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Role of Smart ICT in the design and planning of infrastructure

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Submission prepared by:

Lynnwood Consulting (ABN 21 264 459 541)
PO Box 700
Round Corner, NSW 2158

www.lynnwood.com.au

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1. Terms of Reference

The House Standing Committee on Infrastructure and Communications (The Committee) has issued the following Terms of Reference as part of the inquiry into the role of Smart ICT in the design and planning of infrastructure:

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

1. Identifying innovative technology for the mapping, modelling, design and operation of infrastructure;
2. Identifying the new capabilities smart ICT will provide;
3. Examining the productivity benefits of smart ICT;
4. Harmonising data formats and creating nationally consistent arrangements for data storage and access;
5. Identifying international best practice in the use of smart ICT in the design and planning of infrastructure;
6. Considering the use of smart ICT in related fields, such as disaster planning and remediation; and
7. Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity.

This submission provides Lynnwood Consulting's response to this invitation to respond to the Terms of Reference. Lynnwood has provided information and recommendations against Topics 1 to 5, and Topic 7.

2. Introduction

Lynnwood Consulting (Lynnwood) provides consulting services to the owners of physical assets (infrastructure, buildings and other fixed facilities) on how to manage these assets across their lifecycle, and also on how best to adopt technology to support the planning, design, construction and operation & maintenance of these physical assets.

Recent engagements have focussed on providing advice to Australian asset owners on how best to implement Building Information Modelling (BIM) for the planning, design and construction phases. This task immediately presented a number of challenges due to the lack of a common language used for BIM or Virtual Design Construction & Operation (VDCO) of physical assets in Australia.

BIM has become one of the main discussion points in the design, construction and facility management industry, with more and more projects in Australia 'doing BIM'. In short, BIM is more than just 3D design, it is essentially a process for creating and managing all of the information on a project – before, during and after construction – e.g. management of asset related information across the asset life cycle. A key product of this total process is the BIM, which is the digital description of every aspect of the built asset.

BIM requires 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. Key features of BIM include:

- collaboration across the Architecture, Engineering, Construction and Operations (AECO) industry;
- engagement through the entire asset life cycle;
- collation and exchange of information in common formats;
- shared 3D models and associated data such as cost, schedule, operations and maintenance documentation, and
- intelligent, structured databases.

Adopting BIM effectively means that everyone involved in the development, construction and maintenance of infrastructure and facilities will be working around a model-based process to deliver better, more integrated projects.

It is widely acknowledged that very early on in the lifecycle of a infrastructure or physical asset project the chosen design commits the owner to roughly 70% of the lifecycle cost of the asset (whether infrastructure or buildings), which highlights the importance and benefits that the adoption of smarter ways of working can bring to the early phases of a project.

Currently in Australia a key challenge for any asset owner is deciding which framework and standards to adopt when confronted with the decision on Smart ICT. The majority of these decisions are then “”made” by the design and construction stakeholders.

For an SME providing advice on these important decisions requires a significant amount of effort to understand the benefits and disadvantages of selecting a particular framework and or methodology. This cost is passed through to the asset owner and ultimately forms part of the total cost of ownership of the asset.

The timing of this inquiry and the topics covered in the Terms of the Reference are certainly appropriate for Australia, and Lynnwood is pleased to provide the following responses to the topics listed.

