# MATLAB EXPO

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

*Jim Tung MathWorks Fellow* 





#### **Consider the doorbell**



Access to the cloud

Is this still a doorbell?

#### Add a motion sensor

Add a camera

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### Digital transformation has changed the doorbell

#### **Digital technology**

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





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

#### **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
- Motion detection
- Smartphone interface
- AWS Cloud

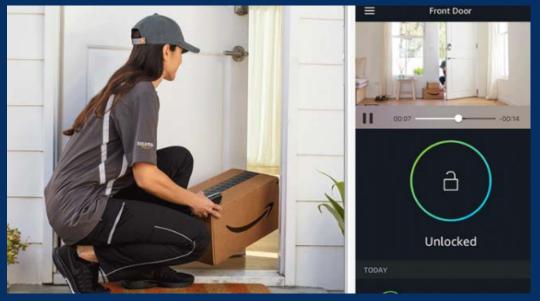
#### **Business value**

Amazon buys Ring for \$1.2 billion+ in 2018

#### **New revenue opportunities**

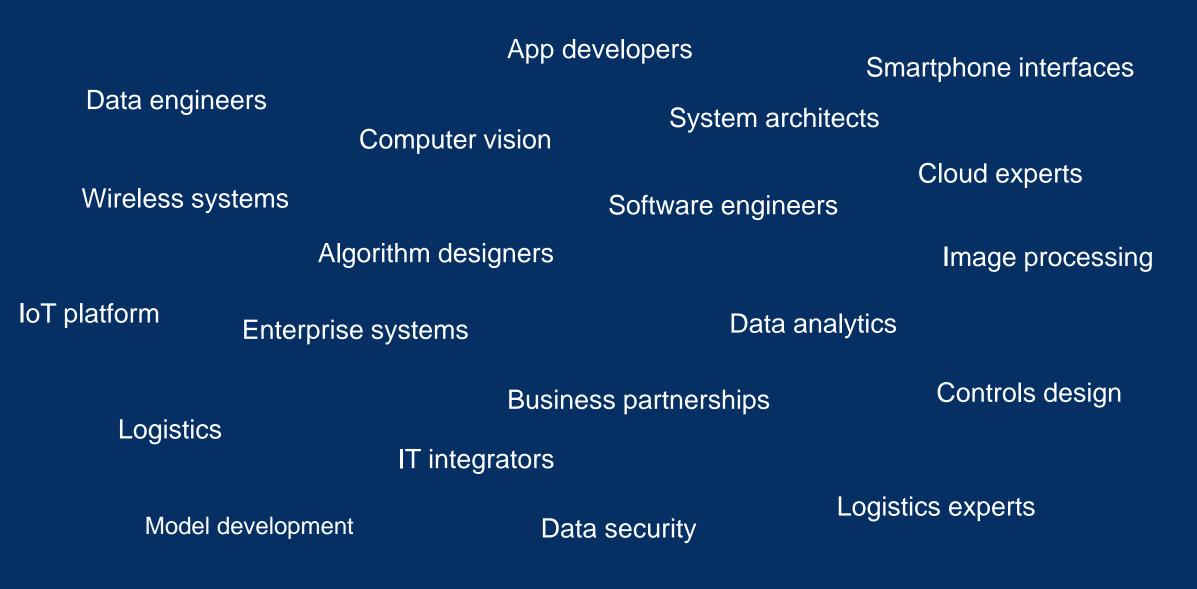
- "Ring Protect" subscription plans (\$99-\$499)
- Additional security with Ring Alarm kit
- More secure delivery through Amazon Key







#### 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

Logistics Business partnerships Data security Enterprise systems Model development Data analytics

**Processes** 

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

#### **Technologies**

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#### More than just doorbells ...

