The role of Simulation and AI in the implementation of a Digital Twin

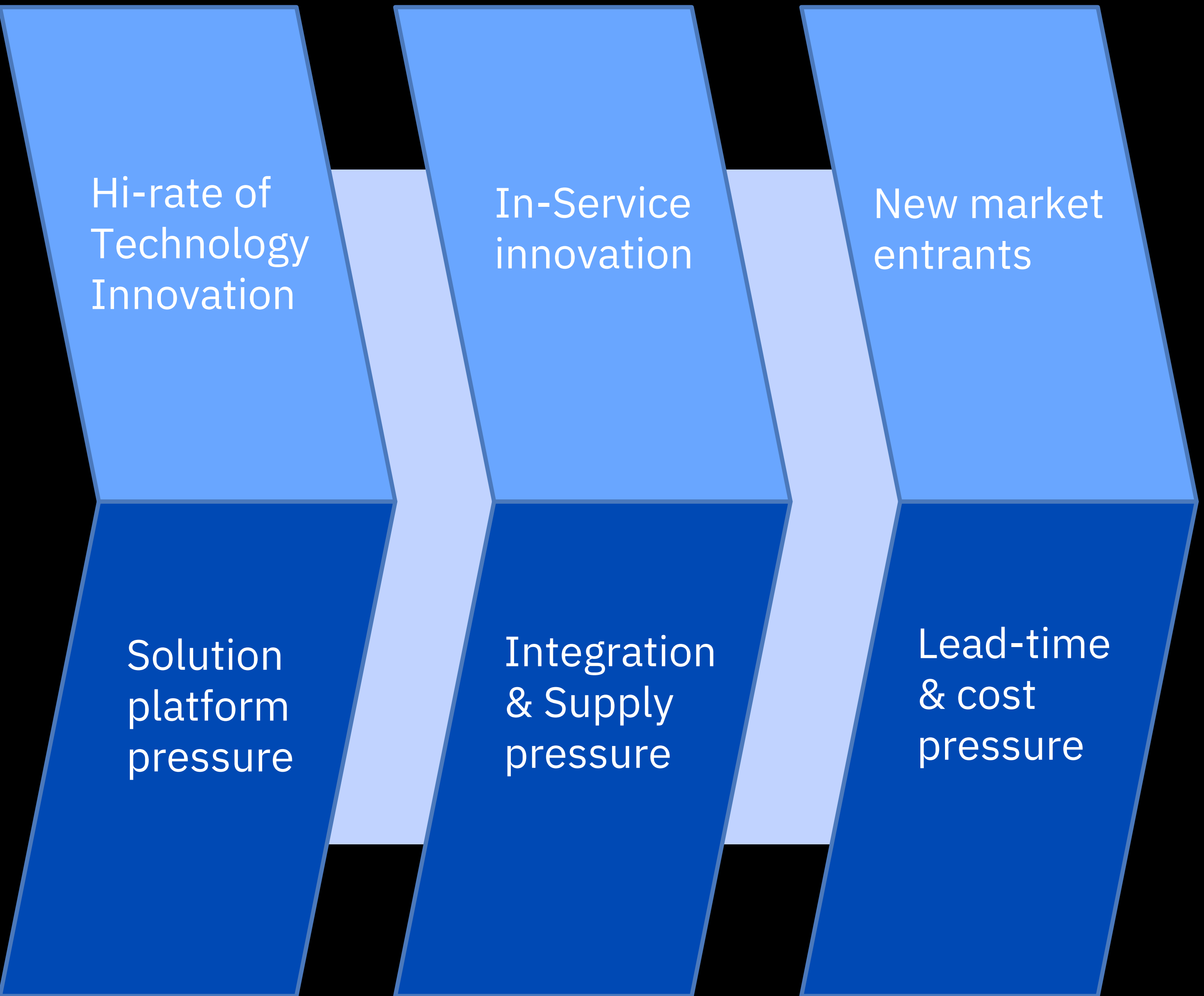
Dr. Graham Bleakley. IBM
Offering manager Modelling and MBSE solutions

Graham.bleakley@uk.ibm.com

Outline

- Todays challenges
- Main areas of interest from our customers
- Introduction to Digital Twins
- Different types of Digital Twin
- How IBM supports the Digital Twin
- Use cases for Digital Twins
  - Demo example

Today’s leaders of systems solutions face significant challenges
In 2019 how to find new sources of productivity and acceleration….



Unprecedented opportunities & challenges for technology companies

Engineering remains at the heart of innovation

How to move engineering & innovation to a new level ?

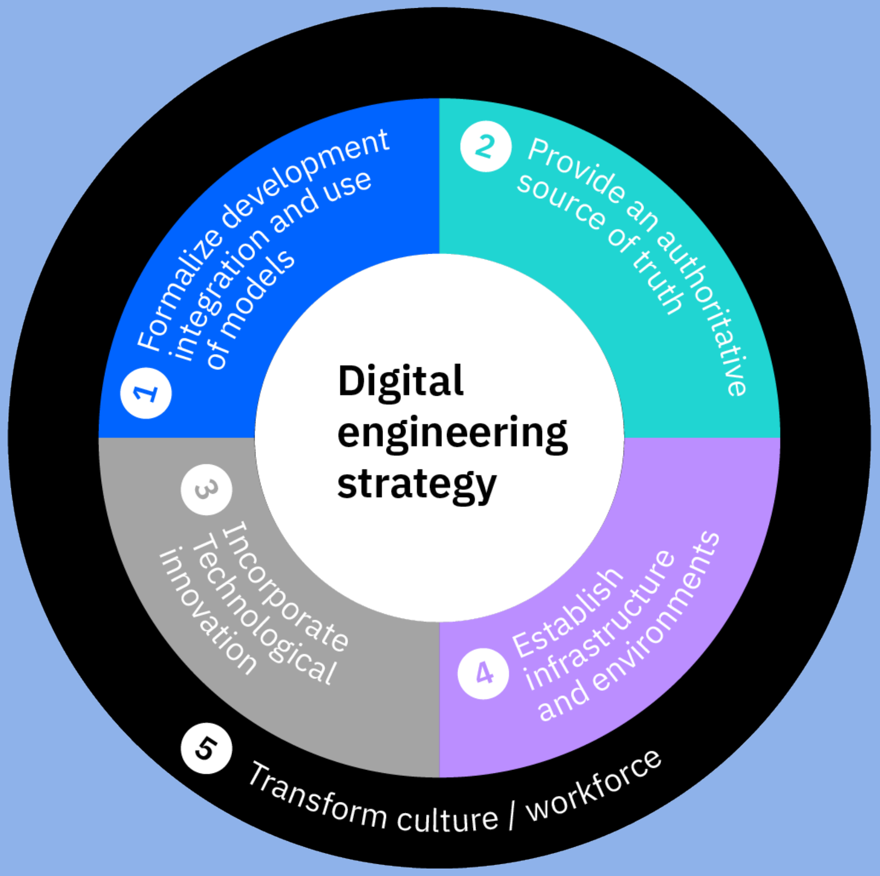
Predictability
Productivity
Quality
Flexibility

Industry vision: Digital Engineering initiative by US Department of Defense

*“**conduct engineering in more integrated virtual environments** to increase customer and vendor engagement, improve threat response timelines, [..], reduce cost of documentation and impact sustainment affordability.*

