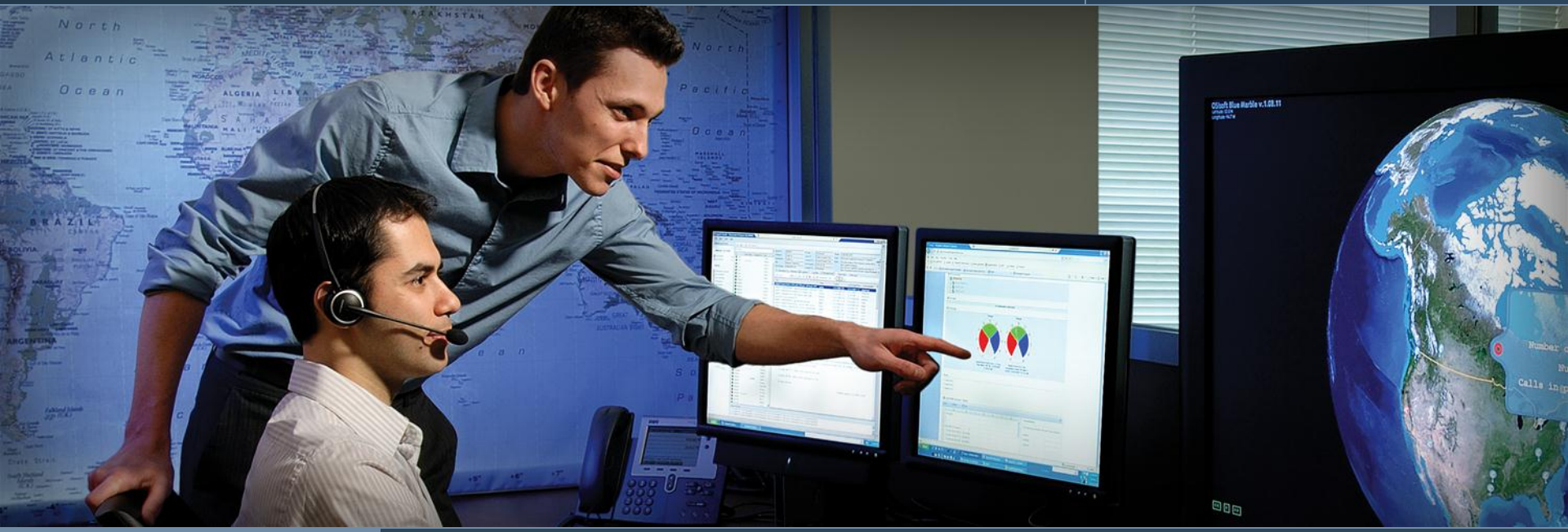
Regional Seminar Series

Bucharest, Romania



PI System Customer Use Cases Part 2
Transmission & Distribution

Zsolt A. Oros
Sales Account Manager, CEE
OSIsoft Europe Gmbh.

Athene Palace Hilton
Bucharest, Romania

25 November 2010

Empowering Business in Real Time.

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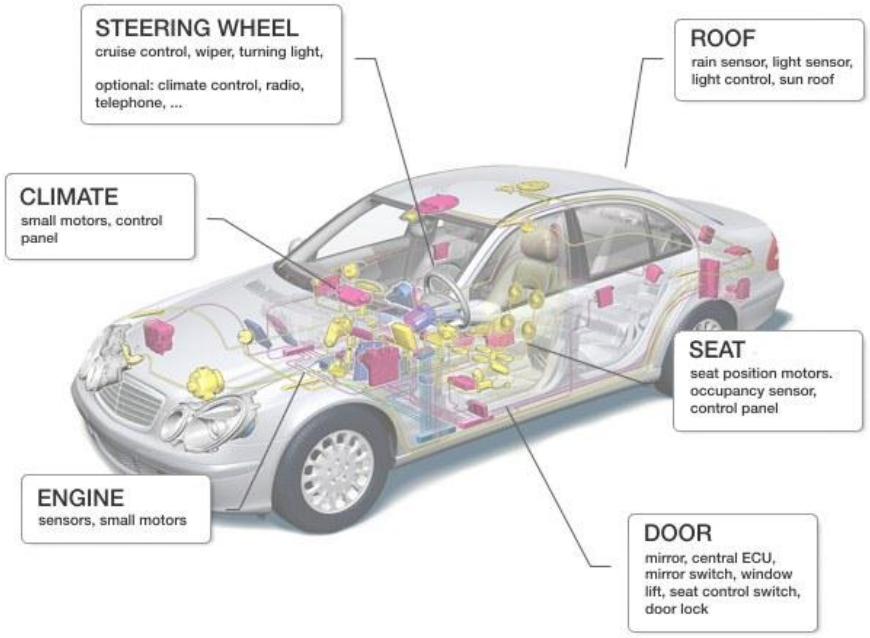
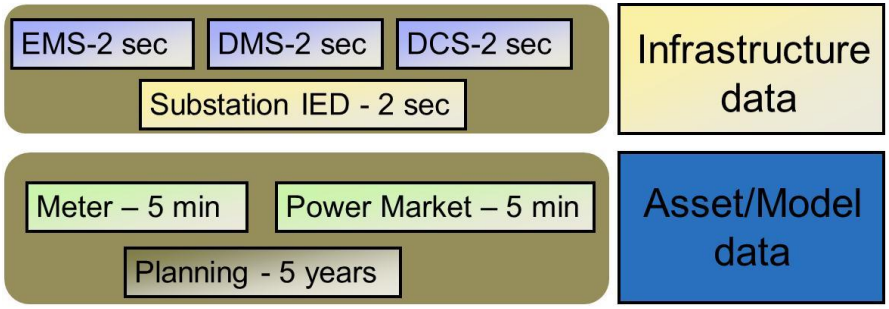
Industry Characteristic

- Very complex and complicated
  - Lots of small systems and devices
- Required to manage many different generation sources
- Geographically dispersed networks
- Data, data, data...
  - SCADA, DMS, OMS, IED, GIS etc.
- Various data granularity and delivery frequencies, that increase over time
  - from sub-second to years range
- Infrastructure / Asset Model





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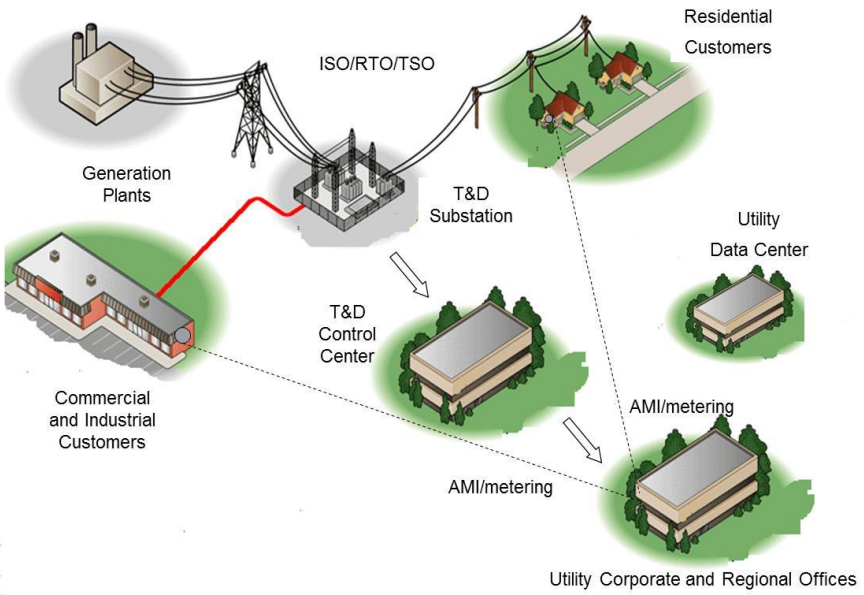
Industry Challenges / Initiatives

- Grid Operations and Reliability
- Power Quality/Transient/Dist. Data
- Condition Based Maintenance
- Asset Management
- Substation Automation
- Distribution Automation
- AMI-Advanced Metering Infrastructure
- Distributed Generation
- Smart Grid/Intelligent Grid



The Common Thing in All:

Requires

- *Accessible, precise, real-time data*
- *long-term persistent data store*
- *Notifications and analysis*

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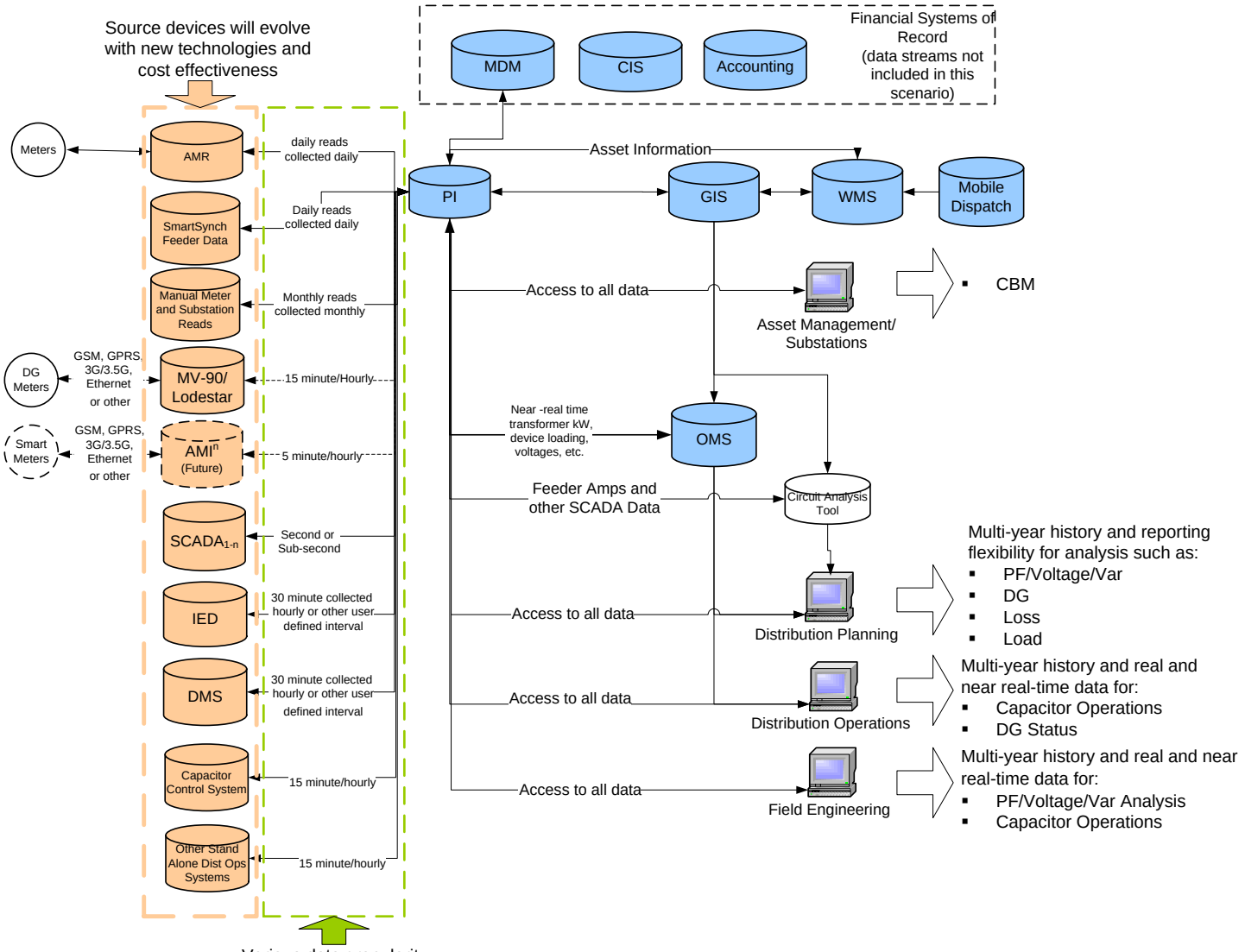
PI System for Operation & Maintenance

Sample Data Flow



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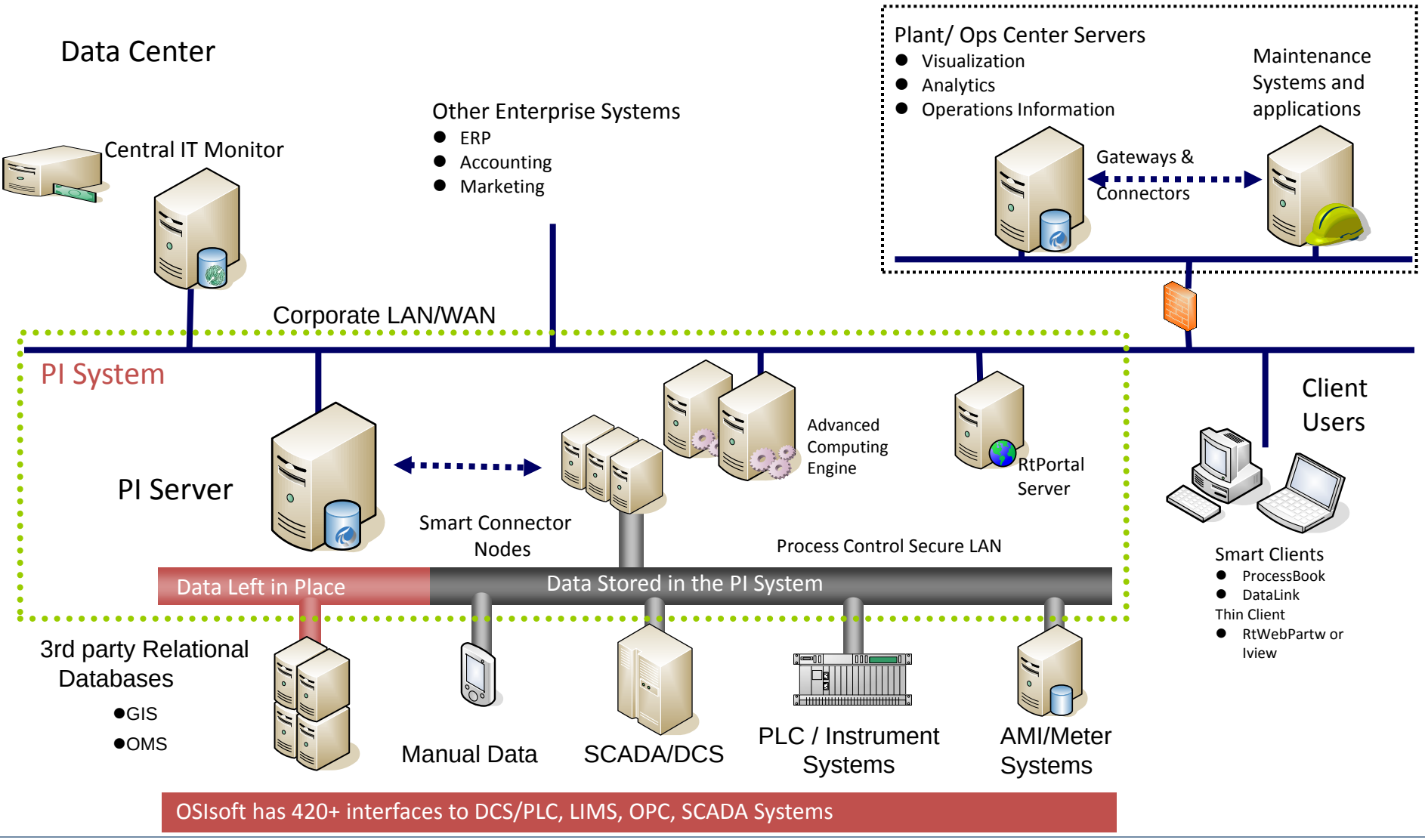
Sample Architecture



