MATLAB EXPO INDIA

11 July 2024 | Bengaluru

# Model-Based Design for Digital Engineering: Impact and Directions

*Tom Erkkinen*

MathWorks

# Application Trends

Autonomous

Connectivity

Electrification

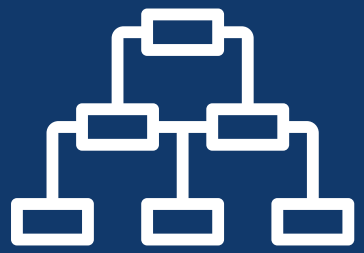
# Application Trends

Autonomous

Connectivity

Electrification

# Workflow Trends



Systems Engineering & Design

Modern Software Practices

AI for System Development

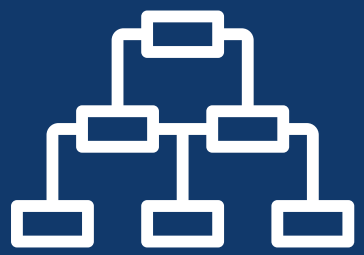
## Application Trends

Autonomous

Connectivity

Electrification

## Workflow Trends

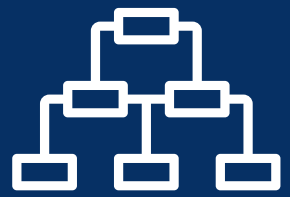


**Systems Engineering & Design**

**Modern Software Practices**

**AI for System Development**

# Workflow Trends

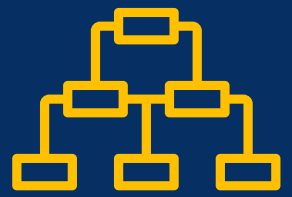


1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early

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

**Modeling**

Simulation | Analysis

+

**Automation**

Coding | Verification

# ① Automate everything

**Next Talk**: What's New in MATLAB and Simulink R2024a

**Modeling**

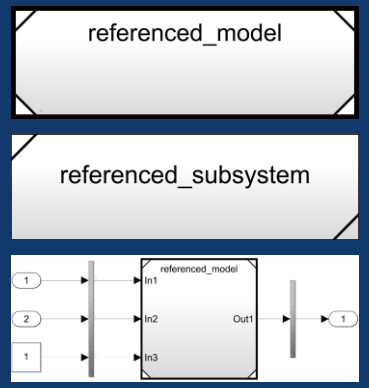
Simulation | Analysis

+

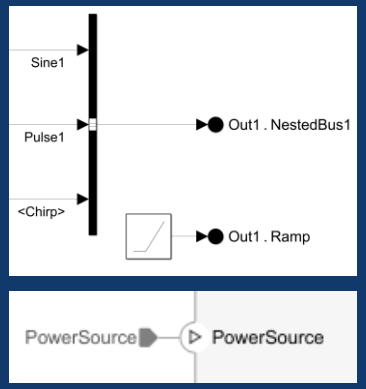
**Automation**

Coding | Verification

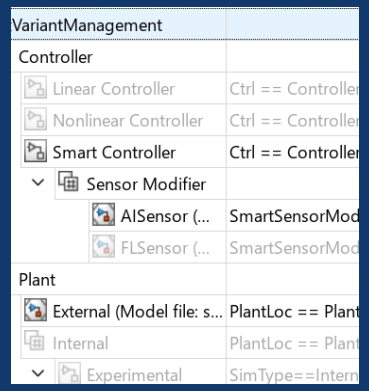
# ② Scale to complex systems



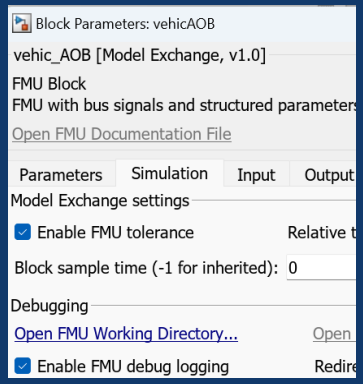

## Components



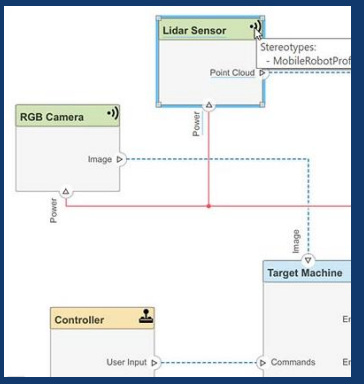

## Buses, Ports, and Connectors




## Variant Manager

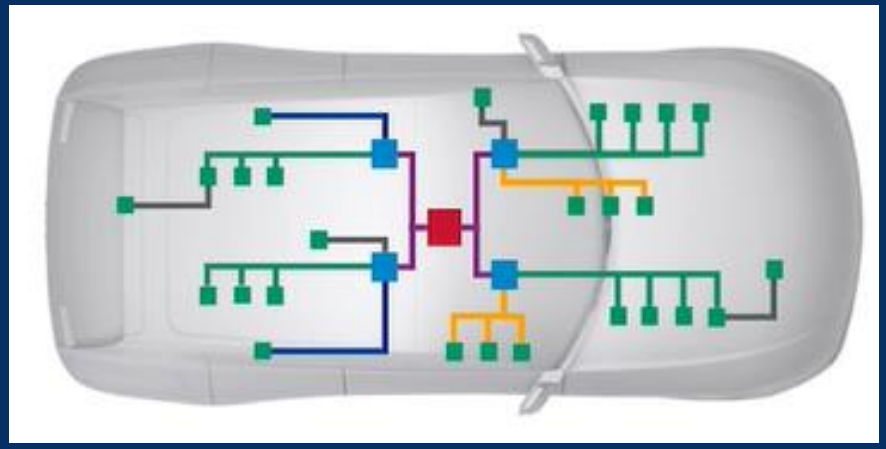



## Third-Party Tool Integration

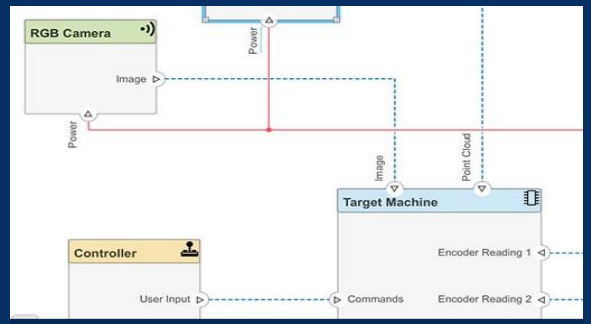



## Architecture

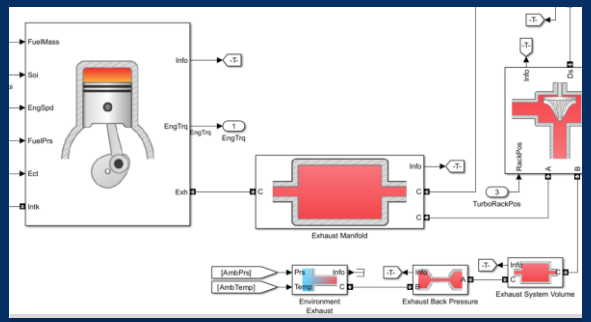
# ② Scale to complex systems



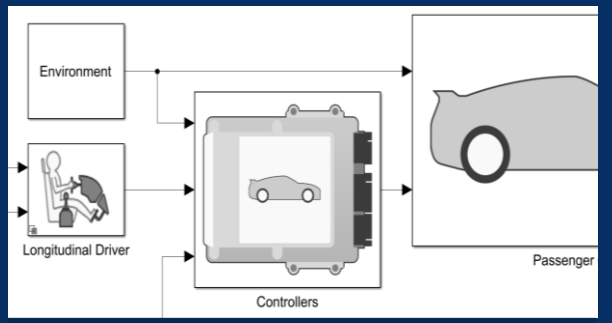

## Service-Oriented Architecture




System Composer



Components

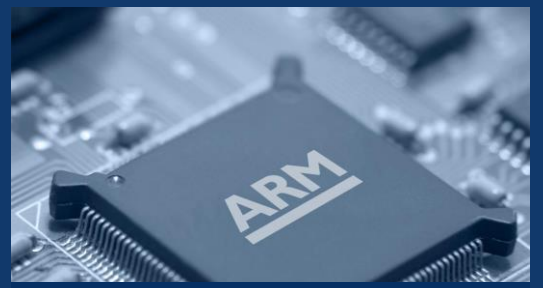



Full System

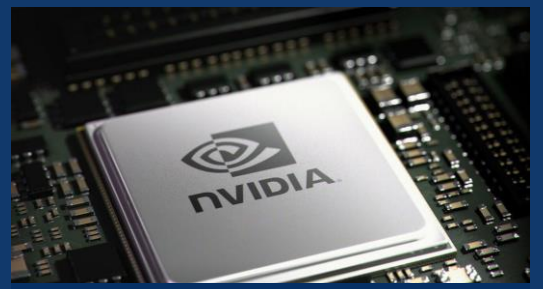
# 3 Use automatic code generation

**3700**

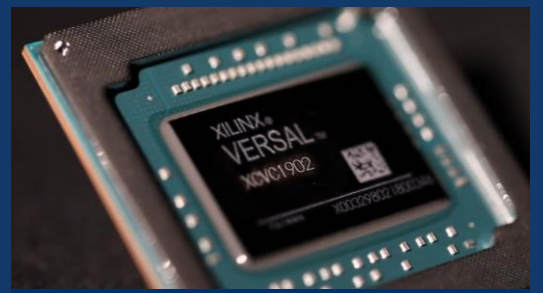
Organizations use automatic code generation




