

# MATLAB EXPO

## **Pragmatic Digital Transformation** Through the Systematic Use of Data and Models

*Jim Tung*  
*MathWorks Fellow*



## Consider the doorbell



Access to the cloud

Add a camera



Add a motion sensor

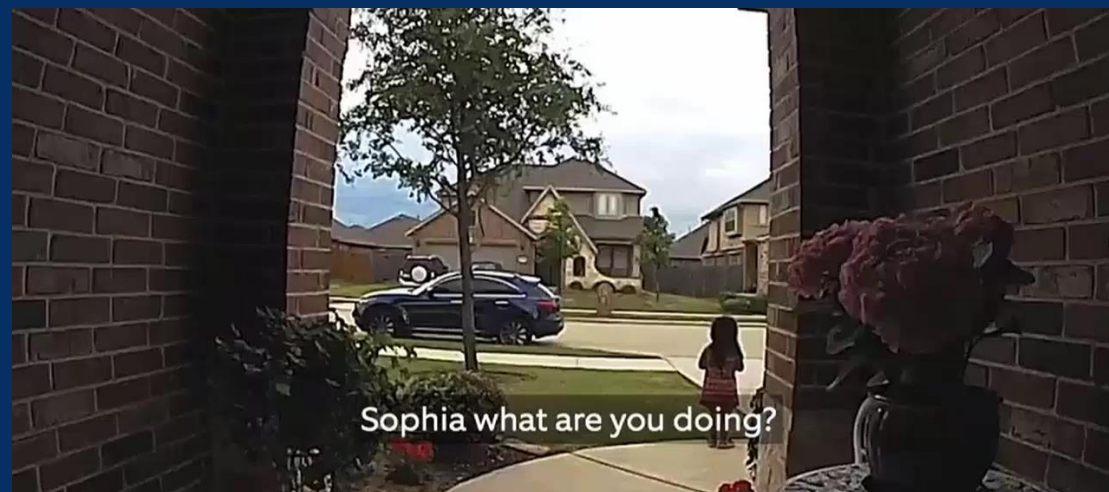


*Is this still a doorbell?*

# Digital transformation has changed the doorbell

## Digital technology

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



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## Business value

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

### Amazon Acquires Ring, Maker of Video Doorbells

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

# Digital transformation has changed the doorbell

## Digital technology

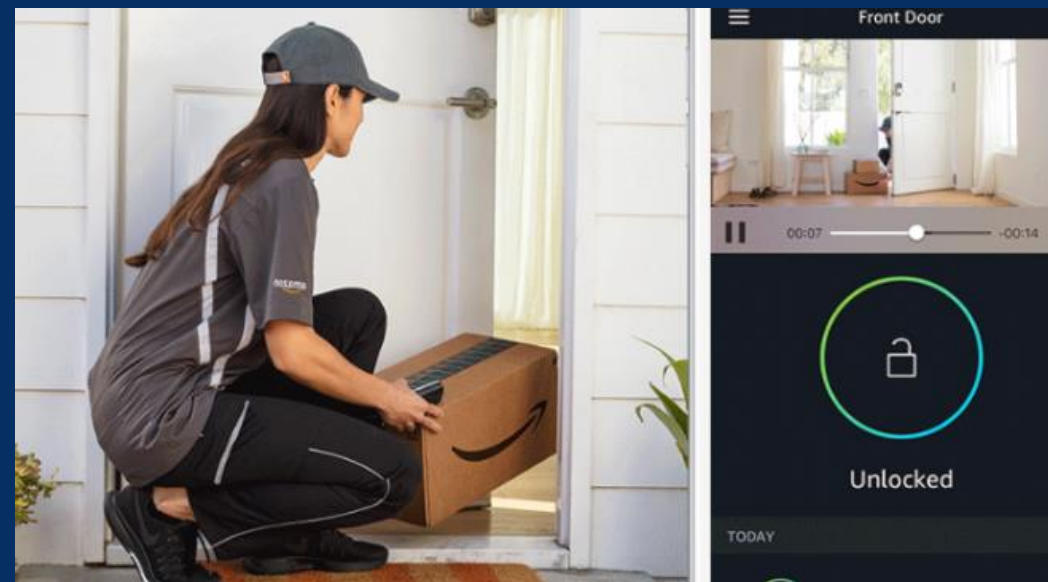
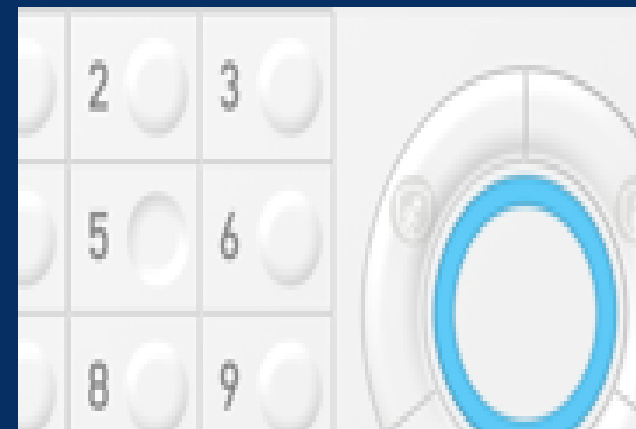
- HD video
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## Business value

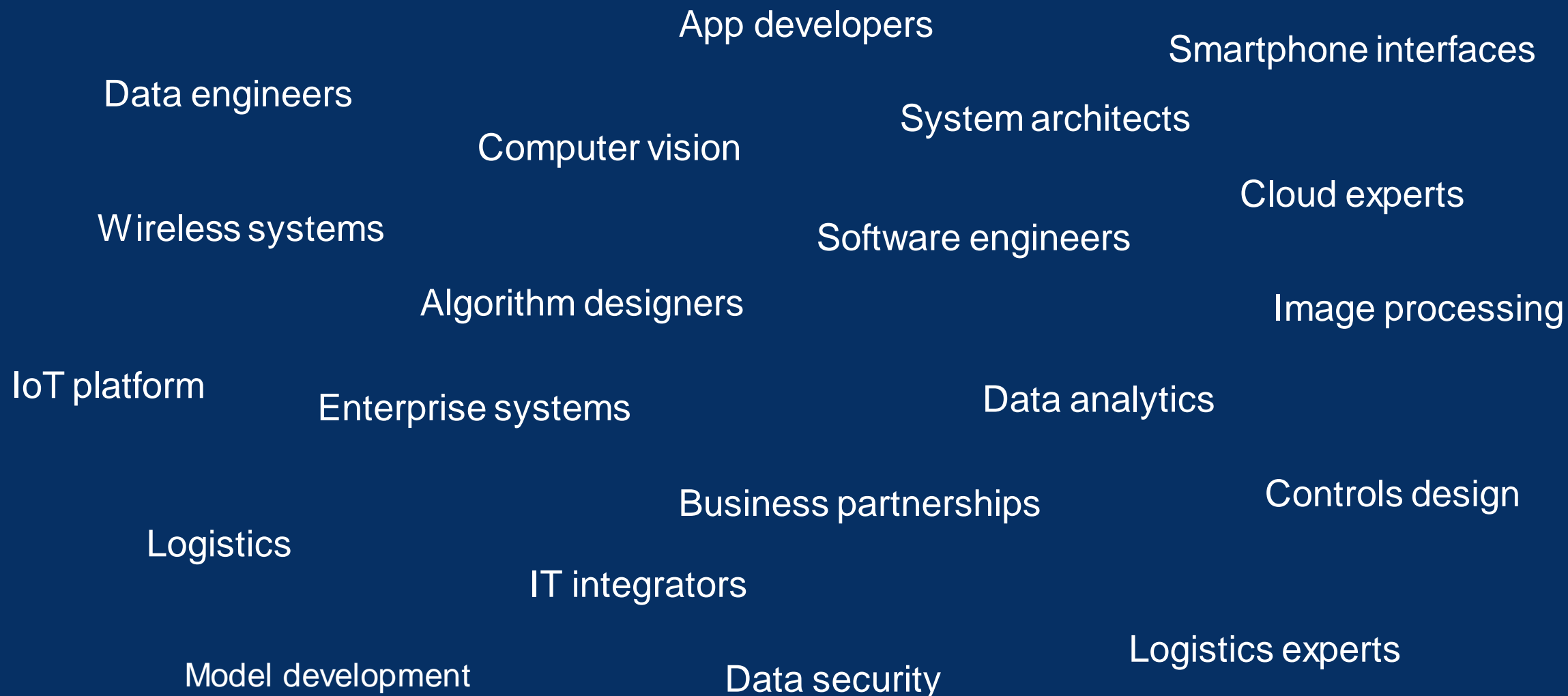
- Amazon buys Ring for \$1.2 billion+ in 2018