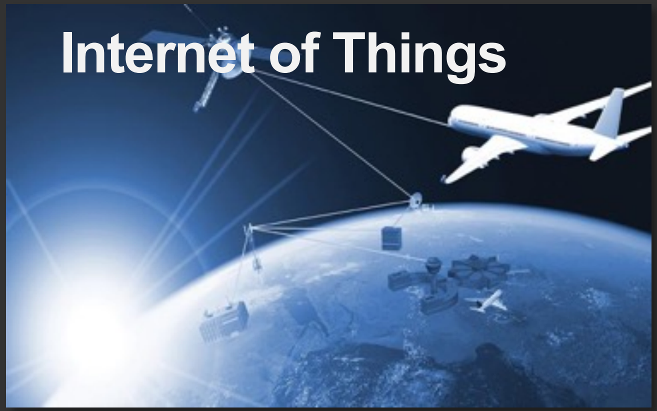
Such engineering environments will allow DoD and industry partners to evolve designs at conceptual phase, reducing the need for expensive mockups, premature design lock, and physical testing.” [1]

1. DoD Digital Engineering Initiative: https://www.acq.osd.mil/se/initiatives/init_de.html



Some key concepts to support Digital Transformation in A&D

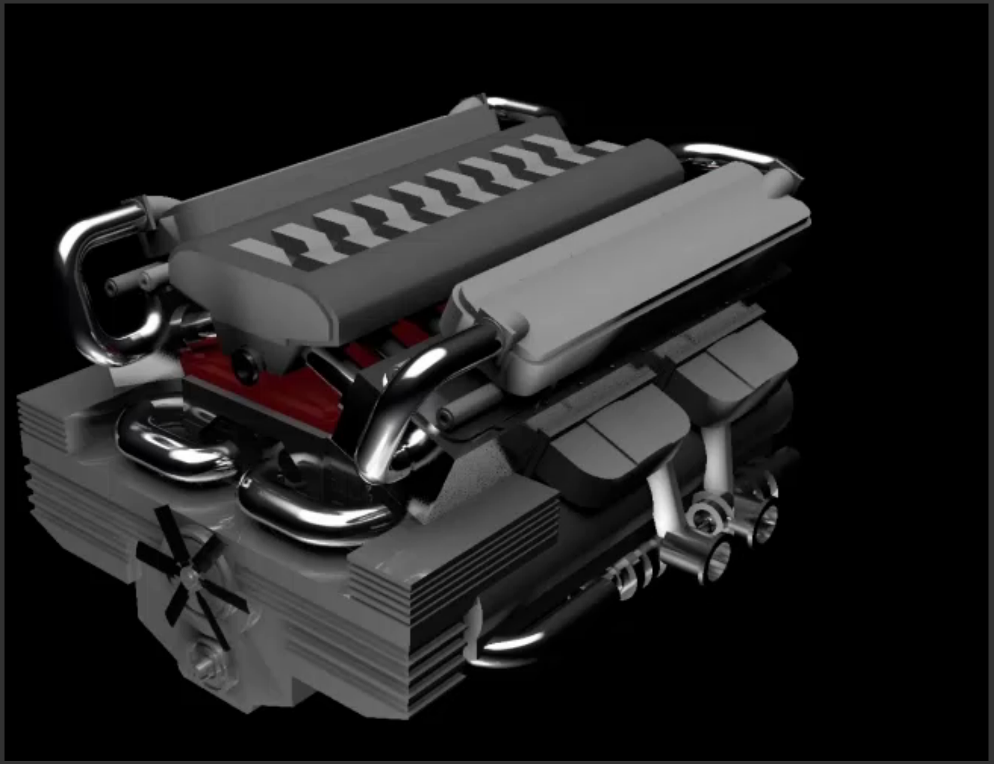
Engineering
for Connected Products



Cyber Physical System
for Connected
Operations/Products

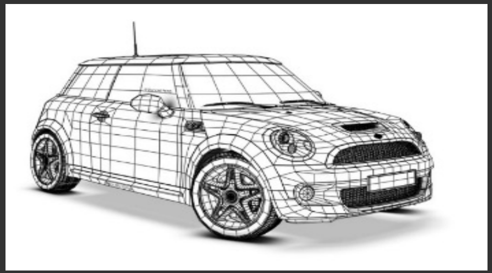
What is a Digital Twin?

“The Digital Twin is the virtual, state-full representation of a physical product and the system behind across its life-cycle using operational real-time data and other sources to enable understanding, learning, reasoning, and dynamically recalibrating for improved decision making"



