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Expanding the value of AVEVA™ PI System™ with online process simulation & predictive analytics

Unlocking additional value from your operations data through predictive asset optimization

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Agenda

- AVEVA PI System as operational data infrastructure
- AVEVA PI System with process simulation
- AVEVA PI System with predictive analytics
- Predictive Asset Optimization (PAO)
- Customer success story
- How AVEVA accelerates data potential journey
- Call to action

THE MODERN PI SYSTEM

AVEVA™ PI System™ as operational data infrastructure

AVEVA™ PI System™
Industrial data backbone for digital transformation

40% market share	**2.0B+** data streams	**30,000+** sites	**130+** countries	**1500+** case studies	**68%** of Industrial Fortune 500

INDUSTRIAL DATA INFRASTRUCTURE BACKBONE

Oil & Gas	Power & Utilities	Chemicals	Metals & Mining	Life Sciences	Pulp & Paper	Infra-structure
95% of top 60 companies	**1000+** of the world's leading companies	**38/50** of the world's largest companies	**100%** of Fortune 500 companies	**9/10** of top pharma companies	**400+** Sites	**600+** Sites

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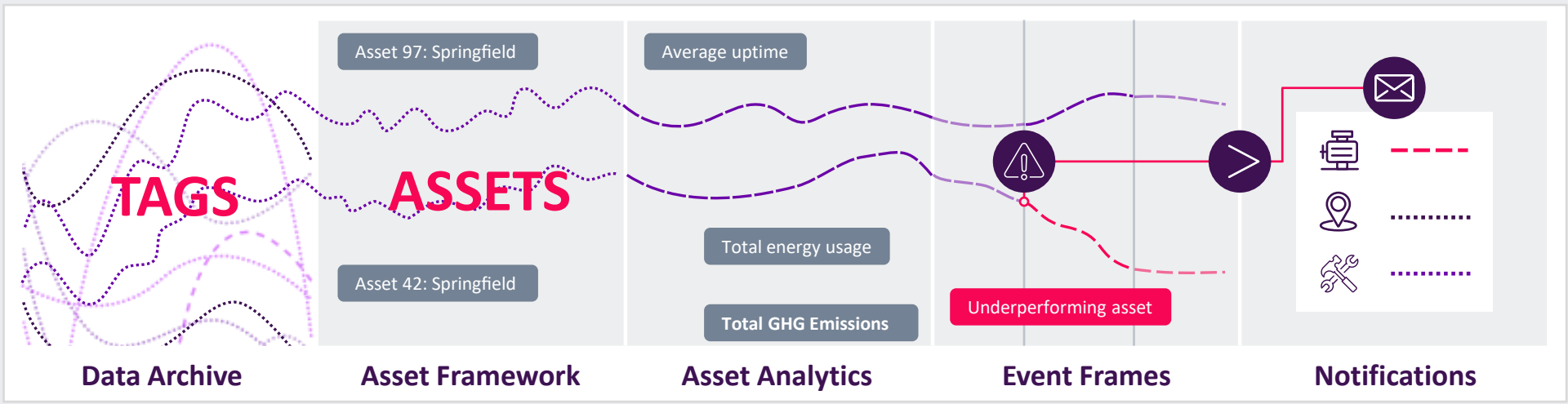
Turning data into decision-ready information

Add structure and meaningful context to your operations data

Automatically **pinpoint important events** in your operations



How can you keep expanding your data potential?

Optimized storage & access to massive volumes of operational data

Transform raw data into actionable KPIs using streaming calculations

Send automatic alerts to the right people with the right information

Turning data into decision-ready information

Data Archive
Optimized storage & access to massive volumes of operational data

Asset Framework
Add structure and meaningful context to your operations data

Asset Analytics
Transform raw data into actionable KPIs using streaming calculations

Event Frames
Automatically **pinpoint important events** in your operations

Notifications
Send automatic alerts to the right people with the right information

Expand the data potential with additional capabilities

Cloud-based collaboration	Advanced visualization
AI and ML models	Immersive environments
Risk assessment tools	Optimization models
Automated procedures	Mobile operator tools
Execution management	Digital twins

Integration readiness by PI maturity levels

Predictive analytics

Process simulation

Level 4

Advanced analytics
(predictive, equation-based)

Forecasting & actual vs predicted comparisons

Level 3

Complex calculations
(CBM, OEE, rollups)

Use of **Event Frames**
(downtime, startups, shifts tracking)

Notifications
(emails, work order generation via web service)

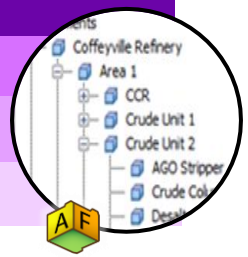
Level 2

Metadata integration - add **context** via data references and linked tables

Simple calculations
(data quality, totals, averages)

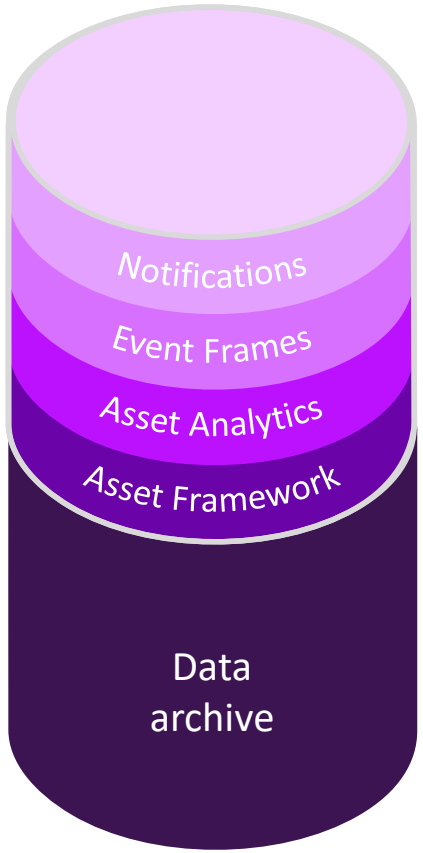
Level 1

Data directory
(tag mapping)
Abstraction
(std. Lexicon)
Normalization
(UOM, time zones)
Organization
(Dynamic hierarchy)



AVEVA PI System Data Archive

- Tag-based, **high fidelity** historical data ingress/egress
- **"Rich" time-series data** created by PI AF analytics & calculations (health index, efficiency etc.)
- **Future** data (forecasts, projections etc.)



How to get new value from integration of your data infrastructure with process simulation?