## New revenue opportunities

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



# Who and what were required to undergo this transformation?



## People

Data engineers  
 Algorithm designers  
 App developers  
 IT integrators  
 Cloud experts  
 Software engineers  
 System architects  
 Logistics experts

## Processes

Logistics  
 Business partnerships  
 Data security  
 Enterprise systems  
 Model development  
 Data analytics

## Technologies

Controls design  
 Smartphone interfaces  
 Wireless systems  
 Image processing  
 Computer vision  
 IoT platform

# More than just doorbells ...

## Industrial Automation



Individually customized  
manufactured units

## Automotive



Fully autonomous  
driving capabilities

## Petroleum



Increased energy efficiency  
with predictive maintenance

## Medical



Wearable devices to  
monitor mental health

## Aerospace



Global management  
of aircraft fleet

## Finance



Real-time data analytics  
for predictive insights



# Why Digital Transformation?

## Do things better Optimization

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

## Do new things Transformation

# Why Digital Transformation?

## Do things better Optimization

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## 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**

Plan and Pilot

Launch!



Actual project duration

Plan

Plan Some More

Pilot

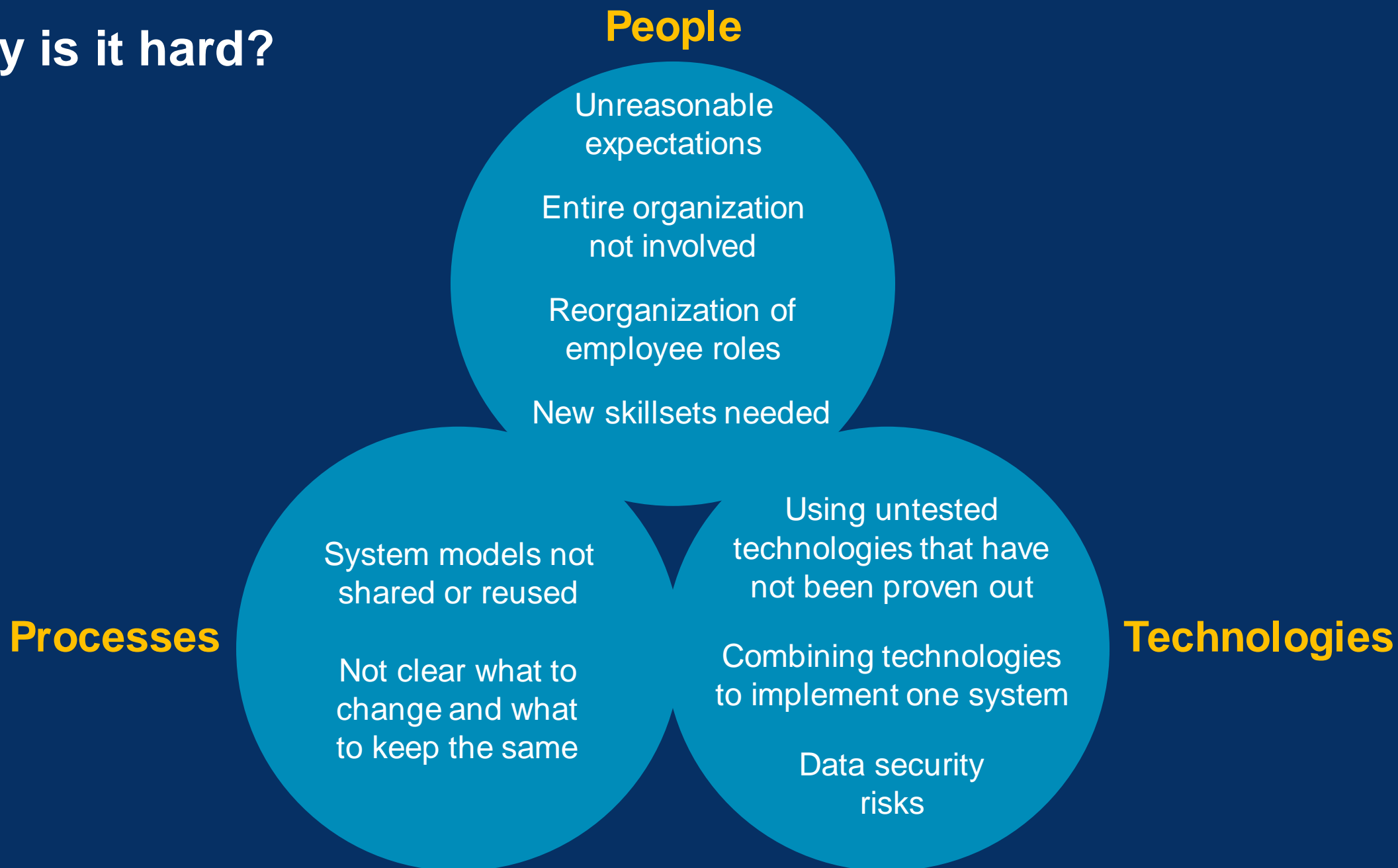
Keep Piloting

Launch?

