



**AVEVAWORLD**  
PARIS



# How CONNECT data services Enables Analytics in Mining

Karl Leetmaa  
Michael Bigras

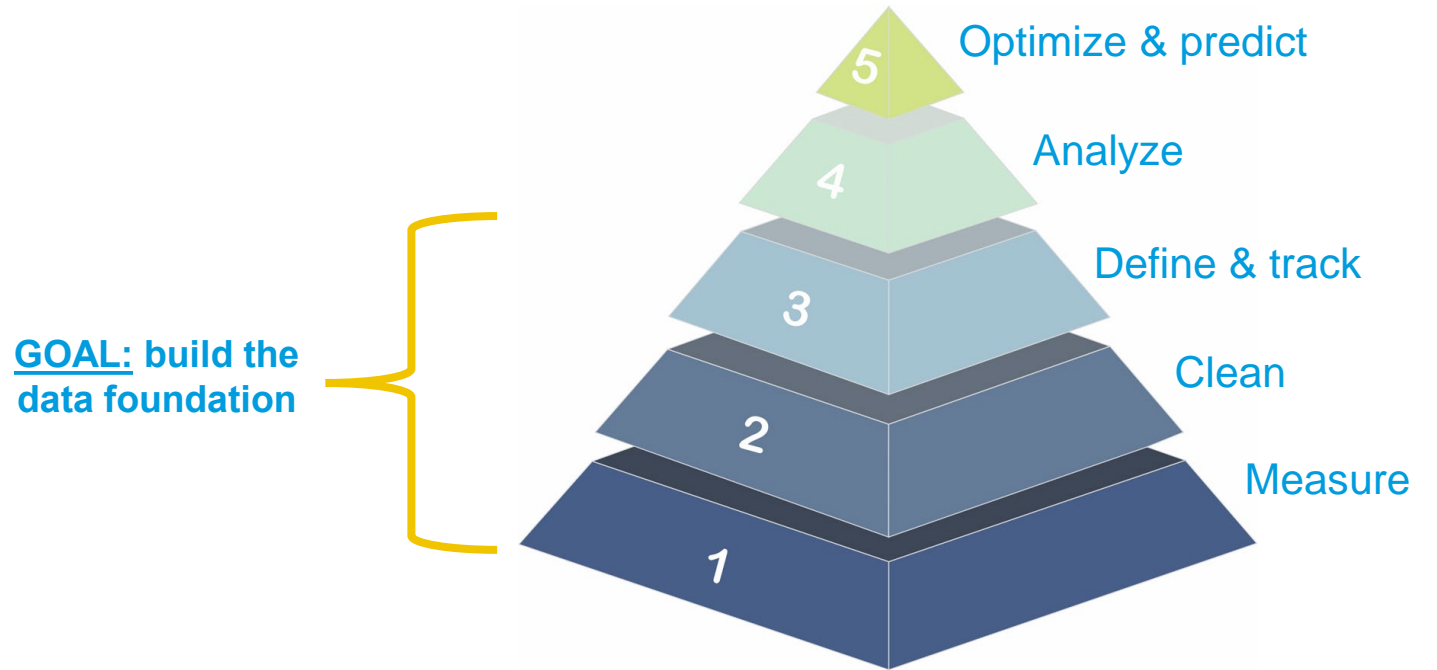
October 15<sup>th</sup>, 2024



# AGENDA

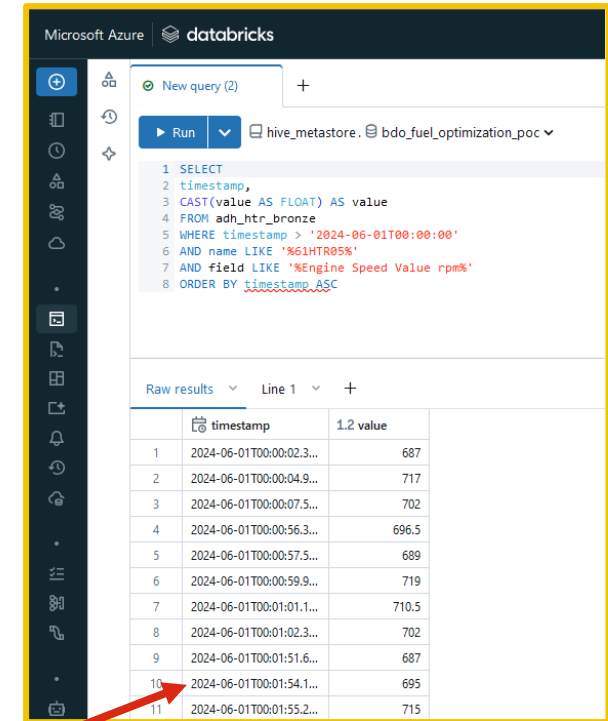
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- The business challenge
- Overview of Agnico Eagle Mine's digital transformation
- Analytics opportunities
- Lighthouse program
- Integrated Operations Center
- Conclusions



# THE BUSINESS CHALLENGE

- Many analytics opportunities are limited by data access challenges
- Discussed with AVEVA to seamlessly integrate industrial asset data with other relational data
- Initiated a Lighthouse engagement for direct integration between CONNECT data services and Azure Databricks
- The new feature will allow direct Databricks Unity Catalog access to a pre-materialized copy of a CONNECT data services data view



Microsoft Azure | databricks

New query (2) +

Run | hive\_metastore . bdo\_fuel\_optimization\_poc

```
1 SELECT
2 timestamp,
3 CAST(value AS FLOAT) AS value
4 FROM adh_htr_bronze
5 WHERE timestamp > '2024-06-01T00:00:00'
6 AND name LIKE '%1HTR05%'
7 AND field LIKE '%Engine Speed Value rpm%'
8 ORDER BY timestamp ASC
```

Raw results | Line 1 | +

	timestamp	1.2 value
1	2024-06-01T00:00:02.3...	687
2	2024-06-01T00:00:04.9...	717
3	2024-06-01T00:00:07.5...	702
4	2024-06-01T00:00:56.3...	696.5
5	2024-06-01T00:00:57.5...	689
6	2024-06-01T00:00:59.9...	719
7	2024-06-01T00:01:01.1...	710.5
8	2024-06-01T00:01:02.3...	702
9	2024-06-01T00:01:51.6...	687
10	2024-06-01T00:01:54.1...	695
11	2024-06-01T00:01:55.2...	715

