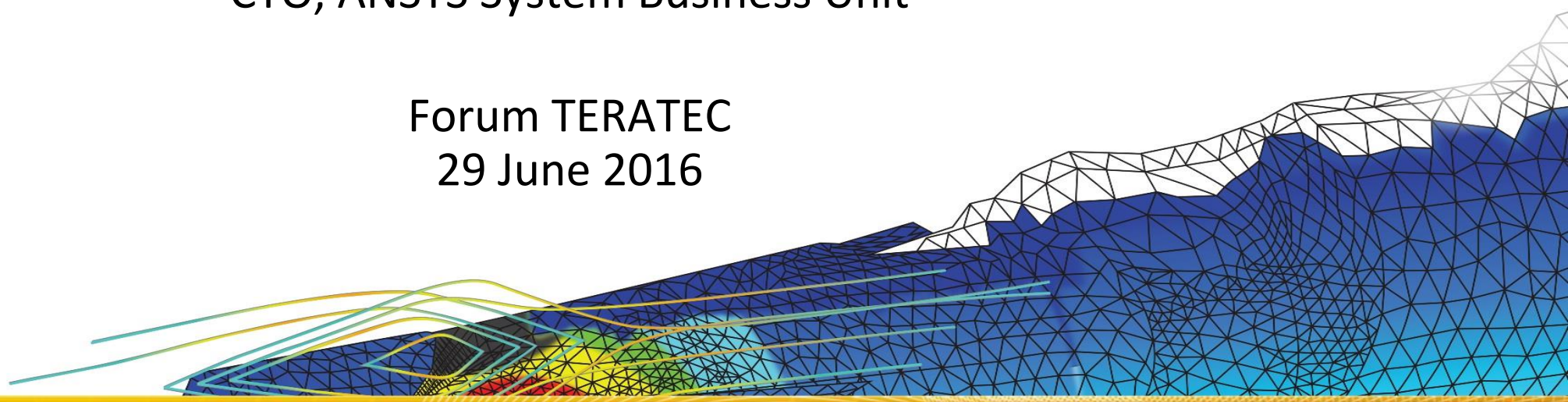
Predictive Analytics and the Digital Twin

Bernard Dion
CTO, ANSYS System Business Unit

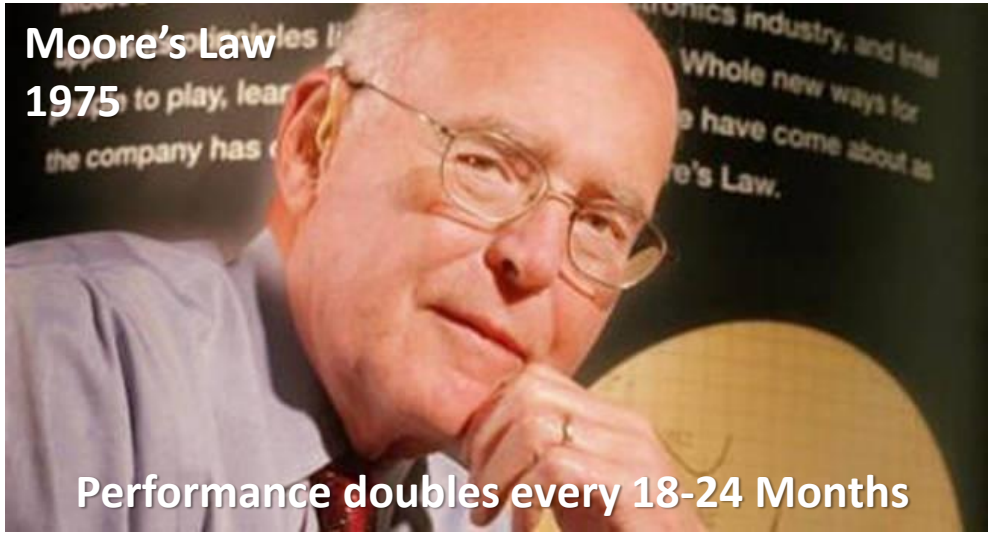
Forum TERATEC
29 June 2016

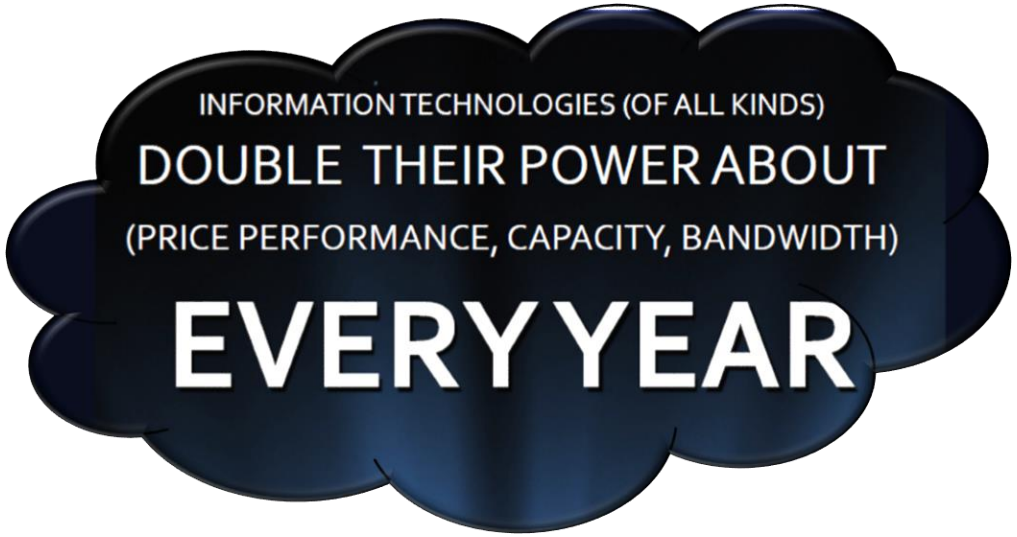


Agenda

- Introduction
- Model-Based Systems Engineering (MBSE)
- Predictive Analytics and the Digital Twin
- Demonstration
- Q&A

Unprecedented speed of technology evolution





The Age of Exponential Thinking

The era of "Accelerating Returns" and
a new balance of "Price, Performance, Capacity and Bandwidth"

"...We better disrupt ourselves in our own way before somebody does an Uber to us."
Doug Oberhelman, CEO CATERPILLAR @ CIW, Oct15, 2015

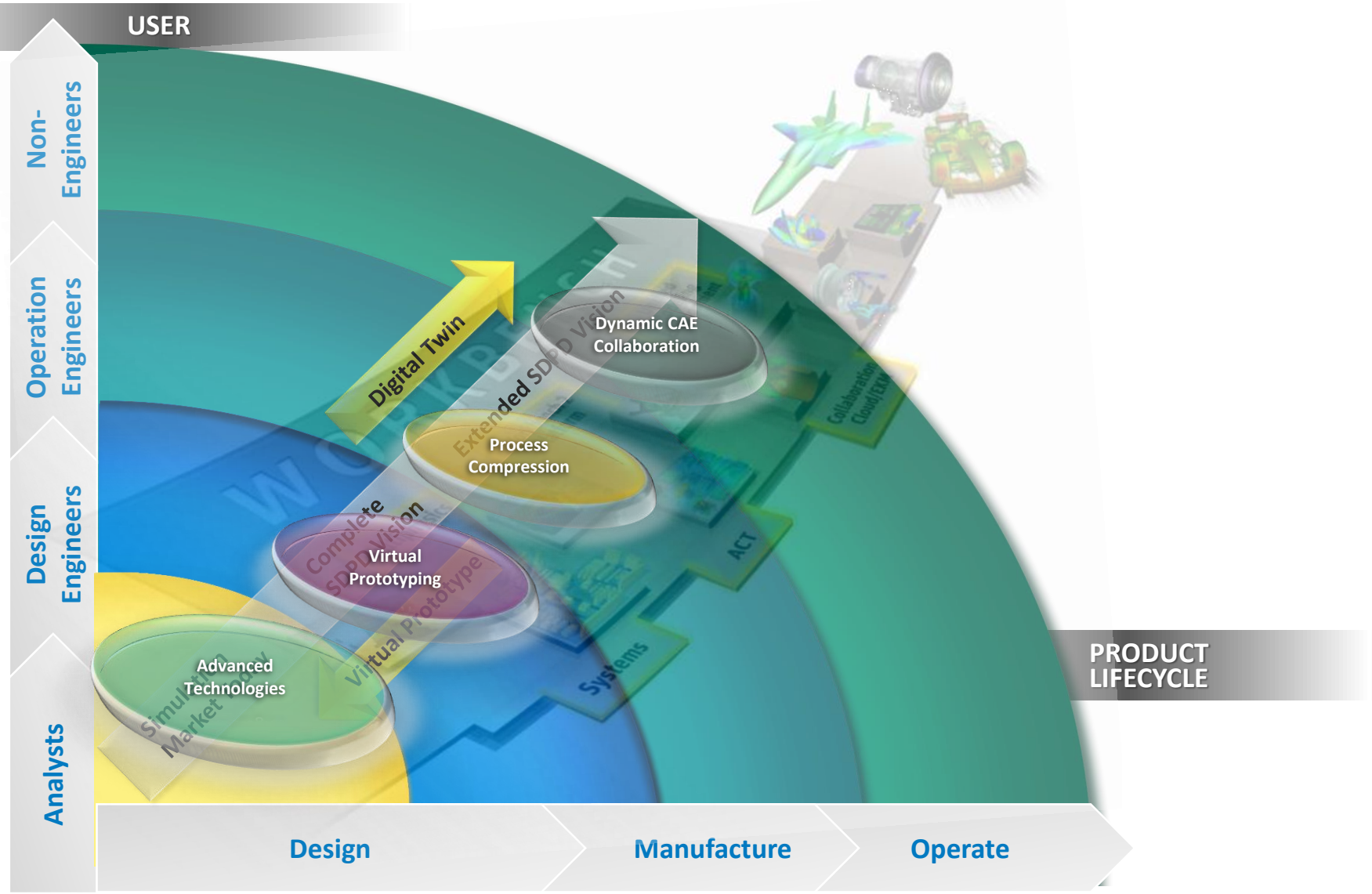
Evolution of simulation

- ACT Apps
- Embed Simulation

- Simulation on Demand
- MBE

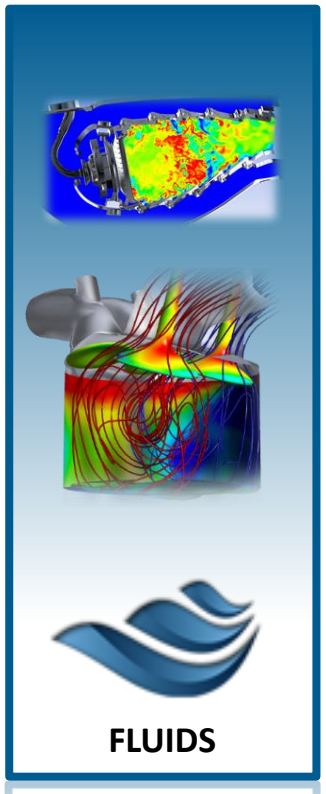
- Usability (UX Enhancement)

