Condition Assessment of T&D Assets Using OSI PI

By Bill Cozzens

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Condition Assessment Agenda

- Overview of Condition Assessment (CA)
- PI Architecture for CA
- CA Components
- Using CA Information
- Implementing the Equipment CA Program
- Wrap-Up & Questions

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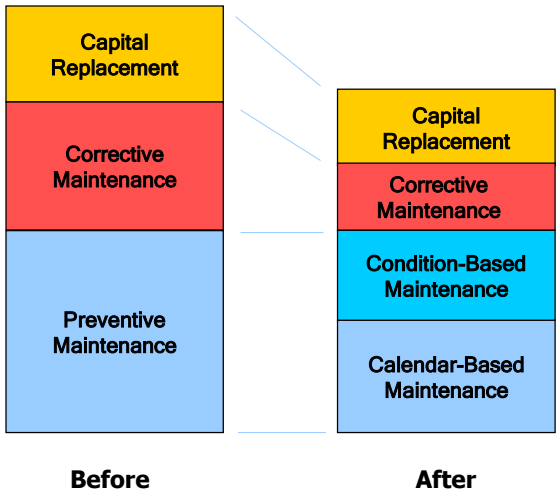
Business Challenges in T&D

- Aging assets
- Increased load
- Expected reliability improvements -- PBR
- Need for competitive edge -- return on capital
- Departing expertise

Condition Assessment Business Drivers

- Determination of asset health to focus maintenance and capital replacement activities
- Provide an analysis platform for engineering activities
- Perform condition-based maintenance
- Reduce capital and maintenance costs to drive improved return on assets



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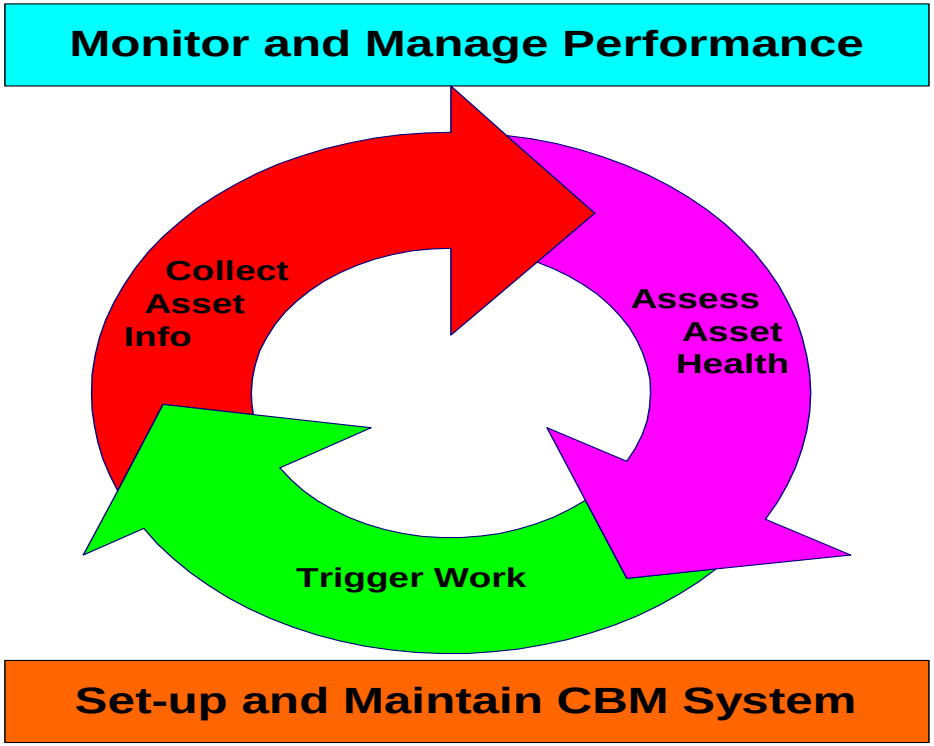
The CBM & Condition Assessment Life Cycle



