

Realizing APM

Andrew Attebery



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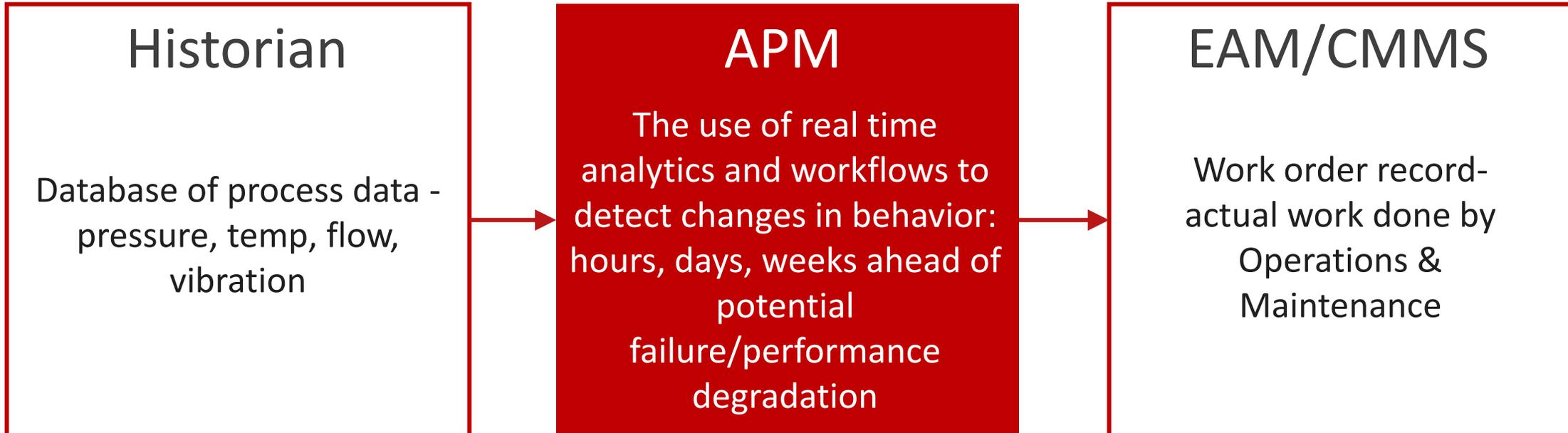
Sr. Functional Consultant, APM

*-Just a Mechanical Engineer that loves cars and
the Kansas City Chiefs*

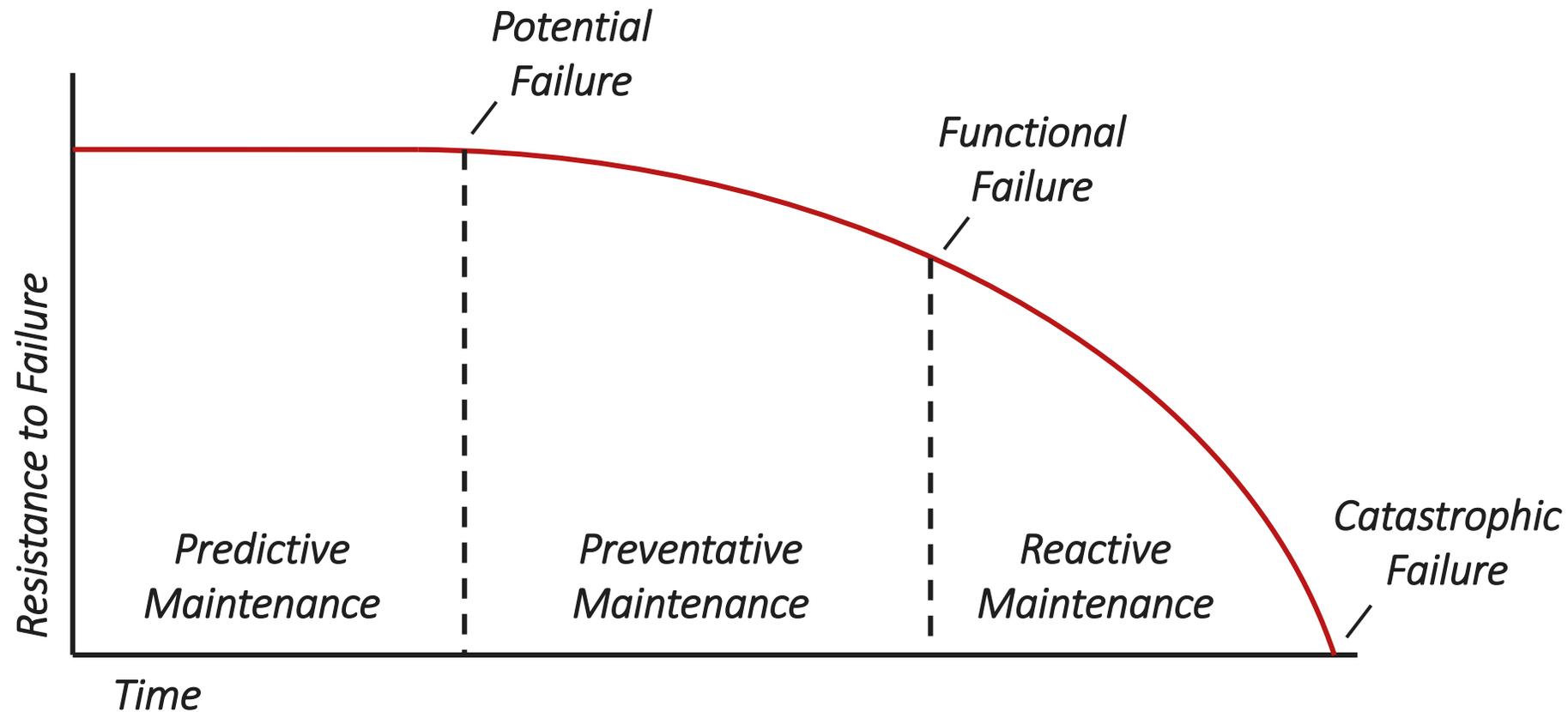
Asset Performance Management Intro

Definition:

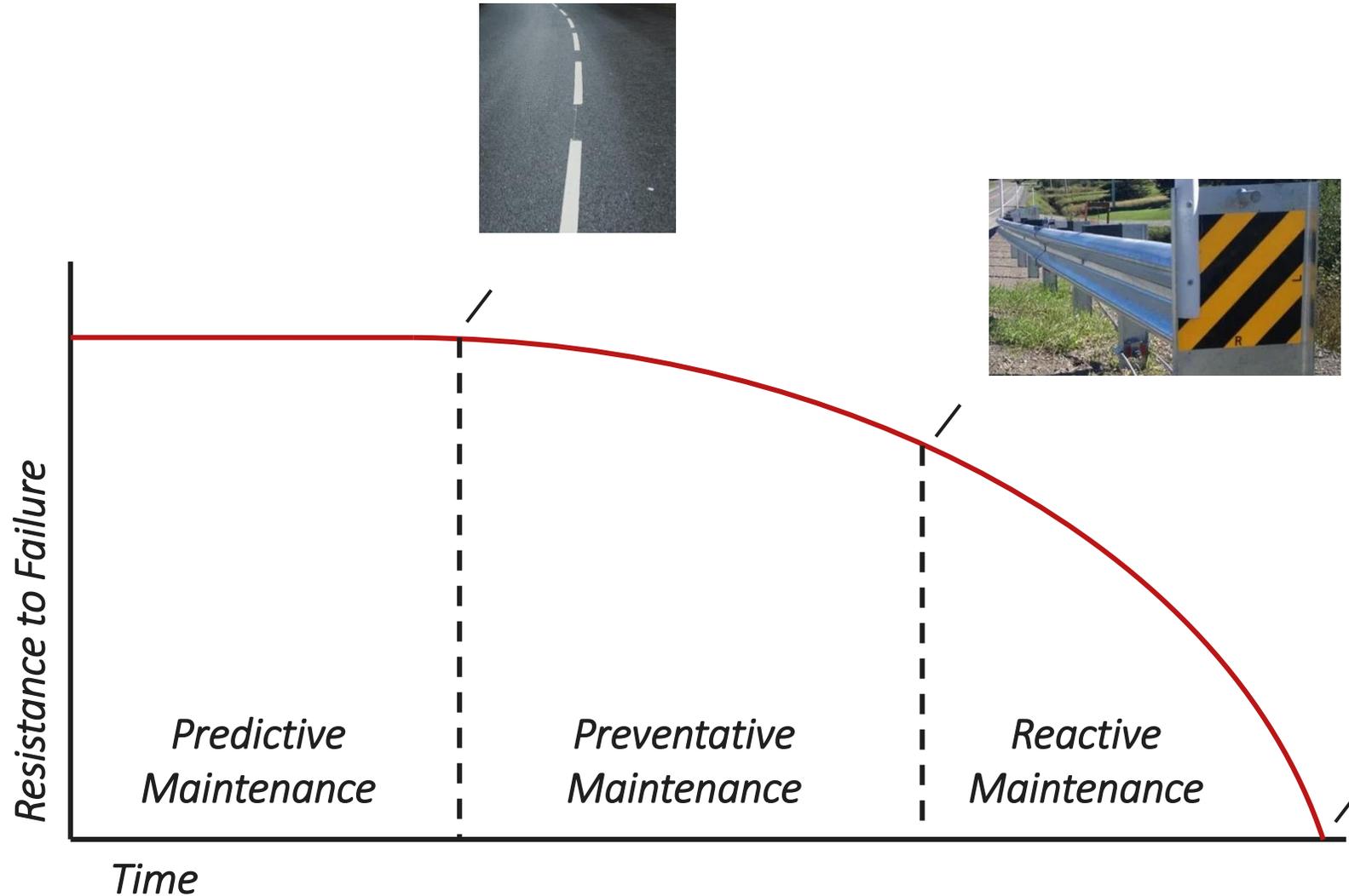
APM is the use of data and analytics to improve reliability and efficiency of assets.



