SUBNET IoT to the PI System:

A Bridge to Support Business Use Cases

Presented by **Alan Lytz**

Ben Smith

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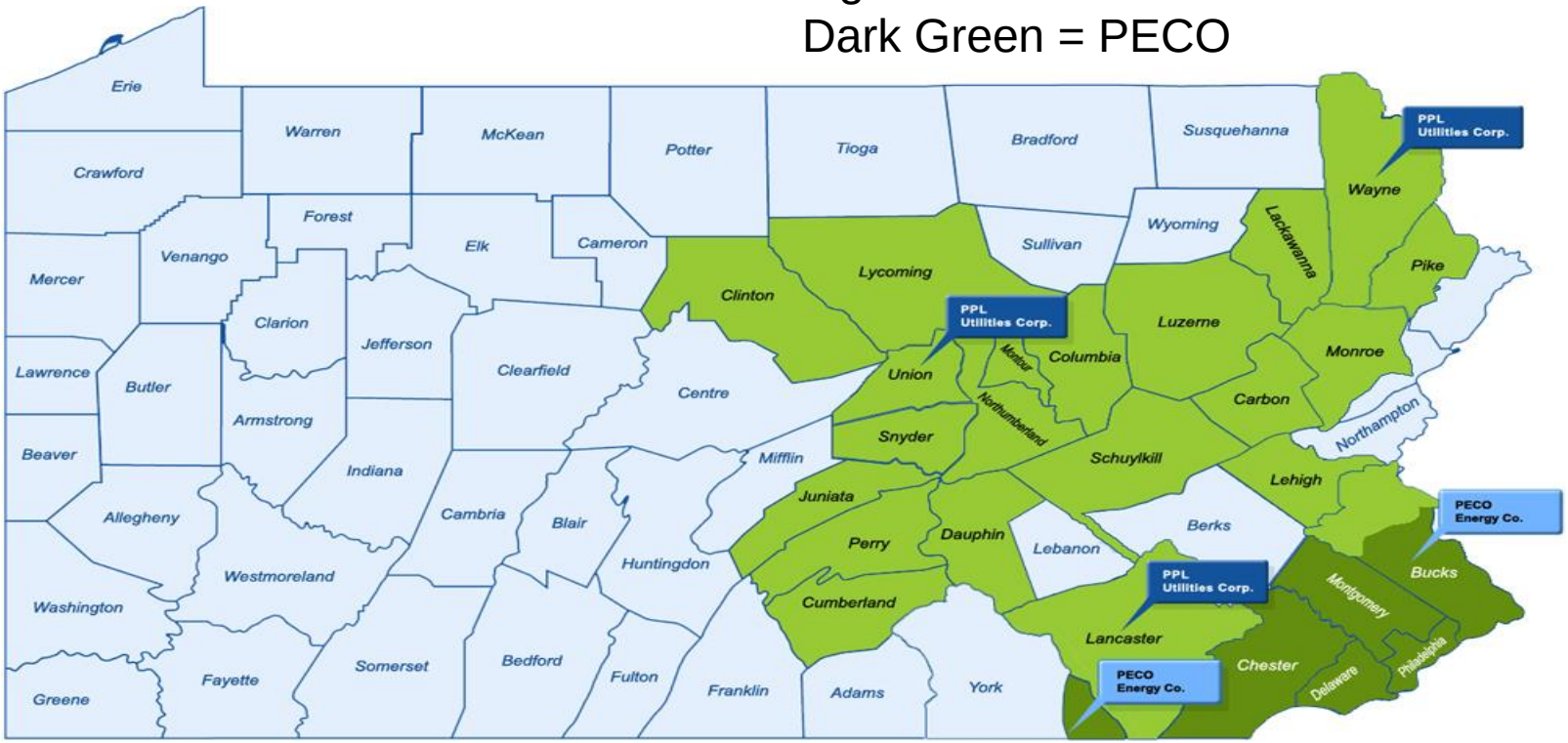
PPL Electric Utilities

- PPL Corp Parent Company of PPL EU, LGE-KU, and WPD (UK)
- PPL Electric Utilities
  - HQ: Allentown Pennsylvania
  - 10,000 sq. mile service territory in eastern PA
  - 50,000 miles of Distribution circuits
  - 8,000 miles of Transmission lines
  - 1.4 million meters (transitioning to Smart Meters)

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PPL EU Service Territory

Light Green = PPL
Dark Green = PECO

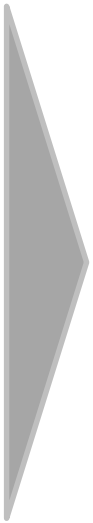


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PPL T&D Analytics PI System Goals

PPL has used PI System for over 10 years but only recently began to develop the ecosystem for advanced analytics using Asset Framework.

