

# Leveraging IoT and Cognitive Capabilities in Field Operations and Asset

Internet of Things (IoT) and Smart Grid--The 21st Century Technologies for the Power Sector

5 June 2017

# *The IBM Utilities POV outlines three strategic imperatives shaping the future of the industry*

## Embrace the role of energy integrator



### 1. Viable Substitutes

**Rise** introducing the business and technical challenges of intermittency, dispatchability and disintermediation

#### WHAT WE SEE SHIFTING

- Alternatives reach grid parity in both capacity and price
- From centralized to distributed

## Engage customers as individuals



### 2. Customer Engagement

**Deepens** through rich and instant interaction, delivered via social and mobile apps

#### WHAT WE SEE SHIFTING

- Energy intensity is sinking
- Prosumer supply is expanding

## Disruptive Innovation



### 3. Core Expectations

**Persist** requiring the continued delivery of safe, reliable and low cost energy with sustainability embedded

#### WHAT WE SEE SHIFTING

- Grid essentiality is challenged
- Agile new entrants emerging
- Growth stunted by #1 and #2

*All three strategic imperatives are affected by the IOT megatrend, and a new approach that addresses the complexity from the proliferation of data*

# Case study: Transmission & Distribution Utility

## Asset Management & Analytics



### Overview

- Electricity & gas generation, transmission and distribution
- Core to the value chain are generators, import / connection points, transmission and distribution network and equipment and end customers (home & offices)

### Motivation



**Regulatory framework's** goal is to ensure reliable and sustainable energy networks that give consumers value for money



Enable supply of **low carbon energy** and reduction in Greenhouse gas levels aligning national mandate

20% of energy has to be from **renewable** sources. Less predictable & controllable nature of renewable energy requires flexible grid

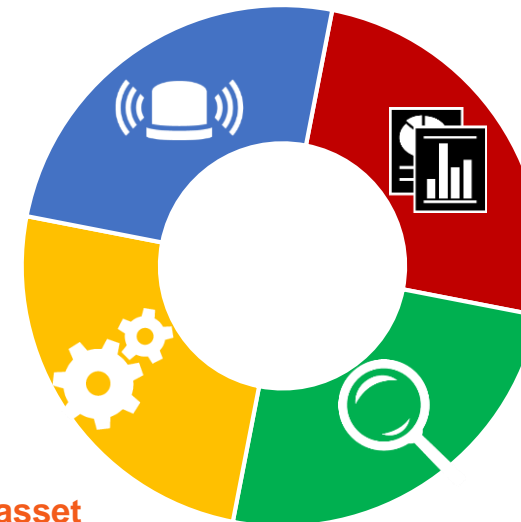


Many electricity **assets are ageing** and reaching to end of useful technical lives. Investment required for asset replacement / refurbishment

### Benefit & Value

Improved & more **access to data** – risk, criticality based approach, asset health, network risk modelling etc.

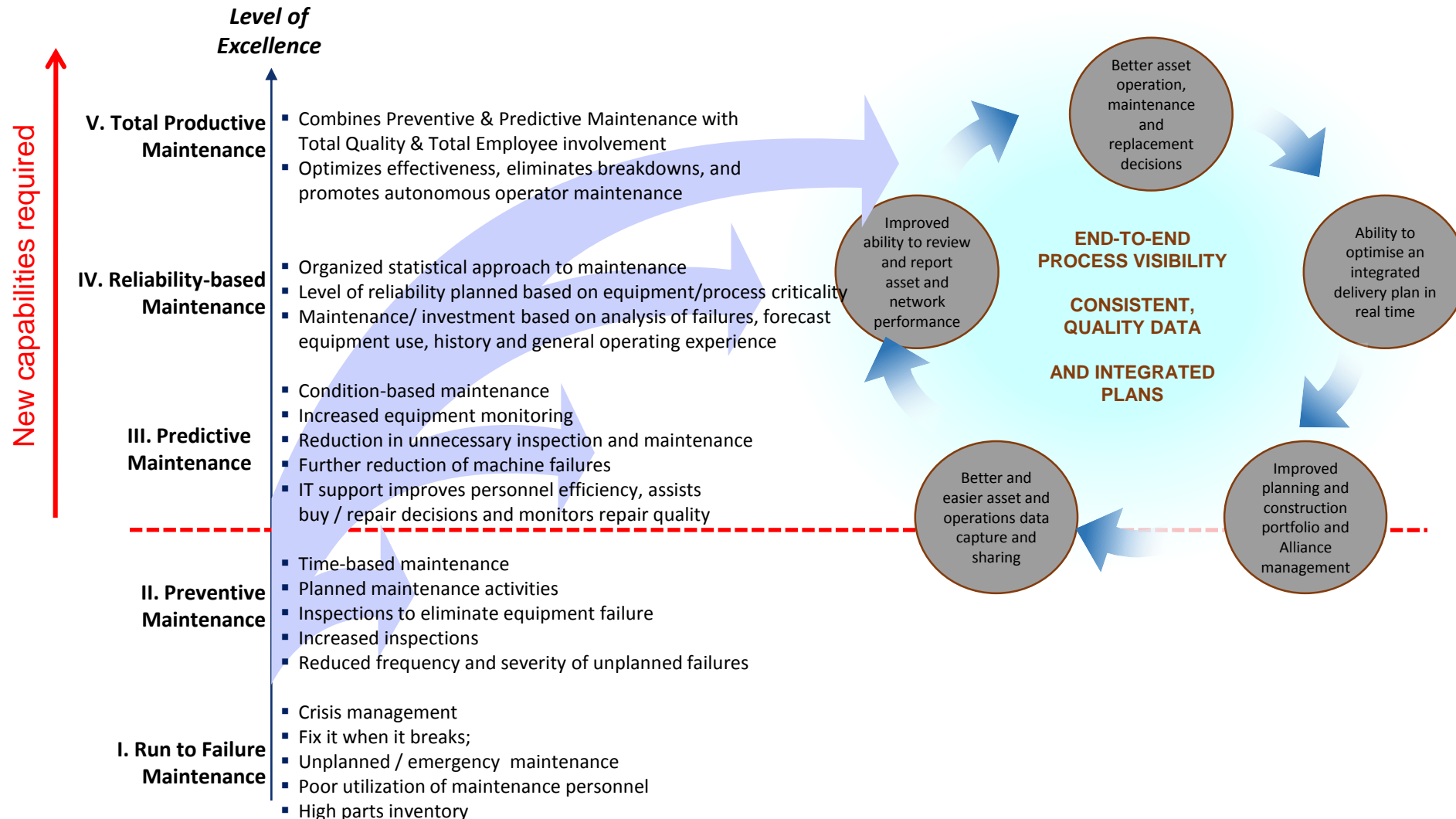
Efficiently use **non-invasive maintenance data** (e.g. HD photos, infrared imaging, RFI monitoring)



**Optimize asset maintenance / investment and replacement choices**

A modular & integrated platform support **future growth in analytics** – faster deployment, data sharing, models etc.

