Digitalization Themes in Mining

Mineral Traceability and Energy Efficiency

Trade Mission to Colorado School of Mines

September 2024

expanding **human possibility**®

Speaker Introduction & Topics

— Mineral Traceability: Rockwell Automation's solutions focused on the role of Process, Technology and Digitalization

— Energy Efficiency, Rockwell Automation´s solutions for monitoring, control, integration and optimization – FactoryTalk Data Mosaic & Model-based Predictive Control (MPC)

Tommy Mitchell
Global Principal – Process Industries
Rockwell Automation Digital

- 10 years consulting experience in operations, enterprise technology and data science
- BA – University of Colorado, Boulder, MBA-Pepperdine University
- Leads the Rockwell Digital Process Industry team that covers Mining, Metals & Cement, Energy, Oil & Gas, Chemicals, Wood Products, Water/Wastewater

Rockwell Automation **KALYPSO**

Contents

Rockwell Automation's Evolution

We continue to invest in **acquisitions and partnerships** to deliver our strategy for the Autonomous Enterprise.

Investments to enhance our Digital capabilities

More than **$3B**

Doubling our delivery capacity

Increased by **100%**

Co-innovation with industry leading technology companies

ACQUISITIONS

KALYPSO

Knowledge Lens
Accelerating Actionable Insights

PLEX
A ROCKWELL AUTOMATION COMPANY

ASEM

OTTO MOTORS

AVNET

EMULATE3D

fiix

AVATA

oylo Trust Engineering

MESTECH

VERVE
INDUSTRIAL PROTECTION

odos imaging

MagneMotion

CLEARPATH
ROBOTICS™

PARTNERSHIPS

Microsoft

NVIDIA

CISCO

accenture

Ansys

OpenAI

ptc

CLAROTY

aws

ORACLE

unity

COGNITE

KEZZLER

Endress+Hauser
People for Process Automation

SENSIA
Rockwell Automation + SLB

RA Rockwell Automation

KALYPSO

Rockwell Automation Digital Global Operating Model

Combining world-class resources with localized support

Belgium
Rockwell EMEA HQ

Milwaukee, WI
Rockwell Global Headquarters

Bucharest, RO
Kalypso Innovation Center

Pune, IN
Kalypso Innovation Center
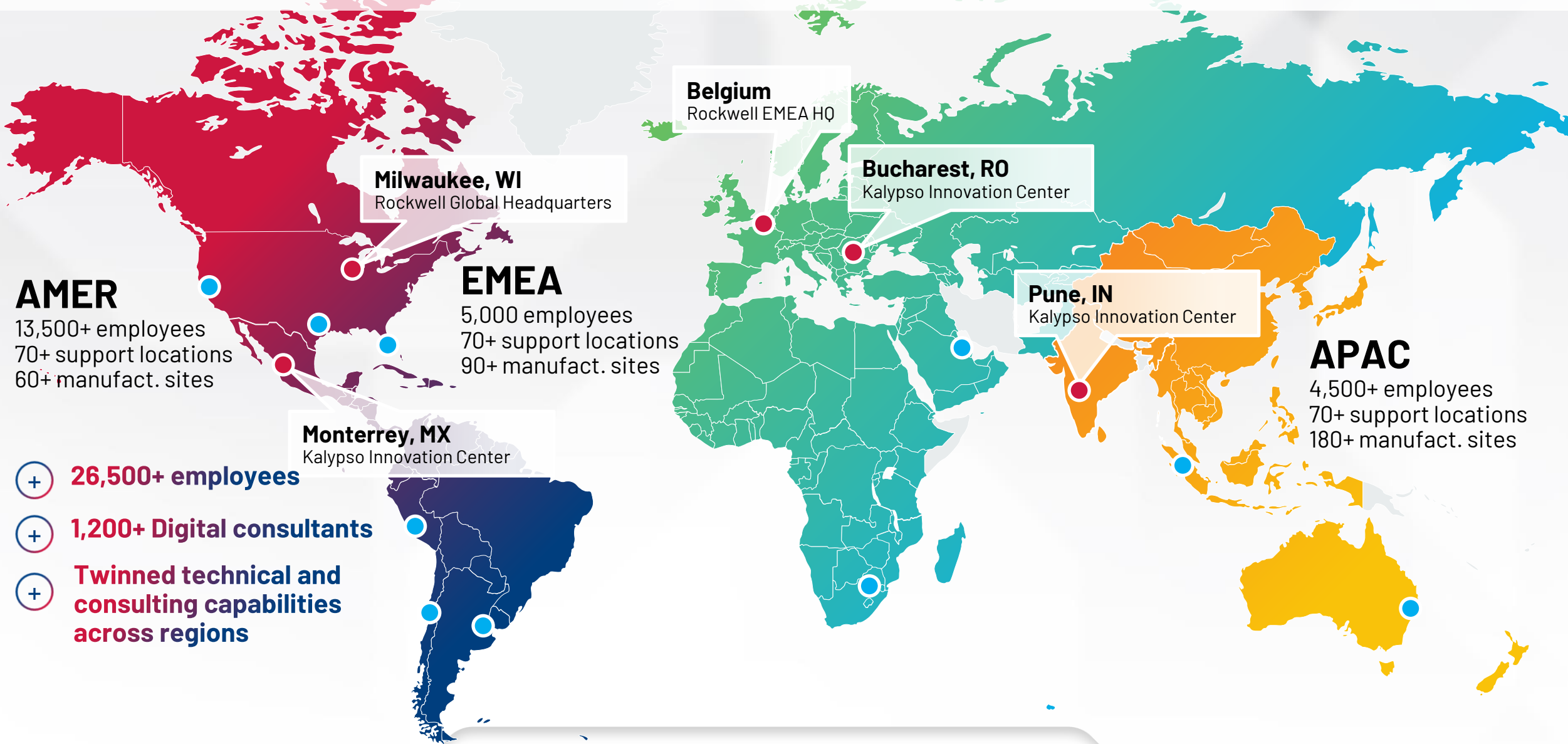
AMER
13,500+ employees
70+ support locations
60+ manufact. sites

EMEA
5,000 employees
70+ support locations
90+ manufact. sites

APAC
4,500+ employees
70+ support locations
180+ manufact. sites

Monterrey, MX
Kalypso Innovation Center

+ **26,500+ employees**

+ **1,200+ Digital consultants**

+ **Twinned technical and consulting capabilities across regions**

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Our commitment to the Mining industry globally

Rockwell Automation has a team dedicated to serving mining interests worldwide*

Sahil Datta
Industry Sales Manager – MMC, NA

Warren Ryberg
Regional Account Manager

Jonathan Hubert
Industry Sales Director – MMC, NA

Joseph Plant
Industry Consultant – Mining

Kumar Parekh
Principal – MMC

Jean-Emmanuel Hetier
Global Account Manager

Jelle Eijzinga
Strategic Account Manager

Paul McRoberts
Industry Consultant – Mining

Ana Mello
Director, Global Accounts

Chad Glover
Strategic Account Manager

Robert Walshaw
Global Account Manager

Syd Hosseini
Regional Account Manager

German Marcano
Country Manager – Peru & Bolivia

Alesio Lanzara
Sales Director, Digital Services – Process

Geoff Irvine
Global Account Manager

Juan Rivera
Regional Account Manager

Bruno de Cesar Olivera
Global Account Manager

Ricardo Rivera Estay
Large Capital Projects

Pablo Machado
Regional Account Manager

Leonardo Acevedo
Regional Account Manager

Illustrative example, additional mining-focused resources omitted for clarity

Contents

- Introduction to Overview of Rockwell Automation

» • Mining Industry Themes
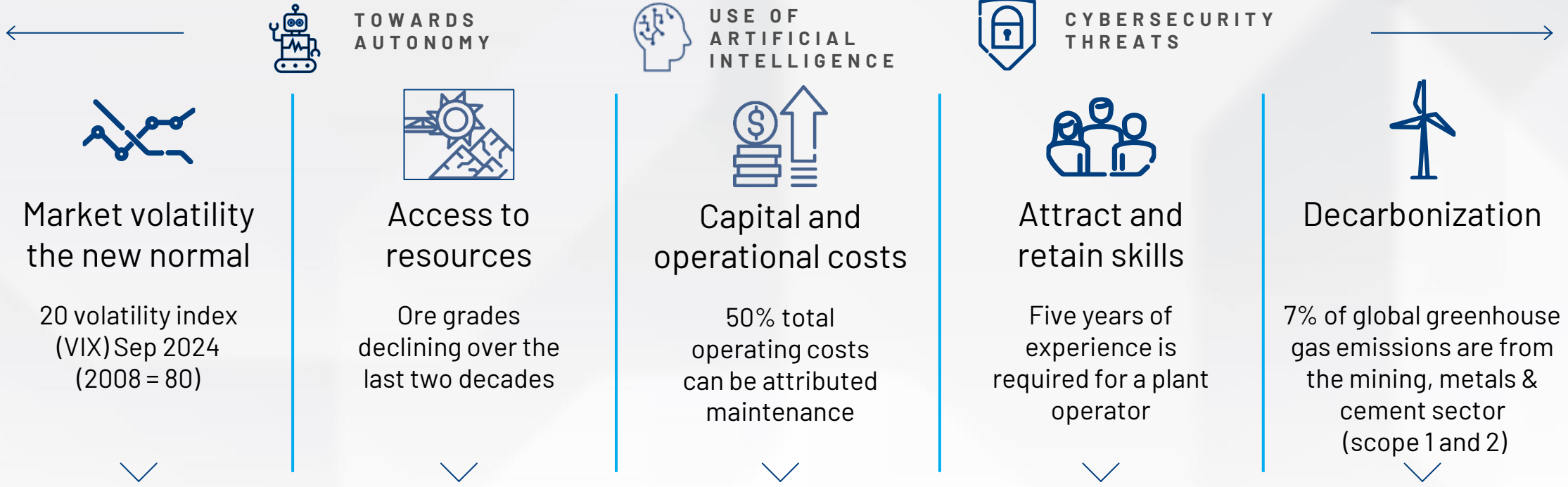
- Defining Digitalization

- The Connected Mine

- Mining Applications

- The Promise of Artificial Intelligence & Machine Learning

- The Path to Autonomous Mining

- Summary and Wrap Up

These are the biggest challenges we hear from clients

TOWARDS AUTONOMY

USE OF ARTIFICIAL INTELLIGENCE

CYBERSECURITY THREATS

Market volatility the new normal	Access to resources	Capital and operational costs	Attract and retain skills	Decarbonization
20 volatility index (VIX) Sep 2024 (2008 = 80)	Ore grades declining over the last two decades	50% total operating costs can be attributed maintenance	Five years of experience is required for a plant operator	7% of global greenhouse gas emissions are from the mining, metals & cement sector (scope 1 and 2)

STRATEGIC OPTIONS

An **integrated view of operations** for better response to market changes	Ability to **process lower-grade ores** in the most economical fashion	Implementing effective operating and **maintenance strategies**	Leveraging technology to make the **workplace more attractive and safer**	Sustainable operations through **automation and digitalization, electrification and renewables**

Rockwell Automation   KALYPSO

FROM STRATEGIC OPTIONS

| An integrated view of operations for better response to market changes | Ability to **process lower-grade ores** in the most economical fashion | Implementing effective **operating** and **maintenance strategies** | Leverage technology making the **workplace** more **attractive and safer** | Sustainable operations through **automation and digitalization, electrification and renewables** |

TO OUTCOMES
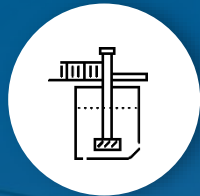
| Mine-to-market optimization | Optimized processes | Reliable operations and assets | Connected worker | Sustainable operations |

The connected mine

Rockwell Automation

Mine-to-market optimization

MINING OPERATIONS MANAGEMENT (MOM) PLATFORM

Scalable fit-for-purpose applications designed for mining under a unique IoT platform

Leverages existing site infrastructure for a single source of truth

EVENT SIMULATION

Run "what-if" scenarios to evaluate proposed process change

Determine the impact of uncertainty and variability on system performance

Improve mine operations that impacts directly the bottom line

Reduce uncertainty, risk and improve operations performance

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Optimized processes

UNIFIED CONTROL, POWER AND DEVICES

Seamless integration between process controls, power distribution, motor control, safety and sensing

A system approach connecting process areas, equipment and utilities

ADVANCED PROCESS OPTIMIZATION AND ANALYTICS

Optimization solutions and services that address complex processes with multi-objective and constraints

Lower total cost of ownership (TCO)

**Increase throughput
Reduce variability, energy, water consumption and emissions**

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Reliable operations and assets

ASSET PERFORMANCE MANAGEMENT SUITE

Collect, visualize and analyze the condition of critical assets — in a single scalable solution

DIGITAL MAINTENANCE MANAGEMENT PLATFORM

Cloud-based platform to plan, track and optimize maintenance activities

Reduce maintenance costs and help prevent equipment failures

Maintenance efficiency Spare parts reduction

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Connected worker

UNIFIED MOBILE PLATFORM FOR FIELD WORKERS ("DIGITAL STAPLER")

It brings together multiple applications, which do not share data, to a single and consistent user experience

REMOTE OPERATION CENTERS

Integration of applications from mine to port (control rooms, supply chain, operations management)

Expedite decision-making through immediate availability of data and collaboration tools

Enhance decision-making by integrating functions across the value chain

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Sustainability

ENERGY

Energy management software that puts energy data in context to production data, to reduce energy use across the value chain

WATER

Smart water solutions leverage modern software and analytics to improve operations visibility and system reliability

WASTE

Optimization solutions reduce waste across the supply chain (processes, stockpiles, tailings)

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enabling Technologies

Integrated Operation Center

Digital Twin
Represent a physical entity or system across its lifecycle using data, analytics, simulations and emulations

Virtual Assistance
Combine AR collaboration tools with real-time video to connect field technicians with experts

Mining Operations Management
Aggregate, contextualize and display information from various systems

CYBERSECURITY

Mines

Extended Reality
Enhance situational awareness of field workers with mobility, VR and AR technology

Artificial Intelligence
Support miners in the processes of problem solving

Predictive Analytics
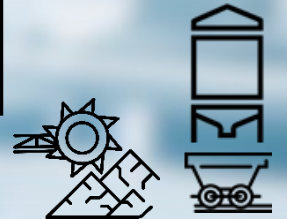Identify potential quality and downtime events before they occur
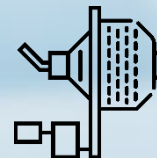
Smart Sensors
Monitor conditions like temperature, vibration, emission levels and particulate matter
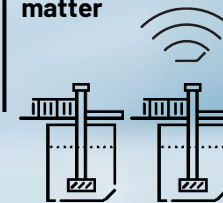
Decision Automation
Use business rules and data to make decisions in a process without the need for human intervention

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- Mining Industry Themes

- Defining Digitalization

- The Connected Mine

- Mining Applications

- The Promise of Artificial Intelligence & Machine Learning

- The Path to Autonomous Mining

- Summary and Wrap Up
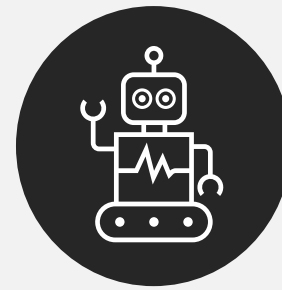
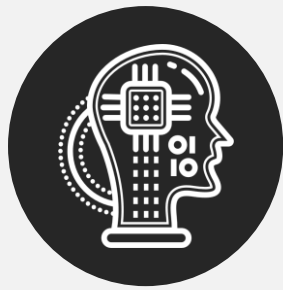**Rockwell Automation** **KALYPSO**

Defining Digitalization

By now many of you are familiar with the terms "**Digital Transformation**", "**Industry 4.0**/4IR", "**Digital Thread**" and "**Artificial Intelligence**/AI" but how many of you have clearly identified the pathway to enabling these concepts? Simply put, **Digitalization** is the process by which organizations move from analog systems to digital silos to a unified digital architecture.

Gartner: "*Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.*"

SAP: "*Digitalization is when data from throughout the organization and its assets is processed through advanced digital technologies, which leads to fundamental changes in business processes that can result in new business models and social change.*"

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Digitalization in mining is about the pursuit of an autonomous, closed loop operating system (CLOS model) across the entire mining footprint, including but not limited to operations, maintenance and supply chain.

Operating System Journey

DESCRIPTIVE	DIAGNOSTIC	PREDICTIVE	PRESCRIPTIVE	AUTONOMOUS
Can you capture data	**Can you report on data**	**Can you trend data/apply BI**	**Can you model the data**	**Can your data automate operations**

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Contents

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The Connected Mine

Mining Enterprise Digitalization Journey
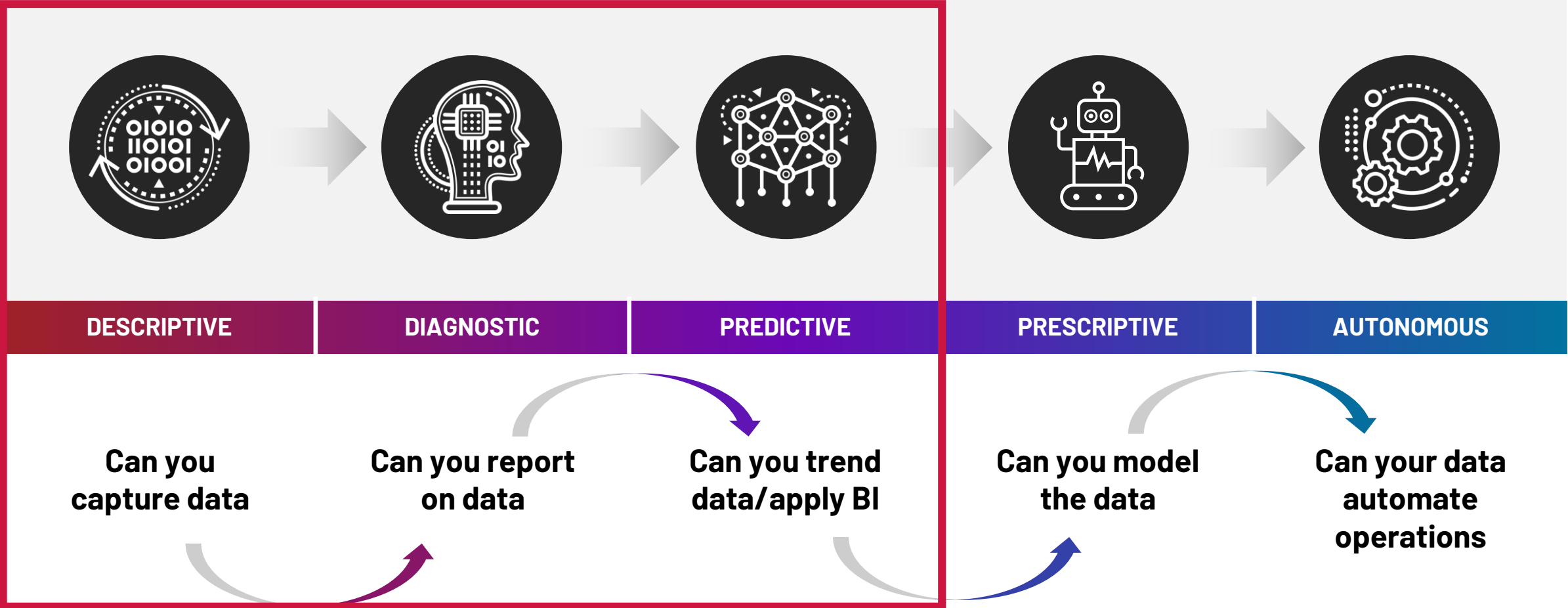
DESCRIPTIVE	DIAGNOSTIC	PREDICTIVE	PRESCRIPTIVE	AUTONOMOUS
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Rockwell Automation   KALYPSO
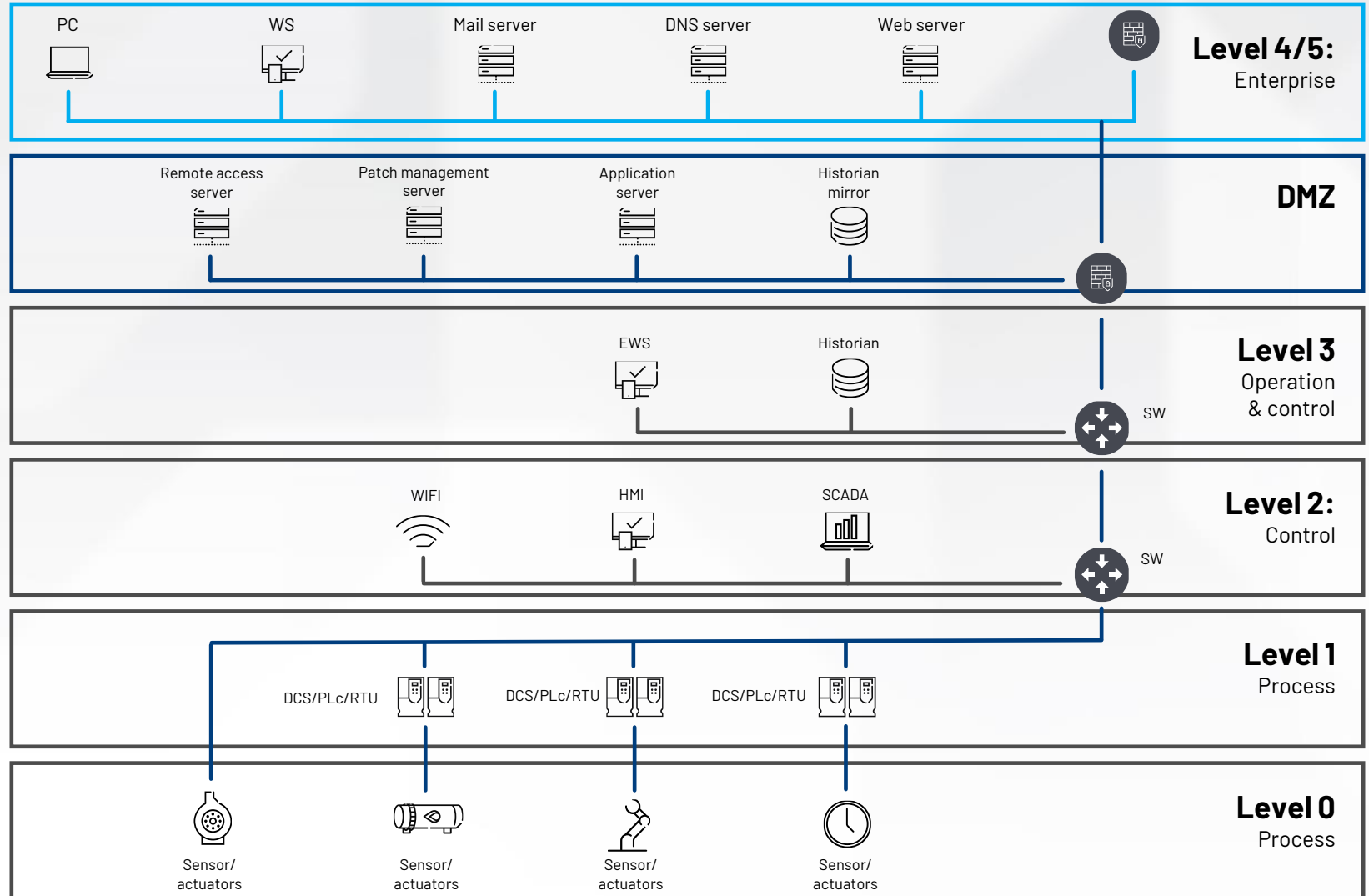
Integrated Process Solutions