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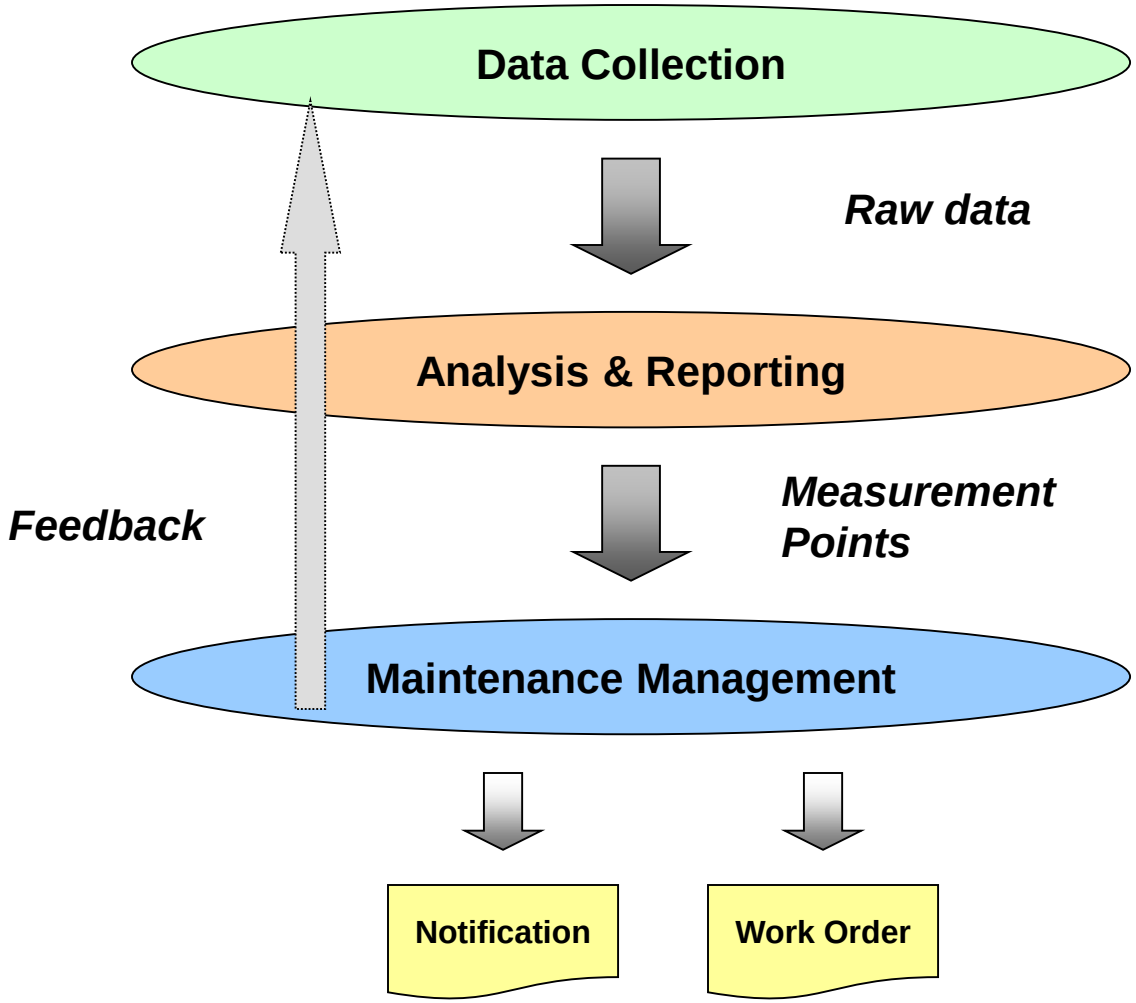
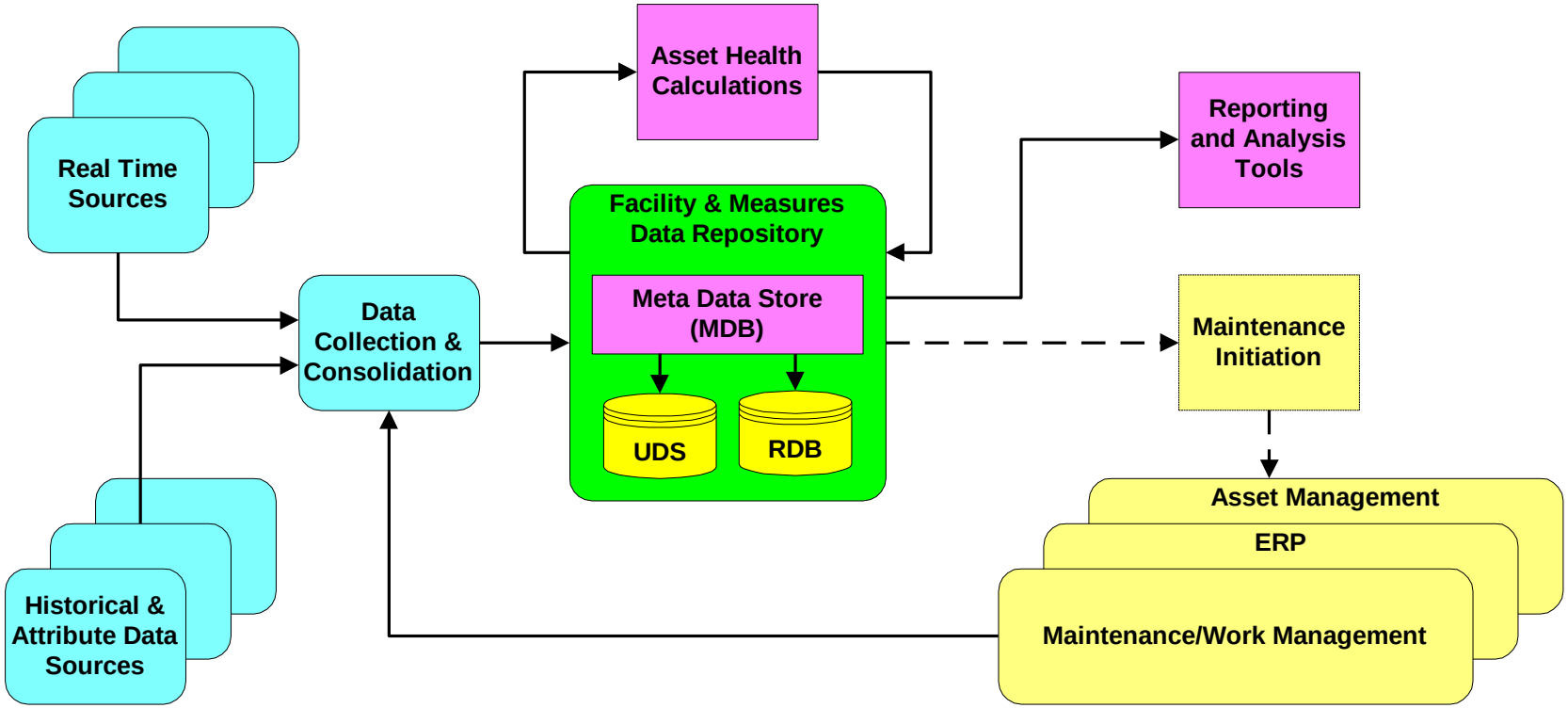
Functional Requirements



