Industrial Intelligence:
Cognitive Analytics in Action

Presented by
Greg Herr, Flowserve
Josh Lyon, Flowserve
Stuart Gillen, SparkCognition

FLOWSERVE®

Flowserve Background

- **Leading manufacturer and aftermarket service provider of comprehensive flow control systems**
  - History dates back to 1790 with more than 50 well-respected brands such as Worthington, IDP, Valtek, Limitorque, Durco and Edward
- **Design, develop, manufacture and repair precision-engineered flow control equipment for customers' critical processes**
  - Portfolio includes pumps, valves, seals and support systems, automation and aftermarket services supporting global infrastructure
  - Focused on oil & gas, power, chemical, water and general industries
- **Worldwide presence with approximately 20,200 employees**
  - 71 manufacturing facilities and ~200 aftermarket Quick Response Centers (QRCs) with Flowserve employees in more than 50 countries
  - SIHI Group acquisition in January 2015 includes 28 facilities (15 service center)
- **Long-term relationships with leading energy customers**
  - National and international oil & gas, chemical and power companies, engineering & construction firms, and global distributors
- **Established commitment to safety, customer service, and quality with a strong ethical, compliance and performance culture**

Oil/Gas | Power | Chemical | Water | General Industry

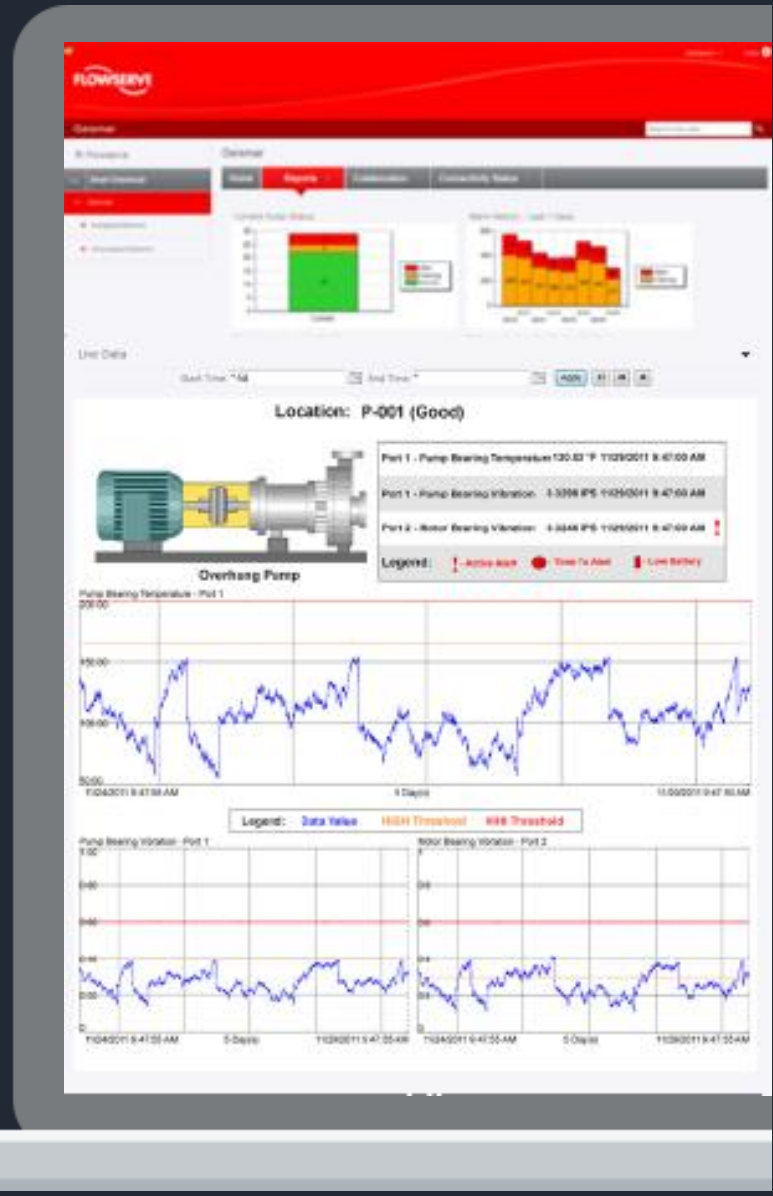
The Business Problem and Current Limitations

Limitations

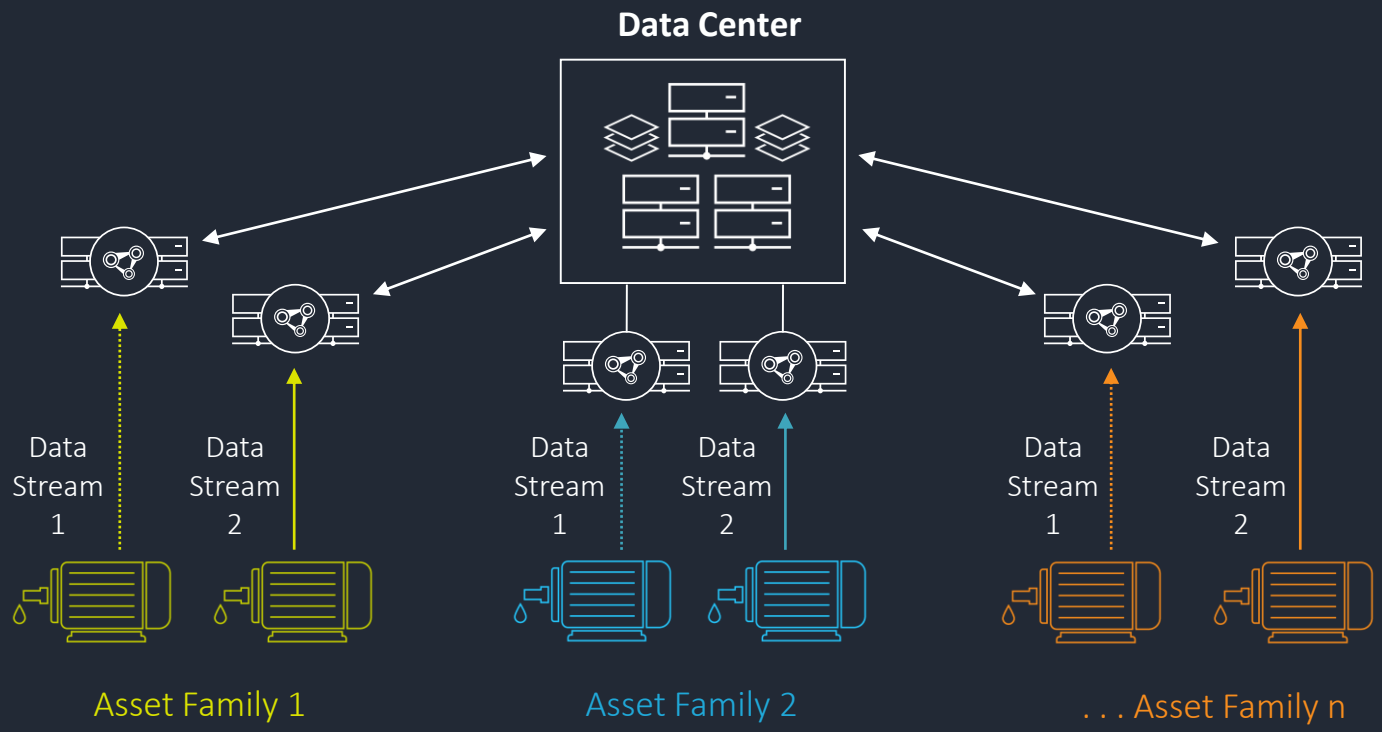
Current threshold based monitoring systems can only identify failures a few hours prior to them occurring, this limited the ability to respond fast enough and prevent unplanned failures. In addition, custom engineered algorithms for predictive capability for each pump type and application has proven to be a lengthy process.

