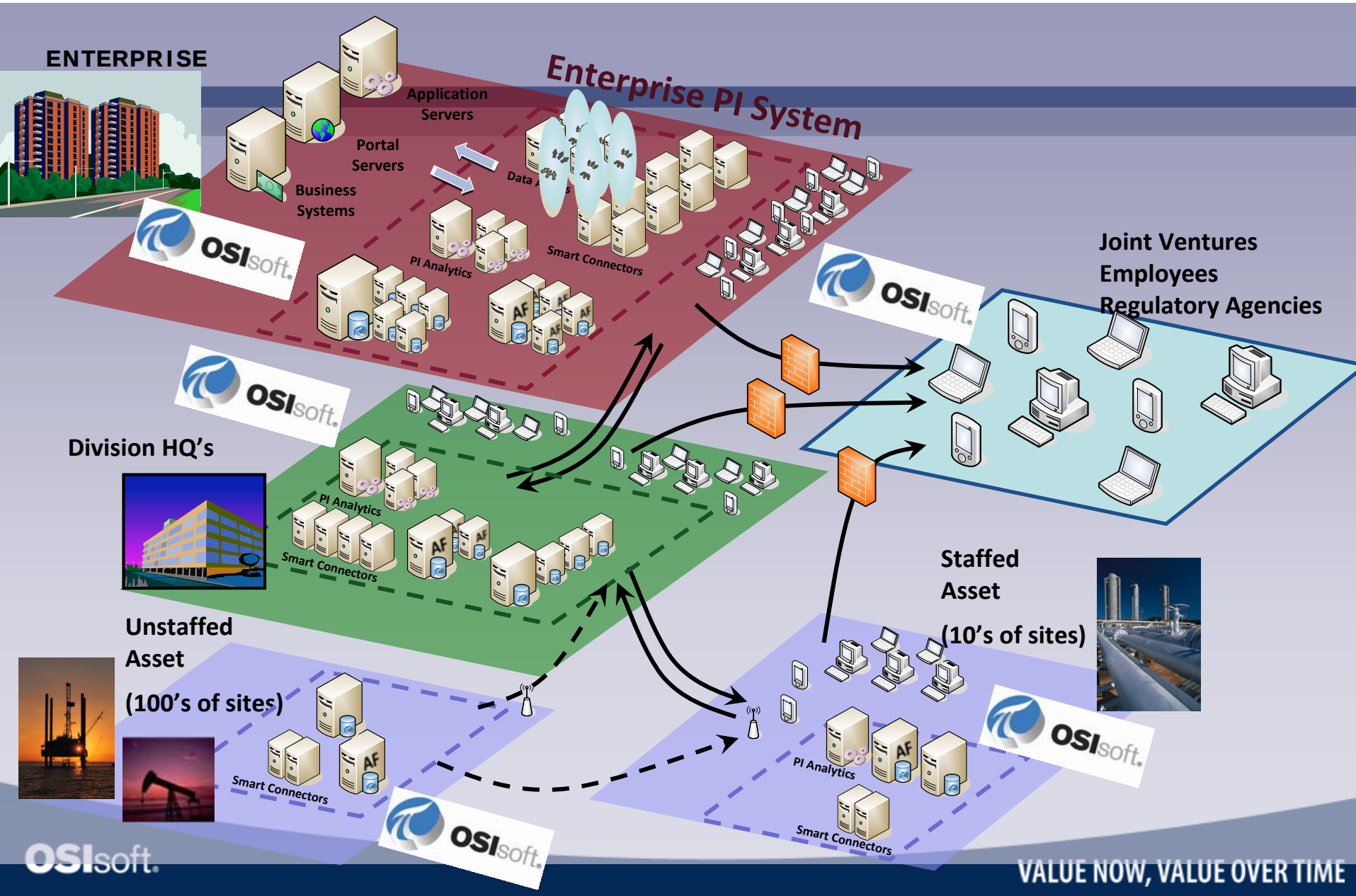
Building a Real-Time Event-Driven Enterprise Infrastructure

Ann Moore – Business Development Executive

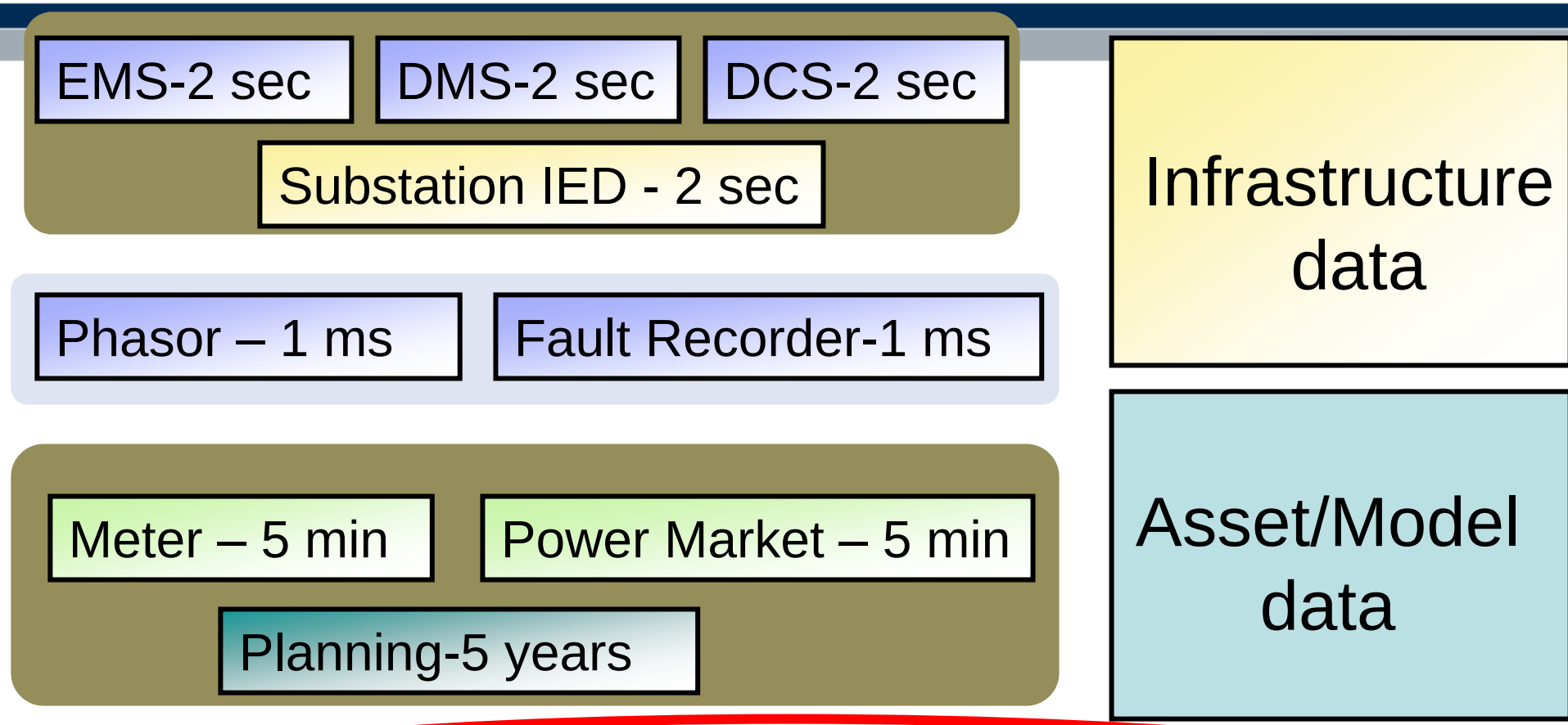
Agenda

- PI for Enterprise Infrastructure
- Utility Industry Use Cases
  - Operational Data
  - Non-Operational Data
  - Asset/Model and Analytics
  - Critical Infrastructure Monitoring
- Summary and Q&A

Enterprise Deployment Example



PI Centric Infrastructure



PI Platform/Infrastructure

Proven Utility Industry Use Cases

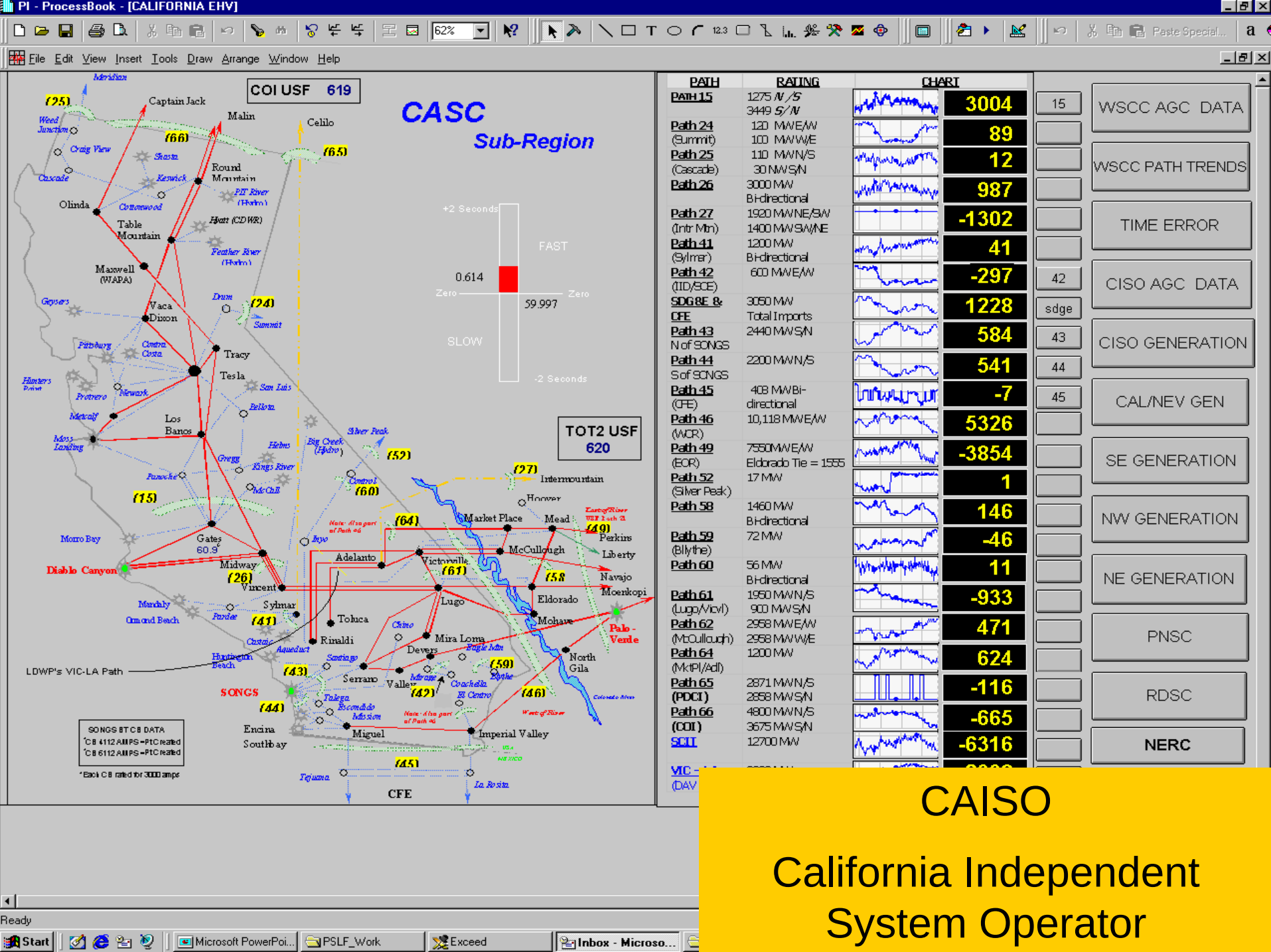
- **Operational**: EMS/DMS/DCS/SCADA data monitoring, archiving, event reporting and analysis
- **Non-operational:** substation field device non-SCADA data monitoring and archiving
- **Asset/Model:** metadata management and analytics
- **Security/Infrastructure:** Critical Infrastructure Protection (CIP) and monitoring
- **Enterprise:** integration, correlation and repository

