

2020 MathWorks 中国汽车年会

务实的数字化转型
MathWorks和MATLAB如何帮助客户解决问题

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MathWorks中国区技术经理



门铃的数字化转型

Digital technology

- HD video
- Motion detection
- Smartphone interface
- AWS Cloud



Amazon Acquires Ring, Maker of Video Doorbells

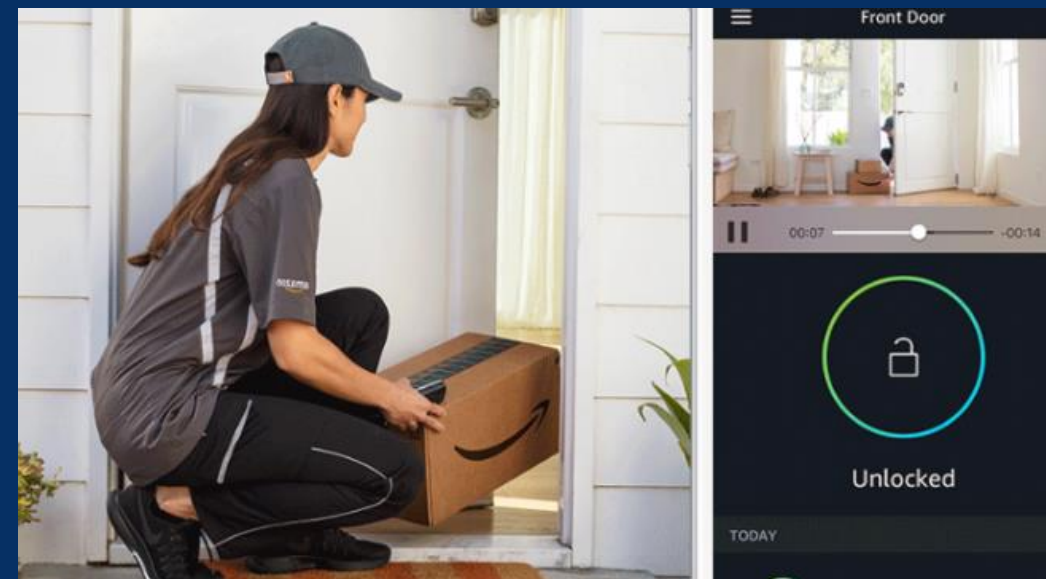
Front-door monitoring device plays to buyer's ambitions in home-security business

Business value

- Amazon buys Ring for \$1.2 billion+ in 2018

New revenue opportunities

- “Ring Protect” subscription plans (\$99-\$499)
- Additional security with Ring Alarm kit
- More secure delivery through Amazon Key



数字化转型的初衷

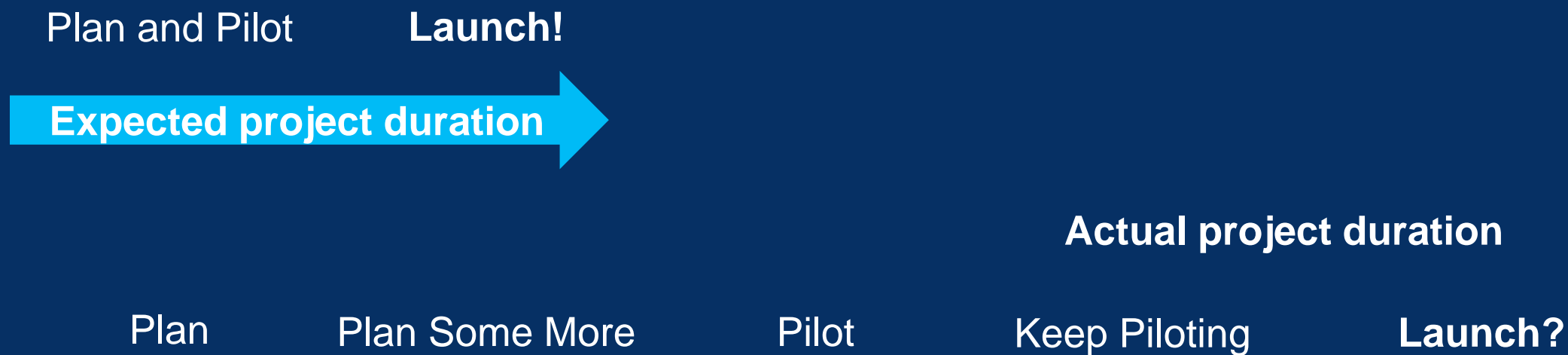
Do things better Optimization

- Optimize design performance in-operation
- Predict when system needs maintenance
- Manage a fleet of connected systems

Do new things Transformation

- Go into new industries and markets
- Expand into an entire platform service
- Provide unique value to your customer

The doorbell illustrates both types



**< 20% of organizations are on target
with their digital transformation objectives**

Source: McKinsey, *Can IT Rise to the Digital Challenge?*, October 2018.

为什么这么难

People

Unreasonable expectations

Entire organization not involved

Reorganization of employee roles

New skillsets needed

Processes

System models not shared or reused

Not clear what to change and what to keep the same

Using untested technologies that have not been proven out

Combining technologies to implement one system

Data security risks

Technologies

大家尝试过哪些解决方案



Big Bang Approach

Build complete infrastructure first
Value not delivered to customer

Risky

Pragmatic Approach

Build on models you already have
Extend beyond siloed use of data

Unleash untapped value



Siloed Approach

Each group works in own silo
Stuck in business model

Obsolete

Pragmatic Digital Transformation

Systematic use of data and models
to **create** and **deliver** superior value to customers
throughout the entire lifecycle

数据中心化使工程工作变得更难

Field data



System data



User data



Environment data



Data diversity complexity

- Engineering, Scientific, and Field
- Business & transactional
- Noisy, Outliers, Missing data
- Time series synchronizing

Modern data management multiplies complexity

- Proliferation of data systems
- More siloes
- Cloud, on-premise, hybrid
- Big Data