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European Power & Utility Customers

ABB Energie
ABB Power Plant Controls
AES Thames
Air Liquide
AKZO
Alcan Power UK
Alcoa
Alstom Power
British Energy
British Nuclear Fuels
BP Gas & Power
Eastern Group - UK
EDF
Electricidad de Portugal
Electricity Authority of Cyprus
Endesa Generacion
ENEL
Energetyka Cieszynska
Energy Management
Energy Moscow
Energy Northwest
Enfield Energy Centre
Enron Power
Entergy

E-ON UK Plc.
E-ON Italy
EPON
EPZ
Eskom
Essent
Eugene Water & Electric Board
Euratom
European Gas Turbines
Ever Power
EWSA
EZH - Holland
Fluor Daniel
Forschungszentrum Karlsruhe
Gainesville Regional Utility
GEC Alsthom
GE Drive Systems
GE Industrial Systems
GE Power Systems
Genesis Power
Hyder
IASE
Iberdrola
IES Utilities

NRG Morris
PG&E Generating
AES Power Corporation Tisza
Power Pool of Alberta
PowerGas
PowerGen
PP&L
Premier Power
PSE&G
Public Power Corporation
RWE Energie
Scottish Hydro
Scottish Power
Scottish & Southern Energy
Söderenergi
Soluziona
Stadtwerke Cottbus
Stadtwerke Luedenscheid
Stadtwerke München
TransAlta Energy
Transener
UNI-MAR Enerji
Vattenfall
VEAG
Yorkshire Electricity

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Customer Use Cases

Electricity Distribution

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Proven Use Cases

- **Operational:**
  - EMS/DMS/SCADA data monitoring and archiving, event reporting and analysis
- **Non-operational:**
  - substation field device IED, SOE, Power Quality and DFR data monitoring and archiving
- **Asset/Model:**
  - asset model management and analytics
- **Cyber Security / IT:**
  - Critical Infrastructure Protection and Control System IT Infrastructure Monitoring
- **Enterprise:**
  - integration, correlation and repository

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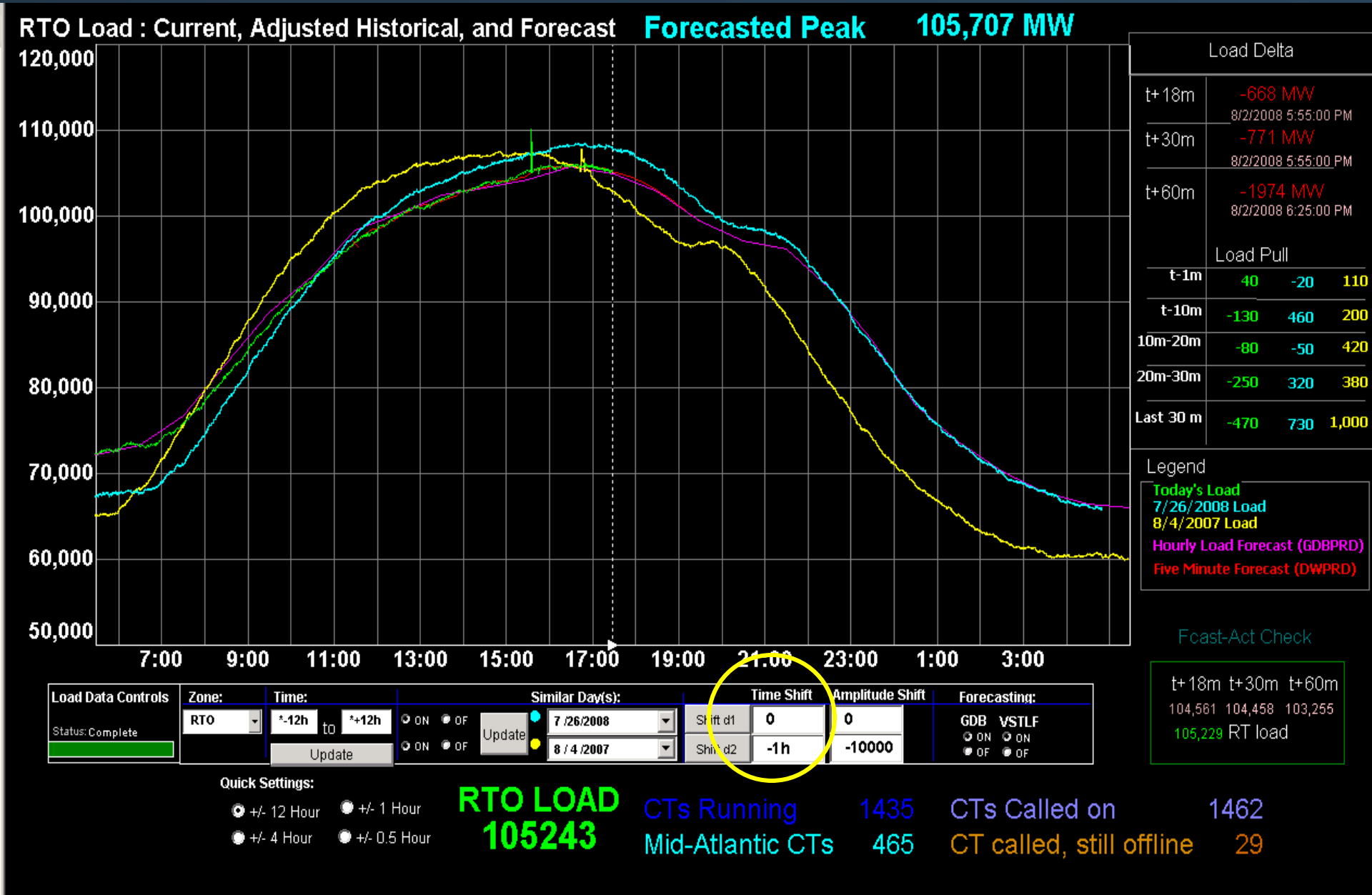
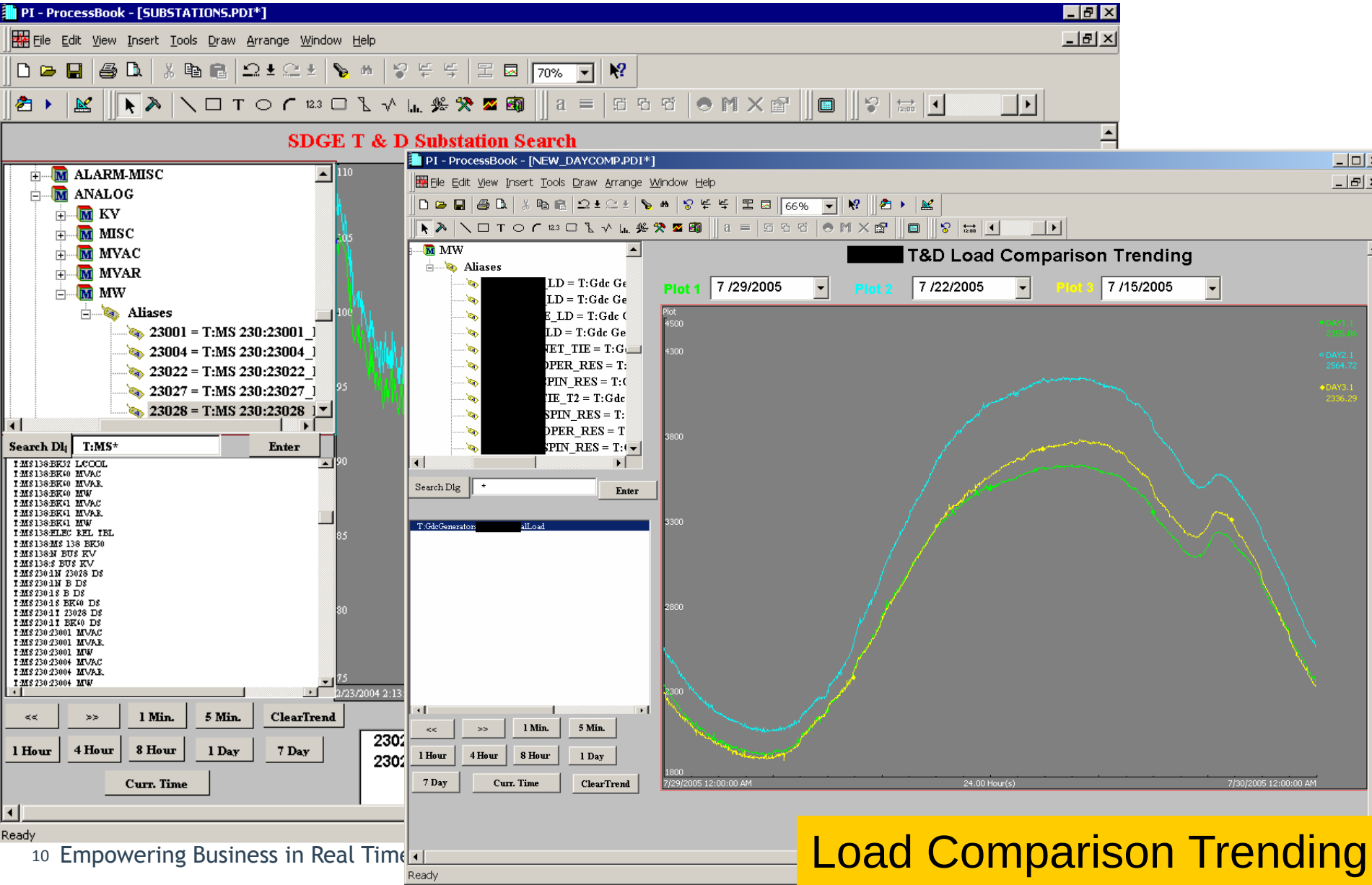
Forecasting Load Peaks