1. Improve System Reliability (ISR)
2. Support Condition Based Maintenance programs (CBM)
3. Provide Operational Performance Visibility (OPV)
4. Build a foundation for advanced analytics capabilities such as machine learning and predictive analytics (FFA)



- Reduce customer interruptions, improve service, and provide PPL customers with reliable power delivery
- Reduce O&M costs through improved maintenance programs driven by asset condition
- Support operator decisions by providing key data and operating conditions to support decision making
- Move towards a data driven organization, that views information as an asset

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Completed Business Driven Use Cases for ISR and CBM

These use cases were completed in 2016 by Bridge Energy Group

Power Quality Monitoring

- Detect, monitor, and diagnose high voltage events across 350 Distribution Substations
- High Bus voltage monitoring and event root cause analysis
- Foundation to build geospatial visualization for power quality issues

OH Recloser and Circuit Breaker CBM

- Electrical contacts health assessment and optimized maintenance
- Support real-time notifications of condition issues
- Foundational use case for subsequent Smart Grid asset classes

Capacitor Troubleshooting

- Rapidly determine Capacitor Bank issues by monitoring CB neutral amps
- Event Frames designed to narrow focus on critical issues, reduce research and analysis time
- Foundation for future predictive analytics for capacitor bank issues

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Business Problem That Initiated This Project

- Distribution Asset Management inspects and maintains Substation and Overhead devices.
- Rather than physical inspections, leveraging PI System data to monitor device condition saves expense dollars.
- We needed an extensible way to feed condition based data to the PI System separate from our DMS system.
- IT team needed a way to add new data to the PI System dynamically and easily.

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SCADA Data takes Two Paths to the PI System

DMS (GE / Alstom)

- Operational data **only**

  Examples:
  - Amps
  - Volts
  - Status
- How many licensed points do we use?
  - 140,000+ tags
- Comm protocol
  - DNP3

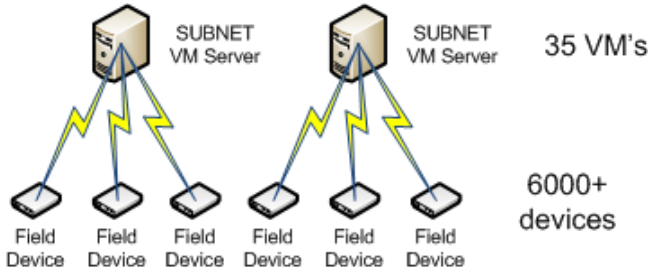
SUBNET

- Maintenance and ‘other’ data such as:
  - Device wear points
  - ArcSense High Impedance Faults
- Why send data from SUBNET to the PI System? Why not through DMS?
  - No disruptions due to DMS system maintenance, and saves on DMS point licensing
  - Support larger number of SCADA points
- Comm protocol
  - DNP3

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The SUBNET System Overview

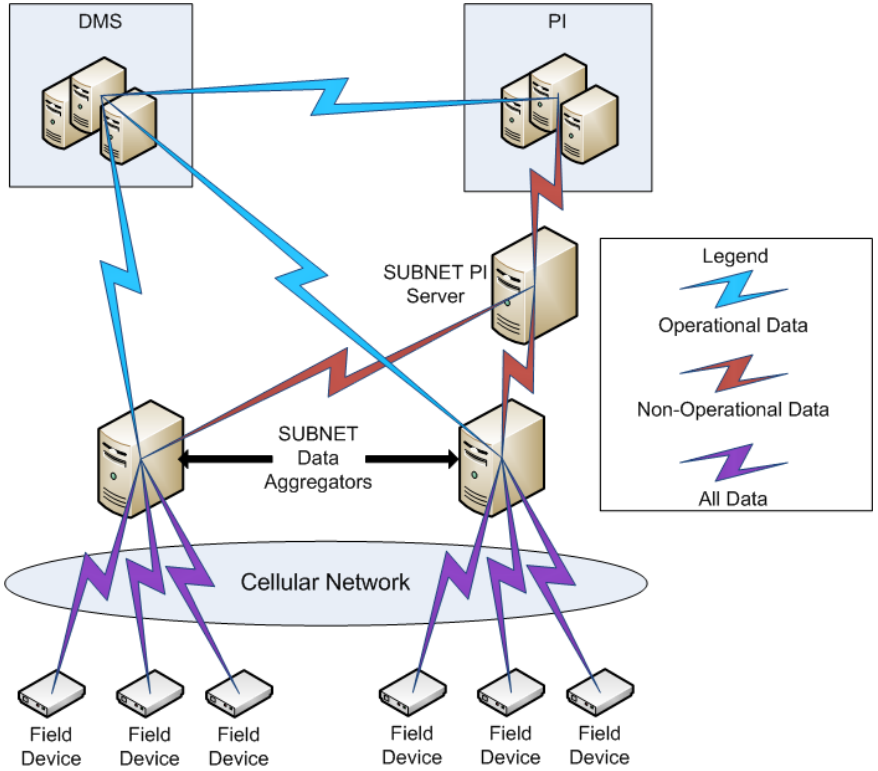
- Provides data aggregation for over 6,000 Overhead devices on a virtual server platform.
- Currently using 25 VMs with 200 devices per VM.