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

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

# Why is it hard?



# What approaches have people tried?



## 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**

# **Systematic Use of Data**

# Data centralization has made engineering even more difficult

## 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





# National Oilwell Varco (NOV): Challenges



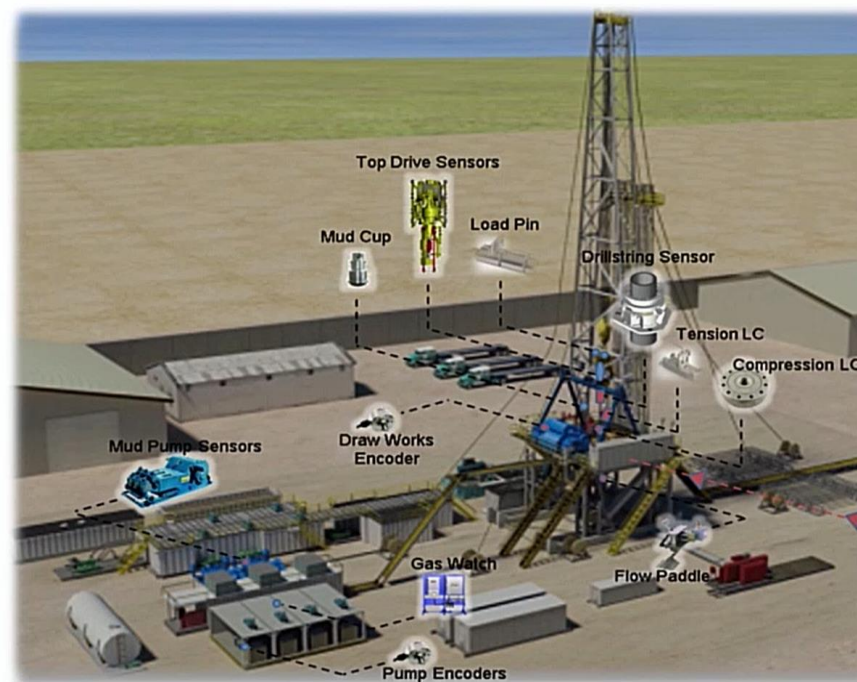
- Offline and siloed analytics for
  - Drilling models
  - Equipment health
  - Sensor models
  - Drilling optimization
- Improve efficiency and quality for drilling automation
- Location and mobility of drilling rig limit data transfer abilities

# NOV

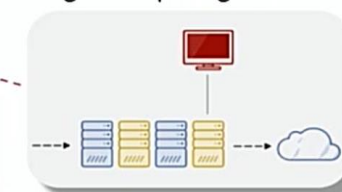
## Real-Time Edge Analytics with MATLAB & Simulink

Analysis  
Modeling  
Deployment  
Testing

### How: Prototype Deployment



Edge Computing Platform



# Standardized Operational Platform for Drilling Analytics

## Process

- Cross-group workflow
- Used throughout rig operation
- Optimized drilling automation and data analytics platform
- Optimized customer experience

## People

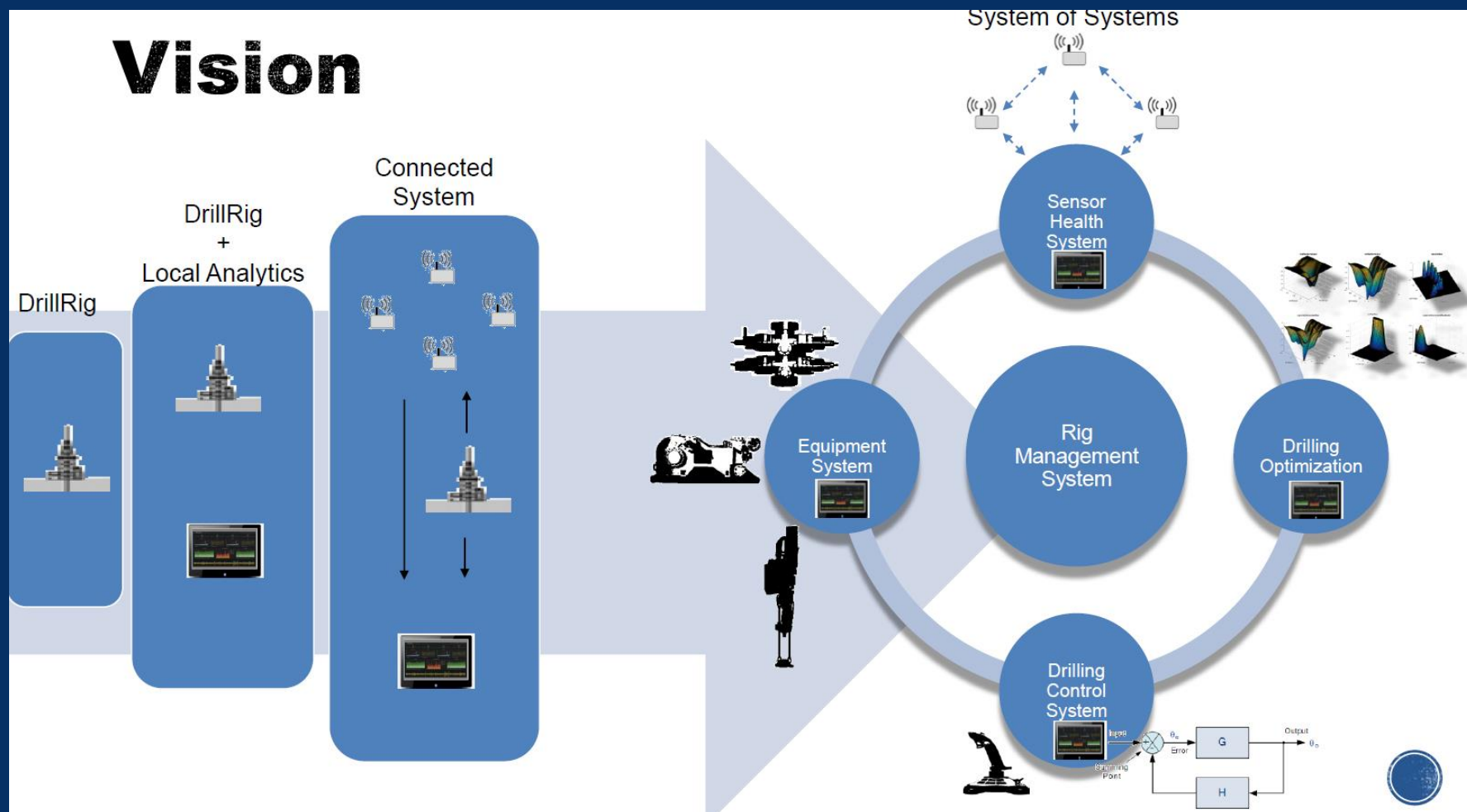
- Collaboration platform for efficient communication
- Rapid prototyping capabilities for engineers

## Results

- Productized edge analytics platform for customers
- Quick implementation of upgrades
- Accelerated development timelines establish NOV's industry leadership

# Results of Digital Transformation at NOV

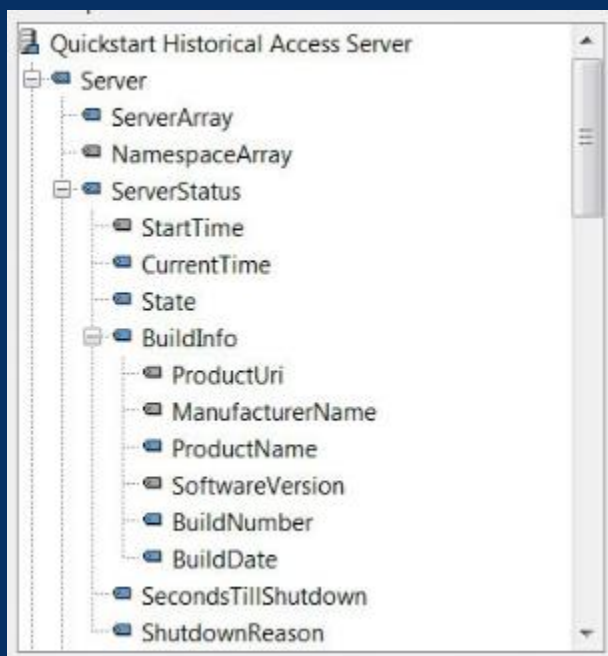
## Industry leadership in drilling automation systems



