March 29, 2023

# Model Based Systems Engineering (MBSE)

# Turning Complexity into YOUR Competitive Advantage

Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Brian Thornton

## I help customers assess, plan & initiate MBSE business transformations

Background

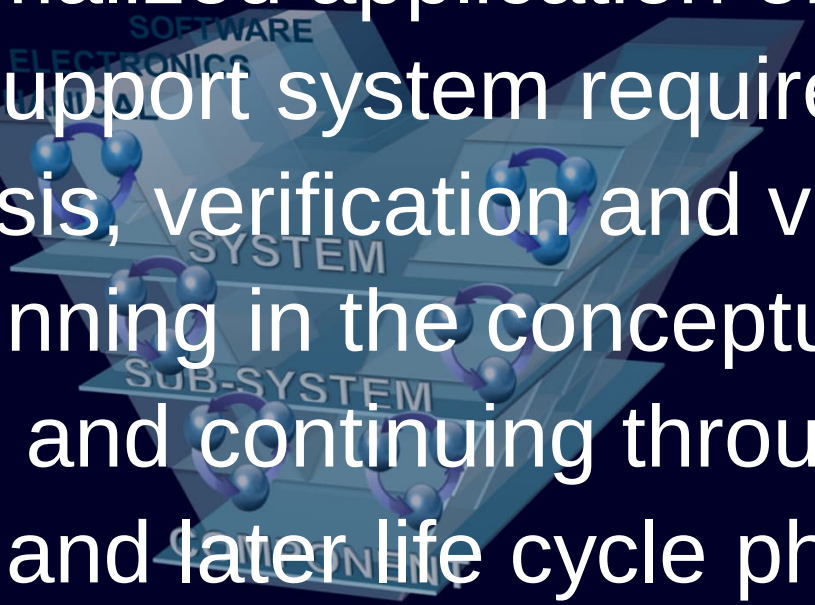
- Ford North America Account Executive @ Siemens for the previous 10 years
- 30+ years Automotive OEM and Tier 1 sales & deployment
  - Simulation & systems engineering solutions
  - Test Systems
- Detroit, Michigan


