American Electric Power – How We Use FAM (YFA)

Paul Pagur

5/15/24

Powering Business Worldwide

KEY AGENDA

- What is AEP and Who Manages FAM (YFA)?
- History of Feeder Automation at AEP
- Reliability and Operations
- Feeder Automation Implementation
- How does Eaton help AEP?
- What is next at AEP?

AEP – Who are we?

AEP consists of 7 operating companies: AEP Texas, AEP Ohio, Appalachian Power, Indiana Michigan Power, Kentucky Power, Public Service Company of Oklahoma, and Southwestern Electric Power Company. The AEP territory map is depicted on the next slide.

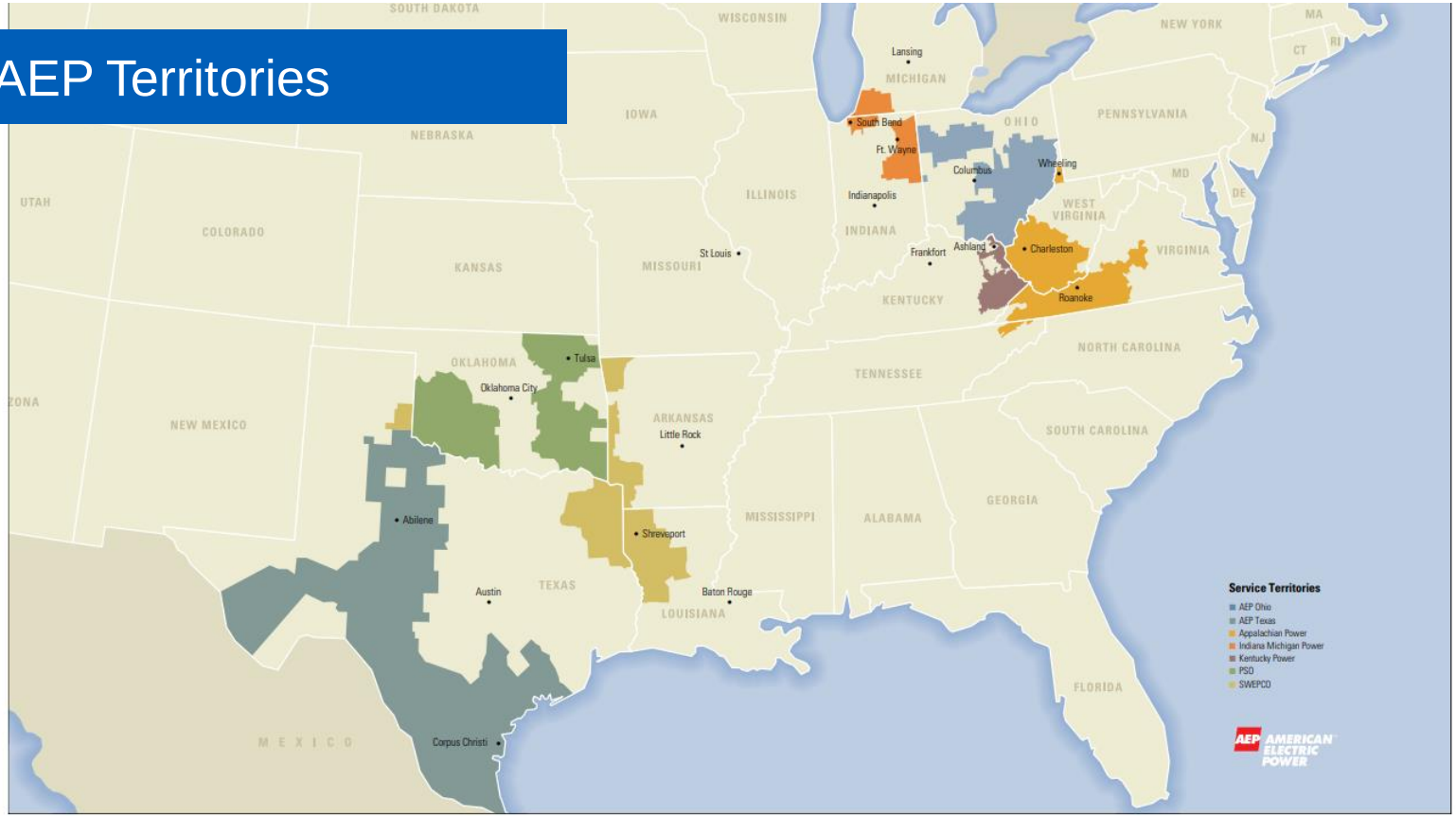
There are over 6,000 reclosers and switches that are directly tied into AEP Distribution SCADA system, either in a local Distribution Automation (DA) scheme or a centralized system. Some field devices are set up for monitoring purposes only in our SCADA system, while most are utilized in YFA and other systems throughout the AEP footprint.

AEP owns the nation's largest electricity transmission system, a more than 40,000-mile network that includes more 765-kilovolt extra-high voltage transmission lines than all other U.S. transmission systems combined. AEP also operates more than 223,000 miles of distribution lines.

There are 5 of the 7 Operating companies in AEP using YFA, which utilize a combined 12 YFA servers with over 2,500 switching devices (licenses).

