



Predicta

Agenda

- Project Objective
- Solution Requirements
- Solution Approach
- Milestones
- Tools & Techniques
- Current Status
- Risks and Challenges
- Demo
- Team Introduction

Mining Site



Mining Site



**Electric Shovels 85 ton/pass
320 ton capacity**



Rio Tinto Operations Centre



Rio Tinto Operations Centre

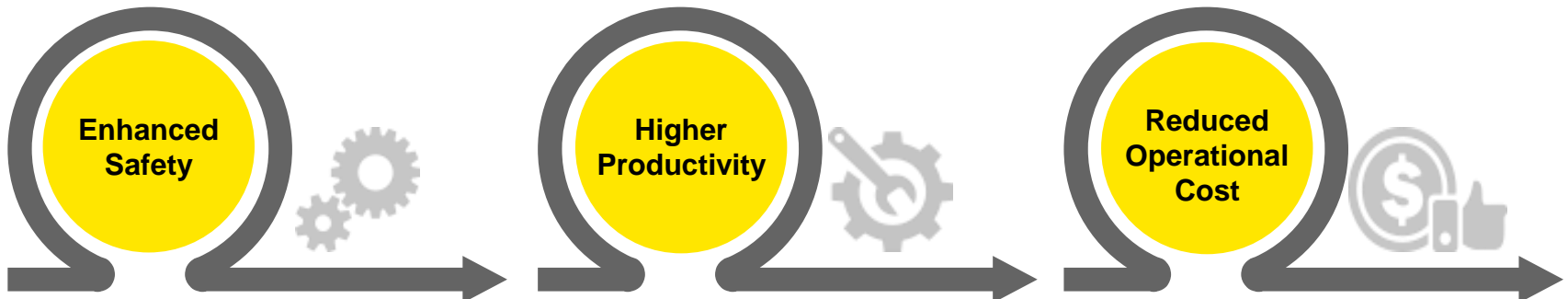


Project Objective

What is Predicta?

- Predictive Analytics solution for Heavy Equipment.
- Processes data acquired from multiple data sources.
- Issues advanced failure warnings and determines Remaining Useful Life.
- Generates automated diagnostics

Business Benefits



Solution Requirements

- ☐ Asset agnostic framework with configurable rule engine.
- ☐ Provide failure notifications 4+ weeks in advance.
- ☐ Reduce number of generated alarms as compared to OEM systems.
- ☐ Process large amount of data from multiple assets.

Solution Approach

Input data

- QSK60, QSK 78 engine data
- Oil analysis reports from lab
- Electrical Shovel Data from KUC site
- Cyclone Feed Pump data.
- Dispatch data.

Preliminary data analysis

- Box plot analysis
- Normal distribution analysis
- Missing data identification and interpolation
- Bad data identification and data cleaning

Pre Processing

- Derived value calculation
- Data preparation.

Predicta Process Flow – Advisory Generation

Modeling

- Fault classification
- Feature extraction
- Symmetry based modelling
- Data smoothing and change point detection

Business rule

- Data pattern matching with pre defined business rule.
- Identify diagnostic details
- Identify recommendation.
- Assess health status as risk score.

Generate advisory

- Map identified pattern with component.
- Generate advisory.

Milestones



Haul Truck Engine

- Predicting failures for QSK 60, QSK 78 engine components of haul fleet
- Significant reduction in events that need to be monitored by Asset Health Evaluators (End users)
- Zero events missed so far on the monitored components



Slurry Feed Pump

- Estimating impeller wear and remaining useful life
- Completed successfully for KUC feed pumps
- Extending to OT site.



Electrical Shovel

- Predicting Swing, Crowd, and Hoist Motor, Brake system, Gear case, Bearing and Electrical Transformers.
- Planned to extend to across sites.

Value creation through innovation, productivity and partnership

Greg Lilleyman, group executive, Technology & Innovation
Austmine 2015, Brisbane

19 May 2015

We also have our new Analytics Excellence Centre (AEC) in Pune, India. The team uses Big Data and small data, mathematics, machine learning and advanced modelling.

Internally, the AEC team likes to talk of "predictive asset health solutions."

Externally, we just say they seek to "identify problems before they occur."

For example 'data scientists' assess massive volumes of data captured by the array of sensors attached to Rio Tinto's fixed and mobile equipment. This enables our team to predict and prevent engine breakdowns and other downtime events, significantly boosting productivity and safety.

