Executable Digital Twin

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Simcenter Experience

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Agenda

Scaling the comprehensive digital twin

Executable Digital Twin Solution

Use Cases

Conclusion

Digital Twin at a glance
Basic view

There are many definitions of a digital twin

While each vendor has a different definition, based on the maturity of their solution

Most agree on the following:

A virtual representation of a physical object

Evolves with the lifecycle

What is a Comprehensive Digital Twin and why does it matter?

- **Precise virtual representation of a physical product or process**

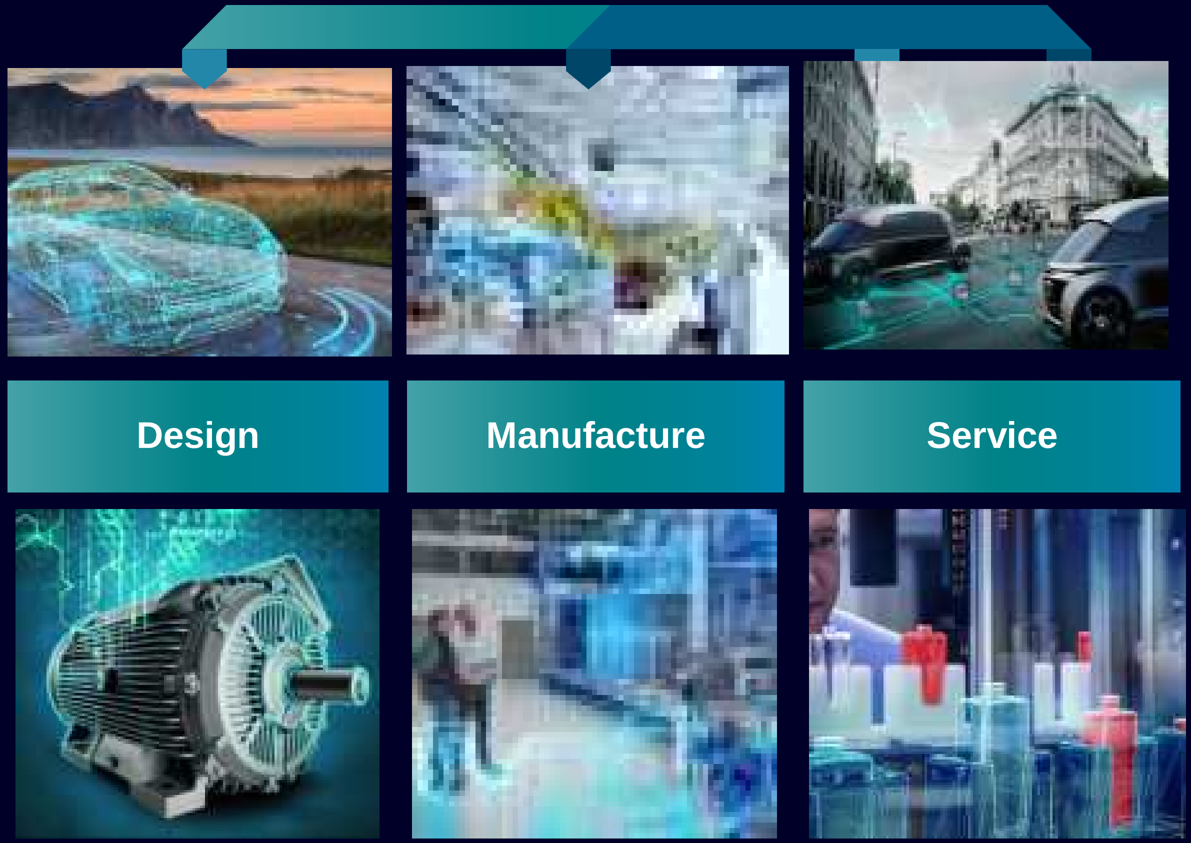
- **Used across its lifecycle to simulate, predict and optimize the product and production system**

- **Made up of multiple representations or models for different aspects of physical behavior**

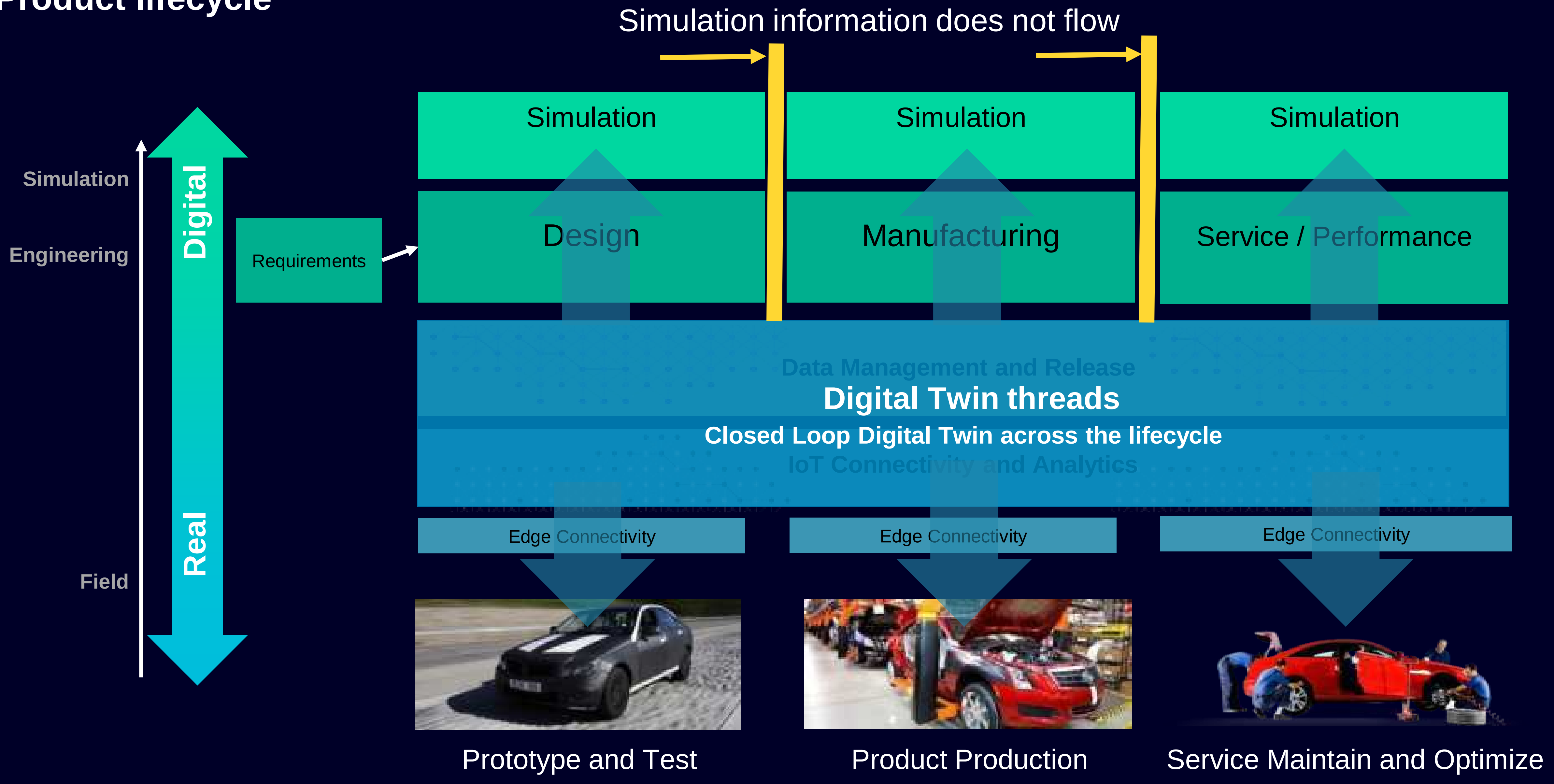
- **An evolving object with a lifecycle that needs to be managed**

- **Closed-loop digital twin provides for bi-directional connectivity between the physical asset and the virtual representation**

Provides insights to continuously optimize product and production



Product lifecycle



Product lifecycle

Simulation information does not flow

Simulation
Engineering
Field

Digital
Real

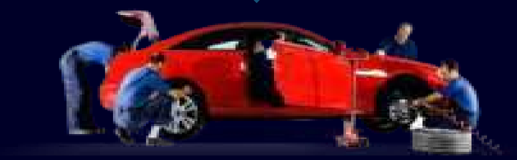
Requirements

Design	Manufacturing	Service
Simulation	Simulation	Simulation
Design	Manufacturing	Service / Performance
Edge Connectivity	Edge Connectivity	Edge Connectivity

Teamcenter
Data Management and Release
Digital Twin threads
Closed Loop Digital Twin across the lifecycle
IoT Connectivity and Analytics

