Powering Innovation That Drives Human Advancement

Future of Digital Engineering

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Chief Technology Officer, Ansys
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Powering innovation that drives human advancement

50 YEARS OF INNOVATION

#1 IN ENGINEERING SIMULATION SOFTWARE

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World-class companies leverage our open platform

Customers

Partners

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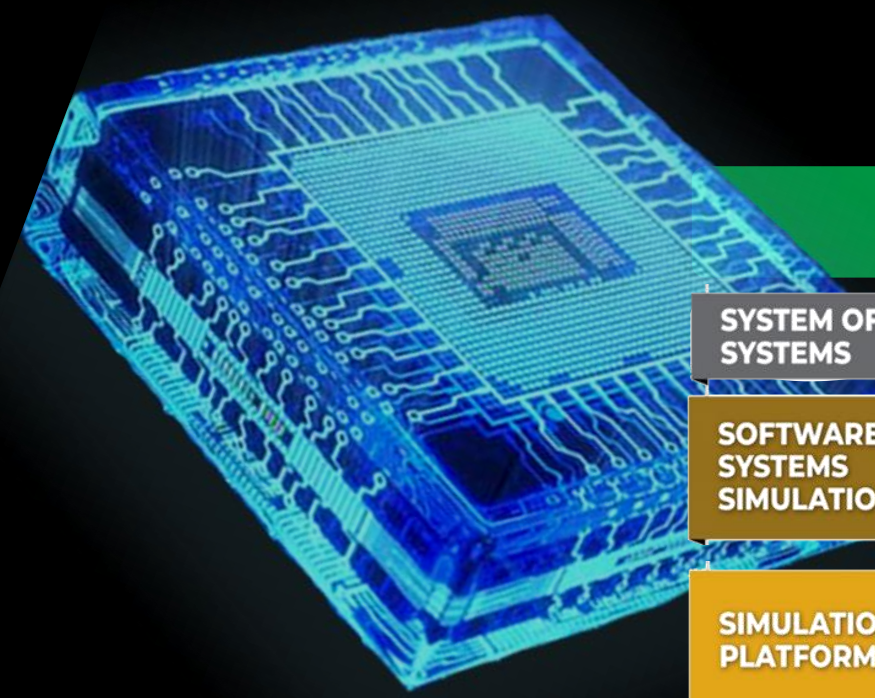
Optimizing Product Development From Component to Maintenance

Unique design of the Ansys product portfolio, platform, and ecosystem for your development processes



SUSTAINABILITY

SYSTEM OF SYSTEMS

DIGITAL MISSION ENGINEERING

SOFTWARE & SYSTEMS SIMULATION

DIGITAL TWIN | SYSTEMS | EMBEDDED SOFTWARE | SAFETY ANALYSIS

SIMULATION PLATFORM

MATERIALS | CLOUD / HPC | OPTIMIZATION | PROCESS & DATA MANAGEMENT | MULTIPHYSICS

PHYSICS-BASED SIMULATION

STRUCTURES | FLUIDS | ELECTRONICS | SEMICONDUCTOR | OPTICAL | 3D DESIGN | PHOTONICS

Ansys

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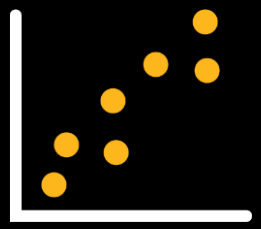
Our investments align with our 5 pillars of innovation

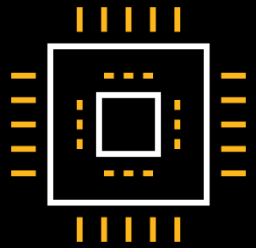
Driving your greatest innovations and solving your toughest challenges

NUMERICAL METHODS



- Solver methods
- Geometry and meshing
- Shape and topology optimization
- Advanced analysis
- Multi-physics
- Multi-scale

HIGH-PERFORMANCE COMPUTING



- Shared-memory
- Message-passing
- Fine-grained GPUs
- New architectures: FPGAs & AI Hardware
- Quantum computing

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

- Solver acceleration
- Solver settings
- Top-down methods
- Bottom-up methods
- Reduced order models
- Generative AI

CLOUD AND EXPERIENCE

- Cloud Enabled
- Cloud Native
- Platform, Collaboration
- Open APIs and developer ecosystem
- Common user experience

DIGITAL ENGINEERING

- MBSE
- Requirements & architecture connections
- Safety, security & software
- Digital twins
- Simulation process & data management
- Mission Engineering

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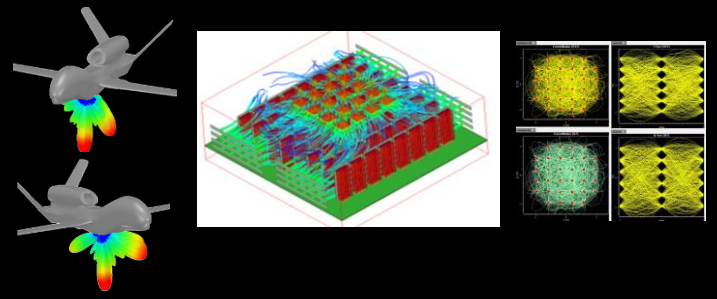
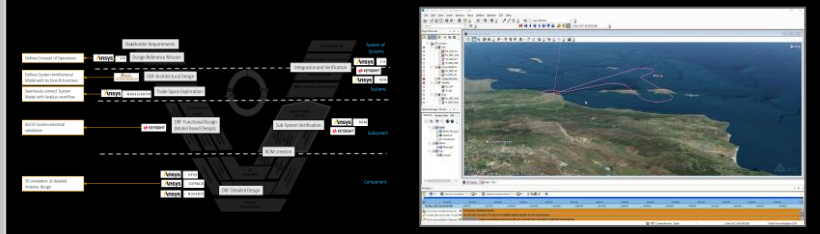
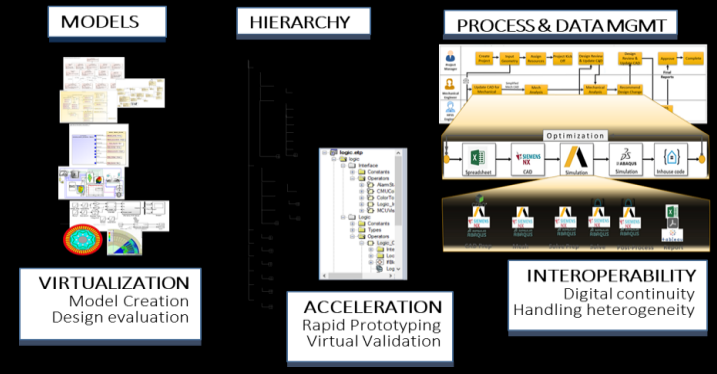
The Imperative for Digital Transformation

Modeling & Simulation (M&S)	• Using M&S to reduce physical prototypes
Digital Engineering (DE)	• Using M&S in a connected, collaborative manner
Digital Transformation (DX)	• Transforming an engineering ecosystem from excessive physical testing, siloed analysis swim lanes, & disconnected data streams into a connected, model-based, traceable ecosystem across the life cycle







