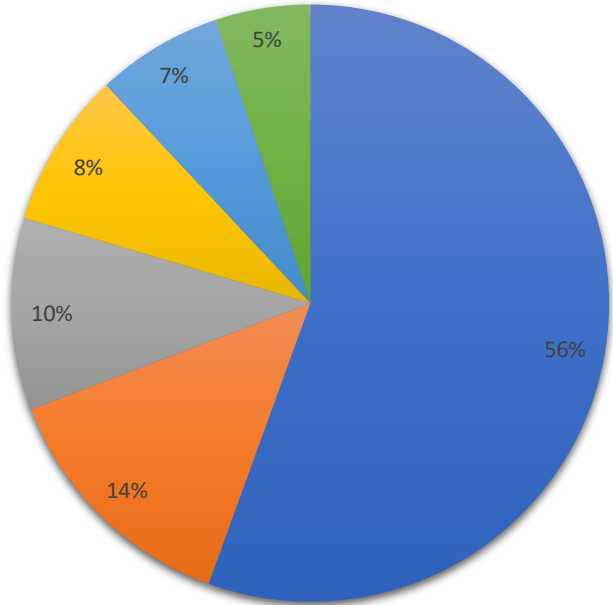# pulse

Predictive Suite

by ExactSpace

AI for Flexible Operations Impact On Environment
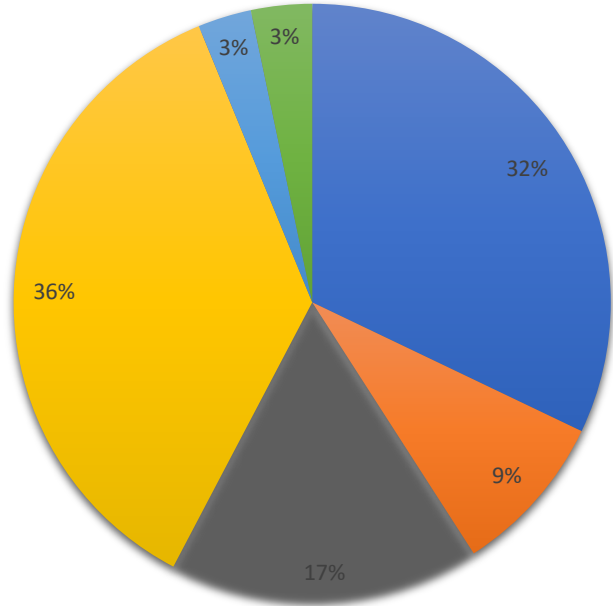
Using data for improved Reliability and Performance of Thermal Power plants during Flexible Operations