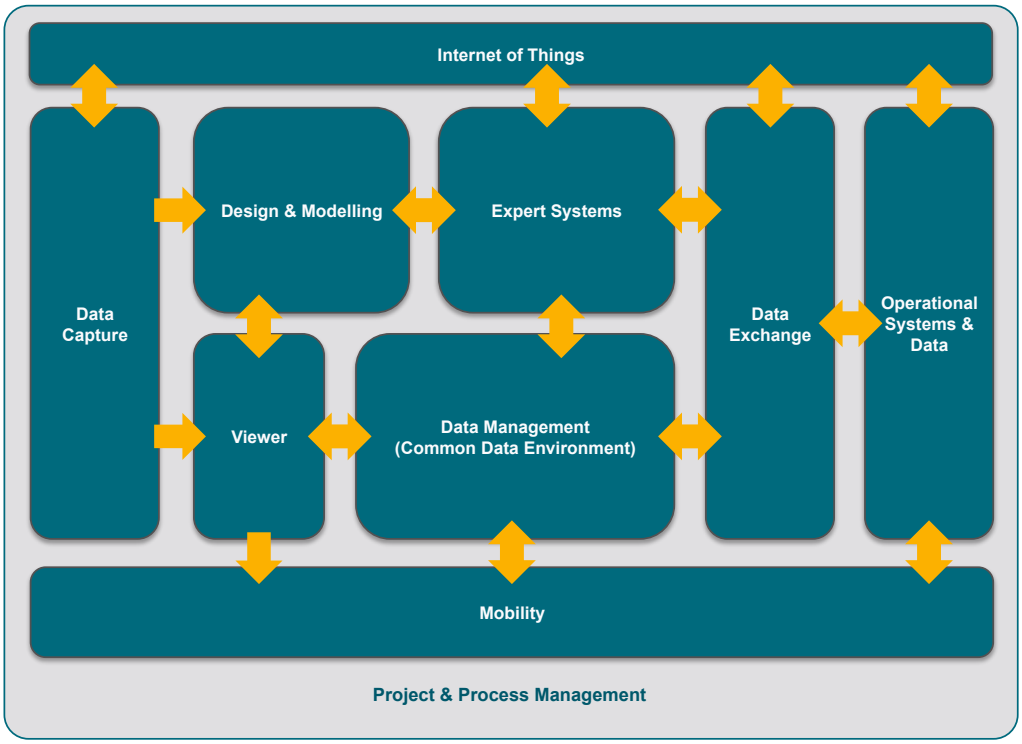
3. Response to Topics

3.1 Innovative Technology and New Capabilities

Topic 1 - Identifying innovative technology for the mapping, modelling, design and operation of infrastructure

Topic 2 – Identifying the new capabilities Smart ICT will provide

Technology is obviously a key component of Smart ICT in support of the mapping, modelling, design and operation of infrastructure. The following diagram has been adapted from the European 5D-initiative (www.5d-initiative.eu) to help in understanding the inter-play between the different technologies involved.



This model captures the basic system elements required to support a BIM environment, including:

- **Data Capture**, which is the different mechanism of providing information to support the planning and design process. This includes from paper based drawings and documentation, mapping of the physical environment through methods such as laser scanning and photogrammetry;
- **Design and Modelling**, the main purpose is to accommodate an environment wherein a well-structured 3D-Model can be created. The modeling software will be the key tool for translating existing planning (e.g. 2D or 3D) into 3D BIM models;
- **Expert Systems**, which typically include specific software applications fulfilling functions such as scheduling, cost estimation, structural analysis, environment analysis, etc. These expert systems require integration with the use of a Common Data environment (CDE) to support an efficient work process;
- **Viewer**, where the viewing capability is required to support decision-making and to inform stakeholders. To that end, the viewer is essentially a graphical interface to the common data environment (main database). Even though it is identified as a viewer, it may have editing functions to support marking up of drawings, etc.;
- **Data Management**, which essentially means a common data environment that allows for management of the federated or integrated BIM models, including the ability to manage configuration and ownership of the design iterations;
- **Data Exchange**, which provides the capability of exchanging data between systems that are not using common data formats, and do not have their own in-built conversion abilities;
- **Operational Systems & Data**, which identifies the requirement for the BIM environment to integrate with standard operational systems, with the majority of the data flowing from the BIM model environment to the operational systems. This is of particular relevance if 6D BIM is used;
- **Mobility**, which signifies the ability to have access to the BIM models and associated data hosted in the common data environment on mobile devices. This typically supports access to all working information on a mobile device, and extends to capabilities such as Augmented Reality;
- **Internet of Things,** which is continually changing and advancing at a rapid pace, and basically allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems; and
- **Project and Process Management**, which should enable a process manager to define the process, workflow, roles and authorisations of key players, the approval mechanisms, and consequences of decisions. This way the flow of information and the creation of new data is monitored and can be managed and controlled from this system;

The greatest benefit is achieved through the seamless integration of the information from one end of the process (data capture) to the final end user in the operations phase. There are many systems available commercially and it would require a separate study to identify the relevant technologies. Currently the majority of large-scale one-off projects make these decisions on a project-by-project basis. For some large asset owners, such as State Government entities, there is a challenge in deciding the appropriate combination of technologies to support the assets over the asset life cycle.

