PETRONAS ROTATING EQUIPMENT ANALYTICS (PROTEAN)

Presented by
Khairil Azwan B Khabri – COE Upstream
Gavin Halls – COE Upstream

Company Overview

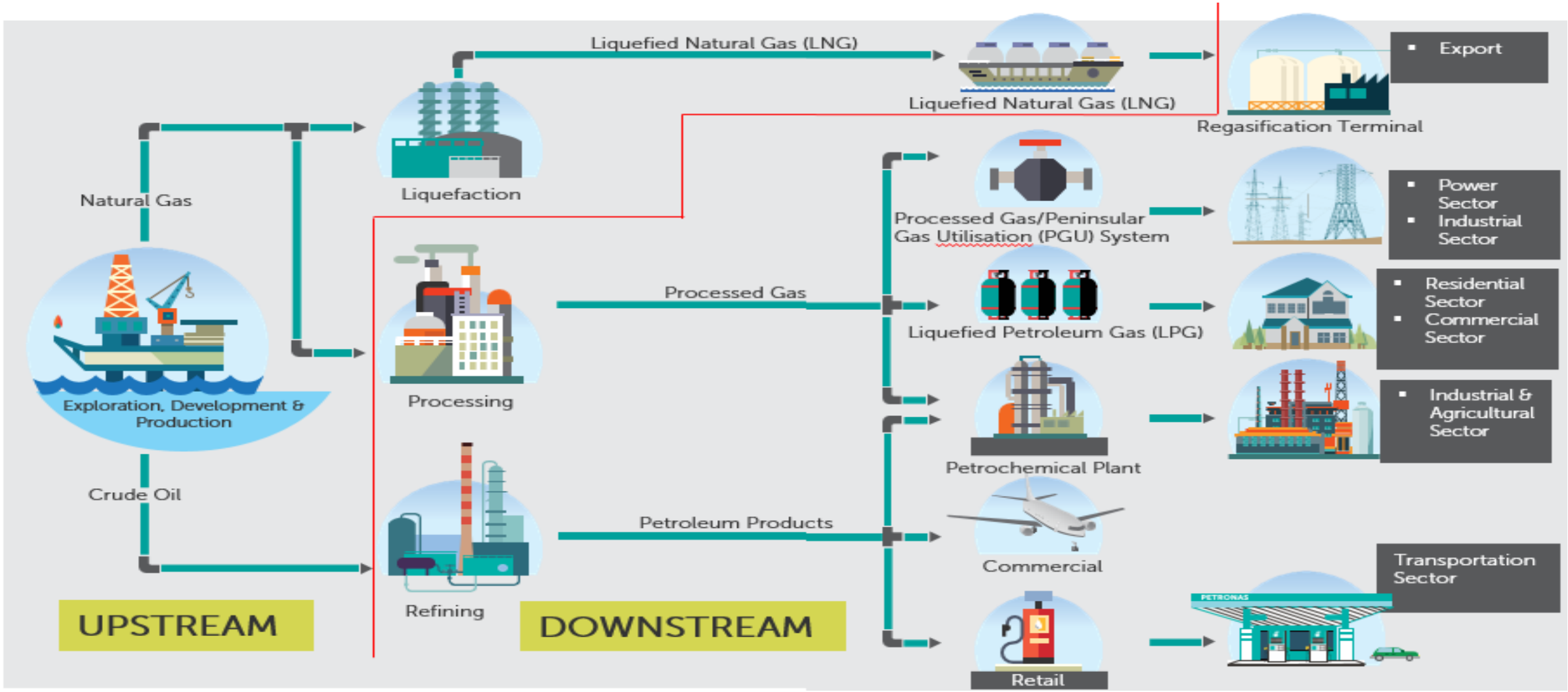
Petroleum Nasional Berhad (PETRONAS) is Malaysia's fully integrated oil & gas multinational with proven capabilities in a broad spectrum of the petroleum chain value.

Establish in August 17, 1974, PETRONAS vision is to be a Leading Oil and Gas Multinational of Choice

PETRONAS mission statements are

- We are a business entity
- Petroleum is our core business
- Our primary responsibility is to develop and add value to this national resource
- Our objective is to contribute to the well-being of the people and the nation

PETRONAS Core Business



Initial Problem Statement

Over 130 pieces of gas turbine driven equipment

- Numerous manufacturers
  - Centrifugal Gas Compressor
  - Generator

30+ Pieces of Super Critical Equipment – single duty high value

Numerous Reciprocating engines and pumps

OEM and 3rd Party solutions mean financial commitment would be considerable

Management directive to go digital

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When did all begin?

