REAL-TIME PERFORMANCE MANAGEMENT FOR THE ENTERPRISE

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Perspectives on NERC

And Impacts on Utilities

Who is PJM?

- PJM Interconnection is a regional transmission organization (RTO) that plays a vital role in the U.S. electric system.

- PJM ensures the reliability of the largest centrally dispatched control area in North America by coordinating the movement of electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

- PJM, acting neutrally and independently, operates the largest competitive wholesale electricity market in the world.

- PJM manages a sophisticated regional planning process for generation and transmission expansion to assure future electric reliability.

- PJM facilitates a collaborative stakeholder process. Stakeholders include participants that produce, buy, sell, move and regulate electricity.

PJM stats

- Population of area served: >45 million.

- Over 1,000 sources of electrical generation.

- Generating capacity: ~140 Gigawatts.

- Transmission line miles: ~50,000 miles.

- Annual energy delivery: ~625 Gigawatt hours.

- PI Tags – you don't want to know.

What is NERC?

- North American Electric Reliability Council

- NERC mission is to ensure that the bulk electric system in North America is reliable, adequate and secure.

- Voluntary organization – for now.

- Divided in regional reliability councils.

NERC regional councils

NERC approach to it mission

- Create standards

  - Organized into 14 categories

- Monitor compliance with standards

  - Reporting

- Auditing

What does NERC want?

- NERC standards and procedures are the backbone of the reliability of the electrical system.

- NERC needs enough information to be able to asses the effectiveness of the existing documents.

- While the reporting requirements are published – NERC could ask for just about anything.

What happens if NERC doesn't like what you send them?

- There are numerous "procedural adjustments" that can be made to the operation of an electrical system.

- Adjustments are designed to enhance the reliability of the grid.

- Invariably, these adjustments end up having a cost associated with them.

Ex: Spinning Reserve

- Spinning Reserve is extra generation maintained in an on-line, but generating very little power, state.

- Used to compensate for the unexpected outage of a generator that was producing power.

- NERC has guidelines for how long it should take to handle a "unit trip" event.

- Take too long, and NERC procedures dictate that you must now maintain more spinning reserve.

Fine, so why PI?

- Even if we stored data only for the required reporting, it's huge. There are only ~200 variables, but:

  – NERC data is sampled every 2 seconds

  – ~17 million 2 second intervals / retention cycle

  – Oracle tables with <u>3.5 billion</u> rows? No thanks!

- There is a lot of other data we would like to keep, and we would like to keep it longer than 13 months.

Why PI? (continued)

- Real-Time access to the data

- NERC reporting calculations are simple. If the data is available in real time, you can easily provide NERC based KPIs to the operators.

- Operators can make better control decisions, helping to improve the end of month results reported back to NERC.

Case Study: CPS

- Control Performance Specification

  – Measures the degree to which the grid is in control

  – #1 Frequency check

  – #2 Area Control Error (ACE) check

- CPS compliance is reported to NERC monthly. It is the most prominent indication of how effectively a control entity is doing its job.

Following the standard for CPS

- In order to follow a standard you need to you (along with what it says) how you are doing at any point in time.

- PI ProcessBook and PI DataLink allow us to display to operators and operations engineers the status of our CPS compliance *in real time.*