# What is new to make this easier?

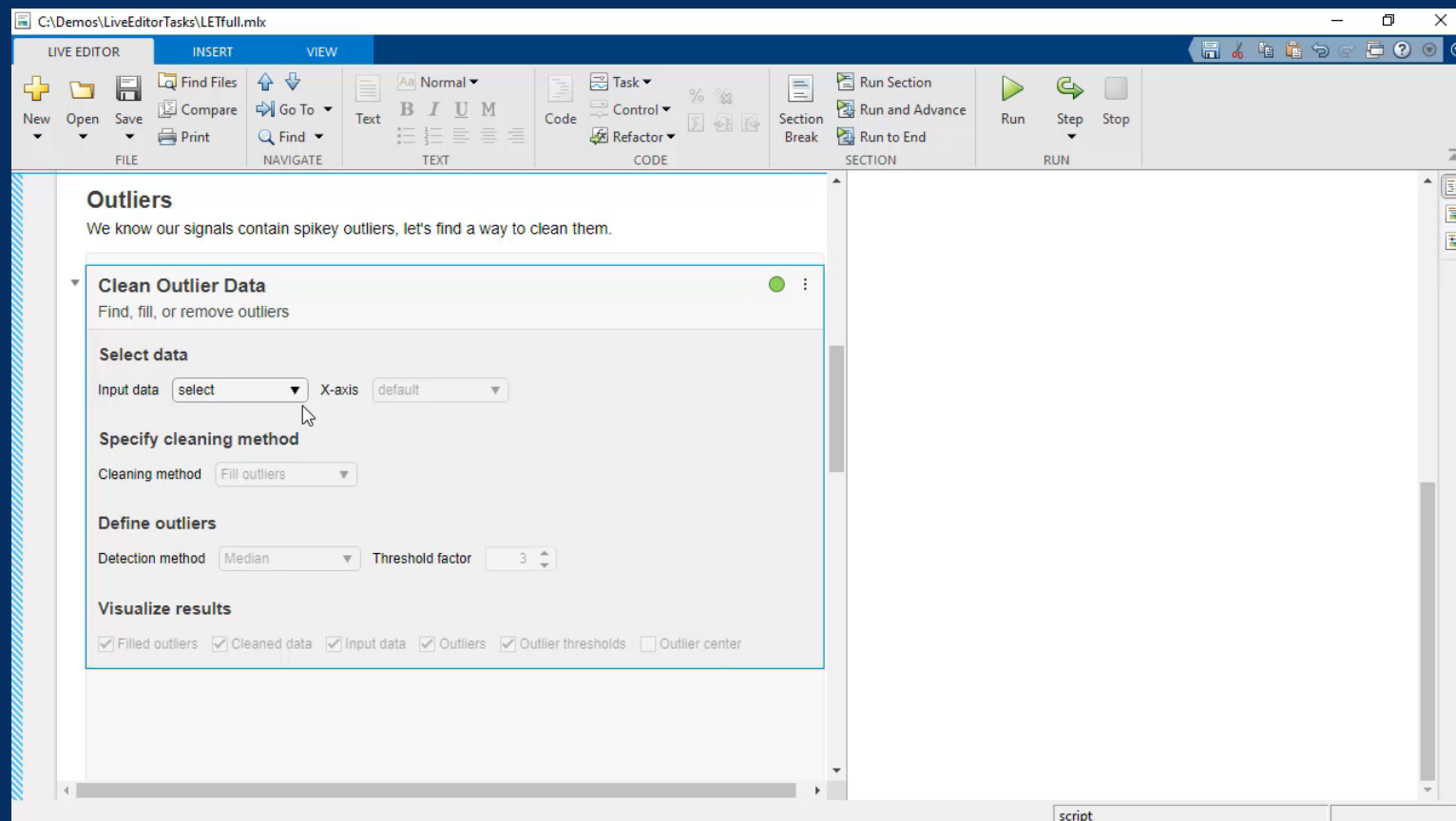
## OPC UA

Access plant data securely from OPC UA-compliant servers.



## Live Editor Tasks

Apps that help you reduce development time and errors



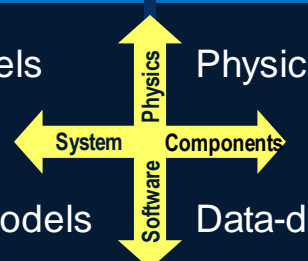
## Predictive Maintenance Toolbox

Design condition indicators and estimate RUL of machinery

# **Systematic Use of Models**


# Model-Based Design: Systematic Use of Models in Development

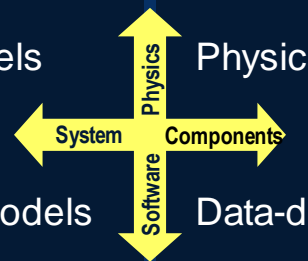
System Requirements	System Functionality and Architecture	Subsystem Design	Subsystem Implementation	System Integration and Qualification
Use Cases Docs & models	Behavior models Architecture models	Physics-based Data-driven	C, C++ VHDL, Verilog GPU code Structured text	Model-based V&V Code-based V&V Certification workflows



