PI System as the foundation of Data Science platform for optimising mining processes

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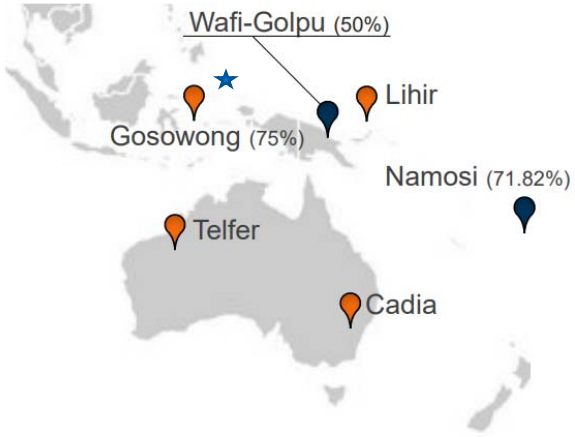
AGENDA

- About Newcrest Mining
- Evolution of our Data Science platform
- Architecture overview and the role of PI System
- Use Case - Crushed Ore Bin Level Soft-Sensor
  - Overview
  - Model at work
  - Performance monitoring
  - Business KPIs
- Summary
- Q & A

Newcrest Mining at a glance

Overview
One of the world's largest gold producers
Portfolio of operating mines across 3 countries
Production of 2.49 million ounces of gold for the year ended June 2019
Strong pipeline of growth assets and exploration projects



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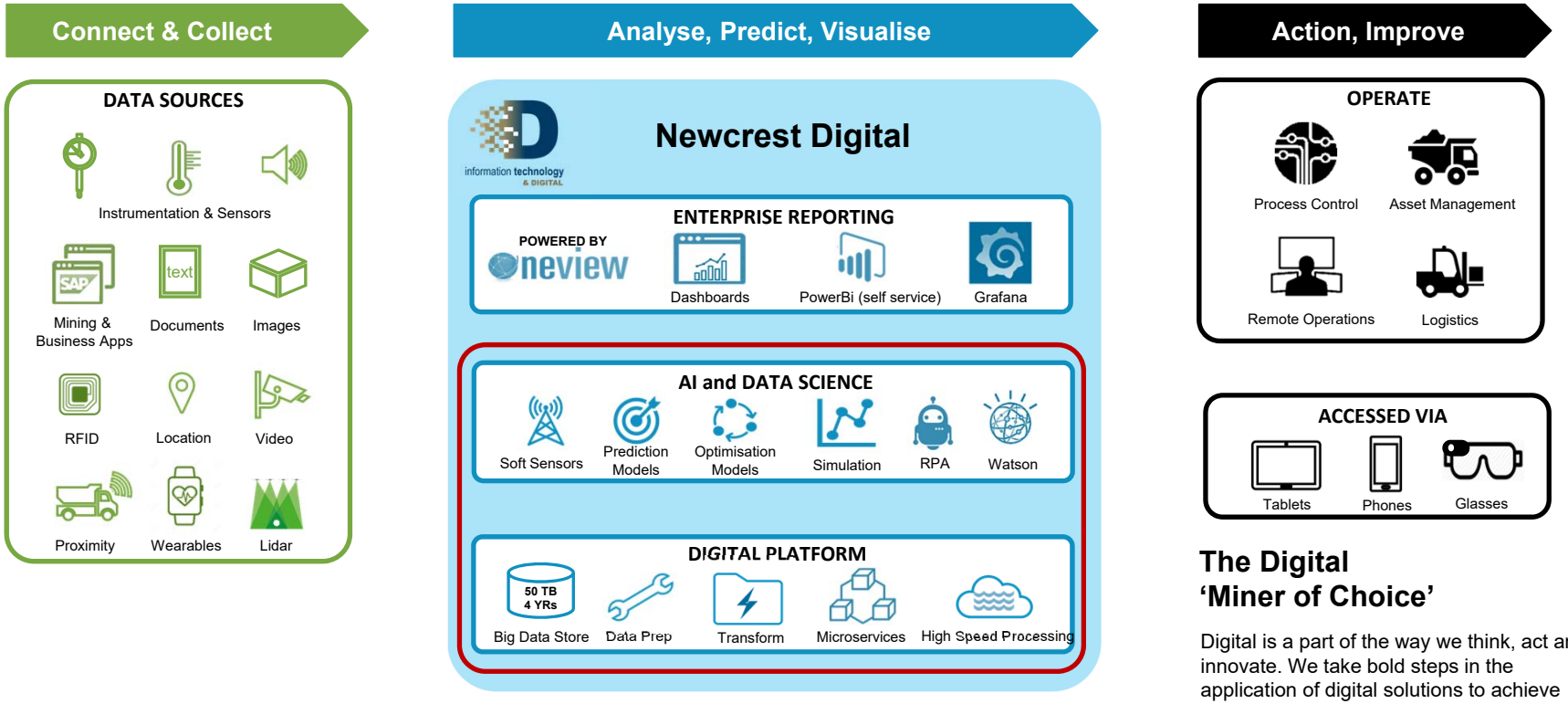
The Digital Value Stream



The Digital 'Miner of Choice'

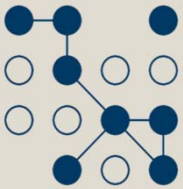
Digital is a part of the way we think, act and innovate. We take bold steps in the application of digital solutions to achieve our 2020 world class aspirations.

