2

What is smart infrastructure?

2.1 Smart Information and Communications Technology (smart ICT) has the potential to transform the way we plan and manage infrastructure. New developments in computer hardware, new applications and software are changing the face of the infrastructure sector, and society more generally; driving greater efficiency, increasing productivity, and greatly simplifying construction processes and life-of-asset maintenance.

2.2 While Australia has generally been proactive in adopting these new technologies for the planning, design and ongoing maintenance of infrastructure, the fast pace of new developments means that there is much more that needs to be done.

2.3 This chapter will focus on defining and contextualising the new technologies and applications that are transforming the infrastructure sector. It will alsolook at the opportunities this transformation raises in urban and regional areas, as well as in the water, energy and transport sectors, before examining the productivity benefits of using smart ICT.

New technologies and applications

2.4 A wide and ever increasing array of technologies and applications are opening up new ways of planning and maintaining infrastructure, and improving quality of life in urban and regional cities and towns. The total scope of smart ICT is broader than the focus of this report, which deals with the key ICT applications that are applied to designing and planning infrastructure.

Building information modelling

2.5 Building information modelling (BIM) is a powerful new ICT tool that can achieve efficiencies in construction. According to many of the submitters to this inquiry, BIM brings the construction industry into the digital age.

2.6 The simplest definition of BIM is 'a digital representation of the physical and functional characteristics of a building'. BIMcan provide a shared knowledge resource or single source of truth for all of the parties to a particular construction project.[1]

2.7 In defining BIM, Autodesk placed it in the wider context of Computer Aided Design (CAD) which has been developing for around three decades:

> For centuries, projects have been designed and documented using hardcopy paper drawings, sometimes supplemented by physical small-scale models of the project. With the advent of computer-aided design (CAD) systems, people used software programs to create digital versions of the 2D drawings, changing labour-intensive drafting into more efficient electronic documentation. But the output from CAD-based design is still drawings.
>
> Today, these drawing-based approaches are being replaced by BIM. BIM is a model-based process that relies on a digital representation of the physical and functional characteristics of buildings or infrastructure. In BIM processes, these intelligent, 3D project models serve as the principal means for communication between project activities and collaboration between project teams, as well as the foundation for advanced analytics, simulation and visualization to optimize designs to achieve desired outcomes. This model can be shared between the design team (architects, surveyors, civil and structural engineers), then handed to the main contractor and subcontractors, and finally the owner/operator. Each team adds discipline-specific data to the project model. This reduces information losses that traditionally occur when a new team takes 'ownership' of the project, and provides more extensive lifecycle information to owners.[2]

2.8 According to the Strategic Forum for the Australasian Building and Construction Industry (the Strategic Forum):

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1 Australasian Procurement and Construction Council, *Submission 9*, Attachment 1, *A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, p. 10.

2 Autodesk Asia Pty Ltd, *Submission 4*, p. 2.

> BIM provides predictability as essentially the building is constructed twice: first through the virtual build, second physically on site. Therefore BIM has the ability to proactively resolve design limitations before they impact upon construction. It also provides a level of 'comfort' for the supply chain in respect to design proofing, early detection and resolution of clashes between construction components and cost savings.[3]

2.9 Autodesk elaborated on how BIM contributes to predictability:

> Project teams can explore 'what-if' scenarios to test alternatives and optimise constructability. Models can be used to assess the sustainability of a project by incorporating social, political, environmental, cultural, and economic information. High-end in-context visualisations such as still renderings and movie files that are engineering-accurate can be generated from the model to support public outreach efforts.[4]

2.10 In a joint white paper produced by buildingSMART Australasia and Spatial Industry Business Association (SIBA), the authors pointed out that BIM can refer to two related aspects:

> Construction information is managed using a technology referred to as BIM, standing for Building Information Modelling when referring to the process, and Building Information Model when referring to the entity being modelled.[5]

2.11 Furthermore, the white paper noted that:

> BIM supports the management of construction works throughout their full life cycle: one way of comprehending that is to consider a design brief (or program) as a BIM that defines the requirements for a construction project and, as design and construction proceeds, the BIM represents the instantiated realisation of the construction works and finally, during the use phase of the facility, the BIM supports the management, refurbishment as required and ultimately its demolition or refit.[6]

2.12 The white paper also described how the modelling technology works:

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3 Australasian Procurement and Construction Council, *Submission 9*, Attachment 1, *A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, p. 14.

4 Autodesk Asia Pty Ltd, *Submission 4*, p. 2.

5 Jim Plume, Bob Owen, Richard Simpson and Alan Hobson, *Integration of Geospatial and Build Environment: National Data Policy*, Joint buildingSMART and SIBA White Paper, June 2015, pp. 7-8.

6 Jim Plume, Bob Owen, Richard Simpson and Alan Hobson, *Integration of Geospatial and Build Environment: National Data Policy*, Joint buildingSMART and SIBA White Paper, June 2015, p. 8.

> The modelling technology is based on 3D object-relational concepts directed towards capturing the way things fit together three-dimensionally within a broader built environment context, specifically in relation to the operational, design, analysis and management processes that must be supported throughout the life cycle of the constructed facility. This principle applies at all scales, from the component parts to a building (often manufactured and brought to site), through the way those parts are assembled or formed on site during the construction process, to a broader view of how a structure relates or connects to other facilities in its immediate context, or in its broader urban or rural context.[7]

2.13 As this indicates, BIM goes beyond providing detailed construction information and a description of the physical components of a construction project:

> Perhaps more important from an information management perspective are the spatial relationships that are captured in a BIM. This includes explicit definitions of the nature of spaces at appropriate levels of aggregation (e.g. site, building, storey and the internal spaces within a storey), identifying the function or ownership of those spaces and how they relate to other spaces.[8]

2.14 BIM is used in relation to a wide range of infrastructure projects:

> In spite of the traditional focus on buildings, the term BIM is now widely seen to encompass all built environment entities that are constructed to support or house human activities, including buildings, transport infrastructure, civil infrastructure (bridges, tunnels etc.), urban space, utility networks (water, sewerage, energy, communications etc.) and all forms of street furniture and fixtures. The term Virtual Design and Construction is sometimes used to cover this broader view…[9]

2.15 In its submission, Autodesk Asia stated that entire project teams can benefit from the BIM process:

> BIM enables designers and contractors to work together early in the process—relying on an intelligent and integrated 3D project model to assess options and optimise potential construction approaches. By virtually modelling a complex infrastructure

7 Jim Plume, Bob Owen, Richard Simpson and Alan Hobson, *Integration of Geospatial and Build Environment: National Data Policy*, Joint buildingSMART and SIBA White Paper, June 2015, p. 8.

8 Jim Plume, Bob Owen, Richard Simpson and Alan Hobson, *Integration of Geospatial and Build Environment: National Data Policy*, Joint buildingSMART and SIBA White Paper, June 2015, p. 8.

9 Jim Plume, Bob Owen, Richard Simpson and Alan Hobson, *Integration of Geospatial and Build Environment: National Data Policy*, Joint buildingSMART and SIBA White Paper, June 2015, p. 8.

> project in 3D, it is easier for teams to understand what is being designed and observe in a digital environment ways to improve the design. The model can also be used for project coordination, making sure project elements fit together and can be built within the constraints of the existing environment (physical, environmental, legal, and so forth).[10]

2.16 The Strategic Forum argued for the approach to the BIM process that involves entire project teams, known as Project Team Integration (PTI), which is generally defined as:

> A process to facilitate integration and encourage collaborative behaviour and harness the talents and insights of all participants, as well as to reduce waste and optimise project outcomes through all phases of design, fabrication, construction, project handover, and facilities management.[11]

2.17 According to the Strategic Forum:

> The powerful combination of PTI and BIM can significantly reshape the way project teams work together in increase productivity and improve outcomes for all project participants. Utilised together, PTI and BIM are capable of driving the most transformative change the building and construction industry has ever experienced.[12]

2.18 The Strategic Forum noted that Australia and New Zealand, when taken together, 'rank the third highest adopters of BIM in the world', and that Australia and New Zealand both 'demonstrate global leadership in the frequency with which they leverage BIM to visualise design intent.'[13]

2.19 buildingSMART stated that NSW was particularly well-recognised for its use of BIM:

> In NSW, Transport for NSW is another leader in Australia's BIM adoption. This year they will create a dedicated BIM implementation team. Digital Engineering is being used on a range of transport projects, but to this point is has mostly been led by

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10 Autodesk Asia Pty Ltd, *Submission 4*, p. 6.

11 Australasian Procurement and Construction Council, *Submission 9*, Attachment 1, *A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, p. 10.

12 Australasian Procurement and Construction Council, *Submission 9*, Attachment 1, *A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014,, p. 10.

13 Australasian Procurement and Construction Council, *Submission 9*, Attachment 1, *A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, p. 17.

> industry, not Government. Transport for NSW have also included BIM requirements on their latest major projects such as North West Rail Link, the Wynyard Station Upgrade, as a part of the Sydney Metro and on elements of WestConnex.[14]

2.20 Furthermore, in its submission buildingSMART noted that BIM is:

> Now becoming 'business as usual' for a large number of contractors seeking to create savings and efficiencies, and drive greater collaboration, on projects. Projects that have used elements of digital engineering include:
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> - Royal Adelaide Hospital Project
> - Moorebank Intermodal Terminal Project
> - Barangaroo development, including Wynyard Walk
> - North West Rail Link
> - Southern Freight Link
> - Regional Rail Link Victoria
> - South West Rail Link
> - Auburn Stabling Yard
> - New Generation Rolling Stock Stabling, Ipswich
> - Sydney CBD light rail early works
> - Perth Children's Hospital
> - Perth Stadium
> - Perth Museum[15]

2.21 QUT, SIBA and AECOM, in their joint submission, agreed that BIM is becoming standard practice in the private sector, arguing:

> The major private infrastructure construction firms have all implemented some form of BIM into their workflows based on the evidence of cost savings from international experience and other government mandates. However, the extent of implementation on any particular project varies, as does the extent of open standards used and the deliverables provided to clients (e.g., an as-built BIM for full life cycle asset management). They are now looking for guidance from the Australian Government as to how this can be implemented in a standardised way as a consistent means of executing projects.[16]

2.22 Mr Josh Murray, of Laing O'Rourke, told the Committee about a specific example of the use of BIM in a rail infrastructure project:

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14 buildingSMART Australasia, *Submission 10*, p. 3.

15 buildingSMART Australasia, *Submission 10*, p. 4.

16 QUT, SIBA and AECOM, *Submission 49*, p. 13.

> On a train depot that we are delivering for the Queensland government on a public-private partnership model, we built the entire construction model as a digitally engineered asset. […] It is not just a detailed fly through; it can be zoomed into for nuts and bolts accuracy or taken apart piece by piece to examine the components. We recently hosted the end users, including the train drivers, giving them a virtual walk-through. 'Here's where you'll leave the train, here's where you'll walk through the centre and here's where you'll have your lunch and take your breaks.' We tested the visibility of safety markers and stop signs all in a simulation from the same piece of design data that was being used in the field to actually build the facility at the time when nothing existed in an actual, deliverable physical form.[17]

2.23 QUT, SIBA and AECOM stated that more widespread adoption of BIM would lead to significant taxpayer saving:

> There is much evidence, particularly from the UK as to the potential for monetary savings (often quoted as 15 to 20 per cent per project for buildings), more reliable time estimates, improved client and stakeholder satisfaction and reduced risk of variation and legal disputes caused through misunderstandings and different interpretations, particularly of design intent. The reduction of variation from planned time, cost and quality may well be even greater in the delivery of infrastructure other than buildings because over-runs of schedule and budget are so typical.[18]

2.24 Furthermore, those savings refer to capital expenditure on major infrastructure. QUT, SIBA and AECOM also noted the expectation 'that overall 33 per cent could be unlocked' over the lifecycle of the infrastructure asset.[19]

2.25 Specifically, according to QUT, SIBA and AECOM, the use of BIM in the planning and design stages of major infrastructure projects can lead to:

- Decreased cost of procurement;
- Decreased contingency required;
- Decreased cost of programme management overheads;
- Increased stakeholder engagement and confidence;
- Decreased cost of design resources;
- Decreased cost of design materials; and

17 Mr Josh Murray, General Manager, Corporate Affairs, Australia and Asia, Laing O'Rourke, *Committee Hansard*, 21 August 2015, p. 26.