**Digital Thread**

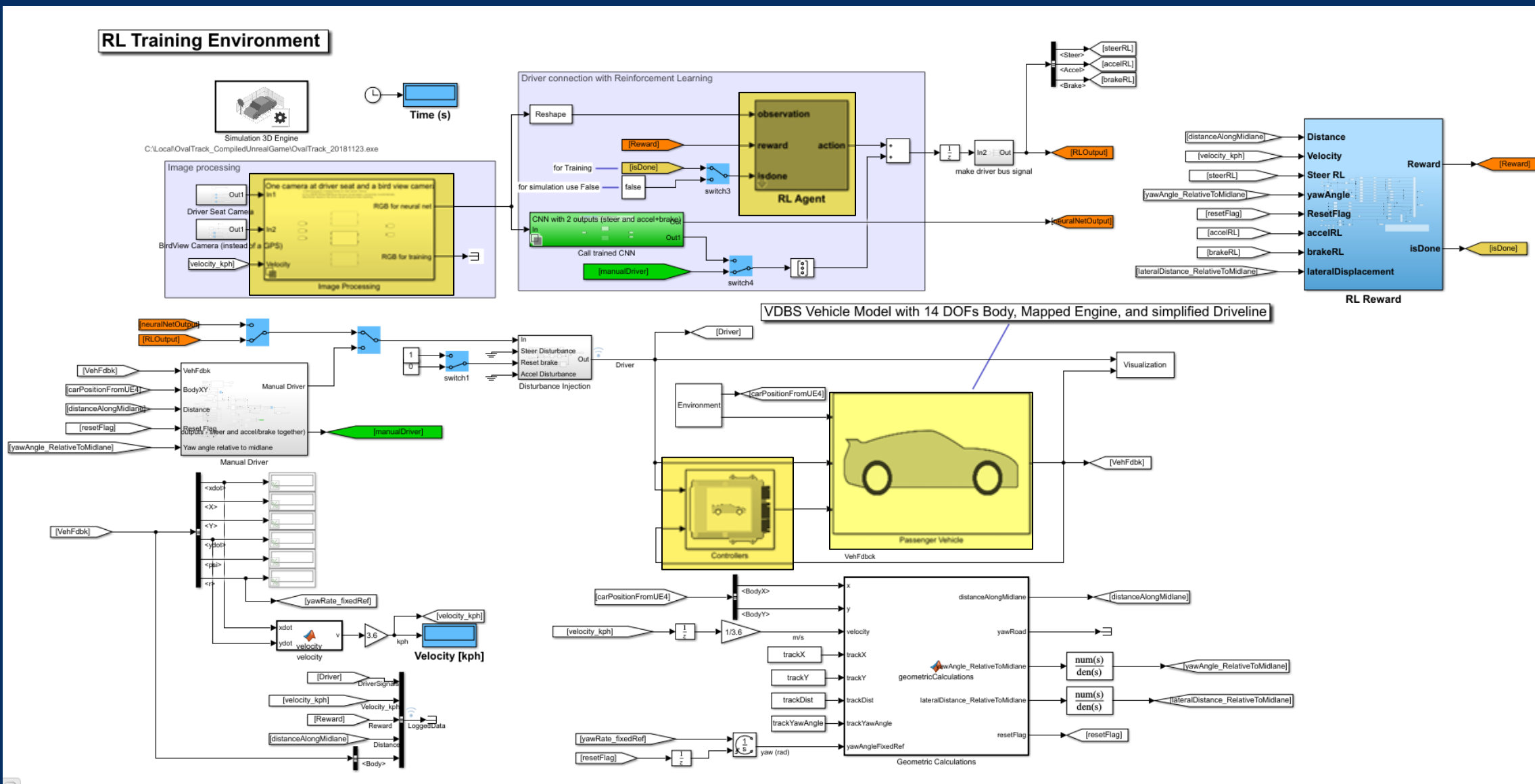
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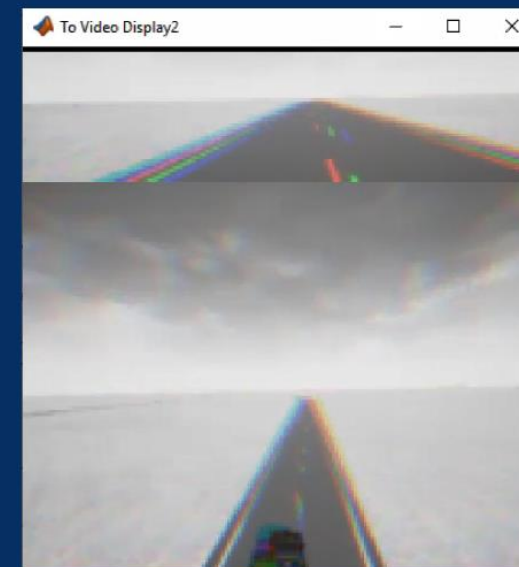
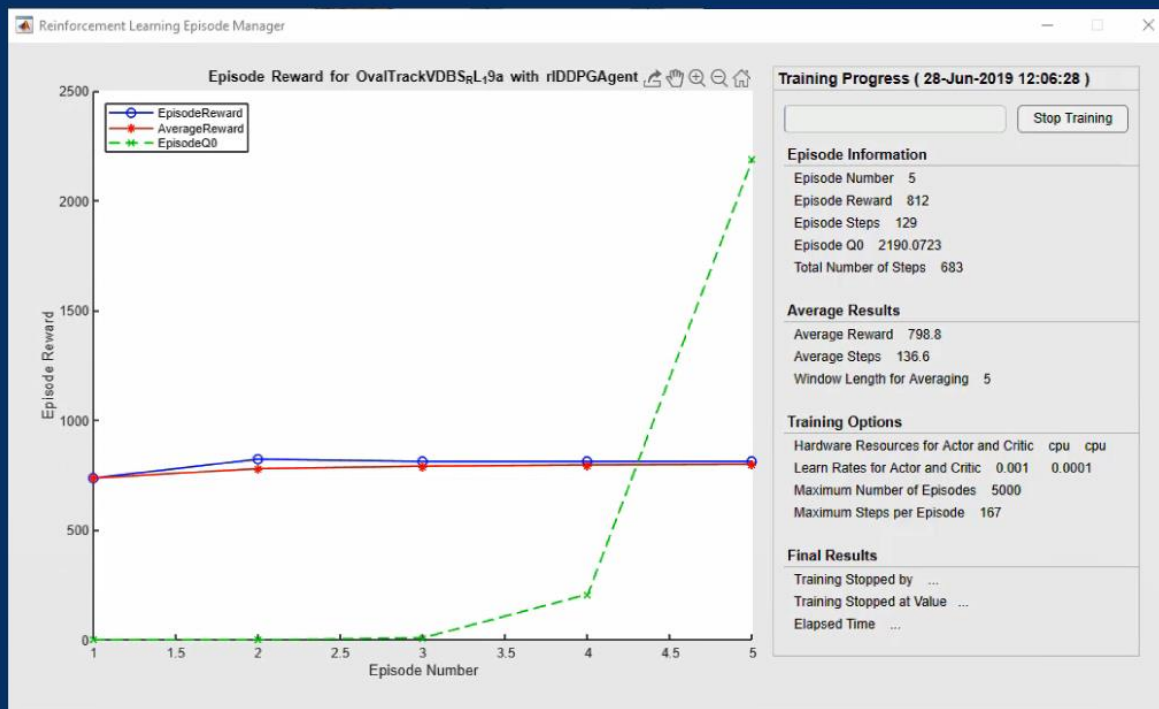
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	AI 	Data labeling Training Quantizing	C,C++ GPU code	<b>AI Integration in Simulink models</b>

