SIEMENS
Ingenuity for life

Systems Digitalization:
Start integrated, stay integrated!

Model Based Systems Engineering

We are

Siemens Digital Industries Software

Introductions

Piet van Dongen

Stefan Hovens

Marco Peters

Agenda

- Introduction
- Vision Siemens Digital Industries Software (Piet)
- Digitalization of Systems Engineering (Stefan)
- Requirement Management with Polarion (Marco)

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1847

A small garage startup in Berlin, Germany

Employees	Start-up capital	1st year revenue
10	6.842 thalers	3,420 thalers

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Today

Leading position in Electrification, Automation and Digitalization.

Employees
377,000+

Revenue
€82.9 billion

Net Income[1]
€6.1 billion

Profit margin Ind. Business
11.2%

Key figures as of Oct 2017 **1** Strategic Unit

Siemens at a glance

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Operating Companies

Gas and Power

Smart Infrastructure

Digital Industries

Strategic Companies

Mobility

SIEMENS Gamesa
RENEWABLE ENERGY

SIEMENS Healthineers

Service Companies

Financial Services

Global Business Services

Real Estate Services

We are

Siemens Digital Industries Software

Organization

Business Unit of Siemens Digital Industries
Workforce: 22,000+
Locations: 250 in 36 countries
Customers: 170,000+

Products

Product Lifecycle Management
Electronic Design Automation
Manufacturing Operations Management
Performance Analytics Software
Rapid Application Development tools and Services

Focus on Industry

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Siemens Digital Industries Software Industry Sectors

Aerospace and Defense

Automotive and Transportation

Electronics

Semiconductors

Consumer Products and Retail

Energy and Utilities

Industrial Machinery and Heavy Equipment

Marine

Medical Devices and Pharmaceuticals

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Digital Twin Product

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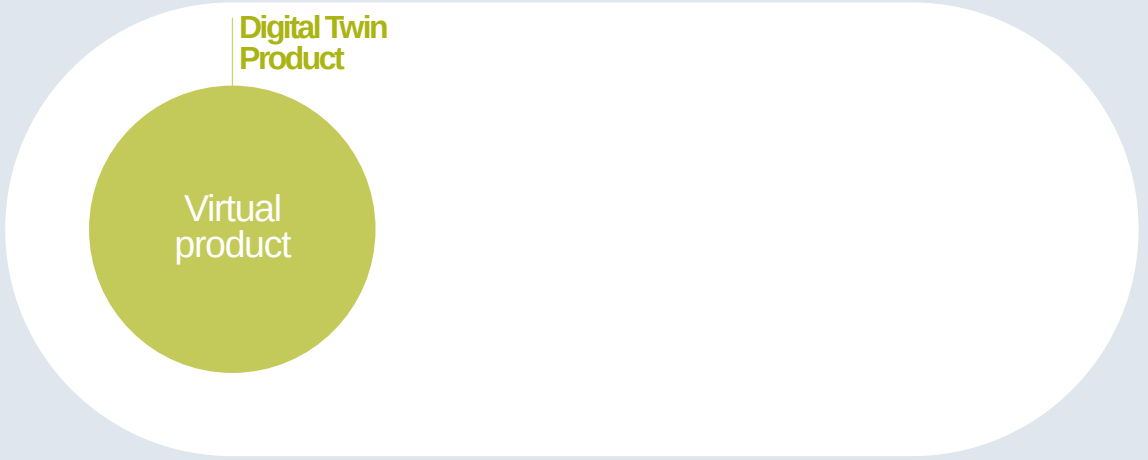
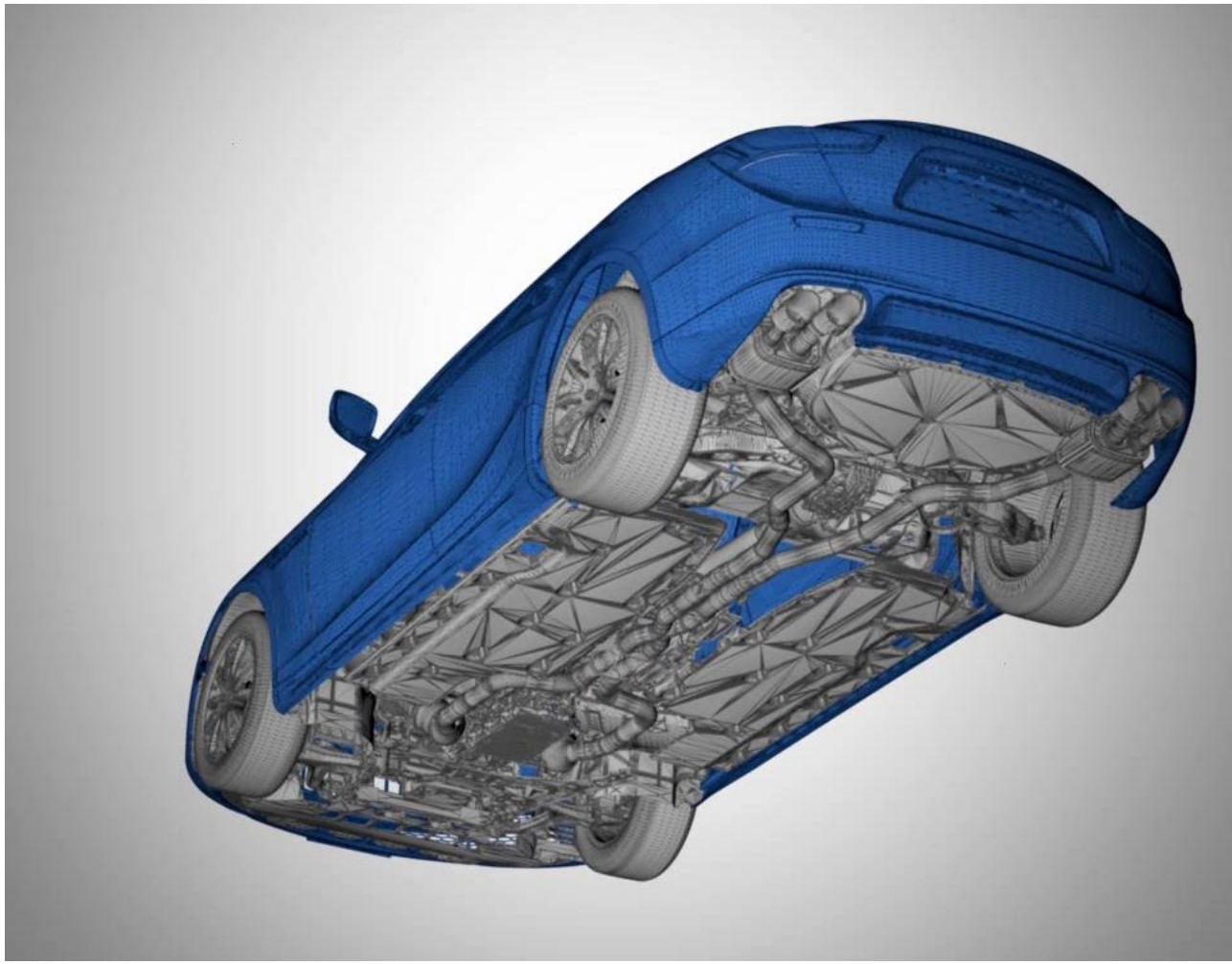
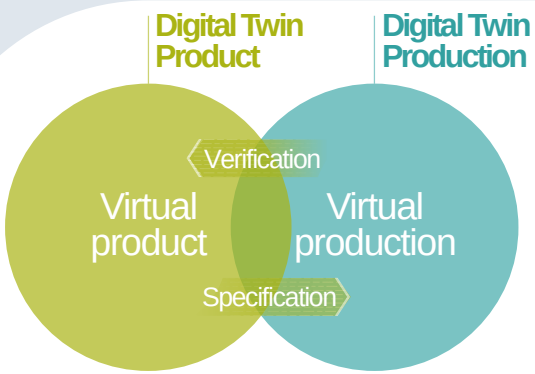


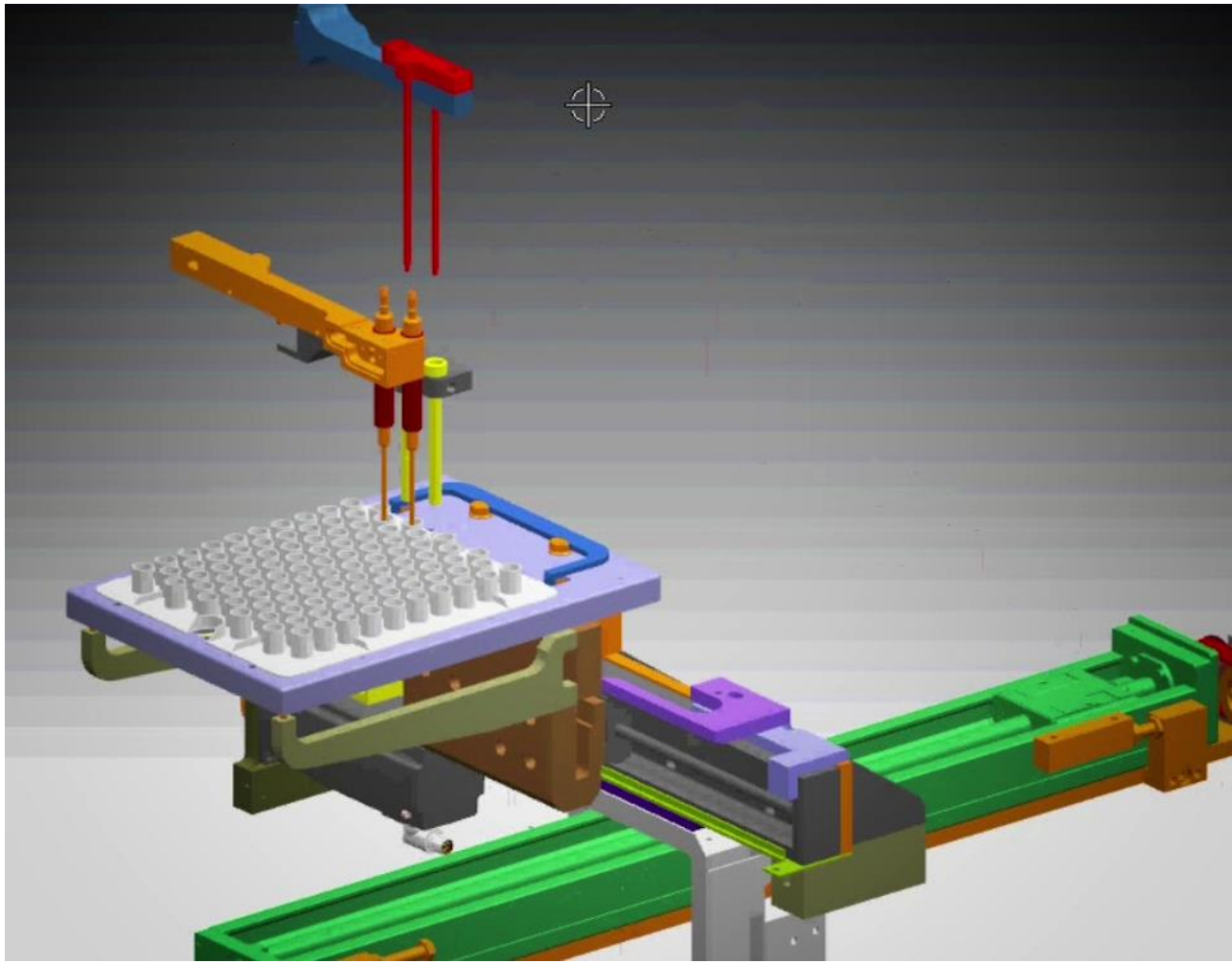
Design, simulate and verify products digitally, including mechanics and multi-physics, electronics and management of software



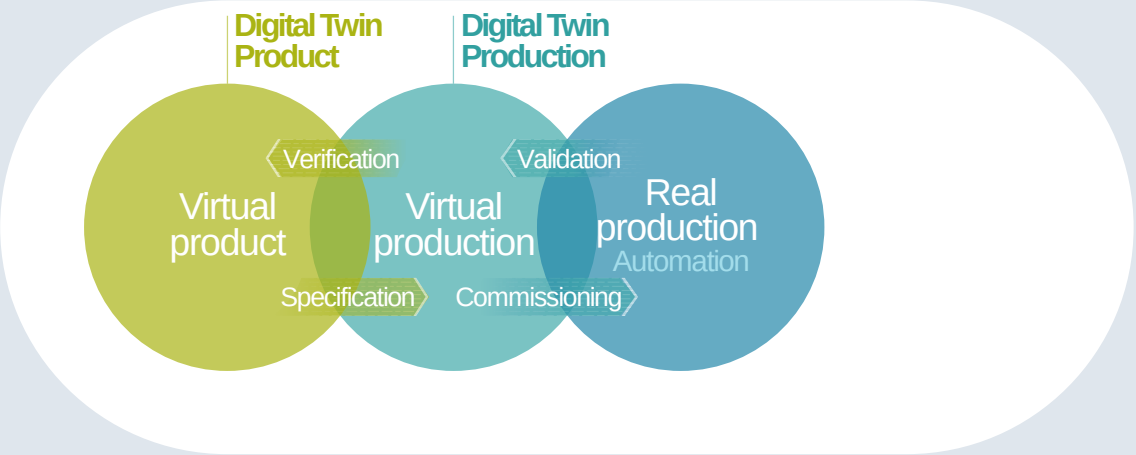
Digital Twin Production



Plan, simulate and optimize production digitally with PLC code generation and virtual commissioning.

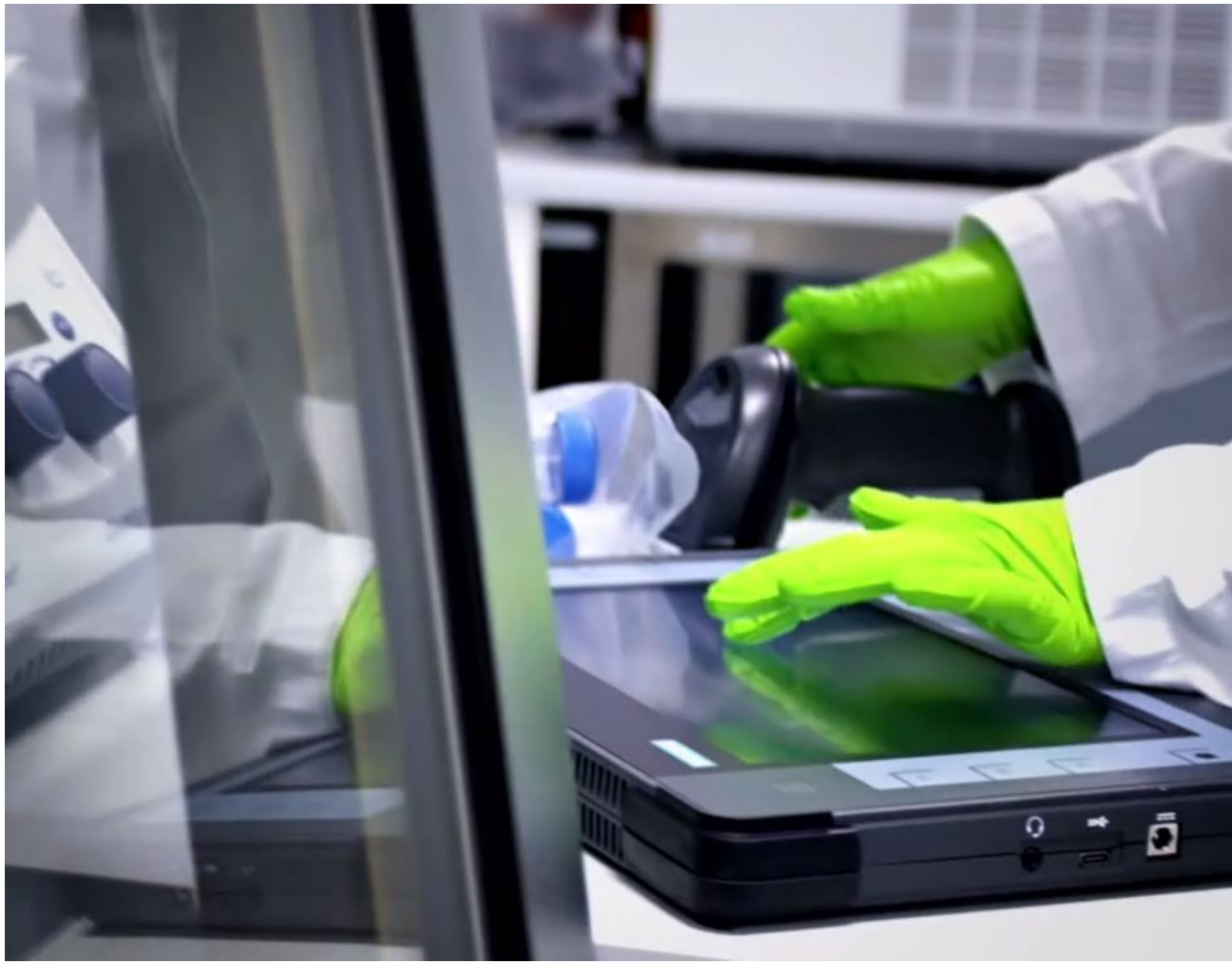


Real production



Execute production, run quality inspections, schedule and process work operations