Multi-Disciplined Control for the Process Industries

Remote Operations Center
Digitally enabled technologies

Project / Design / Commissioning
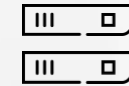
Operations / Maintenance

Characterized Systems

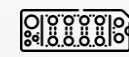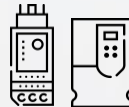**Rapid Code Development Process focused functions Native alarms / diagnostics**

PlantPAx
Distributed Control System

Operational Awareness/ Asset Management

EtherNet/IP

Process Plant
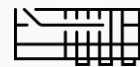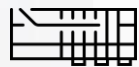
Standalone Equipment / Skids

Power Integration

Motor Control Integration

High Availability

Instrumentation Integration
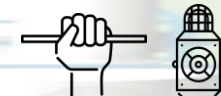
Safety Systems Integration

Flexible Implementation & Scalability

Rockwell's Logix PLC family – capturing data

- **Safety rated controllers highlighted in Red circles**

Process & Plant Primary Machine Systems
ControlLogix® controllers

Plant-wide

Integrated

Scalable

Information-enabled

	5570		5580
Integrated	Armor™	5570	Process
Scalable	Armor™ GuardLogix®	GuardLogix®	5580
Information-enabled	XT	GuardLogix® XT	GuardLogix®
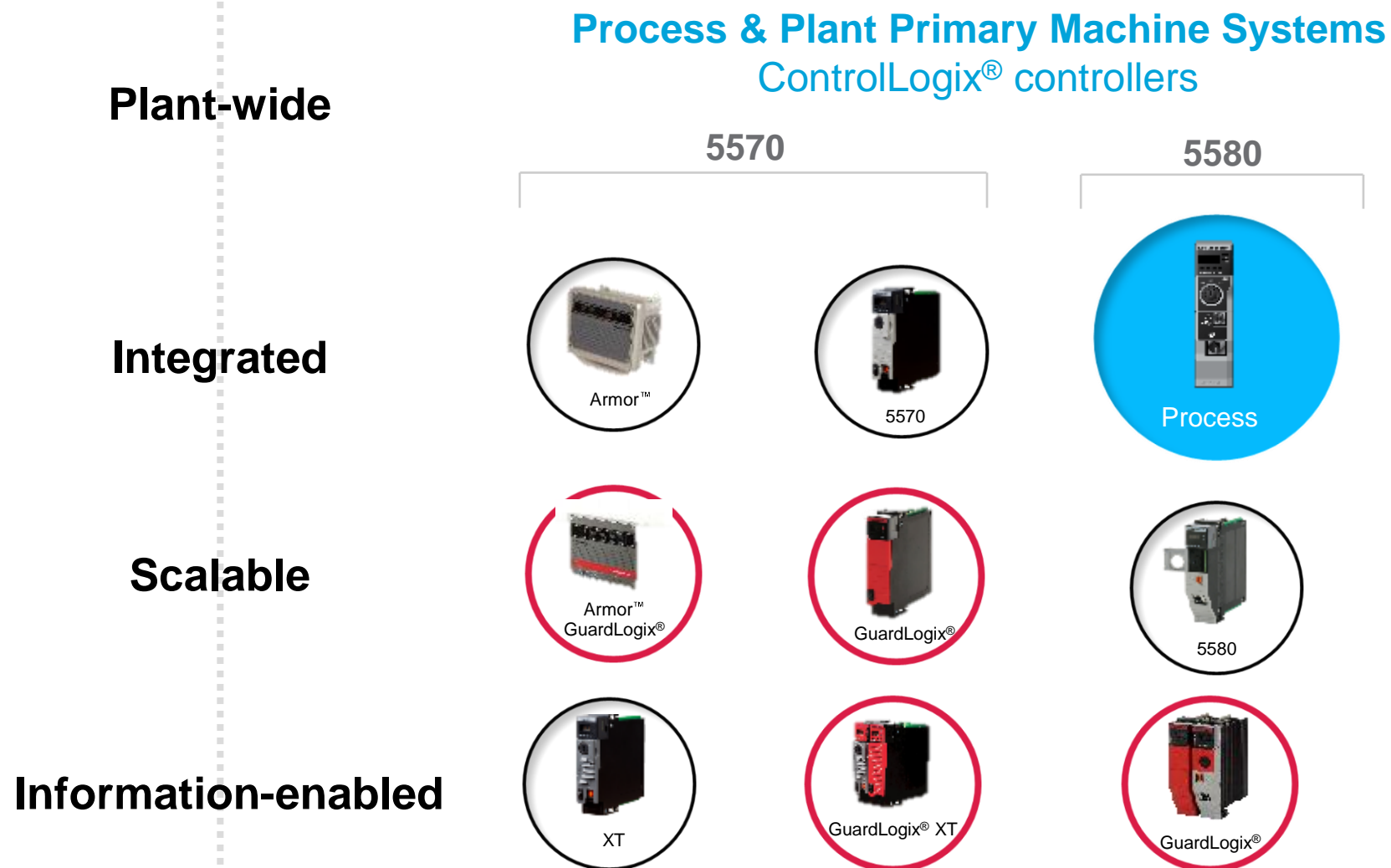
OPC UA embedded in the controller

- Enables third-party connectivity natively

- Expose controller data via OPC UA

- As an OPC UA Server, or as an OPC UA Client

- Integrated OPC UA Security directly into a machine

Logix Embedded Edge Compute™ hosting FactoryTalk® Optix™

Embedded hardware solution optimized for FactoryTalk® Optix™

Logix Embedded Edge Compute

- Scaled to meet wide range of customer needs:
  - OEM focus – small to large machines, simple to complex applications
  - End User Focus – Simple to complex Machines and Applications
- Includes
  - FactoryTalk® Optix™ Runtime FactoryTalk® Remote Access™ Runtime **Pro**
  - Ability to host FT Optix and
    - C#, Python, .NET projects
  - OPC UA, MQTT, REST API

Key technical specifications	
CPU	❖ NXP iMX8M Plus Quad Cortex-A53 1.6 GHz Cortex-M7 800 MHz
Memory	❖ RAM 4GB 20GB eMMC
Ethernet	❖ 2x 10/100/1000 Mbps
USB	❖ 1x USB 3.0
User memory	❖ 32GB uSD
Embedded OS	❖ Linux Yocto 64bit

FactoryTalk Historian Logical Diagram

Information Presentation (types of clients to Historian SE)

DataMosaix™ Extractor

View **SE**

Historian **Vision** — Based on PI Vision

Historian **DataLink** — MS Excel Add-in

Historian SE Server

Historian SE

Data Collection

***** Interface

Other Sources

Linx

FTLD Interface

FTLD Interface

kepware

ODBC Interface

SQL

Data Sources

Rockwell Controller Data Sources

Historian ME Module Data Sources

Historian ME

Other Data Sources

→ Data Flow

Rockwell Automation

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Mining Operations Management

Designed for Mining

Scalable, fit-for-purpose applications specifically designed for mining

Integrated

Leverages existing site infrastructure (ERP, Historian, LIMS, FMS...) to provide a single source of truth, and models that data in the context of the value-chain

Flexible

Multiple architectural options to suit on-premise, centralized, cloud-hosted, or hybrid as best suits each site's infrastructure constraints

Scalable

Add applications at your own pace and easily expand to address additional requirements

From Mine to Market

Enterprise Resource Planning / Enterprise Asset Management & Compliance Systems (Health, Safety, Environmental)

Integrated Remote Operations / Remote Support

Mine to Market Operational Dashboard, Visualization & Reporting

Laboratory Info. Management System (LIMS)

Mine Technical Apps (Geology, Planning, Scheduling)

Fleet Management System / Dispatch

Data Integration

Data Integration

Market

Rail

Port

Mining Operations Management (MOM) Applications

OEE / Asset Utilization KPIs	Downtime / Loss Accounting
Production Reporting	Short Interval Control
Inventory Management and Storage Balances	Metal Reporting
Statistical Process Control	Sustainability Metrics

Digital Field Worker

Operator Logs

AR Work Instructions

Mobile Rounds Inspections

Process Historian

Asset Performance Management Platform

Process and Power

| MPC | DCS | Motor Control | Power Systems |

Third-party Device Integration

Third-party Device Integration

MINE ASSETS & PROCESSES

Utilities

Mine

Material Handling

Comminution

Concentrator

Material Handling

Rail & Port

MOM Applications

Downtime / Loss Accounting

Identifies the business impact of planned and unplanned stoppages by correlating production losses with events

Production & Performance Reporting

Material types, quantities, rates, and totalization reported in the context of where they are consumed, produced, recovered, or recirculated

Asset Utilization / OEE

Automated capture, reporting and visualization of OEE and other KPIs in the context of the Plant Model Processing areas don't all contribute equally to the aggregate: the solution aggregates / proportion time & losses intelligently

Short Interval Control

Data from mining processes are periodically reviewed and action is taken in response to them

Statistical process control (SPC)

Application of statistical methods to monitor and control the quality of a production process

Inventory Management and Storage Balances

Automatically tracks the sources and destinations of material movements, the running and net balances in process areas and storage units
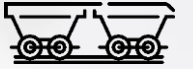
Metal Reporting

Aligns sample results with material movements to calculate the constituent quantities within the overall ore flow

Production & Performance Reporting

Mine to Market optimization

Reporting is often done in spreadsheets in different versions This wastes time and is prone to errors - Specialists are wasting time collecting, collating, and data entry

Challenges Addressed

- › Lack of visibility of materials and key consumables (water and energy) across the production chain
- › Manual adjustment of data
- › Double-counting losses
- › Lack of accountability as to how results were obtained
- › Hard to report consumption and quality in relation to process areas and responsibilities
- › Instrumentation is not available

Our Solution

- › Automates data management and reports
- › Identifies all material inputs and outputs in the process.
- › Audit trails of all manual adjustments
- › Considers material types, quantities, rates, and totalization reported in the context of where they are consumed, produced, recovered, or recirculated
- › Generates performance, gross rate, net rate, and yield statistics
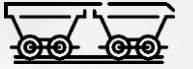
Potential Results...

- ► Saves time from data collection and specialists can focus on added value tasks
- ► Understand performance vs target
- ► Reduce water and reagents consumption

Rockwell Automation

Short Interval Control

Mine to Market optimization

The constant struggle to align long-term schedule objectives with medium-term, short-term and operational schedules

Challenges Addressed

› Wait until the end of shift to generate a production report

› No in-shift checks on performance against shift-goals

› No in-shift visibility to shift/area leads on compliance to operational strategies

› No long-term visibility or trends aligned with operating targets

› Lack of visibility across shifts/crews for ongoing operational deviations

Our Solution

› Establishes intra-shift intervals with shift targets distributed across these intervals

› Manage parameters / behaviors vs. short-interval goals

› Delivers real-time alerts when goals are not achieved

› Analyzes deviations, causes, and responses

› Identifies continuous deviations which are not being addressed / recovered and communicate to the shift/area leads or process experts

› Raises actions which cannot be resolved within the shift, and track actions to completion

› Proposes recovery actions for each SIC rule, tailored by the process experts

› Provides feedback as to the cause of the deviation, and what actions they took to recover

› Facilitates communications between shifts

Potential Results...

► Improve production

► Respond to changes as they occur

► Gives the oncoming team visibility of the previous shift as well as the plan to complete

Rockwell Automation

Asset Utilization / OEE Downtime & Loss Accounting

Mine to Market optimization
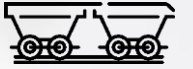
OEE is a gold standard for measuring productivity, but challenges make OEE in mining more complex – Miners also have trouble implementing OEE when the focus is limited to the metric itself, rather than investigating to find the cause that is affecting the metric

Challenges Addressed

› The intricacy of operations

› Time classification is more complex

› Data is not always available in real time

› Data aggregation is more complex

› Focus is on the performance of the whole circuit, rather than individual machines

Our Solution

› Automatically captures, reports and delivers the visualization of OEE and other KPIs in the context of the Plant Model

› Identifies the business impact of planned and unplanned stoppages by correlating production losses with events

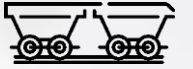› Allows the analysis of both downtime and rate loss incidents

Potential Results...

► Supports a mine's continuous improvement efforts

► Identify and eliminate systemic causes of failure or loss

Rockwell Automation

Inventory Management and Storage Balances

Mine to Market optimization

Being able to identify available stock-on-hand, and work in progress (WIP) segmented by grade, in real-time is a big challenge in mining operations

Challenges Addressed

› Inventory levels and grades are inferred from disparate data sources

› Data is managed by isolated systems and manual processes

› Saleable product has already shipped by the time the loadout quality is known

Our Solution

› Automatically tracks the sources and destinations of material movements, the running and net balances in process areas and storage units, supported by surveys, dips, and stock adjustments.

› Enables month end reconciliation for gross material quantities

› Leverages upstream grades, stockpile models, and genealogy tracking to predict the loadout quality

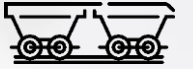## Potential Results...

› Confidence in sales order compliance

› Timely response to variances from planned production

› Identify the current level of stock available

› Predict compliance to grade specification prior to ship

Rockwell Automation

Metal reporting

A reliable metal reporting solution requires comprehensive instrumentation, lab sampling, and analysis results to ensure coverage of the process

Mine to Market optimization

Challenges Addressed

› Disparate data sources with data arriving at different times

› Metal quantities inferred from composite averages over the period

› Instrumentation is located to suit control instead of to identify yield and recovery

› Instrumentation gaps are filled with assumptions and constants

› Spreadsheets used to collect, store and process metallurgical accounting data

› Lack of data integrity due to manual data manipulation

Our Solution

› Aligns sample results with material movements to calculate the constituent mineralogical quantities within the overall ore flow and identify processing recoveries

› Estimates downstream qualities from upstream samples using genealogical and stockpile models

› Links quality results with equipment positions / locations to calculate weighted-average grades on stockpiles

› Generates recovery and loss statistics

Potential Results...

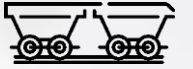► Improved compliance to specification

► Improved process performance due to lower material variability

► Standardizes methodologies for yield and recovery calculations

Rockwell Automation

Statistical Process Control (SPC)

Any mining operation has some inherent and expected variability in quality, often driven by changes in feed-stock or blends. Companies need tools which help identify variability which is not being handled well by the process, and which may be driven by other factors such as human error, equipment behavior, or outside influences

Mine to Market optimization

Challenges Addressed

› Identify feed-stock variability, even when it appears to be within acceptable limits

› Identify when the process does not have control over the qualities before they except specification limits

› Identify in-process and finished product variability against grade specifications before product is loaded out

Our Solution

› A SPC solution that uses statistical methods to monitor and control product quality

  › Graphical view of actual performance

  › Reveals when the process is drifting out of control

  › Monitors and control the variation in a process so that it remains within acceptable limits / inspecting whether a process proceeds in a normal way or not

  › Methods across feed, in-process, tailings/rejects, and finished product

  › Alerts operators in real-time as soon as an abnormal pattern of qualities arises

  › Provides recommended actions (tailored by process experts)

  › Feedback from operators (cause and responses) to allow long-term analysis

Potential Results...
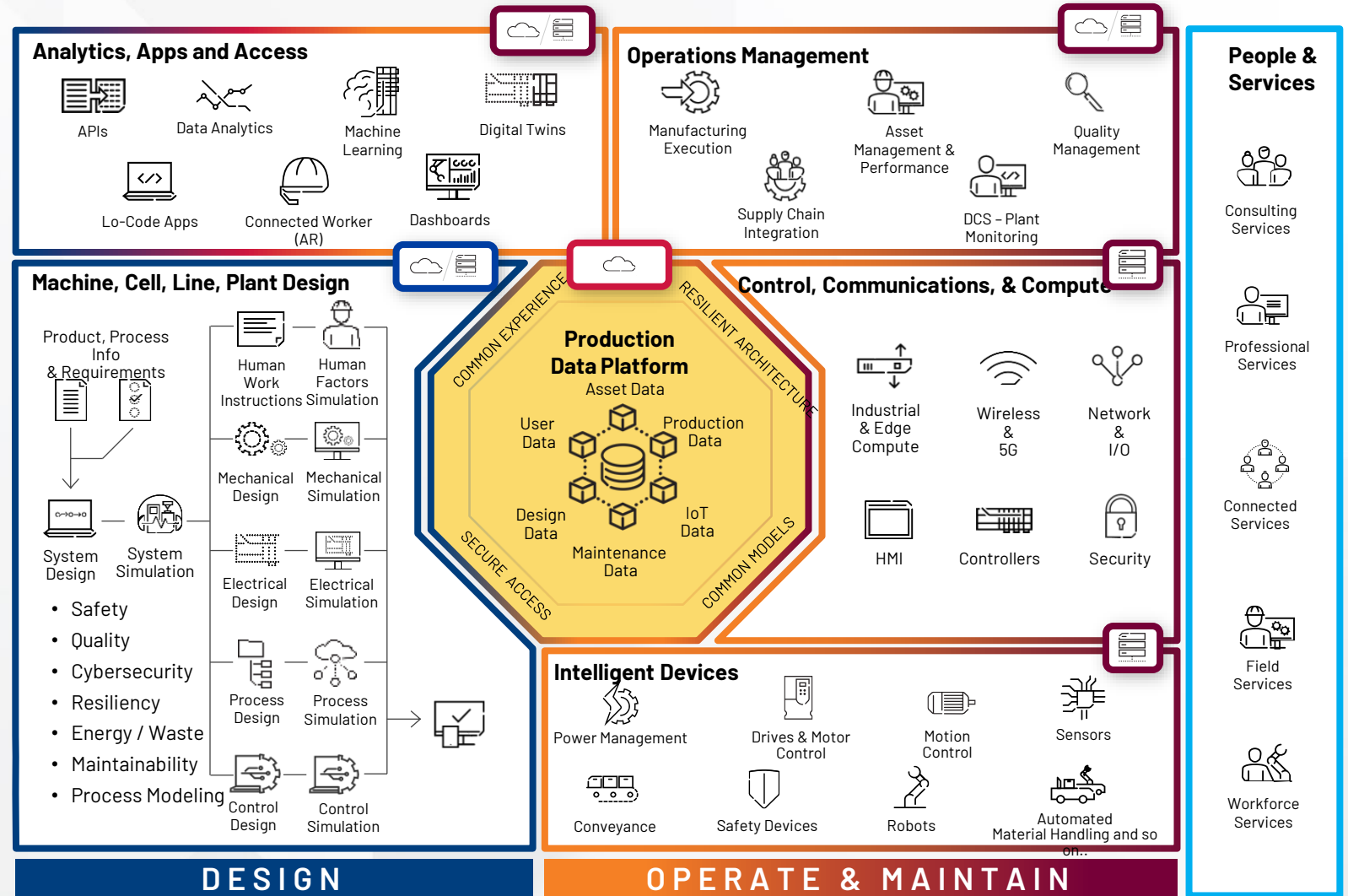
► Improved compliance to specification

► Improved process performance due to lower material variability

Rockwell Automation

The Connected Enterprise® Production System

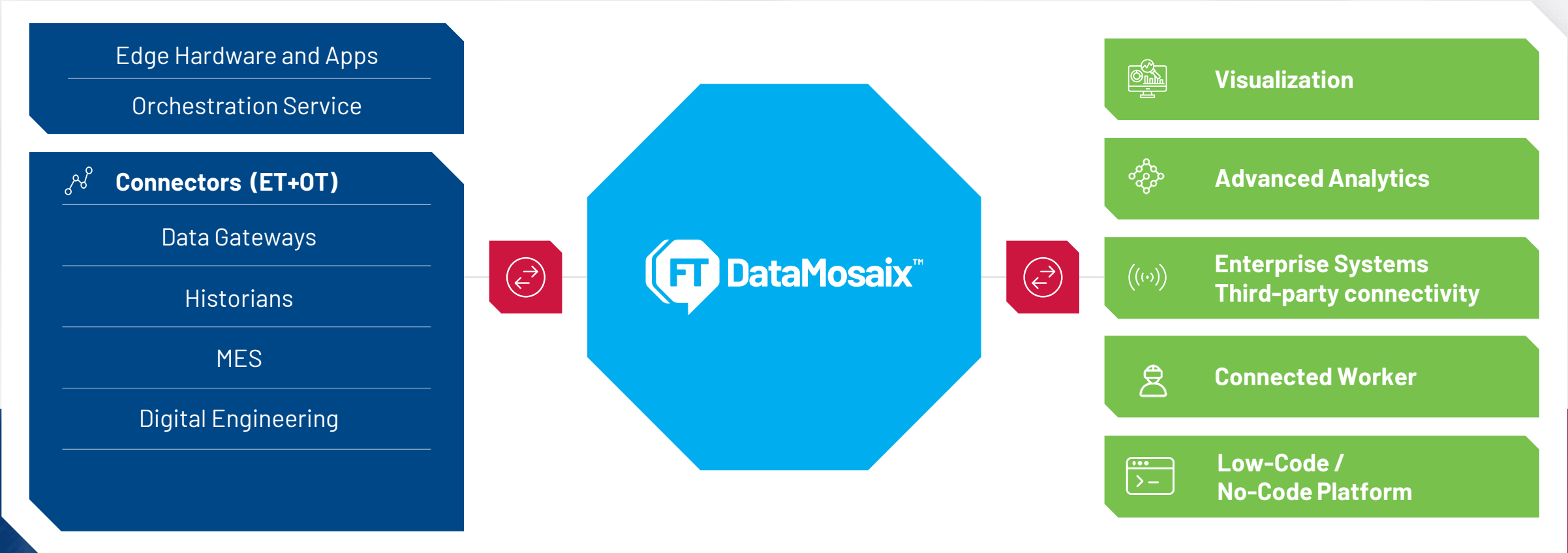Transforming enterprise operations holistically

Using data and automation to connect people, processes and tools so they can operate at maximum capacity

Engineered for agility, scalability and security with data at its core

Analytics, Apps and Access
- APIs
- Data Analytics
- Machine Learning
- Digital Twins
- Lo-Code Apps
- Connected Worker (AR)
- Dashboards

Operations Management
- Manufacturing Execution
- Asset Management & Performance
- Quality Management
- Supply Chain Integration
- DCS – Plant Monitoring

Machine, Cell, Line, Plant Design
- Product, Process Info & Requirements
- Human Work Instructions
- Human Factors Simulation
- Mechanical Design
- Mechanical Simulation
- System Design
- System Simulation
- Electrical Design
- Electrical Simulation
- Process Design
- Process Simulation
- Control Design
- Control Simulation

- Safety
- Quality
- Cybersecurity
- Resiliency
- Energy / Waste
- Maintainability
- Process Modeling

Production Data Platform
- Asset Data
- User Data
- Production Data
- Design Data
- IoT Data
- Maintenance Data

COMMON EXPERIENCE · RESILIENT ARCHITECTURE · SECURE ACCESS · COMMON MODELS

Control, Communications, & Compute
- Industrial & Edge Compute
- Wireless & 5G
- Network & I/O
- HMI
- Controllers
- Security

Intelligent Devices
- Power Management
- Drives & Motor Control
- Motion Control
- Sensors
- Conveyance
- Safety Devices
- Robots
- Automated Material Handling and so on..