Digital applications

Digital at Newcrest - improving safety, increasing production and lowering costs

People productivity

Digitalising operating practices to enhance the execution of current tasks. Reduce boots on the ground for a safer environment



Data-driven insights

Applying advanced analytic techniques (big data, data mining, statistical analysis) to understand and make better or faster decisions

Automation and process control

Automating decisions, processes, or assets to increase consistency in production & safety processes

Data reliability and resilience

Centralising information and improving sensor reliability and data integrity

Value Creation

Enabler

Data Science Platform at inception

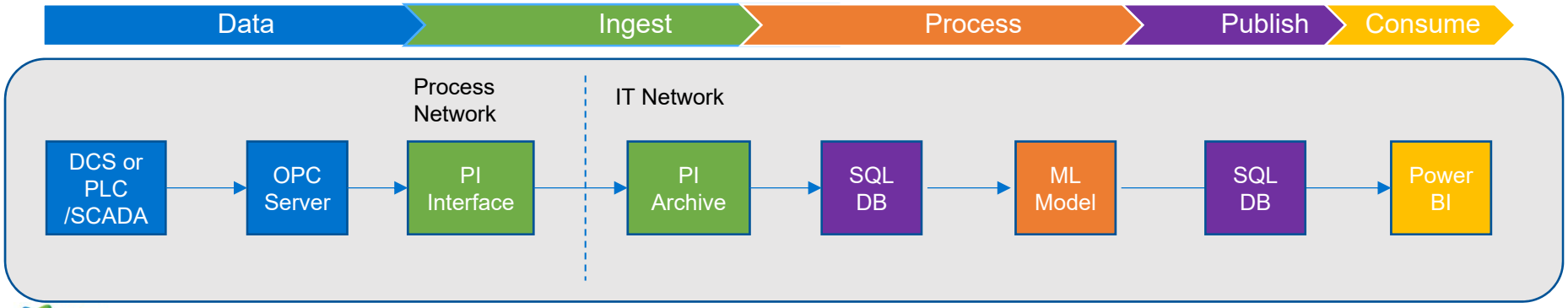
Types of models:

- Batch models (running every > 2 mins)
- Model outputs used to inform the operator decision

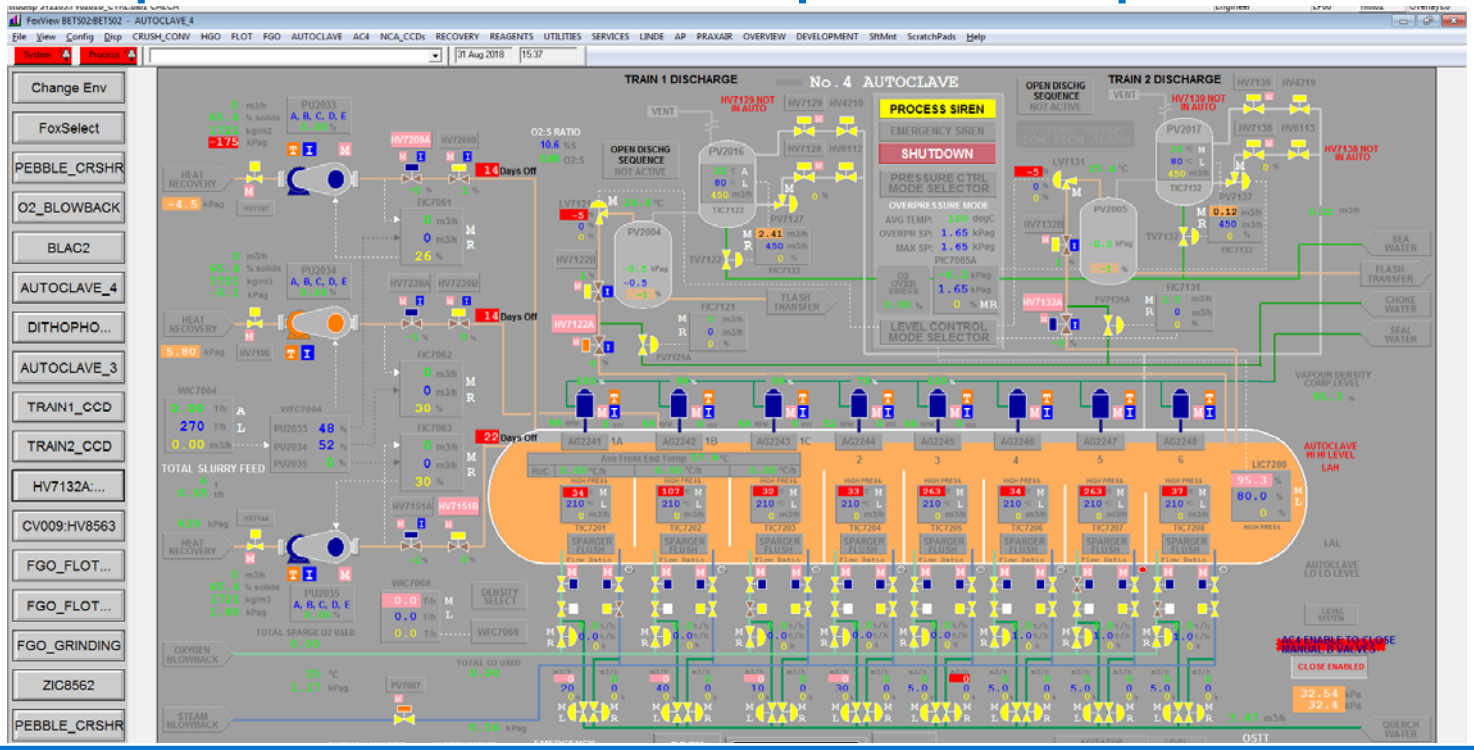
Challenges:

- Data from the PI System replicated into SQL using OLEDB – slow batched data ingestion
- Model orchestration done using SSIS with input data from SQL, not reliable enough for running production critical models
- Models built as one complex module, hard to troubleshoot and maintain

Example: Autoclave temperature prediction model

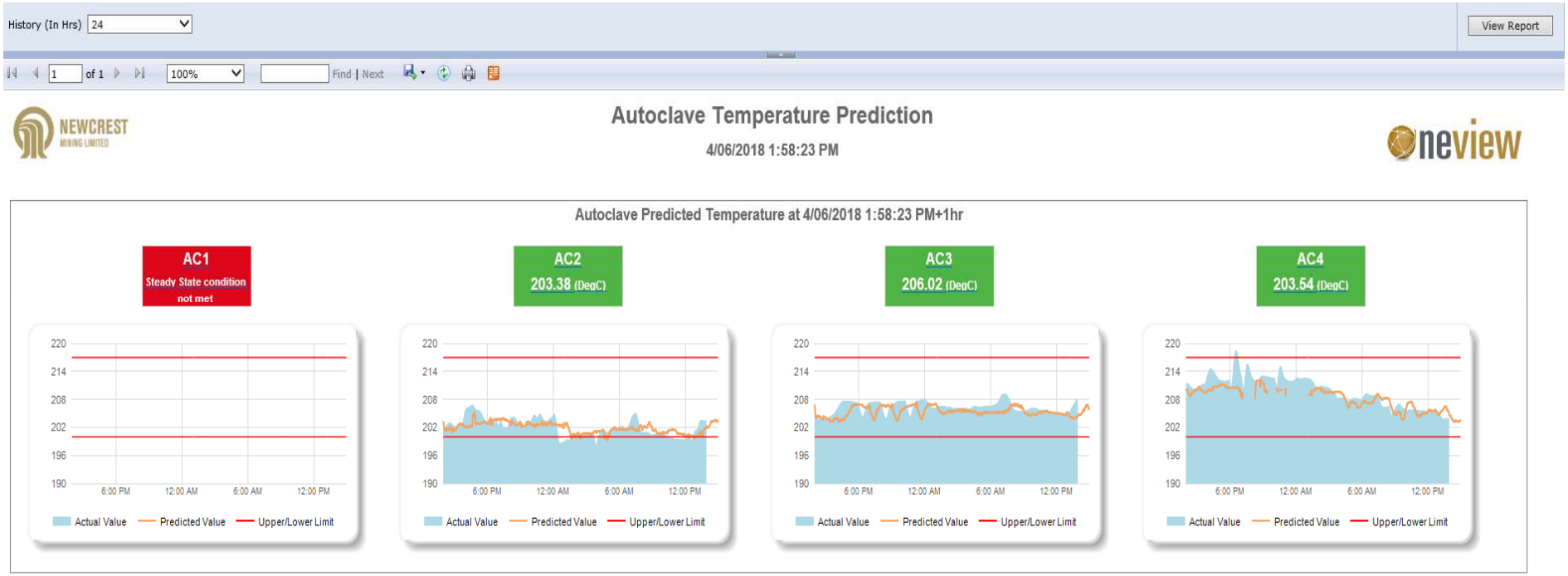


Example -Autoclave temperature prediction



Throughput through the POX circuit is most frequently constrained by the low autoclave front end temperature. Below a Front end Temperature (Compartment 1A) threshold, the oxidation reaction ceases to be autothermal, resulting in the autoclave to be stopped and reheated to a temperature to allow the reaction to restart - this can take up to 7 hours of unproductive time.

