ANY GRID PROJECT. ONE INTEGRATION Solution.





Multi-Vendor Data Concentration of 7000 Distribution Devices to Facilitate Asset Optimization

Alan Lytz | System Architect

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PPL Electric Utilities

- HQ: Allentown Pennsylvania USA
- 1.4 million customers
- 80,000 km of Distribution circuits
- 13,000 km of Transmission lines
- 26,000 sq. km service territory in eastern PA

PPL EU Service Territory Light Green = PPL 0 Dark Green = PECO Erie PPL Utilities Corp. Warren Susquehanna McKean Bradford Potter Tioga Crawford Wayne Lackawanna Forest Wyoming Cameron Elk Sullivan Venango Pike Lycoming Mercer Clinton PPL Utilities Corp. Luzerne Clarion Jefferson Monroe Columbia Clearfield Lawrence Union Butler Centre Car Northampton Armstrong Snyder Beaver Schuylkill Mifflin Indiana Lehigh Juniata PECO Cambria Allegheny Energy Co. Blair Berks Dauphin Perry Lebanon Huntingdon Bucks PPL Utilities Corp. Westmoreland Cumberland Washington Lancaster Bedford Somerset Chester PECO Fulton Fayette York Energy Co. Franklin Adams Greene

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PPL Analytics Goals



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

- Reduce customer interruptions
 & improve service quality
- Reduce O&M costs through improved maintenance programs driven by asset condition
- Provide key data and asset conditions to support decision making
- Move towards a data driven organization



Completed Business Driven Use Cases

These use cases were completed in January 2017

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 Condition Based Maintenance

- 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
 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



Non-Operational Data needed by Asset Management (ISO 55000)

- Recloser Wear Calculations (# of operations x FM by ø)
- Recloser Battery Voltage check (Digital)
- Capacitor Bank Monitoring (Alarms)
- High Impedance Faults (ArcSense)
- Underground Vault Temps and Water levels (Analogs)



Operational Data needed by System Operators

- Voltage by Phase (Analogs)
- Current by Phase (Analogs)
- VARs (Analogs)
- Switch Status (Digital)
- Alarms (Digital)



Example of Devices – G&W Viper | SEL-651R Relay







- 6,000 Overhead Vacuum Circuit Reclosers
- Plans for 1,000s more
- Can perform individual phase tripping
- Lots of device diagnostic data from relay

Business Drivers That Initiated this Project



- Desire to leverage the PI System to monitor asset condition and predict maintenance cycles to save O&M dollars.
- Needed an extensible way to feed asset condition data to the PI System *separate* from the DMS system.
- IT team needed a way to add new devices and data to PI dynamically and easily.



Data Concentration Solution

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Options to get device data to a central server



