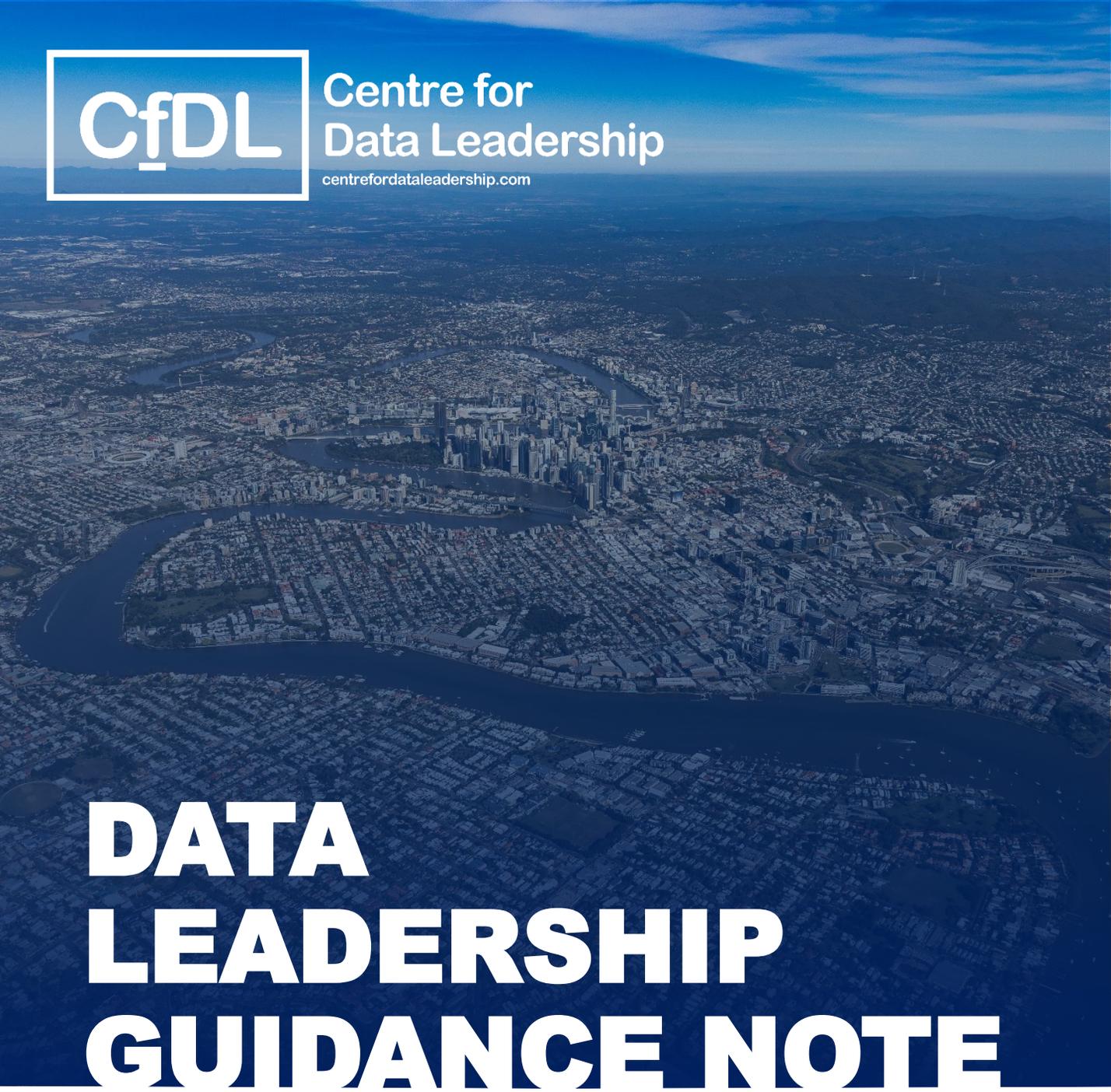




Centre for
Data Leadership

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An aerial photograph of a city, likely Auckland, New Zealand, showing a dense urban area with a river winding through it. The image is overlaid with a blue gradient that darkens towards the bottom.

DATA LEADERSHIP GUIDANCE NOTE

Digital Twin

April 2020

Powered by

Smart**Cities**Council
Australia New Zealand

About us



Smart Cities Council Australia New Zealand (SCCANZ) is part of the Smart Cities Council, the world's largest network of smart cities companies, practitioners and policy makers, embracing technology and data to accelerate liveability, workability and sustainability in our cities and towns.

