Digital Twins

Dr Robert Smith PhD FRSA
Director of AI and Data Science
Digital Catapult
robert.smith@digicatapult.org.uk

8/9/2022

Overview

- What is a Digital Twin?
- Where are Digital Twins Currently Providing Real Value *(in defence)*?
- What Value Can Digital Twins Potentially Provide?
- What Are the Impediments to Gaining These Advantages?
- Why Is DC proposing a The Design Smarter Digital Twin Centre (DSDTC) Now?
- How will The DSDTC Address These Challenges?
- What will DSDTC Do (inc. defence use cases)?
- Questions

What is a Digital Twin?

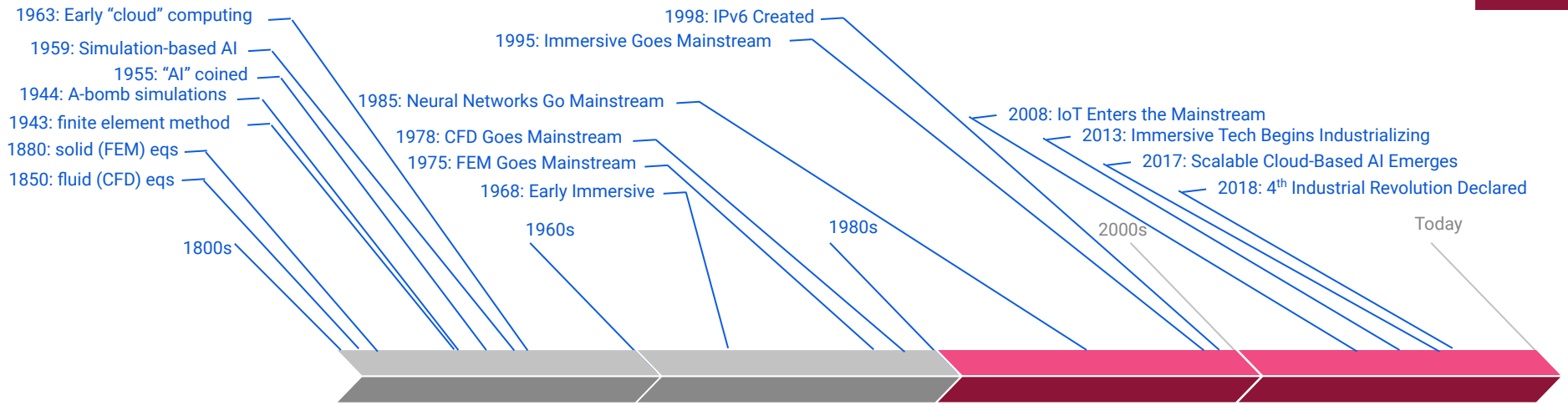
A digital twin is a virtual model which is informed by ongoing data from a real-world object or system (which the model “twins”).

For example, consider an oil rig outfitted with various sensors, which produce data about the rig’s complex network of flow rates, pressures, temperatures, stresses etc. These data feeds update a digital twin rig model, which also merges in external data feeds, like weather, oil prices, maintenance requirements, staffing etc., to gain a focused picture of the rig’s evolving state.

Simulations starting from this digital twin can explore what-if scenarios, make predictions, generate insights and facilitate optimizations, which can then update the rig’s operation, either episodically or automatically.

SumitAwinash/Wikimedia Commons

Why Now? (digital twins are not your grandfather's computer models…)



Deep Roots

Digital Twins are the culminations of mathematical, technological, and scientific work that spans centuries, but it is only recently developed tech that makes the productionlzed value of true Digital Twins possible.