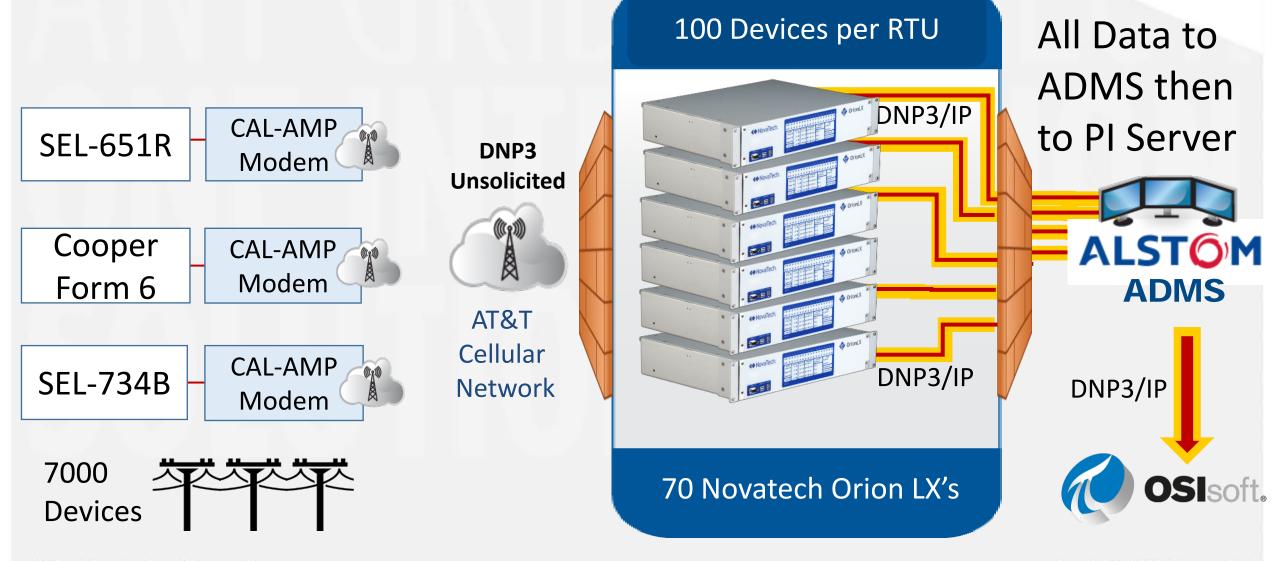
1. Direct DNP3 interface to each device

- Impractical

- 2. Use substation RTU to collect proximity overhead device data
 - Many very rural devices, not ideal
- 3. Install RTUs on poles
 - More hardware to maintain, very expensive
- 4. Install RTUs in central data center
 - Previous strategy
- 5. Virtual RTUs
 - Innovative solution

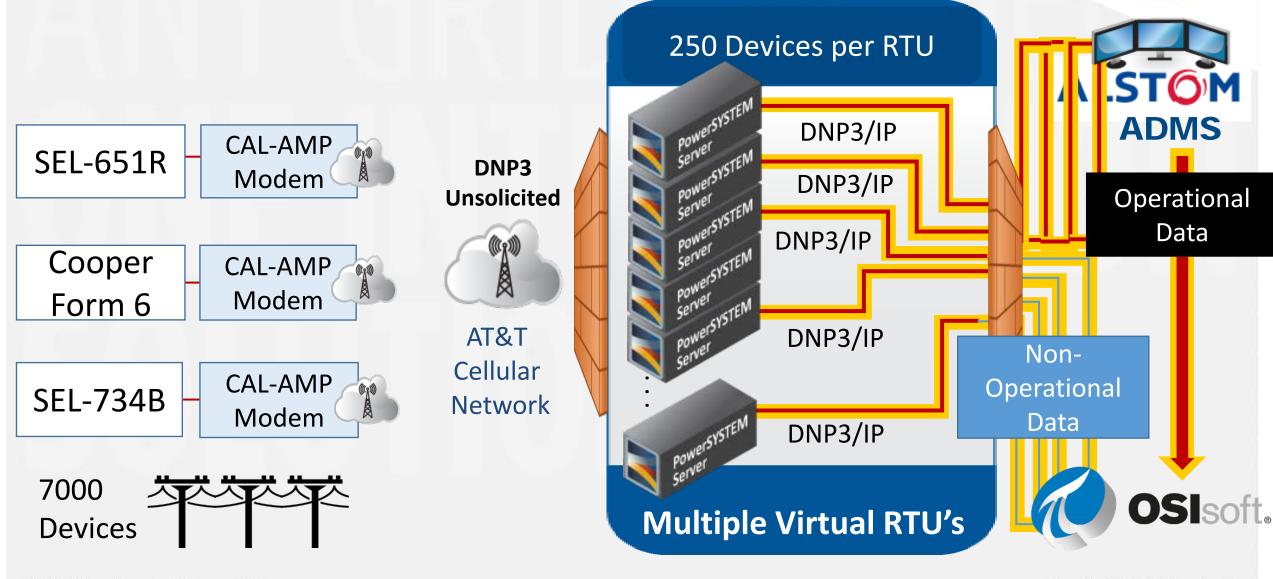
Before Architecture: Physical RTUs in Data Center





