Enterprise Products Partners L.P.

Matthew Richardson Jose Silvestre

Advanced Asset Monitoring

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Advanced Asset Monitoring

Jose Silvestre

Supervisor, Operational Analytics
Enterprise Products

Matthew Richardson

Engineer, Operational Analytics
Enterprise Products

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Agenda

- Company Background
- Introduction
- Advanced Asset Monitoring (AAM)
- Value Findings
- Future Plans

EPD's Integrated Footprint

In the Hub of U.S. Supply and Domestic & International Markets

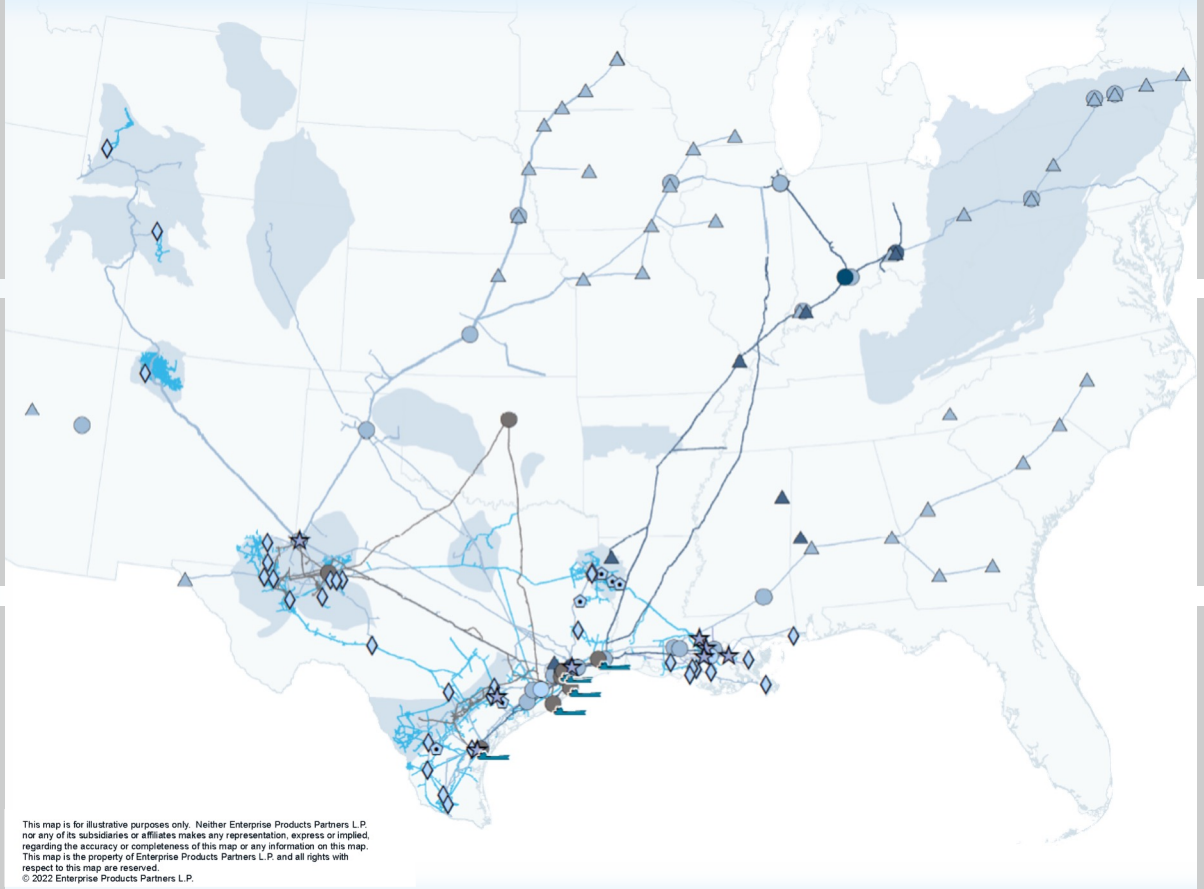
Our Platform

NGLs, Crude Oil, Natural Gas, Petrochemicals and Refined Products

>50,000
Miles of Pipeline

>300
MMBbls of Liquids Storage

20
Deepwater Docks



42
Natural Gas Processing Trains

26
Fractionators

2
PDH(1)

2
iBDH(1)

A full interactive map of our assets is available on our website, enterpriseproducts.com.
(1) PDH means propane dehydrogenation. iBDH means isobutane dehydrogenation

About the Speakers

- Jose Silvestre, Supervisor – Operational Analytics
  - BS, Chemical Engineering
  - MS, Eng. Data Science
  - 5 years of engineering and operations experience
    - Process engineering
    - Operations engineering
    - Operational analytics
- Matthew Richardson, Engineer – Operational Analytics
  - BS, Chemical Engineering
  - 6 years of engineering and operations experience
    - Measurement
    - Leak detection
    - Operational analytics

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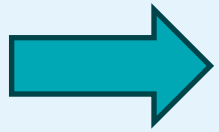
Problem statement

- How can we use modern technology to augment conventional monitoring methods?

Conventional Monitoring

- Reactive state
- Default local alarms
- Limited communications
- Periodic maintenance



Advanced Monitoring

- Proactive state
- Advanced/smart alarms
- Expanded communications
- Condition-based maintenance

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Advanced Asset Monitoring (AAM)

Goal

- Proactive state
- Reduce equipment breakdowns
- Improve maintenance efficiency

Approach

- Utilize ML-based anomaly detection models
- Utilize Seeq as our front-end and investigation platform
- Utilize Seeq alarming

Impact

- Reduce mean-time-to-awareness
- Reduce mean-time-to-identification
- Reduce mean-time-to-resolve

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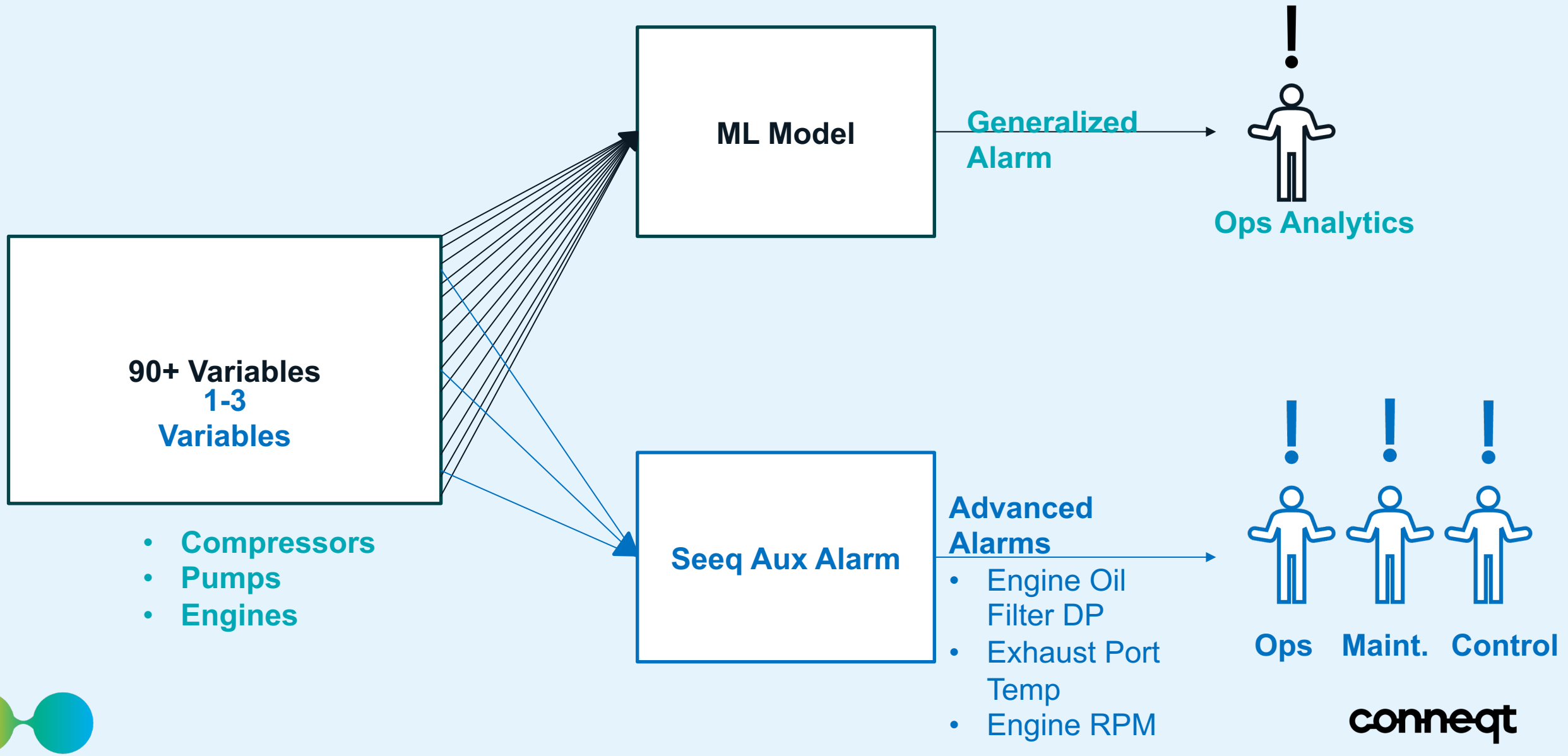
AAM Overview



