AI & Simulation

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Artificial Intelligence Overview

Engineering / Operations / Performance

- **Predictive**
- **Performance**
- **Prescriptive**
- **Prognostic**

Maintain
Increased longevity and performance of assets while ensuring a safe, reliable environment for the workforce through predictive, prescriptive, prognostic analytics

Engineer
Analysis and automated design generation enabling lower total cost, time, risk in capital project engineering



Monitor | Control
Predictive and autonomous operational control to ensure safety, performance

Operate | Optimize
Improved Optimization & OEE for safe and profitable operations within constraints and regulatory norms

Plan | Schedule
Self-learning approach to model planning, scheduling in order to maximize profitability and efficiency

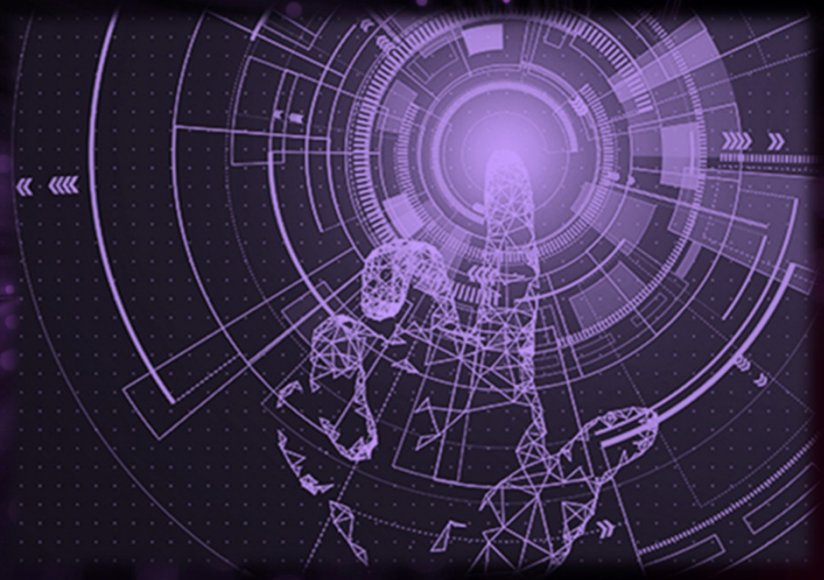
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Simulation Overview

Process Modeling & Simulation

- Validate and improve design
- Monitor & analyze running processes for correct operation
- Provide input for real-time process control
- Optimize existing processes
- Simulate processes for operator training
- Predict failure
- Optimize operations & maintenance



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The Value of Combined AI & Simulation

	Simulation (physics driven)	AI (data driven)
Data:	Small Data	Big Data (for training)
Domain expertise:	High reliance upon deep domain expertise	Can provide useful results with little domain knowledge
Fidelity & robustness:	Universal algorithms can handle highly non-linear and complex relations	Limited to the range of values spanned by the training set
Adaptability & deployability:	Requires complex and time-consuming derivation to account for new relations	Rapid adaptation to new situations and data relationships
Interpretability:	Consistent, physically meaningful link between parameters	Statistical, not physical, correlation

- **Complement** – overall solution can be a combination of both models
- **Supplement** – one model can improve upon the accuracy of the other
- **Embed** – one model can be embedded in the other
- **Integrate** – output of one model can be the input to another

