



April 18, 2011 Randy Schrieber

Asset Health Center

Optimization of Maintenance Spend Across the Power
Equipment Fleet Using On-Line Condition Data

PPO-000-2

Managing the Aging Installed Base

- Very aged infrastructure (average 40+ years)
- Lack of expert knowledge (retirees, non-replacements, etc.)
- Utilities cannot afford to continue time-based maintenance
- Utilities cannot afford to replace aging equipment

- Utilities would like to move to condition-based maintenance to reduce cost and also reduce risk
- Data for asset management is often distributed in various locations and formats
- Monitoring systems are being installed to provide timely data

- Several utilities are pulling data from many places and concentrating it in new data servers, then prompting the questions ...
 - What do I do with all this data?
 - and what data should I be gathering?

And, I only want one system for all my assets!

Traditional Scope of ABB Support Services



- **Transformers**

- 70% of large power transformers are ABB legacy
- Risk assessment and life extension
- Advanced diagnostics and testing
- LTC repairs and replacements
- Factory repair and remanufacturing



- **High Voltage Breakers**

- Support capability for 60-70% of installed base
- Parts, Refurbishment and Retrofit
- Advanced diagnostics – radiography and SF6 leak detection
- Risk assessment and life extension

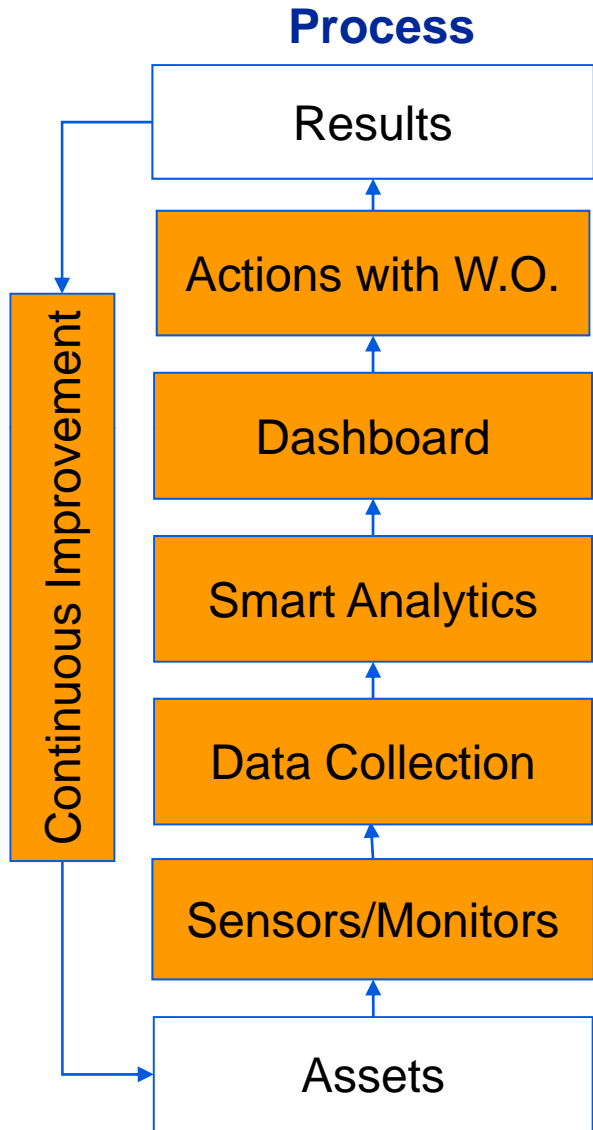


- **Low- and Medium-Voltage Switchgear**

- Over 1 million breakers in service in US
- Parts, Refurbishment, Retrofit, Roll-in Replacement
- Protection & Control assessment and upgrades
- Nuclear & Non-nuclear



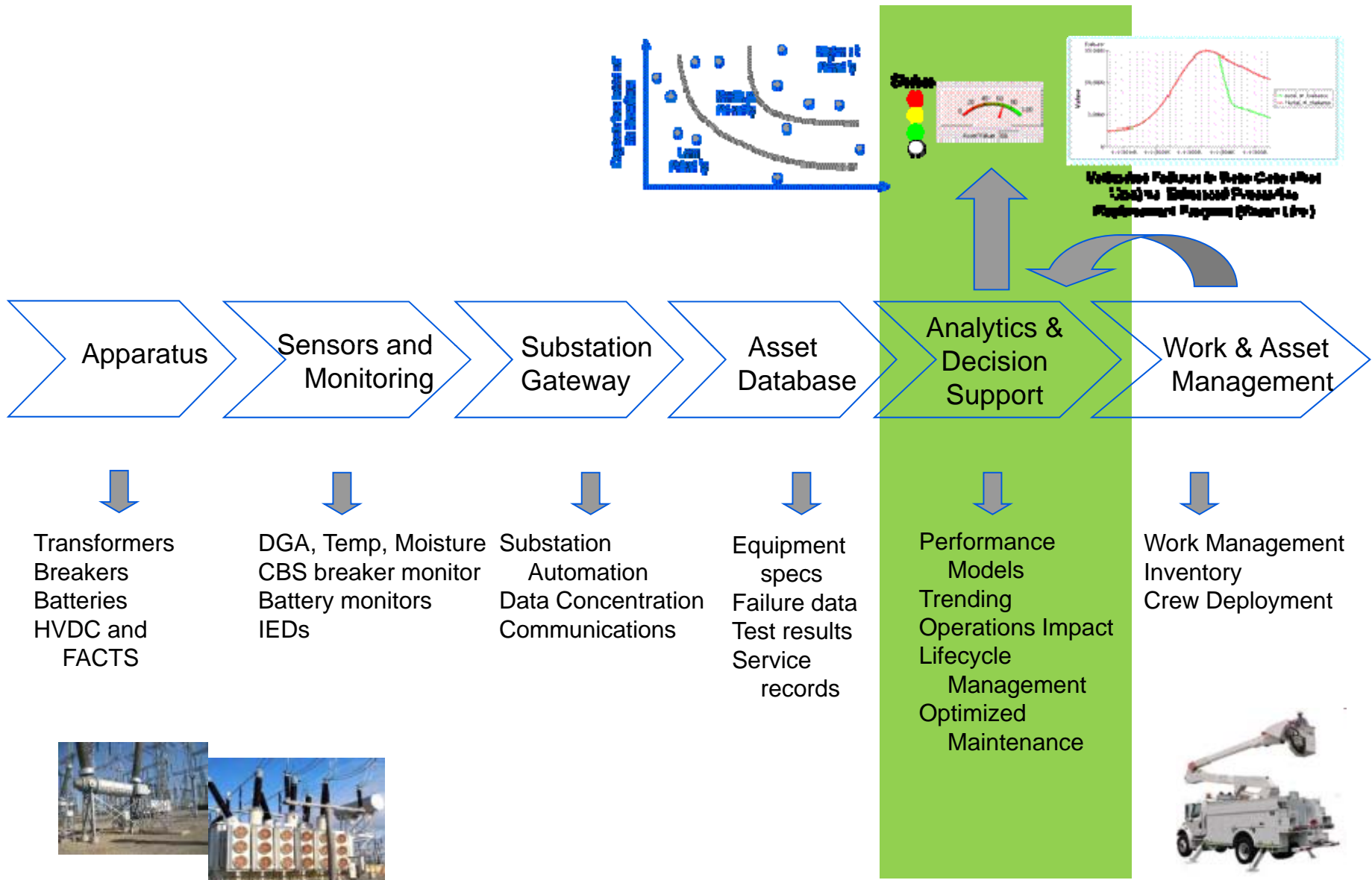
Overall Asset Health Center Vision



Benefits

Business Management	Overview of system operational conditions with drill down capability
Service Levels	Clear and complete set of service performance levels
Decision Making	Business decisions based on data to minimize uncertainty and increase confidence in the direction of the organization.
Operation Improvement	Improved operational efficiencies by making high priority information available to employees
Life Cycle View	Life cycle cost analysis consistently applied to determine how to best spend funds.
Financial Impact	Forecasts of asset performance impacts to future revenue requirements
Risk Management	Management of system operational risks with streamlined proactive sensing, analytic and data mining technology.