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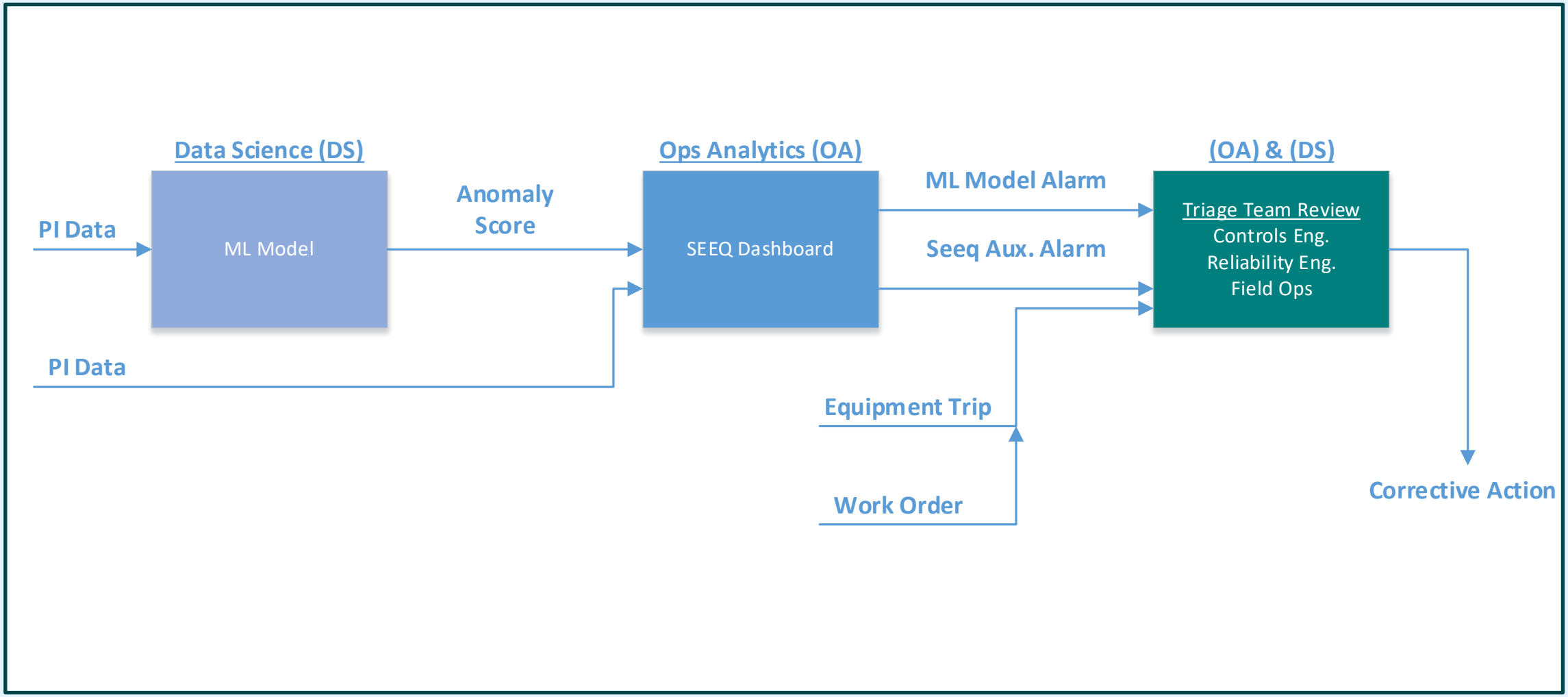
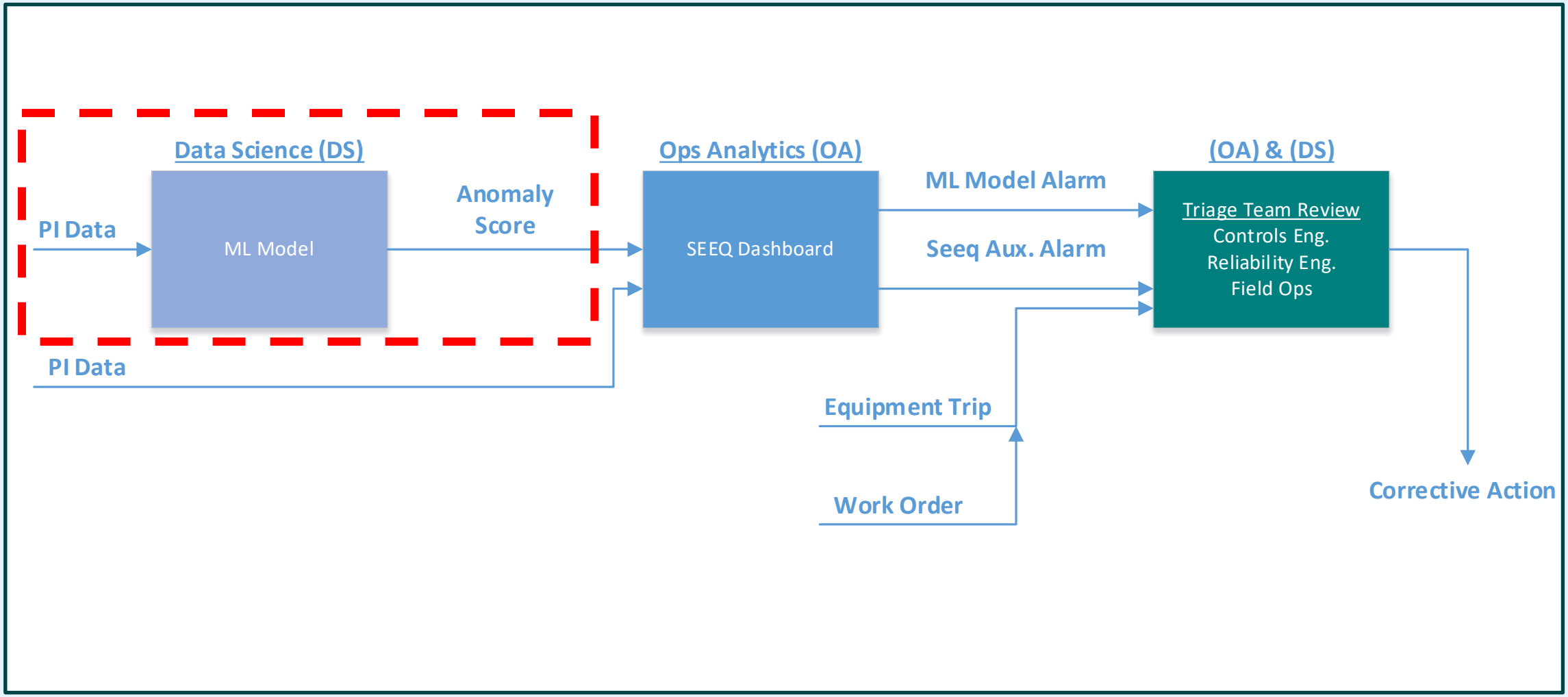
AAM Process Diagram