Evolving Power Mix

ExactSpace

India Power Mix - 2019

5%
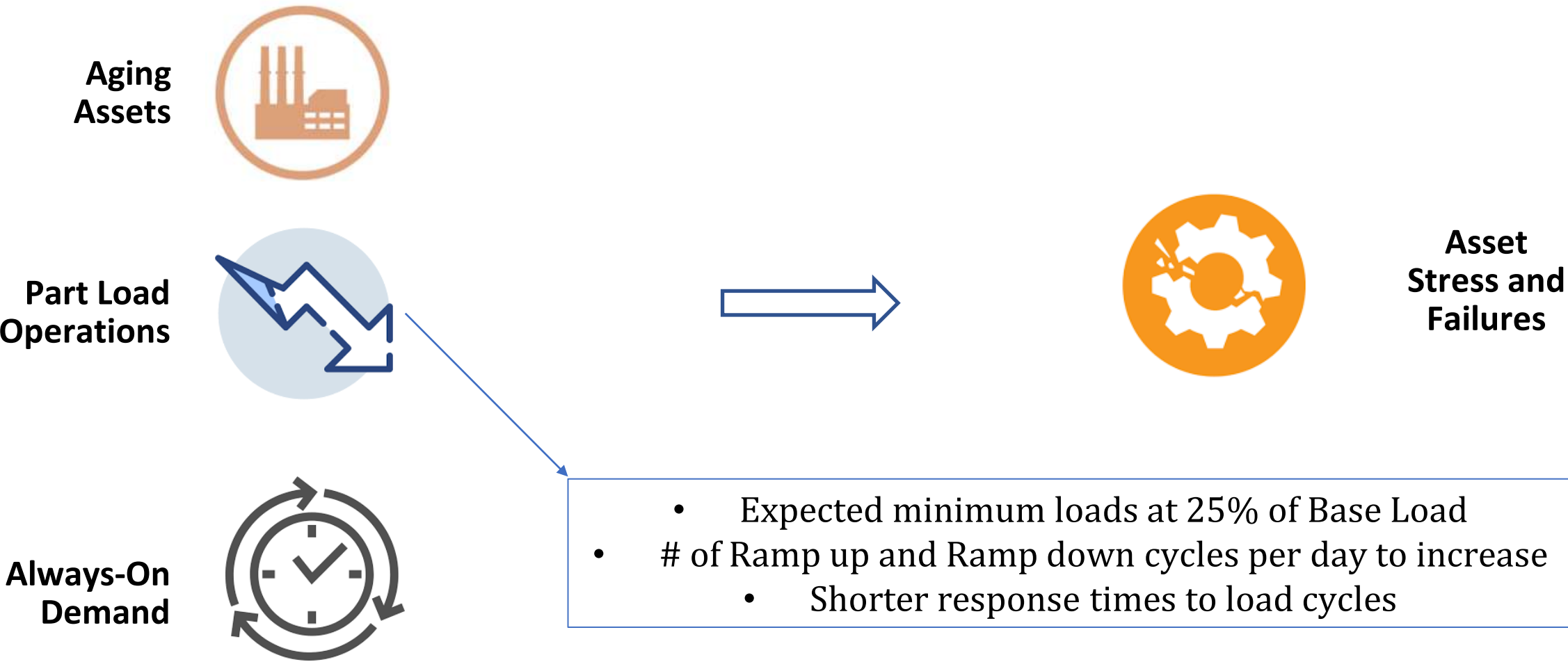7%
8%
10%
56%
14%

■ Coal ■ Hydro ■ Wind ■ Solar ■ Gas ■ Others

India Power Mix - 2030

3% 3%
32%
36%
9%
17%

■ Coal ■ Hydro ■ Wind ■ Solar ■ Gas ■ Others

Contribution of Thermal Power in overall mix is still very significant

Flexibility - Thermal Power challenges

Aging Assets

Part Load Operations

Always-On Demand

Asset Stress and Failures

- Expected minimum loads at 25% of Base Load
- # of Ramp up and Ramp down cycles per day to increase
- Shorter response times to load cycles

Predictive Asset Analytics

ExactSpace

We believe asset reliability is driven by great **communication** – between the asset and its owner. With *Pulse*, your assets will reach out to you when they are stressed and need your attention.

We leverage advanced analytics technologies and a wealth of available data to help run the industrial world with ***ZERO unplanned downtime***, ***highest possible performance*** and ***utmost safety***.

CUSTOMER BENEFITS

Reduced Downtime and Maintenance Costs

Improved Asset Performance and Environment Norms Compliance

Maintenance Workforce Empowerment

Asset Stress Evaluator

Use AI to monitor development of stress over time to avoid costly failures

Digital Twin of Assets and Processes

- Models of commonly used industrial equipment (50+)
- Models of common Thermal plant processes
- Over **500 asset-specific fault diagnostics** and recommendations derived from prior known failures
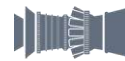- Reliability-centred maintenance strategy for given failure

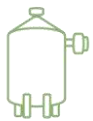| Heat Exchanger	Pulverizer	Condenser	Turbine	Centrifugal Pump	Gear Box	Industrial Fan

Boiler	Generator	Inverter	ESP	Valves	Compressor	Transformer

And more…

Case Study – Boiler stress degradation in Boiler Tube Leak

ExactSpace

Case Study – Boiler Stress evaluation

Customer Background:

- Coal-based 180 MW Power plant

Issue:
Frequent boiler tube leaks

- Unable to detect the onset of tube leak early enough to control the damage

- Cyclic (flexible) operations makes detection of signals more challenging

- Demand for Plant availability makes taking preventive shutdowns difficult

Advanced pattern recognition

Analytics and Outcome:

- Studied patterns of data and changes in relationships between various tags

- Comparison of pattern changes in a 15 days period leading upto a tube leak

- Able to detect minor changes in boiler operations close to 8 days before actual tube leak incident and observe the progression of the issue

This abnormal region of operations is observed from 10 days before a Tube Leak compared to Steady operations (May)
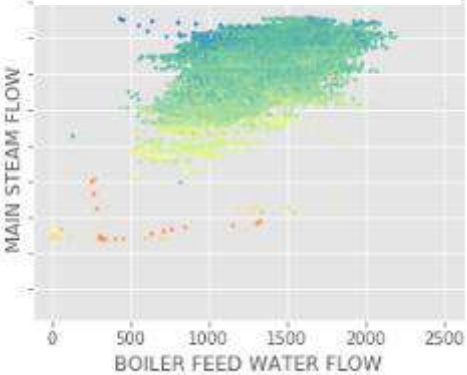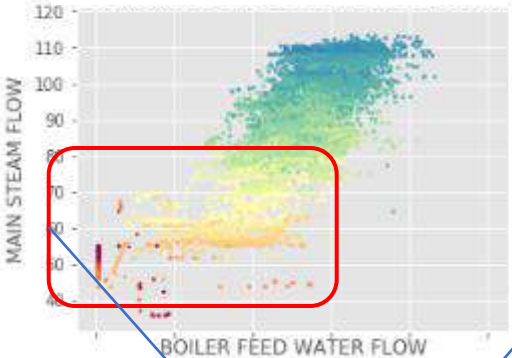
Normal Operations