May 2015

PETRONAS Maintenance & Engineering team looked at how to perform diagnostics using unit data on one single unit cost effectively

August 2015

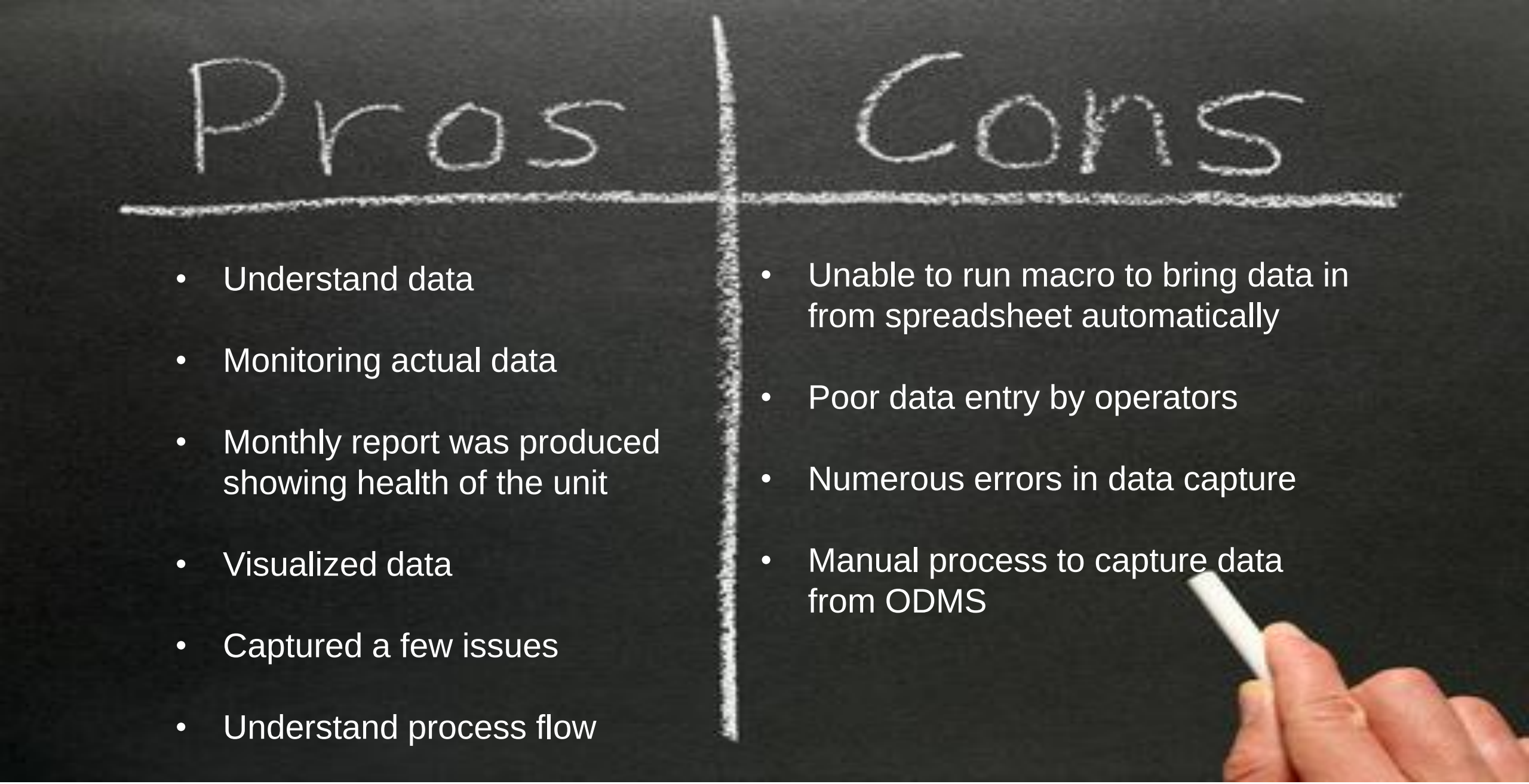
Utilized Operation Data Management system (ODMS) which is a data capture system using handheld data loggers

October 2015

Team compiled monthly report using running data and equipment vibration and lube oil health status

December 2015

Team developed the process flow and investigated ways to improve the overall monitoring system



Basic Design Brief

- Not to duplicate machinery HMI
- Not to duplicate the unit control system
- Powerful automatic analytical tools to identify issues before they become issues
- Simple visuals whilst providing as much relevant information to the engineer as possible
    - Trends and graphs take human process power to look for issue ☹
- Automated alert system
    - Email
- Ability to review historical data
- Not limited to Major Rotating Equipment
    - Support other disciplines
    - Electrical health
    - Pumps
    - Vessels
- Ability to evolve system
    - Visuals
    - Algorithms
    - Integrate with other systems

