



AI in Manufacturing Application

Digital Transformation

May 2019



**CONNECTED SYSTEMS
INSTITUTE**

Agenda

1 Introduction

2 Quiz:
AI – Myth vs
Reality

3 Applications
Manufacturing
Common Uses

4 Evolution and
Strategies

5 Solution
Architecture

6 Solution
Execution / AR-
MR

7 Realizing Value +
Q&A

8 Workshop Close





Industrial companies are navigating a rapidly changing landscape



NEW WORKFORCE REQUIREMENTS

~85% of manufacturers expect human-machine-centric environments to be commonplace by 2020 ⁴



EXPLOSION OF IIOT DATA

~3.2 Billion, the number of vertical-specific Industrial IoT devices by 2020 ¹

CHANGING CUSTOMER EXPECTATIONS

36% of manufacturing leaders indicate customer requirements are driving accelerated innovation ²



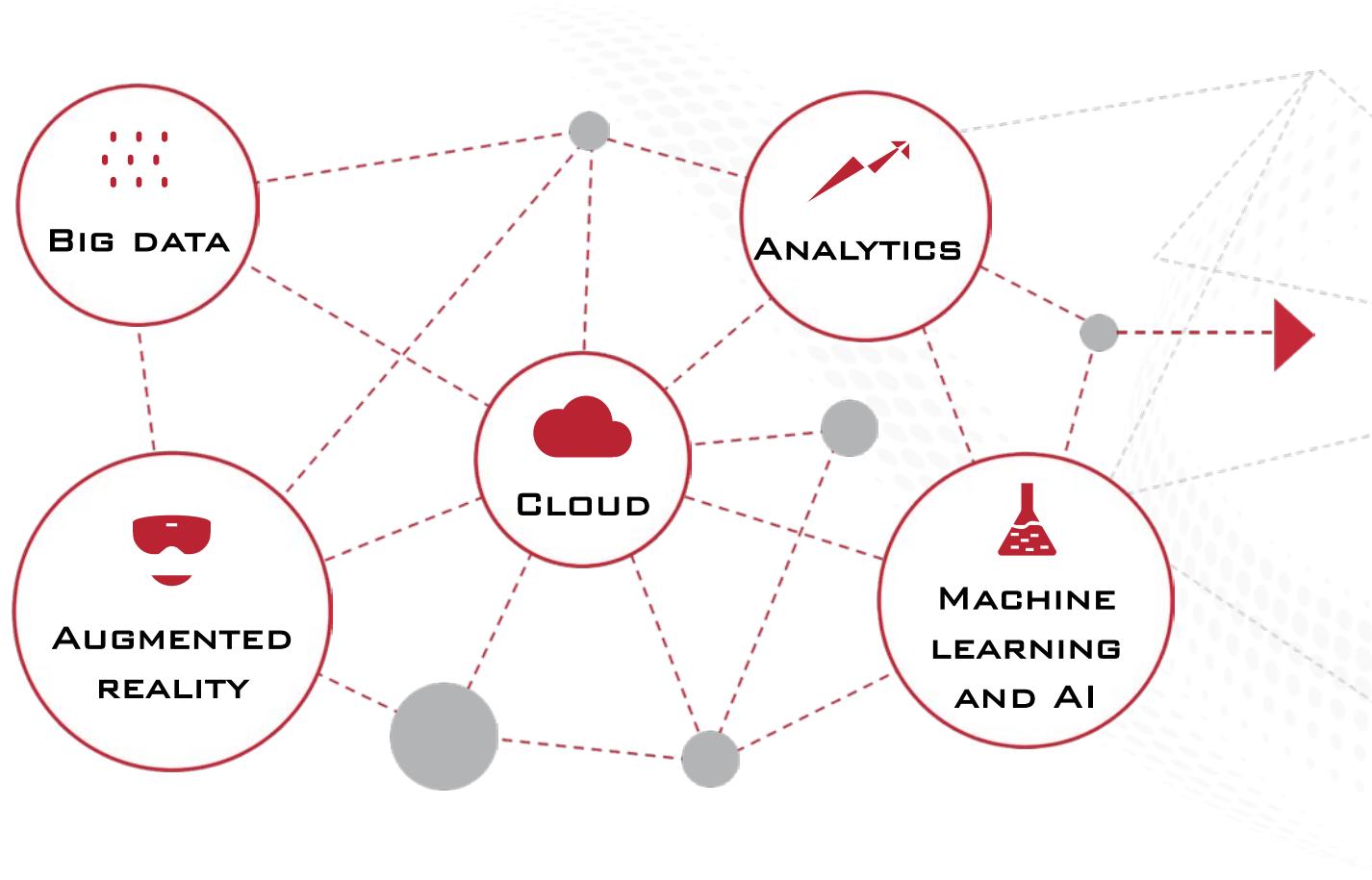
INCREASING SECURITY STANDARDS

28% of manufacturing organizations report a loss of revenue due to security incidents in the last year ³





Advances in technology are creating new opportunities for digital innovation and growth



Reduce unplanned downtime

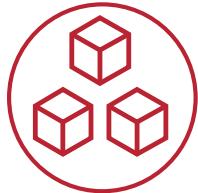
Prevent quality issues

Eliminate waste

Increase efficiency



Capitalizing on the promise of digital can be challenging



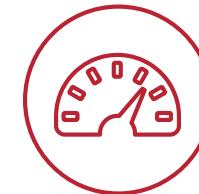
SILOED INFRASTRUCTURES

DISPARATE PLANTS AND ASSETS OPERATE IN SILOES



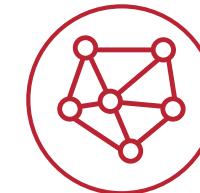
INCONSISTENT KPIs

DISCONNECTED DATA SOURCES CREATE VARYING OPERATIONAL MEASURES



LIMITED SCALABILITY

PROPRIETARY SYSTEMS WEREN'T BUILT FOR MODERN REQUIREMENTS



CROWDED ECOSYSTEMS

NUMEROUS VENDORS OFFER THEIR OWN, OFTEN PROPRIETARY SOLUTIONS



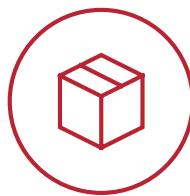
LEGACY EQUIPMENT AND TECHNOLOGY

AGING ASSETS DON'T ALWAYS SCALE EASILY

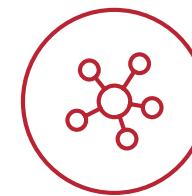


Together Rockwell Automation®, PTC, and Microsoft Creates Solution

**COMPREHENSIVE
PORTFOLIOS**



**READY-TO-
CONFIGURE
SOLUTIONS**



**INDUSTRY-
LEADING
SECURITY**



**EXTENSIVE IIOT
ECOSYSTEM**



**SCALABLE
SOLUTIONS**



**Rockwell
Automation**

Best-in-class automation and control products, information software, services and technologies



ptc

Industry Leading IoT, industrial connectivity, and AR/MR

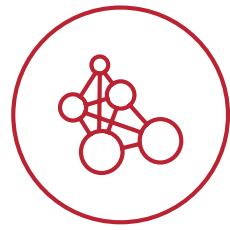


Microsoft

Microsoft Azure®, the largest and most trusted cloud



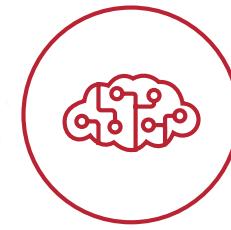
Take advantage of a comprehensive strategy to ...



SIMPLIFY INDUSTRIAL TRANSFORMATION



ACCELERATE BUSINESS OUTCOMES



INNOVATE WITH AGILITY

Streamline the convergence of digital, physical, and human with comprehensive, integrated, secure, and proven solutions from market leaders

Increase productivity and efficiency of people, processes, and products in the enterprise with unified operational insights

Position business for long-term growth with a scalable, flexible, and future-proof digital foundation built for rapid and continuous innovation



