AVEVA PI WORLD

Asset Performance Management (APM) with the combined PI System and AVEVA stack

Presented By:

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Asset Performance Management (APM) with the combined PI System and AVEVA stack
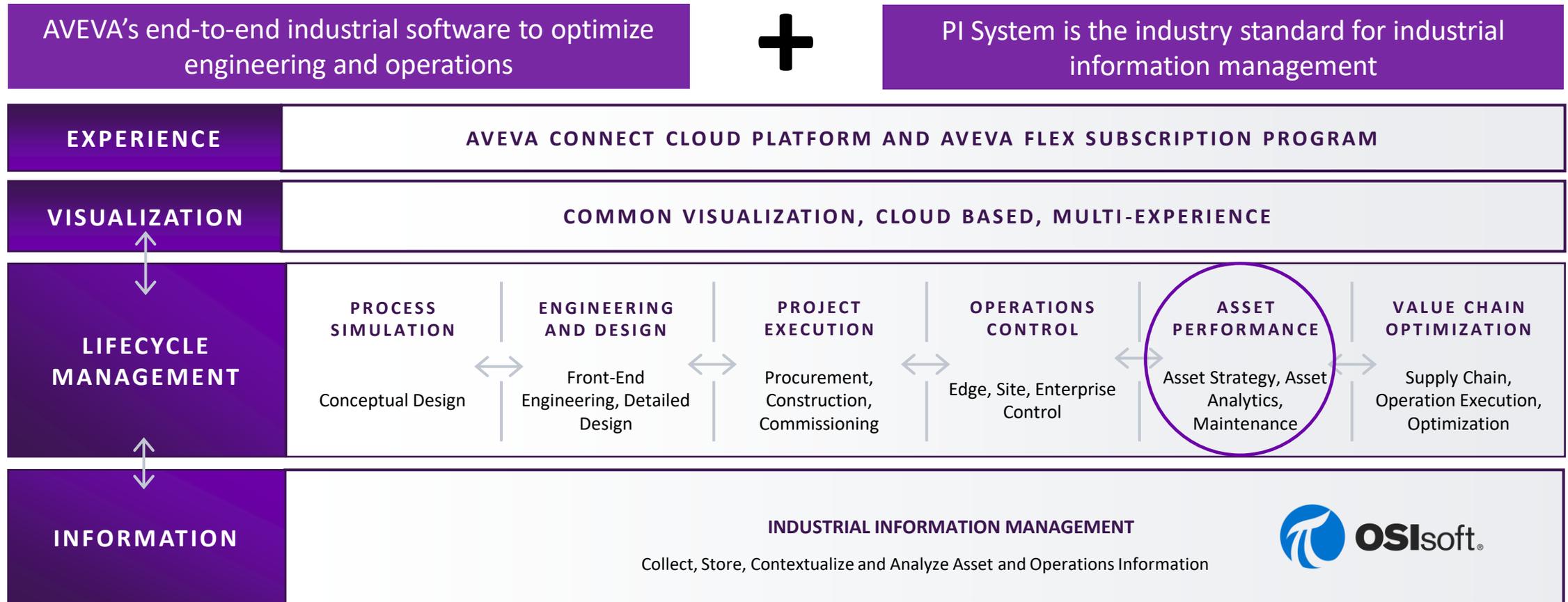
Join us for a deep dive into APM where we walk-through how the PI System and AVEVA product portfolios come together to address several closely related APM topics, such as:

- A layered approach to maintenance
- Maintenance alerts with the combined use of process and machine condition data
- Anomaly detection, root-cause analysis, fault-code library, corrective action list
- Predictive and prescriptive maintenance
- Asset reliability, strategy and optimization
- Connected worker, operational safety and compliance
- Business process integration with Work Management Systems such as SAP, Maximo etc., and others
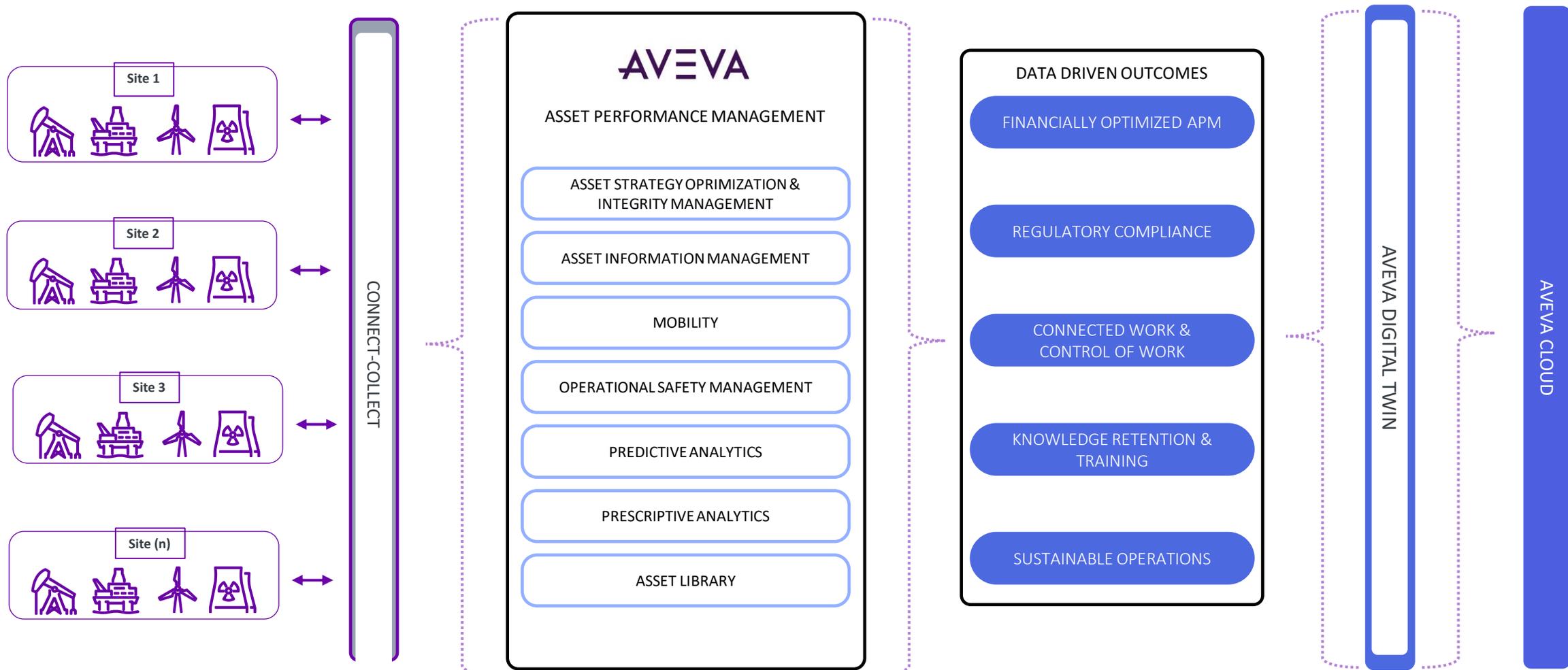
We will also discuss the Maintenance Maturity Assessment.

