

MCARTeChTM

Machinery Cognition & Advanced
Reliability Technologies



*Industrial Asset
Reliability Solutions*

***Maximize Reliability.
Minimize cost.***



Equipment Reliability ensures “Predictable and Reliable” business performance



In reality, the possibility of unexpected failure is inevitable



Unexpected failures seriously affect safety, availability, product quality and cost



Effective tools for predicting failure are generally absent in the industry

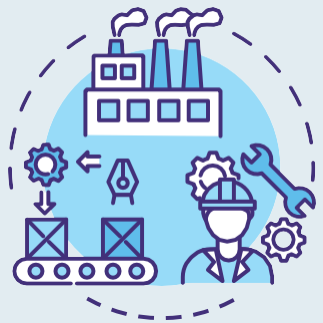
Consequences of Equipment Failures



- *Health and Safety, including loss of human life.*



- *Serious violation of environmental safety norms.*



- *Serious damage to machinery causing long stoppages, leading to production loss.*



- *Significant quality deviations.*



- *Missed delivery dates and credibility.*



- *Potential cost impact of unexpected failures: 1-3% of Revenue.*

THE SOLUTION:

ALERT

(Adaptable Leading-Edge Reliability Techniques)

*A Cloud-based
Remote Monitoring and
Predictive Diagnostics
System*

Developed by

MCARTE^hTM

Machinery Cognition & Advanced
Reliability Technologies





The Solution Demands:

- *Continuous real-time condition monitoring of Critical Assets.*
- *Recognition of performance degradation at an incipient stage.*
- *Predicting failures using real-time signals and algorithms (knowledge-based cause-and-effect relationships).*
- *Advance notification with guidance for safe, timely and accurate countermeasures.*
- *The Solution must be specifically suited for equipment installed in hard-to-access locations.*

ALERT
does all of the above

ALERT - General Architecture

Real Time Data

Critical Processes & Equipment

Failure Modes

Sensor Signals

ALERT Gateway
(OPC Server & ALERT Logger)

Dynamic Data

Equipment Technical Information

CATEGORY A:

- Equipment name, OEMs, OEM Contacts
- Equipment functions & specifications
- Manuals
- Standard instructions/procedures
- Pictures/audio/video files
- PLC program listing, if applicable

CATEGORY B:

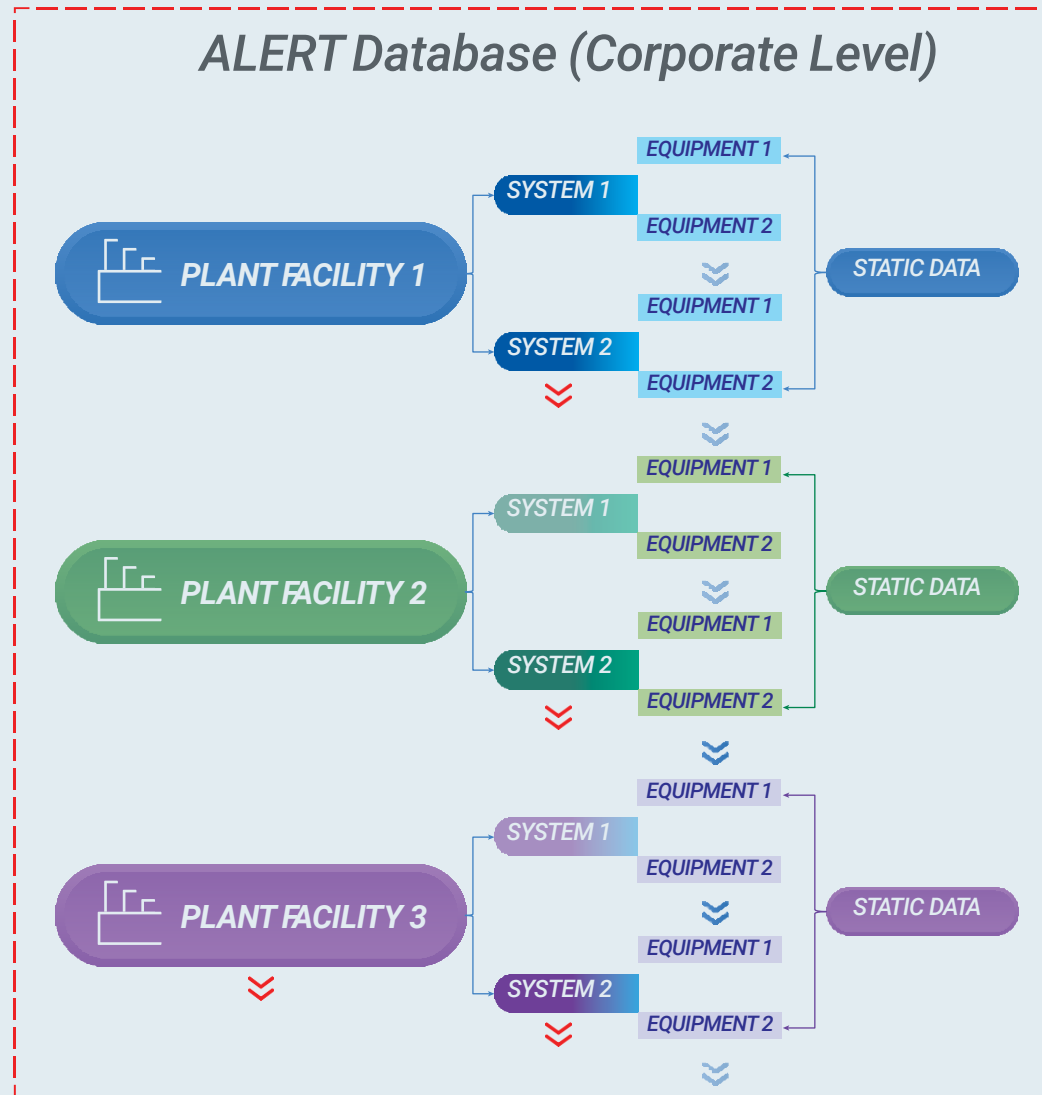
- Drawings – Electrical, Mechanical, Wiring, Interlocks, Control, etc.

