 2 depicts factors influencing new technology adoption in PPDR. Key activities potentially resulting in a lower degree of innovation than the commercial mobile sector include a lower degree of available applications and entrenched processes required due to safety and mission critical requirements. The recent international auctions of 4G and 700MHz represent a potential step change for PPDR, however, in addition to private voice and narrowband data networks in use, PPDR organisations are increasingly utilising the public mobile telecommunications networks for broadband services to complement their operations. [41] This represents the commencement of a transition by PPDR agencies from narrowband communication to a more data-rich model. For this to continue successfully, key PPDR-specific network management and security issues need to be addressed to ensure that these

[37] http://venturebeat.com/2013/07/10/state-of-the-apposphere/
[38] http://appscend.com/blog/explosive-growth-in-apps-usage/
[39] Ibid.
[40] http://www.tandcca.com/Library/Documents/Broadband/Harmonised_dedicated_spectrum_MCC_final.pdf
[41] http://www.telstra.com.au/business-enterprise/download/document/business-public-safety-whitepaper-mbb-4g.pdf

are factored by commercial network operators and that mission and safety critical communication can occur on an everyday basis and in the event of major disasters. Socioeconomic value could be maximised when control over the activity chain for public safety communications resides with PPDR agencies and these sector-specific attributes are factored. A closer alignment with commercial network operator requirements can potentially dilute this value if critical requirements are not met.

1.2 A Crossroad in European spectrum management for PPDR

Secure and reliable wireless communication between PPDR resources and their command posts is vital for the successful management of emergency situations.[42] To date, this has primarily been accomplished through a strategy of dedicated, exclusive-use spectrum: this exclusive allocation for public safety provides agencies with full control over this resource.[43] To date, harmonisation across Europe on the required amount of spectrum required for a public safety, its timing and allocation exists. TETRA and Tetrapol technologies operating in the 380 - 400MHz band provide the backbone of public safety dedicated networks offering narrowband mobile communications, with the harmonisation of this spectrum occurring in 1996.[44] A greater focus on mobile data by PPDR agencies has shifted the discussion of spectrum allocation for mission and safety critical communications into a more mainstream environment. This complements ECC Decisions (ECC/DEC/(08)05) and (ECC/DEC/(04)06) that specify recommendations for the harmonisation of additional frequency bands in the 380-470MHz range for both narrowband and wideband[45], with commercial mobile operators also offering High Speed Packet Access (HSPA) technology that can provide up to 21 Mbps as a further transition to higher data rates. A key difference between the use of TETRA and 3G/4G is coverage: the latter's lower land mass coverage is driven by commercial considerations including the increased number of smaller cells that would be required to offer coverage to the same degree as TETRA. PPDR agencies across Europe are generally harmonised, in requiring coverage; security; stability; quality of service, and other operational factors. An opportunity exists for EU Member States to address the issue of mission critical mobile spectrum for emergency services within 700 MHz for PPDR at the ITU World Radiocommunications Conference in 2015. One key factor for discussion is

[42] Ahokas, J et al. (2012). Secure and Redundant Public Safety Communication Network for Public Protection and Disaster Relief (PPDR) Organizations. International Journal of Communications. Issue 3(6); pp:12-127.
[43] ETSI TR 102 970 V1.1.1 (2013-01). Reconfigurable Radio Systems (RRS): Use Cases for spectrum and network usage among Public Safety, Commercial and Military domains; p11.
[44] WIK-Consult. Final Summary Report. PPDR Spectrum Harmonisation in Germany, Europe and Globally. December 2012.
[45] Ibid.

the implementation of the provisions of Article 8.31 from the Radio Spectrum Policy Programme (RSPP): "*The Commission shall, in cooperation with the Member States seek to ensure that sufficient spectrum is made available under harmonised conditions to support the development of safety services and the free circulation of related devices as well as the development of innovative interoperable solutions for public safety and protection, civil protection and disaster relief*." [46] The European Parliament and Council approved this in the first RSPP in 2012, defining a comprehensive roadmap for the creation of an internal market for wireless technologies and services that was consistent with the *Europe 2020* initiative and the *Digital Agenda for Europe*.[47] These initiatives outline general principles and call for actions to occur in order to meet the objectives of EU policies, with harmonisation a recurring theme that is also inclusive of considerations for public safety services.[48] Recognition appears to be occurring by policy makers that harmonisation of PPDR across Europe is a key facilitator for interoperability and the achievement of economies of scale for public safety communications equipment, technical efficiency and customer convenience.[49] The debate poses a challenge for spectrum regulatory authorities and Government: the same frequency under consideration for PPDR utilisation also has an opportunity cost defined by an auction process that permits commercial operators to bid for the spectrum in order to offer television broadcasting, 3G and 4G mobile communications.[50]

1.3 PPDR characteristics: Common themes across Europe

A review by the European Electronic Communications Commission (ECC) reported that most national security networks were merging into one common network technology, with a trend for greater integration between public safety communication networks and other security related agencies including defence.[51] A minimum of 2 × 10MHz has been identified in Europe for broadband PPDR mobile data networks, without the inclusion of voice.[52] European PPDR national agencies have generally invested in dedicated narrowband digital mobile networks for voice and data communications and deployed a wide area network nationally. [53] These organisations require reliable, high availability and secure systems, with the ECC

[46] 1 Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012
[47] http://ec.europa.eu/digital-agenda/en/rspp-roadmap-wireless-europe
[48] Council of the EU. Dec 20111. File No 16226/11. Establishing a multi-annual radio spectrum policy programme.
[49] ECO. Spectrum Harmonisation in Europe: Trends and Topics. 12th September 2012.
[50] Ibid.
[51] ECC Report 102. Public Protection and Disaster Relief. 2005.
[52] Ibid.
[53] Ibid.

defining a number of essential operational requirements to be fulfilled by Public safety radio communication:

- Resilience: Available all the time.
- Coverage: Available in all locations.
- Grade of service: network access instantly available when required that can include flexibility that is managed by the relevant agency.
- Security and interoperability: secure communications between all parties that need to be involved.
- Radio networks for PPDR should provide high quality end-to-end encryption with key autonomy for each user group.[54]

In contrast, PPDR communication in Europe today is based on narrowband digital dedicated radio networks operated in a harmonised 2 x 5MHz band between 380MHz-400MHz.[55] The capabilities of PPDR agencies in the UK and Europe have been considerably improved as new technologies such as dedicated TETRA networks have been deployed, but major incidents such as the London bombing of 7th July 2005, and the UK floods in 2010 have highlighted the challenges faced. A key difference between commercial systems and dedicated PPDR networks such as TETRA is the latter's requirement for inherent resilience, capacity and security. TETRA networks are designed around these criteria, in contrast to the generally economic considerations faced by commercial network operators.[56] Key variations between PPDR and commercial organisations include:

- *Shareholders*: Commercial operators are generally owned by private shareholders with the majority of operators publicly listed: ownership is distributed amongst a large number of individual and institutional owners. PPDR agencies are Government owned with a single shareholder.
- *Targets*: Operators are profit-driven with commercial targets that include, profit, growth and other metrics designed to maximise the return for shareholders. PPDR agencies most often operate to non-profit targets by Government that are predicated around safety and response, although increasingly, additional austerity targets are being established.

[54] Ibid.
[55] Digital Europe. Digital Europe Position on Broadband Public Relief protection and Disaster Relief. Brussels, April 2, 2012.
[56] Europol. Report of the workshop on Interoperable communications for Safety and Security.

- *Network availability*: Although high network availability is required by both PPDR and commercial operators, it is even higher for PPDR organisations that require ubiquity and 'always available'. The tolerance for outage is low amongst consumer and business customers, but is even lower for PPDR organisations dealing with potential loss of life, injury, disaster or other emergencies.
- *Coverage obligation*: Commercial operators are required to meet coverage targets as part of their license agreements but some 'black spots' remain. Although this may be commercially justified, it may not be congruent with the utilisation of commercial networks for PPDR purposes where coverage of emergency and police services are required across the entire population.
- *Security*: In contrast to commercial operators, personnel and data for PPDR often require additional security clearance and protection respectively.

For optimised social benefits to be derived from PPDR activities, a congruent operational delivery mode is required that addresses the unique characteristics of this sector such as the requirement to be 'always available': the inability of safety and mission critical voice traffic to be transmitted due to traffic 'overload' may result in fatal consequences or the impediment of communication at times of emergencies. Equally, as mobile broadband becomes operationalised over time into a more mission critical function, a reduction in service availability can result in the inability of medical, fire, or police teams to utilise situational enhancing information, patient data, intelligence, or other information that can result in loss of life, serious injury, property damage and other negative outcomes, that cause distress and costs to ensue. The socioeconomic cost of a 5 per cent degradation of service availability across the EU sample in times of mission critical dependency could result in a socioeconomic cost of over €27 billion, whilst a one per cent decrease could yield a socioeconomic cost of €2.7 billion.[57] These figures represent a service reduction across the Region and are provided for indicative purposes. Service reduction is more likely to occur within a country if specific conditions exist. A service reduction of 1 and 5 per cent respectively across countries yields the following potential socioeconomic costs: UK: €1.3 billion/€6.8 billion; Sweden: €95 million/€407 million; Greece: €378 million/€1.8 billion. Such a reduction in service could occur in a large-scale emergency where spectrum is not available in a dedicated manner for public safety. Optimised socioeconomic benefits are more likely to occur when PPDR organisations have

[57] Sampling estimates obtained from Johur, J. (2013). Op cit.

greater control over their activity chain and can incorporate and directly manage elements required, such as service availability, security, and other features. Figure 3 depicts four principal network service options in the delivery of PPDR, including a dedicated approach to spectrum allocation that potentially maximises the opportunity to deliver socioeconomic benefits through greater control by providing the highest ability to control activities.

Additional dedicated spectrum options include the use of a carrier's commercial network to provide PPDR. To optimise socioeconomic benefits and ensure service availability, the appropriate hardening and related operational and technical requirements would require implementation. Carriers may be reluctant to undertake this however, as they seek to balance commercial criteria between the consumer and PPDR segments. This could result in a less effective extraction of socioeconomic benefits than a dedicated approach if PPDR-specific attributes are not implemented. An additional approach is a hybrid model utilising both a dedicated PPDR and commercial network: a dedicated PPDR network would target higher-risk and populated areas, whilst a commercial network would be utilised to target rural and low-risk areas. The balancing of services between the two presents some operational challenges, but if implemented successfully, this could result in higher socioeconomic benefits ensuing.

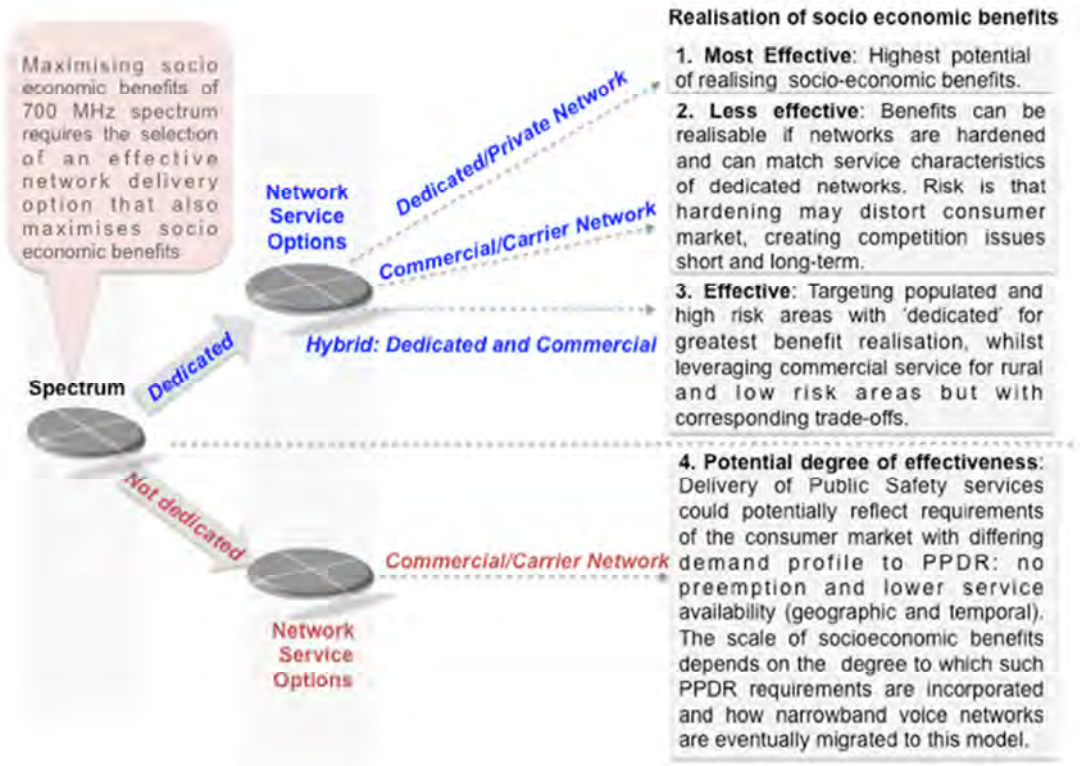

Figure 3: Spectrum implementation options and the maximisation of socioeconomic benefits

These models utilise dedicated spectrum in a variety of modes. A further option reflects the non-dedicated utilisation of spectrum utilising a carrier's commercial network. This could produce lower socioeconomic benefits, particularly if the commercial network is utilised to provide PPDR including narrowband voice and mission critical broadband, but without the existence of other PPDR attributes such as preemption and service availability. Under this scenario, the demand profile of the non-PPDR market is likely to influence the supply-profile and potentially affect the incorporation of PPDR requirements unless they are mandated or a commercial incentive is provided. These PPDR network service models can be consolidated into three principal options available to Government[58]:

(1) Build, operate and manage a network utilising exclusive spectrum allocation.
(2) Outsource the build and subsequently manage the contract, utilising exclusive spectrum allocation.
(3) Acquire service from the market on commercial terms utilising spectrum allocated to an operator.

The model implemented will impact its surrounding ecosystem and define the nature of the relationship between PPDR agencies, Government and Commercial Operators.

1.4 Defining an appropriate PPDR model in Europe

The strategy of PPDR industry associations, policy makers, EU regulators and others involved in this sector appear to be continued efforts to harmonise spectrum.[59] These are supported by the International Telecommunications Union with resolutions defined to promote such an outcome.[60] The focus has migrated to a review of *dedicated* versus *shared spectrum* and the optimal modes by which spectrum can be utilised to achieve both public safety and commercial objectives. Research by the European Union on enhancing PPDR communications concluded that the major challenges faced by PPDR wireless communications systems in emergency and disaster relief scenarios were[61]:

- Lack of broadband.

[58] http://www.tandcca.com/Library/Documents/Broadband/Harmonised_dedicated_spectrum_MCC_final.pdf
[59] ITU Resolution: ITU-R 54-1
[60] ITU Resolution: ITU-R 54-1
[61] EU. FP7 Help Project. The evolution of Public Safety Communications in Europe: the results from the FP7 HELP project. 02/2011-07/2012.

- Lack of the appropriate technology (high bit/s/Hz).
- Lack of dense network deployment.
- Lack of sufficient spectrum/more efficient utilisation
- Lack of capacity.