Big Data

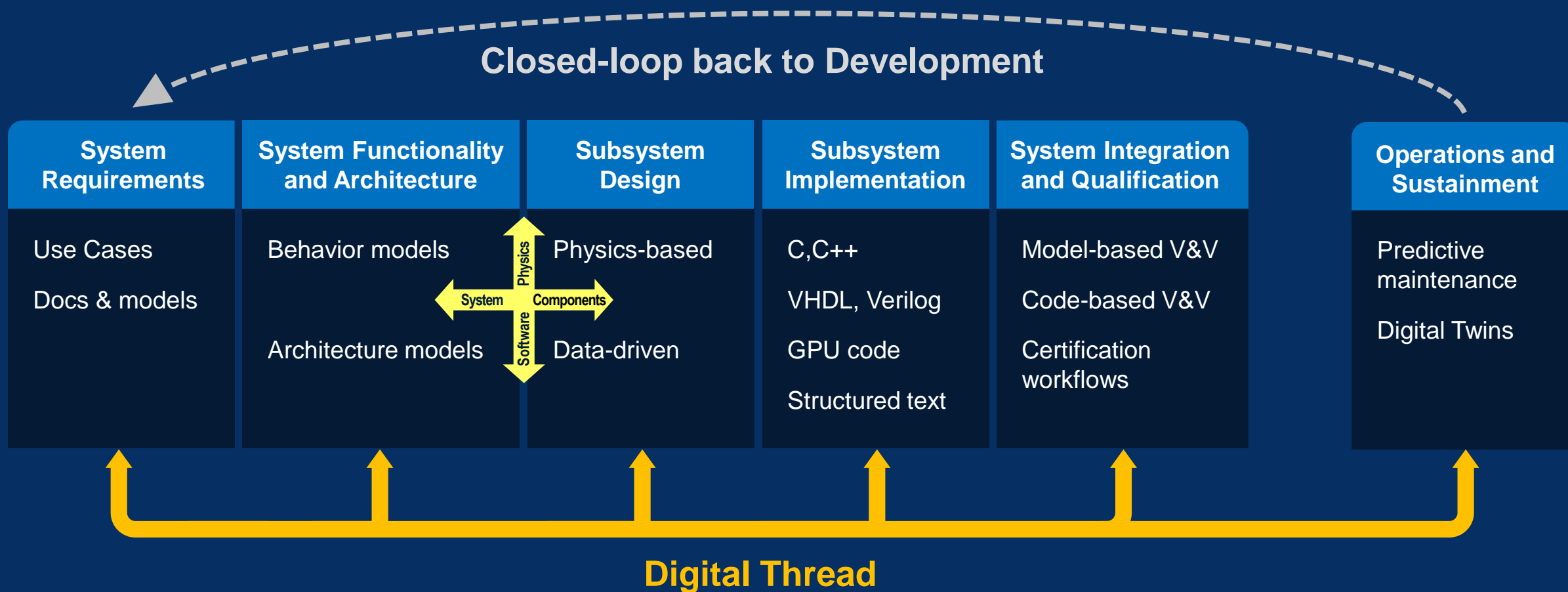


CLUDERA

Cloud Platforms




将模型拓展到系统生命周期




How MathWorks & MATLAB Help Customer Solving

围绕数据与模型进行开发的工作流程


Data Preparation

 Data cleansing and preparation

 Human insight

 Simulation-generated data

Modeling

 Model design and tuning


 Hardware accelerated training

 Interoperability

Simulation & Test

 Integration with complex systems

 System simulation

 System verification and validation

Deployment

 Embedded devices

 Enterprise systems

 Edge, cloud, desktop

Data preparation represents most of your effort

Data Preparation



Data cleansing and preparation



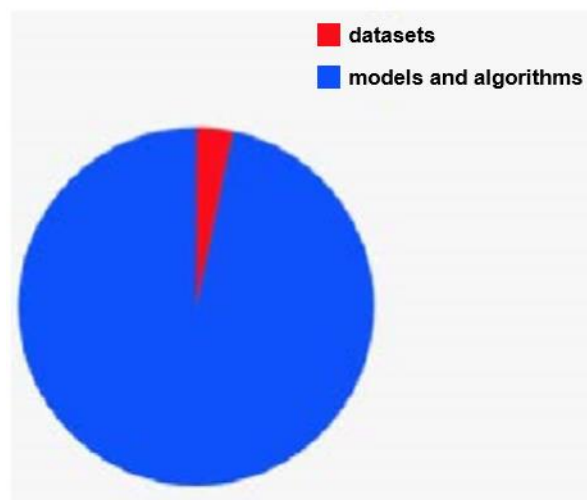
Human insight



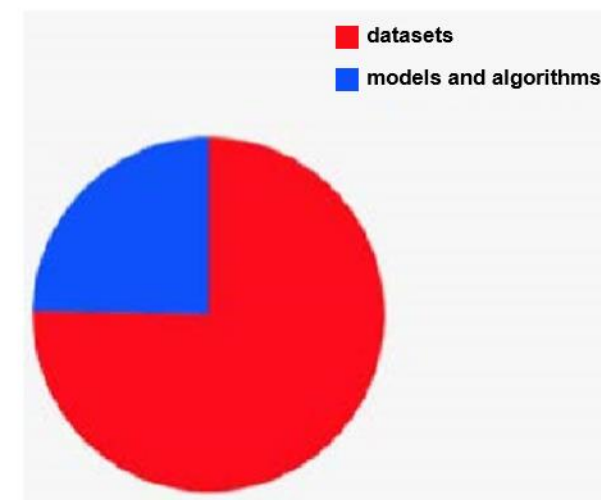
Simulation-generated data

Amount of lost sleep over...

PhD



Tesla



Source: Andrej Karpathy slide from TrainAI 2018

Automated Apps save you weeks to months

Data Preparation



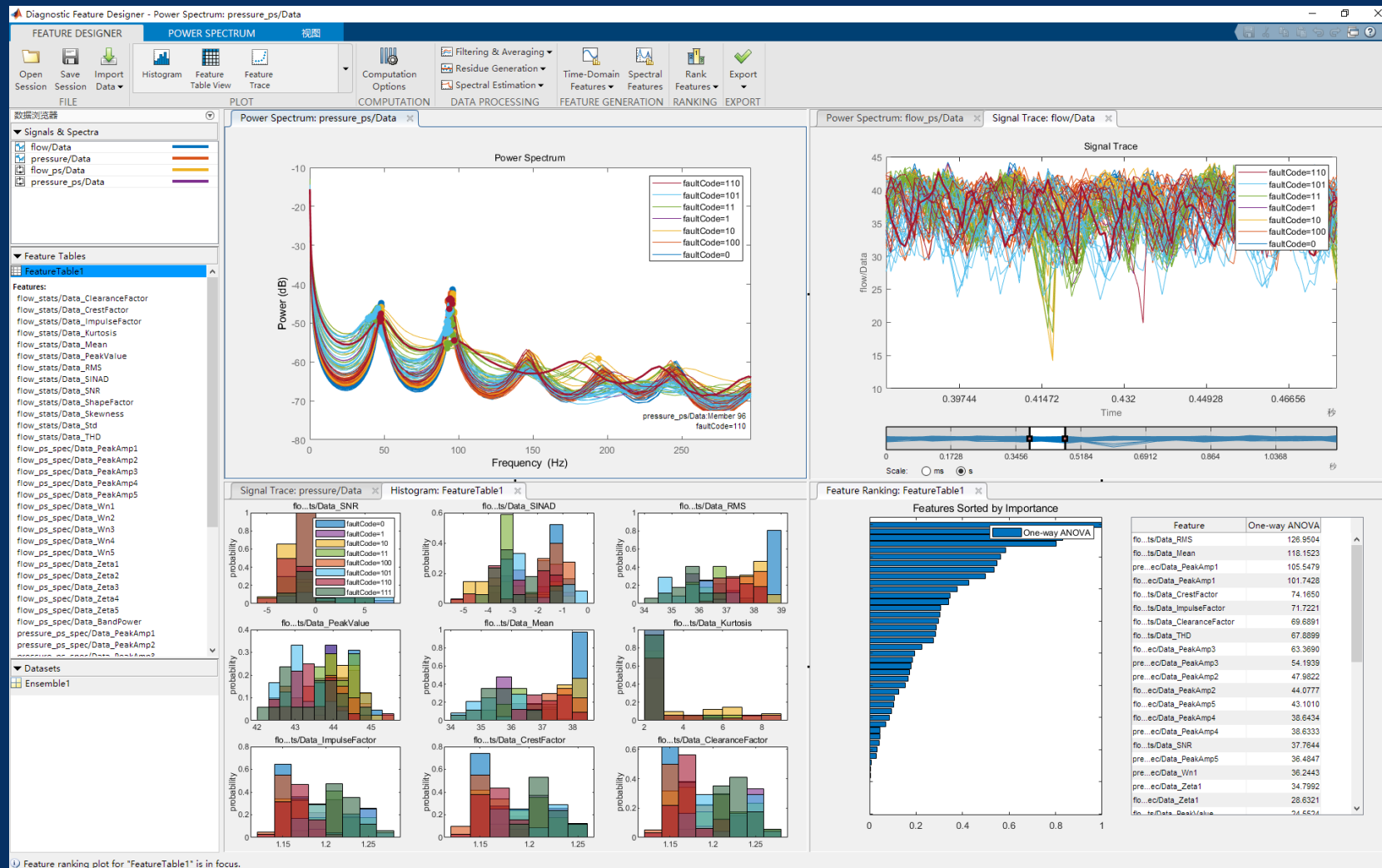
Data cleansing and preparation



Human insight



Simulation-generated data



Feature ranking plot for "FeatureTable1" is in focus.

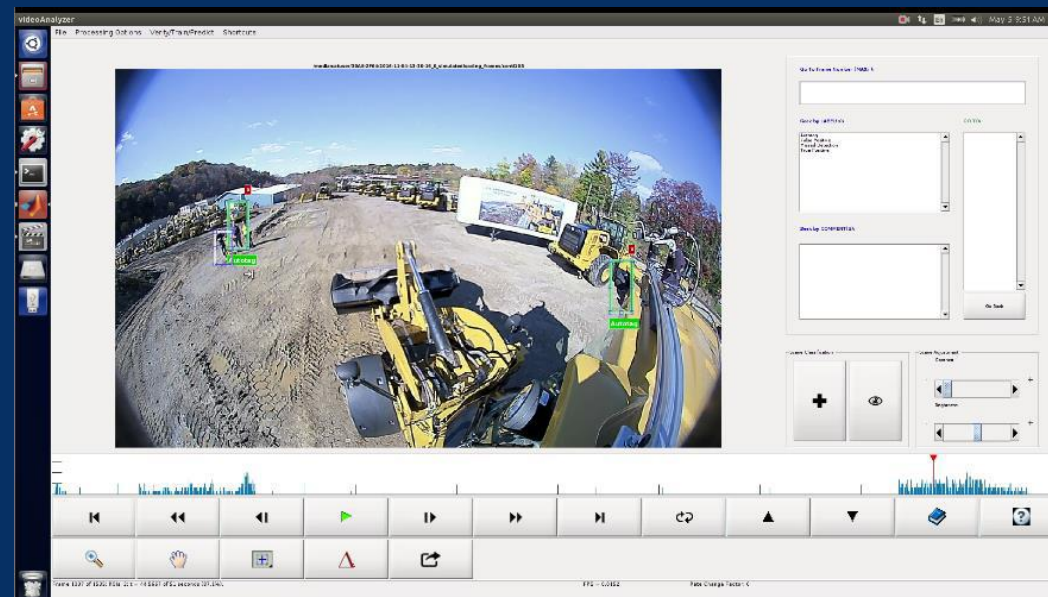
Dramatically reduce human supervision and development time



- Partnered with MathWorks on their big data and machine/deep learning infrastructure
- Automatically ground-truths and labels data, reducing the need for human supervision and development time
- Tight integration with MATLAB for machine learning, visualization, and code generation

“We were spending way too much time hand-labeling our data...**automatic detection and labeling of our data has been a tremendous advantage in efficiency.**”

— Larry Mianzo, Caterpillar



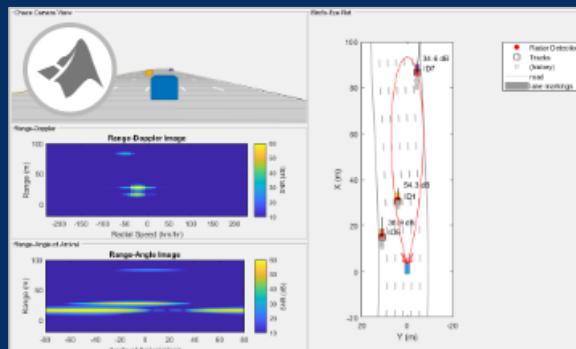
Generate synthetic data from Simulink to improve your datasets

Data Preparation

Data cleansing and preparation

Human insight

Simulation-generated data



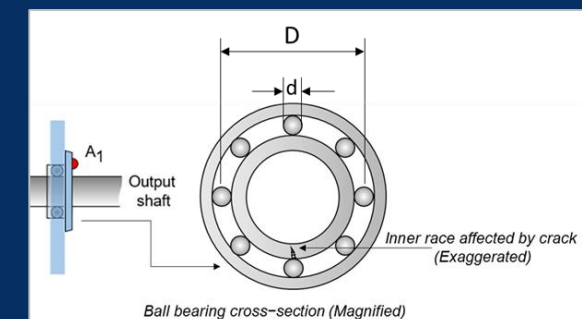
Radar Signal Simulation and Processing for Automated Driving

