Demystifying the Digital Twin

Bridging the Gap Between Design and Asset Management

Demystifying the Digital Twin

AGENDA

- Application Overview
- Implementation Basics
- Case Studies

A glimpse into the future…

What is a Digital Twin?

A virtual replica of a physical product, process, or system.

A bridge between the physical & digital worlds, using sensors to collect real-time data about a physical item.

This data is then used to create a digital duplicate of the item, allowing it to be understood, analyzed, manipulated, or optimized.

Other terms include virtual prototyping, hybrid twin technology, virtual twin, and digital asset management.

Integrate artificial intelligence (AI) & machine learning (ML) to bring data, algorithms, and context together.

Enable organizations to test new ideas, uncover problems before they happen, get new answers to new questions, and monitor items remotely.

WHAT IS A DIGITAL TWIN?

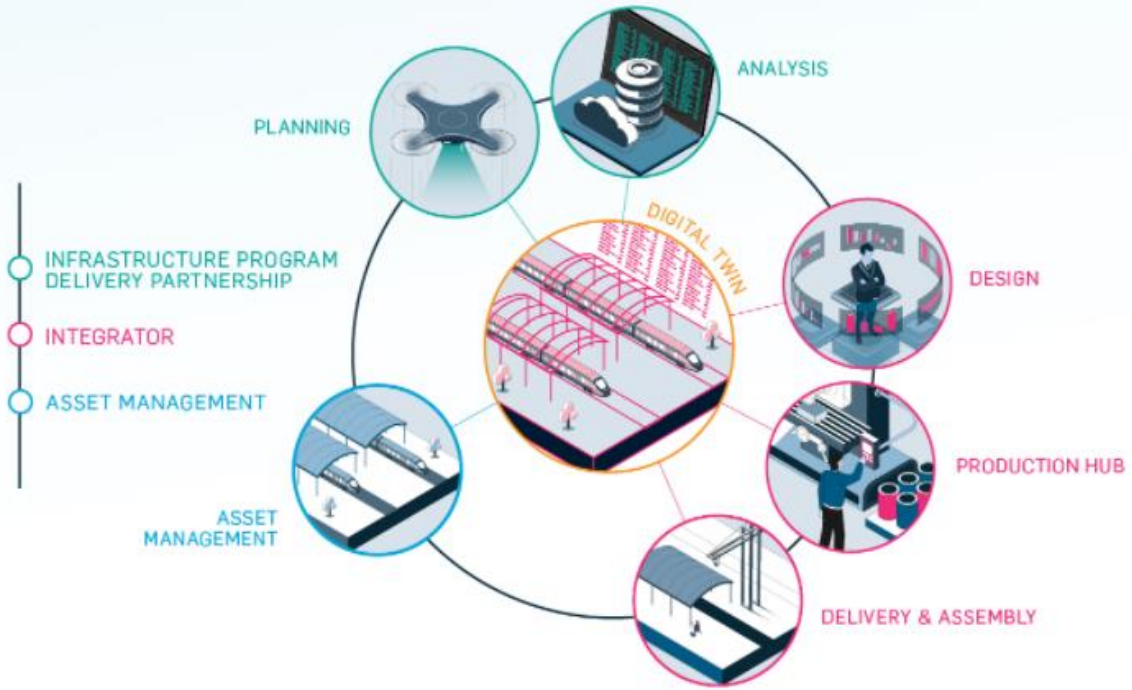
Our industry is facing numerous challenges as it looks to increase the predictability of project delivery and the whole life value of assets, while reducing costs and its carbon footprint. By connecting people, data and technology, we're helping to lead a digital transformation which will see digital twins playing a pivotal role in shaping a more productive future.

A digital twin is a virtual representation of a physical asset that provides the data connection between the virtual and physical asset, enabling its user to make data-driven and informed decisions about an asset-related task or activity throughout its lifecycle.

More than just a 3D or a BIM model, digital twins provide context to the relationship between the asset and its environment, providing the means to monitor, control and optimize the physical asset in a timely manner.

COMPRISED OF TWO CORE COMPONENTS:

1. A virtual representation of the physical asset – this could be very simple or highly sophisticated, depending on user requirements.
2. A data connection between the physical and virtual worlds – the degree of this connection indicates the maturity of the twin, ranging from no data connection for simple 3D survey capture, to live streamed sensor data to enable autonomous asset operation.



How are Digital Twins being used?

Improving complex business processes – building ***predictive models*** and simulations.

Traditionally used to improve the performance of single assets, such as wind turbines/engines.

Now, they connect not just one asset but rather systems of assets or even entire organizations.

As they bring together more and more assets and combine them with information about processes and people, their ability to help solve complex problems is increasing.

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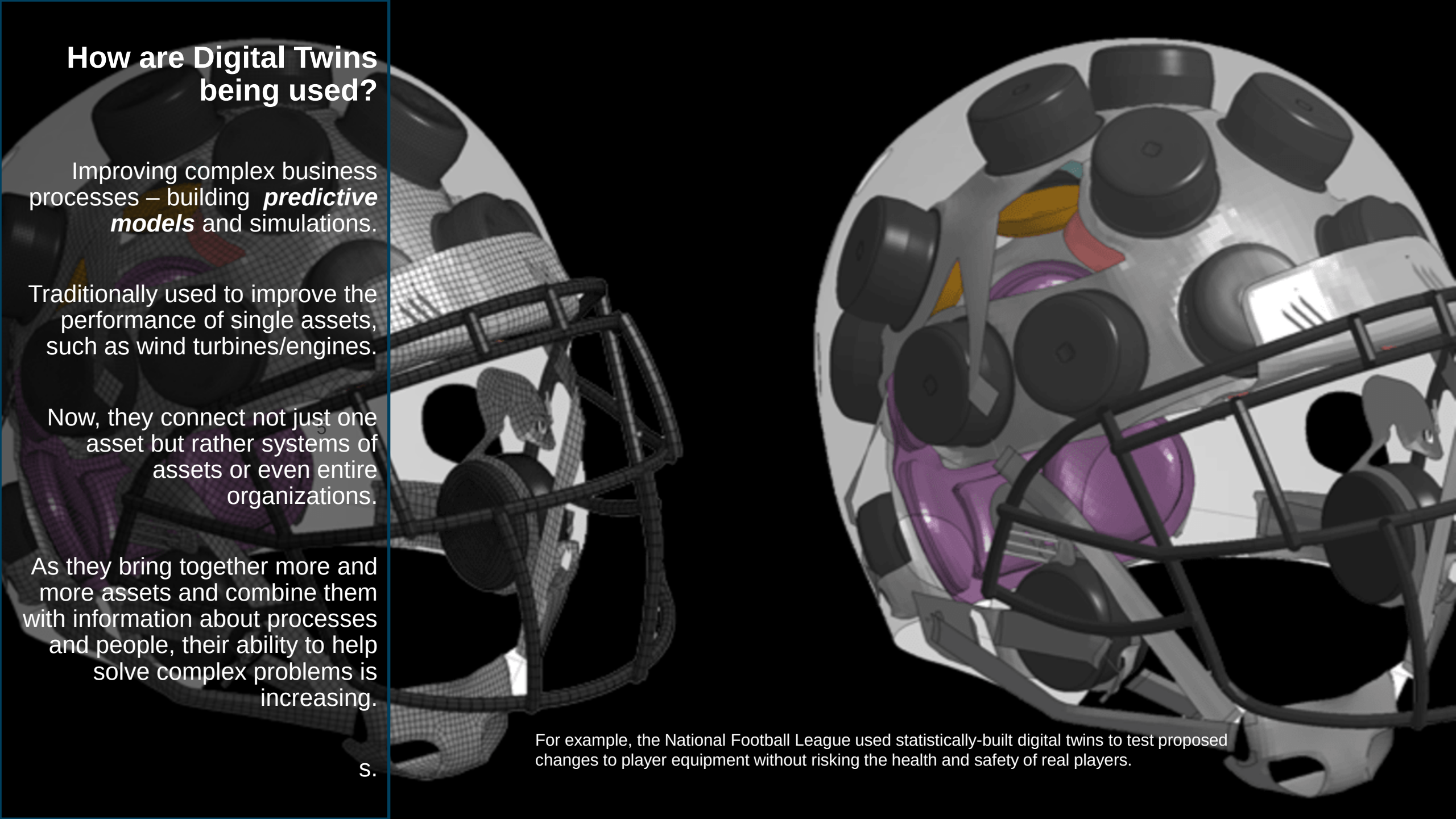


For example, the National Football League used statistically-built digital twins to test proposed changes to player equipment without risking the health and safety of real players.

Use in Commercial Real Estate

Building operators bring together previously unconnected systems.

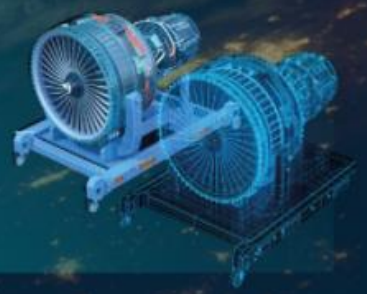
Security, monitoring, HVAC, wayfinding systems provide new insights, optimize workflows, and monitor processes remotely.

Occupant control over spaces & environmental conditions, enhancing the user experience.

By optimizing systems and connecting people - reduce costs, avoid future costs, increase utilization, improve overall asset performance & value.

TRANSFORMATIVE BENEFITS

AN EFFECTIVE DIGITAL TWIN WILL INCREASE THE WHOLE-LIFE VALUE OF ASSETS THROUGH:



Increased productivity and collaboration

Vital information about the built asset can be stored and analyzed throughout its lifecycle and kept current, unlocking unparalleled collaboration across teams and stakeholders.

Optimized asset performance and sustainability

Operational and occupational data can be monitored and analyzed in real-time, providing valuable insights on how the asset is used and currently performing.

Reduced construction and operating costs

Virtual scenarios on construction sequencing and logistics can be run and visualized, familiarizing workers with required tasks and reducing costly re-works. During operational stages, predictive analytics enables targeted maintenance, reduces downtime, optimizes asset performance and reduces whole-life costs.

Improved safety

Improved design consideration, site accessibility, construction staging and maintenance access leads to better safety outcomes and reduced risk.

Minimizing impact on the planet and the climate

Insights on asset performance and associated carbon usage allow unique opportunities to target initiatives to achieve Net Zero objectives.

Here to stay?

Trends suggest that we're on the verge of a digital twin explosion.

Research by **Gartner** has found that 48 percent of organizations using IoT are also using or plan to use digital twins in 2018.

50% of large manufacturers have at least one digital twin initiative launched by 2020. Will triple by 2022.

Digital twin technology integrates sophisticated IoT sensors, AI, and machine learning, to solve difficult challenges.

