IBM Connect 2015
Innovate. Understand. Engage.

Analytics in practice: Maximize productivity and operational performance

Colin Shearer, Advanced Analytics Leader,
IBM Asia Pacific

Thursday, 7th May 2015

#IBMConnect

IBM Connect 2015
Innovate. Understand. Engage.

Analytics In Practice: Maximising Productivity and Operational Performance

Colin Shearer
Predictive and Optimisation Solutions Executive
Asia Pacific

Enterprise Asset Management

Enterprise Asset Management as defined by ARC Research:

Physical assets including equipment, buildings, vehicles, and infrastructure need maintenance to sustain their operations. Particularly for capital-intensive industries, **failure of critical equipment is disruptive and costly in labor**, **production output, and customer satisfaction**. Regulators such as FDA, OSHA, DOT and NRC require industries are compliant by providing records for process maintenance with an audit trail. At the same time, **personal safety** is a concern including compliance with occupational and environmental safety regulations. Organizations understand these issues and employ a maintenance organization to sustain its assets

EAM provides enterprise level visibility across functional departments.

Executives have visibility and control across the organization through common systems enabling better business decisions

Compliance/Risk/ Governance can see asset detail to ensure regulatory compliance and mitigate risk

Planner and Schedulers can see availability of their workforce and use graphical tools to make assignments;

Contract Managers can see asset related contracts; negotiate vendor T&Cs and monitor supplier performance

Purchasing Managers can see costs and orders enterprise-wide for price comparisons, discounting, standardization and order tracking

Maintenance Managers can see job plans enabled by availability of information to increase asset capacity

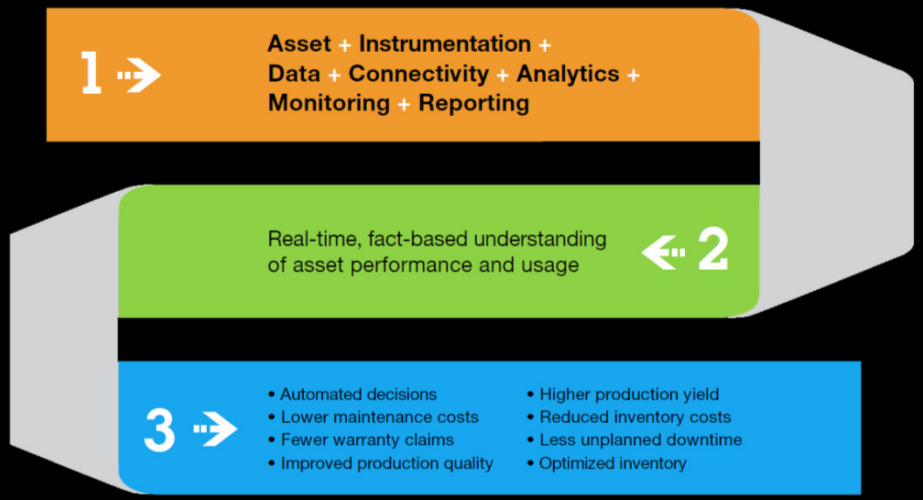
Field Technicians can see work assigned to them and capture critical data about assets in a mobile device

Financial Managers can see the entire inventory and analyze return on assets for financial reporting

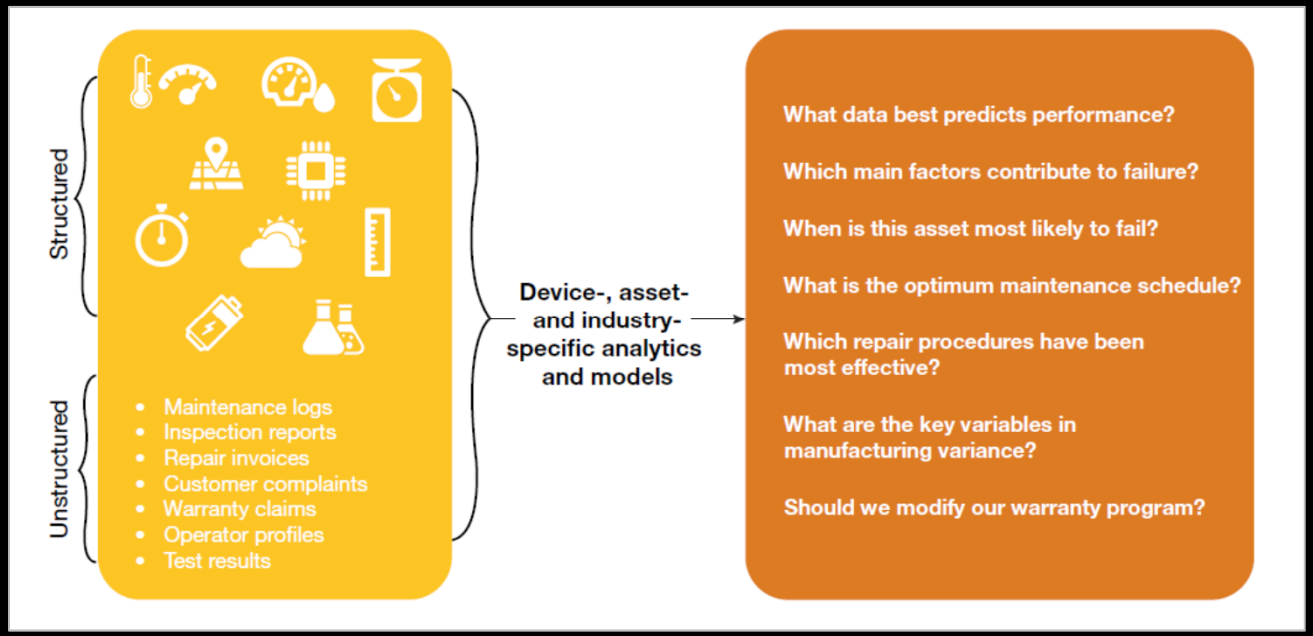
Operations Managers can see asset conditions in sufficient detail to improve asset utilization & performance

IT Managers can see how to streamline inventory and resources across the organization

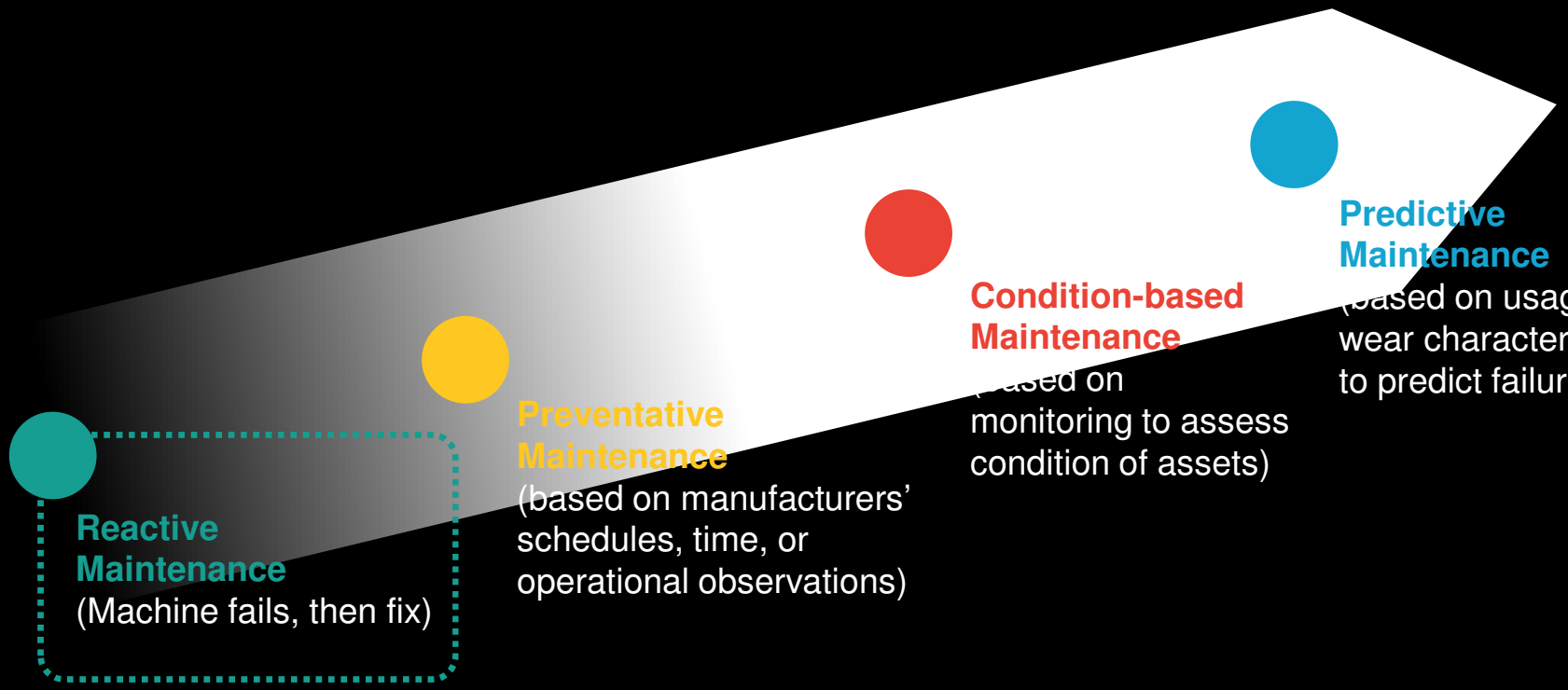
Unlock insights from the Internet of Things