Automated Driving Toolbox
Phased Array System Toolbox



Visualize Automated Parking Valet Using 3D Simulation

Automated Driving Toolbox
Simulink

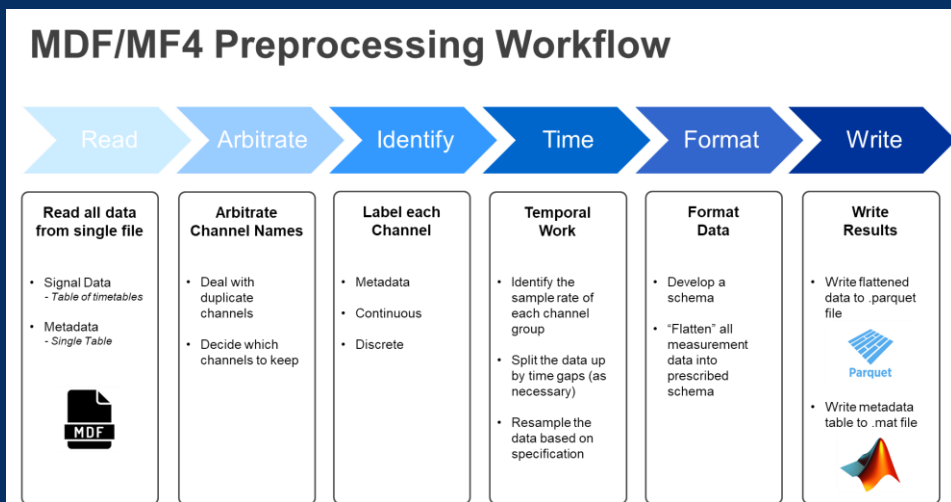


Simulate Ball Bearing Failure Using Simscape

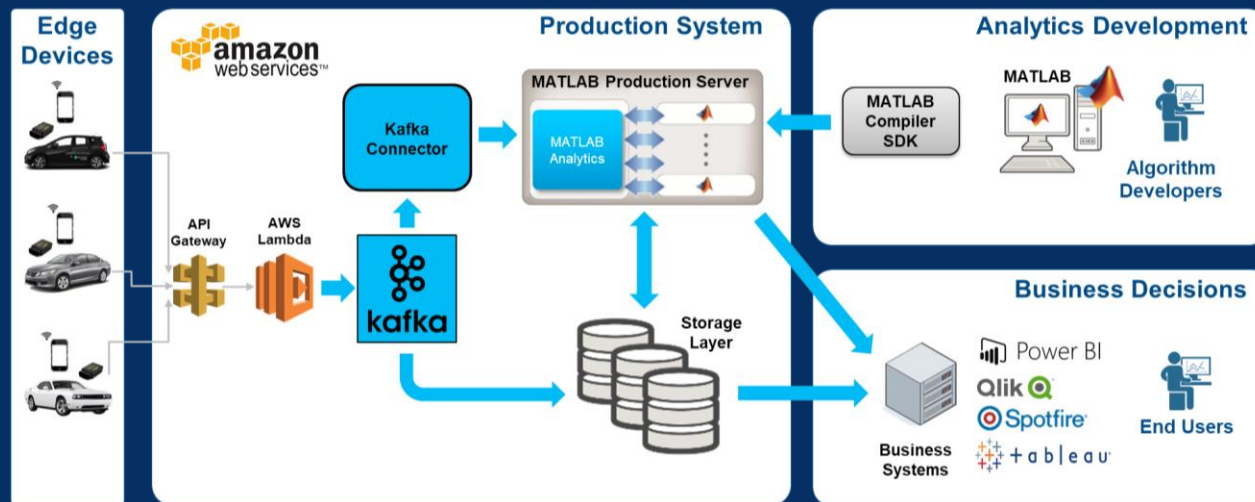
Simulink
Simscape
Simscape Multibody

MathWorkers Help Customer Solving

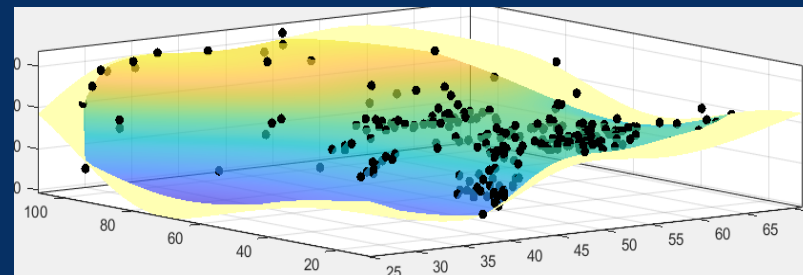
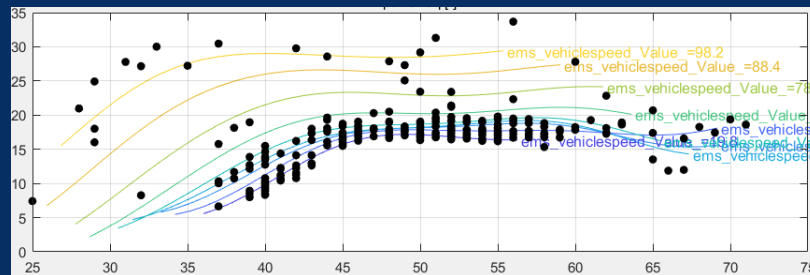
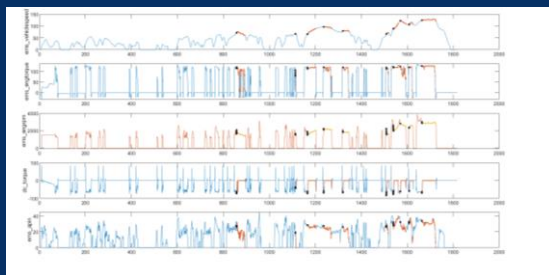
打通数据访问接口



构建大数据开发平台



清洗数据并提取特征



Start with a complete set of algorithms and pre-built models

Modeling



Model design and tuning



Hardware accelerated training



Interoperability

Algorithms

Machine learning

Trees, Naïve Bayes, SVM...

Deep learning

CNNs, GANs, LSTM, MIMO...

Reinforcement learning

DQN, A2C, DDPG...

Regression

Linear, nonlinear, trees...

Unsupervised learning

K-means, PCA, GMM...

Predictive maintenance

RUL models, condition indicators...

Bayesian optimization

Pre-built models

Image classification models

AlexNet, GoogLeNet, VGG, SqueezeNet, ShuffleNet, ResNet, DenseNet, Inception...

Reference examples

Object detection

Vehicles, pedestrians, faces...

Semantic segmentation

Roadway detection, land cover classification, tumor detection...

Signal and speech processing

Denoising, music genre recognition, keyword spotting, radar waveform classification...

...and more...

Apps for modeling turn your engineers into data scientists

Modeling



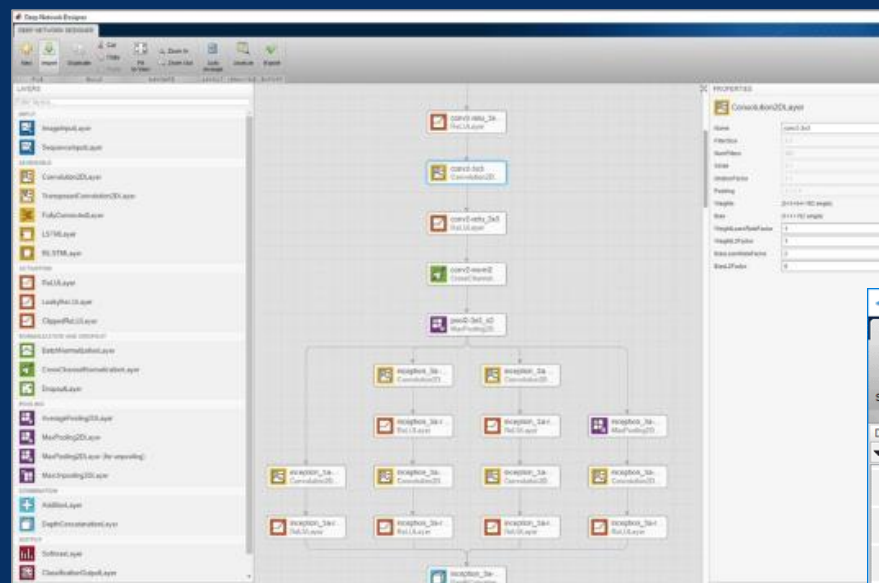
Model design and tuning



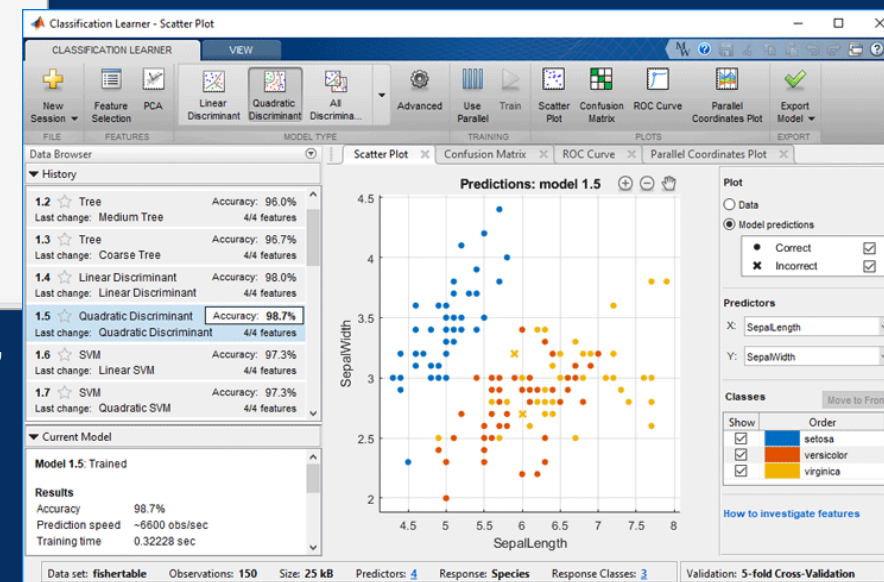
Hardware accelerated training



Interoperability

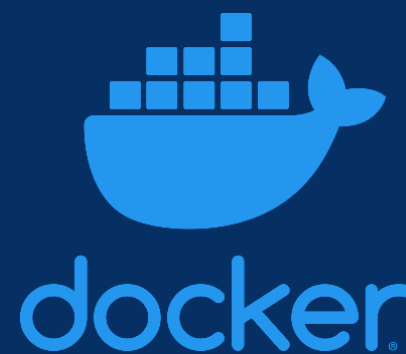





Deep Network Designer app to build, visualize, and edit deep learning networks



Classification Learner app to try different classifiers and find the best fit for your data set

