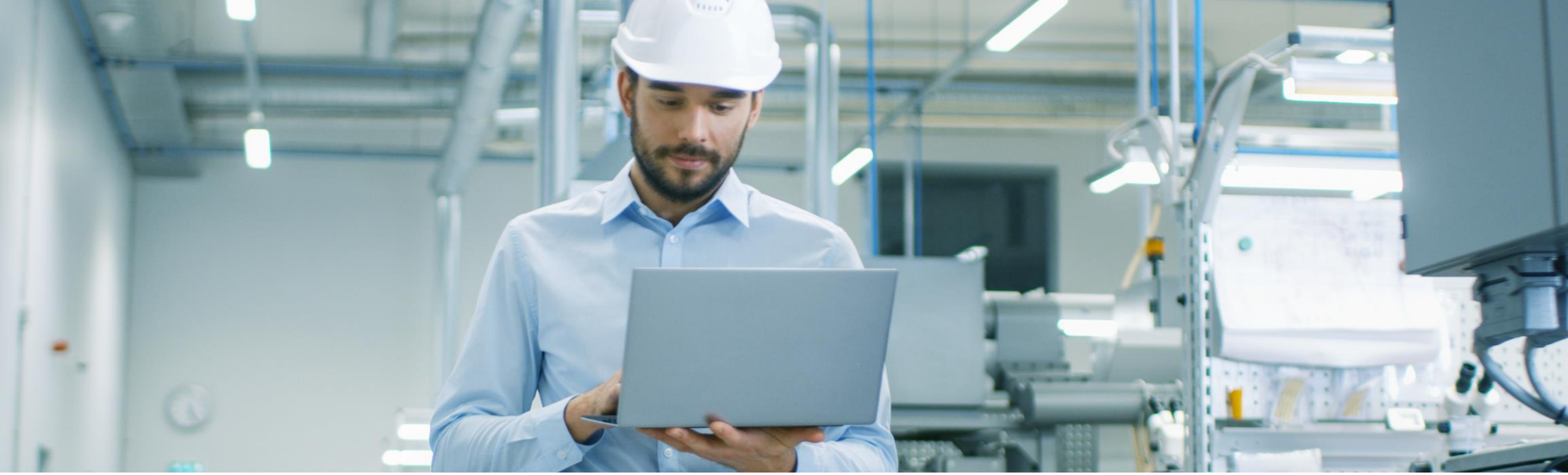

# Start with real-time visibility in factory floor operations

Rockwell Automation

Tomas Knobloch

Solution Architect Visualization, SW, Process

# Agenda

1 FactoryTalk Innovation Suite Overview

2 IIoT – ThingWorx

AR - Vuforia

3 FT Analytics solution overview

4 FactoryTalk Analytics platform

5 Questions


# Main advatages of RA and PTC portfolio?

**Global reach solution**

- ✓ **Scalable** - deployment in any location, factory to factory benchmarking
- ✓ Based on **industrial standards** Kepware – 150 drivers and over 100 protocols
- ✓ Rapid development platform – already prebuilt applications ready to implement
- ✓ **Fast to deploy** – install and configure in less than an hour – no coding for Mnf Apps

**Future extensions:**

- ✓ Integrated ML algorithms ready to use – e.g. Linear Regression, Decision Trees, Neural Nets, Gradient Boost
- ✓ Augemented Reality as logical extention to use for visualization

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# FT Innovation Suite

InnovationSuite
powered by PTC

# operate & maintain

InnovationSuite
powered by PTC

## IIoT

Market-leading industrial innovation platform to drive digital transformation for **increased operational performance and agility across all factories**

## AR

Industry-leading augmented reality development tools to **improve workforce efficiency and training**

## Fit for purpose MES

A set of tools built on top of FactoryTalk ProductionCentre MES platform that target specific needs around **operational performance, quality, production and warehouse**

## Data Analytics

Self-service visual analysis / data discovery tool that create **insightful storyboards that can be shared on any form factor or device**

## Edge Computing

Data from real-time sources, with the ability to store and forward data, reducing loss due to latency. **Enables closed loop feedback applications and provides advanced analytics in the hardware stack**

## ML & AI

Solve complex analytics,
AI and machine learning problems.
Scalable from on-premise server to cloud based infrastructures.
**Handles big data and unstructured data such as text, imagery, audio, etc.**

Rockwell Automation

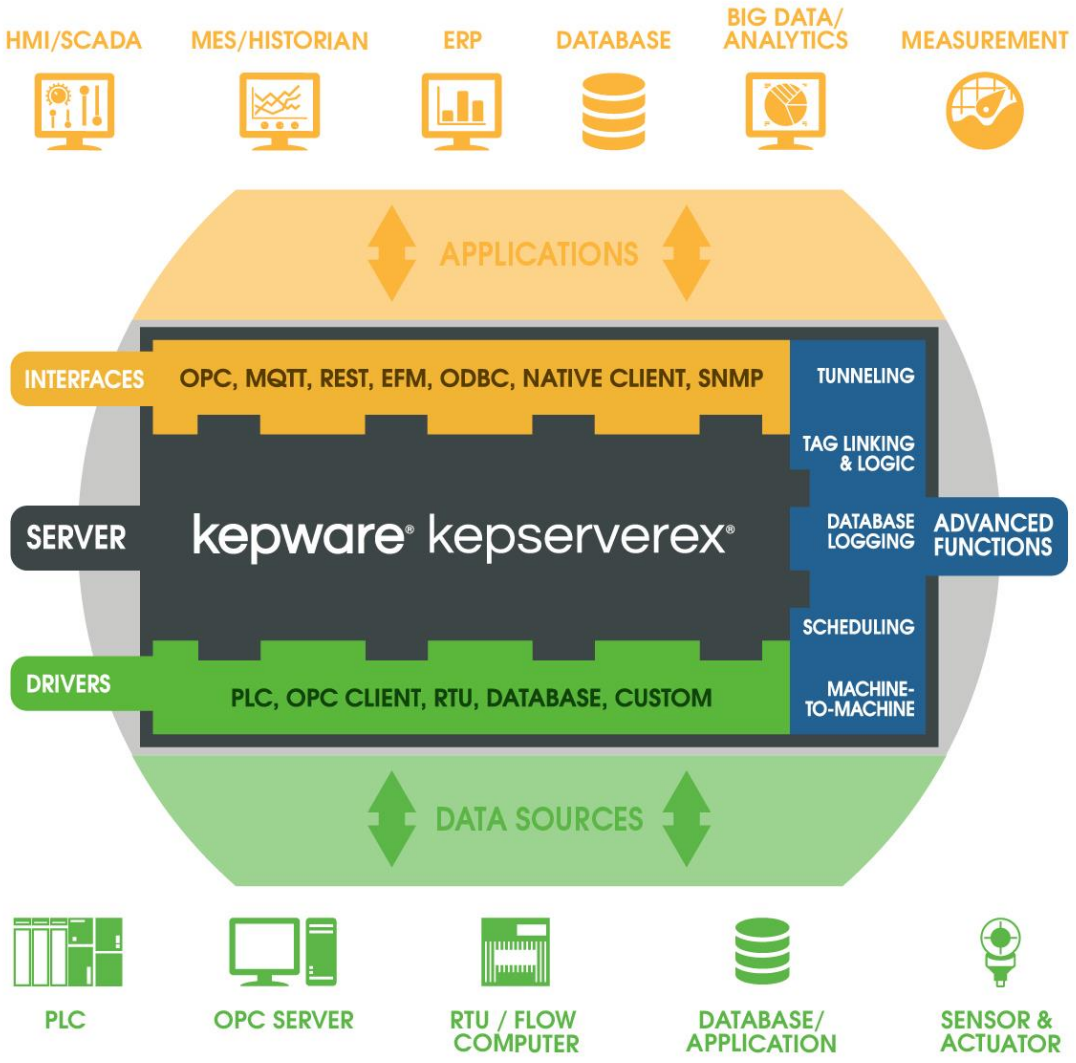
# KEPServer

# Industrial Connectivity Platform - KEPServerEx

**Industrial Connectivity Suite – from PTC**
1.phase will start using Kepware for sourcing data from **OT** (PLC, OPC Servers, Sensors) and **IT** (ERP, MES, DBs, BI, HMI etc.)

**Advatages**

- ✓ Largest collection of manufacturing-based device drivers **including more than 100 protocols**
- ✓ Suite is more then just OPC server **– library of more than 150 device drivers, client drivers, and advanced plug-ins** to fit the communication requirements unique to your industrial control system
- ✓ Number one recognized solution on the market



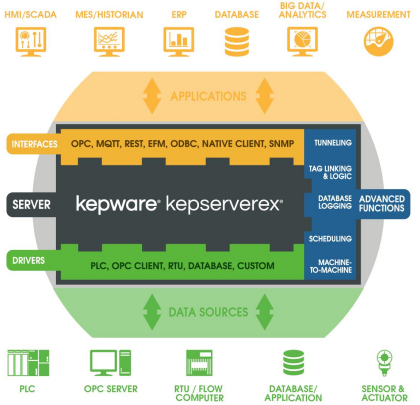
# Advanced Plug-Ins

Advanced plug-ins extend the capabilities of the KEPServerEX connectivity platform.

- Advanced Tags
- Alarms and Events
- DataLogger
- EFM Exporter
- Industrial Data Forwarder for Splunk
- IoT Gateway
- Local Historian
- Scheduler
- Security Policies
- SNMP Agent

# KEPServer Enterprise versus KEPServerEx

KEPServer Enterprise
Provided by RA
9301-OPCSRVENE




- Sold by Rockwell Automation, where the retail price is less than KEPServerEX
- Supported by Rockwell Automation
- Media-Level Redundancy is not available
- Excludes Rockwell Automation device connectivity (because RA device connectivity is provided by FactoryTalk Linx and/or RSLinx Classic)

- Sold by PTC/Kepware, where the retail price is more than KEPServer Enterprise
- Supported by PTC/Kepware
- Media-Level Redundancy is available with the Media-Level Redundancy Plug-In
- Includes Rockwell Automation device connectivity

# When KEPServerEx?

InnovationSuite powered by PTC

DataFlowML Edge
FactoryTalk Analytics

DataView
FactoryTalk Analytics

FactoryTalk MES

vuforia

thingworx

thingworx operator advisor

Microsoft

ORACLE

sas

Microsoft SQL Server

Java

SAP

FactoryTalk View clients

Control Room

Operator Workstation

FT Historian clients

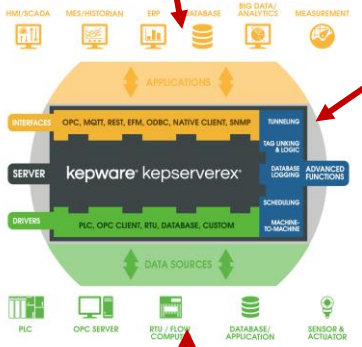
FT VantagePoint clients

Engineering Workstations

Batch Management

Asset Management

FT Linx Information Gateway

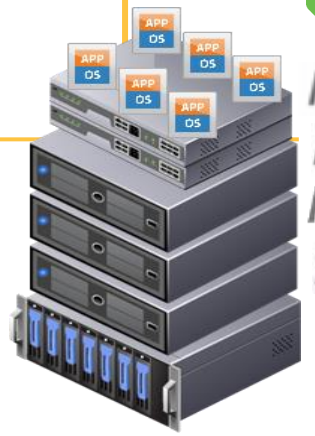



FT Linx

KepServer
Provided by RA

Rockwell Automation IA devices

3th Party Devices



InnovationSuite powered by PTC

FactoryTalk View

FactoryTalk Historian

FactoryTalk VantagePoint

FactoryTalk Batch

FactoryTalk AssetCentre

Microsoft SQL Server

Studio 5000

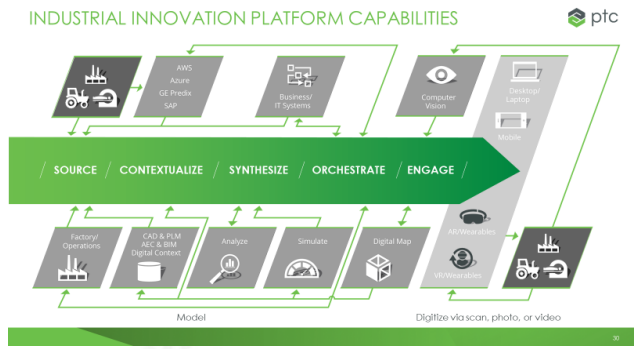
Rockwell Automation

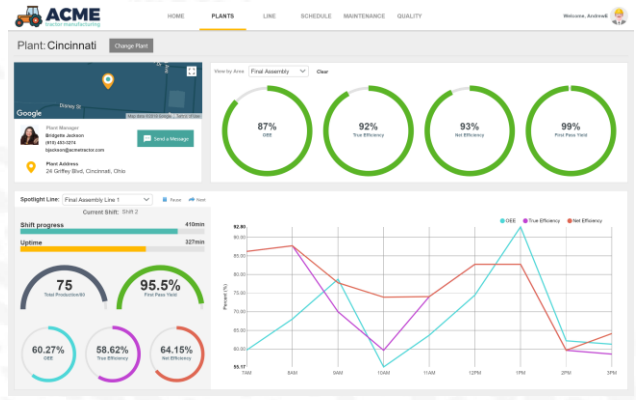
# ThingWorx

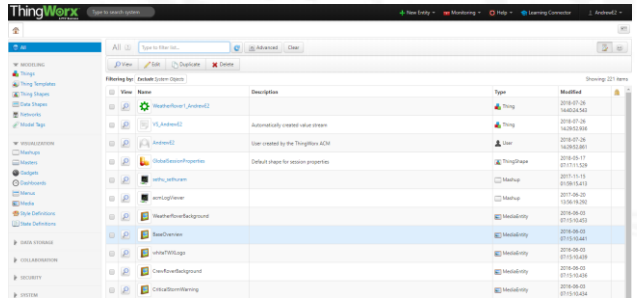
# What is PTC ThingWorx?