Process Simulation 101

Model-based representation of simultaneous chemical, physical, hydraulic & other technical processes

Unit operations & equipment

$$\eta_c = \left[\left(\frac{p_2}{p_1}\right)^{(\gamma-1)/\gamma} - 1\right] \Big/ \left[\left(\frac{p_2}{p_1}\right)^{(\gamma-1)/\eta_p\gamma} - 1\right]$$

- Distillation
- Reactor
- Vessel
- Pump
- Heat exchanger
- Compressors

Thermodynamic models

UNIFAC (Original):

$$\ln(\gamma_j) = \ln(\gamma_{j,c}) + \sum_{i=1}^{N} n_{j,i}\{\ln(\gamma_i) - \ln(\gamma_{j,i})\} \text{ where}$$

$$\ln(\gamma_{j,c}) = \ln(\Phi_j / x_j) + 5q_j \ln(\Theta_i / \Phi_i) + l_j - \Phi_j / x_j \sum_{k=1}^{3} x_k l_k$$

$$\Theta_i = x_i q_i / \sum_{j=1}^{3} x_j q_j \; ; \; \Phi_i = x_i r_i / \sum_{j=1}^{3} x_j r_j \; ; \; l_j = 5(r_j - q_j) + 1 - r_j$$

$$\gamma_{j,k} = Q_{type(k)} \cdot \left[1 - \sum_{i=1}^{N} \theta_{j,i} \cdot \psi_{ki} \Big/ \sum_{m=1}^{N} \theta_{j,m} \cdot \psi_{mi} - \ln \sum_{i=1}^{N} \theta_{j,i} \cdot \psi_{ki}\right]$$

$$\gamma_k = Q_{type(k)} \cdot \left[1 - \sum_{i=1}^{N} \theta_{M,i} \cdot \psi_{ki} \Big/ \sum_{m=1}^{N} \theta_{M,m} \cdot \psi_{mi} - \ln \sum_{i=1}^{N} \theta_{M,i} \cdot \psi_{ki}\right]$$

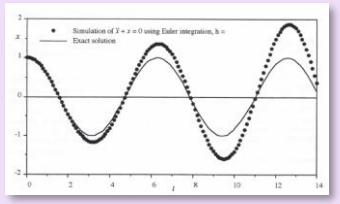
$$x_{j,i} = n_{j,i} / \sum_{m=1}^{N} n_{m,i} \; ; \; \theta_{j,i} = x_{j,i} \cdot Q_{type(i)} / \sum_{i=1}^{N} x_{j,i} \cdot Q_{type(i)}$$

$$x_{M,i} = \sum_{m=1}^{3} x_m n_{m,i} / \sum_{k=1}^{N} \sum_{m=1}^{3} x_m n_{m,k} \; ; \; \theta_{M,i} = x_{M,i} \cdot Q_{type(i)} / \sum_{i=1}^{N} x_{M,i} \cdot Q_{type(i)}$$

