
SUBNET™
SOLUTIONS INC.
ANY GRID PROJECT.
ONE INTEGRATION
SOLUTION.

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

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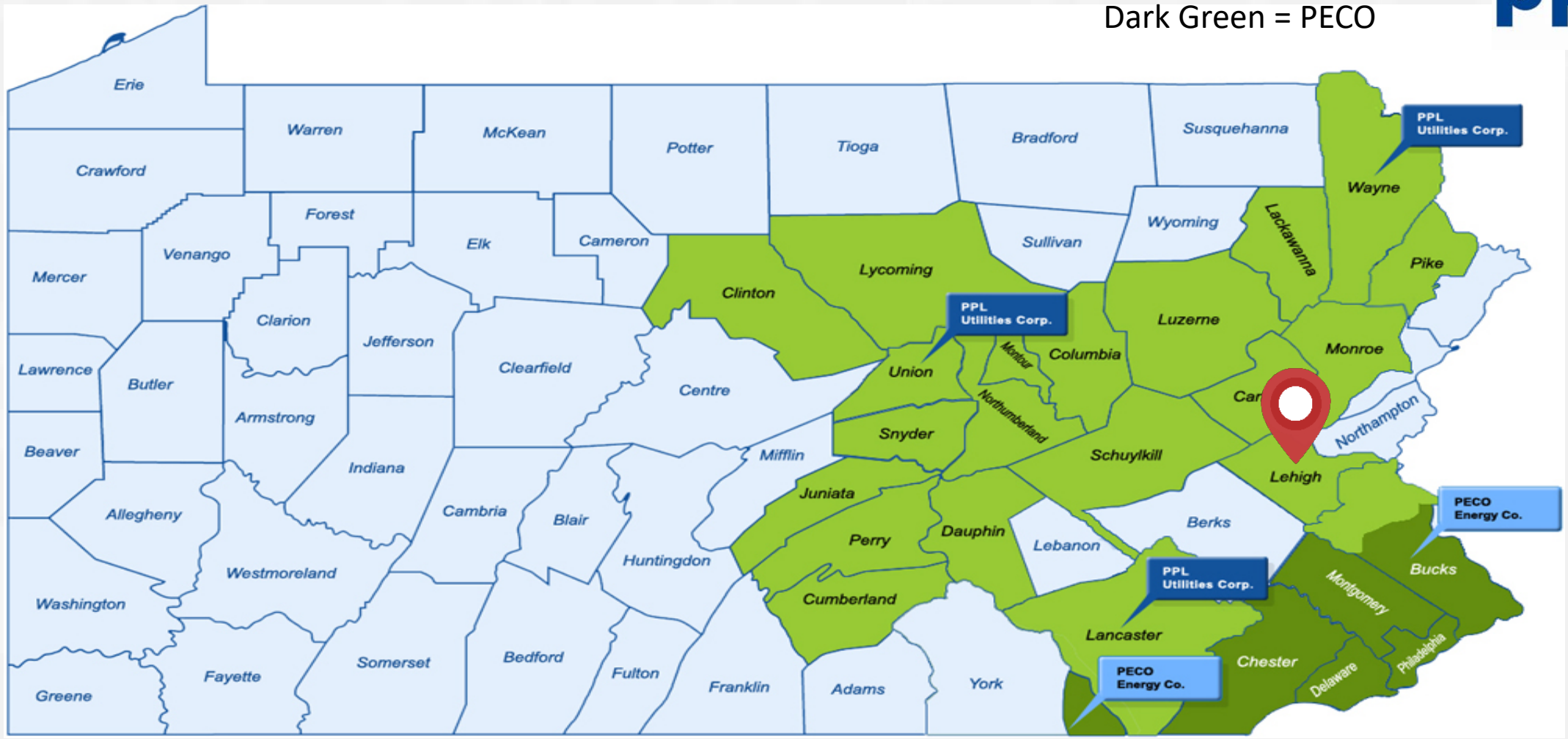
PPL Electric Utilities

- 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
Dark Green = PECO



PPL Analytics Goals

1. Improve System Reliability (ISR)
2. Implement Condition Based Maintenance programs (CBM)
3. Provide Operational Performance Visibility (OPV)
4. 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