- ThingWorx is a platform, that enables:
  - Data Connectivity – live data, transactional and time series
  - Computation – perform calculations on the data
  - Analytics – leveraging the Analytics engine (prediction…)
  - Unified Production Model Development – organize to meet customer needs
  - Visualization – data shared and fused from different data sources in context
  - Configure and Extend – via APIs and configurations

- Create and use the Applications (IIoT applications)

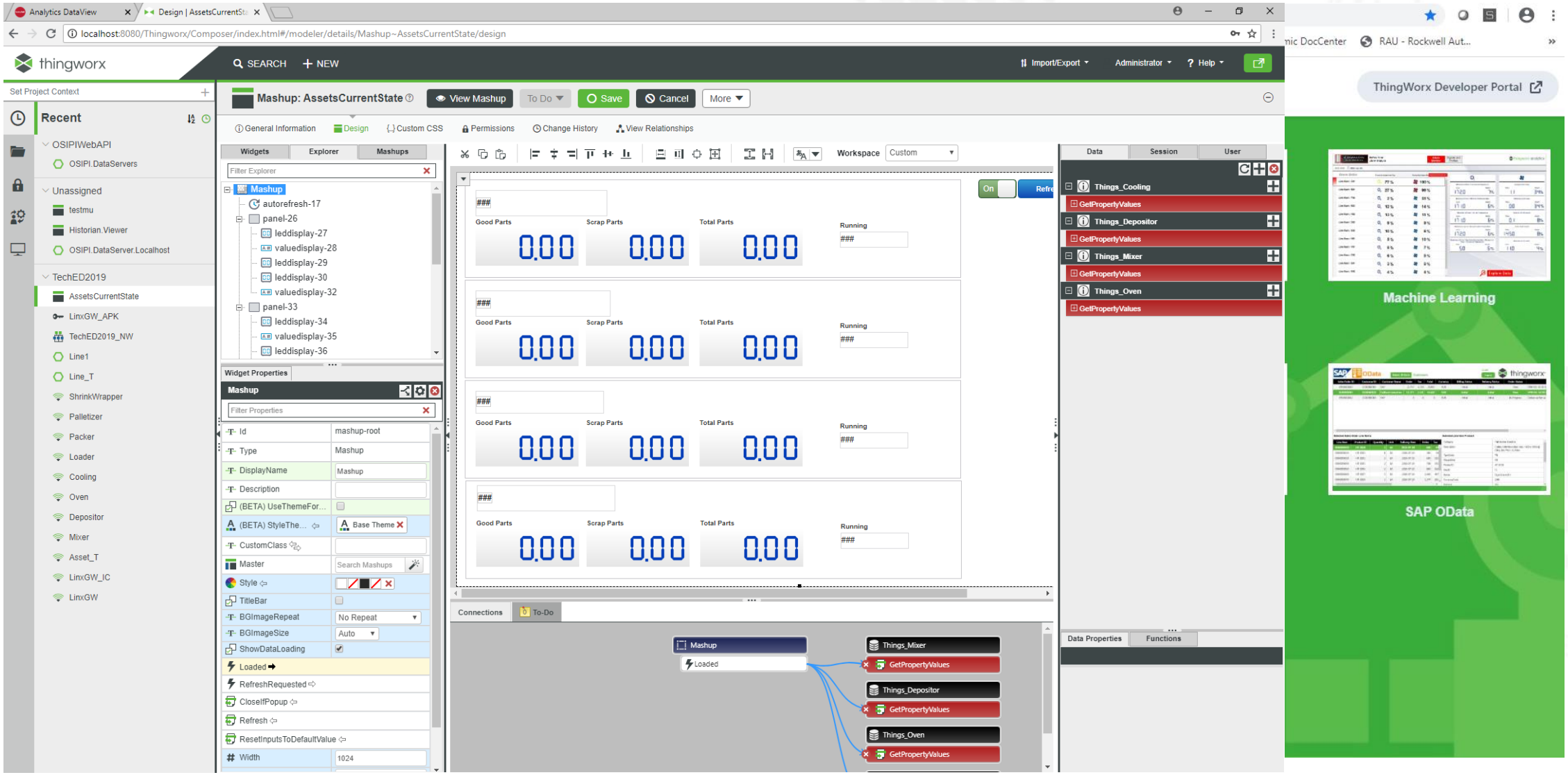


# The Applications build for end users (by SI, OEM etc.)

- With use of ThingWorx development tool



Rockwell Automation

# ThingWorx Advisors

# The Prebuild Applications (by PTC)

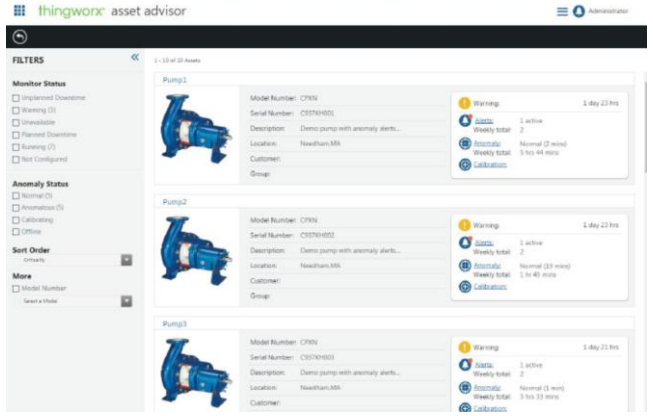
- to help end users or SI or OEM with their own Applications development

thingworx®

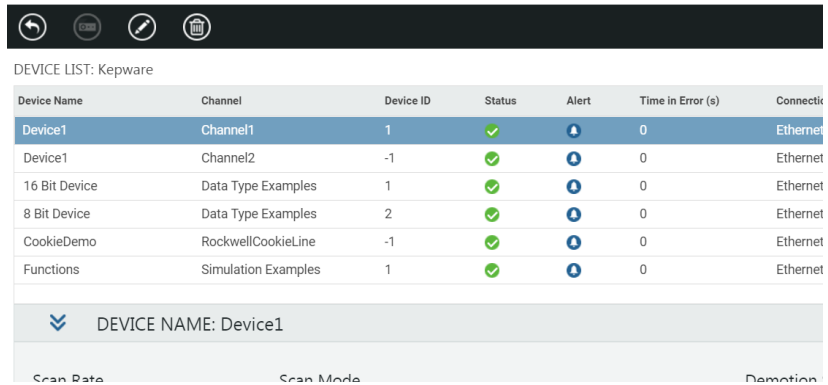
**PRE-BUILT MANUFACTURING APPS**

- Asset Advisor
- Controls Advisor
- Production Advisor
- Alert Monitoring
- Trending and Troubleshooting
- Administration and Configuration

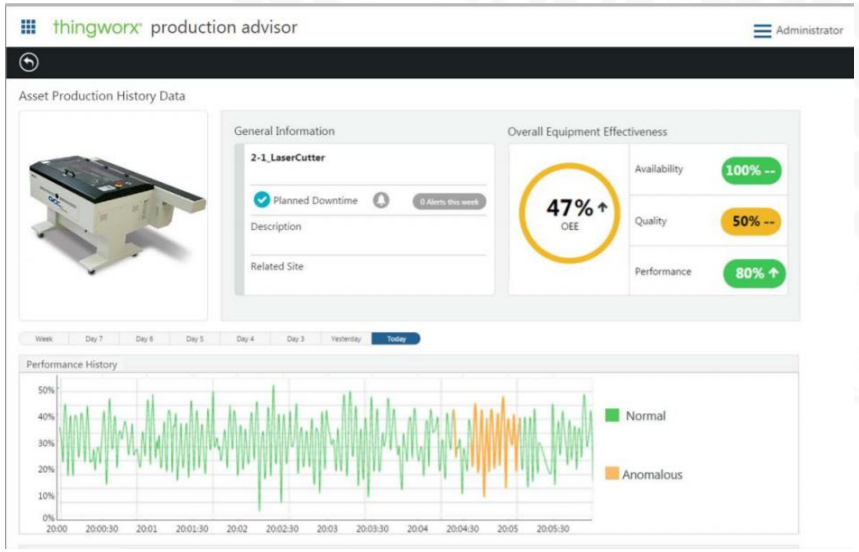
**MONITOR EQUIPMENT**




**MONITOR DATA SOURCES**

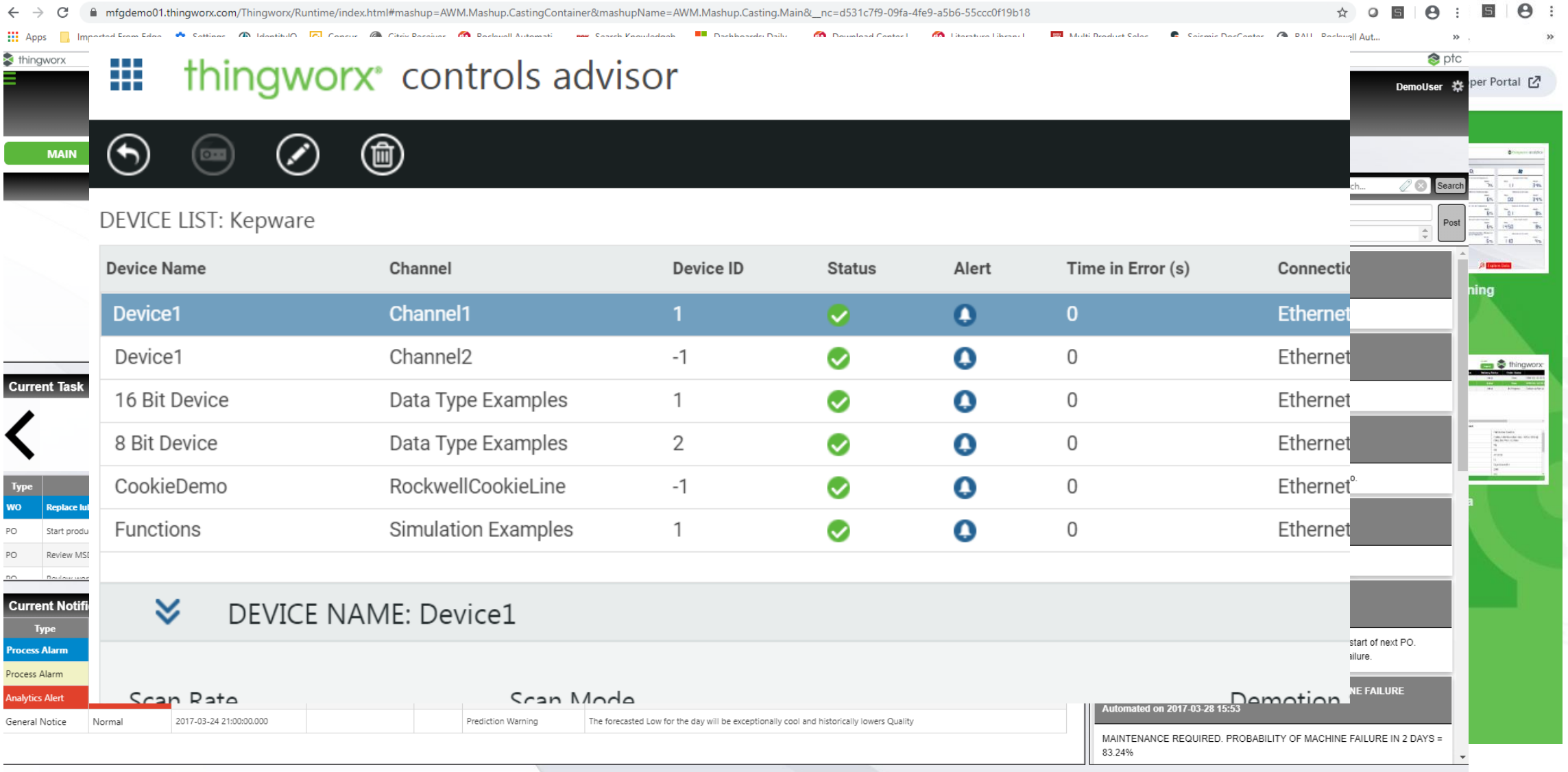



**MONITOR PRODUCTION**



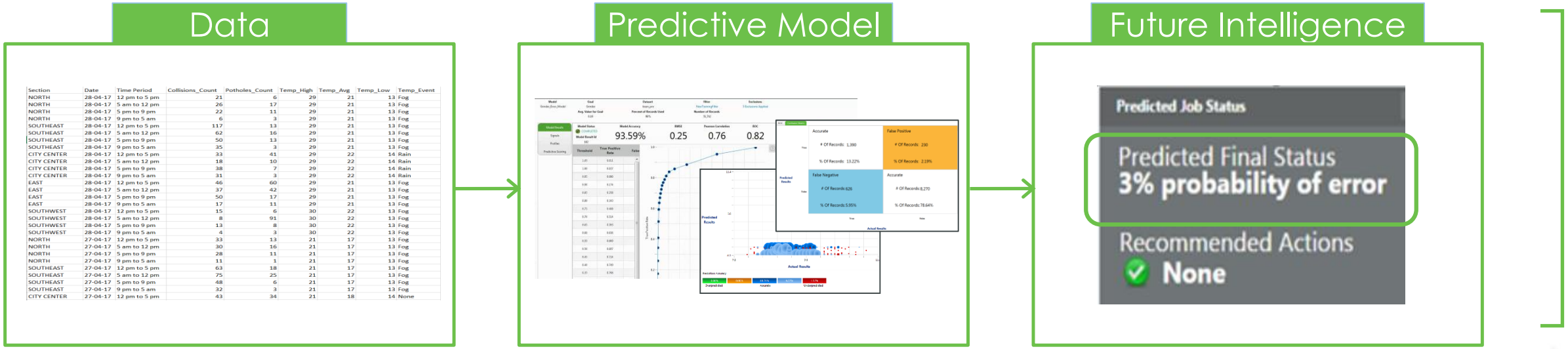
# The Prebuild Applications (by PTC)