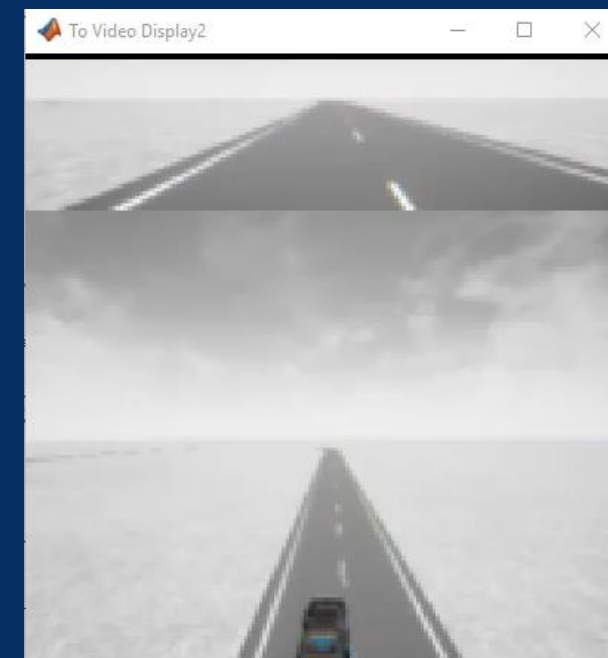
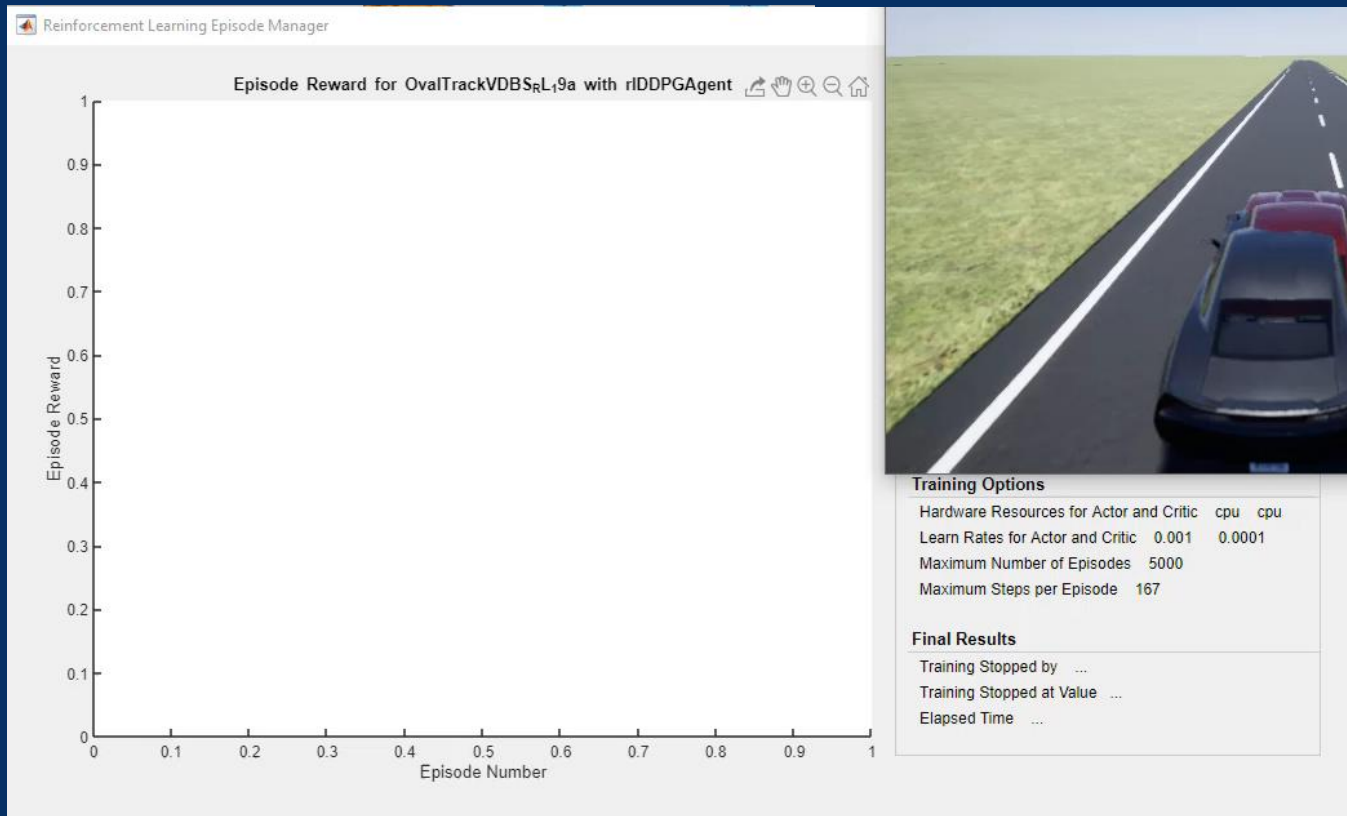




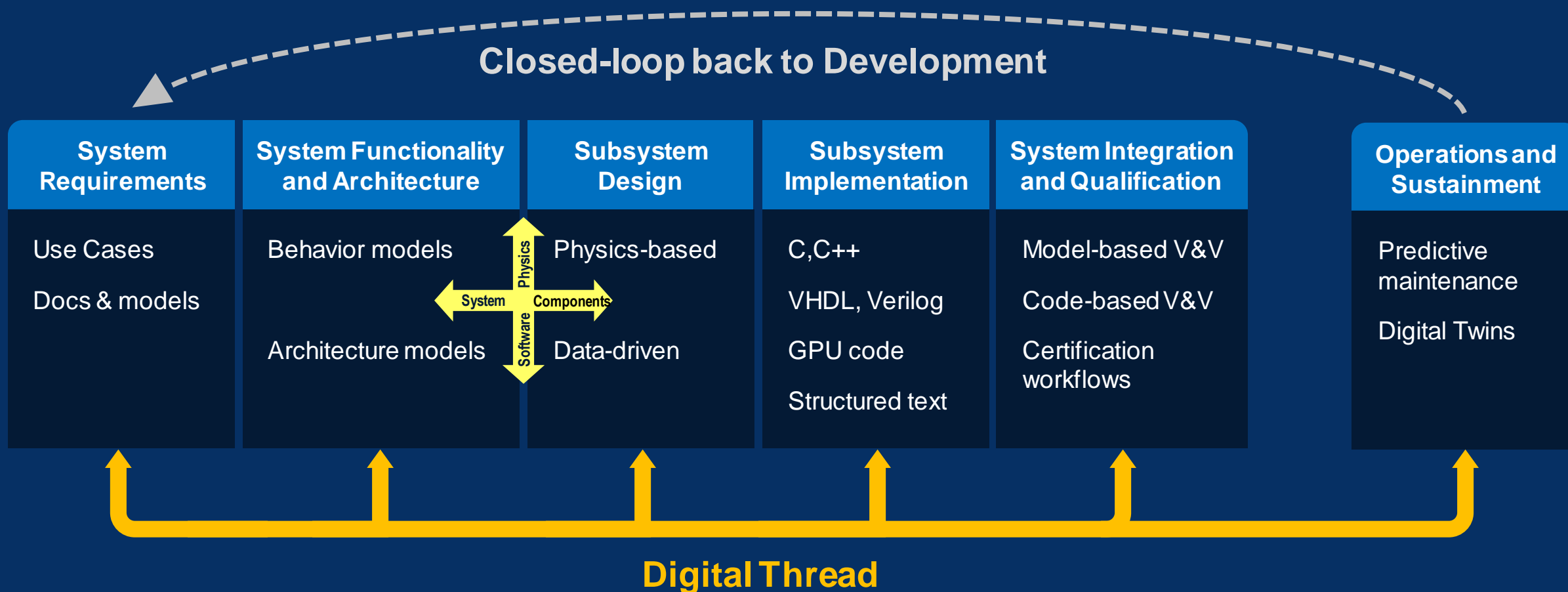
# Example: Reinforcement Learning for Autonomous Vehicles







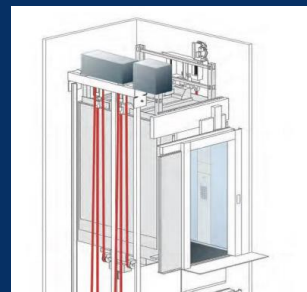
# Extending Through the System's Lifecycle



