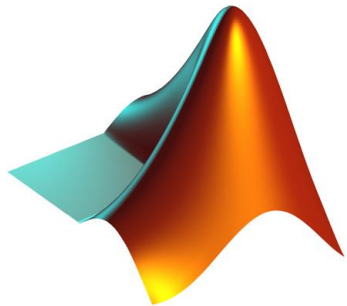# Penny @ MathWorks, Rise of DevOps

- Revision control
- Issue tracking
- Project management
- Test harness
- Continuous integration
- Release processes
- …

MATLAB 5.0

Road to Software Defined Vehicles

| Electrification | Automated driving | Connected vehicles |

Software Defined Vehicle

Challenges for SW Development

- Adopting Central Computers and Service-oriented Architectures
- Deploying AI and Data-driven features
- Adopting Agile & DevOps methodologies

Challenges for Organizations

- Reshaping of the value chain
- Mindset shift to virtual development
- Workforce mobility and talent acquisition

Road to Software Defined Vehicles

Electrification

Automated driving

Connected vehicles

Software Defined Vehicle

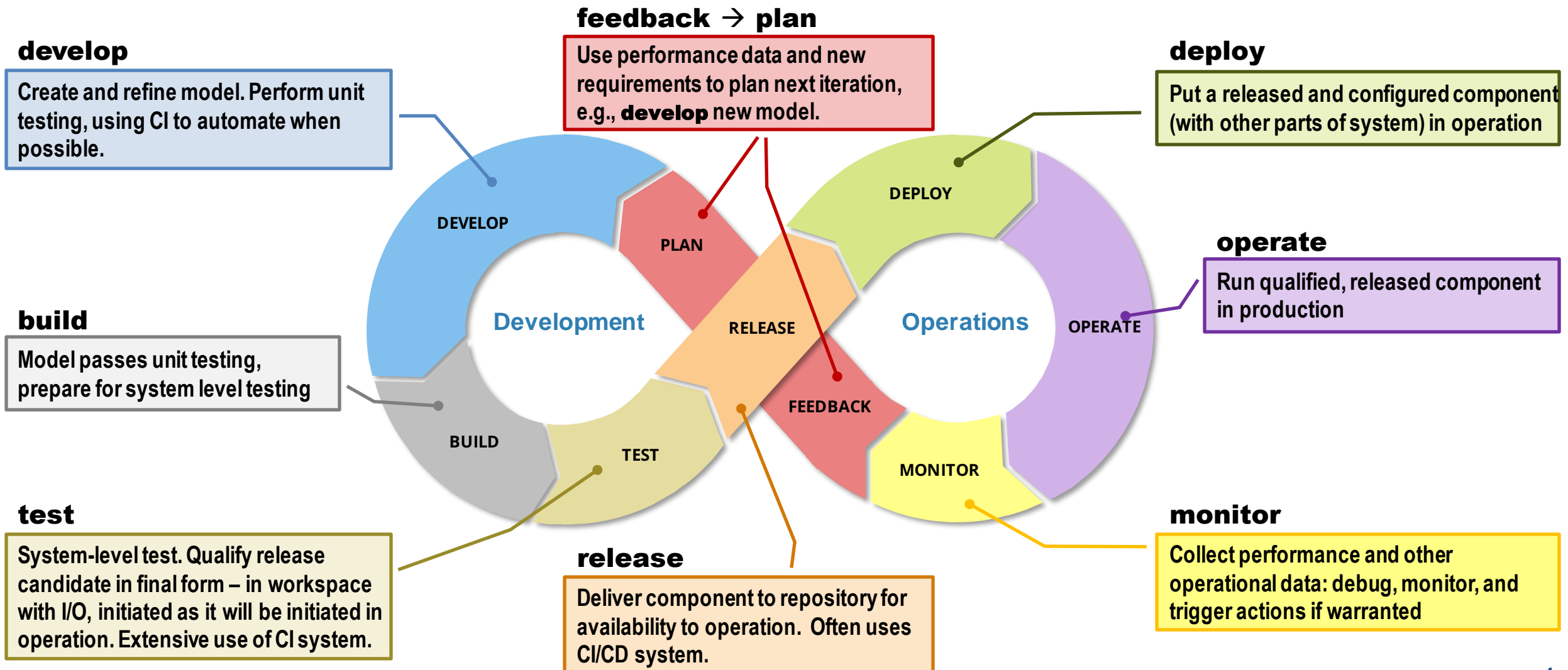## Challenges for SW Development

- Adopting Central Computers and Service-oriented Architectures
- Deploying AI and Data-driven features
- Range Optimization
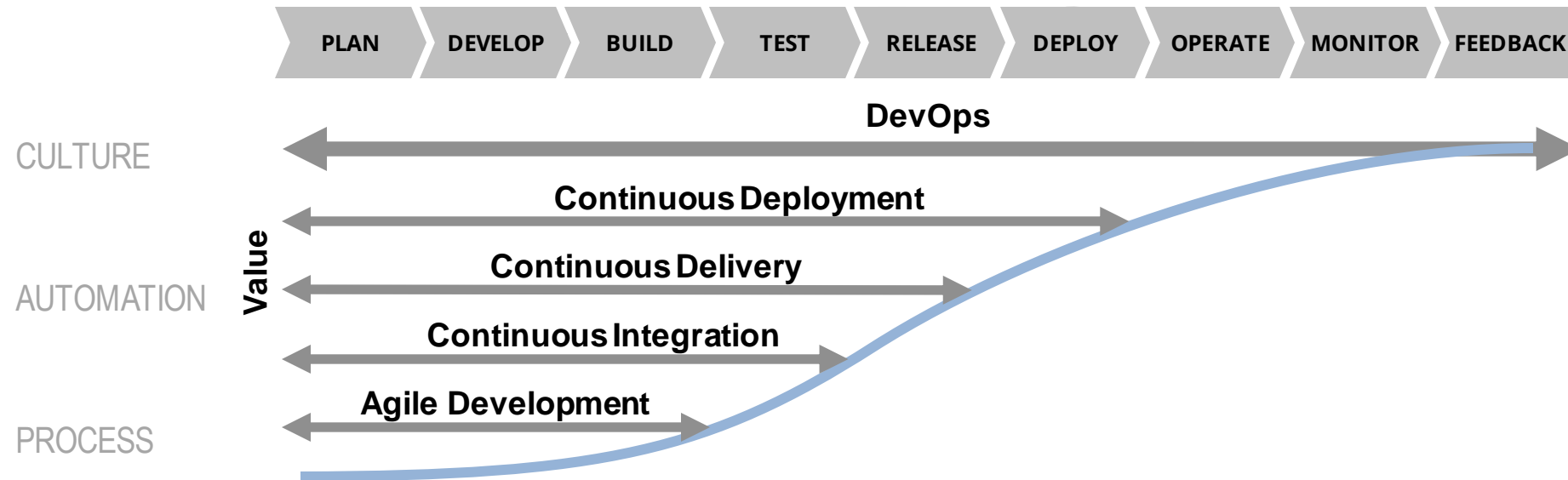
Challenges for Organizations

- Reshaping of the value chain
- Mindset shift to virtual development
- Workforce mobility and talent acquisition