Simplify industrial transformation



Maximize the value of existing investments



Empower IT, OT, and domain experts to collaborate



Deploy interoperable, edge-to-cloud solutions



Ensure a foundation of security and compliance



Streamline the transformation experience



Accelerate business outcomes



Enable employees with timely, relevant, and contextualized information



Drive asset visibility and consistent KPIs



Improve asset utilization without disruption



Reduce unplanned downtime



Improve business performance with automation



Innovate with agility



Respond quickly to market shifts



Embed innovative technology like AI,
ML, and AR



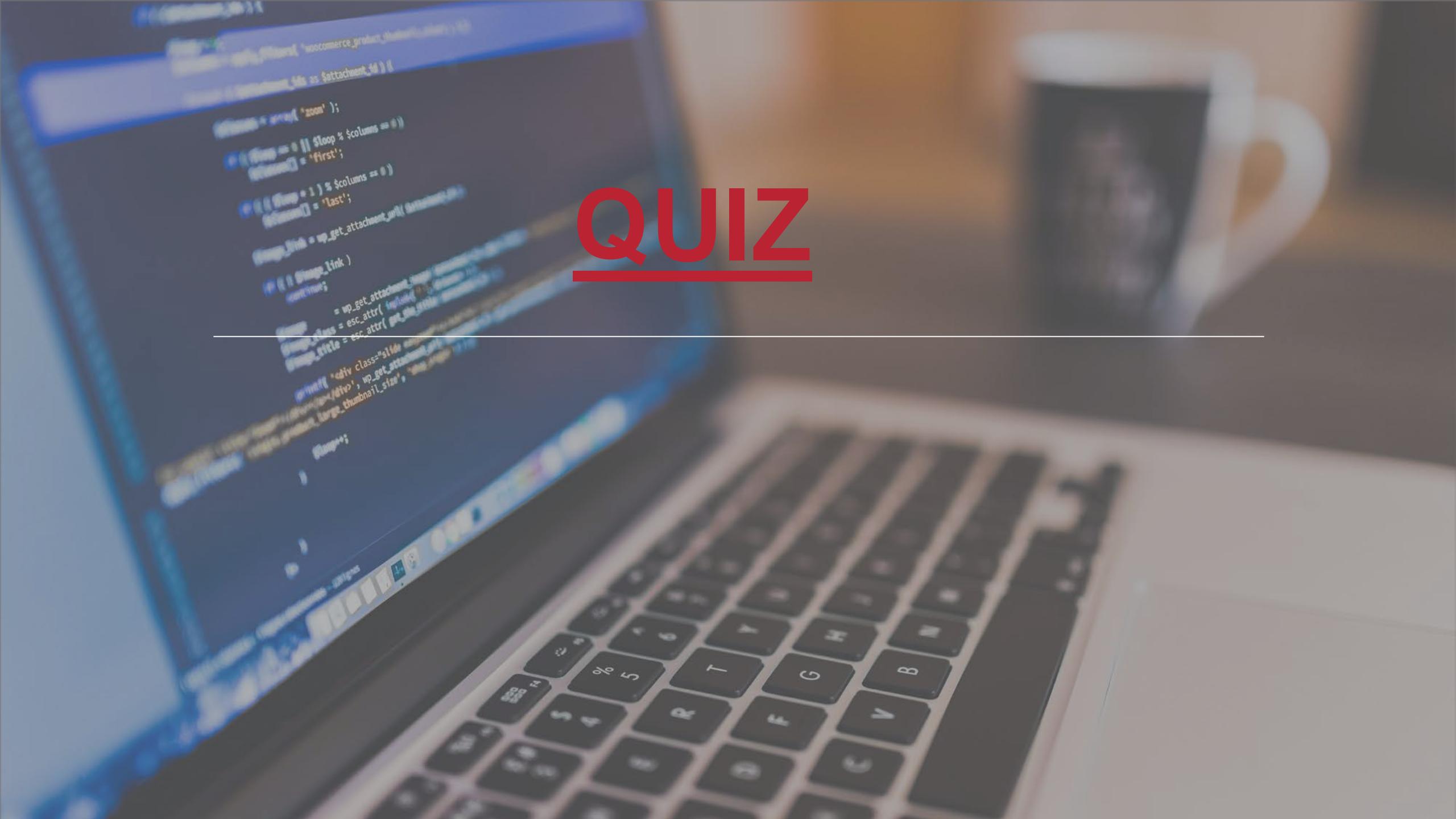
Create new revenue streams



Deploy new capabilities quickly



Deliver targeted workforce training and
guidance



Objectives

AI and ML Myth busting

Myth #1 – AI works like the human brain

Myth #2 – Intelligent machines learn on their own

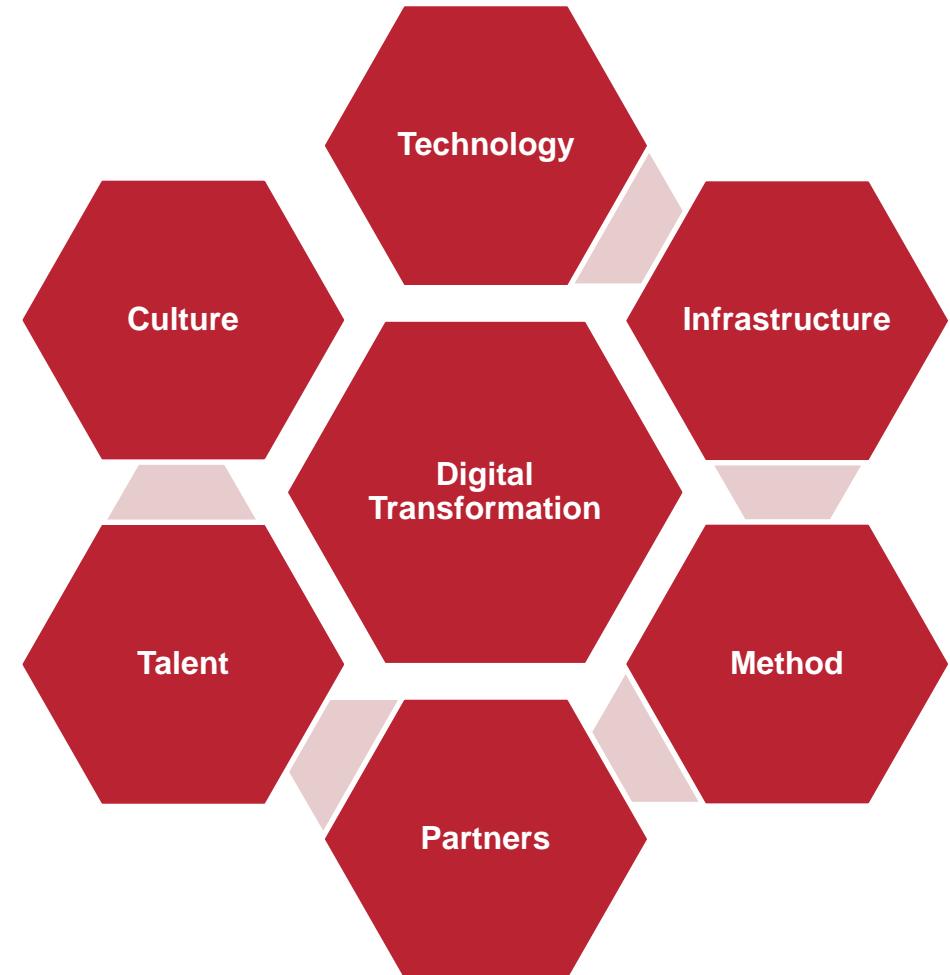
Myth #3 – AI can be 100% objective

Myth #4 – Anyone can build a machine learning platform

Myth #5 – You can go it alone.

“It is crucial that you fully understand how AI can create value for your business — and where it cannot”

Alexander Linden, vice president analyst, Gartner



Objectives - Focus

FACULTY

- Strategy
- Methodology
- How to Approach an Opportunity

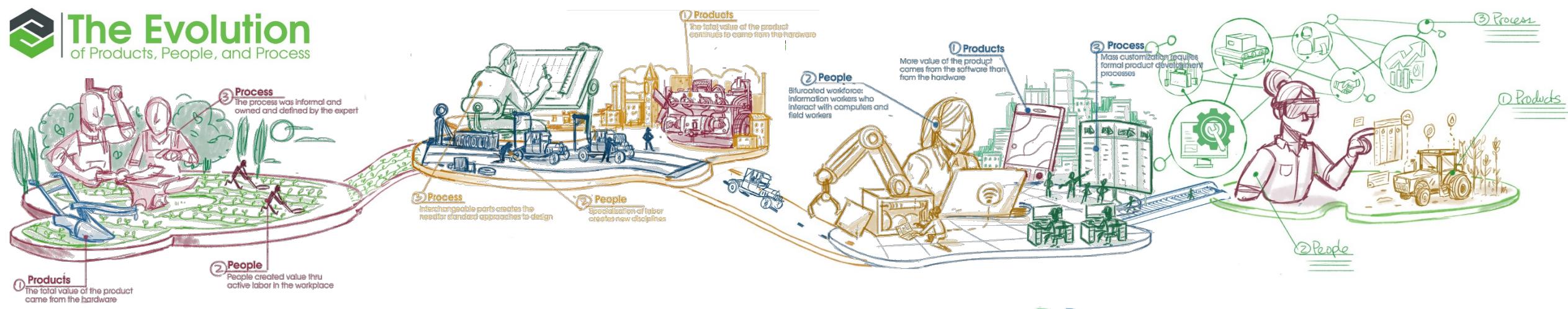
STUDENTS

- Strategy
- Methodology
- Future Roles
- Innovative Applications

INDUSTRY

- Strategy
- Methodology
- Managing Risk
 - Talent
 - Partners
 - Organization



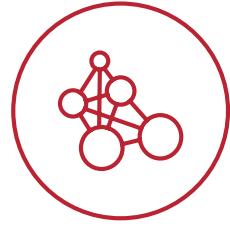


The way people work is changing
Technologies are enabling new possibilities





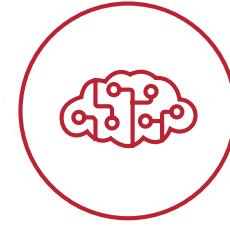
Take advantage of a comprehensive strategy to ...



SIMPLIFY INDUSTRIAL
TRANSFORMATION



ACCELERATE
BUSINESS OUTCOMES



INNOVATE
WITH AGILITY

Streamline the convergence of digital, physical, and human with comprehensive, integrated, secure, and proven solutions from market leaders

Increase productivity and efficiency of people, processes, and products in the enterprise with unified operational insights

Position business for long-term growth with a scalable, flexible, and future-proof digital foundation built for rapid and continuous innovation

Short Over of AI (AI, Digital Transformation, Smart Manufacturing)

Augmented AI

Class
Of
Technology
to Create
Adaptability

Computer
Engineering
Discipline

Machine Learning

Category of
AI

Task
Oriented

Deep Learning

Subset of ML

Multiple Scenario
Capable

Objective Smart Manufacturing

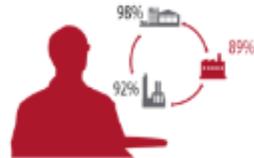
DESCRIPTIVE

DIAGNOSTIC

PREDICTIVE

PRESCRIPTIVE

ENTERPRISE



What plant performed the best?



Why is site A throughput below plan?

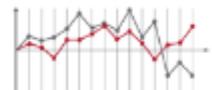


Will I meet plan today? Tomorrow?

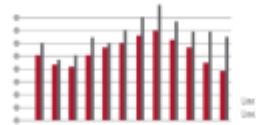


How can I change operations to improve profitability? Yield? Quality?

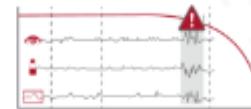
SYSTEM



Is Line 1 running ok?



Why is Line 1 quality poor?

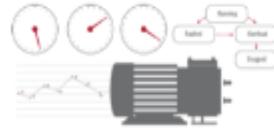


I predict that Line 1 quality is moving out of tolerance.



What action should the operator take to avoid poor quality?

DEVICE



Am I running ok?



Why did a fault happen?



I predict a fault will happen soon.