Prototype and Test

Product Production



Service Maintain and Optimize

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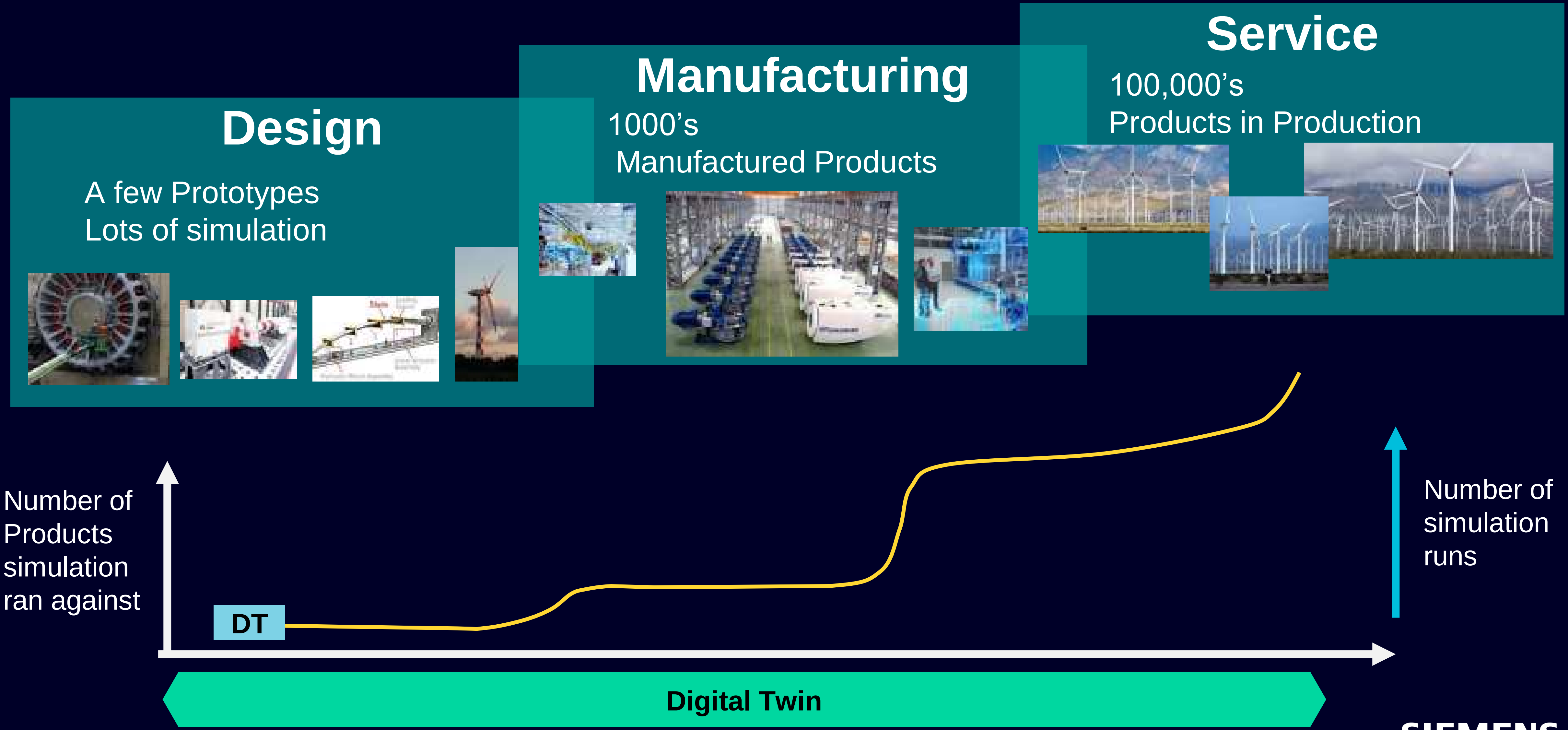
Increasing number of simulations throughout product lifecycle increases complexity



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How can we unlock the power of the digital twin models across the entire lifecycle?

Siemens Executable Digital Twin

For smarter products, systems, processes

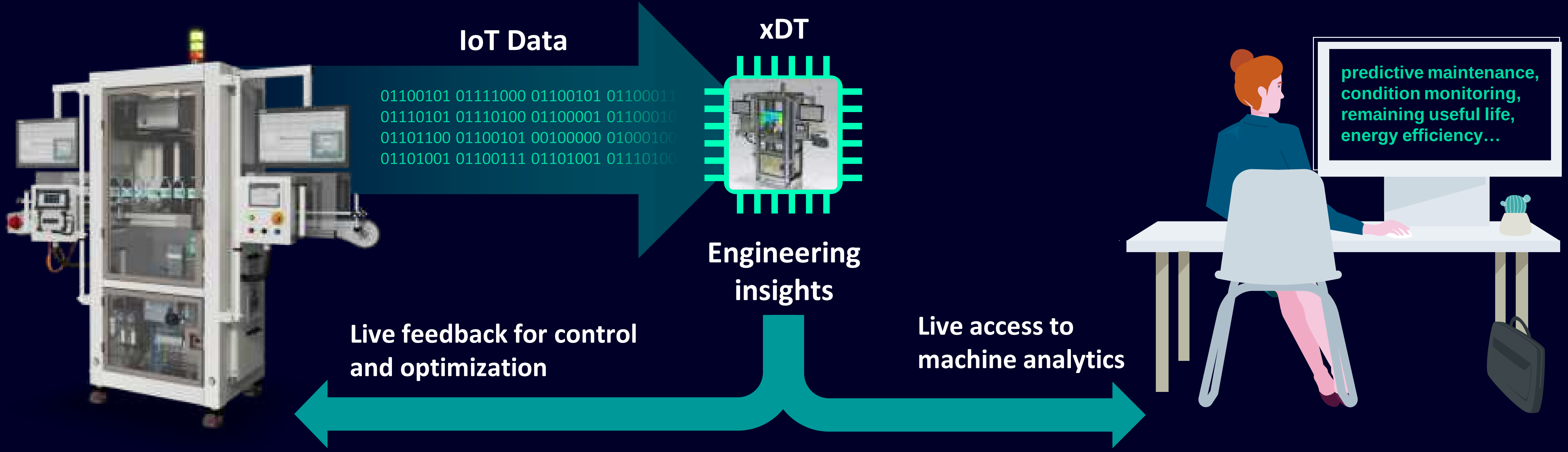
Self-contained executable digital behavior of an asset

Leveraged by anyone at any point in lifecycle

- **Developed & released by experts**
- **Real time enabled**
- **Self-adapting/calibrating**
- **No additional solvers required**
- **Deployed from edge to cloud**

Executable Digital Twin
Leverage engineering insights across the product lifecycle

An executable digital twin (xDT) creates a **live connection between virtual and real worlds**. It continuously **transforms the IoT data through simulation into engineering insights** and drives smarter products that can adapt to changes in operating conditions.



Executable Digital Twin Pillars

Accurate

Transforms live data into engineering-grade information. For single components or large, complex systems it can be used at any point in the lifecycle.

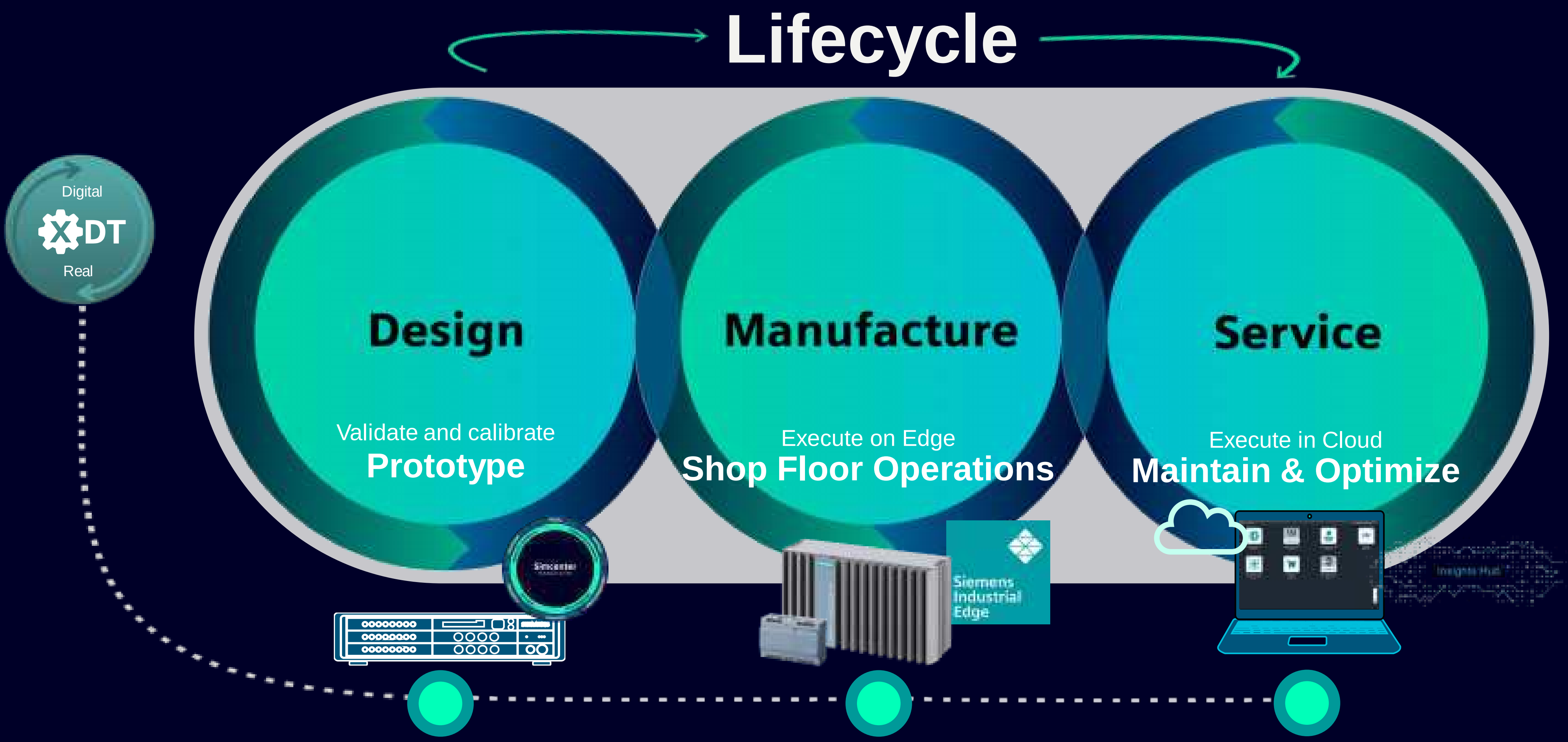
Integrated

Connected to live data, either embedded or alongside the physical system, it provides timely information that fuel real-time decisions. Independently of the original simulation model that was used to create it.