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

MBSE - A formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases

*International Council on Systems Engineering (INCOSE) SE Vision 2020*

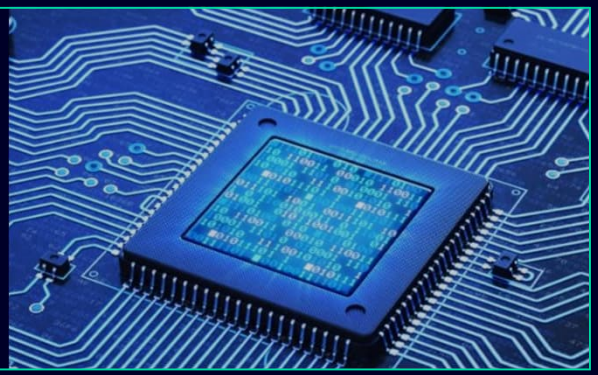




Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

## Why has MBSE become necessary?

Designs are becoming more complex

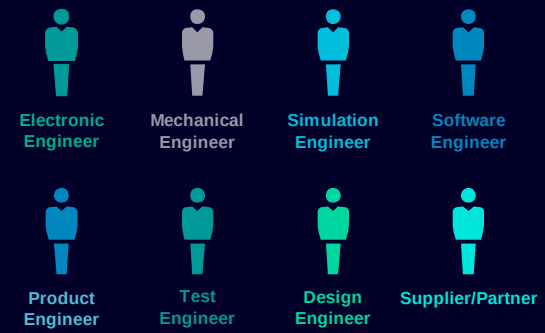


Products are smarter & more deeply connected across systems

*'system of systems'*

Engineering disciplines are becoming blurred

Siloed teams, disconnected tools & manual processes are no longer sufficient

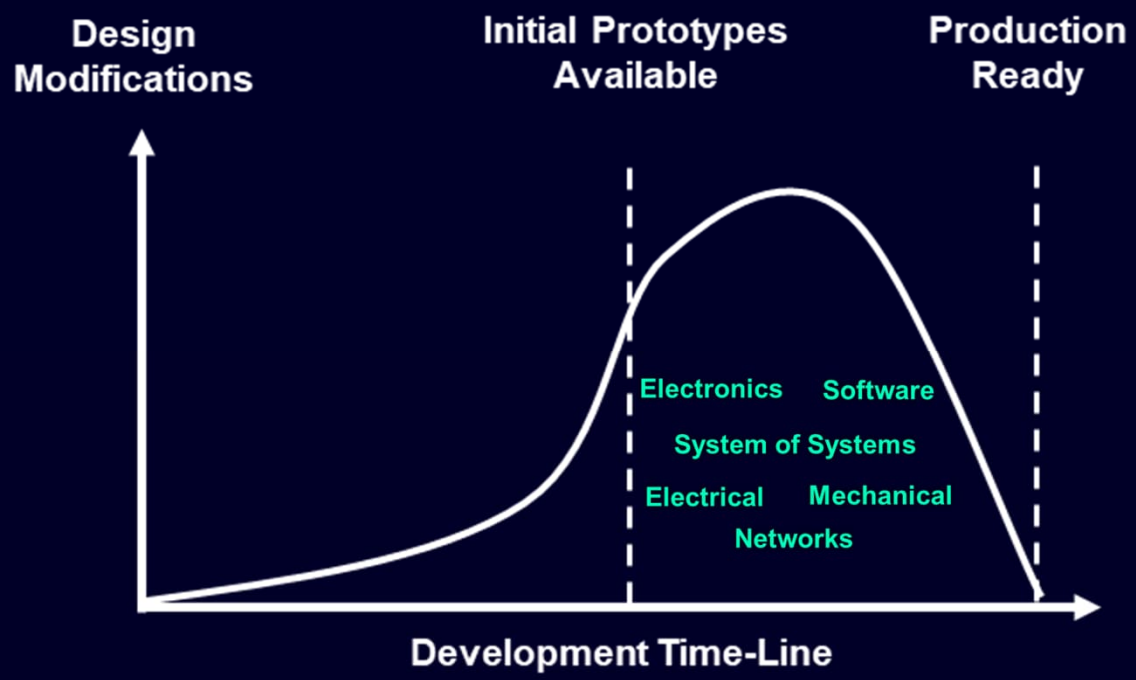




Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

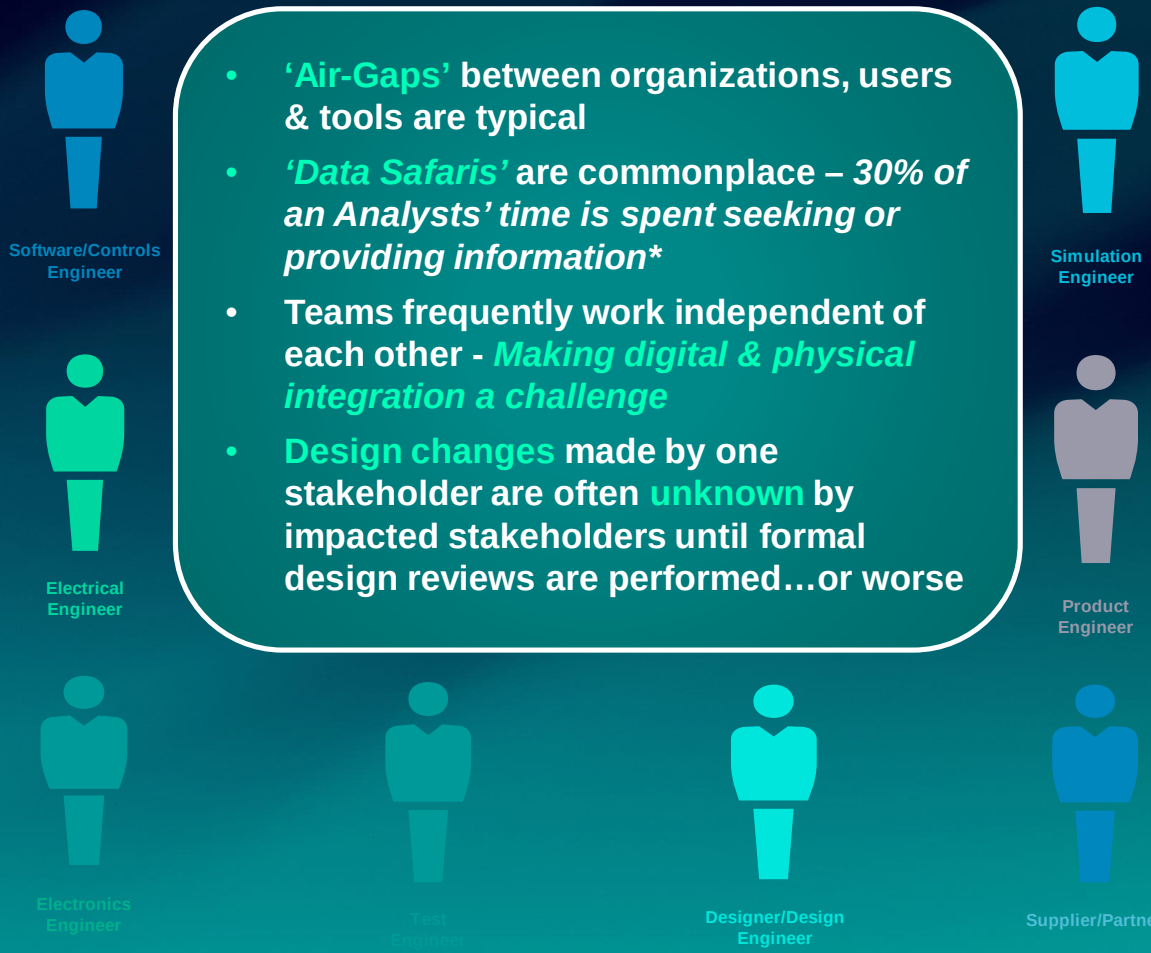
## Between 30 – 70% of program schedule & resource time are consumed by integration issues





Restricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

# Why is this?...What we see across industries




- **'Air-Gaps' between organizations, users & tools are typical**
- ***'Data Safaris' are commonplace – 30% of an Analysts' time is spent seeking or providing information****
- **Teams frequently work independent of each other - *Making digital & physical integration a challenge***
- **Design changes made by one stakeholder are often unknown by impacted stakeholders until formal design reviews are performed…or worse**

* *Reference - Rolls Royce Aerospace*


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.
SIEMENS

# The Impact of Digitally Integrating Your Engineering Enterprise

**Avionics**
- Common Core System (CCS)
- Navigation - FMS
- Navigation – TMS
- Navigation – ADRS
- Navigation – ERS
- Navigation – IRS
- Navigation – CM App
- Displays and Crew Alerting
- Integrated Surveillance
- Communications – SATCOM
- Communication - Recorders
- e-Enabling (Crew Information S
- Maintenance Systems

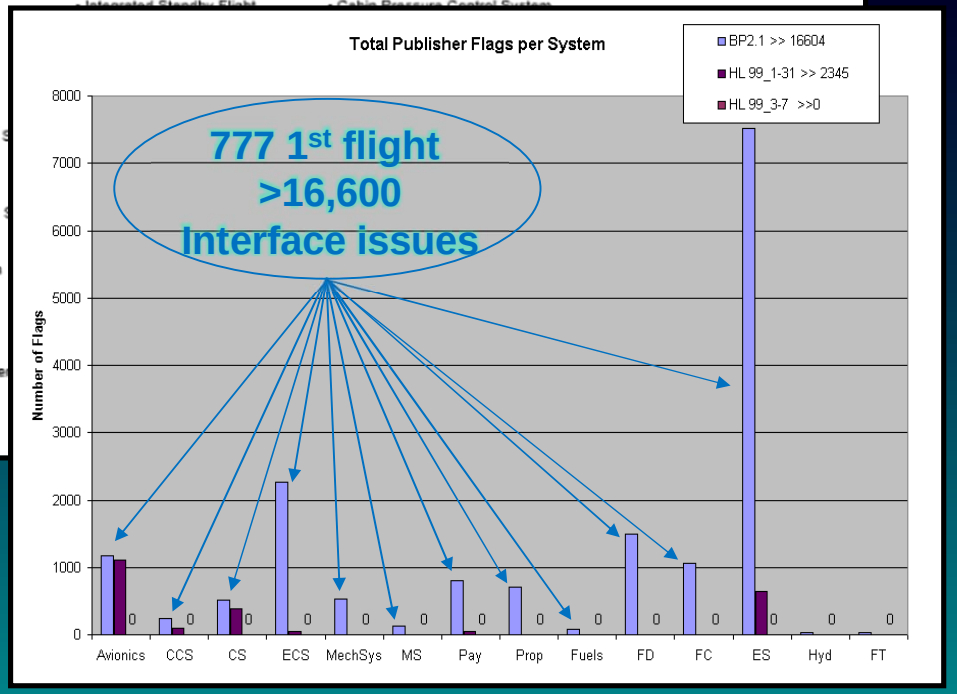
**Cabin Systems**
- Broadband Offboard Satellite S
- Cabin Services Systems
- Emergency Lighting System
- Inflight Entertainment System
- Telephone System
- Video Surveillance System

**Fuels**
- Fuel Quantity Indicating Syste
- Nitrogen Generating System

**Flight Controls**
- Flight Controls Electronics
- High Lift
- Primary Flight Controls
- Autoflight

**Environmental Control Systems**
- Equipment Cooling
- Moisture Control
- Humidification
- CACTCS

**Mechanical**
- Wheels and Brakes
- Brake Control and Monitor
- Landing Gear Actuation
- Nose Wheel Steering





Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# The Impact of Digitally Integrating Your Engineering Enterprise

*…we have modeled the logical interfaces of virtually the entire airplane and created a database that software design tools can assimilate with minimal human intervention.*

*Mike Sinnett 787 Chief Systems Engineer*

**Avionics**
- Common Core System (CCS)
- Navigation - FMS
- Navigation – TMS
- Navigation – ADRS
- Navigation – ERS
- Navigation – IRS
- Navigation – CM App
- Displays and Crew Alerting
- Integrated Surveillance
- Communications – SATCOM
- Communication - Recorders
- e-Enabling (Crew Information System)
- Maintenance Systems

**Cabin Systems**
- Broadband Offboard Satellite System
- Cabin Services Systems
- Emergency Lighting System
- Inflight Entertainment System
- Telephone System
- Video Surveillance System

**Fuels**
- Fuel Quantity Indicating System
- Nitrogen Generating System

**Flight Controls**
- Flight Controls Electronics
- High Lift
- Primary Flight Controls
- Autoflight
- Integrated Standby Flight
- Displays

**Electrical Sub-systems**
- Cargo Compartment Lighting
- Electrical Power Conversion
- Primary Power Distribution
- Remote Power Distribution
- CBIC
- Electrical Power Generation
- Lighting
- Proximity Sensing / Air-Ground
- Current Return Network
- Window Heat
- High Voltage DC Racks and MC

**Environmental Control Systems**
- Equipment Cooling
- Moisture Control
- Humidification
- CACTCS
- Cabin Pressure Control System
- Cargo Air Conditioning, Ventilation
- EE Cooling
- Power Elect Cooling
- Integrated Cooling System
- Compressor Ice Prot. System (CIPS)
- Cargo Fire Protection System
- Engine Anti-Ice (EAI) System
- Primary Ice Detection System
- Wheel Well Fire Detection System
- Rain Removal System (RRS)
- Wing Ice Protection System (WIPS)

**Hydraulics**
- Hydraulics, consisting of:
  - Electric Motor Pump
  - Hydraulics Subsystems
  - Hydraulic Distribution
  - Ram Air Turbine

**Mechanical**
- Wheels and Brakes
- Brake Control and Monitor
- Landing Gear Actuation
- Nose Wheel Steering

**Flight Deck**
- Flight Deck Control Panels
- Flight Deck Area Illumination
- Flight Deck Access System

**Payloads**
- Cargo Handling System
- Galley
- Lavatories
- General Lighting
- Oxygen System
- Water/ Waste System
- Dimmable Windows