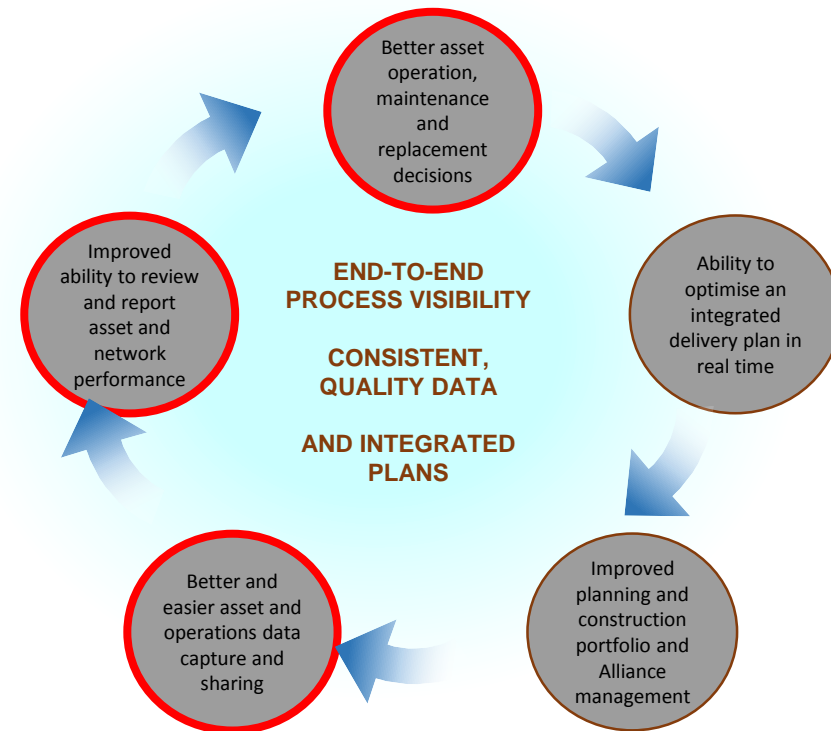
# Regulatory framework has driven a re-assessment of how to manage assets... ...with a consequent need for new capabilities



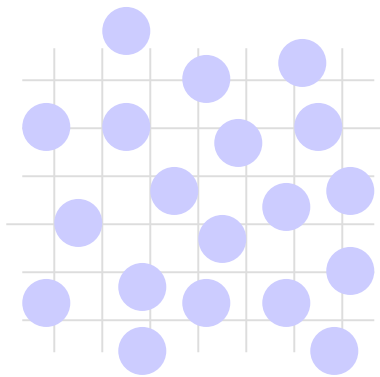
# Phase 1 of the programme focused on capability in the following areas:

1. **New analytic capabilities** allowing improved and more access to data and information. For example, to support a risk and criticality based approach, asset health analysis, network risk modelling, etc.
2. A means to **efficiently use the increased volume of non-invasive maintenance data** and information e.g. RFI monitoring, infrared imaging, HD photography
3. **Tools to make use of the geo-spatial data**, integrated with other structured data that is currently available, e.g. route planning..
4. Consistent tools to **optimise asset maintenance/ investment and replacement choices**, in order to deliver the opportunity for outperformance against incentives arrangements
5. A modular and integrated platform that will **support the future growth in analytic activity**: facilitating faster deployment, sharing of data, models and analyses and avoiding bespoke development of IS systems
6. Provide **more consistent information**, in a single place that all users can access more frequently and with less hand-offs (measure once use many times)

**..delivered via a single focal point for all asset and network analytics and all workers, inc. mobile ones**

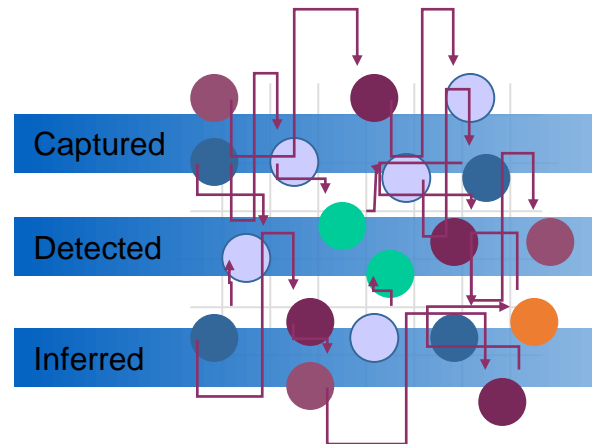


# In practice this means that we have to provide...



Use **structured** and **unstructured** data

- Numeric
- Text
- Image
- Audio
- Video

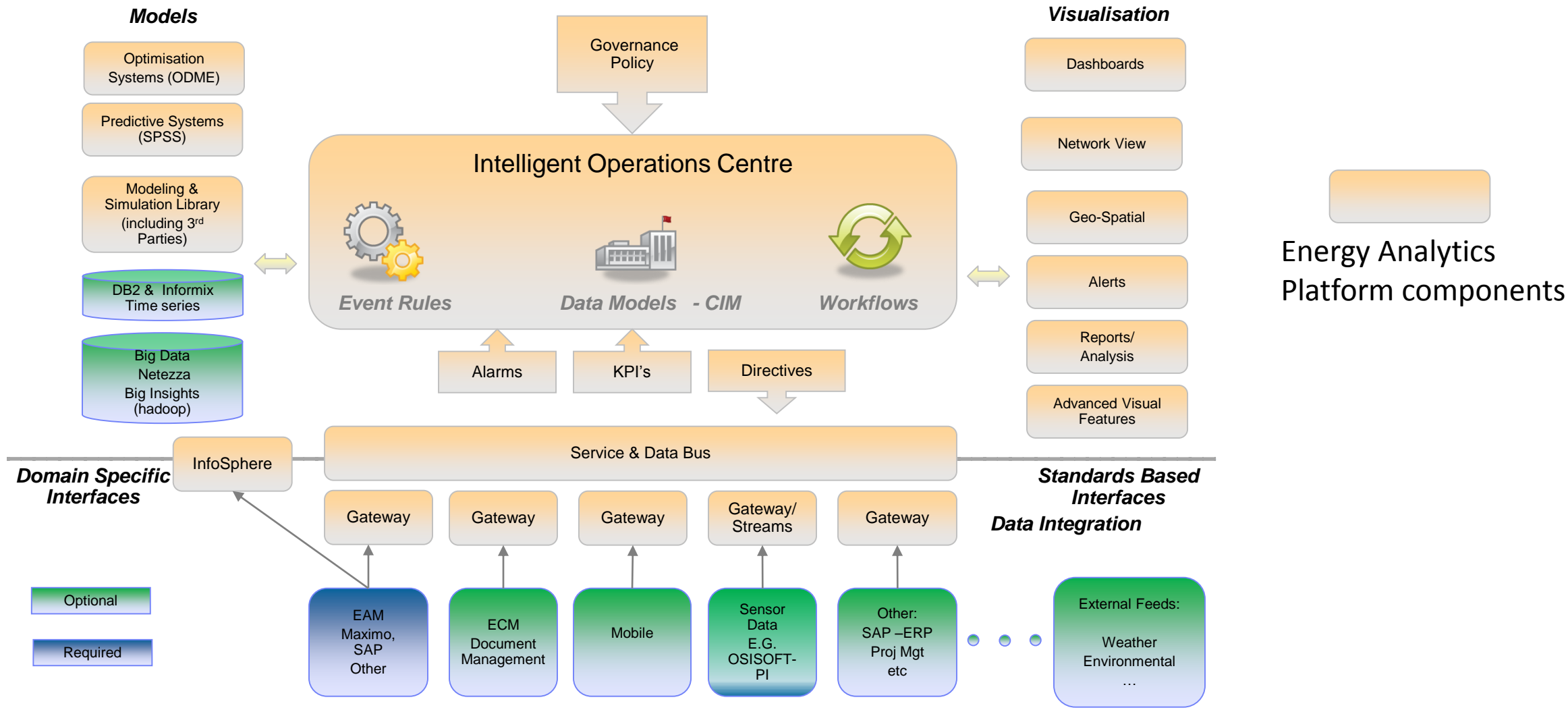


Made consumable and accessible to **everyone**, **optimized** for their specific purpose, at the point of impact, to deliver **better decisions and actions** through:



# Analytics and Optimisation frame work :

## Leveraging IBM Energy Analytics platform - Insights Foundation for Energy

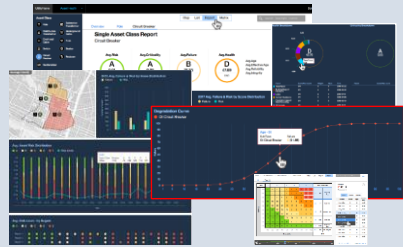


# Enhanced Energy Analytics platform with IoT / Cognitive capabilities

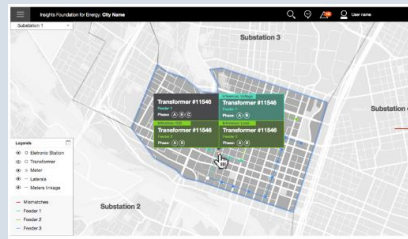
IoT for Energy and Utilities(IFE) - Platform as a service

## IoT for Energy and Utilities PID

### Out of the box applications



Asset Performance Management



Connectivity Models

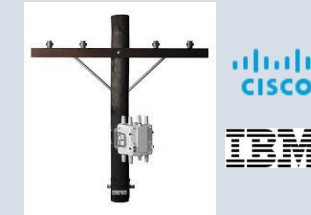


Wind 360

### Custom application selected examples



Image Acquisition and Analytics



Outage Detection Edge Analytics



Worker Safety

Industry Content, Analytics, Weather User Experience, Other Integrations

Data Sources

Native Integration

### IoT Platform on Bluemix



#### Internet of Things Platform

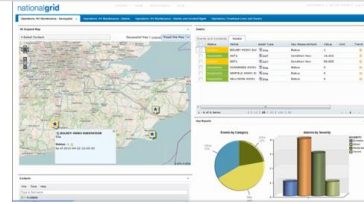
This service is the hub of all things IBM IoT, it is where you can set up and manage your connected devices.

Connected devices



# Analytics capabilities in Phase 1....

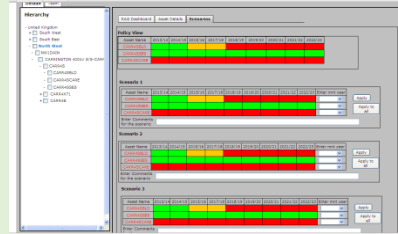
All users



Policy & planning



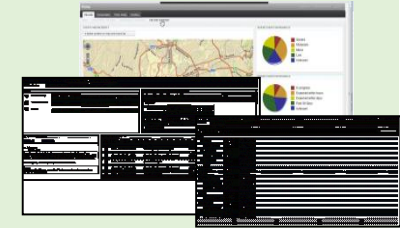
Advanced Analytics + DST



Asset RAG status and scenarios

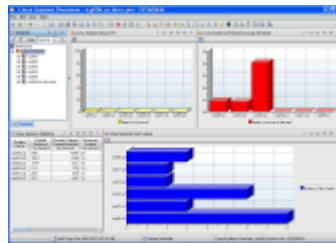


Visualisation options



Data drill down

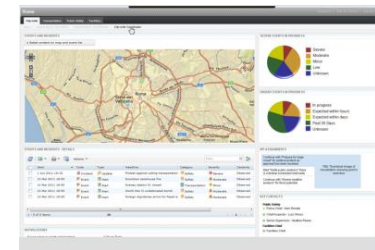
Operations



System Monitoring (Alarms)



Event Mgt. (Alerts)



Click to Action



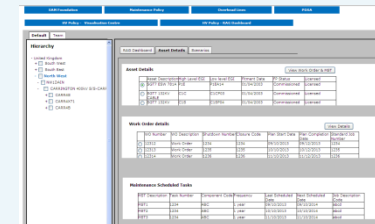
Mobile condition monitoring apps for iOS

All users

Automated Emails/SMS



Roles & Permissions



Data Imp/Exp

# Asset Performance Management ....

Asset Planning Main Interface

Status	Name	Asset Type	Key Measurement	Value	Unit	Trend
Acceptable	CHANDLERS FORD	Substation	Status	0		
Caution	HURSLEY SUBSTAT	Substation	Status	1		

- Asset health tracking
- Health degradation prediction
- Risk and failure consequence
- Connectivity information

Asset Planning Main Interface

Asset Summary

Asset Summary

**Asset Information**

Last Update: 08/06/2015  
 Report Date: 06/05/2016  
 Report Year: 2014

Geography: NIXON

Master Resource ID: ST\_218679  
 Name: ST\_218679  
 Asset ID: 1000012  
 Address: NIXON  
 Manufacturer: PT  
 Age: 12 yrs  
 Installation Date: 03/11/2004  
 Latitude: 42.65379804  
 Longitude: -83.38664498

**Dissolved Gas Analysis**

Gas Component Value (%)

- CH4 Methane
- C2H4 Ethene
- C2H2 Ethyne

DT PD T1 T2 T3

**Advanced Analytics**

To view more detailed historical information about this asset you can visit PMQ.

ST\_218679 (1000012)

Metric	Value	Since last year
Health	64.30%	0.00%
Risk	37.70%	0.00%
Consequence of Failure	34.50%	0.00%

12 Years Old

Asset Information

Last Update: 08/06/2015  
 Report Date: 06/05/2016  
 Report Year: 2014

Geography: NIXON

Master Resource ID: ST\_218679  
 Name: ST\_218679

Scores Over Time

NIXON

Asset Health Risk: 70.10% 0.89%

Details

Failure Probability: 18.00%

Consequence of Failure: 7.00%

Assets

Asset Type	Count
Pole	6852
Substation Transformer	3
Distribution Transformer	2355
Underground Cable	740
Overhead Cable	1813
Fuse	655
Switch	94
Dynamic Protective Device	78
Busbar	125
<b>Total</b>	<b>12718</b>

Actions

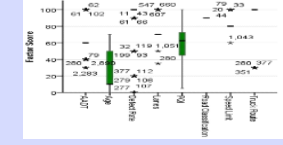


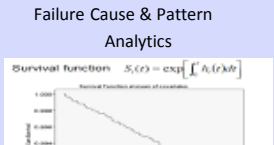



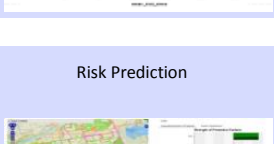
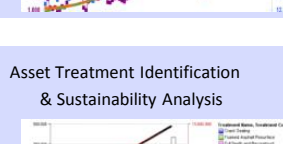
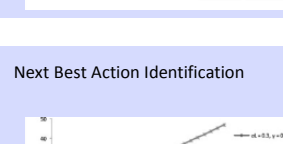


