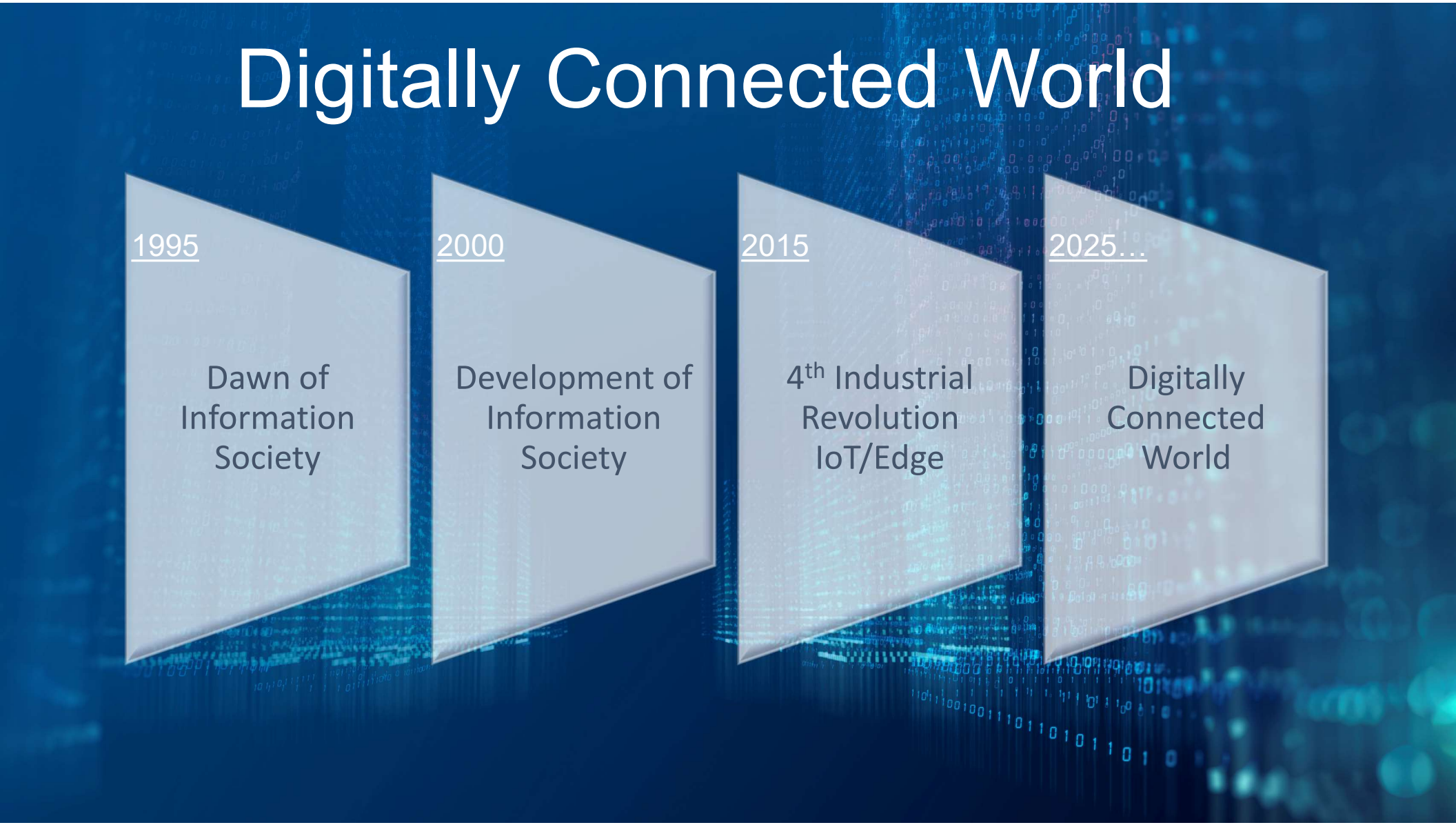
digital twin™
CONSORTIUM

Digital Twins Challenges and Values

Dan Isaacs - CTO

October 4th , 2022

Digitally Connected World



The Active Data Era

Hyper-connected

73.1 Zettabytes

of data will be generated from connected IoT devices by 2025.[1]

Hyper-distributed

75% of data

will be created and processed outside a traditional centralized data center or cloud by 2025.[2]

Hyper-speed

1.8B 5G

worldwide connections, with top speeds up to 20 gigabits-per second, will be achieved by 2025.[3]

100x

Lower power consumption by 2030.[4]

125x

Higher Transmission Capacity by 2030[4]

200x

Lower end-to-end latency by 2030.[4]

1. IDC, IoT Growth Demands Rethink of Long-Term Storage Strategies, 2020
2. Gartner Predicts the Future of Cloud and Edge Infrastructure, 2021
3. GSMA, The Mobile Economy 2021, 2021
4. IOWN Global Forum 2020

Courtesy – Dell Technologies

Innovating with Digital Twins to Optimize Car Performance

>300
sensors

13,000
pieces of information

Split-second
decisions

- **Reduce F1 car build times from 48 months to less than 12**
- **Developed the P1 Hypercar in half the time and half the cost of industry standards (60 to 24 months; ~$1B to <$500M)**
- **Leverage data from the track for analysis to make in-race decisions on car setup and race strategy**

The faster we get data, the faster we can design and engineer components. As a result, we can deliver changes trackside, optimize the cars and ensure we get the best racing results.

Edward Green
Principal Digital Architect, McLaren Racing

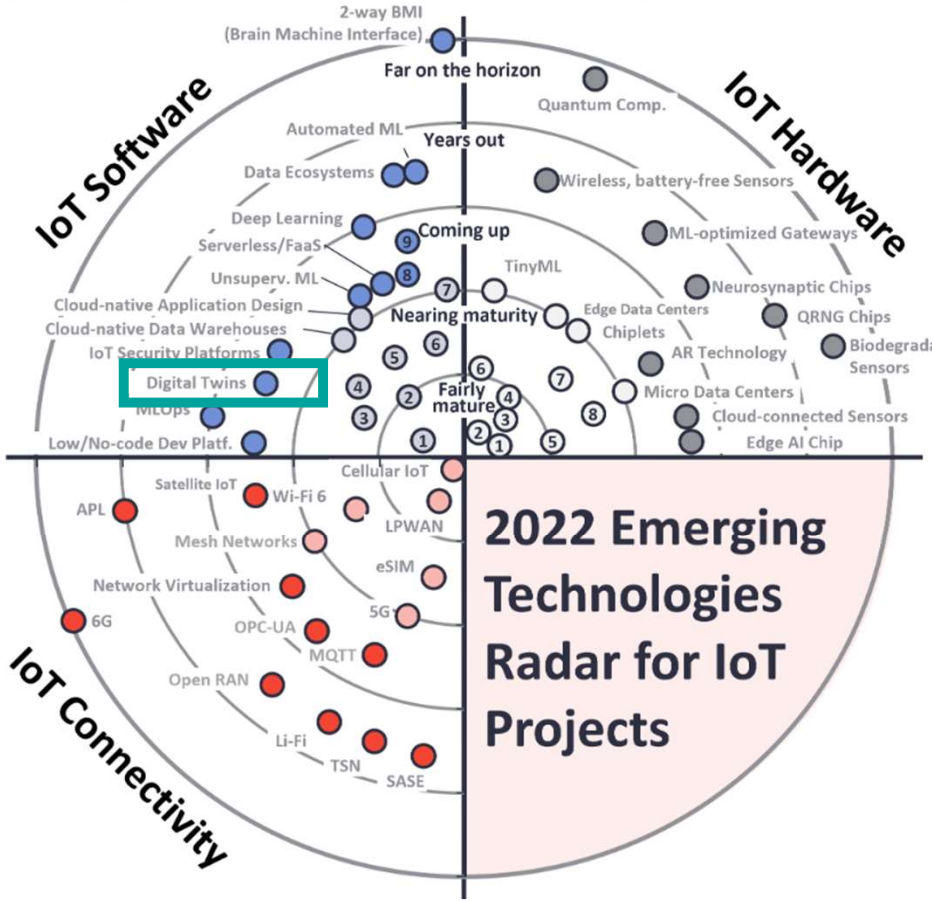
DELL Technologies

IOT ANALYTICS

April 2022

Your Global IoT Market Research Partner

Emerging IoT Technologies Radar 2022



1. Cloud Computing
2. IoT Platforms
3. Containers
4. Supervised ML
5. IoT-based Streaming Analytics
6. Edge AI
7. Real-time Databases
8. IoT Marketplace
9. Edge Data and App Platforms

1. CPUs
2. MCUs
3. GPUs
4. Security Chips
5. Edge Gateway
6. FPGA
7. ASICs
8. Intelligent Sensors

Disclaimer: The 2022 Emerging Technologies Radar for IoT projects represents the analyst view of the IoT Analytics' research team under the disclaimer that, depending on the context, the classification and perception of the project may be different in reality. IoT software refers to middleware, analytics, storage, platforms, and applications. The only relevant positioning of each topic is its distance to the center. The positioning on the axes plays no role.

Source: IoT Analytics Research—April 2022. We welcome republishing of images but ask for source citation with a link to the original post and company website.