CPU

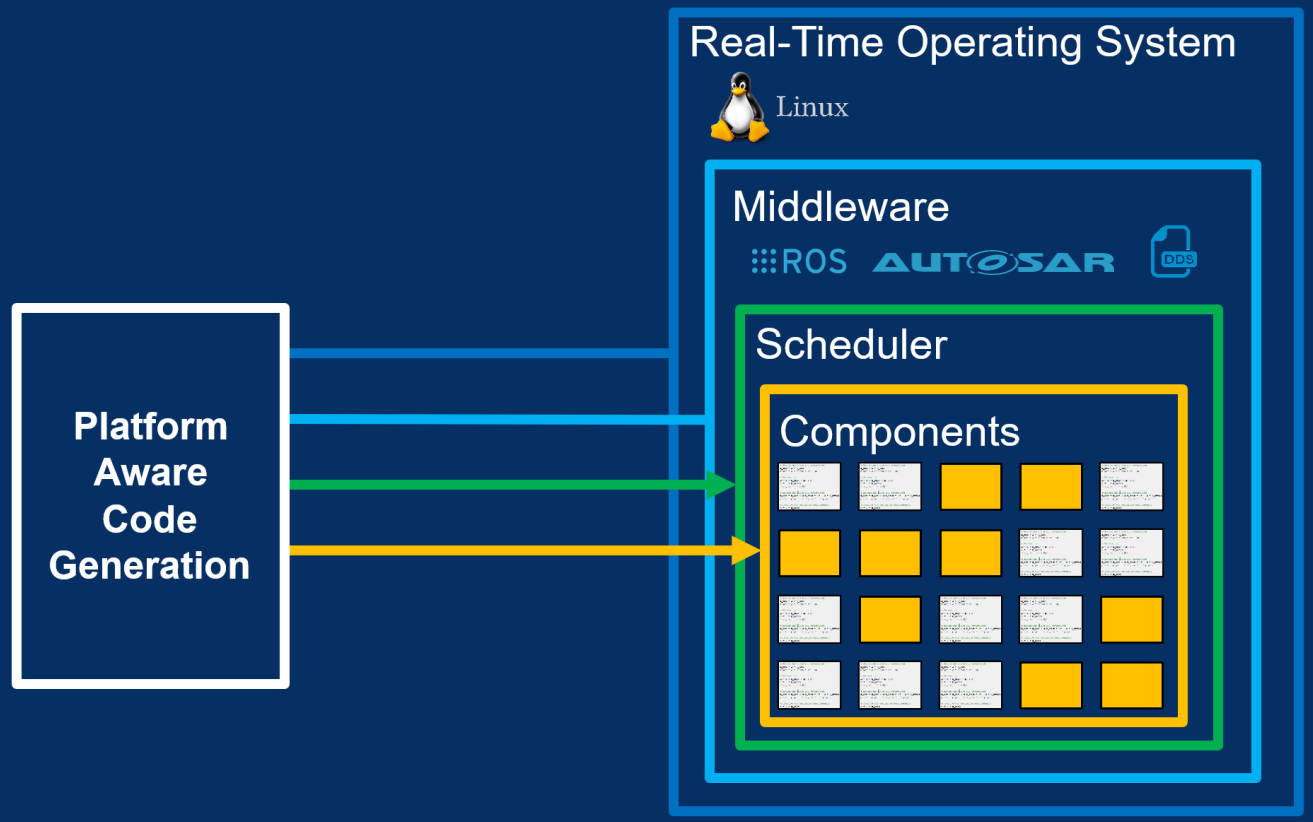


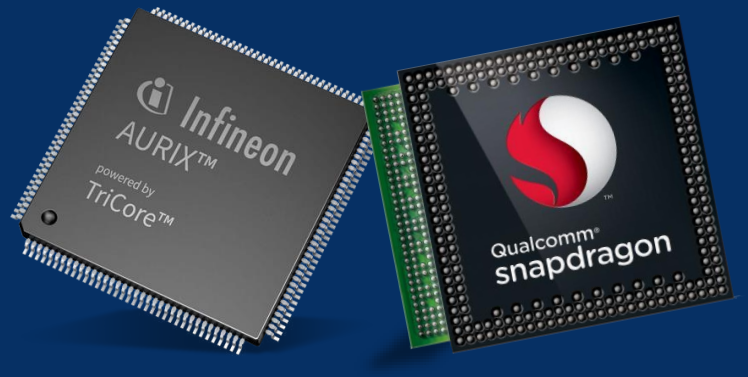

GPU



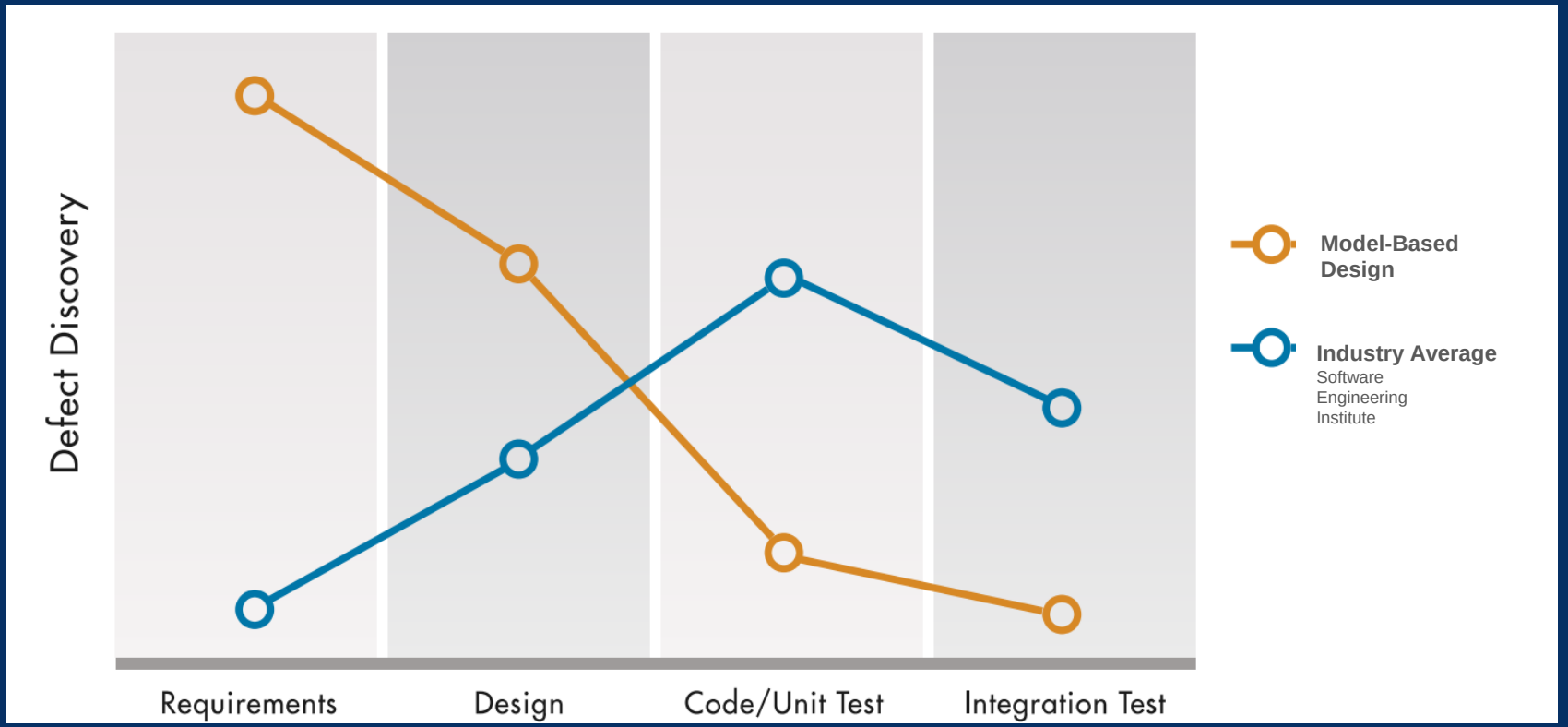

FPGA, ASIC, PLC

# 3 Use automatic code generation




# 4 Prevent and detect defects early



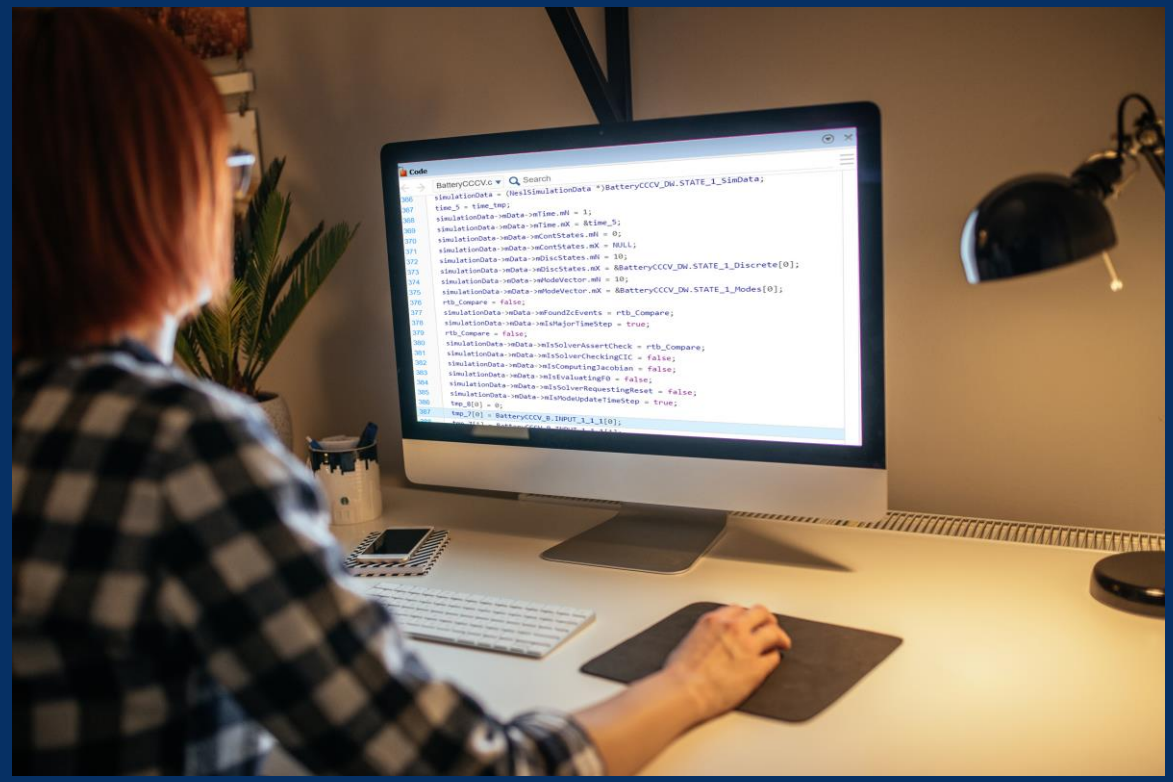
# 4 Prevent and detect defects early

**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 | MATLAB Test | Polyspace Access | Simulink Code Inspector |
| Simulink Fault Analyzer | Polyspace Test | | |

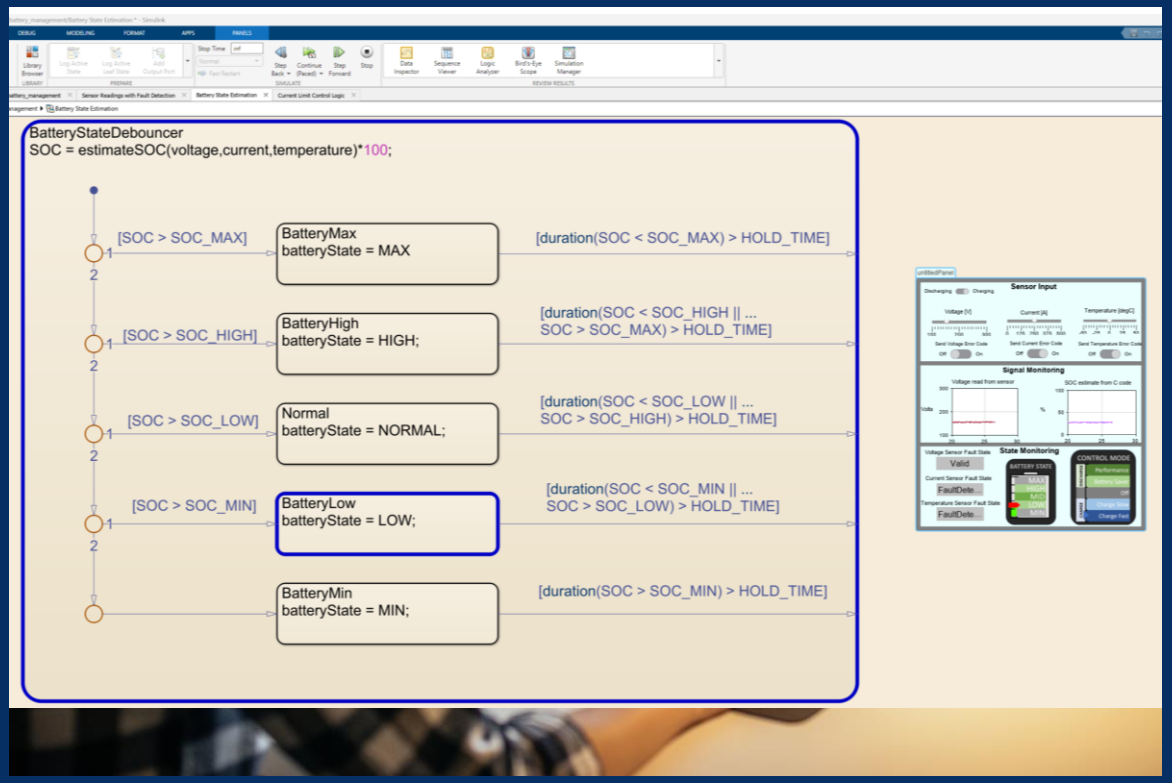
# UL Certification of Battery Management System Software with Model-Based Design