Asset Performance Management Intro



Asset Performance Management Intro



Industry Challenges

Downtime Is a Headache

\$15k

Average hourly cost of paper machine downtime

- *International Journal of Engineering, Science, and Technology*

\$1M

Average daily cost of refinery outages

- *Arc Advisory Group*

\$20B

Estimated annual cost of unplanned downtime in chemical industry

- *American Institute of Chemical Engineers*

Analytics Can Be Ineffective

40% of companies say it takes more than 1 month to deploy a single Machine Learning model into production

- *Algorithmia*

40%

71% of companies say they are NOT good at connecting analytics to action

- *Forrester*

71%

Multiple experts required to deploy and maintain standalone analytics

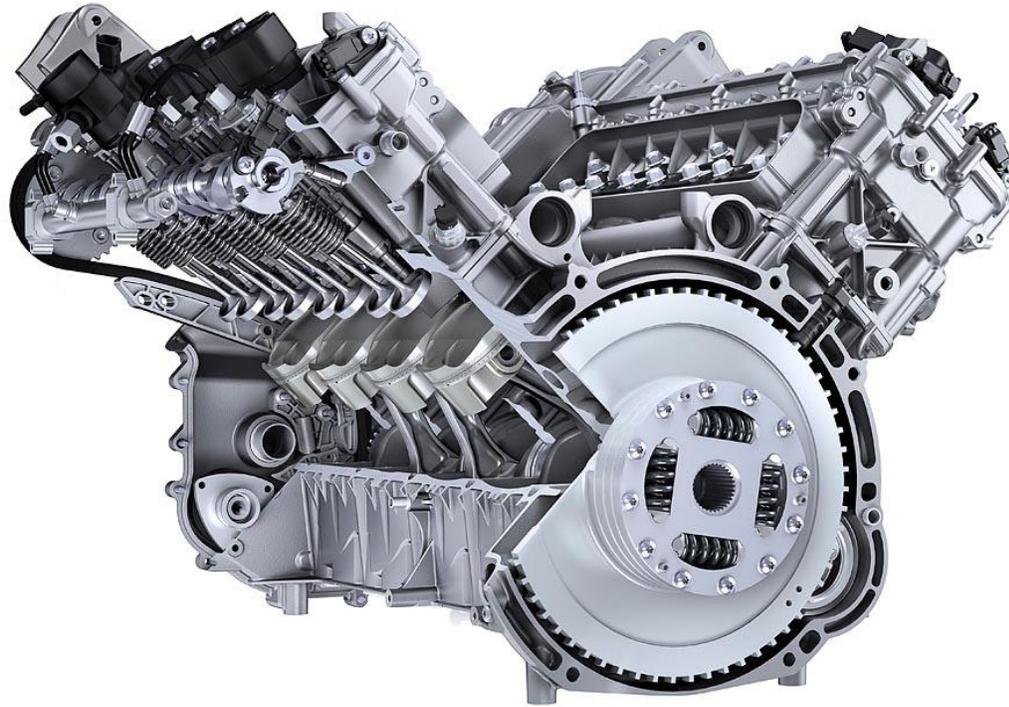
- *Plant Services*

3+

How to Build an *APM* System

“You just take some data scientists
and build some models”

How to Build an APM System



- V8 Naturally aspirated Motor
- 652 kW (875 hp) & 1,280 Nm (944 lbf.ft) torque

How to Build an APM System

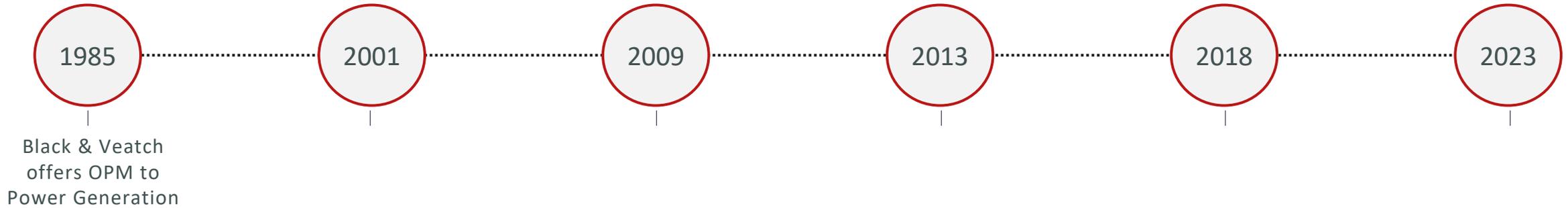


- Porsche 918 Spyder
- 0-60 mph (96 kph)- 2.2 Seconds
- Top Speed 225 mph (362 kph)

How to Build an APM System



Prometheus APM History

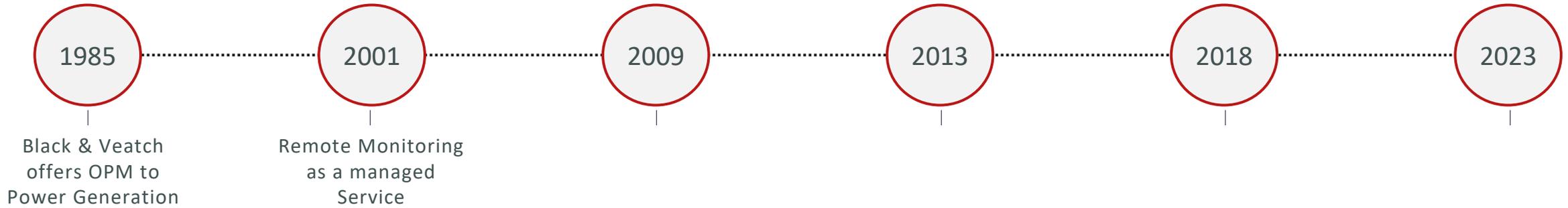


“

I have measured data, but I'd like to understand equipment and process performance

”

Prometheus APM History

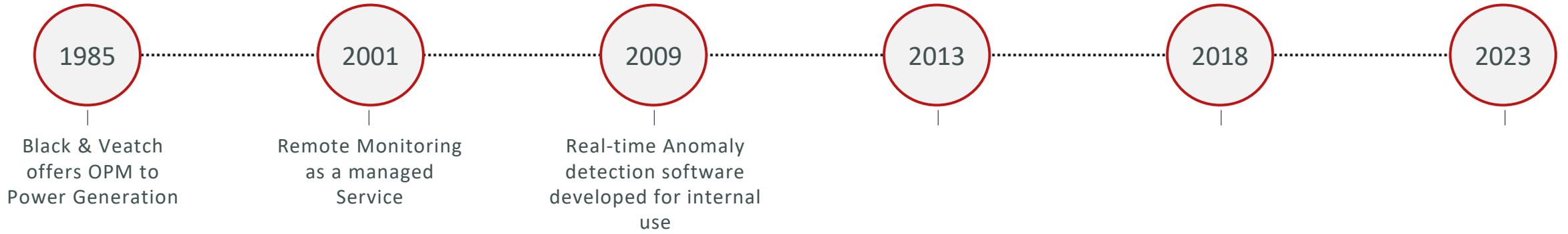


“

These trends and dashboards are great,
but I don't have time to look at all this
data.

”

Prometheus APM History

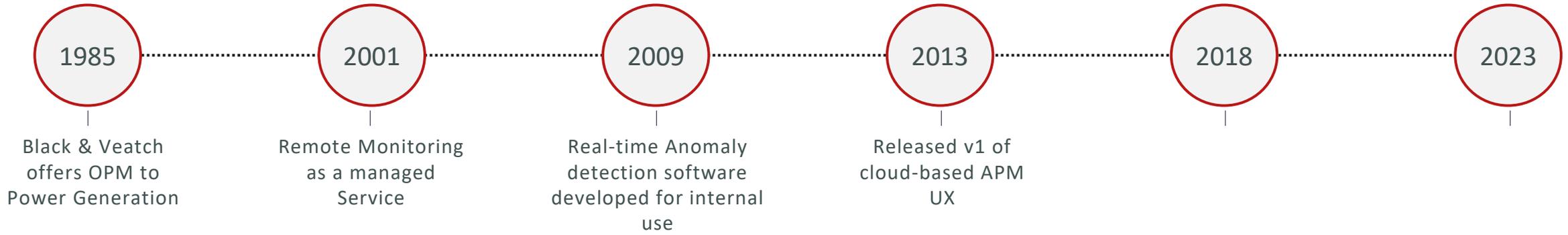


“

Sometimes issues arise quickly.