Source: Emerging-IoT-Technologies-Radar-2022-vf-min.png (4729×2488) (iot-analytics.com)

Digital Twin Adoption is Accelerating

- Aerospace
- Transportation
- Automotive
- Construction
- FinTech

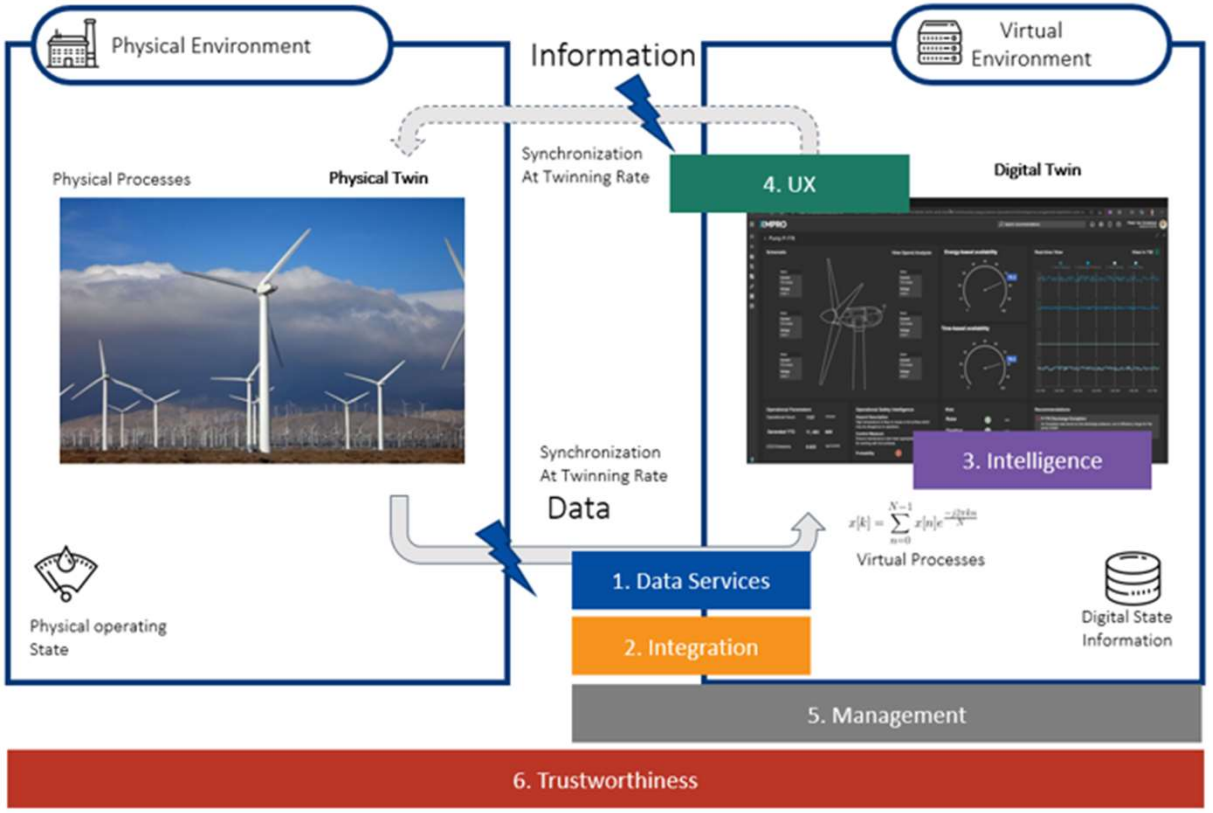



- Energy
- Manufacturing
- Healthcare
- Pharmaceuticals
- Security



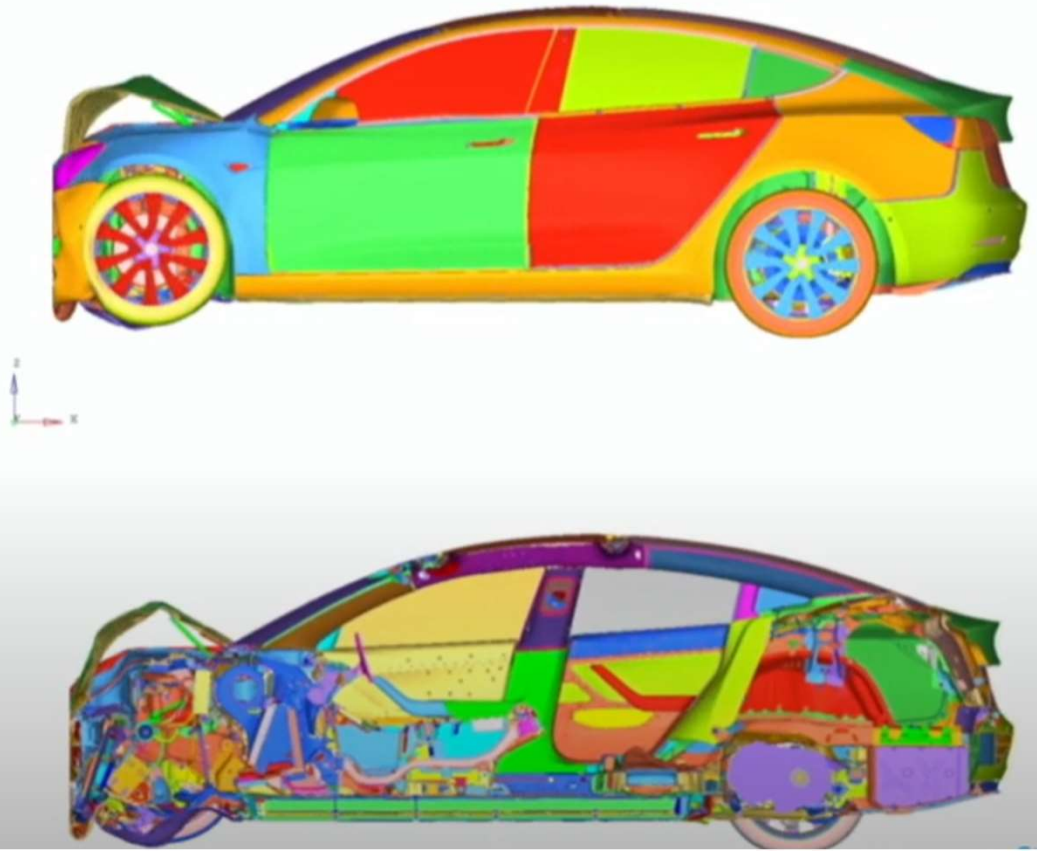

Foundation: Digital Twin Definition

A digital twin is **a virtual representation** of **real-world entities and processes, synchronized** at a specified **frequency** and **fidelity**.



digital twin CONSORTIUM

Model and Simulate



Run simulations

[The Tesla Model Y Digital Twins for benchmarking and cost reduction strategies. - Bing video]

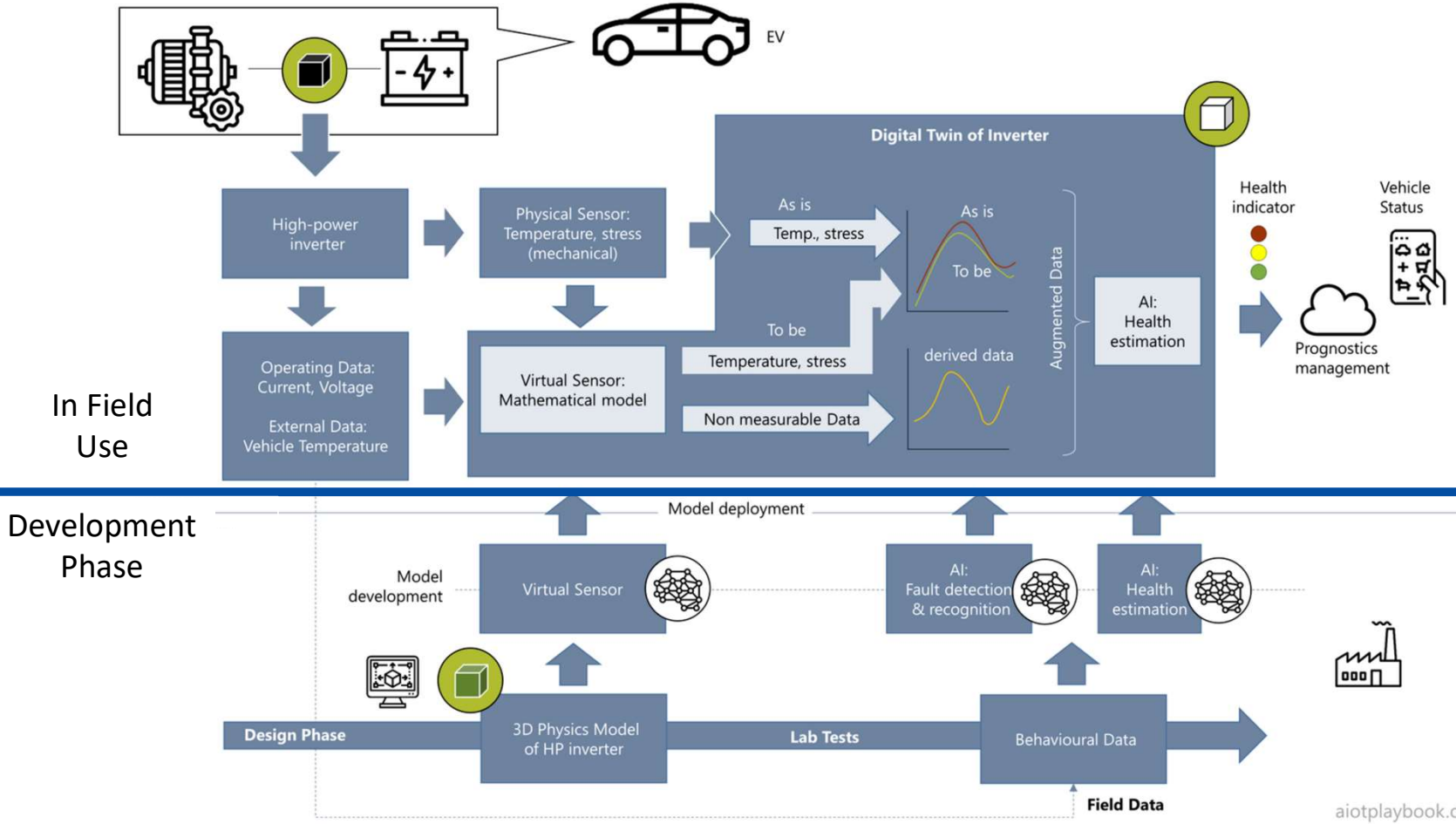
Every Tesla has a Digital Twin

Instant Identity – Situational Awareness

The digital twin is composed of three components i.e. physical entities in the real world, their virtual models and the ***connected data/view that tie the two worlds***.

https://blog.contus.com/digital-twin-solution/

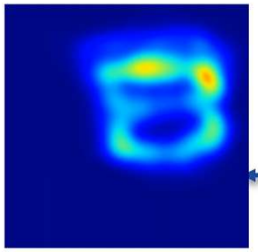
Advanced Digital Twins: Physics Simulation and Virtual Sensors



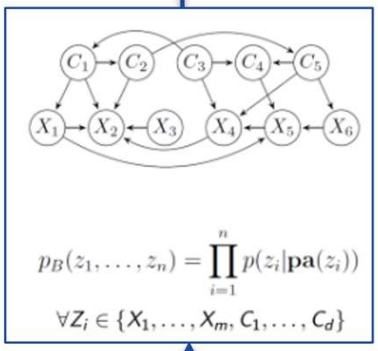
Source: Digital Twin 101 - digitalplaybook.org (aiotplaybook.org)


SMART FACTORY 4.0
Production Optimization in Harsh Environments with Low Latency, High Fidelity Use Cases