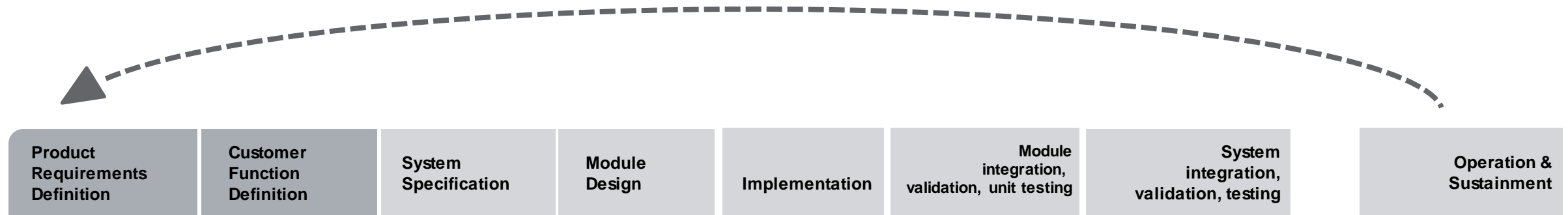**Adopting Agile & DevOps methodologies**

DevOps: a set of practices, tools and philosophy to automate and integrate processes between Development and Operations

develop

Create and refine model. Perform unit testing, using CI to automate when possible.

feedback → plan

Use performance data and new requirements to plan next iteration, e.g., **develop** new model.

deploy

Put a released and configured component (with other parts of system) in operation

build

Model passes unit testing, prepare for system level testing

operate

Run qualified, released component in production

test

System-level test. Qualify release candidate in final form – in workspace with I/O, initiated as it will be initiated in operation. Extensive use of CI system.

release

Deliver component to repository for availability to operation. Often uses CI/CD system.

monitor

Collect performance and other operational data: debug, monitor, and trigger actions if warranted

DEVELOP

PLAN

DEPLOY

Development

Operations

RELEASE

OPERATE

BUILD

TEST

FEEDBACK

MONITOR

We see customers at different levels of DevOps maturity

An Automotive View of the DevOps Lifecycle

Product Requirements Definition	Customer Function Definition	System Specification	Module Design	Implementation	Module integration, validation, unit testing	System integration, validation, testing	Operation & Sustainment

Perpetually Upgradeable Vehicles

- Faster Development and Release Cycles
- Better Leverage Data from System Operation
- Enable New Types of Algorithms and Functionality in the Field