Digital Twin is a journey

Prototype Twin



As designed

- Model-Based Systems Engineering

No physical object

No real-time data

Production Twin

As built

- Simulation-model with real-time data

Service Twin

As maintained

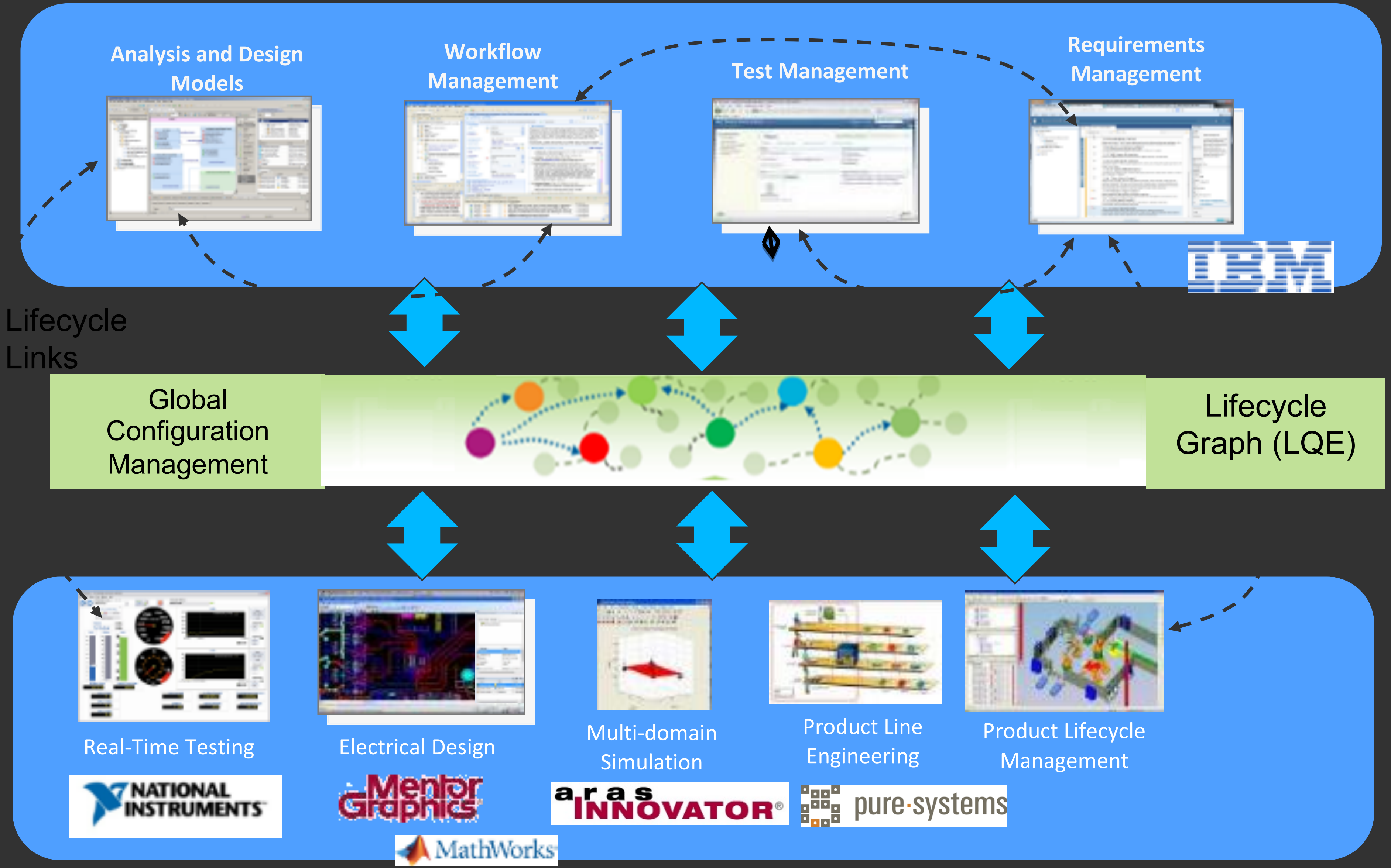
- Prediction
- Augmented Reality

Physical object

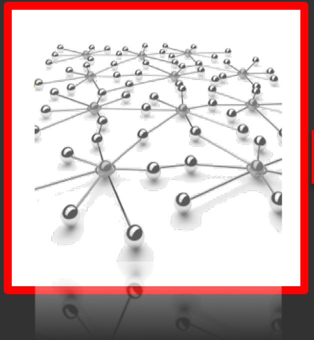
Real-time data

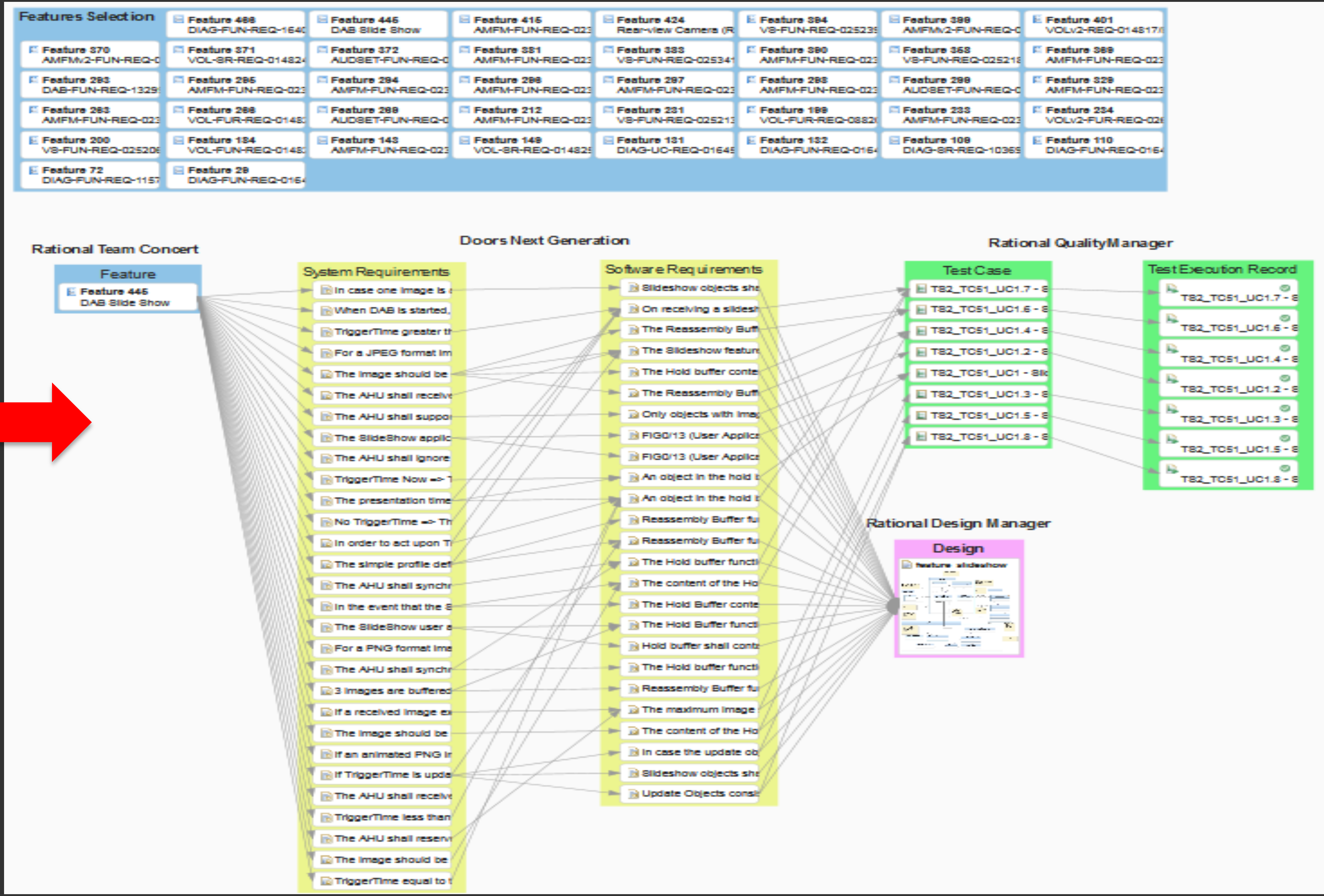
Digital Thread for engineering collaboration

- A standards based engineering lifecycle management architecture and technology platform
- Linking data across disciplines and tools
- Central lifecycle knowledge graph for analytics
- Global configuration management for federated lifecycle tools

