



让PI 系统发掘企业数据蕴藏的无限潜能

Building a Real-Time Event-Driven Enterprise Infrastructure

建立一个实时事件驱动的企业
"信息化"平台基础

Ann Moore – Business Development Executive
策略事务开发总监

Agenda 议程

- **PI for Enterprise Infrastructure**
(PI是企业“信息化”的平台基础)
- **Utility Industry Use Cases (电力公司应用案例)**
 - **Operational Data (操作运行数据)**
 - **Non-Operational Data (非操作运行数据)**
 - **Asset/Model and Analytics (资产模型与分析)**
 - **Critical Infrastructure Monitoring**
(关键平台基础监视)
- **Summary and Q&A (结语和问题与答疑)**

PI Centric Infrastructure

以PI为中心平台基础

EMS-2 sec

DMS-2 sec

DCS-2 sec

Substation IED - 2 sec

Phasor – 1 ms

Fault Recorder-1 ms

Meter – 5 min

Power Market – 5 min

Planning-5 years

Infrastructure
data

Asset/Model
data

PI Platform/Infrastructure

Proven Utility Industry Use Cases

经过证明的电力公司应用案例

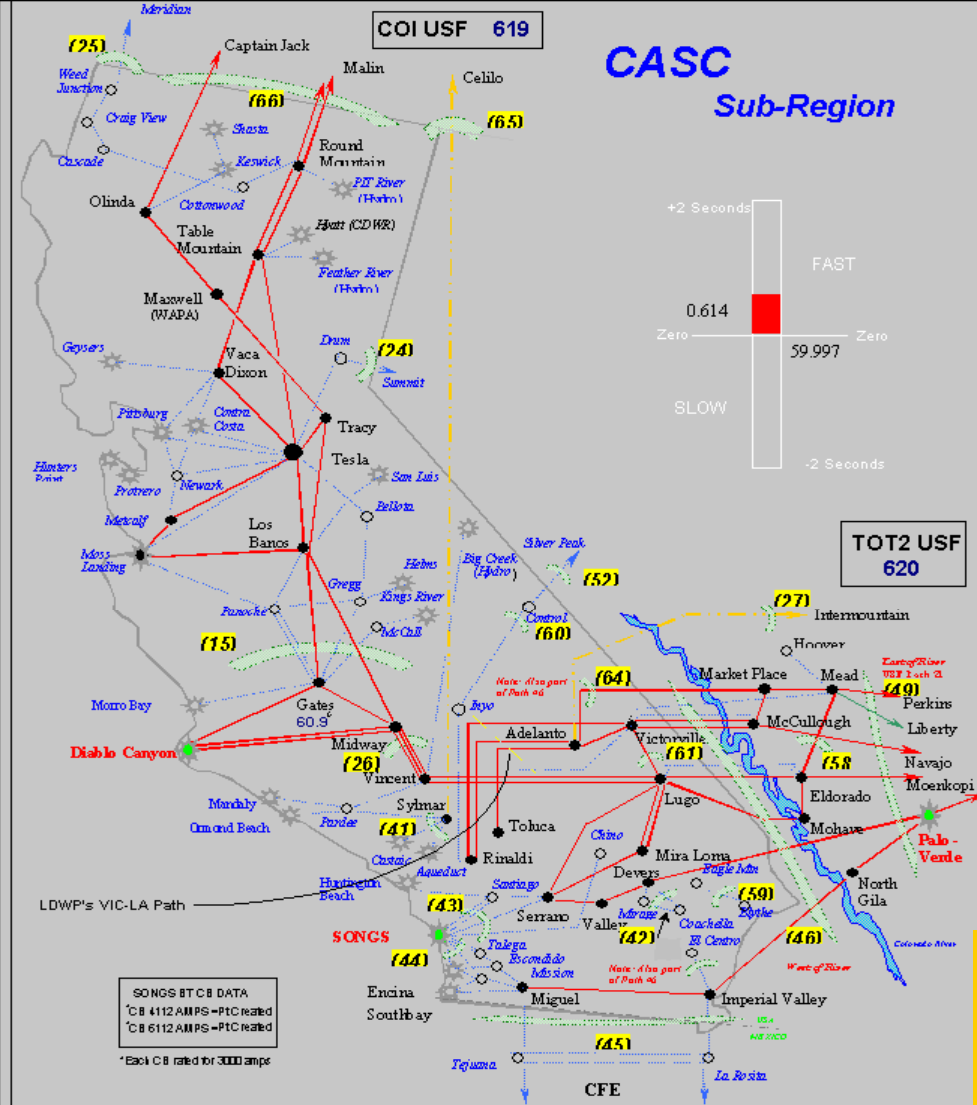
- **Operational:** EMS/DMS/DCS/SCADA data monitoring, archiving, event reporting and analysis
(操作运行: 监视, 存储, 事件报告与分析)
- **Non-operational:** substation field device non-SCADA data monitoring and archiving
(非操作运行: 子站设备装置数据监视与存储)
- **Asset/Model 资产模型:** metadata management and analytics
- **Security/Infrastructure:** Critical Infrastructure Protection (CIP) and monitoring (安全/平台基础: 保护与监视)
- **Enterprise:** integration, correlation and repository
(企业信息化: 整合相关资源数据集中库)

Utility Use Cases

应用案例

PI for Operational Data

操作运行数据



PATH	RATING	CHART
Path 15	1275 MW/S 3449 S/N	
Path 24	120 MW/E/W	
Path 25	110 MW/N/S	
Path 26	30 MW/S/N	
Path 27	1920 MWNE/SW	
Path 41	1200 MW	
Path 42	600 MWE/W	
SDG&E & CFE	3050 MW	
Path 43	2440 MWS/N	
Path 44	2200 MW/N/S	
Path 45	40B MWBi-directional	
Path 46	10,118 MWE/W	
Path 49	7550 MWE/W	
Path 52	17 MW	
Path 58	1460 MW	
Path 59	72 MW	
Path 60	56 MW	
Path 61	1950 MW/N/S	
Path 62	2958 MWE/W	
Path 64	1200 MW	
Path 65	2871 MW/N/S	

3004

89

12

987

-1302

41

-297

1228

584

541

-7

5326

-3854

1

146

-46

11

-933

471

624

116

15 WSCC AGC DATA

WSCC PATH TRENDS

TIME ERROR

42 CISO AGC DATA

sdge CISO GENERATION

44 CAL/NEV GEN

SE GENERATION

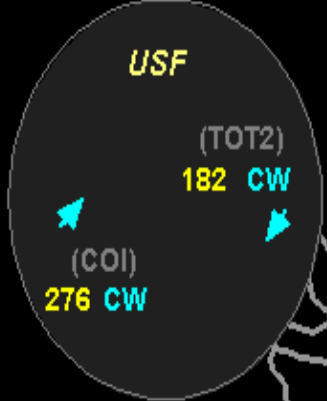
NW GENERATION

NE GENERATION

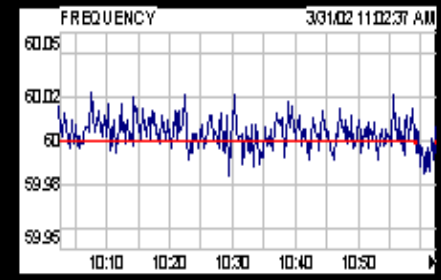
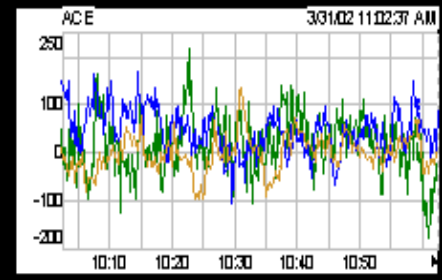
PNSC

