
The Parliament of the Commonwealth of Australia

Smart ICT

Report on the inquiry into the role of smart ICT in the design and planning of infrastructure

House of Representatives
Standing Committee on Infrastructure, Transport and Cities

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Canberra ACT

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Contents

- Foreword v
- Membership of the Committeevii
 - Former Standing Committee on Infrastructure and Communications.....vii
- Terms of referenceix
- List of abbreviations x
- List of recommendations xiii

- 1 Introduction1**
 - Referral and conduct of the Inquiry..... 1
 - Scope of the Inquiry..... 2
 - Structure of the report 2

- 2 What is smart infrastructure?.....3**
 - New technologies and applications 3
 - Building information modelling 4
 - Geospatial technology..... 10
 - Internet of things 13
 - Machine learning..... 14
 - Mobile laser scanning 15
 - Opportunities..... 17**
 - Visions of the future 18
 - Productivity gains 50
 - Committee Conclusions 56**

3	Data collection and harmonisation	59
	ICT and data collection—the importance of data collection to the development of smart infrastructure.....	59
	Open data and smart ICT—the need for data access	62
	Achieving compatibility of different data, devices and systems	69
	Harmonisation—national and international standards	73
	Data collection and storage capabilities	91
	Data security	95
	Committee conclusions.....	103
4	Emergency management and disaster planning and remediation	107
	Current capabilities.....	107
	Future developments.....	112
	Committee conclusions.....	118
5	Promoting smart ICT	121
	Government leadership.....	121
	Mandating use of smart ICT—BIM.....	128
	Linking project funding to technological innovation	133
	Coordinating body—UK model.....	136
	Promoting the development of relevant skills.....	142
	Committee conclusions.....	146
	Appendix A – List of submissions	149
	Appendix B – List of exhibits	153
	Appendix C – List of public hearings and witnesses	157



Foreword

The report on the role of smart ICT in the design and planning of infrastructure had its genesis in the 2014 inquiry by the House Infrastructure and Communications Committee into infrastructure planning and procurement. During that inquiry, the Infrastructure and Communications Committee received evidence outlining exciting new developments in the application of smart ICT to infrastructure. This evidence, particularly from BCE Surveying and Autodesk, revealed a new way of designing, planning, building and managing infrastructure. The Committee determined to explore this further and the smart ICT inquiry was born.

The inquiry began under the House Infrastructure and Communications Committee, led by its Chair, Mrs Jane Prentice. In October 2015 that committee was disbanded and two new committees were formed. This inquiry was adopted and completed by the House Infrastructure, Transport and Cities Committee. It is testament to the importance attached to this inquiry that former committee members, and particularly the former Chair, have maintained a close interest in its progress and outcome.

The inquiry ended up being more comprehensive and time-consuming than originally anticipated. The more evidence that was received about the role of smart ICT in infrastructure, the more the Committee recognised the possibilities inherent in new technologies and systems. These technologies, if used effectively, have the capacity to transform the design, construction and management of infrastructure assets; the management and use of existing assets; and the operation of transport, communications, energy and utility systems. These technologies are *transformational*, with the capacity to increase the productivity of the Australian economy. In order to achieve this, however, governments and industry must be aware of the potential of smart ICT, and must invest in the technologies, skills and systems to make the transformation a reality. That is the core of this report.

In its recommendations, the report urges the Government to take a more coordinated and integrated approach to the development of smart ICT and its application to infrastructure planning. The central recommendation of the report is the formation of a Smart Infrastructure Task Force – based on the UK model – to provide national coordination between governments, industry and researchers for the development and implementation of smart ICT in the design, planning and development of infrastructure, and in the maintenance and optimisation of existing infrastructure. The development of capacity within and between governments is central to a successful Task Force, and several recommendations address this issue.

The collection and management of data is the key to the development of smart infrastructure. Data makes the management of existing systems possible and allows us to explore ever more efficient and effective ways of doing things. Information is the bedrock of innovation. The Committee has recommended that the Smart Infrastructure Task Force be given responsibility for the national coordination of protocols and standards relating to infrastructure data and the development of an objects library. It has also recommended that the National Archives of Australia be given the resources to oversee the development of a whole-of-government infrastructure data strategy.

The Committee has also recognised the capacity of smart ICT to transform emergency management and disaster planning and remediation. It has called on government to give greater recognition to the capacity of new technologies and systems, including recognizing public safety communications systems as critical infrastructure.

I would like to thank all those who have contributed to this inquiry. The Committee received a significant amount of high quality evidence which, nonetheless, only scratched the surface of this fascinating subject. I thank my Committee colleagues and the secretariat for their hard work, enthusiasm and patience in seeing this report through the transition between two committees. Lastly, I would like to thank the members of the former Infrastructure and Communications Committee for having the vision to investigate this important issue, and in particular the former Chair, Mrs Prentice, for her support in seeing this report through to a successful conclusion.

Mr John Alexander OAM MP
Chair



Membership of the Committee

Chair	Mr John Alexander OAM MP	
Deputy Chair	The Hon Matt Thistlethwaite MP	
Members	The Hon Julie Collins MP	Mr Angus Taylor MP <i>(to 02/03/16)</i>
	Mr Andrew Giles MP	Mr Bert van Manen MP
	Mr Andrew Hastie MP <i>(from 04/02/16)</i>	Mr Matt Williams MP
	Mr Keith Pitt MP <i>(to 11/11/15)</i>	Mr Trent Zimmerman MP <i>(from 02/02/16)</i>
	Ms Joanne Ryan MP	Ms Nola Marino MP <i>(to 04/02/16)</i>
Supplementary members	Mrs Jane Prentice MP	Ms Nola Marino MP <i>(from 04/02/16)</i>

Former Standing Committee on Infrastructure and Communications

Chairman	Mrs Jane Prentice MP	
Deputy Chair	The Hon Matt Thistlethwaite MP	
Members	Mr John Alexander OAM MP	Mr Keith Pitt MP
	Mr Andrew Giles MP	Ms Michelle Rowland MP
	Ms Nola Marino MP	Mr Bert van Manen MP
	Mr Clive Palmer MP	Mrs Lucy Wicks MP

Committee Secretariat

Secretary	Ms Lynley Ducker
Inquiry Secretary	Dr Bill Pender
Senior Research Officer	Mr James Bunce
Research Officer	Ms Belynda Zolotto
Administrative Officer	Ms Cathy Rouland



Terms of reference

The Committee to inquire into and report upon the role of smart ICT in the design and planning of infrastructure, in particular:

- identifying innovative technology for the mapping, modelling, design and operation of infrastructure;
- identifying the new capabilities smart ICT will provide;
- examining the productivity benefits of smart ICT;
- harmonising data formats and creating nationally consistent arrangements for data storage and access;
- identifying international best practice in the use of smart ICT in the design and planning of infrastructure;
- considering the use of smart ICT in related fields, such as disaster planning and remediation; and
- considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity.



List of abbreviations

ADAC	Asset Design As Constructed
AECOM	Architecture, Engineering, Consulting, Operations, and Maintenance
AECOO	Architect, Engineering, Construction, Operator and Owner
APCC	Australasian Procurement and Construction Council
ARTC	Australian Rail Track Corporation
ASEAN	Association of Southeast Asian Nations
ATMS	Advanced Train Management System
ATSE	Australian Academy of Technology and Engineering
AURIN	Australian Urban Research Infrastructure Network
BCA	Building and Construction Authority
BIM	Building information modelling
CAD	Computer Aided Design
CAP	Common Alerting Protocol
CAV	Connected and autonomous vehicles
COAG	Council of Australian Governments
COBie	Construction Operations Building Information Exchange
C2C	Centre to Centre
DIRD	Australian Government Department of Infrastructure and Regional Development
DPTI	South Australian Government Department of Planning, Transport and Infrastructure

DRM	disaster risk management
DSSO	Decision Support System Optimiser
EA	Engineers Australia
GIS	Geographical Information Systems
GNSS	Global Navigation Satellite Systems
ICT	Information and Communications Technology
IFC	Industry Foundation Classes
IIC	Industrial Interconnect Consortium
IOM	Integrated Optimisation Modelling
IoT	Internet of Things
IPWEAQ	Institute of Public Works Engineering Australia Queensland Division
ISO	International Organization for Standardization
ITS	intelligent transport systems
ITU	International Telecommunications Union
LCM	Land Capability Modelling
LOD	Level of Detail
MEP	mechanical, electrical and plumbing
MLS	mobile laser scanning
NAMS	National Asset Management Strategy
NATSPEC	National Building Specification
NICTA	National ICT Australia
NCICS	National Committee for Information and Communications Sciences
NSW	New South Wales
OGC	Open Geospatial Consortium
OIC	Open Internet Consortium
OSS	open source software
PTI	Project Team Integration
QUT	Queensland University of Technology
SCATS	Sydney Coordinated Adaptive Traffic System

SIBA	Spatial Industry Business Association
the Strategic Forum	Strategic Forum for the Australasian Building and Construction Industry
TMR	Queensland Government Department of Transport and Main Roads
TISOC	Transport and Infrastructure Senior Official's Committee
UAVs	Unmanned Aerial Vehicles
VDCO	Virtual Design Construction & Operation



List of recommendations

Recommendation 1

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.

Recommendation 2

The Committee recommends to the Australian Government that the proposed Smart Infrastructure Task Force take responsibility for the national coordination of:

- the development of national protocols for the release of infrastructure related data in both the government and private sectors, including creating mechanisms for the brokerage or sale of private sector data;
- the development of standards for the collection and management of infrastructure related data, including metadata standards; and
- an objects library.

Recommendation 3

The Committee recommends the Australian Government appoints and resources the National Archives of Australia to oversee the development of a whole-of-government strategy for the collection, management, storage and security of data related to the design, planning, operation and management of infrastructure.

Recommendation 4

The Committee recommends that the Australian Government recognise public safety communications systems as critical infrastructure, and continue to support the development of these systems, including funding research, promoting implementation, and providing national coordination.

Recommendation 5

The Committee recommends that the Australian Government continue to support the development of disaster planning and emergency response systems, including funding research, promoting implementation, and providing national coordination.

Recommendation 6

The Committee recommends that the Australian Government leads the formation of a suitably qualified and resourced Smart Infrastructure Task Force, led by Infrastructure Australia, on the model of the UK BIM Task Group, representing governments at all levels, academia and industry to provide for the coordination and implementation of smart ICT in the design, planning and development of infrastructure, and in the maintenance and optimisation of existing infrastructure. The Task Force will act as a coordinator and conduit for the development and implementation of policy nationally, including the development of industry and product standards and training and education. The Task Force will have responsibility for the development of a national strategy to accelerate the adoption of new technologies and innovations; and engage Australia with international experience and global best practice.

Recommendation 7

The Committee recommends that the Australian Government, as part of its infrastructure procurement processes, require BIM to LOD500 on all major infrastructure projects, exceeding \$50 million in cost, receiving Australian Government funding, including projects partially funded by Federal Government in partnership with state, territory and local governments, and that it focus on tendering mechanisms that will facilitate this outcome, on a project-by-project basis, with a view to ultimately establishing BIM as a procurement standard.

Recommendation 8

The Committee recommends that the Department of Infrastructure and Regional Development adopts a practice of examining whether the use of Smart ICT, in optimising the operation and maintenance of existing built infrastructure assets, can provide a more cost-effective solution than their physical replacement or upgrade.

Recommendation 9

The Committee recommends that the Australian Government, through COAG, works with state and territory governments to develop a national approach to the application of Smart ICT in the design and planning of infrastructure, particularly with respect to state government responsibilities in land management, utilities, and transport systems.

Recommendation 10

The Committee recommends that the Australian Government invite Infrastructure Australia to consider the use of smart ICT in infrastructure as a means of identifying savings that can be made in the short term.

Introduction

Referral and conduct of the Inquiry

- 1.1 The Inquiry into the role of Smart ICT in the design and planning of Infrastructure (the Inquiry), was referred to the former House of Representatives Standing Committee on Infrastructure and Communications on 25 May 2015. The Inquiry was referred by the Minister for Infrastructure and Regional Development, The Hon Warren Truss MP.
- 1.2 The Standing Committee on Infrastructure and Communications ceased by resolution of the House on 13 October 2015. The Standing Committee on Infrastructure, Transport and Cities (the Committee) adopted the Inquiry on 11 November 2015.
- 1.3 Immediately after referral, details of the Inquiry were made available on the Parliament of Australia's website calling for written submissions. The Inquiry was also promoted through an extensive mail out to interested parties, including peak bodies and organisations, and the relevant government departments.
- 1.4 Over the course of the Inquiry, the Committee received 49 submissions from organisations, government authorities and individuals. A list of submissions is at Appendix A. A range of publications, documents and supplementary material received during the Inquiry was received as exhibits. A list of exhibits is at Appendix B.
- 1.5 In addition, the Committee undertook an extensive program of public hearings. Between August 2015 and December 2015 the Inquiry held 8 public hearings, including one interstate public hearing. Details of the public hearings, including a list of witnesses, are at Appendix C.

Scope of the Inquiry

- 1.6 This inquiry was originally conceived as a limited investigation of new technologies relating to the development of infrastructure. The response from government and industry, however, has seen the inquiry grow into a broader examination of the development of smart infrastructure using new technologies and systems, and possible responses by government.

Structure of the report

- 1.7 Chapter 2 defines the key new technologies being applied to infrastructure and examines the opportunities and productivity benefits these technologies raise for urban and regional areas, utilities, and transport networks.
- 1.8 Chapter 3 examines the questions surrounding data collection and harmonisation, including:
- the importance of data to the development of smart infrastructure;
 - the need for access to data and the value of open data;
 - achieving compatibility and interoperability between different data, devices and systems;
 - the role of national and international standards in achieving the harmonisation of data and processes;
 - data collection and storage capabilities; and
 - data security.
- 1.9 Chapter 4 investigates the role of smart ICT in emergency management and disaster planning and remediation.
- 1.10 Chapter 5 focusses on the actions government and industry can take to promote the uptake of smart ICT in the development of infrastructure.

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 also look 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’. BIM can 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):

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:

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

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:

- 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 Museum¹⁵

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:

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:

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

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:

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 NICTA, *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

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

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

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

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. The lack 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.

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 will assist 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

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 through 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
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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

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

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:

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

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

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

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:

Austrroads 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.

taxi. 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-term 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

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:

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

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 cent 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

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:

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 device 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 travel 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:

- 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.**

Data collection and harmonisation

ICT and data collection—the importance of data collection to the development of smart infrastructure

3.1 The key to smart infrastructure is data. In its submission, Engineers Australia asserted that ‘data and its analysis are at the heart of smart infrastructure’;¹ while Professor Bob Williamson, of NICTA, explained to the Committee that ‘smart infrastructure relies upon data’:

If you cannot get your hands on the data then you cannot do anything with it. There are interventions that we believe a government can make to facilitate that access to data. We will argue why this itself is infrastructure in its own right. Opening up that data through a variety of things can enable a whole bunch of value added services.²

3.2 NICTA observed the connection between the collection and analysis of data and the creation of efficiencies in the planning, design and use of infrastructure. It stated that:

... by collecting data from current infrastructure systems (such as transport networks) and building evidence-based data-driven models, infrastructure performance can be more effectively measured and operating inefficiencies identified. Medium-to-longer term large-scale planning decisions can now be made with far greater certainty.³

3.3 An example of this was city road networks. NICTA explained:

1 Engineers Australia, *Submission 25*, p. 5.

2 Professor Bob Williamson, Interim CEO, NICTA, *Committee Hansard*, 21 August 2015, p. 1.

3 NICTA, *Submission 23*, p. 9.

Transport authorities typically collect a wide range of data from the road network, from real-time traffic volumes to incident management logs and public transport information. Currently, much of this data is not used in an integrated way. The core innovation of the NICTA system is a platform to integrate and fuse transport data from all current and future data sources and to incorporate this fused data into transport models built using the most advanced analytic techniques. This can then feed into operations, planning and traveller information services.

International and local evidence shows that this kind of superior situational awareness in the transport system leads to shorter and more reliable travel times for private vehicles, buses and trucks. The City of Dublin used better information systems to reduce bus travel times by 10%, and by making Sydney's M4 motorway "smart" we predict 40% faster travel times.⁴

3.4 NICTA noted that:

Smart ICT enables active demand management by accessing and presenting data needed to understand demand and the analysis to apply optimal demand shaping. It makes better use of existing data, and fuses new data sources. Machine learning and optimisation techniques – such as mathematical modelling, simulation, visualisation – provide predictive insights to highlight ways of improving operational efficiency, to uncover latent capacity in existing systems, and improve demand prediction to strengthen investment decisions.⁵

3.5 NICTA recommended that governments 'take all actions possible to encourage data creation and access for existing and new infrastructure'.⁶

3.6 Other evidence supported this view. Intel stated that 'the potential of the Internet of Things lies not in otherwise "dumb" objects being able to communicate to each other – it's about the data that is generated'. Intel noted that 'a great deal of the potential relates to what is referred to as the "circulatory value of data"':

If businesses, start-ups and entrepreneurial individuals have access to data – in a way that protects privacy – the opportunities to develop a range of 'spin-off' services are vast. In fact, they are

4 NICTA, *Submission 23*, p. 11.

5 NICTA, *Submission 23*, p. 14.

6 NICTA, *Submission 23*, p. 14.

difficult to be predicted with any accuracy given data can generate surprising insights.⁷

- 3.7 Independent Project Analysis observed that smart ICT played a critical role in measuring the effectiveness of infrastructure projects, including governance and outcomes. The key to this was data:

By acquiring critical data and selected performance indicators at all project phases, inputs can be linked to outcomes and key lessons learned can be captured. Critical metrics and performance parameters can then be benchmarked against historical performance and industry Best Practices. Plans and actions can then be implemented to improve productivity and future project performance.⁸

- 3.8 The Australian Technology Network of Universities highlighted ‘the growing importance of data analytics in moving towards a knowledge based economy’. It noted the work of the joint NICTA-RMIT Data Analytics Lab in ‘applying text, user and data analytics research to industry-driven projects that solve problems and provide efficiencies in areas such as health, logistics, smart cities, environment and security’:

For example, big data plays a role in managing public spaces and services by tracking behaviour and information from personal mobile devices in areas such as shopping malls, airports, and universities. Smart ICT can be used to increase public transport efficiencies, with real-time passenger data being used to optimise links between buses, trains, and trams in smart cities.⁹

- 3.9 For Engineers Australia, the ‘essence of “smart infrastructure” systems’ was ‘collecting information about the system’s health and how it is operating and continuously using this information to improve the services the system provides ... and to improve the adaptability and longevity of system assets’. Engineers Australia believed that ‘what distinguishes smart infrastructure is that information, and lots of it, must be collected, analysed and fed back into system operations adding a new layer of complexity to infrastructure management and development’.¹⁰

- 3.10 Transport for NSW argued that ‘infrastructure or asset information should be considered an asset in itself and can be managed more efficiently and effectively using smart ICT’. It stated that value would be achieved through ‘the application of smart ICT across the whole asset life cycle,

7 Intel, *Submission 42*, p. 5.

8 Independent Project Analysis, *Submission 11*, p. 2.

9 Australian Technology Network of Universities, *Submission 18*, p. 2.

10 Engineers Australia, *Submission 25*, p. 1.

from supporting decisions based on demand and need, to planning the right asset to build, building that asset and then operating and maintaining the asset'.¹¹

- 3.11 The Department of Communications noted that 'integrated spatial data is a fundamental requirement for emerging ICT design, and government has a key role in the coordination of spatial data'.¹²

Open data and smart ICT—the need for data access

- 3.12 Given the importance of data to the development of smart infrastructure, the value of open data access – making datasets containing non-sensitive information publicly accessible, without restriction – was emphasised in much of the evidence presented to the Committee. As Professor Bob Williamson, of NICTA, explained:

... smart infrastructure relies upon data. If you cannot get your hands on the data then you cannot do anything with it. There are interventions that we believe a government can make to facilitate that access to data ... Opening up that data through a variety of things can enable a whole bunch of value added services.¹³

- 3.13 In its submission, Optimatics noted that researchers now have available to them 'the techniques to build innovative new simulation models, predictive analytics and integrated optimisation models but often don't have the required infrastructure data'. However, the inability to access data stifled innovation.

- 3.14 The Victorian Spatial Council highlighted the role of government as a 'significant creator and provider of the information which underpins Smart ICT', and therefore the role of government in authorising access to information. The Council urged that 'to improve the design and planning of new infrastructure, these information resources should be available within and beyond jurisdiction boundaries'. It noted that:

One of the key characteristics of digital information is that individual datasets held by many agencies and collected for a particular purpose can be brought together and readily combined to support planning and decision making in other subject areas.

11 Transport for NSW, *Submission 33*, p. 18.

12 Department of Communications, *Submission 27*, p. 9.

13 Professor Bob Williamson, Interim CEO, NICTA, *Committee Hansard*, 21 August 2015, p. 1.

Given appropriate planning and coordination, this can happen with significant saving of costs.¹⁴

- 3.15 NICTA used the National Map as an example of what could be achieved through open data access. 'Working for the Australian Department of Communications and working closely with partner Geoscience Australia', NICTA's Terria team developed the software for the National Map initiative, 'placing government spatial data, which was previously difficult to access, into the hands of community, software developers and industry'. NICTA noted that:

This initiative is acting as a key enabler of innovation to boost government and industry productivity, prompting new business and providing better services to the community. The National Map website also acts as an incentive to government to release more data, in a searchable and reusable format, into the community. This platform saves departments reinventing the same tools and also allows the whole community to see a single view of all the infrastructure and resources in any location. The long-term productivity Benefits will be substantial.¹⁵

- 3.16 NICTA urged mandating 'the documentation and sharing of all relevant data', ensuring that 'learning from past projects is possible'. NICTA noted that data was often restricted by 'commercial-in-confidence' considerations, but argued that 'if the rule applies to all, and applies to public infrastructure, then all players are impacted (and benefited) equally'.¹⁶

- 3.17 Ms Judy Anderson, of IBM, observed that governments collect a lot of data that can be depersonalised and applied to innovation:

There are various apps that can be developed that we often do not realise we need until we get them and which can be in the public domain and created by small companies or people in garages – that sort of thing.¹⁷

- 3.18 Dr Michael Dixon, of IBM, emphasised that making data openly available would encourage innovation. He stated:

... people have a lot of time and appear from nowhere to make value of these things that we do not expect. The Europeans, particularly, seem to have an unquenchable thirst for data to make

14 Victorian Spatial Council, *Submission 6*, p. 3.

15 NICTA, *Submission 23*, p. 7.

16 NICTA, *Submission 23*, p. 8.

17 Ms Judy Anderson, Government and Regulatory Affairs Executive, IBM Australia and New Zealand, *Committee Hansard*, 25 September 2015, p. 47.

use of, which people do not really expect. Amsterdam, Berlin and Ljubljana all now have groups of incredibly talented young people who have come together because they can get access to the kind of data that people like us would perhaps just say, 'It is data'. But they find gold amongst it. I think that is a really important element of data strategy.¹⁸

3.19 Dr Marc Miska, of the Queensland University of Technology, urged governments 'to make that data available. If that data is not available, you will have no brilliant mind out there actually trying to help you to utilise that data.'¹⁹

3.20 Governments supported the principle of open data. In its submission, the Department of Communications stated that the Australian Government 'is committed to pursuing open data', and that 'nearly 7,000 Commonwealth datasets are already available from the data.gov.au website'. The Department agreed that 'the more data is openly available, the more it can be used, reused, repurposed and built on in combination with other data':

Innovation can occur when datasets are mashed up and the findings are analysed and/or visualised. In a knowledge-based economy, opening such datasets creates value and drives social and economic innovation, growth and development, including facilitating infrastructure planning and management. Private sector expertise can also extend the value of open government data for more effective ICT design.²⁰

3.21 The Department was 'proposing to publish open datasets on new developments and the carriers serving them'. This would help 'new developers identify providers of infrastructure and providers coordinate their roll-out activities'.²¹

3.22 The Department of Communications believed that 'where Smart ICT is deployed in infrastructure projects, providers should be encouraged to collect and manage the resulting data in as open and re-useable a manner as possible'.²² It argued that 'data should be made open by default, subject to privacy, national security and commercial confidentiality

18 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 48.

