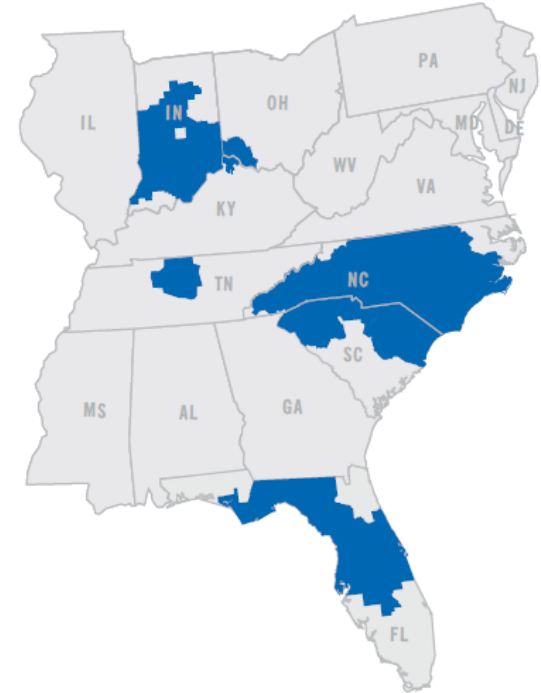


# Simplifying Complexities of Power Distribution by Implementing PI Asset Framework



- 150+ years of service
- Electric retail customers – 7.5 million
- Gas customers – 1.5 million
- 49,300 MW of owned generation capacity
- Transmission lines – 32,200 miles
- Distribution lines – 261,700 miles
- Duke Energy Renewables
  - More than 2.9 GW of wind and solar projects operating in 14 states

Electric and Gas Utilities Service Area



# Company Initiative

- Duke Energy has deployed a new SCADA system in our Florida region for Distribution Management
  - This system will integrate with our OSIsoft PI System
  - Scheduled go-live date is November 7, 2017.



# Company Initiative

- A **Distribution Management System (DMS)** is a collection of applications designed to monitor & control the entire distribution network efficiently and reliably



Electric Substation

# Opportunity of Data Accessibility

## Make Distribution Substation data available to the enterprise

- Quality Reporting
- Technicians, Outage Reduction
- External Applications (i.e. Outage Information)
- Business Analysis

## Make data easy to find

- Standardize names & attributes for ALL data
- Provide the ability to quickly & easily visualize equipment in a standard and consistent manner

OSIsoft PI is a corporate standard – Corporate EA Agreement



# Challenge of Large Data Volumes

## Organization & Visualization

- Millions of data points over time
- > 1,300,000 Transformers
- > 645,000 Protective Devices and Switches
- > 7,300 Circuits
- > 2,000 Total Stations

PI Data Archive  PI Asset Framework  PI ProcessBook

# Core PI System Components

- ↓ • PI Data Archive
  - Standardization of PI Tag Nomenclature
- ↓ • PI Asset Framework
  - Consistent modeling of equipment
- ↓ • PI ProcessBook
  - Element Relative Displays for THOUSANDS of Units
- ★ • Scripting Tools for the PI System



# PI Data Archive Tag Standards

The most critical component of standardization starts with your PI Tag Names

[SUBSTATIONCODE].[EQUIPTYPE].[EQUIPNUM].[UNIT]