These initiatives are not just R&D experiments, they are proven, happening now, and delivering productivity gains that we embed in our business.

Innovation in Mining – a template for Australian Industry

Greg Lilleyman, group executive, Technology & Innovation
Brisbane Mining Club, Brisbane

26 April 2016

In other areas data is harvested and information extracted and applied in different ways. A brilliant application is our Predictive Asset Health system where large quantities of equipment data is captured, cleaned up and then processed using a set of rules developed through machine learning and advanced analytics.

This enables us to quantify the risk of impending failure based on complex relationships between many parameters. Already, this has allowed us to extend the life of a haul truck engine from 25,000 hours to 30,000.

RTCA Strut Advisories

From: Hennessy, Jake (RTCA)
Sent: Thursday, February 09, 2017 3:49 AM
To: Hingmire, Avinash (G&I)
Cc: Turk, Michael (G&I); Raghvendra Singh (RTIC)
Subject: RE: Please add users to RTCA Predicta user group.

Thanks Avinash,

The AHC's are very pleased with the strut advisories.

Sincerest Regards,
Jake Hennessy

Rio Tinto Coal Australia – Asset Health Officer – RTCA Integrated Operations Centre
Mobile: +61 (0)42 979 9000
Email: Jake.Hennessy@riotinto.com

Kennecott Weekly Advisory Report - Cyclone Feed Pumps

From: Mason, Jacob (RTKC) [<mailto:Jacob.Mason@riotinto.com>]
Sent: Monday, September 26, 2016 7:40 AM
To: Patil, Makarand (TI-IGATETECHNOLOGIESINC); Janson, Alan (RTKC); Kesler, Tyson (RTKC)
Cc: Saha, Bipul (TI-IGATETECHNOLOGIESINC)
Subject: RE: Kennecott Weekly Advisory Report - Cyclone Feed Pumps

Bipul,

Last week we replaced the impeller and liner in CP04. I entered this into Predicta. What is interesting is that Predicta was able to successfully tell us CP04 was in bad health, yet our indicators here did not show that. This is a good indicator for the Predicta Model.