19 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.

20 Department of Communications, *Submission 27*, p. 8.

21 Department of Communications, *Submission 27*, p. 8.

22 Department of Communications, *Submission 27.1*, p. 5.

considerations' and suggested that 'where specialised data requests require additional resources, consideration can be given to a nominal service fee to cover costs and the resulting data should be made publicly available'.²³

- 3.23 The Queensland Department of Transport and Main Roads (TMR) noted that it had developed an 'Open Data Strategy which describes the process and type of data that is released on the Queensland Government's Open Data Portal', under which 'currently, 92% of the department's datasets are released, while the remaining eight per cent have been determined as not suitable for public release'. TMR 'assesses each of its datasets to determine whether or not it can be published as open data':

As part of this process, data custodians are required to carry out data assessments to ensure customer privacy and commercially sensitive data are protected and only released in summary or de-identifiable formats. This assessment is then validated by the department's Legal and Ethical Standards unit and approved by the relevant Deputy Director-General.²⁴

- 3.24 The City of Melbourne had a default policy of making data available. Its submission stated:

The City of Melbourne promotes the adoption of smart ICT in a number of ways. We lead by example and we consciously 'showcase' municipal innovation. We proactively welcome partnerships in ICT related initiatives including with small and start-up businesses, and we actively disseminate and encourage the re-use of municipal data by adopting the guiding principles in their release and presentation with a focus upon accessibility and ease of use.²⁵

- 3.25 Mr Austin Ley explained, however, that 'open data is not just about dumping everything you have got out there':

That just overwhelms people and does not achieve the right results, and also they might interpret it in ways that are not appropriate, because the data is not clean and is not useful. It also means that you need to have information provided in a way that the people can rely on it and that you are clear about how often it is going to be available. If they set some sort of business up on that model and then the data is not available in the future, that business has the potential not to continue. So we need to make

23 Department of Communications, *Submission 27.1*, p. 8.

24 Department of Transport and Main Roads (Queensland), *Submission 45*, p. 7.

25 City of Melbourne, *Submission 35*, p. 9.

sure we work in partnership with the community to make information available that is useful. That is the model that we are using at the moment, and I think it is particularly important that the data that we make available is maintained and has integrity.²⁶

- 3.26 Dr Dean Economou, of NICTA, noted that while a lot of data was available, there was still a lot ‘locked up for various reasons’, and that across government, progress on opening data was ‘quite variable’. He stated that:

... anything government can do to encourage its own agencies, both state and federal, to open up the data is important. Part of that is enabling the agencies themselves to do it. Sometimes they do not have the skills, the budget or the equipment. They would like to do it, but they cannot. It may be that we need to make more money available to the agencies to make this happen.²⁷

- 3.27 Dr Economou also noted that ‘it is one thing to collect the data and say that it is open; it is another thing to make it very easy to find’:

There are ways of making it easy to find. You have seen our national map. That is a way of making geospatial data easy to find. In every aspect of the data that is relevant to infrastructure, we need to make it easy to find.²⁸

- 3.28 In its submission, Urban Circus noted that while other forms of data was already being made available, 3-D geospatial data was not readily accessible. It noted that

... advances in survey and mapping have accelerated to the point where accurate 3d information can be produced at modest costs. Whole cities and infrastructure corridors can be scanned in 3d. We would say 3d survey is becoming commoditized.

However, governments often protect and encase this data in regulation and protection. Even the “open data” States like Queensland do not open their 3d geospatial data, such as 3d lidar or contours.²⁹

- 3.29 Urban Circus recommended that the Australian Government:

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

27 Dr Dean Economou, Acting Director, Infrastructure, Transport and Logistics, NICTA, *Committee Hansard*, 21 August 2015, p. 2.

28 Dr Dean Economou, Acting Director, Infrastructure, Transport and Logistics, NICTA, *Committee Hansard*, 21 August 2015, pp. 1-2.

29 Urban Circus, *Submission 3*, p. 4.

- Ensure that 3d geospatial data be made available to Australia owned companies.
- Ensure that this data be treated like other ‘open source’ data and be made available for companies like ours to innovate and experiment with – with suitable conditions (eg do not give or sell the raw data to third parties without partnership royalties etc)
 - ⇒ Geoscience Australia and CSIRO and NICTA or CRCs do not share their data openly and have unfair advantage with huge capital injections from the Federal Government and competing with small companies on an uneven playing field
- Not impose standardizing data formats and details – we can use any format available.³⁰

Access to private sector data

- 3.30 In addition to access to government data, access to private sector data was also highlighted as an important step in promoting smart infrastructure. TMR noted that ‘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’. TMR believed that ‘the capabilities potentially afforded by achieving these linkages’ included providing the ‘opportunity for transport agencies to become ‘information brokers’; and that ‘the de-identified data collected may have valuable commercial applications’.³¹
- 3.31 NICTA also noted that ‘probably most of the good-quality data is collected by private companies’, and that ‘Google, Apple and the mobile phone companies have rich troves of data that are currently not really accessible in a format that is useful for the public good’. NICTA believed that:
- We need to look into ways to liberate that data and encourage people to put it into the public domain so we can combine good publicly available government data with good public benefit private data that is not commercially sensitive.³²
- 3.32 Professor Ian Bishop, of the University of Melbourne, highlighted the fact that private companies were collecting large amounts of valuable data that if available to researchers would allow highly detailed urban models. Often that data was of short-term use to the companies, but long-term use to others. Professor Bishop suggested that ‘it may not be a matter of taking

30 Urban Circus, *Submission 3*, p. 4.

31 Department of Transport and Main Roads (Queensland), *Submission 45*, p. 5.

32 Dr Dean Economou, Acting Director, Infrastructure, Transport and Logistics, NICTA, *Committee Hansard*, 21 August 2015, pp. 1–2.

that data at the time it is useful to those people; it may be a matter of accepting it at a time when it is still useful beyond that'.³³

- 3.33 Dr Gideon Aschwanden, of the University of Melbourne, urged a 'balance between private property and public good'. He stated:

The question over that ownership is who is managing the data in the short term – definitely the companies themselves, because they have the interests. But in the long term the government needs to invest into an infrastructure which is taking care of that.³⁴

- 3.34 Professor Thas Nirmalathas, of the University of Melbourne, proposed separating the issues of ownership and access, stating:

Ownership – people who generate can own the data – is okay, but there has to be fair, flexible and equitable access to that data for the common good so that there is innovation as well as common good.³⁵

- 3.35 On the other hand, Mr Petros Kapoulitsas, of Independent Project Analysis, highlighted the difficulties in, and limitations upon, making private sector information publicly available. He stated:

We do not own the data, as such. Our clients, the industry, have collectively agreed to enrich the database through the provision of information for new projects. The models, the knowledge, improves. That information is then passed onto the industry, who benefit from the latest and greatest et cetera information on developing and executing projects. Technically, it is not our data to make available to the public. There are ways we can normalise the type of information. Although a particular number might not be visible for a particular project, an index would become available. So project A was 10 per cent more expensive than the average performance of similar projects in a similar part of the world.³⁶

33 Professor Ian Bishop, Honorary Professorial Fellow, Department of Infrastructure Engineering, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 42.

34 Dr Gideon Aschwanden, Lecturer in Urban Analytics, Faculty of Architecture, Building and Planning, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 42.

35 Professor Thas Nirmalathas, Institute Director, Melbourne Networked Society Institute, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 43.

36 Mr Petros Kapoulitsas, Office Director, Independent Project Analysis, *Committee Hansard*, 25 September 2015, p. 21.

Achieving compatibility of different data, devices and systems

3.36 Open data, however, requires more than a simple willingness to make data available. It requires open data formats, and the compatibility and interoperability of systems. In its submission, tech giant Intel noted that:

The more open standards and robust security systems are applied, the more citizens and governments alike will extract the benefits of the Internet of Things.³⁷

3.37 Intel observed that ‘systems of intelligent devices must be connected in order to maximize the potential of the Internet of Things’. There had to be ‘some level of interoperability – an ability to ‘speak the same “language”’. Intel noted that:

Proprietary technologies that are inherently antithetical to the concept of the internet of all things will limit scalability, citizen benefits, and delay economic benefits for new entrants. For this reason, with any smart infrastructure project, it is essential to build a platform based on open standards that have been adopted by the industry.³⁸

3.38 Intel stated that ‘an open-standards based solution also fosters industry innovation by allowing smaller entrepreneurs and larger enterprises (including government) to participate on an equal footing’.³⁹ Intel noted that it had ‘co-founded two industry consortia focused on interoperability and open standards: the Industrial Interconnect Consortium (IIC) and the Open Internet Consortium (OIC)’.⁴⁰ Intel believed that:

If smart infrastructure applications are implemented as open, standards-based and secure platform on which services can be incrementally added or upgraded, there can be potential for participation by a broad spectrum of private and public organisations to provide innovative solutions.⁴¹

3.39 Optimatics noted that ‘obtaining quality data on infrastructure for research purposes is difficult’ as ‘much of the data required is held by private (or in the case of utilities, government owned) companies and is often stored within proprietary systems’. This stifled innovation. Optimatics believed that ‘an Open Data Policy is the foundation for providing quality data for research and planning’. It recommended ‘a common open data format for infrastructure with appropriate extensions

37 Intel, *Submission 42*, p. 12.

38 Intel, *Submission 42*, p. 8.

39 Intel, *Submission 42*, p. 8.

40 Intel, *Submission 42*, p. 8.

41 Intel, *Submission 42*, p. 11.

for each type (e.g., transit systems, sewer networks) to ensure sufficient details are present to facilitate innovation'.⁴²

- 3.40 buildingSMART sought 'open standards for sharing information across all construction activities and integrating those with spatial data standards and support access to spatial data.' It argued that:

With those standards in place, smart ICT will enable infrastructure development agencies to plan, design, test, communicate and approve all new activities within our cities before the finalised ideas are manifested in the real world – to deliver better outcomes, more quickly at less cost and with lower risk.

The challenge is how to securely integrate millions of separate models under the control of millions of different entities using many different versions of software and hardware and do it with the least administrative burden.⁴³

- 3.41 Lynnwood Consulting highlighted the difficulties in the implementation of BIM 'due to the lack of a common language used for BIM or Virtual Design Construction & Operation (VDCCO) of physical assets in Australia'. It noted that BIM required the 'collaborative exchange of information across the asset life cycle supply chain, using three-dimensional models of buildings and infrastructure in electronic format, *consistent with open, non-proprietary standards*'. Lynnwood's view was that 'innovative technology is certainly beneficial and a key enabler, as long as the technology is either based on or fully supportive of *open standard architecture, open data standards and provides the user the ability to exchange data between systems in a seamless way*'.⁴⁴

- 3.42 Professor Keith Hampson suggested that projects funded by Infrastructure Australia require 'use of open, interoperable digital formats that would integrate across the various phases of the infrastructure projects: planning, design, construction and asset management':

Use IT systems that are open, meaning that they are not proprietary in respect of locking into a particular proprietary platform; interoperable, so that we are able to have IT transfer of various elements and characteristics of the infrastructure between platforms; and long lasting in respect of feeding into the asset management of the facility.⁴⁵

42 Optimatics, *Submission 39*, p. 10.

43 buildingSMART, *Submission 10*, pp. 6–7.

44 Lynnwood Consulting, *Submission 16*, p. 3. Emphasis added.

45 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 30.

- 3.43 He believed that this was ‘critical to allow us to upgrade, modify and refurbish our infrastructure more effectively’:

If we are making huge investments at this stage they need to be future-proofed and able to be modified for future technologies, and the digitisation of that in *open, interoperable formats will facilitate that*.⁴⁶

- 3.44 Dr Michael Dixon, of IBM, emphasised that one of the keys to governments not getting locked into highly specialised, proprietary systems was to ‘stop asking for them’. He stated:

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 mine, I think, to provide innovation.⁴⁷

- 3.45 Dr Dixon argued that ‘open platforms which enable the aggregation of data from disparate sources should be the foundation on which government, in conjunction with the private sector, can deliver better services at lower cost’.⁴⁸

- 3.46 The implementation of open data formats was supported by government. The Department of Communications believed that ‘data and interoperability of data standards are really important’,⁴⁹ and that making disparate data accessible through use of common standards was an essential step towards ensuring the compatibility of data, devices and systems.⁵⁰ The Department cited the work it was doing nationally, through ANZLIC, and internationally ‘with the OGC and the international standards organisation work’.⁵¹

- 3.47 Transport for NSW believed that ‘open data, stored in a standardised, non-proprietary format’, was the key to the successful implementation of Digital Engineering in the infrastructure industry. Open data enabled ‘interoperability across technologies and business platforms, resulting in

46 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 30. Emphasis added.

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

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

49 Ms Marianne Cullen, First Assistant Secretary, Digital Productivity Division, Department of Communications, *Committee Hansard*, 14 August 2015, p. 6.

50 Department of Communications, *Submission 27.1*, p. 9.

51 Ms Marianne Cullen, First Assistant Secretary, Digital Productivity Division, Department of Communications, *Committee Hansard*, 14 August 2015, p. 6.

true data exchange that prevents information from becoming misinterpreted, duplicated or lost'. Transport for NSW highlighted the UK experience, where:

The UK Government, in partnership with buildingSMART, is leading the development of an open industry standard called 'Industry Foundation Classes' (IFC). The intent of the IFC is "the specification for sharing data throughout the project life-cycle, globally, across disciplines and across technical applications in the construction and facilities management industries".

Through the adoption of a standard open data format such as IFC, infrastructure data and information will be guaranteed future interoperability. This will also enable the industry to tap into future technologies and innovations, avoiding the constraints and costs of being restricted to proprietary systems.⁵²

- 3.48 Transport for NSW believed that 'major software vendors will only invest in compatibility to open data formats if there is a suitable pipeline of mandated demand'. It was 'critical that *governments commit to one common data format for all asset information* to get the greatest return on investment in Smart ICT'.⁵³ Transport for NSW argued that 'the challenge for government is to ensure that the smart ICT systems not only serve the efficient and effective delivery of projects but the effective and efficient delivery of ongoing services'. The key to this was 'the avoidance of cost and incompatibility in the transfer and integration of data from the smart ICT used by the construction and consultant industry with government owned systems'.⁵⁴
- 3.49 An example of a successful open data system was presented by the Institute of Public Works Engineering Australia Queensland Division (IPWEAQ). ADAC (Asset Design As Constructed) 'is a set of tools supported by IPWEAQ that make the exchange of standardised asset information easier between asset designers, constructors and owners'. IPWEAQ observed that 'ADAC is a standard data transfer format, not a software solution per se and is comprised of three components: Data Standard, data transfer mechanism, and supporting documentation'. It allows 'major commercial providers of survey, design, GIS and asset management systems now provide ADAC configurations "out of the box"'.⁵⁵ It also noted that:

52 Transport for NSW, *Submission 33*, pp. 11-12.

53 Transport for NSW, *Submission 33*, pp. 11-12. Emphasis added.

54 Transport for NSW, *Submission 33*, p. 18.

55 Institute of Public Works Engineering Australia Queensland Division, *Submission 44*, p. 3.

The most recent version of the ADAC Schema allows the inclusion of metadata to record the quality level within the asset management systems. Importantly, this allows asset data to be exported digitally from the utility/asset owner direct to external industry using fully automated request systems such as “Dial Before You Dig” in a survey accurate format. This eliminates data interoperability problems, prevents the need to recapture or “digitise” hard copy data and allows industry to value add on the product.⁵⁶

- 3.50 IPWEAQ stated that the ADAC specification was ‘endorsed by the National Asset Management Strategy (NAMS) and is the only data specification referenced in the International Infrastructure Management Manual’. It was envisaged that ADAC would ‘become the industry standard for describing civil infrastructure asset design and as constructed data across a range of public and private asset classes’.⁵⁷

Harmonisation—national and international standards

- 3.51 The need to create data standards to harmonise data and promote interoperability was identified in the evidence presented to the Committee. Mr Brett Casson, of Autodesk, stated:

I would like to touch on harmonising data formats and creating nationally consistent arrangements for data storage and access. This is one of the keys to the success of widespread adoption of BIM in Australia. Without a harmonised national approach there will be great uncertainty and no guarantees in the interoperability of the data throughout the life cycle of the infrastructure project being through proposed design, conceptual design, detailed design, construction, delivery and operations. That is the reason why we are advocating a whole-of-government approach. If the states start developing their own systems then this would lead to possible confusion. The analogy that I would like to draw on that would be the different rail gauges between states, so that is why we are most certainly advocating a whole-of-government approach.⁵⁸

- 3.52 It was indicated that creating data and making it available was not sufficient in and of itself-- there had to be an effective information management framework. The Victorian Spatial Council argued that:

56 Institute of Public Works Engineering Australia Queensland Division, *Submission 44*, p. 4.

57 Institute of Public Works Engineering Australia Queensland Division, *Submission 44*, p. 3.

58 Mr Brett Casson, Infrastructure Development Executive, Autodesk, *Committee Hansard*, 9 September 2015, p. 3.

Critical data should be brought under a standard management regime (to ensure comparable quality); a central store for that information should be established, and the connectivity should be put in place to make that information immediately available, including through smart ICT, for an emergency (and establish physical distribution arrangements for routine operations).⁵⁹

3.53 The Victorian Spatial Council supported ‘overarching legislation’ – not specific legislation but ‘an overarching framework’. It cited international examples of such frameworks, including Japan, the United States and South Africa. Such a framework would define people’s roles and responsibilities for data management.⁶⁰

3.54 Professor Keith Hampson, of Curtin University, stated:

If we look at a range of other determinants to do with the planning, design and operation of our infrastructure, the integration of data across the various jurisdictions – both federal and state and local – clearly needs to be facilitated at a central level, and that becomes an Australian government responsibility.⁶¹

3.55 Dr Matt Wenham, representing the Australian Academy of Technological Sciences and Engineering, was more circumspect about the need for legislation, suggesting instead ‘a role for the national government as a convening authority to get agreed standards across the different jurisdictions, be that state or local government’. Nonetheless, he agreed that ‘one of the key roles of a national government, which was addressed in some of the earlier submissions, is around harmonisation and standards’:

One of the issues with innovation when you have lots of different technologies, programs or initiatives starting up is that, if they use different platforms and different standards for the data, that limits the amount of interoperability you can have and that limits the benefit you can get from these sorts of technologies. Having someone, be it the national government or another grouping, set some standards on how data should be collected and stored – what format and that sort of thing – that can play a big role in enhancing the ability of the technology.⁶²

59 Victorian Spatial Council, *Submission 6*, p. 5.

60 Mr Olaf Hedberg, Chair, Victorian Spatial Council, *Committee Hansard*, 25 September 2015, p. 4.

61 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 31.

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

3.56 Mr David Hassett, of the City of Melbourne, believed it was crucial, '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.'⁶³

3.57 Mr Andrew Dingjan, of the Australian Urban Research Infrastructure Network (AURIN), identified similar problems, noting that 'it is one thing to have an open data policy and to promulgate the benefits of open data policy and access; it is another thing to have some level of harmonisation and standardisation of that data across the states'. He continued:

This is somewhat of a problem and continues to be a problem. It is not to say that there are no initiatives or frameworks in place – for instance, the ANZ OIC initiative and some of the other projects such as the Australian National Data Service project, which are not looking at that. However, it is probably taking a lot longer and it is a more circuitous route to get there. So, in terms of an overall infrastructure solution, I think having some governmental approach to the standardisation of data – for example, how street networks are defined between the states, which is very different between Victoria and New South Wales, and how property valuations differ between each of the individual states – is all important when it comes to the development of regional centres, urban centres, and creating levels of equity in terms of economic, social and urban development.⁶⁴

3.58 AURIN identified its work in harmonising data as an example of what could be achieved, noting that 'there is an opportunity using AURIN as the primary enabler to establish federated urban data hubs across Australia to facilitate a range of research activities related to urban settlements'. AURIN stated:

New ICT based capabilities that augment infrastructure projects such as AURIN can systematise urban and population data standards, coverage across jurisdictions, harmonise that data and, through the application of appropriate benchmarking and analytic procedures, produce a comprehensive suite of value-added data. A corollary is the notion of frictionless infrastructure. Smart ICT may play a more active role in joining up and facilitating constructive coupling of myriad data sets, data infrastructures and all related predictive/analytical/reporting tools. Not only can this

63 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.

64 Mr Andrew Dingjan, Director, Australian Urban Research Infrastructure Network, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 41.

provide a greater degree of data and knowledge co-ordination and leveraging, but it may help contain the escalating cost of investing in new, software heavy infrastructure by shifting the development costs where open-source approaches are adopted.⁶⁵

- 3.59 Likewise, NICTA identified its work as an example of how disparate data could be harmonised and utilised more effectively:

As for the sort of stuff that NICTA is doing now and can already do, we have worked on harmonising data formats, which means it is easier for different bits of infrastructure to talk to each other. We know that trying to mandate a hard standard can often slow things down: 'We're going to wait till the standard's finished.' People can use that as a delay tactic. The other thing you do is have loose guidelines on how data works together, and that lets you build things like dashboards. You may have seen CityDashboard for London or something like that. You pull together a bunch of factors about how the city is performing: what is the state of traffic congestion, how is the stock market going, what is the delay on the call centre – a whole bunch of things that people care about. So we are working with some state governments on different versions of those dashboards, and they are all tied up with National Map and different kinds of visualisations.⁶⁶

- 3.60 However, the need to fix standards to data and systems was questioned in some of the evidence presented to the Committee, with some practitioners arguing that they were already operating successfully without fixed standards. Intel observed that 'the technology is already available to work with and normalise siloed data sets and legacy formats' and that it had 'been involved this process in many countries, including in Singapore, where much of the government data sets are not easily consumable and external independent parties have been brought in to aggregate the data'.⁶⁷

- 3.61 In its submission, the Queensland University of Technology (QUT) noted:

Many efforts from standardisation committees are making headway in creating abstract data standards to fit all but, as mentioned, the approach of starting at the application level is preventing the effectiveness of standards in the short term and

65 AURIN, *Submission 31*, p. 2.

66 Dr Dean Economou, Acting Director, Infrastructure, Transport and Logistics, NICTA, *Committee Hansard*, 21 August 2015, p. 8.