#### **Industrial Automation**



Individually customized manufactured units

#### **Automotive**



Fully autonomous driving capabilities

#### **Utilities & Energy**



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

**Do new things Transformation** 

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



### Why Digital Transformation?

#### Do things better Optimization

- Optimize design performance in-operationPredict 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



Plan and PilotLaunch!Expected project duration

#### 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?

Processes

#### People

Unreasonable expectations

Entire organization not involved

Reorganization of employee roles

New skillsets needed

### 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**

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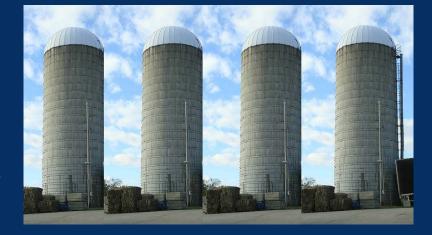


#### What approaches have people tried?



**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

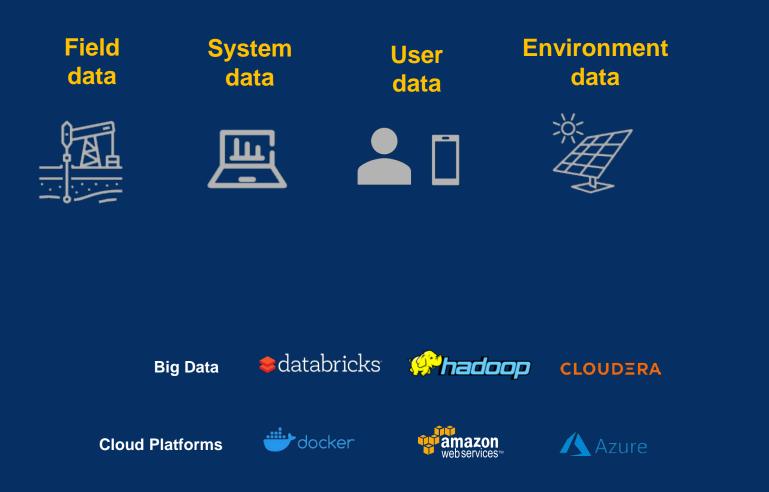
### **Pragmatic Digital Transformation**

Systematic use of <u>data</u> and <u>models</u> to create and <u>deliver</u> <u>superior</u> value to customers throughout the entire lifecycle

### Systematic Use of Data



### Data centralization has made engineering even more difficult



#### 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



### **Example: GSK Consumer Healthcare**

Using big batch process data to make better products



#### £1 billion brand

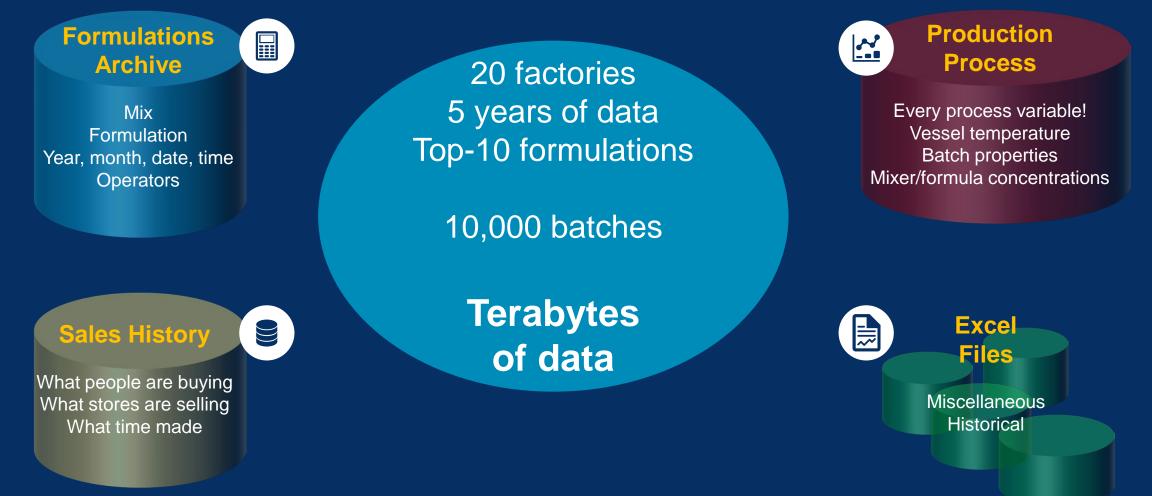
~8% growth Close to capacity at all 20+ factories