Load Picker



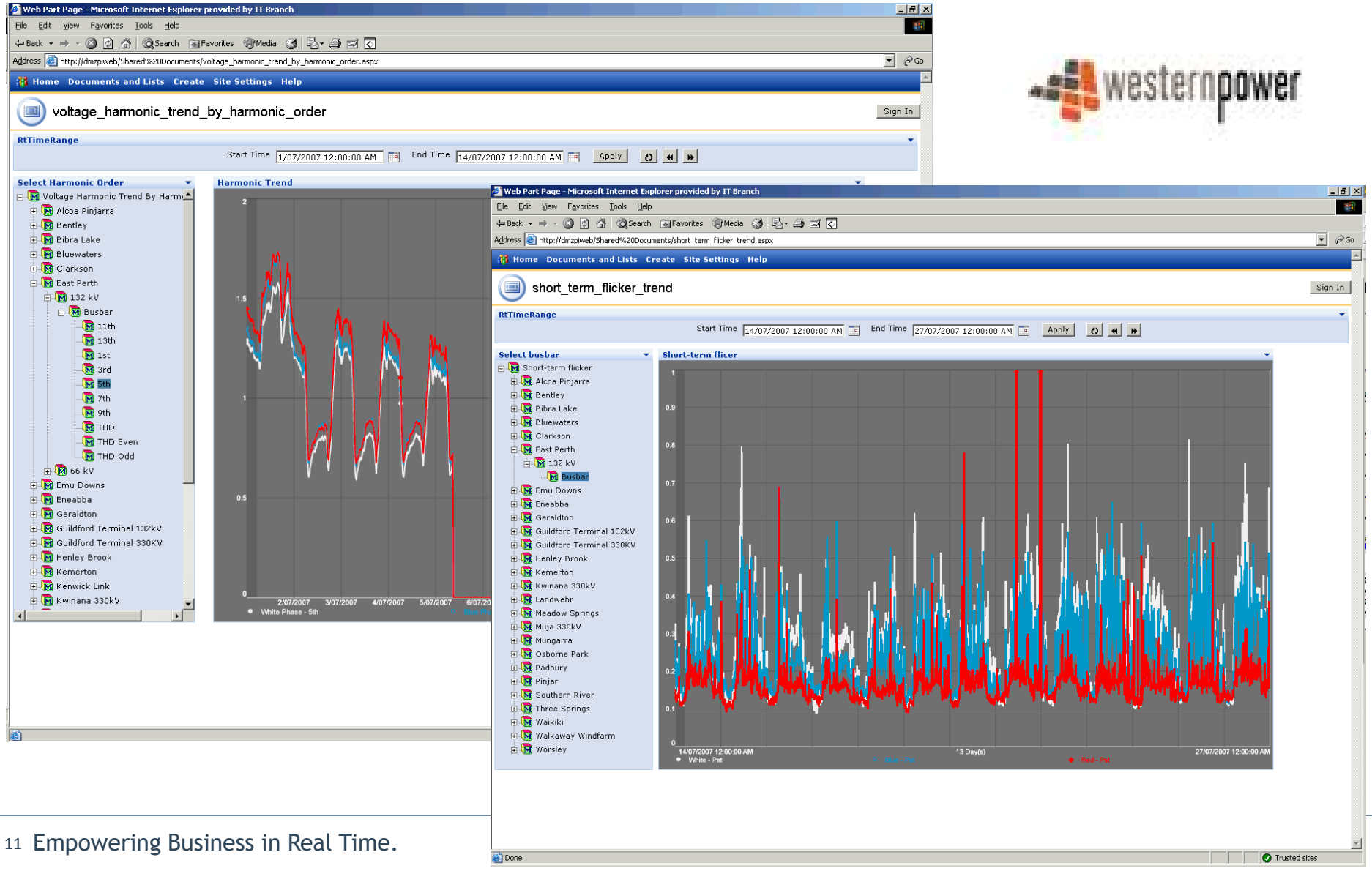
Substation Load Analysis

Load Comparison



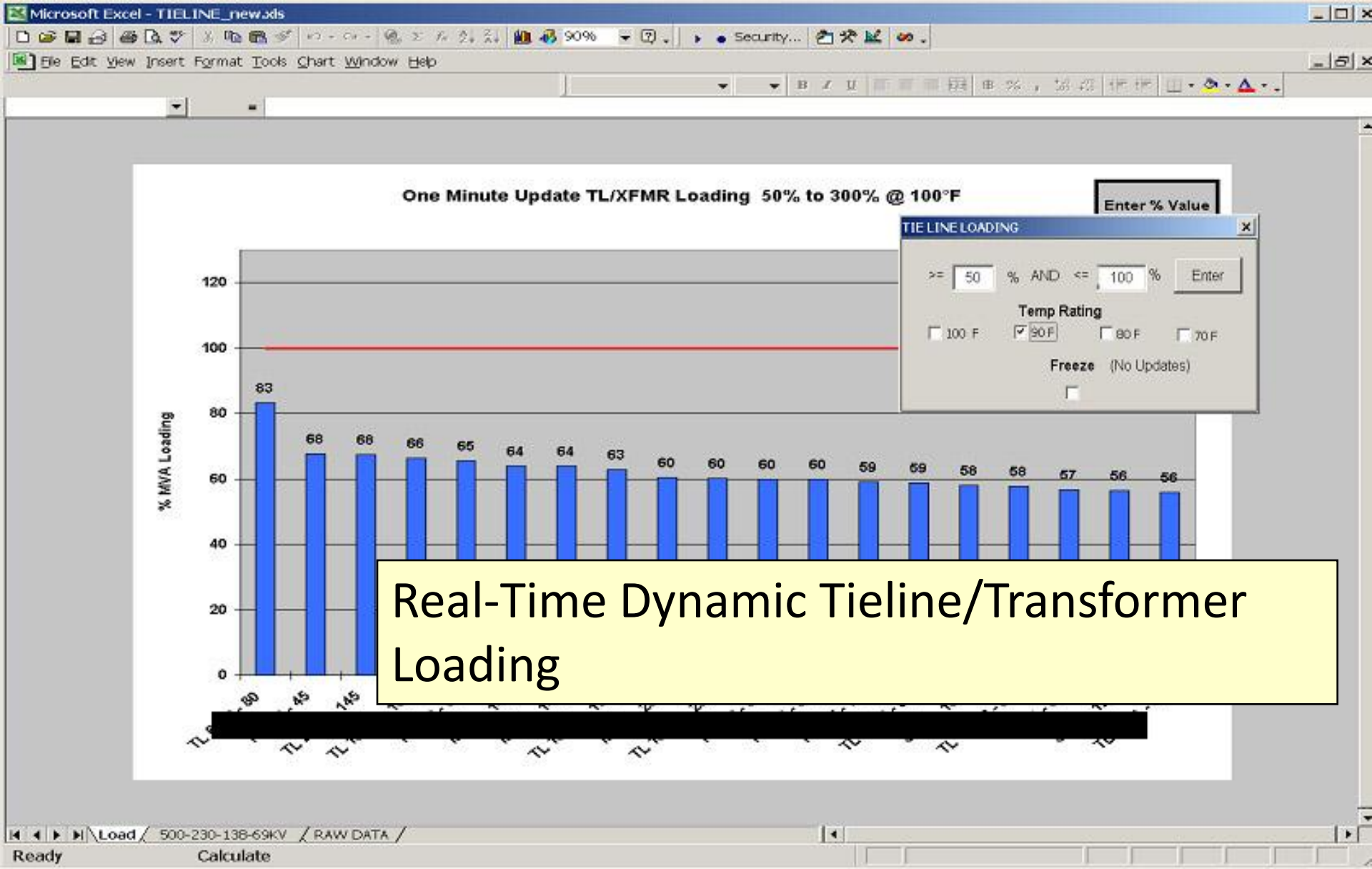
Load Comparison Trending

Power Quality Monitoring
Voltage Harmonics / Flickering



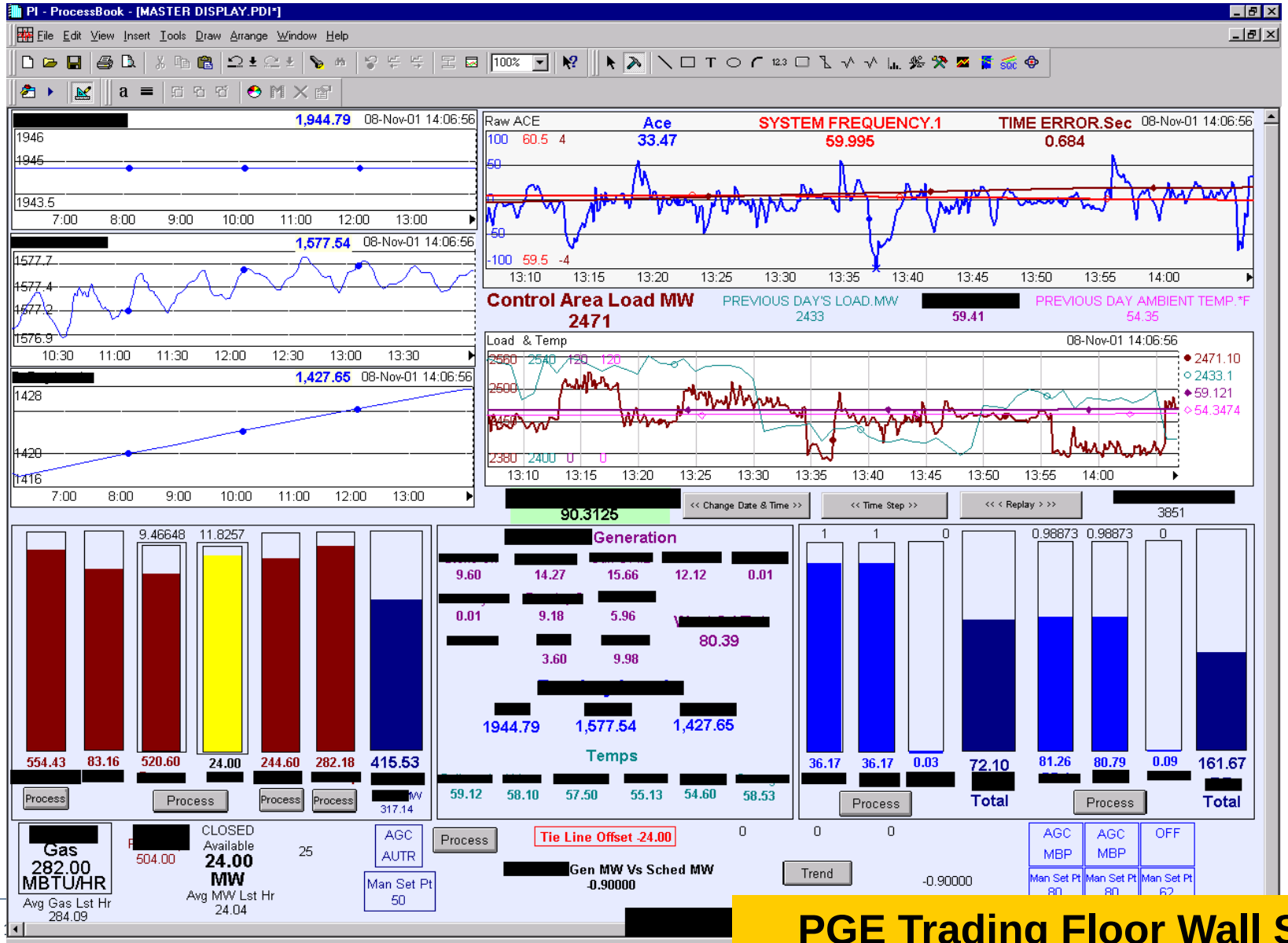
Operations Planning / Tieline Control

Transformer Loading



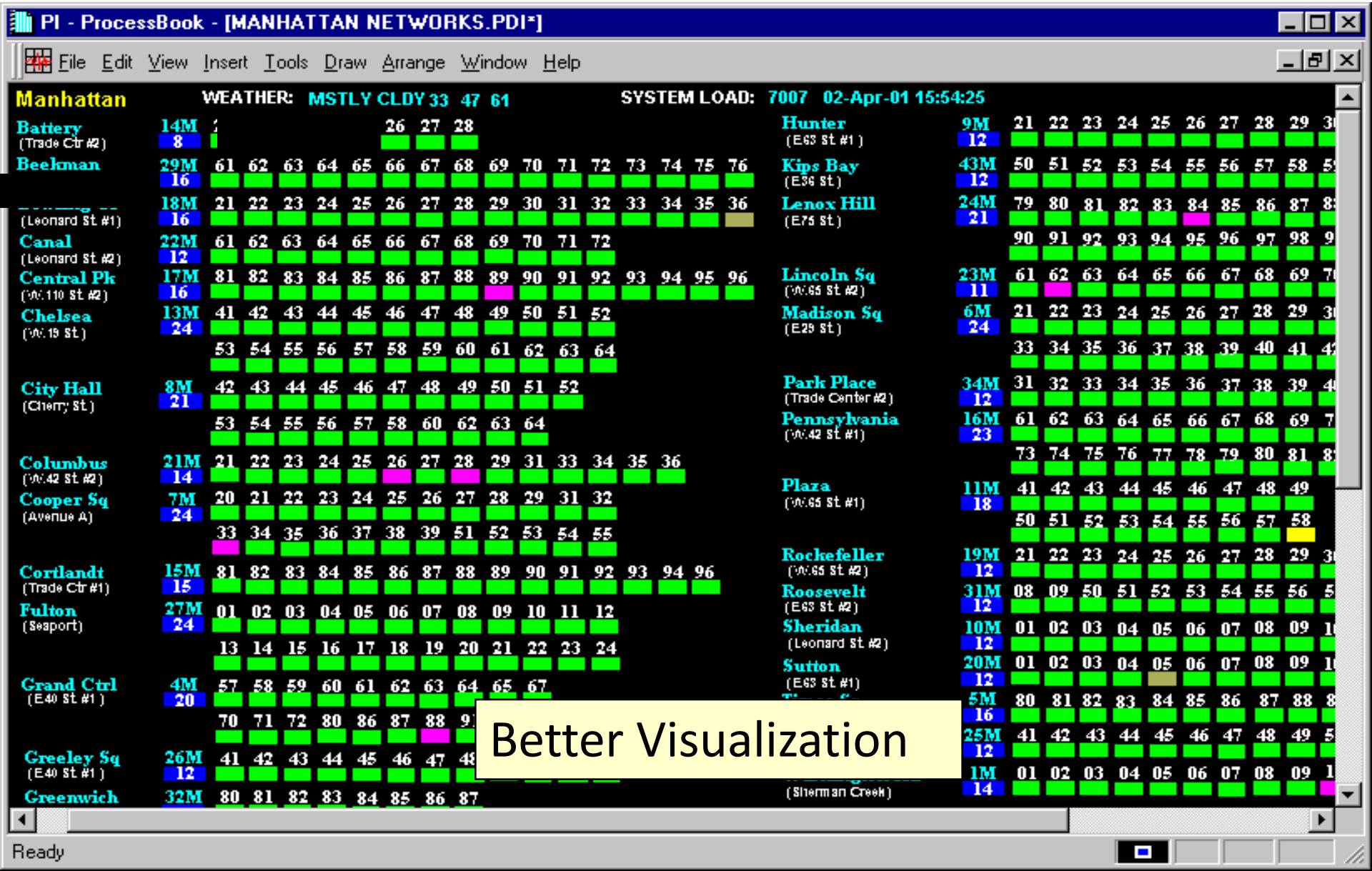
Real-Time Dynamic Tieline/Transformer Loading

