

Trusting the Data: Analytics and Visualization

Presented by **John Juna**

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About us

Electric Delivery Company

- Providing service to approximately 3.8 million customers across Northern Illinois

Manages

- 90,000 miles of power lines in an 11,400-square-miles territory

Investing

- Made capital investments of \$1.4 billion in 2013
- Expects to invest an additional \$5.7 billion over the next three years to further strengthen and modernize the system in Northern Illinois

Understands

- How important safe, reliable power is to customers, and is continuously looking for new ways to improve service

ComEd's Journey to Embrace Analytics and Visualization

- ComEd has been using PI Historian to store the Supervisory Control and Data Acquisition data since 1998. The collected data requires processing and analytics which is a major challenge.
- ComEd Engineers are familiar with using the OSIsoft solutions, PI ProcessBook and PI DataLink, to analyze field data, generate displays and reports.
- Now with the surfacing of Analytics and Data Visualization, it has become easier to monitor health of the assets, diagnose and predict problems, assist the company with prioritizing and planning the maintenance needs.

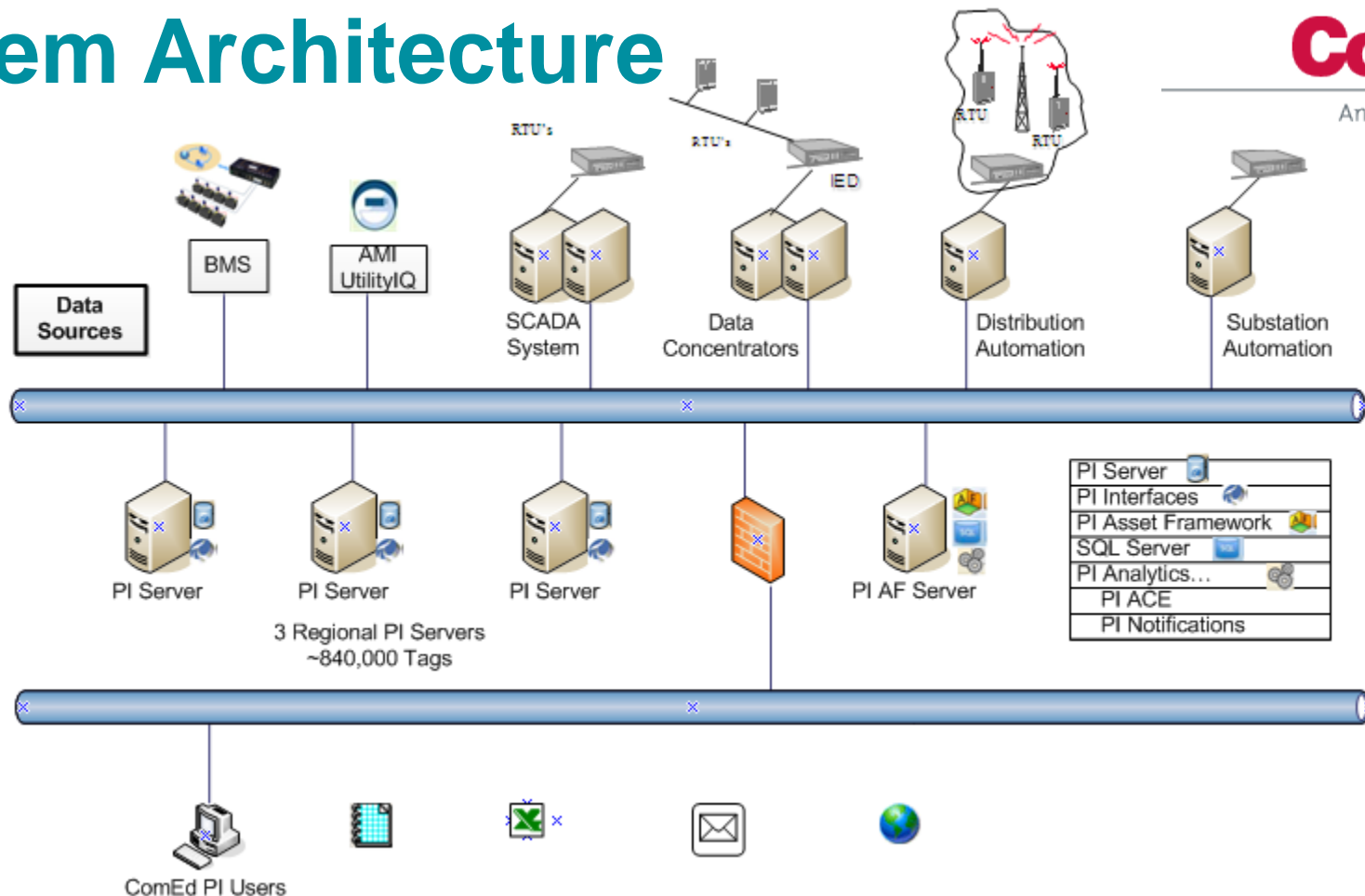
Business Challenge

- What are the appropriate processing tools for visualization of smart grid applications?
- How to efficiently monitor field assets and enable data analytics to be more proactive in decision making?
- How to educate more users to embrace data mining techniques?