Additional problems with the current approach were:

- Prevention of unplanned failures and related downtime
- Insufficient time to respond effectively
- Lengthy process to build and then maintain custom engineered algorithms
- Inadequate for detecting unknown states with various process conditions



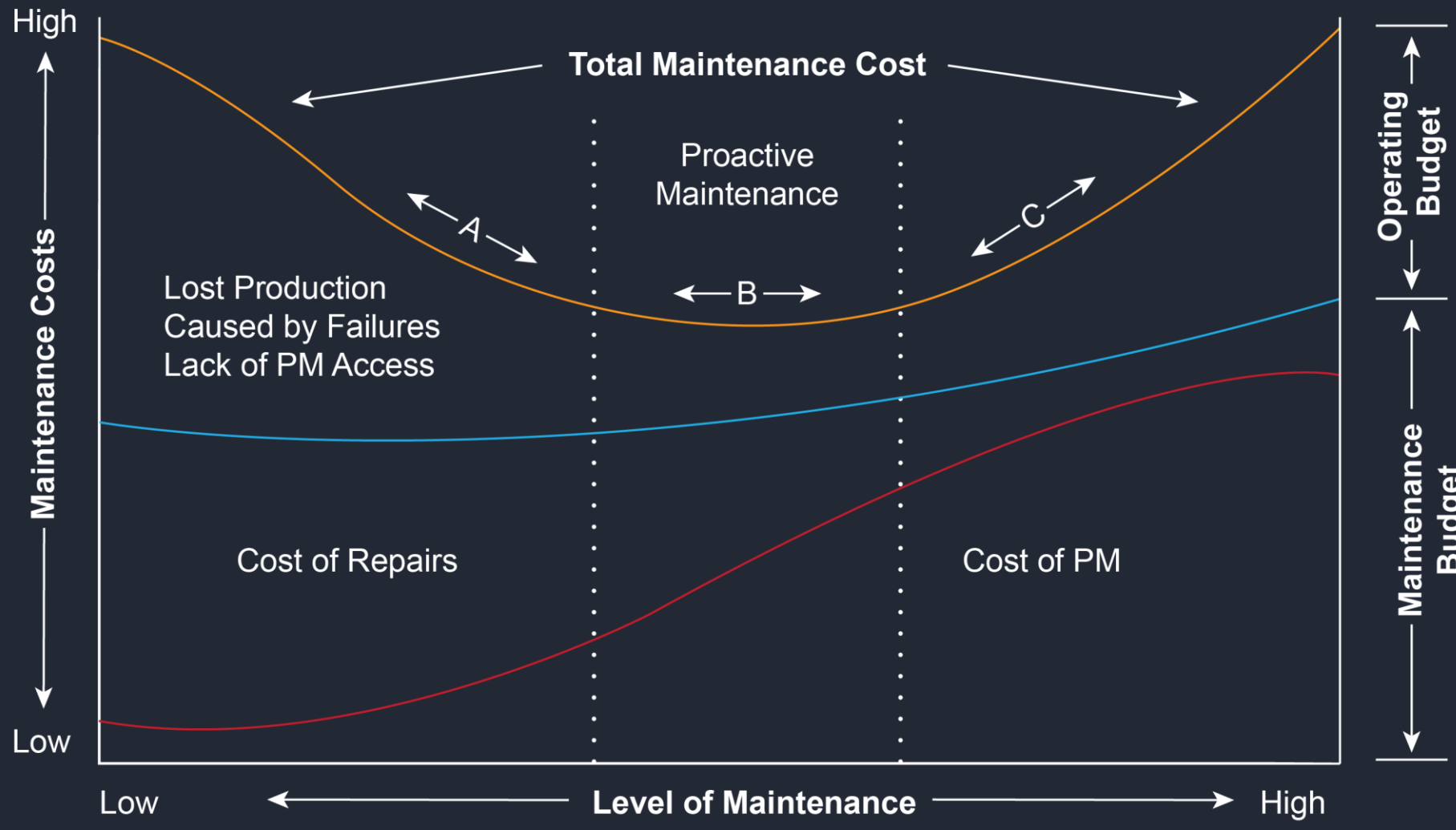
Machine Learning offers multiple advantages over traditional approaches



Benefits of Machine Learning

- **Rapid** model development
- **Adaptable** to different asset families
- **Scalable** across the entire plant
- **Flexible** deployment approaches and model selection
- **Infrastructure** and **Historical data** are utilized to maximize effectiveness

Moving to Intelligent maintenance



How does it work?

Cognitive Analytics

Cognitive Analytics refers to a set of innovations that are inspired by the way the human brain thinks:

Processes information

Draws Conclusions

Codifies instincts & Experience into learning

Benefits

Enables machines to penetrate the complexity of data to identify associations and reason	Presents powerful techniques to handle unstructured data	Continuously learns from new data entering the system and from previous insights	Provides NLP support to enable human to machine and machine to machine communication	Does not require rules, instead relies on hypothesis generation using multiple data set which might always appear connected or relevant

NLP: Natural Language Processing

What is Cognitive – Beyond Machine Learning

Powerful advancements in state of the art

Natural language processing

- Enables recall of answers, in context
- Analysis of human readable text for clues, insights and evidence

Deep Learning and Reasoning algorithms

- Improves accuracy
- Learns complex patterns
- Scales efficiently: High speed, large data implementations