Powered by high-performing databases that can pull together and process many data sets in real-time.

Computing speed, power, cost
Mining/Interpreting Big Data
IoT
AI
Machine Learning
Augmented Reality

Digital Twin Future?

Remarkable possibilities at the organizational level in the built environment.

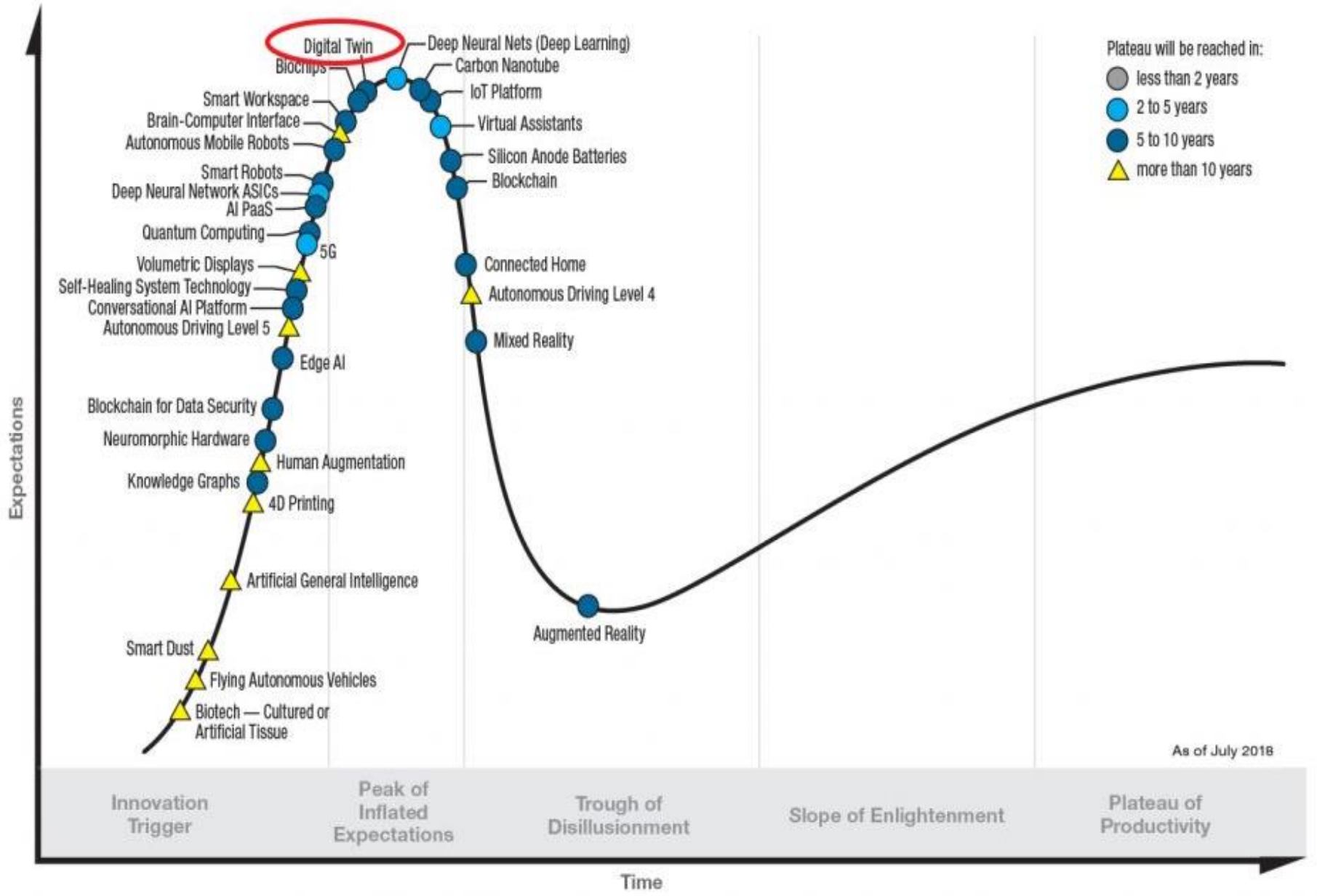
Improve efficiencies, optimize processes, detect problems before they occur, and innovate for the future.

Afford operators and designers detailed, intricate views of physical assets – remotely.

Unprecedented control over information, activation, & visualization.

Facilitates better decision-making.

Gartner “Hype Cycle” for Emerging Technologies, 2018



Digital Twin Future?

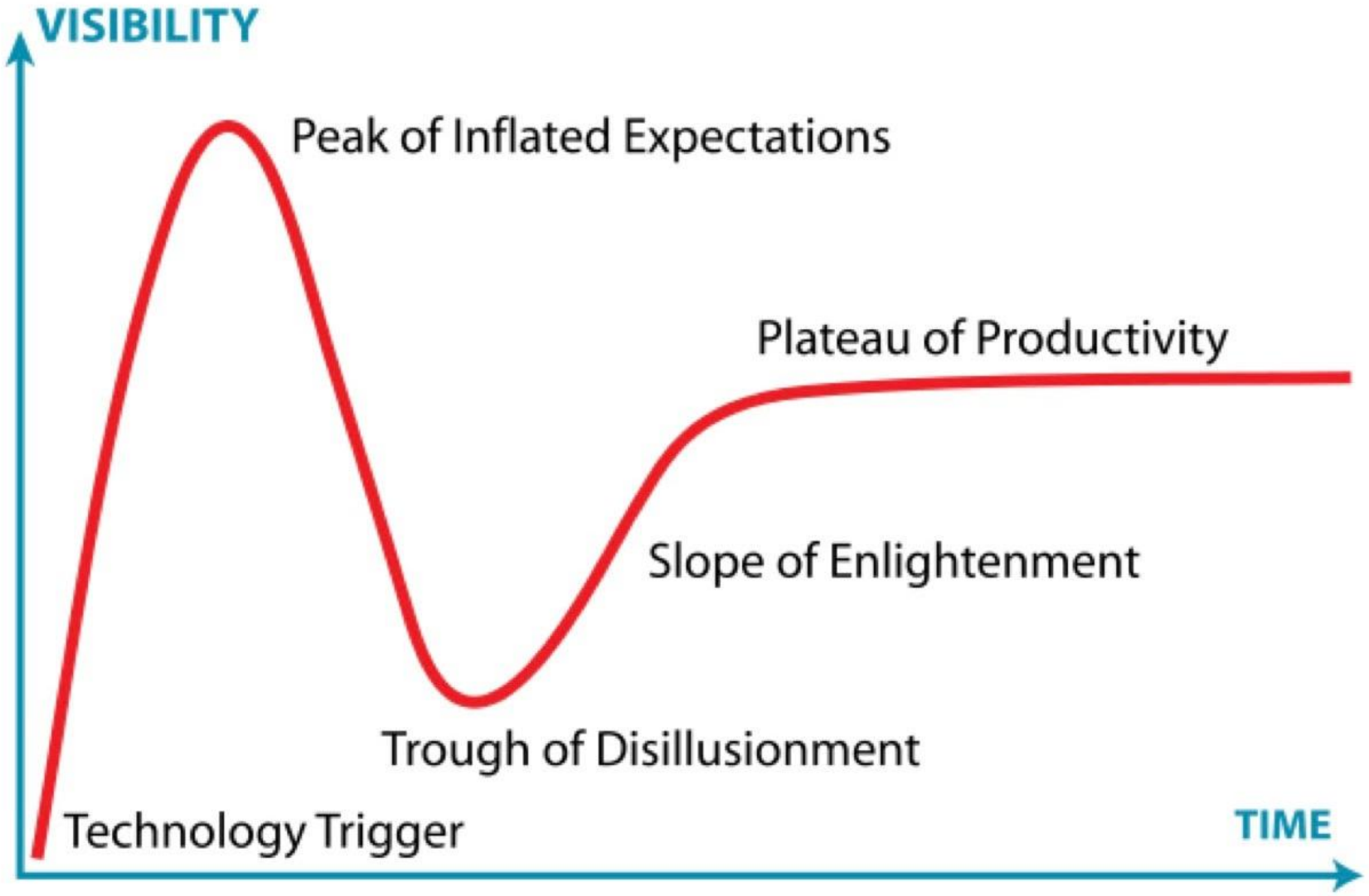
Helping organizations stay ahead of digital disruption by understanding changing preferences, customizations and experiences.

Cognitive digital twins move beyond human intuition to design and refine future machines.

The campus is a machine for community.

DT's fill the gap between construction modeling and digital futures that facilitate smart campus management.

Gartner "Hype Cycle"



Campus Planning?

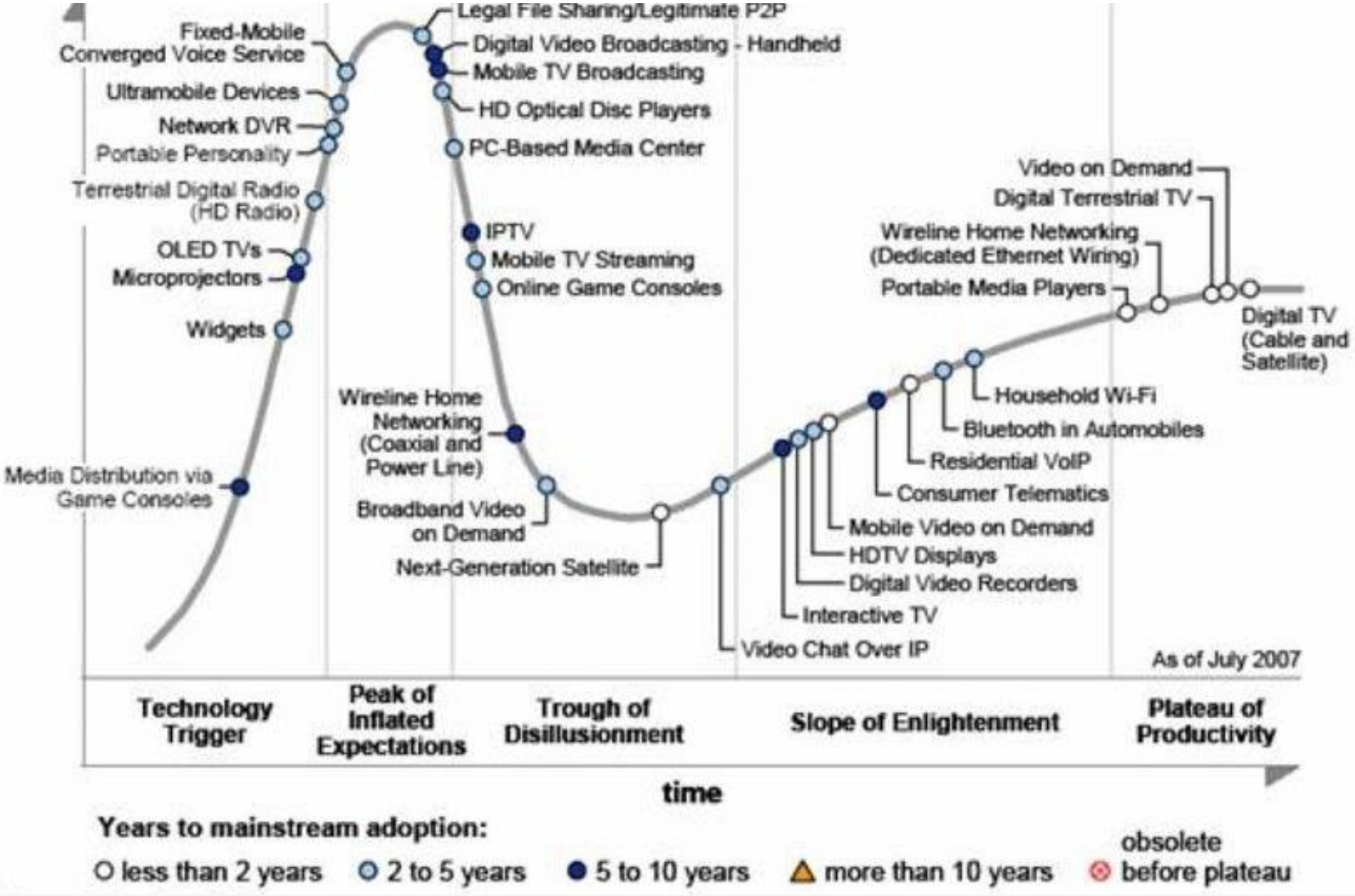
Geographic digital twins have been popularized in urban planning in the Smart Cities movement.