8 days before Tube Leak
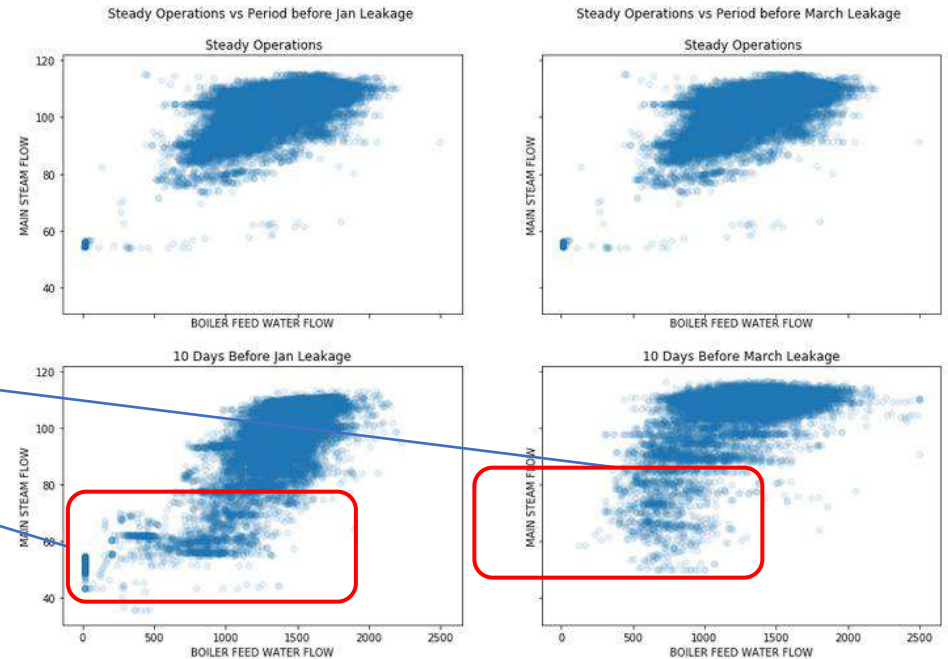
Feedwater pattern change
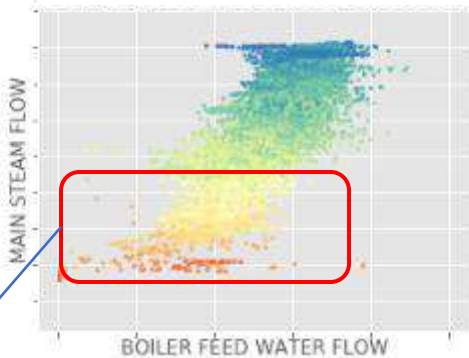

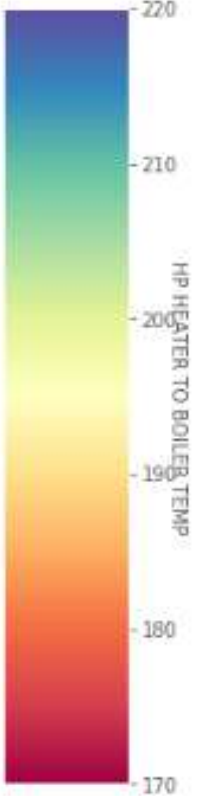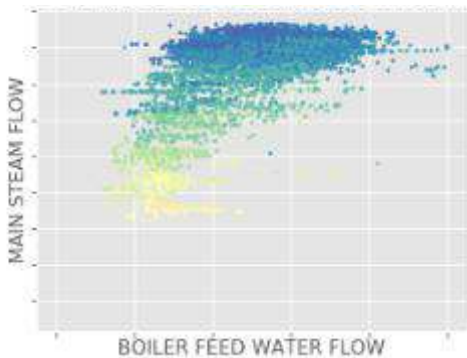**8 days before Tube Leak**

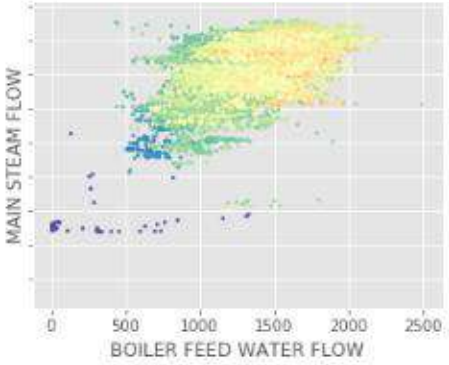**Normal Operations**   **Tube Leak 1**   **Tube Leak 2**   **Tube Leak 3**

FW temperature have started to drop almost 8 days before the tube leak as indicated by the band of Yellow and Red which is absent during normal operations of April and May.

