Submission to the House of Representatives Standing Committee on Infrastructure and Communications Inquiry into "The role of smart ICT in the Design and Planning of Infrastructure"

10 July 2015

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Executive Summary

Approaches towards and capabilities in the planning, design and management of infrastructure across its total lifespan are changing rapidly. Advances in modern information and communications technology (ICT) is leading to a convergence of skills and knowledge associated with infrastructure engineering (IE); computer engineering (CE), urban planning and design (UPD) and electrical and electronic engineering (EEE). Traditional paper-based design has moved into digital design methodology on computers and design tasks are now aided by computer programs or in some cases automated by advanced computer software.

Infrastructure engineers, urban planners and governments are starting to realise some of the potential benefits of Smart ICT and this realisation has led to the concept of 'Smart Cities'. These changes force us to reconceptualise the design and planning of infrastructure in the mobile and digital age. Similarly, there is an urgent need to consider how Australia should prepare tomorrow's infrastructure engineers and urban planners for this new environment. Whilst there are a number of important aspects to Smart ICT the two critical elements of our future world and 'Smart Cities' are;

- Digital broadband communications networks; and
- Geographic Information Systems (GIS) and national Spatial Data Infrastructure (SDI).

Globally broadband communications infrastructure and its associated technologies are driving innovation in the development of products and services that connect individuals, communities, governments and businesses on an "always connected anywhere anytime" basis and in doing so are contributing to economic prosperity and social wellbeing.

This cross sector connectivity and innovation capability relies on the availability of highly resilient, high redundancy, secure infrastructure strategically planned for, procured, operated and maintained to meet public/consumer demand for products and services not yet envisaged but being broadly discussed under the heading of the "Internet of Things".

The prime driver of this infrastructure capability will be the ongoing development of open standards to provide the "interoperability" necessary to provide the always connected anywhere anytime capability and at the same time allow the capture of innovation opportunities that will be continuously presented to markets.

Broadband communications infrastructure will collect and carry data to be used in generating information and creating spatially, visually and temporally enabled intelligence to enhance personal, commercial and government decision making in a manner not seen before and difficult to envisage in the future. Government data released under open data innovation on the basis of "release once and use multiple times" will be a significant supplier of the data carried by broadband communications infrastructure as input to the development of Smart ICT.

Geomatics is a modern academic discipline that integrates the tasks of gathering, storing, processing, modelling, analysing and delivering spatially reference or location information. It encompasses the disciplines of surveying, hydrography, mapping remote sensing and geographic information processing. These models are becoming increasingly complex and require the transmission of complex data sets between designers/developers and users. This type of data underpins the strategic development and management of Australia's infrastructure, urban areas and communities. The spatial attributes of data is the one key element that allows geographic information systems (GIS) to integrate complex and divergent information from multiple sources and represent it in easily understood coherent models and visualisations. To gain the full benefit and potential of these systems the Australian government needs to recognise the importance of national spatial data infrastructure (SDI) as part of any future smart ICT capability.

Government leadership will be required in the development of reference Frameworks to monitor, measure, assess and strategically guide infrastructure planning, incorporating Smart ICT, on a cross sector basis otherwise this function will be left to industry to meet consumer demand on a purely commercial basis. Government and academia need to be collaboratively involved with industry in setting the strategic direction of Australia's infrastructure from a leadership and research perspective.

Under the generic term of "Smart ICT" the Emergency Management Sector, and its constituent Public Safety Agencies, should be significant beneficiaries of the availability of broadband communications and the innovation in products and services it will bring, subject to overcoming the traditional conservative culture and nature of the Sector. The empowerment of the Emergency Management Sector through "Smart ICT" capabilities will help to build a higher level of community resilience and economic productivity across Australia.

Consistent with the partners in this Submission continuing to focus on responding to the Productivity Commission's current Inquiry into Public Safety Mobile Broadband the objectives of this Submission to the Inquiry are to;

(a) Raise the awareness and understanding of the Emergency Management Sector and Public Safety Agencies in the context of a public safety market and Smart Cities;

(b) Highlight the reliance of the Sector and its respective Agencies on mission critical public safety communications infrastructure; its ecosystem and the potential benefit from Smart ICT;

(c) Highlight the importance of GIS, and in particular 3D GIS, as a fundamental element of Smart ICT and its role in the design of Smart Cities;

(d) Promote the need to include mission critical public safety communications infrastructure and national spatial data infrastructure in the broader conversation about the planning and procurement of infrastructure necessary to secure Australia's future economic prosperity and social wellbeing;

(e) Ensure that the Standing Committee is aware of other Inquiries and Submissions related to mission critical public safety communications infrastructure to consider in its deliberations.

Introduction

This Submission provides a response to the House of Representatives Standing Committee on Infrastructure and Communications Inquiry into *"the role of smart ICT in the design and planning of infrastructure"* announced on Monday, 25 May 2015 by the Minister for Infrastructure and Regional Development, The Hon Warren Truss MP.

This Submission is made on behalf of the following organisations:

- The University of Melbourne Centre for Disaster Management and Public Safety (CDMPS);

The CDMPS is a Centre established by the University of Melbourne in November 2013 to specifically focus on research associated with disaster management and public safety. Mission critical communications infrastructure essential to the management of major emergencies and disasters is a specific component of the Centre's Research Agenda. (www.cdmps.org.au);

- The University of Melbourne Centre for Spatial Data Infrastructure and Land Administration (CSDILA);

The CSDILA is a Centre established by the University of Melbourne in 2001 to undertake world-class research supporting sustainable development into the broad areas of spatial data infrastructures, spatial enablement and land administration. The CSDILA is recognised as being as conducting world leading research into spatial data infrastructure, geographic information systems (including 3D GIS) and the development of smart cities. (www.csdila.unimelb.edu.au);

- The Victorian Spatial Council (VSC)

The Council is Victoria's peak body for spatial information policy and management. The Council facilitates opportunities for a strategic focus on the development of spatial information through greater partnership building, collaboration, cooperation and education and has continually promoted a national approach to the management of information spatially. (www.vsc.org.au);

- The Association of Public Safety Communications Officials (APCO) Australasia

APCO is a not for profit mission critical communications public safety association with chapters in the United States of America, Canada, the United Kingdom and Australia. (www.apcoaust.com.au).

Context

It is understood that the Standing Committee is seeking further information through responses to this Inquiry relative to the Committee's Report on *Planning, Procurement and Funding for Australia's Future Infrastructure* published in December 2014 and that this report took into consideration the reports arising from Productivity Commissions' Inquiry into Public Infrastructure in May 2014.

These reports and the submissions made in response to these previous Inquiries did not identify the importance of mission critical public safety communications infrastructure and national spatial data infrastructure. These types of infrastructure are used by Australia's Emergency Management Sector and its constituent Public Safety Agencies to protect the social and economic wellbeing of individual Australians and their respective communities. Similarly, the national investment made in the public safety arena forms a substantial percentage of overall infrastructure investment in Australia, yet it is often overlooked in discussions regarding Australia's critical infrastructure

A key objective of this Submission is to have these infrastructures recognised and included in the national conversation about "infrastructure". Mission critical public safety communications infrastructure and national spatial data infrastructure require the same level of planning, financing, procurement, operation and renewal as other major Australian infrastructure. In the future all of Australia's infrastructure will be connected by Smart ICT to a degree not yet imaginable.