The Saft Flex’ion Gen2



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

The Saft Flex'ion Gen2



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

The Saft Flex'ion Gen2

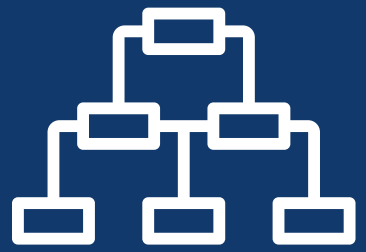
## Application Trends

Autonomous

Connectivity

Electrification

## Workflow Trends

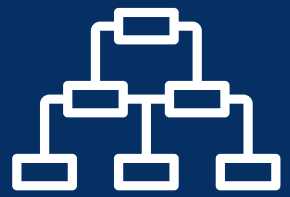


Systems Engineering & Design

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

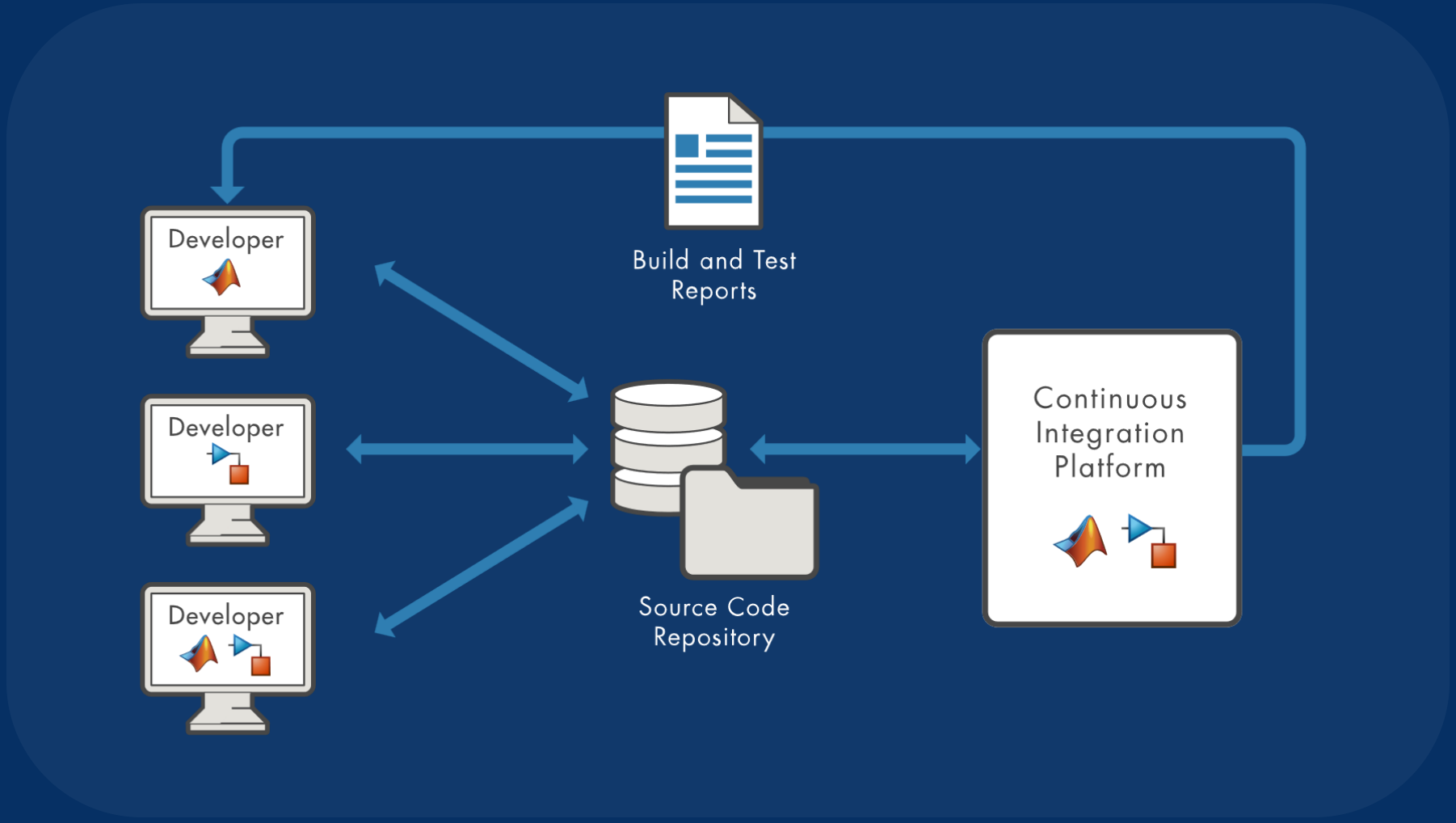
7. Design your system with AI

# 5 Apply standard software workflows

"Software is the language of automation."

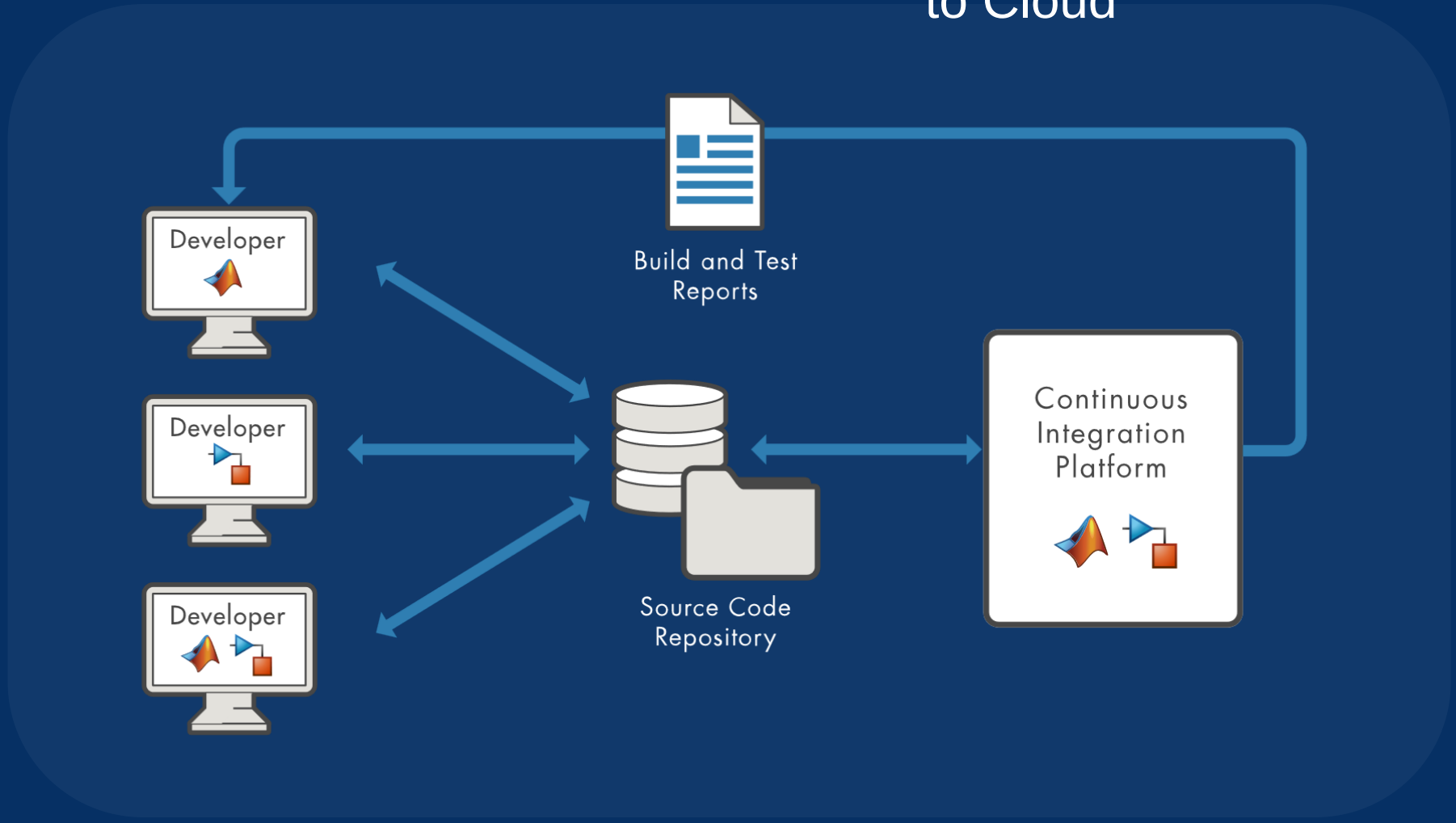
*- Jensen Huang, co-founder and CEO of NVIDIA*