VLLE
Van der Walls
Soave Redlich-Kwong
Peng-Robinson

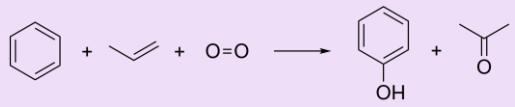
$$PV = nRT$$

Steady state & dynamic



$$u(t) = K_p e(t) + K_I \int e(t)dt + K_D \frac{de(t)}{dt}$$

First principles model

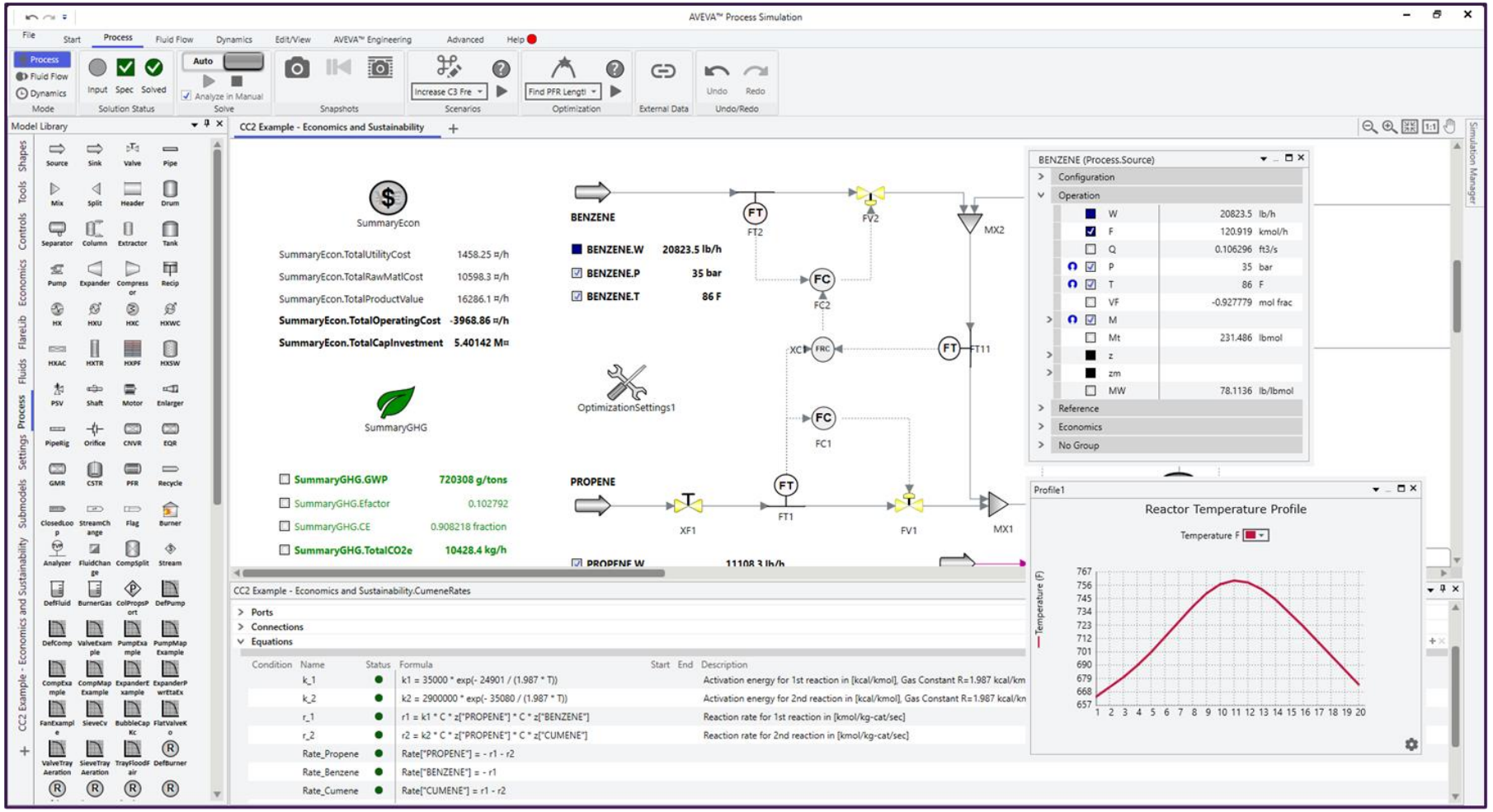


$$k = A \,.\, e^{-E_a/RT}$$

AVEVA

Process Simulation 101

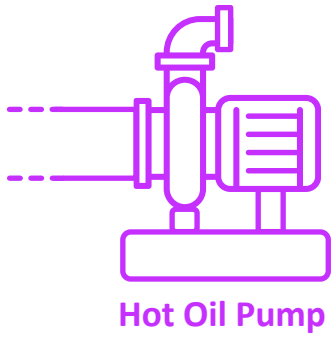
Delivering the process digital twin with a first principles platform

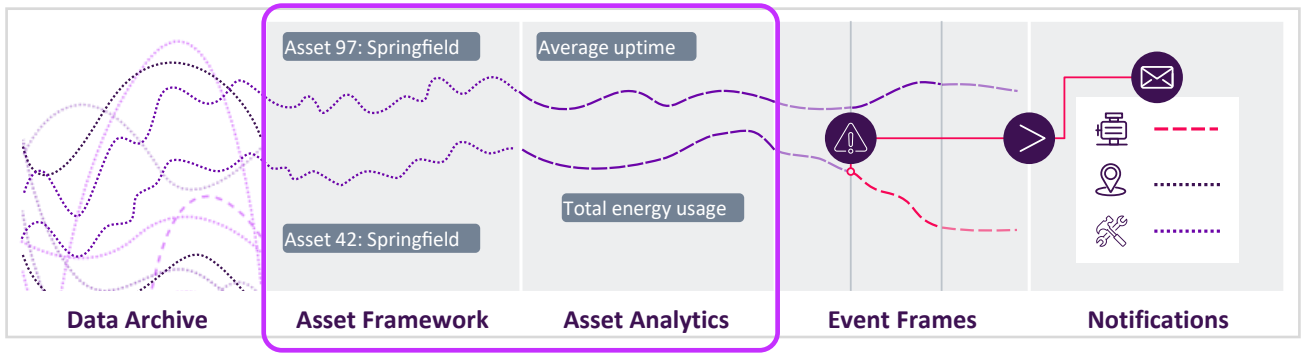


The case for AVEVA™ PI System™ and process simulation

Real-time data + asset analytics

- Create asset templates to calculate and monitor simple KPIs for equipment
- Easily scale and deploy asset templates across your enterprise
- No insight beyond measured mechanical and process data
- Difficult to quantify asset impact on upstream & downstream processes

