Cyber Security and Using OSIsoft to Become Compliant

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President

Northeast Utilities - Background

- Fortune 500 diversified energy company located in Connecticut with operations throughout the Northeast
- Serving customers Connecticut, Western Massachusetts, and New Hampshire

Electrical Distribution Service Areas

- Generation, Transmission / Distribution, and Natural Gas subsidiaries

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Northeast Utilities - Statistics

- Service Territory
  - 11,000+ square miles
  - 2 million+ customers
- Transmission & Distribution
  - 3,000 miles of transmission lines
  - 32,000 miles of distribution lines
  - 513 substations

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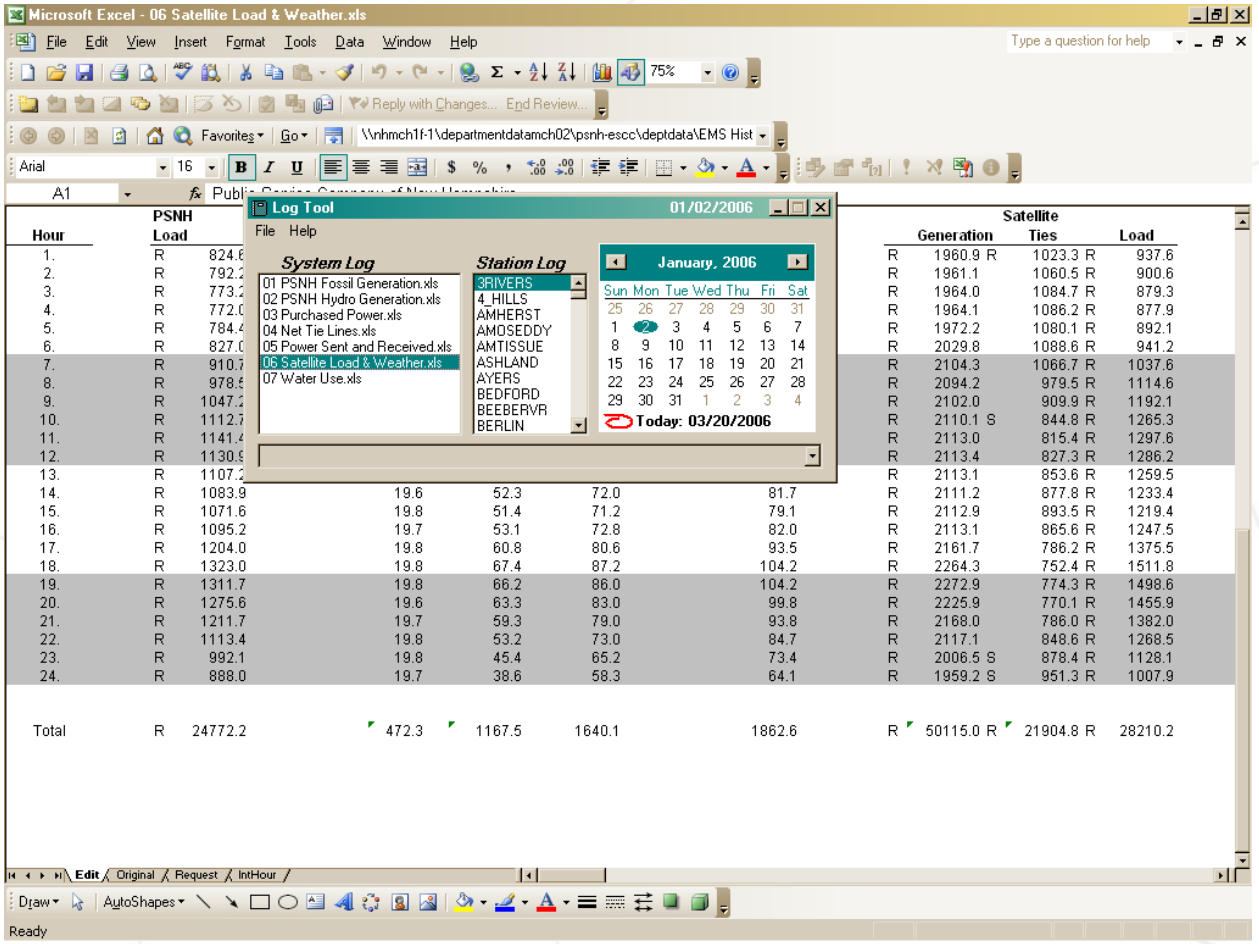
History with OSIsoft

- EMS Upgrade & PI Project – ’03 / ’04
  - Areva EMS system upgrade
    - CONVEX Control Center in Connecticut
    - PSNH Control Center in New Hampshire
    - 150 miles apart
  - Implement PI at each location to replace legacy historians, backfilling 5 years of data to new PI systems
  - Also implement PI for Transmission Business Unit “centralized” server
  - 150,000 licensed data streams amongst 3 servers

Redundancy and Availability

- EMS Redundancy is required for secure operations of the Bulk Power System
  - Both control centers have A&B Systems
- EMS System Availability Statistics are critical to the management of these systems
  - EMS Availability commitment is 99.9%
- Parallel PI servers and API nodes at each site

PI in the Control Center – Log Tool



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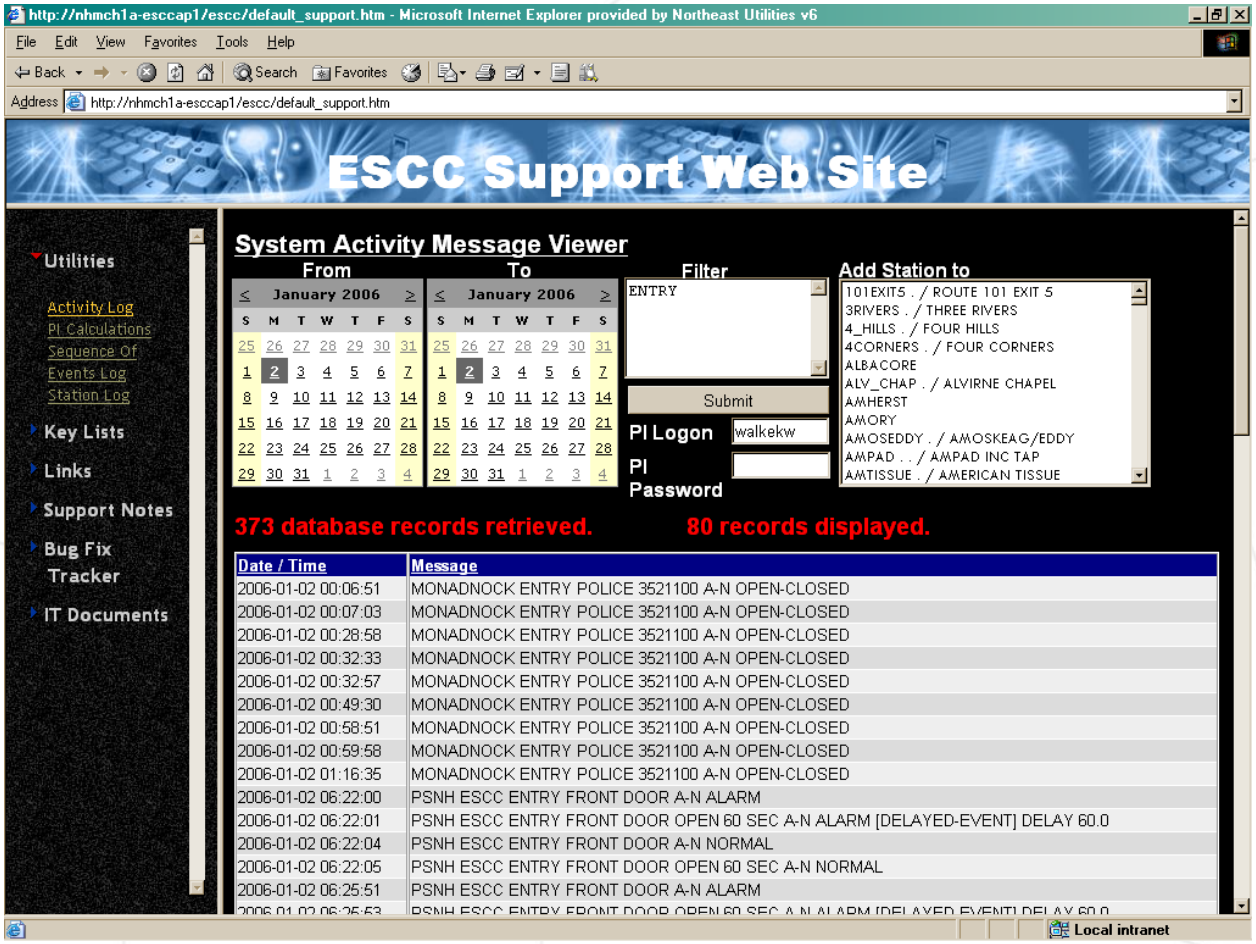
PI in the Control Center – Activity