ADD Value to PETRONAS

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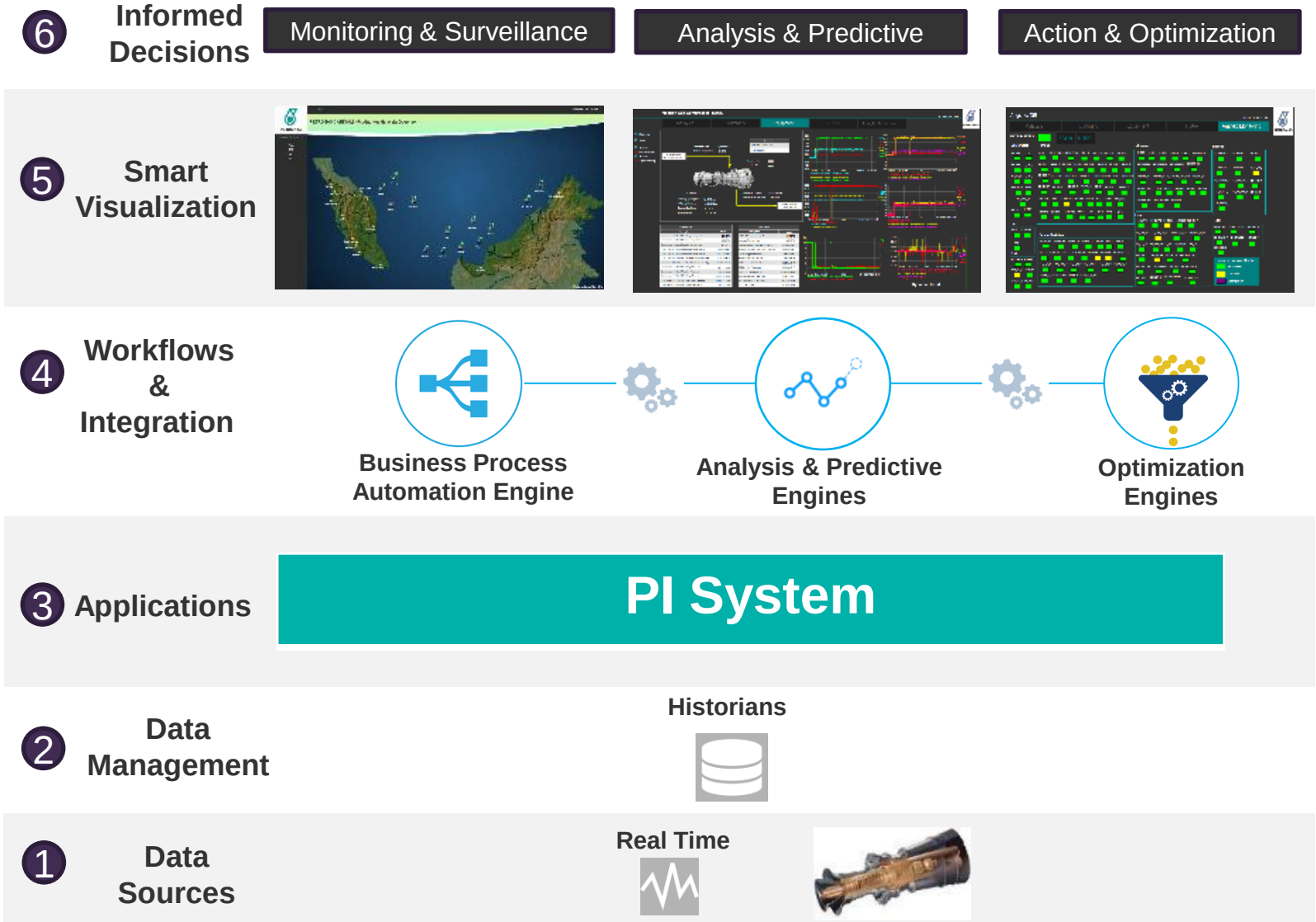
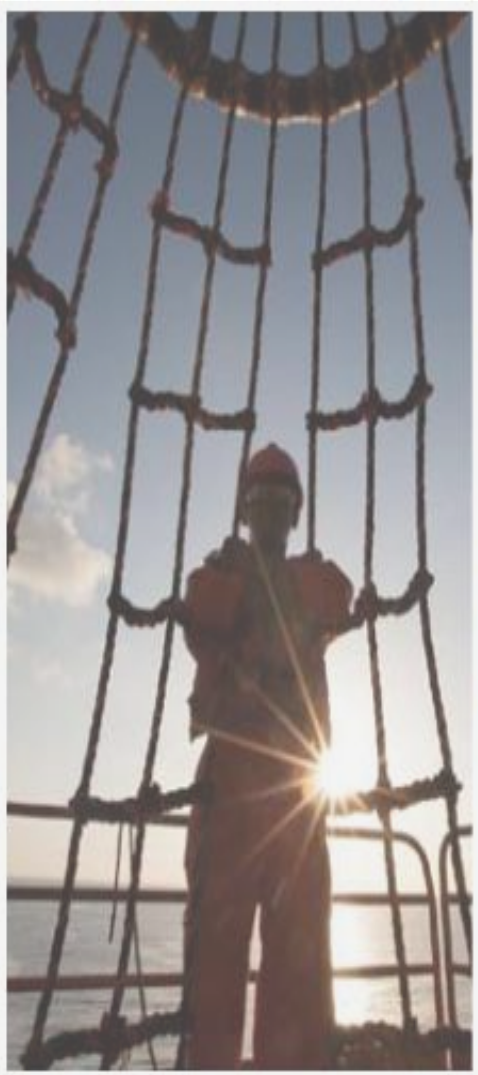
Lessons Learnt and Limitations

System Solution Architecture



Design Brief for next step November 2016

- Clear aim on the system to be developed with element of People, process & Technology
- Visuals should be meaningful
- System does the hard work and complex thinking processes
- Link with other PETRONAS software solutions
- Human to make final decision



How do OSIsoft help PROTEAN

PI Data Archive

Excel not ideal as very ssor heav stant

Ver al to unde alerts

PI AF

No matic

not ns

Notifications

Asset Analytics

No algorithm embedded to the systems

PI Coresight

Da rd

Difficult to integrate into other PETRONAS systems

PI System Access

Early development of PROTEAN

01	Developed system for 2 critical gas turbine driven compressor units
02	Utilized PETRONAS PI System for data collection and algorithms. Utilized PI Coresight for visuals
03	Automatic e-mail notifications of issues proved difficult and unreliable. Email notification of unit shutdown successful
04	Data dump when unit shuts down to aid RCFA : CSV file on shared drive
05	Data points analyzed based on criticality of data point
06	Analytic page simple but effective

