MATLAB EXPO

Pragmatic Digital Transformation Through the Systematic Use of Data and Models

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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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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

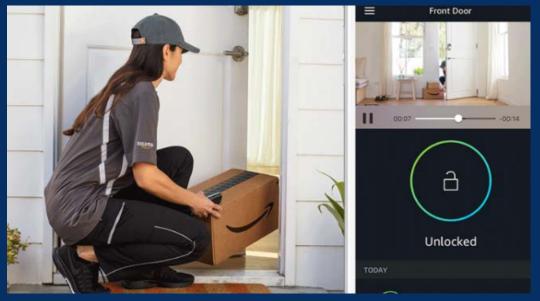
Business value

Amazon buys Ring for \$1.2 billion+ in 2018

New revenue opportunities

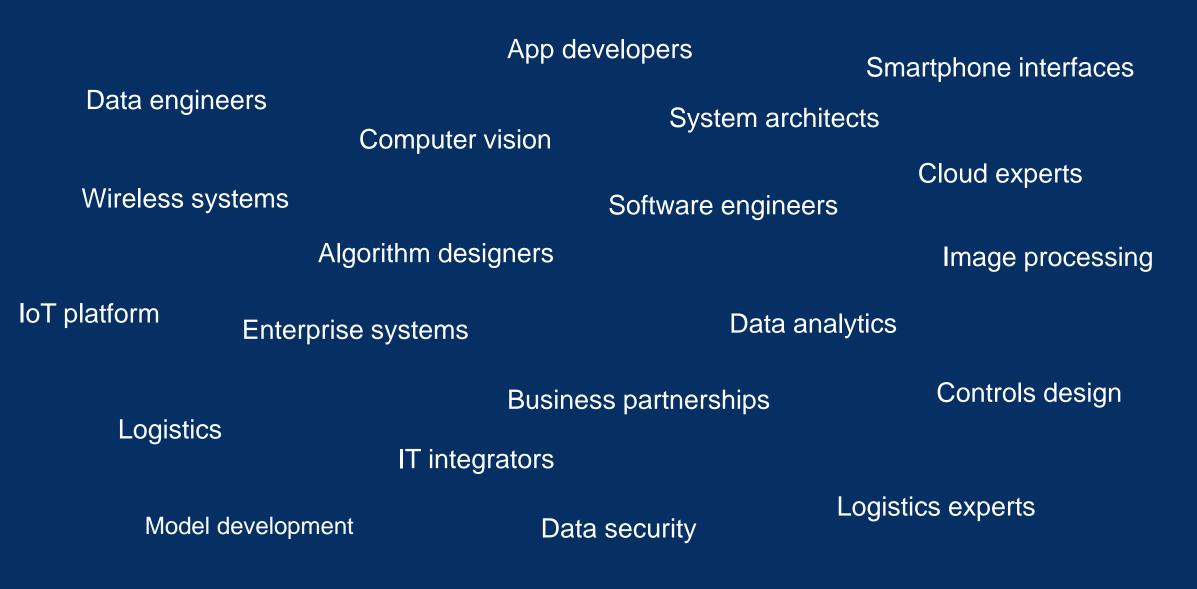
- "Ring Protect" subscription plans (\$99-\$499)
- Additional security with Ring Alarm kit
- More secure delivery through Amazon Key







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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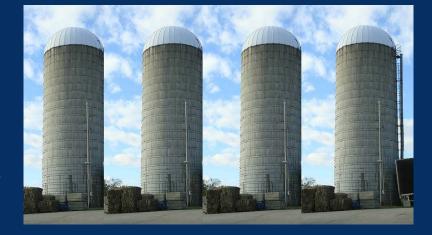


What approaches have people tried?