Flue Gas Pressure changes

ExactSpace

8 days before Tube Leak

Normal Operations
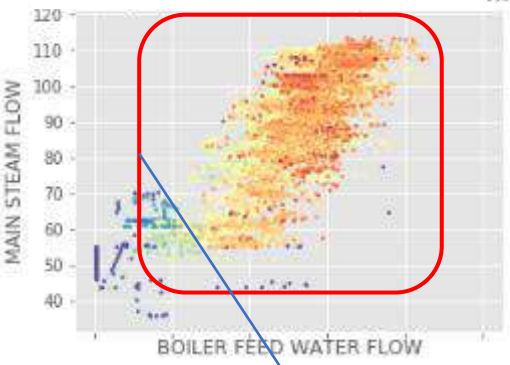
Tube Leak 1
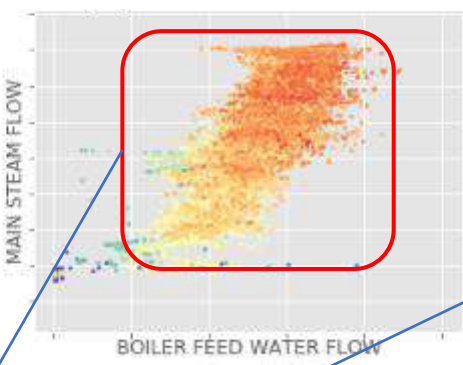
Tube Leak 2
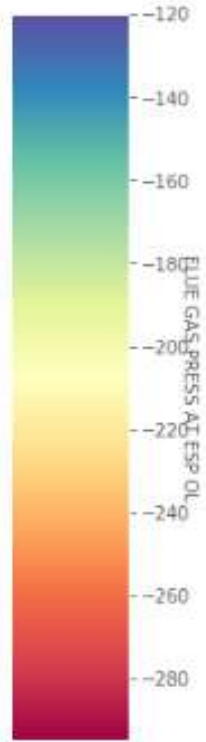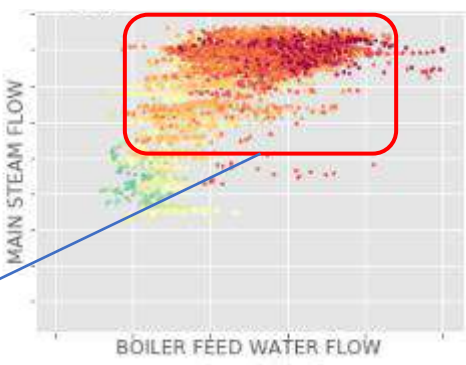
Tube Leak 3

Similar differences in FG Pressure observed (by 40-60 mmwc) in the lead up to the tube leak event.

These are early indicators of an upcoming leak event.

Progression of issue
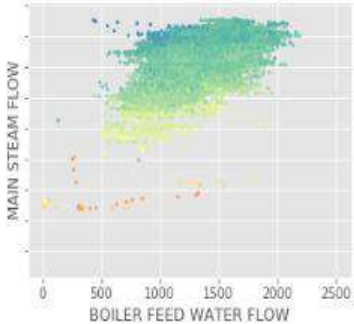
Relationship during normal operations

Day 1 Day 2 Day 3 Day 4

Day 5 Day 6 Day 7 Day 8 (Tube Leak)
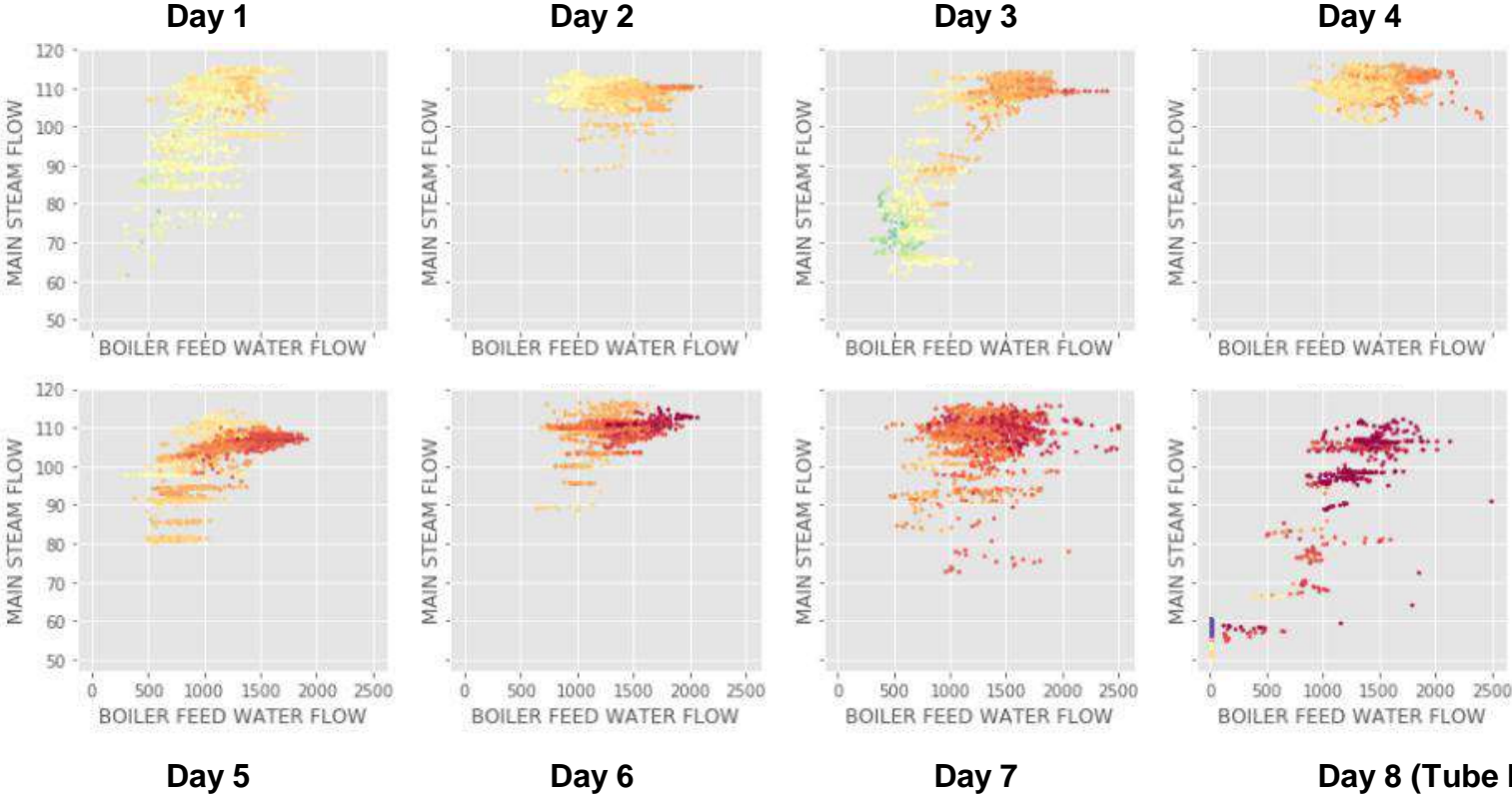
Gradual change in model relationship from 8 days before a Tube Leak indicating significant change in Flue Gas profile as a possible early indicator.