**Propulsion**
- EEC/EMU
- Thrust Reverser System
- Fire and Overheat Detection
- Auxiliary Power System (APS)


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

# The Impact of Digitally Integrating Your Engineering Enterprise…First-Time Capable Products

**Avionics**
- Common Core System (CCS)
- Navigation - FMS
- Navigation – TMS
- Navigation – ADRS
- Navigation – ERS
- Navigation – IRS
- Navigation – CM App
- Displays and Crew Alerting
- Integrated Surveillance
- Communications – SATCOM
- Communication - Recorders
- e-Enabling (Crew Information S
- Maintenance Systems

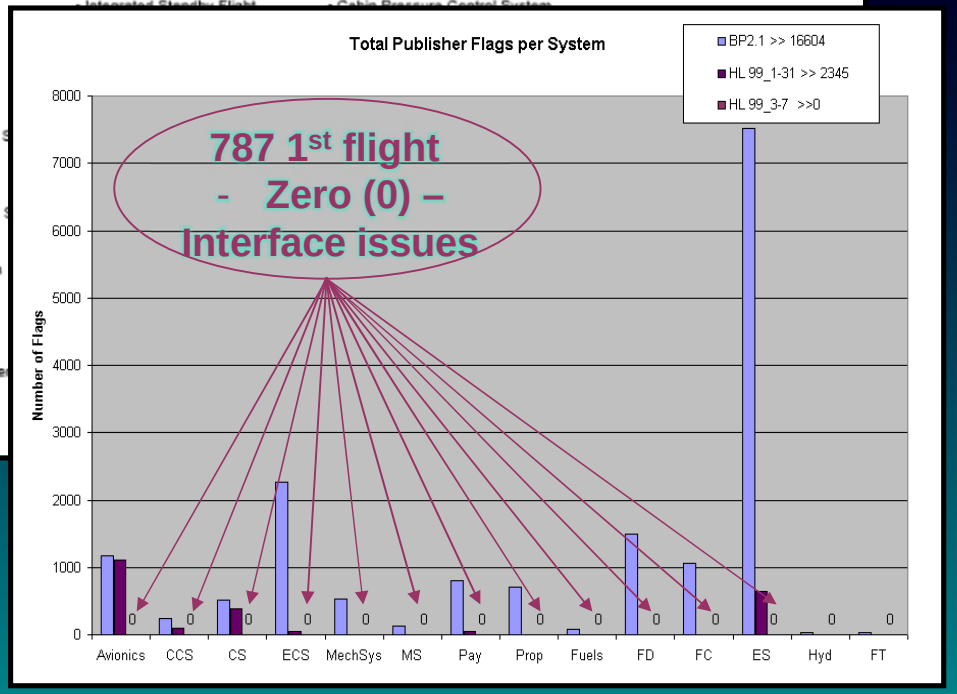
**Cabin Systems**
- Broadband Offboard Satellite S
- Cabin Services Systems
- Emergency Lighting System
- Inflight Entertainment System
- Telephone System
- Video Surveillance System

**Fuels**
- Fuel Quantity Indicating Syste
- Nitrogen Generating System

**Flight Controls**
- Flight Controls Electronics
- High Lift
- Primary Flight Controls
- Autoflight

**Environmental Control Systems**
- Equipment Cooling
- Moisture Control
- Humidification
- CACTCS

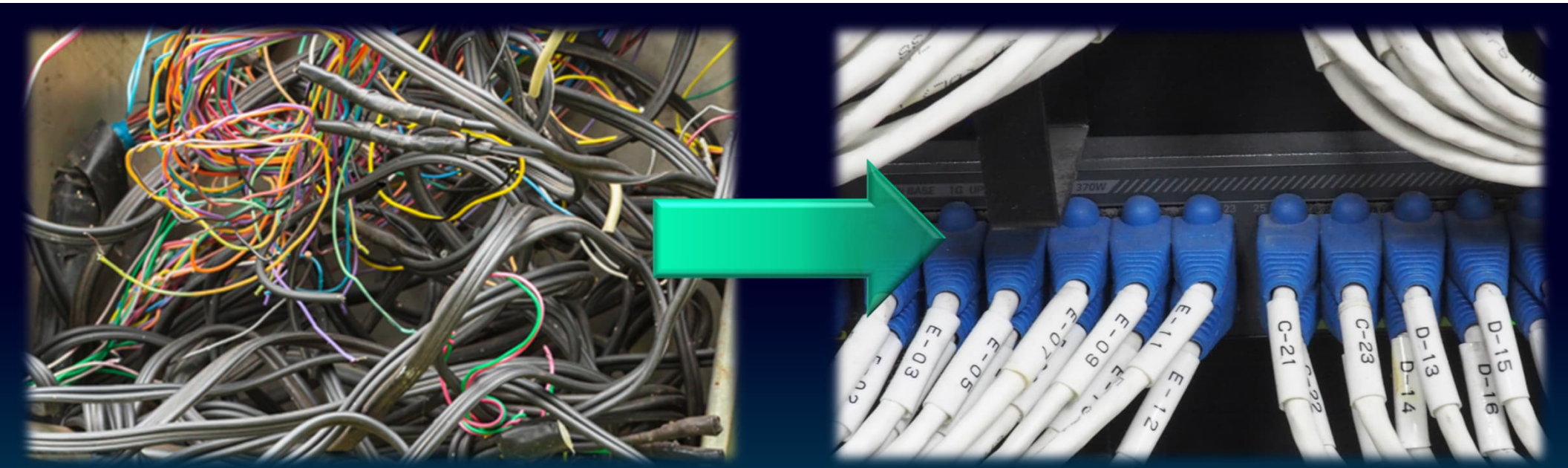
**Mechanical**
- Wheels and Brakes
- Brake Control and Monitor
- Landing Gear Actuation
- Nose Wheel Steering




*…we have modeled the logical interfaces of virtually the entire airplane and created a database that software design tools can assimilate with minimal human intervention.*

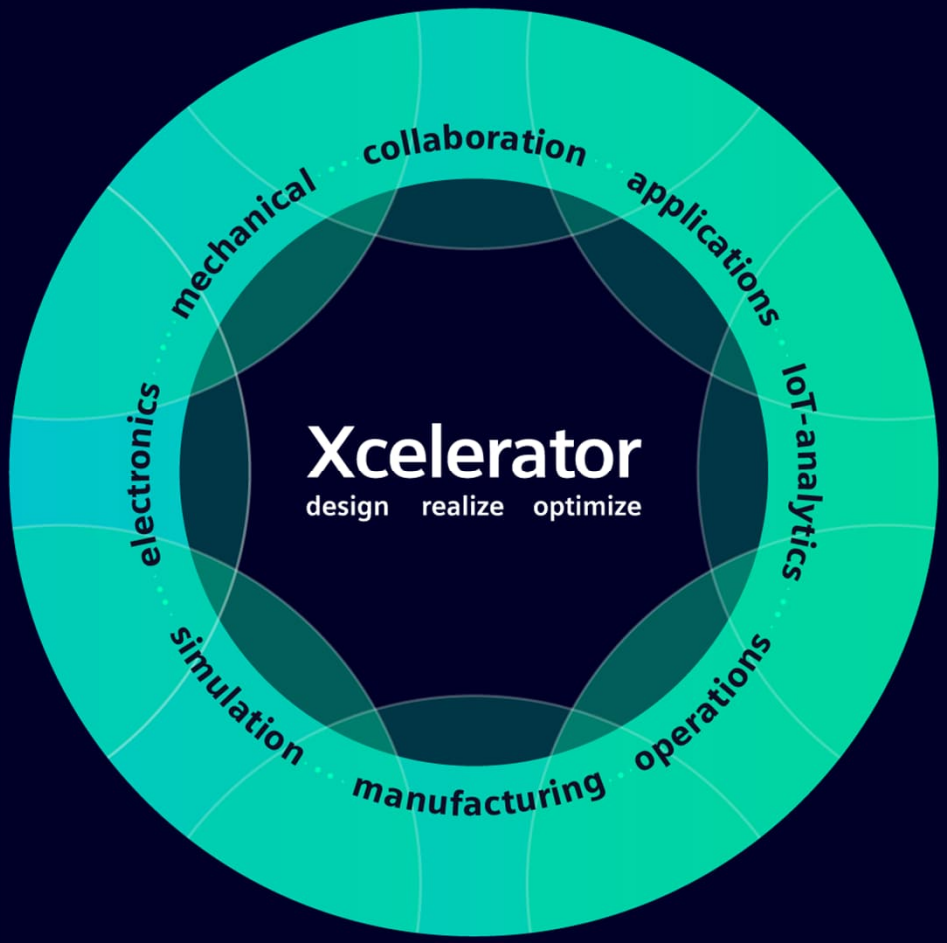
*Mike Sinnett 787 Chief Systems Engineer*


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.
SIEMENS




# Turning Complexity into YOUR Competitive Advantage


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.