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

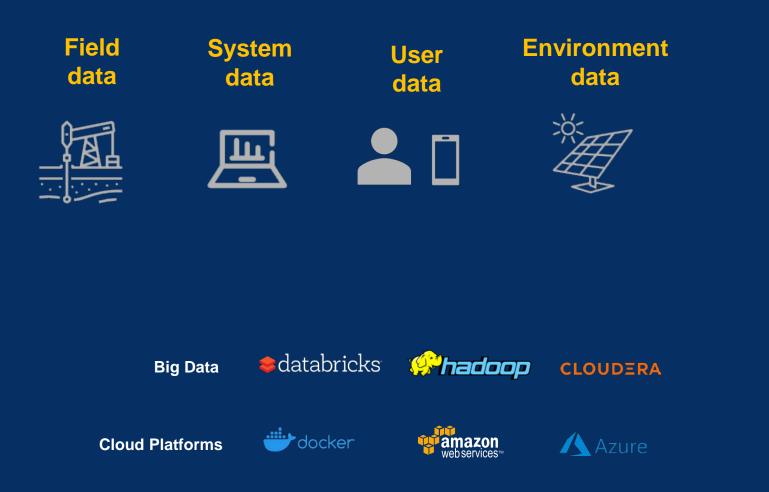
Pragmatic Digital Transformation

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

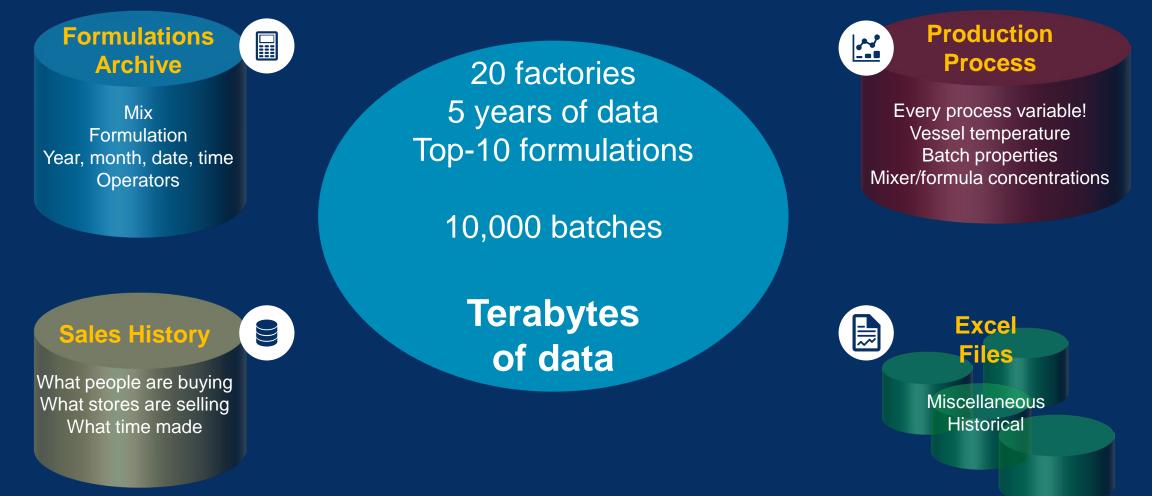
~8% growth Close to capacity at all 20+ factories

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





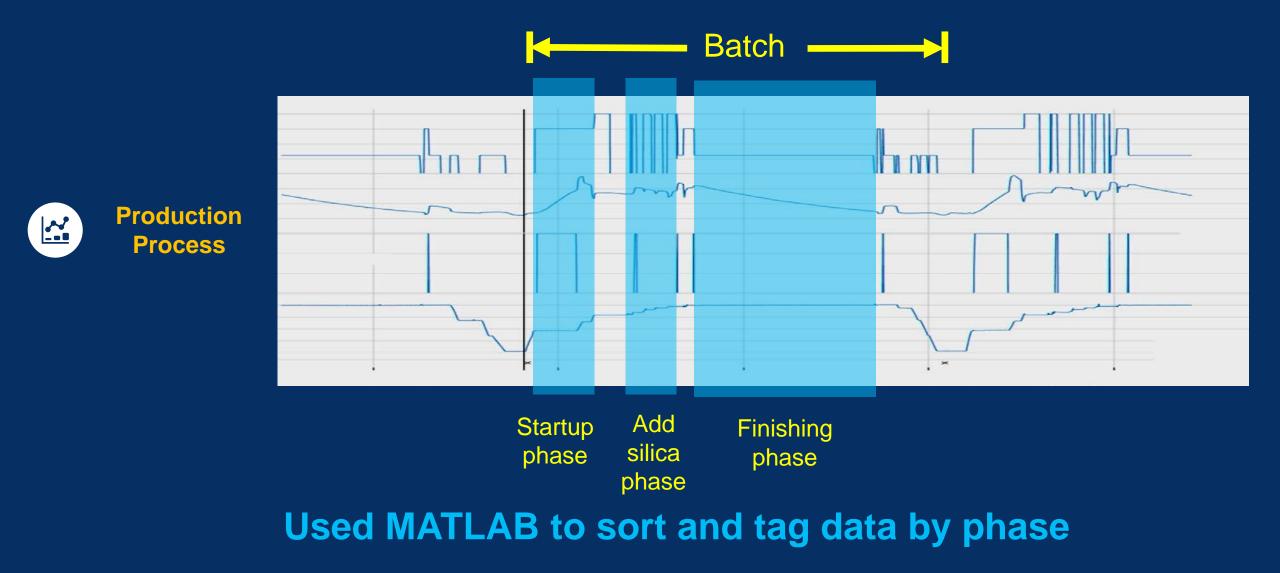
Challenge #1: Big data lives in many siloes