End-to-End Solution to Drive Asset Performance



End-to-End Solution to Drive Asset Performance

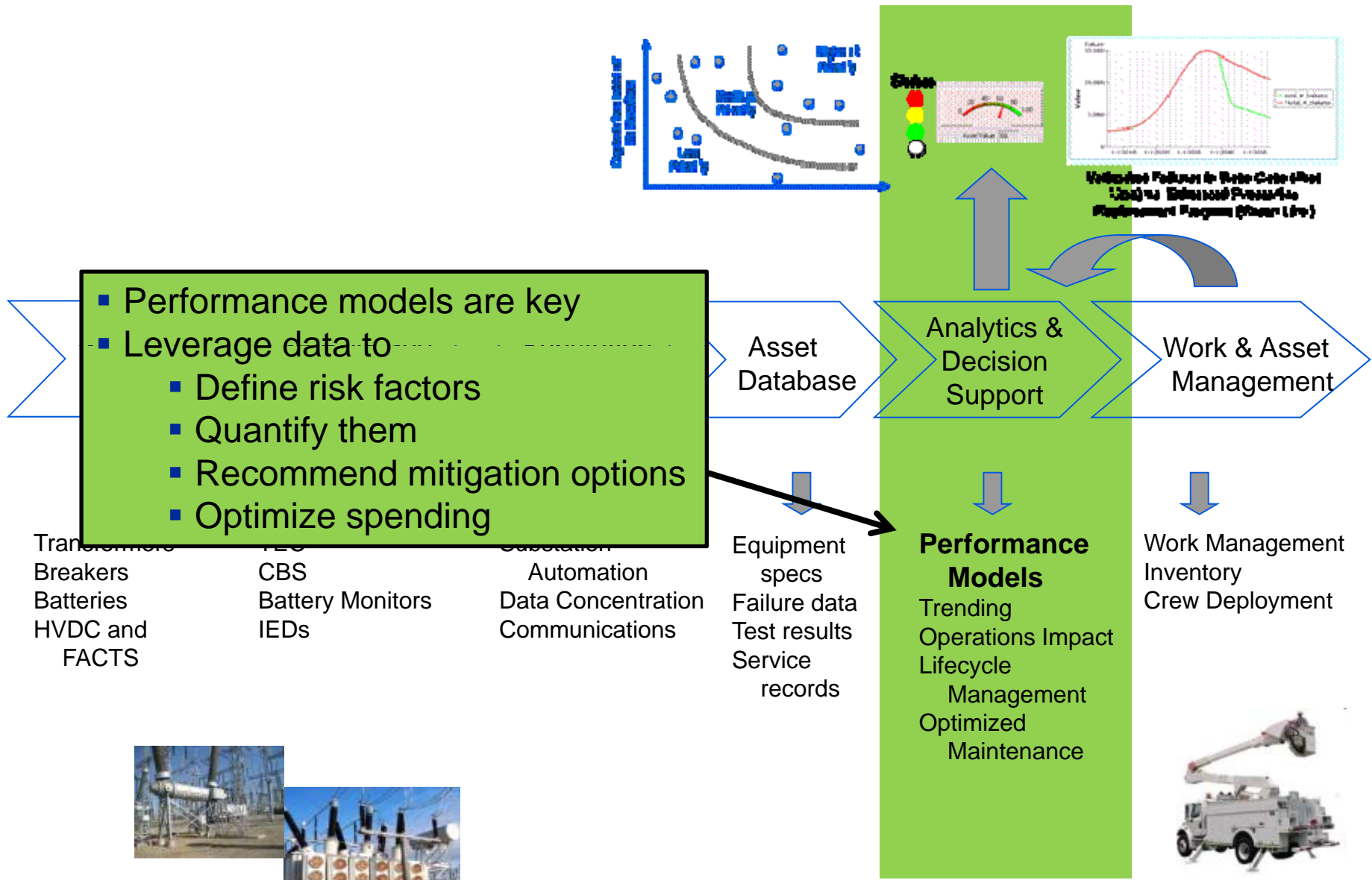
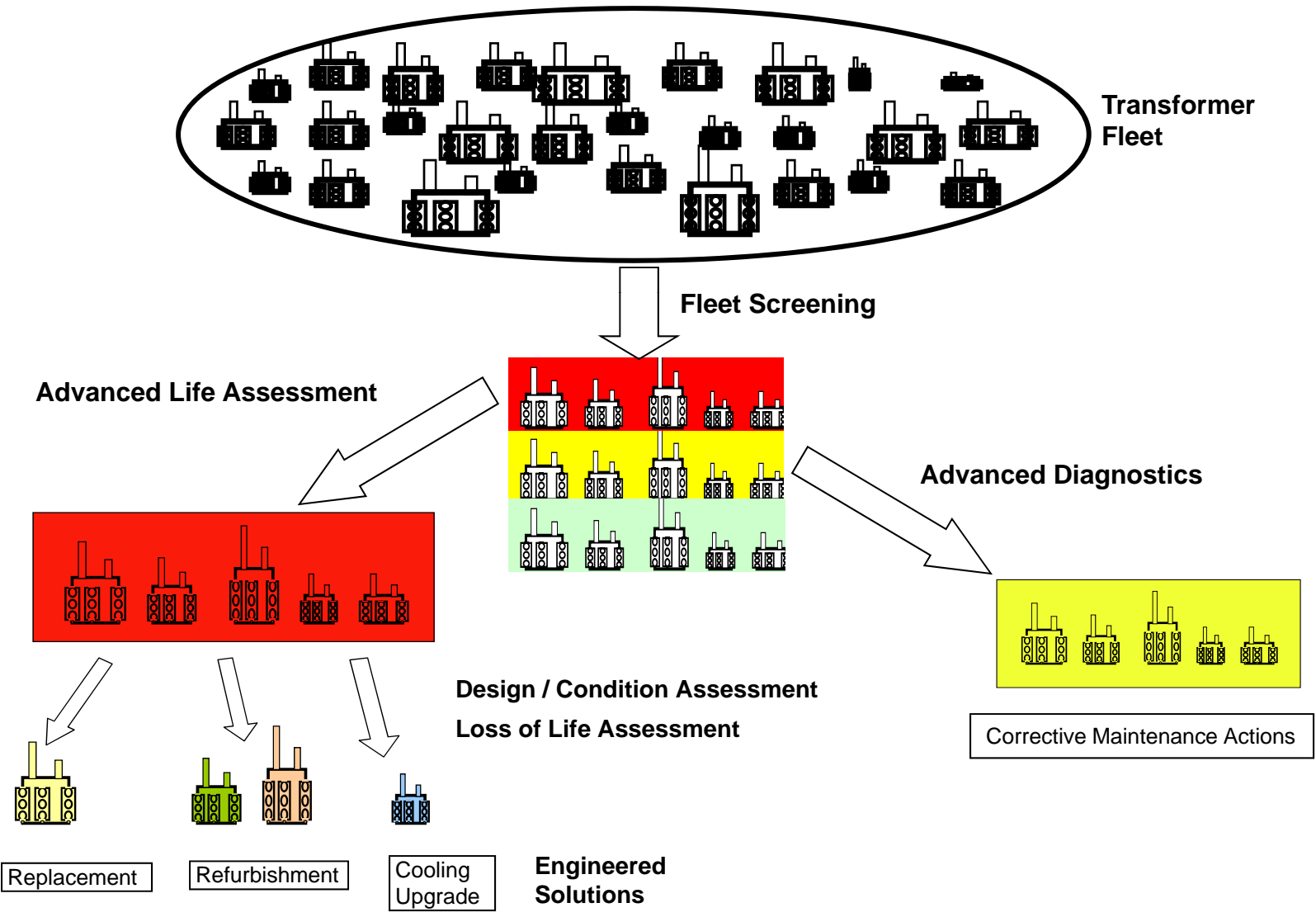


