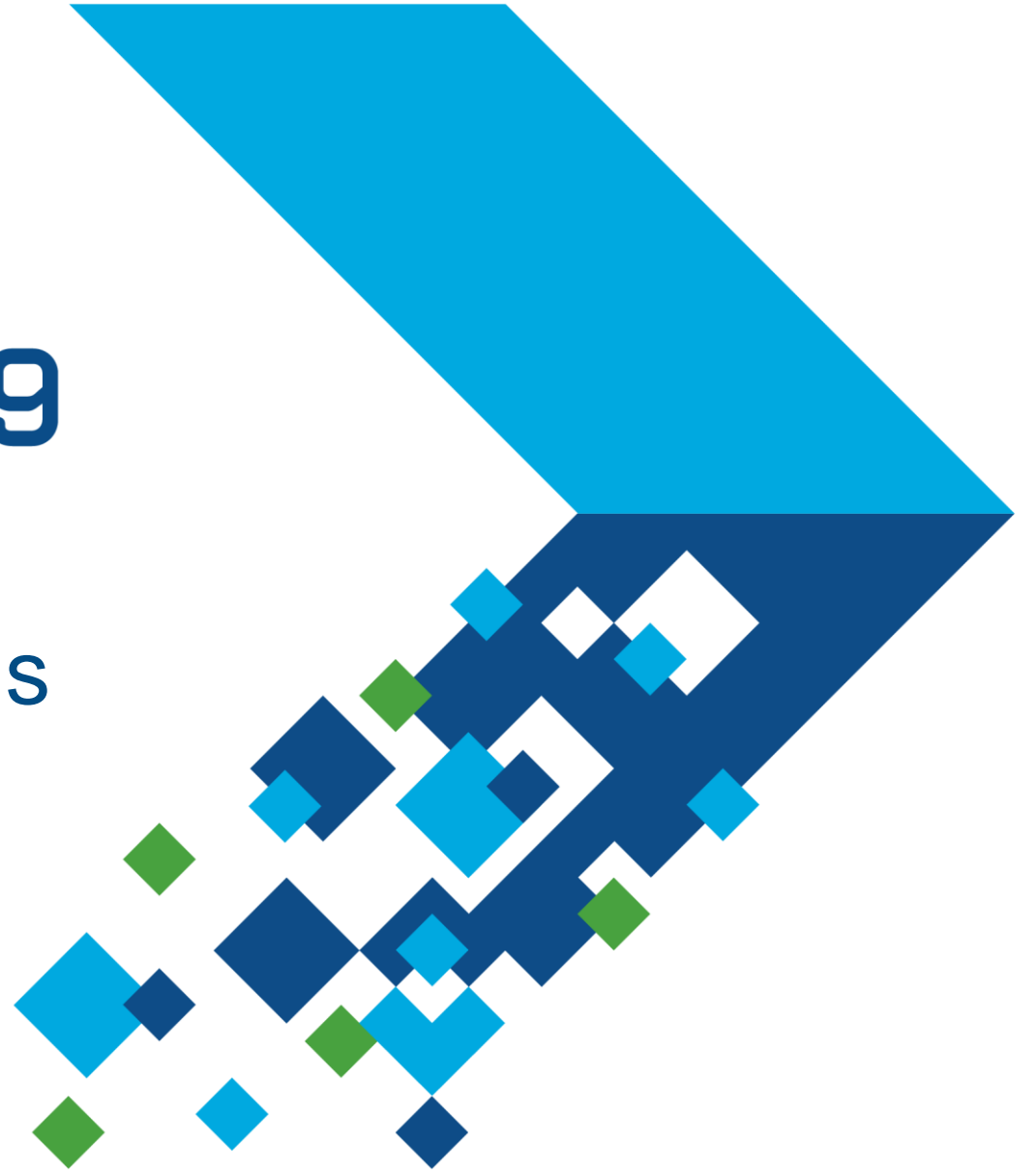


MATLAB EXPO 2019

Industrial IoT and Digital Twins

Paul Lambrechts
Application Engineer



Key Takeaways

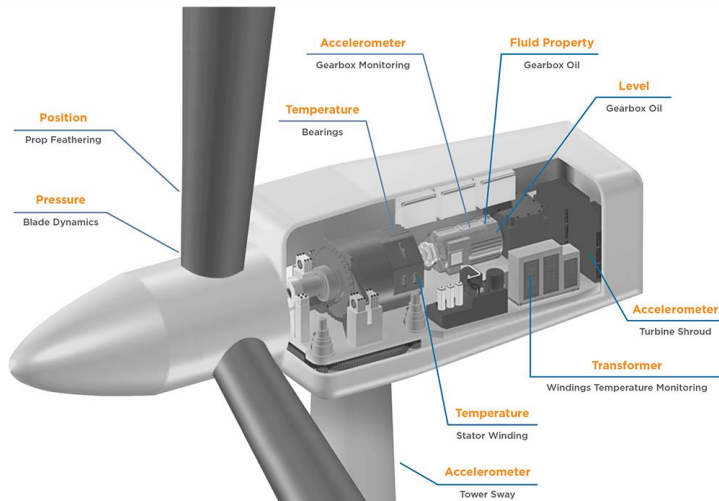
- To support Industrial IoT and Digital Twin applications we extended our modeling, simulation and data analytics capabilities to all levels of enterprise digitalization systems
- Get started with MathWorks' specialists for training and project support
 - predictive maintenance,
 - operations optimization,
 - fleet management,
 - ...

Megatrend: Digital Transformation and IoT

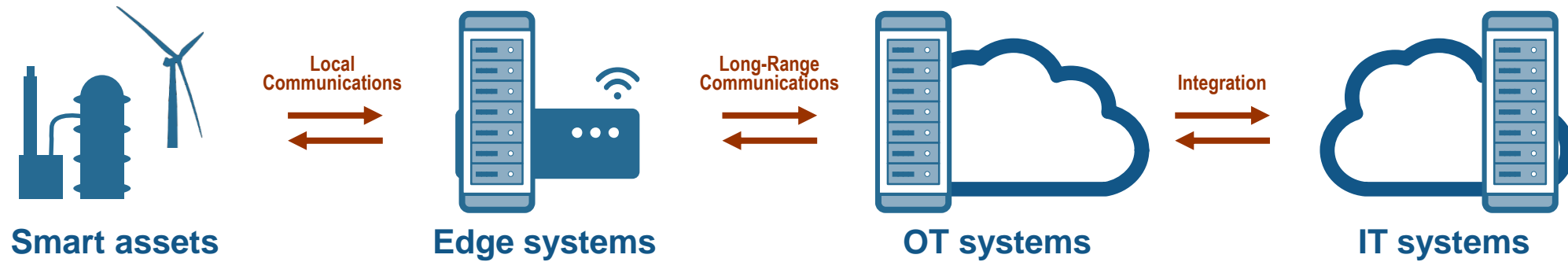
Overall Goals

By connecting machines in operation you can use data, algorithms, and models to make better decisions, improve processes, reduce cost, improve customer experience.