AVEVA

Combining world-class software to drive Performance Intelligence

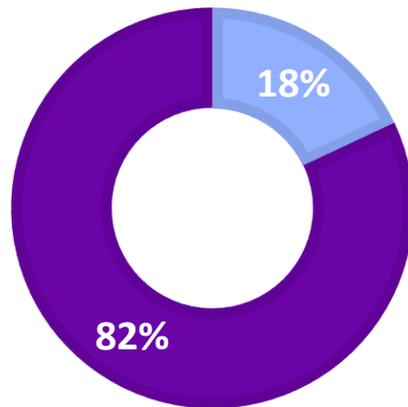## Accelerating digital transformation of the industrial world with complementary product offerings

| AVEVA's end-to-end industrial software to optimize engineering and operations | **+** | PI System is the industry standard for industrial information management |

EXPERIENCE — AVEVA CONNECT CLOUD PLATFORM AND AVEVA FLEX SUBSCRIPTION PROGRAM

VISUALIZATION — COMMON VISUALIZATION, CLOUD BASED, MULTI-EXPERIENCE

LIFECYCLE MANAGEMENT

PROCESS SIMULATION	ENGINEERING AND DESIGN	PROJECT EXECUTION	OPERATIONS CONTROL	ASSET PERFORMANCE	VALUE CHAIN OPTIMIZATION
Conceptual Design	Front-End Engineering, Detailed Design	Procurement, Construction, Commissioning	Edge, Site, Enterprise Control	Asset Strategy, Asset Analytics, Maintenance	Supply Chain, Operation Execution, Optimization

INFORMATION

INDUSTRIAL INFORMATION MANAGEMENT

Collect, Store, Contextualize and Analyze Asset and Operations Information

OSIsoft®

AVΞVA

A Unique APM Solution

Site 1 ↔

Site 2 ↔

Site 3 ↔

Site (n) ↔

CONNECT-COLLECT

AVEVA

ASSET PERFORMANCE MANAGEMENT

- ASSET STRATEGY OPRIMIZATION & INTEGRITY MANAGEMENT
- ASSET INFORMATION MANAGEMENT
- MOBILITY
- OPERATIONAL SAFETY MANAGEMENT
- PREDICTIVE ANALYTICS
- PRESCRIPTIVE ANALYTICS
- ASSET LIBRARY

DATA DRIVEN OUTCOMES

- FINANCIALLY OPTIMIZED APM
- REGULATORY COMPLIANCE
- CONNECTED WORK & CONTROL OF WORK
- KNOWLEDGE RETENTION & TRAINING
- SUSTAINABLE OPERATIONS

AVEVA DIGITAL TWIN

AVEVA CLOUD

OSIsoft

AVEVA

AVEVA APM connects Asset Strategy to Corporate Objectives

Failure Patterns

■ Age-related failure   ■ Random failure

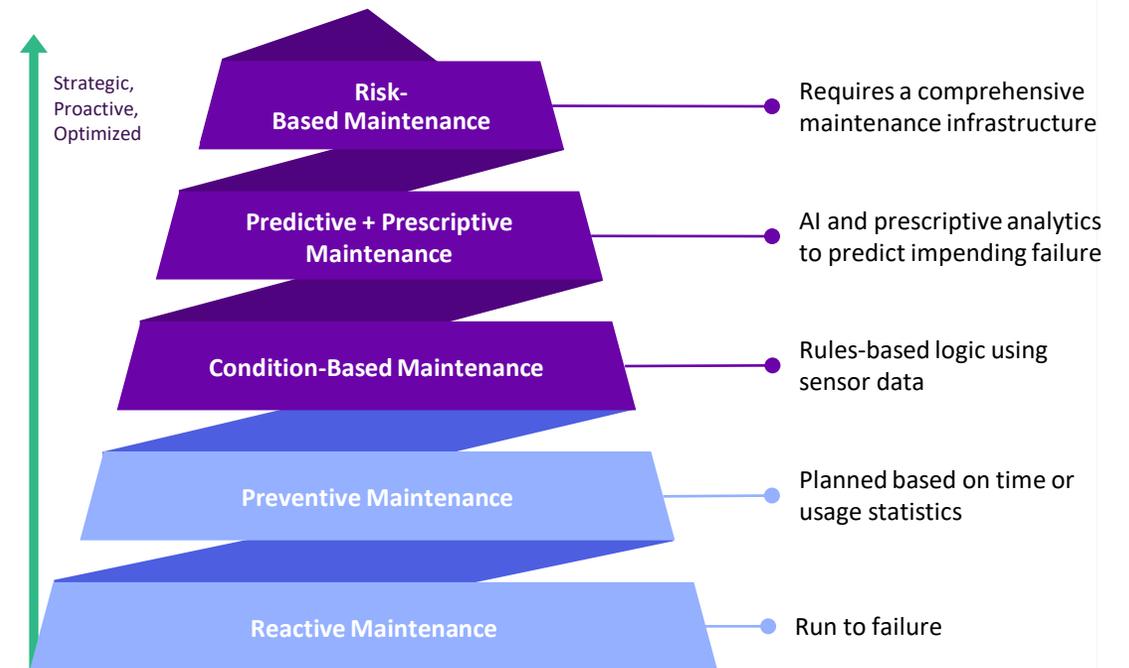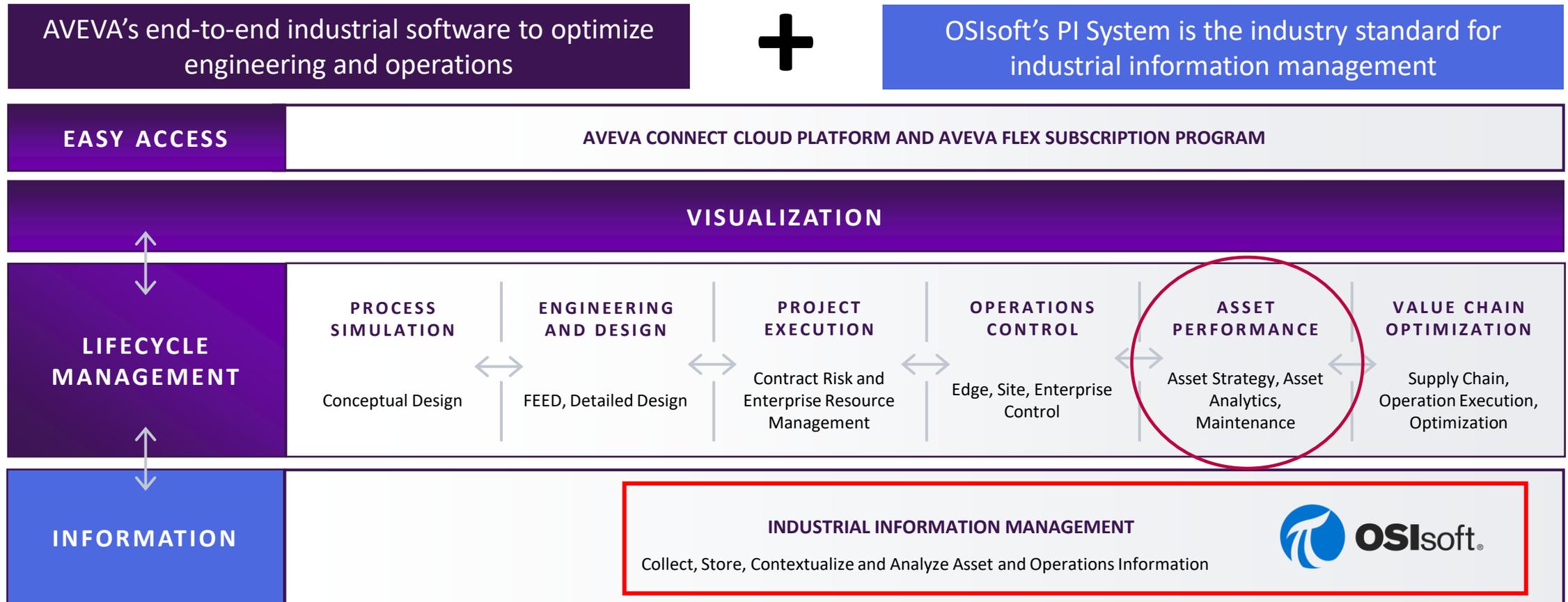**18%** — Reactive and Preventive Programs