Consideration to providing Australia's Emergency Management Sector with the infrastructure necessary to support a public safety mobile broadband capability has been discussed by current and past governments for many years without any definable outcome. As a result Australia continues to fall behind the rest of the world as it works towards embedding this new capability into the mission critical public safety communications ecosystem. Advances in GIS support the development of decision support tools and spatially enabled common operating pictures which are a critical capability required by public safety agencies to protect the community and the Australian economy from natural or manmade disasters. The Australian community has a reasonable expectation that Australian governments will ensure that the provision of key infrastructure is provided in these circumstances.

To provide evidence of the conversation between governments, bureaucracies and industry regarding the need for a public safety mobile broadband capability, the Standing Committee's attention is drawn to previous Submissions by the partners responding to a range of papers released by Commonwealth Government Departments addressing individual components of the ecosystem as follows:

- December 2011 – DBCDE Review of the Integrated Public Number Database;
- February 2013 - ACMA "The 803-960 MHz band – exploring options for future change"
- August 2014 – Department of Communications Triple Zero Review;
- June 2015 - Submission to the Australian Government Productivity Commission's Issues Paper "Public Safety Mobile Broadband".

These Submissions refer to individual components of the ecosystem and in particular the future ability of Public Safety Agencies to be able exchange and share information with the public facilitated by the use of Smart ICT.

The opportunity to provide these Submissions has been appreciated however the apparent fragmented and uncoordinated approach to the announcement of the Inquiries raises concern about the lack of understanding of the connection that exists between the matters being investigated in the Inquiries.

These Submissions have however commenced the establishment of a transparent body of knowledge in the public domain to raise the awareness and understanding of the Emergency Management Sector and Public Safety Agencies and explain the reliance of the Sector on mission critical public safety communications infrastructure, national spatial data infrastructure and the potential to benefit from Smart ICT.

Importantly the Submissions have also identified key stakeholders and their respective positions on proposed government decisions that will set the strategic direction of Australia's Emergency Management Sector for decades to come.

Response

This Submission provides a response using terminology defined as follows under each of the categories identified in the Inquiry's Terms of Reference:

- Emergency and Disaster Management

The terms emergency and disaster management mean a response by Public Safety Agencies within the Emergency Management Sector to events scalable from "business as usual" incidents through to emergency situations and major disasters.

- Public Safety Agencies

The term Public Safety Agencies is used generically to address traditional agencies such as law enforcement, and others involved in emergency management i.e. fire and ambulance. From a Smart ICT perspective the need to develop sound partnerships between these traditional agencies and industry (including the owners and operators of critical infrastructure), academia, bureaucracies and governments has to be acknowledged as being vital to achieving the successful development and use of Smart ICT.

- Spatial Data Infrastructure

The Open Geospatial Consortium (OGC) defines Spatial Data Infrastructure (SDI) as *"the collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data"* (www.opengeospatial.org).

- Public Safety Grade

The term Public Safety Grade as applied to mission critical public safety communications refers to the description given in the National Public Safety Telecommunications Council (NPSTC) document titled "Defining Public Safety Grade Systems and Facilities - Final Report 22 May 2014" (www.npstc.org).

- Smart Cities

Smart Cities is a term used to describe the use of Smart ICT to enhance the quality and performance of urban services; reduce costs and resource consumption; and engage more effectively and actively with its citizens.

Identifying innovative technology for the mapping, modelling, design and operation of infrastructure

As a result of the inefficient operation of city infrastructure and resources a global movement or area of study, named "Smart Cities" has emerged.

It is argued that the strategic investment in and use of Smart ICT will provide a number of benefits to Smart Cities including:

- More efficient use of physical infrastructure;
- Effective engagement with the community and collaborative decision making; and
- Quick and effective decisions regarding infrastructure and urban the environment in changing circumstances.

Based on 3D GIS capabilities advanced algorithms can be designed to support virtual urban-utility platforms that can help lead to resource optimisation, direct governance, participatory operations of civil systems and a more resilient society (Gupta 2015).

It has been argued that by connecting different layers of information a city can be connected, measured and managed effectively.

The components of this 3D GIS approach are outlined in Figure 1 which demonstrates that there are four key elements required to support Smart Cities, namely an intelligent activation of the city, a network, technology and a human interface (Gupta 2015).

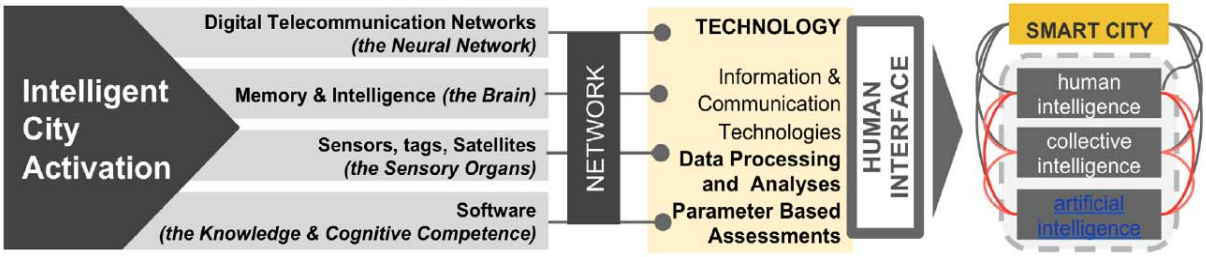

Figure 1: Components of a Smart City (Source: Gupta 2015)

There is an increasing trend towards urbanisation leading to increasing problems of space, place and liveability (Rajabifard & Eagleson 2013; UN 2014). The University of Melbourne conducted a collaborative research project with the Australian Urban Research Infrastructure Network (AURIN), the Australian National Data Service (ANDS), the Victorian Government and a number of key stakeholders. The AURIN/ANDS Project developed a spatially enabled tool that combined multiple data sets into a single platform to provide enhanced evidence-based planning decisions in the North West Melbourne corridor. Features of this spatially enabled tool included:

- The use of agent-based modelling to inform neighbourhood walkability with a view of supporting planning decisions to promote healthy lifestyles;
- A housing affordability application to help understand housing stress where the community has insufficient income to secure adequate housing;
- A mapping tool that integrated health and social data to identify hot-spots of combined or clustered vulnerability; and
- An open-sourced tool for identifying industrial clusters.

The University of Melbourne, through the CSDILA, is recognised as being a world leader in relation to innovative technology mapping, 3D GIS, modelling and design as demonstrated by the research and development conducted during the AURIN/ANDS Project. The investment made in the AURIN/ANDS Project provides the basic SDI for supporting the development of additional products and capabilities for mapping, modelling, analysis and visualisation of complex interrelationships.

Identifying innovative technology for the mapping, modelling, design and operation of infrastructure will require governments, industry, academia and the community to develop a collaborative and strategic approach to national leadership and co-ordination of effort focussed on the planning, financing, procurement, operation and renewal of major Australian infrastructure to ensure Australia's future prosperity and social well being.

The Australian Constitution allocates the States and Territories responsibility for emergency management allowing each to decide what infrastructure is required to perform the wide range of functions associated with this responsibility. As mission critical public safety communications infrastructure and national spatial data infrastructure required by the Emergency Management Sector is a critical capability it needs the same level of planning, financing, procurement, operation and renewal as other major Australian infrastructure. These agencies and capabilities should be included in the conversation about any nationally co-ordinated approach towards infrastructure planning.

As the transition to Smart infrastructure progresses the ability to provide formal education, training and qualifications in the planning, procurement, operation and renewal of infrastructure will also be required to support this approach. The same will apply to both the Emergency Management Sector and mission critical public safety communications infrastructure.