Example -Autoclave temperature prediction



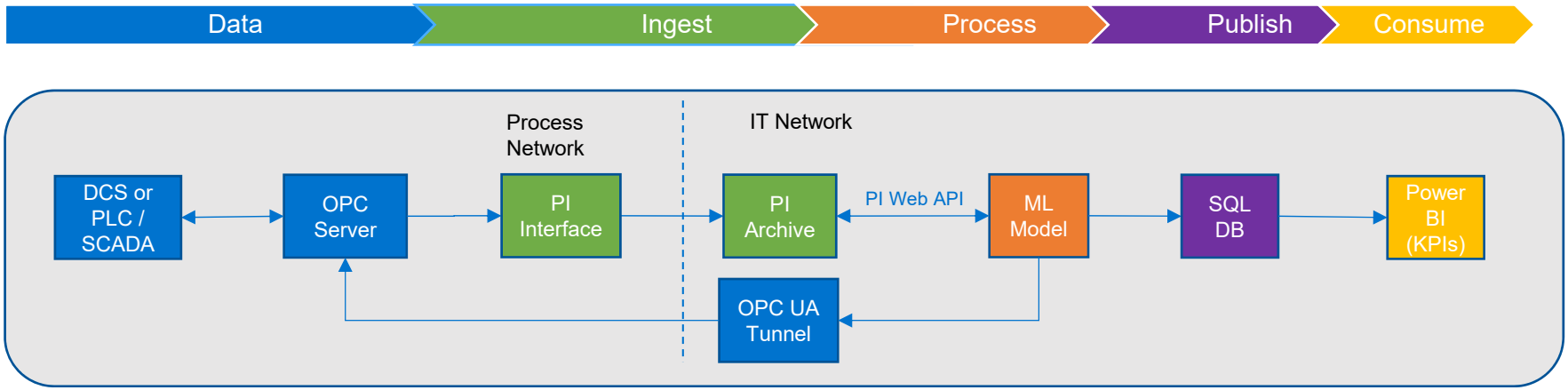
This solution monitors likelihood of temperature excursions in both directions, which increases our ability to prevent unplanned downtime events. Visual trends are displayed on an existing screen in the control centre, as a tool complementing DCS and PI process book displays.

Data Science Platform Evolution

New model requirements:

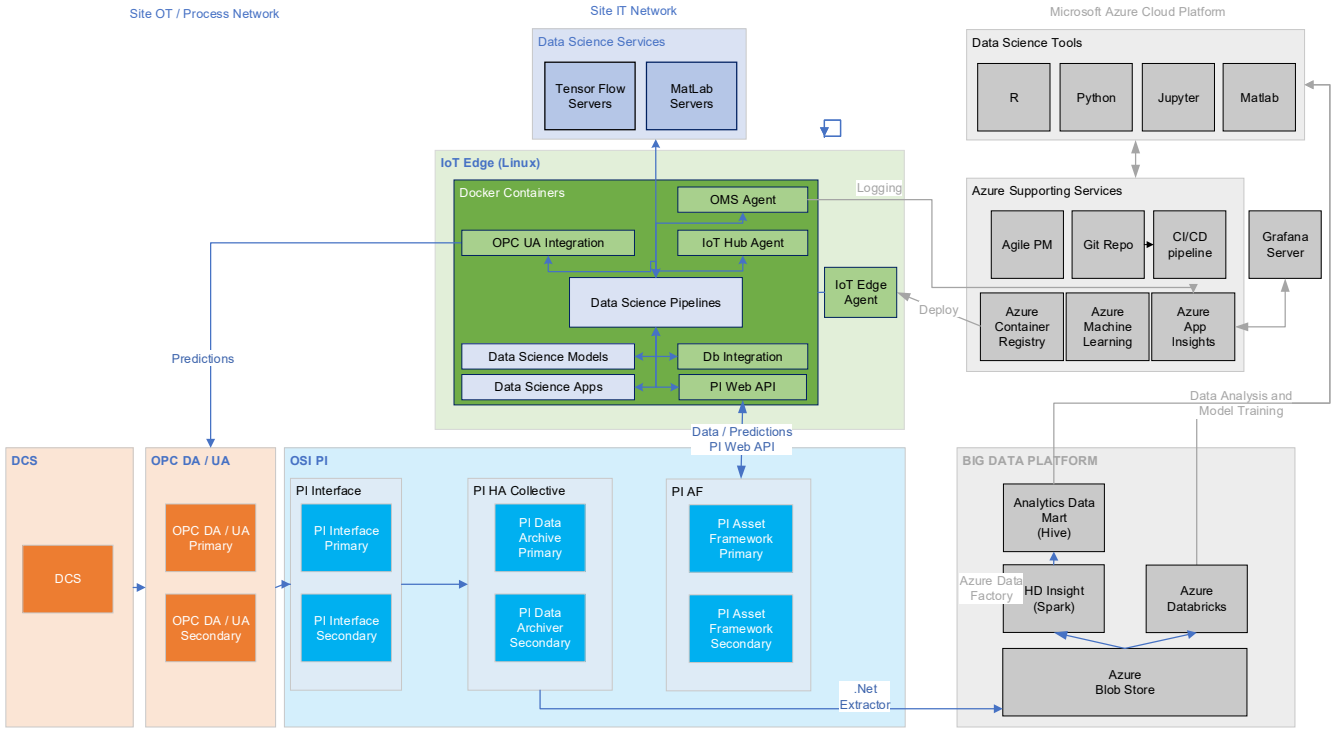
- Tighter integration of models with OT systems making the models business critical (outputs used within process control strategy)
- Near real-time data needed
- Increased numbers of new models in development and support