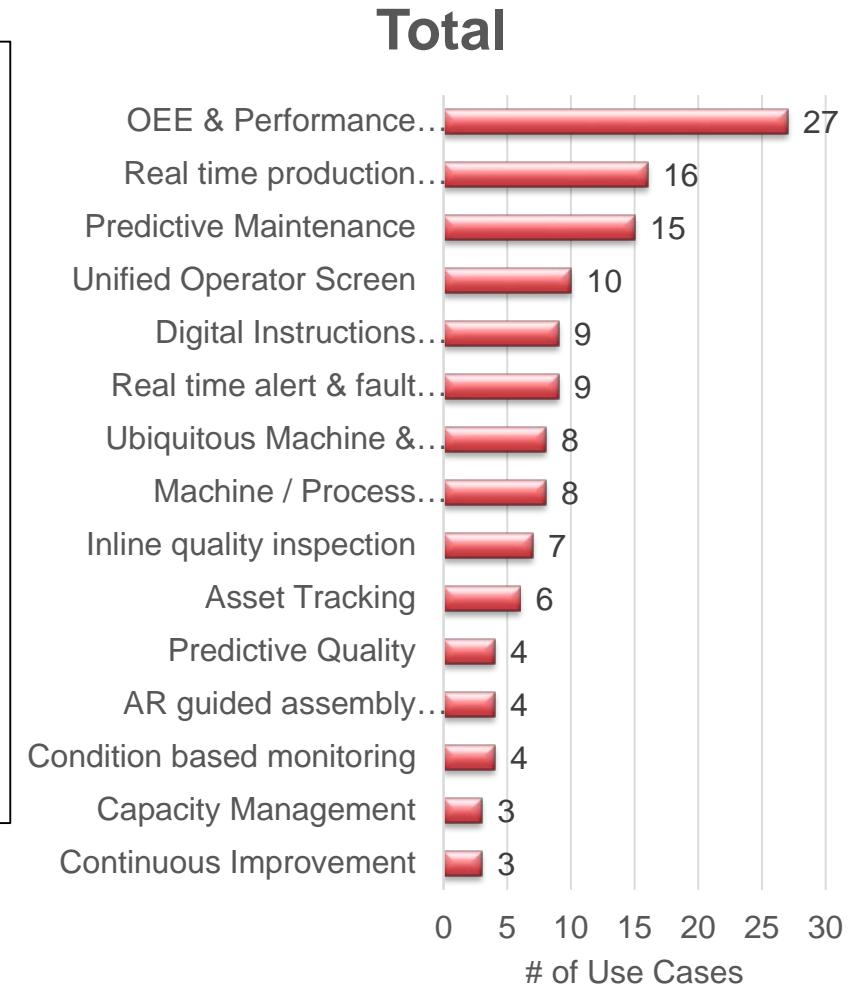
What action should be taken to avoid the fault?

Objectives

IIoT Industrial Applications



Production & Performance Monitoring:	Predictive & Prescriptive Maintenance:	Digital Worker:
<ul style="list-style-type: none">Enterprise Data Visibility & Plant BenchmarkingReal-time Quality KPIs, Throughput/Yield	<ul style="list-style-type: none">Scenario Model based decision makingOptimized Spend and AvailabilityHuman Exposure and Troubleshooting	<ul style="list-style-type: none">Digital Work Instructions (replacing paper OR PDF based)Knowledge Sharing & CollaborationMachine Set Up & Change Over Instructions

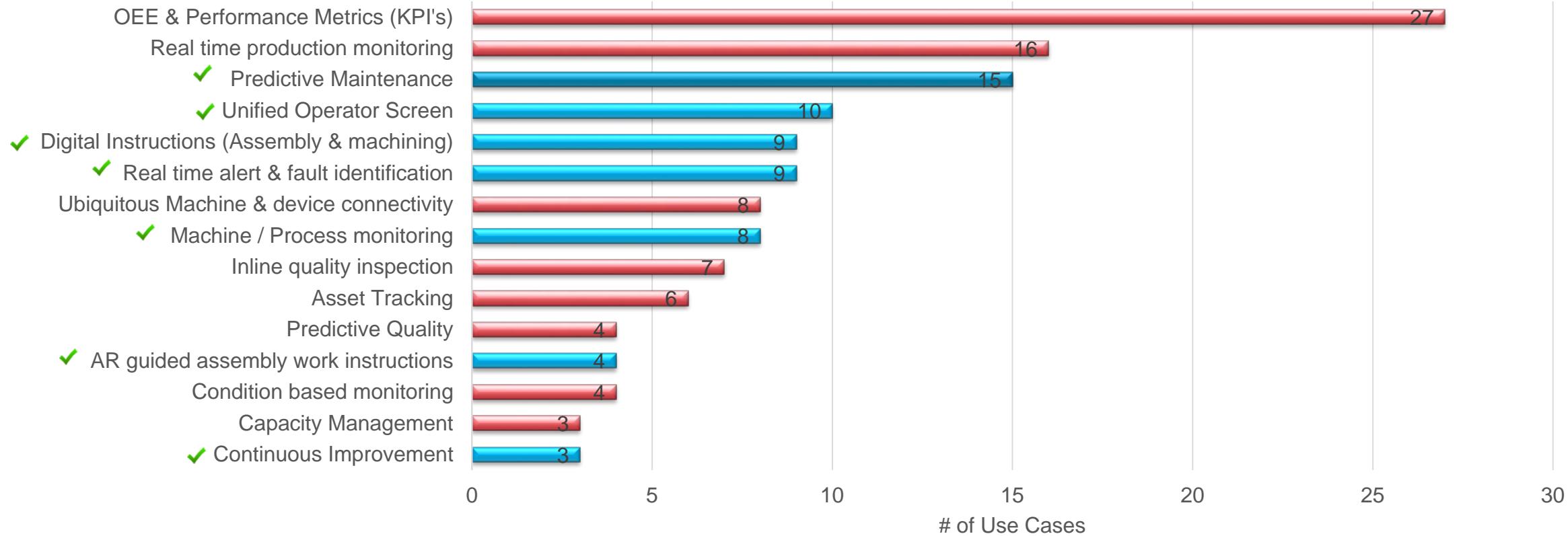


Objectives

IIoT Industrial Applications



Total





Section 1: Strategy



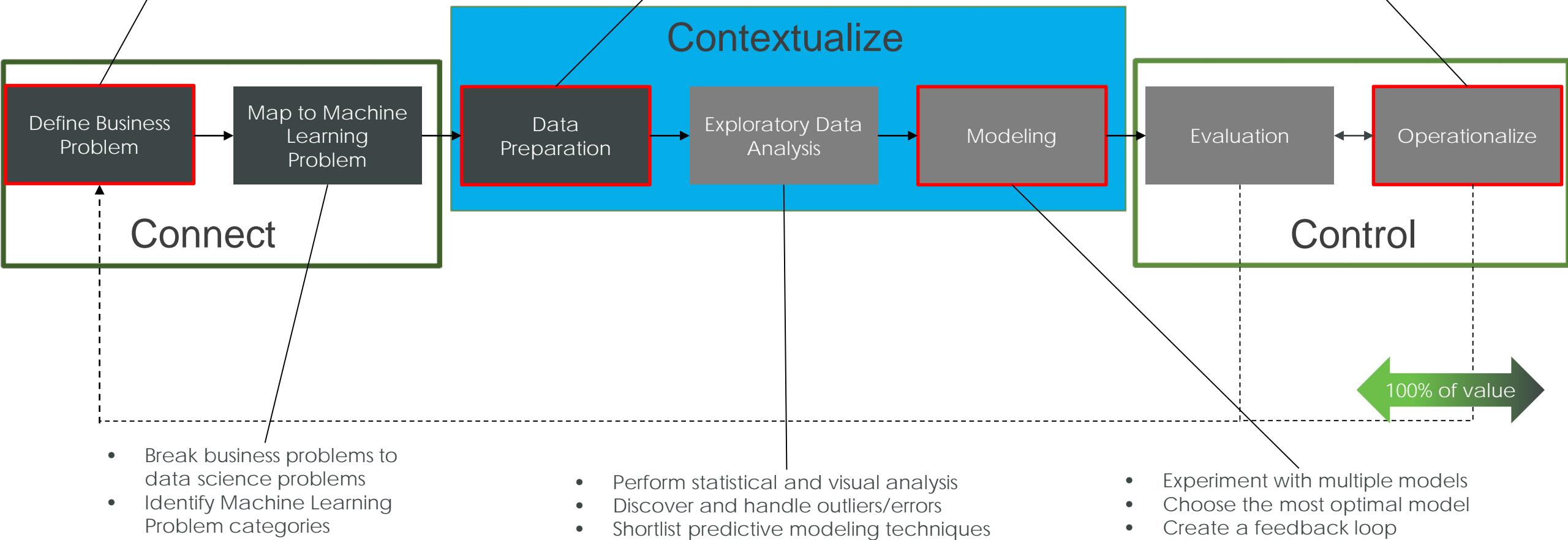
www.rockwellautomation.com

Methodology “How do I start?”

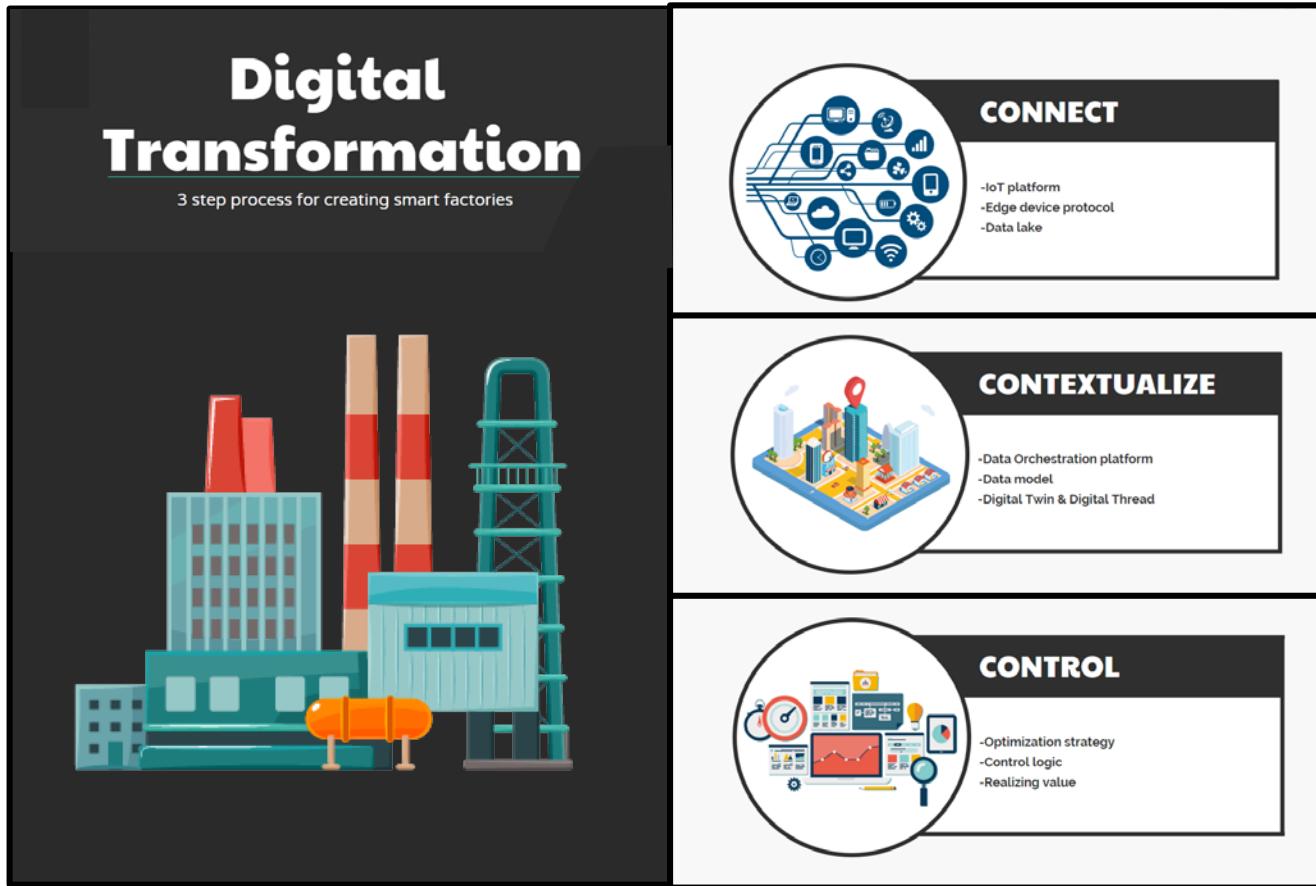
- Clearly defined business problem
- Set success criteria
- Define clear data science objectives