Before Model-Based Design: Highly manual with late integration
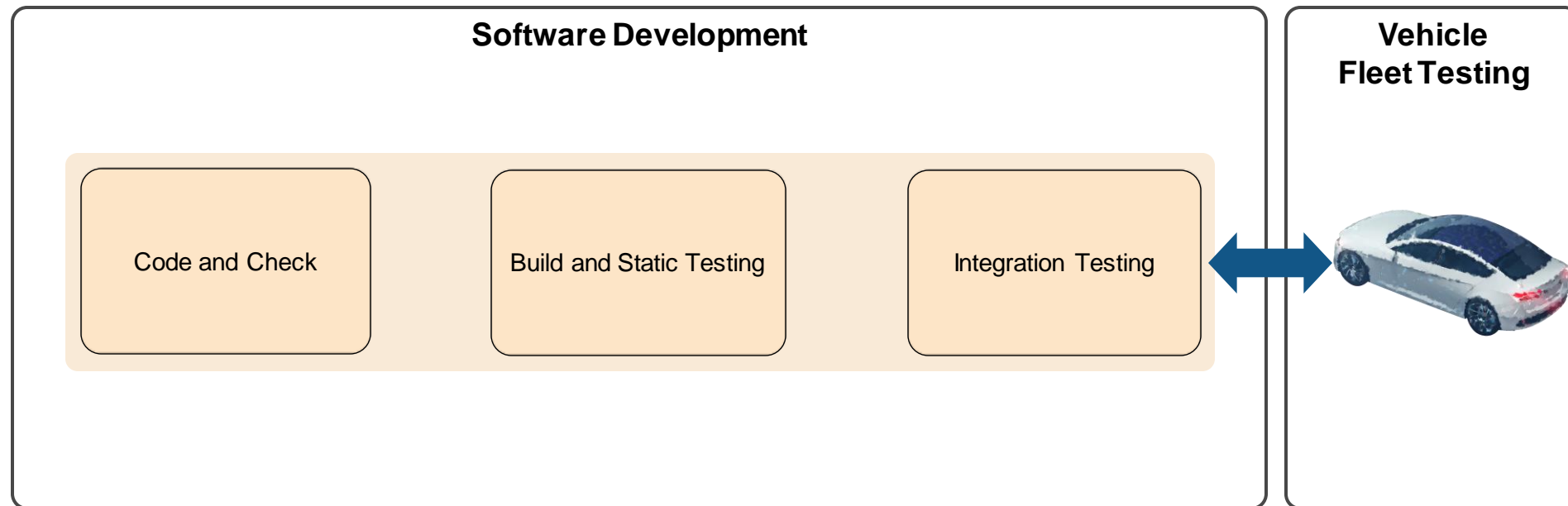
From the 2019 MAC
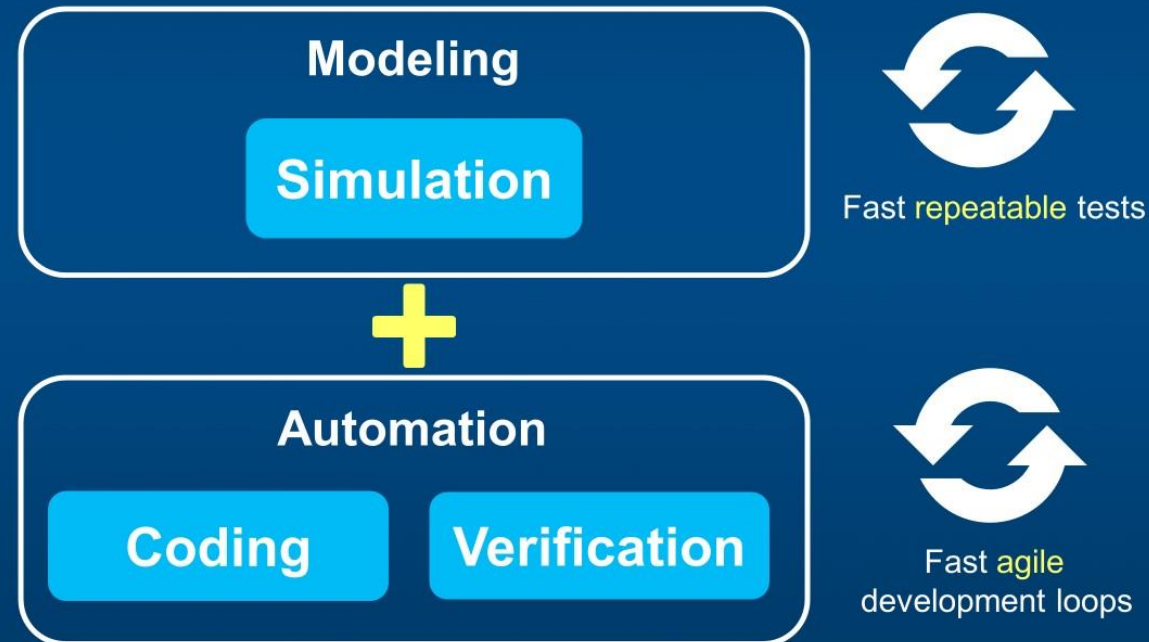
Andy Grace, VP MathWorks
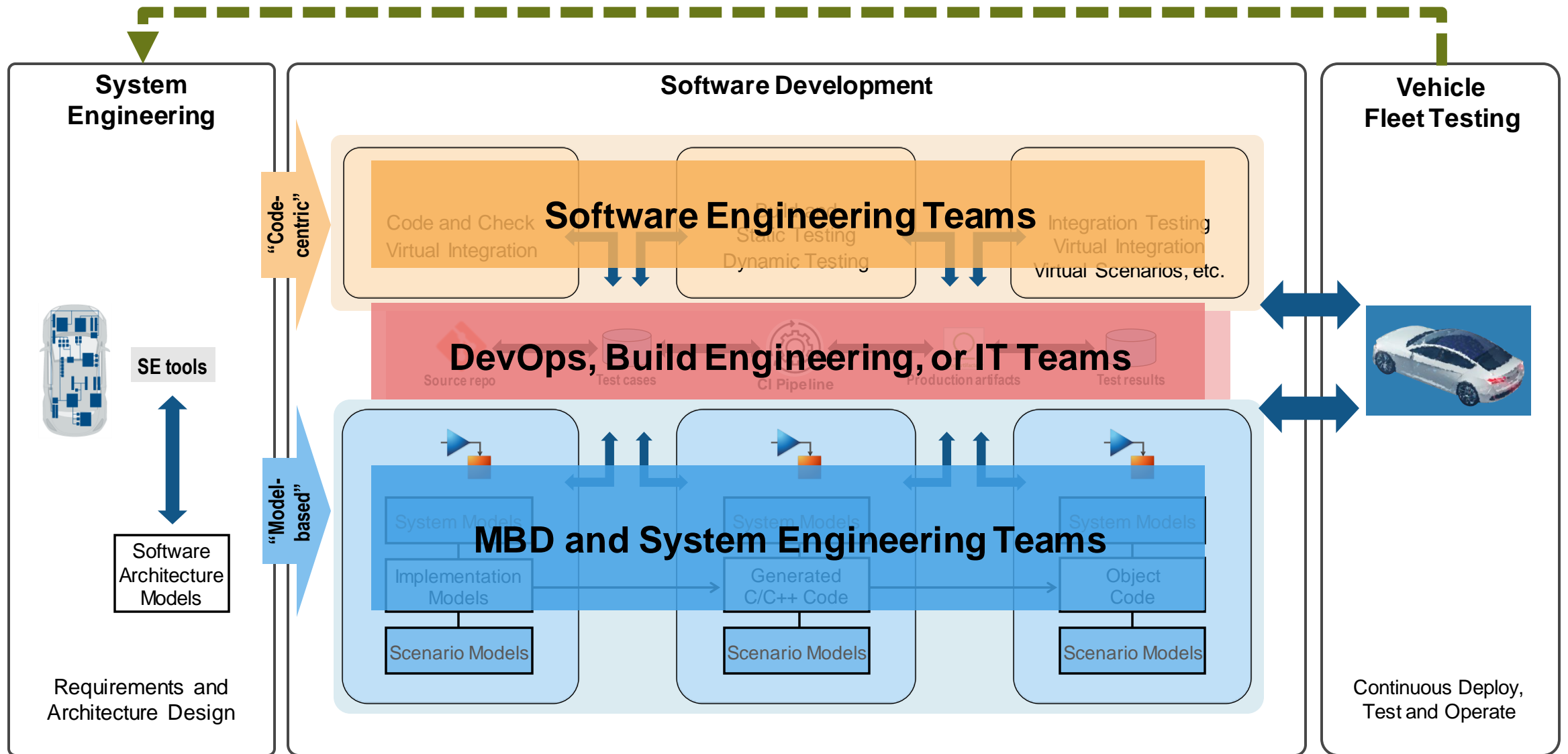*A look to the future with Model-Based Design*
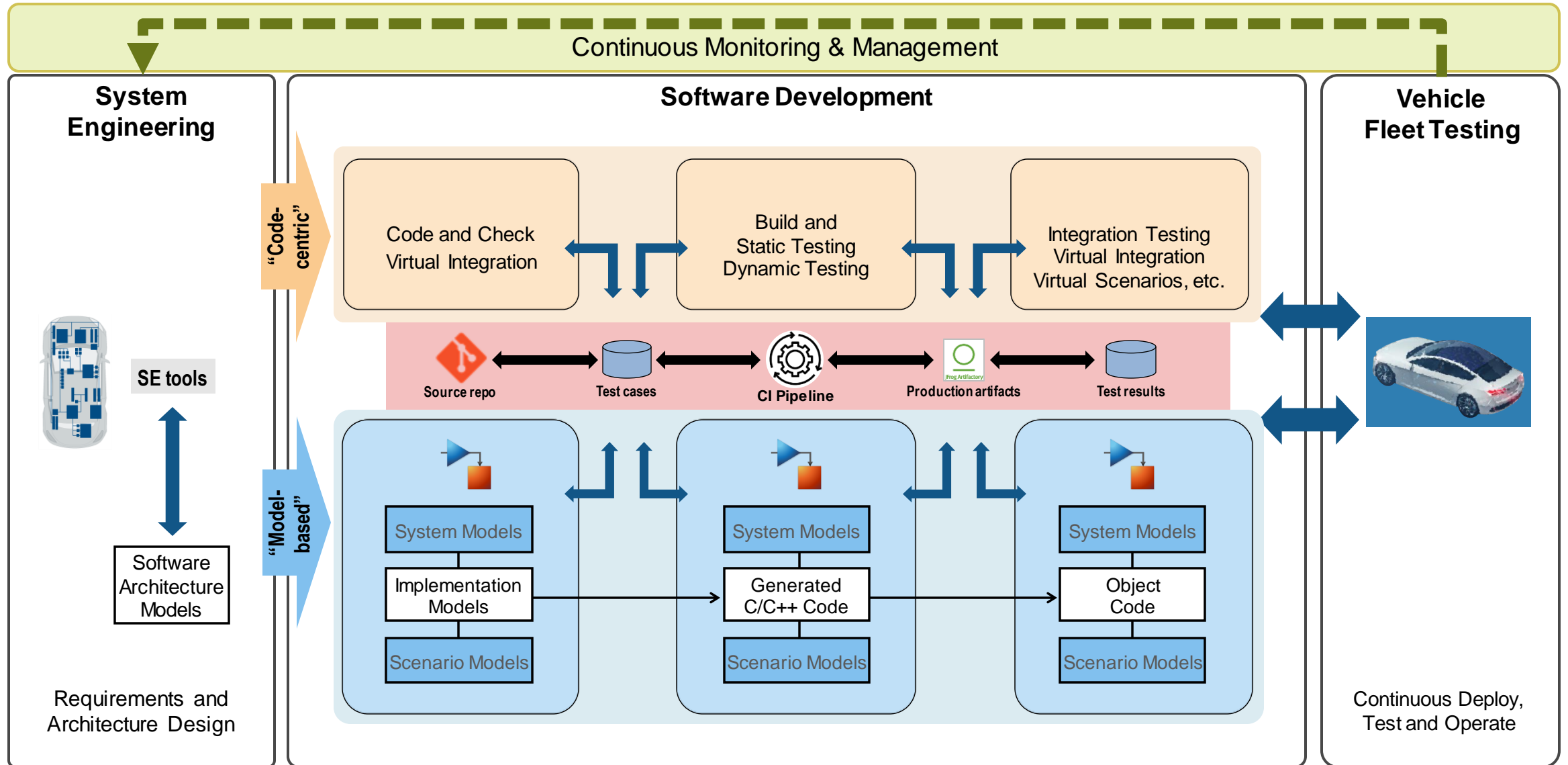
Model-Based Design
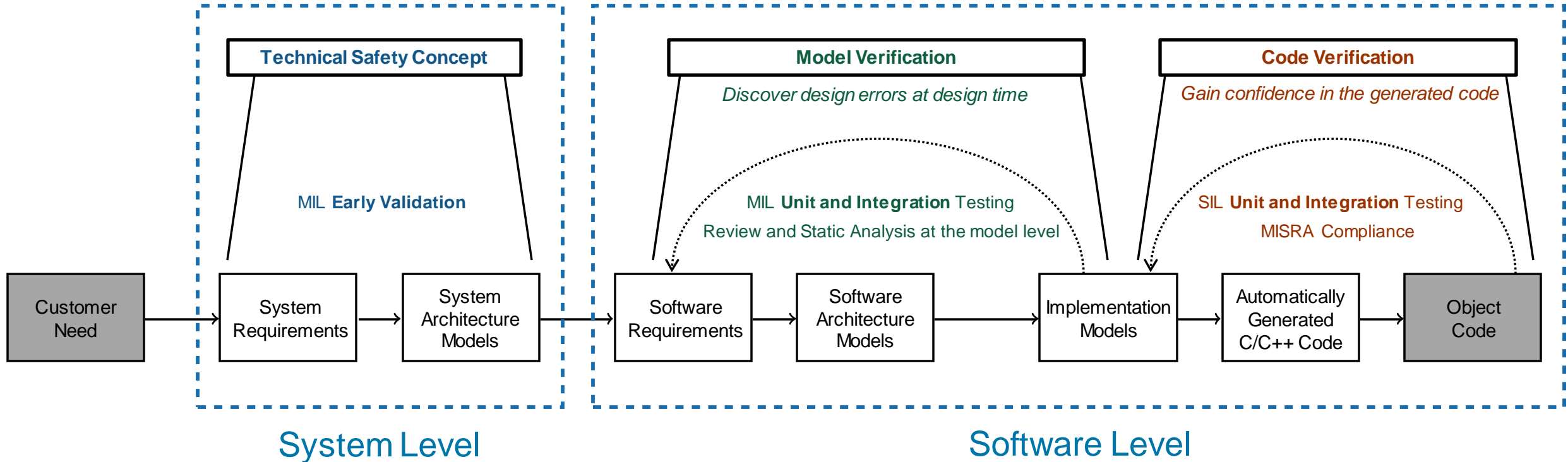
The Broader Software Development Landscape
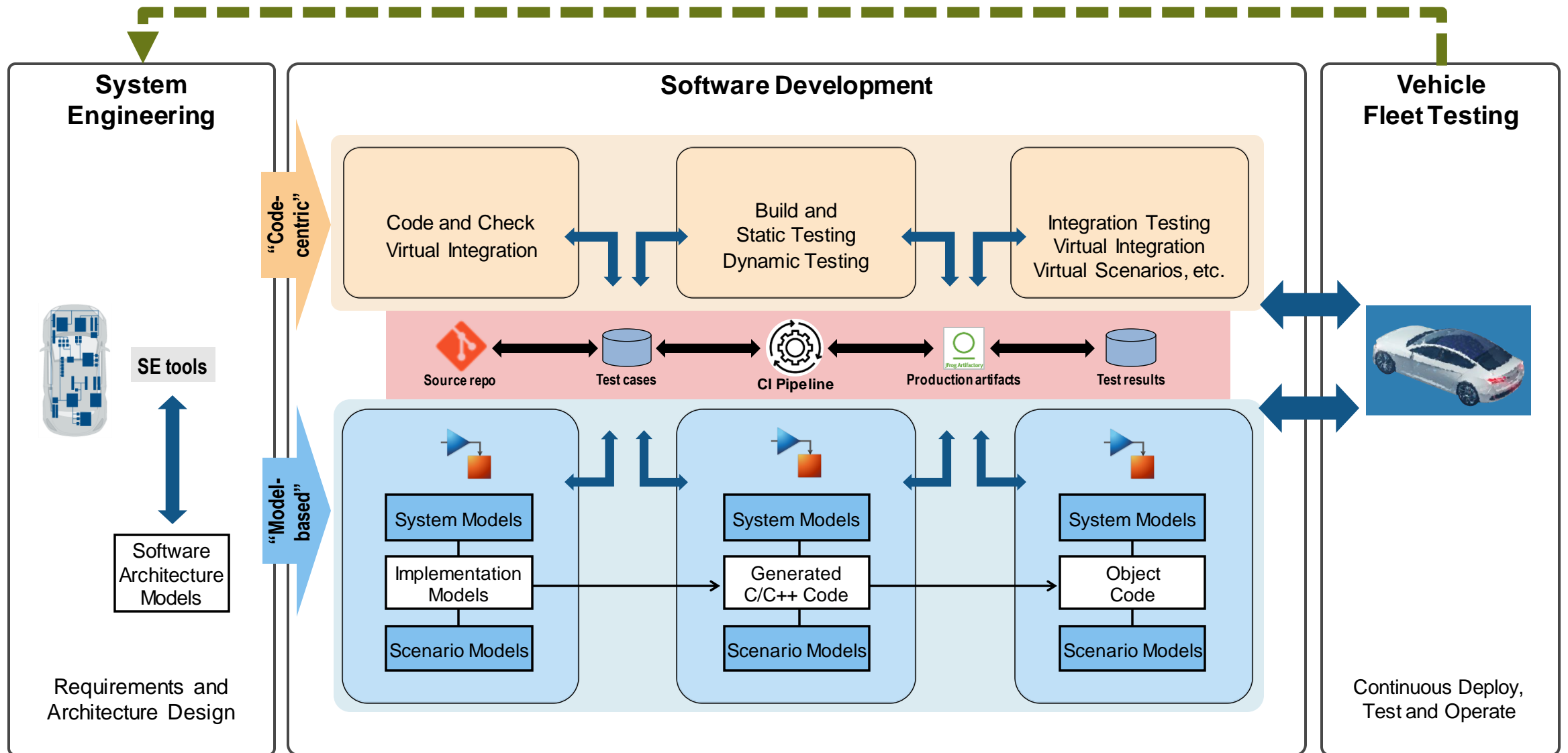
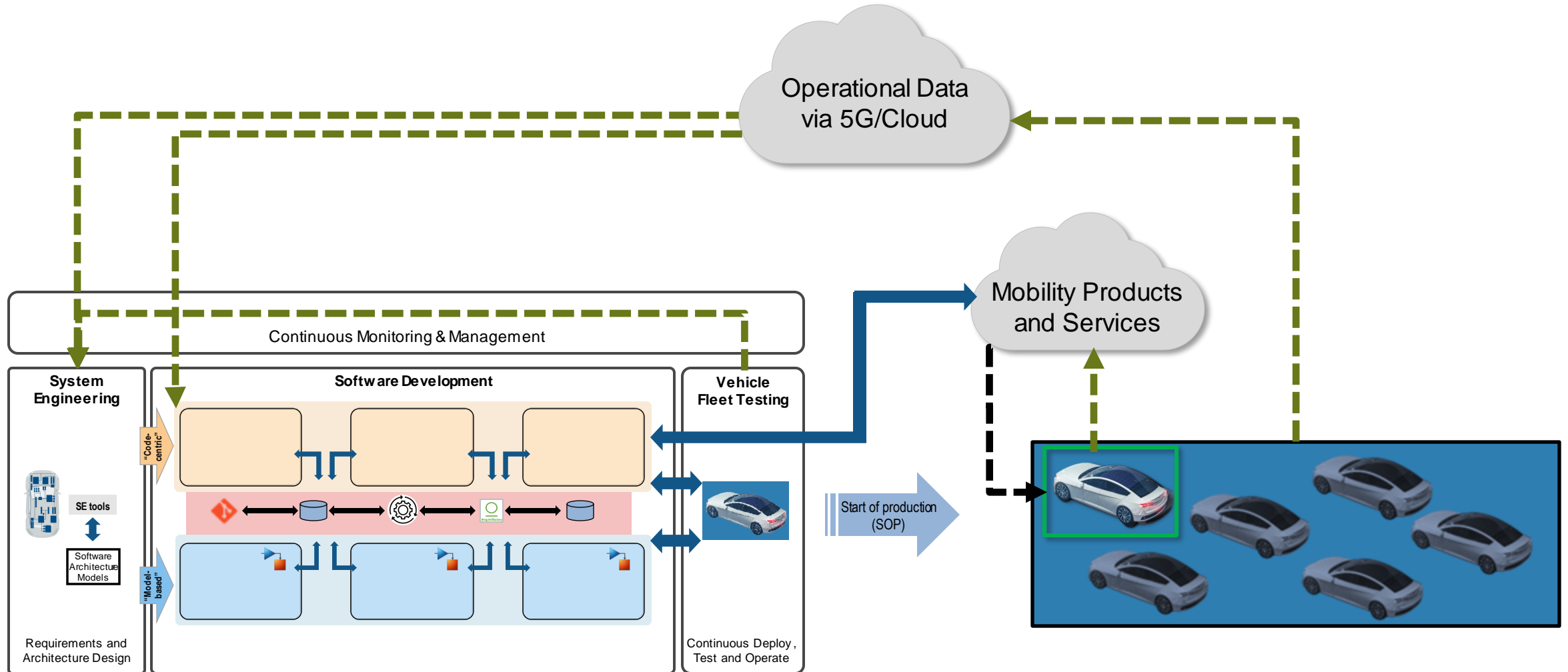# These changes often involve new teams that need to align