- Relatively simple platform to maintain and load. One main advantage is the ability to modify, stop, and start DNP devices individually.
- Other solutions frequently require restarting connections to change configurations, which can be disruptive. Our current device commissioning rate is about 6/day.

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Communications Architecture

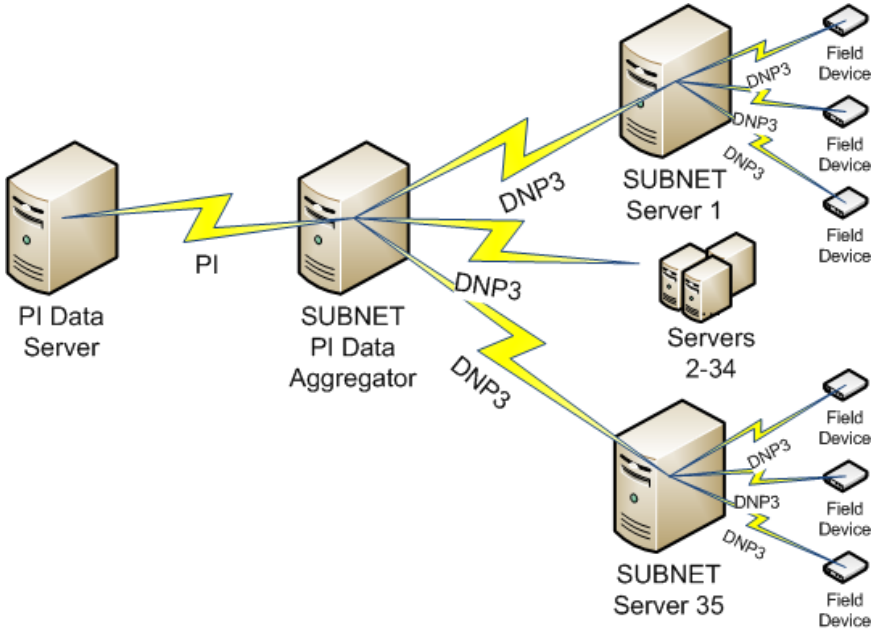


- All operational SCADA data goes to DMS and displayed to System Operators.
- Telemetry not required by DMS goes directly into the PI System. Saves on licensing and network traffic.
- DMS also send data to the PI System, which is useful for calculated outputs.

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SUBNET to PI System Development Work

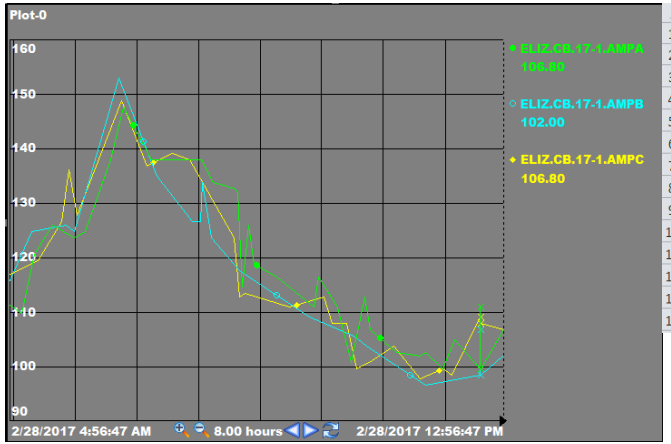
- Implemented in roughly 5 months
- Project team included 5 team members working part-time on the project
- Leveraged native SUBNET PI Interface and PI SDK
- Next steps to implement PI AFSDK



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PI System Data Use Cases & Benefits – DMS Switching Simulation

- MVA, Amps, Volts
- Operators use CB tags to decide when and where to switch



PI Peak Load Look Up for Transfer Study in DMS

Feeder ID	PI Tag	Peak Date	AMPA	AMPB	AMPC	Power Factor	Voltage Target	MW	MVAR	MVA
47001	HUGH.CB.70-1	10/26/15 7:15:00 AM	242	214	234	-0.98	96.58	5.06	-1.07	5.16
43202	MVIL.CB.32-2	10/27/15 8:15:00 AM	85	103	139	-0.99	96.10	2.38	-0.40	2.41
44701	MUNC.CB.47-1	10/27/15 7:45:00 AM	195	177	179	-0.81	98.02	3.45	-2.52	4.27
44703	MUNC.CB.47-3	10/27/15 7:30:00 AM	152	183	157	1	97.32	3.75	0.22	3.75
40701	FFLD.CB.7-1	10/27/15 8:15:00 AM	165	173	154	-0.96	97.77	3.71	-0.78	3.85
47002	HUGH.CB.70-2	10/27/15 7:00:00 AM	186	182	172	-0.99	96.76	3.98	-0.61	4.02