Trading

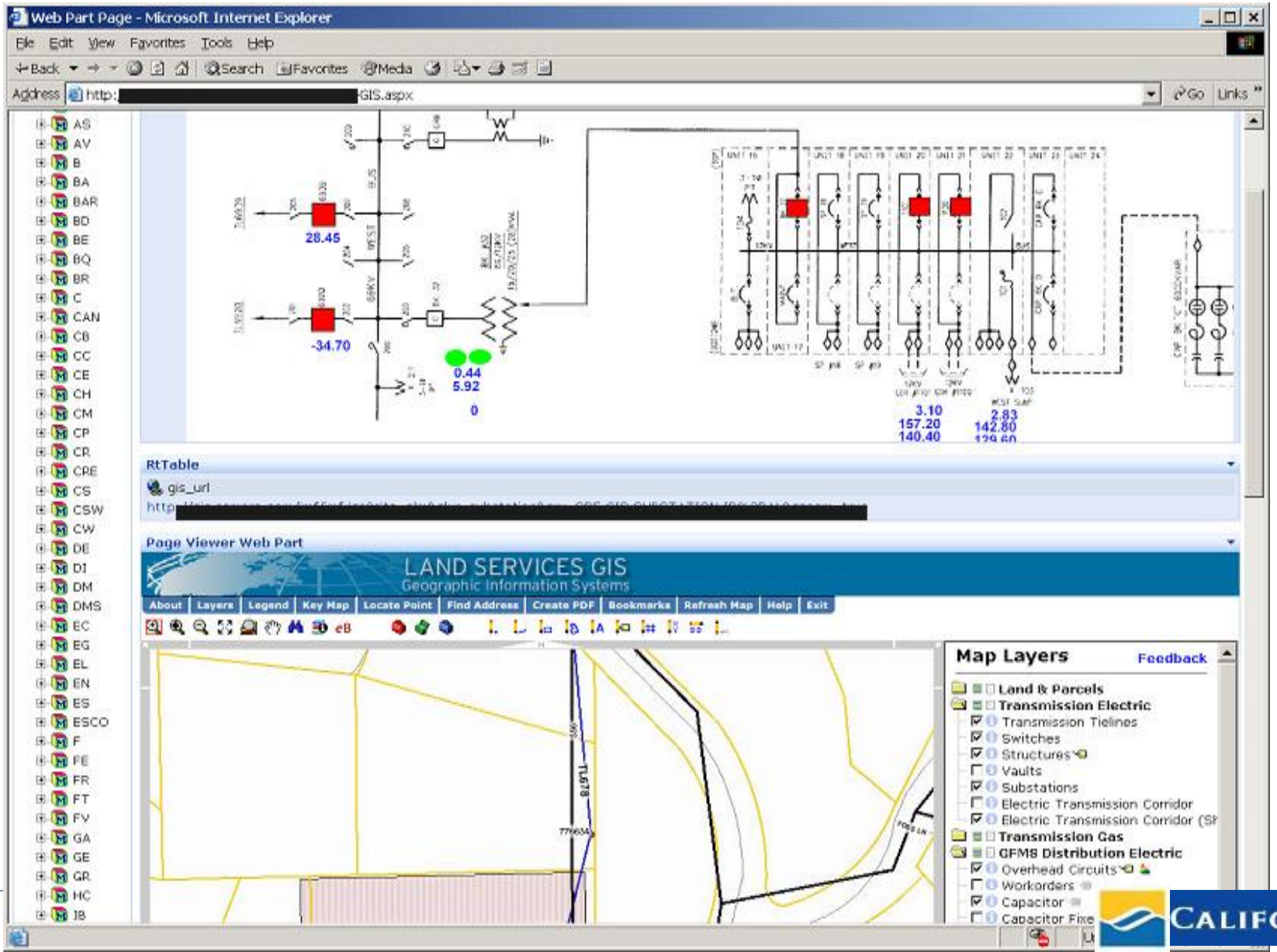


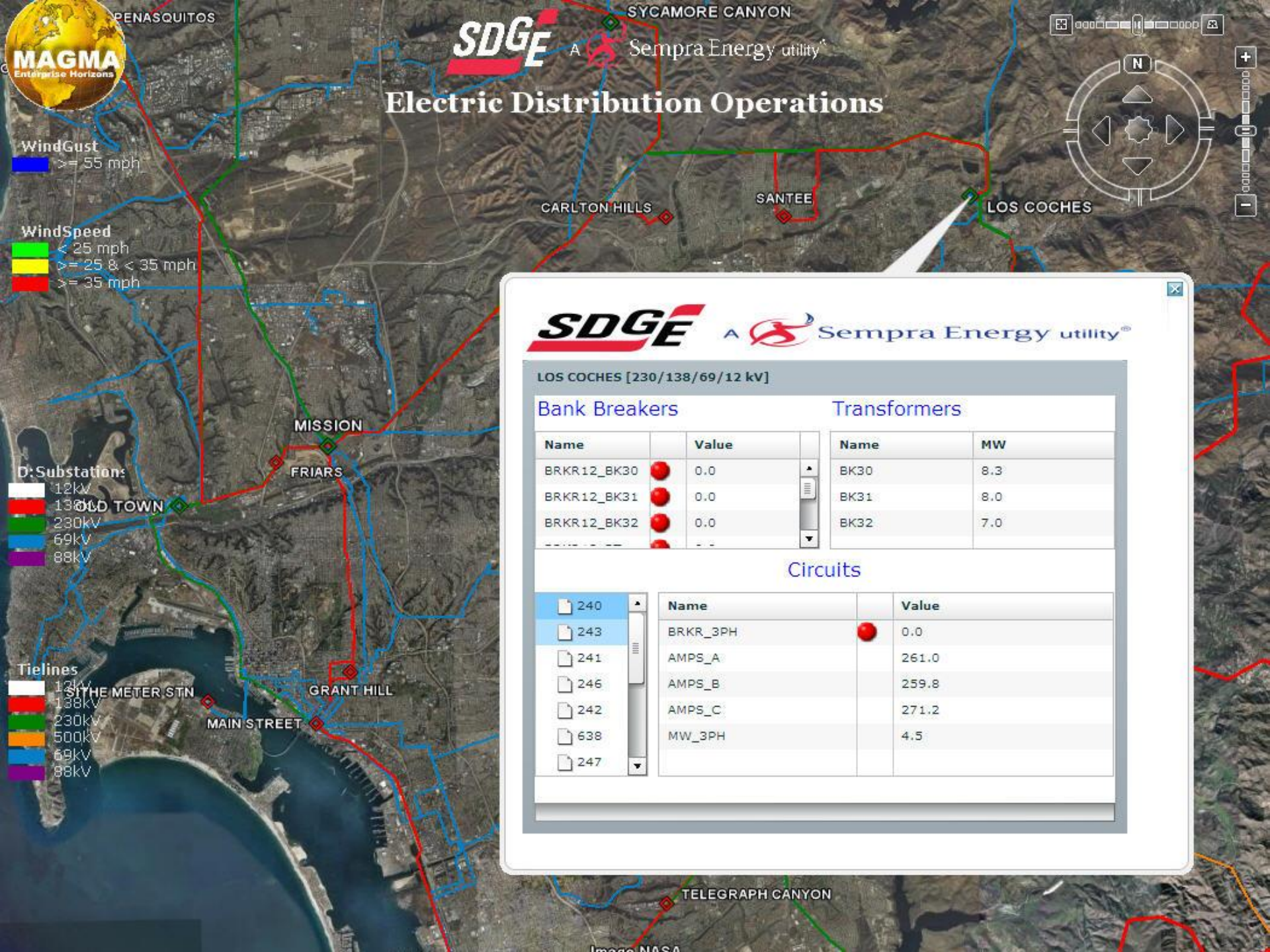
PGE Trading Floor Wall Screen

Substation Overview

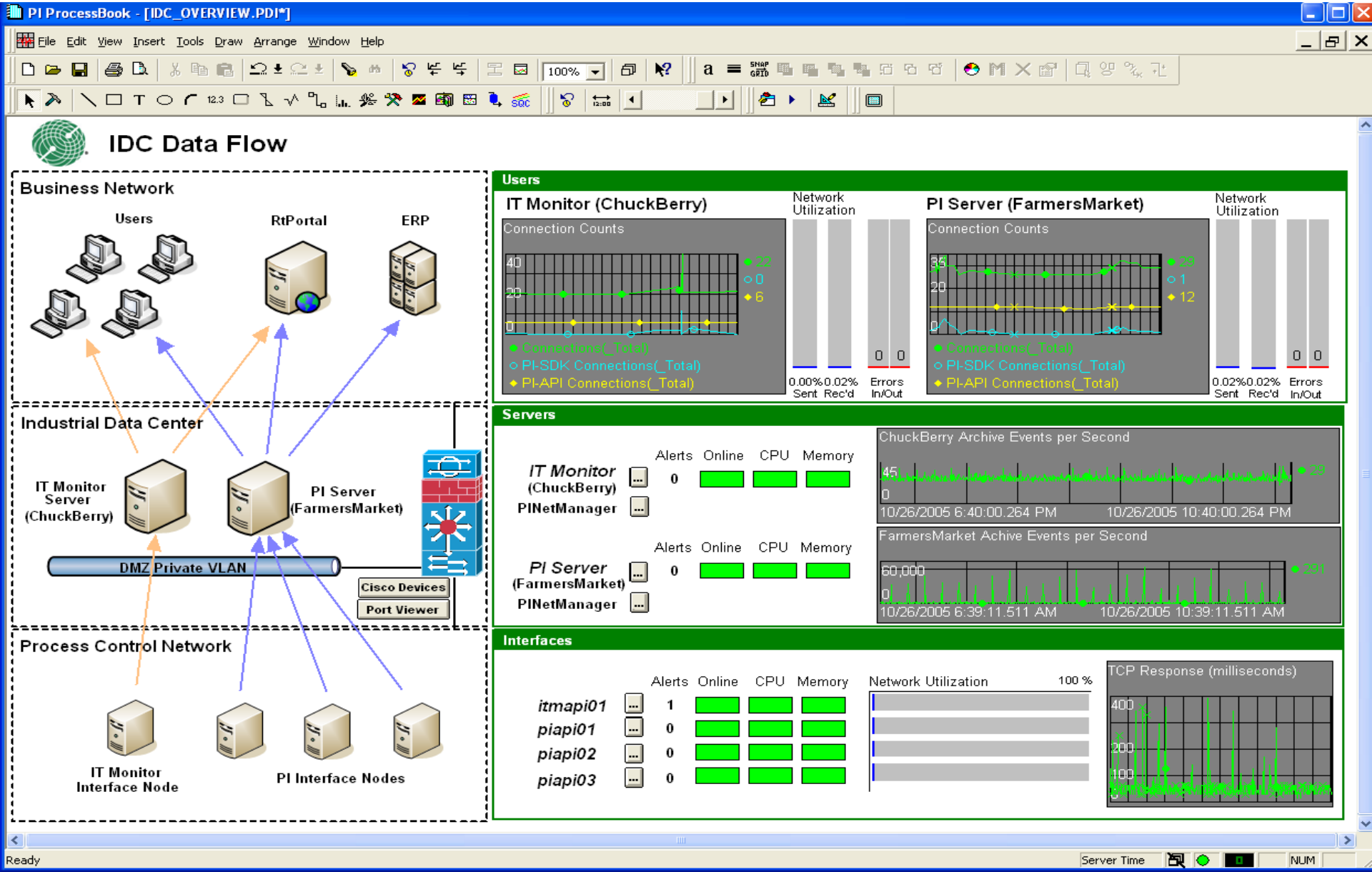


Integration of Geospatial Information

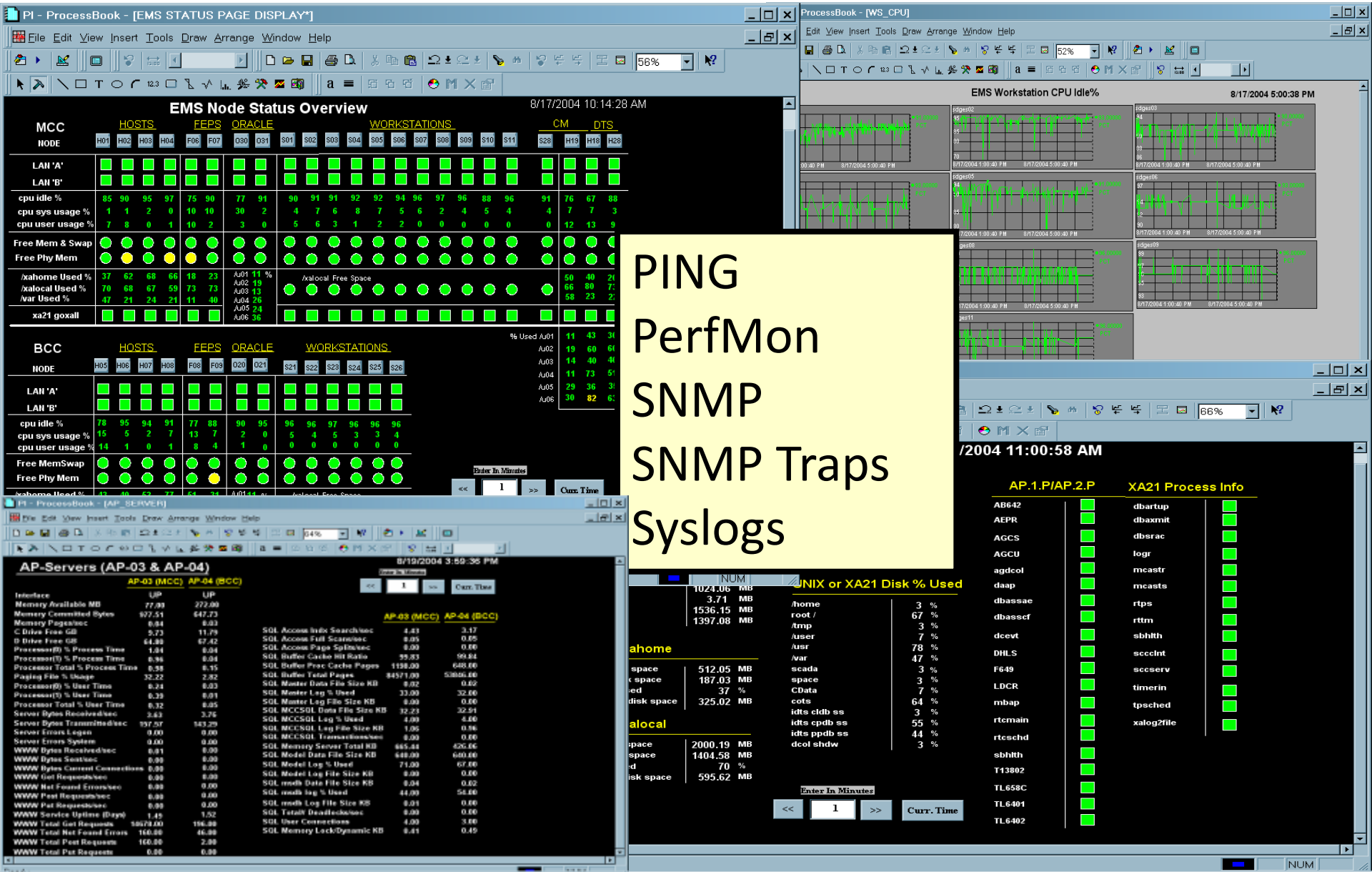



PENASQUITOS
SYCAMORE CANYON
SDGE
A Sempra Energy utility
Electric Distribution Operations
WindGust
>= 55 mph
WindSpeed
< 25 mph
>= 25 & < 35 mph
>= 35 mph
CARLTON HILLS
SANTEE
LOS COCHES
MISSION
FRIARS
OLD TOWN
D:Substations
12kV
138kV
230kV
69kV
88kV
Tielines
12kV
138kV
230kV
500kV
69kV
88kV
SILVETHE METER STN
GRANT HILL
MAIN STREET
TELEGRAPH CANYON
SDGE
A Sempra Energy utility
LOS COCHES [230/138/69/12 kV]
Bank Breakers
Name
Value
BRKR12_BK30
0.0
BRKR12_BK31
0.0
BRKR12_BK32
0.0
Transformers
Name
MW
BK30
8.3
BK31
8.0
BK32
7.0
Circuits
240
243
241
246
242
638
247
Name
Value
BRKR_3PH
0.0
AMPS_A
261.0
AMPS_B
259.8
AMPS_C
271.2
MW_3PH
4.5