Used MATLAB to combine and clean data



Challenge #2: Need systematic pre-processing





Challenge #3: Need systematic views of data

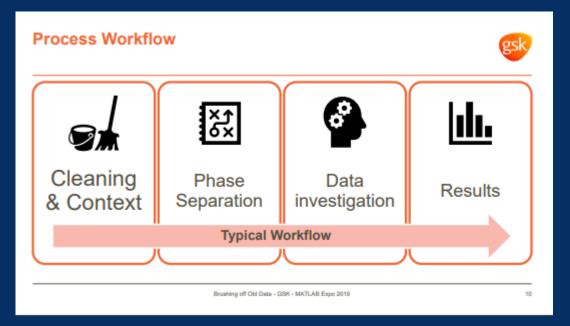
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	U3440 U3442	Mixer 4 Mixer 5			Load		Save	
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Used MATLAB to build views

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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

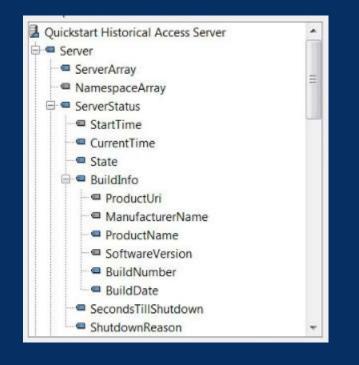
- Reduced time to market for new formulas
- Automated reports for process improvement
- Added capacity without building a new factory



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

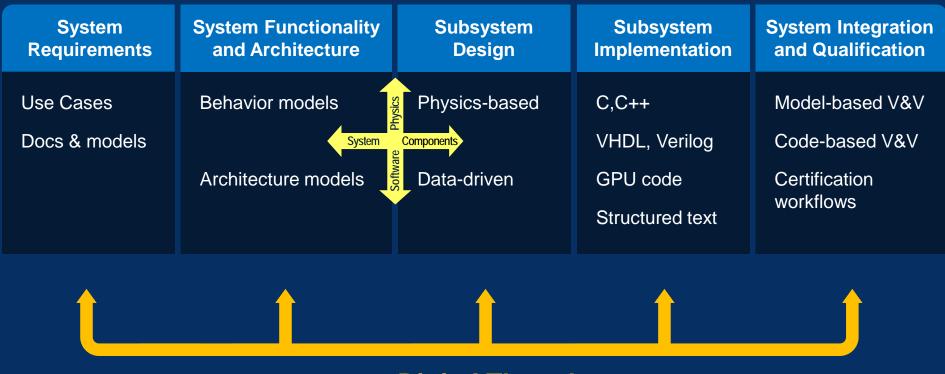
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Systematic Use of Models