"Trying to squeeze every last drop of efficiency ... Last thing we want to do is build another toothpaste factory" Dr. Bob Sochon





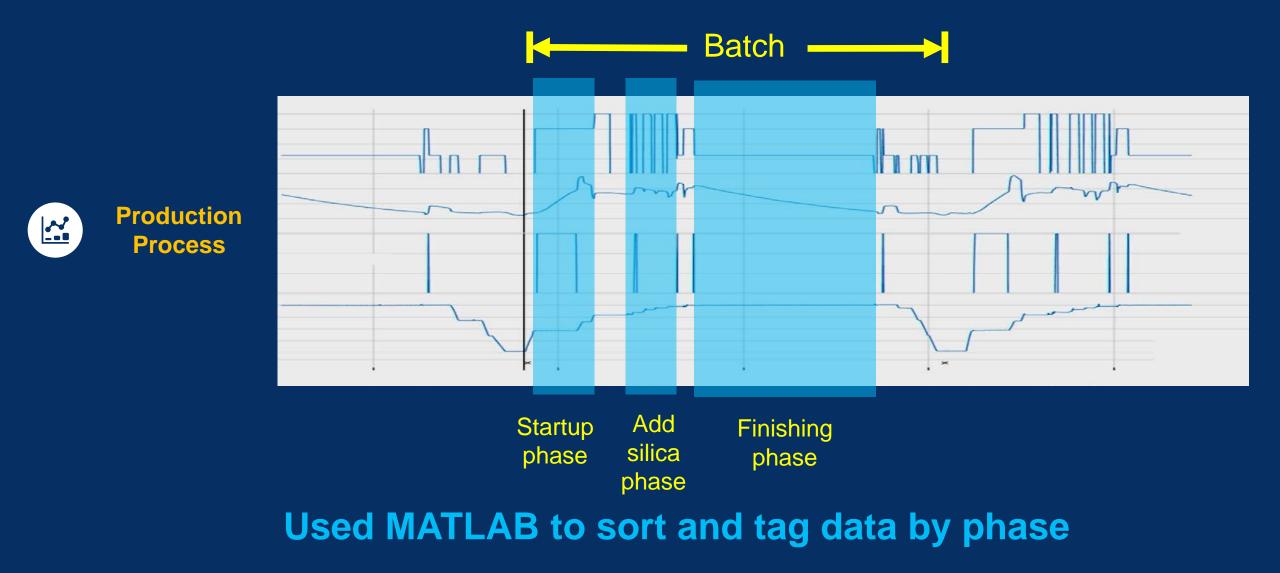
#### **Challenge #1:** Big data lives in many siloes



#### **Used MATLAB to combine and clean data**



#### **Challenge #2:** Need systematic pre-processing





#### **Challenge #3:** Need systematic views of data

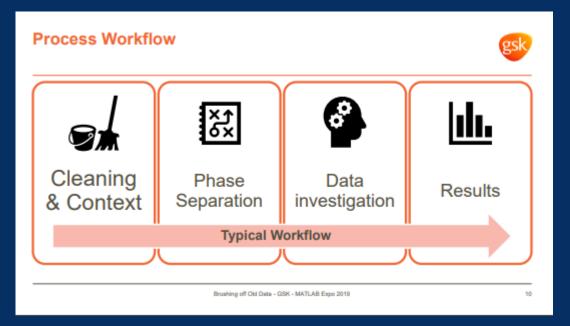
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	U3532							
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	Safety Mode	Plotting Done						
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#### **Used MATLAB to build views**

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### **Results of Digital Transformation at GSK**



#### Systematic use of data

- Combine siloed data
- Sort and tag
- Views to select

#### Can now use data to answer questions

- What affects the process
- How is each phase performing
- What happens if we adjust parameters

#### **Benefits**

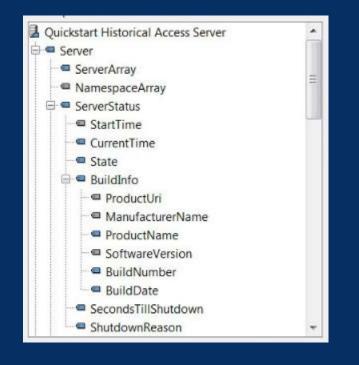
- Reduced time to market for new formulas
- Automated reports for process improvement
- Added capacity without building a new factory