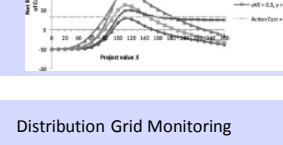
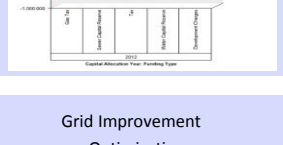
Zoom-in

# Moving towards an App store approach to analytics ....

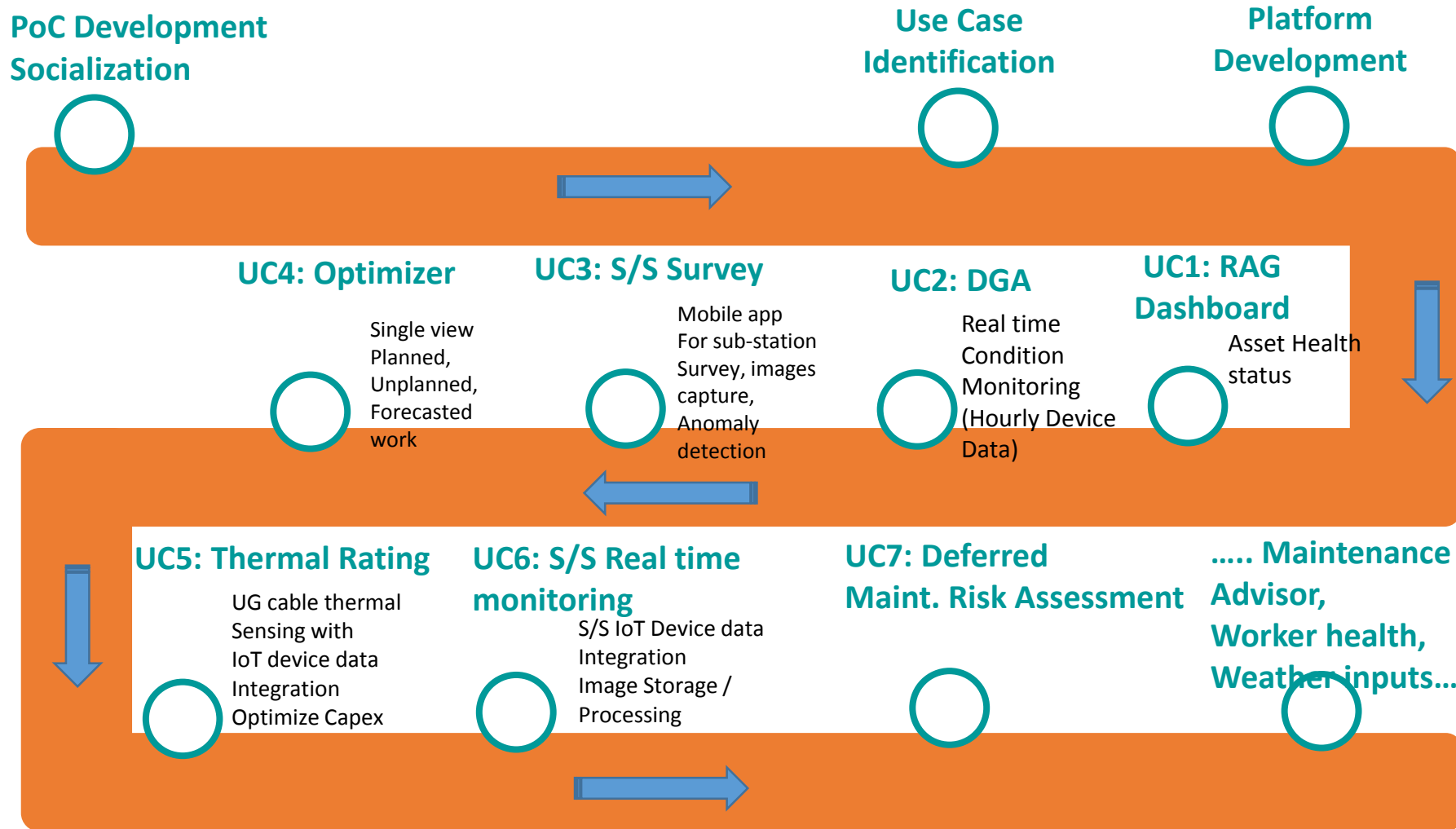
Platform allows usage of pre-built models and experimenting

## Common Asset Decisions

- Replace or upgrade equipment
- Revise network topology
- Apply new technologies
- Revise maintenance strategies
- Improve equipment monitoring
- Increase Automation, IT, Enterprise Integration
- Improve Design standards
- Improve O&M practices
- At the Asset Level
  - Overload
  - Increase Rating
  - Upgrade
  - Monitor Condition
  - Extend Life
  - Replace
- At the System Level
  - System Topology
  - Operations
  - Maintenance Programs
  - Protection/Automation
  - Congestion Mgmt
  - Design Standards

Risk Analytics	Asset Health & Reliability Analysis	Real Time Asset Monitoring	Capex & Opex Optimization
<p>Spatial Risk Analytics</p> 	<p>Asset Health Assessment</p> 	<p>Sensor Analytics</p> 	<p>Spatio -Temporal &amp; Emergency Scheduling</p> 
<p>Failure Cause &amp; Pattern Analytics</p> 	<p>Reliability Modeling</p> 	<p>Failure estimation</p> 	<p>Predictive Maintenance Planning</p> 
<p>Risk Prediction</p> 	<p>Asset Treatment Identification &amp; Sustainability Analysis</p> 	<p>Next Best Action Identification</p> 	<p>Capital Planning</p> 
<p>Risk Analytics for Critical energy Infrastructure (RACE)</p> 	<p>Automated &amp; Real Time Outage Planning</p> 	<p>Distribution Grid Monitoring</p> 	<p>Grid Improvement Optimisation</p> 