Time Range		Day
Start	10/21/15 6:00 AM	Wednesday
End	10/27/15 3:40 PM	Tuesday
Interval	15 m	

Note: make start and end time range smaller before changing the time interval, otherwise Excel might crash due to too much data processing. Time interval can be down to 1 s.

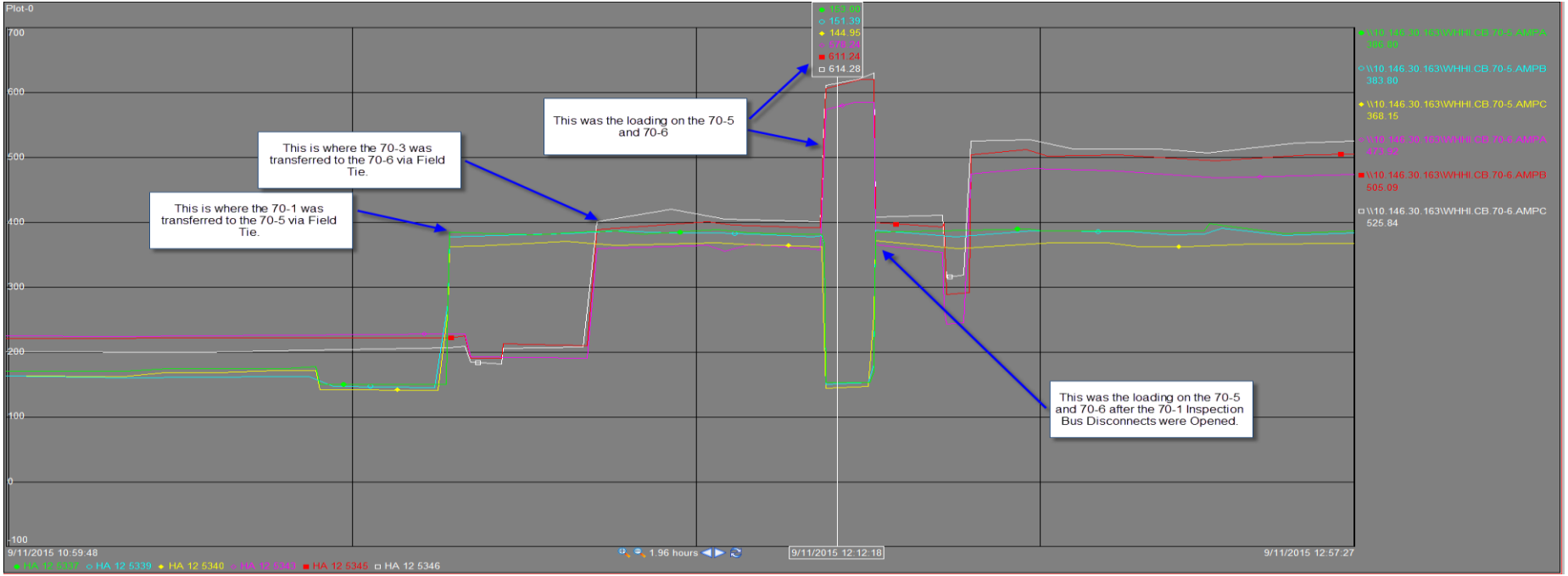
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PI System Use Cases and Benefits – Transfer Tool