- Industrial IoT
- Digital Twin
- Industry 4.0
- Smart 'XYZ'
- Digital Transformation



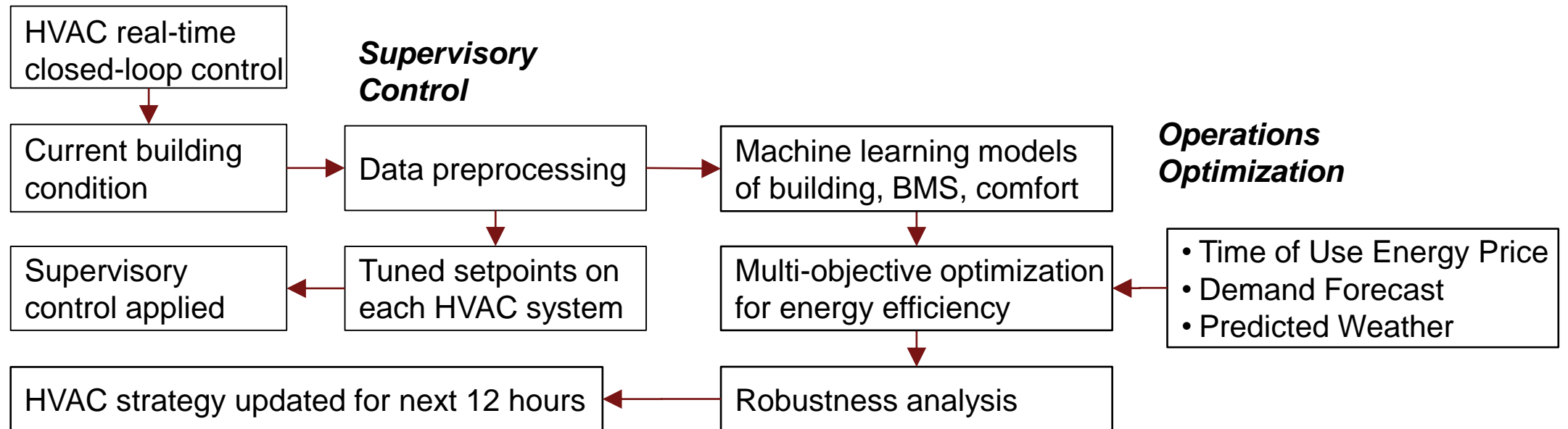
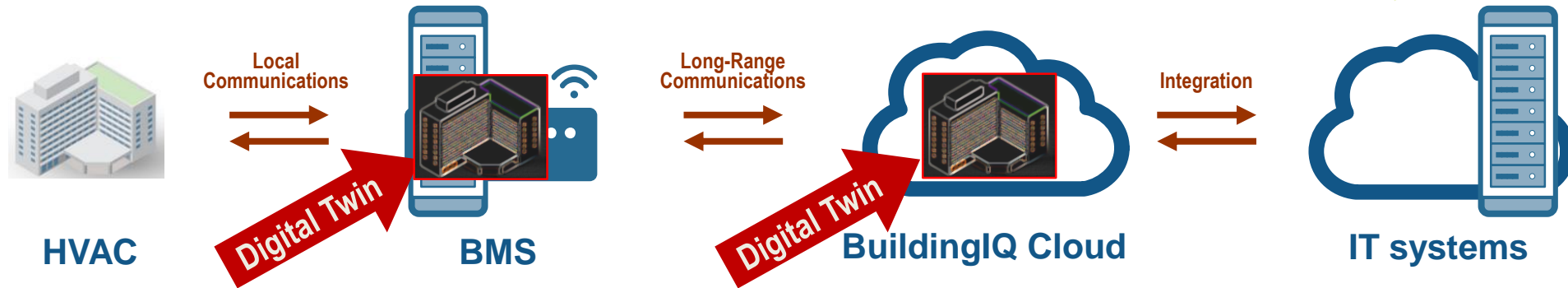
Organizations are defining Infrastructure for Digitalization



How are these used in an actual application?

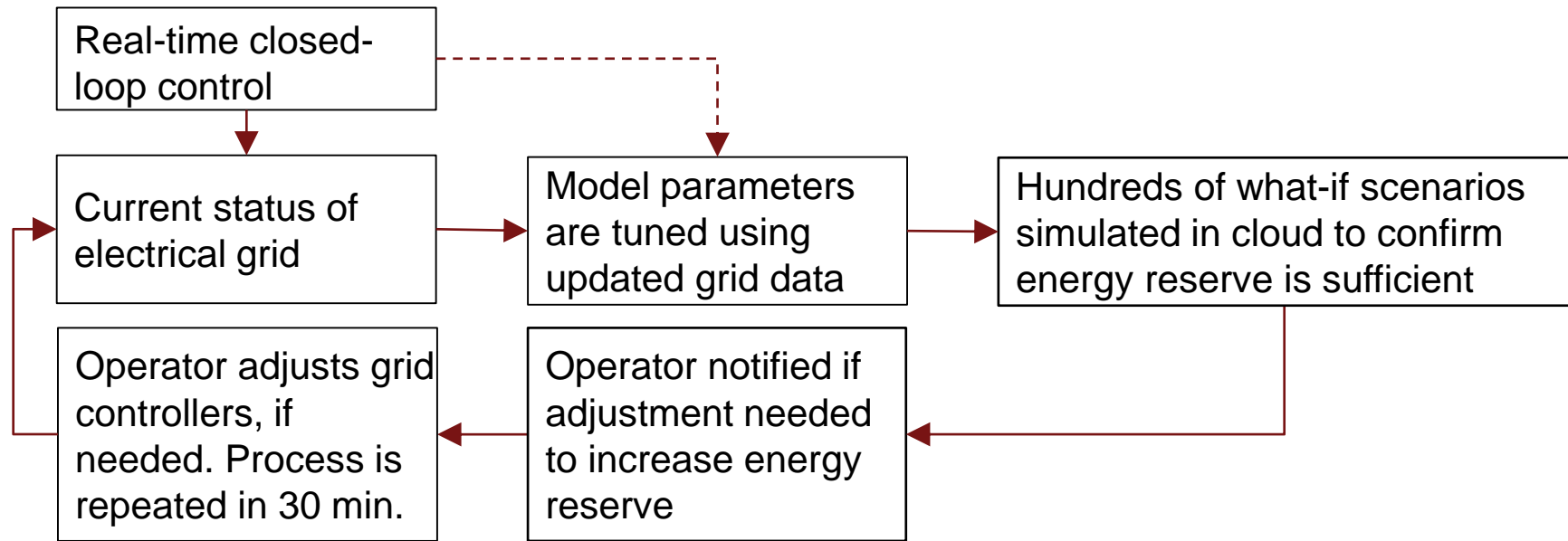
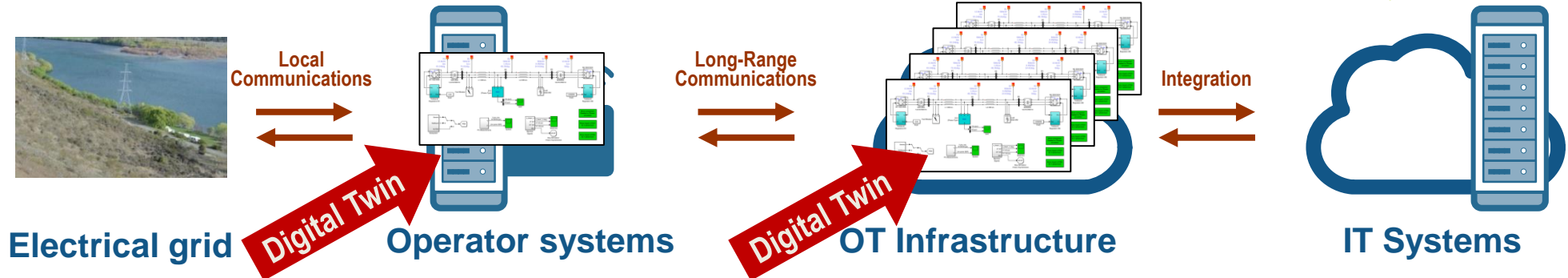
Operations Optimization: BuildingIQ