”

Prometheus APM History

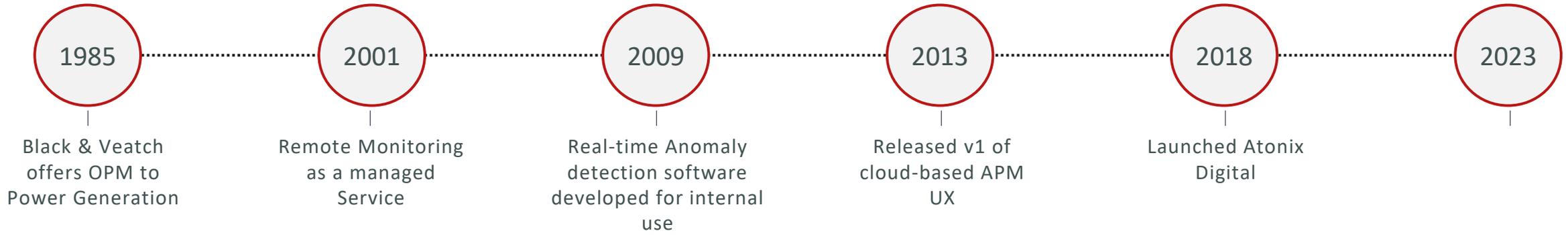


“

That monitoring tool is pretty good! Can we have access to it too?

”

Prometheus APM History

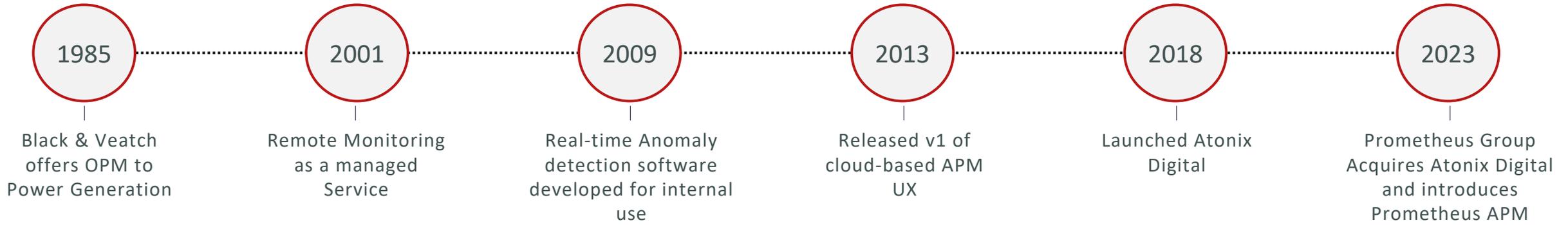


“

We'd like to use our in-house experts to monitor our plants.

”

Prometheus APM History

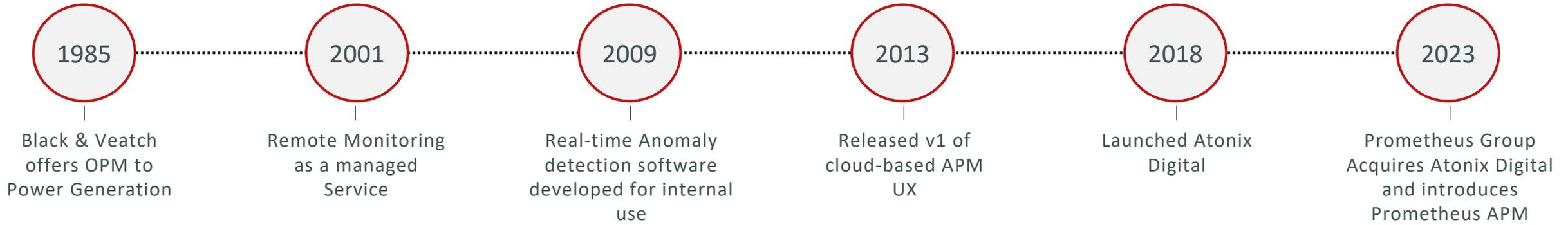


“

We'd like this system to have a closer connection to our EAM/CMMS.

”

Prometheus APM History



30+

Years of Product Development & Evolution

100's

Of Industry Experts Involved in Creating Platform

1000's

Of Machine Learning Model Templates

Decades of iteration leading to software that drives a highly-refined plant monitoring process