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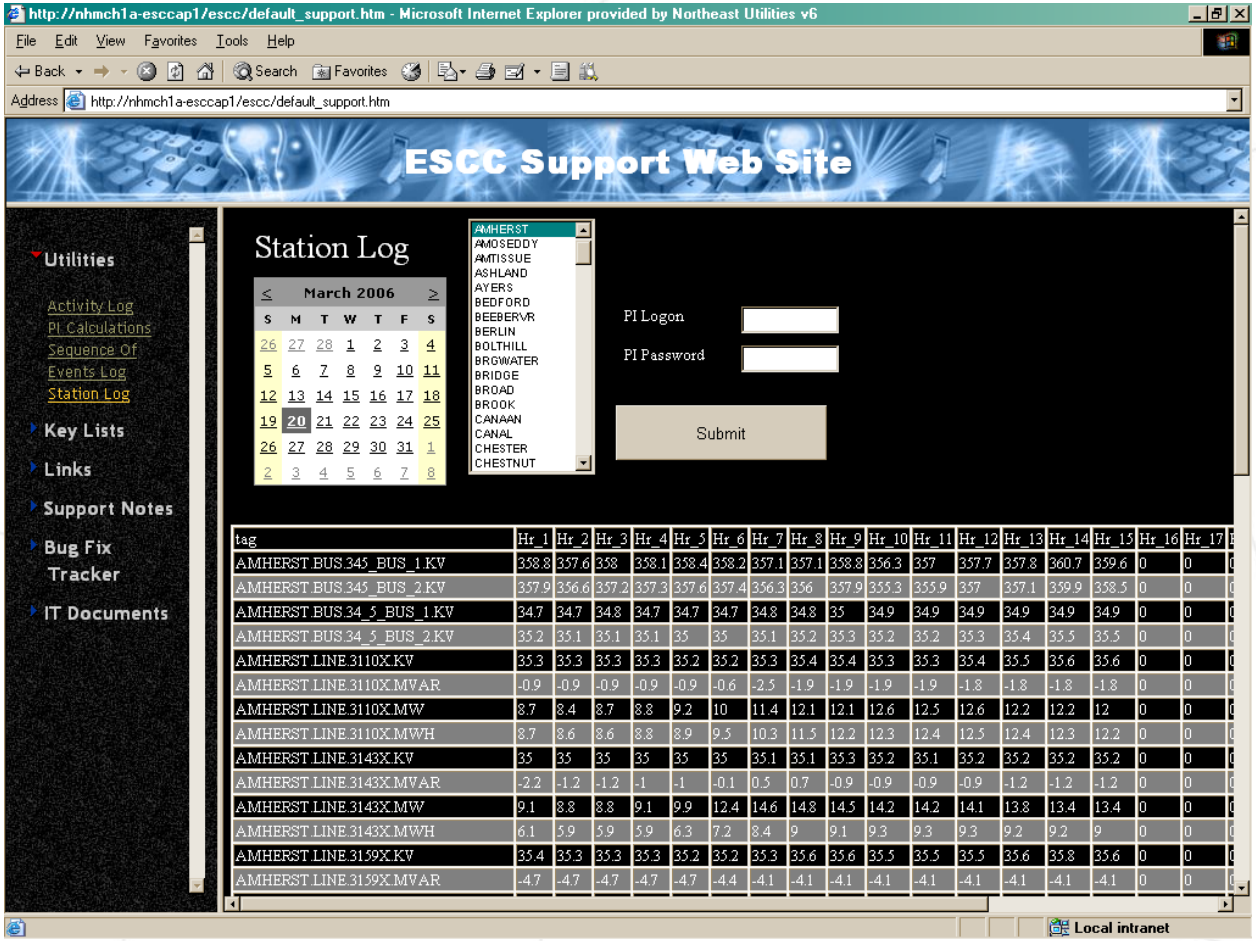
PI in the Control Center – Station Log



tag	Hr_1	Hr_2	Hr_3	Hr_4	Hr_5	Hr_6	Hr_7	Hr_8	Hr_9	Hr_10	Hr_11	Hr_12	Hr_13	Hr_14	Hr_15	Hr_16	Hr_17
AMHERST.BUS.345_BUS_1.KV	358.8	357.6	358	358.1	358.4	358.2	357.1	357.1	358.8	356.3	357	357.7	357.8	360.7	359.6	0	0
AMHERST.BUS.345_BUS_2.KV	357.9	356.6	357.2	357.3	357.6	357.4	356.3	356	357.9	355.3	355.9	357	357.1	359.9	358.5	0	0
AMHERST.BUS.34_5_BUS_1.KV	34.7	34.7	34.8	34.7	34.7	34.7	34.8	34.8	35	34.9	34.9	34.9	34.9	34.9	34.9	0	0
AMHERST.BUS.34_5_BUS_2.KV	35.2	35.1	35.1	35.1	35	35	35.1	35.2	35.3	35.2	35.2	35.3	35.4	35.5	35.5	0	0
AMHERST.LINE.3110X.KV	35.3	35.3	35.3	35.3	35.2	35.2	35.3	35.4	35.4	35.3	35.3	35.4	35.5	35.6	35.6	0	0
AMHERST.LINE.3110X.MVAR	-0.9	-0.9	-0.9	-0.9	-0.9	-0.6	-2.5	-1.9	-1.9	-1.9	-1.9	-1.8	-1.8	-1.8	-1.8	0	0
AMHERST.LINE.3110X.MW	8.7	8.4	8.7	8.8	9.2	10	11.4	12.1	12.1	12.6	12.5	12.6	12.2	12.2	12	0	0
AMHERST.LINE.3110X.MWH	8.7	8.6	8.6	8.8	8.9	9.5	10.3	11.5	12.2	12.3	12.4	12.5	12.4	12.3	12.2	0	0
AMHERST.LINE.3143X.KV	35	35	35	35	35	35	35.1	35.1	35.3	35.2	35.1	35.2	35.2	35.2	35.2	0	0
AMHERST.LINE.3143X.MVAR	-2.2	-1.2	-1.2	-1	-1	-0.1	0.5	0.7	-0.9	-0.9	-0.9	-0.9	-1.2	-1.2	-1.2	0	0
AMHERST.LINE.3143X.MW	9.1	8.8	8.8	9.1	9.9	12.4	14.6	14.8	14.5	14.2	14.2	14.1	13.8	13.4	13.4	0	0
AMHERST.LINE.3143X.MWH	6.1	5.9	5.9	5.9	6.3	7.2	8.4	9	9.1	9.3	9.3	9.3	9.2	9.2	9	0	0
AMHERST.LINE.3159X.KV	35.4	35.3	35.3	35.3	35.2	35.2	35.3	35.6	35.6	35.5	35.5	35.5	35.6	35.8	35.6	0	0
AMHERST.LINE.3159X.MVAR	-4.7	-4.7	-4.7	-4.7	-4.7	-4.4	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	0	0

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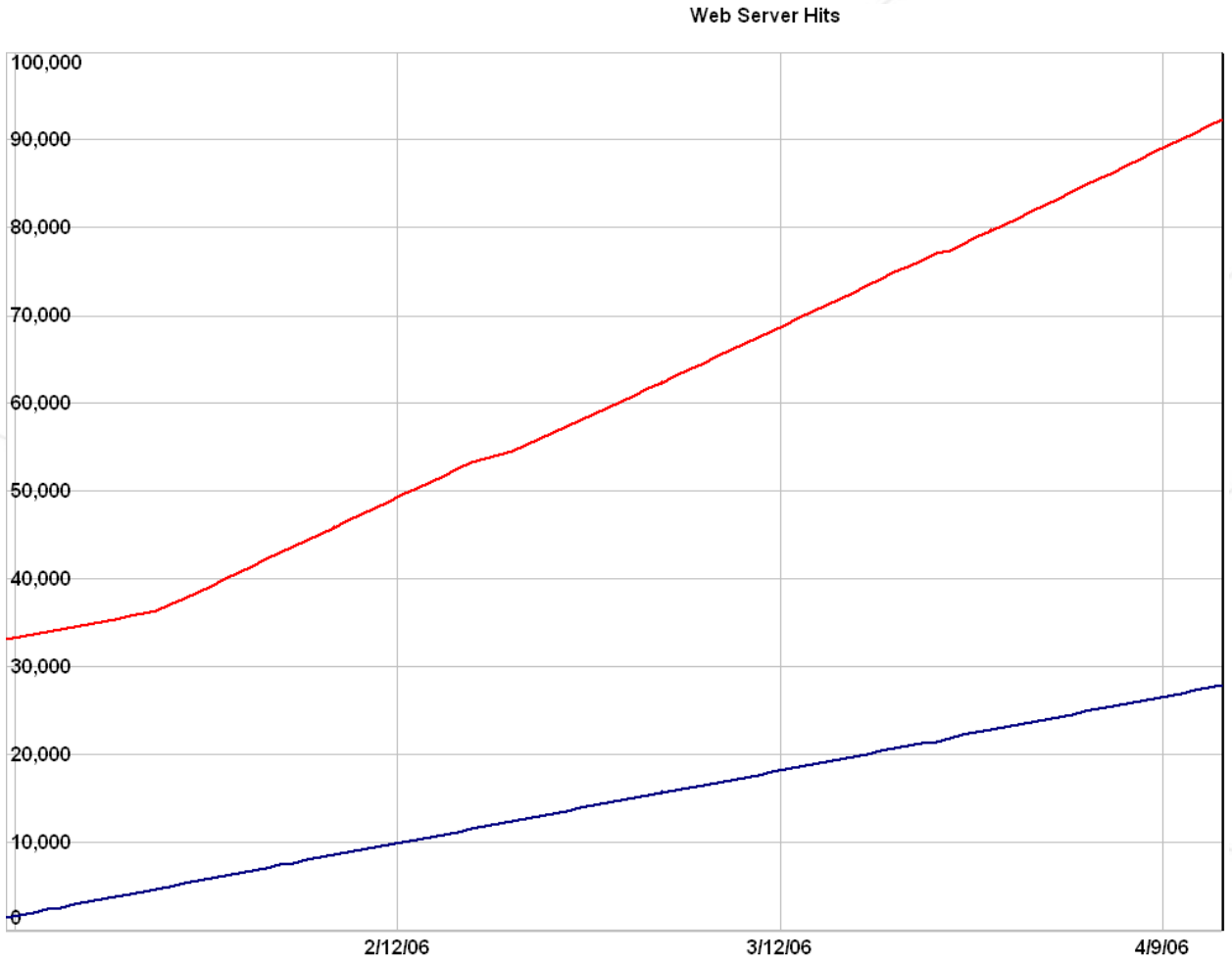
PSNH SCADA PI Statistics



- All internal apps use web services and PI-OLEDB
- ~20k streams
  - Value & Status
  - Alarm & Event
  - SOE, using PI BatchFile auto creates tags as needed

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Who is NERC?