# Case Studies: Use of Data and Models in Operation



**Atlas Copco:** Digital thread for compressor systems



**Schindler Elevator:** Virtual commissioning



**BuildingIQ:** Predictive energy optimization



**Tata Steel:** Controller optimization



**Fuji Electric:** Real-time analysis of Smart Grid



**Lockheed:** Aircraft fleet management



**Mining company:** Fault detection and predictive maintenance



**Transocean:** Condition and performance monitoring of BOP

# Atlas Copco: Challenges



Air Compressor System

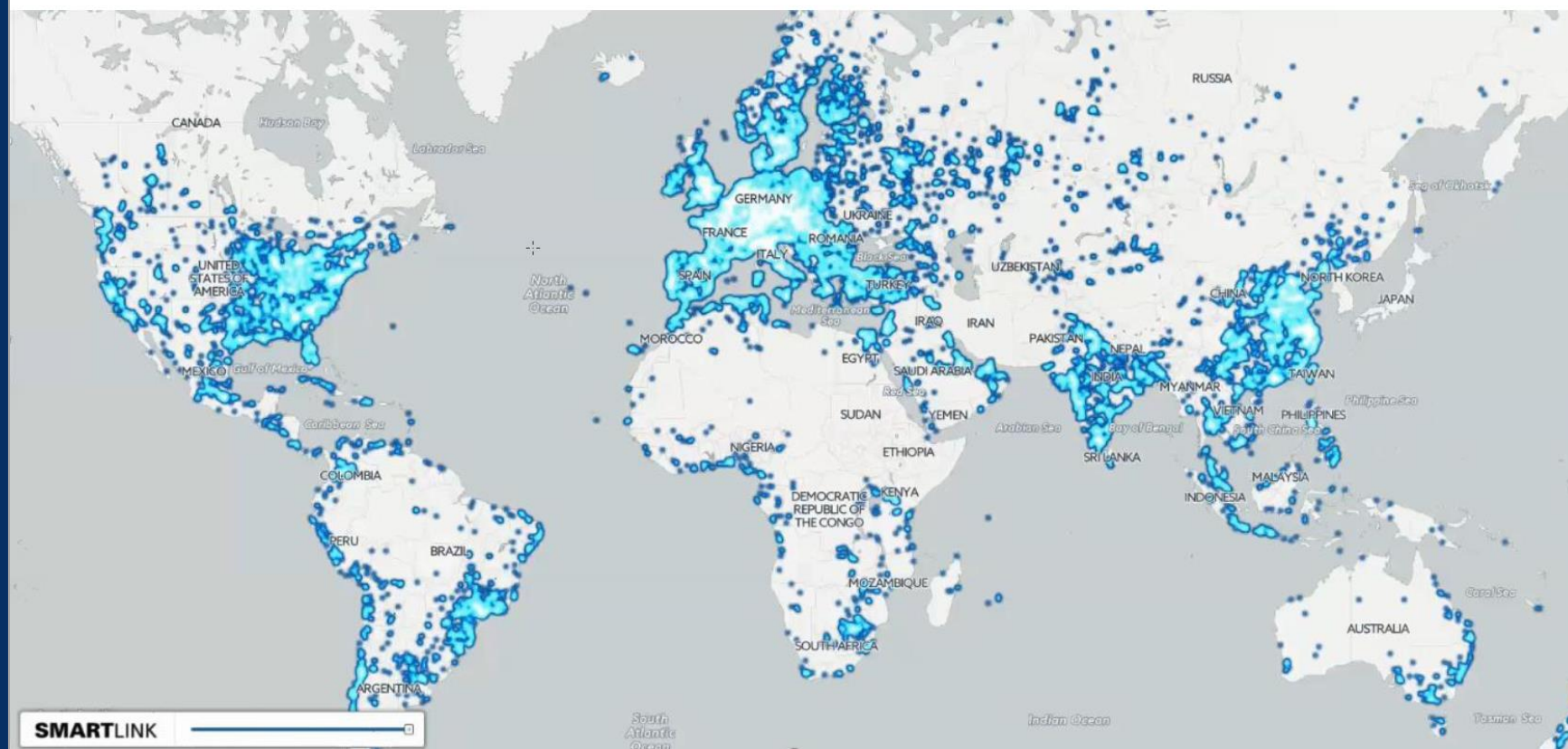
- Shorter Time to Market
- Cross divisional development
- Improve reliability and efficiency
- Control total development, production and service costs
- High product variability

# Atlas Copco

## System Lifecycle Use with MATLAB & Simulink

As Designed  
As Configured  
As Produced  
As Maintained

As Maintained: > 120.000 Machines Connected



# As Achieved: Standardized Model Based Engineering Platform

## Process

- Company-wide workflow
- Used throughout product lifecycle
- Optimized maintenance and Data Analytics platform
- Continuously updated digital twins

## People

- Collaboration platform for efficient communication
- Standardized accurate configuration tool used by global sales

## Results

- 120k+ connected machines
- Quick implementation of upgrades
- Re-establishing Atlas Copco as undisputed global market leader



# What is new to make this easier (more powerful/effective)?

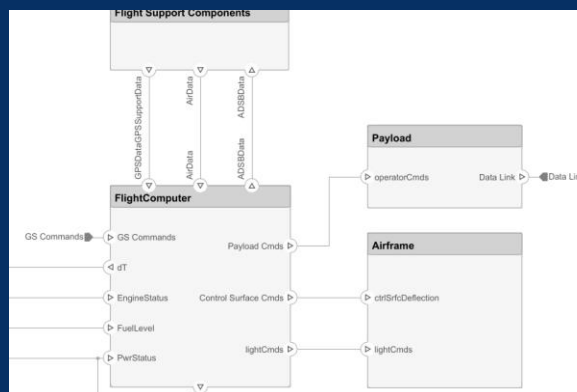
## Simulink Requirements

View: Requirements Search

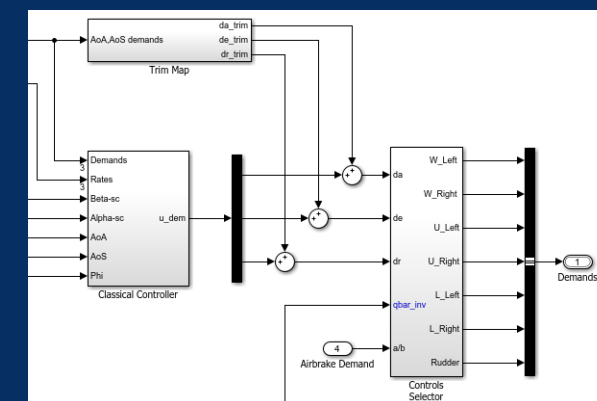
Index	ID	Summary
scExampleSmallUAVModel		
1	#1	Aircraft Capabilities
1.1	#3	Airworthiness
1.1.1	#5	Range
1.1.2	#6	Rain Conditions
1.1.3	#7	Power
1.1.4	#8	Emergency Power
1.1.5	#9	Control Surface Fault-Tolerance
1.1.6	#10	Fuel
1.1.7	#19	No Payload Flights
1.1.8	#21	Flight Data Recorder
1.1.9	#22	Flight Identification



## System Composer

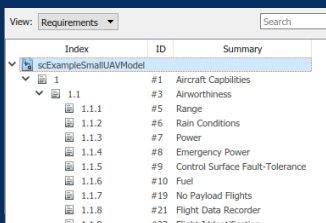


## Simulink

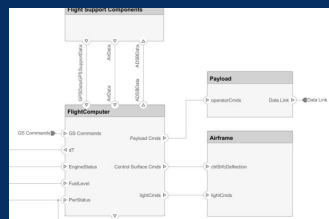


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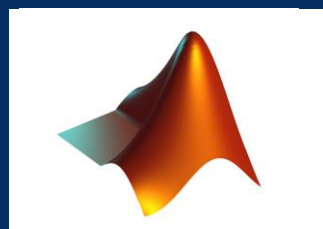
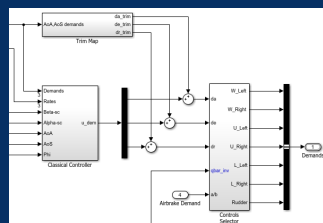
Simulink Requirements