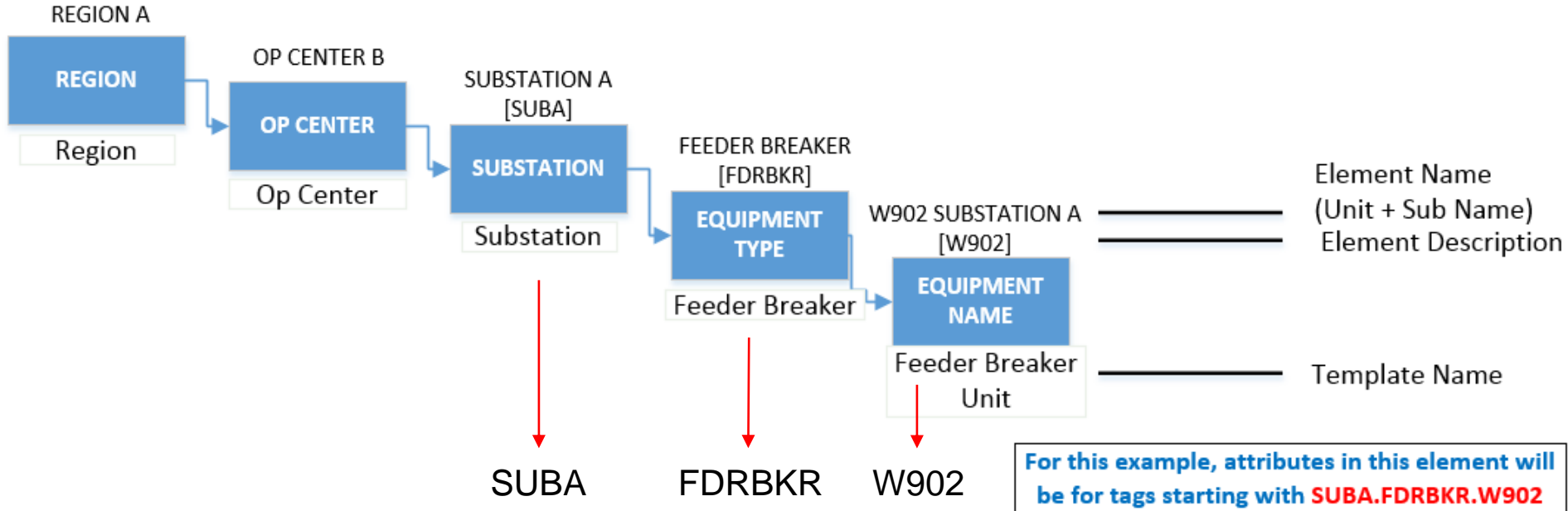
- SUBSTATIONCODE = SUBA (Substation A)
- EQUIPTYPE = FDRBKR (Feeder Breaker)
- EQUIPNUM = W902 (Unique Identifier)
- UNIT = MWA (Phase A Megawatts)
  - Tag Example: SUBA.FDRBKR.W902.MWA





# PI Asset Framework

A geographical process layout that utilizes the PI Tag standardization to easily and quickly deploy a structure:



# PI Asset Framework Structure

- ✓ Use templates for everything
- ✓ Plan ahead
- ✓ Understand the business needs
- ✓ Include as much meta-data as possible

The screenshot displays the PI Asset Framework software interface. On the left, a hierarchical tree structure shows the following elements:

- Elements
  - DISTRIBUTION
    - REGION A
      - OP CENTER A
      - OP CENTER B
        - SUBSTATION A
          - FEEDER BREAKERS
            - W902 SUBSTATION A
            - W903 SUBSTATION A
            - W904 SUBSTATION A
            - W905 SUBSTATION A
          - LINE SENSORS
          - REG SUBSTATION BUS
          - SATELLITE
          - SWITCHES
          - TIE BREAKERS
          - TRANSFORMERS
          - TRANSMISSION
        - SUBSTATION B
        - SUBSTATION C
        - SUBSTATION D
        - SUBSTATION E
        - SUBSTATION F
        - SUBSTATION G
        - SUBSTATION H
        - SUBSTATION I
        - SUBSTATION J
      - OP CENTER C
      - OP CENTER D