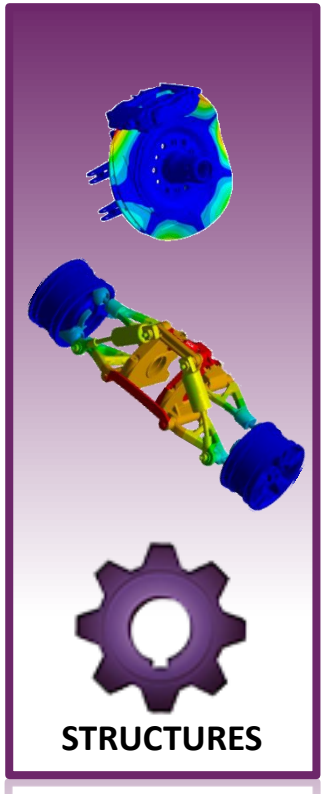
- Performance

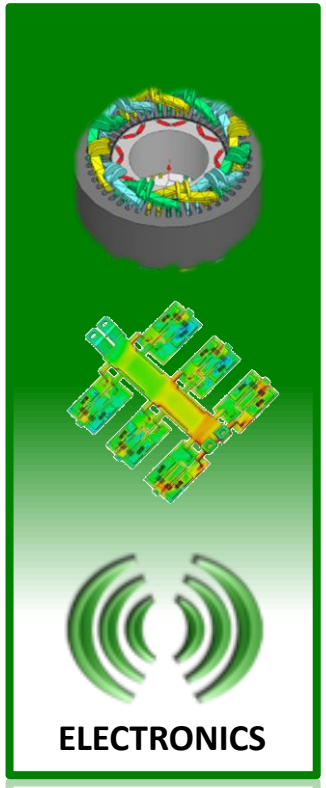


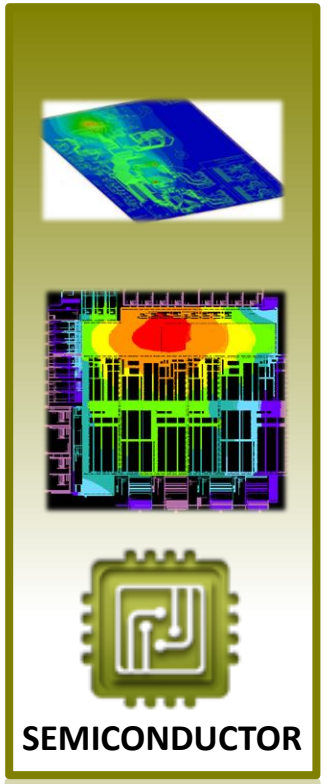
ANSYS enables systems

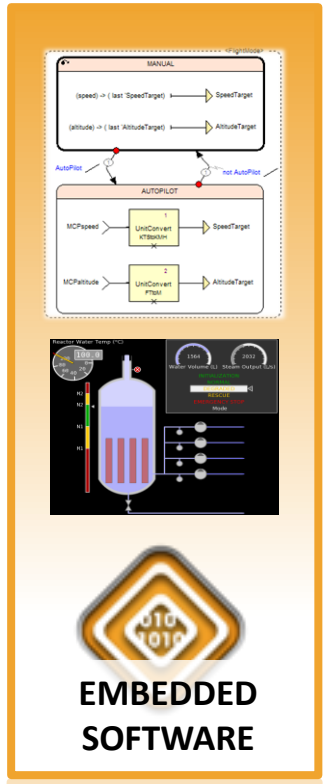
From comprehensive component-level design & simulation …