AAM Process Diagram



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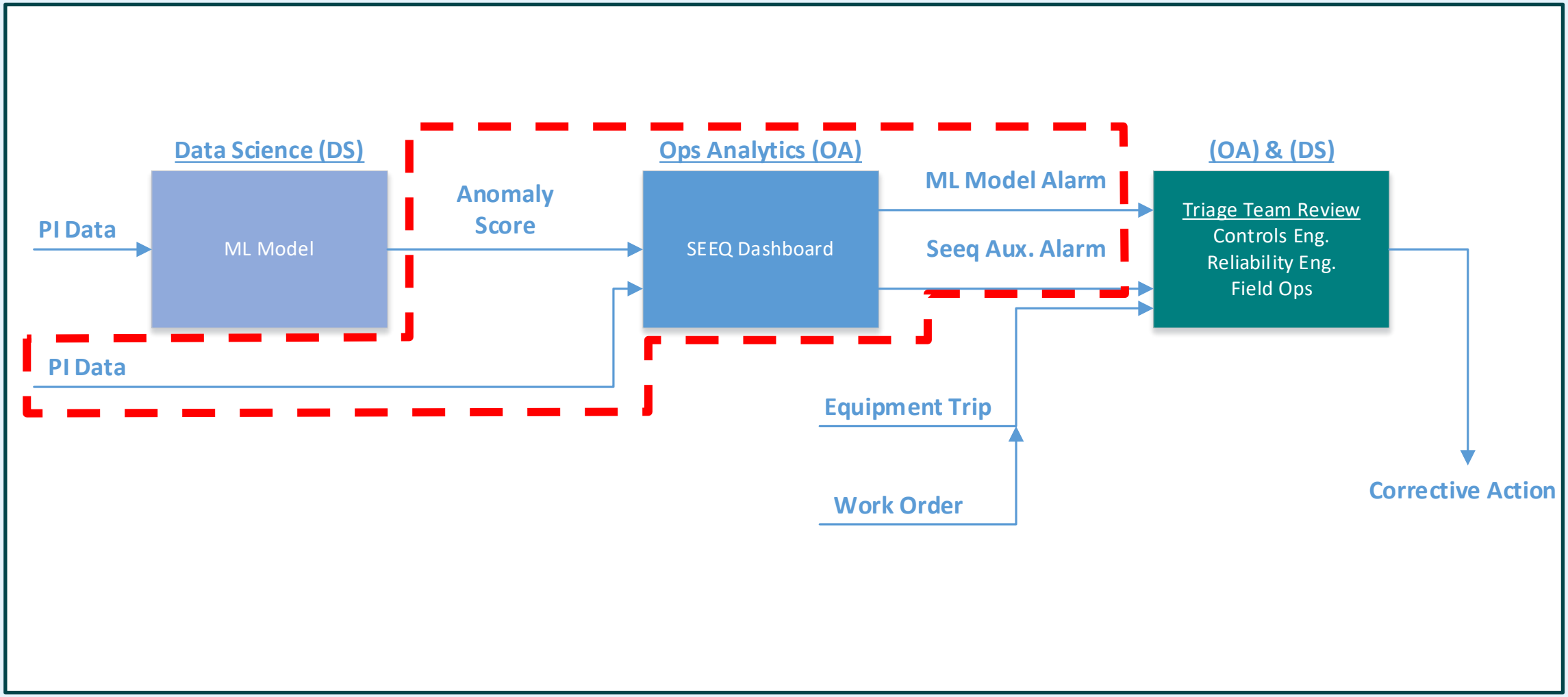
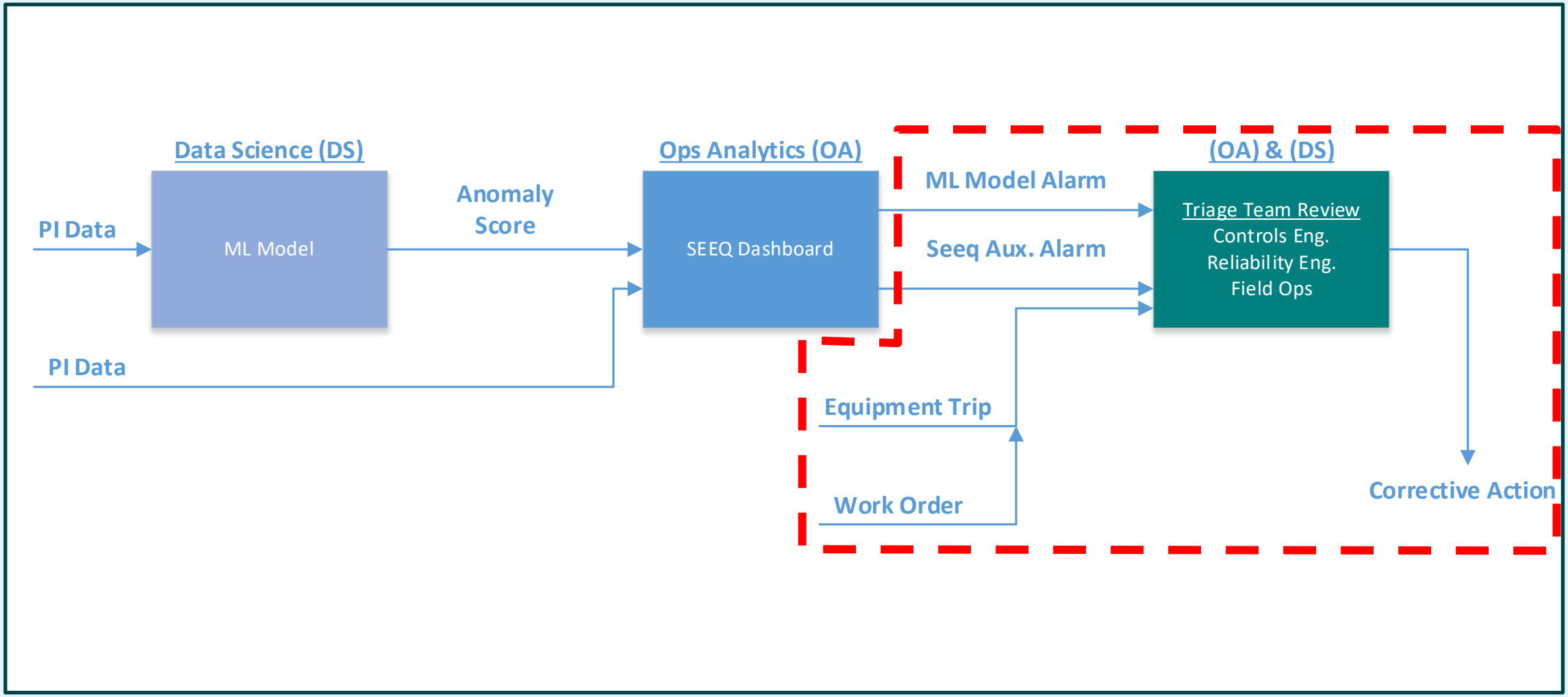