18 QUT, SIBA and AECOM, *Submission 49*, p. 3.

19 QUT, SIBA and AECOM, *Submission 49*, p. 3.

- Decreased cost of duplicate design environments.[20]

2.26 Additionally, QUT, SIBA and AECOM noted the potential benefits of the use of BIM during the construction stage of major infrastructure projects:

- Decreased amount of rework on site;
- Decreased cost of plant;
- Decreased cost of mobilisation;
- Decreased materials used in construction;
- Decreased resources used in construction;
- Decreased number of requests for information;
- Decreased accidents on site;
- Decreased insurance premiums; and
- Increased clarity of test criteria.[21]

2.27 Finally, QUT, SIBA and AECOM outlined the potential benefits of using BIM during the operation of the infrastructure:

- Decreased slips and trips;
- Decreased cost of maintenance;
- Decreased down-time of assets;
- Increased speed of access to the right information;
- Decreased carbon emissions;
- Decreased noise pollution and air quality;
- Decreased impact on habitats;
- Decreased security risks;
- Decreased amount of unutilised data stored;
- Decreased future project costs; and
- Increased confidence of data for decision making.[22]

Geospatial technology

2.28 Geographic Information Systems (GIS) describes information systems that capture, store and display geographic information. A common example of a GIS is Google Earth.[23]

2.29 Queensland University of Technology (QUT) told the Committee about an application it had developed in conjunction with the Queensland Department of Transport and Main Roads (TMR) called Jellyfish, which provides 'a data management framework for transport related data that provides a single point of truth for mapping, modelling, design and operation'. QUT elaborated on its functions:

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20 QUT, SIBA and AECOM, *Submission 49*, p. 4.

21 QUT, SIBA and AECOM, *Submission 49*, p. 4.

22 QUT, SIBA and AECOM, *Submission 49*, p. 4.

23 Google Earth homepage, <https://www.google.com/earth/>, accessed 17 February 2016.

> Geo-spatially enabled data sets can be interrogated, overlaid and analysed to support decision-making from design to operation. Data sharing among all involved parties provides better, more accurate information, thus increasing the efficiency of infrastructure-related projects. The Jellyfish system is in use in Queensland as part of the preparations for the challenging transport task ahead of the 2018 Commonwealth Games.[24]

2.30 Dr Marc Miska, of QUT, told the Committee that Jellyfish is:

> a GIS representation of every physical object that is outside—a piece of road, a traffic light, a streetlight. If you have it geospatially represented then you know where it is and that will not change—except for a drift of seven centimetres a year. You know where it is and then you can start adding attributes to it. The attributes will become more and more rich as the years go by. A couple of years back, the attributes that we were looking into for our roads were very small; we just wanted to know how many lanes there are and how fast you can drive. Unfortunately, most of the road authorities in Australia and worldwide have no idea what the speed limits of their roads are because they do not know where their road signs are.[25]

2.31 Dr Miska told the Committee of his view that:

> GIS is the only representation that I have found over my career that is essentially the common truth that is out there and that we can actually measure. The attributes on top of it will change. But if they change over the years, you can just add attributes, and make them more granular if you want, and it will be sustainable for the future.[26]

2.32 Mr David Hassett, of City of Melbourne, commented on the next generation of GIS, and the significant new capabilities it offers:

> We are now looking at, for example, modelling overland floods. We are able to get very accurate data on services from lidar, from our airborne laser type stuff, and we would want to share this around as well… [T]he sort of capabilities that this would provide to us in the city are better planning and design outcomes. Clearly,

24 QUT, *Submission 19*, p. 1.

25 Dr Marc Miska, Senior Research Fellow, School of Civil Engineering and Built Environment, Smart Transport Research Centre, Queensland University of Technology, *Committee Hansard*, 24 September 2015, p. 9.

26 Dr Marc Miska, Senior Research Fellow, School of Civil Engineering and Built Environment, Smart Transport Research Centre, Queensland University of Technology, *Committee Hansard*, 24 September 2015, p. 10.

> that is the case because we are looking at getting evidence based decisions, not guessing whether my shadow will overshadow your house or occlude your solar panels.[27]

2.33 Geospatial technology such as Global Navigation Satellite Systems (GNSS) are becoming essential to many industries, and also play an important role in other smart ICT such as BIM. Geoscience Australia is responsible for 'geoscience information, services and capability to Australia's most important challenges', and administers several programs designed to:

> …improve the national positioning infrastructure underpinning these technologies and this work is largely driven by a new era of GNSS.[28]

2.34 Geoscience Australia told the Committee of the benefits to infrastructure of maintaining highly accurate positioning abilities through GNSS:

> National access to reliable and accurate positioning information strengthens interoperability, leading to greater productivity, safety and innovation. A piece of infrastructure like a major road for example requires positioning information to design, plan, construct, maintain and use the road. All assets above, below, beside and on the road itself must be positioned with high accuracy and integrity.
>
> Positioning systems also guide machinery and equipment during construction, and monitor the position of assets before, during and after installation (e.g. to detect any hazardous movement). Accurate positioning creates efficiencies at each step in the supply chain by aligning and integrating data for planning, design and verification purposes.[29]

2.35 Furthermore, Geoscience Australia noted that it was necessary to continue to upgrade and build on Australia's current GNSS capabilities:

> Accurate and reliable positioning and location information is essential for agriculture, mining, emergency management, air and sea navigation, surveying, mapping and autonomous road transport. Positioning enables faster and more informed decisions, leading to increased productivity, community safety, innovation and efficiency. Multi-GNSS and the Foundation Spatial Data Framework in particular will eliminate technical, economic and

27 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne *Committee Hansard,* 25 September 2015, p. 19.

28 Geoscience Australia, *Submission 46*, p. 2.

29 Geoscience Australia, *Submission 46*, p. 3.

> institutional barriers that prohibit these benefits been accessed on a national scale.
>
> Multi-GNSS is enabling greater access to more signals from multiple constellations. Each system has unique characteristics that increase positioning accuracy when combined, thereby reducing vulnerability to single system failure. More signals across the sky leads to better coverage on the ground, particularly in obstructed environments. The opportunities for Australia are profound.[30]

Internet of things

2.36 The Internet of Things (IoT) refers to the network of physical objects—including smartphones, cars, computers, televisions, even refrigerators—that are embedded with software or sensors, are connected to a network, and are capable of sending and receiving data. According to the UK Government' Chief Science Advisor, the Internet of Things:

> …is made up of hardware and software technologies. The hardware consists of the connected devices – which range from simple sensors to smartphones to wearable devices – and the networks that link them, such as 4G Long-Term Evolution, Wi-Fi and Bluetooth. Software components include data storage platforms and analytics programs that present information to users.[31]

2.37 Dr Economou, of National ICT Australia (NICTA), described the IoT as bringing the digital and physical economies together:

> One side is the digital economy, which is all about software and media and smartphones and computers and new kinds of virtual services. The other side is the physical economy, which is the world of things. What is happening is that those two worlds are actually merging, and they can work off each other. Uber is an example, where taxis now are driven by smartphones, but that is just the very beginning. The thing is that all that digital technology can optimise the way you act in the physical world. If we optimise our smart infrastructure, we get more for less by being clever. That is how we position Australia for a productivity dividend.[32]

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30 Geoscience Australia, *Submission 46*, p. 4.

31 UK Government Office for Science, *The Internet of Things: Making the most of the second digital revolution*, December 2014, p. 13.

32 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 25 March 2015, p. 3.

2.38 Dr Wenham, of Australian Academy of Technology and Engineering (ATSE), noted the potential efficiencies that the IoT could help achieve:

> …as the internet of things or the internet of everything becomes more widespread and grows and we have more devices, appliances, vehicles and pieces of machinery and infrastructure connected to the internet, that will present a number of opportunities around cost savings and different ways of using infrastructure, but it will also present some challenges in dealing with the data that is produced, who looks after that and how it is used.[33]

Machine learning

2.39 Machine learning is a powerful new ICT tool, which allows large volumes of data to be analysed and patterns in the data identified, in a way that far surpasses the capacity of human operators and analysts.

2.40 According to Dr Economou:

> Machine learning is a form of artificial intelligence. It is algorithms and software that can learn from past data to predict future behaviour, and that data can be anything. This is really useful for because, now that we are getting more and more data from more and more sources, you can fuse together that data and then you can start to look for patterns and make predictions about the future. So you could predict future demand much more confidently than before. That is very important.[34]

2.41 NICTA described machine learning as facilitating:

> …evidence based decision making in the presence of uncertainty. It does this by combining disparate pieces of information and distils the results in a way to make better decisions. Machine learning is the science that banks and retailers use to predict take up of new products and services to great effect. The power of machine learning stems from its capacity to use all available data to make predictions, far beyond the power of conventional statistical techniques.[35]

2.42 NICTA discussed an example of the use of machine learning in demography:

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33 Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technological Sciences and Engineering, *Committee Hansard*, 25 September 2015, p. 7.

34 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia (NICTA), *Committee Hansard*, 25 March 2015, p. 3.

35 NITCA, *Submission 23*, p. 6.

> For example, applying machine learning techniques to demographics generates better insights into brownfields urban growth rates ('urban infill') and can help inform planning for greenfields urban development. These techniques can make effective use of a much wider range of input data sources than existing practice based on conventional statistical techniques. Presenting this information in 'spatially rich' contextual environments, fusing data from multiple sources and developing analytics tools to support data-driven decision making will unlock new levels of infrastructure insight into demand.[36]

2.43 Dr Economou, of NICTA, told the Committee about how machine learning was applied to urban planning in southwest Sydney:

> [O]ur machine learning people – who are not demographers, urban planners or anything – were just asked to look at how dwellings are changing based on public domain information. There is nothing here we even bought; it was all on the web. They looked at development applications in southwest Sydney and a bunch of other economic factors, and what came out of it was that a prediction that… Camden is going to be a hot spot for population growth in 2016. […] What that means is that, if you are Sydney Water, a road authority or whatever, you have a little bit of a heads up on where the demand is going to go. It could be that that means you might need to provide more classrooms or more beds in a hospital as well.[37]

Mobile laser scanning

2.44 Mr David Purnell, of BCE Surveying, explained mobile laser scanning (MLS) for the Committee:

> It is a state-of-the-art vehicle mounted system, and it combines high resolution photography with a highly accurate laser and a very highly accurate GPS system. It is an innovative technology that is a major advancement and has the potential to significantly change the way that people capture this type of information in the future. Whilst it is probably at the start of its life cycle, we can see that these types of systems are now being utilised in things from smart cars to automated transport systems. Automated vehicles,

36 NITCA, *Submission 23*, p. 7.

37 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 21 August 2015, p. 8.