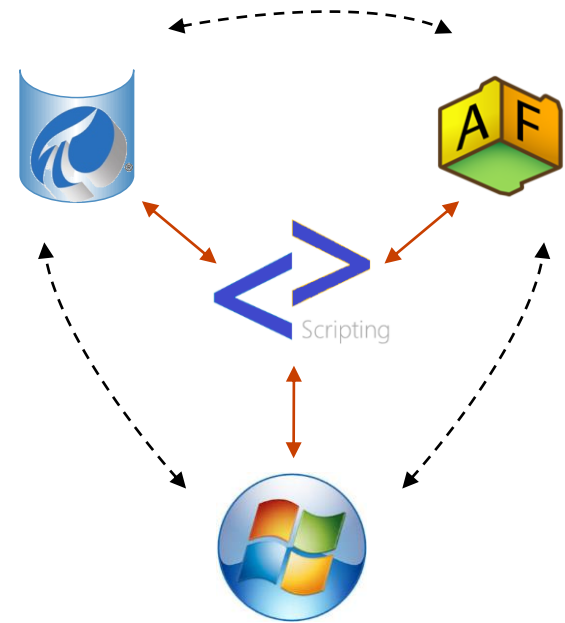
On the right, the detailed view for 'W902 SUBSTATION A' is shown, including tabs for General, Child Elements, Attributes, Ports, Analyses, Notification Rules, and Version. The 'Attributes' tab is active, displaying a table of extended attributes and phase amp data.

| Name                          | Value              | Time Stamp               | Description |  |
|-------------------------------|--------------------|--------------------------|-------------|--|
| Category: Extended Attributes |                    |                          |             |  |
| CODE                          | W902               | 1/1/1970 12:00:00 AM     |             |  |
| Display Note                  | -                  | 10/20/2017 1:33:30.67... |             |  |
| NAME                          | W902 SUBSTATION A  | 1/1/1970 12:00:00 AM     |             |  |
| OP CENTER                     | OP CENTER B        | 1/1/1970 12:00:00 AM     |             |  |
| PI Tag Format                 | SUBA.FDRBKR.W902   | 1/1/1970 12:00:00 AM     |             |  |
| REGION                        | REGION A           | 1/1/1970 12:00:00 AM     |             |  |
| SUBSTATION                    | SUBSTATION A       | 1/1/1970 12:00:00 AM     |             |  |
| UNIT NAME                     | W902               | 1/1/1970 12:00:00 AM     |             |  |
| Category: Phase Amp           |                    |                          |             |  |
| Phase A - Amps                | 133.259506225586 A | 10/20/2017 1:33:23 PM    | AMPA        |  |
| Phase B - Amps                | 45.8137588500977 A | 10/20/2017 1:33:23 PM    | AMPB        |  |
| Phase C - Amps                | 138.566299438477 A | 10/20/2017 1:33:23 PM    | AMPC        |  |
| Neutral - Amps                | 28.6908702850342 A | 10/20/2017 1:33:23 PM    | AMPN        |  |
| Phase Amps Balance Cal        | 6.23848438762939 A | 10/20/2017 1:33:23 PM    | ADHR        |  |

# Bringing systems together with scripting

## Scripting tools for the PI System

- Scripting language, similar to batch
- Fast & efficient
- Provides access to the PI Data Archive
- Provides access to PI Asset Framework
- Provides access to the Windows System