Model-Based Design: Systematic Use of Models in Development



Digital Thread

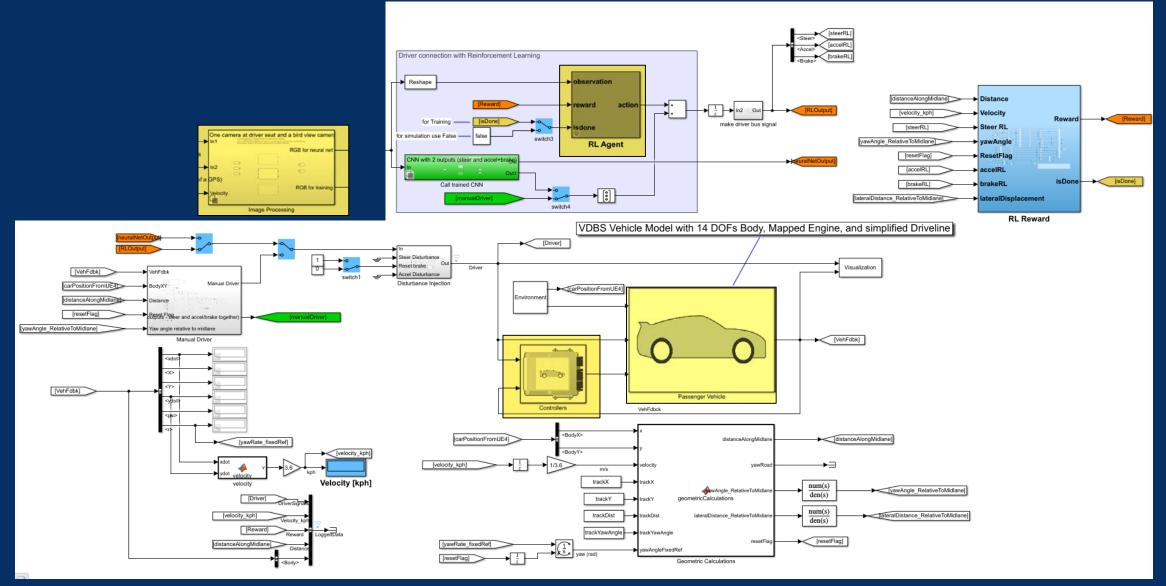


Model-Based Design: Systematic Use of Models in Development

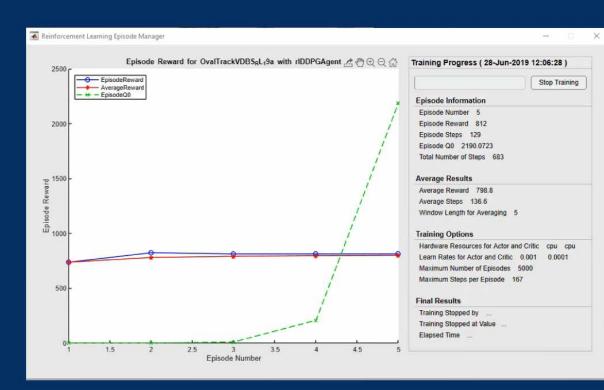
System Requirements	System Functionality and Architecture	Subsystem Design	Subsystem Implementation	System Integration and Qualification
Use Cases Docs & models	System	Physics-based Components Data-driven	C,C++ VHDL, Verilog GPU code Structured text	Model-based V&V Code-based V&V Certification workflows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