Furthermore, technology is a rapidly changing environment, which is now coinciding with the movement towards cloud based solutions, whether it is for capturing, processing or consuming of information. For example two interesting and innovative initiatives here in Australia with regards to mapping are the Virtual Australia & New Zealand Initiative (VANZI) and Smarter Scheduling NSW (SSN):

- VANZI (www.vanzi.com.au), is an authorised, federated, fully integrated, secure 3D Data Set, that enables users to model the Natural and Built Environment across Australia and New Zealand, using any software and portal of their choice; and
- Smarter Scheduling NSW (SSN) is a location-based platform for the coordination of street infrastructure works across the State (www.smarterscheduling.nsw.gov.au). Developed as a joint initiative between the Department of Premier and Cabinet and Land and Property Information, SSN assists collaboration between local councils, state government and utility providers.

A company with an interesting approach to the overall integration required to properly support the concept of Smart Cities is Living PlanIT (living-planit.com). Living PlanIT's plan is to code cities like

software – in which buildings, sensors, and traffic apps alike are connected through the cloud. The company will own the Urban Operating System (UOS) – the glue of the urban fabric – and the process, from drafting blueprints to "decommissioning" an obsolete building. They have two major projects on the go, one is PlanIT Valley outside of Porto in Portugal, and the other is Korea's New Songdo. It will be interesting to see how disruptive their approach will be to traditional approaches to urban development, including their ability to define the blueprint for scalable city environments.

Lynnwood's view is 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.

Recommendations for Topics 1 and 2:

- The Commonwealth of Australia must identify a national strategy for construction and management of infrastructure with specific targets to assist with the adoption of innovative technology.
- The Commonwealth of Australia to coordinate the efforts of different departments and agencies into a consolidated approach to adoption of Smart ICT in support of infrastructure and construction in general.
- The Commonwealth of Australia to assist Australian industry, including Small to Medium Enterprises, in adopting innovative technology through assistance with training and education

3.2 Productivity Benefits

Topic 3 - Examining the productivity benefits of smart ICT

Early access to the data rich information in the BIM models will help everyone involved in a project to gain more insight into the project and their role within the successful delivery thereof. As a result, the team can make more-informed decisions much earlier in the planning, design, construction, or renovation process — at the times when decisions can have the greatest impact on project cost, schedule, and sustainability.

The benefits of adopting and using BIM is by now well documented, with some of the productivity benefits summarised below:

- **Increases performance**. Through the ability to have a single model, which allows the ability to quickly show different options or design scenarios in a 3D environment leading to the ability to create more sustainable, efficient and cost effective solutions. This is really important during the early design stages allowing owner and operator to understand the implications of the design options and decisions.
- **Promotes collaboration**. Through the technology that supports BIM all project stakeholders use the same 3D model. This forces a more collaborative working relationship, which requires better cooperation and communication through the planning, design and construction process. This ensures that all stakeholders are focused on their individual goals in supporting the overall project objective, including playing their role in providing the best value for money.
- **Increases project certainty**. It is simpler, faster and cheaper to visualise projects at the concept and design stage using 3D BIM (virtual reality) to give owners a better idea of the intent of the design. This process provides the ability to make modifications early in the design process, which greatly reduces cost of design changes and manufacturing changes. Before construction, BIM allows the creation of a virtual building, and if the schedule is added the construction process can be virtualized. This provides the opportunity to rehearse the complex procedures and also planning the procurement of equipment, manpower and materials.
- **Faster project completion**. Through the use of BIM projects are able to achieve approximately 50% timesavings through agreeing on the key design early on in the project. Through modular design philosophies it also allows the use of typical design elements (where practical). Through virtual reality and visualisations it is also possible to de-clash intricate construction details prior to the project starting physical construction thereby avoiding or eliminating on-site clashes

during construction. The construction process can also take advantage of the automation and intelligence in the model for checking design integrity. A 3D model is also able to support offsite manufacturing of building elements, which then only require assembly on site, reducing waste at the construction site.