CA Conceptual Model

SCG's approach to Condition Assessment uses the MDB as a central meta data repository for asset information and calculations.



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Condition Assessment Components

- Data Collection & Consolidation
- Asset Health Calculations
- Meta Data & the Facility & Measures Data Base

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Data Collection & Consolidation

Philosophy: Consolidate in one place all available information useful for making asset "health" determinations

- Real time & "trendable" data
  - Sources: SCADA, transformer load data, DeltaX (transformer oil analysis), substation relay data, inspection results
  - Storage: PI UDS
  - Methods: PI to PI, PI Batch file interface, PI-API & PI Manual Logger
- Attribute information (equipment changes, work, costs, diagnostics)
  - Sources: ERP, MMS, Doble
  - Storage: RDB
  - Methods: Batch ETL, transactions

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Asset Health Calculations : Condition

- Condition Assessment (CA) = $S_1(W_1) + S_2(W_2) + S_3(W_3) \ldots + S_n(W_n)$
- **S** = case **score** for each **factor**, values = 0 to 10
  - 0 = Best Condition 10 = Worst Condition
  - Converting to an integer case value allows the combination of many quantitative and qualitative measures
- **W** = **weight** in % for each factor, total = 100% Based on the relative importance of each factor
- Condition Assessment is performed separately on different **classes** of equipment (breakers, relays, LTCs, transformers, etc.)
  - Every class can have several or many **subclasses**. Each subclass can have its own factors and weights

Asset Health Factors Example

- Factors for GCB >= 138KV subclass
  - Historical maintenance cost
  - Historical count of work orders
  - Incorrect operations
  - Gas addition quantity
  - Compressor motor run-time
  - Compressor crankcase oil -- added quantity
  - Compressor crankcase oil -- added frequency
  - Megger
  - Ductor
  - Timing

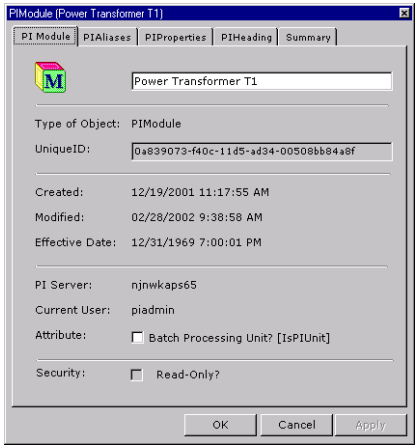
Asset health Calculations: Criticality

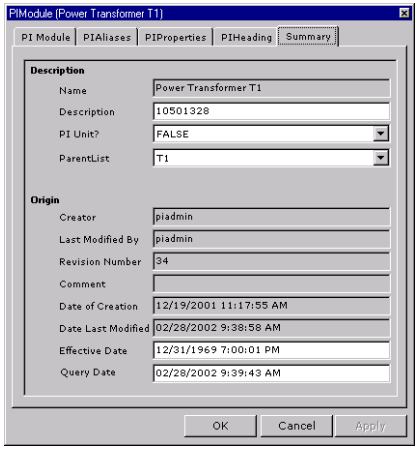
Criticality: Attempts to quantify the subjective measure of how important an asset is and/or the risk or loss that its failure would represent