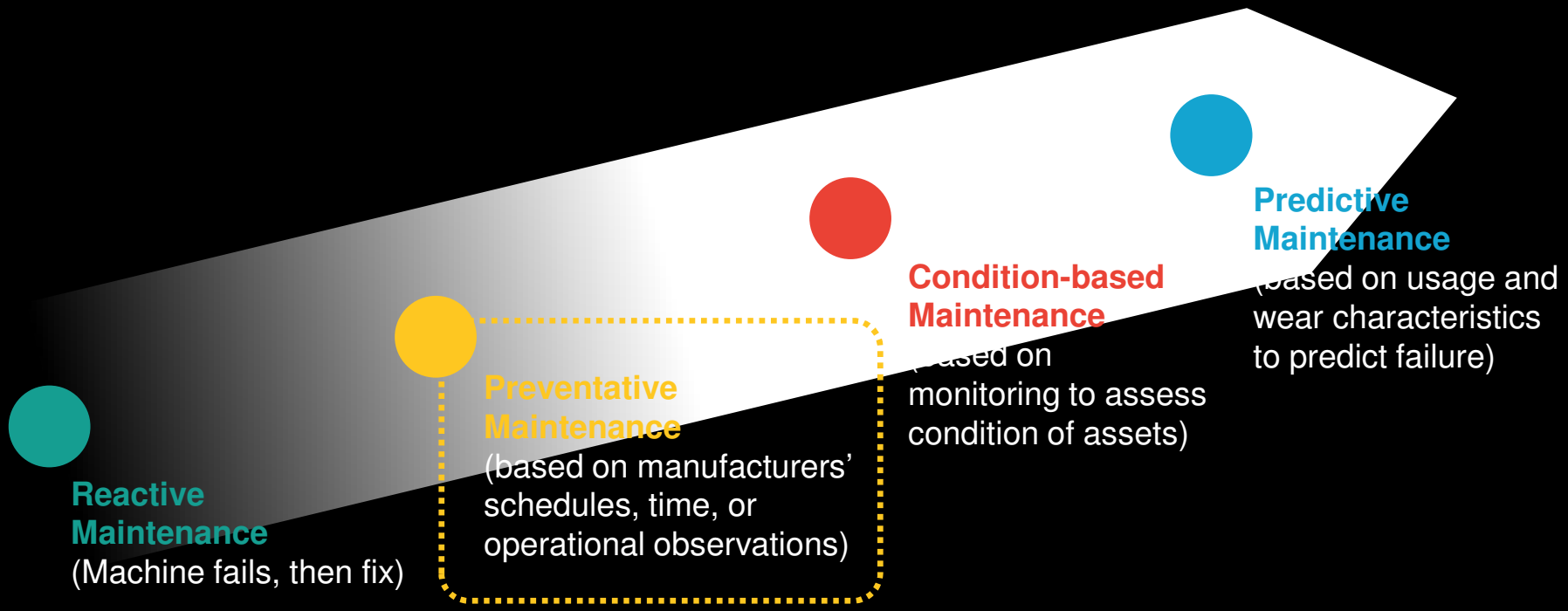
Create accurate Predictive Models that inform makers and operators