Scalable

Leverages Siemens open ecosystem to easily deploy at scale, from edge to cloud. xDT performances remain consistent regardless of the instances deployed.

xDT delivers value throughout the product lifecycle



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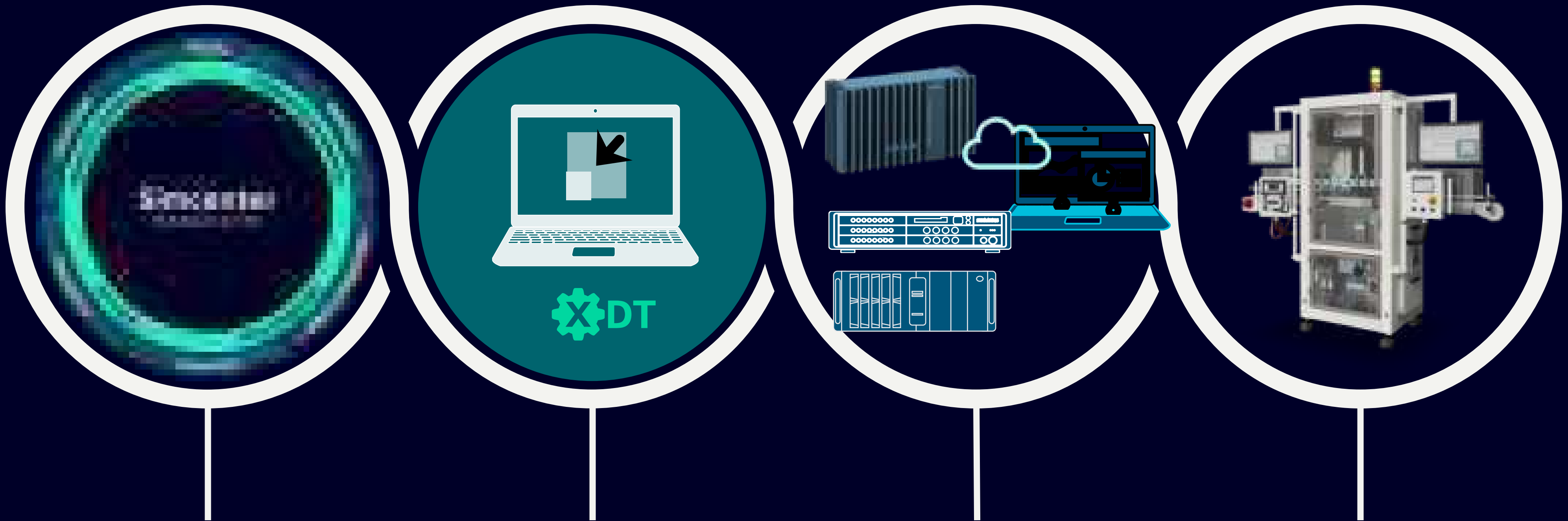
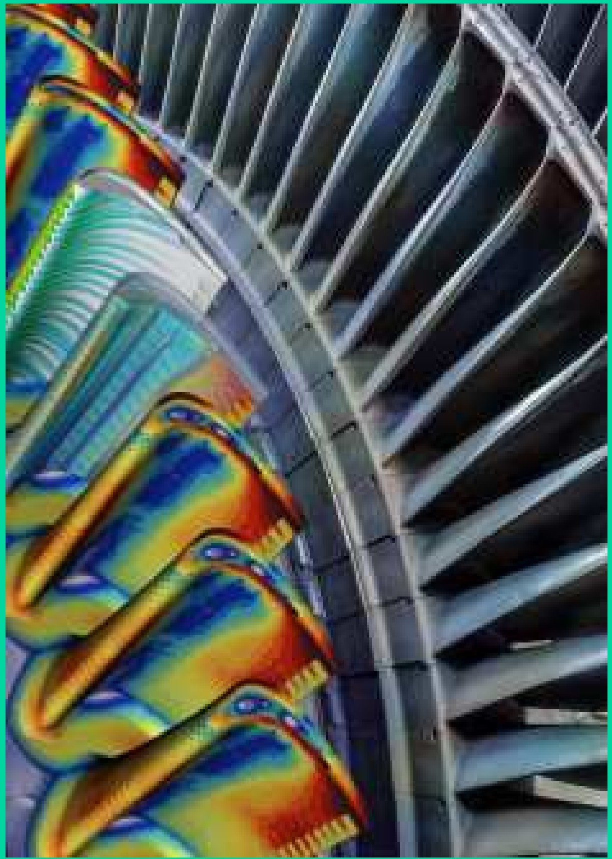
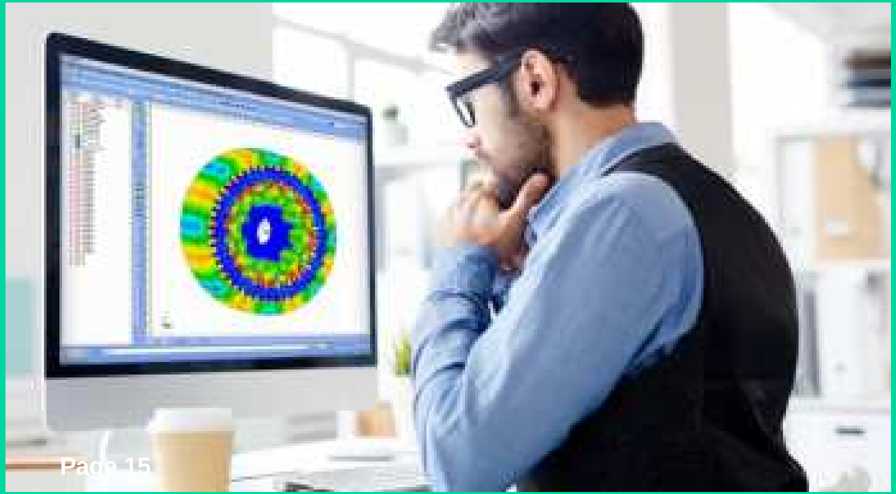
Siemens Executable Digital Twin solution



Digital Twin Creation | xDT Authoring | Deployment | Physical Asset

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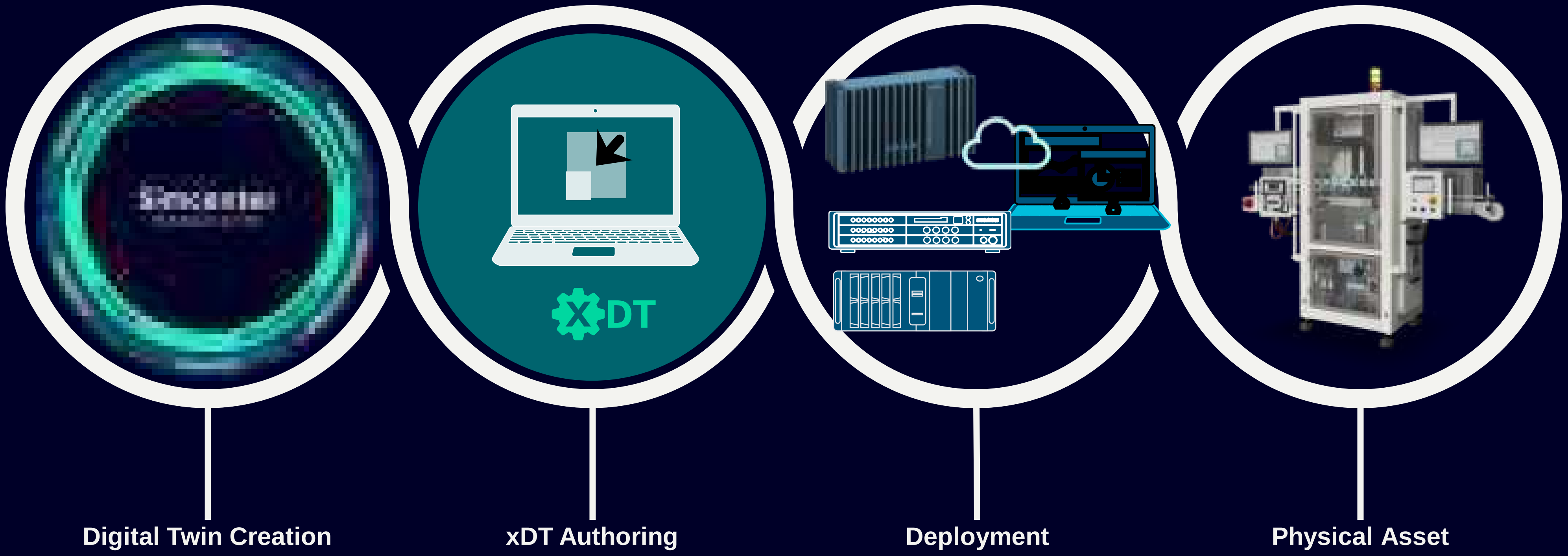
Siemens Executable Digital Twin solution