#### What is new to make this easier?

#### **OPC UA**

#### Access plant data securely from OPC UAcompliant servers.



#### **Live Editor Tasks**

Apps that help you reduce development time and errors

#### **Predictive Maintenance Toolbox**

Design condition indicators and estimate RUL of machinery

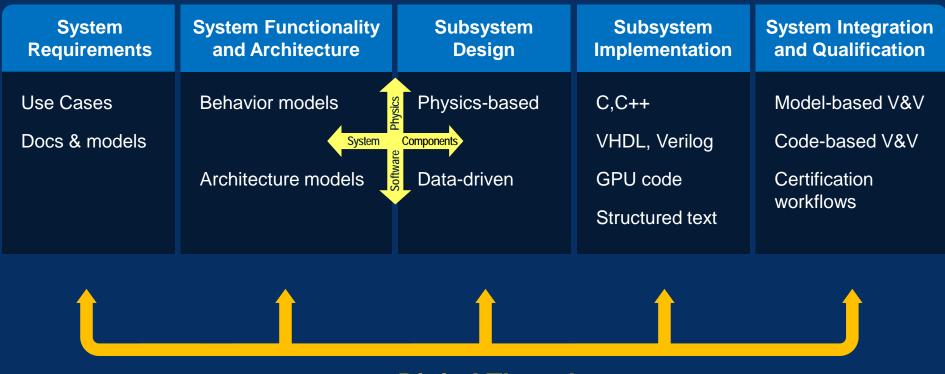
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### **Systematic Use of Models**



