cdbb
Centre for Digital Built Britain

The Gemini Principles

Digital twins of physical assets are helping organisations to make better-informed decisions, leading to improved outcomes.

Creating an ecosystem of connected digital twins – a national digital twin – opens the opportunity to release even greater value, using data for the public good.

To make this possible an information management framework is necessary. This paper sets out proposed foundational definitions and guiding values for the framework – the Gemini Principles.

Play a part in shaping our digital future

All involved in creating and managing the built environment stand to benefit by driving effective information management. Industry leaders must act as champions and get involved, unlocking value for their own organisations, the national economy and society.

There is both opportunity and risk. The fourth industrial revolution is starting to affect all industries involved in the built environment. Those that play an active part can help to guide the direction of travel and the outcomes; those thatignore it could find themselves left behind or losingcontrol. If you lead in planning, creating and managing the built environment you are invited to play a part in:

- Building consensus on the Gemini Principles
- Co-developing and implementing the
- framework
- Developing digital twins that comply
- with the Gemini Principles

Engage and join the conversation.

Please share comments on the Gemini Principles:
enquiries@cdbb.cam.ac.uk

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Gemini: the Latin for ‘twins’ and, in astronomy, a northern constellation containing the bright stars Castor and Pollux.

This paper is the first deliverable from the Digital Framework Task Group, part of the Centre for Digital Built Britain.

It starts to address the key recommendations in the National Infrastructure Commission’s report **‘Data for the public good’.**

Digital twin

A digital twin is a realistic digital representation of assets, processes or systems in the built or natural environment.

Based on data from a physical asset or system, a twin unlocks value by supporting improved decision making, which creates the opportunity for positive feedback into the physical twin.

A digital twin must represent physical reality at a level of accuracy suited to its purpose. The extent of realism depends on three essentials:

- **Data** – the quality of the data on which the twin is based.
- **Model** – the fidelity of the algorithms, the validity of the assumptions and the competence of the code at the heart of the digital representation.
- **Visualisation** – the quality of presentation of the output.

Digital twins can be used for many purposes:

a. Potential futures: Strategy and planning support, running 'What if?' scenarios, predictive and preventive maintenance regimes
b. Current state: Intervention management (operation and maintenance interventions or capital investment projects), real-time status monitoring and control, diagnostics and prognostics to optimise performance and safety of assets
c. History: Record-keeping and learning from the past

Digital twins may address a variety of spatial scales:

a. Asset or building scale
b. Network or neighbourhood scale
c. System, city or regional scale
d. National scale

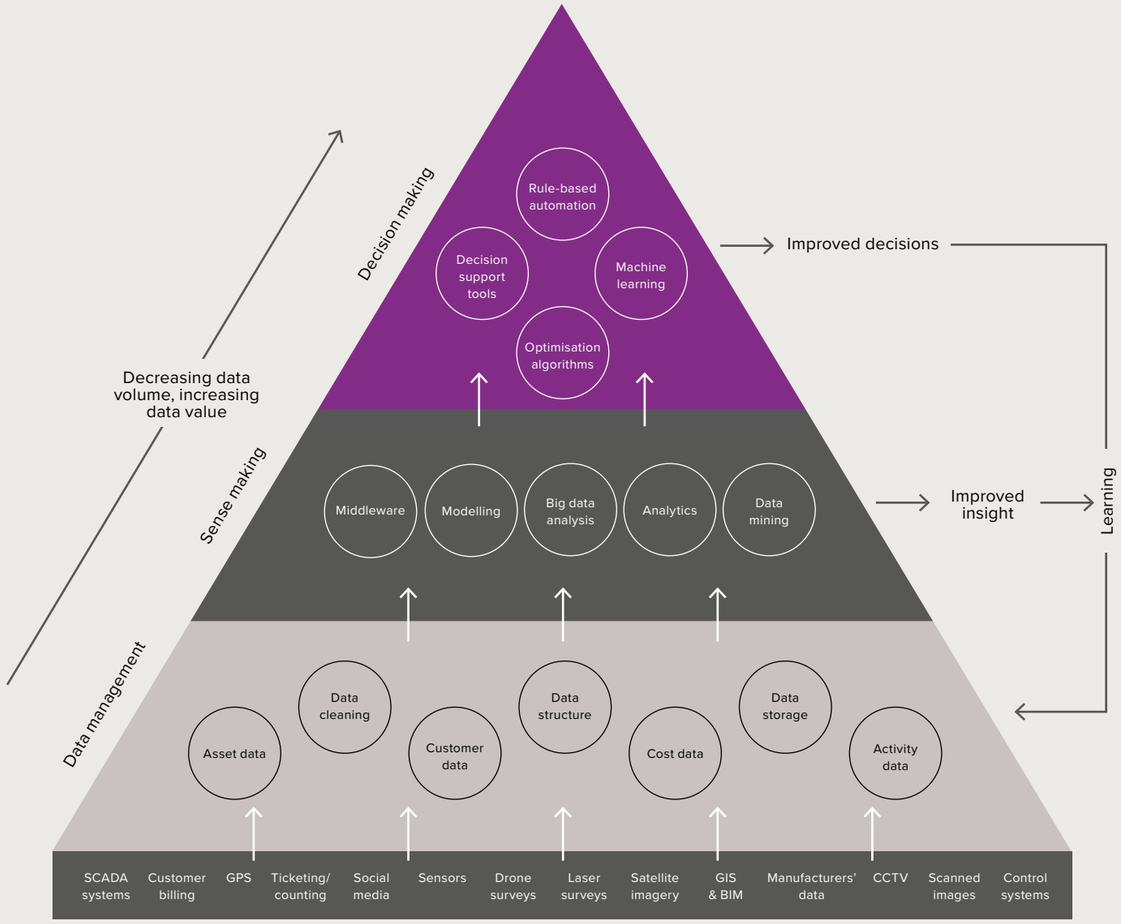
Digital twins may represent any point in the lifecycle of assets, processes and systems, be static or dynamic, and address different temporal scales:

a. Operational timescale
b. Reactive maintenance timescale
c. Planned maintenance timescale
d. Capital investment timescale