Reduced HVAC energy consumption by 10–25%



Performance Management: Transpower

Energy reserve ensured for 100s scenarios



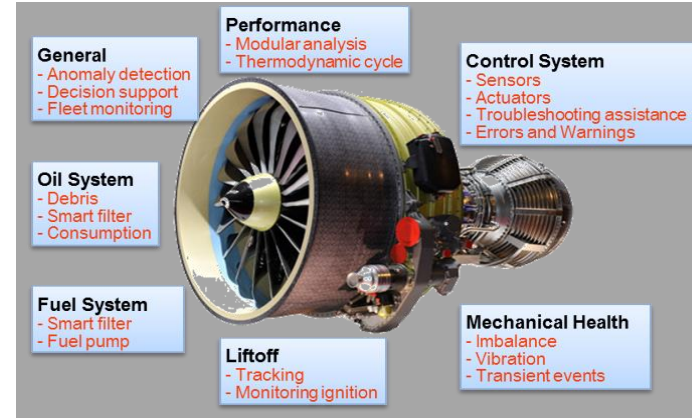
Other Examples of Digital Twins Across Industries



Commercial Vehicles
Driving-data logs and digital twin used to verify and tune automatic braking system



Space
Controller retuned to adjust for degraded thruster, confirmed with digital twin, and uploaded during deep space mission

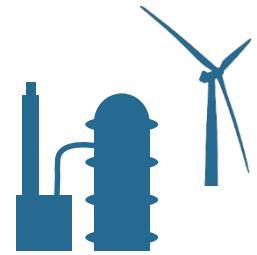


Aerospace
Operation data used to plan maintenance, improve aircraft availability, and reduce engine out-of-service time



Industrial Automation
Statistical models constantly updated to inform operators when plant is performing outside of optimal range