- Can be then a part of their own Applications



# Apply Predictive Analytics on your data

- **ThingWorx analytics**




- Applies machine learning to historical data to make predictions about future outcomes
  - Rapid experimentation using a variety of learners
  - Automated ensembling of models
  - Automated handling of time series data
- Example Use Cases
  - Predict failures
  - Predict quality
  - Determine when service is needed
  - Predict sales, risk of churn

Available Learners:

- Linear Regression
- Logistic Regression
- Decision Tree
- Support Vector Machines
- Neural Network
- Random Forest
- Gradient Boost

Rockwell Automation

# Augmented Reality

# Usecases of Augmented Reality

## Augmented 3D Work Instructions

***Vuforia Studio***

- Efficient creation of scalable AR work instructions leveraging existing CAD
- Easily incorporate animated sequences
- Leverage IoT data to provide deeper situational understanding

## Augmented Training and Demonstration

***Vuforia Studio***

- Utilize 3D CAD models to provide interactive digital twins of physical assets
- Real-time, on-the-job training and upskilling for new or unfamiliar tasks
- Train in or out of context of physical product or equipment

## Augmented Expert Guidance

***Vuforia Expert Capture***

- Fast and easy creation of AR-enabled training and hands-on guidance
- No pre-existing assets required to create step-by-step instructions
- Efficient documentation of standards operating procedures

## Augmented Remote Assistance

***Vuforia Chalk App***

- Easy access to remote experts
- Leverage existing devices
- Annotate on shared  live view of environment

vuforia®

# vuforia®

## vuforia® studio™

**for Enterprise Content Creation**

Powerful AR content creation and publishing solution for industrial enterprises


## vuforia® chalk™

**for Remote Assistance**

Allows an expert to "see what I see" and annotate shared 3D workspace

## vuforia® expert capture™

**Rapid Expert knowledge capture**

Rapidly capture and transfer 1st person perspective expert knowledge


## vuforia® engine


**for Application Development**

Allows custom apps to "see" and places content in the world

Rockwell Automation

# Rockwell Analytics Solutions

# operate & maintain

InnovationSuite
powered by PTC

## IIoT

Market-leading industrial innovation platform to drive digital transformation for **increased operational performance and agility across all factories**

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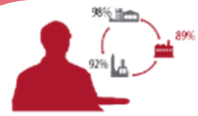
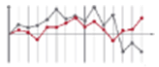
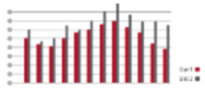
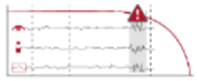
Solve complex analytics, AI and machine learning problems. Scalable from on-premise server to cloud based infrastructures. **Handles big data and unstructured data such as text, imagery, audio, etc.**

# Scalable Analytics Landscape

Who's the key stakeholder and why is information valuable to achieving theirs goals?

PlantPAx® MPC
FactoryTalk® Analytics
PAVILION8 for Devices

| | DESCRIPTIVE | DIAGNOSTIC | PREDICTIVE | PRESCRIPTIVE |
|---|---|---|---|---|
| ENTERPRISE |  Which facility performed the best? |  Why is Site A throughput behind plan? |  I predict that Site A will be behind plan soon. |  What action should I take to avoid Site A from falling behind plan? |
| 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? |

DataFlowML

Value Prop
Train and execute models
Use open source algorithms
Operationalize ML models (sec)

Target Audience
IT / Data Scientist

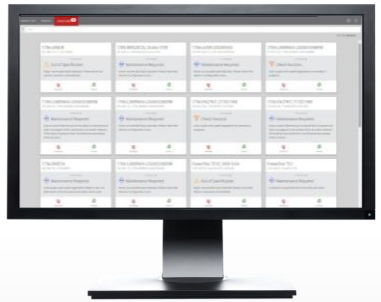
Data Source Targets
Data warehouse


SCALABLE
SOLUTIONS
ARE KEY

Rockwell Automation

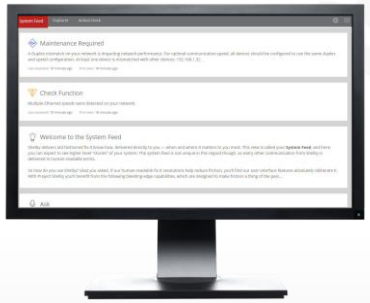

# FT Analytics for Devices

# FactoryTalk® Analytics for Devices

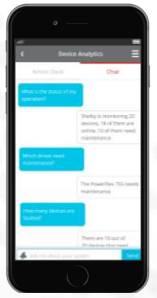


Action Cards

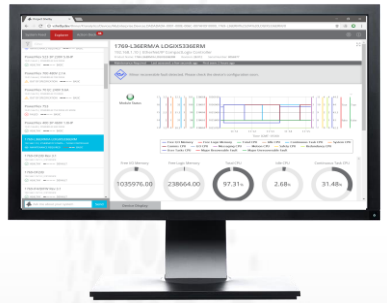
Mobile Action Cards



System Feed



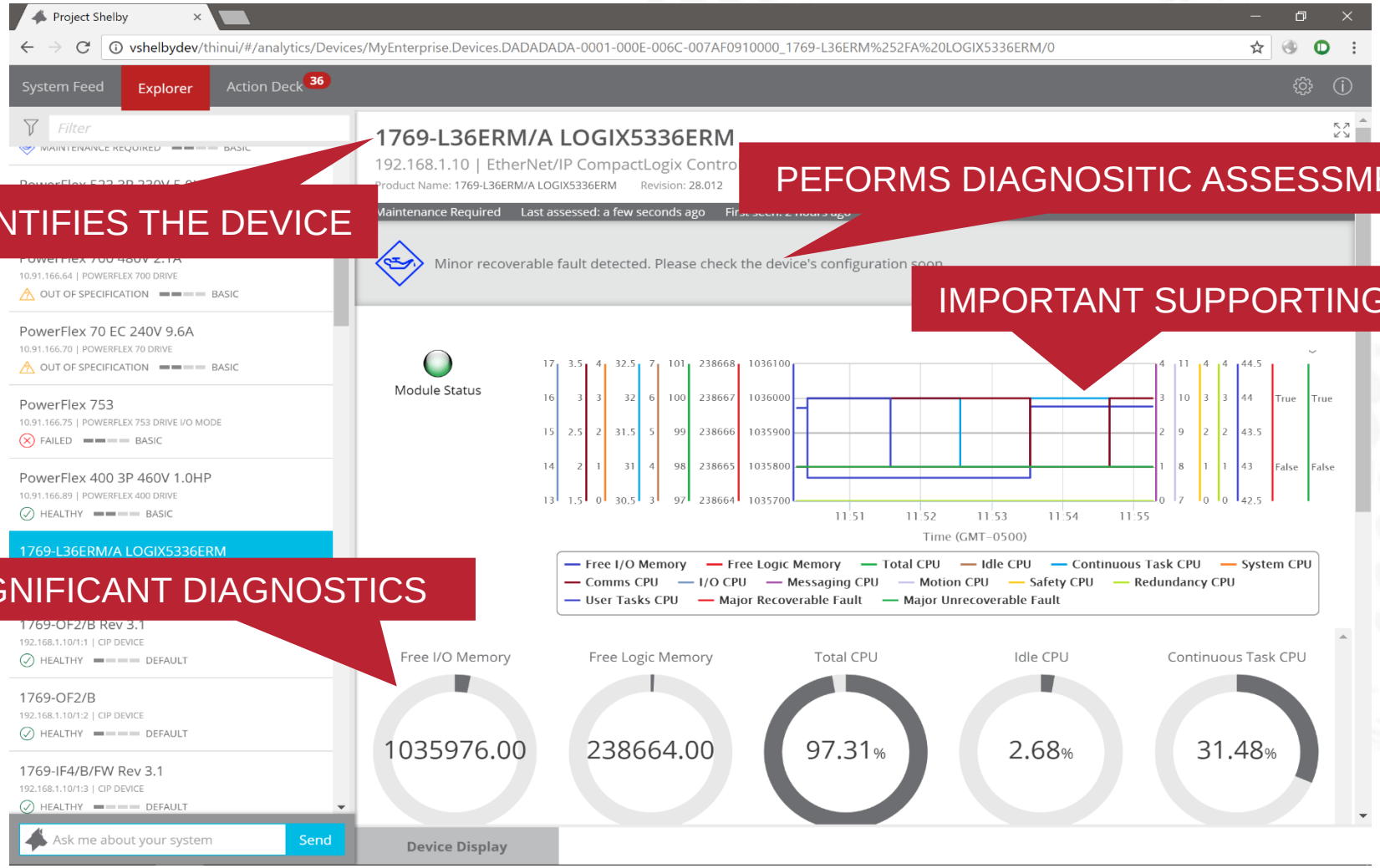
Chat



Automatically Created Dashboards

ALL DONE AUTOMATICALLY!

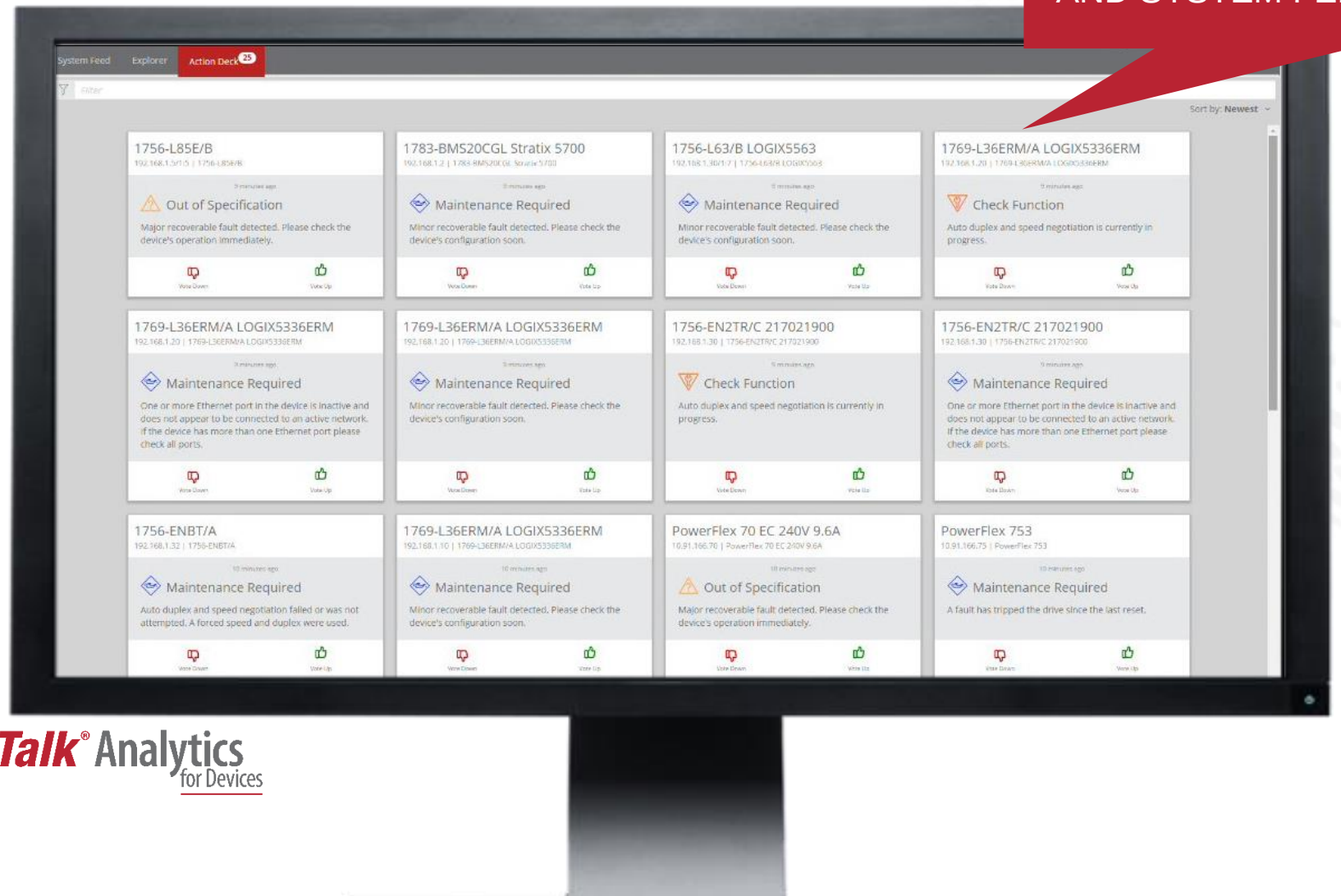
# DASHBOARDS

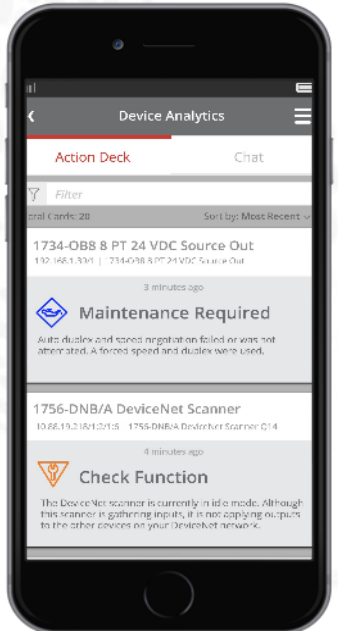



FactoryTalk® Analytics for Devices

# ACTION CARDS

DELIVERED WHEN SOMETHING OCCURS AND SYSTEM FEELS ACTION IS REQUIRED



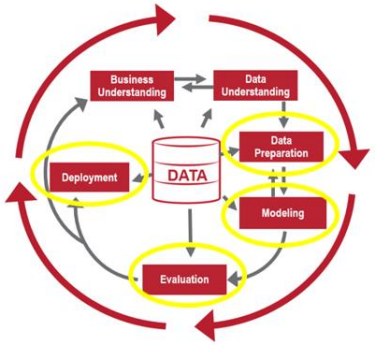

FactoryTalk® Analytics for Devices

Rockwell Automation


# Logix AI

LogixAI

FactoryTalk Analytics





Train the model using Studio5000

Configure

Identify data

Model

Monitor

Integrate

EMPOWER CONTROLS ENGINEERS WITHOUT DATA SCIENCE SKILLSET

**Automated Machine Learning Modeling for CLX Tags as Primary Data Source**

# AID 1089453 – Basic sampling guidelines for LogixAI

**Is FactoryTalk LogixAI right for my application?**

- Pre-qualification guidelines for LogixAI
- Identifying applications that can benefit from LogixAI
- Defining the “Variable-of-Interest”
- Identifying “good” data for LogixAI