People & Services
- Consulting Services
- Professional Services
- Connected Services
- Field Services
- Workforce Services

DESIGN

OPERATE & MAINTAIN

Rockwell Automation   KALYPSO

Industrial Data Operations with FactoryTalk® DataMosaix™

Transform your data into value with an Industrial Data Hub

Edge Hardware and Apps

Orchestration Service

Connectors (ET+OT)

Data Gateways

Historians

MES

Digital Engineering

DataMosaix™

Visualization

Advanced Analytics

Enterprise Systems Third-party connectivity

Connected Worker

Low-Code / No-Code Platform

Rockwell Automation

KALYPSO

What makes DataOps *industrial*?

Industrial DataOps

An industrial DataOps solution simplifies and accelerates the journey to scalable and sustainable digital transformation

Standard OT Connectivity

Industrial data is trapped in many disconnected systems.

Industrial DataOps simplifies access to industrial data sources with standard connectivity.

Scalability for Industrial Data

Industrial systems have massive amounts of time series data.

Industrial DataOps simplifies scaling to the quantity and variety of data that's needed.

Links Digital to Physical

Industrial organizations live in the physical world.

Industrial DataOps simplifies contextualizing data with diagrams, images and 3D models that represent the real-world environment.

OT / Production Self Service

Transformation happens when people change the way they work.

Industrial DataOps simplifies adoption with data contextualization, discovery and modeling tools geared for industrial users.

Engineering Analysis

Domain experts need to conduct complex engineering analysis.

Industrial DataOps simplifies both ad-hoc and repeatable data analysis using engineering functions and simulation data.

You have data: Now what?

Having access to your data is the beginning. Putting it to work for you is the next step.

Avallabile

Standard connectivity to IT/OT/ET data from industrial data sources at scale.

Improve organizational productivity with all relevant data already in one place.

Meaningful

AI-supported and scalable contextualization of data across data sources, allowing for data to be interpreted and understood in the relevant business context.

Useful

Easy to search single source of information with full traceability for unparalleled self-service data discovery, orchestration and solution development.

Valuable

Real-time visualization and advanced analytics applications deployed at scale that drive optimal decision-making and autonomous closed-loop actions.

What is data contextualization?

Contextualization is the process of establishing meaningful relationships between data sources and types to traverse and find data through a digital representation of the relationships that exists in the physical world.

Sensor data

Work Order → Maintenance Report

3D Model → Hardware specification

Sensor data
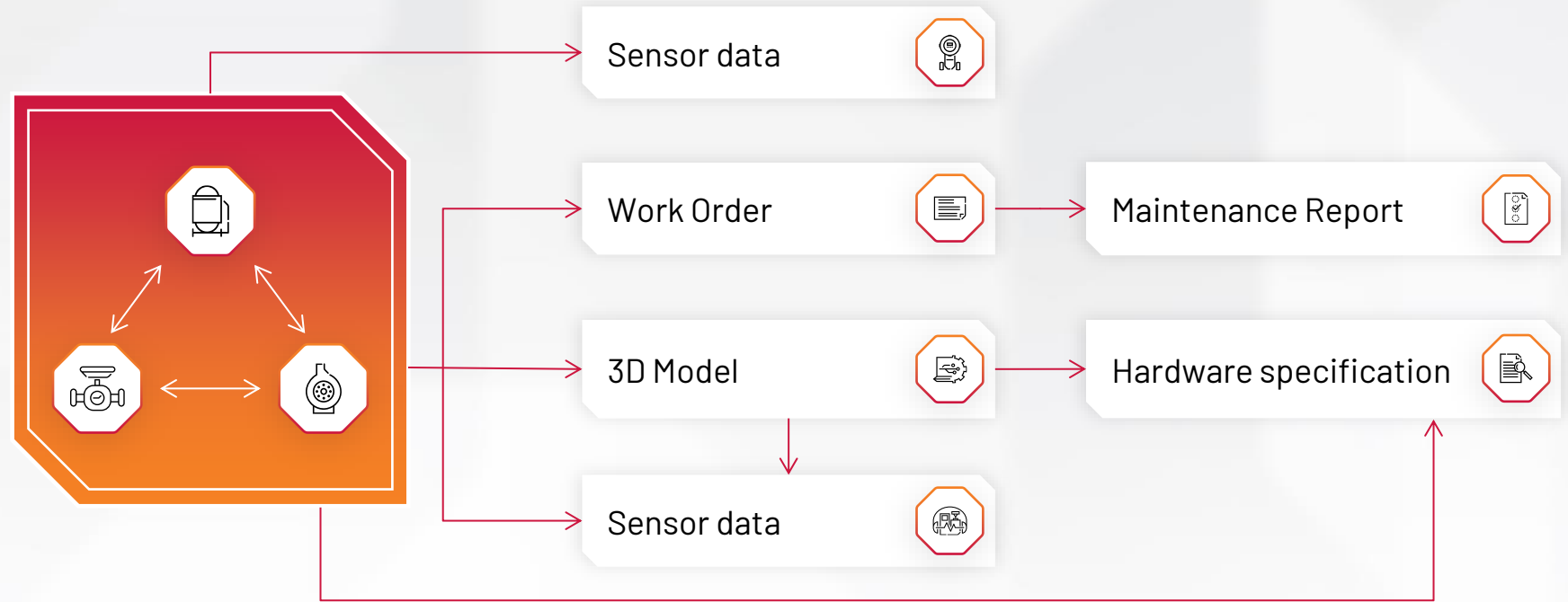
Data contextualization simplifies the complex nature of industrial data with logical relationships.

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# Foundational Use Case: Next generation Historian

Easy, centralized and contextualized data across multiple plants for faster root cause analysis by off-site SMEs

Ability to store and analyze time series and events data from a production asset or process.

Enrich time series with context from enterprise and third-party data systems to enable problem solving

Rockwell Automation

KALYPSO
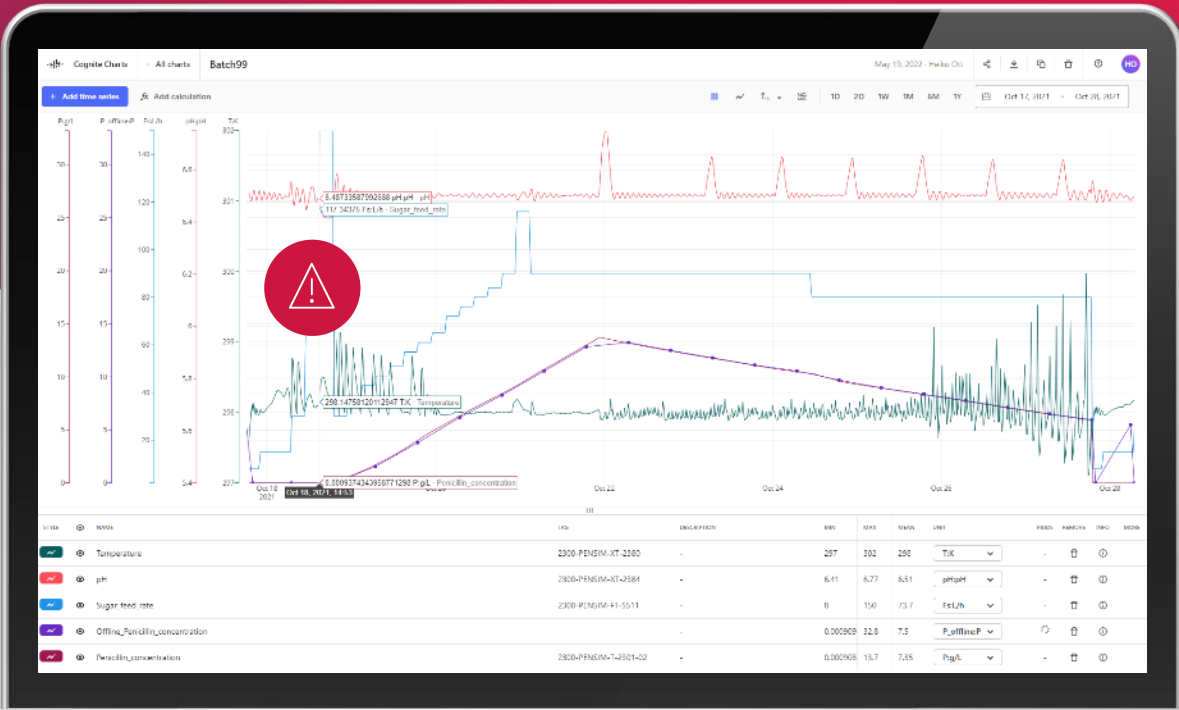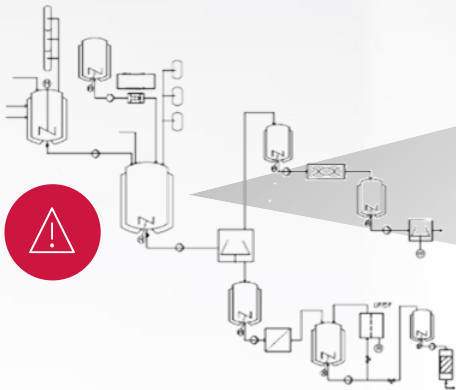
Foundational Use Case: Enterprise production reporting

Real-time and trusted enterprise visibility to plant performance to optimize production planning

Compare OEE by plant, line, equipment or shift and conduct ad-hoc queries to understand plant performance
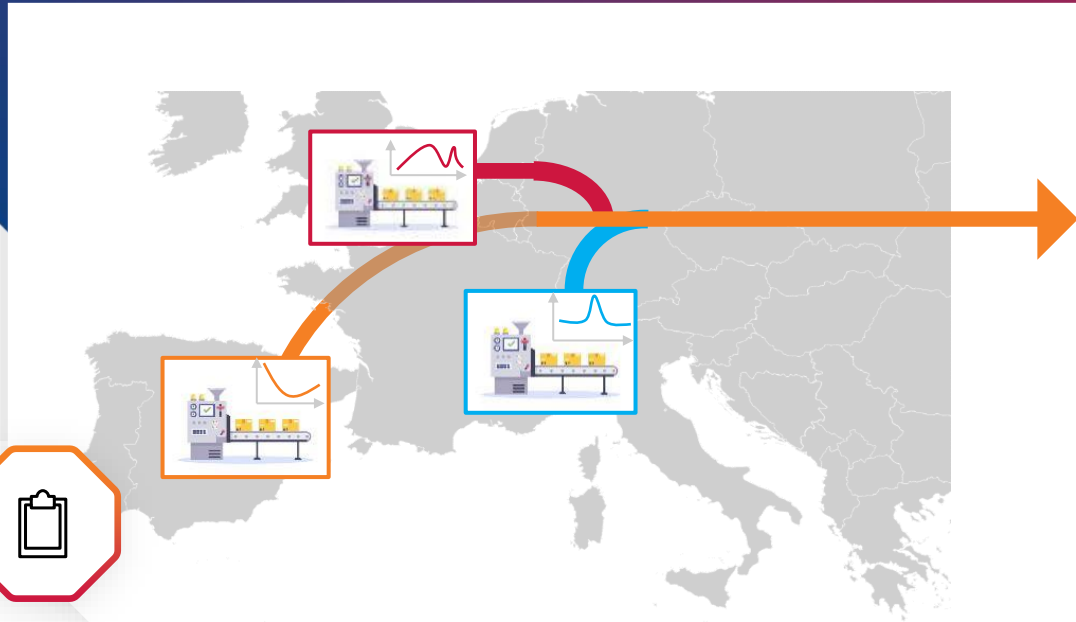
Off the shelf OEE calculations that don't require an extensive IT project

Leverage the existing investment in on-premise OEE reporting tools by reusing the existing context

Make informed production planning decisions

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KALYPSO

Foundational Use Case: Asset monitoring

Analysis of real time asset data to detect issues and determine what corrective actions are needed

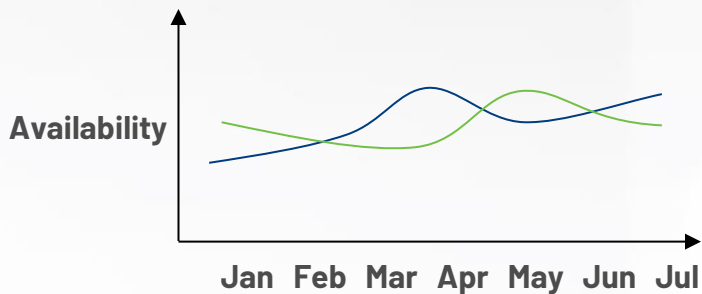Compare reliability of similar equipment across multiple plants

Improve meaning of sensor data trends with the related IT/OT/ET context (e.g., maintenance work orders)

Quickly find root causes of downtime events with ad-hoc engineering analysis

Enterprise Asset Dashboard

Availability

Jan Feb Mar Apr May Jun Jul

All Ovens ✕   Product A ✕

Top Alarms by Equipment

Plant B Oven	254	296	-42		
Plant A Oven	246	181	65		
Plant B Mixer	101	191	-90		
Plant B Extru	303	76	227		
Plant C Oven	200	217	-17		
Plant C Mixer	118	273	-155		
	201	148	53		

Rockwell Automation   KALYPSO

Scaling high value applications

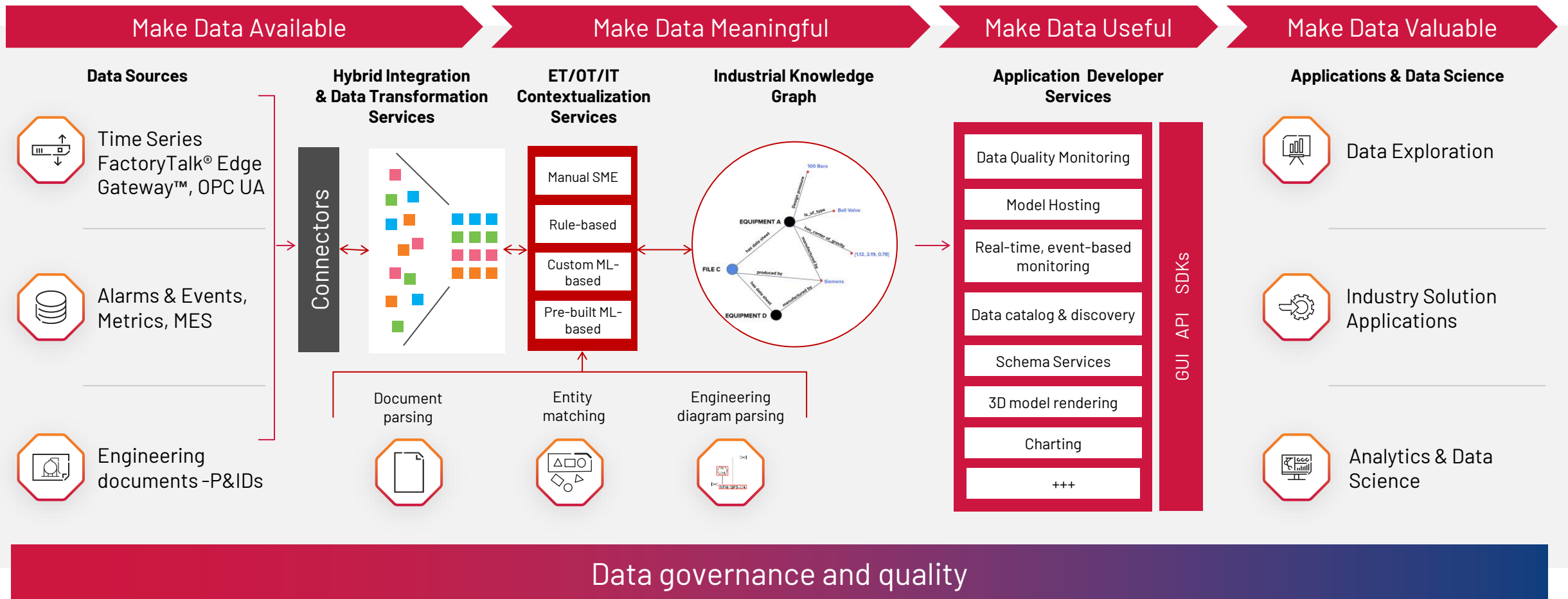Foundational use cases generate rapid value while also providing a scalable data foundation to rapidly develop and deploy visualization and data science applications.

Predictive & Prescriptive

- Material Routing Optimization
- Real-time Operator Guidance
- Automated Vision Inspection
- Real-time Energy Optimization
- Predictive Maintenance

Descriptive & Diagnostic

- Process Performance Analytics
- Yield Loss Analytics
- Quality Control Analytics
- Energy Usage Analytics
- Asset Performance Analytics

Foundational

- Enterprise Production Reporting
- Next Generation Historian
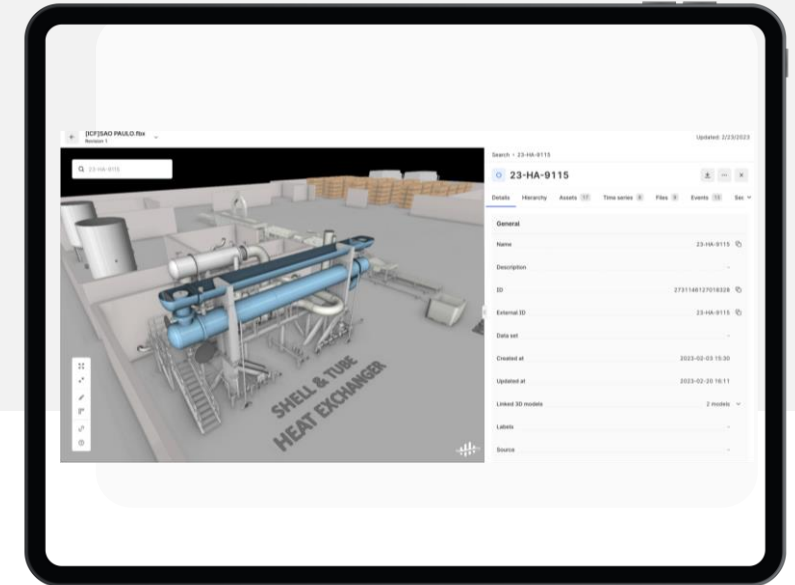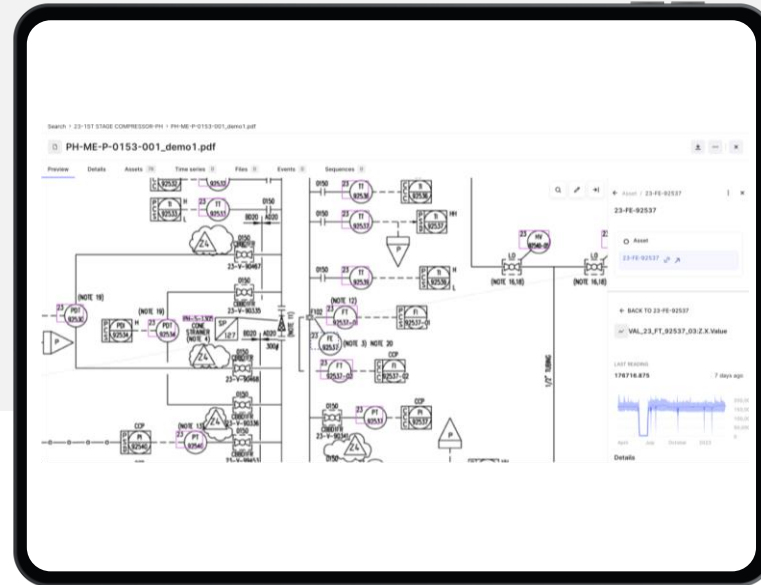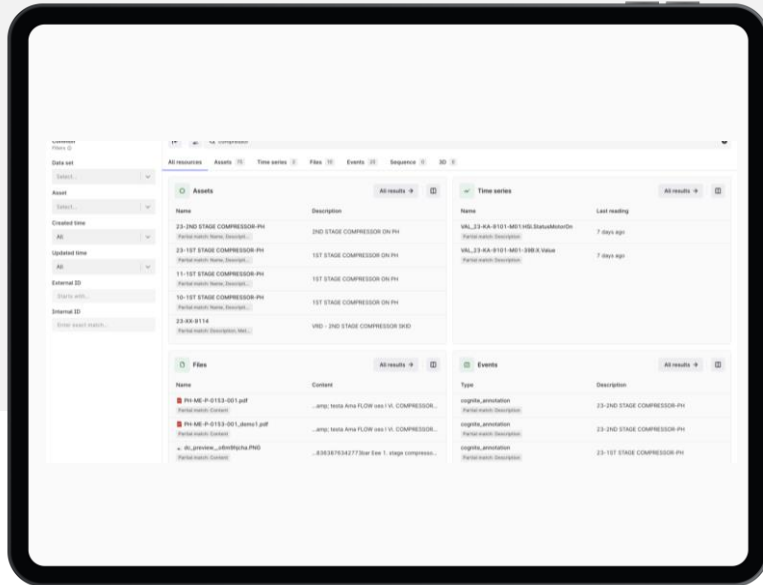- Asset Monitoring

Rockwell Automation   KALYPSO

FactoryTalk® DataMosaix™ overview

Expose industrial data in an Industrial Knowledge Graph to realize value through apps and analytics

Make Data Available	Make Data Meaningful	Make Data Useful	Make Data Valuable

Data Sources

- Time Series FactoryTalk® Edge Gateway™, OPC UA
- Alarms & Events, Metrics, MES
- Engineering documents –P&IDs

Hybrid Integration & Data Transformation Services

Connectors

ET/OT/IT Contextualization Services

- Manual SME
- Rule-based
- Custom ML-based
- Pre-built ML-based

Document parsing

Entity matching

Engineering diagram parsing

Industrial Knowledge Graph

100 Bara
Design pressure
Is_of_type — Ball Valve
EQUIPMENT A
has data sheet
has_center_of_gravity
manufactured by
[1.12, 2.19, 0.78]
FILE C
produced by
Siemens
has data sheet
manufactured by
EQUIPMENT D

Application Developer Services

- Data Quality Monitoring
- Model Hosting
- Real-time, event-based monitoring
- Data catalog & discovery
- Schema Services
- 3D model rendering
- Charting
- +++

GUI API SDKs

Applications & Data Science

- Data Exploration
- Industry Solution Applications
- Analytics & Data Science

Data governance and quality

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KALYPSO

Data exploration

Find data in seconds, not hours

Explore all data through a **traditional asset hierarchy** and **add additional search context** for enhanced filtering