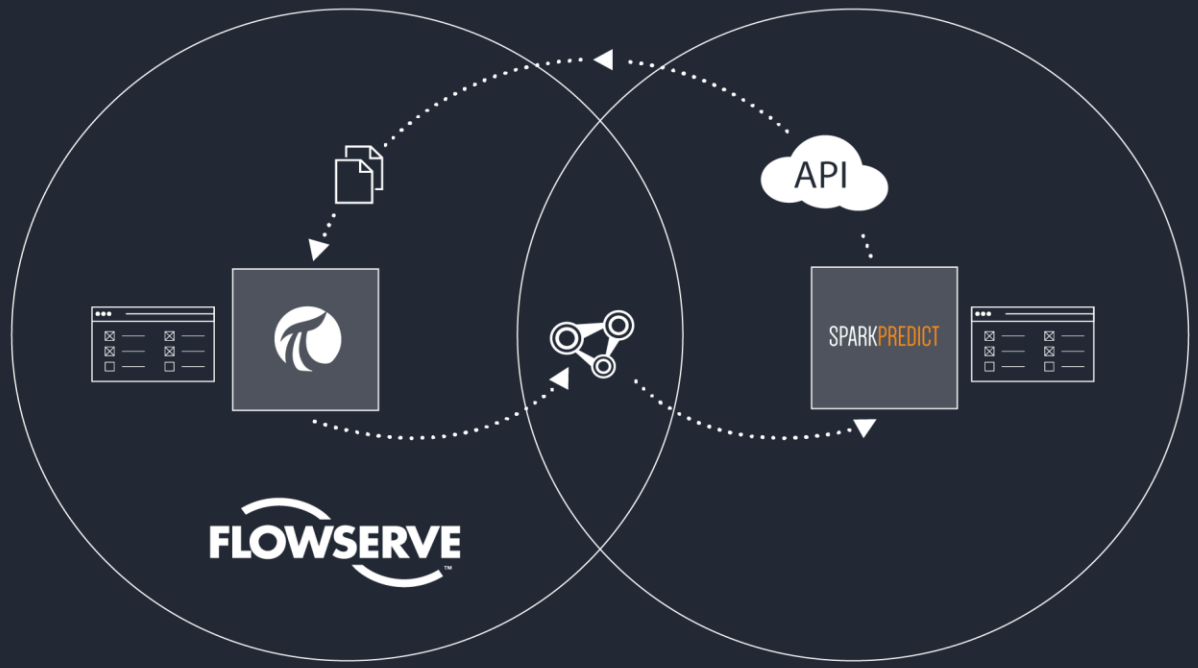
Automated Model Building and Infinite Learning

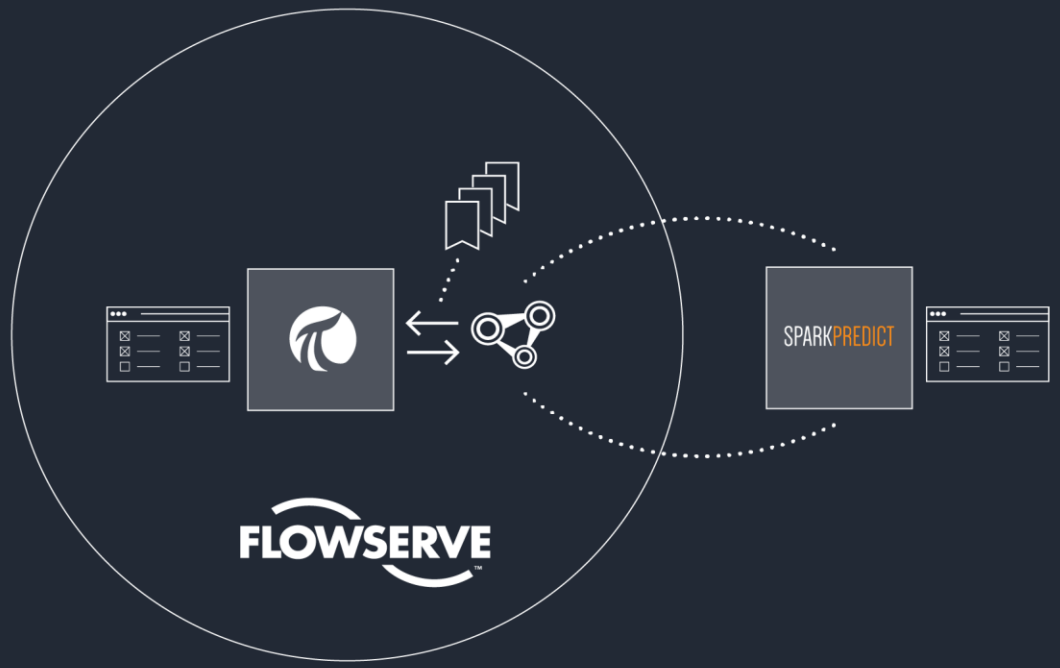
- Watches data and derives rules
- Incorporates human feedback to strengthen or dismiss conclusions
- Automatically learns from feedback and greater volumes of data
- More data = more accuracy, capability & insight.

Powerful Visualization with Evidential Insights

- Provides transparency and evidence about what the cognitive system is learning and proposing
- Presents data elegantly – Analyst friendly interface, easy feedback
- Elevates evidence / reasoning for machine decisions