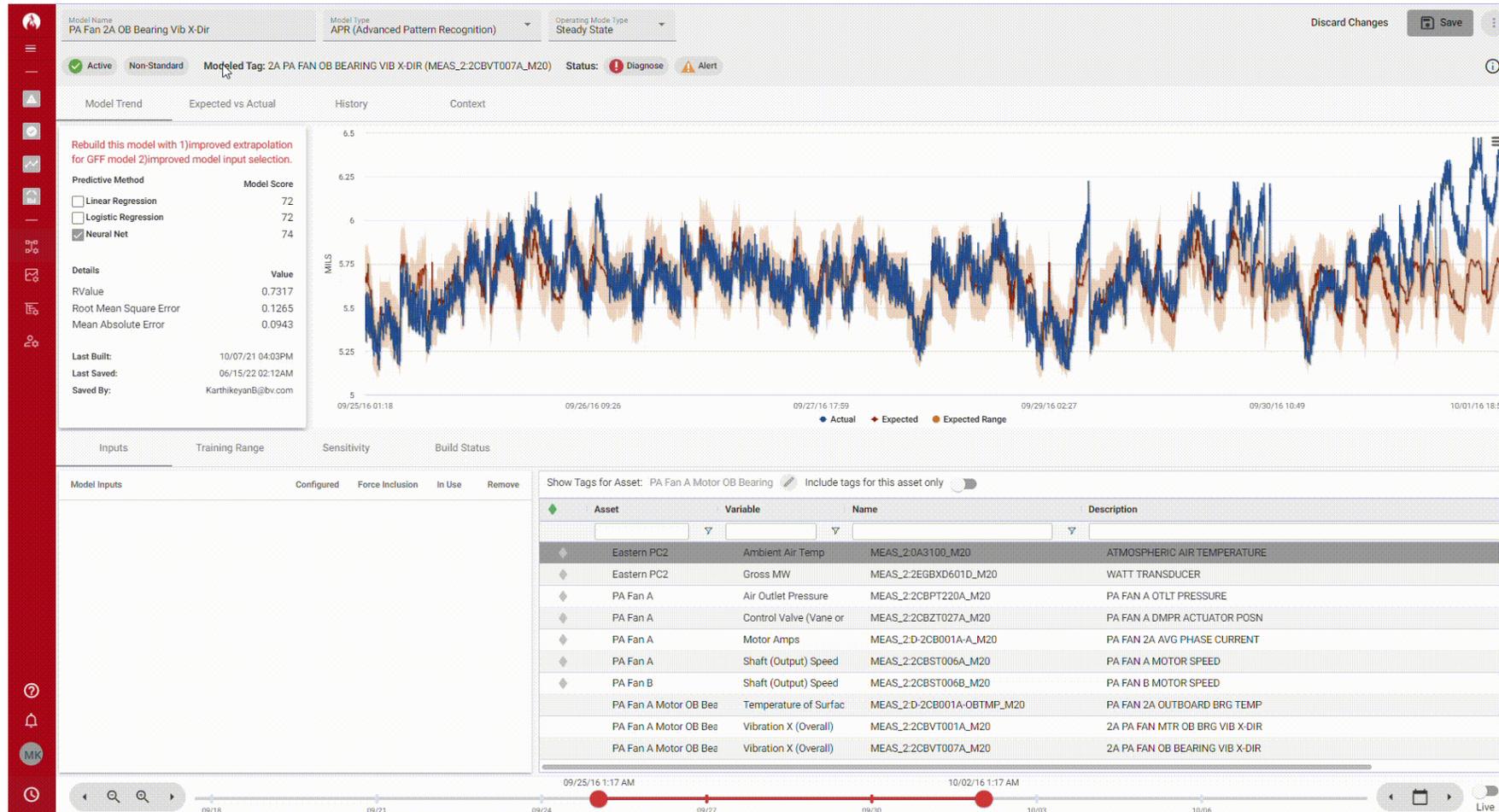
Realizing APM – Prometheus Approach

Realizing APM

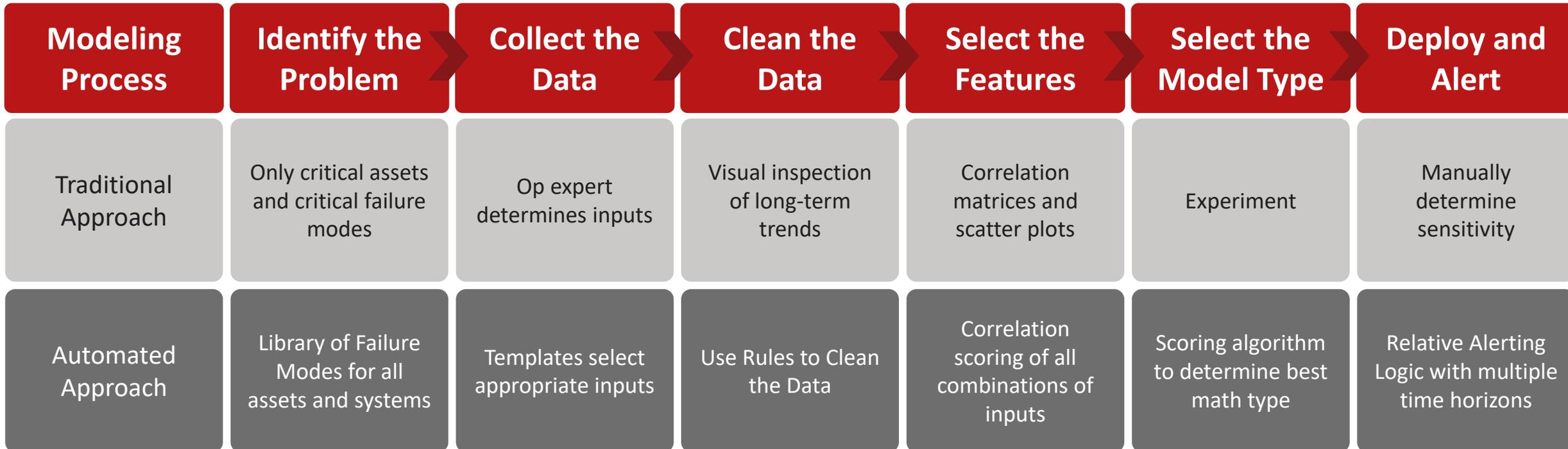
Asset Experts & Data Scientists

Role	Skills	Effective Use
 Asset Expert	<ul style="list-style-type: none">• Experts at asset/process failures and causes• Understand Process Data Relationships• Desire full plant coverage	<i>Empower with tools that make analytics easy</i>
 Data Scientist	<ul style="list-style-type: none">• Experts at Data and Mathematics• Limited Expertise of assets & process• Build Great Individual Models	<i>Focus on the new & complicated problems</i>

1. Use Asset Experts for Modeling and Evaluation



2. Templatize and Automate



Project Start to full site analytics coverage in 1 month!

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Project Start to full site analytics coverage in 1 month!

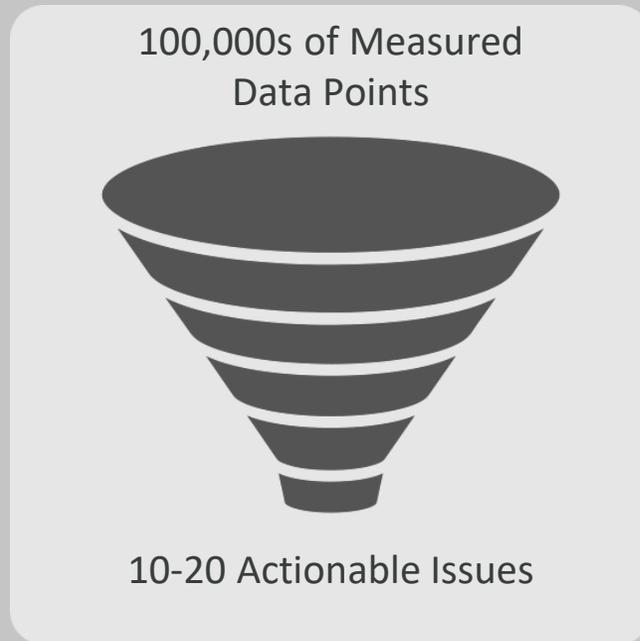
2. Templatize and Automate

The screenshot displays a software interface for model configuration. On the left is a 'Default Asset Tree' with a red sidebar containing various icons. The tree is expanded to show 'Pulp & Paper Facility' > 'Paper Machine' > 'Stock Prep'. The main area is titled 'Model Configuration' and contains a table of models. A message in the center states: 'Cannot display models at this level. Please select an asset lower in the asset tree.' Below this is a table with columns for 'Model Name', 'Last Build Status', and 'Live Build Status'. The table lists several models, all with a 'Build Successful' status. At the bottom, a timeline shows dates from 09/18 to 10/06, with two red markers indicating specific build times: 09/24/16 8:55 PM and 10/01/16 8:55 PM.

Model Name	Last Build Status	Live Build Status
QD_WT1 Actual spinner temperature - Steady State	Build Successful	
QD_WT1 Actual rotor rpm - Steady State	Build Successful	
QD_WT1 Actual power produced - Steady State	Build Successful	
QD_WT1 Actual pitch angle - Steady State	Build Successful	
QD_WT1 Actual nacelle Temp. - Steady State	Build Successful	
QD_WT1 Actual hydraulic pressure - Steady State	Build Successful	
QD_WT1 Actual gear oil temp. - Steady State	Build Successful	
QD_WT1 Actual gear bearing temp. - Steady State	Build Successful	
QD_WT1 Actual direction of nacelle - Steady State	Build Successful	

3. Focus on the Process, Not Just the Analytics

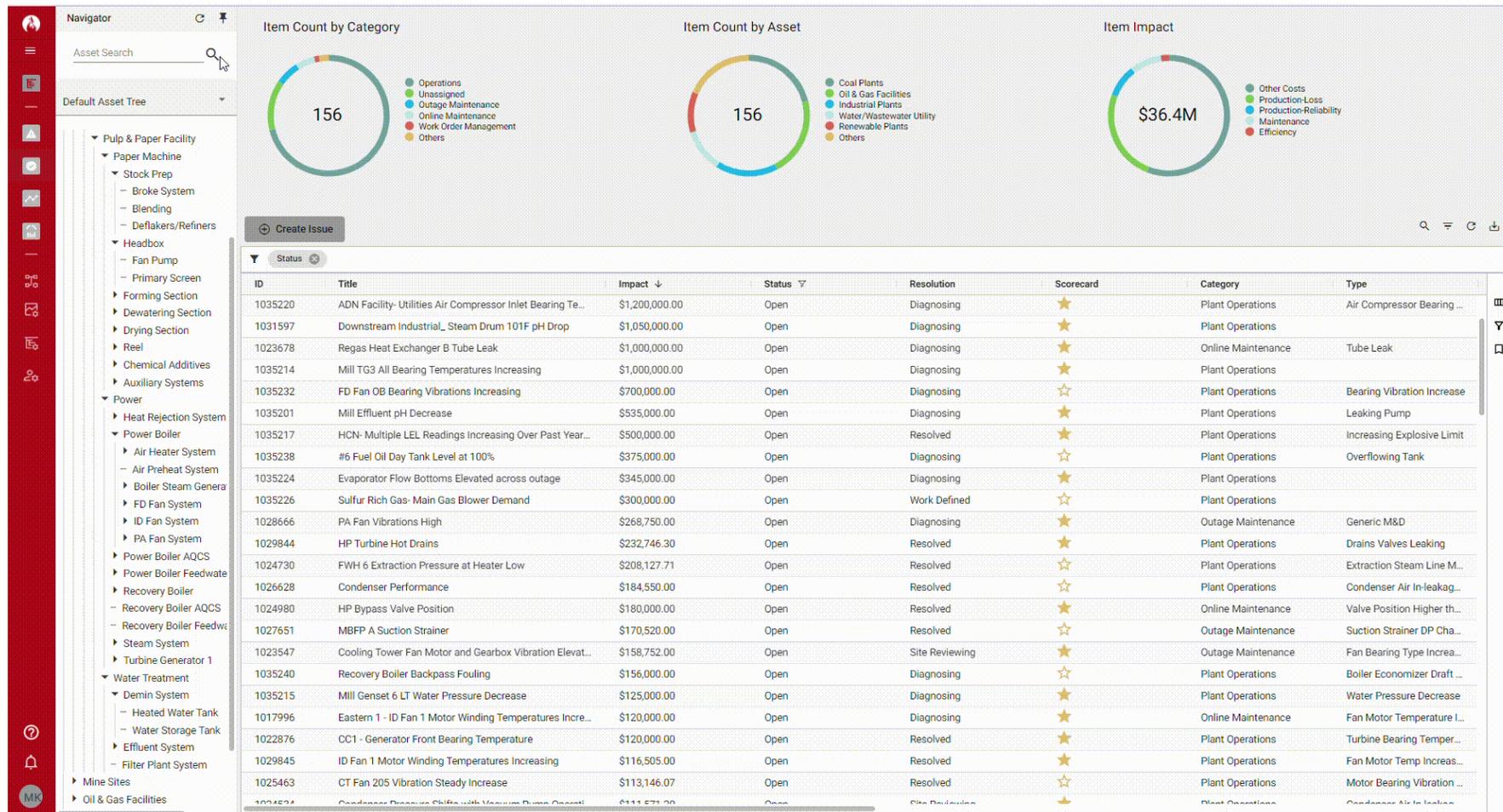
Detect.
Diagnose.
Resolve.