Commercial network operators offer the opportunity to address these issues, but PPDR agencies require the fulfillment of key criteria such as very high network availability. This is a key distinction between commercial and PPDR network utilisation, as depicted in Figure 4 that could act as a deterrent by the participation of commercial operators. Hybrid solutions could leverage commercial mobile broadband network infrastructure to fulfill the requirement from Public Safety users for availability and capacity during routine operation in addition to utilisation during disaster and major events when commercial network could fail due to overloading.[62]

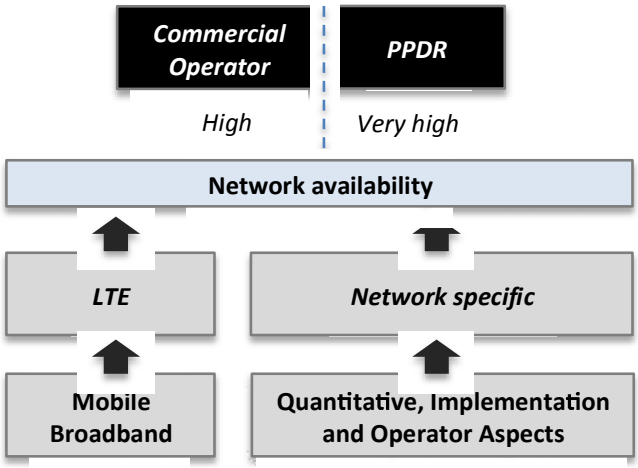

Figure 4: Commercial vs. PPDR network availability

In order to address PPDR challenges, Government can outsource the PPDR network to a third party commercial operator, as has occurred in around one third of European countries.[63] In these scenarios, where control of network design and operations is typically outside of the control of the PPDR agency, the issue of availability becomes more complex. Network operators must also comply with additional stringent provisions with some targeted at the need to maintain quality of service including:[64]

- The absence of 'force majeure': A lack of network availability can have implications for safety and risk lives, with this clause not included.

[62] ECC Report 199 - ECO DocDB
[63] http://www.tandcca.com/Library/Documents/Broadband/Harmonised_dedicated_spectrum_MCC_final.pdf
[64] Ibid.

- Severe non-performance penalties to ensure high network availability and support.
- Operational staff employment contracts that reflect the requirement for high service availability through the 'no right to strike' provision.
- Contractual conditions requiring approval of ownership changes and permitted activities.
- Financial 'health checks' with Government ability to seize control should non-compliance occur.

These and other conditions designed to obviate reduced service availability have to date resulted in outsourced mission critical service provision being undertaken by dedicated operators experienced in meeting the demands of this segment. In scenarios where commercial networks are 'shared' to provide a PPDR service, a number of factors need to be considered by operators in order to meet stringent PPDR operational provisions, particularly quality of service. A formal definition for 'network sharing' does not exist. The European Telecommunications Standards Institute (ETSI) has defined the term as: *"The shared use of a network, or a part of it, by multiple users. Different types of services for different user organizations may be provided through the shared network by one or several network operators that may have a different degree of control over the resources of the shared network*".[65] Key factors for consideration include:

- A hardened network with dedicated (segregated) parallel operations across emergency services (700MHz) spectrum and other commercial spectrum providing the ability to partition PPDR and commercial traffic.
- Priority functions, with PPDR-voice prioritised above broadband data and with both of these prioritised above commercial traffic.
- The ability to utilise the PPDR partitioned spectrum to carry commercial traffic if capacity exists and the reciprocal capability for PPDR traffic to be carried across the commercial spectrum if the need arises, as prioritised traffic.
- A seamless, 'instant' and automated capability to prioritise PPDR traffic and 'spike' capacity when required, such as in times of major emergency incidents when PPDR and other traffic surge and quality of service must be maintained for PPDR use.

[65] ETSI TR 102 970 V1.1.1 (2013-01). Reconfigurable Radio Systems (RRS): Use Cases for spectrum and network usage among Public Safety, Commercial and Military domains; p11.

Major emergency incidents often exhibit a number of common characteristics: unexpected events with peaks of traffic demand in the first hours after the crisis; impact across a large number of people and assets; concentration in one area; the engagement of multiple public safety organisations; timely communication access requirement. [66] Natural disasters can magnify these both geographically and temporally. Dedicated public safety networks are normally scoped to include a degree of additional capacity to manage demand spikes, but the possibility exists that dedicated network capacity may not be sufficient for such operational scenarios, with additional network or spectrum required. The timely provision of this can present a challenge under more 'rigid structures' where the option of acquiring immediate spectrum is not available.[67]

In addition to existing network hardening and prioritised spectrum options, other sharing options are emerging, such as Licensed Shared Access (LSA) and Authorised Shared Access (ASA). These permit spectrum licensed for international mobile telecommunications to be utilised by more than one entity when the primary licensee is not utilising its designated frequencies.[68] The ITU defines the sharing of spectrum as: "*Spectrum sharing typically involves more than one user sharing the same piece of spectrum for different applications or using different technologies, [and] encompasses several techniques - some administrative, technical and market-based. Sharing can be accomplished through licensing and/or commercial arrangements involving spectrum leases and spectrum trading. Spectrum can also be shared in several dimensions: time, space and geography*".[69] This is an emerging area that will increase in focus as 700MHz auctions continue to occur and the use of commercial service providers for mission critical broadband on a shared basis remains a topical issue however, with a view by some PPDR agencies that such services should not be provided by commercial broadband providers, as iterated by New Zealand Police: *"There are serious issues surrounding capacity, redundancy, security and reliability needed for PPDR broadband purposes that result from the different design and provisioning standards that typically apply in commercial networks…There is ample evidence of network congestion being caused by too many call start events for the network to handle, which in turn impacts on the ability of emergency first responders to access the networks in the event that such*

[66] Ibid.
[67] Ibid
[68] http://www.gsma.com/spectrum/wp-content/uploads/2013/04/GSMA-Policy-Position-on-LSA-ASA.pdf
[69] International Telecommunications Union. Radio Spectrum Management

commercial networks are their primary form of communication." [70] For the foreseeable future, quality of service, resilience, security, and other features specific to PPDR will continue to drive debate on the optimal mode of spectrum allocation, sharing and use. When these considerations are factored as requirements for PPDR, the acquisition of service from the market on commercial terms utilising spectrum allocated to an operator may offer the lowest opportunity to maximise socioeconomic value and poses a challenge for regulators, Government and both commercial operators and PPDR agencies to successfully address.

2. Why Broadband?

2.1 The evolution of mobile broadband

European PPDR radio systems are constructed to provide nationwide mobile coverage, with Terrestrial Trunked Radio (TETRA) the dominant standard, but often with lower indoor and rural handheld coverage, with budget constraints defining the degree and extent of coverage. [71] These systems operate in 380MHz–400MHz band with frequencies harmonised for public safety use and only provide voice and narrowband data services. They have been designed around the key criteria of support for group voice communication, availability and security. Limited bandwidth exists that can only support lower bit rate data services. This limits mobile data to shorter data messages.[72] In addition, the radio network is most often shared among PPDR agencies but this also permits easy and flexible cooperation between agencies in the field. TETRA is an established technology utilised widely internationally for mission critical and business critical organisations. The inherent data capabilities are low however and partly bridged by the wideband data standard, *TETRA Enhanced Data Services* ('TEDS'), also known as 'TETRA 2', that will increase data throughput tenfold from the existing TETRA standard.[73] Greater data carriage however requires additional spectrum. This is not deployed in a harmonised manner however, and wide bandwidth channels (50 kHz and greater) are not generally available. Over time however, increasing demand has occurred from PPDR agencies for access to mobile broadband data applications.[74]

In Europe and other regions, the utilisation of the Long Term Evolution (LTE) standard for 4G is a key catalyst for the convergence of other standards such as

[70] New Zealand Police, 6 October 2011. Digital Dividend Submission; p4.
[71] Digital Europe, 2012. Op cit.
[72] Ibid.
[73] http://www.tetra-applications.com/item.html&objID=15195
[74] Analysis Mason. 'Exploiting the digital dividend- A European Approach': Final Report. August, 2009.

TETRA 2, 3G, and WiMAX mobile, with supporting standards such as IEEE 802.16 supporting PPDR through enhanced reliability of resilience, multicast connection based group communications; IP based push-to-talk and nearby direct communications among users.[75] A key requirement of TETRA is to provide interoperable, inter-agency communications during incidents that require a multi-agency response. In the US, LTE has been selected as the standard for broadband data services for public safety, with large network rollouts the primary mode of operation.[76] The adoption of mobile broadband in Europe can enhance everyday functions for European PPDR agencies, in addition to ensuring that in an increasingly cyber-driven terrorism environment, law enforcement and emergency agencies do not lag the sophisticated technical capability of many activists and criminals

The radio coverage of European countries' PPDR nationwide networks is very high, and in most cases approaches 100 per cent: in the UK, this exceeds 98 per cent of the landmass.[77] Ubiquitous indoor coverage appears to still be an issue for PPDR agencies[78], with network operators generally lagging this.[79] An absence of radio coverage may impede the ability of frontline police officers to perform their role, with inadequate communications potentially delaying or preventing their response to an incident. Mission-critical radio networks target national radio coverage with service availability in excess of 99.9 per cent, whilst commercial networks typically provide radio coverage to densely populated areas with service availability significantly lower than this: this factor however, in addition to security hardening and disaster recovery, assist to underpin a mission-critical network.[80]

2.2 Mobility: Ushering a step-change in European PDDR

In 2013, European PPDR agencies are poised at the cusp of change, with increasing demand for PPDR users to access broadband data applications whilst mobile access to patient records for ambulance services; criminal records for police services; real time video images when responding to major emergency incidents, and others.[81] The bandwidth provided by current wireless PPDR networks is proving to be inadequate in meeting current PPDR demand and forecast future needs. A wireless

[75] Chang, S. Broadband Mobile Communication for PPDR Applications - IEEE 802.16 GRIDMAN – 2012.
[76] http://www.etsi.org/plugtests/RCS-VOLTE/pres/PSCR%20-%20ETSI%20MSF%20GSMA%20RCS.pdf
[77] Ofcom. Infrastructure Report, December (2012).
[78] Johur, J. (2013). Op cit.
[79] Ofcom. Infrastructure Report, December (2012).
[80] Johur, J. (2013). Op cit.
[81] Analysis Mason, (2009). Op cit.

broadband network offers a range of benefits that include enhanced efficiency; higher intervention rates for Police; faster response times, and other life-saving and asset protection capabilities.[82] The evolution of PPDR mobile broadband services can deliver enhanced services that agencies such as Police, Fire and Ambulance can benefit from when responding[83]:

- *Wideband access for 'video from the scene':* Increased spectrum can provide interactive consultation with specialists from the scene of an incident; reduce collateral damage to property through greater information; provide a video stream for live incidents to other agencies and command posts.
- *Creating local LANs at the scene:* The dissemination and communication with a wider PPDR team on-site for an incident can yield benefits through expedient information, image and other knowledge transfer and for monitoring.
- *Enhancing situational awareness*: Utilisation of smart devices for enhanced situation awareness such as en-route mapping of deployed assets, automated incident reporting from the frontline, and others.

The migration to LTE as an optimal mobile broadband model for PPDR can be maximised further when the two key *operational features* of narrowband public safety networks are factored: *group calling* and *operation outside of the network.* Group Call System Enablers (GCSE_LTE) has been agreed in 3GPP from LTE Release 12, which is planned for freezing in mid-2014.[84] Figure 5 depicts the role that these two critical narrowband features have in shaping a network strategy. If the narrowband feature of PPDR users being able to call other users in a group is incorporated, along with radio-to-radio functionality to permit out-of-coverage communication, mobile broadband LTE networks offer a more seamless migration to mission critical operations that embody some existing network features. In the absence of this, hybrid solutions may be required that segment the 'alongside operation' of narrowband voice and critical-data networks with broadband data LTE networks.[85]

[82] www.gsma.com/newsroom/gsma-announces-new- global-research-that-highlights-significant-growth-opportunity-for- the-mobile-industry
[83] Spectrum Harmonisation in Europe: Trends and Topics 12th September, 2012.
[84] http://www.3gpp.org/Public-Safety
[85] Source: Drawn from: Analysis Mason, LTE Advances in Public Safety Communication, 03 July, 2012 at http://mason.analysysmason.com/News-and-Events/News/LTE-advances-in-public-safety-communications/

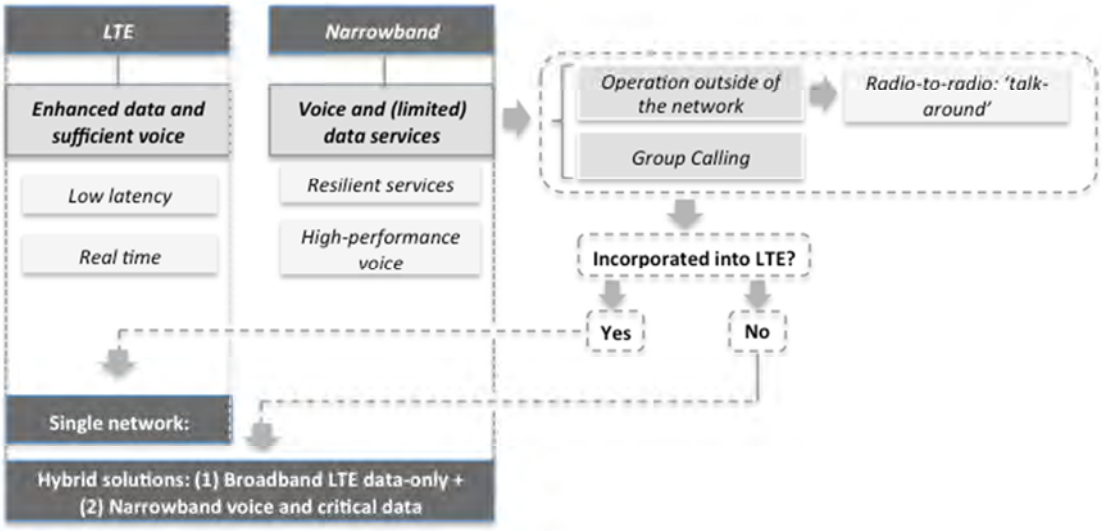

Figure 5: LTE versus narrowband networks and the role of key characteristics

Concomitant to, or perhaps as a result of the success of smartphones in commercial markets, suppliers continue to make billion dollar R&D investments annually to deliver new innovative features and products, as epitomised by leading players such as Apple, Samsung, Google, and others.[86] Today's smartphones possess greater processing power than a 1970s supercomputer[87], and have spawned a billion dollar applications industry in the process. The emergence of LTE as the global technology standard for mobile broadband has facilitated its increased adoption by government, regulators and the PPDR sector for mission-critical mobile broadband communication services[88] (MCMB). The US Government has recently allocated new radio frequency spectrum and a US$7 billion investment for the implementation of a national, federal communications data network to augment the existing ASTRO P25 mission-critical voice and narrowband data networks that support the US equivalent of PPDR. In Europe, the TETRA and Critical Communications Association (TCCA) also selected LTE as the technology for future MCMB communications.[89] This is occurring against a backdrop of austerity with many PPDR agencies being reduced in size and their budgets curtailed[90], and debate on the appropriate future technology model and standards for PPDR. The TETRA standard is evolving to provide the TETRA Enhanced Data Service (TEDS), which will be an overlay to existing TETRA

[86] Johur, J. (2013). Op cit.
[87] www.newscientist.com/article/mg21528803.800-harness-unused- smartphone-power-for-a-computing-boost.html
[88] www.fas.org/sgp/crs/homesec/R42543.pdf
[89] TETRA (Terrestrial Trunked Radio) is the accepted digital radio standard for critical communications. TETRA is an open standard where the focus is on meeting the critical communications needs of public safety and security agencies and an increasingly wide range of other market sectors. The technology has been standardised by ETSI (The European Telecommunications Standards Institute), at: http://www.tandcca.com/Library/Documents/About_TETRA/TETRA_Fact_sheet_09-12_Final_2.pdf
[90] HMIC (2013). Policing in Austerity: Rising to the Challenge.