67 Intel, *Submission 42*, p. 10.

rendering them obsolete in the long term. Rapidly-changing technology requires responsive standards, and examples such as the General Transit Feed Specification from Google show that de-facto standards have the ability to regulate international data harmonisation without the need of lengthy ISO committee processes, if there is a real need.⁶⁸

- 3.62 QUT cited trials of its Jellyfish technology, which had ‘shown a large acceptance with industry to adapt a non ISO standard, purely by solving a common and agreed problem – data access in transport.’⁶⁹ According to QUT, the key was to avoid ‘application-driven standardisation’ which ‘renders itself obsolete within a short time due to rapidly changing technology’:

Infrastructure is growing at a comparatively slower pace than technology and remains in place over decades. The Jellyfish approach of attaching data in a way that is descriptive way to the infrastructure (ie asset) allows generations of applications to interpret the information as required without jeopardising the usefulness of data stored. The existence of national performance indicators in transport demonstrates the need for harmonisation and highlights the costs that arise from antiquated systems that yield false or incomplete data sets. This can be eliminated through a simple paradigm shift and by storing asset data agnostic to application models.⁷⁰

- 3.63 Dr Ben Guy, of Urban Circus Pty Ltd, observed that he had never had issues with getting data to talk to other data, regardless of the system on which it was produced:

From my personal experience, if you were to say to me, ‘I have some geospatial data that was collected on a Trimble machine,’ or, ‘it sits in Autodesk or Bentley,’ I would not mind. What I would want to know is how accurate it is, how valid it is and how good it is. I would do something magical with that, from that point. I do not care where it sits. I am impartial.⁷¹

- 3.64 All he required to do his work was access to data:

We were in Perth recently, and you have data sitting in Esri products, in Hexagon products and in 12d, Bentley, Autodesk and

68 Queensland University of Technology, *Submission 19*, p. 2.

69 Queensland University of Technology, *Submission 19*, p. 2.

70 Queensland University of Technology, *Submission 19*, p. 2.

71 Dr Ben Guy, Chief Executive Officer, Urban Circus Pty Ltd, *Committee Hansard*, 24 September 2015, p. 2.

all these kinds of things. It is our skill – that is what we do – to pull that data out, mash it all up, create interesting new products and enable the clients to do various things within the planning space. So, again, it has not been a barrier for us in our 10 years and \$70 billion worth of infrastructure experience. If other people are telling you different, I am not going to say that they are wrong. I would say, from my point of view, do not get too caught up on it.⁷²

- 3.65 Dr Marc Miska, of QUT, asserted that the Geographic Information System (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’.⁷³ He stated:

The GIS system has not changed in in a very long time, and it is the one place where we have our surveyors out there who make sure that we know actually where our land is, so to speak. With the attribute tables on top of that, as in every good computer age nowadays, you would have a certain type of attributes that is valid for the year 2016-17. There will be an update and you will keep maintaining these attribute sets. You just amend these attributes or add attributes to it, and after a couple of years you would retire the old datasets, because you would have requested that all the different states, and possibly all the local governments, have updated their data in a five-year cycle.⁷⁴

- 3.66 In its submissions, the Department of Communications highlighted the work already being done nationally and internationally on standards. The Department itself participates in ‘various local and international forums involved in devising standards for the ICT industry’ promoting ‘authoritative standards development across the ICT sector’, including:
- Standards Australia
 - ANZLIC – the Spatial Data Council
 - International Organization for Standardization (ISO),
 - Open Geospatial Consortium (OGC)
 - International Telecommunications Union (ITU).⁷⁵

72 Dr Ben Guy, Chief Executive Officer, Urban Circus Pty Ltd, *Committee Hansard*, 24 September 2015, p. 2.

73 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.

74 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. 11.

75 Department of Communications, *Submission 27.1*, p. 9.

3.67 The Department noted that:

Open ICT standards are playing a central role in the emergence of ‘hyper-connected’ devices, many of which will be attached to or embedded in the built environment. Open standards will allow disparate streams of data to be meshed together and accessed on a location or position-aware basis. Bodies such as the ISO and OGC will be key to the successful development of IoT.⁷⁶

3.68 The Department stated that the ISO was currently focussed on the Internet of Things under its ‘Working Group on Sensor Networks.’ The OGC was developing standards relating to ‘SensorThings, Smart Cities, Sensor Web Enablement and Observation and Measurement Encoding Standards supporting location-aware and real-time services’. The Department noted that the:

OGC is also developing new land and 3D building standards and has established a Point Cloud Domain Working Group for big spatial data. Point Clouds provide precise 3D digital modelling of the built environment, including textures and surface features.⁷⁷

3.69 The Department highlighted Australia’s own contribution internationally to the development of ITC standards:

In the data policy area, in particular with this spatial information ... we are very vocal in the international standards community. In fact, Australia is leading the international standards around addressing and geospatial information standards. At the moment that is all around looking at what we call semantic interoperability, where each of those data sets can come together in a mash-up, whereas currently that takes quite a bit of effort to do. We are leading that. We are also very closely tied with the Open Geospatial Consortium, which is a major consortium that looks at spatial standards and ICT standards. Indeed, we are holding an OGC international event in Sydney at the end of this year. We are very closely tied with them. Through Geoscience Australia, of course, we are also very engaged in the international community around global satellite navigation systems. GA are currently our lead on looking at how we are going to transition to what we call global navigation satellite systems into the future, which will give us down to five centimetre resolution on the ground. So there is a whole lot of activity going on and, certainly from a spatial

76 Department of Communications, *Submission 27*, p. 7.

77 Department of Communications, *Submission 27*, p. 7.

perspective, our role in the standards is very strong and Australia is doing very well in that space.⁷⁸

- 3.70 The Department observed that ISO and OGC standards were central to the development of the ANZLIC-sponsored Foundation Spatial Data Framework (FSDF), which was 'aimed at realising the highest degree of interoperability of these datasets across the Australian and New Zealand economies'. The Department believed that 'in collaboration with industry, government has a key role in developing authoritative standards across the ICT sector'. The Department noted that, 'in this regard, certain countries such as the United States are taking an early lead in developing key standards across a range of industry sectors'.⁷⁹
- 3.71 The Department of Infrastructure and Regional Development (DIRD), highlighted its own work in this field including:
- application of international standards for local use
 - collection and distribution of data to promote economic productivity and efficient use of resources
 - developing Intelligent Transport Systems (through membership of Austroads)
 - developing and implementing a protocol for the electronic exchange of Development Assessment data between stakeholders (including Local Government).
- 3.72 DIRD believed that 'harmonising infrastructure data nationally' was 'a pre-requisite for achieving significant benefits, e.g. for analytics, predictive modelling, optimisation, etc.' DIRD indicated that harmonising data would 'also enable infrastructure models to integrate to deliver even greater benefits in the future, e.g. providing a picture of relationships between assets, and to provide future new capabilities'.⁸⁰
- 3.73 In its submission, Standards Australia emphasised the importance of international standards to the development of smart ICT in Australia, stating:

The adoption of International Standards should continue to be a first consideration in Australia. Standards Australia has long supported, and continues to support, the participation in and

78 Ms Helen Owens, Assistant Secretary, Data Policy Branch, Digital Productivity Division, Department of Communications, *Committee Hansard*, 14 August 2015, p. 4.

79 Department of Communications, *Submission 27*, p. 7.

80 Department of Infrastructure and Regional Development, *Submission 28*, p. 13.

adoption of International Standards in the Information & Communication Technology sector.⁸¹

- 3.74 Standards Australia highlighted Australia's involvement in the ISO's Joint Technical Committee on Information Technologies and participation in the work of a range of international ICT Sub Committees which 'work on the development of standards directly or indirectly related to the smart ICT design and planning of infrastructure'. Standards Australia also facilitates the development of Australian Standards related to smart ICT through a range of committees. 'Standards Australia has more than 800 publications and standards related to the ICT Sector within its catalogue of published standards'.⁸² Standards Australia has also been active in the development of standards relating to cyber security. It noted that:

Standards Australia facilitated the participation of Australian Stakeholders in the development of the ISO/IEC 27000 series of standards. The recently developed ISO/IEC 27000 Information Security Management Systems series of standards are used as the building block for IT Security.⁸³

- 3.75 In its submission, the National Archives of Australia emphasised the importance of metadata to the interoperability of data and that 'agreed metadata standards are essential to achieve data harmonisation'. It noted that:

Interoperability of data and systems based on standards allows data discovery, sharing, analysis and reuse, as well as enabling data to be stored, controlled, managed, understood and preserved over time. Agreed standards also enable data sharing for business continuity purposes and disaster planning and recovery.⁸⁴

- 3.76 The Archives observed that 'Government can promote preservation, interoperability and optimisation of data related to infrastructure by supporting the further development and adoption of format and metadata standards'. The Archives noted that it had 'developed metadata standards for use in the Australian Government' and that it was 'developing interoperability standards based on formats and metadata'. It also noted that 'these standards are applicable outside Government and some have been adopted as national standards'.⁸⁵

81 Standards Australia, *Submission 43*, p. 1.

82 Standards Australia, *Submission 43*, pp. 3-4.

83 Standards Australia, *Submission 43*, p. 2.

84 National Archives of Australia, *Submission 1*, p. 3.

85 National Archives of Australia, *Submission 1*, p. 3.

- 3.77 The importance of metadata standards was highlighted in the submission of the University of Wollongong’s SMART Infrastructure Facility. SMART advised the Committee that:

The SMART Infrastructure Facility with the collaboration of the CSIRO has developed a SMART metadata and data management system. The metadata system is built on the open source metadata software GeoNetwork and has been developed specifically to cater to the strengths of the SMART Infrastructure Facility.

The SMART Metadata System and its associated guidelines provide a central e-research platform where infrastructure planners, designers and researchers can access knowledge about infrastructure data from various sources.⁸⁶

- 3.78 This system allowed SMART to ‘catalogue datasets from disparate data providers, research outputs, Commercial and Academic research projects and is designed to be flexible enough so that any type of infrastructure information can be catalogued’. It used a ‘subset of the ANZLIC Metadata Profile: AS/NZS ISO 19115:2005,’ standard, which allows access to information that had ‘previously been unmanaged, hidden and unused’. SMART observed:

The SMART metadata system has been configured to harvest research outputs from simulations and models from a number of different research projects. The ability to automate, harmonise and standardise research in this way is an example of how Academia can innovate and contribute within the ITC space.

The data climate of the SMART Infrastructure Facility has been harmonised so that Data Inputs, Outputs, Simulations, Modelling and Teaching have all been made consistent; this consistency facilitates good research outcomes for the Facility and the University.⁸⁷

Standards—BIM

- 3.79 The need for consistent standards for Building Information Modelling was also highlighted in the evidence presented to the Committee. buildingSmart observed that:

Currently Project delivery is typically based on a disjointed model as a result of the many and varied authorities, consultants, contractors and subcontractors organisations involved. Each individual organisation typically has their own formats they may

86 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 15.

87 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 16.

output information in, and there is no incentive for organisations to share data in formats that are legible to others, in fact the opposite may be considered advantageous.⁸⁸

3.80 buildingSMART was concerned that ‘left to the market, digital infrastructure will be governed by a wide range of often-conflicting rights, responsibilities and restrictions, including different corporate terms of use, licences and contracts’. Even worse, ‘each jurisdiction – be it local, State, Federal or internationally – could have their own set of rules and laws’. This would ‘lead to a total lack of ability to work with other organisations or Governments in digital infrastructure’.⁸⁹ buildingSMART believed that ‘a framework from the Government would provide consistent guidance about best practice implementation of BIM’. Such a framework would ‘enable businesses to self-innovate and would empower greater efficiencies, productivity and quality control’.⁹⁰

3.81 The importance of open standards was emphasised by Lynnwood Consulting. It noted that:

BIM promotes collaboration between a number of disciplines and this collaboration needs to be enabled by adopting a “common language”. Most BIM practitioners refer to this common language as open standards. Open standards and true, non-proprietary interoperability are key to the long and short term success of the Architect, Engineering, Construction, Operator and Owner (AECOO) industry as it moves forward with Smart ICT processes and technology.

There is a real need for open standards when it comes to data formats, exchange, storage and access, as the potential of BIM can only be realised if the information contained in the model remains accessible and usable across a variety of technology platforms over a long period of time. For this reason, it is essential that Smart ICT (BIM) incorporates a universal, open data standard to allow full and free transfer of data among various software platforms (software applications) and between the stakeholders involved.⁹¹

3.82 Lynnwood argued that the advantages of open data standards was that it:

- Allowed each stakeholder to use any tools available on the open market that best suit their needs;
- Facilitated data exchange throughout the asset and project life cycle;

88 buildingSMART, *Submission 10.1*, p. 4.

89 buildingSMART, *Submission 10*, p. 7.

90 buildingSMART, *Submission 10*, p. 7.

91 Lynnwood Consulting, *Submission 16*, p. 7.

- Maintained consistent data standards across an asset portfolio or multiple projects;
 - Maximized the openness and competitiveness of the market for planning, design and construction services; and
 - Ensured that data created during a project remains usable in the future, independent of the policies and business decisions of individual asset owners or software vendors.⁹²
- 3.83 Lynnwood recommended that the Australian Government, in consultation with asset owners and industry, identify and agree upon the most appropriate suite of open data standards to adopt for use in Australia.⁹³
- 3.84 Aurecon stated that ‘having a non-proprietary format that is used by the supply chain will hugely improve productivity through the efficient use of one format, as opposed to multiple proprietary formats that populate the industry’.⁹⁴ Aurecon suggested that ‘Industry Foundation Class (IFC) provides an open ISO standard schema for the data structure of the digital assets to determine what information is exchanged’.⁹⁵
- 3.85 Aurecon argued that:
- To realise the benefits of a universal classification system, a non-proprietary open standard data structure/file format is required. This neutral open standard is critical in ensuring interoperability across multiple technologies and platforms. This interoperability provides true data exchange that prevents information from being reproduced, lost or misinterpreted, and supports long term future access and reuse.⁹⁶
- 3.86 Aurecon believed that ‘for the immediate future’, governments should ‘collaboratively agree with industry on the right form and format of data, which is appropriate for the intended use’. Beyond that, Aurecon believed that ‘data should be structured to ISO16739 (also known as IFC) and when in an ifcXML format (also known as IFC HTML), this can support an integrated, object-oriented and web-enabled dataset of the future’.⁹⁷
- 3.87 Mr Brett Casson, of Autodesk, took a similar view. He explained:
- We are advocates of an open BIM platform, meaning that it is vendor agnostic. We are very much in favour of having open standards and open format so that industry can use whatever

92 Lynnwood Consulting, *Submission 16*, p. 7.

93 Lynnwood Consulting, *Submission 16*, p. 9.

94 Aurecon, *Submission 22*, p. 16.

95 Aurecon, *Submission 22*, p. 15.

96 Aurecon, *Submission 22*, p. 17.

97 Aurecon, *Submission 22*, p. 17.

authoring tool they like, but we also recognise that there needs to be a common data environment and common framework and standards associated with those data formats so that, for example, a structural design for a bridge can marry with the road design for a bridge or the pavement design for a bridge, so the development of standards around those disciplines and the framework is absolutely critical for the success of BIM in this country.

At the moment there are definitely a few open data formats, so there are definite formats that are standards. One of them is IFC, which is an interoperable format between different vendor platforms for not only the 3D context or the 3D geometry but also there are other standards for the interoperability of data, so the associated data attached to those objects. I will draw on the UK experience as well. They have actually mapped out exactly how that would look, and one of those formats they use is IFC; the other one is COBie.⁹⁸

So the British standard, BS 1192, is being developed in certain phases. The vision for all of these platforms and all of these formats is that it will develop into an ISO standard. IFC is an ISO standard at the moment.⁹⁹

- 3.88 In its submission, Bentley Systems noted that ‘the list of all potential standards is too long to be included’ in one submission, and that constant change meant that any standards selected should be ‘chosen by the relevant infrastructure owner, are project/ discipline specific and are outcomes based’. Bentley noted that ‘there are standards that are relatively mature such as BS 1192–2007, ISO 10007, ISO 55000’ and suggested that these ‘could be, and indeed are being investigated and adopted in Australia’.¹⁰⁰ Bentley was, however, sceptical of the value of certain formats:

Construction Operations Building Information Exchange (COBie) and or Industry Foundation Class (IFC) or ISO16739 are often suggested as a silver bullet for information interoperability across the lifecycle of building. Neither COBie nor IFC, in their current form, are fit for purpose for civil infrastructure so we recommend that care be taken in ensuring that if standards, formats and

98 Mr Brett Casson, Infrastructure Development Executive, Autodesk, *Committee Hansard*, 9 September 2015, pp. 5–6.

99 Mr Brett Casson, Infrastructure Development Executive, Autodesk, *Committee Hansard*, 9 September 2015, p. 6

100 Bentley Systems, *Submission 29*, p. 10; see also, Mr Alan Savin, Vice President, Project Delivery, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 25.

processes are to be mandated that they are fit for purpose, industry supported and non-restrictive.¹⁰¹

3.89 The key, according to Bentley, was to take the mature standards that were available and adapt them to each new situation:

We are absolutely saying there is a foundation of standards that you need to adopt and then adapt. It is a different one for a rail project to a different one for a road project to a different one for a bridge project to a different one for a building project because of the fundamental needs, but it is no more complex than: this is the information which is required to successfully operate and maintain the asset. That is really what is important. So it is defining that clearly upfront and how you want that information and when you want that information handed over.¹⁰²

3.90 The Australasian Procurement and Construction Council (APCC) observed that the 'consistent application of standards will be essential for interoperability and collaboration between BIM model authors'. It stated that there was 'a need to define minimum deliverables including models at the end of building construction, and with data exchange protocols to allow maximum benefit of building information over building life'.¹⁰³

3.91 The APCC stated that the following objectives for the development and application of BIM standards:

- The establishment of a collaborative work environment where all participants operate in the same context: that is, there are Standards for modelling, terminology, and process.
- Automation of supply chains to achieve greater industrialisation and productivity within the construction industry.
- To ensure the Australian and New Zealand construction industry is compatible and competitive in the global construction sector.¹⁰⁴

101 Bentley Systems, *Submission 29*, p. 10; see also, Mr Brian Middleton, Senior Director, Transportation, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 25.

102 Mr Alan Savin, Vice President, Project Delivery, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 26.

103 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. 42.

104 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. 41.

- 3.92 The APCC noted that the UK BIM Task Force had ‘facilitated the development of Guidelines working with industry in their formulation’, including:
- PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling
 - PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling.¹⁰⁵
- 3.93 The APCC recommended that:
- National adoption of ISO and related BIM standards across the Commonwealth, and all States and Territories;
 - in Australia, adoption of the NATSPEC guidelines as a national standard;
 - adoption of open formats to ensure data access for an owner over a building’s life;
 - development of digital Standards for key supply chains, e.g. AMCA BIM-MEPAUS;
 - development of a standard for the asset/facilities management industry on data sets and information asset register outcome requirements to enable the handover from design and construction to operation in a BIM environment; and
 - links to ISO and global BIM developments.¹⁰⁶
- 3.94 The APCC also suggested that ‘standards and other recognised protocols that are prepared should be scalable with a short version for small projects and a comprehensive Standard for large projects’.¹⁰⁷

Objects library

- 3.95 One key element of establishing a system of standards is asset classification. Lynnwood Consulting explained:

A classification system is an essential tool for organising information. Without an agreed, comprehensive system for organising construction information, it is impossible to ensure interoperability between different information systems, design

105 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. 42.

106 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. 42.

107 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. 42.

tools, and facilities management tools, or achieve the aim of having data entered once and re-used several times through the asset life cycle.¹⁰⁸

3.96 Lynnwood noted that ‘an asset classification system must include buildings, infrastructure and integrated project and office management’. It must also ‘be able to map project information from the initial concept through development brief, detailed design, construction, commissioning, handover, and operation and maintenance’. Lynnwood noted that ‘there are currently two main asset classification systems competing globally to fulfil this role – Uniclass and OmniClass’:¹⁰⁹

3.97 Aurecon agreed, stating that ‘a common language is intrinsic to delivering the right data, to the right person, with the right level of detail’. Aurecon noted that:

Within the UK , they have found a solution to delivering a common language with the creation of the Digital Plan of Works (DPoW), a classification scheme and a free-to-use system for managing the flow of design and construction information, which is being project managed by the Technology Strategy Board (TSB) on behalf of the UK BIM Task Group. The DPoW will provide greater clarity on the information needed at each stage of a project. This, combined with standardised data templates, will help to develop a common language and set of data flows.¹¹⁰

3.98 Aurecon indicated that standardised data templates would ‘provide a consistent approach for product manufacturers by generating a single template for each product type that can be readily understood by all users’. These data templates would ‘then allow BIM data operations to be automated and users to extract the information they require’.¹¹¹

3.99 Aurecon believed that ‘a standardised national data classification and format is an essential tool for organising information’:

Without an agreed, comprehensive system for organising construction information it will be impossible to ensure interoperability between different information systems, design tools, and facilities management tools, with data entered once and re-used several times through the project lifecycle.¹¹²

108 Lynnwood Consulting, *Submission 16*, p. 8.

109 Lynnwood Consulting, *Submission 16*, p. 8.

110 Aurecon, *Submission 22*, p. 16.

111 Aurecon, *Submission 22*, p. 16.

112 Aurecon, *Submission 22*, p. 17.

- 3.100 Aurecon stated that 'classification is critical to industry standardisation, and if left to the supply chain will cause unnecessary complexity and confusion'. It believed that 'government must take the lead with industry to ensure consistency across the industry'. Aurecon suggested Data Classification (ISO12006) to use as reference.¹¹³
- 3.101 In its submission, Transport for NSW stated that 'Uniclass is currently the most advanced classification system in the world':
- This system was originally established by the Royal Institute of British Architects (RIBA) and is now owned and being further developed by the UK Government. Over time, Uniclass is expected to become an ISO standard, along with a number of other associated UK DE (or Building Information Modelling (BIM)) Standards.¹¹⁴
- 3.102 Transport for NSW observed that the development of a classification system is a 'complex and challenging problem that will require significant leadership and cross-sector alignment to solve'. It noted that 'there was currently a number of classification initiatives under development in Australia that are not harmonised. Transport for NSW stated that 'if these continue down their divergent paths, both the long-term productivity losses and rectification costs for Australia will be significant'.¹¹⁵ Transport for NSW believed that:
- A standardised approach to coding and classifying model objects will also enable local industry to develop consistent, re-usable libraries of objects. This will allow designers to build-up new designs with pre-designed and assured building blocks, resulting in a significant boost in productivity on infrastructure projects.¹¹⁶
- 3.103 The APCC advised that industry body NATSPEC have been developing National standards, including a National Object Library, 'within the Australian and New Zealand context'. These standards were to 'provide a consistent approach for road, bridge and building projects across Australian governments and industry'. They also 'set out processes for developing strategies and establishing a series of BIM standards, policies and principles'.¹¹⁷ The National Object Library would ensure that:
- Information about building and infrastructure asset elements, such as building fabric or building services or furniture and equipment,

113 Aurecon, *Submission 22*, p. 17.

114 Transport for NSW, *Submission 33*, p. 11.

115 Transport for NSW, *Submission 33*, p. 11.

116 Transport for NSW, *Submission 33*, p. 12.

117 Australasian Procurement and Construction Council, *Submission 9*, p. 3.

necessary for the design, construction, operation and management life cycles, is shared in a common format, across all participants in the asset/facility development and management sector.¹¹⁸

3.104 Similar activity being undertaken in Australia and New Zealand included:

- The Sustainable Built Environments National Research Centre (SBEnrc) has developed a pilot on Interoperable Object Libraries that establishes a library of generic objects, accessible by the three major BIM tools in the Australian market intended to demonstrate a national solution for industry access to building product data.
- User groups for proprietary software applications such as Revit have developed Australian and New Zealand Revit Standards (ANZRS) for developing 'Families' and best practice.
- BIM-MEPAUS, an initiative by the Air Conditioning and Mechanical Contractors' Association of Australia, has implemented product data for the building services supply chain.
- The National Building Specification (NBS) in the United Kingdom provides free universal access to its National BIM Library and is a leader in the UK, and globally, of product information management & BIM technology development.
- BuildingSMART Australasia's National BIM Initiative Working Group 3 – Object Libraries, has developed a more detailed version of the QUT Interoperable Object Libraries prototype and joined an international pilot of the BuildingSMART Australasia Data Dictionary creating both Australian and New Zealand versions of a ceiling tile system property definitions.¹¹⁹

3.105 The APCC asserted that:

It is important that Australian and New Zealand manufactured products that comply with Australian and or New Zealand BIM Standards are accessible in a BIM Library. It is desirable that Australia and New Zealand share compatible systems, and international consistency of BIM objects for international services and trading competitiveness. The development of Australia and New Zealand-specific objects will maximise growth in the Australian and New Zealand BIM services markets. Development

118 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. 38.

