Real-time Visualization of Power Systems Using PowerWorld and the PI

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Introduction

- ComEd - Who We Are
- Motivation
- Implementation
- Examples
- Summary - Lessons Learned

ComEd - Who We Are

- Electric Utility for Chicago and Northern Illinois
- Subsidiary of Exelon Corp.
  - Exelon Energy Delivery
    - ComEd
    - PECO
- 3.4 Million Customers
- Peak Load: August 1, 2002 - 21,804 MW

PI Usage at ComEd

- PI has been in place since mid-1998
- ComEd's Transmission and Distribution PI has 246,827 points as of 9/20/2002
- 5 T&D PI Servers
  - 1 Transmission
  - 4 Distribution

Motivation

- Mapboard Replacement
  - Mosaic mapboard was replaced with 12 Electrohome “cubes” in 1999
  - The displays initially put on the new mapboard were unsatisfactory
- Progression of Data Requirements
  - The amount of data that dispatchers must process is constantly increasing
  - Use new techniques to visualize data

Chicago Edison - 1904

Commonweath Edison -1919

Recent ComEd Control Center

Implementation

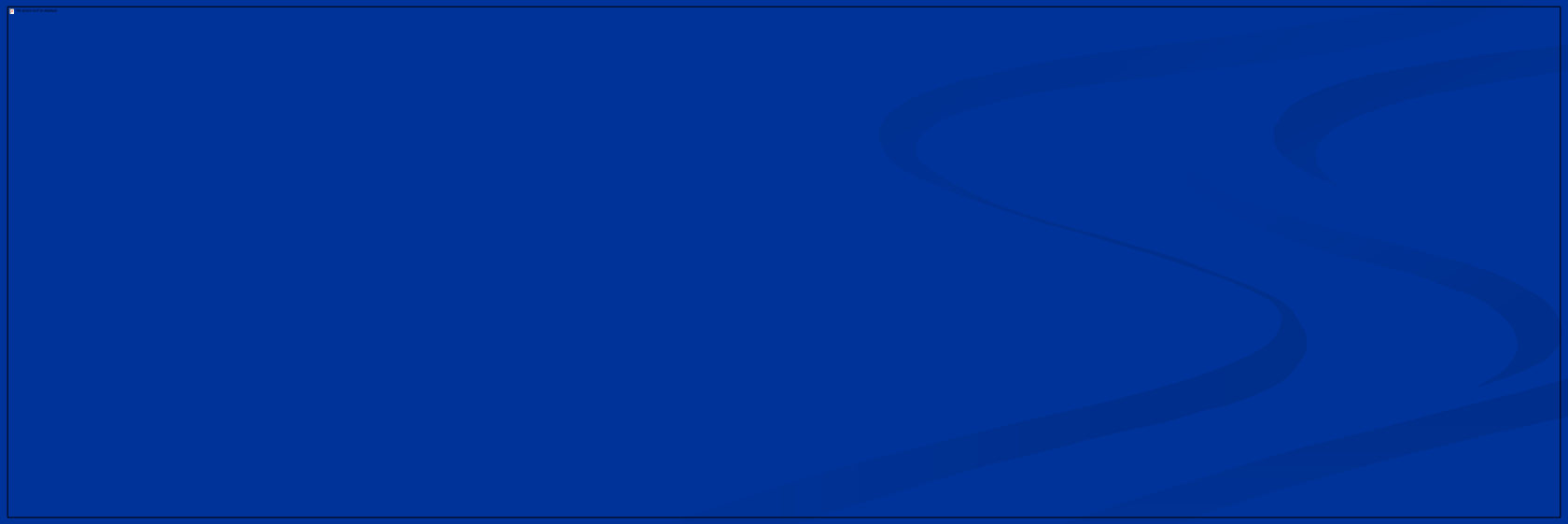
- Use of Improved Technologies
- Data Visualization
- ComEd/PowerWorld Visualization Project

Use of Improved Technologies

- Modern computing and display technologies give us new capabilities…
  - Improved displays, i.e., smaller pixels
  - More computing power - 3D in real-time
- How Do We Take Advantage of New Technology?
  - Better implementation of existing displays
  - New displays not previously possible

The Way Not To Do It…

- Electronic mapboard
  - The dispatchers considered this to be a step backward.