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



**Digital Thread** 

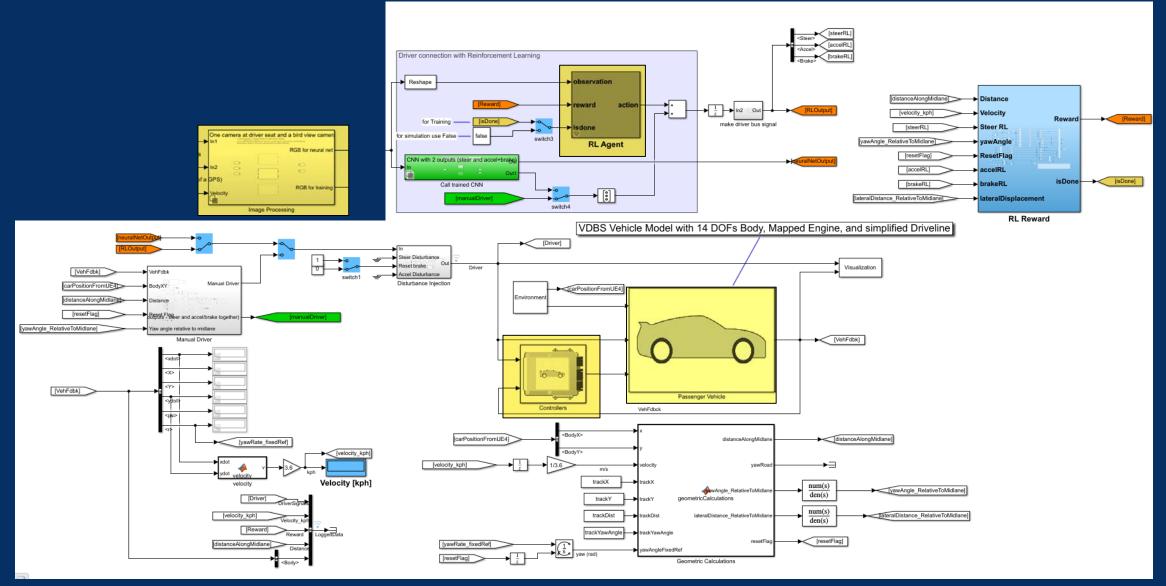


### Model-Based Design: Systematic Use of Models in Development

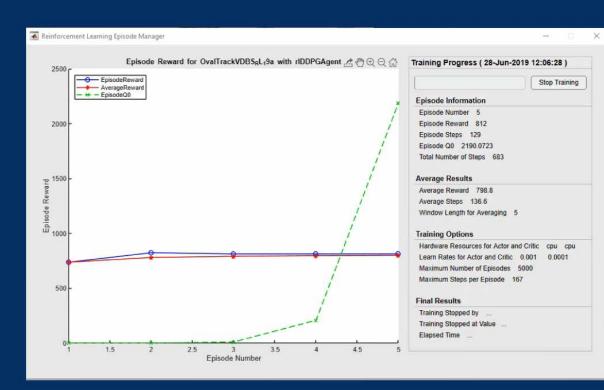
System Requirements	System Functionality and Architecture	Subsystem Design	Subsystem Implementation	System Integration and Qualification
Use Cases Docs & models	System	Physics-based Components Data-driven	C,C++ VHDL, Verilog GPU code Structured text	Model-based V&V Code-based V&V Certification workflows
	Al View of the second s	Data labeling Training Quantizing	C,C++ GPU code	Al Integration in Simulink models



#### **Example: Reinforcement Learning for Autonomous Vehicles**

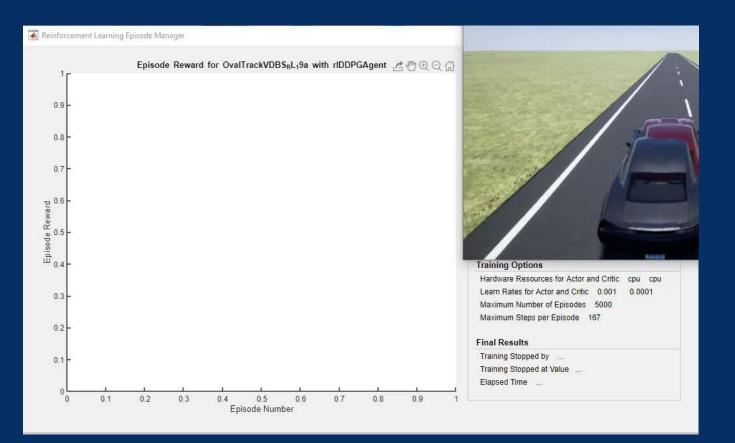








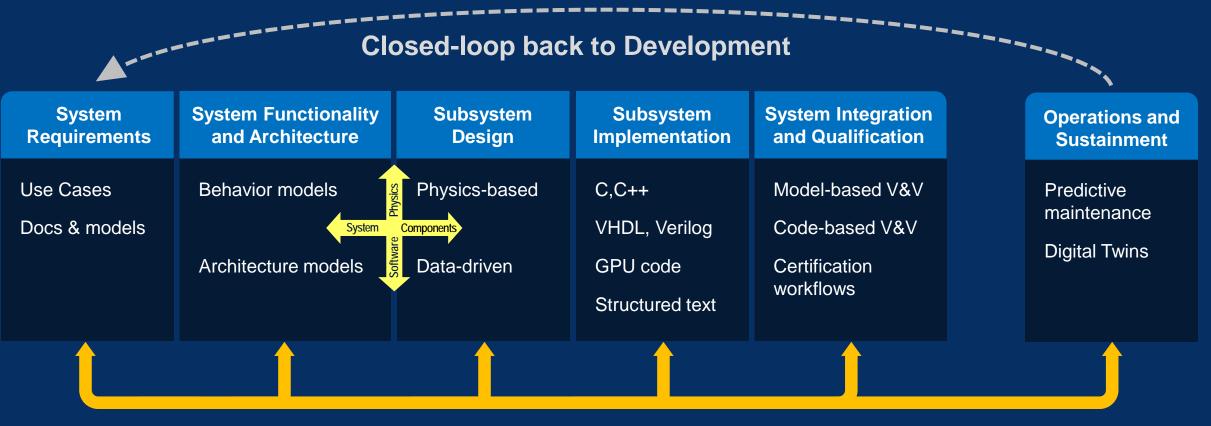








### **Extending Through the System's Lifecycle**



**Digital Thread** 



#### **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



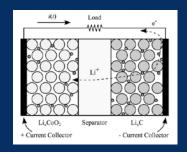
Fuji Electric: Real-time analysis of Smart Grid