AEP utilizes various means of communication between field devices based on funding, terrain, and feasibility. Those include MESH radios, cellular, and fiber, with use of serial and Ethernet configurations to ensure proper network isolation throughout the Transmission & Distribution areas.

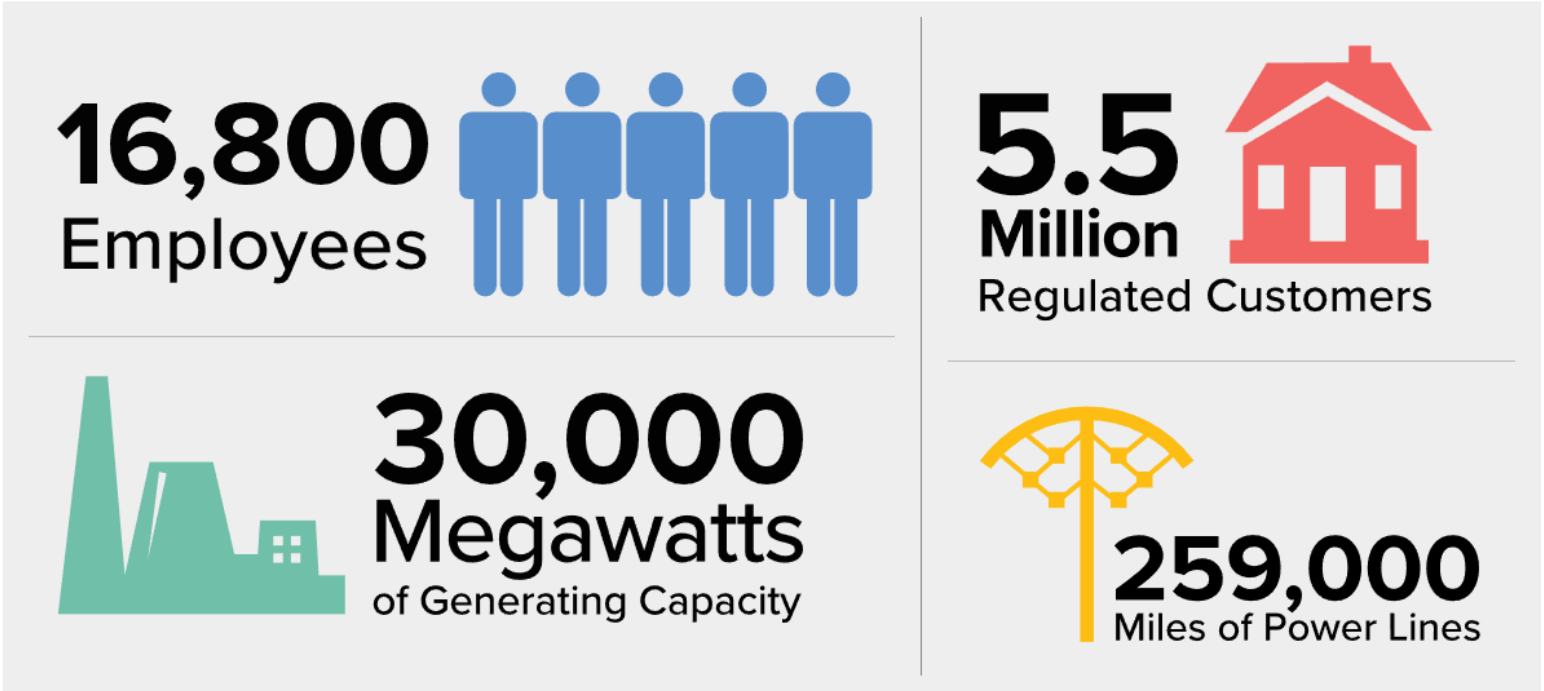
AEP Territories



AMERICAN ELECTRIC POWER®
BOUNDLESS ENERGY™

EATON
Powering Business Worldwide

Company Information



American Electric Power is one of the largest electric utilities in the United States, delivering safe, reliable power to nearly 5.5 million regulated customers in 11 states.

Who Does YFA Implementations?

Powering Business Worldwide

DSCADA Engineering Organization

- ✓ Staffing
  - ✓ One manager and two supervisors (East & West)
  - ✓ Testing & standards group (Lead Engineer + other support resources)
  - ✓ 20+ DSCADA Engineers
- ✓ Our Role
  - ✓ Implement point mapping standards between field devices, DSCADA, & YFA
  - ✓ Provide SME knowledge to OPCO's for YFA, DRTU's, and field devices
  - ✓ Implement YFA scheme designs, layout, and configurations
  - ✓ Manage all aspects of YFA including licensing & software
  - ✓ Provide Day 2 support to distribution operations in all OPCO's related to DA
  - ✓ Develop new standards for new distribution technologies through testing & validations