Utility Use Cases

PI for Operational Data

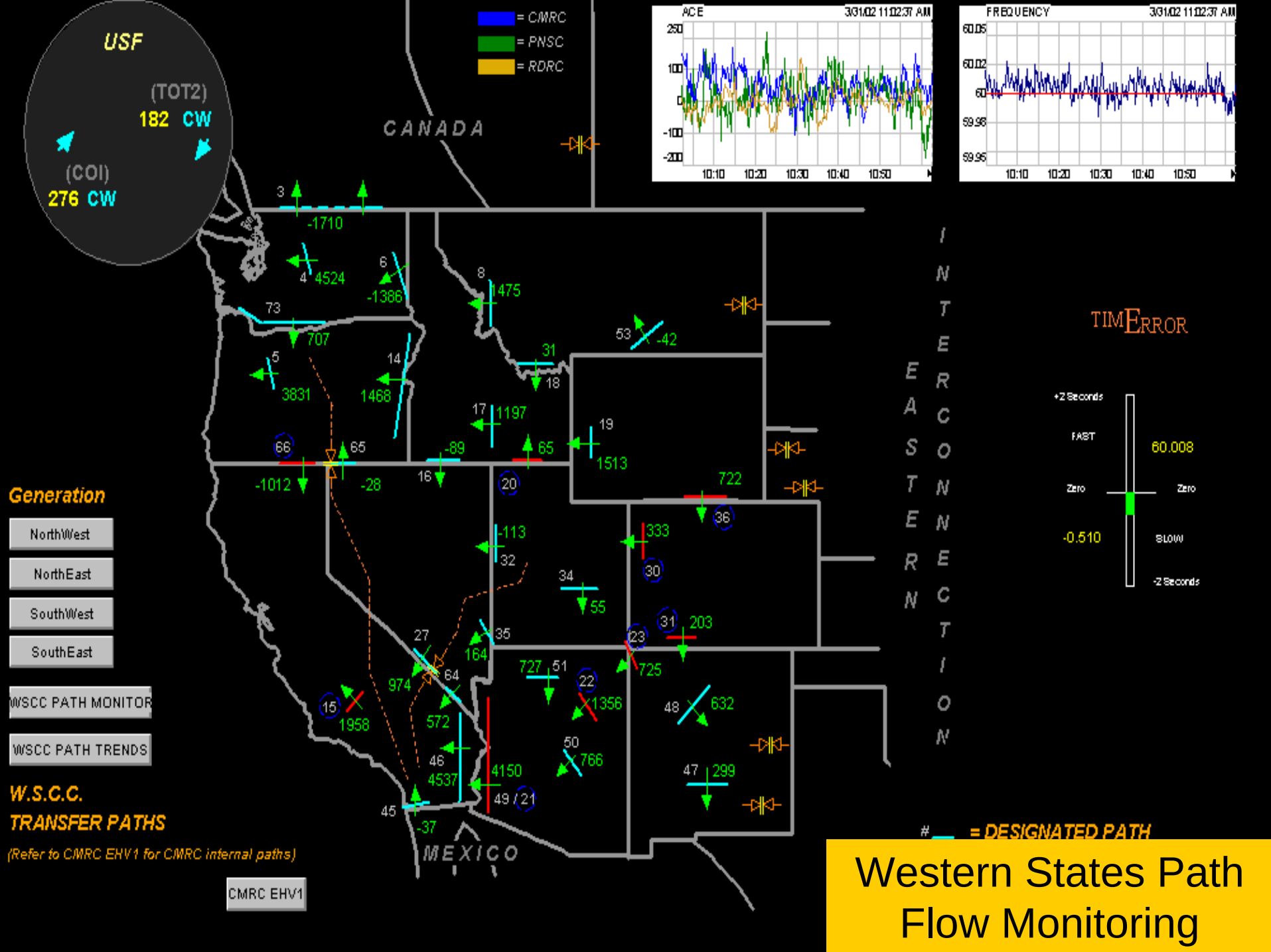
Enhancing and Complementing

- Real-time data analysis
- Real-time decision making
- Real-time visualization
- Long-term data archiving/retrieval
- Interfacing multiple external data sources
- Centralized data repository and user interface
- What-if case studies
- Easy of use and accessibility for everyone
- Off load from real-time control and operations