- North American Electric Reliability Council
  - Sets standards for the reliable operation and planning of the bulk electric system
  - Monitors, assesses, and enforces compliance with reliability standards
  - Reliability standards compliance is *currently* voluntary, but the Energy Policy Act of 2005 will change that – soon enough…

NERC 1300 Cyber Security Standards

- 41 core “requirements” divided into 8 categories
  - ~3 can benefit through this implementation
  - ~8 must be considered for this system to be compliant
- Effective 1-June-2006
  - Compliance assessment begins in 3Q2007
  - Begin Work, Substantially Compliant, Compliant, and Auditably Compliant
  - Many requirements do not need to be “AC” until 3Q2010

Critical Infrastructure Protection

CIP #	Title / Scope	Req's
002	Critical Cyber Asset Identification	4
003	Security Management Controls	6
004	Personnel and Training	4
005	**Electronic Security**	5
006	Physical Security	6
007	**Systems Security Management**	9
008	Incident Reporting / Response Planning	2
009	Recovery Plans	5

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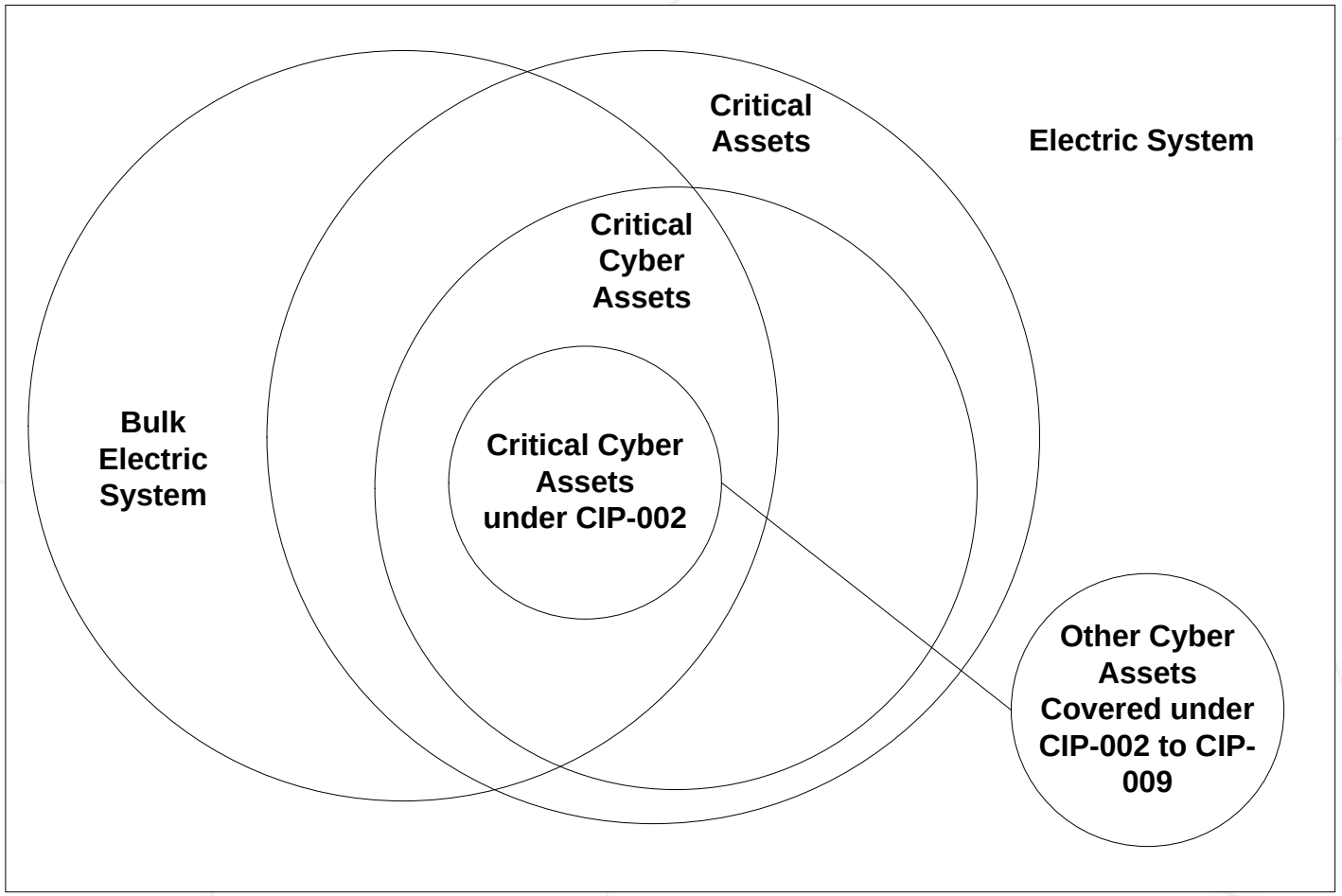
Assets Under NERC 1300



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NU Cyber Security Initiative

- Kicked off it's Cyber Security Compliance Project Team in January 2006
  - Executive Sponsor
  - Oversight Committee
  - Program Manager
  - Critical Asset and Critical Cyber Asset Identification Teams
- Completed CIP-002 Requirements
- Kicking off CIP-003 to CIP-009 compliance teams September 2006

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IT Monitor Project Objectives

- Provide situational awareness of PSNH ESCC infrastructure health
  - Network equipment, servers, desktops, RTU's
- Support SCADA availability reporting
- Easy navigation through the information
- Tag and display templates to simplify on-going maintenance

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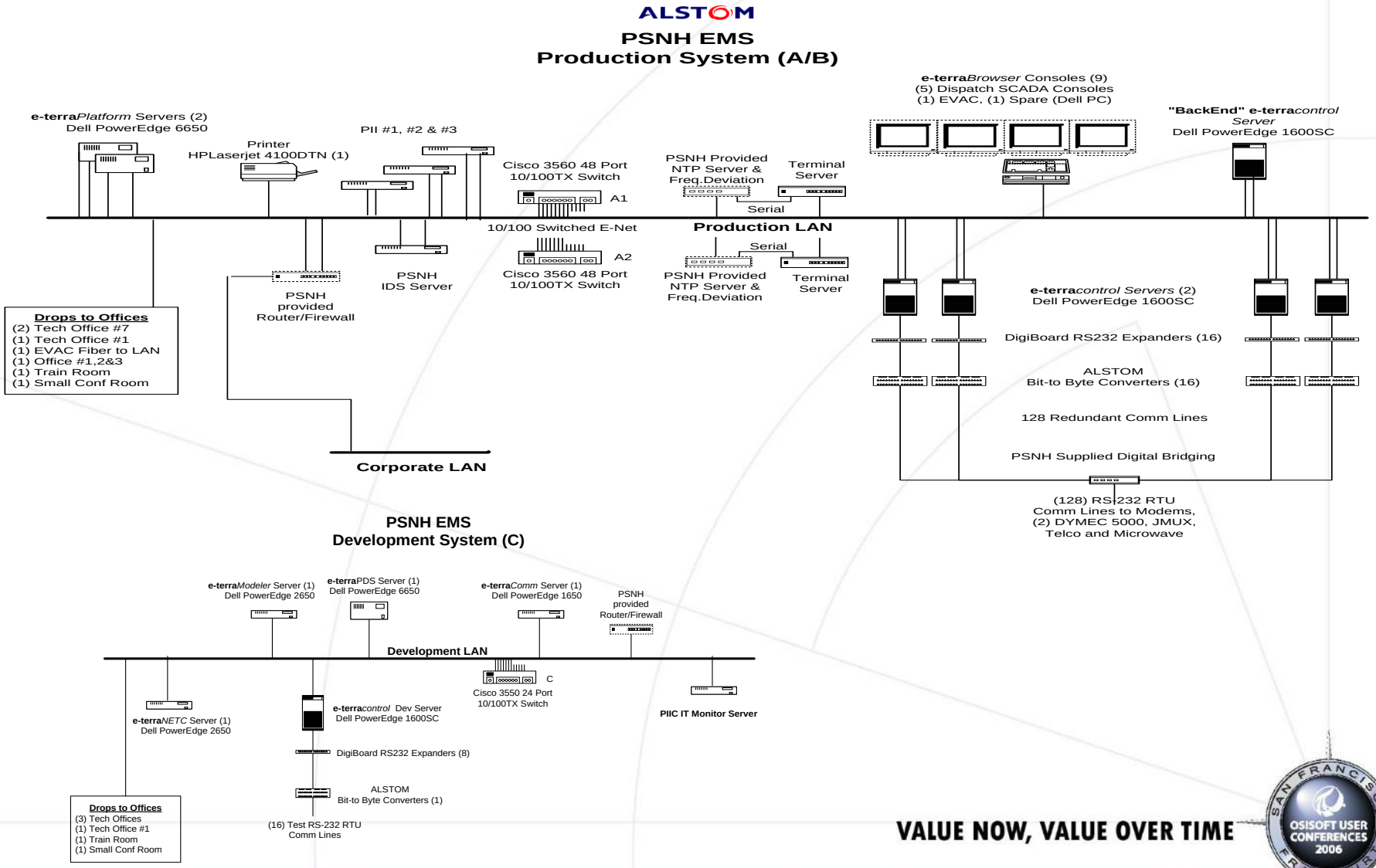
Project Challenges