Data Visualization…

- New Visualization Techniques
  - Use of graphical elements to show direction of power flow, line loading, etc...
  - Contouring
  - 3D

ComEd/PowerWorld Visualization Project

- PowerWorld
  - Performs analysis of power systems and shows the results graphically
  - PowerWorld software was not originally designed for real-time analysis
- ComEd contracted with PowerWorld Corp. to add real-time capabilities.
  - “PowerWorld Retriever”

Bringing Measurements Into PowerWorld

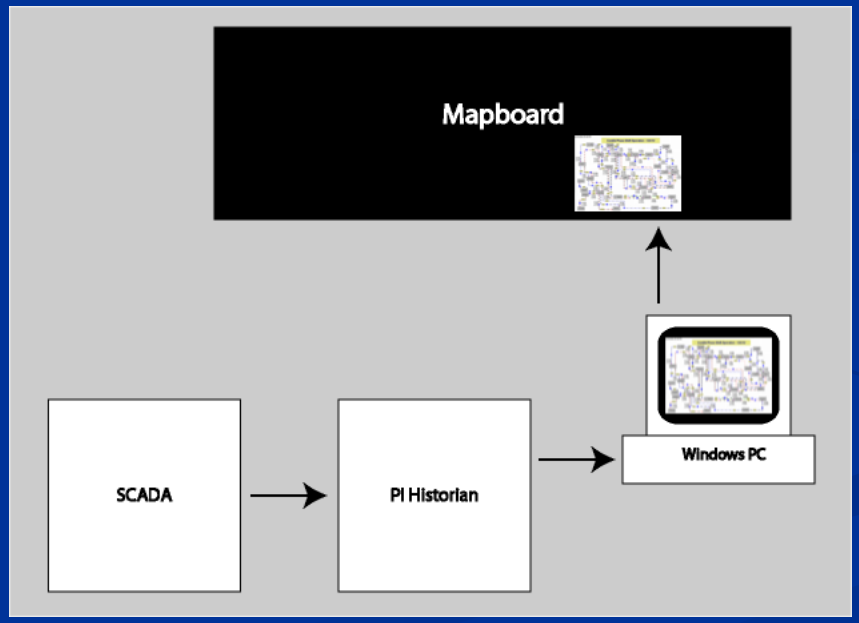
- PI Historian
  - Real-time Data
  - Historical Data
- Other Possibilities For Data Sources
  - Text Files
  - Remote Databases, i.e., Oracle, etc...