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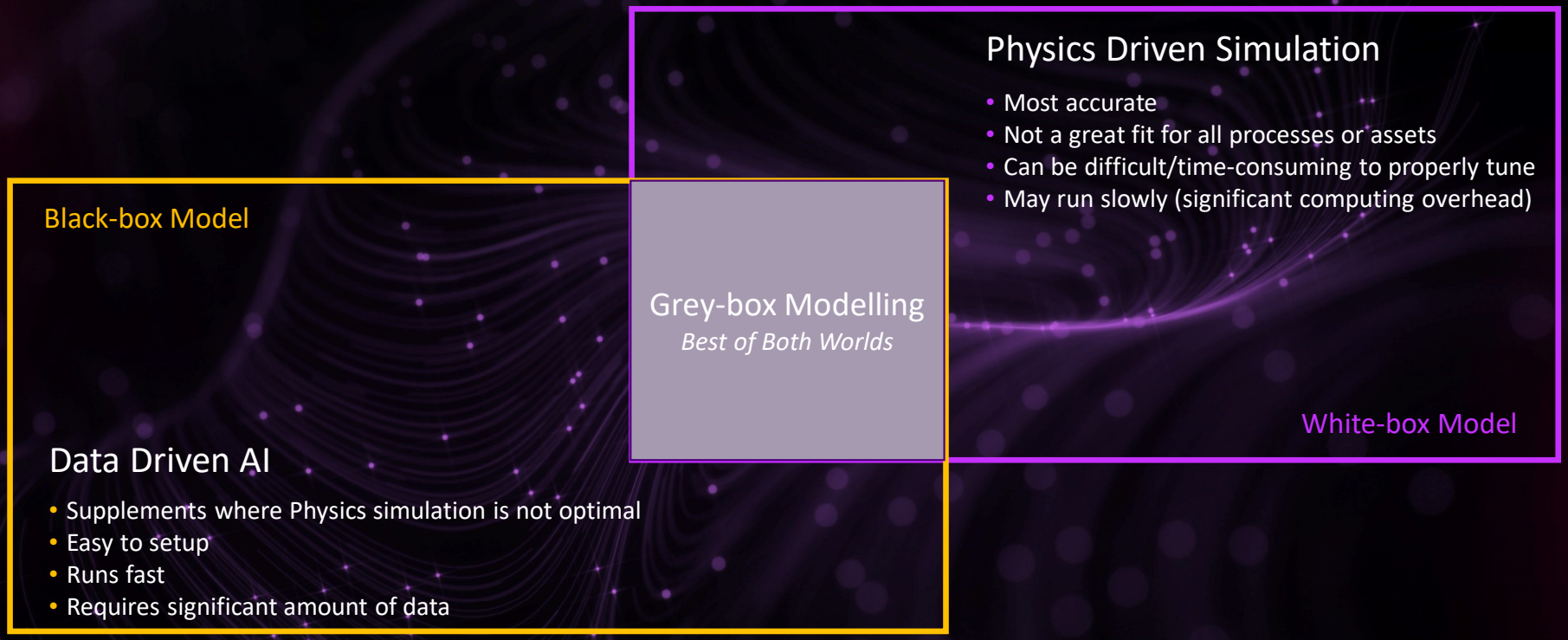
The Value of Combined AI & Simulation

Examples

- Grey-box Modelling