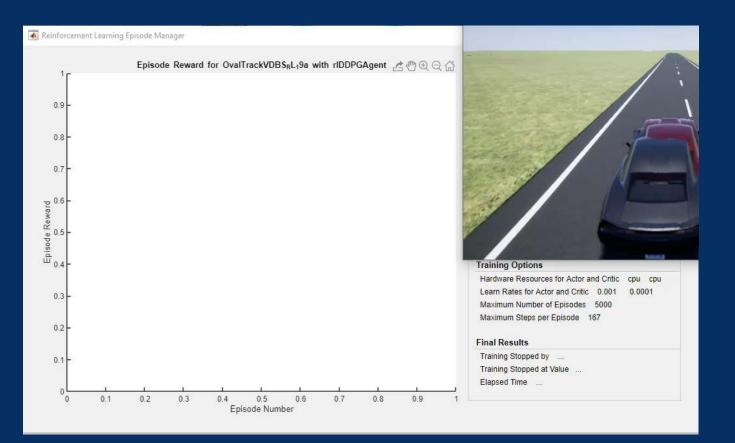








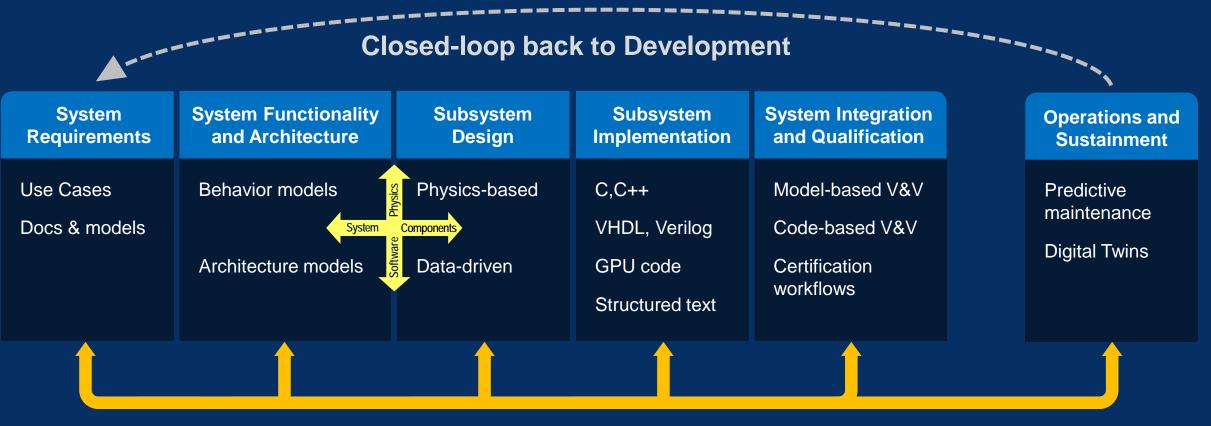








Extending Through the System's Lifecycle



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



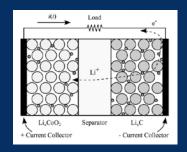
Fuji Electric: Real-time analysis of Smart Grid



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

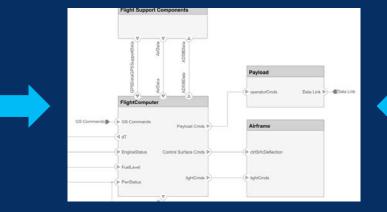


What is new to make this easier (more powerful/effective)?

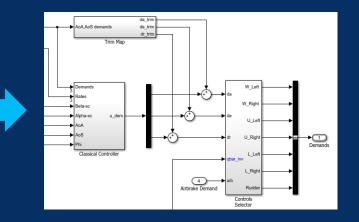
Simulink Requirements

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



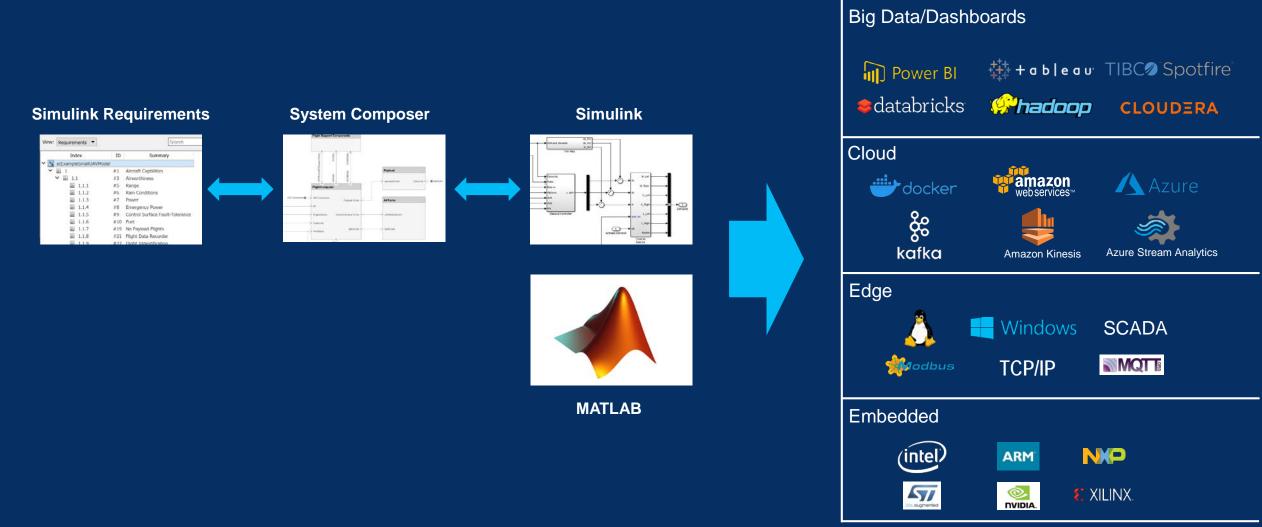
Simulink





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

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*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

Altervx Databricks IBM KNIME H20 a Domino EXECUTE Anaconda 10 Altai BILITY As of November 2019 © Gartner, Inc COMPLETENESS OF VISION Source: Gartner (February 2020)

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



Why MathWorks for Pragmatic Digital Transformation?

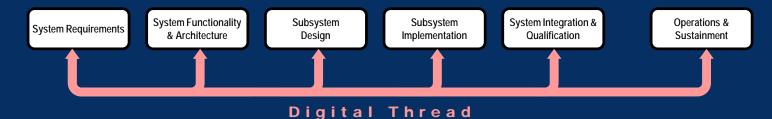
Systematic use of data and models

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!