Outcome

The solution

- Real-time Pattern Recognition helps monitor asset stress

- Solution inherently tuned for flexible operations and compares with best known historic operations

- Relationship changes between multiple tags and predictive models help accurately detect component level degradation

Outcome

- Providing a predictive score (probability index) helps plant modify operations to reduce stress on boiler or plan well for an unavoidable shutdown

- Real-time monitoring also enables operations at peak performance

AI for improved Environment Norms Compliance

ExactSpace

Monitor ESP health for Environment

Environmental compliance from ESP monitoring

- Continuously monitor ESP fields and their operations to maintain ideal stack opacity levels in the plant.

- Use stack outlet images to correlate opacity with ESP health

- Avoid excess stack emissions and stay compliant with Environmental norms

Minimize stack emissions by continuous monitoring and optimization of ESP health

ExactSpace + Synengco

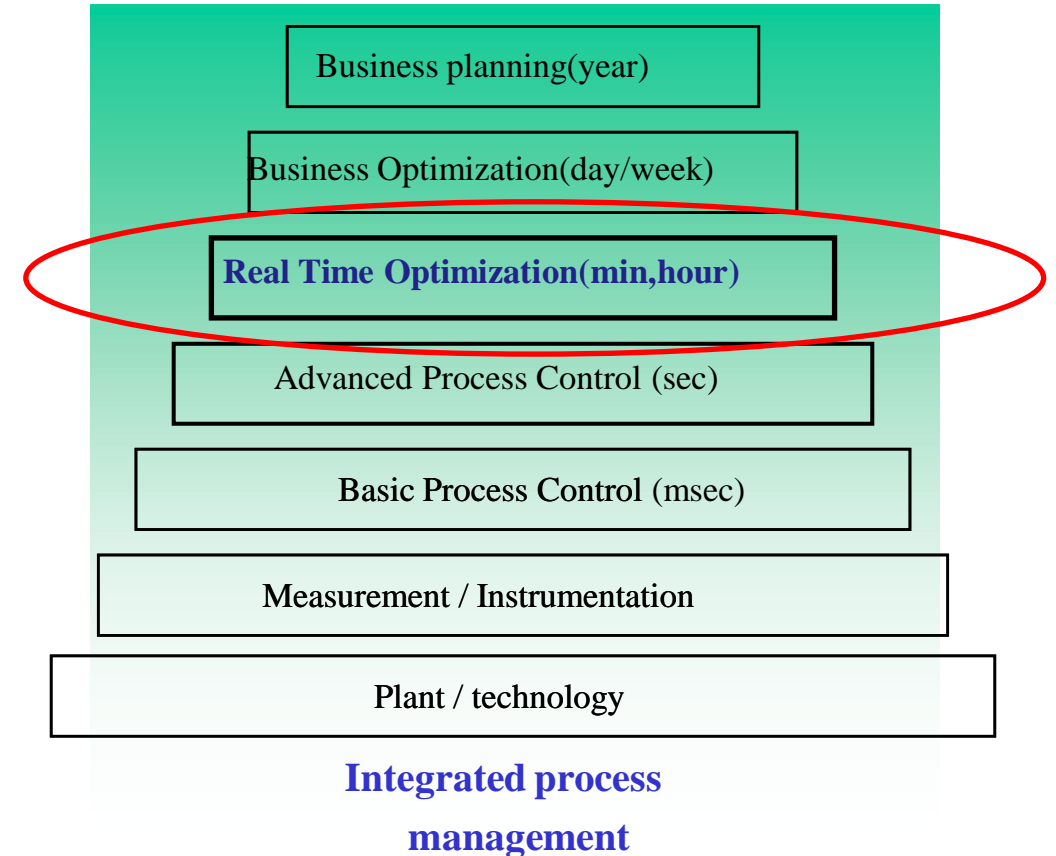- MoU for exchange of best practices between Australia and India in areas of AI, Asset Reliability and Real-time Optimization
- **Synengco Background:**
- 20+ years of solutions for Thermal Power
- Specific focus on Flexibilization

- **Real-time Optimization modules**
- Throttle Valve RTO
- Combustion RTO
- Sootblowing RTO
- Condenser RTO
- GasPath RTO
- Cooling Water RTO
- Airheater RTO
- Dispatch RTO

Real-time Optimization

- Real Time Optimization, in the hierarchy, is above the APC and/or BPC layer.