Static Data

ALERT Applications

ALERT Output

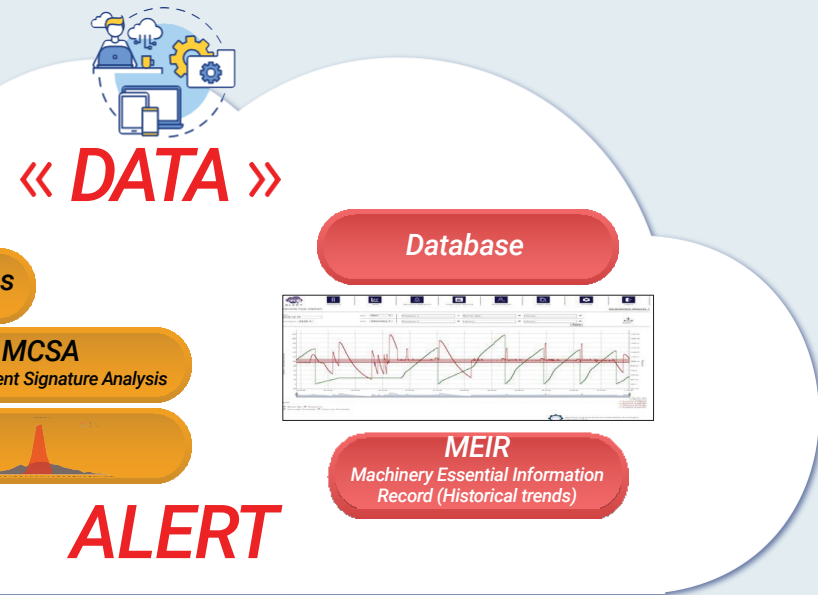
ALERT Database (Corporate Level)



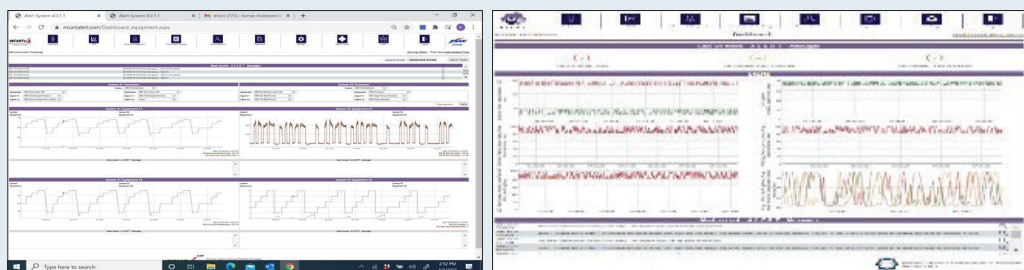
PREDICTIVE DIAGNOSTICS DASHBOARD
REAL-TIME NOTIFICATIONS