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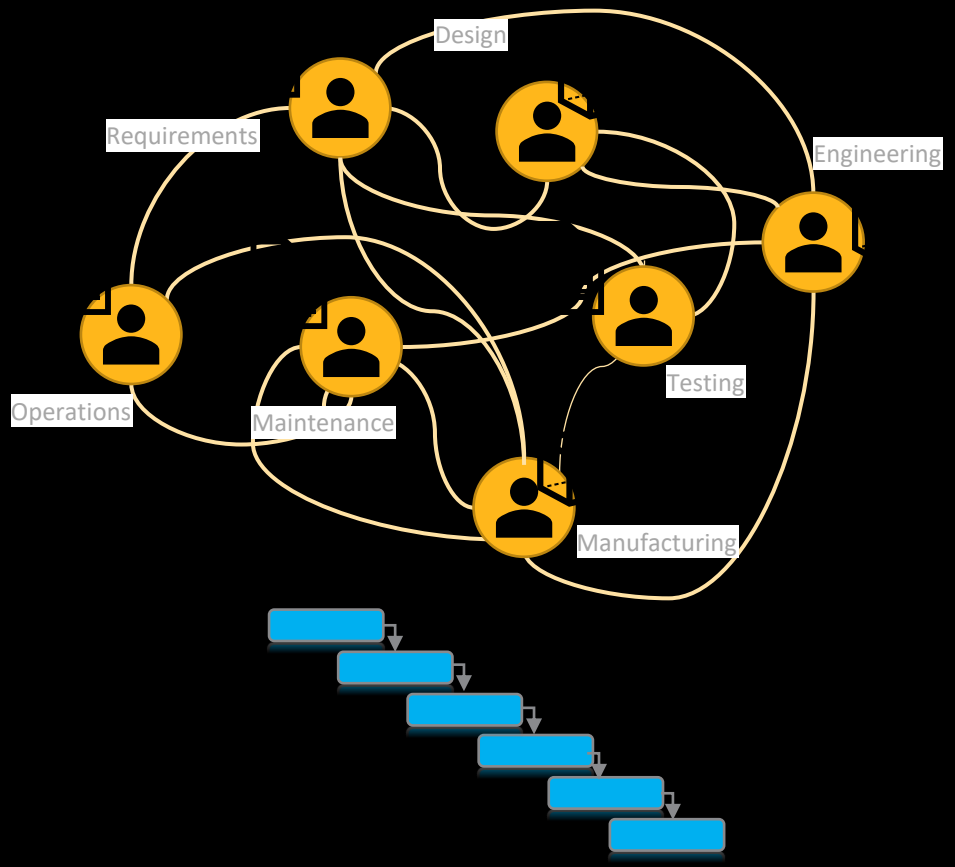
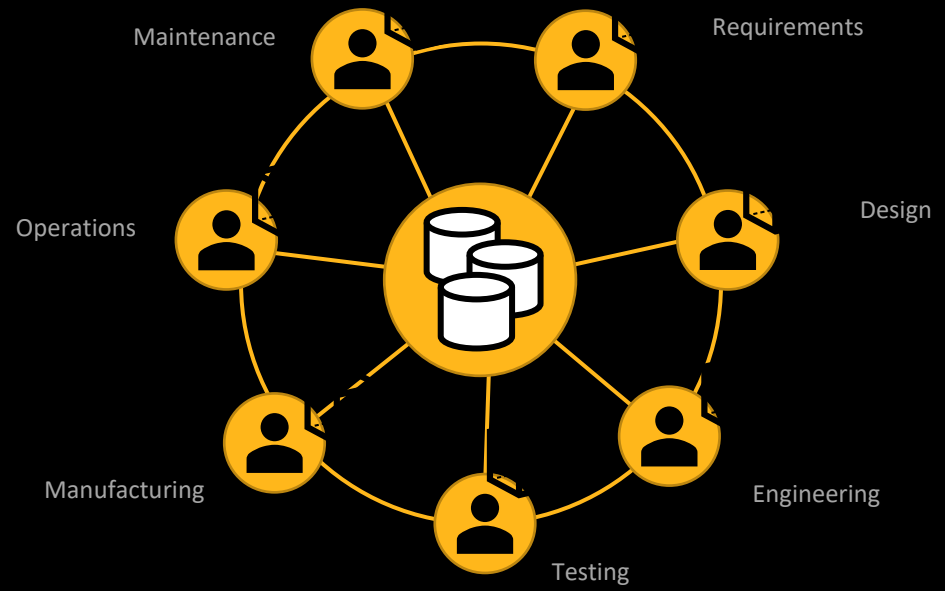
Shift from Traditional Engineering to Digital Engineering

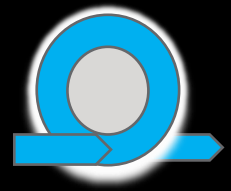
Current State



- Model-based
- Collaborative
- Agile
- Connected
- Traceable:
  - Right Information
  - Right Time
  - Right Format
- Dev(Sec)Ops

Future State





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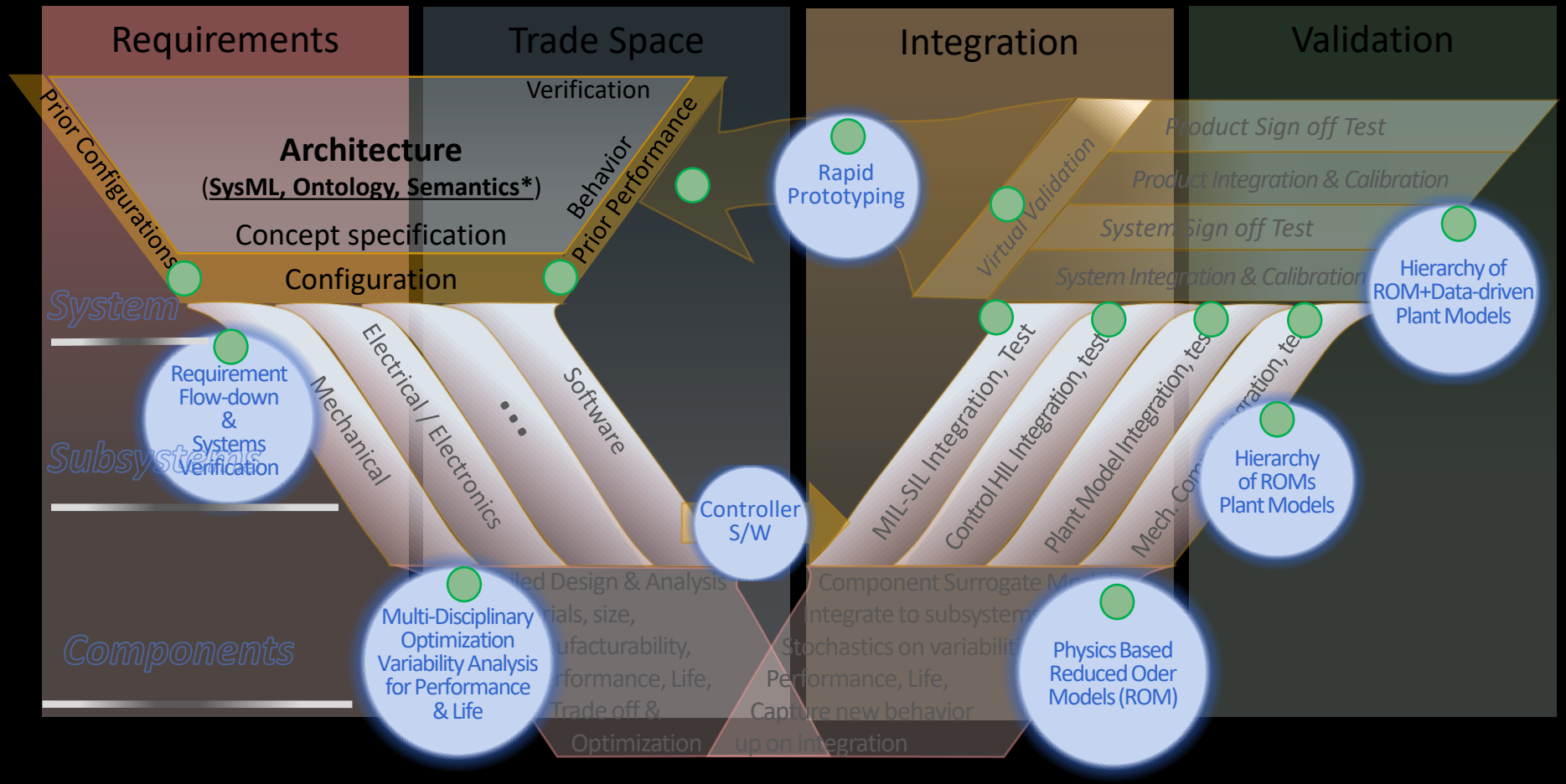
Digital Engineering V-Cycle