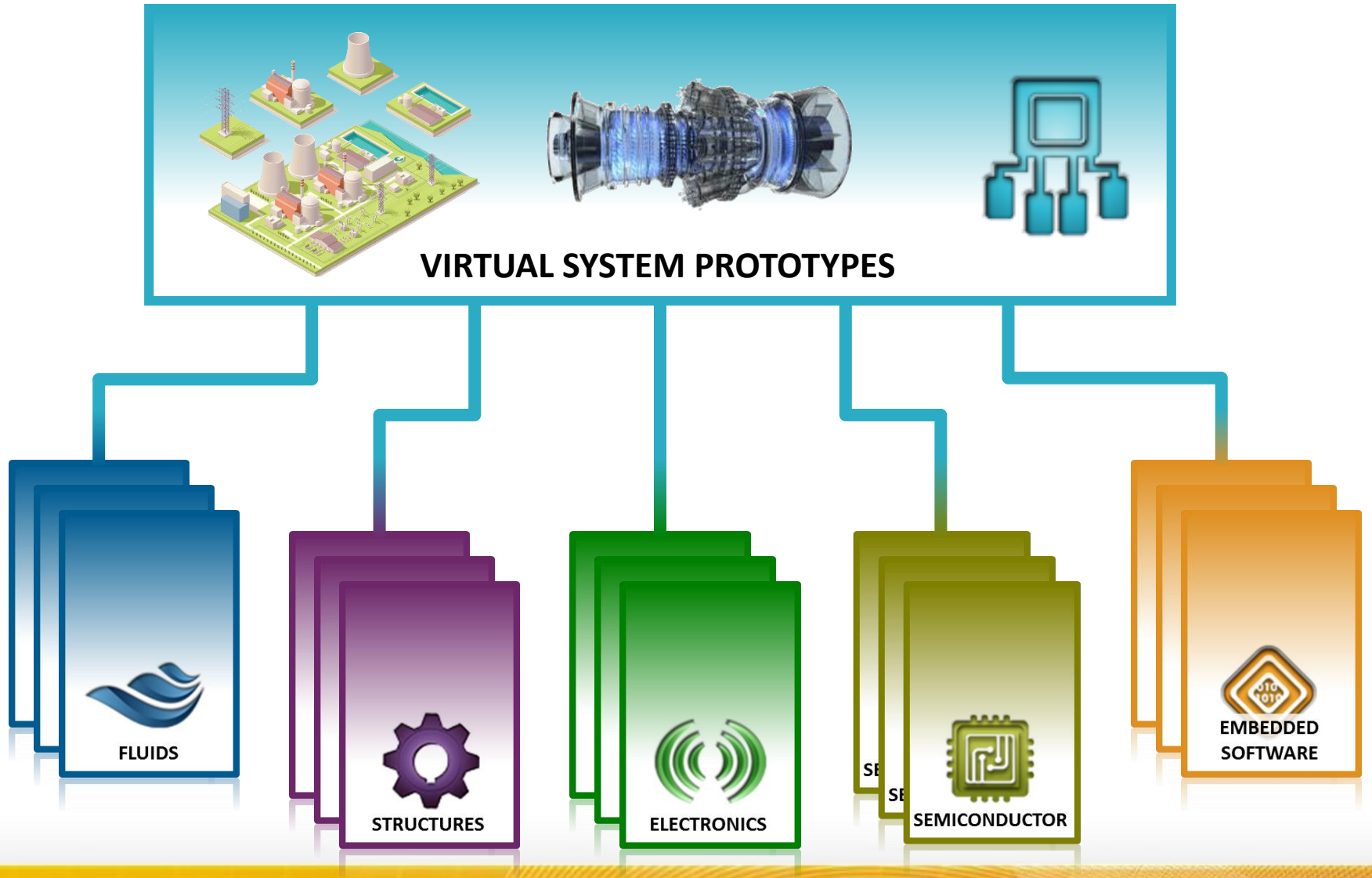






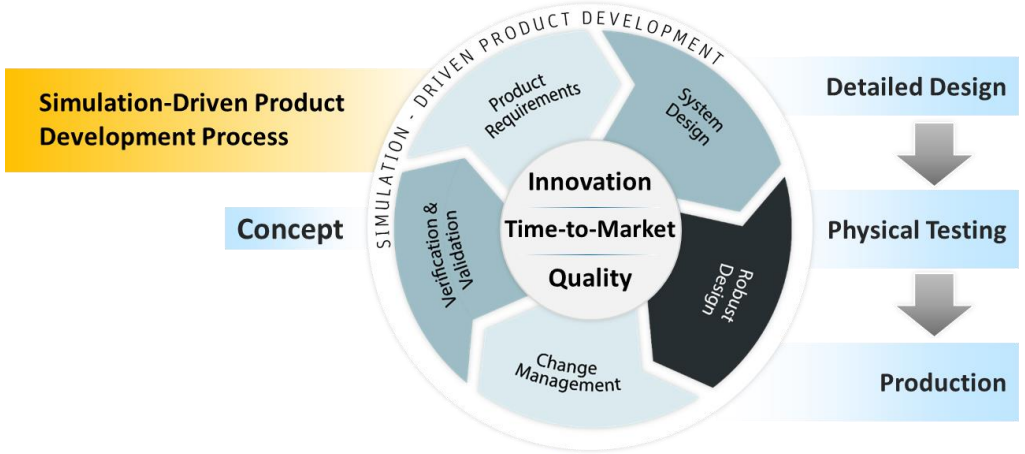
ANSYS enables systems

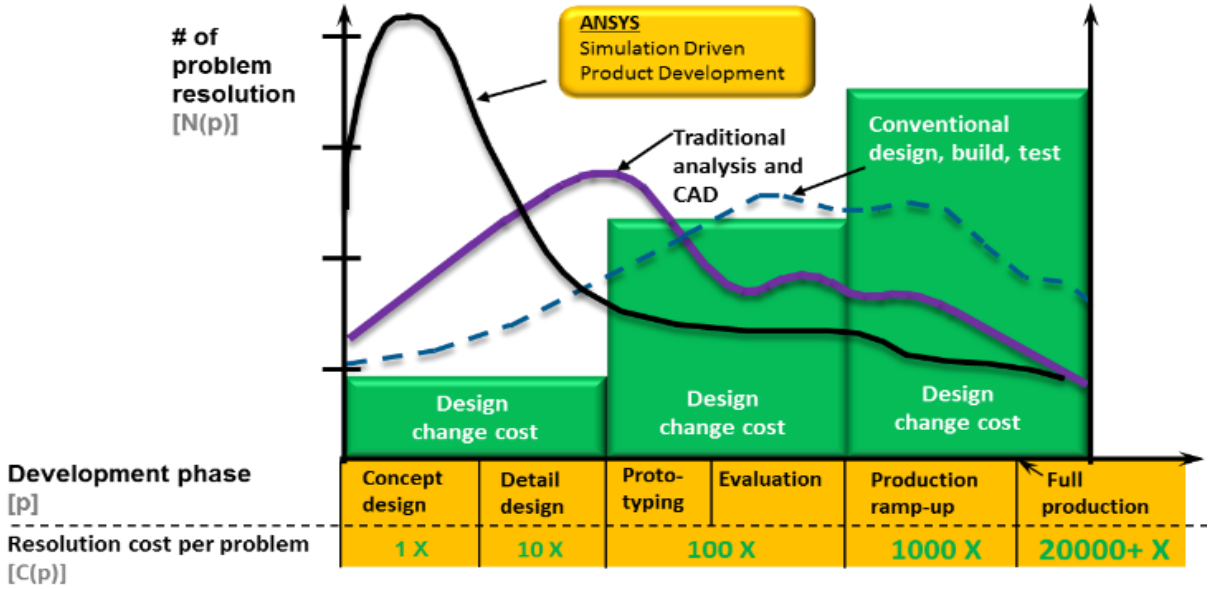
… to complete systems simulation



Simulation Driven Product Development

From build & test to virtual development

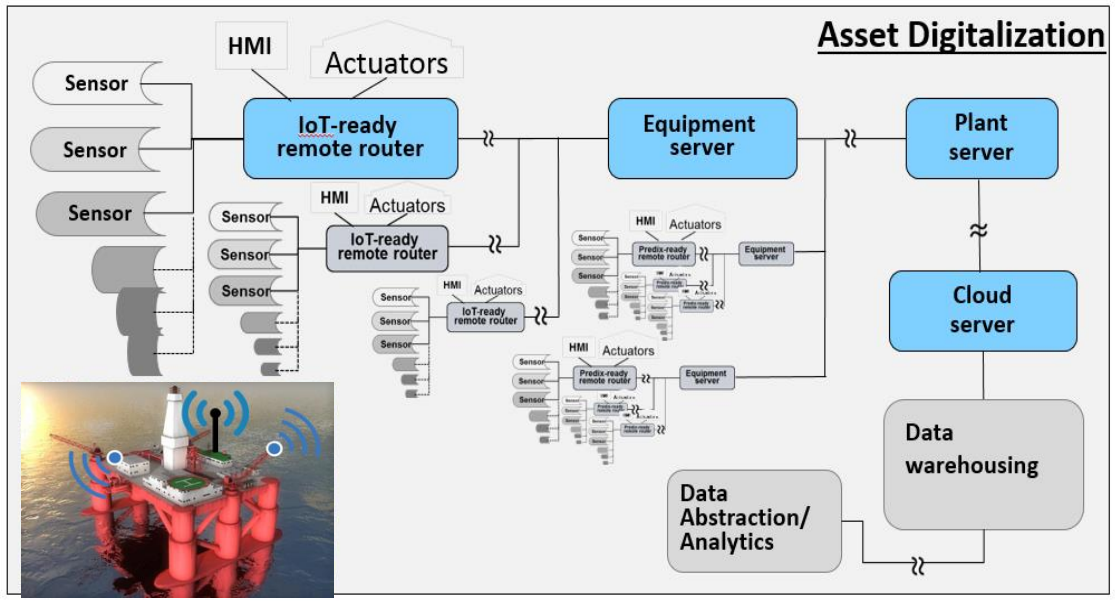




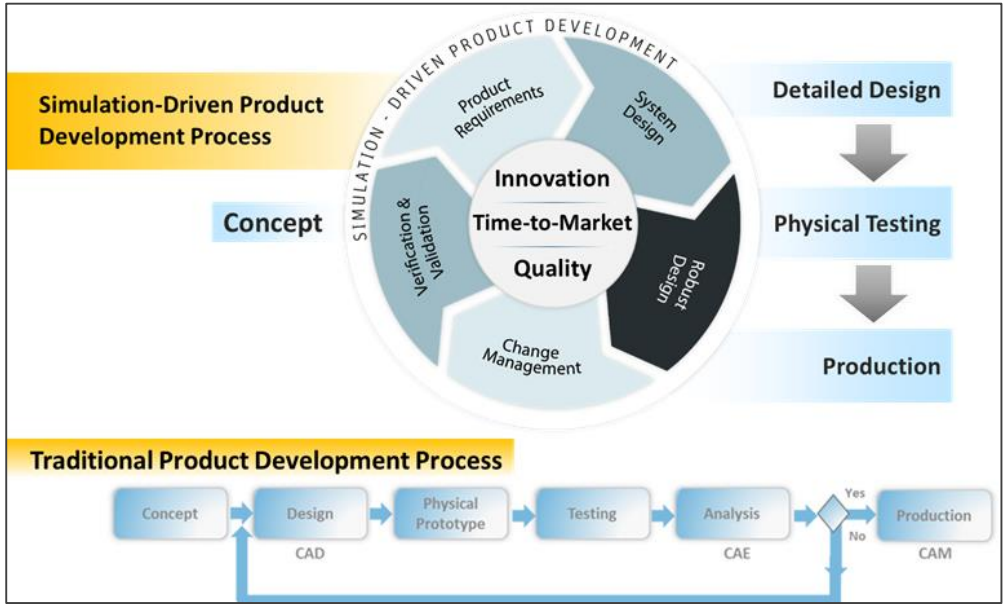
Platform based SDPD adoption enables enterprise level scalability for NPI acceleration