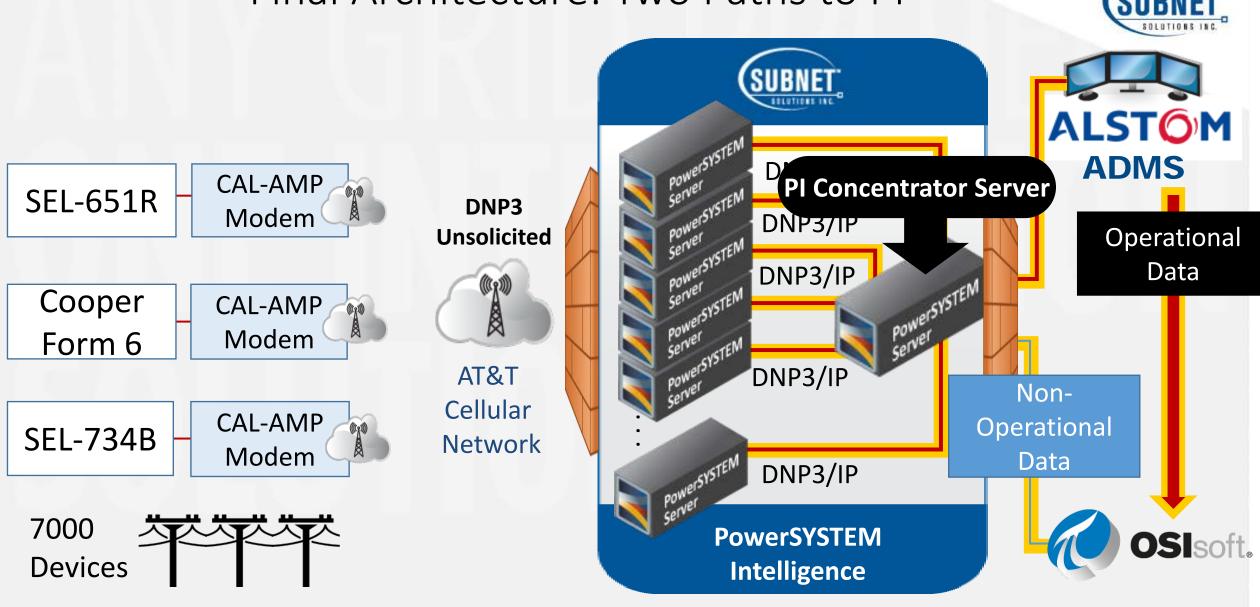
Proposed Architecture: Virtual RTUs



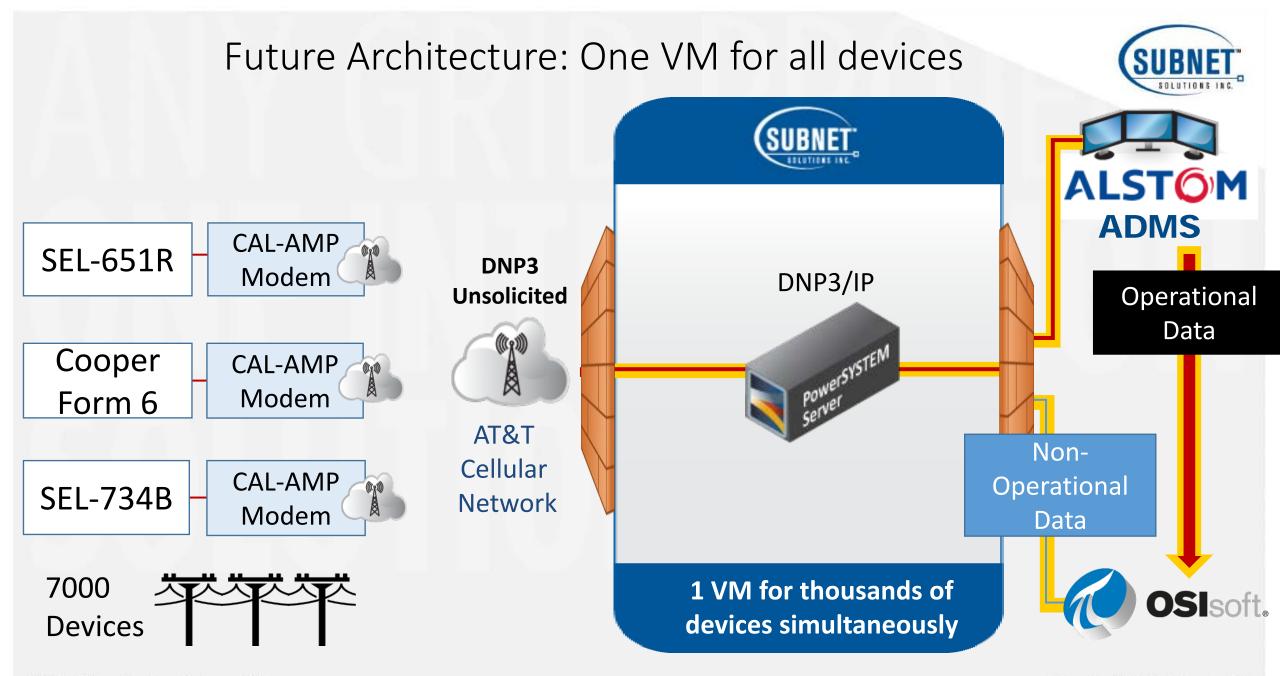


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Final Architecture: Two Paths to PI



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The PowerSYSTEM Server Virtual RTU



- Centralized Device Polling
- Expandable to 1000s of Devices
- Add/Edit Devices on the fly
- Virtual Machine Servers
- One main advantage is the ability to modify, stop, and start DNP devices individually.