- IT vs. the world
  - Access to “their” equipment
- Security Integrity
  - Monitoring it without degrading it
- Actionable Information
  - You can’t watch everything all the time

SCADA Architecture



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OSISOFT USER CONFERENCES 2006 SAN FRANCISCO FRANKFURT

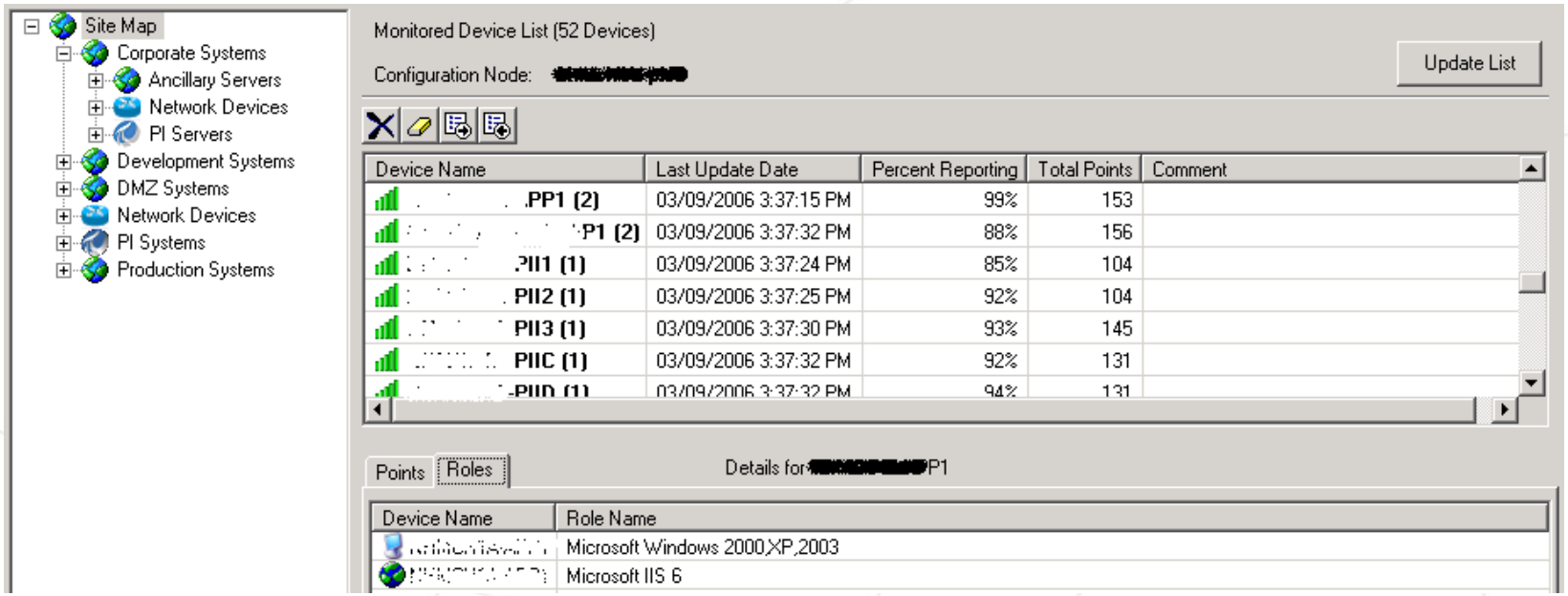
Industrial Data Center Architecture

- 1 PI Server
  - On the business LAN with the EMS PI servers
  - Also serves as API node for business LAN
- 3 API Nodes
  - Control Center Network
  - Development Network
  - DMZ Network
- ~ 6,000 data streams of IT information

IT Monitor Interfaces Being Used

- Performance Monitor
  - A single instance on each API node monitoring all computers on that network
- SNMP
  - “Managed” network devices and computers that don’t support PerfMon
- Ping
  - Simple, periodic, heartbeat metric
- TCP Response
  - Application connectivity for Web, FTP, PI, and IP Terminal Servers
- Windows EventLog
  - Security audit events and critical system messages

IT Organizer



- Part of the MCN Health Monitor and IT Monitor
  - Integrated into PI-SMT
- Simplifies and centralizes IT Monitor configuration
  - Tag and ProcessBook Display templates
  - Provides “Role” association capability

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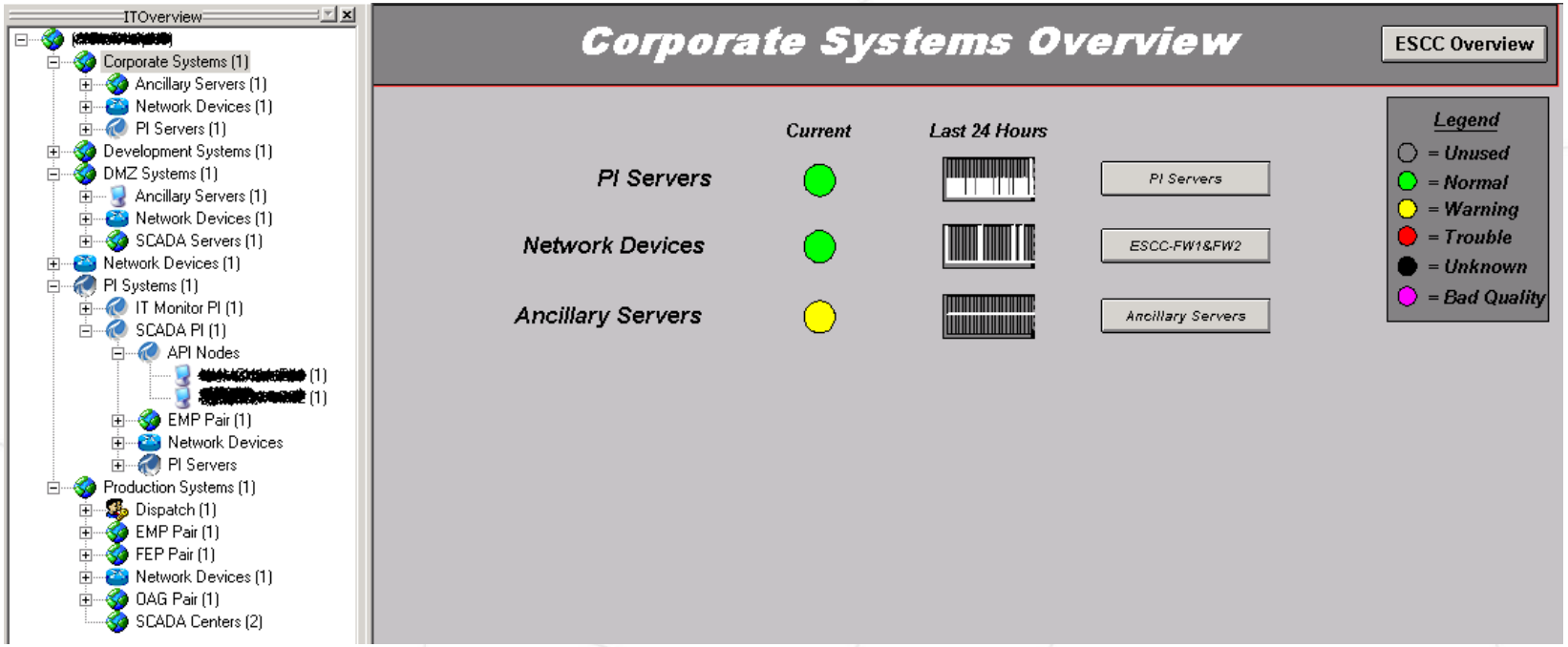
ProcessBook and IT Overview



- Links displays to network elements, greatly simplifying navigation and access to contextual information

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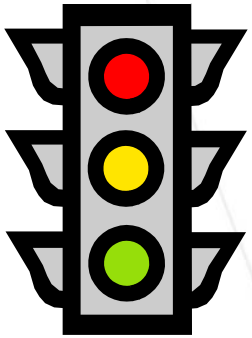
RtAnalytics Adds Value