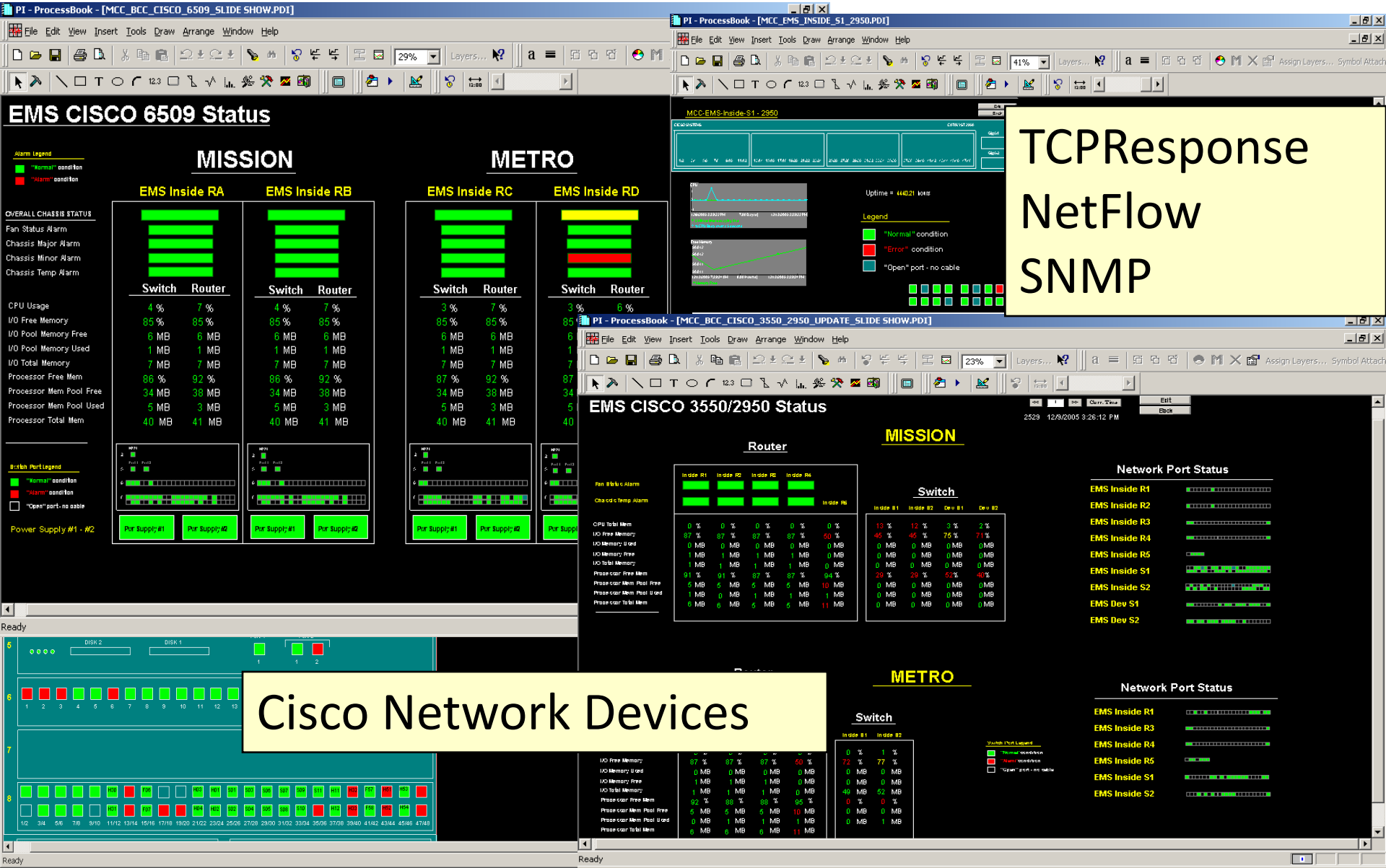
Industrial Data Center and IT Monitor



Monitor and Protect Critical Systems



Monitor and Protect Networks



Enterprise Integration

CAISO - Operator Console

Enterprise Integration

PJM Transmission Video Wall

California ISO: Governor's visit

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Examples for Leveraging the Value of PI System in Operations & Maintenance

Transformer Condition Based Monitoring

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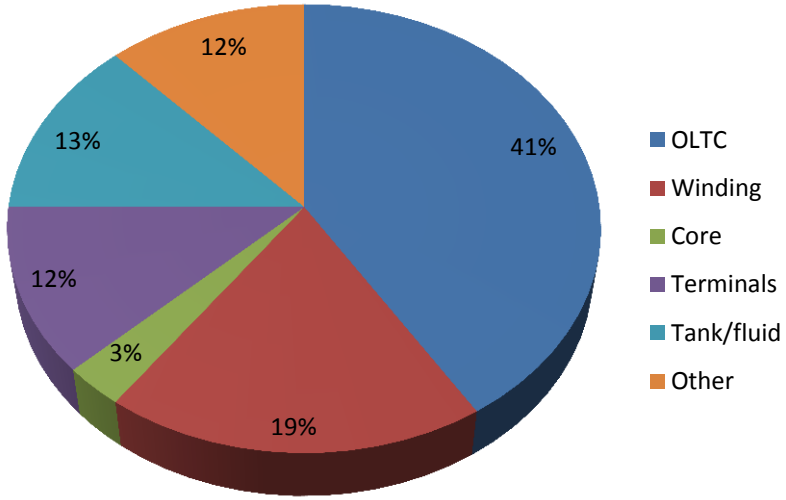
Example: Transformer Condition Monitoring
Failure Modes

- Transformer Condition Monitoring
  - » OLTC Monitoring
  - » Dissolved Gas Analysis (DGA)
  - » Transofrmer Temperature
  - » Cooling System Monitoring

Transformer Failure Modes



- The two most probable failure modes on a Transformer are
  - » Load Tap Changer
  - » Windings (including insulation)
- These are 60% of total

MIN. AVGERAGE LOAD CURRENT
APPARENT POWER, MVA
HOTTEST-SPOT ON WINDING
INSULATION AGING RATE
WATER CONTENT
STEADY LOAD
DYNAMIC OVERLOAD
COOLING EFFICIENCY
LTC WEIGHTED TEMP. DIFFERENCE

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Example: Transformer Condition Monitoring

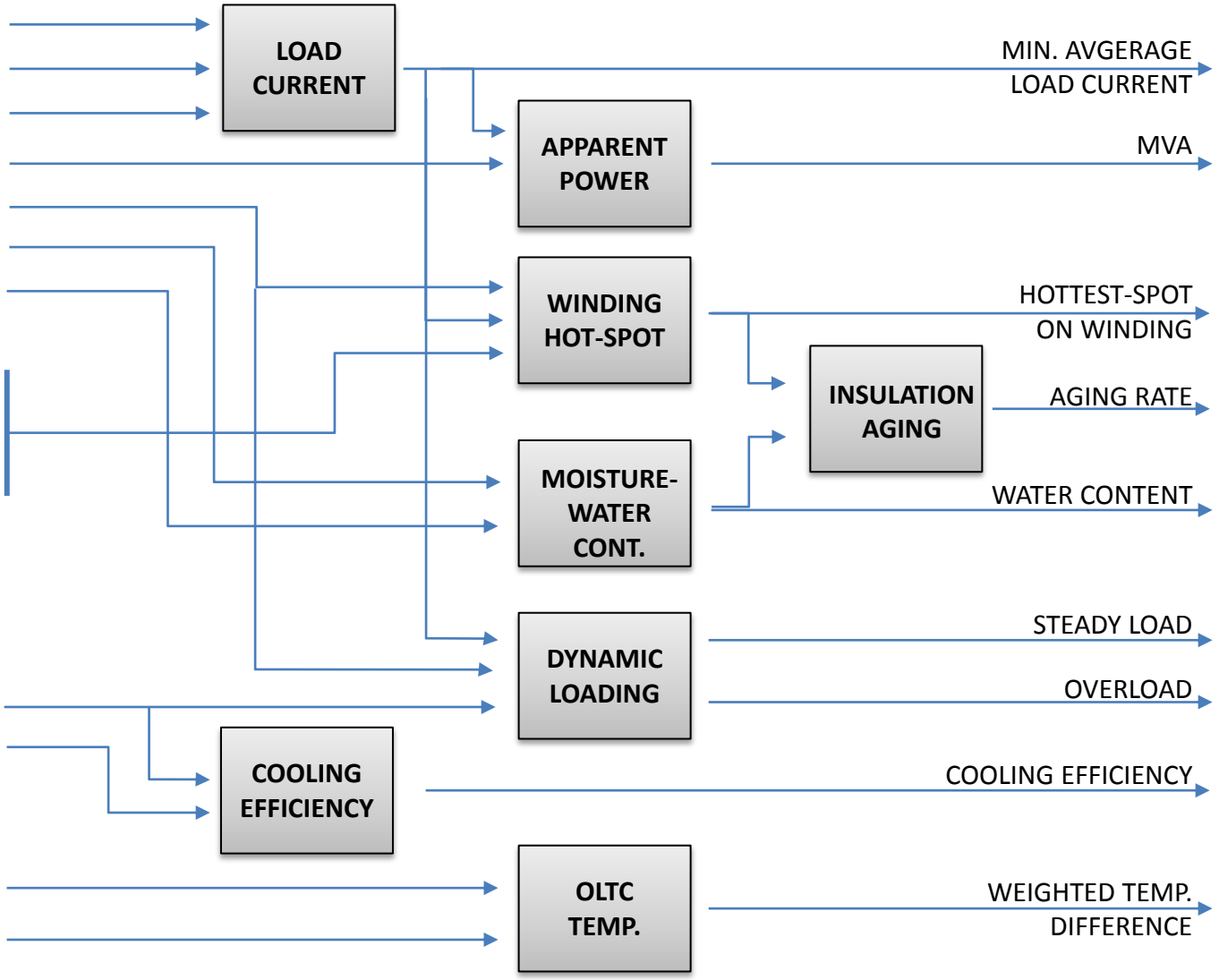
Standard Calculations (IEEE and IEC Standards)

- H winding current
- X winding current
- Y winding current
- H winding voltage
- Top oil temperature
- Moisture reading
- Moisture sensor temp

- Rated HST rise
- Rated load
- Winding Characterist.

- Ambient temperature
- Cooling stage status

- Tap Changer temp.
- Main tank temp.



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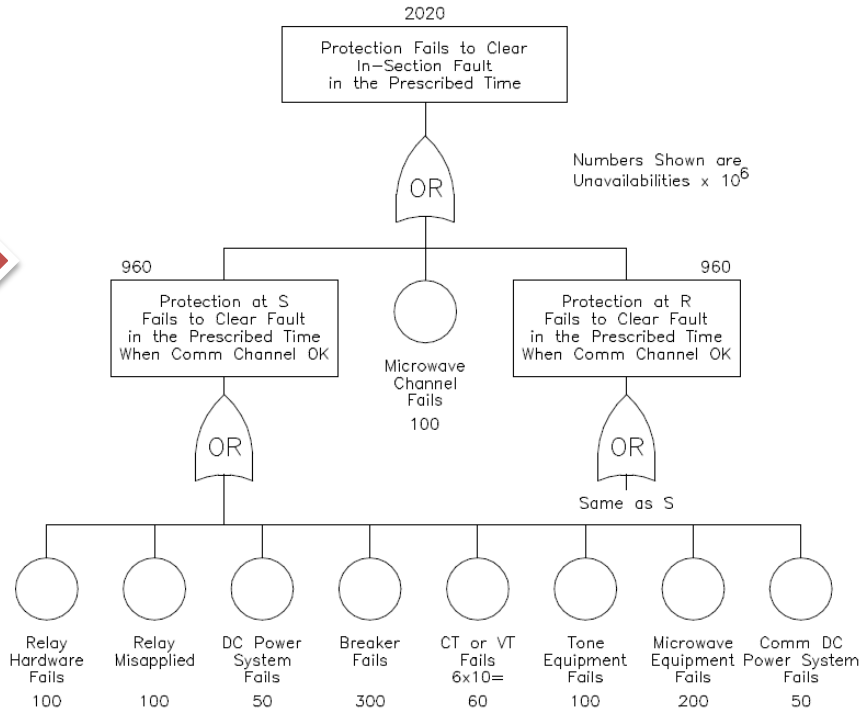
Example: Transformer Condition Monitoring

Root Cause Analysiy (RCA) and FMEA / FMECA

Fault Tree

(FMEA, RCA)

Root Cause Analysis



Top Event
FAILURE

Logic

Basic Event
SYMPTOM

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Example: Transformer Condition Monitoring

The process of turning data into information

OSIsoft.

CONNECT *Data Sources* → **COLLECT & ARCHIVE** *Compressor Data* → **CALCULATE** *Performance* → **VISUALIZE & NOTIFY** *The Right People* → **CORRECTIVE ACTION**

Control System
- DCS
- PLC
- SCADA

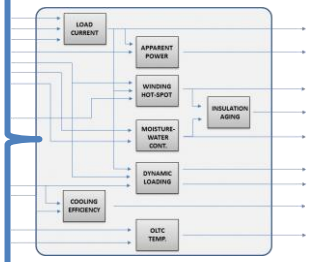
On-line Monitors
- WINDING
- LTC POSITION
- BUSHING
- WATER IN OIL

DGA
- DISSOLVED GAS ANALYSIS

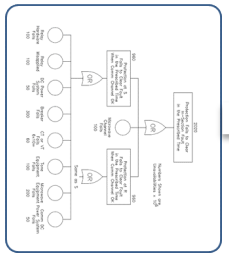
Databases
- FMEA
- RCA

- H winding current
- X winding current
- Y winding current
- H winding voltage
- Top oil temperature
- Moisture reading
- Moisture sensor temp
- Ambient temperature
- Cooling stage status
- Tap Changer temp.
- Main tank temp.
- Rated HST rise
- Rated load
- Winding Characterist.
- etc.

CALCULATION



FAULT TREE

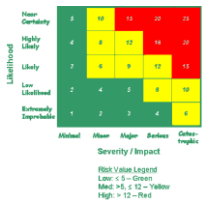


Failure

Risk Based Assessment

Business Criticality Analysis

Prioritization Matrix
(Risk-based)



Failure Notification

CMMS
SAP PM
Maximo

REQUIREMENT:
Calculate condition parameters and implement failure logic$

RULE:
What is the PRIORITY of the Failure?

ACTION:
Work Order Generation

Empowering Business in Real Time.