Navigate process diagrams and other engineering drawings for a **process-oriented view**

Use **contextualized 3D models** to access time series, drawings, events, files and more through a unified UI

Rockwell Automation

KALYPSO

Scalable connectivity with FactoryTalk® Edge™ Manager and FactoryTalk® Optix™

FT Edge™ Manager — FactoryTalk Hub™

FT DataMosaix™ — FactoryTalk Hub™

- Assets
- Events
- Time Series
- Files

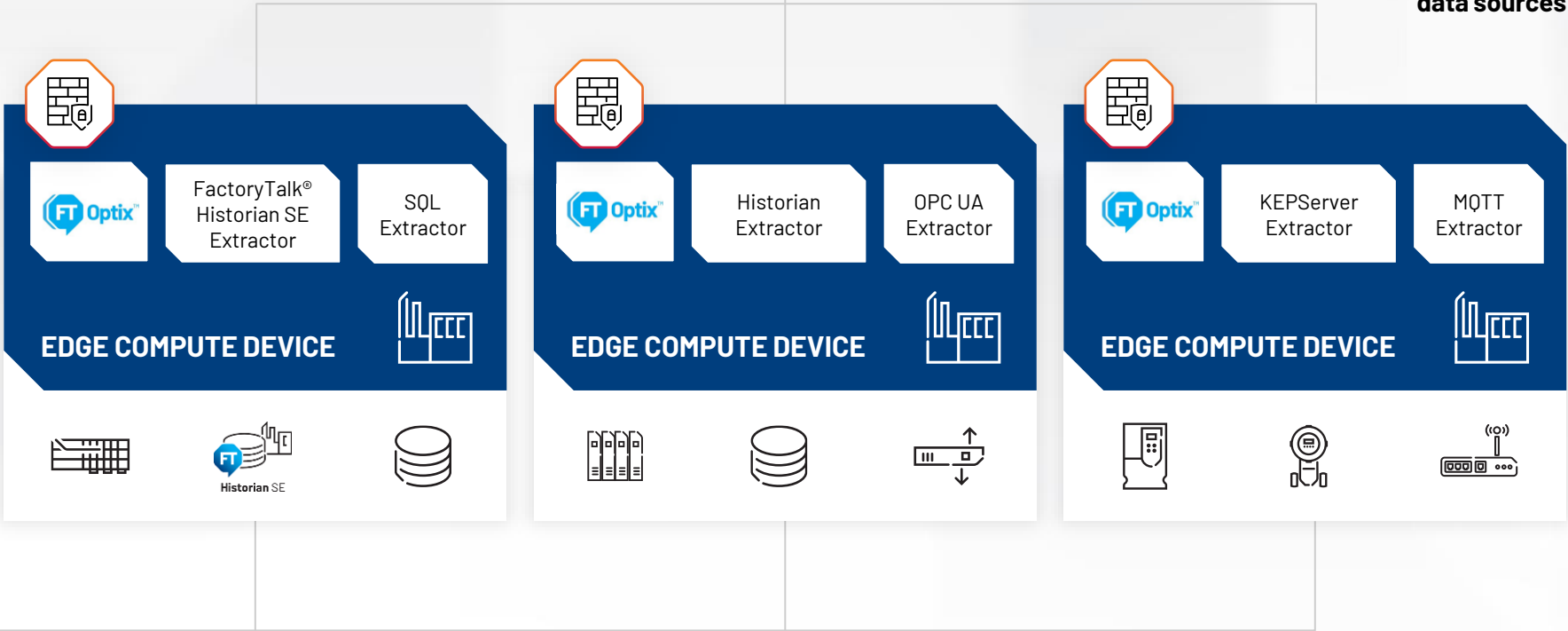**Connect disparate OT data sources**

Public and Private Edge Connector Marketplace

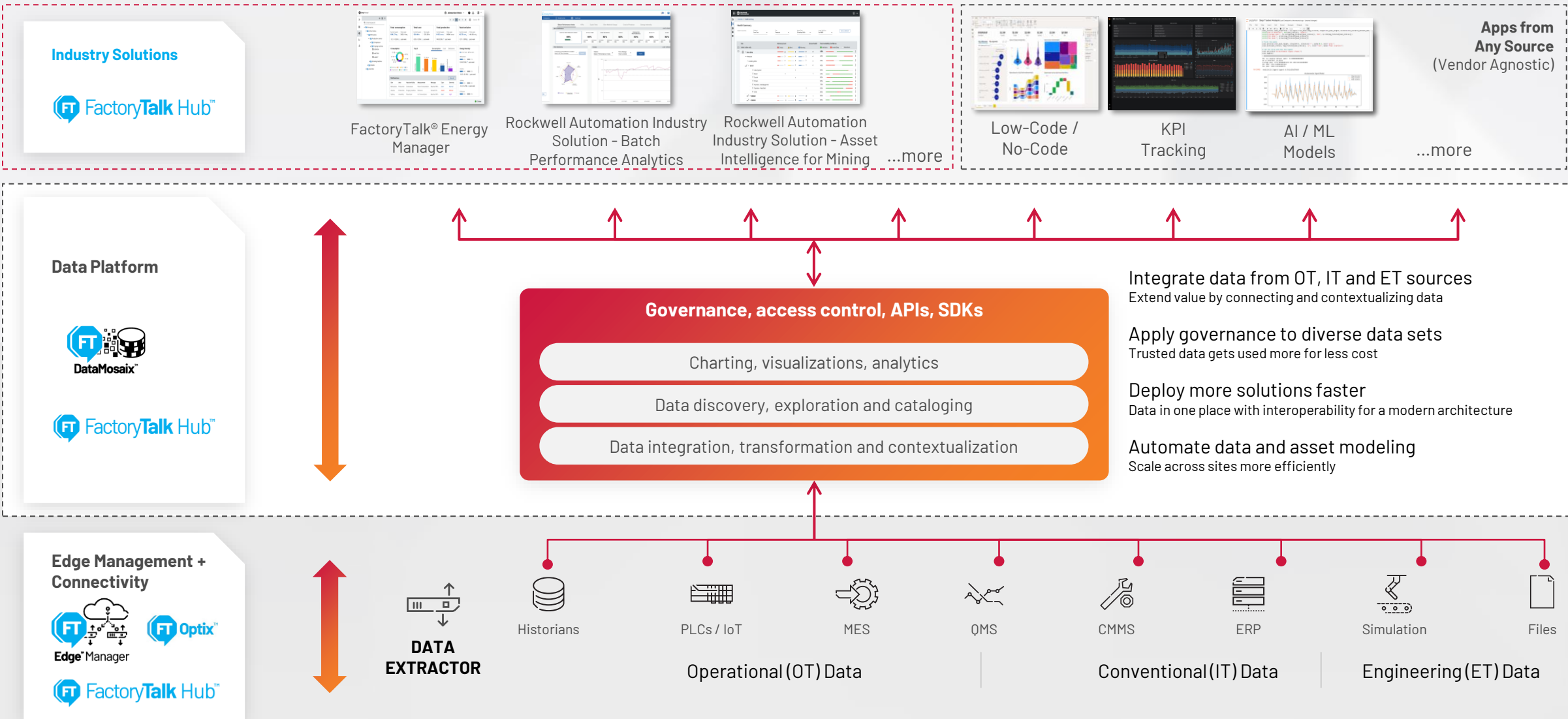**Industrial Edge Application and Device Fleet Management**

Centralized FactoryTalk® Edge Optix™ Management

FT Optix™ | FactoryTalk® Historian SE Extractor | SQL Extractor

EDGE COMPUTE DEVICE

Historian SE

FT Optix™ | Historian Extractor | OPC UA Extractor

EDGE COMPUTE DEVICE

FT Optix™ | KEPServer Extractor | MQTT Extractor

EDGE COMPUTE DEVICE

Edge Orchestration

Rockwell Automation

KALYPSO

FactoryTalk® DataMosaix™ at the center of a scalable app strategy

Industry Solutions

FactoryTalk Hub™

FactoryTalk® Energy Manager

Rockwell Automation Industry Solution - Batch Performance Analytics

Rockwell Automation Industry Solution - Asset Intelligence for Mining ...more

Apps from Any Source
(Vendor Agnostic)

Low-Code / No-Code

KPI Tracking

AI / ML Models ...more

Data Platform

DataMosaix™

FactoryTalk Hub™

Governance, access control, APIs, SDKs

Charting, visualizations, analytics

Data discovery, exploration and cataloging

Data integration, transformation and contextualization

Integrate data from OT, IT and ET sources
Extend value by connecting and contextualizing data

Apply governance to diverse data sets
Trusted data gets used more for less cost

Deploy more solutions faster
Data in one place with interoperability for a modern architecture

Automate data and asset modeling
Scale across sites more efficiently

Edge Management + Connectivity

Edge™ Manager

FT Optix™

FactoryTalk Hub™

DATA EXTRACTOR

Historians

PLCs / IoT

MES

QMS

CMMS

ERP

Simulation

Files

Operational (OT) Data

Conventional (IT) Data

Engineering (ET) Data

Rockwell Automation

Contents

- Introduction to Overview of Rockwell Automation

- Mining Industry Themes

- Defining Digitalization

- The Connected Mine

>> - Mining Applications

- The Promise of Artificial Intelligence & Machine Learning

- The Path to Autonomous Mining

- Summary and Wrap Up

Rockwell Automation KALYPSO

Our Energy Management Approach

Energy Consulting
Energy Consultancy, Energy Audit, Identification of Energy Optimization opportunities, and Power Quality

Design and Implementation
Design and Implementation of Building/ Utility Management Solutions/ Process Optimization Solutions

Smart Energy and Artificial Intelligence
Energy optimization through the implementation of AI, MPC and Closed-Loop Algorithm

AI-Powered Energy Management System
Deployment and configuration of New Generation Energy Management solution

Distribution Energy Generation
Load shedding, Demand Management, cogeneration and renewables integration

- Understand Energy Use
- Identify Savings Opportunities
- Plan and Prioritize Energy Projects
- Implement
- Monitor, Verify, and Report

Rockwell Automation

KALYPSO
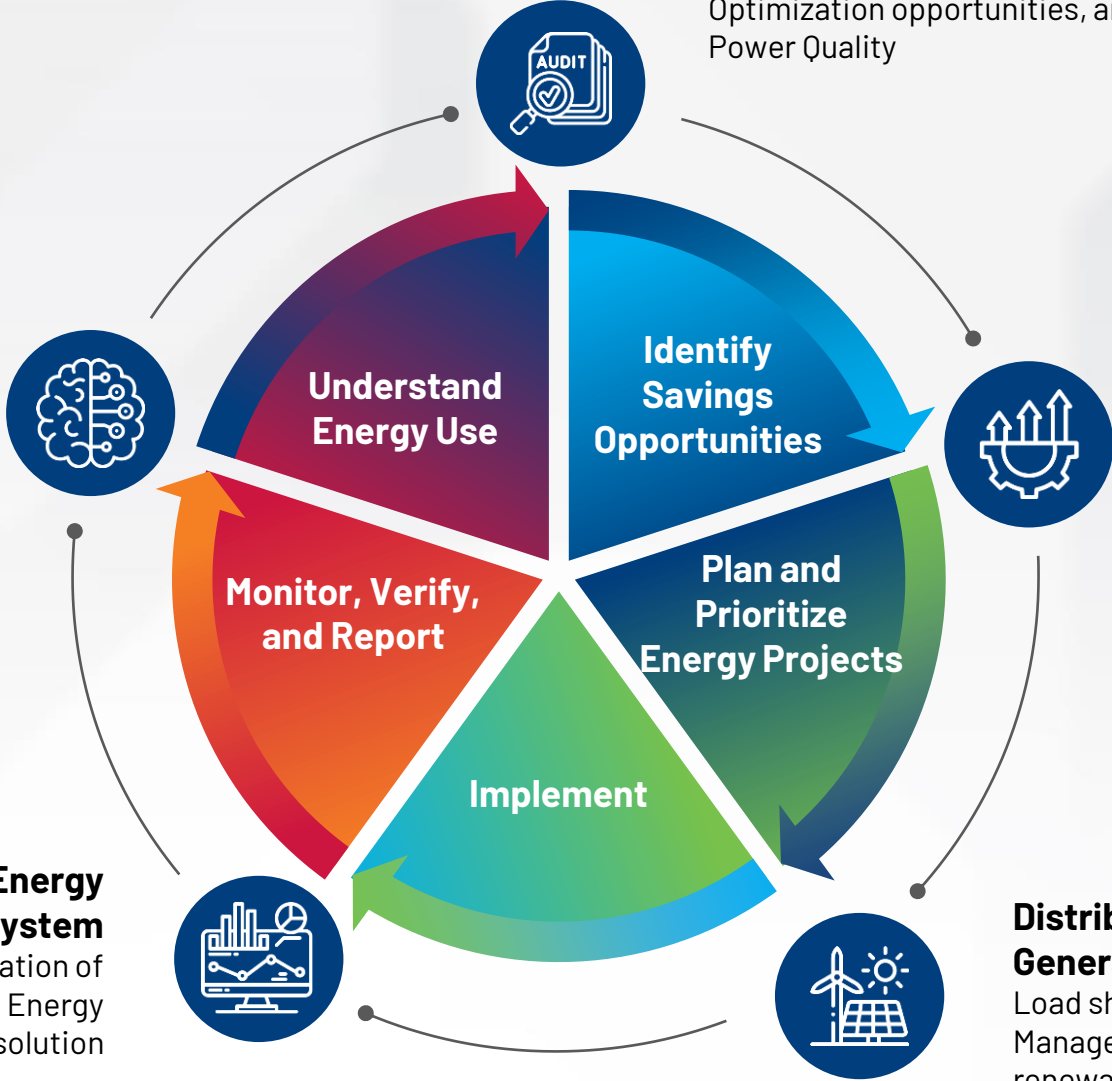
Make ENERGY data valuable

**50 m³ Natural Gas,
Machine A,
Last 24h,
Asset Utilization 50%**

Operational State and Process Data

50 m³ Natural Gas

Aggregate data from disparate sources

Make Data Available	Make Data Meaningful	Make Data Useful	Make Data Valuable

Asset Hierarchy and Time Context

**50 m³ Natural Gas,
Machine A,
Last 24h**
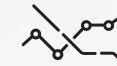
Operational Data

**50 m³ Natural Gas,
Machine A,
Product Z,
by Unit of Output**

→ **Energy/Emissions
Intensity by Product or Batch**

Rockwell Automation   KALYPSO

Make ENERGY data valuable

TIME

ENERGY MODEL

DATA

4

OPERATIONAL DATA

OPERATIONAL STATE AND PROCESS DATA

ENERGY MODEL HIERARCHY

ELECTRICITY
- Demand
- Consumption
- Power Quality

NATURAL GAS

PROPANE

BIO GAS

GASOLINE

DIESEL OIL

HYDROGEN

COAL

CRUDE OIL

TALLOW
- Mass/Flow Rate
- Consumption

COMPRESSED AIR*

HOT WATER*

CHILLED WATER*

STEAM*
- Mass/Flow Rate
- Consumption

WATER

WASTE WATER
- Mass/Flow Rate
- Consumption

- Unit of Output Count
- Product ID
- Batch Start-End Time
- Batch ID or Recipe

- Utilization
- Asset State or Status
- Temperature
- Quality

- Hierarchy
- Physical Location
- Resource Type

**3600 kJ Energy,
Machine A,
Product Z,
by Unit of Output**

**→ Energy/Emissions
Intensity by Circuit or Asset**

Rockwell Automation

KALYPSO

Energy Management – bringing it all together

Ability to monitor and start saving energy

- WAGES Meters
- Production Yield
- Energy Costs
- GHG Emissions

Drive insights for optimum energy and production efficiency

- Utility API
- Weather Data
- Product Level Contextualization
- Energy Generation

Closed-Loop Control and optimization of energy demand and supply

- Closed-Loop Control
- Real-Time Optimization
- Distributed Energy Resources Dispatch
- Production Scheduling Optimization

Forecast and simulate scenarios to improve energy efficiency and productivity

- Forecasting
- Predictive Maintenance
- AI-Based Energy Savings Detection
- Production Scheduling Simulation

ENERGY MANAGEMENT SYSTEM

AUTONOMOUS

ENERGY CONTEXTUALIZATION

ANALYTICS
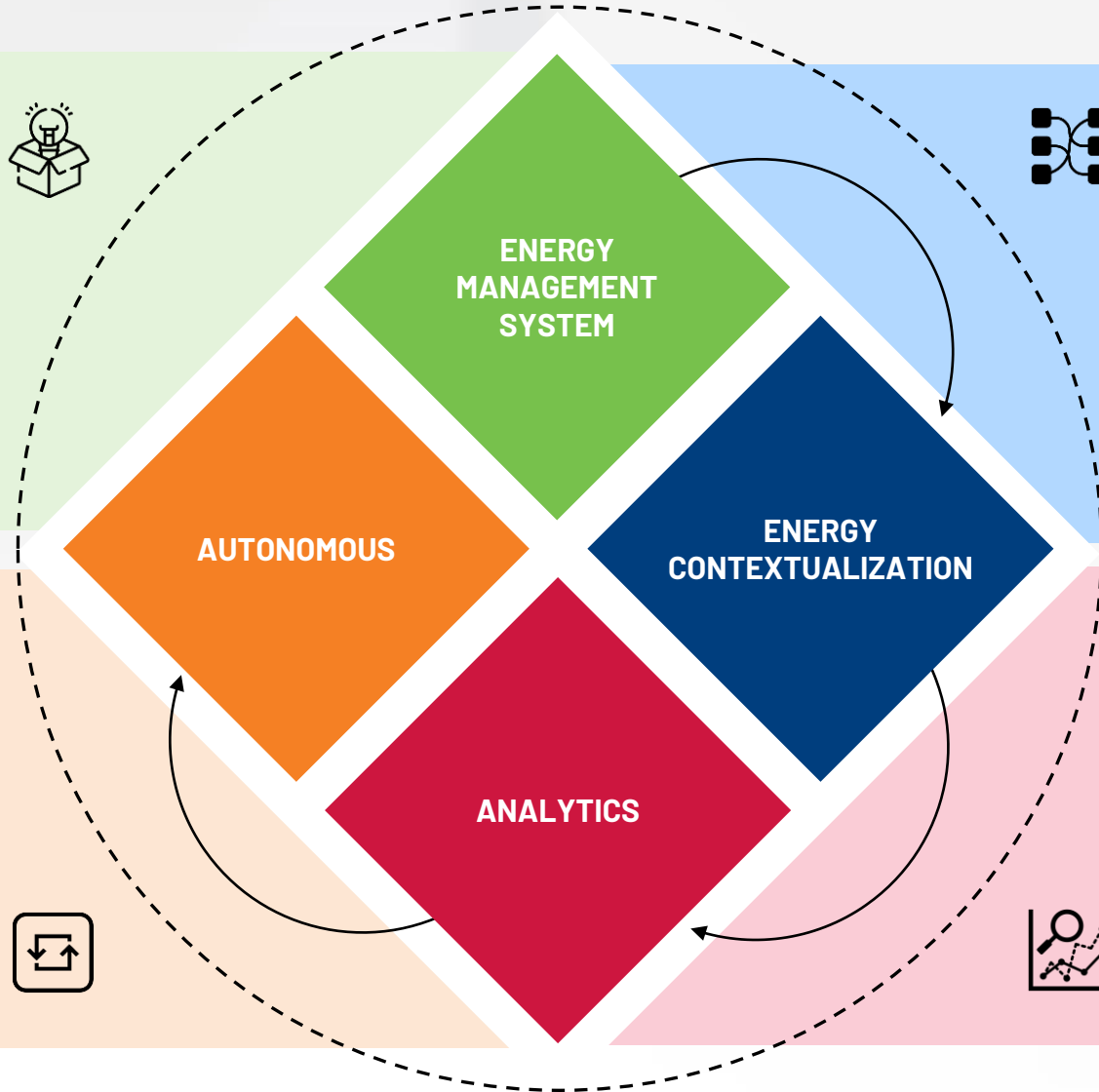
Implementing a real-time energy management solution leveraging IIoT platforms

Leading Chemicals Company

A global leader in chemicals required platform-based energy management capabilities to achieve significant energy costs savings within the enterprise.

Approach

1. Provided insights into plant's WAGES & costs with interactive real time energy dashboards starting at one plant, and rapidly scaled to additional plants

2. Tied-in with core IT & OT data systems

3. Achieved energy per product batch KPI

4. Kept stakeholders informed with different levels of data aggregation

5. Enabled data-driven decision making for continuous improvement
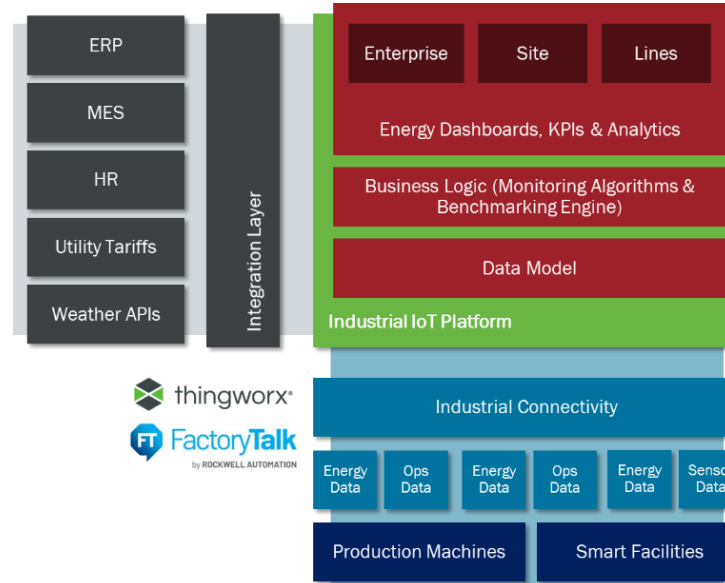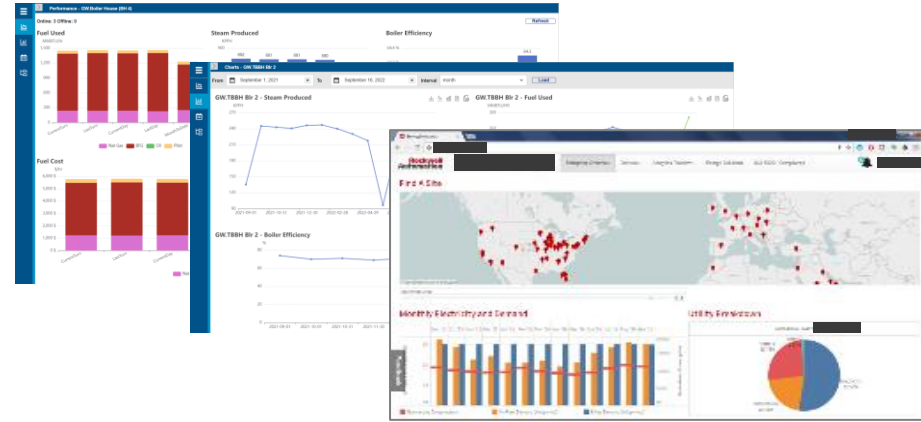
Results

10%
Reduction in energy costs by improving the overall system efficiencies with steam, compressor, process heating and process cooling

Delivered capabilities to minimize the variation of energy usage by product batch, production shifts etc.