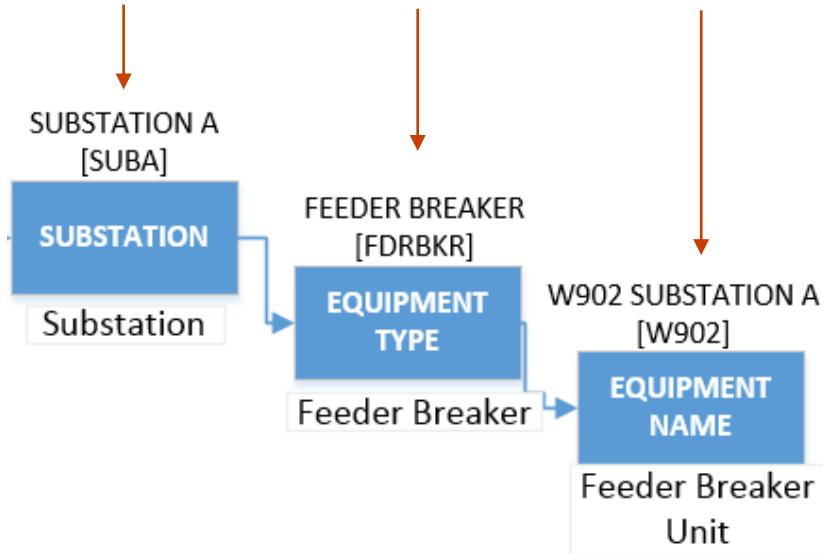


**Brings all the pieces together!**

# PI Asset Framework Automation

Keeping PI Asset Framework up to date with the PI Data Archive using Scripting

[SUBSTATIONCODE].[EQUIPTYPE].[EQUIPNUM]



A =

Retrieve a list of all unique PI Tags from the Substation code to Equipment Number

B =

Retrieve a list of all unique Elements in PI Asset Framework

Compare

- ✓ If A is not found in B: **Add It**
- ✓ If B is not found in A: **Remove It**

# PI ProcessBook needs and concerns

## To Do:

- Create standard displays for thousands of pieces of equipment that exist in PI Asset Framework

## Obstacles:

- Having too many Elements of Interest for an Element Relative Display makes it difficult to quickly locate what you need
- Previous efforts in the company have resulted in the creation of over 150,000 separate PI ProcessBook Displays, a lot to support
- Leveraging VBA can limit the use of a PI ProcessBook Display



# Elements of interest filtering

## Elements of Interest

- Filtering requires the user to know the name of the Element

The image shows two screenshots from a software application. The left screenshot is a window titled 'Element Relative Display' with a search bar and a table of 'Elements of Interest'. The right screenshot is a 'SUBSTATION W1102' overview page showing a table of electrical components and their status.

**Element Relative Display**

Search

Search Mask

Elements of Interest

Group by

Filter

| Name               |
|--------------------|
| W1108 SUBSTATION C |
| W1109 SUBSTATION C |
| W1110 SUBSTATION C |
| W121 SUBSTATION F  |
| W123 SUBSTATION F  |
| W124 SUBSTATION F  |
| W126 SUBSTATION F  |

**Time:** 10/20/2017 2:51:17 PM

**BACK**

**SUBSTATION W1102**

COMMS: **NORMAL**

Overview

|           |       |                       |                       |                       |
|-----------|-------|-----------------------|-----------------------|-----------------------|
| 3 PH MW   | 425.9 | COMM                  | TRIP                  | INST BLK              |
| A MW      | 857.8 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B MW      | 622.2 |                       |                       |                       |
| C MW      | 622.2 |                       |                       |                       |
| 3 PH MVAR | 463.4 | PINS                  | PTOC                  | GINS                  |
| A MVAR    | 466.3 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B MVAR    | 489.4 |                       |                       |                       |
| C MVAR    | 466.0 |                       |                       |                       |

○ = NORMAL ● = ABNORMAL

SUBSTATION C

\* For this reason, consider naming your Elements with key information users are familiar with, like Substation names

# PI ProcessBook needs

Each Substation will have it's own set of displays

- One per template
- Limit the Elements of Interest list to just the equipment in that substation
- Build one set of displays to be used for all substations, including navigation
- Create navigation directly based on the AF Hierarchy



# PI ProcessBook SVG files to the rescue

Build a single set of displays:

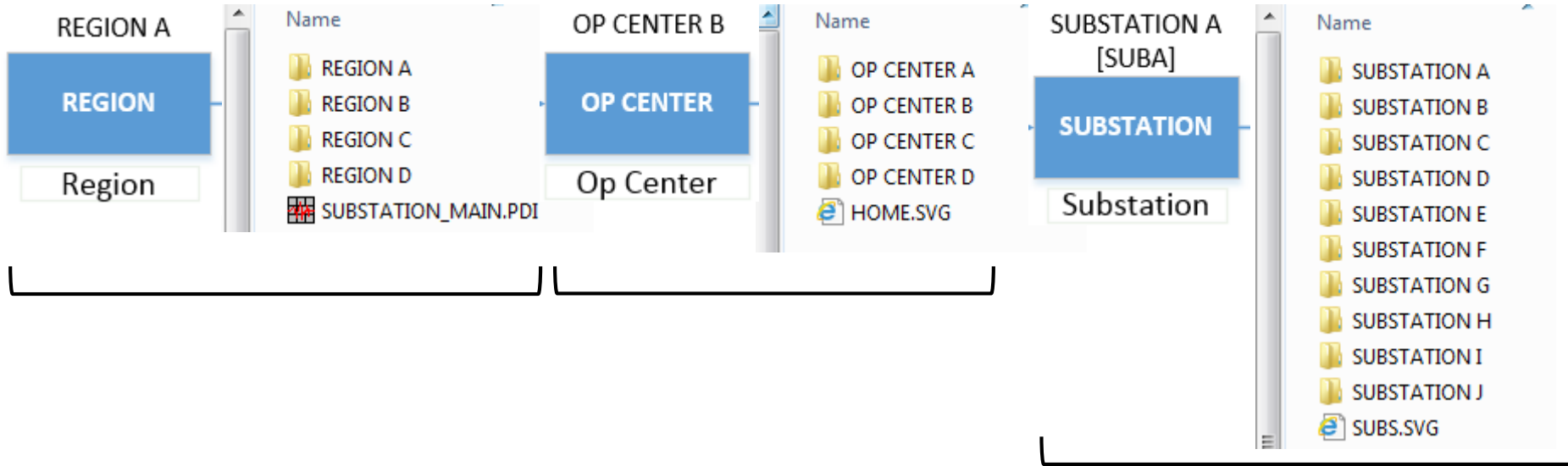
- Only include AF Attributes from a template (must be Element Relative)
- Save your displays as SVG files from PI ProcessBook
  - ✓ SVG, or Scalable Vector Graphic, files can be modified with a plain text editor and use XML formatting