Digital Twin for Quality Control

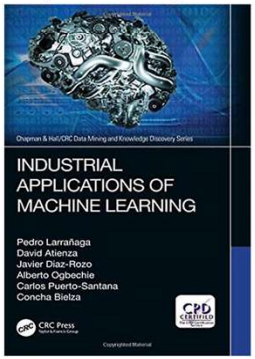


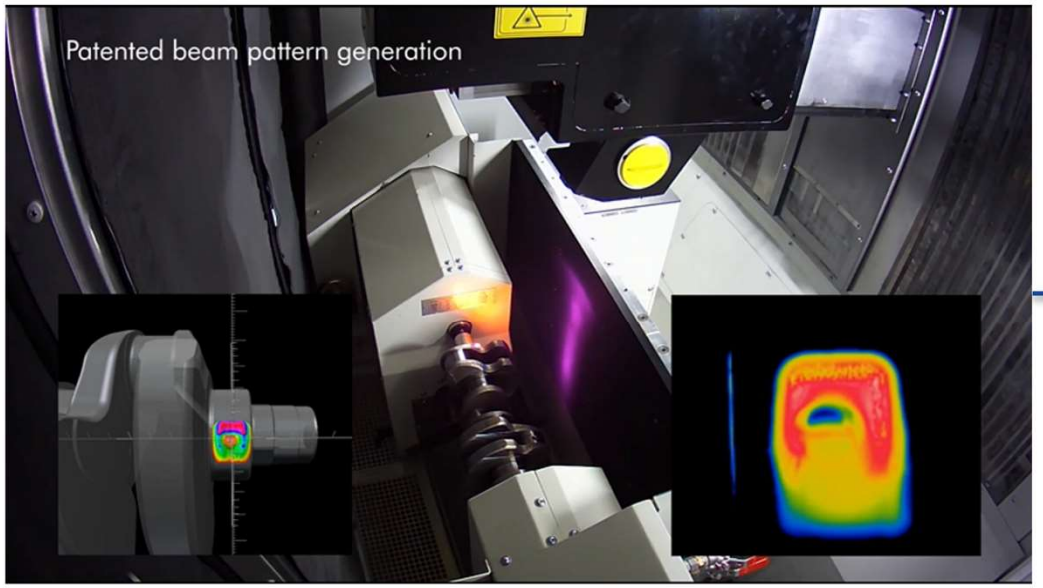
Machine Learning application: Kernel Density Estimation (KDE)



Ability to detect product quality issues

- Understanding the process variables
- Understanding hardware and software interaction with process performance





High speed thermography analysis. Process Max fault detection: 3s

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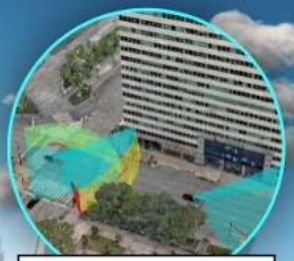
THE ACTIVE DIGITAL TWIN FOR INDUSTRY 4.0

COLLECT COMPUTE VISUALIZE PLAN ANALYZE SIMULATE MODEL RESPOND PREDICT

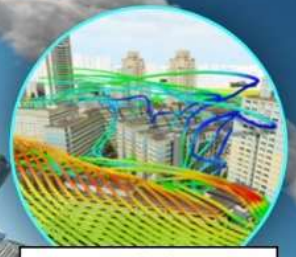
AUTONOMY INSTITUTE

Gaming



Simulation

Mapping



Modeling

BIM

Digital Twin

"Only with a digital twin in place, can government agencies effectively analyze what can be done with the data and improve citizen living, create economic opportunity and revitalize a closer community," Thomas Pramotedham, CEO of Esri Singapore

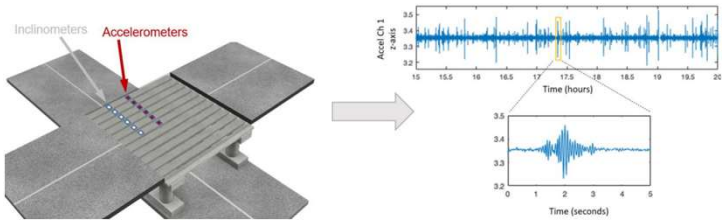
UNREAL ENGINE · Dactle · NVIDIA · voxelmaps · Hewlett Packar Enterprise · exyn technologies · esri · endeavorvr

CARMA · NASA · EVAA · OGC · OpenCV · SIMDIS · TENA

Digital Twin for Infrastructure Structural Integrity - Bridges

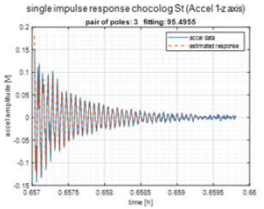
1 DAQ

- Data is extracted from accelerometers and/or inclinometers located at the bridge beam
- The objective is to record impulses created by normal traffic over the bridge



2 Bridge Model Estimation

- Once impulses are detected a proprietary online model estimation algorithm is applied
- Natural frequency and damping factor values are estimated as the best dynamic description of the bridge
- This dynamic description is the first step of the bridge digital twin



modes	Damping factors[%]	Period Comp.[s]
Si	ξ_n	T_n
-0.4±27.3i	1.50	0.2297
-1.1±49.4i	2.39	0.1270
-2.2±83.7i	2.68	0.075

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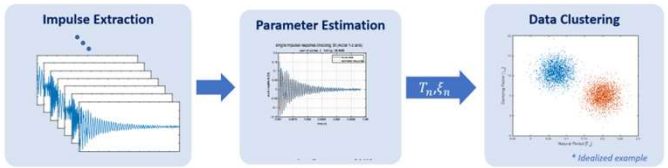
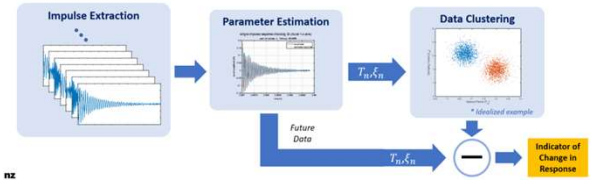
3 Bridge Digital Twin

- Bridge Digital Twin is created using clustering techniques
- This digital twin should include the bridge normal behavior during specific time span, i.e., week, month, year.



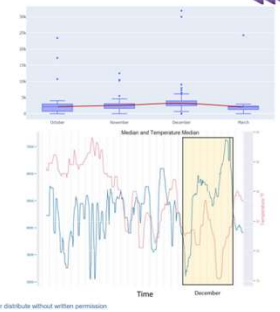
Bridge Health Monitoring

- Once digital twin is built, it can be compared to new data to see if the bridge has changed its response over time
- The comparison is done online producing a unique KPI that could be analyzed:
  - By its value
  - By its trend



Bridge Health Analysis

- PoC done in three bridges
  - Located in the U.S.A.
- Detection of outliers
  - That could be correlated to abnormal traffic
- Trend analysis
  - That could provide bridge degradation information
  - High sensibility: it can correlate weather effect on the structure




XMPRO
Nov 2019 vs May 2020
~184hrs of preventable borer downtime
identified worth ~44k product tonnes

$4m PdM - Underground Long Conveyor

Challenge

Reduce long conveyor (underground) downtime by 30%

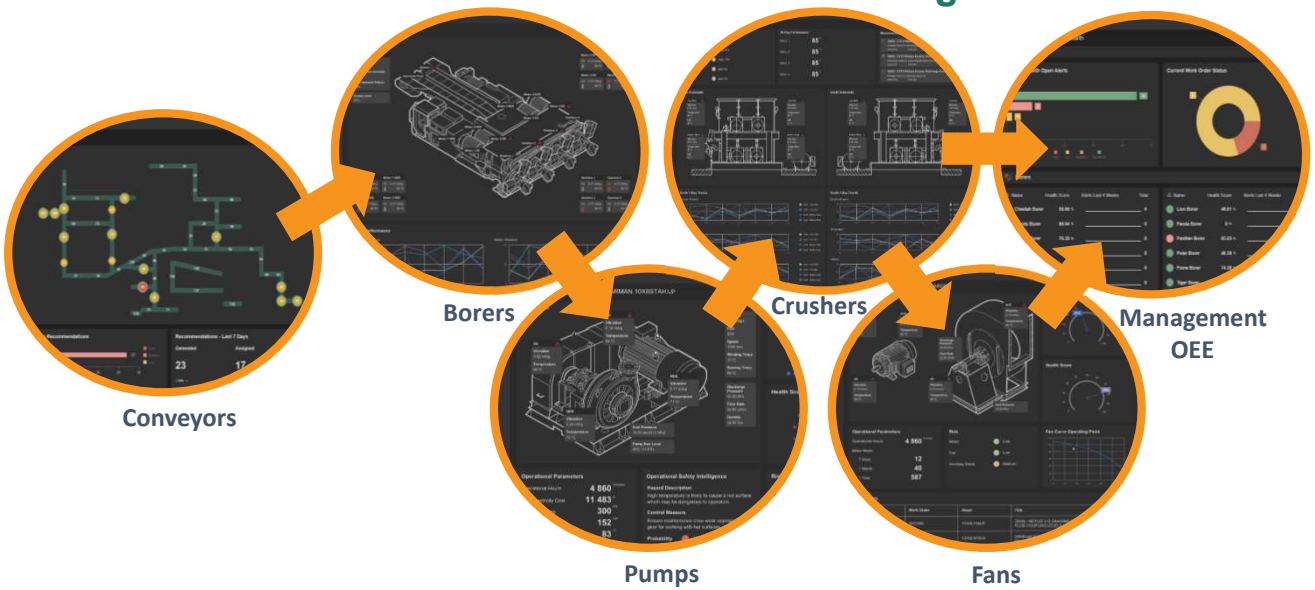
Solution

XMPro monitor 52 (80+km) conveyors and predict fluid coupling and lagging failures

Benefits

~184hrs of preventable borer downtime identified worth ~44k product tonnes

CUSTOMER STORY - Mining



Measures of Success

Time to value - 30 days to deploy initial release

- Integration with OSIsoft Historian and Oracle EAM
- Complex Engineering models
- predictive analytics executed at 2 sec intervals
- 30% reduction in conveyor downtime due to fluid coupling failures add $+4m in revenue

Always On, Situational Awareness

- 52 long conveyors in series
- Monitored and analyzed every 2 seconds
- Real-time dashboards with notifications
- Drill-down for decision-support and automation