# Xcelerator

An integrated portfolio of software, services and an application development platform that transforms product development.

**E2E Product Lifecycle & Digital Thread**

**Comprehensive Digital Twins & Design Exploration**

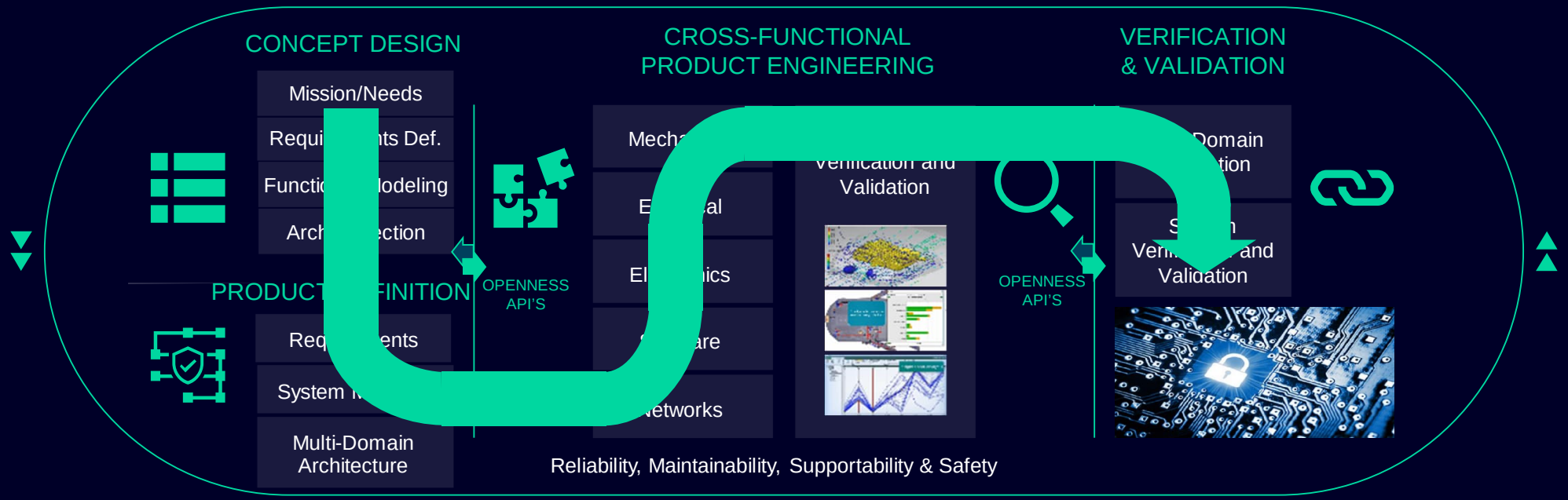
**Flexible & Open Ecosystem**

Where today meets tomorrow.


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# ***Get Connected, Stay Connected*** **with Xcelerator**
## Siemens' flexible & open MBSE ecosystem