Creation of the digital twin

Connected Industrial Assets



Digital Prototype

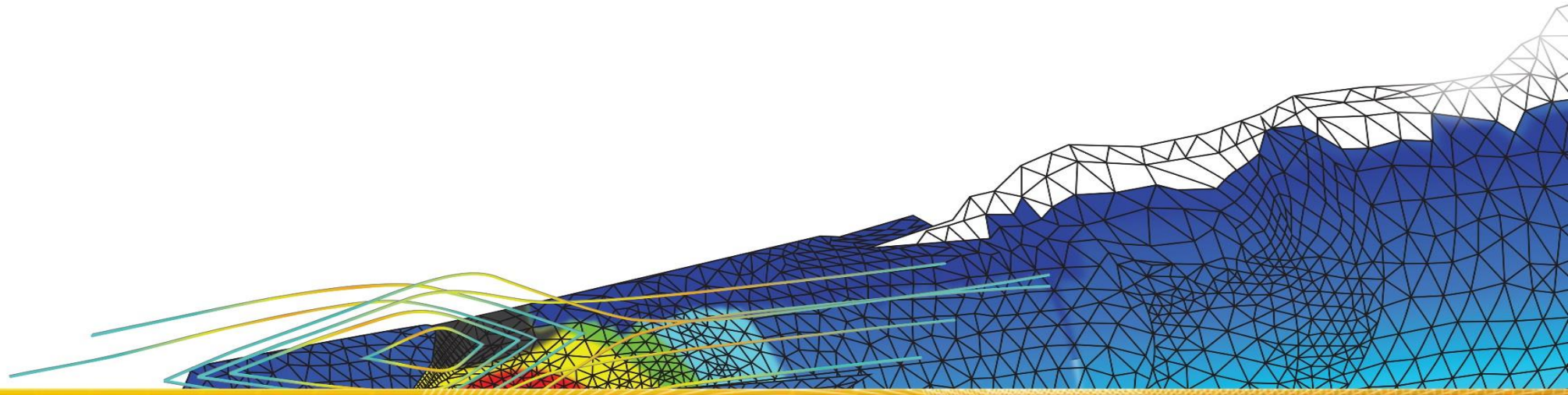


Digital Twin

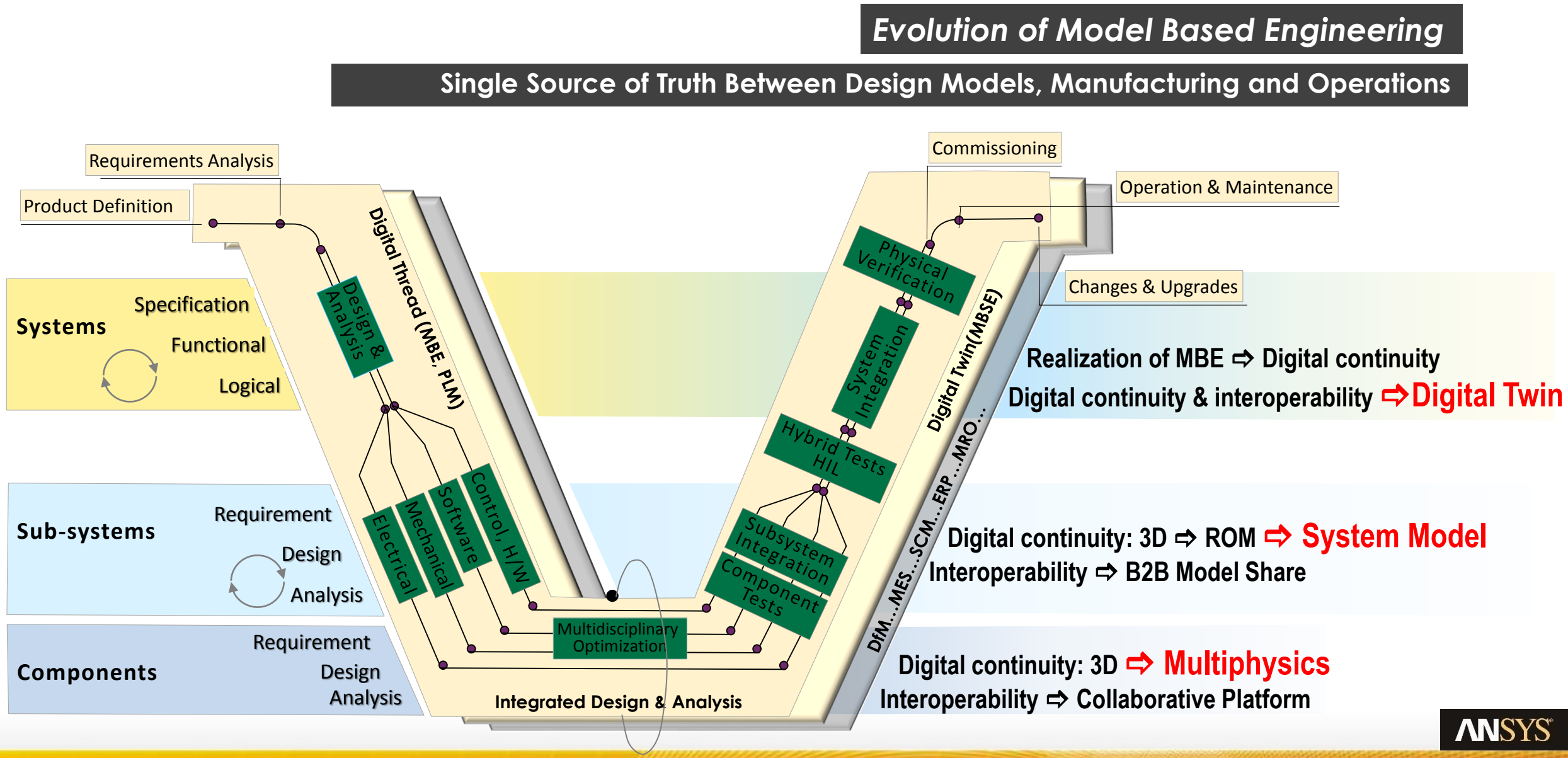
Predictive Maintenance
Zero Unplanned Downtime
Asset Performance Management

ANSYS®

Model-Based Systems Engineering (MBSE)

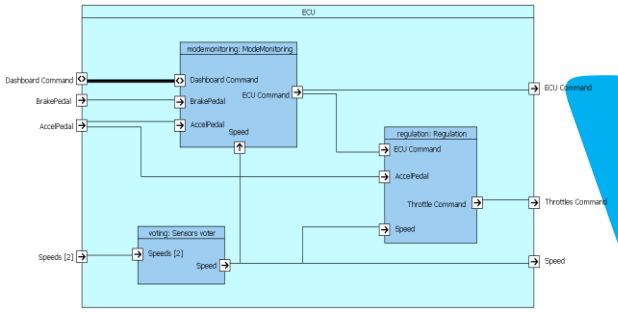


Model-Based System Engineering (MBSE): Product Lifecycle

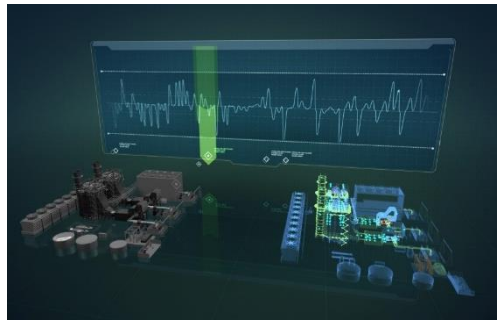


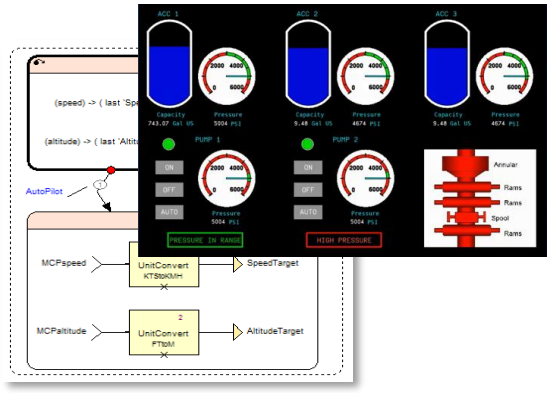
Model Based System Development

Model-Based System Engineering

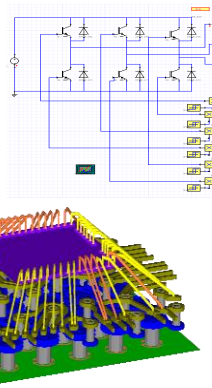


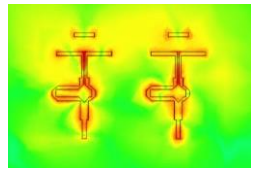
Virtual Prototyping of Complete System





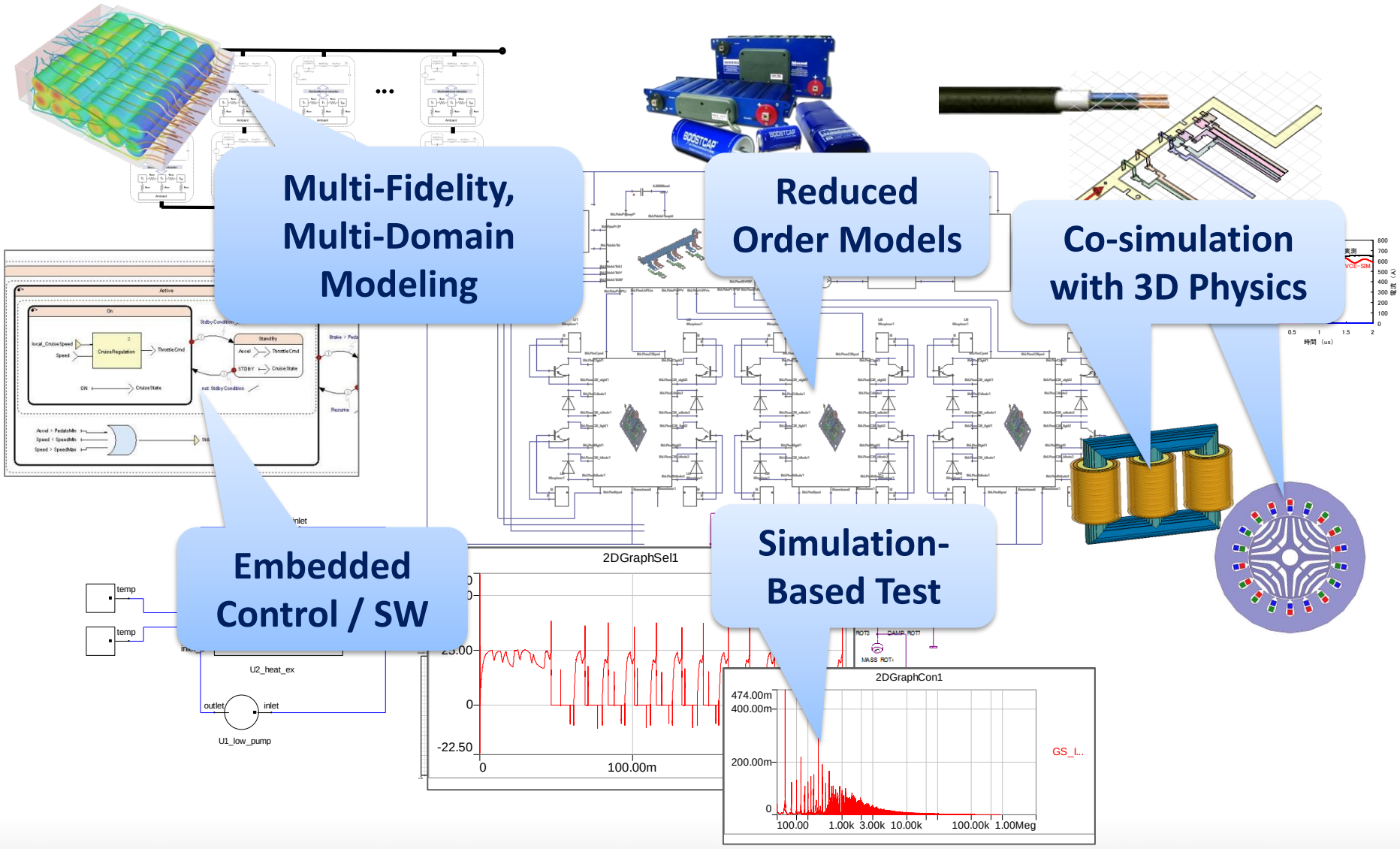
Model-Based Embedded Software Development