Expert Knowledge Capture

- XMPro Recommendations capture expert knowledge on maintenance best practices
- Replaced ad-hoc BI style Excel (.xls) analysis with continuous analysis and notifications for reliability engineers to prescribe appropriate actions
- Recommended actions incorporated into predictive/prescriptive maintenance processes

XMPRO

Search everything | Everything

Kirsten Schwarzer
ADMINISTRATOR

Mining Value Chain Health

Daily Production Target
55 k tonnes
Target 60

Monthly Production Target
1 650 k tonnes
Target 1 800

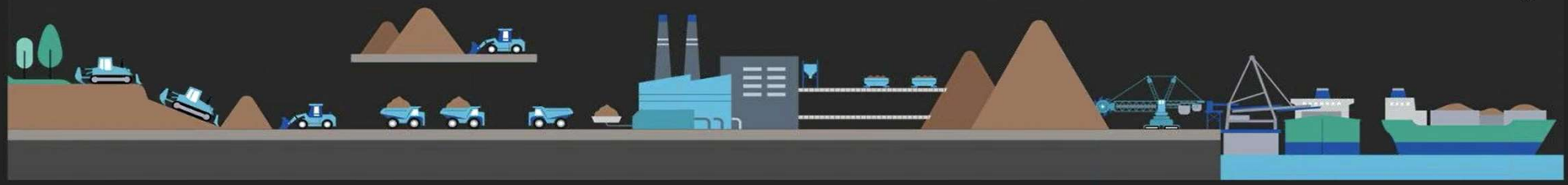
Quarterly Production Target
4 832 k tonnes
Target 5 400

Annual Production Target
19 328 k tonnes
Target 21 600

Daily Value Chain Health

Actual | Target

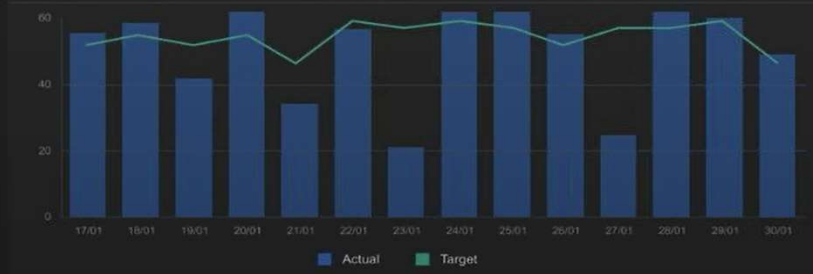
	Clearing & Raking	Stripping	Ripping	Load	Haul	Inventory Mine	Crude Ore Dump	Beneficiation or Crushing	Train Load	Rail Cycle	Trail Unload	Stacking	Inventory Port	Reclaiming	Ship Loading	Load Planning	Ship Scheduling
Production in k tonnes	53	52	51	49	48	47	47	47	47	48	48	48	50	51	47	47	45
	65	64	63	63	62	62	62	61	61	61	60	60	60	60	60	60	60
Grade in Al_2O_3						49.8	49.7	49.6	49.6	49.6	49.5	49.5	49.4	49.4	49.2		
						50.4	50.4	50.4	50.4	50.4	50.4	50.2	50.2	50.1	50.1		



Top 5 Most Frequent Bottlenecks
Last 7 Days

	Avg % Off Target	Alerts
Stripping	- 22%	25
Trail Unload	- 18%	21
Crushing	- 13%	19
Haul	- 11%	14
Load	- 9%	11

Daily Target vs Actual K Tonnes Shipped
Last 14 Days



Executive Recommendations

Grade out of spec - crude ore dump
Check ripping geolocation data to mine plan
06/06/2021 09:50 AM

Crusher 1 & 5 maintenance schedule conflict
Change maintenance schedule to remove conflict
06/06/2021 10:52 PM

High frequency of pit exit alarms detected
Review mobile fleet schedule
06/06/2021 12:40 PM

Descriptive

Predictive

Prescriptive

Autonomous

Functional visibility

E2E Visibility & control tower

End to end digital twin

Digitally enabled & autonomous

Characteristics

- Functional E2E ecosystem visibility and synchronous collaboration
- Clear reporting and analytics
- Balance cost optimization, risk mitigation, and growth

- Integrated end-to-end visibility with cross-functional real-time dashboards
- Synchronized parameter setting and optimization
- Early warning system with clearly defined alerts
- Respond to global shocks and shifting customer demands

- Design flexible, cost effective, and resilient supply chain ecosystems
- Prescriptive recommendations based on AI
- Scenario capabilities spanning the entire supply chain
- Integrated optimization tools to optimize key supply chain parameters in real-time

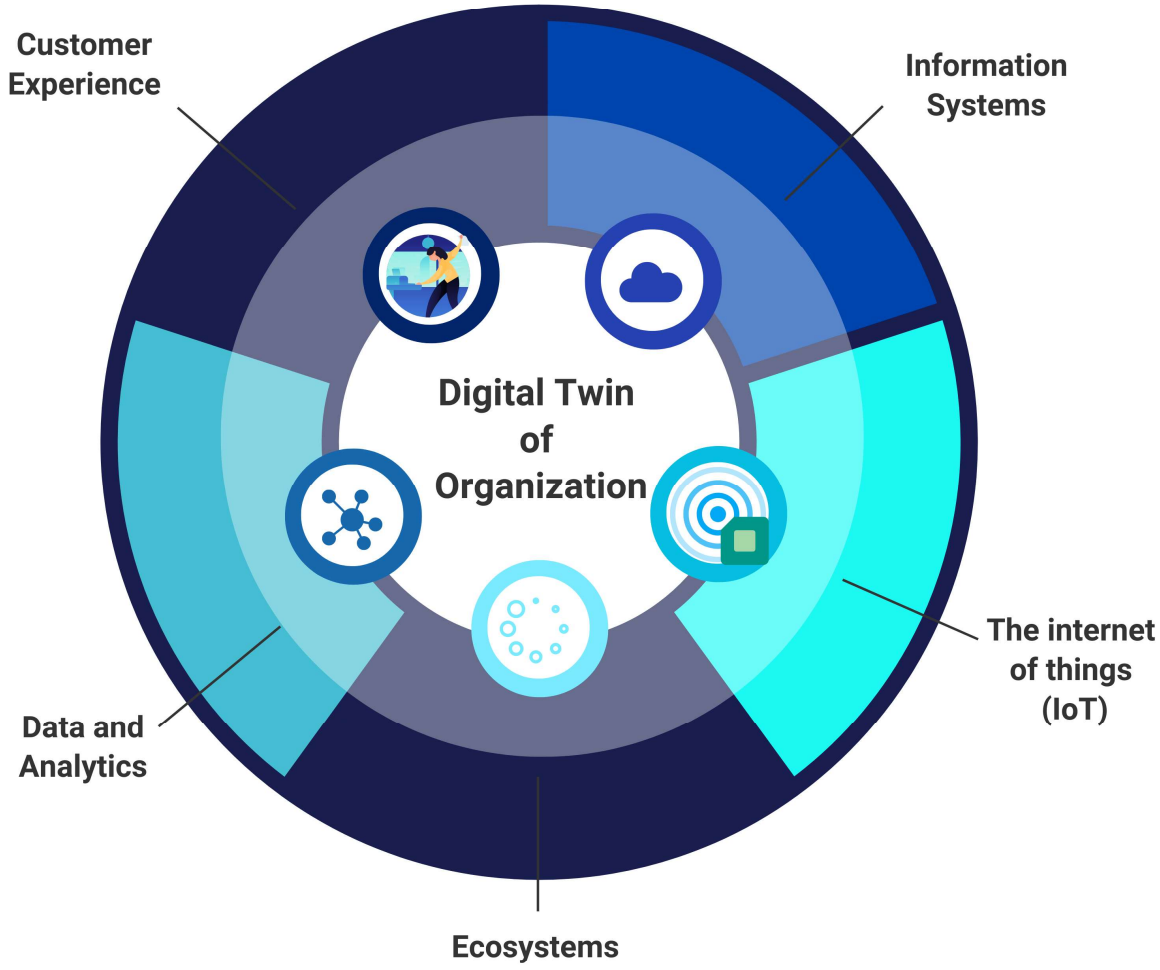
- Self healing master data and planning parameters
- Digital twin orchestration of supply chain with continuous planning
- Enterprise level digital twin

Source: Can a supply chain digital twin make you twice as agile? | EY - US

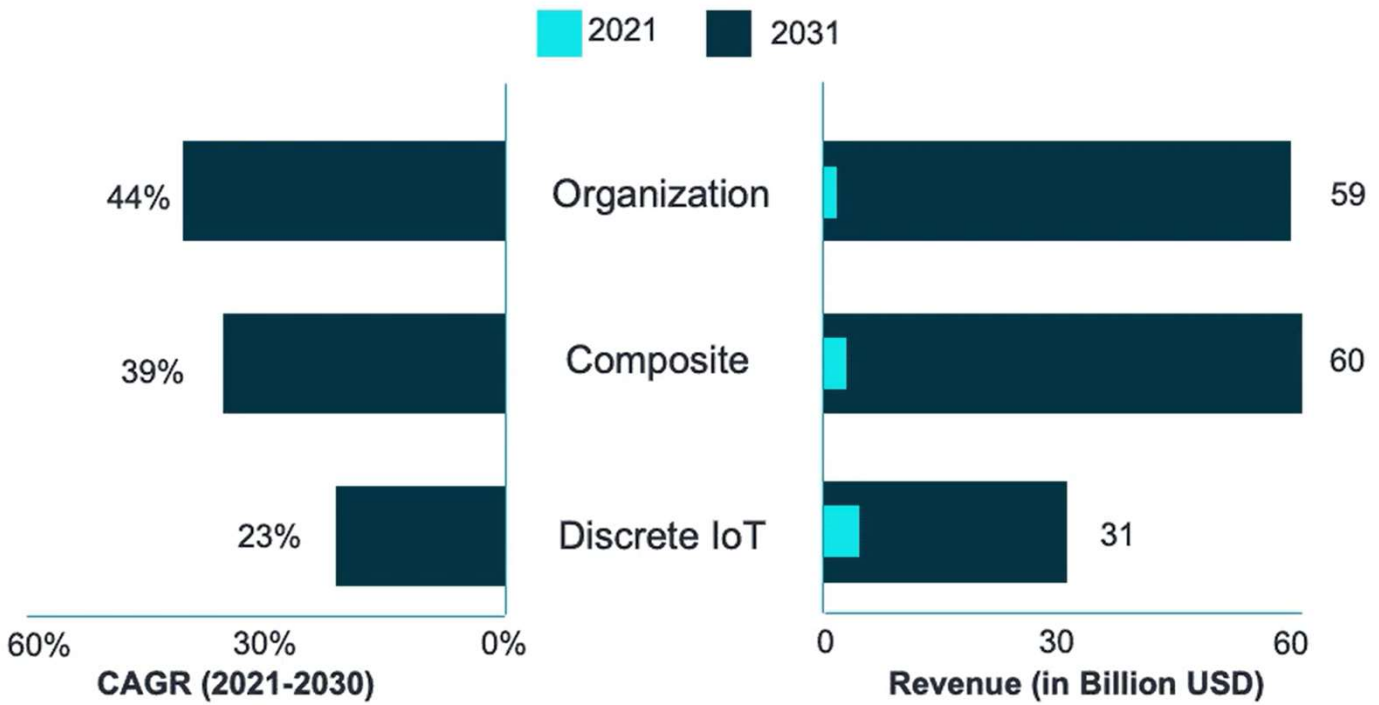
Linear supply chain

Networked ecosystem

Digital Twin for Efficiencies in Business Operations



Digital Twin Growth by Type



The market for digital twin **software and services** is expected to reach global revenue of **$183 billion by 2031**, up from $9 billion in 2021.