82% — Predictive Technology for Early Warnings

It's a Journey

Strategic, Proactive, Optimized

Risk-Based Maintenance — Requires a comprehensive maintenance infrastructure

Predictive + Prescriptive Maintenance — AI and prescriptive analytics to predict impending failure

Condition-Based Maintenance — Rules-based logic using sensor data

Preventive Maintenance — Planned based on time or usage statistics

Reactive Maintenance — Run to failure

AVEVA

Combining world-class software to drive Performance Intelligence

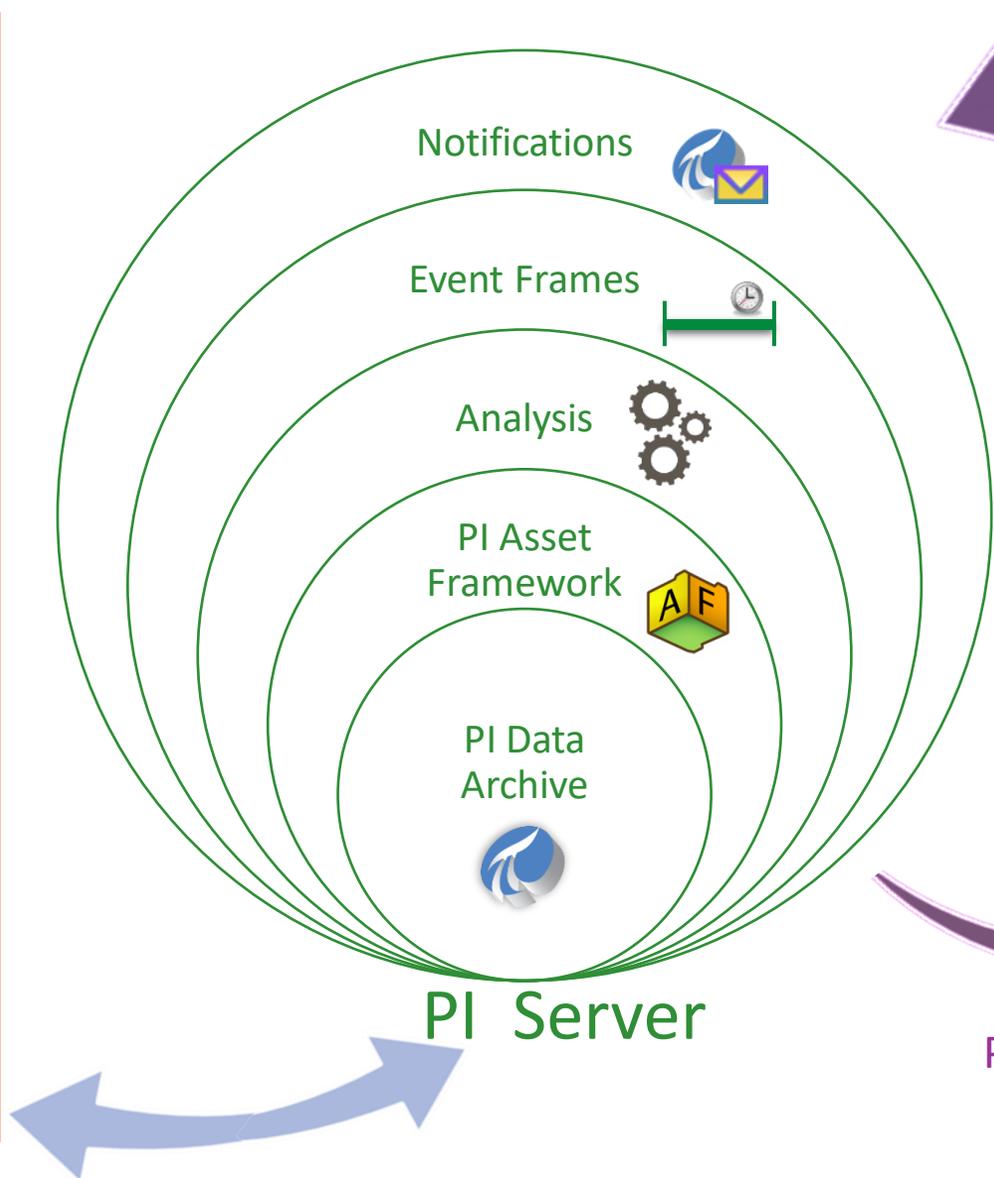## Accelerating digital transformation of the industrial world with complementary product offerings

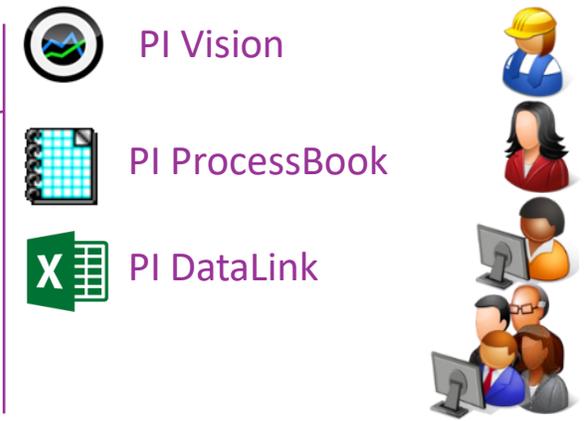| AVEVA's end-to-end industrial software to optimize engineering and operations	**+**	OSIsoft's PI System is the industry standard for industrial information management

EASY ACCESS — AVEVA CONNECT CLOUD PLATFORM AND AVEVA FLEX SUBSCRIPTION PROGRAM

VISUALIZATION

LIFECYCLE MANAGEMENT

PROCESS SIMULATION	ENGINEERING AND DESIGN	PROJECT EXECUTION	OPERATIONS CONTROL	ASSET PERFORMANCE	VALUE CHAIN OPTIMIZATION
Conceptual Design	FEED, Detailed Design	Contract Risk and Enterprise Resource Management	Edge, Site, Enterprise Control	Asset Strategy, Asset Analytics, Maintenance	Supply Chain, Operation Execution, Optimization

INFORMATION

INDUSTRIAL INFORMATION MANAGEMENT

Collect, Store, Contextualize and Analyze Asset and Operations Information

OSIsoft®

AVEVA

PI System

AVEVA

PI System

PI Interfaces & PI Connectors

Notifications

Event Frames

Analysis

PI Asset Framework

PI Data Archive

PI Server

PI Integrators & PI System Access

Microsoft® SQL Server® · infor · SAS · SAP · ORACLE® · IBM · JDEdwards · AVEVA™ Predictive Analytics

1. **Connect to relevant sources**

2. **Collect and archive data**

3. **Assign context (asset-based)**

4. **Add Analytics logic**

5. **Event Frames**

6. **Alert and notify**

7. **Visualize (browser)**

PI Visualization Suite

PI Vision

PI ProcessBook

PI DataLink

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PI System - built-in functions for time-series data

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Operational diagnostics - use cases

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PI Vision – Displays

Nitrogen Fluctuations

1sgp233
MSIV ACCUM #1 FOR UV-171
1/26/17   1/27/17

Event Frame Setup

- Establish trigger and event duration
- Backfill historical data
- Fidelity Check
- Tweak the data
- Repeat

Name		Value
PressureA		5254.313 psig
PressureB		5275.875 psig
Status		NFC
UnitNum		1

Name	Expression
StartTrigger	Abs(('PressureA'- TagVal('PressureA','*-10s')))>11.5 and 'PressureA' > 4999 and 'PressureA' < 5501

Engineered Analytics

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Maintenance – Simple Engineered Analytics

- **Simple engineere...**
  - run-hours, start/st...