According to a 2010 study of firms implementing BIM published in the Journal of Information Technology in Construction, half of the firms reported a decrease in project costs of up to 50 percent, and 62 percent reported a decrease of project times of up to 50 percent, compared with projects run with a traditional approach. In addition:

- less than 1.5 percent of the project costs went to approved change orders;
- claims and disputes represented less than 0.5 percent of the costs; and
- correcting errors and omissions also represented less than 0.5 percent of the cost.

From a financial perspective the following information illustrates the productivity benefits and potential for cost savings possible through adopting of BIM:

"The UK government estimates that it saved £1.7 billion (2 billion Euro) on major public building projects since 2012 and that 66 per cent of the UK's Major Project Authority portfolio is now being delivered on time and within budget, a substantial improvement on the 33 per cent seen in 2010[1]."

Recommendation for Topic 3:

- The Commonwealth of Australia to define and mandate specific performance targets that will assist in driving efficiencies and cost savings in the management of infrastructure, facilities and buildings across the asset lifecycle (total cost of ownership)

3.3 Harmonising Data Formats

Topic 4 - Harmonising data formats and creating nationally consistent arrangements for data storage and access

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.

Open standards are thus mandated by those governments and commercial organisations who recognise the advantages of such a strategy, which typically includes:

- Allowing each stakeholder to use any tools available on the open market that best suit their needs;
- Facilitating data exchange throughout the asset and project life cycle;
- Maintaining consistent data standards across an asset portfolio or multiple projects;
- Maximizing the openness and competitiveness of the market for planning, design and construction services; and

[1] Source - Construction News (cnplus.co.uk)

- Ensuring 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.

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

An asset classification system must include buildings, infrastructure and integrated project and office management. It must be able to map project information from the initial concept through development brief, detailed design, construction, commissioning, handover, and operation and maintenance. There are currently two main asset classification systems competing globally to fulfill this role – Uniclass and OmniClass:

- **Uniclass.** Uniclass is a classification system defined as a unified classification for the construction industry, initially published in 1997 in the United Kingdom. Uniclass 2 (www.cpic.org.uk/uniclass) is the latest development suited for use in dynamic and electronic systems. PAS 1192 uses the Uniclass 2 classification system as the underlying mechanism for identifying assets throughout the asset life cycle. The UK Government has taken over ownership of UniClass 2 and is planning to release an updated version during 2015, along with revised COBie tools that align with the Uniclass classification system.
- **OmniClass.** OmniClass[2] has also been developed for the construction industry and is more prevalent in the USA and Canada, with a growing significance within the National BIM Standard-United States. Standard COBie uses OmniClass tables to organise information created by designers and product manufacturers so that it can be submitted to facility managers efficiently.

A number of groups are actively promoting the use of "open standards" in relation to BIM. These include the following groups and base standards (this is not an exhaustive list):

- buildingSMARTalliance and buildingSMART International who promote Open BIM, IFC, and IFC-based standards, processes, and technologies;
- Industry Foundation Classes (IFC), the data model specification for building information modeling and data exchange. IFC is now also defined as an ISO standard - ISO 16739:2013 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries;
- Construction Operations Building Information Exchange (COBie), an information exchange specification for capturing DE data related to building life cycle management;
- BIM Collaboration Format (BCF), an XML schema that encodes messages to enable workflow communication between different BIM software tools;
- Open Geospatial Consortium (OGC), an international industry consortium for developing standards for geospatial data-enabled technologies;
- Green Building XML (gbXML), a file format schema for exchanging BIM data for building energy performance simulation and analysis; and
- BIMXML - an XML schema developed to represent a simplified subset of BIM data for web services.

A critical aspect for Smart ICT related to infrastructure is the ability to exchange or, at a minimum, link the information managed by BIM and GIS systems. BIM offers detailed 3D visualisations and the ability to organise large volumes of data related to built assets, such as buildings and infrastructure. GIS provides the context from a global perspective, providing the linkage at a country, state or city level, which is critical for infrastructure projects. As noted above, IFC is a method of organising building / infrastructure data to enable the easy exchange of data. IFC uses the OmniClass table structure as its foundation, however there is a gap in the capability of this data structure, as the geometric data (GIS data elements) of the assets, are not easily recorded.