119 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. 39.

of a shared international BIM Library to suit Australian and New Zealand construction practice is currently being undertaken.¹²⁰

3.106 It recommended:

- establishment of a National Object Library system to be stewarded by NATSPEC as the authoritative national Information Broker for product information (this may be via a Memorandum of Understanding between NATSPEC and NBS);
- development of a business plan to implement an Australian National BIM Library with appropriate resourcing and funding, including evaluating collaboration with NBS UK to share potential use of the UK BIM Library, and technology development cooperation to enhance availability of digital product data;
- in Australia, liaison with CIL, NZ, to arrive at an aligned trans-Tasman business model;
- engagement of product manufacturers (particularly in specialist domains) to work with BIM users developing supply chain sector specific object libraries;
- engage the product manufacturing industry as part of the adoption of the BIM journey in the Australian and New Zealand construction industry; and
- engagement globally on object library Standards developments (for example ISO, COBie, bsDD, SPie etc) where it suits our national interests and to exploit and expedite the potential of BIM.¹²¹

Data collection and storage capabilities

3.107 The need to develop capacity and systems for the collection and storage of data was highlighted in the evidence presented to the Committee. In its submission, the National Archives observed that the 'consequences of inadequate data and information management include data loss, poor business decisions, unnecessary risk and compromises to safety'. The Archives believed that 'data management should be considered through all stages of infrastructure planning, development and maintenance, and that the 'creation and management of data should be incorporated into contract arrangements to ensure data remains available for the life of the infrastructure'.¹²²

120 Australasian Procurement and Construction Council, *Submission 9*, p.3.

121 Australasian Procurement and Construction Council, *Submission 9, Attachment 1, A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, pp. 39–40.

122 National Archives of Australia, *Submission 1*, p. 2.

3.108 Dr Marc Miska, of QUT, emphasised the need for consistency across government. He stated:

... if you leave it to all the different states, everybody will have their own solution. Look at all the data portals that are out from every state now. None of those can interoperate with each other. It is very difficult to pull data from two different states and compare. It is just not possible. If this is run at a national level, you can actually compare things. You can say how New South Wales compares to Victoria, Queensland or Western Australia in terms of what return on investment they get, and you can make a fair judgement. Right now there is no way to compare, because you are comparing apples and oranges and you do not know where it actually comes from.¹²³

3.109 Aurecon suggested that the Australian Government ‘look at how governments such as the Singaporean government host all publically procured assets’:

Their vision is to implement the fastest building permitting process in the world. The Building and Construction Authority (BCA) led a multi-agency effort in 2007/2008 to implement Singapore e-submission, the world’s first BIM electronic submission tool (e-submission). The BIM e-submission system streamlines the process for regulatory submission. Project teams only need to submit one building model, which contains all of the information needed to meet the requirements of a regulatory agency. In 2010, nine regulatory agencies accepted architectural data rich graphical models for approval through e-submission. This was followed by the acceptance of mechanical, electrical and plumbing (MEP) and structural BIM models in 2011. In 2013 the Singapore government began mandating architectural BIM e-submissions for building projects greater than 20,000 square meters. In 2015 BIM e-submissions will be required for all projects greater than 5,000 square meters.¹²⁴

3.110 Aurecon believed that by ‘centrally hosting all government procured assets this would enable a single source of truth for a digital built Australia’.¹²⁵

123 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.

124 Aurecon, *Submission 22*, pp. 17–18.

125 Aurecon, *Submission 22*, pp. 17–18.

3.111 buildingSMART proposed the creation of Property Data Banks ‘to hold and connect the official models of each property into a secure fully-integrated digital built environment’. The Banks would include ‘rights of access mirroring our real-world rights, and standardised data exchange formats for use and trade’. The Property Data Banks would operate on commercial principles – ‘Just like traditional banks compete to hold and transact our money, new organizations should compete to hold and share our property models’.¹²⁶

3.112 The question of the physical storage of data was also raised. Mr Carl Catalano, of BCE Surveying noted that improvements in data collection and the increasing volumes of data collected required the regular upgrade of computer systems:

Over the last 2½ years, we have upgraded our computer systems three times to be able to handle it. We recently spent \$40,000 on storage and upgrades on our computer system to be able to do our job better.¹²⁷

3.113 Dr Catherine Ball, of URS, observed that:

One of the things we are trying to assist our clients with across the board is their data storage, data interrogation and data amalgamation. We are going to have to start looking at cloud based services and off-site storage. ... A lot of data will be collected in the next couple of years very quickly and I am not certain of the capacity of the local council to handle that and whether the federal government and the ANU need to look at their supercomputers, for example, in Canberra to have national data storage system ... from my experience of working with local council, they are not quite prepared for the terabytes that are going to come flying in alongside the AUVs.¹²⁸

3.114 Mr Andreas Wohlsperger, of AECOM, indicated that the questions of where data was stored was more easily answered:

... once you have standards and documentation procedures in place, because that would allow you to have data stored in a distributed federated system, at maybe state government or federal level with various agencies, but, as long as you have

126 buildingSMART, *Submission 10*, pp. 7–8.

127 Mr Carl Catalano, Operations Manager, BCE Surveying Ltd, *Committee Hansard*, 4 September 2015, p. 9.

128 Dr Catherine Ball, Regional Unmanned Aerial Systems Lead, URS, *Committee Hansard*, 24 September 2015, p. 15.

standardisation in place in terms of the data and documentation around it, you can bring the data together in a holistic way.¹²⁹

3.115 The Queensland Department of Transport and Main Roads viewed the ‘development of a common data repository into which both government and third party providers could access consolidated smart ICT-enabled information as being a valuable contribution to fostering innovation’.¹³⁰

3.116 Telstra believed that the advent of the cloud would largely resolve the problem of data collection and storage, stating:

The advent of cloud services has led to an abundance of computing capacity which can be used to store and process the information that is flooding in from both human and machine sources. The combination of abundant capacity and abundant data has led to a resurgence of interest in machine learning algorithms over the last five to 10 years. By feeding a machine data, we can teach it to recognise patterns in a manner analogous to human thought processes.¹³¹

3.117 These views were echoed in the submissions of Bentley Systems and the Government of South Australia, both of which saw the future in the power of cloud based computing;¹³² while Dr Ben Guy, of Urban Circus, told the Committee:

I have just put 5,000 square kilometres of New South Wales on the cloud. It cost me about \$1,000 and took me about three days. That is about a terabyte of data. It is all aerial photography in ECW format and lidar. Amazon Web Services are not infinitely big, but they are pretty damn big. So I would say that that is not such a problem.¹³³

3.118 Indeed, according to BCE surveying, such were the improvements in the spatial processing environment that ‘increases in the computing capability around Geographic Information Systems (GIS) and cloud based solutions and apps can bring much of this geographic and location information to the palm of your hand’.¹³⁴

129 Mr Andreas Wohlsperger, Associate Director, GIS Practice Area Lead Australia New Zealand, Technology and Strategic Asset Management Lead, Northern and Western Australia, AECOM, *Committee Hansard*, 24 September 2015, p. 15.

130 Department of Transport and Main Roads (Queensland), *Submission 45*, p. 7.

131 Telstra, *Submission 14*, p. 3.

132 Bentley Systems, *Submission 29*, p. 4; Government of South Australia, *Submission 30*, p. 3.

133 Dr Ben Guy, Chief Executive Officer, Urban Circus Pty Ltd, *Committee Hansard*, 24 September 2015, p. 2.

134 BCE Surveying, *Submission 26*, p. 1.

Data security

- 3.119 The aggregation of large amounts of data presented security and privacy challenges; to protect data from loss, protect citizens from the misuse of personal data, and protecting data and hard infrastructure from attack. According to the Department of Defence:

Because any Internet-connected device or computer system is highly susceptible to malicious cyber activity, our dependence on ICT also brings greater exposure to threats. The threat is not limited to classified systems and information. A wide range of institutions, both public and private, have been subjected to malicious cyber activities.¹³⁵

- 3.120 In its submission, Engineers Australia stated:

The demands of smart infrastructure emphasize the importance of engaging the appropriate engineering, ICT and risk management skills to ensure that inter-connections between infrastructure systems do not present new sources of vulnerability that could lead to system failure. Infrastructure designers, developers and managers need to be conscious of the roles played by back-up systems to mitigate the consequences of failures.¹³⁶

- 3.121 Symantec, a global internet security company, has noted that data breaches continue to be common:

In 2014, cybercriminals continued to steal private information on an epic scale, by direct attack on institutions such as banks and retailers' point-of-sale systems. While there were fewer "mega breaches" in 2014, data breaches are still a significant issue. The number of breaches increased 23 percent and attackers were responsible for the majority of these breaches. Fewer identities were reported exposed in 2014, in part due to fewer companies reporting this metric when disclosing that a breach took place. This could indicate that many breaches – perhaps the majority – go unreported or undetected.¹³⁷

- 3.122 Symantec discussed an example of a high profile data breach from 2014:

The release of nearly 200 celebrity photographs on the website 4chan in August 2014 received wide media coverage and increased consumer anxiety about privacy. According to Apple, the images were obtained using highly tailored targeted attacks on individual

135 Department of Defence Intelligence and Security, *Australian Government Information Security Manual: Principles*, 2015, Commonwealth of Australia, p. 2

136 Engineers Australia, Submission 25, p. 5.

137 Symantec, *2015 Internet Security Threat Report*, Volume 20, 2015, p. 78

accounts rather than general weaknesses in the company's security. People's personal and financial information continues to command high prices on the black market, and that means cybercriminals will continue to target major institutions for large scores and small companies for small, easy ones. Many breaches are preventable with the right security measures, including elements such as data loss prevention, encryption, and intrusion detection systems, as well as with effective security policies and training.¹³⁸

3.123 Symantec also highlighted a major server data breach that occurred in 2014:

Heartbleed hit the headlines in April 2014, when it emerged that a vulnerability in the OpenSSL cryptographic software library meant attackers could access the data stored in a web server's memory during an encrypted session. This session data could include credit card details, passwords, or even private keys that could unlock an entire encrypted exchange.

At the time, it was estimated that Heartbleed affected 17 percent of SSL web servers, which use SSL and TLS certificates issued by trusted certificate authorities. This had a massive impact on businesses and individuals. Not only was a great deal of sensitive data at risk, but the public also had to be educated about the vulnerability so they knew when to update their passwords. Website owners had to first update their servers to the patched version of OpenSSL, then install new SSL certificates, and finally revoke the old ones. Only then would a password change be effective against the threat, and communicating that to the general public posed a real challenge.¹³⁹

3.124 Dr Dean Economou, of NICTA, highlighted security issues around the Internet of Things, 'where you will have a lot more relatively simple devices connected to the internet that might be measuring temperature, how many cars are going past et cetera'. He noted that 'a lot of attention needs to be paid to the security there', and advised that:

Half of our software team looks at what we call 'trustworthy systems', which is basically trying to alter the culture and

138 Symantec, *2015 Internet Security Threat Report*, Volume 20, 2015, p. 78

139 Symantec, *2015 Internet Security Threat Report*, Volume 20, 2015, p. 32

technology around how you store and protect data, and how the software itself maintains its integrity and cannot be hacked.¹⁴⁰

- 3.125 Symantec has also commented on the data security issues associated with the Internet of Things:

Computing and connectivity have enhanced our lives. Phones now play videos. Cars now have navigation and entertainment systems. In our homes, lighting, heating, and cooling can be controlled from an app. The possibilities are exciting, but there is also a dark side. For example, in May 2014, the FBI and police in 19 countries arrested more than 90 people in connection with “creepware” – using Internet-connected webcams to spy on people. Similarly, as cars get “smarter” (meaning more digital and more connected), they are also at greater risk. Researchers found that many cars are vulnerable to cyberattacks. Researchers were even able to use a laptop to control a standard car.¹⁴¹

- 3.126 Professor Thas Nirmalathas, of the University of Melbourne, argued that ‘cybersecurity is going to be critically important. I can only emphasise that we need to scale up the investment in that space.’¹⁴²

- 3.127 The Department of Infrastructure and Regional Development highlighted the security risks involved in the management of large quantities of data. DIRD stated:

There are a couple of different aspects there. There is critical infrastructure protection and making sure that the information about infrastructure is available for planning purposes and also available for productivity purposes but is not too disclosed for interference, if you like – so making sure that the systems underneath are protected. The other aspects of security are looking at things like cyber security and hacking.¹⁴³

- 3.128 DIRD noted the security compliance requirements attendant on all government agencies and the level of coordination across departments:

That is required across all of the government. In terms of departmental security, obviously we have to comply with all of those requirements also. So, there are many mechanisms across

140 Dr Dean Economou, Acting Director, Infrastructure, Transport and Logistics, NICTA, *Committee Hansard*, 21 August 2015, p. 3.

141 Symantec, *2015 Internet Security Threat Report*, Volume 20, 2015, p. 27

142 Professor Thas Nirmalathas, Institute Director, Melbourne Networked Society Institute, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 40.

143 Ms Nicole Spencer, Policy and Research Division, Deregulation Unit, Department of Infrastructure and Regional Development, *Committee Hansard*, 14 August 2015, p. 19.

government where departments are able to actually collaborate, but there are many different aspects to smart ITC; there is not just one issue that needs to be addressed. It is never just through one channel but many channels, which can make it a challenge.¹⁴⁴

- 3.129 Dr Matt Wenham, of the Australian Academy of Technological Sciences and Engineering, while highlighting the benefits of data access, also highlighted the risks:

The flip side of that is: it makes that record much more vulnerable to that sort of cyber security intrusions. That is a big issue for, in this case, governments to handle because we are talking, for the most part, about the public health system. In terms of where it should be stored, I do not think that I can say that authoritatively. But there are cyber security experts and people within government who can make those judgements. But that needs to be the guiding principle – that security of this information is incredibly important and that it is a constantly evolving threat environment. There are people in groups who are constantly trying to get at this information.¹⁴⁵

- 3.130 From the perspective of spatial data, the Department of Communications took the view that ‘there are not that many security issues, provided that we are not, obviously, making public things like Defence sites, critical infrastructure and so on’. The Department noted that ‘the spatial community believes that the foundation spatial data that we are building should be open’, and that ‘from a policy perspective, our aim is to make it free to the end user as well’.¹⁴⁶

- 3.131 AECOM thought that cybersecurity was very important. Mr Richard Morrison, noted AECOM’s experience with handling sensitive facilities in the UK. He agreed that ‘there needs to be some streaming in that data; it should not all be public access’. He noted however, that much potentially security sensitive data was already publicly available for those wishing to misuse it:

... if you go to Geoscience Australia’s website, you can obtain the GIS references to every single Australian exchange, currently. So,

144 Ms Nicole Spencer, Policy and Research Division, Deregulation Unit, Department of Infrastructure and Regional Development, *Committee Hansard*, 14 August 2015, p. 19.

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

146 Ms Helen Owens, Assistant Secretary, Data Policy Branch, Digital Productivity Division, Department of Communications, *Committee Hansard*, 14 August 2015, p. 4.

if you wanted to call that targeting information, you have that targeting information right now, publicly available.¹⁴⁷

- 3.132 Dr Ben Guy, of Urban Circus, emphasised the benefits of openness over secrecy. He stated

I think the benefits far, far outweigh the risks, and there always will be naughty people doing naughty things. I remember hearing a story about a terrible mine incident where there were some people trapped in a mine and in my head I was like, 'Man, if you had that in 3-D you would know where they are.' You would be able to get to them, where it must be so complicated without that. So there is the safety aspect and it is the same with, say, the airport link tunnel. If there was an incident you would have it mapped exactly in 3-D and available at your fingertips.¹⁴⁸

- 3.133 Dr Michael Dixon, representing IBM, argued that security was not so much a matter of restricting access to data as eternal vigilance:

From a security point of view, I think the problem is bad, it will continue to be bad and it will always be difficult. I think that is because humans have been malevolent. There have been malevolent humans since Cain and Abel, and they get very, very sophisticated in wreaking havoc. The problem we have now is that very capable but malevolent people can wreak havoc through electronic means on a scale that, historically, we have not seen.¹⁴⁹

- 3.134 Dr Dixon noted that IBM had 'a very big security practice':

It is very important. It is something that we spend a fortune on. We work with our clients around the world to protect them from all sorts of attacks in all sorts of various ways. There is no escaping that, and I think you need to have a very clear focus on security issues in protecting systems and access to them.¹⁵⁰

- 3.135 On the other hand, smart ICT had the potential to significantly increase the security of infrastructure assets. In its submission, Transport for NSW stated:

147 Mr Richard Morrison, Practice Lead, Information and Communications Technology, Australia New Zealand, AECOM, *Committee Hansard*, 24 September 2015, p. 16.

148 Dr Ben Guy, Chief Executive Officer, Urban Circus Pty Ltd, *Committee Hansard*, 24 September 2015, p. 6.

149 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 46.

150 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 46.

Smart ICT may be a focus for reducing the requirements for labour intensive network monitoring tasks. A reliable system (with inherent redundancy) integrating operational monitoring and incident detection technologies can enhance situational awareness, reduce response times and improve productivity across security, safety and operational continuity for critical infrastructure.

Smart ICT presents opportunities in the following areas:

- Integration and optimisation of CCTV networks
- video analytics
- electronic access control systems
- intruder detection systems
- vehicle tracking systems
- response crew work status
- (voice and data) communications networks in a single user interface.¹⁵¹

- 3.136 Intel noted, however, that security by design was critical – ‘especially when it comes to safeguarding critical infrastructure and protecting the privacy of users’:

This requires sensor to the cloud security being implemented from the beginning of any project.

Merely bolting on security at the end of the project is inadequate. Usually each supplier creates their own security system. When there are attempts to link these discrete systems, security risks arise.¹⁵²

- 3.137 Mr David Hassett, of the City of Melbourne, stated that there was ‘no doubt that in building an ICT framework security has to be not an afterthought but something which is actually, basically, built into the entire design of it so, indeed, we can secure people’s information correctly’.¹⁵³

- 3.138 Privacy was another important issue. The Queensland Department of Transport and Main Roads acknowledged that ‘issues around privacy need to be managed to fully realise the benefits that smart ICT solutions provide, including better practice in linking cross-agency data sets, data retention and cross-border flow’.¹⁵⁴

151 Transport for NSW, *Submission 33*, pp. 9–10.

152 Intel, *Submission 42*, p. 9.

153 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne, *Committee Hansard*, 25 September 2015, p. 15.

154 Department of Transport and Main Roads (Queensland), *Submission 45*, p. 10.

- 3.139 Professor Rod Tucker, of the Australian Academy of Science, noted that the need for privacy very much depended on the type of data and its uses:

For example, if it is medical data for managing a smart approach to health maintenance and health care, then clearly security and privacy is of utmost importance. In that case, the data would need to be held in some very secure way, and with privacy having the utmost priority. If it is data to do with the movement of pedestrians and commuters in the inner city, to do with public transport and so on, and that data has to do with management of smart applications for people to negotiate the city transport system, then clearly it is anonymised and that kind of data could well benefit from being widely available and open. So I think the answer really depends on the particular data that one is dealing with.¹⁵⁵

- 3.140 Intel believed it was ‘critical to ensure that privacy is protected in order to encourage adoption by citizens and for that to happen, data must be secure at all points’. Intel stated that ‘consumer notice and consent are important, but accountability for appropriate collection, use, and data protection must also be emphasised’. It also noted that the level of privacy required depended on what data was use for:

For example, license plate number recognition using cameras allows vehicles to be identified to deliver personalised services and enforcement notices to drivers. Such data might be used to identify drivers who have opted in to be offered promotions by nearby retailers without divulging personal information. In such cases intelligent, programmable gateway devices should be used to encrypt and filter out personal information before forwarding them to their appropriate destination – to the city’s cloud server and a retail hub respectively.¹⁵⁶

- 3.141 The City of Melbourne had grappled with this issue. Mr David Hassett believed ‘that there needs to be an understanding of the balance between privacy – which we all understand – and public benefit, and where that should be properly calibrated’. He noted:

For example, the City of Melbourne is at the moment supporting the Melbourne Metro Rail initiative with a mail-out. We have to provide them with a lot of data. Some of that data is subject to privacy. Naturally, we understand that. Where is the proper

155 Professor Rodney Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 2.

156 Intel, *Submission 42*, p. 9.

arrangement where we can share information easily between organisations to make these things more efficient? So it is very difficult for some of those businesses just to communicate with their stakeholders without a whole raft of legal hoops to go through. We understand why they are there, but, in some circumstances, some of those arrangements could be made significantly easier.¹⁵⁷

- 3.142 Mr Austin Ley, also representing the City of Melbourne, thought that ‘we really need to have a good discussion about what the nature of privacy is and how you can actually provide information which does not impact on privacy constraints or privacy’.¹⁵⁸ Dr Dixon concurred. He noted that:

What we are seeing there is that people are prepared to exchange some level of privacy for a real or perceived level of service. I think that it is also quite different with the younger generation. They see privacy issues quite differently to, perhaps, people of our age.¹⁵⁹

- 3.143 The Department of Infrastructure and Regional Development (DIRD) thought that ‘the risks to privacy presented by data collected and distributed through Smart ICT’ were being ‘addressed satisfactorily by existing legislation, the Australian Public Service Big Data Strategy 2013 (for the Commonwealth) and the Better Practice Guide for Big Data 2015’. DIRD acknowledged, however, that ‘significant challenges remain for Government to continue to improve regulatory frameworks that mitigate privacy risks and which have implications for liability and insurance matters that affect individuals and industry differently’.¹⁶⁰

- 3.144 The Department of Communications thought it:

... possible – and desirable – to safely release much of the data collected and held by government agencies publicly by adhering to best practice guidelines regarding the treatment of data and by using anonymising tools and aggregated datasets where necessary.¹⁶¹

- 3.145 It suggested, however, that ‘opening up real-time data to general use will only be desirable in certain cases, such as weather and traffic monitoring’. The Department stated that ‘sensitive data will need to be restricted to

157 Mr David Hassett, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place, City of Melbourne, *Committee Hansard*, 25 September 2015, p. 15.