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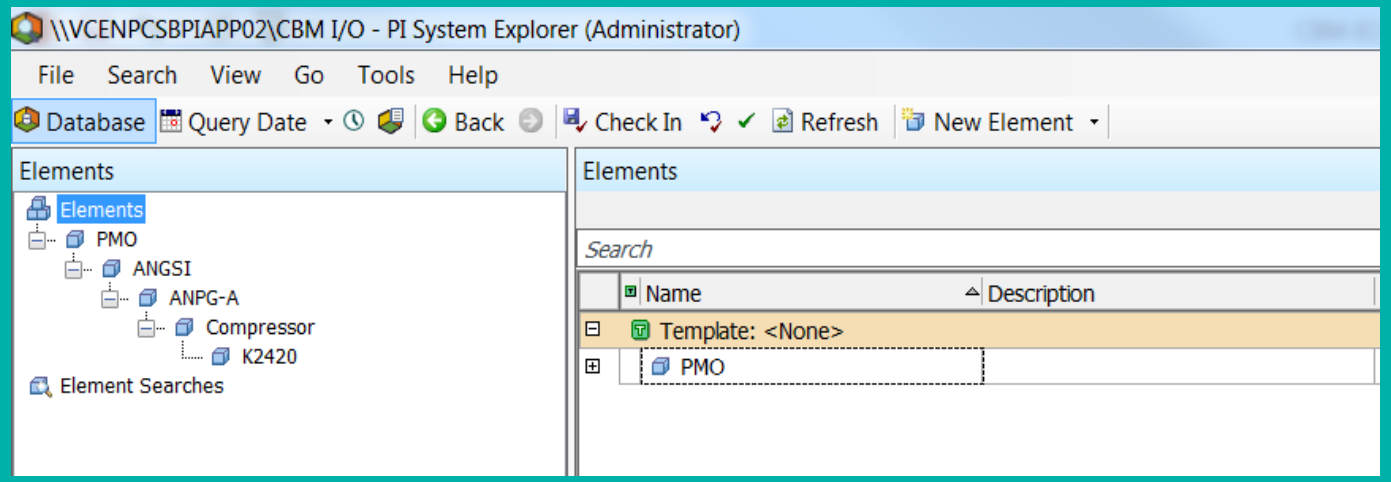
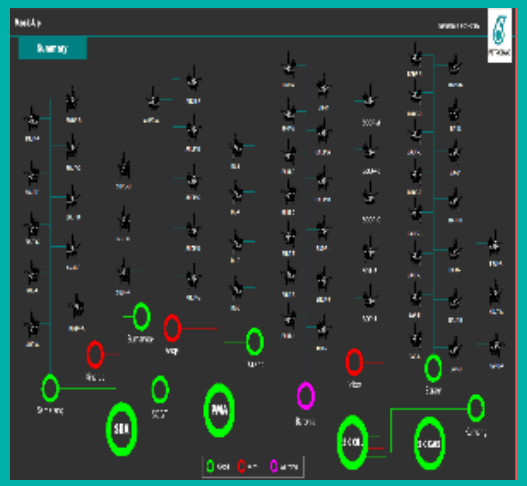
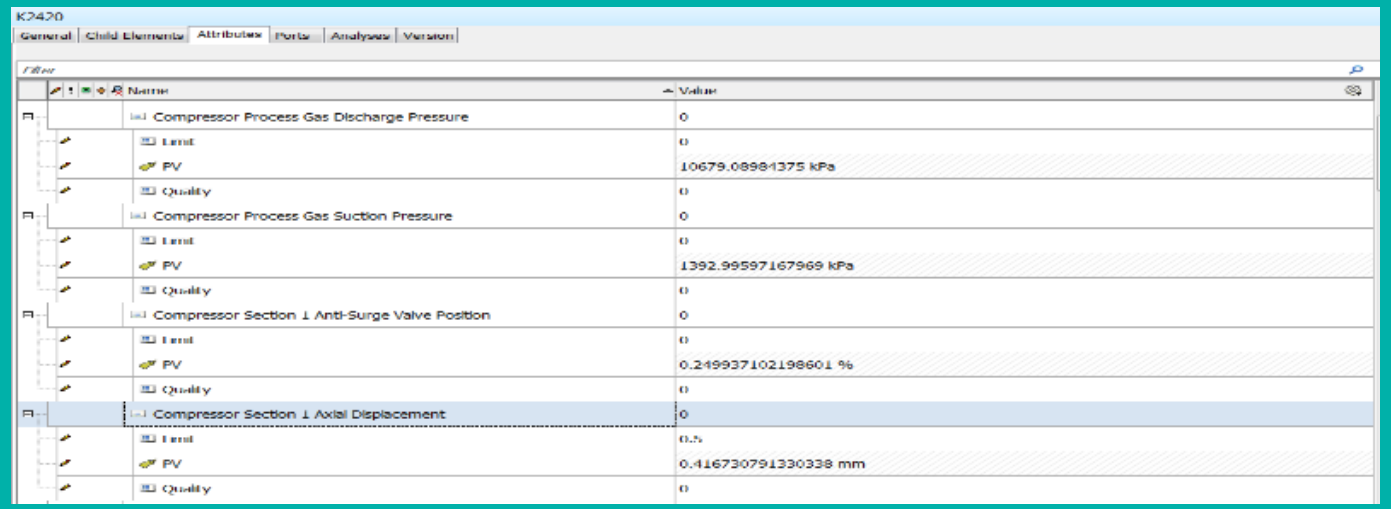
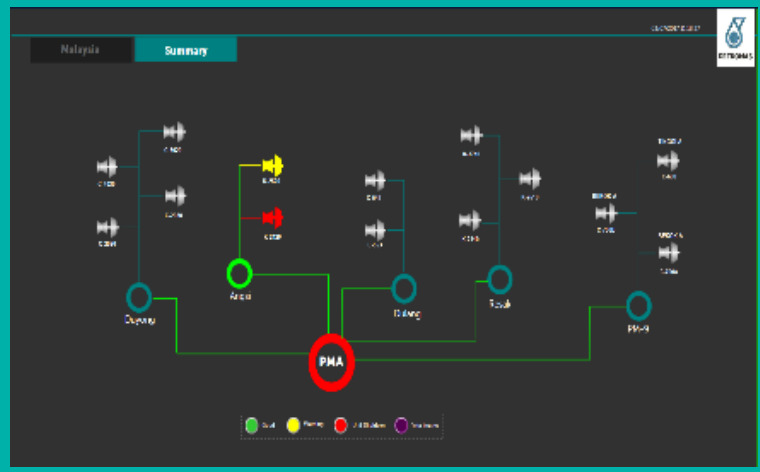
Developed PROTEAN in PI System Environment