> mine site automation and things like that are all using these types of technologies to advance their productivity.[38]

2.45 Mr Purnell also described what he considers the three main features of MLS:

> The number one feature is its accuracy. We have been able, through refinement and development of our workflows, to get survey accuracy within this particular system which is really unprecedented amongst most of these systems. Main Roads, one of our main clients, have an audit and test facility, and that is managed for them by Curtin University… They have tested the BCE [MLS] system and found it to be the best system in achieving this survey-grade accuracy.
>
> The secondary feature is just its comprehensiveness. The amount of information that it can capture and the detail that it can capture cannot be replicated by any traditional survey means. Even if we go and take photos, the photos that you get are not enabling the type of measurement analysis that this system enables.
>
> A third feature is that it is fast. Fundamentally, we call it a rapid capture device. We were describing 200 kilometres of road, and that is a fairly reasonable two-lane highway, with 200 kilometres in a day at survey grade accuracy. That type of survey would take thousands of man hours, and then postprocessing it and then trying to deliver that dataset within the constrained time frames that many businesses are now facing are often a challenge as well.[39]

2.46 In terms of how this technology can be applied, Mr Purnell stated that it was:

> …a solution waiting for some problems. So far we utilise it in the capture of as-built and as-constructed information, for inventory assessment, for inspection, for audit, for encroachment, for dilapidation and for analysis and asset management, but there are many other applications that we are rapidly finding for this particular capture device. Whilst the traditional markets that we are in are the hard infrastructure, the physical infrastructure, such as the road, the bridges, the rails and the utilities, including underground utilities and infrastructure, the newer markets that

38 Mr David Purnell, Perth Survey Manager, BCE Surveying Pty Ltd, *Committee Hansard*, 4 September 2015, p. 2.

39 Mr David Purnell, Perth Survey Manager, BCE Surveying Pty Ltd, *Committee Hansard*, 4 September 2015, p. 2.

> are emerging are around the flood plain mapping, disaster planning, issues with measuring biomass, environmental degradation, and land use planning.[40]

2.47 Mr Purnell also noted that the key benefit of using MLS is its efficiency:

> It is a changing paradigm for surveyors to be able to move from the very field intensive system into this notion of 'capture once and use many'. Being able to drive the corridor, drive the street, drive the site and capture the data and then being able to use it for environmental, for infrastructure, for engineering and for architecture purposes for a host of different clients and a host of different outcomes has been a big change in the mindset for the industry. We are extracting intelligent information and, in many cases, we can extract it automatically as well. The value of the system, we believe, is in its ability to rapidly capture this high quality data.[41]

Opportunities

2.48 Smart ICT offers a range of opportunities for realising efficiencies and improving processes in a large number of sectors, including transport networks and infrastructure, urban planning, export of services, and construction. Dr Economou discussed the importance of changing the way we view infrastructure:

> The idea is that infrastructure is more than a physical thing. We have all seen people pouring concrete. Economic activity is good. Everybody likes that. But around that concrete and steel there are now systems that do measurements and that control and manage the interface for the people who use the infrastructure.[42]

2.49 Dr Economou continued:

> We think it is important to take a broader view and a longer term view of what infrastructure is beyond the poles, wires, pipes and all that kind of stuff. It is about the smart stuff around the

40 Mr David Purnell, Perth Survey Manager, BCE Surveying Pty Ltd, *Committee Hansard*, 4 September 2015, p. 2.

41 Mr David Purnell, Perth Survey Manager, BCE Surveying Pty Ltd, *Committee Hansard*, 4 September 2015, p. 3.

42 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 21 August 2015, p. 4.

> infrastructure that lets you use it better but also allows you to control the demand for those resources intelligently.[43]

Visions of the future

2.50 A range of submitters to this inquiry presented their thoughts on what could be achieved through using smart ICT in a more comprehensive way. Submitters to this inquiry put forward examples of the use of smart ICT that will improve Australia's urban, regional and rural areas, ranging across such areas as transport systems, housing, agriculture, water and power grids.

Smart cities

2.51 Given that around 80 per cent of Australians live in urban areas, a particular focus of the evidence received was the use of smart ICT in planning more efficient and liveable cities – so called smart cities.

2.52 Furthermore, as noted by Dr Economou, infrastructure needs in Australia's cities will certainly grow:

> The thing is that our cities are growing. By 2050, Sydney and Melbourne, and Perth too, are forecast to have double the population. However, roads and other kinds of infrastructure cannot possibly double. So we have to use smart ICT to inform where and how to increase the utilisation of our assets and also to inform new investment so we make the best possible use of scarce money. I will not go through all the themes because it is quite complex, but the common issues that are hitting everybody who has to deal with infrastructure and use it are that we have congestion and we have excessive demand.[44]

2.53 Dr Michael Dixon, of IBM, told the Committee about its Smarter Cities vision, and that building smart cities will transform our urban environments:

> In simple terms, Smarter Cities is about applying the currency of the 21st century data to all manner of challenges historically faced by cities in order to make traditionally dumb things smart and enable everything, from machine to machine communication through to the most sophisticated predictive modelling. In turn, ICT is providing management information and decision support

43 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 21 August 2015, p. 5.

44 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 25 March 2015, p. 3.

> systems which increasingly optimise existing systems, enable the design of new and advanced systems and provide the ability for the interaction of such systems across a city. While the underlying technology is very sophisticated, the effects of its applications are readily identified. The results are obvious in better services, better cost efficiencies and cities that distinguish themselves for their liveability, vitality and economic prosperity.[45]

2.54 Dr Ben Guy, of Urban Circus, told the Committee that smart ICT gives governments and planners the 'power to manipulate space, manipulate cities and manipulate infrastructure in a very efficient way'.[46]

2.55 Professor Tan Yigitcanlar discussed the example of South Korea as one where smart cities are built from scratch, noting that it has sought to make smart ICT capabilities the basis for planning new urban centres:

> Their goal is very ambitious. They choose to develop new towns from scratch—with the attractive brand of 'Ubiquitous Cities'. For a while they called them 'Ubiquitous Eco-cities', and then they dropped the 'eco'. They are developing everything from scratch. I think government is available to purchase land—or maybe they are developing the government's own land. With the help of the major developing company and the IT company—they are large companies—they are investing in the development of new towns. In terms of technology and city development, maybe they look more advanced. But the major criticism is that they are creating enclaves of elite people. These areas are not affordable for the general population.[47]

2.56 Professor Yigitcanlar also noted that Barcelona and San Francisco provide good examples of ICT being utilised to make existing cities 'smarter':

> In Barcelona there is the 22@ precinct. It was a brownfield development. An old industrial area close to the city centre was converted into a creative industry innovation district. It is one of the famous ones around the world. They use quite a lot of green technologies to build green buildings and the space there. And they have smart parking. A similar example exists in San Francisco as well. Basically, every parking lot has an RFID chip that sends signals and with your mobile phone you can find the right parking spot. Apparently, people spend 30 per cent of their journey time to

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45 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 44.

46 Dr Ben Guy, CEO, Urban Circus, *Committee Hansard*, 24 September 2015, p. 1.

47 Professor Tan Yigitcanlar, Private capacity, *Committee Hansard*, 24 September 2015, p. 21.

> find parking. So that is a big cost saving and it prevents a lot of emissions from going into the atmosphere and so forth. So things that look small and relatively unimportant might turn out to have a combined impact that is quite important.[48]

2.57 Dr Dixon discussed an example of the use of smart ICT in Madrid, Spain, where municipal authorities switched from an input based system for dealing with public bins to an output based approach. This involved determining that the authorities were seeking to have 3000 of their bins emptied twice a week, and would pay for 6000 bins to be emptied weekly. It was then identified that only 20 per cent of the bins being emptied were actually in need of emptying, and IBM told the Committee about the solution to this issue:

> We then put sensors in the bins, and that has dramatically reduced the cost to government because they are emptying many fewer bins. The service provider is much happier because they have now optimised their cost in providing a service and their profit is higher because they have optimised their business.[49]

2.58 Dr Dixon discussed how the community was engaged in the project in innovative ways:

> The community loves it. If someone has a party in the park they are straight onto Instagram sending a photo on to the business process and workflow and the supplier goes and sorts it out. Innovation in that regard was, 'We don't want any rubbish in the city; sort it out' as opposed to saying 'This is what we want.'[50]

2.59 Furthermore, Dr Dixon stated that this approach could be extended to other areas of infrastructure management as well:

> It is the same for streetlights, potholes, playgrounds and another 162 variables. When we talk about innovation it is more about governments finding the right words to say, 'Help us solve the problem' rather than telling us down to the subatomic level what it is they need, which makes it very difficult for companies like [IBM] to provide innovation.[51]

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48 Professor Tan Yigitcanlar, Private capacity, *Committee Hansard*, 24 September 2015, p. 22.

49 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 47.

50 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 47.

51 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*,25 September 2015, p. 47.

2.60 When it comes to integrating smart ICT into cities, Professor Yigitcanlar posits two potential approaches: that used primarily in Asia of building from scratch with the necessary smart-enabled infrastructure; and the Western approach of retrofitting existing cities with smart technology.[52]

2.61 In the case of Australia's cities, Professor Yigitcanlar told the Committee that the second approach of integrating smart ICT into existing cities would be more suited to Australian conditions.[53]

2.62 Associate Professor Hussein Dia, of Swinburne University of Technology, also supported the idea of making Australia's existing infrastructure technology-enabled:

> I think that the case for smart infrastructure, or when we converge the physical and digital infrastructure with user elements, is very compelling… [B]ased on a very large number of case studies from Australia and around the world, the benefit-to-cost ratio for the technology approach is, on average, around nine to one. So for every dollar that the taxpayer invests the return on that investment is nine dollars.[54]

2.63 Furthermore, Professor Dia noted that retrofitting existing infrastructure is far cheaper than building new infrastructure:

> When we build a new tunnel, like the previous case in Melbourne, you start talking about billions of dollars. With a technology approach it is $100 or $200 million, so the initial capital outlay is actually much smaller.[55]

2.64 Organisations such as the Australian Urban Research Infrastructure Network (AURIN) are positioned to play an important role in realising these visions of the future when it comes to urban development. Mr Andrew Dingjan, of AURIN, noted that AURIN seeks to provide:

> Programmatic online access to spatial data relating to almost every aspect of Australian society, built environment and infrastructure; data from multiple sources across all jurisdictions; and the ability to integrate those data and interrogate them using state of the art statistical spatial analysis and modelling tools with advanced visualisation.[56]

52 Professor Tan Yigitcanlar, Private capacity, *Committee Hansard*, 24 September 2015, p. 20.

53 Professor Tan Yigitcanlar, Private capacity, *Committee Hansard*, 24 September 2015, p. 20.

54 Associate Professor Hussein Dia, Centre for Sustainable Infrastructure, Swinburne University of Technology, *Committee Hansard,* 25 September 2015, p. 26.

55 Associate Professor Hussein Dia, Centre for Sustainable Infrastructure, Swinburne University of Technology, *Committee Hansard,* 25 September 2015, p. 26.

56 Dr Andrew Dingjan, Director, Australian Urban Research Infrastructure Network, University of Melbourne, *Committee Hansard,* 25 September 2015, p. 34.

2.65 NICTA is currently using a wide range of data to produce more robust demographic predictive modelling in areas such as 'predictive maintenance, crime prediction and predicting where road incidents will occur'. It described this approach to the Committee:

> Working with a planning agency in one Australian state, NICTA is building a dwelling production infill model incorporating data-driven planning assumptions and methods. This more fine-grained model uses many more data sources as input than is possible with conventional techniques and will be used to better inform infrastructure project selection across all classes of infrastructure including school asset planning.[57]

2.66 Dr Economou discussed how this is superior to current modelling methods:

> Currently people who build roads and run roads have incredibly detailed simulation models of those roads. It is down to the position of the lanes, where the traffic lights are, where the loop sensors are, where you can turn left. It is like a Meccano set of the road built in a computer. The issue is input. You make assumptions about how the traffic is behaving, and those assumptions are quite simplified. If your modelling about some big piece of infrastructure is about what is going to happen in 20 years, you want to use all the available evidence about how the traffic is going to change on that infrastructure. If you are not using all the available information properly, how can you get the best possible answer? What we are saying is that there is information that you could be using and integrating into those models about how traffic is going to move around and change in the future, but at the moment that is not generally being done.[58]

2.67 This approach is already achieving results:

> The prediction method is based on discovering relationships between all potentially relevant data and the historical record of where and when new dwellings have been developed in existing urban areas. NICTA applies machine learning and data fusion techniques to discover these relationships and builds the models, working with, and informed by planning experts. Machine learning models can be trained with historical data, allowing predictions to be compared against the historical records and

57 NICTA, *Submission 23*, p. 6.

58 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 21 August 2015, p. 6.