Applications at the Asset, the Edge, or Operational Technology Platform



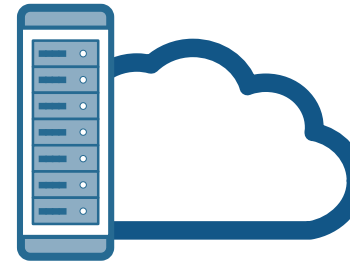
Smart assets

Local Communications



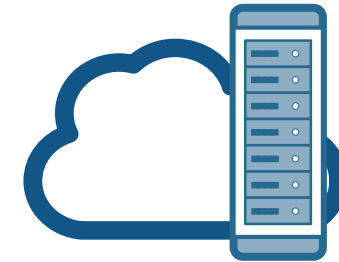
Edge systems

Long-Range Communications

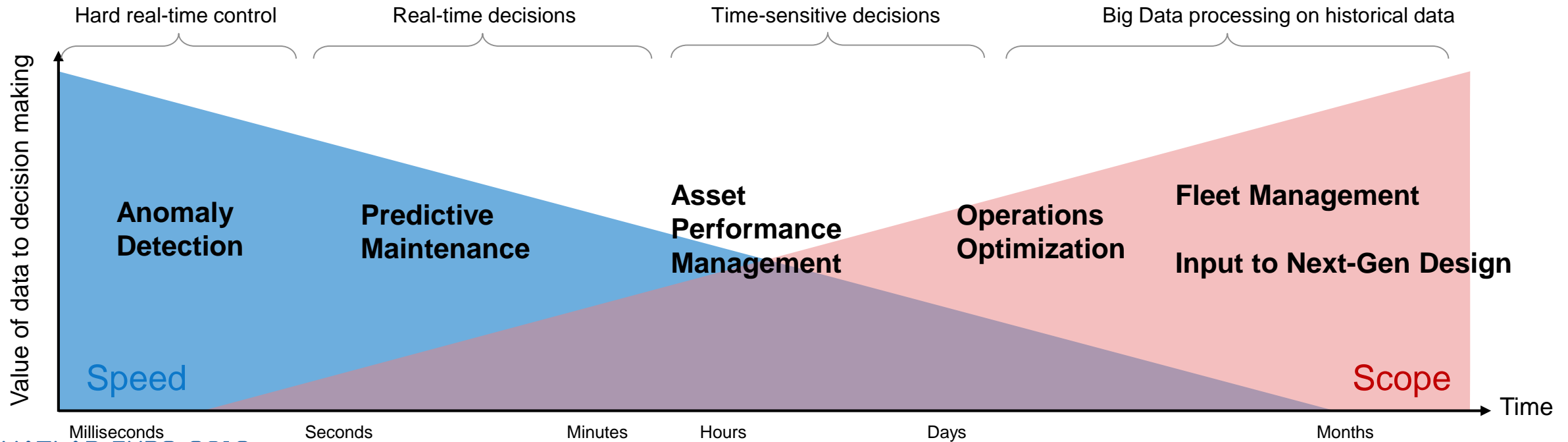


OT Infrastructure

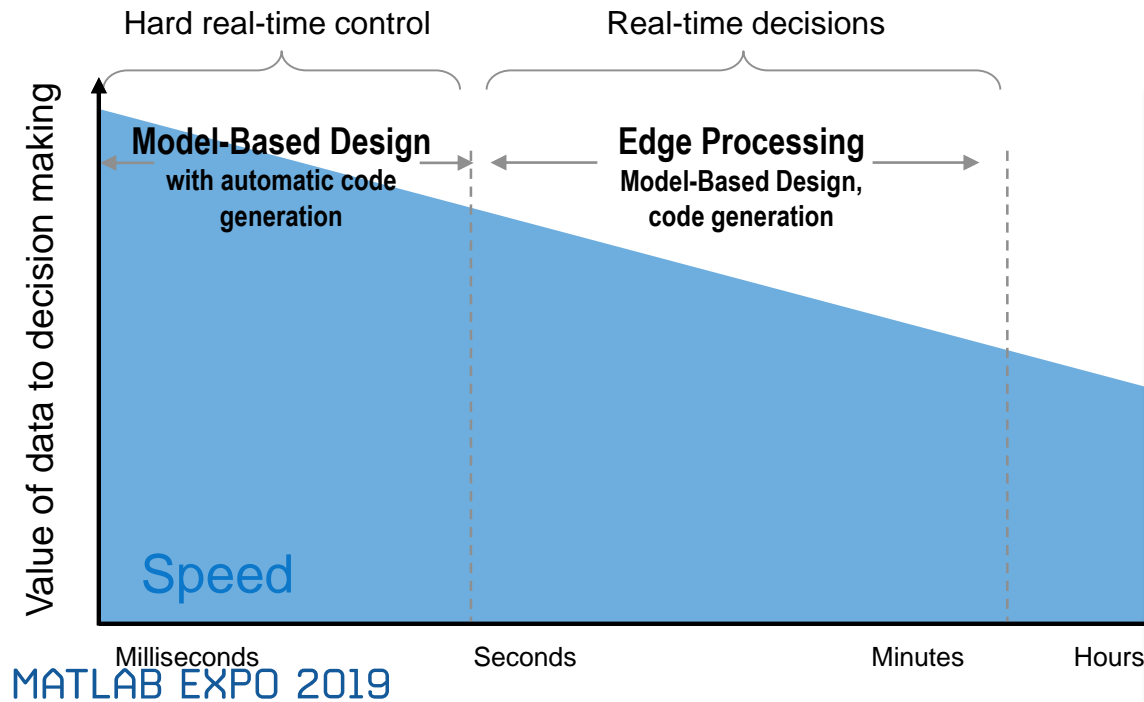
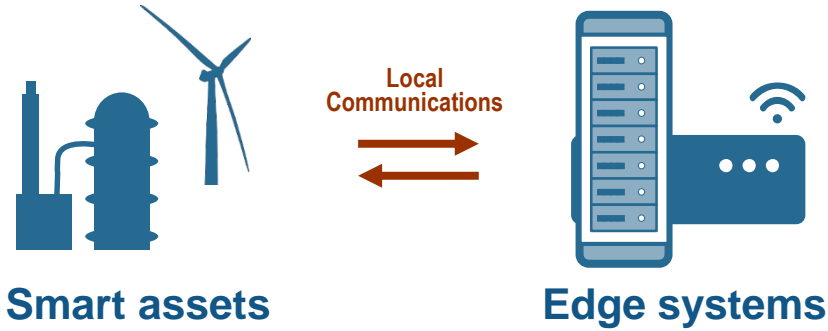
Integration



IT Systems



Development for Fast and Highly-Deterministic Systems



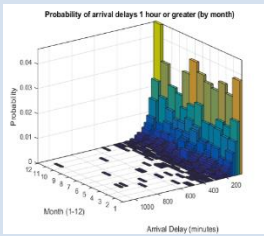
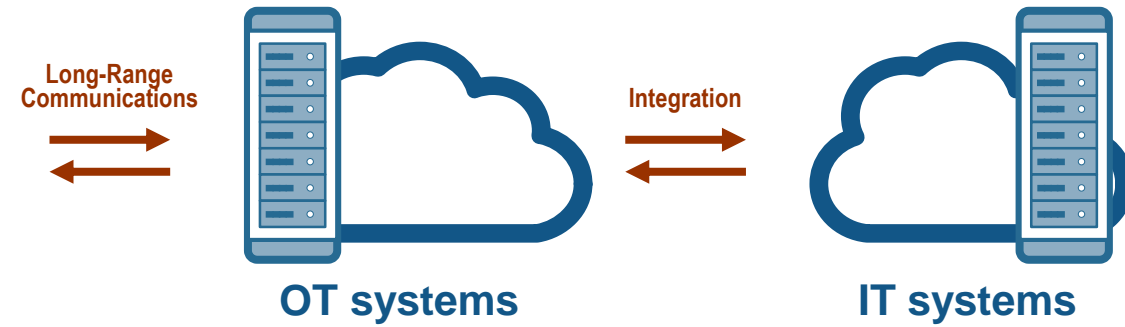
Model-Based Design

Multi-domain system modeling

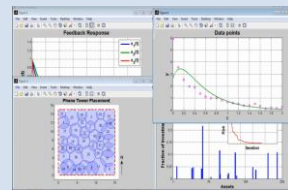
Parameter estimation

Automatic code generation

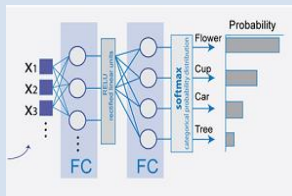
Development to OT/IT On-Prem and in Cloud