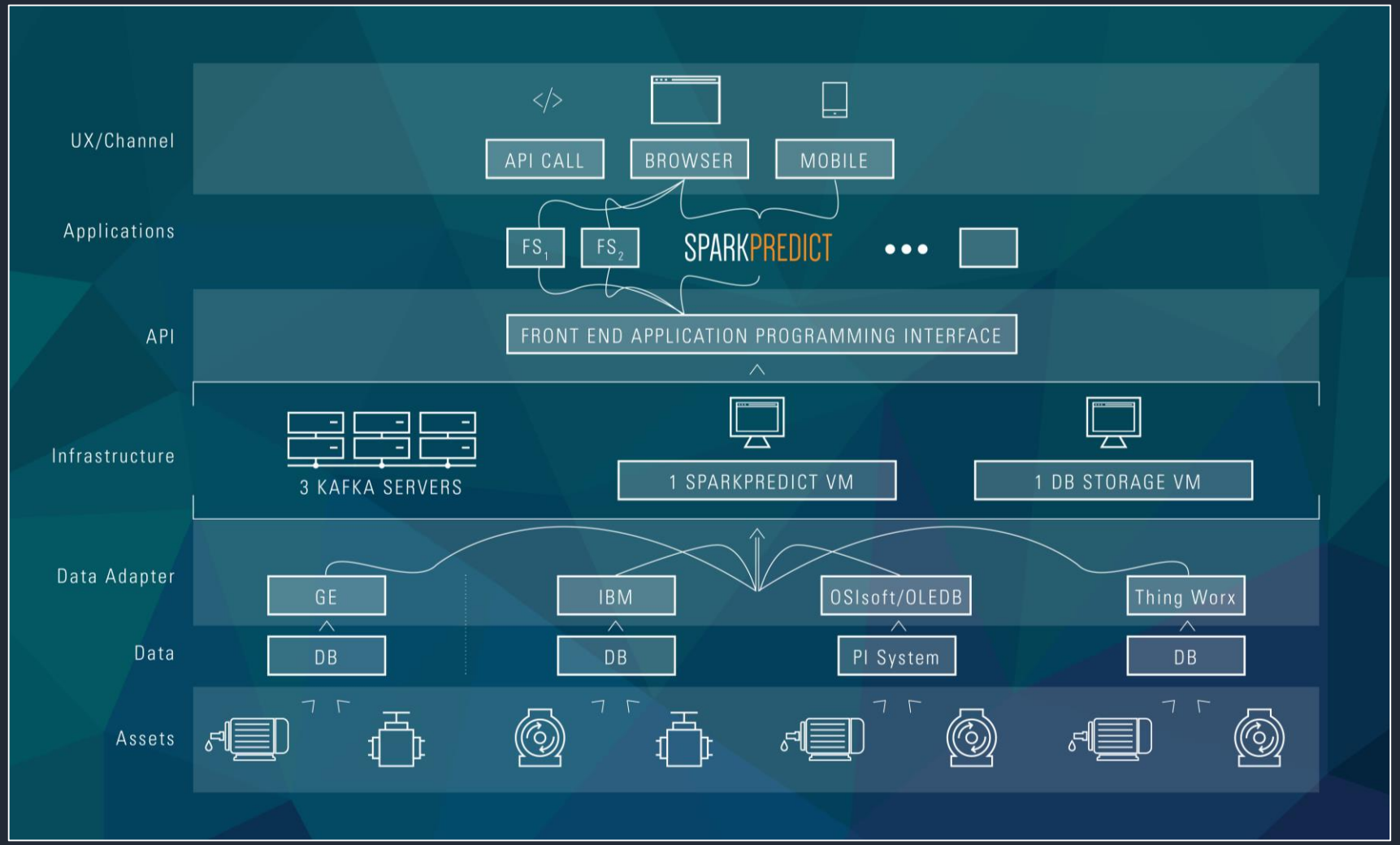
SparkPredict is supported by flexible, adaptive PI System





sparkcognition™

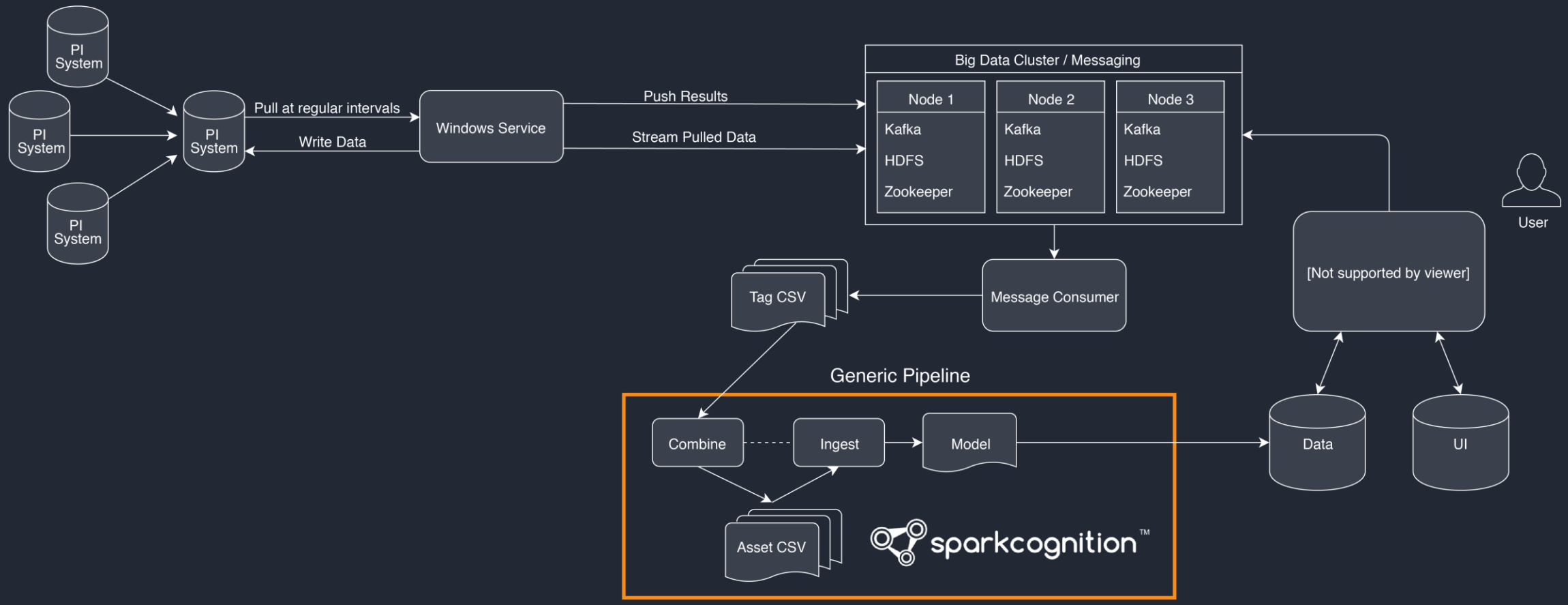
Data adapters provide **flexible approach** to **system architecture**