The challenge is to decide how this collaborative effort might be established and the discussion about the expanded role of Infrastructure Australia is noted. It is suggested that the Trusted Information Sharing Network (TISN) model should be considered to inform further discussion.

The Commonwealth Attorney General's Department manages both the Trusted Information Sharing Network (TISN) (www.tisn.gov.au) and the Critical Infrastructure Program for Modelling and Analysis (CIPMA) as part of the government's Critical Infrastructure Resilience Strategy to help reduce Australia's exposure to risk; recover from major disruptions and disasters and to learn from incidents.

The TISN provides a secure environment for *critical infrastructure* owners and operators across seven sector groups to regularly share information and cooperate within and across sectors to address security and business continuity challenges. These sector groups are: banking and finance, health, transport, energy, food, water and communications. The TISN also provides a medium for discussion on appropriate cybersecurity measures and initiatives to prevent and protect against the compromise of what is considered critical data sets and operations.

The TISN offers the opportunity to identify cross sector innovation in the use of Smart ICT and the use of CIPMA in validating these opportunities in the context that the focus of Smart ICT at this time is on "data, data standards and meta data" and its enablement by broadband infrastructure and technologies using open standards to achieve interoperability e.g. the potential role of the National Broadband Network (NBN) in the Emergency Management Sector and the development of Smart ICT.

Smart ICT across all sectors will require the two common factors of interoperability and open standards but none more so than the Emergency Management Sector.

Interoperability

The mission critical public safety communications ecosystem relies on infrastructure to provide the ability for Public Safety Agencies to be able to communicate both within and between these Agencies. This communication occurs under all scenarios ranging from business as usual through to major emergencies and disasters of varying complexities and duration arising from the combination of natural environment, built form and human activities. As indicated in all major inquires of significant events, a key component of this communication involves providing these agencies with access to a spatially enabled common operating picture which supports a higher level shared situational awareness between all key stakeholders.

This capability, known as "interoperability", is considered to the Holy Grail in the Emergency Management Sector. The ability to develop and use Smart ICT will require interface standards that provide interoperability between Smart ICT systems, products and services.

Originally focused on achieving *technical* interoperability achieved by taking an open standards based approach to mission critical public safety communications infrastructure in recent years it has been realised that *human* interoperability is just as or even more important to effective emergency management.

Open Standards

Land Mobile Radio (LMR) technical interoperability for mission critical public safety communications has been achieved through the development of open standards. International Standards Development Organisations (SDOs) undertake the development, documentation and publication of these Standards. In Australia the P25 LMR Standard developed in the United States of America has

emerged as the “defacto” national standard for voice based mission critical public safety communications infrastructure. The TETRA LMR Standard has also been developed in Europe and both the P25 and TETRA are international Standards.

Each Australian State and Territory has invested in the purchase of P25 infrastructure or the purchase of services based upon this standard. At a national level it has been estimated that this investment in communications capability is approximately $2 billion for digital communications infrastructure. This estimation does not include investment in legacy analogue systems. The degree to which interoperability exists between these P25 networks at both the intra-State and inter-State level from investment in this infrastructure is not currently visible.

Public Safety Agencies globally are continuing to invest in new LMR infrastructure or renewal of existing infrastructure on the growing understanding that LMR and the public safety mobile broadband capability based upon Long Term Evolution (LTE) technology must be seen as being compatible and not competitive and that one is not a direct substitute for the other. Smart ICT research is now being undertaken into the merging of the two technologies to provide interoperability hence the need to ensure an open standards approach is taken to the development of Smart ICT for the Emergency Management Sector.

Public Safety Agencies and Public Safety Communications Associations, such as APCO and the TETRA Critical Communications Association (TCCA) (www.tcca.org) are the international peak advisory bodies for developing open standards for public safety communications systems. The 3G Partnership Project (3GPP) SDO is developing “mission critical” public safety LTE standards, the first version of which has recently been released.

The Open Geospatial Consortium (OGC) (www.opengeospatial.org) is an international industry consortium of 518 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

OASIS (www.oasis-open.org) is a non-profit consortium that drives the development, convergence and adoption of open standards for the global information society. OASIS promotes industry consensus and produces worldwide standards for security, Internet of Things, cloud computing, energy, content technologies, emergency management, and other areas. OASIS open standards offer the potential to lower cost, stimulate innovation, grow global markets, and protect the right of free choice of technology.

Open data is closely aligned to open standards and the Australian Bureau of Statistics (ABS) has recognised its potential to unleash innovation which will encourage the development of creative solutions to contemporary issues facing Australian society. As such the ABS is working collaboratively with all Australian governments and agencies to promote and support open data initiatives. The use of open standards and open data are key requirements of Smart ICT to support future innovative design and planning of infrastructure.

Identifying the new capabilities Smart ICT will provide

The "Internet of Things" is a term used internationally to describe hardware and software technologies. Hardware can consist of a wide range of connected devices, for example sensors, wearable devices, 3D printers, mobile communications devices, fixed infrastructure and the networks that connect them.

The "Internet of Things" will be a key component of future Smart ICT systems; however it has a very broad definition and links to other emerging technologies such as autonomous systems, robotics, data analytics and artificial intelligence. Advanced 3D modelling, analysis, simulation and visualisation capabilities using inputs from the "Internet of Things" will allow us to understand system behaviour states and complex interrelationships.

This innovation will provide us with a unprecedented capability for developing advanced decision support systems, virtual reality environments and augmented reality capabilities. The United Kingdom's Government believes that "The internet of things has the potential to have a greater impact on society than the first digital revolution" (GOfS 2015:6).

As shown in Figure 2 the "Internet of Things" will allow any person, access to any service or business, any place, anywhere, using any device via a communications network. Whilst the "Internet of Things" will impact different industry sectors and communities at different rates, it has been estimated that the global economic benefit will be $2.3 trillion in manufacturing alone (GOfS 2015:20).

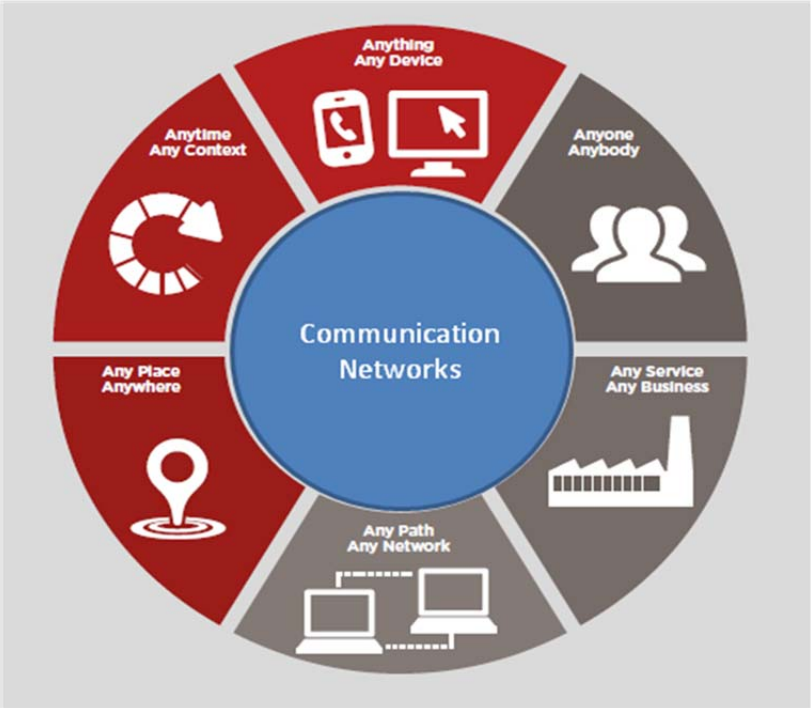

Figure 2: Internet of Things Ecosystem (Source; Adapted from GOfS2015:13)

It is anticipated that the "Internet of Things" or more accurately the "Internet of Public Safety Things" will also deliver significant productivity gains and public safety outcomes for Public Safety Agencies. These enhancements have the clear potential to save lives in many different situations.