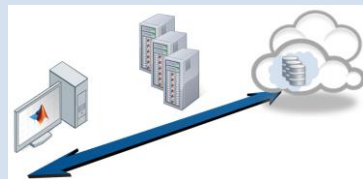
Variety and Volumes of Data



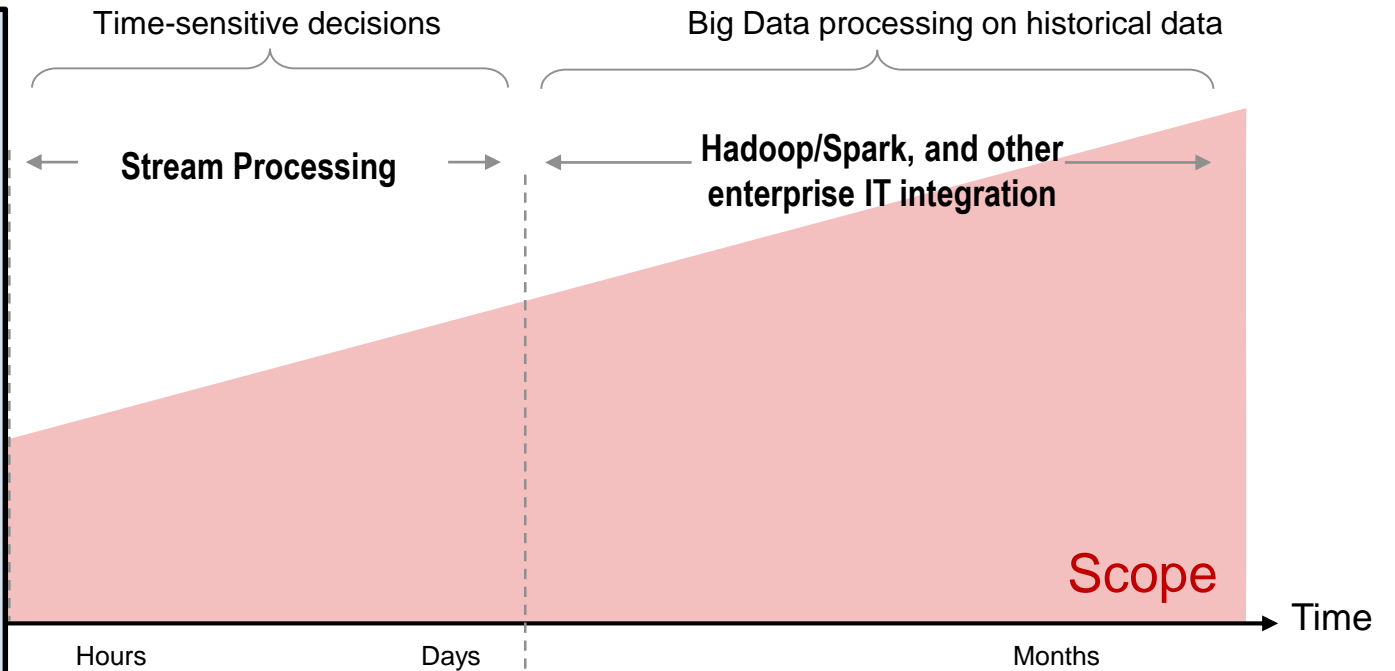
Optimization



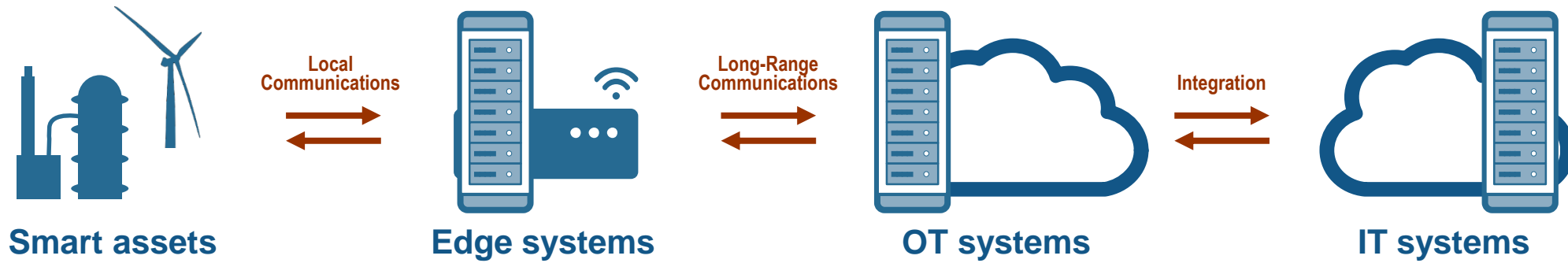
Machine Learning and Deep Learning



Enterprise system integration, (on-prem/cloud)



A Complex Collection of Tools, Platforms and Protocols



NXP

ARM

XILINX

NVIDIA

intel

ST

life.augmented

TCP/IP

MQTT

Rest APIs

Windows

Linux

Apache Kafka

MindSphere

Azure Stream Analytics

Amazon Kinesis

AWS IoT

thingworx

Azure IoT Hub

Amazon Web Services

Docker

Azure

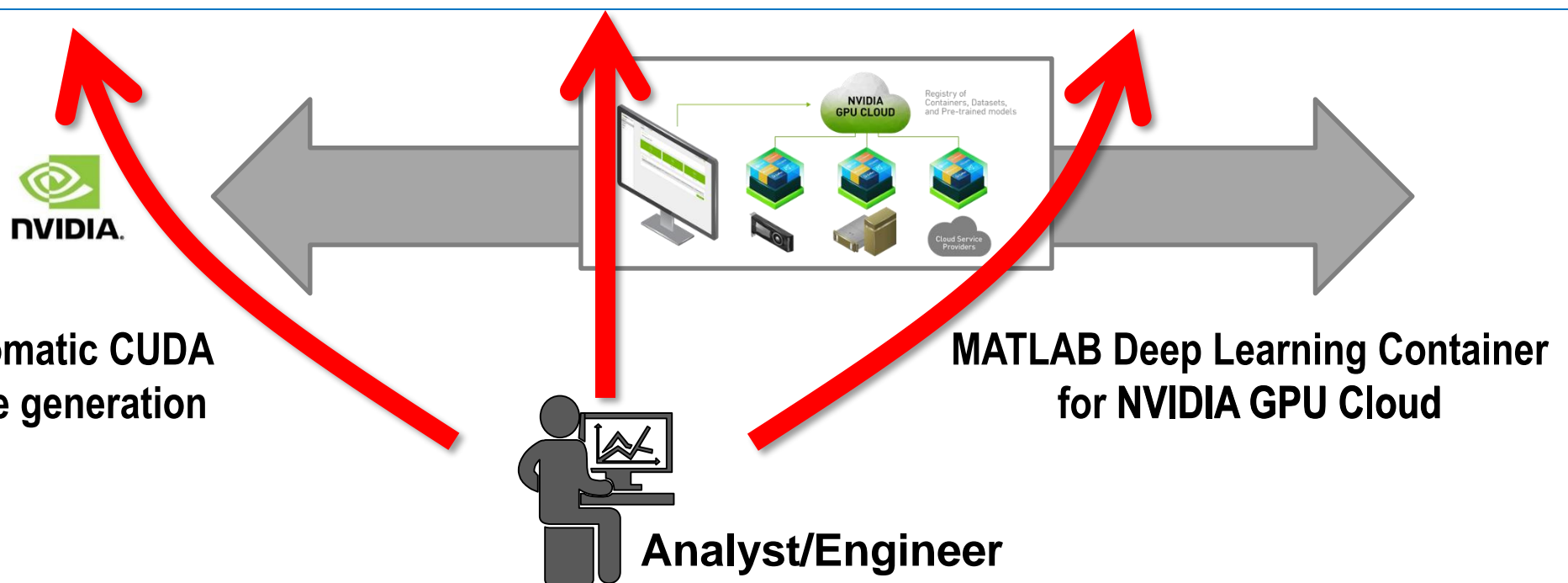
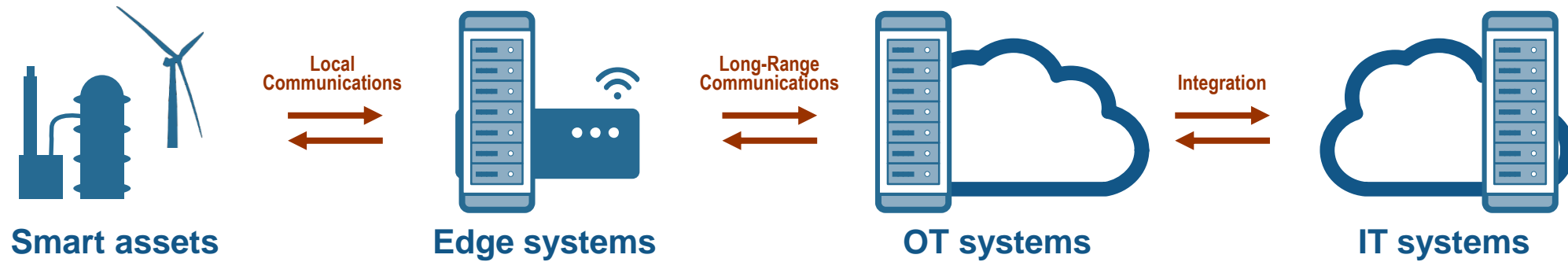
TIBCO Spotfire

