

MATLAB EXPO

JAPAN

Model-Based Design for Digital Engineering: Impact and Directions

Dominic Viens





Application Trends



Autonomous



Connectivity



Electrification

Application Trends



Autonomous

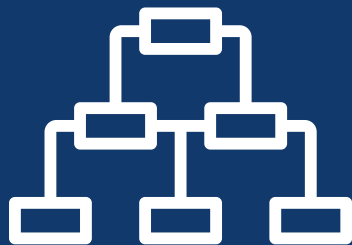


Connectivity



Electrification

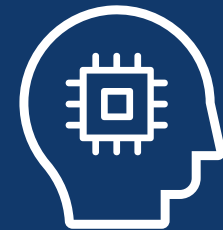
Workflow Trends



**Systems Engineering
& Design**



**Modern
Software Practices**



**AI for
System Development**

Application Trends



Autonomous

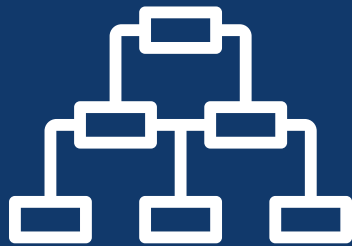


Connectivity



Electrification

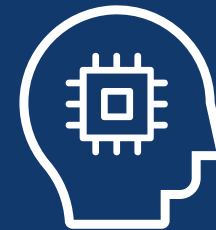
Workflow Trends



Systems Engineering
& Design



Modern
Software Practices



AI for
System Development

Workflow Trends



1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early

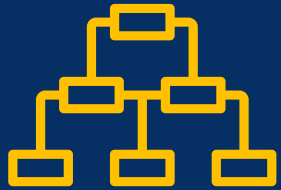


5. Apply standard software workflows
6. Design and simulate in the cloud



7. Design your system with AI

Workflow Trends



1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early



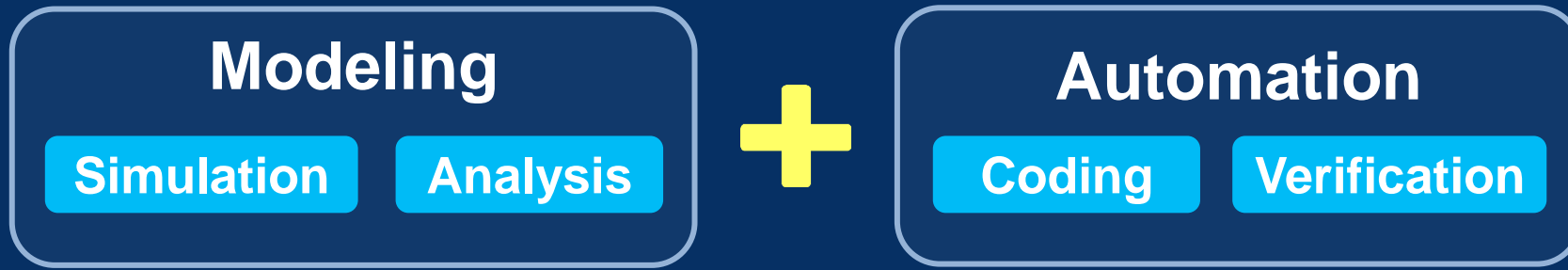
5. Apply standard software workflows
6. Design and simulate in the cloud



7. Design your system with AI



① Automate everything





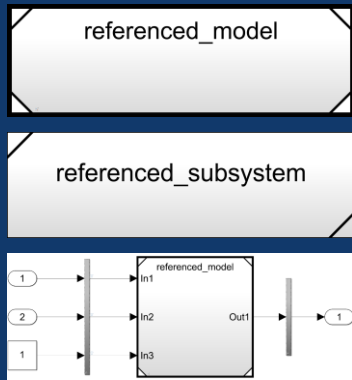
1 Automate everything



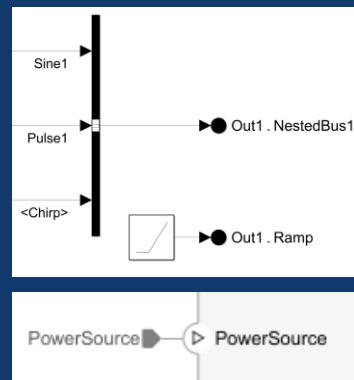
ling + Automation
From the simulation of multi-physics to the generation of industrial codes
Analysis Coding Verification
Rémi Fayolle and Anthony Michel, Symbio



2 Scale to complex systems



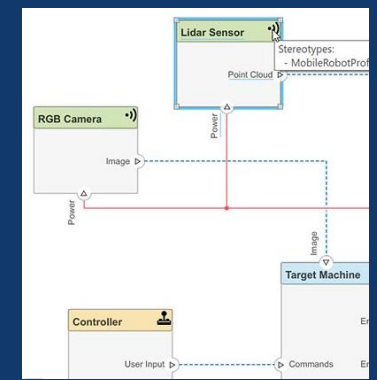
Components



Buses, Ports, and Connectors

Variant Manager

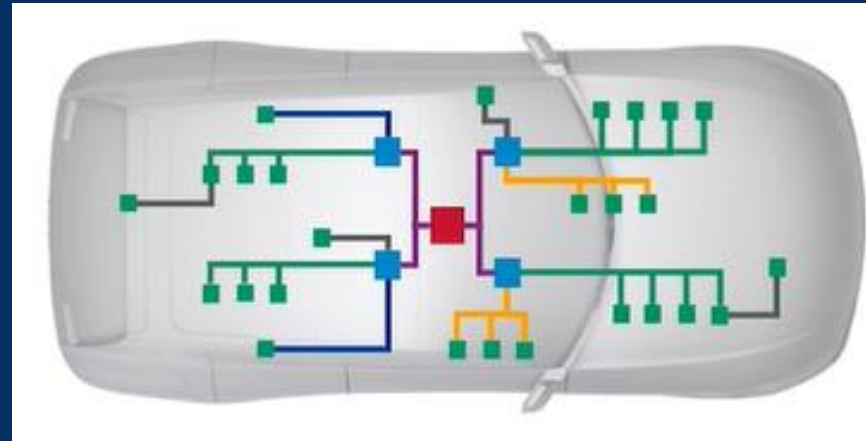
Third-Party Tool Integration



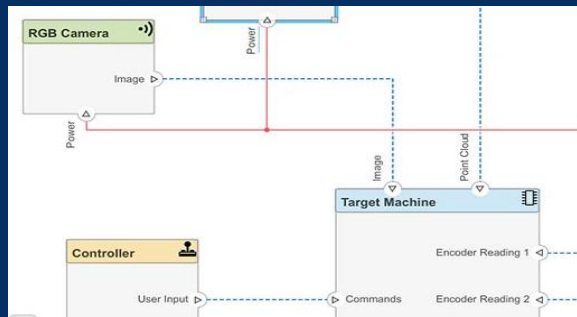
Architecture



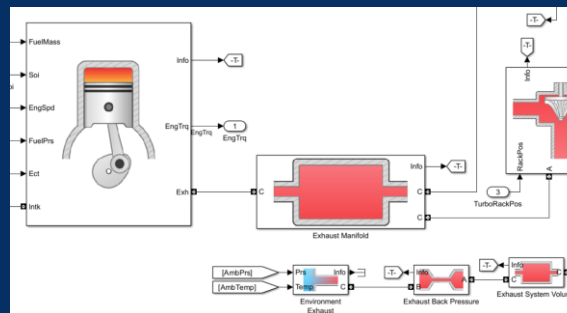
2 Scale to complex systems



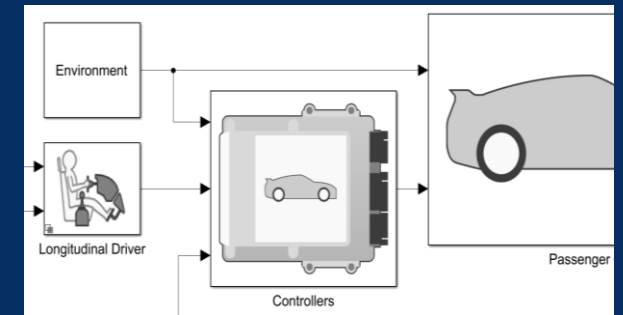
Service-Oriented Architecture



System Composer



Components



Full System



③ Use automatic code generation

3700

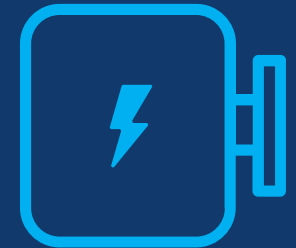
Organizations use
automatic code generation



CPU



GPU

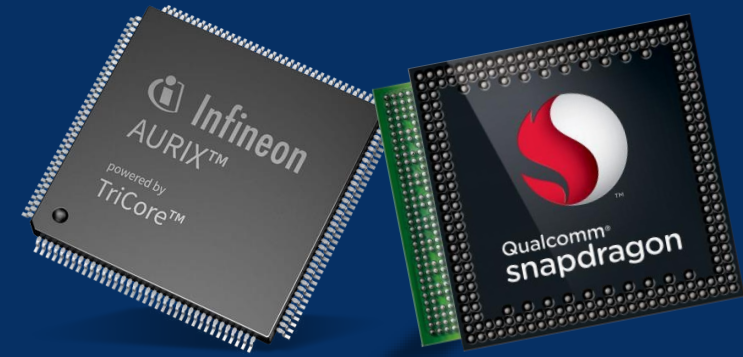
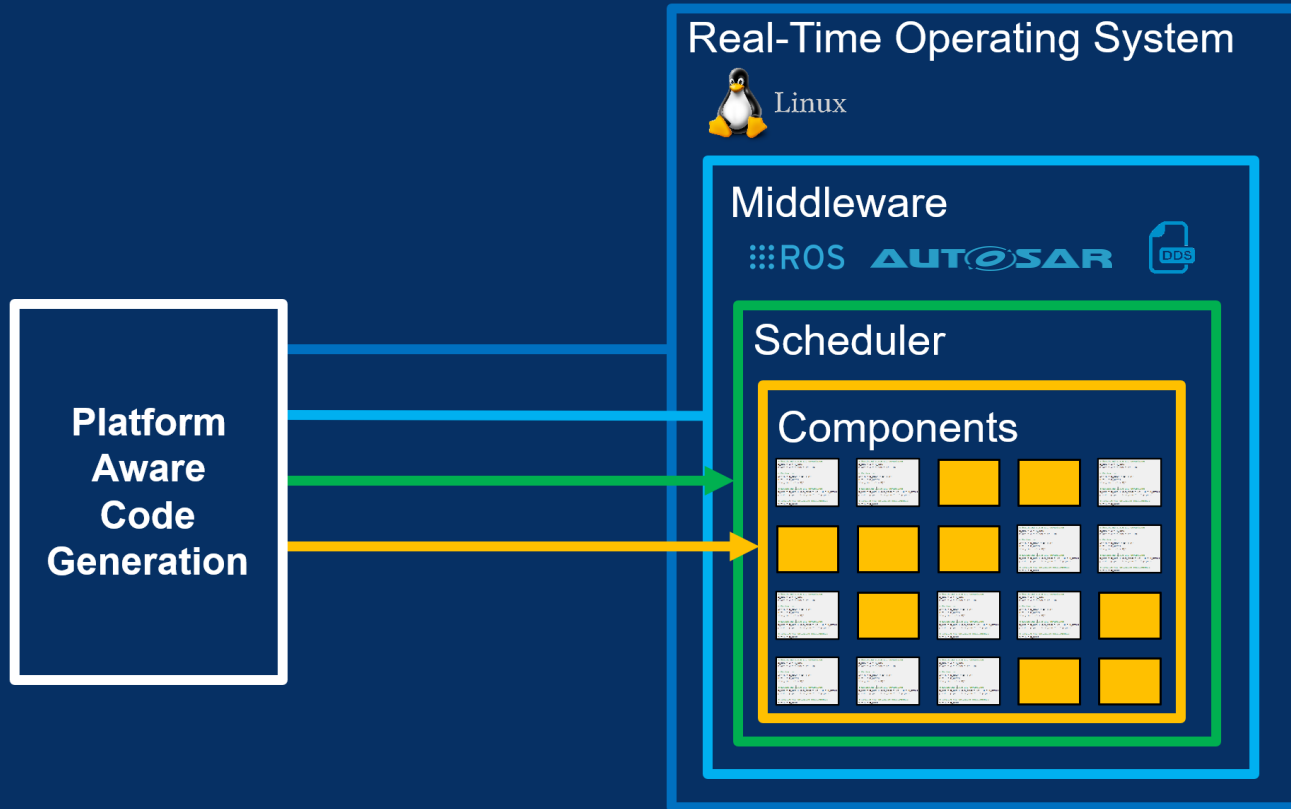