* Cyber-physical systems need ontology & semantics to manage complexity

Candidates for data-&-physics infused AI-ML accelerators

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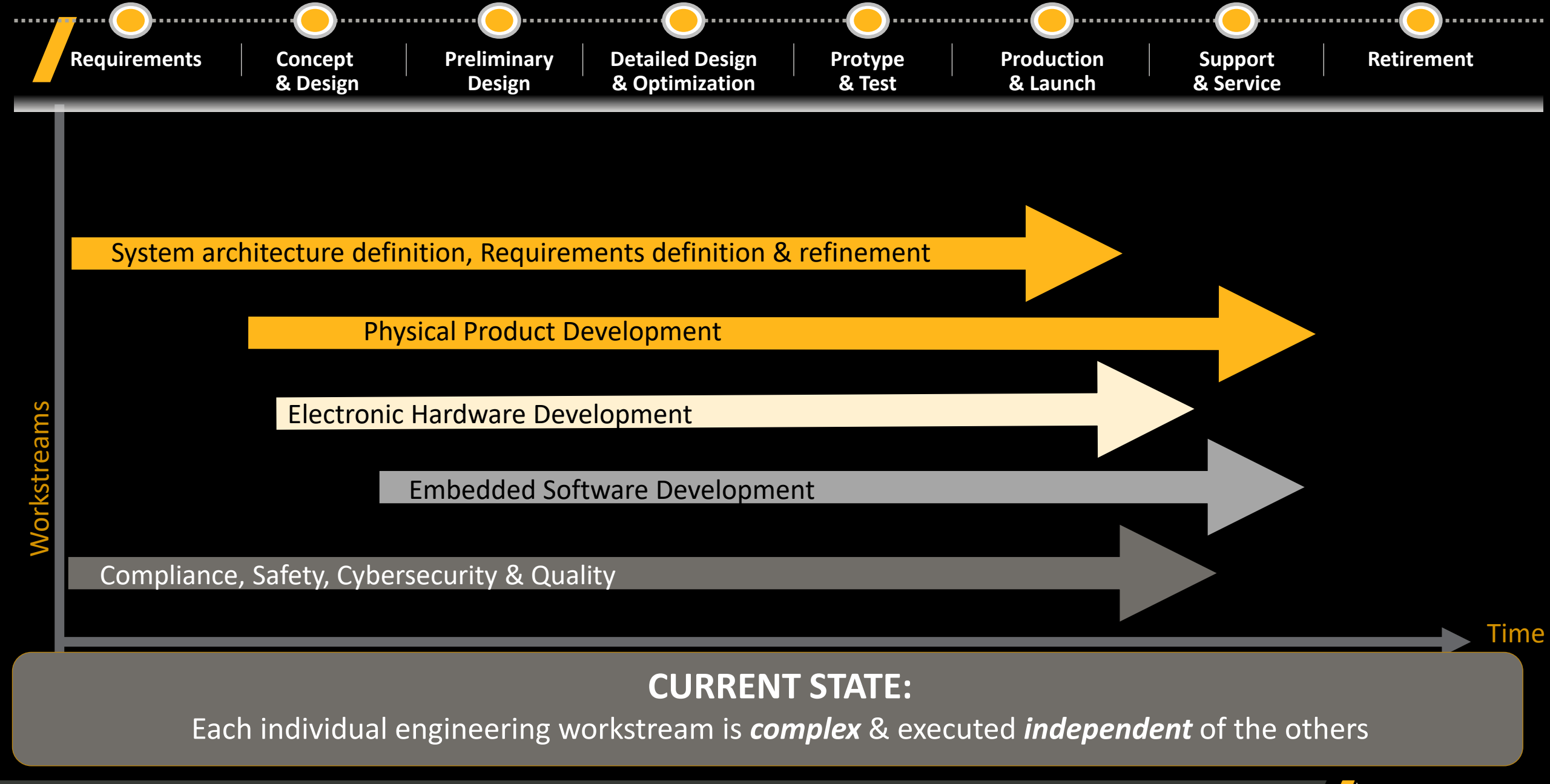

CURRENT STATE:

Each individual engineering workstream is ***complex*** & executed ***independent*** of the others

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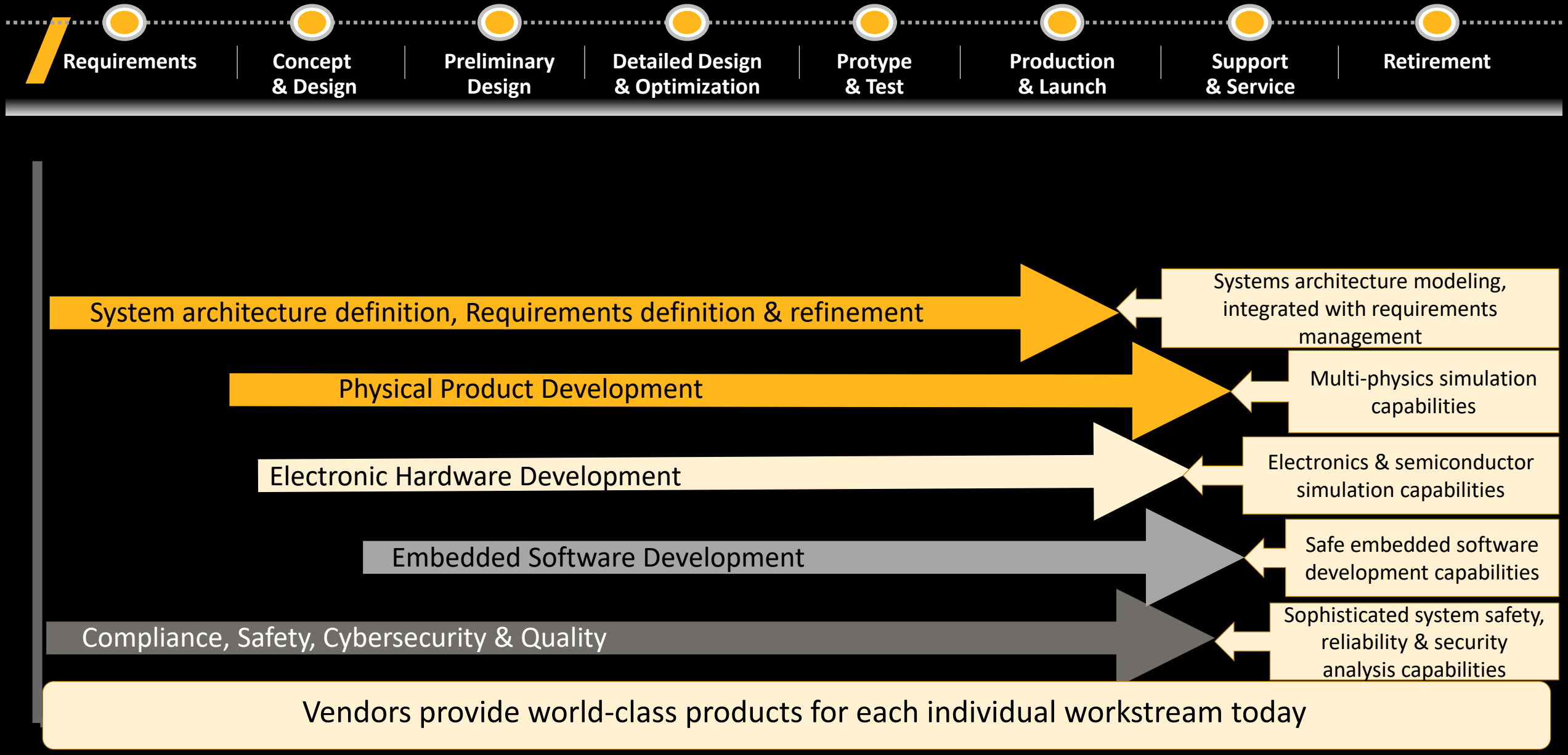