- Understand data points and constraints
- Formulate data analytics strategy
- Perform required transformation

- Put your models to work for you in production
- Data transforms need to be applied
- **Organize around new knowledge and decisions**
- **Define Roles and Personas around updated decision driven organization**



Strategy “What Technology Do I Use? Who are my Success Partners”



Connect



Data Lake

- Data format
- Data to store



Cloud connections

- Cloud communication protocol
- Cloud data sources



Edge connections

- Edge device communication protocol
- Edge devices



Contextualize

Digital Thread

- Enterprise data
- Manufacturing process data
- Engineering process data

Digital Twin

- AR model connected to data
- 3D geometry model connected to data
- Data model

Control

Current

IIoT Structured Analysis

ISA-95

L4/
L5

Business Systems
(ERP, SCM, PLM)
Governance & planning

L3

Production Execution
(MES / MOM)

L2

Process Monitoring
(HMI-SCADA)

L1

Process Sensing,
Manipulating
(PLC)



LOGISTICS

SUPPLIERS

ENVIRONMENTAL

IOT GATEWAY

Innovation Platform

Engage
Orchestrate
Synthesize
Contextualize
Source

Break-
Thru
Innovation

PLANT & CORP.
MANAGEMENT



MAINTENANCE



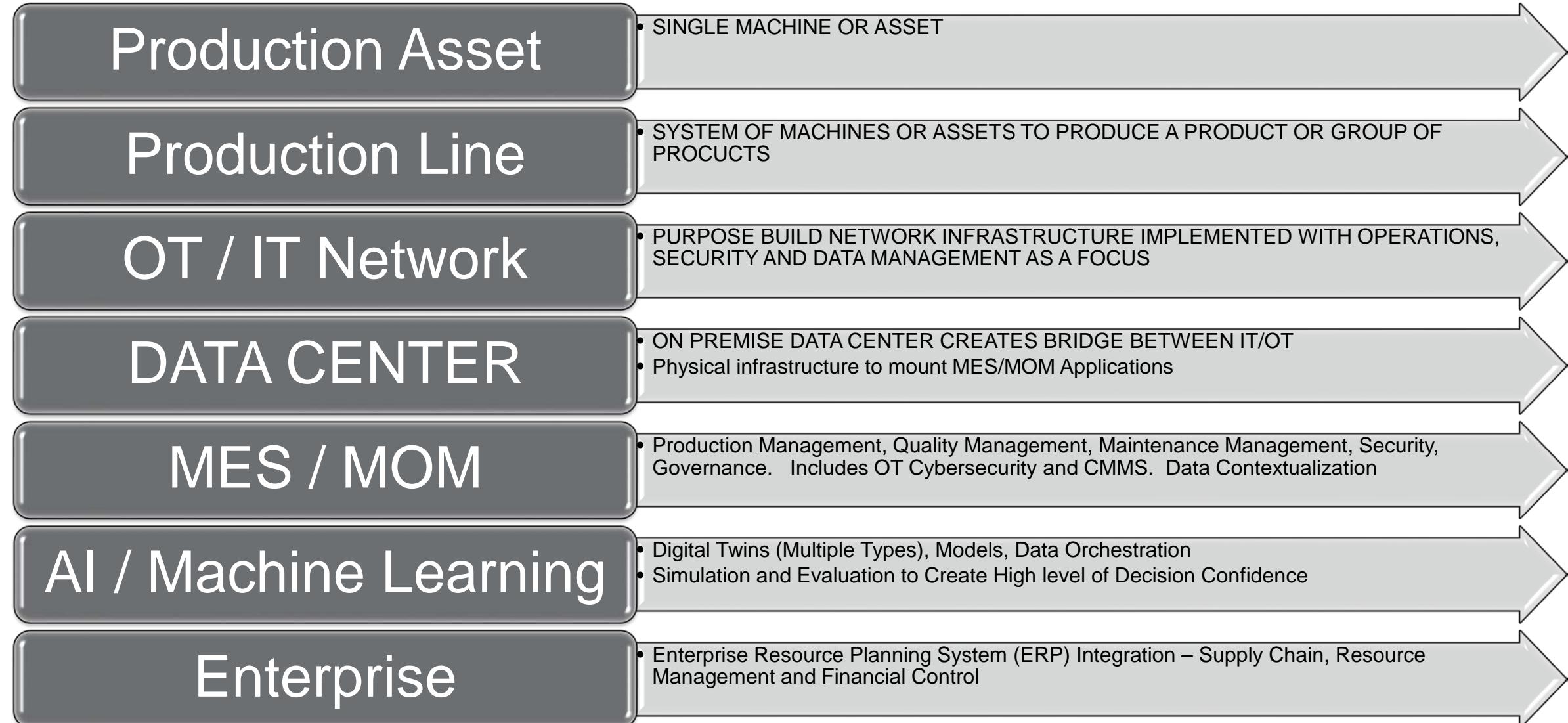
QUALITY



OPERATORS

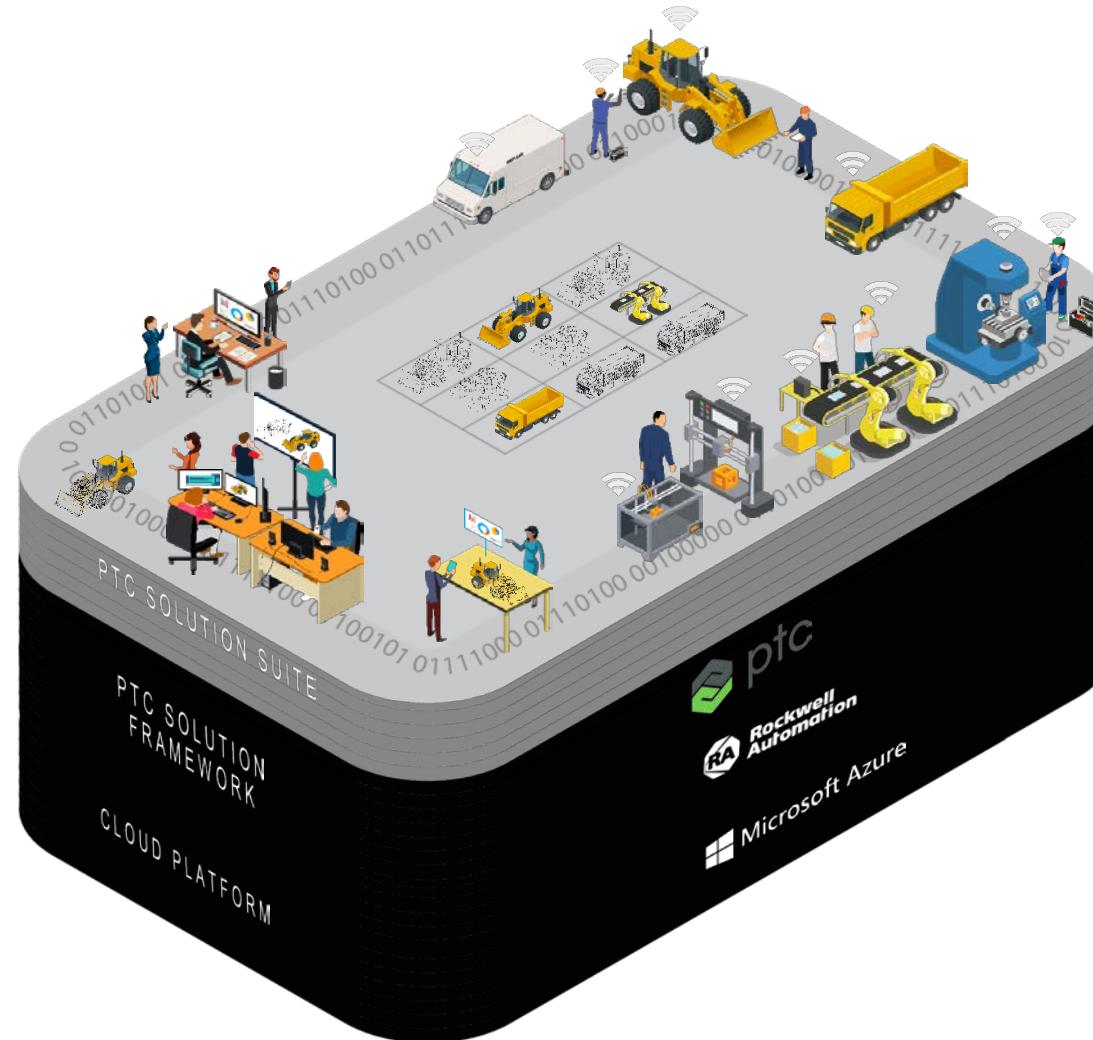
- **Connected**
- **Real-time**
- **Persona flexible**
- **Predictive / Prescriptive**
- **Mobile & augmented**
- ***Enhanced Capability***

Methodology – Systems – “How is My Infrastructure Architected”