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

159 Dr Michael Dixon, General Manager, Smarter Cities, IBM Corporation, *Committee Hansard*, 25 September 2015, p. 46.

160 Department of Infrastructure and Regional Development, *Submission 28*, p. 6.

161 Department of Communications, *Submission 27.1*, p. 9.

trusted users. Providers will need to carefully consider how necessary this requirement is during system development.¹⁶² The Department observed that:

In terms of data security, when releasing datasets government agencies must continue to uphold their existing public sector obligations to maintain the highest standards of privacy, national security and commercial confidentiality with respect to data that they hold.¹⁶³

3.146 Nonetheless, the Department took the view that ‘data should be made open by default, subject to privacy, national security and commercial confidentiality considerations’.¹⁶⁴

Committee conclusions

3.147 The importance of data to the development of smart infrastructure was highlighted in the evidence presented to the Committee. The generation, analysis and application of information are essentially what makes smart infrastructure ‘smart’. This, however, presents a range of challenges, not least of which is making provision for access to data.

3.148 The Committee acknowledges the utility of open data policies and the fact that most governments in Australia are already moving down this path. Open data allows researchers and entrepreneurs to interrogate data from diverse sources, finding innovative solutions to new problems – often in ways unforeseen. As one witness put it – the information potentially available to researchers and business is a solution looking for a problem to solve. The Committee supports the concept of open data as a default.

3.149 The Committee acknowledges, however, that there are limitations to open data, related to security, privacy and commercial considerations. Security is a critical consideration. Infrastructure needs to be protected, as does the infrastructure related data itself. This should be a primary consideration in the development of all infrastructure related smart ICT and in the release of data. Asset and data protection should be part of the development of every infrastructure project. The release of data should always take account of potential security issues; but also be realistic – there is little point suppressing data on the location of assets if similar information is publicly available.

162 Department of Communications, *Submission 27.1*, p. 8.

163 Department of Communications, *Submission 27.1*, p. 9.

164 Department of Communications, *Submission 27.1*, p. 8.

- 3.150 The Committee believes that the security risks surrounding the application of smart ICT to infrastructure have been downplayed in the evidence presented. The Committee notes that there have been very graphic demonstrations around the world of problems in the cybersecurity area, where a range of organisations have sought to use publically available data for their own ends, including for commercial or terrorist purposes. Given the amount of information that has been illegally accessed and released, questions of security, storage and access to data, need to be highlighted. The challenges of terrorist organisations and their use of certain sets of key data are real; and the Committee wishes to draw attention to the problems of maintaining the integrity of the security of incoming data, the storage of it and how it is used. There are risks inherent in having a 3D map of every single building in the country.
- 3.151 Privacy is another concern, although, as was pointed out in the evidence, concepts of privacy are changing with technology. Personal information – such as individual medical records – should not be publicly available. Yet the value of depersonalised and aggregated data must be recognised and efforts made to make such data available. The creation and promotion of such aggregated data should be the responsibility of government and industry alike.
- 3.152 The ownership of data is another key consideration to accessibility. Governments own, and are increasingly willing to release, valuable data. Private corporations and utilities also own much useful data, obtained for commercial purposes and not publicly available. Some organisations store and collate data on behalf of several owners. The suggestion has been made that governments mandate the release of this data. Another suggestion is that this data be made available through some form of brokerage, perhaps through central repositories. The Committee believes that data collected through private effort at private cost should remain the property of the owner. Nonetheless, the idea that this data should be managed with a view to its sale or public release is attractive. The Committee is of the view that the Smart Infrastructure Task Force (recommended in Chapter 5) should include as part of its role the development of protocols for the release of private sector infrastructure data with a view to promoting research and innovation. The Task Group should also focus on creating consistent protocols for the release of government data nationwide.
- 3.153 Open data requires open standards to be accessible and useful. The locking up of data within proprietary systems has the potential to render data unusable beyond its original purpose – an outcome antithetical to the concept of smart infrastructure. However, the extent to which data standards need to be prescriptive was challenged in the evidence

presented to the Committee, with a number of organisations indicating that they could make use of any data they could access. Others highlighted the importance of metadata – that ensuring the integrity of the fundamental attributes of data would enable interoperability and harmonisation.

- 3.154 The Committee is conscious of the work being done in Australia and internationally to create and adapt standards for the collection and management of data – especially in relation to BIM. The Committee believes that Australia should make every effort to learn from overseas experience, particularly that of the UK, in the development of standards for data collection and management and BIM. The Committee acknowledges the value of the creation of an objects library as part of this process.
- 3.155 The creation of massive and increasing volumes of data presents challenges to both government and the private sector. Some have undertaken investment in increased computing capacity while others have resorted to the cloud. Different organisations will need their own solutions, but the Australian Government should seek a coordinated response to the need for improved data collection and storage capabilities within government. A whole-of-government strategy for the collection, management and storage of data related to the design, planning, operation and management of infrastructure is essential to ensure that the capacity to collect and analyse data is available as needed.

Recommendation 2

- 3.156 **The Committee recommends to the Australian Government that the proposed Smart Infrastructure Task Force take responsibility for the national coordination of:**
- **the development of national protocols for the release of infrastructure related data in both the government and private sectors, including creating mechanisms for the brokerage or sale of private sector data;**
 - **the development of standards for the collection and management of infrastructure related data, including metadata standards; and**
 - **an objects library.**

Recommendation 3

- 3.157 The Committee recommends the Australian Government appoints and resources the National Archives of Australia to oversee the development of a whole-of-government strategy for the collection, management, storage and security of data related to the design, planning, operation and management of infrastructure.

4

Emergency management and disaster planning and remediation

4.1 Emergency management and disaster planning and remediation are key areas where smart ICT has, and will continue to make, significant improvements in government and public responses. The ability to predict emergency scenarios, model and manage responses, and remediate outcomes is essential to effective and coordinated responses to emergencies and disasters. In its submission, Transport for NSW noted that:

Beyond disaster relief, governments around the world are beginning to implement smart ICT strategies to improve disaster planning, with significant developments using digital engineering for city precinct planning and management.

Work is underway in a number of global cities, such as Singapore, Seoul and Vancouver, to break down existing data silos and improve access to current and accurate information for town planners and emergency services. The development of these precinct wide information models, or Virtual Cities, provide a trusted digital representation that can be re-used for response and scenario training, feed real-time monitoring data (video, audio, etc.) to emergency vehicles, identify access roads, egress points, highlight underground utilities, etc.¹

Current capabilities

4.2 The evidence presented to the Committee included a substantial list of areas where smart ICT is already contributing to emergency management

¹ Transport for NSW, *Submission 33*, p. 20.

and disaster planning. The Australian Information Industry Association (AIIA) illustrated several examples including:

- NICTA modelling of the flow of water from a potential spill at Warragamba Dam in Sydney. This enable the authorities to make informed decisions on optimal evacuation paths for residents in affected areas.
- Rio De Janeiro has developed a central operations centre, integrating data from 30 agencies to enable analysis of weather, energy, building, transportation and water data in real time. It has allowed the prediction of flood events before they occur, reducing reaction times to hours instead of days.
- Victorian Bushfire Warning System: the IBM built One Source Message System provides a warning system for writing and sending bushfire emergency messages.
- Crowd tracker: developed for Tennis Australia by IBM, this app allows fans to track themselves , crowds and events within the Melbourne and Olympic Park precincts. 'By using social media ad GPS enabled devices, this solution is very relevant to dealing with crime spots (e.g. Kings Cross) or major security threats or catastrophes.'²

4.3 The University of Melbourne advised the Committee of recent developments in bushfire management. The Phoenix RapidFire computer program can map out where a bushfire is likely to spread within minutes of reporting 'helping managers decide if they should send firefighters or evacuate communities':

Within seconds, the program crunches data on weather, wind, vegetation, the slope of the land and how dry the bush is. It turns this into a map of where the fire is likely to go, overlaid on Google Earth, and displays the results as a video. The program also diagnoses the type of fire – how hot will it burn? How high will the flames go? Where might embers land? Trained fire analysts monitor and act on the results ... Hundreds of fire analysts have been trained to use it.³

4.4 Transport for NSW identified a range of technologies and systems that had been introduced to assist in disaster management and remediation, including:

- The use of Unmanned Aerial Vehicles (UAVs or drones) in the aftermath of Typhoon Haiyan (2013), in the Philippines, to survey the

2 Australian Information Industry Association, *Submission 7*, pp. 7-8.

3 University of Melbourne, *Submission 32*, p. 5.

landscape, locate missing persons and create 2D and 3D maps of the disaster zone. Other uses of UAVs have included:

- ⇒ Nepal Earthquake (2015) – Drones fitted with thermal imaging cameras to detect survivors in remote locations;
- ⇒ Papua New Guinea (2014) – use of drones to transport medical samples in remote locations.

- Use of online tool Future Build, following the Christchurch earthquake (2010). This tool uses a form of GIS, enabling contractors to enter in consistent,, critical details about reconstruction works, including scheduling, delivery and access points. This promotes clash detection and program optimisation. It has also allowed agencies and other users to access a shared online view of linear infrastructure repair, planned buildings and other construction.⁴

4.5 Transport for NSW also noted that Sydney Trains had trialled the use of drones fitted with high definition cameras ‘to inspect and record data on assets in hard to reach or high risk locations’.⁵

4.6 The Queensland Department of Transport and Main Roads (TMR) noted that it was ‘currently utilising smart ICT solutions to deliver improved outcomes for Queenslanders through Emergency Vehicle Pre-emption (EVP) Technology’:

... an intuitive and dynamic ITS solution that triggers a green traffic light signal for emergency response vehicles in advance of their arrival at an intersection, reducing the number of times an emergency response vehicle crosses an intersection against a red traffic light.⁶

4.7 TMR is also ‘currently undertaking extensive flood mapping across the state to further identify parts of the network vulnerable to extreme weather events’.⁷ TMR believed that a greater level of system integration across multiple stakeholders will enable improved responses to events that impact the transport network.⁸ TMR identified system resilience as ‘a key strategic priority for the department in all future infrastructure planning and investment considerations’.⁹

4.8 Brisbane City Council identified a number of areas where it had made use of social media to improve emergency management at a local level:

4 Transport for NSW, *Submission 33*, p. 19.

5 Transport for NSW, *Submission 33*, p. 19.

6 Department of Transport and Main Roads, *Submission 45*, p. 9.

7 Department of Transport and Main Roads, *Submission 45*, p. 9.

8 Department of Transport and Main Roads, *Submission 45*, p. 9.

9 Department of Transport and Main Roads, *Submission 45*, p. 8.

Council created a social media Facebook profile after The Gap storms in 2008. Council's social media channels have expanded considerably since that time and Brisbane City Council is now the most followed local council on social media channels in Australia. Social media provides the opportunity for Council to get to know its residents and businesses better and this modern style of interaction with the community serves to build Council's reputation, credibility and thought leader status.¹⁰

- 4.9 Social media was also used in the aftermath of the 2011 Brisbane floods 'to provide vital information to the community on sandbag locations, road closures, flooded areas and key service disruptions'; and to connect residents 'with tradespeople and cleaning groups'. In January 2013, 'Council implemented a crowdsourced map displaying information on incidents and road closures'.
- 4.10 Brisbane City Council now regards social media as 'a mainstream consumer technology that can be easily leveraged to communicate with residents anywhere, anytime on any subject', and urges 'digital leaders ... to think strategically about how social media can play an active role in managing cities'. The Council also acknowledged the limits of social media, however, stating:
- During emergency events Council uses a multi-channel approach to communication. Social media alone has a dependency on the services from telecommunications carriers and in times of emergency these services become less reliable.¹¹
- 4.11 A detailed case study of the use of smart ICT in emergency management and disaster planning was provided by the University of Wollongong's SMART Infrastructure Facility – the PetaJakarta project. PetaJakarta.org is a research project led by the SMART Infrastructure Facility in collaboration with the Jakarta Emergency Management Agency (BPBD DKI Jakarta) and Twitter Inc. PetaJakarta is 'a web-based platform which runs on custom built open source software, called CogniCity, which turns the geo-tagged Tweets by Jakarta's citizens into a real time flood map'. The PetaJakarta platform allows 'citizens to share flood information with social media peers while simultaneously providing BPBD DKI Jakarta with data to support decision making for disaster response'.¹²
- 4.12 The SMART Infrastructure Facility stated that:

10 Brisbane City Council, *Submission 34*, p. 6.

11 Brisbane City Council, *Submission 34*, p. 6.

12 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 5.

PetaJakarta.org has demonstrated social media's valuable niche within the disaster risk management information ecosystem, as an operational tool capable of providing decision support at the various spatial and temporal scales required by the different actors within city. It offered an innovative and inexpensive method for the crowdsourcing of time-critical situational information in disaster scenarios.¹³

- 4.13 SMART urged policy makers to 'embrace social media platforms as an avenue for gathering crowd sourcing data that can inform decision makers during emerging situations'. It highlighted the benefits of Twitter, stating:

As the leading social media platform for real-time information sharing, Twitter offers a variety of functional elements that can be more thoroughly leveraged in the DRM sector. These functionalities include account verification, 'retweet validation' of citizen reports, Twitter Cards, programmatic reply functionalities, and the PowerTrack API Connection.¹⁴

- 4.14 One key element of success in platforms like PetaJakarta is the open availability of data. In its submission, SMART noted:

The development of open source software (OSS) platforms are crucial for wide spread dissemination of real-time information.

In the field of disaster management and remediation we believe a platform, that is open source and can harvest and display data in real-time, would be of invaluable assistance to decision makers and first responders. OSS should be designed for scalability and transferability with respect to the domain of application, the location, and the language of the users. Tools and platforms built for single-use applications are both costly and inefficient.¹⁵

- 4.15 Another important element is adopting or adapting metadata standards to the requirements of disaster risk management (DRM). SMART argued that:

DRM OSS for social media integration should be built with the aim of complimenting existing institutional frameworks and offer an open API for further integration into DRM information ecosystems; when possible, the storage of social media-sourced data should adapt to standard metadata formats such as the Common Alerting Protocol (CAP).¹⁶

13 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 11.

14 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 3.

15 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 3.

16 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 4.

- 4.16 Adopting simple metadata standards would allow efficient capture and store of information including datasets, software, projects and other resources. It also meant that 'seemingly unrelated information can be linked to, queried and discovered on a number of different platforms'. Well linked metadata would allow researchers from different disciplines to access information:

This allows these researchers to join in on and add to the conversation as simple standards reduce technical or discipline specific barriers to information. Well linked open data is an essential part of information management. These links form a web of connectedness that promotes consistency across the infrastructure landscape and provides multiple access points to these datasets, collections and resources.¹⁷

Future developments

- 4.17 The potential for smart ICT to improve emergency management and disaster planning and remediation was emphasised in the evidence presented to the Committee. buildingSMART believed that:

As Governments increasingly focus on disaster preparedness, community awareness, capability development and disaster response and recovery, smart ICT solutions and the digital built environment will be able to play a strategic and sustainable role in addressing these major challenges to society.¹⁸

- 4.18 In its submission, Downer highlighted the breadth of activity where smart ICT is being engaged to solve issues of disaster planning and remediation, including 'management of biosecurity outbreaks, crisis management, emergency response, and recovery'. It noted that:

Having complete and visible asset data on a common platform (e.g. remote monitoring of water flow, water quality and street light function) enables resources to target faults and expedite critical repair activities. Deploying wireless cameras, temporary lighting and temporary signals enables agencies to manage safety, security and traffic flows. Similarly, journey time modelling and matrix boards to inform motorists of changes and monitor the impact of traffic movements due to relocation of business

17 SMART Infrastructure Facility, University of Wollongong, *Submission 12*, p. 4.

18 buildingSMART, *Submission 10*, p. 9.

operations out of the centre, are valuable tools during these times.¹⁹

4.19 Downer observed that ‘a number of the above technologies have been employed as individual solutions’, but there was also ‘great potential to combine them as part of a structured response toolkit’.²⁰

4.20 Brisbane City Council identified a range of areas where smart technology was expected to add to Council’s additional disaster management capabilities, including:

- Improved options for multi-agency data sharing.
- Access to improved intelligence through the use of drones and rapid response aerial photography.
- More sophisticated real time modelling and event simulation.
- Better access to data from remotely sensed sources.
- Smarter mobile field services to coordinate response and remediation.
- More effective task coordination through improved schedule and despatch processes.
- Use of common operating pictures and dashboards.
- Use of predictive analytics and machine learning to activate early intervention measures (e.g. bushfire burns).
- Availability of digital building plans and electronic records for sharing and distribution.²¹

4.21 The City of Melbourne stated that in the field of disaster planning and remediation, ‘we fully expect to benefit from a range of ICT attributes, including scenario modelling, assumption testing and instant, real-time and anywhere communication’. The City of Melbourne believed that ‘smart ICT will allow us to be better prepared for emergency management and to better connect with the community during emergencies’.²² Mr Austin Ley, representing the City of Melbourne, told that Committee that the council had been an IBM smart city grant:

... to assist the city in better understanding how to encourage the community to anticipate and coordinate responses before, during and after extreme events that might impact on the health and safety and infrastructure of our city.²³

4.22 In its submission, Transport for NSW noted that:

19 Downer, *Submission 20*, p. 3.

20 Downer, *Submission 20*, p. 3.

21 Brisbane City Council, *Submission 34*, p. 6.

22 City of Melbourne, *Submission 35*, p. 9.

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

Access to smart ICT technologies can provide enhanced situational awareness through monitoring and controlling networks, more rapid assessment and resolution of physical and information network disruptions and better interoperability resulting in collaboration between agencies.²⁴

4.23 Using the example of a major bridge malfunction, Transport for NSW observed that smart ICT gives agencies the capability to:

- rapidly identify the location and cause of the malfunction
- alert crews to the pending task and required parts/actions
- notify Transport Management Centre of the disruption
- potentially automatically develop and implement alternate routes or transport solutions
- communicate these through Intelligent Traffic Systems, smart vehicle control systems, GPS alerts/updates, apps, Variable Message Signs and social media.²⁵

4.24 Despite these opportunities to use smart ICT in emergency management and disaster planning and remediation, a number of challenges were identified to the uptake and use of smart ICT.

4.25 Mr Geoff Spring, from the Centre for Disaster Management and Public Safety at the University of Melbourne, observed that one barrier to the uptake of smart ICT was the conservative culture of the emergency management sector. He stated:

The emergency management sector should be a significant beneficiary of the availability of broadband communication technologies, smart ICT and the innovation in products and services it will bring; however, ... the sector will need to overcome its traditional conservative nature in order to capture opportunities associated with broadband technologies and smart ICT. These opportunities will empower the sector to contribute to building a higher level of community resilience and social wellbeing and hence economic productivity across Australia.²⁶

4.26 Mr Spring emphasised the importance of grassroots consultation with emergency services workers to establish effective systems – and these workers have to be aware of what solutions available in order to ask for them. He suggested that:

24 Transport for NSW, *Submission 33*, p. 21.

25 Transport for NSW, *Submission 33*, p. 21.

26 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 36.

One of the things that I think the Commonwealth government and the state governments could do is invest in a trial broadband communications network so that people can experience it—I was going to say ‘play with it’, but that is too simple a term—and get used to what broadband technologies mean in the emergency management space, because we simply do not know at this point in time. It is all guesswork.²⁷

4.27 Another key challenge to the adoption of smart ICT from an emergency management perspective is the growing dependence on ‘power and telecommunications networks for safety and efficiency’. Risk convergence, the ‘interdependencies between individual assets, transport networks and across sectors (Communications, Energy, Water, Transport etc.),’ needed to be ‘considered as a part of any incident, crisis and disaster planning’. Nonetheless, it was expected that smart ICT would itself ‘contribute to the resilience of local, state and national networks’; and would deliver other benefits, ‘including improved fuel efficiency, reduced travel times, avoidance of hazards and better awareness of incident impacts’.²⁸

4.28 The Department of Communications observed that:

... the effectiveness of new and emerging Smart ICT can be constrained within an emergency services context by issues associated with jurisdictional diversity, regulatory inconsistencies, the incompatibility of ICT systems, the capacity of networks and technologies to prioritise emergency communications, and the varying organisational capabilities and operational processes of individual emergency response organisations themselves.²⁹

4.29 The Department noted that:

These challenges present real and significant risks to network operators, policy makers, and emergency service organisations who remain focussed on ensuring (among other things) the efficient deployment of limited resources, funds for service and system upgrades are appropriately prioritised, and the highest possible level of protection to individuals is being achieved.³⁰

27 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 39.

28 Transport for NSW, *Submission 33*, p. 20.

29 Department of Communications, *Submission 27*, p. 5.

30 Department of Communications, *Submission 27*, p. 5.

- 4.30 Despite these issues, the Department believed that ‘the opportunities Smart ICT offers in providing service enhancements within the emergency service environment are undeniable’.³¹
- 4.31 Mr Andrew Dingjan, Director of the Australian Urban Research Infrastructure Network (AURIN), argued that with regard to emergency services and public safety, ‘spatial data infrastructure such as AURIN and public safety communications need to be considered as national critical infrastructure’. He noted that ‘public safety communications is no longer about voice, and there is now a greater focus on data and location’; and that ‘investments in the AURIN and ANDS, the Australian National Data Service, projects have provided the basis for the national Intelligent Disaster Decision Support System’.³² This system focusses on mission critical data in the management of events, using spatially enabled location based services and data analytics to convert mission critical data ‘into meaningful information for the purpose of enhanced decision making supported by real-time simulation and visualisation at points of service delivery and coordination’.³³
- 4.32 Mr Spring identified the need for investment in communications and computing infrastructure, noting that ‘for the first time the public has a greater communications and computing capability than public safety agencies and the emergency management sector more generally’. He stated that:
- To redress this imbalance, public safety agencies globally are being provided with access to broadband technologies with dedicated spectrum and spatially enabled public safety applications to meet community expectations for service delivery.
- Public safety communications need to be recognised as critical infrastructure and be included in any national conversation regarding investment in Australia’s infrastructure across all sectors.³⁴
- 4.33 Mr Spring highlighted AURIN’s proposal to:
- ... establish federated urban data hubs across Australia to facilitate a range of research activities related to urban settlements links directly to mission critical public safety communications

31 Department of Communications, *Submission 27*, p. 5.

32 Mr Andrew Dingjan, Director, Australian Urban Research Infrastructure Network, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 35.

33 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 37.

