Accelerating Safe Railway Application Development using Model-Based Design

Daran Smalley
Brakes Subsystem Manager

May 10 2023

ALSTOM
• mobility by nature •

Agenda

01

About us

Leading the way to greener and smarter mobility solutions

We are where mobility is needed

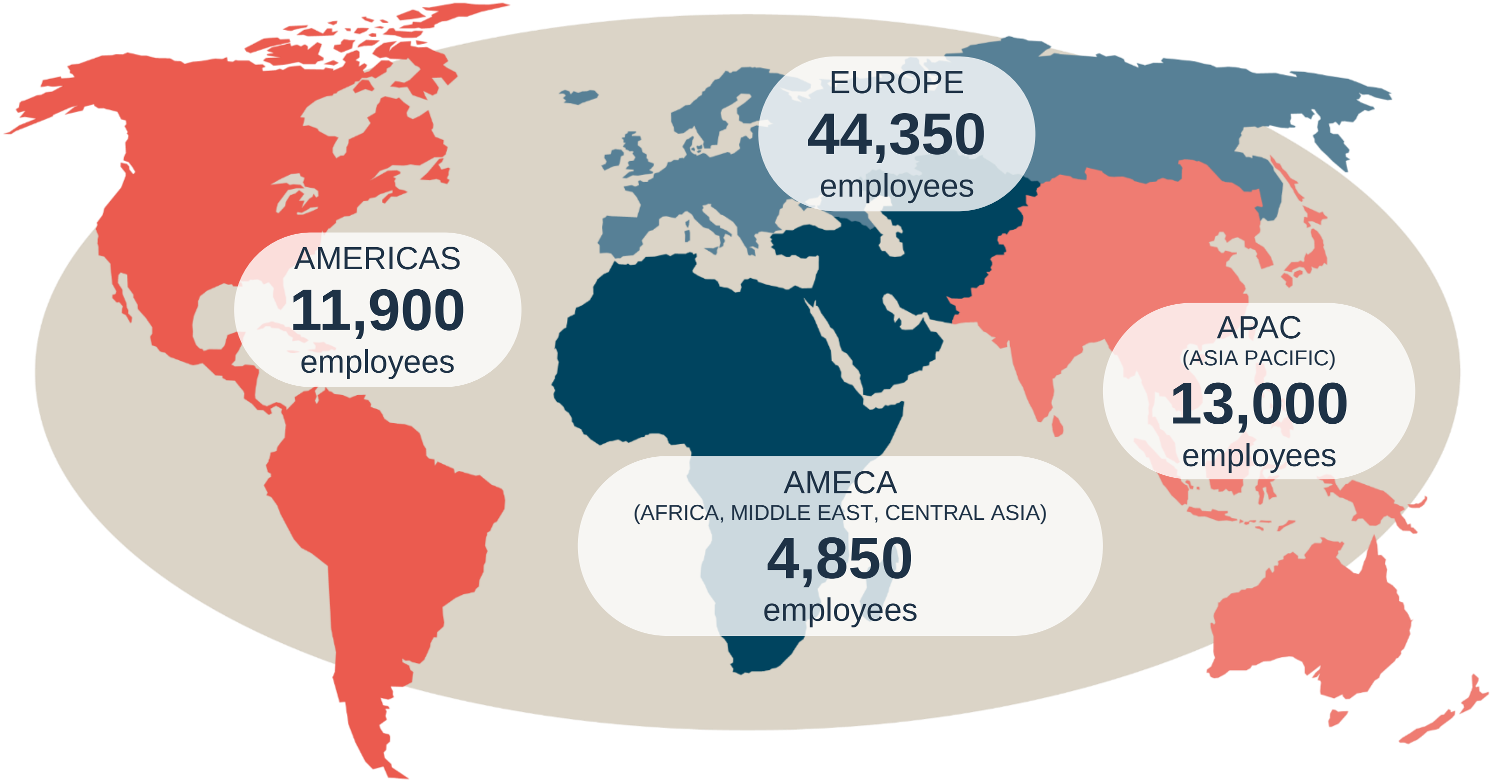
Over
74,000
employees worldwide

From
166
nationalities

70
countries

140 sites

250 depots



19,700
engineers

More than
9,400
patents

Over
150,000
vehicles in commercial service

Partner to over
300
cities

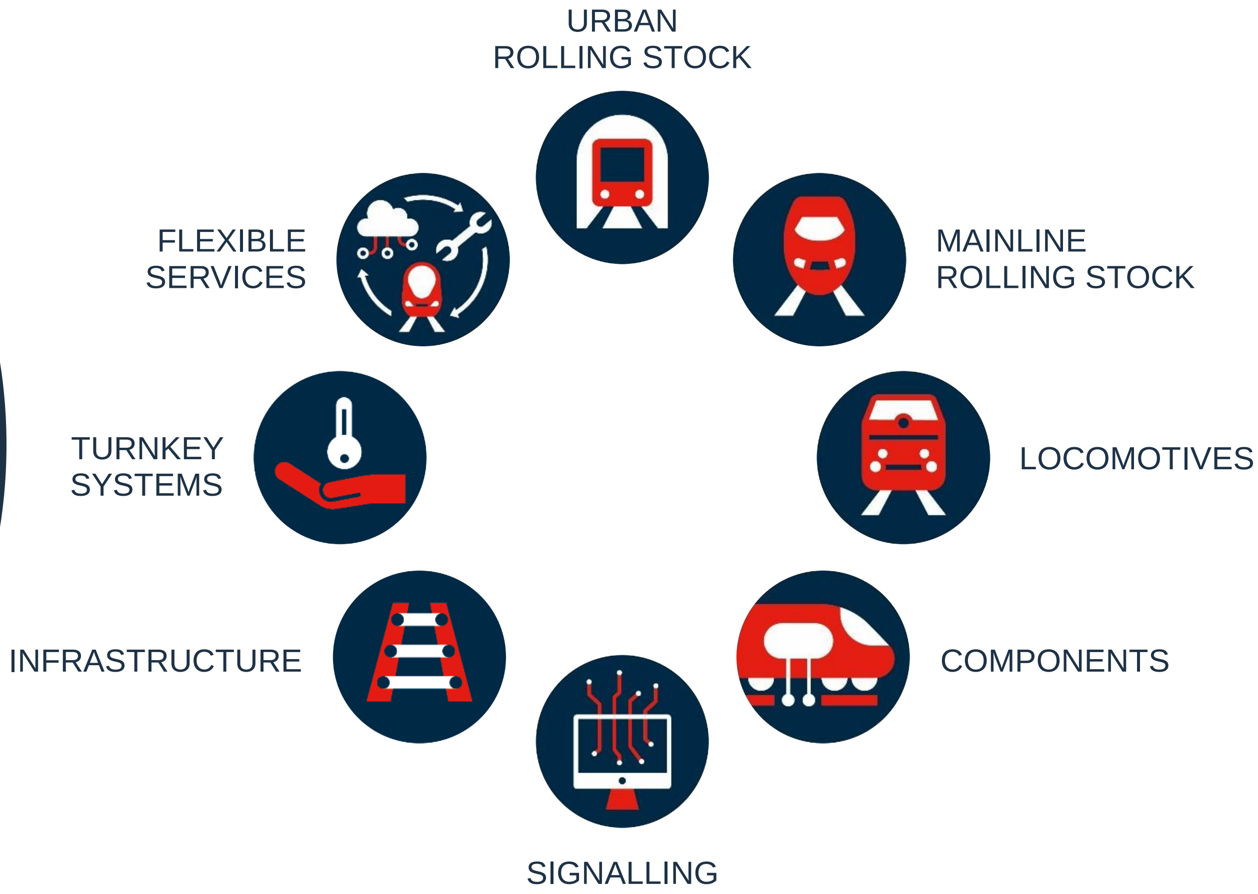
As of 31 March 2022

A global leader in the transportation sector in the digital age

Leading societies to a low carbon future

Alstom develops and markets mobility solutions that provide sustainable foundations for the future of transportation.

Our comprehensive product portfolio ranges from high-speed trains, metros, monorail and trams, to turnkey systems, services, infrastructure, signalling and digital mobility solutions.