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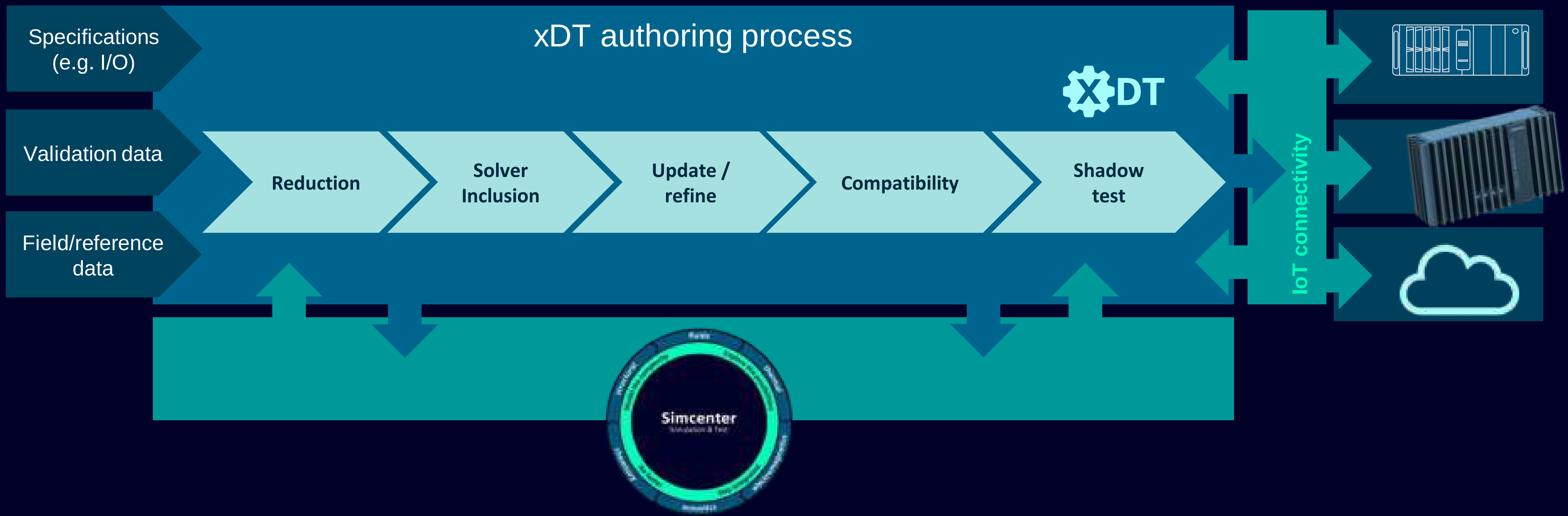
xDT Authoring
Authoring process concept



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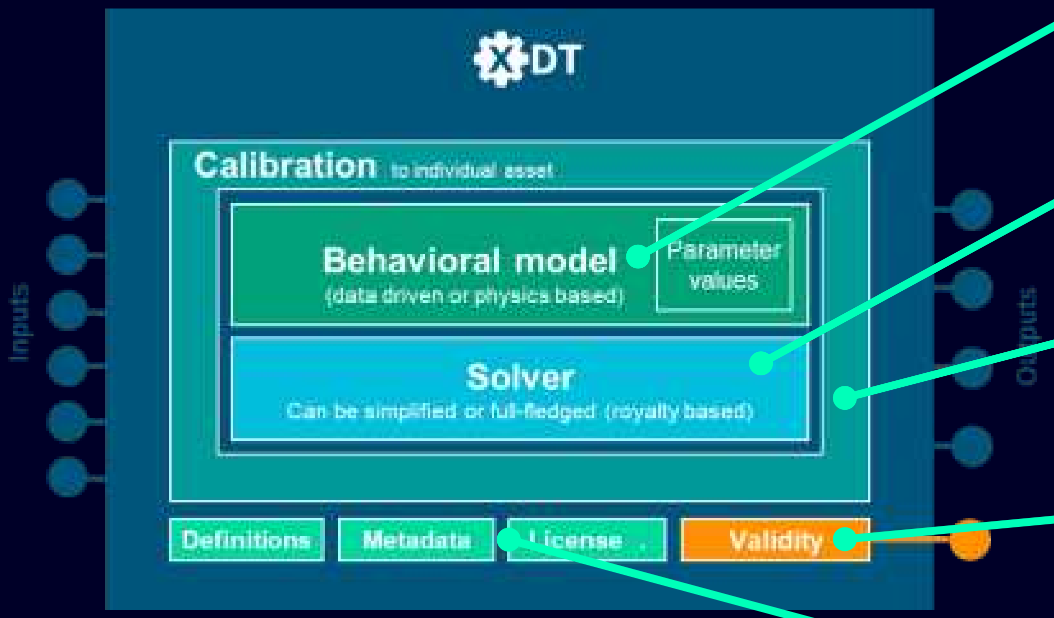
xDT Authoring

The xDT element comprises key information that makes it executable and self-contained



A behavioral model that represents the standard product it wants to describe. That behavioral model is derived from the simulation model.

The calculation engine, to run the model standalone.

A calibration loop, that ensures that this specific xDT will not just mimic the theoretical asset, but really mimics a very specific asset.

Important to realize that the model will only be valid in a specific range based on the way the model has been built.

As you use it independently, the model will need to contain all definitions of the input and output ports, all required metadata to identify the xDT and where needed also specific license information to protect the model.

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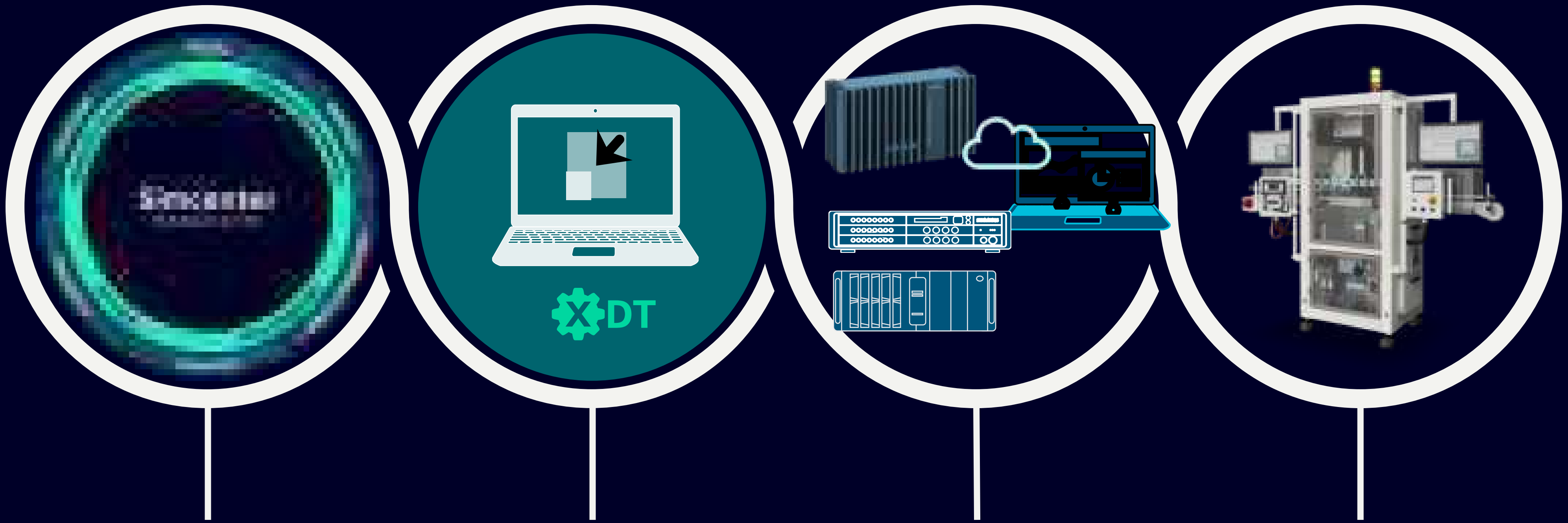
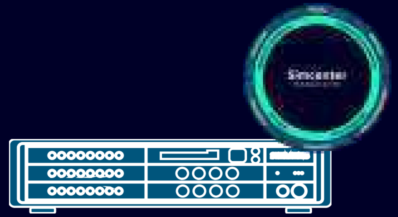
Siemens Executable Digital Twin solution



Digital Twin Creation | xDT Authoring | Deployment | Physical Asset

Executable Digital Twin
Deployment environments

MBST



- High-frequency & Hard real-time
- High-accuracy for data acquisition and processing
- Lab scale deployment for model based testing

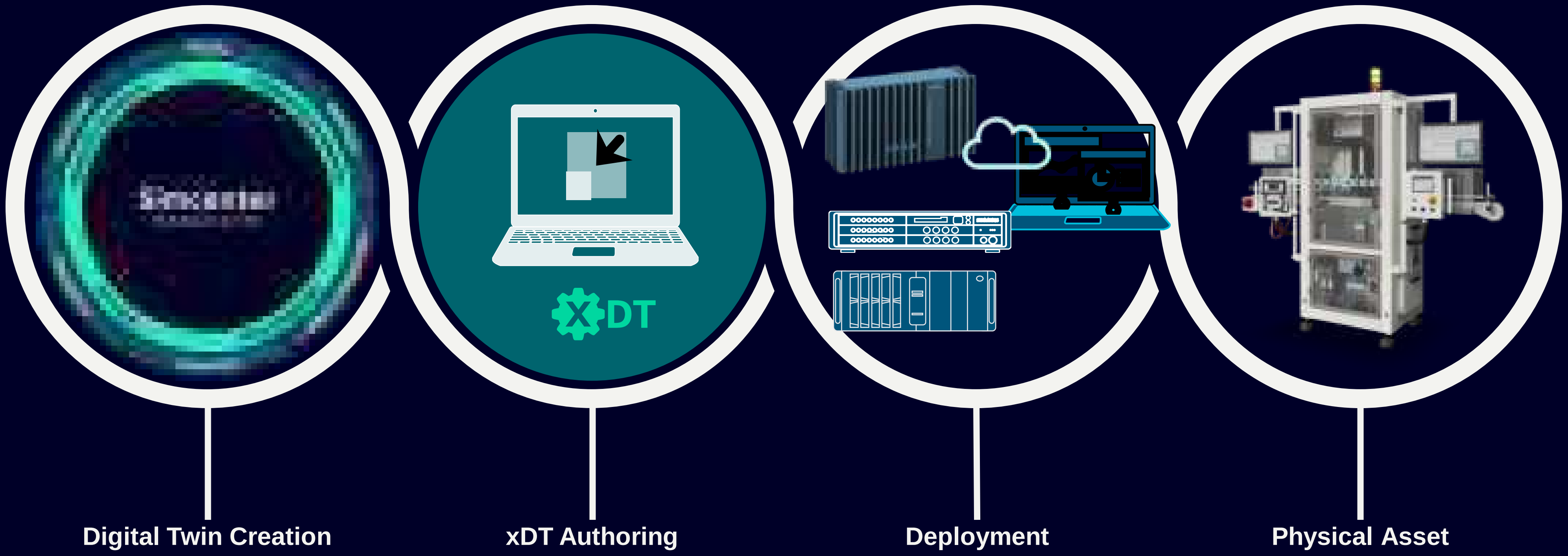
Edge

- Mid-frequency & Soft real-time
- Accurate data acquisition for factory wide deployment
- Simple interfaces to automation systems