# 5 Apply standard software workflows

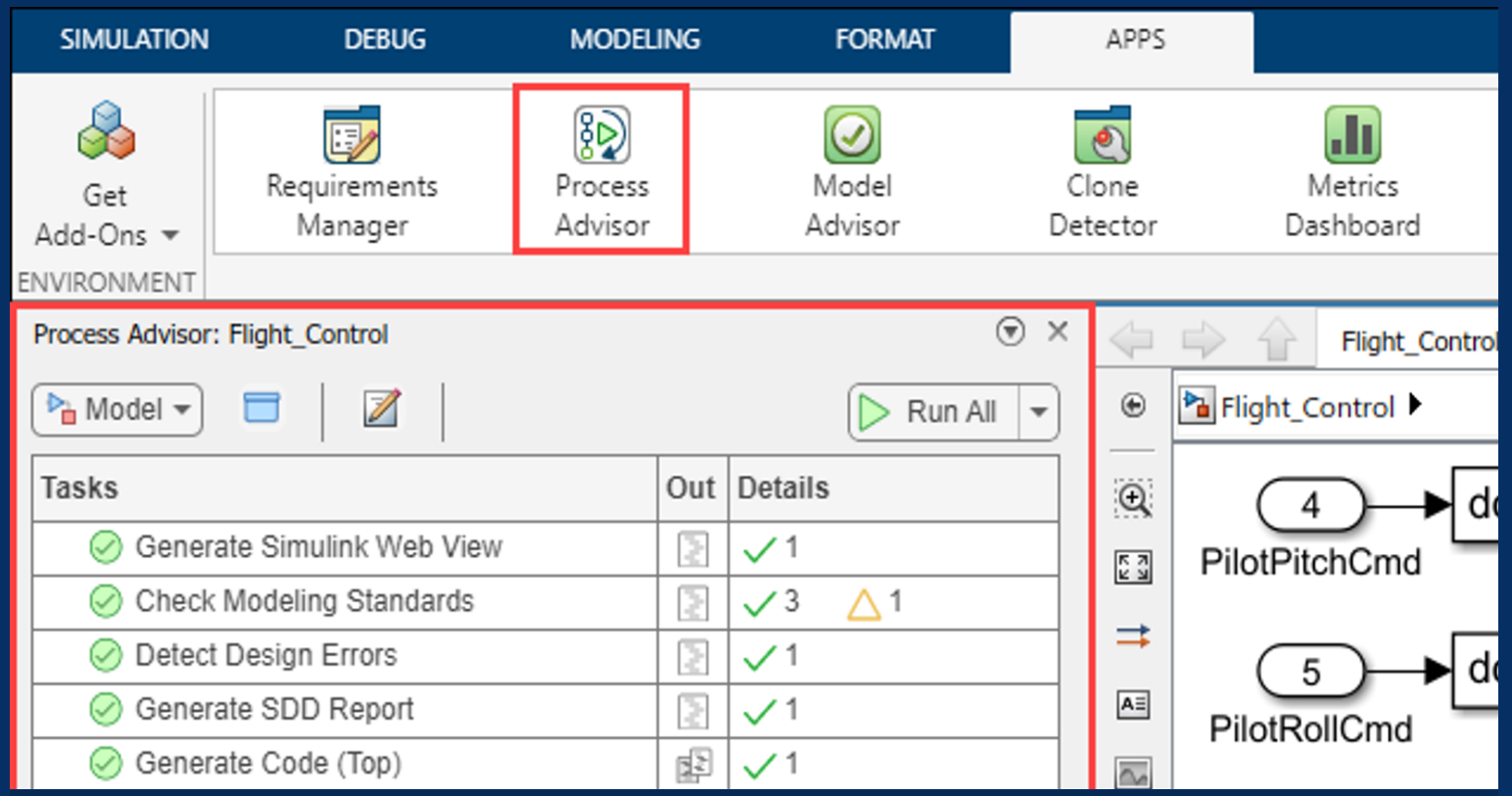


# 5 Apply standard software workflows

**Tech Talk**: Shaping Future Software Factories: Leveraging Model-Based Design for Scalability from Desktop to Cloud



# 5 Apply standard software workflows




**Process Advisor**

# From Scripted Pipelines to Process Advisor

Continental

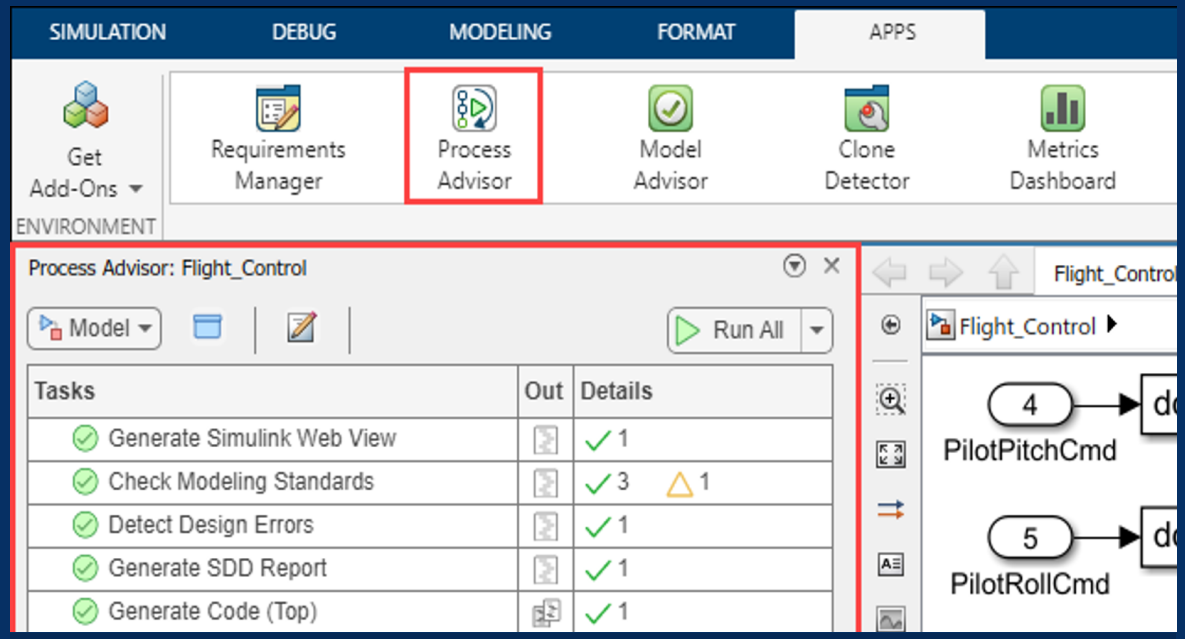
# From Scripted Pipelines to Process Advisor

# From Scripted Pipelines to Process Advisor

"Bring everything into MATLAB."