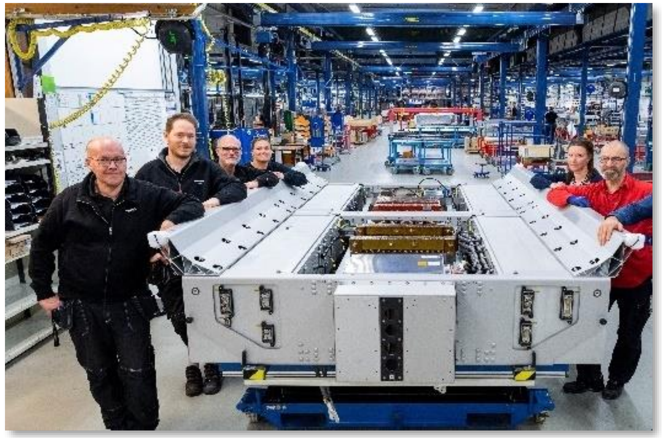


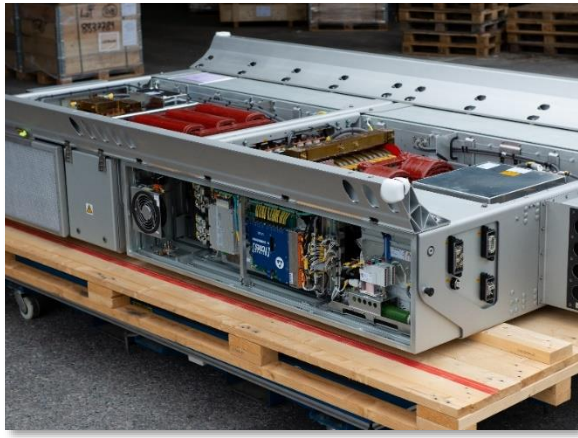
Alstom in Västerås -
Rolling Stock & Components

- One out of three Global Component Development Sites for Traction equipment
- A Global Test and Technology Centre for Powertrain Systems
- Product responsibility for Mitrac control electronics

Site scope:

- Development of Powertrain Systems including converter- and traction-motor design with validation & verification at in-house, large scale, PowerLab
- Traction equipment manufacturing, from prototyping to after market
- Train Control and Communication electronics
- TCMS Applications including Control, I/O and visualization products





About Me

Daran Smalley

Daran.Smalley@alstromgroup.com

Brakes Subsystem Manager

- Mechatronics Engineer from Monash University in Melbourne, Australia. Now enjoying the freezing cold in Sweden.
- 3 years Electrical Engineer at Rio Tinto aluminium smelter.
- Gap Year travelling Europe
- 7 years Control Software Engineer working in Bombardier/Alstom Traction Control for Traction.
  - Software control engineer transforming Traction Control to a Model Based Design development approach
  - Train performance simulations for Bids and Tenders
  - Customer interface verifying and closing requirements

02

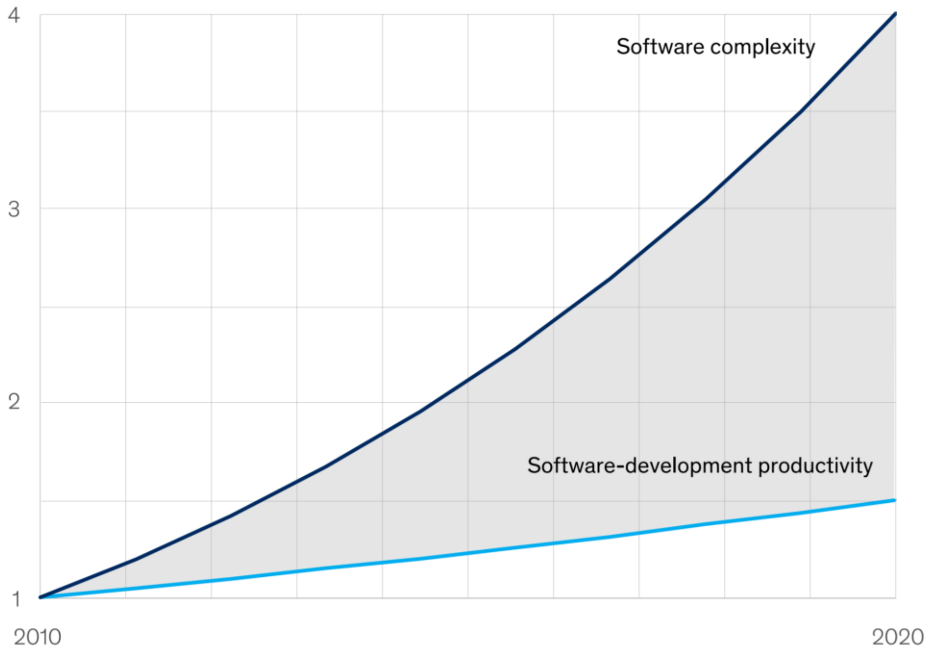
Global Trends

Megatrends affecting the global rail market

Digitalisation / Automation	Emission reduction	Urbanisation	Connectivity
Seamless journey	Globalisation	Environmental awareness	Safety

Source: UNIFE, Roland Berger

Growing system and software complexity



Source: McKinsey & Company

NEWS Home / News

Driverless cars will require one billion lines of code, says JLR

Jaguar Land Rover says autonomous vehicles will need ~~1,000~~ times more computer code than Apollo 11

10,000

by: Tristan Shale-Hester 16 Apr 2019

Source: Auto Express

The changing face of test: testing advanced aerospace systems

Aerospace electronics and avionics continue to advance at a rapid pace, with few signs of slowing. As aerospace systems grow in complexity, engineers face myriad challenges in the test, validation, and verification of these modern devices. This trend is changing the face of test, and accelerating the need for flexible, scalable test solutions.