Benefits of the PI System

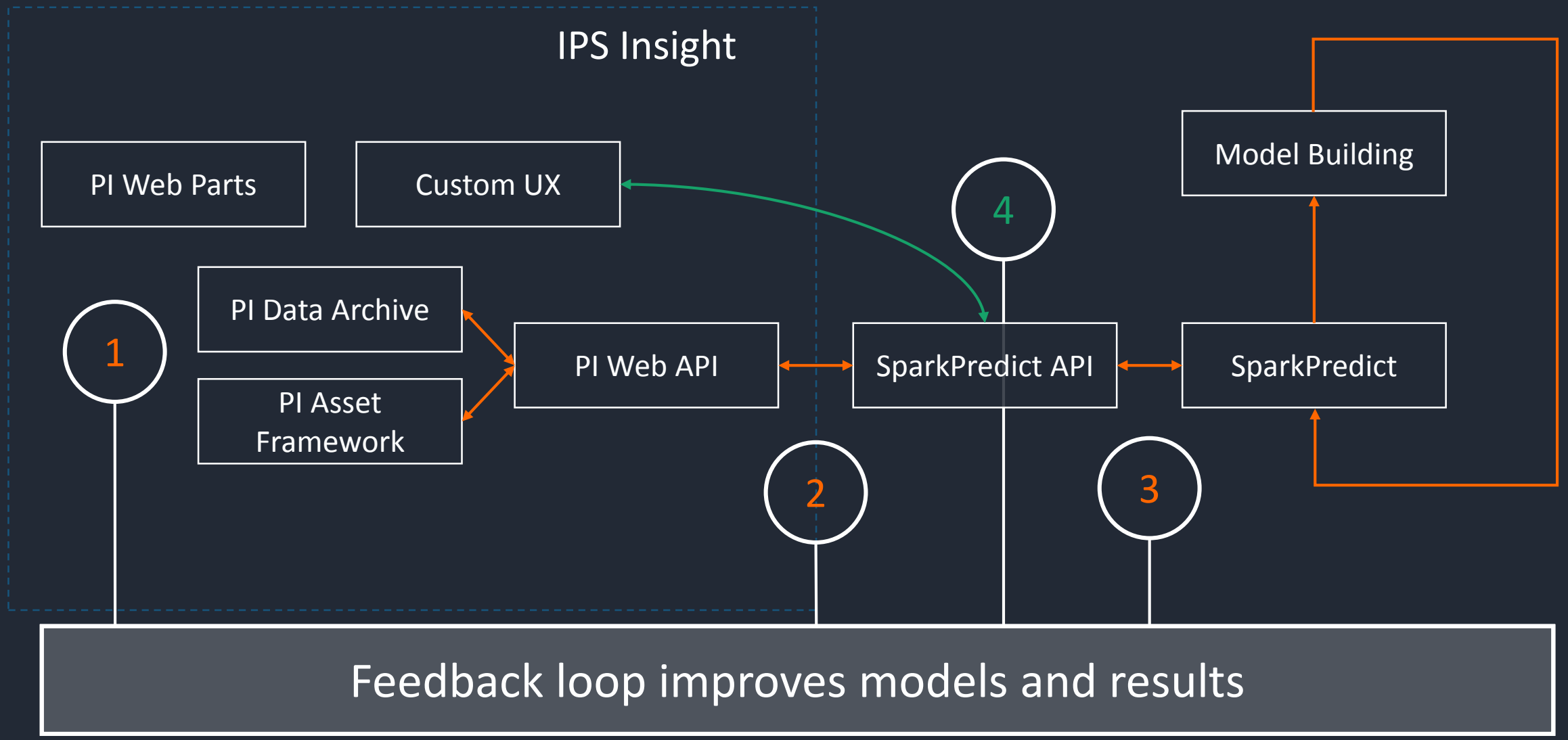
- Asset Abstraction
- Built-in Asset Framework
- Metadata Support
- Multiple Interfaces for Data Exchange
- Archiving Capabilities
- Compression Support

Machine Learning requires a robust, agile and Big Data Architecture

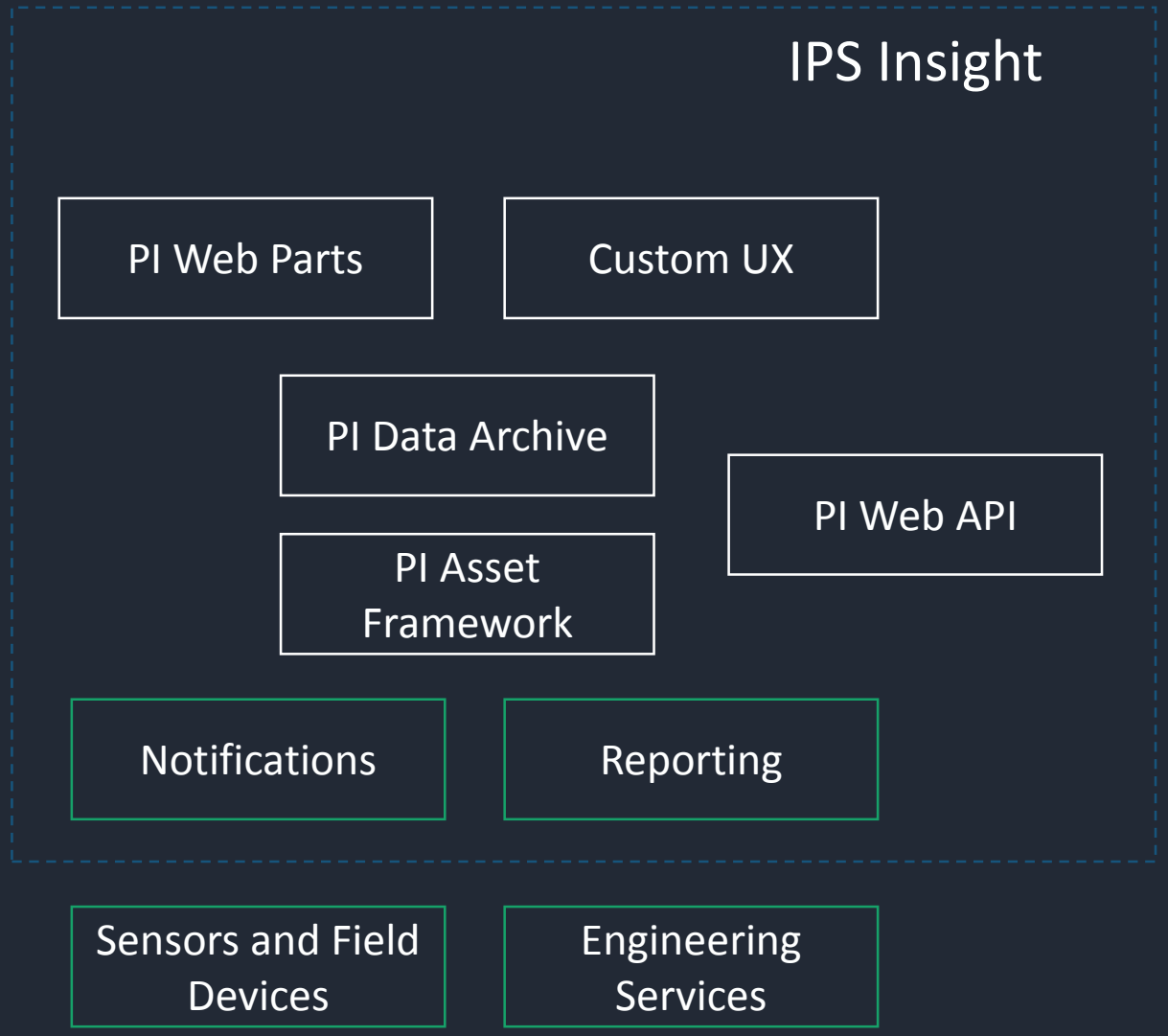


How was it implemented?