FPGA, ASIC, PLC





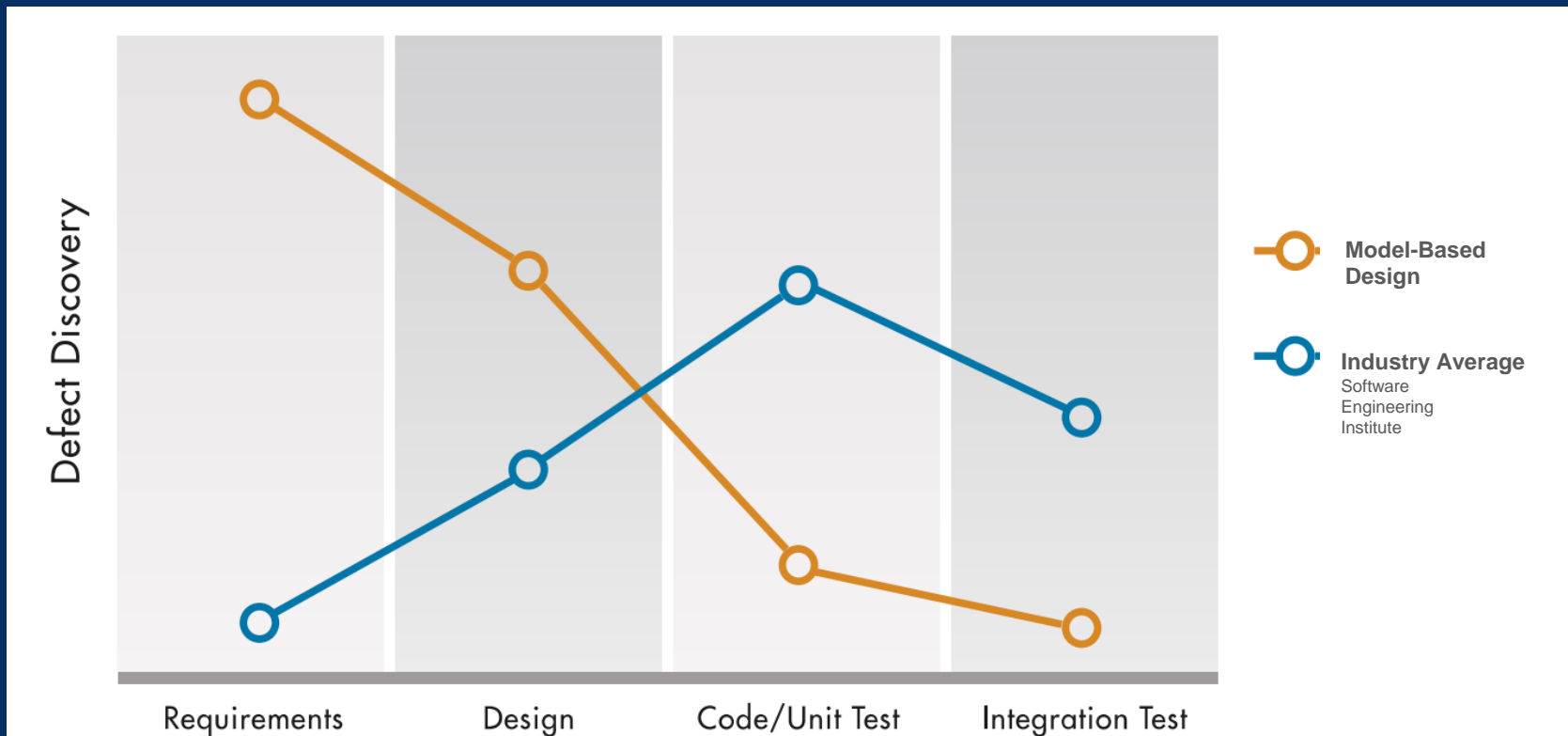
3 Use automatic code generation



The screenshot shows the Infineon website's "Market News" section. The article title is "MathWorks Simulink products now support Infineon's latest AURIX™ TC4x family of automotive microcontrollers". The page includes a search bar, navigation links like "Products", "Applications", and "Design Support", and a breadcrumb trail: "Home > About Infineon > Press > Market News > MathWorks Simulink products now support Infineon's latest AURIX™ TC4x family of automotive microcontrollers".

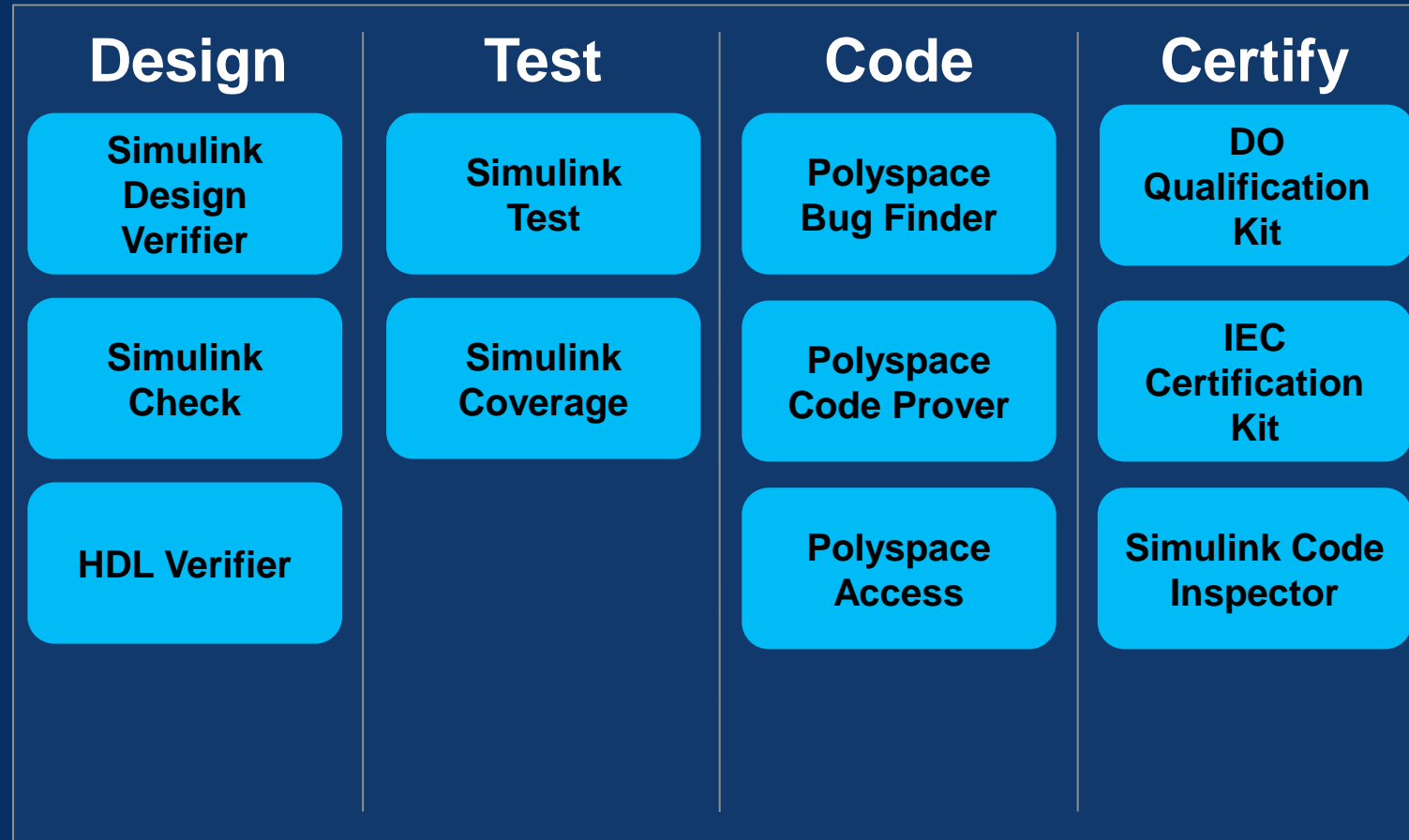


4 Prevent defects early





4 Prevent defects early





④ Prevent defects early

← Find Defects Sooner

Design	Test	Code	Certify
Simulink Design Verifier	Simulink Test	Polyspace Bug Finder	DO Qualification Kit
Simulink Check	Simulink Coverage	Polyspace Code Prover	IEC Certification Kit
HDL Verifier	R2023a MATLAB Test	Polyspace Access	Simulink Code Inspector
R2023b Simulink Fault Analyzer	R2023b Polyspace Test		