  - exchanger fouling
  - bearing temp rate ...
  - vibration trend ext...
  - pump curves
  - vibration limits dyn...
  - parametric curve fi...
  - steam traps
  - tube metal tempera...
  - count of temperatu...

  - analytics for BoP assets

Elements
- Elements
  - STATIONS
    - HUNTLY
      - HLY01: UNIT 1
        - A: UNIT TRANSMISSION AND DISTRIBUTION
        - B: POWER STATION ELECTRICAL SYSTEM
        - C: INSTRUMENTATION AND CONTROL EQUIPM...
        - E: FUEL SUPPLY AND ASH AND DUST DISPOSAL
        - G: WATER SUPPLY AND DISCHARGE SYSTEM
        - H: BOILER SYSTEM
        - L: STEAM WATER AND GAS CYCLES SYSTEM
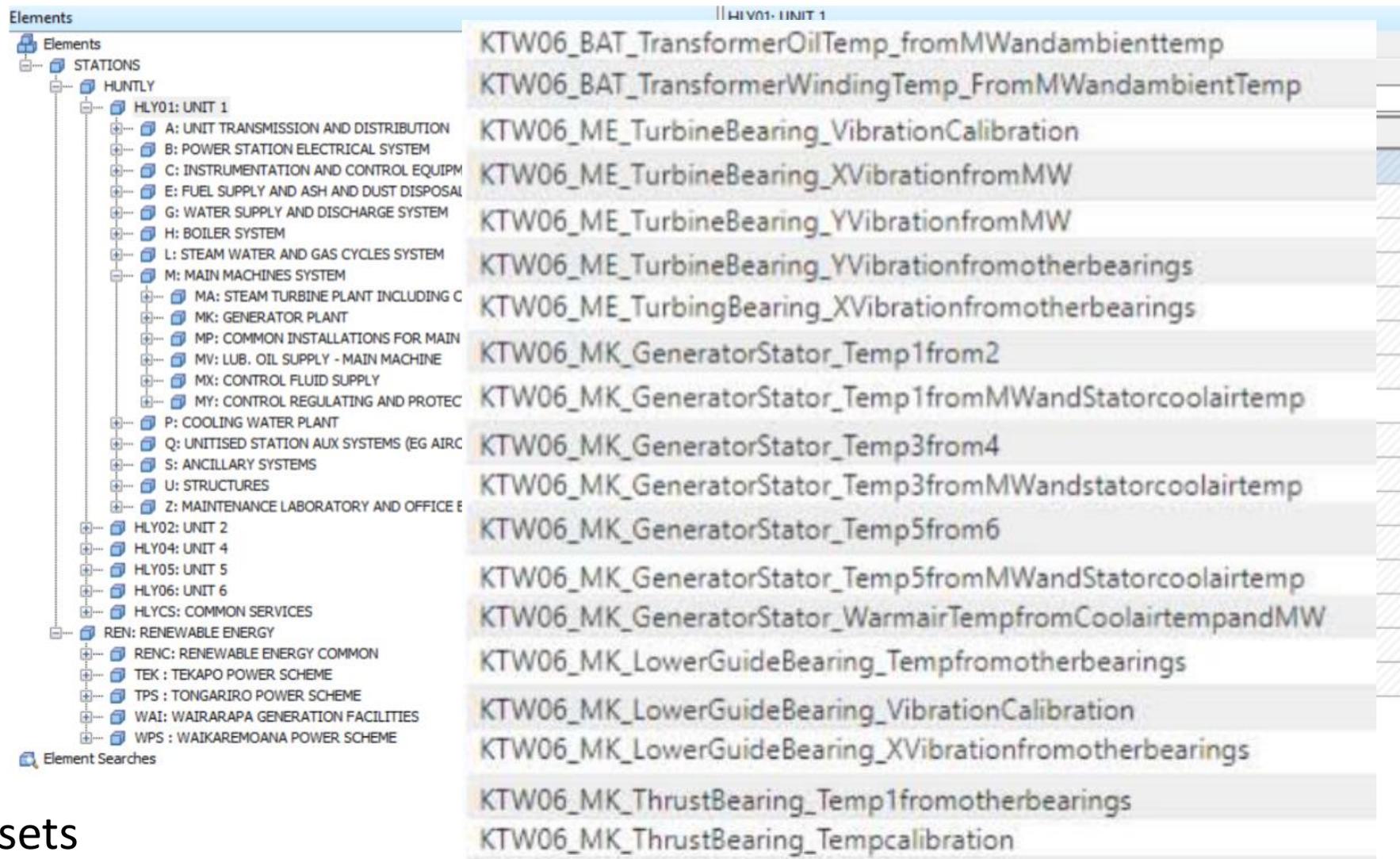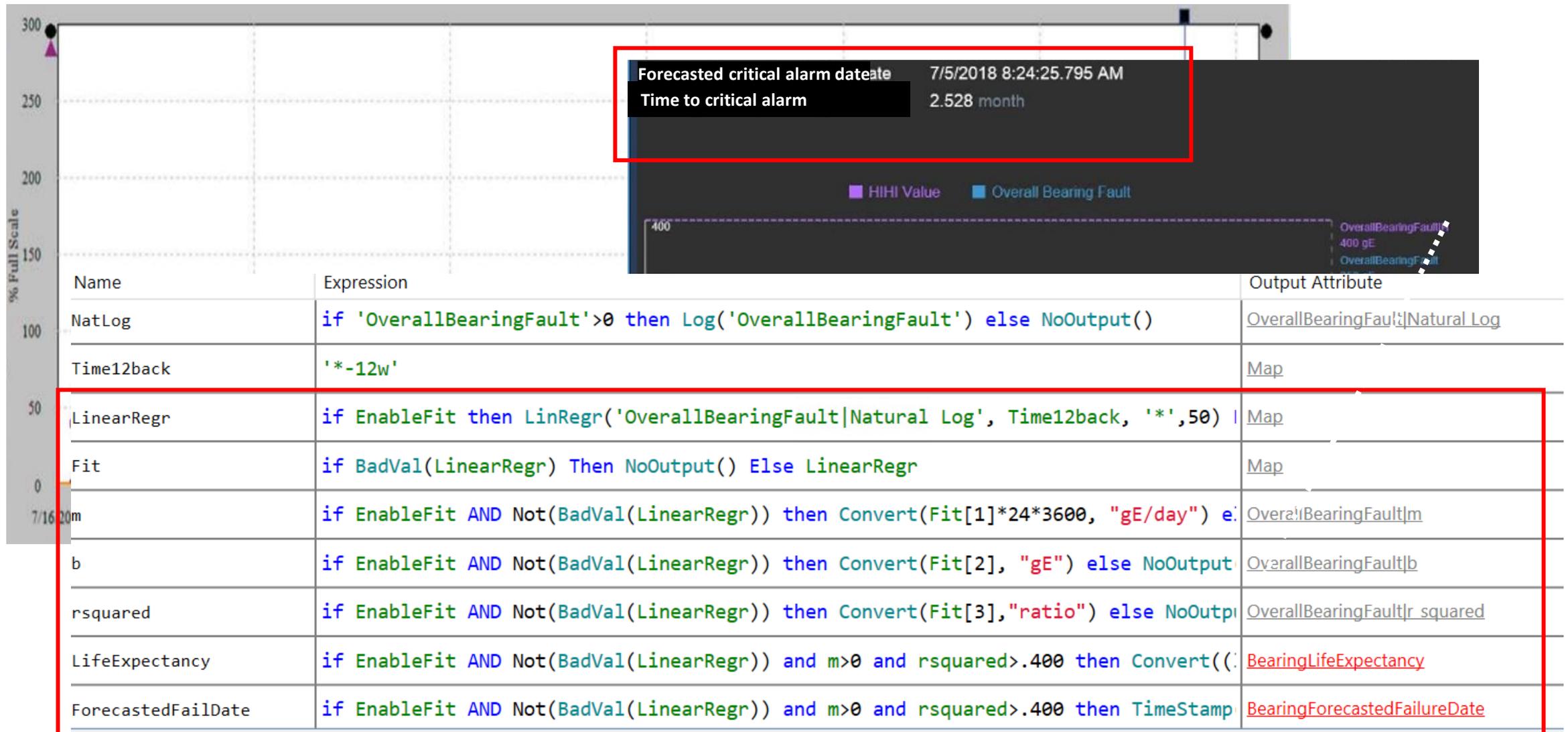   - M: MAIN MACHINES SYSTEM
          - MA: STEAM TURBINE PLANT INCLUDING C...
          - MK: GENERATOR PLANT
          - MP: COMMON INSTALLATIONS FOR MAIN...
          - MV: LUB. OIL SUPPLY - MAIN MACHINE
          - MX: CONTROL FLUID SUPPLY
          - MY: CONTROL REGULATING AND PROTEC...
        - P: COOLING WATER PLANT
        - Q: UNITISED STATION AUX SYSTEMS (EG AIRC...
        - S: ANCILLARY SYSTEMS
        - U: STRUCTURES
        - Z: MAINTENANCE LABORATORY AND OFFICE E...
      - HLY02: UNIT 2
      - HLY04: UNIT 4
      - HLY05: UNIT 5
      - HLY06: UNIT 6
      - HLYCS: COMMON SERVICES
    - REN: RENEWABLE ENERGY
      - RENC: RENEWABLE ENERGY COMMON
      - TEK : TEKAPO POWER SCHEME
      - TPS : TONGARIRO POWER SCHEME
      - WAI: WAIRARAPA GENERATION FACILITIES
      - WPS : WAIKAREMOANA POWER SCHEME
- Element Searches