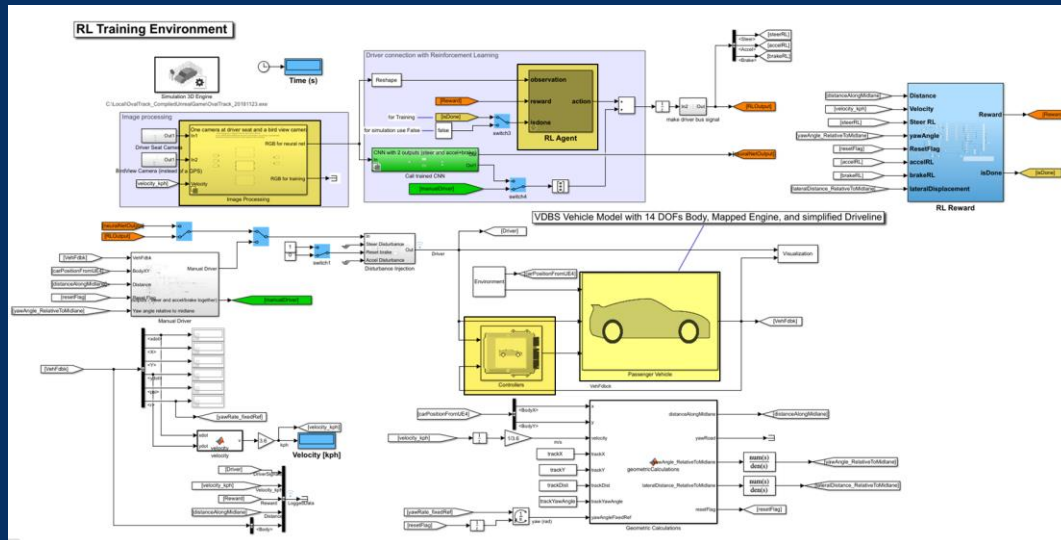
Adapts to cluster, GPUs, cloud, and datacenter resources



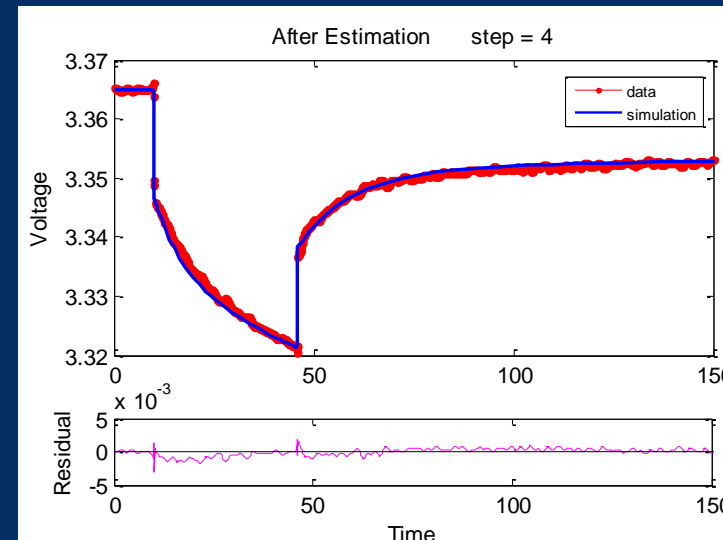
Modeling	
	Model design and tuning
	Hardware accelerated training
	Interoperability

MathWorks Help Customer Solving

尝试新的方法

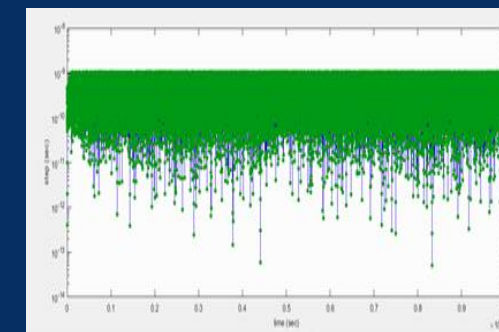
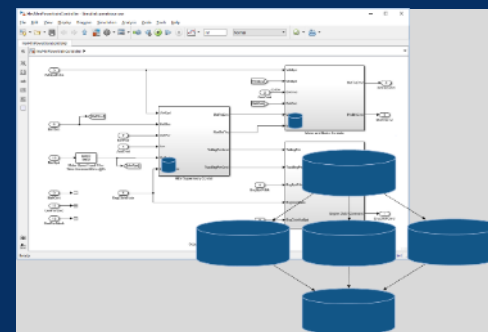
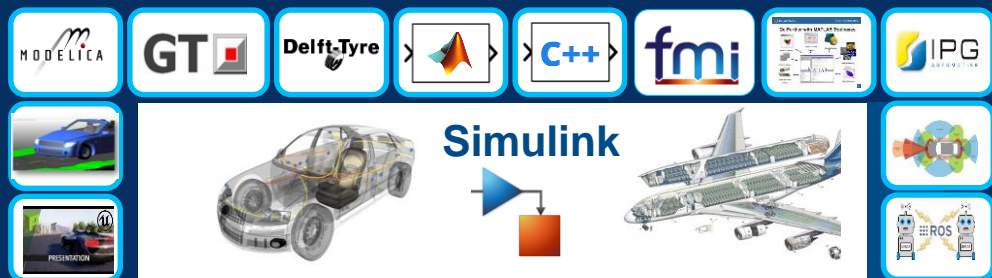


创建/精确化多域物理模型



优化模型架构、提高建模效率、促进持续集成.....

MATLAB as Simulation Platform Infrastructure



Data Management

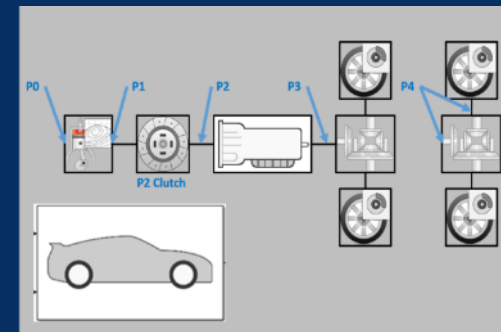
Solver Technology

Simulation & Test

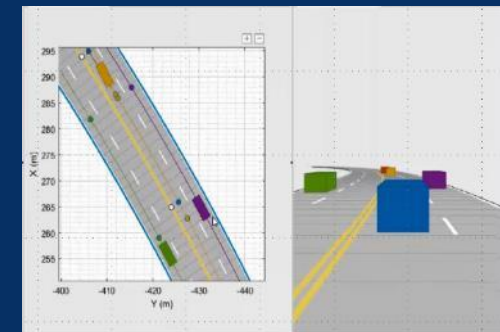
Integration with complex systems

System simulation

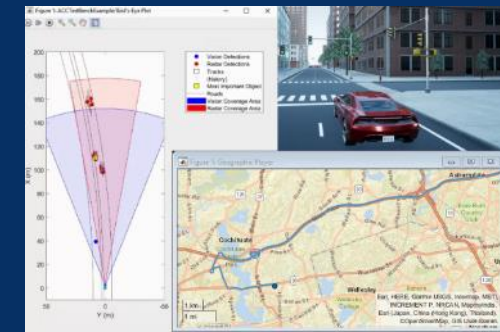
System verification and validation



Model Configuration



Scenarios



Visualization

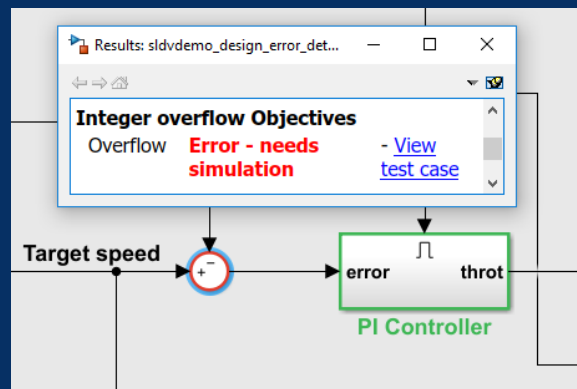
Automated Test and Verification

Simulation & Test

Integration with complex systems

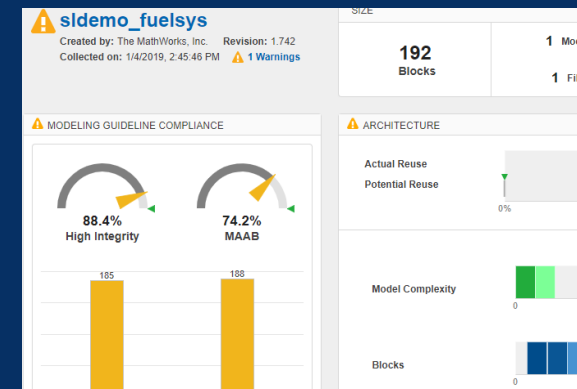
System simulation

System verification and validation



Find Bugs

Simulink Design Verifier
Polyspace Bug Finder



Check & Coverage

Simulink Check
Simulink Coverage

Manage Tests

Simulink Test

Code Verification Results : Verified

Function Interface Verification Results : Verified

Function	Status	Details
slcidemo_roll_initialize	Verified	-
slcidemo_roll_step	Verified	-