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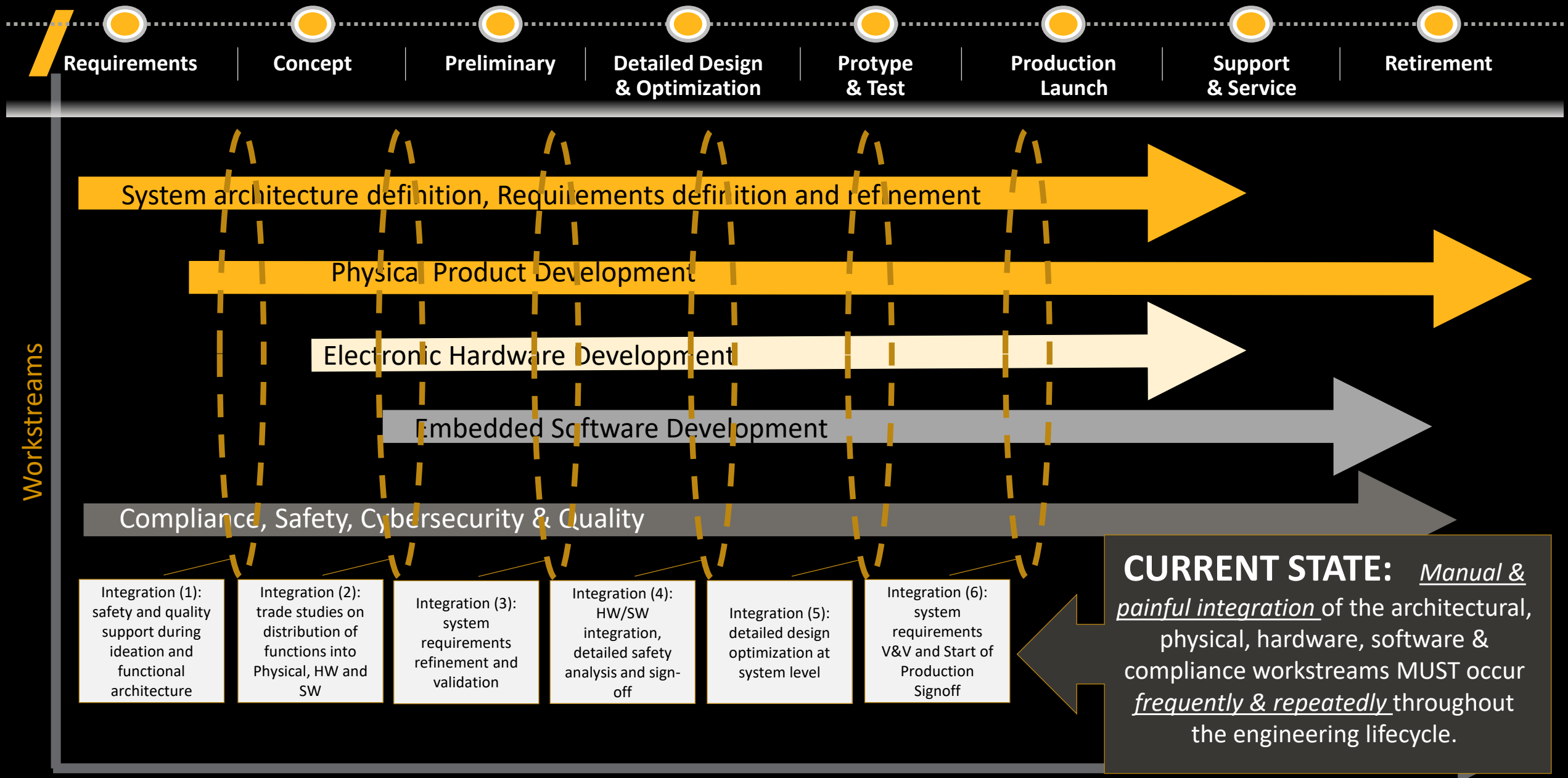

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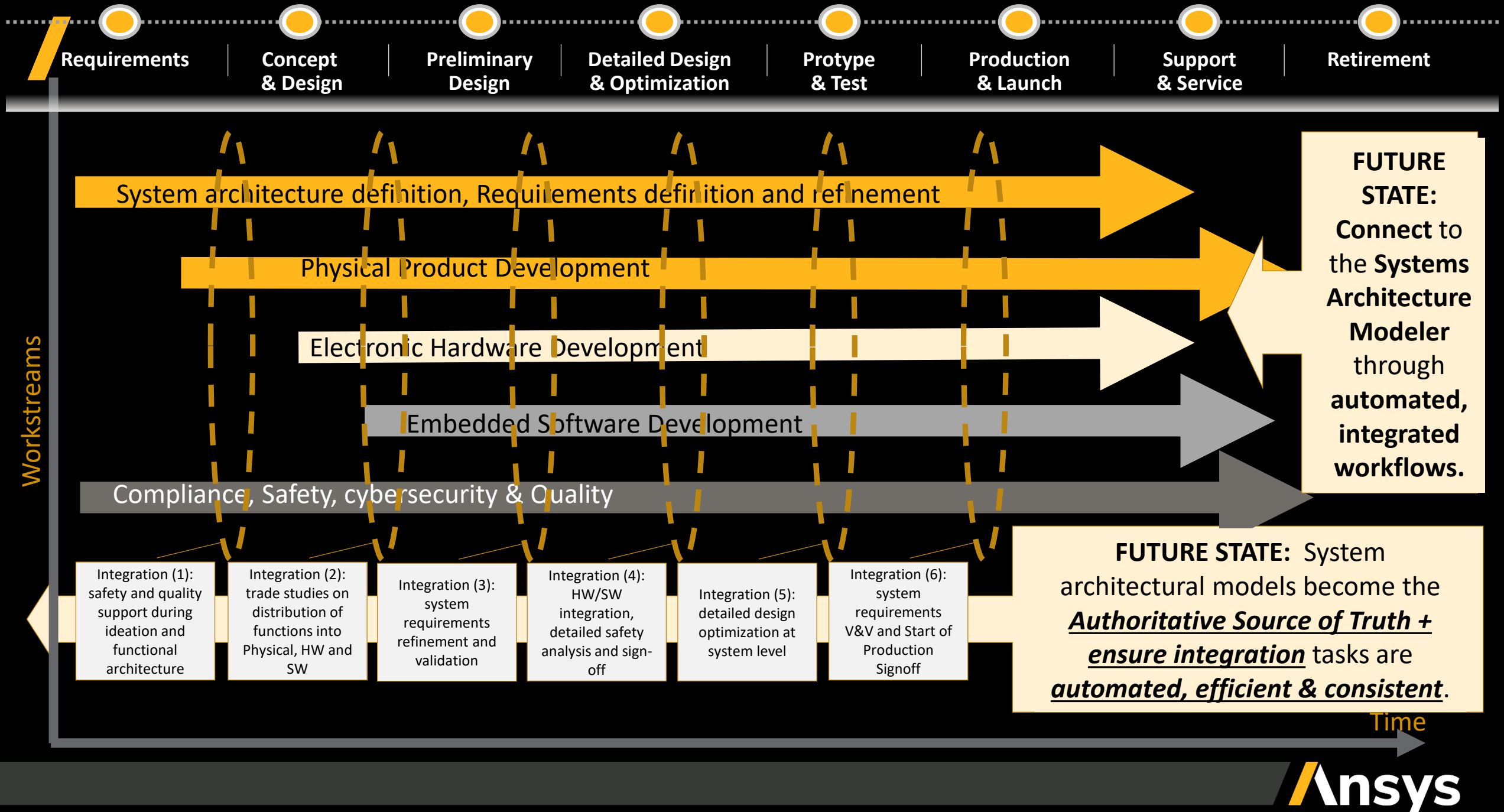

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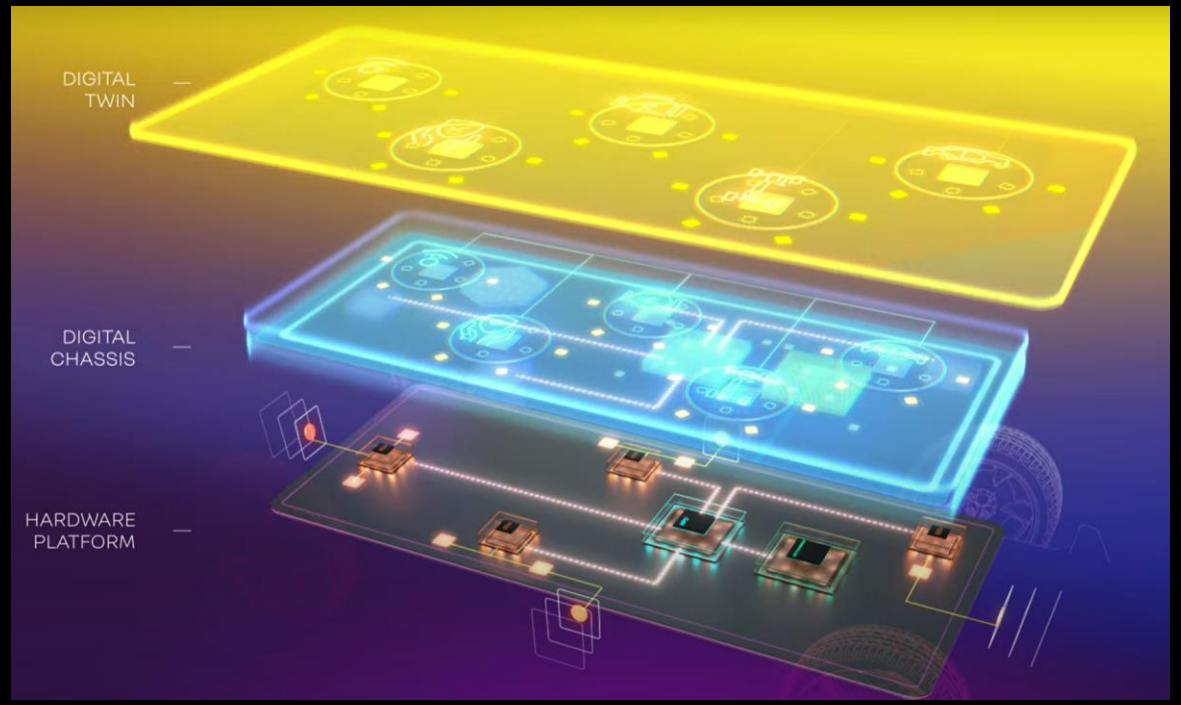
Digital Engineering Vision