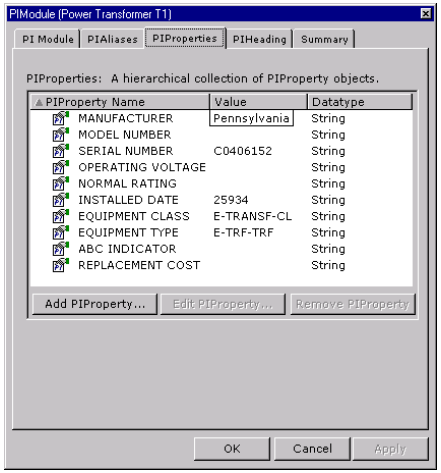
- Criticality = $F_1(W_1) + F_2(W_2) + F_3(W_3) \ldots + F_n(W_n)$
  - Potential **factors**: replacement cost, age of asset, type of customers impacted, number of customers served, size, voltage, load
  - Usually only estimated for most valuable and important classes of assets: eg. transformers, breakers, relays
  - Simpler calculations: Subclasses usually not needed. Factors and weights can apply to all classes
  - As with condition assessment, use case statements (values = 0 - 10) to combine diverse and qualitative measures

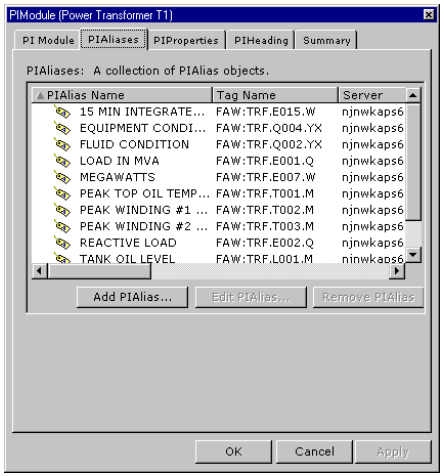
PI Module Database Overview

- Define Module
  - Descriptive Information
  - Properties
  - Tag Alias
- Define Module Taxonomy
  - Define Hierarchies
  - Each level has a parent-child relationship
  - Any module can appear many times in the hierarchy
  - Load the hierarchies









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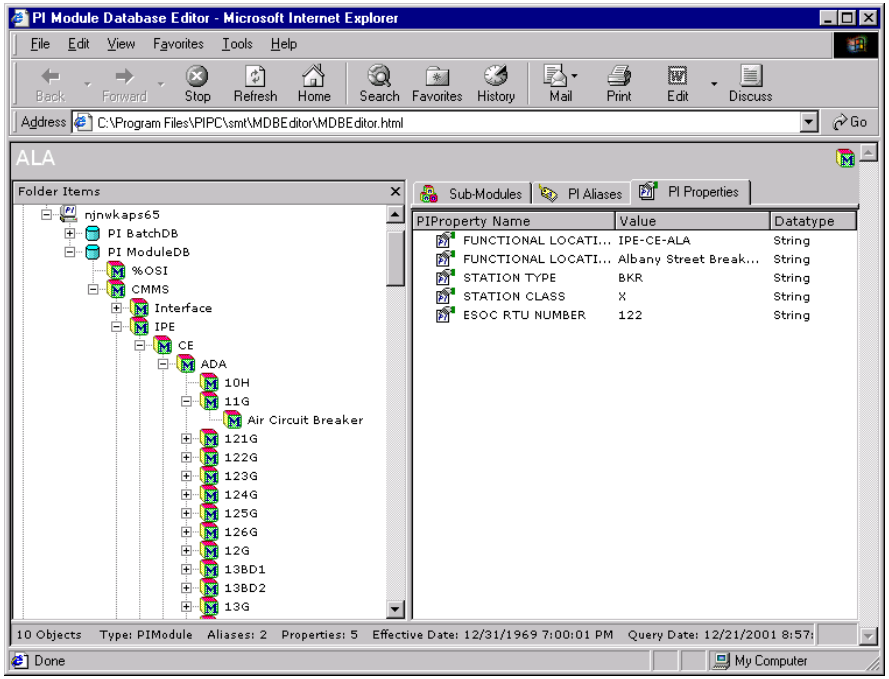
Utilizing PI MDB as the meta data store

- MDB is the repository for asset information and condition assessment methods
  - Equipment Hierarchies
  - Asset descriptive information
  - Equipment peer groups
  - Storage of factor and weight definitions
  - Look-up capability to retrieve the values needed to calculate factor values



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CA Information Has Valuable Uses

- Reporting and Analysis
  - Capital Replacement or Maintenance Priority Lists
  - Engineering & Maintenance Planning Analysis
- Work Management Interface
  - Triggering Alerts/Alarms, Maintenance Work Orders

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Capital Replacement or Maintenance Priority Lists

Finding the "Needle in the Haystack" -- prioritization of maintenance and capital replacement activities

Equipment ID	Location	Type	Overall Condition	Criticality	
BKR1005	Media Sub	ACB	75.2	92.0	
BKR2012	Sol Switch	OCB	75.2	90.0	
BKR3006	Rosetree Sub	OCB	75.0	92.0	
BKR3015	Rosetree Sub	ACB	71.6	93.0	
BKR3010	Rosetree Sub	GCB	71.5	93.0	
BKR2008	Sol Switch	OCB	71.4	95.0	
BKR1001	Media Sub	OCB	70.0	85.0	
BKR1011	Media Sub	OCB	70.0	85.0	
BKR9003	Cust1 Sub	ACB	70.0	91.0	
BKR2007	Sol Switch	ACB	69.3	88.0	
BKR9002	Cust1 Sub	GCB	69.1	91.0	
BKR9101	Cust2 Sub	OCB	68.9	90.0	