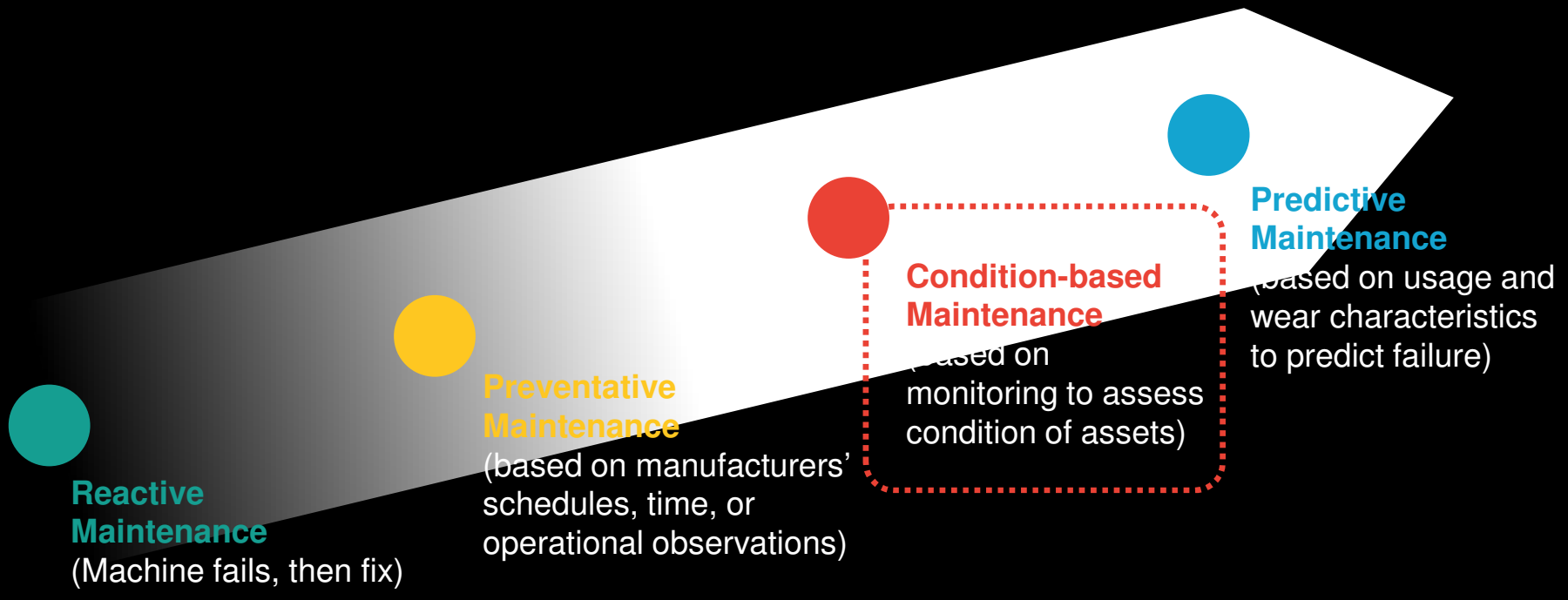
The Evolution of Maintenance



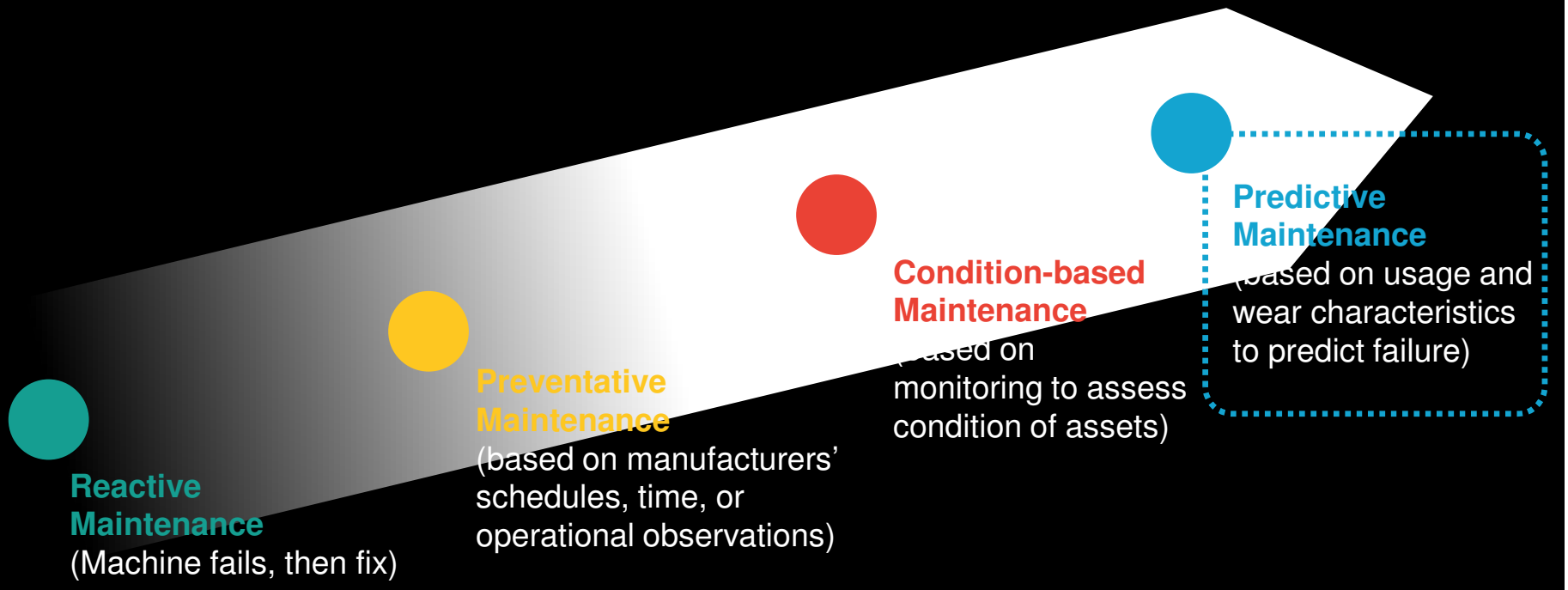
The Evolution of Maintenance



The Evolution of Maintenance

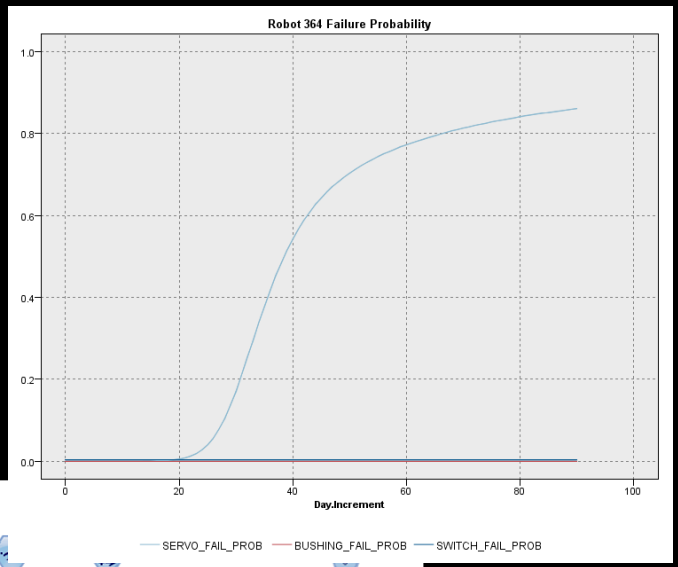


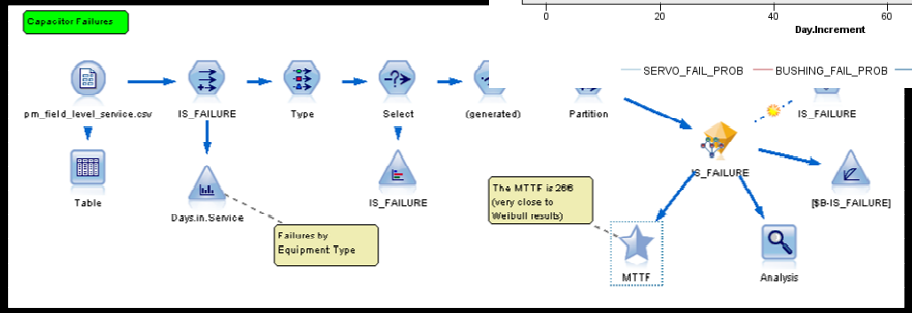
The Evolution of Maintenance



Predicting equipment failure

Core capability:
Leverage ***all available data*** such as sensor logs, maintenance logs (including unstructured text), condition monitoring data, etc. to accurately predict the probability that ***this item*** of equipment, under ***these conditions***, will fail in ***this way*** within a ***specific time***.





IBM Connect 2015

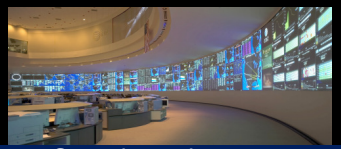
Innovate. Understand. Engage.

Moving from Reactive to Proactive Action

Reactive

Alarms

Wayside detectors



- Stop the train
- Slow orders
- Pull car at next station

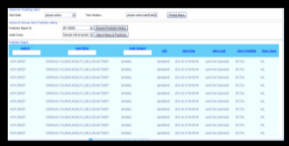
- Alarm Prediction Based on Historical Analysis
- Data mining, machine learning, predictive modeling and failure analytics

Historical and Predicted Alarms Analysis

Alarm Predictions /Maintenance Requirement

Perform Non-Emergency Maintenance

Suspect equipment



Successfully Predicted Alarms in advance:

- Proved ability to predict severe alarms within 7 days with a 98% level of accuracy (with 6% false positive)
- Developed machine learning rules that were more accurate than SME rules developed over the course of 10 years

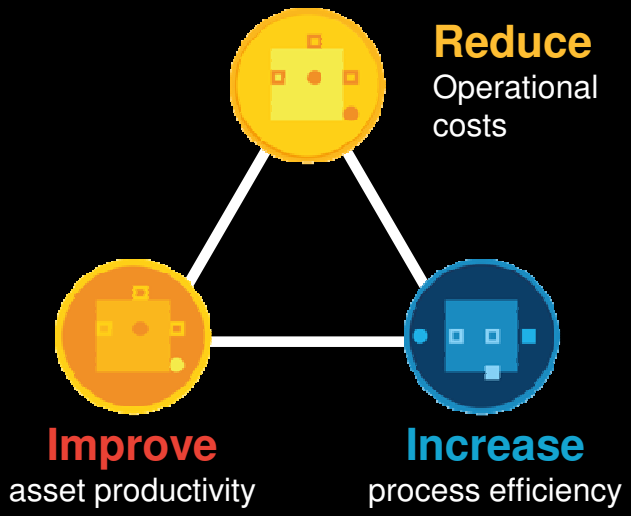
Predictive maintenance drives significant tangible value for…

- Users of Things
  - Prevent unplanned outages and equipment failures
  - Reduce planned maintenance
  - Reduce spares inventory

- Makers of Things
  - Reduce scrap and manufacturing defects
  - Expand revenue opportunities through new business in equipment servicing
  - Optimise supply chain

IBM Predictive Maintenance and Quality

Leveraging big data analytics to:



Enabling better business outcomes:

- Helps monitor, maintain and optimise assets for better availability, utilisation and performance
- Helps predict asset failure to better optimise quality and supply chain processes
- Reduces guesswork during the decision-making process

IBM Predictive Maintenance and Quality offers business value for organisations

Predict asset failure

BUSINESS USE CASES

- Assess failure based on usage and wear characteristics
- Use individual-component information, environmental information or both
- Help identify conditions that can lead to high failure

BUSINESS VALUE

- **Estimate and extend component life**
- **Increase return on assets**
- **Improve maintenance, inventory and resource schedules**

Improve part/component quality

BUSINESS USE CASES

- Help detect anomalies within processes
- Compare parts against a master
- Conduct in-depth, root-cause analysis

BUSINESS VALUE

- **Improve quality and reduce recalls**
- **Reduce time to identify issues**
- **Improve customer service**

Israel Electric increases grid reliability

20% cost reduction
by avoiding the expensive process of reinitiating a power station after an outage

Increased efficiency
of preventive maintenance schedules, costs and resources, resulting in fewer outages and higher customer satisfaction

USD80,000 savings
on petrol combustion costs by avoiding the malfunction of a turbine component

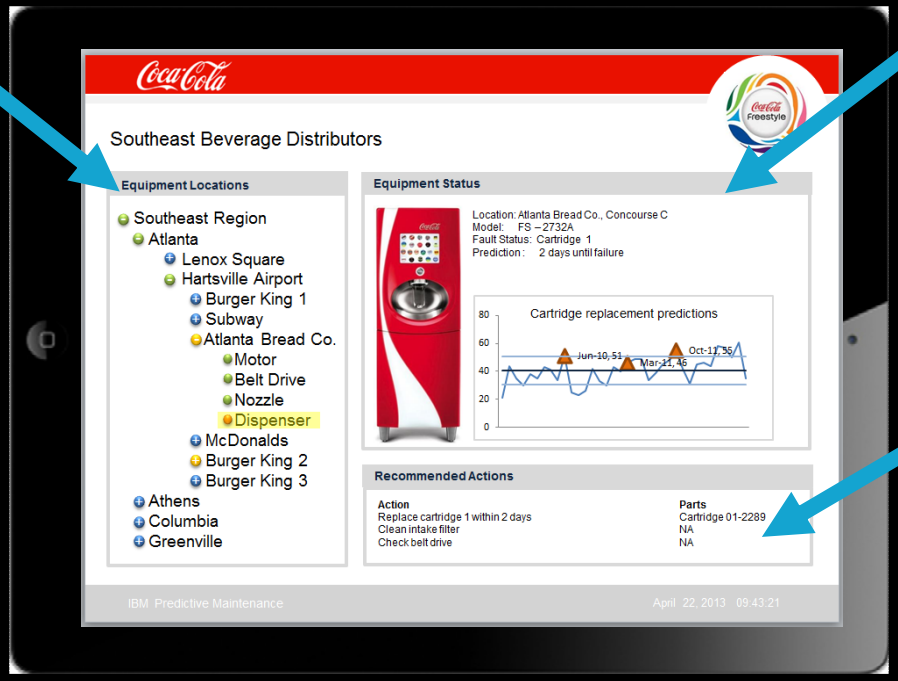
Business problem: The company's research institute is charged with improving the safety and reliability of power generation and transmission while fueling innovation. That includes planning for disruptive events such as solar storms, making improvements in transmission efficiency, incorporating new sources of renewable energy into the grid and analyzing growing volumes of data from an increasingly smart grid.