Achieved insights to optimize peak demand proactively to reduce peak & ratchet charges

Rockwell Automation   KALYPSO

Building closed loop energy optimization models on top to further reduce energy consumption

A leading food and beverage client has committed to **reducing its energy footprint by 30% by 2025.**

Client has expressed interest to utilize a modern approach to optimize facility system efficiencies leveraging a diverse set of Data Science & AI techniques, employing FT Innovation Suite.
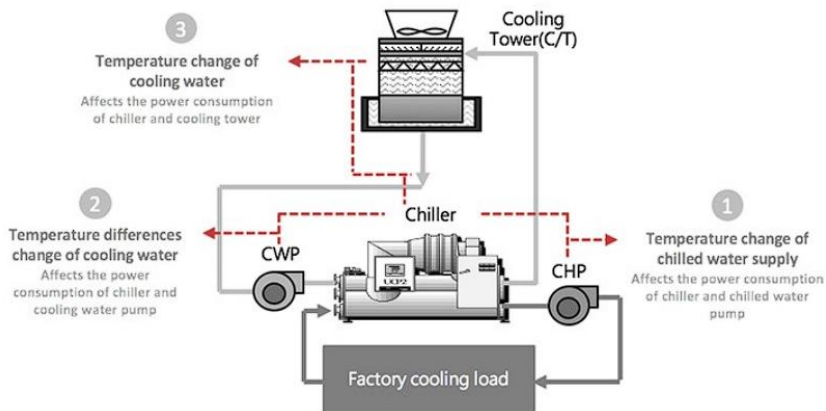
Traditional Approach
Outside-In

- Approach energy from conversion equipment
- Focused on equipment efficiency over system
- No tie-in to critical manufacturing process

Leading Approach
Inside-Out

- Optimize energy usage starting from end-use
- Focused on overall system-level efficiencies
- Close tie-in to critical manufacturing process

Traditional Approach

Energy Supply Savings

Energy End-Use Savings

Leading Approach

FACILITY EQUIPMENT   DISTRIBUTION   USE

Energy optimization at the end-use by integrating sensors translates to a **decrease in the overall energy demand**

Improved efficiency throughout the value chain results in **higher overall savings** in energy use, energy supply, and conversion equipment

Extends the life of equipment throughout the energy value chain by optimizing processes

Results

15%
Reduction in energy costs by improving the overall system efficiencies with steam, compressor, process heating and process cooling

Leveraged advanced machine learning control for process optimization to achieve consistent quality & optimized energy usage with predictive methods

Proactively identified and eliminated equipment cycling issues to increase the lifespan and reduce maintenance

With the technical capability to drive industrial decarbonization across the value chain

CONTEXT

Development and demonstration of low carbon technologies to transform CO_2 and CO streams from the steel industry into new value chains.

ACTION

PlantPAx DCS and Discrete Systems, Controllers and I/O, Drives, Network, Visualization, Project management and Consultancy.
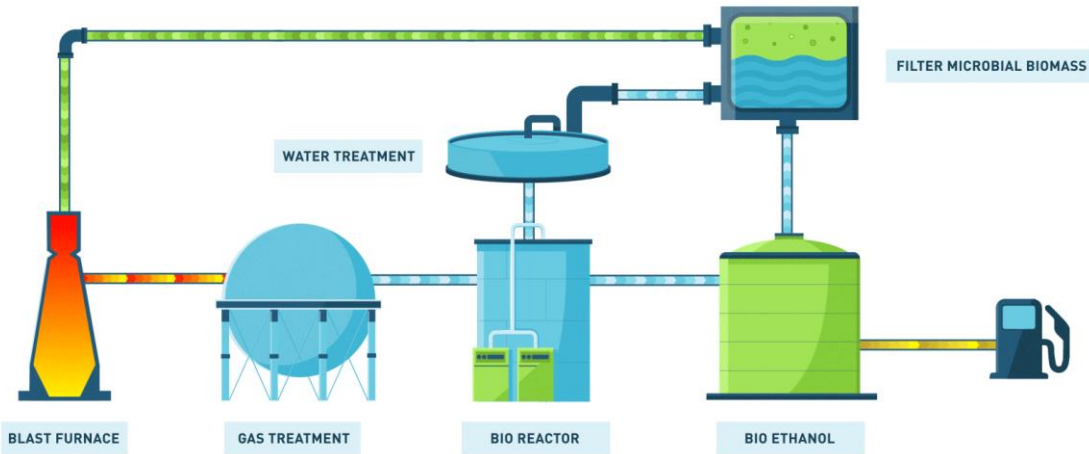
RESULTS

- Arcelor will convert 10% of its CO_2 exhaust into Ethanol.

- Yearly ethanol (C_2H_5OH) production: 64kTon/year; +/-80,000 m³/year (+/-10m³/h).

- 85 P&ID's, 3000 electrical I/O's, 225 Motors, 17 MW installed electrical power.

- Staffing during production phase: +/- 30 Full Time Engineers.

- Nearly full water reuse, no discharge to environment.

Steelanol — Fueling a sustainable future

Model Predictive Control

Mining Enterprise Digitalization Journey

DESCRIPTIVE	DIAGNOSTIC	PREDICTIVE	PRESCRIPTIVE	AUTONOMOUS
Can you capture data	Can you report on data	Can you trend data/apply BI	Can you model the data	Can your data automate operations

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KALYPSO
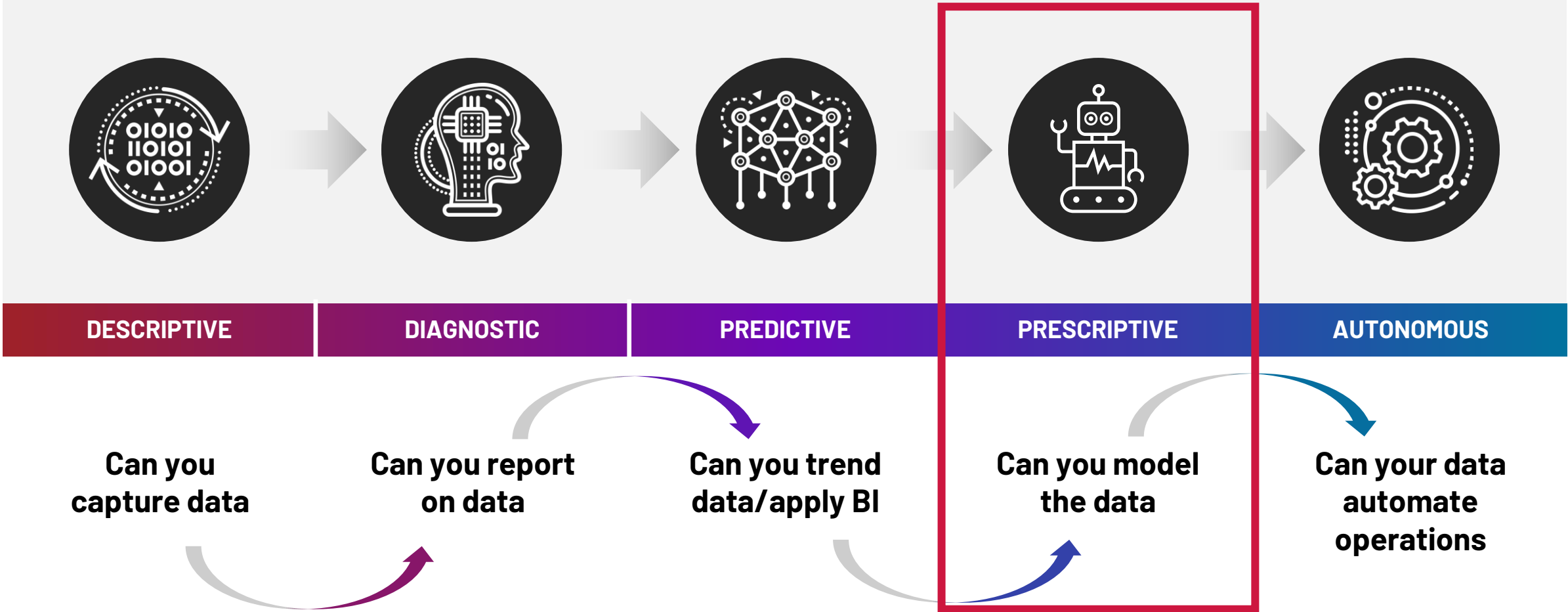
Model predictive control in mineral processing

Controlled Variables (CVs)

Process variables to maintain at a target or within a range (it can be considered outputs)

Constrain Variable (CCVs)

The state is forbidden to penetrate or may have physical limitations

Manipulated Variables (MVs)

A manipulated input is one that can be adjusted by the control system (or process operator)

Disturbance Variables (DVs)

Disturbance variables - these are also called "load" **variables** and represent input **variables** that can cause the controlled **variables** to deviate

CV — Mill level

MV — Feed (tons)

DV — Feed size

CCV — Power

Rockwell Automation   KALYPSO
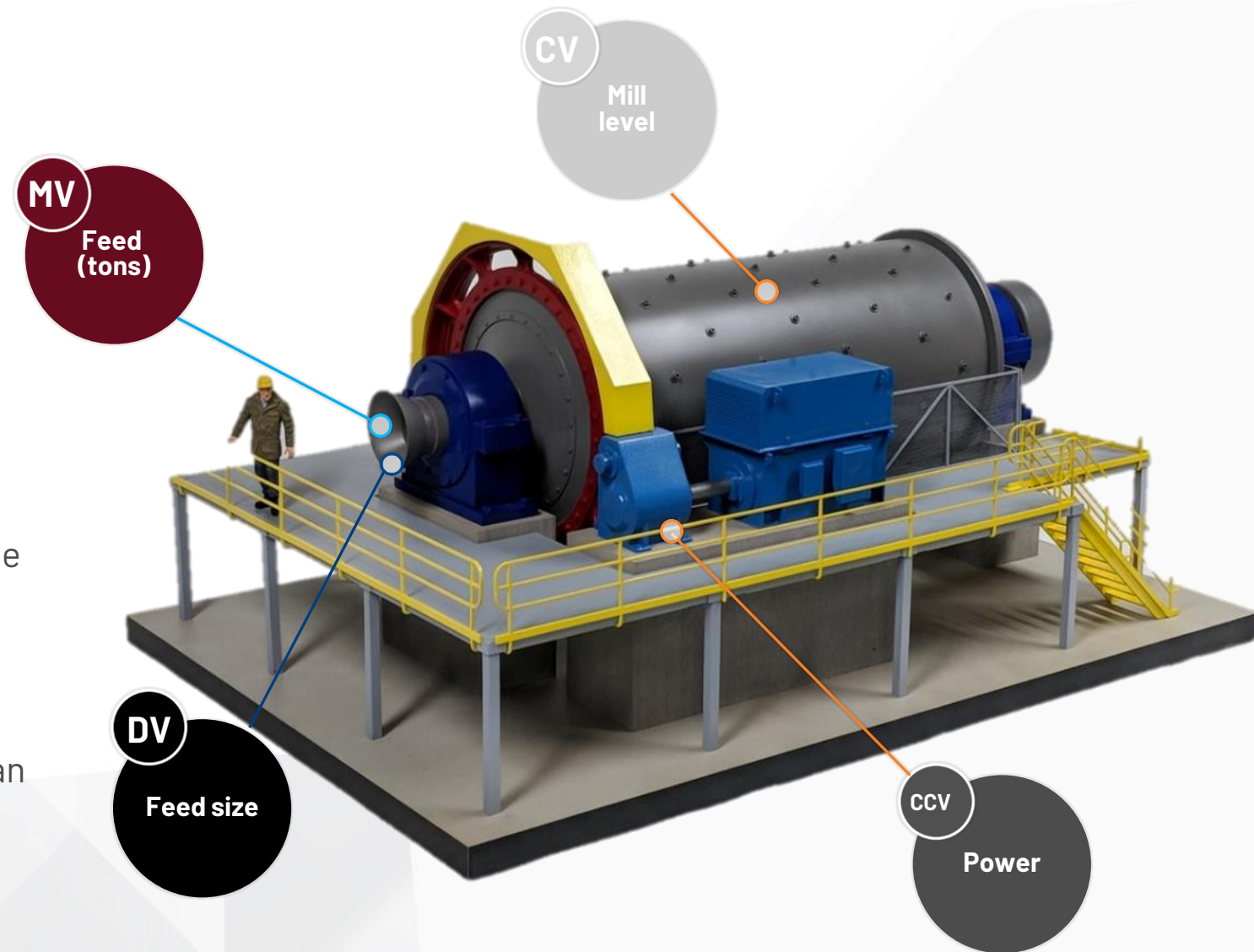
Model predictive control solution

MPC is a proven technology that improves plant and asset performance by reducing process variability

Controller based or software based

Hybrid modeling functionality allows the user to take advantage of all known information (empirical data, equations, equipment specifications, etc.)

Handle slow or complex processing lags

Virtual Online Analyzers replace sparse, or infrequent, feedback from lab or analyzer

Console for KPI's, value presentation and runtime visualization

Console

Virtual Online Analyzers©

MPC (Models)

PID   PID   PID

DCS Layer

Lab

FT Analytics™ Pavilion8™
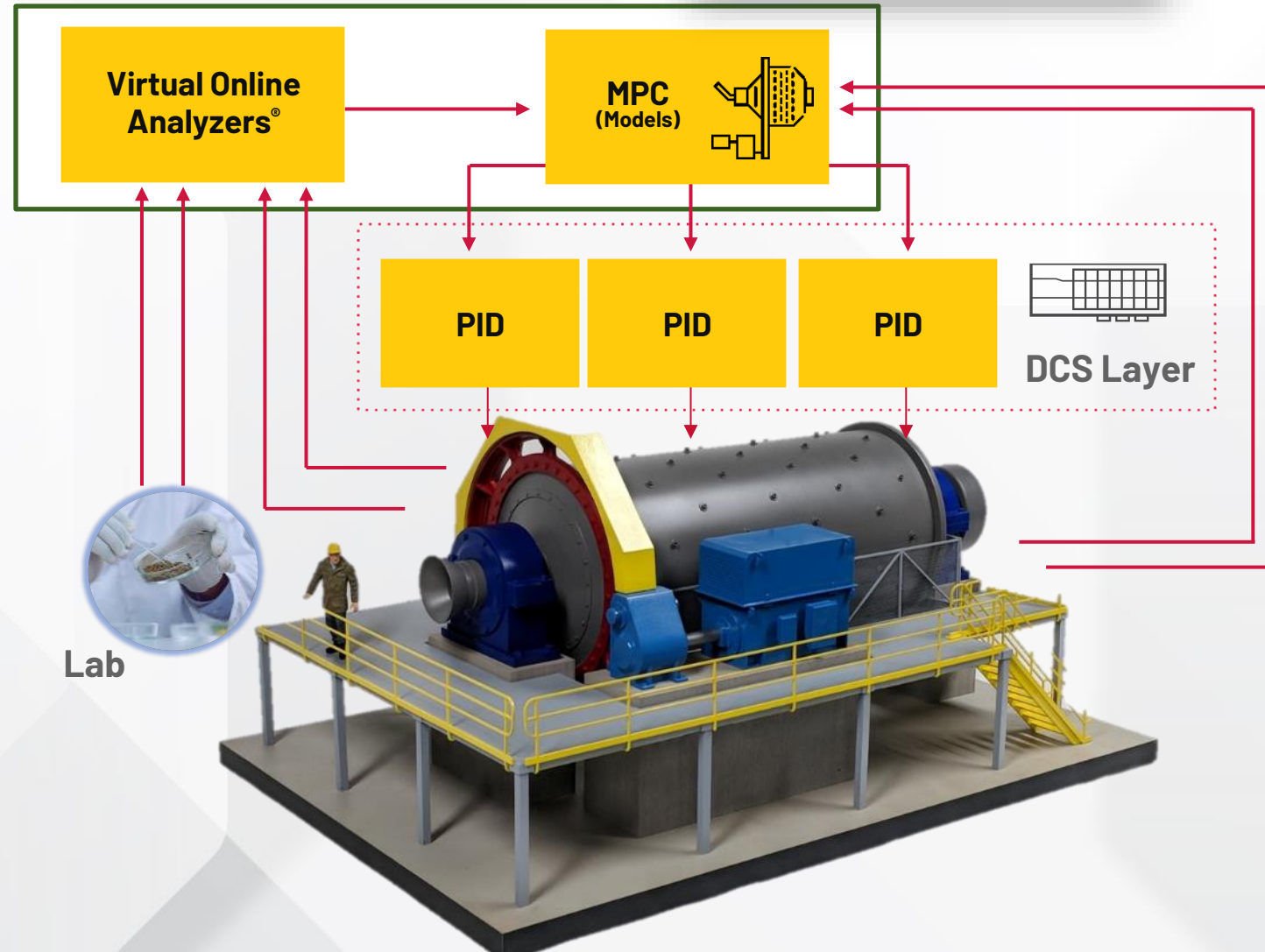
How model predictive control generates benefits

FT Analytics™ Pavilion8™

KEY PRODUCT PROPERTY PERCENT OF LIMIT

Process/Specification Limit

104
102
100
98
96
94
92

▲
▲
▲ **Benefits**

Push process toward limits

Variability under operator control

Variability reduction with MPC

Maintain quality just within specification

Before | **During** | **After**
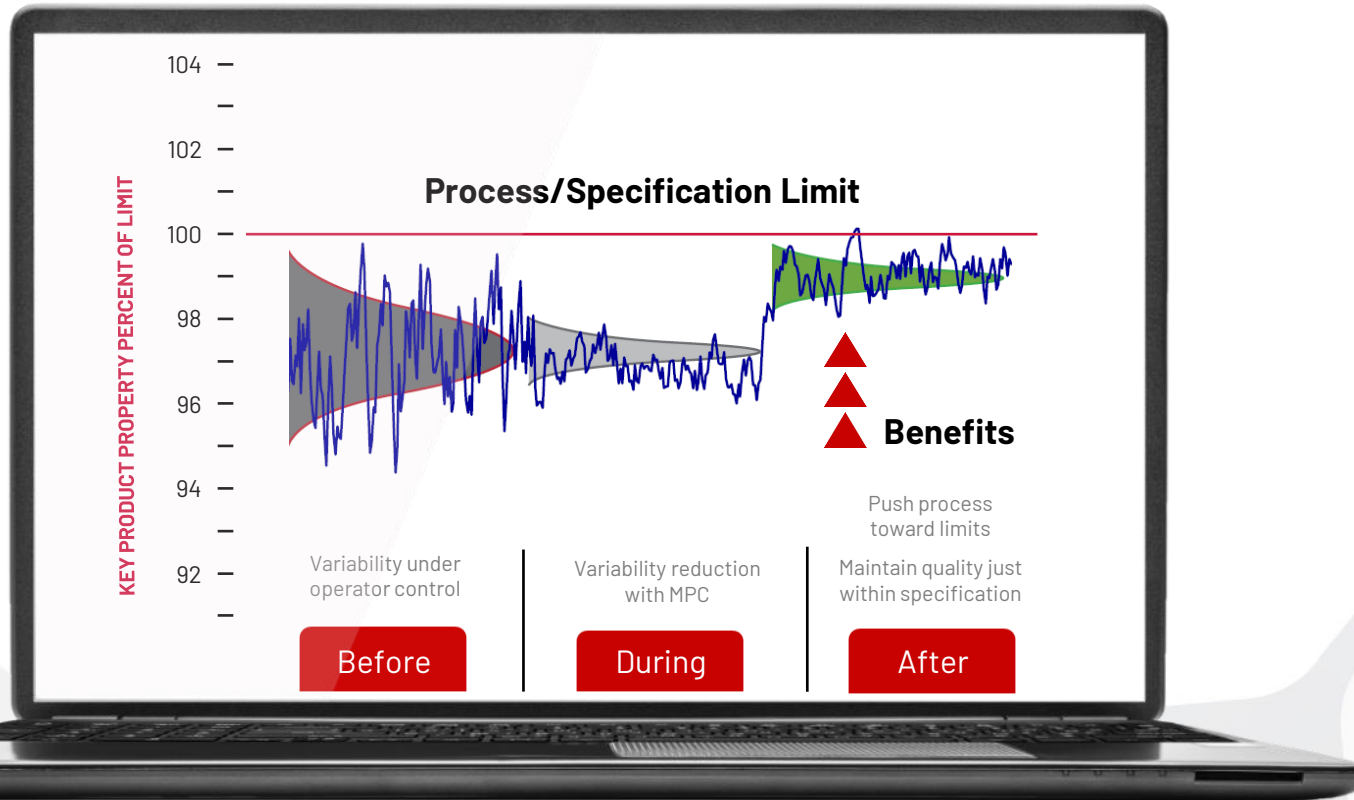
REDUCES variability

ACHIEVES plant stability

MANAGES the process within constraints

ACHIEVES UPLIFT – operate closer to specifications and performance limits while maintaining safety margins

Reduce variability, increase recovery and save consumables

Rockwell Automation

KALYPSO

MVP#1: AI/ML for closed loop optimisation on grinding circuits – Model Predictive Control

Process challenges

Complex behavior

Process disturbances

Relationship between variables is non-linear

Energy waste due to overgrinding

Requires operators with extensive experience

Balance between throughput and downstream constraints such as optimum particle size