Source: Gartner Dec 2021, Digital Twin Revenue Opportunity Projection (adapted)

Our Family


OMG
Object
Management
Group


digital twin
CONSORTIUM


Industry IoT
Consortium


AREA
Augmented Reality for Enterprise Alliance


OMG
Standards
Development
Organization


Responsible.
Computing()


An OMG Managed Community
BPM+
Health


CISQ
Consortium for Information & Software Quality

digital twin CONSORTIUM

Digital Twin Consortium Steering Committee

Consortium Focus

Improving Interoperability

- We are ensuring digital twin models interoperate throughout your product lifecycle
- We are influencing the requirements for digital twin standards
- We are developing best practices for security, privacy and trustworthiness
- We are creating a library of reference implementations for digital twins
- We are providing frameworks to better work across the digital twin technology stack

Accelerating the Market

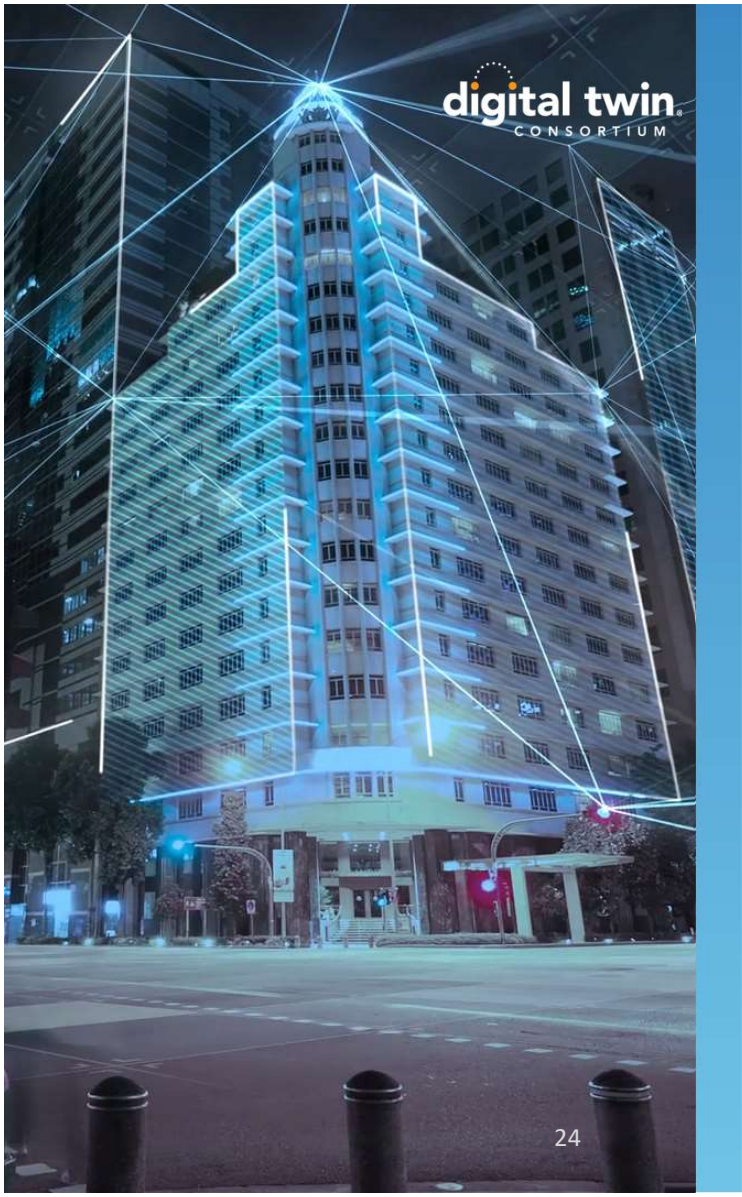
- Our members are benefiting from a neutral ecosystem to drive industry collaboration
- We are helping our members to combine their resources, therefore reducing their risks
- We are learning from shared use cases
- We are reducing the skills gap and involving employees from various departments in the proper consortium group
- We are influencing the solution roadmaps for digital twin vendors
- We provide access to the world's leading experts throughout your digital twin journey

Demonstrating the Value

- We are fostering the development of a collaborative environment for open-source code
- We are enabling our members to learn from experts
- We developing use cases and applying them to your industry
- We are accelerating your project investment
- We are working to help you maximize quantifiable outcomes
- We are helping to influence the direction of the market and get your project online faster

Standards and best practices

- DTC is not a standards body, however we are part of the OMG umbrella
- We work to align with standards bodies to evolve existing standards
- These collaborations provide recommendations for interoperability and standards requirements
  - Joint DTC-IIC Interoperability Working Group
  - Open-Source, Standards Requirements, and Platform Stack



Structure

Working Groups

Academia & Research
- Develop digital twin program
- Accelerator program
- POC, Pilot Programs
- Educational collateral

Aerospace & Defense ★
- Assets –Land, Sea, Air
- Dev Sec Ops
- EOL Extension
- Logistics / Management
- Supply Chain and Value Chain

Architecture, Engineering, Construction & Operations (AECO) ★
- Smart buildings to Cities
- Greenfield to Brownfield
- Lifecycle - BIM to Twin
- Operations / Maintenance

Agriculture, Food & Beverage
- Agriculture (field to fork)
- Aquaculture (ocean to plate)
- Supply chains,
- Value chains
- Harvest to Process - Delivery

FinTech
- Transactions
- Governance
- Compliance
- Risk Tolerance
- Risk Management
- Access control

Healthcare & Life Sciences
- Predictive and Preventative
- Healthcare management
- Medical devices
- Patient journey
- Pharmaceuticals

Manufacturing ★
- Manufacturing equipment
- Industrial Automation
- Additive Manufacturing
- Product development
- Supply chain

Mobility & Transport
- Transport - Autonomous Vehicles / Systems
- Operation / Management Vehicles, People
- Infrastructure , Corridors
- Airports, seaports, Rail/Trucking
- Supply chain Operations

Natural Resources ★
- Oil & gas
- Mining
- Alternative Energy
- Renewables
- Waste Management
- Environmental Impact

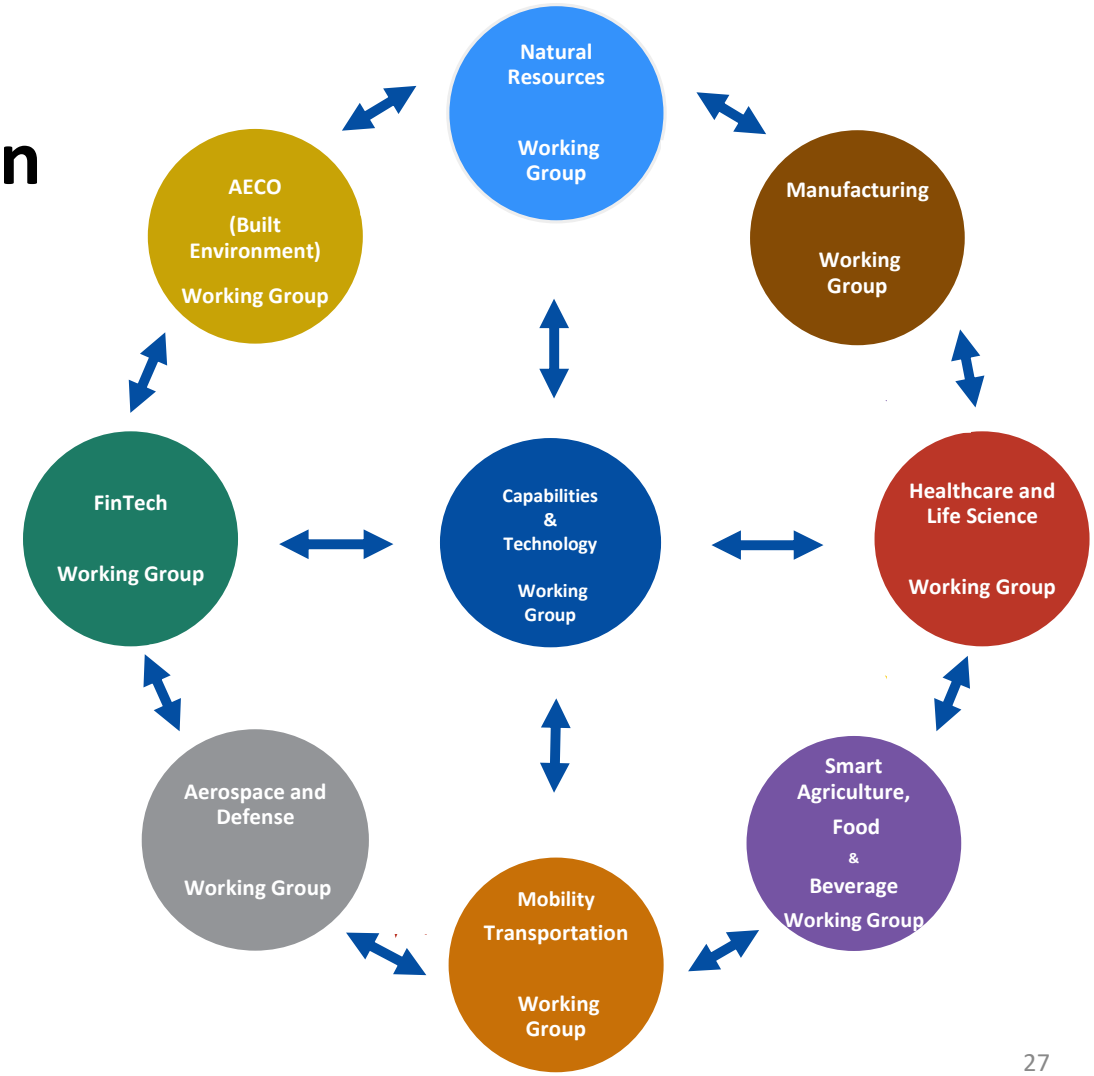
Capabilities and Technology ★
- Terminology /Taxonomy
- Technology (Horizontal)
- Security & Trustworthiness
- Frameworks,
- Full Stack Platform
- Ref architecture