Historically, mission critical public safety communications has comprised LMR analogue technologies specifically designed to meet the needs of Public Safety Agencies. The emergence of digital, cellular and broadband technologies means for the first time in history the public has a greater communications capability then Public Safety Agencies.

These technologies now exist within an ecosystem which will provide the Emergency Management Sector with a new level of blended operational and technical capability requiring the Sector to

increase its knowledge and understanding of the change in function, education, qualification, training and culture of the human resources who will be required to use these technologies.

LTE broadband technologies and the innovation opportunities these technologies present is moving the communications “ecosystem” rapidly into mainstream ICT and the need to understand, assess and utilise existing ICT industry standards as applied to the ecosystem particularly in relation to cyber security.

Smart ICT will be an integral component of the design of Smart Cities which will use broadband infrastructure to provide the communications capability and capacity expected of these Cities. Public Safety Agencies must be able to articulate their needs and level of connectivity in these future Smart Cities i.e. the ability of Smart ICT and broadband connectivity will mean Public Safety Agencies will have access to data and information provided from Building Information Management (BIM) systems, autonomous vehicles, autonomous homes and sensor technologies to enhance situational awareness and build a common operating picture across all stakeholders.

The NBN will provide significant national capability and capacity for Smart Cities, yet to date it appears that no consideration has been given to the use of the NBN as part of communications infrastructure that has to be incorporated in future Smart Cities infrastructure. This has the potential to significantly enhance the engagement of the community and deliver various levels of community relevant information including emergency alerts and warnings.

Research has commenced on the development of Smart ICT applications that will allow Public Safety Agencies to dynamically use enhanced intelligence in their operational and business planning. Whether this new level of information and intelligence will fit the traditional Preparation, Preparedness, Response and Recovery (PPRR) continuum will require consideration.

Rather than PPRR there will be movement driven by public/consumer needs to Patterns, Predication, Presentation and Personalisation (PPPP) through understanding the relationship between the use of spatial enablement, visualisation and sensor technologies to generate location, imaginary, sensory and temporal *mission critical data* for use by Public Safety Agencies in applications currently being developed or yet to be imagined.

There is currently no agreed definition for *public safety mission critical data.*

Public Safety Agencies (in particular law enforcement) are becoming more focused on pattern identification, prediction and intervention hence improving the productivity from the use of human resources and high value discrete natural resources such as wireless spectrum and human resources to produce enhanced social, economic and environmental outcomes and build community resilience.

Examining the productivity benefits of Smart ICT

It is anticipated that the "Internet of Things" and Smart City approaches will lead to significant productivity gains through the increased efficiency and strategic development of infrastructure. New technologies like 3D printing have the potential to streamline and create new manufacturing methodologies. Advances in autonomous systems and robotics also have the potential to revolutionise construction e.g. a recent innovation in Western Australia involved the development of a robotic bricklayer which could raise the shell of a new home within two days.

The key benefit of this design is that robots can function 24 hours a day 365 days a year (Fox 2015). Australian mining operations have been revolutionised by the introduction of autonomous mining technology (Diss 2014). It is foreseeable that these innovations will lead to autonomous road

construction, especially in remote areas. If this were to occur there would be significant implications and savings for the development of Australian road/transportation infrastructure.

LTE broadband technology has been acknowledged by Public Safety Agencies as being the prime enabler of innovation and its application to the development of mission critical products and services required to meet the public expectations of these Agencies in an always connected world.

From the perspective of the Emergency Management Sector there is limited information in the public domain of the examination of the productivity benefits from investment in Smart ICT even though decision support systems like Phoenix RapidFire, which provides a deterministic, continuous, empirical fire characterisation model, are a critical element of Australian emergency management systems.

The requirement by Government Bureaucracies for evidence based Business Cases to assist in the assessment of the allocation of funds on a sector basis e.g. health, transport, education requires the Emergency Management Sector to produce evidence of these productivity benefits for examination on a cross sector basis using accepted methods of evaluation.

The Terms of Reference for the Productivity Commission's current inquiry into providing a mobile broadband capability for Australia's Public Safety Agencies requires it to undertake a Cost Benefit Analysis of the options being examined to provide this capability.

The Australian Radio Communications Association (ARCIA) (www.arcia.org.au) produced an evaluation of the economic value of LMR spectrum in November 2013 the results of which supported the findings of studies by the London School of Economics into the use of spectrum from a social rather than a traditional economic view point.

Smart ICT in the form of body worn cameras by police agencies still requires suitable infrastructure to support this application of technology and the ability to be able to capture the innovative uses and productivity opportunities it will provide. Smart ICT, such as wearable technologies, will also present the opportunity to incorporate data analytics capability allowing decentralised data processing to enhance intelligence generation and decision making at the point of service delivery or incorporated in base station infrastructure illustrating the design decisions that will need to be made to support Smart ICT adoption.

It should be noted that Smart ICT in the Emergency Management Sector will produce legislation and privacy issues that need to be provided for in the planning, design, delivery and use of Smart ICT.

Effective planning and preparation for the use of Smart ICT will encourage its adoption and demand for continual increase in capability and capacity as has occurred with consumer demand for on-line services and mobile devices. Just as commercial providers struggle to meet this demand the mission critical communications ecosystem will need to have the agility and flexibility to be able to continually adjust to meet this demand at government, industry and community levels.

Australia's Public Safety Agencies are independently purchasing mobile broadband capability from commercial network providers with no known co-ordinated effort to capture the lessons learned to develop a shared national understanding of the potential benefits arising from a public safety broadband capability. Similarly, Public Safety Agencies across Australia are purchasing and developing GIS capability and decision support systems in isolation. The introduction of a national Smart ICT strategy that encompasses both of these elements will ensure a higher level of return on investment for Australia.

Building and maintaining community resilience will be based upon a continuous exchange of information between Public Safety Agencies and the public and the communities in which they live,

work and travel to and from. The quality of service from the ecosystem will be of paramount importance. The Quality of Service, Prioritisation and Pre-Emption (QPP) capabilities associated with Smart ICT as used by the Emergency Management Sector, particularly where commercial services are being purchased, will therefore be of primary importance.

The environment described in the preceding paragraphs is about rapid and continuing change to meet demand which commercial providers are responding to with investment in network coverage and capacity even as research into 5G capabilities is underway. Therefore the ability to use emerging Smart ICT developments to future proof against; new 'data hungry' computing innovations such as quantum computers; the need to transmit large quantities of spatially enabled data; and accommodate M2M; automation and sensor inputs should be a key consideration.

Public Safety Agencies by their conservative nature will need the assistance of governments, industry and academia to be able bring about the cultural and organisational change required to drive the innovation offered by Smart ICT and provide the agility required to capture opportunities as they appear. Long established procurement processes will need to be significantly changed.