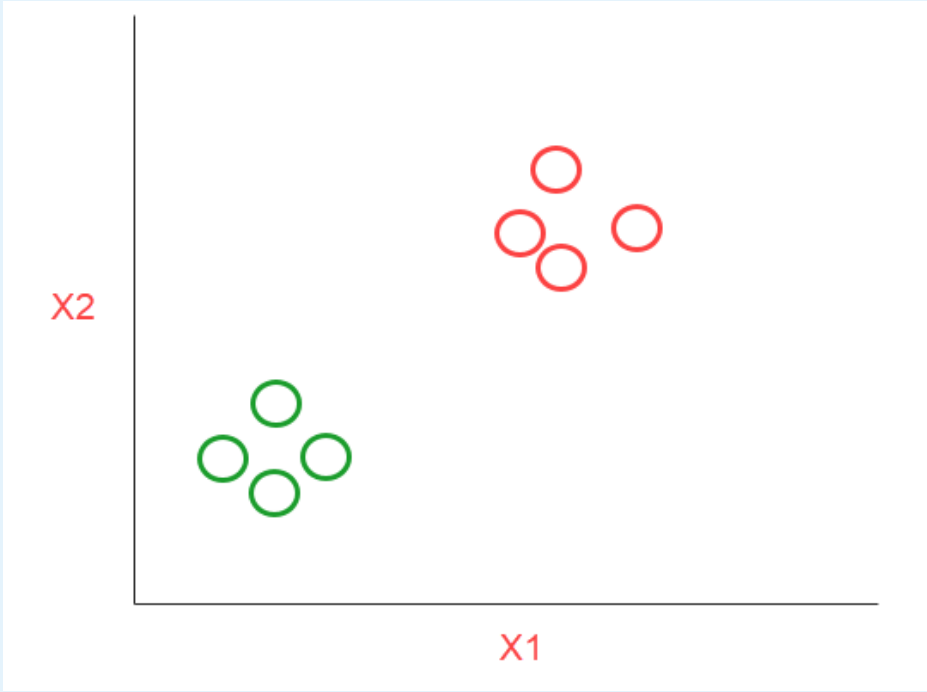
AAM Process Diagram



Machine Learning - Intro

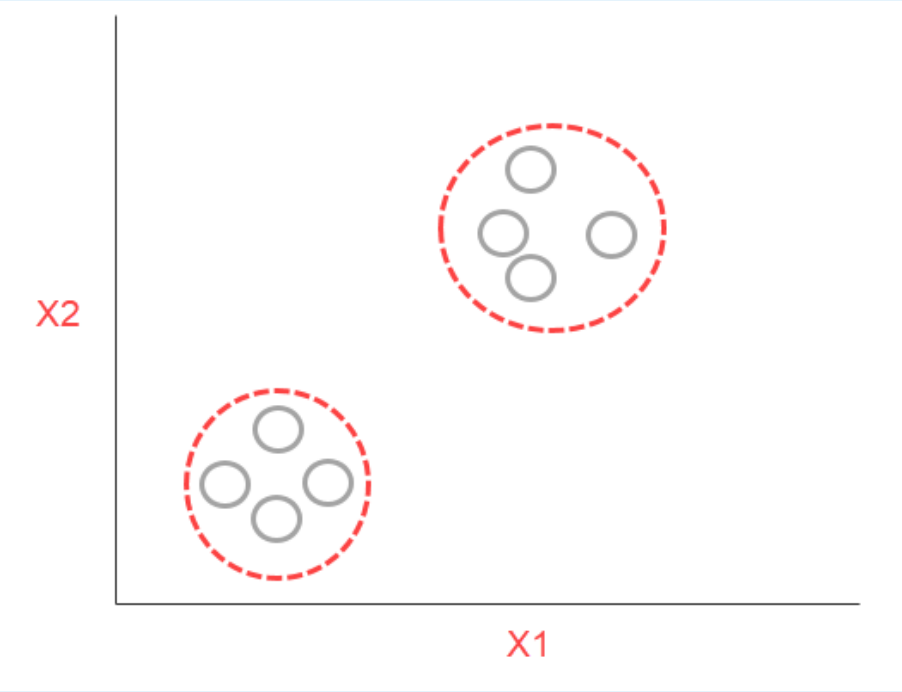
Supervised

- Labels needed
- Specific categories



Un-Supervised

- No labels needed
- Categories identified through data patterns



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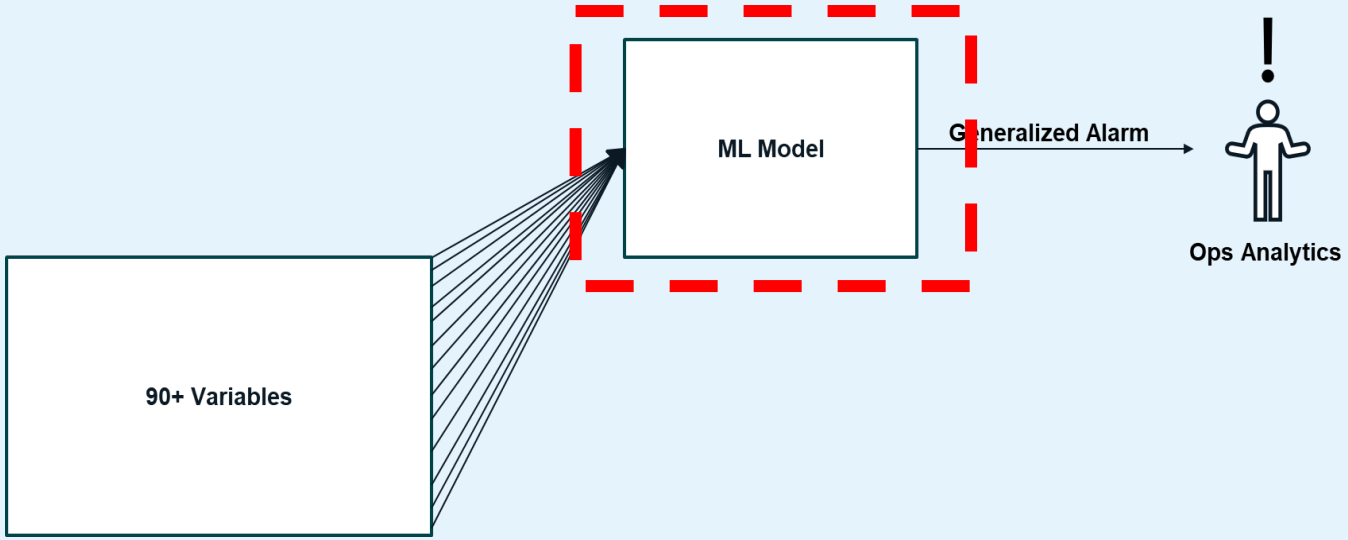
ML Model overview

- Un-supervised Anomaly Detection Model
  - No labels needed
- Neural Net based model
  - Temporal Convolutional Network – Auto Encoder
- Learns what is “normal”



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How we utilize Seeq for AAM

Workbench Analysis

- Data cleansing / pre-processing
  - Signal Smoothing
- Formula Functions
  - Derivative/Running Delta
  - Capsule manipulations
- Asset Groups
- Notifications on Conditions
- Journal