[2] OmniClass - www.omniclass.org

As the current versions of IFC are intended for buildings, buildingSMART has initiated the IFC for Infrastructure project to extend the IFC standard to support linear transportation infrastructure (BIM for Infrastructure) such as rail, road, bridges, and tunnels. The first BIM standard based on a common conceptual model, shared between the BIM and GIS worlds, was released for public comment by buildingSMART in early 2015. Simultaneously the OGC released the OGC LandInfra Conceptual Model, the first draft of the InfraGML conceptual model for land parcels and the built environment.

These different standards have the potential to add further confusion, however one of the first IFC projects is the IFC Alignment project. It is intended to provide the data model for geolocation information for 3D and 2D alignments and has been developed in concert with the OGC. The objectives of the IFC Alignment project are to enable the exchange of alignment information through the full infrastructure lifecycle from planning through design and construction to asset management. It will be interesting to see how quickly a common standard can be agreed and published for use with the rest of the IFC standards.

In general, in order to share information, the following three specifications should be in place for any Smart ICT infrastructure project to maximise the use of data:

1. An exchange format, defining *how* to share the information;
2. A reference library, to define *what* information is to be shared; and
3. Information requirements, defining *which* information to share *when*.

It is important to emphasise open standards that promote maximum interoperability and it is imperative that the Commonwealth endorses standards that promote such levels of interoperability, which also advances industry efficiency.

Recommendation for Topic 4:

- The Commonwealth of Australia to identify and agree, in consultation with Australian asset owners and industry, the most appropriate suite of open data standards to adopt for use in Australia

3.4 International Best Practice

Topic 5 - Identifying international best practice in the use of smart ICT in the design and planning of infrastructure

One of the key challenges in providing advice to project owners, whether it is an infrastructure or building project, is on which frameworks, standards, software, etc., to suggest be used for a project or asset portfolio. Unless the client has already adopted certain technology these recommendations require the development and approval of a business case to demonstrate the benefits to be achieved. This typically happens irrespective of the fact that Smart ICT, in particular BIM, has been adopted globally in support of planning, design and construction of infrastructure.

A number of countries have developed and adopted different frameworks, methods, protocols and standards to assist with the implementation of Smart ICT and integrated project delivery methods in support of planning, design and construction of infrastructure and buildings. Australia has its own range of guides and protocols, which in itself creates confusion for owners and advisors. From Lynnwood's perspective the following countries stand out as having developed defined and workable frameworks, including guides, protocols and mandates:

3.4.1 Finland

Finland, through the support of buildingSMART Finland (www.en.buildingsmart.kotisivukone.com), have developed Common BIM (COBIM 2012) Requirements, based on the requirements of the Senate Properties Guidelines as published 2007. Senate Properties is a Finnish unincorporated state-owned enterprise, which manages a major part of the real estate assets owned by the Republic of Finland. The aim of COBIM 2012 was to produce an operating culture for the use of BIM in building projects and BIM-

based maintenance across Finland. COBIM consists of 13 parts that provide guidance to all BIM users in how best to adopt and use BIM.

In addition to the Common BIM initiative, buildingSMART Finland is also working on developing a longer-term strategy for infrastructure (InfraBIM), releasing the INFRA 2025 vision, which emphasised the importance and benefits of digitising all infrastructure processes. The goal of this group is to have fully digitised infrastructure design and production processes by 2025. From their perspective standardisation of the infrastructure sector data exchange is complex. They originally adopted LandXML because it was the only format that allowed for exchange of infrastructure data with attributes. These Common InfraBIM Requirements were planned for release in May 2015 (not currently available in English).

Finland is expecting international standardisation of BIM, which will require them to update the Common BIM. At the same time they are also planning to align the Common BIM with the newer Common InfraBIM guidelines.

3.4.2 Singapore

In Singapore, through the Singapore Building and Construction Authority (BCA), an implementation roadmap was developed in 2011. They have also mandated the use of BIM from 2015 onwards (www.bca.gov.sg) for construction of buildings larger than 5000m^2. The Singapore Government has also provided funding to encourage adoption of BIM, including making provision for the training of users to increase the proficiency of key players across the AEC industry.