- Monitor RTU Communication Link Status
  - We ACE'd it!
  - Created a calculation that generates batches for every service interruption
- Create Actionable Information
  - Analysis Framework does the work
  - Red, Yellow, Green – it's that easy



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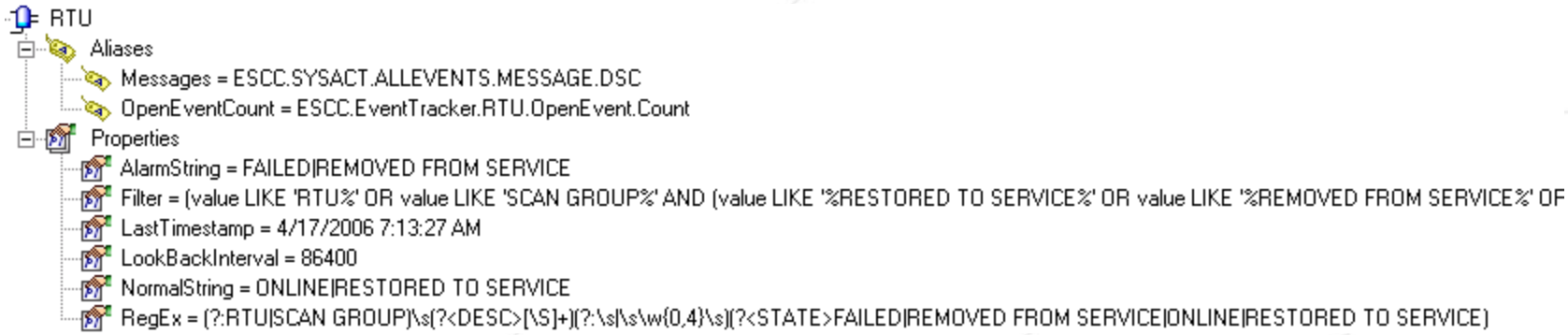
Advanced Computing Engine

- ACE calculation that uses PI-OLEDB provider
  - Parse EMS SysAct messages in PI string tag
  - Open / Close batches based on trigger messages
- Allows at-a-glance identification of what communications errors currently exist
- Enables analysis and reporting of overall comm. system availability, worst offenders, most intermittent, etc.

PI ACE Context Configuration



- Currently 7 contexts parsing messages
- Properties define regular expressions for message parsing, SQL ‘where clause’ filters, and start-up recovery information

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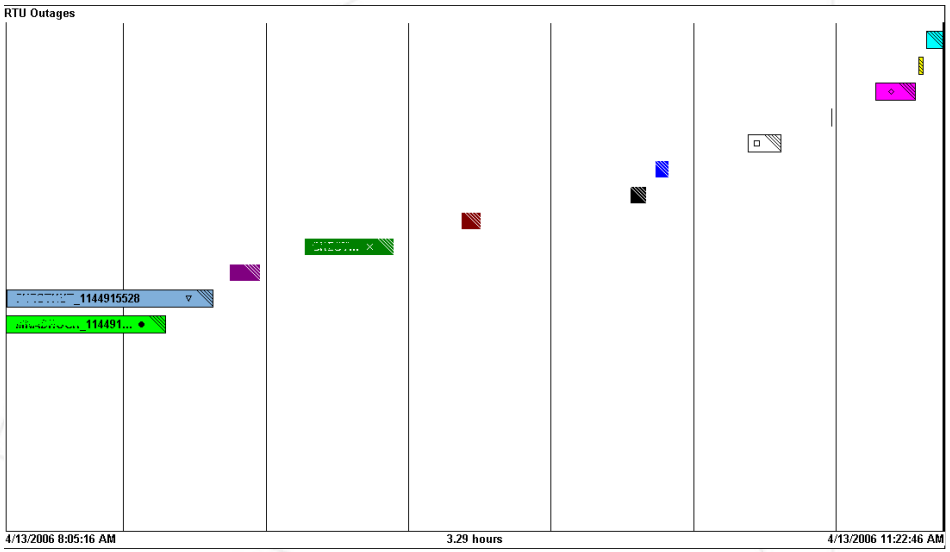
Communication Outages Batches

13-Apr-06 08:05:16 SCAN GROUP MNADNOCK C000 FAILED
13-Apr-06 08:05:16 SCAN GROUP MNADNOCK X336 FAILED
13-Apr-06 08:05:28 SCAN GROUP MNADNOCK X317 FAILED
13-Apr-06 08:05:28 SCAN GROUP CHESTNUT X317 FAILED
13-Apr-06 08:05:40 SCAN GROUP CHESTNUT X300 FAILED
13-Apr-06 08:05:41 SCAN GROUP MNADNOCK X300 FAILED
13-Apr-06 08:05:41 RTU MNADNOCK FAILED
13-Apr-06 08:06:26 SCAN GROUP CHESTNUT C000 FAILED
13-Apr-06 08:07:13 SCAN GROUP MNADNOCK C000 FAILED
13-Apr-06 08:07:14 SCAN GROUP MNADNOCK X336 FAILED
13-Apr-06 08:07:16 SCAN GROUP MNADNOCK X300 FAILED
13-Apr-06 08:07:16 SCAN GROUP CHESTNUT X300 FAILED
13-Apr-06 08:07:49 SCAN GROUP MNADNOCK X317 FAILED
13-Apr-06 08:07:49 RTU MNADNOCK FAILED
13-Apr-06 08:07:49 SCAN GROUP CHESTNUT X317 FAILED
13-Apr-06 08:08:05 SCAN GROUP CHESTNUT C000 FAILED
13-Apr-06 08:08:05 RTU CHESTNUT FAILED
13-Apr-06 08:39:01 SCAN GROUP MNADNOCK C000 ONLINE



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Accelerated InfoQuest (AIQ)

- Interactive OLAP Tool
- Flexible analysis of underlying PI data

Outage Events

Category	starttime	endtime	OutageID	Duration(MIN)	Device
Grand Total				61764	
Total ApplicationSet				390	
ApplicationSet	03/17/2006 8:34:43 AM	03/17/2006 12:13:41 PM	NHPLAA_EMSHOST_1142584483	219	NHPLAA_EMSHOST
	03/24/2006 1:51:11 PM	03/24/2006 1:51:21 PM	NHCOMB_OAGHOST_1143208271	0	NHCOMB_OAGHOST
	03/24/2006 1:53:49 PM	03/24/2006 4:44:39 PM	NHCOMA_OAGHOST_1143208429	171	NHCOMA_OAGHOST
	03/24/2006 4:50:01 PM	03/24/2006 4:50:53 PM	NHCOMB_OAGHOST_1143219001	0	NHCOMB_OAGHOST
Total CFEReader				9	
CFEReader	03/03/2006 2:23:51 PM	03/03/2006 2:26:33 PM	NHCFEA_A_SIDE_B_1141395831	3	NHCFEA_A_SIDE_B
	03/09/2006 3:32:12 PM	03/09/2006 3:34:41 PM	NHCFEA_A_SIDE_B_1141918332	2	NHCFEA_A_SIDE_B
	03/27/2006 2:17:30 PM	03/27/2006 2:21:34 PM	NHCFEA_A_SIDE_A_1143469050	4	NHCFEA_A_SIDE_A
Total Equipment				3101	
Equipment	03/02/2006 10:28:07 PM	03/02/2006 10:34:32 PM	NHPLAA_TRUETIMEA_1141338487	6	NHPLAA_TRUETIMEA
	03/03/2006 8:02:59 AM	03/03/2006 8:03:13 AM	NHPLAB_NHD90B_1141372979	1	NHPLAB_NHD90B
	03/03/2006 8:03:05 AM	03/03/2006 8:03:09 AM	NHPLAA_NHD90B_1141372985	0	NHPLAA_NHD90B
	03/03/2006 2:24:22 PM	03/03/2006 2:25:56 PM	NHPLAB_NHCONB1_1141395862	1	NHPLAB_NHCONB1
	03/03/2006 2:24:31 PM	03/03/2006 2:25:55 PM	NHPLAA_NHCONB1_1141395871	1	NHPLAA_NHCONB1
	03/03/2006 2:34:38 PM	03/03/2006 2:36:22 PM	NHPLAB_NHCOMB_1141396478	2	NHPLAB_NHCOMB
	03/03/2006 2:34:41 PM	03/03/2006 2:36:15 PM	NHPLAA_NHCOMB_1141396481	2	NHPLAA_NHCOMB
	03/03/2006 2:34:47 PM	03/03/2006 2:36:18 PM	NHCOMA_NHCOMB_1141396487	2	NHCOMA_NHCOMB
	03/07/2006 12:11:59 PM	03/07/2006 12:20:55 PM	NHPLAB_TRUETIMEB_1141733519	9	NHPLAB_TRUETIMEB
	03/08/2006 8:45:55 AM	03/08/2006 8:49:09 AM	NHPLAA_NHD90B_1141807555	4	NHPLAA_NHD90B
	03/08/2006 8:45:59 AM	03/08/2006 8:49:13 AM	NHPLAB_NHD90B_1141807559	4	NHPLAB_NHD90B
	03/08/2006 8:50:27 AM	03/08/2006 8:50:31 AM	NHPLAB_ESCCFW2_1141807827	0	NHPLAB_ESCCFW2
	03/08/2006 9:25:17 AM	03/08/2006 9:25:31 AM	NHPLAB_NHD90A_1141809917	0	NHPLAB_NHD90A
	03/08/2006 9:25:20 AM	03/08/2006 9:25:34 AM	NHPLAA_NHD90A_1141809920	0	NHPLAA_NHD90A
	/2006 11:14:37 PM	03/08/2006 11:16:02 PM	NHPLAA_TRUETIMEA_1141859677	2	NHPLAA_TRUETIMEA
	/2006 11:50:41 AM	03/09/2006 11:52:15 AM	NHPLAA_NHCOMA_1141905041	2	NHPLAA_NHCOMA
	/2006 11:50:46 AM	03/09/2006 11:52:10 AM	NHPLAB_NHCOMA_1141905046	2	NHPLAB_NHCOMA
	/2006 11:50:53 AM	03/09/2006 11:52:11 AM	NHCOMB_NHCOMA_1141905053	2	NHCOMB_NHCOMA
	/2006 2:40:51 PM	03/09/2006 2:41:45 PM	NHPLAA_NHCOND_1141915251	1	NHPLAA_NHCOND
	/2006 2:40:52 PM	03/09/2006 2:41:46 PM	NHPLAB_NHCOND_1141915252	1	NHPLAB_NHCOND
	/2006 3:32:51 PM	03/09/2006 3:34:15 PM	NHPLAA_NHCONB1_1141918371	2	NHPLAA_NHCONB1
	/2006 3:32:52 PM	03/09/2006 3:34:16 PM	NHPLAB_NHCONB1_1141918372	2	NHPLAB_NHCONB1
	/2006 9:51:29 PM	03/09/2006 10:07:24 PM	NHPLAB_TRUETIMEB_1141941089	16	NHPLAB_TRUETIMEB
	/2006 8:46:37 AM	03/12/2006 9:03:02 AM	NHPLAA_TRUETIMEA_1142153197	17	NHPLAA_TRUETIMEA