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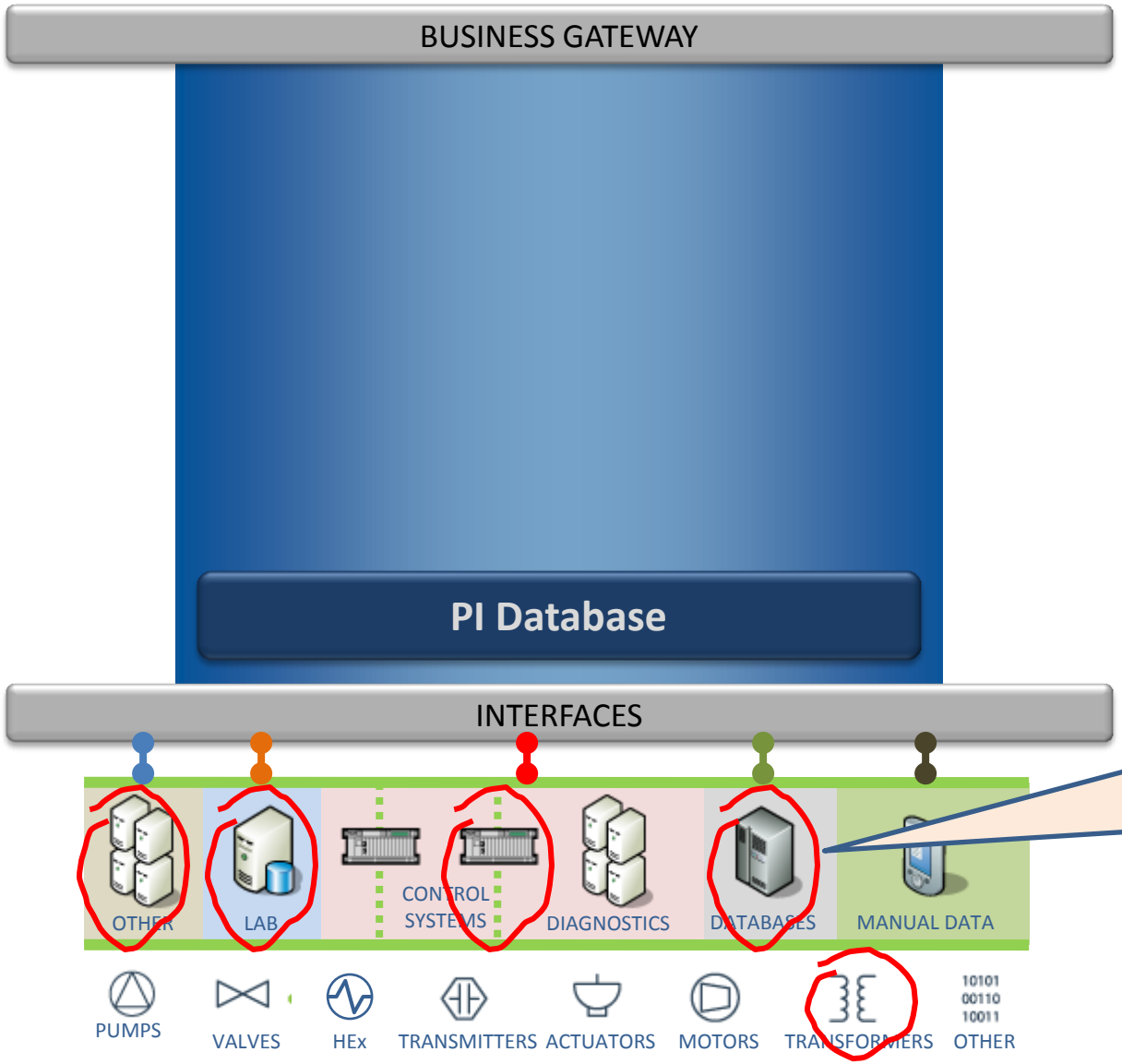
Example: Transformer Condition Based Monitoring

STEP 1: CONNECT RELEVANT DATA SOURCES

CONNECT
Data Sources



Transformer **Data appears in different systems** (data sources):

- Control System
- On-line Monitors
- DGA
- Databases

T-201

Example: Transformer Condition Monitoring

STEP 2: COLLECT AND ARCIVE EQUIPMENT DATA (Tag-based)

COLLECT & ARCHIVE
Heat Exchanger Data

BUSINESS GATEWAY

PI Database

INTERFACES

OTHER | LAB | CONTROL SYSTEMS | DIAGNOSTICS | DATABASES | MANUAL DATA

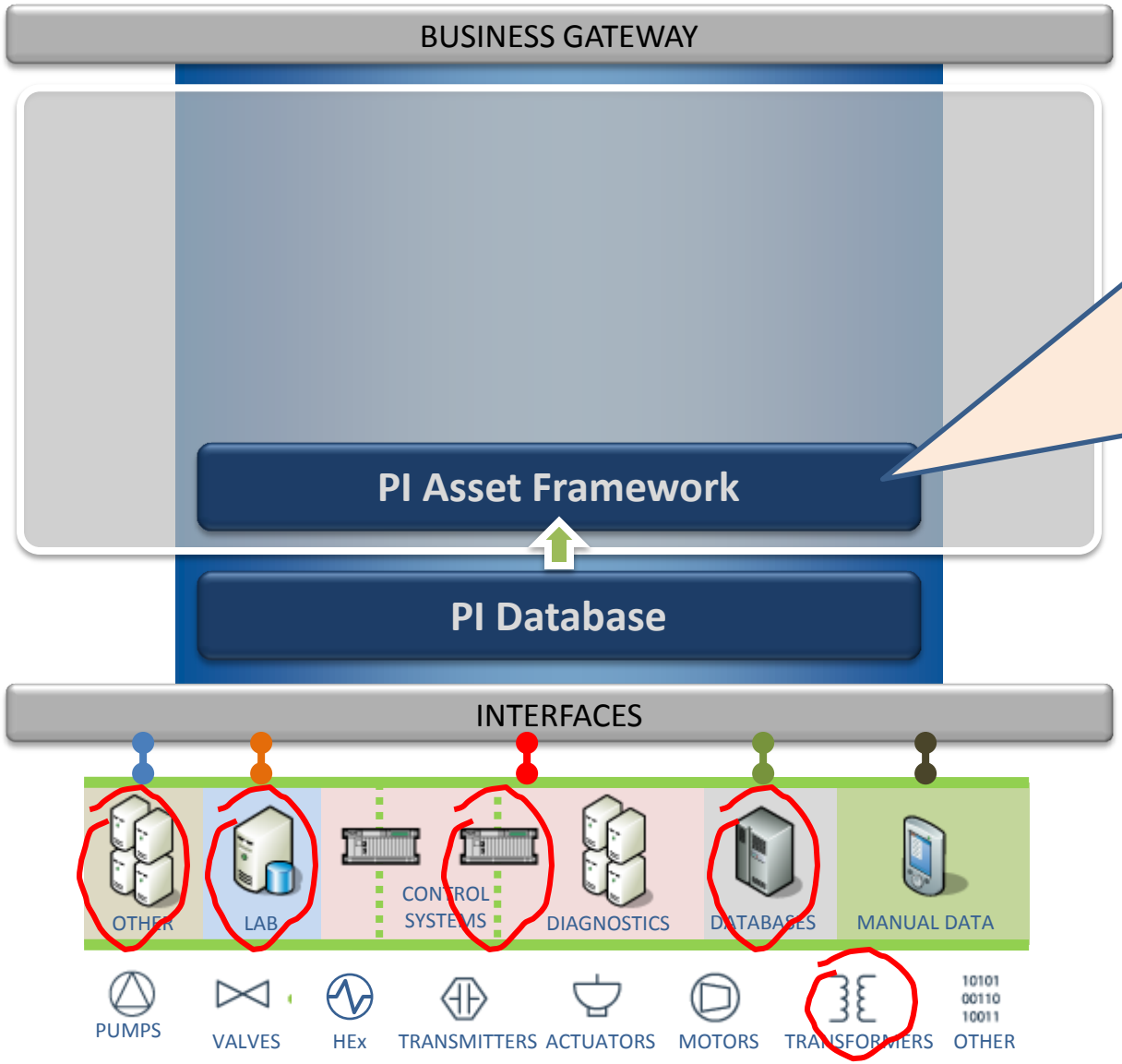
PUMPS | VALVES | HEx | TRANSMITTERS | ACTUATORS | MOTORS | TRANSFORMERS | OTHER

Compressor Data **is collected and archived** in PI Database *(TAGS)*

T-201

Example: Transformer Condition Monitoring

STEP 3: ASSIGN CONTEXT (Asset-based)



COLLECT & ARCHIVE
Heat Exchanger Data

Data is assigned to an individual equipment (Transformer 201):

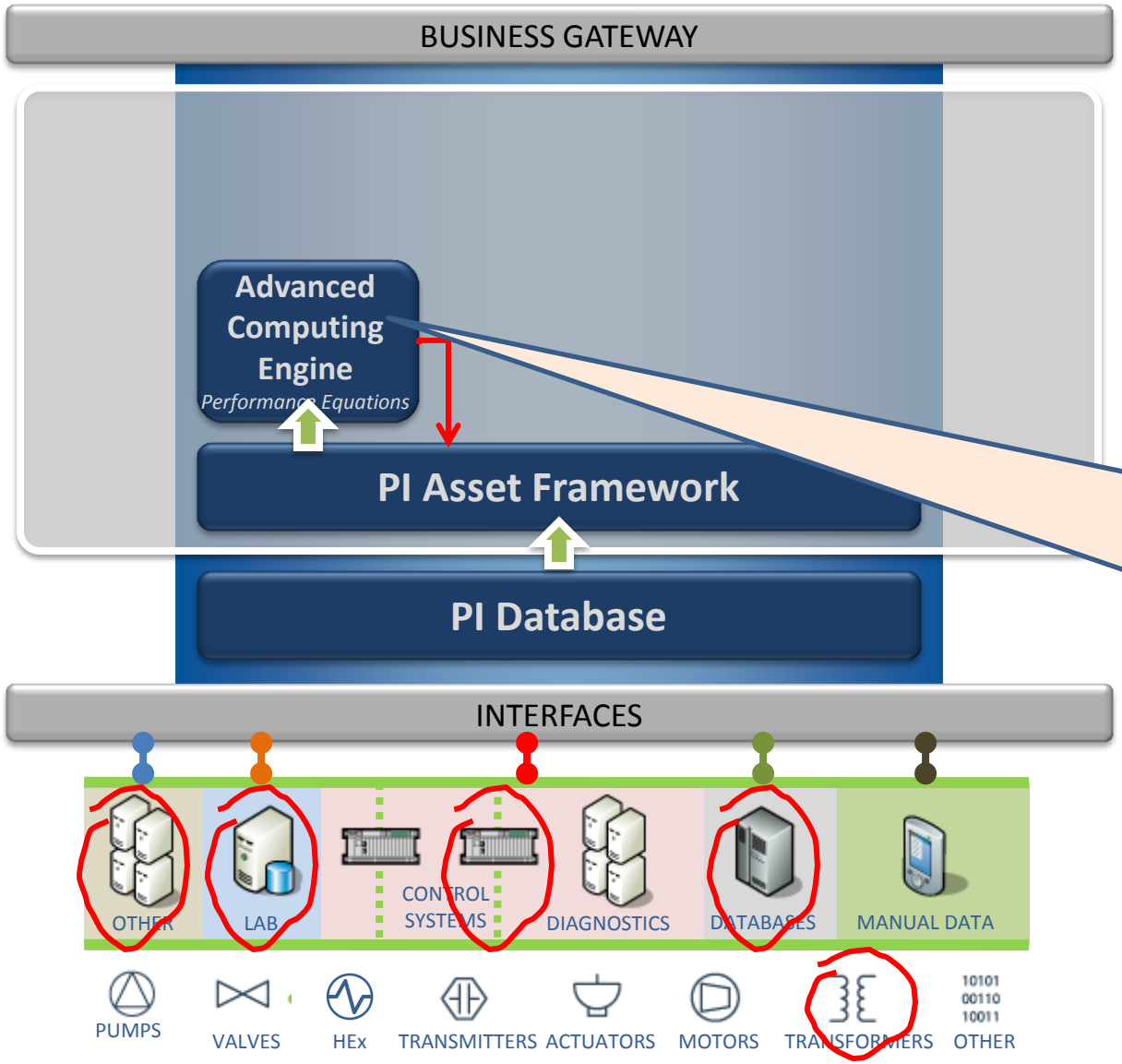
- **Asset-centric** representation of data. **Model driven** measurements
- Asset model complies with **IEC61970/68 CIM**
- Integration & synchronisation with SAP PM asset structure

T-201

T-201

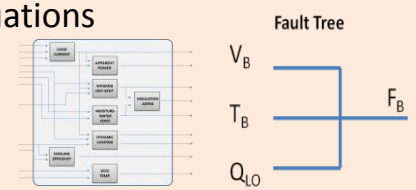
Example: Transformer Condition Monitoring