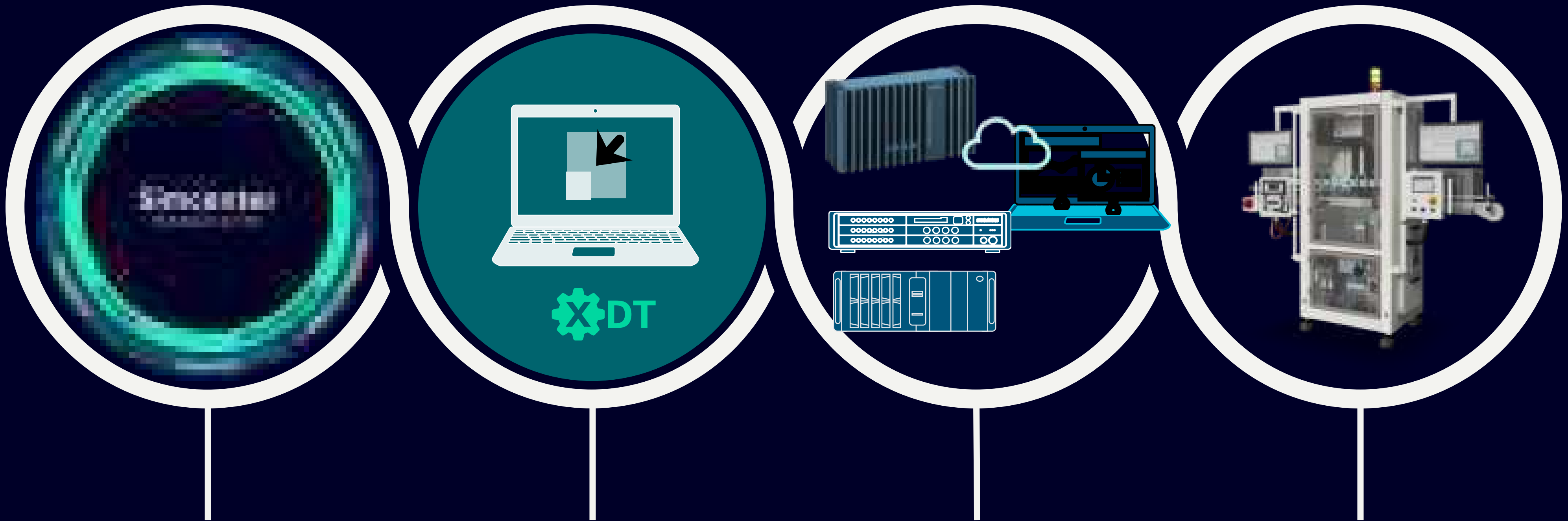
Cloud

- Low-frequency centralized data processing
- Fleet-wide KPI monitoring
- Remote access to asset performances

Siemens Executable Digital Twin solution



Siemens Executable Digital Twin solution



Digital Twin Creation | xDT Authoring | Deployment | Physical Asset

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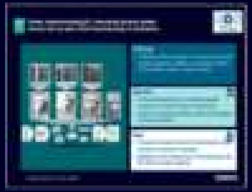
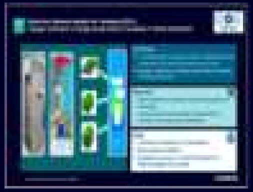
Executable DT driving business value cross industry

Aerospace/Def | Automotive | CP&G | High tech | IM/HE | Marine

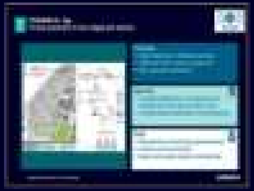
Design



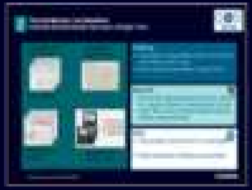


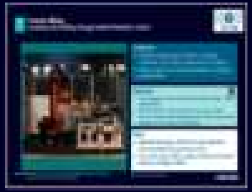
Manufacture



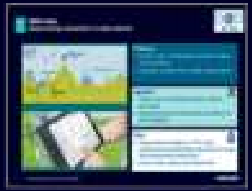
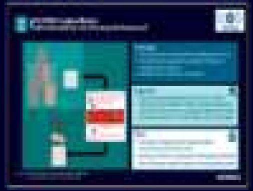





Service





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Siemens executable digital twin

Major categories of executable digital twin

xDT Category	Use this application when you want to…	Selected use cases
Virtual Testing & Commissioning	… prepare for how your asset or system would interact with other assets, systems, or people.	• Testing of automation by virtual commissioning • Testing new control strategies on gas turbines • Operator training
Virtual Sensing	…measure something in your asset or system where it isn't feasible to put a sensor.	• Temperature inside electric rotor • Pressure distribution inside a gas turbine • Free-flow inside a sewage network
Diagnosis & Identification	…know why your asset or system is behaving the way it is.	• Unbalance detection of large rotors • Leakage detection in a water distribution network • Predictive maintenance for machine tools
Performance Prediction	…know how your asset or system might behave in future operation.	• Remaining useful lifetime of electric motors • Monitoring of coking in steam cracking furnaces • Movement of people in emergencies
Performance Optimization	…inform actions on how to control the asset or system (with or without a Human-in-the-Loop).	• Model predictive control of a chemical reactor • Pump schedule optimization of oil pipelines • Operating point setting of catalyst modules

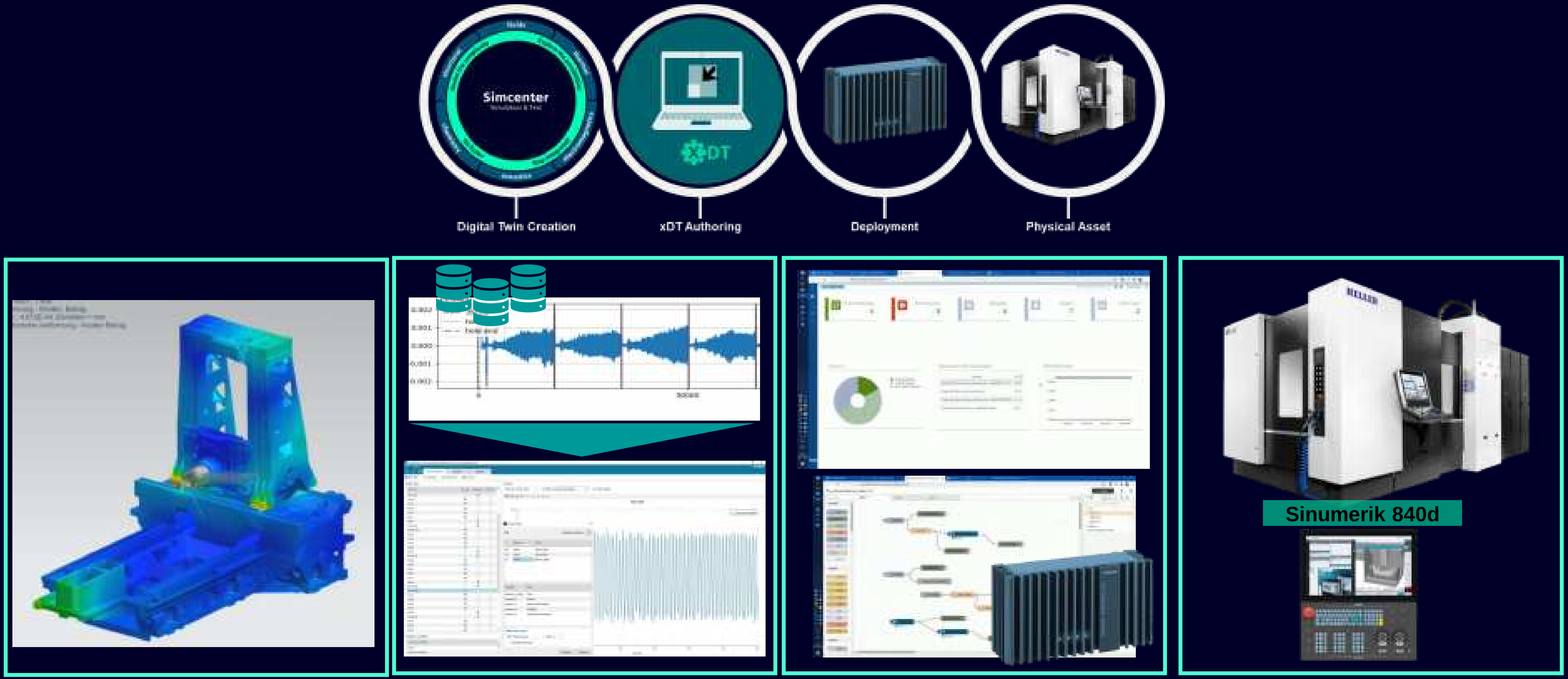
Improve machine diagnosis with brownfield compatibility

Challenge

- Metal chips from machining get stuck in the clamping system of the spindle
- Vibration of the tool leads to lower quality
- Current strategy is to clean the clamping at each tool change