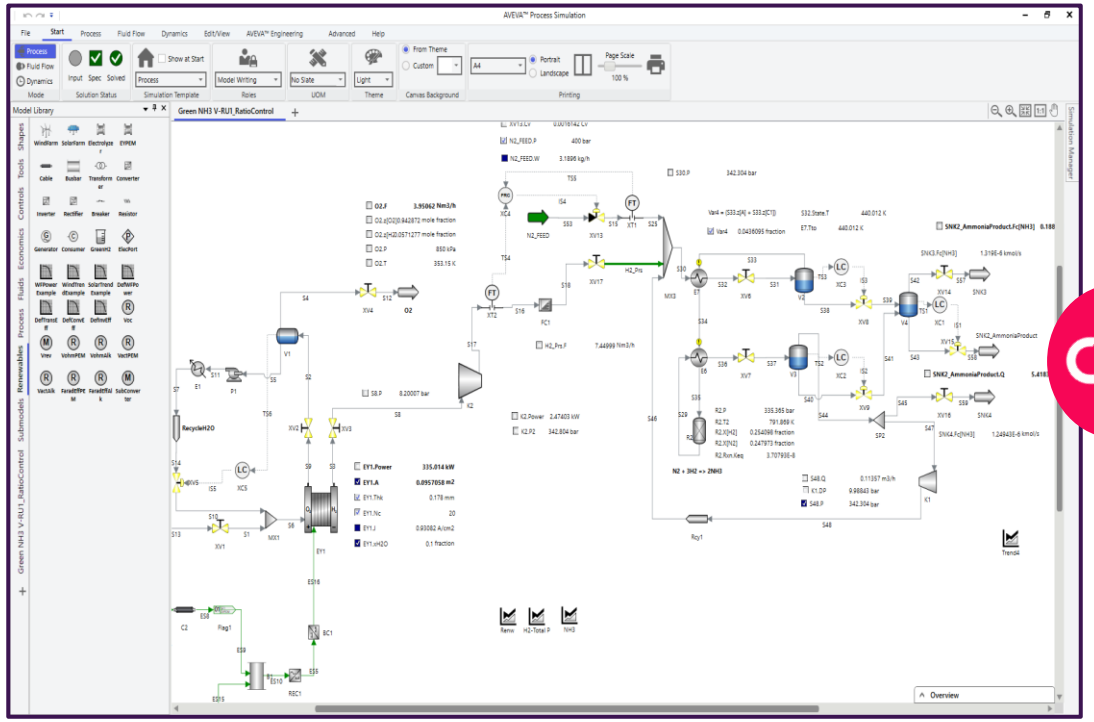




AVEVA™ PI System™ integration with process simulation

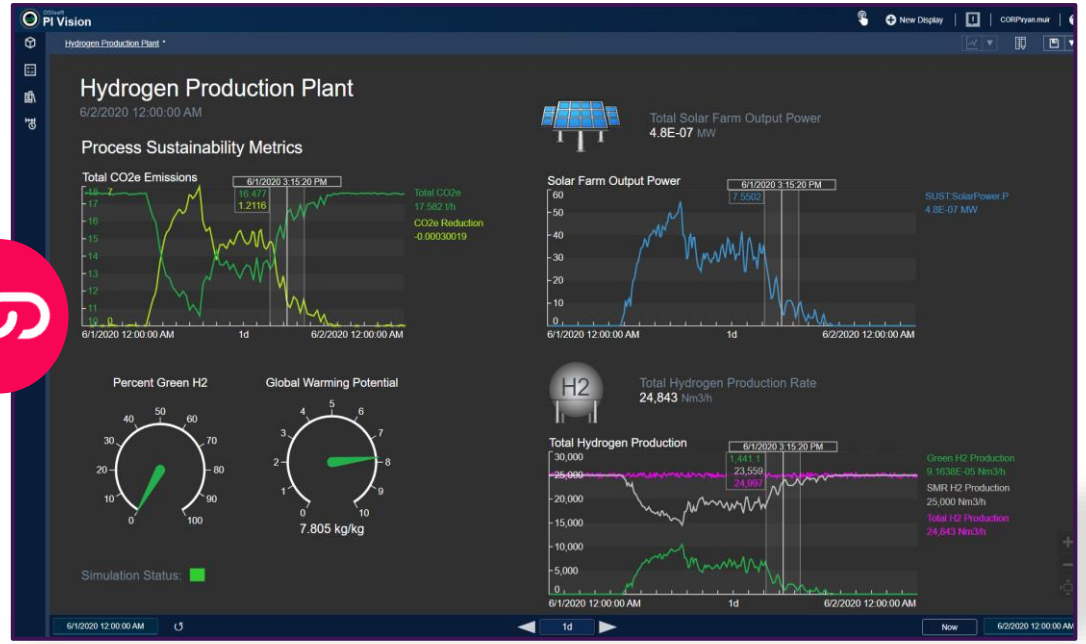
Deploy models online for real-time optimization and performance monitoring

Process simulation



First principles physics, chemical & hydraulic models

Live / archived process data



Operating digital twin

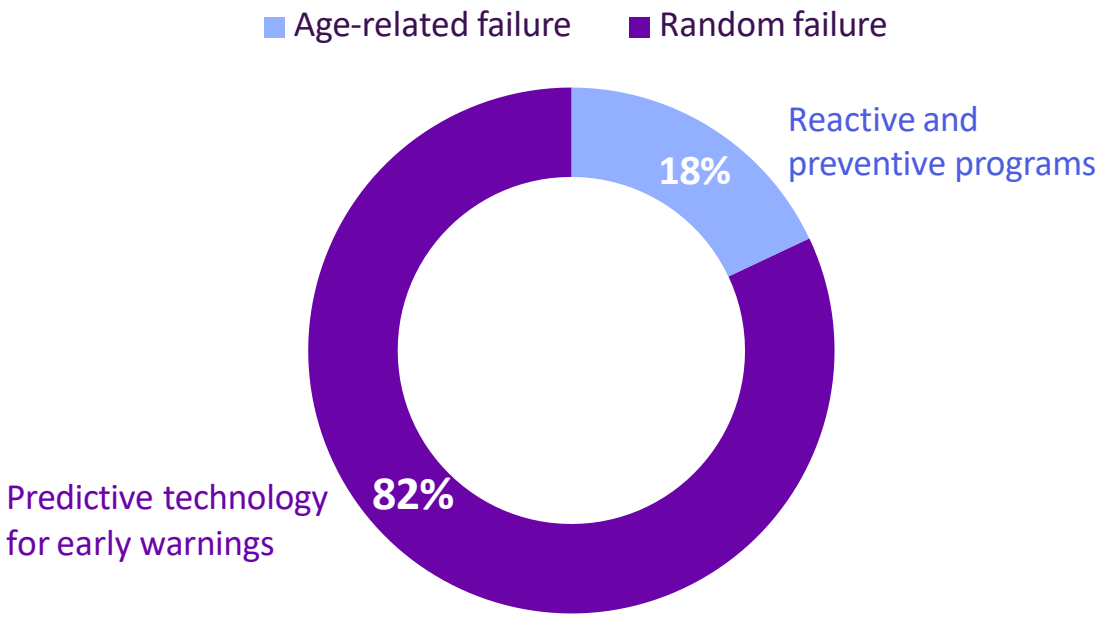
- Troubleshoot past & real-time operations
- Provide soft sensors
- Improve operation & efficiency
- Testing platform

How to get new value from integration of your data infrastructure with predictive analytics?

Optimize your asset reliability, maintenance and performance

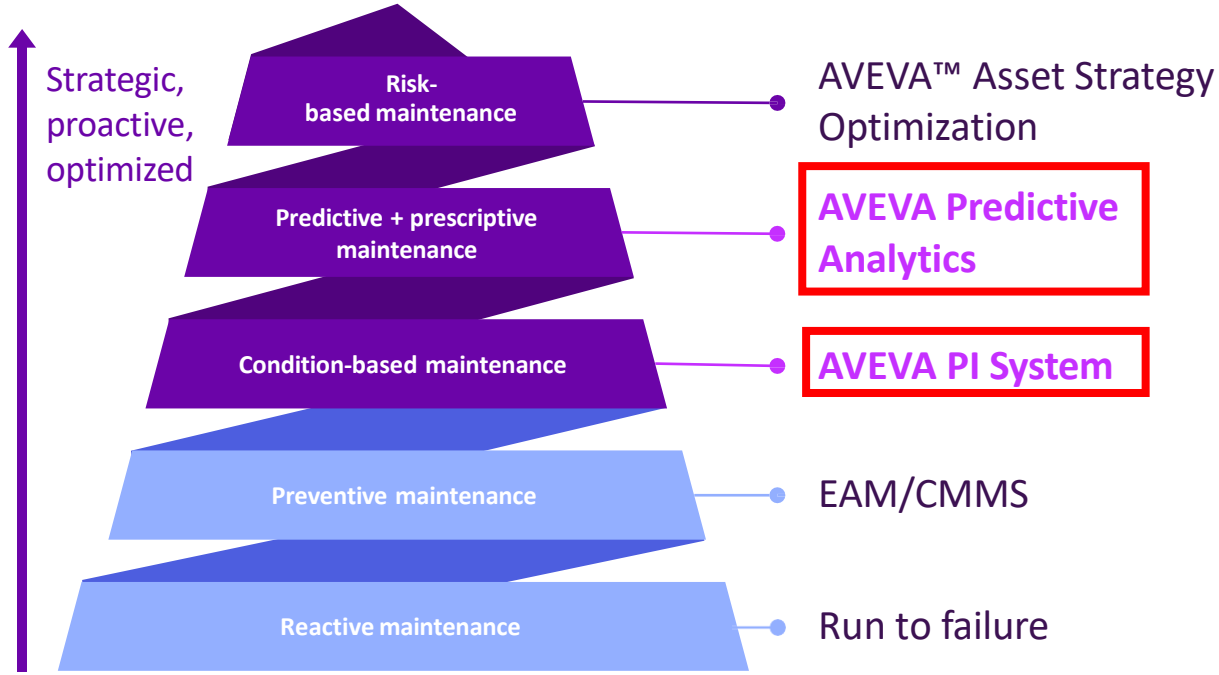
A journey in operational reliability with AVEVA PI System and AVEVA Predictive Analytics