HLY01: UNIT 1

KTW06_BAT_TransformerOilTemp_fromMWandambienttemp
KTW06_BAT_TransformerWindingTemp_FromMWandambientTemp
KTW06_ME_TurbineBearing_VibrationCalibration
KTW06_ME_TurbineBearing_XVibrationfromMW
KTW06_ME_TurbineBearing_YVibrationfromMW
KTW06_ME_TurbineBearing_YVibrationfromotherbearings
KTW06_ME_TurbingBearing_XVibrationfromotherbearings
KTW06_MK_GeneratorStator_Temp1from2
KTW06_MK_GeneratorStator_Temp1fromMWandStatorcoolairtemp
KTW06_MK_GeneratorStator_Temp3from4
KTW06_MK_GeneratorStator_Temp3fromMWandstatorcoolairtemp
KTW06_MK_GeneratorStator_Temp5from6
KTW06_MK_GeneratorStator_Temp5fromMWandStatorcoolairtemp
KTW06_MK_GeneratorStator_WarmairTempfromCoolairtempandMW
KTW06_MK_LowerGuideBearing_Tempfromotherbearings
KTW06_MK_LowerGuideBearing_VibrationCalibration
KTW06_MK_LowerGuideBearing_XVibrationfromotherbearings
KTW06_MK_ThrustBearing_Temp1fromotherbearings
KTW06_MK_ThrustBearing_Tempcalibration

Predictive analytics – Genesis Energy (recording)   Layered approach to maintenance/reliability (blog + workshop intro)

Maintenance – Simple Predictive – Time to Critical Alarm

Name	Expression	Output Attribute
NatLog	if 'OverallBearingFault'>0 then Log('OverallBearingFault') else NoOutput()	OverallBearingFault|Natural Log
Time12back	'*-12w'	Map
LinearRegr	if EnableFit then LinRegr('OverallBearingFault|Natural Log', Time12back, '*',50)	Map
Fit	if BadVal(LinearRegr) Then NoOutput() Else LinearRegr	Map
m	if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[1]*24*3600, "gE/day") e	OverallBearingFault|m
b	if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[2], "gE") else NoOutput	OverallBearingFault|b
rsquared	if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[3],"ratio") else NoOutp	OverallBearingFault|r_squared
LifeExpectancy	if EnableFit AND Not(BadVal(LinearRegr)) and m>0 and rsquared>.400 then Convert((	BearingLifeExpectancy
ForecastedFailDate	if EnableFit AND Not(BadVal(LinearRegr)) and m>0 and rsquared>.400 then TimeStamp	BearingForecastedFailureDate

Within the chart callout:

Forecasted critical alarm date	7/5/2018 8:24:25.795 AM
Time to critical alarm	2.528 month

HIHI Value ■ Overall Bearing Fault ■
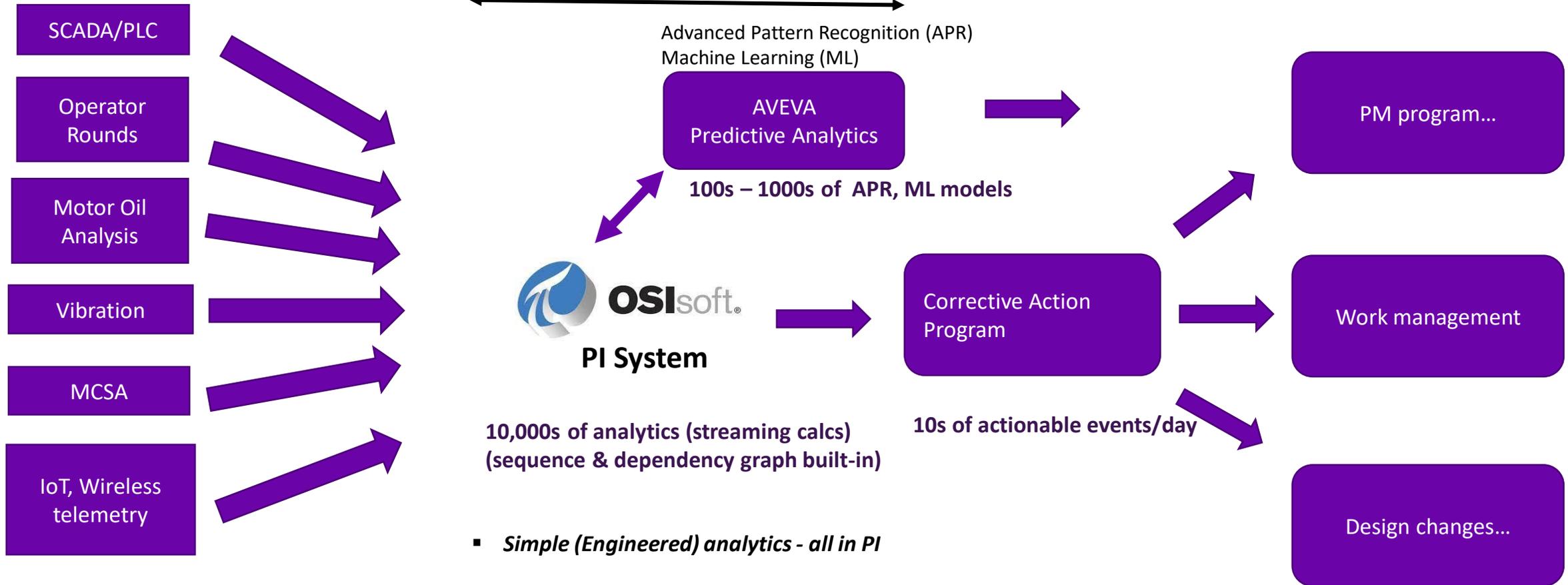
Layered approach to maintenance/reliability (blog + workshop intro)