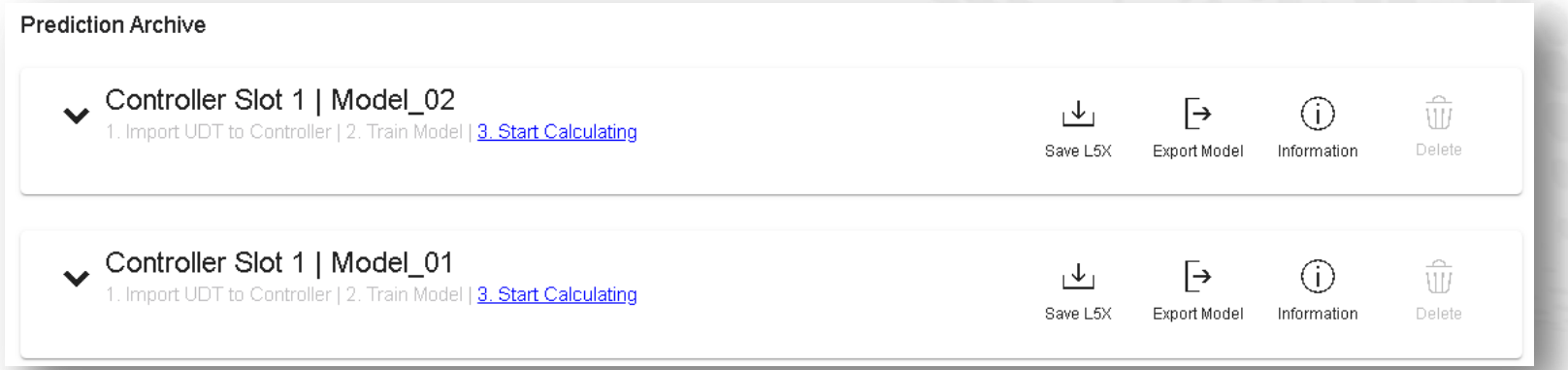
**How do I prepare data samples for LogixAI?**

- Using historical data
- Collection intervals
- Datasets
- LogixAI variable types

**Basic sampling guidelines for FactoryTalk Analytics LogixAI**

1089453 | Access Level: TechConnect | Date Created: 08/21/2019 | Last Updated: 12/12/2019

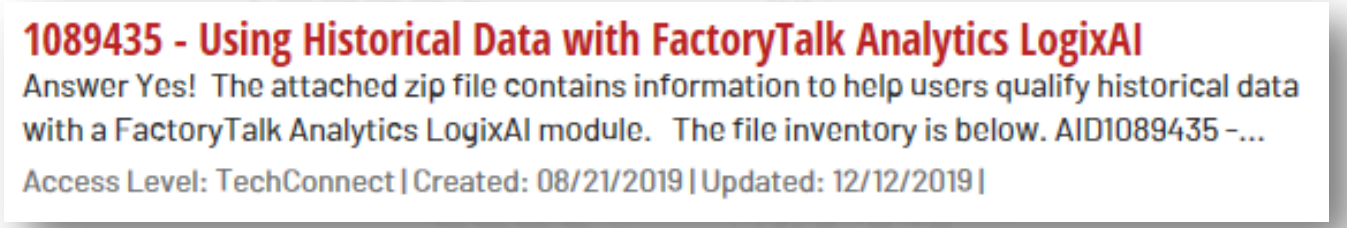
Answer: Pre-Qualification Guidelines for FactoryTalk Analytics LogixAI It is possible to work with FactoryTalk Analytics LogixAI and historical data sets to pre-qualify the potential for automated...

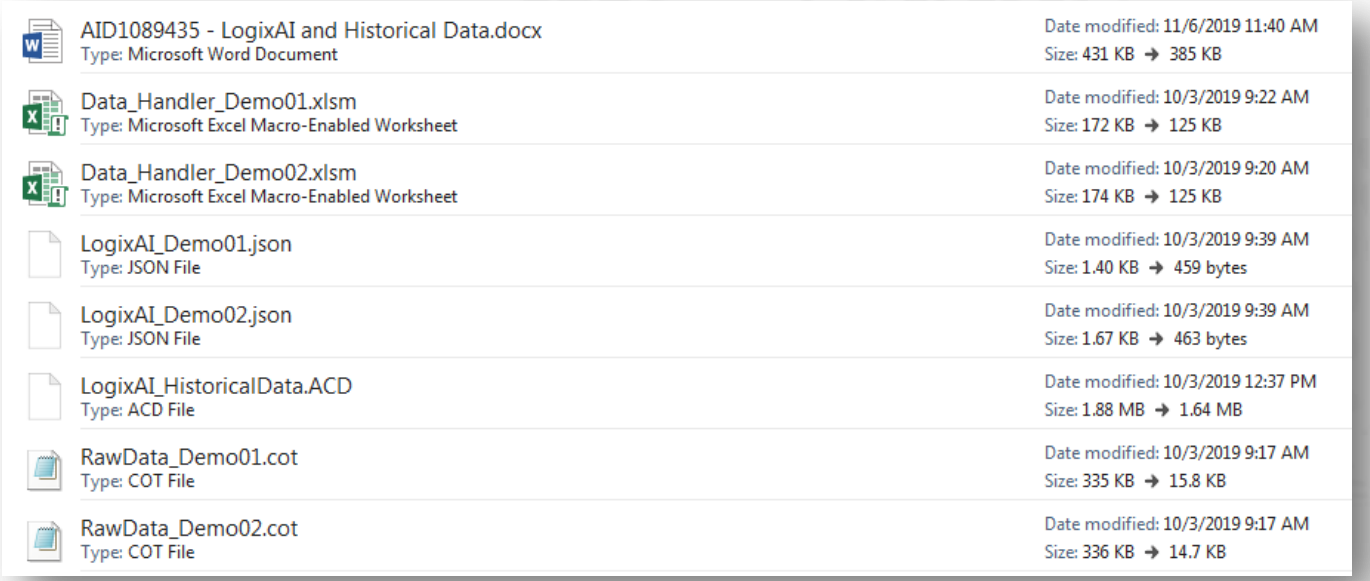


# AID 1089435 – Using Historical Data with LogixAI

**This AID provides sample code and a procedure for using historical data to qualify a given dataset with LogixAI**

- Contains all sample code for two examples
- Sample code can be manipulated for specific use cases
- Procedure provides step by step instructions for using sample code
- Solution utilizes the free Logix Tag Upload Download Tool (PCDC, search “Studio 5000 Tools”)
- ACD file includes sample code for “auto train” and “auto calculate”



# Understanding two common modes of operation

## Value Estimation (Virtual Sensing) vs. Anomaly Detection

### What is a soft sensor ?

**Physical sensor:** a device that converts the state of an observed physical quantity into a usable quantity
**Physical sensor:** the speed measurement of a car into a display on the dashboard for the driver

**Soft sensor:** it estimates a quantity indirectly using for ex. measurable quantities for a low cost or dynamic model of observed system
To sum up, the **soft sensor is a software program** which estimates a physical quantity using information from other sensors instead of measuring it directly.

**Concrete examples:**

**Estimation of efforts between tire and road:**
What for: trajectory control (ESP, ABS …)
Physical sensor: it exists but is expensive (a dynamometric wheel costs more than €100k)
Soft sensor: uses other measurements easier to access (tire deformation, speed, vibrations …)

**Tire pressure estimation:**
What for: detect flat tire, under-inflation …
Physical sensor: classical pressure sensor (one on each tire)
Soft sensor: use the tire deformation measure (flattening) or speed differentials between wheels

# Understanding two common modes of operation

## Value Estimation (Virtual Sensing) vs. Anomaly Detection

| • Good Use Cases | • Operational Mode |
|---|---|
| • Predict paper roll diameter before a cut in order to position blade optimally | • Value Estimation – “Virtual Sensing” |
| • Anomalies in input ingredient flow to identify quality variation | • Anomaly Detection |
| • Predict vibration levels to optimize the crushing force needed in a mining operation | • Value Estimation – “Virtual Sensing” |

LogixAI
FactoryTalk Analytics

1 Define Prediction — 2 Assign Tags — 3 Review — 4 Finish

# 1. Define Prediction

Select Prediction Creation Method

- (●) Create New Prediction (this will create a new model)
- ( ) Add New Prediction to existing Model

Enter model name *
MyModel

Controller Slot
1

Project: PumpDemo
Type: 1756-L75/B_LOGIX5575

Select the process you want to predict. You can manually build your own, or you can build using a process tutorial, which will guide you through creating a common prediction.

Build your own

Manual

OR

Build using process tutorial

Boiler

Generator

Pump

Select Prediction Type

- (●) Operation Monitoring

Select this option if you want LogixAI™ to predict anomalies against a baseline. (Example: Quality deviations, Process changes)

- ( ) Value Estimation

Select this option if you want to estimate a value (Ex. Soft sensor).