Model To Code Verification Results : Verified

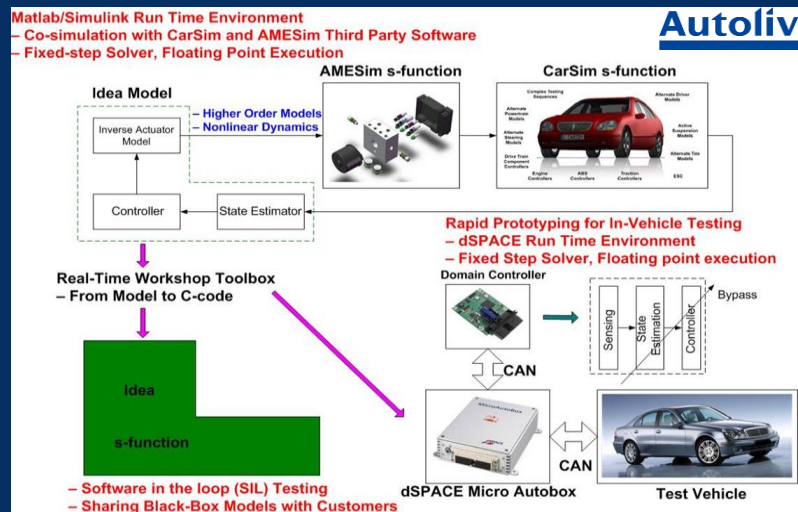
Status	Details
Model objects with status Verified :	42
Model objects with status Partially processed :	0

Inspect code

Simulink Code Inspector

MathWorks Help Customer Solving

打通仿真接口/环节



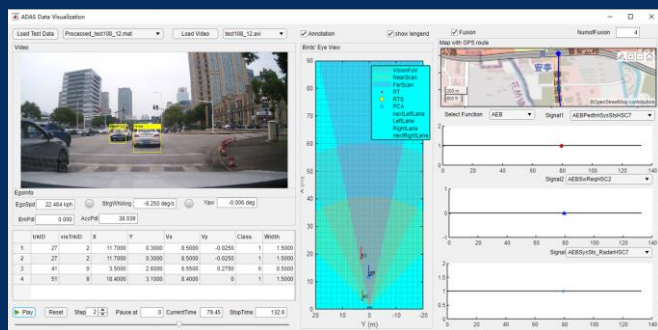
提高仿真效率

10 Practical Tips to Speed Up Your Simulink Simulations

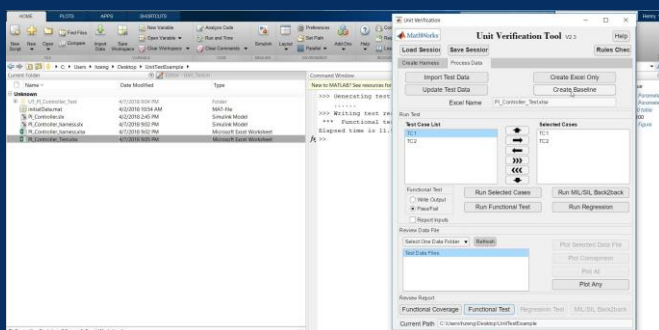
Desktop → Multicore → Cluster

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定制可视化App



定制自动化验证App



为行业认证提供帮助

Process Group	MathWorks Solution										
	Simulink	StateFlow	Embedded Simulink Coder	Simulink Requirements	System Composer	Simulink Test	Simulink Check	Simulink Design Verifier	Simulink Coverage	Polyspace Bug Finder	Polyspace Code Prover
System Engineering Process Group	System Requirements Analysis			○							
	System Architectural Design			○	○						
	System Integration/Integration Test			○		○					
	System Qualification Test			○		○					
Software Engineering Process Group	Software Requirements Analysis			○							
	Software Architectural Design			○	○						
	Software Detailed Design	○	○				○	○			
	Unit Construction			○						○	○
	Software Unit Verification						○	○			○
	Software Integration and Integration Test			○		○					
	Software Qualification Test			○		○					

Deep experience in safety critical certification enables us to drive new standards for AI

Today



IEC Certification Kit for ISO 26262 and IEC 61508
Qualify code generation and verification tools for ISO 26262 and IEC 61508 certification

Tomorrow



EUROCAE WG-114
“Artificial Intelligence”

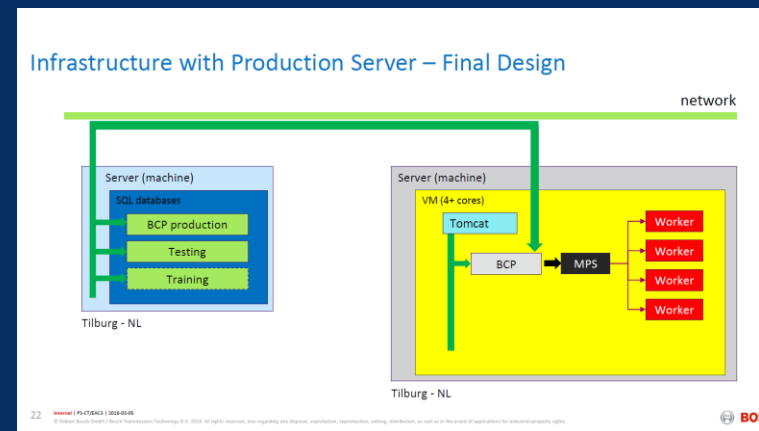
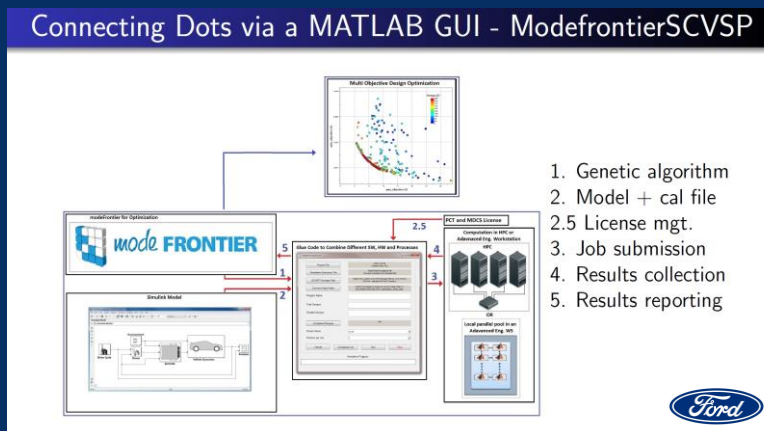
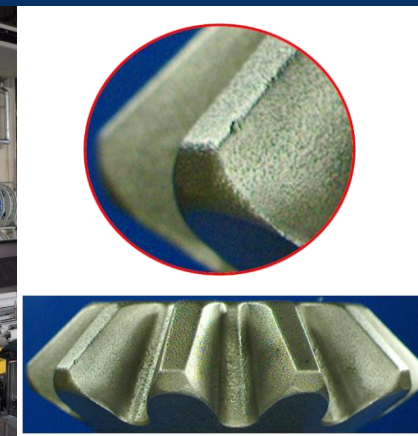


DO Qualification Kit (for DO-178 and DO-254)
Qualify Simulink and Polyspace verification tools for DO-178, DO-278, and DO-254



SAE G-34 “Artificial Intelligence in Aviation”

Models are useful everywhere



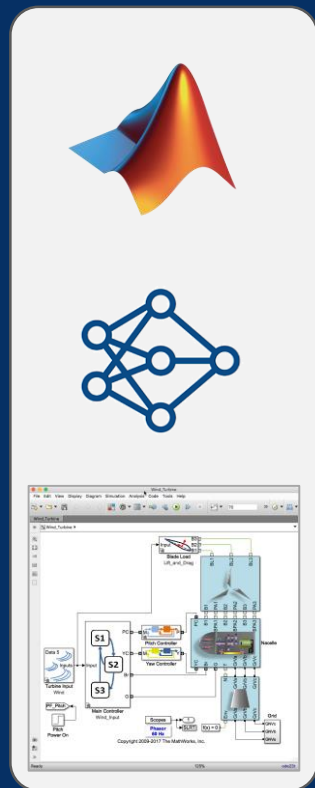
Deployment

- Embedded devices
- Enterprise systems
- Edge, cloud, desktop

Deploy to any processor with zero coding errors

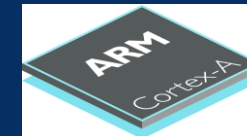
Deployment

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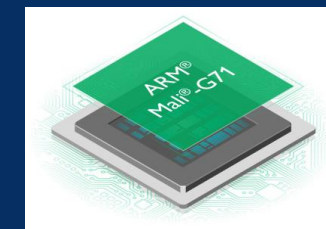