Partners and Digital Transformation





Rockwell-on-Rockwell Use Case

23
SMT* Lines

~250K
Chip Placements/Hour

24-7
Operation

> 22M
Finished Goods
from Twinsburg

~ 300
Nozzles/Machine

~3B/Plant/Year
Data Points



Cause

Nozzle misalignment /
Clogging / Wear



Impact

Machine
Downtime

Manual Failure
Detection

Product
Waste

Quality
Issues

Product
Returns



Rockwell + Microsoft



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Solution Scope



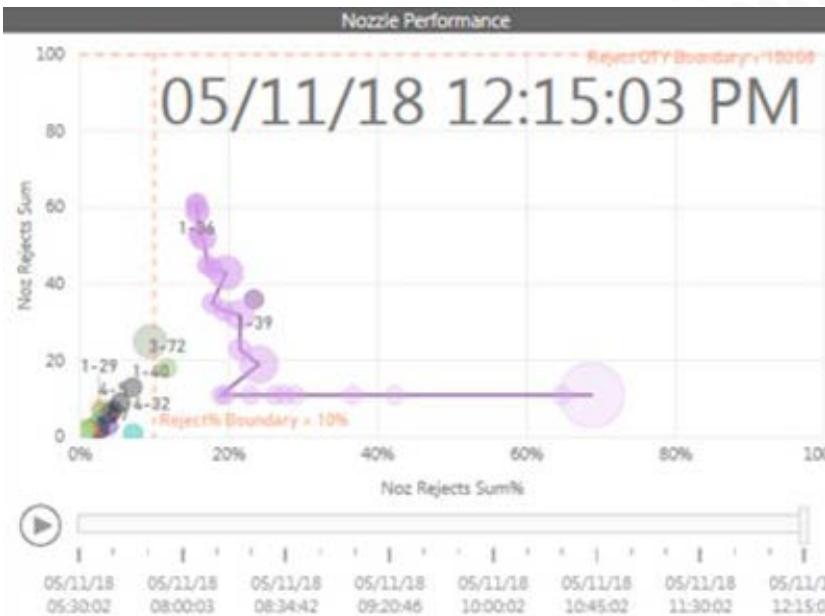
- Surface Mount Technology (SMT) Lines: 23
- Pick and Place Machines: 2-3
 - **7 machines: GC2, GC3, GC5, GC6, GC7, GC9, GC10**
- Nozzles: 300
 - 60-70 active during production
- Users
 - Operators, Maintenance Technicians, Production Management, Maintenance Management

Pick and Place Machine



Solution Goal

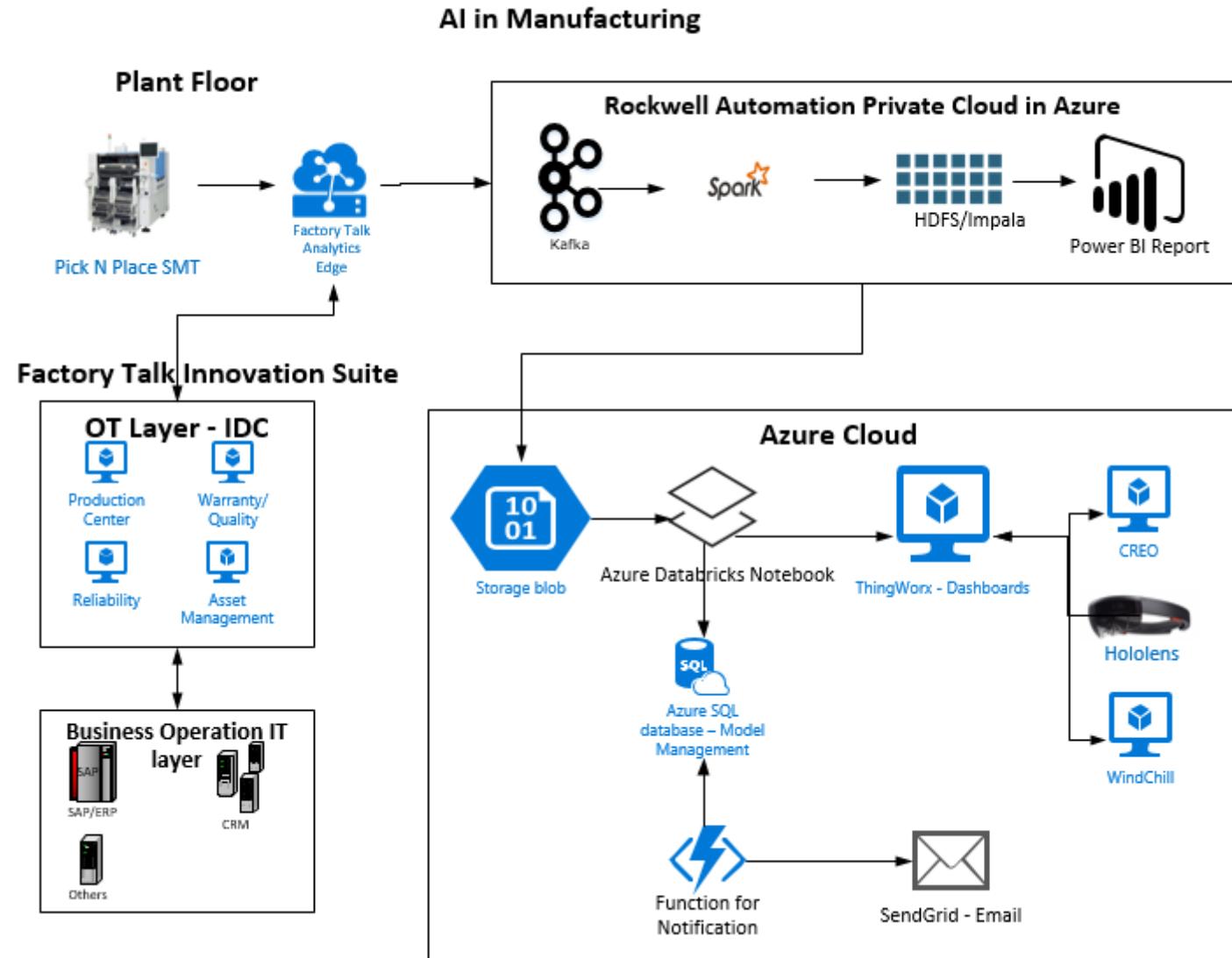
- Automatically detect flyaway nozzles with no user intervention



Expected Outcomes

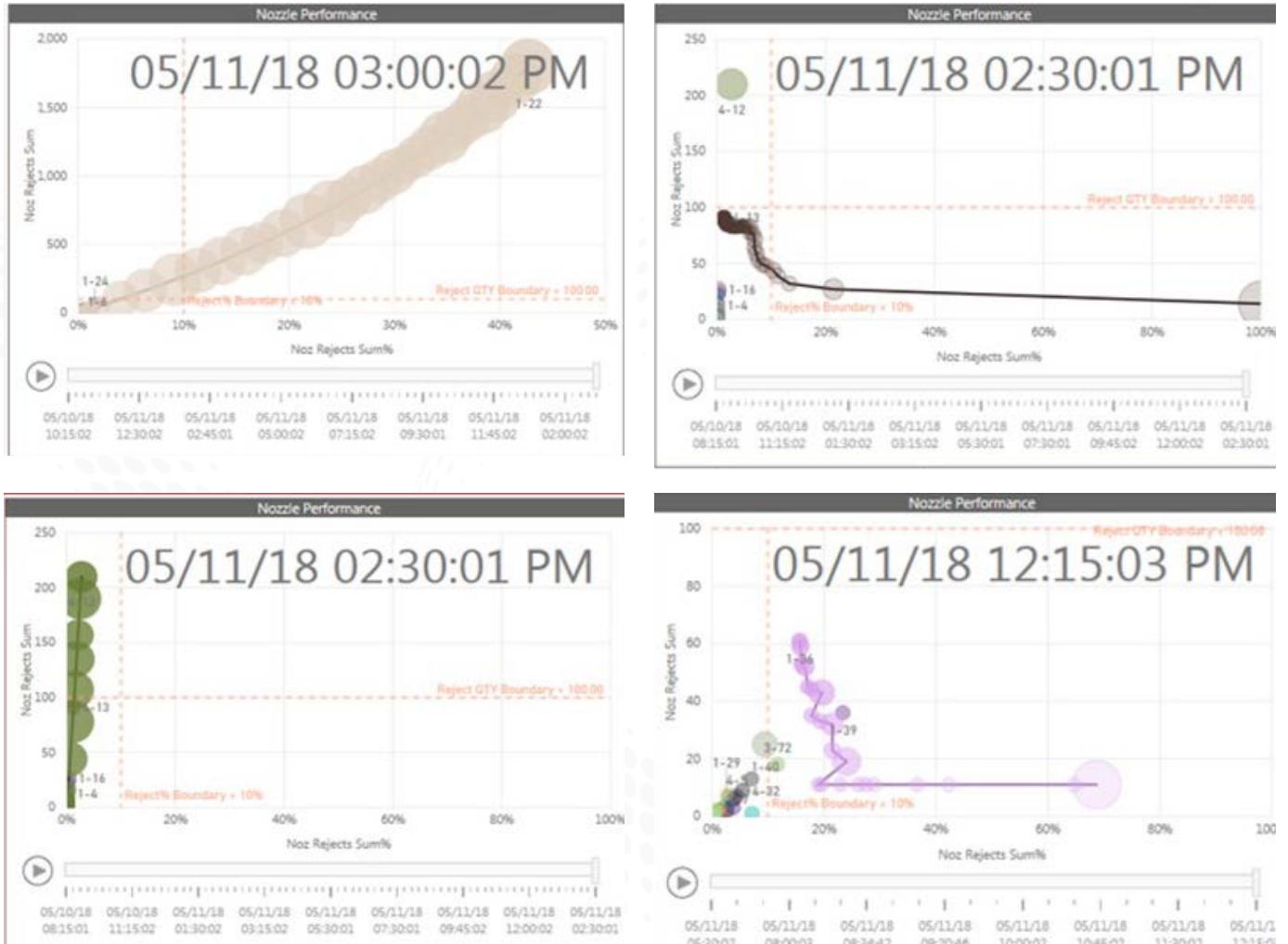
- Control Downtime - Predicting with high confidence the point of nozzle failure will transform the maintenance process into a proactive activity based on factual calculations and higher certainty.
- Minimize Troubleshooting Time - Creating knowledge of which nozzle will fail and when.
- Avoid False Positives - False positive overwhelm the operators with false alerts.