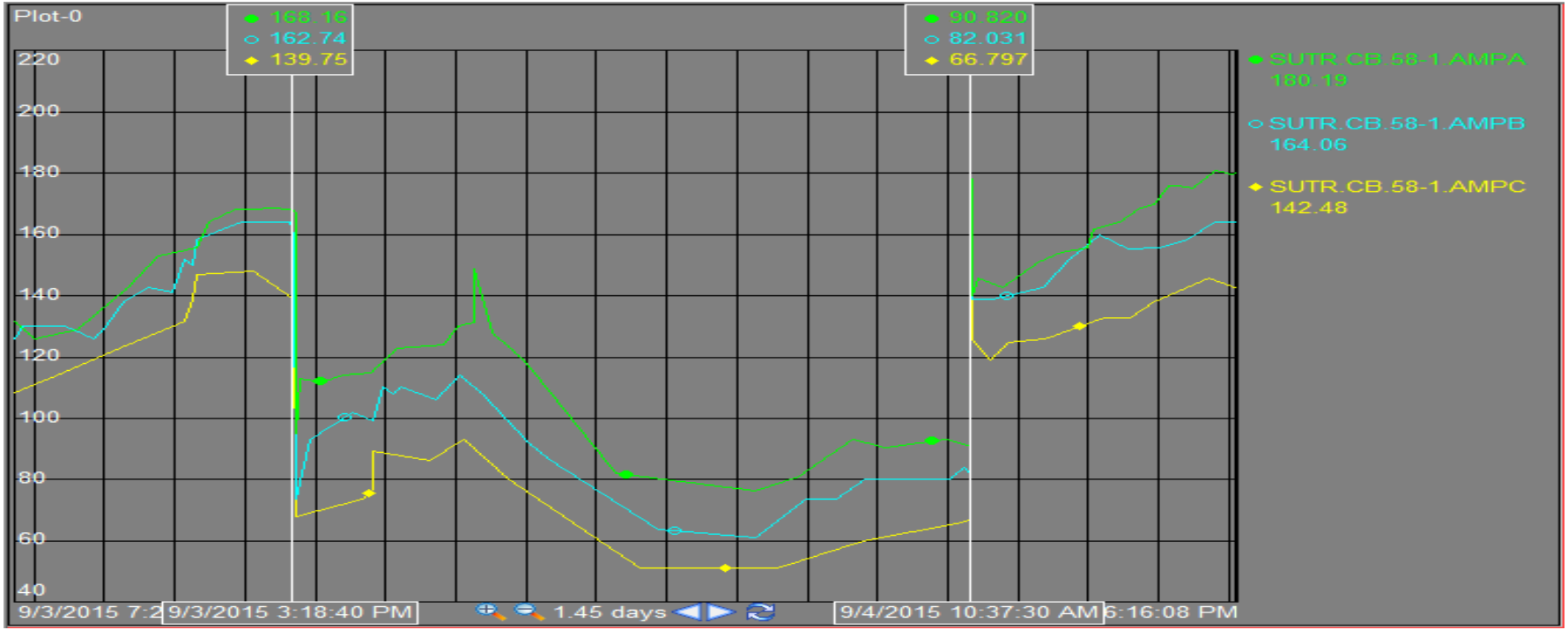
- PI ProcessBook / PI Coresight are used as a real-time tools by System Operators.
- The display below shows a screen used by operators when transferring load from one CB to another to ensure that the load transfers as expected.



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PI System Use Cases and Benefits – Identifying Issues

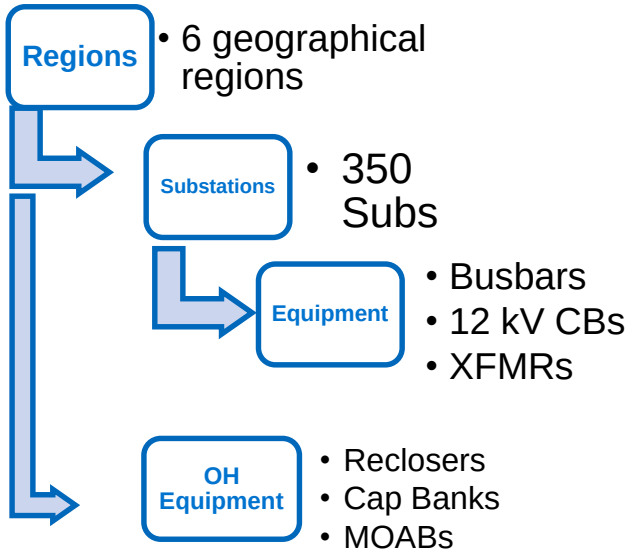
- Example of an operator using PI ProcessBook to confirm there is a line problem.

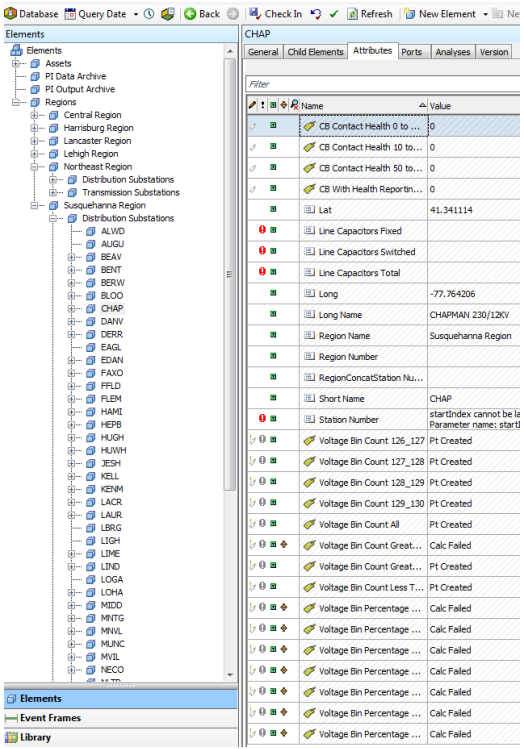


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Distribution Asset Framework