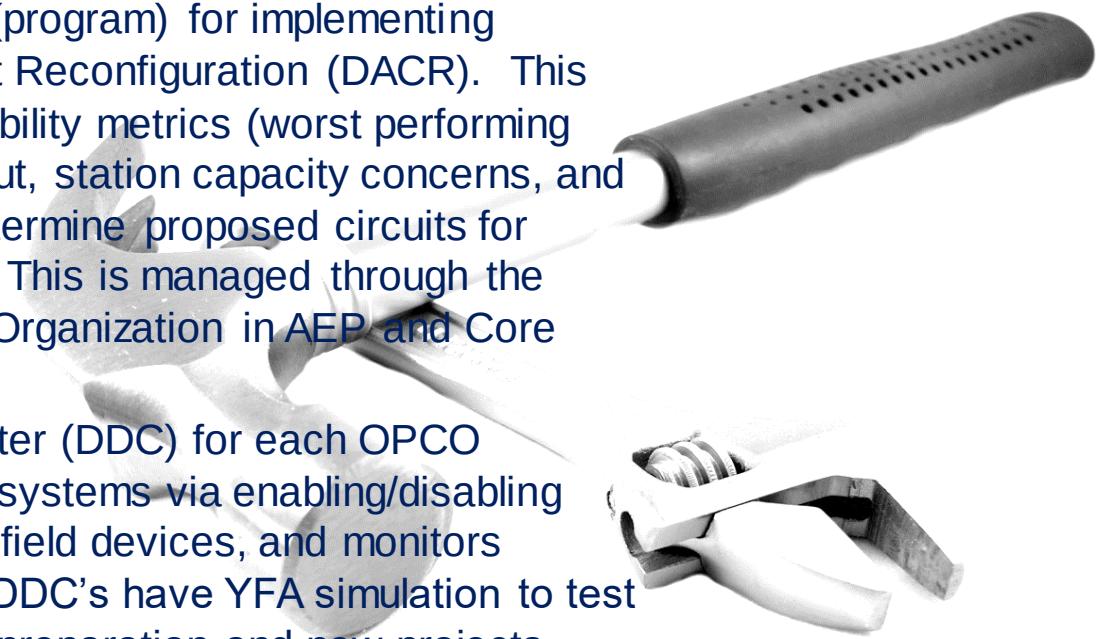
Feeder Automation for AEP

- History of Feeder Automation at AEP
  - Distribution automation was started back more than 15 years ago with local controls for reclosers and switches. Starting with equipment such as S&C Intelliteam with Intellirupters and switches to provide local reconfigurations. Through modernization of the grid technologies and central systems such as YFA, we have been able to greatly improve our reliability to address outages for our customers.
  - Other systems in use along with YFA include SEL RTAC and S&C Intelliteam systems.
- Feeder automation implementation and acceptation
  - Originally, our first YFA pilot was implemented in AEP Ohio. This allowed us to pilot other OPCO's, such as APCO to begin to utilize YFA for new projects.
  - Our typical method of communication in a DSCADA system is to utilize a designated cellular network from the field to either a station DRTU (Eaton SMP) or a centralized DRTU. From the DRTU, it is then mapped into our YFA system and the DSCADA system.
  - AEP utilizes field devices from various manufacturers, G&W Viper with SEL-651R controls, Nova with Form 6 controls, Eaton SMP Gateway, NovaTech Orion RTU, S&C Intellirupter, S&C SCADAMate switch, and various fault current sensors.
  - Standard mapping – station transformers with bus differential indication, station breakers with DA control, field devices such as reclosers and SCADA switches, and line transformers.
  - Common problems with our designs - communication issues due to terrain, bus differential not available on older stations, cost of breaker relay replacement resulting in schemes without breaker controls in YFA, loading limit issues due to cable sizing and coordination issues. These problems cause concern to overloading transformers.
  - AEP utilizes CYME to make sure we do not overload the system.

Reliability, Operations, and Day 2 Support

Reliability & Operations

- Circuits are selected by the OPCO through a Project Value Ranking (PVR) selection tool (program) for implementing Distribution Automation Circuit Reconfiguration (DACR). This tool utilizes data from the reliability metrics (worst performing circuits), customer service input, station capacity concerns, and regulatory requirements to determine proposed circuits for Distribution Automation (DA). This is managed through the Distribution System Planning Organization in AEP and Core Project Team.
- The Distribution Dispatch Center (DDC) for each OPCO manages the operation of DA systems via enabling/disabling circuits & schemes, individual field devices, and monitors alarms. Most of the OPCO's DDC's have YFA simulation to test different scenarios for outage preparation and new projects.