Virtual Prototypes of Physical Components

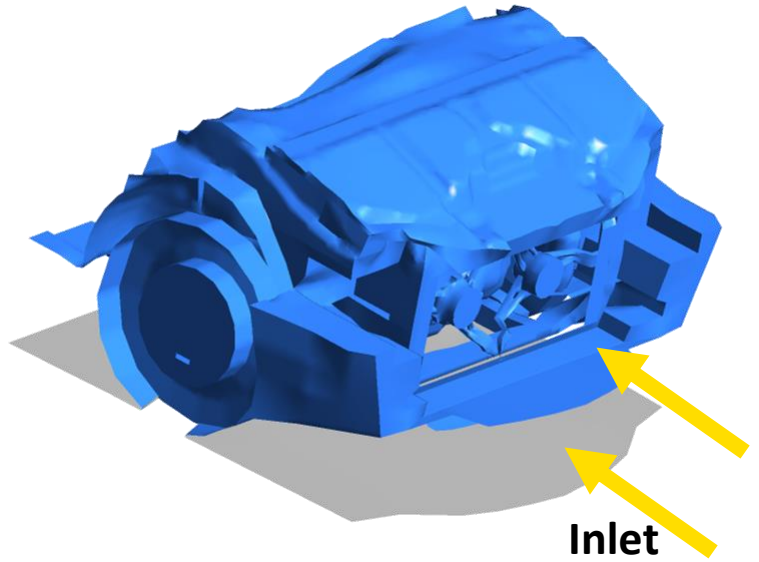
System Modeling & Simulation

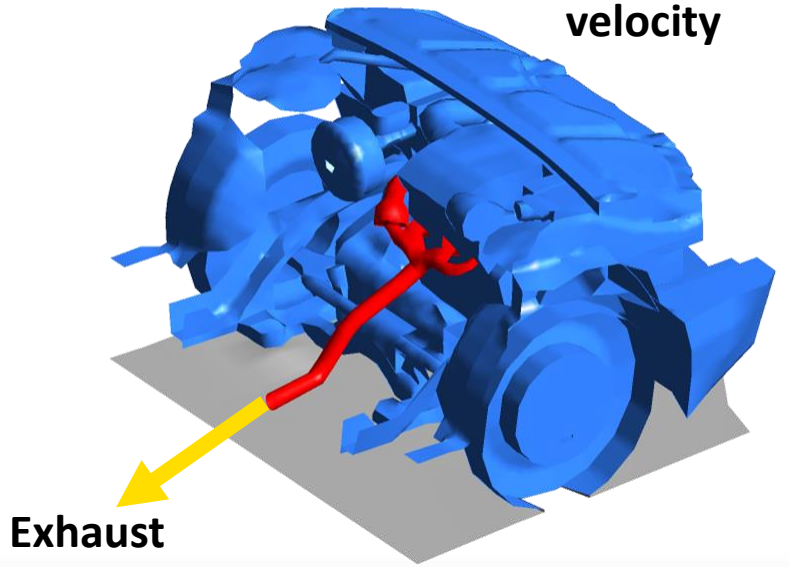


ROM creation example: Generic underhood test case

- 3D thermo-aerodynamic

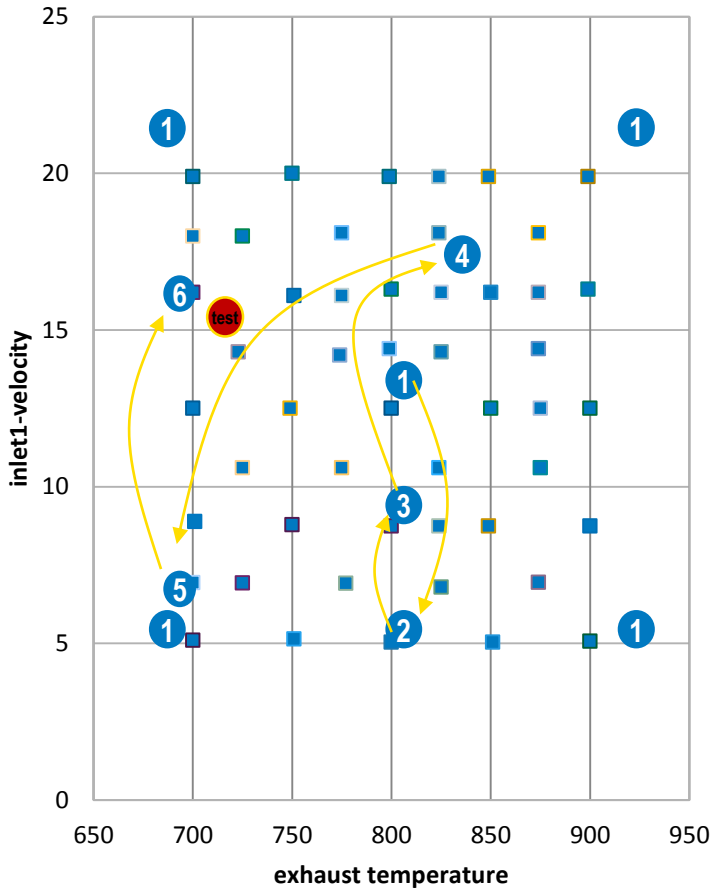
- 2 parameters :
  - Inlet velocity from 5 m/s to 20 m/s
  - Exhaust Temperature from 700K to 900K



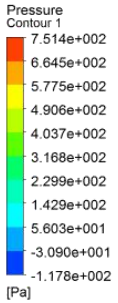


Reduced Order Model generation process (learning process)

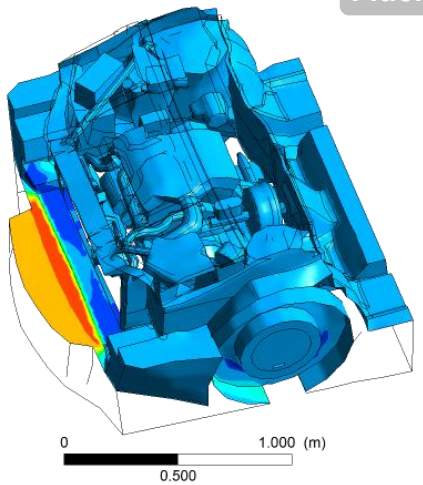
- 50 calculations were done
  - 10 were used to create the model
  - 40 others used for verification
- ROM Model creation is 9 seconds
- Average error on velocity : 0,06 m/s
- Average error on temperature : 0,49 K
  - Quantitative differences in between Fluent calculation and ROM model are presented on the worst verification point



Static Pressure Comparison

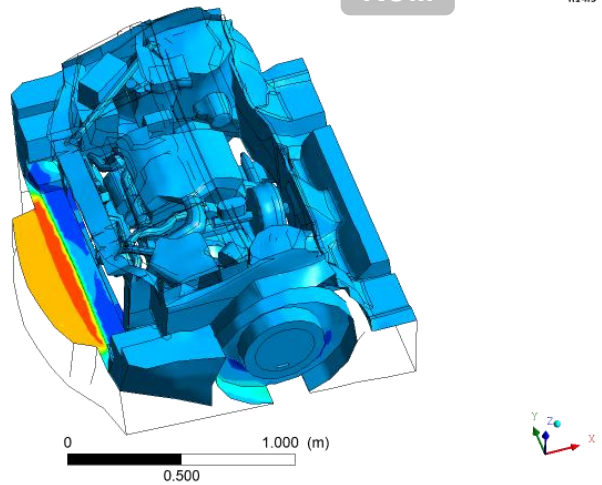


Fluent

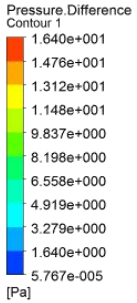


2 hours on 16 cores cluster

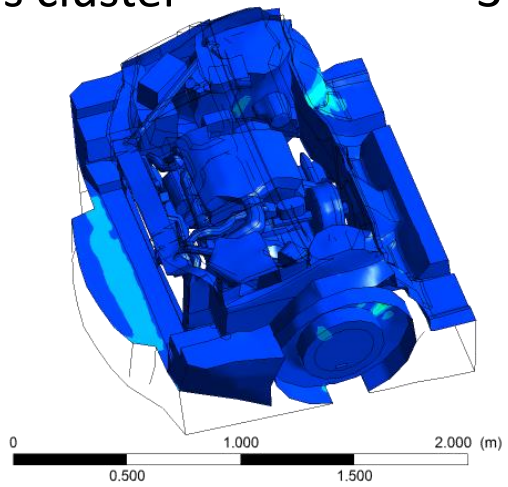
ROM



3 seconds on laptop



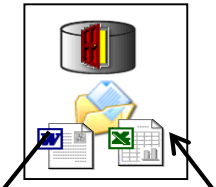
Absolute Difference



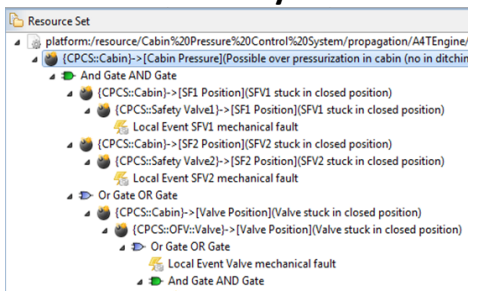
$T_{exhaust}$ = 723K
V_{car} = 14,3 m/s

System Design and Safety Analysis

System Requirements



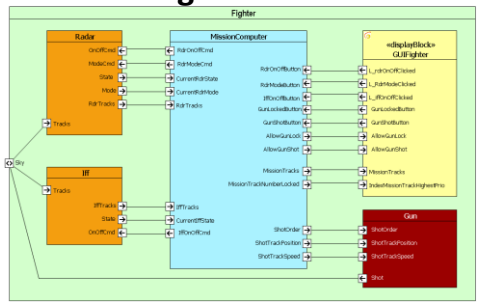
Safety Analysis



FTA
FMEA
etc.