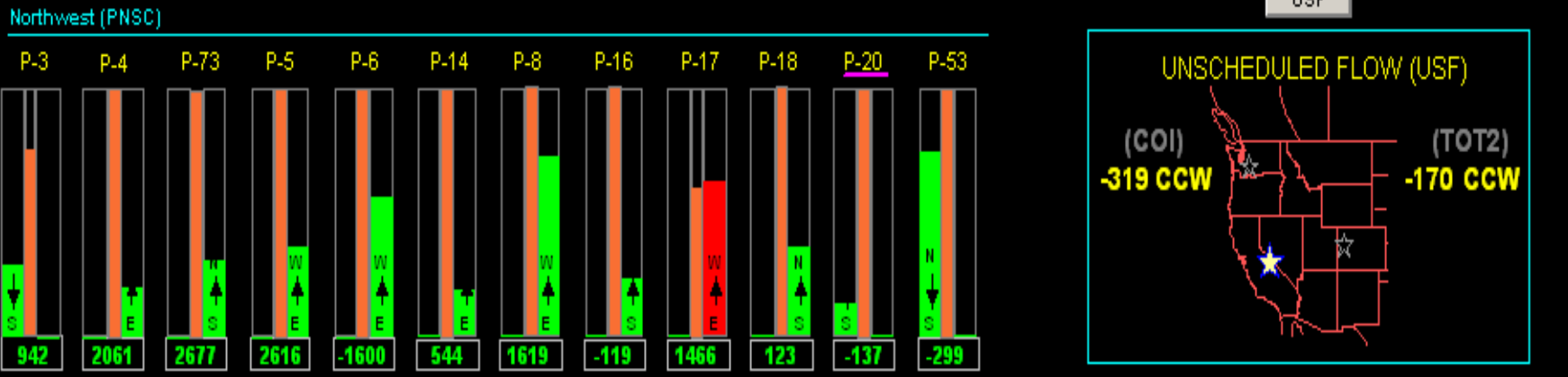
CAISO

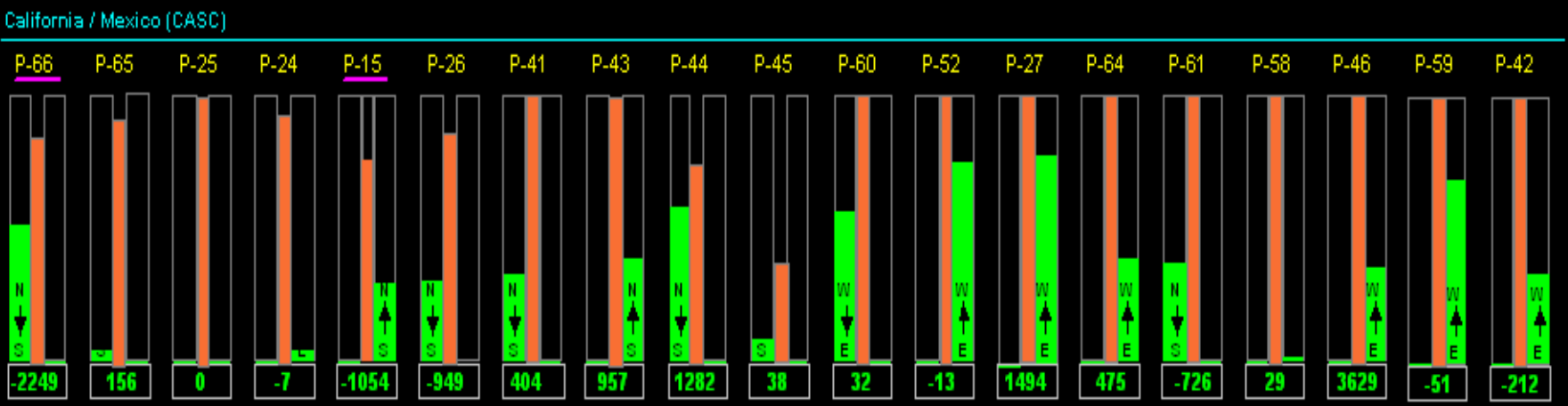
California Independent System Operator

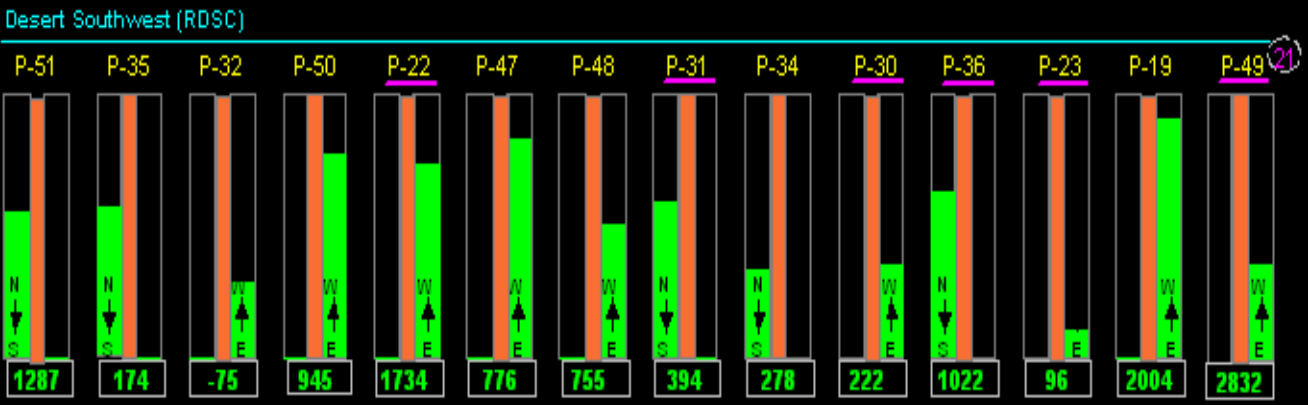


Western States Path Flow Monitoring

WSCC TRANSFER PATHS



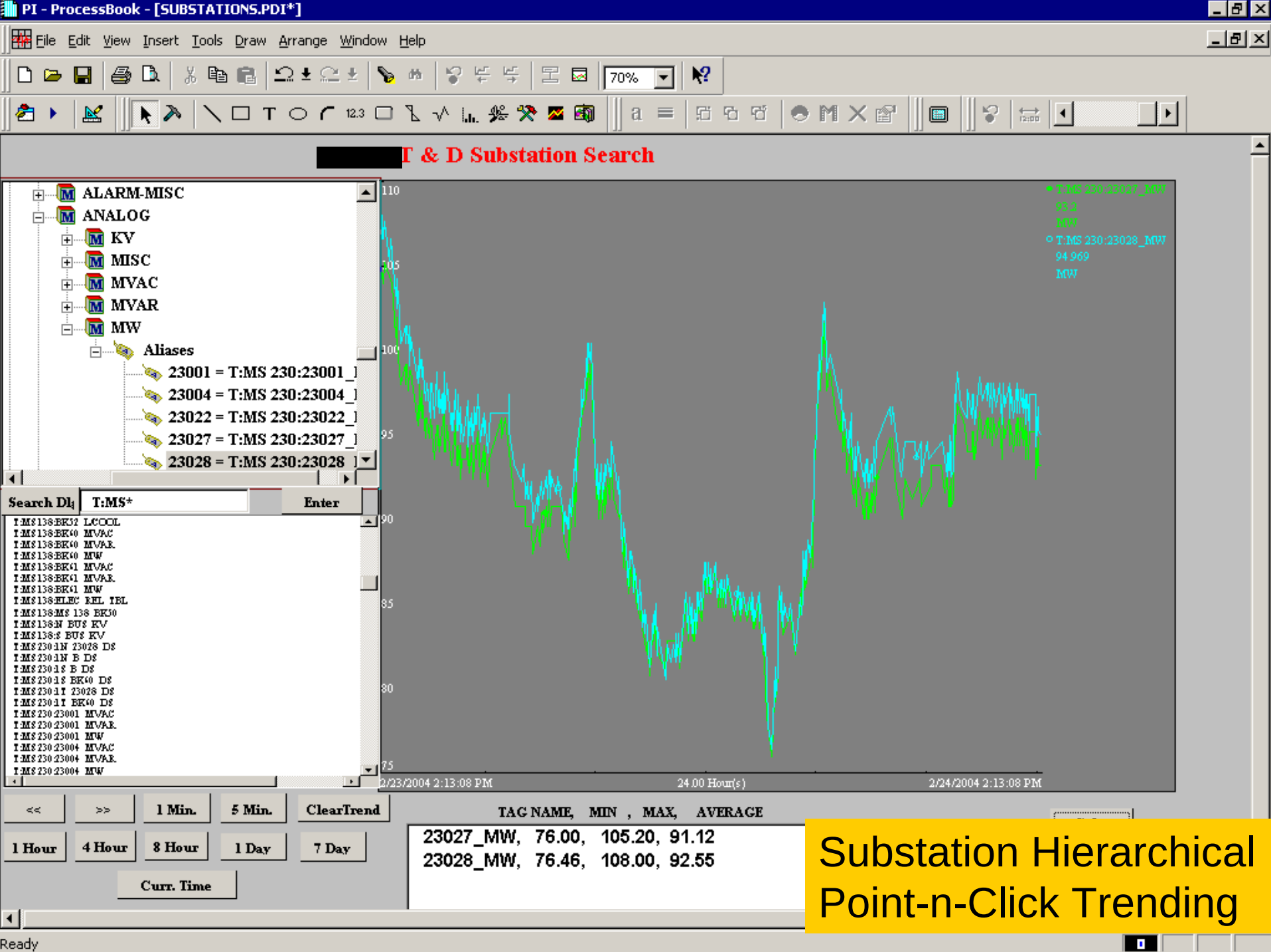




HZ | KV | AGC | CASC | CHARTS

0 - 92% | 92 - 95% | 95 - 100% | QUALIFIED PATH (USF) | OTC

Western States Transfer Paths


PI - ProcessBook - [SUBSTATIONS.PDI*]
File Edit View Insert Tools Draw Arrange Window Help
70%
[redacted] T & D Substation Search
ALARM-MISC
ANALOG
KV
MISC
MVAC
MVAR
MW
Aliases
23001 = T:MS 230:23001_
23004 = T:MS 230:23004_
23022 = T:MS 230:23022_
23027 = T:MS 230:23027_
23028 = T:MS 230:23028_
Search Dlg
T:MS*
Enter
T:MS 230:23027_MW
93.2
MW
T:MS 230:23028_MW
94.969
MW
110
105
100
95
90
85
80
75
2/23/2004 2:13:08 PM
24.00 Hour(s)
2/24/2004 2:13:08 PM
<<
>>
1 Min.
5 Min.
ClearTrend
1 Hour
4 Hour
8 Hour
1 Day
7 Day
Curr. Time
TAG NAME, MIN , MAX, AVERAGE
23027_MW, 76.00, 105.20, 91.12
23028_MW, 76.46, 108.00, 92.55
Substation Hierarchical
Point-n-Click Trending
Ready

PI - ProcessBook - [NEW_DAYCOMP.PDI*]

File Edit View Insert Tools Draw Arrange Window Help

66%

MW

Aliases

[redacted]_LD = T:Gdc Ge
[redacted]_LD = T:Gdc Ge
[redacted]E_LD = T:Gdc (
[redacted]LD = T:Gdc Ge
[redacted]NET_TIE = T:G
[redacted]OPER_RES = T:
[redacted]SPIN_RES = T:(
[redacted]TIE_T2 = T:Gdc
[redacted]SPIN_RES = T:
[redacted]OPER_RES = T
[redacted]SPIN_RES = T:

Search Dlg *

Enter

T:GdcGenerator[redacted]alLoad

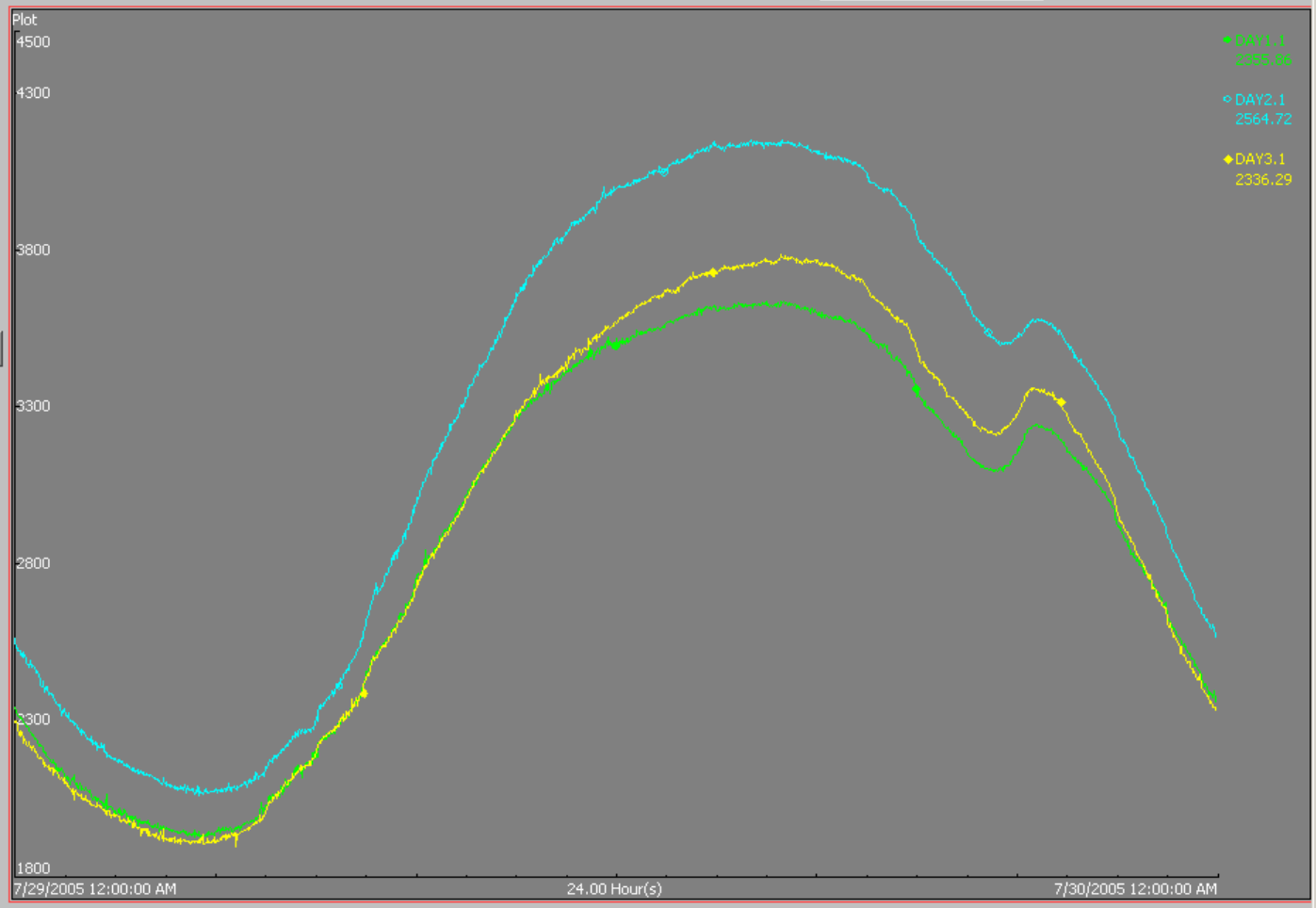
<< >> 1 Min. 5 Min.

1 Hour 4 Hour 8 Hour 1 Day

7 Day Curr. Time ClearTrend

[redacted] T&D Load Comparison Trending

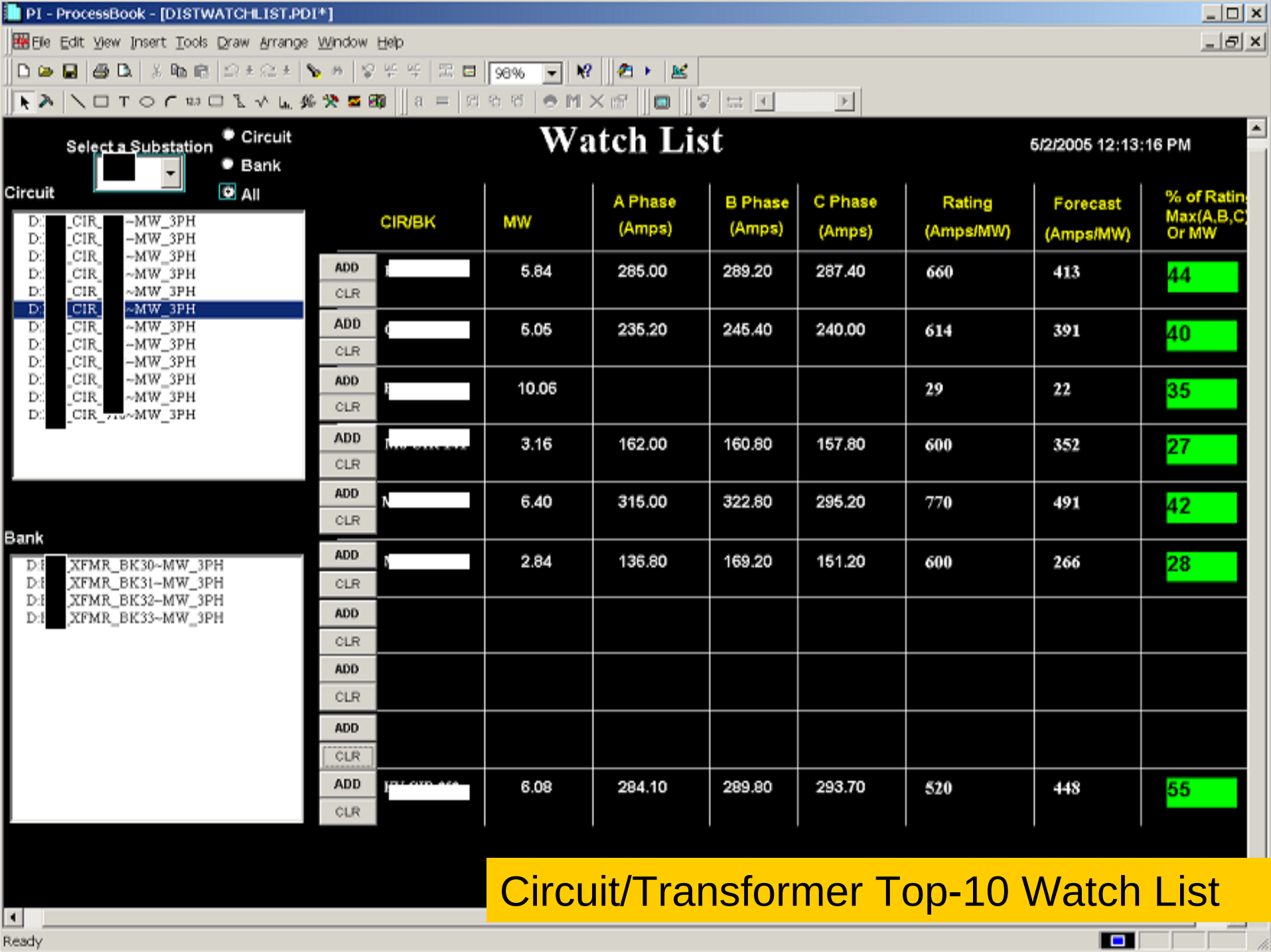
Plot 1 7 /29/2005 Plot 2 7 /22/2005 Plot 3 7 /15/2005



Load Comparison Trending

Ready

NUM


PI - ProcessBook - [DISTWATCHLIST.PDI*]
File Edit View Insert Tools Draw Arrange Window Help
Select a Substation
Circuit
Bank
All
Circuit
Bank
Watch List
5/2/2005 12:13:16 PM
CIR/BK
MW
A Phase (Amps)
B Phase (Amps)
C Phase (Amps)
Rating (Amps/MW)
Forecast (Amps/MW)
% of Rating Max(A,B,C) Or MW
ADD
CLR
5.84 285.00 289.20 287.40 660 413 44
5.05 235.20 245.40 240.00 614 391 40
10.06 29 22 35
3.16 162.00 160.80 157.80 600 352 27
6.40 315.00 322.80 295.20 770 491 42
2.84 136.80 169.20 151.20 600 266 28
6.08 284.10 289.80 293.70 520 448 55
Circuit/Transformer Top-10 Watch List
Ready

MSNBC Weather

Tucker

Current conditions | **Tomorrow**

75°

Wind: 7VAR
Baro: 29.81"
Humidity: 31%

75°/43°

All temps shown in F° | Change to C°

MSNBC For extended forecasts, go to MSNBC.com

Web Links

New | Organize

- http://schedmem.gasoc.com
- http://ecs_team2/tms

Microsoft Outlook Messages - Inbox

New | Delete

From	Subject	Received
Sarracini, Loreto	FW: Dat...	Wed 10/22/...
Taganajan, Tito	Owner ...	Wed 10/22/...
McCafferty, ...	Comput...	Wed 10/22/...
Taganajan, Tito	Question	Tue 10/21/2...
Devnet SL	OSI Dev...	Mon 10/20/2...
Denning, Helen	RE: Req...	Fri 10/17/20...
Paschall, Sara	Benefits...	Mon 10/13/2...