Organizer Topic

- Summarized View
- Drill down to details

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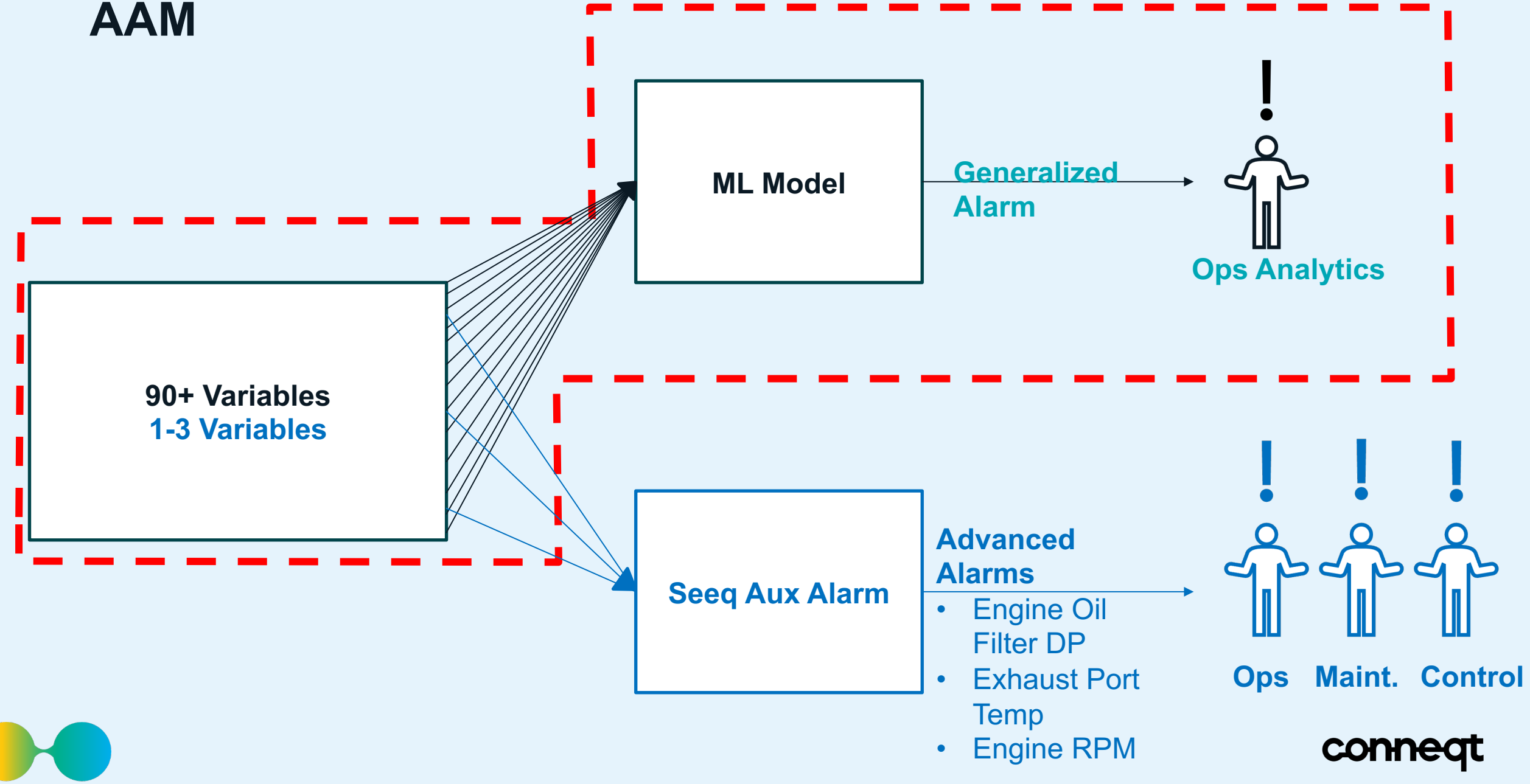
AAM


ML Model
Generalized Alarm
Ops Analytics
90+ Variables
1-3 Variables
Seeq Aux Alarm
Advanced Alarms
• Engine Oil Filter DP
• Exhaust Port Temp
• Engine RPM
Ops
Maint.
Control

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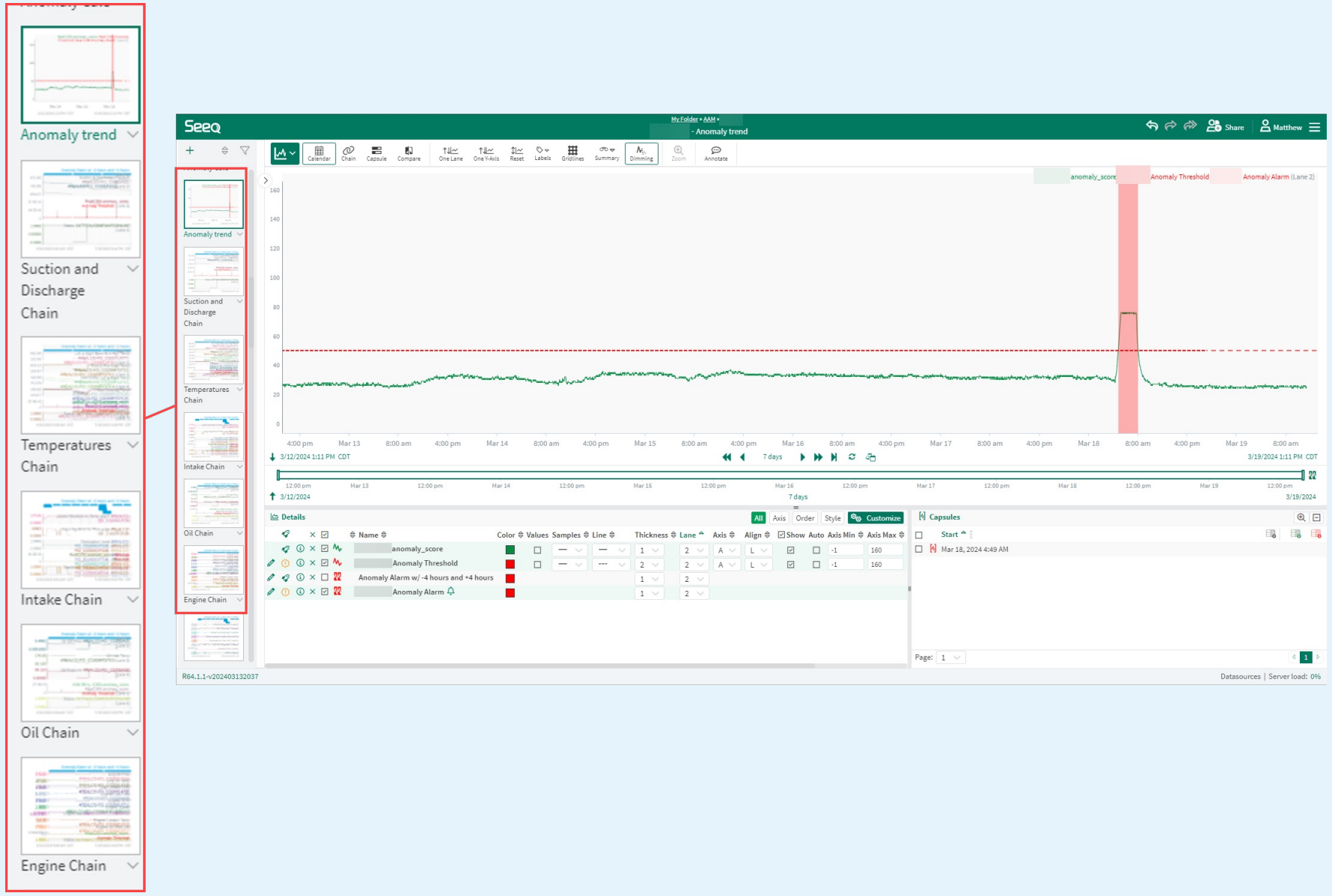
AAM – Workbench Analysis Set Up