RAFT FEATURES

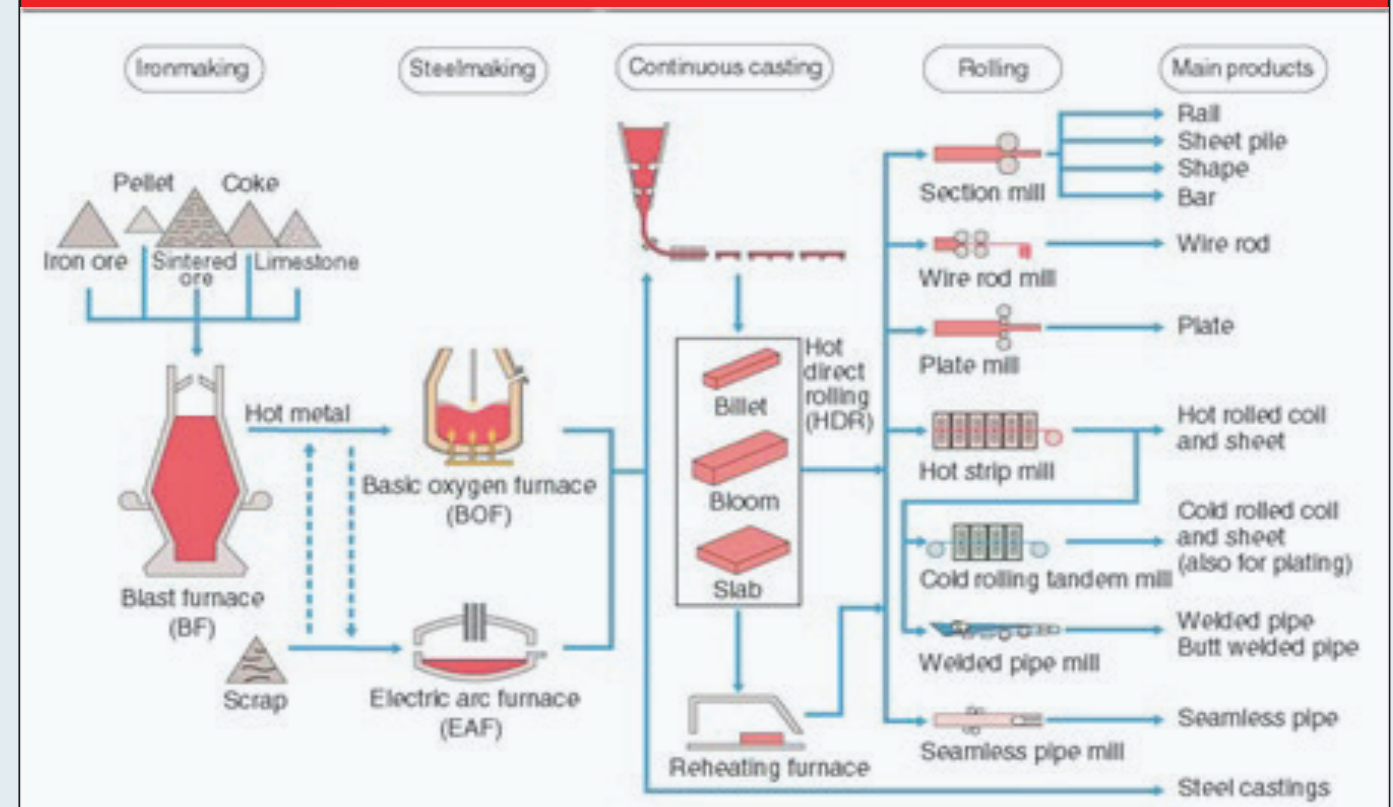
- Access to real-time data
- Access to Category-A equipment data
- Access to Category-B drawings with real-time equipment status



Web based Dashboards
Real time & Historical Data Diagnostic
Notifications with Safe Work Procedures Reports