Failure patterns



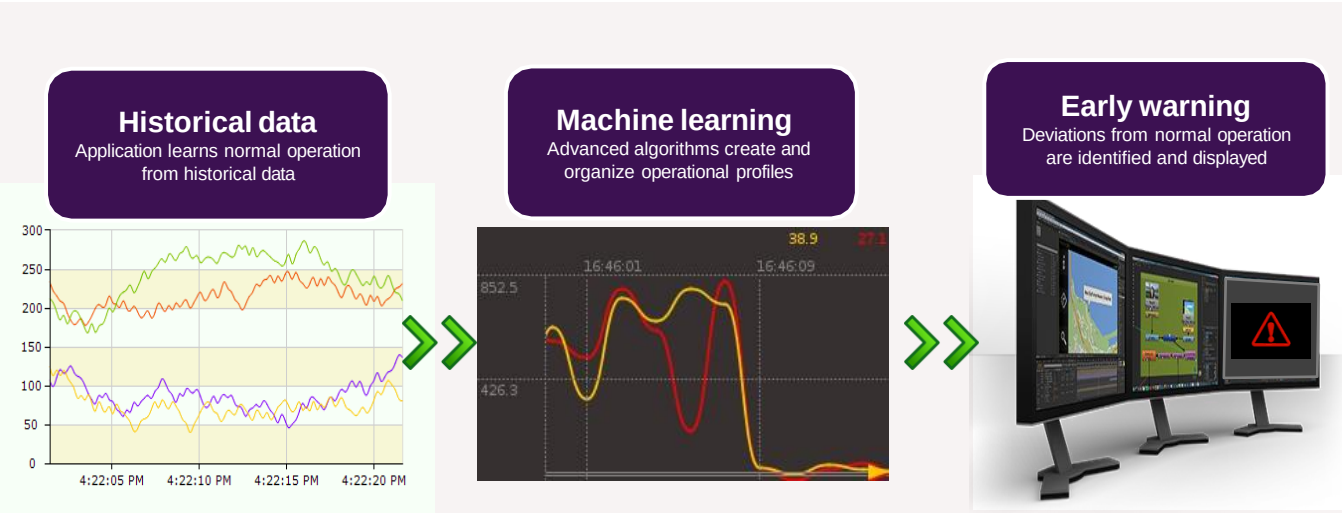
▲ARC studies show only 18% of asset failure is age-related. Based on these data, preventive maintenance provides a benefit for just 18 percent of assets, and monitoring for predictive maintenance is a recommended option for the rest.
Www.Arcweb.Com/lists/posts/post.Aspx?Id=260

It's a journey



Monitoring with predictive analytics

The approach



The advantage

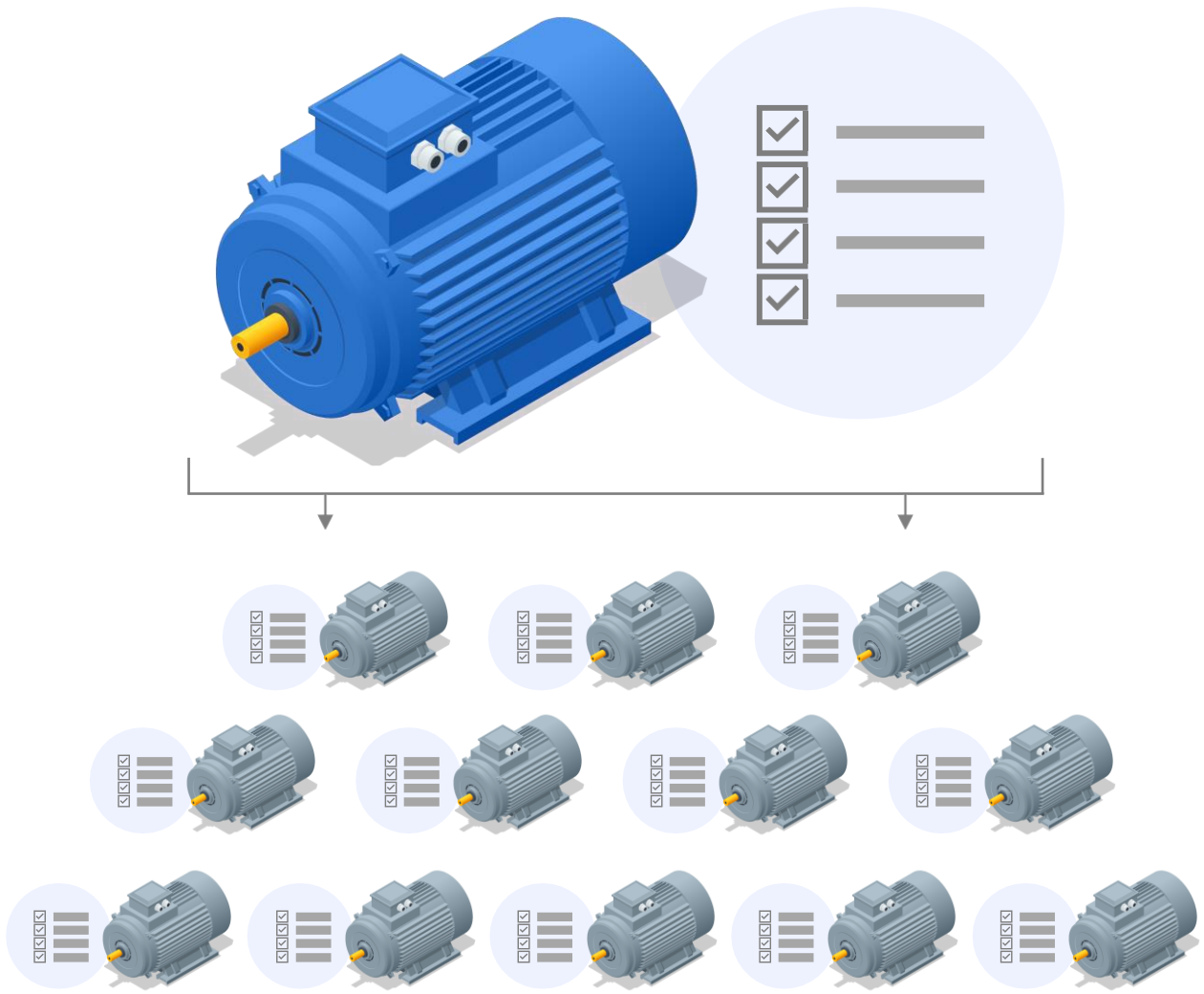
- Machine learning continuously monitors behavior in real time 24/7
- Alerts when operation differs from historical norm
- Early warning detection of equipment problems
- Advanced analysis capabilities including problem identification & root cause analysis