Heller Use Case

Intelligent automation with Executable Digital Twin

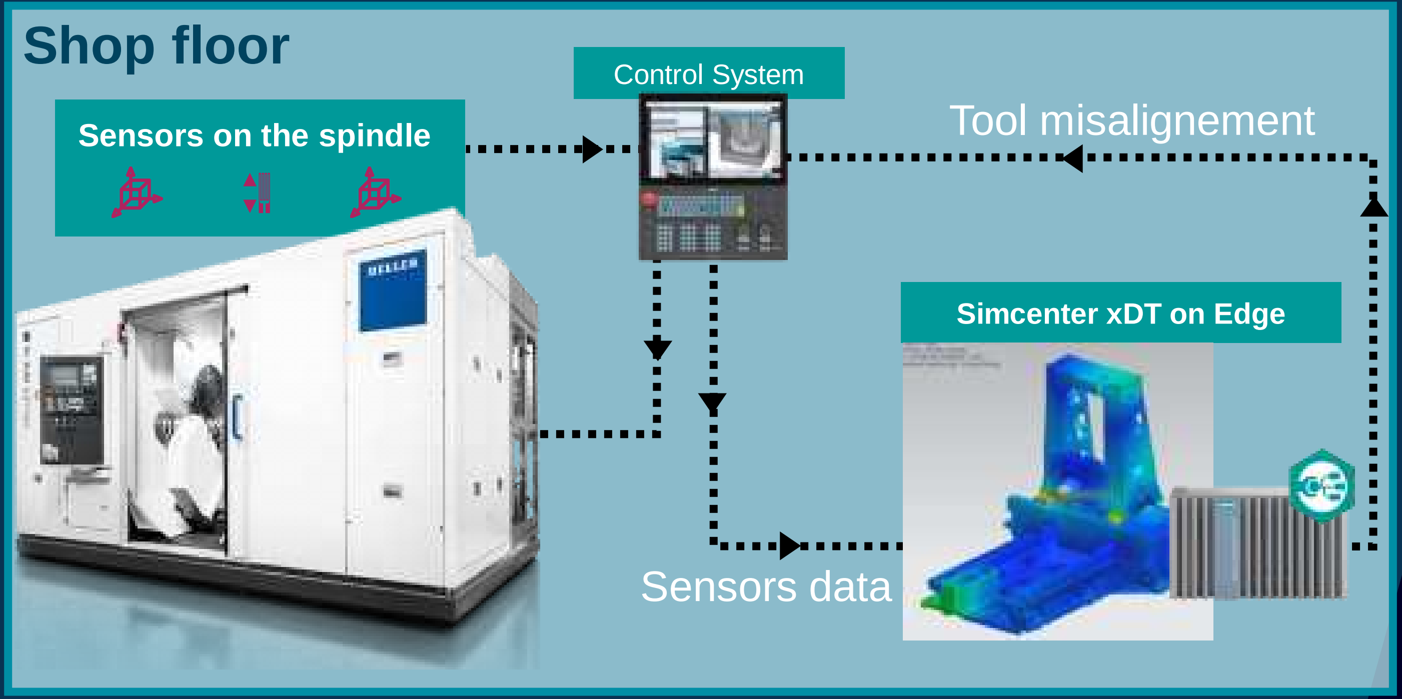


Improved machine diagnosis with brownfield compatibility

HELLER

Challenge

- Live detection of tool misalignemnt using existing sensors



400ms Detection time

20 µm Accuracy

25% Increased Productivity

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Improved operational control and performance while reducing costs

Enhanced information

xDT provides a path to a digital future

>10% Reduction on operational costs

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Improve operational efficiency of water reservoirs

Challenge

Over/underfilling the reservoirs causes shortages

Uncertainties in the piping layout and impossibility to measure in some locations

Current control strategy relies on operator experience

Solution

Real-time full-fidelity model providing virtual measurements of fluid flows, liquid levels and energy usage. This enables the smart control of the plant and increase sustainability.

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Impact of new bio-based material for packaging production

Challenge

- Simulate and understand the impact of bio-based materials for pouches
- Film cracks stopping the production and causing downtimes
- Cause of failures cannot be controlled in real time

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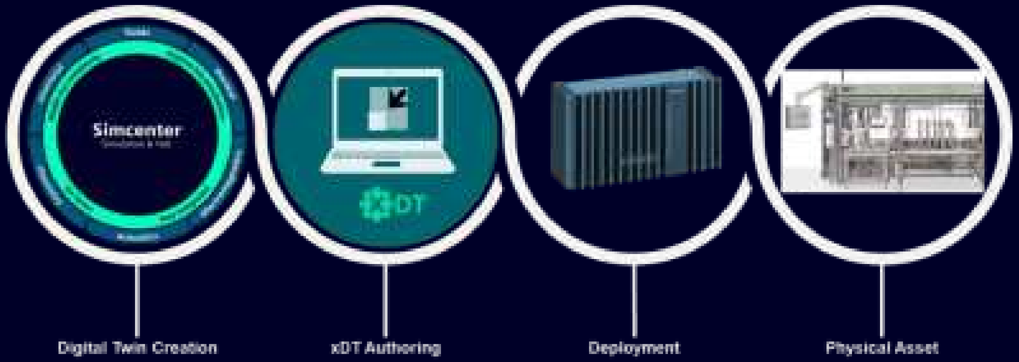
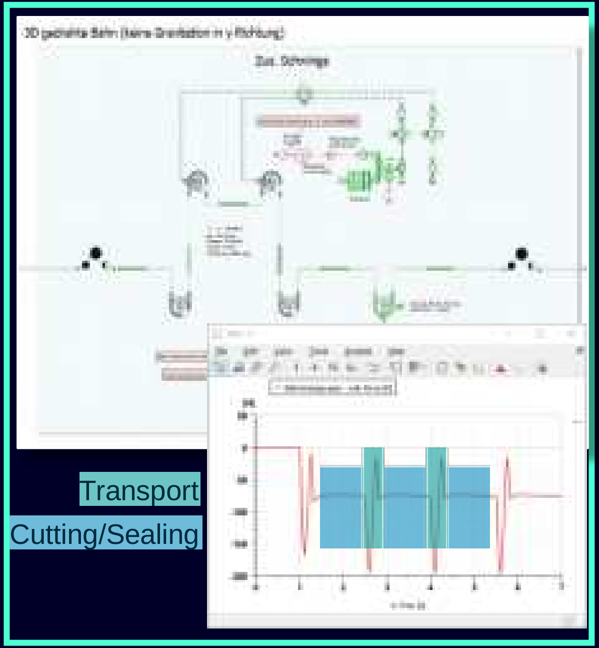
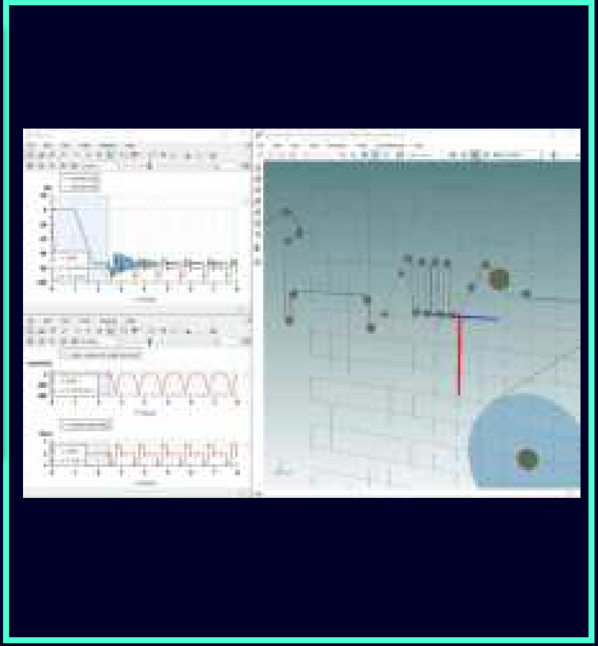
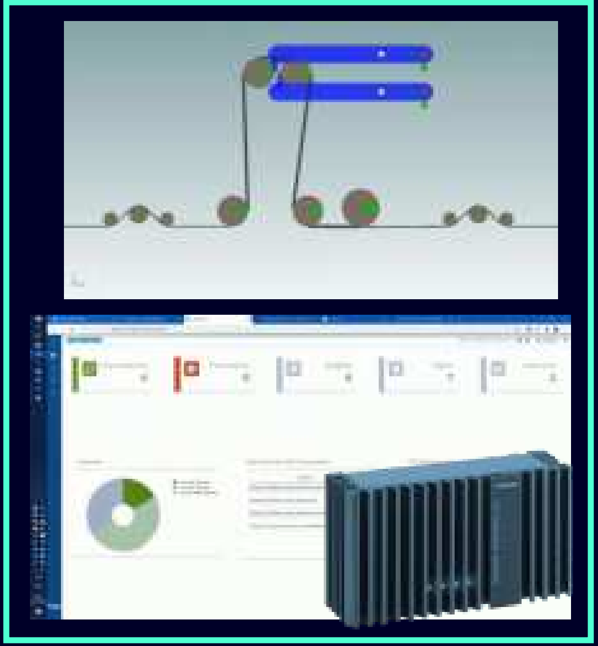
SN – Impact of new bio-based material for packaging production