★ Initial Working Groups at DTC Launch

Cross-Collaboration

Member Directed

- Innovative
- Collaborative
- Demonstrative



Capabilities & Technology Working Group

Categories	Capabilities	Characteristics
Digital Twin Maturity & Assessment	Security & Trustworthy	Environmental, Societal, Governance
Composable Framework	Reliability	Sustainability
Digital Twin System Reference Architecture & Open Source	Safety	Circular Economy
Technology Spotlight	Resiliency	Reusable
Technology Showcase	Interoperability	Scalable
Value Innovation Platform	Privacy	Repeatable

Terminology, Taxonomy, Technology

Security & Trustworthiness

Trust Vectors Demonstrator

Description:

Live demonstration of commercially available technologies that can be used to implement the "trust vectors" model of trustworthiness assessment and dynamic risk management for Digital Twin systems.

Underpinned by principles of dynamic connectivity and zero trust security, the demonstration proves that the ideas discussed in the S&T group are practically achievable and can be built into the software stacks and operating models of all Digital Twin use case verticals.

Objective:

1.show that the idea is practical and ROI positive for business stakeholders

2.spark imagination of the vertical WGs

3.demonstrate in a strong forum (exp - Q4 member meeting)

- Get Involved:
  - If you would like to find out more about the Trust Vectors Demonstrator, then please reach out to the Chairs – Jon Geater

12

Trust Vectors Whitepaper

Description:

A technical whitepaper describing the principles of Trust Vectors in some detail, including trust scoring mechanisms, zero trust security principles, and maturity models.

As well as explaining the abstract concept of trust vectors there will be more concrete contents including:
- A technical write-up of the demonstrator
- A worked real-world example
- An explanation of how system Trust Vectors can be composed from system components

- Get Involved:
  - If you would like to find out more about the Trust Vectors Whitepaper, then please reach out to the Chairs – Jon Geater

Objective:

1.Promote the Trust Vectors concept to business and use case level stakeholders (ie raise S&T horizontal work into vertical groups)

2.Grow acceptance of the language of Trust Vectors and Zero Trust in the general community, to aid communication and reduce fear of adoption

3.Show to stakeholders outside the DTC that the DTC has a strong model of trust and security for Digital Twins that is practical and real-world-ready.

13

Terminology

Glossary Released on DTC Public Site

Criteria for inclusion of terms

Will Proposal

- Does the definition/entry…
  - Add value in the form of clarification that is not available in a common dictionary?
  - Solve a terminology problem for the author of a digital twin use case?
    - "I need a term that means ____"
    - "I need to clarify which possible meaning of ____ that I intend."
- Is the term too domain-specific?
  - E.g. "bridge abutment", "rotator cuff", "supply chain", "financial asset"
- Is the term too implementation-specific?
  - "In this implementation, we use a 'sensor sync event queue'."
- Unnecessary terms dilute the value of the glossary.
  - Increase authoring effort
  - Increase maintenance costs
  - Reduce "value density" in the final product

15

Business Maturity

Business Maturity Model Focus

Linking to the Digital Twin Maturity Model

Business/ Digital Twin Maturity	The anchors are here	The industry is here	The leaders are mainly here	The evangelists are here	Some enlightened companies are here	Future	Future
Maturity Level	-1	0	1	2	3	4	5
Areas	Legacy	Involved	Realizing	Evaluating	Evolving	Maturing	Excelling
se of Technology	Enterprise systems in need of replacement. Not equipped to adopt new technology.	Upgrading the technology estate but slow and sub-optimal.	Integrated technology platform. Well-equipped to adopt new technology opportunities	Actively scanning the market for technology optimization opportunities	AI and machine learning in place. Business is equipped to extend its use of innovative technology.	Business is able to rapidly adopt new technologies supporting its customer value proposition.	
ata Management (collection, uality and governance) OK							
Digital Thread	No threads, no data	Some documents, not interactive	Linked documents, not interactive	Linked, interactive documents	Versioned, linked, interactive documents	Shared, versioned, linked, interactive documents	Constructive adaptation of shared, versioned, linked, interactive docs
Budget Allocation							
Interoperability (System of Systems)							
Digital skills & capabilities	No understanding of digital	Limited digital skills & understanding	Mainly reliant on external expertise	Growing skills & capabilities, mainly in silos	Ability to collaborate	Skills deployed across systems & org units	Extensive multi-dimensional collaboration

12

Joint DTC-IIC Interop

SoS Constituent Relationships

Anto Budiardjo, CEO Padi, Inc. Jan/19/2022

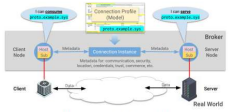
Modeling Composable Relationships

Relationships between Constituent Systems in Systems-of-Systems are inherently multi-faceted. For such relationships to be modeled, they have to be composable to handle different types of information to be exchanged between them in different use cases, different circumstances, and potentially constantly changing dynamic systems.

In Human relationships, a person can carry multiple credential documents: Driving License, Passport, Pilot License, etc. When the police stop him on the Freeway, he presents his Driving License. If at a Flying School, he will show his Pilot License. These are all "standard" and accepted information about the person in specific contexts, some more general than others.

In the digital realm, to model relationships between Constituent Systems, we need a standard, flexible, and composable way to communicate metadata about the entities. The proposed mechanism is Connection Profiles as a digital analog to the documents we humans carry.

A Connection Profile (CP) is a published and immutable named model of how systems interact in an SoS. Each CP prescribes a set of Properties that a Client and a Server system each need to provide when an instance of the CP is created in a specific context as managed by a Broker. The Broker instantiates a connection between systems with complementary CP and roles within a defined context.



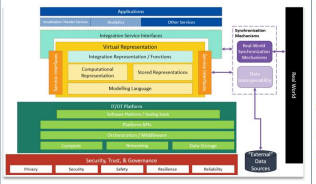
Operation Diagram of Connection Profile Mechanism

Platform Stack, Open Source & Standards Requirements

Platform Stacks Deliverables

Use Case Mapping

- **Description:** Map 2-3 use cases as vetted by the TAC onto the reference architecture
- **Key Objectives/Milestones:**
  - Review the EcoICafe project
  - Review the Connection profile project
  - Review the DTDL/OPCUA project
  - Set of use cases mapped onto the reference architecture.
- **Deliverable Lead(s):**
  - David McKee
- **Target Completion Date:** EOF September
- **Next Steps/Timeline:**
  - Identify Use Cases
  - Map Use Cases to reference architecture
  - Review open source projects



Document Reference Architecture

- **Description:** Document the reference architecture making use of the capability periodic table and referencing the IIC work including things like the RAMI architecture
- **Key Objectives/Milestones:**
  - Identify the key elements to be incorporated, e.g. RAMI, IVAS, etc.
  - Individually document each block of the reference architecture
  - Draft white paper
  - Publication of white paper
- **Deliverable Lead(s):**
  - David McKee
- **Target Completion Date:** October/November
- **Next Steps/Timeline:**
  - Finish first draft
  - Member review
  - Finish final draft

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Capabilities Periodic Table

An innovative framework for delivering digital twin projects based on use case capabilities

- Architecture and technology agnostic requirements definition framework.
- Aimed at organizations who want to design, develop, deploy and operate digital twins based on use case capability requirements (versus the features of technology solutions).

Composable Framework:

- Provides a foundation for an emerging marketplace
- Enables development teams to collaborate, design, and build
- Accelerates digital twin adoption

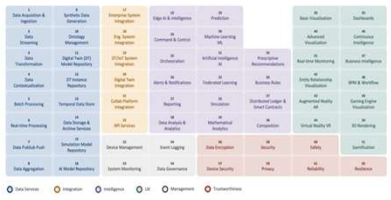
Frameworks

Business Maturity Model

Dimensions	% Passive (20%)	Starter (40%)	Progressive (60%)	Mature (80%)	Master (> 90%)
Strategy & Ambition	Strategic vision, digital ambition, strategic planning and alignment.				
Leadership	Style and skills to lead the organizational transformation.				
Culture, Change & Capability	Openness, innovation, collaboration, change resistance and management and digital capabilities and skills.				
Operating Model & Process Standardization	Processes description, operating model agility and how decisions are made.				
Digital Twin Technology	Models, external data sources, intelligent services and digital thread.				

Composable Capability Table

Periodic Table

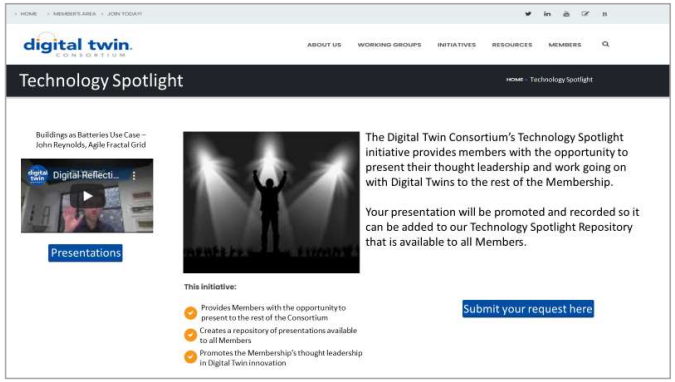


Excel Toolkit

User Guide

Technology

Technology Spotlight



Reference Library – Use Cases and Case Studies

Opportunities for Collaboration

Working Group Deliverables include but are not limited to:

White Papers	Tech Briefs	Webinars	Frameworks	Industry Round Tables	Use Cases / Case Studies

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ABOUT US WORKING GROUPS INITIATIVES RESOURCES MEMBERS

CURRENT SHOWCASES

- Buildings as Batteries
- Ecolcafé: Realizing Industry 4.0 Using Open-Source
- Upgrading Emergency Communications Services
- Scope 3 Carbon Emissions Reporting
- Manufacturing Quality Control Via Remote Operator

Welcome to the digital twin industry's definitive use case reference library

The Technology Showcase is a living journal that chronicles the evolution of digital twins. Here, you

Technology Showcase – Use Cases in Progress

Healthcare & Life Science

- Long-haul COVID Management
- Bio-mimicry in Life Science
- Senior Living / Nursing Facilitation

Infrastructure

- Buildings as Batteries
- Health assurance Buildings
- Emergency Services

Natural Resources

- Water Management
- Carbon Sequestration
- Windfarm Operations

Manufacturing

- Industrial Automation
- AI Realtime Quality Control
- Supply Chain Composability

Mobility

- Intelligent Transport
- Smart Corridors
- Fleet Charging Stations

Financial Technology

- Financial transactions
- Operational Resiliency
- Carbon Credit Futures

Buildings As Batteries

OBJECTIVE

To develop and provide an energy infrastructure to enable rural and campus communities to achieve energy security and meet renewable energy goals.