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <svg height="100%" viewBox="0 1 4120 2199" width="100%" fill="#COCOCO" image-rendering="optimizeSpeed" onload=
  "SVG_doc_loaded(evt);" PB:pid="" xlink:xid="" xmlns:svg="OSI_SVG_20090601" xmlns:xlink="
  http://www.w3.org/1999/xlink" xmlns:PB="urn:osisoft-com-pb" xmlns:PBI="urn:osisoft-com-interface" xmlns:PBD=
  "urn:osisoft-com-data" xmlns:xsi="http://www.w3.org/1999/XMLSchema/instance">
3   <defs><PBD:TagUses tag="\piserver\sinusoid" PB:BO="PWSPIEventsBO.cBOEvents">
4     <PBI:Symbol name="Value18" PB:Type="7"/>
```



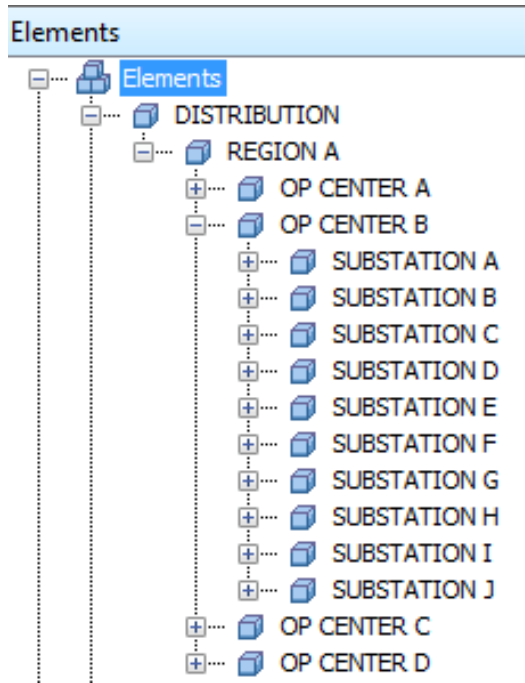
# Display navigation building

Using scripting to access your PI Asset Framework structure, you are able to retrieve each level of the hierarchy using template names and create a folder structure in Windows for your navigation:

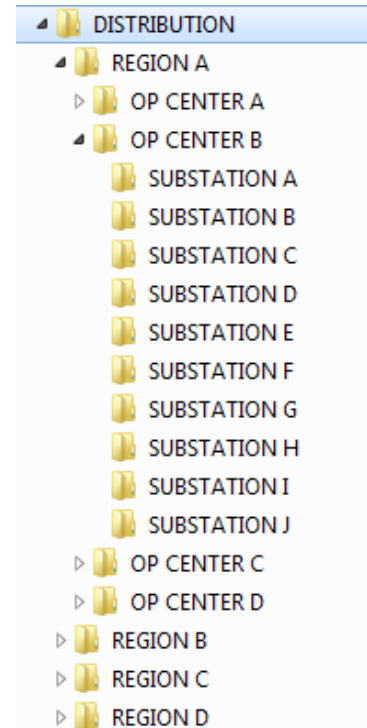


# PI ProcessBook navigation

## PI Asset Framework



## Windows Folder Structure



# Retrieving Elements of Interest

Use scripting to retrieve all Elements using your Equipment Template Name:

- Get Element Name of the Equipment & the Name of its Parents
  - Region -> Op Center -> Substation [+ Element Name]
- Using a combination of all 4 of the Element Names, you now have the paths for your “Elements of Interest”
- This is also the Windows Path created earlier

REGION A\OP CENTER B\SUBSTATION A\W902 SUBSTATION A

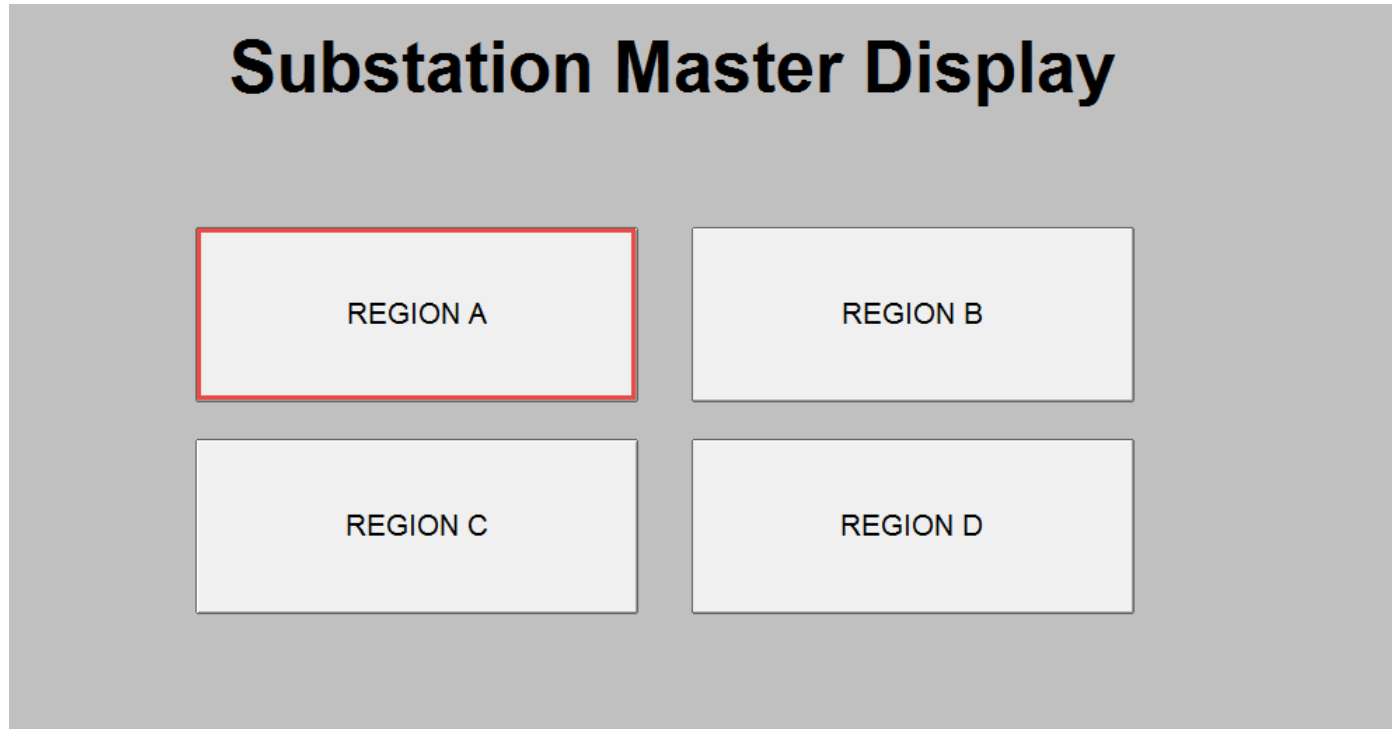


# Display auto-creation

- Use scripting to import the SVG Display made for that template
- Replace the Elements of Interest from your standard display with the paths you retrieved from PI Asset Framework
- Export the SVG Display to the 'Region\Op Center\Substation' path in Windows
  - ✓ Do this for every piece of equipment for your template displays and you have just automated screen replication using AF
- Use the same method to retrieve your Op Center & Substation names to create the navigation pages



# PI ProcessBook - Results



\* Built using Region Template



# PI ProcessBook - Results

BACK

## REGION A OP CENTERS

OP CENTER A

OP CENTER B

OP CENTER C

OP CENTER D

\* Built using Op Center Template



# PI ProcessBook - Results

BACK

## OP CENTER B SUBSTATIONS

SUBSTATION A