- Next-generation Predictive Analytics

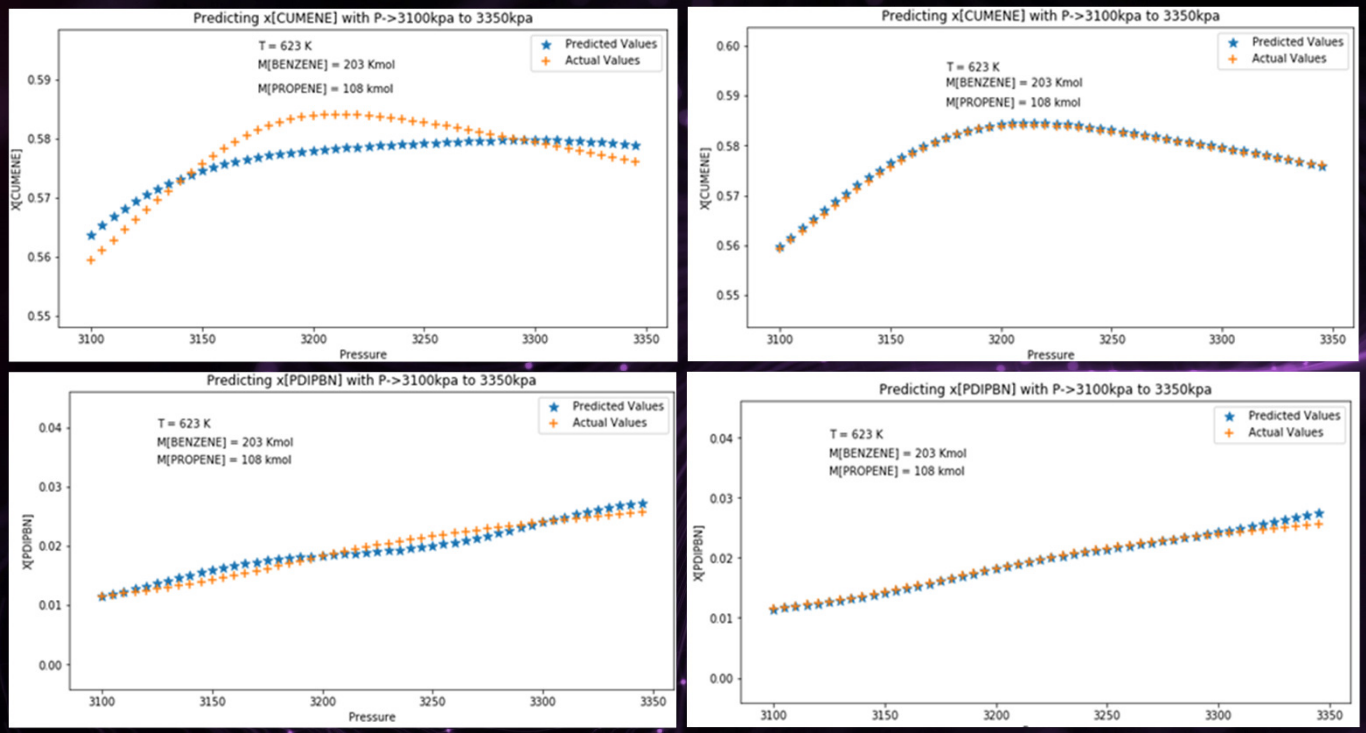
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Grey-box Modelling