Independent academic research needs to underpin the evidence based business cases that Public Safety Agencies need to produce to secure the funding required for investment in Smart ICT in a competitive cross sector environment while at the same time adding to the body of knowledge supporting the application of Smart ICT and the sharing of lessons learned from its use.

Harmonising data formats and creating nationally consistent arrangements for data storage and access

The Australian New Zealand Land Information Council (ANZLIC) (www.anzlic.gov.au) is the peak national spatial governance body in Australian and New Zealand and it recognises the need for a consolidated effort to develop an agreed foundation spatial data framework to provide easy access to Authoritative government spatial data.

In 2014 ANZLIC launched the Australian New Zealand Foundation Data Framework to make common foundation spatial data ubiquitous across Australian and New Zealand (ANZLIC 2014). As shown in Figure 3 the Foundation Spatial Data Framework (FSDF) consists of a number of base spatial layers required by most users and they are generally not sourced from other spatial layers (ANZLIC 2014).

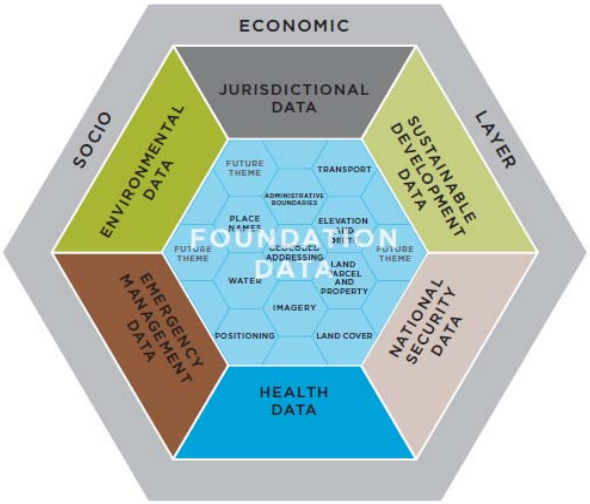

Figure 3: Conceptual View of the Foundation Spatial Data Framework (Source: ANZLIC 2014:6)

Within the FSDF a number of dataset profiles have been developed for specific themes. These *"profiles detail the description, purpose, use, current status in jurisdictions and future status of the dataset. Profiles also cover the relevant standards access and licensing, quality, coverage, related websites, key users and the custodian, aggregator and distributor and related products and formats"* (ANZLIC 2014:8).

The FSDF provides the basis for developing a national strategy to harmonise data formats and create nationally consistent arrangements for data storage and access. As shown in Figure 4 it is estimated that the global economic impact of *"geo services"* is approximately $150 - 270 billion per year. This analysis highlights the importance of the FSDF and national spatial data infrastructure in supporting the growth of the Australian economy.

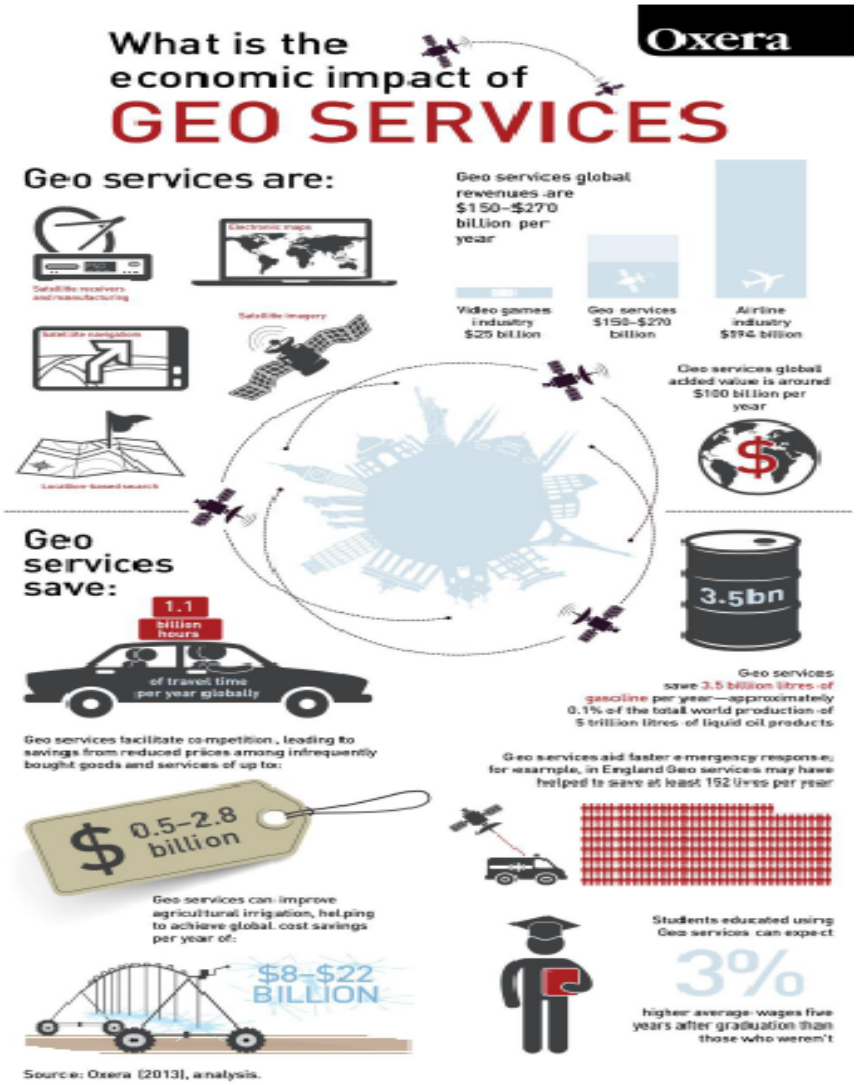

Figure 4: Economic Impact of Geo Services (Source: Oxera 2013:i)

The consolidation of a national "geo services"/Smart ICT strategy will provide a policy framework to support the development of Australia's next generation infrastructure and communications networks. The National Broadband Network (NBN) and National Mobile Broadband Networks (NMBNs) are key elements of this next generation environment.

Broadband LTE communications infrastructure for the Emergency Management Sector is about providing the capability to carry mission critical public safety data and *NOT* mission critical public safety voice - although this voice capability will emerge as the LTE standard continues to be developed.

Given the progressive move of mission critical public safety communications into mainstream ICT it seems desirable that the data standards established for ICT should be progressively assessed as "fit for purpose" and adopted by the Emergency Management Sector to meet its specific needs e.g. cyber security

The challenge to be met is to ensure that open standards based approach is taken to LTE interoperability for mission critical data and that lessons to be learned from spectrum harmonisation for mission critical voice are taken into consideration. Similarly there is a need to use open standards for building the FSDF and the national SDI.

Likewise the data storage and access arrangements for mission critical data need to be defined and addressed in the current development of broader policy and legislation associated with use of data.

The Victorian Spatial Council identified some years ago the emerging need for overarching legislation for spatial data and in the Emergency Management Sector this will become apparent through the exchange of information between the public and Public Safety Agencies with the inclusion of "the public" and its communications capability in the ecosystem through the introduction of NG000.