Interactive platforms capture and display real-time 3D and 4D spatial data in order to model urban environments (cities) and the data feeds within them.

AR can be used to create augmented reality maps, buildings, and data feeds projected onto tabletops for collaborative viewing.

Digital twins of built assets are seen as a logical extension at an individual asset level and even at a national level in the UK.

Gartner “Hype Cycle” for Consumer Technologies, 2007



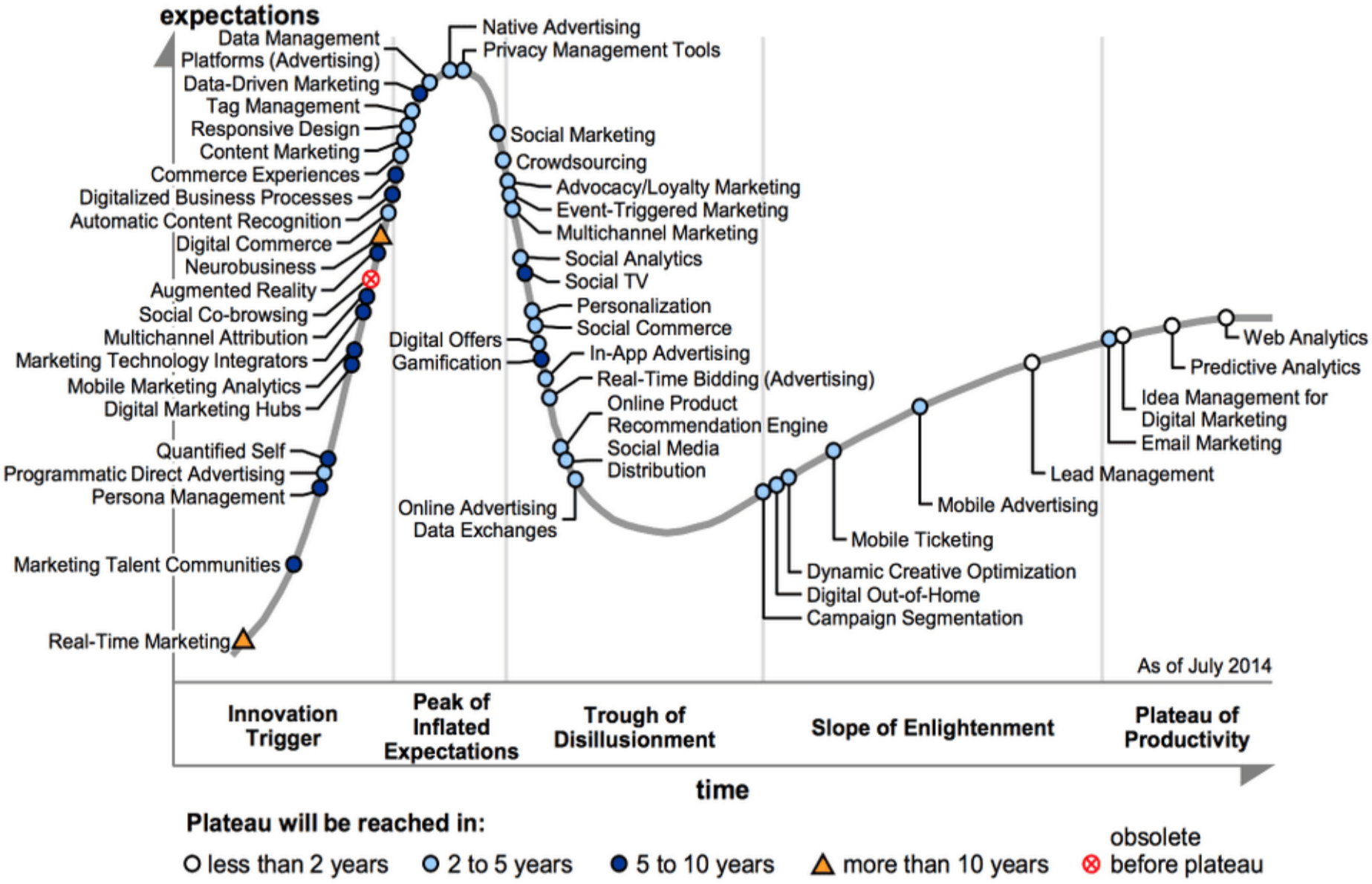
Campus Planning?

Combining big data analytics with reality modeling establishes the digital twin campus...

…which displays various levels of temporal and spatial data needed to manage a building's facilities efficiently in a unified dashboard.

Allows facilities managers to operate and troubleshoot systems from remote locations, improving productivity and comfort of building occupants and eliminating energy waste.

Gartner "Hype Cycle" for Marketing Technologies, 2014



Intelligent 3D Data

Intuitive access to asset information.

IoT sensor data feeds the model, environmental status is current.

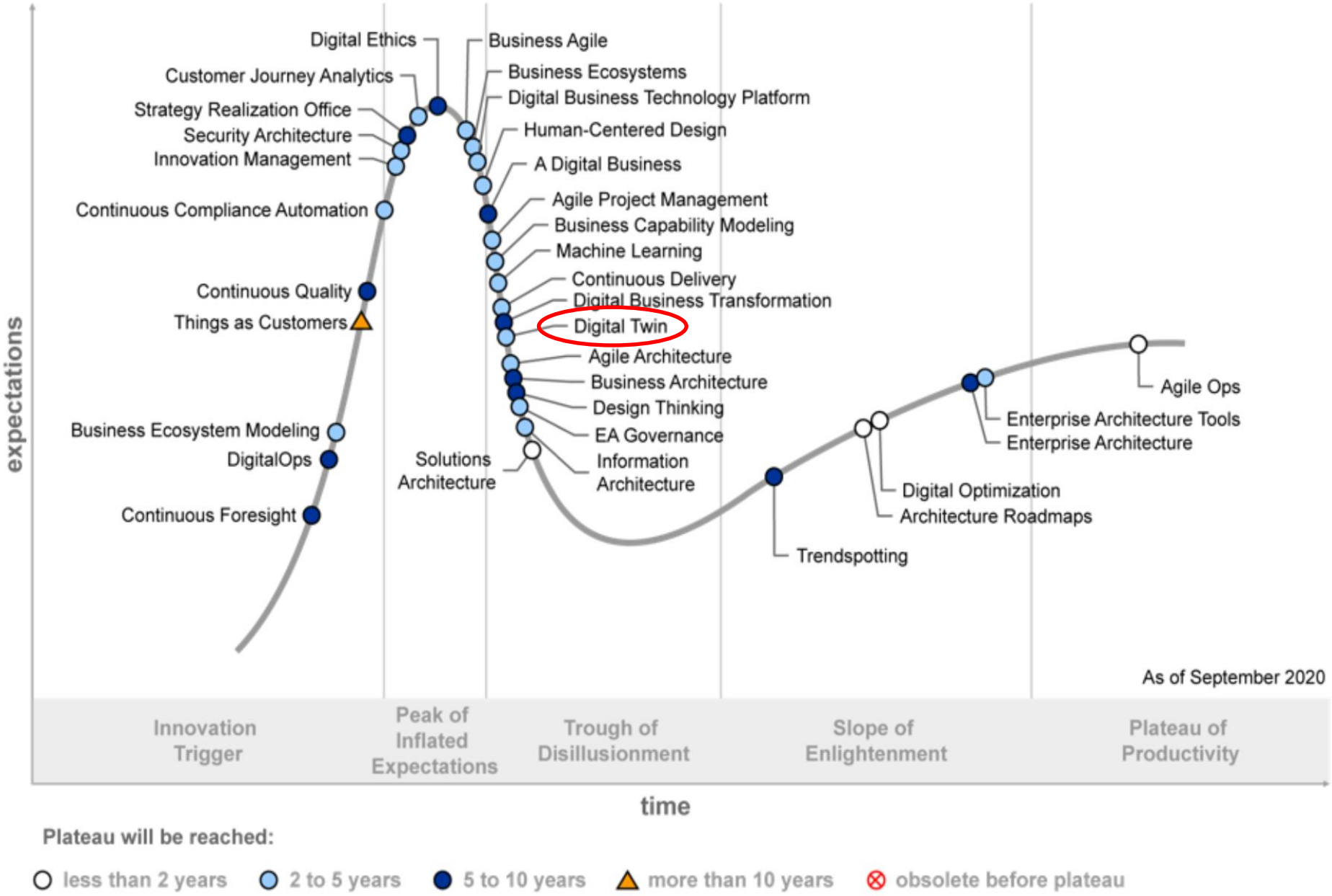
Real-time visibility of utilization, equipment status, utilities, devices, construction, and maintenance.

Optimization for temporary conditions, including safe routing for pedestrians, traffic, and autonomous vehicles.

Enhances signage, wayfinding, digital brand presentation & consistency.

Increased maintenance efficiency.