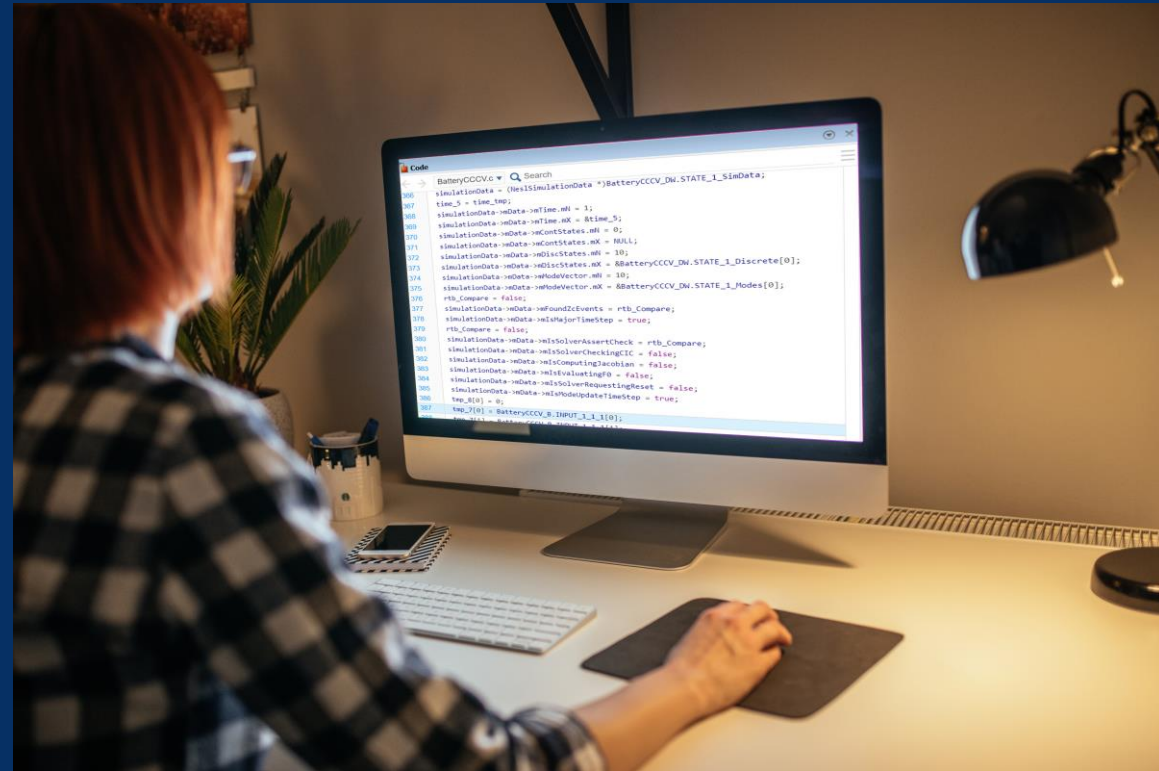


SAFT

UL Certification of Battery Management System Software with Model-Based Design



The Saft Flex'ion Gen2



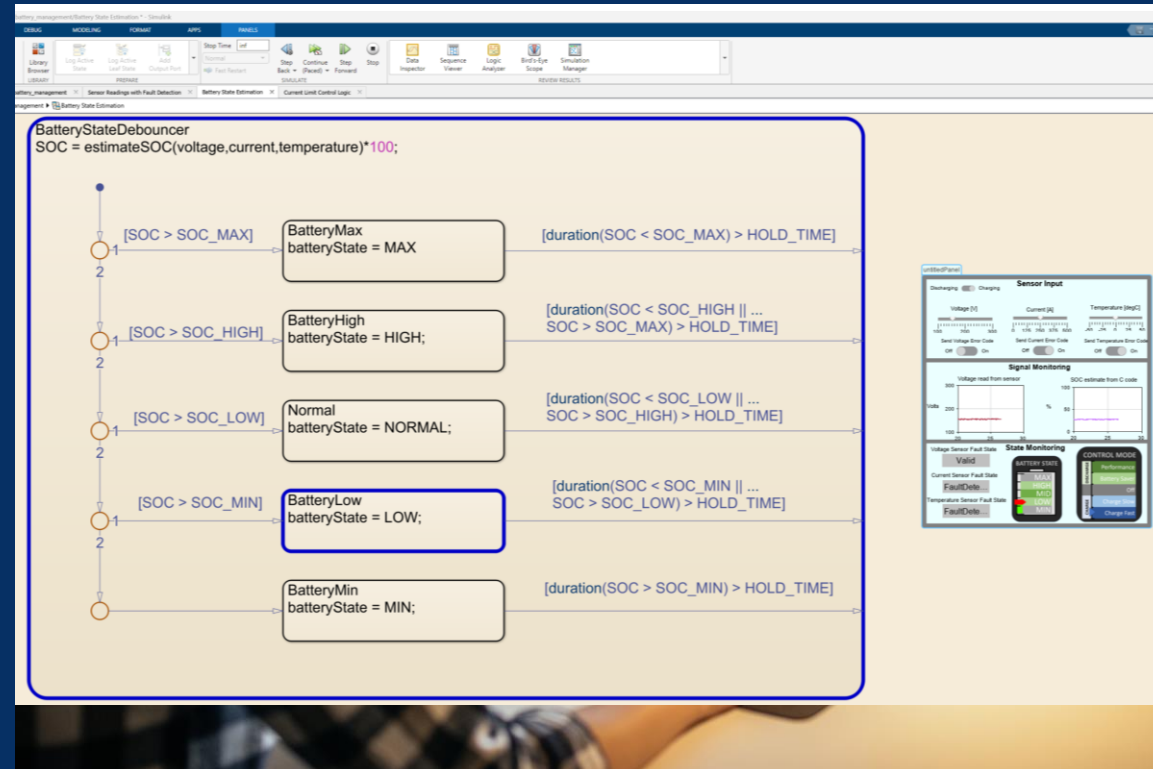


SAFT

UL Certification of Battery Management System Software with Model-Based Design



The Saft Flex'ion Gen2





SAFT

UL Certification of Battery Management System Software with Model-Based Design



The Saft Flex'ion Gen2



Application Trends



Autonomous

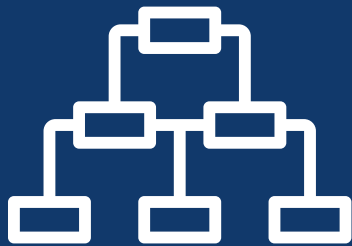


Connectivity



Electrification

Workflow Trends



Systems Engineering
& Design

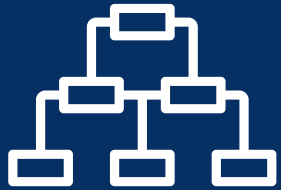


Modern
Software Practices



AI for
System Development

Workflow Trends



1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early



5. Apply standard software workflows
6. Design and simulate in the cloud



7. Design your system with AI



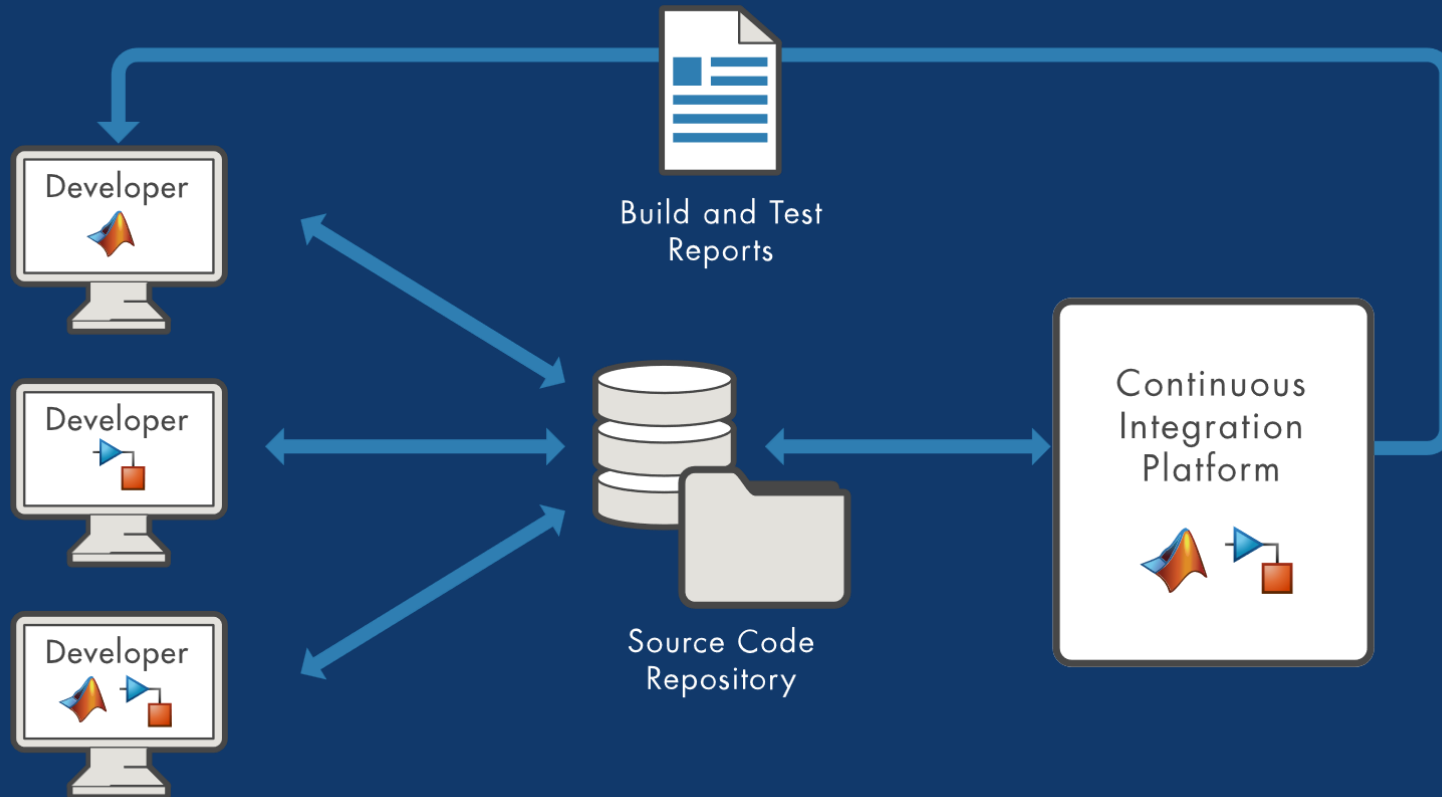
⑤ Apply standard software workflows



“Software is the language of automation.”