Identifying international best practice in the use of smart ICT in the design and planning of infrastructure

Internationally the use of Smart ICT in the design and planning of infrastructure is broadly addressed by the concept of Smart Cities. Developments within the European Union (EU) and South Korea are good examples of best practice in the design of Smart Cities. Within the European Commission *Horizon 2020* is the biggest EU Research and Innovation Programme ever launched in the EU and it provides approximately €80 billion of funding over 7 years to support innovation and secure Europe's global competiveness. (http://ec.europa.eu/programmes/horizon2020/). Within Horizon 2020 ICT has a specific work package established to underpin innovation and competiveness. As part of this program the European Innovation Partnership on Smart Cities and Communities integrates the ICT, energy and transport sectors. The program aims to apply innovative solutions to tackle issues such as congestion, air pollution, high energy costs and to achieve better mobility, cleaner urban environment, energy efficiency (http://ec.europa.eu/eip/smartcities/index_en.htm).

Within South Korea the Songdo International Business District is at the forefront of the construction of a Smart City of the future (http://www.songdo.com/). Within Australia, *Smart Grid, Smart City* was a $100 million Australian government funded project, led by Ausgrid to test a range of smart grid technologies and gather information about the benefits and costs of implementing these technologies in an Australian setting (http://www.smartgridsmartcity.com.au/).

The most prominent international example of Smart ICT in mission critical public safety communications is the research activities being undertaken by the Public Safety Communications Research Program (PSCR) (www.pscr.org) in the United States of America to support the design of the FirstNet Project (www.firstnet.org) which will provide a dedicated public safety mobile broadband capability to all Public Safety Agencies across the United States.

The PSCR Program has used a futures thinking approach to identify Location Based Services and Data Analytics as the two major (Smart ICT) research activities into what services, using broadband infrastructure and technologies, need to be delivered to Public Safety Agencies through the FirstNet Project. The PSCR recently released its Research Technology Roadmap and the Location Based

Services Report (http://www.nist.gov/ctl/pscr/roadmap-for-public-safety052615.cfm). The PSCR has been allocated $US300 million through legislation passed by the American Congress to undertake research into broadband public safety communications.

The Location Based Services research highlights how fundamental "*location*" is to mission critical data and the 3 D spatial enablement of "*location data*" by X, Y and Z co-ordinates is to the development of public safety Smart ICT. The importance of the "Z" co-ordinate to Public Safety Agencies is demonstrated by the project currently underway in the United States to be able to provide a "Dispatchable Address" to all 911 calls received by Public Safety Answering Points (PSAPS) across America.

The Dispatchable Address Project is also an example of the collaboration between the United States' three major mobile carriers, APCO International (www.apcoint.org) in conjunction with the National Emergency Number Association (NENA) (www.nena.org) and the Federal Communications Commission to produce innovative Smart ICT solutions required to be able to locate events and people in high rise apartments towers connected to Smart ICT networks which will form future Smart Cities.

The concept of "apps" continues to change the way people lead their lives and businesses and governments provide services and share information with communities. Likewise the importance of apps to the Emergency Management Sector and Public Safety Agencies is becoming better understood. APCO International has created a web site (www.appcomm.org) to assist in the identification of the issues that will need to be addressed to develop mission critical public safety applications which it is envisaged will become available through an "Apps Store" as part of the FirstNet Project.

In the Emergency Management Sector the most fertile area for the application of Smart ICT will be in the evolution of Next Generation (NG) broadband technologies at the interface between the public and the Emergency Management Sector (NG000, NG911, NG999, NG112) which will focus on the sharing of data relevant to specific events and importantly the continued growth of the utilisation of social media.

In the United States NG911 Projects have identified high quality Geographic Information Systems (GIS) systems as a critical success factor for these projects.

Considering the use of smart ICT in related fields, such as disaster planning and remediation

In previous sections of this response comments have been made about the ability to capture the innovation opportunity and productivity benefits from Smart ICT needing evidenced based Business Cases to support the introduction of Smart ICT to the Sector Cases. This evidence needs to be in turn based upon independent high quality academic research.

The University of Melbourne has two Centres undertaking research relevant to the use of Smart ICT by the Emergency Management Sector. These Centres are:

- The Centre for Disaster Management and Public Safety (CDMPS); and
- The Centre for Spatial Infrastructure and Land Administration (CSDILA).

These Centres and their respective research agendas complement each other and will provide the Spatial Data Infrastructure (SDI) capability required by the government, emergency management sector and key stakeholders to support the introduction of Smart ICT.

These Centres have a diverse range of research underway and the current research activity includes the following:

Building Design

The CSDILA research into the use of 3D Building Information Models (BIMs) in the design of Smart Cities is supporting CDMPS research into the use of BIMs by the Emergency Management Sector to provide input into tall building planning and the communication infrastructure required leading to improved outcomes from emergency events taking place in these buildings. This includes developing indoor navigation capabilities.

Simulation Platform

The CDMPS has developed an Intelligent Disaster Decision Support System (iDDSS) platform based on the previous investment in the AURIN/ANDS project. As shown in Figure 5 the iDDSS enables the incorporation and assimilation of various complex data bases into an easily understood visual medium to assist in emergency event simulation and planning e.g. fire and flood simulation.

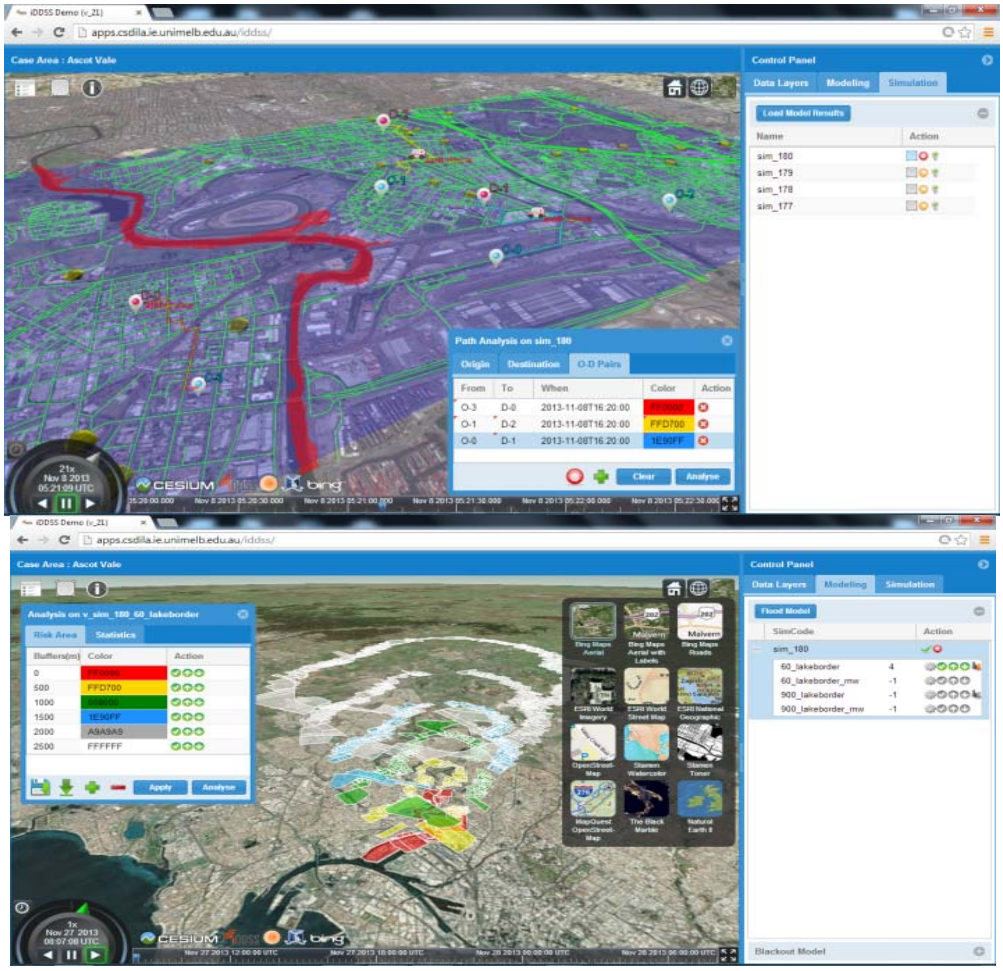

Figure 5: Intelligent Disaster Decision Support System

The modelling, simulation and visualisation are configurable to the user requirements as required. This system can be used to develop advanced modelling tools to assist in planning decision to build new infrastructure and to enhance the resilience of critical infrastructure.