System Architecture

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PI System Products

- PI Asset Framework provides a data source for Intelligent Substation Dashboard, and Equipment Monitoring, which span across multiple PI Servers
- PI Notifications aided with delivering equipment alerts and reports to users.
- PI Advance Calculation Engine facilitated with analytic development and maintenance of complex calculation and apply to many similar equipments and monitor for failed precursors.
- PI ProcessBook displays and PI DataLink reports for monitoring asset health, view vast amount of data in visualized fashion and easy to analyze and assess.
- PI ODBC, PI OLEDB Driver, PI OLEDB Enterprise, PI SDK, PI SNMP, PI SNMPTrap.

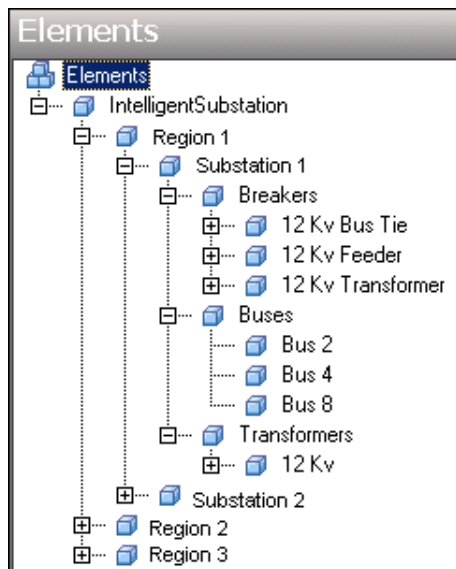
Diverse PI Users

- Capacity Planning
- Relay and Protection Engineering
- Transmission System Operations
- Transmission and Substation Equipment Standards
- Distribution Dispatch Support, Operations
- Testing Groups
- Energy Acquisition
- IT Real Time
- Energy Infrastructure Modernization Act – IT
- Corporate Security

ComEd's Standards



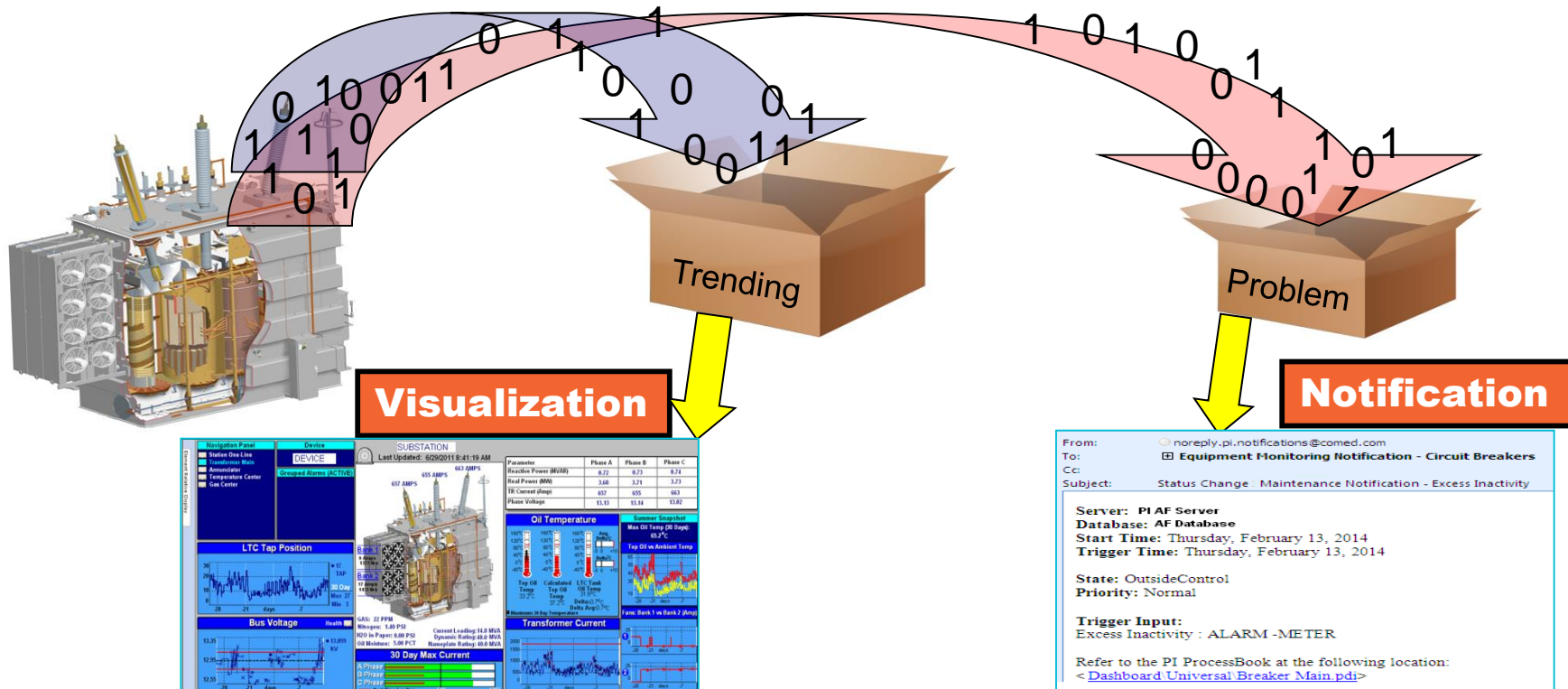
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- Adhere to a PI Tag Naming convention which makes it easy for users to efficiently find the data they need (SubstationName, VoltageCode, SwitchNumber/LineNumber, Engineering Unit)
- Self-contained AF databases to support project needs.
- The hierarchy for AF assets is based by regions, substations, equipment class, equipment subclass whose attributes map to PI tags.
- Universal templates are used to create similar notifications throughout the substations.