Example: Crushed Ore Bin Level Soft-Sensor



Edge to cloud architecture

- **PI Web Integrator** module creates data pipeline calls from the PI System using Web API
- **Inference Pipeline Controller** module translates the data pipeline from Web API module format to JSON format required by the Matlab model
- **ML Model** runs are orchestrated by the Inference Pipeline Controller
- **IoT Edge Hub** provides services for managing deployment, pipeline, configuration and module life-cycle
- **SQL Integrator** module performs writes into Data Science Datawarehouse SQL database for logging and reporting on model performance
- **OPC UA Integrator** module performs writes to OPC Server via OPC UA tunneller



Use Case - Crushed Ore Bin soft-sensor

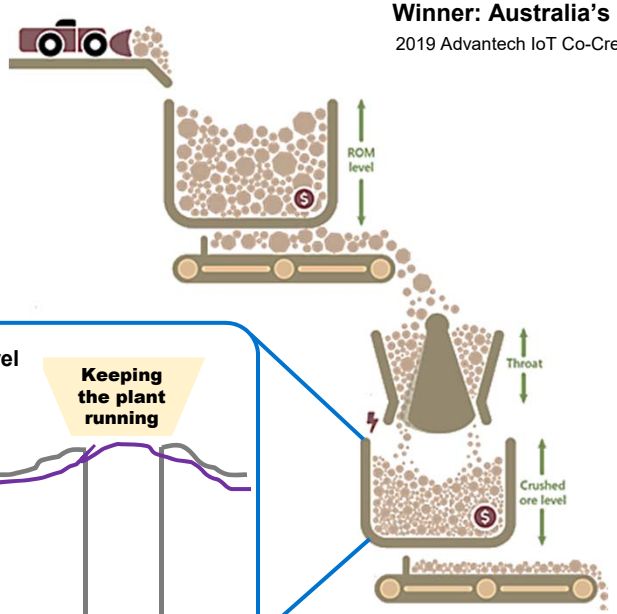
Winner: Australia's Best Primary Industry IoT Project
2019 Advantech IoT Co-Creation partner conference

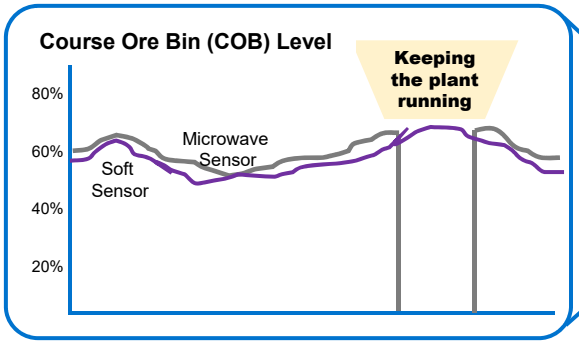
PROBLEM

- Cadia: Microwave Sensors in underground crushers monitor level of material in bins and are regularly damaged resulting in unplanned downtime

SOLUTION

- Virtual sensors "Soft Sensor" run in parallel to actual sensors and predict levels of bins when real sensors are damaged
- This allows the operation to continue until sensors are replaced during scheduled maintenance



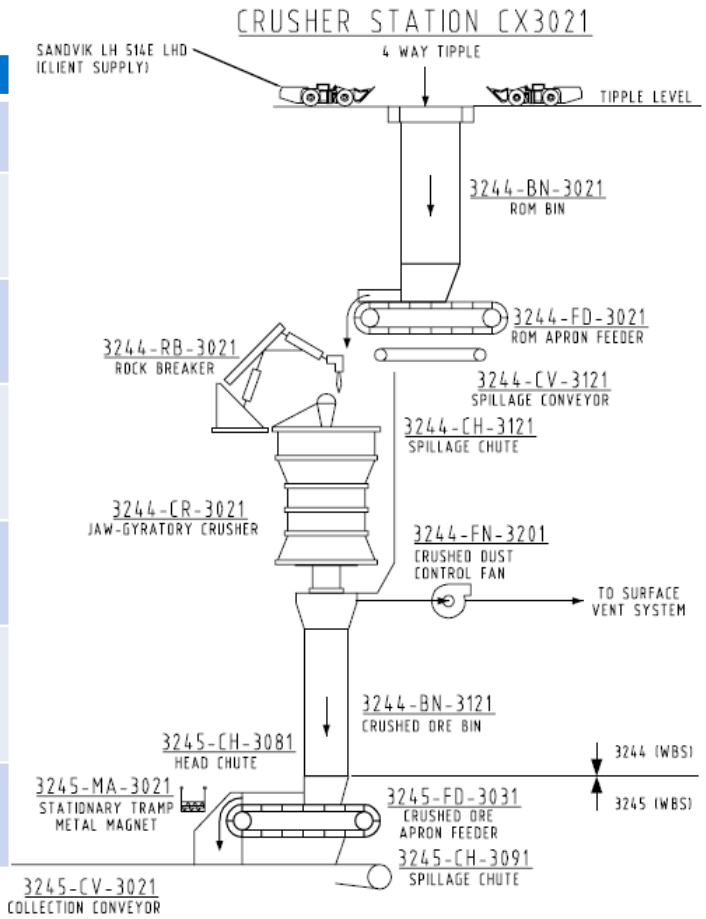


BENEFITS

- Targeting to reduce crusher unplanned outages by 50% using the soft sensor to run the circuit for up to 4 hours