SUBSTATION B

SUBSTATION C

SUBSTATION D

SUBSTATION E

SUBSTATION F

SUBSTATION G

SUBSTATION H

SUBSTATION I

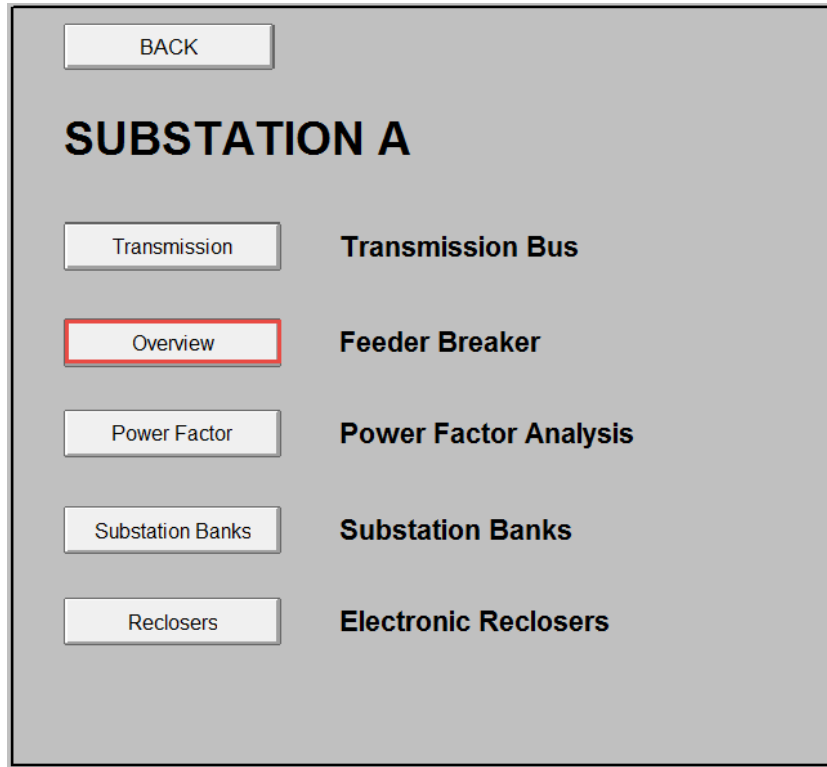
SUBSTATION J

SUBSTATION K

\* Built using Substation Template



# PI ProcessBook - Results



- 5 displays created for each substation
- Buttons only show up if the substation has that template assigned to it
- Adding and removing from the SVG's XML as needed



# PI ProcessBook - Results

Element Relative Display

---

**Search**

Search Mask

---

**Elements of Interest**

Group

Filter

| Name                          |
|-------------------------------|
| Template: Feeder Breaker Unit |
| W902 SUBSTATION A             |
| W903 SUBSTATION A             |
| W904 SUBSTATION A             |
| W905 SUBSTATION A             |

Time: 10/20/2017 4:02:17 PM

**BACK**

## SUBSTATION A W902

**Feeder**

---

COMMS: No Data

**Overview**

|           |         |
|-----------|---------|
| 3 PH MW   | No Data |
| A MW      | No Data |
| B MW      | No Data |
| C MW      | No Data |
| 3 PH MVAR | No Data |
| A MVAR    | No Data |
| B MVAR    | No Data |
| C MVAR    | No Data |
| A Amps    | No Data |
| B Amps    | No Data |
| C Amps    | No Data |
| G Amps    | No Data |

**Relay Status**

|                       |                       |                       |                       |                       |                       |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| COMM                  | TRIP                  | INST BLK              | AUTO BLK              | GND BLK               | LO                    |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| PINS                  |                       |                       |                       | A B C                 |                       |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- NORMAL    - ABNORMAL

**Fault Type**

| SUBSTA |
|--------|
| 1.0    |
| 0.8    |
| 0.6    |
| 0.4    |
| 0.2    |
| 0.0    |

---

**SUBSTATION A**   **Fault Magnitude**

|     |
|-----|
| 1   |
| 0.8 |
| 0.6 |
| 0.4 |

- E. NAME
- E. Fault Magnitude
- No Data
- ◆ E. Fault Type

| SUBSTA |
|--------|
| 1.0    |
| 0.8    |
| 0.6    |
| 0.4    |

# Results

- ✓ Creating or removing PI Tags for equipment will automatically be added or removed in PI Asset Framework