Quickly being able to drill down to examine the contributory factors

Equipment ID	Location	Type	Overall Condition	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
BKR1005	Media Sub	ACB	75.2								
BKR2012	Sol Switch	OCB	75.2								
BKR3006	Rosetree Sub	OCB	75.0								
BKR3015	Rosetree Sub	ACB	71.6								
BKR3010	Rosetree Sub	GCB	71.5								
BKR2008	Sol Switch	OCB	71.4								
BKR1001	Media Sub	OCB	70.0								
BKR1011	Media Sub	OCB	70.0								
BKR9003	Cust1 Sub	ACB	70.0								
BKR2007	Sol Switch	ACB	69.3								
BKR9002	Cust1 Sub	GCB	69.1								
BKR9101	Cust2 Sub	OCB	68.9								

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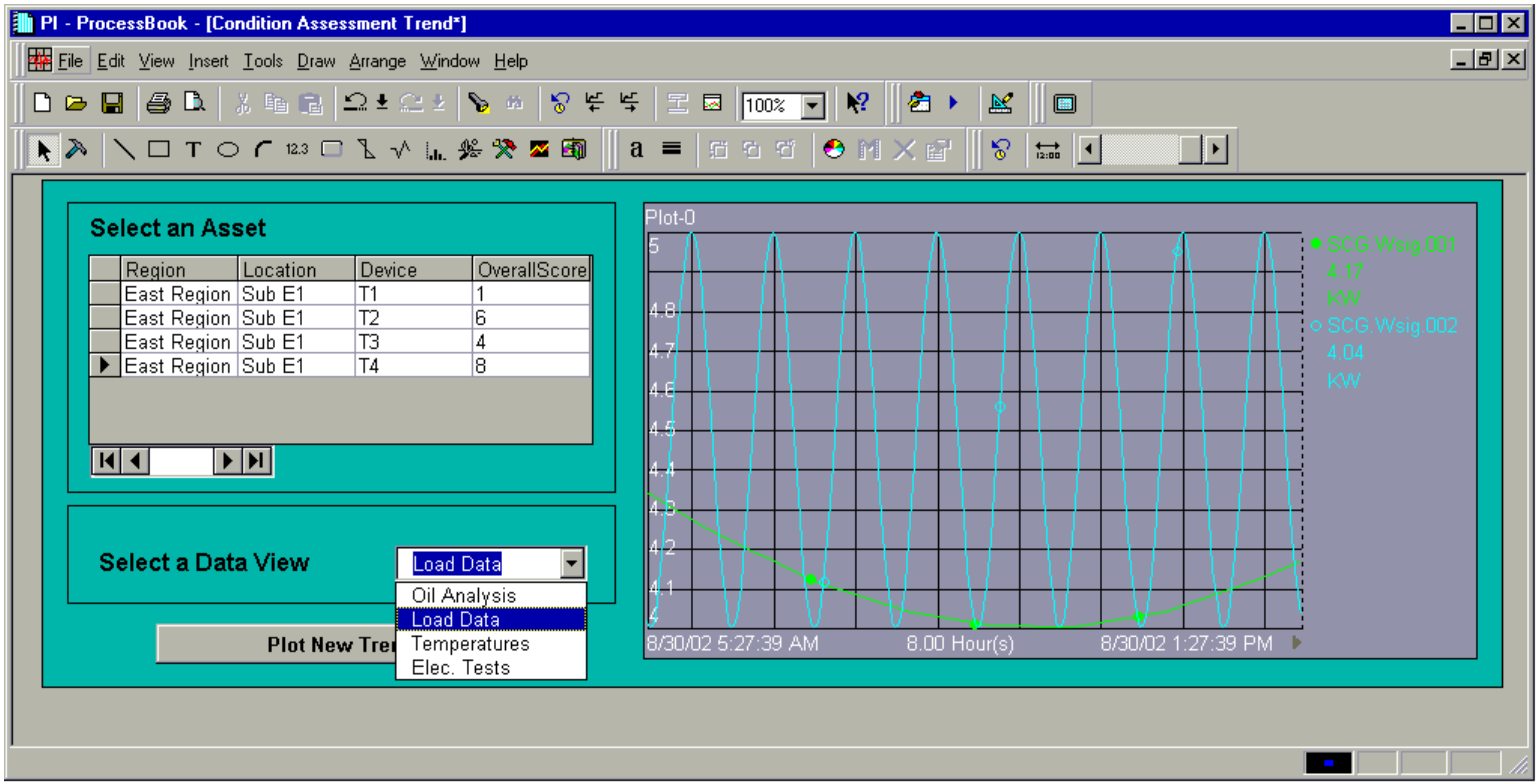
Engineering Analysis

PI graphical tools (Process Book, Active View, ICE) can be used to examine the underlying real-time data and distribute information across the organization.