Run production efficiently and securely with Totally Integrated Automation



Digital Twin Performance

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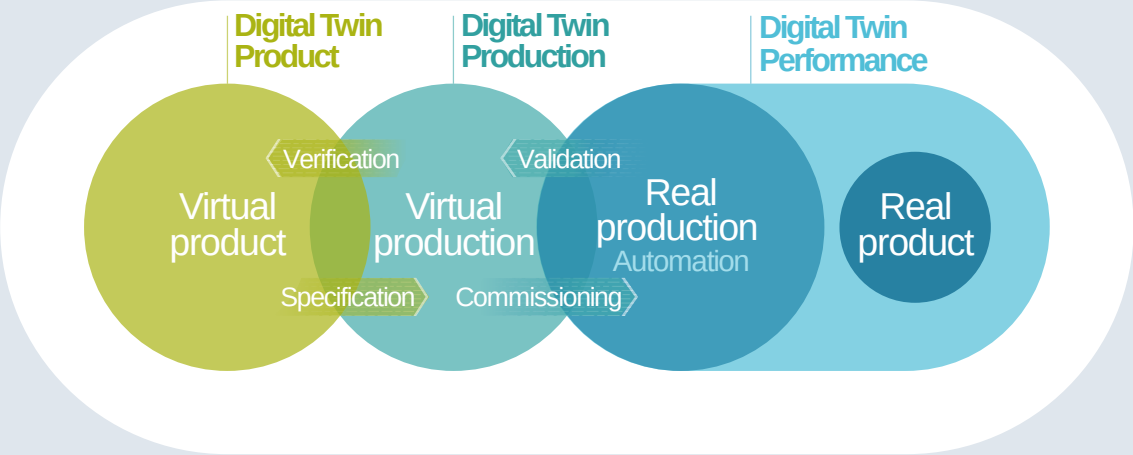
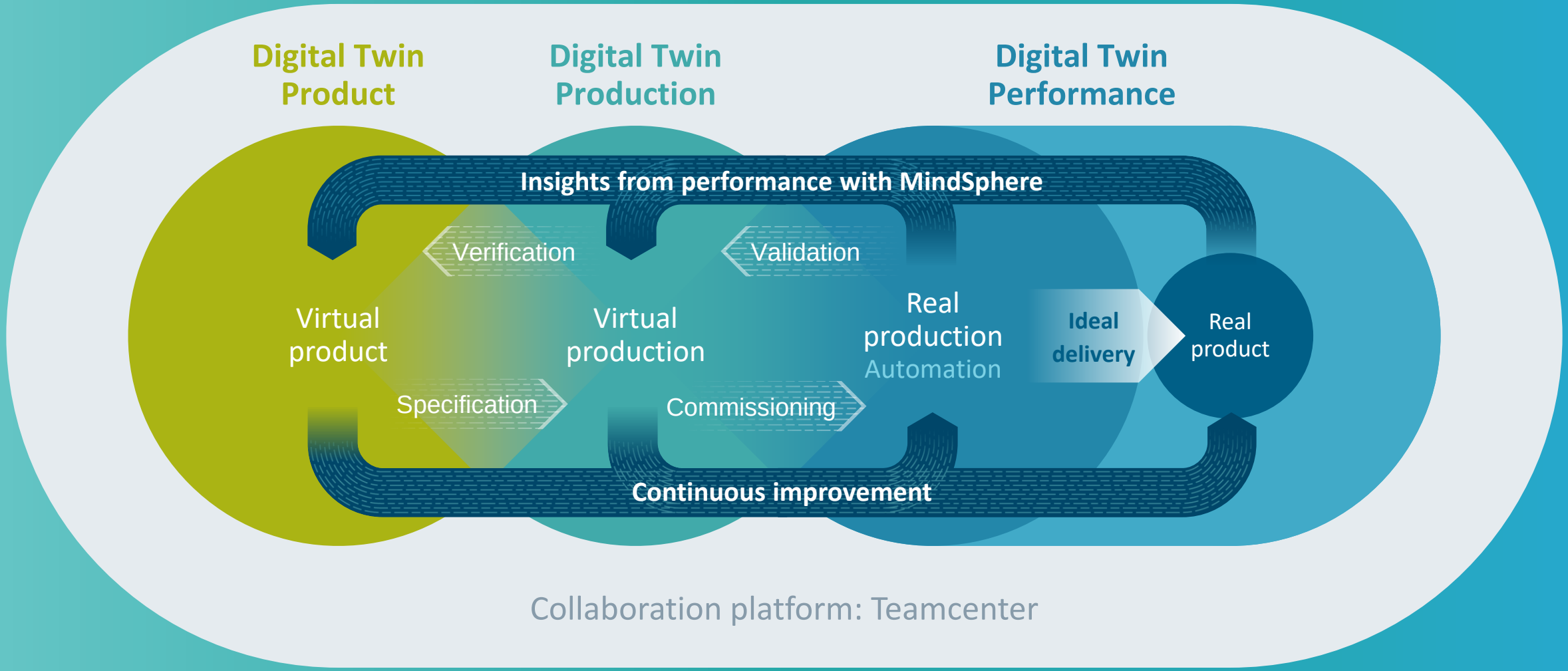


Analyze and evaluate product and production performance

Proven examples of Customer Value



Siemens continuously invests in the future

…which is increasingly Digital

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1958 - Start of production automation: Siemens receives the patent for SIMATIC

1996 - Totally Integrated Automation (TIA) enables inter-operability between all automation components

2009 - TIA Portal provides access to all automation tasks

2013 - Siemens is currently the only company whose technologies combine the real and the virtual production world under one roof

2015 / 16 - Siemens establishes leadership in product and process simulation to enable full digitalization

Production engineering and execution (Siemens Automation)

Product development (Siemens PLM)

Cloud strategy

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EXPERIENCE
APPLICATIONS

Siemens Cloud Solutions

CONNECT

BUSINESS INSIGHTS
AND NEW CUSTOMERS

MindSphere

ACCESS

DOMAIN EXPERTISE

BUILD - INTEGRATE - EXTEND

RAPID APPLICATION
DEVELOPMENT

mx mendix

Accelerate Innovation in the Cloud

Unlock and Extend *any* existing data or system

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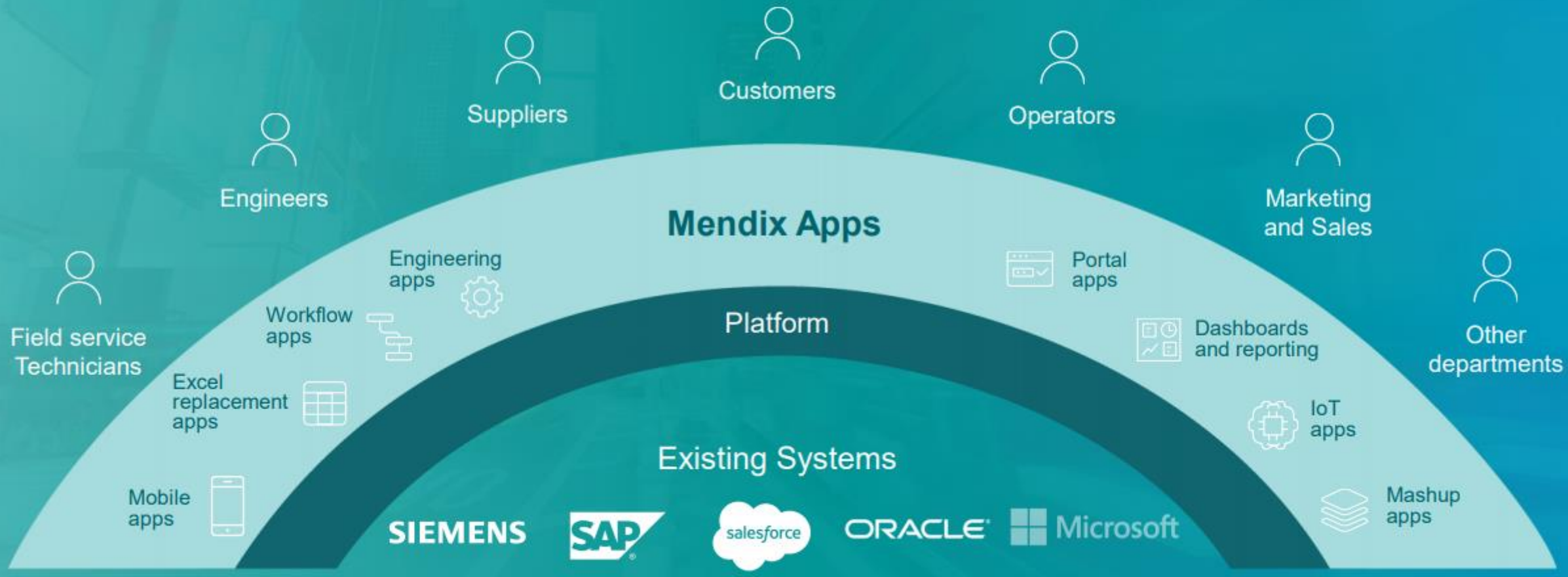

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Teamcenter integrated multi-domain system modeling

INCOSE defines **MBSE** as

“Model-based systems engineering (**MBSE**) is the 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. ”May 17, 2019

Comprehensive Product Digital Twin

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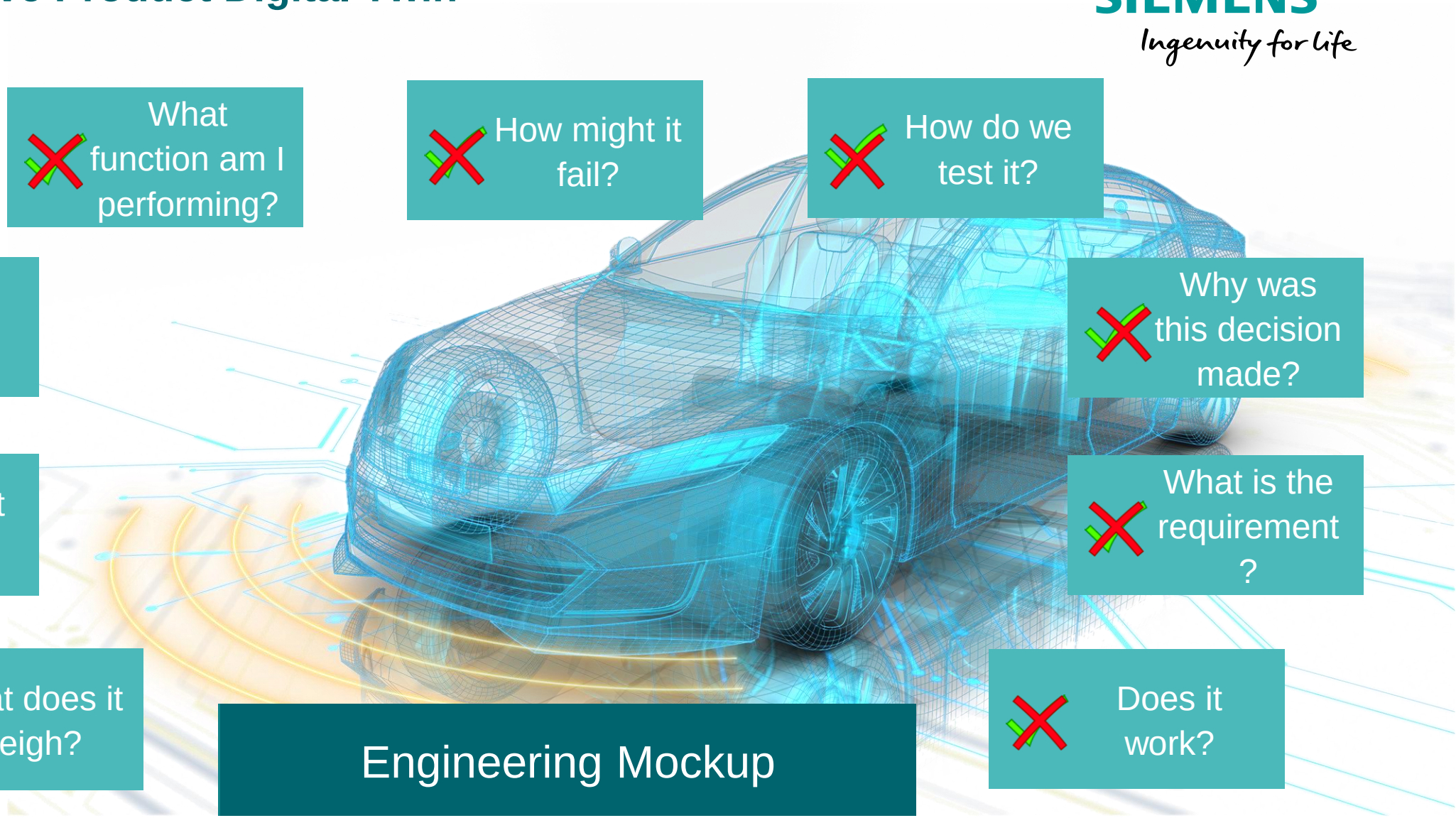
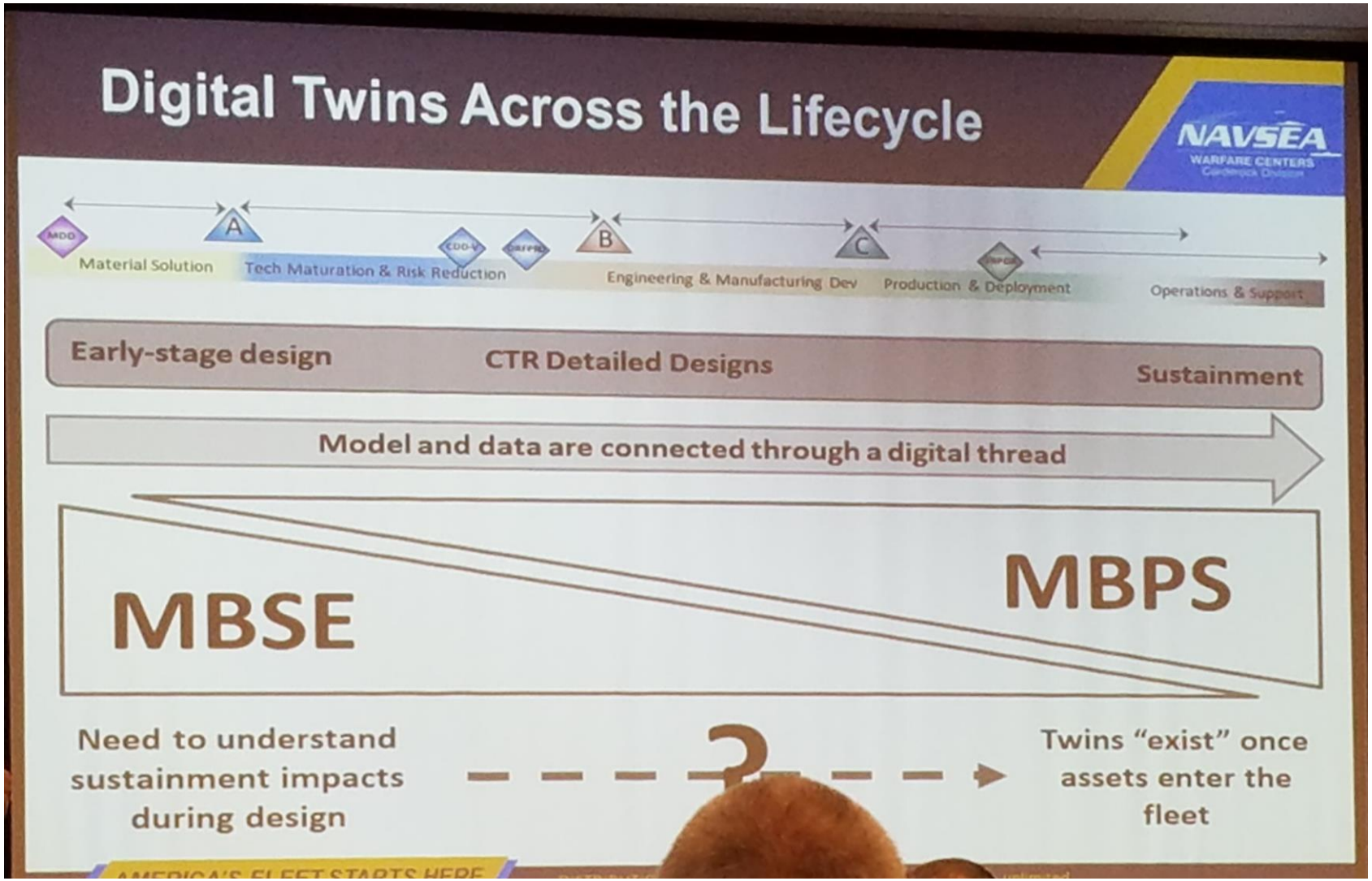


Digital Twins across the Defense Lifecycle



Program Execution Excellence
Digital Thread Solutions

Program Execution Excellence
Digital Thread Solutions on the Digital Innovation Platform

Model Based Systems Engineering
OPTIMIZATION & INNOVATION

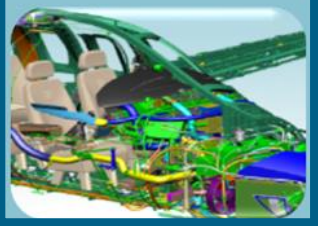
A Model Based Systems Engineering approach leveraging systems engineering and 3D models from idea thru to support.

Integrated Prog. Planning and Execution
MEETING COST, SCHEDULE AND TECHNICAL REQUIREMENTS

A systems approach to project planning a fully planned, resourced, budgeted and executed program management solution.

Product Engineering & Design
EFFICIENT FIRST TIME RIGHT

Design with advanced materials, integrated CAD/CAE, maximize reuse, advanced configuration management.



Supplier Source Selection and Management
EFFECTIVE SUPPLIER MANAGEMENT

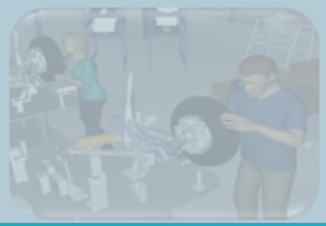
Enabling traceability from OEM requirements to suppliers. Proactive supplier management.

Verification Management
FASTER TIME TO CERTIFICATION

Enabling traceability from requirements thru virtual and physical test to ensure product verification.

Product Realization
MEETING COST & PRODUCTION GOALS

"Shift left" manufacturing planning to ensure cost, schedule & safety goals are achieved with fully integrated factory.



Model Based Product Support
INTEGRATE SERVICE WITH THE FACTORY

Design for support. Plan for support. Manage service planning. Closed loop support with manufacturing and design.