*- Martin Römpert, Continental Automotive Technologies GmbH*

# From Scripted Pipelines to Process Advisor

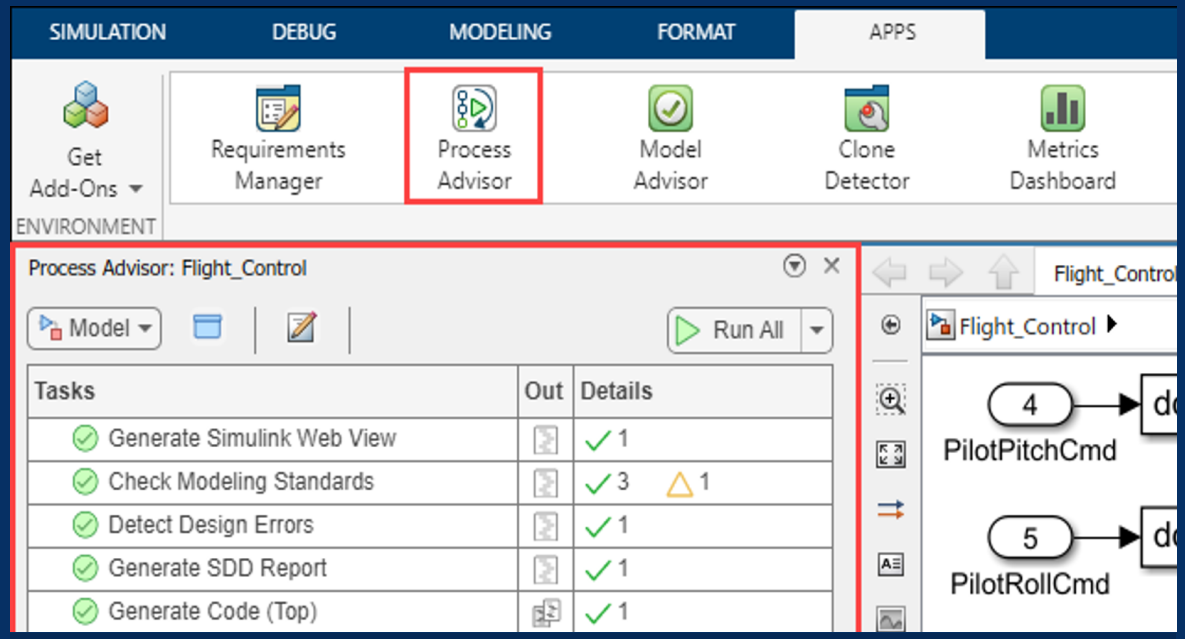



Process Advisor

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

2X

# From Scripted Pipelines to Process Advisor




Process Advisor

**500** interfaces

**1,000** components

**100** compositions

# 6 Design and simulate in the cloud

# 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);
```

**Parallel Computing Toolbox**

**MATLAB Parallel Server**

## Massive simulations

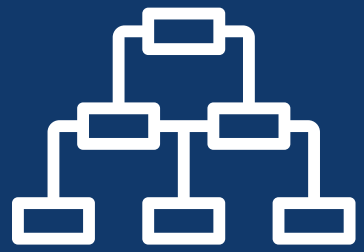
## Application Trends

Autonomous

Connectivity

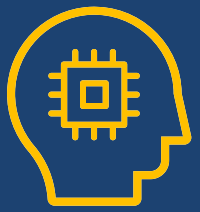
Electrification

## Workflow Trends



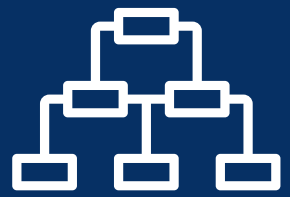
**Systems Engineering & Design**

**Modern Software Practices**



**AI for System Development**

# Workflow Trends

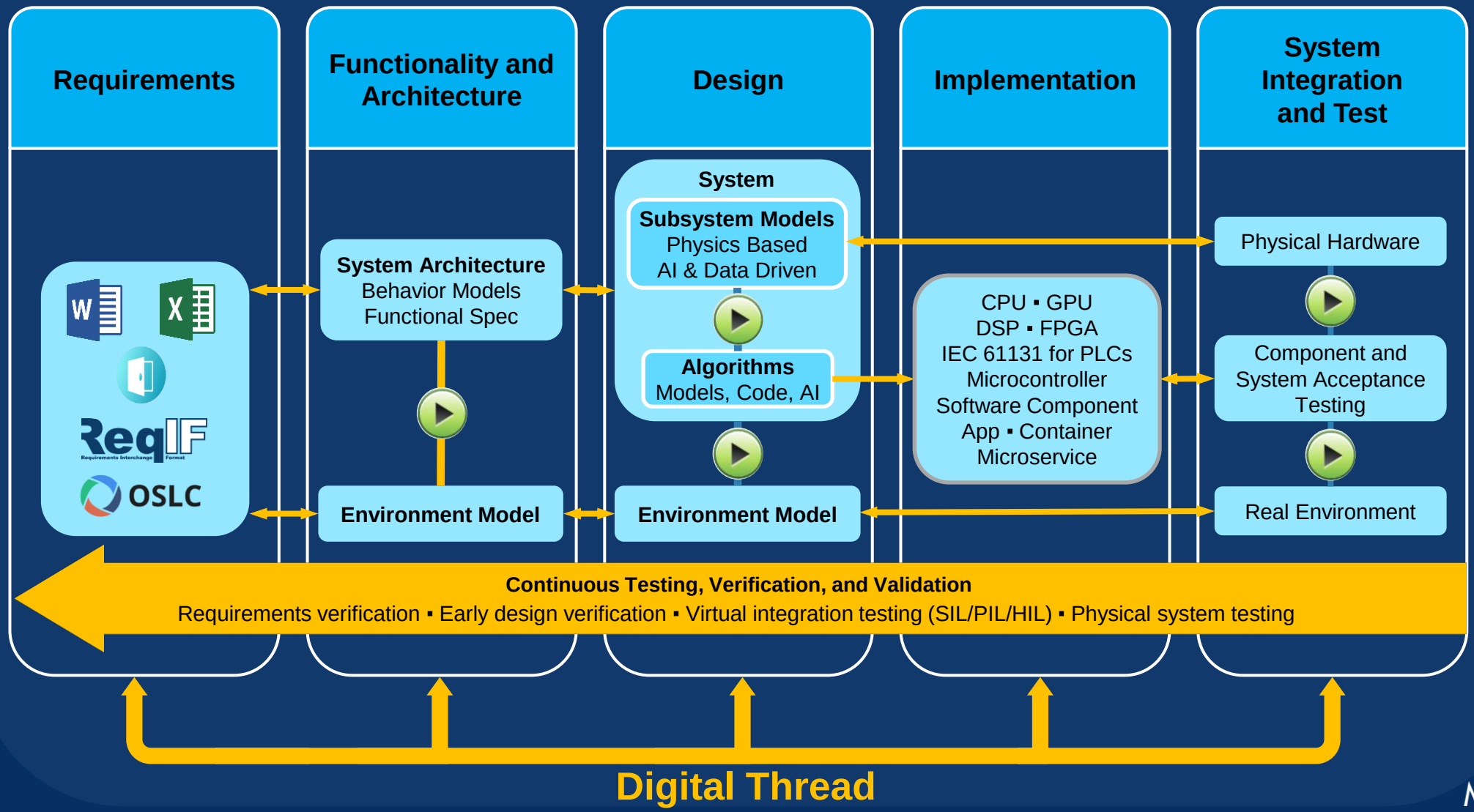


1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early

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

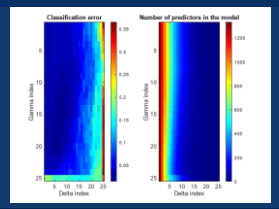
7. Design your system with AI

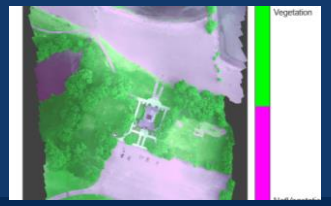
# 7 Design your system with AI

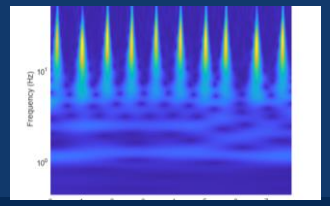


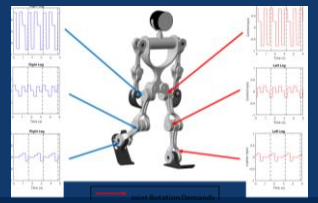
# ⑦ Design your system with AI

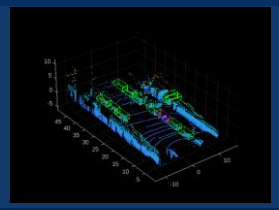
## AI Reference Examples

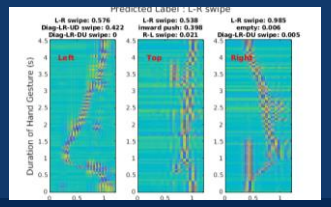

Predictive Maintenance

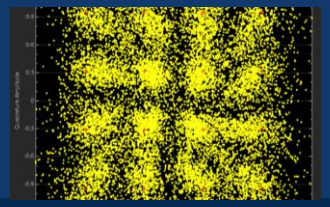

Hyperspectral Imaging


Signal Processing

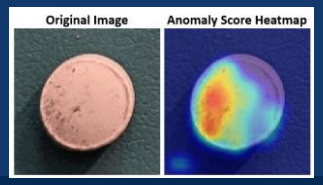

Robotic Control


Lidar Processing

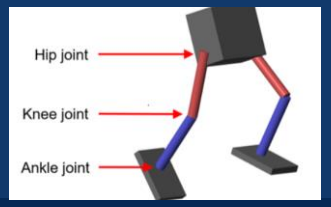

Radar Processing


Wireless Communications

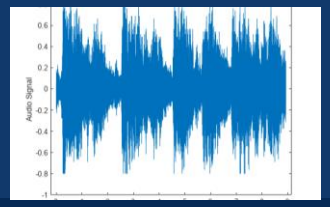

Automated Driving

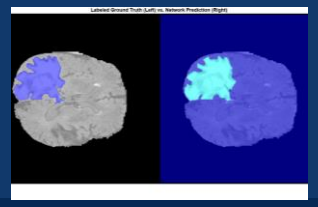


Visual Inspection



Reinforcement Learning

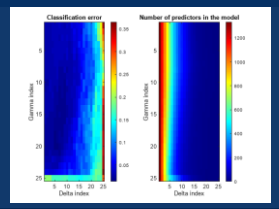

Audio

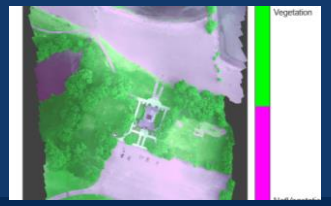

Medical Imaging

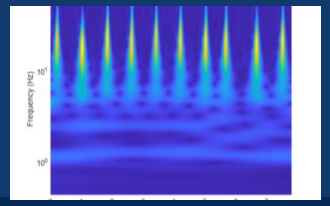
# ⑦ Design your system with AI

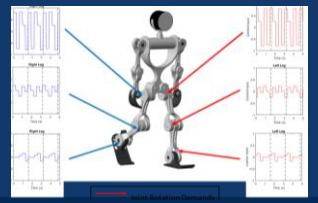