> current departmental assumptions, and generating estimates of confidence in the modelling output and a view of which input factors are most relevant.[59]

2.68 The City of Melbourne has made considerable advances towards integrating smart ICT into its infrastructure, and thus towards becoming a smart city. Mr Austin Ley of City of Melbourne told the Committee:

> Our vision for the City of Melbourne is to function as a smart city, and by this we mean that the city uses ICT to enhance liveability and achieve our sustainability goals. We aspire to achieve global recognition for our ability to capitalise on opportunities presented by smart ICT not just as an enabler for our own efforts in infrastructure management, but also as a mean, with external stakeholders, to jointly address the issues facing the city or to meet their own business needs.[60]

2.69 In order to achieve this vision, the City of Melbourne sees a need to shift from being builders of ICT systems to 'being consumers of services provided by third parties'. In terms of pursuing this shift, Mr Ley stated:

> There are some major trends shaping the innovation landscape for cities. These include rapid developments in ICT, smart and mobile devices, sensing, cloud computing and other internet technologies, along with human capital that exploits them. These trends have created new possibilities for collaborative action. Complex urban challenges can now be addressed by smart communities comprising hyperconnected, technologically agile and often entrepreneurial innovators.[61]

2.70 As a result, the City of Melbourne has established smart city office which incorporates 'research, innovation and geographic information systems', and collaborates with 'industry and the university and community sectors to encourage experimentation and the generation of ideas and solutions to infrastructure management issues'.[62] Mr Ley elaborated on the work of this office at a public hearing:

> City of Melbourne employs applications to spatially and temporally model objects, behaviours, relationships and

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59 NICTA, *Submission 23*, p. 6.

60 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 13.

61 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,*, 25 September 2015, p. 13.

62 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 13.

> dependencies. We also employ applications that enable designs to be scalable, agile, interactive and immersive, and web enabled.[63]

2.71 Currently, the City of Melbourne's smart city office focuses on the following areas:

> …open data; engagement with and the involvement of external players; development of urban spaces that are ICT enabled; high-bandwidth connectivity, both wired and wireless; using ICT to enhance performance; responding to both the positive and negative disruptive impacts of emerging business models on the city; and exploiting ICT to encourage coordination and shared service delivery between governments.[64]

2.72 At present, the City of Melbourne is already using smart ICT in a variety of ways, including asset management, integrated parking, design, mapping, modelling, public tools for wayfinding, and community engagement'.[65]

2.73 The City of Melbourne raised a case study of an instance where it had deployed smart ICT:

> City of Melbourne established *CityLab*, an internal innovative 'practice', in 2013 with the broad general objective of enabling the city to be faster, leaner, more productive, more innovative, more collaborative and more agile. Our *CityLab* team works with internal and external partners to provide a means by which new approaches and technologies can be prototyped and trialled within creative, yet risk-controlled environment.[66]

2.74 A number of projects have already been delivered under the *CityLab* initiative, including:

- 'Open data' with the developer and academic communities;
- Sensor deployment for the Internet of Things project with ARUP and Melbourne University;
- Maker exploration project with Second Muse and the Melbourne maker community; and
- Accessible Navigation project with Studio Thick and members of the accessibility community.[67]

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63 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 14.

64 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 13.

65 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, pp. 13-14.

66 City of Melbourne, *Submission 35,* p. 5.

67 City of Melbourne, *Submission 35,* p. 5.

2.75 Another smart ICT-enabled initiative pursued by City of Melbourne is pedestrian counting. This initiative measures pedestrian activity via data from 42 wireless pedestrian counting sensors. According to City of Melbourne:

> This web-based tool is specifically designed to allow external stakeholders as well as the public to visualise pedestrian patterns at all locations at any given time and day. It is a valuable tool for a range of data users. Retailers, for example, might use the data to identify or anticipate staffing and resource requirements or to develop marketing strategies to maximise their exposure.[68]

2.76 Enhancing the liveability and quality of life in urban spaces has been a focus for City of Melbourne in its application of ICT assets to urban issues. For example, Mr David Hassett, of City of Melbourne, told the Committee:

> Most [urban planners] like to look at quality of life. I think there are other factors and drivers. How much blue sky will be lost in a city if a 40-storey building goes up in the street? I look at that and I can calculate that these days. They become part of the inputs into better decision making, so we all feel happier on our streets. I think these technologies will give us a while range of other things as well.[69]

2.77 Many of these applications of smart ICT are dependent on reliable data being shared. Thelack of a 'single data of truth' has been an impediment for City of Melbourne:

> I think it is absolutely critical that, when we are comparing things, we are all using the same data sources to get the same results. At the moment, we are using disparate data sources and we come up with different answers.[70]

2.78 However as the technology— and urban planners' ability to adapt this technology— advances, it enhances urban planning capabilities:

> In the early days a lot of this tuff was about simulation and visualisation. A lot of people might have had trouble reading plans in 2D because they are quite complex, but in a 3D model, or something of that nature, you can visualise it and you can understand what is being proposed. What I think we are going to see is a shift towards what we would call parametric models.

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68 City of Melbourne, *Submission 35,* p. 5.

69 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne, *Committee Hansard*, 25 September 2015, p. 19.

70 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne, *Committee Hansard*, 25 September 2015, p. 19.

> These are models which will enable us to model scenarios, test assumptions and, as I said before, build the thing in the virtual world before we commit enormous resources on occasions to measure when we may not be sure if they are going to work.[71]

2.79 In addition to using smart ICT to enhance urban life in Melbourne, City of Melbourne has also opened up its data to other users through the development of an Open Data Portal. City of Melbourne states that this portal:

> …allows municipal data to be publicly available. This initiative has the general objective of encouraging wider dissemination of data and encouraging its wider re-use. While demonstrating greater transparency and fostering accountability, it may also drive innovation and economic opportunities and lead to a more cost effective, efficient and responsive local government.[72]

2.80 Free wireless internet coverage across the City of Melbourne is another initiative currently being pursued in a partnership between the Victorian Government and the City of Melbourne. The aim of this initiative is further 'supporting tourism and the education sector as well as increasing social inclusion and encouraging new business models'.[73]

2.81 In terms of future development, the City of Melbourne is seeking to identify new ways of exploiting ICT to improve the urban environment, including by:

- Undertaking community engagement and digital democracy campaigns;
- Developing a digital council prototype that guides our online and social media presence;
- Building a more secure online account system for residents and ratepayers; and
- Moving high volume work to digital platforms.[74]

2.82 Melbourne's progress in implementing ICT solutions to urban issues has been recognised by the recent award of an IBM Smarter Cities Program grant. The grant willassist in the development of its 'understanding of community engagement processes, specifically related to anticipation and coordination of municipal responses' to extreme events, and to minimise their impact on health, safety, infrastructure and the economy.[75]

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71 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne, *Committee Hansard*, 25 September 2015, pp. 19-20.

72 City of Melbourne, *Submission 35,* p. 6.

73 City of Melbourne, *Submission 35,* p. 6.

74 City of Melbourne, *Submission 35,* p. 7.

75 City of Melbourne, *Submission 35,* p. 7.

2.83 City of Melbourne is currently partnered with academia in a three year ARC project called 'Creating a Smart City though the Internet of Things'. This project installs solar powered sensors 'to collect real time data on temperature, light and humidity in the Fitzroy Gardens and in the Docklands precinct'.[76]

2.84 Brisbane has also made significant achievements through the application of smart ICT to infrastructure issues. Although the Brisbane City Council has been using GIS and CAD for the last 30 years:

> Rapid improvements in data storage capacity and processing power associated with those technologies has facilitated the ability to more effectively utilise 3D and 4D modelling techniques and simulations. Council maintains a virtual 3D model of the city, enabling Council to visualise new infrastructure proposals and better engage and consult with key stakeholders and citizens to ensure the best outcomes for the city.[77]

2.85 Brisbane City Council is currently applying this technology in the following areas:

- Location of buses and ferries;
- Traffic flows, travel times and congestion on major roads, bridges and tunnels;
- Water and air quality;
- Flood levels in the city's rivers and creeks;
- Energy and water consumption; and
- Waste management services and management of landfill.[78]

2.86 In terms of future developments, Brisbane City Council is seeking to leverage the greater availability of sensory data and improved data collection capabilities to further enhance local governance. It stated that:

> In addition to Council sensors, use of smart consumer technologies through purpose built smartphone applications enable residents to directly report on the condition of city assets (eg potholes on roads) and through crowdsourcing applications provide Council with data to support more effective infrastructure planning.[79]

2.87 Similarly, this data will result in economic and community benefits:

> Council has recognised the opportunity for Brisbane businesses, residents and visitors to utilise Council's information as an enabler of greater economic and community benefit and has invested in its

76 City of Melbourne, *Submission 35,* p. 6.
77 Brisbane City Council, *Submission 34*, p. 4.
78 Brisbane City Council, *Submission 34*, p. 4.
79 Brisbane City Council, *Submission 34*, p. 5.

> open data services. Council is committed to publish open data that provides most value and has recently upgraded its open data portal and released 70 categories of information including real time traffic and ferry information.[80]

2.88 Brisbane City Council expects that adopting cloud-based ICT applications has the potential to 'fast track the introduction of new smart ICT capability', in turn leading to 'more mature, modern work practices and more efficient services'.[81]

Smart regional and rural areas

2.89 In addition to increasing the economic and social prospects of cities, many submitters to this inquiry noted the importance of smart ICT capabilities in helping further develop Australia's regional and rural areas. In areas such as smart power grids and the use of smart ICT in building and maintaining roads, the benefits in regional and rural areas are similar to those outlined above for urban areas. However, the challenges of applying them to regional and rural areas are greater than in urban areas, largely due to a lack of in-house expertise and capacity.

2.90 Mr Ley discussed one way in which Australia's regional areas could be strengthened using smart ICT:

> The difficulty is the communications side. Smart ICT has the ability to overcome that communication element and to enable people to connect and work and live wherever. So I think that it has the ability to enable people to live in regional areas and to connect to the other areas where business is occurring.[82]

2.91 Ms Lorraine Tighe of City of Melbourne stated that many regional councils are 'struggling', and that ICT can help 'deliver services more effectively for their communities'. Conversely, Ms Tighe noted that the right expertise and infrastructure may not currently exist for many regional councils:

> A lot of these regional councils have one IT person who does everything for them, but part of the issue is them having available fast networks—cloud-based services and so on. So there is real opportunity here to share services across councils and regional

80 Brisbane City Council, *Submission 34*, p. 5.

81 Brisbane City Council, *Submission 34*, p. 5.

82 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 16.

> Victoria, but it is about having that infrastructure in place, and that is not there today.[83]

2.92 In addition to sharing services between councils, there has been a focus on developing the required capacity within local councils:

> The University of Technology Sydney has a facility for local government research. We have worked with them to try to share information and look at how other local governments might develop research capabilities. The difficulty often is that they are, unfortunately, not as well equipped as the City of Melbourne is, and the individuals, are not necessarily researchers or people who are in the information space specifically. They are usually policy people or people who are doing their area or implementing particular activities and services of the councils.[84]

2.93 Agriculture was one area where the application of smart ICT could see significant gains for Australia's regional and rural areas. The ATSE told the Committee that:

> The development of ICT systems could also be applied to Australia's agricultural sector to place Australia in a competitive position as a global producer. The sector faces pressures on the availability of natural resources for agricultural production, due to drought, changing land and water use patterns, competition from other industries, increased input cost (eg energy and nutrients), and environmental degradation.[85]

2.94 Specifically, ATSE stated that:

> ICT use can assist in the development and use of innovative farm management techniques and technologies, including robotics and sensor networks, precision tracking systems and post-farm gate techniques and technologies, including food processing, transport and storage.[86]

2.95 Currently, a range of ICT is being applied to agriculture in Australia. According to ATSE:

> Unmanned aerial vehicles or drones are already used in the agricultural sector to collect information relating to soil type boundaries, 3D profiles and crop vigour, among others. The

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83 Ms Lorraine Tighe, Program Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 17.

84 Mr Austin Ley, Acting Manager, Smart City Office, City Strategy and Place Group, City of Melbourne, *Committee Hansard,* 25 September 2015, p. 18.