PI Graphic - emc_ld_sum_v1.0.svg

EMC Load Summary

ECS/PI Link
Receiving

EMC	Load (MW)	CurHr (MWh)	EMC	Load (MW)	CurHr (MWh)	EMC	Load (MW)	CurHr (MWh)
Altamaha	93.66	76.68	Irwin	21.52	17.23	Slash Pine	19.85	15.94
Amicalola	51.61	41.44	Jackson	459.67	376.79	Snapping Shoals	150.74	122.94
Canoochee	42.00	34.09	Jefferson	58.22	47.24	Sumter	38.77	30.91
Carroll	93.28	75.25	Lamar	29.74	24.14	Three Notch	25.51	20.40
C. Georgia	89.64	72.27	L. Ocmulgee	20.73	17.15	Tri-County	32.71	26.66
Coastal	35.10	28.84	Middle GA.	15.74	12.68	Troup	50.16	40.45
Cobb	377.40	308.72	Mitchell	53.46	43.26	Upson	13.52	11.01
Colquitt	135.39	109.82	Ocmulgee	19.11	15.18	Walton	220.58	179.62
Coweta-Fayette	138.08	112.05	Oconee	25.11	19.69	Washington	43.38	35.49
Excelsior	39.80	32.22	Okefenoke	61.82	49.32	Sterling Pulp	11.58	
Flint	168.51	137.42	Pataula	10.67	8.64	Total System Load	3658.70	
Grady	38.97	31.63	Planters	23.58	18.51	System Frequency	60.00 Hz	
Greystone	202.94	165.88	Rayle	25.81	20.48	Temperature	76.88 F	
Habersham	43.19	35.03	Satilla	119.89	96.48			
Hart	54.30	44.16	Sawnee	270.98	221.06			

Web Portal Enterprise Data Repository

Forecast - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address [redacted] Go Links

Forecast

Welcome | LogOut | Publish | Adhoc Trend | Content | Layout | Settings

Welcome Forecast Save All USER ID: PIWEB1\MPRICE

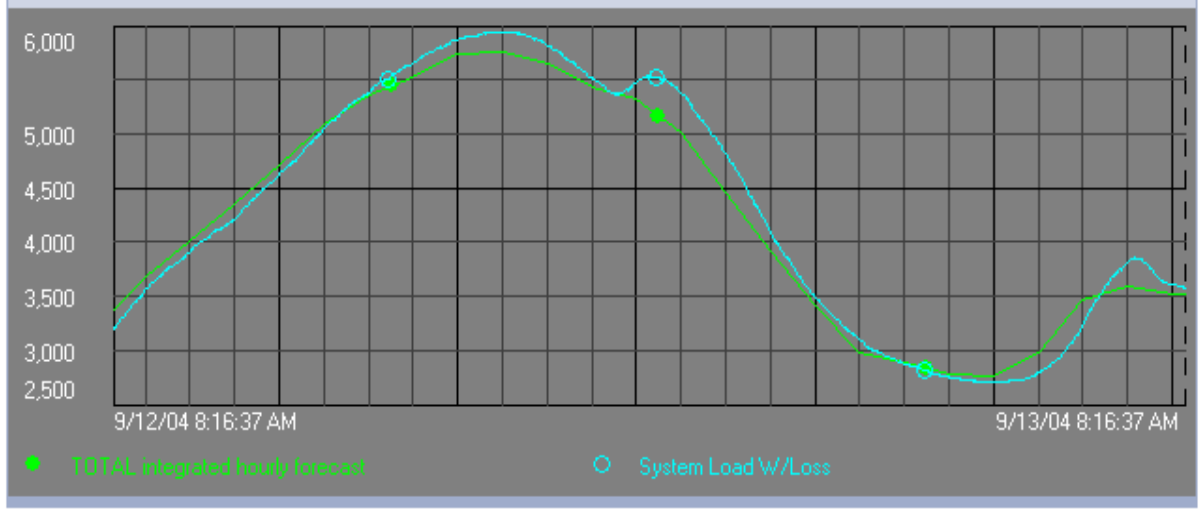
Day Ahead Load Forecast

First Back Next Last

Date	Hour	Load(MWh)	Current State
9/13/2004 1:00:00 AM	1	2973	0.0000 12,000.
9/13/2004 1:00:00 AM	2	2886	0.0000 12,000.
9/13/2004 1:00:00 AM	3	2780	0.0000 12,000.
9/13/2004 1:00:00 AM	4	2770	0.0000 12,000.
9/13/2004 1:00:00 AM	5	2978	0.0000 12,000.
9/13/2004 1:00:00 AM	6	3467	0.0000 12,000.

Showing 1 to 6 of 48

Load-Forecast vs Actual



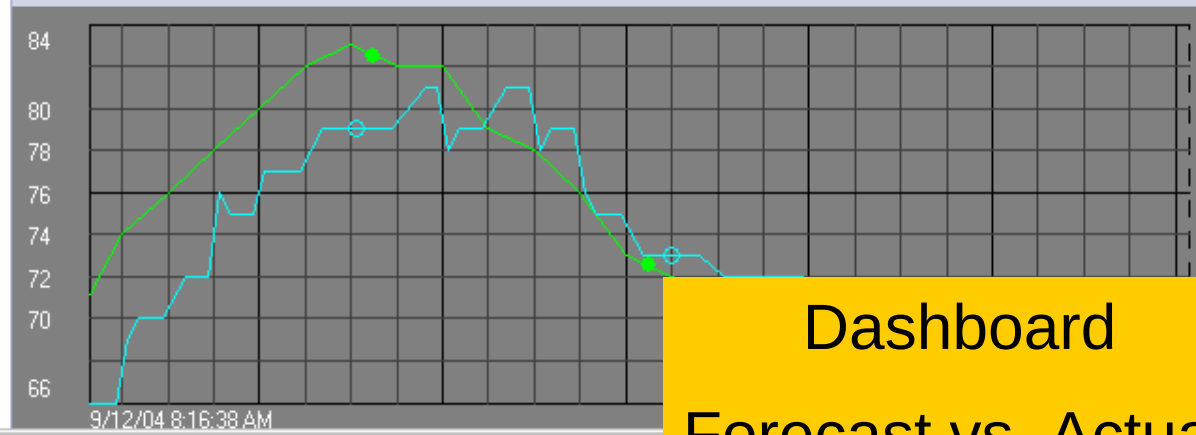
Day Ahead Temperature Forecast

First Back Next Last

Date	Hour	Temp(F)	Current_State
9/13/2004 1:00:00 AM	1	68	32.000 100.00
9/13/2004 1:00:00 AM	2	68	32.000 100.00
9/13/2004 1:00:00 AM	3	67	32.000 100.00
9/13/2004 1:00:00 AM	4	67	32.000 100.00
9/13/2004 1:00:00 AM	5	67	32.000 100.00
9/13/2004 1:00:00 AM	6	67	32.000 100.00