AEP Value Drivers and Metrics

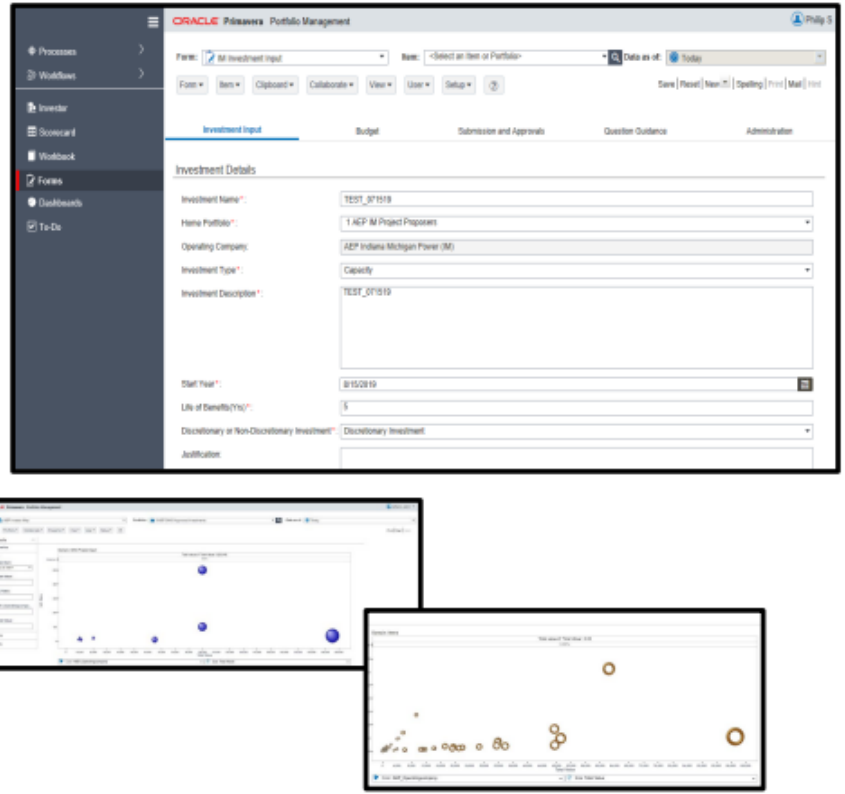
Value Drivers (**bold**) and Metrics identified by Core Project Team.

Business Value Driver - Investment Criteria (Metric):

- **Compliance & Legal**
  - Mandate (Mandate)
  - PUC Inquiries (PUC Inquiries)
- **Financial**
  - Avoided O&M (avoided O&M ($))
  - Incremental Revenue (incremental revenue ($))
- **Reputational**
  - Media Coverage (regional media coverage)
- **Reliability**
  - CMI (customer minutes)
  - CI (customer interruptions)
  - CEMI (Reduction in CEMI 5 customers)
  - CI Reduction for CEMI 5 Customers (CI reduction for CEMI 5 customers bonus)
  - % Overload, MVA peak load (% Overload, MVA peak load)
  - Power Quality - Low Voltage (low voltage customers)
  - Power Quality - Flicker (flicker customers)
  - Power Quality - Harmonics (harmonics customers)
  - Number of Strategic Customer (Strategic Customer)
- **Safety**
  - Safety Impact (Type of Impact)
  - Safety Mitigation (WRC Mitigation)
- **Strategy**
  - Grid Modernization
- **Risk**
  - Risk Matrix

Oracle Primavera Portfolio Management (OPPM)

- OPPM is a **decision support tool** to facilitate this process
- Most important feature of this effort is the process and methodology developed by the AEP Core Team
- OPPM allows AEP organizations to rank the priority of their investments prior to authorizing funding for them



Reliability Savings with YFA

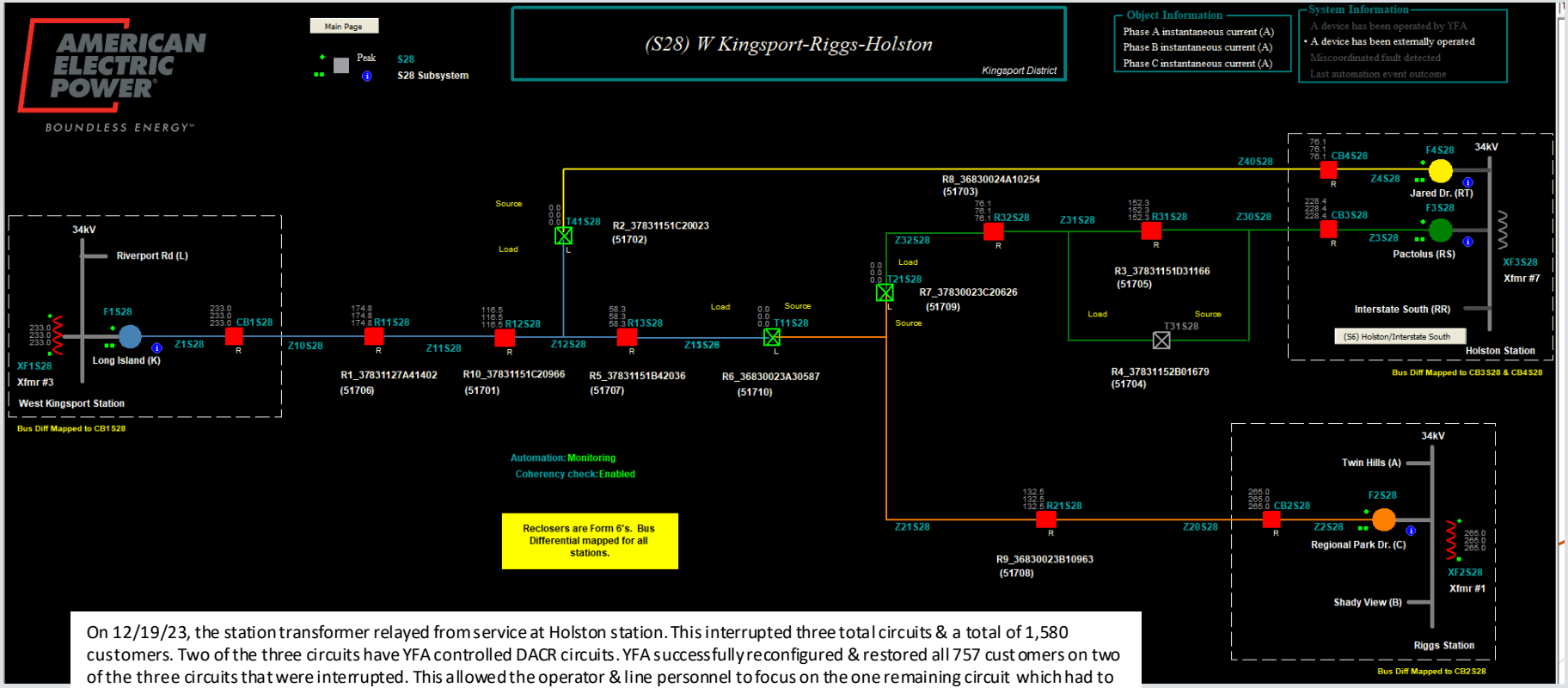
- APCO YFA Information
  - 6 Districts within APCO
  - 3 states (VA, WV, TN)
  - 42 schemes (5 not in service yet)
  - ~ 120 circuits implemented
  - 613 reclosers installed