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Cumene Reactor AI Model

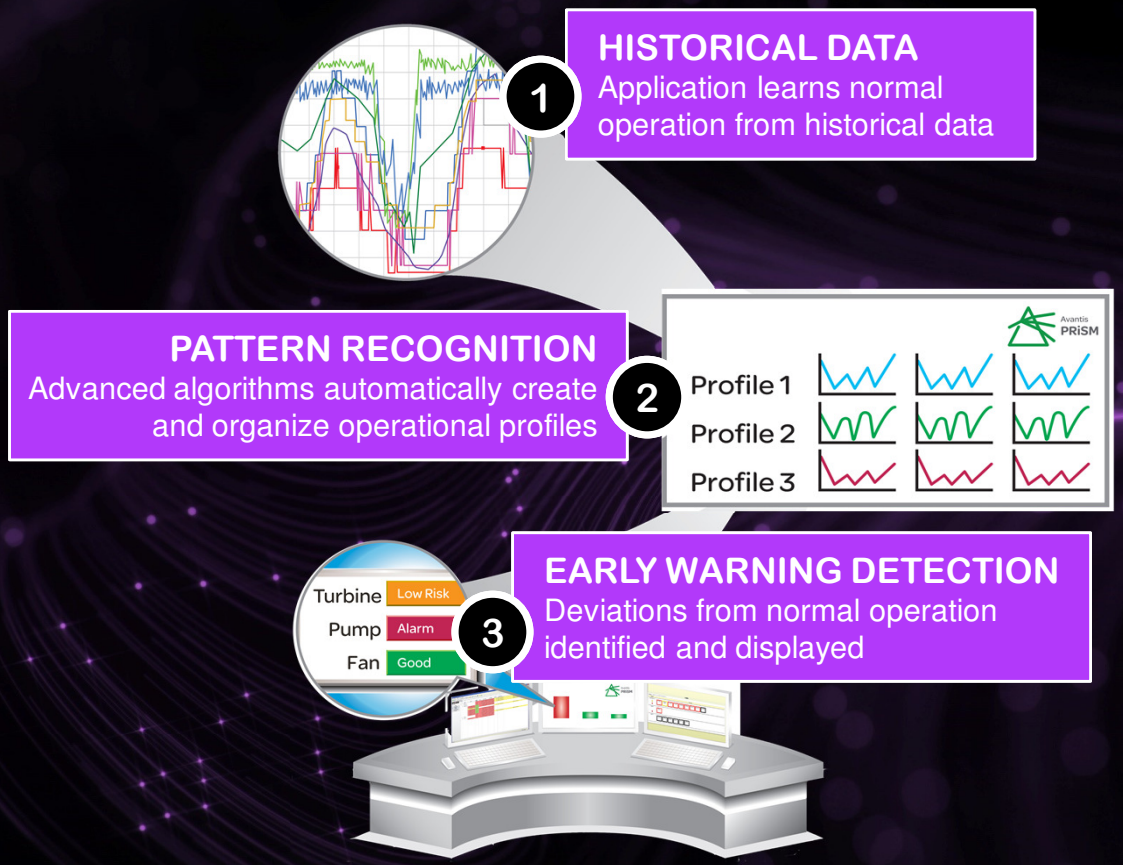


Models improve with additional training data

Data

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Predictive Analytics: How Does It Work?