Author — Courtney E. Howard

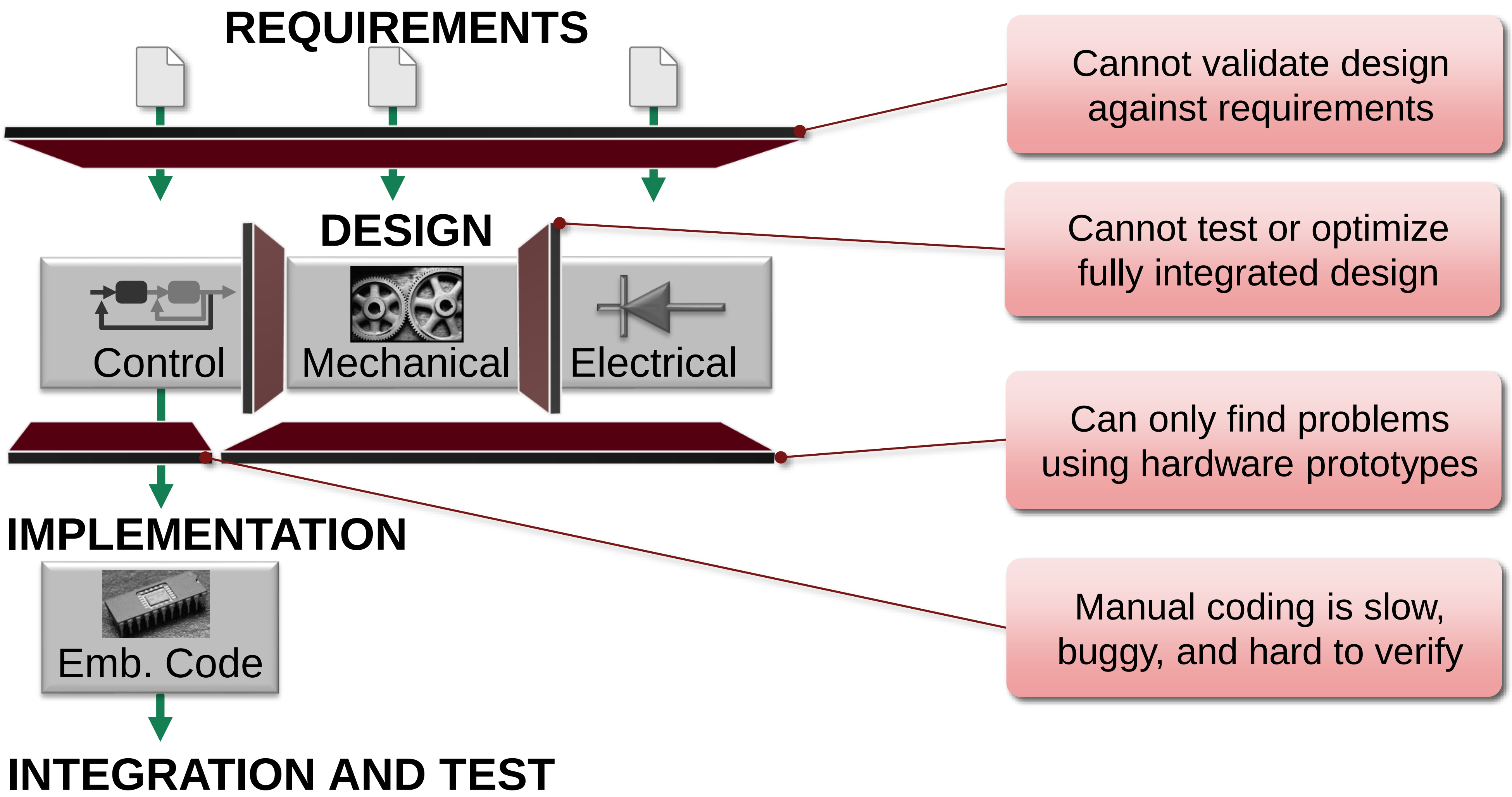
Apr 14th, 2017

Source: Intelligent Aerospace

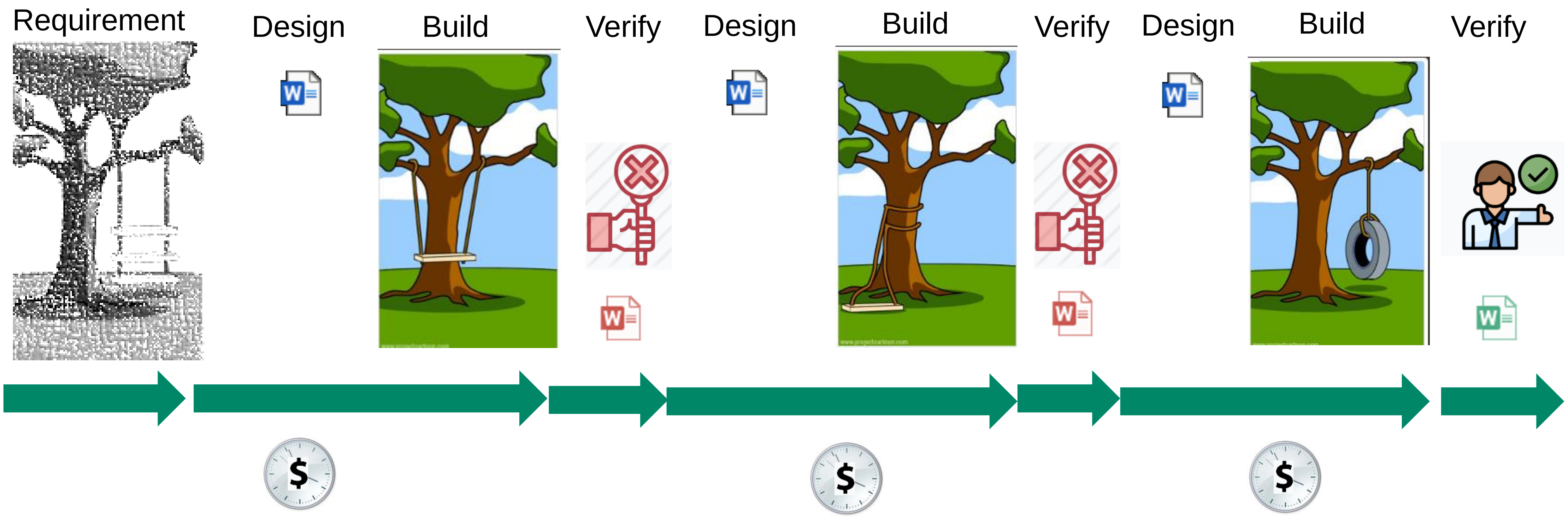
03

Our Traditional workflow

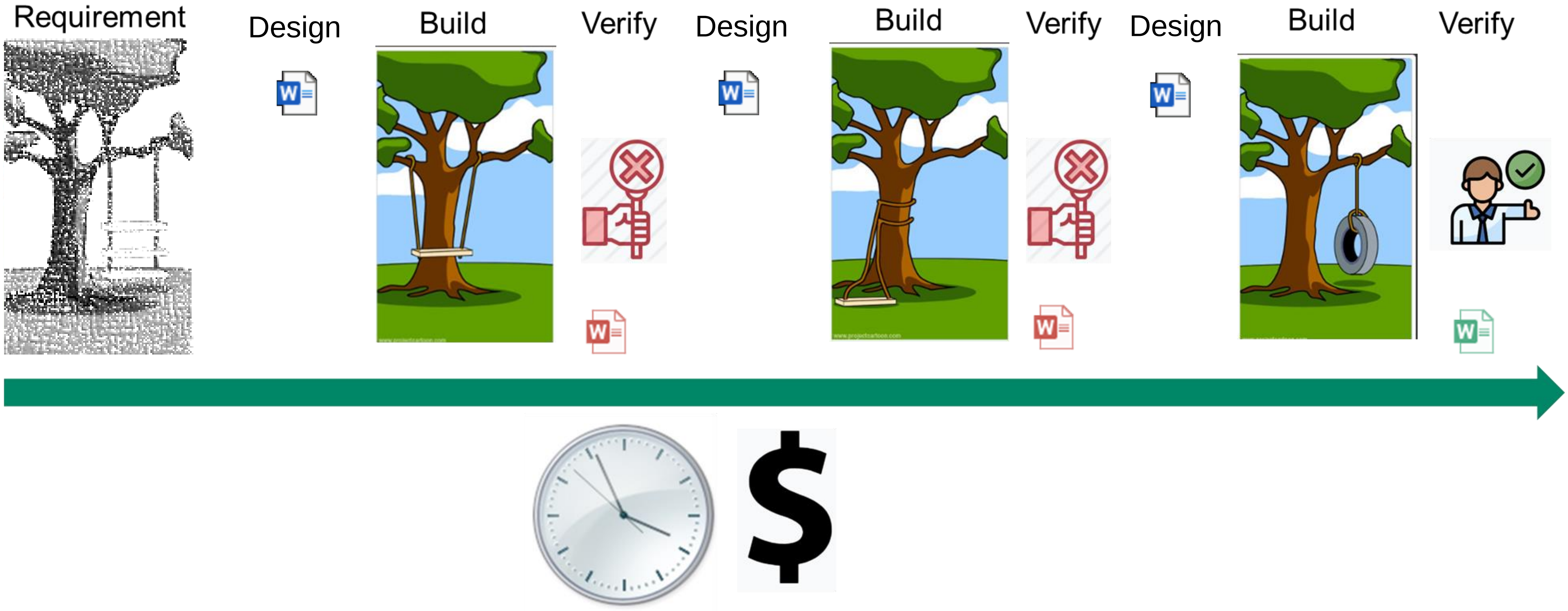
Typical Design Process



Traditional design and verification



How to reduce time and cost with quality?