Code Generation

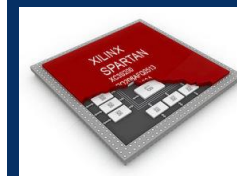
CPU



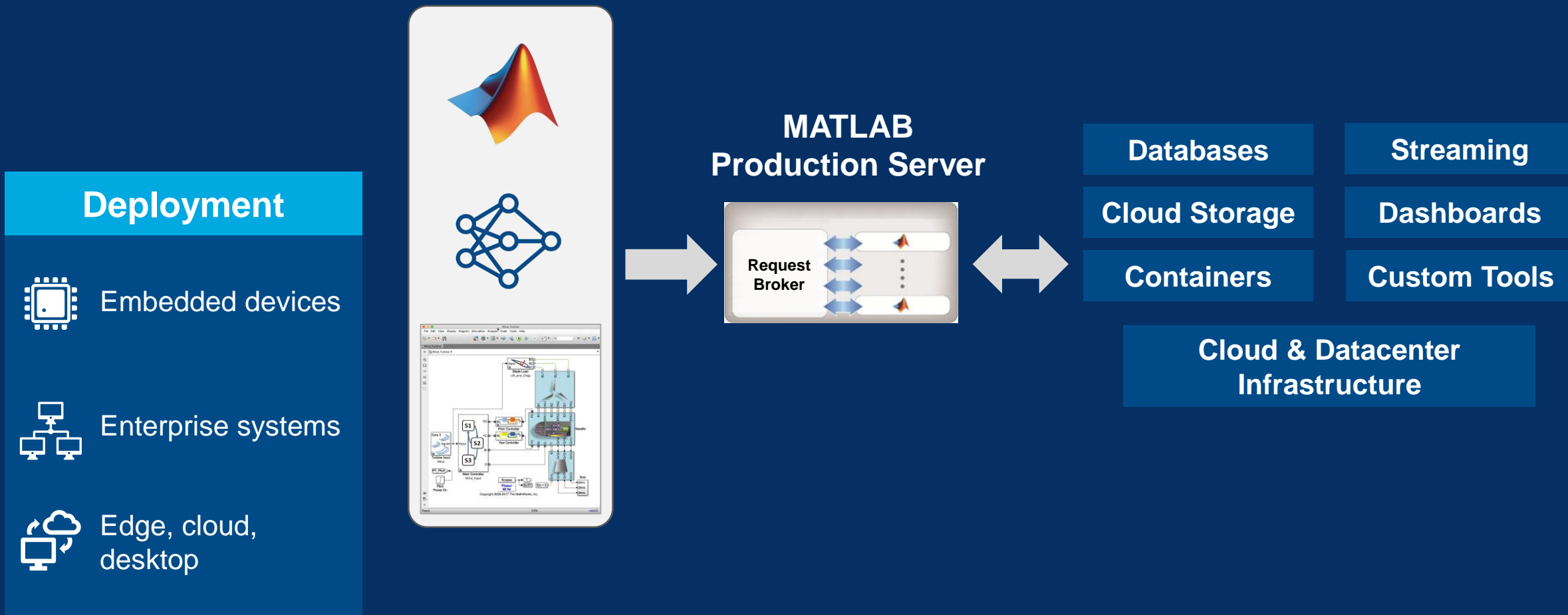
GPU



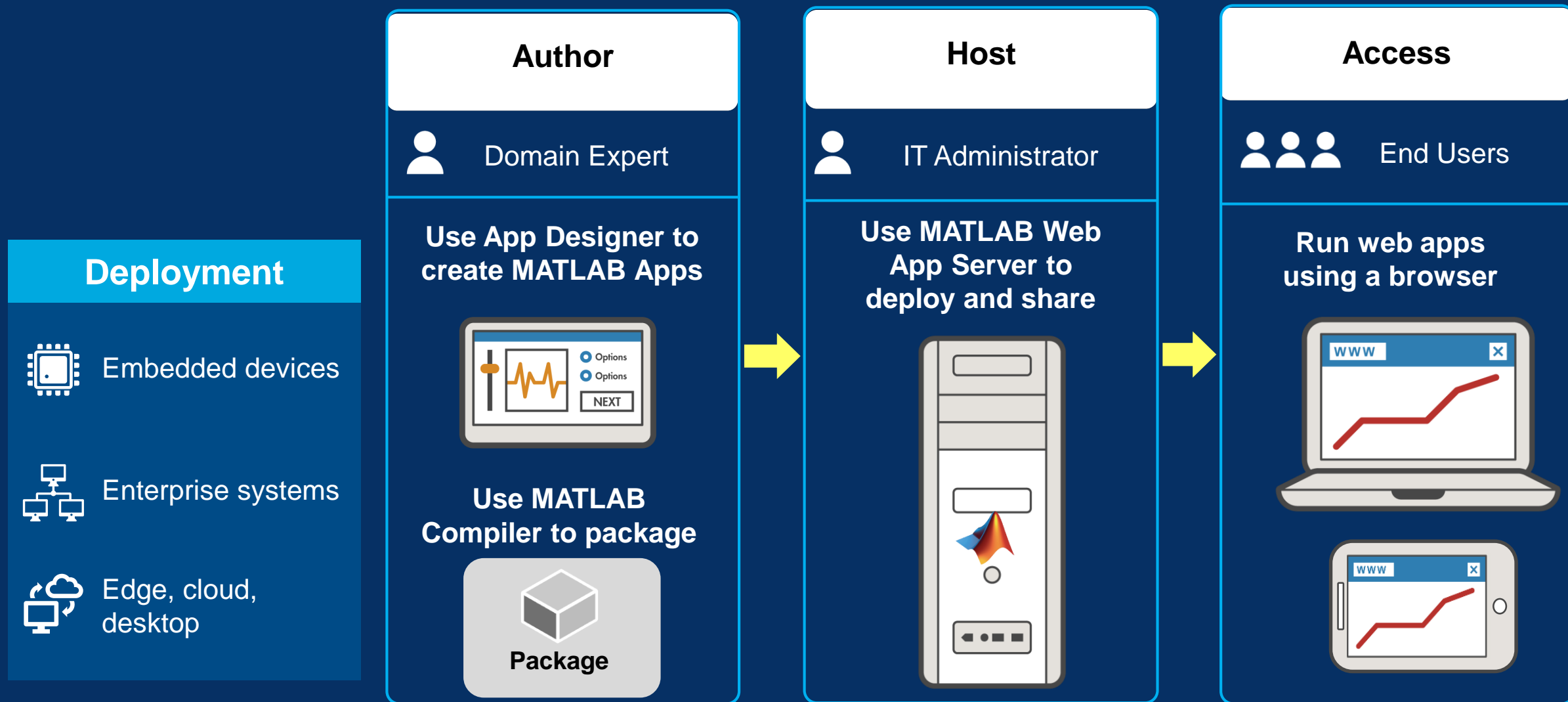
FPGA



Deploy to enterprise IT infrastructure



What's New: MATLAB Web App Server



MathWorks Help Customer Solving

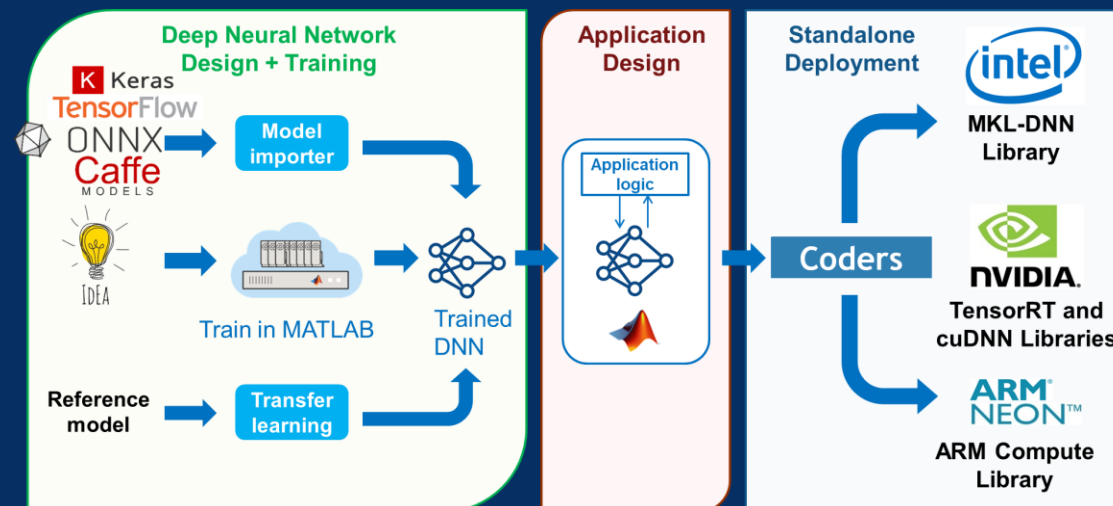
打通硬件接口

GPU Fastest

FPGA / ASIC Lowest Power

MCU Low Cost

优化目标代码生成



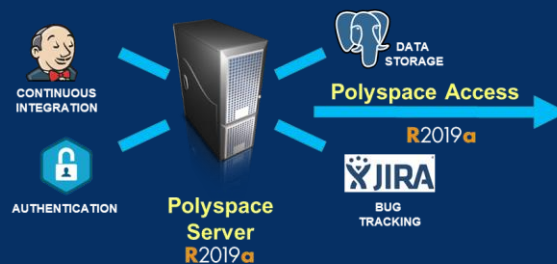
为特定架构生成代码

Hand Code **Internal Libraries** **Vendor Libraries**

Middleware

ROS AUTOSAR DDS

开展持续的代码集成与验证



进行企业部署

Web browser

Acceleration Feature Extraction

案例分享：创建精确的电池模型

Tesla

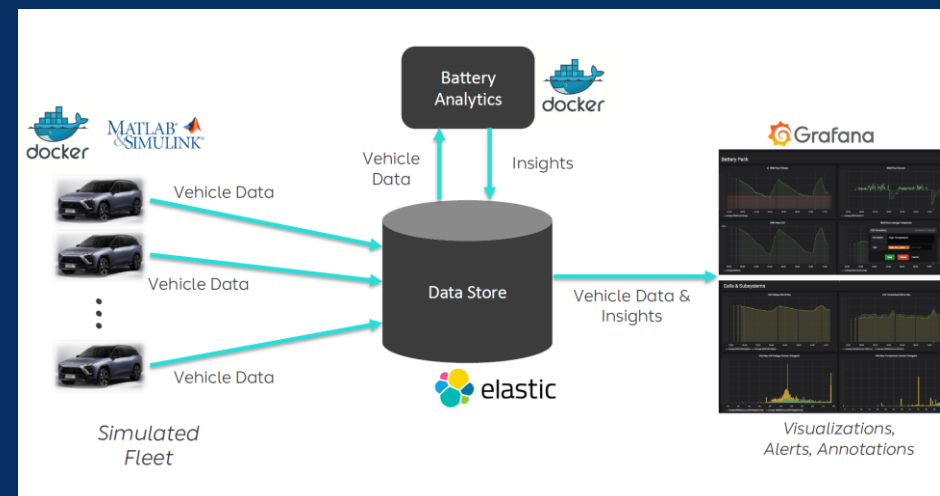


Calibrated system model, improving simulation accuracy

Multidomain effects simulated, enabling dramatic advances in battery technology

<https://www.mathworks.com/company/newsletters/articles/using-model-based-design-to-build-the-tesla-roadster.html>