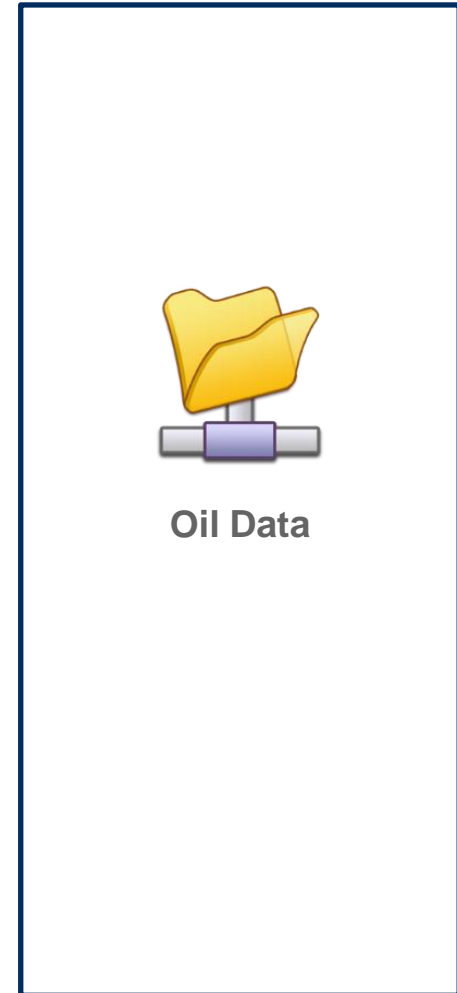
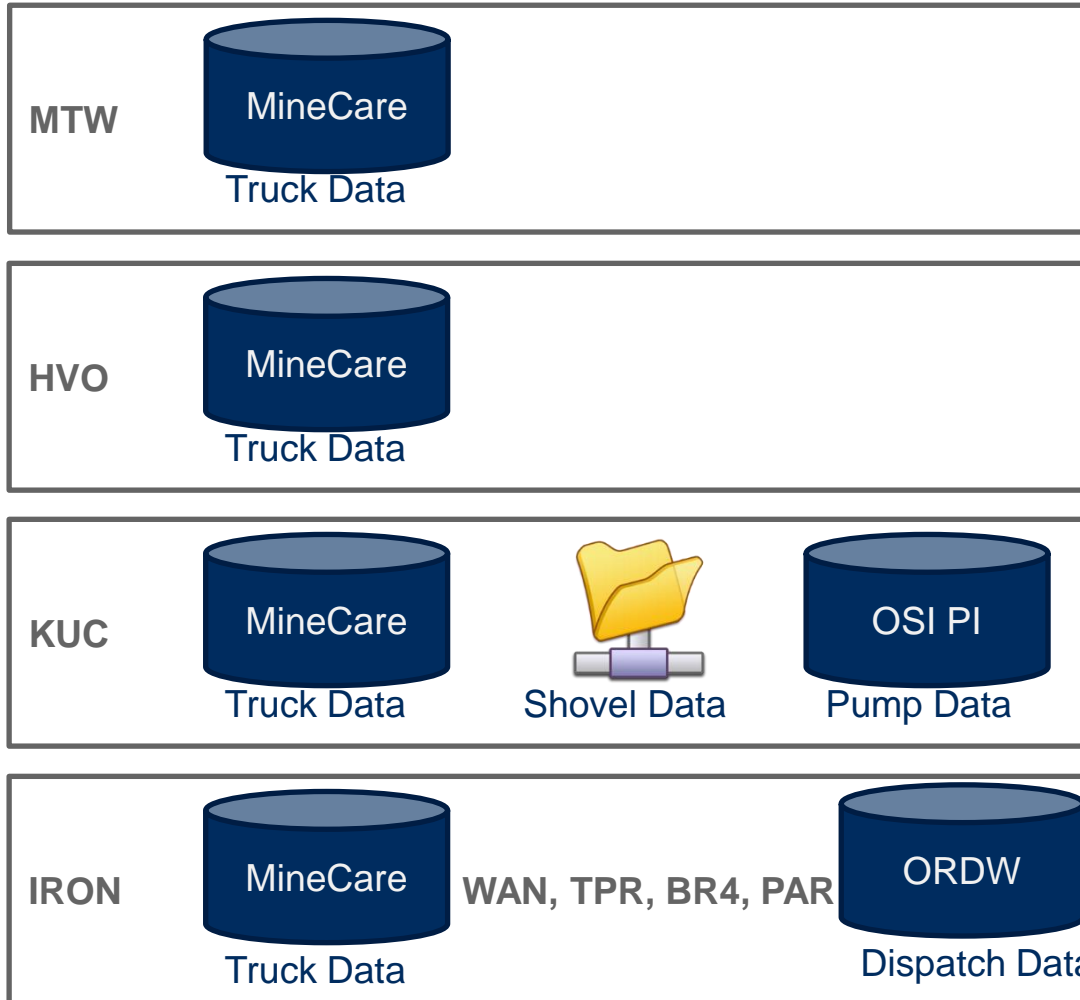
Jacob

Assets with Predicta



Site	Trucks	Pump	Shovel
Brockman 4	28		
Hunter Valley Operations	81		
Kennecott Utah Copper	83	9	3
Mount Thorley Warkworth Operations	46		
Paraburdoo	12		
Tom Price	17		
West Angelas	23		
Total	290	9	3

Data Sources



Tools & Techniques

❑ User Interface :

- Framework: Play Framework 1.2.5
- Technologies : HTML5, JavaScript, CSS, jQuery, JavaBean, Java 1.7
- Database : SQL Server 2008 R2
- Charts:- Highstock graph.

❑ Data Processing :

- MapReduce 2.4
- Sqoop
- Oozie

❑ AWS Cloud :