MPC delivers

Maximized throughput rate

Decrease energy/ton

Increased stability

Reduction in particle size variation

Delivers grinding circuit stability to achieve throughput and grind size targets
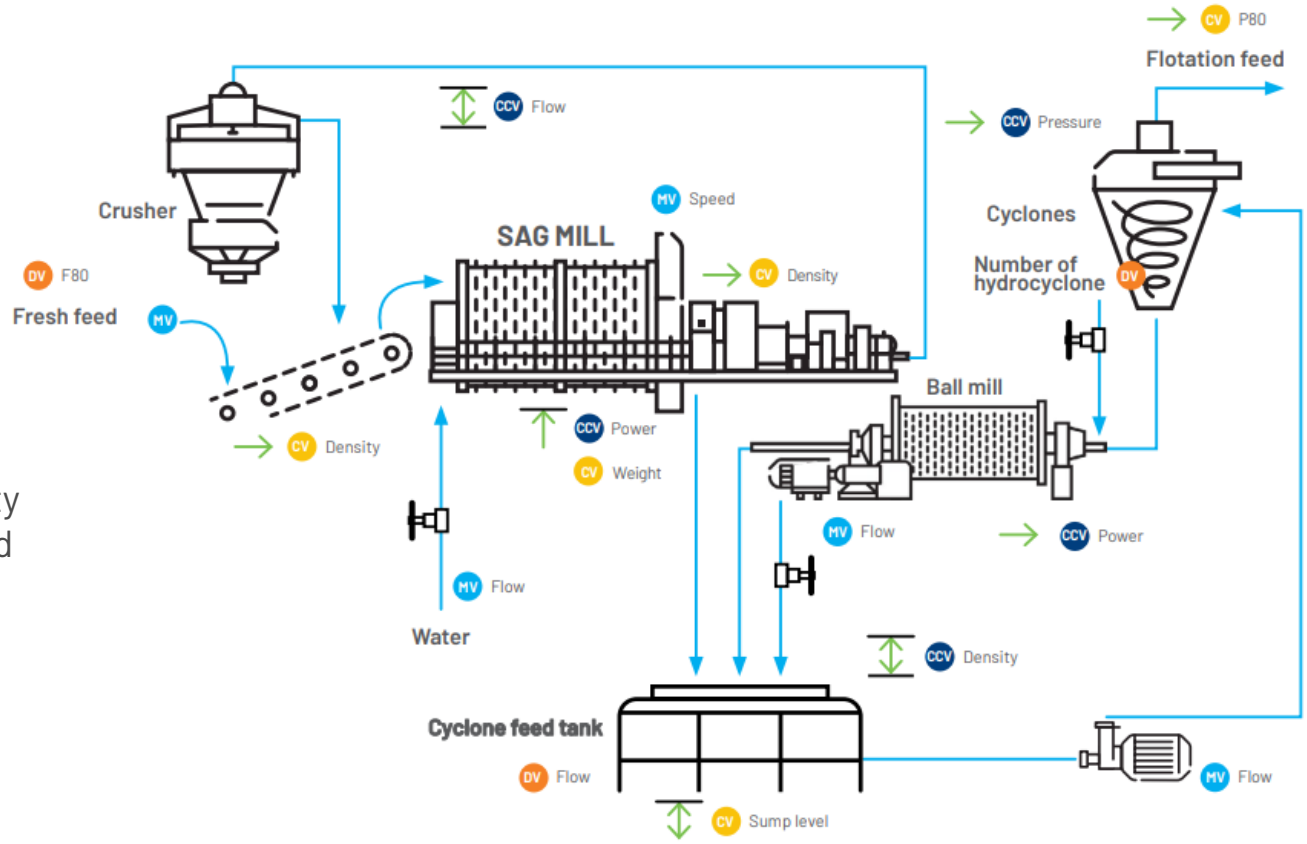
Potential gains:

Up to 10% increased throughput and same on reduced specific energy, with a P80 variability reduction of up to 50%

Newmont Mining: Cadia Concentrator 2 Grinding Circuit Optimization

Challenge

- Increase the stability of the overall process for recovering gold from ore
- Decrease the variability in process conditions
- Run the processing plant closer to operator constraints, and optimize the grinding circuit to increase throughput and yield

Solution

- Kalypso studied 12 months of historical data from the CON2 concentration circuit to identify key process parameters
- Applied the Grinding Circuit Application to monitor and control multiple process parameters simultaneously while adhering to plant constraints
- Configured MPC grinding application to adapt to variation of feed stock and other conditions to maximize throughput

Results

Increased stability of SAG mill operations

Increased throughput of grinding circuit

MPC implementation achieved well above initial project targets

MPC Grinding Circuit application was designed, implemented, and validated in 9 months

Rockwell Automation   **KALYPSO**

Asset Analytics/Performance Management

Mining Enterprise Digitalization Journey

DESCRIPTIVE	DIAGNOSTIC	PREDICTIVE	PRESCRIPTIVE	AUTONOMOUS

Can you capture data

Can you report on data

Can you trend data/apply BI

Can you model the data

Can your data automate operations

Rockwell Automation   KALYPSO
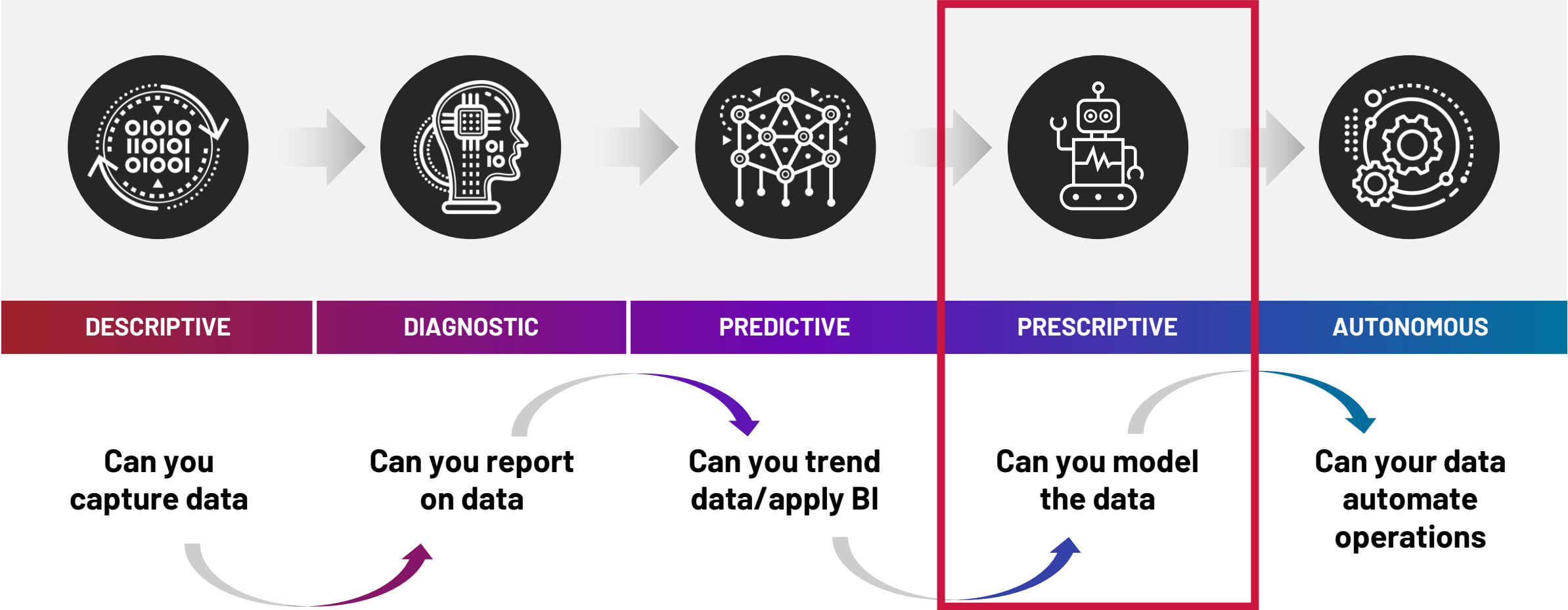
MINING SOLUTIONS ASSET ANALYTICS

Designed for Mining

Scalable

Powerful

Open

Built-in Mining Assets

Integrated Asset Classes

Aggregated equipment overview - Parent child relation detail

Automatic KPIs rollup

Asset Health with Remaining Useful Life estimates

Build your own Asset & Component Class and Formula Definitions
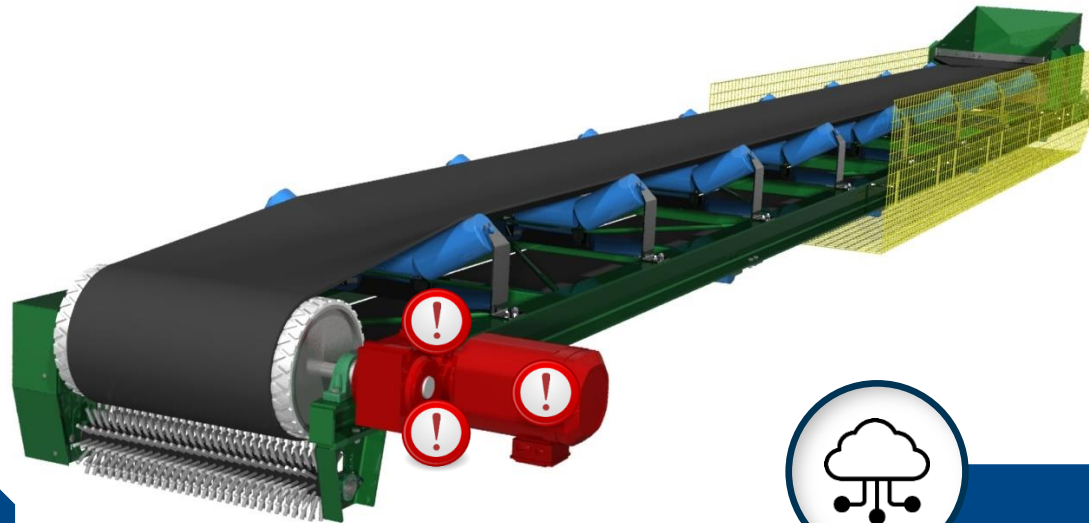
Open connectivity with OT / IT systems

Built-in sensor health with Alerting and Notifications

Multisite / Enterprise Application

Rockwell Automation

Built-in Mining Assets

Pre-built Asset Class Definitions help teams focus on what really matters

Challenges Addressed

› Lack of consistency (across sites, assets).

› Excessive use of internal resources for applications development.

› Teams spending more time developing applications and building assets classes than using them.

› Variability in measuring performance, availability and reliability of assets.

Our Solution

› Library of common assets (Ball Mill, conveyors, pumps, ...).

› Prebuilt mining asset classes

  › Main KPIs (Remaining useful life, Asset Health, ...).

  › Exhaustive list of Sensor Inputs (Bearing temp., conveyor pulley speed.).

  › Configured analytics functions (Calculated / formulas).

› Create your own Asset Class, define your own Formulas and KPIs.

▶ Faster time to value - Templates save time and money.

▶ Reduction in errors across sites.

▶ Creates flexibility to move from site to site.

Rockwell Automation
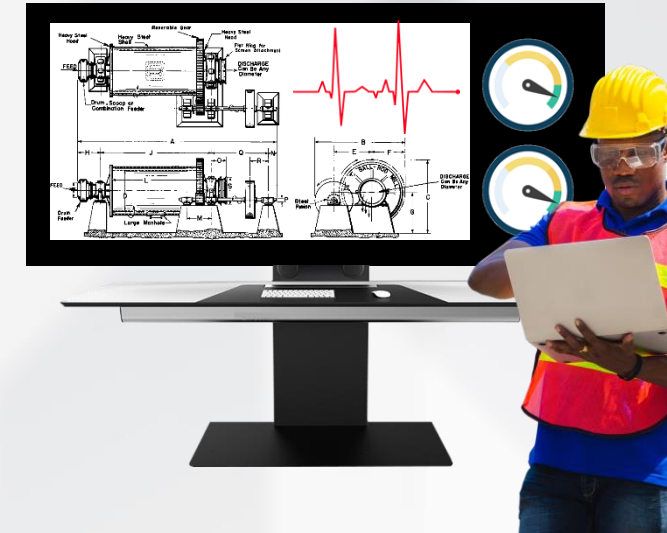
Ball Mill Pre-Built Asset Class

Predefined Formulas and KPIs

Predefined Inputs

Predefined Component List

Remaining Useful Life and Health Estimates

Alerting and Notifications

Ball Mill Asset Class Example:

Components (8)
Sensor Inputs (63)
Analytics and KPI Functions (6)
RUL & Health Estimates (2)
Alerting and Notifications (All)
Predefined UI

Integrated Asset Analytics

Unlock proactive and data-driven asset management through analytics.

Challenges Addressed

› Information Chaos: Stressful scavenger hunts for data and solutions.

› Operational Hazards: Pressure to resolve issues quickly, often risking safety.

› Data Silos: Fragmented knowledge and tools leading to poor decisions.

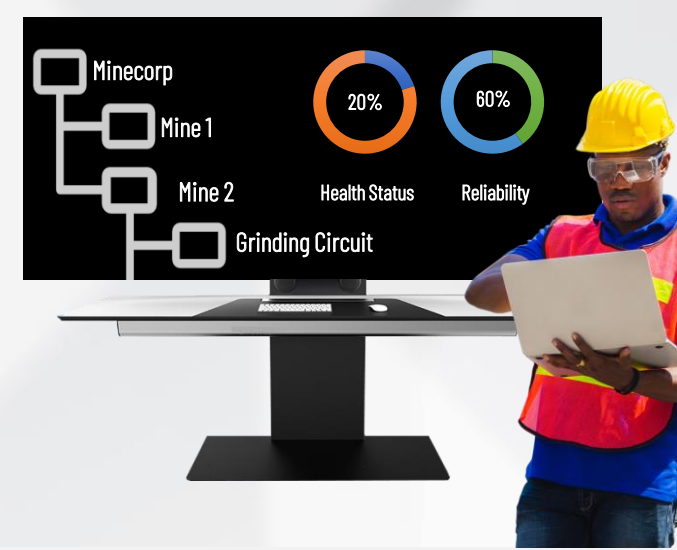› Flexibility & Complexity: Inability to adapt analytics to unique asset needs.

Our Solution

› Alerts and Notifications with rules to minimize information overload.

› Aligned asset hierarchies with parent-child relations.

› Customizable KPIs, failure estimates on Components and Assets, and easy third-party integration.

› Integrated sensor health checks and plotting tools.

► Simplified processes for maintenance teams.

► Captured knowledge for better organizational practice.

► Reduced unnecessary maintenance expenses.

► Better coordination between IT and Maintenance teams.

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Unified Visibility

Improved asset visibility and decisions by integrating disparate data into unified platform

Challenges Addressed

› Lack of an integrated view of all assets across all the operations.

› No benchmarking between operations or assets.

› Poor situation awareness.

› Too many assets / conditions and sub-conditions can drive wrong analysis and consequently bad decisions.

› Poor prioritization of activities.

Our Solution

› Simple visualization, configuration and navigation.

› Unified visibility with KPIs rolled up as per hierarchy definition, with weighted average option.

› Have a big picture of your asset's management activities.

› Easy identification of worst performers.

› Easy identification of highest priority items.

▶ Benchmarking operations / assets alike.

▶ Facilitate continuous improvement.

▶ Better decisions.

Rockwell Automation

Open & Scalable Data Ops Solution

Seamlessly grow your asset management capabilities without compromise, all while ensuring secure and open integration across your enterprise.

► Meet goals within time and budget, while reducing Total Cost of Ownership.

► Easily expand your asset scope and scale your operations.

► Lower maintenance costs and reduced vulnerability risks.

► Simplified IT and OT integration for a more cohesive operational strategy.

Challenges Addressed

› Scalability hurdles: From multi-site limitations to tool proliferation and a lack of standardization.

› Vendor lock-in: Proprietary systems that tie your hands and balloon costs.

› Complexity and knowledge gaps: Tools that are too complex for daily operations and require specific expertise.

› Compliance and support risks: IT constraints, support vulnerabilities, and end-of-life issues.

Our Solution

› Expandable across sites and assets, with cloud scalability.

› Constantly evolving with new modules and functionalities.

› Seamless connection with existing systems, IT tools, and future applications.

› Built on the robust FactoryTalk® DataMosaix™ platform, ensuring data security and compliance.

Rockwell Automation

Contents

- Introduction to Overview of Rockwell Automation

- Mining Industry Themes

- Defining Digitalization
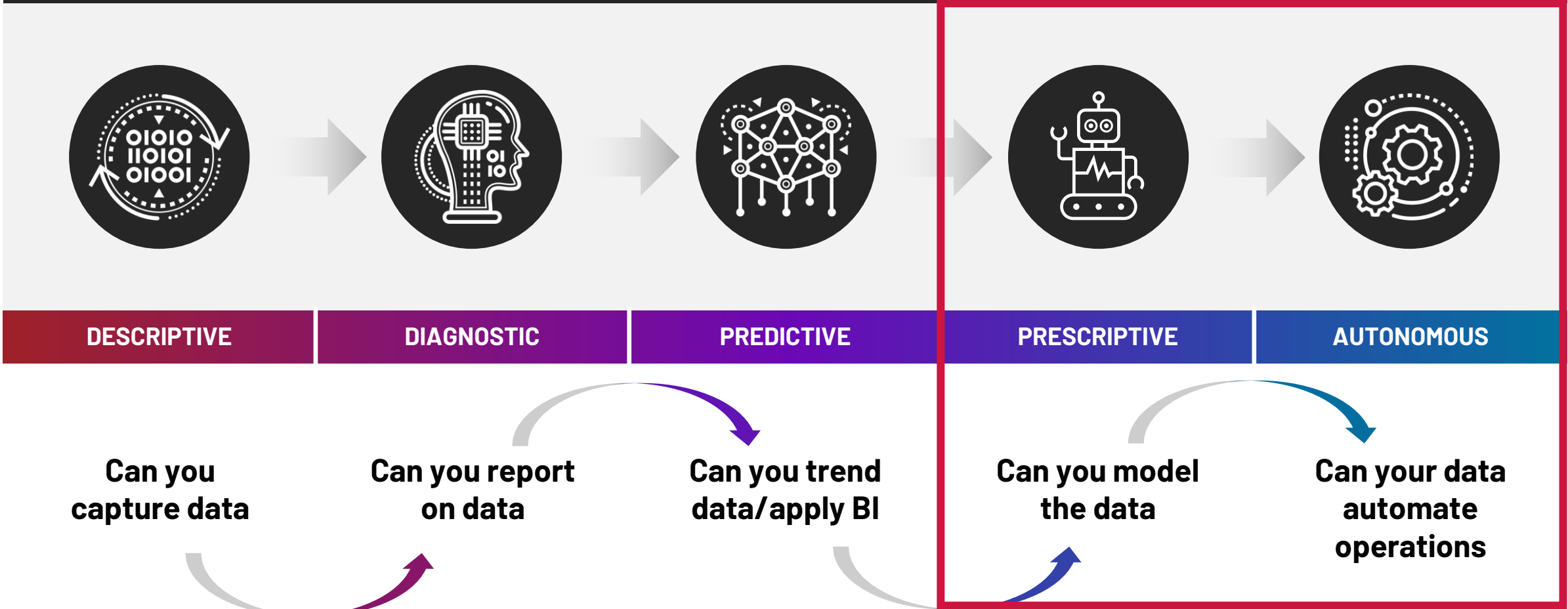
- The Connected Mine

- Mining Applications

- The Promise of Artificial Intelligence & Machine Learning

- The Path to Autonomous Mining

- Summary and Wrap Up

Artificial Intelligence & Machine Learning

Mining Enterprise Digitalization Journey

| DESCRIPTIVE | DIAGNOSTIC | PREDICTIVE | PRESCRIPTIVE | AUTONOMOUS |

Can you capture data

Can you report on data

Can you trend data/apply BI

Can you model the data

Can your data automate operations

Rockwell Automation

KALYPSO

AI and autonomous systems will change the industrial automation landscape the way autonomous vehicles have changed automotive

FROM AUTOMATION

System is programmed to perform tasks in the absence of human intervention

TO AUTONOMY

System *learns* to perform tasks, and adapts learnings in environments of uncertainty

|	FROM AUTOMATION	TO AUTONOMY
DEFINITION	Programmed	Programmed + Learned
ADAPTATION	Manually re-programmed	Dynamically adapted with continuous learning
TALENT	Engineers	Engineers + Data Science Skillsets
KNOWLEDGE ASSETS	Domain knowledge, first principles	Domain Knowledge + High volume of diverse data
BEST APPLICATION	Simple, linear problems with few variables	Multi-variable, nonlinear, dynamic problems

Rockwell Automation   KALYPSO
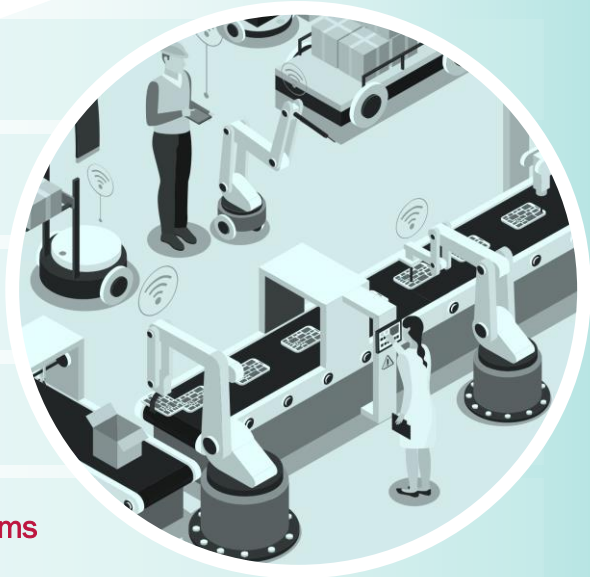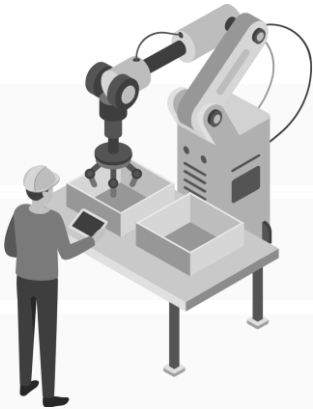
AI Opportunities in Industrial Automation

AI helps solve complex planning, optimization and control problems across the automation landscape

DECISION HIERARCHY		OPPORTUNITY	IMPACTED PLATFORMS	NEW CAPABILITIES	
LEVEL 4+	BUSINESS PLANNING	*Better forecasting and equilibration of supply and demand*	ERP, PLM	Intelligent Supply Planning	Predictive Demand Forecasting
LEVEL 3	OPERATIONS MANAGEMENT	*Optimized production plans and allocation of production resources*	MES, MOM CMMS	Finite Scheduling Optimization	Inventory Optimization
				Predictive Maintenance	Energy Modeling & Optimization
LEVEL 2	CONTROL	*More robust control of complex dynamic production processes*	PLC, DCS & SCADA	GPT CoPilot for PLCs	AI-based Control Methodologies
				Digital Process Models	AI-based Design & Emulation
LEVEL 1	SENSING	*More accurate measurement of process, product and equipment parameters*	Physical and virtual sensors	Soft Sensing	Machine Vision
				Anomaly Detection	Condition Analysis
LEVEL 0	EQUIPMENT				

Rockwell Automation   KALYPSO

Our core AI innovation programs help clients to achieve Autonomous Operations

Autonomy and Closed Loop Optimization can be achieved at various levels through vertical integration.

LEVEL 3 — OPERATIONS MANAGEMENT

- Finite Scheduling & Inventory Optimization
- Plant Level Process Optimization
- Maintenance Planning
- Optimizing Production Designs in Simulation

OptimAI

OptimAI is the *brain for manufacturing operations management (MOM)*. It is designed create *optimized operating plans* including production schedules, preventative maintenance cycles, inventory, worker allocation and more.

LEVEL 2 — CONTROL

SUPERVISORY

- Dynamic Process Models
- Model-Based Control Methodologies

TwinAI

TwinAI is designed to operate as a *next gen control system*. Its job is to execute against the plan defined by OptimAI.