  - RTO computes the optimal operating conditions from the plant economy point of view

  - RTO typically uses optimization engines.

  - RTO horizon exceeds that of APC; often considers only steady state.

  - Scope of RTO may be local (the same process as controlled by APC), may include several units or may be plant-wide.

- RTO specifies targets (set-points, set-ranges and/or MV targets) for APC or basic process control

Business planning(year)

Business Optimization(day/week)

Real Time Optimization(min,hour)

Advanced Process Control (sec)

Basic Process Control (msec)

Measurement / Instrumentation

Plant / technology

Integrated process management

E.g. Sootblowing Optimization

ExactSpace

Learned cause & effect
- Impact of each SB on each boiler element's TC
- Impact of each SB on back end temperature
- etc.

Control Constraints
- Min/max frequency
- Maintaining control limits (spray flow, emissions, etc.)

Operator control points
- Soot blower sequence
- Soot blower time

OPC write →

Performance constraints
- Max back-end temperature

When should each soot blower be scheduled to maximise performance?

System efficiency
- Back-end temp & flows
- Boiler element TCs
- L/R temperature balance
- Steam consumption

Thermodynamic performance calculations

Instrumentation

← OPC read

Case Study

Customer Background:

- Australian Power Station – approx. 2800 MW
- Located in environmentally sensitive area
- Multiple coal sources with high ash content
- Facing transition due to renewables addition to grid

Solution:

- Deployed Real-time optimization modules to help improve plant performance during flexible operations

Outcome:

- 2+ years of solution deployment
- Continued benefits of optimization worth multiple initial investment
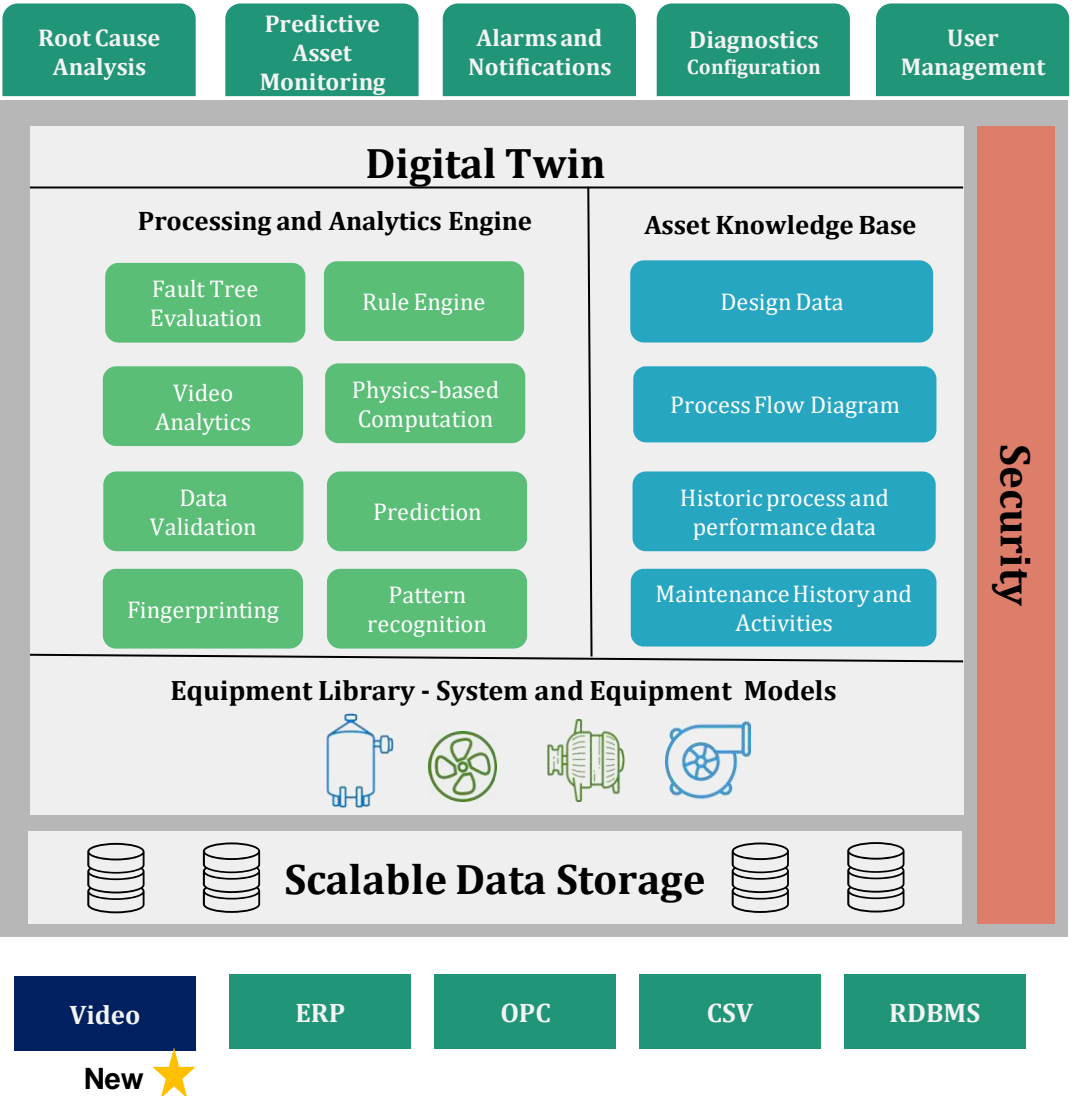- Support from across plant and corporate level