- EMR – Elastic Map Reduce
- S3
- AWS CLI

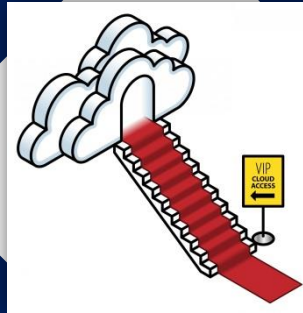
Predicta - Designed for Cloud

Sticking to Core Hadoop

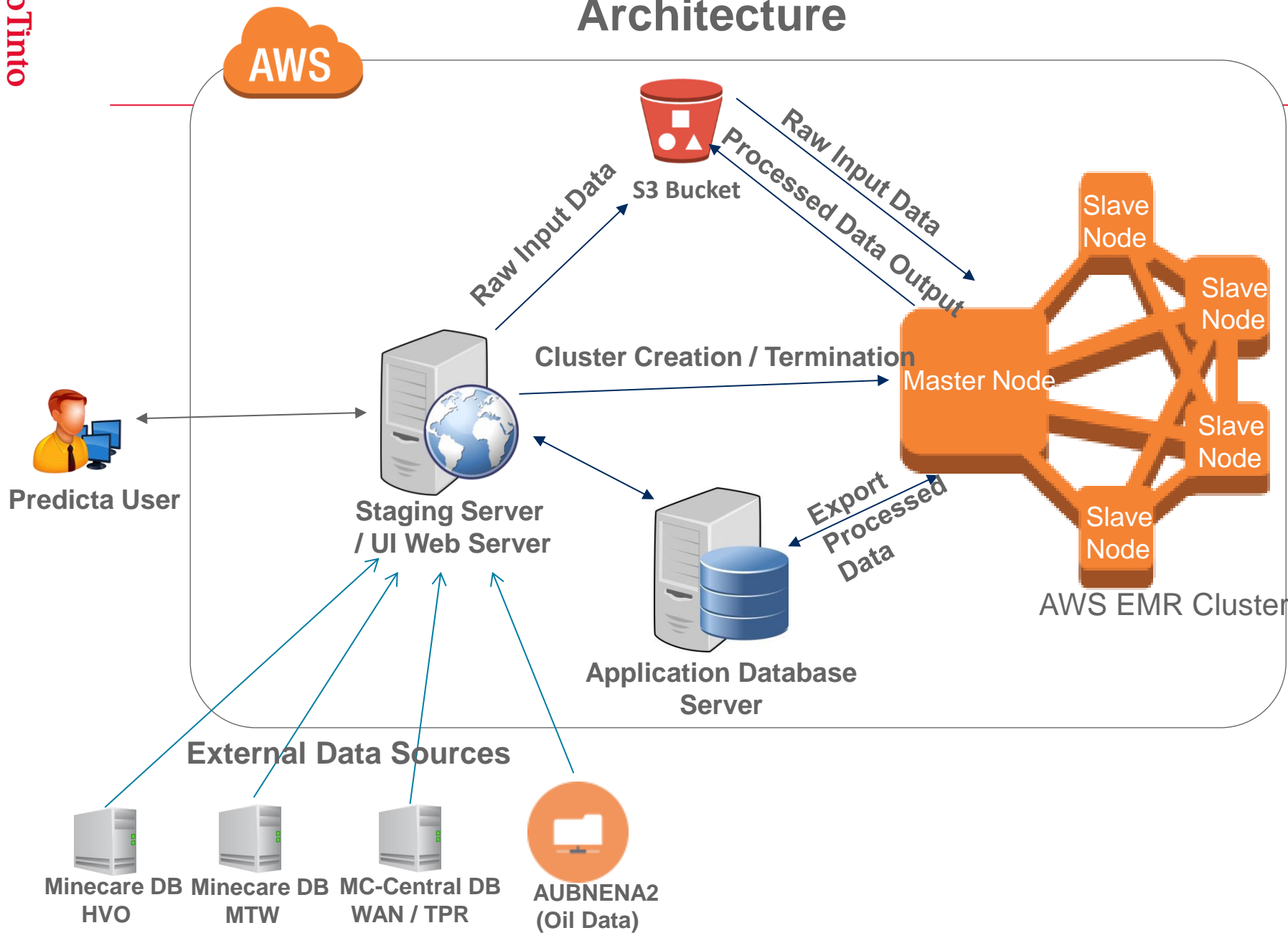
Predicta was designed using standard open source components without any vendor specific tool dependency.

MapReduce as Analytical Engine

MapReduce can access data directly from S3, this eliminated costly re-work when Predicta moved to cloud.



Architecture



Work In Progress

- ❑ Dispatch Data integration.
 - Use dispatch information to generate advisories.

- ❑ Suspension system advisories for RTIO.
 - Detect faults in Front or Rear suspension.

- ❑ Self Learning Module.
 - Automatically change the alarm limits based on historical data.