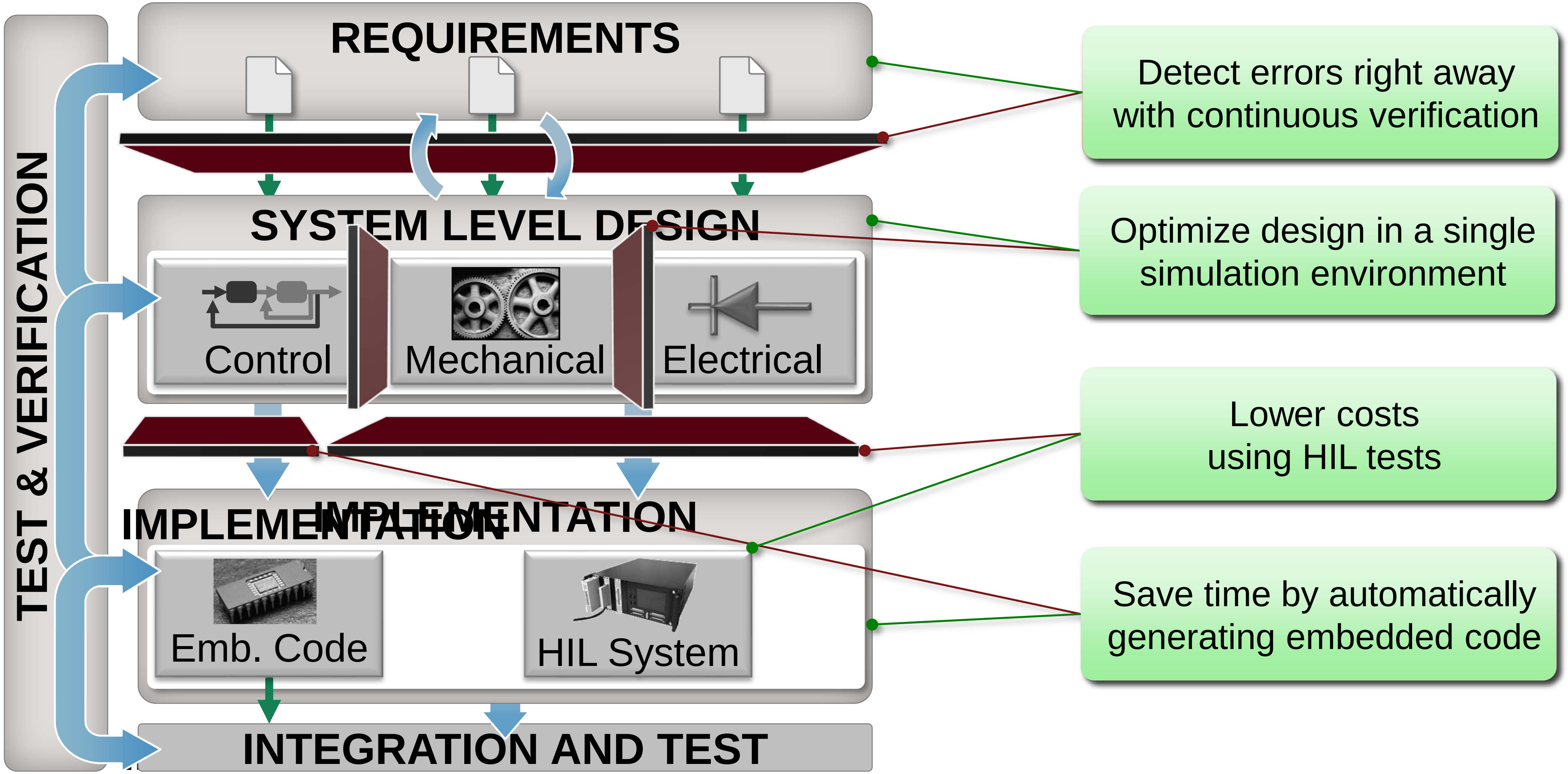
04

Model-Based Design

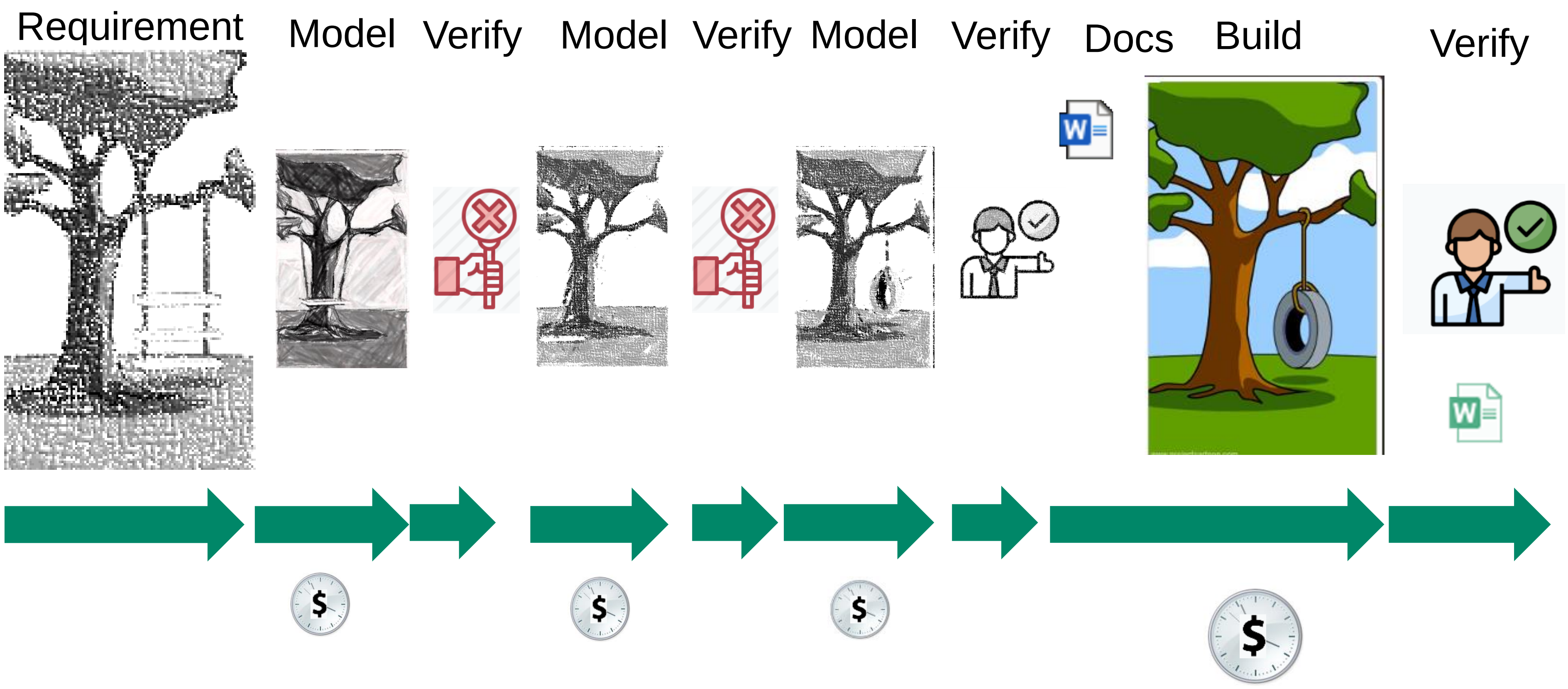
Modelling instead of documenting

Failing Fast

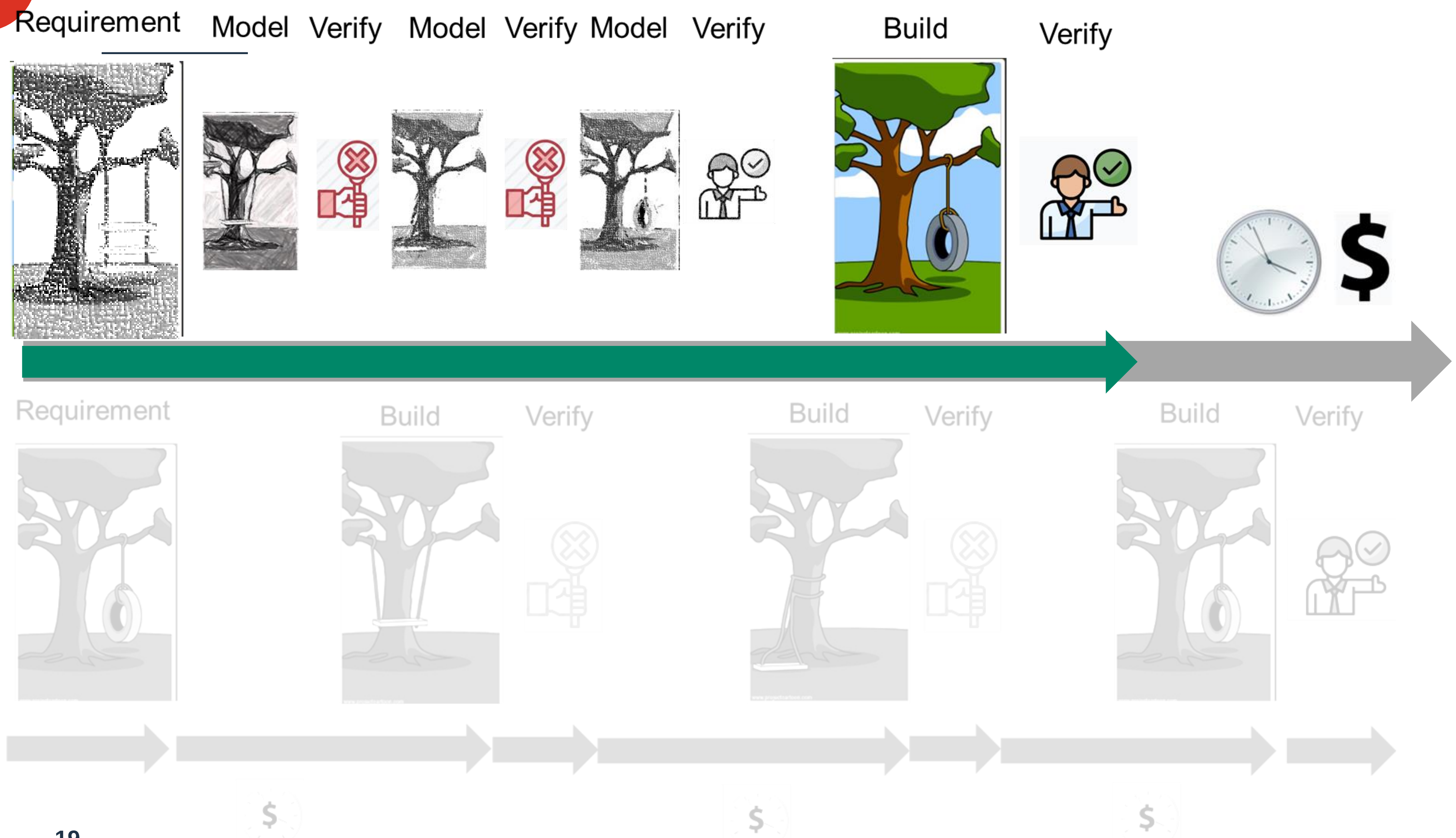
Model-Based Design Benefits



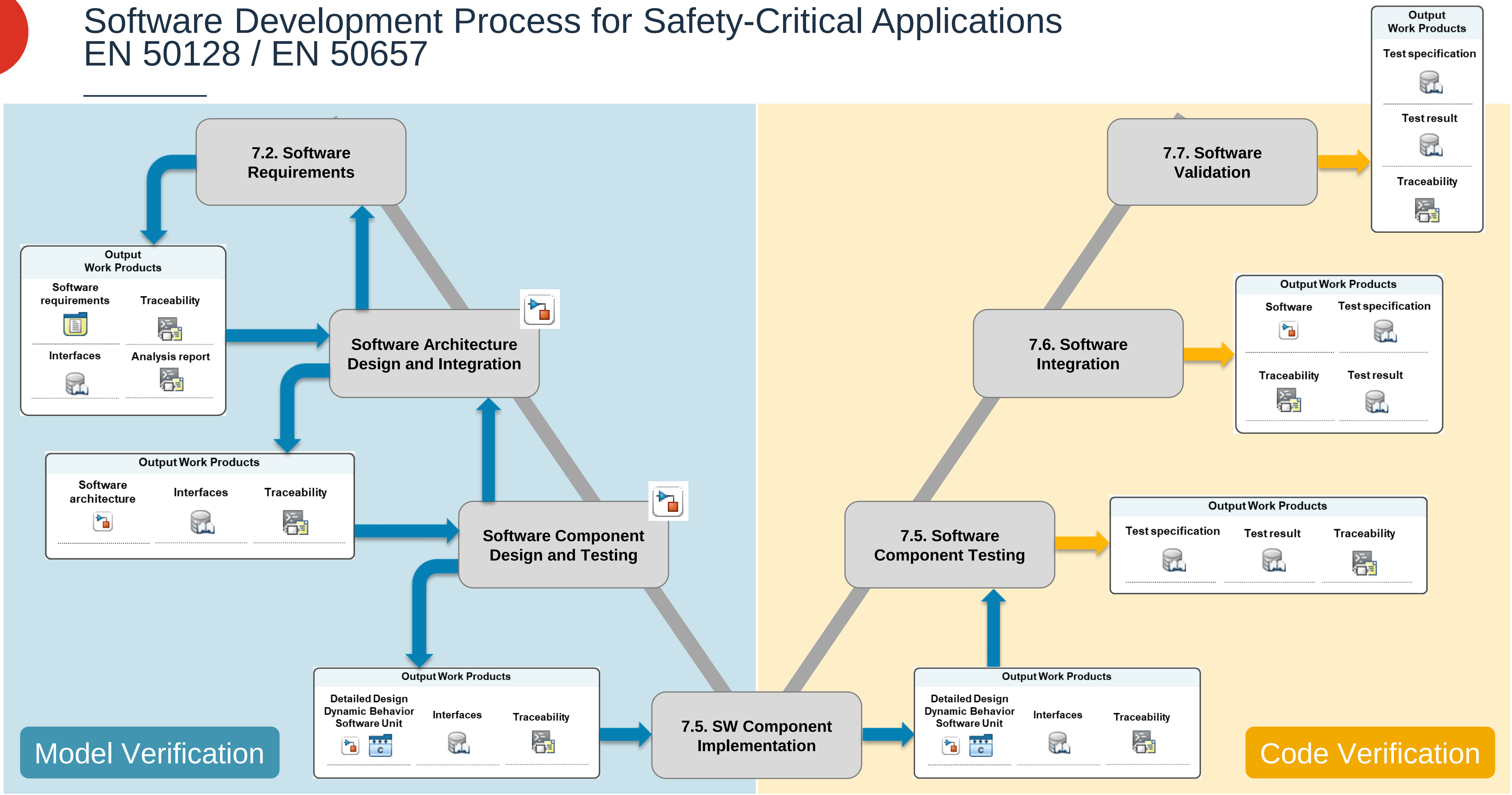
Fail Fast - Detect errors early with Model-Based Design (MBD)