Intelligent Substation Data Mining

Joint effort between Engineering and IT to create Station Health Dashboard that would consolidate a vast amount of information in a visualized fashion.



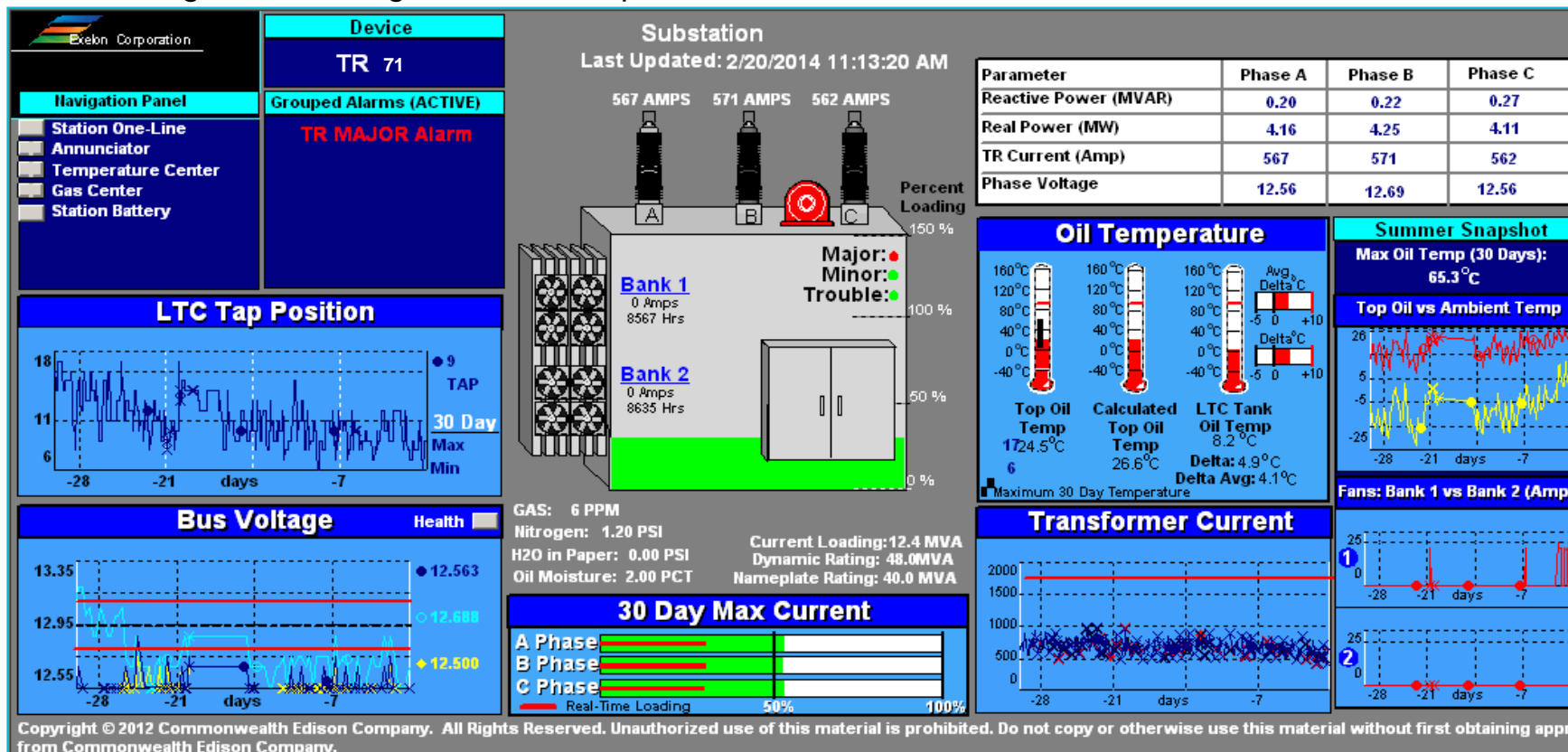
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Transformer Asset Health