**Tech Talk**: The Industrial AI Lifecycle: Dreaming, Designing, and Delivering in the Digital Age

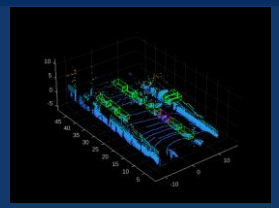
## AI Reference Examples

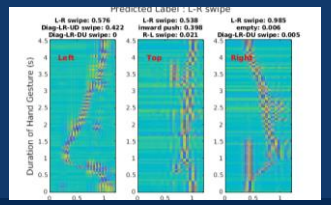

Predictive Maintenance

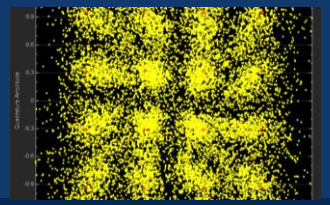

Hyperspectral Imaging


Signal Processing

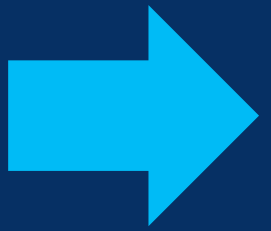

Robotic Control


Lidar Processing


Radar Processing

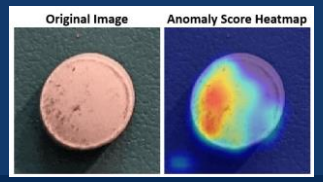

Wireless Communications


Automated Driving

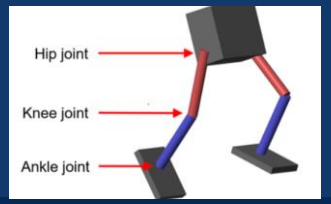


CPU

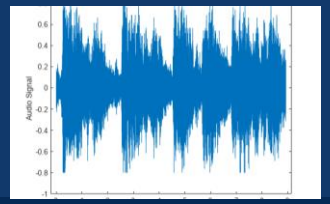
GPU

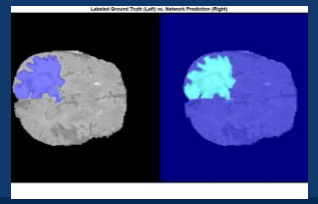


Visual Inspection



Reinforcement Learning


Audio


Medical Imaging

FPGA, ASIC, PLC

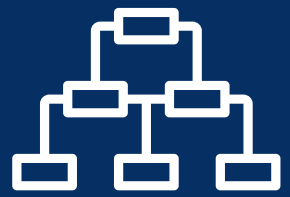
# Simulates Hardware Sensors with Deep Neural Networks

*"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*

6X

# Workflow Trends

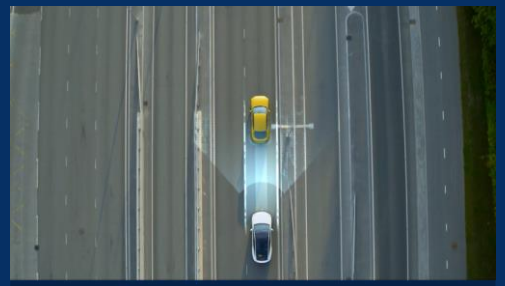


1. Automate everything
2. Scale to complex systems
3. Use automatic code generation
4. Prevent defects early

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

7. Design your system with AI

# Application Trends



Autonomous

Connectivity

Electrification

## Workflow Trends

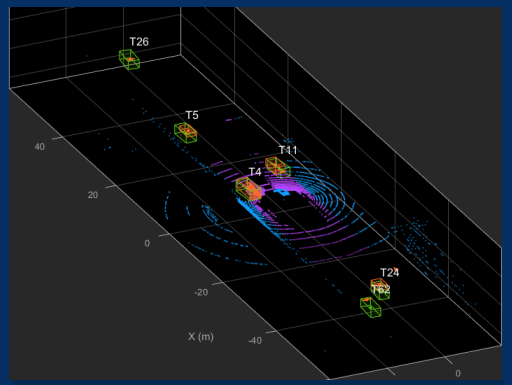
Systems Engineering & Design

Modern Software Practices

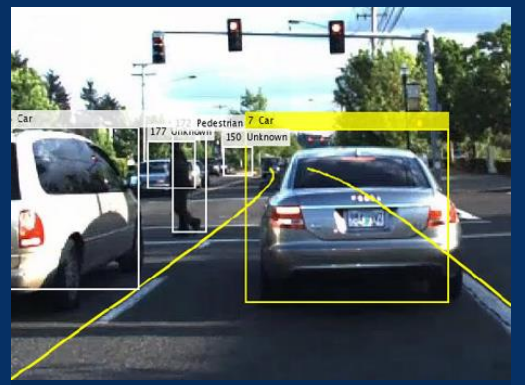
AI for System Development

# Deliver autonomous systems

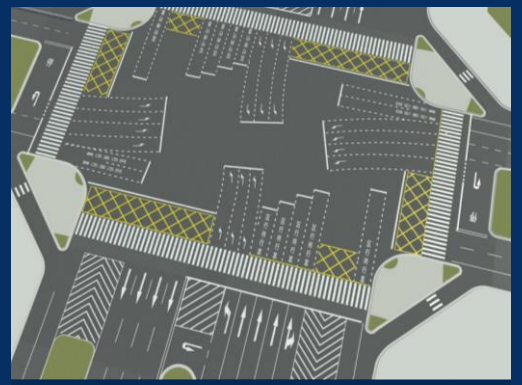
**Braking and Steering**



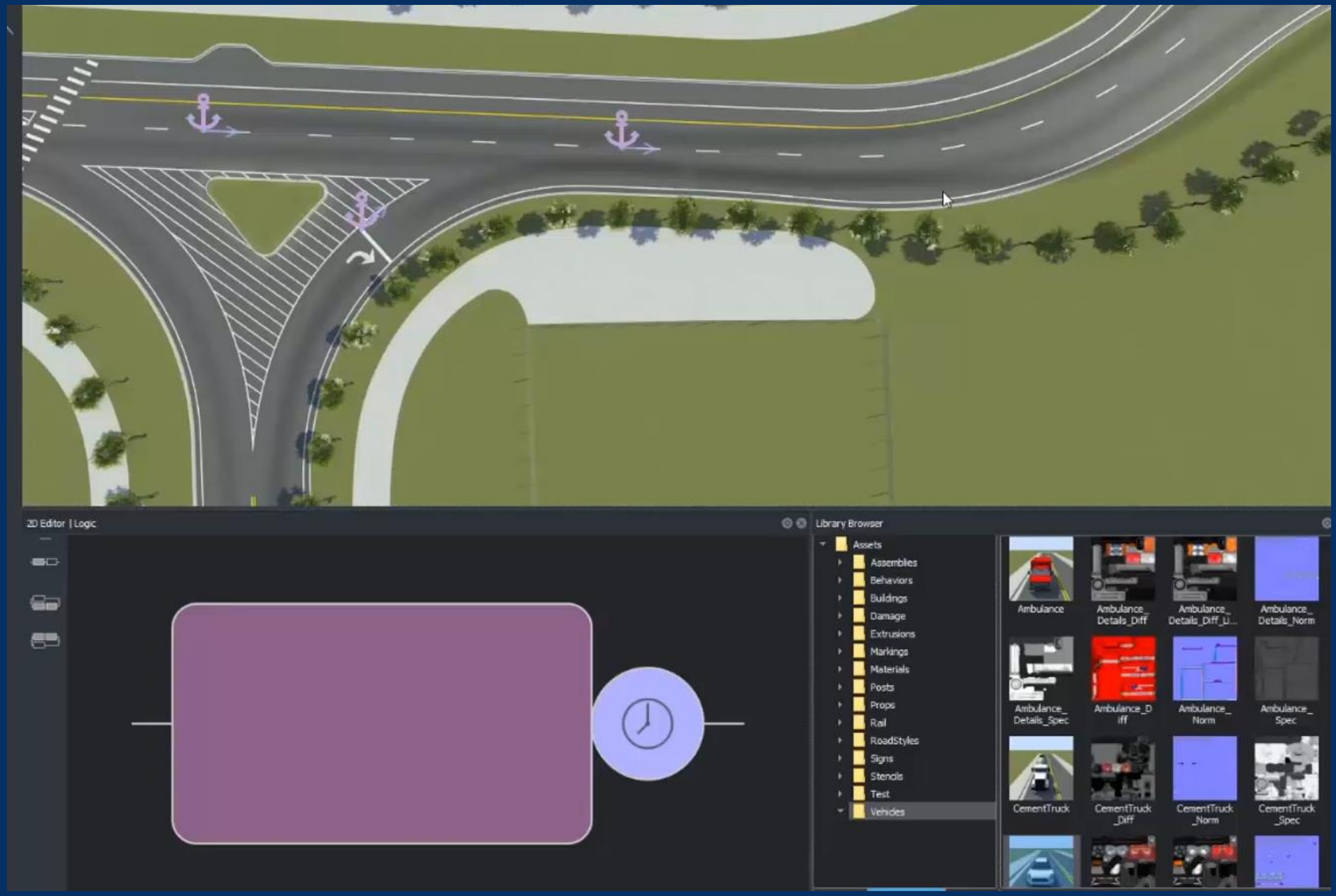

**Sensor Fusion and Tracking**

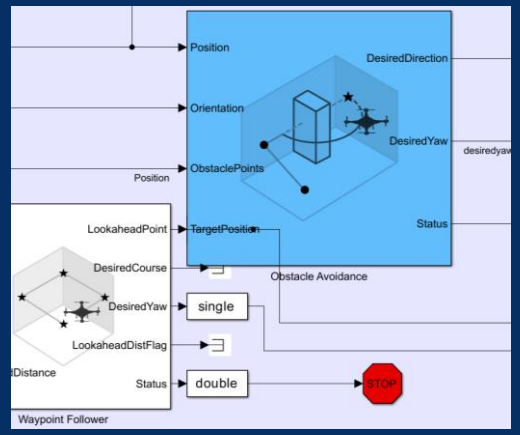


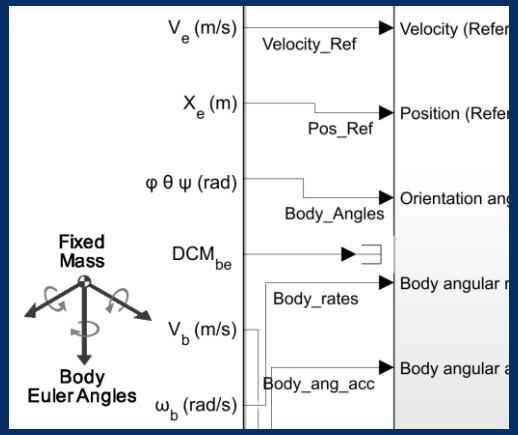

**Computer Vision Radar, Lidar**

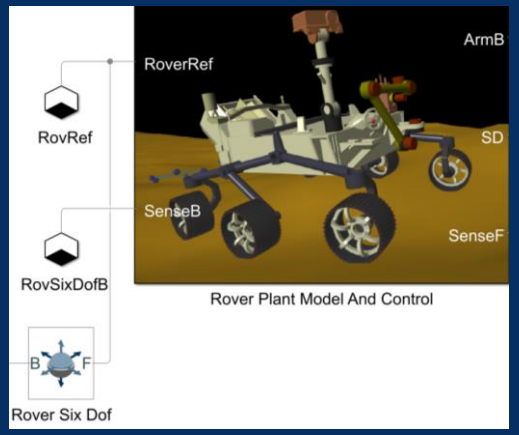


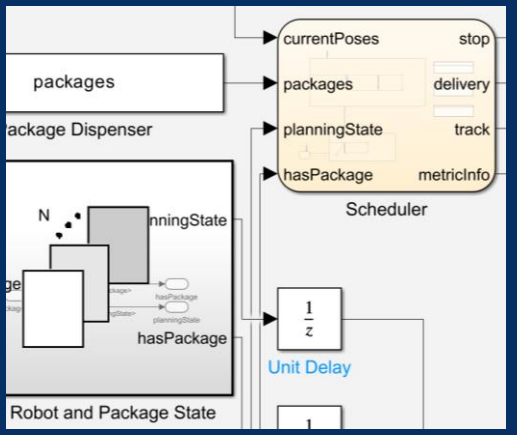
**Road Network Design**


2D Editor | Logic
Library Browser
Assets
Assemblies
Behaviors
Buildings
Damage
Extrusions
Markings
Materials
Posts
Props
Rail
RoadStyles
Signs
Stencils
Test
Vehicles
Ambulance
Ambulance_ Details_Diff
Ambulance_ Details_Diff_Li...
Ambulance_ Details_Norm