Showing 1 to 6 of 48

Temperature-Forecast vs Actual



Dashboard

Forecast vs. Actual

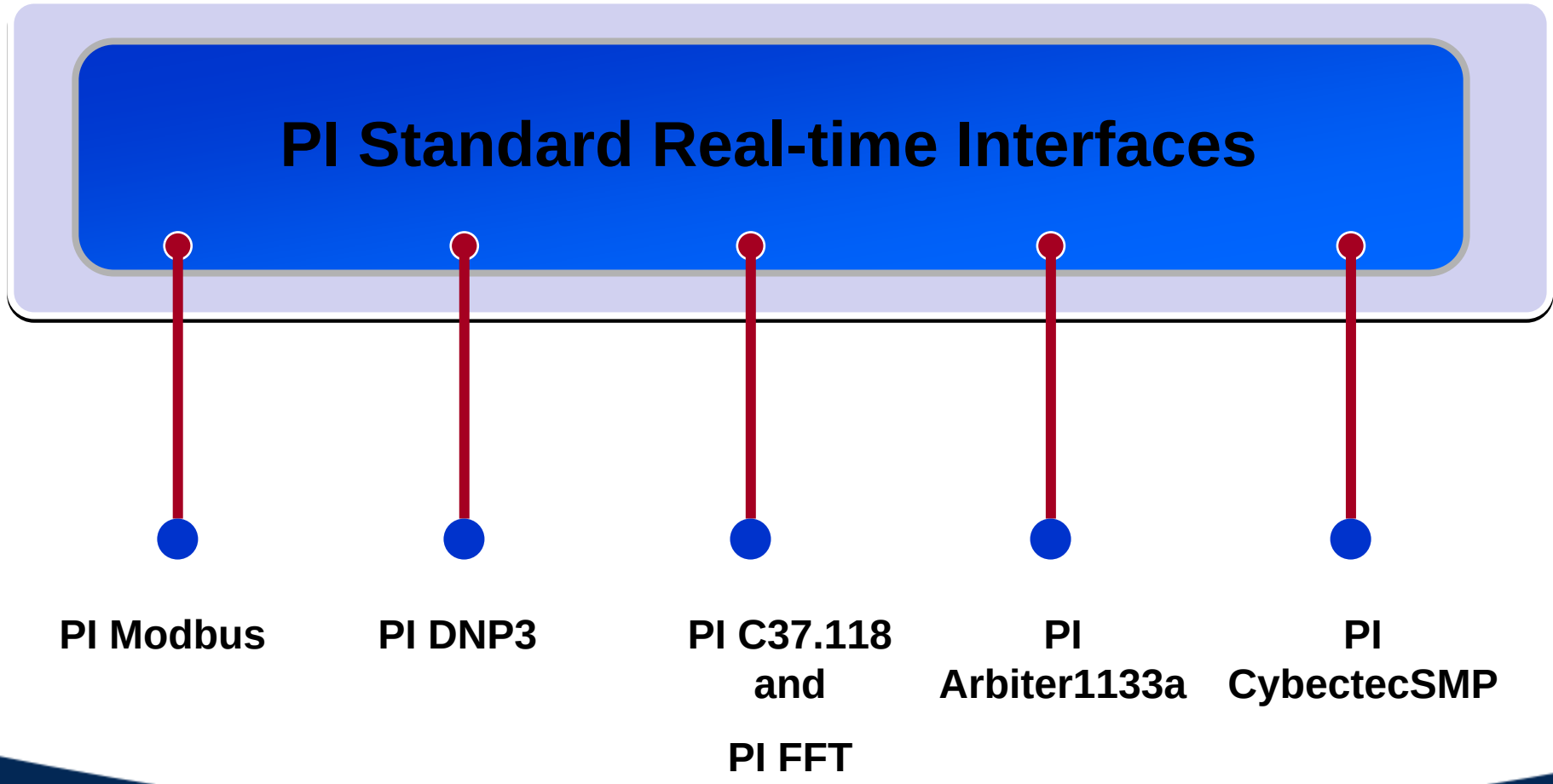
Done

PI for Non-Operational Data

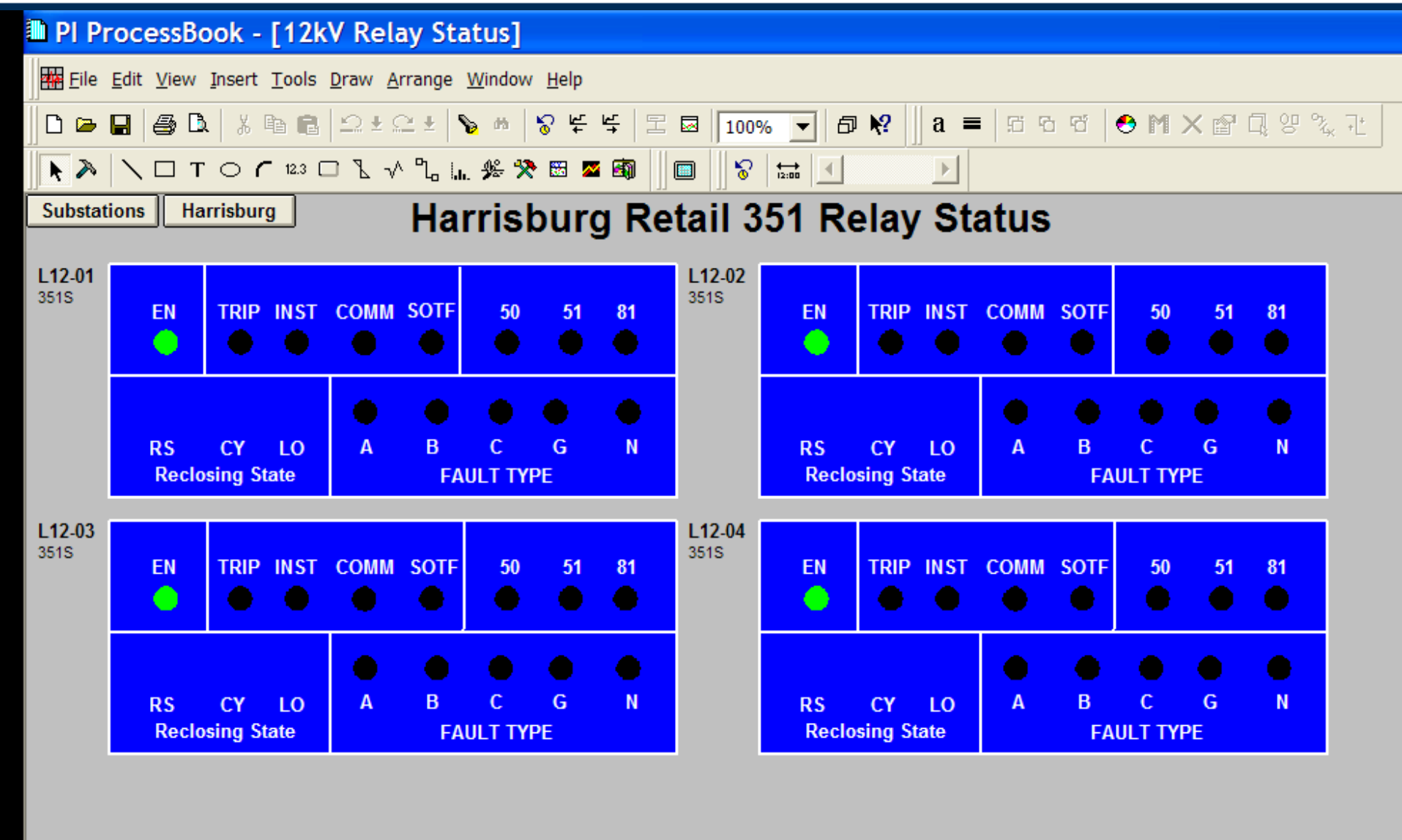
PI T&D Trends

- Distributed Generation
- Power Quality/Transient/Disturbance Data
- Fast Sampling PMU Phasor data
- Condition Based Maintenance/Monitoring
- Asset Management
- AMR
- Substation/Distribution Automation
- Smart Grid/Intelligent Grid

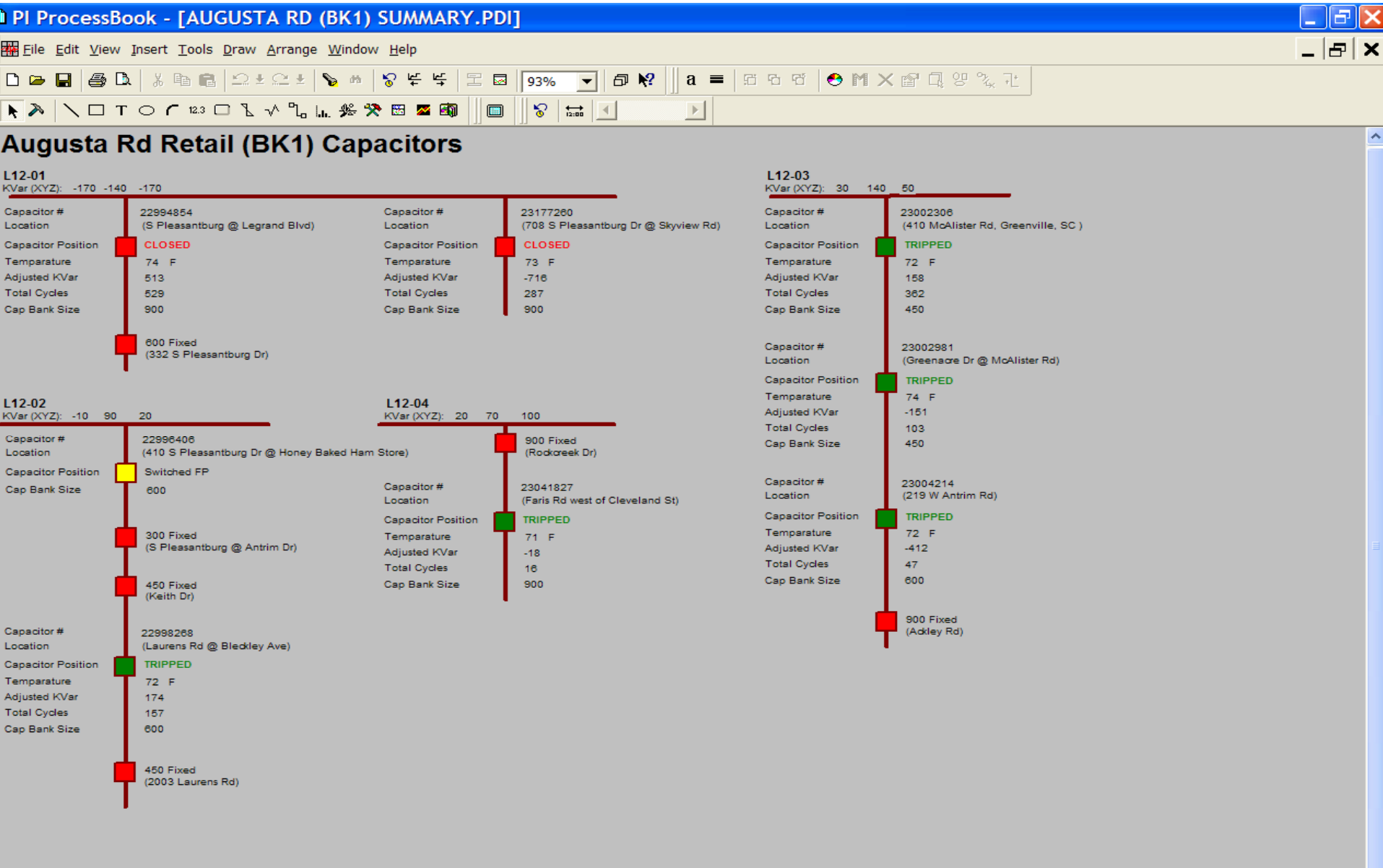
PI T&D Substation Interfaces



PI DNP3 Circuit Relay Status



Line Capacitor Status

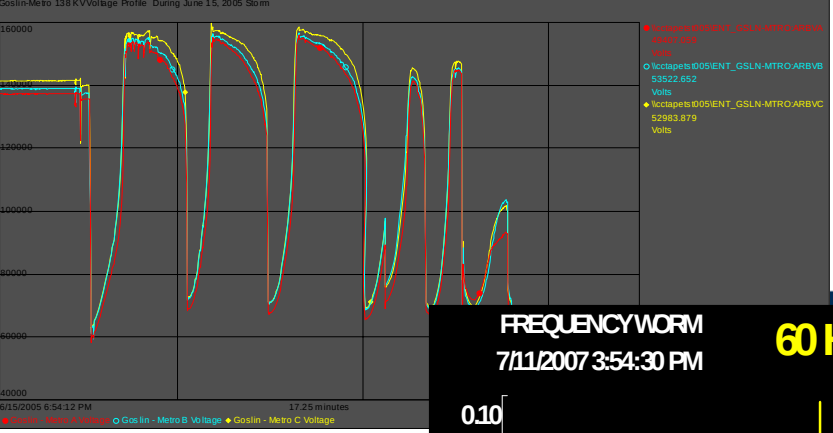


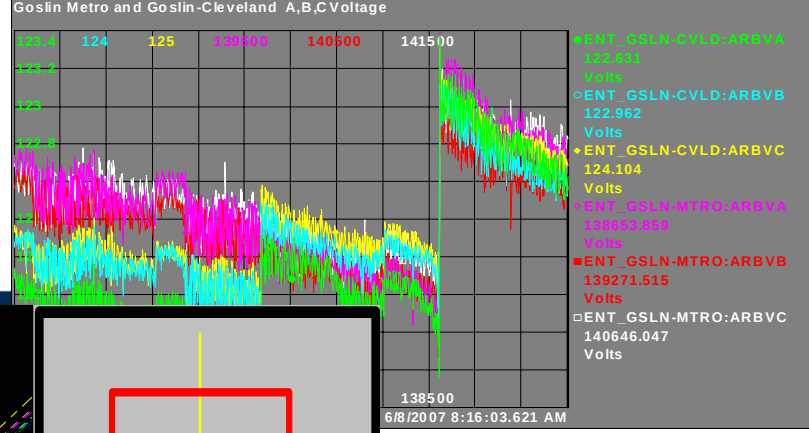
Protocol Standard IEC61850

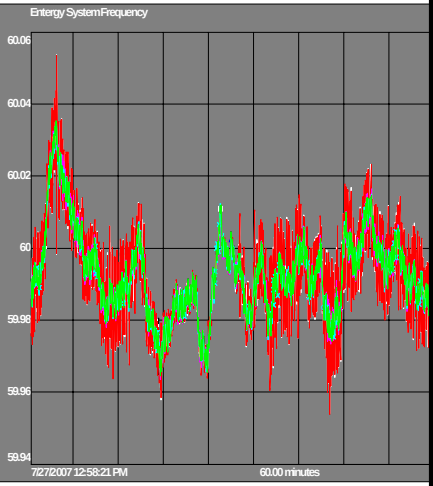
- IEC61850 is an object oriented substation automation standard that defines:
  - Standardized naming convention and object models
  - Standardized meaning of data
  - Standardized abstract services
  - Standardized device behavior models
  - Standardized protocols for:
    - *Control*
    - *SCADA*
    - *Protection*
    - *Transducers*
  - Self-describing devices
  - Common configuration language

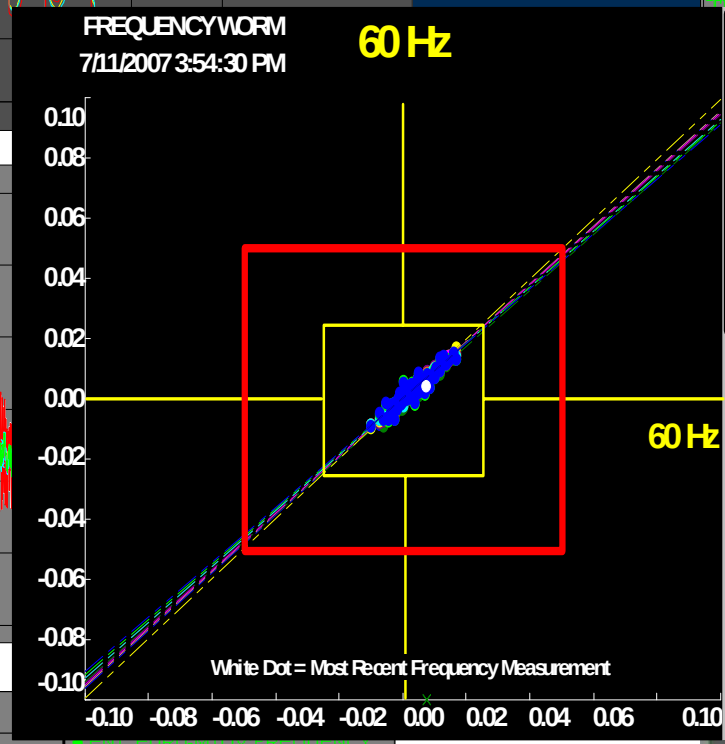
PI-based WAMS
Wide Area Measurement Systems

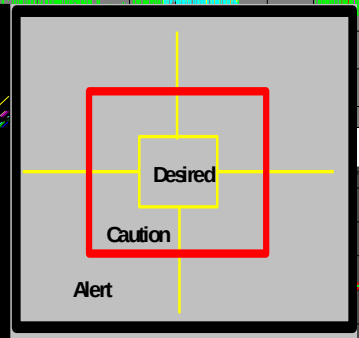
- Streaming Server
  - Very fast synchronized sampling with standard PI IEEE C37.118 Interface
- Real-time Analytics
  - Fast and synchronized real-time calculations (phase angle difference, FFT, etc.)
- Visualization/Alerts
  - Enhance operations and early warning to prevent grid instability and cascade collapse