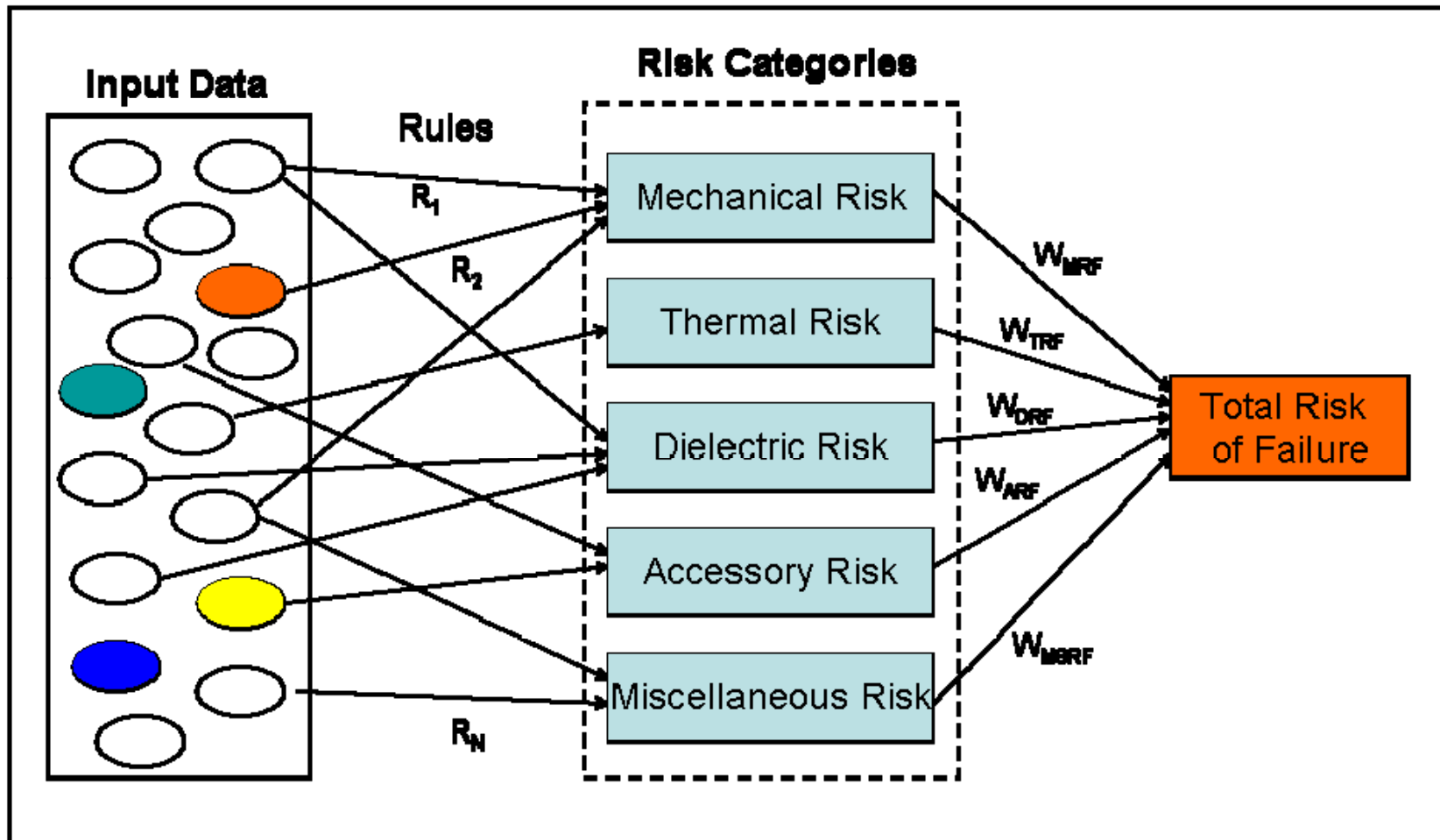
ABB MTMProgram

Well Established Fleet Risk Assessment – Patented Process



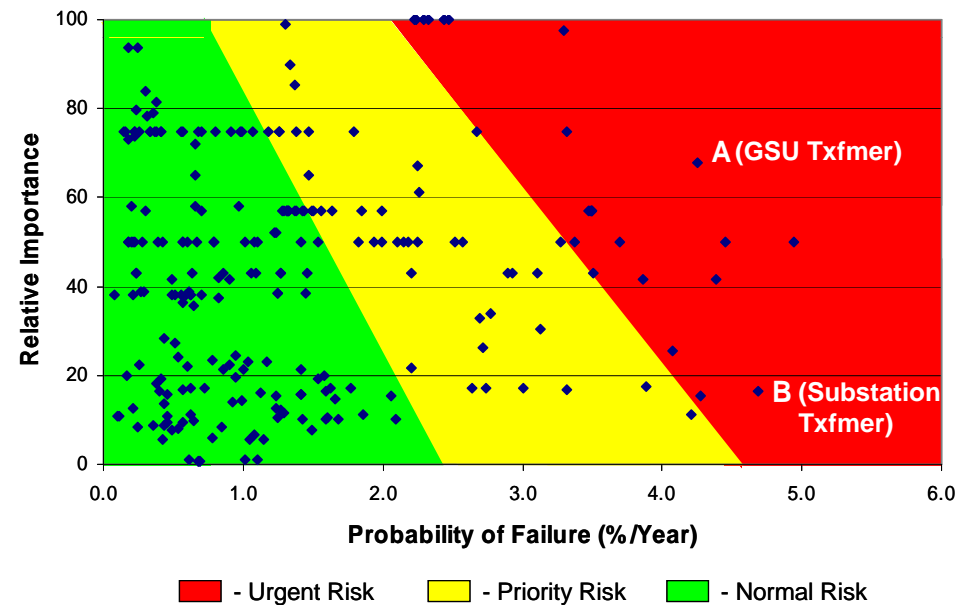
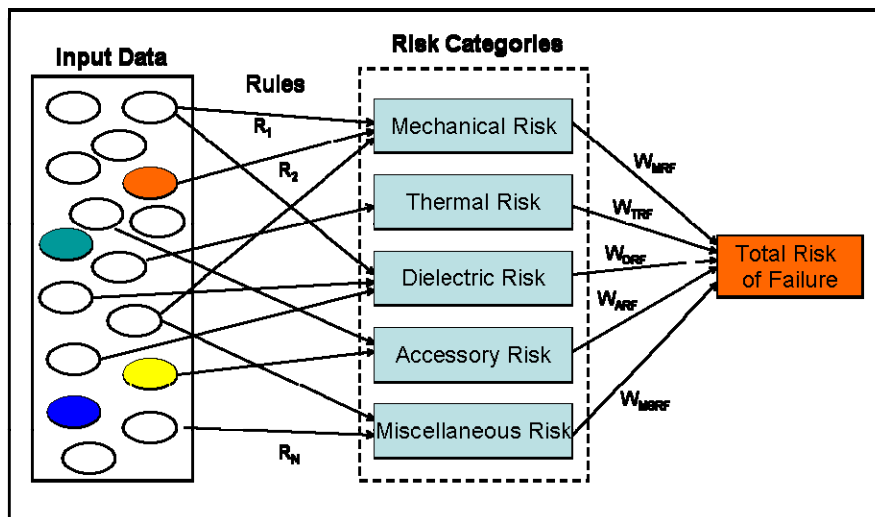
Transformer Fleet Assessment – Process Flow Map