Solution Architecture



Solution Algorithm

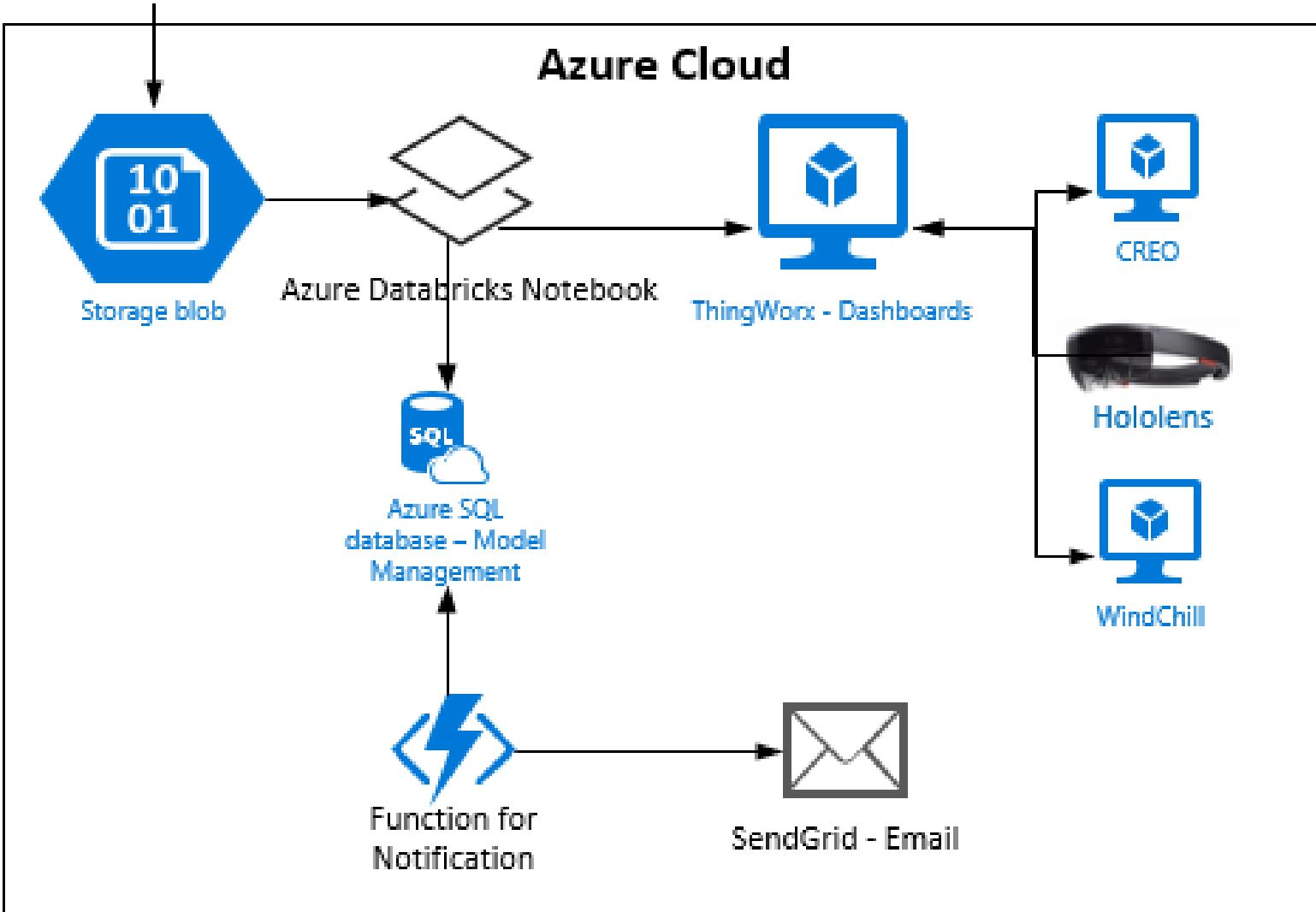
- Algorithm evaluates the vector path of each nozzle and tabulates a nozzle score over time
- When the nozzle score reaches a trigger value, additional logic is checked and if satisfied an alert is created and routed to support personal using a notification hub
- Parameters can be changed to adjust sensitivity





Solution Demo

Solution Architecture



Parameters to Adjust Sensitivity

```
// Set thresholds for nozzle detection  
val nozzles = new NozzleSlopeTracker.NozzleSlopeClass(0.1, 90, 0.33, 1, false)
```

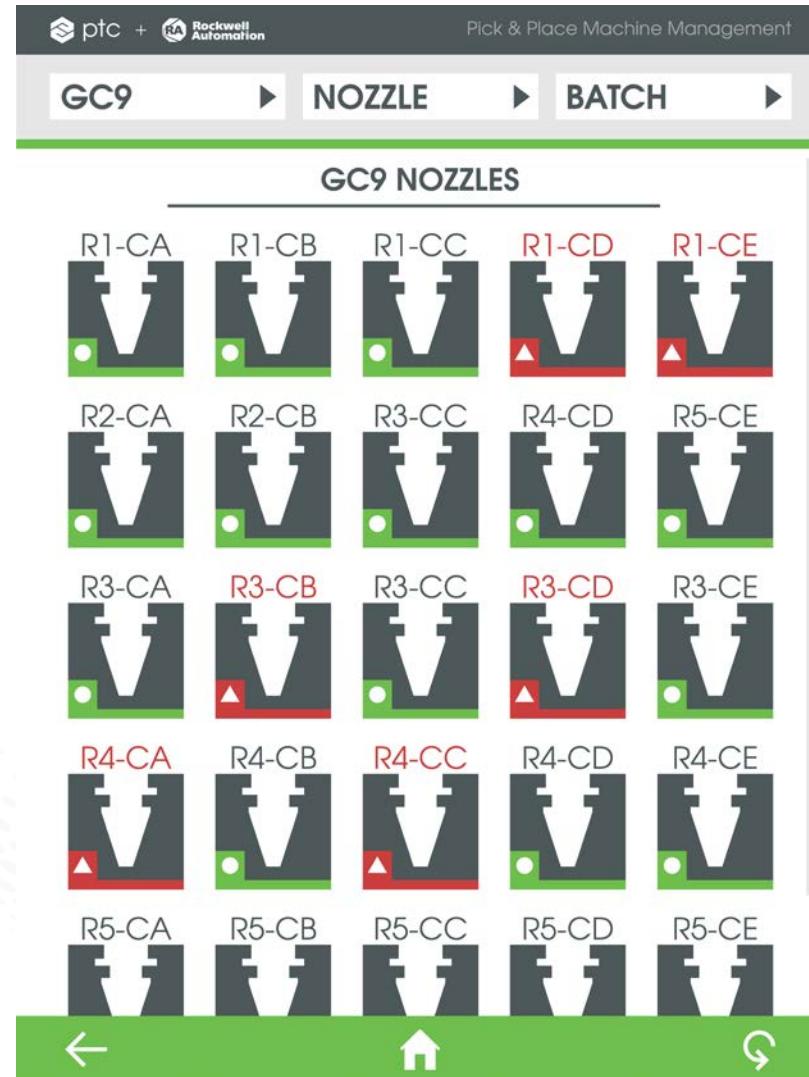
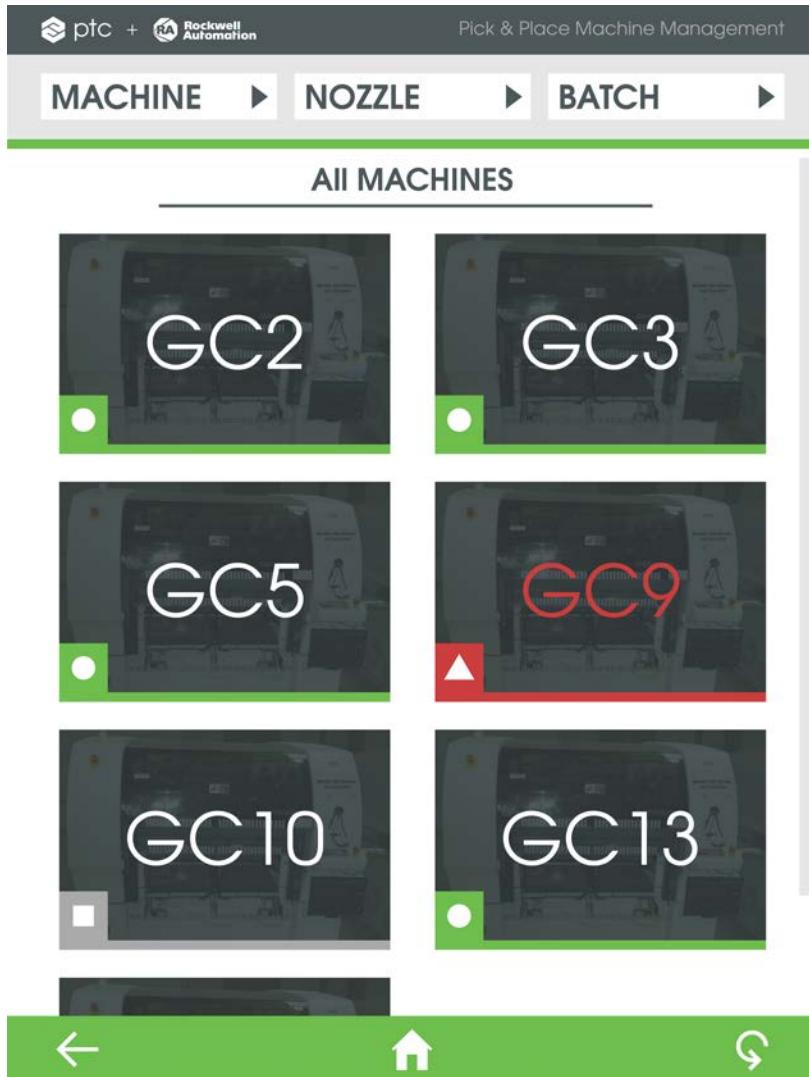
x-axis: % of rejects

y-axis: total # of rejects

Nozzle score penalty

Max slope count

Solution Visualization



Solution Outcomes

- Successfully identify flyaway nozzles
- Produce data for Thingworx dashboards
- Provide technicians with information needed to make informed decisions
 - Control downtime
 - Minimize troubleshooting time
 - Avoid false positives

The dashboard displays the following information:

Batch ID: 4009240377T	
Machine	GC9
Nozzle	R1-CD
Avg. Success Rate	65%

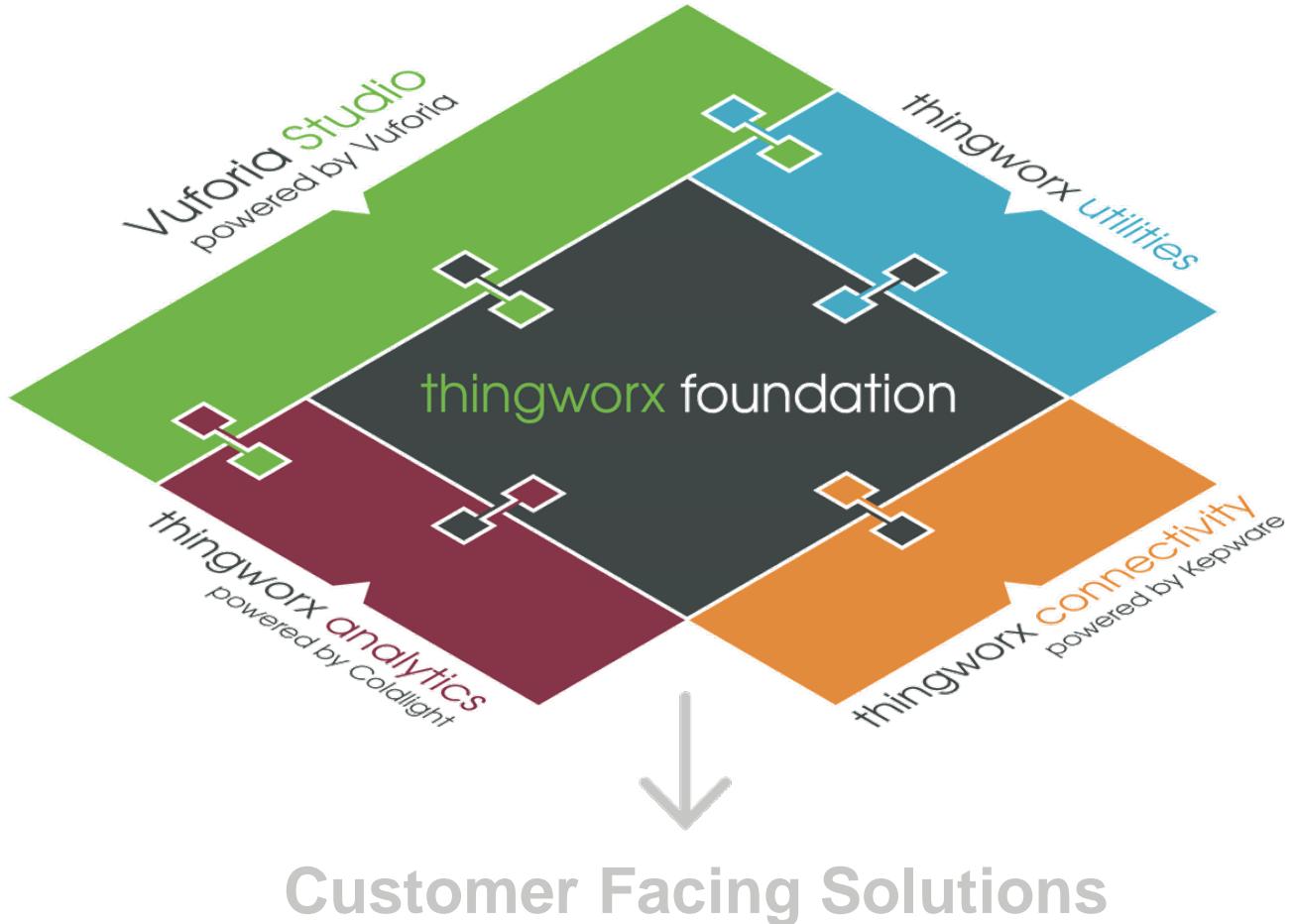
Below the table, a grid shows the status of ten nozzles:

40376T	40377T	40378T	40379T	40380T
40381T	40382T	40383T	40384T	40385T

Each nozzle icon includes a small green circle at the bottom and a colored arrow (green, red, or white) pointing up or down.

Navigation icons at the bottom right: back, home, and forward.

ThingWorx Platform & Taxonomy of Data



Types of Data

- Properties
 - String
 - Number
 - Boolean
- Events
- Services

Contextualizing the Digital World

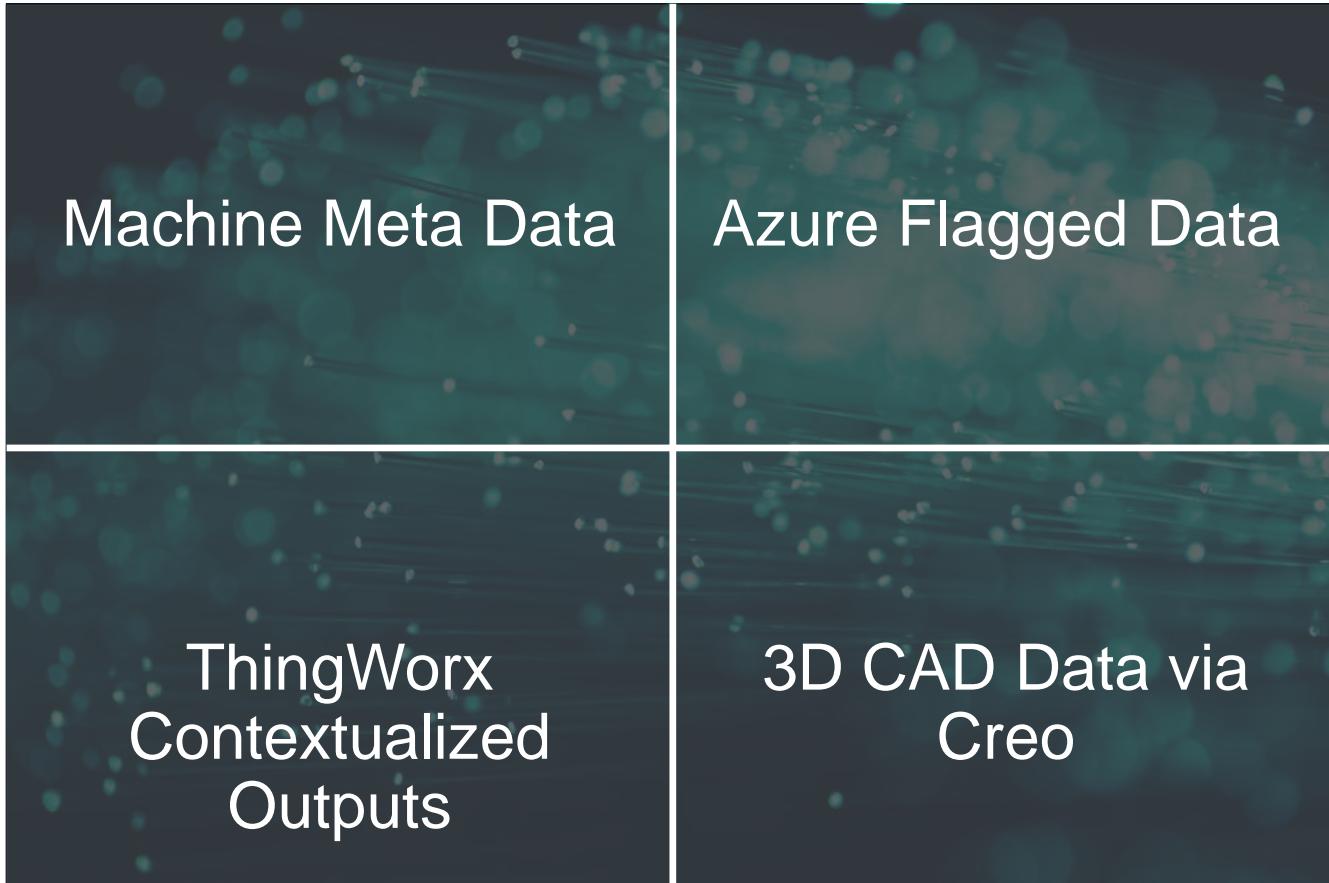
Digital Thread

- Enterprise data
- Manufacturing process data
- Engineering process data

Digital Twin

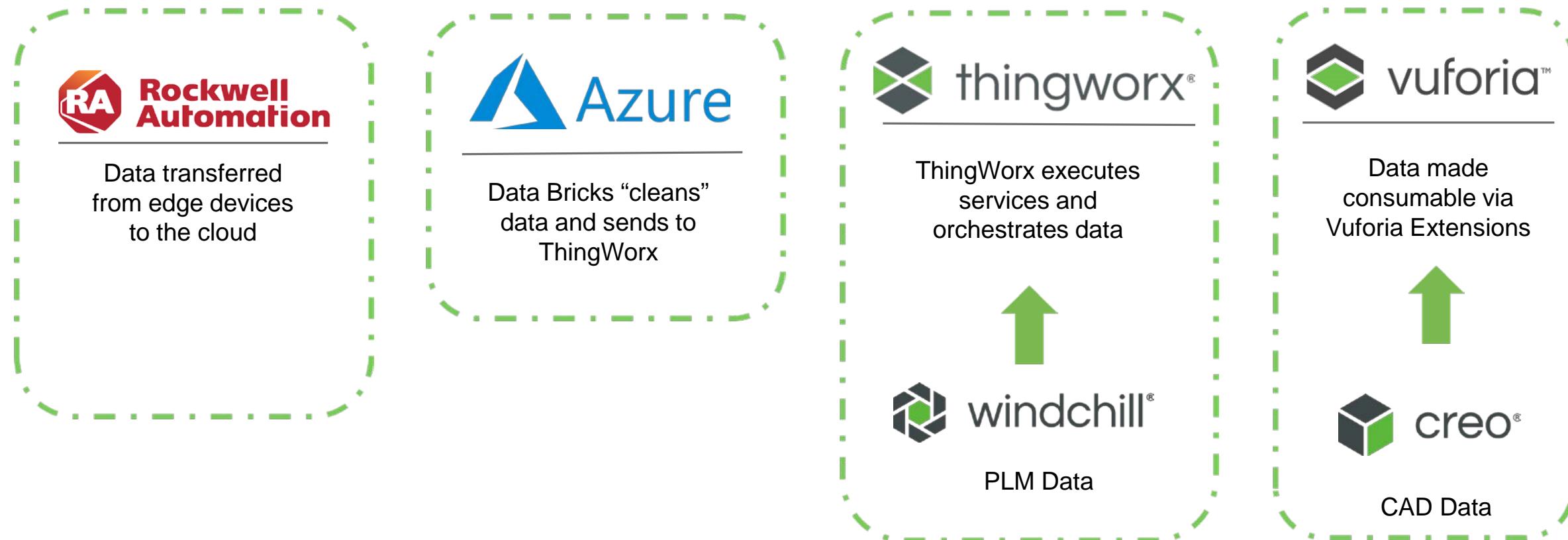
- Geometric asset data
- Sensor data from the asset
- Data model of the asset