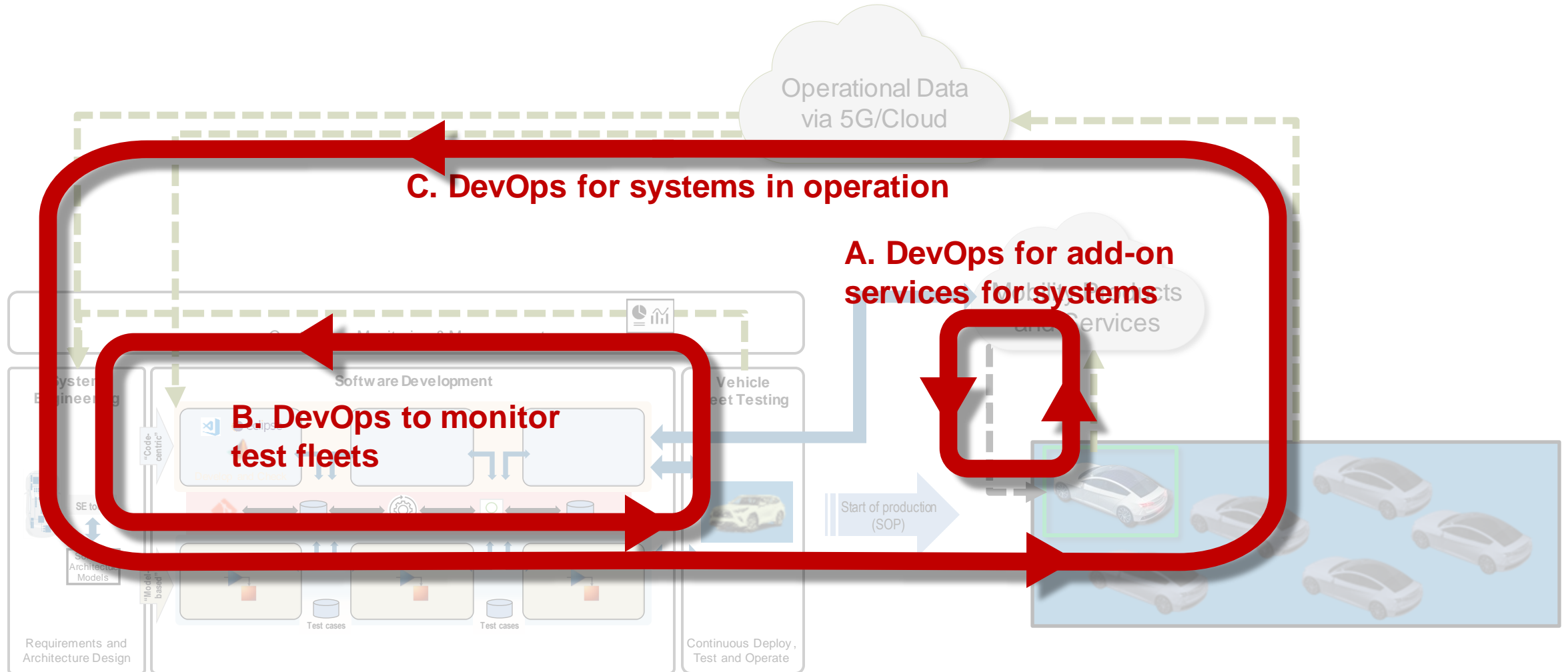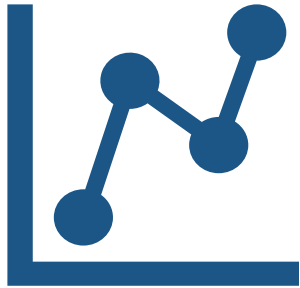# Changes in how feedback is done for test fleets