Combining and Trending different data points to assess asset health.

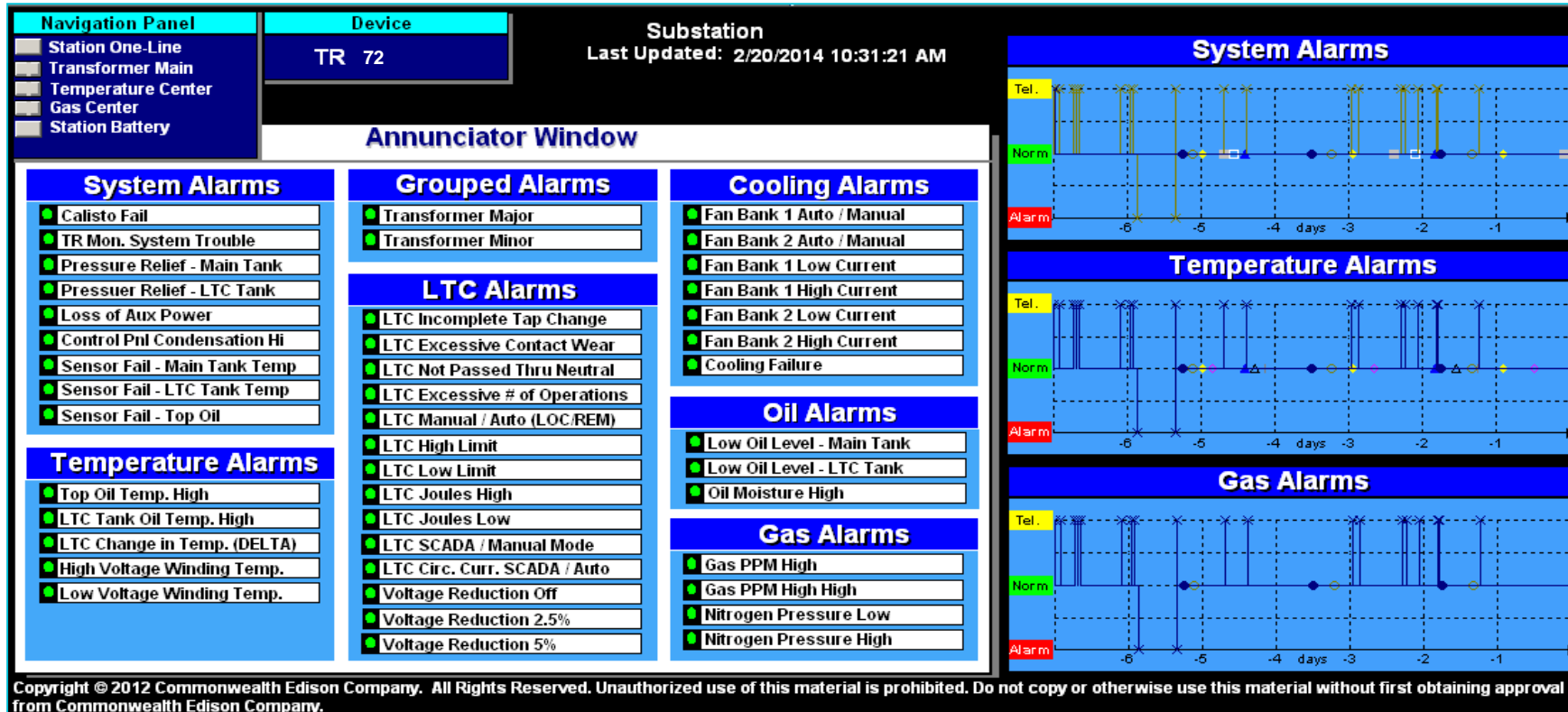


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Transformer Alarm Annunciator

Detailed Transformer Alarm Monitoring Data which mimics the hardware status in substations representing different alarms for the transformers.