85 ATSE, *Submission 13*, pp. 3-4.

86 ATSE, *Submission 13*, p. 4.

> power of the data generated lies in the analysis. Communication technologies and the necessary infrastructure that underpin field robotics applications will be a major limiting factor in the use of Australia's innovative technologies at home and globally.[87]

2.96 In the future smart ICT will enable the achievement of further efficiencies:

> Recent advances in technology now make the management of soil on an industrial scale possible. In the near future, 'big data' analysis, combined with a range of soil sensing technologies and 3D soil mapping, will provide farmers with a view of the soil system in their paddocks in real time. While the scientific and technical capability to achieve this largely exists already, government planning and investment to link up relevant information systems, education for farmers and a regulatory framework for data management will be needed.[88]

2.97 NICTA put forward two steps that Australia could take to use smart ICT to increase agricultural productivity and competitiveness:

- Developing a more robust decision-support tool for farmers fusing historical data sets (weather, soil types, crop yields, and so on) in a far more granular way that has been done to date, providing more robust prediction capability to increase future crop yield; and
- Superior supply chain management to reduce the cost of exports and increase global competitiveness. While it costs more to move a container of good 20 kilometres across a metropolitan city than it does to ship that container from an Australian port to Shanghai, we have work to do. NICTA's work developing port community systems is a ready example of how Australia can inject smart ICT to better design and planning of agricultural supply infrastructure.[89]

2.98 Optimisation, or 'the science of being able to take all these constraints and conflicting factors and getting the best answer possible', is one means of making transport and logistics more efficient, thus increasing the viability of agriculture and other industries in Australia's regional areas. According to NICTA, these methods can not only improve the functioning of ports and urban transport networks, they are 'completely applicable to rural and regional supply chains as well'.[90]

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87 ATSE, *Submission 13*, p. 4.

88 ATSE, *Submission 13*, p. 4.

89 NICTA, *Submission 23*, p. 13.

90 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard*, 21 August 2015, p. 10.

2.99 In terms of improving freight and logistics, DIRD informed the Committee about two initiatives being pursued:

> With Austroads funding, the Department is currently managing a project to investigate the impact of enhanced end-to-end supply chain visibility technology in a real-time industry pilot being coordinated by the Australian Logistics Council and Global Standards One (GS1) Australia. This project will quantify the benefits to multi-modal supply chain efficiency through improved tracking of freight and associated activities, and assess whether such benefits would be achieved through adopting a national standard for end-to-end supply chain visibility technology. Project findings are expected for release in early 2017.
>
> The Department is also collaborating with Australian ports and the Department of Foreign Affairs and Trade on establishing an 'e-ports' network in the Asia Pacific Economic Cooperation region. This would see the sharing of real-time data to better connect the network of container ports with Shanghai – the world's largest container port.[91]

2.100 The Victorian Minister for Planning, the Hon Richard Wynne MP, told the Committee of two Victorian Government initiatives involving smart ICT which will particularly benefit regional and rural areas of Victoria: Land Capability Modelling (LCM) and GPSnet.

2.101 According to Mr Wynne, 'LCM is a simple but effective query and modelling tool that allows land capability to be assessed' according to multiple characteristics via a single platform:

> The core capability of LCM is to bring together into a single cohesive platform the broad range of information inputs necessary for effective decision-making, planning, modelling and management.[92]

2.102 Currently, datasets from a range of agencies, including the Bureau of Meteorology, the Australian Bureau of Statistics, Land Services, and the Victorian Spatial Data Library, have been incorporated into LCM, and Mr Wynne further noted that:

> Almost any data can be brought into its spatial modelling environment, including:
>
> - Environmental;
> - Natural resource;
> - Emergency management;

91 DIRD, *Submission 28*, p. 9.

92 The Hon Richard Wynne MP, *Submission 24*, p. 2 and 5.

- Infrastructure and assets;
- Planning;
- Weather and climate; and
- Socio-economic and demographic.[93]

2.103 During the pilot for the LCM program, the five use cases, 'designed to validate the expected benefits to be achieved from LCM', were:

- Strategic Agricultural Land Management;
- Agricultural Stress Monitoring;
- Strategic Planning;
- Natural Resource and Environment Management; and
- Emergency/Risk Management.[94]

2.104 The use case owners' assessment of the LCM pilot reported the following benefits:

- Improved data access across the wider Victorian public service;
- Rapid sharing of new models/processes/policies;
- Single source of truth;
- Reduced duplication;
- New insights;
- Improved strategic risk planning; and
- Messages, findings and decision-making are supported by evidence.[95]

2.105 The second initiative, GPSnet 'provides Victoria-wide. Real-time, high-precision (2 centimetre) location and position services.' Mr Wynne told the Committee:

> GPSnet is in broad general use, with most take-up in precision agriculture, water and energy utilities, the survey and construction industry and logistics/transportation. GPSnet offers significant productivity savings for asset and infrastructure operators.[96]

Transport

2.106 Transport network improvements are likely to be made more efficient by the application of smart ICT capabilities. Urban transport networks, public transport, and freight transport networks all stand to benefit from new technologies and processes like BIM, the IoT and machine learning.

2.107 IBM explained how machine learning can be applied to data gathered via the IoT to improve transport systems:

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93 The Hon Richard Wynne MP, *Submission 24*, p. 2.

94 The Hon Richard Wynne MP, *Submission 24*, p. 5.

95 The Hon Richard Wynne MP, *Submission 24*, p. 12.

96 The Hon Richard Wynne MP, *Submission 24*, p. 2.

> ICT and the Internet of Things (IoT) empowers us to infuse intelligence into our entire transportation system by instrumenting it with sensors, meters, appliances, cameras, smart phones, biometric devices- giving us the ability to measure, sense and see the exact condition of everything. Instrumentation is about sensing what is happening right now, whether it is the temperature of a train wheel bearing, the location of a misplaced suitcase, metal fatigue in a bridge.
>
> At the same time, sophisticated analytic systems can detect patterns and relationships and enable continuous decision making in near-real time. We can better plan routes and schedules, reduce congestion and optimise vehicles, equipment and facilities to expand capacity. These new traffic systems can improve drivers' commutes, give better information to city planners, increase the productivity of businesses and raise citizens' quality of life.[97]

2.108 As an example, Professor Dia discussed the potential offered by intelligent transport systems (ITS):

> We have ITS, which have been around for 20 years. I think they are very well accepted in the industry and acknowledged as a means to reduce our reliance on building new roads. Again, roads are limited even by physical space in some cases. The main issue is how we actually do this paradigm shift into the technology space. So far the approach has been on a project-by-project basis. In Melbourne, we have a number of exciting projects. We have the Monash Freeway, which is a fully managed, or controlled, motorway. The benefits have been around 42 per cent reduction in travel times, and the benefits in financial terms have been very good as well.[98]

2.109 Transurban also noted the potential offered by the implementation of ITS in existing road infrastructure:

> The implementation of ITS on road networks optimises traffic flow, enhances the management of road space and creates extra capacity within the existing footprint, with little impact on the surrounding environment and minimal disruption to the public. ITS also effectively builds resilience into the network by controlling traffic flow and volumes at critical bottlenecks.[99]

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97 IBM, *Submission 2*, p. 5.

98 Associate Professor Hussein Dia, Centre for Sustainable Infrastructure, Swinburne University of Technology, *Committee Hansard,* 25 September 2015, p. 26.

99 Transurban, *Submission 47*, p. 2.

2.110 Transurban explained how ITS can be used to make a 'smart' road:

> Smart roads use a freeway or lane-use management system with variable speed signs, overhead lane use signs and ramp metering to ensure traffic is moving as safely and efficiently as possible.[100]

2.111 A major component of ITS's ability to reduce travel times is using traffic data to make traffic flows more efficient. According to Professor Dia:

> [I]n a city like Melbourne, Sydney or Brisbane, the signals could be linked to a computer system. […] Essentially it is linked to a computer on the side of the road that measures the number of vehicles that are needing to use the facility, in the background it has a lot of smart algorithms and software that can optimise the travel for these vehicles – for example by providing a green wave so that if your vehicle is travelling at a certain speed then you are met with a green light all the way to the end of that particular facility.[101]

2.112 A practical example of the application of this approach was offered by Professor Dia:

> [T]he Managed Motorway transport technology solution on the M1 Freeway in Melbourne has been reported to result in 42 per cent reduction in travel times, 11 per cent reduction in greenhouse gas emissions, and more than $2 million savings per day in reduced travel times and delays.[102]

2.113 The Queensland Department of Transport and Main Roads (TMR) provided an example of its current efforts in ITS:

> Managed Motorways, an operational management program that is being rolled out across Southeast Queensland, employs smart technology to reduce stop-start travel, improve safety and provide more predictable travel times. Managed Motorways technologies include:
>
> - Variable speed limit and lane control signs to manage the flow of traffic, improving safety and fuel efficiency;
> - Coordinated use of traffic lights on motorway on-ramps (ramp signals) to control the rate at which vehicles merge onto the motorway in order to maximise traffic flow;
> - Travel time and electronic messaging signs to provide drivers with real-time advice about travel conditions;

100 Transurban, *Submission 47*, p. 3.

101 Associate Professor Hussein Dia, Centre for Sustainable Infrastructure, Swinburne University of Technology, *Committee Hansard,* 25 September 2015, p. 27.

102 Swinburne University of Technology, *Submission 36*, p. 4.

- Roadside data systems such as traffic detectors and closed circuit television cameras to quickly detect and respond to incidents and built intelligence on the operation of Southeast Queensland's motorway network; and
- Arterial traffic signal optimisation (including interfaces with other systems, such as emergency vehicle pre-emption).[103]

2.114 The South Australian Department of Planning, Transport and Infrastructure (DPTI) is also actively using ITS to improve transport networks:

- DPTI's state-of-the-art Traffic Management Centre (TMC) enabling management of one of the most sophisticated traffic signal systems in the world, and is responsible for the smooth flow of traffic through more than 850 sets of coordinated traffic lights and pedestrian crossings, as well as Adelaide's expressways. The TMC is central to managing traffic impacts from road works, incidents and planned on-road events, using 500 closed circuit television cameras, and automated and/or remotely controlled road signs, such as variable speed limits along the South Eastern Freeway and land use management on the South Road Superway.
- Real-time public transport information from Adelaide Metro providing commuters with information on bus arrival times as well as notifications of interruptions to the system, such as major event services, service changes and temporary outages.
- Traffic SA website showing real-time road works, incidents and planned events across the state, as well as 45 remotely controlled outback road condition signs across the remote far north of the state.
- The Safe-T-Cam system for enforcement of heavy vehicle driving hours.
- In-vehicle technologies such as navigation systems, electronic stability control, adaptive cruise control, intelligent speed assist, tyre pressure monitoring, etc.[104]

2.115 NICTA provided another example of the efficiencies achieved in a managed motorway:

> In late 2014, NICTA investigated a component of the managed motorway concept on Sydney's M4, with cooperation from the NSW RMS. The purpose was to evaluate the performance of ramp metering in managing traffic on selected sections of the M4. NICTA developed a new ramp metering system and traffic data analytic tool, simulating coordinated ramp signals along the entire

103 Queensland Department of Transport and Main Roads, *Submission 46*, pp. 3-4.

104 DPTI, *Submission 30*, p. 2.

managed motorway section, to optimise control performance. The traffic data analytic tool uses motorway detector data and SCATS data to estimate origin-destination matrix.[105]

2.116 This initiative resulted in:

- Travel time reduction: travel time during the most congested period for trips travelling west along the M4 mainline from Prospect to Roper Road is reduced from 16 minutes to nine minutes, registering a benefit of more than 40 per cent travel time;
- Capacity improvements: on the most congested part of the M4, an additional 1000 cars an hour can move through the system smoothly – equivalent to an extra physical lane; and
- Economic impact: during one year, these saving represent 400,000 commuter hours – equivalent to 300 people working for a year. The direct economic cost equates to about $22 million a year, excluding social and environmental costs.[106]

2.117 Transurban raised the case of a smart road it managed in Northern Virginia in the United States:

> In the US, our 95 and 405 Express Lanes have a sophisticated dynamic tolling system which varies pricing according to real-time traffic conditions to ensure traffic remains free-flowing.
>
> The toll price can change as frequently as every three minutes and is displayed to motorists, allowing them to decide whether to use the Express lanes or the free lanes which run alongside. The benefit is that Express Lanes send a pricing signal to all motorists about the level of congestion across the motorway.[107]