systems. Other potential solutions include commercially available technologies such as WiMAX and LTE. These technologies may offer economies of scale and the availability of handsets, whilst dedicated commercial networks are most often optimised to meet consumer demand, price pressure and customer service expectations. These commercial objectives are not necessarily congruent with the objectives of PPDR, with such networks not generally hardened or scoped to cater to the stricter requirements of PPDR agencies.[91]

With increased spectrum, PPDR agencies will continue to evolve from a narrowband focus and utilise efficiency enhancing and lifesaving applications and services that generate socioeconomic benefits. Although these are likely to still lag the plethora of applications and terminal choices available to consumers, the evolution of mobile broadband for PPDR will most likely have shifted from its current position. A key consideration for Government, policymakers, and PPDR agencies is the selection of the optimal operating and delivery mode. This is required to maintain current mission critical functionality, in addition to providing access to mobile broadband that widens existing service offerings. Debate continues on this theme, to assess the use of LTE and TETRA to deliver mission critical wireless broadband and voice in a manner that fulfills the objectives of multiple stakeholders. Wireless broadband networks present a unique opportunity to revolutionise how public safety agencies respond to emergencies, with first responders able to utilise new and significant applications that contrast a previous reliance on narrowband voice.[92] The evolution to viable commercial LTE for Public Safety is likely to take the next decade to achieve, with existing solutions utilised during this transition, and an increasingly greater adoption occurring by PPDR organisations as time progresses.[93]

2.3 Adoption by public safety agencies of mission critical mobile applications: A focus on Police

Emergency services generally encompass Fire, Ambulance and Police. All three of these services have a critical reliance on mission critical mobile applications.[94] The overwhelming majority of the European PPDR resources are in Police, with this

[91] Analysis Mason, (2009). Op cit.
[92] Peha, J. M. (2007). How America's fragmented approach to public safety wastes money and spectrum. Telecommunications Policy; 31 (10-11); pp:605-618.
[93] Shortland, J. (2013). Broadband PMR/LMR Solutions – World.
[94] Peha, J. M. (2005). How America's fragmented approach to public safety wastes spectrum and funding. Proceedings of the 33rd Telecommunications Policy Research Conference

segment also arguably representing the most diverse use of mobile communication.[95] Although sharing point-to-point dispatch with the Ambulance Service and the Fire Brigade, day-to-day Police work includes frontline patrolling in the community on foot, car, motorcycle or bike.[9697] Change has been occurring across Europe in policing, reflected by austerity measures that have been in place for a number of years, such as in the UK.[98] These changes are occurring against a backdrop of spending reviews on ICT and strategies for technology change by many forces as they adopt mission critical technology to 'work smarter', with the UK Home Office Minister confirming: *"Exciting work is already underway: apps are being developed to allow forms to be filled in automatically on the street, rather than in time-honoured (and time-consuming) pen and paper fashion at the station. Officers should be able to collect video and picture evidence on the street and download it straight into a digital file."* [99] In contrast to UK Police reduction,, Police officer numbers have remained relatively stable across the EU between 2004-2010.[100] Italy, Germany and Spain have the largest number of police officers, accounting for almost half of the European total. This has increased from 44 per cent, in 2006.[101] The Greek Government has also stated plans to streamline the Police through the transfer of 4,000 municipal Police officers to the main police force in an effort to comply with its second tranche of funds of €8.1 billion from its Eurozone bailout.[102] Spain has also been reducing its public servants over the past decade to 2011, with 0.88 Spanish Police Officers per 1,000 people, down from 1.05 in 2005.[103]

The utilisation of mobile broadband and new applications is likely to occur across Europe in a fragmented and staggered manner as countries implement higher bit-rate mobile networks and PPDR agencies commence the process of trialing and adopting mobile broadband.[104] Half of the EU member states have requested a postponement of the 800MHz band for wireless broadband, missing a deadline of January 1 2013. This is likely to affect the timing of a rollout of mobile broadband and the adoption of enhanced mobile broadband services by PPDR agencies. With a

[95] Johur, J. (2013). Op cit.
[96] Bowers, K., et al. (2011). Do Geographically Focused Police Initiatives Displace Crime or Diffuse Benefits? A Systematic Review. Journal of Experimental Criminology: v7(4); pp:347-374
[97] Shortland, J. (2013). Broadband PMR/LMR Solutions – World.
[98] HMIC. Adapting to Austerity: A review of police force and authority preparedness for the 2011/12–14/15 CSR period.
[99] Speech given by Home Office Minister Damian Green on the need for police reform - 8 July 2013. https://www.gov.uk/government/speeches/damian-green-speech-on-police-reform
[100] Eurostat, 2010. Op cit.
[101] Eurostat, 200. Op cit.
[102] http://www.ekathimerini.com/4dcgi/_w_articles_wsite1_1_05/07/2013_507801
[103] http://www.catalannewsagency.com/politics/item/more-than-half-of-recently-graduated-spanish-police-agents-to-be-sent-to-catalonia
[104] http://www.siliconrepublic.com/comms/item/33572-delay-of-800mhz-band-adopti

longer time-horizon for the adoption of mobile broadband services however that is at least a decade way from today, such delays are believed to be transitory. Countries like the UK and the US offer evidence of the step-change transformation potential occurring in Police, with the Metropolitan Police's ('the Met') Assistant Commissioner confirming that mobile technology would play a key role in policing going forward: '*We know that the resolve of victims in domestic violence can fade away very quickly for a whole range of complicated reasons. If [officers] are able then and there to take a statement, and photograph it [using a mobile device] so your evidence capture at the start is much stronger, your chance then with the offender of pushing through with that is much greater'.*[105] Demand from the Police Force, driven in part by austerity, will continue to be an influencing factor in the evolution of mobile data internationally. EU member states in particular are continuing to migrate through fiscal changes that are affecting the structure of their public sector and PPDR agencies, but with increased pressure to utilise resources and assets more efficiently to deliver services.[106] The UK has demonstrated some of the largest gains, with savings of 30 minutes per shift per officer and over €7m per annum saved by some Police Forces using Blackberry devices, with the benefits attributed to these trials including[107]:

- Extra time spent policing in the community.
- More effective crime fighting such as the ability to perform visual identity checks.
- Photographic and CCTV evidence capture to help secure convictions.

The UK's largest Police Force, the Met, intends to expand its use of mobile technology over the next few years with around 20,000 mobile devices added and a stated intention for officers to 'use their cars as an office' in 2014-15.[108] This is expected to maximise officer visibility, reduce costs and improve community confidence: three key objectives for Police forces.[109] Between 2008-2011, Leicestershire Police utilised enhanced mobile data terminals to streamline its incident report process, yielding an estimated €5.9m saving during this period, increasing visibility by 44 per cent due to greater retention of officers on the front line;

[105] Assistant Commissioner Mark Rowley, MPS, speaking to the Budget and Performance Committee, 18 June 2013. London Assembly Budget and Performance Committee: Smart policing How the Metropolitan Police Service can make better use of technology. August 2013.
[106] Ibid.
[107] http://uk.blackberry.com/content/dam/blackBerry/pdf/a/europeMiddleEastAfrica/english/blackberry-case-study-southyorkspolice-en.pdf
[108] London Assembly. Op cit.
[109] Chief Constable Simon Parr, Association of Chief Police Officers, speaking to the Budget and Performance Committee, 5 March 2013.

reducing crime by 26 per cent and doubling public confidence to 85 per cent.[110] Germany is rolling out mobile broadband to more rural areas following the May 2010 spectrum auctions as well as implementing Europe's largest public safety network using TETRA technology.[111]

In the US, more than 2 million PPDR first responders exist.[112] This encompasses around 630,000 police patrol officers; 300,000 firefighters; other public safety workers and 100,000 Federal Government employees in protective service occupations. Many of these utilise advanced communication infrastructure and devices in their day-to-day functions, including mission critical wireless broadband.
Over 60 per cent of all US law enforcement agencies utilised automated incident report transmission in 2007 versus 38 per cent in 2003, with the current figure expected to be higher still.[113] The trend for 'crossover' applications that augment narrowband technology with mobile broadband is reflected by the Queensland Police Service's rollout in Australia in mid-2013 of 400 iPad mini's. These will utilise the Force's intranet and a newly designed in-house app, that will mitigate the need for in-field officers to utilise their two-way radio to speak to an operator, with the State's Minister for Police and Community Safety announcing that: *"With the mobile system, police officers will have [all that] information at their fingertips, saving officers waiting time, and allowing them to move onto other jobs. It is hoped that by reducing the time it takes to perform searches, this Police app will save each police crew around 30 minutes each shift.*"[114] A similar strategy to negate radio calls to an operator and empower front-line police with mobile broadband occurred in the Tasmanian Police Force, with 40 3G-capable tablets introduced and the State's Commissioner for Police confirming that: *"One of the main benefits of using this more responsive technology is the amount of time it can save our officers working on the front line. For example, officers using these tablets will be able to submit reports live from the field, rather than having to return to the station to complete their paperwork*."[115] This theme is increasingly emerging across Police forces, with a growing number of municipalities in the US now leveraging wireless broadband networks to enable officers to access real-time information, upload reports, view video and in the process sever the need to be joined to the dispatch center awaiting instructions.[116]

[110] London Assembly. Op cit.
[111] http://www.wireless-mag.com/Features/13229/Germany_rolls_out_TETRA_and_LTE.aspx
[112] The Benefits of Transitioning to a Nationwide Wireless Broadband Network for Public Safety. The White House. June 2011. http://www.whitehouse.gov/sites/default/files/uploads/publicsafetyreport.pdf
[113] http://www.policechiefmagazine.org/magazine/index.cfm?fuseaction=display&issue_id=12011&category_ID=4
[114] http://www.zdnet.com/qld-police-to-trial-ipad-mini-police-app-7000018640/
[115] Ibid.
[116] http://www.wi-fiplanet.com/columns/article.php/3499546/Wi-Fi-Policing-Comes-to-Georgia.htm

Solutions currently being offered to US Public Safety agencies today and over the next 5-10 years will likely support multi-mode operation that can operate across dedicated mission-critical mobile broadband networks, commercial broadband networks and WiFi networks. Multi-mode operation is also expected to be complemented by national roaming agreements with one or more commercial broadband networks. These capabilities will provide frontline police officers with a greater number of sources of radio coverage, increased service availability compared to today's mobile communication solutions, and in the process, address a number of the requirements inherent in the continued use of dedicated narrowband voice networks today.[117] Debate continues at present however on whether data and video applications are mission critical *today,* or whether this is a future outcome.

The increased utilisation of mission critical mobile broadband presents technical and operational challenges to Government, policy makers and PPDR agencies, but it also offers significant opportunities. In addition to services already defined in this report, enhanced services offered to PPDR resources in the field such as video streaming, body-worn cameras, vehicular cameras, facial recognition, automatic number plate recognition and others, offer the chance to add significant value to the ability of police to operate into the future.[118] The Chief Executive Officer Police Federation of Australia, one of two countries where 700MHz auctions have already occurred, stated*: "This is a generational opportunity for policing to get access to such technology*."[119]

3. The Opportunity Cost of 2x10MHz in 700MHz in Europe

Analysis of the use of mission critical broadband by emergency services has estimated a socioeconomic benefit for the use of 2x10MHz 700MHz of €20.98 billion p.a., that encompasses 60 per cent of the European population across 10 selected countries representing 3 regions. This figure is higher if it is extrapolated to cover the EU28 figure of 500 million people, yielding a socioeconomic benefit of €34.94 billion p.a. The market, through the auction of capacity, sets the opportunity cost of spectrum. To date, only two auctions have occurred for 700MHz, with spectrum earmarked for the provision of public safety communications. Analysis indicates that

[117] Johur, J. (2013). Op cit.
[118] Commonwealth of Australia. Parliamentary Joint Committee on Law Enforcement. *Spectrum for public safety mobile broadband.* July, 2013.
[119] Ibid.

the opportunity cost of the alternative one-off sale of this spectrum across the 10 European countries could be €3.72 billion or €3.60 billion reflecting UK high and low figures respectively. Ofcom, the UK Spectrum Regulatory Agency provides an insight into the regulatory drivers for Governments seeking to liberalise this portion of spectrum: *"Ofcom's UHF Strategy Implementation work concerns the future of a part of the radio spectrum which we call the 700MHz band (694-790MHz). Implementing our UHF Strategy is a priority for Ofcom and our objective is to secure the best outcome for citizens and consumers. To do this, we are supporting the international and European work that is underway to harmonise the 700MHz band, which would allow it to be used for mobile broadband. At the same time, we are doing work to ensure that the current users of the 700MHz band (mainly digital terrestrial television and programme-making and special events) will be able to continue to provide services in the event of any future change of use of the 700MHz band."*[120] Ofcom's objectives with regard to the use of UHF bands IV and VI, which cover the frequency range 470MHz-862MHz, are two-fold and can equally have applicability for other European countries:

- Enable the release of additional low frequency spectrum for mobile broadband use, to help meet the rapidly increasing demand for mobile data capacity; and:
- Secure the ongoing delivery of the benefits provided by Digital Terrestrial Television (DTT).[121]

The 700MHz spectrum was auctioned in the United States in early 2008 across five blocks of frequencies. The fourth block, D Block, included 10MHz for auction to one licensee to provide public safety communications throughout the US. The D Block only received one bid of US$472 million, but a license was not awarded as this did not meet the US$1.3 billion reserve price.[122] The Federal Communications Commission (FCC) raised more than US$19.6 billion for the remaining blocks of the 700MHz spectrum, and awarded 1,090 licenses, with AT&T Mobility and Verizon Wireless securing the majority of these for commercial wireless communications. In early, 2012 US Congress passed a law establishing the First Responder Network Authority (FirstNet), an independent authority within the U.S. Department of Commerce that will provide emergency responders with the US' first high-speed, nationwide network dedicated to public safety. This will utilise the 10MHz D Block spectrum. In Australia in May 2013, the Digital Dividend auction that included the 700MHz and 2.5GHz spectrum occurred and raised AU$1.96 billion, but that was

[120] http://stakeholders.ofcom.org.uk/spectrum/uhf700mhz/
[121] http://stakeholders.ofcom.org.uk/binaries/consultations/700mhzcfi/summary/UHF_SI_call_for_inputs.pdf
[122] http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=73

below the government's expectations. One-third of the spectrum, with a reserve of AU$1 billion did not sell.[123] The 700MHz auction lasted only one round, with the spectrum selling for its reserve price.

A key consideration in the assessment by Government of the sale of 700MHz spectrum commercially is the alternative socioeconomic benefits that can accrue to the UK from the dedicated utilisation of this by public safety and disaster recovery agencies. Any socioeconomic benefits derived are *recurring* and can yield increasing returns over time as public safety resources benefit from the experience of utilising enhanced mobile broadband for mission critical activities. Utilising the common measure for spectrum pricing, per MHz/pop data from 700MHz and 800MHz auctions indicate that the opportunity cost of the commercial sale of 2x10MHz in 700MHz is €3.66 billion, as depicted in Chart 1, reflecting the UK high and lower figures for 2x10MHz in 800MHz of €529 million and €646million.