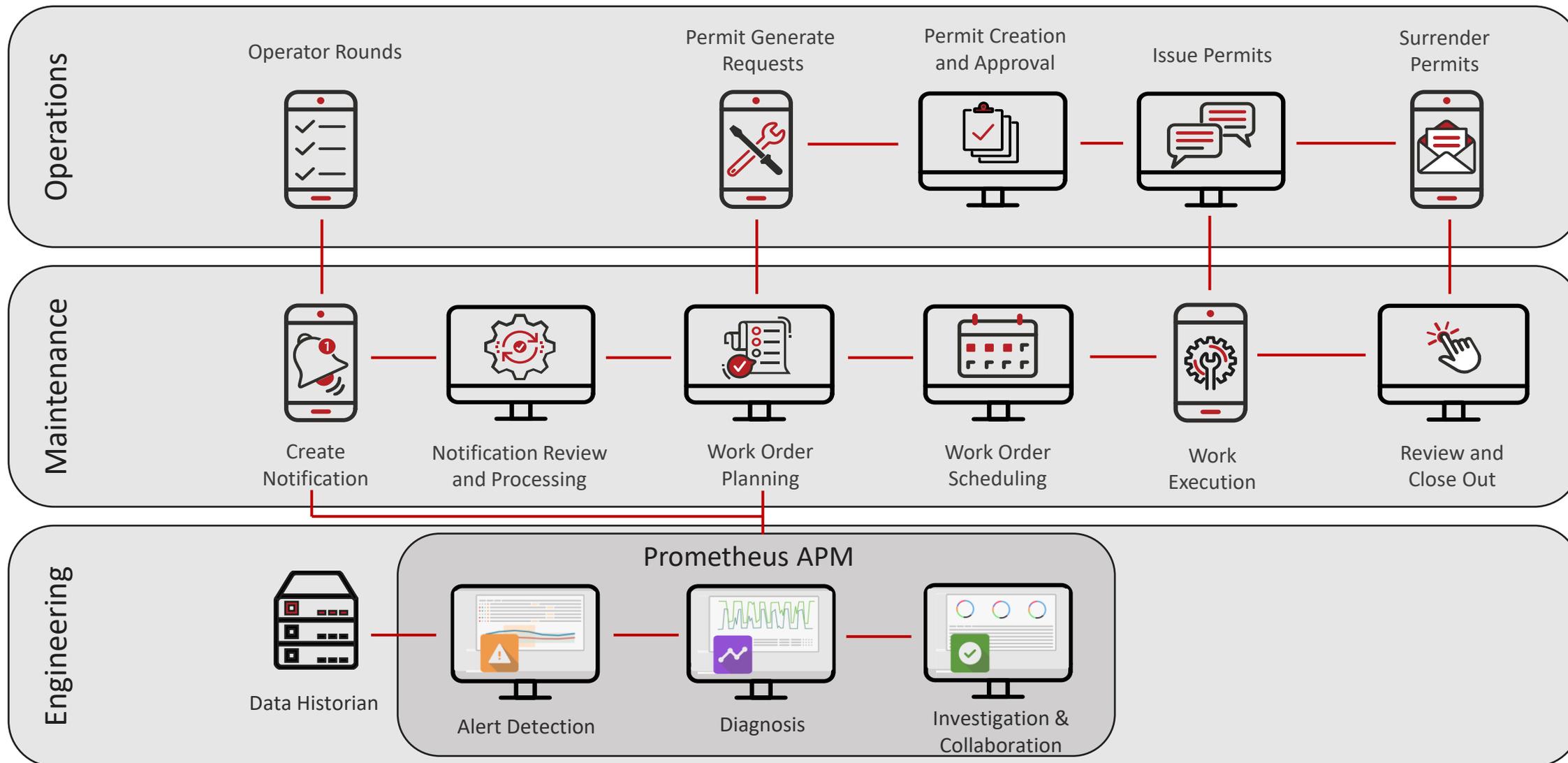
- Most companies are thinking of APM as an analytics problem
- Prometheus APM drives a complete process that ensures analytics lead to action.

Analytics only provide value if they lead to action.

3. Focus on the Process, Not Just the Analytics



PG + APM = Fastest, Most Complete Solution



SAP Integration

#1043354: APM/SAP: Condenser Performance Drop

Status: Open

Created By: aattebery@prometheusgroup.com

Age: 12 days old

Last Modified: aattebery@prometheusgroup.com

May 19, 2023 10:51 AM

Resolution Status: Diagnosing

Assigned To: aattebery

Change Notifications: List of Notifications

SAP Change Notifications: List of Notifications

SUMMARY

Condenser backpressure decreased across condenser tubes due to Exhauster 2B no longer in service. To quantify the impact of condenser clean-up, a test was performed post-outage (clean, NO air blanketing). Values were as follows:

1. Backpressure decreased 0.42 inHgA from 1.00 inHgA to 0.58 inHgA
2. Backpressure decreased 0.94 inHgA from 1.00 inHgA to 0.06 inHgA

The impact of running without Exhauster 2B is significant. The overall improvement in backpressure rate impact savings of \$184,550/month.

Discussion

Show Auto-Generated Entries

New Discussion Post aattebery@prometheusgroup.com

May 15, 2023, 2:00:25 PM

Condenser performance appears worse as the unit returns from outage with two Circ Water Pumps in service. Terminal Temperature Differences trend near 54 deg F. Values trended between 30 and 40 deg F with both pumps in service last year. Circ Water Temperature Rises values trend at 10 deg F when 18 deg F is much more typical for 2 pumps in service. The step increase in TTD corresponds with FWH 1A and 2 Temp Rises returning to normal values after they had been trending high. Is the plant aware of any abnormal operation of the condensate or condenser systems as the unit returns online?

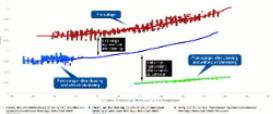


Image: BPvsCWIT.jpg

Notif. date	P	Notification	T...	Description	Functional Location	Equipment	Description of technical o
05/24/2023		10017250	M1	Gearbox Vibration Elevated	JK-HZA-D1	JK-HZA-D1/C	Condensor
05/24/2023		10017255	M1	Cooling Tower CT Fan Motor	JK-HZA-D1	JK-HZA-D1/C	Condensor
05/24/2023		10017267	M1	APM/SAP: Condenser Performance Drop	JK-HZA-D1	JK-HZA-D1/C	Condensor
05/18/2023		10017197	M1	Condensate Pump B Stator Temp	JK-HZA-D2	JK-HZA-D2/M	Main Circulation Pump
05/19/2023		10017202	M1	Unit 2 - Feedwater Flow Discrepancies	JK-HZA-D2	JK-HZA-D2/M	Main Circulation Pump
05/24/2023		10017266	M1	Pump Vibration High	JK-HZA-D2	JK-HZA-D2/P	Condensate Pump