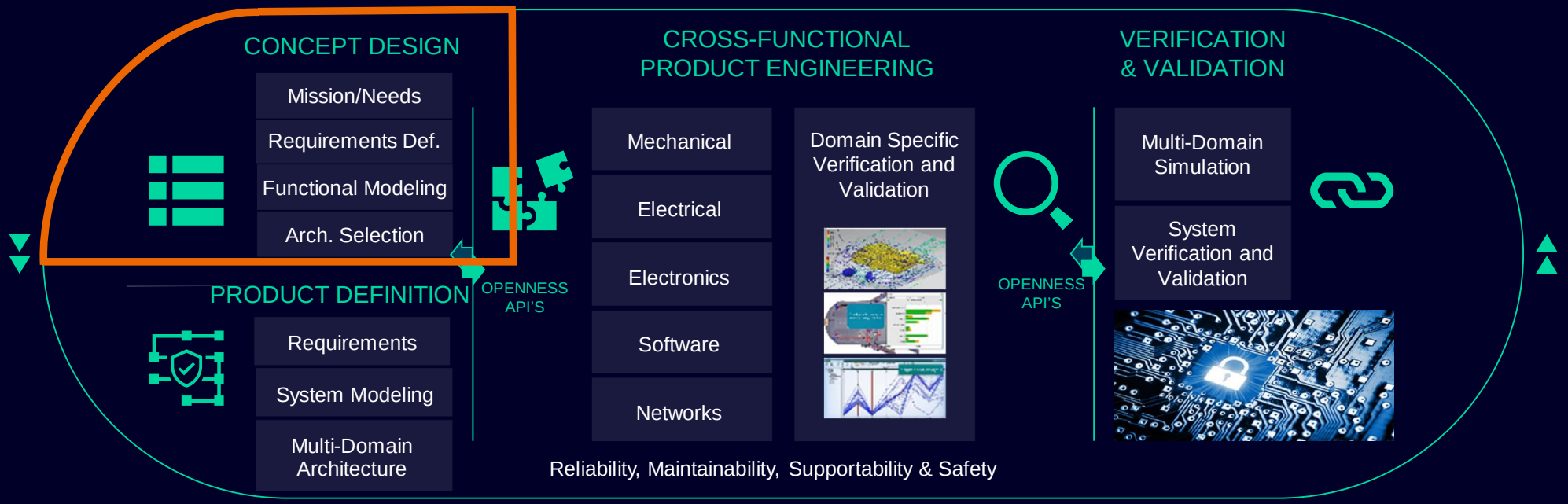



Continuous Verification and Validation


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.
SIEMENS

# *Get Connected, Stay Connected* with Xcelerator

Siemens' flexible & open MBSE ecosystem



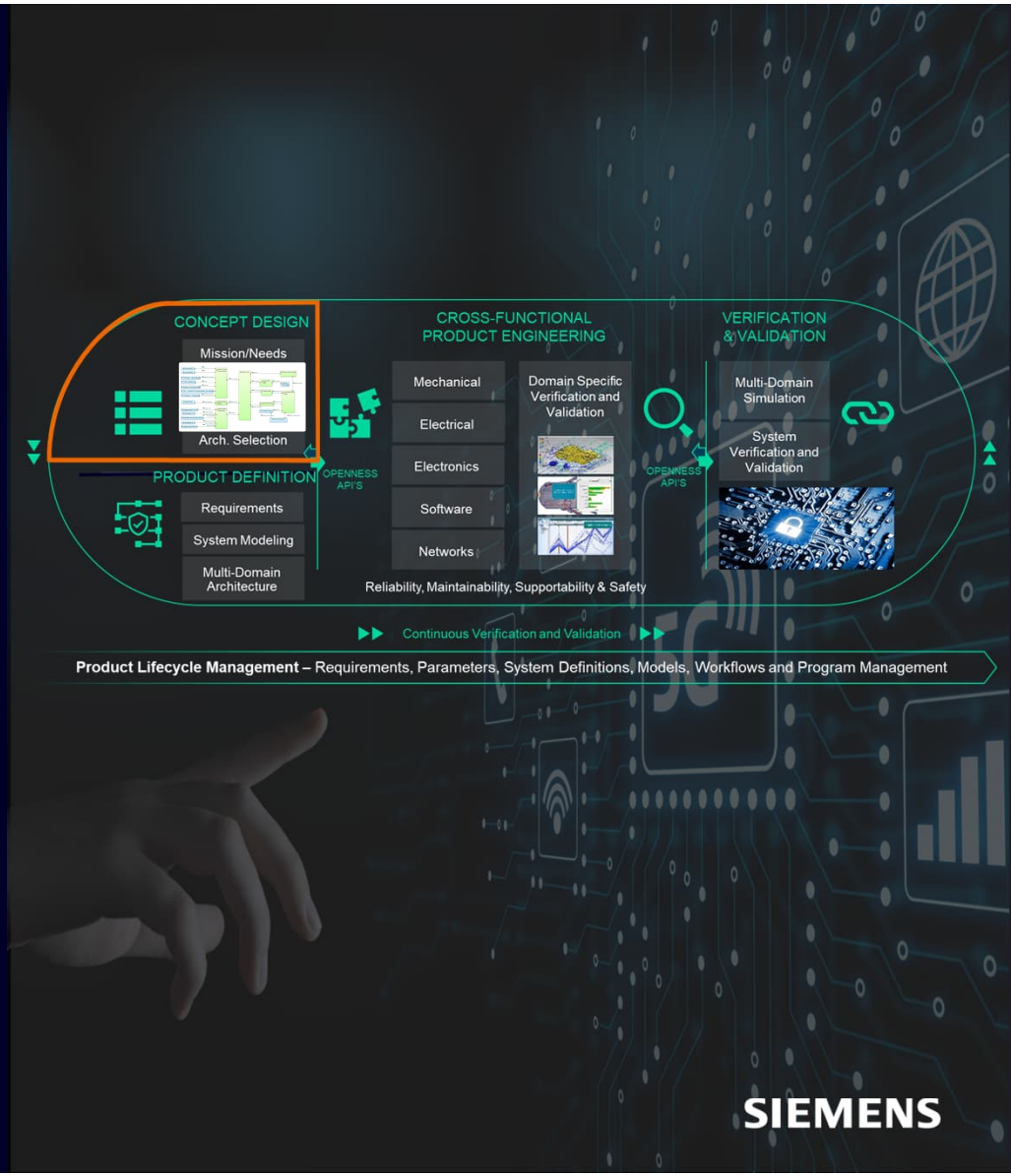



Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Increasingly complex products benefit from a numerical approach to ID the best possible product architecture to deliver requirements

- Patented web enabled application replaces ‘guess-timation’ with numerical calculation
- Evaluate 100’s – 1,000’s of possible architectural solutions
- **ID the best product architecture** to deliver multi-domain requirements for given constraints
- **Provides a QUALIFIED foundation for conceptual system simulation & detailed architecture modeling**



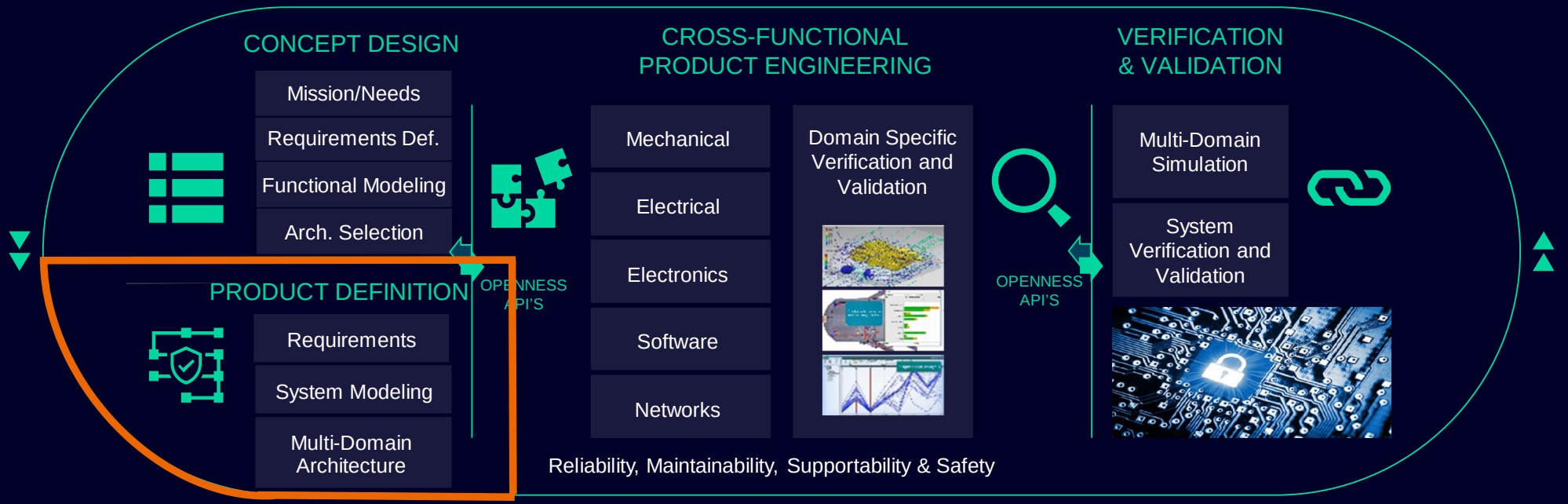



Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# ***Get Connected, Stay Connected*** **with Xcelerator**

Siemens' flexible & open MBSE ecosystem




Continuous Verification and Validation

**Product Lifecycle Management –** Requirements, Parameters, System Architectures, Models, Workflows and Program Management



Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Multi-domain system architecture models provide an interface ‘Blueprint’ to guide the construction, integration & verification of your product

- Siemens’ solution **guides the creation of system model architectures**
- Resulting models are **easily decomposed into shareable sub-systems & components** which span all product & engineering domains
- **Appropriate system models are distributed to the right individual at the right time *(internal or supplier/partner)***

Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Aggressive schedules demand timely delivery of appropriate information to ensure successful completion of your engineering tasks

- Requirements
- Test Cases
- Architecture
- Parameters
- Geometry

‘Verification Package’

- Your resources receive task specific ‘Verification Packages’ to perform his/her assignments

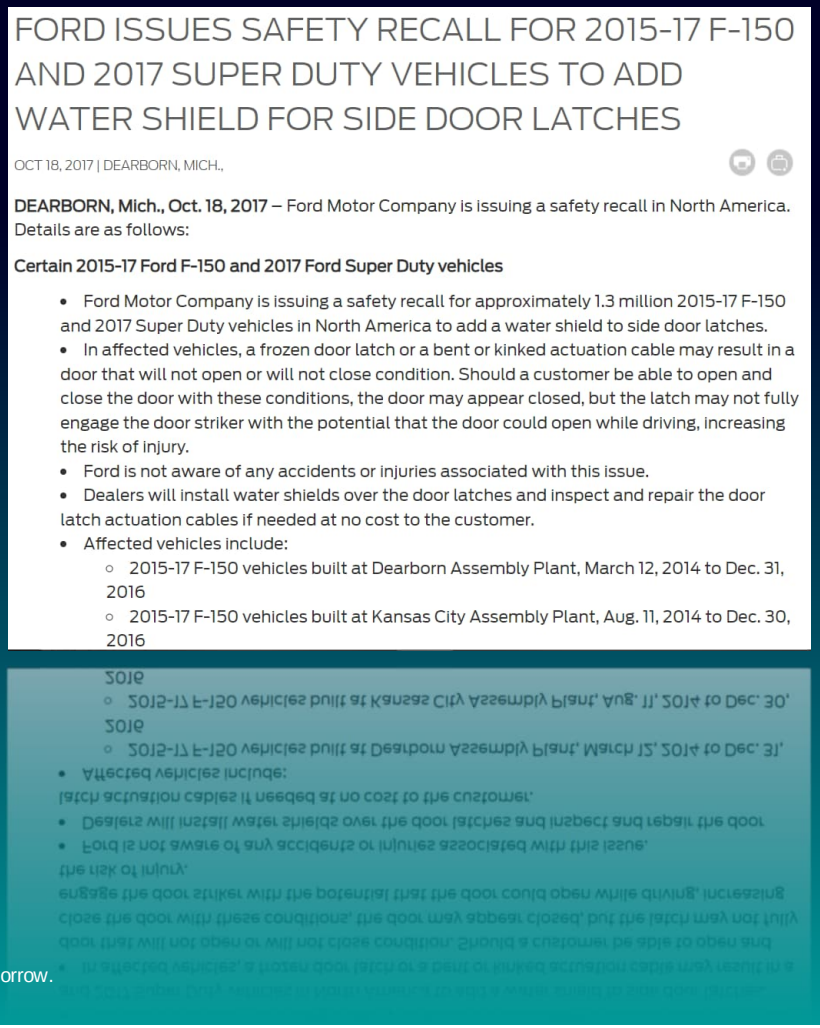
….**Bringing an end to your ‘Data Safaris’**

Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# The Impact of Unverified Requirements

- Affected 1.3M trucks
- *Automotive News* reported that this recall cost Ford ~$267M to resolve
- Ford agreed to settle a class action lawsuit for $5.3M
- Ford created and documented the routing requirement in ~1992 because they experienced this design issue…**History repeated itself because the requirement was not verified**



FORD ISSUES SAFETY RECALL FOR 2015-17 F-150 AND 2017 SUPER DUTY VEHICLES TO ADD WATER SHIELD FOR SIDE DOOR LATCHES

OCT 18, 2017 | DEARBORN, MICH.,

**DEARBORN, Mich., Oct. 18, 2017** – Ford Motor Company is issuing a safety recall in North America. Details are as follows:

**Certain 2015-17 Ford F-150 and 2017 Ford Super Duty vehicles**

- Ford Motor Company is issuing a safety recall for approximately 1.3 million 2015-17 F-150 and 2017 Super Duty vehicles in North America to add a water shield to side door latches.
- In affected vehicles, a frozen door latch or a bent or kinked actuation cable may result in a door that will not open or will not close condition. Should a customer be able to open and close the door with these conditions, the door may appear closed, but the latch may not fully engage the door striker with the potential that the door could open while driving, increasing the risk of injury.
- Ford is not aware of any accidents or injuries associated with this issue.
- Dealers will install water shields over the door latches and inspect and repair the door latch actuation cables if needed at no cost to the customer.
- Affected vehicles include:
  - 2015-17 F-150 vehicles built at Dearborn Assembly Plant, March 12, 2014 to Dec. 31, 2016
  - 2015-17 F-150 vehicles built at Kansas City Assembly Plant, Aug. 11, 2014 to Dec. 30, 2016

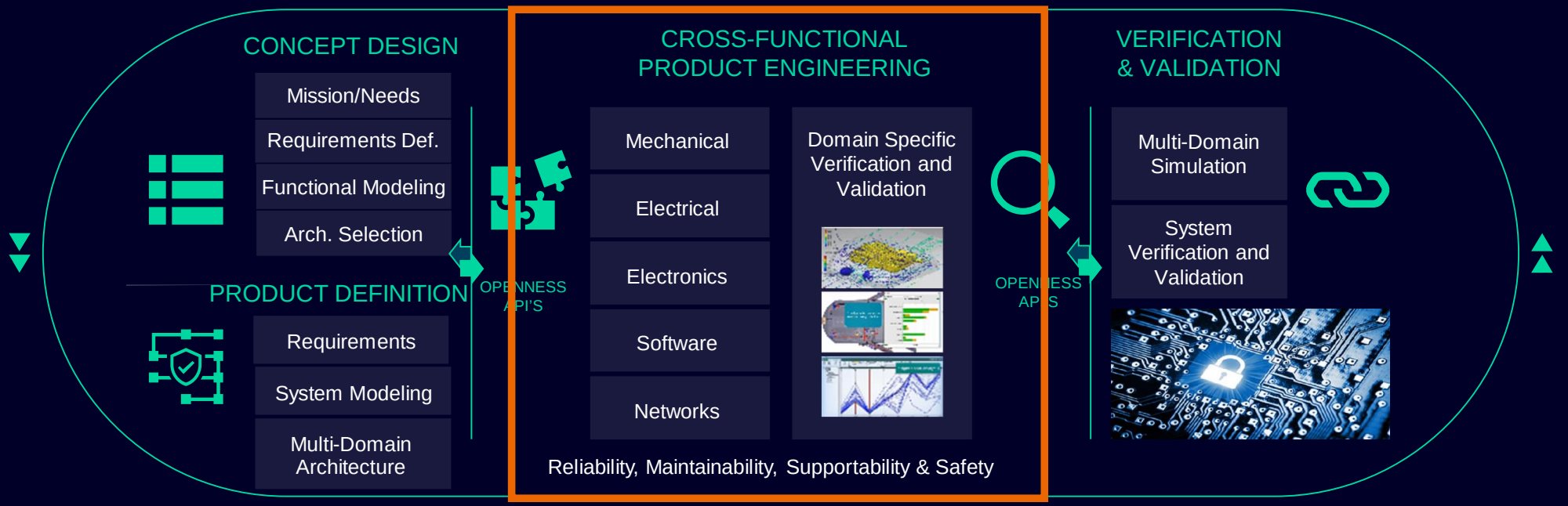


Restricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# *Get Connected, Stay Connected* with Xcelerator

Siemens' flexible & open MBSE ecosystem





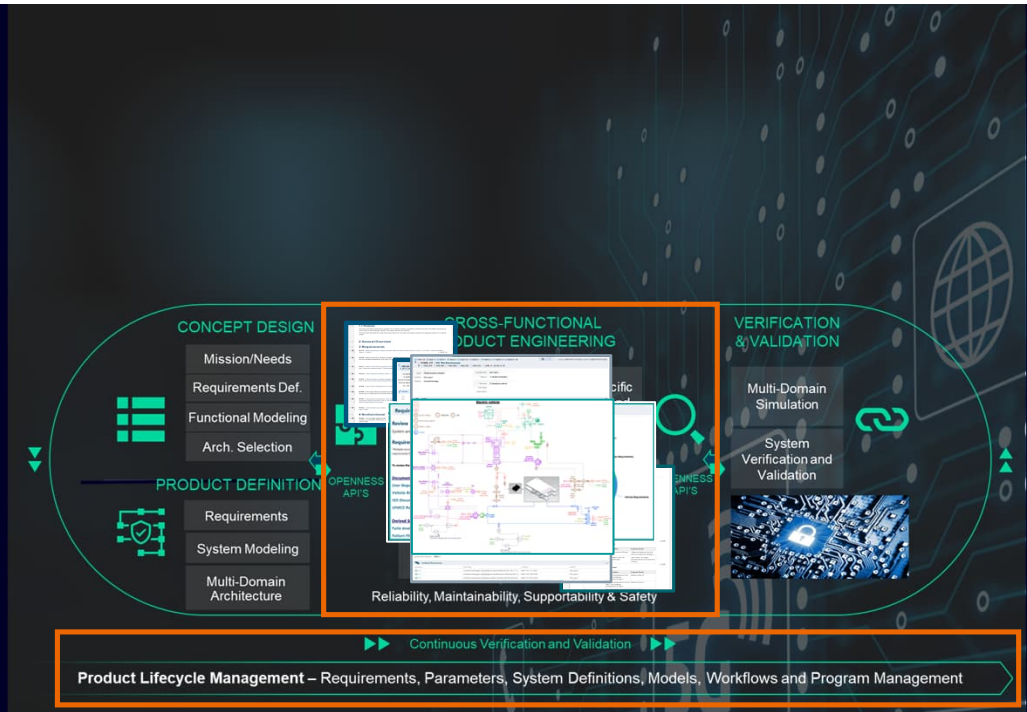

Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# With ‘Verification Packages’ in hand, your resources have what they need to create their Digital Twins & perform assigned verifications