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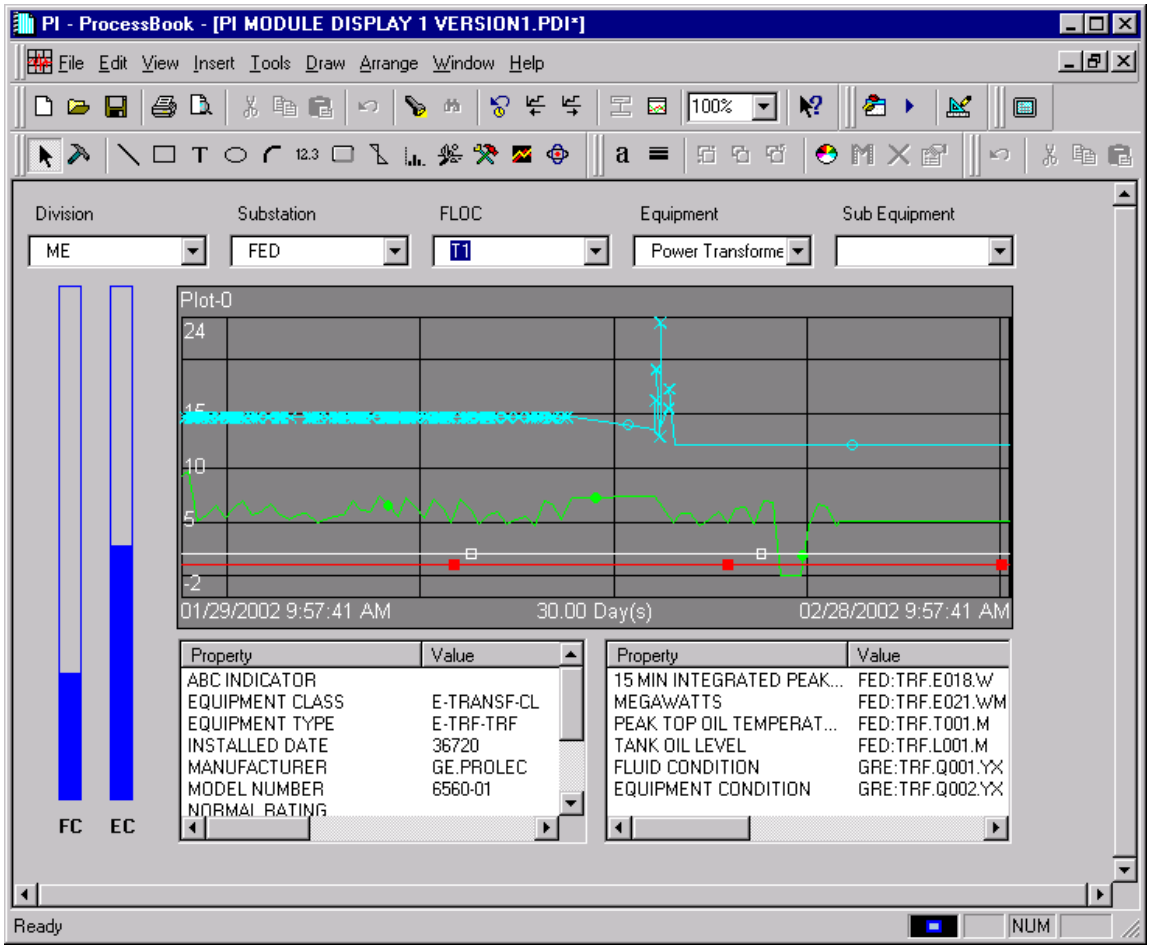
PI Module Database Driven Display



Work or Maintenance Management Interfaces

- A link between Condition Assessment and Work Management can enable condition- or counter-based maintenance
- Counter-based Preventive Maintenance. Suitable when PM criteria can be defined in terms of running time or number of operations
  - Focus maintenance
  - Reduce calendar-based PM costs
- Generate notifications or alerts based on operating parameters exceeding specified limits.
  - Reduce failures and trip outs
  - Reduce corrective maintenance dollars

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Work Management interface options

- SAP Plant Maintenance (PM)
  - OSIsoft offers the RLINK certified interface application
- MRO - Maximo
  - Version 5 programming interfaces expose Maximo data and methods for external systems
- Indus PassPort
  - Indus Connect Series with PassPort 9.0 enables connections to external digital systems
- Digital Inspections - Cascade
  - DI is currently building an interface to OSI PI