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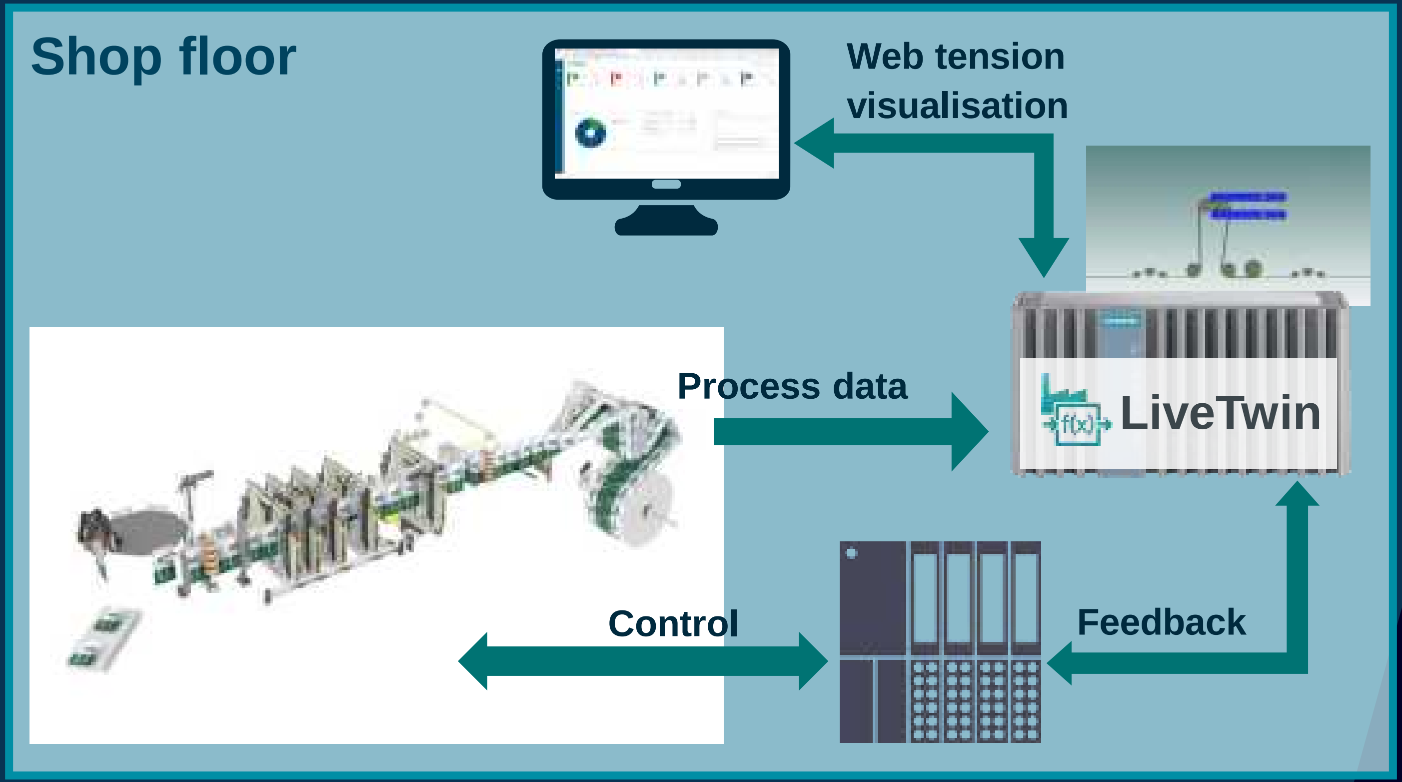
SN – Impact of new bio-based material for packaging production

Challenge

- Control optimization to prevent film rupture



Improved model calibration

Improved product performance

Improved service offerings

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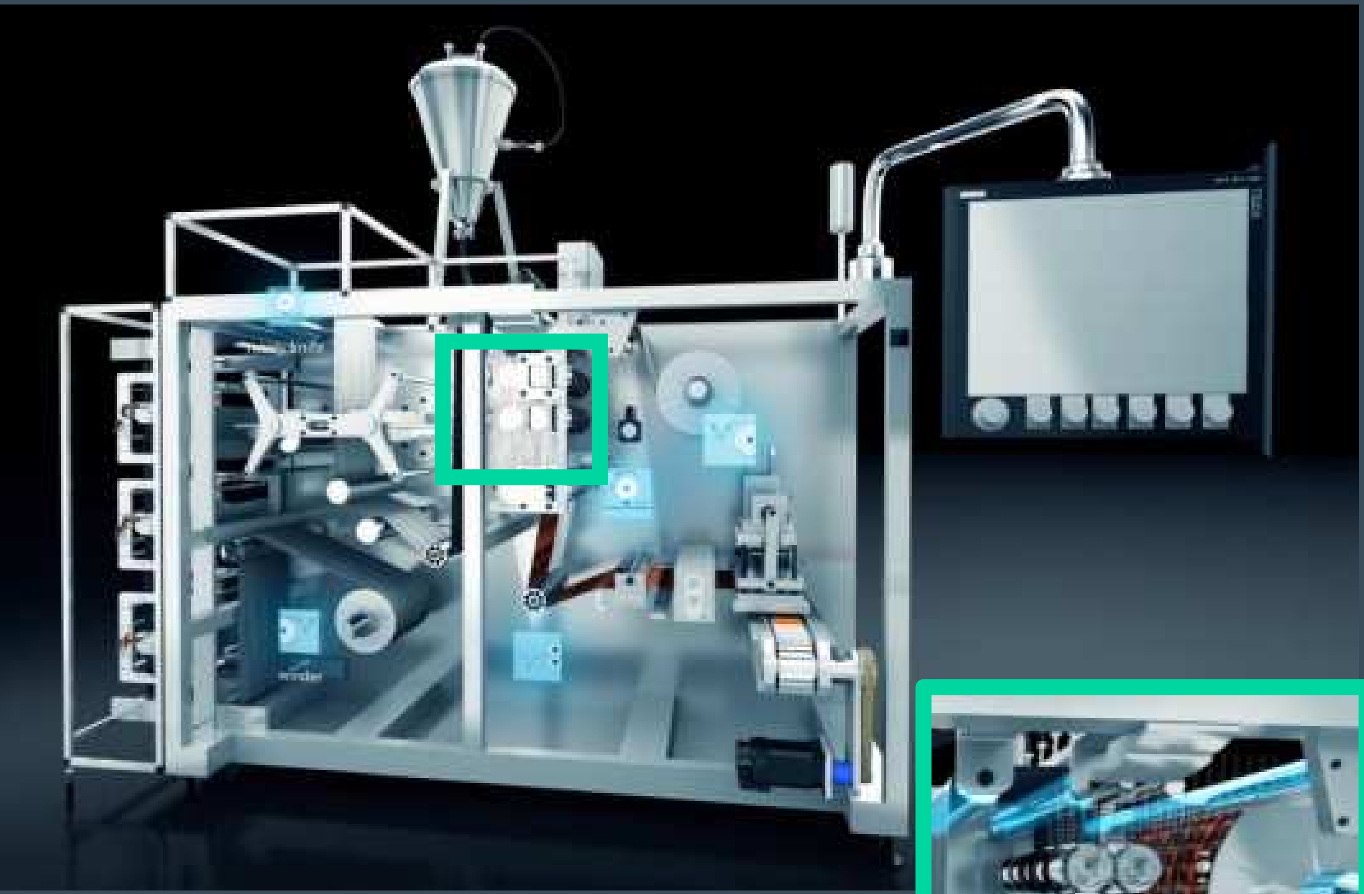

Roller welding optimization for plastic packaging

Challenge

- Understand the thermal behavior of the roller
- Identify and diagnose eventual failures without stopping production
- Update control strategy to maximize productivity

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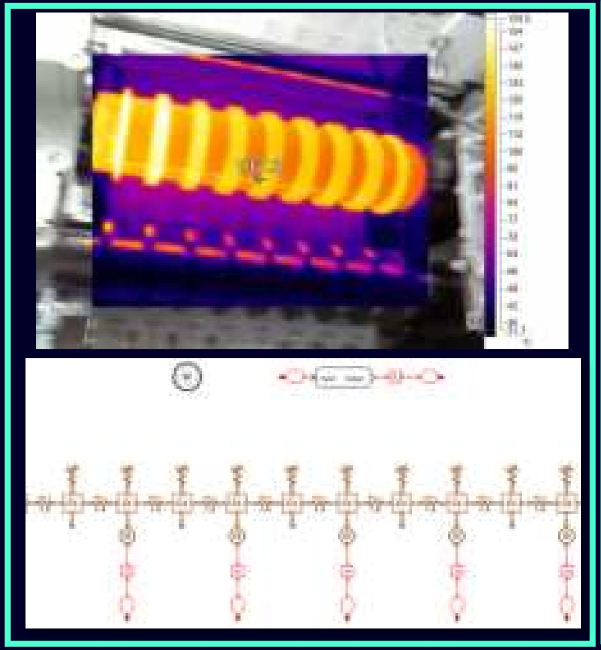
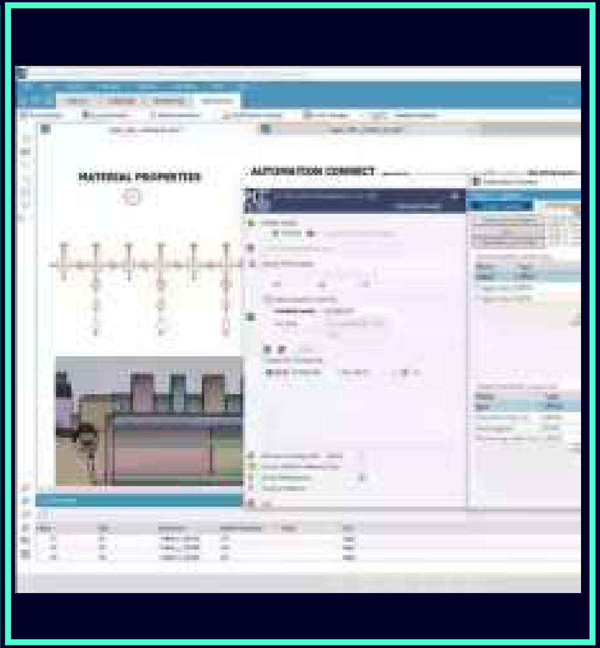
Roller welding optimization for plastic packaging