- System model architecture (aka the ‘Blueprint’) guides the creation of Digital Twins across all product domains
- Exercise Digital Twins per test cases to assess performance vs. requirements…then refine as needed
- Digital Twins from one organization are compatible with those from another organization

…**Enables Digital Integration**



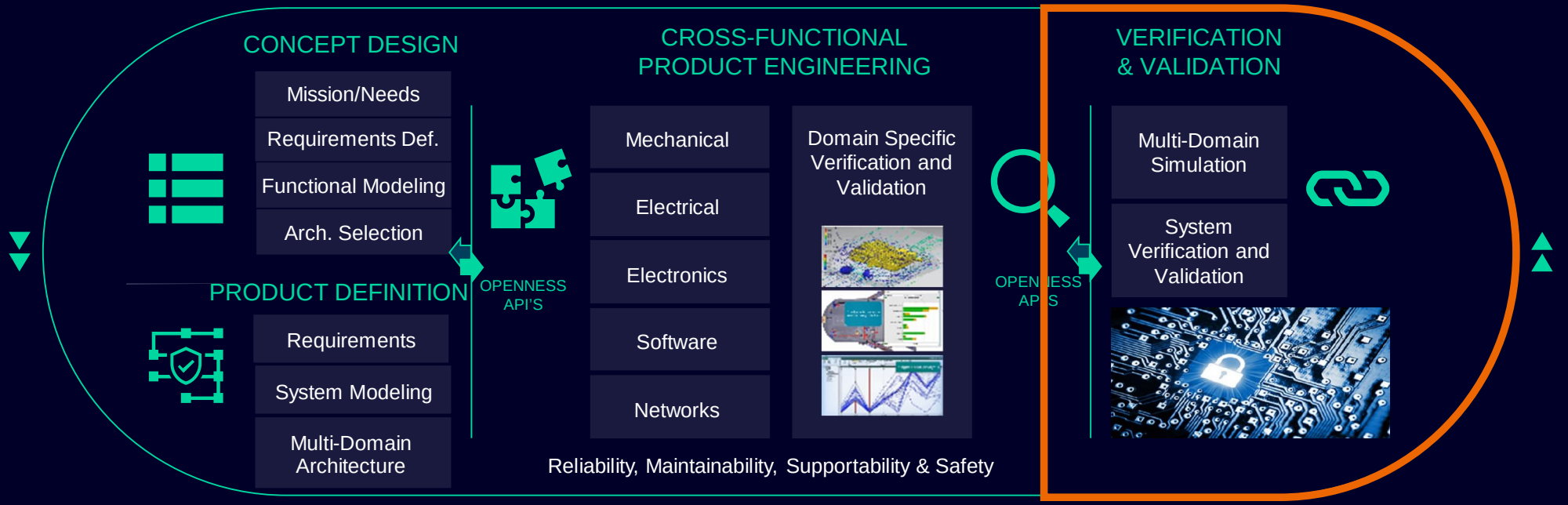



Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# ***Get Connected, Stay Connected*** **with Xcelerator**

Siemens' flexible & open MBSE ecosystem






Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Attainment of domain specific requirements is a good start… Balancing performance across all domains produces a well integrated product

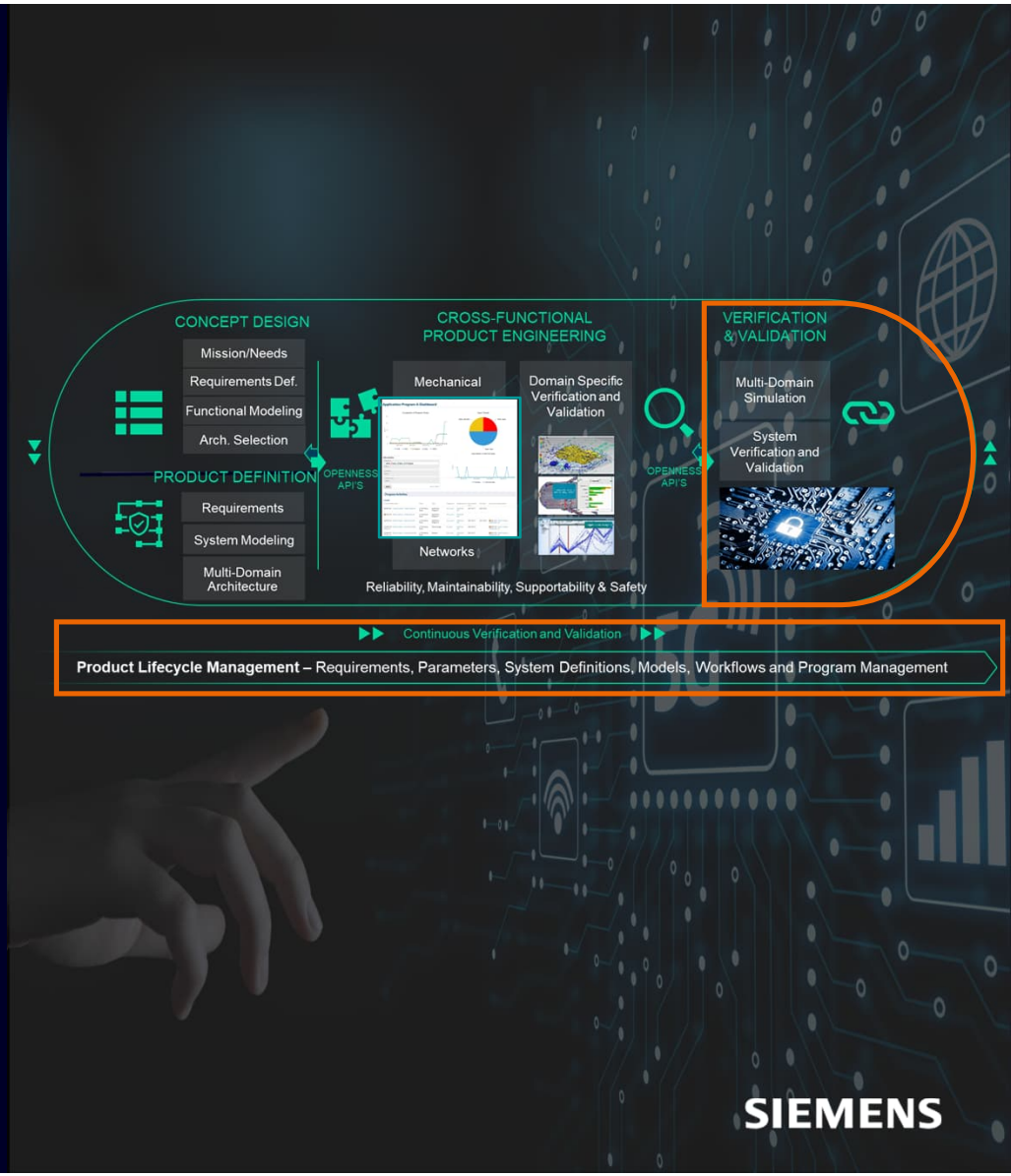
- Multi-attribute / multi-domain design space exploration enables **performance balancing across product domains & requirements**
- Resulting **design updates are pushed to impacted stakeholders** via Siemens' Digital Thread

Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS

# Attainment of domain specific requirements is a good start… Balancing performance across all domains produces a well integrated product