CAISO
California Independent System Operator

更直观和丰富的显示数据



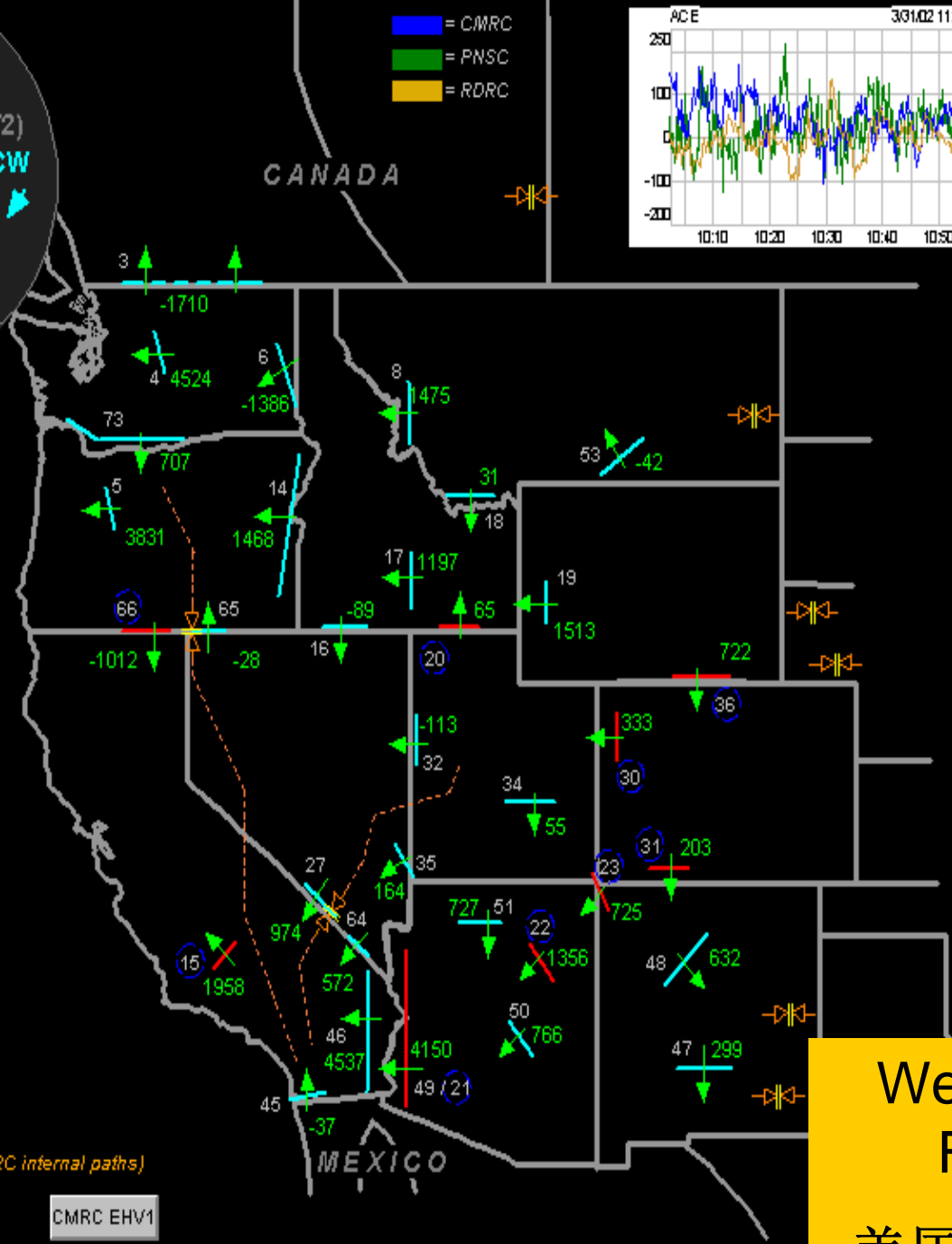
- CMRC
- PNSC
- RORC



- Generation**
- NorthWest
 - NorthEast
 - SouthWest
 - SouthEast
- WSSC PATH MONITOR
- WSSC PATH TRENDS

W.S.C.C. TRANSFER PATHS
(Refer to CMRC EHV1 for CMRC internal paths)

CMRC EHV1



INTERACTION

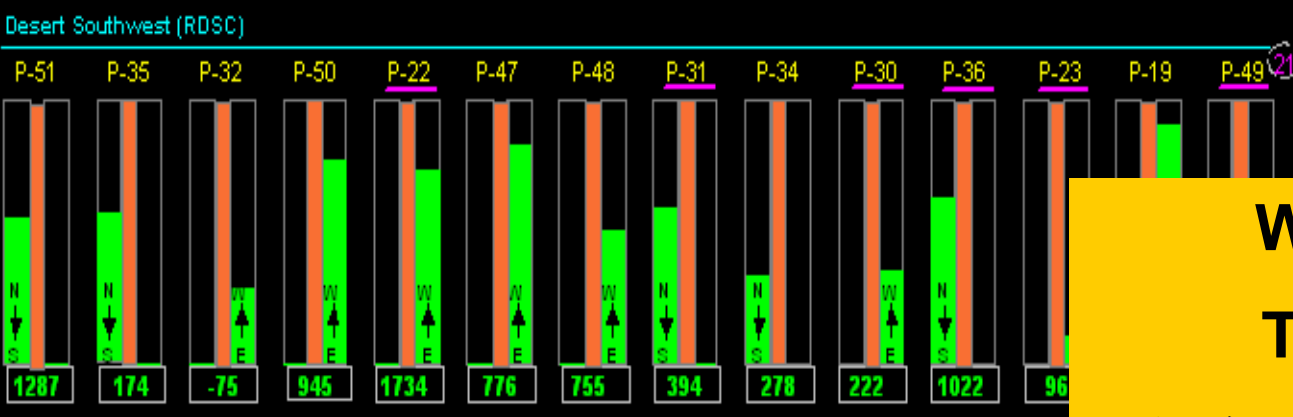
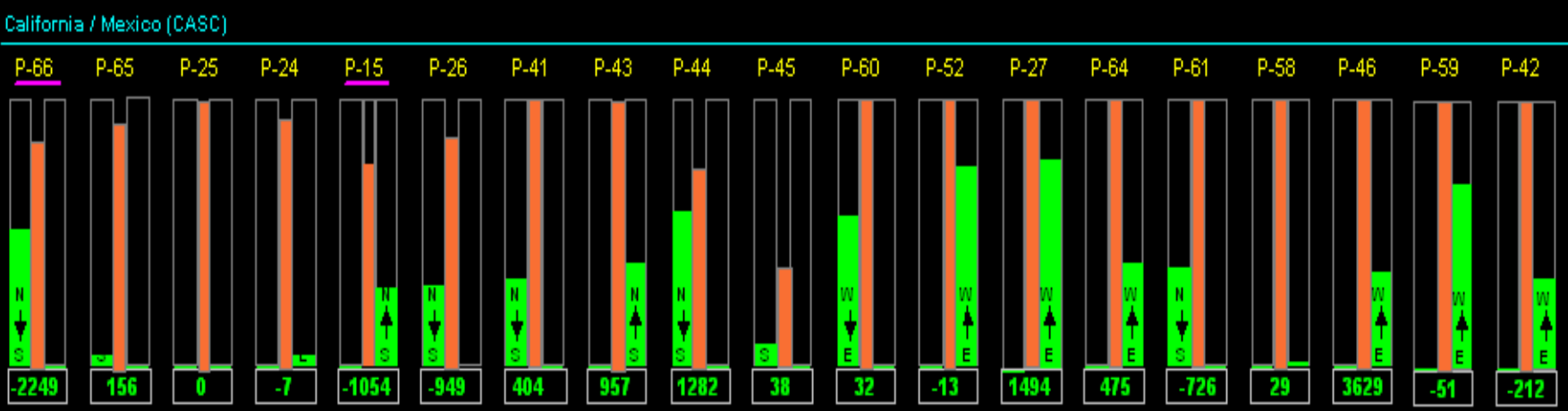
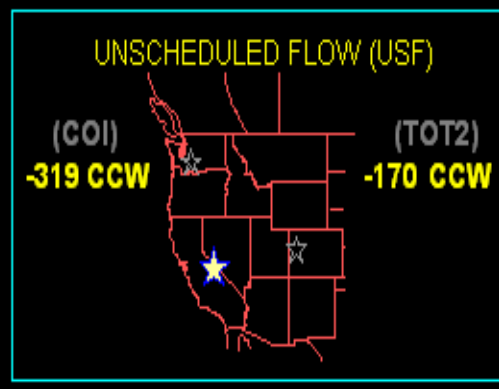
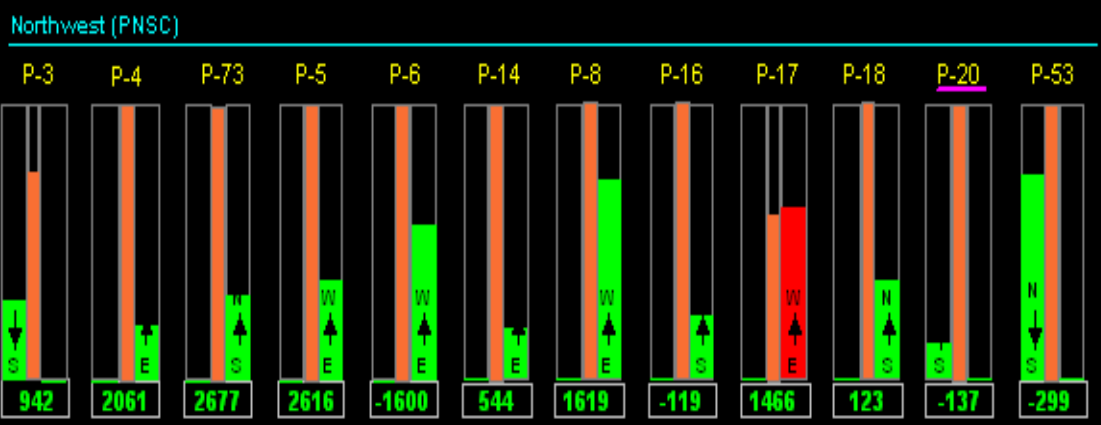
TIME ERROR