3.4.3 United States

In the US, a main driver for the adoption of BIM has been the General Services Administration (GSA), which is responsible for the construction and operation of all federal facilities in the US. In 2003, the GSA established a National 3D-4D-BIM program through the Office of the Chief Architect of its Public Buildings Service. The GSA requires mandatory BIM submissions for government projects since 2008. The National Institute of Building Sciences (NIBS) is the overarching entity that provides standards and direction for the ongoing use of BIM for infrastructure and buildings (www.nibs.org), including the National BIM Standard-United State (NBIMS-US), which provides the BIM standards for the built environment. The buildingSMART alliance is also a key player within the NIBS domain, providing the lead for the development and deployment of national information standards and practices. The GSA's strong advocacy of BIM is influencing the AEC industry in the US and has assisted in the industries' ability to adopt the latest technology.

3.4.4 Europe

The European Union, through the European Parliament, has recently made a decision to modernise European public procurement rules by recommending the use of electronic tools such as building information electronic modelling, or BIM, for public works contracts and design contests.

The adoption of the directive, officially called the European Union Public Procurement Directive (EUPPD), means that all the European Member States may encourage, specify or mandate the use of BIM for publicly funded construction and building projects in the European Union by 2016. Currently the UK, Netherlands, Denmark, Finland and Norway already require the use of BIM for publicly funded building projects.

3.4.5 United Kingdom

In 2011, the UK Government provided a mandate for the adoption and use of BIM. The UK Cabinet Office published a "Government Construction Strategy" document that covered "Building Information Modelling," within which it specified that Government will require fully collaborative 3D BIM as a minimum by 2016 for all central Government construction works. However, key to the success of the strategy was the fact that the UK Government recognised the lack of compatible systems, standards and protocols, and that owners, designers and contractors have different requirements. A critical part of the strategy was for the UK Government to also focus on developing the standards to enable all members of the supply chain to work collaboratively through BIM.

To assist with the coordination to achieve BIM Level 2, the UK Government established the Building Information Modelling (BIM) Task Group (www.bimtaskgroup.org) to support and help deliver the objectives of the Construction Strategy. This included working with the public sector to increase their BIM capability with the aim that all central government departments will be able to adopt Level 2 BIM by 2016. Essentially, the requirements for BIM Level 2 are the ability to manage CAD in 2 or 3D format with a collaboration tool providing a common data environment, supported by standard data structures and data formats.

PAS 1192 has been developed and adopted by the UK Government to assist with implementation of BIM to meet the Construction Strategy targets, including achieving BIM Level 2. The suite of standards in PAS 1192 establishes the methodology for managing the production, distribution and quality of construction information, including that generated by CAD systems, using a disciplined process for collaboration and a specified naming policy. Adopting PAS1192 also provides alignment with ISO55000 – Standards for Asset Management. The PAS 1192 standards are applicable to all parties involved in the preparation and use of information throughout the design, construction, operation and deconstruction phases of the project and asset life cycle, including the elements of the supply chain. It is also stated that the principles adopted by the standards for information sharing and common modelling are equally applicable to building and civil / infrastructure projects.

Earlier this year the UK Government released their strategic plan on how to achieve Level 3 BIM[3] (digital-built-britain.com). The strategy aims to implement several key measures to assist with the achievement of Level 3 in the UK, including:

- The creation of a set of new, international 'Open Data' standards, which would pave the way for easy sharing of data across the entire market;
- The establishment of a new contractual framework for projects which have been procured with BIM to ensure consistency, avoid confusion and encourage, open, collaborative working;
- The creation of a cultural environment which is co-operative, seeks to learn and share;
- Training the public sector client in the use of BIM techniques such as, data requirements, operational methods and contractual processes; and
- Driving domestic and international growth and jobs in technology and construction.

Part of the vision for the future, as set by the UK Government strategy, includes the implementation of new business models to support the expected changes in the way that all stakeholders interact through the BIM process. This is linked to advances in collaboration, changes to contractual models, and technology improvements that facilitates on-line collaboration in sharing models and data.