Includes Risk Factors Specific to Individual Designs



Transformer Fleet Assessment – Process Flow Map

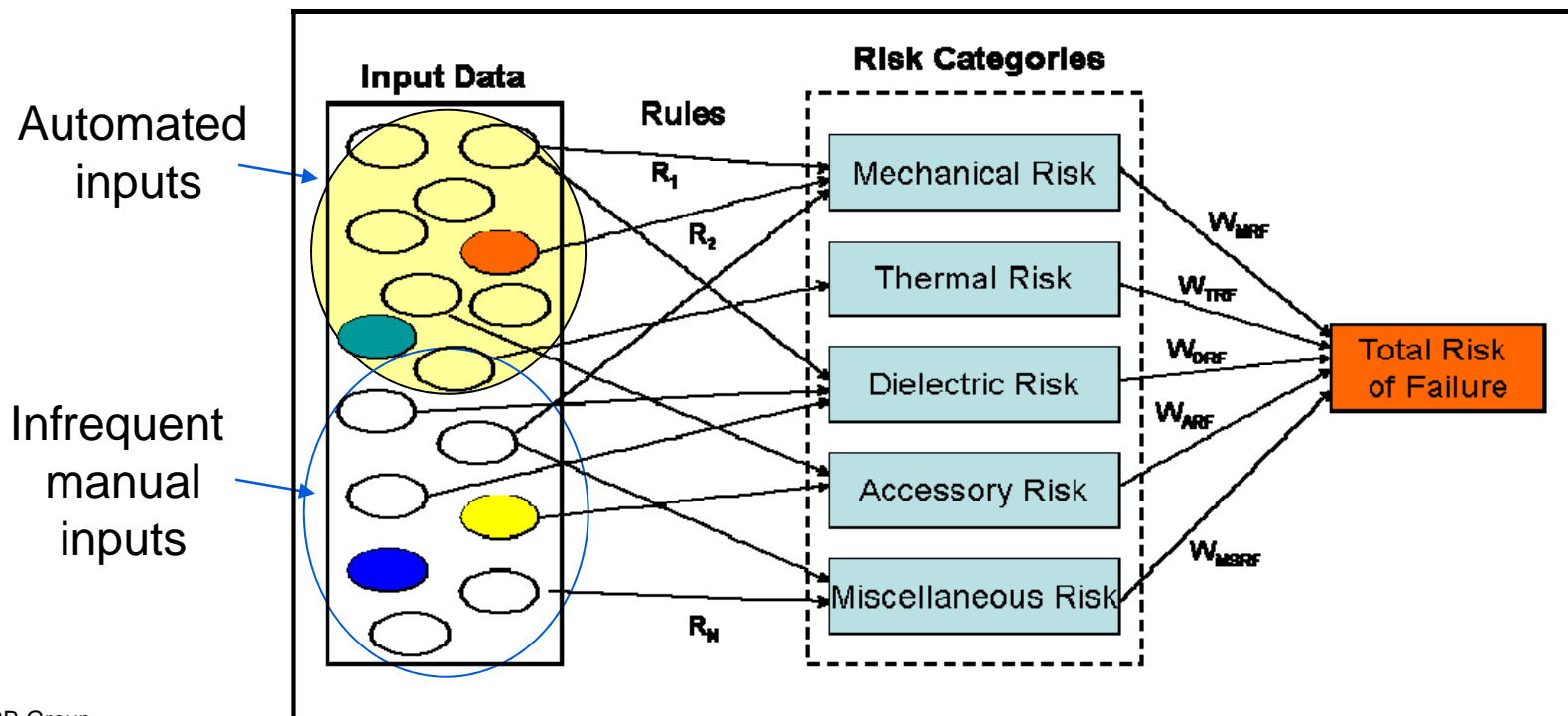
- One-time data gathering process
- Utilizes ABB Risk of Failure algorithms developed using ABB legacy design knowledge and field experience
- Uses the unit criticality as defined by the utility to prioritize the work required to reduce risk



Transformer or Breaker Risk Assessment

Risk Monitoring with Remote Monitoring and Consolidated Data

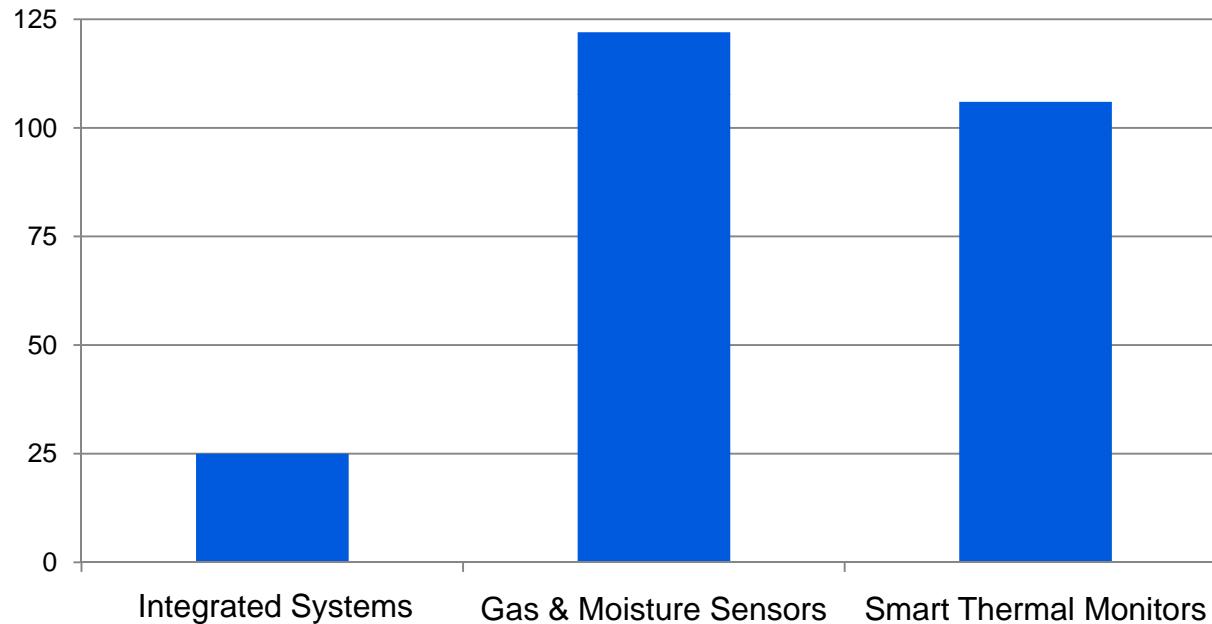
- Remote monitoring can continuously update many factors in the risk assessment to provide a near-real time alert for critical risks as they develop
- Defer routine inspections and PM but still stay ahead of risks that can cause an unexpected outage



Mix of Sensor Usage

Units Shipped with ABB Transformers

Gas & Moisture sensors and Thermal Monitors are the predominant sensors installed on new power transformers



Sensor Price Range

System / Sensor	Price Range (\$)
Integrated monitor	12 K – 60 K
Gas in Oil	5 K – 50 K
Moisture in Oil	1.5 K – 3 K
Thermal Monitor	5 K – 15 K
Bushing Monitor	3 K – 15 K

Individual Asset Assessment

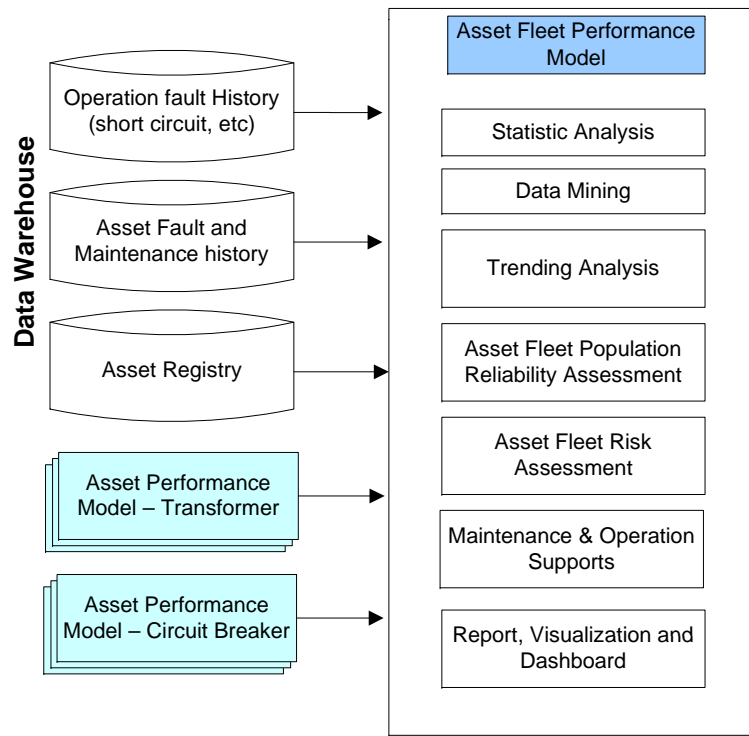
- Define contributing risks
- Quantification of Risk Factors
- Recommendation of mitigation actions and urgency
- Auto-notification of responsible parties
 - Everyone knows all we know
- Generation of draft work order for review
- Data mining capability to allow searches for similar issues and/or similar units in the fleet



Fleet Assessment

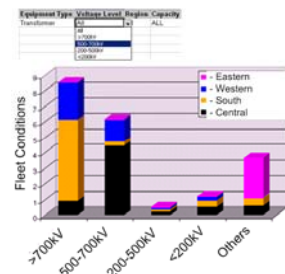
- Optimize spending across an asset fleet to address the highest risks first
- Quantify the unaddressed risks at selected spending levels
- Optimize the capital replacement program to evaluate the tradeoffs with continued maintenance expense and/or unaddressed risk
- Compliance reporting