NIO



In the product design phase, battery data is available only under laboratory and limited driving conditions

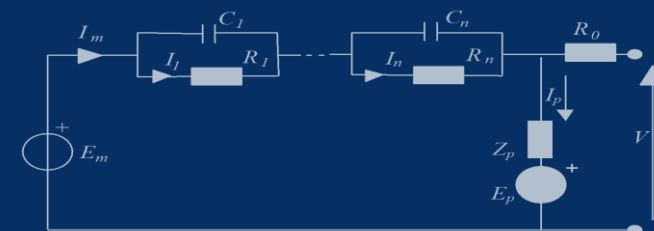
Solution: Scalable simulation-based data generation deployed in the cloud

<https://cn.mathworks.com/videos/building-battery-state-of-health-estimation-pipelines-for-electrified-vehicles-1558961478286.html>

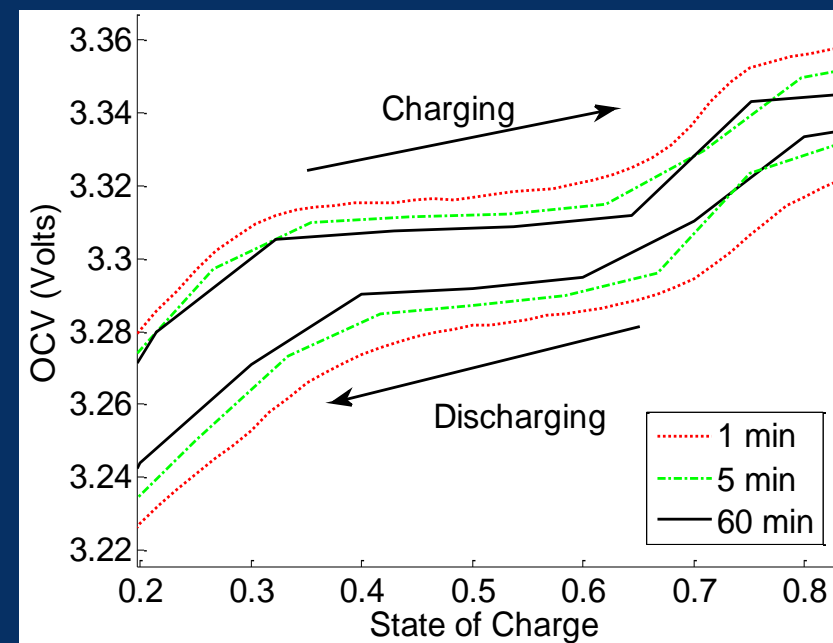
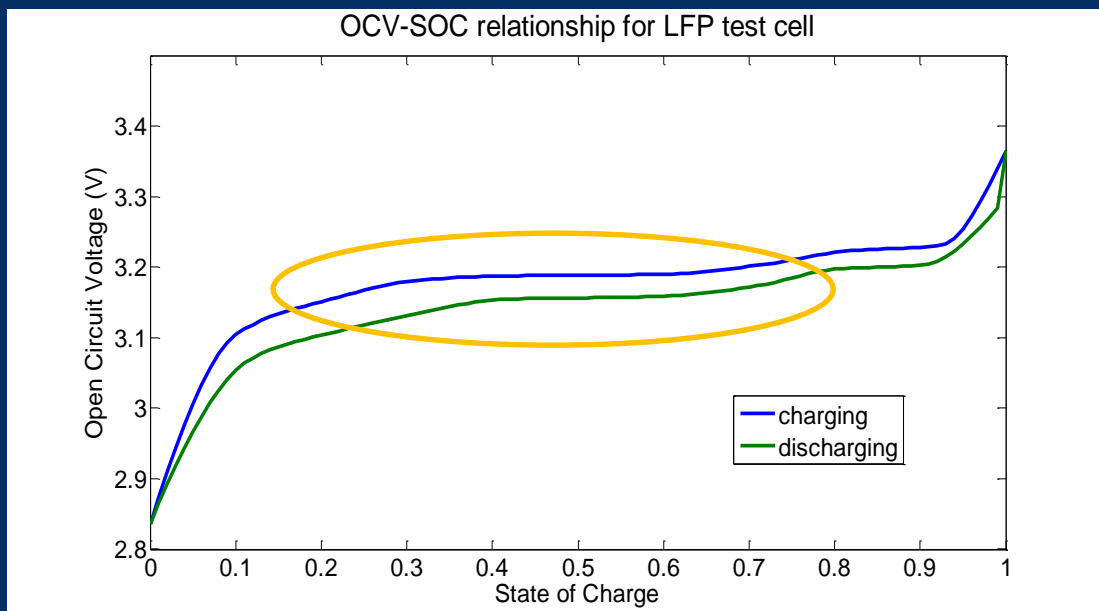
电芯建模存在的挑战

锂电池化学特性（以磷酸铁锂为例）：

- Complex transient response dynamics
- Significant voltage hysteresis
- Flat OCV-SOC relationship

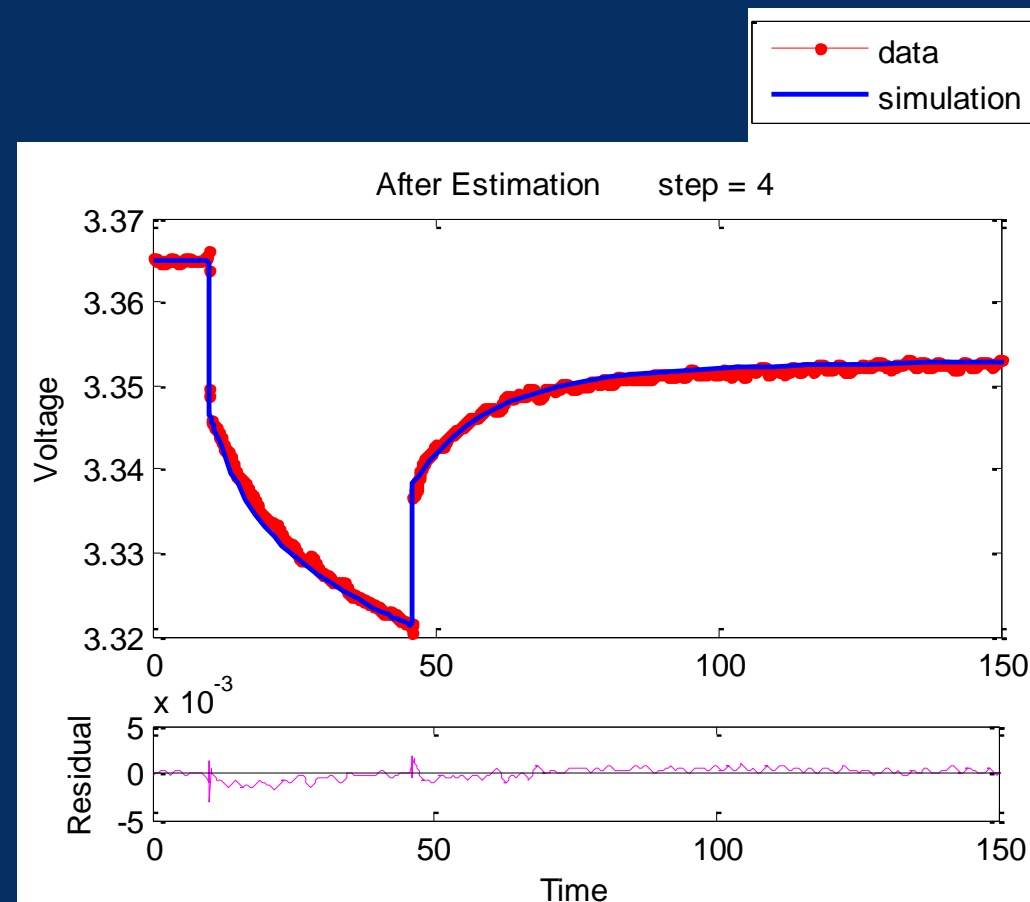
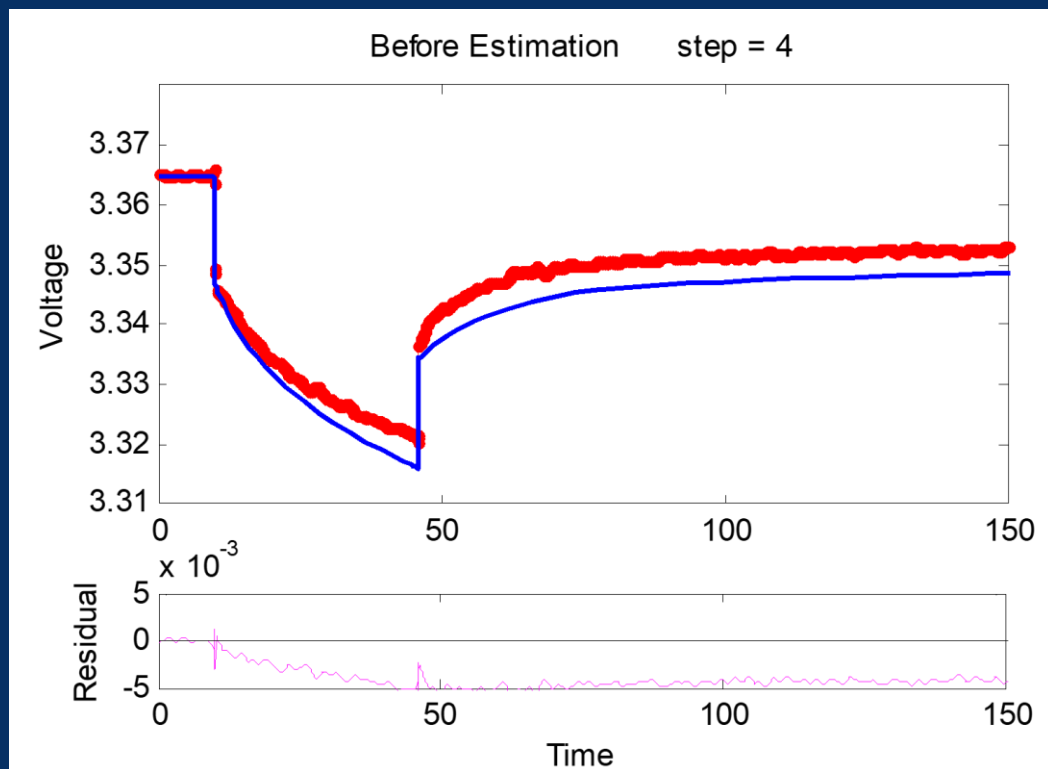