Systems Digitalization
Start integrated, stay integrated

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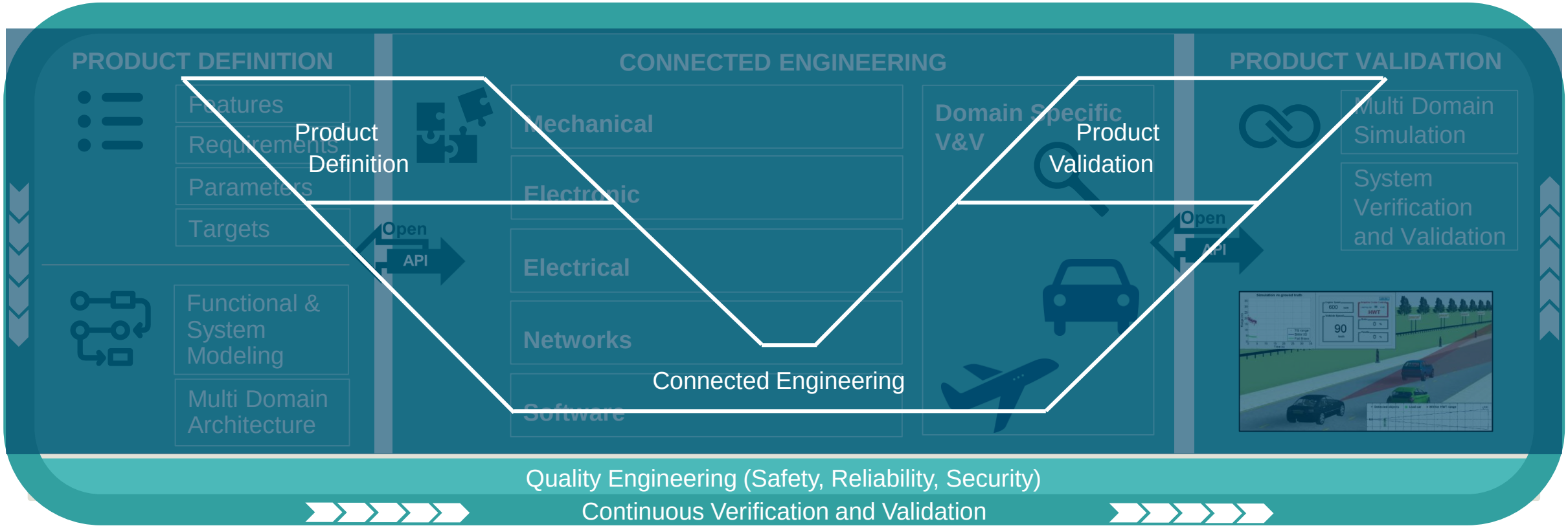

What is Arcadia

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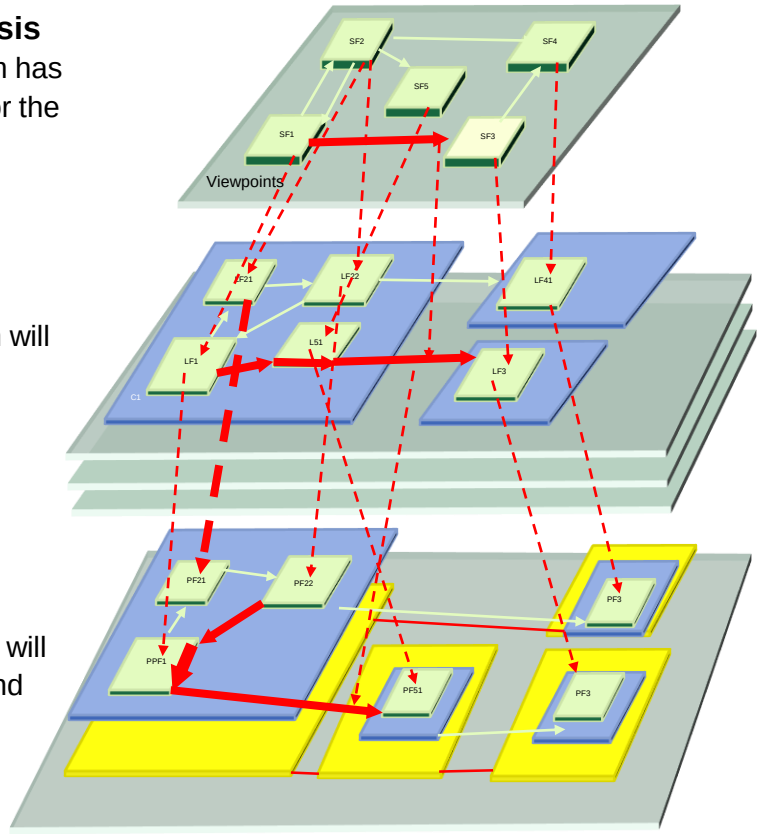
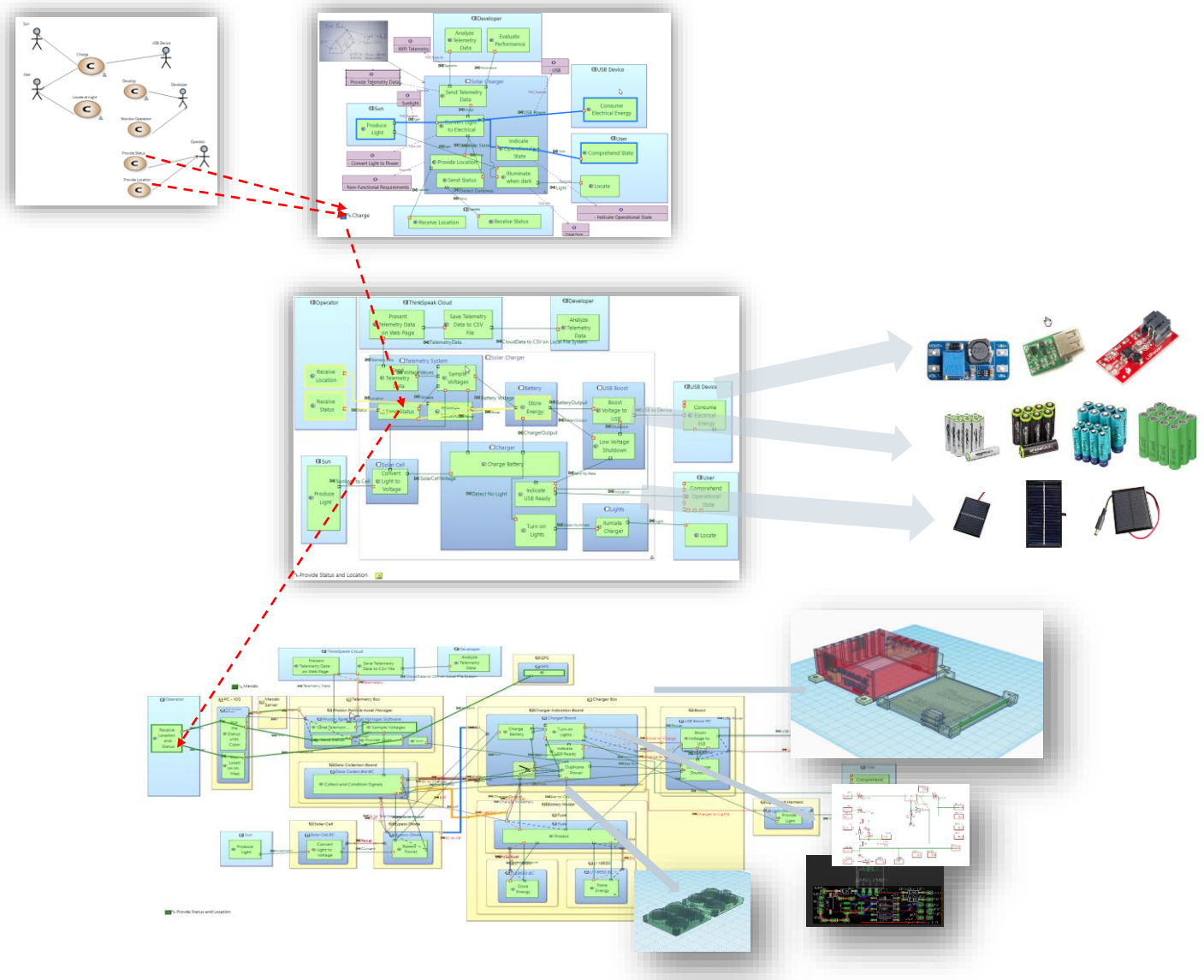
ARCADIA Phases supported by SMW

System Analysis
What the system has to accomplish for the user.

Logical Architecture
How the system will work to fulfil expectations..

Physical Architecture
How the system will be developed and built.





What is Capella

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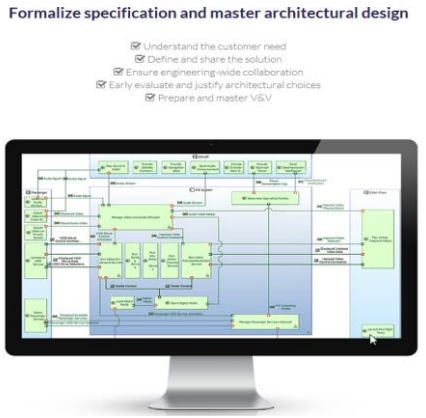
Capella is an Open Source solution for model-based systems engineering (MBSE). Hosted at polarsys.org, this solution provides a process and tooling for graphical modeling of systems, hardware or software architectures, in accordance with the principles and recommendations defined by the Arcadia method. Capella is an initiative of PolarSys, one of several Eclipse Foundation working groups. https://en.wikipedia.org/wiki/Capella_(engineering)

Open Source Solution for Model-Based Systems Engineering
Comprehensive, extensible and field-proven MBSE tool and method to successfully design systems architecture https://polarsys.org/capella/



Creating end-to-end traceability

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Requirement Management

Stake Holder Requirements
Business Requirements

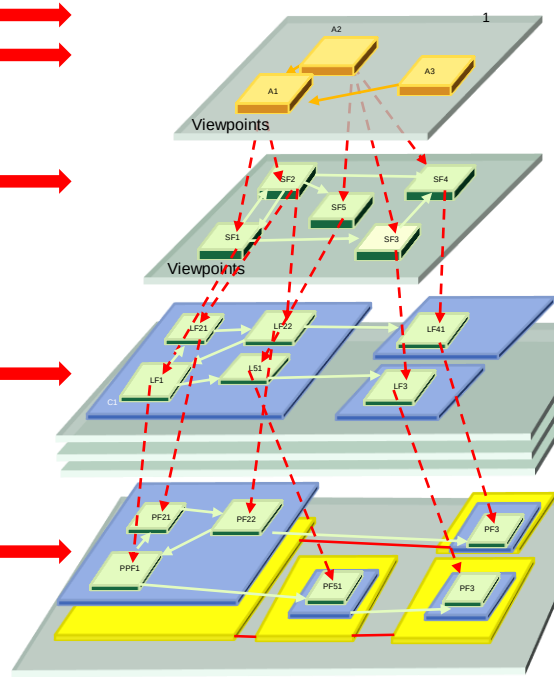
System Requirements

R

Sub-System Requirements

Component Requirements

System Modeling



F **Operational Analysis**
What the user of system needs to accomplish.

L **System Analysis**
What the system has to accomplish for the user.

Logical Architecture
How the system will work to fulfil expectations..

P **Physical Architecture**
How the system will be developed and built.

Domain Tools

Performance Engineering

Specialty Engineering

PHMT MADe

STAR-CCM+

Imagine.lab

Integrated Test and Validation

Matlab

Program Planning

E/E Engineering FEMAP

HEEDS

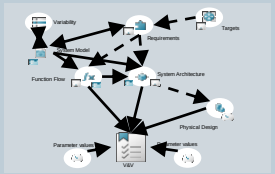
BOM Management

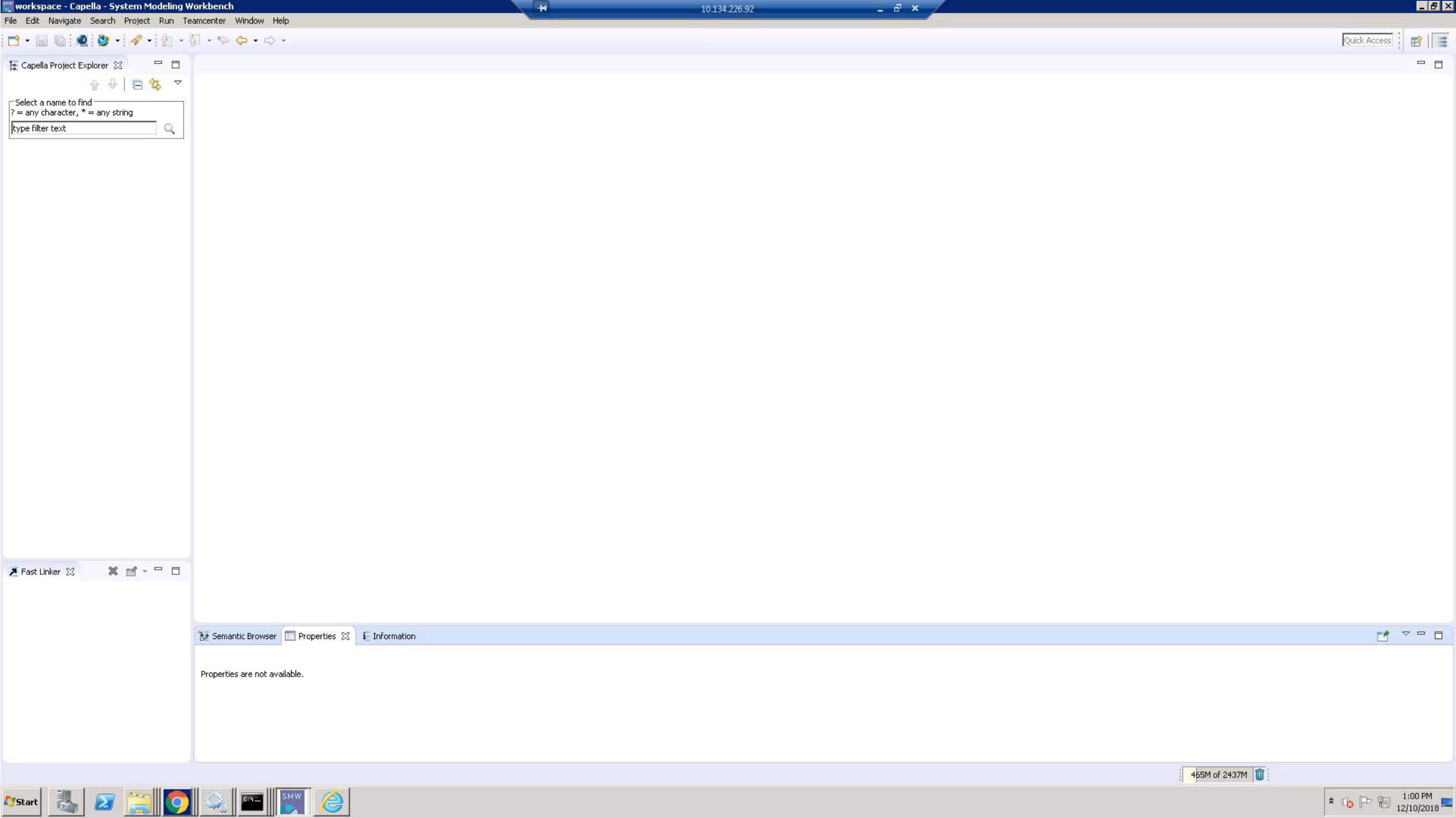
Capital

Xpedition

Mechanical Engineering

TEAMCENTER
Common Information Model and PLM Services




workspace - Capella - System Modeling Workbench
10.134.226.92
File Edit Navigate Search Project Run Teamcenter Window Help
Quick Access
Capella Project Explorer
Select a name to find
? = any character, * = any string
type filter text
Fast Linker
Semantic Browser
Properties
Information
Properties are not available.
465M of 2437M
Start
1:00 PM
12/10/2018

Multi-Domain Architecture

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Open

Integrated System Modeling

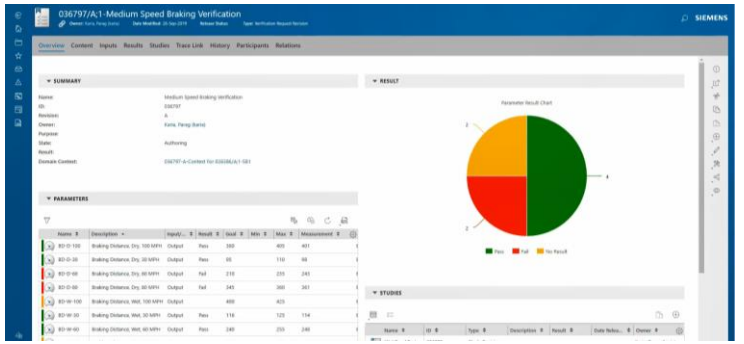
Verifiable

From Virtual Verification to Physical Testing

Future-Proof

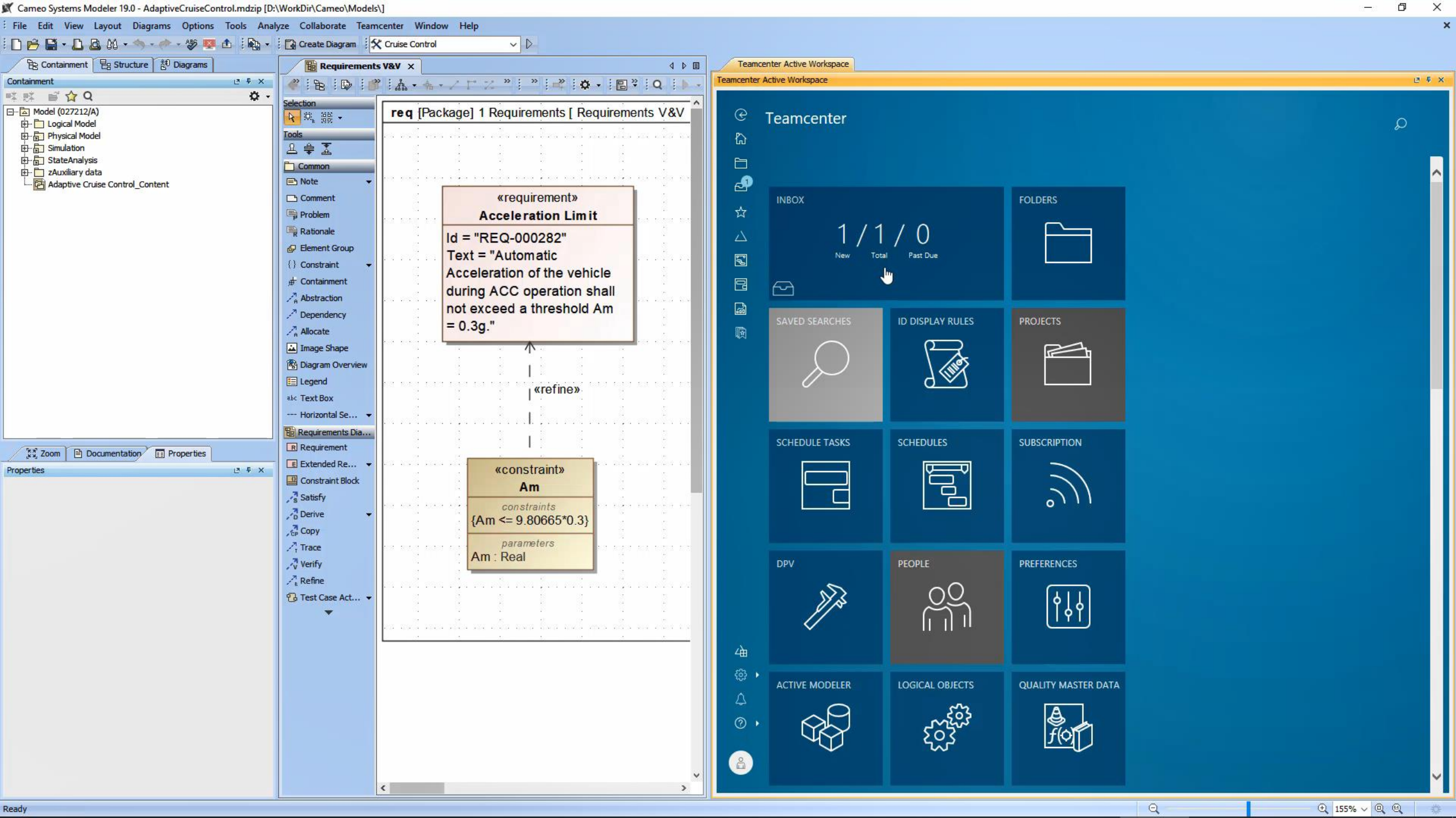
Proven solutions ready for the future

OBEO
SPARX SYSTEMS
IBM
No Magic



ARCADIA
SysML v2

Multi-Domain Architecture Produces the Blueprint for the Entire Product Lifecycle