- On-premises
- Cloud / SaaS
- Hybrid architectures

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AI-Driven Next-Gen Predictive Analytics

Integrated Simulation and Machine Learning

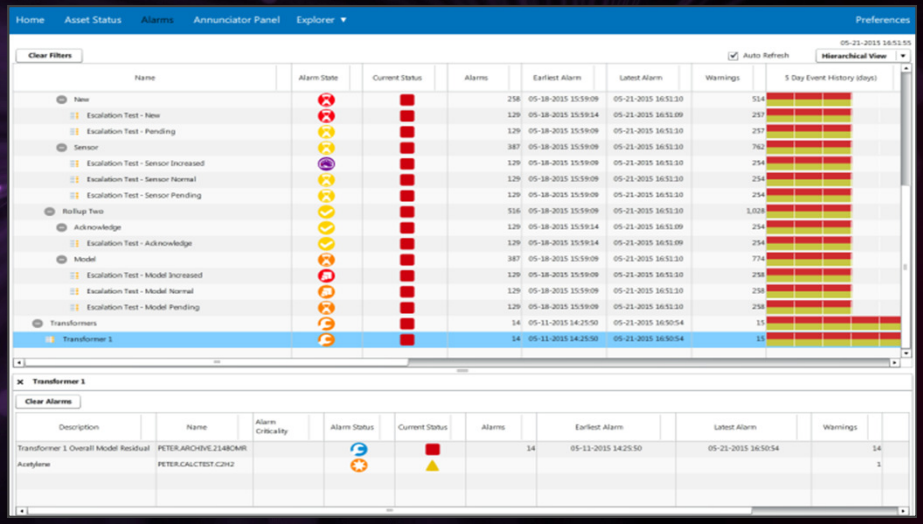
Asset Performance

Operate and Optimize

High Dynamic Range Models (earlier detection of issues through physical and "soft" sensors)

Risk-based AI Analysis

Single Enterprise Notification System



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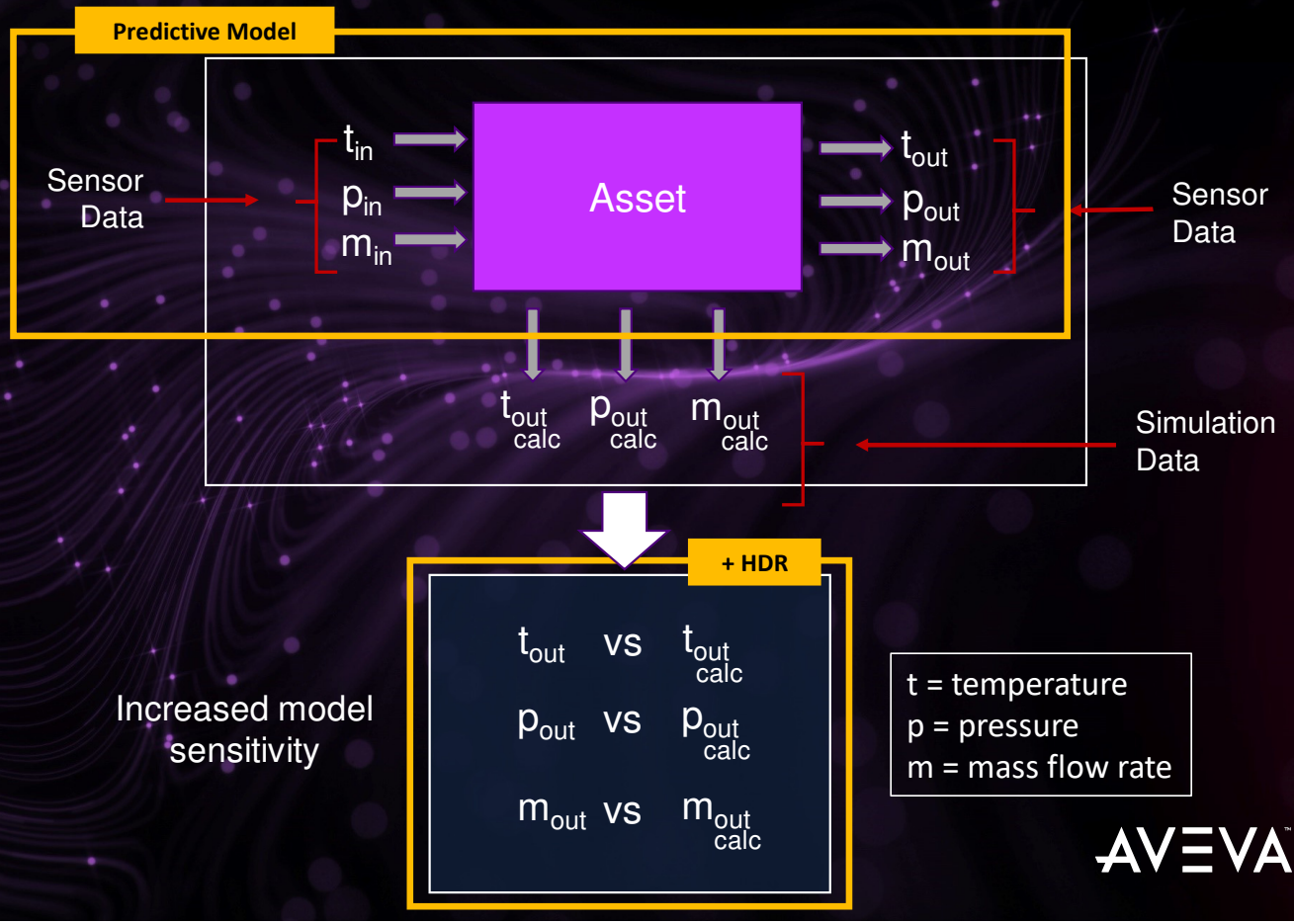
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High Dynamic Range (HDR) Models