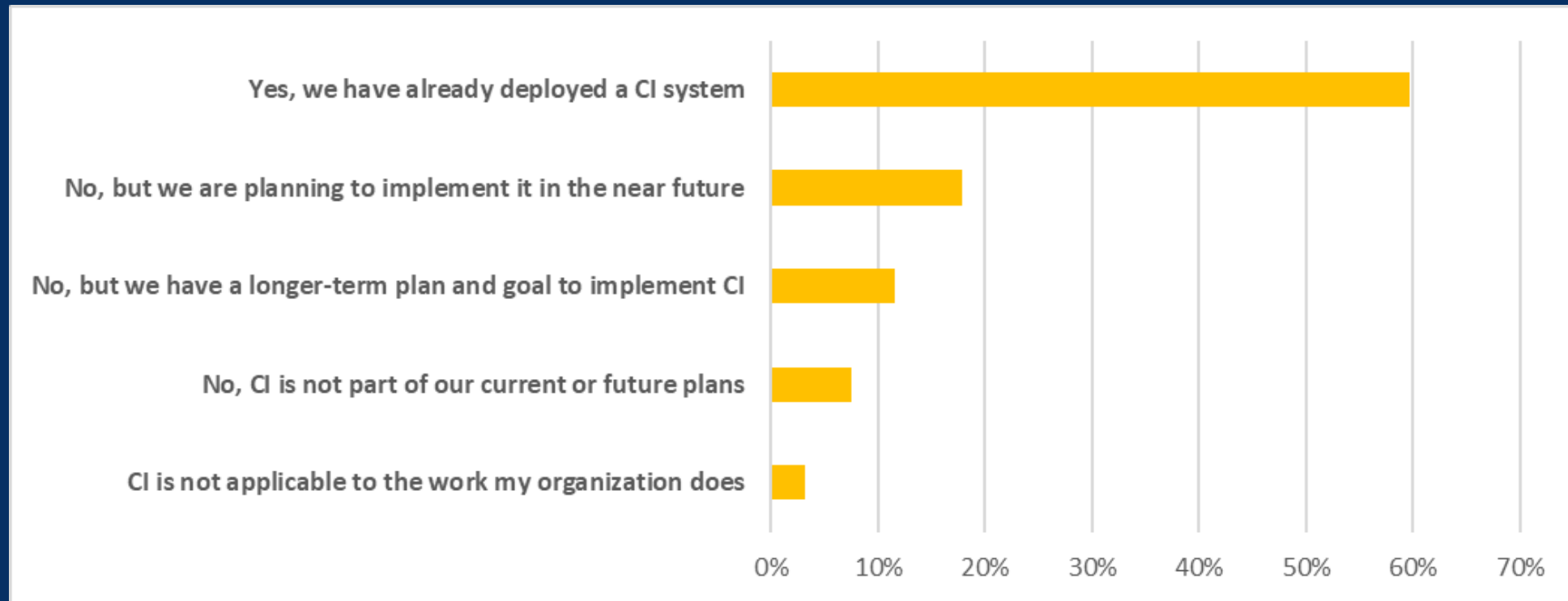
- *Jensen Huang, co-founder and CEO of NVIDIA*

5 Apply standard software workflows



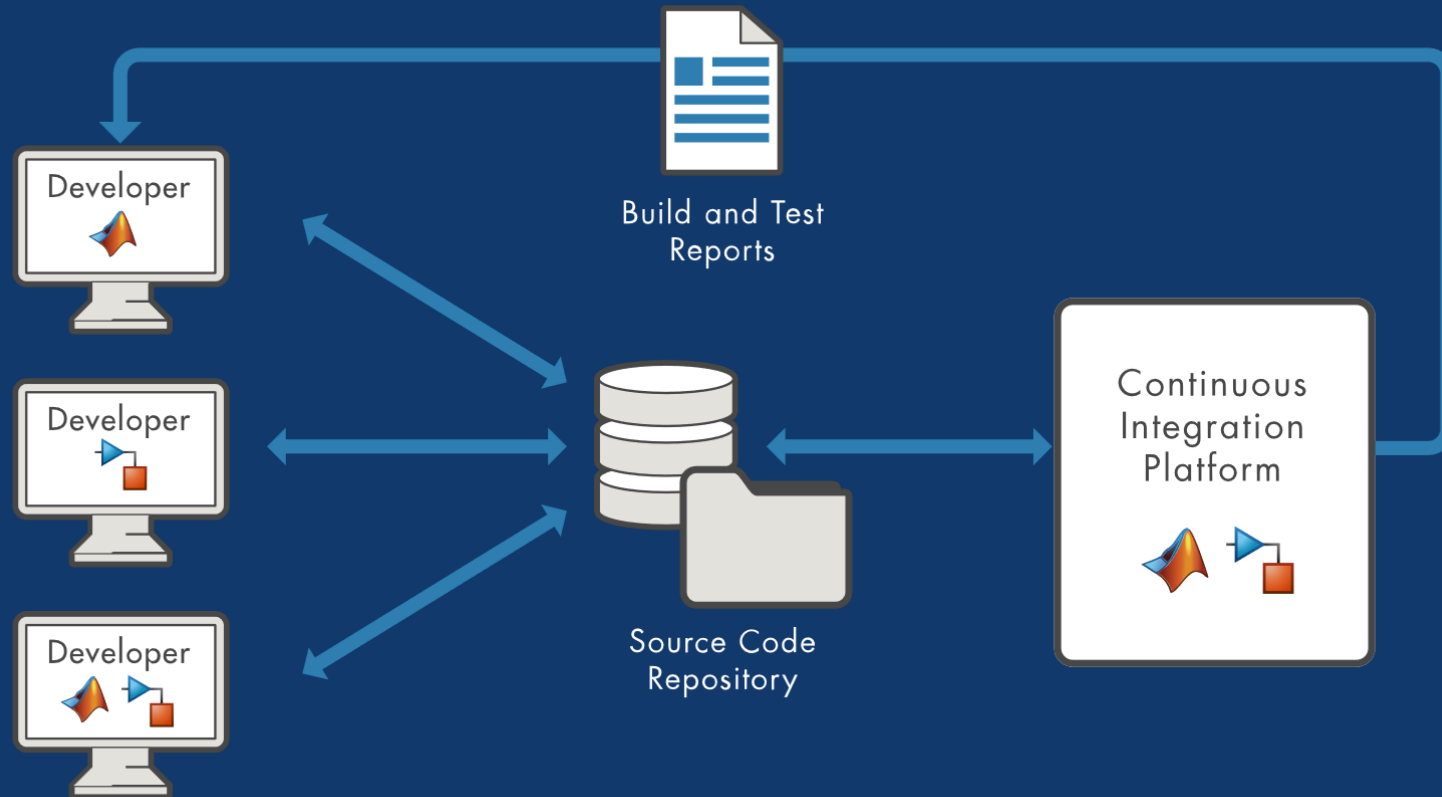


Does your organization currently use a continuous integration (CI) system? (select one)





5 Apply standard software workflows



5 Apply standard software workflows



Technical Articles and Newsletters

Overview Search Technical Articles Newsletters ▾ Cleve's Corner Collection

Workflow Steps

The workflow consists of the following steps (Figure 4):

1. **Trigger** a pipeline in GitLab and observe that the Verify and Build stages
2. **Detect** a test-case failure in GitLab CI pipeline and create an Issue to tra
3. **Reproduce** the issue on our desktop MATLAB.
4. **Fix the issue** in the model.
5. **Test locally** to ensure the test case passes.
6. **Review** the changes on the testing branch.
7. **Commit** the change to Git and trigger the CI pipeline in GitLab.

Step-by-Step Tutorials

The screenshot shows the MATLAB Process Advisor interface. The 'MODELING' tab is selected, and the 'Process Advisor' tool is highlighted with a red box. The interface displays a table of tasks and a diagram of the model structure.

Tasks	Out	Details
Generate Simulink Web View	Out	✓ 1
Check Modeling Standards	Out	✓ 3 ⚠ 1
Detect Design Errors	Out	✓ 1
Generate SDD Report	Out	✓ 1
Generate Code (Top)	Out	✓ 1

The diagram on the right shows the model structure with blocks labeled 'PilotPitchCmd' and 'PilotRollCmd'.

Process Advisor



From Scripted Pipelines to Process Advisor





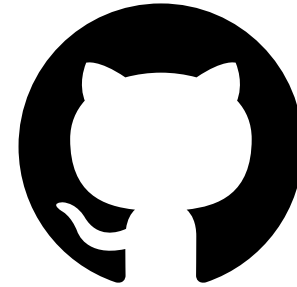
From Scripted Pipelines to Process Advisor



Jenkins



git



MATLAB® & SIMULINK®



AUTOSAR



From Scripted Pipelines to Process Advisor



“Bring everything into MATLAB.”

- *Martin Römpert, Continental Automotive Technologies GmbH*



From Scripted Pipelines to Process Advisor



Tasks	Out	Details
Generate Simulink Web View		✓ 1
Check Modeling Standards		✓ 3 1
Detect Design Errors		✓ 1
Generate SDD Report		✓ 1
Generate Code (Top)		✓ 1

Process Advisor

- Leverage the digital thread
- Identify stale tests
- Interact with the model

2X



From Scripted Pipelines to Process Advisor



Process Advisor: Flight_Control

Tasks	Out	Details
✓ Generate Simulink Web View		✓ 1
✓ Check Modeling Standards		✓ 3 1
✓ Detect Design Errors		✓ 1
✓ Generate SDD Report		✓ 1
✓ Generate Code (Top)		✓ 1

Flight_Control

PilotPitchCmd

PilotRollCmd

Process Advisor

500 interfaces

1,000 components

100 compositions



6 Design and simulate in the cloud

A screenshot of a web browser displaying the MATLAB Online login page. The browser's address bar shows 'matlab.mathworks.com'. The page features the MathWorks logo and 'MATLAB Online' text. A large 'MATLAB Online' heading is centered. Below it is another MathWorks logo, followed by an 'Email' label and a text input field containing 'mcarone@mathworks.com'. There are links for 'No account? Create one!' and 'By signing in you agree to our privacy policy.'. A blue 'Next' button is positioned to the right of the input field, with a mouse cursor hovering over it. At the bottom, there are links for 'Learn about MATLAB Online' and 'Use MATLAB Drive™ to synchronize your MATLAB files'.