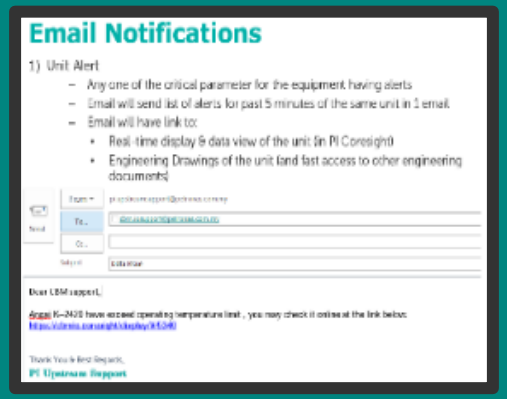


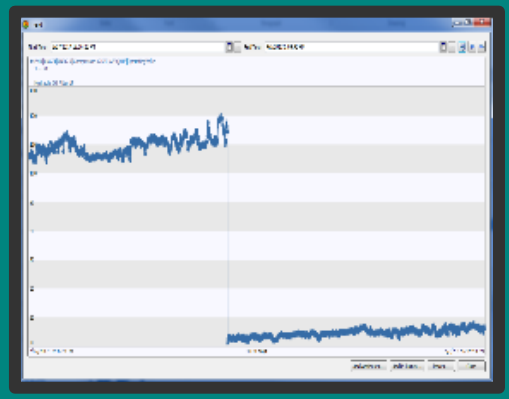






Did it Work?





- Yes
- System alerted to numerous concerns over a 2 month period
- Email notifications worked
- Visuals worked well
- PROTEAN Dashboard

During development and implementation May 2017

Increase number of units covered and ISO 14224 system classification

Multiple data point comparisons Increase number of units covered

Understanding of PI AF structure and power

Better email notifications. More information to recipient. Utilized Event Frame process

Create templates for algorithm. Reduce processor and server loading.
Not all algorithms are required on all data points