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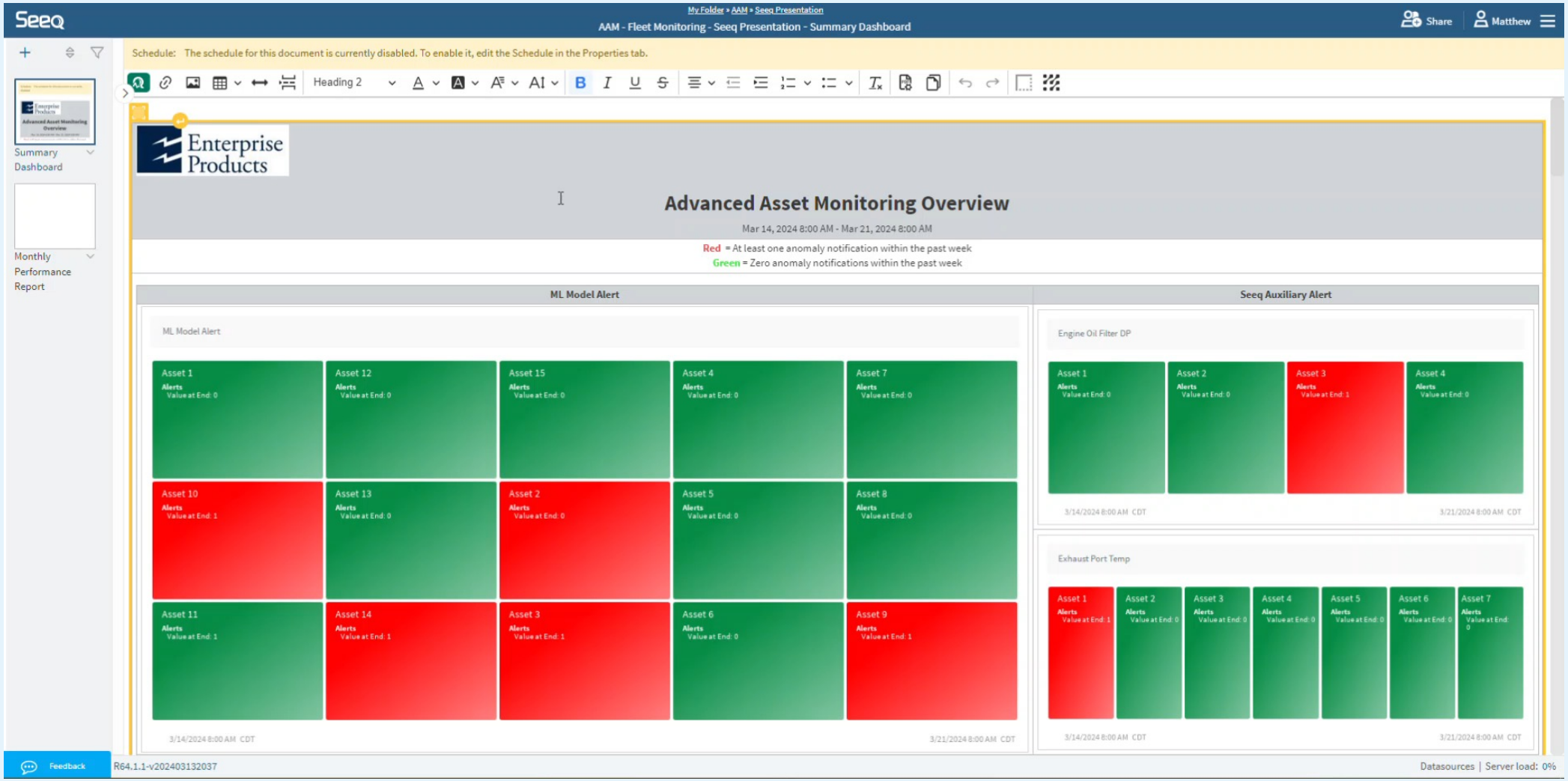
AAM – Organizer Topic Fleet Monitoring



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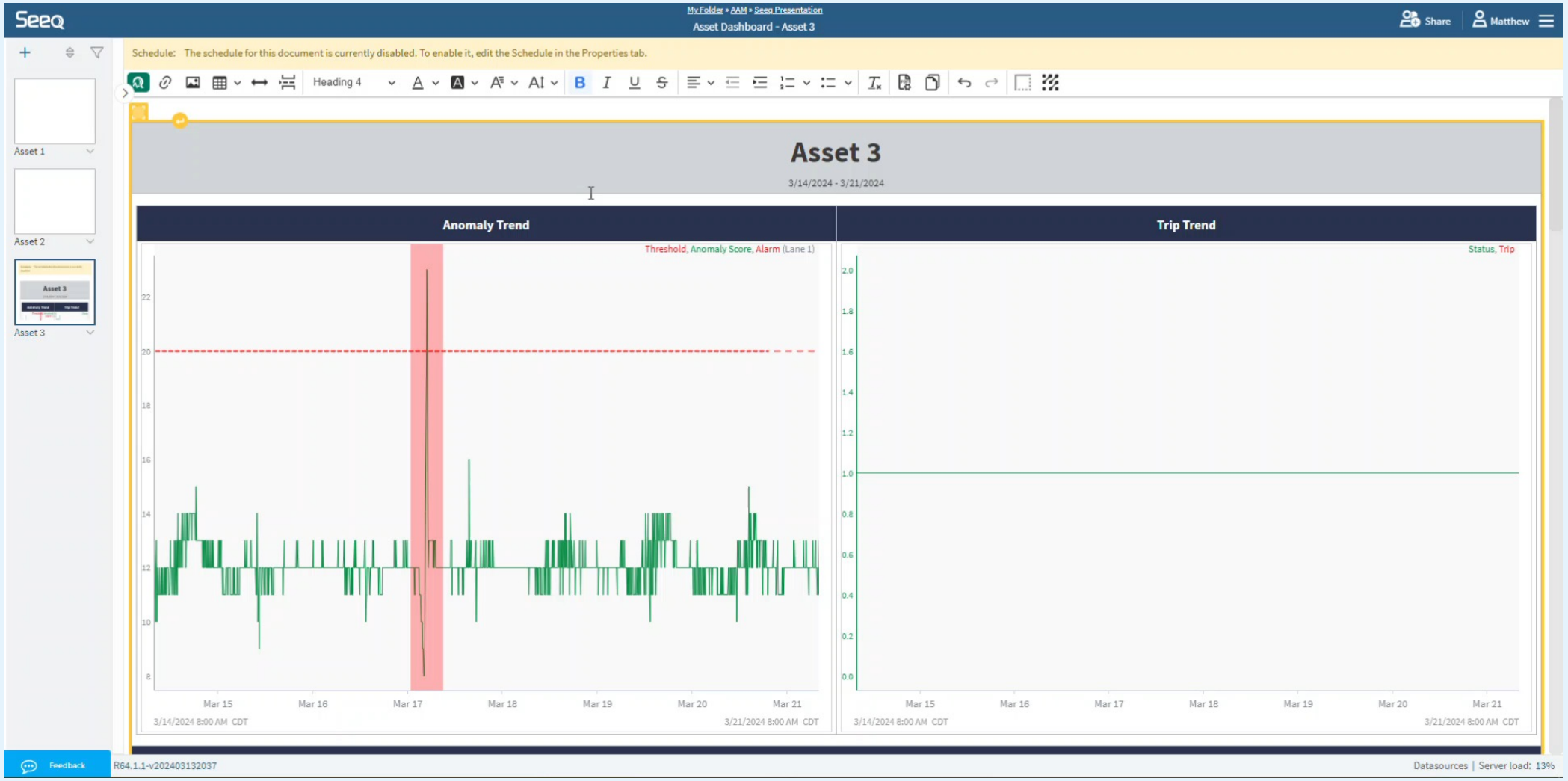
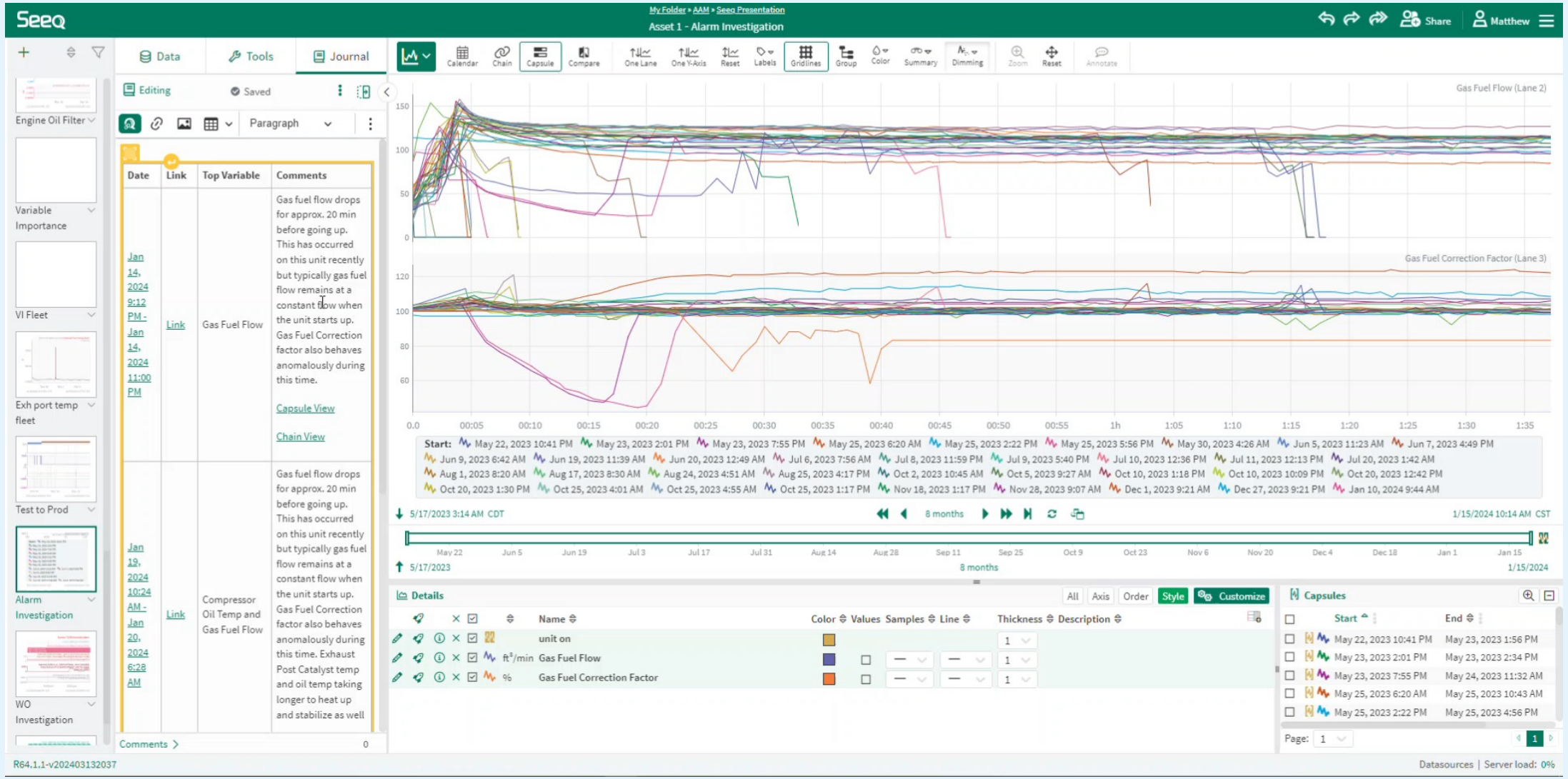
AAM – Organizer Topic Asset Specific