REGULATORY

- Adaptive Process Tuning

TuneAI

TuneAI is designed to execute on the set point recommendations that come from TwinAI. This is done by continuously optimizing PID gains

LEVEL 1 — SENSING

- Computer Vision — **VisionAI**
- Soft Sensing — **FT Analytics™ LogixAI®**
- Condition Analysis — **FT Analytics™ GuardianAI™**

PRODUCT

PROCESS

ASSET

VisionAI is designed to visualize the state of the product

LogixAI is designed to *infer* process variables that cannot be measured directly.

GuardianAI is responsible for sensing the health of the equipment and its electromechanical components.

R&D Initiatives

Products

Recent product releases:
- *LogixAI 3.0 (Feb '24)*
- *GuardianAI 1.0 (Mar '24)*

RA Rockwell Automation   **KALYPSO**

Autonomous Production System

AI investments designed to accommodate essential components of a production system

Which product..
...with which **materials**
...at which **volume**
...on which **equipment**
...with which **operator**
...at which **time**.

Operations Management

Production Logistics

Control

Sensing

Equipment

OptimAI — Operating Plan — FEEDBACK

OTTO AI — AMR (×3)

TwinAI — PLC (×3) — FEEDBACK / CONTROL ACTIONS

EQUIPMENT CONDITION — PROCESS STATUS — VISUAL QUALITY

GuardianAI — LogixAI — LenzAI (×3)

MIXER — *EXTRUDER* — *CONVERTER*

1) **OptimAI** determines best *operating plan* – the best production schedule along with the right materials, production assets and operator skillsets.

2) The materials determined by **OptimAI** are delivered to the right equipment by **OTTO AMRs** using on–board AI navigation and perception methods

3) This production targets are then passed to **TwinAI** which begins controlling physical equipment

4) **TwinAI** continuously checks with **LenzAI** to obtain visual feedback on the Lenasia product being produced and **LogixAI** for other sensory information. **TwinAI** adjusts the control actions based on this multi-modal feedback.

5) While the machine behavior is being controlled, **GuardianAI** continuously monitors the electrical and mechanical components of the machine to assess their working condition and ensure reliability

Rockwell Automation

KALYPSO

Rockwell Clients Advance Capabilities Towards Autonomy

Control Towers & Connected Workforce

Employees can be centralized and augmented with contextualized data to improve productivity, lower operating costs and combat workforce shortages

IOT, Machine Vision & Advanced Robotics

IoT, advanced robotics, and machine vision applied to operations create highly automated and responsive and agile operations

Advanced Scheduling & Resource Optimization

Intelligent, scheduling and resource optimization algorithms automate and improve the scheduling process

Advanced Simulation & Emulation

Digital Twins enable rapid iteration of design changes, validation of PLC Logic, and process optimization in current and future plants

Advanced Process Control & Optimization

Machine learning algorithms control and optimize manufacturing processes for higher yield, and optimal product quality and cost

Asset Performance Optimization

Artificial Intelligence detects and predict faults in assets before they happen and prescribes preventative maintenance for productivity and cost reduction

Energy Management & Sustainability

Effective strategies & digital technologies to optimize energy and water use for lower costs and a reduced environmental footprint

IT/OT Data Enablement (Data & Architecture that enable Advanced Manufacturing and Automation)

Contextualize OT factory data and IT data from across the enterprise to provide visibility and derive actionable insights for performance improvement while maintaining security

Rockwell Automation   KALYPSO

Maintenance planning challenges

Reactive
APPROACH

Run to failure

Only performing maintenance when problems occur

- x Unexpected equipment failures
- x Expensive repairs
- x Costly unplanned downtime
- x Lost production during extended downtime events

Proactive
APPROACH

Regularly scheduled maintenance

Based on time intervals or equipment manufacturer recommendations

- x Unnecessary, frequent planned downtimes
- x Increased need for maintenance resources
- x Expensive asset maintenance or replacements

KALYPSO

Guardian**AI Vision**

Utilizes all available data (electrical, vibration, process, vision, ...) for holistic predictive maintenance

FT Analytics™ GuardianAI™
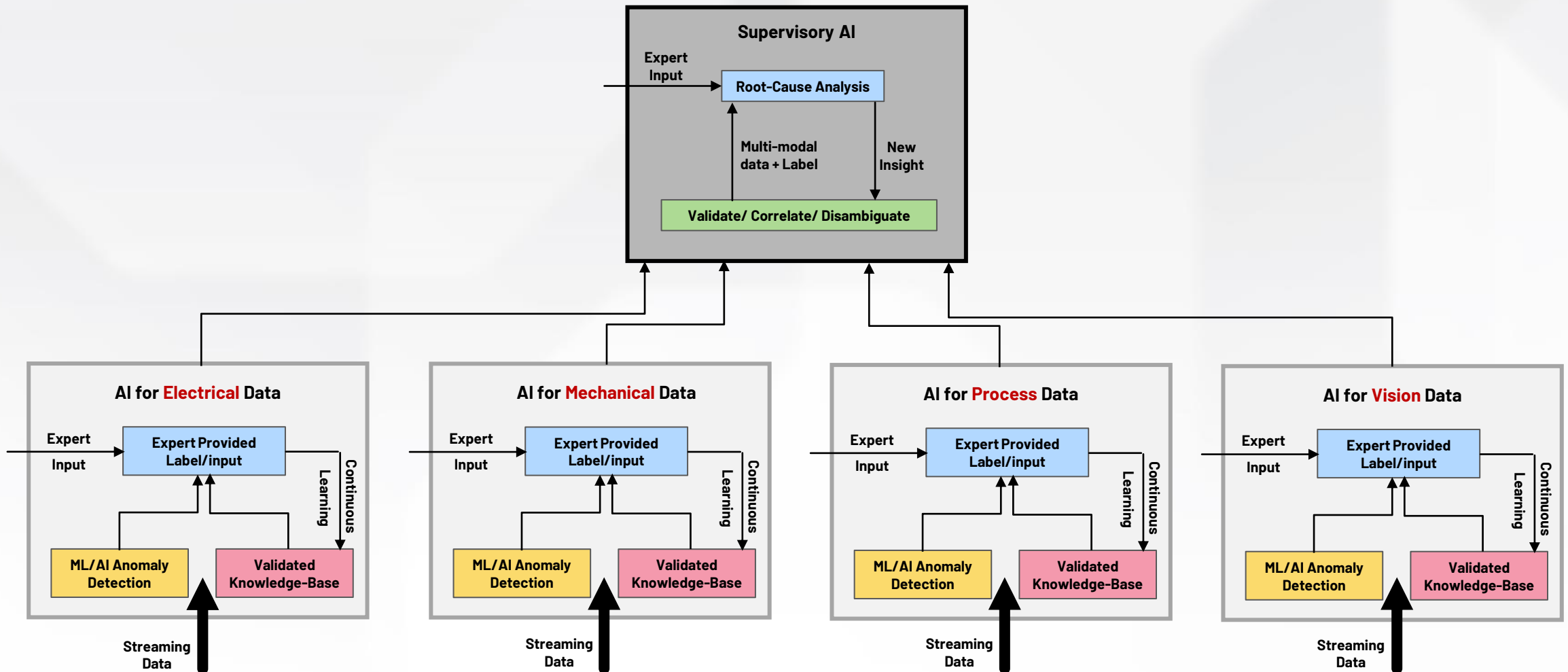
Machine learning for predictive maintenance at the edge

Use existing devices as sensors.

Get more insights out of your existing equipment data

No data science required.

Empower your OT professionals with easy-to-use machine learning

Advance from anomaly detection to anomaly identification.

Minimize investigation time with context about the type of failure that is going to occur

Analyze at the edge.

Train and run right at the edge for near real time predictions

Rockwell Automation

KALYPSO

Leverage drive data for predictive maintenance

FT Analytics™ GuardianAI™

Use existing devices as sensors

Detect upcoming equipment failures via **electrical signal analysis**

- Acquires buffered drive signals via trend object
- 3 phase current data
- Performs time and frequency domain analysis
- Data fidelity is enhanced algorithmically
- Useful in detecting bearing fault, stator fault, broken-bar, misalignment as well as application related faults

ASSET
Pump | Fan | Blower

Device
Variable frequency drive | More to come...

FT Analytics™ GuardianAI™
Anomaly Detection | Anomaly Identification

ALERTS
Email

Rockwell Automation | **KALYPSO**

Premier integration with PowerFlex® drives

With a comprehensive range of power options and innovative features, PowerFlex variable frequency drives bring performance and capability to a wide variety of industries and applications.

PowerFlex 755 drive

Low voltage drive suited for a wide variety of motor control applications including pumps, and fans

PowerFlex 755TL TR & TM drives

Provide harmonic mitigation, regeneration and common bus solutions

PowerFlex 755TS drive

Suited for common traditional variable frequency drive applications and specialized applications that require high performance motor control

PowerFlex 6000T drive

Medium voltage drive suited for a variety of applications including fans, pumps and compressors
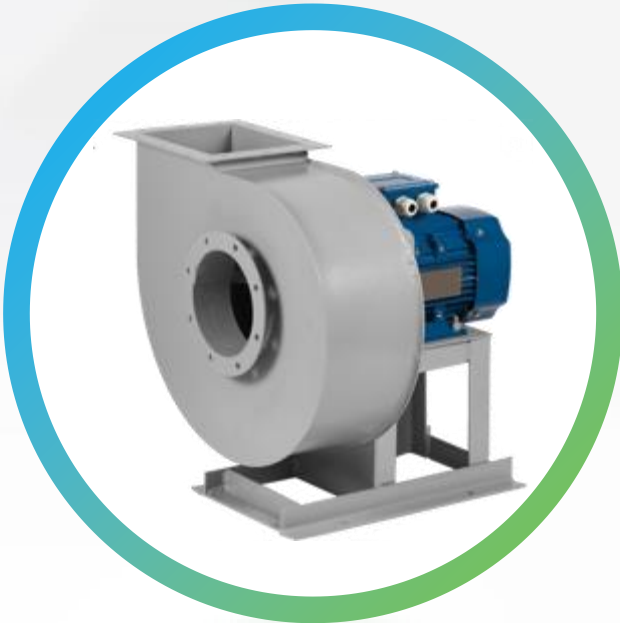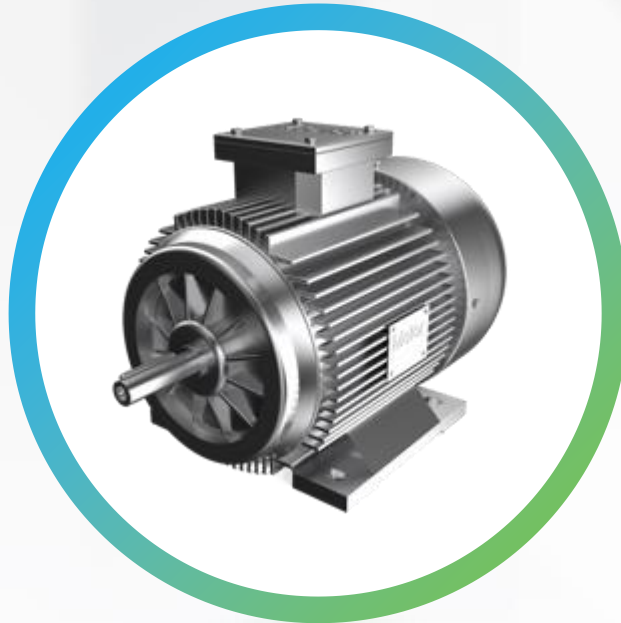
Out of the Box Supervision for Plant Assets

Pumps

Fans & Blowers
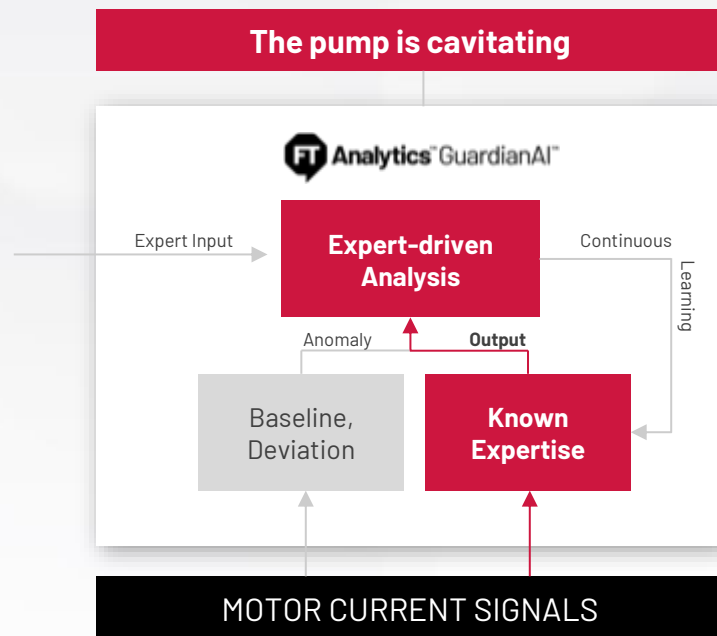
Motors

Embedded expertise

EMBEDDED EXPERTISE

FactoryTalk® Analytics™ GuardianAI™
recommends causes of faults

The pump is cavitating

Analytics™ GuardianAI

Expert Input → **Expert-driven Analysis**

Continuous Learning

Anomaly | **Output**

Baseline, Deviation

Known Expertise

MOTOR CURRENT SIGNALS

First principle faults detected out of the box

Pumps
- ✓ Impeller Unbalance
- ✓ Blade Fault
- ✓ Cavitation
- ✓ Viscosity Changes
- ✓ Shaft Misalignment
- ✓ Change in Fluid Dynamics

Fans and Blowers
- ✓ Blade Misalignment
- ✓ Blade Unbalance
- ✓ Blade Wear
- ✓ Loose Blade
- ✓ Electrical Fault
- ✓ Motor Fault
- ✓ Shaft Misalignment
- ✓ Fan Bearing Fault
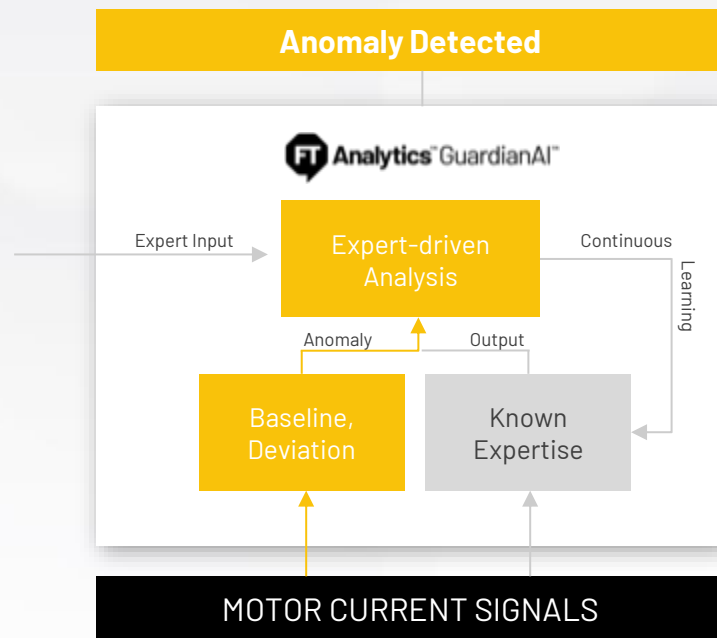
Motor Analytics
- ✓ Unbalance
- ✓ Shaft Misalignment
- ✓ Loose Structural Mounting(Soft Foot)
- ✓ Mechanical Looseness
- ✓ Rotor Rub
- ✓ Ball Bearing Fault
- ✓ Inner Race Bearing Fault
- ✓ Outer Race Bearing Fault
- ✓ Bearing Cage Fault

User classification

USER CLASSIFICATION

Train FactoryTalk® Analytics™ GuardianAI™
to identify anomalies specific to your operation

Continuous Learning

+ Enhance FactoryTalk Analytics GuardianAI with AI by **labeling** and **training new failure modes**

+ **Contextualize new faults** that occur by incorporating feedback directly from maintenance engineers

+ A contextualized signature is **automatically embedded**

Rockwell Automation

KALYPSO
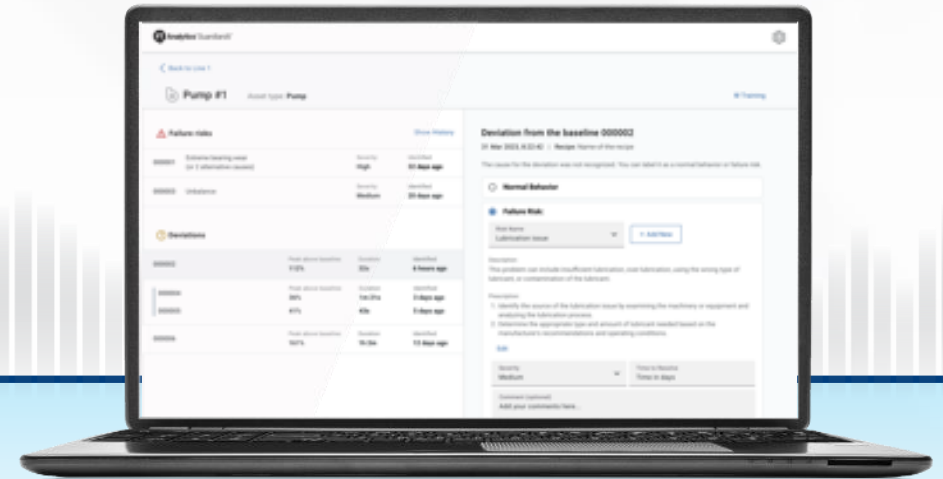
FactoryTalk Analytics GuardianAI

Production Assets
- Pump
- Fan/Blower
- Motor

Intelligent Device

Control Layer

HMI

Edge Layer

FT Analytics™ GuardianAI™

Edge to Cloud Lifecycle Managed

fiix

FactoryTalk Hub™

Edge™ Manager

The Future of FactoryTalk Analytics GuardianAI

Controller Connection
Add production contextualization and operator notifications

Rockwell Portfolio Integration
Surface insights for higher level analytics

DataMosaix™   Optix™

Vibration Monitoring
Expand supported applications

Rockwell Automation

KALYPSO

Improve worker safety with predictions about equipment failures

OBJECTIVE

Ventilation systems are essential to mining operations. They help to deliver the safety and well-being of the miners by circulating fresh air and removing stale air, hazardous gases and dust from the mine.

Any unplanned downtime of a mine's ventilation system endangers miners and results in substantial lost revenue.

APPROACH

PowerFlex® 6000T medium voltage drives are used to drive the ventilation system fans.

FactoryTalk® Analytics™ GuardianAI™ leverages data from drives to identify anomalies in the ventilation system operation.

The maintenance team is alerted when anomalies occur so they can perform the required maintenance on the system and correct the issue.
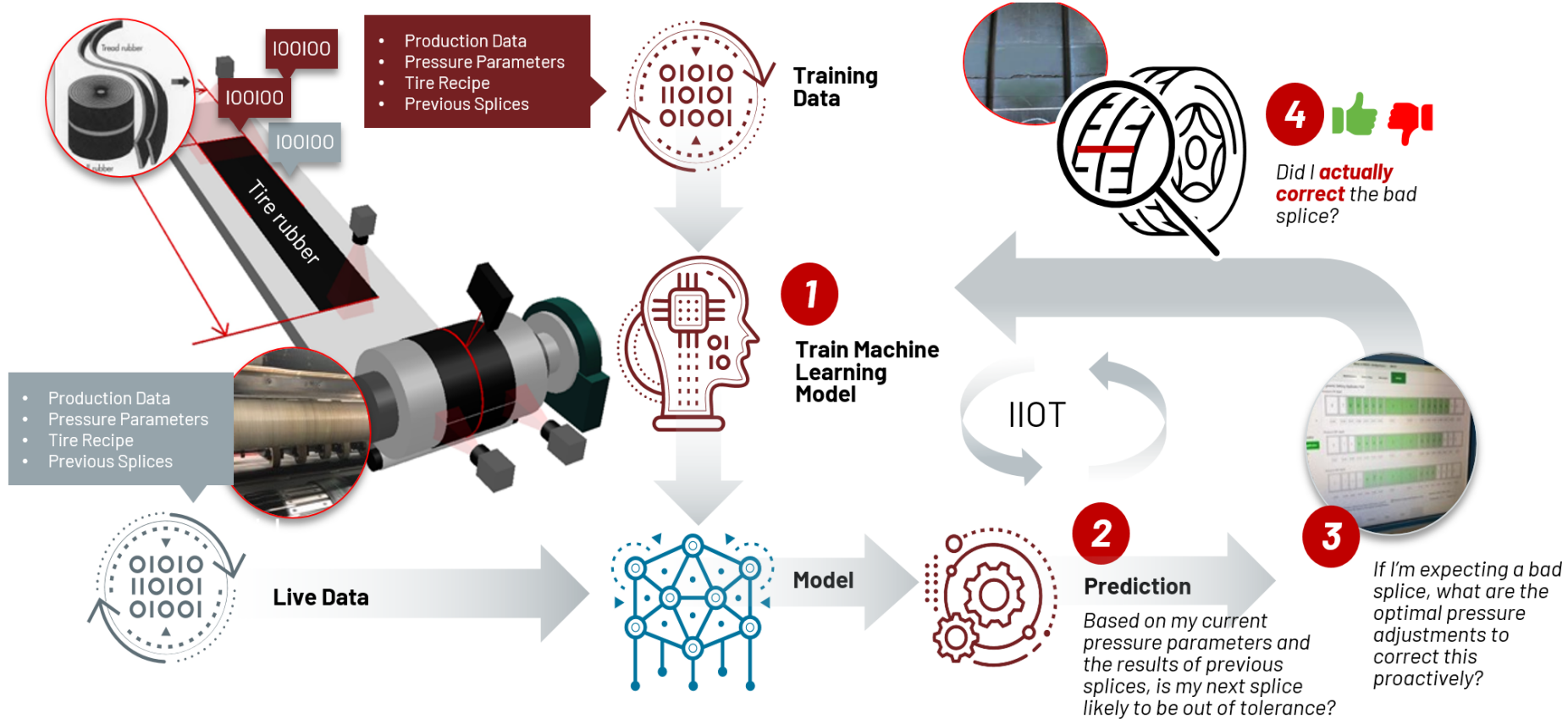
RESULTS

- Helped prevent unplanned downtime by detecting fan blade alignment issues

- Increased miner safety by predicting equipment failures before they occur

Rockwell Automation

Implementation of AI/ML for Closed Loop Optimization on Tire Manufacturing Processes

Goal: Increase tire quality by reducing machine deviations (out of tolerance splices)

- Production Data
- Pressure Parameters
- Tire Recipe
- Previous Splices

Training Data

- Production Data
- Pressure Parameters
- Tire Recipe
- Previous Splices

Live Data

1 Train Machine Learning Model

IIOT

Model

2 Prediction

Based on my current pressure parameters and the results of previous splices, is my next splice likely to be out of tolerance?