3.4.6 Australia

From a BIM activity point of view Australia is not lacking, and we have a range of guides and protocols that aim to assist with the adoption of BIM, including those as developed by buildingSMART Australasia (buildingsmart.org.au) and NATSPEC (bim.natspec.org). A recent report for the Department of Industry, Innovation, Science, Research and Tertiary Education, titled "National Building Information Modelling Initiative", prepared by buildingSMART Australasia, goes some way towards defining a strategy for adoption of BIM.

However, even though these reports, various BIM guides and protocols were developed with Commonwealth assistance and funding, there is no clear unified Commonwealth strategy and mandate for the adoption of Smart ICT to assist with the delivery of infrastructure. Without a clear, common vision and mandate there is no unambiguous driver unifying all stakeholders to collectively work in the same direction. This lack of a cohesive driver creates uncertainty and confusion for asset owners, agencies, and other stakeholders in terms of what better practice to adopt for planning, design, construction and operation of infrastructure.

3.4.7 Projects

[3] HM Government, Digital Built Britain, Level 3 Building Information Modelling - Strategic Plan, dated February 2015

A number of projects have been included here for the diverse scale and range of information these projects have contributed to the common knowledge around the use of BIM. A short overview is provided on each of these projects, and some of the learnings available:

- **UK Cross Rail Project** (www.crossrail.co.uk): Crossrail is probably the poster child for BIM, being one of the biggest construction projects in Europe and being one of the largest single infrastructure investments undertaken in the UK. Crossrail relied heavily on Smart ICT, including 3D designs, which were linked to a bespoke database (backbone of a Common Data Environment - CDE). It has been stated that everyone on the project has access to the CDE. The ability to access a single source of data, that is correct and up to date, has provided significant efficiency and productivity benefits to the project, even though the cost to implement the supporting IT software and infrastructure was substantial.
- **London 2012 Olympics Games** (learninglegacy.independent.gov.uk): The London Games used Smart ICT across a number of activities to prepare for the Games. A range of topics are covered as part of the Lessons Learned that have been published, including how technology was used to support the infrastructure and facilities at the Games. Topics covered includes how an integrated CAD model was used for design coordination, how GIS data was used to assist with earthworks and remediation design, and how a GIS browser was made available to all project delivery partners, which greatly improved the efficiency, assurance and reliability of data used. The Olympic Delivery Authority (ODA) also made use of a detailed 3D model to not only support planning decision making, but also to assist with media relations.
- **UK Network Rail's ORBIS Project** (www.networkrail.co.uk): Network Rail's 330 Million pound ORBIS (Offering Rail Better Information Services) project is an 8 year program that involves the creation of a comprehensive and highly detailed 3D digital model of the UK's entire railway network. The creation of this digital model is expected to dramatically lift the efficiency of maintenance and repair works. Existing data will be added to new data collected from LiDAR scanning, some of which will be completed via helicopter. This data is then used to create a rail infrastructure network model (RINM), an information-saturated BIM tool to enable engineers to "make far more informed decisions about the maintenance and operation" of sections of rail. As part of the ORBIS Project, engineers can already download an app with the latest up to date version of the RINM, meaning they can access the data via mobile tablets on-site when working on maintenance.
- **Sydney Opera House – FM Exemplar Project** (http://www.construction-innovation.info/index3ca5.html?id=53): The Sydney Opera House (SOH) project was one of the leading projects at the time (2005) to understand the impact and subsequent benefits of digital modeling (BIM) on the maintenance of a facility. The project was initiated with funding from The Australian Government (through the Department of Industry, Tourism and Resources) to understand the development of the emerging facility management industry. The research highlighted the significant opportunities for SOH to improve facility management through the use of BIM, and also provided an indication of the possibilities that BIM held for the broader construction and Facility Management industries.

It is unfortunate that Australia was at the forefront of adopting and using BIM more than 10 years ago, but we haven't been able to translate that into a defined mandate for the adoption of Smart ICT.

With so much development happening across the world, and a plethora of organisations developing frameworks and mandates, it is becoming increasingly difficult for owners to identify the best frameworks to ensure that they adopt the best Smart ICT for their management of their assets, infrastructure or otherwise.

In providing advice to clients, Lynnwood has found that the best developed framework and methodologies are those used by the UK Government based around PAS1192 and the associated support systems.