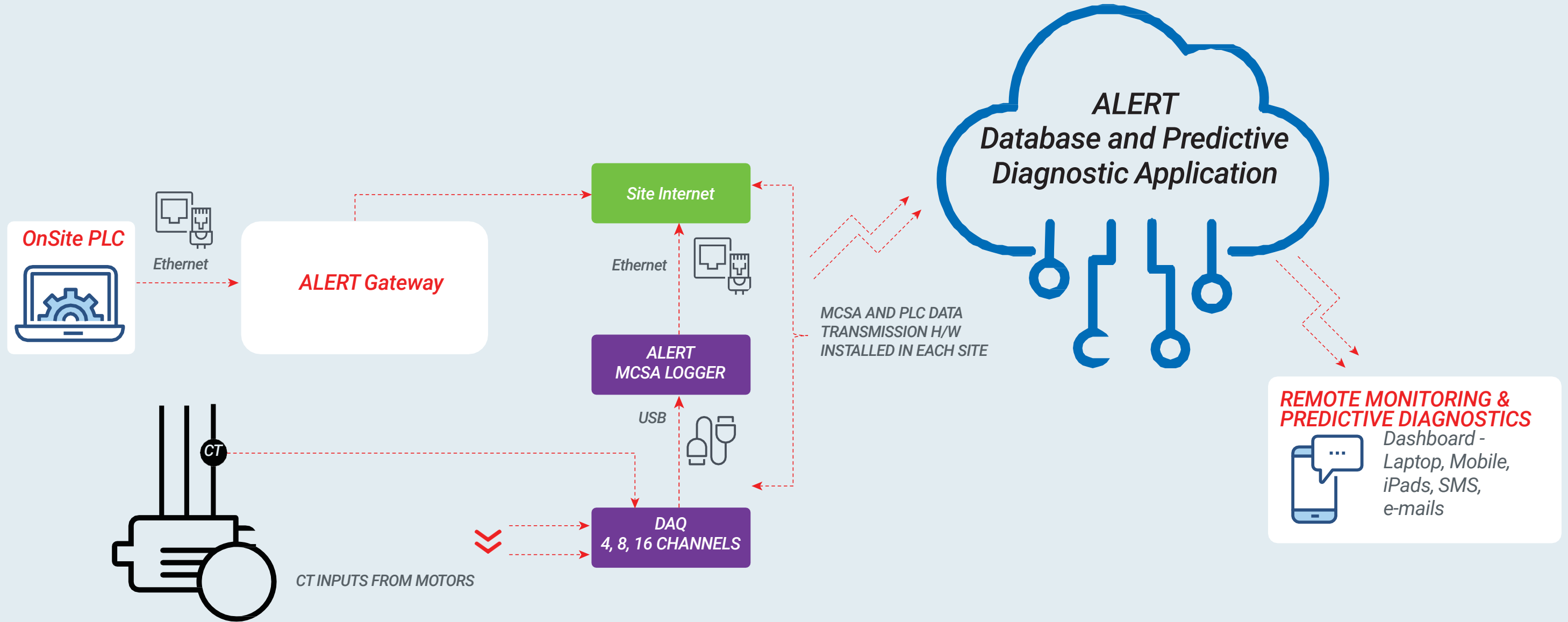


Manufacturing Process for Iron and Steel

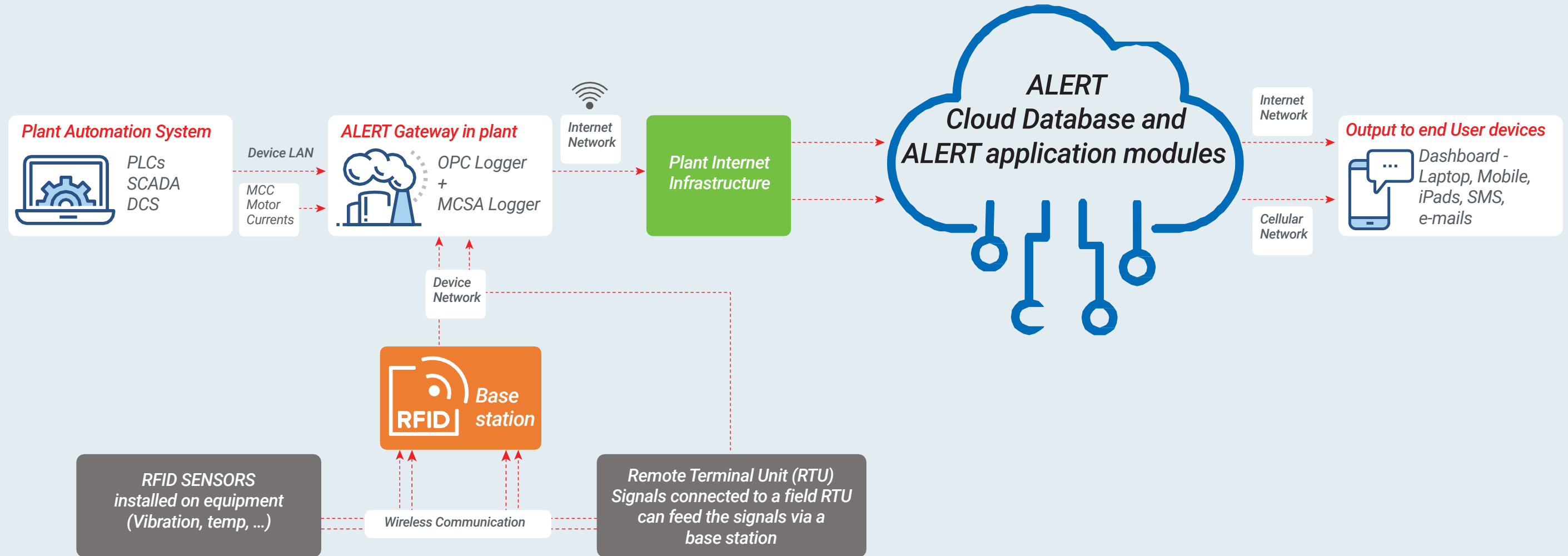


Real Time Sensor signals from Equipment and Processes

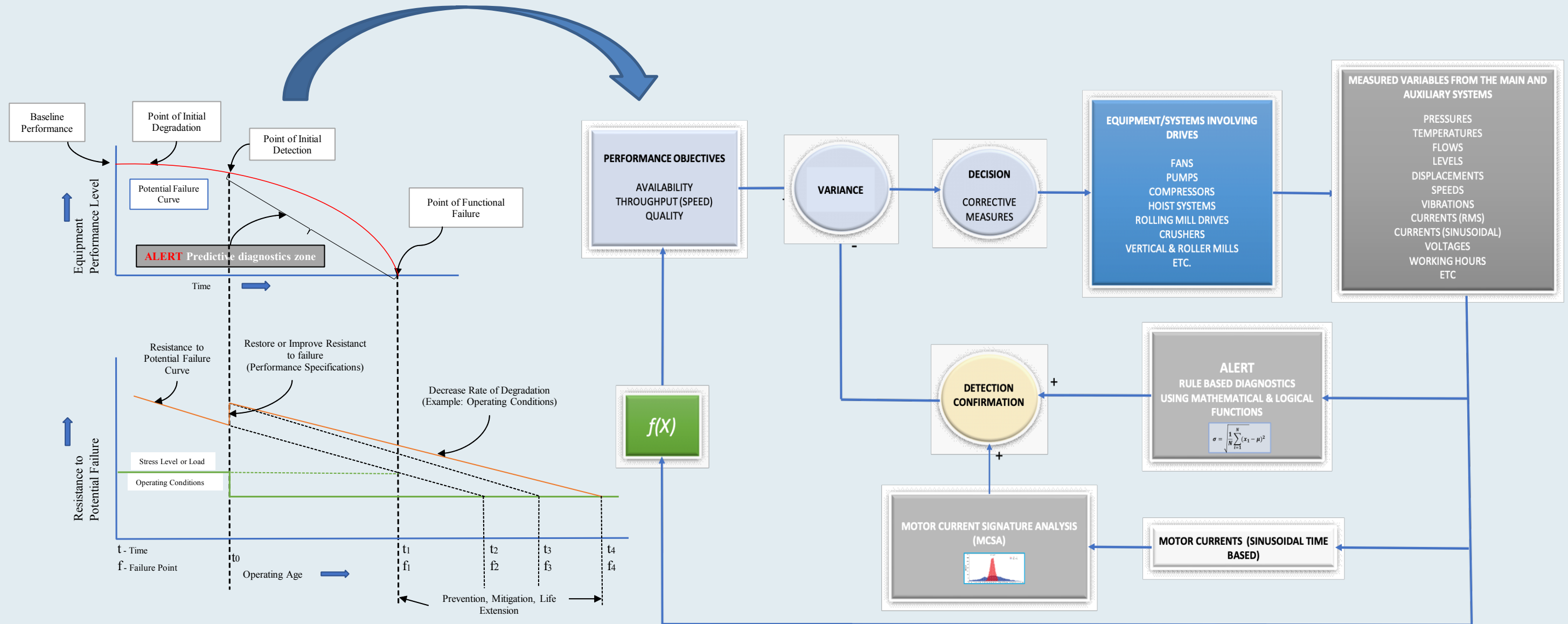
ALERT - Data Acquisition



ALERT - Data Transmission



ALERT Predictive Diagnostics Concept



- ❖ **Universally equipment performance degradation arises from 5 fundamental causes:**
 - **Lubrication deficiency**
 - **Physical looseness**
 - **Improper temperature**
 - **Inadequate cleanliness**
 - **Load discrepancies**
- ❖ **While the first four causes are equipment centric, Load is an external entity, subjected to the equipment. These fundamental caused has a detrimental impact on the equipment's "resistance to failure" and hence the variety of "Failure Modes" that we encounter.**
- ❖ **Barring cleanliness, all the other factors are quantifiable fairly accurately with sensors which are quite versatile today.**