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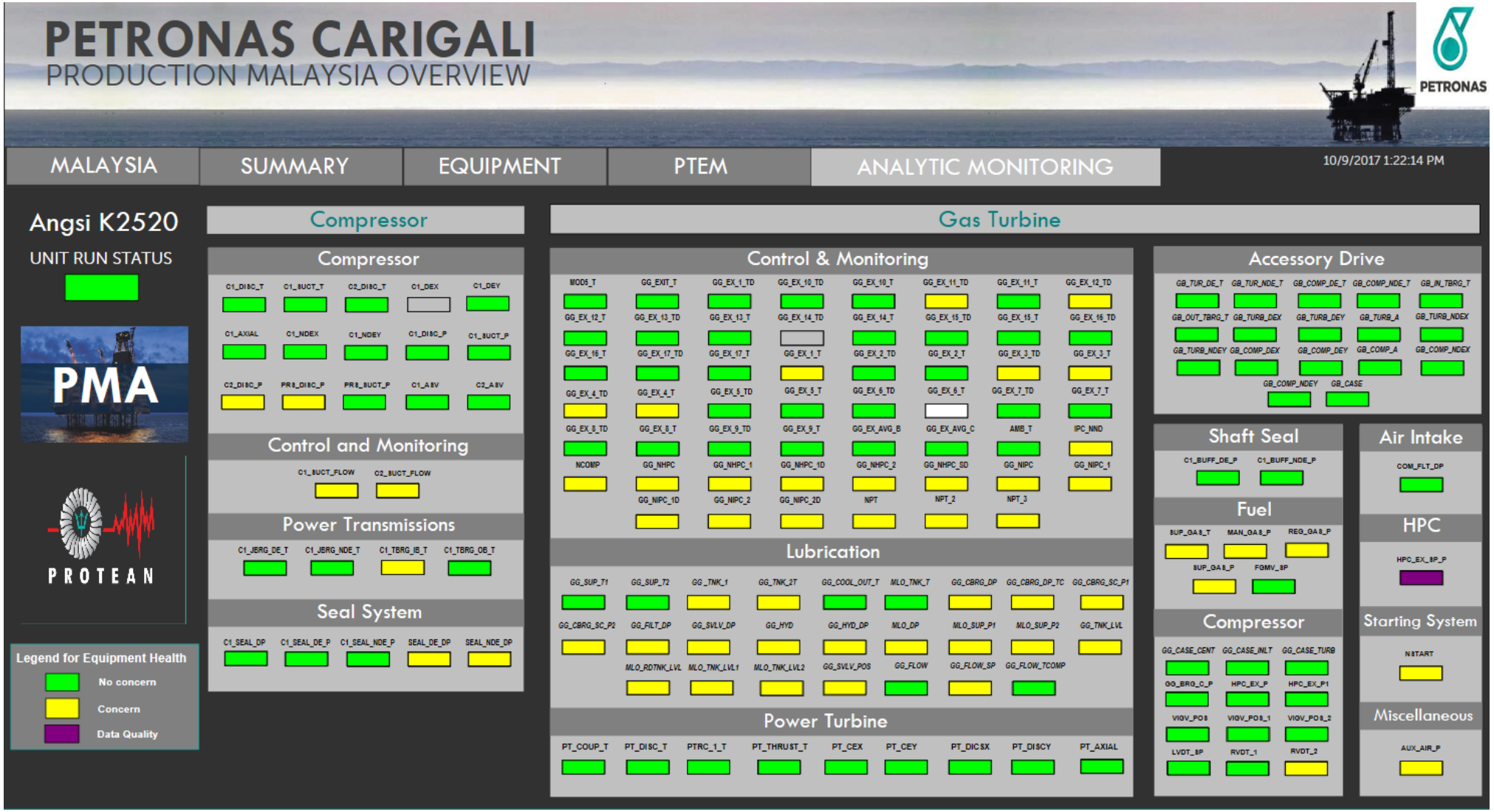
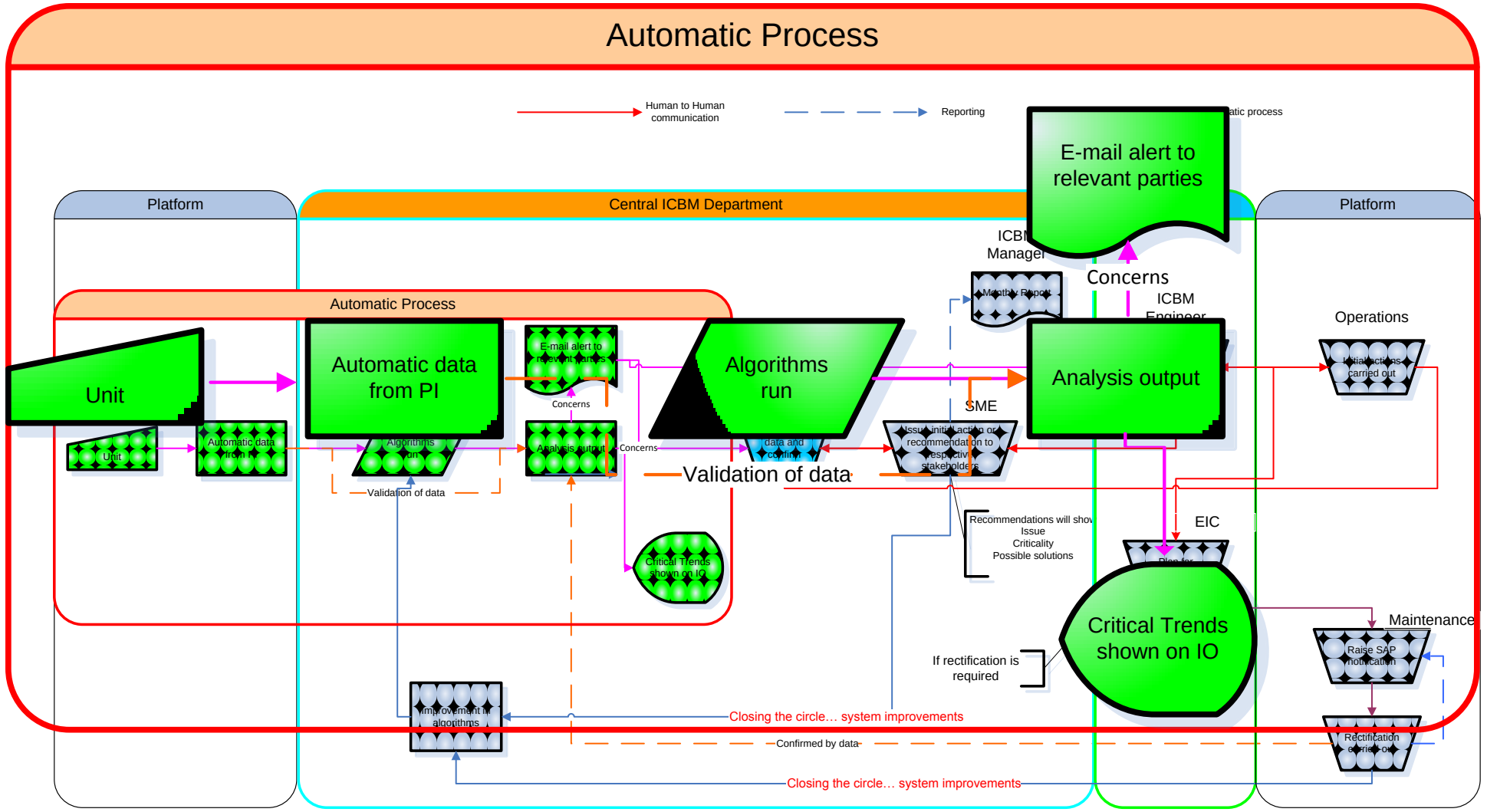
Current Look and Feel