Solution: This energy provider uses powerful predictive analysis to understand when and why outages occur so it can take steps to prevent them.

Distributor's equipment across their region Colors indicate an issue

Predictive statistics for selected machine

Recommended corrective actions



Visibility : Management Cockpit using digital signage system the summary of a specific test car

References : Development of Battery Traceability System for EV, Technical Review Vol.25 No1, Apr.,2013. Honda R&D Co.,Ltd.

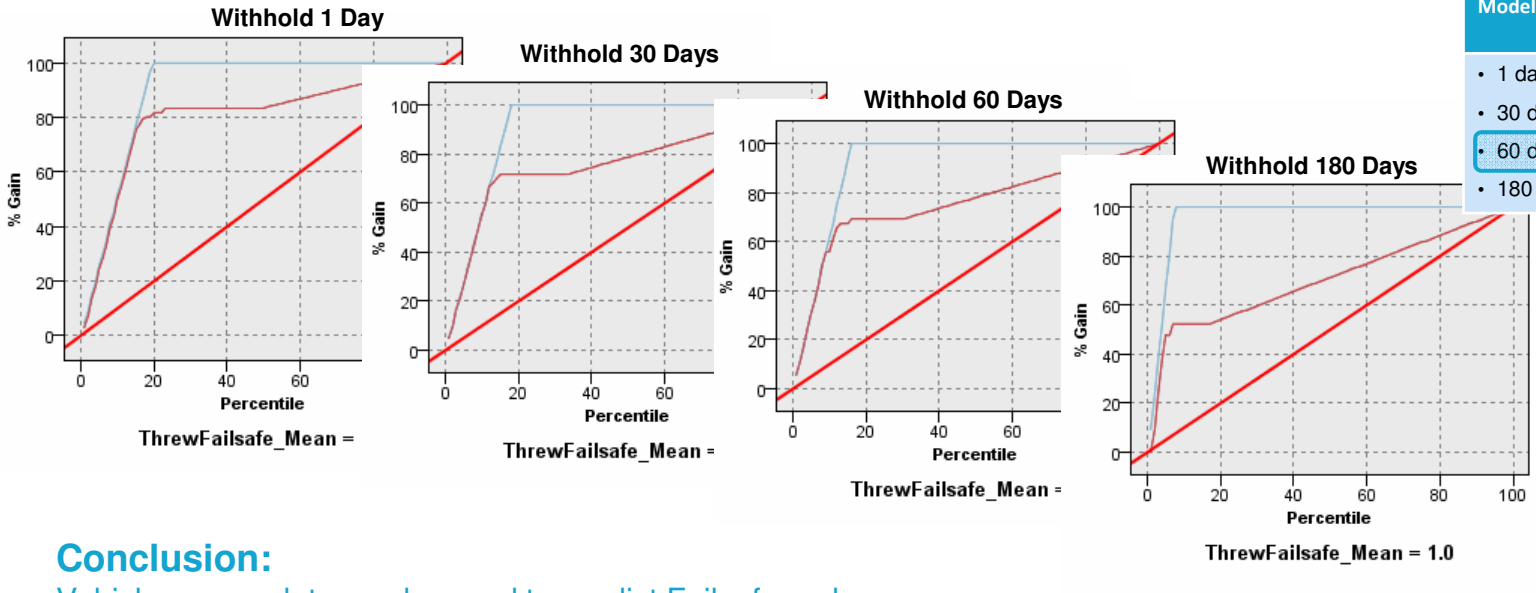
Internavi LINC　Premium Club : EV Telematics Service

- ECO driving advice to driver via Smartphone
- Detailed and archival data provide TabletPC/PC

（出典：自技研工業「EVテレマティクス」取扱ブック一冊）

Analyse Failsafe Prediction Capabilities for Earlier Detectiont

- Evaluate predictive capability by withholding from the model a specific number of days of vehicle data prior to Failsafe.
- Withholding data simulates the amount of time in advance that Failsafe codes would be predicted.



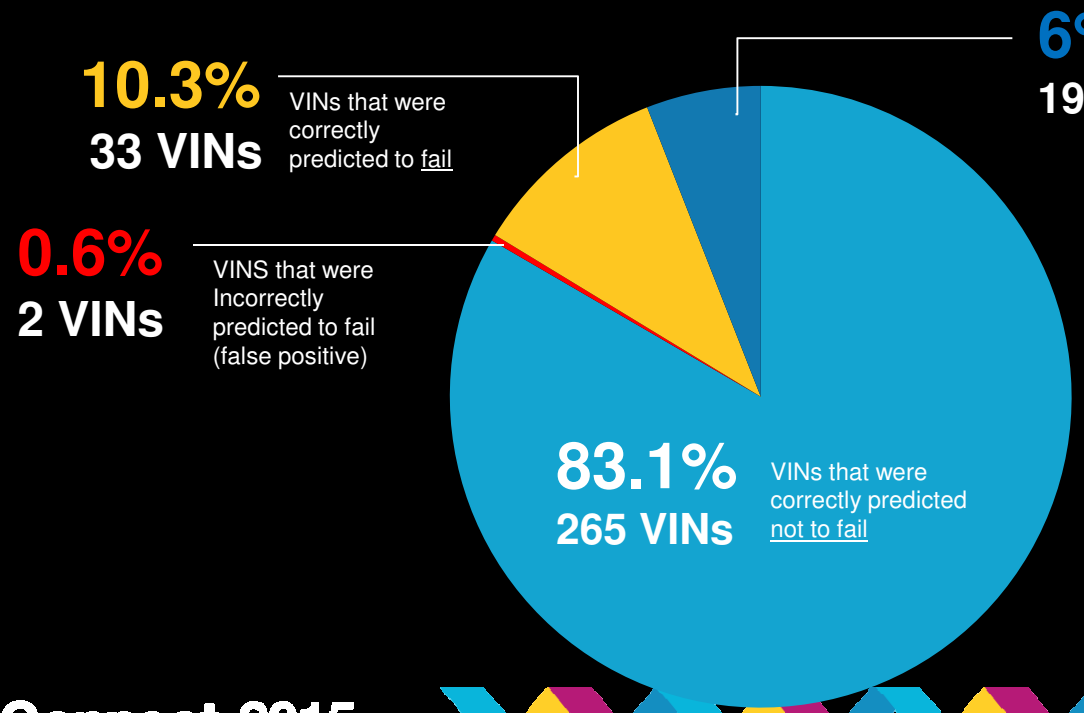
Models	% VINs Identified Correctly for Failsafe
• 1 day	• 80%
• 30 days	• 70%
• 60 days	• 63%
• 180 days	• 50%

Focus on 60 Day Predictions as best trade-off between accuracy and early warning

Conclusion:

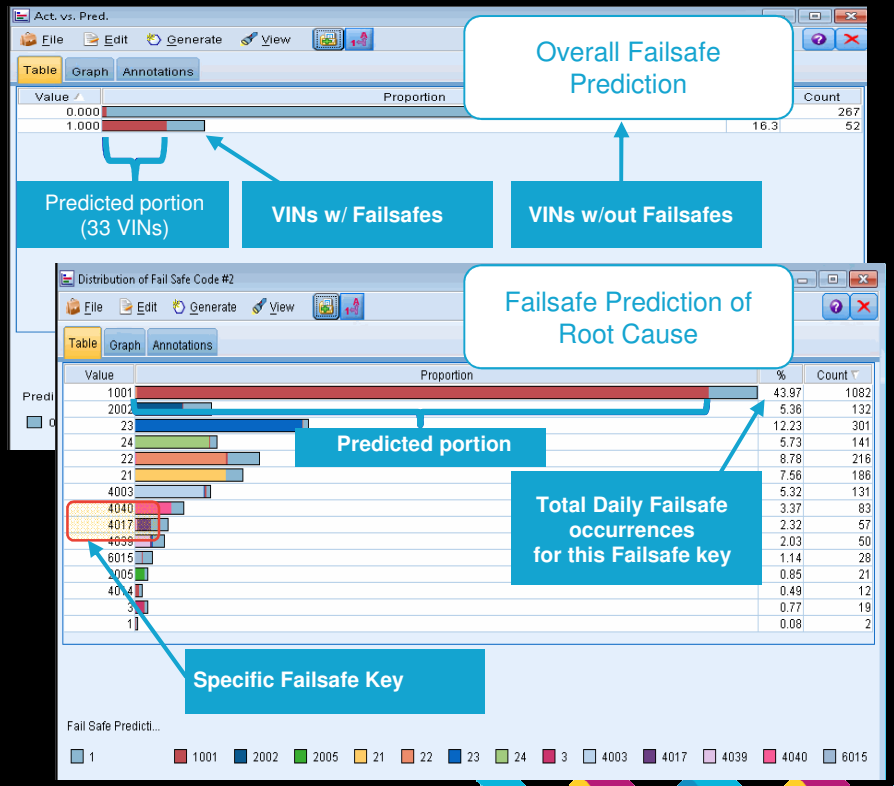
Vehicle sensor data can be used to predict Failsafe codes

SPSS Model correctly predicted Failsafe outcomes for 93.7% of VINs 60 days before the failsafe occurred, including identifying nearly two thirds of all VINs that would experience a failsafe



Key Message:
Model has very high accuracy with very low incidence of false positives

Failsafe prediction performed at specific Failsafe Key level



- Model identifies 63% of the vehicles that will fail **2 months** in advance - and it also predicts **WHY** they will fail
- **Honda Implications / Value**
  - Take remediating actions on specific VINs
    - Execute **low cost repair** actions vs. more costly post Failsafe repairs
    - **Improve customer experience**, resulting in larger probability of future customer service / vehicle purchases
  - Track daily predictions to **identify largest or fastest growing future issues**

Numerous uses cases in Chemical & Petroleum e.g.