- ❖ **Equipment performance deviates from designed objectives when the five fundamental causes coexist in a complex manner. The performance deviation can be interpreted by looking for signs of the causalities.**
- ❖ **Interpretation is achieved via "diagnostic" techniques. ALERT Rule Based Diagnostics and Motor Current Signature Analysis (MCSA) are some of the most effective techniques available for interpretation. These tools utilizes real time signals to identify signs of imminent performance degradation.**
- ❖ **The manner in which an equipment responds to load disturbances could be a good indication for future performance degradation.**
- ❖ **MCSA allows drive current signature analysis to interpret load discrepancies and help corelate current signatures with various detrimental attributes of loads.**
- ❖ **ALERT, using its cause-and-effect algorithms (knowledge/rule based) and MCSA (electrical signature analysis) enables the detection of the potential variance of the present performance as "predictive diagnostics".**
- ❖ **The diagnostic output can be used to execute appropriate corrective measures to prevent a failure from occurring or mitigating the effect of the consequences. ALERT provides a feature to incorporate the proper response action to a particular diagnostic output. This is a feature which is helpful for a lean workforce during shifts when experienced experts are normally unavailable.**



ASSESSMENT OF THE POTENTIAL ROOT CAUSES OF OPERATIONAL PROBLEMS AND PRIORITIZE

- Safety - Fire & Explosions
- Equipment Availability – Critical equipment Failures
- Operational Variability – Equipment delays causing Throughput, Quality and Shipment plan deviations
- Cost of Maintenance

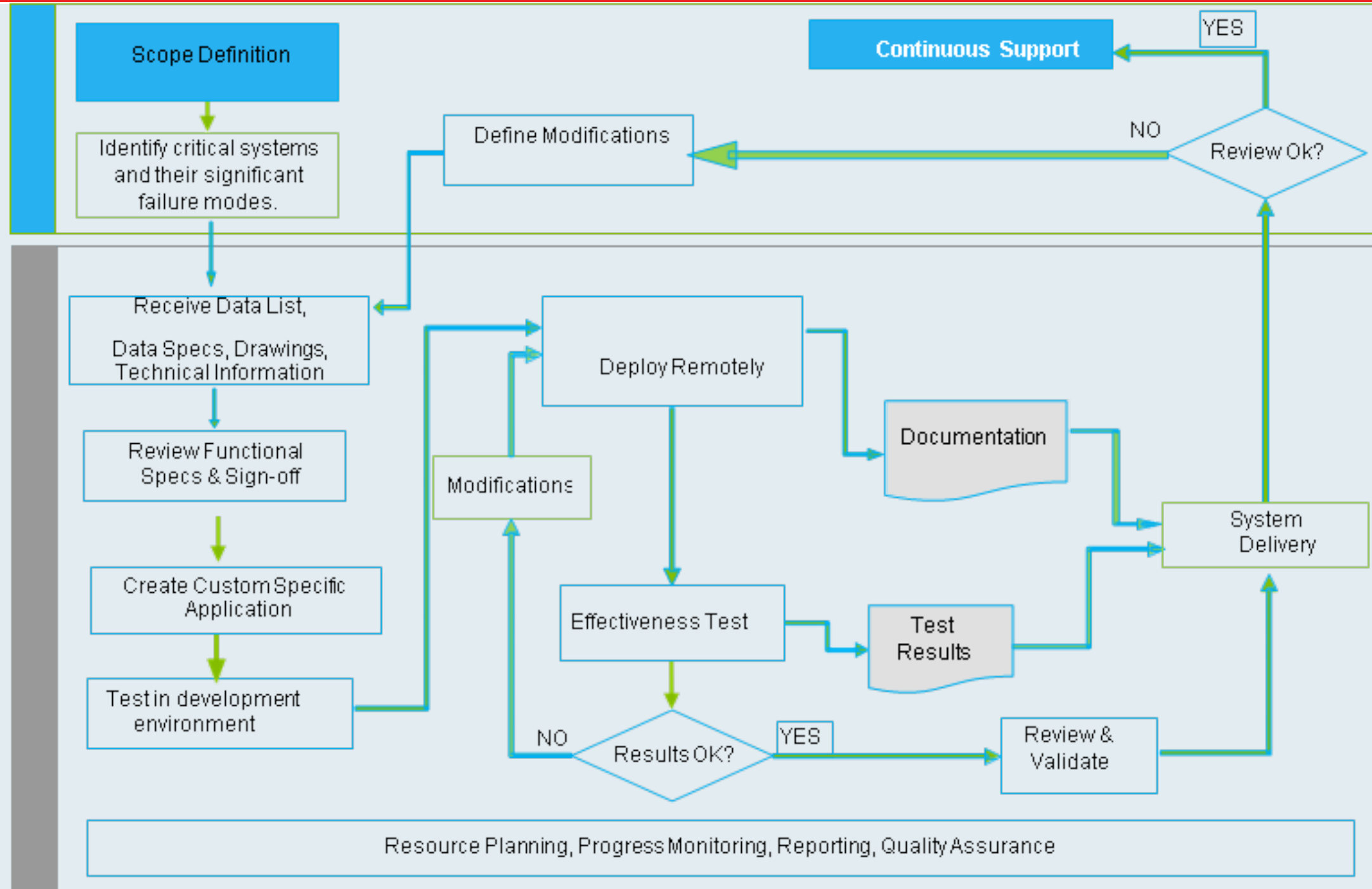
IDENTIFY EXISTING REAL-TIME SIGNALS AND THEIR AVAILABILITY