CONNECT data services data here



# Company Overview

- Agnico Eagle Mines
- Digital Transformation group



**High-Quality  
Portfolio**



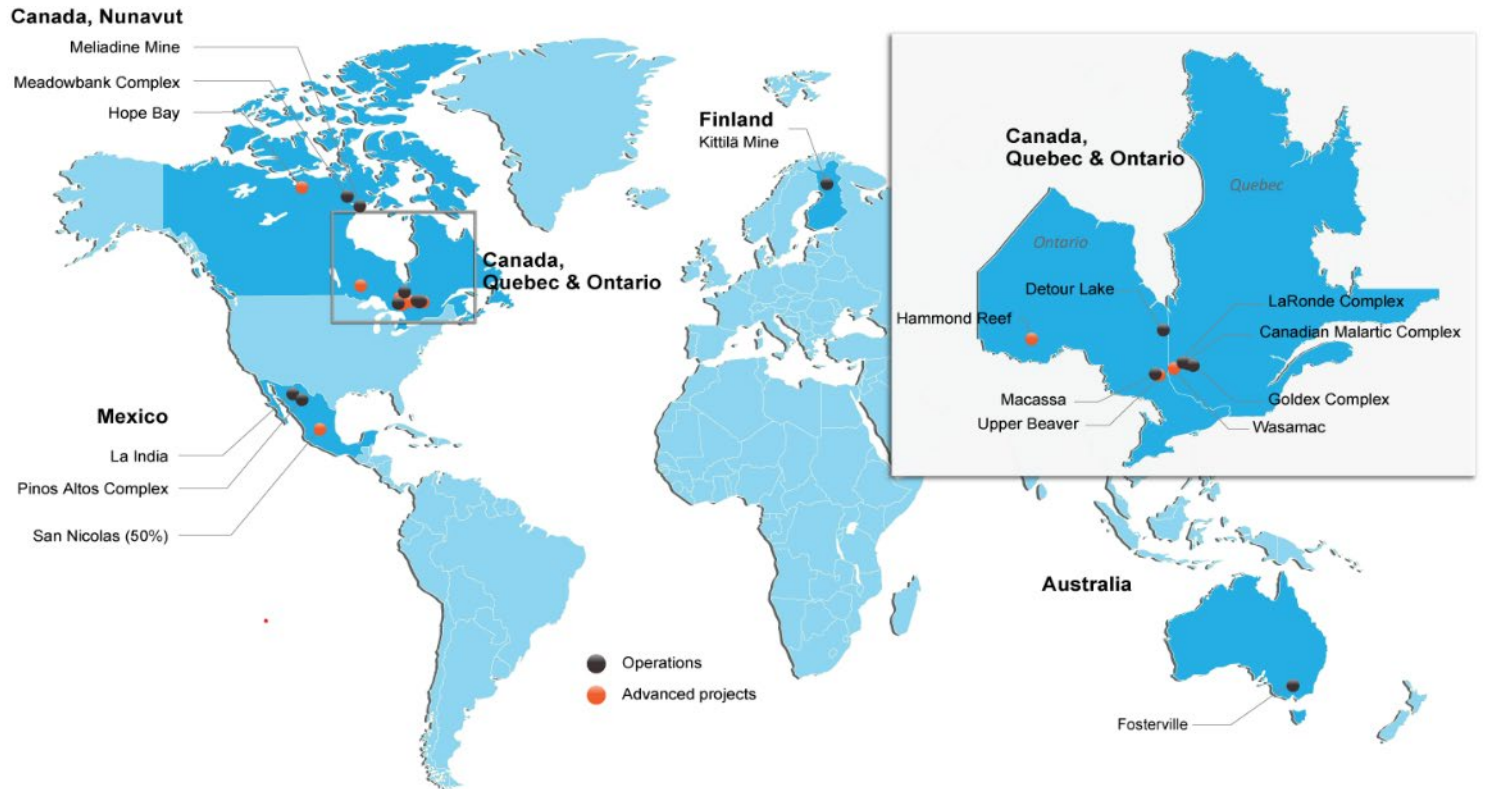
**ESG  
Stewardship**



**Generating Superior  
Long-Term Returns  
to Shareholders**

# AGNICO EAGLE MINES OVERVIEW

- Third largest gold producer in the world (2023 Global Gold Production: 3.44 Moz)
- 11 operating mines in Canada, Australia, Finland and Mexico
- 16,000+ global workforce



# DIGITAL TRANSFORMATION GROUP



Established in 2022



Provide guidance for data integration and analytics



AEM Data Academy



Strategies for Data Quality & Integrity



BI reporting support and enablement



Integrated Operations Centers in Abitibi and Ontario



Build internal Data Science capabilities



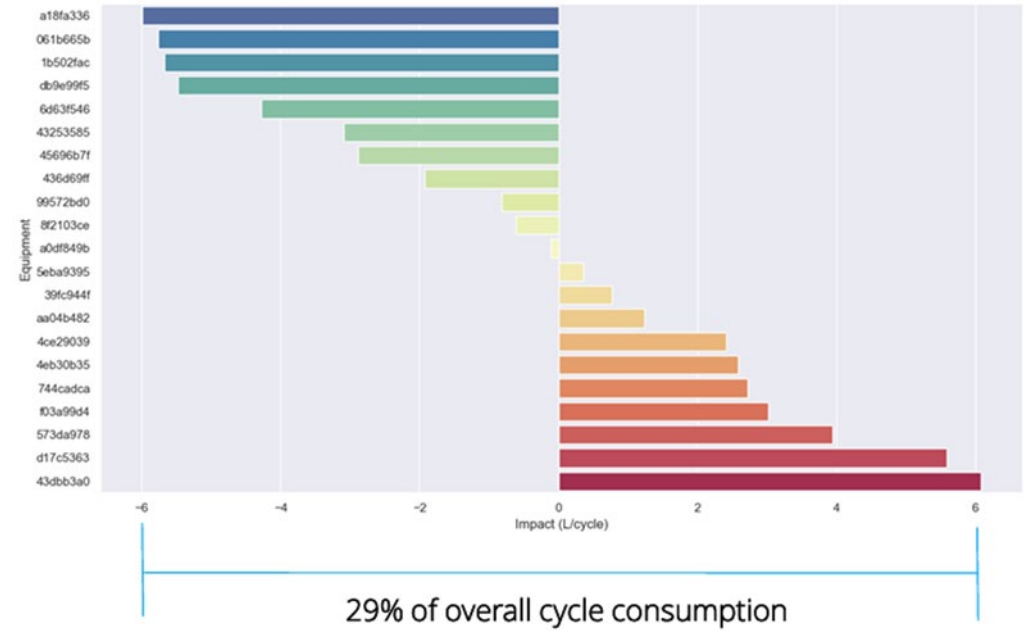
**Michael Bigras**  
OT Automation Specialist