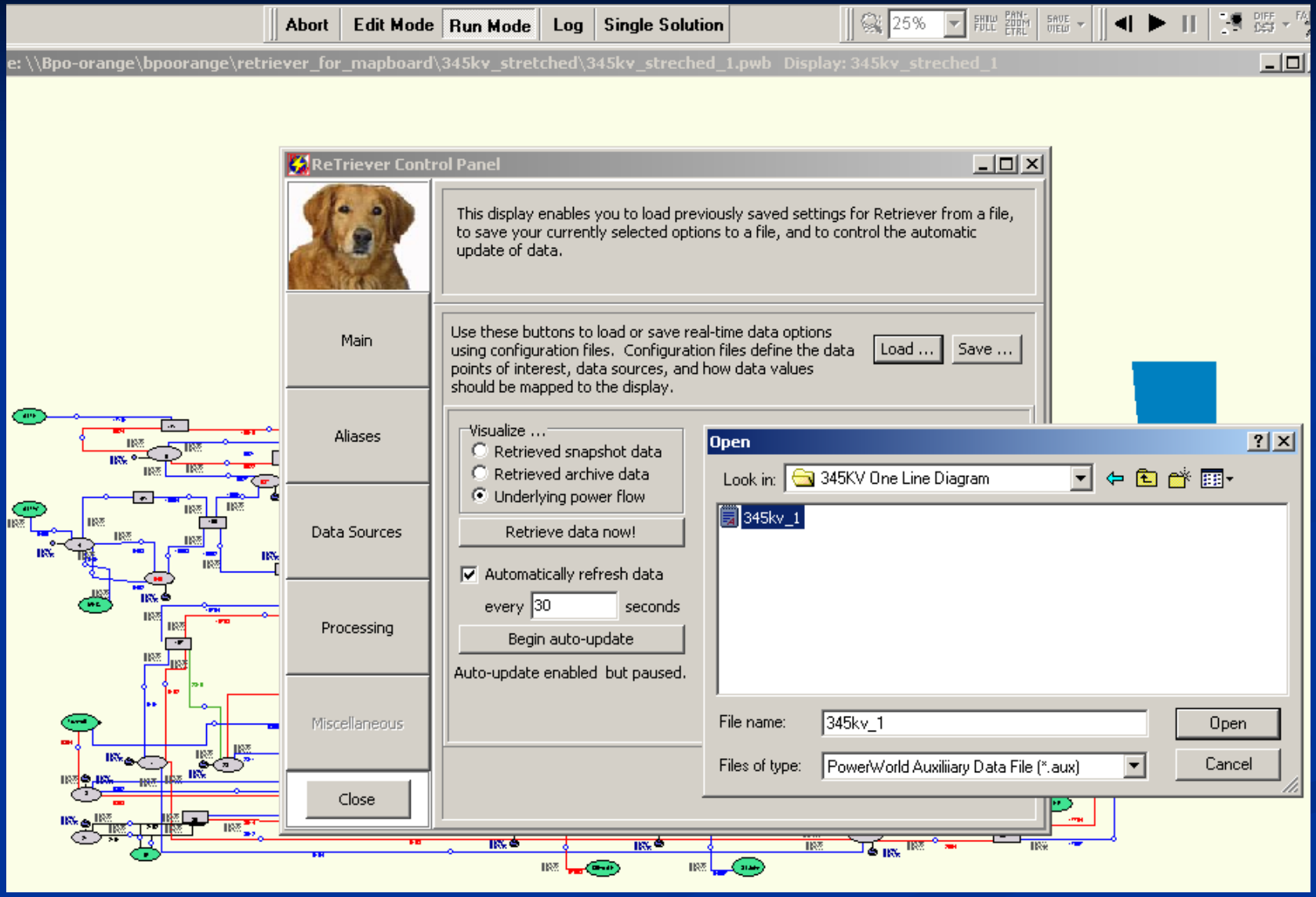
ComEd Implementation

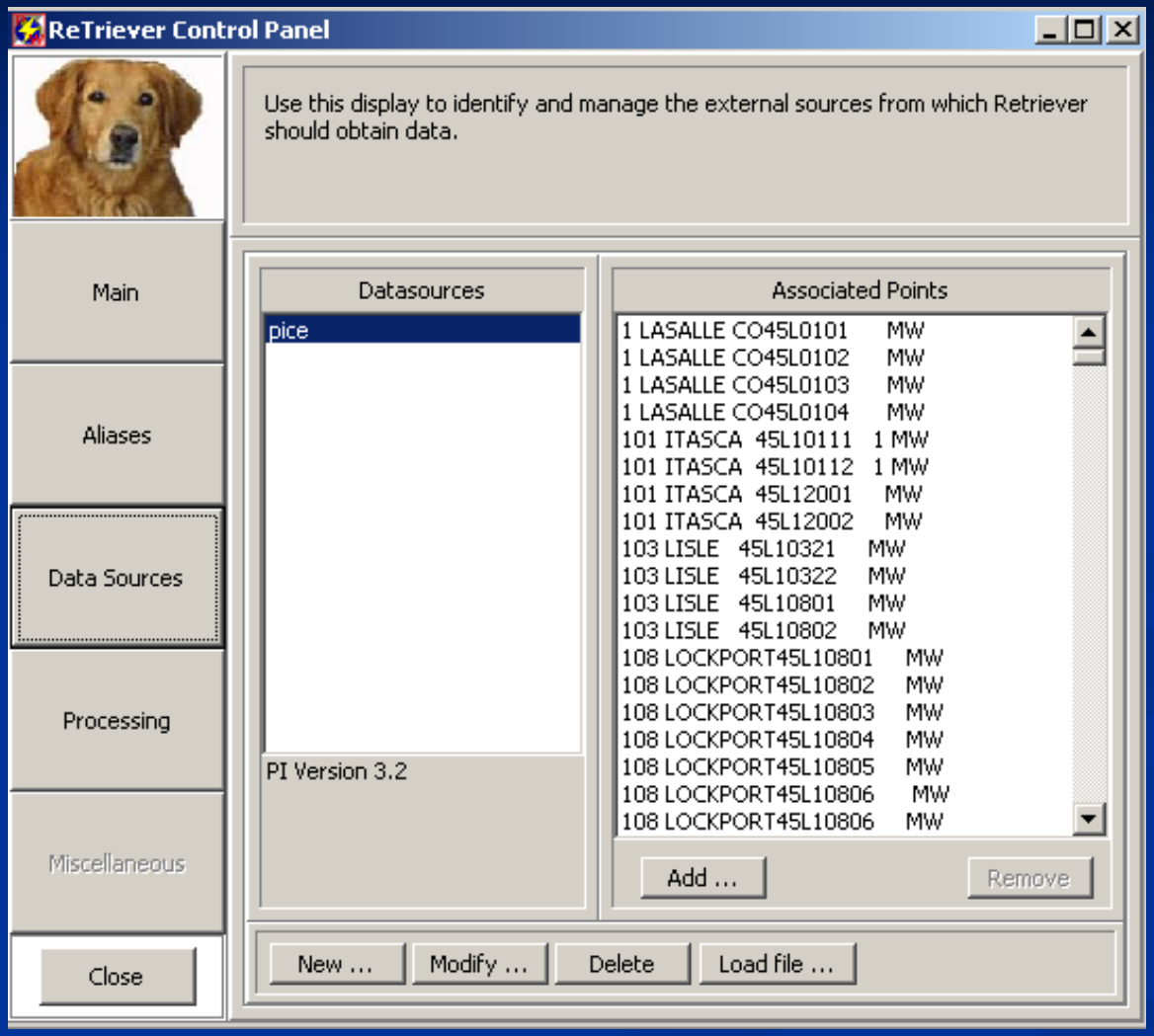
- Mapboard
- Connecting PowerWorld to the PI Historian