Pre-history

Mathematical simulation and modelling methods developed in the 18th and 19th century only come into their own with the development of electronic computers in the 1950s and 60s, but real-world scale is challenging

Early Computer Modelling

Electronic computers allow for models of scale and speed that are just usable for the premier levels of real-world design and ad-hoc analytical work

True Digital Twins Only Recently Became Possible

Enabling computational power and tools (including sensing tech, high-speed networking, IoT, cloud computing, scalable AI, ML, and simulation, and more realistic immersive technology) become readily available

State-of-the art Today: Expensive, Bespoke Efforts

There is currently no established methodology and toolset for creating digital twins…

What is a Digital Twin?
Some Reality Notes

- It's only a real Digital Twin if it is continuously updated from the physical system it twins.
  - **In reality, most of the main uses of digital twins in industry (what if exploration, optimization, prediction) explicitly don't require real time data.**
- It's only a real Digital Twin if it *automatically* controls or updates the behaviour of the physical system it twins
  - **In reality, industry absolutely is not ready for, and does not require this.**
- It's only a digital twin if it has a 3-D model of the physical system it twins.
  - **In reality, 3-D models are nothing new, and seeing the physical system modelled by the digital twin, while showy for presentations, isn't the primary means that people need to interact with a digital twin. It can be much more valuable to see the connections between physical things in non-physical spaces: the space of contracts, logistic chains, organizational structures, etc.**

Where are Digital Twins Currently Providing Real Value?

(many places, including…)

AIRBUS

Digital Twin of their global supply chain, representing propagated risk across 100s of 1000s of suppliers for all their fixed wing products.

Yielded substantial discounts to their supply chain insurance premiums

Chevron

Modelling their distributed production facilities for production control.

Yielded substantial savings through better predictive maintenance

Modelling of windfarms, including their local surroundings

Yielding location-specific optimizations of their individual operations

Defense Use Cases

- People naturally assume a number of defence use cases:
  - **Battlespace Digital Twin**
  - **Vehicle/Platform/Facility Digital Twin**
- However, there are other powerful use cases in defence
  - **Force Planning Digital Twins**
    - Addressing the distribution of defence funds
    - Addressing long-term mission objectives, supply chain, training pipeline, etc.
  - **Digital twins in platform design, operation, and redesign**
  - **Digital twins of full defence procurement cycles**
  - **Digital twins of defence organization structures and operations**

What Value Can Digital Twins Potentially Provide?

Market Opportunities

The global market is growing at 38% annually and is expected to reach $34.6 billion by 2026.

The UK is well positioned to capture a substantial role in this market

There are other substantial public service benefits for UK plc as well

What Are the Impediments to Gaining These Advantages?

- DTs depend on *scale:*
  - **By their very nature, to yield value digital twins must be of the scale of a challengingly complex physical object or system**
  - This means that there is **significant investment required in the proof of concept/ value phase**
  - Moreover, digital twins require **large scale deployment efforts**, often at an enterprise scale, incurring significant cost and risk
  - **Meaningful demonstrations of innovation can be challenging for SMEs**

What Are the Impediments to Gaining These Advantages?

- **This fundamental scale barrier creates:**
  - A Business Case Barrier: it is challenging to develop a DT business case, for industry and SMEs alike
  - A Tech Stack Barrier: there is no common tech stack or DT methodology
  - An Information Sharing Barrier: the lack of common methods means DT-relevant information remains siloed, and the strategy of developing large-scale digital twins via an ecosystem of interoperable digital twins is not forthcoming.
  - A Skills Barrier: lack of common methods also means there is no common and coordinated skills base that can develop for digital twins