Rockwell Automation

# FT Analytics Platform

InnovationSuite
powered by PTC

# FactoryTalk® Analytics Platform

A full stack analytics platform

CONNECTED ASSETS

DATA INGRESS

STREAMING DATA

ENTERPRISE DATA

DATA MASHING

ORCHESTRATED DATA

DATA STAGING

OPEN, SECURE

IIoT CONNECTIVTY

APP MARKETPLACE

ASSET MANAGEMENT & RELIABILITY

OPERATIONAL PRODUCTIVITY

ENTERPRISE RISK

CONNECTED SERVICES

Edge

FactoryTalk® Analytics

DataFlowML

FactoryTalk® Analytics

DataView

FactoryTalk® Analytics

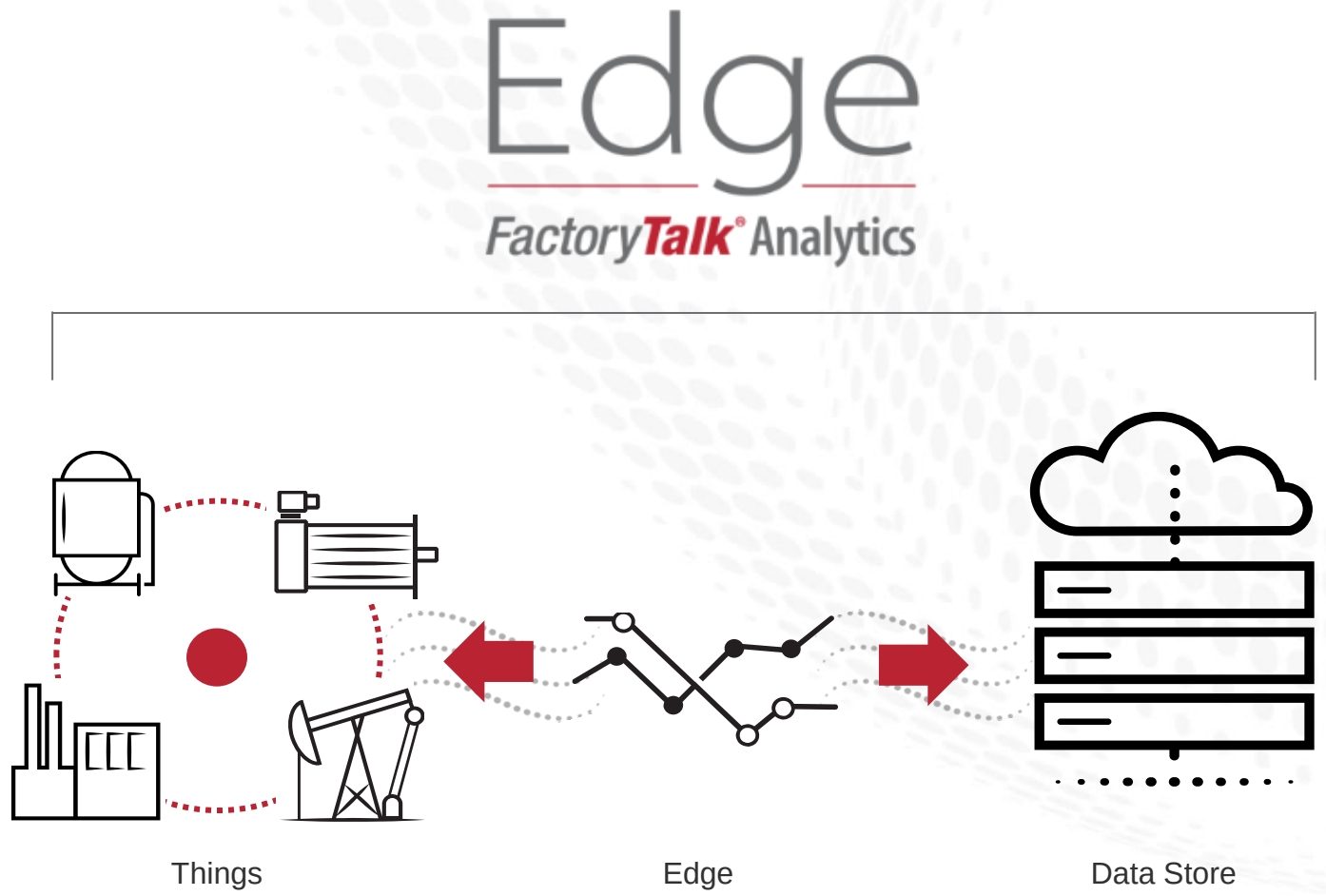
# Edge

## FactoryTalk® Analytics

Edge
FactoryTalk® Analytics

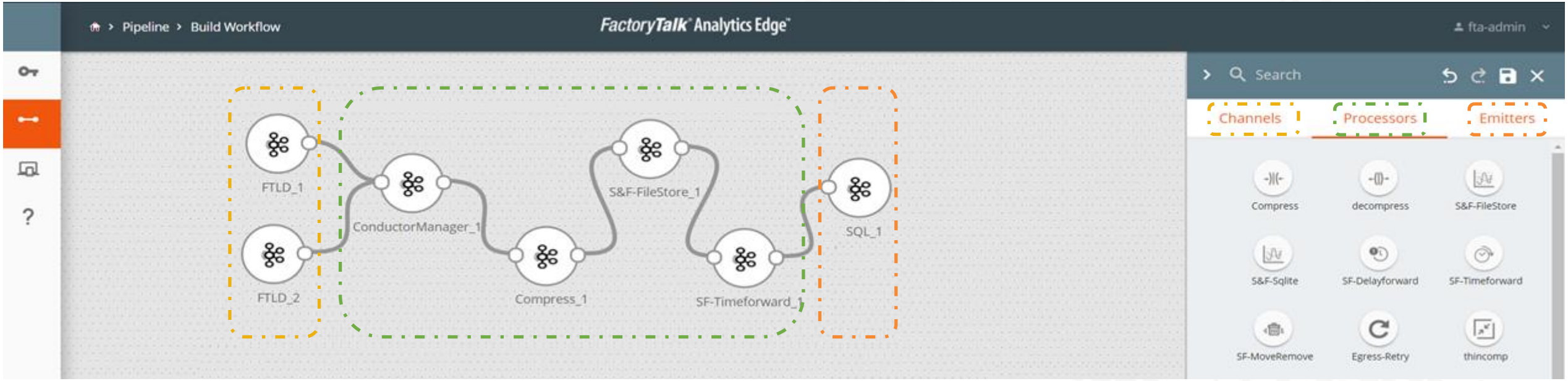
## Features

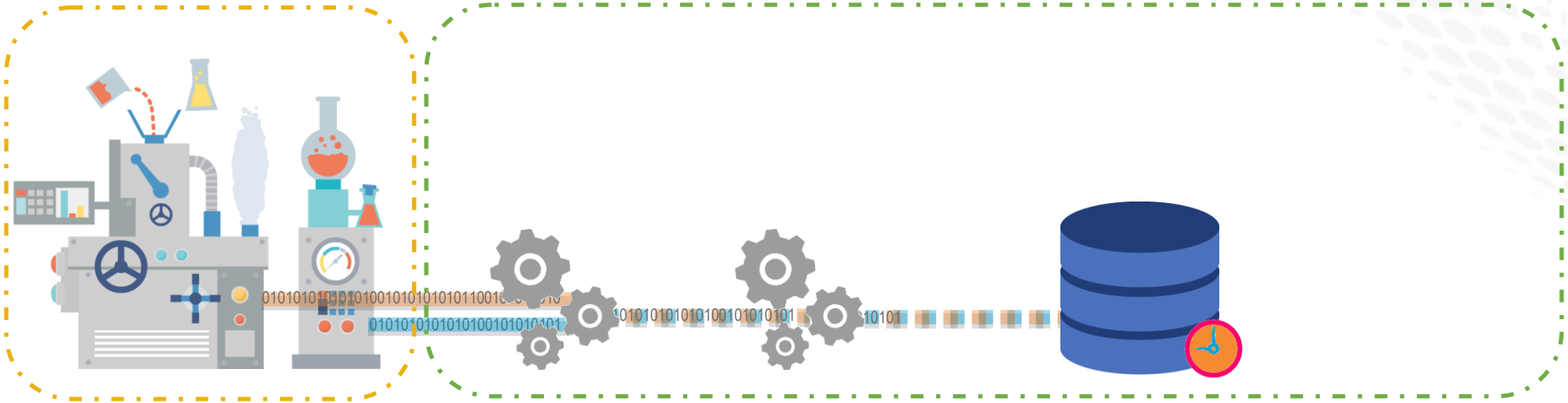
- Accessing the data in your intelligent devices
- Pre-process data for effective analytics
- Enable bi-directional transactional type data
- Execute closed loop edge level machine learning
- Allow the development of custom applications and connectors
- Intuitive on-Premise and remote device management




**Expert Driven Machine Learning**

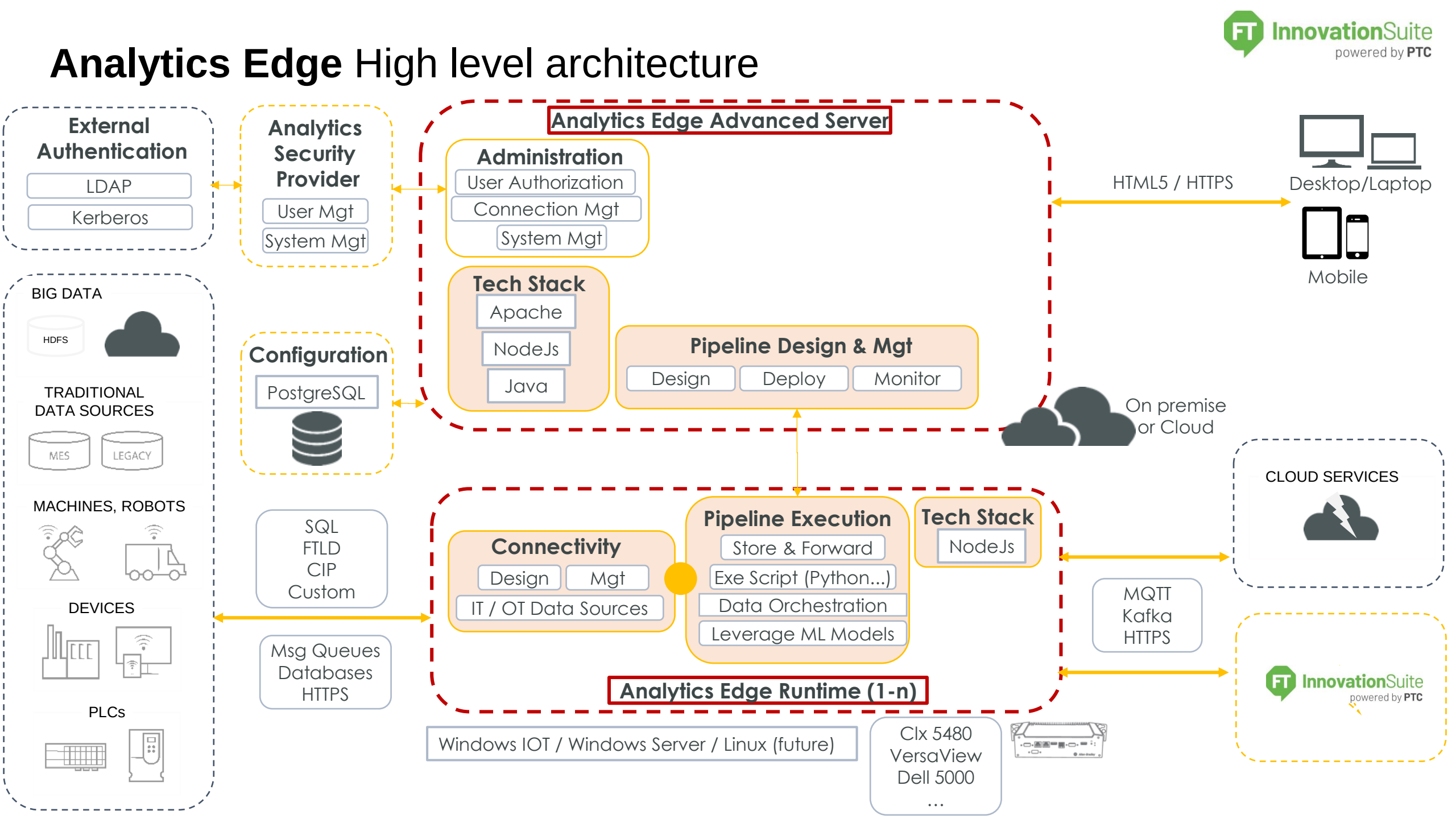
# Edge


Pipeline
Build Workflow
FactoryTalk Analytics Edge
fta-admin
FTLD_1
FTLD_2
ConductorManager_1
Compress_1
S&F-FileStore_1
SF-Timeforward_1
SQL_1
Search
Channels
Processors
Emitters
Compress
decompress
S&F-FileStore
S&F-Sqlite
SF-Delayforward
SF-Timeforward
SF-MoveRemove
Egress-Retry
thincomp




Microsoft
SQL Server

# **Analytics Edge** High level architecture



# Customer Use Cases

Process - I have temperature, pressure and flow rate available in a PLC.

On any change of temperature above 0.5 degrees, I would like to record temperature, pressure and 30 sample moving average of flow rate data and send to end point.

Oil & Gas - I have a stream of flow rate information from a pipeline.

When the flow rate value is an anomaly (based on a Machine Learning algorithm), I want to send an alert with the value and time stamp information to operator, or write the score back to the controller to adjust operations within the response horizon.