Mapboard

- PowerWorld Display




Abort
Edit Mode
Run Mode
Log
Single Solution
25%
e: \\Bpo-orange\bpoorange\retriever_for_mapboard\345kv_stretched\345kv_streched_1.pwb Display: 345kv_streched_1
ReTriever Control Panel
This display enables you to load previously saved settings for Retriever from a file, to save your currently selected options to a file, and to control the automatic update of data.
Main
Aliases
Data Sources
Processing
Miscellaneous
Close
Use these buttons to load or save real-time data options using configuration files. Configuration files define the data points of interest, data sources, and how data values should be mapped to the display.
Load ...
Save ...
Visualize ...
Retrieved snapshot data
Retrieved archive data
Underlying power flow
Retrieve data now!
Automatically refresh data
every 30 seconds
Begin auto-update
Auto-update enabled but paused.
Open
Look in: 345KV One Line Diagram
345kv_1
File name: 345kv_1
Open
Files of type: PowerWorld Auxiliary Data File (*.aux)
Cancel


ReTriever Control Panel
Use this display to identify and manage the external sources from which Retriever should obtain data.
Main
Aliases
Data Sources
Processing
Miscellaneous
Close
Datasources
pice
PI Version 3.2
Associated Points
1 LASALLE CO45L0101 MW
1 LASALLE CO45L0102 MW
1 LASALLE CO45L0103 MW
1 LASALLE CO45L0104 MW
101 ITASCA 45L10111 1 MW
101 ITASCA 45L10112 1 MW
101 ITASCA 45L12001 MW
101 ITASCA 45L12002 MW
103 LISLE 45L10321 MW
103 LISLE 45L10322 MW
103 LISLE 45L10801 MW
103 LISLE 45L10802 MW
108 LOCKPORT45L10801 MW
108 LOCKPORT45L10802 MW
108 LOCKPORT45L10803 MW
108 LOCKPORT45L10804 MW
108 LOCKPORT45L10805 MW
108 LOCKPORT45L10806 MW
108 LOCKPORT45L10806 MW
Add ...
Remove
New ...
Modify ...
Delete
Load file ...

ReTriever Control Panel

Main

Aliases

Data Sources

Processing

Miscellaneous

Close

Aliases are used to map data from external sources into this application. Use this display to manage the list of aliases that are currently recognized.