Asset Fleet Performance Model

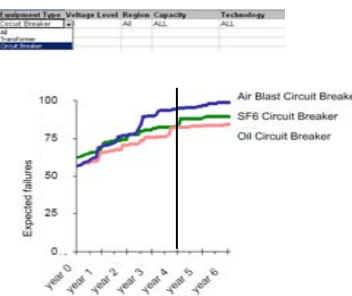


Sample Outputs

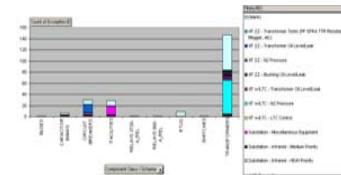
Fleet Condition



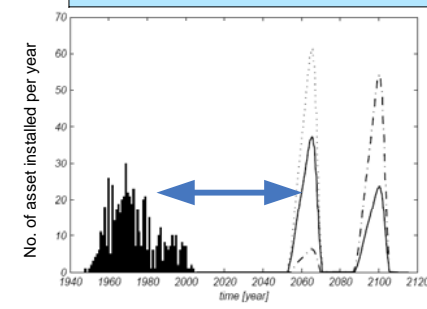
Fleet Performance Trending



Root Cause Identification



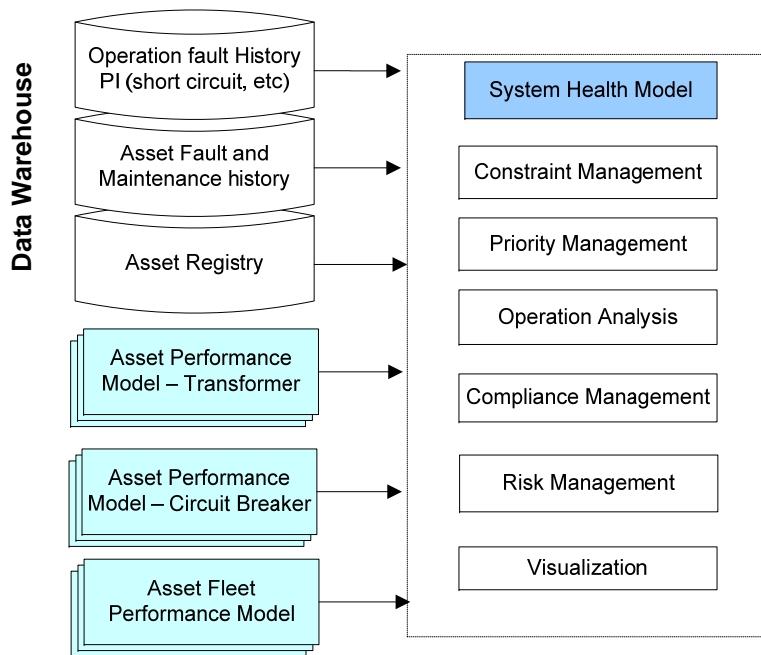
Fleet Replacement Planning



System-Wide Assessment

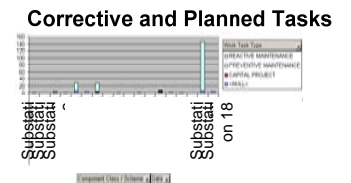
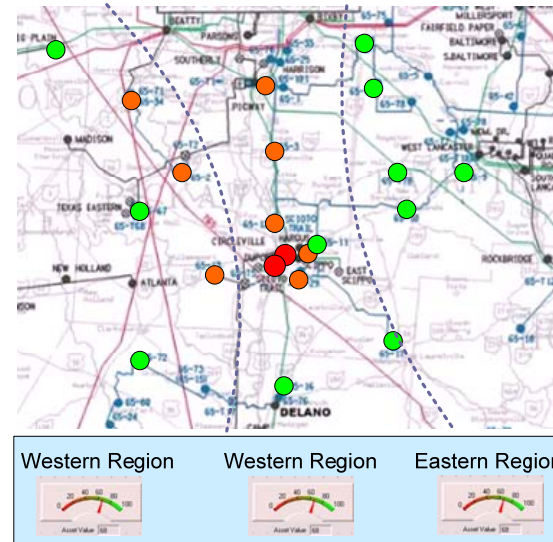
- Define risk by region or substation
- Optimize O&M and CapEx replacement spend across assets for a balanced risk mitigation plan
 - Transformers
 - HV Breakers
 - Station batteries, ...