Solution Overview

BENEFITS

- Earlier Warning of Equipment and Process Issues than Predictive alone
- Modelling for greenfield sites
- Modelling for remanufactured equipment
- Modelling for assets with limited historical data

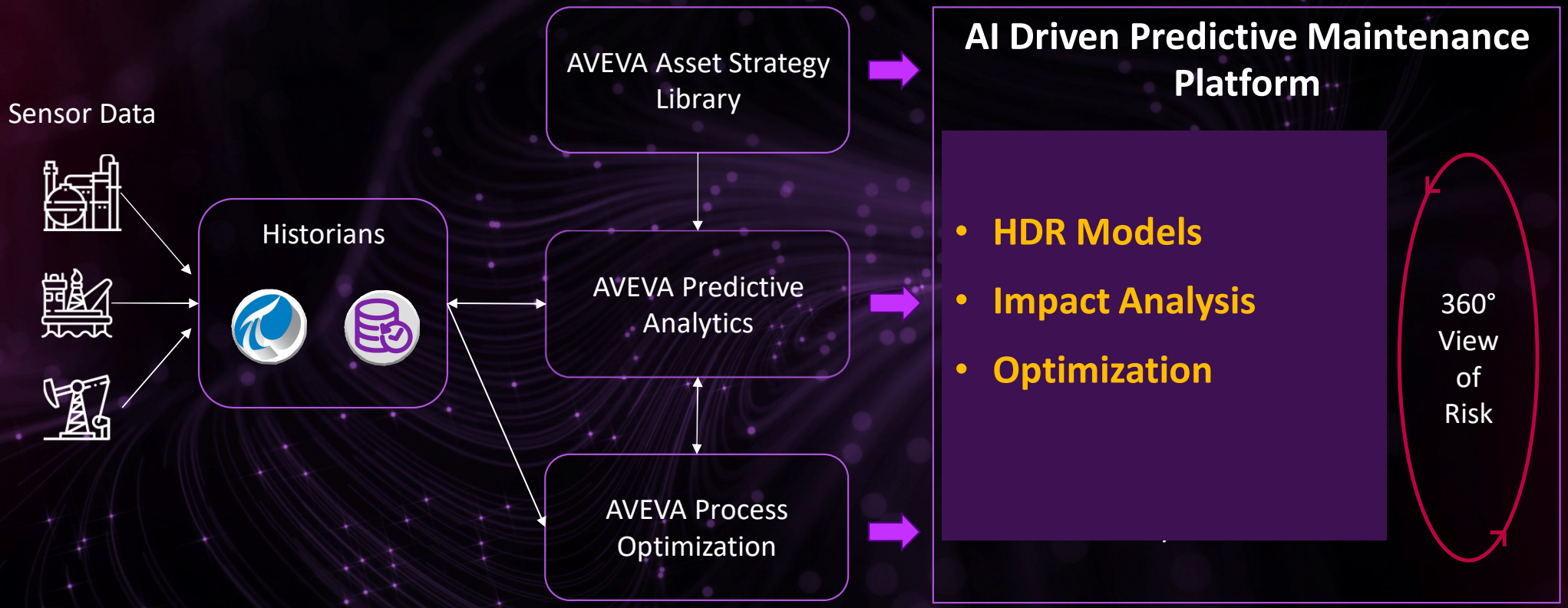


Increased model sensitivity

t = temperature
p = pressure
m = mass flow rate

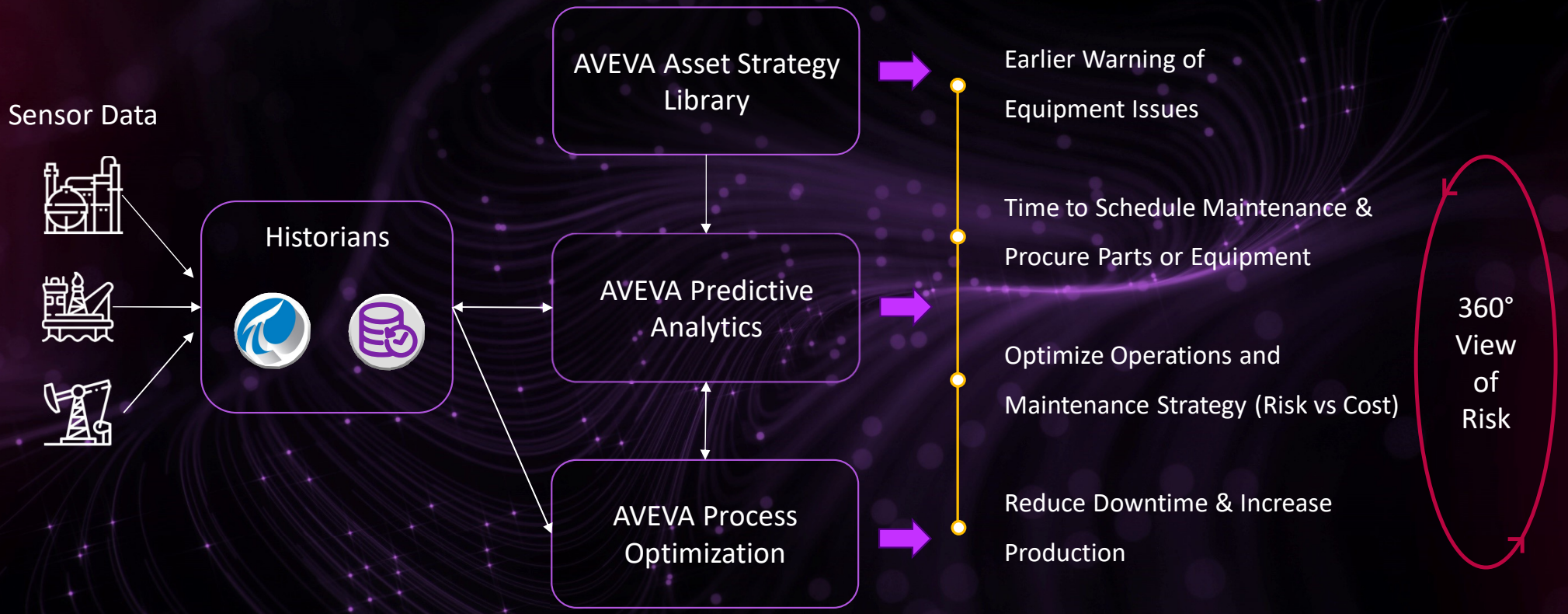
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Taking Predictive Analytics to the Next Level with Simulation



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Questions?