AAM – Workbench Journal Logging



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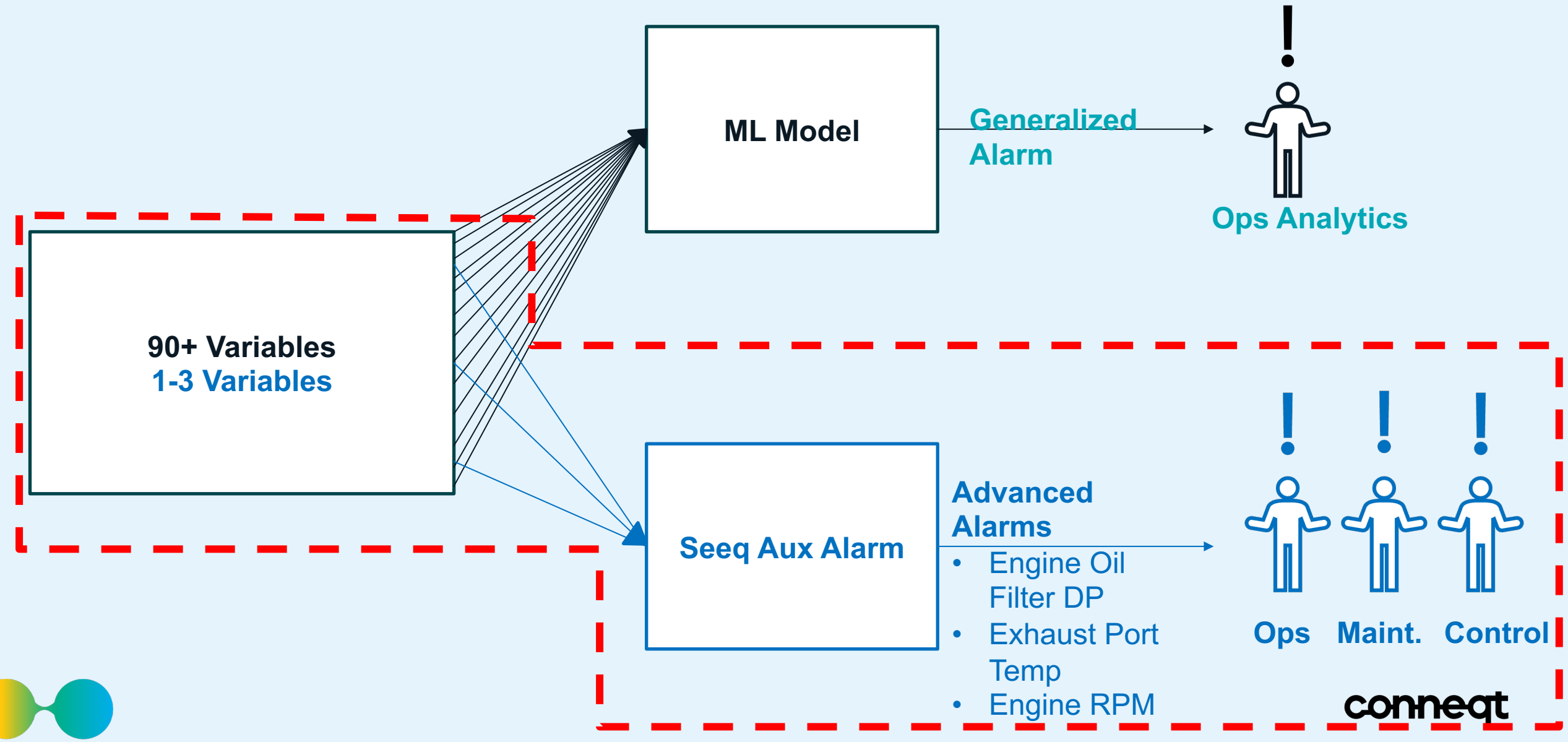
AAM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Ops
Maint.
Control
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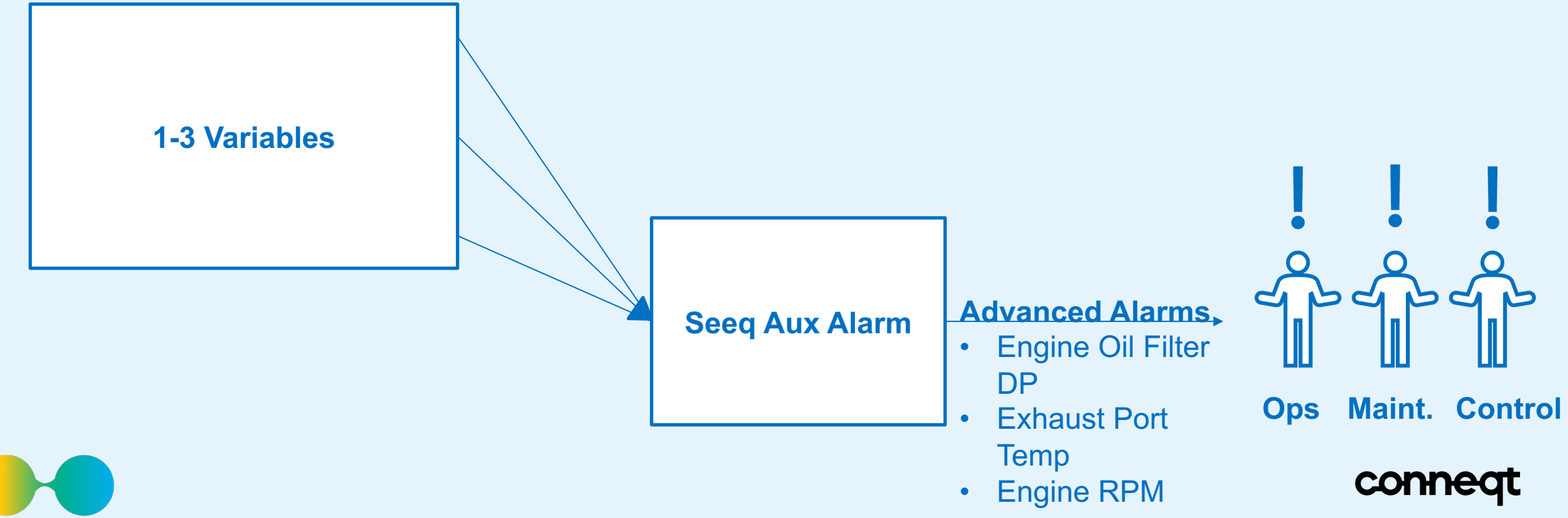
Seeq Auxiliary Alarms