Automated model building

Deployment at scale for fast time to value

- PI Asset Framework templates integrate with AVEVA Predictive Analytics templates
- Minimize manual work with template integration
- Automatically include filters, alert thresholds, and fault diagnostics
- Automatic cleansing of training data

Minimize errors
Ensure consistency
Improve productivity

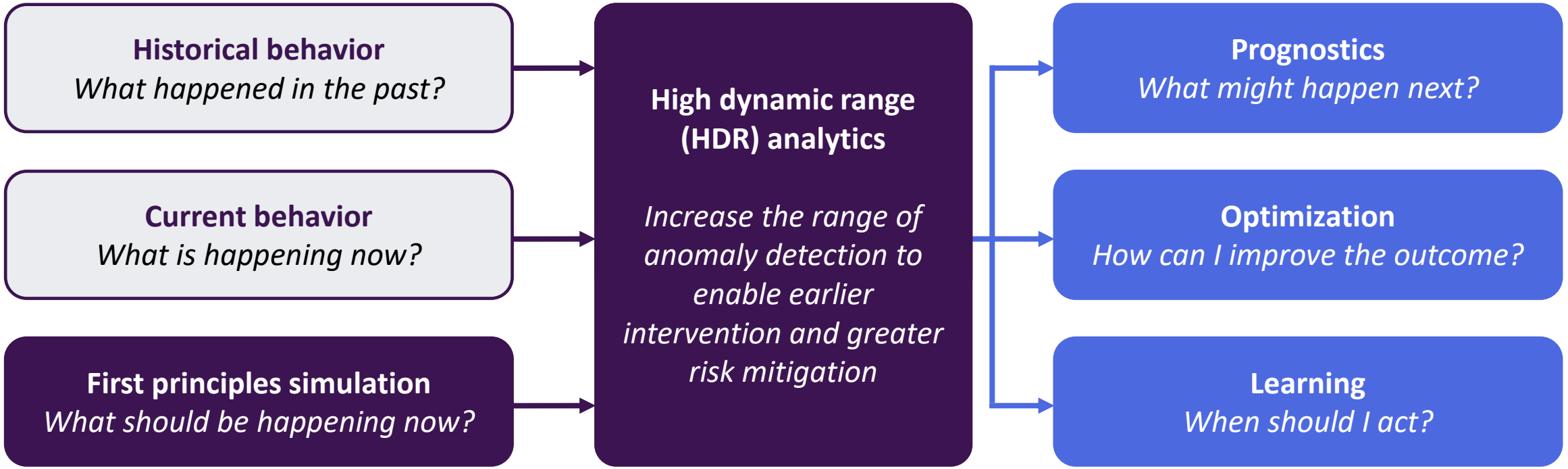


How to get additional value from integration of data infrastructure with BOTH process simulation & predictive analytics?

A: Predictive asset optimization (PAO)

What is predictive asset optimization (PAO)?

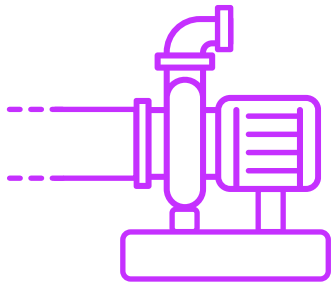
What is PAO? Real-time data + artificial intelligence + simulation + optimization



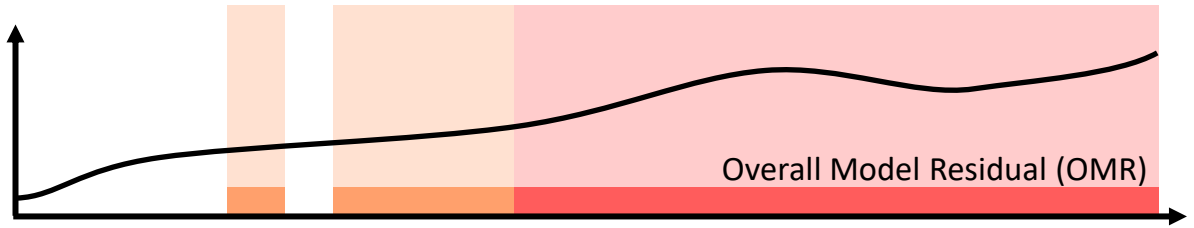
The case for AVEVA™ PI System™ and predictive analytics

Real-time data + predictive analytics

- AI and condition-based multivariate analysis of process deviations
- Early warning notifications, time-to-failure, and remaining useful life estimates
- No insight beyond measured mechanical and process data
- Difficult to quantify asset impact on upstream & downstream processes