Western States Path Flow Monitoring
美国西区电网安全监控

WSCC TRANSFER PATHS

USF

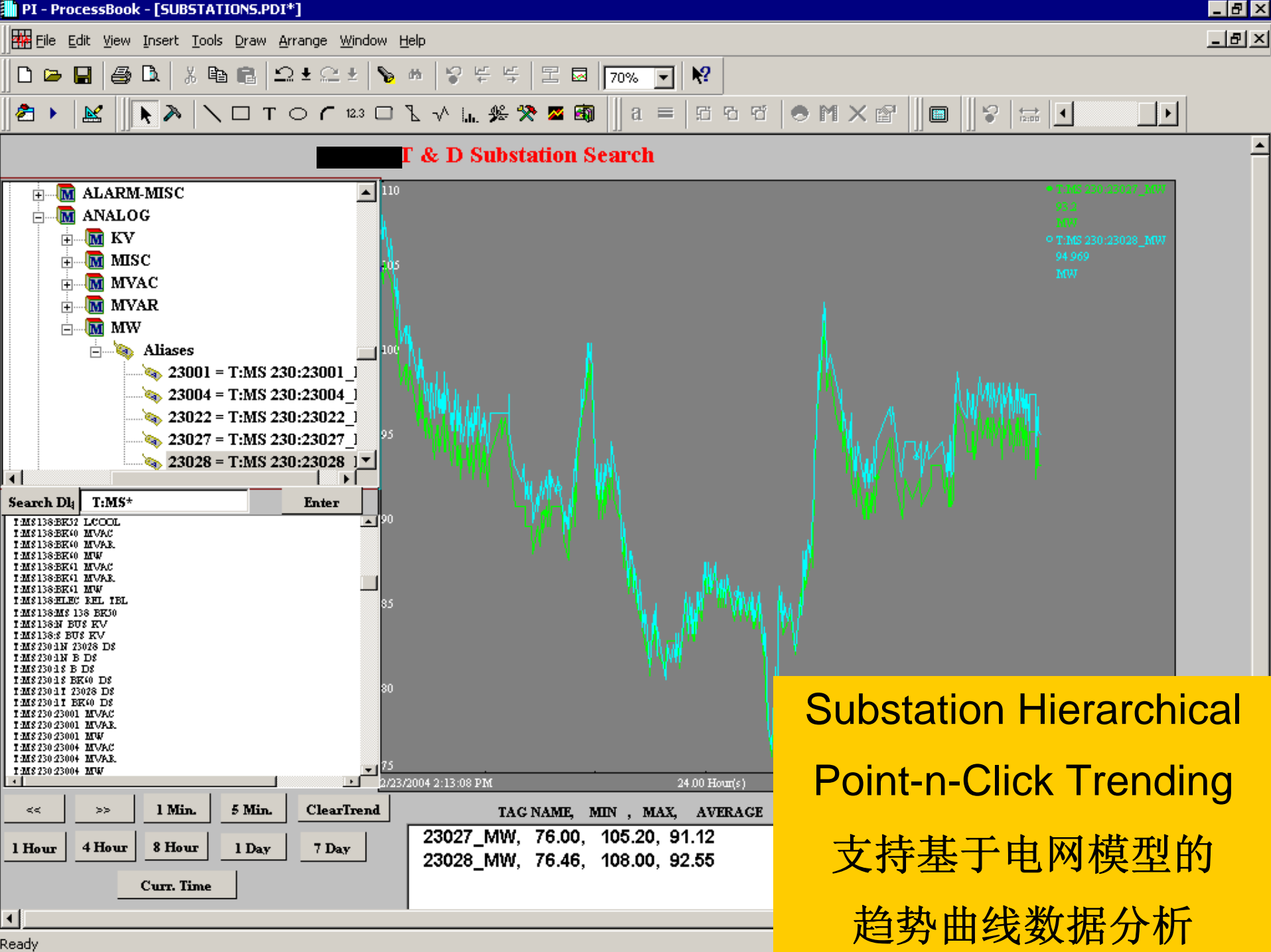


TIME ERROR

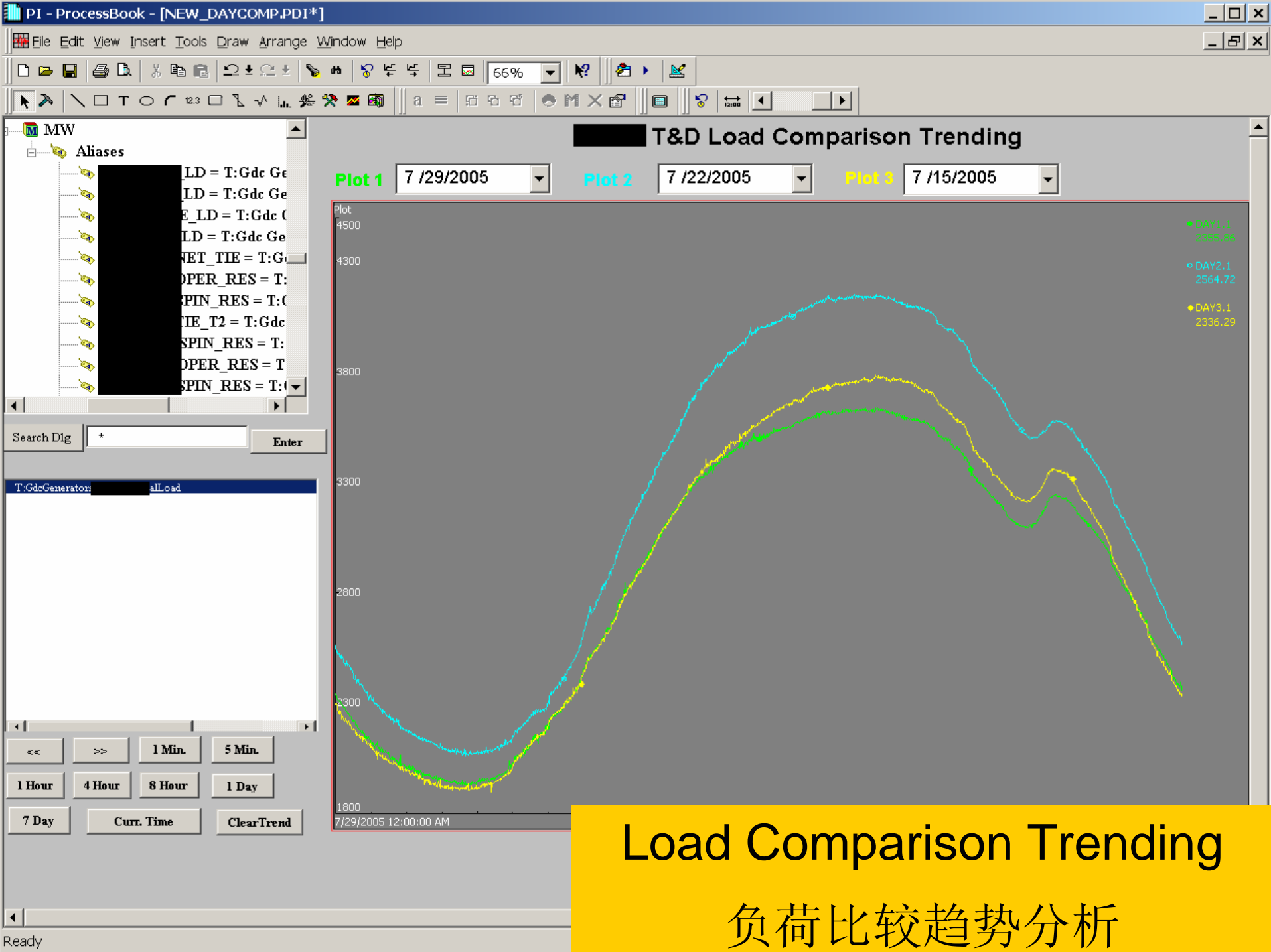
+2 SECOND

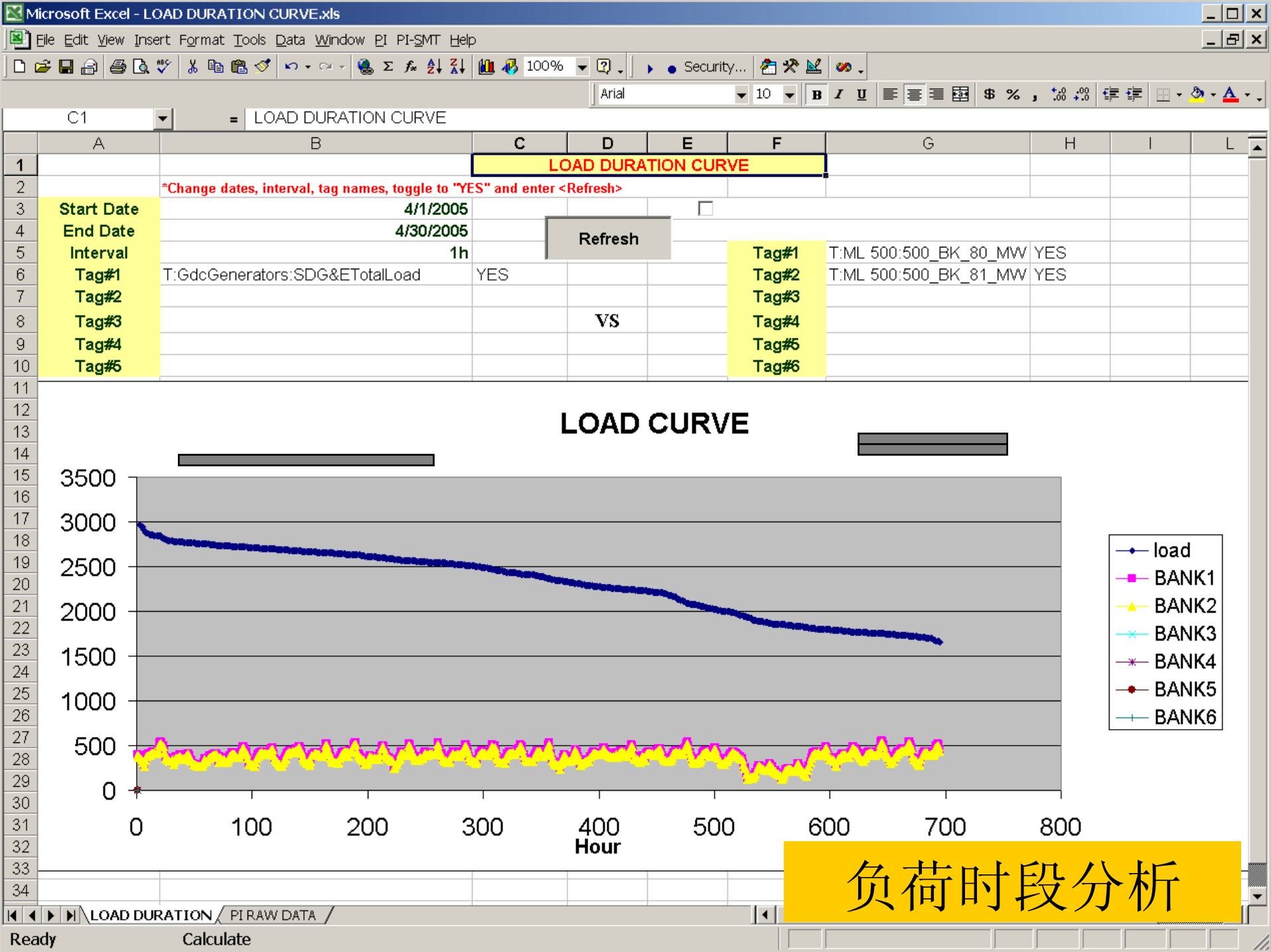
**Western States
Transfer Paths**

潮流路径监控与负荷分析



Substation Hierarchical
Point-n-Click Trending
支持基于电网模型的
趋势曲线数据分析





Watch List

6/2/2006 12:13:16 PM

Select a Substation
 Circuit
 Bank
 All

- Circuit
- D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH
 - D:\CIR_...-MW_3PH