Gartner “Hype Cycle” for Enterprise Architecture, 2020

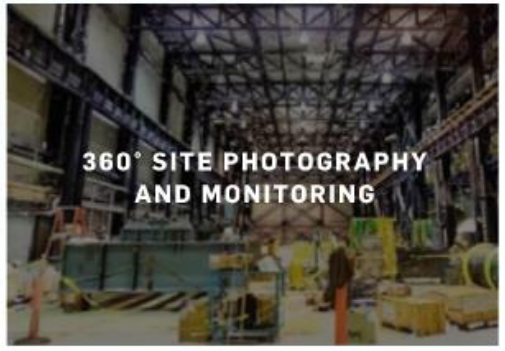


SURVEY AND REALITY CAPTURE

Our experts are at the forefront of integrating geospatial information applications and software solutions that allows the mapping and analysis of a spectrum of spatial data to reduce and eliminate the need for site visits.

Our service encompasses the entire data lifecycle; capturing data from satellite imagery and aerial photography, digitising information from existing maps and plans, collecting data in the field and using digital image correlation and ultra-high definition photography to determine deflections and strains in structures.

Once captured, using computer gaming engines, our experts manage the immense fields of data to create computer simulated augmented reality visualisation of the physical environment that allow users to interact with the asset in a safe environment.



From Micro to Macro

A realistic digital representation of assets, processes or systems in the built environment that adds social and economic value by augmenting decision processes.

Ideally able catalog information and to mimic the dynamics of real-world elements.

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All functionalities, internal mechanics, simulated behaviors.

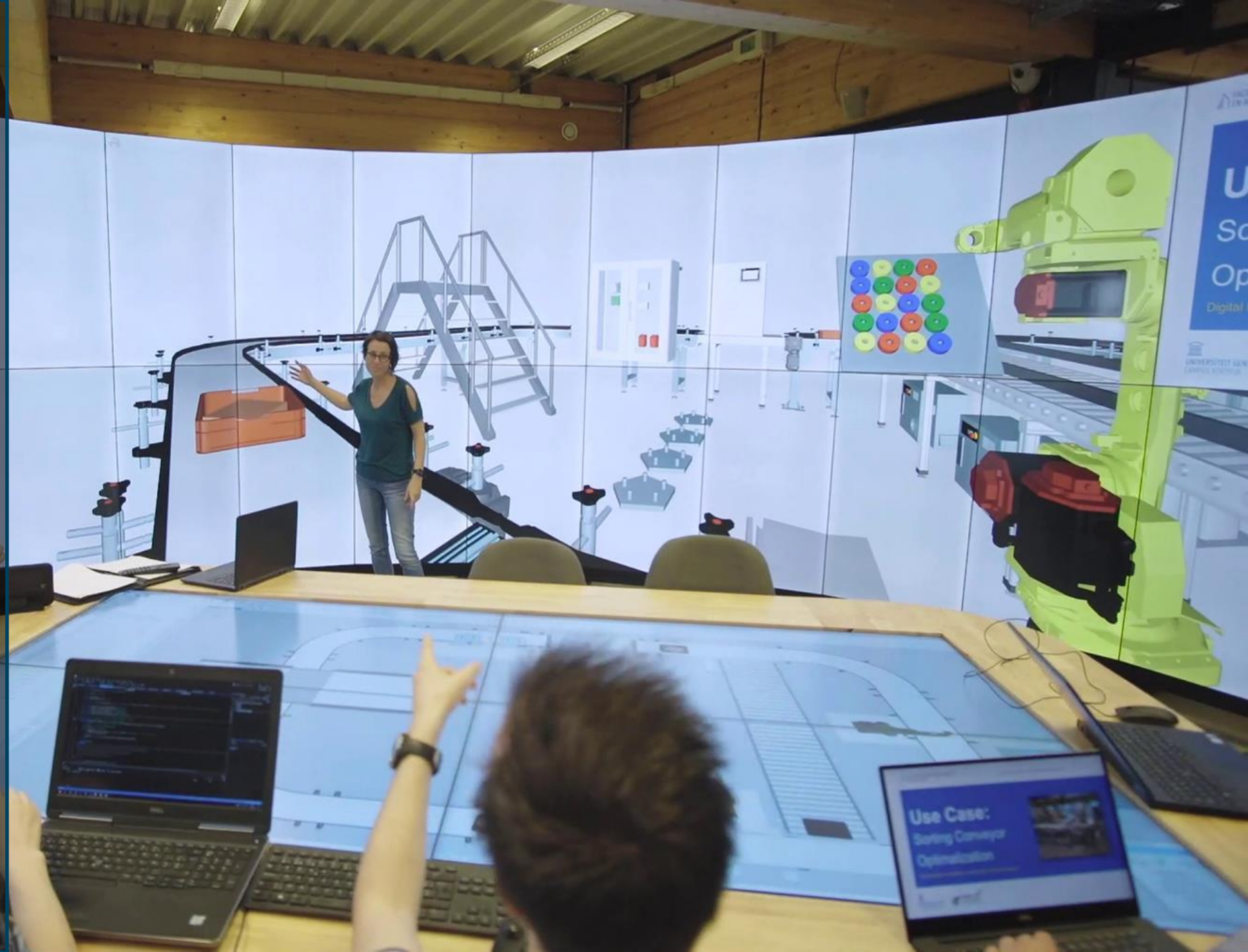
Relationship with environment throughout the entire lifecycle.

Diverse scales of digital twins, from asset fabrications, to buildings, to precincts, to communities & cities.

From Micro to Macro

With the advent of the IoT, digital twins can monitor for desired state and act when a desired state is not reached.

Digital twins are created in the BIM environment.



Challenges?

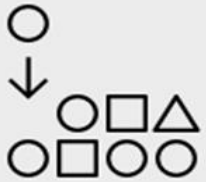
Interoperable DT’s required across entire networks & supply chains.

Challenges involve globalization, new sharing & interoperability capabilities.

Managing all data for digital twin among partners as systems evolve will be a challenge.

Genuine value requires a holistic approach to store, manage and manipulate digital data.

Need for a robust industry change management process to ensure accurate maintenance and alignment of virtual and physical configurations.



Component twins/Parts twins

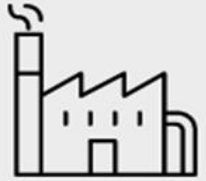
Component twins are the basic unit of digital twin, the smallest example of a functioning component. Parts twins are roughly the same thing, but pertain to components of slightly less importance.

Asset twins

When two or more components work together, they form what is known as an asset. Asset twins let you study the interaction of those components, creating a wealth of performance data that can be processed and then turned into actionable insights.

System or Unit twins

The next level of magnification involves system or unit twins, which enable you to see how different assets come together to form an entire functioning system. System twins provide visibility regarding the interaction of assets, and may suggest performance enhancements.



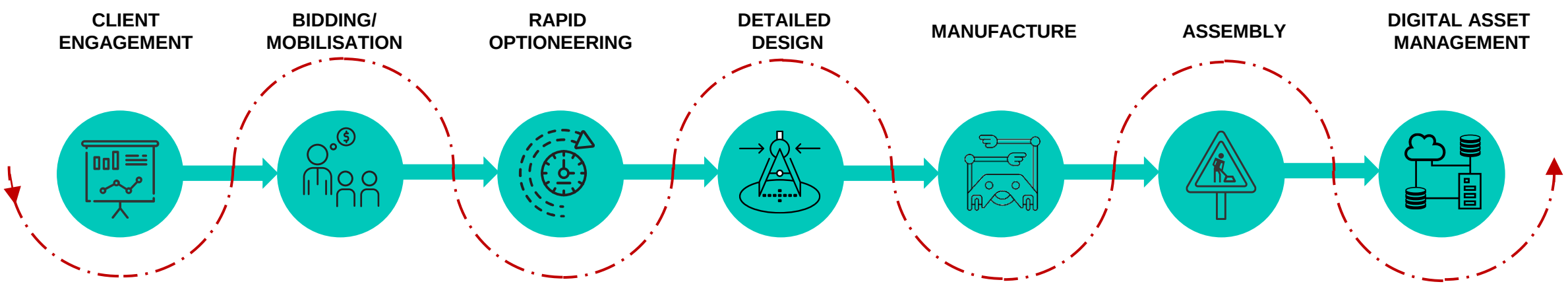
Process twins

Process twins, the macro level of magnification, reveal how systems work together to create an entire production facility. Are those systems all synchronized to operate at peak efficiency, or will delays in one system affect others? Process twins can help determine the precise timing schemes that ultimately influence overall effectiveness.