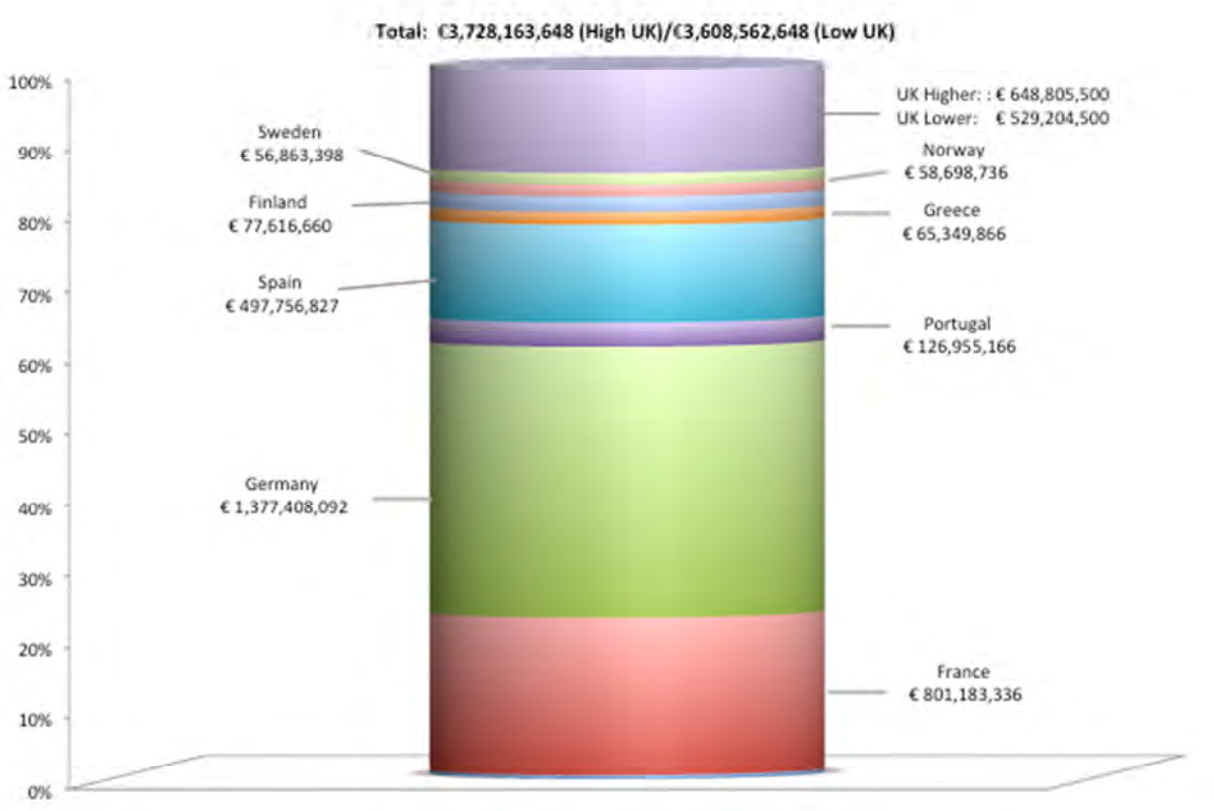

Chart 1: Opportunity cost of the commercial sale of 2x10MHz 700MHz Spectrum in the UK

The commercial auction of this spectrum represents 'one off' income for Government, until the expiration of the license period. Chart 2 depicts the estimation

[123] http://engage.acma.gov.au/digitaldividend/

of the opportunity cost of for the auction of the 2x10 MHz spectrum utilising per MHz per POP data. Even the highest estimated one-off opportunity cost of €3.72 billion for the alternative sale of the 2x10MHz component of the spectrum is significantly lower than the estimated annual socioeconomic benefit of €20.98 billion generated by the utilisation of the spectrum by PPDR agencies.

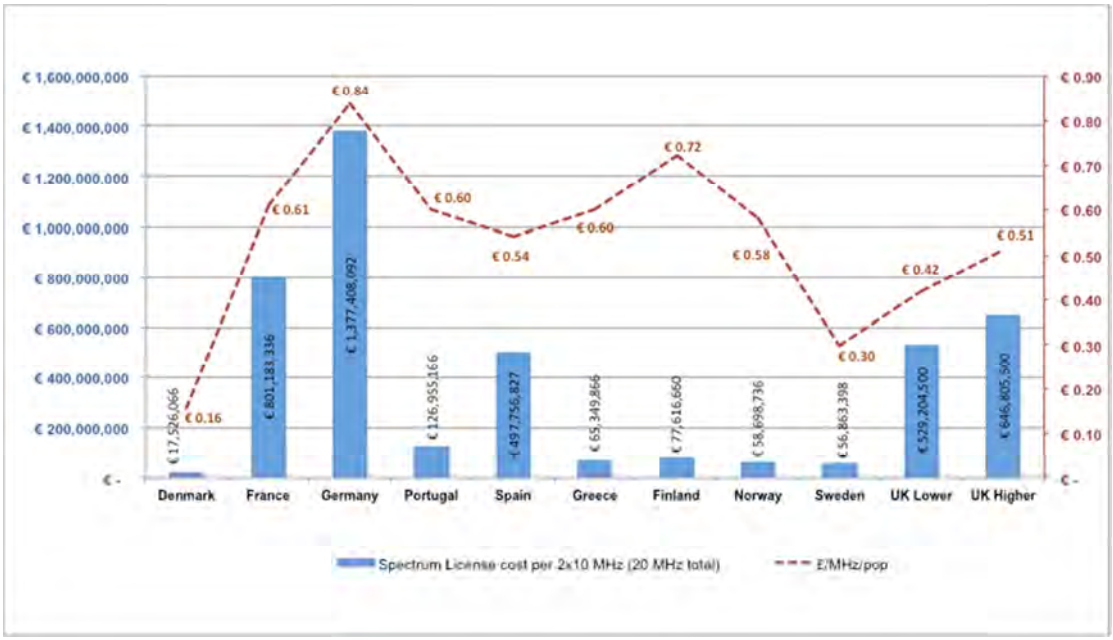

Chart 2: Opportunity cost of the commercial sale of 2x10MHz 700MHz Spectrum in the UK using cost (€) per MHz/pop from auction results

The existing operational mode for emergency communication and data access is likely to continue over the next 5-10years, augmented by the utilisation of 2x10MHz in 700MHz spectrum. As the plethora of new services offered become operationalised in public safety agencies, their return to shareholders ('the Public') should increase. The opportunity cost of seeding this must be considered today: any 700MHz spectrum decision at WRC-15 will be in effect for the next 20 years.

4. Defining the Social Benefits of Mission Critical Mobile Broadband Applications by Public Safety Agencies in Europe

4.1 Establishing the benefits ecosystem across the 10 European countries

A cadre of cost-benefit analysis exists on crime and the value of life.[124] A lacuna exists however on the socioeconomic benefits that mission critical communication

[124] Brandon, C. et al (2001). Costs and Benefits of Preventing Crime. Westview Press. U.S.;, M. R., (2013); A Note on the Role of Basic Theory in Thinking About Crime Prevention. European Journal on Criminal Policy and Research. V(19)2; pp 91-97; Hall, R. E., and Jones, C.I., (2007) The Value of Life and the Rise in Health Spending. The Quarterly Journal of Economics. V(122)1: pp: 39-72.

can precipitate for public safety.[125] In order to bridge this, an ecosystem of activities has been defined and the socioeconomic benefits estimated and consolidated. It is recognised that this is not inclusive of all relevant applications and services, and that this is an evolving area. It should be viewed as a starting point for further discussion on the potential socioeconomic value that can be assigned to spectrum and compared to the opportunity cost of the commercial sale of this scarce resource.[126] An estimation of the socioeconomic benefits of mobile broadband for PPDR has been undertaken across four areas: *Safety*; *Efficiency; Dedicated versus sharing spectrum (quality of service)* and *GDP:*

Safety: This represents the major area of investigation, focusing principally on Police to assess the use of mobile broadband for crime intervention, reduced mortality for the Ambulance Service, and reduced mortality through the Traffic Police. Some elements of assessment are also applicable in 'Efficiency', but are presented in this section due to their utilisation for intervention.

***Efficiency*:** This section focuses on efficiency benefits accruing by Police in the main across two areas: (i) an improvement in efficiency that results in greater interventions occurring across the spectrum of crime, and (ii) enhanced operational efficiency based on results being achieved by a number of UK and US Police Forces facilitated by learning that can re-engineer some processes.[127]

Service Availability: An estimate is provided of the possible socioeconomic impact of service outage at a consolidated European level and at an individual country level.

***GDP*:** Significant difficulties exist in attempting to assign causality to an estimated impact on GDP from a reduction in crime or efficiency, with recent research highlighting the cost of crime as a proportion of GDP. A summary is presented of relevant research highlighting benefits that can accrue from reduced crime.

The Efficiency and Safety components of the analysis comprise the base estimation for socioeconomic value as depicted in Figure 6. The additional components are reviewed briefly but do not form the foundation of the socioeconomic value due to the inherent difficulties in their estimation across a heterogeneous Europe with respect to crime data. More granular analysis could occur, but such effort is outside of the scope of this research.

[125] Johur, J. (2013). Op cit.
[126] http://media.ofcom.org.uk/2013/02/20/ofcom-announces-winners-of-the-4g-mobile-auction/
[127] http://www.straighttalkonline.com/cio-articles/going-mobile-wiltshire

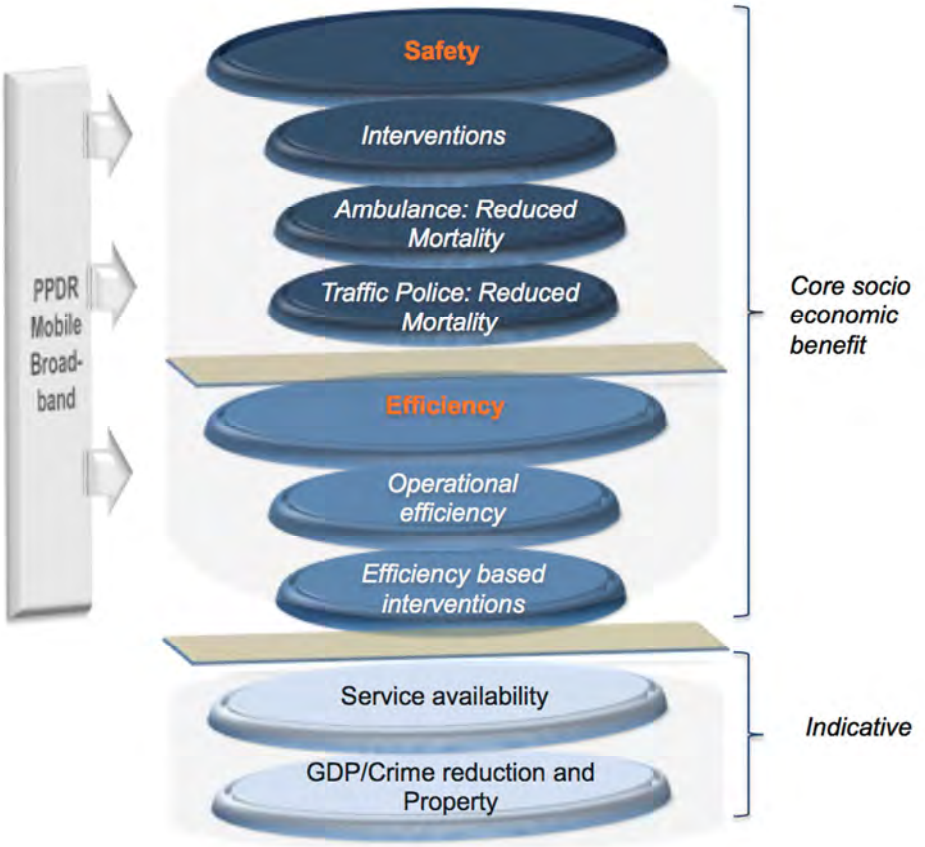

Figure 6: The layering of assessed socioeconomic value

Through interventions, Police and Ambulance provide the largest consolidation of forecast socioeconomic benefits, with a focus on *safety*.

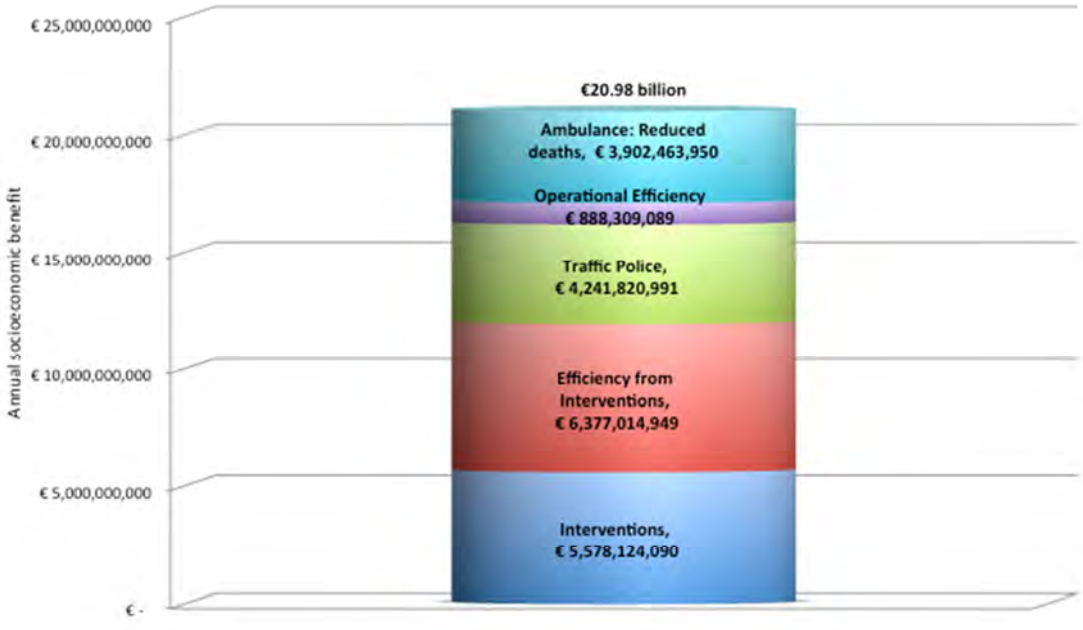

Chart 3: Consolidated socioeconomic benefit in Europe from PPDR use of 2x10MHz in 700MHz

This focus on safety within Police concomitantly provides insight into the PPDR market as a whole, including Fire and Ambulance. This is further complemented by the utilisation of mobile broadband to gain efficiencies on the beat, both on-foot and by Traffic Police.

4.2 Socioeconomic benefits in Europe

4.2.1 Safety

Three areas were reviewed to forecast safety related socioeconomic value driven by PPDR mobile broadband utilisation: (i) crime reduction through interventions; (ii) mortality reduction due to reduced ambulance response times, and, (iii) mortality and serious accident reduction through enhanced greater visibility and time spent on the road by Traffic Police.