APCO Example

Year	Customers Transferred	CMI Saved	SAIDI Minutes Saved
2020	26,207	6,171,935	5.9
2021	37,525	13,455,702	12.8
2022	36,189	9,671,793	9.2
2023	51,766	12,418,976	11.7
2024	8,636	1,713,176	1.6

- AEP Texas YFA Information
  - 6 Districts within AEP Texas
  - 61 schemes
  - ~ 178 circuits implemented
  - 443 reclosers mapped in YFA out of 976 reclosers installed

- Future plan > 100 circuits per year pending regulatory approval & funding



On 12/19/23, the station transformer relayed from service at Holston station. This interrupted three total circuits & a total of 1,580 customers. Two of the three circuits have YFA controlled DACR circuits. YFA successfully reconfigured & restored all 757 customers on two of the three circuits that were interrupted. This allowed the operator & line personnel to focus on the one remaining circuit which had to be manually transferred to an alternate source. Without YFA, customer restoration would have been delayed for hours.

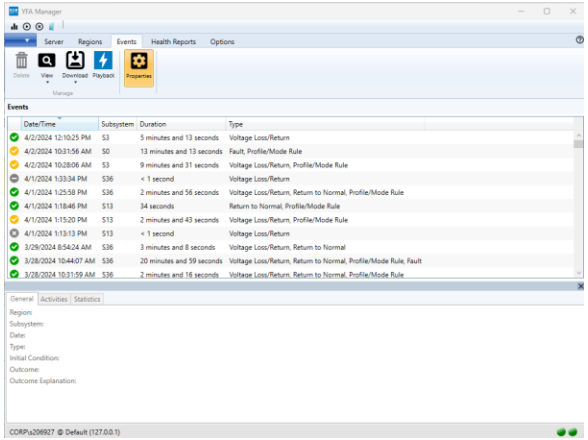
Lesson’s Learned

Lesson's Learned & Improvements

- Implementation
  - Regions
  - Diagram device dashboard
  - Loading YFA software
  - Licensing & point limits
  - Disabling in configuration & Topology
  - Communication delays & timers
  - Point naming issues
  - Redundant server failover – *see next slide*

Troubleshooting

- Events & logging
  - Email notification
  - Playback feature



YFA Redundant Failover Issue

It looks like you're running into an issue we've found where automation function points are automatically persisted. The issue occurs when it's a point that is updated frequently, like currents. I see several analogs in your persistence file.

To resolve the issue, we want to remove those points from the persistence file.
Follow the procedure below in order to do so:

1. Open the file in Notepad++
   "%fadir%\Persistence\CPS.Messaging.MessageBus.Persistence.exe.config"
2. At the end of line 17

```
16          <add key="Heartbeat.ProviderDescription" value="Regi
17          <add key="Persistence.Point.ExclusionList" value="__
18          <add key="MessageBus.YfaEvent.LogFileName" value="pe
```

3. Paste this: ;_I(A|B|C)$
4. It should look like this:

```
)?$;_ReversePowerFlow;_I(A|B|C)$"/>
```

We can also change the persistence integrity check to 1 day instead of every 10 min, reducing the chance for the problem to pop up. The integrity check is the validation of the complete list of persisted data points. Each data point transitions will still be constantly updated on the Standby as this mechanism is independent.