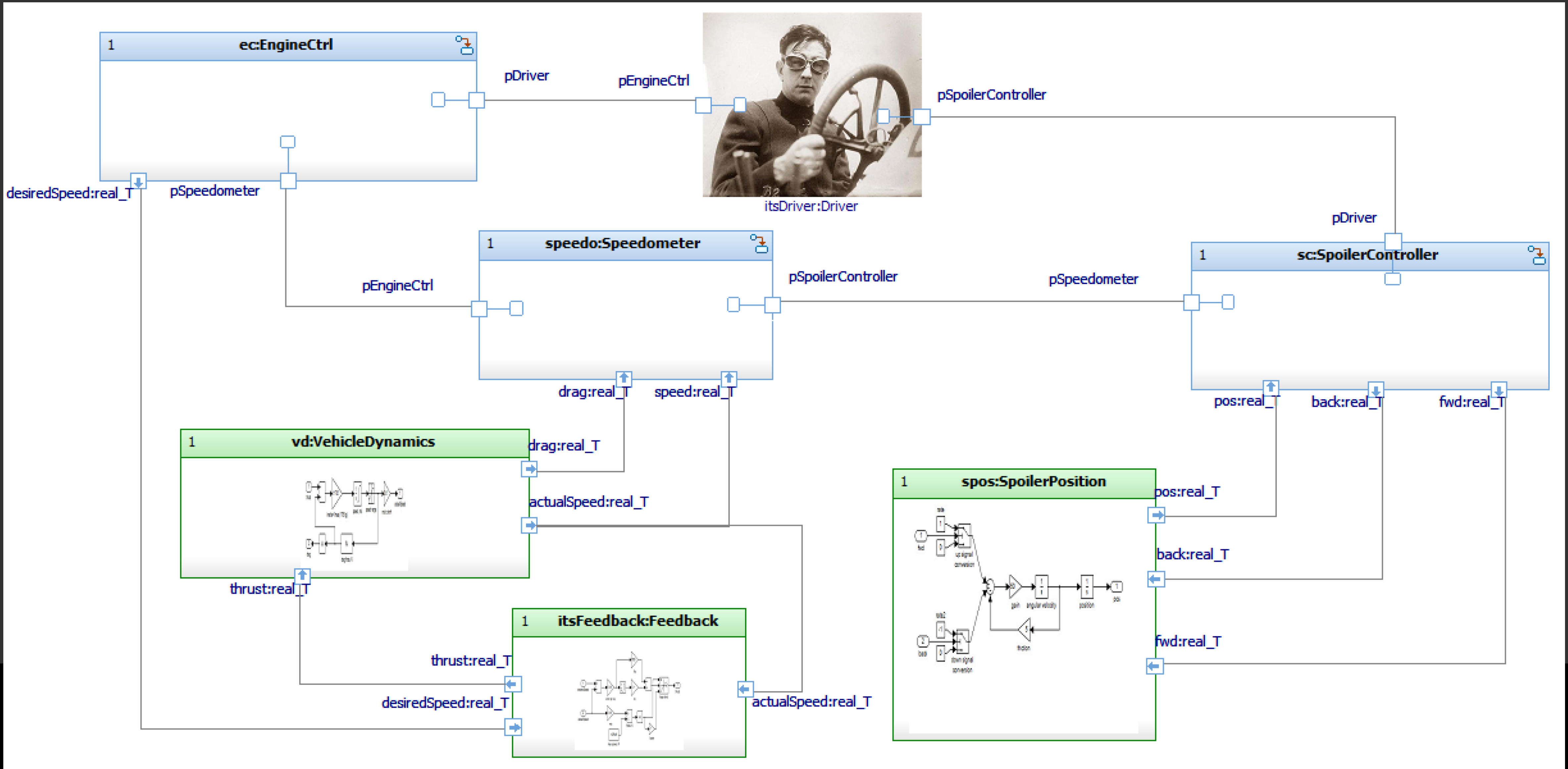


Digital Thread = Collaboration of Toolchain



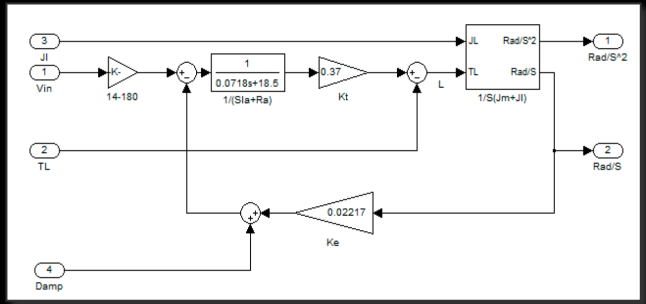


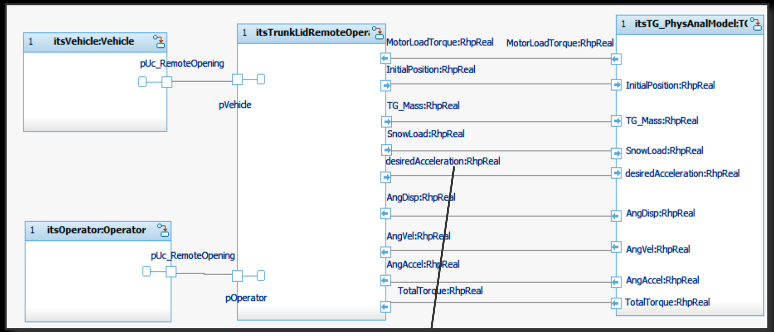
Digital thread as a Model

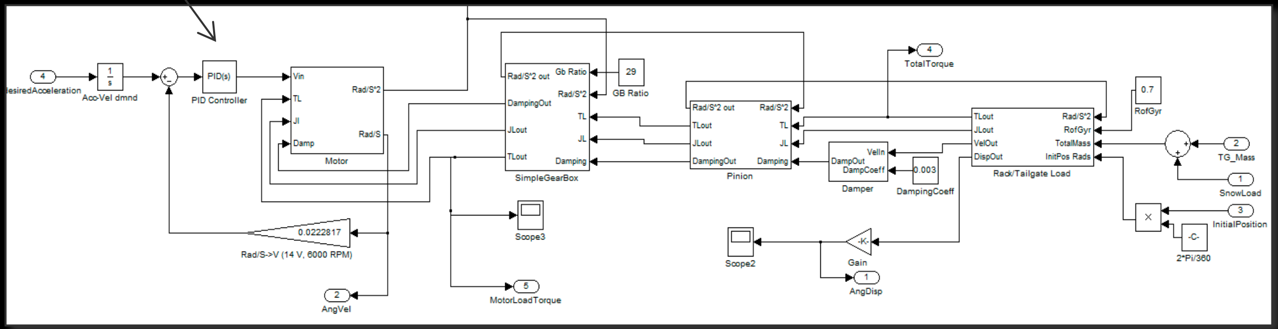


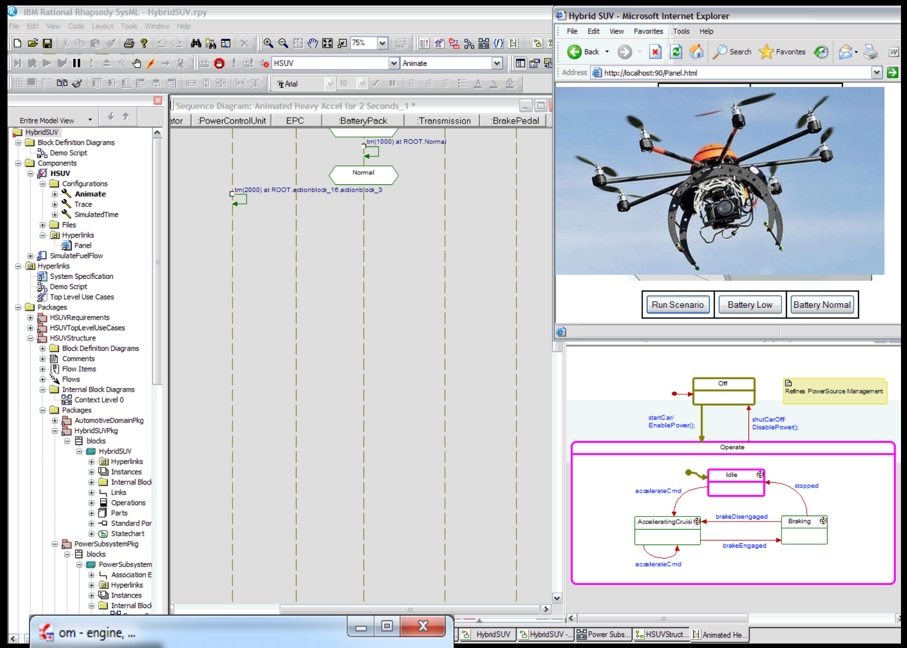
Digital Twin = Simulated representation of physical device