# **Edge Deployments** High level data flow

InnovationSuite powered by PTC

On premise or Cloud

CLOUD SERVICES

TRADITIONAL DATA SOURCES

MES

LEGACY

**Edge Adv Srv**

Pipeline Mgt & Development

HTML5 / HTTPS

Desktop/Laptop

Mobile

**Edge Runtime**

Pipeline Exec

Execute ML

Orchestrate

**Edge Runtime**

Pipeline Exec

Execute ML

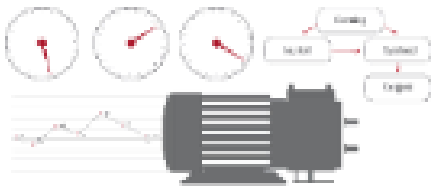
Orchestrate

**Edge Runtime**

Pipeline Exec

Execute ML

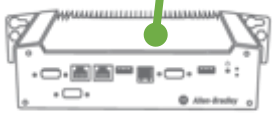
Orchestrate



Machine / Equipment

Compute Module

Line / Equipment Group



Appliance

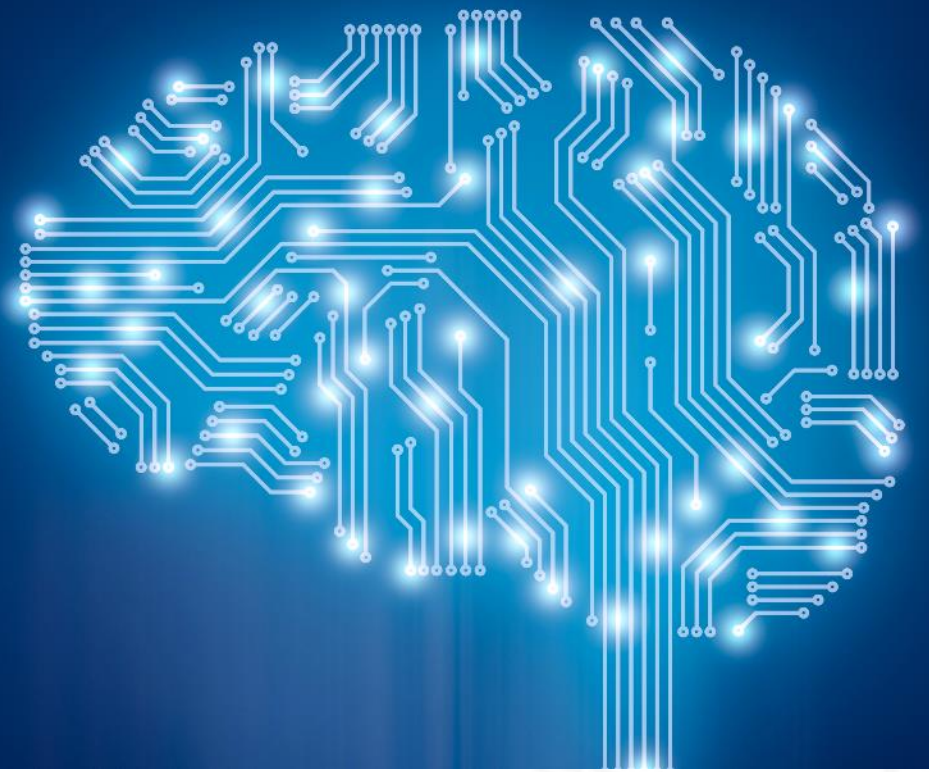
Plant / Area

Server


Edge
FactoryTalk® Analytics
DEMO

# DataFlowML

FactoryTalk® Analytics

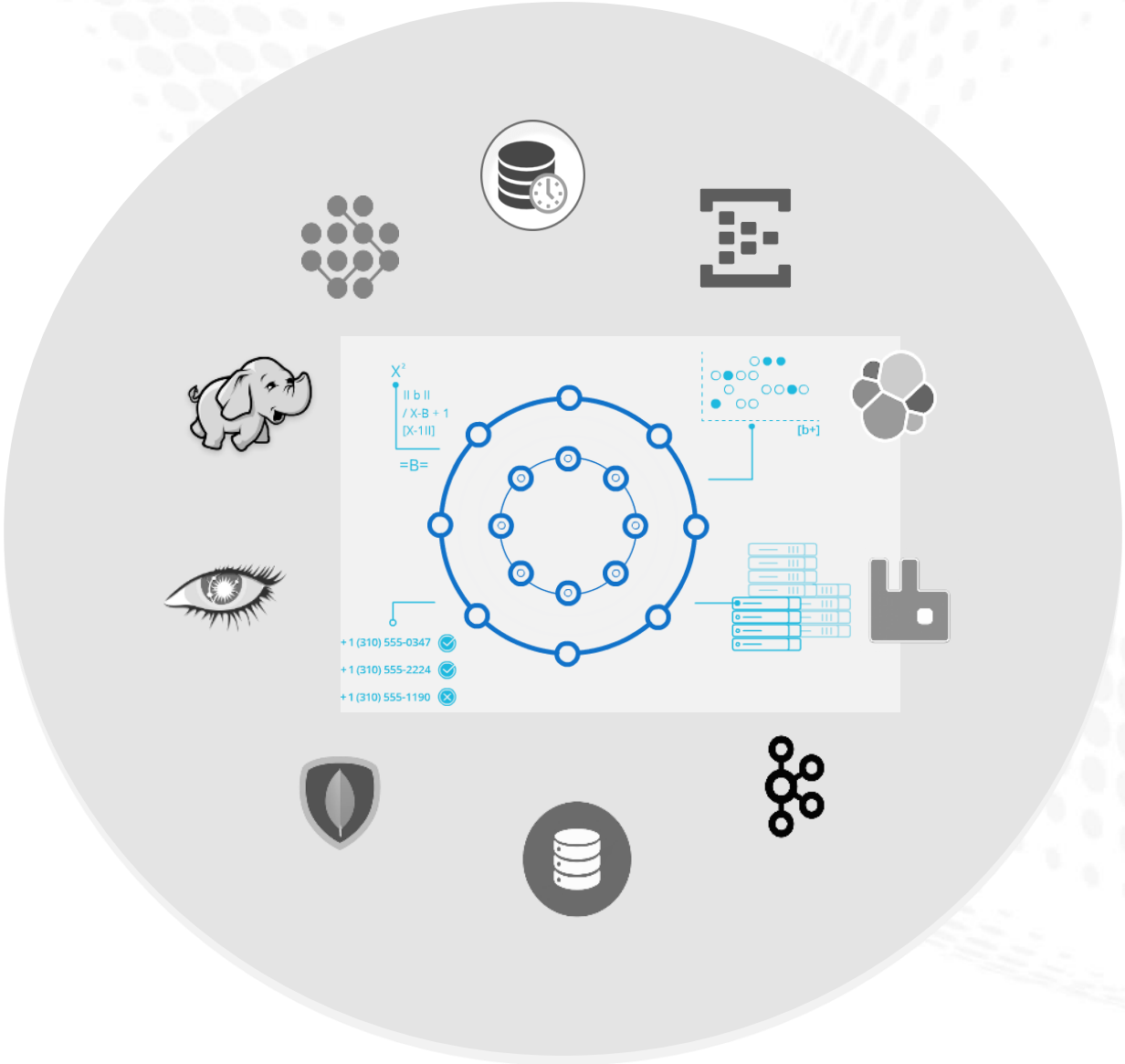


# DataFlowML

FactoryTalk® Analytics

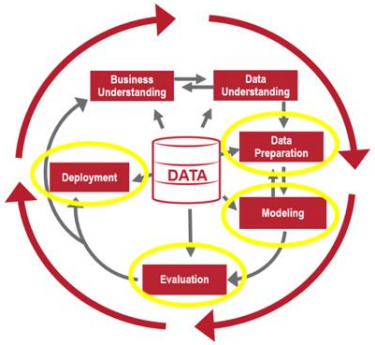
## Features

- Connect multiple types of complex machine learning models with the data from your intelligence assets
- Process data to be executed in machine learning models
- Score models to ensure accuracy
- Reuse models across your enterprise
- Connect model results with multiple applications
- Close the loop with your control system



# DataFlowML

FactoryTalk® Analytics




- DataFlowML **requires expert level data science skill set to implement.**
- DataFlowML works with ***huge*** **amounts of data and requires major IT infrastructure**, like Hadoop.
- Winning will require high level technical interactions with IT and Data Science experts.
- The best guidance we can give you is when you uncover an opportunity, find out as much as possible regarding; the use case, funding and key stakeholders from your champion. With the details, contact the Information Software Sales Executive team to gain support win strategy.

**Expert Driven Machine Learning**


DataView
FactoryTalk® Analytics

DataView

FactoryTalk Analytics

## VALUE PROPOSTION

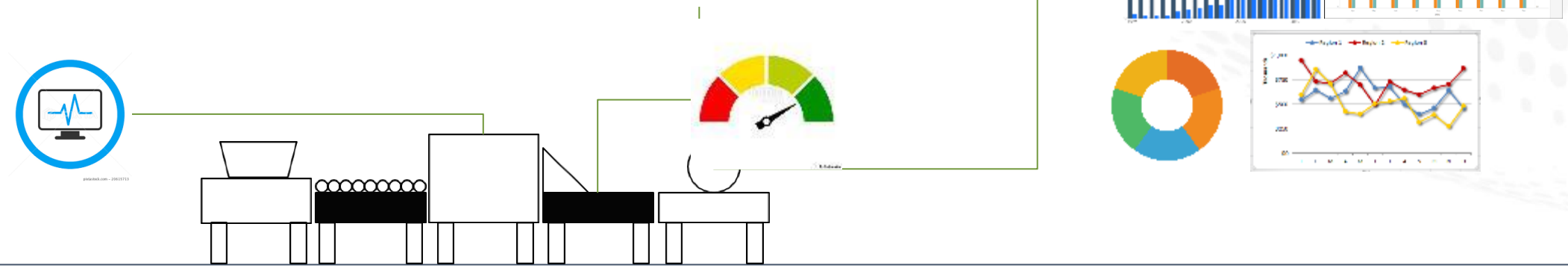
- BI tool with strong focus on manufacturing data connectivity
- Eliminate the need for expensive infrastructure associated with traditional warehousing
- Reduces time to value by reducing dependence on data architects and data scientists, which allows the users to interact and explore data in a self service manner
- Enable business users for self service analytics

## CAPABILITIES

- Easily fuse data together without relying on an IT workflow
- Eliminate the need for a complex data schema
- Find relationships in data
- Self-service storyboards
- Easily share data relationships with others within an organization
- Mobility, Collaboration, Alerts and Notifications built in
- Built in Predictive Functions

## COMPETITIVE DIFFERENTIATOR

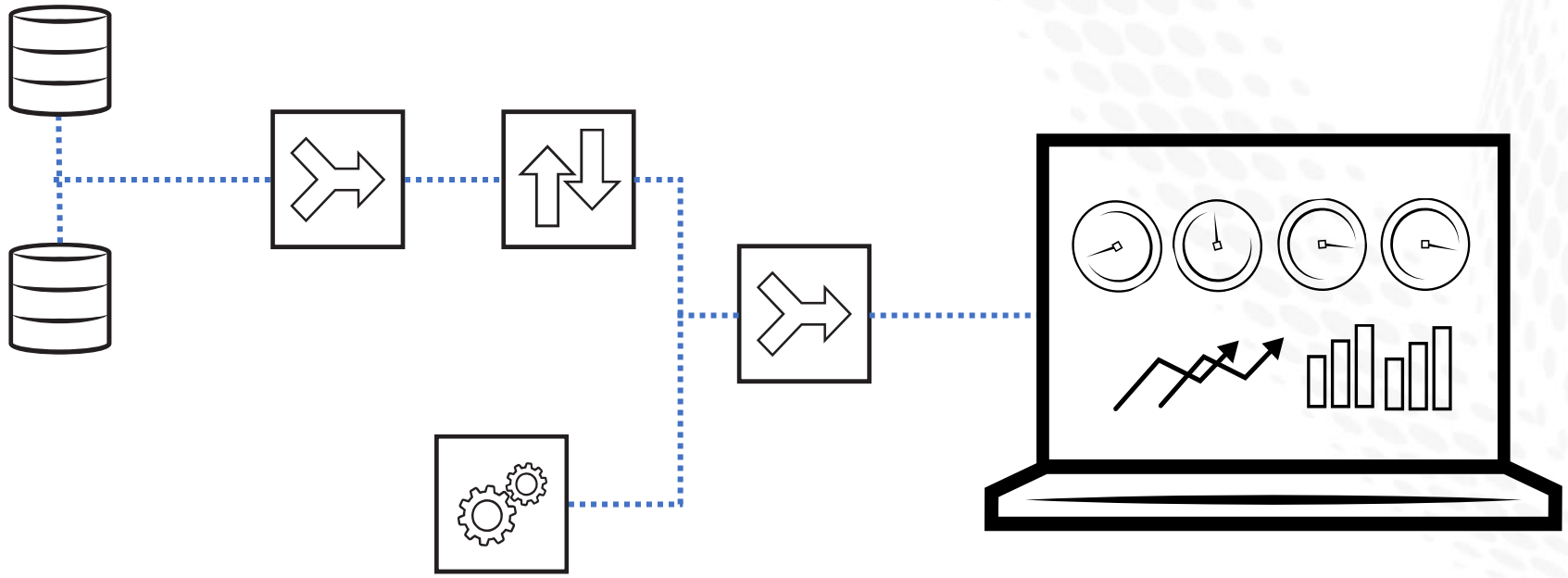
- Simple connectivity and Insights from manufacturing data
- Self service with end user persona
- Standard user interface for disparate data types & sources
- Cloud agnostic
- Persistence for streaming data with filtering and custom field options
- Unlimited direct queries against data sources
- Global Data Search