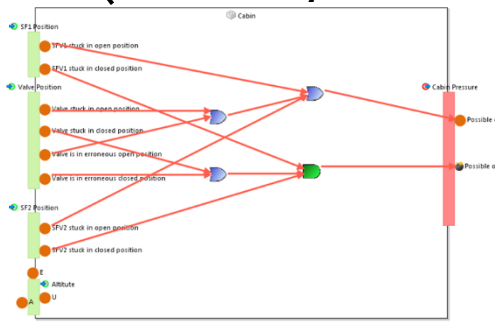
SCADE SYSTEM®

System Design



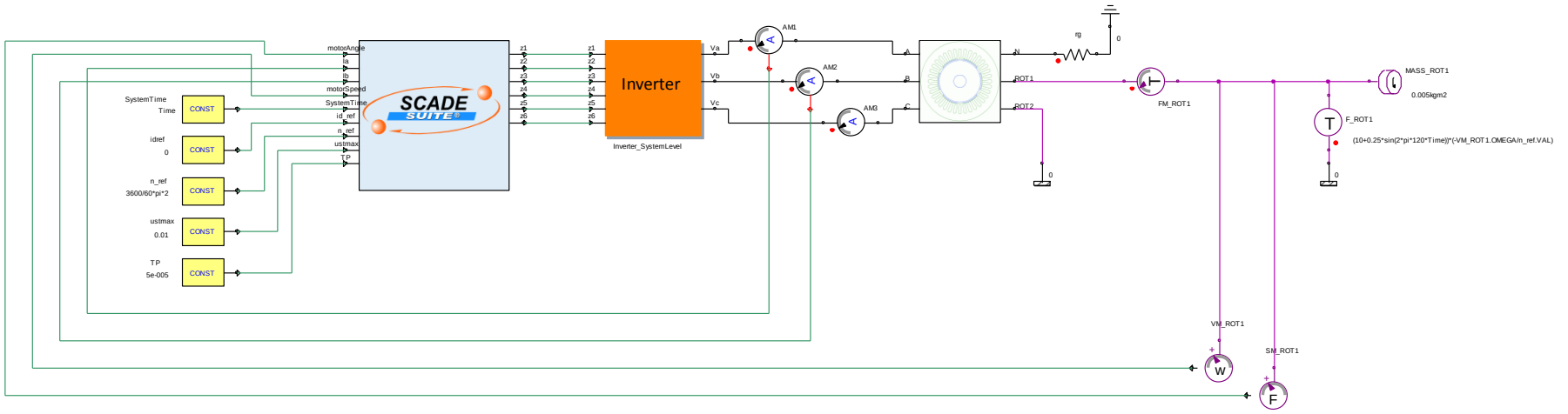
Translation and Merge

Safety Analysis

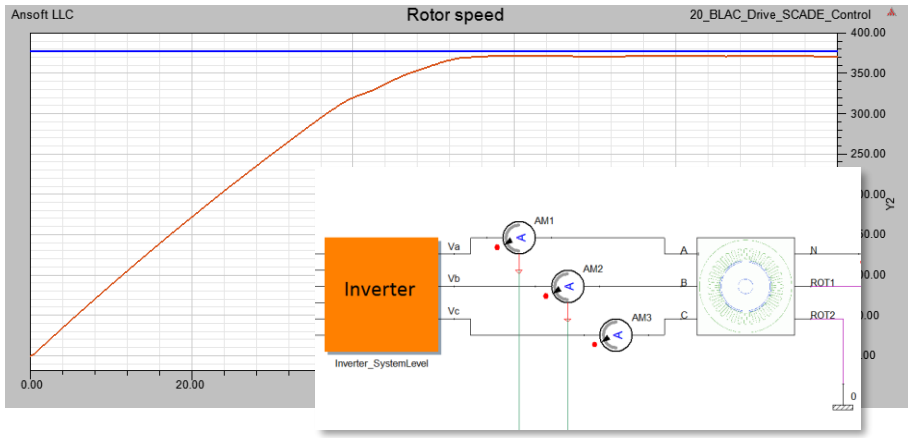


System Simulation and Safety Analysis (FMEA)

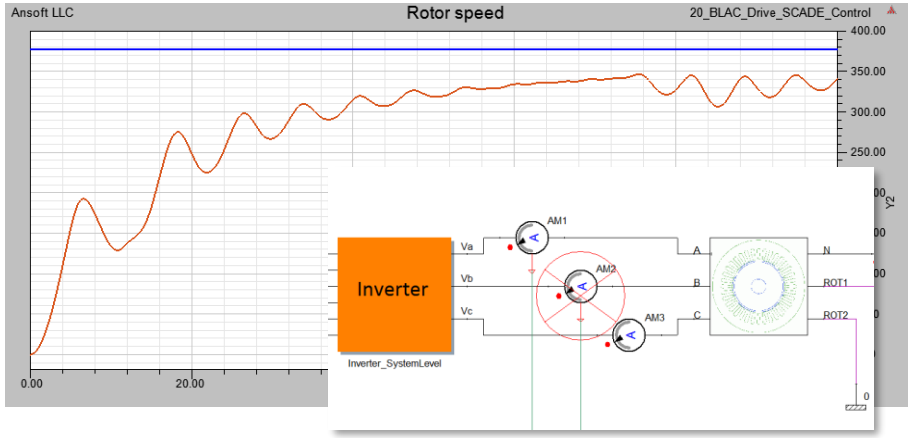
Injecting and analyzing faults



Normal Behavior

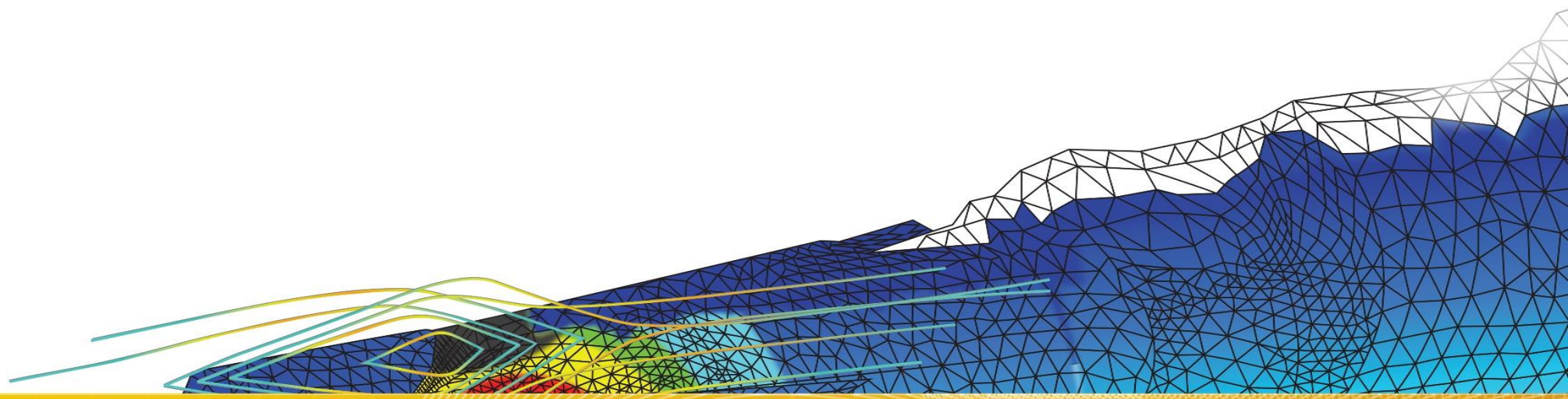


Sensor Failure



Simulation has been used so far to Engineer better products and improve Bottom line.

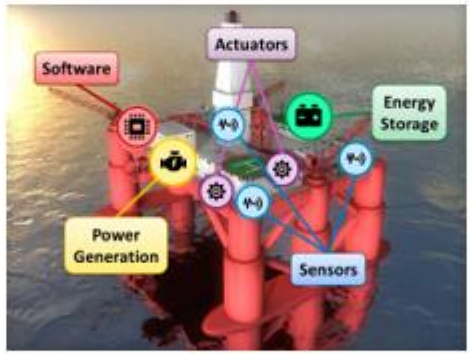
Predictive Analytics and the Digital Twin