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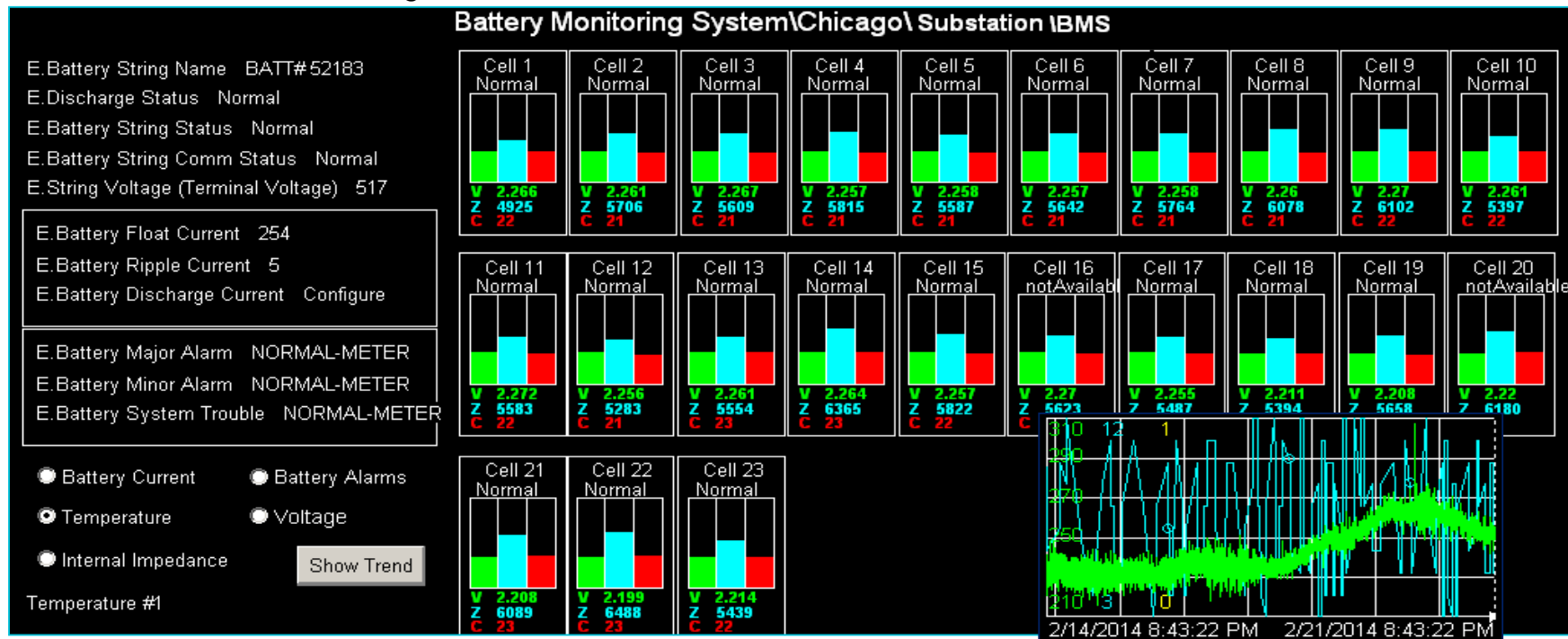
Detailed advanced Breaker Monitoring Data is available regarding electrical and mechanical time to operate for each breaker. PI Calculations are used to derive the 30 Day Max Current.



Battery Monitoring System Visualization

Detailed Battery Monitoring System Data providing measured information on cell by cell basis.

These displays are used by the T&S Equipment Standards to track component level trends that may lead to reliability issues and premature failures. Also to troubleshoot issues without having to immediately send resources onsite to investigate.