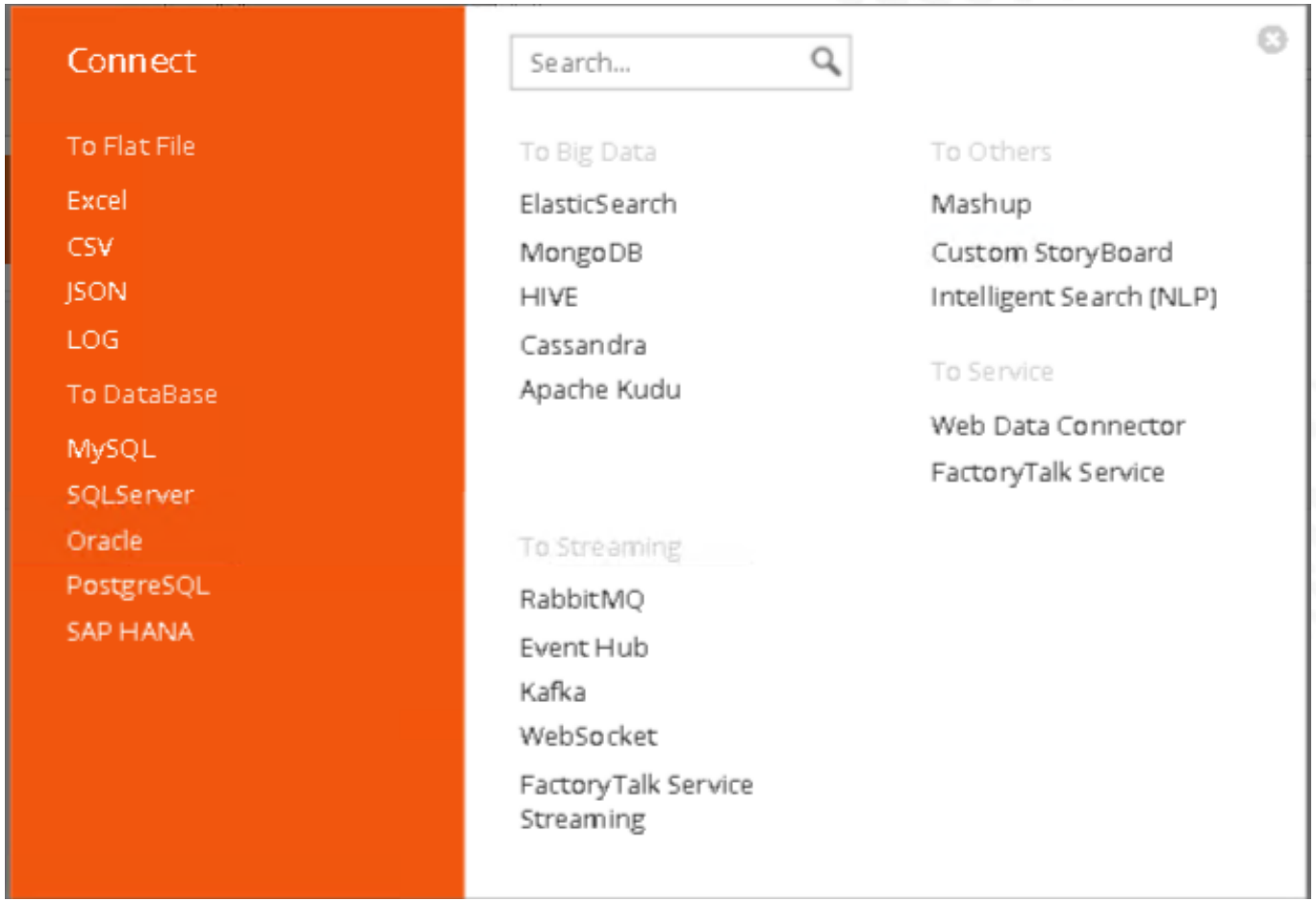
Rockwell Automation

# Product Features

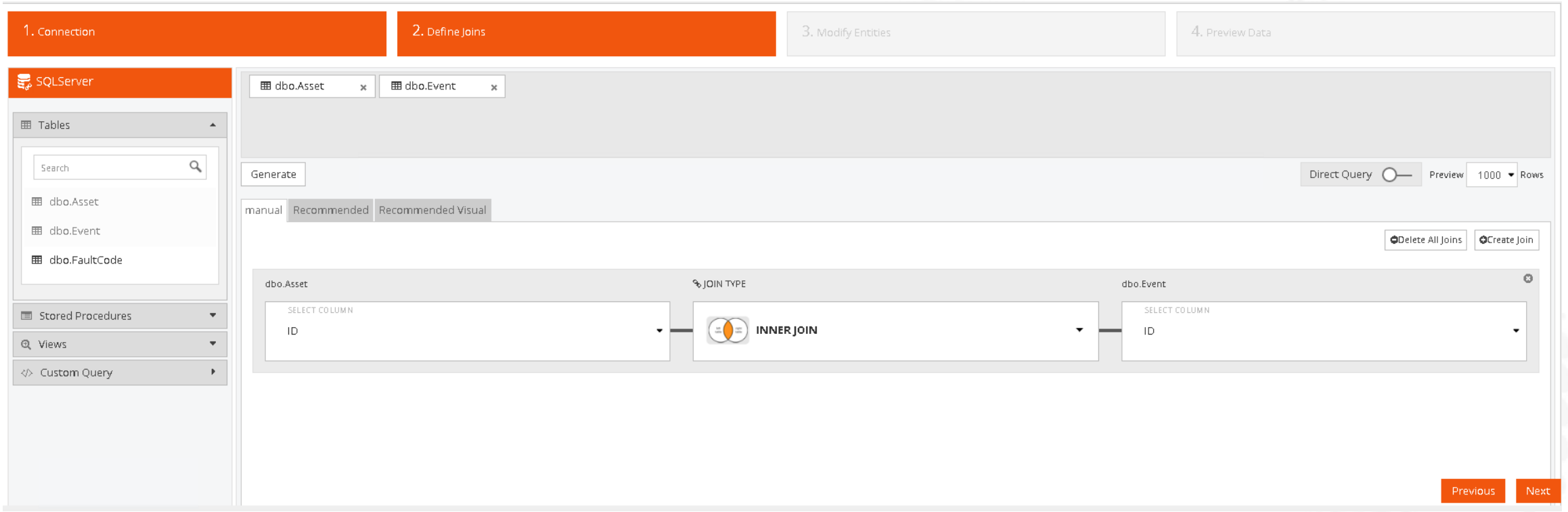
# DataView Workflow



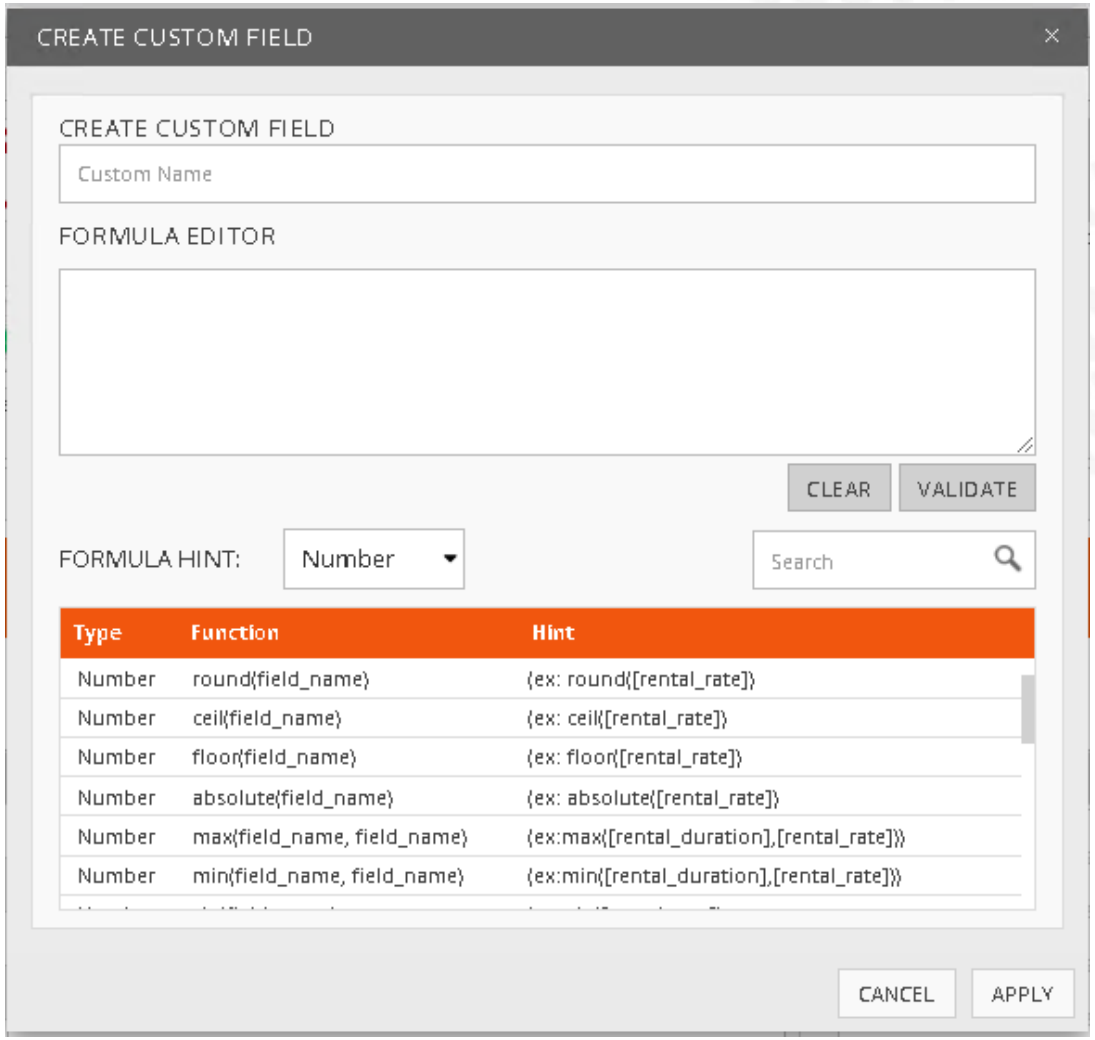
# Data Source Ingestion



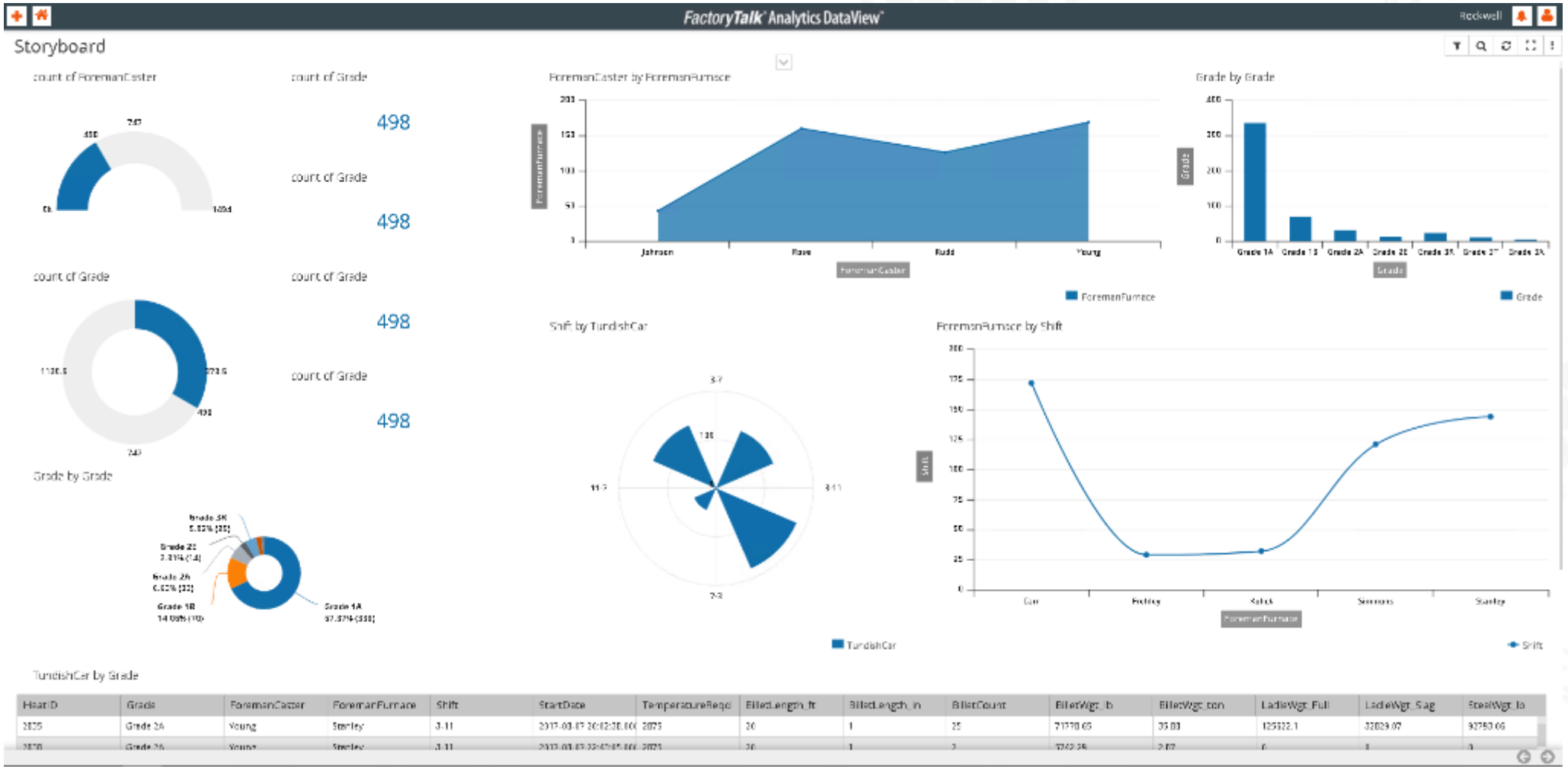
# Joining Data Sets



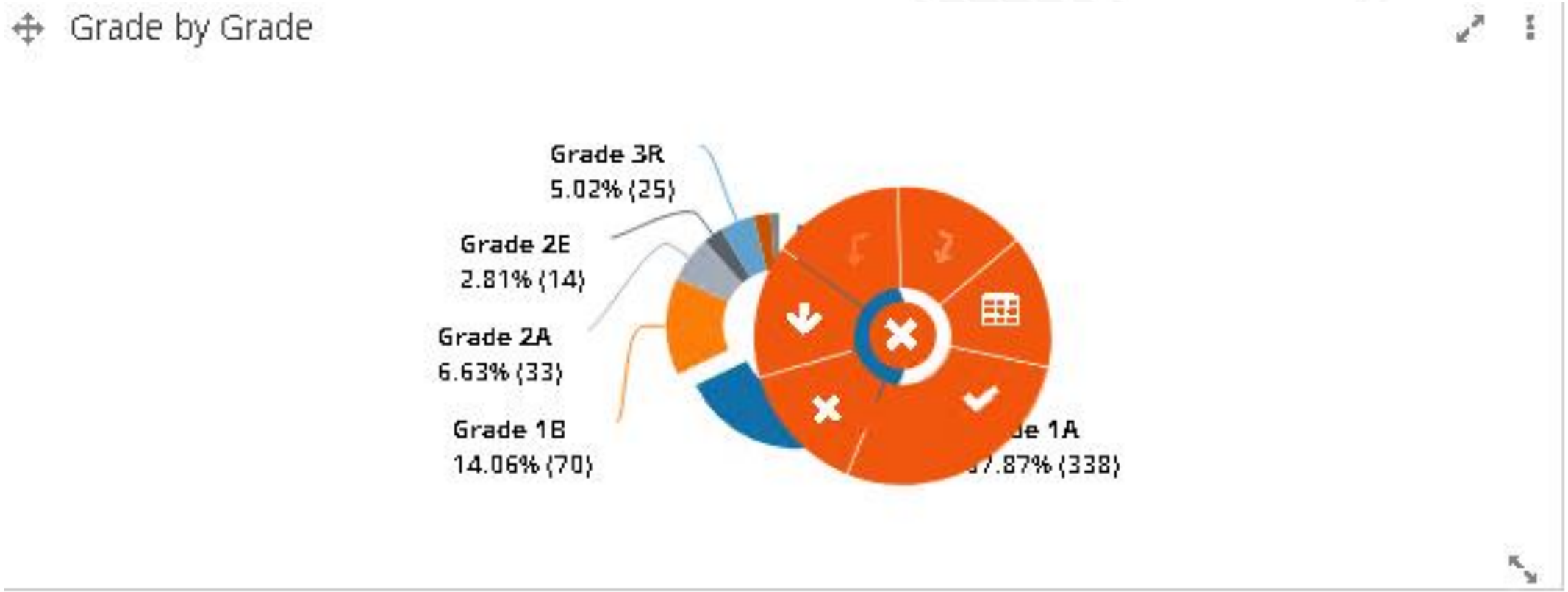
# Custom Fields



# Storyboards



# Filtering of Data



# **Analytics DataView** High level architecture

InnovationSuite powered by PTC

**External Authentication**
- LDAP
- Kerberos

**Analytics Security Provider**
- User Mgt
- System Mgt

**Analytics DataView**

**Administration**
- User Authorization
- Connection Mgt
- System Mgt

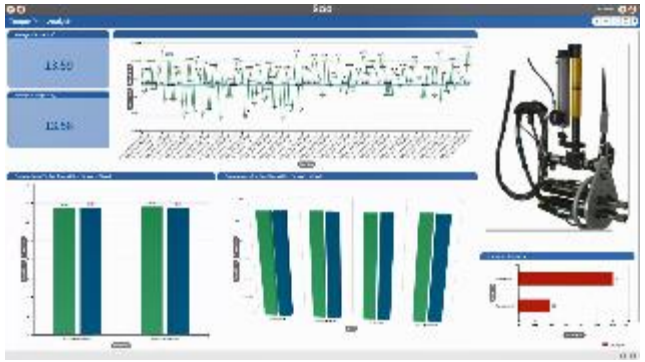
**Runtime**
- Apache Tomcat

HTML5 / HTTPS

Desktop/Laptop

Mobile

**Storyboard Consumer**
- Prediction
- Reporting
- Collaboration
- Drill Down
- UI
- Notification
- Filters
- Intelligent Search



**Configuration**
- PostgreSQL

**Data Store**
- ElasticSearch

**Storyboard Composer**
- Widgets
- UI Design
- Storyboard Management

**Data Ingress**
- Connect
- Schedule
- Manipulation
- Mashup

BIG DATA
- HDFS

TRADITIONAL DATA SOURCES
- MES
- LEGACY

MACHINES, ROBOTS

DEVICES

PLCs

Files
Msg Queues
Databases
Web Data
Azure IoT
Time Series

On premise or Cloud

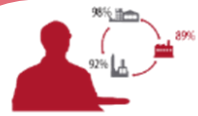
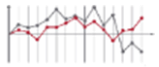
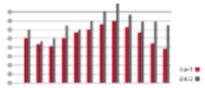
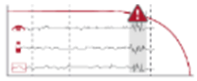
Windows Server


DataView
FactoryTalk® Analytics
DEMO

# Scalable Analytics Landscape

Who's the key stakeholder and why is information valuable to achieving theirs goals?

PlantPAx® MPC
FactoryTalk® Analytics
PAVILION8 for Devices

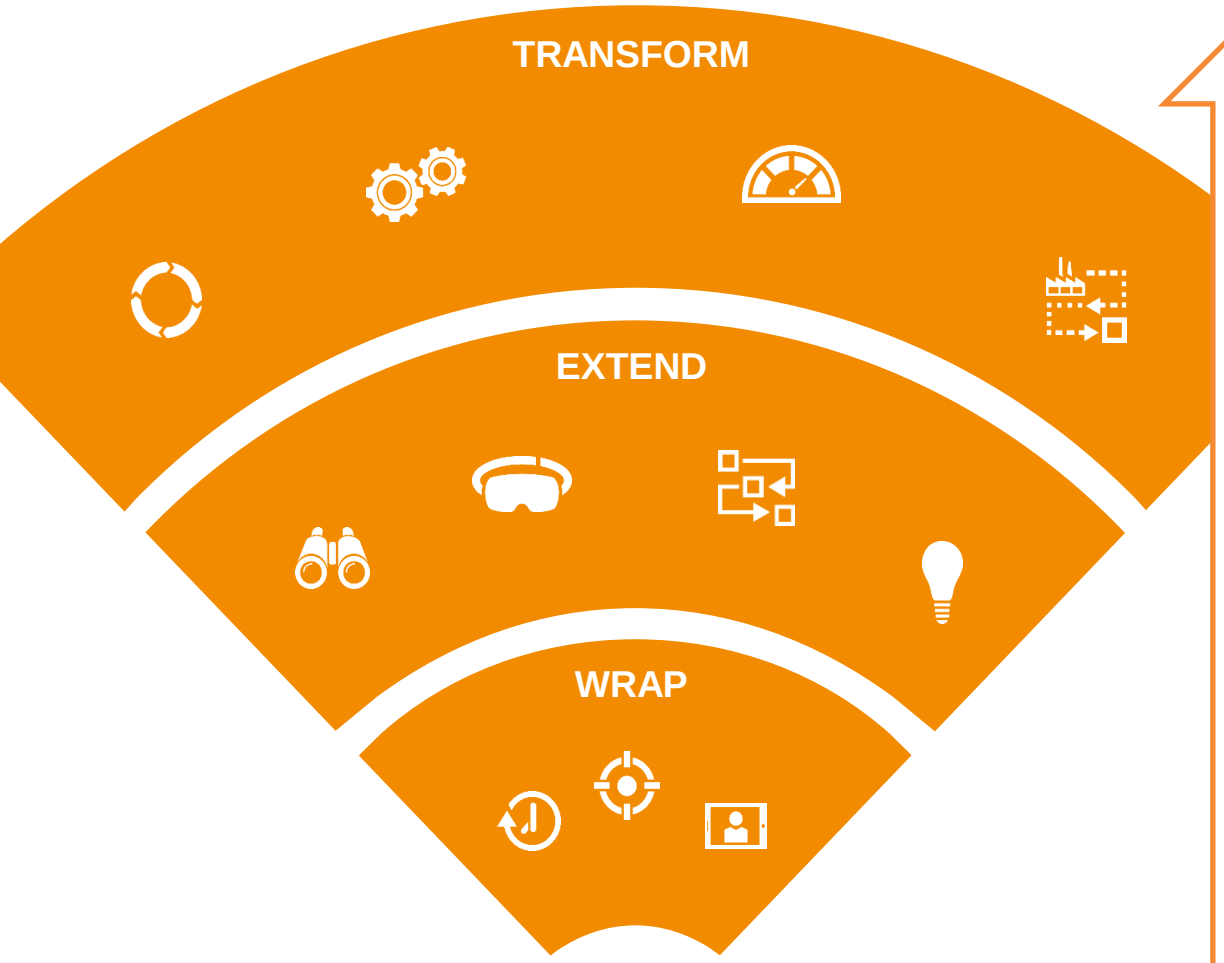
| | DESCRIPTIVE | DIAGNOSTIC | PREDICTIVE | PRESCRIPTIVE |
|---|---|---|---|---|
| ENTERPRISE |  Which facility performed the best? |  Why is Site A throughput behind plan? |  I predict that Site A will be behind plan soon. |  What action should I take to avoid Site A from falling behind plan? |
| SYSTEM |  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? |

DataFlowML

Value Prop
Train and execute models
Use open source algorithms
Operationalize ML models (sec)

Target Audience
IT / Data Scientist

Data Source Targets
Data warehouse





Digital Transformation Adoption Plan