About ExactSpace Solution

Backup Slides

pulse ⫿⫿⫿ - Technology and Features

ExactSpace

Built on our proprietary AI-platform **pulse** ⫿⫿⫿
our solution comes with deep asset knowledge to ensure the best decisions for each asset!

- Continuous and real time Analytics
- Secure, Cloud-based data storage
- Diagnostics and Recommendations
- Mobile and Web Notifications, Dashboards
- Collaborative Troubleshooting
- Add custom analytic modules

Root Cause Analysis	Predictive Asset Monitoring	Alarms and Notifications	Diagnostics Configuration	User Management

Digital Twin

Processing and Analytics Engine

Fault Tree Evaluation	Rule Engine
Video Analytics	Physics-based Computation
Data Validation	Prediction
Fingerprinting	Pattern recognition

Asset Knowledge Base

- Design Data
- Process Flow Diagram
- Historic process and performance data
- Maintenance History and Activities

Security

Equipment Library - System and Equipment Models

Scalable Data Storage

Video	ERP	OPC	CSV	RDBMS

New ⭐

pulse▬▬ - Overview

Pulse is purpose-built to apply advanced AI techniques to solve the most critical Industrial problems.

Technology Infrastructure
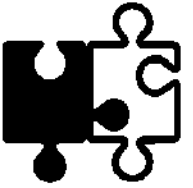
Integration – The first step to a robust industrial AI solution is a secure integration with field assets and data transfer to a remote platform. We support industrial protocols (OPC, Modbus, Data Files, RDBMS) and automation systems (DCS, PLC)
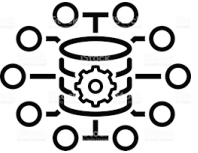
Scalable Data Management – Based on a non-conventional database system designed for handling voluminous data, this layer forms the foundation to reliable and fast analysis. Also functions as an asset/plant historian on the cloud.

Security – Pulse takes every measure to ensure data integrity and security. This includes using Firewall at the asset/plant side, read-only data access from assets, encrypted data transfer to cloud and user-restricted access to data from cloud

Analytics Infrastructure

Digital Twin – This forms the core of the platform and is solely responsible for efficiently converting asset data into useful and timely insights. This comprises the proprietary analytics framework as well as pre-built asset-specific models.
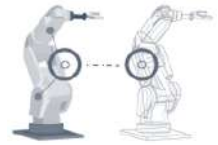
Business Applications – Analytics is only beneficial when used by the right stakeholders to make their decisions in a timely manner. This is enabled by the applications layer which is responsible for delivering insights on web/mobile
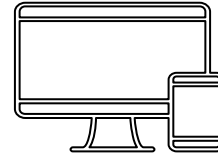
Digital Twin

The Digital Twin is the core engine that combines Raw Data, Machine Learning and Asset Specific knowledge to create insights for our customers.

CORE COMPONENTS

Equipment Library

Asset
Knowledge Base

Processing and Analytics
Engine

Digital Twin - Equipment Library

Benefit from our library of pre-built asset and system models which drastically reduces the time to deploy AI for your assets and delivers value from Day 1.

What are Asset/System models?

We use Models as a proprietary way to digitally describe the functioning of an asset or system, the relationship between various data points within an asset or system and provide deeper context to the higher-level machine learning algorithms to draw useful inferences.

***Pulse* Equipment Library contains:**

- Models of commonly used industrial equipment (50+)
- Models of common industrial processes
- Over **500 asset-specific fault diagnostics** and recommendations derived from prior known failures
- Reliability-centred maintenance strategy for given failure

Digital Twin - Knowledge Base

Two assets (e.g. Compressors) designed to the exact same specifications still have their own individual characteristics. Knowledge Base is Pulse's way to treat every single asset individually.

What is a Knowledge Base?

The Knowledge Base is an evolving document store of all information specific to an individual asset or process. This is used by the higher level AI models to 'learn' and 'develop' deep knowledge of the functioning of a specific asset or process. *Pulse* Knowledge Base contains:

Design Data – This is critical information that helps map the Asset model to expected functionality of an asset

Process Flow – This is specifically useful to understand the physical connectedness of various assets within a system
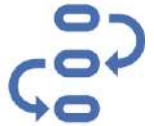
Maintenance Records – Knowledge of the existing maintenance process, history of issues/breakdowns to understand criticality of asset

Historic Data – This is the most critical piece of information used by the machine learning models to understand and benchmark an asset's performance

Digital Twin – Analytics Engine

ExactSpace

For an Always-On asset/plant, it is critical to have a robust engine which is performing thousands of analyses and applying hundreds of predictive models to generate timely and accurate insights.