Ambulance_ Details_Spec
Ambulance_D iff
Ambulance_ Norm
Ambulance_ Spec
CementTruck
CementTruck _Diff
CementTruck _Norm
CementTruck _Spec

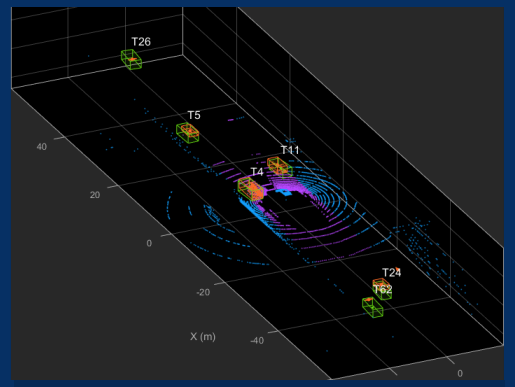



**Unmanned Aerial Vehicle**

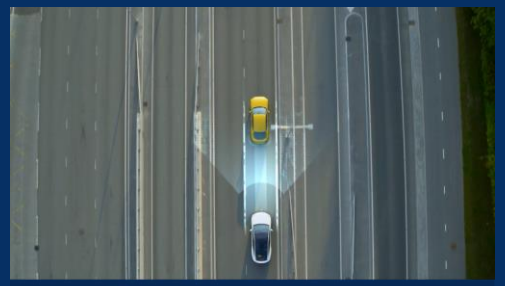



**Autonomous Underwater Vehicle**

**Ground Robot**

**Industrial Robot**

# Application Trends



Autonomous

Connectivity

Electrification

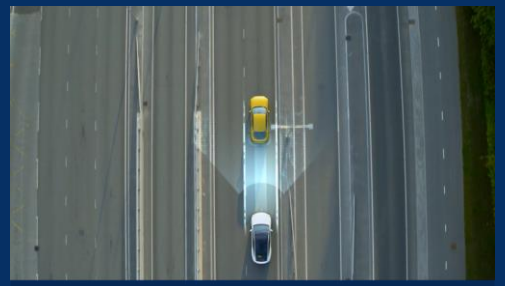
## Workflow Trends

Systems Engineering & Design

Modern Software Practices

AI for System Development

# Application Trends



Autonomous

Connectivity

Electrification

## Workflow Trends

Systems Engineering & Design

Modern Software Practices

AI for System Development

# 5G Standard

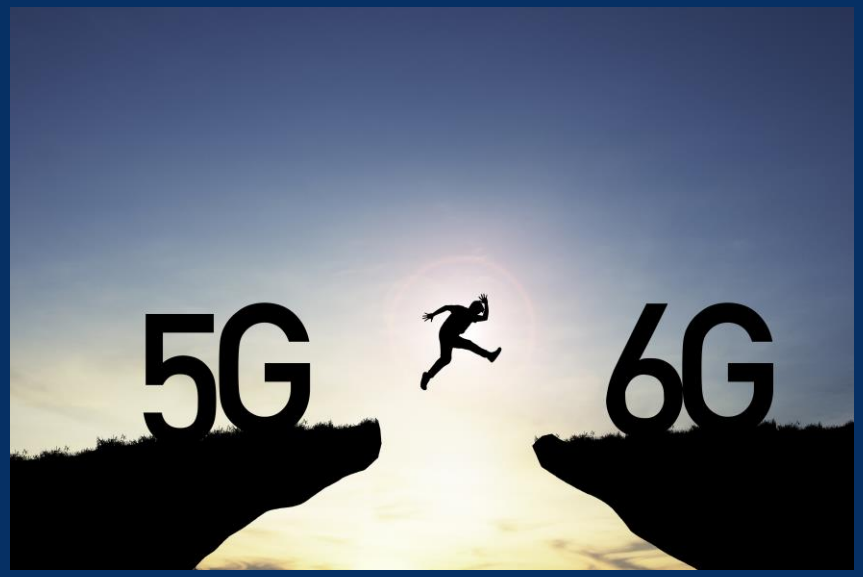

*ucts*

*tasets*

*l that*

*neering,*

# 6G standard



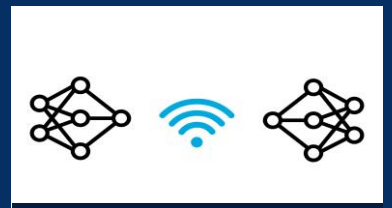
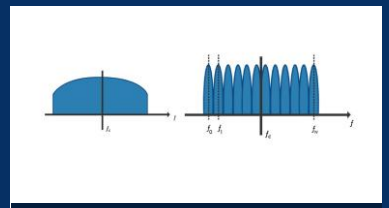
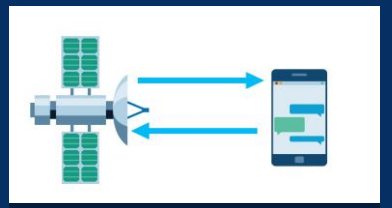

RCRWireless News
INTELLIGENCE ON ALL THINGS WIRELESS

China aims for 6G commercialization by 2030: Report

By **Juan Pedro Tomás** December 13, 2023

6G Standards

# 6G being designed now

| | | | | | |
|---|---|---|---|---|---|
| **Key Technologies** |  **Artificial intelligence and machine learning** |  **Spectrum bands** |  **Network that can sense** |  **Extreme connectivity** |  **New network architectures** |
| **MathWorks Products** | Communications, 5G, WLAN Toolboxes, w/ Deep Learning Toolbox | RF Blockset, Antenna Toolbox | WLAN Toolbox, 5G Toolbox, Radar Toolbox | Satellite Communications Toolbox | Future |

6G Exploration Library (R2024a)

# 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-enhanced wireless communications

## AI strengths

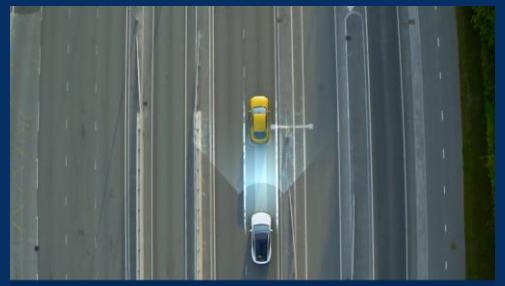
- Determining appropriate representations for hard-to-model problems
- Finding near-ideal and computationally realizable solutions
- Modeling non-linear functions

## Applying AI to solve difficult wireless challenges

Deep wireless domain knowledge is required to optimally use AI capabilities