Model inputs

Element	Function
ROM Bin	Provides buffering of uneven input of ROM ore from the extraction operation.
ROM Apron Feeder	Provides a constant flow of ROM ore to the Jaw-gyratory Crusher, allowing it to operate under optimal conditions.
Jaw-gyratory Crusher	Reduces the size of the ore to what is suitable for belt conveying.
Crushed Ore Bin	Provides a buffer to allow for uneven throughput of the Jaw gyratory Crusher and to allow the crusher to empty under downstream fault conditions.
COB Apron Feeder	Ensures a uniform feed to the collection conveyor.
Collection Conveyor	Transports the ore from the crushing station to the lateral conveyor and provides a suitable ore flow profile for the removal of tramp iron.
Belt Weigher	Each collection conveyor will include a belt weigher to monitor the throughput rate of CO.

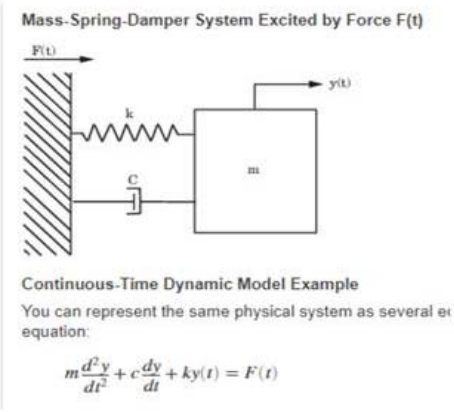


Crusher Station

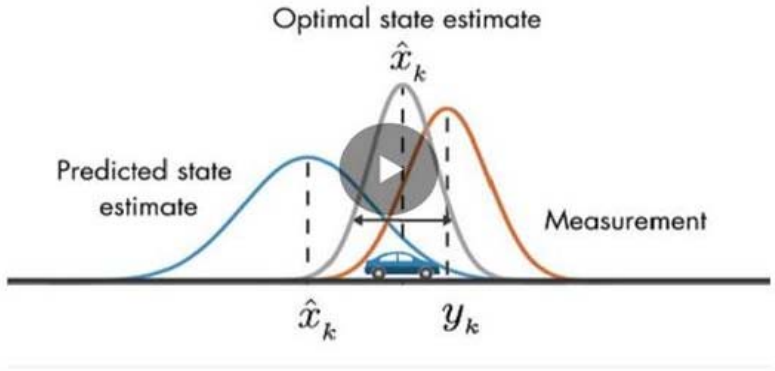
Data Science team at the bottom of COB

Inside the model

Time-Series Model
System Identification

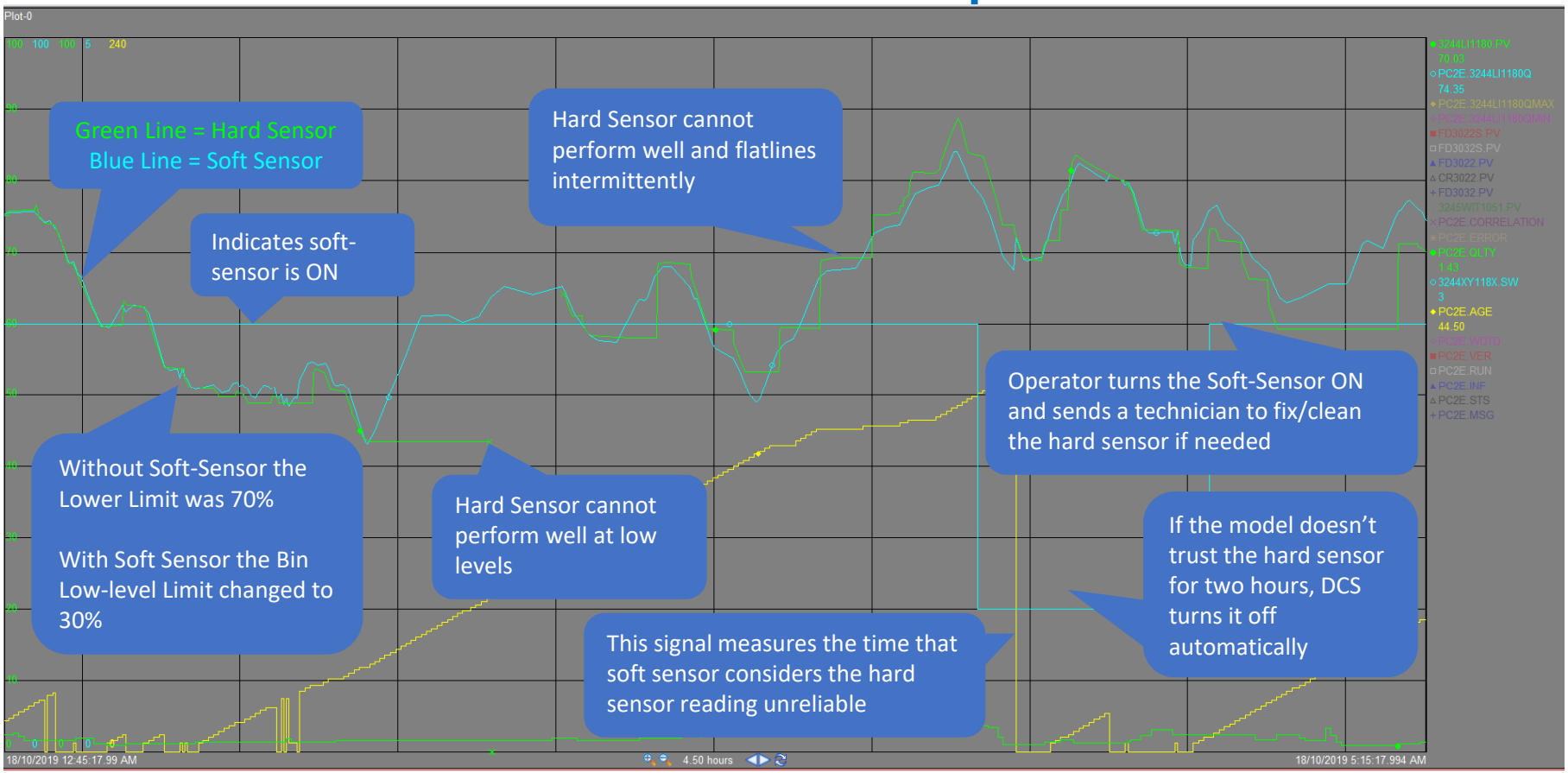


Combine Model and Actual Sensor Values
Kalman Filter



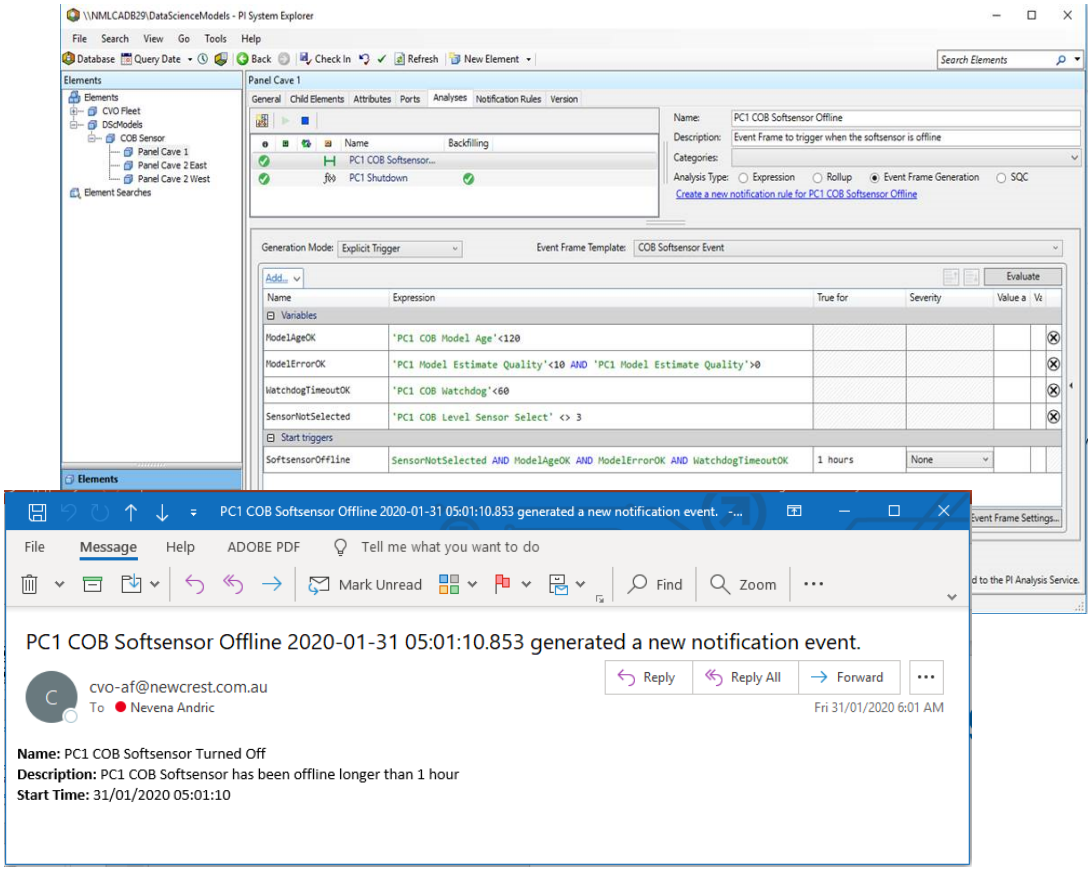
The predicted ore level is used to control the flow of ore to the crusher, keeping the ore moving at an optimal level of productivity and preventing the bins from depleting or over filling.