Further information about the Smart Cities Council can be found [here](#).

Acknowledgements



This guidance note was developed in collaboration with our partner company, PCSG.

PCSG is a leading built-environment consultancy. From our bases in the UK and Australia we are a trusted partner to some of the biggest names in industry.

We help our clients to deliver, operate and optimise their built assets – unlocking value and building resilience into their projects and day-to-day operations.

Further information about PCSG can be found [here](#).

Introduction

The digital twin context



Overview

Our cities and built environment are entering an unprecedented period of infrastructure investment across transport, health, education, justice and local government. This investment is vital to support the continued economic prosperity of cities while supporting a continued growth in population and quality of life..

This growth will support an increasingly competitive economic position, but also presents new challenges while compounding existing issues. Primarily, these challenges centre on infrastructure capacity, housing affordability and the multiple sustainability outcomes we are seeking to achieve through [the UN Sustainable Development Goals](#).

Affordability of infrastructure development and management of assets continues to be a pressing concern, with the region facing a widening fiscal gap due to a changing demographic, among other things. Our construction industry is well established but is constrained in capacity, with productivity in the sector plateauing over the last 20 years.

Given this context, it is vital that our governments consider significant changes to the way infrastructure is planned, delivered and operated, to optimise capital investment, reduce whole life costs and ensure the best possible service delivery is provided and that social outcomes are achieved.

The development and implementation of digital technologies presents an opportunity to support the change required. Digital enablement can provide a platform for integrated planning, improved design and drive efficiency in construction. More importantly, such digital enablement – as provided through a Digital Twin – can significantly help to optimise asset operation and performance and thus service enhancement.

Governments and all infrastructure asset owners in Australia and New Zealand have a shared challenge - to achieve operational efficiencies while delivering better outcomes for the people they serve. They also have a responsibility to spend tax payers money in an open, transparent and diligent way that benefits all.

By integrating asset data with other social, economic and environmental datasets in a cost-effective way, governments can unlock substantial value over the life of their projects and programs and solve key business issues more dynamically.

In simple terms, our cities and built environment need to focus on three key questions:

1. How do we enable better services and value for our citizens?
2. How do we deliver greater economic value for the nation?
3. How do we achieve net zero greenhouse gas emissions from our assets?

Answering these questions will depend on our ability to enhance our city and infrastructure planning processes, as well as our methods for building and operating assets, and delivering social services.

This of course is possible, but requires a new generation of tools, approaches and mindsets.

We believe the Digital Twin is exactly this.

The opportunity

The economic benefits of Digital Twins, smart cities and emerging digital technologies are considerable. The global digital twin market is projected to be US\$29.1 billion (AU\$43.3 billion) by 2025.

In Australia, emerging digital technologies such as IoT and big data are predicted to increase our annual GDP growth rate by 0.5 to 1.0 percent, and the aggregate direct and indirect value of government data in Australia was AU\$25 billion per annum in 2014. In 2018 Data61, Australia's innovation agency, estimated that digital innovation can deliver \$315 billion in gross domestic value to Australia over the coming decade.

In developing and implementing a Digital Twin strategy, governments and infrastructure owner/operators would be able to realise multiple benefits – from Improved national/state/territory/regional productivity from higher-performing and resilient infrastructure to the creation of new markets and business models to drive prosperity while reducing greenhouse gas emissions.

Existing Digital Twin guidance in the region

The Australia New Zealand Land Information Council (ANZLIC) published the [Principles for Spatially Enabled Digital Twins of the Built and Natural Environment in Australia](#) in November 2019. Its purpose is to guide Digital Twin development and delivery of spatially enabled digital twins. These principles are depicted in Figure 1 below.

The intent of the ANZLIC principles is to help industry, government, and the research sector develop digital twins in an aligned way that can feed into a wider ecosystem.

This Guidance Note supports these principles, and builds on them to provide further information to policy makers and practitioners.

The ANZLIC principles (below) are intentionally simple, and purposefully describe overall intent rather than point to specific solutions.



Figure 1: ANZLIC Digital Twin Principles

Purpose of this Guidance Note

The purpose of this Guidance Note looks at how implementing a Digital Twin can help answer these questions in planning, designing, constructing and operating our cities and built environment assets.