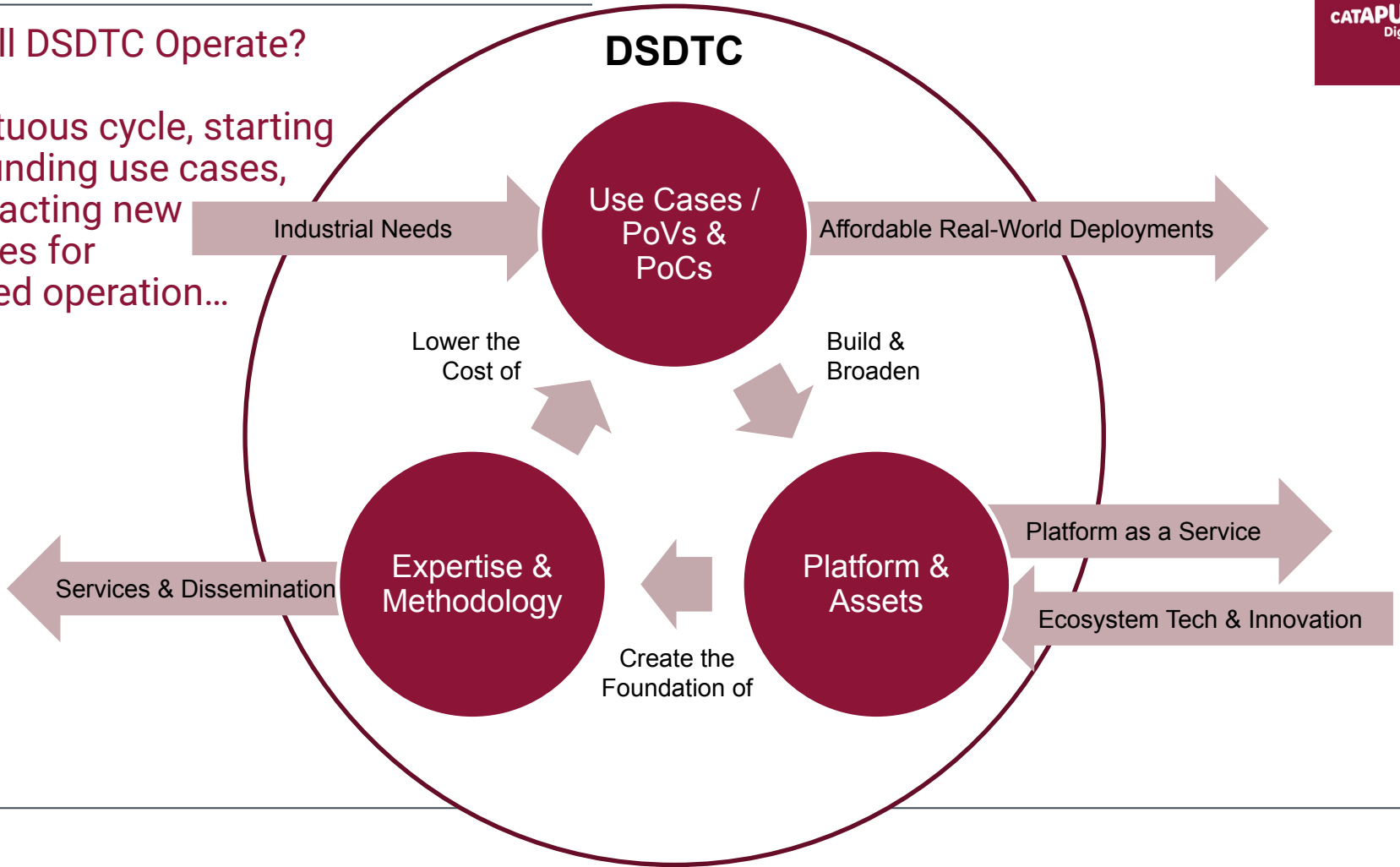
- **These reasons are all why Digital Catapult is proposing to form the Design Smarter Digital Twin Centre (DSDTC)**

How will The DSDTC Address These Challenges?

- **DSDTC will be:**
  - **A hub of expertise** in the areas identified as key enablers for Digital Twin adoption
  - **A partner with industry**, not just from the technology sector, but from established UK businesses who are on their own Digital Twin journeys, to remain real-world-aware
  - **A real-world-relevant demonstration space** for innovative digital twin technology from UK SMEs
  - **A common *methodology* and *platform*** for Digital Twin PoC/PoV efforts, with an emphasis on cost effective transition to real-world deployment

How Will DSDTC Operate?

As a virtuous cycle, starting with founding use cases, and attracting new use cases for sustained operation…



How Will DSDTC Operate?