ComEd's Success Stories in Adopting Data Analytics

Identify Pre-cursor Trends

Build a Sandbox to Identify the Condition

Analyze the Results

Automate & Improve

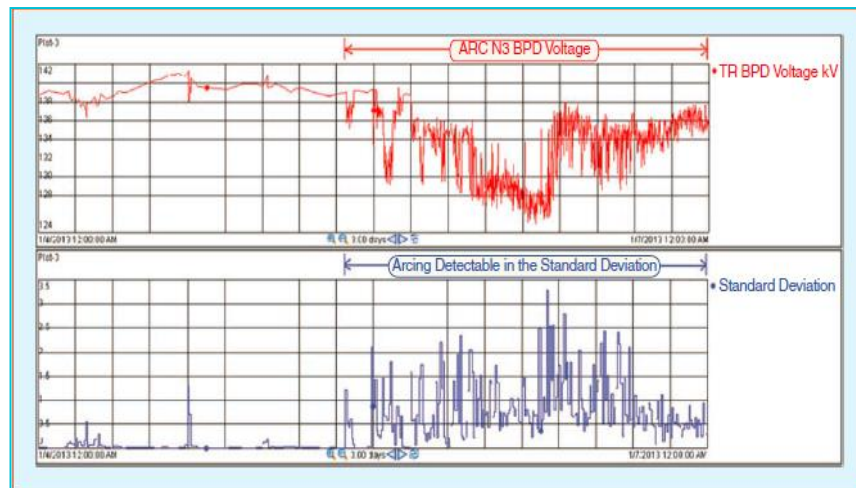
Bushing Pot Device

Identify failing bushing pot devices by detecting erratic voltage measurements

STATUS: In production, 255 transformers are monitored.

From: PI-ACE.BushingPotDeviceNotification,noreply@ceco.com
To: ComEd Bushing Pot Alarm Notification
Cc:
Subject: Bushing Pot Device Alarm - 38TR76 BKV

```
38TR76      BKV = 135.5
38TR76      M = CLOSED-METER
Start Time: 12/13/2013 6:10:00 AM
3 day Stdev = 3.772986
10 min Stdev values for the past hour:
12/13/2013 6:00:00 AM to 12/13/2013 6:10:00 AM = 0.042971
12/13/2013 5:50:00 AM to 12/13/2013 6:00:00 AM = 0.043006
12/13/2013 5:40:00 AM to 12/13/2013 5:50:00 AM = 1.120646
12/13/2013 5:30:00 AM to 12/13/2013 5:40:00 AM = 4.730449
12/13/2013 5:20:00 AM to 12/13/2013 5:30:00 AM = 7.349881
12/13/2013 5:10:00 AM to 12/13/2013 5:20:00 AM = 5.998719
```



OUTLOOK: Working as expected. We have already prevented several transformer outages by notifying Engineers in time.

ACE
PI

Success Stories Continued...

Identify Pre-cursor Trends

Build a Sandbox to Identify the Condition

Analyze the Results

Automate & Improve

Transformer Paralleling

We detect excessive circulating VAR's between transformers which cause operational inefficiencies.

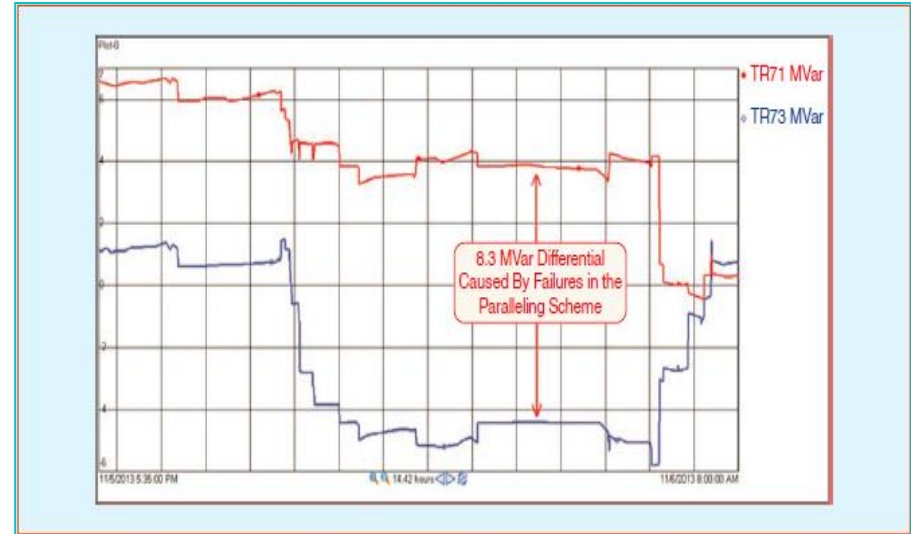
STATUS: Analytic running at 53 substations.

Transformers in Alarm - Weekly Detail Report

Report Period: 1/30/2014 - 2/6/2014

Date & Time	Substation Name	Type	Transformer Pairs in Parallel	Maximum MVar Difference
1/30/2014 12:10:00 AM	SUBSTATION 1	A-2	TR71 - TR73	7.125
1/30/2014 7:40:00 AM	SUBSTATION 1	A-2	TR71 - TR73	7.625
1/30/2014 11:40:00 PM	SUBSTATION 1	A-2	TR71 - TR73	7.125

Report Created at: 2/13/2014 2:06:14 PM]



OUTLOOK: Paralleling issues identified at numerous locations. Taught us about the benefits of weekly reports rather than instantaneous notifications.