A few hours of soft-sensor operation

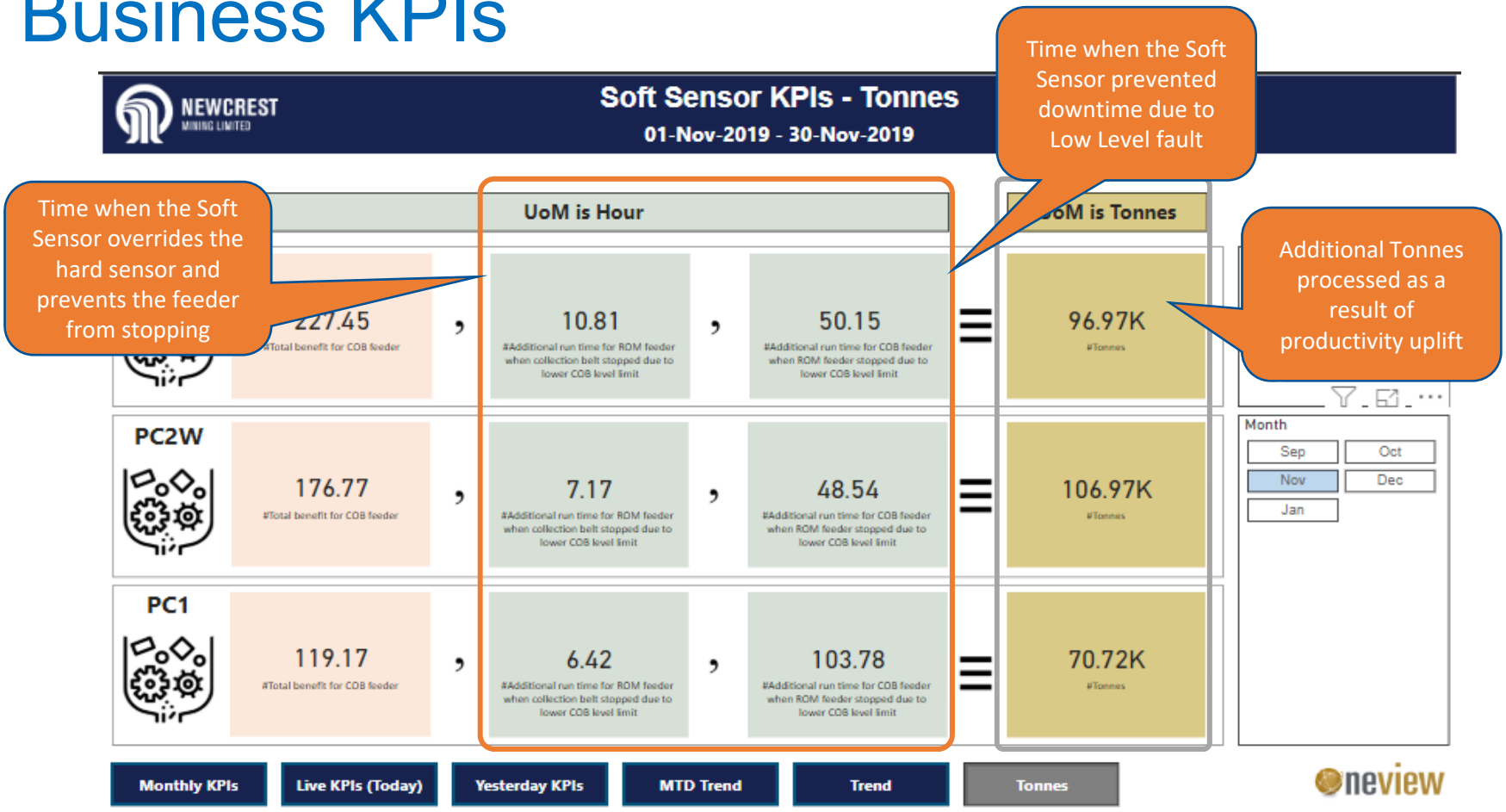


PI AF in monitoring model usage / performance

- COB Level prediction is dependent to the crusher state and ore characteristics so the model includes accuracy measure
- PI AF is used to monitor the accuracy of the model and send notifications to support when the model is offline
- Model accuracy along with input data drift over time is used to trigger re-training of the model



Business KPIs



Summary

NEWCREST MINING LIMITED

CHALLENGES

- ~ 80 hours of downtime due to COB level sensor failure
- Inefficient ingestion of data limiting model run frequency
- Dependency on SSIS with multiple single points of failure

SOLUTION

- PI Web API and PI HA Collective for fast and scalable data ingestion
- Microservices architecture for scalable platform
- PI AF for easy monitoring and alerting on model performance

BENEFITS

- Increased throughput by ~ 650k tonnes in the first 6 months
- Decreased crushing circuit downtime by > 50%
- Trust established between Site and IT teams enables faster delivery

"“We can now continuously operate the COB, run of mine (ROM) and loaders, even in the event of a COB level sensor failure. This helps ensure the conveyors are at full capacity and don’t stop operating unnecessarily, leading to increased production,” Peter Sharpe, Cadia GM"

Speaker

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