Continuous Monitoring & Management

System Engineering

Software Development

Vehicle Fleet Testing

SE tools

"Code-centric"

Code and Check
Virtual Integration

Build and
Static Testing
Dynamic Testing

Integration Testing
Virtual Integration
Virtual Scenarios, etc.

Source repo

Test cases

CI Pipeline

Production artifacts

Test results

"Model-based"

System Models

System Models

System Models

Implementation Models

Generated C/C++ Code

Object Code

Scenario Models

Scenario Models

Scenario Models

Software Architecture Models

Requirements and Architecture Design

Continuous Deploy, Test and Operate

These changes are steps to a broader DevOps view

These changes are steps to a broader DevOps view

Operational Data via 5G/Cloud

C. DevOps for systems in operation

A. DevOps for add-on services for systems

B. DevOps to monitor test fleets

Software Development

Vehicle Fleet Testing

Start of production (SOP)

Requirements and Architecture Design

Continuous Deploy, Test and Operate

Test cases

This broader view involves more than embedded code

Operational Data
via 5G/Cloud

- **Engineer the operational data; look for insights and apply analytics**
- **Stream operational data to large-scale streaming frameworks**
- **Train and deploy models in big data systems/in the cloud**
- **Use models as a digital twin**
- **Deploy models as microservices, in containers**
- **CI integration for models and code**

Mobility Products
and Services

System
Engineering

Software Development

Vehicle
Fleet Testing

SE tools

Software
Architecture
Models

Test cases

Test cases
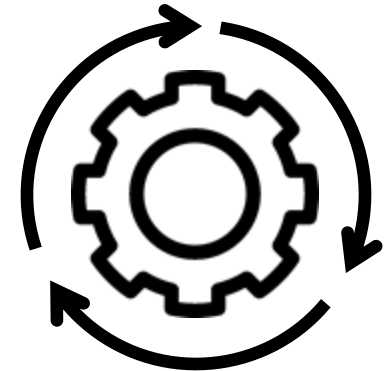
Start of production
(SOP)