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

SEL-651R — CAL-AMP Modem

Cooper Form 6 — CAL-AMP Modem

SEL-734B — CAL-AMP Modem

7000 Devices

DNP3 Unsolicited

AT&T Cellular Network

100 Devices per RTU

DNP3/IP

DNP3/IP

70 Novatech Orion LX's

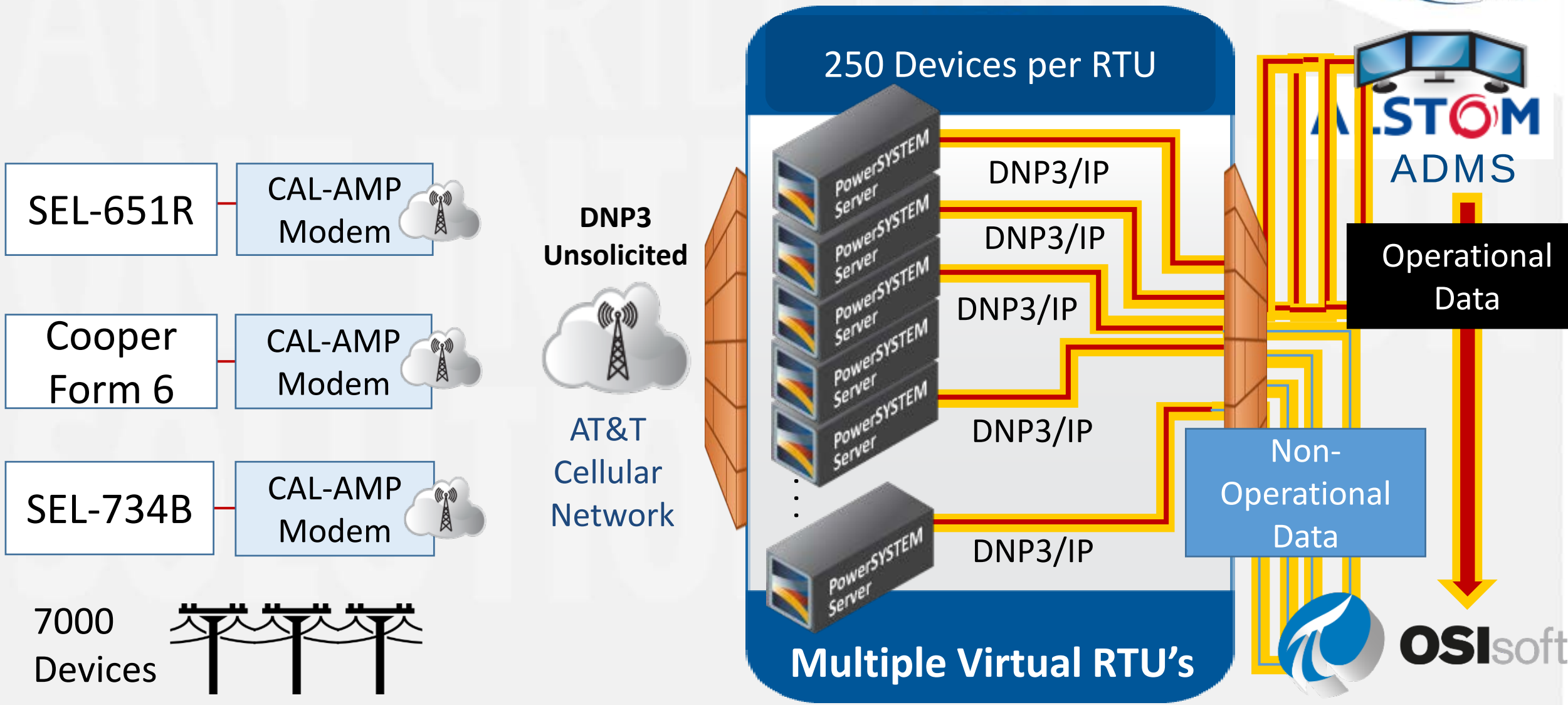
All Data to ADMS then to PI Server

ALSTOM ADMS

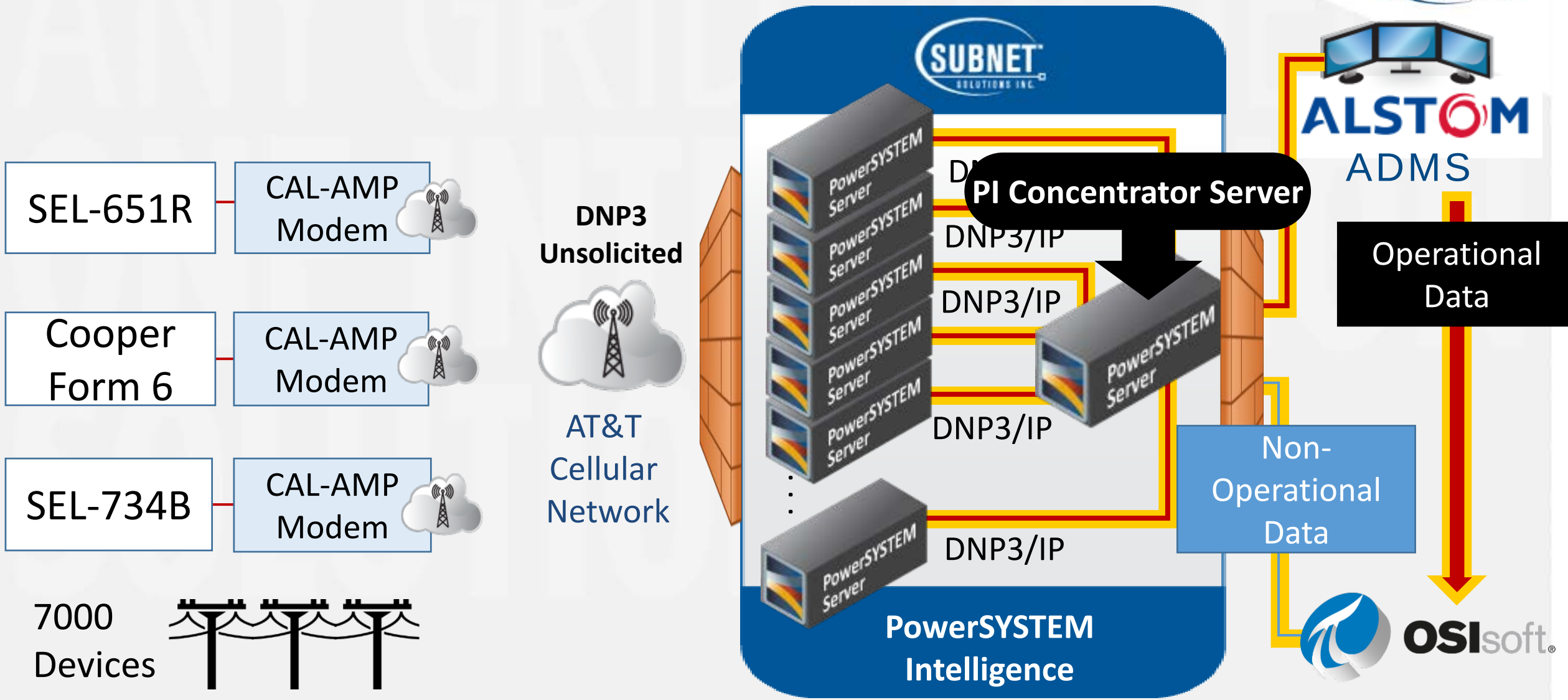
DNP3/IP

OSIsoft.