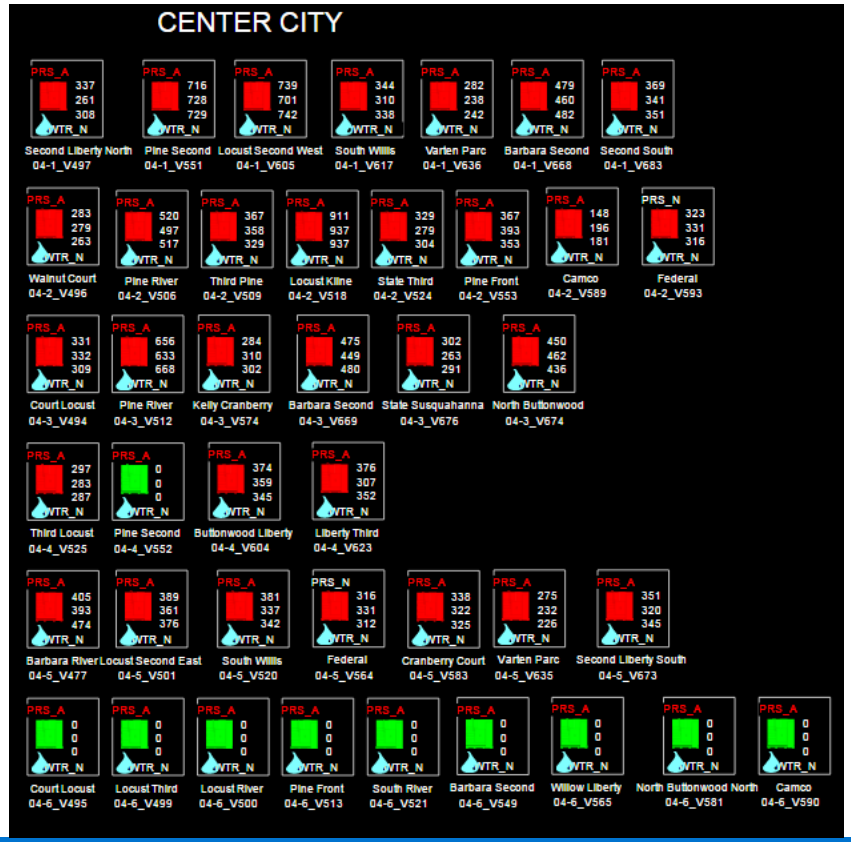
- 2016 Asset Framework built for Distribution Substations and Overhead equipment
- 140,000 total tags
- 30,000 analyses tags
- 2 Event Frames templates
- Structured PPL's future analytics strategy