- ❑ Email Functionality.
 - Send email for the new faults detected.

- ❑ New Site Integration.
 - Adding multiples assets from different sites.

New Sites Planned for Integration by Q1 - 2017



Site	Trucks	Pump
Oyu Tolgoi	✓	✓
Iron Ore Company of Canada	✓	
Pilbara Iron - Yandi	✓	
Pilbara Iron - Mesa A	✓	
Pilbara Iron - Hope Downs 1	✓	
Pilbara Iron -Brockman 2	✓	

Challenges

- Data Quality.
 - Trucks with faulty sensors.
 - Trucks not configured to send sensor data.
- Large number of parameters for Shovel (more than 500)
- Deployment of Predicta application on Cloud instead of in-house cluster.
- Getting access to secured MineCare databases.

Predicta Visualisation

Welcome Pimplikar, Kedar (TI)

Summary

Advisory

Alarm

Data Review

Sensor Fault

Data Availability

Energy

Iron Ore

Alcan

Copper

☒ Select Active Only

Expand

Collapse

	Advisory Count			Sensor Fault Count	30-Day Data Availability %
<div>▶</div> <div>Hunter Valley Operations</div>	1	4	23	216	16
<div>▼</div> <div>Mount Thorley Warkworth Operations</div>	2	0	9	67	43
<div>▼</div> <div>Mobile Equipment</div>	2	0	9	67	43
<div>▼</div> <div>Komatsu 830E-AC Rear Dumper Truck Fleet</div>	2	0	9	67	43
<div>▶</div> <div>T401</div>	0	0	0	9	0
<div>▼</div> <div>T404</div>	0	0	1	5	71
<div>▼</div> <div>Engine - Diesel</div>	0	0	1		
<div>▶</div> <div>Turbo Charger</div>	0	0	1		
<div>▶</div> <div>T405</div>	0	0	0	2	100

Predicta Visualisation

Advisory Summary

Site	Category	Fleet	Asset	Adv Start Date	Change Point	Adv Description	Status	Risk Score	SAP No
MTW	HME	RD-AC	T422	2015-10-16 13:00:17	2015-06-26 14:35:00	Oil Filter fault	Open	100	0
MTW	HME	RD-AC	T416	2015-10-19 11:40:49	2015-10-09 07:27:00	Oil Filter fault	Open	100	0

Advisory Details

Oil Filter Differential Pressure

Diagnostic Details : Eliminator or Oil Filter fault
Oil Filter Differential Pressure is running high, last daily Avg : 22.0 and daily Max : 99.33

Recommended Action : Check for causes of filter blockage. Check eliminator operation

RUL : -

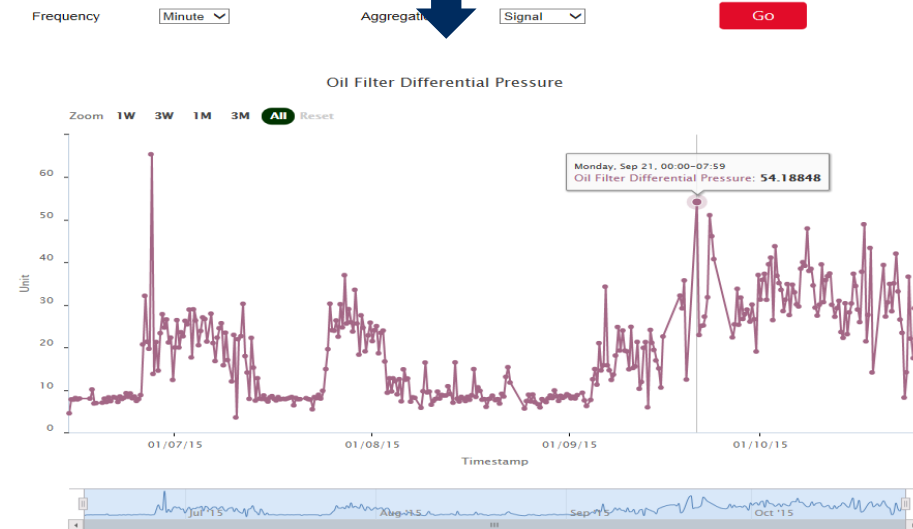
SAP Notification No. : 0

Status : Open

User Comments :