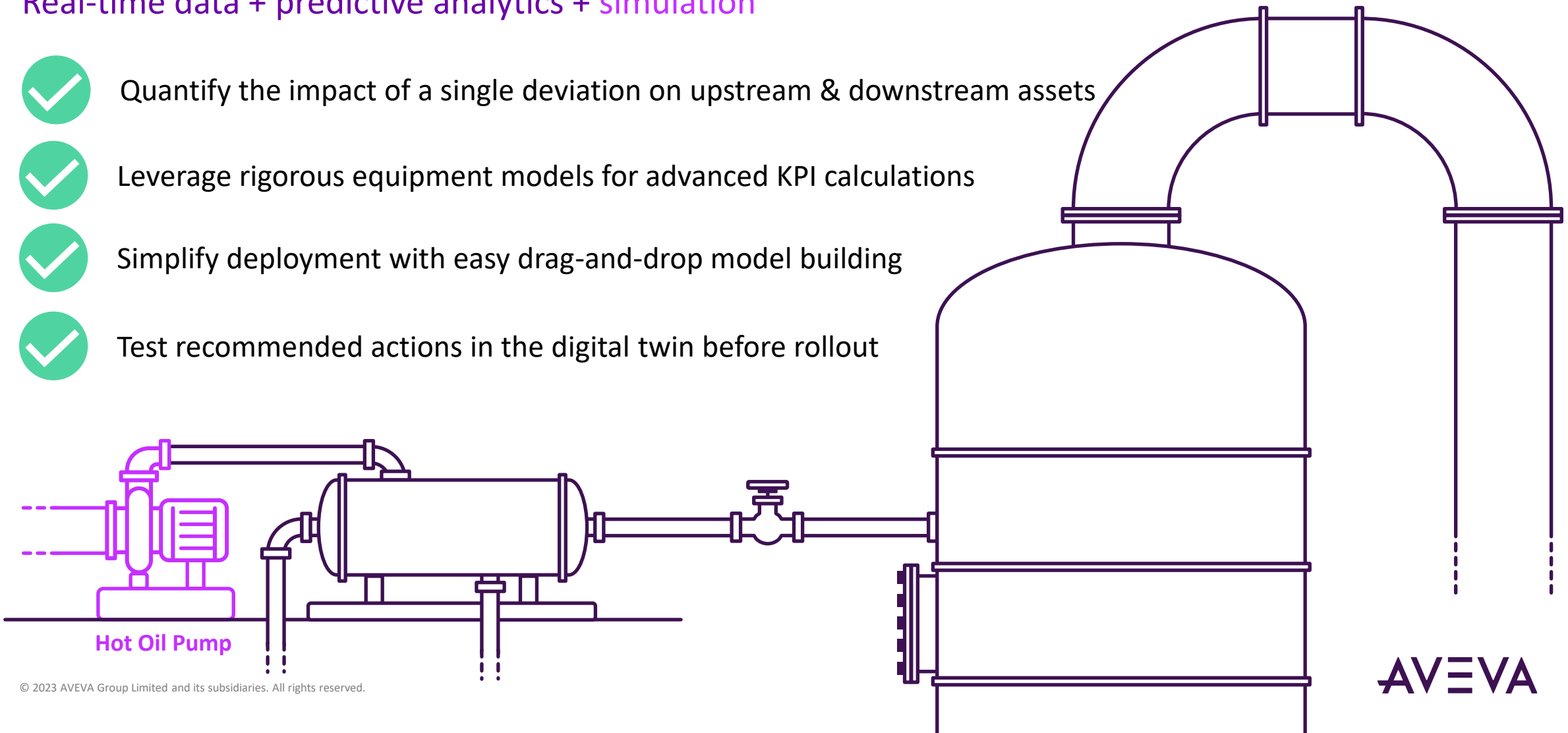
Hot Oil Pump



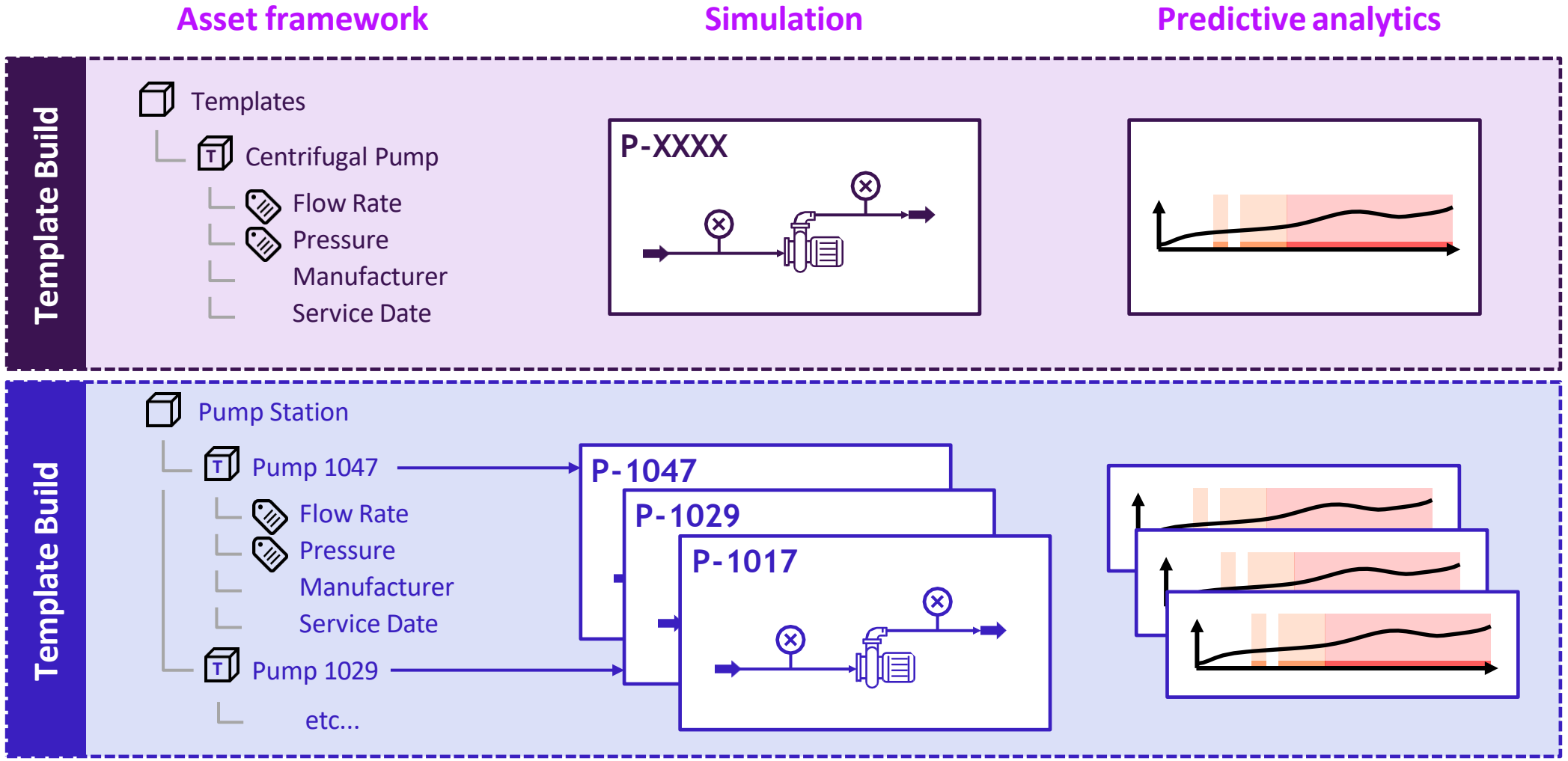
The case for AVEVA™ PI System™, predictive analytics, and process simulation

Real-time data + predictive analytics + simulation

- Quantify the impact of a single deviation on upstream & downstream assets
- Leverage rigorous equipment models for advanced KPI calculations
- Simplify deployment with easy drag-and-drop model building
- Test recommended actions in the digital twin before rollout



Scalability of predictive asset optimization



Customer success story

How Saudi Aramco is using PAO to improve their operations

OIL & GAS | SAUDI ARABIA

Please join Aramco's AWC Presentation on Wed, Oct 25 from 11:40-12:10 in Oil, Gas & Energy Track

Challenge

- How to manage & improve asset reliability & major equipment performance across dozens of distributed sites?
- How to predict asset failure in advance to optimize resource planning & maintenance schedules?