34 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 36.

ecosystem, the next generation triple zero system, the proposed public safety mobile broadband capability and the use of open standards to capture the opportunity for harmonised data in interjurisdictional analysis at both the national and intrastate level.³⁵

4.34 Mr Spring also urged greater collaboration ‘between governments, industry and academia around research associated with the use of broadband technologies for disaster management and public safety’.³⁶

4.35 In its submission, the Victorian Spatial Council also urged greater coordination between jurisdictions, and with private industry, in emergency management and disaster planning and remediation, stating:

The focus should be to encourage and direct the development of a network of government agencies and private sector organisations that will work together under this framework to deliver coordinated and managed spatial information for emergency management.

Such a capability should be based on ensuring participants are prepared and connected (ie always available), evidenced by:

- availability and quality of relevant data
- knowing that data exists
- knowing who to contact to get it
- knowing that it will technically fit with other data (ie compatibility of data and systems, and ‘interconnectivity’ to enable the exchange and sharing of data and products)
- being able to achieve this in meaningful timeframes (hours, not days or weeks)³⁷

4.36 Transport for NSW, recommended that the Australian Government fund ‘research and development of new technologies for disaster planning, emergency response and humanitarian relief’ and ‘the establishment of Virtual Cities or Precinct Information Models in Australia’.³⁸

4.37 The Queensland University of Technology highlighted the need for better spatial data on infrastructure as a critical element of emergency management, stating:

Past disasters have highlighted the need for better information on infrastructure. Local events, such as cyclones in Northern

35 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 37.

36 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 36.

37 Victorian Spatial Council, *Submission 6*, p. 4.

38 Transport for NSW, *Submission 33*, p. 21.

Queensland, have shown that lag of knowledge on asset location (ie road signs) cripples recovery and makes planning more challenging than it should be. Better spatial data is able to show scenarios of floods (i.e. 3D modelling of infrastructure and terrain) that identifies infrastructure that may lie in the path of a cyclone, and provides information on household sizes for evacuation plans that is crucial and needs to be current. If standardisation of access to such information can be achieved, emergency service and authorities can plan for events faster and more reliably, even across State borders.³⁹

4.38 In a similar vein, AECOM recommended the creation of an online national disaster-related Geographical Information System (GIS) which can be updated with public and private infrastructure for disaster related planning and automated emergency warning purposes.⁴⁰

4.39 In its submission, Orange Horizons urged governments to avoid a silo mentality in the development of smart ICT, particularly in relation to emergency management, utilising capacity and redundancy in existing systems to develop new ones. Orange Horizons suggested that the utilisation of existing capacity would significantly reduce the cost of developing a Public Safety Mobile Broadband (PSMB) system by accessing the capacity of systems with high levels of redundancy that were already in operation.⁴¹

Committee conclusions

4.40 The principal focus of this report is the deployment of smart ICT in the design and planning of infrastructure. It is not possible for the Committee to consider all the many variables in the deployment of such technologies to emergency management and disaster planning and remediation. The evidence presented to the Committee, however, makes it clear that smart ICT has an important role to play in the development of systems which will allow better planning for and responses to emergencies and disasters.

4.41 The capacity to anticipate the impacts of flood and fire through modelling of scenarios, to map the predicted and actual course of events, to create systems which allow access to granular data in real time, and determine the allocation of resources in minutes, is already a reality. What is required is the coordinated development and dissemination of technology and

39 Queensland University of Technology, *Submission 19*, p. 2.

40 AECOM, *Submission 21*, p. ii.

41 Orange Horizons, *Submission 41*, pp. 1-3.

systems. The Committee supports the work of AURIN and the Centre for Disaster Management and Public Safety in this field. It also supports the position of Orange Horizons in urging governments to take a holistic approach to the development of public safety communications systems – incorporating the development of public safety communications into the broader development of communications infrastructure rather than in isolation. Public safety communications systems are critical infrastructure and should be recognised as such.

Recommendation 4

- 4.42 **The Committee recommends that the Australian Government recognise public safety communications systems as critical infrastructure, and continue to support the development of these systems, including funding research, promoting implementation, and providing national coordination.**

Recommendation 5

- 4.43 **The Committee recommends that the Australian Government continue to support the development of disaster planning and emergency response systems, including funding research, promoting implementation, and providing national coordination.**

Promoting smart ICT

- 5.1 The potential benefits of using smart ICT to develop smart infrastructure have been canvassed extensively in the evidence presented to the Committee, and outlined in earlier chapters of the Report. This chapter will focus on the actions government and industry can take to promote the uptake of smart ICT in the development of infrastructure.

Government leadership

- 5.2 Views on the best way to promote the adoption of smart ICT in infrastructure varied in the evidence presented to the Committee. Many industry representatives, influenced by the example of the United Kingdom, called for Australian Government leadership in the adoption of smart ICT, particularly in relation to Building Information Modelling (BIM). In its submission, Aurecon argued that:

In the absence of any Australian construction digital strategy Federal and State governments are missing out on the commercial benefits in digitally procuring information on publically procured assets. Further, our recent consultations with government departments and agencies indicate to us that currently there is no coordinated BIM strategy.¹

- 5.3 Aurecon believed that:

As with some International Governments, including the UK, the Australian Federal/State Governments as a client can derive significant improvements in cost, value and carbon performance through the use of open sharable asset information that comes

¹ Aurecon, *Submission 22*, p. 18.

with adopting the BIM process as formal policy and embedded within procurement practices.²

- 5.4 Aurecon emphasised that ‘poor and inconsistent procurement practices, particularly in the public sector are leading to waste and inefficiency’. This was compounded by ‘low levels of standardisation, and fragmentation of the public sector client base’. Aurecon argued that:

Australian government leadership can provide the right stimulus within the construction industry and increase economic productivity through leadership, policy and procurement measures which will enable the digital transformation of the construction industry.³

- 5.5 Mr Brian Middleton, of Bentley Systems, emphasised the need for government leadership in the adoption of smart ICT, stating:

You have heard an awful lot about mandating of standards and formats and processes and policies and people for and against it. The one thing that we would say is that the rapid adoption of any improvements and the benefits realisation will only be accelerated through the involvement of clear government direction, and that is something we would like to help to inform and to shape as we move forward.⁴

- 5.6 Mr Middleton believed that the appetite within the infrastructure construction industry for the adoption of smart ICT ‘is huge...They just need to be given a platform to deliver it by the government. They will not do it on their own, because they work on a risk base.’⁵ Governments needed to update their own requirements and specifications relating to infrastructure procurement to make new technologies effective:

If you say, ‘Look, we’re going to do BIM level one, the 3D modelling element of that’, it is nothing new; it has been around for 20 years. It is far more advanced. All of your contractors who do major civil projects in Australia are designing in 3D today and just publishing in 2D to give to government, because you are not requesting the information. If you establish your employer’s information requirements upfront, that is a critical element. Each project needs to say: this is the information that we require from this project to enable us to efficiently and effectively operate and

2 Aurecon, *Submission 22*, p. 18.

3 Aurecon, *Submission 22*, p. 19.

4 Mr Brian Middleton, Senior Director, Transportation, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 24.

5 Mr Brian Middleton, Senior Director, Transportation, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 28.

maintain our physical infrastructure with minimum impact on the environment, lower cost of operations, achieving our service levels for our traveling public or for users of that particular infrastructure. If you do not, then how do you know that you are getting a good outcome?⁶

- 5.7 Mr David Burchard, of AECOM, argued that if government wanted industry to adopt new technologies, governments had to ‘set that benchmark and the industry will align with the expectation’. He acknowledged there would be a cost to this innovation, but asked ‘What is the cost of not doing this?’. He, too, argued strongly for the adoption of the UK model:

We in Australia should not be so isolated in our thinking. We should take on what is happening in the rest of the world – because we will get left behind if we do not. There are already proven government and private sector collaborative arrangements that have been used to bridge these same sorts of challenges. I know that the UK – certainly in the way they publicise what they are doing there – are doing it very intentionally to market themselves as a highly competitive and technologically advanced economy. They are very keen to share their knowledge with us, I guess to show off what they have achieved. So, the offers are there, and we do have experts visiting the country regularly to share this information, but I guess we just need to create the forum for that information to be received for it to be acted on.⁷

- 5.8 buildingSMART believed that the market would ‘eventually adopt BIM for all infrastructure and building projects’, but argued that ‘it would be short-sighted for the Government not to seek to accelerate that development’. buildingSmart emphasised the ‘need for Government to take a strong stand to ensure national consistency’.⁸ buildingSMART suggested that:

Without government leadership, different states, government departments and industry players could adopt different standards – potentially the 21st century equivalent of states adopting different rail gauges, leading to missed opportunities and a loss of productivity.⁹

6 Mr Brian Middleton, Senior Director, Transportation, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 26.

7 Mr David Burchard, Associate Director, Transportation, AECOM, *Committee Hansard*, 24 September 2015, p. 17.

8 buildingSMART, *Submission 10*, p. 9.

9 buildingSMART, *Submission 10*, p. 10.

- 5.9 buildingSMART emphasised the leading role governments were taking in the development of smart infrastructure around the world. It stated:

Other nations around the world provide a framework, guidance and lessons learned for Australia and New Zealand, including the need for government involvement in smart ICT. In the Western world there is already a leader and great advocate in the use of BIM in the UK Government. The UK Government has provided leadership in telling the market what the Government wants; not how to do it. Aligning Australia to the UK's success in this field will drive reform, improve projects and set a new reputation for infrastructure delivery there.¹⁰

- 5.10 buildingSMART noted that 'other government jurisdictions that already require the use of BIM for government building procurement include the United States, Norway, Finland, Denmark, Germany and France'. It observed that in our region, 'China, including Hong Kong (SAR), South Korea and Singapore have taken steps to achieve BIM implementation through a planned approach'. It also noted that 'the Singaporean Government is progressing toward applying a mandate for BIM, offering incentives to those willing to be the early pathfinders towards a goal of increased industry adoption, and ultimately full BIM submissions'; and that 'the UK, France and Singapore all have Ministers who are responsible for BIM'.¹¹

- 5.11 The Australasian Procurement and Construction Council (APCC) also highlighted the lack of coordination within government in terms of smart infrastructure development:

In the public sector, jurisdictions (and their agencies) are moving at their own pace to adopt BIM as a tool to design and construct assets, including ongoing management after they are commissioned. Some agencies are more advanced than others: those that regularly commission projects to deliver new or refurbished assets, and have significant asset portfolios to manage (including Defence, health and education agencies), are more advanced in their thinking and development of internal policies and processes.¹²

10 buildingSMART, *Submission 10*, p. 8.

11 buildingSMART, *Submission 10*, p. 8.

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. 18.

- 5.12 In its submission, Lynnwood Consulting stated that it ‘is our view that Australia should adopt world’s best practice as quickly as possible to drive the adoption of BIM nationally’.¹³
- 5.13 Professor Keith Hampson, of Curtin University, argued that ‘government has an intractable responsibility to lead’:
- ... to lead by way of helping in determining projects that are applicable for pilot projects; to lead in respect of providing incentives – not necessarily financial incentives, but they could be – for project proponents, such as owners, design and construction teams and, importantly, asset management teams, to get on board with national and international standards; and to provide a supportive environment for more advanced and consistent use of ICT or smart ICT in the infrastructure sector.¹⁴
- 5.14 The New South Wales and Queensland Governments also urged strong leadership from government to promote smart ICT in infrastructure. In its submission, Transport for NSW stated:
- In order to achieve a sustained increase in economic productivity, the government must act as the catalyst, by demonstrating leadership and commitment, and directing industry to unite, commit investment and follow. For the digital transformation of the infrastructure industry to be successful, this will require a vision, with clear objectives supported by appropriate policy and funding.¹⁵
- 5.15 Transport for NSW observed that it had been recognised that ‘the countries with the most technologically advanced industries have typically been led by governments setting clear targets for digital engineering implementation and use’.¹⁶
- 5.16 The Queensland Department of Transport and Main Roads (TMR) argued that ‘to expedite industry adoption, all levels of government must come together’ to drive the development and adoption of technical, procedural and procurement standards for BIM. TMR supported ‘the coordinated implementation of BIM as a critical component of a smart ICT framework’ and was ‘committed to working with government and industry to fast-track BIM’. TMR believed that ‘Australia needs to make considerable

13 Lynnwood Consulting, *Submission 16*, p. 13.

14 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 30.

15 Transport for NSW, *Submission 33*, p. 22.

16 Transport for NSW, *Submission 33*, p. 16.

efforts to match the pace of international BIM adoption by aligning itself to the time schedules of leading nations such as the UK'.¹⁷

- 5.17 Federal agencies were more cautious in advocating government leadership on Smart ICT. In evidence before the Committee, the Department of Communications indicated that consideration of the use of BIM was in an embryonic stage at the federal level. The Department highlighted a paper from the Spatial Industries Business Association, focussing on the use of BIM in the Christchurch earthquake rebuild which emphasised that 'there is a role for government because the building industry is so fragmented that it cannot get itself together to do this, even though the benefits flow mostly directly to them'. It noted 'a gap in the market there that potentially needs some sort of government policy to assist it along'. The Department noted ongoing discussions within government on the issue, but that 'policy leadership on building information management and how that occurs is yet to be determined'.¹⁸
- 5.18 The Department of Infrastructure and Regional Development (DIRD) emphasised the need for caution in adopting new technology, highlighting the importance of taking a case-by-case approach to the application of technology, and applying a cost-benefit analysis to each proposal. Nonetheless, the DIRD noted that the application of technology could actually help shape the assessment of a project by Infrastructure Australia:

For example, the Australian government contributed \$9.9 million towards the \$19.8 million upgrade of the Monash Freeway in Melbourne. This project upgraded four kilometres of ITS systems between High Street and Warrigal Road. The new systems were formally commissioned into service on 14 August 2015. It is estimated that the project will improve traffic flow and reduce travel times by around 10 per cent and improve emergency response times by about 20 per cent. That is just one example where systems are actually being incorporated. Each of these projects, though, as they occur, is subject to the same cost-benefit analysis.¹⁹

- 5.19 DIRD observed that:

...there are quite different capacities across the sector in using BIM. There may well be other tools that evolve over time as well. The importance of cost-benefit analysis certainly needs to be

17 Department of Transport and Main Roads (Queensland), *Submission 45*, pp. 1-2.

18 Ms Helen Owens, Assistant Secretary, Data Policy Branch, Digital Productivity Division, Department of Communications, *Committee Hansard*, 14 August 2015, p. 6.

19 Ms Nicole Spencer, Policy and Research Division, Deregulation Unit, Department of Infrastructure and Regional Development, *Committee Hansard*, 14 August 2015, p. 18.

mandated, and, whatever tool is used to derive that cost-benefit analysis, if BIM is involved in that then it is involved, but there may well be other tools also. So, I would not like to err on the side of mandating at this stage.²⁰

- 5.20 DIRD suggested that 'the best way to promote the appropriate use of Smart ICT solutions' is 'to foster an environment in which projects are selected based on a robust assessment of the costs and benefits of alternative options to meet a recognised need'. It noted that through the Australian Government's Infrastructure Investment Programme, funding preference was already given:

to projects which, amongst other things, have considered, and where appropriate applied, solutions which are alternative or complementary to construction which result in enhanced use of existing infrastructure. This includes the use of technological solutions and the use of innovative project delivery options.²¹

- 5.21 DIRD further noted that Australian Government already 'supports the use of new modelling technologies in the design and planning of major infrastructure and recognises the potential to reduce whole-of-life costs of infrastructure'.²² Examples of this include:

There are a range of existing formal mechanisms already in place. The Department works with the states, territories, local government, industry, and international partners to coordinate Smart ICT developments. The Council of Australian Government's (COAG's) Transport and Infrastructure Council and the Transport and Infrastructure Senior Official's Committee (TISOC) sets the agenda for our work on Intelligent Transport Systems (ITS).

In 2011, 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, which will include governance arrangements and an action plan, to be completed in 2016.

The Department works closely with Transport Certification Australia, established to support state, territory and federal government needs in relation to the growing use of Cooperative Intelligent Transportation Systems.

20 Ms Nicole Spencer, Policy and Research Division, Deregulation Unit, Department of Infrastructure and Regional Development, *Committee Hansard*, 14 August 2015, p. 21.

21 Department of Infrastructure and Regional Development, *Submission 28.2*, pp. 4–5.

22 Department of Infrastructure and Regional Development, *Submission 28.2*, pp. 4–5.

Transport Certification Australia is working with the European Commission and United States Department of Transportation on Harmonisation Task Groups relating to the international deployment of Cooperative Intelligent Transportation Systems.²³

- 5.22 The Australian Government believed that ‘individual government delivery agencies’ were ‘best-placed to consider the benefits of using such technology, on a case-by-case basis’.²⁴

Mandating use of smart ICT—BIM

- 5.23 While there was near unanimity amongst industry for government leadership in smart ICT, there was less agreement on the issue of whether government should mandate outcomes, especially in relation to BIM. NICTA recommended that the Australian Government ‘mandate use of Smart ICT in upgrades and new infrastructure’, suggesting the federal government ‘require that only projects demonstrating use of smart ICT can access its infrastructure funding’. NICTA believed the federal government should ‘also use its influence in national and state regulations to encourage the use of Smart ICT’.²⁵

- 5.24 Aurecon also called upon ‘the Government to mandate the use of BIM in all public infrastructure projects’, and do so ‘consistently across all construction works’. It urged the Australian Government to ‘take the lead in developing national guidelines’ and work with the States and Territories ‘to achieve a uniform national position on the use of BIM, including standardised bidding approaches for public infrastructure projects based on digital engineering/BIM’.²⁶

- 5.25 Mr Alex Shuttleworth, of Lynnwood Consulting, advocated adopting a similar approach to the UK, where BIM is mandated at a national level:

They have mandated for 2016 that it has to comply with a level 2 capability or competency level, based on the frameworks that they have defined. Everybody is working towards that specific point in time for any new facilities that are constructed so that they comply with the requirements. Therefore, through that, they are driving certain processes, efficiencies and cost savings through the design and construction process.²⁷

23 Department of Infrastructure and Regional Development, *Submission 28.2*, p. 6.

24 Department of Infrastructure and Regional Development, *Submission 28.2*, pp. 4–5.

25 NICTA, *Submission 23*, p. 3.

26 Aurecon, *Submission 22*, p. 10.

27 Mr Alex Shuttleworth, Principal, Lynnwood Consulting, *Committee Hansard*, 21 August 2015, p. 12.

5.26 The UK strategy first addressed construction, then ‘cascaded down to the actual data environment’. It ‘defined the whole data environment, framework and processes around how to go through’ ensuring ‘that you can support your assets from a digital perspective’.²⁸ Mr Shuttleworth noted that:

The UK is now one of the leading countries in terms of being able to support these types of activities within industry. You will even find in Australia that expertise from the UK is coming down here and advising asset owners on how to go about adopting these methodologies to get to a certain level of competence and capability.²⁹

5.27 Lynnwood Consulting noted that in addition to the UK, the Netherlands, Denmark, Finland and Norway ‘already require the use of BIM for publicly funded building projects’.³⁰

5.28 Laing O’Rourke emphasised the importance of the UK’s BIM legislation ‘in giving the industry confidence that there is no going back in terms of the investment in new tools, skills and technology’. The company noted that:

We have proven that the use of smart ICT in our own operations has made us more efficient, it has made the assets we have created more valuable and it has increased our clients’ confidence in delivery. We have a clearer line of sight over the project’s performance during planning, design, construction and into its operation.³¹

5.29 Laing O’Rourke ‘now mandates a digital engineering and smart ICT requirement in all its tenders and projects within Australasia’.³²

5.30 In contrast, the Australasian Procurement and Construction Council (APCC) noted that ‘the state and territory governments who are responsible for this space’ are not currently ‘at a stage where they are able to consider mandating’. Likewise, many in the construction industry were ‘not in a position at this point to endorse a mandate’. Rather, what the industry wanted was an acceleration of the adoption of BIM, ‘and that they will actively work with government to try and accelerate the

28 Mr Alex Shuttleworth, Principal, Lynnwood Consulting, *Committee Hansard*, 21 August 2015, p. 13.

29 Mr Alex Shuttleworth, Principal, Lynnwood Consulting, *Committee Hansard*, 21 August 2015, p. 12.

30 Lynnwood Consulting, *Submission 16*, p. 10.

31 Mr Josh Murray, General manager, Corporate Affairs, Australia and Asia, Laing O’Rourke, *Committee Hansard*, 21 August 2015, p. 25.

32 Laing O’Rourke, *Submission 15*, p. 10.

adoption of BIM because there are obvious benefits'. APCC argued for a case-by-case adoption of BIM:

Every project is bespoke. You need to look at it on a project-by-project basis and whether it makes sense for that project, rather than looking at a holistic view on mandating.³³

- 5.31 Likewise, Engineers Australia (EA) did 'not think it is a good idea for government to mandate. They should facilitate, they should encourage and they should lead'. EA agreed, however, that if government was to provide leadership in the application of smart ICT to infrastructure, it should be using smart ICT in its own projects.³⁴
- 5.32 Mr Roger Somerville, of Autodesk, noted that the Government of Singapore had mandated that 'any structure over the size of 5,000 square metres needs to be submitted to the Singaporean government using a BIM or 3D model before the permissions will be granted for that construction to proceed'. Other ASEAN countries, including Vietnam, the Philippines and Indonesia were 'mandating, or considering mandating, the use of BIM for their public infrastructure'. Further north in the region, South Korea had a relatively mature BIM mandate', while China was in the process of implementing a BIM mandate. Autodesk also noted that 'a number of United States government agencies have mandated the use of BIM for a number of years' and that globally 'a large number and a growing number of governments that are mandating, or in the process of mandating, the use of BIM'.³⁵
- 5.33 Mr Somerville observed that typically governments 'would not mandate immediately', but 'would develop a multi-year road map that involved the development of a BIM standard...the provision of training or upgrading to their national infrastructure or construction industry' and the development of 'guidelines and materials for industry to follow'. This involved upfront costs to government, but 'projected savings from the use of BIM over time would certainly outweigh that funding outlay by a significant degree'.³⁶ This 'phased approach', involving a number of pilot

33 Ms Teresa Scott, Executive Director, Australasian Procurement and Construction Council, *Committee Hansard*, 14 August 2015, p. 15.

34 Mr Peter Hitchiner, Immediate Past Chair, Information, Telecommunications and Electronics Engineering College Board, Engineers Australia, *Committee Hansard*, 14 August 2015, p. 26.