**Karl Leetmaa**  
Metallurgy Subject Matter Expert

# Analytics Opportunities

## Haul truck analytics



29% of overall cycle consumption

KPI	Shift	Target	Stability	Circuit/Score	KPI	Shift	Target	Stability	Circuit/Score	KPI	Shift	Target	Stability	Circuit/Score	KPI	Shift	Target	Stability	Circuit/Score	
		Pass/Fail					Pass/Fail					Pass/Fail					Pass/Fail			
Mill Availability	D/S 24H	●	●	Overall Plant	Throughput (dry)	D/S 24H	●	●	Overall Plant	Tonnage (dry)	D/S 24H	●	●	Overall Plant	Start of Visual Dayshift	8/30/2024 6:00:00 AM	Start of Visual Nightshift	8/30/2024 6:00:00 PM		
Crusher Throughput	D/S N/S	▲	●	Crusher	pH	D/S N/S	●	●	SAG Mill	Product Grind	D/S N/S	▼	●	Ball Mill	Product Grind	D/S N/S	●	●	Regrind	
Availability	D/S N/S	▼	●		Aware Utilization	D/S N/S	●	●		Aware Utilization	D/S N/S	●	●		Mass Pull	D/S N/S	▼	●		●
Crusher Product Grind P80 (in)	D/S N/S	●	●		Aware PPC Utilization	D/S N/S	●	●		Aware PPC Utilization	D/S N/S	●	●		Feed % Solids	D/S N/S	▲	●		●
Time at high Power	D/S N/S	▲	●		% Solids	D/S N/S	●	●		Cyclone O/F % Solids	D/S N/S	▼	●		Regrind Utilization	D/S N/S	▼	●		●
CaCl2 Consumption	D/S N/S	●	●	Power	D/S N/S	●	●	Power	D/S N/S	●	●	Feed % Solids	D/S N/S	●	●	46 %	●	●	59 %	
HPGR	D/S N/S	▼	●	Bearing Pressure	D/S N/S	●	●	Bearing Pressure	D/S N/S	●	●	Cyclone Pressure	D/S N/S	●	●	87 %	▲	●	0 %	
				Sound Level	D/S N/S	▲	●	Sound Level	D/S N/S	▲	●									
Water Flow	D/S N/S	▼	●	Gravity	U/F % Solids	D/S N/S	●	●	Grinding Thickener	Tank Levels	D/S N/S	●	●	Leach	U/F % Solids	D/S N/S	●	●	Recovery Thickener	
Operating Pressure	D/S N/S	●	●		Bed Level	D/S N/S	●	●		pH	D/S N/S	●	●		Bed Level	D/S N/S	▲	●		●
Utilization	D/S N/S	▼	●		Torque	D/S N/S	●	●		Dissolved Oxygen	D/S N/S	●	●		Torque	D/S N/S	●	●		●
				Max Torque	D/S N/S	●	●	Max Torque	D/S N/S	●	●	Max Torque	D/S N/S	●	●	20 %	●	●	91 %	
				Flocculant Consumption	D/S N/S	▲	●	Flocculant Consumption	D/S N/S	▲	●	Cyanide Consumption	D/S N/S	▲	●	76 %	●	●	75 %	
CuSO4 Consumption	D/S N/S	▲	●	Cyanide Destruction																
SMBS Consumption	D/S N/S	▲	●																	
Sulfur Consumption	D/S N/S	●	●																	
SO2 Plant Availability	D/S N/S	▼	●																	
CN WAD	D/S N/S	●	●																	
pH	D/S N/S	●	●																	