Support our customers' **digital engineering transition** for **cyber-physical systems** with an integrated **suite of tools** that **connect** the **parallel engineering workstreams** for systems architecture & requirements; safety & cyber-security; physical engineering, software & controls, **across the product lifecycle.**



Renault Group & Software Defined Vehicle technology
https://youtu.be/cWnsCMtX9f8?si=2eqhuiCOd6rMblSK

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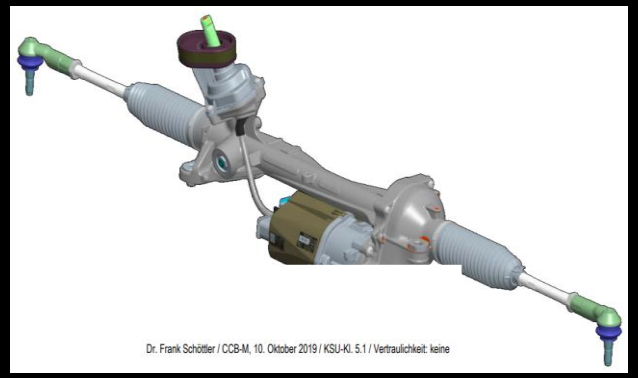
Customer Value of Digital Engineering

integrate sensing, computation, control and networking into physical objects and infrastructure
Aircraft and trains today – and even modern cars

Customer value illustration of semi-automated integration:
productivity** (reduce integration & testing time) **+ shift left

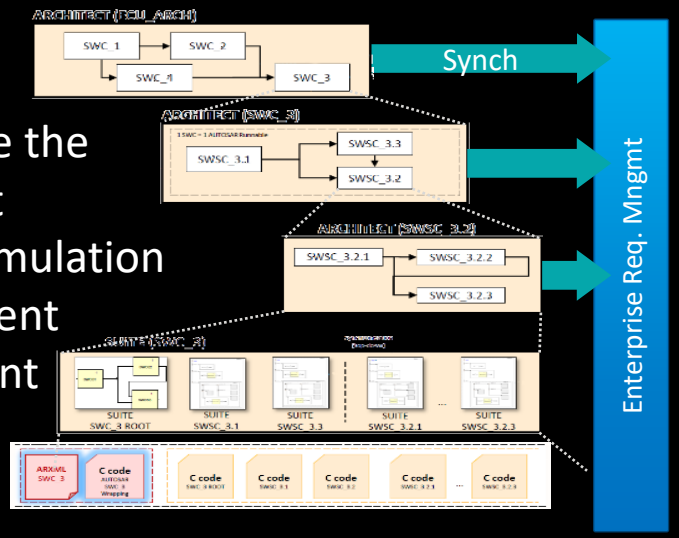
What?

Volkswagen electric powered steering



How?

Synchronize the component
+ system-simulation
+ requirement management



Value?

Integration time reduced:
6 weeks to 2 days

Testing time reduced:
16 weeks to 4 weeks

System retains full ASIL-D certification

(*) Source: Dr. Frank Schöttler: „Using SCADE in High Availability Steering Systems", DSC Shanghai, November 2020

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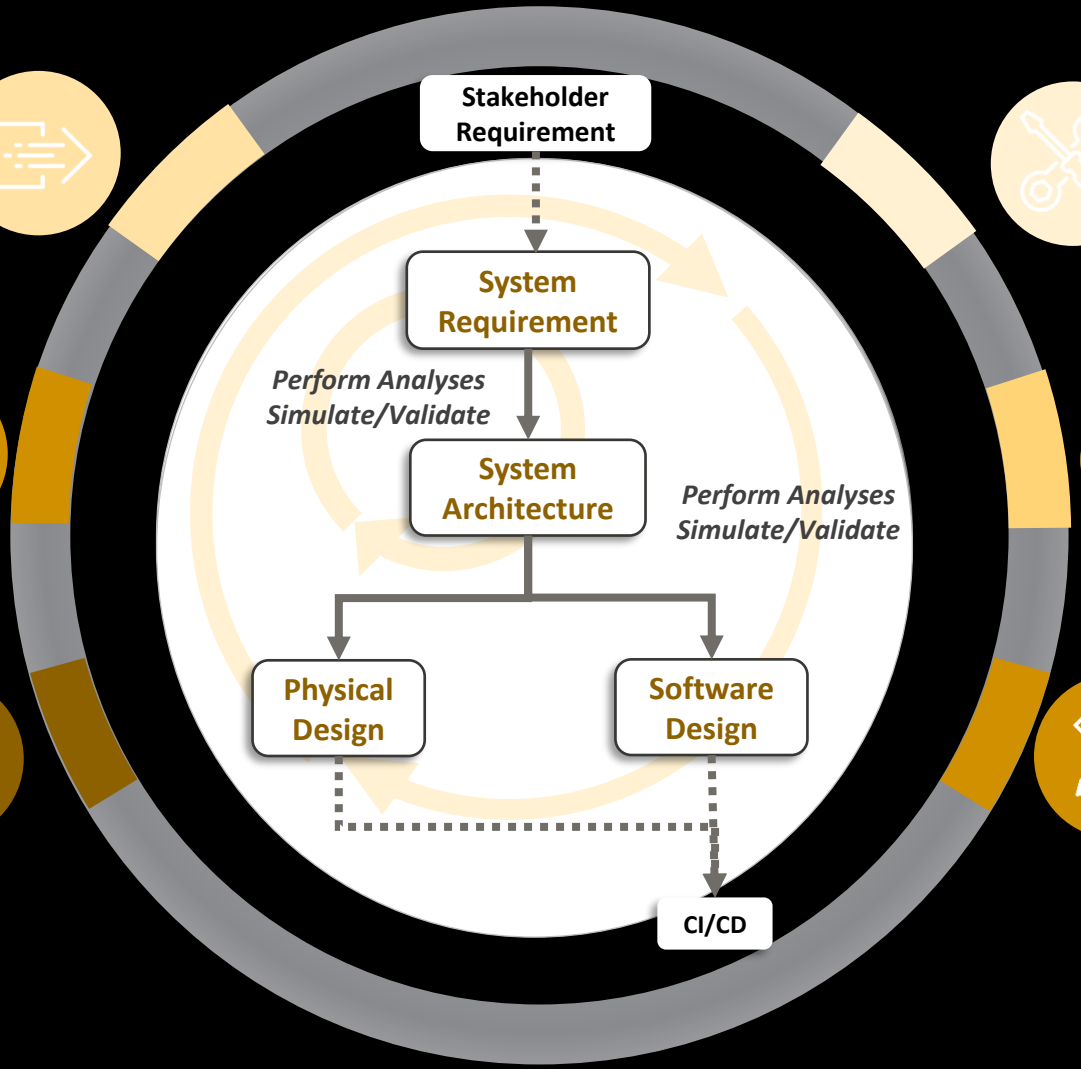
Requirements, Architecture and Analysis in Iterations

Models serve as input for design

Standardized system modeling being applied

Tools to support the methodology



it is about iterative refinement of requirements and architecture

applied during all product life cycle phases

Systematic, objective analyses supports refinement

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Digital Engineering Capabilities / Supporting MBSE

Provide **Safety and Cybersecurity Analysis** for System Architectural Models

Ansys System Model Analysis

Connect Engineering Analysis, Simulation & verification workflows to System Architectural Models