- Real time access to this data allows corrections to be made, eliminating periods of non-compliance.
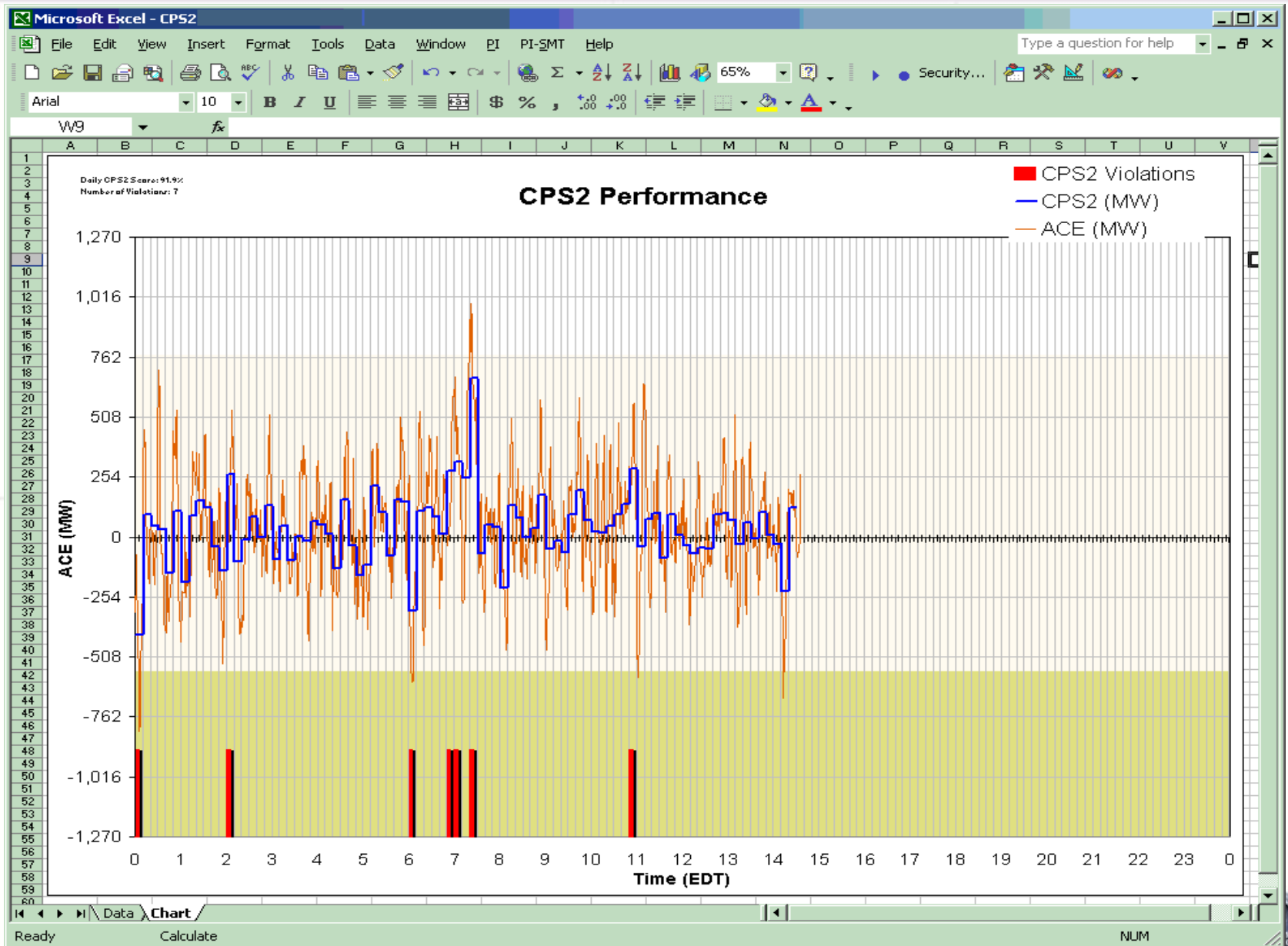
Reporting on CPS

- The CPS report follows a format established by NERC.

- Luckily – it's an Excel spreadsheet so population of the data from PI DataLink is a breeze!

- Automation of delivery of the report to NERC eliminates the possibility of non-compliance through omission

  - Users still get to approve the report, but the workflow is automated

Tips for Excel based reporting:

- Treat Excel reports the same way as you would treat an HTML application

  - Separate the logic from the presentation. Fetch data, do calculations and present the results on separate worksheets.

  - Control access to the workbook the same as access to source code.

- There are many options for the automation of Excel based reports.

Auditing by NERC

- Similar to auditing by other regulatory agencies:
  - Typically on-site
  - Questions like
    - "Can you prove that this data you recorded hasn't been changed"
    - Can you prove which recorded data was used in your calculations.
- Requires independent testimony to resolve.

Auditing in a PI world

- The PI audit subsystem tracks when changes are made to critical values or configuration parameters.

  - Replaced or deleted archive events are of primary interest to NERC.

  - Changes to configuration parameters related to compression, on/off scan, etc. are also noteworthy.