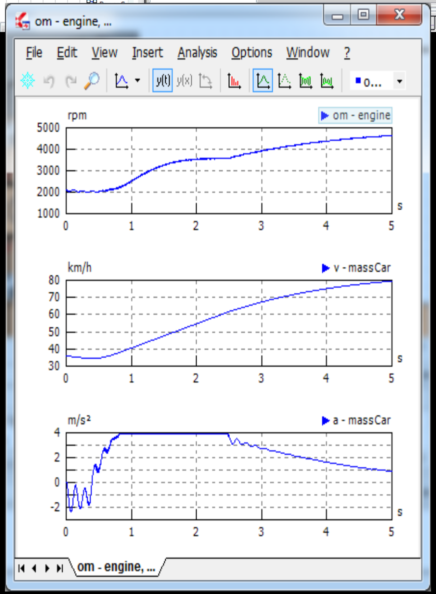
- Allows virtual testing and prototyping of the systems
  - State based models
  - Activity based models
- Hi Fidelity heterogenous models used to validate systems behavior requirements



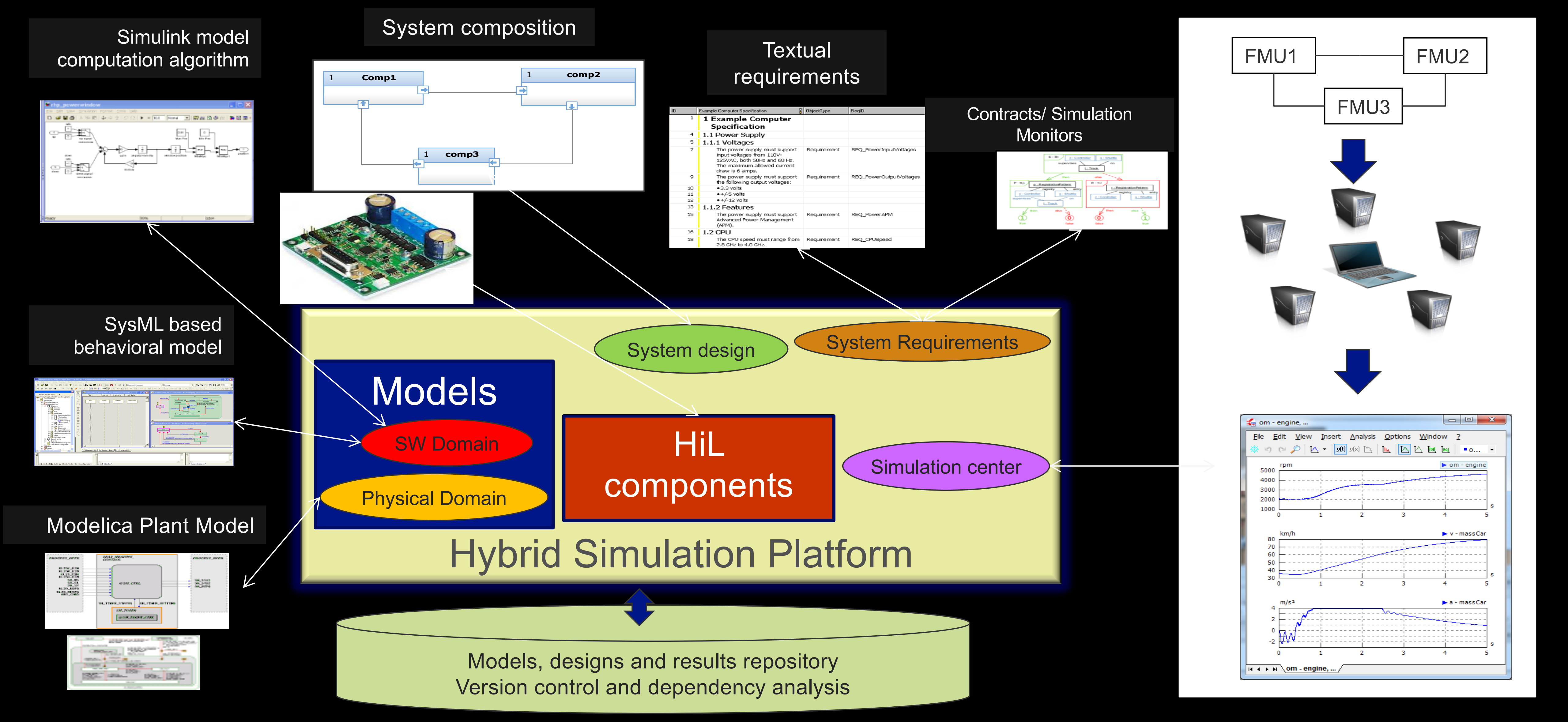








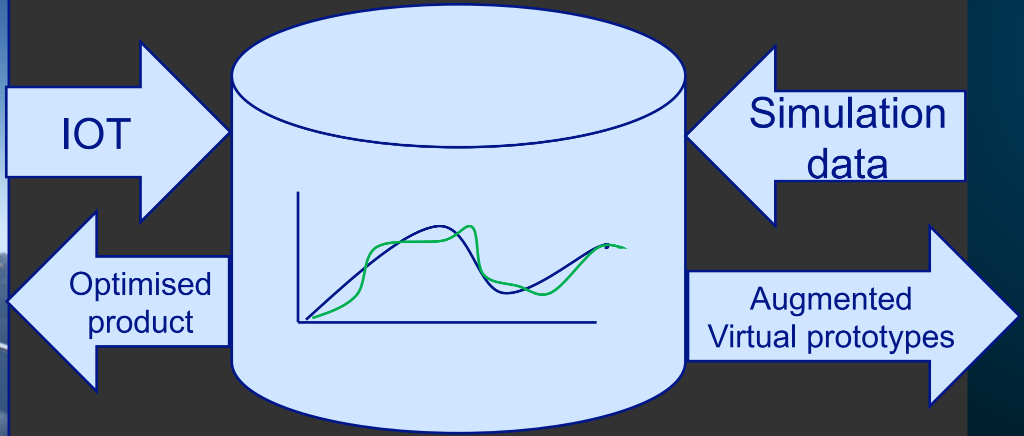
Hybrid Simulation Platform supporting the Digital Twin



Digital Twin as a Digital Shadow enabled by IOT

Data from the real artifact captured and compared to information in the virtual prototype