4.2.1.1 Crime Reduction: A focus on police

The economic impact of violent crime in the UK alone is estimated to be €124 billion in 2012, or 7.7 per cent of GDP.[128] Comparable data for some European countries are difficult to obtain, but an approximation based on a proportion of GDP spend can be made. In 2012, the EU generated a GDP of around €12.9 trillion.[129] If the cost of crime was congruent with the UK proportion, this would yield a figure of €998 billion. A lower figure of 5 per cent would yield €648 billion. This includes expenditure by government for police, justice, prisons, asset damage and destruction. It also includes direct personal lost productivity from crime such as injury and lost earnings, and wider lost productivity in other parts of the economy.[130] The opportunity to assess the nature of any socioeconomic benefits from the utilisation of mission critical broadband is arguably most evident in policing, with around 1 million Police Officers employed in the 10 sample countries[131] in total across frontline and back-office functions.[132] The three countries of the UK, France and Germany account for over 50 per cent of this figure. With austerity measures impacting European Police Forces in varying manners, these large *service-based organisations* could be impacted further through headcount reductions as this accounts for the majority of staff cost for Police. The key attributes that contribute to the suitability of Police to adopt enhanced mobile broadband include:[133]

[128] Institute for Economics and Peace. (2013). UK Peace Index.
[129] http://epp.eurostat.ec.europa.eu/
[130] Institute for Economics and Peace. Op cit.
[131] Evans, D. (2013) IHS Research. Vertical Insights – Public Safety and Security Mobile Radio – World – 2013.
[132] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=crim_plce&lang=en
[133] Institute for Economics and Peace. Op cit..

- A reduction in the Police budgets due to austerity pressure to reduce the size of the public sector.[134]
- A reduction in some frontline Police.[135]
- A reduction in the number of officers in the back office.[136] [137]
- A reduction in police stations, front counters, and shared locations.[138]

The reduction in some back office staff roles across European Police is designed to comply with cost saving targets and to concurrently 'protect' frontline police officers with the UK Police Minister stating: *"This is the way policing will go. It is the next big stage of reform – to make sure police come into the 21st century and the digital world fully...Whether that is using tablets so officers can stay on patrol and not go back to the police station to file reports, or using body-worn cameras so if any incidents happen they can record them."* [139]

Benefits to the end-user drive the estimation of the wider socioeconomic benefits from PPDR adoption of mobile broadband. In the context of policing, the desirable user benefit is *intervention* before harm can occur to the individual.[140] This tenet is at the core of the methodology utilised to assess the socioeconomic benefit of mobile broadband utilisation, having previously been defined and utilised in primary research with the UK Police Service.[141] A distinction can be made between *mission critical* and *safety critical* decisions. The term 'safety-critical decision' can be defined as: *"A decision that results in either lives being saved or serious injury being avoided."*[142] 'Mission critical' has already been defined earlier in this paper, and relates to a function whose failure leads to catastrophic degradation of service that places public order or public safety and security at immediate risk.[143] The principal mode by which intervention occurs is through the dispatch of frontline police, or the engagement of frontline officers already at or near an incident. Visible frontline policing is recognised as a key factor in reducing the fear of crime and certain types of crime such as anti-social behaviour, street crime and property[144], with the mission and measure of Police efficiency defined by the Association of Chief Police Officers

[134] http://www.ilo.org/global/about-the-ilo/newsroom/comment-analysis/WCMS_211430/lang--en/index.htm
[135] http://www.spiegel.de/international/europe/greek-parliament-agrees-on-more-public-sector-austerity-and-job-cuts-a-911795.html
[136] http://www.accenture.com/SiteCollectionDocuments/PDF/Preparing-Police-Services-Future.pdf
[137] http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Streamlining-Security.pdf#zoom=50
[138] Ibid; Interpol, Annual Report, 2011.
[139] Ibid.
[140] Johur, J. (2013). Op cit.
[141] Ibid.
[142] Johur, J. (2013). Op cit; additional primary research undertaken to define the term.
[143] TCCA, 2013. Op cit.
[144] Machin, S., and Marie, O. (2005). Crime and Police Resources: the Street Crime Initiative. CEP Discussion Paper No 680. London School of Economics.

('ACPO') as "the absence of crime and disorder".[145] Any reduction in crime can have significant socioeconomic benefits: a marginal reduction in the European estimated cost of crime approaching €1 trillion annually can have a significant impact. In the UK for example, a street crime reduction initiative in early 2000 in England and Wales was estimated to have delivered a net socio-economic benefit of €107million-€130million with incremental policing costs of €24.1million: a return of 4.5-5.4 times the investment.[146] Few studies exist that quantify such activities. Primary research has indicated that a number of the activities undertaken between frontline police and an operator can be undertaken with a mobile broadband device, including: accessing information; obtaining evidence; collaborating with other officers, and others.[147]

4.2.1.2 Estimating the socioeconomic intervention benefits: European Police

The use of mobile broadband by Police can provide better information to frontline police officers in real time, and result in higher quality outcomes and improvements efficiency and effectiveness.[148] In the near term, over the next 5 to 10 years, mission critical voice communication will remain the primary mode of communication for safety critical decisions. Mobile data is currently less likely to be utilised for safety critical decisions, but over time, it is anticipated that mobile broadband will be utilised for safety and mission critical scenarios, as depicted in Figure 7.

Figure 7: Safety-critical decision making and future mobile broadband evolution

An assessment of reported crime categories indicates that the greatest socioeconomic impact is from 'Violence against the Person'. This is comprised of

[145] www.acpo.police.uk/documents/reports/2012/201210Policinginthe UKFinal.pdf
[146] Machin, S., and Marie, O. (2005). Op Cit.
[147] Johur, J. (2013). Op cit.
[148] Kleijnen, J., P., C. (1982). Quantifying the benefits of information systems. Department of Business and Economics. Tilburg University (Katholieke Hogeschool Tilburg). 5000 LE Tilburg, Netherlands.

'Homicide' and 'Wounding' ('Serious' and 'Other')[149] utilising UK and EU crime reporting categories, and 'Sexual Offences'. Data exist on the socioeconomic costs of these crimes, with an intervention offering the potential to save a life or avoid serious injury before a crime has occurred, and result in a benefit to the individual and society. The approach to define European socioeconomic benefit draws on the approach utilised for the assessment of the socioeconomic benefits for the UK: primary research undertaken within the UK Police Service is utilised to define the frequency of the use of mobile communications by frontline police officers making safety critical decisions that can save lives or avoid serious injury. Juxtaposing this on data that define the cost of each crime category and the frequency of each, it is possible to provide an indicative estimate of the socio-economic benefits that mission critical mobile communications can deliver via frontline police. For the purpose of this assessment, a simplified comparative process will occur as depicted in Figure 8:

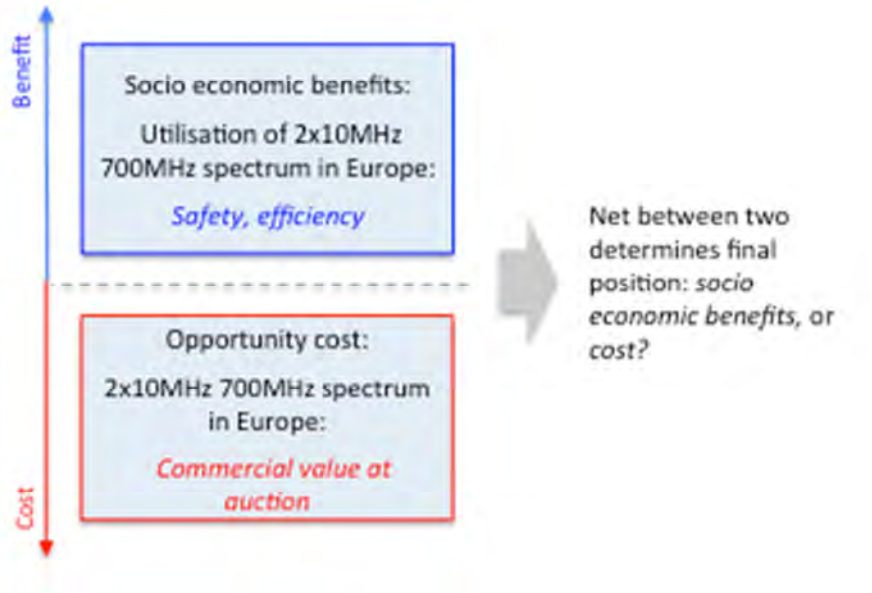

Figure 8: Net socioeconomic position of 2x10 700MHz spectrum

The socioeconomic value generated by the use of the 2x10MHz spectrum for public safety can be compared against the potential value from the commercial auction of the spectrum. The net result is either the socioeconomic benefit or cost, as determined by the greater value.

Initial primary and secondary research undertaken during early 2013[150] in the UK was extended to encompass European countries in order to estimate socioeconomic value. This is comprised of a staged approach:

[149] Home Office Online Report 30/05. The economic and social costs of crime against individuals and households 2003/04.
[150] Johur, J. (2013). Op cit; additional LSE research.

i. Define the relevant crimes, their economic cost and frequency per annum.
ii. Define the *safety-critical intervention frequency* per annum for frontline officers where lives are saved or serious injury or sexual assault avoided.
iii. Define the proportion of safety critical interventions *likely to benefit from mobile broadband*.
iv. Apply the mobile broadband proportion to interventions.
v. Define socioeconomic value.

The majority of European crime data provide detail on the type of crime and the number of relevant incidents in a given year. In attempting to standardise statistics across the EU, gaps in some crime categories have in been bridged through the utilisation of ratios from known categories in the UK or other countries where detail exists and the data have a historical base. Underpinning this is the definition of an intervention methodology drawn from primary work in UK Police that defines the number of interventions and the relevant crime categories that they are applicable to. This is subsequently applied to European crime figures to define estimates in the ten selected countries. In contrast to the majority of research that focuses on the impact of crime *after the event*, this approach assesses the benefits that can accrue from the prevention of crime before it can occur. The three major categories of crime utilised for safety-critical interventions are *Homicide*, *Serious Crime (assault),* and *Sexual Offences*. These are summarised in Table 1.

Northern Europe	Population	Serious Crime: Homicide	Serious Crime: Assault	Sexual Assault
Sweden	9,555,893	91	87,854	17,167
Denmark	5,602,628	47	10,573	2,642
Norway	5,051,275	29	2,925	2,448
Finland	5,426,674	118	33,063	2,417
Total	**25,636,470**	**285**	**134,415**	**24,674**
Central Europe				
UK	63,256,141	1,000	76,000	269,000
Germany	82,020,688	690	515,853	46,869
France	65,633,194	682	193,405	23,253
Total	**210,910,023**	**2,372**	**785,258**	**339,122**
Southern Europe				
Spain	46,006,414	390	80,910	9,958
Portugal	10,542,398	124	30,816	2,206
Greece	11,290,067	176	7,869	713
Total	**67,838,879**	**690**	**119,595**	**12,877**
TOTAL	**304,385,372**			

Table 1: European serious crime frequency for intervention analysis[151,152,153]

[151] UNODC, 2011. Global Study on Homicide.
[152] Home Office, UK. Online Report 30/05.
[153] UNODC, 2013: International Homicide Statistics; Assault Statistics; Sexual Violence Statistics; Robbery Statistics; Theft Statistics; Burglary Statistics.

This regional cost of crime has utilised available crime cost data in conjunction with UK data where this has not been available, adjusted with a purchasing power parity filter to normalise the utilisation of this as much as possible. This yields a total cost of crime of £73 billion p.a. and a total cost for the three categories denoting harm to the individual of £22 billion p.a.[154] These are defined in Table 2 and Chart 4. These costs are narrow however and include this utilised to define immediate costs: they do not include wide costs that spill into the economy for the judicial system, the Prison Service, and others. The cost of these three categories equals 30 per cent of the total cost of the crimes.

	Cost	
Total by Region	Total Crime: Individuals and Households	Total Homicide, Serious Wounding, Sexual Assaut
Northern Europe	€ 4,422,663,867	€ 1,473,563,676
Central Europe	€ 63,495,015,649	€ 18,450,883,404
Southern Europe	€ 5,236,303,296	€ 2,309,991,031
Total	**€ 73,153,982,813**	**€ 22,234,438,110**

Table 2: Total cost of offences and for major crimes against the individual.

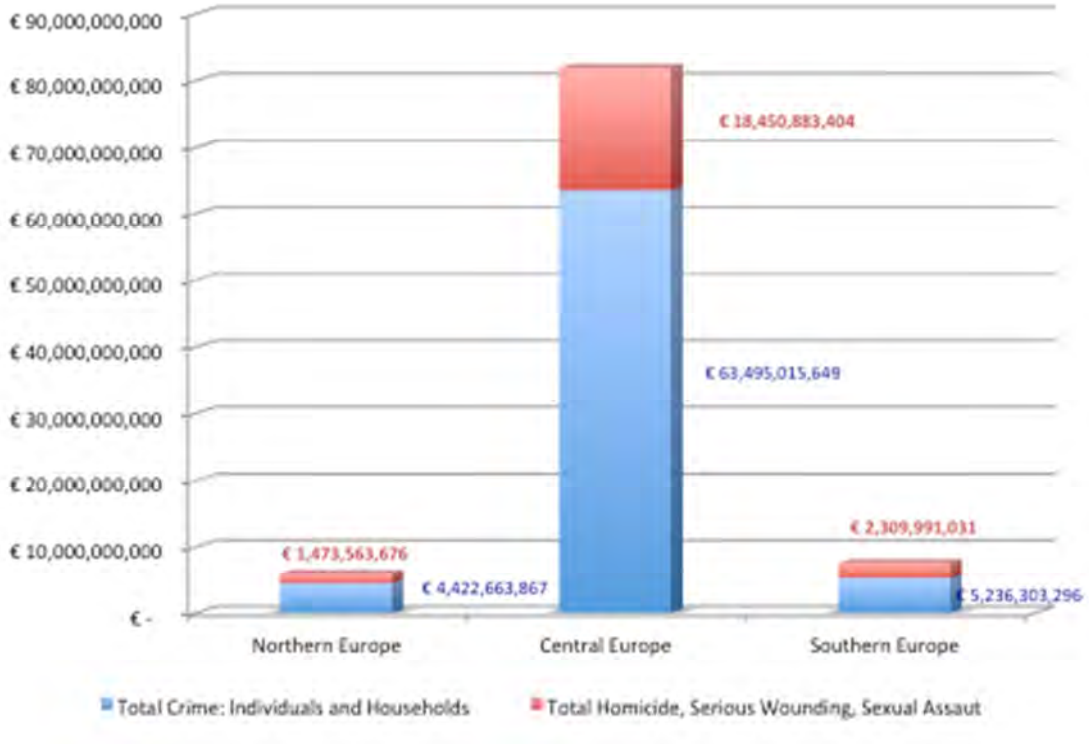

Chart 4: Total cost of offences and for major crimes against the individual.[155]

[154] UNODC, 2013: International Homicide Statistics; Assault Statistics; Sexual Violence Statistics; Robbery Statistics; Theft Statistics; Burglary Statistics.
[155] Source: Ibid.

Primary research estimated that frontline officers in the UK Police Force make 3.5 million safety related interventions per annum that save a life or result in a serious injury being avoided. Applying the same methodology underpinning this to the crime statistics for the 10 European countries, a total of 16.8 million interventions are estimated, with 4.4 million estimated for Southern Europe; 11.1 million estimated for Central Europe and 1.2 million estimated for Northern Europe.[156] Chart 5 below depicts the country segmentation for interventions.