- Bank
- D:\XFMR_BK30-MW_3PH
 - D:\XFMR_BK31-MW_3PH
 - D:\XFMR_BK32-MW_3PH
 - D:\XFMR_BK33-MW_3PH


	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		5.84	285.00	289.20	287.40	660	413	44
CLR								
ADD		5.05	235.20	245.40	240.00	614	391	40
CLR								
ADD		10.06				29	22	35
CLR								
ADD		3.16	162.00	160.80	157.80	600	352	27
CLR								
ADD		6.40	315.00	322.80	295.20	770	491	42
CLR								
ADD		2.84	136.80	169.20	151.20	600	266	28
CLR								
ADD								
CLR								
ADD								
CLR								
ADD		6.08	284.10	289.80	293.70	520	448	55
CLR								


Circuit/Transformer Top-10 Watch List

MSNBC Weather


Tucker

Current conditions **Tomorrow**

75°  Wind: 7VAR
Baro: 29.81"
Humidity: 31%

 **75°/43°**

All temps shown in F° | Change to C°

 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...

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	Upton	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					
Hart	54.30	44.16	Sawnee					

Web Portal Enterprise Data Repository

实时数据直接在门户中展现

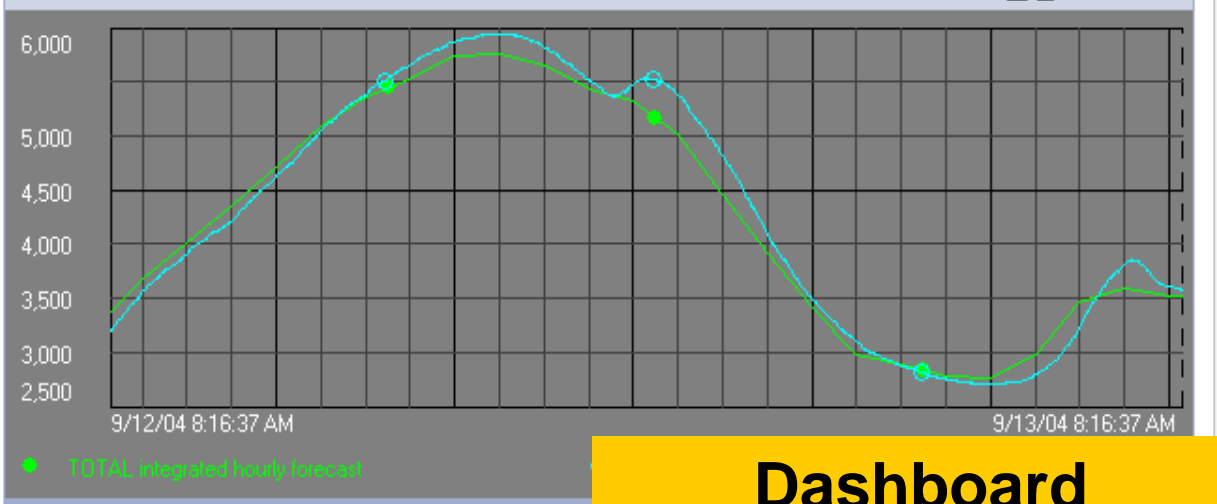


Day Ahead Load Forecast

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

Showing 1 to 6 of 48

Load-Forecast vs Actual

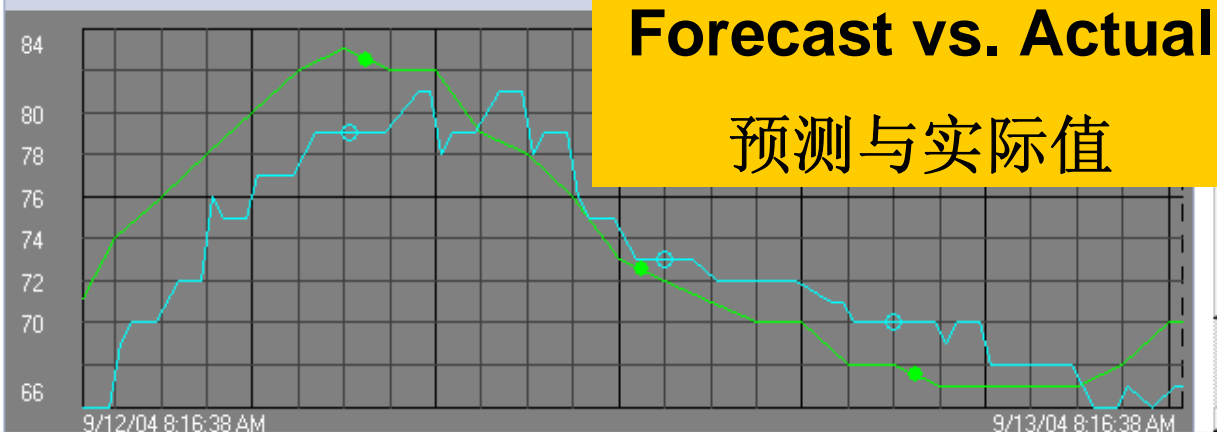


Day Ahead Temperature Forecast

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

Showing 1 to 6 of 48

Temperature-Forecast vs Actual



PI for Non-Operational Data

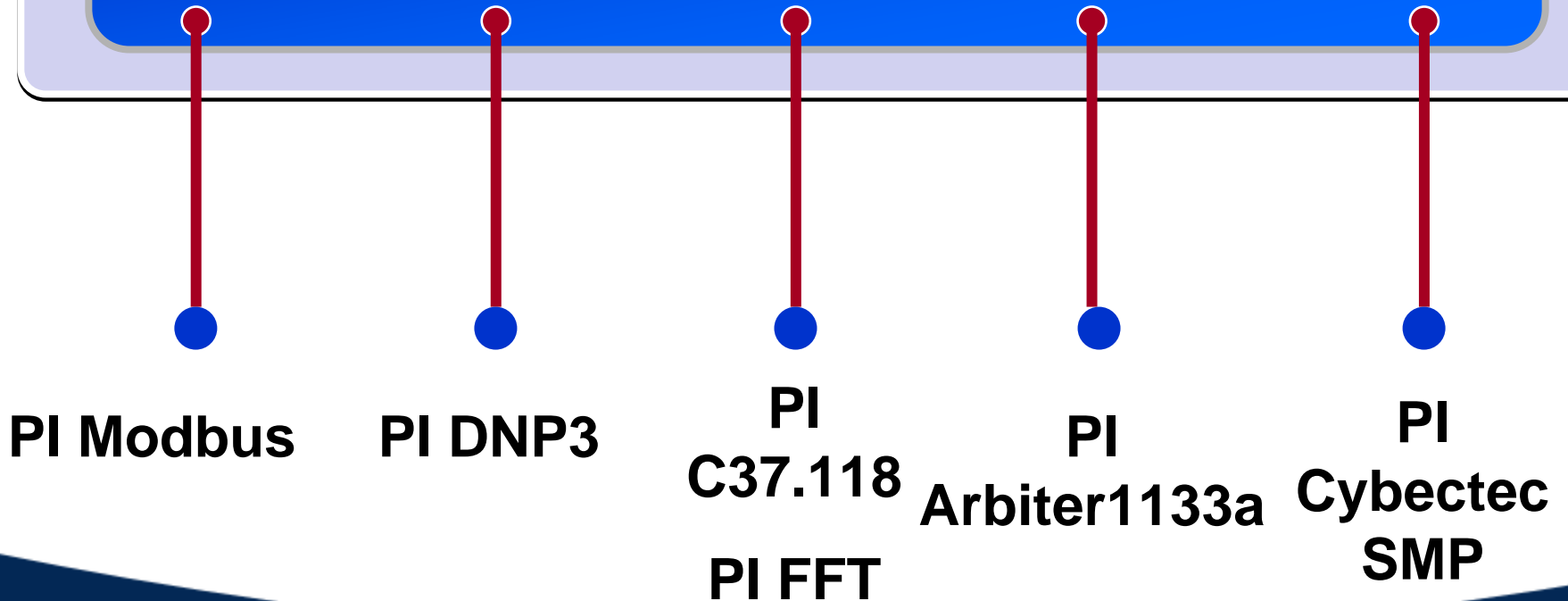
非操作运行数据

PI T&D Trends (趨勢)

- 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

Substation Interfaces 接口

PI Standard Real-time Interfaces



PI DNP3 Circuit Relay Status

PI ProcessBook - [12kV Relay Status]

File Edit View Insert Tools Draw Arrange Window Help

Substations Harrisburg

Harrisburg Retail 351 Relay Status

Relay ID	EN	TRIP	INST	COMM	SOTF	50	51	81	RS	CY	LO	A	B	C	G	N
L12-01 351S	●	●	●	●	●	●	●	●				●	●	●	●	●
L12-02 351S	●	●	●	●	●	●	●	●				●	●	●	●	●
L12-03 351S	●	●	●	●	●	●	●	●				●	●	●	●	●
L12-04 351S	●	●	●	●	●	●	●	●				●	●	●	●	●

Reclosing State: RS, CY, LO

FAULT TYPE: A, B, C, G, N

Line Capacitor Status

PI ProcessBook - [AUGUSTA RD (BK1) SUMMARY.PDI]