Cameo Systems Modeler 19.0 - AdaptiveCruiseControl.mdzip [D:\WorkDir\Cameo\Models\]
File Edit View Layout Diagrams Options Tools Analyze Collaborate Teamcenter Window Help
Create Diagram
Cruise Control
Containment Structure Diagrams
Containment
Model (027212/A)
Logical Model
Physical Model
Simulation
StateAnalysis
zAuxiliary data
Adaptive Cruise Control_Content
Zoom Documentation Properties
Properties
Requirements V&V
Selection
Tools
Common
Note
Comment
Problem
Rationale
Element Group
Constraint
Containment
Abstraction
Dependency
Allocate
Image Shape
Diagram Overview
Legend
Text Box
Horizontal Se...
Requirements Dia...
Requirement
Extended Re...
Constraint Block
Satisfy
Derive
Copy
Trace
Verify
Refine
Test Case Act...
req [Package] 1 Requirements [Requirements V&V
«requirement»
Acceleration Limit
Id = "REQ-000282"
Text = "Automatic Acceleration of the vehicle during ACC operation shall not exceed a threshold Am = 0.3g."
«refine»
«constraint»
Am
constraints
{Am <= 9.80665*0.3}
parameters
Am : Real
Teamcenter Active Workspace
Teamcenter Active Workspace
Teamcenter
INBOX
1 / 1 / 0
New Total Past Due
FOLDERS
SAVED SEARCHES
ID DISPLAY RULES
PROJECTS
SCHEDULE TASKS
SCHEDULES
SUBSCRIPTION
DPV
PEOPLE
PREFERENCES
ACTIVE MODELER
LOGICAL OBJECTS
QUALITY MASTER DATA
Ready
155%

Multi-Domain Simulation

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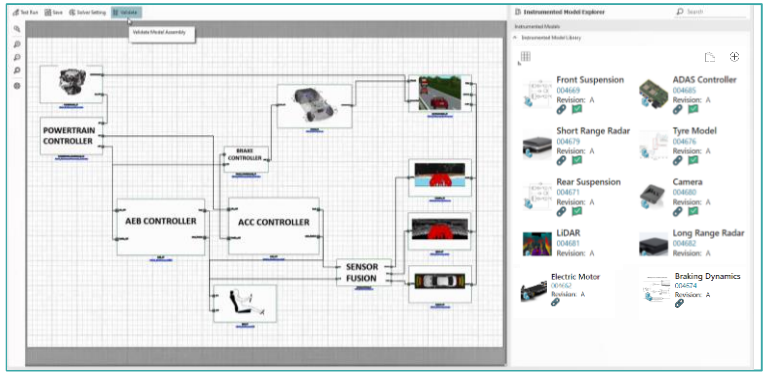
Open

Integrated Behavior Modeling and Simulation

Simcenter™
MATLAB SIMULINK
GT Gamma Technologies
NASTRAN
FEMAP
Dymola
ANSYS
ABAQUS

Configurable

Scalable and Reusable Simulations



Standard

Facilitate Collaboration Maximize Reuse

MODELICA
S FUNCTION
fmi FUNCTIONAL MOCK-UP INTERFACE

Multi-Domain Simulation to enable Closed-Loop Performance Engineering

Systems Digitalization
Start integrated, stay integrated

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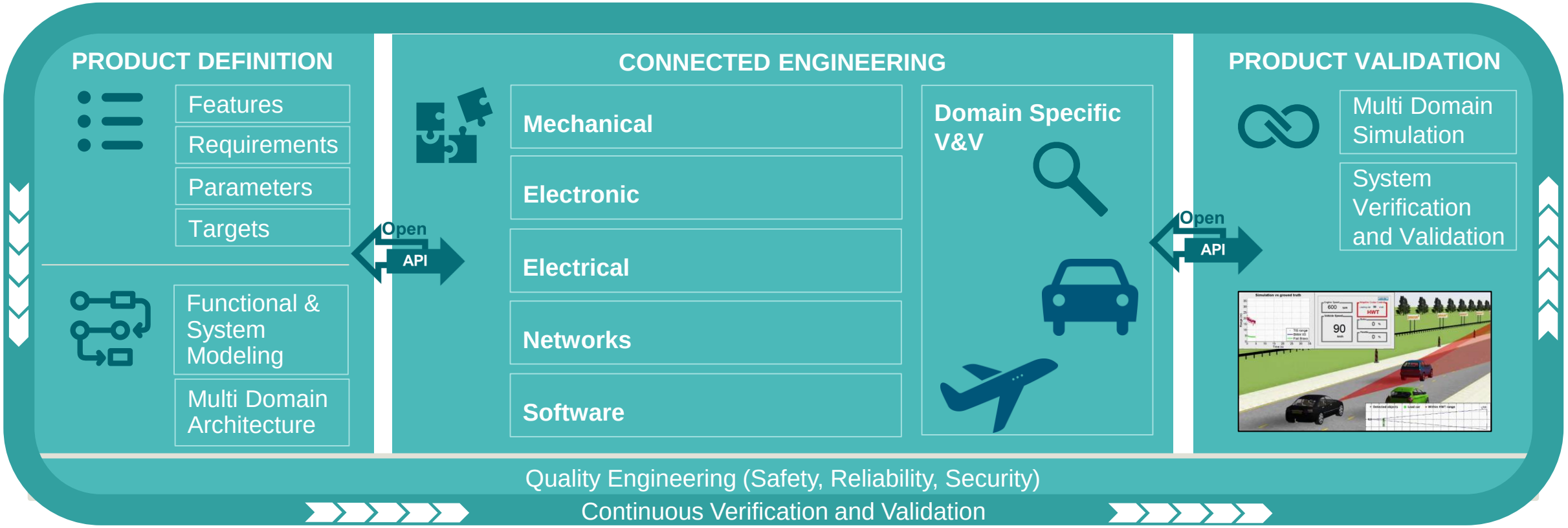

Mechanical Engineering

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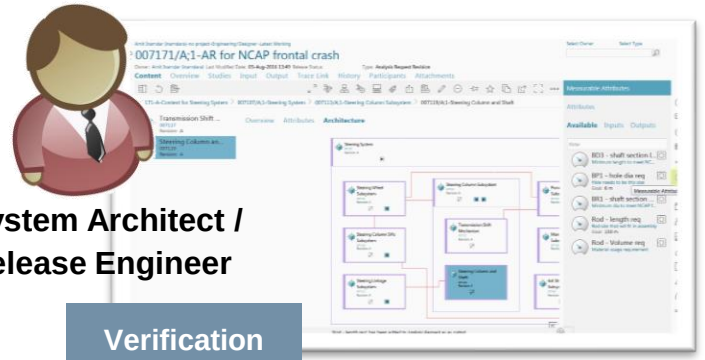
Typical user workflow



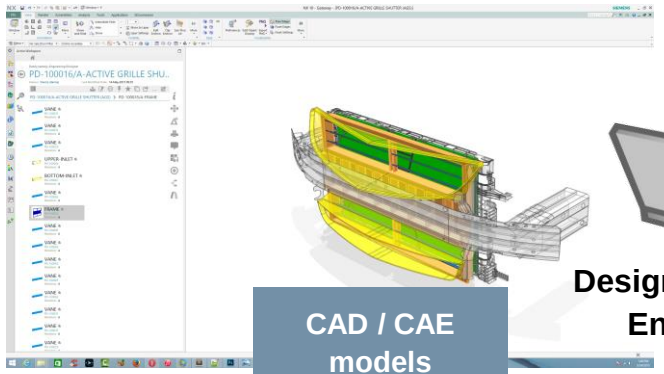
System Architect / Release Engineer

Verification Request

Requirements and output request

Allocate goals to measurements on CAD/CAE models

2



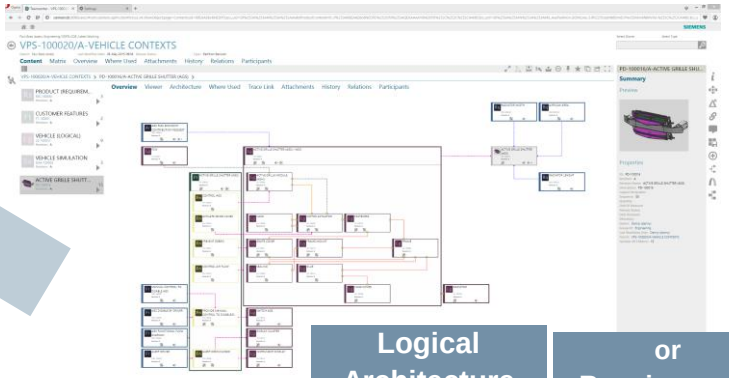
CAD / CAE models

Design/Simulation Engineer

Selection of parameters to define task

1

Parameter goals



Logical Architecture model

or Requirements breakdown

Measured Values results

3

Update of measurable attribute result values in logical architecture model

PLM

CAD/CEA

Two Key Stages in E/E Systems Development

Architecture Optimization & Creation of Downstream Added Value

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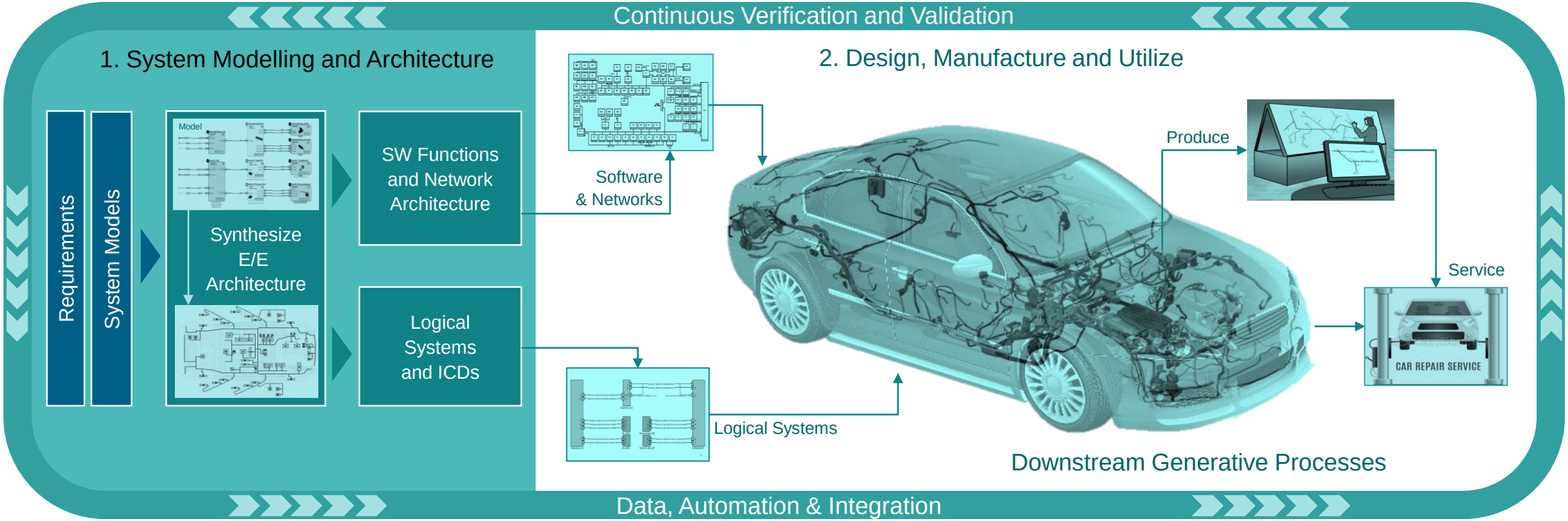

Downstream – Electrical Distribution System Design

Generative Design and Validation of Wiring with Full Traceability

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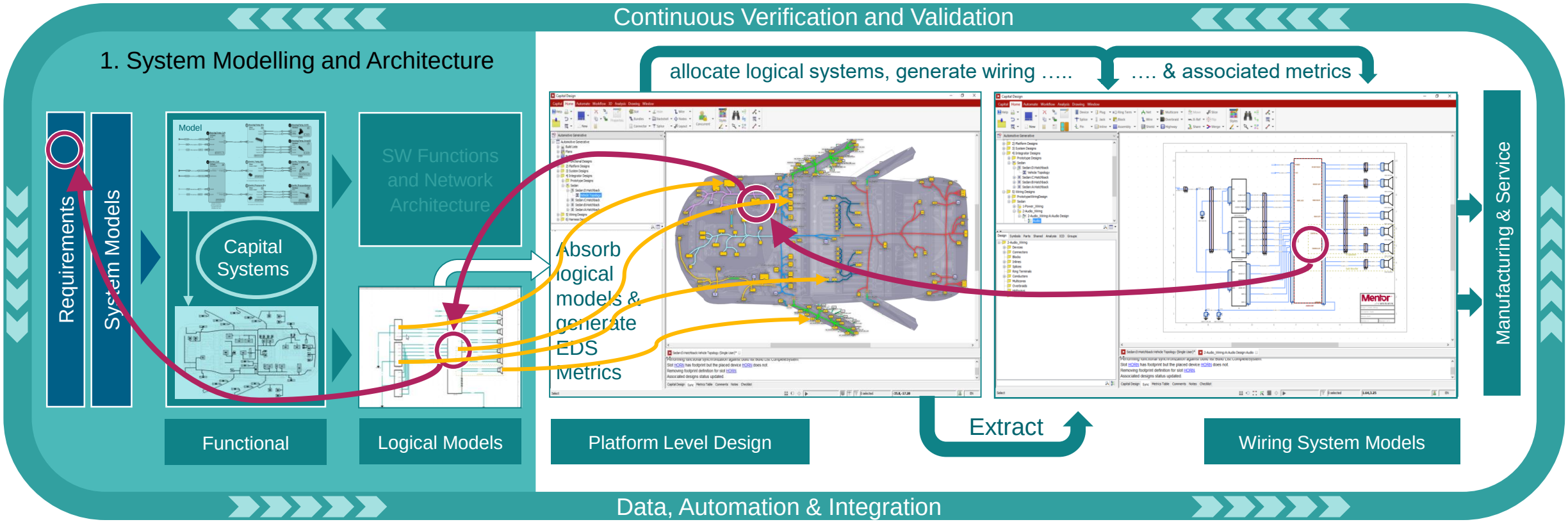

Optimize Software In Complex Products

Continuous integration of hardware & software lifecycles

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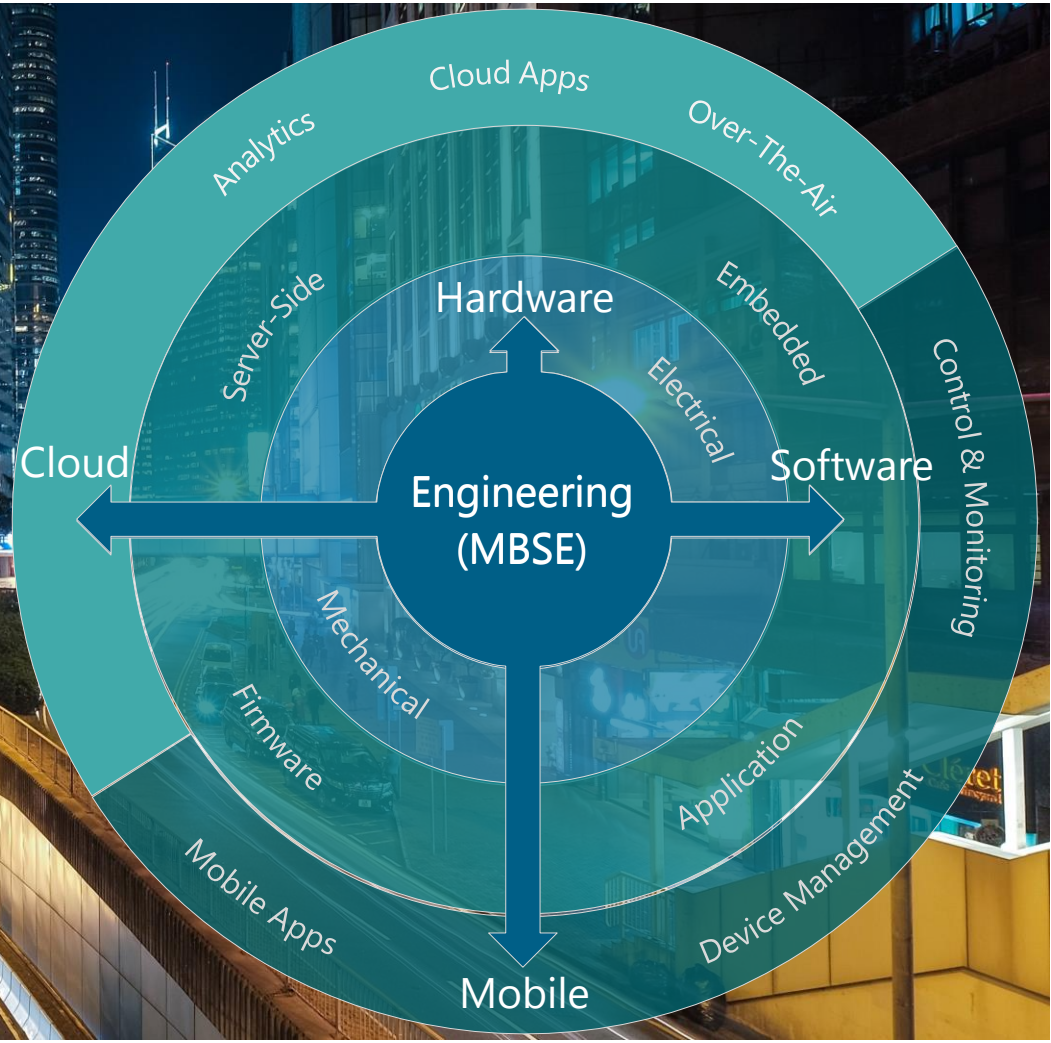
Hardware-Software Integration Challenges

HW & SW Lifecycle Synchronization	Best in class tools, integrated
Continuous Integration & Development	Traceability from requirements to development to simulation (HiL, SiL. MiL) to test
Greater Complexity & Variability	Integrated BOM and configuration



Orchestrate Development Across the Application Lifecycle

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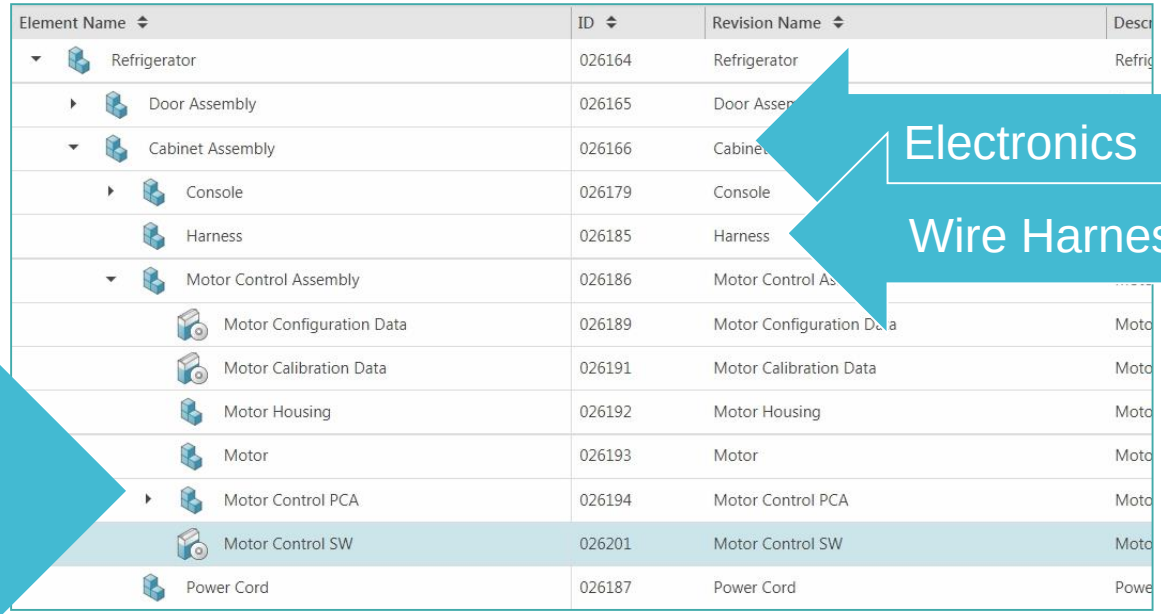
Software lifecycle in Polarion

Executable, Calibration, Installer, etc.