Model-Based Design compared to traditional approach



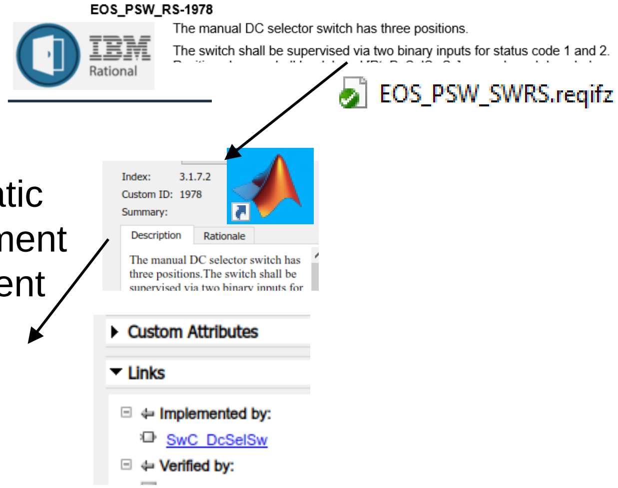
Software Development Process for Safety-Critical Applications EN 50128 / EN 50657

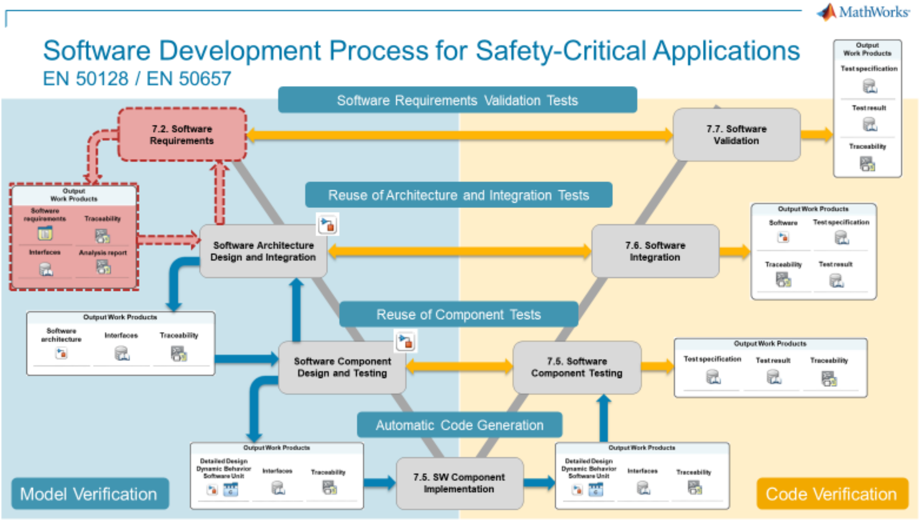


Model-Based Design: Software development

Source Requirements

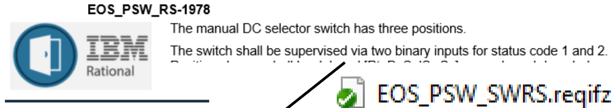
Automatic Requirement Document



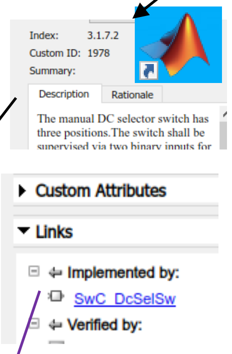


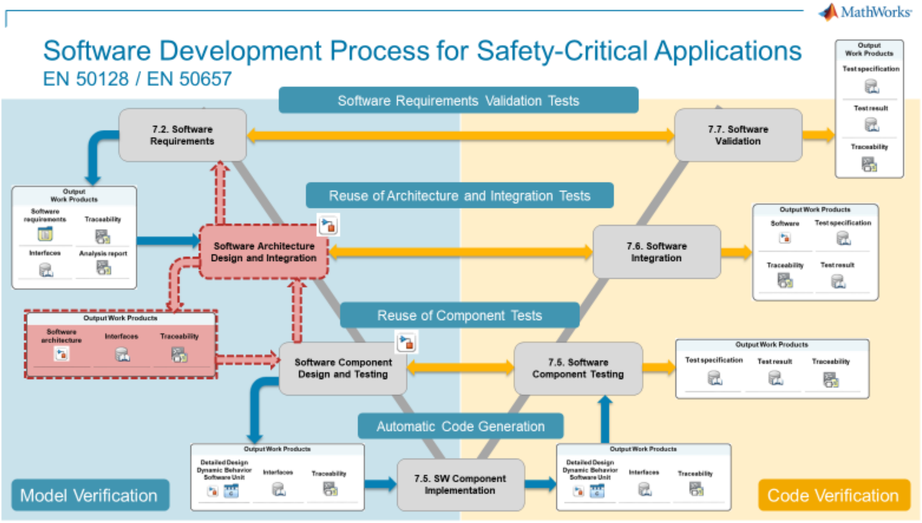
Model-Based Design: Software development