Success Stories Continued...

Identify Pre-cursor
Trends

Build a Sandbox to
Identify the Condition

Analyze the Results

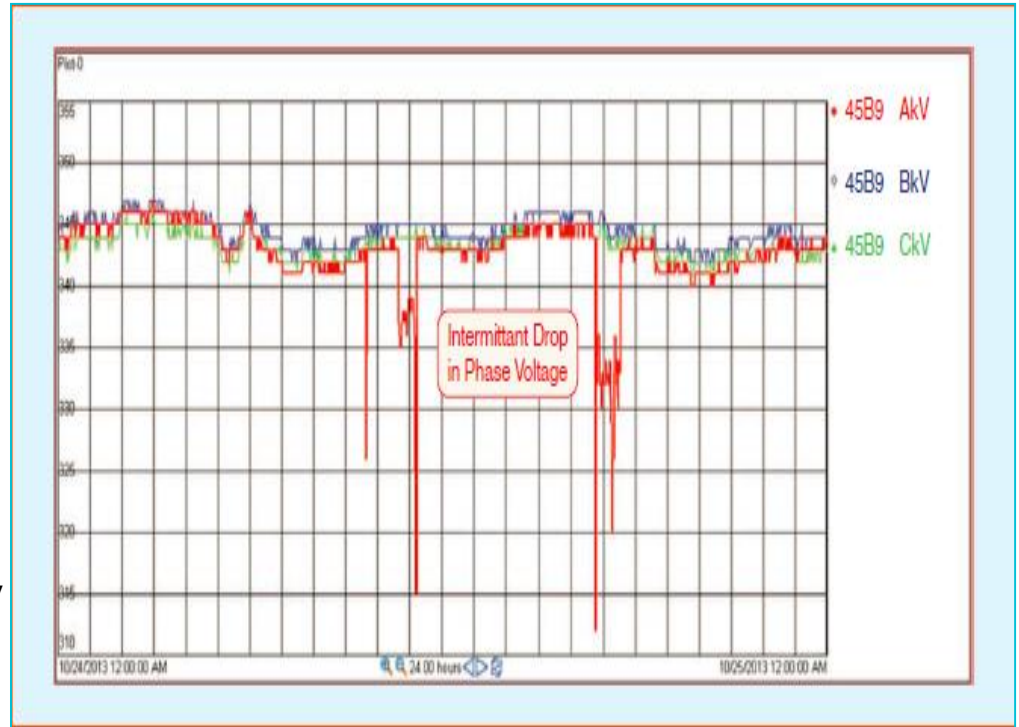
Automate & Improve

Intermittent Electrical Condition

Identifies when an intermittent electrical condition is present and notifies the field engineer to visit the equipment with the least possible delay.

STATUS: The notification was implemented within 8 hours.

OUTLOOK: The collaborative effort between Engineering and IT to deploy this type of notification in hours was achieved.



Contingency Analysis

Identify
Contingencies

Build Logic

Process

Visualize

Special Protection Schemes

Created contingency displays for complex scenarios for dispatchers. Zooming feature allows engineers to view the logic behind the schemes.

STATUS: The concept has been proven.

The following conditions initiate a trip of one of the Generating Station Units:

- I. With Generating Station Unit 2 operating while Unit 1 is out of service,
NORMAL 1) ☐ Any multi-phase fault on LINE 3 close to Generating Station
- II. With Generating Station Unit 1 operating while Unit 2 is out of service,
NORMAL 1) ☐ Any multi-phase fault on LINE 3 close to Generating Station
ARMED 2) ☐ Any multi-phase fault on Bus 1 at Generating Station and a

```
[[if (A and B and not(C)) then W else X]]
```

A= \SUBSTATION\ Data Points\ STATION UNIT 1\ IsClosed

TRUE

B= \SUBSTATION\ Interrupted Paths | LINE 3

TRUE

☐ C= \SUBSTATION\ Interrupted Paths | LINE 6

FALSE

W= \SUBSTATION\ Data Points\ ARMED

ARMED

X= \SUBSTATION\ Data Points\ NORMAL

NORMAL

OUTLOOK: Provide immediate situational awareness to contingency events.



Substation Security

Identify Objective

Build Logic

Visualize

Respond

A screening tool for the dispatchers to identify unauthorized substation entry.

STATUS: In use since 2010

OUTLOOK: Successfully aided in apprehending several intruders.