Bringing the Digital Thread to Life



Components of Digital Thread

Data Orchestration Processes





Data Orchestration

Physical Asset



Azure

thingworx®

vuforia™

Digital Twin



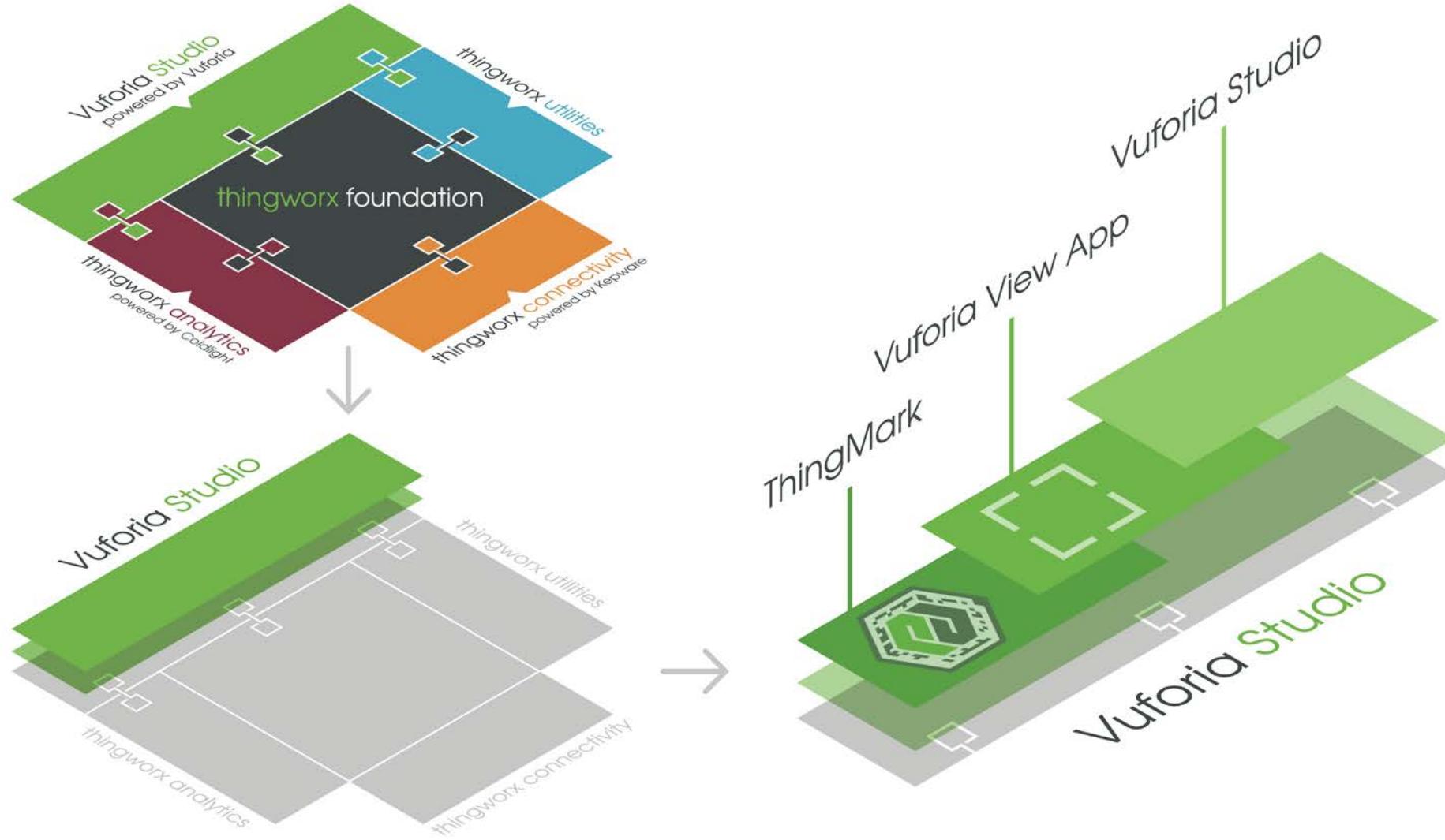
Machine

- Nozzle List

Nozzle Level

- Latest Batch
- Trigger Count
- Average Nozzle Sum
- Batch Count

Bringing the Digital Thread to Life





What Is Good Data?

Data Type	Question	Solution
Raw Data Specific Taxonomy and Features	What data components are necessary?	<ul style="list-style-type: none">• Clean, concise sourcing• Origin, pathway and purpose for each data source
Cloud Infrastructure	What capabilities are needed?	<ul style="list-style-type: none">• Connectivity, Flexibility, Scalability
GUI / UI / HMI Infrastructure > Solution + AR + VR	Why is this important?	<ul style="list-style-type: none">• User Facing Deployment > AR/VR/ Mashup



Components of Solution

Device Level Components

Edge Device

Edge Device Firmware

Mfg Line

Rockwell Kepware

Cloud Supported Components

Cloud Hosted Database

Industrial IoT Orchestration Platform

Digital Experience Solution

End User Deployment

Azure Data Bricks

ThingWorx Core Platform

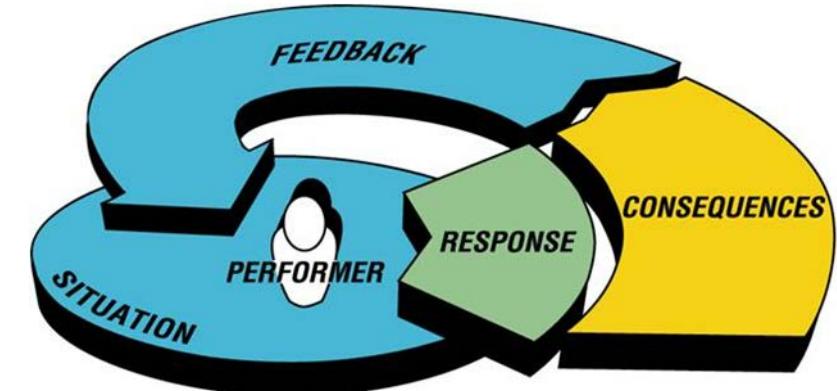
Vuforia Studio

Vuforia View

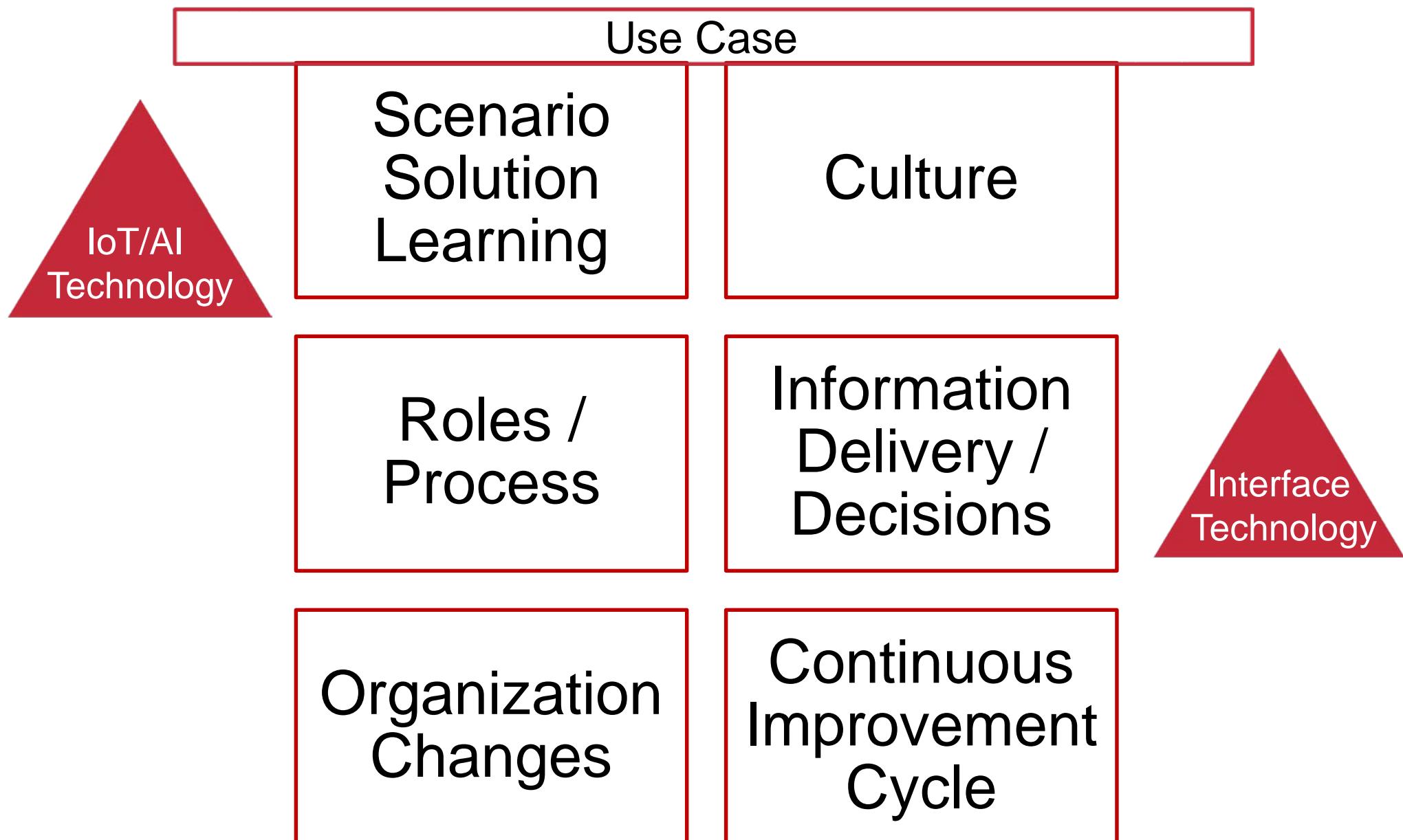
Value Realization

Continuous Improvement Mindset

- Scenario / Solution Learning
- Roles and Process Changes - Personas
- Organizational Changes – Solution vs Functions
- Behavioral Changes - Culture
- Informed Decision Making –
- Continuous Improvement Cycle



Use Case Development Assignment





Thank you



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