Requirements and
Architecture Design

Capabilities on the Road to DevOps

Data Analytics for Automotive

Containers,
Microservices
and more

Continuous
Integration

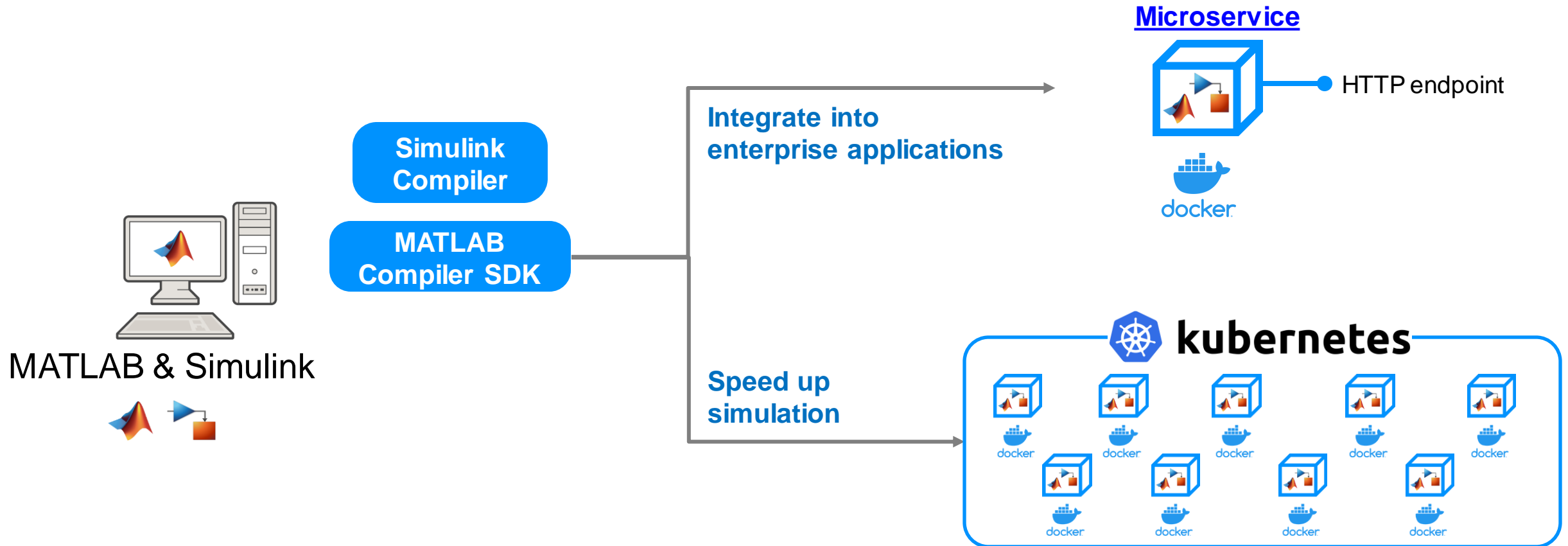# Perform Fleet Analytics at Scale

We can work with you to analyze your fleet data with MATLAB
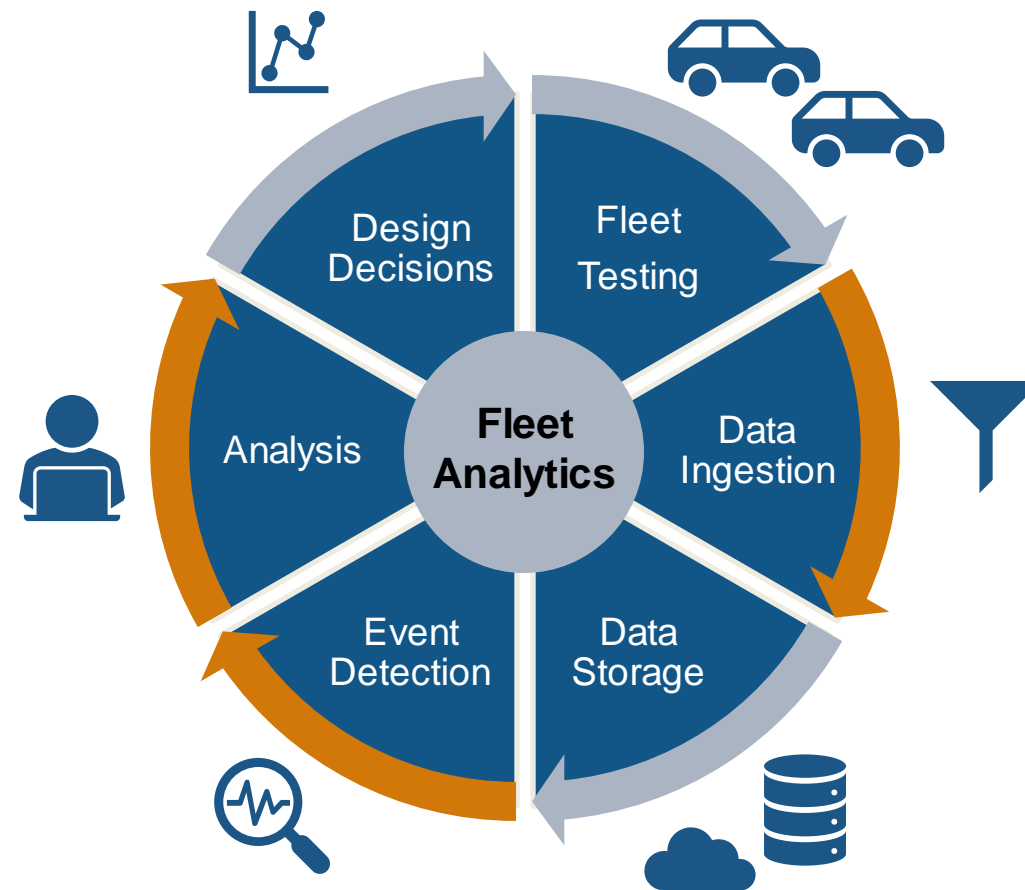
Develop & deploy analytics for large-scale streaming environments