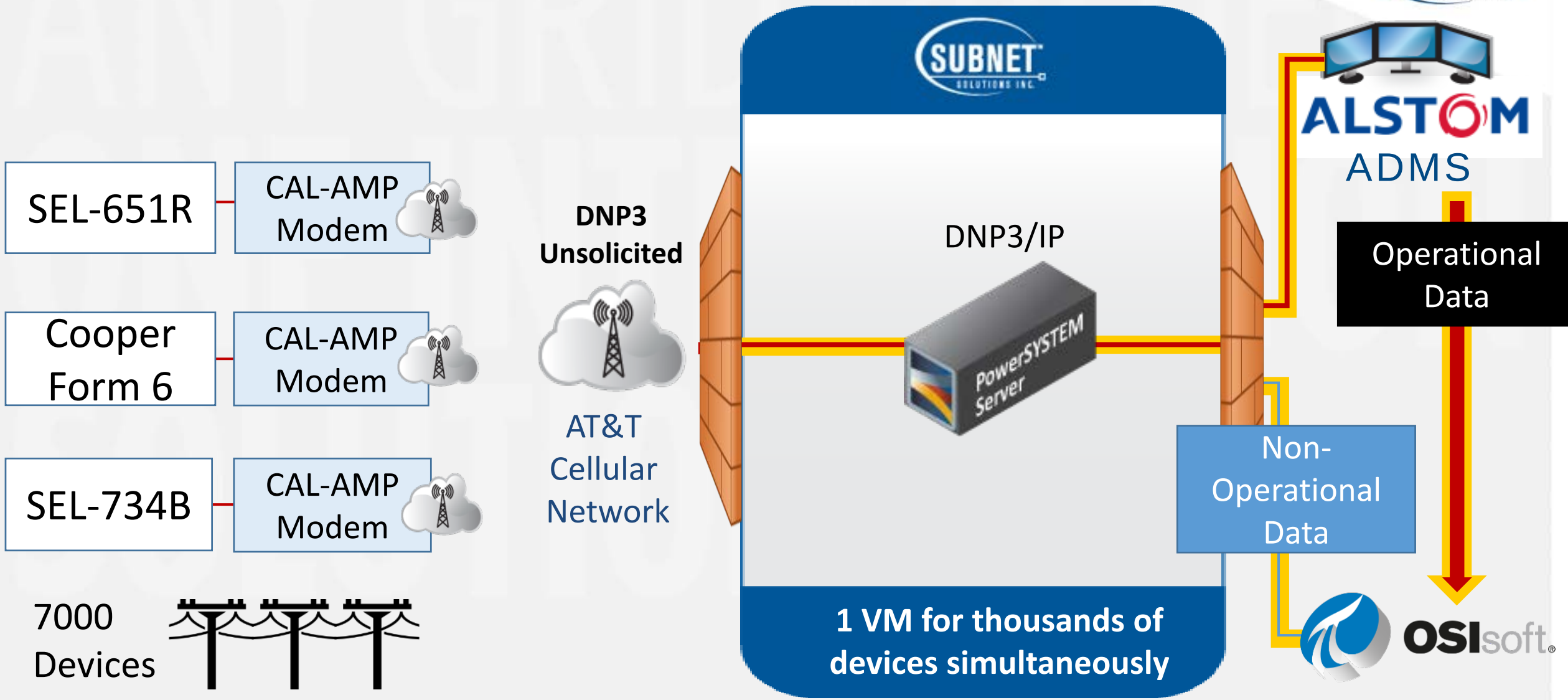
Proposed Architecture: Virtual RTUs



Final Architecture: Two Paths to PI



Future Architecture: One VM for all devices

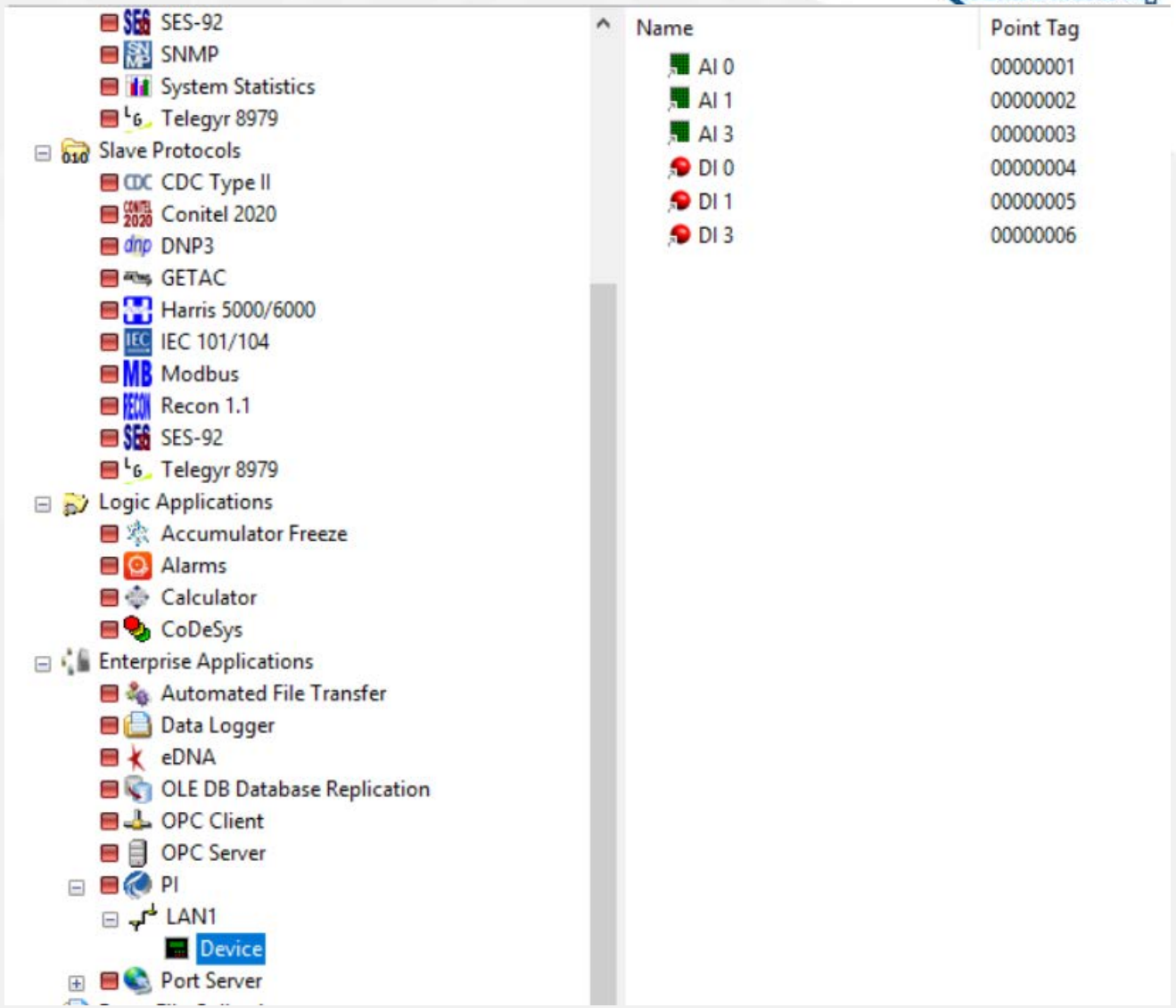


The PowerSYSTEM Server Virtual RTU