2.118 Transurban stated that they use three integrated systems to ensure 'a constant travel speed of 45 miles per hour' in the Express Lanes:

- Electronic Toll Collection System – roadside equipment such as gantries, cameras and vehicle detection and classification laser scanners;
- Dynamic Pricing System – the tolling back office system, based on a suite of integrated modules, including trip construction, dynamic pricing, image viewing, trip adjudication, violations processing, payment portal website, reporting, and customer management;
- Traffic Management System – this includes an advanced system that manages the microwave vehicle detectors, the dynamic message signs and closed circuit television cameras, as well as

105 NICTA, *Submission 23*, p. 12.

106 NICTA, *Submission 23*, p. 12.

107 Transurban, *Submission 47*, p. 4.

> the automated incident detection cameras. The system is also integrated with variable speed limit signs, lane use management signs and remote gate control to manage the daily Express Lanes reversibility.[108]

2.119 Smart roads also capture more data about how these roads are used, which in turn can be used to make the roads smarter. Transurban commented:

> These rich data sources can be leveraged to inform long-term network forecasting, planning and design. Currently Transurban's world-class traffic team analyses roadside and probe data sets to determine travel patterns and speeds across the broader network. This allows us to accurately identify issues impacting traffic flow and safety (eg bottlenecks). These data sets are also applied to our sophisticated traffic models to understand the performance of the network and identify areas that would benefit from capacity enhancements. With advances in technology and more ITS installed across the broader network, road operations will have access to more and better quality data. This will underpin greater insights that could inform the future provision of services and optimisation of the network.[109]

2.120 IBM agreed that access to data allowed for more complete situational awareness for traffic operators, and discussed an example of an ITS in operation:

> The City of Lyon has deployed a new multi-modal predictive traffic management solution for the entire network of roads, buses and trams. The solution uses the IBM Decision Support System Optimiser (DSSO), to combine incident detection, incident impact prediction and propagation, traffic prediction and control plan optimisation and is built into the IBM Intelligent Operations Centre platform. By combining advanced analytics and algorithms to help model predicted conditions under both normal and incident conditions, the system is used to estimate drive times and traffic patterns in a region more accurately and in real-time. Over time, the algorithms 'learn' by incorporating best practices and outcomes from successful plans to fine-tune future recommendations. Additionally, the command centre can develop traffic contingency plans for major events such as large sporting events or concerts.[110]

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108 Transurban, *Submission 47*, p. 4.

109 Transurban, *Submission 47*, p. 5.

110 IBM, *Submission 2*, p. 6.

2.121 IBM provided more examples of cases where increased amounts of data had advanced analytical methods applied to that data, resulting in greater efficiencies in Sydney and Melbourne's transport networks:

> Sydney Airport in Australia needed to look deeper inside the massive volumes of data collected every day by baggage, customs, carriers, retailers and numerous other systems to gain insights that would allow it to more precisely orchestrate its vast operations. The airport tested an advanced analytics and reporting platform that allows it to more accurately predict passenger volumes and movements and generate actionable insights for improving customer services and operational efficiencies. For example, an analysis of vehicle traffic patterns outside the airport revealed that drop-off zones experienced heavy congestion whenever major airlines ran low-fare promotions. Airport managers are using the new insights to redesign the airport's parking and traffic management systems.[111]

2.122 The Department of Infrastructure and Regional Development (DIRD) told the Committee about federal efforts to make use of ITS:

> In Australia and internationally, governments and industry are undertaking a range of Intelligent Transport Systems (ITS) initiatives using ICT in transport networks to improve transport outcomes. In 2011-12, federal, state, and territory transport ministers endorsed an Australian ITS policy framework targeting road transport.
>
> The Department is leading a review and update of the framework, to be completed in 2016. This will ensure Australia remains well placed to seize Smart ICT opportunities in alignment with international approaches.[112]

2.123 Another aspect of ITS was discussed by the Academy of Technological Sciences and Engineering:

> Globally, several companies are using technological and algorithmic advances to develop autonomous cars, and making them a viable part of the infrastructure. Pilot studies are taking place all over the world and it is thought that while the technology is there, government legislation and regulation is a limiting factor.[113]

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111 IBM, *Submission 2*, p. 6.

112 DIRD, *Submission 28*, p. 5.

113 ATSE, *Submission 13*, p. 3.

2.124 Transurban noted that autonomous vehicles will soon be available to consumers:

> The automotive industry is confident that we are five to ten years away from driverless vehicles being on the market, with mass adoption likely by 2040.[114]

2.125 Professor Dia also commented on the potential offered by autonomous vehicles, stating:

> [I]n a modelling study recently released by the International Transport Forum, it was estimated that a hypothetical fleet of shared autonomous vehicles would provide nearly the same mobility as today, in a medium-sized European city, by using 65 per cent fewer cars during peak hours and 90 per cent fewer cars when considering a 24 hours scenario.[115]

2.126 However, Transurban noted that the introduction of autonomous vehicles raises a number of challenges :

- Security – With all vehicles connected to the road, roadside systems and new reliance on connected and autonomous vehicles (CAV) to drive safely and in compliance with road rules, cyber security of onboard and backend systems will be critical;
- Integrated operations model – The responsibility of managing the road will need to be shared between road operators and the makers of CAVs;
- Enhance data processing capabilities – With vehicles on the road sending and receiving data in real time to traffic management systems and other CAVs, a tremendous amount of data will need to be processed. Complex algorithms, data processing and analytics will be required to provide effective road management and road performance improvements;
- Market penetration – Stakeholders including road and public transport authorities, freight, road, taxi and fleet operators and the automotive industry will need to agree on a set of principles to accelerate the penetration and desirability of ITS technology to support the new and existing vehicle market; and
- Infrastructure standardisation – Existing road infrastructure such as line marking and safety barriers will require modification and standardisation to provide a safe environment for CAVs on the road network.[116]

114 Transurban, *Submission 47*, p. 6.

115 Swinburne University of Technology, *Submission 36*, p. 4.

116 Transurban, *Submission 47*, pp. 6-7.

2.127 DIRD also noted the potential impact of autonomous vehicles, emphasising safety:

> While Australian road vehicle occupant deaths reduced by over 26 per cent over the 10 years to 2014, crashes on the road cost the community an estimated $27 billion per year and high risks remain for vulnerable users (such as motorcyclists, pedal cyclists, older drivers and road users in remote communities). Despite significant road safety improvements over the last 40 years, human error remains a major contributing factor in the annual cost of road trauma. There is growing evidence that fully autonomous, self-driving vehicles could significantly reduce the incidence of road trauma and impact on vulnerable road users.[117]

2.128 DIRD noted that autonomous vehicles already formed a part of current strategies to improve road safety:

> The recent review of Australia's National Road Safety Strategy noted that forward collision avoidance technologies such as autonomous emergency braking may be particularly important for preventing crashes with vulnerable road users. These systems rely on increasing use of Smart ICT and sensors embedded in vehicles.
>
> Planning for highly automated vehicles in Australia is at an early stage. South Australia has recently announced the first on-road driverless vehicle trials for November 2015. Broader future adoption is likely to be heavily influenced by the decisions of other countries, given Australia's small position in global markets and relatively limited research and development capacity in this area. When adopting new technical standards (Australian Design Rules) for road vehicles, Australia harmonises with international standards - primarily the United Nations vehicle regulations. This allows the widest choice of the safest and most environmentally friendly vehicles from the global market to be sold into the Australian market.[118]

2.129 However, DIRD also noted that more work needs to be done before autonomous vehicles could be introduced on a wide scale:

> Austroads has identified planning for the introduction of automated vehicles as a strategic priority and will begin three new projects in 2015-16:
>
> - assessment of key road agency actions to support automated vehicles;

117 DIRD, Submission 28, p. 10.

118 DIRD, *Submission 28*, p. 12.

- investigation of potential registration and licencing issues; and
- safety benefits of connected and automated vehicles.

Further work in relation to autonomous vehicles is also being undertaken by the National Transport Commission (NTC). The NTC was established to provide independent, expert advice to Government on regulatory and operational reforms of road and rail transport. The NTC's forward work programme includes a project that seeks to identify regulatory and operational barriers to uptake of more autonomous road and rail vehicles.[119]

2.130 ATSE told the Committee that the application of ITS to Australian road infrastructure could result in large reductions in government spending:

> The planning and development of roads is expensive and occurs over long time periods, often across multiple terms of government. Integration and use of 'big data' and autonomous car technologies can make a substantial contribution to ensuring efficient and best use of our current infrastructure, potentially reducing the need for future large investments in new roads.[120]

2.131 NICTA discussed a number of technology solutions that could be woven into existing road infrastructure in order to increase its capacity:

- ICT modelling that optimises current traffic signalling in urban areas to reduce the drag on productivity caused by congestion;
- Informing preventative maintenance on major infrastructure such as bridges, road and rail networks to lower costs and reduce disruption;
- Integrating crowd-sourced social media into traffic management operations, for improving incident notification, reducing clearance times and congestion; and
- Making motorways 'smart' with dynamically tuned ramp-metering algorithms, significantly reducing travel times and lifting throughput in peak periods.[121]

2.132 Similarly, the application of soft infrastructure to make more efficient use of existing road and public transport infrastructure (as well as the IoT) was seen as an important facet of making urban transport systems operate more effectively. Dr Economou told the Committee that companies like Uber and the service they offer are important to this process:

> Effectively [Uber] is a platform for how you make better use of the physical infrastructure that exists. In Uber's case it is the taxi fleet and cars. In the case of BusPlus, it is a combination of buses and

119 DIRD, *Submission 28*, p. 12.

120 ATSE, *Submission 13*, p. 3.

121 NICTA, *Submission 23*, pp. 5-6.

> taxis. That kind of platform is something that can sit over the top of physical infrastructure and give value. It is nice that Uber is worth $40 billion because they are leveraging a platform of public infrastructure. It would be really nice of the Australian people could get that kind of leverage off their infrastructure as well.[122]

2.133 In terms of realising the possible advances that ITS—and smart ICT more generally potentially offer— TMR noted that cooperation between the public and private sector was necessary:

> Integrating government and private operator data will be crucial for ensuring that system-wide information is available to map, model, design and operate infrastructure using smart ICT. The capabilities potentially afforded by achieving these linkages include:
>
> - Access to live data feeds, which may support the transport industry in daily and short-terms trip planning, as well as informing transport service providers of real time system conditions;
> - Stronger identification of temporal system usage patterns, which will assist in regulatory and planning approaches to 'off peak' usage;
> - Real time data via Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications infrastructure, which will assist in detecting incidents faster through crowd sourced information and delivering better incident management for road users; and
> - Provide the opportunity for transport agencies to become 'information brokers'. The de-identified/aggregated data collected may have more valuable commercial applications.[123]

2.134 According to DIRD, 'one of the greatest opportunities for Smart ICT in Australia is for better management of road networks'. It stated that Australia is already in a leading position when it comes to road network management:

> Australia has a strong record in smart traffic management, with the Sydney Coordinated Adaptive Traffic System (SCATS) being used in all Australian cities and being exported to other countries. This system facilitates traffic flows by coordinating traffic signals in a way that adapts to traffic conditions. There may be scope for some enhancements of these systems, including increased use of

122 Dr Dean Economou, Acting Business Team Director, Infrastructure, Transport and Logistics, National ICT Australia, *Committee Hansard,* 21 August 2015, p. 6.