OSIsoft PI System and SparkPredict Integration



OSIsoft PI System and SparkPredict Integration



Existing infrastructure is used for:

- ✓ Data ingestion, Archival, and Metadata
- ✓ Analytics, Notifications, Visualizations, and Reporting

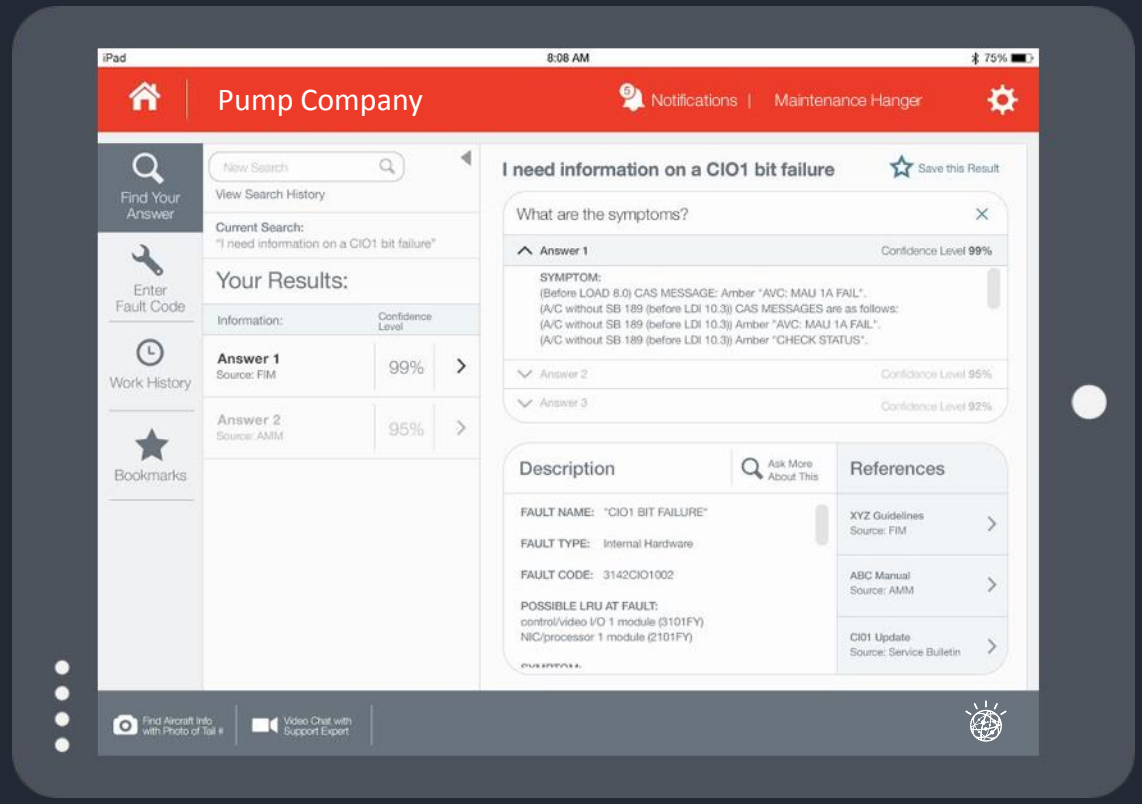
What’s Next?

Intelligent Documentation to empower the end-user to improve business operations

SparkCognition developed an IBM Watson powered "Advisory" application for maintenance

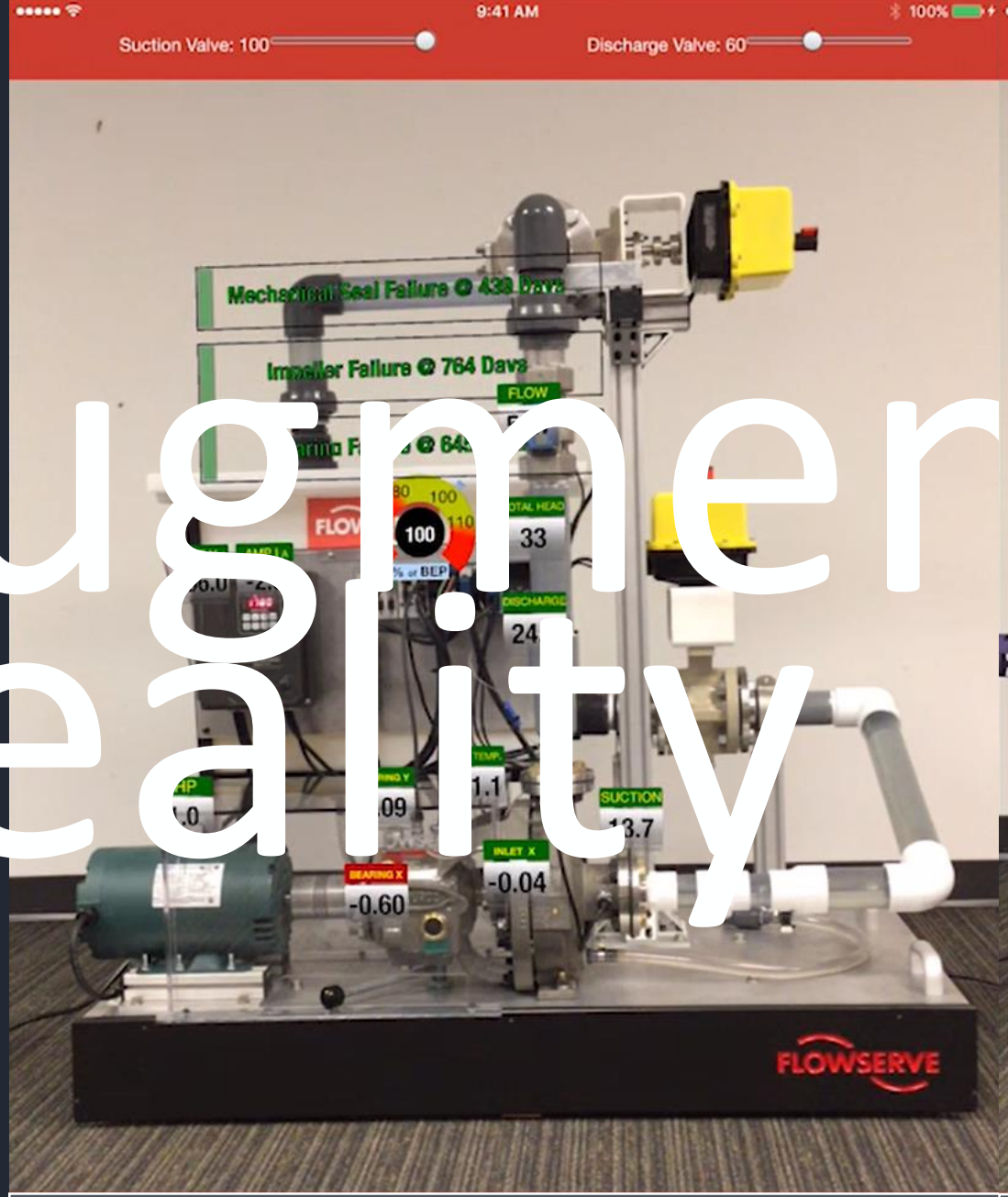
Application enables maintenance and technicians to:

- Conduct machine to human dialog to troubleshoot with **high accuracy**
- **Speedy identification to map** the right fault codes and troubleshooting tips using **Natural Language Processing (NLP) queries**
- Optimize work flow and deliver relevant documentation for a **faster turnaround** of planes



Lowered the cost of maintenance and improved asset availability for operators by up to 10%

Augmented Reality



Augmented Process Values and Predictions

Exploded Asset View

Industrial Intelligence: Cognitive Analytics in Action

COMPANY and GOAL

Flowserve is the leader of fluid and motion control products (pumps, valves, seals) and wanted to **improve response time** and **prevent unplanned failures**

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CHALLENGE

Threshold based monitoring systems only identify failures a few hours prior and **limited the ability to respond fast**

- Insufficient time to respond effectively
- Lengthy process to build and then maintain custom engineered algorithms

SOLUTION

Data paired with cognitive analytics enabled early detection of events and shortened algorithm development

- Tight integration with the PI System + Bidirectional data transfer
- Utilize internal SME knowledge and external ML capabilities

RESULTS

Build models in **days** instead of months. **Detect events** measured **in days** instead of hours

- Identified operating modes with >99% accuracy
- Predicted failures 5 to 6 days in advance (20x improvement)

Contact Information

Josh Lyon

JLyon@flowserve.com

Marketing and Technology

Flowserve Corporation

Stuart Gillen

SGillen@sparkcognition.com

Director, Business Development

SparkCognition

Greg Herr

GHerr@flowserve.com

GM, Monitoring and Reliability

Flowserve Corporation

Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

Please remember to…

Complete the Online Survey for this session

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado


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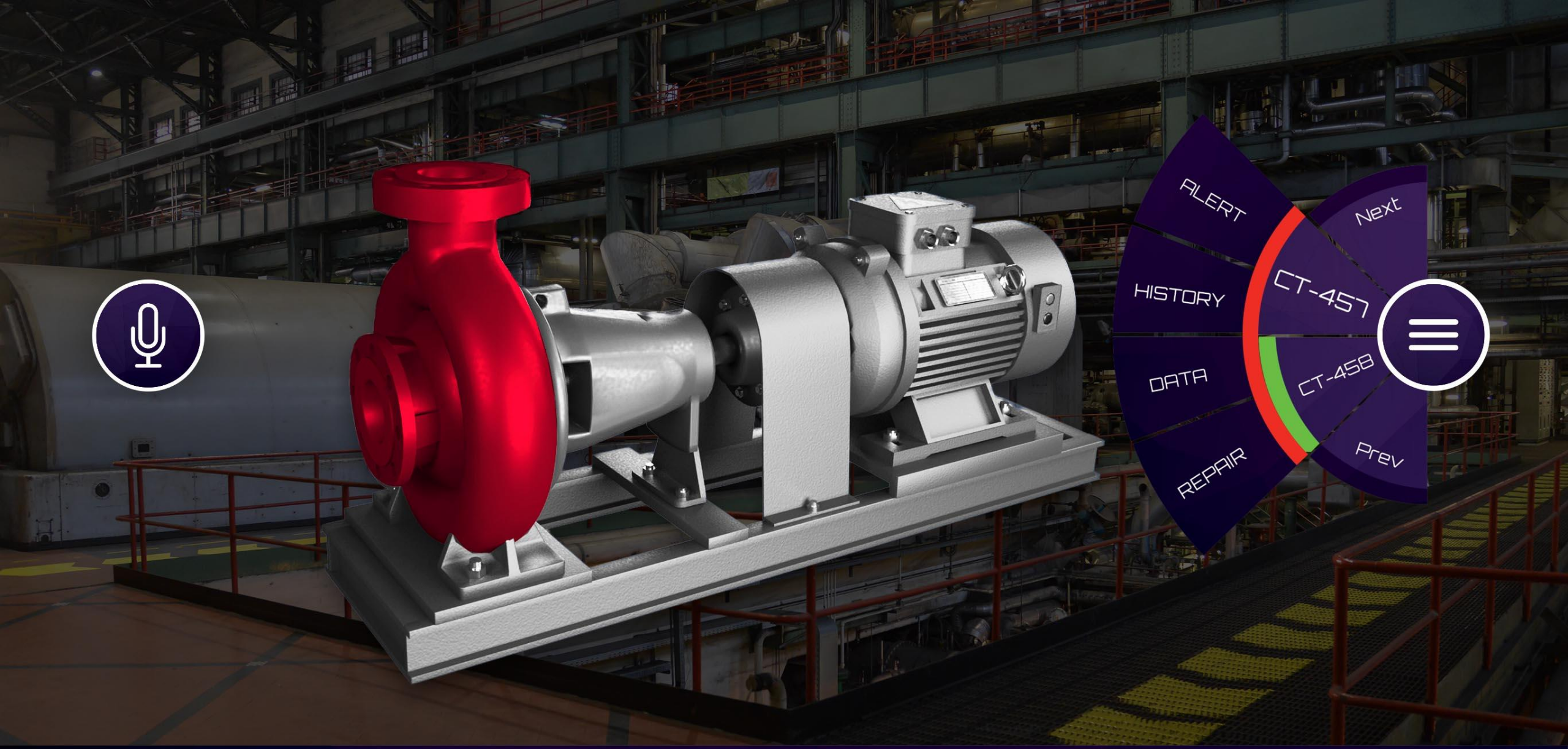
Appendix