- 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.

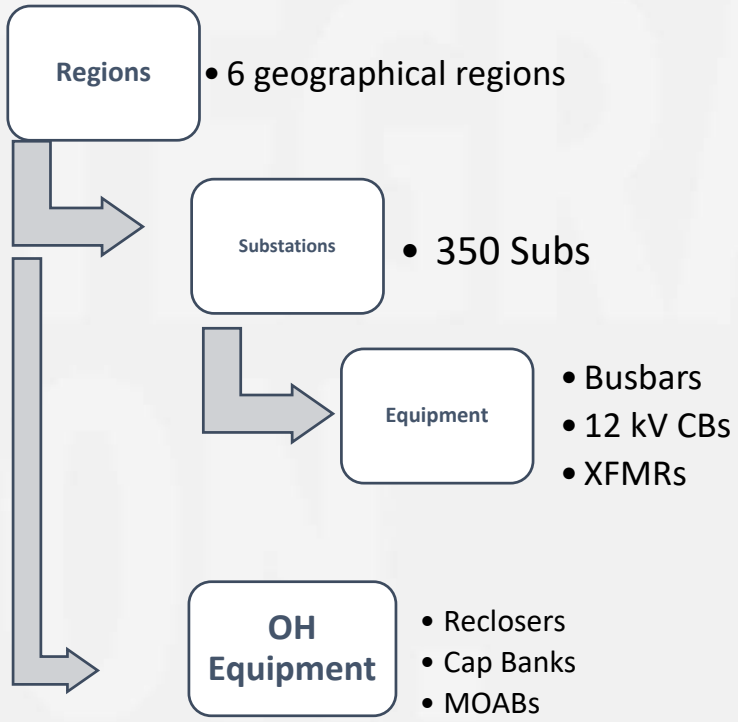
Configuring the SUBNET-PI Interface

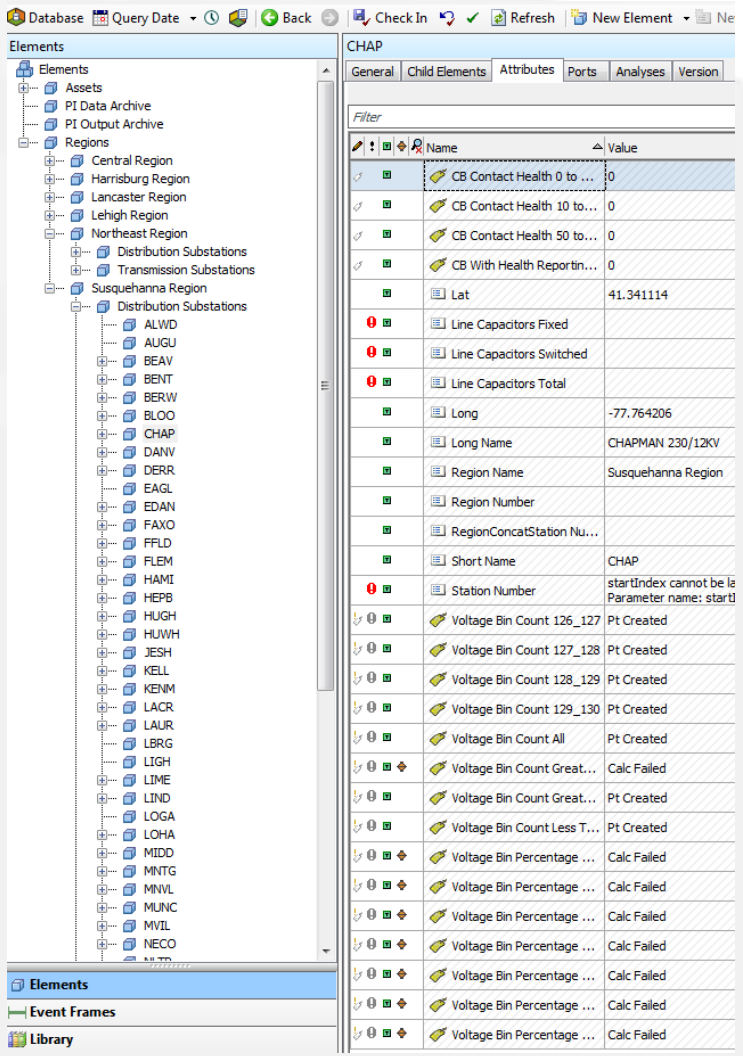
- Uses Native PI SDK
- One DNP connection to PI Server
- Plans to use PI Web API in the future for AF templatizing