123 Queensland Department of Transport and Main Roads, *Submission 46*, p. 5.

> ramp metering on urban freeways, and improved support for public transport movements.[124]

2.135 Regulation of heavy vehicles was another focus for DIRD:

> An important application of satellite-based heavy vehicle telematics is the Intelligent Access Program (IAP). This is a voluntary program that uses the GNSS to monitor heavy vehicles' road use. Road agencies can provide transport operators using IAP with greater access to their road networks, while the data generated by IAP provides them with the assurance that heavy vehicles are complying with agreed access conditions. The IAP is administered by Transport Certification Australia, which certifies and audits IAP Service Providers. As of April 2015, over 3,000 vehicles were enrolled in IAP-related programs. Australian road agencies also use on-board mass (OBM) monitoring to undertake in-vehicle compliance monitoring of high productivity heavy vehicles, in exchange for allowing heavy vehicles greater access to the road network. The Interim OBM Solution is progressively being rolled out to jurisdictions and is focused on providing the necessary integrity and robustness to support different operational environments, privacy and security measures. There are currently 140 vehicles enrolled in the Interim OBM Solution that Transport Certification Australia has been administering since September 2013.[125]

2.136 DIRD told the Committee that smart ICT is also improving Australia's rail networks:

> Advanced Train Management System (ATMS) is a communications-based train management system that replaces traditional line-side signalling, enhancing safety and allowing rail operators to increase the capacity of existing rail infrastructure through running trains closer together. It provides the precise location of the front and rear of the train at all times, and has the capacity to slow or completely stop the train, if the driver exceeds speed limits, does not stop when required to, or there is a conflict with other rail vehicles on the track. While the first stage will demonstrate the benefits prior to a broader roll-out, the proposed new Melbourne to Brisbane Inland Rail project has been designed to use ATMS rather than traditional signalling.[126]

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124 DIRD, *Submission 28*, p. 10.

125 DIRD, *Submission 28*, p. 10.

126 DIRD, *Submission 28*, p. 10.

2.137 Furthermore, DIRD noted that this new system will benefit both intra- and inter-urban rail networks:

> While the new control systems will primarily benefit passenger services within the metropolitan regions, a common platform will reduce the cost of operating trains between cities. This will primarily impact interstate freight trains traversing the ARTC's network between capitals. While ARTC is developing a separate communication system (based on the 900 MHz frequency), by creating a common platform in the capital cities, freight rail operators will require less communication systems in order to operate on multiple networks without risks to network efficiency or safety.[127]

Energy

2.138 Smart energy grids will play an important role in both urban and regional areas in a variety of ways. ATSE elaborated on this:

> Specifically, intelligent networks (sometimes called smart grids) will contribute to improved network utilisation, including demand management (both opportunities and effectiveness), in the electricity network. The need to acquire, store and use large sets of data to model a more complex network and predict its operation increasingly in real time relies heavily on ICT. The utilisation of ICT provides the basis for the evolution of more intelligent and increasingly self-managed networks, generating large-scale efficiencies and an efficient way to supply energy for some remote communities in Australia.[128]

2.139 Dr Wenham discussed the challenges of applying this new technology to energy grids:

> The intelligent energy grid or smart grid is becoming increasingly important as we see the expansion of distributed generation. In most cases we are talking about solar panels on people's roofs. That presents challenges to the electricity grid because we have got grids that are built for power going in one direction, which is from large generating plants into homes, and we are now changing to a situation where more of those homes are becoming generators themselves and feeding electricity back into the grid.

127 DIRD, *Submission 28*, p. 10.

128 ATSE, *Submission 13*, p. 4.

> So the ability for the network and the grid to manage that change in purpose, if you like, is a difficult one for it to cope with.[129]

2.140 However, Dr Wenham also emphasised the benefits of making the changes necessary to support a smart grid:

> There are obviously a lot of benefits from smart meters and that sort of smart grid technology that go to the utilities and the distributors in being able to manage that. From a consumer perspective, there are advantages, if you are using that sort of distributed generation – if you are using solar power and, hopefully, with storage, as that starts to become more common. Being able to have information about when you are using electricity and to maximise the power that you are generating from your own solar panels means that there are opportunities to reduce costs, in that you will obviously want to try to push more of our energy use into the middle of the day when you are producing power from your solar panels and rely less on the grid at night when you are paying for power from the grid.[130]

2.141 Professor Rod Tucker, in his capacity as a fellow at ATSE, elaborated on some of the advantages:

> Having people use power at a different time can greatly improve the stability of a network and the efficiency of using the existing coal power stations to make sure that they do not have to turn on and turn off so rapidly.[131]

2.142 However, these benefits will not be realised until the capacity to store power becomes commonplace in households, as Professor Tucker explained:

> [W]ithout storage, one of the main things that smart meters can do is manage the power consumption in a home or in a business so that items that do not necessarily need to use power at any particular time of day can be switched on when the power is more readily available or when prices are lower.[132]

2.143 As a result, Professor Tucker noted that smart grid technology is not currently being used to the fullest extent possible:

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129 Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technological Sciences and Engineering, *Committee Hansard*, 25 September 2015, p. 8.

130 Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technological Sciences and Engineering, *Committee Hansard*, 25 September 2015, p. 8.

131 Professor Rod Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 8.

132 Professor Rod Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 8.

> [T]here have been billions of dollars spent on smart meters in Australia, and they are sitting there in most houses, but their capabilities are barely used. The only thing they are really being used for today is to avoid having to have someone read the meter. But they are capable of much more than that.[133]

2.144 Professor Tucker commented that 'there is a lack of knowledge among consumers about what is possible', and told the Committee what needs to happen for these technologies to be used more effectively:

> There has not been the investment in the technologies to get the interactions happening inside the home. To fully utilise the ability of a smart meter to manage the power consumption in a home, you need to go one step further and add a home network and smart appliances that then interact with the smart meter. So far those home networks and smart appliances are not really readily available. Some of the manufacturers have them, but they are not being widely distributed and there seems to be little incentive at the moment for customers to do that.[134]

2.145 Furthermore, ATSE drew the Committee's attention to a 2014 report from UBS and Navigant Research, which stated that 'the cost of solar plus battery generation is anticipated to fall below that of conventional power generation around the end of this decade'. According to ATSE, this will 'allow households to become affordably energy self-sufficient with clean generation'.[135]

Health

2.146 Many submitters agreed the health sector would benefit from the application of smart ICT. Improvements to health services delivery would also benefit both urban and regional areas. ATSE discussed the impact smart ICT potentially has in the health sector:

> While in the past, ICT has been central to the transformation in medical sciences, from mapping the human genome to the development of medical devices, ICT also has a strong future in transforming the healthcare system to reduce accident and emergency admissions, reduce hospital bed-days, and decrease mortality rates.[136]

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133 Professor Rod Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 8.

134 Professor Rod Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 8.

135 ATSE, *Submission 13*, p. 4.

136 ATSE, *Submission 13*, p. 2.

2.147 One means by which smart ICT can transform the healthcare sector is through the use of the increasing amounts of data available. According to ATSE:

> Healthcare providers need the necessary ICT infrastructure to store, mine and systematically integrate specific information with other medical data. The successful integration and analysis of data will drive beneficial health outcomes and inform public health policy, while security and privacy measures are tightly regulated.[137]

2.148 ATSE noted that the effective use of data will require 'electronic patient records to be exchanged easily between healthcare providers'[138]. Dr Wenham discussed the advantages of this:

> There are quite large benefits that come to patients from having their records, particularly for people with chronic diseases who have a lot of interactions with the health system who might go to a GP, several different hospitals which, at the moment, probably all have separate records for that person. Being able to put that in one place can have huge benefits in terms of adverse events, better treatment, reducing waste and a whole lot of things.[139]

2.149 However, given the concentration of private data that this would cause, Dr Wenham noted that any such system should not be compulsory:

> I think it is worth looking at an opt-out system. The current system is opt-in; it has not seen a great take-up rate. There is value in looking at opt-out systems where people who particularly object can take themselves out of the system, but the default position is that you have an electronic health record.[140]

2.150 ATSE also discussed an example of the effective use of data in the United States healthcare sector:

> An open-source platform, Informatics for Integrating Biology and the Bedside (i2b2), was used to create the Shared Health Research Information Network that allows physicians to use an online search tool to access aggregate numbers of patients seen at participating hospitals who meet criteria of interest. The de-identified data allows physicians to study what treatments were

137 ATSE, *Submission 13*, p. 2.

138 ATSE, *Submission 13*, p. 2.

139 Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technological Sciences and Engineering, *Committee Hansard*, 25 September 2015, p. 11.

140 Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technological Sciences and Engineering, *Committee Hansard*, 25 September 2015, p. 10.

> used and what the outcomes were. Currently, the i2b2 platform has been adopted by more than 100 medical institutions around the world.[141]

2.151 In addition to the benefits expected to flow from the use of patient data, ATSE also emphasised the impact that delivering health services via ICT will have:

> Telecare and telehealth services delivered at home via ICT have been demonstrated to deliver cost effective, timely and improved access to quality care. They also reduce social dislocation and enhance the quality of life within these communities by allowing chronically ill, aged and disabled people to stay in their homes and communities for longer.[142]

Water

2.152 Several submitters to this inquiry have noted the impact that smart ICT has had on water utilities. For example, IBM told the Committee that:

> ICT and IoT for water is all about sensor networks, smart metering and advanced computing and analytics to helping ensure the flow of clean, plentiful water around the planet. These sophisticated sensors collect and analyse the tremendous amounts of data generated in complex water systems, from rivers and reservoirs to the pumps and pipes in our homes.[143]

2.153 Specifically, IBM stated that the following capabilities are being applied to water utility networks:

> Using internet to connect real-world sensors and control water management systems from a cloud-based platform, management can pull in streams from any other data source, including weather reports.
>
> We can apply advanced computing and analytics to move beyond 'real time' to anticipate potential delivery disruptions, better forecast long-term water demand, support better-informed policy and management decisions. It also enables the coordination of resources and stakeholders to protect water supply and driver conservation and sustainability.
>
> Consumers will be able to connect to their utilities via their smart phones – enabling the industry to engage with its customers more proactively. We can leverage social media and people to

141 ATSE, *Submission 13*, pp. 2-3.

142 ATSE, *Submission 13*, p. 3.

143 IBM, *Submission 2*, p. 8.

effectively manage water such as leak detection, water usage and drive positive behavioural change.[144]

2.154 IBM provided an example of a smart water network:

> The city has implemented a smart water pilot that is breaking new ground in the way data is collected and analysed in near real-time. At its core, it will help identify and enable ways for the people of Townsville to drive water conservation by empowering residents with smart technology to assist with positive behavioural change. By using IBM's Big Data expertise for the pilot project, Townsville City Council is able to deliver near real-time information about daily water usage from digital water meters to the Council and residents via a web portal and reduce overall consumption as well as offset future infrastructure investment. The results of the pilot showed:
>
> - 50 per cent of consumers changed their behaviour after seeing both timely data and insight from their pattern of use on the portal.
> - 98 per cent faster notification time on water leaks, from three months to day, potentially saving millions of litres of water, associated treatment and delivery costs, reduction in bill shocks and complaints to the call center.
> - 10 per cent reduction achieved in overall average household water consumption by residents accessing the portal.[145]

2.155 Optimatics discussed a combination of smart ICT systems called Integrated Optimisation Modelling (IOM), which it argued can deliver 'significant value' by 'assisting planners to select the most effective set of infrastructure projects' and also ensuring that 'the infrastructure is operated efficiently'. Optimatics offered the following examples of the use of IOM on water utility networks:

- South Australian Water reduced the cost of integrating their desalination plant into the existing network by nearly $700 million while supporting an extensive stakeholder engagement process.
- South Australian Water later decreased their operational expenditure by more than $400,000 in the six months following the installation of an IOM for system operations.
- Los Angeles Bureau of Sanitation used an IOM to reduce the cost of a relatively simple transfer pipeline from US$12 million to US$6 million.

144 IBM, *Submission 2*, p. 8

145 IBM, *Submission 2*, p. 8

- The City of Bend, Oregon, used an IOM to recommend changes to how the water infrastructure was operated, reducing energy costs by 23 per cent.[146]

Productivity gains

2.156 While it is difficult to quantify the exact gains in productivity that the application of smart ICT to infrastructure achieves, submitters to this inquiry have been unanimous that productivity will benefit greatly from its adoption.