## Process KPI dashboard



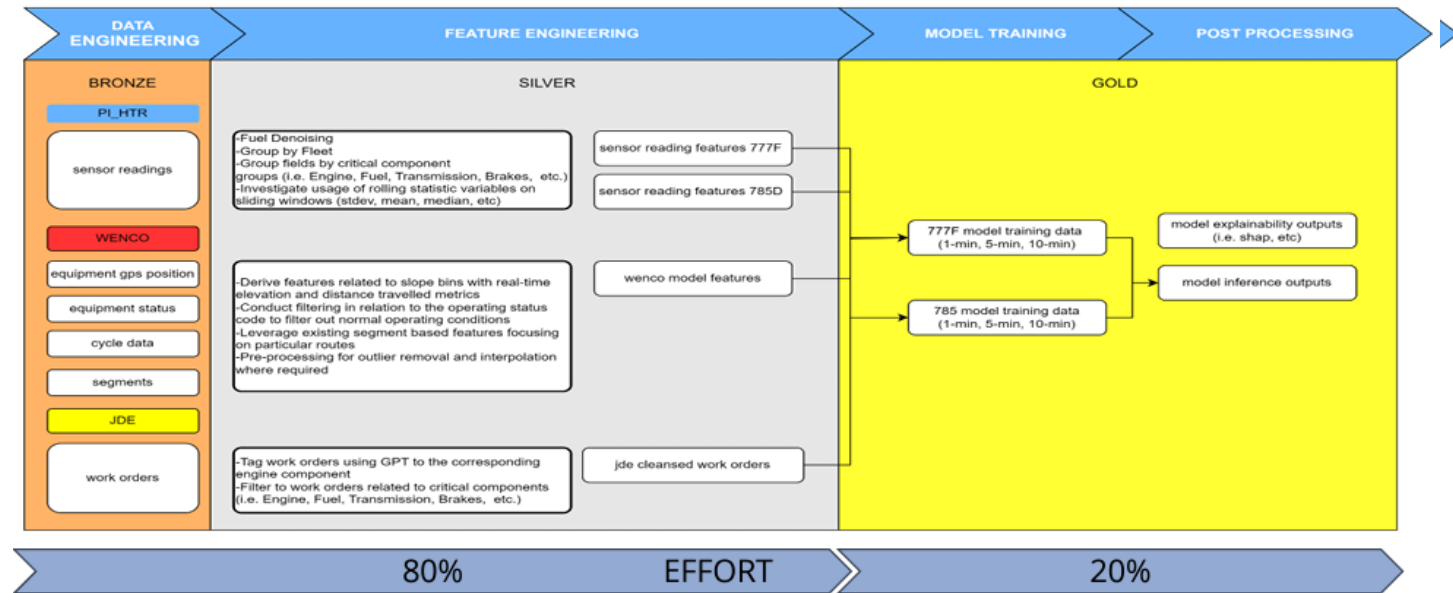


- ***AVEVA and Databricks integration using CONNECT data services will lower the technical knowledge barriers***
- Several ongoing projects would benefit from easier access to time-series equipment and process data:
  - **Paste backfill:** integrate plant batch data with lab results to better manage batch quality through automated reporting
  - **Haul truck analytics:** integrate machine data with logistics and maintenance data to optimize haul routes and asset health
  - **Energy mapping:** Expand visibility of electrical and fuel data for mine sites, sustainability, finance and corporate
  - **Improved BI reporting:** integrate instrumentation data and operational data into common tables for analytics and reporting. Ex: tonnage from trucks and hoists (PI System) combined with mine underground short-term planning systems
  - **Process plant KPI dashboard:** instrument data combined with assay results and operator manual verifications for analytics related to process and asset efficiency

# HAUL TRUCK ANALYTICS OPPORTUNITY

- **The opportunity** - Operational data at one of the Nunavut mine sites has created a mobile fleet analytics opportunity
  - Increase availability of production haul trucks (improve asset health)
  - Reduce energy intensity and CO<sub>2</sub> emissions
  - Optimize route/haul road

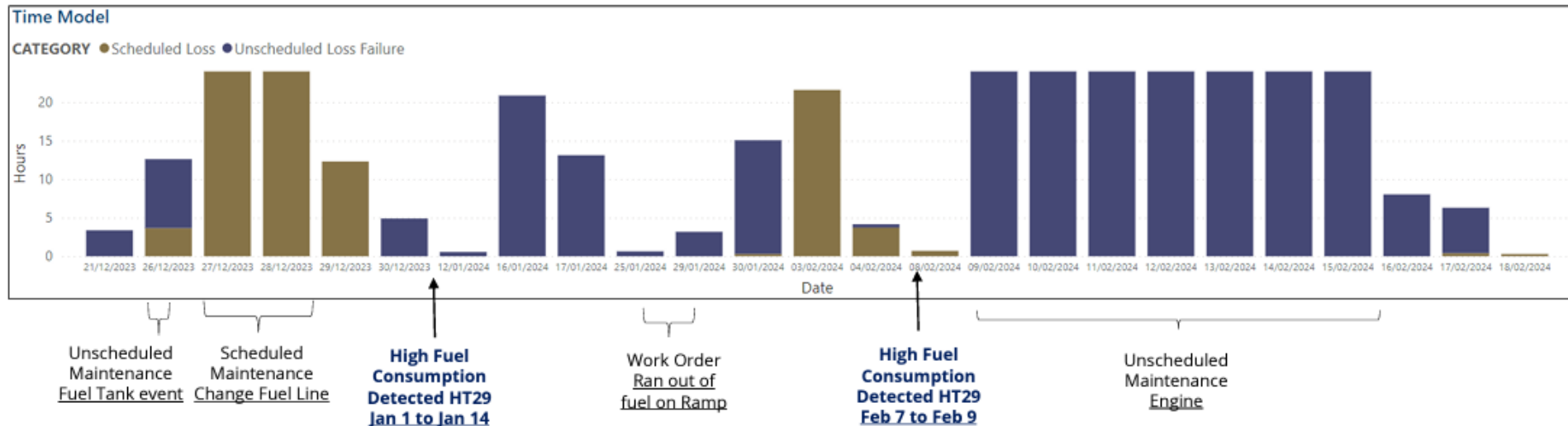
- Two approaches with similar objectives:
  - Vendor solution (site initiative)
  - Data science consulting engagement



- Requires high frequency data from many streams
  - Many API calls and careful optimization before writing to Databricks data warehouse
  - Initial call required 8 - 9 days per month of data & contained gaps
  - Optimized API call: 1 month of data on 28 trucks took 1 – 2 days
  - Data quality is a big challenge

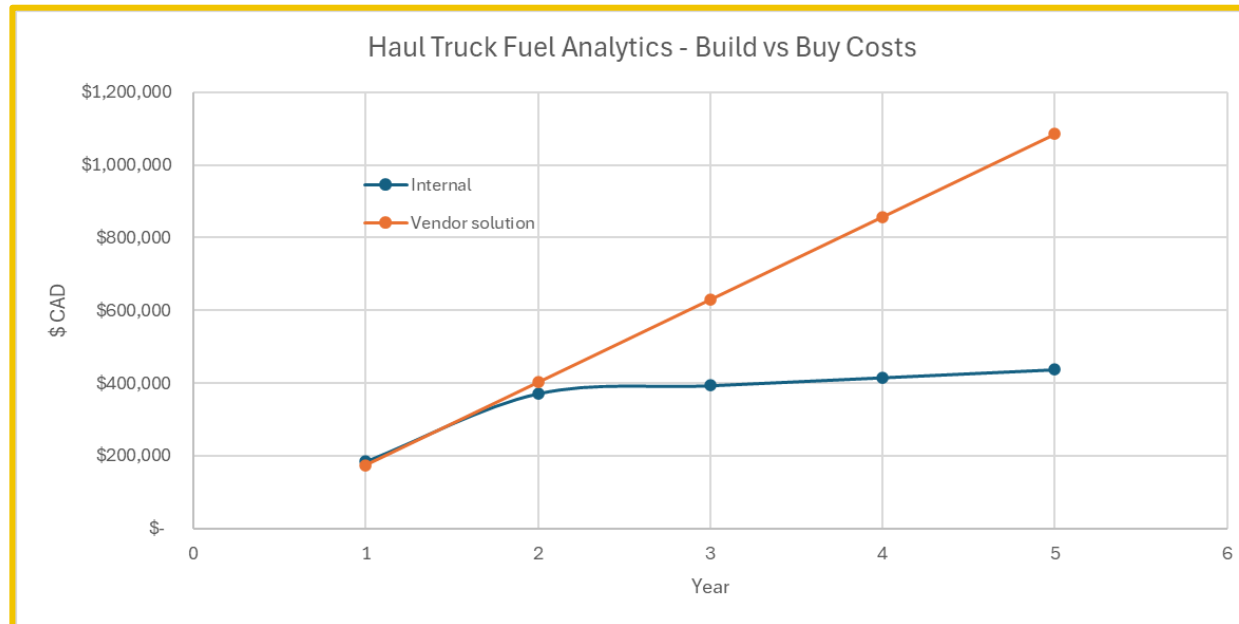
# HAUL TRUCK ANALYTICS IN HOUSE PLATFORM RESULTS