6 Design and simulate in the cloud

```
for i = 1:10000
    in(i) = Simulink.SimulationInput(my_model)
    in(i) = setVariable(my_var, i);
end
out = parsim(in);
```

Massive simulations



Parallel
Computing
Toolbox



MATLAB
Parallel Server





⑥ Design and simulate in the cloud

Global Combat Air Programme



Source: Artist Rendering, Ministry of Defense website, <https://www.mod.go.jp/en/article/2022/12/9/3717bac3e9bca986f2e80ba73f7822065a9f2b.html>



Future Combat Air System



Source: Model of the Future Air Combat System at the Paris-Le Bourget 2019 Airshow, by Ibex73, licensed under CC-BY-SA 4.0 / background logos blurred from original

Application Trends



Autonomous

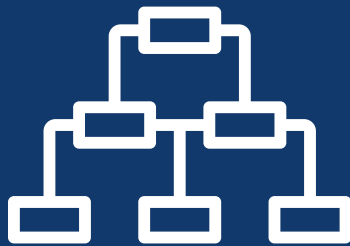


Connectivity



Electrification

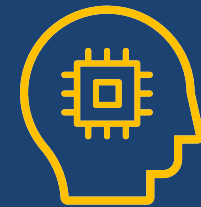
Workflow Trends



Systems Engineering
& Design

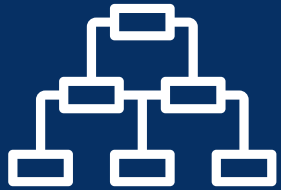


Modern
Software Practices



AI for
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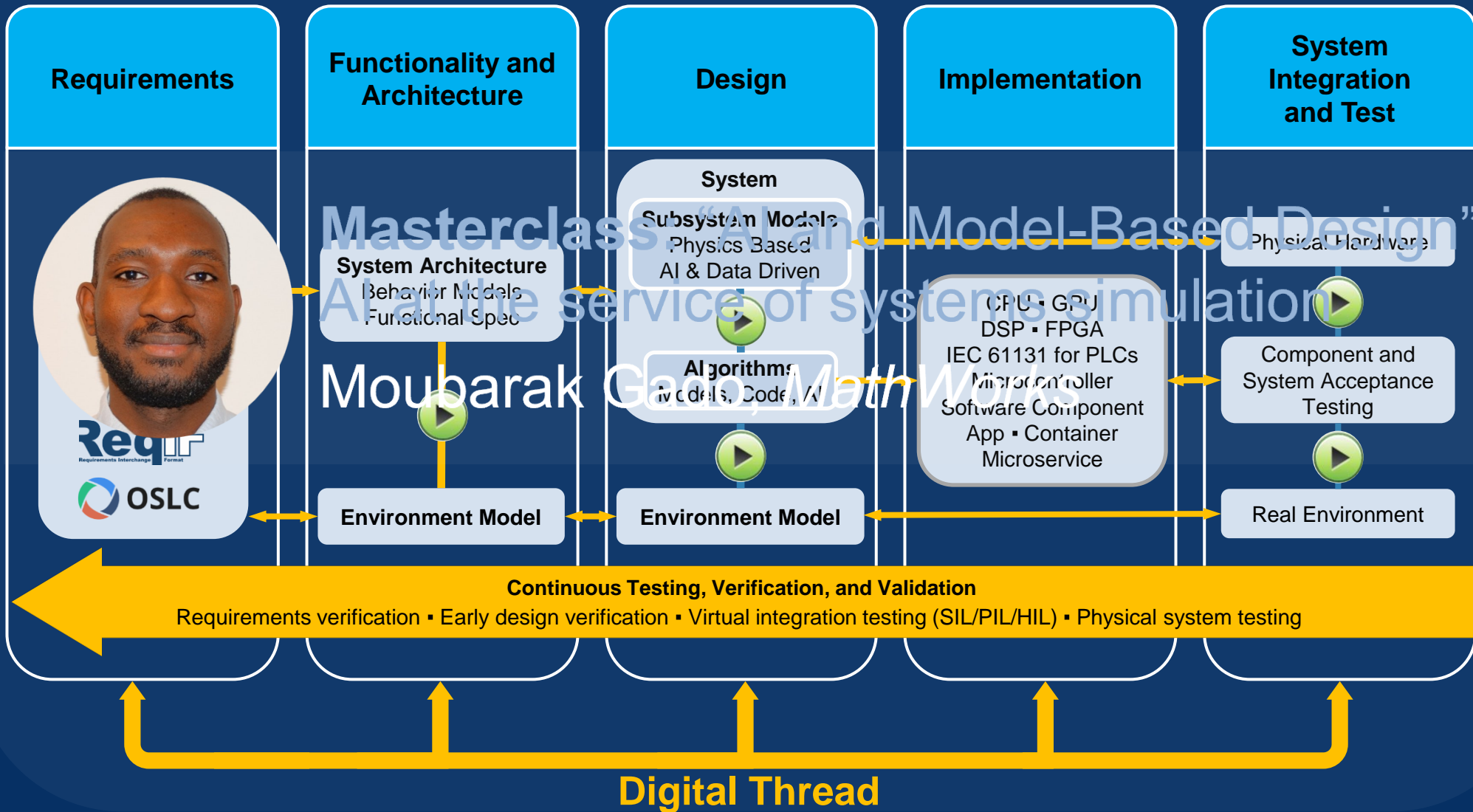


7. Design your system with AI



7 Design your system with AI

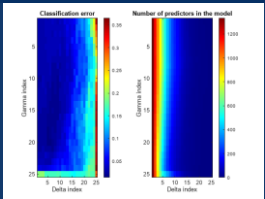
Integrating AI into Model-Based Design



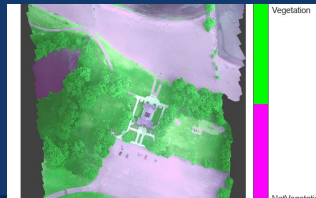


7 Design your system with AI

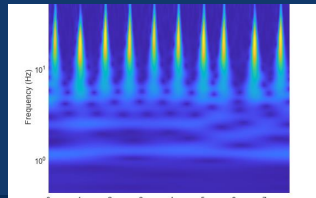
AI Reference Examples



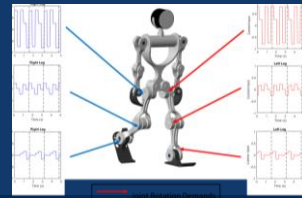
Predictive Maintenance



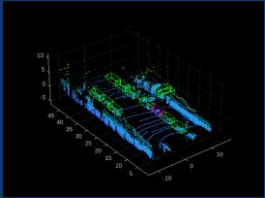
Hyperspectral Imaging



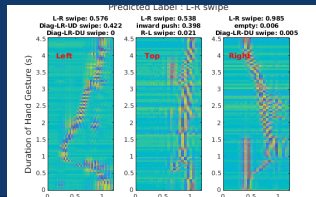
Signal Processing



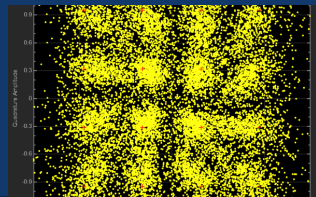
Robotic Control



Lidar Processing



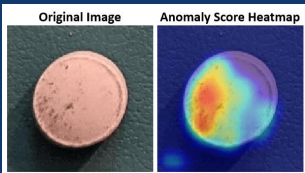
Radar Processing



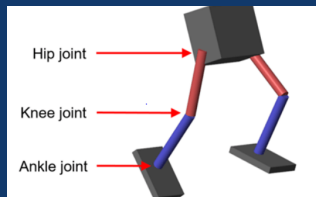
Wireless Communications



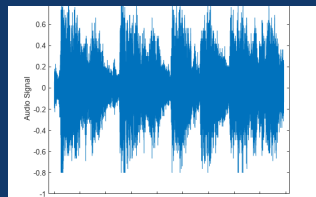
Automated Driving



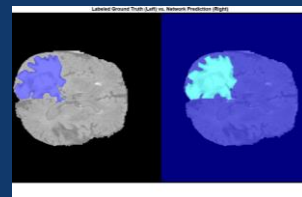
Visual Inspection



Reinforcement Learning



Audio

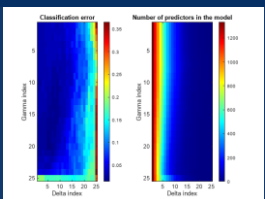


Medical Imaging



7 Design your system with AI

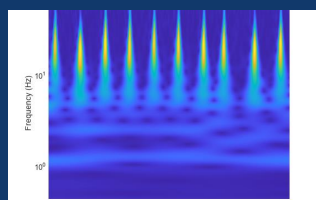
AI Reference Examples



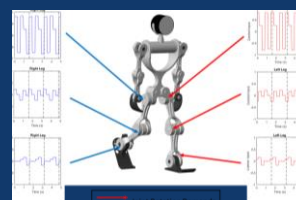
Predictive Maintenance



Hyperspectral Imaging



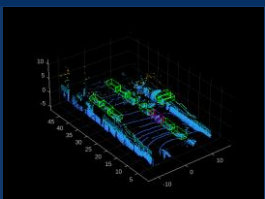
Signal Processing



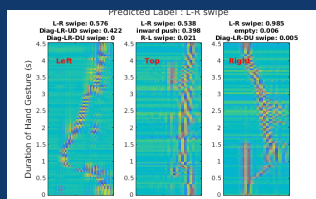
Robotic Control



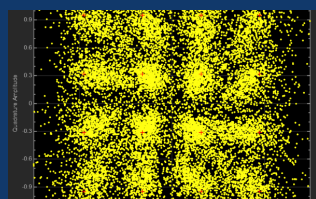
CPU



Lidar Processing



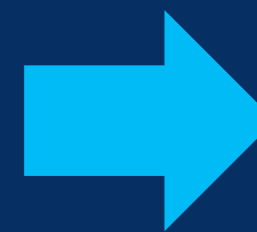
Radar Processing



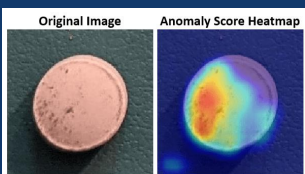
Wireless Communications



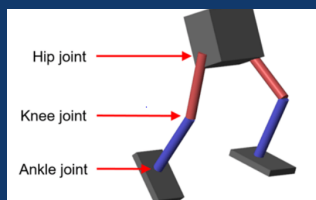
Automated Driving



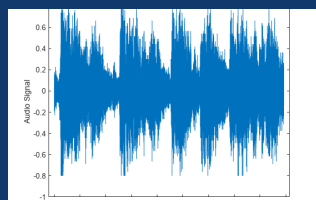
GPU



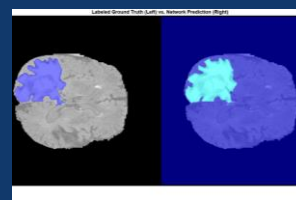
Visual Inspection



Reinforcement Learning



Audio



Medical Imaging



FPGA, ASIC, PLC



Mercedes-Benz

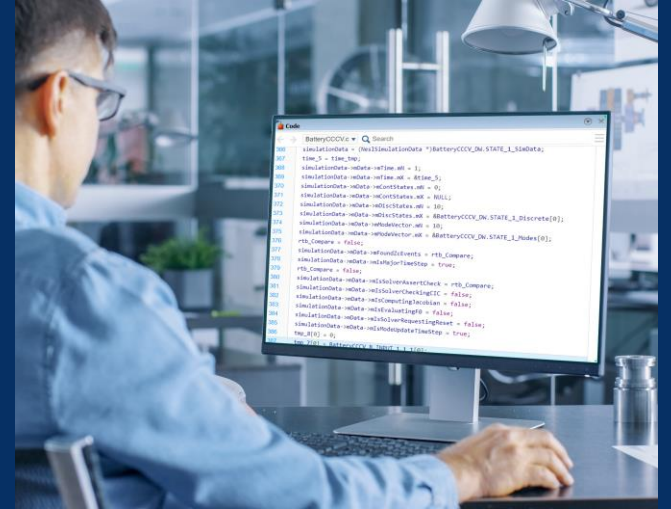
Simulates Hardware Sensors with Deep Neural Networks