How is data handled in *Pulse?*

The Processing and Analytics engine keeps a watch on an assets behaviour before triggering higher-level diagnostics, root cause analysis and failure forecasting. It achieves this by orchestrating a series of validations, computations, pattern detections and predictions for every single data point that the asset generates before generating a single alert. This is done by the interplay between the following processors
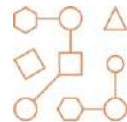
Fingerprinting
Uses self-learning models to understand asset/process behaviour from historic data

Validation
Auto detection of poor quality or erratic data and substitute plausible data values instead

Recognize Pattern
APR Algorithms which mine for relationships and trace abnormal patters and data deviations

Prediction
Models for early detection of issues and forecast Remaining Useful Life of Assets

Physics-Based
Models built based on first principles and physics to help validate actual asset performance

Root Cause
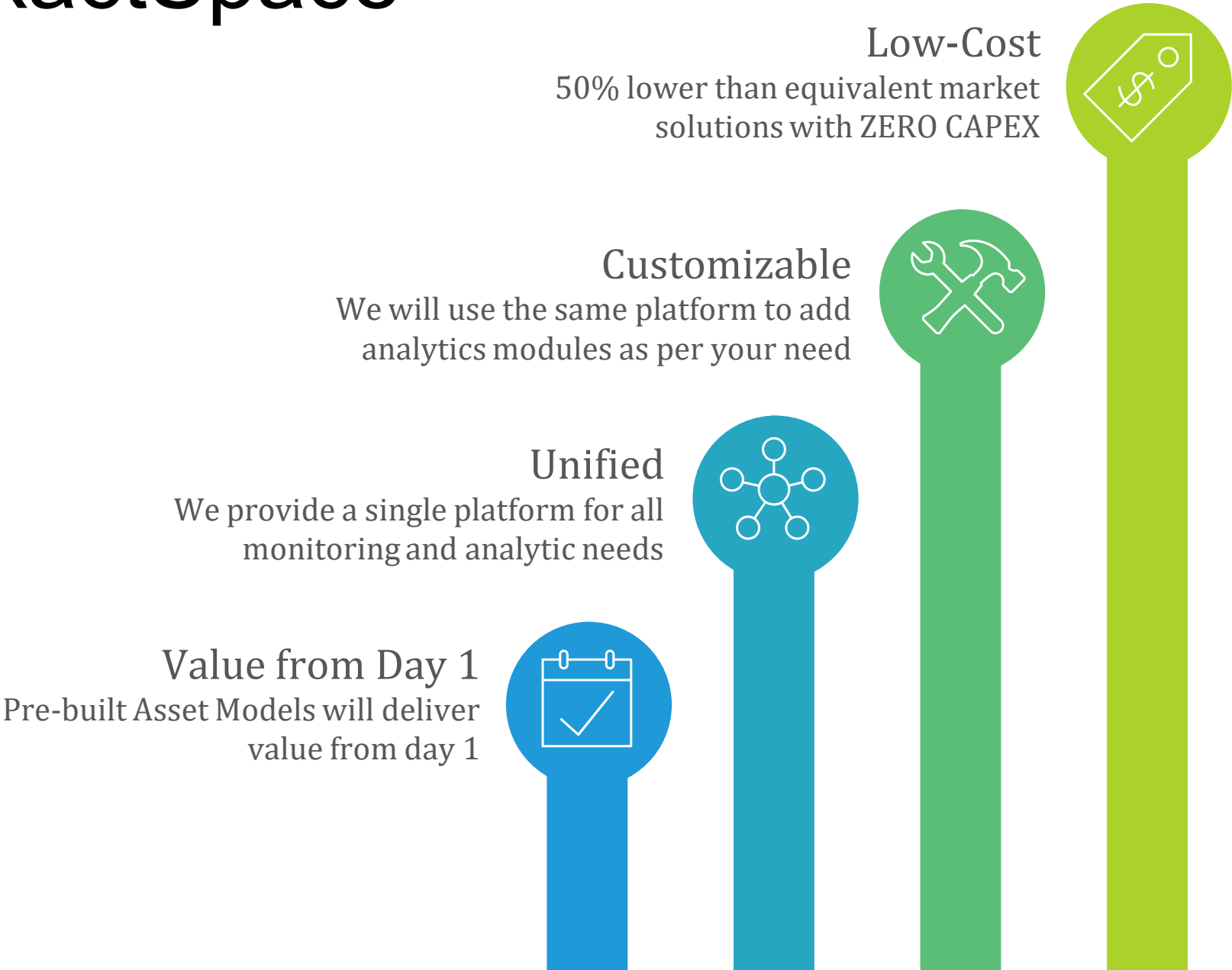Provide diagnostics through fault trees or perform automated RCA using data

New

Video Analytics
Analyze periodic video/audio of rotary equipment to detect minute deterioration in equipment function

Why ExactSpace

Low-Cost
50% lower than equivalent market solutions with ZERO CAPEX

Customizable
We will use the same platform to add analytics modules as per your need

Unified
We provide a single platform for all monitoring and analytic needs

Value from Day 1
Pre-built Asset Models will deliver value from day 1

Thank You!

Reach out to us for more details and solution demo.

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