PI System – data/information flow in the MRO decision lifecycle

data collection & storage

analytics

action and follow-up

SCADA/PLC

Operator Rounds

Motor Oil Analysis

Vibration

MCSA

IoT, Wireless telemetry

Advanced Pattern Recognition (APR)
Machine Learning (ML)

**AVEVA
Predictive Analytics**

100s – 1000s of APR, ML models

OSIsoft.

PI System

Corrective Action Program

PM program...

Work management

Design changes...

**10,000s of analytics (streaming calcs)
(sequence & dependency graph built-in)**

10s of actionable events/day

- *Simple (Engineered) analytics - all in PI*

- *Advanced analytics (enabled by aggregated data from PI)*
  APR, machine learning, open-source libraries etc.

**Analytics for performance/condition assessment
Analytics to enable RCA (root-cause)**

100,000s of measurements

From APM Strategy to Analytics

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The APM Assessment and Reference Framework
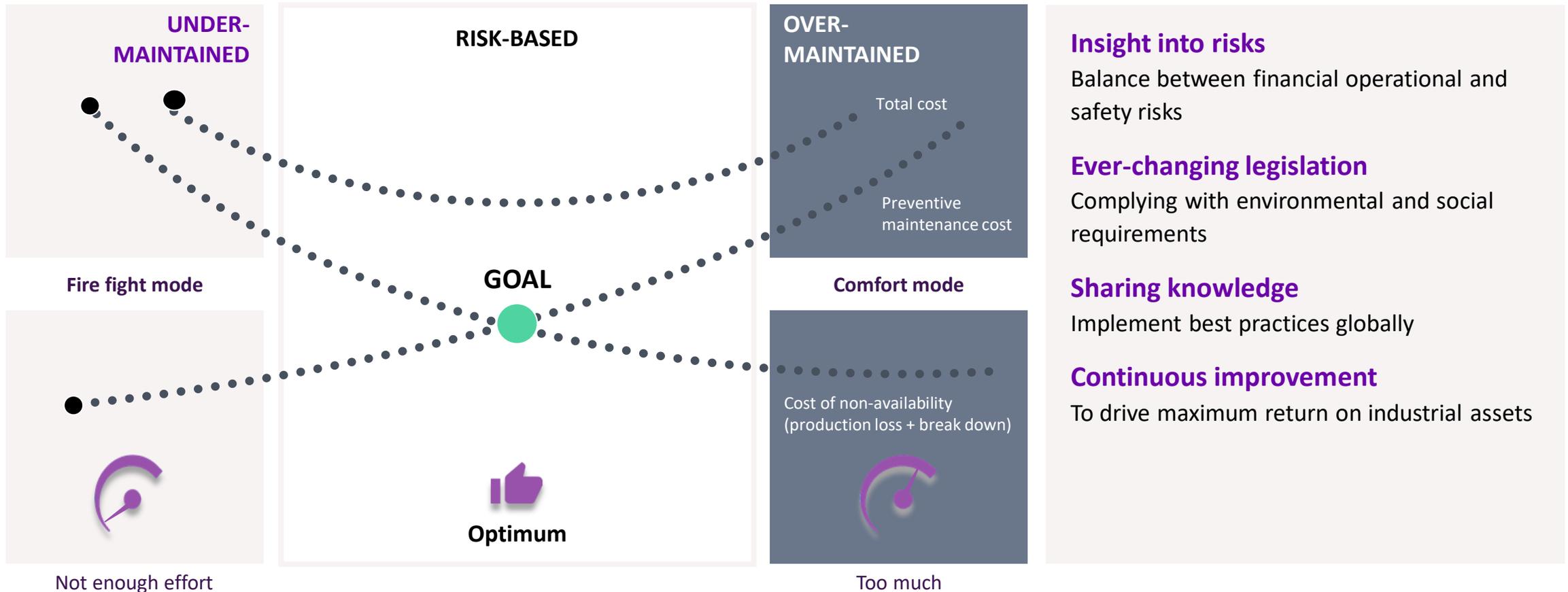
Roadmap for 15 APM topics
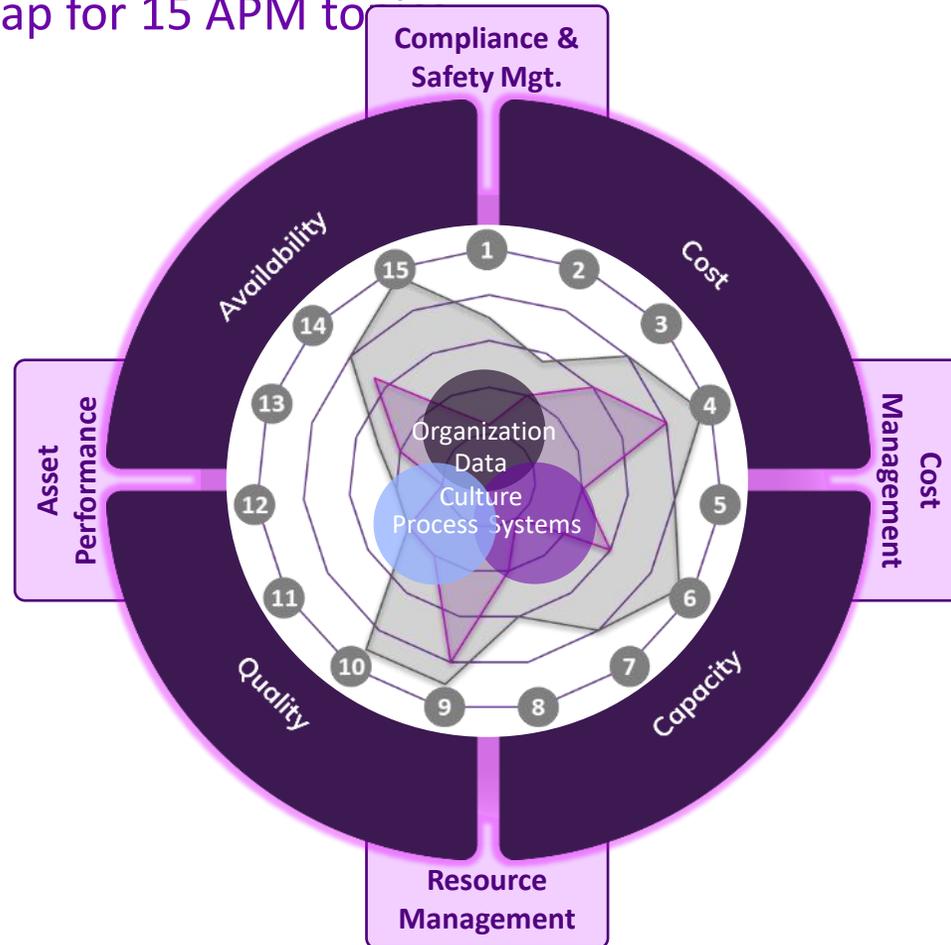
1. Business Objectives Realization
2. Resource Strategies
3. Asset Compliance & Scenario Planning
4. Budget & Cost Control
5. Work intake & Prioritization
6. Scheduling & Work Preparation
7. Work Execution
8. Work close-out & Reporting
9. Work Evaluation
10. Asset Integrity, Data- & Systems handling
11. Asset Portfolio Management
12. Reliability Engineering
13. Predictive Analytics
14. Asset Engineering, MOC & Early Management
15. Sustainability & Energy Management