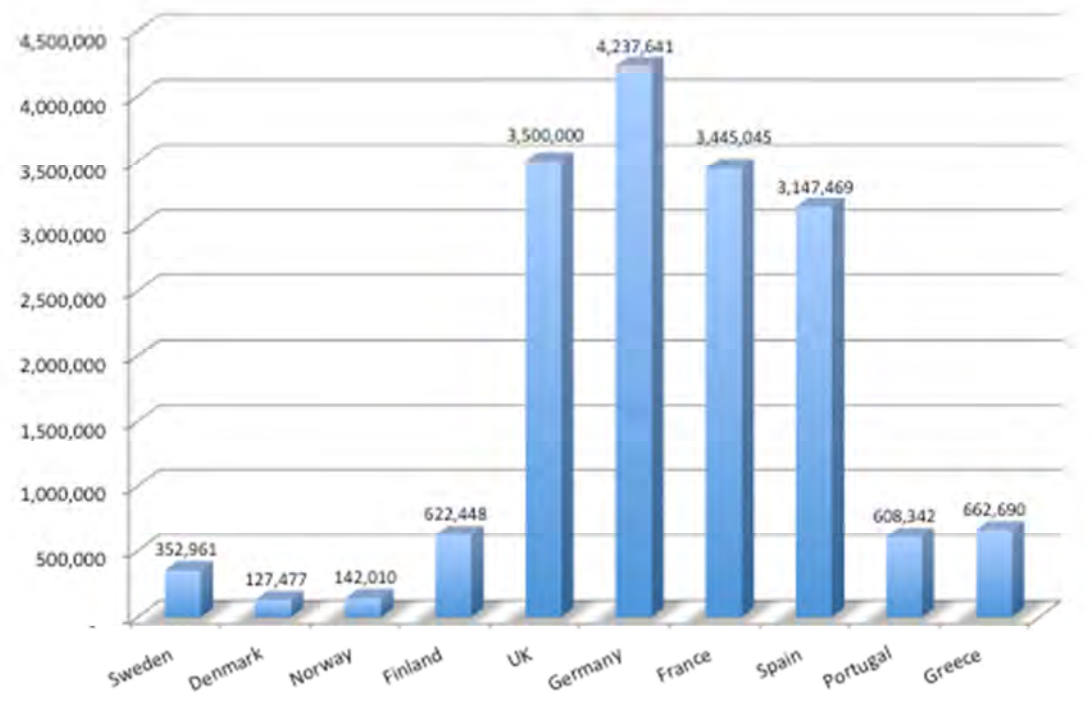

Chart 5: Annual safety-critical interventions by frontline officers: lives saved or serious injury avoided.[157]

The assessment was underpinned by qualitative data including exploring the nature of interventions by frontline officers; the communication modes utilised; the nature of safety and mission critical communication today; how voice and data were utilised; trends, preferences, current and future behaviour with respect to both existing voice and data communication and the proposed rollout plans for higher bandwidth mobile services; other themes. This permits an analysis of socioeconomic benefits to be ensconced within Police and to include operational, frontline, and command areas.

From the 16.8 million estimated annual safety-critical interventions made by European frontline officers, 83 per cent of interventions are estimated to utilise

[156] Methodology used from Johur,J (2013). Op cit.; LSE research has extended this to Europe.
[157] Source: Ibid.

information from mission critical voice mobile technology. Furthermore, the proportion of interventions that mission critical data and video applications were forecast to utilise mobile broadband technology, which in turn benefit improvements to the efficiency and effectiveness of frontline officers and resulting in better outcomes, was estimated to be 12 per cent.[158] The possibility that future mobile data and video services will provide frontline officers with information in safety critical decisions is expected to increase in the future, along with the probability that these services will be mission critical. [159] Results indicate very high levels of perceived improvements to efficiency and effectiveness associated with the operations of frontline policing through the introduction of mission-critical mobile broadband services. With 12 per cent of interventions forecast to benefit from this new capability, the favourable outcomes possible in these instances yield an estimated socio-economic benefit of €5.57 billion per annum, summarised in Table 3.

Region		Socioeconimic Benefit: Intervention
Northern Europe	€	574,496,956
Central Europe	€	4,442,884,308
Southern Europe	€	560,742,825
Total	**€**	**5,578,124,090**

Table 3: Socioeconomic benefit from Intervention

Over life of a 15 year commercial license, the socioeconomic benefits of the Police-driven interventions are estimated to be €83 billion across these serious crime categories. The opportunity cost for commercial sale of a license across the 10 countries is estimated to be €3.76 billion. This amortises to €248 million per annum over the life of a license. The socioeconomic benefits have not factored any multipliers into the UK economy. Arguably, this could be applied and the corresponding figures increased as a result to reflect the continued ability of the individual to work or be a consumer of goods and services and make a corresponding economic and social contribution.

4.2.1.3 Estimating the socioeconomic benefit of service continuity

A key element of PPDR safety is the maintenance of quality of service. This is a key attribute of current Radio communications, with redundancy and the ability to rely on mission critical communications integral to PPDR agencies being able to carry out

[158] Johur, J. (2013). Op cit.
[159] Ibid.

their functions. If a reduction in service availability occurred, the consequences for PPDR include *risk to life* if intervention efforts are hampered. If an inadequate network structure for mission-critical mobile broadband exists, the ability to segment, prioritise and 'protect' public safety traffic may suffer. Utilising the forecast rate of interventions of 16.8 million per annum, an average cost per crime for Homicide, Serious Wounding and Sexual Offences for each country is applied to the 95 per cent of interventions that are forecast to eventually use information from this technology in critical decision-making.[160] A five per cent reduction in service availability can potentially generate a socioeconomic cost of over €23.3 billion, encompassing 832,000 interventions that could be at risk. A one per cent reduction in service quality equates to a socioeconomic cost of €4.6 billion encompassing 168,000 incidents that could be at risk. Any outage or degradation in mission critical voice and data and video can impact intervention capability. This can result in a socioeconomic cost where such interventions are not able to result in a safe outcome. These figures represent a European-wide service continuity outage. If service continuity issues occur, it is likely that they will occur in-country.

4.2.1.4 Ambulance enhancement in Europe to reduce mortality rates

Europe's ambulance service is comprised separate agencies offering emergency care within each country. The models of operation are similar across member sates, including the segmentation of emergencies based on priority; the establishment of targets for arrival at the scene; delivery via a majority public sector labour force[161]

Country	Number of EMS Resources	% of total reources	Annual Journeys	% of total journeys	Type A: Life Threatening	Cardiac Arrests	Additional lives saved if response in 8 mins	Socioeconomic value
Northern Europe								
Sweden	6,493	2.85%	800,000	3.08%	200,000	2,280	44	€ 92,525,570
Denmark	1,749	0.77%	245,000	0.94%	120,000	1,368	26	€ 55,515,342
Norway	6,493	2.85%	454,010	1.75%	340,508	3,882	75	€ 157,528,253
Finland	6,493	2.85%	294,118	1.13%	250,000	2,850	55	€ 115,657,102
Total	**21,229**	**9.31%**	**1,793,128**	**6.90%**	**910,508**	**10,380**	**201**	**421,226,268**
Central Europe								
UK	51,200	22.46%	6,710,000	25.80%	2,542,000	28,979	560	£ 1,176,000,000
Germany	47,000	20.62%	4,980,000	19.15%	2,340,000	26,676	515	£ 1,082,549,174
France	47,534	20.85%	10,000,000	38.46%	1,000,000	11,400	220	£ 462,627,852
Total	**145,734**	**63.94%**	**21,690,000**	**83.41%**	**5,882,000**	**67,055**	**1,296**	**2,721,177,026**
Southern Europe								
Spain	43,428	19.05%	1,470,010	5.65%	958,373	10,925	211	€ 443,369,916
Portugal	8,394	3.68%	500,000	1.92%	325,975	3,716	72	€ 150,805,114
Greece	9,144	4.01%	550,000	2.12%	358,573	4,088	79	€ 165,885,625
Total	**60,965**	**26.75%**	**2,520,010**	**9.69%**	**1,642,920**	**18,729**	**362**	**€ 760,060,656**
TOTAL 3 Regions	**227,929**		**26,003,138**		**8,435,428**	**96,164**	**1,858**	**€ 3,902,463,950**

Table 4: Ambulance Services in the EU

Around 227,000 people are employed in the Ambulance Service across the 10 European countries assessed[162] with a total of 26 million journeys made in 2011,[163]

[160] Johur, J. (2013). Op cit.; methodology reviewed and utilised in LSE Research.
[161] http://www.psiru.org/reports/ambulance-emergency-and-firefighting-services-europe-increasing-commercialisation
[162] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=crim_plce&lang=en

as depicted in Table 4.[164] The UK, France, Germany and Spain account for around 20 per cent of the total resources each, with the remaining 6 countries accounting for the remaining 20 per cent.[165]Around 83 per cent of all journeys are also undertaken by the three Central European countries in the sample.[166] The data also indicate that this region accounts for 70 per cent of Type A emergencies and cardiac arrests[167], classed as *immediately life threatening*. [168] The national standard response percentage for Category A calls in many European countries is for an emergency response vehicle to arrive within 8 minutes in 75 per cent of cases and within 19 minutes by a fully equipped ambulance in 95 per cent of cases.[169] In the UK, this category was further segmented into 'Red 1' (most urgent) and 'Red 2' (serious but less time critical).[170] A total of 96 per cent of Category A incidents that required an ambulance arrived at the scene within 19 minutes. In total Red 1 calls account for around 5 per cent of all Category A calls, or 114,000 in total. These figures indicate that 4 per cent of critical calls are not arrived at within 19 minutes, equating to 118,000 calls from the 2.95 million Category A total calls. Extrapolating this across Europe yields 334,000 calls.

Austerity changes are affecting the Ambulance Service in some EU countries, with the UK Government's reform of the National Health Service (NHS) arguably representing one of the most significant structural changes to emergency services. This includes the transfer of the commissioning of ambulance services from primary care trusts to GP consortia as part of a €23 billion efficiency drive in the NHS by the end of 2014-2015. The ambulance service is required to identify a minimum of 4 per cent efficiency savings within its budget, equating to around €90 million per year.[171] As with the Police, staff costs comprise the largest component for the ambulance service, accounting between 60-70 per cent of expenditure.[172] Continued budgetary pressure by Governments across European member states for public sector reduction is likely to impact resources on an ongoing basis. As with austerity in the Police Force, this has facilitated a step-change in efficiency in Ambulance Services whilst also ushering a review of future data and communication requirements.[173]

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[163] Ambulancecare in Europe, Ambulancezorg Nederland, Januari 2010
[164] Shortland, J. (2013). Broadband PMR/LMR Solutions – World.
[165] http://www.samu-de-france.fr/en/System_of_Emergency_in_France_MG_0607
[166] http://www.sciencedirect.com.gate2.library.lse.ac.uk/science/article/pii/S0300957204002679?np=y
[167] ttps://catalogue.ic.nhs.uk/publications/patient/ambulance/ambu-serv-eng-2011-2012/ambu-serv-eng-2011-2012-rep.pdf
[168] Ibid.
[169] http://www.hscic.gov.uk/article/2907/Ambulance-services-Rise-in-number-of-patients-treated-entirely-at-the-scene.
[170] HSCIC. Ambulance Services, England 2012-2013. June 19, 2013.
[171] Ibid.
[172] Ibid.
[173] https://catalogue.ic.nhs.uk/publications/patient/ambulance/ambu-serv-eng-2011-2012/ambu-serv-eng-

Changes to resourcing levels are not by themselves sufficient to transform the ambulance service: in the short term they will merely meet budgetary targets. The themes of information access, skills, timely response, and others are topical.[174] An increased emphasis on ambulance services to adopt these to a greater degree across Europe is reflected by the Chair of the Association of Ambulance Chief Executives in the UK, who stated in a Parliamentary Review*: "It would also be enormously helpful for front-line paramedics—both those in the control room and responding paramedics—to have access to the national spine, which would enable them to pull down useful and critical information about a particular patient, rather than looking at patients with very limited information, as is very often the case*."[175] The issue of accurate and timely data being available to ambulance crews remains topical, both for navigation and clinical purposes: arrival in the shortest time possible depends on the interplay between multiple factors as depicted in Figure 9.

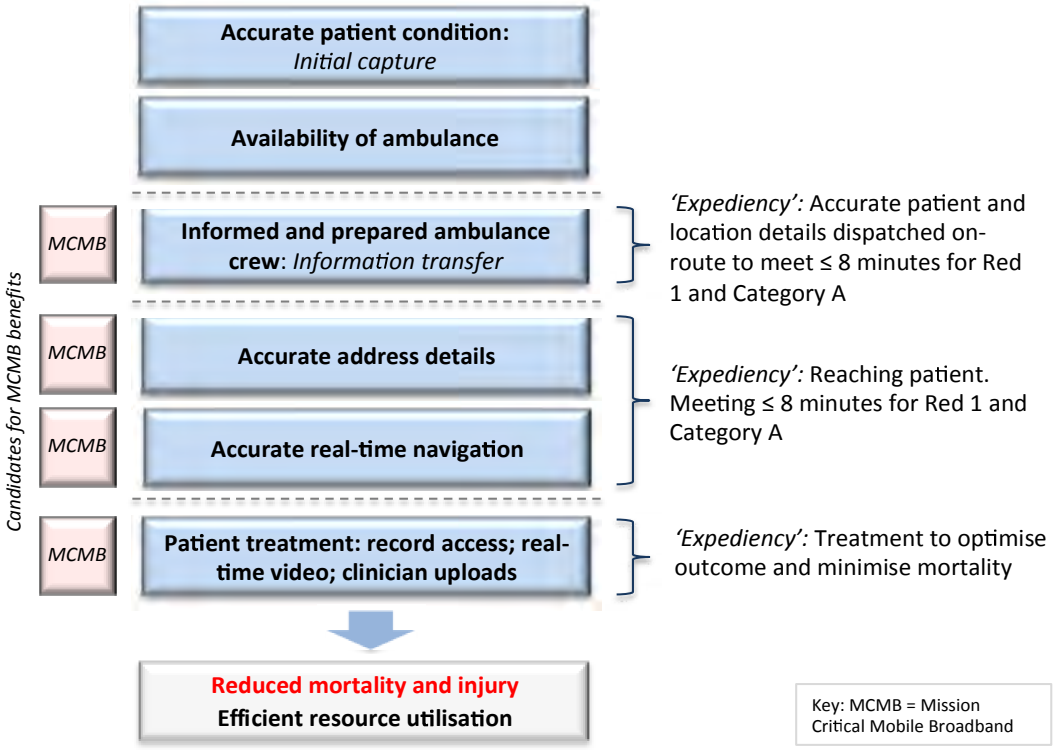

Figure 9: Socioeconomic benefit of expedient and informed ambulance dispatch

Increasingly in Europe, austerity measures; mortality for key emergencies such as out of hospital cardiac arrests (OHCA); diversion of ambulances from a closed emergency room to another *after arrival*; road congestion and other factors, are facilitating a focus on greater accuracy of information at all stages of the journey to

[174] http://www.publications.parliament.uk/pa/cm201314/cmselect/cmhealth/171/17110.htm#n166
[175] Ibid.

and from an emergency scene. A number of the current processes in the ambulance activity chain are candidates for mission-critical mobile broadband including an initial transmission process of patient location and details that complements the radio dispatch process. On route, broadband can enhance real-time mapping, traffic and address guidance. Patient records can be transmitted to the ambulance and upon arrival, these and other broadband-enabled services can be utilised such as real-time video (including for consultant interaction) and access to other data, images and files. Collectively, these may contribute to mortality reduction where such factors are currently undertaken at the hospital upon return and include live wireless video footage and resilient fast two way communications that provide ambulance and hospital teams the ability to undertake remote diagnostic activities while patients are still at an accident location in mission critical timing.