File Edit View Insert Tools Draw Arrange Window Help

93% a

Augusta Rd Retail (BK1) Capacitors

L12-01

KVar (XYZ): -170 -140 -170

Capacitor # 22994854
 Location (S Pleasantburg @ Legrand Blvd)
 Capacitor Position **CLOSED**
 Temperature 74 F
 Adjusted KVar 513
 Total Cycles 529
 Cap Bank Size 900

600 Fixed
 (332 S Pleasantburg Dr)

Capacitor # 23177280
 Location (708 S Pleasantburg Dr @ Skyview Rd)
 Capacitor Position **CLOSED**
 Temperature 73 F
 Adjusted KVar -716
 Total Cycles 287
 Cap Bank Size 900

L12-03

KVar (XYZ): 30 140 50

Capacitor # 23002306
 Location (410 McAlister Rd, Greenville, SC)
 Capacitor Position **TRIPPED**
 Temperature 72 F
 Adjusted KVar 158
 Total Cycles 362
 Cap Bank Size 450

Capacitor # 23002981
 Location (Greenacre Dr @ McAlister Rd)
 Capacitor Position **TRIPPED**
 Temperature 74 F
 Adjusted KVar -151
 Total Cycles 103
 Cap Bank Size 450

L12-02

KVar (XYZ): -10 90 20

Capacitor # 22998406
 Location (410 S Pleasantburg Dr @ Honey Baked Ham Store)
 Capacitor Position **Switched FP**
 Cap Bank Size 600

300 Fixed
 (S Pleasantburg @ Antrim Dr)

450 Fixed
 (Keith Dr)

Capacitor # 22998288
 Location (Laurens Rd @ Bledkley Ave)
 Capacitor Position **TRIPPED**
 Temperature 72 F
 Adjusted KVar 174
 Total Cycles 157
 Cap Bank Size 600

450 Fixed
 (2003 Laurens Rd)

L12-04

KVar (XYZ): 20 70 100

900 Fixed
 (Rockcreek Dr)

Capacitor # 23041827
 Location (Faris Rd west of Cleveland St)
 Capacitor Position **TRIPPED**
 Temperature 71 F
 Adjusted KVar -18
 Total Cycles 16
 Cap Bank Size 900

Capacitor # 23004214
 Location (219 W Antrim Rd)
 Capacitor Position **TRIPPED**
 Temperature 72 F
 Adjusted KVar -412
 Total Cycles 47
 Cap Bank Size 600

900 Fixed
 (Ackley Rd)

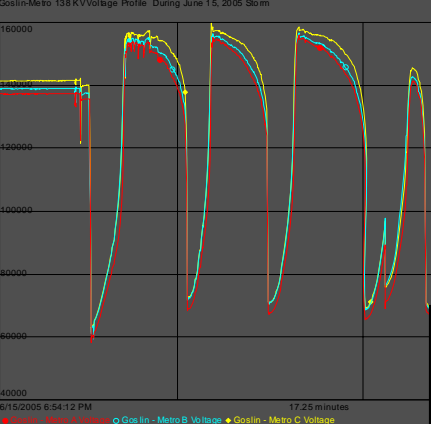
Protocol Standard IEC61850

- 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***
 - ***Protection***
 - ***SCADA***
 - ***Transducers***
 - Self-describing devices
 - Common configuration language

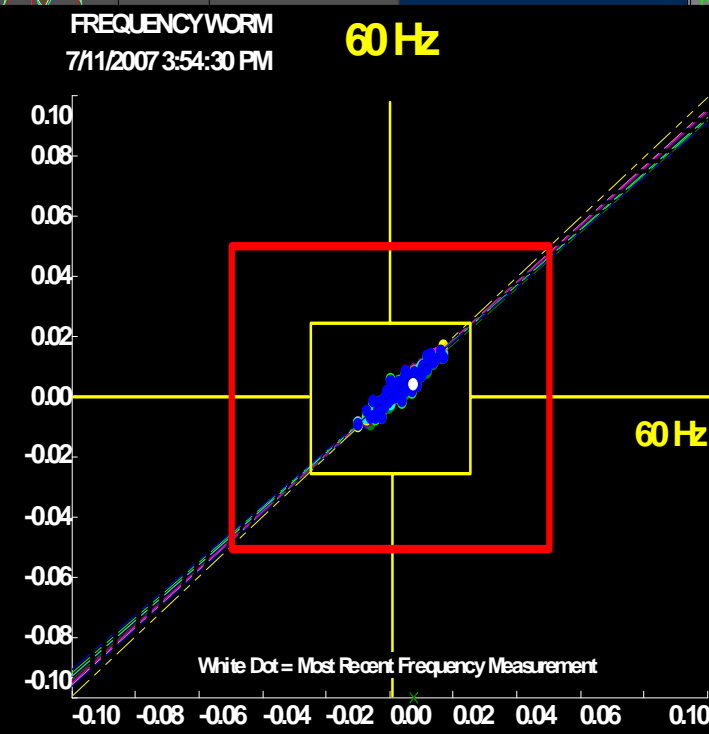
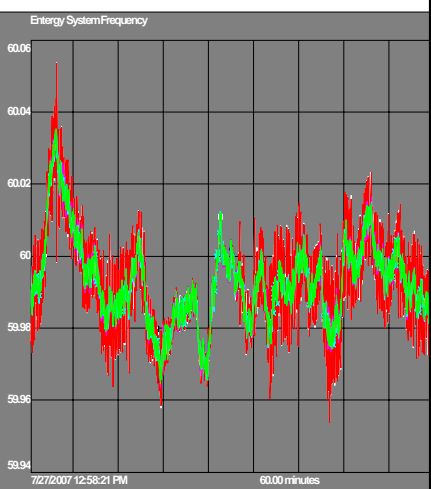
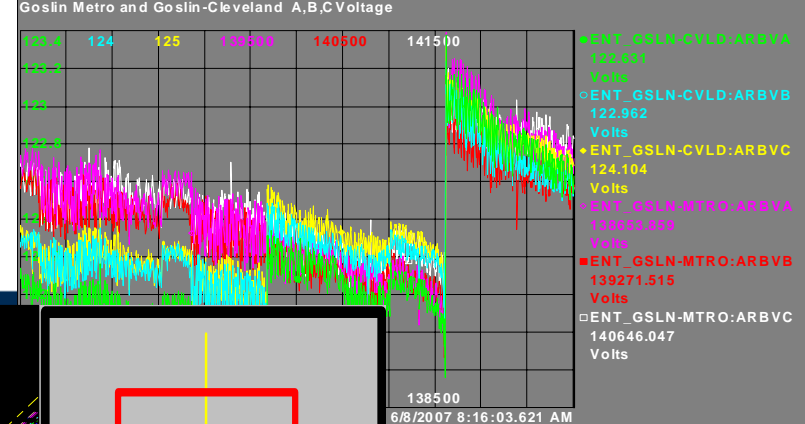
PI-based WAMS Wide Area Measurement System

广域相角监测系统

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



- Goslin Metro A Voltage 1407.204 Volts
- Goslin Metro B Voltage 13522.652 Volts
- ◆ Goslin Metro C Voltage 52983.879 Volts

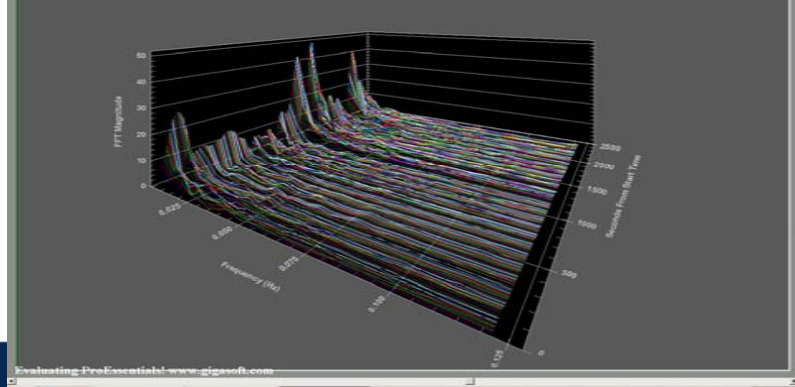
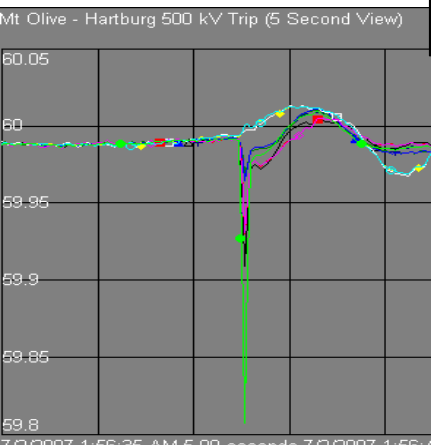
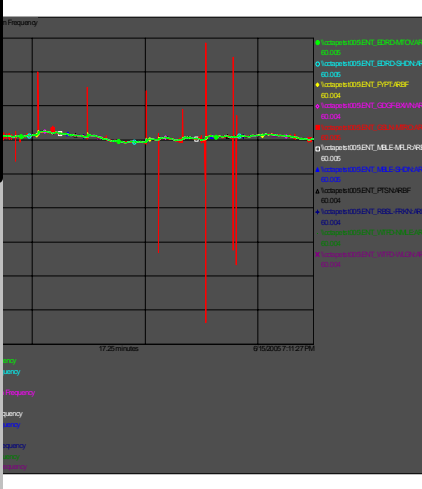


This chart represents your operating frequency domain. Frequency here is represented as a difference from 60 Hz.

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 monitored.