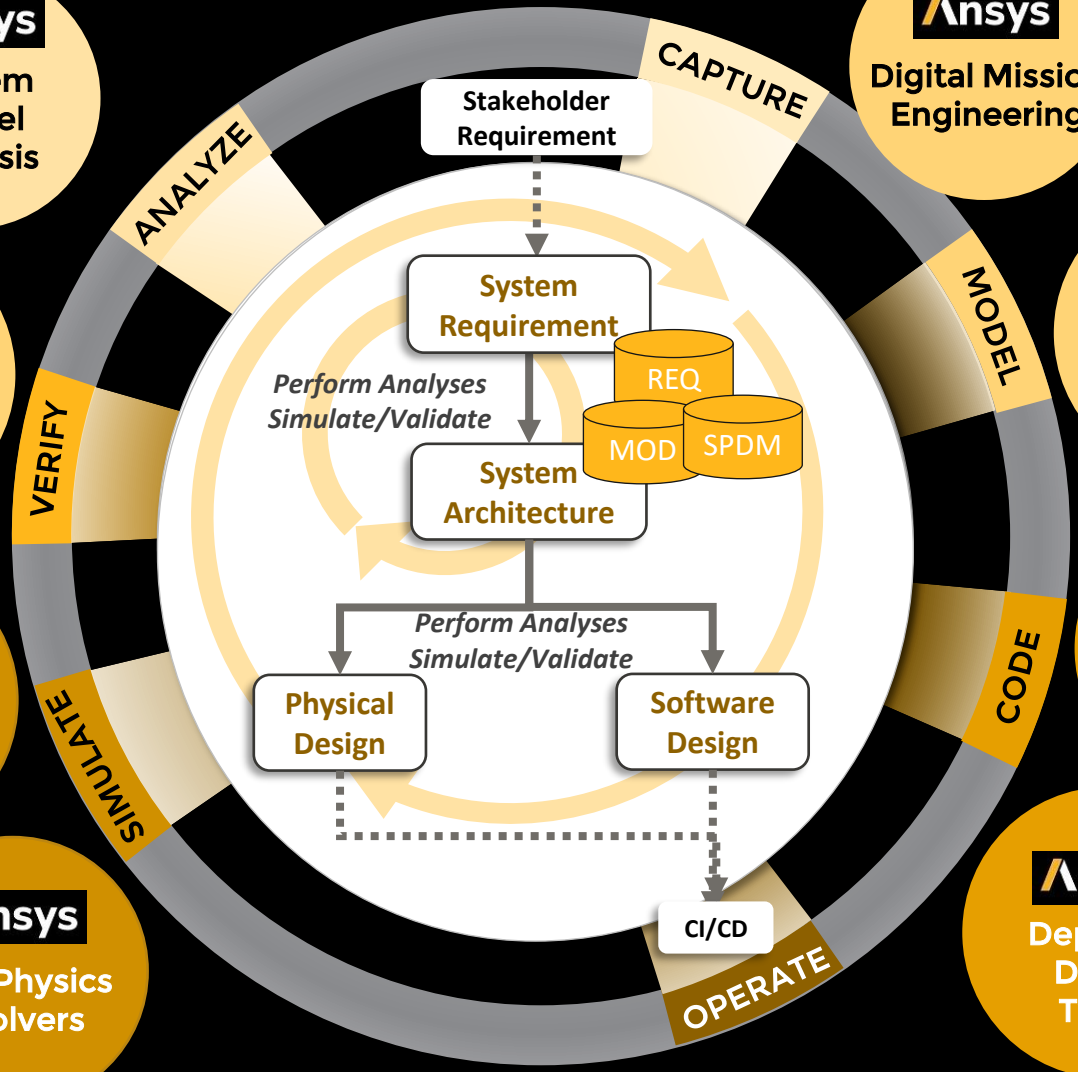
Ansys Interface to Engineering Analysis

Provide detailed **Physics Simulation, Analysis & Optimization** capabilities

Ansys Optimization Digital Twins System Simulation

Ansys Autonomy V&V, Sensors

Ansys 3D Physics Solvers



Ansys Digital Mission Engineering

Integration with **Requirements Management Systems**

Interface with **System Architecture Modeling Tools**

Ansys System Architecture Modeling

Support **System Architecture Modeling:** Structure, Behavior, Requirements

Ansys Embedded Software Flow

Model Based Design & Verification of Safety **Critical Embedded Software**

Ansys Deployed Digital Twins

Predictive maintenance & operational feedback into product design

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Digital Engineering Capabilities

Shared System Information Base

Team Collaboration

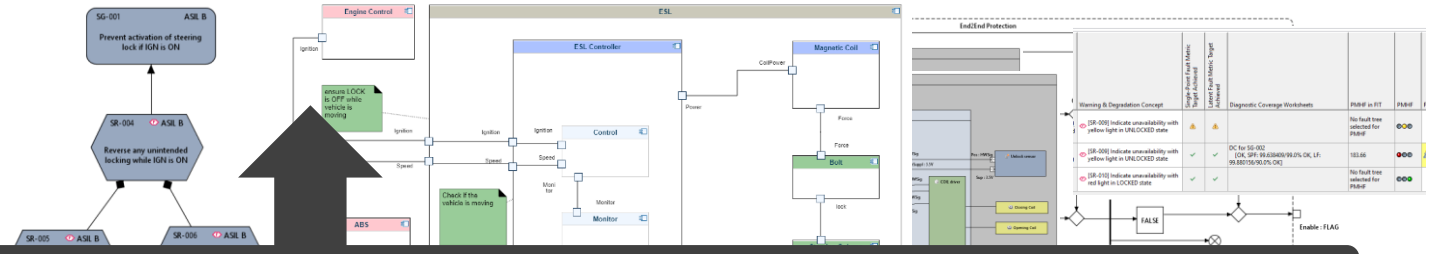
2.

- collaboration across enterprise
- secure storage and sharing
- history, baselines, impact analysis
- technical task management

Descriptive System Architecture Models

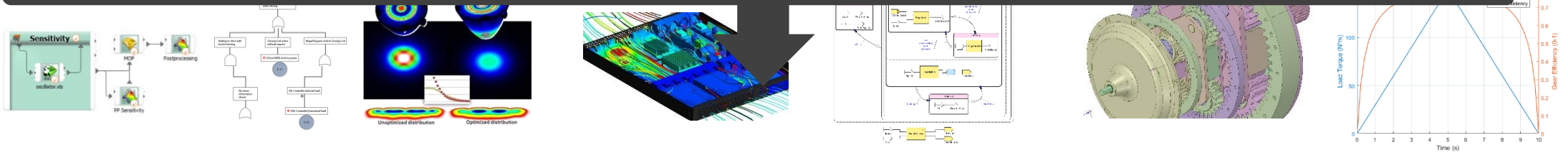
1.

Requirements | Structure/Characteristics | Behavior | Verification



bi-directional interfaces
between descriptive system architecture models and engineering analysis

3.



engineering analysis & simulation / design / verification

Methodology

4.

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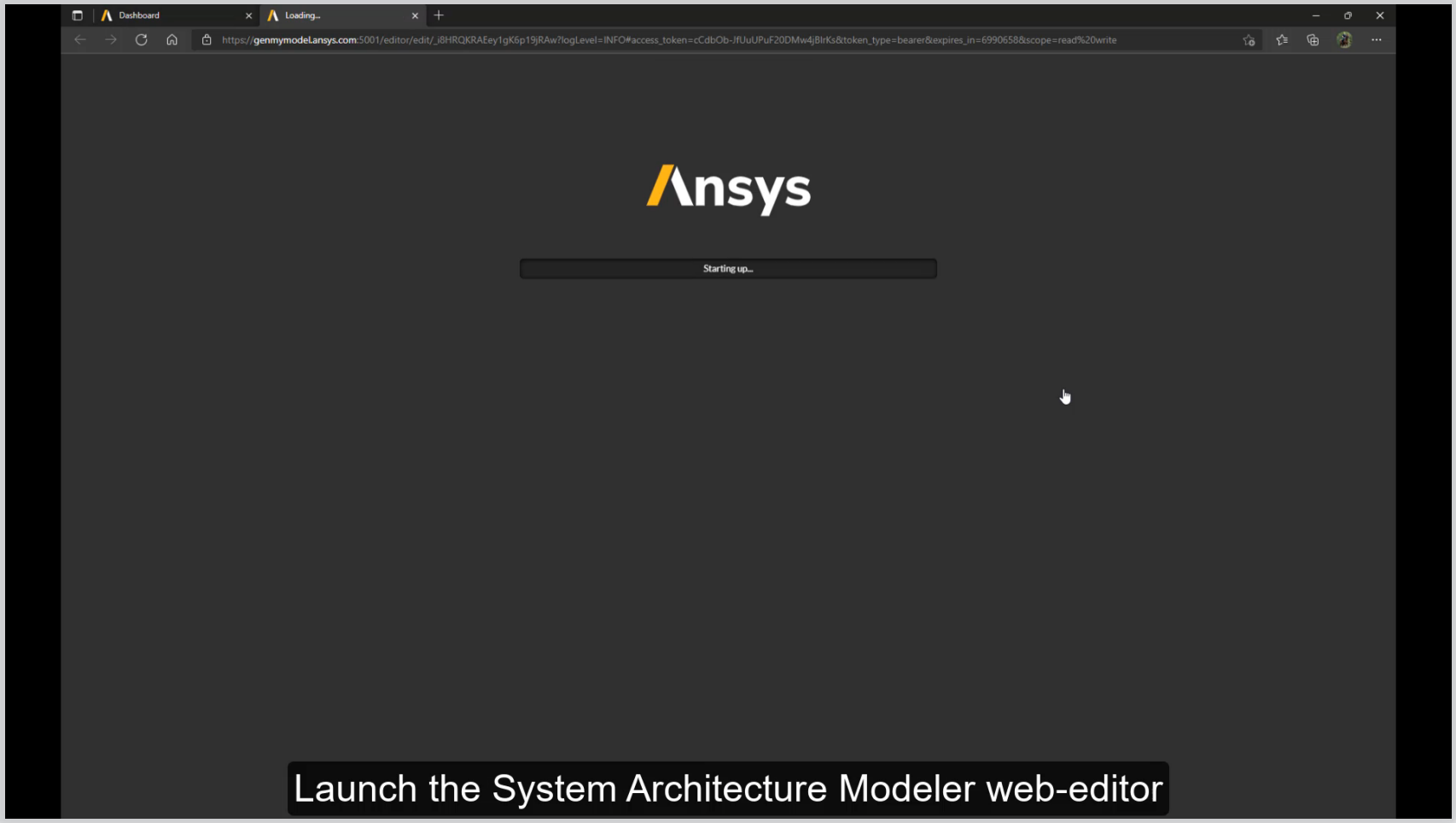
Digital Engineering Capabilities / Supporting MBSE