Real World



Engineering World

Need to capture

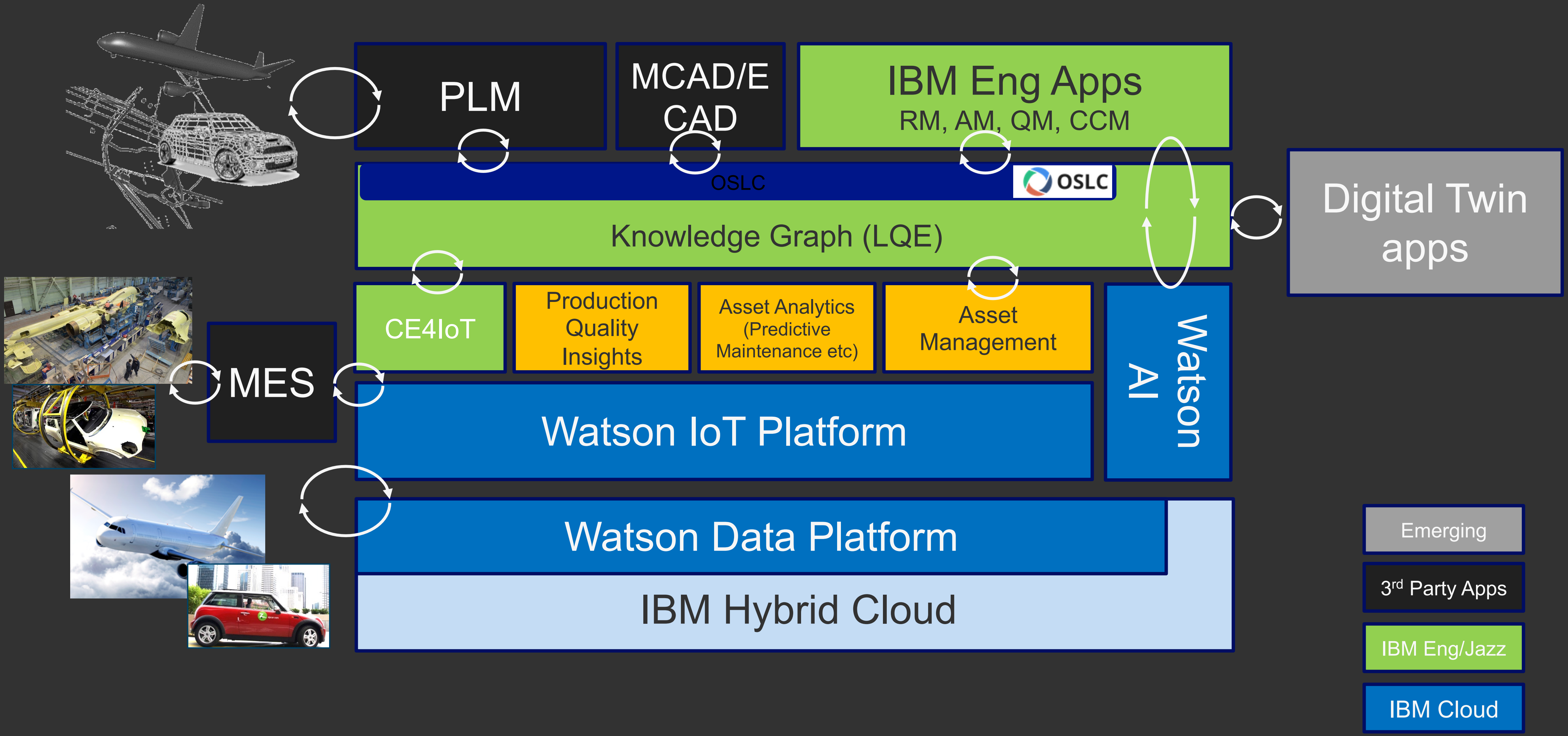
Environment conditions

Operator inputs

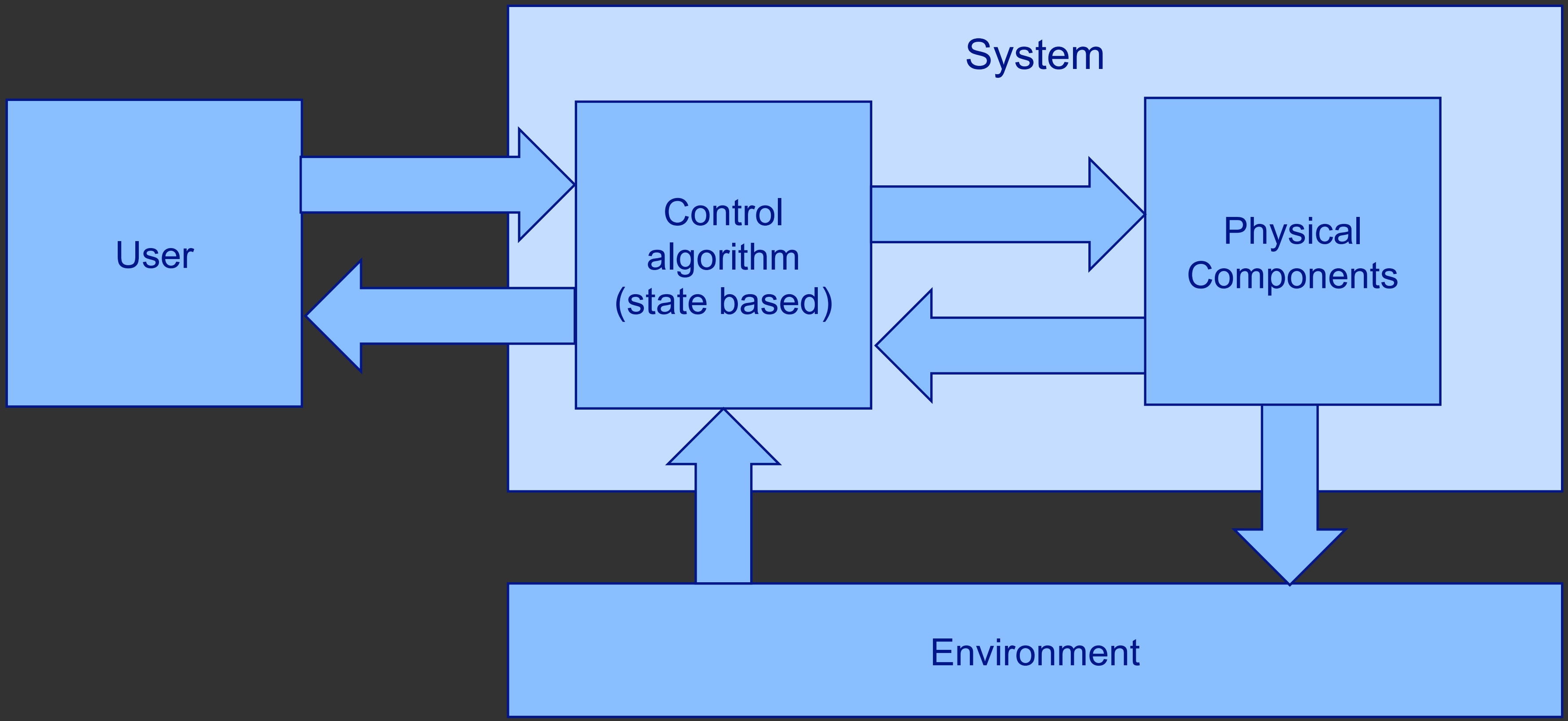
Used to drive the Virtual model

Machine Learning can be used to understand the expected behavior

IBM Watson IoT Engineering Solution Architecture

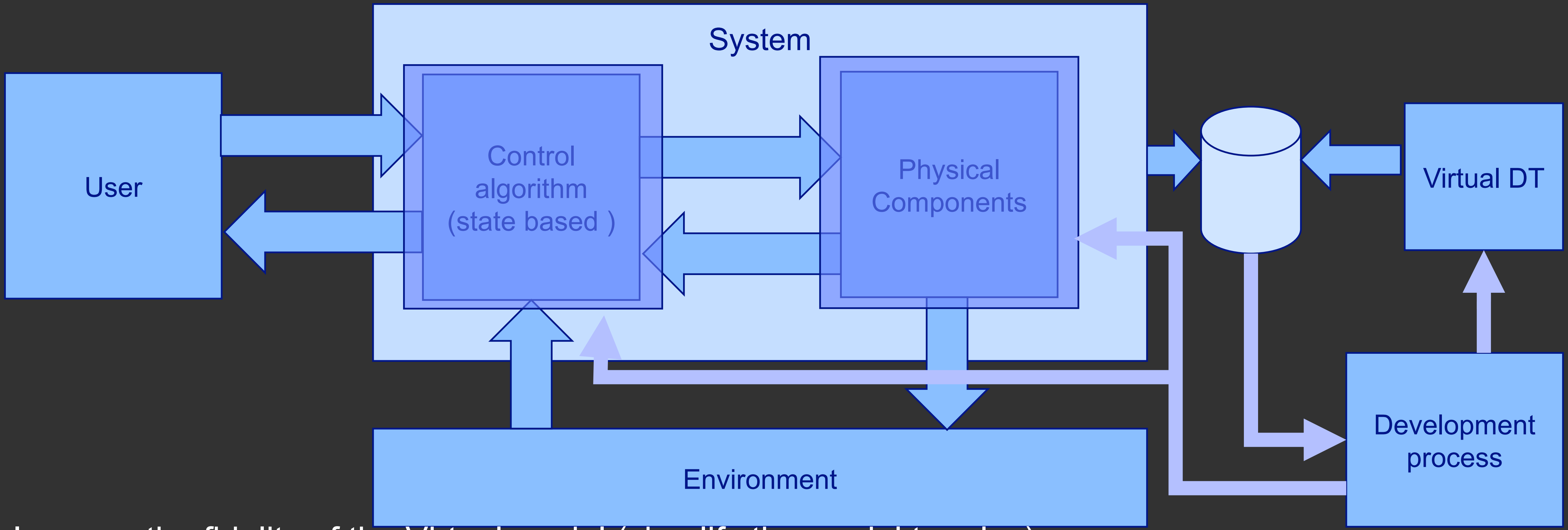


Role of Digital Twins and Shadows



Use cases for the digital twin:- SW and HW

Comparing information from a virtual model digital twin with a shadow digital twin from real systems



Improve the fidelity of the Virtual model (simplify the model to rules)