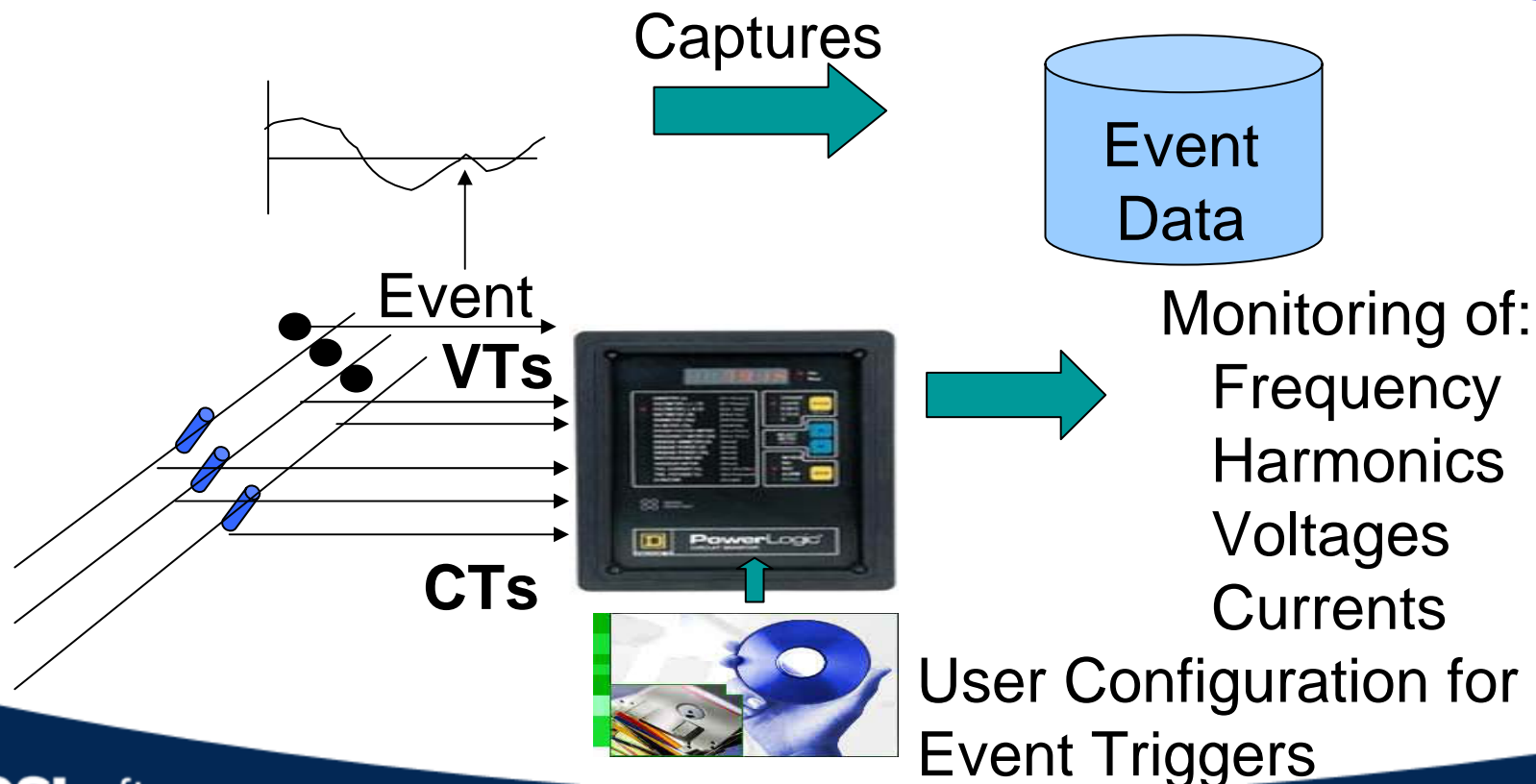
If the frequency worm begins to scatter, this represents potential islanding.



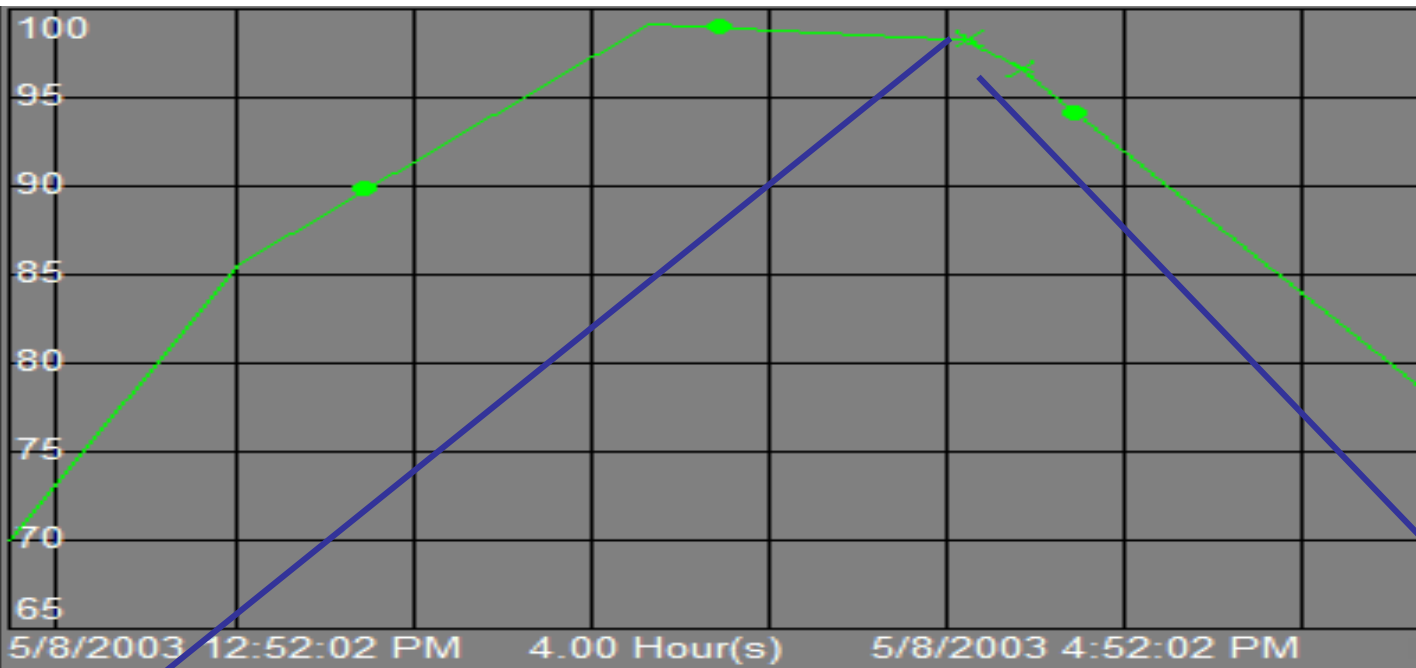
Transient Data in PI

暂态数据可存入PI

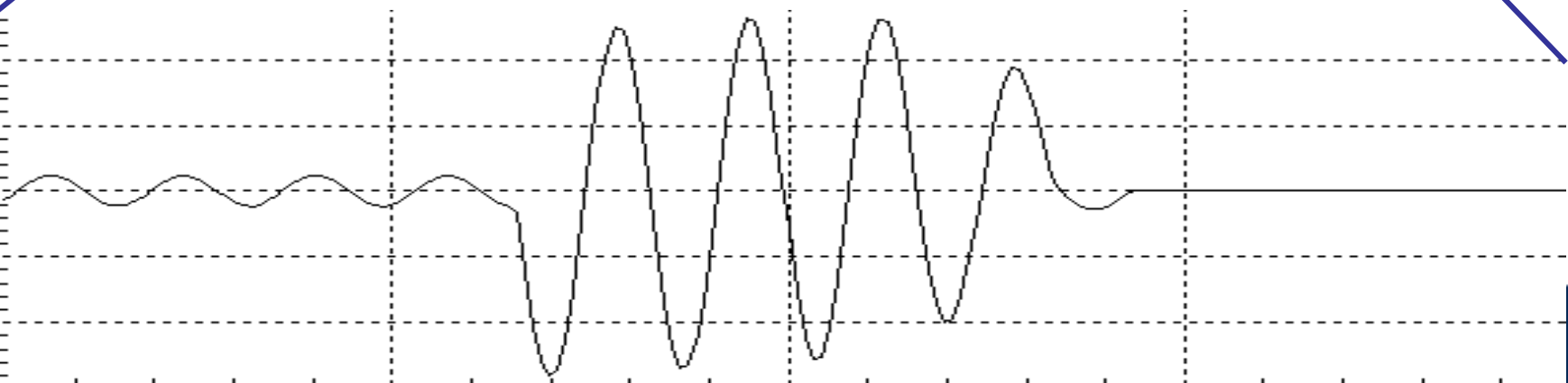
IEEE C37.111-1997 COMTRADE 故障滤波 Common Format for Transient Data Exchange