Digital twins may use different approaches to modelling:

a. Geometric and geospatial modelling
b. Computational/mathematical/numerical modelling
c. Artificial intelligence and machine learning; 'learning systems'

The information value chain: showing the connection between data and better decisions that lead to better outcomes.[4]



National digital twin

An ecosystem of digital twins connected via securely shared data.

The NDT will enable better use, operation, maintenance, planning and delivery of national and local assets, systems and services.

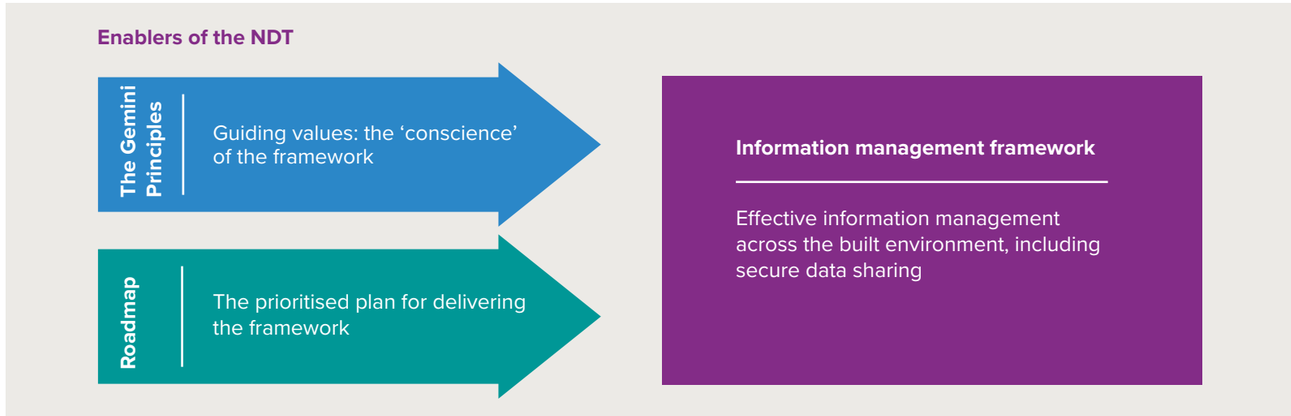
The vision for the national digital twin (NDT) is not that it will be a huge singular digital twin of the entire built environment. Rather, it is envisaged to consist of ‘federations’ of digital twins joined together via securely shared data.

Not all digital twins will be connected, only where it delivers value to do so.

Digital twins can be connected in many ways for a variety of purposes. Therefore, the ecosystem could consist of numerous federations of digital twins. The NDT would become more diverse and interconnected over time.

However, the NDT would never become ‘fully federated’ because there would be limited value in connecting every digital twin to every other digital twin. Nor would it ever be ‘completed’, just as the built environment will never be completed.

- Benefits to society: Improved stakeholder engagement. Better outcomes for the ultimate customers (the public – taxpayers/bill payers/fare payers/voters). Improved customer satisfaction and experience through higher-performing infrastructure and the services it provides.
- Benefits to the economy: Improved national productivity from higher-performing and resilient infrastructure operating as a system. Improved measurement of outcomes. Better outcomes per whole-life pound. Improved information security and thereby personnel, physical and cyber security.
- Benefits to business: New markets, new services, new business models, new entrants. Improved business efficiency from higher-performing infrastructure. Improved delivery efficiency, benefiting the whole construction value chain – investors, owners, asset managers, contractors, consultants, suppliers. Reduced uncertainty and better risk management.
- Benefits to the environment: Less disruption and waste. More reuse and greater resource efficiency – a key enabler of the circular economy in the built environment.



Information management framework

Enabling effective information management across the built environment.

The information management framework is intended to establish the necessary building blocks to enable effective information management across the built environment. This includes the secure data sharing that is fundamental for enabling the national digital twin.

The framework will support the creation of an ecosystem of connected digital twins across the built environment. By complying with the framework, built environment data will be potentially shareable, but it will not necessarily be shared. Data will be shared only when it delivers value and it is appropriate and safe to do so.

Organisations will be able to comply with the framework without their data being part of the NDT. But it will be to their advantage to pursue compliance because they can benefit from other digital twins if their own are compatible.

The information management framework is guided by the Gemini Principles.

The Gemini Principles

Guiding development of the framework and the NDT.

Click below to find out more.

Purpose:
Must have clear purpose

- **Public good**
  Must be used to deliver genuine public benefit in perpetuity
- **Value creation**
  Must enable value creation and performance improvement
- **Insight**
  Must provide determinable insight into the built environment

Trust:
Must be trustworthy

- **Security**
  Must enable security and be secure itself
- **Openness**
  Must be as open as possible
- **Quality**
  Must be built on data of an appropriate quality

Function:
Must function effectively

- **Federation**
  Must be based on a standard connected environment
- **Curation**
  Must have clear ownership, governance and regulation
- **Evolution**
  Must be able to adapt as technology and society evolve

Roadmap for delivering the information management framework