System Health Model



Sample Outputs

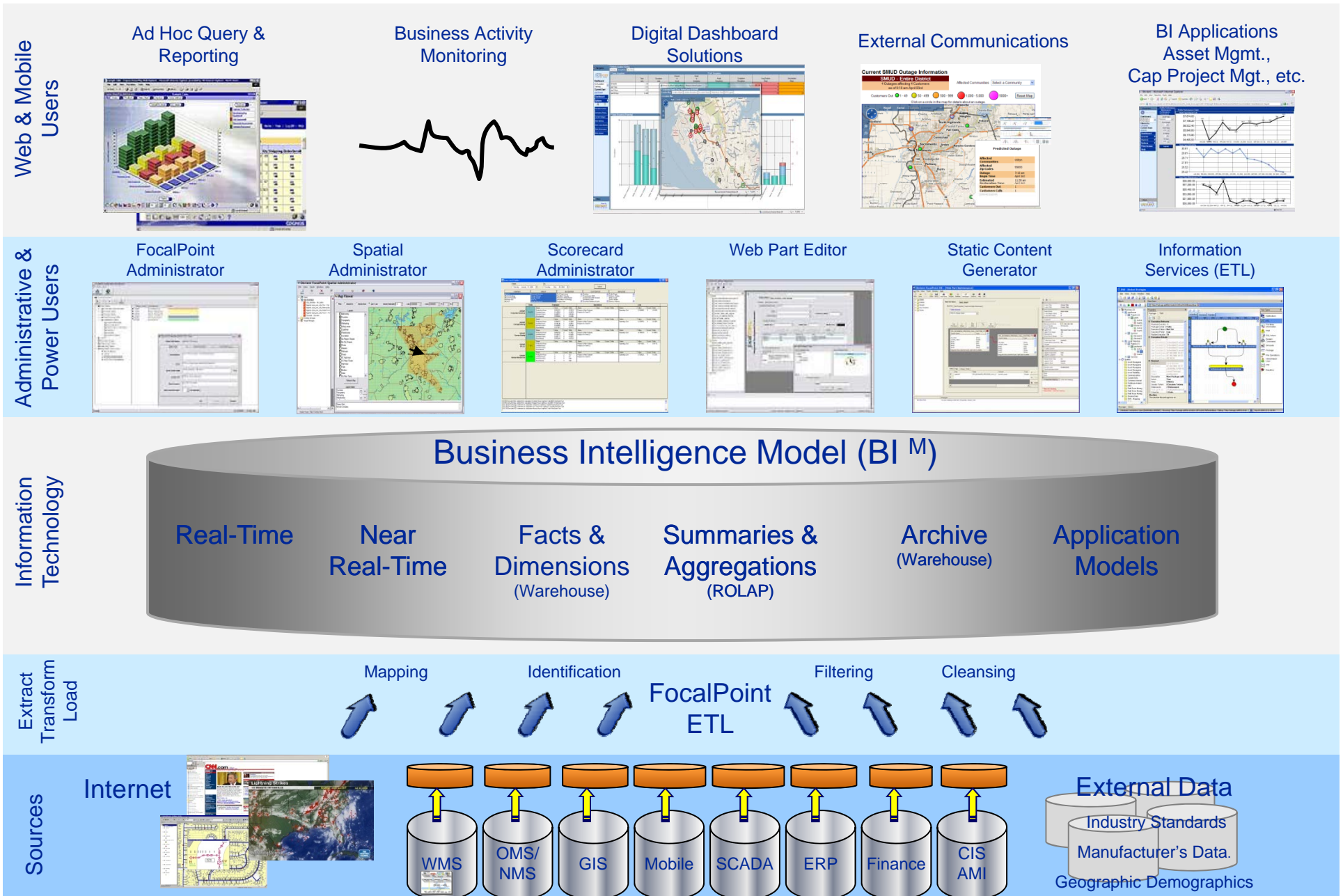
System Health Status



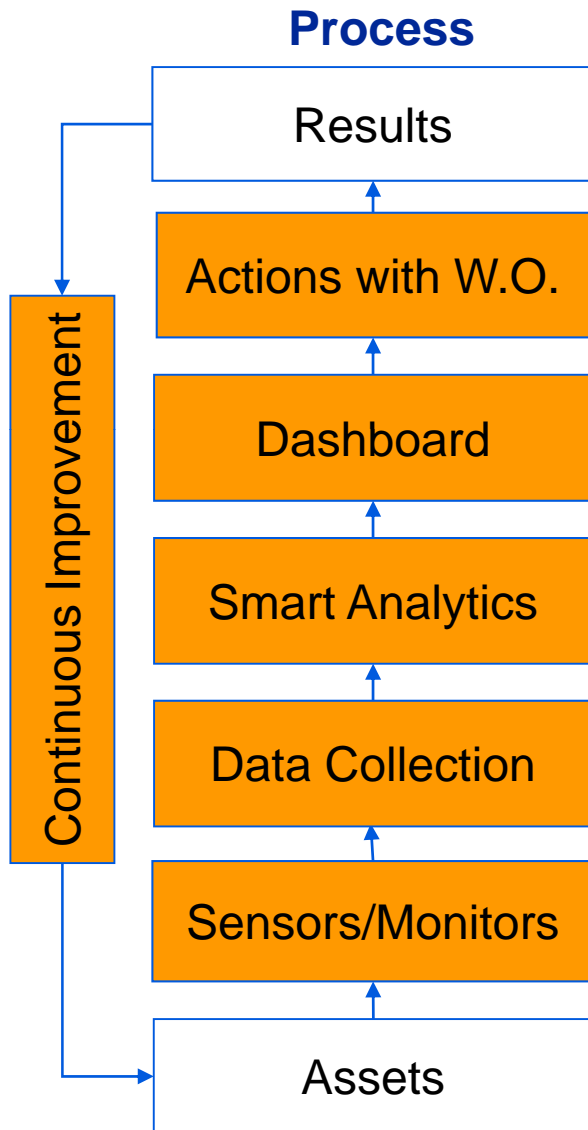
Integrating the Data, Algorithms, Reporting, ERP

- ABB acquired Ventyx in 2010
 - Leading business solutions provider offering software, data and advisory services
- Ventyx acquired Insert Key Solutions in Dec 2010
 - Reliability focused process improvement at nuclear and thermal plants
- Ventyx acquired Obvient Strategies in Jan 2011
 - Obvient's FocalPoint Platform provides data integration and visualization capabilities

FocalPoint Solution Overview



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Asset Health Center

- We believe that the convergence of domain expertise and system integration can be a great step forward in quantifying risk and optimizing spending plans
- Early identification of incipient failures can avoid unexpected and costly outages
- We are working closely with utilities to define their requirements for the system
- Product risk algorithms are already well developed, and more are in process
- Ventyx's Obvient FocalPoint software platform is already applied at many utilities, and seems well suited for visualization and as a dashboard
- Target for pilot application late 2010



April 18, 2011

Circuit Breaker Monitoring

- Diagnostic and monitoring system for SF6 power circuit breakers rated 38kV and above



Dead Tank



Live Tank



GIS

Why Condition Based Monitoring

- Continue to reduce O&M resources
- Unplanned downtime is extremely costly
- Local in-house expertise continues to decline
- Expected to provide more expertise than ever before
- Harder to schedule outages
- Need to make better decisions more quickly
- Legislation is being enacted (i.e. SF6)

SF6 Regulations (US)

U.S. Environmental Protection Agency (EPA) - SF6 gas is currently being regulated and is deemed as a GHG (greenhouse gas).

Mandatory legislation started Jan 1, 2010 with reports due by April 1, 2011.

Effective January 1, 2011, the rule sets an initial emission rate at ten (10) percent of owners' SF6 capacity. Beginning in 2012 owners of equipment using SF6 must reduce emissions by one (1) percent each year, reaching an emission rate of only one (1) percent by 2020. (California)

There is a possibility for legislation to tax greenhouse gas emissions at \$5-10-20 / ton CO₂ equivalent

It is estimated that more than 500,000 lb are emitted annually by US utilities

 Taxing will cost over \$108MUSD annually at the \$20 / lb of SF6

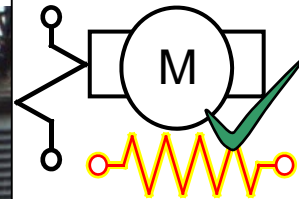
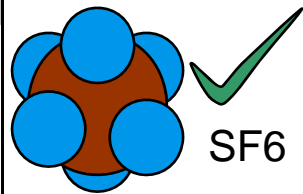
 SF6 will cost over \$4MUSD annually at a price of \$8-\$10 / lb of SF6

CBS – Conditions Overview

Circuit Breaker Sentinel

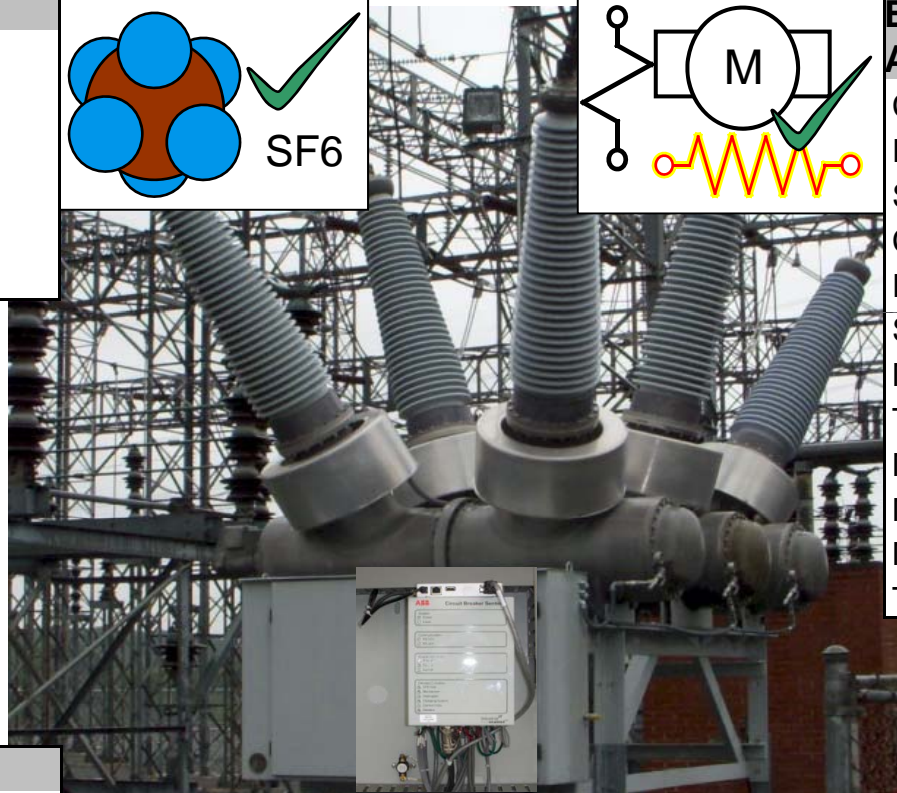
SF6 Gas System

- Tank/Gas Temp. (°C)
- Comp. SF6 Pres. (psi)
- Leak Rate (1) (psi/s)
- Leak Rate (2) (psi/min)
- Leak Rate (3) (psi/h)
- Leak Rate (4) (psi/day)
- Leak Rate (5) (psi/month)



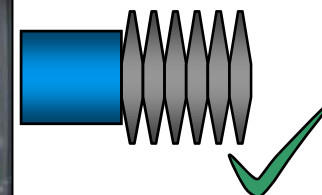
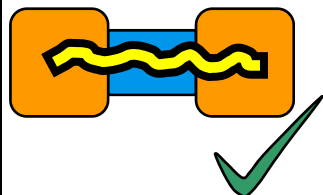
Electrical Controls & Auxiliaries

- Close Coil Monitor
- Primary Trip Coil Monitor
- Secondary Trip Coil Monitor
- Close Coil Energization Time
- Primary Coil Energization Time
- Secondary Coil Energization Time
- Mech/Cabinet Temperature
- Thermostat / Energized Heaters
- Motor Starts (total)
- Motor Starts w/o Operation
- Motor Run Time
- Trip Count



Interrupter Wear

- Contact Wear (%)
- Aux Noz. Wear (%)
- Main Nozzle Wear (%)
- RMS Current(1) kA
- RMS Current(2) kA
- RMS Current(3) kA