Identify issues and faults with the system and trigger the change request process

Improve the algorithm being used in the real world (Over the Air Updates)

AI and Machine Learning algorithms can used to replace the control algorithm

Virtual digital twin can also be replaced by the ML algorithm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Compliance requirements:

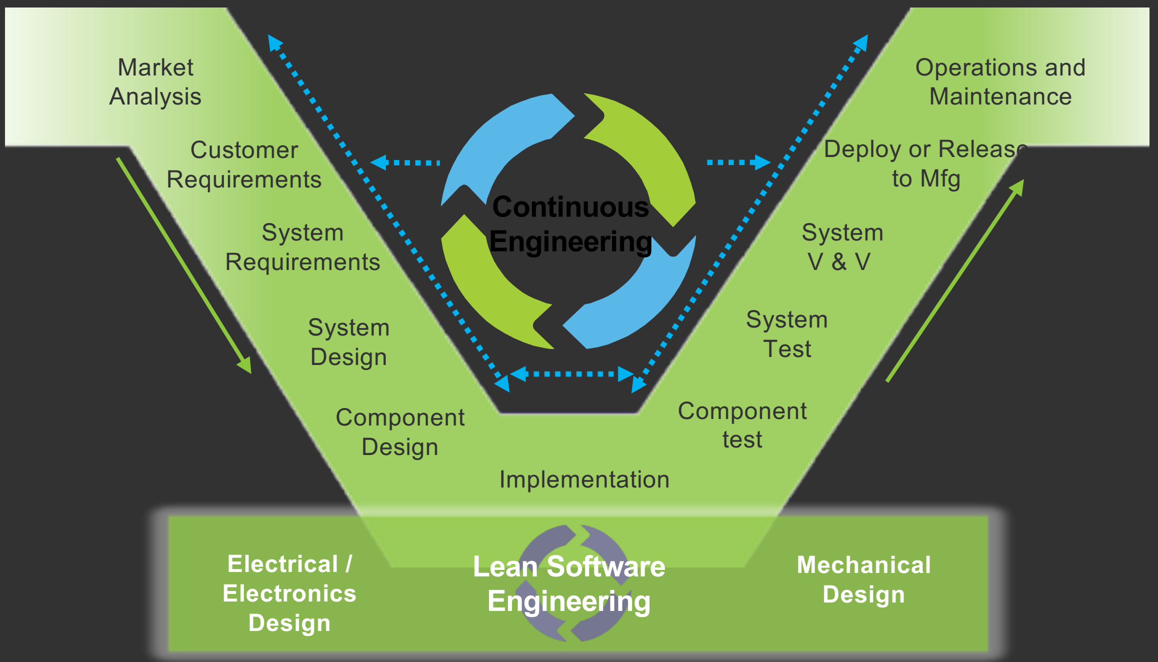
Heating of the wing

Minimum: 10 °

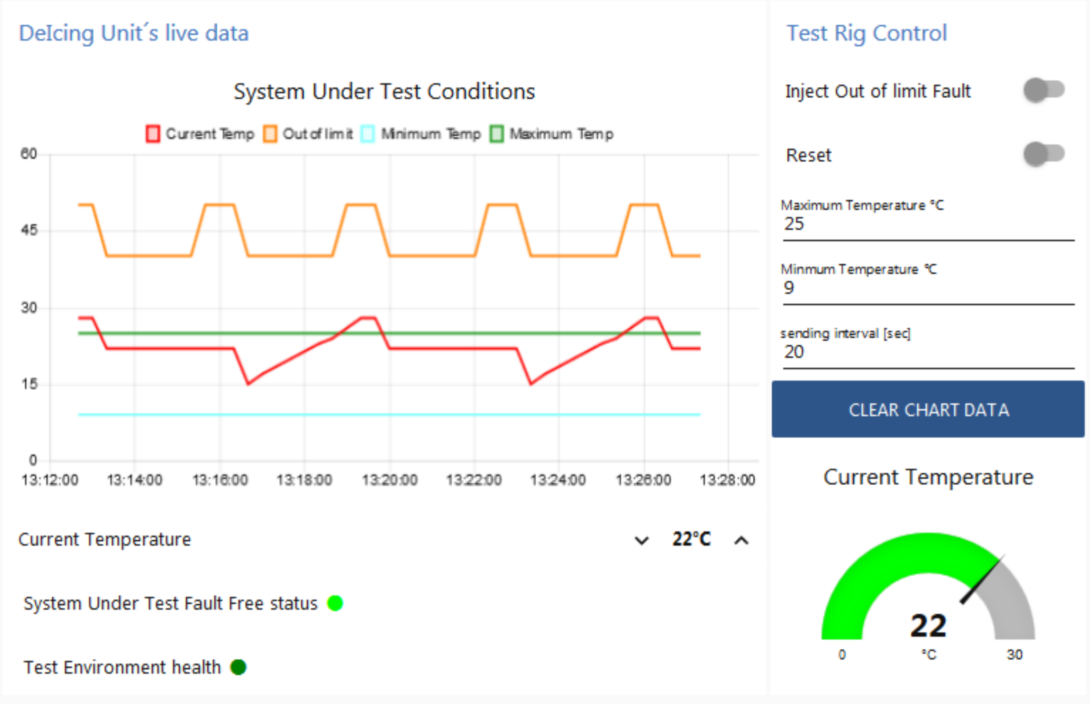
Maximum: 26 °

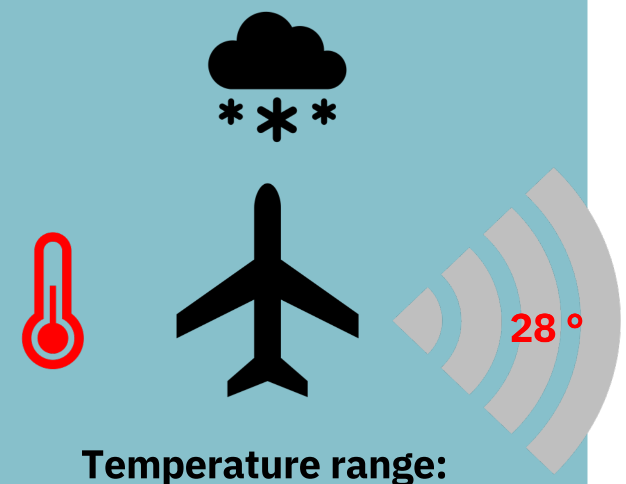
Connecting IoT World & Engineering World