3 *If I'm expecting a bad splice, what are the optimal pressure adjustments to correct this proactively?*

4 *Did I **actually** correct the bad splice?*

The numbers

$285M pa

In benefits from increased tire production

570,000+

Per annum production increase of tires

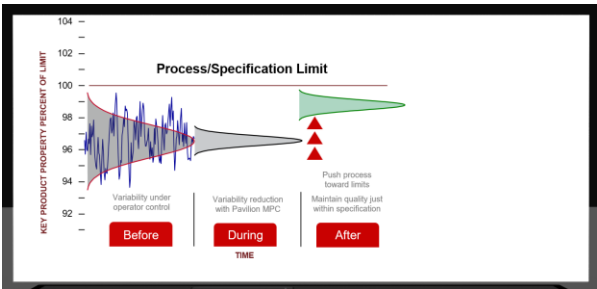**45%**

Reduction in downtime events

90%

Reduction in process variability, resulting in improved product quality

Rockwell Automation   KALYPSO

Global implementation of AI-driven closed loop optimization across 11 sites
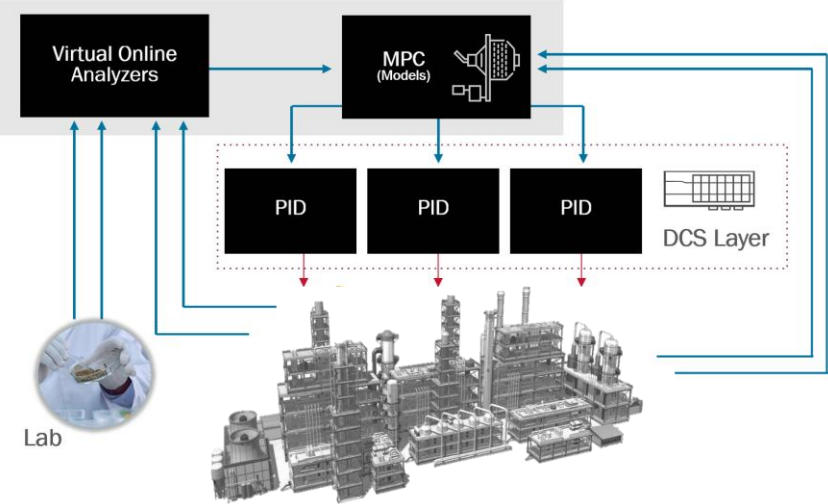

Goal

A chemicals client were looking to undertake an accelerated APC upgrade program across 30+ lines/units at 11 sites over 5 years. This included all business units:
- Olefins and Polyolefins >4000 KTA
- Styrene and Polystyrene >2000 KTA

We implemented our AI-driven closed loop optimization software (Pavilion) to produce a step change in product quality, consistency whilst reducing costs through improved yields and minimized off-grade production.


Implementation (8 mths)

Reactor Section Control:
Goal:
- Maintaining consistent conversion and reactor temperature profile
- Maintain consistent feed composition to distillation section (capacity limit)

Scope:
- Control reactor conversion to target
- Control reactor inlet temperature profile
- Maintain steam ratios at target
- Remain within process constraints:
- Fuel gas valve positions
- Stack Oxygen

Distillation Section Control:
Goal:
- Maintain on-spec product at minimum energy consumption, allowing maximum capacity

Scope:
- Control product impurities to target
- Distribute load and separation between the two recycle columns
- Remain within process constraints:
- Distributor loading
- Valve positions
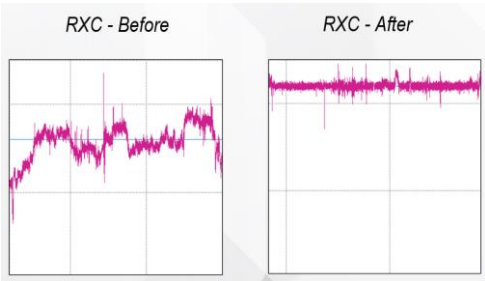
The numbers

$223M pa
In benefits from increased throughput optimization with associated quality
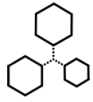
$54M pa
Reduction in non-feedstock variable costs

9%
Reduction in energy use with associated emissions benefit

90%
Reduction in process variability, resulting in improved product quality

Production optimization via AI-driven closed loop optimization with associated emissions reduction benefit

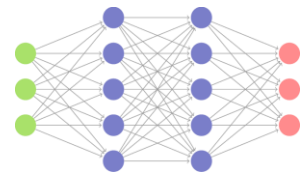Patented, model-based, predictive emissions monitoring system.

Engine to provide real time, highly accurate measurements of various GHGs including NOX, CO, CO2, CH4 and other emissions as an alternative to costly hardware based CEMS

- Observable reduction in overall emissions of 9% from production optimization conducted
- Faster deployment reduces costs and time to achieve and maintain compliance
- Minimizes compliance monitoring, record-keeping and reporting costs

- Fuel flows
- Fuel Quality
- Air Flow
- Process O2
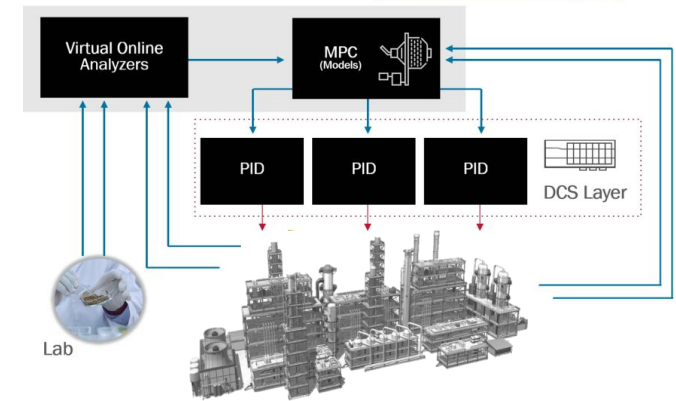- Temperatures
- Ambient
- Humidity

- NOX
- CO2
- CO
- CH4

Inputs

Data Qualification and Sensor Validation

Outputs

Real-time Alerts

Console

Virtual Online Analyzers

MPC (Models)

PID

PID

PID

DCS Layer

Lab

Rockwell Automation

KALYPSO

Combining wireless sensing and hybrid AI models to achieve improved reliability, maintenance and emissions outcomes from trip-related flaring

MAXIMISING PRODUCTION WITH DATA-DRIVEN INSIGHTS	REDUCING EMISSIONS THROUGH CAPTURE AND RECYCLE	GROWING REVENUE THROUGH MARKET-DRIVEN DECISION MAKING
IROC Operators make real-time decisions that deliver maximum production, with forecast precision, through automated tracking and analysis of operational data like weather patterns, equipment condition, and past and simulated plant performance	Emissions are managed in real-time to minimise environmental impact through capture and recycle techniques that generate value from by-products	Production decisions on product type and quantity are made to maximise Woodside's bottom line through precision forecasting of market trends and customer behaviour
MINIMISING HUMAN RISK WITH LOW TOUCH ASSETS	DRIVING GREATER ASSET RELIABILITY	OPTIMISING INVENTORY MANAGEMENT ACROSS AN INTEGRATED SUPPLY CHAIN
Assets operate with more autonomy using IoT and robotics to execute remote surveillance and field work to drive greater safety for our workforce	Assets and equipment self-diagnose failures and faults, sending executable field work instructions that minimise down-time	Inventory management is automated, making real-time decisions using equipment criticality risk models aligned to predictive and condition-based maintenance strategies

Goal

An O&G client are delivering a world-leading, smart, integrated and remotely operated asset portfolio. By 2030, they aim to achieve (1) **2%** annual production improvement and (2) **30%** production cost savings.

They wanted to transform through wireless sensing and predictive analytics, however had experienced minimal success in realising end-to-end value.

The goal was to achieve successful end-to-end products capable of realising real value, focussed on 5 high value equipment (7000+ installations), used to scale out across all operations

Sensor data used

High and low-frequency Vibration, process, temperature, current, flow, maintenance

Action

Designed wireless vibration sensors, capable of high integration, accurate measurement, and data acquisition rates of 1-15 mins and deployed these sensors to 3,000 fin fans, pumps, motors at an LNG Plant.

Leveraged 30+ yrs of client knowledge with 10+yrs of operational data to create and deploy explainable artificial intelligence models to production on 7000+ turbines, compressors, pumps, fans and electrical equipment over 5 years.

Created a wireless sensor strategy assessment framework, capable of rapidly qualifying market sensors and building and developing an integrated architecture

Convinced the client's chief engineers to trust in a transparent sensing analytics approach and architecture across all 7 existing assets and new asset.

The numbers

$300M+
In benefits from increased production, decreased equipment and labour costs at LNG plant

60mths
Transformation journey, bringing end-to-end automation to 7000+ equipment across enterprise

54,000+
Wireless sensing parameters available for fin fans

6-12mths
Reliably detecting failures up to 12 months in advance

Applying natural language processing (NLP) to free text responses to predict & prevent safety incidents

Deep Dive 1

What are the likely top 5 key safety risks?

1. Lifting
2. Isolation
3. Barricading
4. Gloves
5. Line of fire

Significant difference to the top 5 on the overall view across all departments.

A balance of negative and positive comments, no overall trend.

Rockwell Automation   **KALYPSO**

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The Path to Autonomous Mining

- The ability for the mining industry to achieve true autonomous operations will depend on the maturity across three key domains:
  - **Robotics & Machinery**
  - **IT and OT data**
  - **AI and ML**
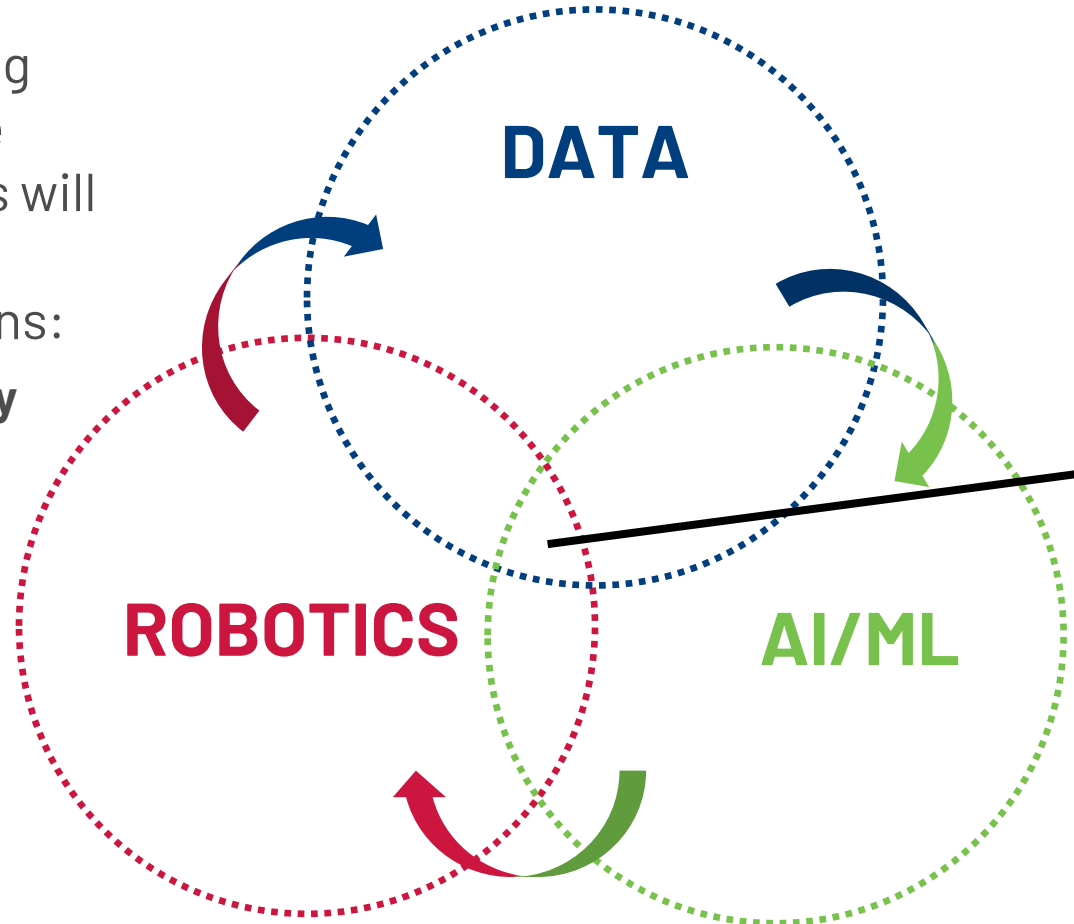
DATA

ROBOTICS

AI/ML

The intersection of these three domains is the enablement of closed-loop autonomous processes, data feeding AI/ML models that control robotics and machine solutions, generating data that is accessible for IT and OT optimization, further driving process optimizations and delivering safer, more reliable, lower cost per ton outputs

Rockwell Automation

KALYPSO

The Robot Supervision System (RSS) – operating cost reduction via operations & logistics automation

Leading energy companies are investigating the use of robotics on offshore facilities with the objective of enabling unmanned operations for long periods, and as the next frontier for increased personnel safety, industry attractiveness for young talents and further OPEX and CAPEX reduction.

Kalypso has partnered with a European Energy Major to implement a Robot Supervision System (RSS) for the remote management of a fleet of mobile ground robots.
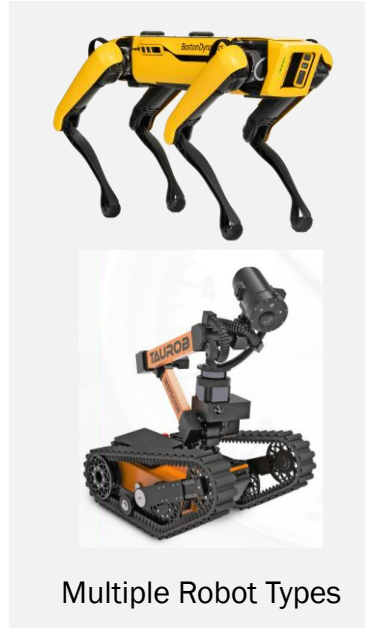
Multiple Robot Types

Use Cases Enabled

- Robot <u>Payload</u> Monitoring & Robot Tracking
- Synchronization with Maintenance Plan & Checkpoint Creation
- <u>Mission</u> Creation, Monitoring & Automation (Closed Loop)
- Robot <u>Training</u> in Gaming Environment
- Site Equipment <u>Monitoring</u> and <u>Alerts</u>
- AI/ML <u>Analysis</u> of Mission Data/Media
- Automated <u>update</u> of operational systems (Mission Output)
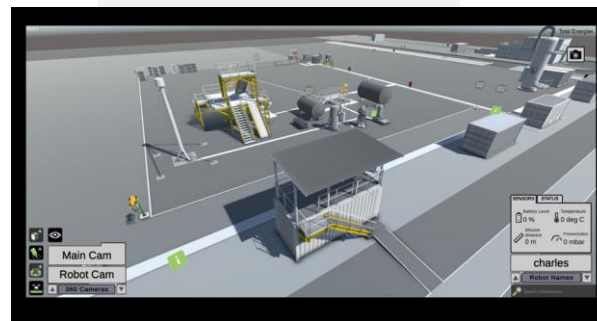
Visual Digital Twin
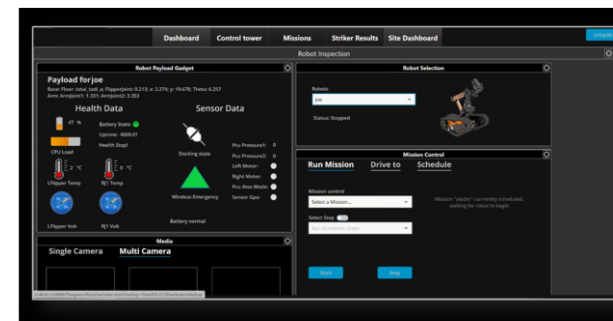
Operator Role Based Dashboards

The numbers

30%
Reduced OPEX through the reduction of maintenance and operational staff on off-shore facilities

6-12mths
Reliably detecting failures up to 12 months in advance through vision AI enhanced operator rounds & IIoT alerts

Improvement to TRIFR score across operations via reduced exposure to hazardous and high-risk areas

Rockwell Automation   KALYPSO

Robot Supervision System (RSS) – User Journey

The user journey depicted below shows the end user functionality of the RSS Solution, around the three main elements; the Operation Room, the Robot and the RSS Application

Robot

Operation Room

1 In the **Operation Room the Robot Operator**:
- Monitors multiple robots
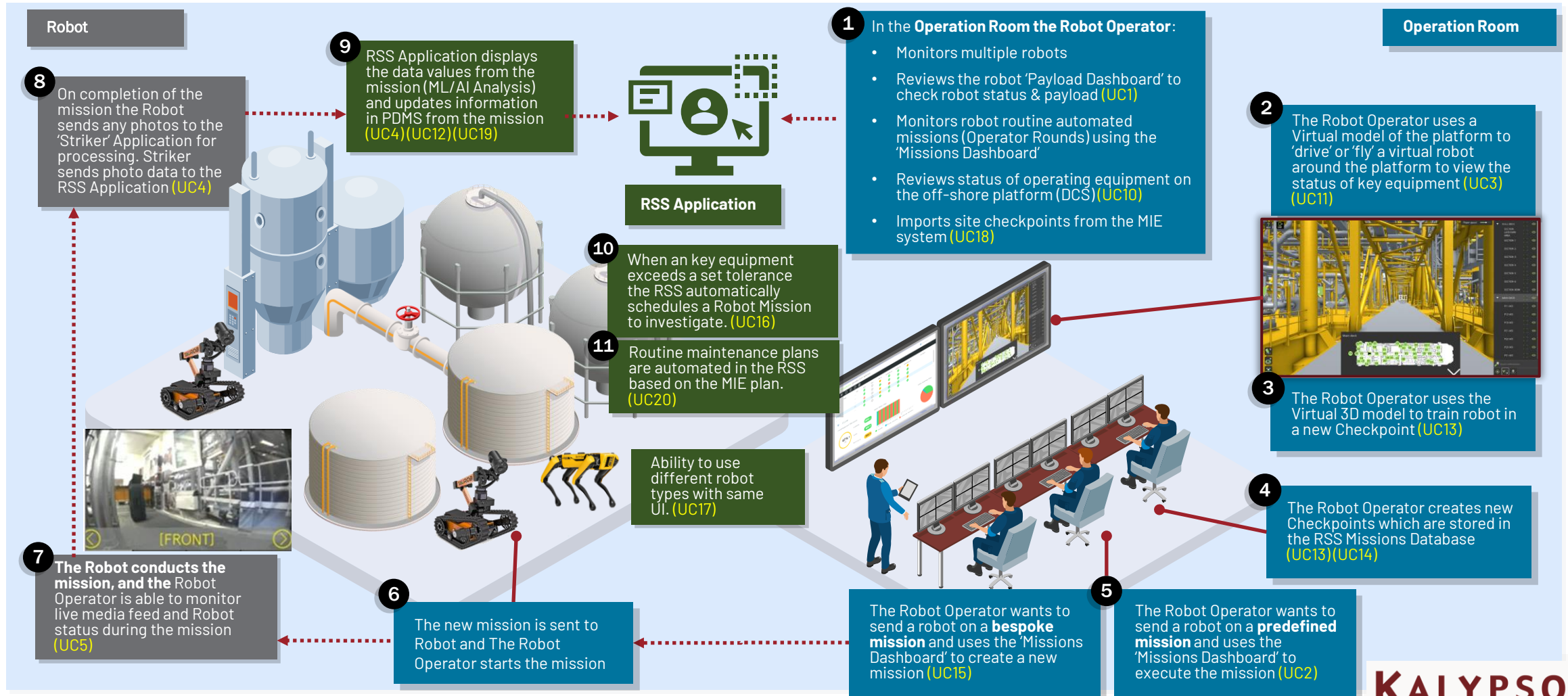- Reviews the robot 'Payload Dashboard' to check robot status & payload (UC1)
- Monitors robot routine automated missions (Operator Rounds) using the 'Missions Dashboard'
- Reviews status of operating equipment on the off-shore platform (DCS) (UC10)
- Imports site checkpoints from the MIE system (UC18)

2 The Robot Operator uses a Virtual model of the platform to 'drive' or 'fly' a virtual robot around the platform to view the status of key equipment (UC3) (UC11)

3 The Robot Operator uses the Virtual 3D model to train robot in a new Checkpoint (UC13)

4 The Robot Operator creates new Checkpoints which are stored in the RSS Missions Database (UC13)(UC14)

5 The Robot Operator wants to send a robot on a **predefined mission** and uses the 'Missions Dashboard' to execute the mission (UC2)

6 The new mission is sent to Robot and The Robot Operator starts the mission

7 **The Robot conducts the mission, and the** Robot Operator is able to monitor live media feed and Robot status during the mission (UC5)

8 On completion of the mission the Robot sends any photos to the 'Striker' Application for processing. Striker sends photo data to the RSS Application (UC4)

9 RSS Application displays the data values from the mission (ML/AI Analysis) and updates information in PDMS from the mission (UC4)(UC12)(UC19)

10 When an key equipment exceeds a set tolerance the RSS automatically schedules a Robot Mission to investigate. (UC16)

11 Routine maintenance plans are automated in the RSS based on the MIE plan. (UC20)

Ability to use different robot types with same UI. (UC17)

The Robot Operator wants to send a robot on a **bespoke mission** and uses the 'Missions Dashboard' to create a new mission (UC15)

RSS Application

[FRONT]

KALYPSO
A ROCKWELL AUTOMATION COMPANY

Rockwell Automation

KALYPSO

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- The Connected Mine

- Mining Applications

- The Promise of Artificial Intelligence & Machine Learning

- The Path to Autonomous Mining

- Summary and Wrap Up

Summary of Key Themes in Digitalization for Mining

— Achieving reliable and trusted mineral traceability is made possible through **Digitalization**, and connected organizations that are using data effectively will continue to make advancements rapidly in this space.

— Process optimization and energy efficiency are the hallmarks of modern mining. **Mining companies that can deliver the safest, most consistent and reliable, environmentally and socially responsible, lowest cost per ton of ore will continue to have a competitive advantage** in the marketplace.

— Advancement in Digitalization on the pathway to **autonomous operations have the potential to unlock tremendous value and contribute significant benefits** to industry and to the consumers of mining products.

Rockwell Automation Industry Events

MINExpo International
Las Vegas, NV – Sept. 24-26, 2024

Stop by and visit us at Booth 6113

2024 Automation Fair
Anaheim, CA – Nov. 18-21, 2024

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The Rockwell Automation® difference

The right partner can mobilize your enterprise for healthy growth and ongoing innovation

Scale DX initiatives faster with an IT/OT convergence leader

Leverage standard connectivity to OT data sources

Enable scalable growth in current and future applications

Accelerate key use cases with trusted solution providers

TRUSTED ADVISOR TO HELP ACHIEVE RESULTS

SIMPLIFIED ACCESS TO DATA

FUTURE-READY DATA PLATFORM WITH STANDARD INDUSTRIAL APPS

SOLUTION PARTNER ECOSYSTEM

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TO DISCUSS FURTHER CONNECTED MINE TOPICS, TECHNOLOGY AND APPLICATIONS

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THANK YOU

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