Tableau

Power BI

Analyst/Engineer

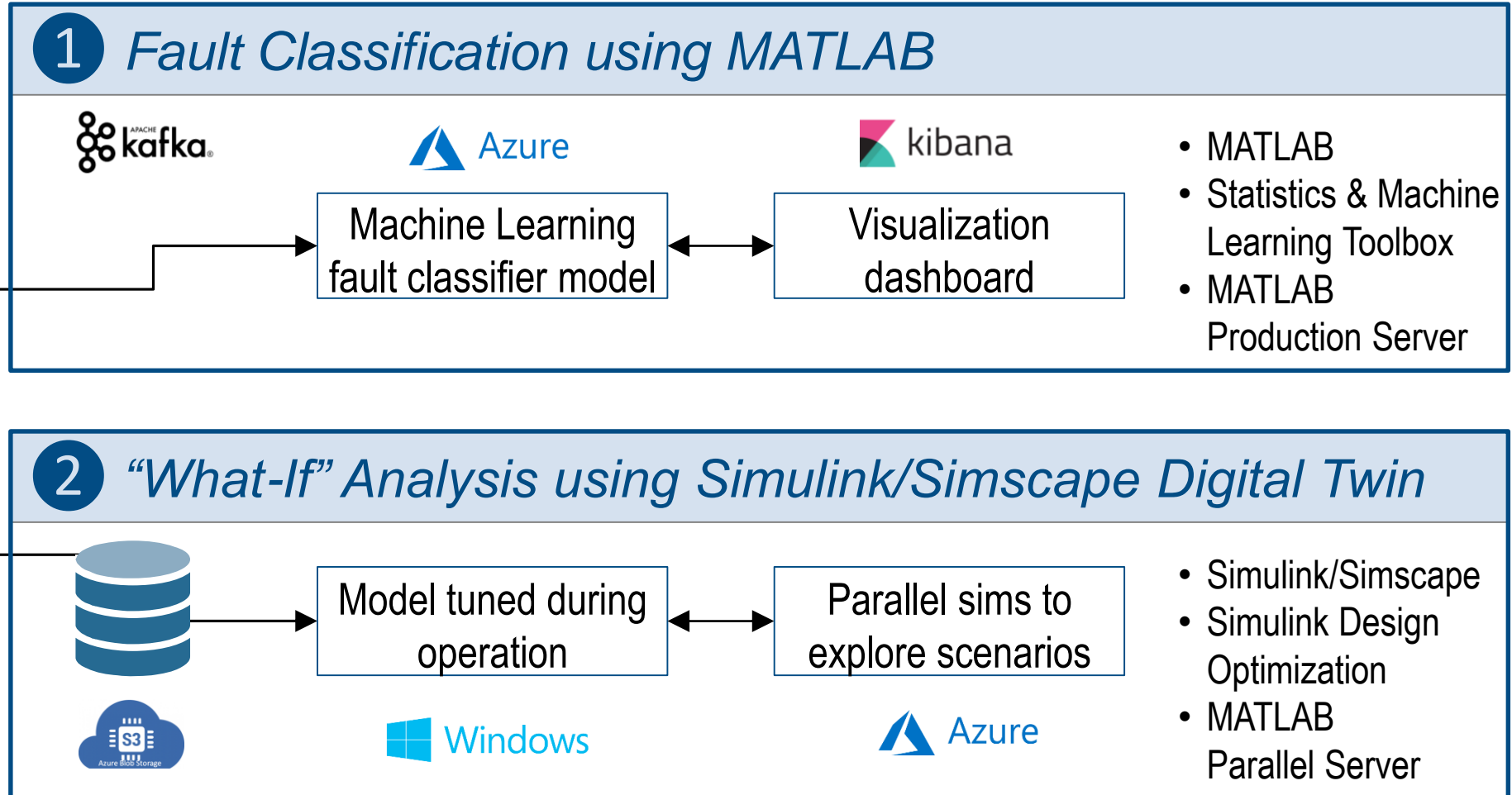
A Complex Collection of Tools, Platforms and Protocols