Teamcenter multi-domain Bill-of-Materials



Electronics

Wire Harness

Integrated hardware and software management

CORVETTE MULTI BOM

IA-HARN ASM WRG-ENGINE LS9-Y-MM

Revision: Global (Latest Working) **Date:** Today **Units:** All Units (CR-0000001/A-CORVETTE MULTI BOM) **Variant:** No Variant Rule (CR-0000001/A-CORVETTE MULTI BOM) **Owner:** Ed (ed) **Date Modified:** 25-Aug-2019 23:55 **Release Status:** **Type:** Design Revision

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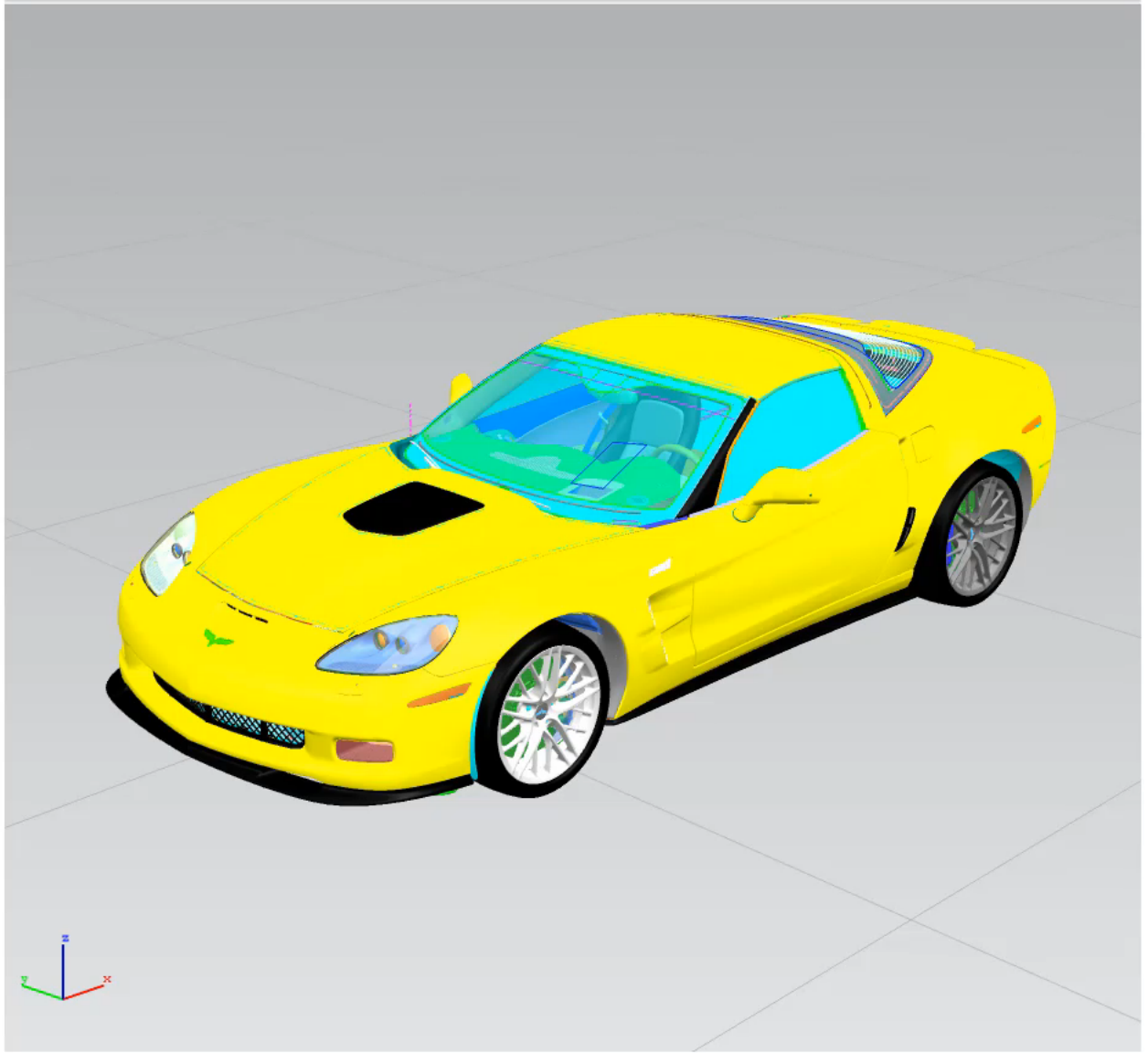
Content Changes

Element Name	Type	Variant Formula
ENGINE 6.2L V8 DI	Design	Engine = '6.2L V8 DI''L V8 DI'
ENGINE 6.2L Supercharged V8 DI and PDFI	Design	Engine = '6.2L Supercharge V8 DI'
IA-HARN ASM WRG-ENGINE LS9-Y-MM	Design	
6.2L DL MAN MASTER ENGINE WRG HARN	Harness	Transmission = '7-speed manual' AND Engine = '6.2L V8
6.2L DL AUTO MASTER ENGINE WRG HARN	Harness	Transmission = '8-speed paddle shift automatic' AND Er
6.2L SC AUTO MASTER SC ENGINE WRG HARN	Harness	Transmission = '8-speed paddle shift automatic' AND Er
6.2L SC MAN MASTER SC ENGINE WRG HARN	Harness	
MASTER ENGINE CONTROL MODULE ASM	Design	
MODULE ASM-ENG CTRL	Harness Module	
ENG CTRL PCB	EDA Printed Cir...	
Eng Cntrl 6,2L SC MAN SW	Software	Transmission = '7-speed manual' AND Engine = '6.2L Su
Eng Cntrl 6.2L MAN SW	Software	Transmission = '7-speed manual' AND Engine = '6.2L V8
Eng Cntrl 6,2L SC AUTO SW	Software	Transmission = '8-speed paddle shift automatic' AND Er
Eng Cntrl 6.2L AUTO SW	Software	Transmission = '8-speed paddle shift automatic' AND Er
MODULE ASM - ELEK SUSP CONT	Harness Module	
Fasteners	Design	
ECM BRKT	Design	
BRACKET-WRG HARN	Design	
IA-MODULE AND BRACKET-Y-MM	Design	
IA-FRONT R/H SIDE DR -Y-MM	Design	
IA-TIRES,WHEELS&TRIM-Y-MM	Design	
IA-ECE FRONT LIGHTING-Y-MM	Design	
IA-FRT INT AIRFLOW COMMON Y-MM	Design	
IA-INFOTAINMENT-Y-MM	Design	
IA-GMX321 I/P ASM-Y-MM	Design	
IA-HARN ASM WRG-DOOR TRIM -Y-MM	Design	

3D Variants Overview Finishes Made From Where Used Changes Attachments History Relations Collaboration



Systems Digitalization
Start integrated, stay integrated

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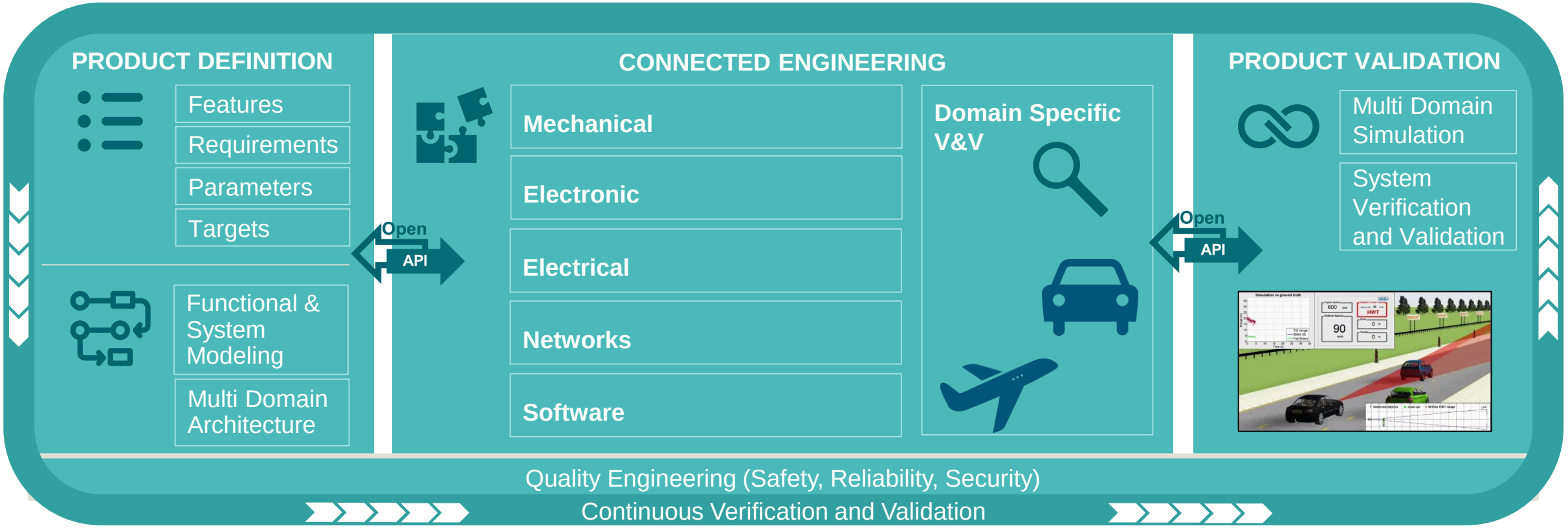

Verification Management
Pulling it all together

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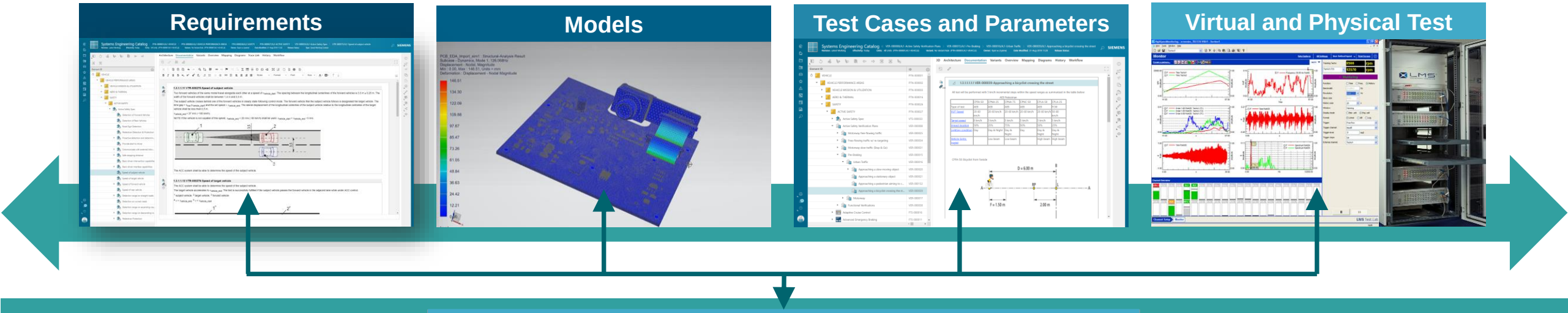
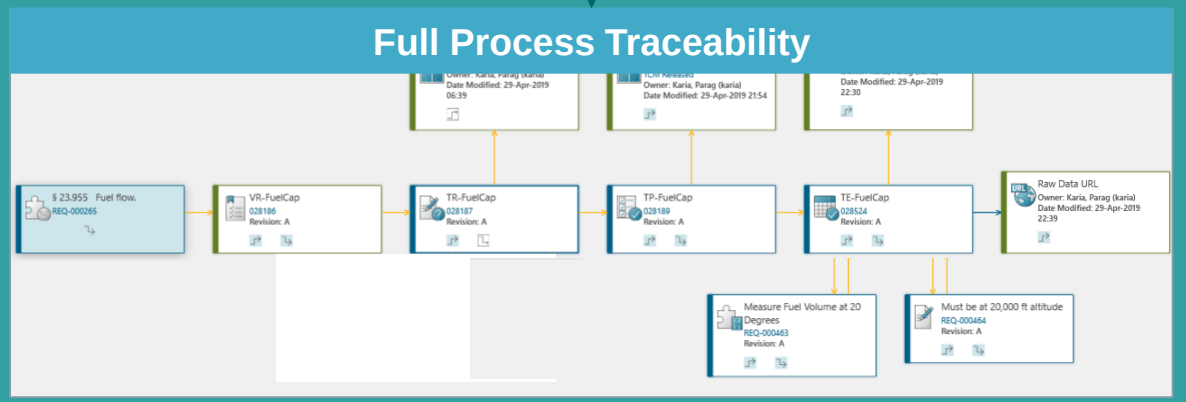


Multi-domain
Virtual or physical
Support for all models
Fully traceable



Small Car

Owner: joez (joez) Date Modified: **16-Jan-2017 12:10** Release Status: Type: **Program**

Plan Levels

NAME	TYPE	STATE
Small Car	Program	Not Started
Model Year 2019	Project	Not Started

Plan Level Events

No Events found

Systems Digitalization
Start integrated, stay integrated

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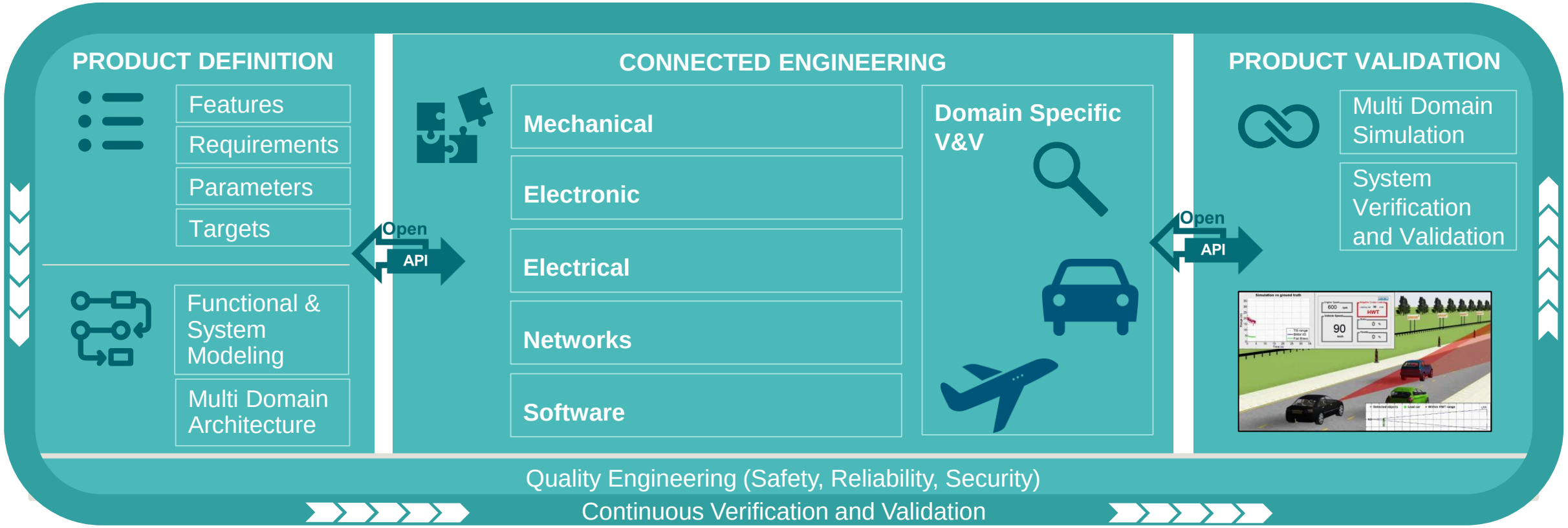

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Vision

MBSE: start integrated stay integrated throughout the complete lifecycle

Technology strategy

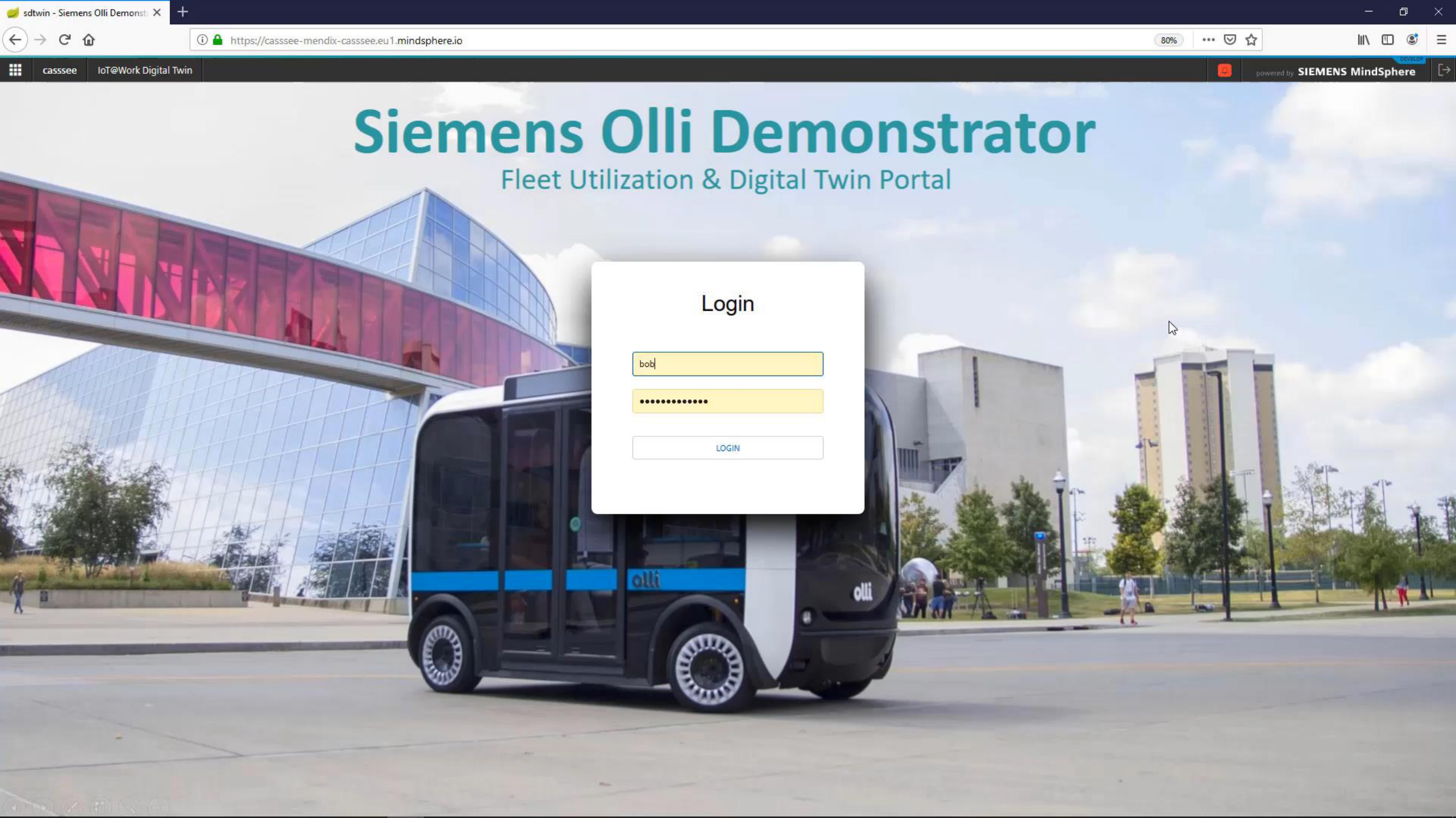
Open Eco system to incorporate MBSE tooling standards in the market place