Industrial IoT (IIoT) is a Logical Evolution of Product

PHYSICAL PRODUCT

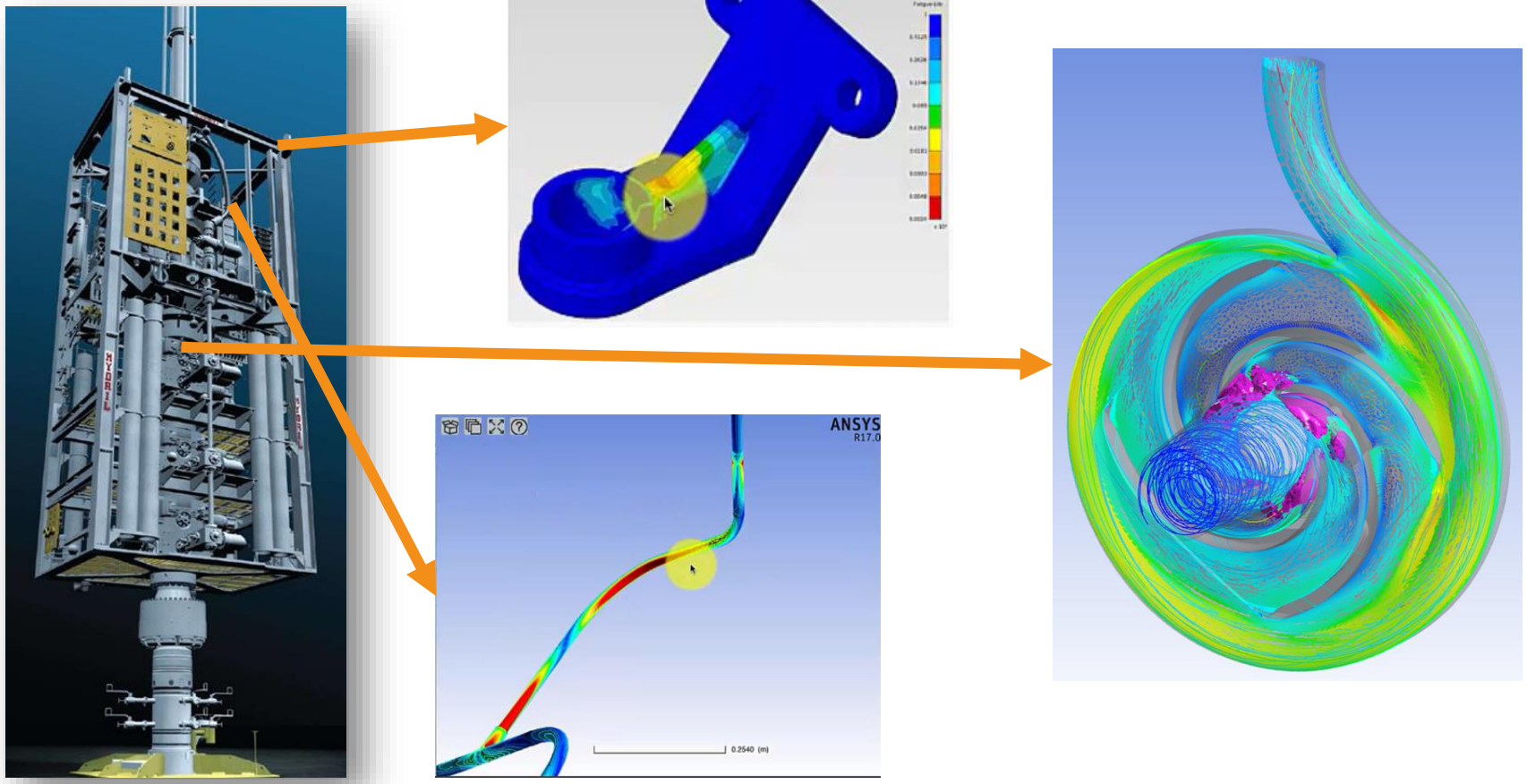
SMART PRODUCT



IoT = SMART & CONNECTED PRODUCT

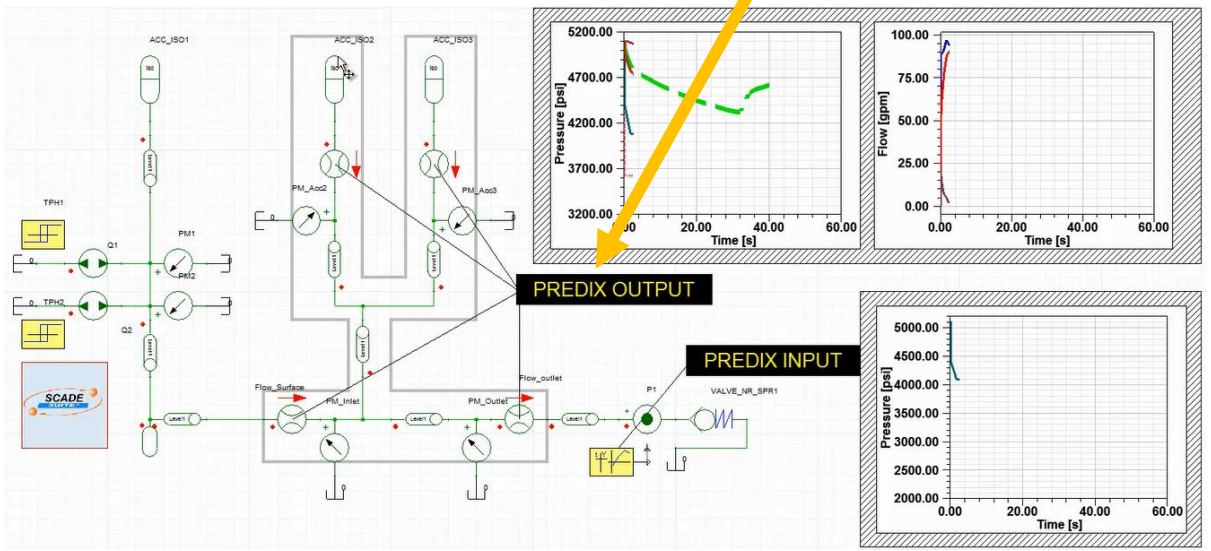
System Simulation coupled with IoT can now be used to Better Operate Products and improve Top Line.

Engineering Simulation: Example Oil Field Blow Out Preventer



Physical Simulation
of all the **Mechanical & Fluids Components** of the BOP System

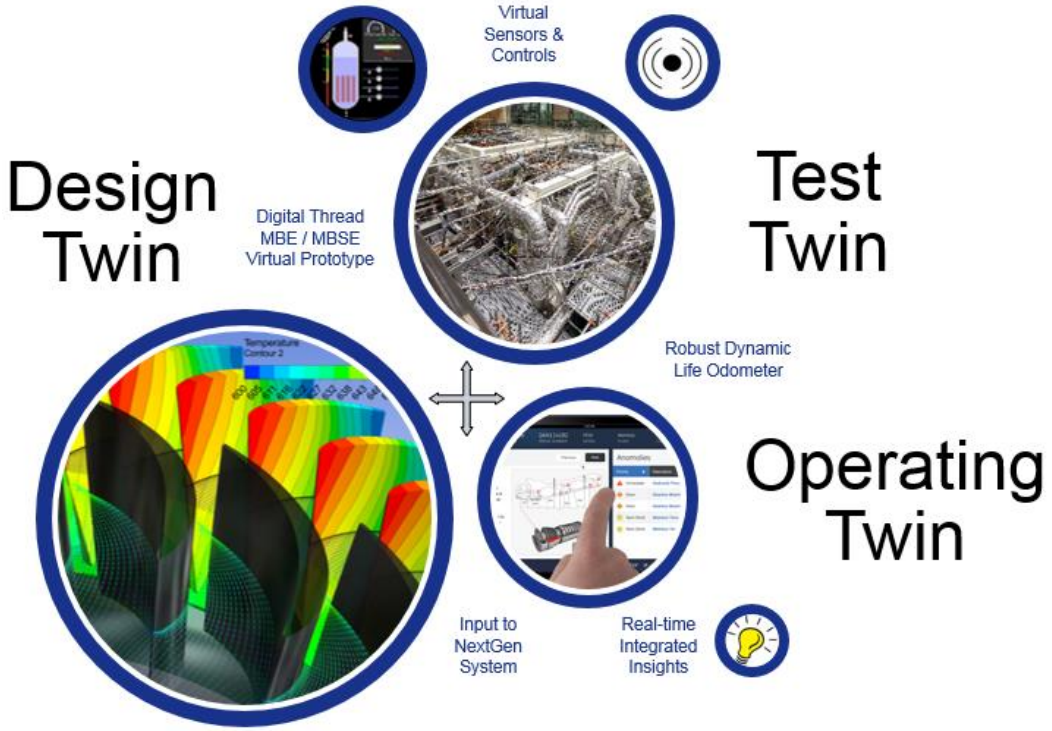
Engineering Simulation: scaling to System Level



Complete System Simulation,
including **Physics, Electronics**
and Embedded Software Controls
=
Digital Twin of the BOP

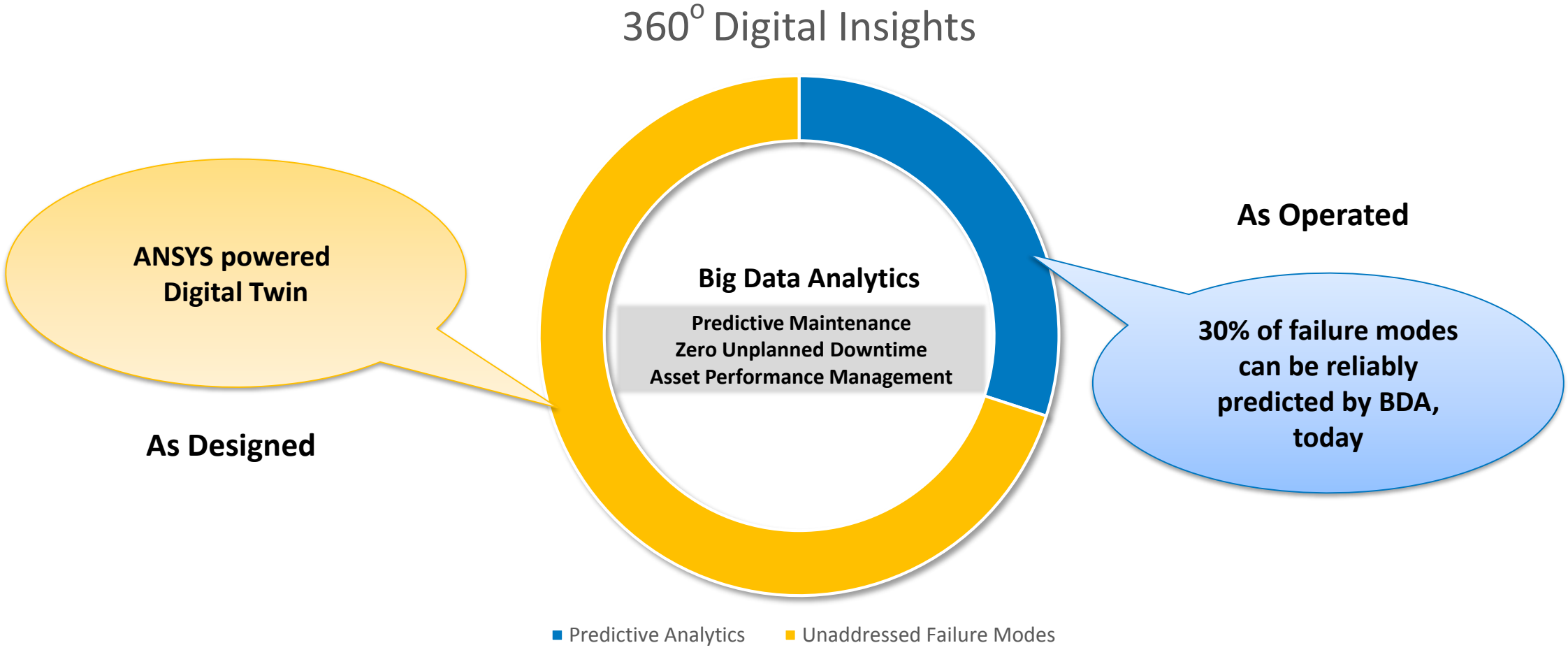
Transformational journey to digital twin