Implementation Basics

Bridging the Gap Between Design and Asset Management

Lifecycle of delivery – continuous flow



Employers Information Requirements

Digital BIM Execution Plans

Generative Design

Model Based Design

Offsite/3D manufacture

On site Data collection

Data Requirements

Digital Survey

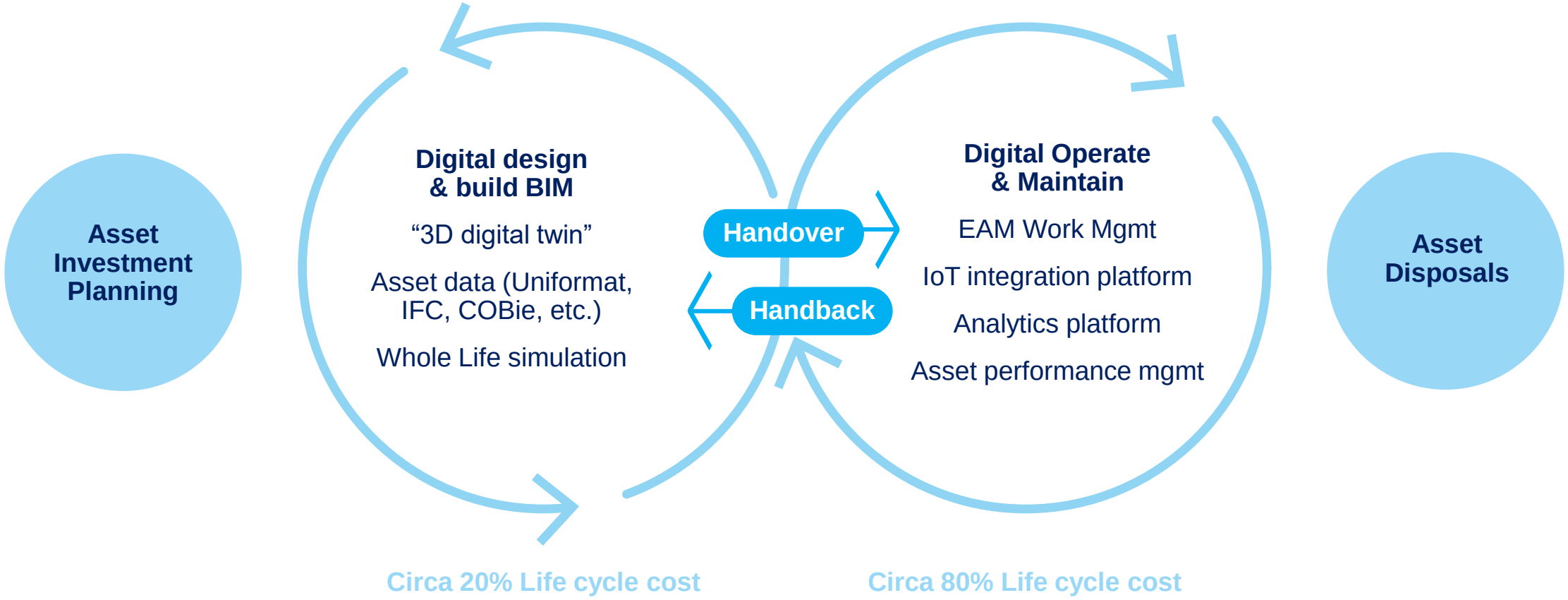
Data Lake, Common Data Environment

Digital Twin

Digital Rehearsal

Digitally enabled project management

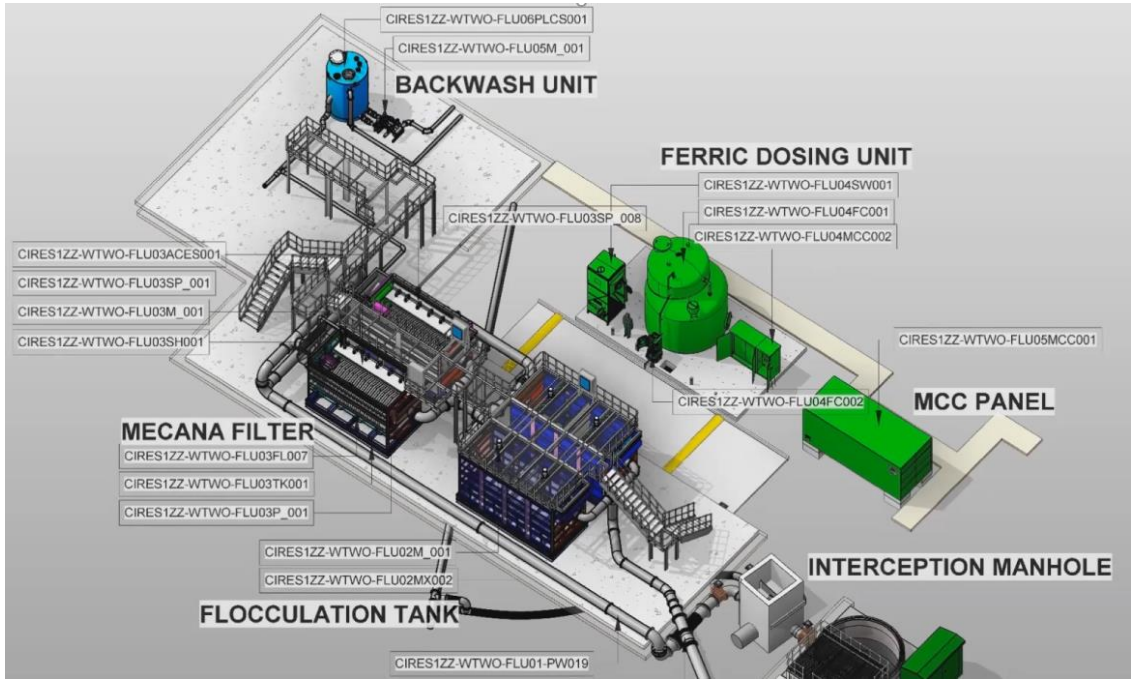
Positioning Digital Asset Management Across The Lifecycle



What is a BIM (Building Information Model)?

As first defined in the National BIM Standard-United States® (NBIMS-US™), a BIM “is a digital representation of physical and functional characteristics of a facility.

As such, it serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life cycle from inception onward.”



National Institute of BUILDING SCIENCES

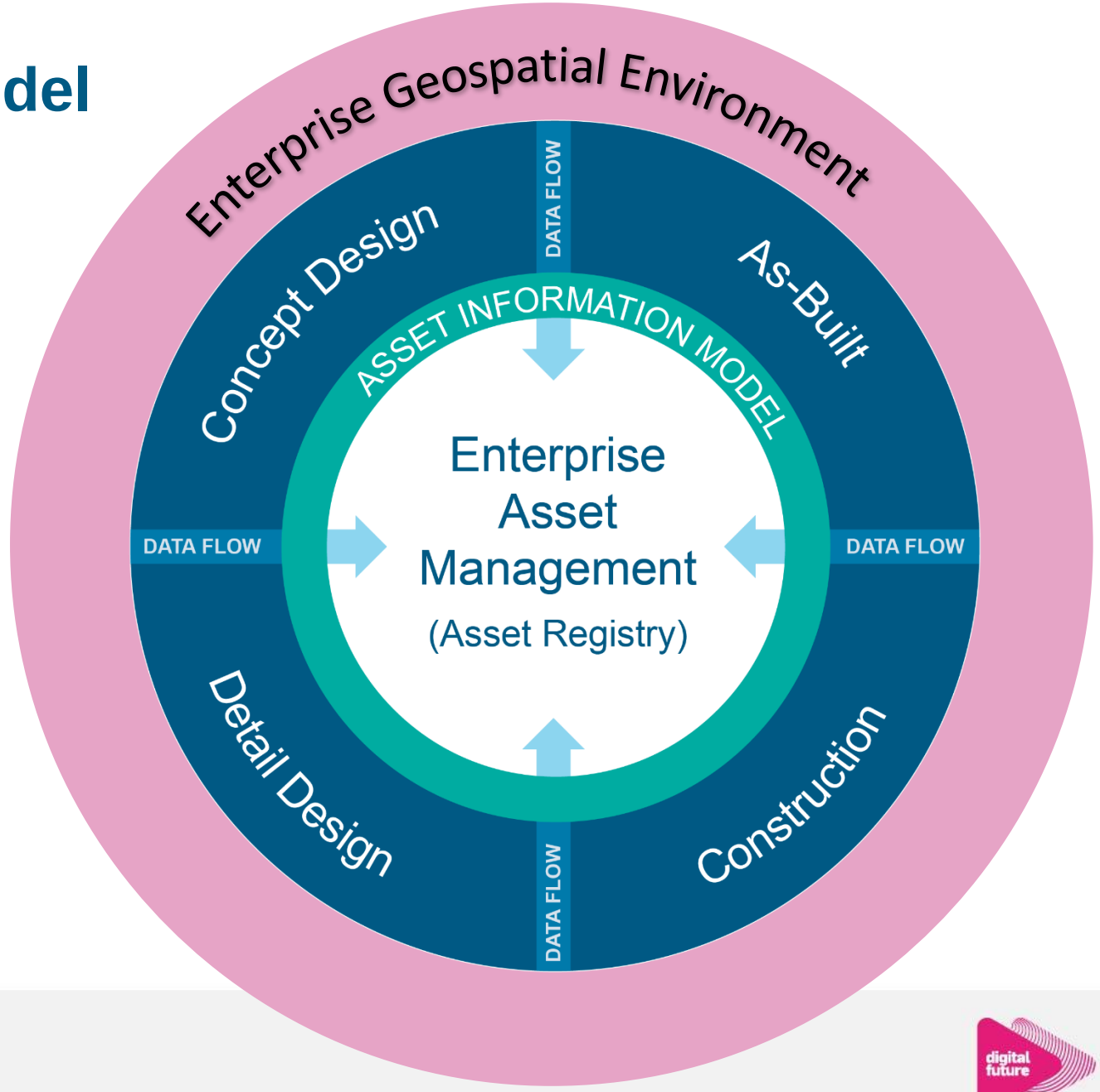
buildingSMARTalliance®

National BIM Standard-United States®

The Asset Information Model

The Asset Information Model matures over time.

It plays a critical role in translating and managing data requirements of the Enterprise Asset Management System.



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What Information Is Collected? And How?

Types of Data

- Geometric Data
- Parametric Data
- Field Data
- Operation and Maintenance Data

Types of Collection

- BIM Authoring Software
- Custom Spreadsheets
- COBie
- FM/Work Order/CMMS Software