The allocation of the 700MHz D Block spectrum signed into law in the US in February 2012 will result in the US$7billion construction of a dedicated broadband network for public safety.[176] Amongst key services touted by Fire and Ambulance Chiefs are LTE apps that will permit them to view situational awareness data including GIS mapping data, building diagrams, hazmat data, video feeds from traffic cameras, and for Ambulance Services to transmit patient information and health metrics to emergency rooms, consultants and others both from the scene and whilst on route. Additional socioeconomic benefits can ensue with Fire and Ambulance teams able to treat patients in their homes, transmit patient information and optimise a path for care. The socioeconomic benefits can be significant with mobile broadband utilised both for mission critical and non-critical situations but with the ultimate common goal of patient care.[177] A topical issue is the expedient dispatch of ambulances to a location, and implications to patient care and ultimately mortality when ambulance diversion occurs. Although a limited resource, London's Air Ambulance management team attends the most serious of the 4,000 daily 999 calls made in the Capital that require an advanced trauma team.[178] In 2013, 4G enabled mobile broadband was introduced, with savings over current solutions from seconds to two minutes: this is significant for trauma intervention. A key benefit has been the replacement of paper maps and slower GPS positioning systems with real-time self-correcting maps, and future plans that include video streaming, consultant access and patient record retrieval in the field.[179]

[176] http://urgentcomm.com/fireems/fires-case-broadband-related-video
[177] Ibid.
[178] http://www.telegraph.co.uk/sponsored/technology/4g-mobile/10166778/london-air-ambulance-4g.html
[179] Ibid.

Recent research has indicated that for out of hospital cardiac arrest ('OHCA') patients in particular, for every 100 diverted ambulances, 3 ‘avoidable fatalities’ occur on route.[180] This can also be extrapolated to encompass ambulance rides that are of a longer than targeted duration. These ‘avoidable deaths’ represents an opportunity to provide a significant socioeconomic benefit through broadband assistance at multiple points in a journey. At present, this could focus on the ability to provide accurate navigation capability and real-time information on hospital availability for critical care patients. As with homicide victims, the socioeconomic benefit that a saved OHCA victim can yield is significant both economically and socially. Research encompassing 10,554 cardiac arrests in the US indicated that reducing the 90th centile of response time to an ambulance to 8 minutes increased the predicted survival rate to 8 per cent from 6 per cent, and reducing this to 5 minutes almost doubled it to 10-11 per cent.[181] If people are reached before the onset of cardiac arrest, research indicates that the survival rate is 33 per cent.[182] Studies indicate that a 10 per cent increase in the relative risk of death occurred for each 10 km increase in distance and a 7 per cent increase for each 10 minute increase in journey time.[183] Debate continues to occur on the exact number of live that could be saved annually if a greater proportion of ambulances reached their destinations faster, or transport patients faster to emergency care. Recent 4G trials in the UK have provided advanced satnav capability to the Ambulance Service and reduced dispatch times by up to two minutes, replacing maps and other tools in the process.[184] These early adoptions of mobile broadband for mission critical safety are validating their value, with the longer term challenge remaining the incorporation of PPDR requirements specific to the sector. In the meantime, early adoption and trialing of options remains a valid mode for establishing benefits.

Studies indicate that an estimated 60,000 out of hospital cardiac arrests occur in the UK each year,[185] and almost 400,000 across Europe.[186] Research in Europe indicates that increased response times theoretically can lead to decreased survival

[180] Shen, Y.C., and Hsia, R. Y. (2011). Association Between Ambulance Diversion and Survival Among Patients With Acute Myocardial Infarction. *JAMA: The Journal of the American Medical Association*. V305(23): 2440 DOI: 10.1001/jama.2011.811

[181] Pell, P. J. et al (2001). Effect of reducing ambulance response times on deaths from out of hospital cardiac arrest: cohort study. BMJ. June: 322:1385.

[182] Ibid.

[183] Nicholl, J., et al. (2007). The relationship between distance to hospital and patient mortality in emergencies: an observational study. Emergency Medicine Journal. V24; pp: 665–668. doi: 10.1136/emj.2007.047654

[184] http://www.cable.co.uk/news/ee-4g-powers-life-saving-satnav-for-londons-air-ambulance-801577116/

[185] Perkins, J. D., and Cooke, M.W, (2012). Variability in cardiac arrest survival: the NHS Ambulance Service Quality Indicators. Emergency Medicine Journal. V(29)1.

[186] Circulation. 2008; 118: 389-396. Published online before print July 7, 2008, doi: 10.1161/

due to delayed time to treatment.[187] Over 50 per cent of the UK arrests are attended by emergency medical services,[188] with this most likely to be the case in other major developed capital cities in Europe, as there exists a lack of accurate data for many. Further European research confirms that the second most significant variable in OHCA survival is the interval between the calling of an ambulance and its arrival,[189] and that reducing the response time to 5 minutes could increase survival rates from the current 6 per cent to 10-11 per cent.[190] The proliferation of mobile phones has assisted in the reduction of the time between OHCA collapse and a call being made to emergency services,[191] with mobility now emerging as a mode of further reducing the time to reach patients.

A further factor that could be addressed through the use of more enhanced mobile broadband is the number of ambulances that are forced to divert to other A&E units or hospitals. In the UK, where data exist, 357 diversions to other hospitals occurred in 2012, equating to an average of one per A&E per day, with these extra delays increasing the risk of a patient's condition deteriorating.[192] Diversions occurred either when the ambulance was already on route to one hospital or in some cases after it had arrived. This delay can contribute to a worsening of a patient's condition, or even to result in avoidable. The ability to utilise mission-critical mobile broadband to provide real time mission critical data to ambulances on route, coupled with accurate alternative route planning early in the return-to-A&E journey can potentially assist to minimise these occurrences when supported with the operational re-engineering of some control room processes. In the US, 45 per cent of A&E Department reported that they were 'on diversion' at some point in the previous 12 months,[193] with evidence that the practice has been linked to several negative consequences including prolonged transport times, delays in care, increased mortality.[194] Efforts being undertaken to minimise this include streamlining front-end operations and tracking: these can be facilitated through enhanced mobile elements such as navigation; robust real-time information, and others. This research estimates that

[187] Ibid.
[188] http://www.bhf.org.uk/pdf/ELS_policy_statement_June2012.pdf
[189] Herlitz J., Engdahl J., Svensson L., Angquist K.A., Young, M., Holmberg S. (2005). Factors associated with an increased chance of survival among patients suffering from an out-of-hospital cardiac arrest in a national perspective in Sweden. Am Heart Journal. 2005; (v)149: pp61–66.
[190] Pell, J.P., Sirel, J.M., Marsden, A. K., Ford, I., Stuart M Cobbe, S, M. (2001). Effect of reducing ambulance response times on deaths from out of hospital cardiac arrest: cohort study. *BMJ* 2001; 322:1385.
[191] Iwami, T., Nichol, G., and Hiraide, A. (2009). Continuous improvements in "Chain of Survival" increased survival after out-of-hospital cardiac arrests: a large-scale population-based study. Circulation; V119: pp:728–733.
[192] http://www.dailymail.co.uk/news/article-2333083/Overstretched-A-amp-Es-turning-away-ambulances-Diversions-hospitals-happened-357-times-past-year.html#comments
[193] Delgado, M.K., Meng, L.M., M.P., J.M., Owens, D.K., West J, Zarich, G.S. (2013). Reducing Ambulance Diversion at Hospital and Regional Levels: Systemic Review of Insights from Simulation Models. Emerg Med. September; 14(5): 489–498. doi: 10.5811/westjem.2013.3.12788
[194] Ibid.

around 1,858 OHCA deaths could potentially be saved n Europe if ambulances were able to achieve the target of reaching 75 per cent of critical Category A patients within 8 minutes.[195] This equates to a socioeconomic value of €3.8 billion p.a.,[196] based on a per value of life figure of €2.1 million.[197] If the ambulance waiting time reduced to 5 minutes, this would increase. Chart 6 depicts the annual potential lives saved versus the socioeconomic value of reduced mortality through faster response times and fewer diversions occurring.

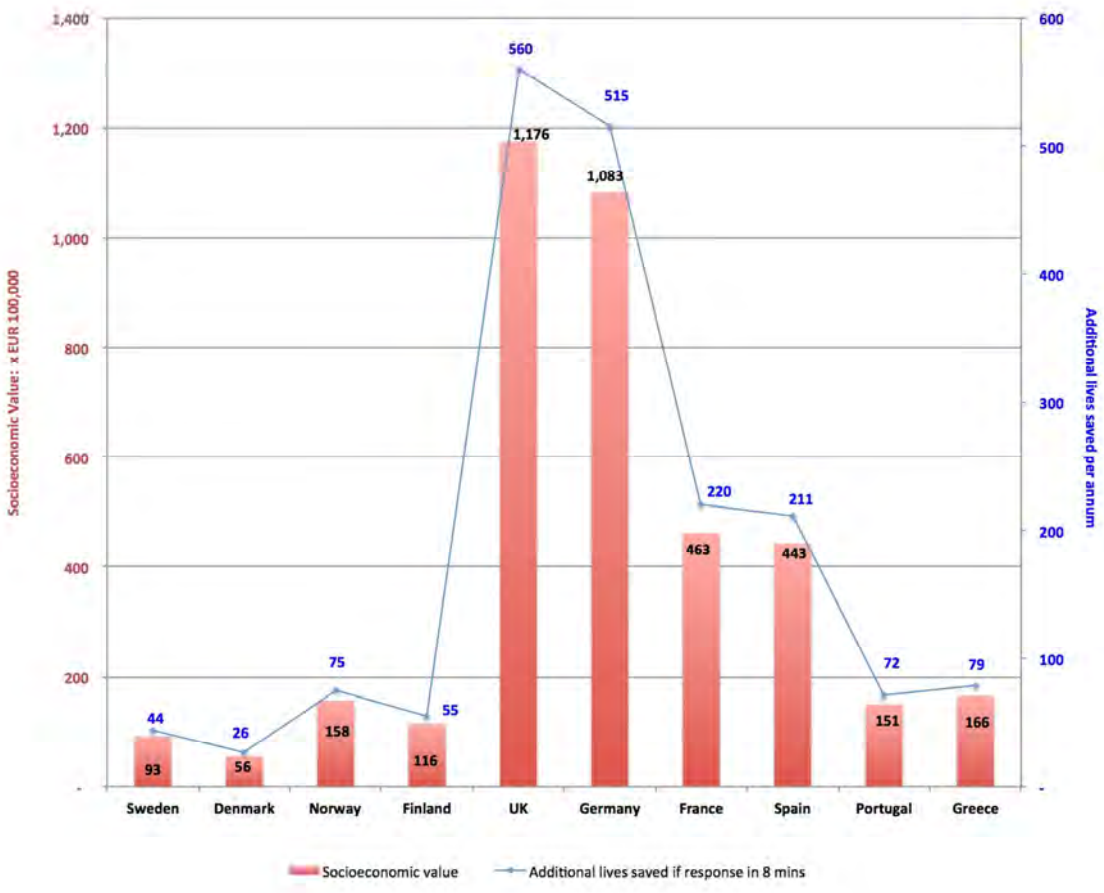

Chart 6: Socioeconomic value of reduced mortality in Europe through faster ambulance response times and fewer diversions.

The UK Government has 'kick started' initiatives to address this issue ahead of further PPDR mobile broadband availability with a €3.9million investment to equip 3,000 emergency response ambulances with satellite tracking and navigation systems.[198] On this basis, a socioeconomic benefit of around €980 million annually is forecast if an additional 560 OHCA's do not result in a fatality when Ambulance

[195] http://www.dailymail.co.uk/health/article-55521/Thousands-die-ambulance-delays.html
[196] Caro, J.U., et al. (2007). Cost-Benefit Analysis of Preventing Sudden Cardiac Deaths with an Implantable Cardioverter Defibrillator versus Amiodarone. Value in Health. V(10)1; pp: 13-22.
[197] http://oru.diva-portal.org/smash/get/diva2:372849/FULLTEXT01
[198] Ibid.

services utilise mobile broadband to a greater degree to reach their patients faster and provide more informed critical care in order to mitigate these fatalities.

4.2.1.5 European Traffic Police: mortality and serious injury intervention

The highly mobile and visible role that Traffic Police (TP) play represents both an opportunity and a challenge for mission-critical mobile broadband and safety-critical voice communication: Officers are consistently travelling between areas of varying coverage for both Radio and cellular networks and are routinely required to cover considerable distances. An inherent danger exists in the role due to the unpredictable nature of vehicle stops and the requirement to be positioned in traffic except when returning to base intra-shift to complete paperwork and/or bring an individual to the counter. In addition, officers often patrol alone with their communication services representing a key 'lifeline' for safety and for mobile data access. These attributes also make TP an ideal candidate for early-stage MCMB adoption.

The Arizona Department of Public Safety's Highway Patrol employs 780 officers patrolling over 6,000 miles of roadway[199] who make half a million traffic stops per annum, in addition to responding to thousands of traffic collisions, motorist assistance and other calls.[200] All Officers have been equipped with 4G LTE or 3G enabled mobile laptop-style computers with cameras, PC capability and apps that enable mobile reporting across a range of areas including undocking and completing reports with stopped motorists, before uploading these to their network. In addition, productivity gains have been made across the Justice chain, with less input errors and without the requirement for back-office staff to input handwritten notes. These benefits support the previous section's analysis of enhanced productivity accrued by MCMB devices. In addition to these however, the major socioeconomic benefit generated by the adoption of mission-critical mobile broadband by TP is potentially, *visibility:* for every minute that a police officer is stopped by the roadside attending to a traffic incident, the probability of a secondary collision occurring has been estimated to increase by 2.8 per cent.[201] This results in a possible roadside collision occurring for 36 minutes that a TP officer is stationary.

[199] http://www.azdps.gov/about/Organization/Highway_Patrol/
[200] http://www.panasonic.com/business-solutions/public-sector-case-study-arizona.asp
[201] Ibid.

The UK employs 4,675 Traffic Police[202] who share many common work and organisational factors with their US counterparts. A range of tasks are undertaken by these officers, including remaining stationary with license plate recognition scanning cars; attending the scene of an accident; undertaking visits to follow-up road accidents, and other tasks. As such, these result in longer 'stops' being undertaken on some days, whilst on others, consistent patrolling may result in higher stops occurring with motorists. Factoring in both US and UK analysis on the working pattern of Traffic Police, metrics have been defined that include an average of around 5 stops per working day, recognising the previous caveat that this may vary considerably between days. Data on European Traffic Police are not readily available, with Police Forces in EU member states not segmenting their officers to this degree of detail. Primary research and investigation has resulted in the utilisation of UK benchmarks for Traffic Police for Europe, adjusted in some cases for country-specific factors. This yielded a total of 22,000 Traffic Police, representing around 2 per cent of the 1.08 million Police Officers in the 10 European member states assessed, and 3 per cent of frontline officers.

A profile was defined to distribute stops across *durations* encompassing six bands ranging from 0-10 minutes to 60 minutes and over. Using UK accident data to define fatal and serious car accidents,[203] the ratio for each of these was calculated and data on the cost to society for each was obtained.[204] Following further data analysis, the socioeconomic benefit of the use of mission-critical mobile broadband by Traffic Police is estimated to be around €4.2 billion per annum, addressing around 13,703 current fatalities per annum and 140,238 serous injuries per annum,[205,206] with an estimated reduction of around 800 of these fatalities and 9,000 serious injuries. In the rollout stages, a staggered socioeconomic benefit could occur if an increasing proportion of Traffic Police were equipped with comparable mission-critical mobile broadband. It is believed that for such benefits to accrue, a period of 10-15 years would be required in order to harmonise adoption across member states and to ensure widespread adoption of supporting practices and learning.