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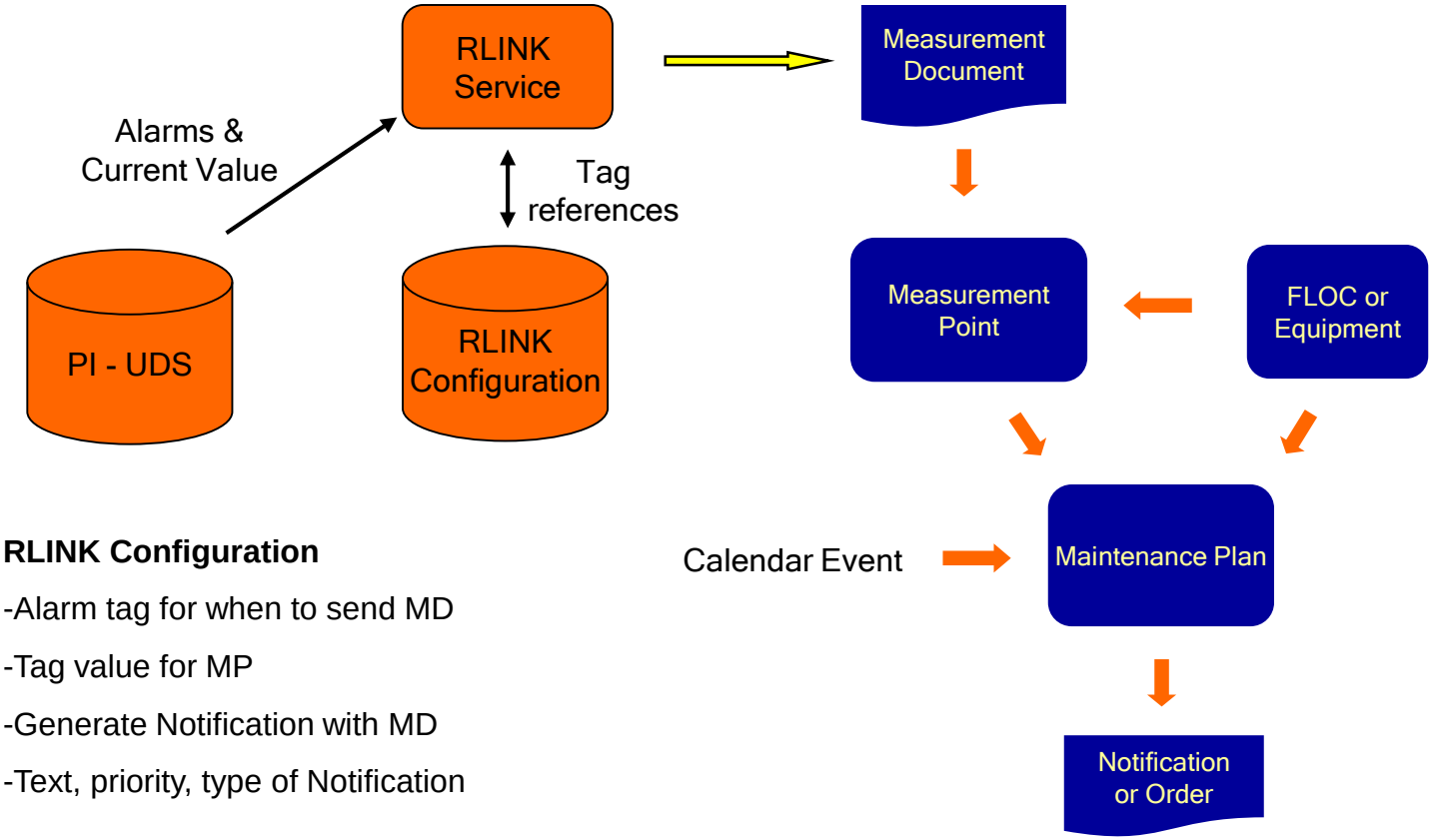
Interface Methodologies

- Measurement Point (MP) Approach
  - Within the WM app. measurement points are defined for each piece of equipment
  - Measurement points can have upper and lower limits; each associated with a maintenance plan or procedure
  - Data readings from PI set or increment the measurement point. When the MP level or counter hits or exceeds the limit work order or alert is issued
- Alternative
  - Define accumulator tags in PI for equipment of interest
  - Establish limits, triggers and id maintenance procedures in MDB for that equipment
  - When limit is exceeded, trigger work in WM application using API or RPC

SAP PM - RLINK Interface



RLINK Configuration

-Alarm tag for when to send MD

-Tag value for MP

-Generate Notification with MD

-Text, priority, type of Notification

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Issues in Implementing Equipment Condition Assessment

- Project Considerations
- Business Process, Organizational and Role Issues
- Criticality of Data

CA Project Components

- Project Strategy: CA should support your RCM and/or Condition Based Maintenance philosophy
- Capturing and articulating T&D system & equipment engineering and maintenance expertise: identification and definition of the condition and criticality factors and weights
- Data management effort (initial and on-going). Asset register. Establishing and correlating data sources with equipment. Data scrubbing.