Diagnostics and ability to capture user inputs

Interactive Charts



Predicta Visualisation

Summary

Advisory

Alarm

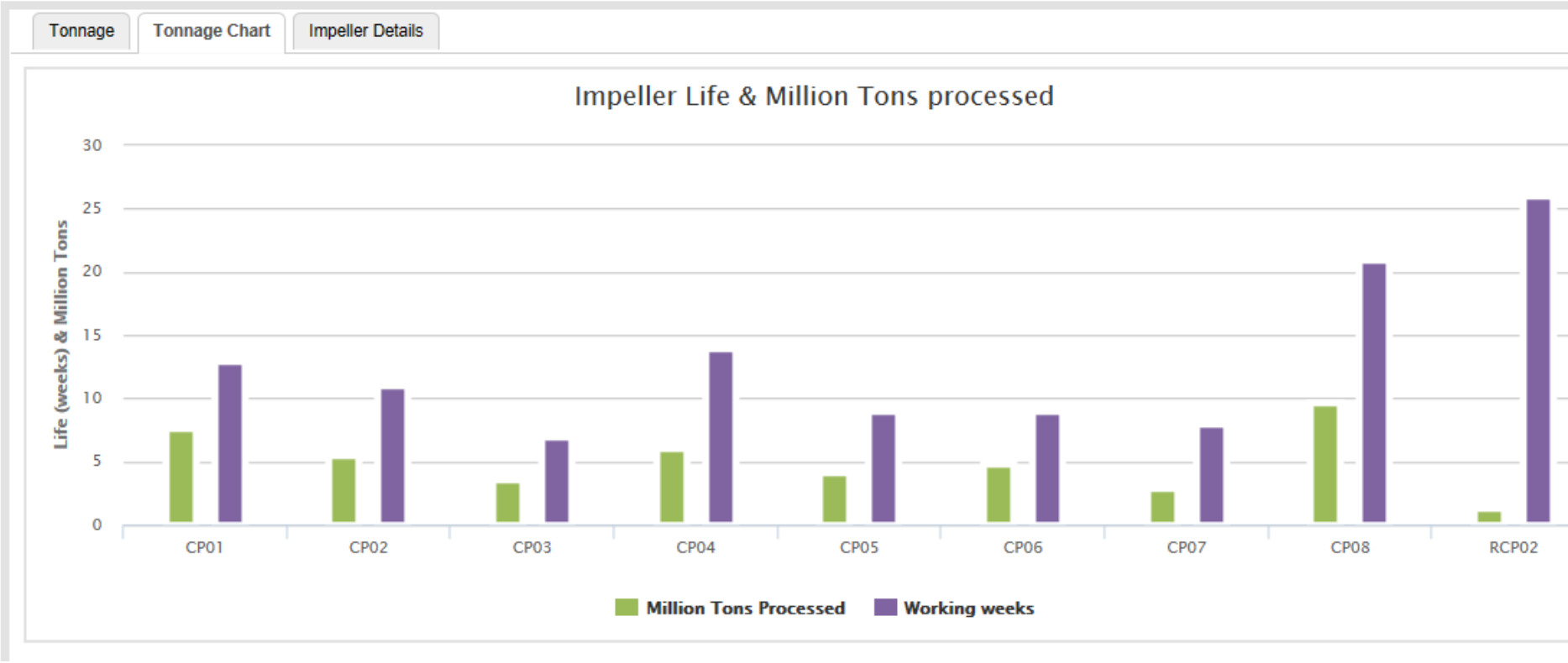
Data Review

Sensor Fault

Signal Health

Pump

Pump Details



Team

Michael Turk	Manager – Predictive Asset Health
Les Williams	Manager – IC, Growth & Innovation
Raghvendra Singh	Project Manager
Pradeep Bilurkar	Data Scientist
Avinash Hingmire	Subject Matter Expert
Bipul Saha	Subject Matter Expert
Makarand Patil	Subject Matter Expert

Development Team

Rahul Gaikwad

Renu Dixit

Nancy Sahu

Suhas Patil

Yarram Rao

Prashanth Kalidindi

Girish Hilage

Sagar Arkadi

Arun Srinivasan

Surya Sallangi

Anwar Shaikh

Testing Team

Preeti Koranne

Prashant Zurunge

Prachi Jirafe

Questions ?

Thanks!!!