Develop targeted Anomaly Detection Diagnostics to trigger advance notification for timely awareness and mitigating actions

DELIVER

- Targeted Remote Monitoring of critical parameters
- Advance Anomaly Detections (With customized guidance for each anomaly detected)
- Maintenance Advisor for:
 - Time Based Maintenance
 - Runtime based Maintenance
 - Condition based Maintenance
- Notification via smart devices
- Web based access to ALERT details and guidance

Delivery Model



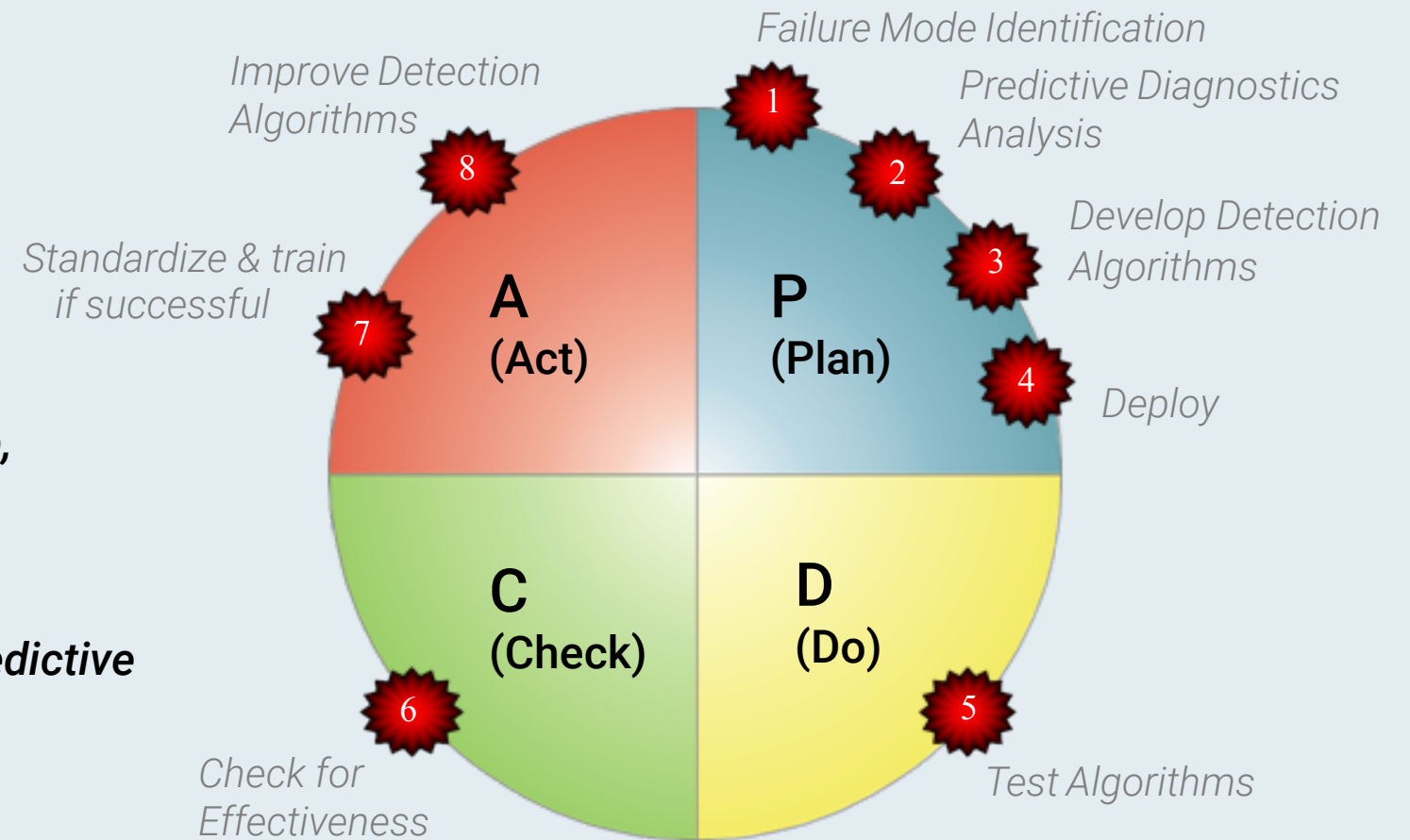
The implementation methodology of ALERT adopts the well proven :P (Plan) – D (Do) – C (Check) – A (Act) approach.