- Exploratory data analysis showed that fuel consumption monitoring can be used for early anomaly detection
- Development of fuel consumption rate Machine Learning (ML) models as proof of concept. Contributing factors:
  - High boost pressure & air filter differential are correlated to high fuel consumption
- Data science enablement partner provided a roadmap to operationalization:
  - Data engineering & architecture updates
  - ML model improvements
  - Deployment and monitoring according to MLOps best practices



# HAUL TRUCK ANALYTICS BUILD VS BUY

- Vendor solution
  - **PROs:** Quick time to value, hands-off approach, facilitates collaboration with maintenance / operations
  - **CONs:** rely on supplier platform / black box, higher costs, 1 dimensional analysis could lead to false conclusions
- Data science enablement firm
  - **PROs:** Development of internal expertise, retain intellectual property, identify additional opportunities, cost scalability
  - **CONs:** Longer time to value, requires additional internal resources





# Lighthouse Program



AGNICO EAGLE



# Integrating CONNECT data services and Databricks should improve haul truck analytics

## Challenge

- Lack of integration between data sets limits the opportunity for haul truck analytics related to asset health, operator performance and lowering emissions
- Secure data integration needs to be easier and faster
- Creating a scalable data infrastructure across OT and IT is an enabler

## Solution

- Deploy an end-to-end solution, from operational data using AVEVA PI System to the cloud via CONNECT data services, efficiently enabling use cases within Databricks.

## Results

- Framework to operationalize solutions involving time series data and other relational data sets
- Internal development of analytical and predictive models that will scale to multiple sites
- Potential for 3% truck efficiency and 1% operator lower costs with improved asset health and lower carbon emissions



“Leveraging CONNECT data services to seamlessly query time series data in the Databricks environment will open the door to many use cases where disparate data sets exist”

*Karl Leetmaa, Metallurgy Subject Matter Expert, Agnico Eagle Mines*

Learn more

AVEVA

## LIGHTHOUSE OBJECTIVES

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Agnico Eagle is participating in a Lighthouse agreement to test an upcoming Databricks integration to:

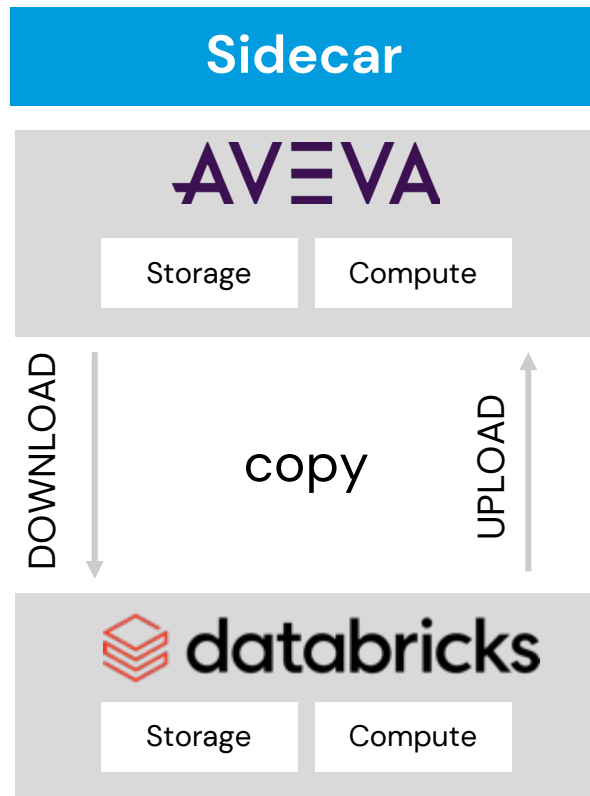
- Improve efficiency with tighter UI and platform integrations
- Enable the ability to preserve metadata (ex: PI System asset framework)
- Create the ability to directly catalog and query PI System data in Unity Catalog
- Improve the speed and reliability of large data transfers between platforms

Current scope for the fuel analytics project is limited to one of the Nunavut sites - with efficiencies gained through the PI System / Databricks integration the analytics can be scaled to other mining operations

This includes sites with separate PI System servers, where CONNECT data services will greatly simplify the onboarding

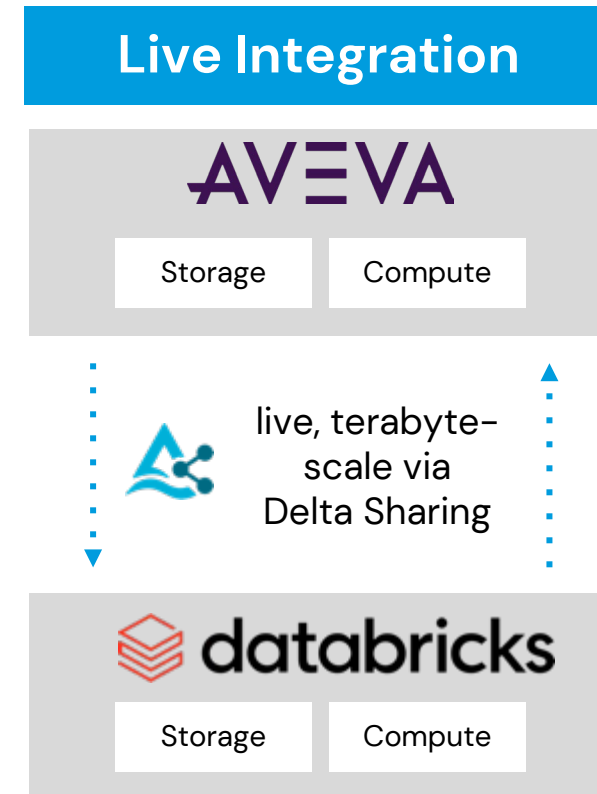
## AVEVA + databricks

Past:



Customers responsible for reliable, performant data ingestion pipelines (or buy 3<sup>rd</sup> party tools that don't scale)

Future:



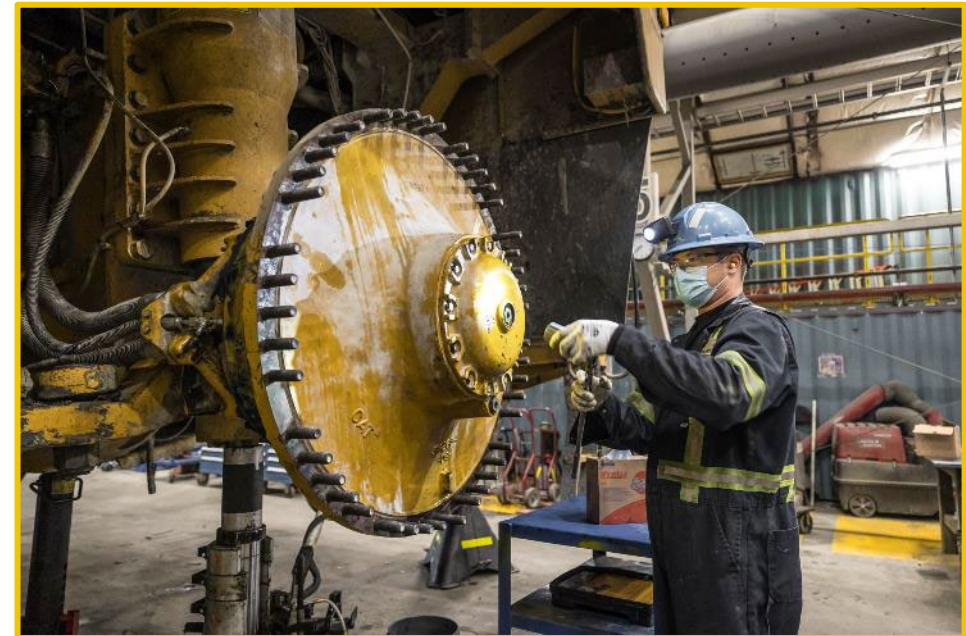
Authoritative, high quality, contextualized live sharing of data between OT and IT environments



# EVOLUTION OF THE LIGHTHOUSE

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- Databricks interoperability was initially not available for testing
- Focus was to optimize the existing data handling scripts
- More than **3x increase** in total transfer speed when compared with the original solution
- Obtaining data from CONNECT data services still requires some manual tasks and project specific optimization



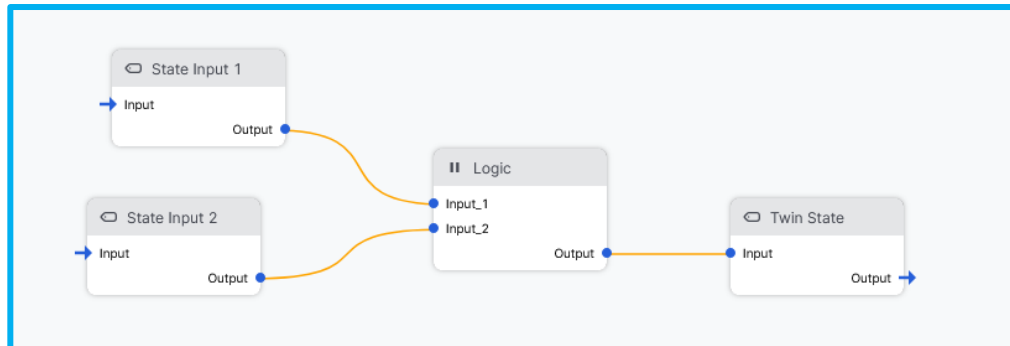
During transfer script optimization, additional AVEVA CONNECT data services products were tested

AVEVA Industrial AI assistant is part of the CONNECT Visualization product

- Simple ‘chat’ style AI assistant to query data services data and events
- Access to on demand analytics and raw data using natural language
- Could be used to find high value but previously unknown data relationships

Testing of the Advanced Analytics platform

- Simple drag and drop low-code interface to create stream-based analytics
- Fast and simple access to machine learning models and associated tools



To determine which assets with the prefix "viz\_62-LRGRI" have the "Dayshift Result" property not between the "Target Minimum" and "Target Maximum" on 13 August 2024, we need to compare the values for each asset.

Asset: [viz\\_62-LRGRI-PPAVAIL](#)

- Dayshift Result: 90.4
- Target Minimum: 94.5
- Target Maximum: 100
- Result: Not between the Target Minimum and Target Maximum

Asset: [viz\\_62-LRGRI-SAGDISPSOL](#)

- Dayshift Result: 82.97
- Target Minimum: 75
- Target Maximum: 100
- Result: Between the Target Minimum and Target Maximum

Asset: [viz\\_62-LRGRI-SAGDPRS](#)

- Dayshift Result: 1312.43
- Target Minimum: 1350
- Target Maximum: 10000
- Result: Not between the Target Minimum and Target Maximum

Based on the provided data, the following assets with the prefix "viz\_62-LRGRI" have the "Dayshift Result" property not between the "Target Minimum" and "Target Maximum" on 13 August 2024:

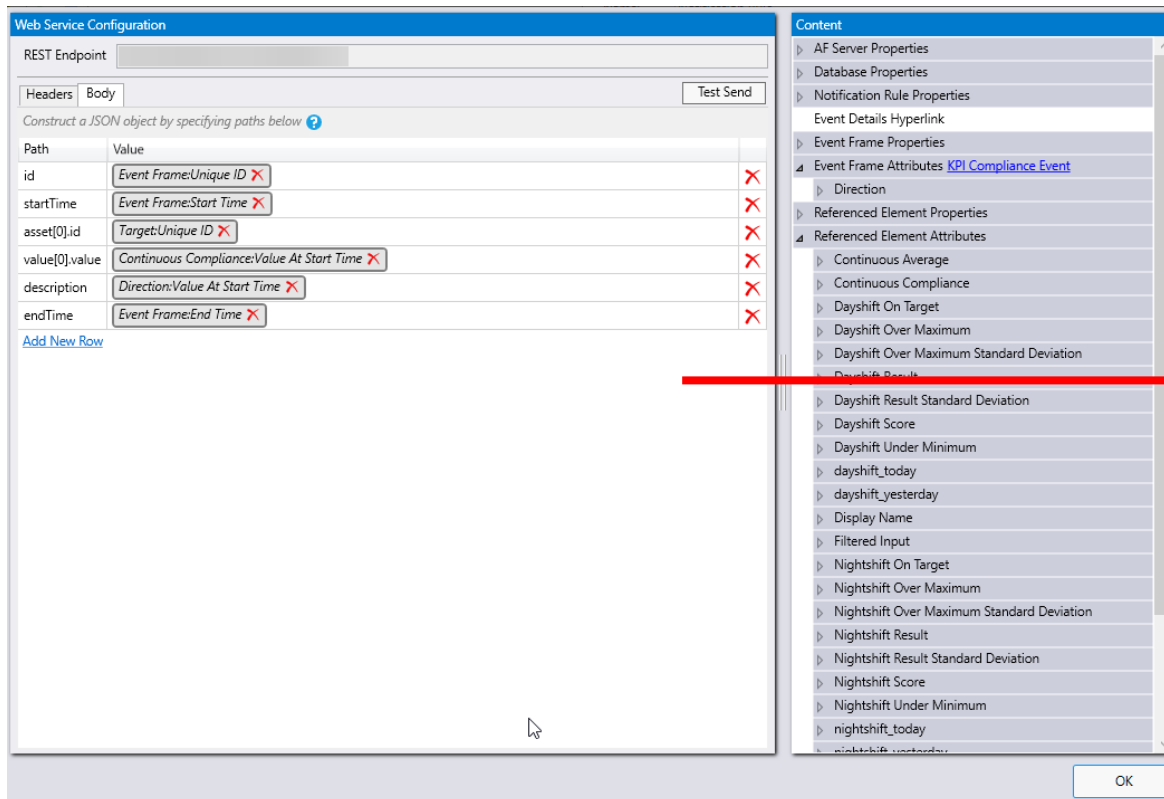
1. [viz\\_62-LRGRI-PPAVAIL](#)
2. [viz\\_62-LRGRI-SAGDPRS](#)

If you need further analysis or additional information, please let me know!

# LIGHTHOUSE – DATAHUB EVENTS PROXY

As part of work with CONNECT data services visualization, discovered a need to send PI System Event Frame data to CONNECT data services.

Created an Azure web application to proxy PI System Asset Framework Event Notification REST API calls to Oauth authenticated calls to the CONNECT data services events endpoint



The screenshot shows the 'Web Service Configuration' dialog box. The 'Body' tab is selected, and a table is used to define a JSON object. The table has two columns: 'Path' and 'Value'. The values are: 'Event Frame:Unique ID', 'Event Frame:Start Time', 'Target:Unique ID', 'Continuous Compliance:Value At Start Time', 'Direction:Value At Start Time', and 'Event Frame:End Time'. A 'Content' tree on the right shows a hierarchy of properties, with 'Event Frame Attributes' expanded to show 'KPI Compliance Event' and 'Referenced Element Attributes'.

Path	Value
id	Event Frame:Unique ID
startTime	Event Frame:Start Time
asset[0].id	Target:Unique ID
value[0].value	Continuous Compliance:Value At Start Time
description	Direction:Value At Start Time
endTime	Event Frame:End Time



The screenshot shows the 'Body' tab of a REST client, displaying a JSON array of event notifications. A red arrow points from the 'KPI Compliance Event' in the 'Content' tree to the first object in the array. The JSON structure includes fields for id, name, description, startTime, endTime, duration, state, asset, value, uom, and createdByUser.

```
1 [
2   {
3     "id": "29277ac0-4ad2-11ef-a30b-00505682c339",
4     "name": null,
5     "description": "",
6     "startTime": "2024-07-24T20:19:00Z",
7     "endTime": "2024-07-25T19:54:00Z",
8     "duration": "23:35:00",
9     "state": "CLOSED",
10    "asset": {
11      "id": "0c3f38f2-c75c-11ee-9996-546cebd4269"
12    },
13    "value": {
14      "value": 1,
15      "uom": {
16        "id": "NONE"
17      }
18    },
19    "createdDate": "2024-07-25T22:06:49.4104409Z",
20    "modifiedDate": "2024-07-25T22:06:49.4104409Z",
21    "createdByUser": "Client|8ad8bf63-3a2a-41f3-8900-3b94f5a3"
22  },
23  {
24    "id": "29277ac2-4ad2-11ef-a30b-00505682c339",
25    "name": null,
26    "description": "",
27    "startTime": "2024-07-25T19:54:00Z",
28    "endTime": "2024-07-25T20:03:00Z",
29    "duration": "00:09:00",
30    "state": "CLOSED",
31    "asset": {
32      "id": "0c3f38f2-c75c-11ee-9996-546cebd4269"
33    },
34    "value": {
35      "value": 0,
36      "uom": {
37        "id": "NONE"
38      }
39    },
40    "createdDate": "2024-07-25T22:06:51.3985871Z",
41    "modifiedDate": "2024-07-25T22:06:51.3985871Z",
42    "createdByUser": "Client|8ad8bf63-3a2a-41f3-8900-3b94f5a3"
43  }
44 ]
```