While it references elements of the social, economic and natural environment, its focus is on the built environment.

This document will be the first in a series of resources published by the Smart Cities Council through the Australia New Zealand [Digital Twin Hub](#).

The Fundamentals

What is a digital twin?

Background

The term 'Digital Twin' is commonly associated with smart manufacturing and Industry 4.0, with the 'twin' part dating back at least to the 1960s. As part of the Apollo program, NASA created 'twins' of the Command Module, Lunar Module and Lunar Rover. The twins all stayed on the ground but were used extensively for maintenance, support and troubleshooting.

So, while having a long history and somewhat definitive scope, the Digital Twin sits in a dynamic present day, with an even more exciting future ahead and the level of interest in them increases.

And this interest increases as our value of data and the insights it can generate increases. The types, sources and frequency of data collection today are evolving rapidly, and this is a good thing for the Digital Twin, as we will highlight in this document.

Definition

The common definition for the Digital Twin is "a digital replica of a physical thing". So, if that's what it is, what does it do?

Well, it activates data, to power better decision making. And given its capability (see over page), it helps you do more with less. And do that in a more engaging and transparent way.

So, let's not undersell the Digital Twin by calling it a digital replica of a physical thing. Let's call it for what it does.

While it can provide a digital representation of an asset, place or even a city - its the data that supercharges its value, and lights up your project with insights, scenarios and representations like no other platform.

As a minimum, a Digital Twin must ingest the following data sets:

- Geometric and graphical data
- Geospatial reference data
- Asset attributes (natural, physical, social, economic)
- Management data
- Real-time asset performance and utilisation data.

Minimum capability

Building on the minimum data sets specified on the previous page, the Digital Twin also has a set of minimum capabilities.

These capabilities are underpinned by the Digital Twin's ability to be fed by live data flows from a physical or natural asset, for example a building, or one of its components, like a lift motor.

Insights and programmed instructions from the Digital Twin can then impact the physical twin using real-time control mechanisms, for example shutting down a faulty lift or adjusting the temperature of a room. This connected and real-time connection between the physical and the digital, are a key capability of a Digital Twin platform.

As a minimum, a Digital Twin must provide the following five capabilities:

Function	Capability
Connect	There must be a 'live' connection between the digital replica and the physical world. This connection allows various disparate information and data from the physical world to come into a unified virtual environment.
Integrate	Intelligently checks and links relevant data from different sources (and across sectors) to effectively enable meaningful analysis to those who see the value.
Visualise	To display real time multisource data to the user. This allows access to the information users need, precisely when they need it, across the whole project and asset operation lifecycle.
Analyse	Federated data sets from various sources can be processed, modelled, analysed and simulated to bring business objectives to life.
Secure	Having a security minded management approach to data and information by applying relevant technical security and privacy standards.

Therefore in summary, a Digital Twin platform can provide insights beyond what is currently seen with existing built asset models and can be used as a tool to aid better decision making.

The Digital Twin is not the 'silver bullet', but appropriately works to capture data on economic and social infrastructure, which can be augmented with other models, predictive asset management approaches and advanced data science tools to optimise the performance of infrastructure systems.

Data as an asset

Data can inform how our infrastructure is built, managed and eventually decommissioned, and real-time data can inform how our infrastructure is operated on a second-to-second basis.

Data is now as much a critical component of our infrastructure as bricks and mortar. Data is an infrastructure and needs maintenance in the same way that physical infrastructure needs maintenance. It must be updated, stored and made secure.

Data about our infrastructure assets needs to be shared in way that opens up the benefits yet maintains appropriate levels of privacy and security. Therefore, our culture must change from one of closed, siloed thinking to an open, transparent culture of effective data management.

For example, private companies could make more data about their infrastructure networks, assets and organisations open, whilst still protecting personal data. Our goal is to ensure we move from keeping all data confidential, to creating minimum levels of commercial confidentiality.

Figure 2 below demonstrates the lifecycle approach on applying a Digital Twin from planning, capital delivery, operations through to delivering citizen services. The figure also demonstrates the different data sets that make up a Digital Twin (ie. BIM, GIS & IoT) and reinforces that the approach of data as an asset.