Analyse real-time streaming sensor environmental data while drilling for oil such as build up of sediment, water opacity, leaking hydrocarbons

- Predict environmental changes that could lead to equipment failures and contamination
- Identify preventative actions to avoid environmental damage

Global machine OEM analyses machine data

- Analysed 2 years of machine operating data combined with publically available data such as: mine locations and production volumes, commodity prices and location algorithms
- Identified potential leading indicators for machine usage, and parts and service demand

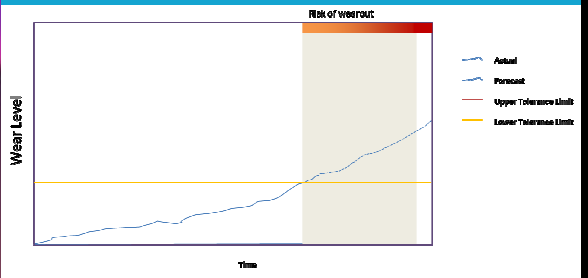
Stuck casing in casing runs is a catastrophic event

- Developed a statistical model using only three data points – hook load weight, bit block position, and depth
  - Derived over 220 variables to account for such factors as casing velocity and travel time implications
  - Trained models on actual static friction events
- 84% of static friction events are accurately predicted by the models
- Estimated Annual Savings in one geo-location: $54MM

Predicting asset failure: Aircraft engines

Airline Engine Manufacturer

- 95% Ability to **predict in-flight shutdowns** within a year
- 97% Ability to **predict on-ground major incidents** within 12 weeks



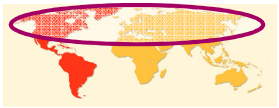
Monitor wear levels by direct measurement or inference (e.g. vibration levels)
Understand wear rate and risk factors for wear
Forecast wear
Calculate probability of wearout using wear rate and tolerances

Warranty
Minimising repeat repairs – one example

Analysis based on PMQ

- Automated Data Mining Services using the PMQ platform
- Automated analysis of patterns, trends and dependencies of fault memories by using e.g. correlation analysis, neural networks, logistic regression, decision trees etc. a
- Proactive identification of systematic failures and their dependencies
- ➔ Significant reduction of warranty costs

Example



Cars in **northern regions** very often have problems with the side mirror

J F M A M J J A S O N D

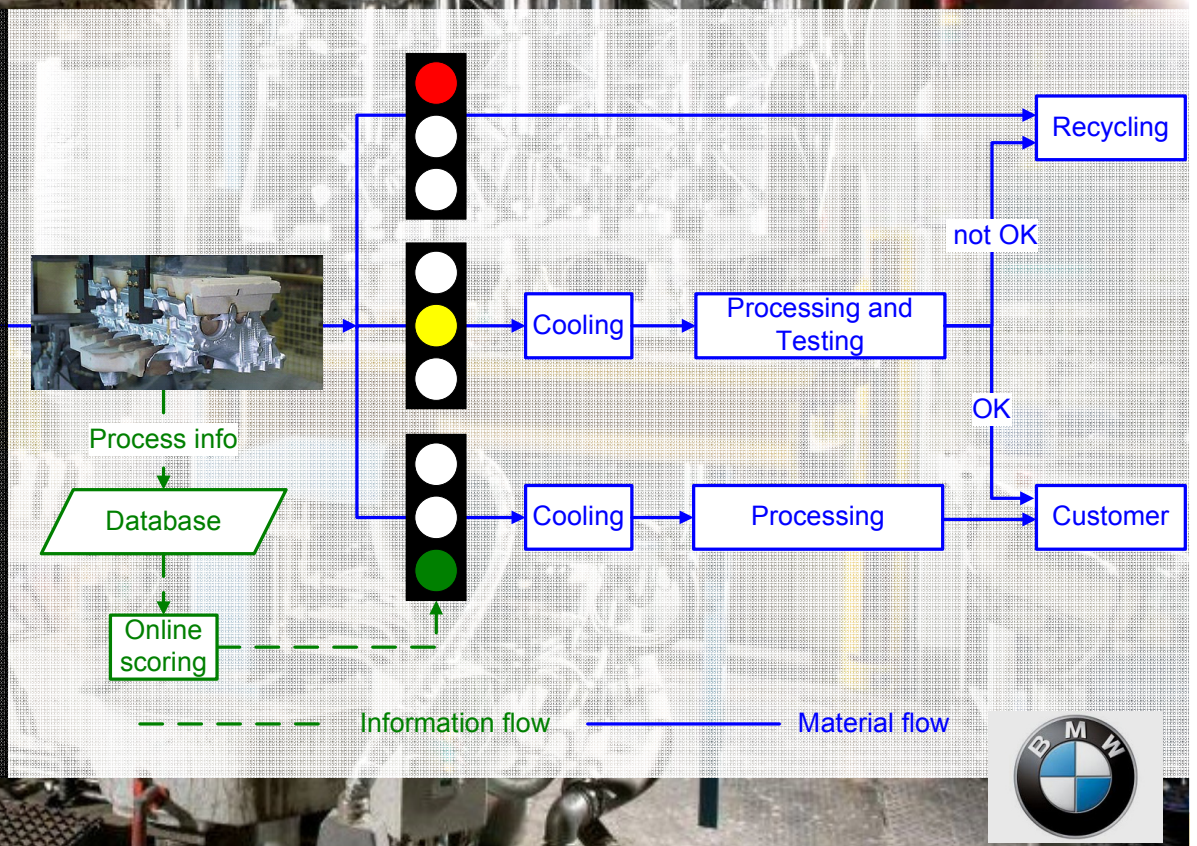
These anomalies to the rest of the world typically occur in the winter.

The problems occured 1-3 weeks after a service in a garage.

Reduction of warranty claims by 5% equals > 11 mio € savings p.a
Reduction of Repeat repairs by 50%

Production: Analytics is used in the BMW light-alloy foundry for the production process to better understand and eliminate problems quickly.

Reduced scrap rate by 80% in 12 weeks




Predictive Quality: Analytics is used in the Daimler Powertrain facility for the production process to better understand and eliminate problems quickly.
Reduced defect rate by 50% in 16 weeks, Cylinder heads
Mercedes-Benz

Japanese vehicle manufacturer predicts and prevents production line down time

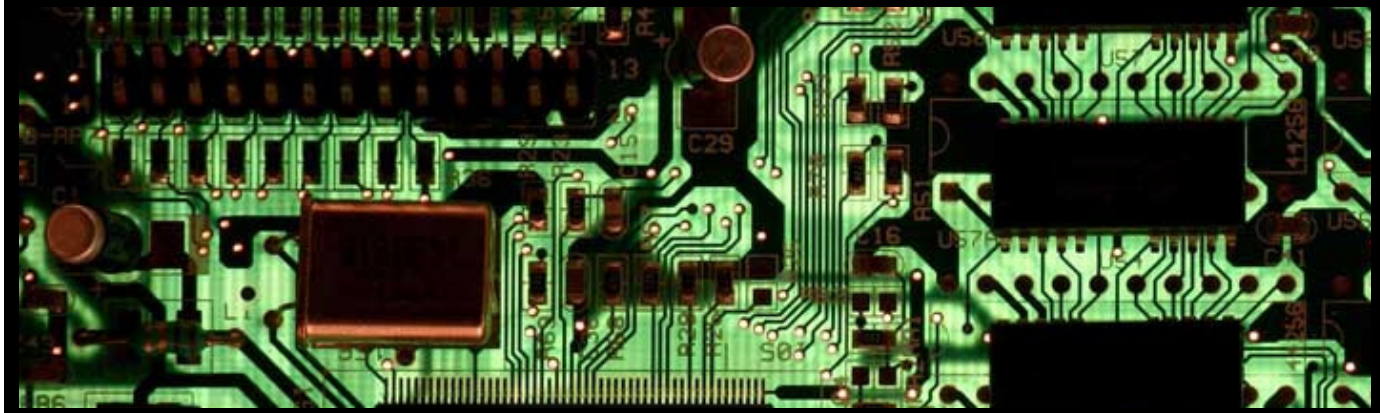
164 out of 180 faults were predicted in advance

by Predictive Maintenance & Quality model,
92 predicted > 2 hours in advance

The above faults accounted for 143 hours of downtime

Approximately 1.5 hour/fault

IBM Bromont gains huge returns on investment through smarter quality management



The transformation: Rather than commissioning time-consuming and expensive lab tests to identify the root cause when quality control systems on the production line detect problems, IBM Bromont is using analytics to identify fault patterns and predict outcomes – saving inspection costs and getting production back online much more quickly.