IMPACT

Impact: \$50,000.00

Monthly Average: \$0.00

ASSET

Condenser

Issues by Owning Asset: 2

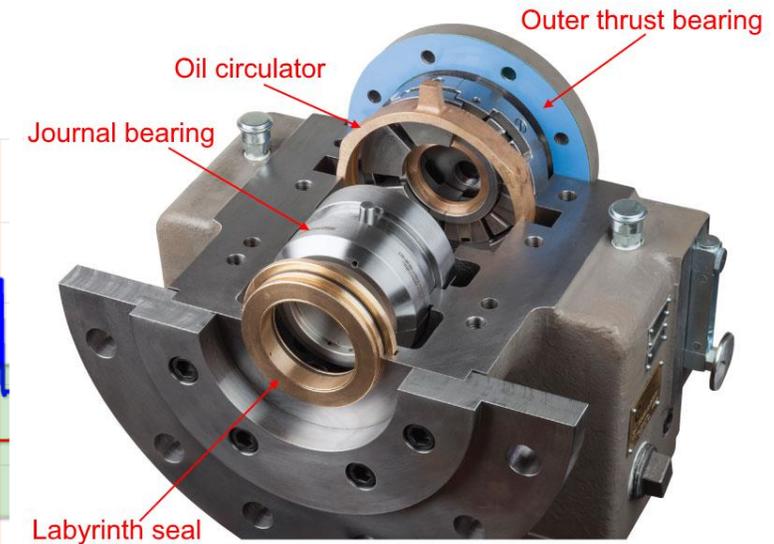
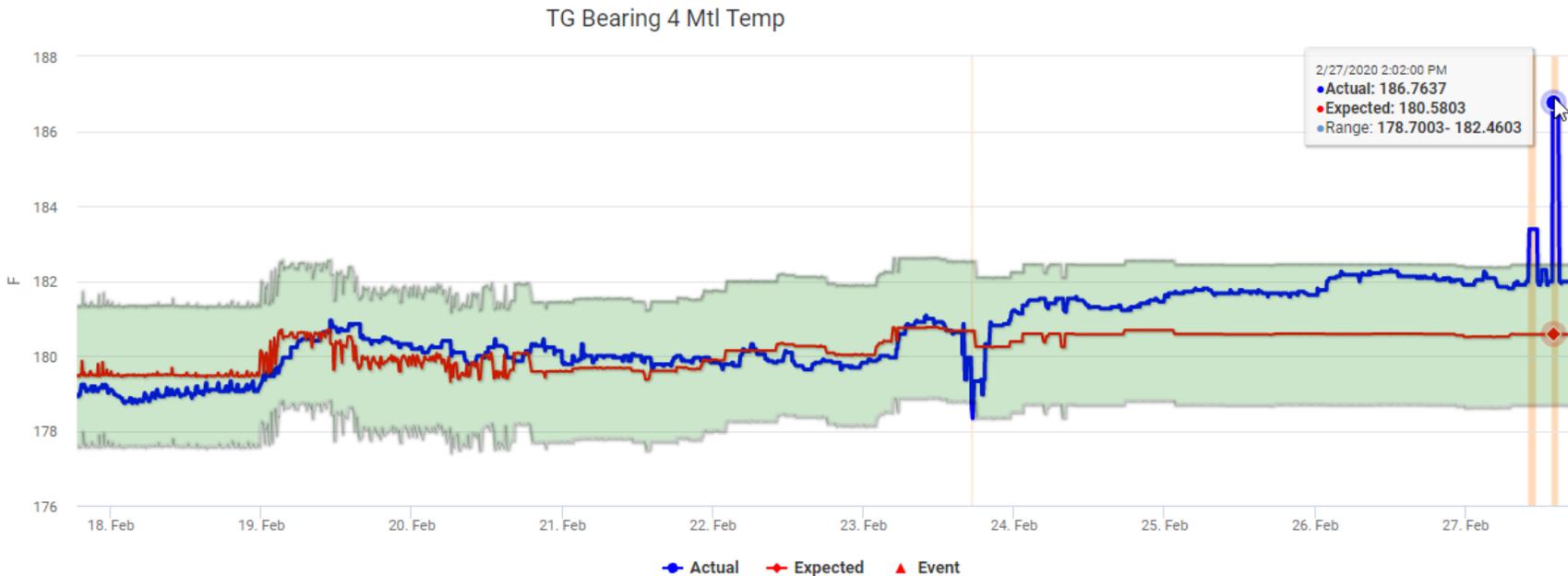
Alerts by Owning Asset: 0

ISSUE KEYWORDS

Keyword Search. ENTER adds the key

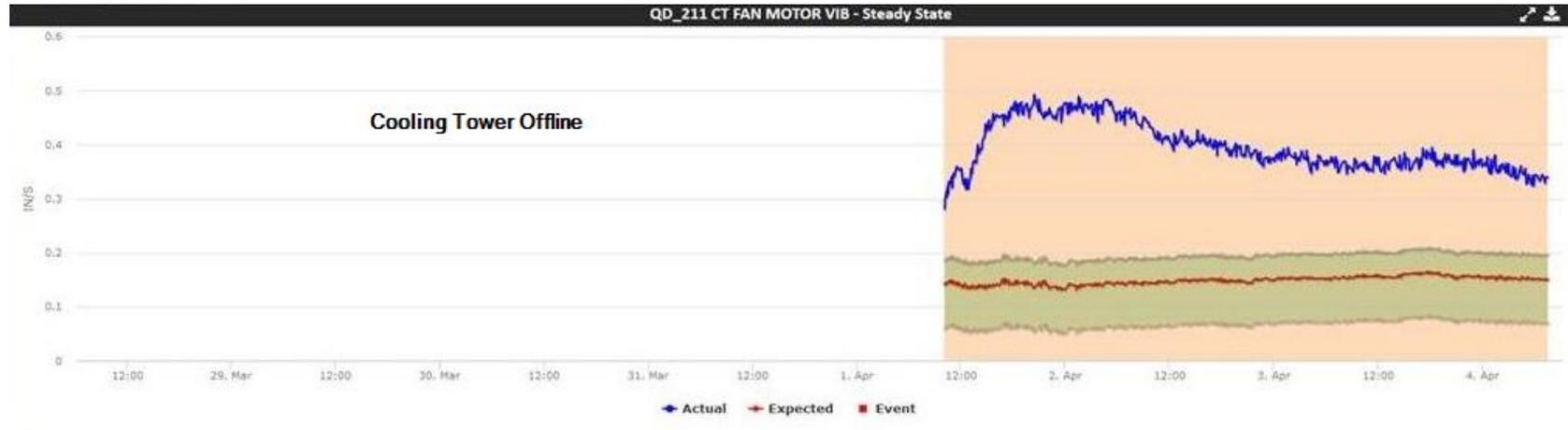
Examples

Turbine Bearing



- **Detect** - Power Turbine Bearing #4 Metal Temperature spiked up from historically steady 180 degF to 186 degF. High frequency data revealed 1min spikes to > 2,000 degF.
- **Diagnose** - Built in diagnostics trends showed that 1) All other bearing metal temperatures were steady 2) All bearing vibrations remained steady with no change 3) Lube oil conditions were steady and 4) Loading on the equipment was not abnormal.
- **Resolve** - Operations took opportunity of existing upcoming weekend outage to pop the bearing cap and inspect locally. It was determined that a coolant oil system was leaking into the lubrication oil, causing varnish on the #4 bearing - resulting in the increased bearing temps.
- **Plant quantified the cost avoidance at > \$2,000,000 due to what would have been a future forced outage avoided!**

Cooling Tower Fan



- **Detect** - Upon startup, Cooling Tower motor vibration 2-3X higher than expected.
- **Diagnose** - User guided context to determine motor & gearbox vibration high. Both were highest vibrations over past year. Additional context determined Cooling Tower vibration was higher than the other 15 cooling towers on site (same instrumentation).
- **Resolve**
 - Local inspection validated vibrations were high. Operations took 'slow motion' video of CT shaft, noting severe vibration.
 - High vibrations below DCS alarm limits, noticed by Plant Operations, and Plant was going into planned outage - would have not done maintenance - and indicated this fan would have torn apart - **\$150k impact**.