PROTEAN as tools in PETRONAS Integrated Operation (IO)



PROTEAN in demand !

Next Development

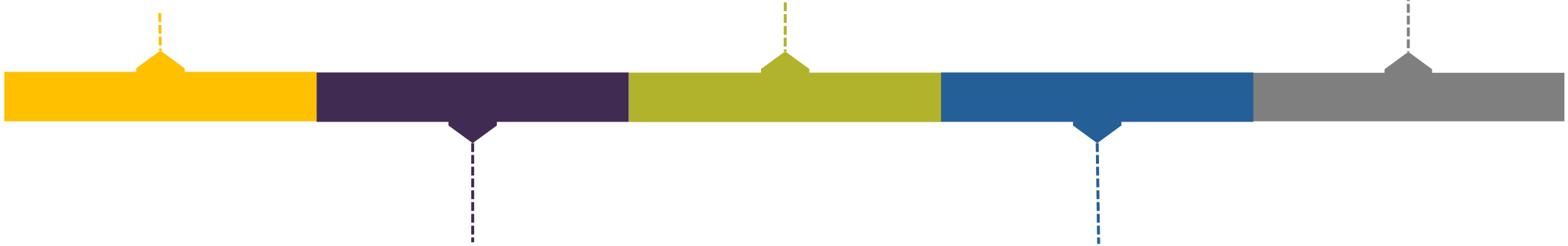
- CMMS, PETRONAS Asset Management, online drawings and other system integrations
- Further Supercritical and C1 units to be incorporated – 100 + units by 2019
- Research more complex algorithms and OSIsoft PI System add-on
- Ability for individuals to run reports on equipment and compare between regions
- Technical Condition Index (TCI) for systems and unit for easy visualization of equipment health
- Develop fault tree to assist engineers with investigation and diagnosis of alerts
- Develop risk based maintenance philosophy (condition based) and move away from fixed periodic maintenance schedules