1. In the same file as in 1 above.
2. Add a new line :
   <add key="Replication.Integrity.Period" value="1.00:00:00"/>

3. Result should be like below

```
13      </startup>
14      <appSettings>
15          <add key="Heartbeat.ProviderName" value="Persistence Service" />
16          <add key="Heartbeat.ProviderDescription" value="Region '{0}' Persis
17          <add key="Persistence.Point.ExclusionList" value="__CommStatus(_\(
18          <add key="MessageBus.YfaEvent.LogFileName" value="persistence.dlog"
19          <add key="Replication.Integrity.Period" value="1.00:00:00"/>
20          <!--Hardening! Set this value to true to ensure persistence databas
21          <add key="Replication.SelfOnly" value="false" />
22      </appSettings>
```

Note that you can change the "1.00:00:00" to "5.00:00:00" or "10.00:00:00" to reduce the change of occurrences

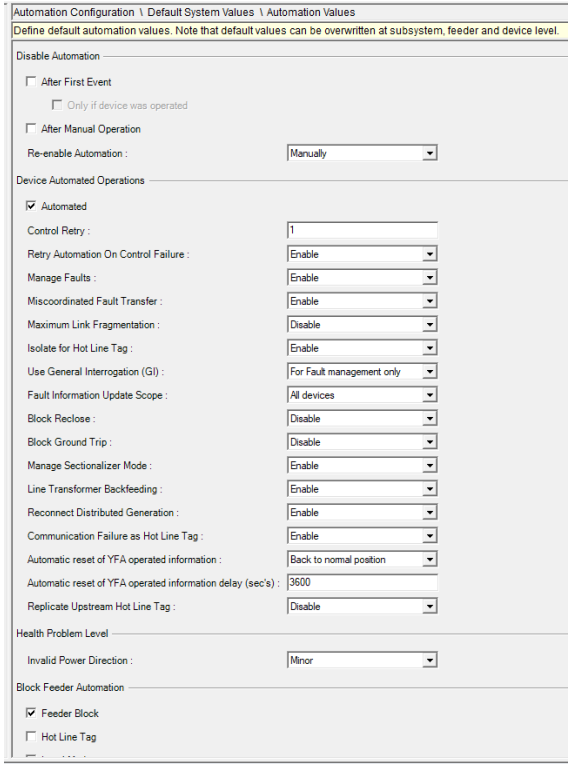
IMPORTANT: You must apply these changes on both the Active and standby servers. When upgrading these changes will be lost, so we recommend saving a copy of this file somewhere.

For your reference, this is just a sample of the points in your persistence file:

```
Bluffs_Bluffs_S3_T1_IA
Bluffs_Bluffs_S3_T1_IB
Bluffs_Bluffs_S3_T1_IC
Bluffs_Bluffs_S4_T1_IA
Bluffs_Bluffs_S4_T1_IB
Bluffs_Bluffs_S4_T1_IC
CokeSt_CokeSt_S14_T1_IA
CokeSt_CokeSt_S14_T1_IB
CokeSt_CokeSt_S14_T1_IC
CokeSt_CokeSt_S19_T1_IA
CokeSt_CokeSt_S19_T1_IB
CokeSt_CokeSt_S19_T1_IC
CollegeHills_CollegeHills_S12_TW_IA
CollegeHills_CollegeHills_S12_TW_IB
CollegeHills_CollegeHills_S12_TW_IC
CollegeHills_CollegeHills_S22_TW_IA
CollegeHills_CollegeHills_S22_TW_IB
CollegeHills_CollegeHills_S22_TW_IC
CollegeHills_CollegeHills_S3_TE_IA
CollegeHills_CollegeHills_S3_TE_IB
CollegeHills_CollegeHills_S3_TE_IC
CollegeHills_CollegeHills_S4_TE_IA
CollegeHills_CollegeHills_S4_TE_IB
CollegeHills_CollegeHills_S4_TE_IC
Concho_Concho_S11_T1_IA
Concho_Concho_S11_T1_IB
Concho_Concho_S11_T1_IC
Concho_Concho_S13_T1_IA
Concho_Concho_S13_T1_IB
Concho_Concho_S13_T1_IC
Concho_Concho_S17_T1_IA
```

Example of Changes

- Topology
  - Changes between version 2.4R1 and 3.3R1
    - Relay automation on control failure
    - Replicate upstream hot line tag
    - Invalid power direction
- These differences/changes caused issues during transitioning between versions.
- Worked with Eaton to resolve the issues and help explain the differences.