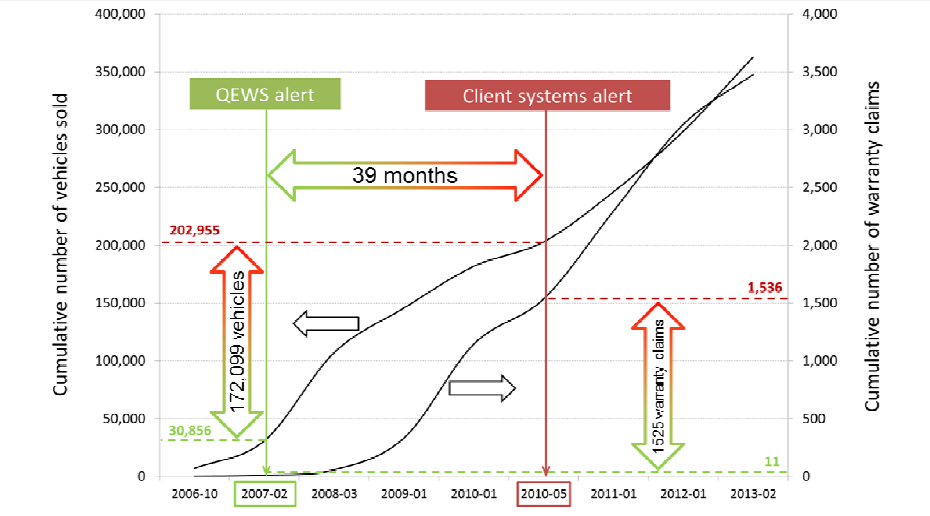
"Insight into fault patterns enables us to identify the underlying defects without having to send so many modules to the laboratory for inspection. By the end of this year, we are expecting to see a 150 percent return on our investment." —Matthieu Lirette-Gelinas, Business Analytics Junior Engineer, IBM Bromont

97% fault recognition
for one specific operation potentially avoids hundreds of thousands of dollars in total costs

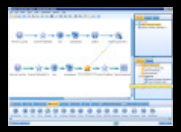
150% ROI expected
from fault pattern recognition analytics

160% ROI expected
from improving product quality by controlling humidity at one point on the manufacturing line

Predicting quality issues



- Has anything changed enough to require action?
- The algorithm detected a problem in warranty claims data 39 months earlier than the clients' existing systems
- By the time the clients' systems detected a problem, an additional 172k vehicles had been sold and an additional 1.5k warranty claims had been made



#2

Generate predictive and statistical models

#3

Attain analytical insights

#4

Display alerts and recommend actions

#1

Collect and integrate data
Structured and unstructured, streaming and at rest

PMQ: The Predictive Maintenance Cycle

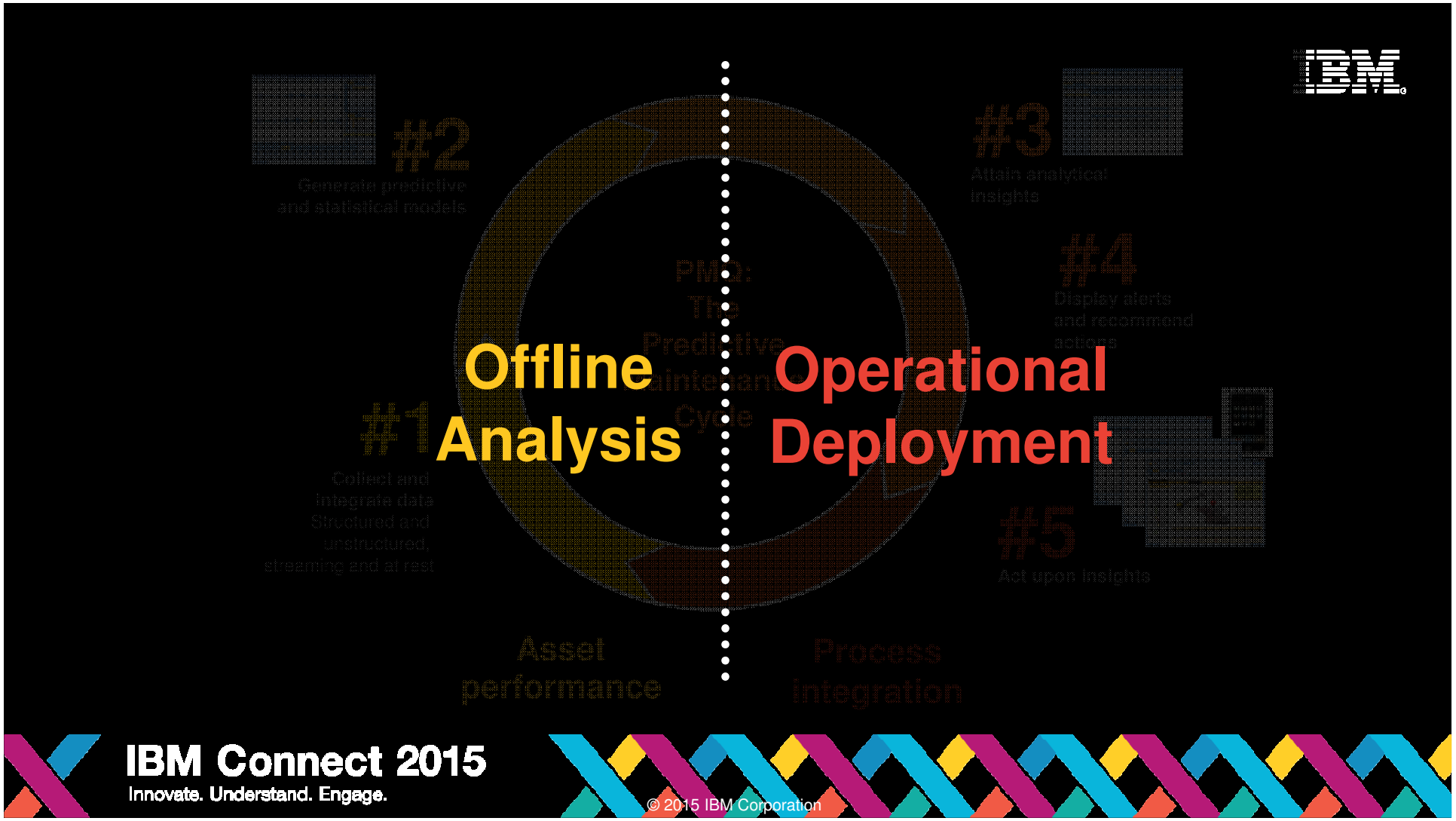
#5

Act upon insights

Asset performance

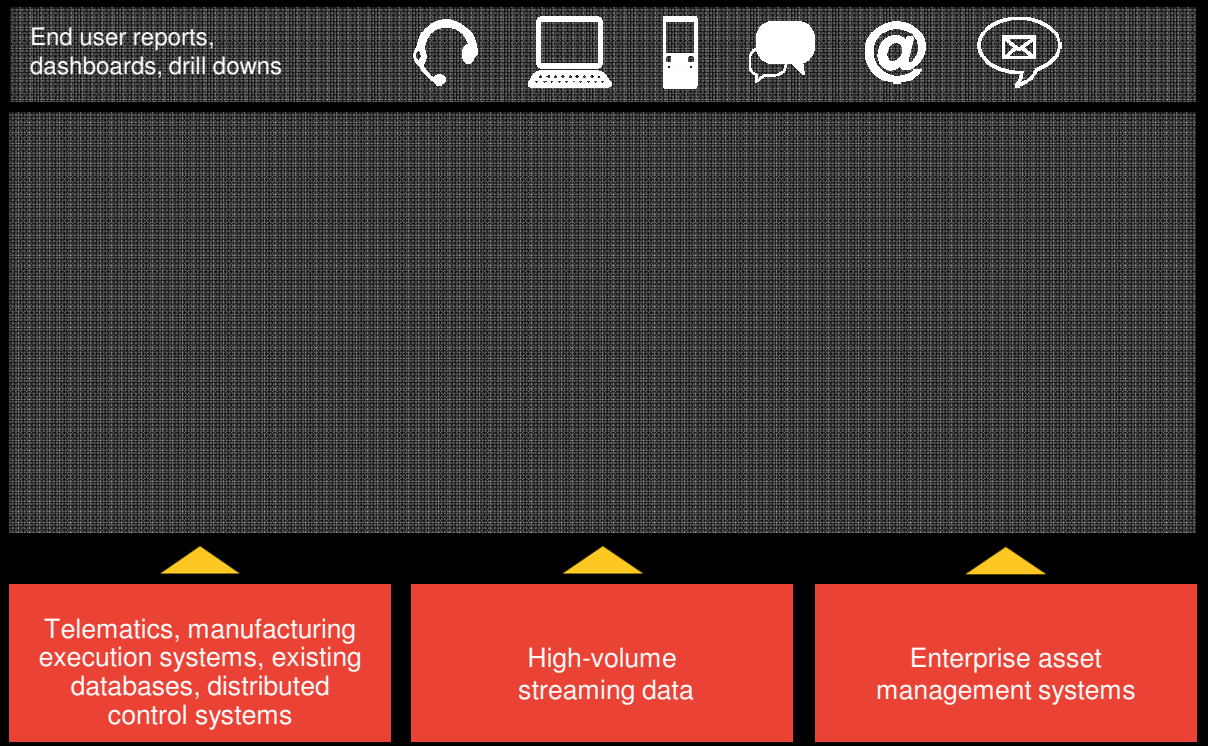
Process integration

IBM Connect 2015
Innovate. Understand. Engage.