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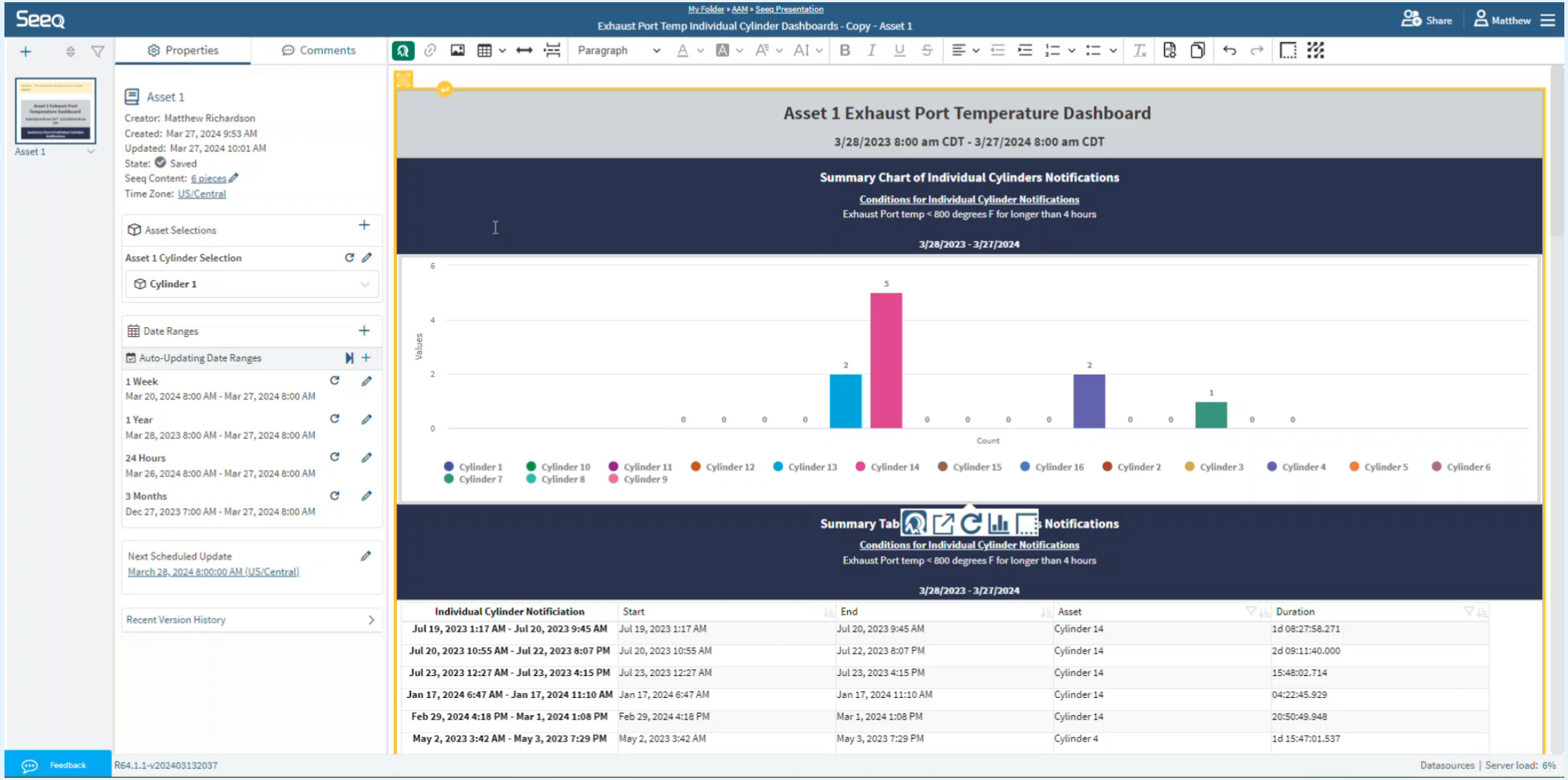
Seeq Aux. Alarm – Organizer Topic

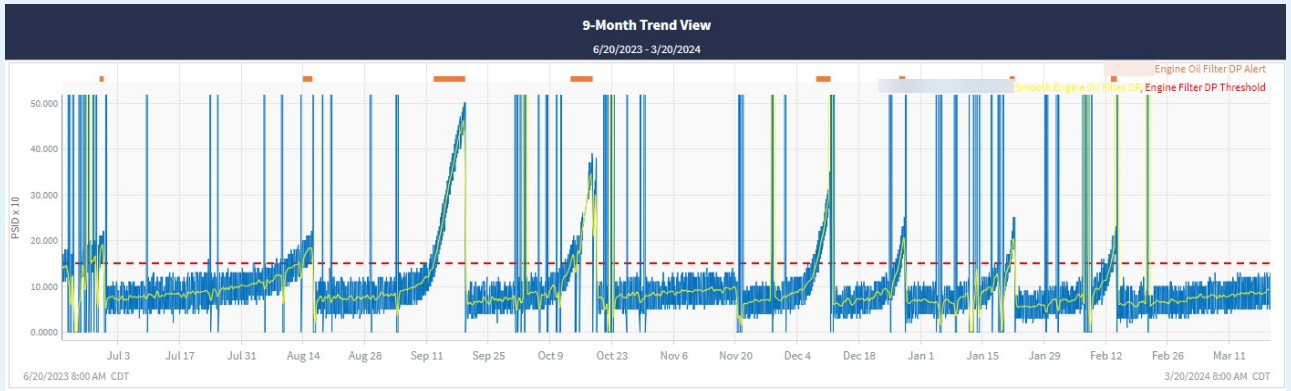


Significant findings/process improvements

Extended Equipment uptime

- Improved equipment operations
  - Engine operations tuned
  - Replacement of faulty equipment

- Moving reactive P1 work orders to proactive P2/P3 work orders
  - Early detection of filter changeout



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Before and After AAM

BEFORE

Conventional Monitoring

- Reactive state
- Default local alarms
- Limited communications
- Periodic maintenance
- Scheduled inspections

AFTER

+ Advanced Monitoring

- Proactive state
- Advanced/smart alarms
- Expanded communications
- Condition-based maintenance

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Future Plans

- Data quality tool for bad data cleanup
- Scale to other identified assets
- Build station-level models
- Expand to process monitoring


Thank You
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