Source Requirements

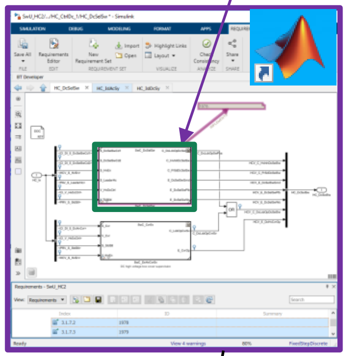


Automatic Requirement Document

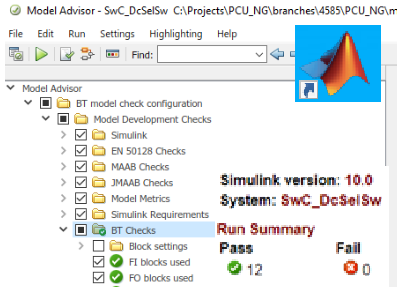




Design Link



Automatic Checks

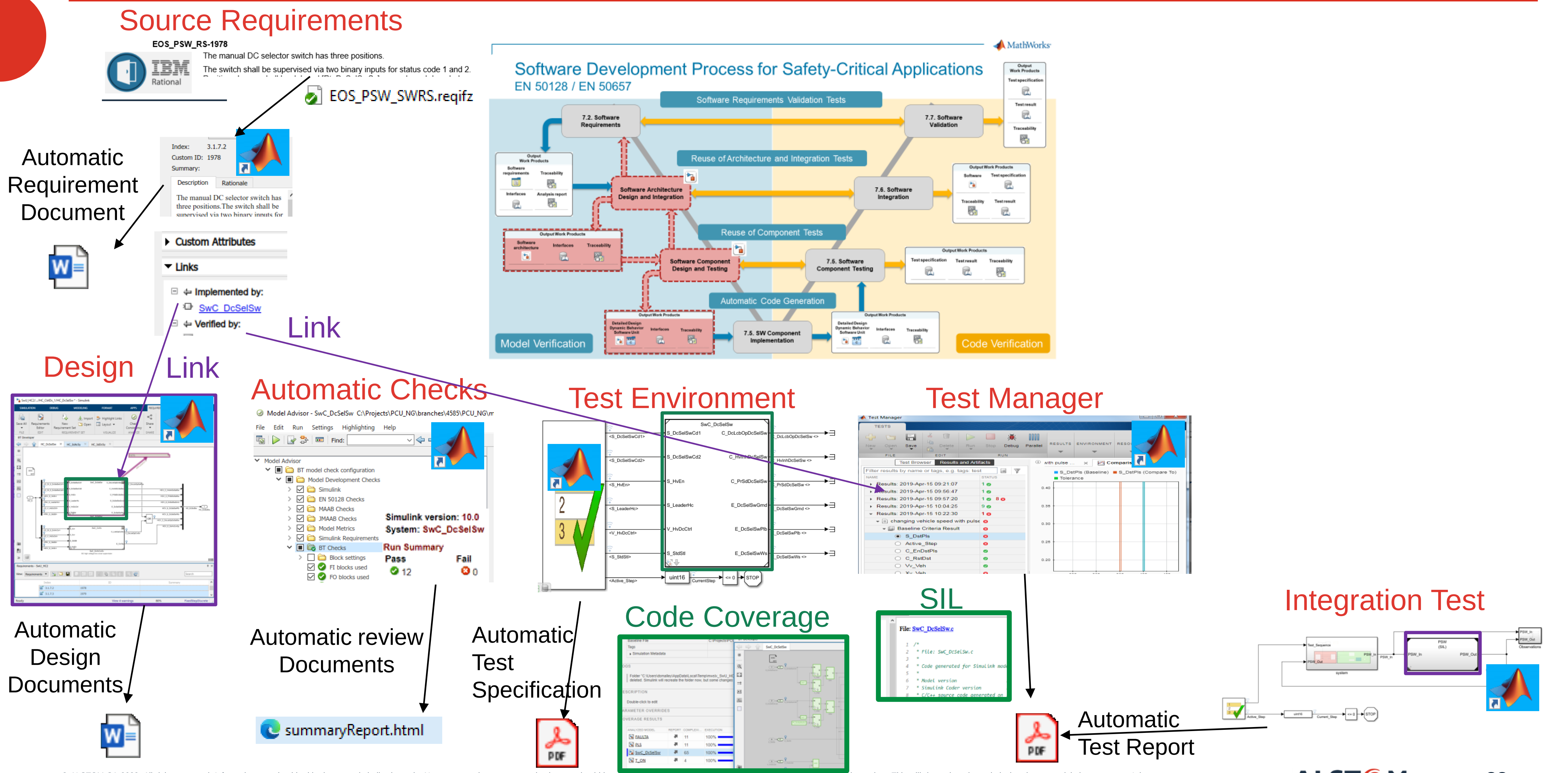


Automatic Design Documents

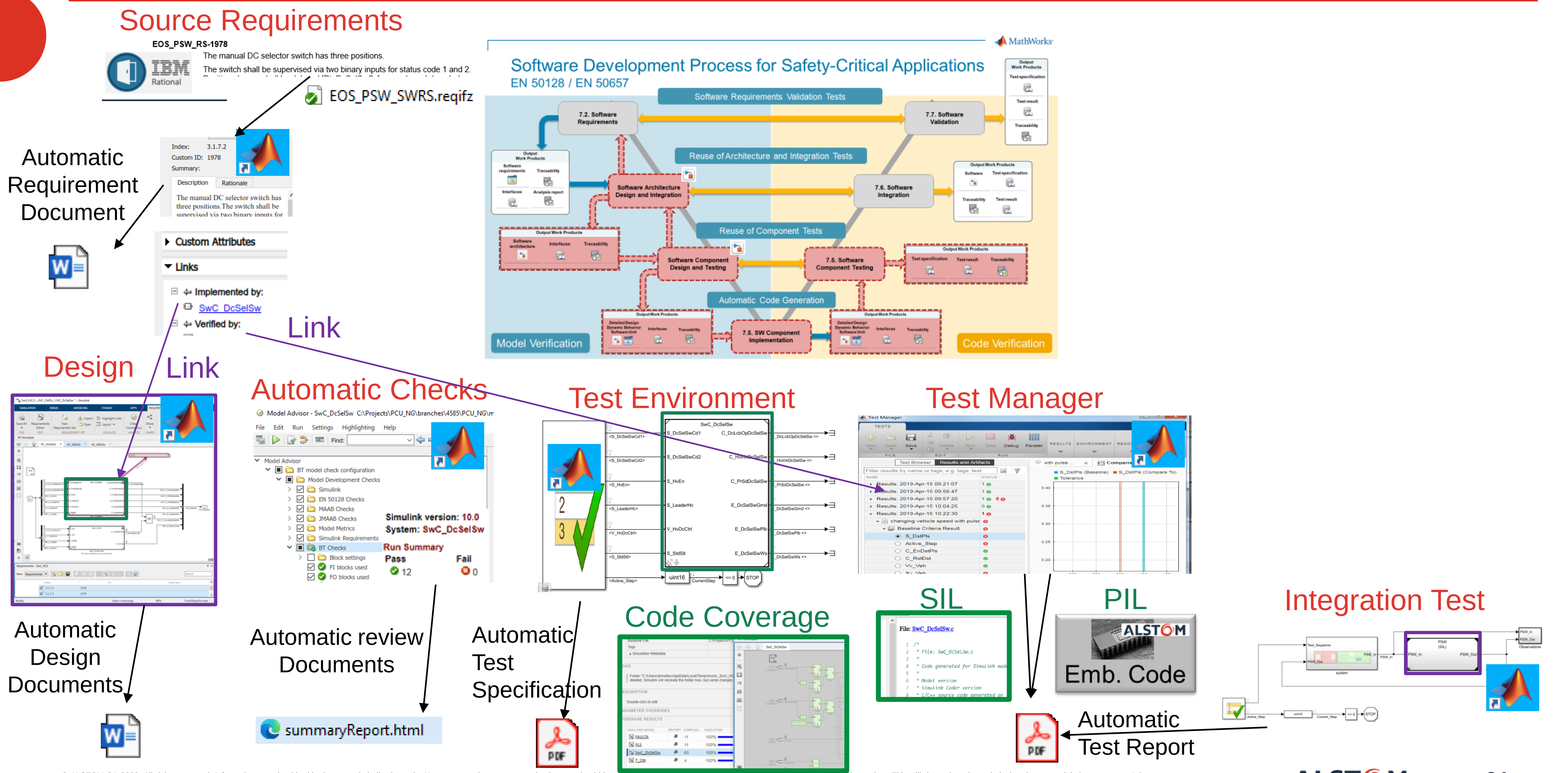
Automatic review Documents

summaryReport.html

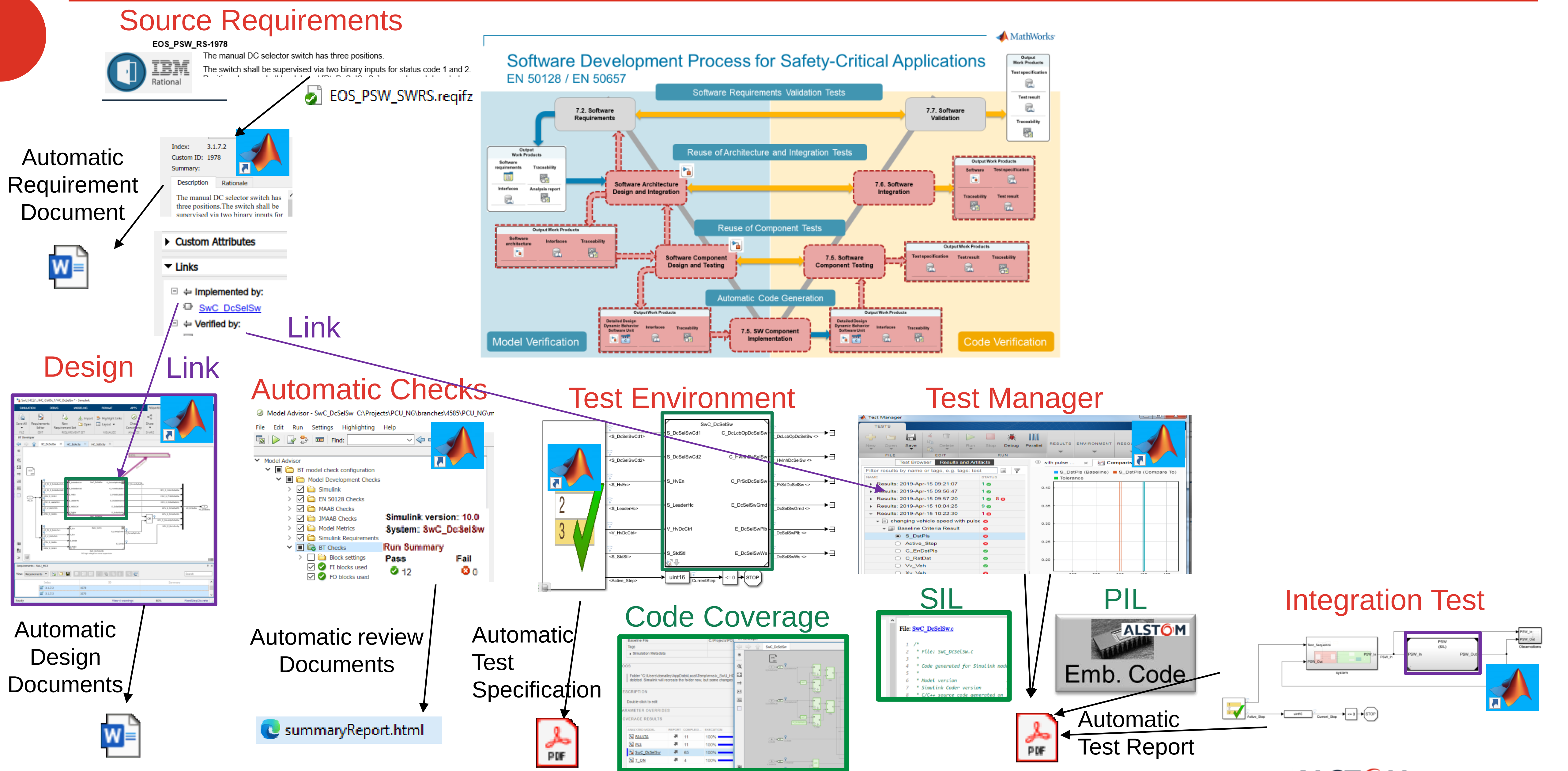
Model-Based Design: Software development