Solution

- AVEVA™ Process Simulation (APS) and AVEVA Predictive Analytics connected to AVEVA PI System

Results

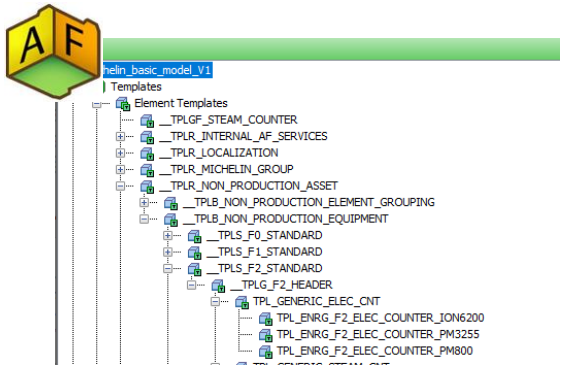
- **Applied process simulation (APS) for real-time performance monitoring**
- **Online fault monitoring (OFM) solution being scaled & deployed**
- **OFM solution provides asset failure prediction & operational support for critical assets**
- **Reduced maintenance costs and improved asset reliability, availability & performance**

How AVEVA accelerates your data potential journey with process simulation & predictive analytics

Stop thinking tags, start thinking assets

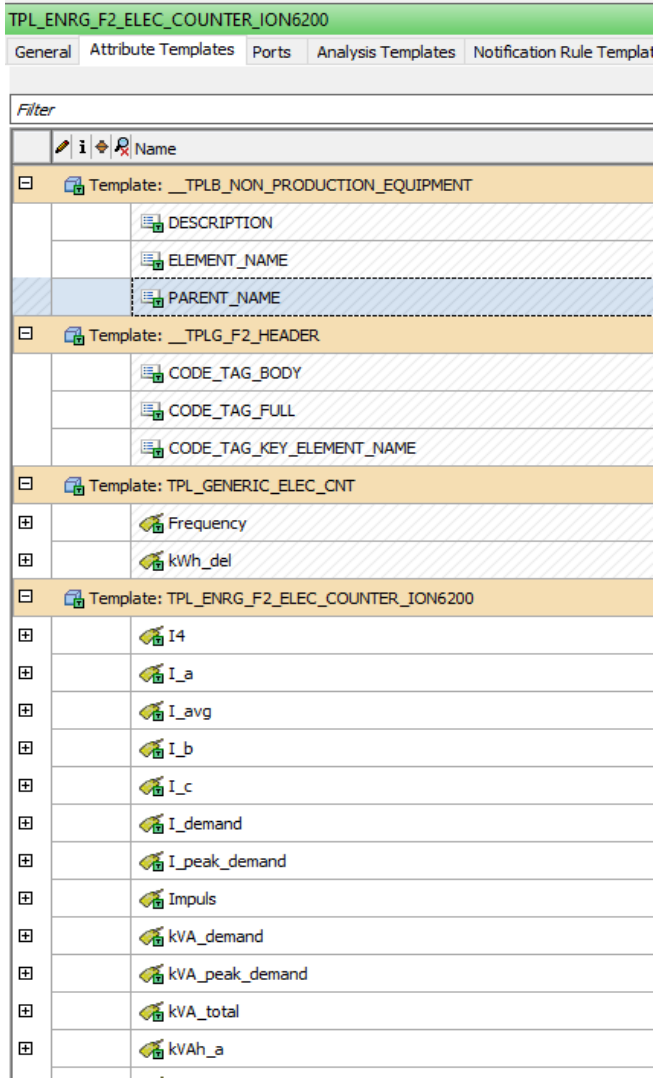
Build once, deploy many!

Counter object



TPL_ENRG_F2_ELEC_COUNTER_ION6200

- Better alignment with Engineering, Operations & Maintenance
- Scalable & consistent
- Less time to develop & deploy
- Safer, fewer errors
- => Structure & context for enterprise analytics



Metadata

Sensor ‘tag’ data

Calculations, analytics & workflows

PI Digital Twin Library

(Please join AWC Presentation on Wed, Oct 25 from 16:30-17:00 in PI System User track for more information)

Base library

- Container
- Sensors
- Calculations

Asset libraries

- Centrifugal Pump
- Compressor
- Gear Reducer
- Electric Motor
- Valve
- Heat Exchanger

Asset classes

Asset super classes

Accessory libraries:

- Vibration monitoring
- PID, composition
- OEE
- Energy/sustainability
- Forecasting
- SAP, Maximo
- Asset Specification storage
- Geographic Tracking
- AVEVA™ Process Simulation
- AVEVA™ Predictive Analytics
- AVEVA™ Connect – AIM

AVEVA™ PI Vision™:

- Anomaly Display: Discovery, Overlays, Annotate
- Asset Displays by class
- Accessory Displays by class
- HOME Screen navigation organizer

MS PowerBI:

Asset Dashboard

Call to action

Call to action

Step 1

Identify a test case

Consider relevant use cases & identify one use case. Consider equipment with high criticality or problems

Outcome

Mutual understanding of model to build & evaluate

Step 2

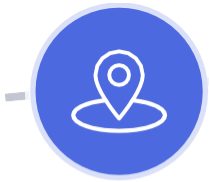
Build and deploy model

During AVEVA PI Digital Twin Workshop, define success criteria & work together to develop & deploy initial integrated model

Outcome

Model built with AVEVA support & success criteria understood

Step 3



Confirm value

Evaluate model against defined success criteria to confirm value of solution

Outcome

Potential value identified & agreed upon. Model utilized as example for future rollouts

Q&A

This presentation may include predictions, estimates, intentions, beliefs and other statements that are or may be construed as being forward-looking. While these forward-looking statements represent our current judgment on what the future holds, they are subject to risks and uncertainties that could result in actual outcomes differing materially from those projected in these statements. No statement contained herein constitutes a commitment by AVEVA to perform any particular action or to deliver any particular product or product features. Readers are cautioned not to place undue reliance on these forward-looking statements, which reflect our opinions only as of the date of this presentation.

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ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com

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