35 Mr Roger Somerville, APAC Government Affairs, Autodesk Asia Pty Ltd, *Committee Hansard*, 9 September 2015, p. 4.

36 Mr Roger Somerville, APAC Government Affairs, Autodesk Asia Pty Ltd, *Committee Hansard*, 9 September 2015, p. 4.

projects, would 'ensure that when the mandate occurred it was meaningful and one that industry could indeed follow.³⁷

5.34 Bentley Systems also rejected the mandating of smart ICT, arguing that:

...the mandating of BIM in the 3D modelling sense is not sensible and mandating standards in an environment where technological advancements significantly outpace the ability for governments to legislate may inhibit achieving the desired outcomes.³⁸

5.35 Nonetheless, Bentley Systems believed that governments had an important role to play in the implementation of smart ICT:

The broader benefits of Smart ICT and / or BIM in our opinion will not be achieved in a reasonable timeframe without the government infrastructure owners acting as the driving force for change and we encourage them to focus on the standards regarding the collection, federation and validation of information across the whole asset lifecycle.³⁹

5.36 Bentley Systems thought that the 'primary drawback of mandating a specific set of policies and processes for use in BIM is that requirements vary significantly between infrastructure disciplines and technology changes rapidly':

What may be cutting edge in terms of design and project development process and tools today may well be obsolete in 18 months. Being wedded to a prescriptive delivery method can actually decelerate innovation as there's reduced opportunity for service providers to bolster efficiency or productivity by developing creative solutions as part of their contract delivery which could further cut down on time and expense.⁴⁰

5.37 Rather than creating a mandate, governments should ensure that:

- Government project delivery teams are required to create and specify their Information Requirements for each project.
- There is a common data environment established where this information can be stored and managed for the life of the Asset
- The information be provided in a format relevant to the specific project (Road, Rail Bridge, Building etc) and that the data format delivered is

37 Mr Roger Somerville, APAC Government Affairs, Autodesk Asia Pty Ltd, *Committee Hansard*, 9 September 2015, p. 6.

38 Bentley Systems, *Submission 29*, p. 10.

39 Bentley Systems, *Submission 29*, p. 10.

40 Bentley Systems, *Submission 29*, p. 11.

both forward and backward compatible to enable reuse throughout the asset lifecycle.⁴¹

- 5.38 Laing O'Rourke noted that generally smart ICT outcomes were being driven by clients rather than contractors at this stage, and offered the option of improved digital outcomes as a precursor to a more substantial transformation. Mr Josh Murray, representing Laing O'Rourke, explained:

In terms of whether that should be introduced in Australia, we certainly see that BIM and digital engineering are becoming more apparent, but it is client driven at this point, unless the contractor or the designer take the view that they will do it on all of their projects, which is something that we have done, because we believe in the internal certainty and the client's certainty that that delivers. We believe it is tracking that way. The other option we have canvassed as an organisation is the ability to ask for digital outcomes, if not full BIM or full digital engineering – but to take a significant piece of national infrastructure and say, 'The government and the taxpayer expect that at the end of this we will have this digital outcome that is relevant to that project, relevant to its location and its workforce.' At least that would be a minimum step off the mark to start raising the profile of those assets.⁴²

- 5.39 Australian Government representatives rejected mandating BIM or other smart ICT. The Department of Communications took the view that 'if people have a strong awareness of the benefits of smart ICT, in whatever capacity, they will make a cost-benefit analysis as to the merits of using them'. The Department suggested that:

Rather than reforming regulations to enforce such provision, education and awareness raising may be more appropriate, particularly given the risk of mandating one-size-fits-all solutions that do not adequately address specific project requirements.⁴³

- 5.40 The Department of Communications' view was that 'some collaboration between stakeholders is already occurring, but more will be needed in future to realise the most potential of smart ICT in infrastructure'. It preferred to 'pursue a cooperative approach rather than mandate the use of Smart infrastructure in developments'.⁴⁴

41 Bentley Systems, *Submission 29*, p. 12.

42 Mr Josh Murray, General Manager, Corporate Affairs, Australia and Asia, Laing O'Rourke, *Committee Hansard*, 21 August 2015, p. 25.

43 Department of Communications, *Submission 27.1*, p. 5.

44 Department of Communications, *Submission 27.1*, p. 6.

- 5.41 DIRD observed that the States and Territories ‘are primarily responsible for the delivery of major public infrastructure projects’. The Department noted that the jurisdictions had indicated that ‘whilst they consider the use of smart ICT on a project-by-project basis, they would not support moves which reduced their flexibility in selecting the most appropriate design mechanism for each project’. However, DIRD also noted that it was ‘common practice for Commonwealth-supported upgrades to urban freeway projects to incorporate ICT elements’ enabling more efficient use of these assets, ‘thereby helping generate the greatest benefits for the Government’s investment’; and that the ‘Commonwealth also funds stand-alone ICT projects through its Infrastructure Investment Programme’.⁴⁵ DIRD’s position was that ‘mandating for or against specific technologies is likely to constrain governments’ capacity to develop the most efficient solutions’, and that it was ‘important that proposed solutions, including the use of ICT, are assessed for fitness of purpose on a project-by-project basis’.⁴⁶

Linking project funding to technological innovation

- 5.42 Alternatives to mandating the use of smart ICT in infrastructure were proposed in the evidence presented to the Committee. In its submission, Brisbane City Council noted ‘a change to Council’s ICT procurement approach through the use of a problem statement in Requests for Tender rather than a specified list of mandatory requirements’. This approach was designed ‘to encourage greater innovation in responses from industry’.⁴⁷
- 5.43 Bentley Systems proposed a system, utilised on major government projects in Perth (Perth Children’s Hospital and New Perth Stadium), whereby ‘infrastructure owners would be able to mandate measurable outcomes’ focused on whole-of-life management of assets. This allowed ‘the project delivery partners to use their subject matter expertise, based on the latest best practice processes to work out the best way to achieve the specified outcomes’.⁴⁸
- 5.44 Professor Keith Hampson suggested a similar solution – ‘an appropriate and workable middle-ground that provides for encouragement of the industry to step up to use typical open, interoperable formats for their design construction bids’. He suggested that governments could ‘make a requirement that does not specify particular platforms ... provided the platforms are interoperable, it does not need to identify a Bentley or an

45 Department of Infrastructure and Regional Development, *Submission 28.2*, p. 5.

46 Department of Infrastructure and Regional Development, *Submission 28.2*, p. 5.

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

48 Bentley Systems, *Submission 29*, p. 10.

AutoCAD brand for the software'. He noted that 'bidding consortia need to understand that this is something that will flow through not just in the very short-term'. It would provide a long term horizon for government procurement around which industry could structure project bids. He stated:

Most transport or infrastructure authorities at the state level have the ongoing responsibility for the road network and they will need to have integrated asset management systems that are populated by the private sector design and construction organisations. In my view there needs to be an encouragement and a continuity of expected business conditions, without necessarily imposing a mandate that absolutely determines that if you do not use this particular software brand then you will not have a look in. So I think there is a midway point that can be workable and can demonstrate leadership and help to give the industry the sense of confidence that there is an investment to be made here for the future productivity of the industry, and, I might say, the health of the nation.⁴⁹

5.45 NICTA proposed linking project funding to innovation, recommending that:

... government could mandate the use of smart ICT in any future infrastructure, upgrades of existing infrastructure or greenfields development. For example, you could mandate that a minimum two per cent spend be on smart ICT. You would have to define it, of course.⁵⁰

5.46 Planning and construction of infrastructure assets could be significantly improved through the use of 'integrated optimisation and planning techniques' to make the building process more efficient and 'minimise disruption to surroundings during construction'. Integrated design and construction activities would also minimise 'optimism bias' – the tendency to underestimate costs, impacts and risks and overestimate revenues and use. NICTA suggested mandating that 'such empirically calibrated methods be used for all major infrastructure projects', and that federal funding be linked 'to the demonstration of these techniques in project proposals'.⁵¹

49 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 32.

50 Professor Bob Williamson, Interim CEO, NICTA, *Committee Hansard*, 21 August 2015, p. 1.

51 NICTA, *Submission 23*, p. 8.

- 5.47 Intelligent operation of infrastructure assets through the use of sensors, analytics and optimisation techniques would increase operational efficiency and allow infrastructure to be integrated with 'other parts of the network and activities using the asset'. NICTA proposed linking funding 'to project proposals that incorporate this kind of Smart ICT and demonstrate integration into the wider infrastructure base', and that 'operating data is made widely available for the most efficient operation of the asset and to guide future investment'.⁵²
- 5.48 Asset life could be extended using 'predictive analytics to ensure assets last longer, reducing costs and improving safety and efficiency'. NICTA suggested linking project funding to require that proposals for upgrading existing infrastructure 'be based on fine-grained data relating to specific maintenance actions, rather than crude whole-of-asset analyses', and that improved instrumentation be requested when upgrades occur.⁵³
- 5.49 The National Committee for Information and Communication Sciences (NCICS), Australian Academy of Science, proposed targeted incentives across a range of technologies and infrastructure assets, including:
- ... action that encourages more use of the full set of features of smart meters in homes and the incorporation of smart meters into a more effective smart grid; require car manufacturers to include smart navigation and collision-avoidance technologies in all new vehicles; and encouragement of local government to use smart technologies for data gathering on infrastructure for effective and timely maintenance and efficient delivery of services.⁵⁴
- 5.50 NCICS also suggested that governments 'consider whether the existing legislative framework is sufficient to protect privacy in an Internet of Things age'.⁵⁵
- 5.51 The APCC recommended a more nuanced approach than imposing a mandate, in which governments developed their smart ICT capabilities and requirements in stages, focussing first on major projects. APCC suggested:
- That Government agencies should consider adoption of BIM for major projects (noting that the definition of 'major' is at the discretion of each jurisdiction therefore variations are expected in regards to possible thresholds);

52 NICTA, *Submission 23*, p. 8.

53 NICTA, *Submission 23*, p. 8.

54 National Committee for Information and Communication Sciences, Australian Academy of Science, *Submission 5*, pp. 4–5.

55 National Committee for Information and Communication Sciences, Australian Academy of Science, *Submission 5*, pp. 4–5.

- When adopting BIM on the project, consideration should be given to the procurement strategy implemented for the project; and
- At completion of any BIM enabled government project, clients should be requiring a 3D view of the asset with embedded data and materials for use across the asset life cycle.⁵⁶

5.52 In its submission, DIRD noted that the Australian Government already plays a role as a strategic investor in infrastructure ‘to support state and territory governments to implement new technologies’:

The \$42 billion Infrastructure Investment Programme, which is overseen by the Department, has provisions for investment in ICT upgrades to infrastructure. In addition, the Government has committed to giving funding preference to future projects where they have considered and incorporated ICT and other mechanisms to improve the efficiency of fixed infrastructure.⁵⁷

Coordinating body—UK model

5.53 The need for adopting some form of coordination within government and between government and industry for the development and implementation of smart ICT in infrastructure was highlighted in much of the evidence presented to the Committee – with much attention focussed on the UK model. In its submission, Transport for NSW noted the success of the UK’s BIM program, which was ‘well documented and may be attributed to the following key drivers’:

- a) Government Mandate – This sent a clear signal demonstrating the commitment by government, and the expectations for industry to respond and transform.
- b) Government Leadership – This strategy has been led from the top down with the Government’s Chief Construction Adviser acting as champion and leading advocate.
- c) Established Working Group – The government funded UK BIM Task Group established a centre of excellence and advocacy for BIM, providing an open channel for engagement and collaboration with industry.
- d) New Industry Standards – Since 2011, the UK Government has published a number of new standards outlining the new processes and obligations to meet the requirements of fully

56 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. 12.

57 Department of Infrastructure and Regional Development, *Submission 28*, pp. 4–5.

collaborative BIM. These standards are now upheld as global best-practice and are currently being re-written as ISO standards.

- e) Standardisation – The UK Government has invested heavily into standardised asset classification and open file formats, to ensure a common platform for interoperability across industry...
- f) Mega-projects – In recent years the UK Government has announced a number of mega-projects such as Crossrail and High Speed 2. These projects have been developed to harness the long-term benefits of DE and as such, have provided significant opportunity for large-scale education and upskilling of industry.⁵⁸

5.54 Transport for NSW observed that the 'UK BIM Task Group is recognised for playing a pivotal role in the success of the UK strategy':

Established in 2011, the group formally aims to "drive adoption of BIM across government". They have now become the public face of the strategy and lead the on-going engagement with industry through their four work streams, as follows:

- Stakeholder and media engagement – broadcasting the vision and value through guidance and publications, stakeholder engagement and regional awareness campaigns.
- Delivery and productivity – development of standardised file formats, data exchange and business processes.
- Commercial and legal – contracts, copyright and IP / PI
- Training and academia – Academic forums, construction skills, accreditation and supply strategies.⁵⁹

5.55 Transport for NSW recommended that:

Australian Governments, through COAG, replicate the UK model, and where possible, utilise and build on the established UK Standards, supporting technologies, training modules, accreditation frameworks and contract models.

This will allow Australia to leverage off global leaders and ensure we maintain alignment with international best practice.⁶⁰

5.56 Transport for NSW further recommended:

58 Transport for NSW, *Submission 33*, p. 22.

59 Transport for NSW, *Submission 33*, pp. 22–3.

60 Transport for NSW, *Submission 33*, p. 23.

- 1) That the Council of Australian Governments (COAG) appoints a single 'Champion' that will lead a task group for smart ICT and digital engineering innovations for infrastructure.
- 2) That the task group develop a measurable, medium term national plan identifying policies and strategies to accelerate domestic implementation of new technologies and innovations.
- 3) That the task group engage with industry and advise Governments on global innovations that will achieve broad productivity benefits.
- 4) To maximise the relevance and utility of its work, the task group should:
 - Learn from International government best practice for digital engineering strategies
 - Develop its plan to align with best international best practice
 - Be given a mandate from COAG or the Transport and Infrastructure Council (TIC) that clearly defines a vision for the adoption of smart ICT, goals and timeframes.⁶¹

5.57 Transport for NSW noted the success of the UK's strategy, stating:

The response to this mandate has been significant, leading to considerable investment and up-skilling of industry throughout the local supply chain in the past four years. The resulting impacts are already retaining benefits, with the UK government reporting a 20% savings in capital construction costs over a three year period, creating an overall reported saving of approximately £840 million. In the long-term it is expected these savings will be realised many times over, due to improved efficiencies for operations and maintenance over the life of the new assets.

The UK Government has now commenced the next stage of their strategy, which is to export their skills globally, under the banner of "Digitally Built Britain". If Australia is to remain competitive when bidding for global mega-projects, we must ensure our local industry continues to drive innovation and are not left behind.⁶²

5.58 Other submissions endorsed the UK option. Bentley Systems stated that 'rather than reinvent the wheel...we would recommend the adoption of the investment made by the UK government'. Bentley believed that 'regarding best practice, it was difficult to go beyond the UK's adoption of

61 Transport for NSW, *Submission 33*, p. 7.

62 Transport for NSW, *Submission 33*, pp. 16-17.

BIM'; and that while 'developed originally for vertical buildings, many elements of BIM are appropriate and relevant to Civil infrastructure'.⁶³

5.59 Autodesk identified the United Kingdom 'as probably the most advanced country for their vision in the reform of the construction sector'. The UK has adopted a whole-of-government approach to the planning, procurement, construction, delivery and management of building and infrastructure projects. Autodesk believed that 'Australia could certainly harness some of the lessons learnt from the UK experience'.⁶⁴

5.60 Aurecon recommended 'Australian Governments look at policy reform similar to the UK', which would 'improve the value offered by public sector construction as a way to improve performance of infrastructure and to meet the requirements of those that use them'.⁶⁵ It urged the Australian Government, in conjunction with the States and Territories, to establish:

... a Digital Infrastructure Task Group over a multi-year programme to enable government as a client to derive significant improvements in cost, value and carbon performance through the use of open sharable asset information.⁶⁶

5.61 Aurecon believed that Australia had:

... a window of opportunity to create a domestic programme and to take on a regional leadership role in BIM exploitation, BIM service provision and BIM standards development. In taking on the role it will greatly enhance the global image of Australian designers, contractors and product manufactures which in turn will translate into winning new work, growth opportunities and increased employment.

This will require the Australian Federal and State governments to work together to create a national Digital Task Group. Without this collaboration each individual state will create their own digital requirements, standards, and thus creating unnecessary complexity and confusion within the supply chain.⁶⁷

5.62 Mr John Mitchell, representing buildingSMART, highlighted the risks of failing to get coordination between governments in Australia. He stated:

What worries us here in Australia at the moment is that we see several state government agencies all working separately. Some of

63 Bentley Systems, *Submission 29*, p. 10.

64 Mr Brett Casson, Infrastructure Development Executive, Autodesk, *Committee Hansard*, 9 September 2015, p. 3.

65 Aurecon, *Submission 22*, p. 19.

66 Aurecon, *Submission 22*, p. 10.

67 Aurecon, *Submission 22*, p. 19.

them are doing excellent work. There is no criticism of what they are doing but it is not being discussed and collaborated and we are not getting a common position. We are just getting individual little silos of reasonably good work that are undervalued for the potential that we could get. So if we have a Commonwealth commitment, if we get the engagement of the states then the industry will avidly support this process. If we are the best users of this technology, which we can be, then we will compete very strongly in our Asian sector and internationally.⁶⁸

- 5.63 In Australia, Transport for New South Wales has formed a BIM task group. Drawing heavily on the UK experience, the task group had 'formed over the past 12 to 18 months and are quite mature in the understanding of not only delivery but how the technology will assist in productivity gains for the operations and maintenance of the rail network in Sydney, in New South Wales'.⁶⁹ In addition, the WA Government has undertaken the development of the new Perth Children's Hospital 'under WA Treasury's mandate of a full BIM model':

It has produced an exceptional level of BIM and has certainly upskilled and leveraged up the industry design and engineering in the construction industry in Perth on the basis of that, which is acknowledged through some of the software companies as leading-edge BIM in the whole Australasian region.⁷⁰

- 5.64 The question of where best to host a national smart ICT task group was raised by a number of witnesses. Mr David Burchard (AECOM) noted that the UK model was 'driven by Treasury, with a number of industry-focused strategic focus groups that advise government, and also secondees from private industry to government departments'.⁷¹

- 5.65 Mr Burchard also highlighted the central role of Infrastructure Australia in the procurement process, noting that 'they certainly are a very important stakeholder in this':

Probably their most important contribution will be in cost data benchmarking in their governance role for endorsing infrastructure projects. They will be able to access data from all

68 Mr John Mitchell, Chair, buildingSMART Australasia, *Committee Hansard*, 21 August 2015, p. 19.

69 Mr Brett Casson, Infrastructure Development Executive, Autodesk, *Committee Hansard*, 9 September 2015, p. 6.

70 Mr Donald Cameron, IPD and BIM Systems Manager, John Holland Group, *Committee Hansard*, 21 August 2015, p. 20.

71 Mr David Burchard, Associate Director, Transportation, AECOM, *Committee Hansard*, 24 September 2015, p. 16.

projects and be able to compare proposed projects against national cost data benchmarks.

- 5.66 He stated that ‘there needs to be leadership provided by... the federal government, and Infrastructure Australia plays an important role in that’.⁷²
- 5.67 Professor Hampson supported Infrastructure Australia playing a leading role in the coordination of smart infrastructure development, stating:
- I think it would seem that Infrastructure Australia is an institution that is being supported for the future. Not only should Infrastructure Australia look at which projects should be delivered across the states and territories but it should provide a performance framework for – for example – the use of building information modelling in integrating the various elements of the supply chain and looking towards performance assessment that can be carried on from phase to phase within a project and from project to project across the nation. I think we have an opportunity on our doorstep that is there.⁷³
- 5.68 Mr Brian Middleton, of Bentley Systems, suggested that ‘there is probably going to be a little bit of a combination’ of agencies involved – ‘I think business skills and innovation is an obvious place to be involved in this, as well as Treasury’.⁷⁴ In the end, however, Mr Middleton did not believe it was important where the coordination between agencies, governments and industry occurred, so long as it did occur:

There needs to be the procurement change. Finance currently holds that responsibility under the public works conference rules. It just needs collaboration between the agencies to make sure it happens. APCC already has an integrated state and New Zealand perspective. We do not mind where it happens, or if it is called the Department of BIM, which it is called in France – a 20 million euro investment was just made at the beginning of this year, and it is run by the minister for housing, or ‘ministress’ for housing. In the UK it is a mandate. They set up a construction working party called the BIM working group, I think. They set up a special group in the Commonwealth. It was already in part of Treasury. So I do not think it will be hard to quickly decide where that body should

72 Mr David Burchard, Associate Director, Transportation, AECOM, *Committee Hansard*, 24 September 2015, p. 14.

73 Professor Keith Hampson, Faculty of Humanities, Curtin University, *Committee Hansard*, 25 September 2015, p. 30.

74 Mr Brian Middleton, Senior Director, Transportation, Bentley Systems, *Committee Hansard*, 24 September 2015, p. 27.

be located and focused. I think from then on you will see rapid progress, much greater adoption and benefits throughout the entire supply chain.⁷⁵

Promoting the development of relevant skills

5.69 The incorporation of smart ICT into the design and planning of infrastructure, as well as its construction and management, will demand the development of a range of skills. The Department of Communications acknowledged that ‘greater emphasis on STEM skills, and particularly data analysis qualifications, will be an important resource in making use of Smart ICT in infrastructure in future’;⁷⁶ while the National Committee for Information and Communication Sciences (NCICS) of the Australian Academy of Science stated:

Widespread adoption of smart infrastructure across Australia will require a supply of skilled professionals with expertise in Science Technology, Engineering, and Mathematics (STEM), and more specifically in ICT and its application to infrastructure. NCICS is concerned that there is a growing shortage of ICT professionals in Australia, and as smarter infrastructure is developed and implemented, this shortfall could increase. This shortage of ICT professionals could hold back the growth of smart infrastructure.⁷⁷

5.70 In its submission, the Department of Infrastructure and Regional Development (DIRD) observed that ‘Smart ICT require a new wave of technical expertise in transport’. While traditional engineering skills would be required ‘increasingly software and computer engineering as well as data analysts will be needed to transition Australia to broader use of Smart ICT’.⁷⁸

5.71 The development of these skills will require greater cooperation between industry, government and the education sector. The Australian Technology Network of Universities, noted that ‘building new capabilities in smart ICT must integrally involve the higher education sector, with training elements forming an importance component of multi-partner initiatives’.⁷⁹

75 Mr John Mitchell, Chair, buildingSMART Australasia, *Committee Hansard*, 21 August 2015, p. 20.

76 Department of Communications, *Submission 27.1*, p. 7.

77 National Committee for Information and Communication Sciences, Australian Academy of Science, *Submission 5*, p. 5.

78 Department of Infrastructure and Regional Development, *Submission 28*, p. 6.

79 Australian Technology Network of Universities, *Submission 18*, p. 2.

- 5.72 Professor Rod Tucker urged higher standards of education in maths, sciences and technology in schools, but also highlighted the need for a growing nexus between universities and industry to promote engagement with new technology:

There is a need for greater collaboration between universities and industry to give students more of a sense of engagement in the technologies that they are likely to be working in when they finish their university education. There is quite a lot of scope for the universities to engage with industry and students in university engineering, science, mathematics and computer science courses, but they need to work more closely with industry perhaps through industry placements and industry-based projects and so on.⁸⁰

- 5.73 Focussing primarily on emergency management, Mr Geoff Spring, of the Senior Research Adviser, Centre for Disaster Management and Public Safety at the University of Melbourne, urged 'the provision of training and qualifications required at both vocational and tertiary level to be able to plan, design, implement, operate and maintain broadband infrastructure'. He noted that:

The submission from ARCIA⁸¹ that you received addresses this issue at the vocational level, while the CDMPS is planning professional tertiary level qualifications coupled with executive level short-course training for senior executives in the emergency management sector.⁸²

- 5.74 Mr David Purnell of BCE Surveying, who works 'with Curtin University, as part of their advisory committee, and with the Royal Institution of Chartered Surveyors international body on the structure of courses', was optimistic about the uptake of technology training at the university level:

The uptake and the training at that level has increased significantly. So what we are seeing is students emerging from the universities who actually have a very good grappling and understanding of the fundamentals around these systems. They are quite complex. So the talent pool is, fortunately, increasing.