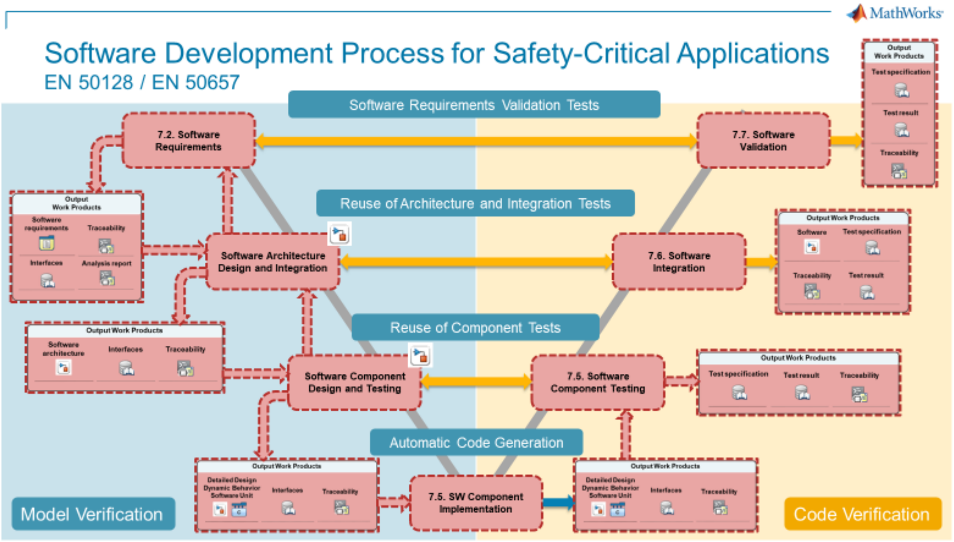
Model-Based Design: Software development



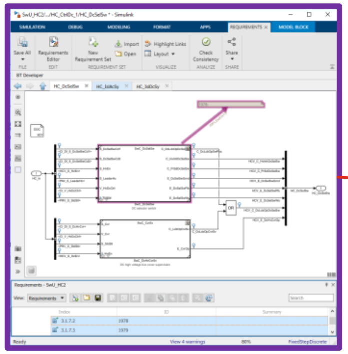
Model-Based Design: Software development



Model Based Design: Deployment

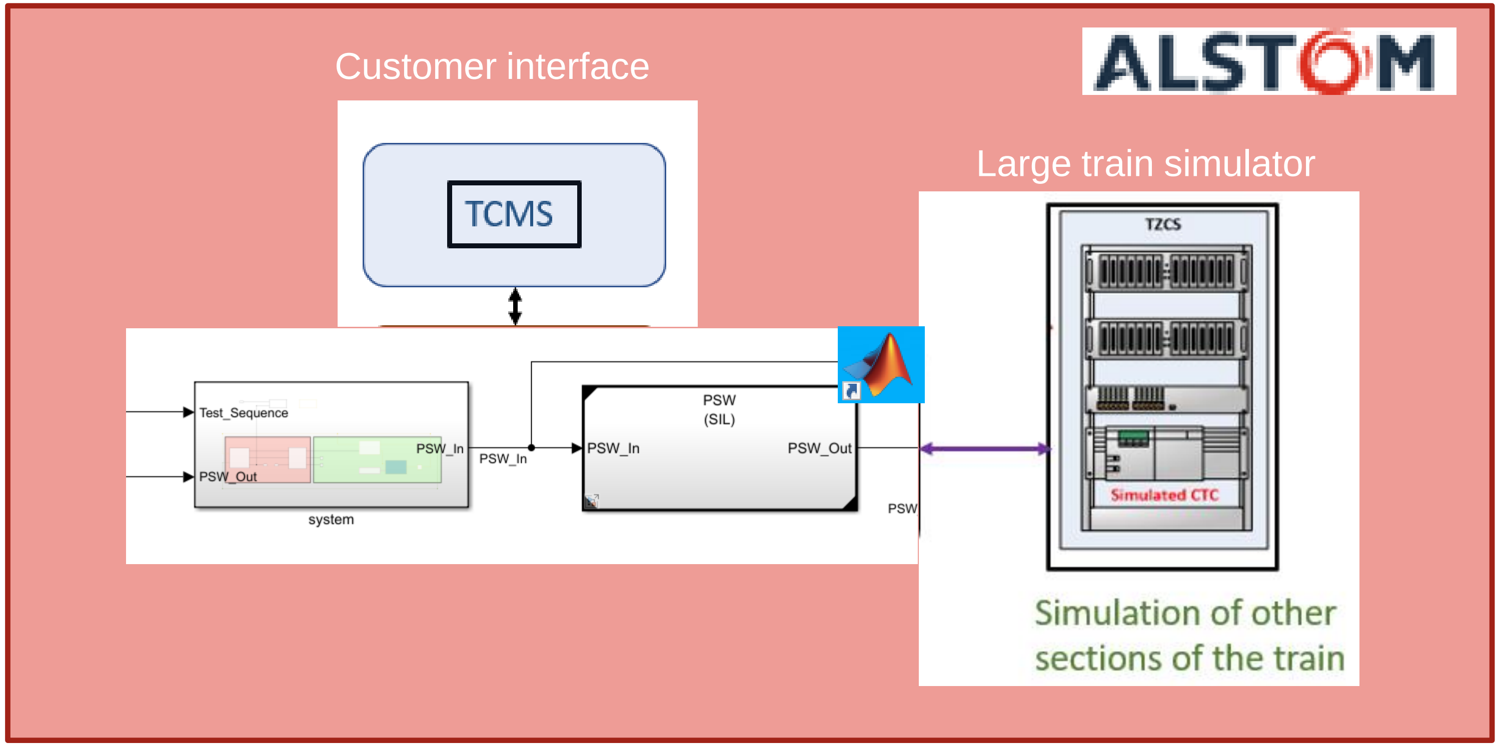


Design



Code Generation +Target Code

Model Based Design: Simulate together - Share models



Timeline – How far we have come

10 Year Journey and more to come

2013 - 2018

- MathWorks Model-Based Design Workflow running on controllers controlling 4MW traction systems
- Traction System functions verified with MBD
- First Software Development Process using MBD
- Targeted First order project
- Training and upskilling Traction Control Department

MathWorks®

MATLAB EXPO 2018 SWEDEN

A Model-Based Design Adoption Story from Bombardier Transportation

15:00–15:30

Bombardier Transportation, Rolling Stock Equipment delivers world-class propulsion systems for trains. The propulsion system's main functionality is to convert electrical power to tractive effort to make the train move. The control system consists of multiple different sub-parts that together control various parts of a joint electrical circuit. With new development and applications including major customization needs, there is a consistent challenge to deliver on time with maintained quality. The propulsion system and control teams at Bombardier Transportation in Västerås decided to adopt Model-Based Design to address these challenges.

The goal of this presentation is to share the experience of transforming from virtually no use of Model-Based Design to where we are today. The presentation outlines the vital steps of our adoption story, including the need for changes, problem statements, use cases, commercial aspects, challenges, and the business case.

Erik Simonson, Bombardier

2019
- **MATLAB 2019b**
- **4 order project using MBD**
- **train simulators using Traction System models from Simulink**
- Train global control departments on MBD

2020
- Evaluate MathWorks **System Composer & Design Verifier**.
- 3 Train simulators using traction MBD models

2021
- Alstom Purchase Bombardier
- 1st Safety Certificate for safe MBD software process

2022
- **MATLAB 2022b**
- Jenkins Servers using Simulink projects
- Simulink products for all Alstom
- Alstom global review best practices

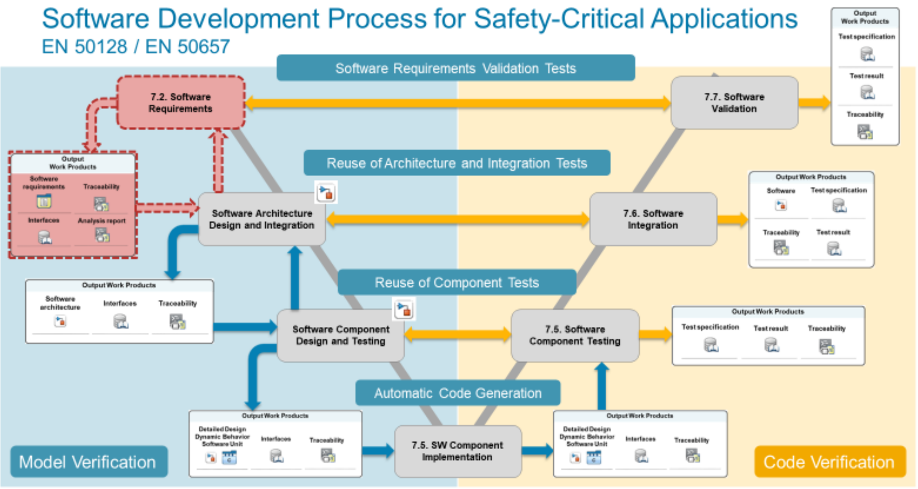
2023
- New department utilises latest MathWorks workflows and experience from traction.