Configuring the SUBNET-PI Interface

SUBNET

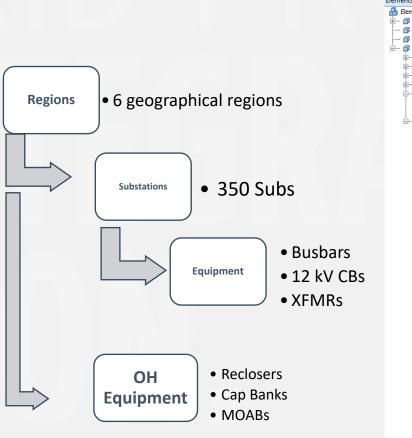
- Uses Native PI SDK
- One DNP connection to PI Server
- Plans to use PI Web API in the future for AF templatizing

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Distribution Asset Framework



- Asset Framework built for Distribution Substations and Overhead equipment
- 200,000 total tags
- 30,000 analyses tags
- Event Frames templates
- Structured PPL's future analytics strategy



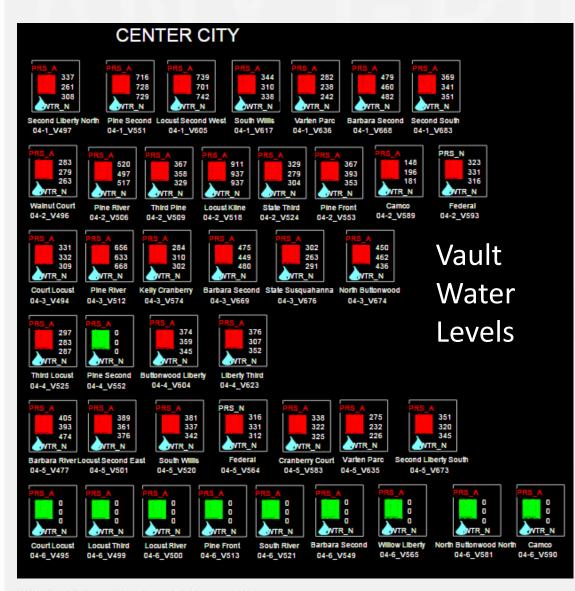
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PI Coresight Displays for Operational Intelligence



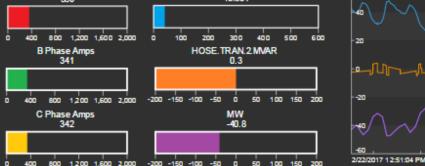


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Hosensack Transformer 2 Monitor





Oil Condition



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Asset Framework allows for quick and easy building of rich element relative diagnostic dashboards displaying asset condition.



Value Added to Each Use Case

Power Quality Monitoring

Detect, monitor, and diagnose high voltage events using Event Frames

Saved **300+ hours per quarter** in engineer's analysis time OH Recloser Condition Based Maintenance

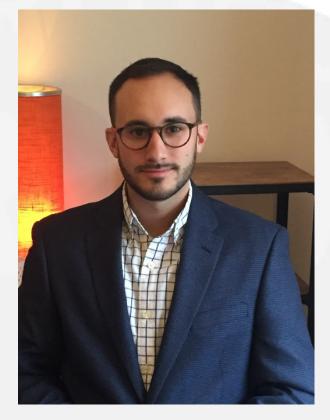
- Dynamic asset condition monitoring eliminates need for OH Recloser inspection program
- Cost Avoidance of ~\$600,000
 per year

Capacitor Troubleshooting

- Rapidly determine capacitor
 bank issues using Event
 Frames
- System Operations reaction time is drastically reduced
- Fewer Diagnostic truck rolls
- Increased key customer voltage satisfaction
 - ~\$150,000 per year savings



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THANK YOU!

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