Mercedes-Benz

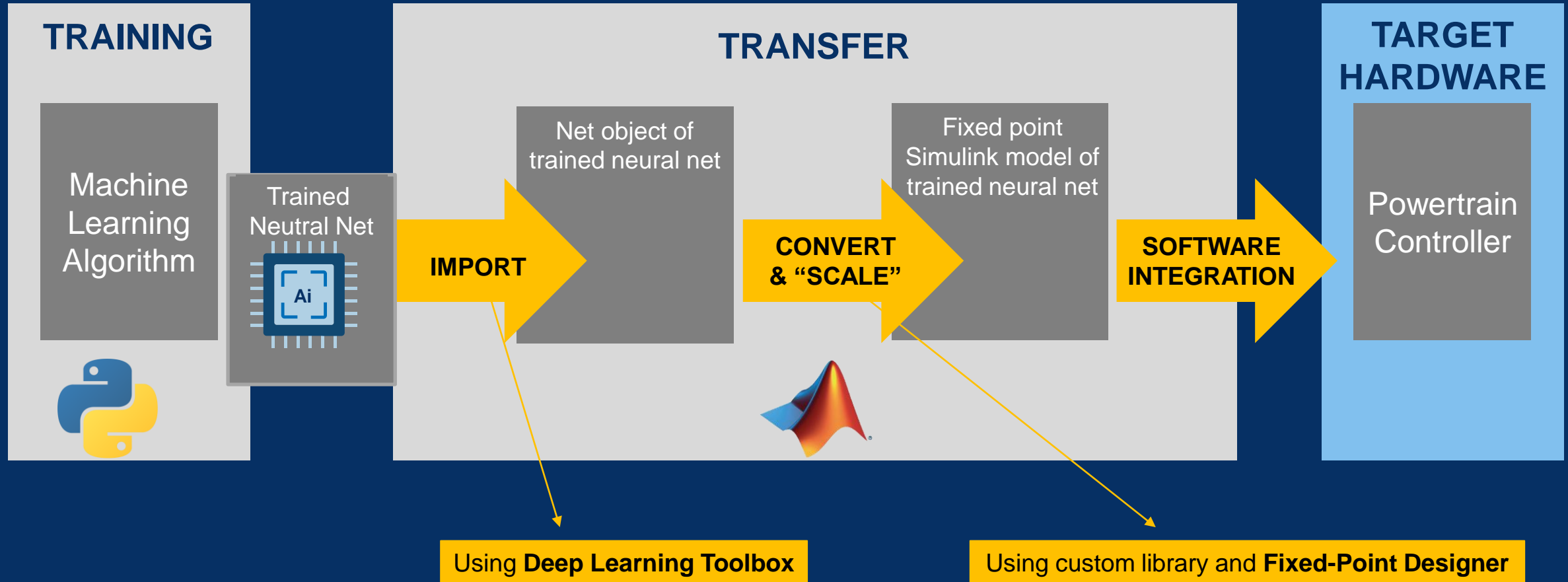
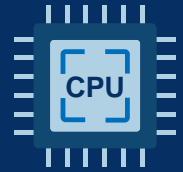
Simulates Hardware Sensors with Deep Neural Networks





Mercedes-Benz

Simulates Hardware Sensors with Deep Neural Networks





Mercedes-Benz

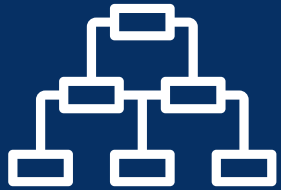
Simulates Hardware Sensors with Deep Neural Networks



*“We are already using the **automated workflow** we created with MATLAB and Simulink for other use cases ... small adaptations to support deployment on two different powertrain controllers, and the workflow is also applicable to **other types of deep learning models** such as gated recurrent units and fully connected neural networks ... we **committed fewer errors** in creating the model and the code.”*

- Katja Deuschl, AI Developer, Mercedes-Benz

Workflow Trends



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**Systems Engineering
& Design**



**Modern
Software Practices**



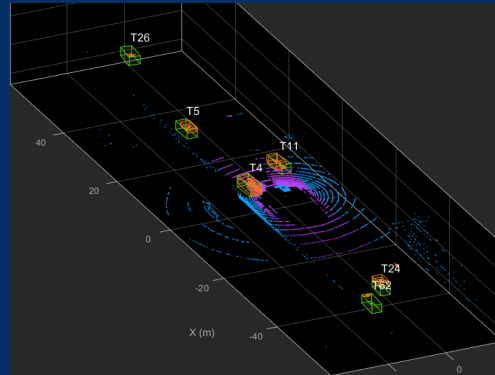
**AI for
System Development**



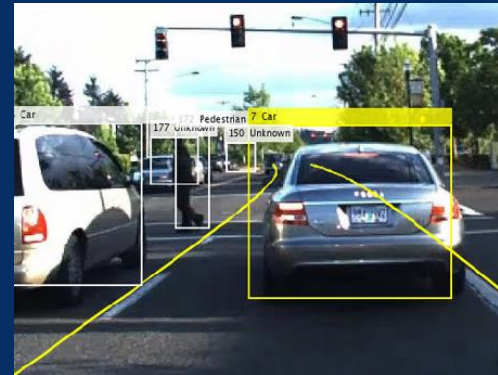
Deliver autonomous systems



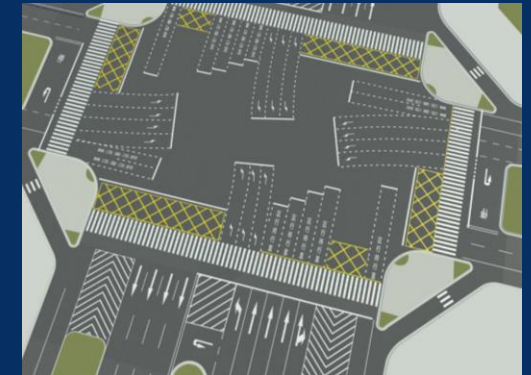
**Braking and
Steering**



**Sensor Fusion and
Tracking**



**Computer Vision
Radar, Lidar**



**Road Network
Design**



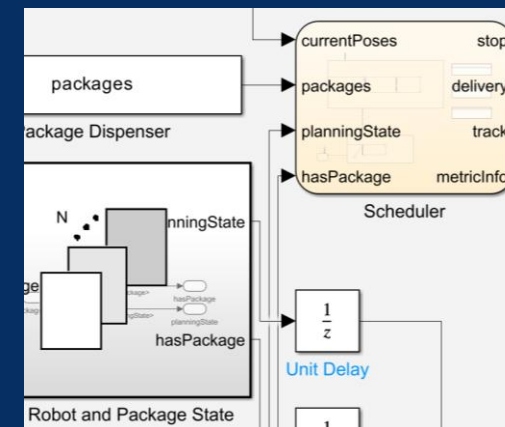
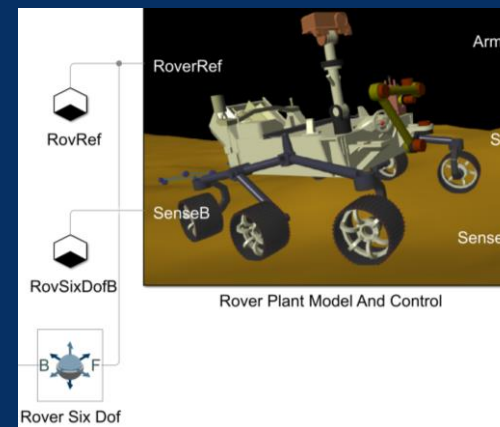
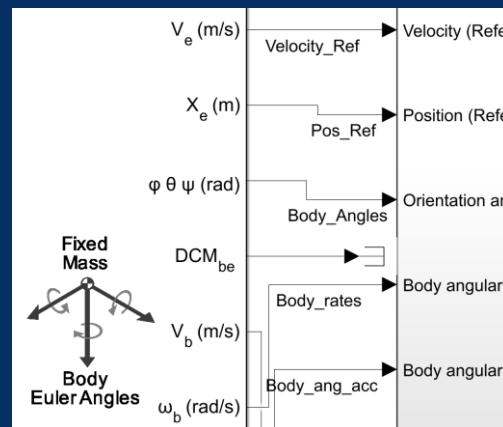
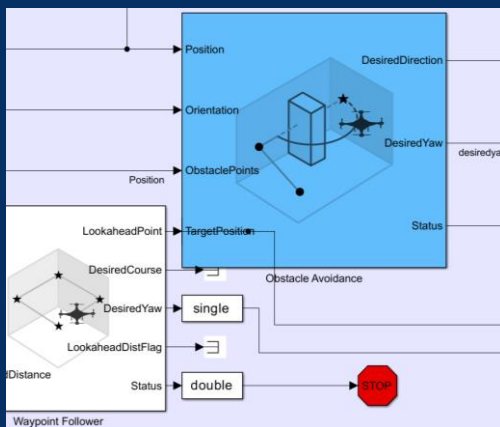
The image displays a 3D modeling software interface for road design. The main view is a 3D perspective of a road with a roundabout. Three purple anchor icons are placed on the road surface. A white curb is visible around the roundabout. The interface includes a 2D logic editor at the bottom left with a purple rectangle and a clock icon, and a library browser at the bottom right with a list of asset categories and their corresponding 3D models.

Library Browser Categories:

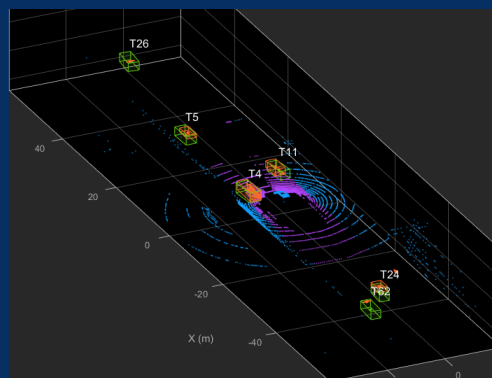
- Assets
 - Assemblies
 - Behaviors
 - Buildings
 - Damage
 - Extrusions
 - Markings
 - Materials
 - Posts
 - Props
 - Rail
 - RoadStyles
 - Signs
 - Stencils
 - Test
 - Vehicles

Library Browser Assets:

- Ambulance
 - Ambulance_Details_Diff
 - Ambulance_Details_Diff_U...
 - Ambulance_Details_Norm
 - Ambulance_Details_Spec
 - Ambulance_Diff
 - Ambulance_Norm
 - Ambulance_Spec
- CementTruck
 - CementTruck_Diff
 - CementTruck_Norm
 - CementTruck_Spec



Unmanned Aerial Vehicle



Autonomous Underwater Vehicle



Ground Robot



Industrial Robot

Application Trends



Autonomous



Connectivity



Electrification

Workflow Trends



**Systems Engineering
& Design**



**Modern
Software Practices**



**AI for
System Development**

Application Trends



Autonomous



Connectivity



Electrification

Workflow Trends



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**AI for
System Development**



5G Standard



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6G Technology Implications







- Artificial Intelligence
- Joint Communications and Sensing
- Reconfigurable Intelligent Surfaces
- Non-Terrestrial Networks (NTNs)
- Physical Layer Design
- Extreme Data Rates and Higher Frequencies