CA Project Components

- System architecture, design and integration.
- Planning for information utilization
- Modification or setting up new equipment maintenance and engineering business processes to feed, maintain and utilize the new information

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Benefits of This Approach to CA

- CA takes advantage of your existing information technology
- CA is agnostic or at least ecumenical in terms of the various maintenance religious beliefs. Can support RCM, PMO, etc.
- CA is flexible -- reporting, engineering analysis, triggering work management
- CA minimizes your IT maintenance costs by being completely end-user configurable
- CA involves a minimum number of products – reducing complexity and interface requirements

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CA Impacts and Results

Condition Assessment Impact	Result
Target attention on assets with the highest payback in terms of improved reliability and reduced maintenance costs	Improved capital expenditures
Transition from a primarily calendar-based preventive maintenance program to a condition- or counter-based program	Reduced overall maintenance costs
Improved preventive maintenance task lists and PM targeted on the worst condition and poorest performing assets.	Reduction in corrective maintenance
Analysis based on equipment peer groups (voltage class, manufacturer, etc.), network nodes, substations, or other modeled components of the asset hierarchy	Greater ability to spot trends in performance
Use of criticality measures to gauge importance to the delivery of energy and their maintenance and health indicator profiles.	Improved prioritization of assets

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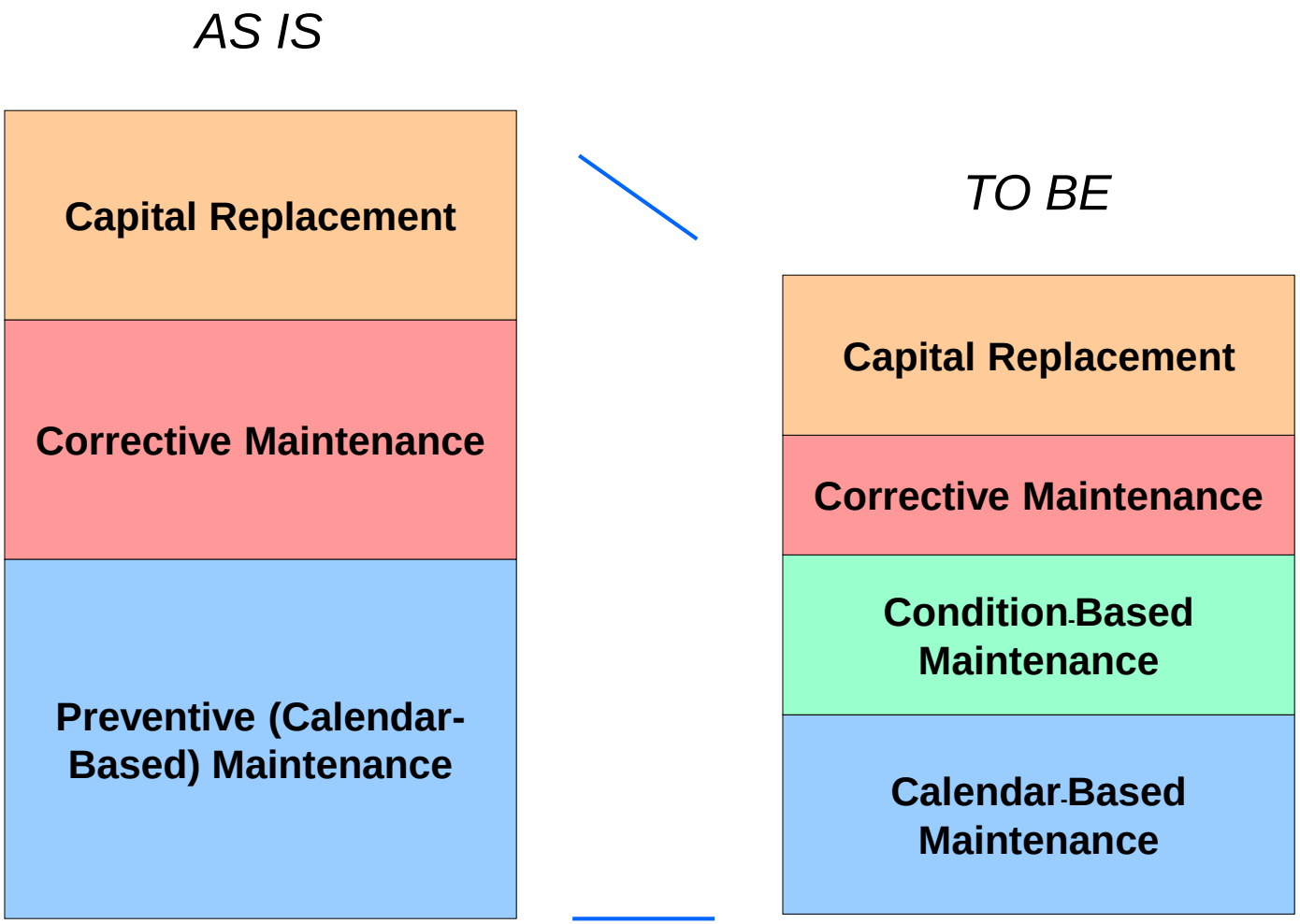
Keep Your Eye on the Big Picture



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Questions & Discussion

Automating Processes. Managing Information. Driving Business.

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