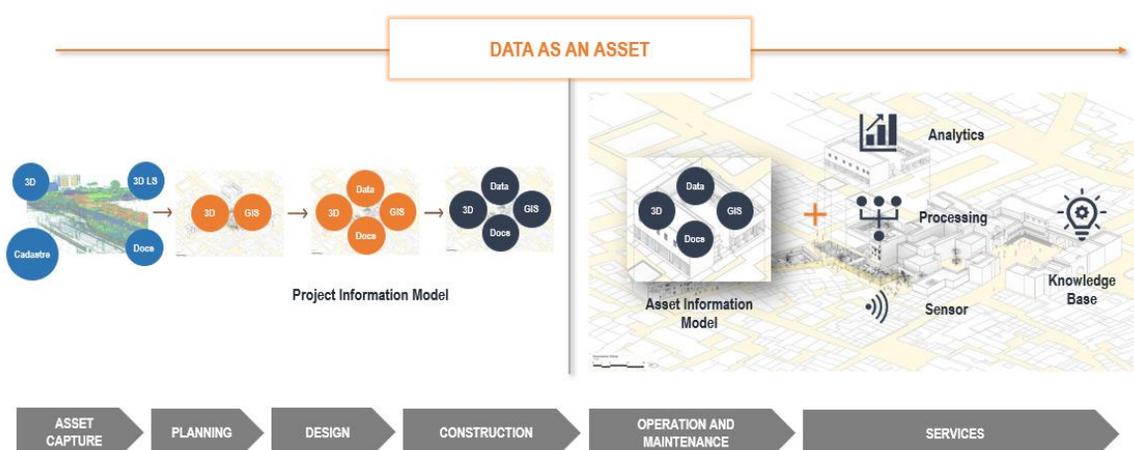


Figure 2: Data as an asset across the project lifecycle.



Furthermore, the Digital Twin can help organise data and pull it into interoperable formats so that it can be used to optimise infrastructure use. Digital Twins can also share this data, with defined levels of access, to inform better decisions on how to manage current and future infrastructure and what should be built.

This modelling, analysis and simulation capability can power predictive asset maintenance, support planning decisions and enable performance optimisation.

As an example, a Digital Twin platform can:

- Integrate and prioritise the maintenance needs of transport networks (for example by road and rail) from a spatial perspective to minimise disruption to consumers
- Overlay planned infrastructure on existing infrastructure to show interdependencies and evaluate the optimal timing of investment
- Identify efficiencies in energy use which can be tested across different sectors through simulations.

Through the input of verified data to the Digital Twin platform, it is possible to develop a richer understanding of the way the infrastructure system works.

Applying deep learning techniques can offer extended predictive capabilities, as well as the ability to ask questions of the platform. Integrating supporting data activation capabilities – such as a data exchange or civic data trust – further extends the value of the Digital Twin

And going forward, with the increasing level of data variety, combined with data analytics ‘apps’, the Digital Twin is well positioned to serve government and asset operators in their role of delivering the highest possible level economic and social value.

Realising Digital Twin Success

The Smart Cities Council has identified six foundational areas to help realise Digital Twin success across the region. These areas have been considered to reflect the various levels of governments across Australia and New Zealand.

These are:

1. Policy
2. Governance
3. Standards
4. Strategy
5. Education and Training
6. Research and Development



Without a Roadmap to help advance each of these, a thriving Digital Twin marketplace will be more of an aspiration than a reality. This Guidance Note is not this Roadmap we need, but provides the basis to build one. The Smart Cities Council Digital Twin Task Force and the ANZ Digital Twin Collaborative are two mechanisms that will help achieve these outcomes.

Policy

There is an important need to link Government policy to individual departmental procurement and client behaviours across public and private sector. This is the foundation for comprehensive Digital Twin policy.

All 'in-scope' spending departments need to be encouraged to operate consistently and procure against common standards, methods and protocols. This will create consistent market investment and deliverables. A Digital Twin policy roadmap is underway by the Smart Cities Council.

Governance

To realise the improved value from investing in a Digital Twin program, an effective governance structure will need to be put in place so that risks are managed effectively, and that important activities associated with a Digital Twin program are aligned with the overall business objectives of the organisation.

For example, a governance structure would have an information management and data environment that adequately defines relevant stakeholders, processes, information and technology requirements with a reference point to facilitate data use in line with security, legal, commercial, privacy and other relevant concerns.

Standards

Whilst there are currently no Digital Twin standards in their own right, there are numerous data standards that make up a Digital Twin.

Standards are codified knowledge, and a representation of what ‘good’ looks like. This makes them an essential ingredient to scale Digital Twin opportunities.