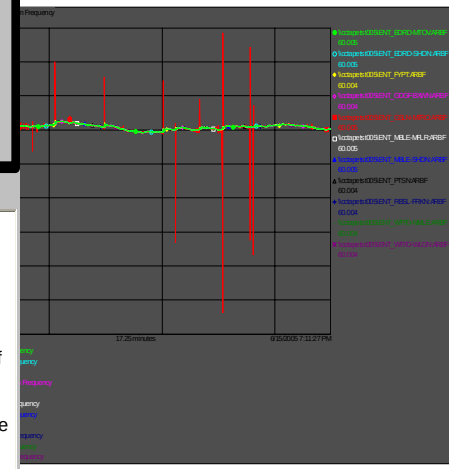


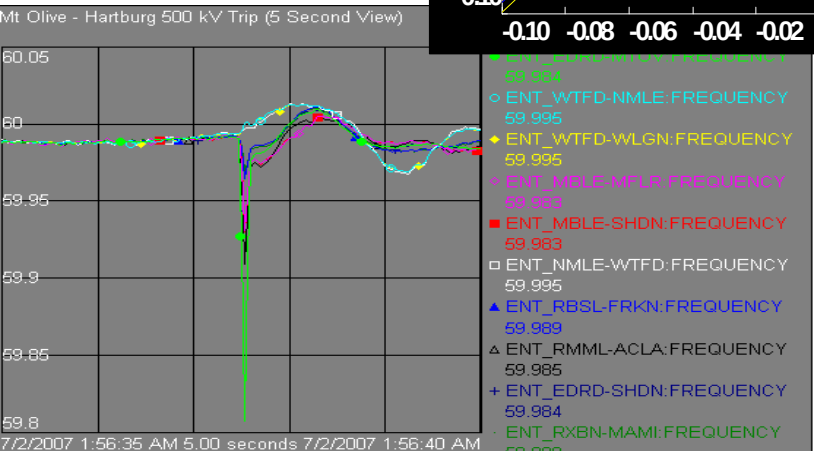
This chart represents your operating frequency domain. Frequency here is represented as a difference from 60 Hz.

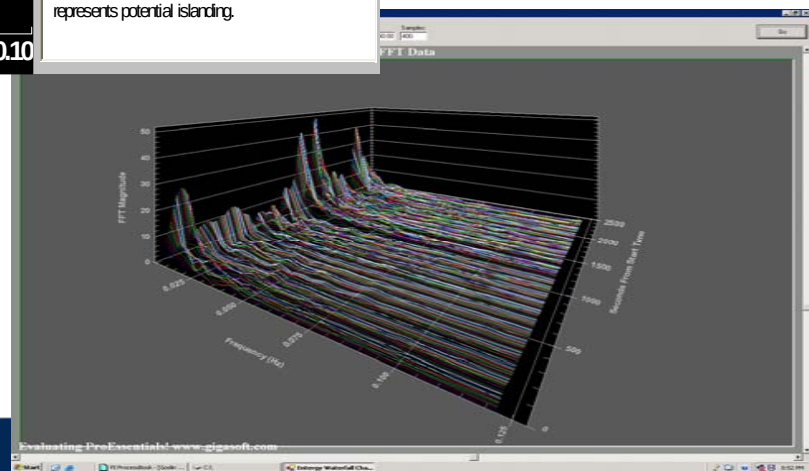
The system should be operated within the desired range (the yellow dashed box). Caution should be noted when frequencies begin to migrate outside of the yellow dashed box.

Frequencies falling in the alert region (outside of the red box) should be closely monitered.

If the frequency worm begins to scatter, this represents potential islanding.