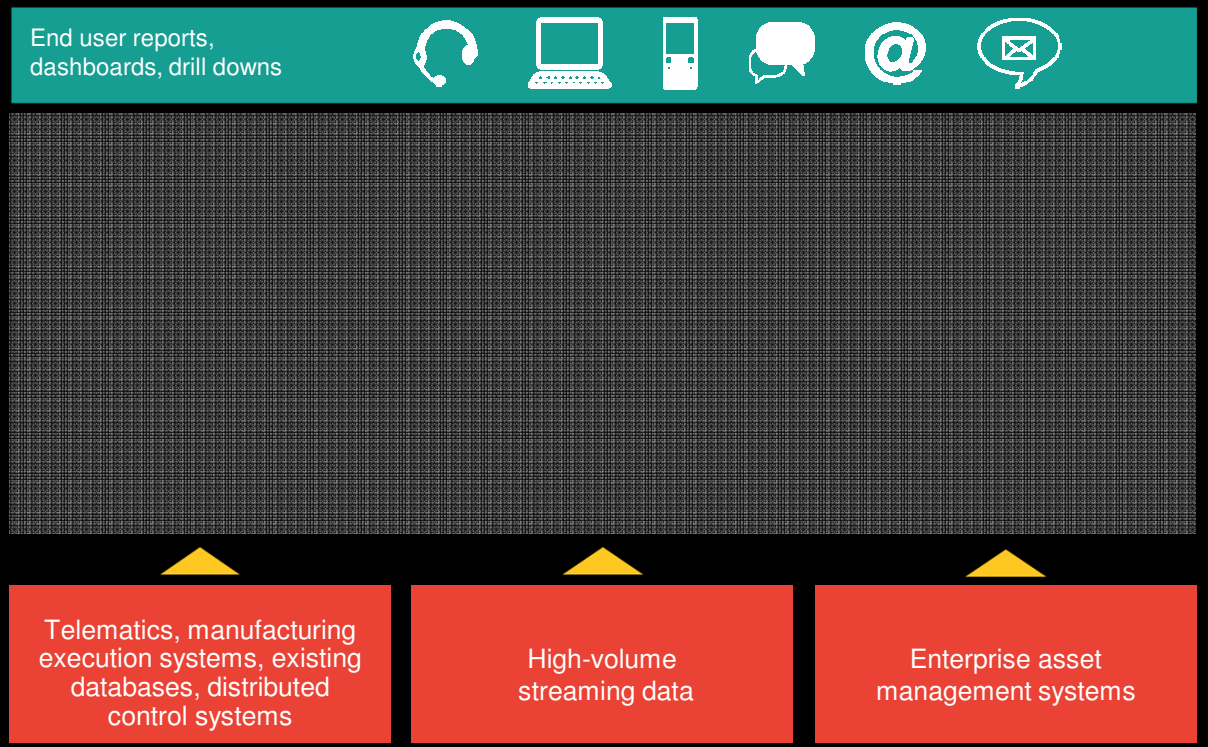


IBM Connect 2015
Innovate. Understand. Engage.

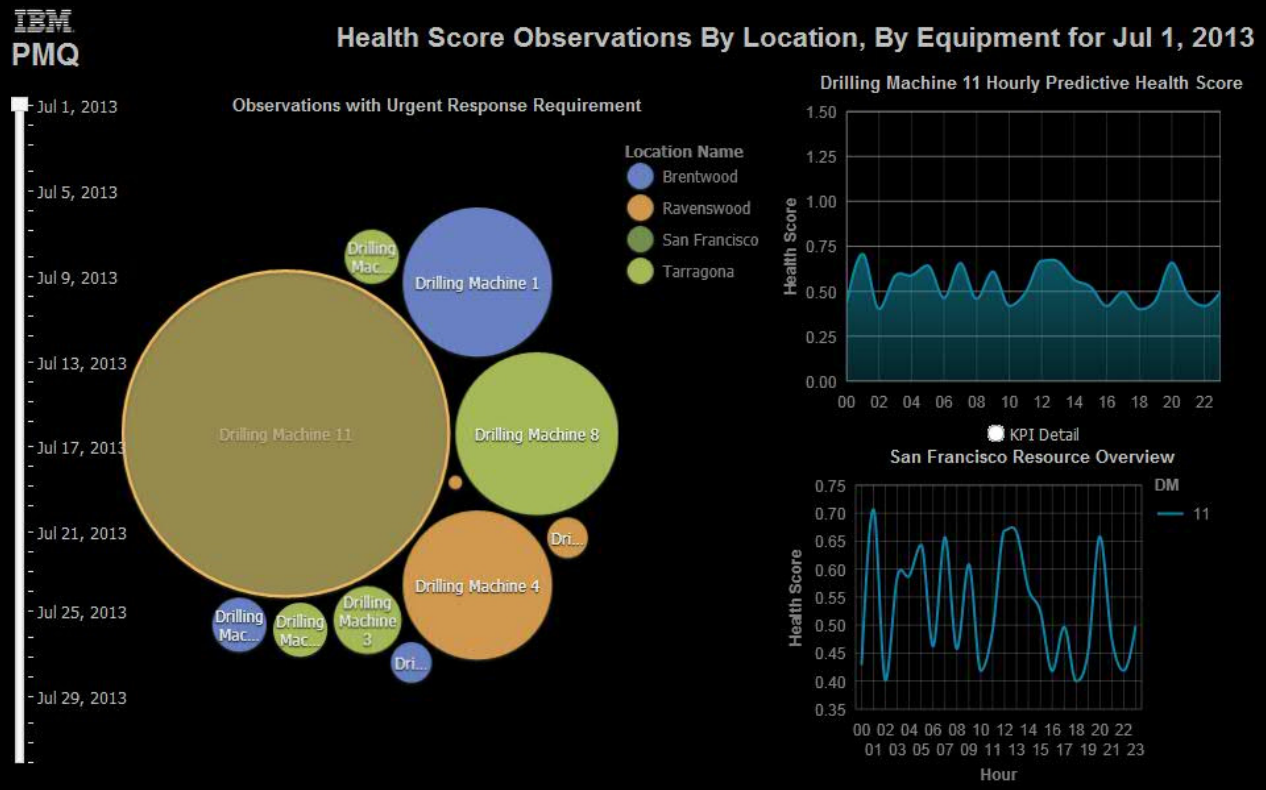
Operational analytics for maintenance: a range of data sources…