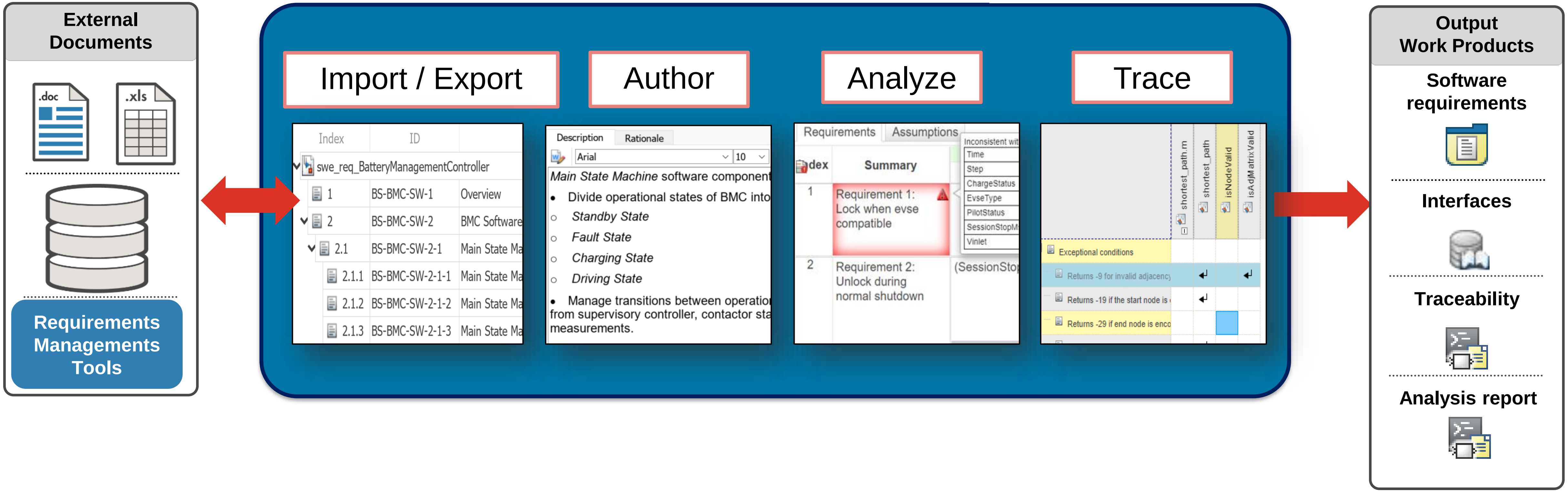
ALSTOM

05

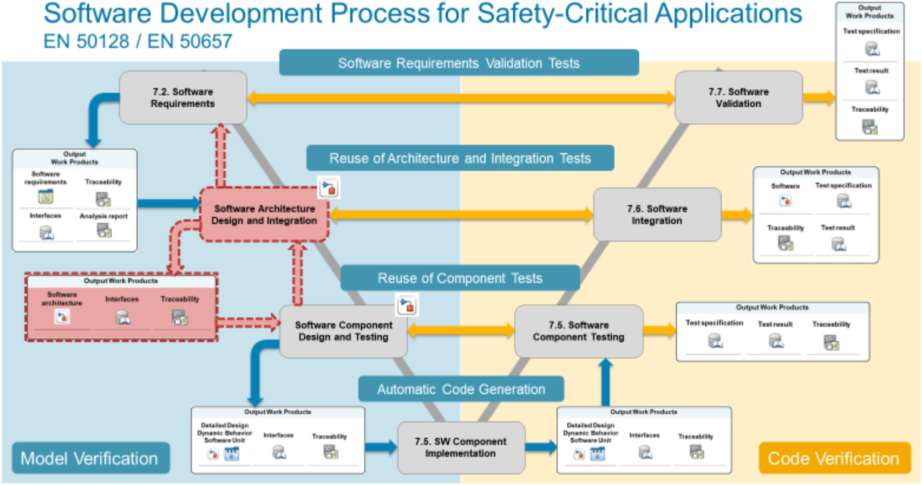
Future Model-Based Design
Even Earlier modelling
Failing Faster

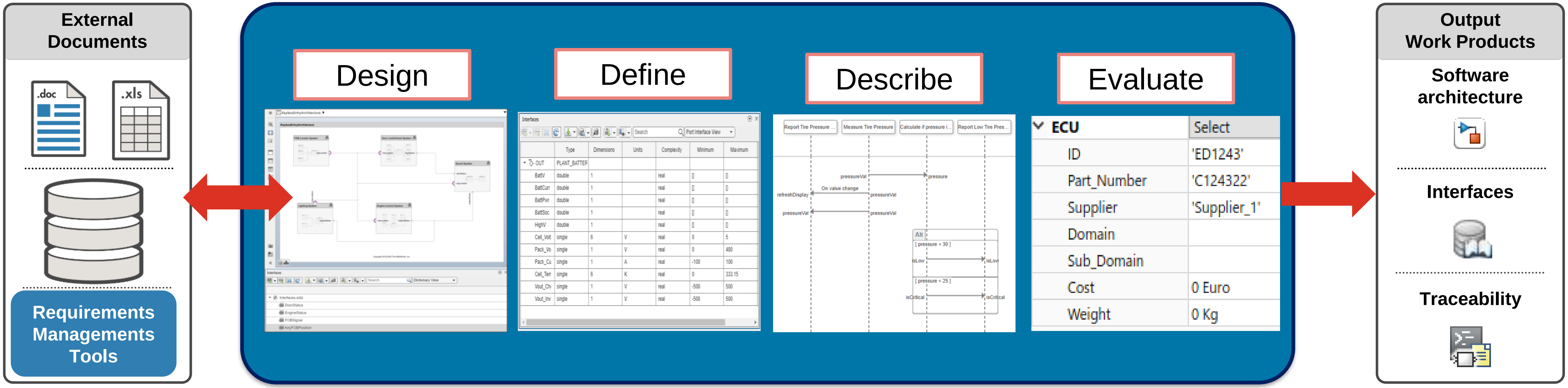
Software Requirements Analysis



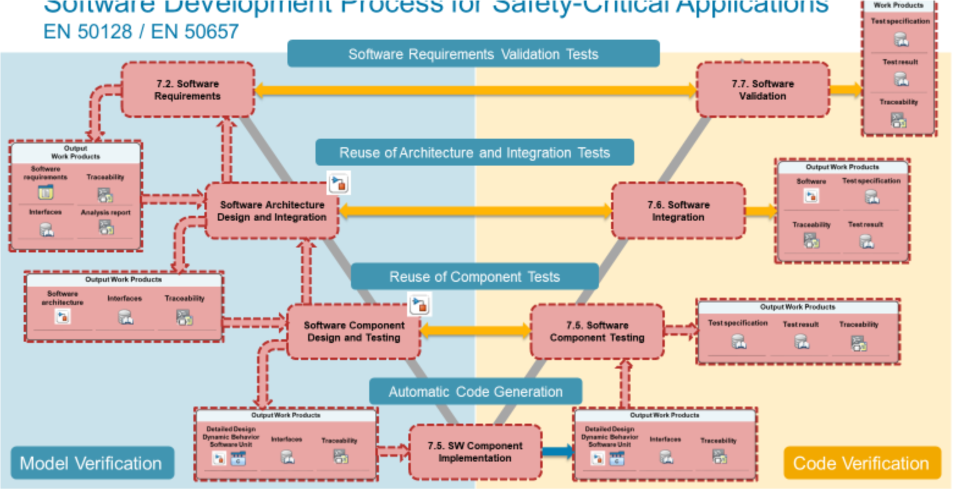


Software Architecture Design

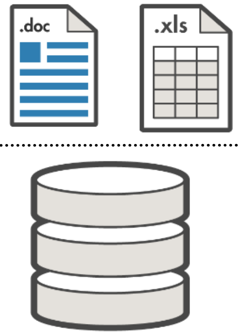




7.7 Software Validation



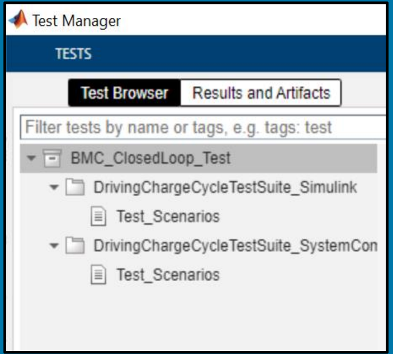
External Documents



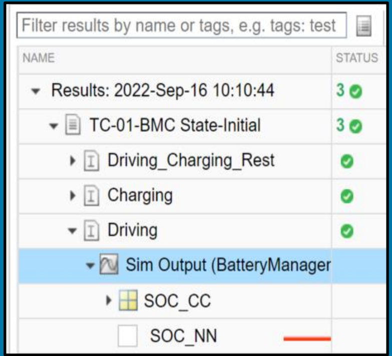
Requirements Managements Tools

Specify

Select



Test



Output Work Products

Test specification

Test result

Traceability

Thank You
Welcome

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