Dynamic Critical Decision Making Capability

Smart ICT will provide the dynamic critical decision making capability expected in the evolution of disaster management. This capability will be based upon the supply of spatially and temporally enabled data from a wide range of sources provided by high speed broadband networks and applications e.g. sensor monitoring technologies already provide the capability for automated collection of a vast variety of spatial enabled information in near real-time.

As per previous comments on interoperability and open standards, the challenge is that these sensors and the data they provide comes from a diverse range of types of sensors operating under the administration of independent organizations e.g. weather stations, rainfall and river height gauges, surveillance cameras, traffic and pedestrian monitoring sensors. These sensors are just a few examples of the ever-increasing range of sensors that supply (near) real-time information from the natural and built environments. There is a need for an overarching national strategy and framework to support the access to and integration of the data outputs into Smart ICT systems.

The supply of integrated multi-vendor sensor information for use in disaster management requires interoperability in the context of sensor data access and exchange. Substantial standardization efforts in Australia (such as the ANZLIC initiative) have been undertaken to address interoperability issues in the context of static spatial data and metadata exchange[i]. However in regard to real-time data management and exchange for disaster management in Australia, sensor data producers mainly use their own propriety data formats and standards.

Smart ICT will provide the dynamic critical decision making capability expected in the evolution of emergency and disaster management capability and capacity. This capability and capacity will supply spatially and temporally enabled data from a wide range of sources delivered by high speed broadband networks and applications providing automated collection of a vast variety of information in near to real-time from a diverse range of sources. One of these sources will be sensors in natural and built environments operating under the administration of independent organisations.

Substantial standardization efforts in Australia have been undertaken to address the supply of integrated multi-vendor sensor information in the context of static spatial data and metadata exchange. The harmonisation of sensor data formats and creating nationally consistent arrangements for sensor data exchange is required so that homogeneous exchange of sensor data between Public Safety Agencies and sensor data producers can be established.[ii]

Framework for a Micro-level Assessment and 3D visualisation of Potential Flood Damage and Risks to a Building

Smart ICT, such as 3D modelling, the use of BIM and GIS to provide multi-scale spatial information, will be of major benefit to the evolution of the flood risk management process from the traditional hazard-based method and its focus on suppressing and mitigating the hazards, to a more a comprehensive integrated framework taking into account the potential consequences of decisions made to treat the risks of flood.

Importantly this framework will be complementary to the current flood damage assessment methods used at a larger scale and contribute towards improving the overall community resilience against floods and their adverse social, economic and environmental impacts.

As depicted in Figure 6 part of this research, a new integration method for bringing together information from BIM and GIS has been proposed that can fit within the overall framework of VANZI[1iii] to realise multi-scale spatial information.

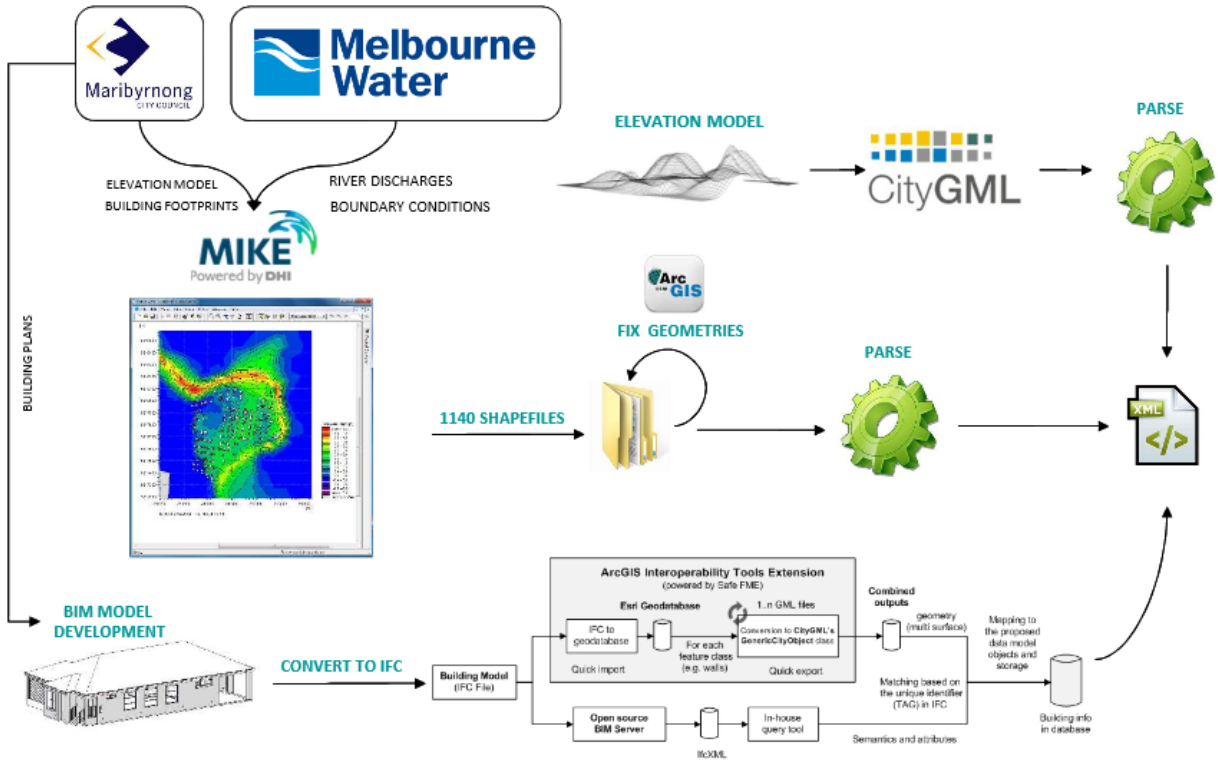

Figure 6: Micro-Level Assessment and 3D Visualisation of Potential Flood Damage and Risks

3D Modelling For Emergency Response

Current research into the application of 3D building models for emergency response is advancing with dedicated research currently investigating how Public Safety Agencies can envisage a building in 3D with fire assets, emergency exits, external evacuation assembly areas, the location of fire alarm service panels and other associated key infrastructure.

As shown in Figure 7 this innovative application of smart ICT has the potential ability to allow emergency responders to pre-plan their tactics prior to their arrival e.g. Public Safety Agencies can use a mobile device to strip away components of a building to expose stairways and fire exits. This is a critical capability that will allow public safety agencies to rapidly navigate their way in a complex building to locate an incident scene and render assistance to the community.

Further research is also being conducted into the most effective tall building evacuation planning also using 3D building models, refugee floors and fire rates lift wells. This will ensure that the elderly, infirmed and disabled can be efficiently evacuated.