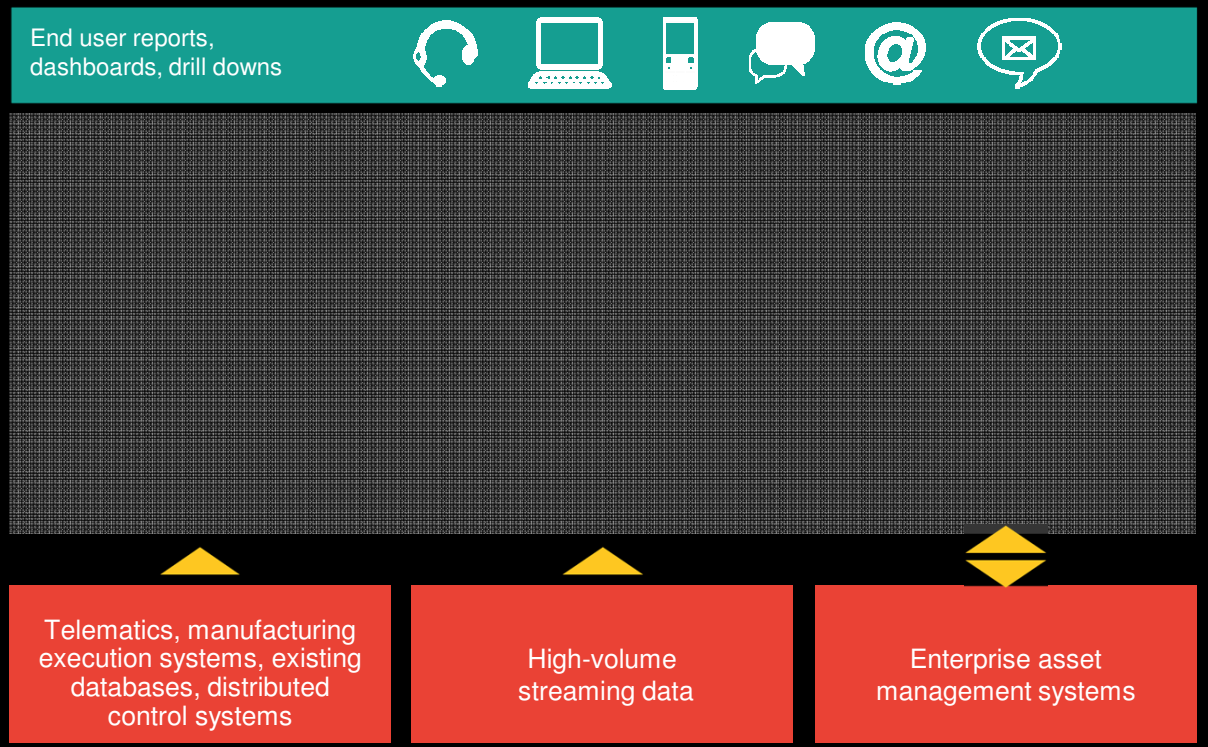
….and a range of outputs



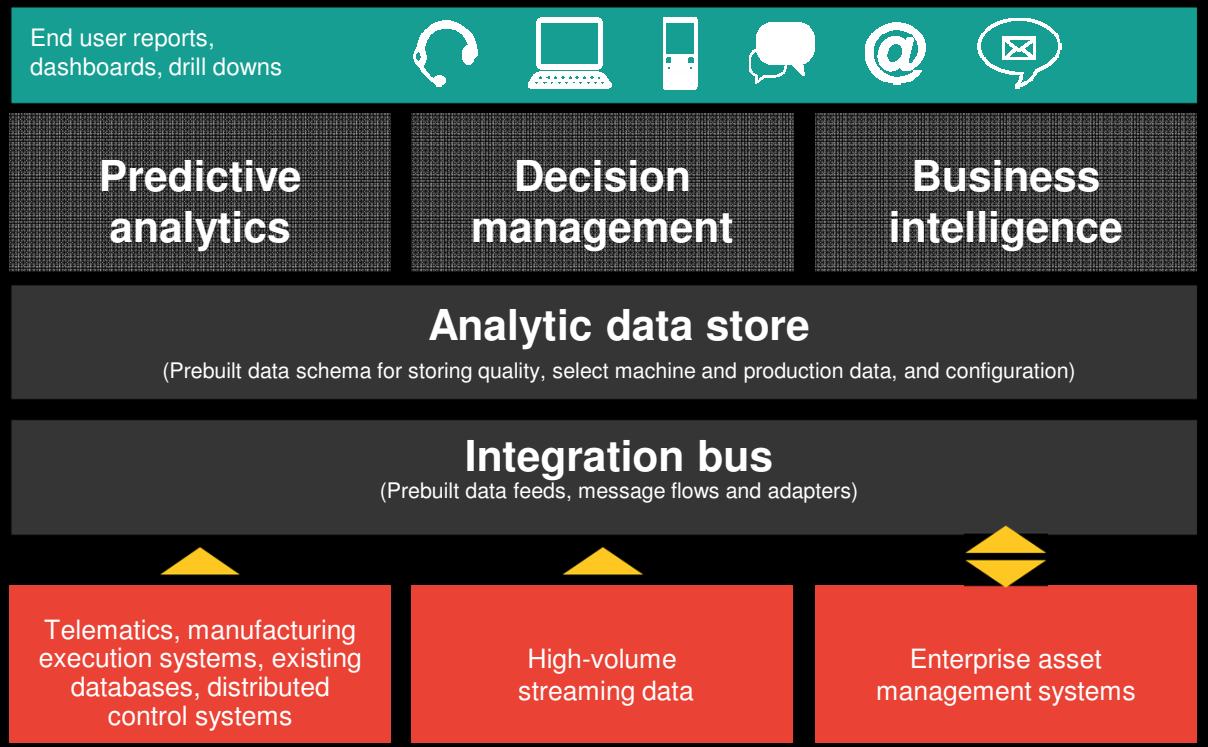
Foresight that can directly drive action



….including *actionable* outputs



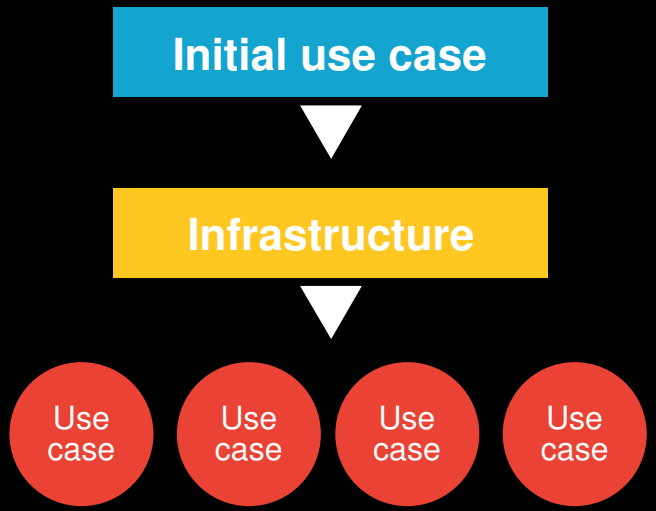
IBM Predictive Maintenance and Quality from raw data to action



How to get started?

- Always bear the “big picture” in mind, and the benefits that accrue from a holistic deployment of predictive maintenance…

- …. but look at opportunities for quick wins
  - *Where are the points in your operations where a predictive maintenance approach would quickly deliver significant returns?*



Predictive Maintenance and Quality converges enterprise asset management and analytics capabilities

Enterprise asset management → **Predictive Maintenance and Quality** → **Better outcomes**

- Asset maintenance history
- Condition monitoring and historical meter readings
- Inventory and purchasing transactions
- Labor, craft, skills, certifications and calendars
- Safety and regulatory requirements

- Better maintenance windows to reduce operating expense
- More efficient assignment of labor resources
- Enhanced capital forecasting plans
- Enhanced spare parts inventory
- Automated analytical techniques, including anomaly detection for assets and sensors
- Improved reliability and uptime of assets

Assets "talk"….PMQ "listens"!

Predictive maintenance drives significant tangible value for industrial companies in all industries

Prevent unplanned outages

- 5-7% forced outages due to unexpected failures of upstream petroleum production equipment @ 1 million barrels/ day production is $1.8B annually
- Mechanical unavailability represents ~6% of oil refining capacity. 350 global refineries @ 250KBD with marginal production valued @$1/b = $1.9B/yr
- Haul Trucks (mining) value up to $1.8 M / day
- For Giant Excavators (mining) value up to $5 M / day
- For a 10million tons steel producer caster downtime up to $7.3m / day
- In Semiconductor, 1% downtime across the 50 most critical tools in a fab plant is $100m

Reduced planned maintenance

- 13% of oil drilling time is spent waiting on maintenance activities @ avg. ~$100k/d/rig that's $4.7B.
- Maintenance represent 20% of cash opex for oil production license (PL) companies. For 10 largest NA PL co's. 5% improvement yields $1.6B annually.
- Cost of maintenance (from time-based repair to actual equipment condition) can improve up to 15% in mining and metals
- Reduced short-interval maintenance drives savings of upwards of $50-100m in parts and lost production time in Semiconductor.

Reduced Scrap & mfg Defects

- Semiconductor lot values can range from $100K to >$1M
- Reduced defects and scrap in automotive mfg

Expanded revenue opportunities through new business in equipment servicing

- Aircraft and Engines; Mining, Farm, and Construction Equipment; Commercial Trucks and Automobiles
- Improved customer satisfaction

IBM Advanced Analytics

A long history
of **predictive maintenance** applications

Today, opportunities exist to dramatically improve the bottom line

Interconnected growth, lower data-capture cost

1 trillion, USD0.03

Number of sensors by 2015[1]

Estimated price of average passive sensor by 2021, representing a 66 percent decrease in eight years[2]

Risk of asset failure

#1

Failure of critical assets was the top risk stated by executives as having the biggest impact on operations[3]

Focus on operational processes

99%

Percent of CIOs with mandates to transform the business who are looking to simplify key internal processes[4]

1Making Markets:Smarter Planet. IBM Investor Briefing, 2012
2 Big Data-Startups, "The Great Sensor-Era: Brontobytes Will Change Society," April 16, 2013.
3 Aberdeen Group, *Asset Management: Using Analytics to Drive Predictive Maintenance*, March 19, 2013.
4 IBM, *The Essential CIO: Insights from the Global Chief Information Officer Study*, May 2011.