VALUE

- Operational Resiliency
- Optimized Energy Consumption
- Economic Opportunity

DIGITAL TWIN ROLE

- Performs autonomous monitoring and analysis
- Enables efficient load balancing and storage
- Provides prioritized real time optimization of energy consumption

An innovative approach to digital twins that enables decentralization of power grids at unprecedented speed and scale.

This use case provides optimization of the power, thermal, and related aspects for campuses and buildings. Through decentralization, the distribution of energy can be performed at scale. This allows unparalleled energy redistribution speeds and enables the solution to scale up to cities and states.

DOWNLOAD THE TECHNICAL SUMMARY

The solution provides templates for enabling mass customization at scale, allowing for continuous improvement based

Ecosystem Expansion

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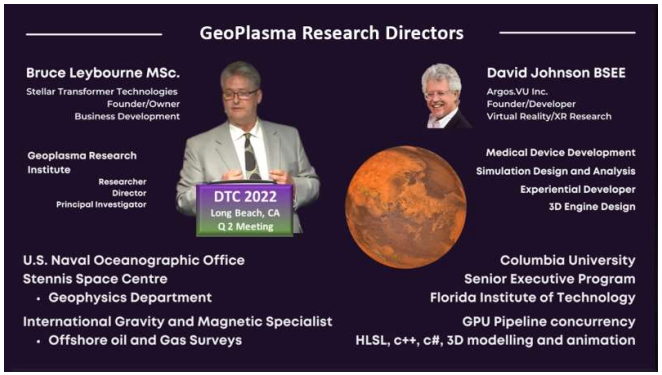
Accelerator Program

Companies Involved



Objectives & Values

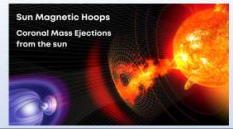
- **Objective**
  Integral step for interdisciplinary space weather & geophysics-based environmental impact predictive methodology
- **Value**
  Bottom-up approach to develop planetary weather and related environmental impact predictive forecasting
- **Digital Twin Role**
  Support development of real-world monitoring, simulation, and for improved forecasting of existing deployed solutions

Challenges

Project Overview:
Geophysical Monitoring Station – GeoPlasma Research Institute
Business Development - Stellar Transformer Technologies

Challenges to the Project:

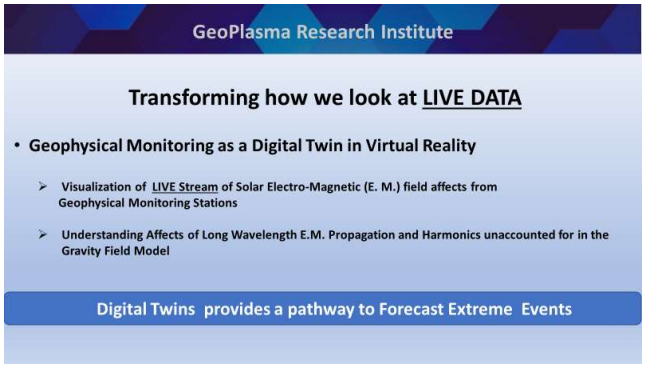
- Create a new *interdisciplinary space weather forecasting* technology
- From multiple satellite solar/earth monitoring systems using *Geophysical Intelligence*
- Combines monitoring e.m. activity in the:
  i. ionosphere
  ii. earth
  iii. power grids
- Applies "Stellar Transformer" an innovative e.m. tectonic model accounting for internal induction effects from space weather interaction
- Built on an innovative electro-dynamic model of the solar system



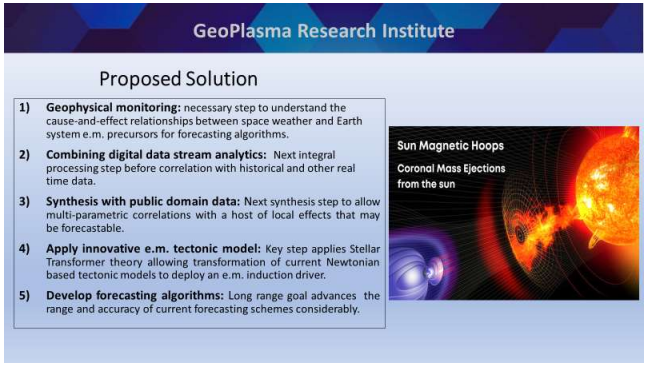
Project Highlights: Challenges & Solutions

- Geophysical monitoring - integral step
- Combine digital data stream analytics
- Synthesize with public domain data
- Apply innovative e.m. tectonic model
- Develop forecasting algorithms

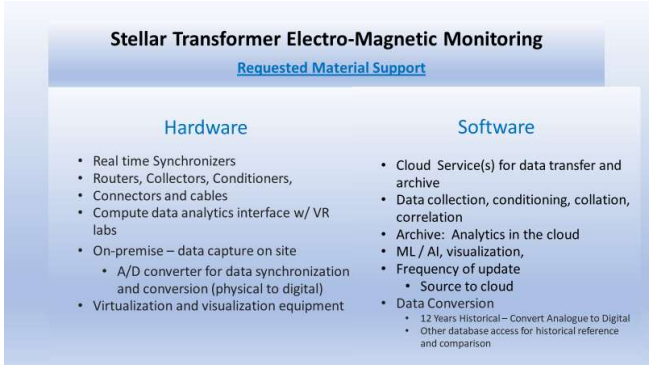
Use Case Overview



Solution Proposal

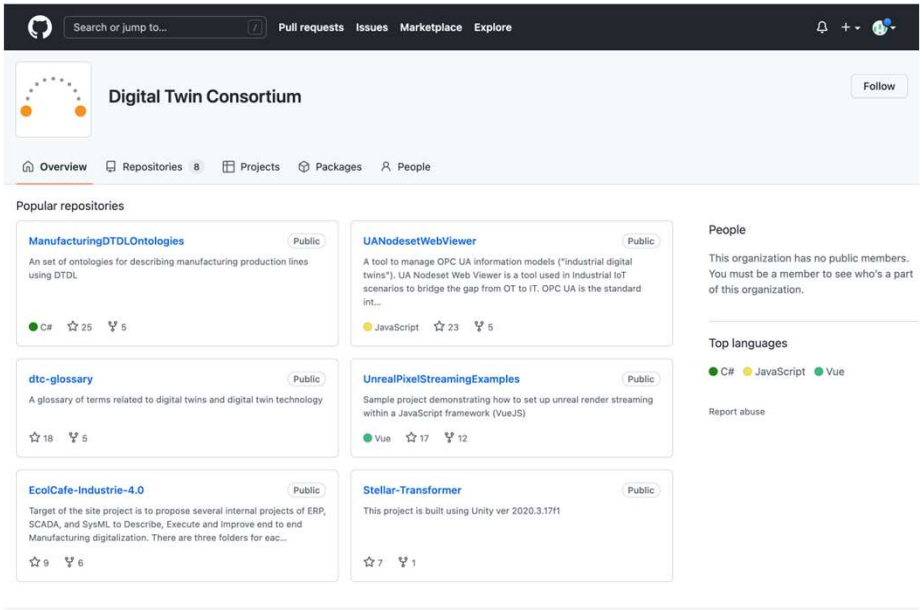


Request



Open-source Collaboration Community

GitHub projects and contribution:



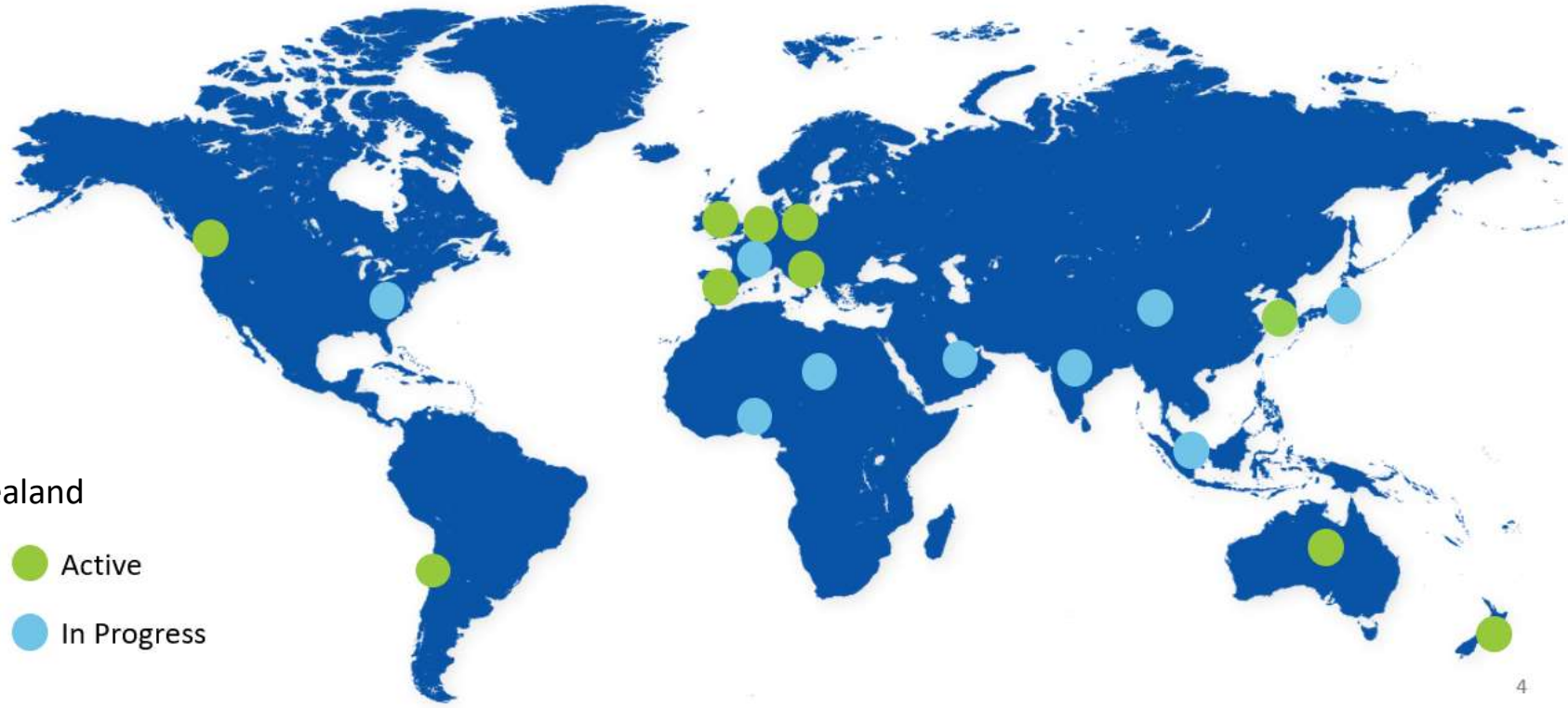
Accelerates the adoption of enabling technology and techniques

- Contributions may include:
  - Open-source code implementations,
  - Collaborative documents for guidance and training,
  - Open-source models,
  - Other assets that are of value to the digital twin community.
- Initial entries include high-profile and high-impact projects.