# Use Cases ..

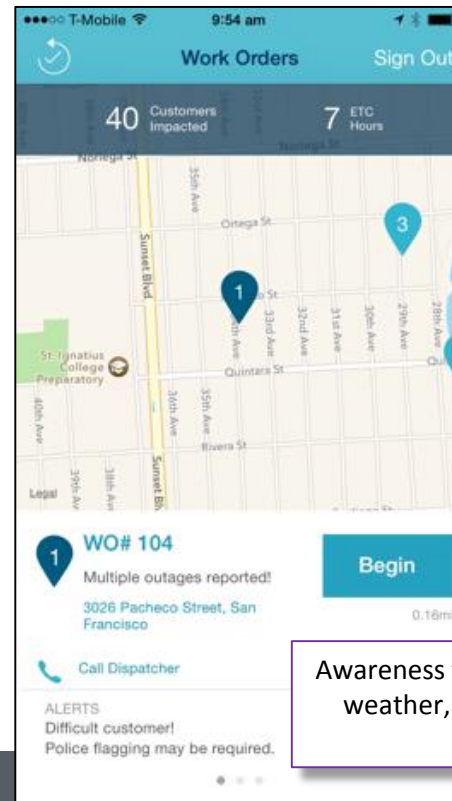
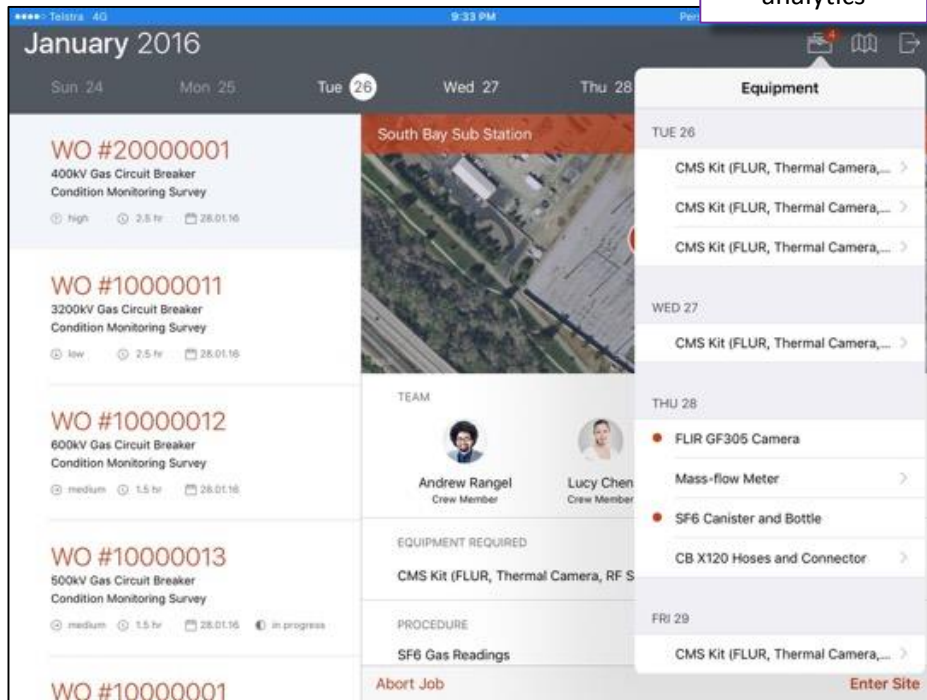


# Mobility technologies to deliver new levels of field work effectiveness and safety....

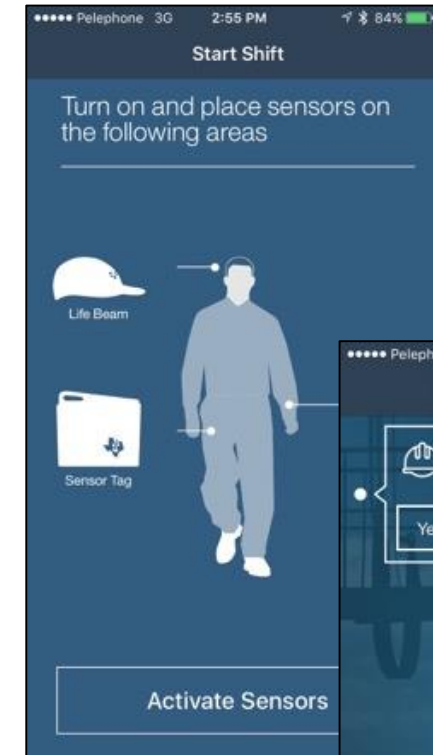
- Analytics driven field worker
- Role based – task orientated
- Real time weather alerts
- Training..
- Enhanced Safety through IoT/ Wearables

IBM/Apple Apps:  
Field Connect  
Asset Inspect

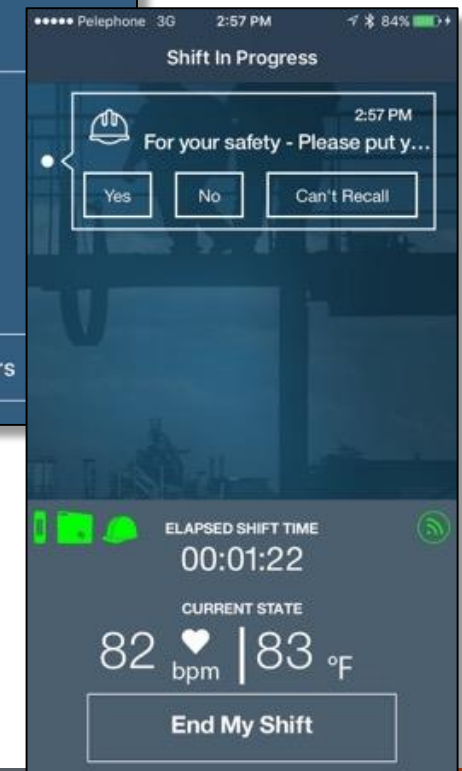
Prescriptive & Cognitive analytics



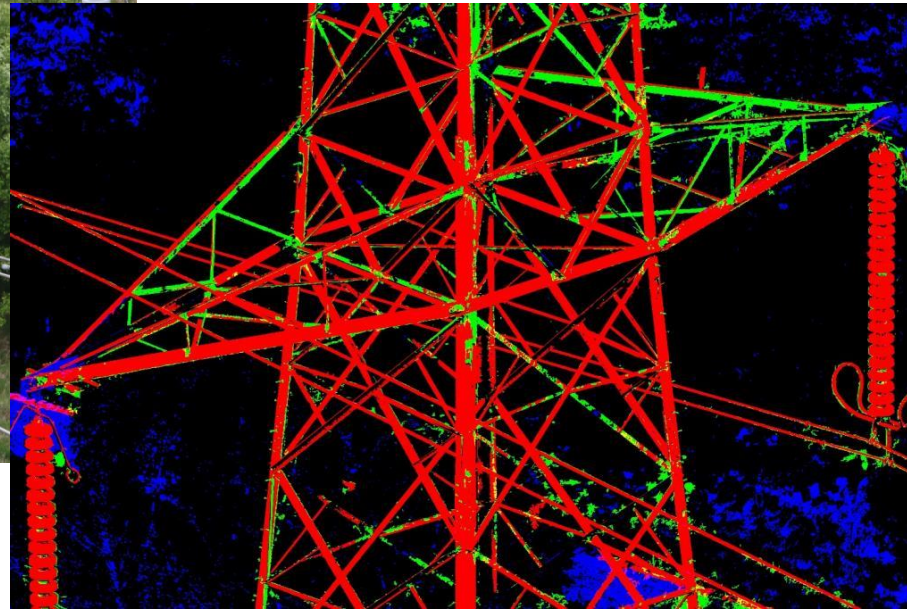
Awareness factors from weather, proximity



Digital at the cornerstone of safety



## Visual Recognition Service for Asset Condition Inquiry




A way to complement/supplement IBM VR ("Watson") using domain specific models of regions of interest

The system is able to recognize most of the beams (shown in red color) and rust (shown in green). The blue indicates the false alarms our system was able to discard, This model is not yet hardened and needs to be further improved using more domain knowledge and sophistication

## Weather data can be used with data collected from assets for predictive maintenance

Weather Data	Purpose
Damaging Winds	<p>a. Hyper local weather information is combined with asset information to understand the impact of weather on assets</p> <p>b. Predictive asset maintenance algorithms can be used to understand the impact of weather on asset performance and provide alerts when they are in need of maintenance or at risk of failure</p>
Flood	
Hail	
Ice & Snow	
Severe	
Tornado	
Tropical Cyclone	