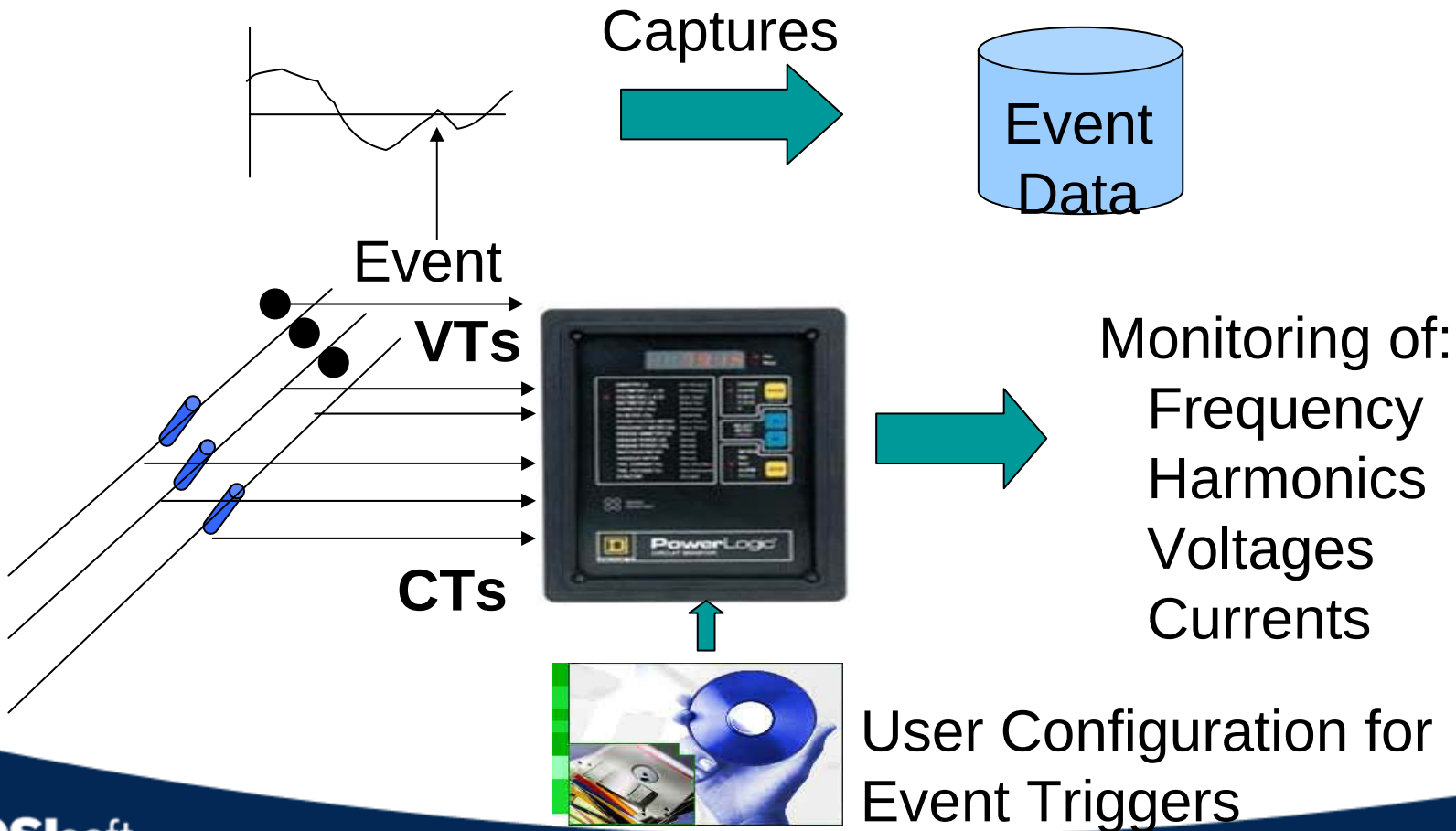




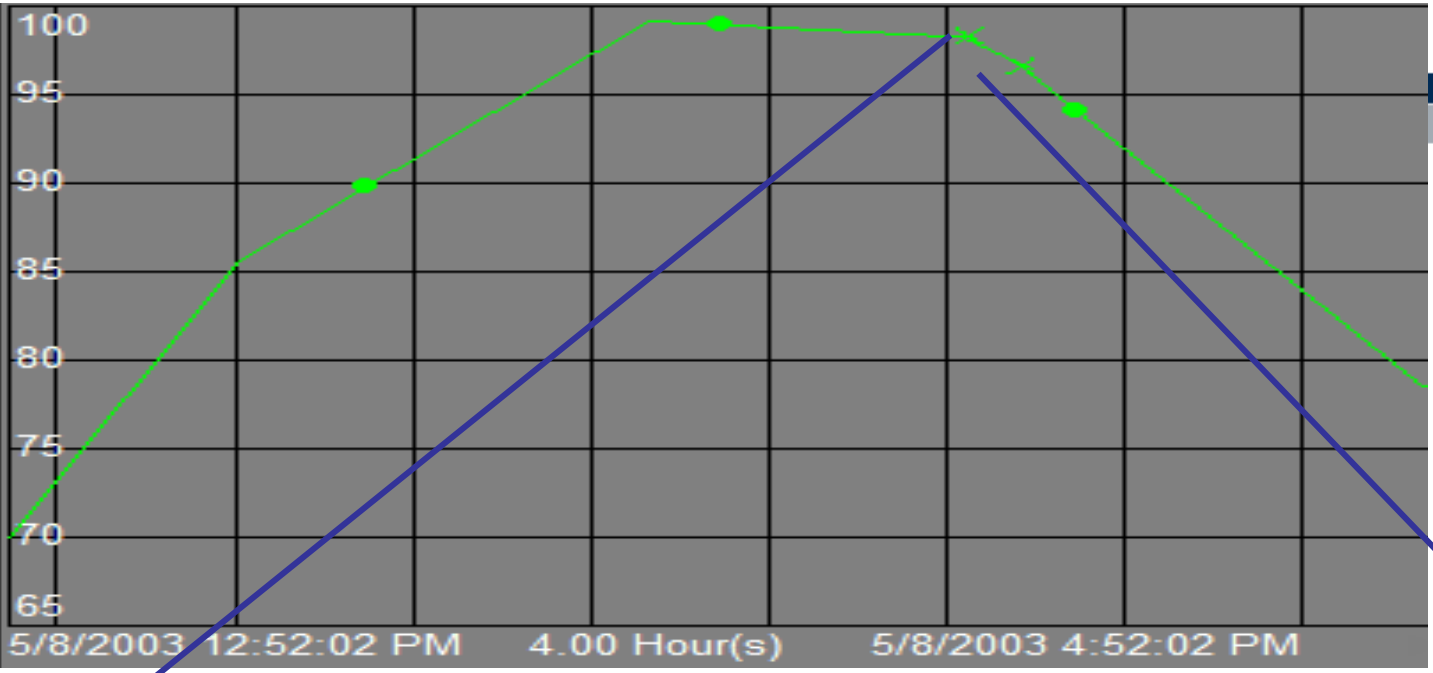


Transient Data in PI

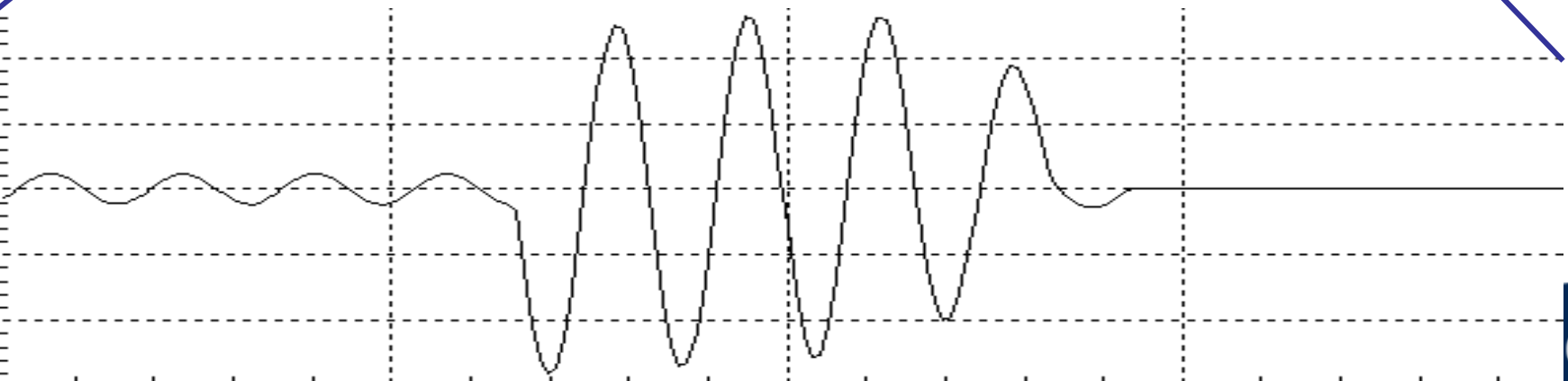
IEEE C37.111-1997 COMTRADE



Process Information Integration

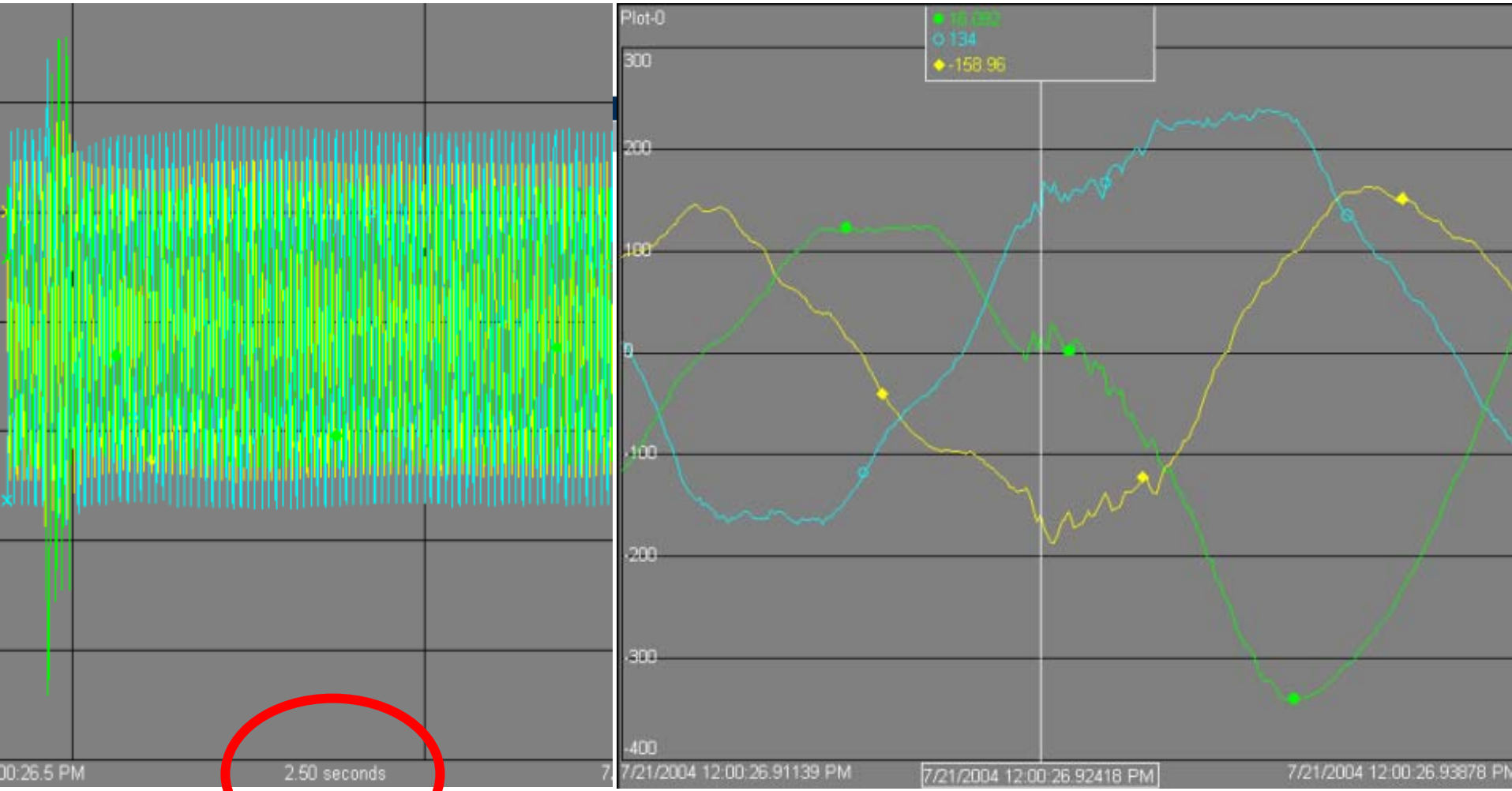


What really happened?



OVER TIME

Waveforms in PI



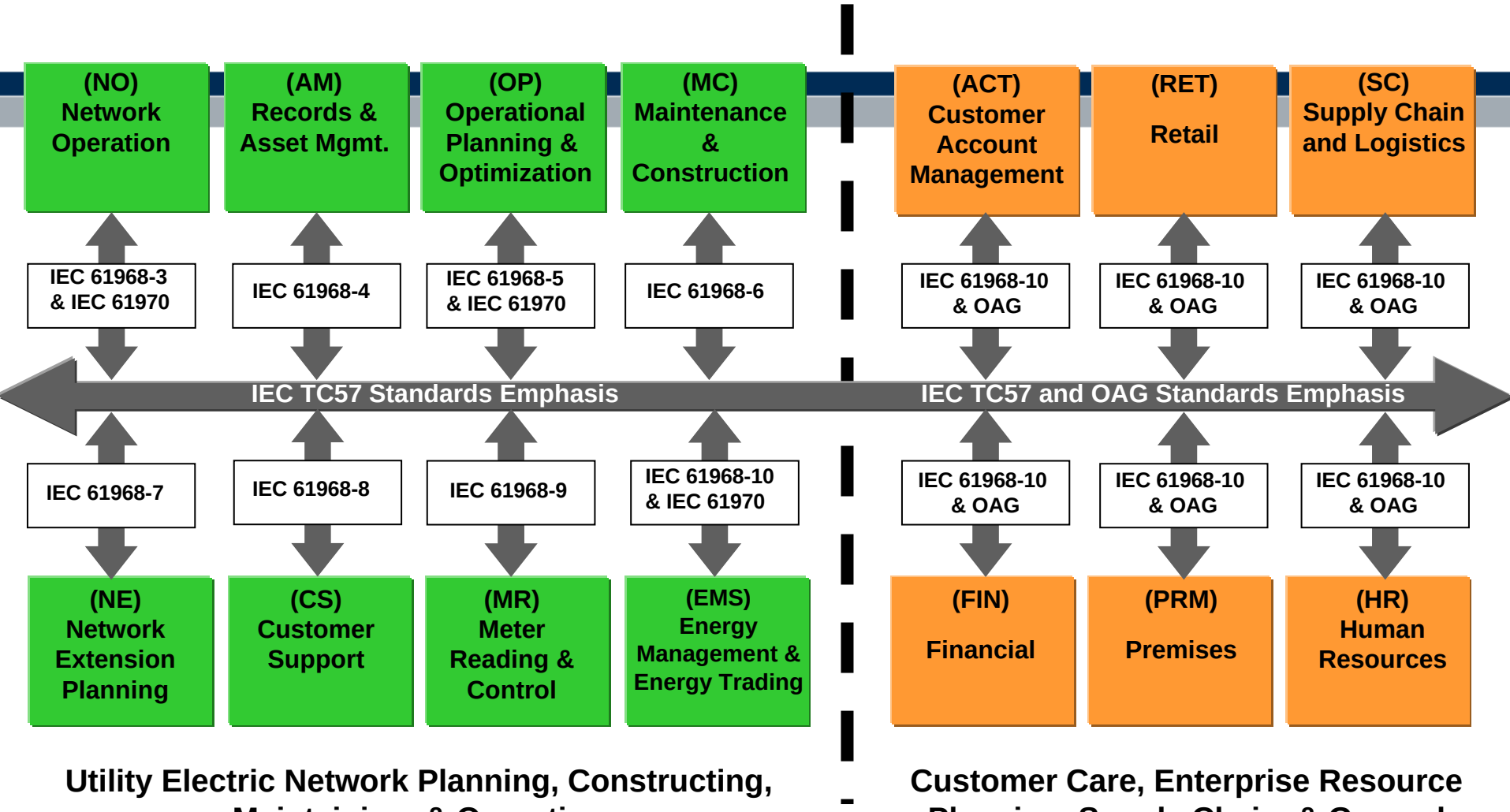
2.5 seconds

12:00:26:91139 **12:00:26:92418** **12:00:26:93878**

hundredth of second

PI for Asset Models and Analytics

Common Information Model (CIM)



Utility Electric Network Planning, Constructing, Maintaining, & Operating

Customer Care, Enterprise Resource Planning, Supply Chain, & General Corporate Services

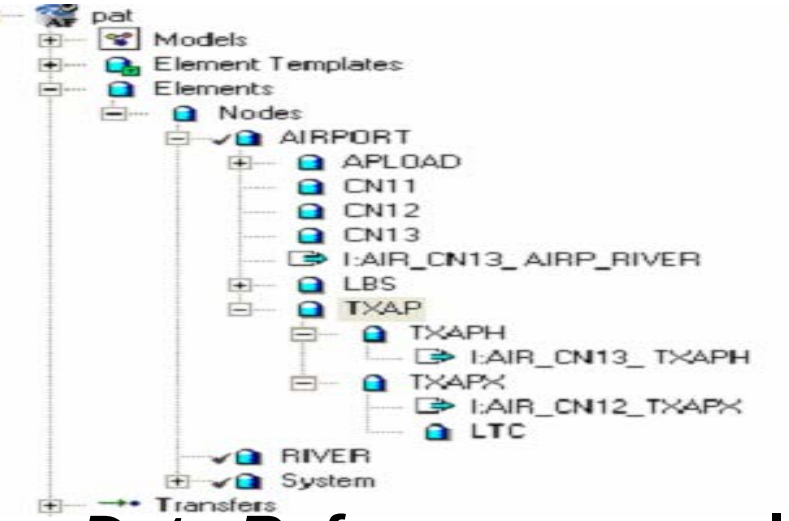
Why CIM Matters to PI Analysis Framework (AF)

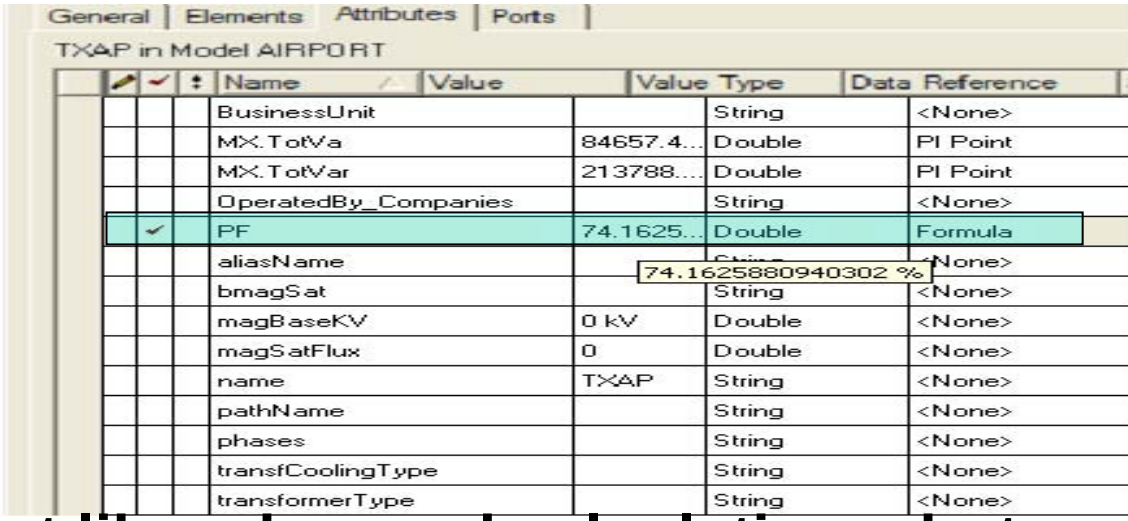
- Both about modeling the business
  - PI brings history to the model
  - CIM brings deep definition to the model
- PI is moving from "tag-centric" to **"asset-centric"**
- The industry has moved along in parallel
  - T&D has always been a real-time, no-inventory business – measurements matter
  - A smart grid without standards is a dumb grid
  - AF + CIM makes sense
- AF is a **"Measurement Model Manager"**

CIM Model in Analysis Framework

- Models can be built manually, using the downloading, or programmatically
- Building the template for elements (i.e. line)
- Elements have attributes
  - Another measurements, line rating, power factor, graphic symbols
- Elements have connections
- Building analysis rules (calculations, schedules)
- Values back into any other sources

Data References ease Analysis





***Data References* are a lot like advanced calculations, but**

A ***Data Reference*** can be:

- PI Points
- A calculation
- A reference to data in other systems
- XML Web Services
- Relational Databases (IEEE specs, line ratings, etc.)
- A reference to a CIM model