80 Professor Rodney Tucker OAM, Chair, National Committee for Information and Communication Sciences, Australian Academy of Science, *Committee Hansard*, 25 September 2015, p. 1.

81 Australian Radio Communications Industry Association, *Submission 37*.

82 Mr Geoff Spring, Senior Research Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 25 September 2015, p. 37.

That is a benefit not only to the surveying industry but then all the affiliated industries around it.⁸³

- 5.75 Focussing on BIM and Project Team Integration (PTI), the APCC noted that ‘fundamentally there is a need for education and training designed to increase the understanding of PTI and BIM technology and processes’:

The focus for education needs to include the benefits of PTI and the pathways to achieving integration together with BIM awareness, technical skills, knowledge and understanding BIM as a collaborative working tool. It is important to highlight that BIM is more than technology changes; it provides significant collaboration and competitiveness benefits.⁸⁴

- 5.76 The APCC noted that ‘PTI and BIM education and training is being integrated into education courses with universal adoption, secondary, trades, universities, TAFE’s, polytechs, vocational etc.’ The key aim was ‘consistent baseline training ... to build a shared understanding across the industry with learning outcomes resulting in transferrable skills’. APCC argued that universities and other educators needed ‘to incorporate consistent BIM education and training into degrees and coursework (more than the basic principles of BIM technology)’, and that ‘web based training is an important option that needs to be accessible and available’.

- 5.77 The APCC believed that the ‘traditional silos of architecture, engineering and building and construction schools’ was not ‘conducive to the delivery of education and training programs that facilitate a consistent approach to BIM service delivery’. Integrating the principles of PTI and BIM into existing course curriculum can reduce the need for developing new courses and drive consistency of delivery.

- 5.78 The APCC noted that ‘PTI and BIM training is ongoing and all industry stakeholders need to acknowledge that those who are skilled and trained require continuing support and a thorough understanding of the PTI and BIM process’ The APCC highlighted the Perth Children’s Hospital as ‘an excellent example of how PTI and BIM training can be seamlessly and effectively facilitated at the project level with minimum effort and disruption for all project stakeholders’.⁸⁵

83 Mr David Purnell, Perth Survey Manager, BCE Surveying Pty Ltd, *Committee Hansard*, 4 September 2015, p. 1.

84 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. 22.

85 Australasian Procurement and Construction Council, *Submission 9, Attachment 1, A Framework for the Adoption of Project Team Integration and Building Information Modelling*, December 2014, pp. 22-3.

Current capabilities and future skill needs within government agencies

5.79 The importance of government agencies having the requisite skills to achieve optimum outcomes in the application of Smart ICT to infrastructure was highlighted in the evidence presented to the Committee. Aurecon observed that:

An intelligent client is critical to the success of procurement and in unlocking value for all stakeholders through a digital approach. This can be a challenge for government where relatively few public servants have substantial experience and expertise in this emerging digital approach. Developing commissioning skills is key to creating intelligent customers in government. There can be a language gap between engineers and public servants, and this barrier to communication needs to be acknowledged and addressed to support successful outcomes to engineering procurement projects.⁸⁶

5.80 Unfortunately, the absence of these skills in government was also highlighted to the Committee. Mr David Burchard, of AECOM, noted the lack of technical capacity, either inside Infrastructure Australia or elsewhere, to manage smart infrastructure of projects;⁸⁷ while Dr Ben Guy, of consulting firm Urban Circus, argued that the technical skills required to manage smart infrastructure projects did not currently exist inside federal government departments. He told the Committee:

I worked really hard with a particular state government agency ... to try to build up the capability from the inside, and it was too difficult. Culturally, it was too hard. Too many rubber bands in the way, so we just pulled out.⁸⁸

5.81 Nonetheless, Urban Circus had supported 'capability development within government agencies':

There are multiple staff now operating on a full time basis with advanced smart planning capability within Victorian government. We have trained and enabled these capabilities.⁸⁹

86 Aurecon, *Submission 22*, pp. 19–20.

87 Mr David Burchard, Associate Director, Transportation, AECOM, *Committee Hansard*, 24 September 2015, p. 14.

88 Dr Ben Guy, Chief Executive Officer, Urban Circus Pty Ltd, *Committee Hansard*, 24 September 2015, p. 7.

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

Committee conclusions

- 5.82 The need for government to engage at some level with the smart ICT in infrastructure design and planning is evident from the evidence presented to the Committee. The question is ‘to what extent and in what form?’
- 5.83 The evidence presented by Australian Government agencies indicates that engagement is already occurring but, by accident or design, there seems to be little urgency or coordination in this engagement. State departments and agencies appear to be well in advance of their federal colleagues in engaging with the complexities of smart ICT, as are sections of industry.
- 5.84 Elements of the construction industry and some State Governments are calling for the adoption of the UK model of infrastructure procurement, which mandates the use of BIM. They regard this as the quickest and most efficient way of advancing the adoption of smart ICT and producing smart infrastructure. Others have urged caution, noting that neither government nor industry have reached a level of maturity in their use of smart ICT, particularly BIM, to warrant a mandate. They urge a more graduated approach to new technologies beginning with major projects or particular technologies and working out from there. The Committee believes there is much to commend this approach, not least being that it is inherently more flexible than a mandate. The industry consensus appears to be that projects exceeding \$500 million in cost is the optimum starting point for implementing smart ICT through procurement processes.
- 5.85 Almost everyone who has contributed to the inquiry has agreed that there needs to be greater coordination within and between levels of government, and between government and industry, on the design, planning, procurement, construction and management of smart infrastructure, and that this coordination must operate from a national level. The UK model of a BIM task group – coordinating the efforts of government agencies and industry – has been advanced as an ideal. The success of the UK model is widely acknowledged. Adapted to Australian conditions, it can and should be replicated here.
- 5.86 The Committee advocates the formation of a Smart Infrastructure Task Force, representing governments at all levels, academia and industry to provide for the coordination and implementation of smart ICT in infrastructure. The Task Force will act as a coordinator and conduit for the development and implementation of policy nationally, including the development of industry and product standards and training and education. The Task Force would have responsibility for the development of a national strategy to accelerate the adoption of new technologies and

innovations; and engage Australia with international experience and best practice globally.

- 5.87 The Committee is also conscious of the need to develop the requisite skills to take advantage of new technology and practices. The key to this is ensuring that government agencies have the necessary knowledge and skills to effectively engage with the private sector in the development of smart infrastructure. Essentially, government agencies must know what to ask for in order to get it. This in turn means engaging with industry effectively to see what it can provide.
- 5.88 A graduated approach to the implementation of smart ICT will allow industry to adapt to new requirements while learning on the job. The implementation of new technologies and practices, such as BIM, on major projects will see the development of a skill base and the dissemination of knowledge and skills throughout the construction sector. The Committee is confident that if government procurement sets the right direction, industry will rise to the challenge and competitive pressures will mean that enterprises will adapt or fail, as the case may be.

Recommendation 6

- 5.89 **The Committee recommends that the Australian Government leads the formation of a suitably qualified and resourced Smart Infrastructure Task Force, led by Infrastructure Australia, on the model of the UK BIM Task Group, representing governments at all levels, academia and industry to provide for the coordination and implementation of smart ICT in the design, planning and development of infrastructure, and in the maintenance and optimisation of existing infrastructure. The Task Force will act as a coordinator and conduit for the development and implementation of policy nationally, including the development of industry and product standards and training and education. The Task Force will have responsibility for the development of a national strategy to accelerate the adoption of new technologies and innovations; and engage Australia with international experience and global best practice.**

Recommendation 7

- 5.90 **The Committee recommends that the Australian Government, as part of its infrastructure procurement processes, require BIM to LOD500 on all major infrastructure projects, exceeding \$50 million in cost, receiving Australian Government funding, including projects partially funded by**

Federal Government in partnership with state, territory and local governments, and that it focus on tendering mechanisms that will facilitate this outcome, on a project-by-project basis, with a view to ultimately establishing BIM as a procurement standard.

Recommendation 8

- 5.91 **The Committee recommends that the Department of Infrastructure and Regional Development adopts a practice of examining whether the use of Smart ICT, in optimising the operation and maintenance of existing built infrastructure assets, can provide a more cost-effective solution than their physical replacement or upgrade.**

Recommendation 9

- 5.92 **The Committee recommends that the Australian Government, through COAG, works with state and territory governments to develop a national approach to the application of Smart ICT in the design and planning of infrastructure, particularly with respect to state government responsibilities in land management, utilities, and transport systems.**

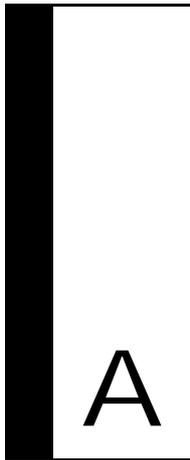
Recommendation 10

- 5.93 **The Committee recommends that the Australian Government invite Infrastructure Australia to consider the use of smart ICT in infrastructure as a means of identifying savings that can be made in the short term.**

Mr John Alexander OAM MP

Chair

9 March 2016

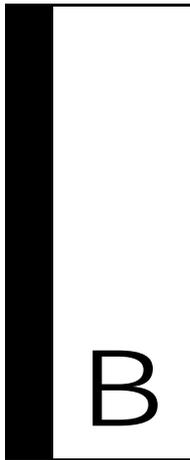


Appendix A – List of submissions

- 1 National Archives of Australia
- 2 IBM Australia Ltd
- 3 Urban Circus Pty Ltd
- 4 Autodesk Asia Pty Ltd
- 5 Australian Academy of Science
- 6 Victorian Spatial Council
- 7 Australian Information Industry Association
- 8 Royal Melbourne Institute of Technology University
- 9 Australasian Procurement and Construction Council Inc
- 10 buildingSMART Australasia
- 10.1 Supplementary to Submission 10
- 11 Independent Project Analysis Inc
- 12 SMART Infrastructure Facility, University of Wollongong
- 13 Australian Academy of Technological Sciences and Engineering
- 14 Telstra Corporation Ltd
- 15 Laing O'Rourke Australia Construction Pty Ltd
- 16 Lynnwood Consulting
- 17 Centre for Disaster Management and Public Safety and APCO Australasia
- 18 Australian Technology Network of Universities
- 19 Queensland University of Technology
- 20 Downer Group
- 21 AECOM
- 22 Aurecon
- 23 National ICT Australia

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- 23.1 Supplementary to Submission 23
 - 24 The Hon Richard Wynne MP, Minister for Planning, Victorian Government
 - 25 Engineers Australia
 - 25.1 Supplementary to Submission 25
 - 26 BCE Surveying Pty Ltd
 - 26.1 Supplementary to Submission 26
 - 27 Australian Government Department of Communications
 - 27.1 Supplementary to Submission 27
 - 28 Australian Government Department of Infrastructure and Regional Development
 - 28.1 Supplementary to Submission 28
 - 28.2 Supplementary to Submission 28
 - 29 Bentley Systems Pty Ltd
 - 29.1 Supplementary to Submission 29
 - 30 The Hon Stephen Mullighan MP, Minister for Transport and Infrastructure, South Australian Government
 - 31 Australian Urban Research Infrastructure Network
 - 32 The University of Melbourne
 - 33 Transport for NSW
 - 34 Brisbane City Council
 - 35 City of Melbourne
 - 35.1 Supplementary to Submission 35
 - 36 Swinburne University of Technology
 - 37 Australian Radio Communications Industry Association Inc
 - 38 VAC Group
 - 39 Optimatics
 - 40 Infrastructure Partnerships Australia
 - 41 Orange Horizons Pty Ltd
 - 41.1 Supplementary to Submission 41
 - 42 Intel Australia
 - 43 Standards Australia Limited
 - 44 Institute of Public Works Engineering Australasia Queensland
 - 45 Queensland Government Department of Transport and Main Roads
 - 46 Geoscience Australia

- 47 Transurban
- 48 Senator the Hon Marise Payne MP, Minister for Defence, Australian Parliament
- 49 AECOM, Spatial Industries Business Association and Queensland University of Technology

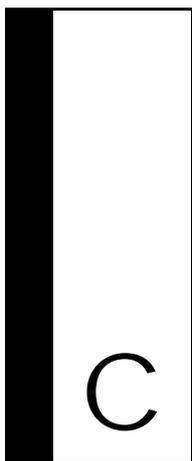


Appendix B – List of exhibits

- 1 *Ubiquitous urban infrastructure: Infrastructure planning and development in Korea*, eContent Management Pty Ltd, 'Innovation: management, policy & practice' (2008), 10: 282-292 (Provided by Associate Professor Tan Yigitcanlar)
- 2 *Korean ubiquitous-eco-city: A smart-sustainable urban form or a branding hoax?*, 'Technological Forecasting & Social Change' 89 (2014), p 100-114 (Provided by Associate Professor Tan Yigitcanlar)
- 3 *Technology and the City: Systems, Applications and Implications* (Provided by Associate Professor Tan Yigitcanlar)
- 4 ARRB Group, *Asset Management Systems Review - Brochure*, April 2015 (Provided by Northern Territory Department of Transport)
- 5 ARRB Group, *Asset Management Systems Review – Final Report*, April 2015 (Provided by Northern Territory Department of Transport)
- 6 Dave Coplin, 'Embrace the Change', *Infoworks*, 2014/15, Issue 4, pp. 29-31 (Provided by Laing O'Rourke)
- 7 'Joining the Dots', *Infoworks*, 2014, Issue 3, pp. 26-7 (Provided by Laing O'Rourke)
- 8 Jess Unwin, 'Military Precision', *Infoworks*, 2014, Issue 2, pp. 22-4. (Provided by Laing O'Rourke)
- 9 'Working with Workpacks', *Infoworks*, 2015, Issue 1, pp. 29-31. (Provided by Laing O'Rourke)
- 10 *Integration of Geospatial and Built Environment – National Data Policy*, Joint BuildingSMART – SIBA White Paper, June 2015 (Provided by Australian Government Department of Communications)

- 11 The Australian and New Zealand Foundation Spatial Data Framework, ANZLIC, Edition 2, April 2014
(Provided by Australian Government Department of Communications)
- 12 The Internet of Things: making the most of the Second Digital Revolution. A report by the UK Government Chief Scientific Adviser
(Provided by the Centre for Disaster Management and Public Safety (CDMPS), The University of Melbourne)
- 13 White Paper – PetaJakarta.org: Assessing the Role of Social Media for Civic Co-Management During Monsoon Flooding in Jakarta, Indonesia, 2015.
(Provided by SMART Infrastructure Facility, University of Wollongong)
- 14 2014 Infrastructure Yearbook (Provided by Bentley Systems)
- 15 Sustainable Built Environment National Research Centre, *Innovation underpinning Australia's built environment industry*. (Provided by Professor Keith Hampson)
- 16 Sustainable Built Environment National Research Centre, *Report 2.24: Integrated Project Environments*. (Provided by Professor Keith Hampson)
- 17 Sustainable Built Environment National Research Centre, Project 2.24: *Integrated Project Delivery, Fact Sheet*. (Provided by Professor Keith Hampson)
- 18 Sustainable Built Environment National Research Centre, Project 2.34: *Driving Whole-of-life Efficiencies through BIM and Procurement, Fact Sheet*. (Provided by Professor Keith Hampson)
- 19 Submission to the Australian Government Productivity Commission's Issues Paper, *Public Safety Mobile Broadband*, 2 June 2015. (Provided by Centre for Disaster Management and Public Safety, University of Melbourne)
- 20 Productivity Commission, *Public Safety Mobile Broadband*, Draft Report, September 2015. (Provided by Centre for Disaster Management and Public Safety, University of Melbourne)
- 21 Williamson R C et al, Australian Council of Learned Academies, Project 5, *Technology and Australia's future: New technologies and their role in Australia's security, cultural, democratic, social and economic systems*, September 2015.
(Provided by Australian Academy of Technological Sciences and Engineering)
- 22 Daly J et al, *Australia's Agricultural Future*, Report for the Australian Council of Learned Academies, Project 7, 2015. (Provided by Australian Council of Learned Academies)
- 23 Armstrong B et al, *Delivering Sustainable Urban Mobility*, Report for the Australian Council of Learned Academies, Project 7, 2015. (Provided by Australian Council of Learned Academies)

- 24 *Basic Act on the Advancement of Utilizing Geospatial Information (Act No. 63 of 30 May 2007)*, Japan. (Provided by Victorian Spatial Council)
- 25 *Spatial Data Infrastructure Act (54 of 2003)*, South Africa. (Provided by Victorian Spatial Council)
- 26 Victorian Spatial Council, *A new framework of rules for managing spatial information*, 'Examination of the need for a new framework of rules for managing spatial information in Victoria', September 2010. (Provided by Victorian Spatial Council)
- 27 Victorian Spatial Council, *A legislative framework for spatial information*, Position Paper No. 2, July 2015. (Provided by Victorian Spatial Council)
- 28 Victorian Spatial Council, *Victoria's Spatial Information Management Framework and directory of resources*, May 2010. (Provided by Victorian Spatial Council)
- 29 Institute of Public Works Engineering Australasia (IPWEA), *Asset Design As Constructed, Getting it right first time with constructed data*. (Provided by IPWEA Queensland)



Appendix C – List of public hearings and witnesses

Friday, 14 August 2015 - Canberra ACT

Aurecon

Cotterill, Mr Gavin, Digital Advisory Leader

Hackney, Mr William, Digital Infrastructure Leader

Negus, Mr Stephen Mark, Market Director, Advisory Australia and New Zealand

Australasian Procurement and Construction Council

Lloyd, Ms Debbie, Project Officer

Scott, Mrs Teresa, Executive Director

Australian Government Department of Communications

Cullen, Ms Marianne, First Assistant Secretary, Digital Productivity Division

Mason, Mr Philip, Assistant Secretary, Market Structure, Infrastructure Division

Njuguna, Mr Emmanuel, Director, Market Analysis, Digital Productivity Division

Owens, Ms Helen, Assistant Secretary, Data Policy Branch, Digital Productivity Division

Australian Government Department of Infrastructure and Regional Development

Collett, Mr James, Policy and Research Division, Planning Analysis Branch

Spencer, Ms Nicole, Policy and Research Division, Deregulation Unit

Engineers Australia

Hitchiner, Mr Peter, Immediate Past Chair, Information, Telecommunications and Electronics Engineering College Board

Kaspura, Mr Andre, Policy Analyst, Public Affairs and Marketing

Stewart, Mr Mark, Policy Analyst, Projects, Public Affairs and Marketing

Friday, 21 August 2015 - Eveleigh NSW

John Holland Group

Cameron, Mr Donald, IPD and BIM Systems Manager

University of Wollongong

Brown, Ms Tania, Chief Operating Officer, SMART Infrastructure Facility,

Du Chemin Holderness, Dr Tomas, Research Fellow, SMART Infrastructure Facility

buildingSMART Australasia

Mitchell, Mr John, Chair

Laing O'Rourke

Hardcastle, Mr Ian, Head, Digital Engineering, Australia and Asia

Murray, Mr Josh, General Manager, Corporate Affairs, Australia and Asia

Lynnwood Consulting

Shuttleworth, Mr Alex, Principal

NICTA

Economou, Dr Dean, Acting Director, Infrastructure, Transport and Logistics

Jakubowski, Ms Liz, Director, Government Relations

Runcie, Mr Peter, Business Leader, Intelligent Structures

Williamson, Professor Bob, Interim Chief Executive Officer

Friday, 4 September 2015 - Bunbury WA

BCE Surveying Pty Ltd

Catalano, Mr Carl Jason, Operations Manager

Purnell, Mr David Grahame, Perth Survey Manager

Wednesday, 9 September 2015 - Canberra ACT

Autodesk

Casson, Mr Brett Michael, Infrastructure Development Executive

Autodesk Asia Pty Ltd

Somerville, Mr Roger Paul, Director, APAC Government Affairs

Wednesday, 16 September 2015 - Canberra ACT

National Archives of Australia

Johnston, Ms Christine, Director, Digital Strategy and Solutions

Lyons, Ms Anne Maree, Assistant Director-General

Macfarlane, Ms Linda, Director, Strategic Initiatives and Policy

Thursday, 24 September 2015 - Brisbane QLD

Private Citizen

Yigitcanlar, Professor Tan

AECOM

Ball, Dr Catherine Marie, Regional Unmanned Aerial Systems Lead, URS Corporation

Burchard, Mr David, Associate Director, Transportation

Morrison, Mr Richard Scott, Practice Lead, Information and Communications Technology, Australia New Zealand

Wohlsperger, Mr Andreas, Associate Director, GIS Practice Area Lead Australia New Zealand, Technology and Strategic Asset Management Lead, Northern and Western Australia

Urban Circus Pty Ltd

Guy, Dr Ben, Chief Executive Officer

Queensland University of Technology

Miska, Dr Marc Philipp, Senior Research Fellow, School of Civil Engineering and Built Environment, Smart Transport Research Centre

Bentley Systems

Middleton, Mr Brian, Senior Director, Transportation

Savin, Mr Alan, Vice President, Project Delivery

Friday, 25 September 2015 - Melbourne VIC

Australian Academy of Science

Tucker, Professor Rodney, OAM, Chair, National Committee for Information and Communication Sciences

Australian Academy of Technological Sciences and Engineering

Wenham, Dr Matt, Executive Manager, Policy and Projects

Curtin University

Hampson, Professor Keith Douglas, Faculty of Humanities

IBM Corporation

Dixon, Dr Michael, General Manager, Smarter Cities

IBM Australia and New Zealand

Anderson, Ms Judy, Government and Regulatory Affairs Executive

City of Melbourne

Hassett, Mr David, Team Leader, Geographic Information Systems, Smart City Office, City Strategy and Place

City of Melbourne LEY, Mr Austin, Acting Manager, Smart City Office, City Strategy and Place Group

Tighe, Ms Lorraine, Program Manager, Smart City Office, City Strategy and Place Group

University of Melbourne

Aschwanden, Dr Gideon, Lecturer in Urban Analytics, Faculty of Architecture, Building and Planning

Bishop, Professor Ian, Honorary Professorial Fellow, Department of Infrastructure Engineering

Dingjan, Mr Andrew, Director, Australian Urban Research Infrastructure Network

Nirmalathas, Professor Thas, Institute Director, Melbourne Networked Society Institute

Spring, Mr Geoff, Senior Research Adviser, Centre for Disaster Management and Public Safety

Swinburne University of Technology

Dia, Associate Professor Hussein, Centre for Sustainable Infrastructure

Independent Project Analysis Inc

Kapoulitsas, Mr Petros, Office Director

Victorian Spatial Council

Hedberg, Mr Olaf Hilmer, Chair

Tuesday, 1 December 2015 - Canberra ACT**Telstra Corporation Ltd**

Bradlow, Professor Hugh Simon, Chief Scientist