Outage Events

Device	Category	starttime	endtime	OutageID	Duration(MIN)
Grand Total					61764
Total 3RIVERS					68
3RIVERS	RTU	03/03/2006 12:11:01 PM	03/03/2006 12:43:22 PM	3RIVERS_1141387861	32
		03/03/2006 12:47:35 PM	03/03/2006 12:49:08 PM	3RIVERS_1141390055	2
	FEP_COM	03/03/2006 12:11:10 PM	03/03/2006 12:43:22 PM	COM60_1141387870	32
		03/03/2006 12:47:43 PM	03/03/2006 12:49:08 PM	COM60_1141390063	2
Total AMHERST					3802
AMHERST	RTU	03/14/2006 6:56:28 PM	03/14/2006 6:56:39 PM	AMHERST_1142362588	0
		03/14/2006 8:28:45 PM	03/14/2006 8:32:31 PM	AMHERST_1142368125	4
		03/15/2006 3:24:56 PM	03/15/2006 3:25:03 PM	AMHERST_1142436296	1
		03/15/2006 3:25:05 PM	03/15/2006 3:25:18 PM	AMHERST_1142436305	0
		03/15/2006 3:25:19 PM	03/16/2006 11:11:00 AM	AMHERST_1142436319	1186
		03/16/2006 11:11:03 AM	03/16/2006 1:35:00 PM	AMHERST_1142507463	144
		03/16/2006 1:35:17 PM	03/16/2006 1:35:31 PM	AMHERST_1142516117	0
	FEP_COM	03/14/2006 8:28:56 PM	03/16/2006 1:35:41 PM	COM13_1142368136	2467
Total AMPAD_INC_TAP_1323					2
AMPAD_INC_TAP_1323	PoleTopRTU	03/08/2006 10:12:35 PM	03/08/2006 10:13:22 PM	AMPAD_INC_TAP_1323_1141855955	1
		03/24/2006 10:04:38 PM	03/24/2006 10:05:26 PM	AMPAD_INC_TAP_1323_1143237878	1
Total ASH_STREET_1713					1
ASH_STREET_1713	PoleTopRTU	03/19/2006 10:02:37 PM	03/19/2006 10:03:30 PM	ASH_STREET_1713_1142805757	1
Total ASHLAND					5765
ASHLAND	RTU	03/21/2006 10:13:27 AM	03/23/2006 10:13:27 AM	ASHLAND_1142936007	2880
		03/25/2006 3:27:29 PM	03/25/2006 3:32:45 PM	ASHLAND_1143300449	5
		03/25/2006 4:42:05 PM	03/27/2006 4:42:05 PM	ASHLAND_1143304925	2880
Total ASHLAND_TAP_1258					5444
ASHLAND_TAP_1258	PoleTopRTU	03/07/2006 10:47:07 AM	03/07/2006 11:20:38 AM	ASHLAND_TAP_1258_1141728427	33
		03/07/2006 10:31:06 PM	03/08/2006 10:30:14 PM	ASHLAND_TAP_1258_1141770666	1439
		03/14/2006 10:27:36 PM	03/15/2006 4:09:00 PM	ASHLAND_TAP_1258_1142375256	1062
		03/16/2006 10:26:34 PM	03/18/2006 3:46:56 PM	ASHLAND_TAP_1258_1142547994	2480
		03/20/2006 10:24:37 PM	03/21/2006 5:34:36 AM	ASHLAND_TAP_1258_1142893477	430
Total BE OAG					3
BE OAG	IntersiteDataPath	03/09/2006 11:50:58 AM	03/09/2006 11:51:13 AM	BE OAG_1141905058	1
		03/24/2006 1:51:13 PM	03/24/2006 1:51:14 PM	BE OAG_1143208273	0
		03/24/2006 1:51:19 PM	03/24/2006 1:53:52 PM	BE OAG_1143208279	2
		03/24/2006 4:50:03 PM	03/24/2006 4:50:04 PM	BE OAG_1143219003	0

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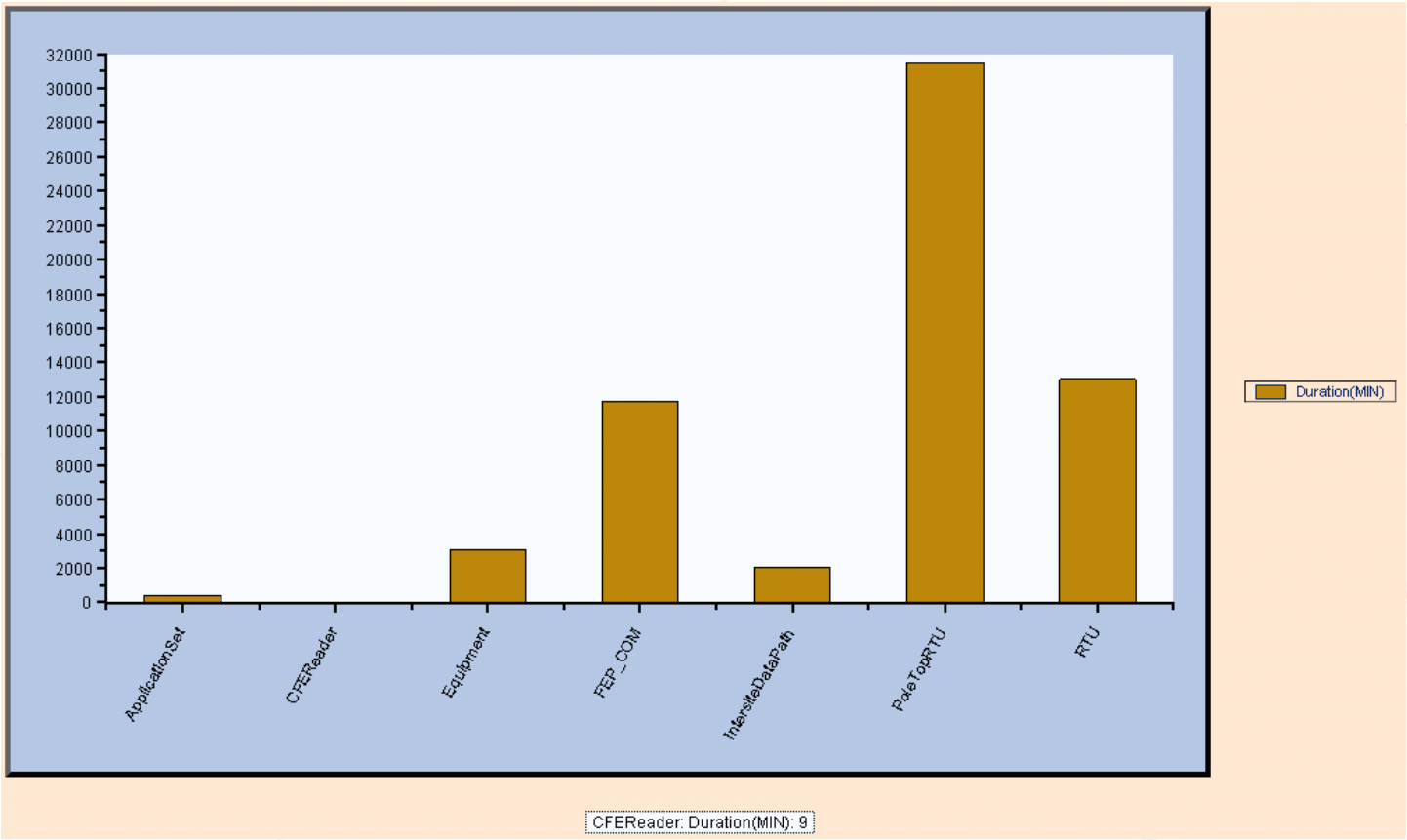
Accelerated InfoQuest Charting