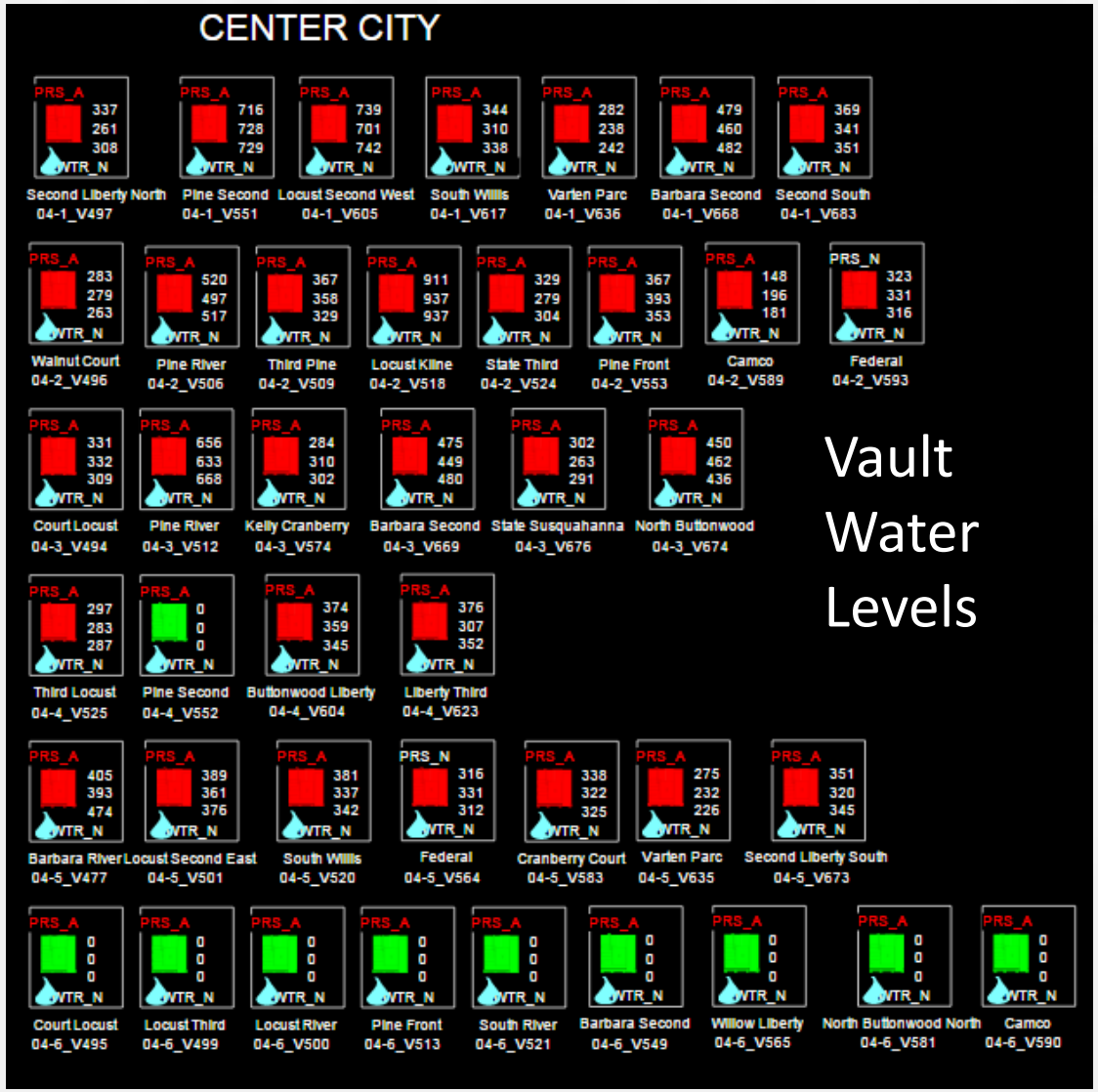
Distribution Asset Framework

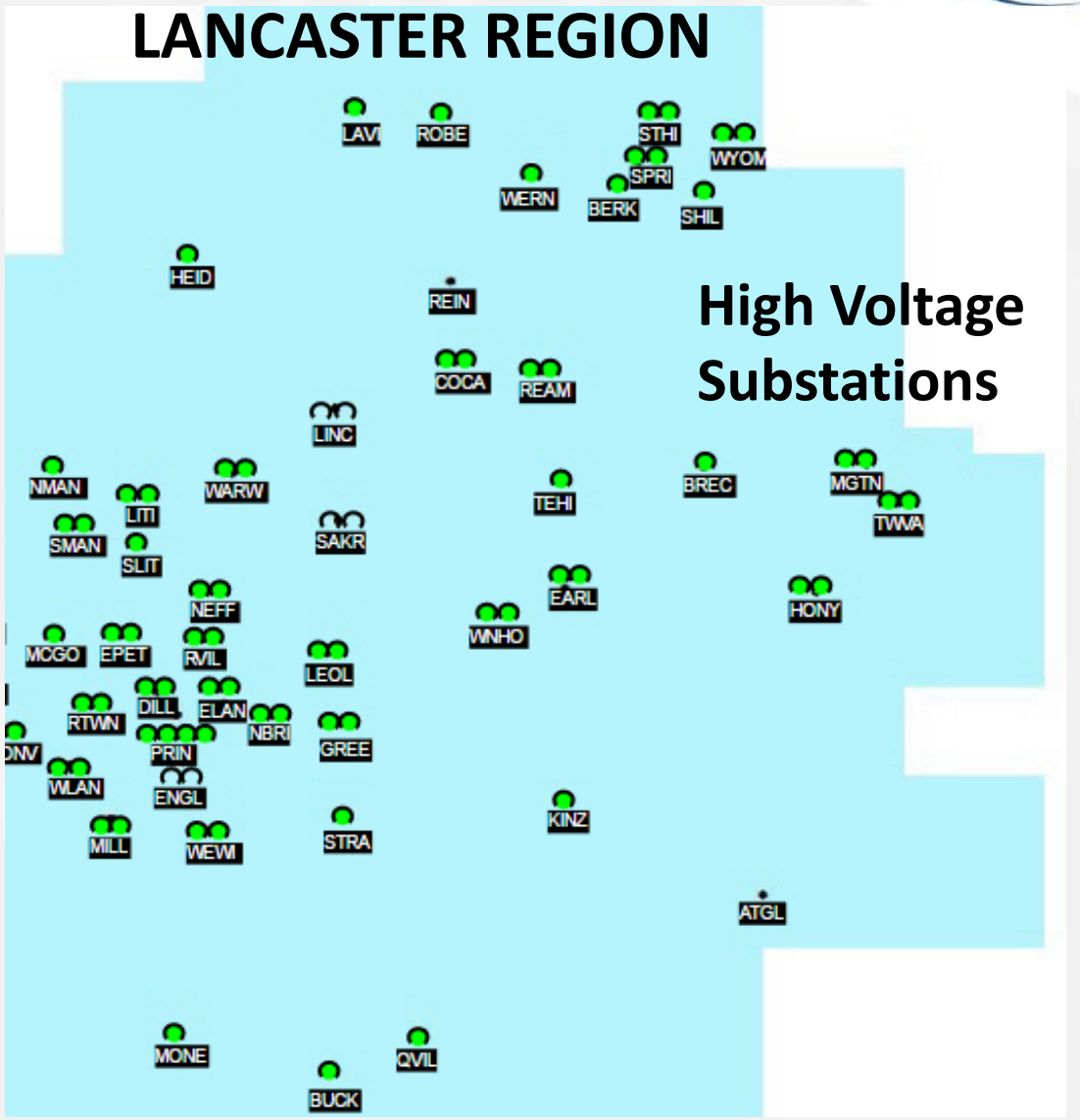
- Asset Framework built for Distribution Substations and Overhead equipment
- 200,000 total tags
- 30,000 analyses tags
- Event Frames templates
- Structured PPL's future analytics strategy