STEP 4: EXECUTE FAILURE PREDICTION LOGIC



CALCULATE
Performance

Calculation and Fault tree is implemented in Performance Equations

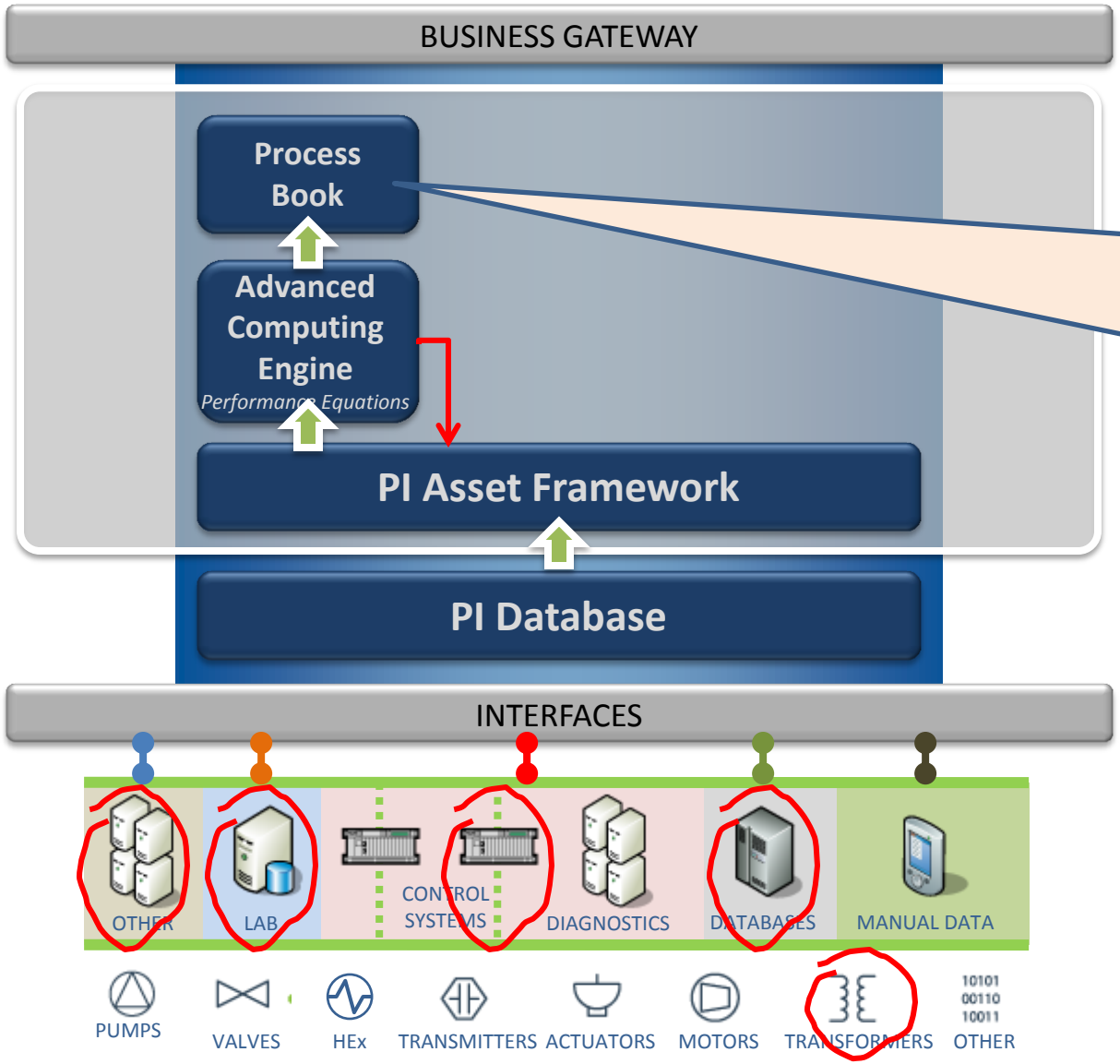


Failure is recorded in PI Database as Event (Abnormal Situation)

T-201

Example: Tramsformer Condition Monitoring

STEP 4: CALCULATE PERFORMANCE MEASURES



VISUALIZE & NOTIFY
The Right People

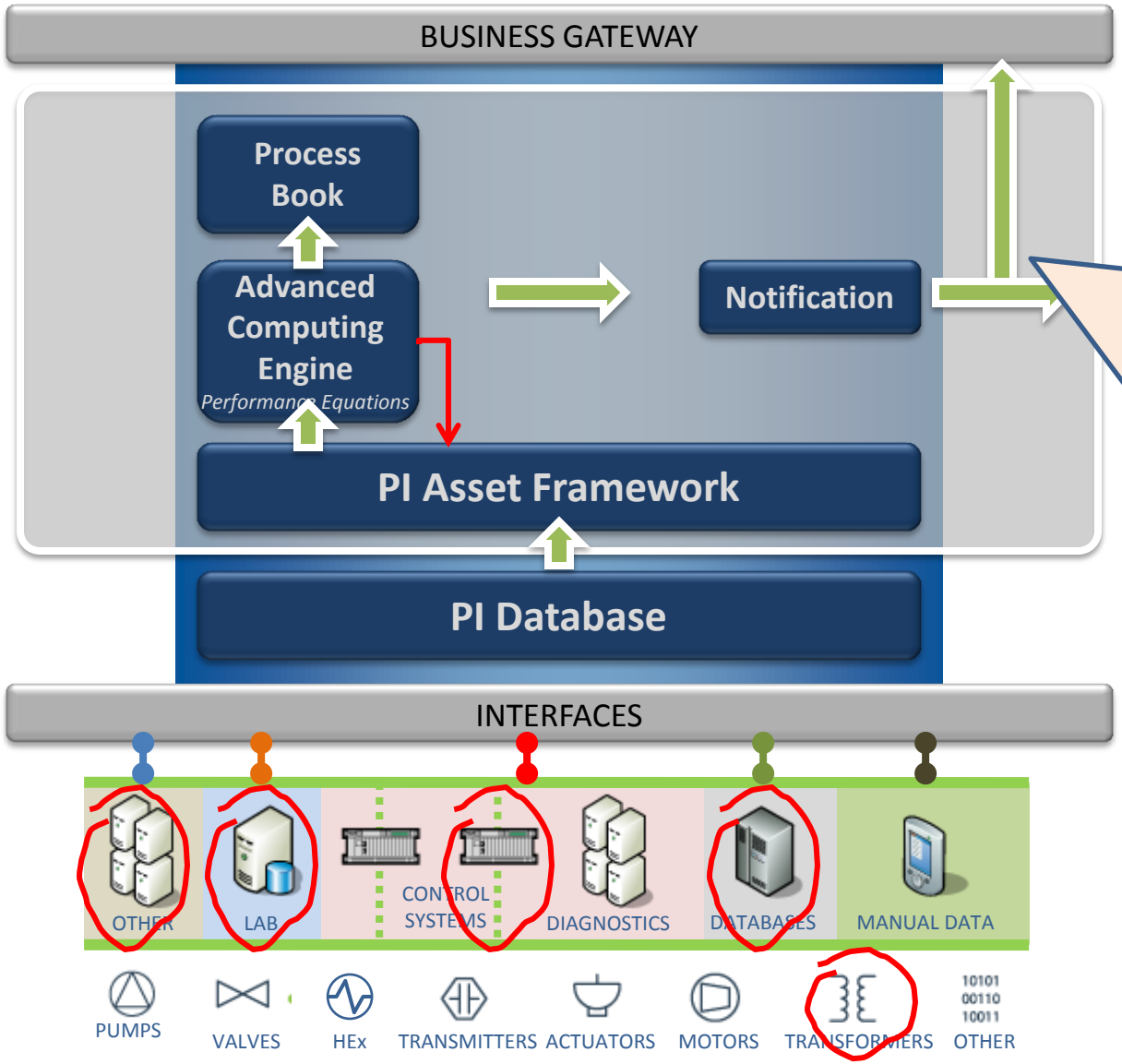
Trend and Visualize Transformer condition

T-201

Example: Transformer Condition Monitoring

STEP 5: VISUALIZE EQUIPMENT CONDITION REAL-TIME

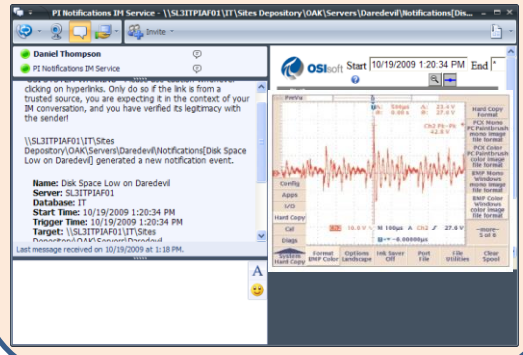
OSIsoft.



VISUALIZE & NOTIFY
The Right People

Notification is sent to shift operators and maintenance personnel, about:
TRANSFORMER LTCFAILURE

Maintenance Notification is sent to CMMS (SAP PM)

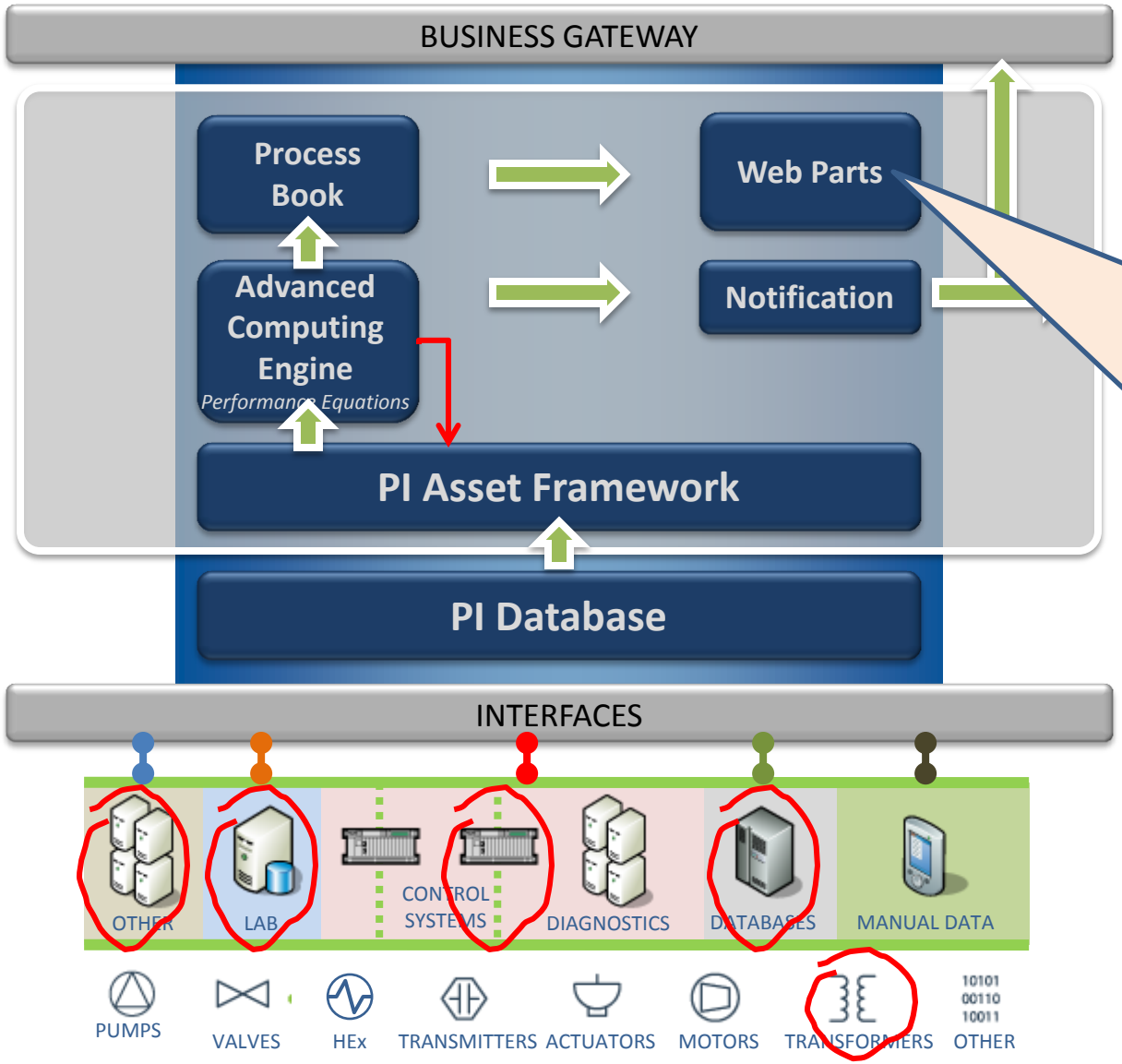


T-201

Example: Transformer Condition Monitoring

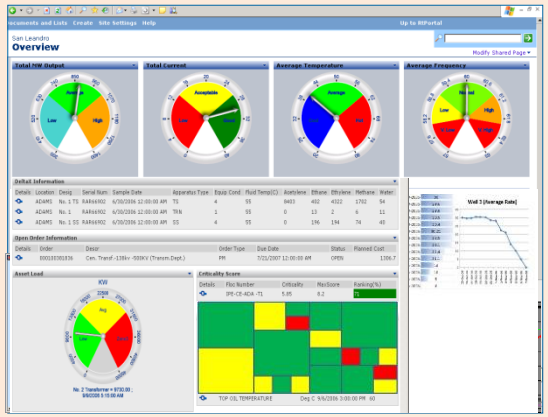
STEP 6: EVALUATE BUSINESS CRITICALITY AND RISK

OSIsoft.



VISUALIZE & NOTIFY
The Right People

Visualize maintenance priority matrix



T-201

Customer Use Case - PSE&G

CBM Architecture

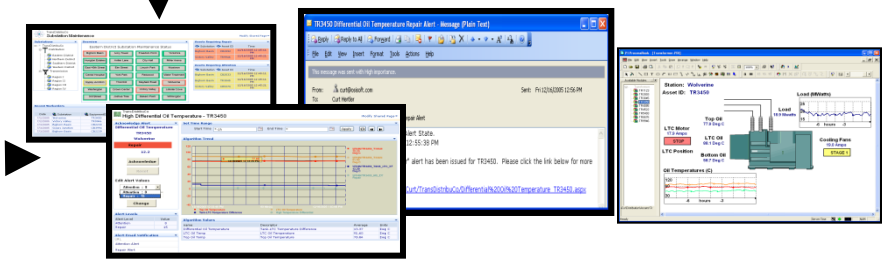
OSIsoft.