2.157 Urban Circus told the Committee about its experiences in using digital modelling processes like BIM, and the increased productivity it can bring about:

> We have built tools that are based on Australian standards to help create road, rail, footpath and bike path as well as building envelopes, in a few short clicks in a 3d urban context space. That is, planning studies that took tens to hundreds of thousands of dollars of engineering consulting and months of work, is now done live, in 3d, in a workshop or meeting – or in a few hours.[147]

2.158 According to Urban Circus, the two main productivity benefits of using digital modelling are 'the improvement of productivity with the reduction in time and costs in the planning and construction phases of major projects'.[148] Dr Guy told the Committee of a recent example where these sort of outcomes had been realised:

> We ran a series of workshops recently in Western Australia with Main Roads, and it was taking them a year to do this phase called optioneering: 'Should we put the road like this on the left? Should we put it like this on the right? Should we go over? Should we go under?' Those are quite difficult decisions. By having the geospatial information there… we are able to come in and weave actual pieces of infrastructure through that space, live, in a meeting, with the smart people in the room. That would have taken a month to go away and do a bit of a planning study, come back, have another conversation, go have another conversation, take another month, come back - $100,000 a hit – compared to what you can actually do now.[149]

146 Optimatics, *Submission 39*, p. 2.

147 Urban Circus, *Submission 3*, p. 2.

148 Urban Circus, *Submission 3*, p. 3.

149 Dr Ben Guy, CEO, Urban Circus, *Committee Hansard*, 24 September 2015, p. 5.

2.159 Aurecon agreed that more widespread use of BIM will result in productivity gains:

> …productivity continues to be an issue confronting the construction industry – implementing digital engineering through BIM as standard practice within industry could solve this productivity problem. Productivity is also an issue for governments as large capital works programs have a long lead time before full productivity benefits of capital and labour can be realised. Also, implementing BIM in a structured and systematic way across governments could generate better value for money and savings in public procurement of infrastructure projects.[150]

2.160 Geoscience Australia noted the savings that had been reported in the UK:

> The UK Government has reported savings of £840m in construction costs in 2013/14 through the implementation of BIM technology, and believes that collaboration between government, industry and academia in the construction sector using this technology has the potential to save around 20% on the delivery costs of new built assets. Application of the same technology in Australia has the potential to realise similar savings in our construction sector, which in 2014 the construction industry was believed to account for around 8.5 per cvent of Australia's GDP.[151]

2.161 QUT, AECOM and SIBA concurred, stating:

> There is much evidence, particularly from the UK as to the potential for monetary savings (often quoted as 15-20 per cent per project for buildings), more reliable time estimates, improved client and stakeholder satisfaction and reduced risk of variation and legal disputes caused through misunderstandings and different interpretations, particularly of design intent. The reduction of variation from planned time, cost and quality may well be even greater in the delivery of infrastructure than in buildings because over-runs of schedule and budget are so typical. The benefits of BIM are well summarised by the UK High Speed 2 (HS2) rail program. Note that these savings are only in CAPEX; it is expected that overall 33 per cent could be unlocked over the whole life cycle of the asset. Also, the costs of doing nothing will leave Australia at the mercy of more far thinking and innovative economies.[152]

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150 Aurecon, *Submission 22*, p. 7.

151 Geoscience Australia, *Submission 46*, p. 5.

152 QUT, AECOM and SIBA, *Submission 49*, p. 3.

2.162 The NSW Government told the Committee that productivity in asset management will be improved by the application of smart ICT like BIM by:

- Substantiating asset decision and better outcomes (investment planning, design, maintenance and disposal) through access and collaboration (single source data);
- Enhancing performance due to swift and accurate comparison of different design options;
- Optimising solutions through cost effective optimisation and optioneering against agreed parameters;
- Providing greater predictability by visualising at an early stage;
- Driving faster project deliveries through time saved by agreement of design concept early;
- Reducing safety risk design, constructability and maintenance by supporting human factors and operational safety at an early stage;
- Enabling 'fit for purpose' integration by integrating multi-disciplinary design into a single model;
- Reducing waste with procurement by scheduling just-in-time;
- Facilitating whole life asset management – information to assist commissioning, operation and maintenance is managed through the infrastructure/asset whole of life management model; and
- Enabling continual improvement by inputting project feedback into performance of processes and equipment.[153]

2.163 Similarly, BCE Surveying noted that the integration of BIM with mobile laser scanning (MLS) has provided significant advances in productivity:

> The development of MLS has resulted in a number of tangible productivity benefits to the surveying industry, clients and the community. Economically the resources required for completing survey using MLS are far less than traditionally required using conventional survey methods. Using traditional methods to survey a one square kilometre site would have taken up to 16 hours, while the MLS can complete the equivalent area in just two hours. The savings in time, money, and manpower has substantial benefits to all parties involved.[154]

2.164 Furthermore, BCE stated that busy roads in particular benefited from MLS methods, as compared to older surveying methods, for the following reasons:

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153 Transport for NSW, *Submission 33*, p. 10.

154 BCE Surveying, *Submission 26*, p. 2.

- Data is now captured with virtually no impact or disruption whatsoever to road users;
- Surveyors are now no longer required to venture into traffic in order to place a prism pole to capture detail;
- The lack of a need for lane closures and other traffic control measures can provide considerable cost savings; and
- Data capture is very rapid, minimising effort and exposure in the field.[155]

2.165 BCE also discussed the less tangible benefits associated with environmental impact and workplace safety:

> The successful utilisation of MLS to capture data means that surveyors no longer need to walk across potentially unstable ground or through fragile flora. This means that protected areas and unstable slopes are no longer exposed to degradation and erosion from being continually walked over. By not having surveyors accessing potentially dangerous or hazardous areas health and safety risks may also be reduced.[156]

2.166 In terms of the productivity gains offered by improved GIS systems and more accurate laser scanning, Mr Wynne provided an estimate of the gains realised in Victoria through the use of GPSnet, discussed above:

> GPSnet offers significant productivity savings for asset and infrastructure operators. It is estimated that, since commencement in late 2010, approximately $80 million in productivity gains have been achieved through GPSnet.[157]

2.167 Brisbane City Council told the Committee that it is quite difficult 'to determine the actual scale of benefits that can be associated' with smart ICT, as 'vendors tend to supply material and case studies that support a particular technology approach'. Thus:

> The level of maturity of the specific technology and the organisational/user readiness for change needs to be carefully considered when assessing the likelihood of delivering productivity benefits.[158]

2.168 The NSW Government discussed the productivity benefits of ITS:

> The productivity benefits of ITS initiatives can be achieved through simulation modelling or through before and after studies. Data collected by ITS can be utilised to assess the productivity

155 BCE Surveying, *Submission 26*, p. 3.
156 BCE Surveying, *Submission 26*, p. 2.
157 Hon Richard Wynne MP, *Submission 24*, p. 2.
158 Brisbane City Council, *Submission 34*, p. 5.

> benefits of the applications of smart ICT to transport infrastructure assets.[159]

2.169 In NSW, this has been largely achieved through partnerships and outsourcing to industry partners with 'not only the experience in ITS maintenance but the proven capability and international experience' to implement the technologies that can achieve improved productivity. The NSW Government provided an example of this:

> The Centre to Centre (C2C) interface provides connection between the independently operated motorway control systems and Transport for NSW traffic control systems. The C2C interface offers a consistent driving experience whether traveling on a government controlled road or a private motorway. The control centre operators interact via the C2C interface to extend information and control to other operators across system boundaries.
>
> This interface provides bilateral exchange of incident and traffic data from across the NSW motorway network to allow remote monitoring of traffic movements and incident management. It includes the visibility and ability to control ITS devices, such as Variable Message Signs on private motorways.[160]

2.170 According to the NSW Government, this approach has resulted in the following productivity benefits:

- Automated generation and usage of the Incident Response Plans across system boundaries to achieve complementary incident response;
- Access to motorway network information providing improved decision making for analysis (ie network operations and network optimisation);
- Improved decision making and overall operator efficiency for Transport Management Centre operators;
- Improved situational awareness and incident verification process;
- Motorway devise locations, status and information visible to the Transport Management Centre and Roads and Maritime Services;
- Improved decision making for motorists due to motorway operator and Transport Management Centre and Roads and Maritime Services being able to display information on motorway variable message signs for real time ravel time information; and

159 Transport for NSW, *Submission 33*, p. 9.

160 Transport for NSW, *Submission 33*, p. 9.

- Collaborative incident detection, response and resolution.[161]

2.171 The South Australian Government Department of Planning, Transport and Infrastructure (DPTI) noted the cost savings and productivity benefits it had achieved in regard to infrastructure planning:

> DPTI's ePlanning Unit is working towards significant Planning System Reform 1. DPTI's proposed ePlanning architecture is aimed at harnessing the value of information and data to make informed planning decisions, while improving the planning processes, creating a gateway which facilitates interaction among the planning system's stakeholders and providing opportunities for commercial partnerships. There are multiple productivity benefits in this approach:
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> - Simplified processes resulting in reduced holding costs for developers.
> - Improved transparency in decision making (via a Planning knowledge base and the electronic planning code).
> - Cost savings and productivity improvements through strategic investment into ICT products and projects.[162]

2.172 Numerous submitters focused on the economic benefits to be gained from decreased travel times. The NSW Government summarised these views, noting that:

> A recent study has demonstrated [the Sydney Coordinated Traffic System (SCATS)] delivers substantial economic benefits to Sydney in travel time savings – estimated to be around $3.6 billion per annum – when compared to simpler methods of traffic signal control.[163]

2.173 Similarly, DIRD noted that ITS would improve productivity:

> One key area of ITS attention for both Government and industry is the advances underway in automated vehicle technology. Such technologies are likely to have a profound impact on the productivity, safety and environmental performance of Australia's transport systems in the medium to long-term.[164]

161 Transport for NSW, *Submission 33*, p. 9.

162 Minister for Transport and Infrastructure, *Submission 30*, p. 5.

163 Transport for NSW, *Submission 33*, p. 6.

164 DIRD, *Submission 28,* p. 11.

Committee Conclusions

2.174 It is clear from the unanimous views put forward by submitters to this inquiry that smart ICT not only has the potential to transform many aspects of our daily lives, but is actually in the process of doing so. From daily activities like commuting to work, to planning and building expensive items of infrastructure that will be in use for many years, smart ICT has the capacity to improve Australian society.

2.175 It is also clear that processes like BIM, coupled with the increased availability of data to inform such processes, provide powerful tools to private sector and government infrastructure planners. This modelling is achieving savings, improving the efficiency of construction processes, reducing waste of time and materials and increasing productivity. Managing the facilities after construction is being made more efficient, in terms of maintenance and upkeep, as well as the day-to-day use of the facilities. The Committee believes it is imperative to continue to pursue these efficiencies. The role of government in this process is examined in greater detail in Chapter Five of this report.

2.176 The vision of the future presented to the Committee during the course of this inquiry has a role for nearly all members of Australian society. Average citizens using their smartphones, driving their cars, posting to social media, using other smart devices in their homes and even simply walking on the streets are helping to provide the data which underpins this new digital revolution. The implications of how to store and manage 'big data' are dealt with in Chapter Three of this report.

2.177 Given the decline in productivity that has been experienced in Australia in recent years,[165] the role of smart ICT in improving productivity and efficiency is needed to help drive economic growth. The Committee is pleased that government agencies at the local, state and federal levels are taking concrete action to realise the potential productivity gain and efficiencies of smart ICT.

2.178 However, the Committee is also cognizant of the fact that different governments have different capabilities and capacity to implement the type of programs that have been successful in Melbourne and Brisbane. In this regard, the Committee commends the City of Melbourne in particular for its use of smart ICT in its urban planning through its Smart City Office. In the Committee's view, all levels of government should seek to continue

165 Professor Bob Williamson, Acting Chief Executive Officer, National ICT Australia, *Committee Hansard*, 25 March 2015, p. 2.

to develop their capacity to implement smart ICT solution to infrastructure issues.

Recommendation 1

2.179 **The Committee recommends that the Department of Infrastructure and Regional Development, the Department of Communications, and Geoscience Australia continue to build their smart ICT capacity, in partnership with private sector actors where appropriate. Where possible, these departments should seek to share their knowledge and thus build capacity with their state and local government counterparts.**