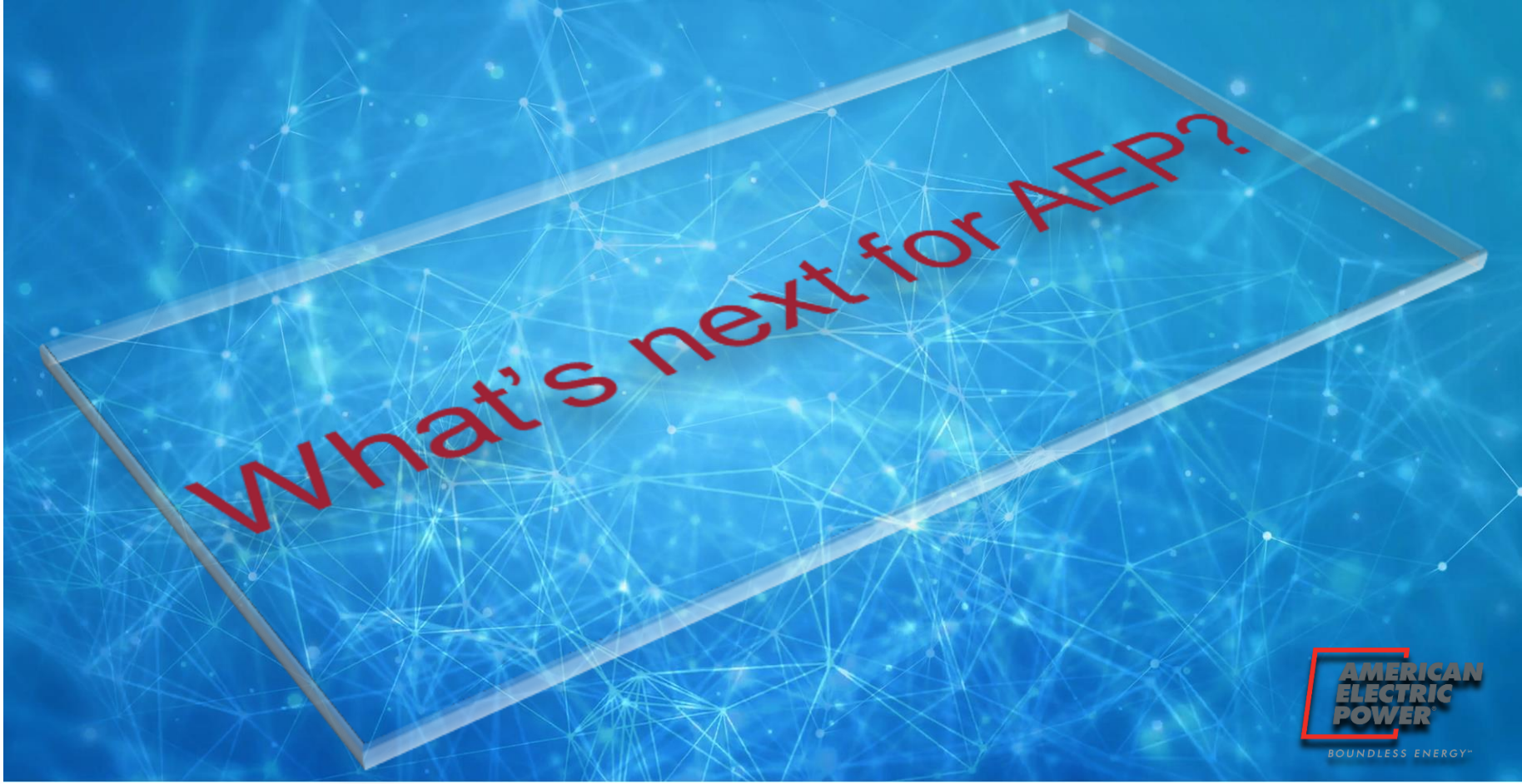


Improving Teamwork Between Eaton & AEP

YFA Support & Teamwork

- AEP has a support contract with Eaton to resolve issues quickly to ensure YFA automation is active and reliable.
- Eaton has quickly responded to calls, emails, and texts from multiple sources in AEP. Response time has been excellent.
- Jointly review successful, partial or failed reconfigurations to help provide root cause analysis. Proposed changes as necessary.
- Supported AEP transition to utilize the same YFA version across all OPCO's. Testing with lab system prior to launching.

Powering Business Worldwide



- Future DER Penetration
- Increased Funding
- Cellular, Fiber & Rural Broadband

Powering Business Worldwide

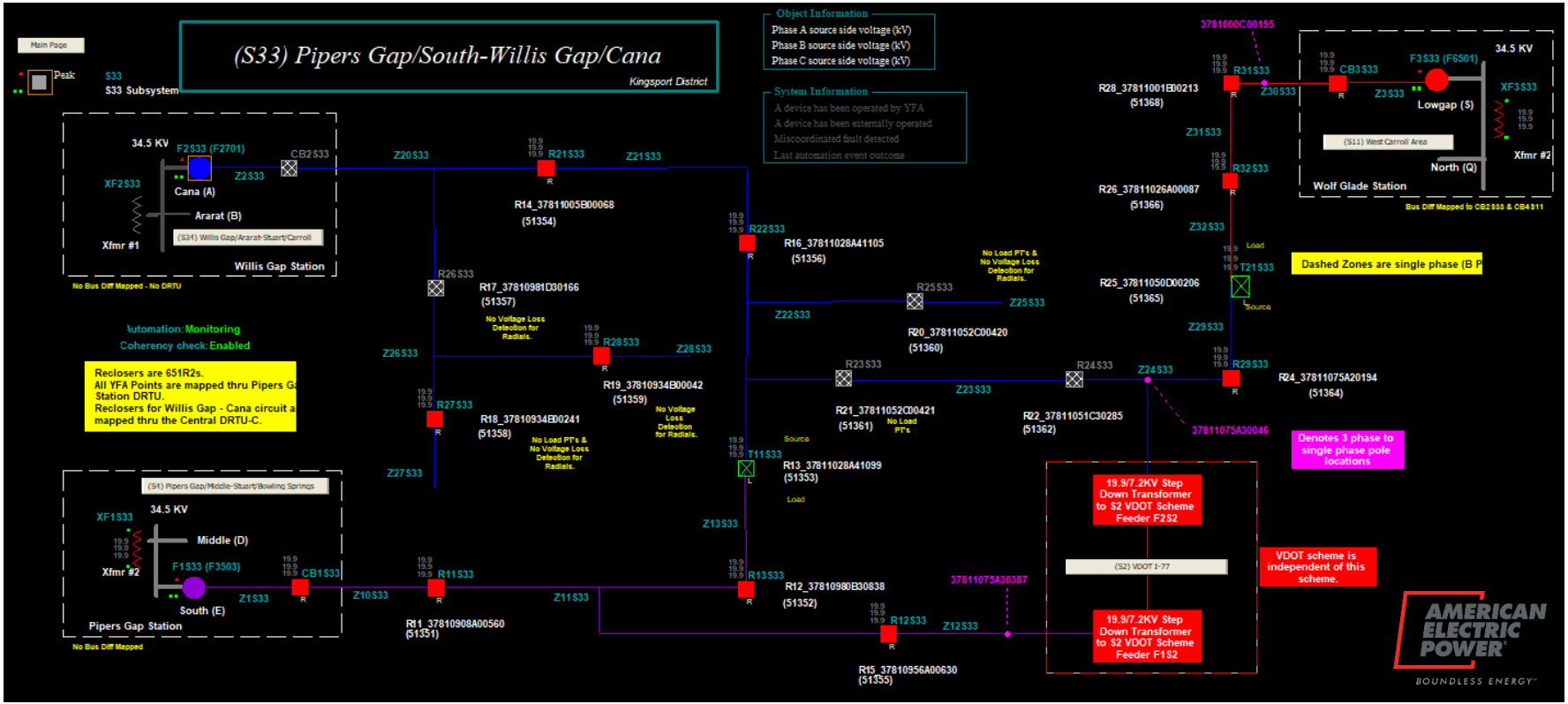
AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY™