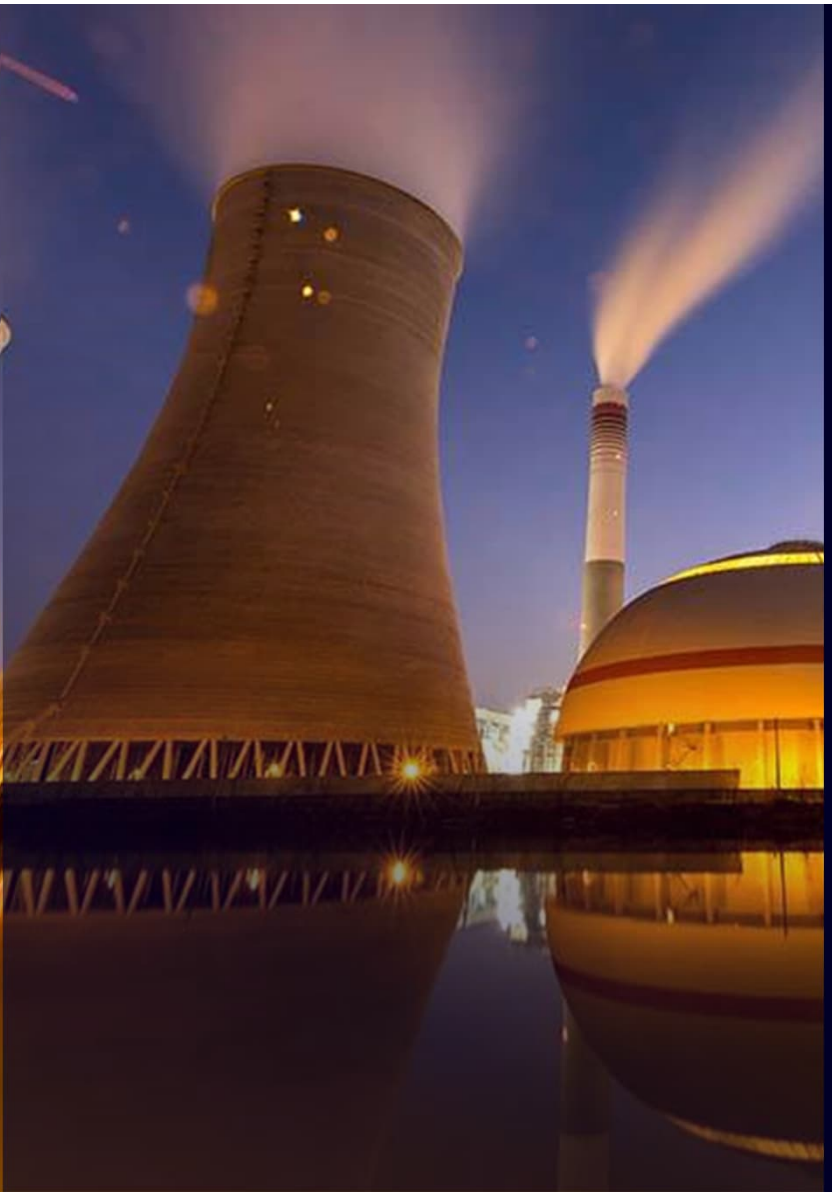
- Multi-attribute / multi-domain design space exploration enables **performance balancing across product domains & requirements**
- Resulting **design updates are pushed to impacted stakeholders** via Siemens' Digital Thread
- **Continuous performance verification** is enabled via real-time electrical, electronics, HW, SW…revisions



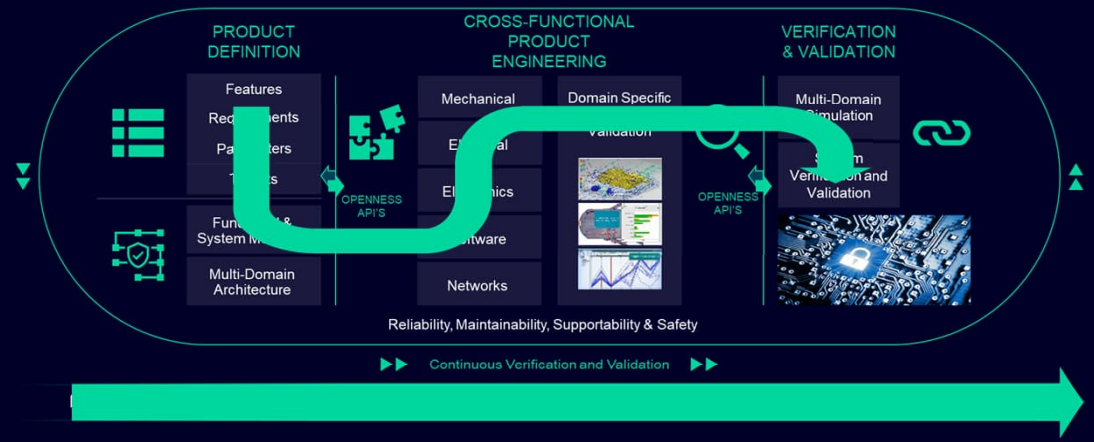


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS



# Siemens can help you
# Bridge, orchestrate & accelerate
# your product development process




## ID the best possible architecture

Numerically evaluate candidate architectures to find the best solution

## Drive simulation

Push the right information to the right person at the right time

## Virtually integrate

Architectures guide the construction and integration of your digital twins

## Balance performance

Multi-discipline design exploration helps you meet all performance requirements

## Continuously verify & validate

See what's changing and verify that requirements are met with up-to-date designs

## …with confidence

Siemens' continuous digital thread links results to everything that produced them

SIEMENS

# Recent digital transformation announcements enabled by **Siemens** through **Xcelerator**

SIEMENS

Pres

Plano, Texas USA

## Hyundai Motor Company and Kia Partners with Siemens for Digital Transformation

•Siemens Digital Industries Software is selected as t for the next generation engineering environment and management environment

•Siemens Digital Industries Software is selected as t for the next generation engineering environment and management environment

Siemens and Hyundai Motor Company and Kia Corp and Kia) announced today a new technology partner their digital transformation and a new future of mobil Kia has selected Siemens as the preferred bidder ar to provide next generation engineering and product through NX™ software and the Teamcenter® portfol Xcelerator portfolio of integrated software, services a platform. Hyundai and Kia has evaluated and assess alternatives including incumbent solutions and selec software, embracing the world's most comprehensiv Hyundai and Kia will cooperate with Siemens as its to drive the future of mobility.

SIEMENS

Pres

Plano, Texa

## Northrop Grumman Corporation (N NOC) has selected Siemens Digita Software's Xcelerator portfolio to d other company initiatives to harne technologies across product lifecy

Northrop Grumman is integrating digital technologies conceptualize, design, build and sustain value-driven company uses Xcelerator to integrate repositories of seamlessly share product performance details.

The company will also leverage Siemens' Xcelerator its technology stack to help manage its digital engine process and product data in an integrated single-sou

"Selecting NX software and the Teamcenter portfolio Xcelerator portfolio for our core design and data man platforms will introduce a new working environment f will pave the way for a leap forward in future car deve Albert Bierman, Head of R&D Division, Hyundai Moto is the beginning of a huge transformation and an imp change for Hyundai Motor Company and with Siemer partner we will work together to achieve our goals thr cooperation and teamwork."

SIEMENS

Press

Plano, Texas USA – January 25 2022

## Lockheed Martin Aeronautics adopts Siemens' Xcelerator portfolio to support digital engineering transformation

- Multi-year contract leverages Simeens' Xcelerator portfolio to achieve mission-driven digital transformation
- Xcelerator provides the ability to work in a collaborative and connected way, significantly reducing cycle times across each digital thread
- Future program to leverage Xcelerator as digital platform.

Lockheed Martin's Aeronautics business has selected Siemens' Xcelerator portfolio of software and services to support its digital engineering transformation. Through a multi-year contract, the company plans to leverage Xcelerator to achieve its goals for mission-driving digital transformation, - accelerating program lifecycles, driving cost savings and fostering greater innovation.

"Lockheed Martin Aeronautics is a leader in the Aerospace industry, and their decision to expand adoption of Siemens' Xcelerator portfolio enables driving digital initiatives and winning programs," said Tony Hemmelgarn, President and Chief Executive Officer, Siemens Digital Industries Software. "Building off of our experience on the F-35 program, and through close collaboration, Siemens is excited to help Lockheed Martin accelerate production and meet DoD contract requirements for both current programs and new initiatives.


Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

# Contact

Published by Siemens 2023

**Brian Thornton**
Portfolio Development Executive, MBSE
38695 7 Mile Road
Livonia, Michigan 48152
United States

Mobile +01 248 514 4539

**E-mail** brian.thornton@siemens.com



Unrestricted | © Siemens 2023 | Siemens Digital Industries Software | Where today meets tomorrow.

SIEMENS