Lockheed: Aircraft fleet management



Mining company: Fault detection and predictive maintenance



NIO: Battery management for electric vehicles



#### **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

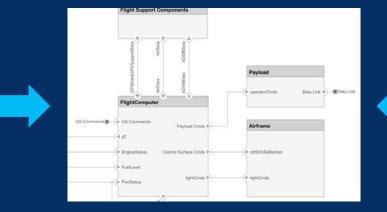


### What is new to make this easier (more powerful/effective)?

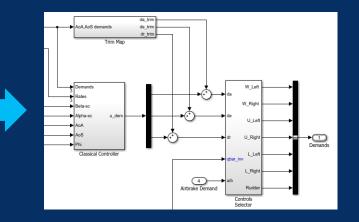
#### **Simulink Requirements**

View: Requirements		Search
Index	ID	Summary
➤ SCExampleSmallUAVModel		
✓	#1	Aircraft Capbilities
✓	#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	Elight Iddentification

#### System Composer



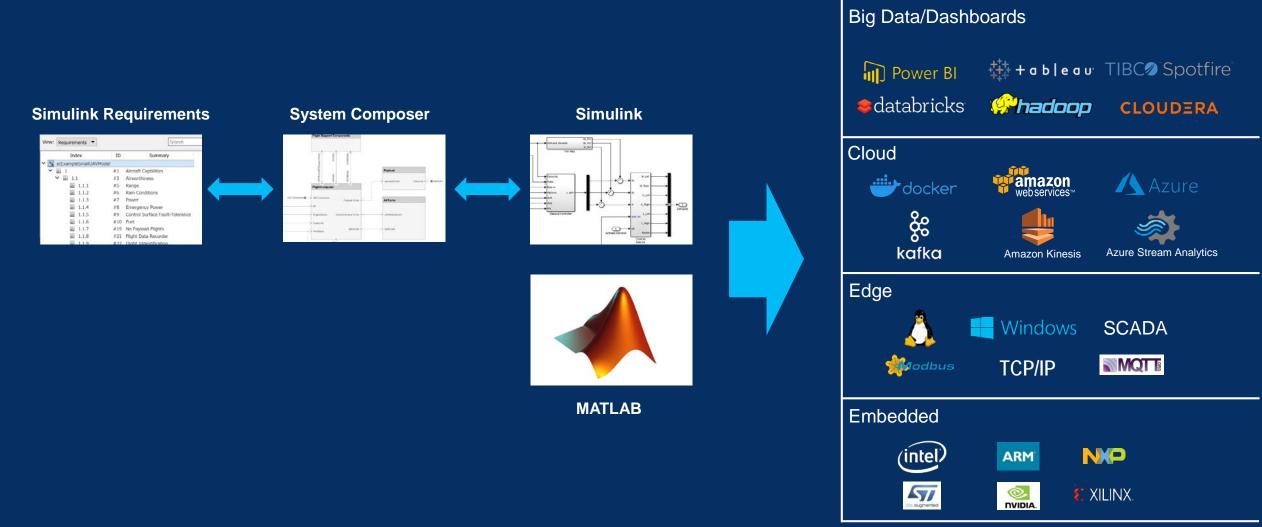
#### Simulink





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

#### **Digital Twins and Predictive Maintenance**





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

Alteryx SAS Databricks IBM lathWorks KNIME H20 ai Domino TO EXECUTE Anaconda BILITY . Altair © Gartner, Inc As of November 2019 COMPLETENESS OF VISION 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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Figure 1. Magic Quadrant for Data Science and Machine Learning Platforms



### 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

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



### Why MathWorks for Pragmatic Digital Transformation?

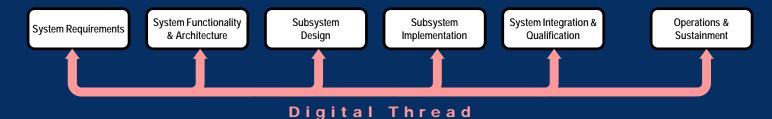
#### Systematic use of data and models

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!