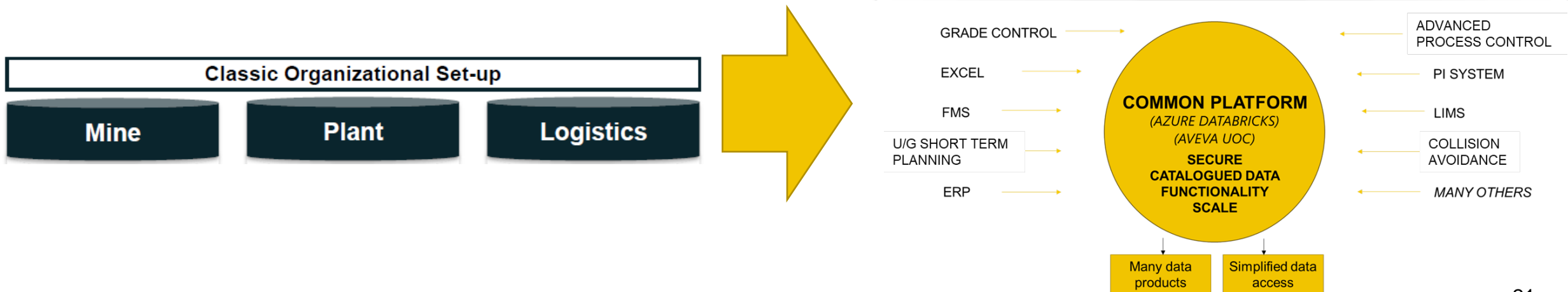
# Integrated Operations Center





# INTEGRATED OPERATIONS CENTER (IOC) CONCEPT

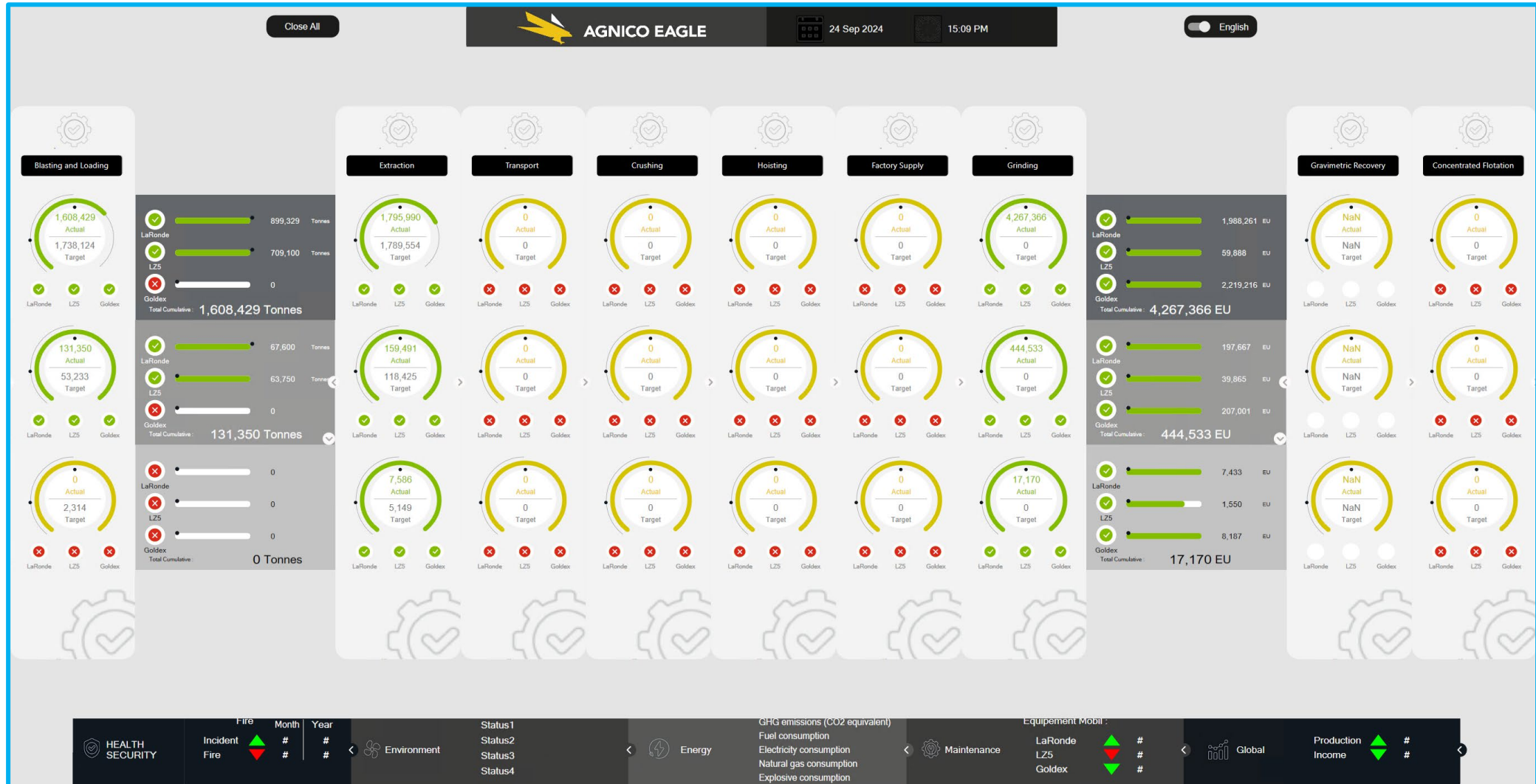
- Optimization tool to move away from operational silos and towards an integrated organization
- Based on the mining value chain: planning, development, drill & blast, mucking & hauling, blend management, processing
- Abitibi IOC will allow departments to **react faster** and **be more proactive**, while increasing **employee satisfaction** and acting as a **knowledge hub**
- The IOC is powered by AVEVA and Databricks



# UNIFIED OPERATIONS CENTER VISUALIZATION DEVELOPMENT



- AVEVA Unified Operations Center proof of concept visualization



# Conclusions





# CONCLUSIONS

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- The Digital Transformation team has been developing the strategies and tools for the company since 2022
- Several ongoing digitalization initiatives have revealed areas for improvement: data quality & accessibility
- CONNECT data services allows easy integration of AVEVA PI System data into the Databricks environment to facilitate advanced analytics
- **Next steps:**
  - Implement data quality monitoring program on time series data – use AVEVA PI System templates
  - Incorporate the new functionality of CONNECT data services to improve access to time series data
  - Haul truck fuel model improvements and operationalization
- **Acknowledgements:**
  - Agnico Eagle Mines
  - AVEVA





# AGNICO EAGLE

## Questions?

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