Other Possible Analysis

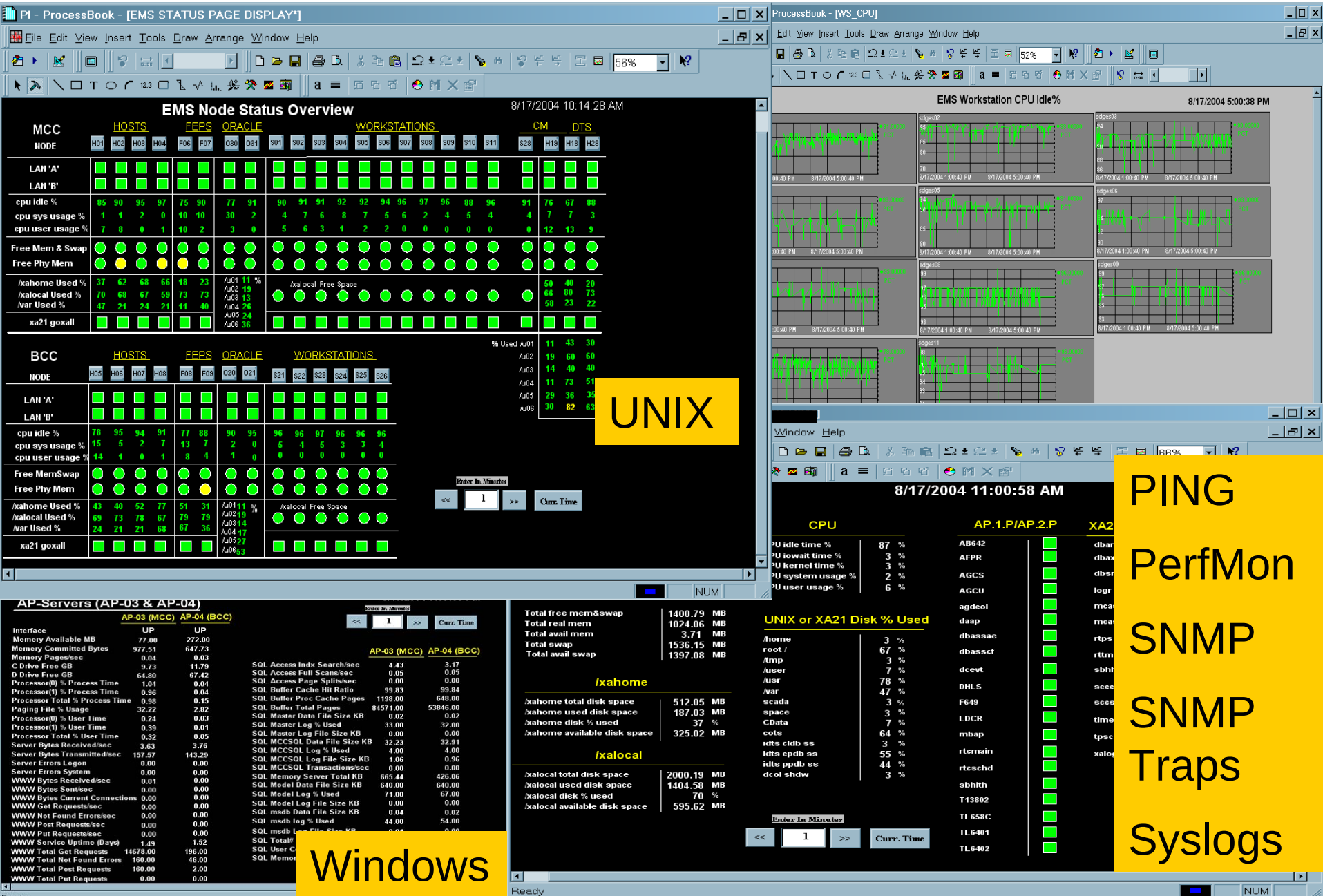
- Telemetry Analysis
- Peak Load
- Peak Circuit Load
- Dynamic Line Ratings
- Load Distribution
- Transformer Gas/Oil Analysis
- Harmonics
- VAR Calculations

PI for Control System and Critical Infrastructure

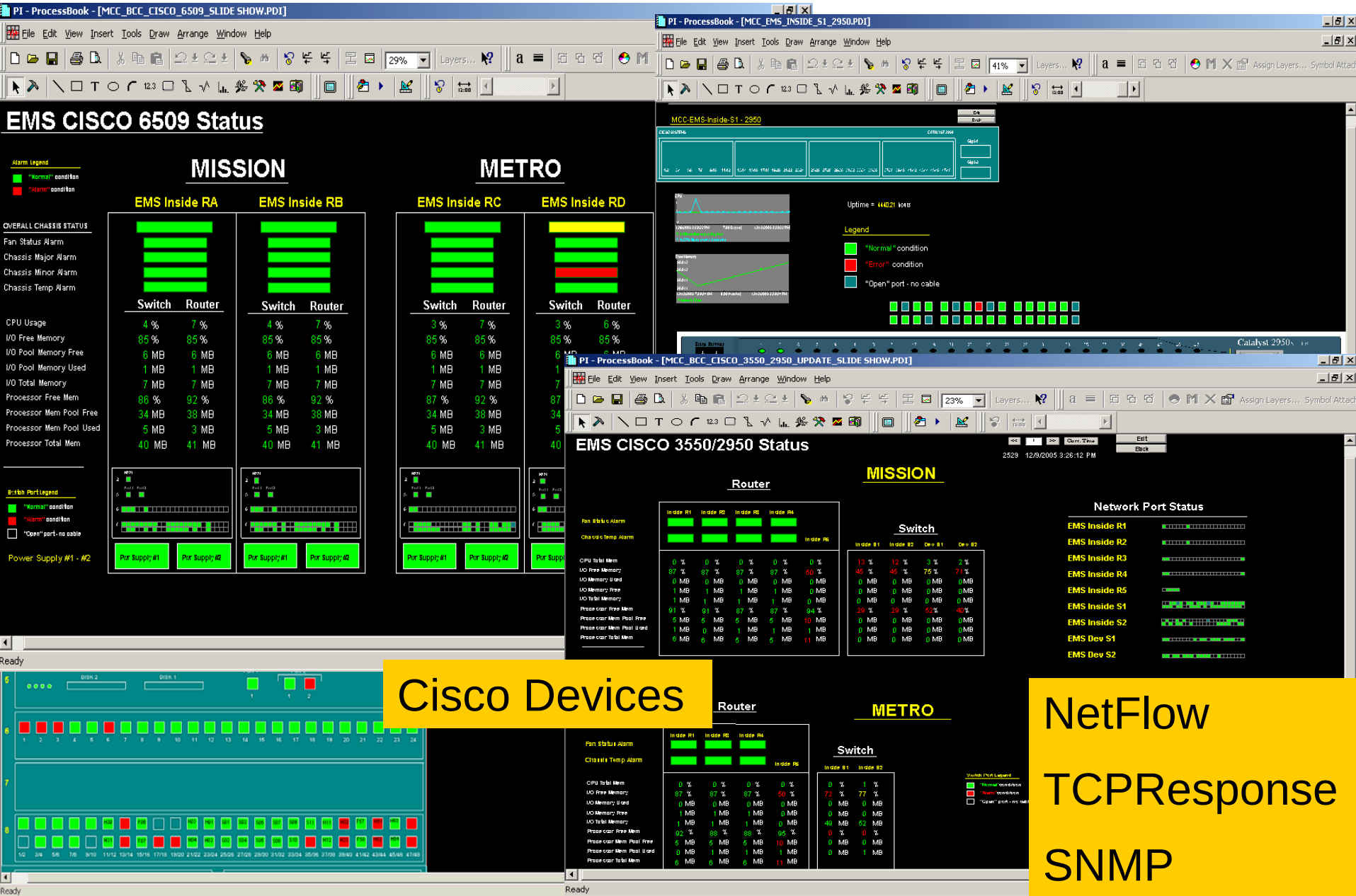
The Solution – IT Monitor

- No requirement for additional Agents to be installed
- A proactive and preventive way to monitor resource health to ensure system reliability and performance
- Monitoring all infrastructure attributes for disk, file, paging, CPU, swap and memory usage, …etc.
- Monitoring the processes and applications
- Establishing performance baseline standards
- Helping avoid finger pointing during trouble shooting
- Root cause analysis and problem solving
- Automatic notification

Monitor and Protect Critical Systems



Monitor and Protect Networks



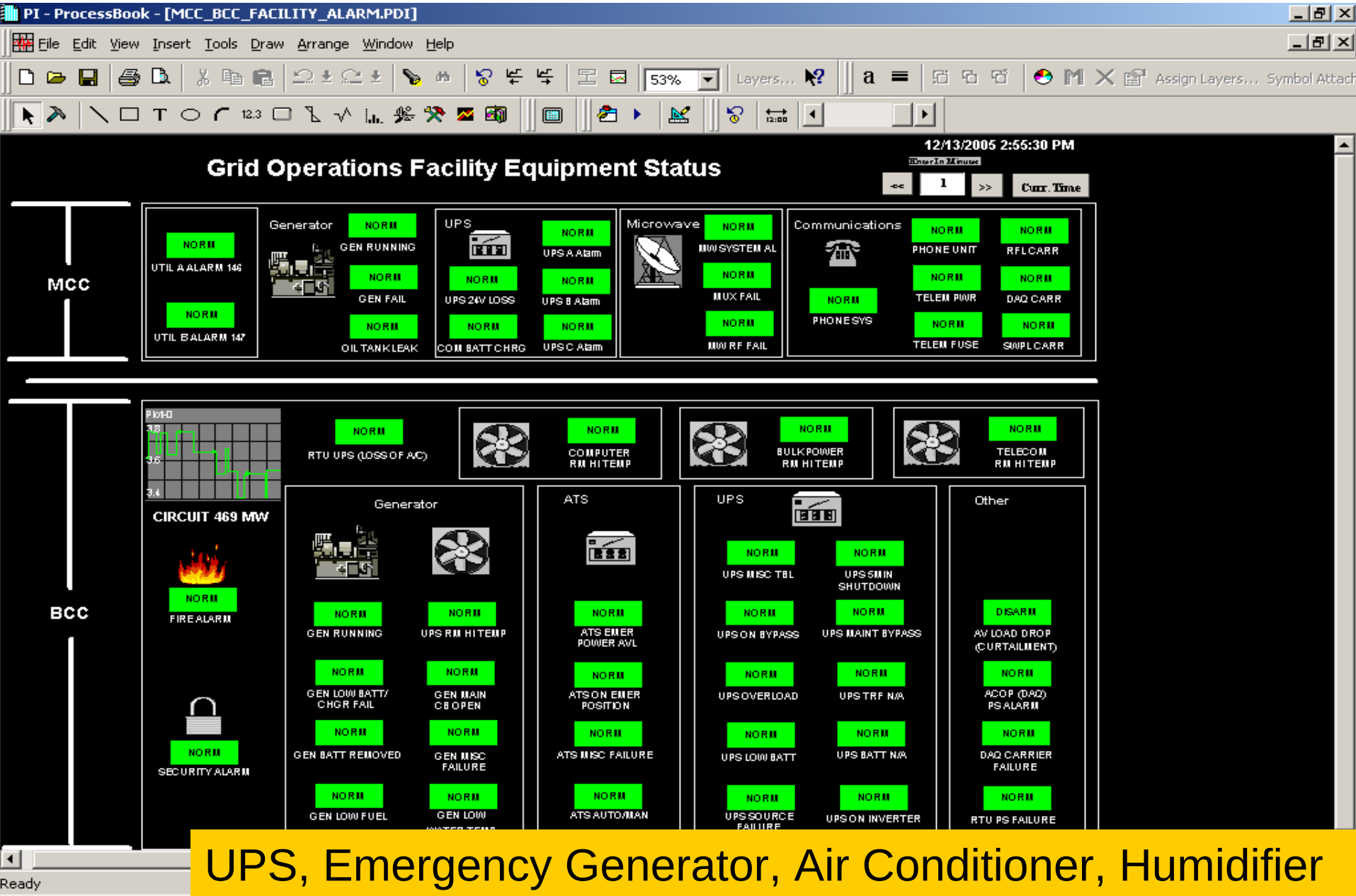
Cisco Devices

NetFlow

TCPResponse

SNMP

Monitor and Protect Facility Equipment



UPS, Emergency Generator, Air Conditioner, Humidifier

Summary

- Building a real-time event-driven infrastructure by utilizing **The PI System**
- Expanding the value from Operations, Engineering, Planning, Protection, Asset Management, Maintenance to **Enterprise**

THANK YOU!!