From project inception to performance management, standards are a necessary tool. A selection of standards relevant to Digital Twin are reflected in Figure 3 below:



Figure 3: A selection of relevant standards applicable to Digital Twin

Strategy

Depending on your maturity and implementation of Digital Twin practices, the approach listed below in Figure 4 provides a methodology for developing a Digital Twin Roadmap. This approach includes:

- Undertaking a clear strategic assessment of the application of a Digital Twin, including a current state and target state analysis
- Producing a strategic business case
- Providing a delivery strategy
- Producing a full business case
- Developing a detailed implementation and procurement plan.

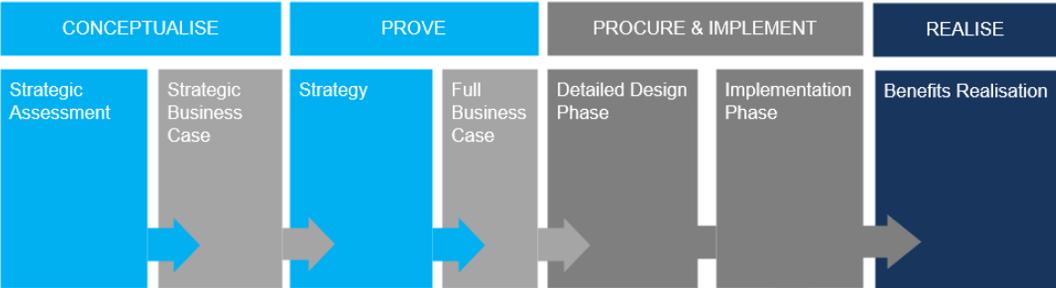


Figure 4: Methodology for developing a Digital Twin Roadmap

Each of these steps is further described in the following pages, and should be used as a guide only and seek to align with existing business practices.

Conceptualise

Strategic Assessment

The purpose of this stage is to understand the current state regarding roles and responsibilities (in relation to information and data), current levels of awareness, knowledge, experience and capability. This is in terms of digital working and information, management, standards, methods, procedures and technology. This information will help understand the current 'as-is' state.

Strategic Business Case

The purpose of the Strategic Business Case stage is to confirm the strategic context of the proposal; to make a robust case for change; and to provide stakeholders and customers with an early indication of the proposed way forward (but not yet the preferred option).

This will be informed by a SWOT analysis (Strengths Weaknesses Opportunities Threats) on a wide range of available options, together with indicative costs.

At this stage, you would typically expect the following components to be included in the Strategic Business Case:

- Strategic Case – This section sets out the rationale for the proposal and makes the case for change at a strategic level. It should set out the background to the proposal and explain the objectives that are to be achieved
- Economic Case – This section assesses the economic costs and benefits of the proposal to a long-list of alternative options. A recommended way forward (including budget) would be provided and an initial recommended shortlist for further examination at Final Business Case stage
- Commercial Case – This section is concerned with issues of commercial feasibility and sets out to answer the question “can the proposed solution be effectively delivered through a workable commercial deal or set of deals?” The first question, therefore, is what procurement does the proposal require, is it crucial to delivery and what is the procurement strategy?
- Financial Case – This section is concerned with issues of affordability, and sources of budget funding. It covers the lifespan of the scheme and all attributable costs. There would also be a discussion of the likely affordability of the proposed scheme
- Management Case – This section outlines the deliverability of the proposal and is sometimes referred to as programme management or project management case.

Prove

Strategy

The purpose of this phase is to undertake enough work to develop a detailed Digital Twin Framework and implementation strategy, and the ability to test this framework upon identified early adopter projects.

Preparing for the work will be required so that project teams are prepared for designing their change management plans.

Organisations will need to also provide the supply chain with support to ensure that all tiers are not disadvantaged by this new program of works.

Outline Business Case

The purpose of the Outline Business Case (OBC) phase is to revisit the Strategic Business Case in more detail and to identify a preferred option which demonstrably optimises value for money. It also sets out the likely deal – ie. it demonstrates its affordability, details the supporting procurement strategy and provides relevant management arrangements for the successful rollout of the scheme.

At this stage, you might expect to see the following undertaken:

- the Strategic Case – revisited
- the Economic Case – completed
- the Commercial Case – outlines envisaged deal structure/s and key contractual clauses and payment mechanisms
- the Financial Case – contains a detailed analysis of affordability and any funding gaps
- the Management Case – develops in more detail how the scheme will be delivered with an outline of the proposed programme/project management plan and if ITC is involved in accordance with the appropriate methodology i.e. PRINCE2, Agile.