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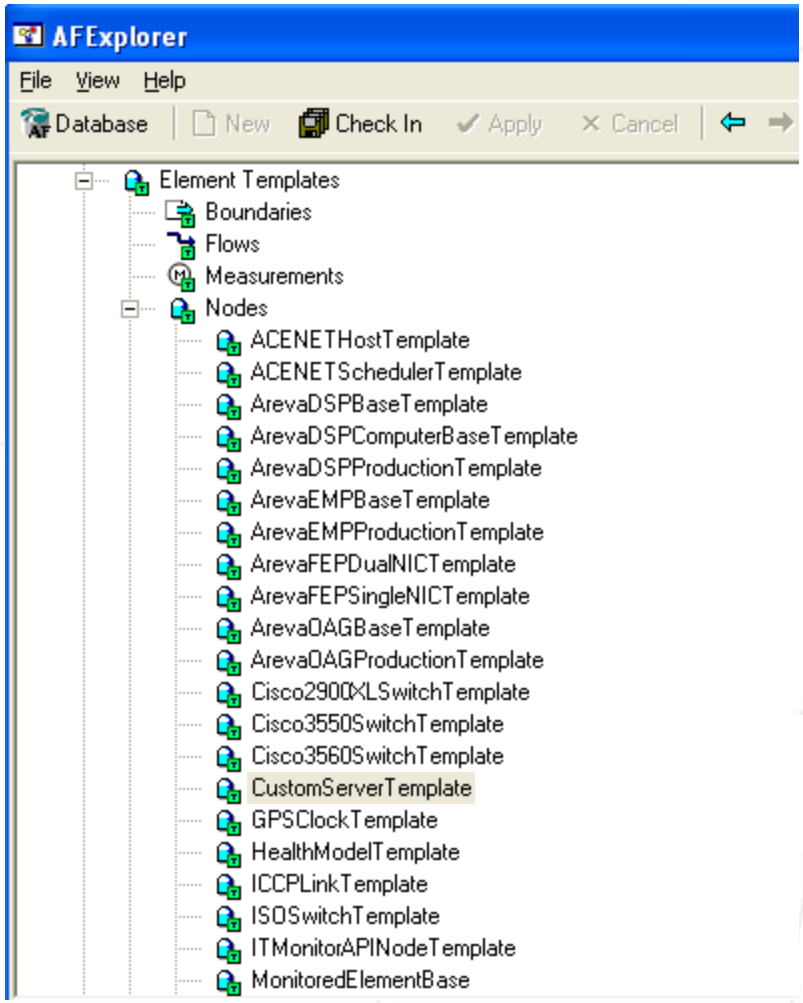
Analysis Framework to the Rescue!

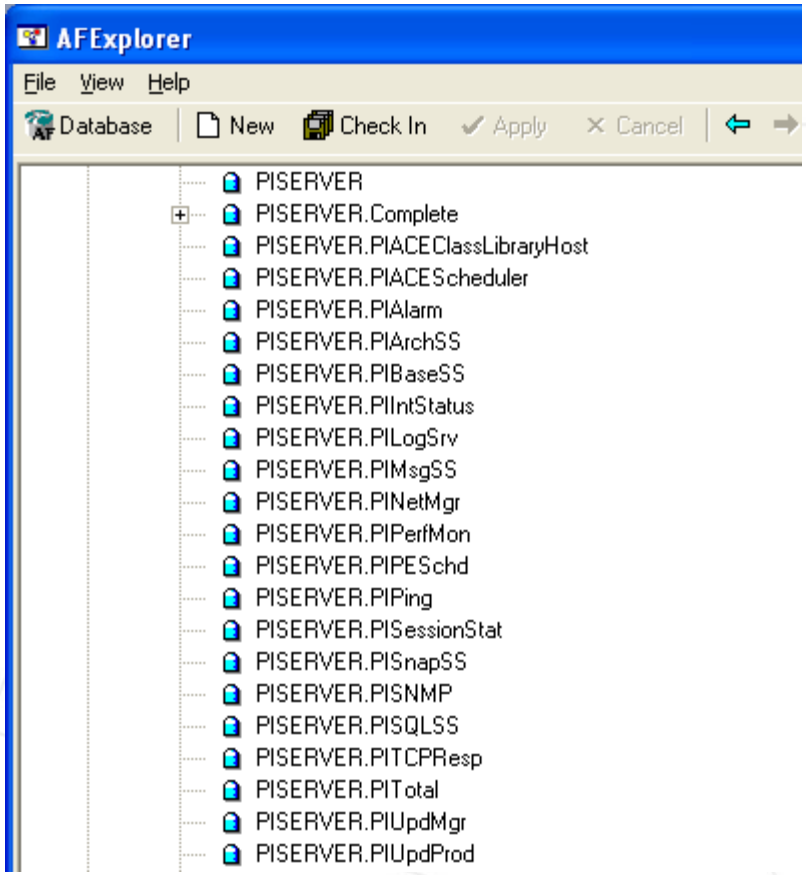
- AF turns the IT Monitor “instrumentation” data into actionable information!
- Models are used to define dependent relationships and logical groupings
- Every computer process, network device, communication link, and PI subsystem is monitored and has a “Health Rating” tag
- Our custom analysis plug-in calculates a simple “Normal”, “Warning”, “Trouble” health rating
- Maintenance is simple configuration – no coding!

The Building Blocks of AF

- We defined 45 “Element Templates”
  - Each template is meant to describe a specific device type or process
  - Templates contain “Attributes” which can reference PI Points, Data Tables, or an AF Formula.
  - Attributes support automatic PI Point creation when new elements are created, which meets a core project objective
  - Templates implement “inheritance”
- Virtually every tag in the IT Monitor PI system is mapped to an attribute of an element

AF Templates and Elements





VALUE NOW, VALUE OVER TIME

Element Attributes and Categories

General | Elements | Attributes | Ports | Derived Templates

Cisco3550SwitchTemplate

Name	Category	Value Type	UOM	Data Reference
EnvMonFanState1	ReliabilityFactor	String	<None>	PI Point
EnvMonFanStatusDescr1		String	<None>	PI Point
EnvMonPresent		String	<None>	PI Point
EnvMonRedundantSupplyNotification		String	<None>	PI Point
EnvMonShutdownNotification		String	<None>	PI Point
EnvMonSupplySource1		String	<None>	PI Point
EnvMonSupplyState1	ReliabilityFactor	String	<None>	PI Point
EnvMonSupplyStatusDescr1		String	<None>	PI Point
EnvMonTemperatureNotification		String	<None>	PI Point
EnvMonTemperatureState1	ReliabilityFactor	String	<None>	PI Point
EnvMonTemperatureStatusDescr1		String	<None>	PI Point
EnvMonVoltageNotification		String	<None>	PI Point
FastEthernet0-1ifAdminStatus		String	<None>	PI Point
FastEthernet0-1ifInErrors	ReliabilityFactor	Long	Count	PI Point
FastEthernet0-1ifInOctets		Double	Count	PI Point

- Analyzed PI values can interpolated or standard PI summary types (avg, total, min, max, delta, stdev)

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Health Rating Limits Table

- Simple table to define the warning and trouble limits for each monitored attribute
- Allows the use of generic or specific matching for each element's attributes