COBie Carl Can’t Find It

As Constructed Info

- Hard Copies, Prints, Plans
- “Digital” PDF’s
- 2D CAD Files

O&M Manuals

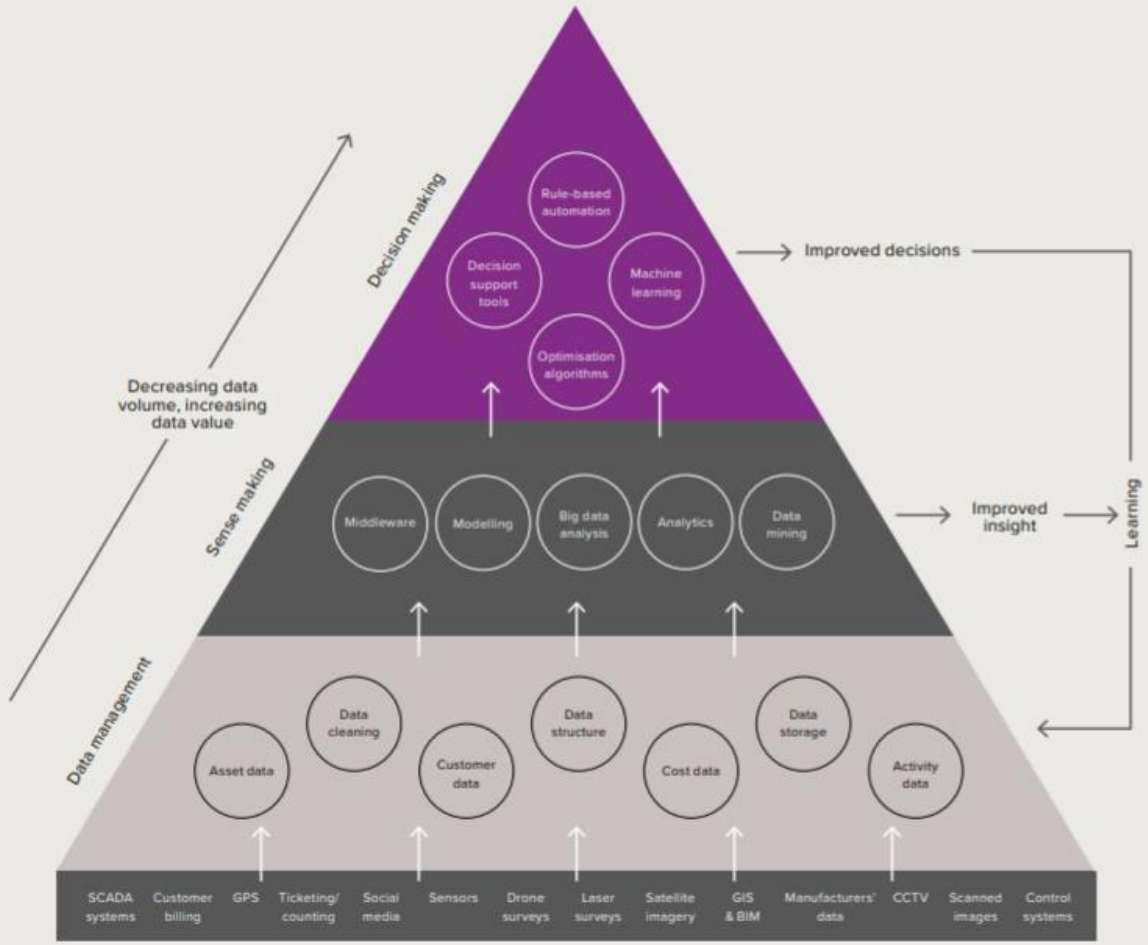
- Binders & Boxes
- “Digital” PDF’s

The Gemini Principles

The Gemini Principles

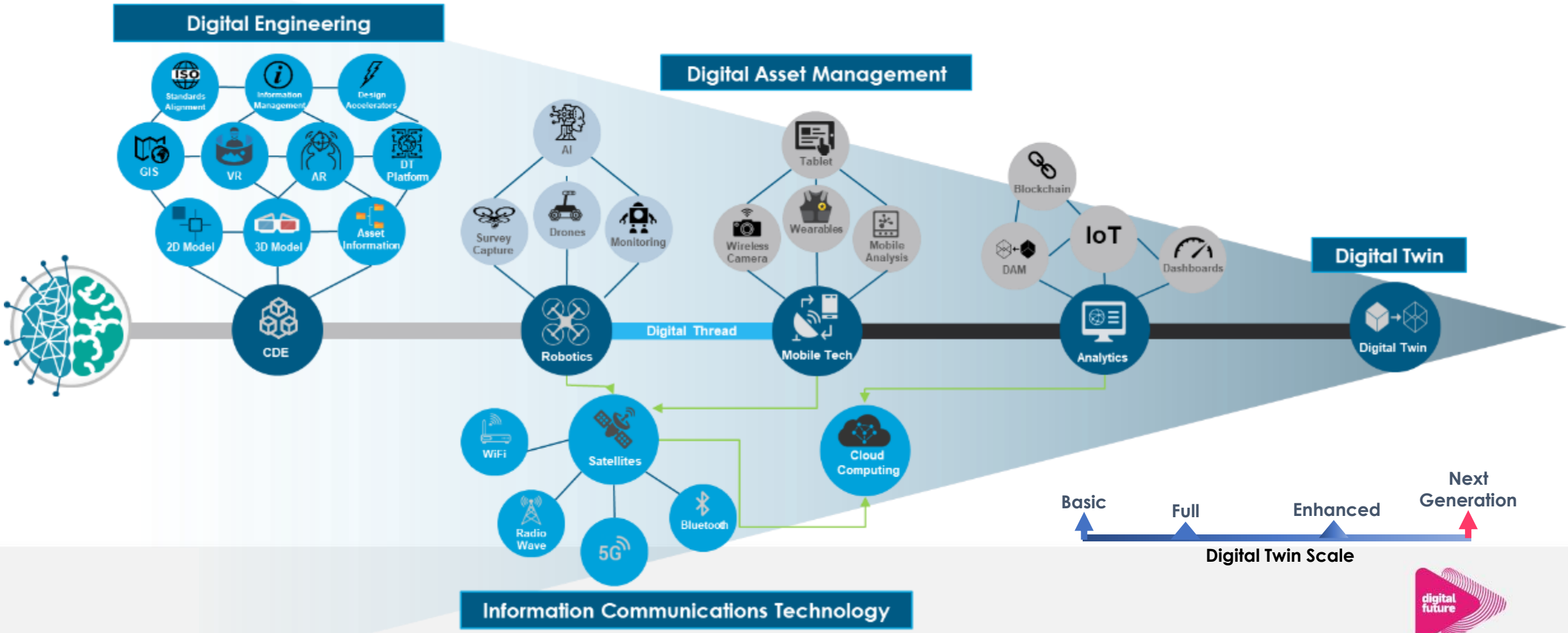
Purpose: Must have clear purpose	**Public good** Must be used to deliver genuine public benefit in perpetuity	**Value creation** Must enable value creation and performance improvement	**Insight** Must provide determinable insight into the built environment
Trust: Must be trustworthy	**Security** Must 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

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



The Digital Twin Thread

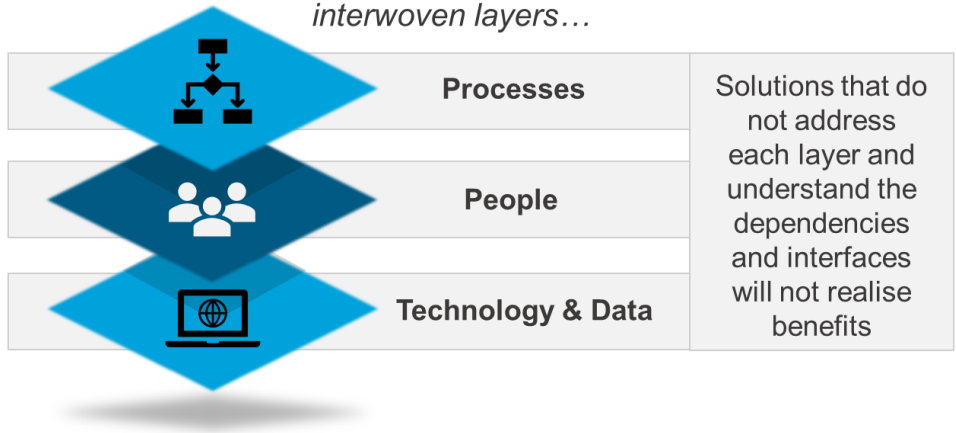
The digital twin is driven by a digital thread whereby **data** is **exchanged** between multiple functions and technologies which are required to enable a digital twin.



Digital Twin Expertise

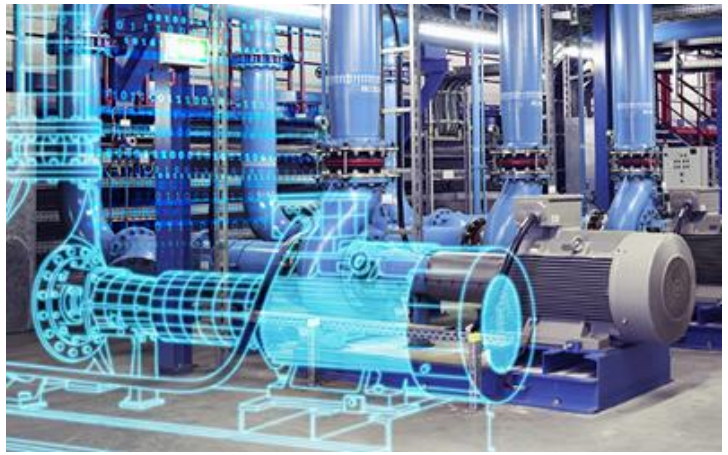
Author, convenor, and contributor to supporting international standards (ISO 55000, BS-1192, ISO 19650, and Digital Twin)

A target model consists of a number of interwoven layers…



People & Processes	Technology & Data	Benefits Management
✓ Domain knowledge and expertise ✓ Business Analyst skills	✓ End to End technology architecture ET, OT, & IT ✓ Information Management Expertise	✓ Integration with enterprise asset management and capital programming to identify and manage benefits realization

Flipping the Process

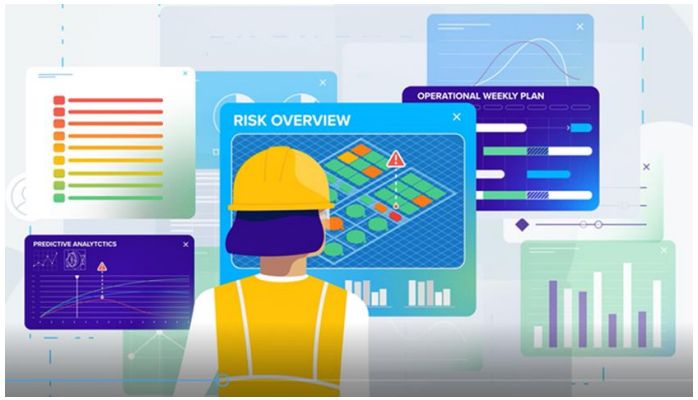


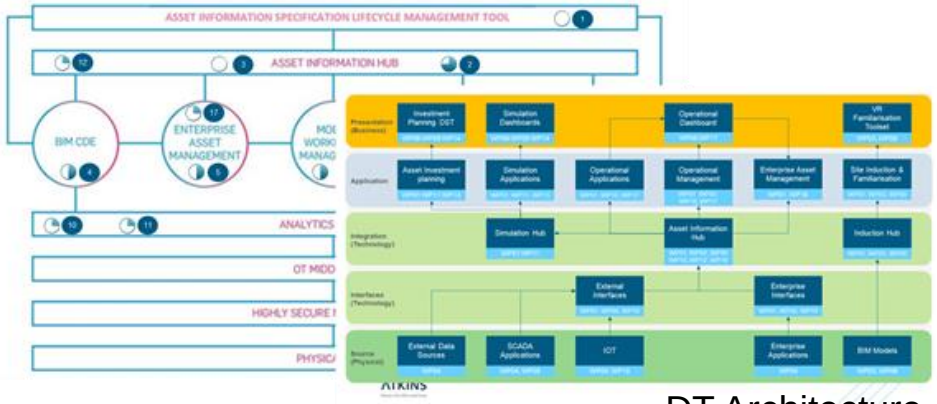
I. Common Approach

Problem Statement → Product → Cost → Capability → Benefit

II. Recommended Approach – Beginning with the Users of the Twin

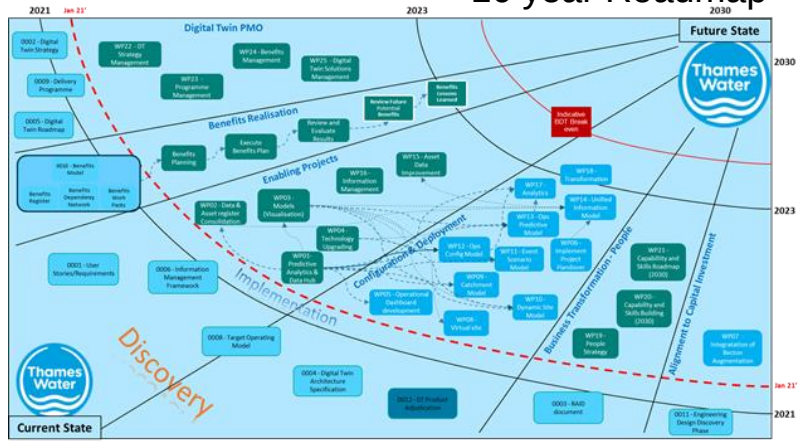
User Story → Capability → Benefit → Cost → Work Package → Product