AEP's Future - Automation

- ADMS - Advanced Distribution Management System for AEP's SCADA network including Distributed Energy Resource Management System (DERMS) being developed via a close collaboration with AEP's software vendor and systems integrators (OSI and Accenture).
- DER's – Rapid growth in penetration of battery storage, solar, and microgrids across all OPCO's.
- Large customer increase (such as Nucor, Intel), EV's, rate cases & regulatory requirements resulting in improved reliability.
- DACR – increased number of circuits in all OPCO's. Planned increase are more than triple the number of current yearly projects.
- Volt-Var Optimization or VVO (IVVC) – increase number of pilot projects in different OPCO's while increasing projects in OPCO's already utilizing VVO.
- SMG Gateway (RTU's)– utilize more centralized RTU's in both Transmission and Distribution in data centers versus having independent RTU's at every station. Increased number of devices on one RTU – close to the maximum allowable number.

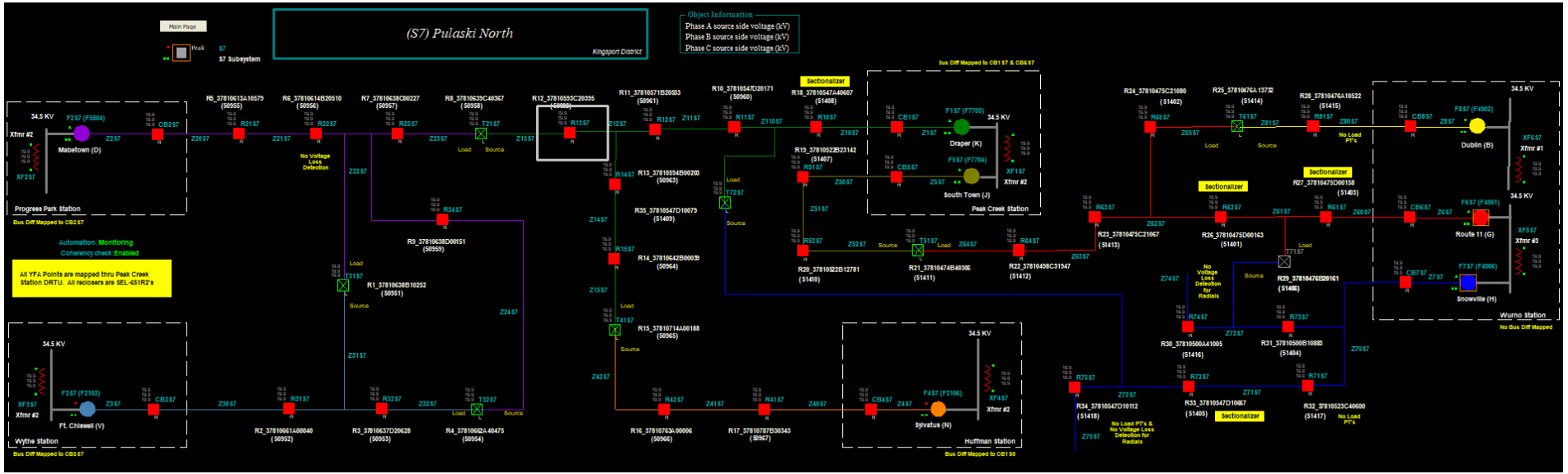
Examples & Simulations

Critical Scheme involving VA DOT Traffic Equipment



Powering Business Worldwide

Complex Scheme in YFA



Eaton.com