1.

- support **SysML v2**, the new systems engineering language created from scratch
- **integrated** with Requirements Management
- ability to **migrate** from SysML v1 products



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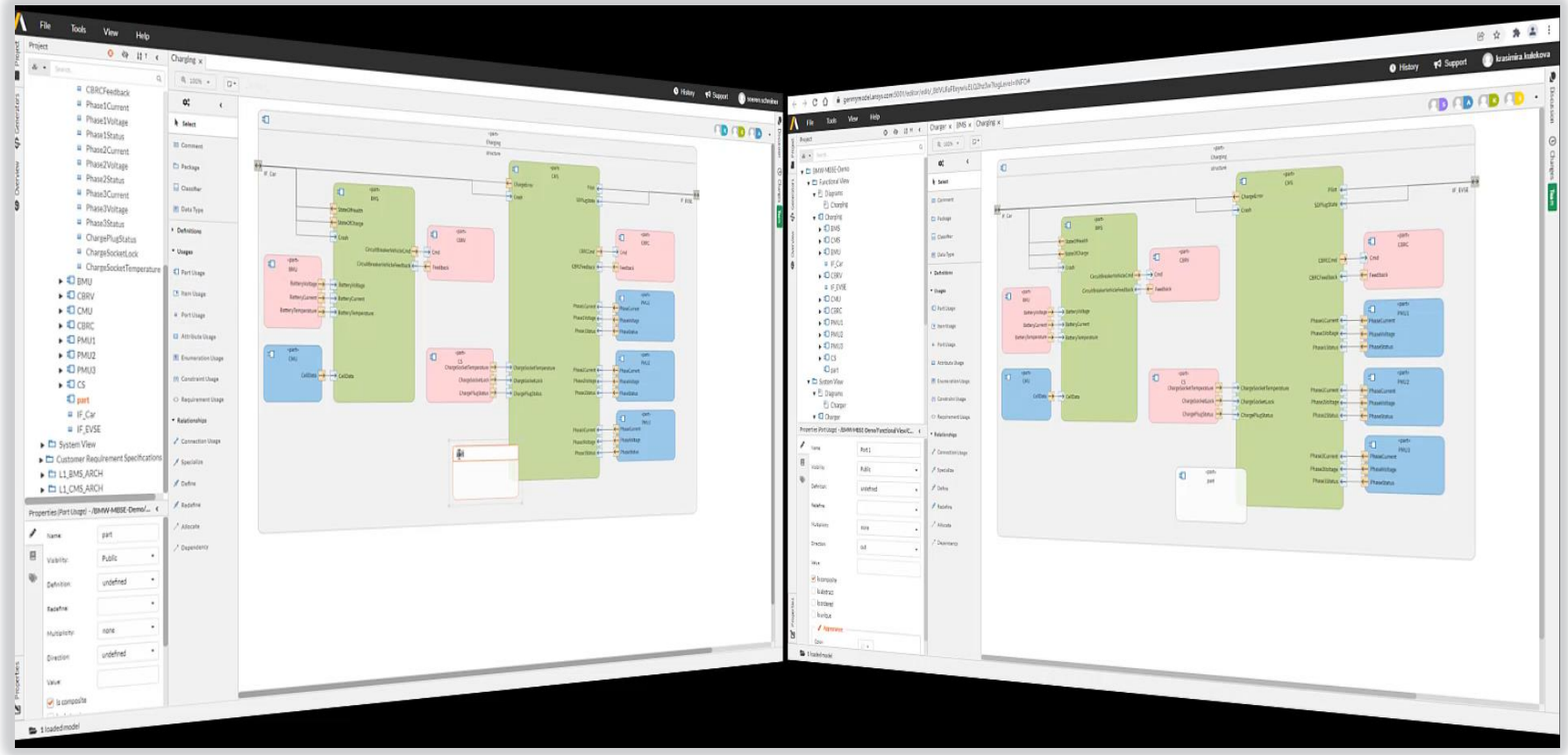
Digital Engineering / Federation, Collaboration and Ease-of-use

2.

- **Cloud-ready,** server-based solution
- **collaboration** and ease-of-use are of upmost importance
- Ease-of-use includes **easy access** to modeling capabilities



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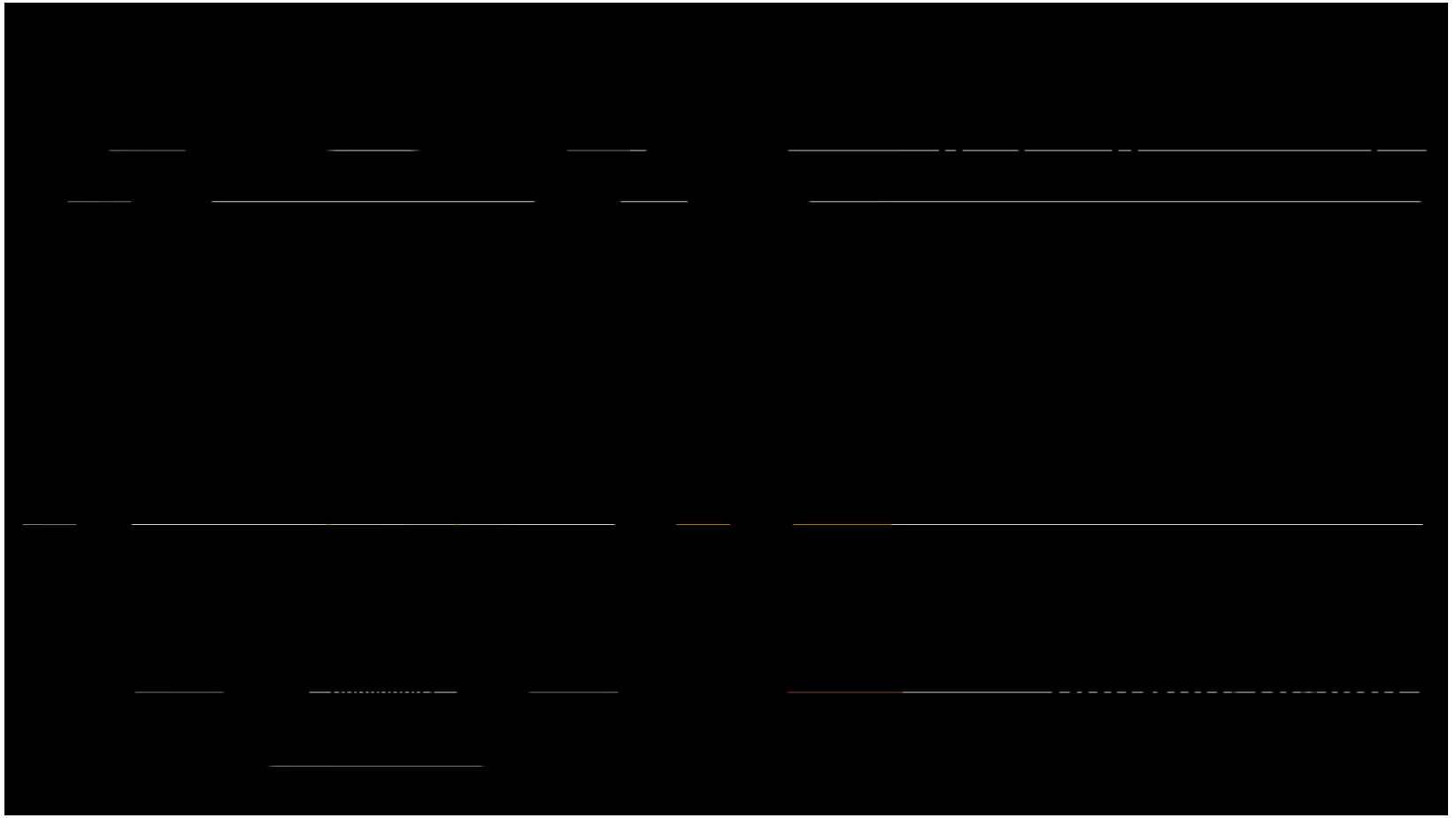
Digital Engineering Capabilities / Focus on Engineering Workflows