DT Architecture

10 year Roadmap



Reality Capture & Visualization
Planning Digital Twin

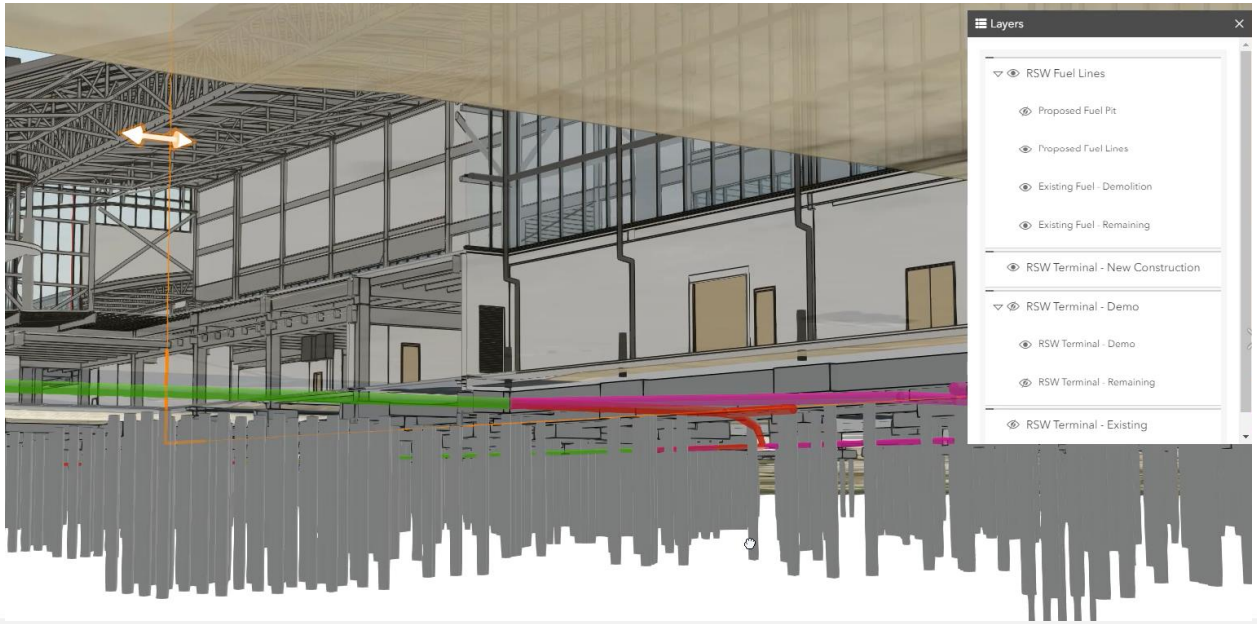
Planners can leverage data on use, availability and type to run scenarios and optimize layouts for a building or entire complex.

In this example, data on space usage from different time periods can be interpreted to consider new use alternatives and optimal space planning.

Reality Capture & Visualization
Rehearsal Digital Twin

Interoperability between systems in a digital twin provide visibility in time and space dimensions to avoid conflicts.

In this example, engineers had the ability to view underground utilities to optimize proposed placement of and relocation of utilities with new pilings.

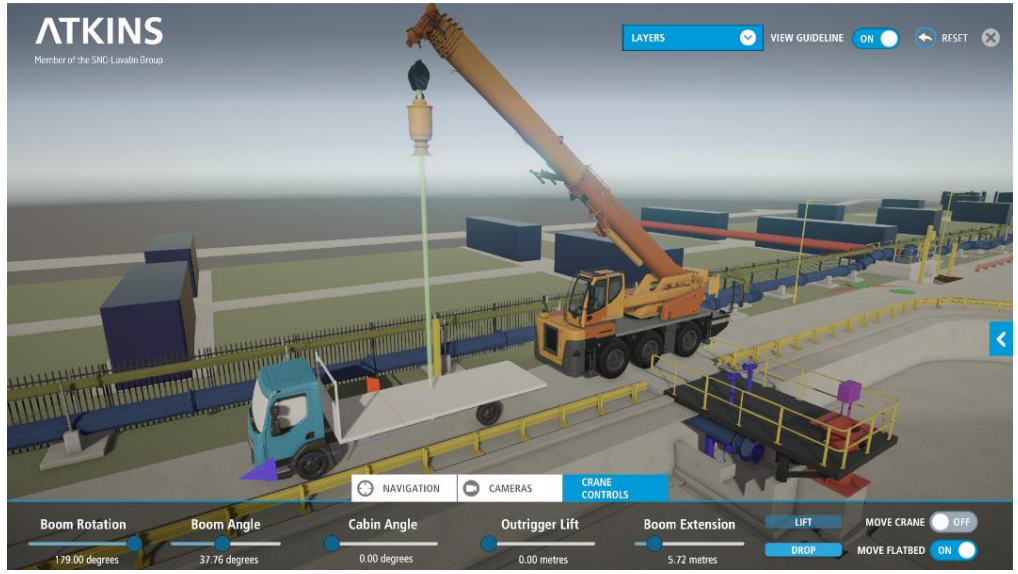


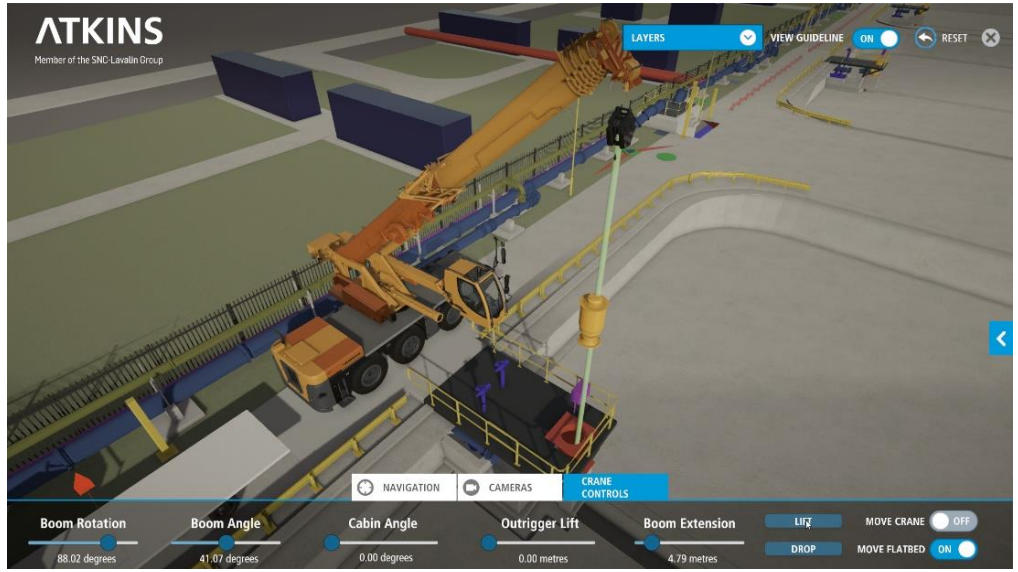

Proposed Fuel Lines
Existing Fuel - Demolition
Existing Fuel - Remaining
Proposed Fuel Pit
Existing Fuel
LEE COUNTY PORT AUTHORITY
AIRPORT OPERATIONS
4X4
argis
solutions

Reality Capture & Visualization
Rehearsal Digital Twin

When it comes to decisions about business investments, high quality visualizations can play a key part.

In this example, interactive and immersive visualization helps to test restricted space suitability.

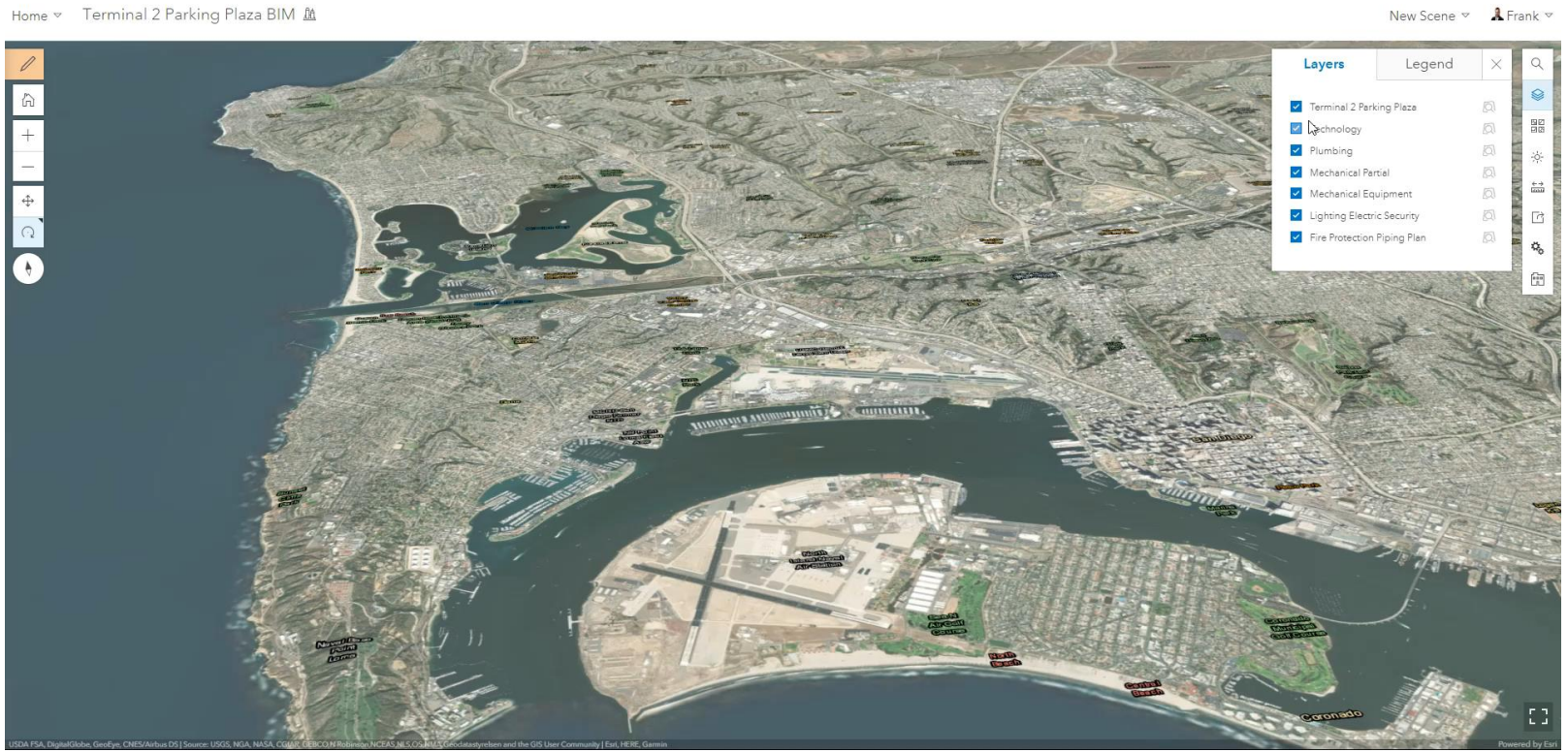




Performance Optimization
Asset Management Digital Twin

Digital twins can be connected to enterprise asset management systems to enhance operations and maintenance activities.