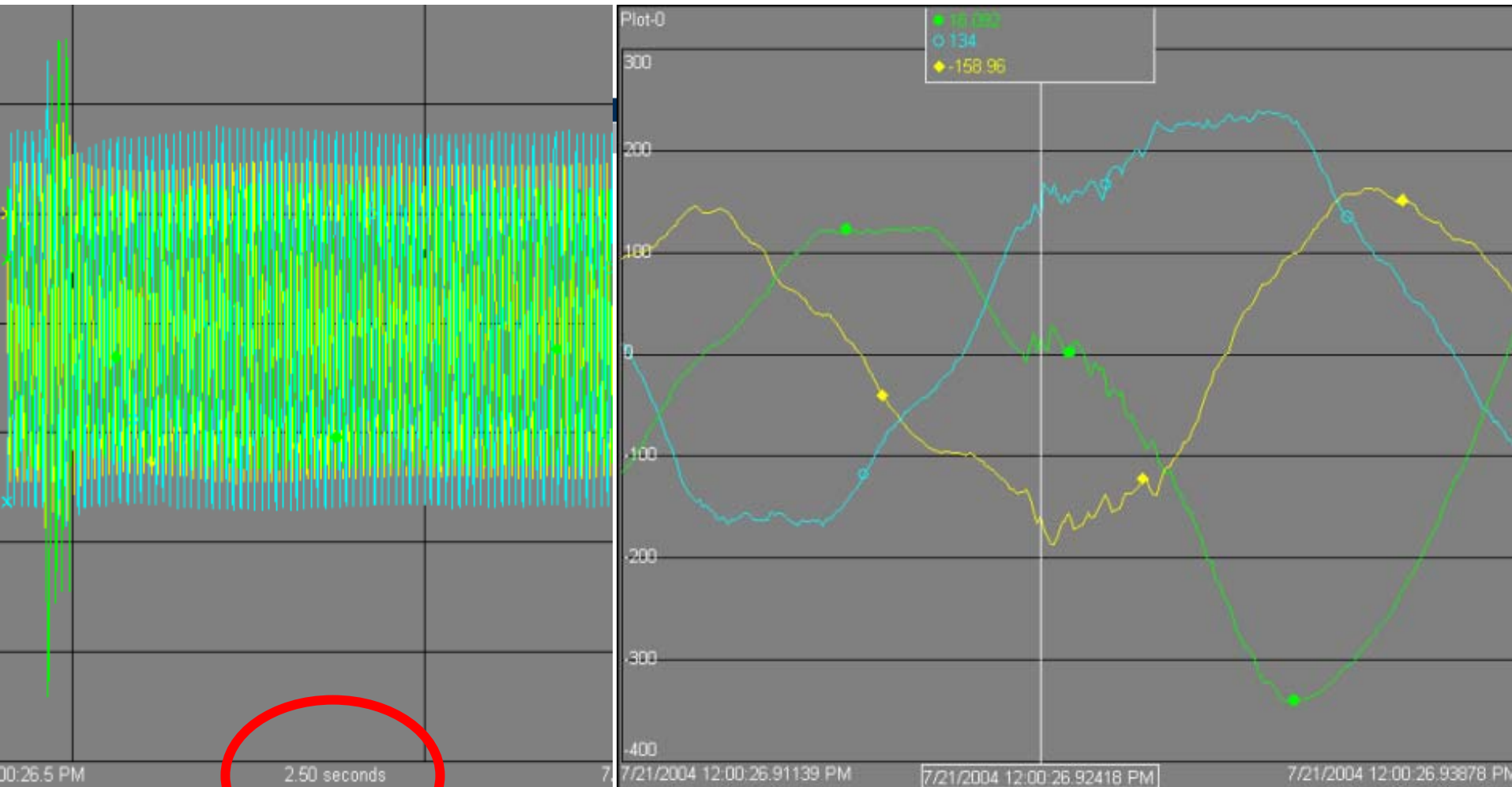
Process Information Integration



What
really
happened?



Waveforms in PI



2.5 seconds

12:00:26:91139

12:00:26:92418

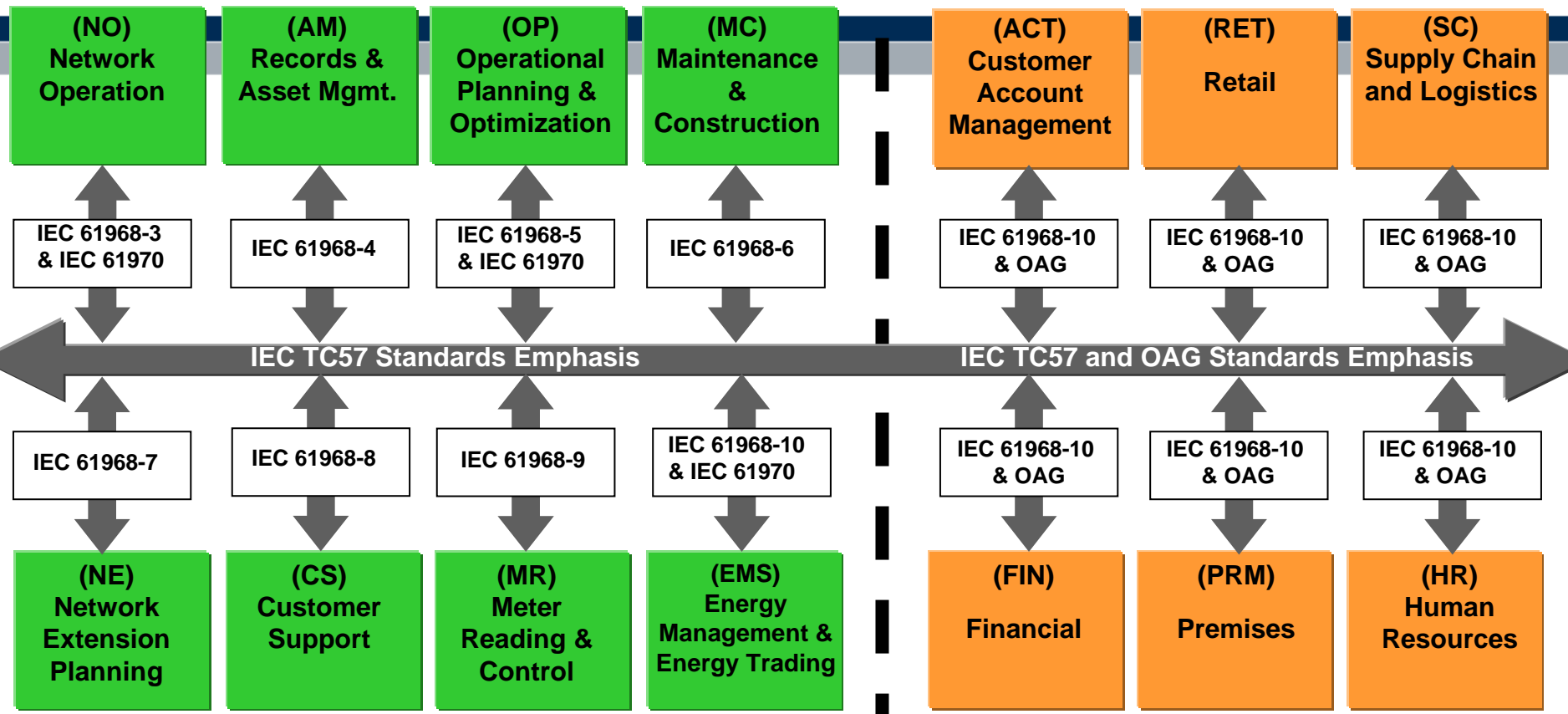
12:00:26:93878

hundredth of second

PI for Asset Models and Analytics

资产模型与分析

Common Information Model (CIM)



Utility Electric Network Planning, Constructing, Maintaining, & Operating

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

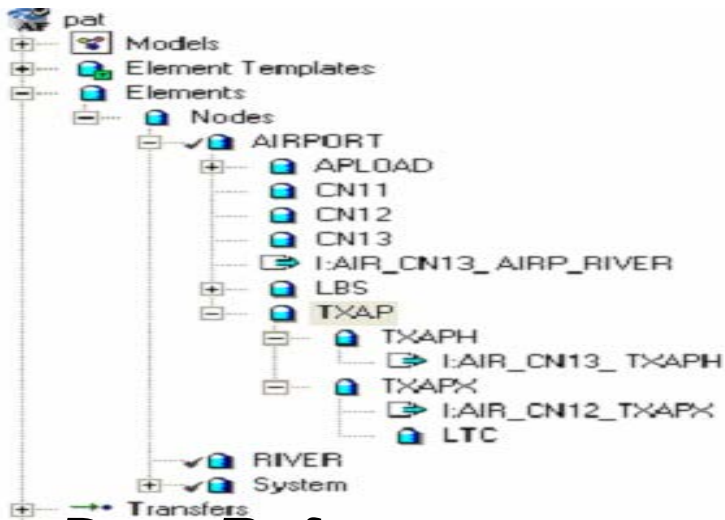
Why CIM Matters to PI Analysis Framework (AF)

- 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



General Elements Attributes Ports				
TXAP in Model AIRPORT				
	Name	Value	Value Type	Data Reference
	BusinessUnit		String	<None>
	MX.TotVa	84657.4...	Double	PI Point
	MX.TotVar	213788...	Double	PI Point
	OperatedBy_Companies		String	<None>
✓	PF	74.1625...	Double	Formula
	aliasName	74.1625880940302 %	String	<None>
	bmagSat		String	<None>
	magBaseKV	0 kV	Double	<None>
	magSatFlux	0	Double	<None>
	name	TXAP	String	<None>
	pathName		String	<None>
	phases		String	<None>
	transfCoolingType		String	<None>
	transformerType		String	<None>

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

控制系统与关键平台基础

重要调度主站设备系统的监控和保护

PI - ProcessBook - [EMS STATUS PAGE DISPLAY*]

File Edit View Insert Tools Draw Arrange Window Help

8/17/2004 10:14:28 AM

EMS Node Status Overview

MCC	HOSTS				FEPS			ORACLE			WORKSTATIONS						CM		DTS						
	H01	H02	H03	H04	F06	F07	F08	O30	O31	O32	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S28	H19	H18	H28
LAN 'A'	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
LAN 'B'	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
cpu idle %	85	90	95	97	75	90	77	91	90	91	91	92	92	94	96	97	96	88	96	91	76	67	88		
cpu sys usage %	1	1	2	0	10	10	30	2	4	7	6	8	7	5	6	2	4	5	4	4	7	7	3		
cpu user usage %	7	8	0	1	10	2	3	0	5	6	3	1	2	2	0	0	0	0	0	12	13	9	3		
Free Mem & Swap	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Free Phy Mem	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
/xahome Used %	37	62	68	66	18	23														50	40	20			
/xalocal Used %	70	68	67	59	73	73			●	●	●	●	●	●	●	●	●	●	●	66	80	73			
/var Used %	47	21	24	21	11	40														58	23	22			
xa21 goxall	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