R2022**b**

Engineering Services

Apache Kafka

Streaming Data

Kafka Connector for MATLAB Production Server

Time-coherent data grouped by device ID

Stream Processing Framework $f(x)$

MATLAB Desktop
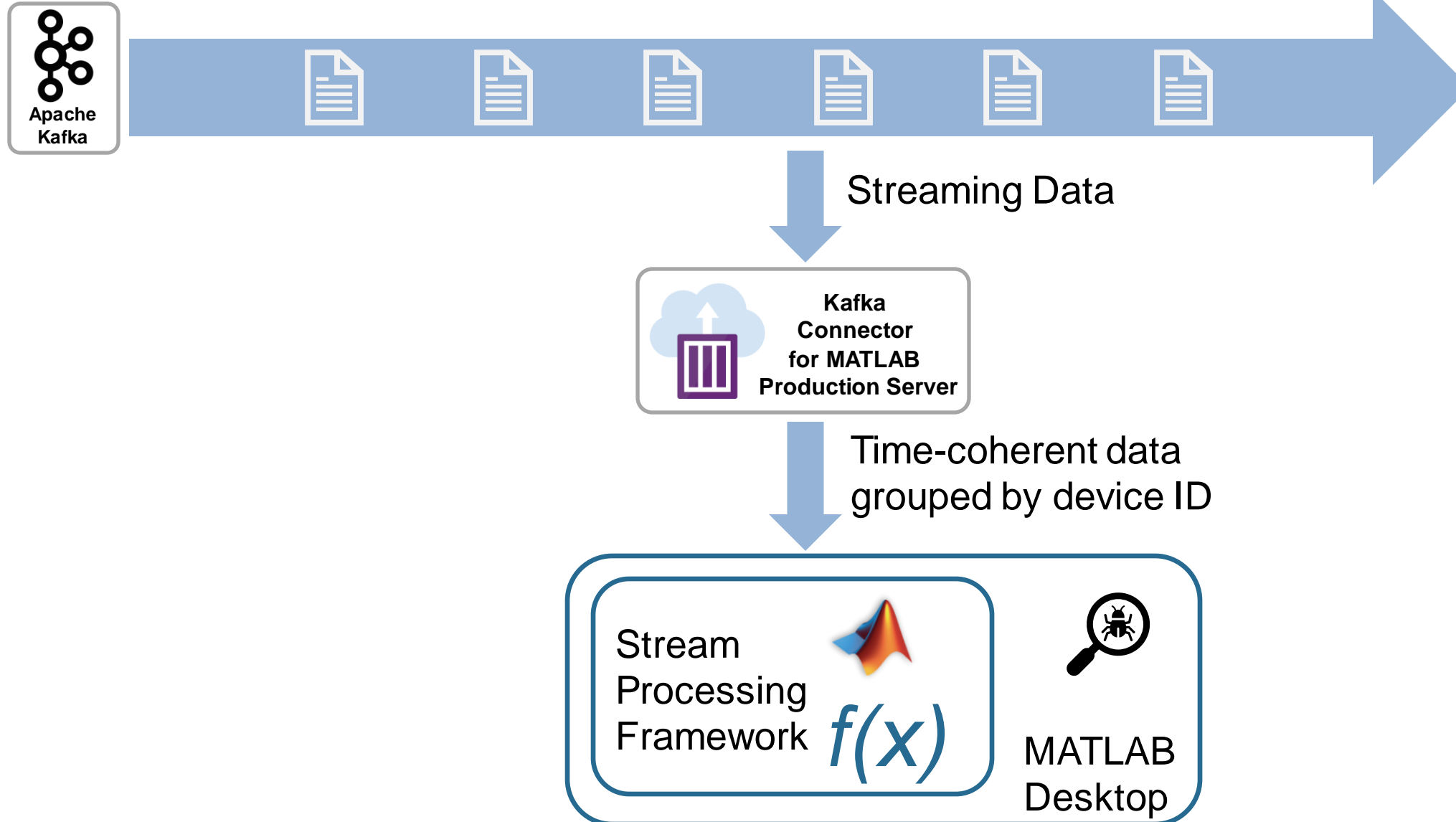
Scale analytics to big data in the cloud with Databricks

R2019**a**
Sample Scripts
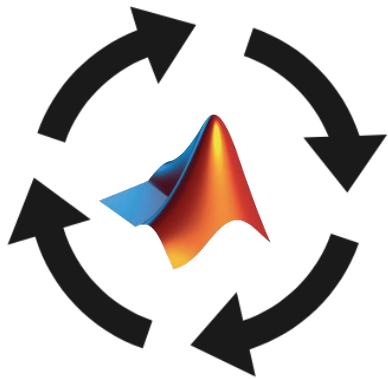
**Use existing
MATLAB Code**

Run it faster

**Self-service access
corporate (big) data**

**Share model and
algorithm with
non-MATLAB users**

Learn more: MATLAB with Databricks

Capabilities on the Road to DevOps

Data Analytics for Automotive

Containers, Microservices and more

Continuous Integration

Deploy your simulations

R2020**a**

- Enable others to run your simulations

- Leverage digital twins for in-operation assets

- Interchange with other simulation environments via FMU

Simulink Simulations

Simulink Compiler
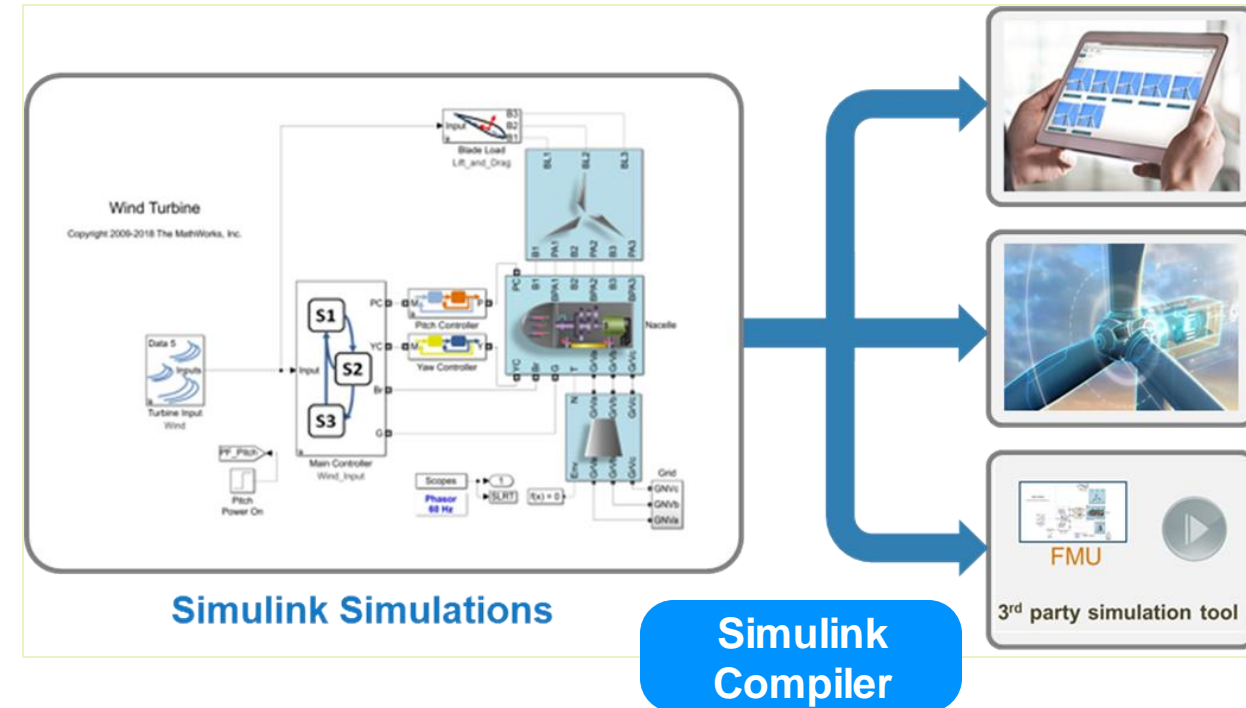
Deploy your simulations as microservice Docker containers

R2022**a**

Microservice

HTTP endpoint

MATLAB & Simulink

Simulink Compiler

MATLAB Compiler SDK

Integrate into enterprise applications

Speed up simulation

docker

kubernetes

docker docker docker docker docker

docker docker docker docker

Capabilities on the Road to DevOps

Data Analytics for Automotive
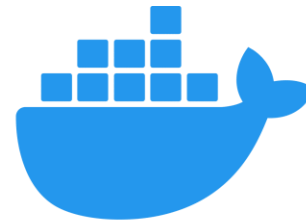
Containers, Microservices and more
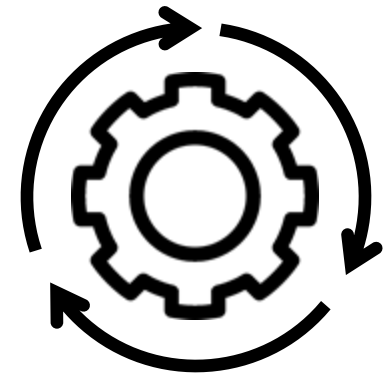
Continuous Integration