PSEG

Microsoft SharePoint Server

RtWebParts

Non-Operations PI Algorithms Email Alerts



User Interface and Analysis Tools

Operations PI Server

SCADA

Relational Databases

Maintenance System

Dissolved Gas Analysis

Others

RTU

WiMax/ Wired LAN Connection

Non Operations/Non-Scada Data On-line Equipment Monitors

Substation Gateway

Real-time Equipment Data

Temperature -Winding, -Top Oil, -LTC

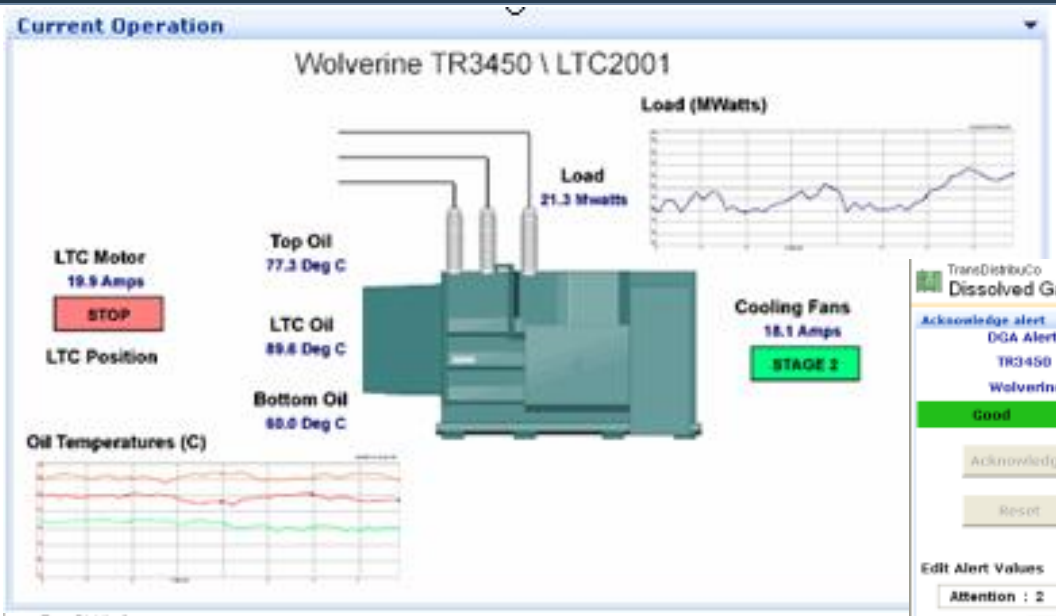
Bushing Monitors Phase A, B & C

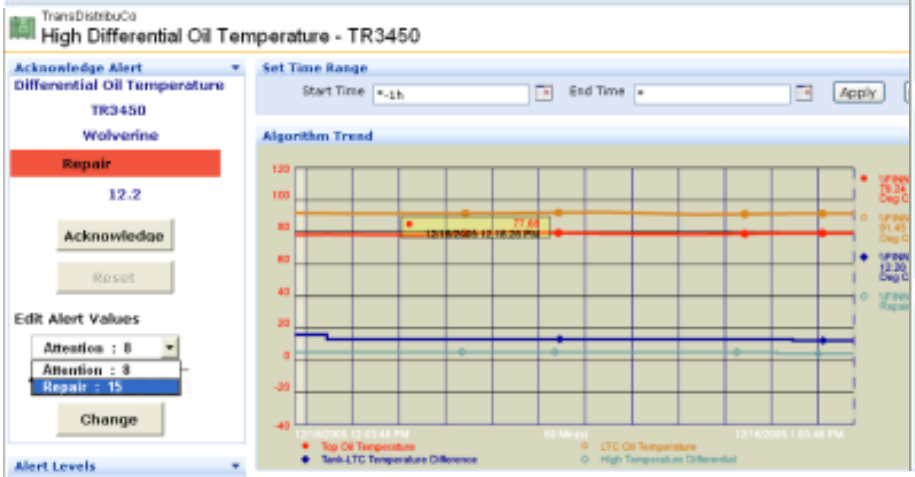
Hydrogen/ Water in Oil Monitor

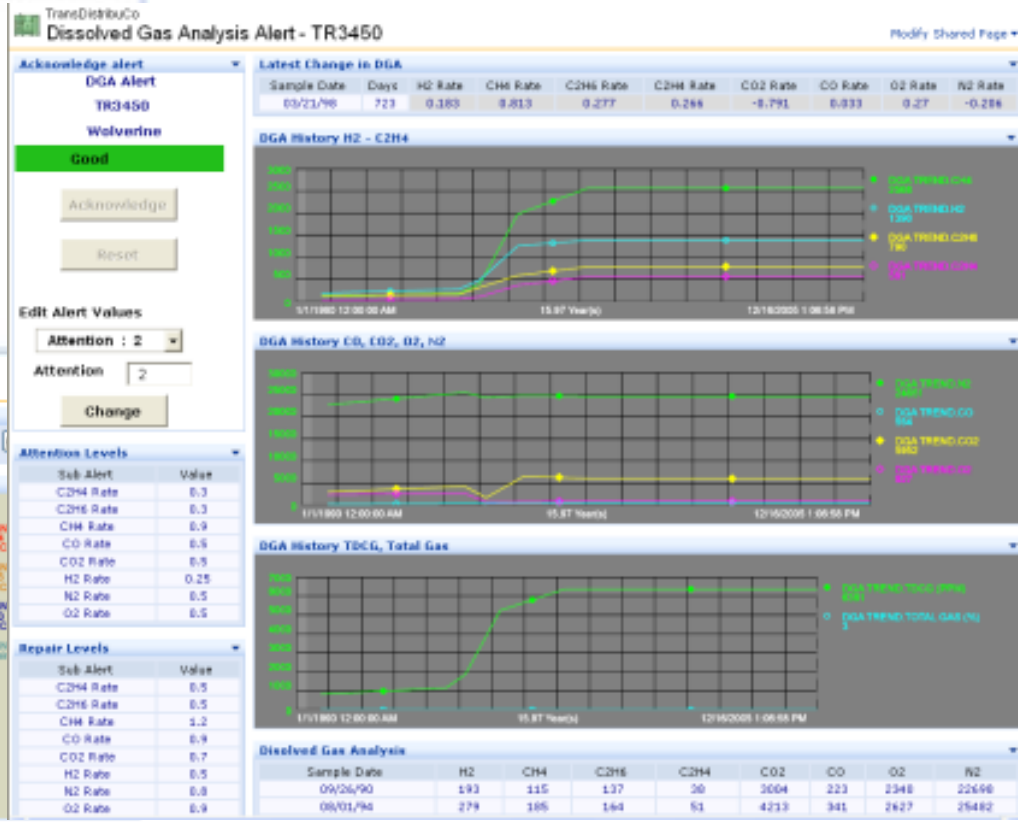
LTC Tap Position Indicator

Customer Use Case - PSE&G

Condition Based Monitoring - Screenshots







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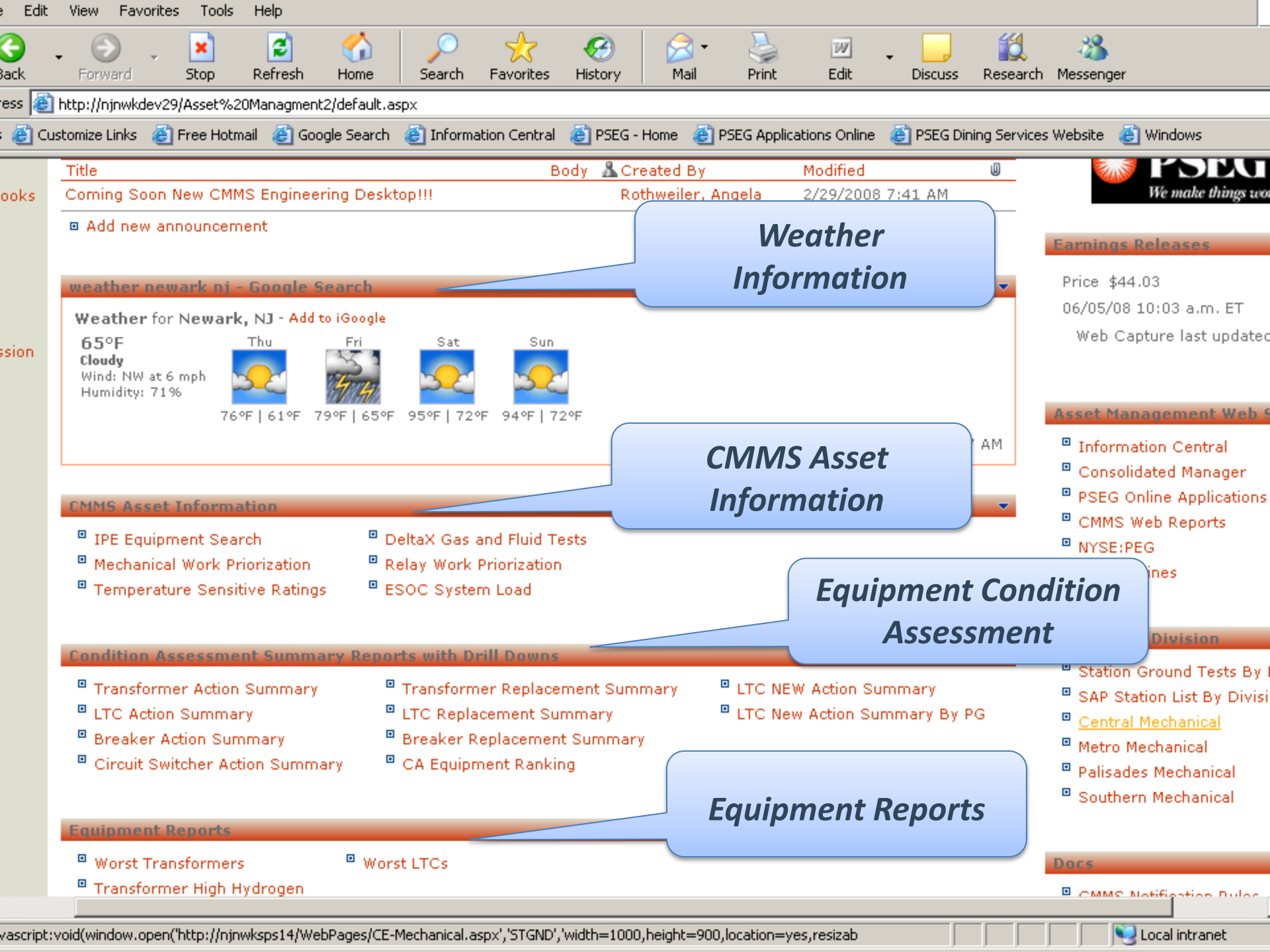
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Add new announcement
Weather Information
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Weather for Newark, NJ - Add to iGoogle
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Humidity: 71%
Thu 76°F | 61°F
Fri 79°F | 65°F
Sat 95°F | 72°F
Sun 94°F | 72°F
CMMS Asset Information
IPE Equipment Search
Mechanical Work Priorization
Temperature Sensitive Ratings
DeltaX Gas and Fluid Tests
Relay Work Priorization
ESOC System Load
Equipment Condition Assessment
Condition Assessment Summary Reports with Drill Downs
Transformer Action Summary
LTC Action Summary
Breaker Action Summary
Circuit Switcher Action Summary
Transformer Replacement Summary
LTC Replacement Summary
Breaker Replacement Summary
CA Equipment Ranking
LTC NEW Action Summary
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Equipment Reports
Worst Transformers
Transformer High Hydrogen
Worst LTCs
Earnings Releases
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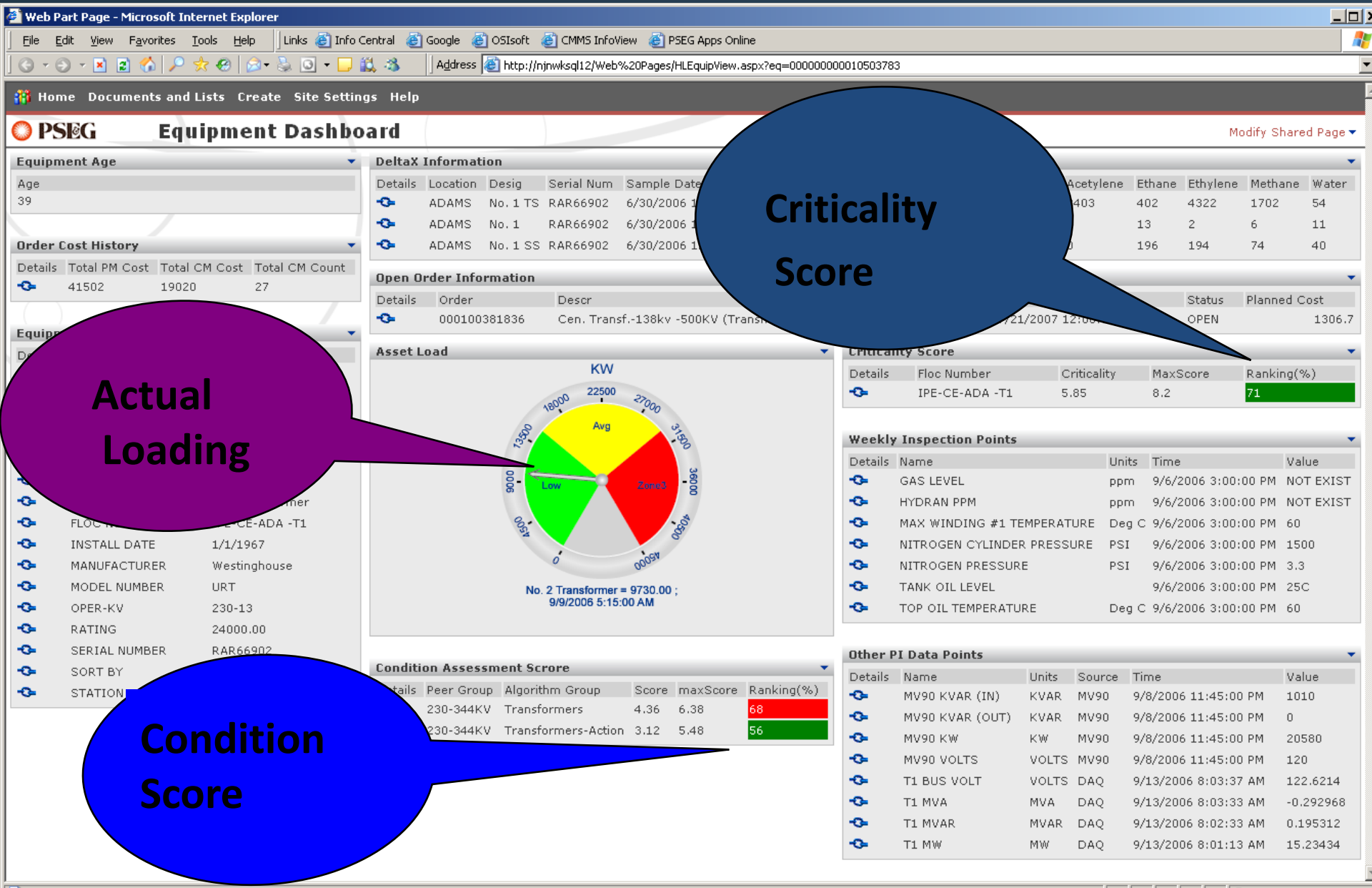
Customer Use Case - PSE&G

Equipment Dashboard



Summary

- What?
  - Infrastructure that
    - » Creates an integration platform to all islands
    - » Connects your plant floor data into the business management system
    - » Supports Integrated Operations (Fleet Mentality)
- Why?
  - Foundation for Business and Operational Improvement Initiatives
    - » Improved Business Agility – real-time decision making
    - » Standardization - One version of truth
    - » Collaboration – Everyone works with the same data, rules & tools
    - » Protection of existing and future investment
    - » Low Risk & Quick option
- How?
  - Build the Foundation first
    - » Infrastructure first, followed by applications supporting Performance Improvement Initiatives

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Thank you

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