TRANSFORM

EXTEND

WRAP

InnovationSuite powered by PTC

## ML

DataFlowML — FactoryTalk Analytics

thingworx analytics Edge — FactoryTalk Analytics

## AR

vuforia™

View
Chalk
Expert Capture
Engine

## Apps


## Analytics

DataView — FactoryTalk Analytics

## IoT Platform

thingworx®

Integrated Architecture, Connectivity, Network, Control, Security, Automation, Data Historization, Infrastructure…

FactoryTalk by ROCKWELL AUTOMATION

# HIGH-LEVEL IIoT USE CASES

## FASTER TIME TO MARKET

### Manufacturing Engineering

- BOM transformation
- Digital process planning
- **Factory Design**
- 3D work instruction authoring
- **Instruction authoring (AR)**

## OPERATIONAL PRODUCTIVITY

### Supply Chain & Logistics

- Smart tools
- Tools tracking
- Automated guided vehicles
- **Supplier visibility**
- **Remote operations**

### Operations Management

- **Real-time production monitoring**
- **OEE & performance metrics**
- **Process monitoring & improvement**
- **Process mgmt. / optimization**
- **Plant benchmarking**
- **Reduced energy usage**

### Production Execution

- **Production order management**
- **Genealogy / Traceability**
- **Labor tracking & shift mgmt.**
- **Paperless operations/EBR**
- **Standard work instruction**
- Unified workforce screen
- **Inventory & material mgmt.**

## ASSET MGMT. & RELIABILITY

### Maintenance & Service

- Real-time asset trending & troubleshooting
- **Asset tracking**
- Real-time alert & fault identification
- **Predictive and prescriptive analytics**
- Performance issues
- **Digital repair & service instruction**

## ENTERPRISE RISK

### Quality & Test

- **Real-time quality KPIs**
- Inline quality inspections (AR)
- Robotic inspection monitoring
- Testing monitoring & calibration

### Health, Environment & Safety

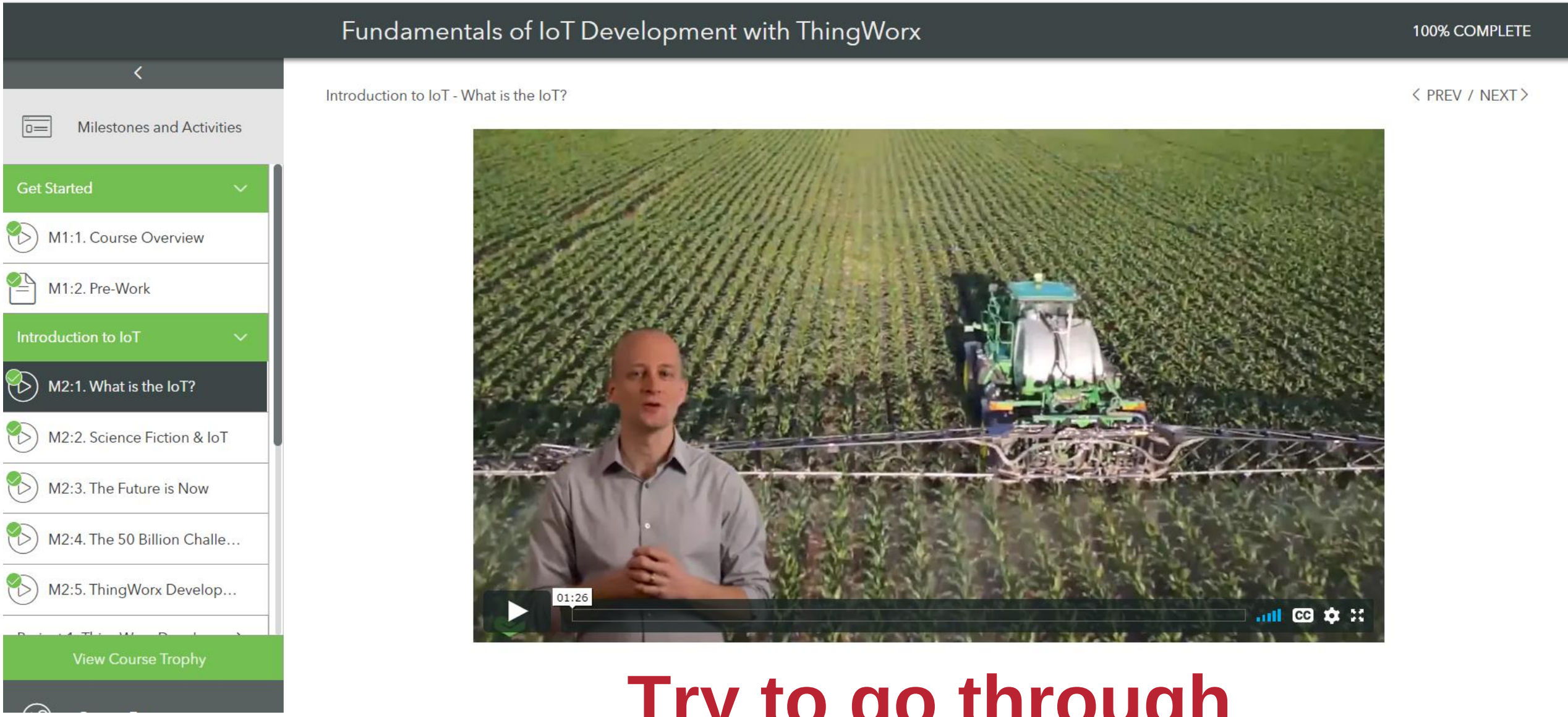
- Monitor operating conditions to alert anomaly or risk
- **Monitor & reduce safety events**
- Health, safety, & training procedures (AR)
- Flexible & adaptable workforce
- **Energy Mgmt.**

### IT/SCO

- Monitor security breaches
- IP protection
- Compliance Mgmt.

# PTC University

https://sso.ptcu.com/auth/realms/ptcusys/login-actions/authenticate?client_id=ptcu-prod&tab_id=Kx1wIqpA2wg




**Try to go through …**

Rockwell Automation

# Questions ?