  - Tying actions back to identifiable users is key, as is keeping a record of *why* things were changed.

Compliance with the spirit of the law

- The whole point of NERC is to ensure that the electrical system remains reliable and stable.

- As the grid grows, the volume of data that needs to be presented and analyzed in order to maintain effective control grows with it.

- In order to ensure that we "play nice" on the grid, we must solve this data presentation problem….

Advanced Data Visualization

- Geographically based displays have been used for years by sales and marketing folks to boil down a large volume of customer information into one easily readable chart.

- Take the following test: You have 3 seconds to decide which of the lower 48 states has the highest and the lowest frequency value using these two displays -

ALABAMA	59.8571	NEBRASKA	59.6857
ARIZONA	60.1917	NEVADA	60.1954
ARKANSAS	60.1462	NEW HAMPSHIRE	60.1765
CALIFORNIA	60.2497	NEW JERSEY	59.8425
COLORADO	60.058	NEW MEXICO	59.9161
CONNECTICUT	60.3904	NEW YORK	59.8396
DELAWARE	59.7957	NORTH CAROLINA	59.7871
FLORIDA	59.8653	NORTH DAKOTA	59.6931
GEORGIA	59.7717	OHIO	60.1305
IDAHO	59.9186	OKLAHOMA	59.9203
ILLINOIS	60.1207	OREGON	60.4833
INDIANA	60.2887	PENNSYLVANIA	60.3478
IOWA	60.4489	RHODE ISLAND	60.051
KANSAS	59.8669	SOUTH CAROLINA	59.6484
KENTUCKY	59.6941	SOUTH DAKOTA	60.3586
LOUISIANA	60.0199	TENNESSEE	59.5161
MAINE	60.264	TEXAS	60.4831
MARYLAND	59.6859	UTAH	59.5804
MASSACHUSETTS	60.1167	VERMONT	59.8826
MICHIGAN	60.1787	VIRGINIA	59.6037
MINNESOTA	59.6652	WASHINGTON	59.9906
MISSISSIPPI	60.4381	WEST VIRGINIA	59.8093
MISSOURI	60.3916	WISCONSIN	60.2655
MONTANA	59.6337	WYOMING	59.8618
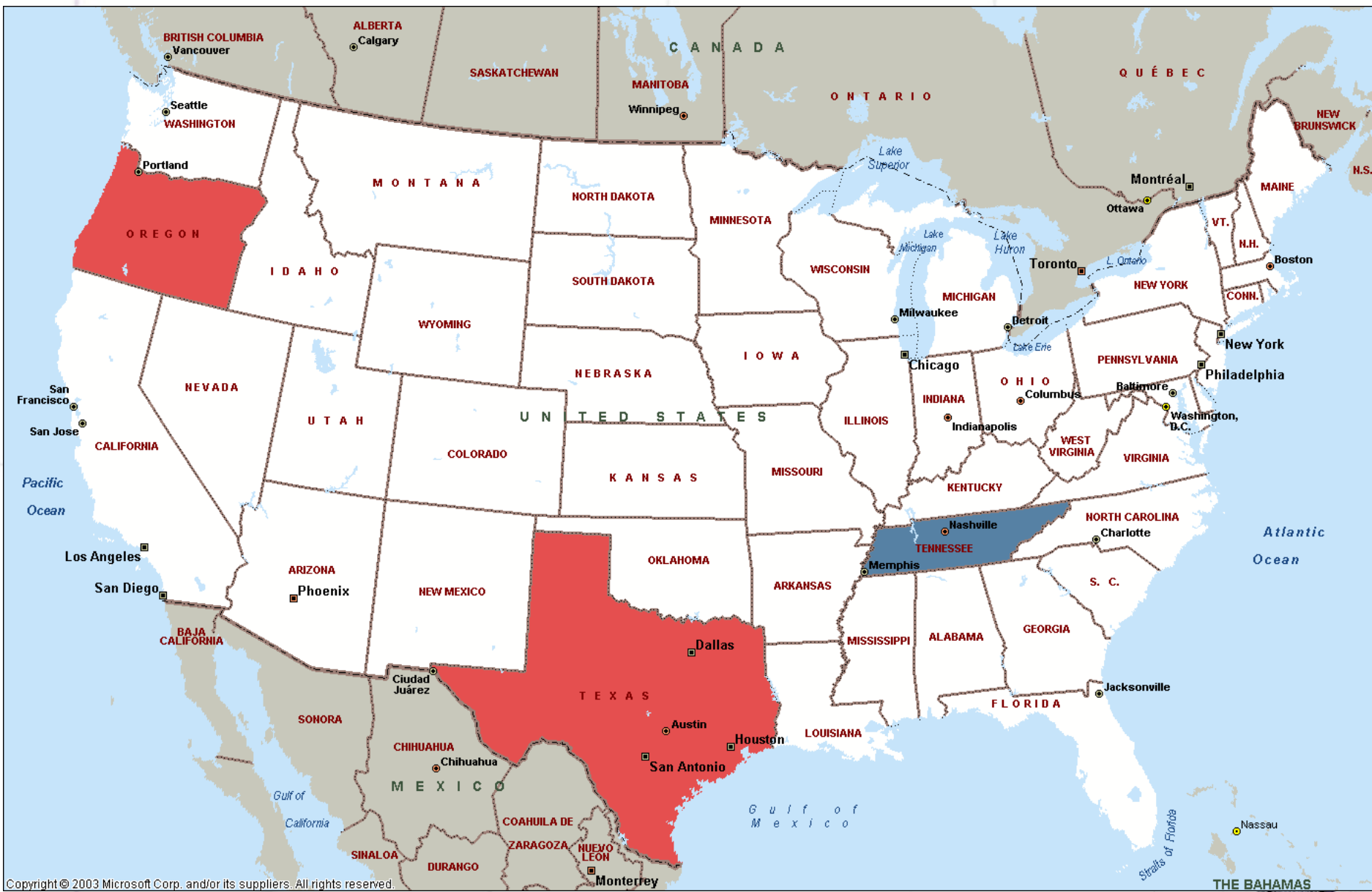
How did you do?