“Plan” focuses on the identification of the critical Failure Modes, the signals, signatures and inter-relationships, followed by testing.

“Do” focuses on physical deployment that involves hardware setup, real-time data acquisition, data telemetry and configurations.

“Check” is involved with verification of the effectiveness of the Predictive Diagnostics deployed.

“Act” focuses on preventive and mitigating actions, and improvement opportunities to render the diagnostics more targeted and effective.



STEP 1

ASSET RELIABILITY MANAGEMENT STRATEGIES (ARMS)

- *Asset Hierarchy assessment*
- *System Functional Criticality Assessment*
- *Critical Systems Identification*
- *Failure Mode (FM) determination & Potential Failure Analysis*
- *Real time Signals & Signatures Analysis for FM recognition*

STEP 2

ALERT

- *Select sensors for FM modeling*
- *ALERT Gateway and data telemetry*
- *Create Predictive Diagnostics using knowledge and rules*
- *Predefine countermeasures (SOPs) for Decision Support*
- *Personalized Notifications*
- *Configure and deploy*

STEP 3

CONTINUOUS CUSTOMER SUPPORT

- *Improve Asset Reliability Performance adopting Continuous Improvement (CI) approach*

Use Case

Critical systems and equipment monitoring of process plants like steel, cement, power, oil and gas, assembly plants, food processing etc. Support time-based maintenance (TBM) & Runtime-based maintenance (RBM) with advance notifications. Generate reliability KPIs.

What it takes

Acquisition of real-time signals utilizing the IIoT infrastructure. Identification of critical systems and critical failure modes. Signature of real-time signals and knowledge-based diagnostics algorithms anomaly prediction, notification and guidance.

analysis for

**Continuous Remote
Monitoring of Critical
Systems and
Equipment**

Benefits

Improve plant Availability, Reliability and Safety by early detection of major problems and be able to respond with timely, accurate and safe counter measures.

Use Case

Remote monitoring and predictive diagnostics of Environmental Protection Systems like fume extraction system and Baghouse performance.

What it takes

Analysis and correlation of logical data to identify/predict conditions arising from equipment malfunction capable of violating EPA stipulations.

Benefits

Predictive detection and responding proactively helps minimize expensive penalties and environmental law violations consequences.

**Prevention of Violation
of Environmental
Norms**

Use Case

Motor Current Signature analysis (MCSA) is an effective Condition Based Maintenance (CBM) tool with advanced detection capabilities. ALERT incorporates the MCSA feature.

What it takes

Remote Monitoring and signature analysis of motor currents to detect incipient internal and external problems in correlation with associated operating conditions detrimental to the drive systems.

Benefits

Early detection of the contributing factors responsible for motor failures. Helps implement proactive corrective measures to prevent high repair cost, production delays and safety.

**Motor Current
Signature Analysis
(MCSA)**

Use Case

Prediction of deviations in process conditions capable of causing serious safety consequences and loss of productivity and quality.

What it takes

Correlation and analysis of multiple process variables which are known to be responsible for causing the deviations. Develop algorithms for the purpose of prediction and mitigation actions.

Benefits

Prevent extreme risk to human lives and catastrophic equipment damage.

**Analysis of Process
Anomalies**



Early detection and mitigation of hazardous conditions, based on common sense, field experience, technical prudence, and cause and effect relationship analysis built into diagnostic algorithms.



Increased revenue is directly proportional to **improved Mean Time Between Failure (MTBF)** and **reduced Unplanned Maintenance Stoppages**.

1 – 5% per year is achievable



Inevitable cost impact of unplanned stoppages:

Typically, 1 – 3% of revenue

World class benchmark on unplanned cost component: **Less than 10% of the overall maintenance cost is achievable.**

SIGNIFICANT INTANGIBLE BENEFITS

- *Lower Asset Insurance exposure.*
- *Reduce and mitigate environmental regulatory violations.*
- *Improve Performance and Reduce cost of Employee Health & Safety Programs.*
- *Generation of corporate wide data on critical equipment performance & benchmarking.*
- *Enabling on-line collaboration and interactive problem solving within the group plants.*