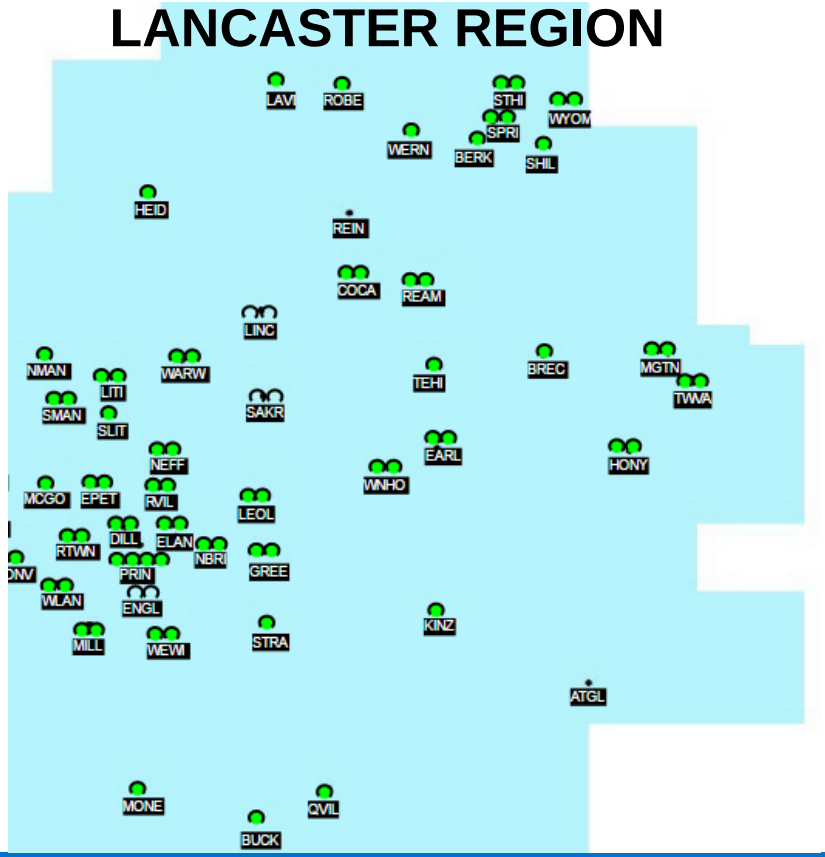




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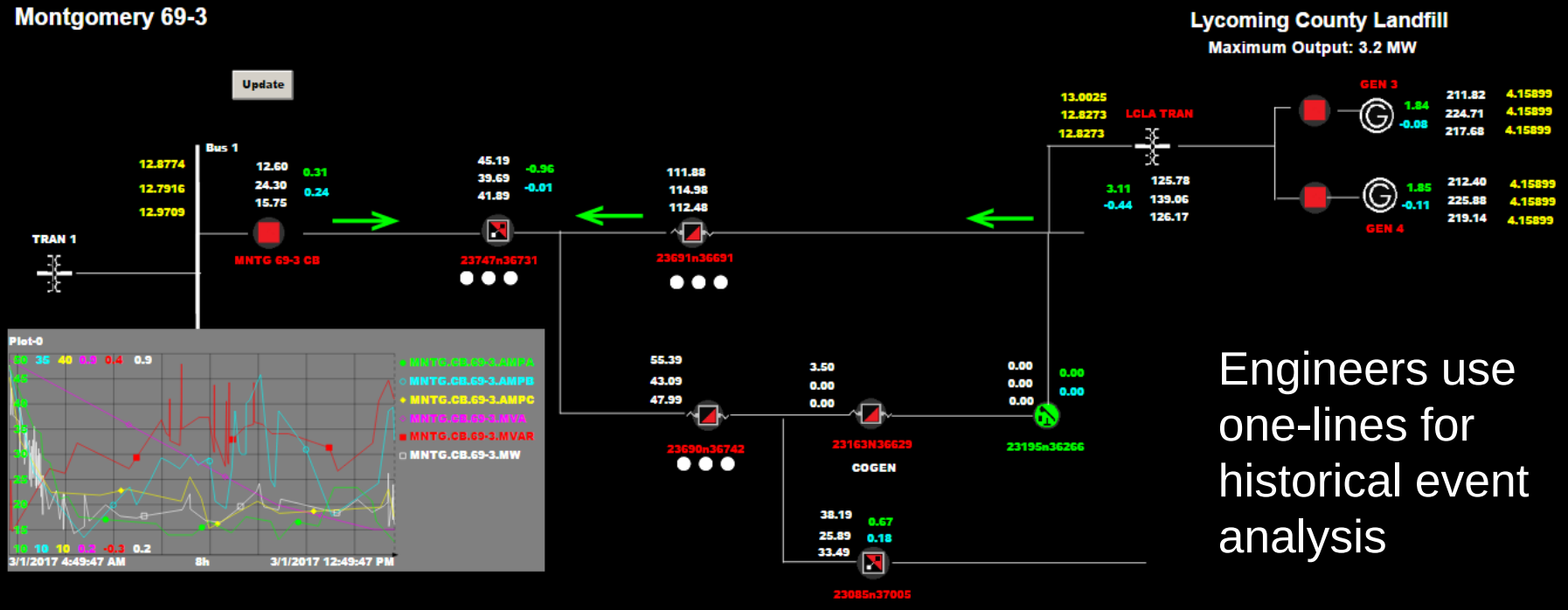
PI Coresight Rollup Voltage Displays for Operational Intelligence