Aliases

1 LASALLE CO24U LA-1 MVA
1 LASALLE CO24U LA-1 MVR
1 LASALLE CO24U LA-1 MW
1 LASALLE CO24U LA-2 MVA
1 LASALLE CO24U LA-2 MVR
1 LASALLE CO24U LA-2 MW
1 LASALLE CO45L0101 MVA
1 LASALLE CO45L0101 MVR
1 LASALLE CO45L0101 MW
1 LASALLE CO45L0102 MVA
1 LASALLE CO45L0102 MVR
1 LASALLE CO45L0102 MW
1 LASALLE CO45L0103 MVA
1 LASALLE CO45L0103 MVR
1 LASALLE CO45L0103 MW
1 LASALLE CO45L0104 MVA
1 LASALLE CO45L0104 MVR
1 LASALLE CO45L0104 MW
101 ITASCA 45L10111 1 MVA
101 ITASCA 45L10111 1 MVR

Load ...

New ...

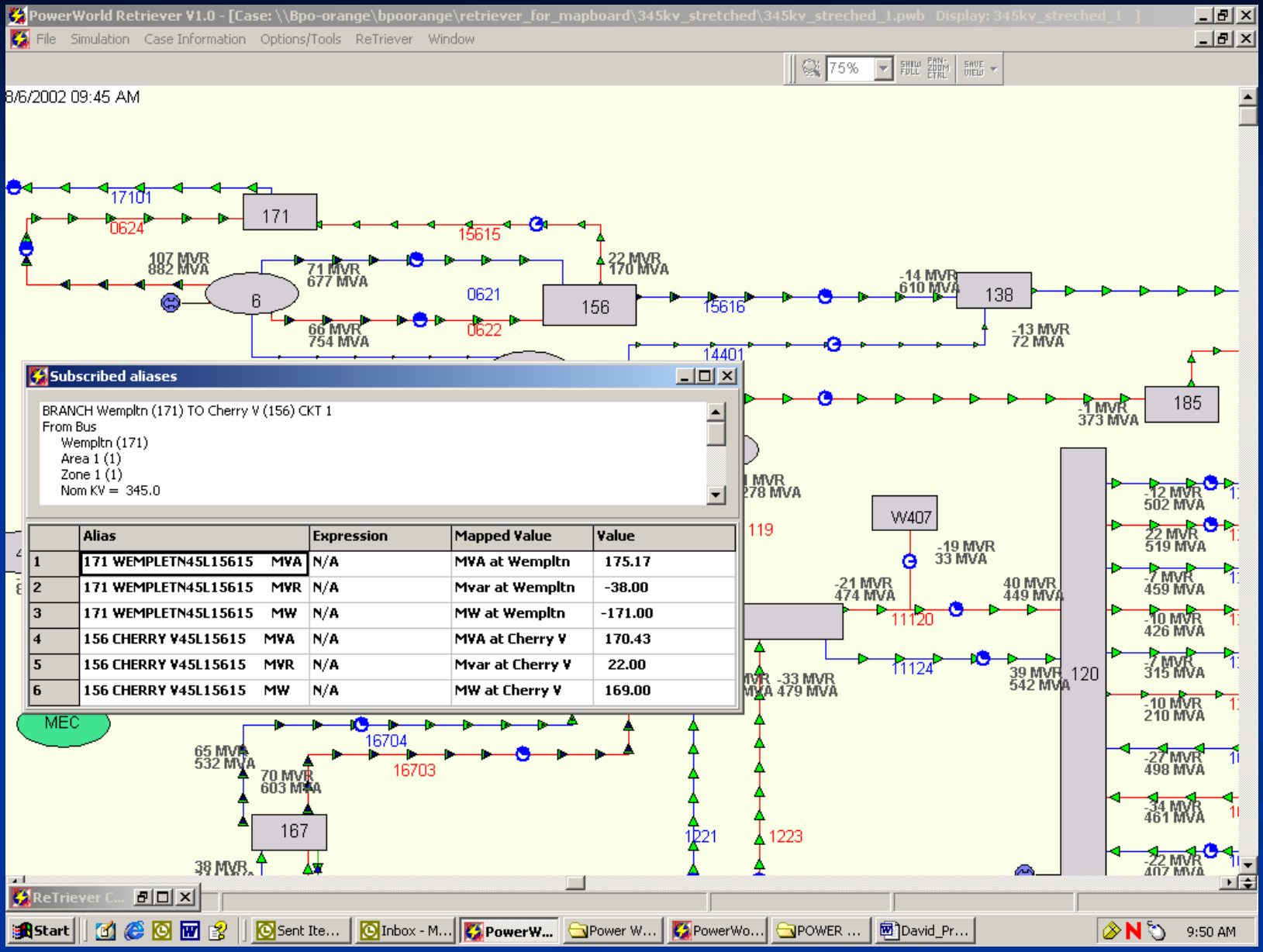
Modify ...