Wireless Trends – AI in Wireless

Wireless challenges

-  Hard-to-model problems
-  Computational infeasibility of optimal solution
-  Efficient modem parameter optimization
-  Dealing with non-linearity



AI strengths

-  Determining appropriate representations for hard-to-model problems
-  Finding near-ideal and computationally realizable solutions
-  Modeling non-linear functions

Applying AI to solve difficult wireless challenges

Deep wireless domain knowledge is required to optimally use AI capabilities

Application Trends



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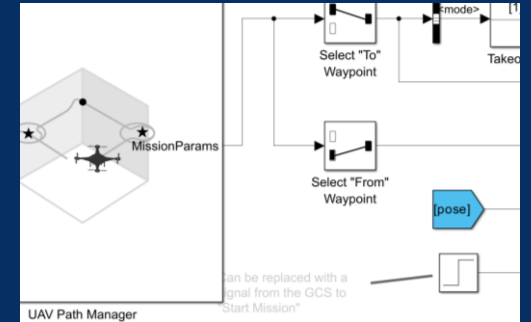
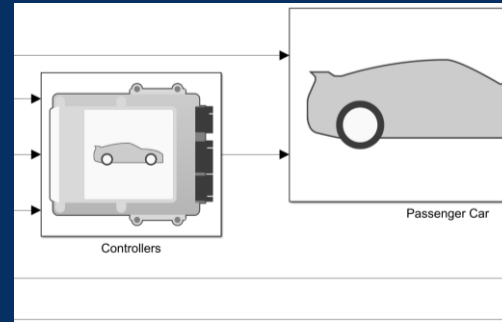
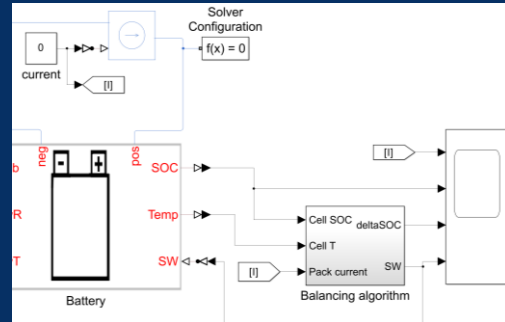
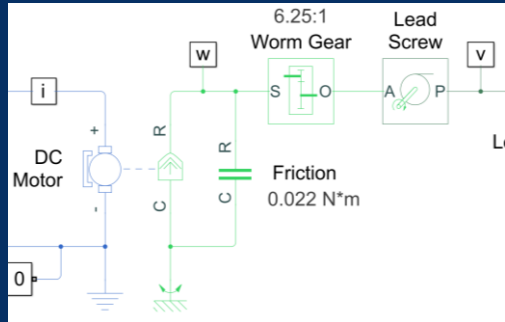


**AI for
System Development**

Electric Vehicles



Accelerate the development and implementation of automotive BMS features
 Vincent Martinez and Léa Pitault, *NXP Semiconductors*



Electric Motors



Battery Packs



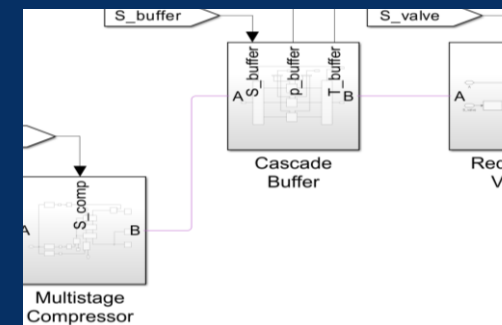
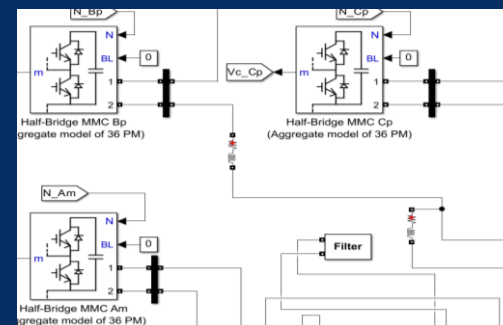
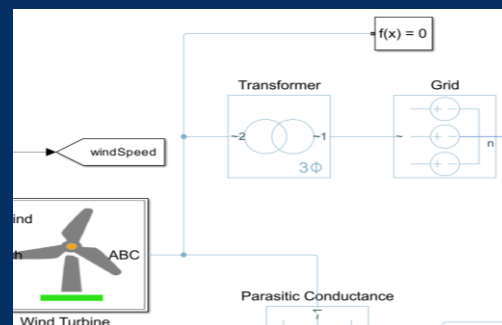
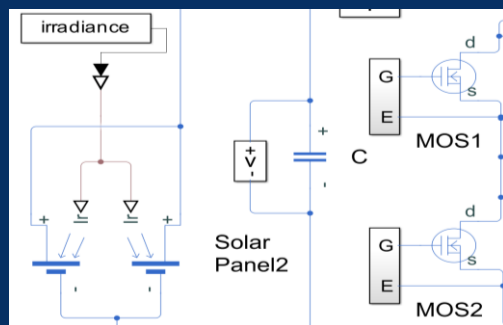
Full Vehicle Models



Aerial Vehicles



Green Energy



Solar



Wind



Hydroelectric



Green Hydrogen

SIEMENS ENERGY

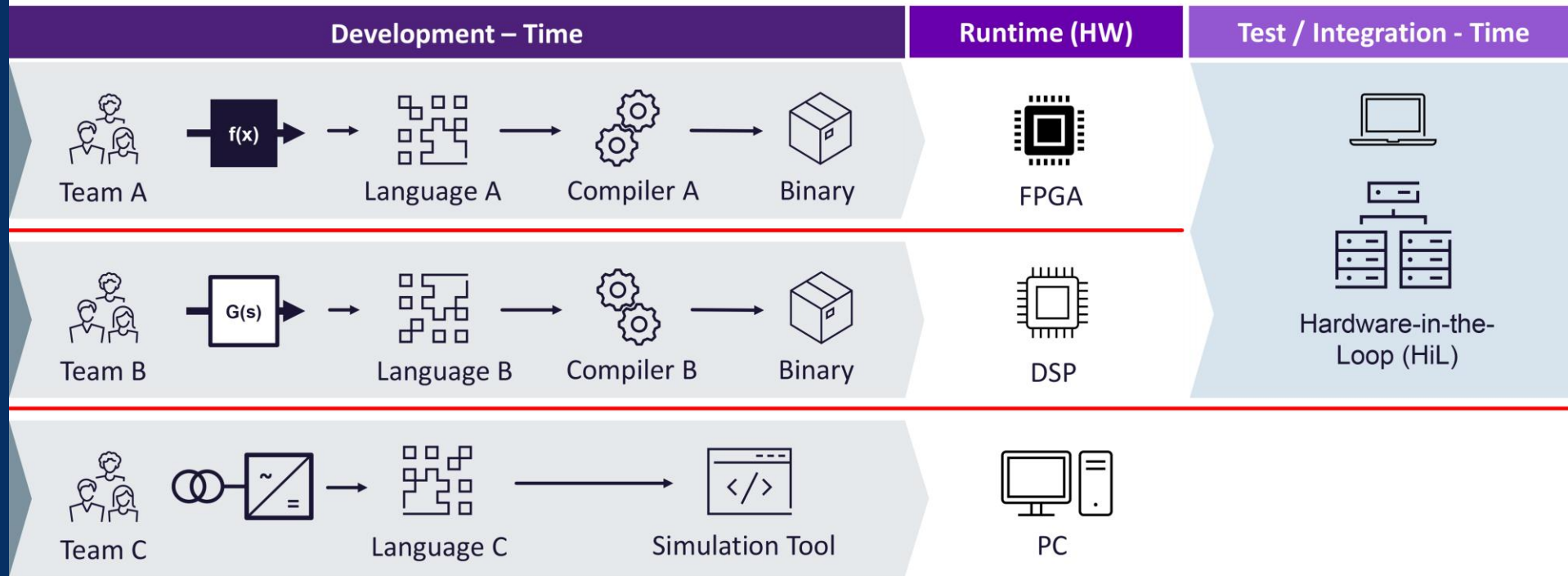
Enables the Global Energy Transition

1. Engineer solutions in solar, biomass, hydrogen, wind
2. Retrofit or upgrade infrastructure
3. Strengthen electrical grid