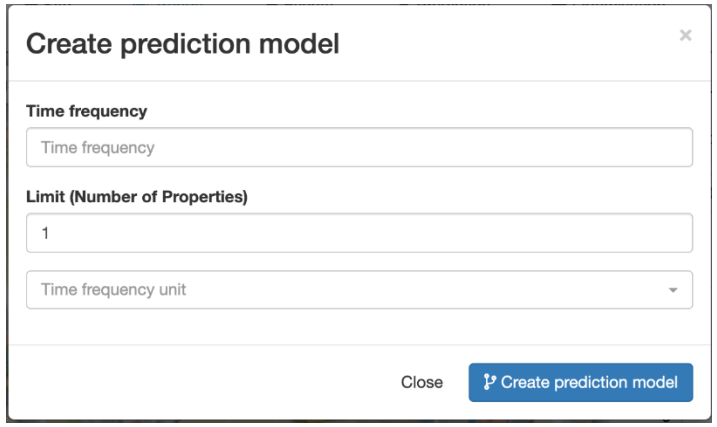
In the example, discrete assets are linked to work order data and manufacturer details to support efficiency in maintenance work.

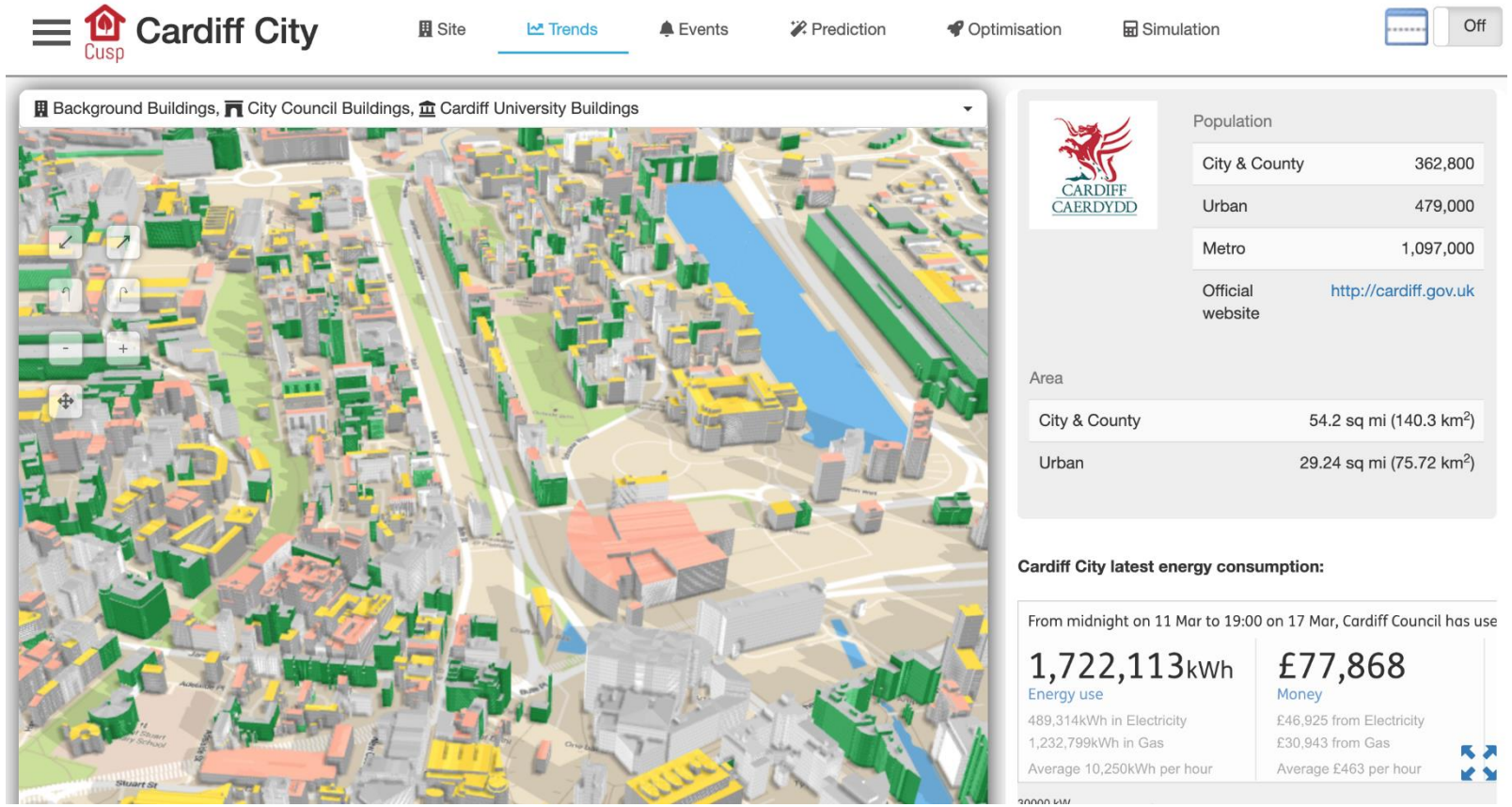


Performance Optimization
Operations Digital Twin

Fully mature digital twins are connected to sensors to support real-time monitoring and response through AI.

In the example, algorithms are interpreting energy consumptions and making recommendations for adjustments.





Data-Rich Design

Obstacles to Overcome

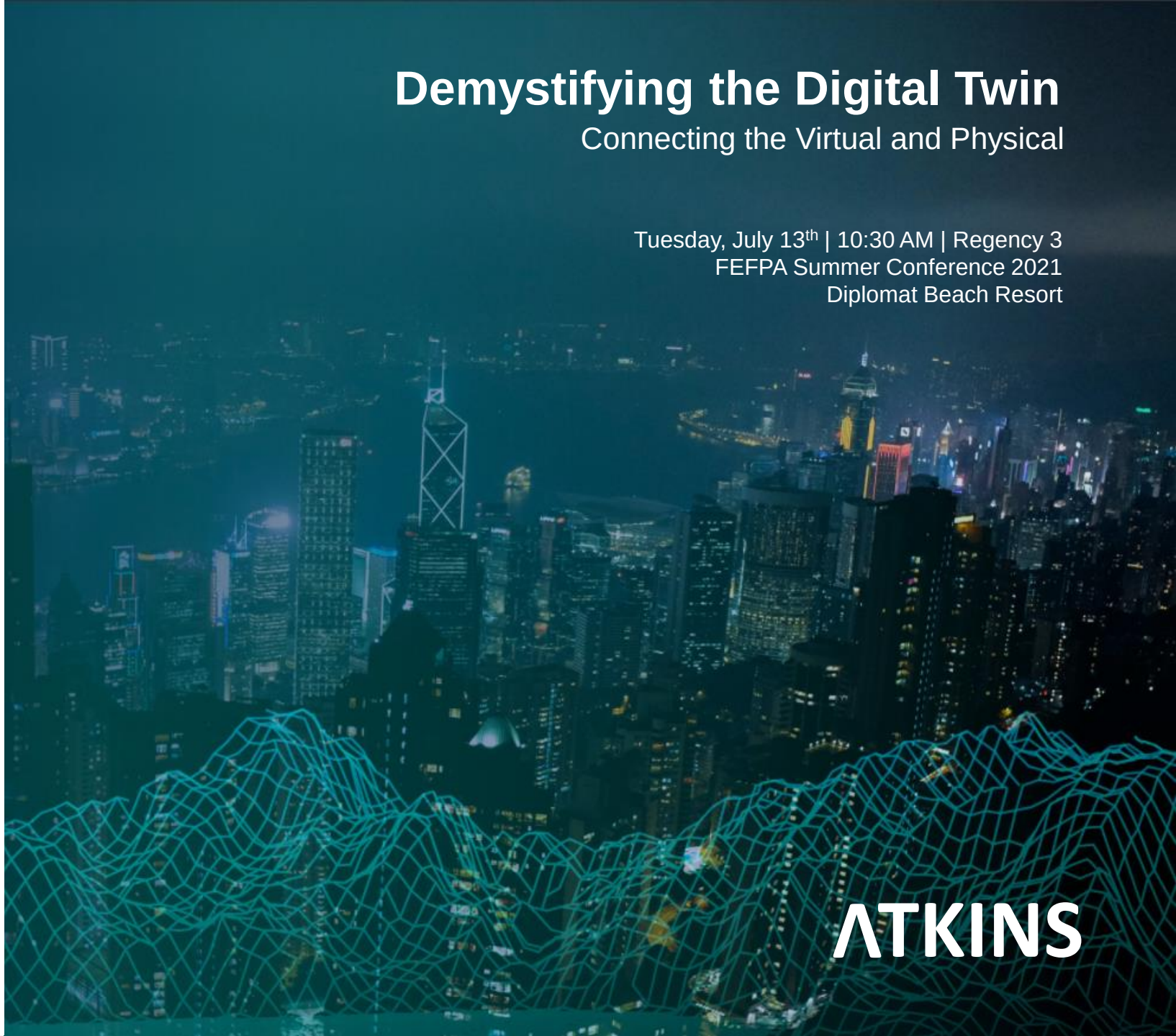
- Tipping point commitment.
- Value recognition.
- Supply chains are still disjointed.
- ISO Standards are still relatively new.
- People store and manage data differently.
- Not everyone is on board – yet…
- 3D work requires industry mindshift!

Data-Rich Design

Where to Start

- Operations & Maintenance In The Room.
- Pick Some Assets (That Matter).
- Require Classification Systems (Off-The-Shelf).
- Focus On Problems Needing Solutions (Not Vice-Versa).

QUESTIONS?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Connecting the Virtual and Physical
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