Delete

Search ...

Subscriptions

Enable drag-and-drop registration


PowerWorld Retriever V1.0 - [Case: \\Bpo-orange\bpoorange\retriever_for_mapboard\345kv_stretched\345kv_streched_1.pwb Display: 345kv_streched_1]
File Simulation Case Information Options/Tools ReTriever Window
8/6/2002 09:45 AM
Subscribed aliases
BRANCH Wempltn (171) TO Cherry V (156) CKT 1
From Bus
Wempltn (171)
Area 1 (1)
Zone 1 (1)
Nom KV = 345.0
Alias Expression Mapped Value Value
1 171 WEMPLETN45L15615 MVA N/A MVA at Wempltn 175.17
2 171 WEMPLETN45L15615 MVR N/A Mvar at Wempltn -38.00
3 171 WEMPLETN45L15615 MW N/A MW at Wempltn -171.00
4 156 CHERRY V45L15615 MVA N/A MVA at Cherry V 170.43
5 156 CHERRY V45L15615 MVR N/A Mvar at Cherry V 22.00
6 156 CHERRY V45L15615 MW N/A MW at Cherry V 169.00
17101
0624
171
15615
107 MVR
882 MVA
71 MVR
677 MVA
22 MVR
170 MVA
6
0621
156
15616
-14 MVR
610 MVA
138
66 MVR
754 MVA
0622
-13 MVR
72 MVA
14401
185
-1 MVR
373 MVA
W407
-19 MVR
33 MVR
-21 MVR
474 MVA
40 MVR
449 MVA
11120
11124
39 MVR
542 MVA
120
-12 MVR
502 MVA
22 MVR
519 MVA
-7 MVR
459 MVA
-10 MVR
426 MVA
-7 MVR
315 MVA
-10 MVR
210 MVA
-27 MVR
498 MVA
-34 MVR
461 MVA
-22 MVR
407 MVA
MEC
65 MVR
532 MVA
16704
16703
70 MVR
603 MVA
167
38 MVR
1221
1223
ReTriever C...
Start
Sent Ite...
Inbox - M...
PowerW...
Power W...
PowerWo...
POWER ...
David_Pr...
9:50 AM