Two Demos based on a Triplex Pump



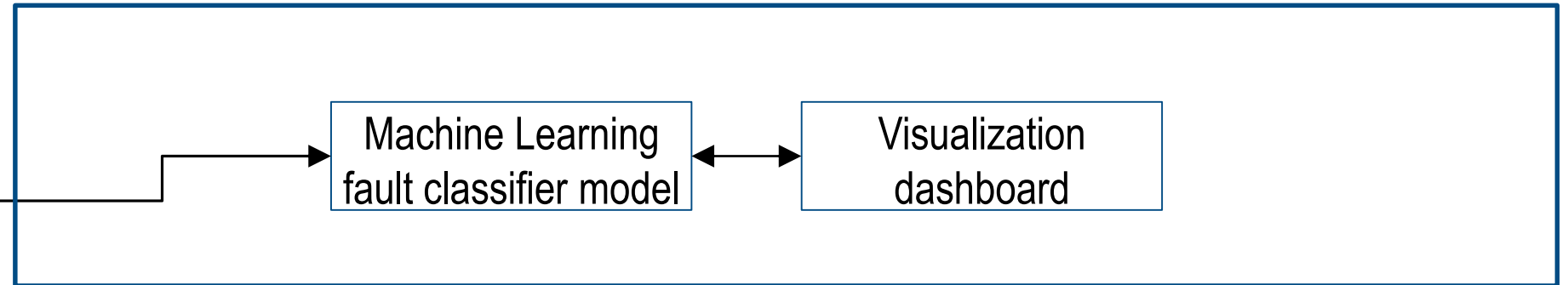
Triplex Pump



Fault Classification using MATLAB



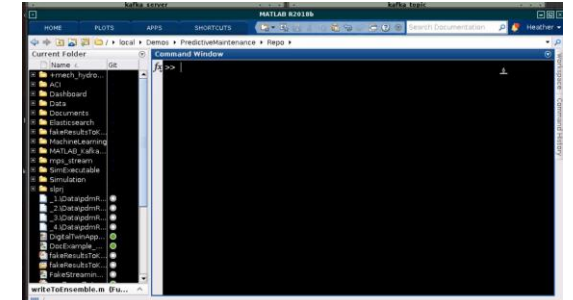
Triplex Pump



Manual fault classification is a time consuming process

Current system requires operator to manually monitor operational metrics for anomalies. Their expertise is required to detect and take preventative action

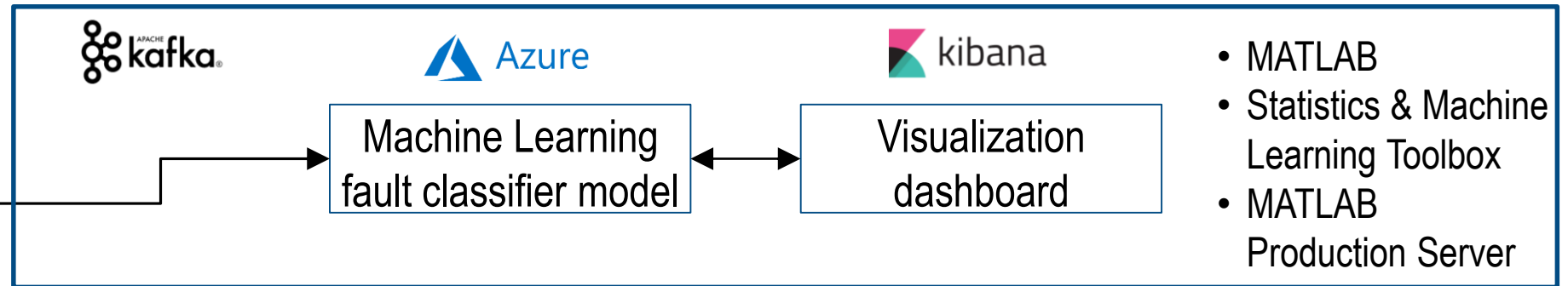
Fault Classification using MATLAB



Fault Classification Using MATLAB



Triplex Pump



Data:

- Processed in chunks or
- Streaming continuously via Kafka

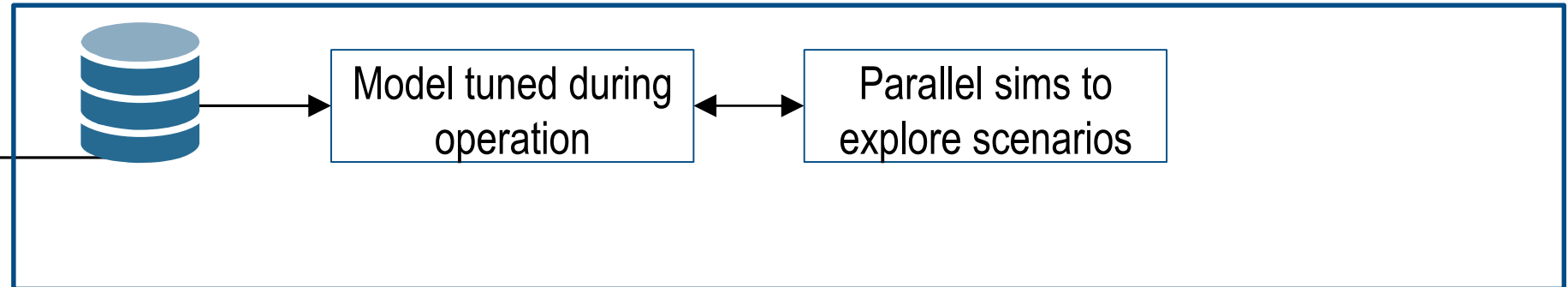
- A previously designed classifier, processes incoming stream, identifying faults
- Processing is elastic and can scale to any number of incoming streams/pumps via MATLAB Production Server

- Visualization dashboard shows data stream and deduced fault classification

“What-If” Analysis using Simulink/Simscape Digital Twin



Triplex Pump



Trouble using data to update digital twin and make use of it

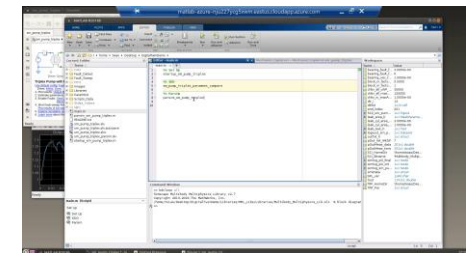
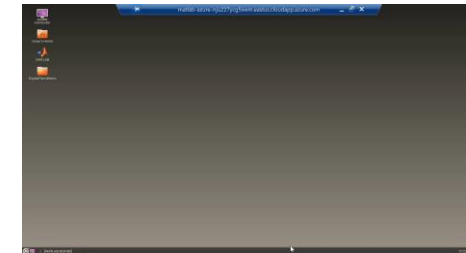
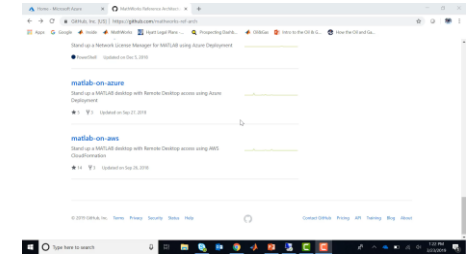
Current system gathers operational data from the pump, but not expertise on how to leverage data to update the digital twin and apply it to run what-if analysis in a scalable way