Extraction Line Valve



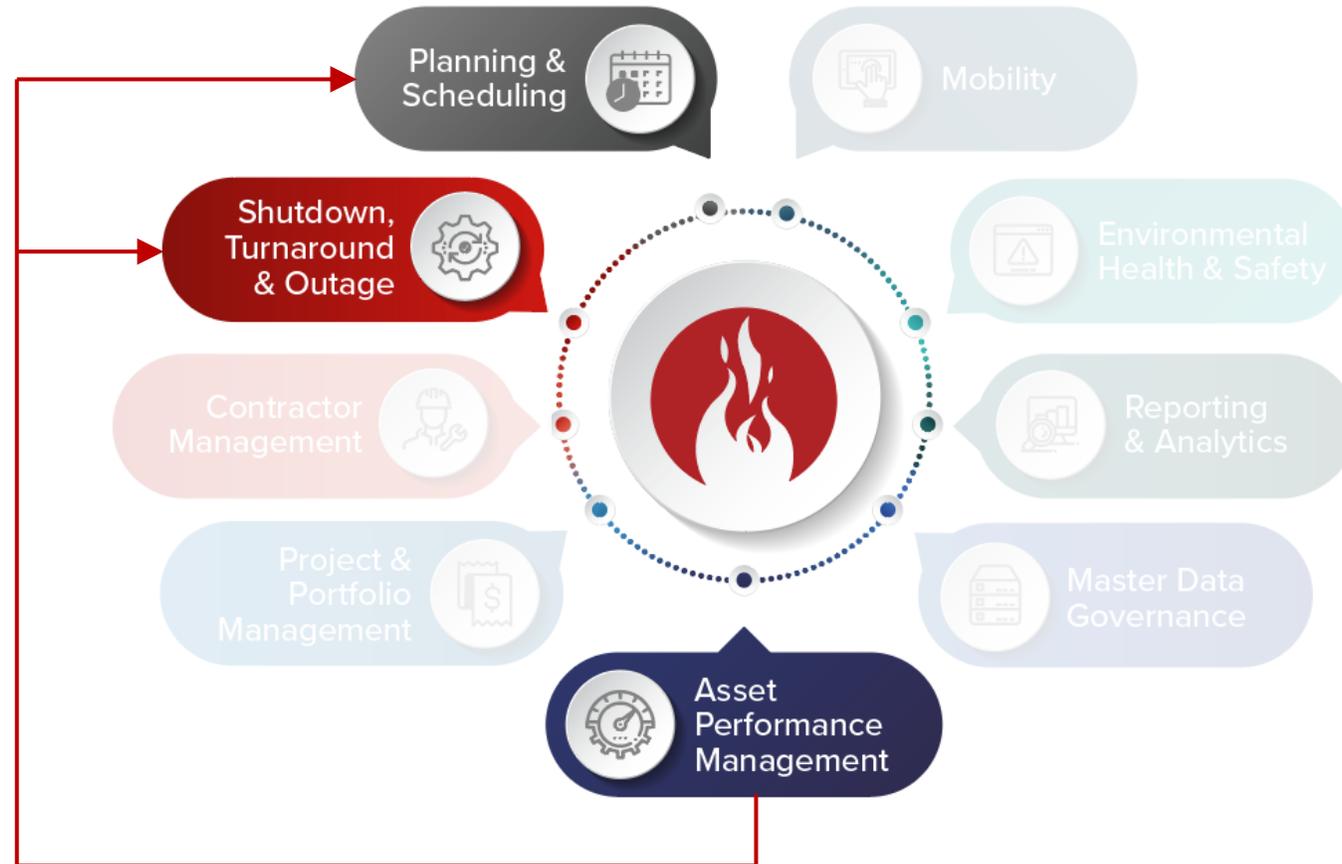
- **Detect** - Across short outage, extraction line steam pressure dropped 7 psi (from 285 psi to 278 psi)
- **Diagnose** - User guided context trend determined upstream extraction pressure instrument was unchanged, but valve position indicated closed. Supplemental P&ID helped pinpoint where issue might be for Ops to walk down the line.
- **Resolve** – Plant Ops discovered valve disk stem nut had backed off valve stem and found valve disc inside extraction line. Shutdown procedure control logic could have caused a turbine overspeed event and catastrophic damage to turbine.
\$1.2M Risk.

The Roadmap

Development Initiatives

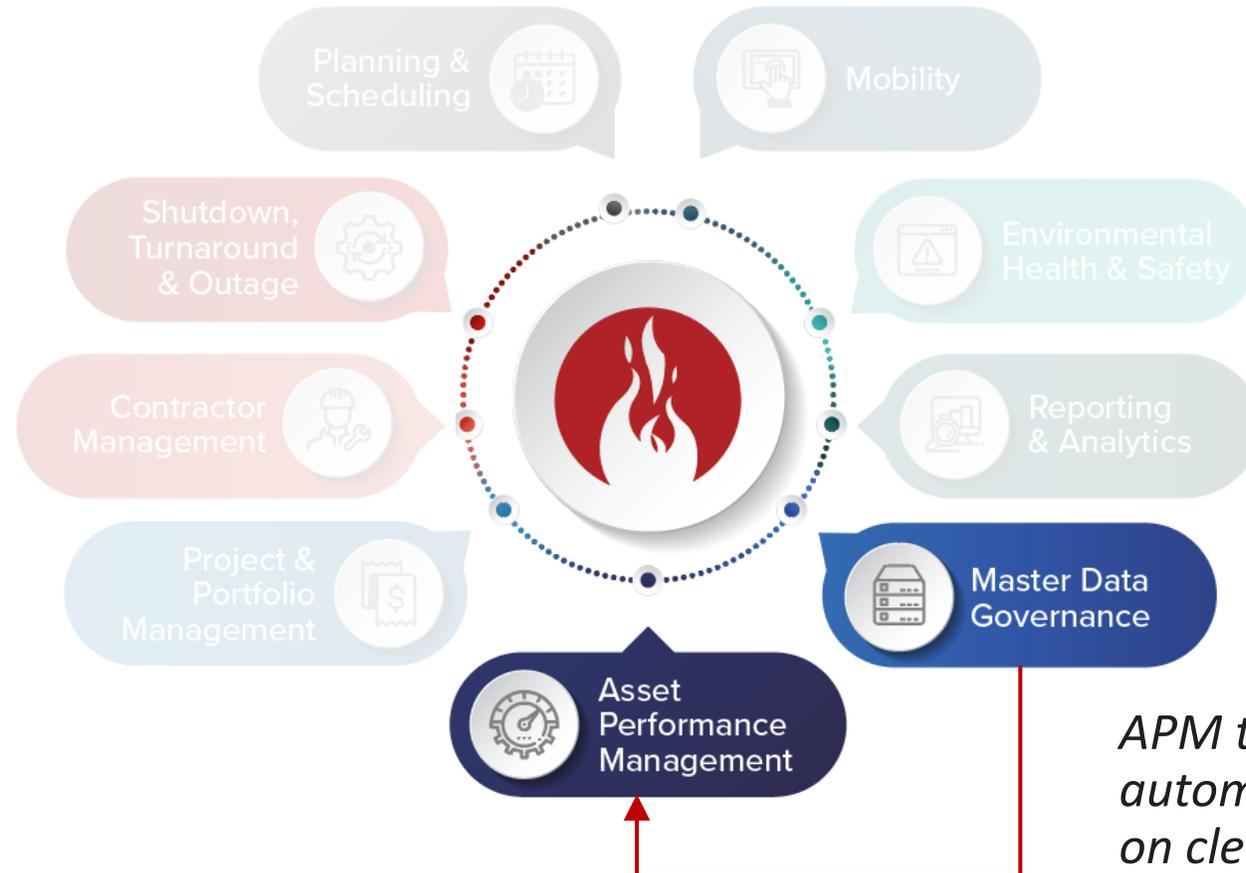
Prometheus Platform Integrations

APM generates maintenance projects that need to be scheduled and executed, many of which need to happen at the next planned downtime