## Predictive maintenance solution can reduce operating expenses and improve the quality of service

**Hyper local weather information**



+

**Predictive asset maintenance**



+

**Integrated dashboard with proactive alerts**

Assets	Failure risk (7 days)
Tower-1	90%
Tower-20	89%
Tower-2	85%
Tower-4	60%

- A** Proactive maintenance of assets before failures occur
- B** Condition based maintenance instead of scheduled maintenance
- C** Better insights into purchasing decisions by assessing quality of assets



### Value Propositions

- IOT and cognitive system mitigate skill and expertise shortage, also a tool for training new personnel
- Minimized time for manned-operations using as drones & robots. Increased time for unmanned operations
- Reduction of human error with improved accuracy, efficiency and reliability by bringing pertinent equipment and system information at the right time and right place
- Enabled event driven monitoring. Improved efficiency may facilitate more frequent operations

### IOT Opportunities

- Transmission Tower Visual Inspection – identify levels of rust/ energy leakage/ minimize Health & Safety risks
- Wind Turbine Blade Inspections – micro-cracking/ high resolution/ H&S minimized
- Vegetation Clearance (Powerlines/Pipelines) – using cognitive to pull together: visual images, regulatory requirements, plant species (growth rates)
- Solar Farm Visual Inspections and remote fault detection
- Ingested data including manufacturer manuals, utility procedures and Maximo work order repository

### Ecosystem

- **Utilities** looking to adopt latest technology
- **Drone and cameras manufactures.** Drones are used to inspect equipment status in hard to reach areas. Partnership with Spanish Drone maker and Aerialtronics are in the work



DISRUPTIVE TIPPING POINTS FOR UTILITY INDUSTRY IS QUITE VISIBLE.....

EMBRACE DISRUPTION THROUGH DIGITAL OPERATIONS

**Thank You**



**Santhosh S Nair**

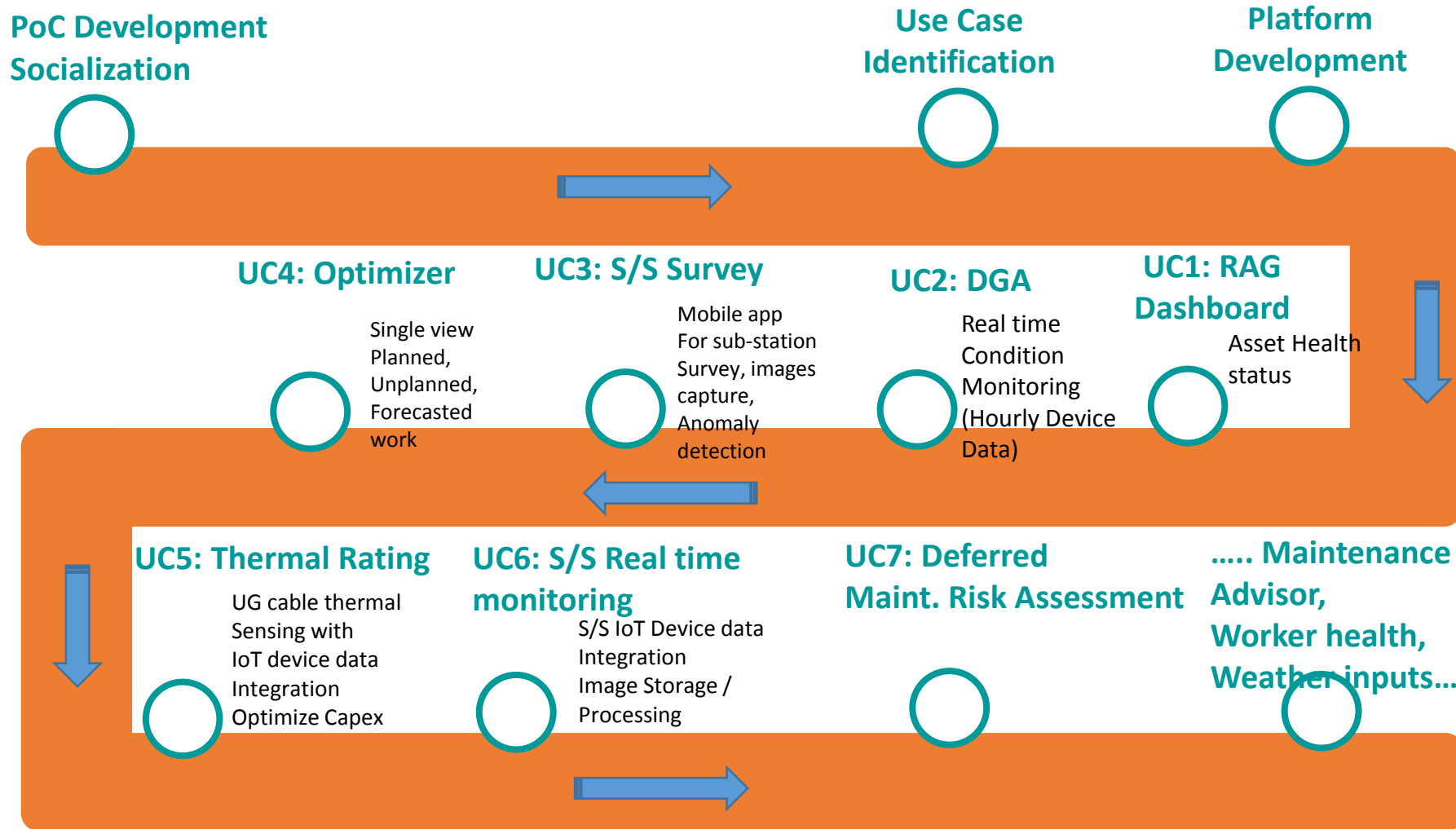
ASEAN Leader, Energy & Utilities

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## Strategic Asset Management Use Cases vs. ROI

Use Case	Technical Delivery	Benefit	Est. Total
<b>Use Case 1 - Asset RAG Dashboard</b> (Decision Support Tool for Totex planning)	<ul style="list-style-type: none"> <li>RAG Dashboard with asset health and maintenance details</li> <li>Cognos Reports</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance policy decision support tools to enable risk- and condition-based maintenance of substation assets</li> </ul>	<b>\$10.8m</b>
<b>Use Case 2 &amp; 3 - Dissolve Gas Analysis &amp; Substation Survey</b>	<ul style="list-style-type: none"> <li>Dashboard</li> <li>SoP based automated work flow</li> </ul>	<ul style="list-style-type: none"> <li>Offline condition analysis and reporting of thermal and oil condition monitoring surveys to enable less intrusive maintenance practices</li> </ul>	<b>\$7.6m</b>
<b>Use Case 4 - Single View of Plan</b>	<ul style="list-style-type: none"> <li>Resource modelling and scenario planning capabilities</li> </ul>	<ul style="list-style-type: none"> <li>Improve the optimisation of resource and outage requirements to deliver work</li> </ul>	<b>\$12.5m</b>
<b>Use Case 5 - Thermal Ratings Management</b>	<ul style="list-style-type: none"> <li>Analytic models to determine thermal ratings</li> </ul>	<ul style="list-style-type: none"> <li>Bring the intellectual property associated with thermal ratings models in-house</li> <li>Increase the robustness and supportability of existing models</li> </ul>	<b>\$4.5m</b>
<b>Use Case 6 - Risk Management (DMRA)</b>	<ul style="list-style-type: none"> <li>Support for deferred maintenance risk assessments</li> <li>Overlays of condition, safety, compliance and alarms on Ops Diagrams</li> </ul>	<ul style="list-style-type: none"> <li>Provide improved visibility of safety risk compliance to increase confidence in NG's operations</li> </ul>	<b>\$2.7m</b>
<b>Use Case 7 - Substation Monitoring</b>	<ul style="list-style-type: none"> <li>Functionality to support online substation monitoring</li> </ul>	<ul style="list-style-type: none"> <li>A more detailed view of asset condition will increase confidence in deciding when to maintain/replace assets</li> <li>Enabler of de-commissioning of the TSAM C3 platform</li> </ul>	<b>\$7.4m</b>