Procure & Implement

Detailed Design

This takes place within the procurement phase of the project, following detailed negotiations with potential service providers/suppliers prior to the formal signing of contracts and the procurement of goods and services. This is usually the stage at which final business approval is required.

The purpose of this phase is to revisit the OBC and record the findings of the subsequent procurement activities, together with the recommendation for an affordable Digital Twin solution which continues to optimise value for money, and detailed arrangements for the successful delivery of required goods and implementation of services from the recommended supplier/s.

At this stage, you might expect:

- the Strategic Case – revisited and revised if required
- the Economic Case –the findings of the procurement included in the analysis, and recorded
- the Commercial Case – the recommended Deal written-up
- the Financial Case – affordability and funding issues resolved
- the Management Case – the detailed plans for delivery and arrangements for the realisation of benefits, management of risk and post evaluation are recorded.

Implementation

The purpose of this phase is to progressively implement the Digital Twin program as per the Digital Twin Framework.

Realise

The purpose of this phase is to include activities related to embedding Digital Twin so that it becomes business-as-usual and that support structures are in place to ensure that the new ways of working are followed.

The program of lessons learned, commenced during the early adopter projects, should be continued so that challenges that arise to the new ways of working are addressed.

As the new ways of working become business-as-usual, a program of measurement of the required benefits needs to be undertaken, not only to justify the program expenditure but also to drive continual improvement.



Education and training

To take advantage of and realise the benefits of the Digital Twin, it is necessary that we build greater technology and data literacy among built environment policy makers and practitioners alike.

The Smart Cities Council Digital Twin Task Force will be developing a Digital Twin Skills Framework, to help government and industry navigate the key attributes and issues relevant to Digital Twin capability.

It is anticipated that key areas of awareness and competency will include the following categories:

- Introductory/Foundational
- Information and Data Management
- Technology Platforms
- Digital Twin Functionality
- Value Creation
- Procurement and Implementation
- Policy and Leadership.

In developing the skills framework, the Task Force will consider the various types of education that may be relevant, ensuring that the maximum number of stakeholders can access opportunities for furthering their knowledge and skills. This will include on-line and in-person options, as well as the type of learning (self-paced, group work, assessment-based etc).

Research and development

Ensuring the industry has a strong pipeline of research projects is critical to ensure Digital Twin technology and capability in Australia and New Zealand is world leading and delivers the best possible impact for citizens.

The SCCANZ Digital Twin Task Force will work with SCC's broader Digital Twin Collaborative initiative – a regional network of Digital Twin stakeholders across government, industry and academia – to identify areas of research and innovation that should be advanced.

With more than four universities involved in the Inaugural Digital Twin Symposium in Sydney in November 2019, there is strong interest from research institutions to engage deeply in the Digital Twin agenda.

The SCC Digital Twin Task Force has commenced a program of work for 2020, and includes capability mapping, technology functionality, data leadership and policy impact. With this, we believe there is a foundation for the creating a national and regional Digital Twin research agenda across Australia and New Zealand.



Next Steps

The Smart Cities Council has identified three immediate opportunities for further industry, government and academic engagement in supporting the creation of a Digital Twin marketplace in the region, namely:

1. Educate yourself, understand the benefits and align your data and information management strategy with Digital Twin opportunities – head to the ANZ Digital Twin Hub to join the Digital Twin community, download resources and engage in real time discussions.
2. Engage with credible Digital Twin education, networking and research opportunities, such as Digital Twin Week 2020 (October 19-23) - refer www.scwaustralia.com
3. Develop and implement a Digital Twin strategy for your organisation.

Additional Resources

The Australia New Zealand Digital Twin Hub provides a range of resources for policy makers, practitioners and researchers alike.

It is accessible at - <https://www.digitaltwinhub.org/>

It includes the following:

- A '**Fundamentals**' section, which provides an overview of the what, why and how of Digital Twin
- A '**Forum**', where stakeholders can join a community of peers and exchange questions and comments
- A '**Blog**', where articles and news items will be published by the Hub Administrator's
- A '**Resources**' library, where key downloadable resources and links will be posted.

We thrive on feedback and would welcome your comments to help make this work as impactful as possible. Please contact us at anytime.

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