Summary as of Q3 2017

PROTEAN is developing very well and meeting expectations

Low cost and high return on investment predicted

Evolution rather than revolution



270 man hours each unit to replicate due to template system

PROTEAN future upgrades will be based on benefit to user

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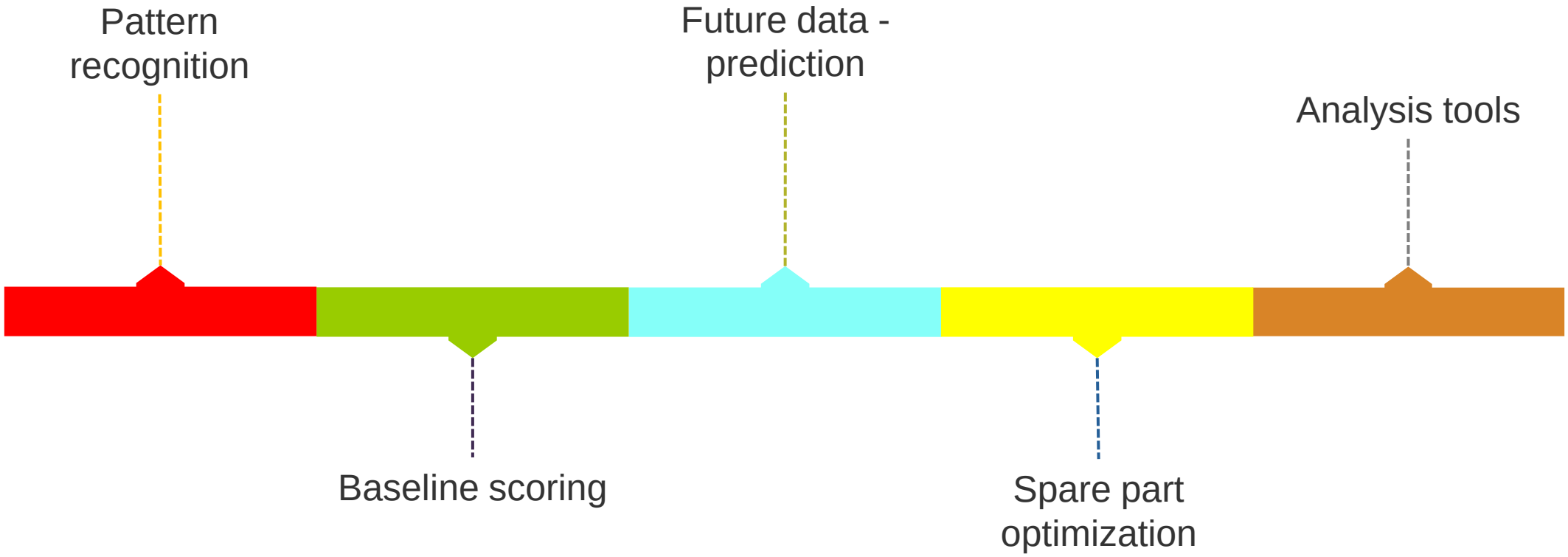
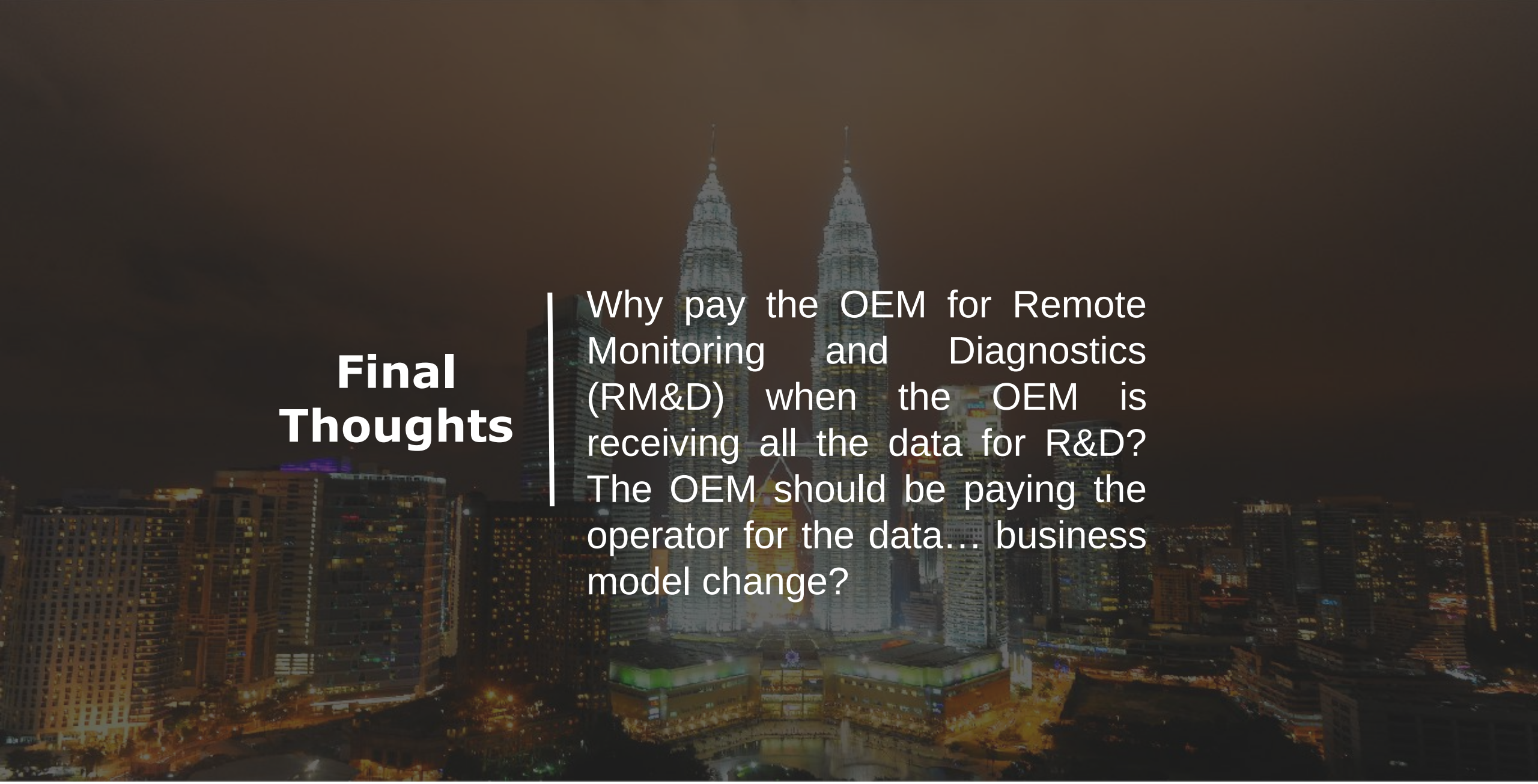
The Future





Final Thoughts

Why pay the OEM for Remote Monitoring and Diagnostics (RM&D) when the OEM is receiving all the data for R&D? The OEM should be paying the operator for the data… business model change?

THE FUN PART IS WE DESIGNED A FANTASTIC LOGO!!!!

Symbolizes the rotating element

Symbolizes the machinery heartbeat

Trident for Predictive Diagnostic Prognostic

Khairil Azwan Bin Khabri
khairilazwan@petronas.com
Head Reliability Management
Operational Excellence
Center of Excellence
PETRONAS Carigali

Gavin Warren Halls
Gavinwarren.halls@petronas.com
Rotating Machinery Specialist
Operational Excellence
Center of Excellence
PETRONAS Carigali

Nazrul Hsyraf M Mokhtar
nazrul.mokhtar@petronas.com.my
PI Specialist
Group Technical Data
Project Delivery and Technology
PETRONAS

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