Examples

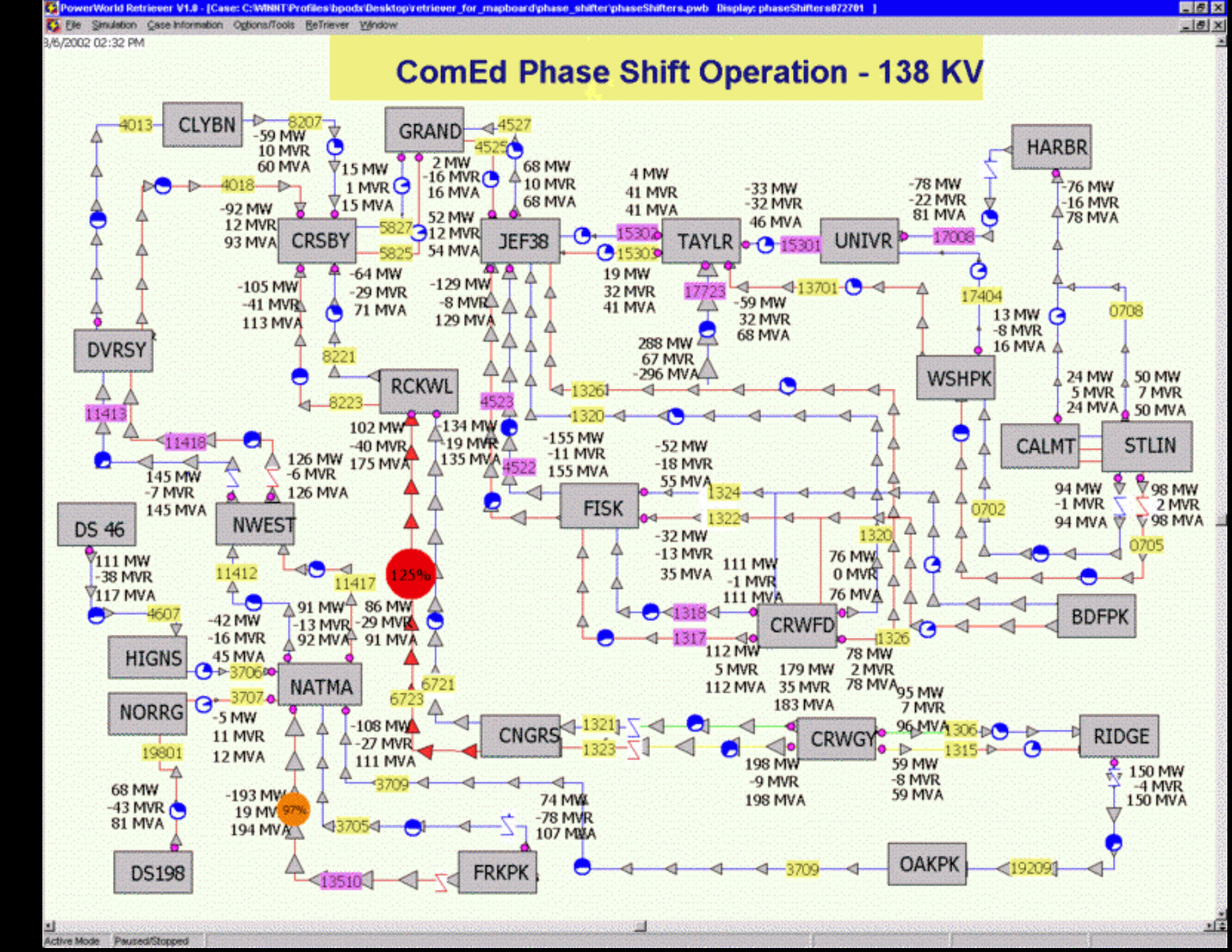
- Phase-shifter Display
- 345kV Display
- Voltage Contour

SCADA Phase-Shifter Display

Visual Phase-Shifter

- Uses color to represent system status
- Uses arrows to show line flows
  - Arrow size is proportional to line flow
  - Arrow speed is proportional to line flow
- Uses pie charts show limits

Phase Shifter Movie


PowerWorld Retriever V1.0 - [Case: C:\WINNT\Profiles\bpodx\Desktop\retriever_for_mapboard\phase_shifter\phaseShifters.pwb Display: phaseShifters072701]
File Simulation Case Information Options/Tools ReTriever Window
3/6/2002 02:32 PM
ComEd Phase Shift Operation - 138 KV
CLYBN
GRAND
HARBR
CRSBY
JEF38
TAYLR
UNIVR
DVRSY
RCKWL
WSHPK
CALMT
STLIN
DS 46
NWEST
FISK
BDFPK
CRWFD
HIGNS
NATMA
NORRG
CNGRS
CRWGY
RIDGE
DS198
FRKPK
OAKPK
125%
97%

345kV Display

- Three separate displays in the SCADA system
- Same issues as phase shifter
  - It is difficult to get a feel for where the megawatts are going
  - How do the flows compare to the ratings
  - SCADA display does not show generation

345kV Movie

345kV Movie Zoom

Voltage Contour

The Mapboard Today

Lessons Learned

- Data quality
  - Measurements that should be equal must be equal.
    - “A man who has one clock always knows what time it is. A man who has two clocks never knows what time it is.”

      -- Albert Einstein
- Proper handling of bad data is vital

Summary

- The amount of data that system operators must process will only increase.
- Modern technology should be used in ways that assist operators in making decisions.
- Improper use of technology does not help