System Composer



Simulink



MATLAB



## Digital Twins and Predictive Maintenance

### Big Data/Dashboards



### Cloud



### Edge



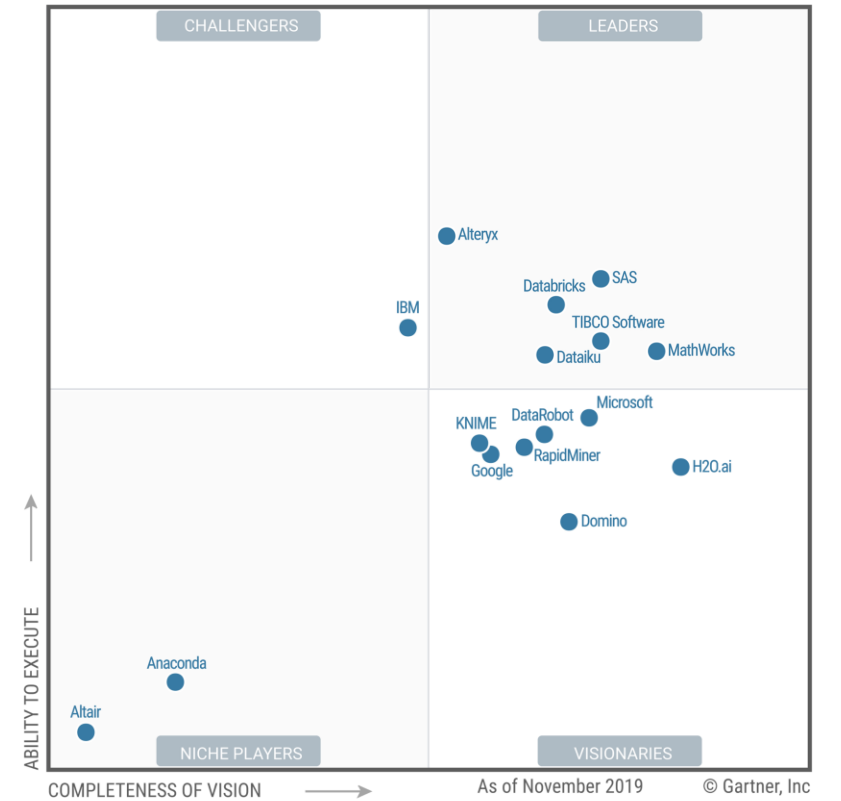
### Embedded





# A **Leader** in the Gartner Magic Quadrant for 2020 Data Science and Machine Learning Platforms

Figure 1. Magic Quadrant for Data Science and Machine Learning Platforms



Source: Gartner (February 2020)

\*Gartner Magic Quadrant for Data Science and Machine Learning Platforms, Peter Krensky, Erick Brethenoux, Jim Hare, Carlie Idoine, Alexander Linden, Svetlana Sicular, 11 February 2020 .

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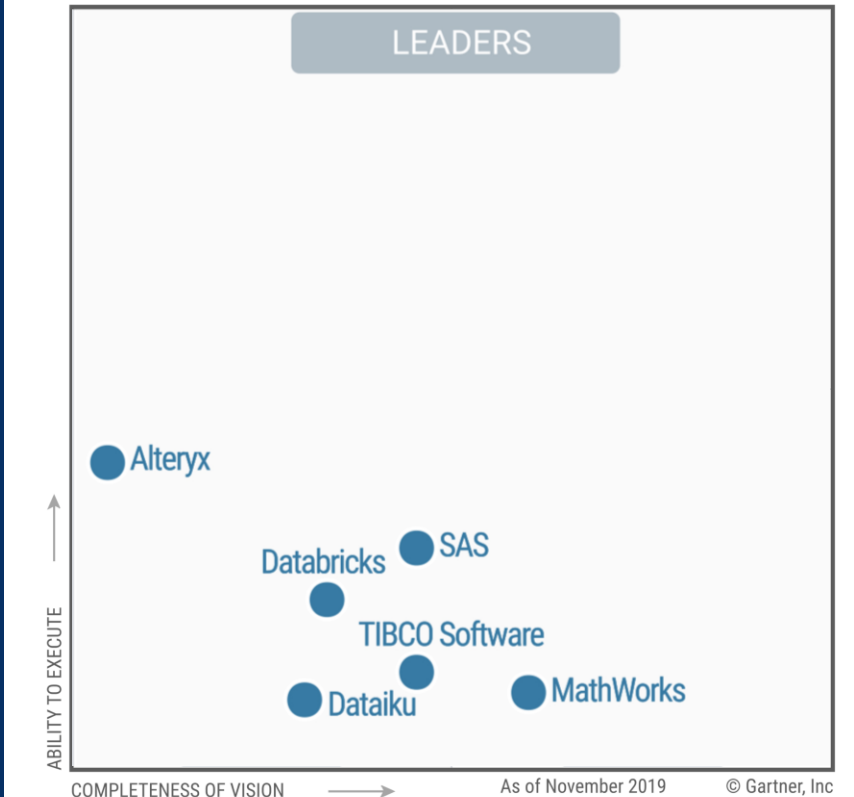


## A **Leader** in the Gartner Magic Quadrant for 2020 Data Science and Machine Learning Platforms

*We believe this recognition demonstrates our ability to:*

- Empower teams, even those with limited AI experience
- Support entire AI workflows
- Deploy to embedded, edge, enterprise, and cloud
- Tackle integration challenges
- Manage risk in designing AI-driven systems

Figure 1. Magic Quadrant for Data Science and Machine Learning Platforms



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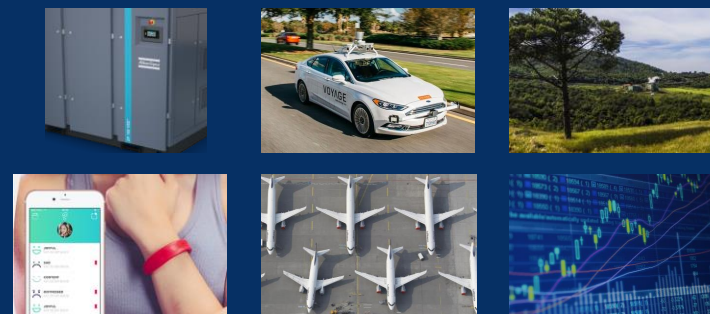
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# Why MathWorks for Pragmatic Digital Transformation?

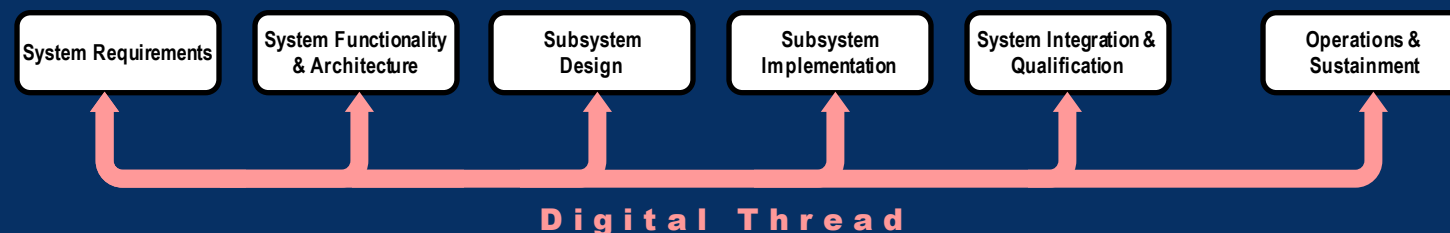
Systematic use of data and models

MATLAB®  
& SIMULINK®

to create and deliver superior value  
to customers



throughout the entire lifecycle



Keep in mind today:

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

Enjoy the Conference!