Recommendations for Topic 5:

- Review and understand the scope and implications of the UK Government's Construction Strategy of 2011 and Digital Britain Strategy of 2015

3.5 The Role of Government

Topic 7 - Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity

The Australian Government is already involved in arrange of activities related to the adoption of Smart ICT, in particular around the adoption of BIM. However, most of these activities result in reports, which attempts to define strategies and roadmaps for the adoption of Smart ICT.

A good example of this is the report for the Department of Industry, Innovation, Science, Research and Tertiary Education, titled "National Building Information Modelling Initiative", prepared by buildingSMART Australasia. As mentioned previously it provides a roadmap for the adoption of BIM. However, as noted the in the report there is still no mandate for public works to use BIM.

Another example is the creation of a Global Infrastructure Hub in Sydney. In press releases it has been stated that:

"The $15 million-a-year Global Infrastructure Hub Sydney will be funded by eight countries including Australia, the United Kingdom, China, Saudi Arabia, New Zealand, the Republic of Korea, Mexico and Singapore. The initiative, which was endorsed by world leaders at the G20 Summit in Brisbane last year, will have a four-year mandate to improve the quality of infrastructure investment across the world. The leaders' communique said the hub would contribute to a "knowledge-sharing platform and network" between governments, the private sector and other international organisations."

It is unclear where this initiative fits in with all the other current Australian BIM initiatives.

In summary, we believe that the key element that is missing compared to the word leaders like the UK, is a firm commitment from the Australian Government, as a whole of Government initiative, to define a mandate to drive the adoption of BIM.

Recommendations for Topic 7:

- The Commonwealth of Australia to adopt the UK Government operational model for use of BIM in support of planning, design, construction and use infrastructure

4. Conclusion and Recommendations

4.1 Conclusion

Australia is in a unique position that we have access to a wide range of Smart ICT, including BIM, initiatives with various levels of support from Federal and State Governments. We also have access to skills and experience with Smart ICT, including BIM, that in some cases are leading the world in adopting the technology and processes to support planning, design and construction activities.

However, in a way Australia has missed the opportunity to be a world leader in development of BIM for infrastructure, facilities and buildings. This does not mean that Australian Government and Industry organisations have not been doing BIM. We are developing a diverse range of technologies, such as Aconex (www.aconex.com) and are delivering BIM enabled projects, both big and small.

However, to immediately start to realize the full potential, including benefits, that are possible with BIM, requires strong direction from the Commonwealth of Australia. It is our view that Australia should adopt world's best practice as quickly as possible to drive the adoption of BIM nationally.

This will require a concerted and focused effort across a wide range of stakeholders, including government entities, AEC industry players, and last but not least, major asset owners and operators.

4.2 Recommendations

To summarise the following recommendations have been made against the topics:

Topics	Recommendations
Topic 1 - Identifying innovative technology for the mapping, modelling, design and operation of infrastructure Topic 2 – Identifying the new capabilities Smart ICT will provide	• The Commonwealth of Australia must identify a national strategy for construction and management of infrastructure with specific targets to assist with the adoption of innovative technology. • The Commonwealth of Australia to coordinate the efforts of different departments and agencies into a consolidated approach to adoption of Smart ICT in support of infrastructure and construction in general. • The Commonwealth of Australia to assist Australian industry, including Small to Medium Enterprises, in adopting innovative technology through assistance with training and education
Topic 3 - Examining the productivity benefits of smart ICT	• The Commonwealth of Australia to define and mandate specific performance targets that will assist in driving efficiencies and cost savings in the management of infrastructure, facilities and buildings across the asset lifecycle (total cost of ownership)
Topic 4 - Harmonising data formats and creating nationally consistent arrangements for data storage and access	• The Commonwealth of Australia to identify and agree, in consultation with Australian asset owners and industry, the most appropriate suite of open data standards to adopt for use in Australia
Topic 5 - Identifying international best practice in the use of smart ICT in the design and planning of infrastructure	• Review and understand the scope and implications of the UK Government's Construction Strategy of 2011 and Digital Britain Strategy of 2015
Topic 7 - Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity	• The Commonwealth of Australia to adopt the UK Government operational model for use of BIM in support of planning, design, construction and use infrastructure