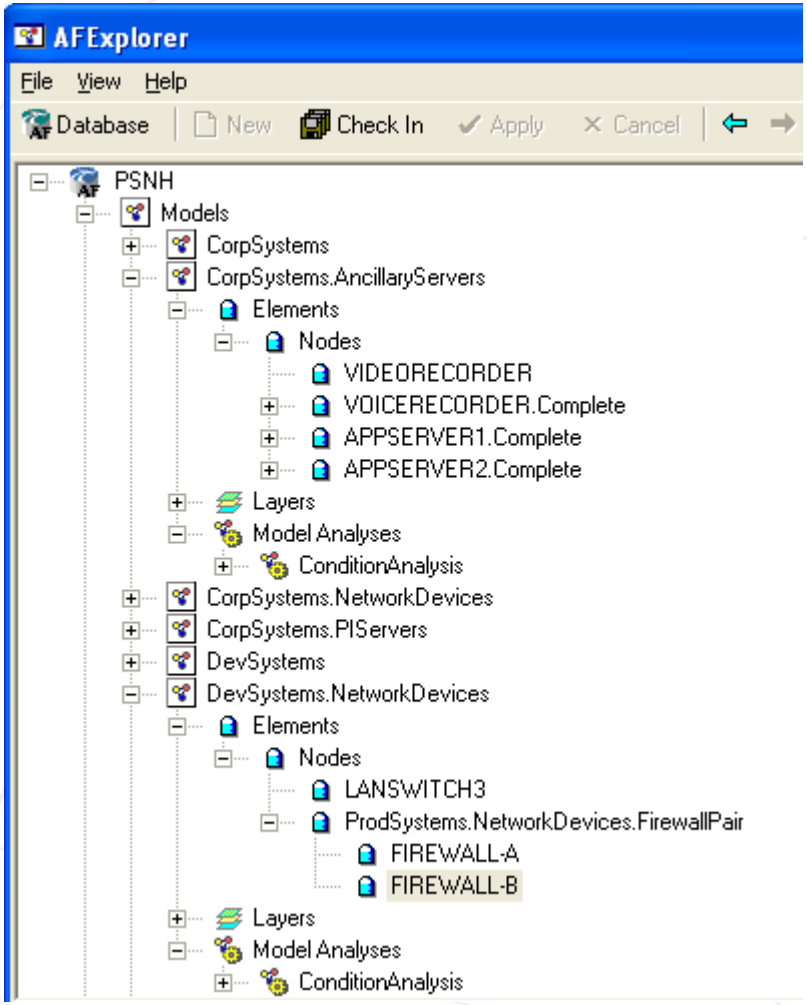
General | Table | Define Table

Health Rating Limits

Model	Element	Template	Attribute	TroubleBelowLimit	WarningBelowLimit	WarningAboveLimit	TroubleAboveLimit	WarningStates	TroubleStates	DataAgeLimit
			APPSETDISABLED	0	0	0	0		True	0
			InterfaceStatus	0	0	0	0		NOT RECEIVING DATA	0
			PAIRAPPSETSTATUS	0	0	0	0	2	3	0
			CompressionRatio	0.05	0.1	0.9	0.95			0
			OverflowQueueCount	-0.1	-0.1	1	2			0
			GPSSatMaxSigStrength	-0.1	-0.1	1	2			0
			FEPPairHealthRating	-0.1	-0.1	2	3			0
			PingLatency	-0.1	-0.1	3	4			0

AF Models

- Over 50 “Models”
- The health of EVERY element and model is calculated once per minute
  - Each unique element is only calculated once
- It takes less than 9 seconds to analyze everything
- Excellent integration with ProcessBook!



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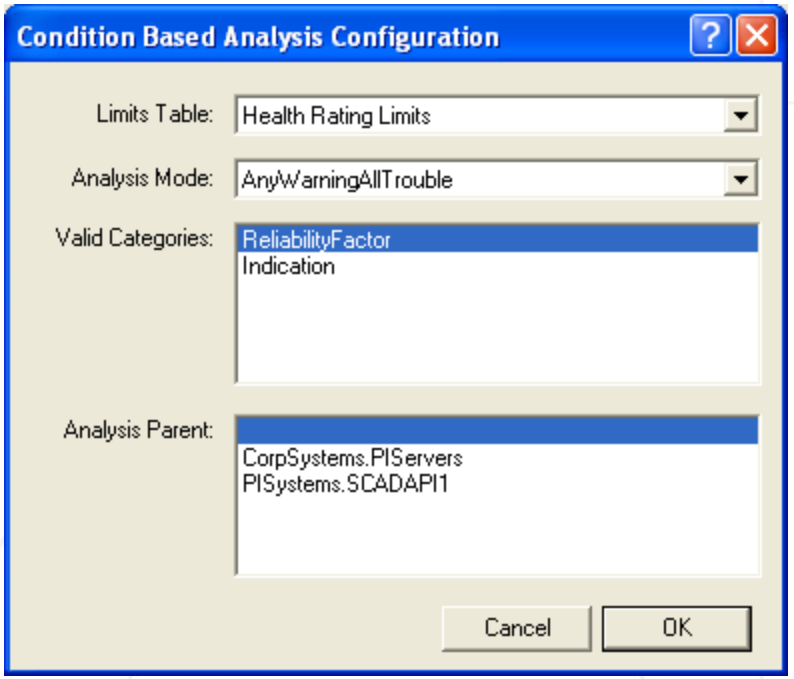
Analysis Plug-In Configuration

- Analysis Mode
  - Best Case
  - Worst Case
  - Any Warning All Trouble
  - All Trouble
- Valid Categories
  - Allows selection attribute categories
- Analysis Parent
  - Defines which parent model will control execution



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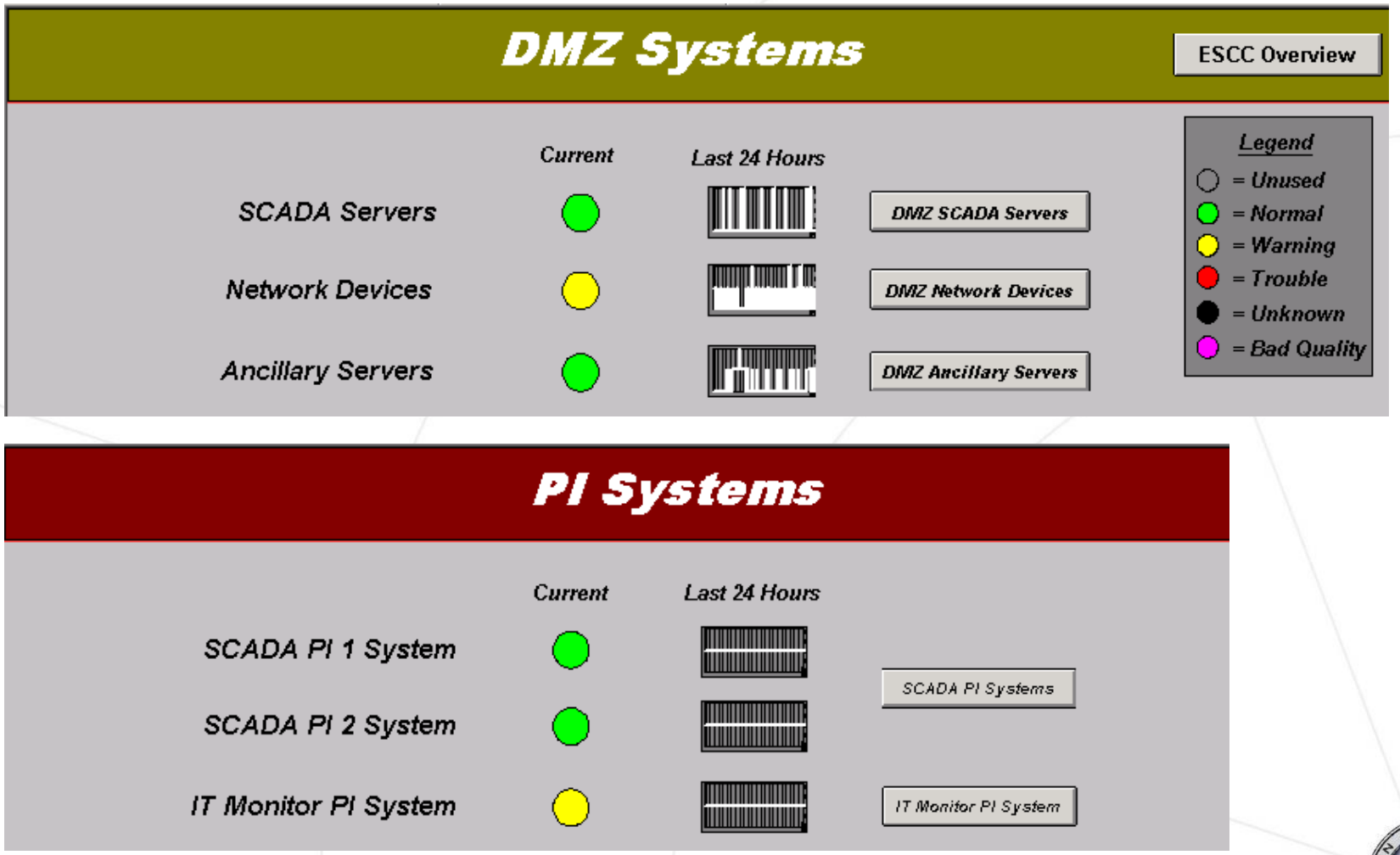
Health Monitoring Overview Screens



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What About Compliance?

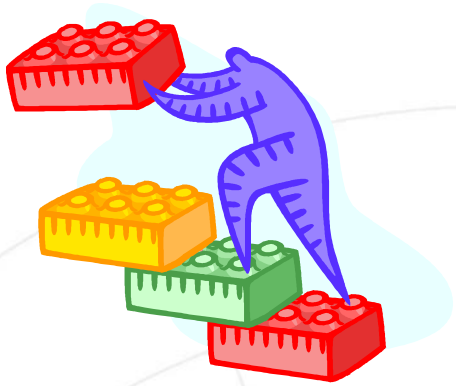
- NU's approach was two fold
  - Meet current requirements to provide strong EMS Availability Reporting to meet ISO-NE requirements
  - Develop a solid baseline Critical Cyber Asset Monitoring System to be used within our control centers and with the ability to expand to field critical cyber assets.

Lessons Learned

- As always, standards and conventions are critical
- Use empirical evidence to enlist support
- NERC 1300 is like ISO 9000 or FDA Validation
  - Define a corporate standard, follow that standard, and make sure that you can prove that you followed it
- Compliance is a constantly moving target, so your system must be able to easily adapt with little effort

The Path Forward

- More SNMP, SysLog, and NetFlow data
- CONVEX Control Center
- Enhancements to AF Model and Analysis



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Thank You!

Questions?

- Special thanks to:
  - Dennis Mullen, PSNH
  - Ken Walker, PSNH
  - Mark Wunderli, PSNH
  - Faisel Ahmed, PSNH
  - Phil Ryder, Accelerated Information Technologies

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