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Next-gen Predictive Example: Cogen

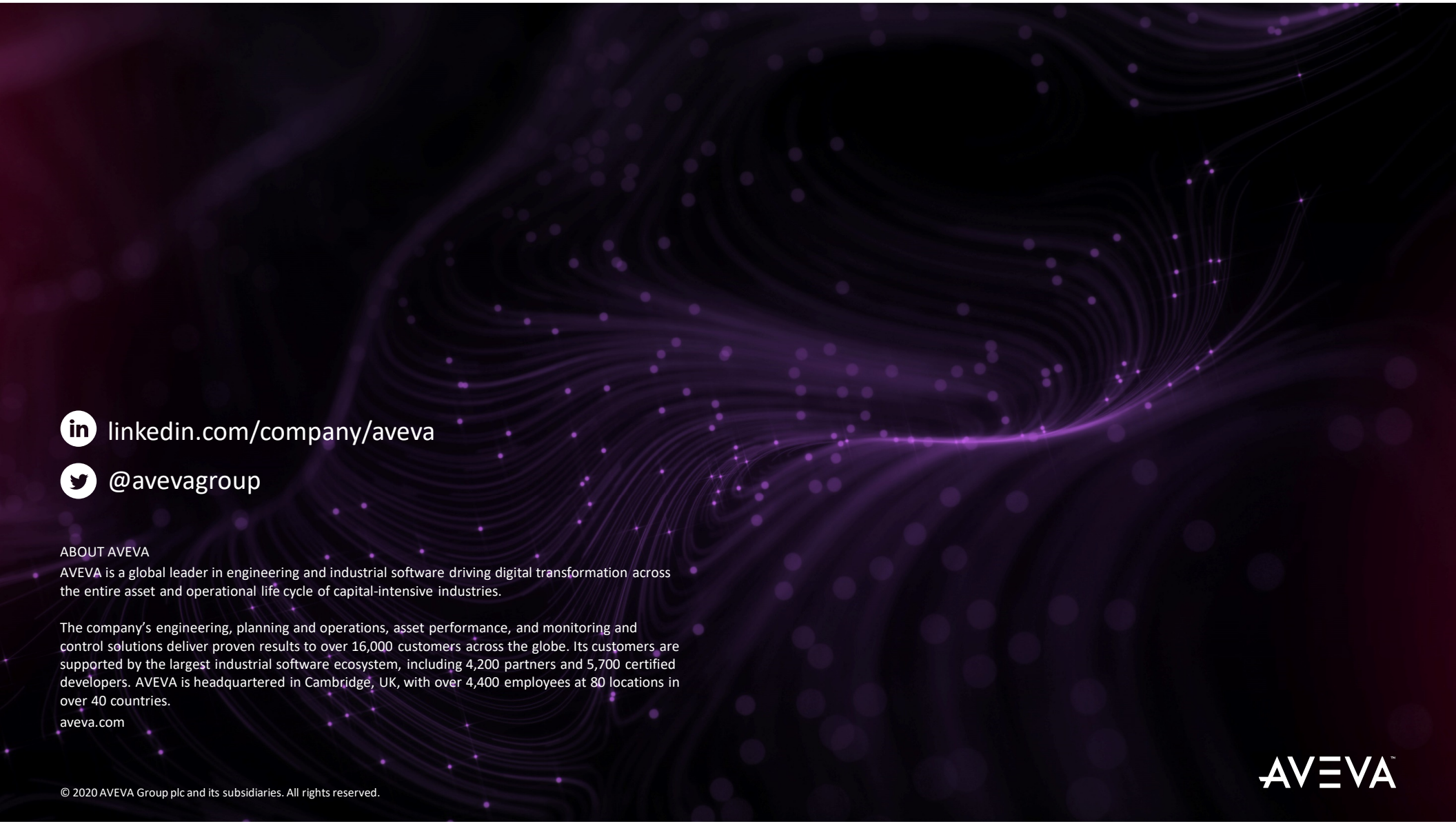
- Early issue detection of HP Evaporator tube fouling within HRSG (HDR model with machine learning & simulation data)
- Evaporator Remaining Useful Life forecast to be 24 days, with potential for leakage
- Simulation risk analysis shows a potential loss of unit 1 with low gas/water heat transfer in HP Evaporator
- Optimization analysis shows capability to cross-connect steam flow from unit 2 HRSG (currently not running) to feed into the main steam turbine



- Optimization also shows that the duct burner could be fired to increase gas heat energy to produce more HP steam, and the IP and LP sections of the HRSG will automatically increase heat transfer to produce additional steam
- Maintenance process improvement opportunity: Clean the tubes more frequently
- **This analysis not possible through "single-pass" performance calcs**

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