# Use Cases ..



# UC 1: Asset Health (RAG Dashboard) & Scenario Play

## Decision Support Tool for Annual Capital Planning

Maintenance Filter view
Legend

- UKI
- BOLNEY 400KV S/S
  - AUXILIARIES AND AIR SYSTEM BAY
  - BOLNEY 400KV BAY
  - BUS COUPLER 1 BAY
  - BUS COUPLER 2 BAY
  - BUS SECTION 1 BAY
  - LOVEDEAN 1 BAY
  - LOVEDEAN 2 BAY
  - NINFIELD 1 BAY
  - NINFIELD 2 BAY
  - RESERVE BUS SECTION 1 BAY
  - SGT1 BAY
  - SGT2 BAY

Total Records: 7

Asset	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23
110V S/S COMMON BATTERY 2	Red	Red	Red	Red	Red	Red	Red	Red	Red
SUBSTATION LIGHTING	Green	Green	Green	Green	Green	Green	Green	Green	Green
48V S/S BATTERY 1 400KV LVAC ROOM	Red	Red	Red	Red	Red	Red	Red	Red	Red
110V S/S COMMON BATTERY 1	Red	Red	Red	Red	Red	Red	Red	Red	Red
48V S/S BATTERY 2 400KV LVAC ROOM	Red	Red	Red	Red	Red	Red	Red	Red	Red
SUBSTATION PORTABLE EARTHS	Green	Green	Green	Green	Green	Green	Green	Green	Green
SUBSTATION EARTHING SYSTEM	Red	Green	Green	Red	Green	Green	Red	Green	Green

[Export to Excel](#)

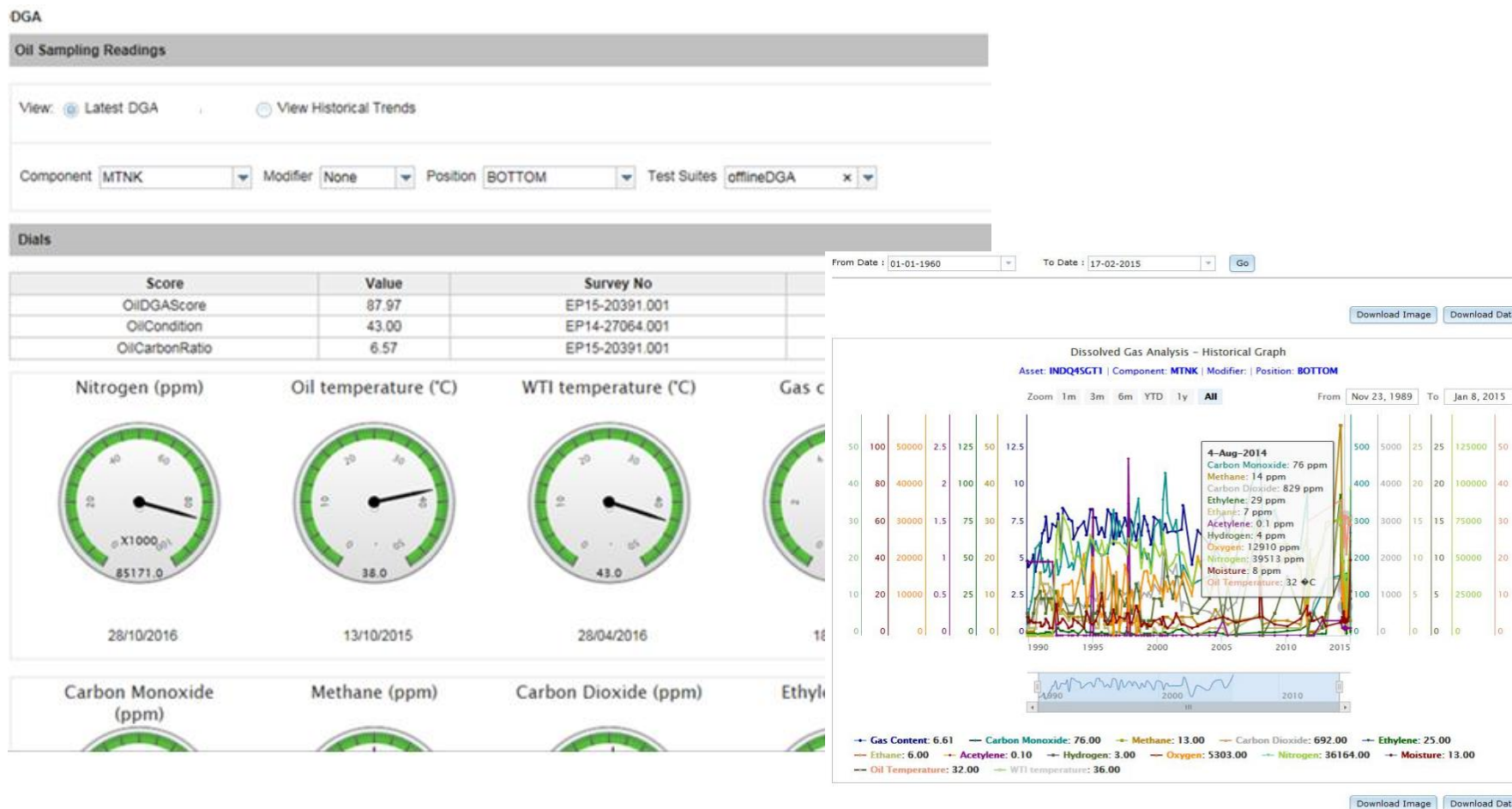
**Scenario 1:**

Asset	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	
110V S/S COMMON BATTERY 1	Red	Red	Red	B	Red	Green	Red	Green	Red	<input type="checkbox"/>
110V S/S COMMON BATTERY 2	Rfb	Red	Green	Red	Green	Red	Green	Red	Green	<input type="checkbox"/>
48V S/S BATTERY 1 400KV LVAC ROOM	Red	Red	Red	Red	Red	Red	Red	Red	Red	<input type="checkbox"/>
48V S/S BATTERY 2 400KV LVAC ROOM	Rfb	Red	Green	Red	Green	Red	Green	Red	Green	<input type="checkbox"/>
SUBSTATION EARTHING SYSTEM	Red	Green	Green	Red	Green	Green	Red	Green	Green	<input type="checkbox"/>