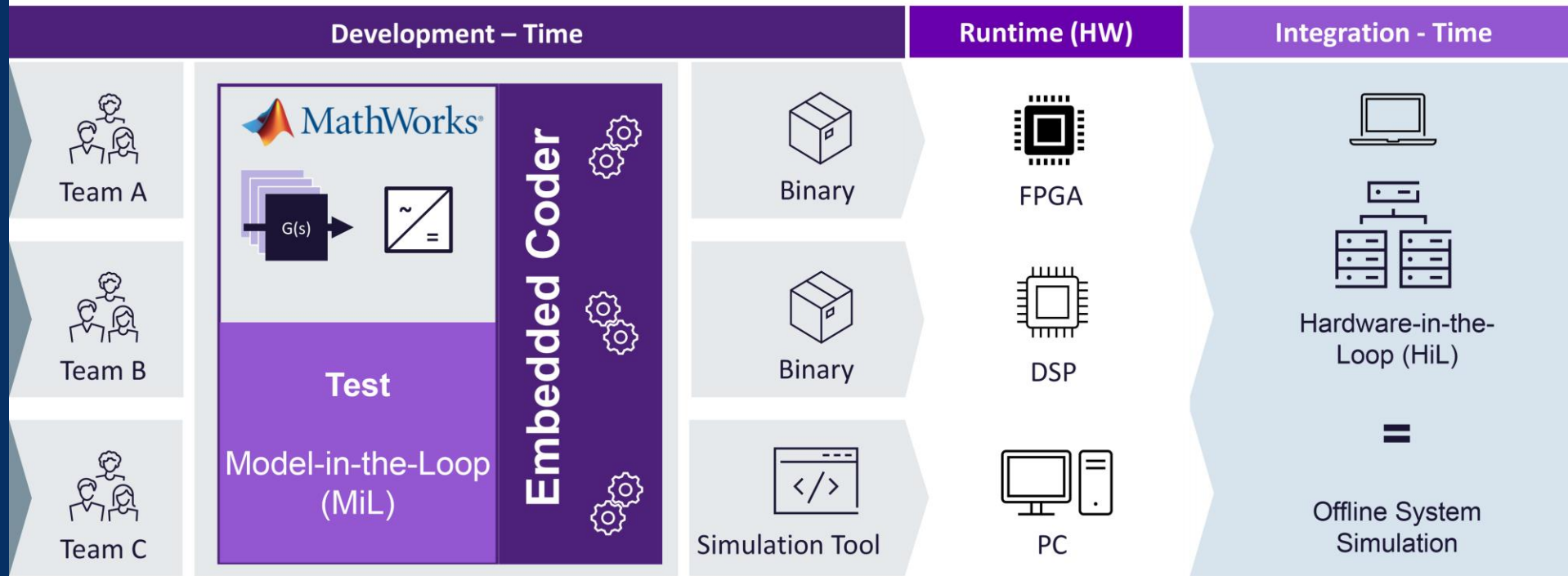
Swimlane Engineering

When the organization shapes development



Centralized Engineering Ecosystem

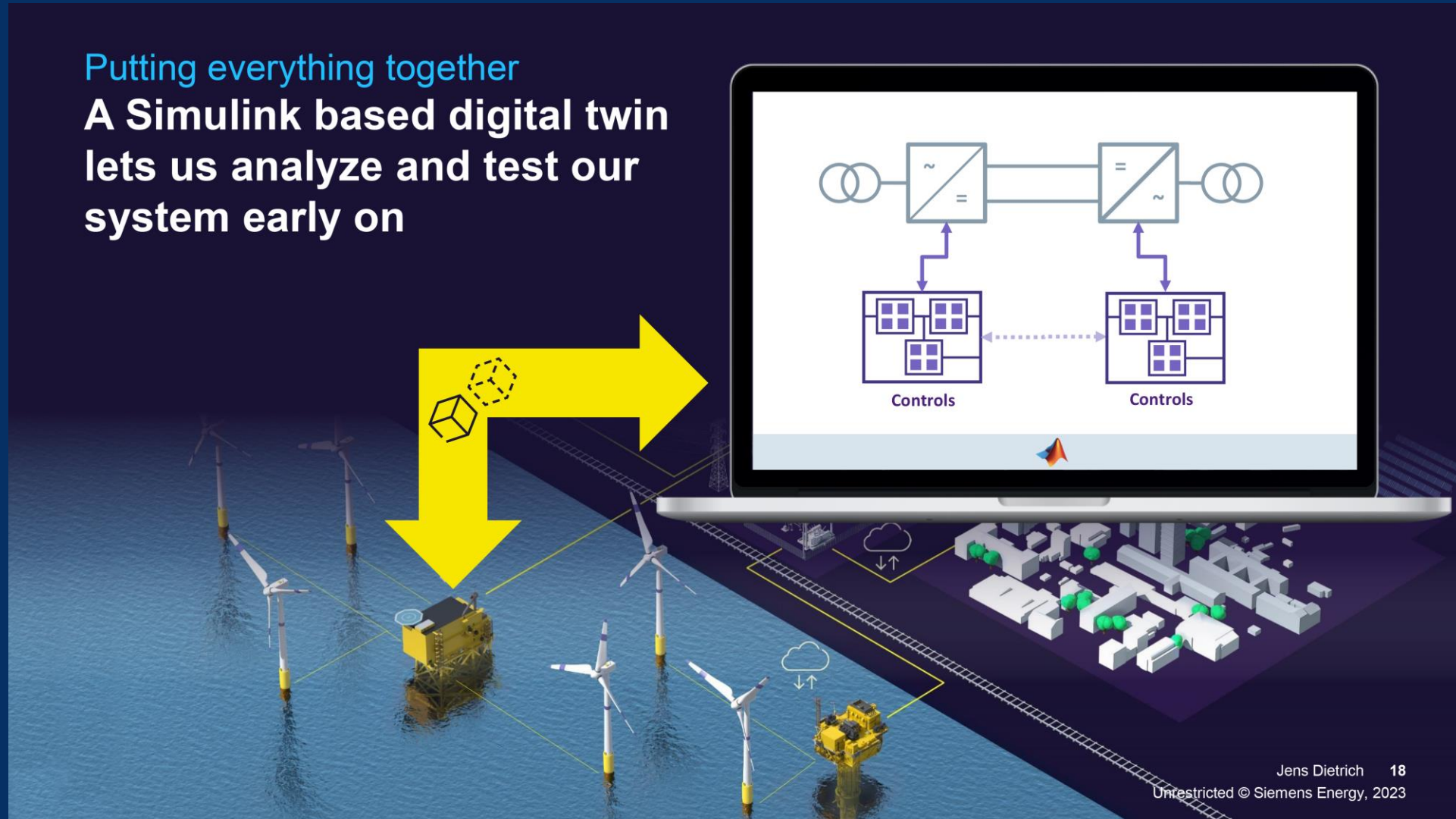
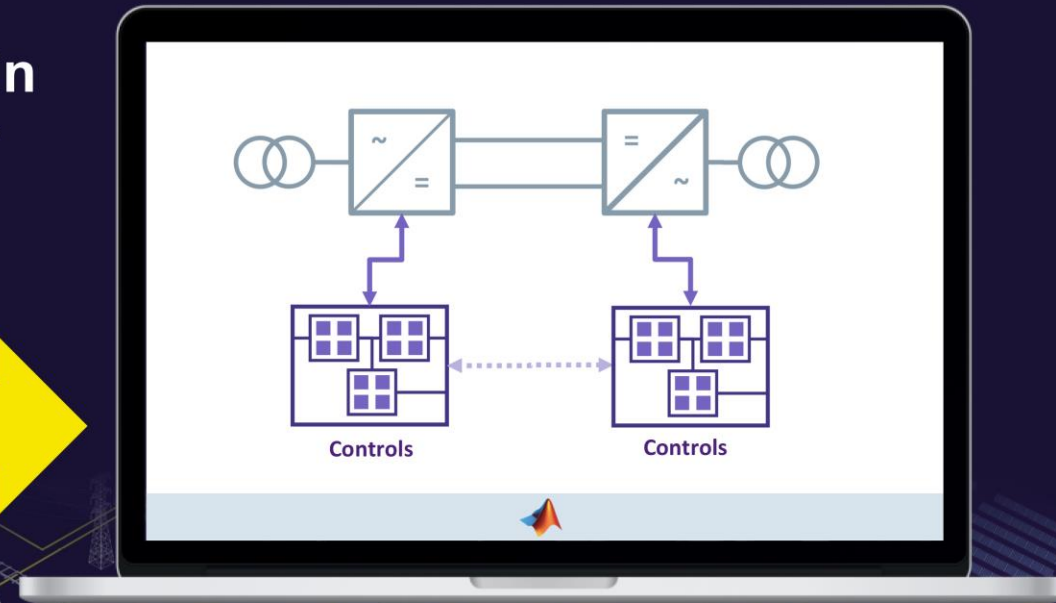
When development extends across the organization



SIEMENS ENERGY

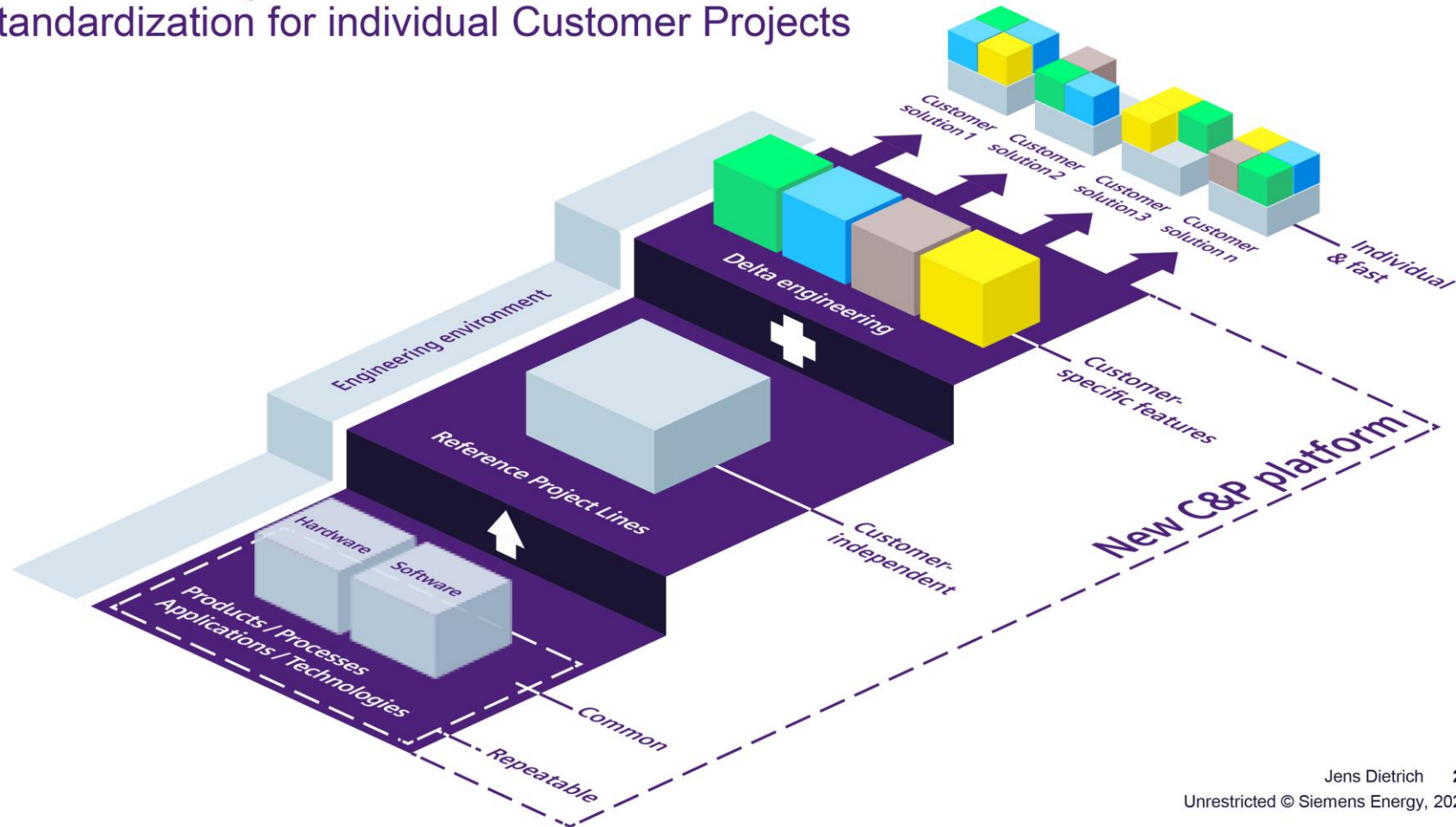
Enables the Global Energy Transition

Putting everything together
A Simulink based digital twin
lets us analyze and test our
system early on



Enables the Global Energy Transition

Reference Project Lines Standardization for individual Customer Projects



Application Trends



Autonomous

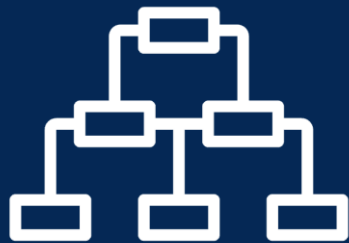


Connectivity



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AI for
System Development

Application Trends

- ① Automate everything
- ② Scale to complex systems
- ③ Use automatic code generation
- ④ Prevent defects early

Workflow Trends

- ⑤ Apply standard software workflows
- ⑥ Design and simulate in the cloud
- ⑦ Design your system with AI

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Software Practices

AI for
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MATLAB EXPO

FRANCE

Thank you



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