Development Initiatives

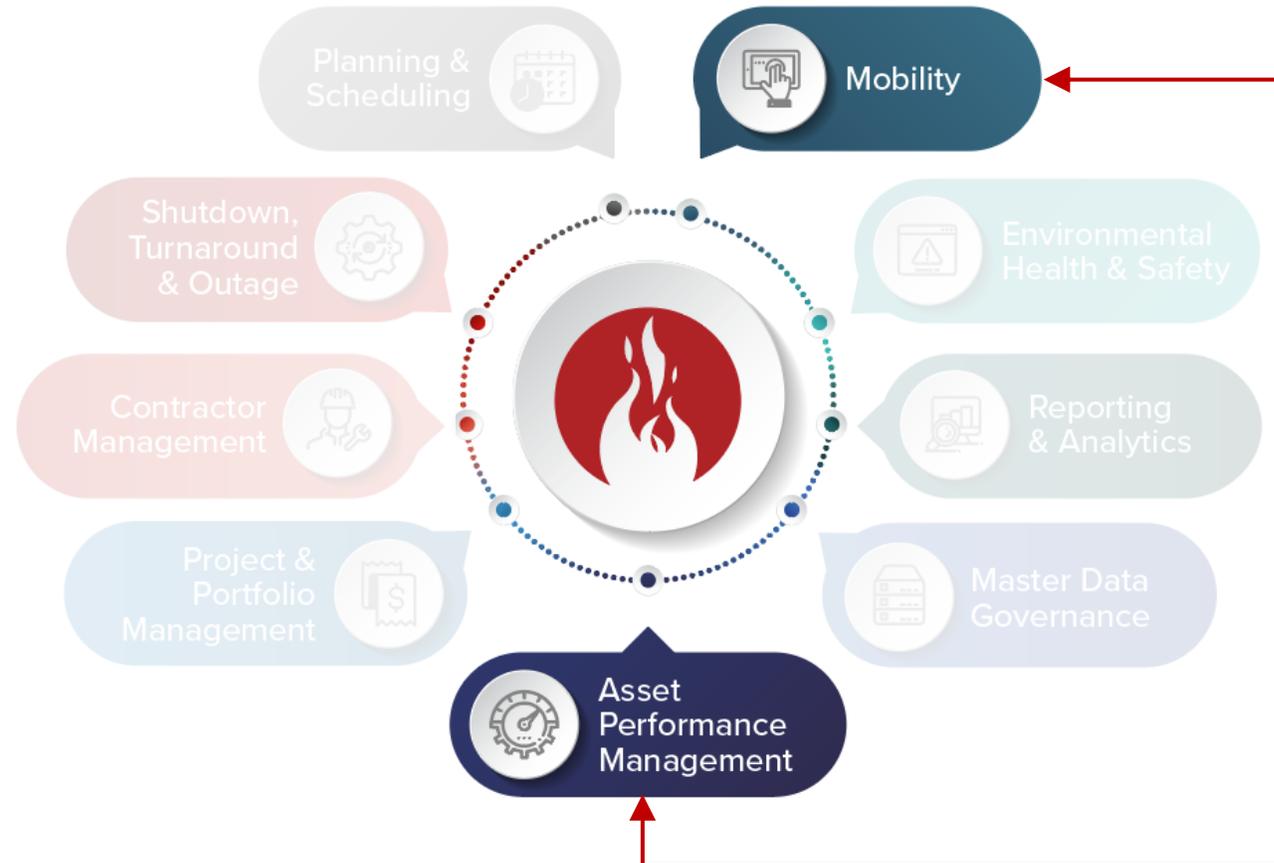
Prometheus Platform Integrations



APM templates and automation are based on clean master data

Development Initiatives

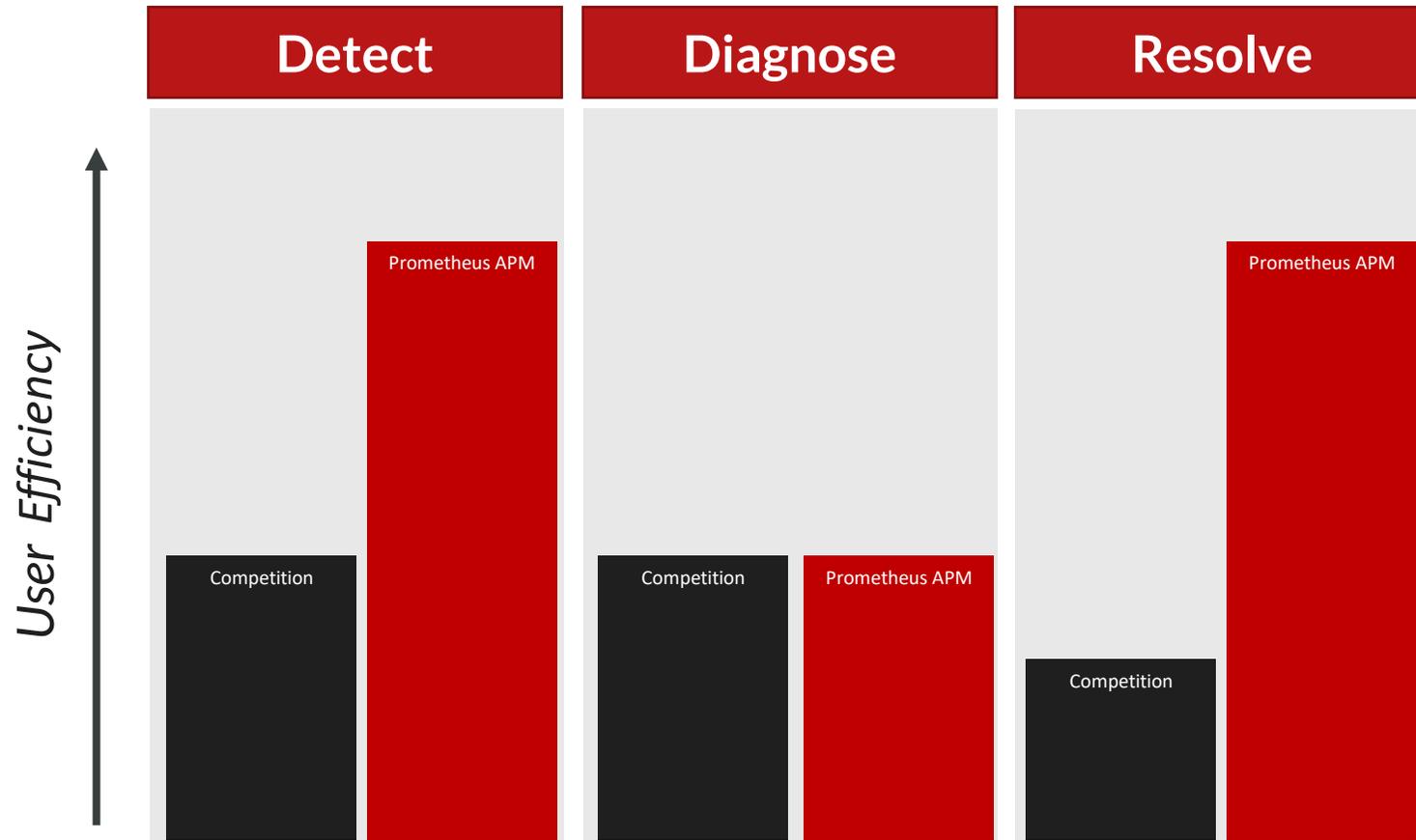
Prometheus Platform Integrations



The diagnosis and resolution of issues requires field investigation

Development Initiatives

Diagnostics



Frequency

40%

Of the historical Boiler Feed Pump Vibration Issues had shaft misalignment as the alert cause.

Process Data

72%

72% of issues with a similar process data signature have tube fouling as the alert cause.

Development Initiatives

Custom Predictive Analytics



Prometheus APM is the fastest APM solution to implement, but there is still room for new and innovative modeling tactics.

Proven Returns

75,000

Customer Issues Detected

\$1B

Probability-weighted Savings

500

Plants Monitored



\$2M

Turbine Flow Restriction



\$750K

Fan Failure



\$185K

Heat Exchanger Efficiency



\$150K

Cooling Tower Failure



\$100K

Aeration Blower Failure

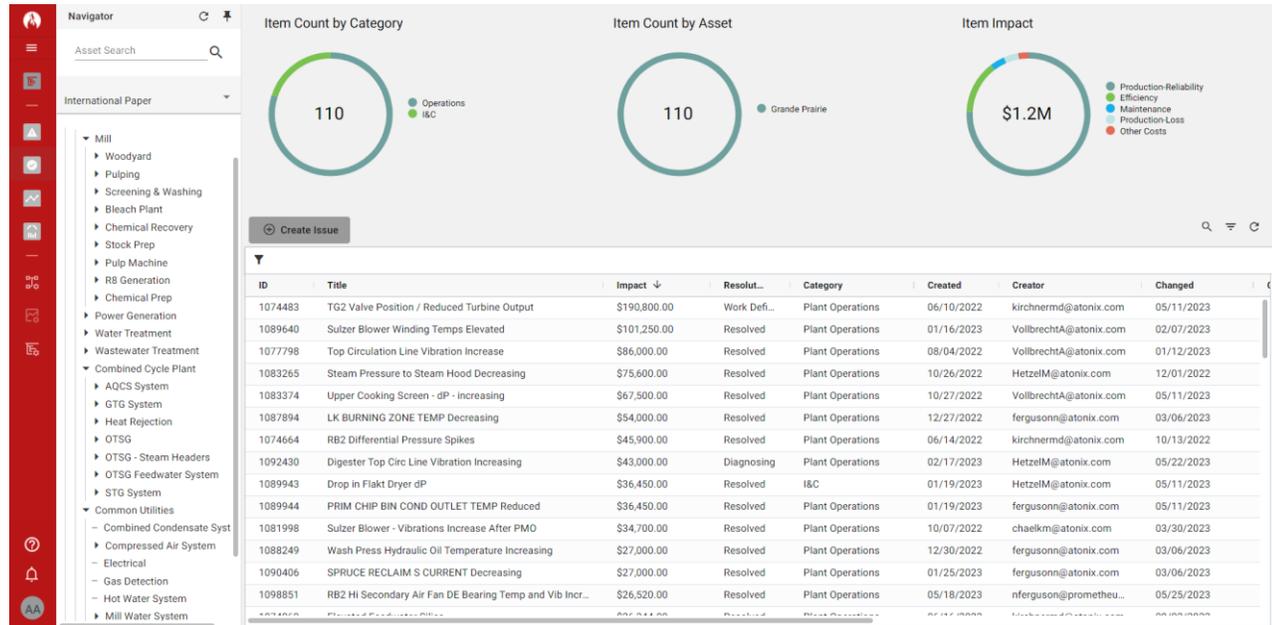


Safety

Chemical Explosion

Business Case

- 3-week implementation of Paper Mill (1200+ ML models)
- ~6 months of live site monitoring
- **100+ operational issues identified with Probability-weighted value of \$1.2M**



Area of Mill	Issue Count	Issue Impact
Bleach Plant	14	\$26,780
Caustic Plant	9	\$127,900
Common Utilities	9	\$13,845
Power & Recovery	34	\$375,757
Pulp Machine	8	\$282,500
Pulp Mill	11	\$280,050
Screening & Washing	4	\$27,540
Stock Prep	4	\$12,475
Waste Treatment	2	\$25,300
Total	100+	\$1,172,147

Project Kickoff
May 31

Data Backfilled
Jun 3

Configuration Complete
Jun 10

Baseline Review Complete
Jun 17

Monitoring Kickoff Meeting
Jun 22

Take the Prometheus APM Challenge!

Getting started is *EASY and FAST*

- › **Instant Replay Pilot** – Build the models and see what we would've caught in the *past 12* months
 - › Automatically Builds the business case in 1 month

€30,000 Conference Promotion

Questions?

Thank you



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