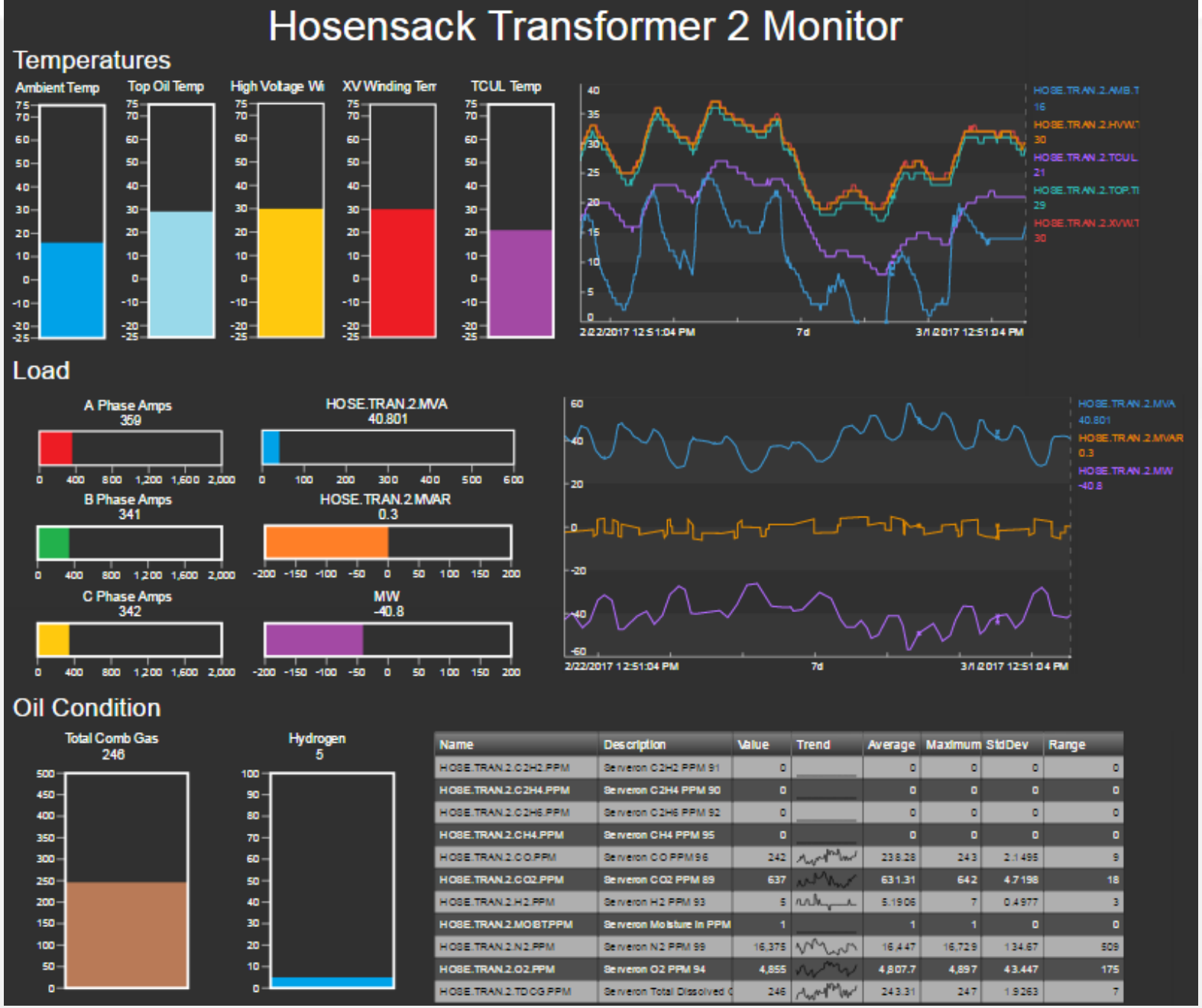




PI Coresight Displays for Operational Intelligence







Name	Description	Value	Trend	Average	Maximum	StdDev	Range
HOSE.TRAN.2.C2H2.PPM	Serveron C2H2 PPM 91	0		0	0	0	0
HOSE.TRAN.2.C2H4.PPM	Serveron C2H4 PPM 90	0		0	0	0	0
HOSE.TRAN.2.C2H6.PPM	Serveron C2H6 PPM 92	0		0	0	0	0
HOSE.TRAN.2.CH4.PPM	Serveron CH4 PPM 95	0		0	0	0	0
HOSE.TRAN.2.CO.PPM	Serveron CO PPM 96	242		238.28	243	2.1495	9
HOSE.TRAN.2.CO2.PPM	Serveron CO2 PPM 89	637		631.31	642	4.7198	18
HOSE.TRAN.2.H2.PPM	Serveron H2 PPM 93	5		5.1906	7	0.4977	3
HOSE.TRAN.2.MOISTPPM	Serveron Moisture In PPM	1		1	1	0	0
HOSE.TRAN.2.N2.PPM	Serveron N2 PPM 99	16,375		16,447	16,729	134.67	509
HOSE.TRAN.2.O2.PPM	Serveron O2 PPM 94	4,855		4,807.7	4,897	43.447	175
HOSE.TRAN.2.TDCG.PPM	Serveron Total Dissolved C	246		243.31	247	1.9263	7

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!