Slide courtesy of Qualcomm

# Application Trends



Autonomous

Connectivity

Electrification

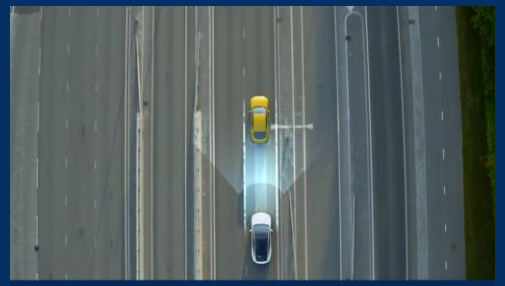
## Workflow Trends

Systems Engineering & Design

Modern Software Practices

AI for System Development

# Application Trends



Autonomous

Connectivity

Electrification

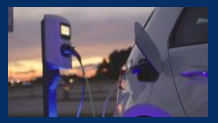
## Workflow Trends

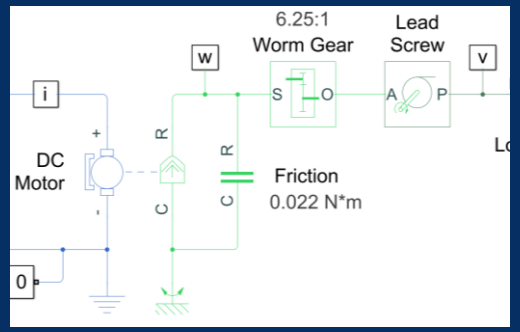
Systems Engineering & Design

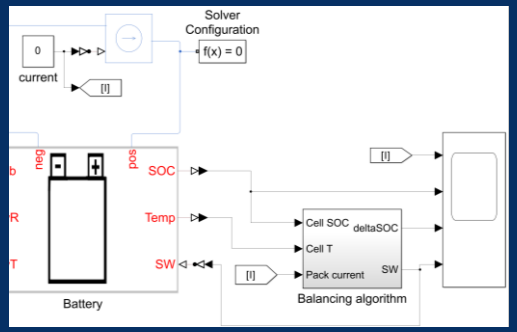
Modern Software Practices

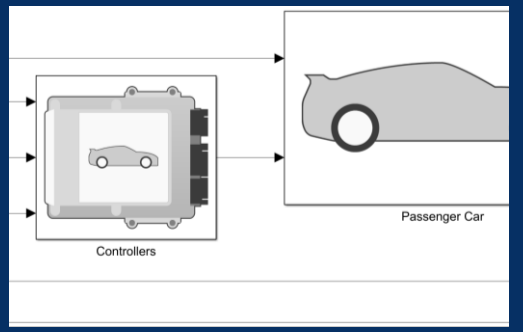
AI for System Development

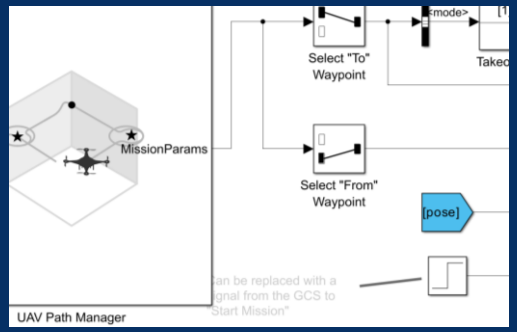
# Electric Vehicles






Electric Motors

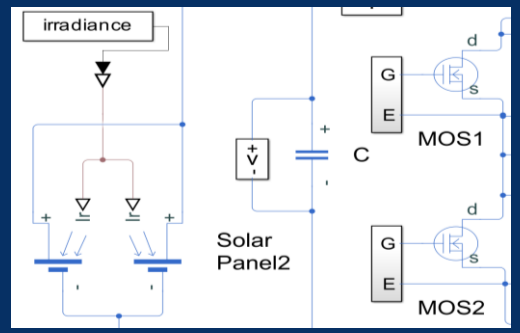
Battery Packs

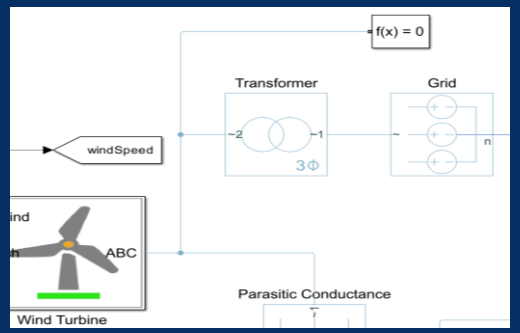
Full Vehicle Models

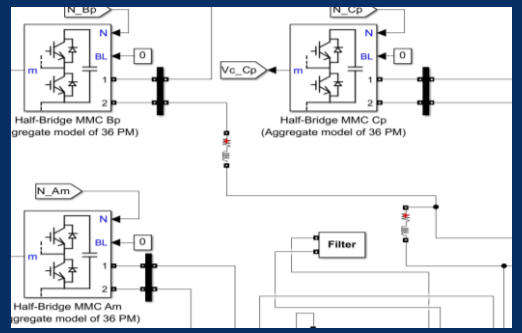
Aerial Vehicles

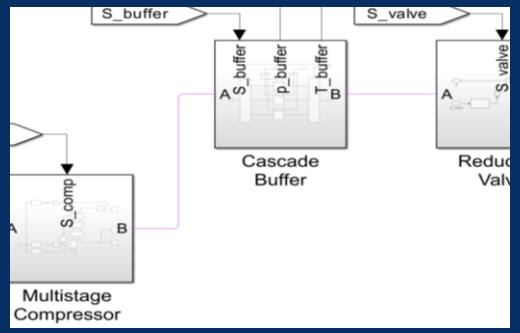
# Green Energy

**Tech Talk**: Addressing Challenges of Meeting Net-Zero Goals with Simulation and Model-Based Design




**Solar**

**Wind**

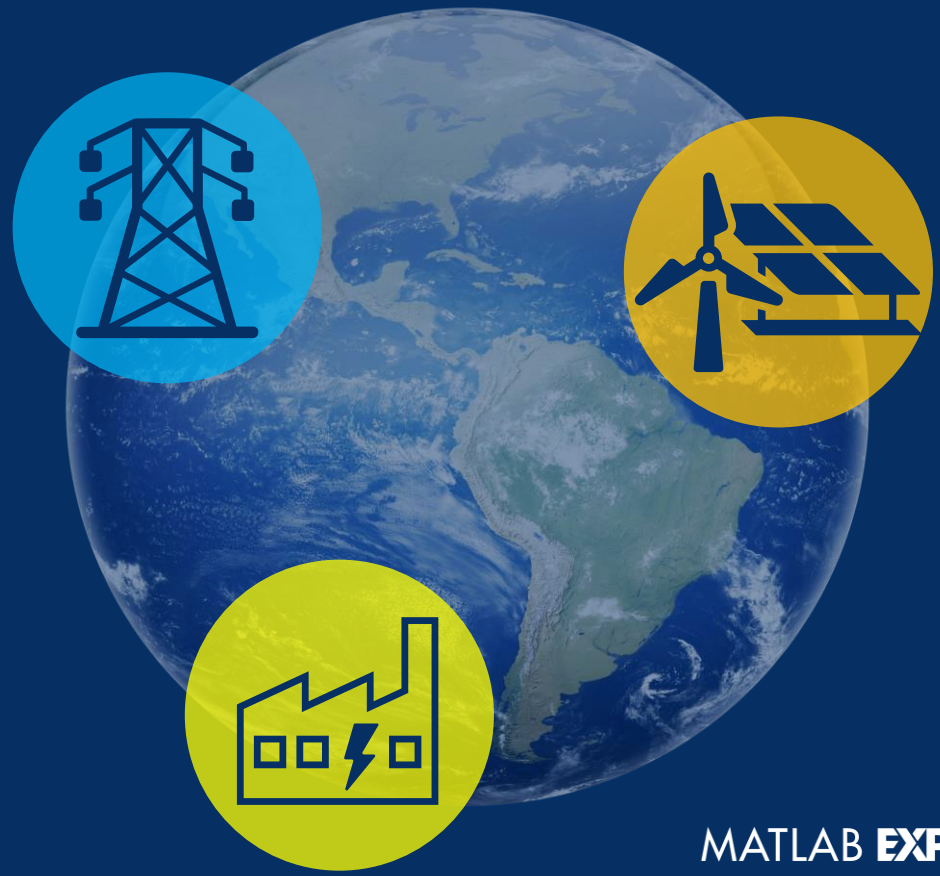
**Hydroelectric**


**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

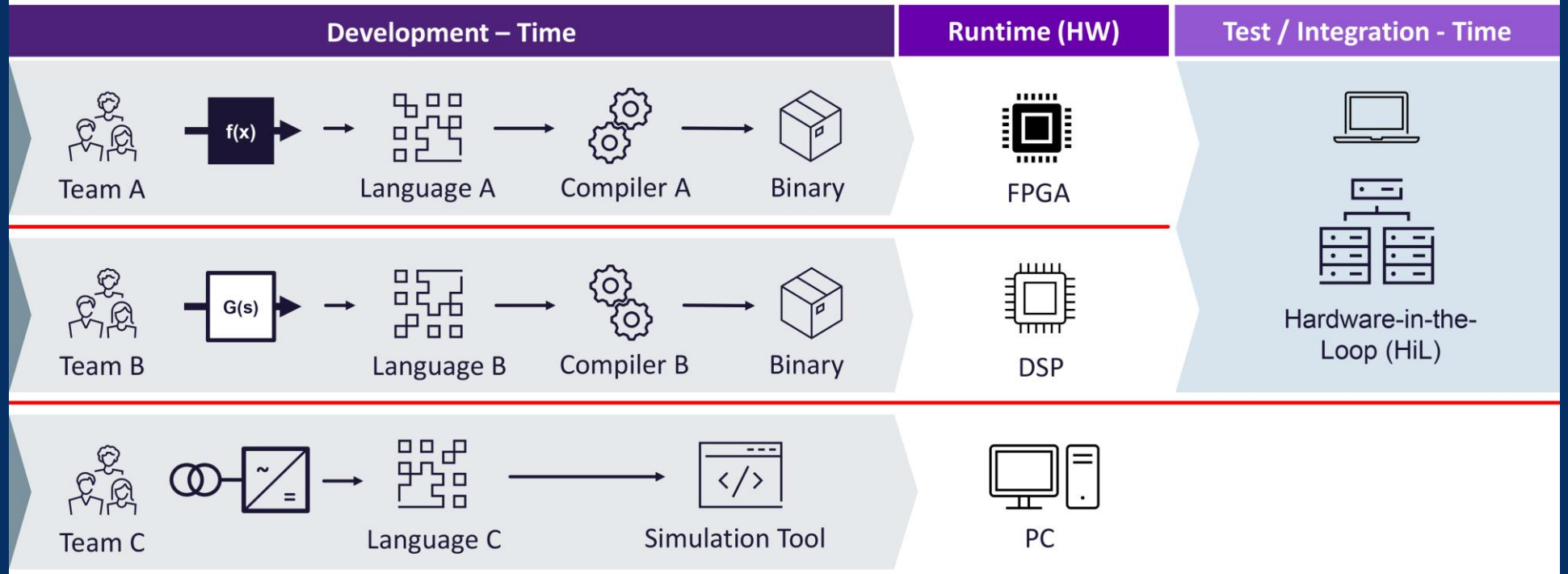


SIEMENS energy

# Enables the Global Energy Transition

## Swimlane Engineering

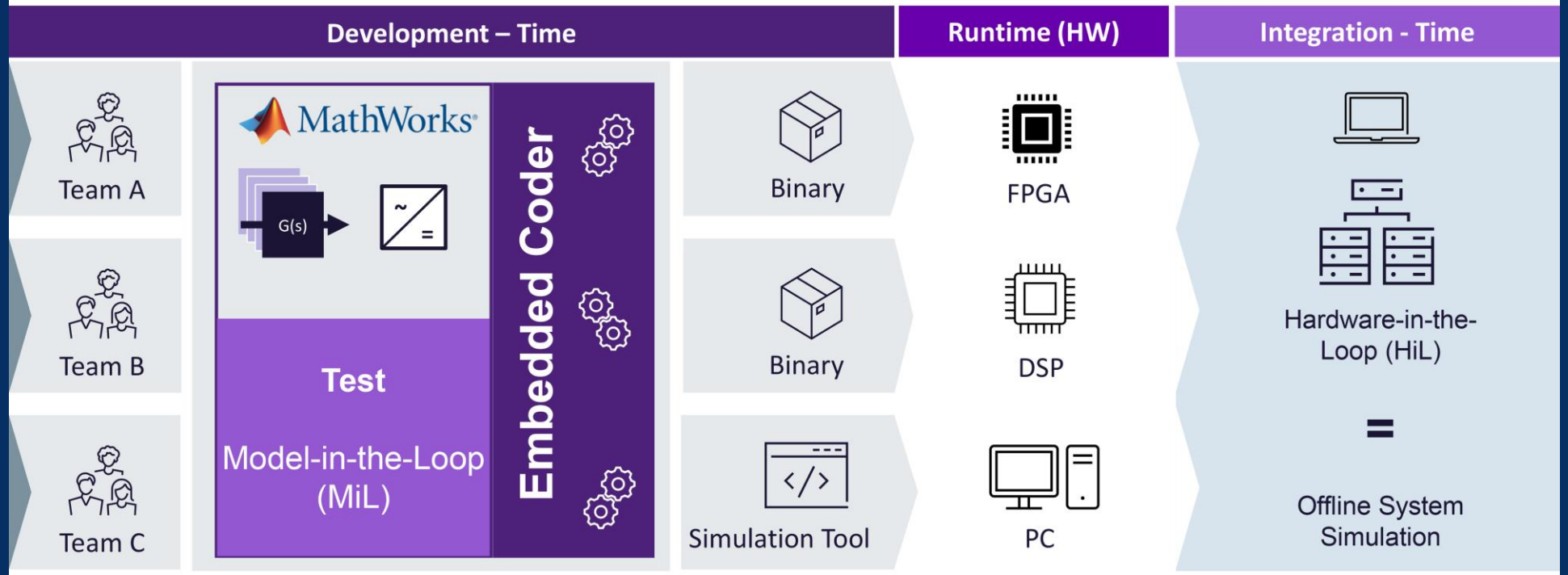
When the organization shapes development



# Enables the Global Energy Transition

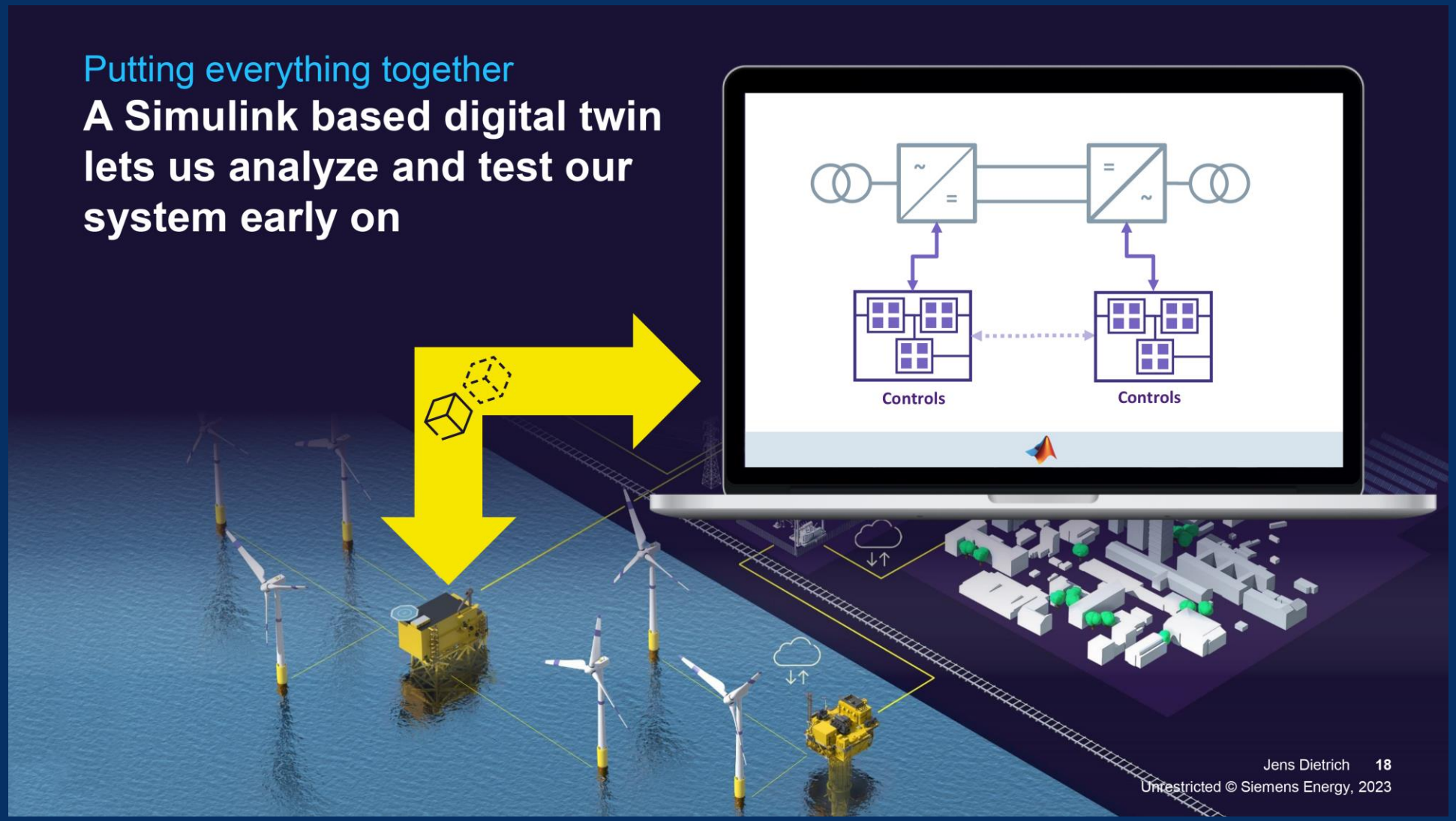
## Centralized Engineering Ecosystem

When development extends across the organization



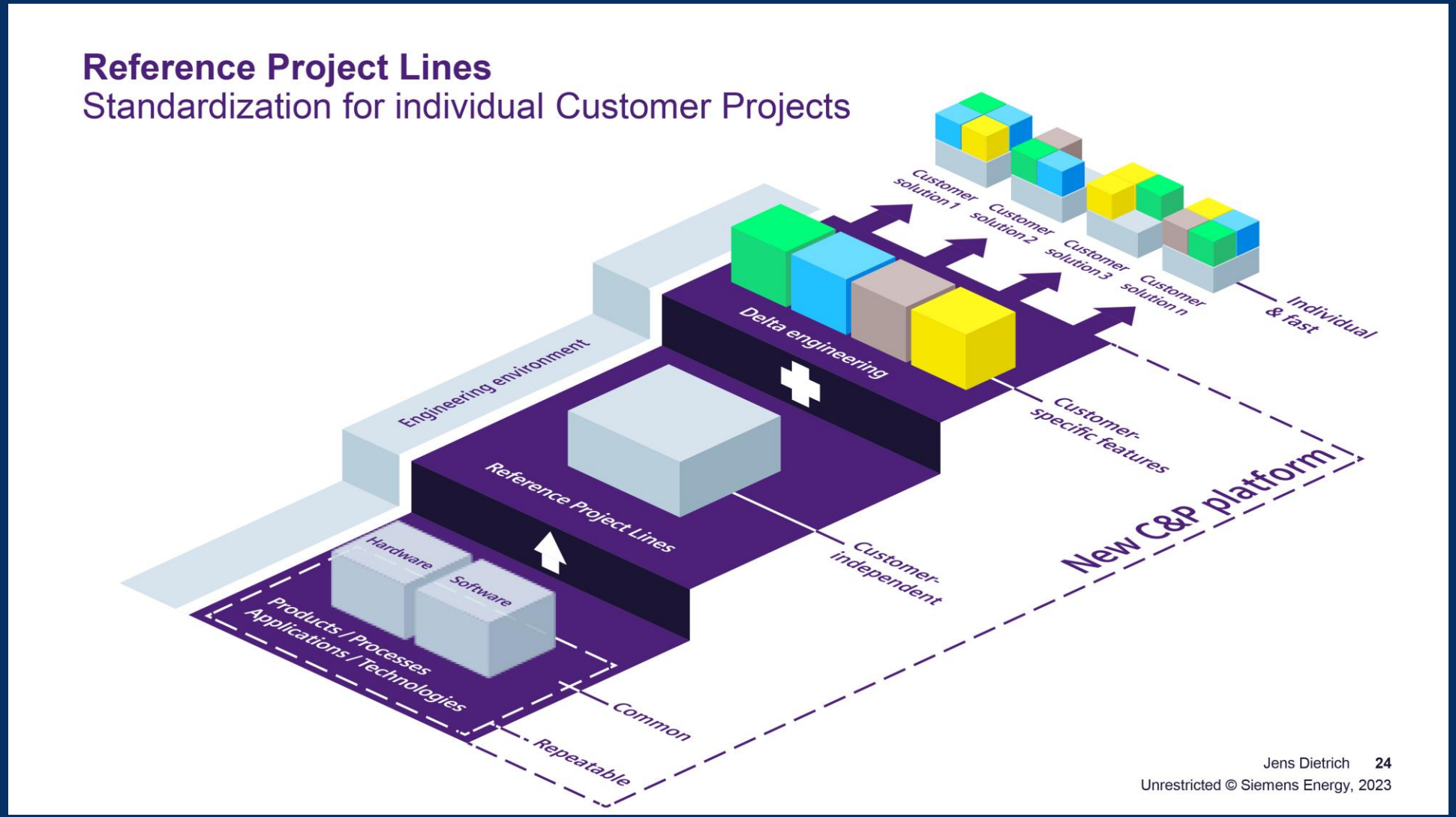
SIEMENS energy

# Enables the Global Energy Transition

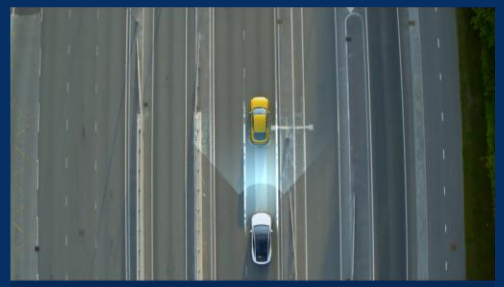


SIEMENS energy

# Enables the Global Energy Transition



# Application Trends

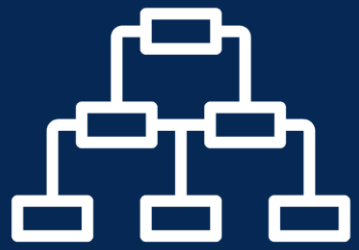


Autonomous

Connectivity

Electrification

# Workflow Trends



Systems Engineering & Design

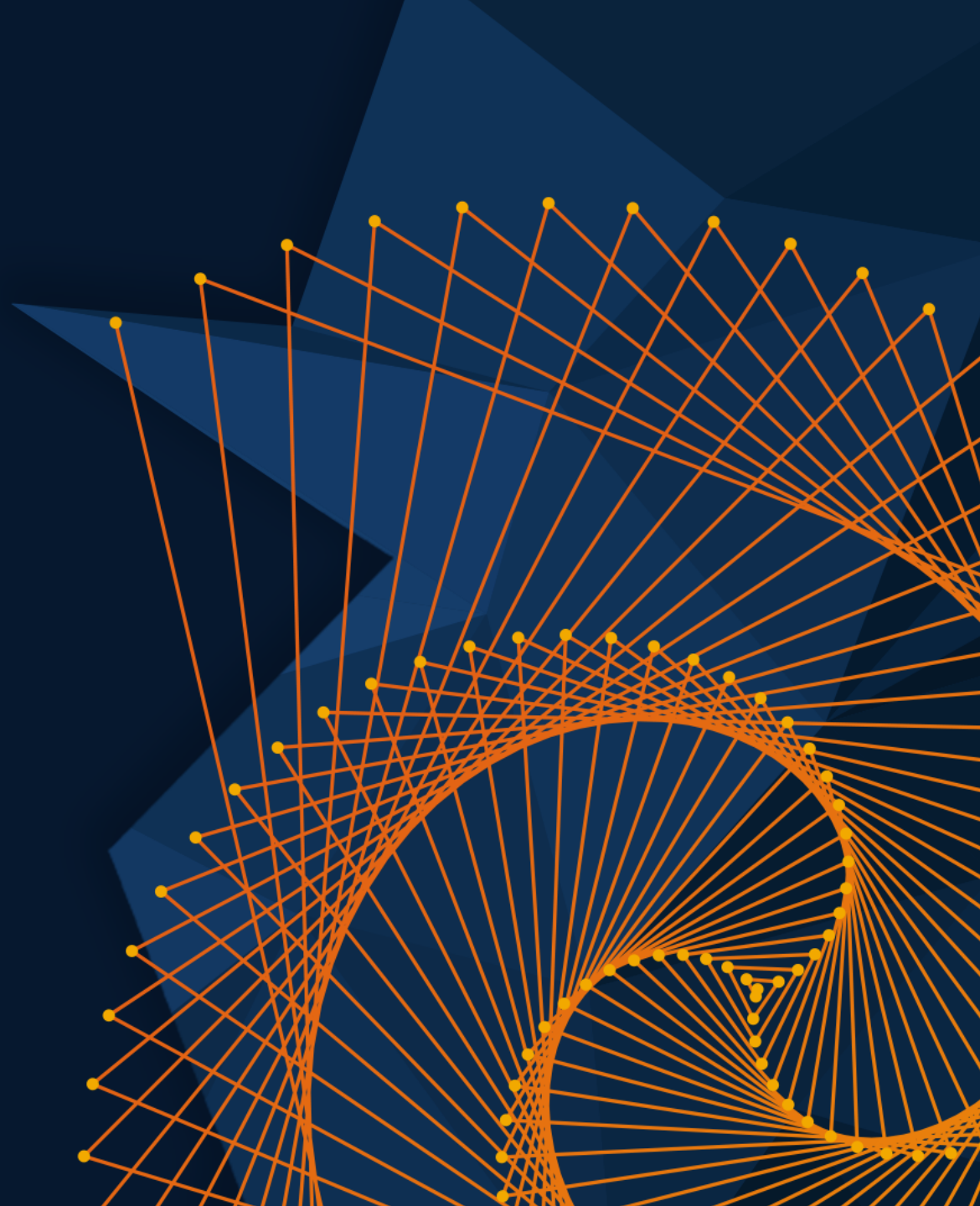
Modern Software Practices

AI for System Development


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

# MATLAB EXPO

INDIA



MathWorks®