Solutions offering

Siemens provides System Modelling Workbench which integrates MBSE with TC (PLM)

Goal

Enabling continuous V&V: to speed up development, reduce/prevent errors


sdtwin - Siemens Olli Demonst
https://casssee-mendix-casssee.eu1.mindsphere.io
80%
casssee
IoT@Work Digital Twin
powered by SIEMENS MindSphere
Siemens Olli Demonstrator
Fleet Utilization & Digital Twin Portal
Login
bob
LOGIN

Agenda

- Introduction
- Vision Siemens Digital Industries Software (Piet)
- Digitalization of Systems Engineering (Stefan)
- Requirement Management with Polarion (Marco)

Trends & Challenges

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Increase in product variants

Regulatory Compliancy

Global Setup

Fast changing consumer demands

High Quality Demand

Global Supply Chain
Operational Cost and Quality

Stressed financial and program performance

World Wide Competition

Well known (often used) Requirement Management solutions

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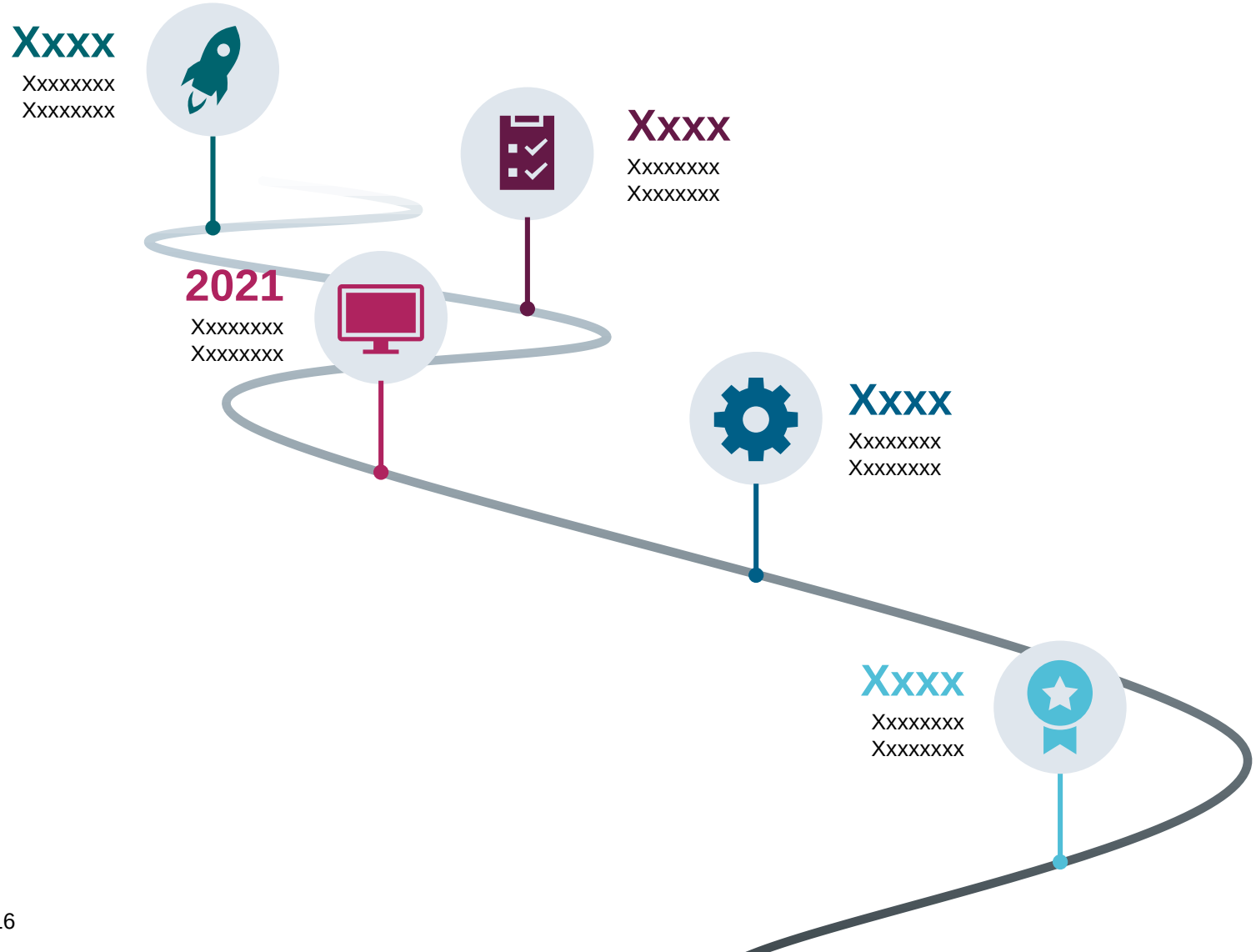
Roadmap


Xxxx
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2021
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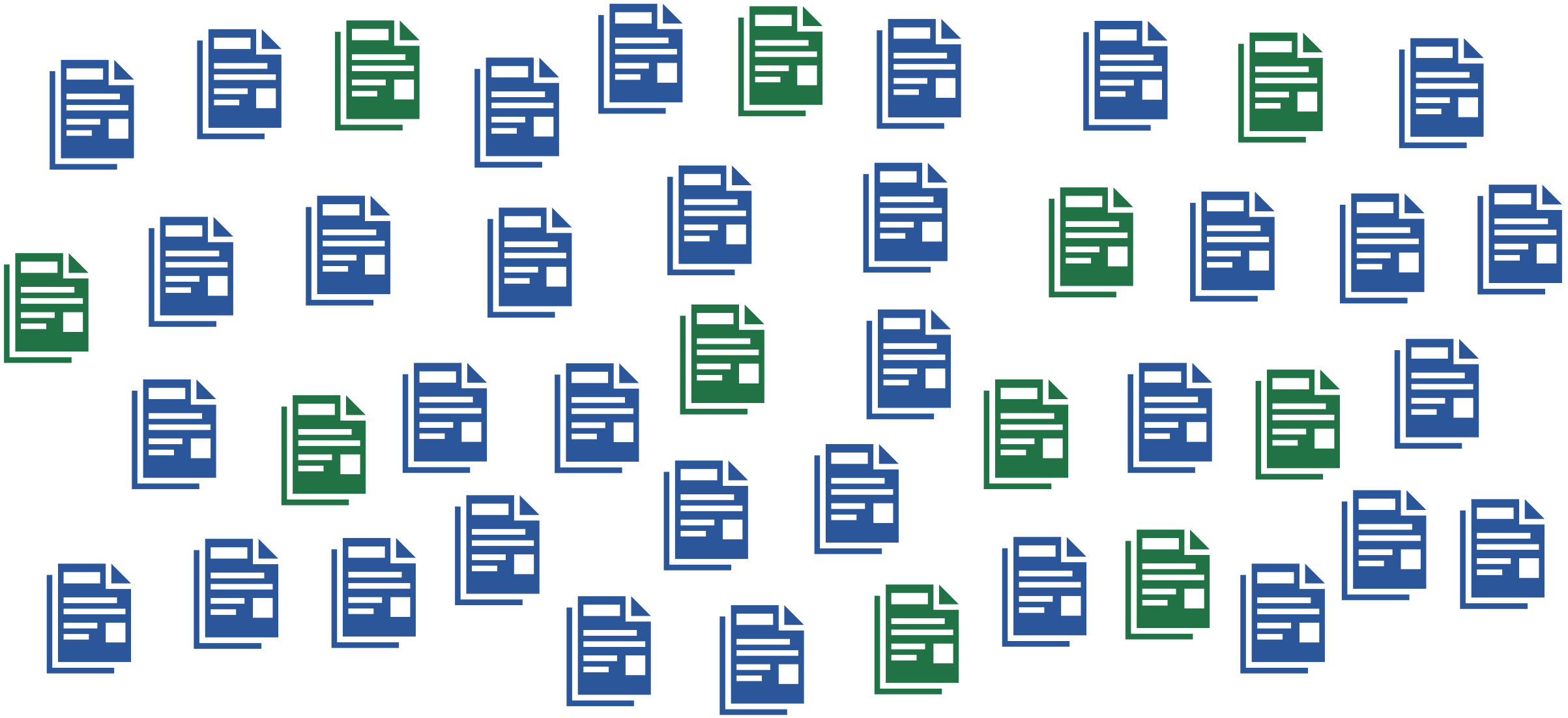
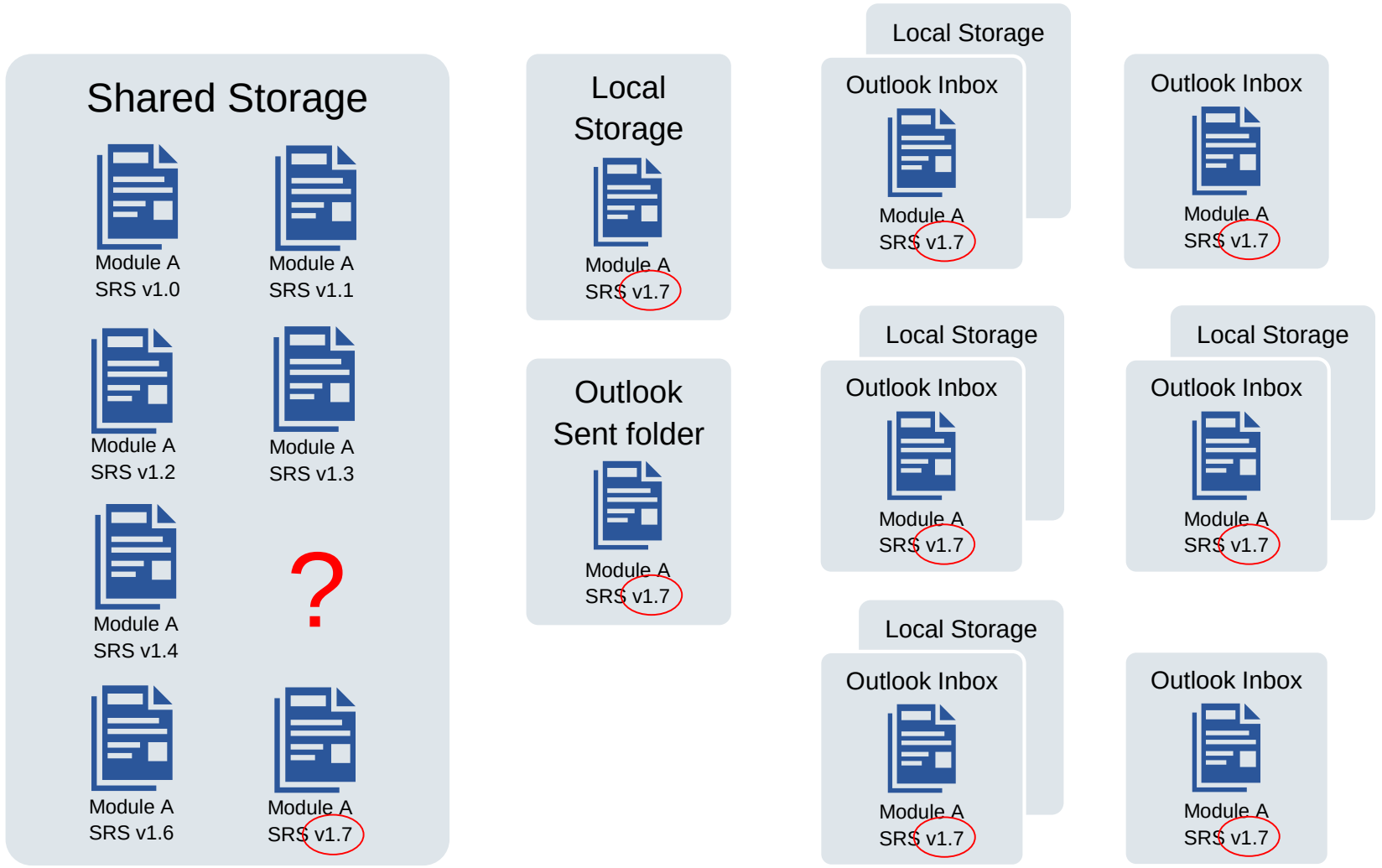
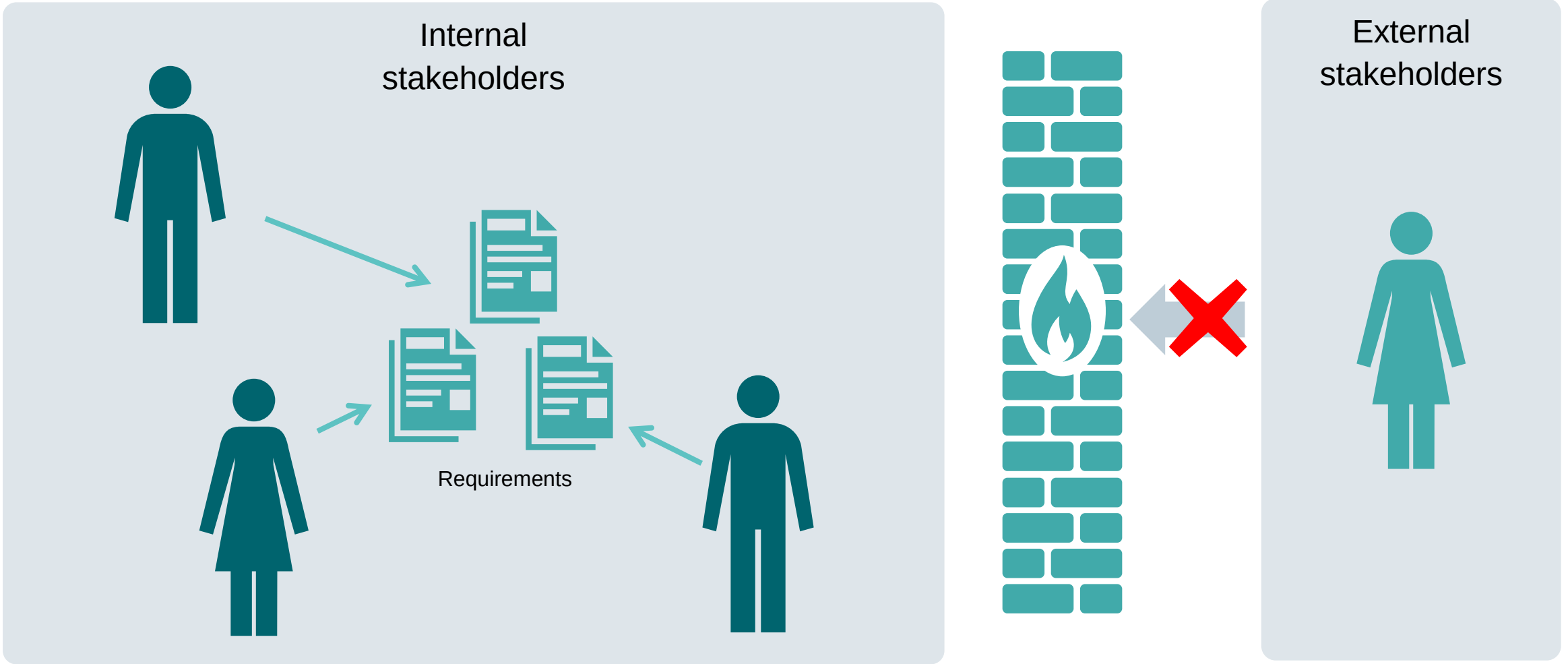
Massive number of specification documents



Single source of truth



External stakeholders



Challenges

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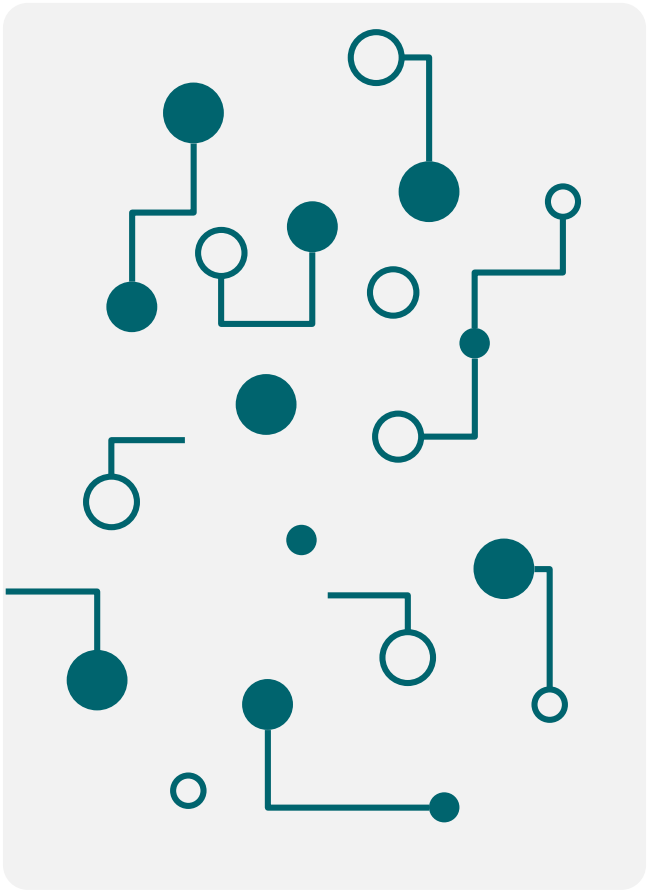
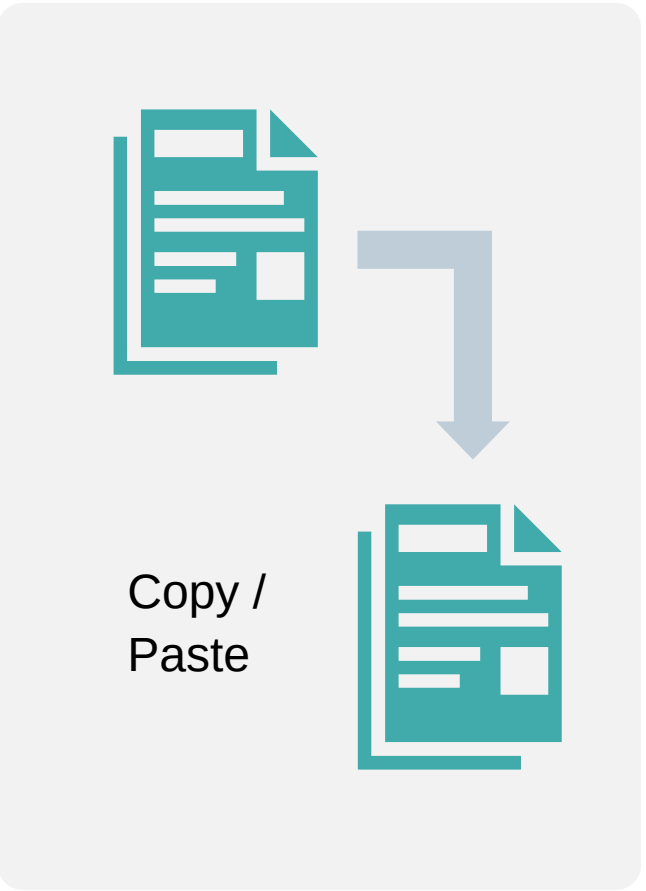
Collaboration