Engineering World = Jazz Platform

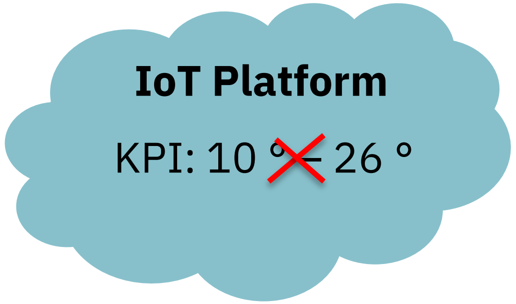


IoT World = IoT Platform

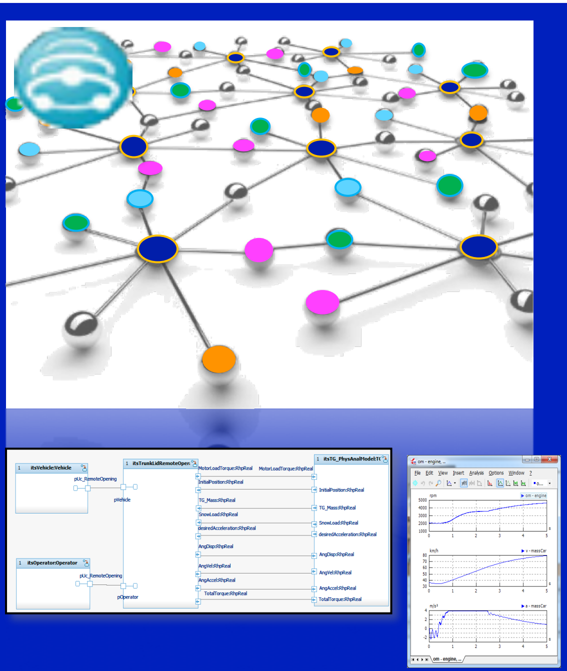


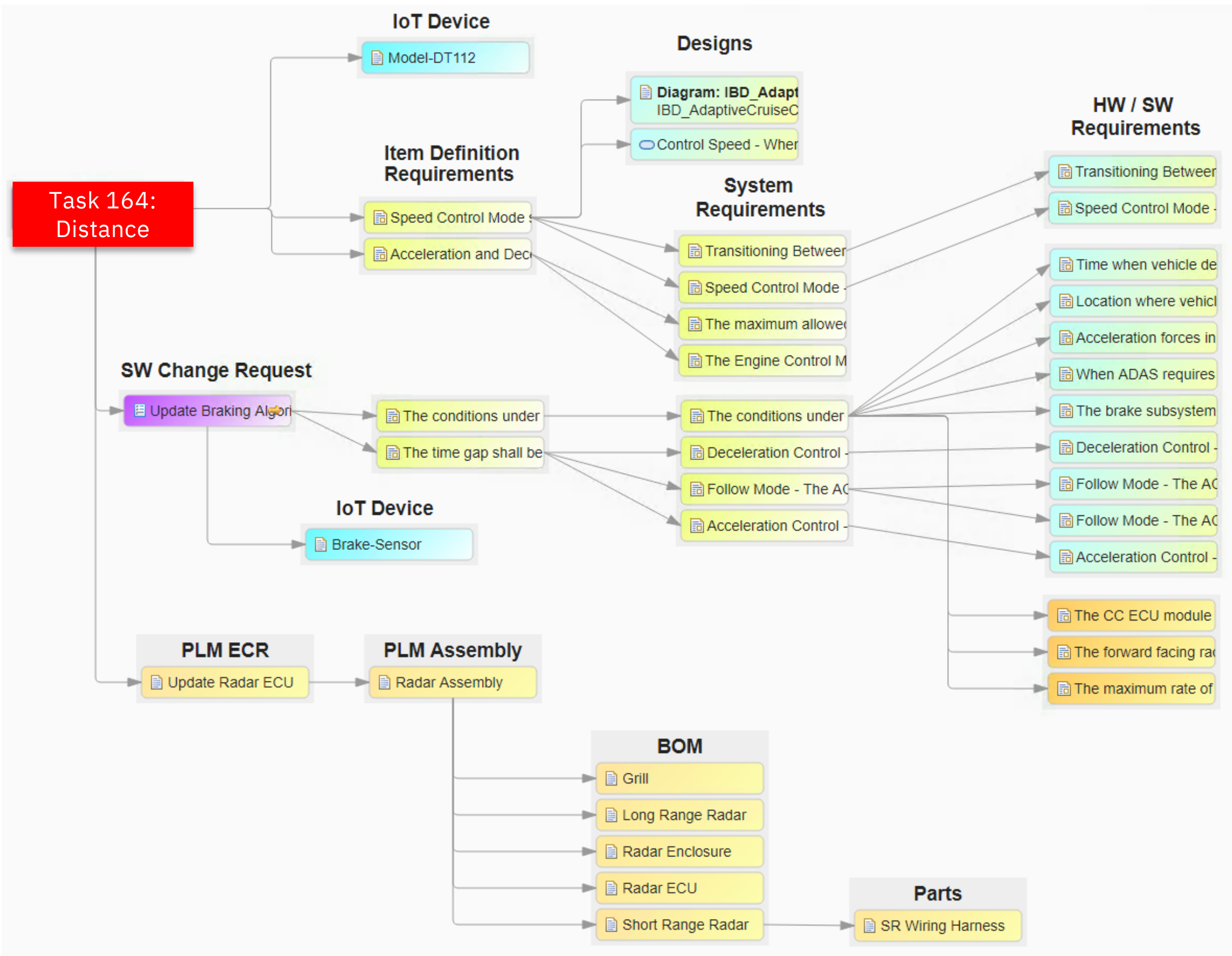


Temperature range:
10 ° – 26 °
failed



New Task





Summary

- To enable a digital twin it requires the implementation of a digital thread
- Digital thread allows you identify
  - Impact of change
  - Root cause analysis
- Digital twin is used to reveal failures in the system by comparing digital shadow
  - IOT sensor data to requirements and/or model constraints
  - Digital twin simulation consuming the IOT sensor data
- Digital twin can be used to do predictive fault analysis on the system based upon comparison of Virtual digital twin simulations and Shadow twin.
- ML can be used to represent physical and behavioural systems models
  - Very dependent upon the learning data being captured
- Engineering becomes an integrated part of your product lifecycle

Thank You

Any Questions ?