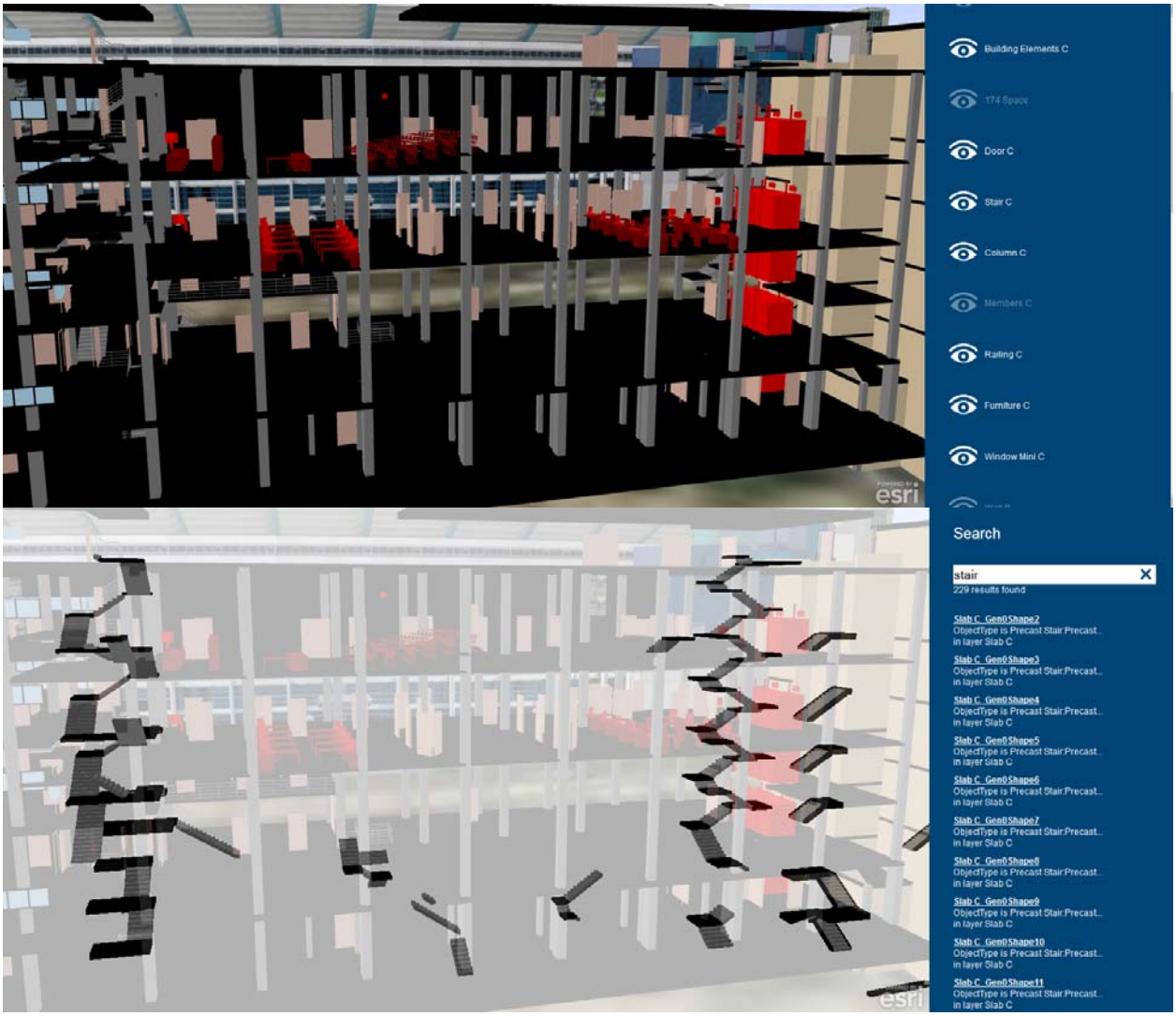

Figure 7: Exposing Building Elements for Emergency Responders

Disaster Management and Mission Critical Data

The CDMPS has been considering the characteristics of mission critical data in the context of mission critical public safety communications ecosystem SDI and Smart ICT and its role in Safer Cities of the Future.

To date this work has proposed a series of filters to examine Big Data and hence identify what has been described as “Little Data “ and “What keeps public safety managers awake at night” i.e. public safety communications mission critical data. These filters, under the acronym of LISTS, are:

- **L**ocation; - spatial enablement of data
- **I**magery; - video, pictures, visualisation
- **S**ensory; - data collection, analysis and evaluation
- **T**emporal; - real time
- **S**tandards; open non proprietary

This approach ensures that the right information is available, at the right time, in the appropriate format for an official to make a critical decision regarding resource allocation and operational priorities to manage an incident.

Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity

Preceding discussion has identified the need for government and academia to be collaboratively involved with industry in setting the strategic direction of Australia's infrastructure from a leadership and research perspective.

This particularly applies to the Emergency Management Sector to ensure that Australia's capability and capacity to meet public expectations of Public Safety Agencies being able to plan for, respond to, and effectively communicate and manage the business as usual incidents, emergency events and major disasters arising from natural and built environments and human activity.

Broader public expectations need to be met through appropriate governance arrangements that result in a national strategic approach to infrastructure planning based upon a Framework(s) to monitor, measure, assess and strategically guide the planning for infrastructure on a cross sector basis. One of these Frameworks could deal with the impact of Smart ICT.

The Victorian Spatial Council, in its separate response to the Inquiry recommends that "an Information Management Framework should operate alongside the necessary physical infrastructure to ensure access to and sharing of information".

The establishment of such a Framework approach and its application to the Emergency Management Sector would assist in addressing the following objectives:

- Raise the awareness and understanding of the Emergency Management Sector and Public Safety Agencies in the context of a public safety market;
- Explain the reliance of the Sector and its respective Agencies on mission critical public safety communications infrastructure; its ecosystem and the potential to benefit from Smart ICT;
- Highlight the importance of GIS, and in particular 3D GIS, as a fundamental element of Smart ICT and its role in the design of Smart Cities;
- Include mission critical public safety communications infrastructure in the broader conversation about the planning and procurement of infrastructure necessary to secure Australia's future economic prosperity and social wellbeing.
- Provide co-ordination between government industry and academia in seeking advice on infrastructure;
- Promote and disseminate research being undertaken by academia relating to infrastructure and Smart ICT technologies.

The absence of such an approach will leave the strategic planning of Australia's infrastructure solely to industry**.**

Conclusion

Smart ICT will provide the opportunity to improve living standards for all Australians provided that there is the ability to conduct a national strategic conversation about the infrastructure required to deliver the products and services required to support these standards.

This infrastructure may be provided by governments, industry or a combination of the two however public expectation would be that leadership by government will provide the framework through which this infrastructure will be delivered to meet demand for access to products and services directly related to the future living standards of all Australians.

Smart ICT is about enabling enhanced decision making at all levels of society that ultimately will impact the economic prosperity and social wellbeing of all Australians.

Australia's Emergency Management Section must have the opportunity to be actively involved in the national conversation, supported by communities, industry and academia, to ensure the needs of the Sector for mission critical public safety communications infrastructure and national spatial data infrastructure are recognised and addressed because of its the relationship with the future public safety of all Australians.

Public safety agencies are charged with protecting property and lives. The development of Smart ICT forms a key component of their ability to mitigate against, respond to and resolve incidents of any scale. With the increasing trend of more frequent and more intense natural disasters across the Australian landscape the investment in infrastructure to support the public safety agencies will help to minimise the loss of and damage to Australia's critical infrastructure and enhance community resilience.

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