The Benefit of Asset Strategy Optimization

The importance of a risk-based approach

UNDER-MAINTAINED

RISK-BASED

OVER-MAINTAINED

Total cost

Preventive maintenance cost

Fire fight mode

GOAL

Comfort mode

Cost of non-availability (production loss + break down)

Optimum

Not enough effort

Too much

Insight into risks
Balance between financial operational and safety risks

Ever-changing legislation
Complying with environmental and social requirements

Sharing knowledge
Implement best practices globally

Continuous improvement
To drive maximum return on industrial assets

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Asset Strategy Definition

- Asset Strategy is a mix of different maintenance types
  - Reactive
  - Preventive
  - Condition based
  - Predictive

- Based on dynamic customer business objectives

- Prescriptive actions defined for all strategies

- For all equipment

Asset Strategy Optimization

- Predictive Maintenance
- Condition-based Maintenance
- Preventive Maintenance
- Reactive Maintenance

Prescriptive Actions

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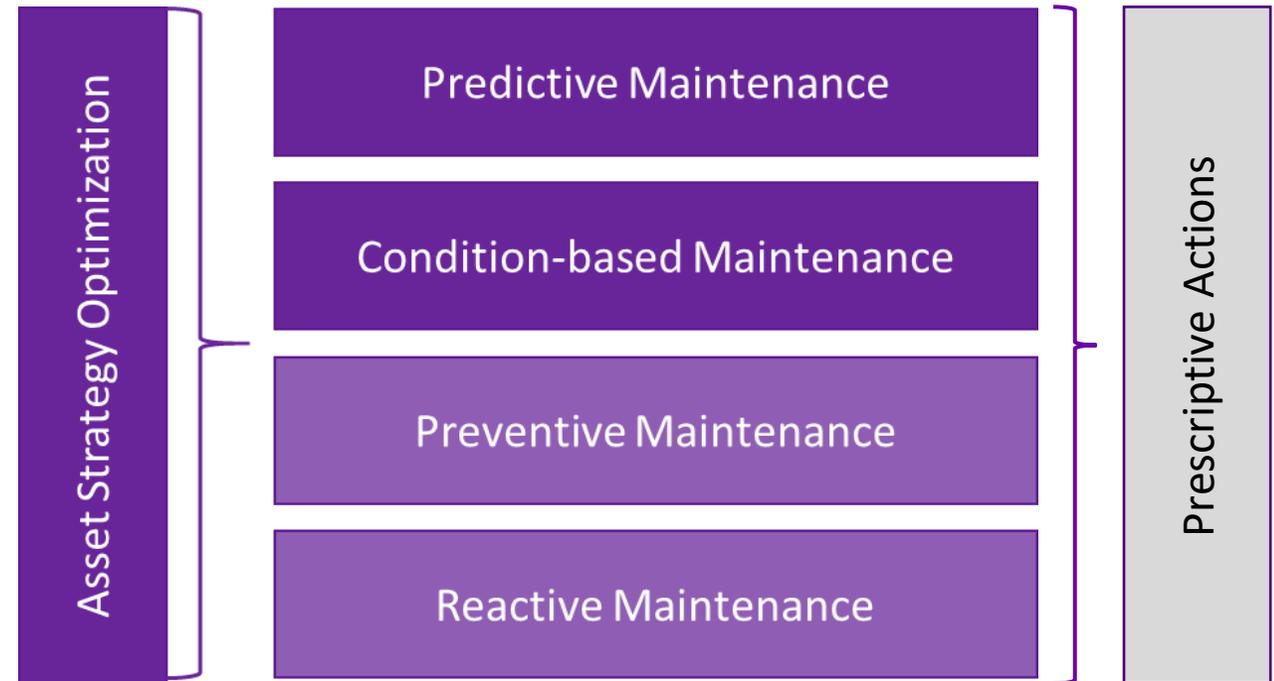
Asset Strategy Optimization

Catch critical failures in time

- Higher plant output
- Improved HSE performance

Eliminate unnecessary maintenance

- Less scheduled downtime
- Less maintenance cost

Optimize over asset life cycle

- Lowest life cycle cost
- Increased ROA (Return On Assets)