Traceability



Re-use



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Stay close to what you are familiar with

&

Improve the way you manage requirements

Lifecycle Management core pillars

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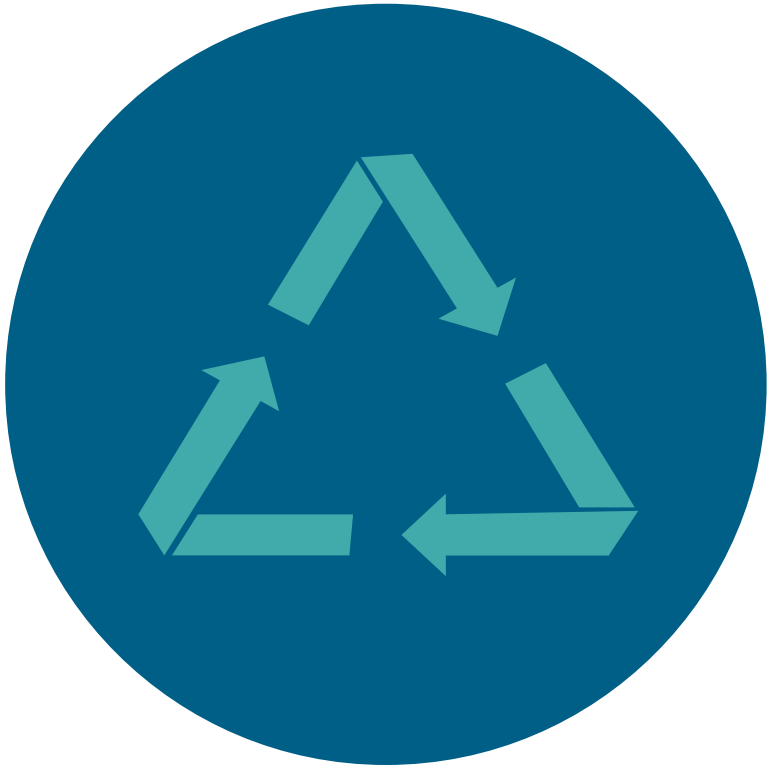
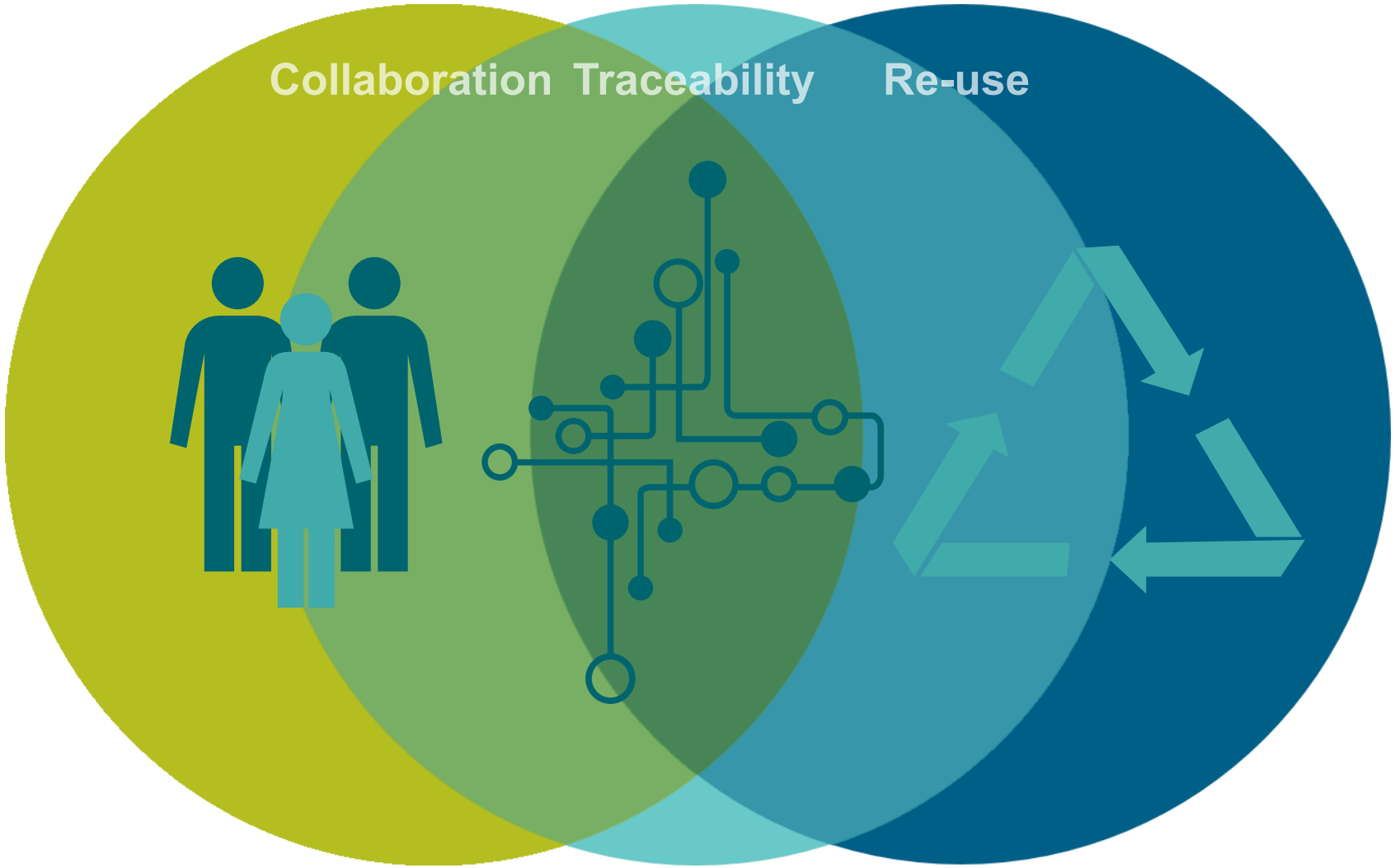
Collaboration

Traceability

Re-use



The boundaries between pillars are disappearing



Polarion

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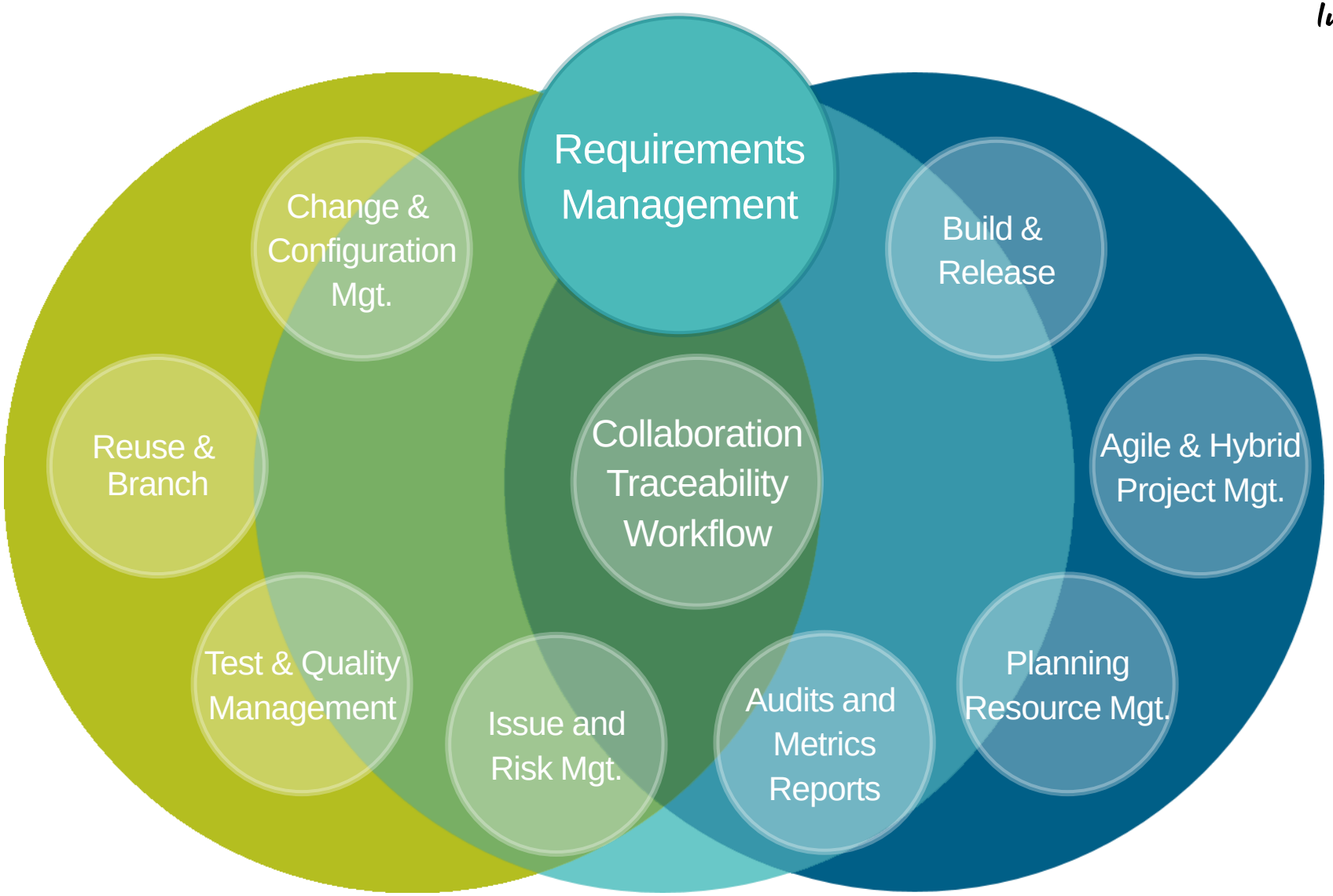

Existing specification documents

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3 Requirements¶

3.1 General·State¶

The·car·should·have·approximately·following·Dimensions:¶

Dimension¤	Interval¤
width¤	2000-2300·mm¤
length¤	4200-4300·mm¤
height¤	1100-1200·mm¤

¶

The·car·must·have·alloy·wheels·with·minimum·20·inch·for·a·sporty·look.¶

3.2 Range¶

The·car·must·have·a·range·of·minimum·500km·with·a·battery·charge.¶

3.3 Engine¶

The·car·must·have·an·electric·engine·with·following·properties:·¶

- → The·electric·engine·must·provide·at·least·700ps.¶
- → V-Max·should·be·more·than·300·km/h.¶
- → The·weight·should·not·be·more·than·200·kg.¶

3.4 Brakes¶

It·must·be·possible·to·operate·the·kers-system·with·the·used·breaking·technology.¶

The·brake·calipers·should·be·visible·and·painted·in·Polarion-Blue.¶

The·brakes·should·look·sporty.¶

3 Requirements

3.1 General State

MRM-557 - The car should have approximately following Dimensions:

Dimension	Interval
width	2000-2300 mm
length	4200-4300 mm
height	1100-1200 mm

Should Have, Reviewed

MRM-558 - The car must have alloy wheels with minimum 20 inch for a sporty look.

Must Have, Reviewed

3.2 Range

MRM-560 - The car must have a range of minimum 500km with a battery charge.

Must Have, Reviewed

3.3 Engine

MRM-562 - The car must have an electric engine with following properties:

Must Have, Reviewed

MRM-563 - The electric engine must provide at least 700ps.

Must Have, Reviewed

MRM-564 - V-Max should be more than 300 km/h.

Should Have, Reviewed

MRM-565 - The weight should not be more than 200 kg.

Should Have, Reviewed

3.4 Brakes

MRM-567 - It must be possible to operate the kers-system with the used breaking technology.

Must Have, Reviewed

MRM-568 - The brake calipers should be visible and painted in Polarion-Blue.

Should Have, Reviewed

MRM-569 - The brakes should look sporty.

Should Have, Reviewed

Documents & Individual requirements

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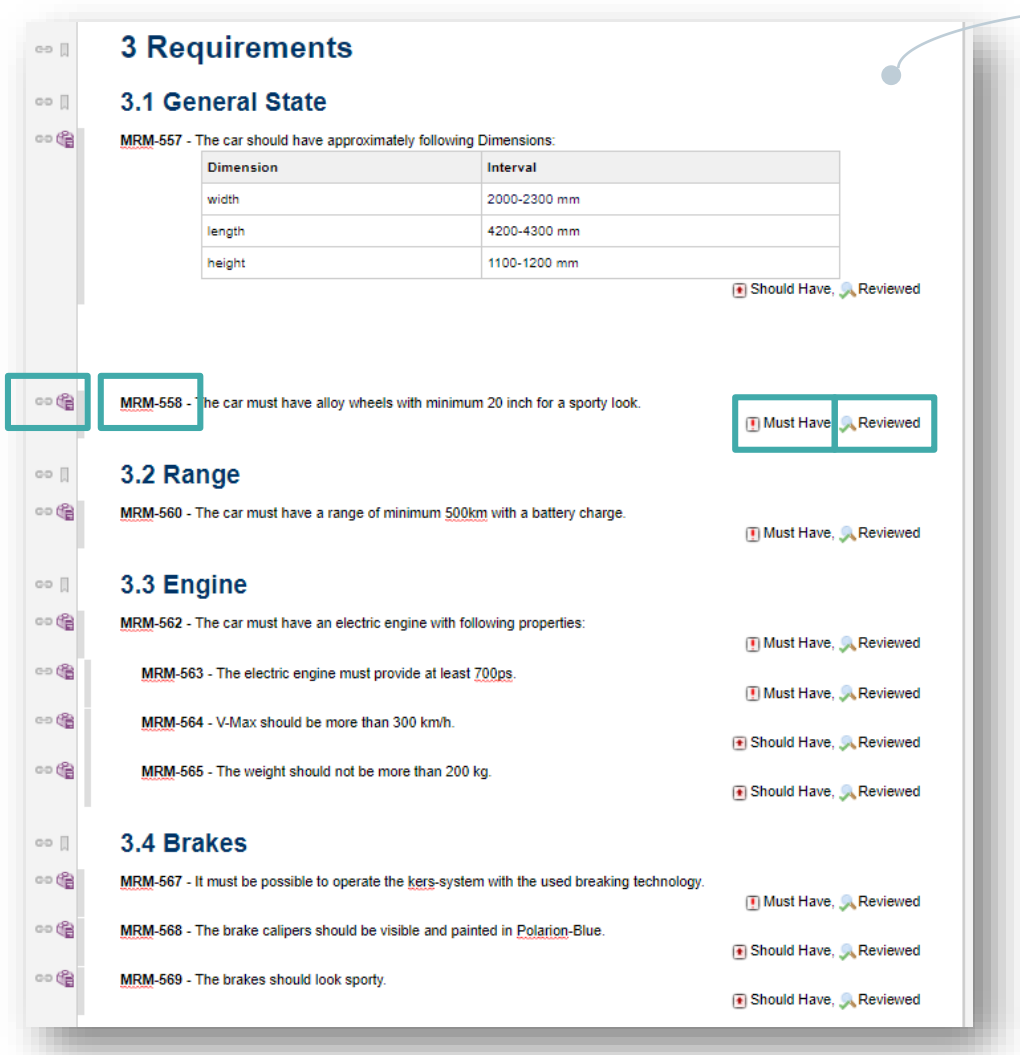


3 Requirements

3.1 General State

MRM-557 - The car should have approximately following Dimensions:

Dimension	Interval
width	2000-2300 mm
length	4200-4300 mm
height	1100-1200 mm

Should Have, Reviewed

MRM-558 - The car must have alloy wheels with minimum 20 inch for a sporty look. Must Have, Reviewed

3.2 Range

MRM-560 - The car must have a range of minimum 500km with a battery charge. Must Have, Reviewed

3.3 Engine

MRM-562 - The car must have an electric engine with following properties: Must Have, Reviewed

MRM-563 - The electric engine must provide at least 700ps. Must Have, Reviewed

MRM-564 - V-Max should be more than 300 km/h. Should Have, Reviewed

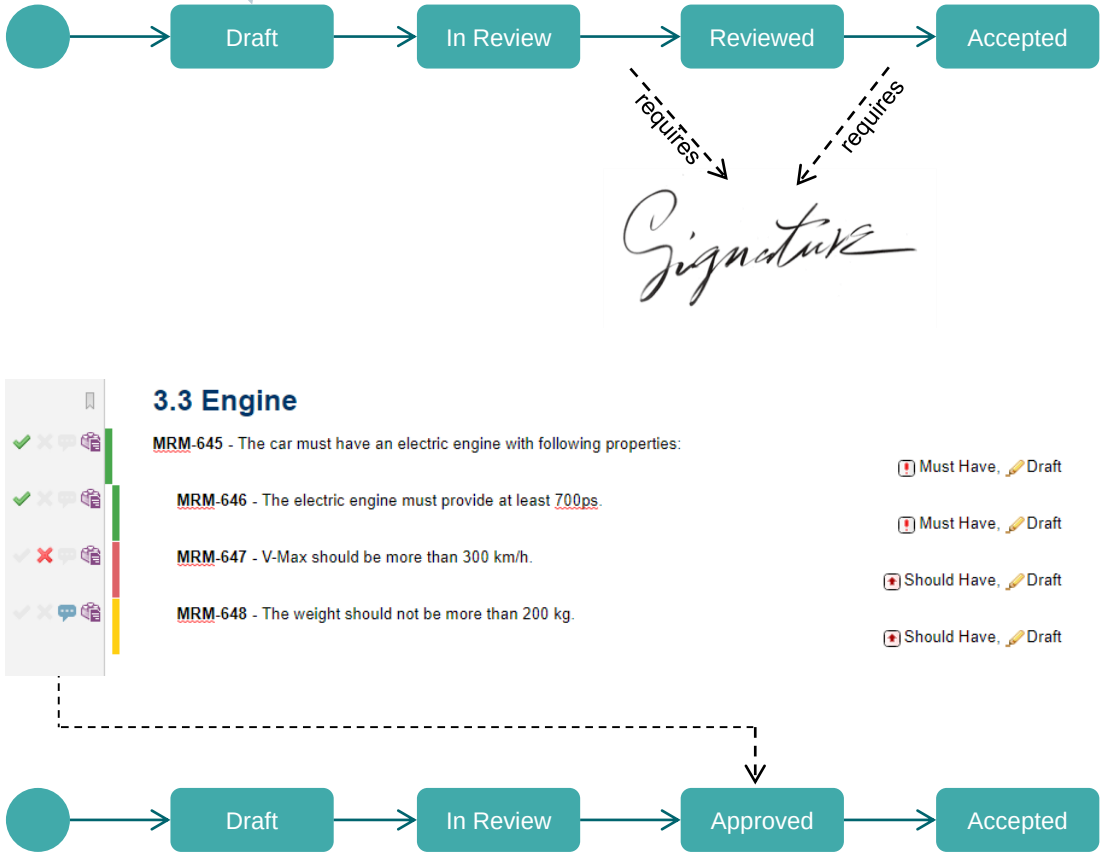
MRM-565 - The weight should not be more than 200 kg. Should Have, Reviewed