Through Developing repeatable **Workflows** supported by **Services** supported by **Assets**:

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DT Use Case PoV/PoC Workflow

- **Use Case Elicitation (for PoC/ PoV & Tech Demos)**
- **Creating / Connecting A Baseline DT "Skeleton"**
- **"Fleshing out" w/ Data Sources & Feeds**
- **Integrating Simulation, Analyses, Optimization & Prediction**
- **Enabling Visualization, Interaction, Collaboration & Dissemination**
- **Transitioning to Enterprise Deployment**

Services built on DSDTC Expertise & Methodology

Use Case Dev Services:

- Validation
- Scoping
- Xtech Roadmap
- RoI Case Dev
- Role Definition
- Security by Design
- Innovation Services

Data System Services:

- Data Strategy
- Data Engineering
- Legacy Data Integration
- Reusing Domain Schema
- Reusing Domain Assets
- IoT system design

Simulation & Analysis Services:

- Legacy Software Integration
- AI Prediction Integration
- AI Optimization Integration
- Compute System Design
- Comms Systems Design
- Cloud Services Planning

Visualization & Collaboration Design Services:

- Visualization Design
- VR Integration
- AR Integration
- UI/UX Design
- Secure Collaboration Design

All Services Co-developed for Transition

Platform & Assets to Support

Network of Expertise & Domain Knowledge

DSDTC Core Platform: providing guided, common access to 3rd party:

- Data Integration & Interoperability Tools
- Simulation & Analytics Tools
- Visualization & Collaboration Tools

Domain Knowledge & Reusable Support Assets (Schema, etc.)

Reusable digital twins of entities and environments

All Assets Co-Developed for Transition

How Will DSDTC Operate?
Through Mutually Beneficial Partnership Roles:

- **Domain Partners:** bringing use-case knowledge, some of which becomes core DSDTC knowledge for relevant domains:
  - **Founding Domain Partners: Artemis, Spirit, and Thales**
- **Deployment Partners:** bringing knowledge of the real-world deployment issues, often specific to application domains:
  - **Founding Deployment Partner: Thales**
- **Platform Partners:** bringing tools-based knowledge that can be connected to by the DSDTC core:
  - **Potential Platform Partners: Zenotech, Hadean, Mathworks, NVIDIA, AWS, Hartree Centre, etc.**
- **Ecosystem Partners:** Emerging Digital Twin Consultancy and Capability Companies that draw on DSDTC's methodology, platform, assets, and community
- **Managing Partner:** Digital Catapult, developing and maintaining the core, services, and operations of DSDTC

Why This Team? Part 2: Founding Use Cases:

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THALES

As integration partner, Thales is focusing of building reusable methodologies and assets for digital twin deployment, with **multi-domain digital twin use cases:**

UAV Digital Twin

GBAD

Multi-Domain Operations

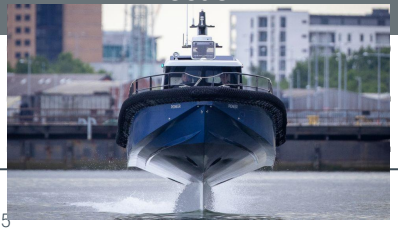
(and more…)

Artemis

The world's first real-world viable ***Zero Emission Marine Vehicle***

Designed to take operations crews between wind farms

Digital Twin will facilitate the next prototype design, operation, and ongoing analysis, which includes complex docking and charging operations in high seas

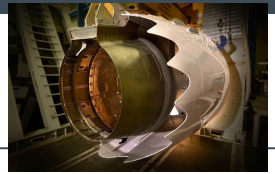


SPIRIT AEROSYSTEMS

Using Digital Twins in cross-company ***Model-Based Systems Engineering***

E.g., jet thrust reverser analysis and redesign, where conventional modelling still requires days of simulation.

Will explore modern simulation & build MBSE capability that exploits open tools and interoperability, building the DT ecosystem



NATS

Building a digital twin of the future of air traffic control, including both individual control towers, and the systems of towers working collaboratively across a region.

Distinct and complementary as a regional scale digital twin

Questions?

If you are interested in talking more about a Digital Twin Use Case, or other ways you might get involved in DSDTC, please contact me!

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