Standardize data structure and improve data quality

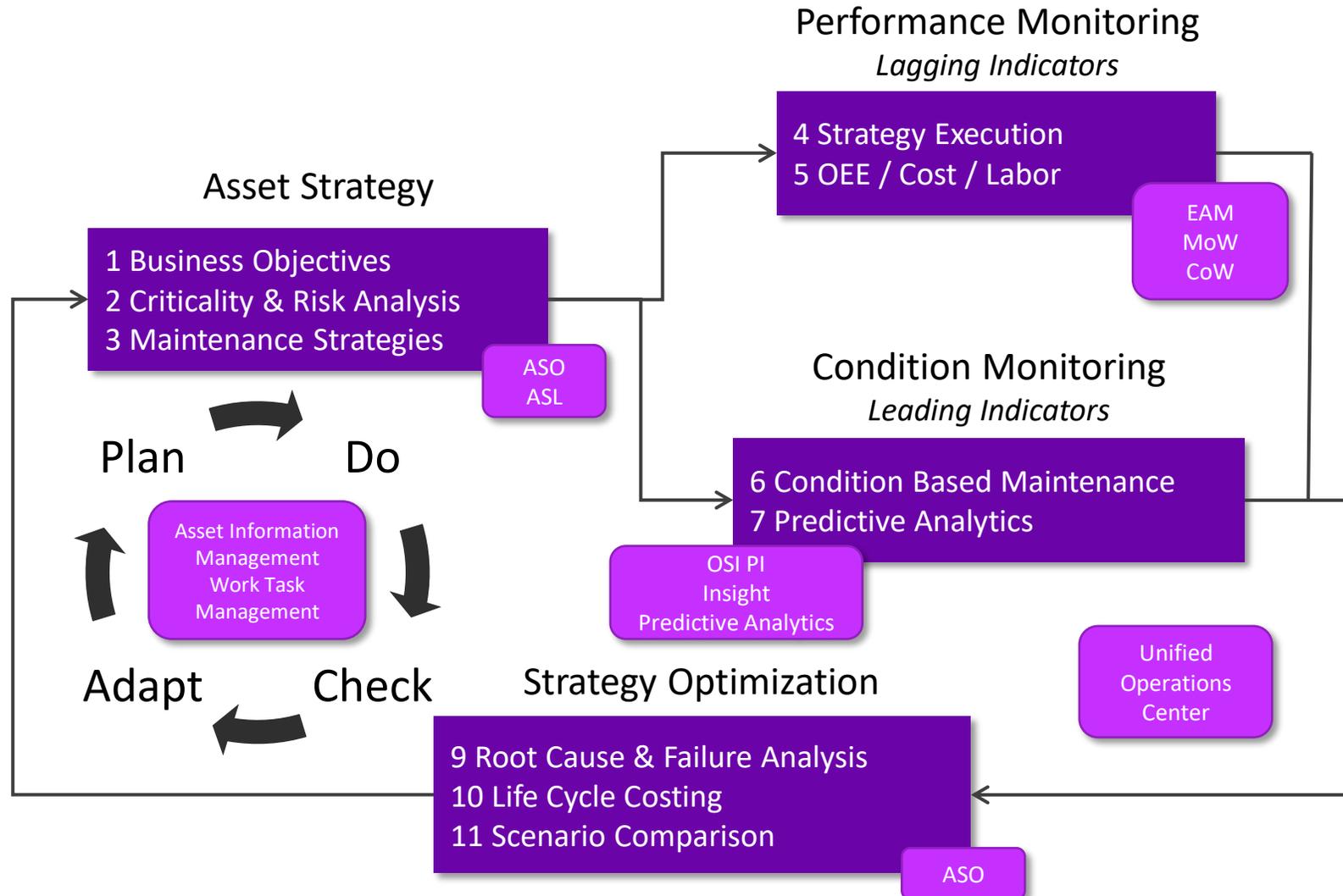- Improved compliance
- Rapid fleet deployment

Asset Library Templates

80% of assets
90% effectiveness

Asset Life Cycle Costing (What/If scenarios)
Scenario Comparison

Optimized Strategy
Monte Carlo simulation

Spares Strategy Optimization
Spare Levels

Root Cause Analysis
Continuous Improvement

Risk Based Strategy
Reliability Centered Maintenance

Generic Risk Based Strategy
Library templates

Prioritize assets
Criticality Assessment

Increasing maturity and expertise in APM

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AVEVA Asset Library

Content

- **4 Content Packages**
  - Asset Library (general)
  - Asset Library – O&G
  - Asset Library – Power
  - Asset Library – MMM
- **Current content supports prescriptive actions**
  - ISO14224 Equipment breakdown (Type, Subunit, Maintainable Item)
  - Failure modes
  - Prescriptive actions

Asset Classes	Asset Types	Faultdiagnostics	Prescriptive Actions
14	75	553	889

Asset Class	Asset Type	Content Packages			
		Asset Library	Asset Library - O&G	Asset Library - Power	Asset library - MMM
Blowers and Fans	Blower	x	x	x	x
Compressors	Compressors - Centrifugal	x	x	x	x
Compressors	Compressors - Reciprocating		x		
Compressors	Compressors - Screw		x		
Electric generators	Electric generators			x	
Electric generators	Electric generators - Gas-turbine driven			x	
Electric Motors	Electric Motors - Alternating Current	x	x	x	x
Gas Turbines	Gas Turbines - Aero-derivative			x	
Gas Turbines	Gas Turbines - Industrial			x	
Heaters and boiler	Heaters and boilers - HC-fired Boiler		x		
Heaters and boiler	Heaters and boilers - Indirect HC-fired Heater		x		
Heat exchangers	Heat exchangers - Air Cooled		x		
Heat exchangers	Heat exchangers - Plate Fin		x		
Heat exchangers	Heat exchangers - Rotary		x		
Heat exchangers	Heat exchangers - Shell and Tube		x		
Mills	Mills - Tube Ball Mill				x
Mills	Mills - Vertical Spindle				x
Steam Turbines	Steam Turbines - Multi-stage		x		
Pressure vessels	Pressure vessels - De-aerator		x		

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How AVEVA Asset Strategy Optimization fits in the APM Work Process

Performance Monitoring
Lagging Indicators

4 Strategy Execution
5 OEE / Cost / Labor

EAM
MoW
CoW

Asset Strategy

1 Business Objectives
2 Criticality & Risk Analysis
3 Maintenance Strategies

ASO
ASL

Plan   Do

Asset Information
Management
Work Task
Management

Adapt   Check

Condition Monitoring
Leading Indicators

6 Condition Based Maintenance
7 Predictive Analytics

OSI PI
Insight
Predictive Analytics

Unified
Operations
Center

Strategy Optimization

9 Root Cause & Failure Analysis
10 Life Cycle Costing
11 Scenario Comparison

ASO

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Close out and further information

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Takeaways and Call to Action

- Engineered analytics vis-à-vis AI/ML and advanced analytics

- Layered approach to Maintenance
  - Usage-based, condition-based, simple predictive and advanced predictive

- Maintenance maturity assessment to get started

- APM is a journey...think big, start small and scale fast

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APM Resources

- Infographic
  - [Fast Forward to Now: How Resilience & Agility are Driving Next Gen Industries](#)

- Blogs
  - [Improving Efficiency with a Data-Driven Asset Strategy](#)
  - [5 Key Takeaways from Decades of Successful Asset Management](#)

- White Papers
  - [Operational Excellence (OpX) Achieved byCompanies That ARE Operationally Resilient](#)
  - [How to realize a digitalized future Asset Performance Management strategy](#)
  - [Sensor-Based Decision Making with True Lead Performance Indicators](#)

- eBook
  - [A Blueprint for Industrial Operational Efficiency](#)

- Hubs
  - [Achieve Operational Excellence with AVEVA APM in the Cloud](#)
  - [Is your team truly connected?](#)

- Case Study
  - [Refinery reliability starts with APM Assessment](#)

- Success Stories
  - [SCG Chemicals](#)
  - [Duke Energy](#)
  - [Enel](#)

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PI Resources

[PI System 101](#) (webinar recording – 1 hour)

[Analytics for industrial sensor data in the PI System](#) (3-part series, recording and slides)

[Arizona Public Service – Palo Verde - Event Frames for more effective decision making – MSIV use case](#) (recording)

[Exelon – Ginna – PI System story](#) (recording)

[Genesis Energy - Predictive analytics](#) (recording)

[Layered approach to maintenance/reliability](#) (blog + workshop intro)

[Industrial IoT time-series data engineering - a layered approach to data quality](#) (blog + workshop intro + recording)

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AVEVA

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ABOUT AVEVA

AVEVA, a global leader in industrial software, drives digital transformation for industrial organizations managing complex operational processes. Through Performance Intelligence, AVEVA connects the power of information and artificial intelligence (AI) with human insight, to enable faster and more precise decision making, helping industries to boost operational delivery and sustainability. Our cloud-enabled data platform, combined with software that spans design, engineering and operations, asset performance, monitoring and control solutions delivers proven business value and outcomes to over 20,000 customers worldwide, supported by the largest industrial software ecosystem, including 5,500 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 6,000 employees at 90 locations in more than 40 countries. For more details visit: www.aveva.com

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