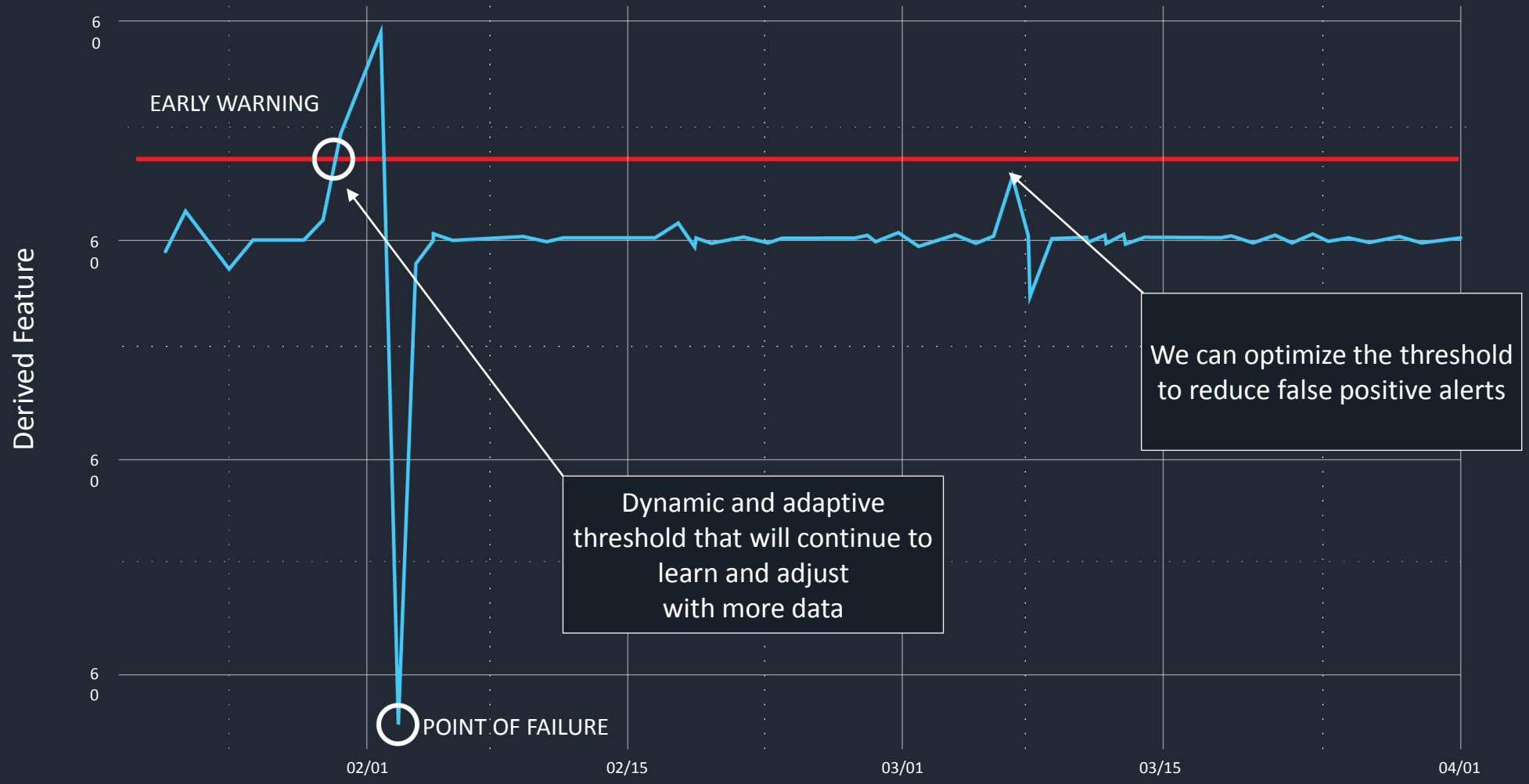


CT-457

Pump is experiencing some type of cavitation. Reduce operating speed and check for defects.

Multi-dimensional analysis

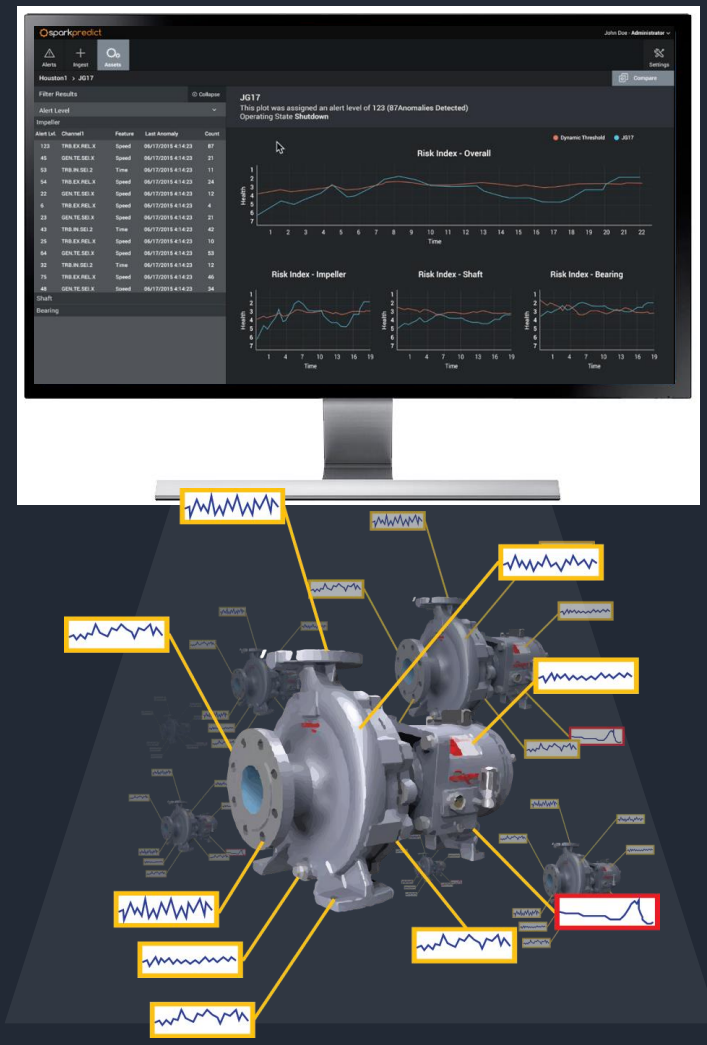
Multi-dimensional analysis feature provides early and accurate warning with minimal false positives



Proven Use Case in Pump Monitoring

SPARKPREDICT™

- Objectives
  1. Recognize Operating States
  2. Detect Anomalies
  3. Predict Pump Failure
- Data Analyzed
  - Pre-filtered FFT data (feature data)
- Results
  - Identified operating modes with >99% accuracy
    - Accounted for four criteria defined by client to handle imperfect data and operating conditions
  - Predicted failures 5 to 6 days in advance (20x improvement)
    - Previous method predicted only 12 hours in advance
    - Completed with less than 2% false positive rates



Cognitive Analytics is Essential to the Future of Energy

Data to Insight

By better understanding the ideal operating states of solar, wind, and battery assets, the efficiency of those generating units can be increased, resulting in more energy production and lower maintenance costs.

Advanced Analytics can adapt to thousands of different environments and conditions to optimize models for the operating conditions of various wind and solar plants.

Variable Integration

Correlation with external variables such as weather patterns can be incorporated to ensure false positives are not generated, and the overall predictions for operating state and efficiency are kept accurate.

Cognitive for Competitive Edge

Keeping equipment profitable over the amortization period means keeping efficiency as high as possible.

Identifying the types of solar inverter failures automatically will minimize human error, and reduce time to remediation for wind and solar assets.