$$R_x = f(\text{SOC}, \text{Temperature}, I, V)$$



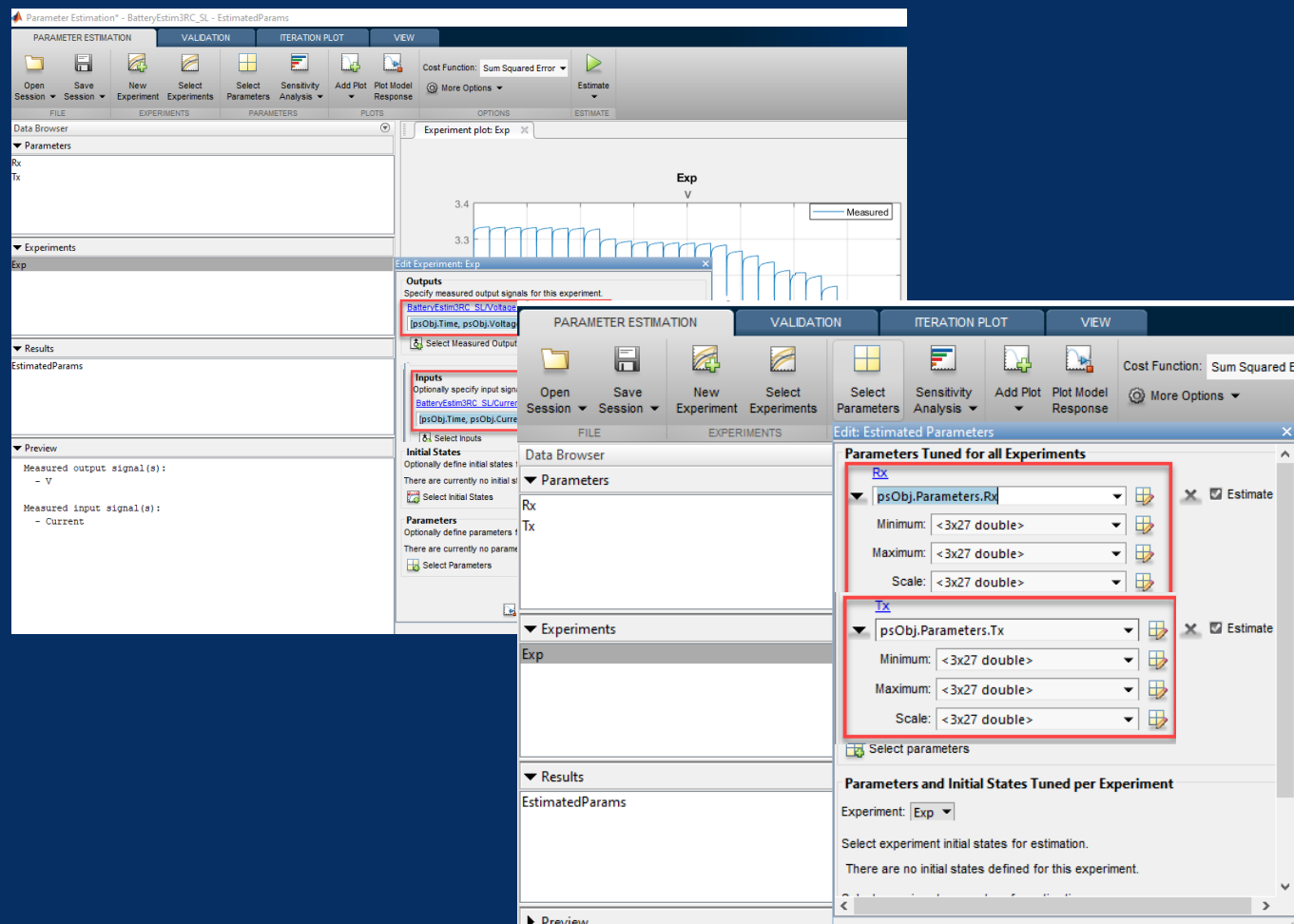
参数估计很复杂

目标：模型应尽可能与真实数据匹配

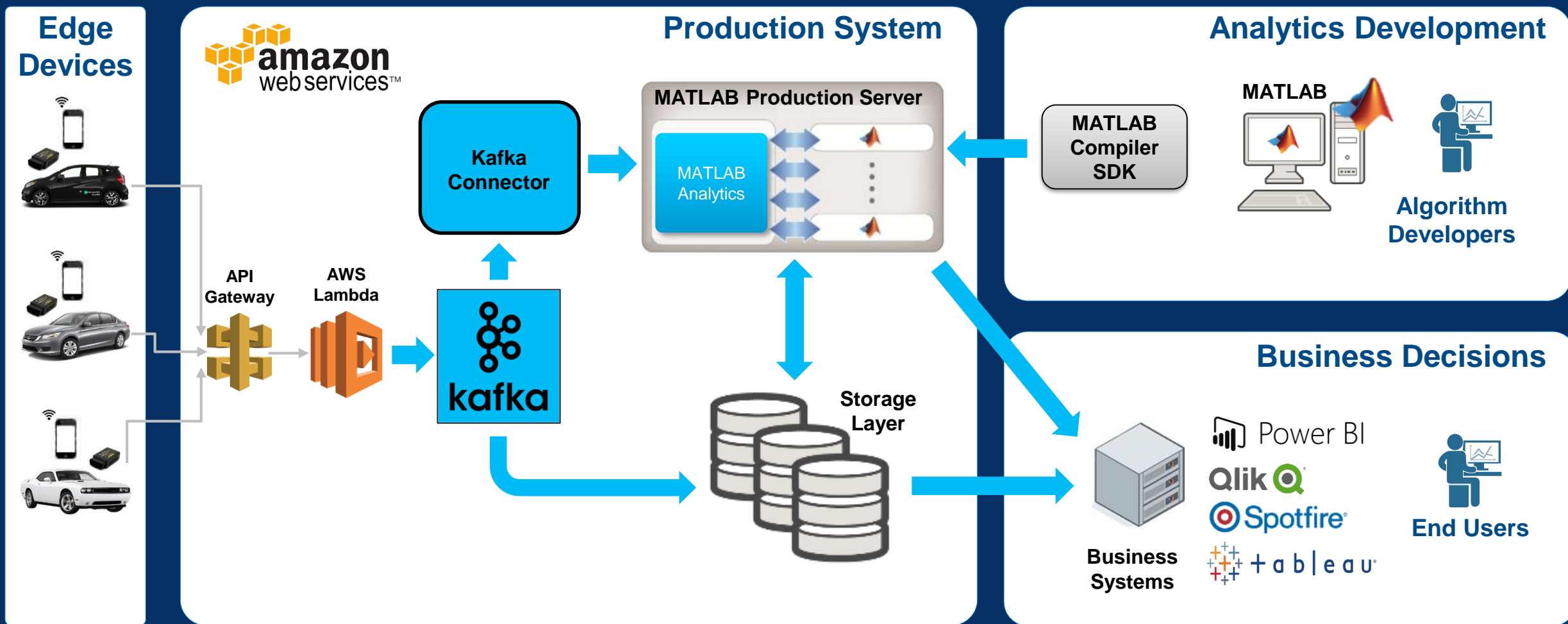


精确化锂电池建模的工作流程

- 一. 设计HPPC脉冲实验
- 二. 实验数据预处理
- 三. 选取电路拓扑
- 四. 电芯参数估计
- 五. 数据平滑和后处理
- 六. 参数估计验证



构建大数据与人工智能开发与应用平台



Keep in mind today:

How can **you** systematically use models and data as part of **your** pragmatic digital transformation?

Partner with MathWorks !