- Texas and Oregon have high frequency, Tennessee is low.

- This exercise involves only 50 data points and the comprehension delta is obvious.
  - Even with the text list sorted and color coded, almost no-one gets the correct answer in 3 seconds.

- There are over 100,000 data points that must be reviewed in order to ascertain the condition of the transmission system in the PJM footprint.

PI can provide the necessary data

- The point of this is that PI is capable of delivering to our visualization toolset the requisite set of data needed.

- This visualization technology is necessary for us to make control decisions consistent with NERC guidelines.

- Relational database technology is simply not up to the task.

NERC 1200 and 1300

- Cyber security standards from NERC

- 1200 published in 8/2003

  – Subtitled "Urgent Action"

- 1300 is the permanent standard

  – Expected in 8/2005

- Cover a substantial breadth of security related topics.

  – Far beyond "change your passwords" type advice.

What's in 'em?

- Physical security

- Electronic security

- System monitoring

- Data monitoring

- Incident response

- Recovery planning

Two implications for PI

- PI as a system must conform to the rules set forth in 1200/1300

- Requires some changes to the default configuration, but not many

- Requires the use of trust-based logins

  – This realistically means that you need to be using the version 3.x or later client tools.

- 1200 includes verbiage about backups.

Monitoring

- NERC included substantial language in the standards on the subject of system monitoring.

- Control systems typically fall outside of the sphere of IT system monitoring
  - Isolation of the system
  - Proprietary nature of the control systems
  - Traditionally few problems

Why is monitoring included?

- You can't manage what you don't monitor

- The fact that control systems are typically very stable makes system monitoring a good indicator of possible attacks

- Hardware dies, software fails, and people make mistakes

  – When the vendor tells you "our system never crashes" … RUN!

Enter IT monitor

- PI with interfaces to IT protocols
  - SNMP
  - Windows performance counters
  - PING
- *Already has access to the control system*
- Familiar to the control system users
- Inherits all of the capabilities of the PI system with respect to reporting and auditing.

Conclusion

- NERC is all about reliability

- Compliance with NERC involves not only reporting against their standards, but actively working towards the enhancement of grid reliability

- With security becoming a bigger concern all the time, system monitoring has become an essential component of control system management.

Questions?