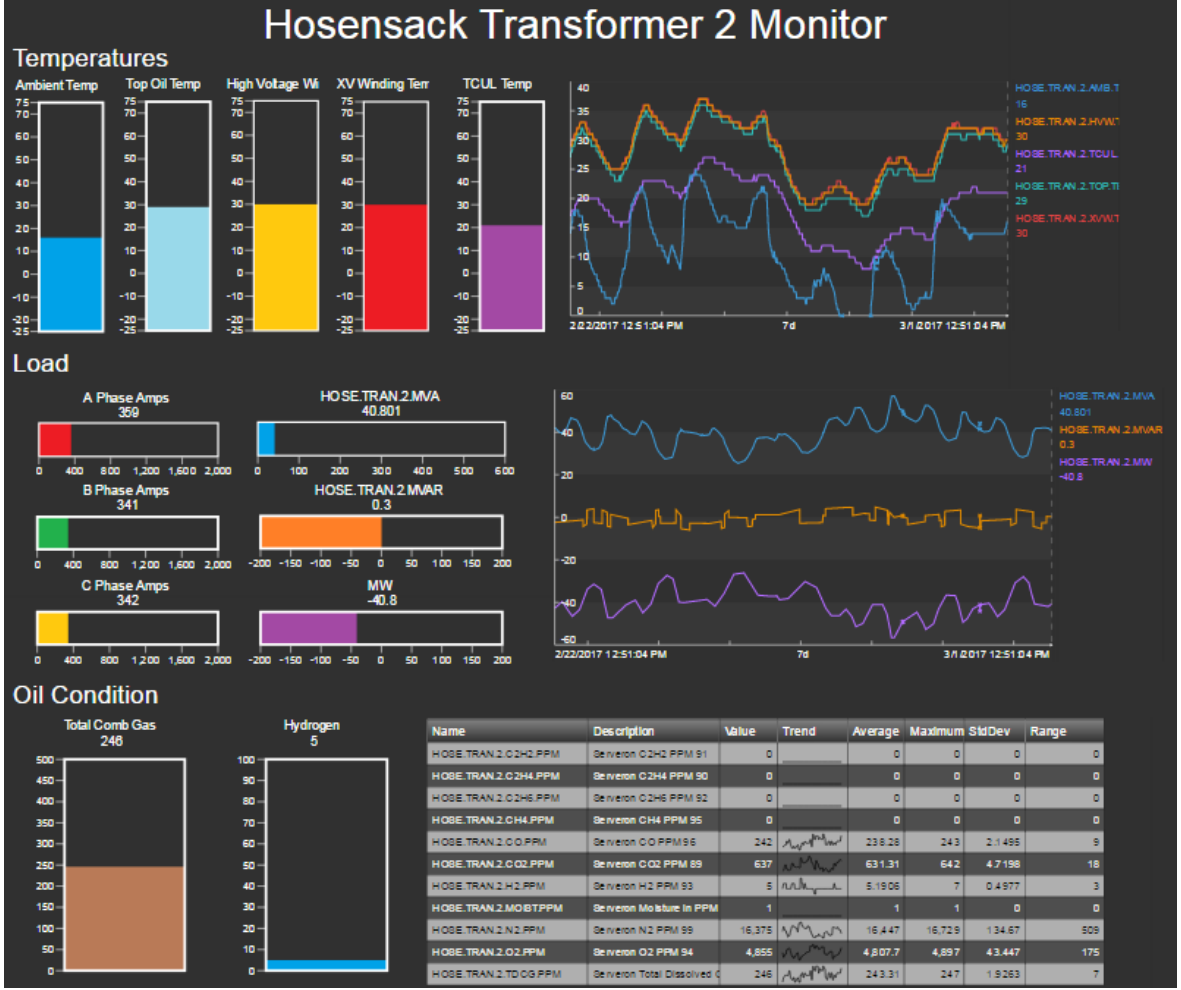
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One-Line Diagram with Operational Data



Engineers use one-lines for historical event analysis

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Asset Framework allows us to build rich element relative diagnostic dashboards displaying asset condition. Next step is to add PI Notifications to alert engineers at critical thresholds.

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Business Impacts of PI System Data on PPL operations

- Detect, monitor and diagnose high voltage events across 350 Distribution substations
  - Immediately saved 300+ hours of engineers analysis time
- Rapidly determine Capacitor Bank issues using Event Frames
  - System Operations reaction time is drastically reduced
  - Fewer diagnositic truck rolls
  - Increased key customer voltage satisfaction
  - **~$150,000/yr savings**
- Cost Savings – dynamic asset condition monitoring rather than periodic physical inspections
  - Move towards touchless substations
  - Eliminates need for OH Recloser inspection program
  - **~$600,000/yr cost avoidance**
- SUBNET costs per device went from $50 → $35
  - **~$75,000** so far in license savings
  - Streamlined VM rollout
  - Allows for additional tag growth from future relay reprogramming

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Summary

COMPANY and GOAL

PPL Electric Utilities aimed to leverage OH device data for CBM by interfacing SUBNET with the PI System



CHALLENGE

We needed a path to the PI System outside of DMS that is scalable and easy to maintain.

- Two paths to the PI System; DMS or SUBNET
- Needed a way to grow our maintenance tags without cluttering DMS

SOLUTION

Interfaced SUBNET with the PI System by creating a collector server for data aggregation.

- Interfaced SUBNET to the PI System by creating a data aggregator to supply data directly to PI as well as our DMS

RESULTS

Benefits: Gives Asset Management insight into OH Asset condition data and IT an extensible solution for future data growth.

- Organization of non-operational data separate from DMS
- $600k cost avoidance for Recloser CBM

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado

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