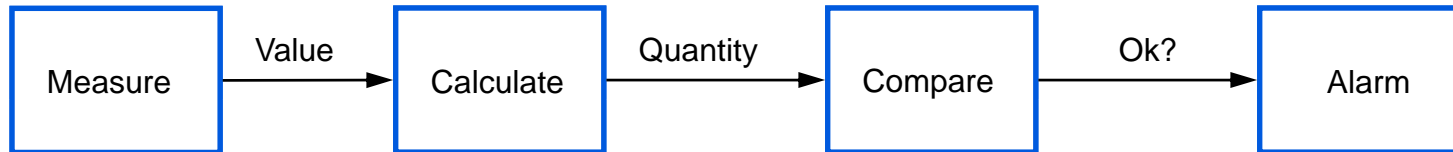


Mechanical System

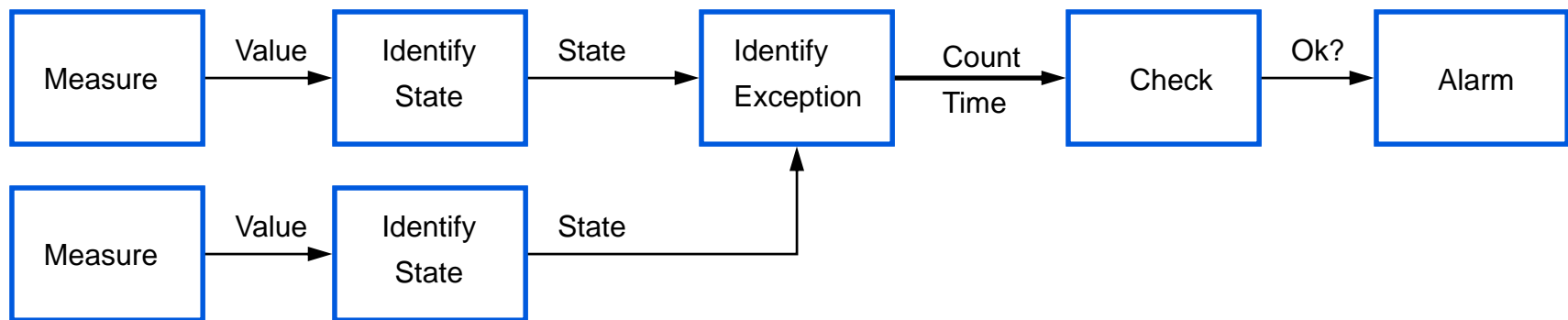
- Total Travel (mm)
- Reaction Time (ms)
- Mechanism Time (ms)
- Contact Velocity (m/s)