- Both Core EAM & Condition Monitoring Data are taken care to asses individual asset health in Red, Amber & Green
- Real time integration established with all sources of data
- SPSS analytics implementation brought up the asset health status, reason and corrected action against each asset
- Business user gets facility for scenario play to assess the need to change the asset health status

# UC 2: Dissolve Gas Analysis (Transformer OIL cond.)

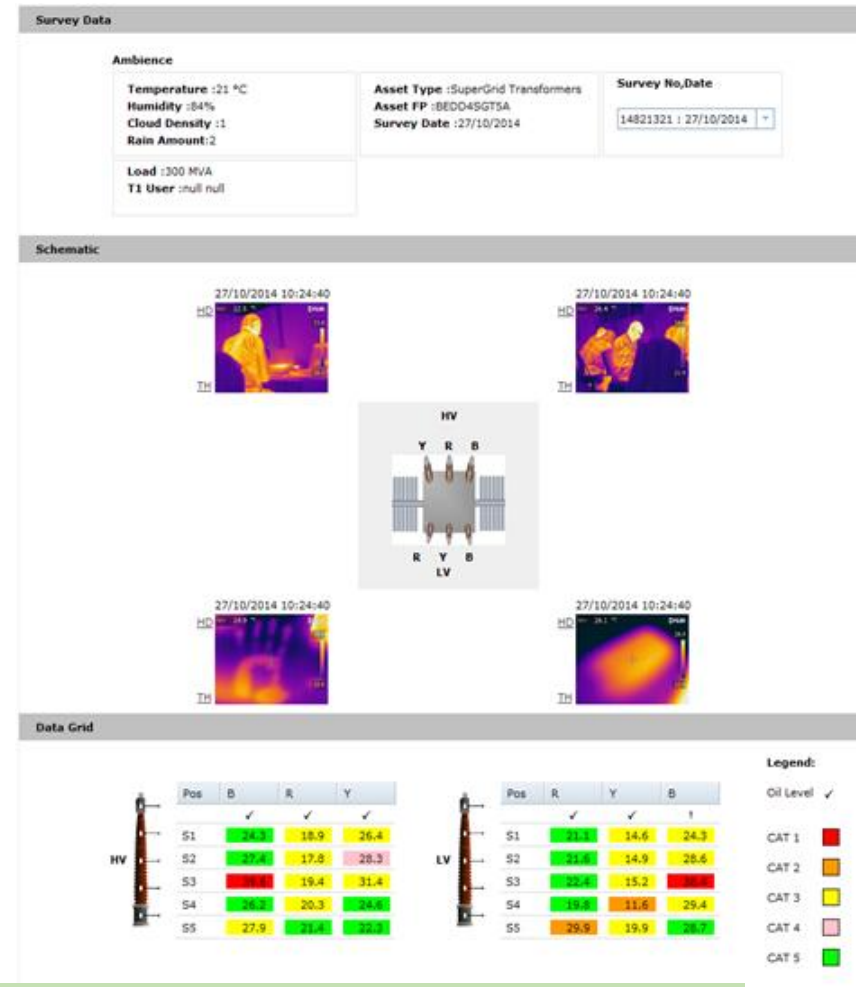
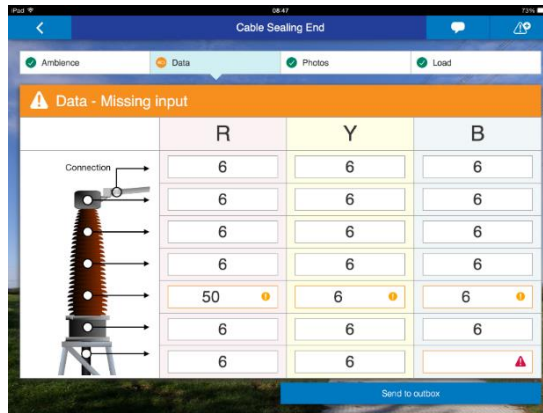
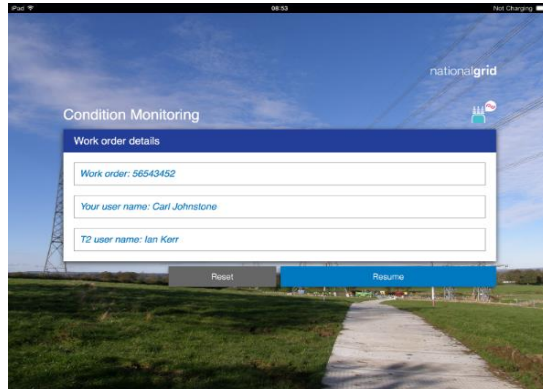
Real time condition monitoring (device data integration +analytics)



- Hourly device data from transformers
- A dashboard with real time and history data
- An analytics backed support tool aiding raising the defect automatically on any anomaly detection
- Massive reduction in human effort on data collection & data analysis
- Significant decrease in time to decision viewing thru the dashboard and related insight from history data trend

# UC 3: Substation Asset Survey

Substation Survey (Mobile App + Anomaly Detection + SoP based Work flow)



- Mobile app is provided to the field engineer to take the survey even at offline
- Post survey, the data (reading) and images are pushed to analytics engine thru the high speed Aspera platform
- SPSS engine identifies anomaly from the survey data and raises defects to the concerned engineer for action
- A SoP based workflow takes care the defect resolution thru various levels
- Engineer can see the defect details in a dashboard and can see the history trend for specific data point



# UC 5: Thermal Rating

Real time over heating monitoring for underground Cables (IoT device data integration + anomaly detection + downstream processing)

View Schedule NASAP Code : A213
SAM Ref ID: BODELWYDDAN - DEESIDEPENTIR 2 (PENTIR LEG)  
A213\_14\_C\_1 Commissioned
Published: 21-Mar-2017 10:23  
Valid From: 20-Mar-2017 00:00  
Until: 11-Mar-2024 23:59

Manage Rating Objects

Select NASAP code or desc \*  Reset

Basic Information **Asset Details** Schedule Details Save & Publish

Assets Currently Live

Asset Type	Asset Description (FP Desc 1)	Asset FP	Downrated?	Derated?	Soft deleted?	Truncated? (CTM)	Thermal Rating Group
No filter applied							
<input type="checkbox"/>	CB	GEC TFC6 (A6)	N/A	N	N	N	Circuit Breaker
<input type="checkbox"/>	DISC	AEI RCP 4000A (B1)	N/A	N	N	N	Disconnecter
<input type="checkbox"/>	OHL	(BK-VI-BK) SPAN (4ZB001-4ZB002)	4ZB001-4ZB002-2	N	N	N	Overhead Lines
<input type="checkbox"/>	OHL	(RE-BU-YE) SPAN (4ZB253-4ZB254)	4ZB253-4ZB254-2	N	N	N	Overhead Lines

Add Asset Delete Asset Undo Delete Plan de-comm Edit Asset Properties

Assets planned for de-commissioning

Asset type	Asset Description (FP Desc 1)	Asset FP	Planned de-comm	Actual de-comm

- Real time thermal heat data from cable sensors
- To provide accurate, reliable and complete thermal rating information to its SO counterparts.
- Reduce the network constraint costs further by providing more detailed thermal rating data
- Deferred capital needed for replacing assets by being able to increase capacity of existing network
- Linkages to limit overload exposure to client's owned damaged assets