North

South

Chicago

West

T-North

T-South

T-Chicago

T-West

ALARM

ALARM

View Alarms

View Alarms

All Alarms

UnResolved: 9 Unacknowledged: 4

Rows Per Page: 10

Deselect All

Select All

☒ North
☒ South
☒ Chicago
☒ West
☒ T-North
☒ T-South
☒ T-Chicago
☒ T-West

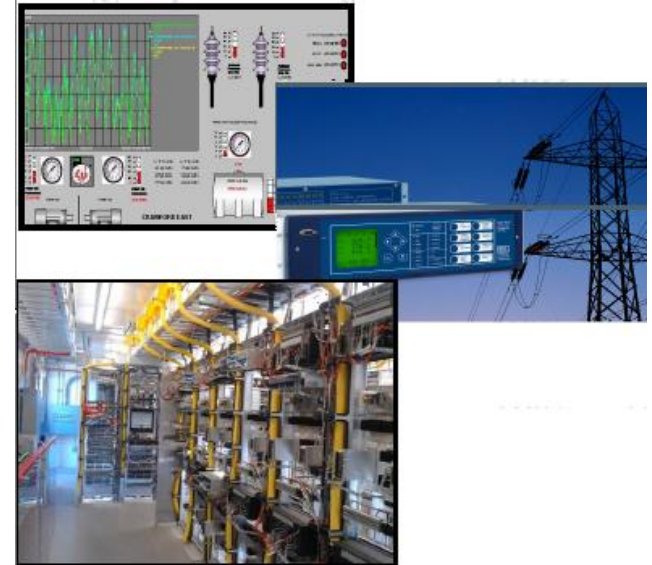
View Selected

Clear Filters

Region	Site	Door	Alarm Time	Acknowledged By	Acknowledged Time	Select All	Select All
	Site Filter OFF	Door Filter Off				Acknowledge	Resolve
CHICAGO	SUBSTATION 1	SUBSTATION 1 BLDG DOOR	03/05/2014 19:23:38			<input type="checkbox"/>	<input type="checkbox"/>
CHICAGO	SUBSTATION 2	SUBSTATION 2 BLDG DOOR	03/05/2014 19:17:52	harwmp	03/05/2014 19:19:50	<input type="checkbox"/>	<input type="checkbox"/>

ComEd's Experience of Smart Data Analytics and Visualization

As part of ComEd's grid modernization program, the Operations , Engineering and IT departments are working together to come up with new ideas and develop new tools to capture the benefits of the collected big data.



Business Challenge

Challenge to deal with hundreds of assets for which information needs to be organized. A formidable task to monitor the data associated with hundreds of grid components in reasonable amount of time.

Solution

Detailed asset models for Substations to improve Data Visualization.
Automate and apply logical algorithms for monitoring hundreds of targeted pieces of equipment.

Results and Benefits

Engineers are certain that the vital equipment is being monitored around the clock.
Implements standardization across Substations within ComEd.

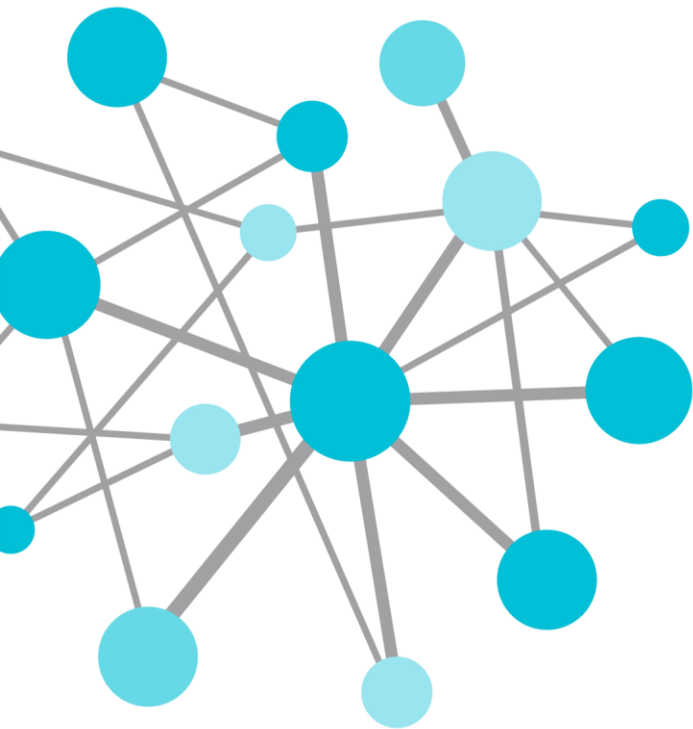
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