[202] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223836/police-workforce-supptabs-mar13.ods
[203] http://www.apccs.police.uk/fileUploads/APCC_Group_Emails/Road_accident_statistics.pdf
[204] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/9280/rrcgb2011-complete.pdf
[205] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223836/police-workforce-supptabs-mar13.ods
[206] http://ec.europa.eu/transport/road_safety/pdf/statistics/historical_country_transport_mode.pdf

4.3 Efficiency Increases in Safety Interventions

4.3.1 Enhancing European Police safety interventions through efficiency

Mission Critical Broadband Communications has the ability to transform Police work across both the back office and the frontline. This is not occurring in isolation however, and is part of a wider system of change that includes procurement centralisation; facilities reduction; headcount reduction; ICT rationalisation and others across constabularies.[207] In some cases, this has resulted in productivity increases of 10 per cent or more, as constabularies utilise outsourced contracts, enhanced mobile technology and apps, and other services to enable frontline officers to stay 'visible' and in the process deliver more interventions.[208] Nottinghamshire Police Authority achieved €1m in savings and increased its front line officers following the success of an initiative to connect mobile devices with the back office to access data, with senior officers stating*: "Officers will be doing less paperwork because we are investing in mobile technology which will keep officers out on the beat and is key to creating our financial savings,"* [209]

The UK Police Service provides a benchmark for enhanced efficiency spurred through austerity measures. The heterogeneous nature of Europe is reflected in the varying strength and status of PPDR agencies across the Region, and the evolving nature of austerity measures affecting the public sector. A lack of comparable UK data has defined the approach taken to estimate operational productivity improvements that could be possible in member states, with the UK Police Service leading many EU Police Forces in the trial and adoption of enhanced mobile broadband, spurred from reduced headcount; IT replacement; some facilities closure; an increasing adoption of mobile communication for both safety-critical and increasingly mission-critical applications; organisational realignment to direct resources to the front line and support them, and other initiatives.[210] Examples include Wiltshire Police's mobile and remote working solution that is estimated to have resulted in a 10 per cent productivity increase: the equivalent of adding 89 officers but without the €4 million annual cost.[211] British Transport Police also experienced a similar productivity increase following a similar implementation.[212] In the US, similar austerity challenges have resulted in Police Forces adopting mobile

[207] Serco Institute, (2008). *Making Time: Freeing Up Front-Line Policing*.
[208] http://www.cbi.org.uk/media/1865156/cbi_police_reform_report_embargoed_261112.pdf
[209] http://www.computerweekly.com/news/2240114611/Nottinghamshire-police-buck-mobile-failure-trend
[210] HMIC. Policing in Austerity: One year On. Greater Manchester Police, July 2012.
[211] http://www.straighttalkonline.com/cio-articles/going-mobile-wiltshire ; and Policing Plan for Wiltshire 2012/13.
[212] http://www.straighttalkonline.com/cio-articles/going-mobile-wiltshire

broadband communications as a way to increase the presence of first responders. An example is the City of Altoona in Pennsylvania, which like other many US Police Forces sought to empower officers to work more effectively and faster, with similar Police Forces in neighbouring areas achieving an efficiency improvement from wireless broadband by at least 10 percent.[213] This Police Force exceeded the objective, providing access to critical data across information sources and the ability to upload field reports directly. A common theme evident amongst Police forces that have implemented mobile broadband applications appears to be the ability to increase frontline productivity. A further example of this is the City of Chattanooga in Tennessee, which implemented a city-wide wireless broadband network that resulted in 56 applications being introduced across public safety agencies with Police reporting a reduction in crime rates; productivity increases equivalent to placing 18 new officers in frontline roles; and an increased degree of intervention evidenced by a doubling of the arrest productivity rate.[214]

The wider longer-term adoption of mobile broadband by European Police Forces is expected to mirror the initial productivity gains obtained by early-adopting UK and US Police Forces, with efficiency drivers common across PPDR organisations and initiated in many cases by budget cuts. If a figure of 10 per cent productivity gain due to mission critical mobile broadband is factored into the forecast 16.8 million annual interventions in Europe, an additional 1.68 million interventions p.a. could ensue. These interventions are *transition-driven* and 'stand-alone': they are not predicated on the further utilisation of mobile broadband technology. Rather, they represent the adoption by European Police Forces of new mission critical broadband technology that augment current solutions, and in the process yield an improvement in productivity. Over time, it is expected that any such incremental productivity gains will become operationalised and the relevant intervention rate at a point will become the new benchmark. Complexities exist on estimating the exact socioeconomic benefit from additional interventions as this will be determined by the mix of interventions undertaken. If the interventions made were distributed across all of the major categories for crime defined by the Home Office in the proportion that these have been recorded,[215] the socioeconomic benefit is around €6.3 billion annually for a 10 per cent productivity improvement. This is derived from 1.6 million additional

[213] http://business.motorolasolutions.com/publicsafety/pdfs/Altoona_CS_FINAL.pdf
[214] http://www.motorolasolutions.com/web/Business/BMS_Landing_Pages/Government/Government_Grants/Chattanooga_Case_Study.pdf
[215] Home Office Online Report 30/05: The economic and social costs of crime against individuals and households 2003/04.

interventions occurring in the UK on an annual basis, with the socioeconomic benefit obtained across individual crime categories including: Homicide (€931m); Serious Wounding (€184m); Other Wounding (€1bn); Sexual Offences (€900m); Common Assault (€164m); Robbery (€780m); Burglary in a Dwelling (€622m); Theft (All categories: €1.2bn); Criminal Damage (€426m). Table 5 summarises the consolidated estimates at the country level across the European 10 countries.

Country	Intervention Effiiency	
Northern Europe		
Sweden	€	90,945,406
Denmark	€	19,695,136
Norway	€	30,267,661
Finland	€	173,265,934
Total	**€**	**314,174,138**
Central Europe		
UK	€	1,204,910,286
Germany	€	1,268,329,536
France	€	1,263,076,736
Total	**€**	**3,736,316,558**
Southern Europe		
Spain	€	1,764,312,215
Portugal	€	308,172,882
Greece	€	254,039,156
Total	**€**	**2,326,524,253**
TOTAL	**€**	**6,377,014,949**

Table 5: European efficiency based interventions by Police (10% efficiency gains)

4.3.2 Operational productivity from frontline and back-office applications

The adoption of mission critical broadband over the next 10 years represents a step-change for European Police Forces. Currently, a fragmented process is evident for the adoption of these, with many initiatives occurring from the US and the UK, and some from Germany and some Northern European countries. A mix drivers is defining this including austerity measures; strategic objectives; local Policing mandates; and others. Forces in the UK and the US have commenced rolling out mobile broadband and achieved operational savings as defined in earlier sections of this report. This includes Nottinghamshire Police, which has successfully utilised mobile devices and software to connect frontline officers to connect directly to back office systems.[216] Collaboration with an external IT Services organisation resulted in the design and development of solutions delivered via a wireless mobile device, with more than 2,000 smartphones deployed with full mobile data access to police systems. The use of mobile broadband on the frontline has reduced the need for one

[216] http://www.computerweekly.com/news/2240114611/Nottinghamshire-police-buck-mobile-failure-trend

officer per shift to undertake paperwork utilising overtime, resulting in over €1m in savings in total.[217] Support from senior Officers has assisted such changes to occur and for gains to be realised, with the Chairman of the Nottinghamshire Police Authority stating: *"Officers will be doing less paperwork because we are investing in mobile technology which will keep officers out on the beat and is key to creating our financial savings."* [218]

In addition to UK Police Forces, US Police Forces have been achieving efficiency successes with the adoption of mobile broadband for PPDR.[219] Utilising data from 'in the field' efficiencies gained by existing Forces; back-office efficiency gains; staffing amendments and other changes, an efficiency figure of €1,141 per frontline Police officer is estimated[220] using UK data and adjusted with a PPP filter across each of the 10 countries assessed. Based on a review of the current initiatives across the Police Forces in the UK, this is believed to be representative of the efficiency-enhancing administrative functionality that mission-critical mobile broadband can provide to the frontline and yields a total socioeconomic benefit across Europe of €888 million p.a., as depicted in Table 6.

Northern Europe	Frontline Police Efficiency	
Sweden	€	15,564,679
Denmark	€	5,019,116
Norway	€	5,293,107
Finland	€	6,730,189
Total	**€**	**32,607,090**
Central Europe		
UK	€	183,739,180
Germany	€	231,361,566
France	€	177,237,152
Total	**€**	**592,337,899**
Southern Europe		
Spain	€	183,407,964
Portugal	€	39,600,714
Greece	€	40,355,422
Total	**€**	**263,364,100**
TOTAL	**€**	**888,309,089**

Table 6: Operational efficiency gained from increased mobile broadband adoption by European Police Forces

[217] Ibid
[218] Ibid.
[219] http://www.rapidacc.com/spec/Tulsa_PD_Case_Study_Wireless.pdf?iframe=true&width=90%&height=90%
[220] http://www.bapcojournal.com/news/archivestory.php/aid/2107/Nottinghamshire_Police_saves_more_than__A31_million_by_using_mobile_solutions.html

The regions with the highest efficiency benefits include Central European countries assessed and Spain, which collectively account for 87 per cent of the socioeconomic value, due to the size of their Police Force and the potential to deliver savings. Table 6 summarises the estimates across the European sample.

It is believed that operational savings beyond these estimates can ensue, driven to a large degree by the aggressive austerity measures being implemented in many European countries either through Government initiatives or as part of EU mandates tied to bailout funding.

4.3.2 Intervention, GDP and Local Community

Significant complexities exist in attempting to assess the socioeconomic effects of public safety and crime reduction at the macro level on GDP. It is widely accepted that crime has a significant impact on society,[221] with research indicating the overall costs of crime as a proportion of output and on a stand-alone basis.[222] In the UK, the total cost of crime has been estimated as being 7.7 per cent of GDP, in contrast to 11.9 per cent in the US.[223] Current research has not adequately addressed the potential benefits that intervention to crime can have on the economy, but it has confirmed that crime negatively impacts economic performance.[224] It is estimated that a one per cent rise in crime rates can reduce real economic growth by 0.0004% in a month.[225] Conversely, it can be posited that a reduction in crime rates could contribute to economic growth. Research indicates that the efficiency of a country's criminal justice system may be an explanatory factor influencing crime variations between countries.[226] The ability of the Police to carry out their functions effectively is arguably an extension of this: current research does not however capture the value or benefit in *interventions to crimes*. Although causality between socioeconomic benefits and GDP cannot readily be proven due to the potential influence of a myriad of other variables, it can be posited that a reduction in crime through an enhanced degree of interventions can reduce the downstream impact across a plethora of areas in the economy including health, property, the judicial system, and others. Collectively, these constitute the cost of crime. A reduction in this cost could arguably impact GDP, but a dependency cannot readily be proven due to the possible influence of other variables. The proportion of GDP accounted for by crime

[221] Detotto, C., and Otranto, E. (2010). Does Crime Affect Economic Growth? KYKLOS. v63(3); pp:330–34
[222] Czabanski, J. (2008). Estimates of cost of crime: History, methodologies, and implications. Springer, Berlin.
[223] Brand, S., and Price, R. (2000). The economic and social costs of crime. Home Office Research Study No. 217; Home Office , London.
[224] Detrott, and Otranto, (2010). Op cit.
[225] Ibid.
[226] Ibid.

can be defined however and is utilised as a more appropriate indicator for the macroeconomic cost of this activity.[227] Arguably a reduction in the crime through enhanced intervention and other factors can affect upstream and downstream elements of the crime-related ecosystem and ultimately GDP.

Limited research has forecast that crime has a negative socioeconomic impact on house prices.[228] In London, a 0.1 per cent standard deviation increase in crime was estimated to have resulted in a 0.94 per cent decrease in property values, equating to a €0.3 billion decrease in early 2000.[229] Conversely, a reduction in crime has been posited to increase property values. US research estimated that a 10 and 25 per cent reduction in violent crime in 8 major US cities increased house prices by 0.83 and 2.1 per cent respectively one year later.[230] This equated to a rise in values of $US16 billion and $US41 billion respectively. In London, property crime fell by 40-50% between the late 1990s and the following decade.[231] Although variations exist in crime reduction across the UK, overall, total homicides have reduced by 28 per cent over five years to 2012; violent crime reduced by 21 per cent, weapons crime reduced by 34 per cent, and public disorder reduced by 29 per cent.[232]

Enhancing intervention measures through ubiquitous mobile broadband could potentially decrease crime as outlined in this research through the longer utilisation of Police on the frontline as they carry out some tasks such as reporting remotely and utilise enhanced information via broadband. These factors can potentially result in neighbourhoods becoming safer and consequently more 'desirable' places to live. House prices can increase as demand increases. Currently, Europe is characterised by a heterogeneous mix of crime statistics, with some increasing and some decreasing. If this methodology were applied across European member states, some would yield a forecast benefit through a forecast rise in process. It is recognised that at present this is an area that can benefit from more granular analysis, with a more cursory assessment occurring at this time. This area nevertheless reflects the potential wider socioeconomic benefits that could be accrue due to an enhanced intervention strategy in policing, with the belief that the sustained reduction in crime over at least the last decade could have a positive flow-on effect on house prices. Increasing earlier and current intervention rates even further

[227] Ibid.
[228] Gibbons, S. (2004). The Costs of Urban Property Crime. Economic Journal; v(114); F441–F463.
[229] Ibid.
[230] Shapiro, R. J., and Hassett, K. A. (2012). The Economic Benefits of Reducing Violent Crime: A Case Study of 8 American Cities. Centre for American Progress.
[231] http://blogs.lse.ac.uk/politicsandpolicy/archives/33606
[232] Institute for Economics and Peace. (2013). Op cit.

through the use of mobile broadband could potentially increase property values to a greater degree than those observed to date and in the process, raise an area's 'attractiveness' and its property values. This research has not factored a socioeconomic benefit for crime reduction's to house price growth that was driven by enhanced crime intervention and reduction. This was due to a lack of available data at a more granular level, combined with the heterogeneous changes in crime across countries. Property related crime such as domestic burglary increased by 62 per cent in some countries such as Greece between 2007-2012, whilst decreasing by 20-30 per cent in others such as Austria and Luxembourg.[233] Motor vehicle theft also reduced between 2007-2010 across EU member states by almost 25 per cent. Overall, recorded crime reduced by 10 per cent between 2005-2010 in the EU.[234]

US research estimates that a 10 and 25 per cent reduction in violent crime could increase housing prices in 8 major US cities by 0.83 and 2.1 per cent respectively in the following year.[235] This would equate to US$16 billion and US$41 billion respectively in the case of the major US cities assessed. Although the UK has experienced over a 15 per cent reduction in violent crime between 2007-2012, which could equate to over £1billion in property value increase, many EU countries have not achieved a comparable property-and-person related crime reduction.[236] Although a more granular degree of analysis could occur in this area, even current crime reduction could arguably still make a socioeconomic contribution through some enhancement to property values where reductions have been more sustained, even at lower levels. This could yield an increase in property values of at least the UK figure of over €1 billion. This has not been factored into this research but it represents a possible future area of inclusion that is dependent on more detailed analysis being undertaken of crime data that could be improved due to enhanced broadband access and police being retained on their rounds longer.

[233] Eurostat, 2012. Trends in Crime and Criminal Justice: 18/2013. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-13-018/EN/KS-SF-13-018-EN.PDF
[234] Ibid.
[235] Shapiro, R. J., and Hassett, K. A. (2012). The Economic Benefits of Reducing Violent Crime: A Case Study of 8 American Cities. Centre for American Progress.
[236] Eurostat, 2012. Op cit.