Integrate with Continuous Integration platforms

R2013b
On-prem Platforms

R2020a
Cloud Hosted

Server

Service

On-Prem   **Hybrid**   **Cloud Hosted**
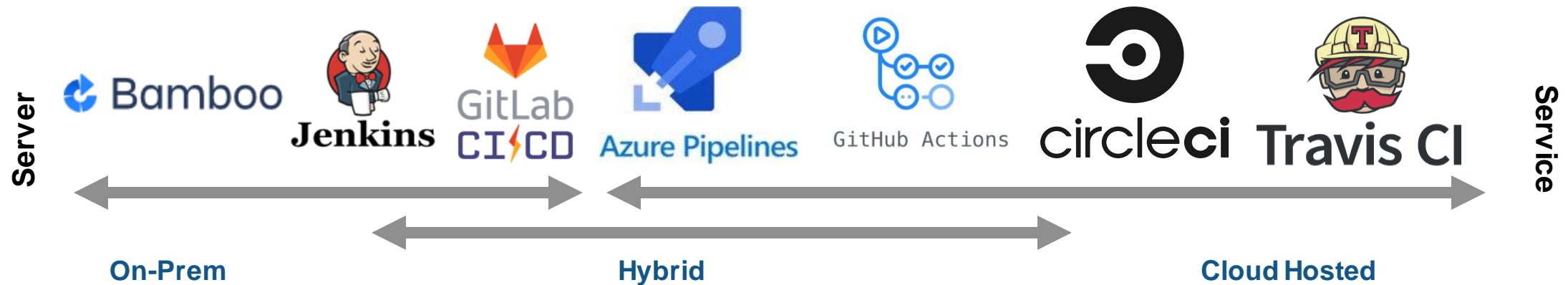
(7) Documented MathWorks CI integrations to
reduce risk and **simplify use** and setup

Learn more: Continuous Integration with MATLAB and Simulink

Leverage CI/CD Automation for MBD workflows

R2022a
Support Package
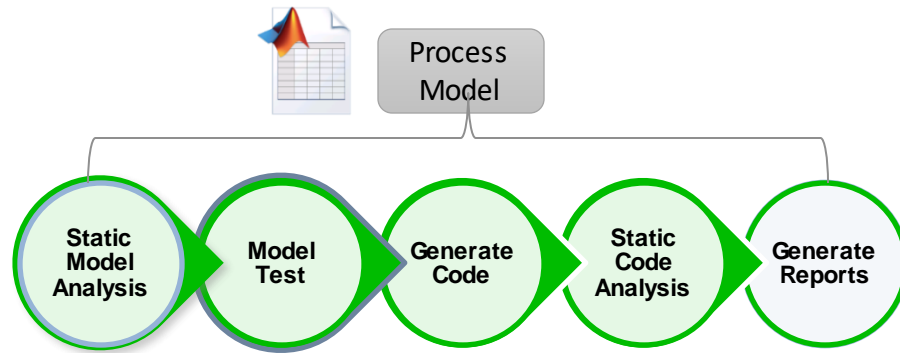
Prebuilt & Tailorable Model-Based Design Pipeline
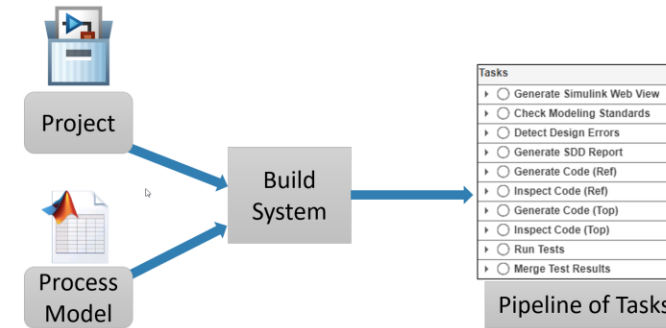
Build system to generate pipeline and optimally execute
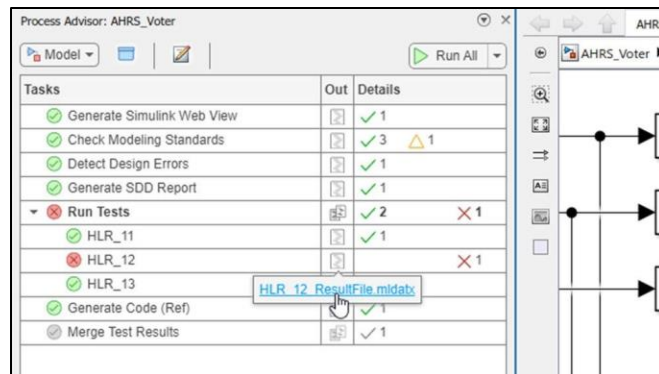
Prequalification with Process Advisor
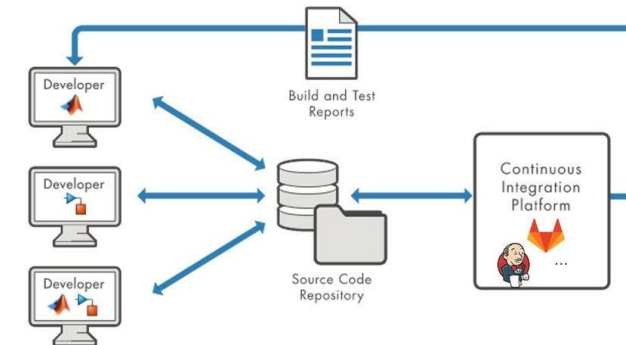
Examples to run process on common CI Systems

Learn more: Continuous Integration for Model-Based Design

Continuous Integration with Polyspace
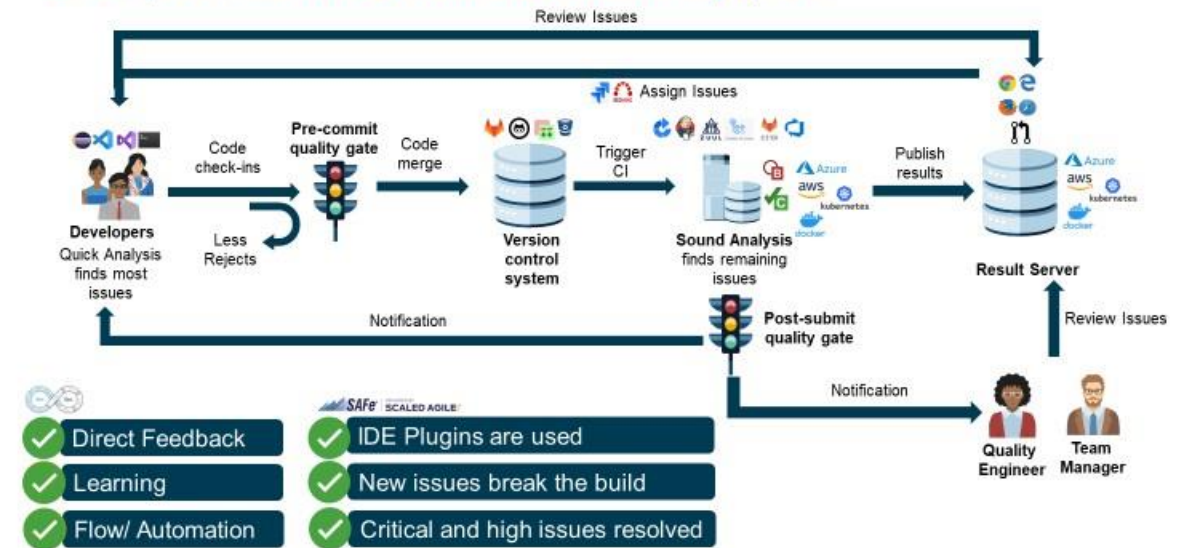
Summary: On the road to software-defined vehicles, DevOps is an important aspect

- We have experience working on DevOps with customers in many other industries

- We want to work with your MBD teams AND your DevOps/Infrastructure teams as you navigate the software trend

- Join us on this DevOps journey!

Enjoy the Conference!

MathWorks®