As Is

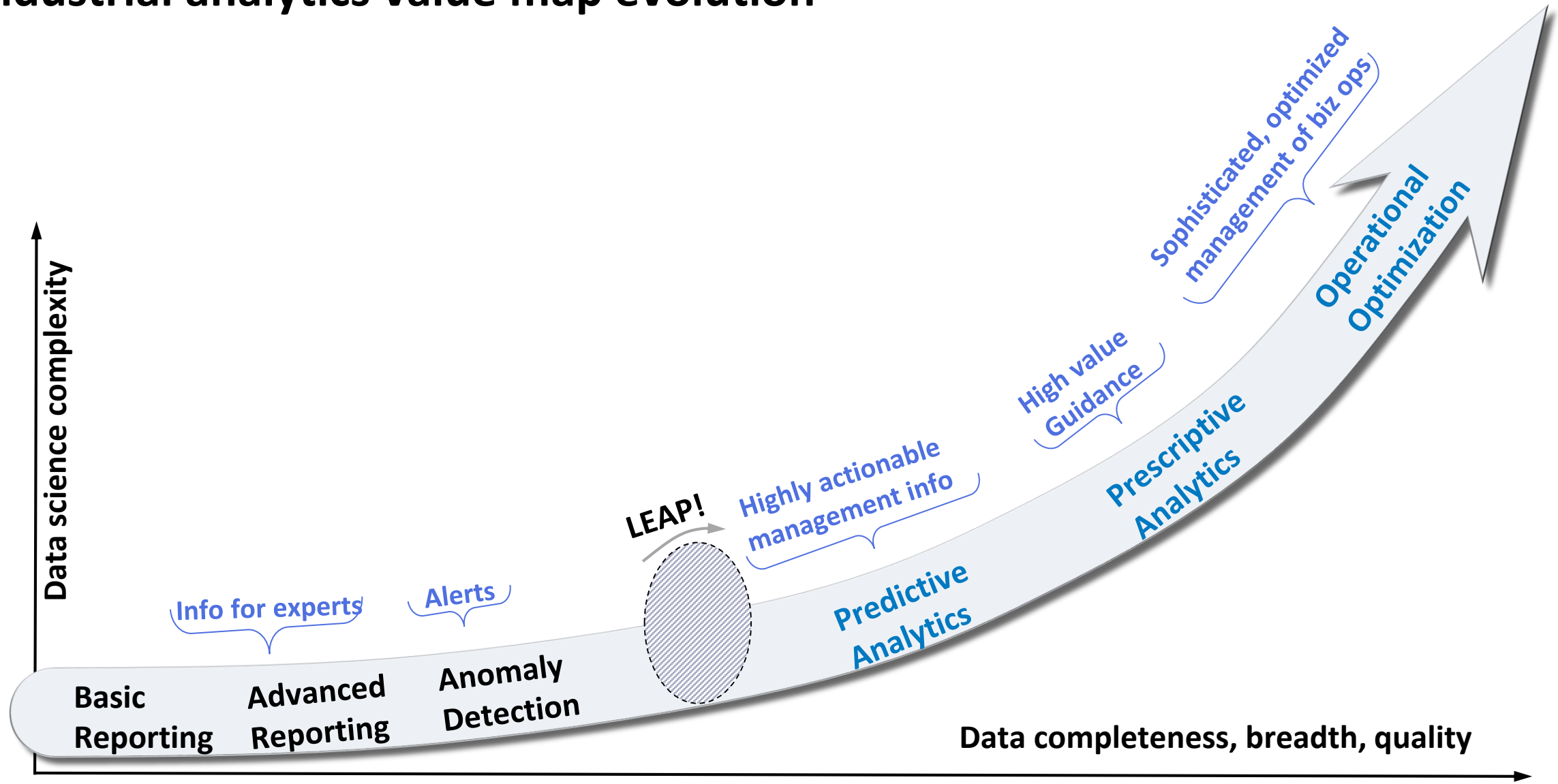


To Be

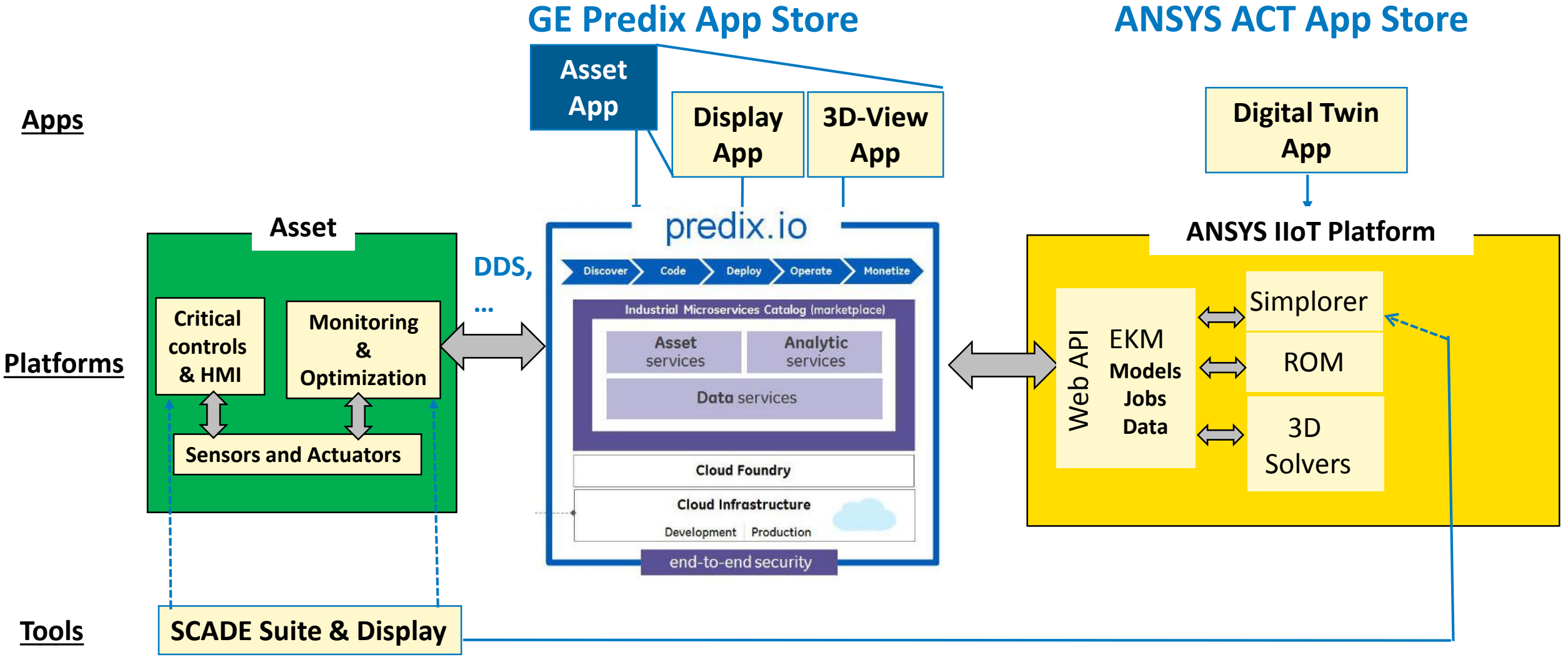
Digital twin opportunity



Industrial analytics value map evolution



GE Predix* and ANSYS Industrial IoT Global Architecture



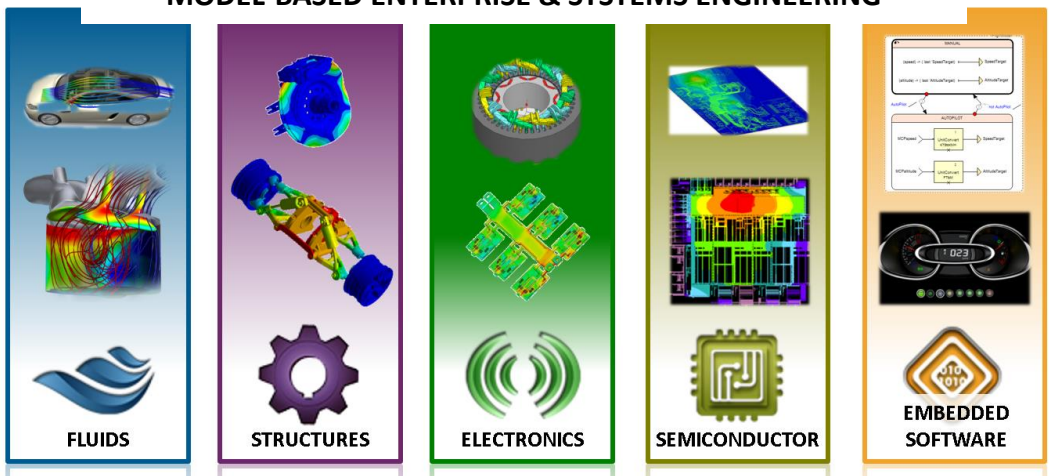
* Similar architecture has been set up with PTC ThingWorx

A Connected Smart Asset

Digital Twin Summary

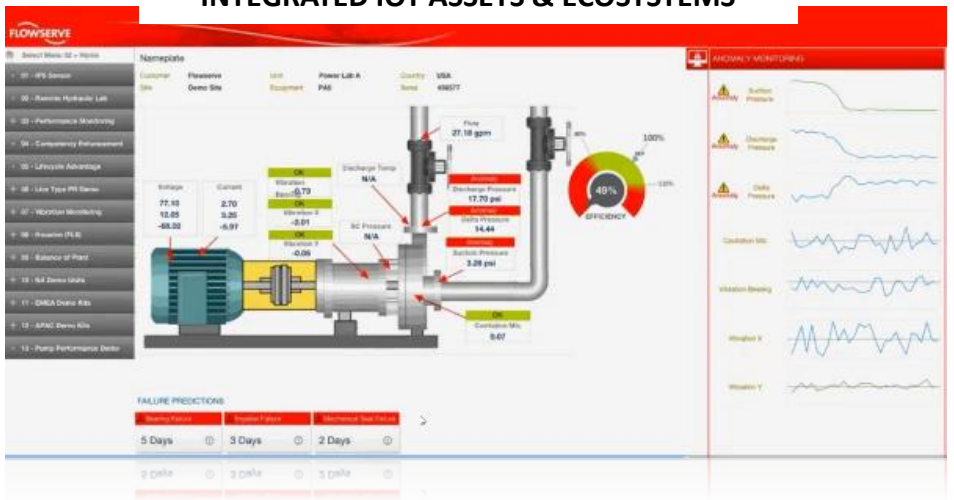
As Designed

MODEL-BASED ENTERPRISE & SYSTEMS ENGINEERING

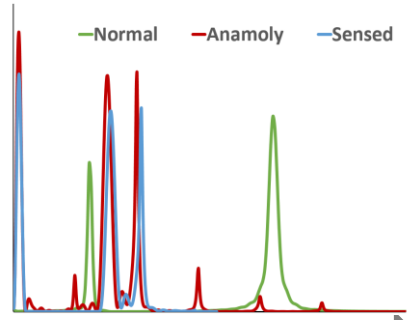


As Operated

INTEGRATED IOT ASSETS & ECOSYSTEMS



Digital Signatures



Virtual Sensors

Design Decisions

- Cost
- Weight
- Efficiency
- Robustness

Operational Decisions

- Life
- Performance
- Diagnostics
- Optimize

ANSYS®

Q&A