Types of Conditions

■ Quantitative Monitoring

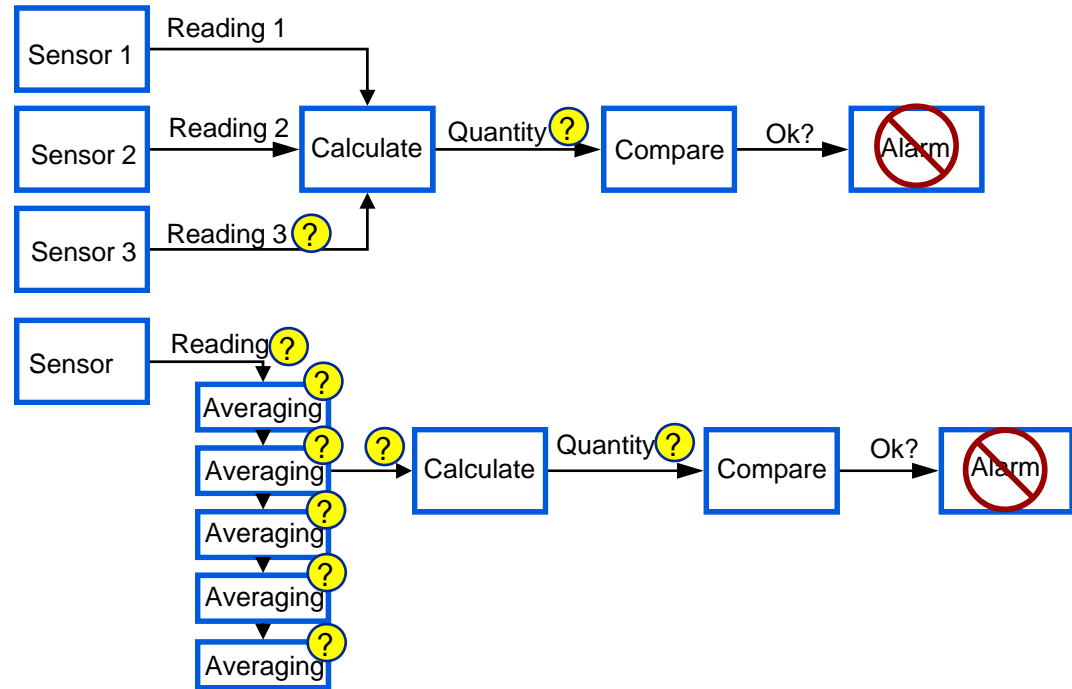


■ Functional Monitoring / Exceptions

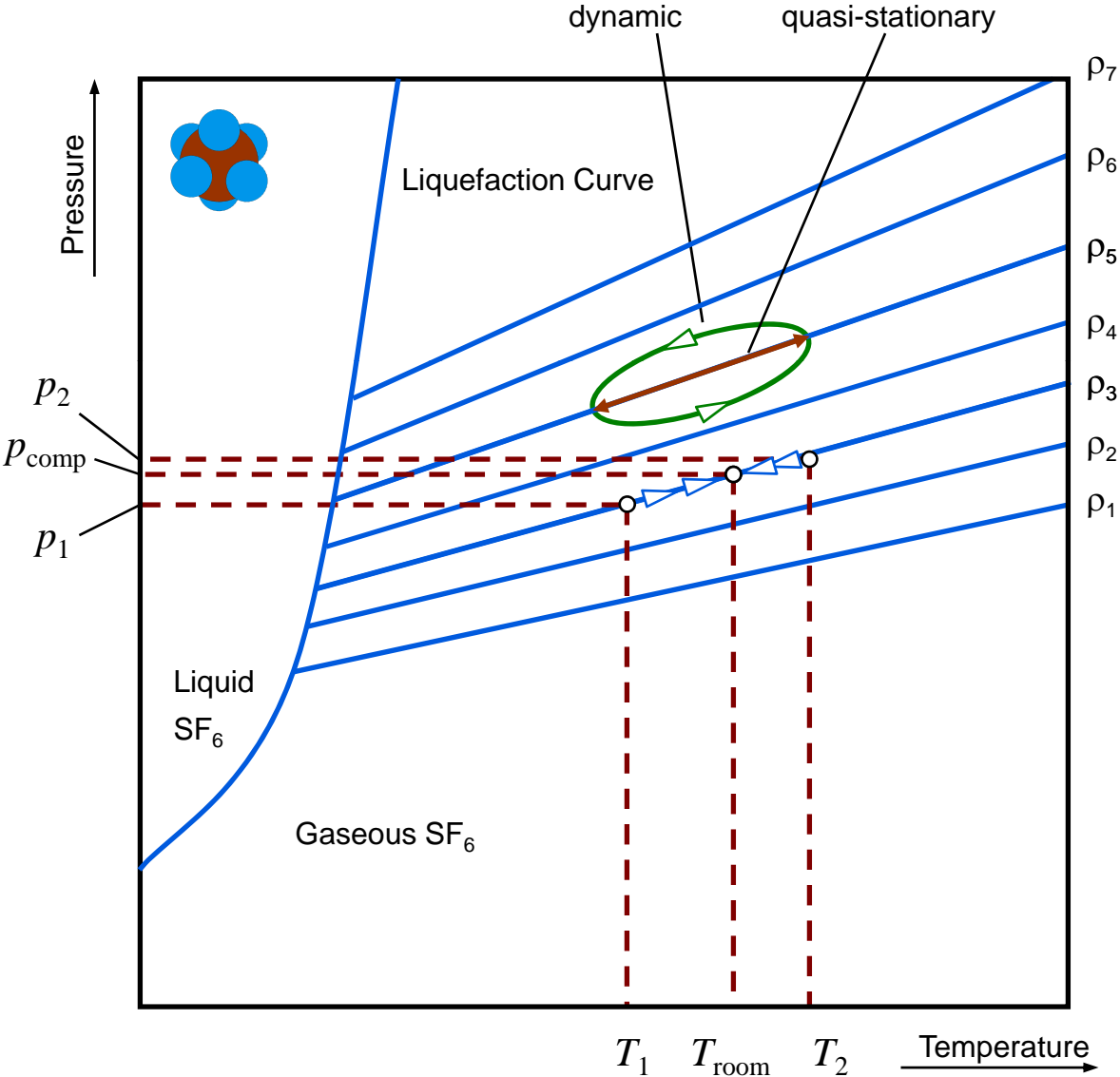


Algorithms: Integrity Alarm

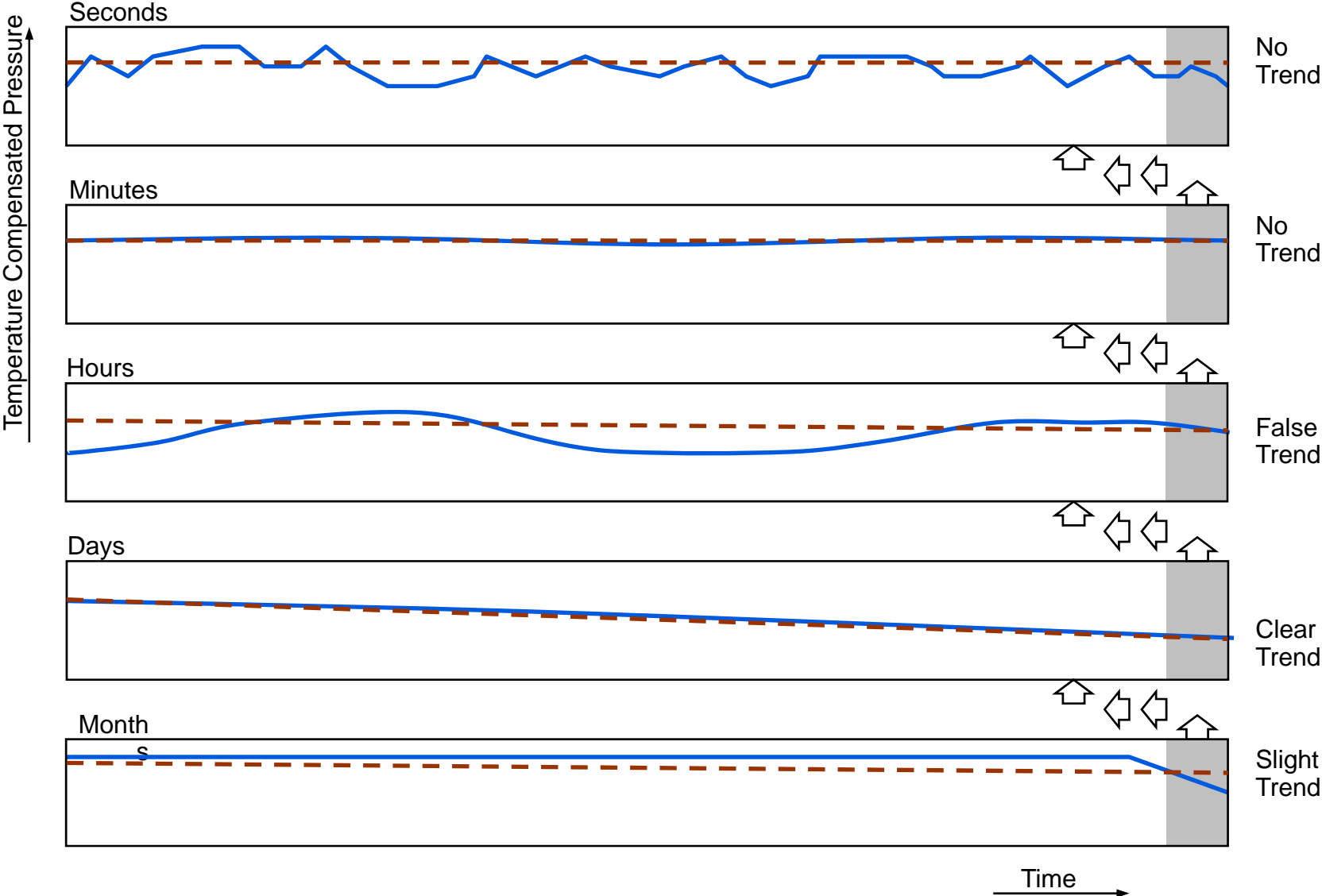
- Integrity is used to eliminate false alarms due to missing data
- Indication of sensor status
 - Sensor Problem
 - Hardware Defect
 - Wiring Problem



Algorithms: Temperature Compensated Pressure



Algorithms: Gas Trending



CBS-F6 Installations

- Customers: Allegheny Power, Empire District Electric, KCPL, Idaho Power, PG&E, Alabama Power, New Mexico Power
- Manufactures: ABB, Siemens, GE



Dead Tank



Live Tank



GIS

ITAIPU – CBS Retrofit Project GIS Application

- **Customer:** Itaipu hydropower plant in South Brazil
- **Opportunity:** (54) CBS on ABB 550kV BBC gas insulated switchgear (GIS)

Project Description:

Customer was looking for a reliability centered program, built around condition monitoring and data analysis to cost effectively manage substation assets.

Article:

<http://www.abb.com/cawp/seitp202/2c2c1dac21f8c834c12577cf0040187d.aspx>



RG&E – CBS / 800xA Retrofit Project

DTB Application

- **Customer:** Rochester Gas & Electric
- **Opportunity:** (18) CBS on ABB 362/121kV DTB w/ Asset Optimization Package

Project Description:

Improvement in maintenance efficiencies due to costly practices
PUC driver for system improvement due to recent rate increases
Includes dedicated Sierra cellular devices for communications



KCPL – CBS Retrofit Project LTB Application

- **Customer:** Kansas City Power & Light
- **Opportunity:** (2) CBS on ASEA 362kV LTB

Project Description:

Monitoring system to support a critical nuclear application.

Reductions in failures to improve asset reliability



National Grid – CBS Retrofit Project DTB Application

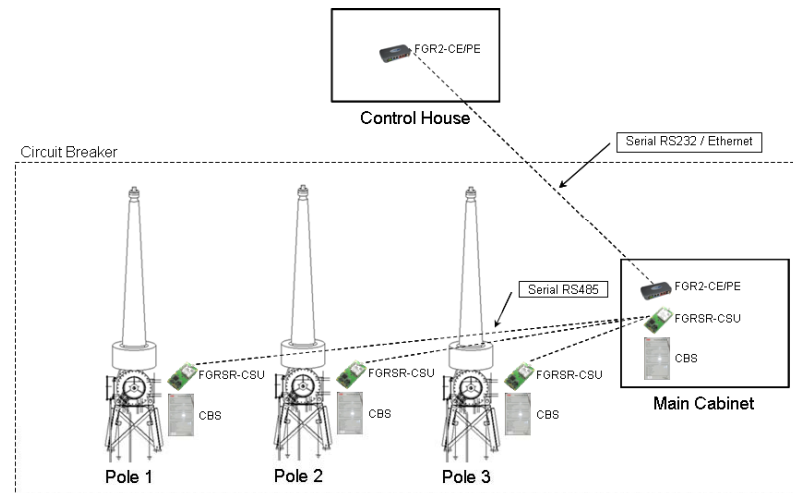
- **Customer:** National Grid
- **Opportunity:** (1) CBS on ABB 362PME (Pilot for 900MHz devices)

Project Description:

First asset monitor device for circuit breakers

Evaluating CBS device to support condition based monitoring

Pilot for 900MHz communications from pole to pole to control house



Business Case

- Innovative technologies

- Our CBS devices provides a compliant “Smart Grid” solution that continually monitors the health of a circuit breaker.

Productivity

Allows users to move from the typical "Time Based Maintenance" to a "Conditioned Based Maintenance" approach.

- Defers/extends maintenance intervals

- Reduces unnecessary downtime
- Extend life of the breaker

Efficiency

Useful tool for maintenance personnel to effectively maintain assets.

- Prioritize higher maintenance (preventive/corrective) actions

- Allow adequate time to schedule outages

Environmental Impact

Compliant with EPA regulations to reduce the usage of SF6 gas.

- Early leak detection

- Proper outage planning

Cost-reduction

- Reduce maintenance intervals

- Reduce/eliminate emergency repairs

- Loss of revenue due to failed equipment

- SF6 gas usage

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