“What-If” Analysis using Simulink/Simscape Digital Twin



Triplex Pump

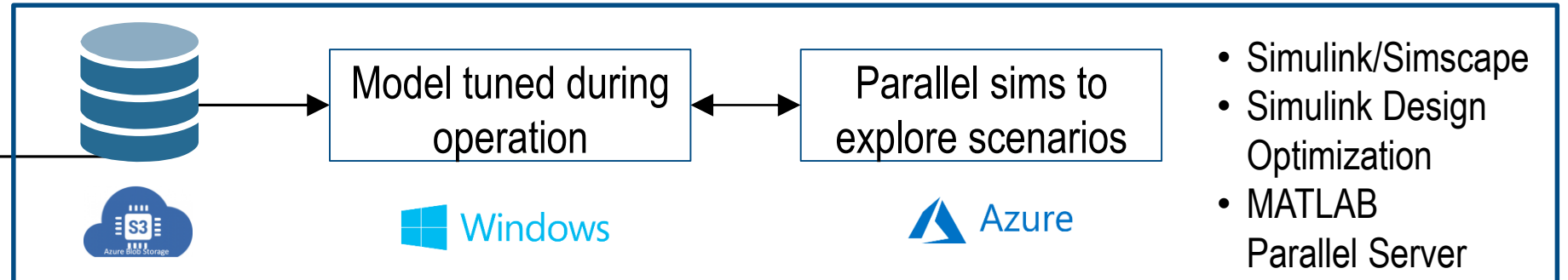
- Setting up MATLAB Reference Architecture on Azure
<https://github.com/mathworks-ref-arch>
- Updating Digital Twin with [Parameter Estimation](#)
- Run “What-if” Analysis from Current State with [Parallel Simulations](#)



“What-If” Analysis using Simulink/Simscape Digital Twin



Triplex Pump



• Data streaming from asset, saved and selected for tuning using cloud storage connectivity

• Tune Digital Twin Parameters from latest available data from real asset using Simulink Design Optimization

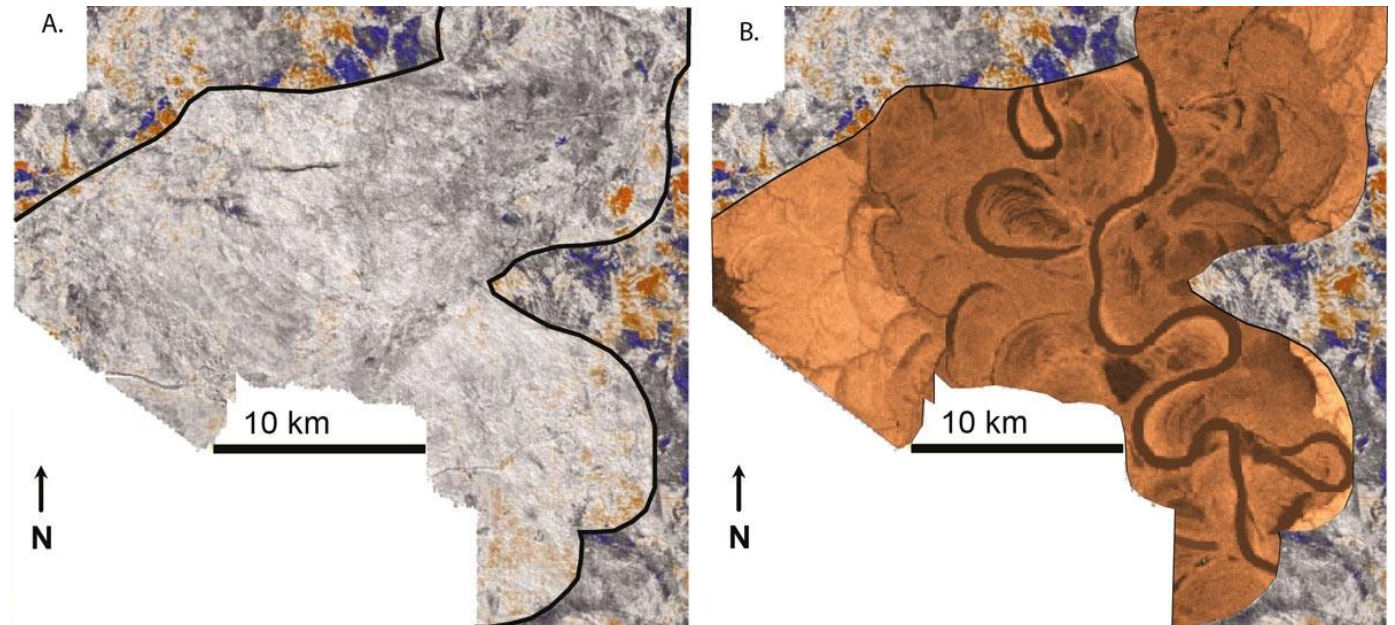
• Run 100s “what-if” scenarios with Parallel Server Reference Architecture on Azure

• Process output for possible operational decision

Two of Many Options: We can Help!

“MATLAB enabled us, as geologists, to use our expertise in predictive frameworks, analytics, and analog matching to implement algorithms that are unique in our industry. With the help of MathWorks consultants, we then deployed those algorithms as an easy-to-use application to our colleagues worldwide.”

Nick Howes, [Shell](#)



Key Takeaways

- To support Industrial IoT and Digital Twin applications we extended our modeling, simulation and data analytics capabilities to all levels of enterprise digitalization systems
- Get started with MathWorks' specialists for training and project support
 - predictive maintenance,
 - operations optimization,
 - fleet management,
 - ...

Find out more:

Triplex pump with Condition Monitoring

Tadele Shiferaw

Load Forecasting System

Toon Weyens



IIoT and Digital Twin Relevant Solution Pages



- [A view on the breath of MathWorks IIoT integration options](#)
- [MathWorks support on-prem and public cloud operations](#)
- [Physical Modeling](#)
- [Predictive Maintenance](#)
- [Data Science with MATLAB](#)
- [MathWorks products access for startups](#)
- [Service offering with consulting](#)
- [Third Party Connections](#)

Related Trainings

- Machine Learning
 - [Machine Learning with MATLAB](#)
- Speeding up code
 - [Accelerating and Parallelizing MATLAB Code](#)
- AppDesigner
 - [Building Interactive Applications in MATLAB](#)

Find out more:
Services Stand:
Training and Consulting

Marlies Terlouw
Titus Edelhofer



<https://nl.mathworks.com/services/training.html>