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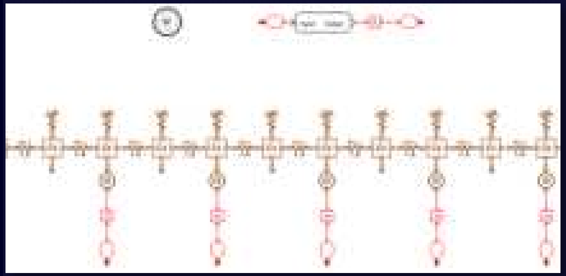
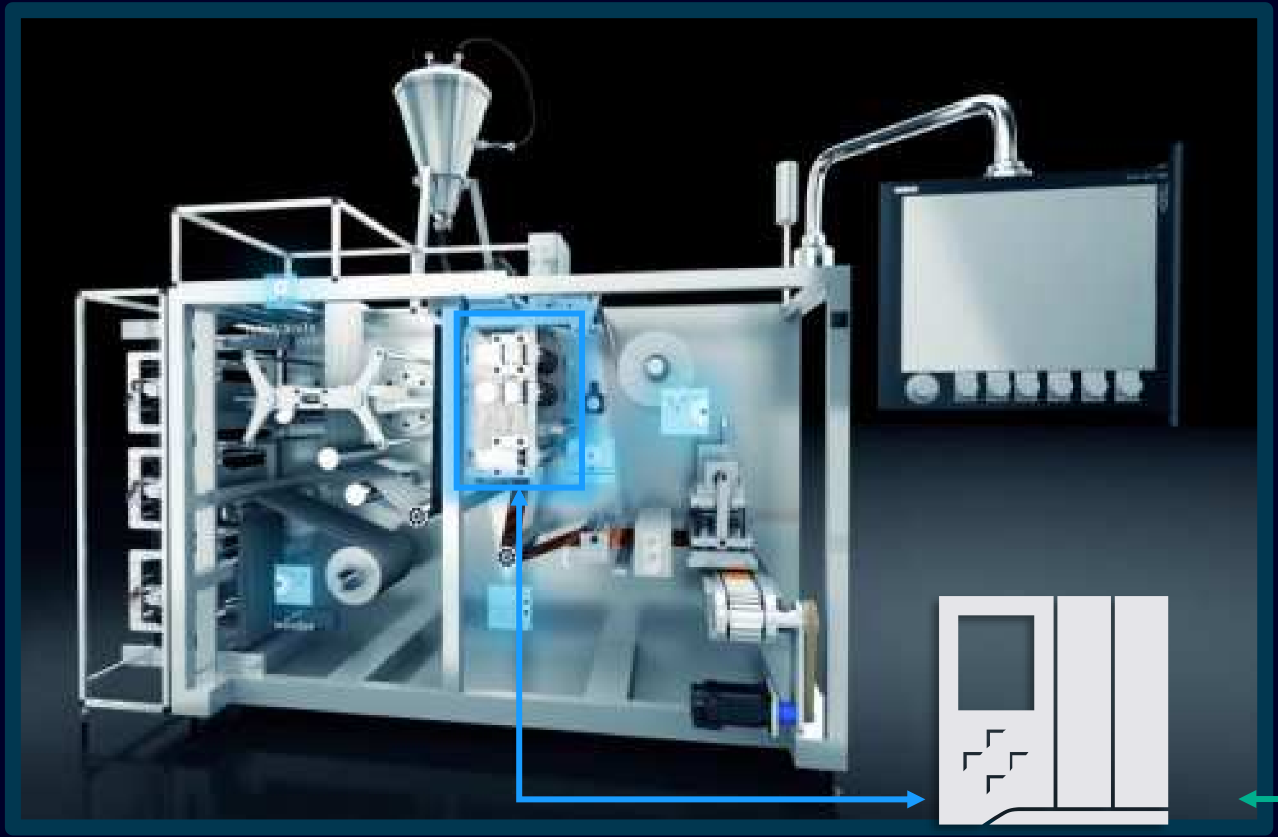
Roller welding optimization for plastic packaging

Real-Time Visualization
of each teeth of the welding roller

Industrial Edge Device (IPC 227E)





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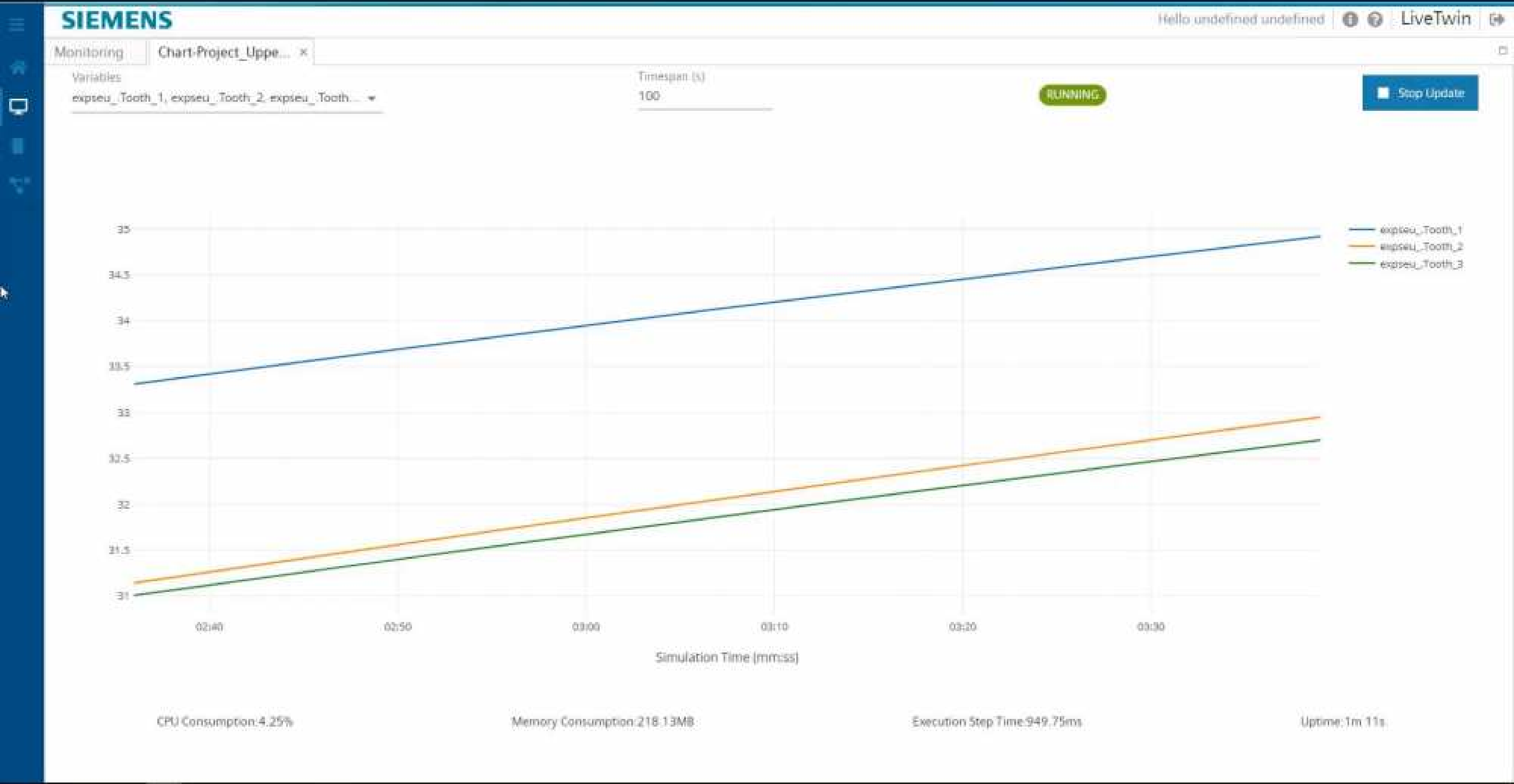
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Hello undefined undefined
LiveTwin
Monitoring
Chart-Project_Uppe...
Variables
expseu_.Tooth_1, expseu_.Tooth_2, expseu_.Tooth...
Timespan (s)
100
RUNNING
Stop Update
35
34.5
34
33.5
33
32.5
32
31.5
31
02:40
02:50
03:00
03:10
03:20
03:30
Simulation Time (mm:ss)
expseu_.Tooth_1
expseu_.Tooth_2
expseu_.Tooth_3
CPU Consumption:4.25%
Memory Consumption:218.13MB
Execution Step Time:949.75ms
Uptime:1m 11s

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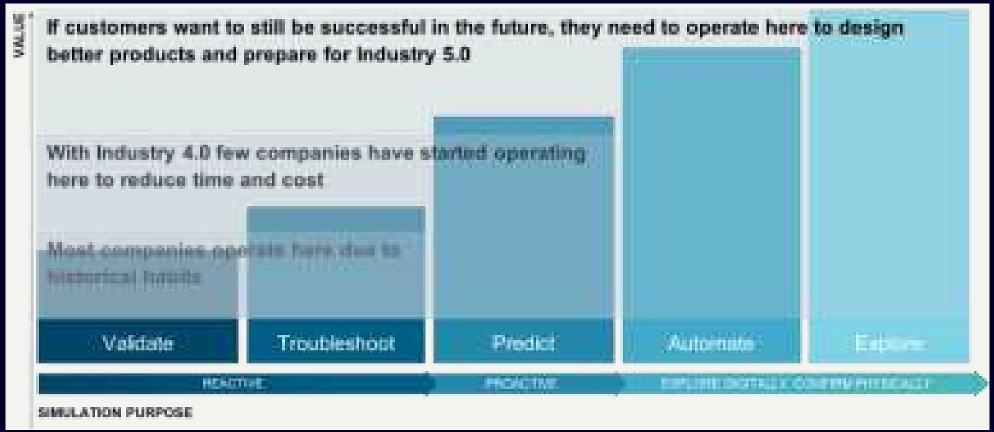
Conclusions
Key takeaways

Smart Production is going to introduce new challenges and companies need tools and technology to frontload them

Digital twin in combination with **smart control algorithms** are the key enablers for **reaching target** KPIs within **reasonable time and cost**



Siemens portfolio covers the **full solution** from the realization of the **digital twin** to **cloud based data storage** system, data analytics and **control development and integration**

Executable Digital Twin is the right solution to make **smart usage** of all the **data and information** collected from the field during plant operation to **optimize the production process**

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Thank you!

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