Global Coverage with Regional Branch Organizers

Active:

- Canada
- Chile
- UK
- Spain
- France
- Netherlands
- Italy
- Germany
- Korea
- Australia/New Zealand



Academia and Research Working Group

- **Establish Digital Twin program(s) for Academia and Universities**
  - Initial focus: Intro level - University coursework
  - Spans Introductory to advanced levels
  - Future potential for developing an entire curriculum
- **Develop Digital Twin educational programs through global outreach**
  - Work with founders and members to identify existing areas of interest and related opportunities
  - Partner with DTC Regional Branch Organizers and Liaison organizations
  - Establish an Educational Accelerator program
- **Develop Digital Twin Research & Proof of Concept / Pilot Programs**
  - Utilize Educational Accelerator program contributions/contributors related resources for project joint development
  - Publish promote results - thought leadership papers, blogs, webinars, articles, …
  - Future - establish a “Digital Twin Solution Architect” training and certification program

Liaisons – global collaboration

American Institute of Aeronautics & Astronautics

AIoT User Group

Augmented Reality for Enterprise Alliance

buildingSMART International

The Smart Manufacturing Institute

Centre for Spatial Data Infrastructures and Land Administration

Continental Automated Buildings Association

Coalition for Smarter Buildings

The FIWARE Foundation

Global Mining Guidelines Group

Global Transaction Center

International Building Performance & Data Initiative

Industry IoT Consortium

Industrial Digital Twin Association

LINUX Foundation – LF Edge/EdgeX Foundry

LINUX Foundation – Public Health

Manufacturing x Digital

National Institute of Building Sciences BIM Council

Project Haystack

Royal Institution of Chartered Surveyors

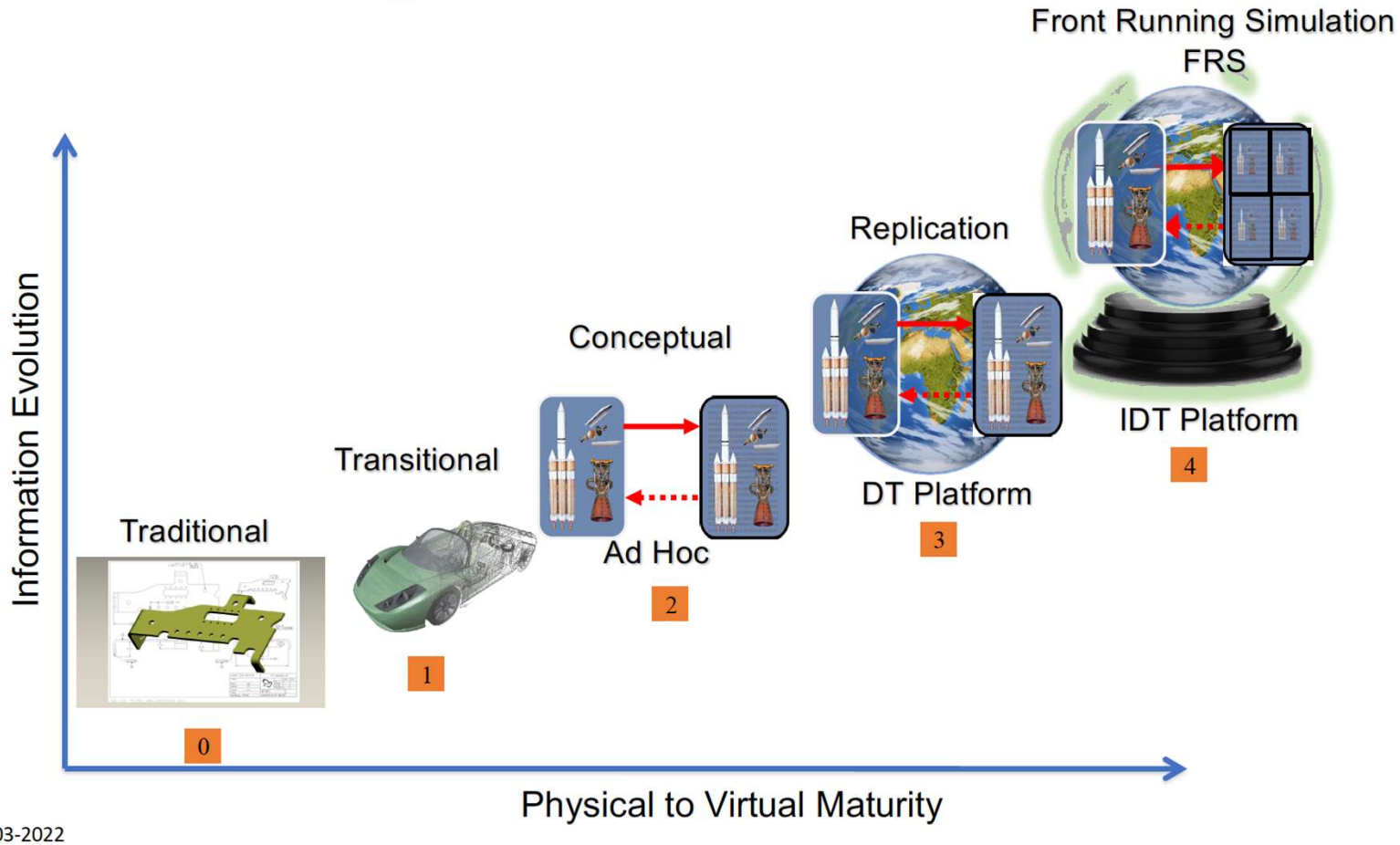
Smart Cities Council

Smart Water Networks Forum

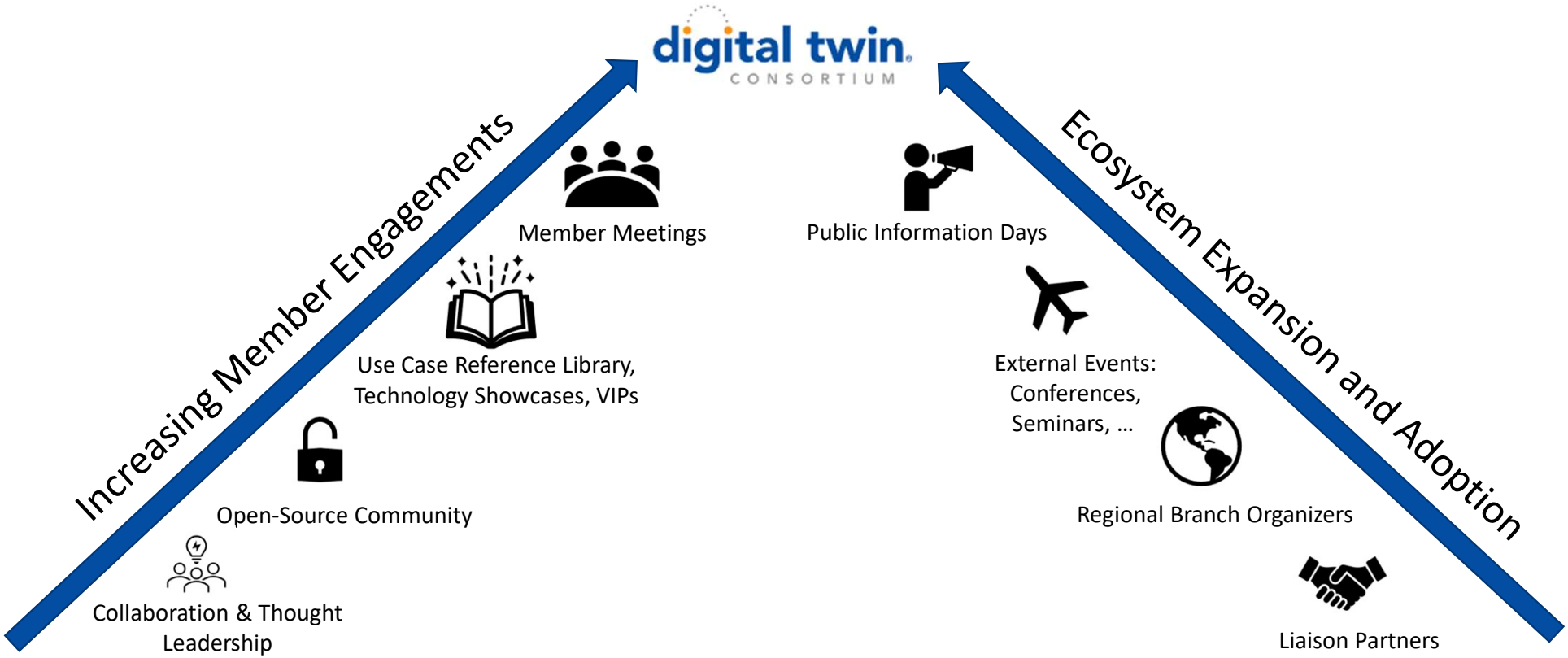
Connecting Companies, Communities, Cities and Countries

Evolution

Digital Twin Evolution



The Authority in Digital Twin



Thank You!