3.4 Brakes

MRM-567 - It must be possible to operate the kers-system with the used breaking technology. Must Have, Reviewed

MRM-568 - The brake calipers should be visible and painted in Polarion-Blue. Should Have, Reviewed

MRM-569 - The brakes should look sporty. Should Have, Reviewed



External stakeholders

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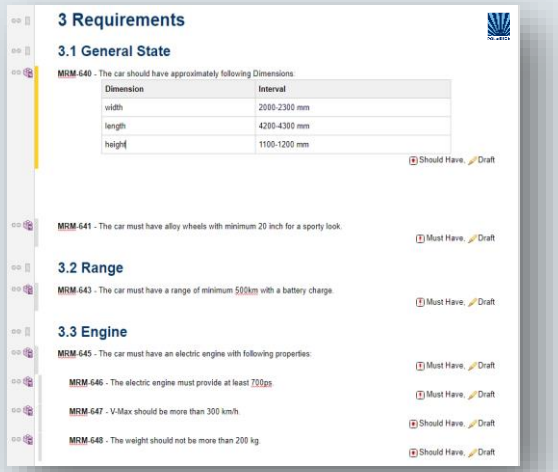
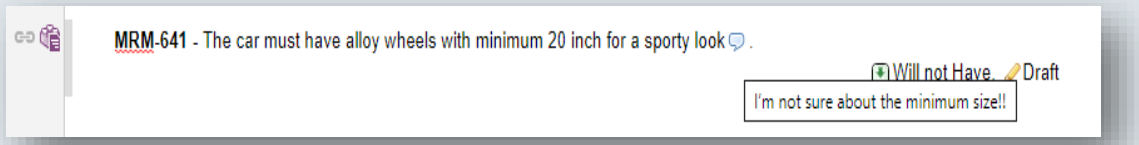
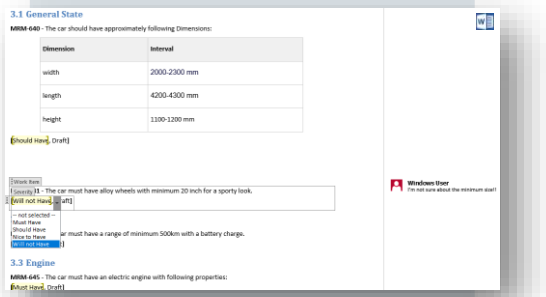
Internal stakeholders

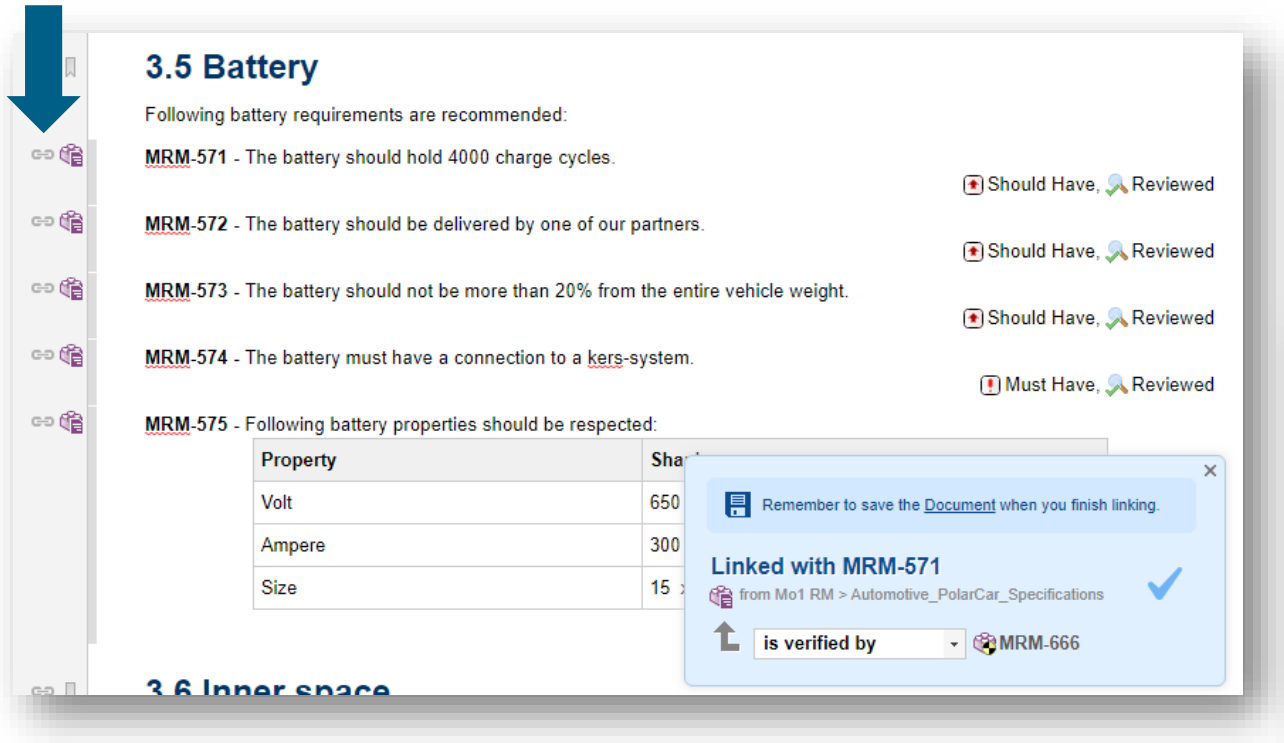


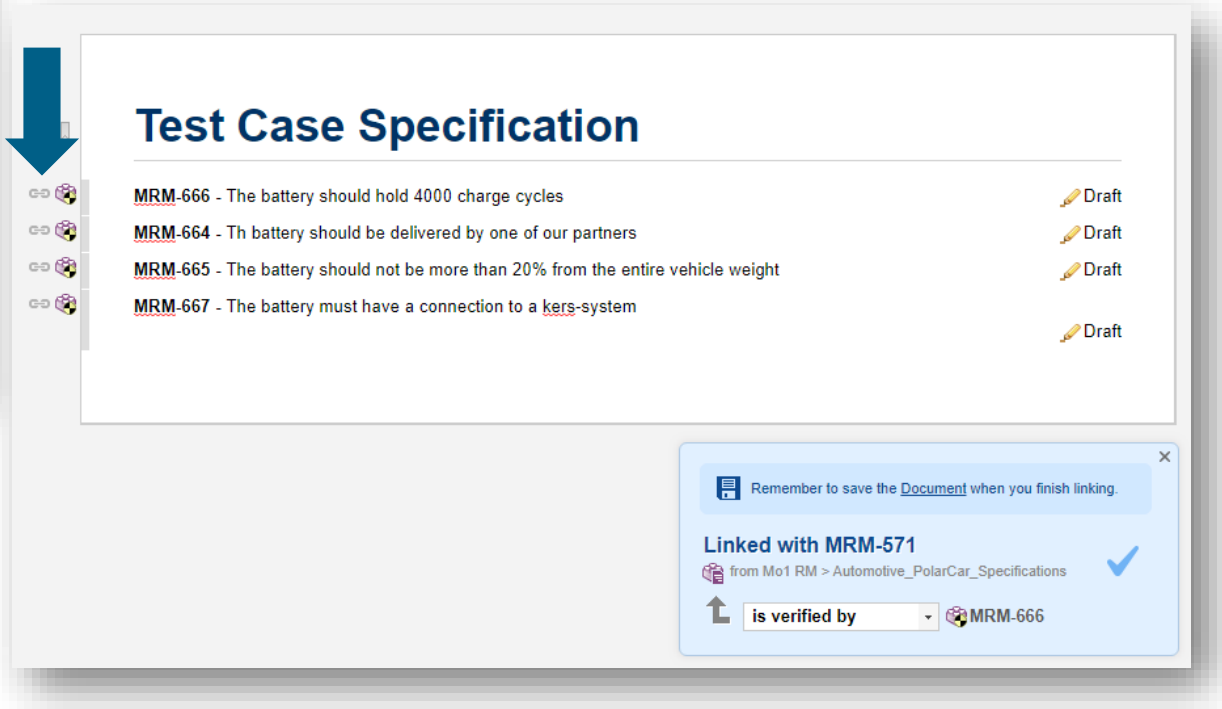


External stakeholders

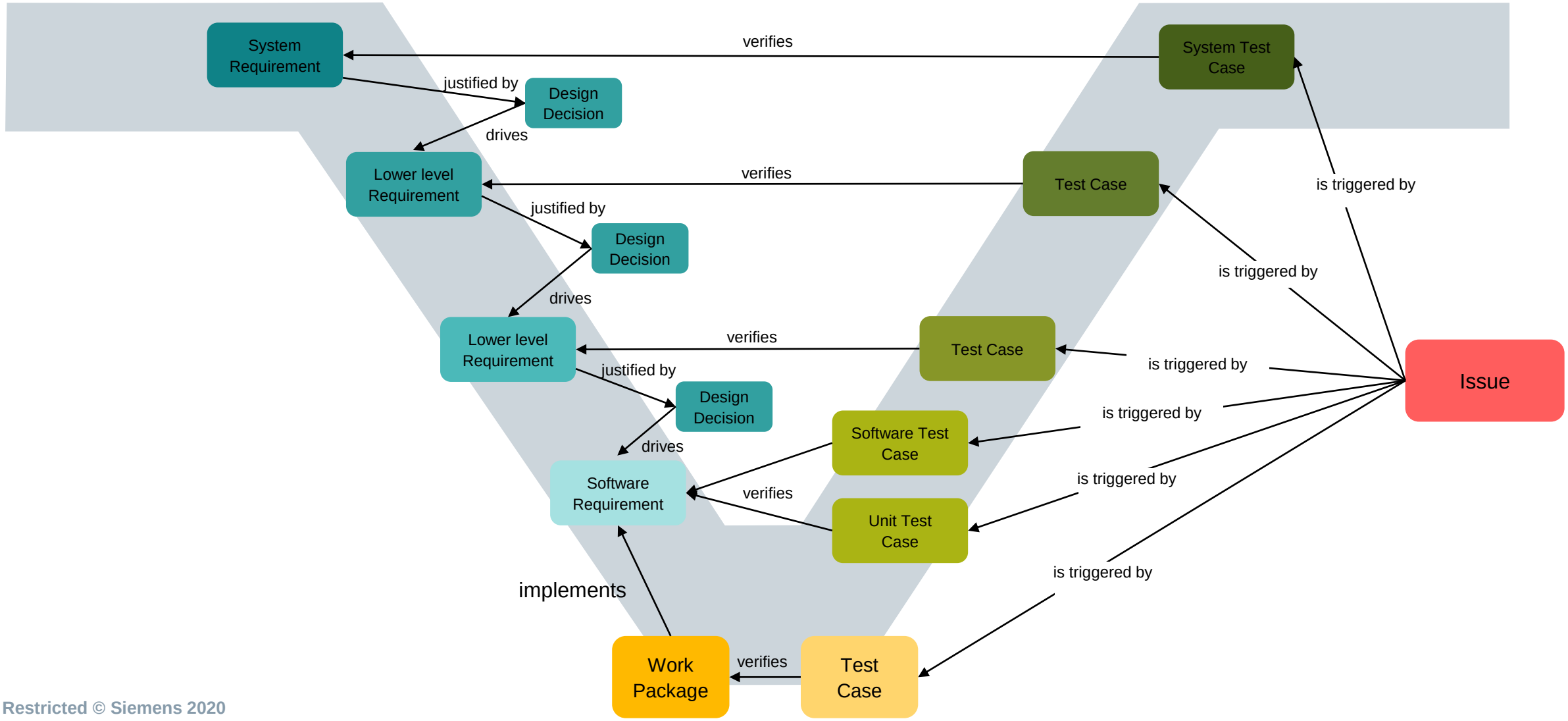


Traceability





Polarion linking model - Example



Traceability & Coverage

Re-use

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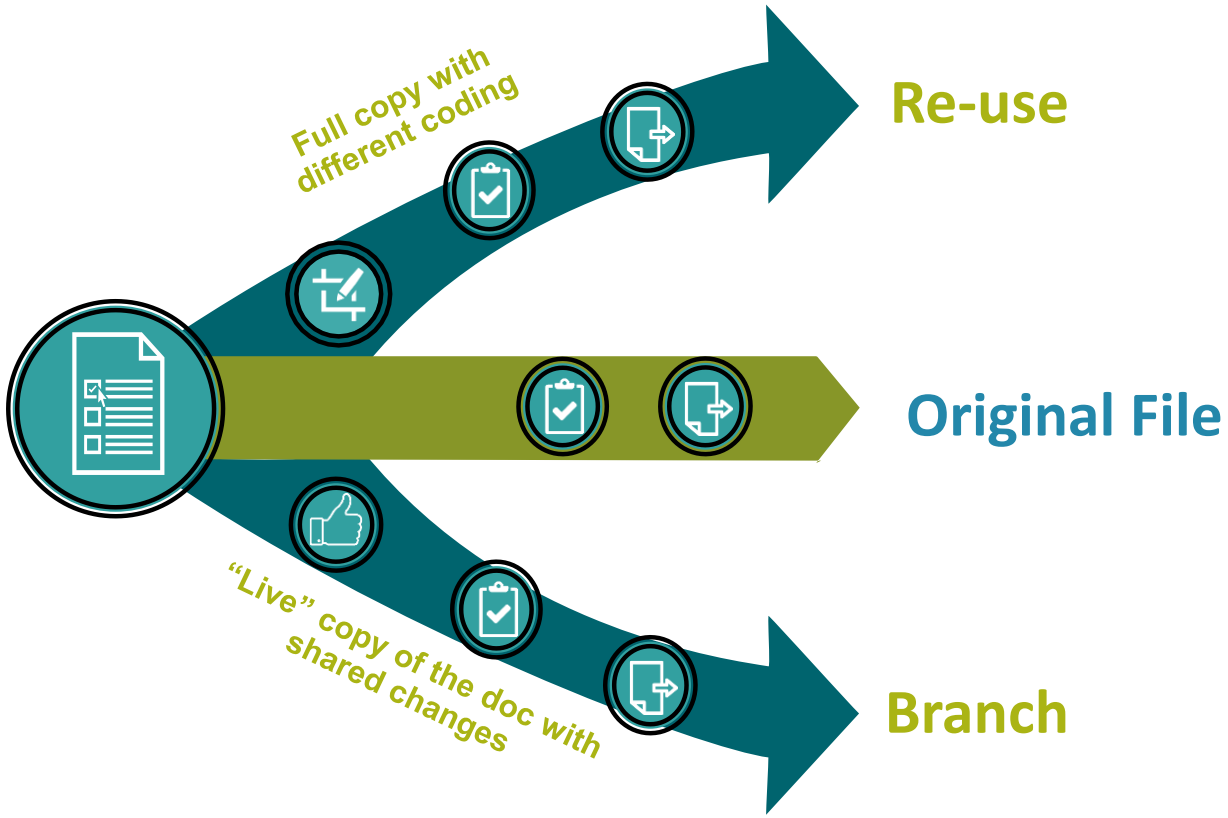

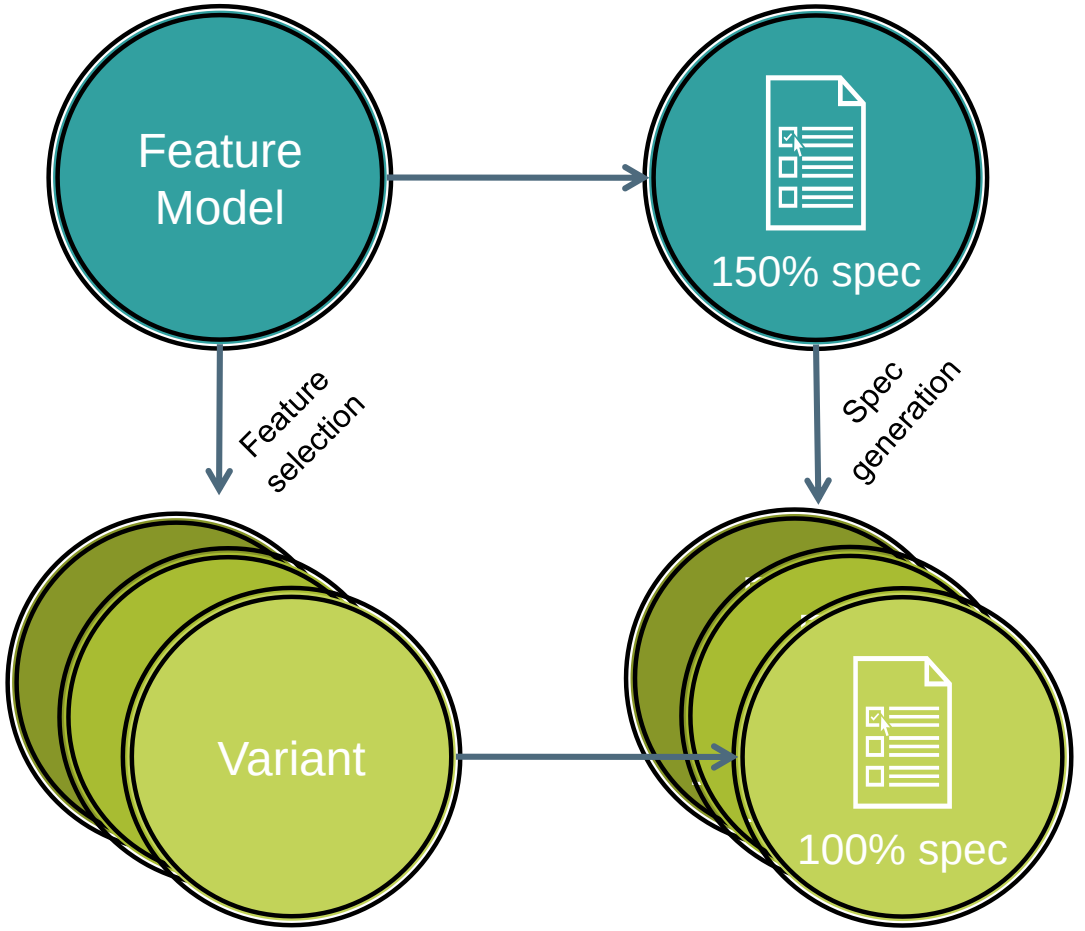

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Collaborate

Ensure traceablity

Effective reuse

Agenda

- Introduction
- Vision Siemens Digital Industries Software (Piet)
- Digitalization of Systems Engineering (Stefan)
- **Requirement Management with Polarion (Marco)**

Q&A

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Thank you.