BCC	HOSTS				FEPS			ORACLE			WORKSTATIONS					
	H05	H06	H07	H08	F08	F09	F02	O20	O21	O21	S21	S22	S23	S24	S25	S26
LAN 'A'	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
LAN 'B'	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
cpu idle %	78	95	94	91	77	88			90	95	96	96	97	96	96	96
cpu sys usage %	15	5	2	7	13	7			2	0	5	4	5	3	3	4
cpu user usage %	14	1	0	1	8	4			1	0	0	0	0	0	0	0
Free MemSwap	●	●	●	●	●	●			●	●	●	●	●	●	●	●
Free Phy Mem	●	●	●	●	●	●			●	●	●	●	●	●	●	●
/xahome Used %	43	40	52	77	51	31			Au01 11 %							
/xalocal Used %	69	73	78	67	79	79			Au02 19 %							
/var Used %	24	21	21	68	67	36			Au03 14 %							
xa21 goxall	■	■	■	■	■	■			Au04 17 %							
									Au05 7 %							
									Au06 3 %							

UNIX

ProcessBook - [WS_CPU]

Edit View Insert Tools Draw Arrange Window Help

8/17/2004 5:00:38 PM

EMS Workstation CPU Idle%

8/17/2004 11:00:58 AM

CPU	AP.1.P/AP.2.P	XA2
PU idle time %	87 %	AB642
PU iowait time %	3 %	AEPR
PU kernel time %	3 %	AGCS
PU system usage %	2 %	AGCU
PU user usage %	6 %	agdc0l
		daap
		mcas
		mcas
		rtps
		rttm
		sbhth
		scce
		scce
		time
		TL658C
		TL6401
		TL6402

UNIX or XA21 Disk % Used	
/home	3 %
/root /	67 %
/tmp	3 %
/user	7 %
/usr	78 %
/var	47 %
scada	3 %
space	3 %
CData	7 %
cots	64 %
rdts cldb es	3 %
rdts cpdb es	55 %
rdts opdb es	44 %
dcol shdw	3 %
/xahome total disk space	512.05 MB
/xahome used disk space	187.03 MB
/xahome disk % used	37 %
/xahome available disk space	325.02 MB
/xalocal total disk space	2000.19 MB
/xalocal used disk space	1404.58 MB
/xalocal disk % used	70 %
/xalocal available disk space	595.62 MB

Windows

PING

PerfMon

SNMP

SNMP

Traps

Syslogs

重要网络的监控和保护

EMS CISCO 6509 Status

MISSION METRO

Category	EMS Inside RA	EMS Inside RB	EMS Inside RC	EMS Inside RD
Switch	4% CPU, 85% I/O Free Mem, 6 MB I/O Pool Mem Free, 1 MB I/O Pool Mem Used, 7 MB I/O Total Mem, 86% Processor Free Mem, 34 MB Processor Mem Pool Free, 5 MB Processor Mem Pool Used, 40 MB Processor Total Mem	7% CPU, 85% I/O Free Mem, 6 MB I/O Pool Mem Free, 1 MB I/O Pool Mem Used, 7 MB I/O Total Mem, 92% Processor Free Mem, 38 MB Processor Mem Pool Free, 3 MB Processor Mem Pool Used, 41 MB Processor Total Mem	3% CPU, 85% I/O Free Mem, 6 MB I/O Pool Mem Free, 1 MB I/O Pool Mem Used, 7 MB I/O Total Mem, 87% Processor Free Mem, 34 MB Processor Mem Pool Free, 5 MB Processor Mem Pool Used, 40 MB Processor Total Mem	6% CPU, 85% I/O Free Mem, 6 MB I/O Pool Mem Free, 1 MB I/O Pool Mem Used, 7 MB I/O Total Mem, 92% Processor Free Mem, 38 MB Processor Mem Pool Free, 3 MB Processor Mem Pool Used, 41 MB Processor Total Mem

EMS CISCO 3550/2950 Status

MISSION METRO

Category	Router	Switch
Router	0% CPU, 87% I/O Free Mem, 0 MB I/O Memory Used, 1 MB I/O Memory Free, 1 MB I/O Total Memory, 91% Processor Free Mem, 5 MB Processor Mem Pool Free, 1 MB Processor Mem Pool Used, 6 MB Processor Total Mem	0% CPU, 87% I/O Free Mem, 0 MB I/O Memory Used, 1 MB I/O Memory Free, 1 MB I/O Total Memory, 91% Processor Free Mem, 5 MB Processor Mem Pool Free, 1 MB Processor Mem Pool Used, 6 MB Processor Total Mem
Switch	13% CPU, 45% I/O Free Mem, 0 MB I/O Memory Used, 0 MB I/O Memory Free, 0 MB I/O Total Memory, 29% Processor Free Mem, 0 MB Processor Mem Pool Free, 0 MB Processor Mem Pool Used, 0 MB Processor Total Mem	12% CPU, 45% I/O Free Mem, 0 MB I/O Memory Used, 0 MB I/O Memory Free, 0 MB I/O Total Memory, 29% Processor Free Mem, 0 MB Processor Mem Pool Free, 0 MB Processor Mem Pool Used, 0 MB Processor Total Mem

Network Port Status

- EMS Inside R1
- EMS Inside R2
- EMS Inside R3
- EMS Inside R4
- EMS Inside R5
- EMS Inside S1
- EMS Inside S2
- EMS Dev S1
- EMS Dev S2

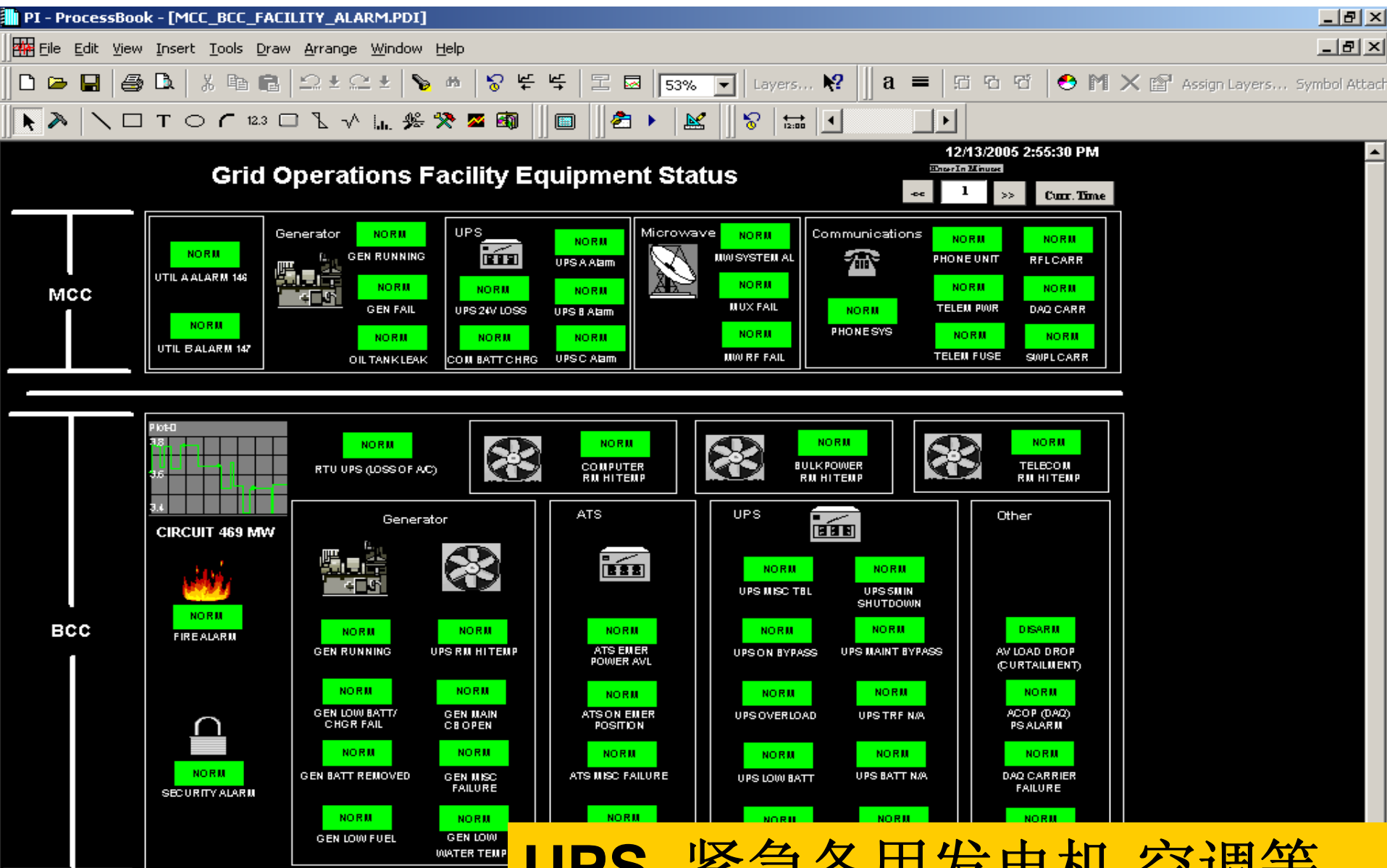
CISCO网络设备

NetFlow

TCPResponse

SNMP

重要设施的监控和保护



UPS, 紧急备用发电机, 空调等

结语

- 利用**PI**系统,建立一个实时事件驱动的企业"信息化"平台基础
- 扩大价值效益,由操作运行,工程,计划,保护,维修和资产管理,到整体企业

谢谢 !!