3.

- **analyze system architectural models** regarding safety and cybersecurity maturity
- **results to flow back** into requirements in the system architecture model



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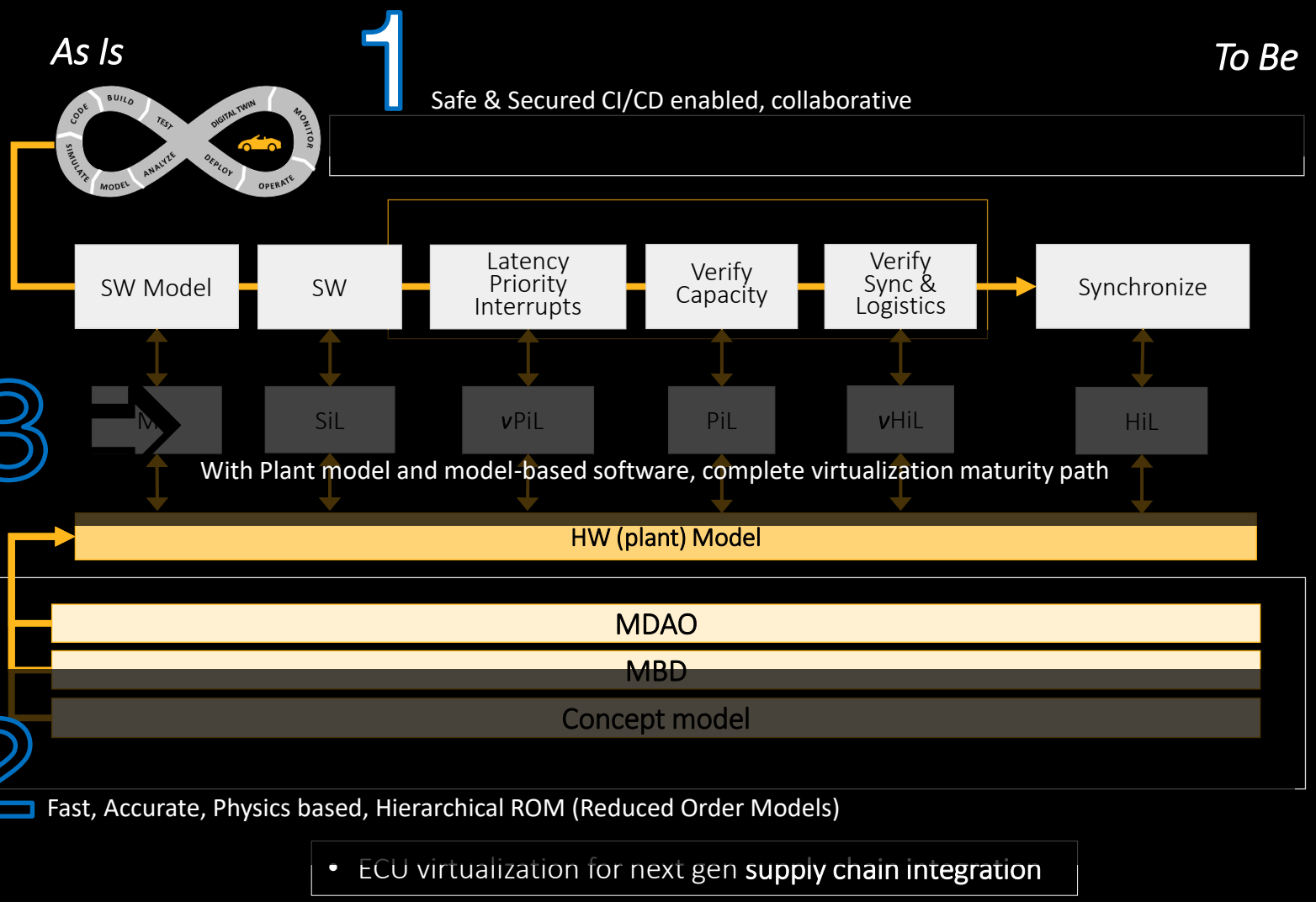
Design of Software Defined Systems (Continuous V & V)



- ECU virtualization for next gen **supply chain integration**

MiL
- Logic verification
- Incremental synchronization with the evolving plant models

SiL
- Latency, interrupt and prioritization
- Consistent plant model

PiL
- Compilation on target processor (eHW)

HiL
- Clock speed, bandwidth, latency synchronization
- Real time
- Consistent plant models

PiL → vPiL & HiL → vHiL
- Parallelization (**emulated targe ECU, co-sim, distributed sim with Plant model**)
- Scenario analyses at scale

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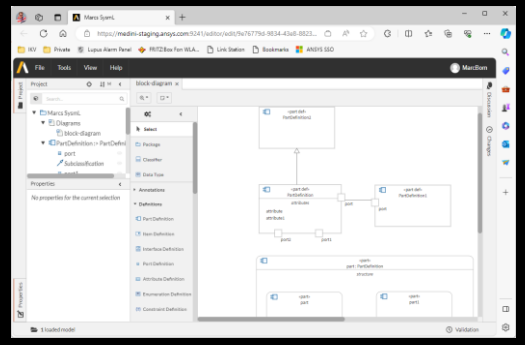
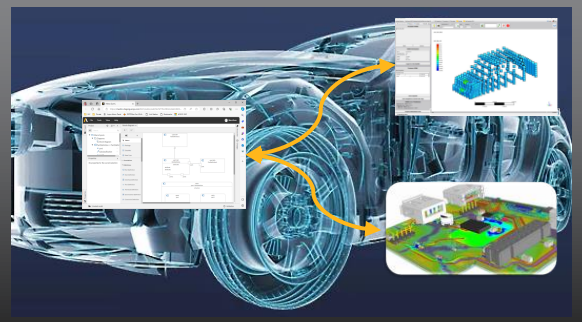
Ansys 2024 R1 – Digital Engineering

- Web-based **System Architecture Modeler** supporting SysML v2
- Center of gravity to support the MBSE methodology
- Works with Scade One, medini, ModelCenter, *more to come*



- **Digital Safety Collaboration Platform + DSM App**
- Accessing and collaborating on safety projects
- Plan, execute and control safety activities
- Addressing safety managers

- **ModelCenter** bridges between system architecture model and engineering simulation
- Supports requirements verification and trade studies
- Integrated with the SAM



- **All new Scade One** for model-based development of embedded software
- Modern UI/UX, support of CI/CD workflows, textual and graphical modeling language
- Certified code generation that meet highest safety requirements

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Summary

- Cyber-physical systems integrate sensing, computation, control and networking into physical objects and infrastructure. Aircraft and modern cars – are examples of such systems.
- Our customers' challenges are the efficient execution of each individual workstream and the continuous integration of these workstreams across the engineering lifecycle
- Provide an integrated **suite of tools** that **connect** the **workstreams** for architecture & requirements; safety & cyber; physical and software, **across the product lifecycle**
- Evolve our existing capabilities towards **support for SysML v2**, **better collaboration** capabilities / user experience and **tighter integration** with engineering analysis and design.
- Ansys MBSE will evolve to support each workstream individually and contribute to an efficient workstream integration

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