- ✓ Additions or removal of Elements in PI Asset Framework will automatically rebuild the displays and pick up the changes
- ✓ Consistency across ALL displays. Updating the base SVG file will replicate across all displays
- ✓ Able to create approximately 4,000 displays in 60 seconds

# Critical components for success

- Coordinated efforts between the business, IT, SCADA, and key stakeholders
  - Clearly communicate expectations and needs
- Standards committees for equipment and data modeling, including tag naming standards
- Plan out your PI System design from the very beginning!



# Takeaways

- **Standard tag naming** enables rapid implementation of your PI Asset Framework system and deployment of visualization solutions and reports
- Minimizes the need for unnecessary maintenance from a support perspective
- Increases the users ability to quickly and easily find the data they need
- Provides visibility into the operation of thousands of substations from Day 1 of system Go-Live



# Lessons Learned

# Next Steps

- System Go-Live on November 7<sup>th</sup>
  - UAT has been completed successfully and signed off by the business
- Leverage standardization and functionality across the rest of the enterprise
- Explore additional use cases that can be leveraged by Analytics and PI Notifications
- Training workshops for control operators and users
- Integration of PI Vision for displays



# Leveraging the PI System for Power Distribution Monitoring

## COMPANY and GOAL

Duke Energy is a leading energy company focused on electric power and gas operations and will improve these operations through our commitment to innovation and standardization



## CHALLENGE

Integrate with a new SCADA system and provide enterprise visibility to operations

- Large amount of data collected
- Meaningful visual solutions
- Verify data from old SCADA system matches the new SCADA system

## SOLUTION

Integrate with the OSIsoft PI System leveraging standardization

- Committee established to define standardization
- Enterprise wide monitoring of operations with real-time displays
- Advanced reporting with Analytics

## RESULTS

Improved operational visibility through verified and trusted data

- Monitor and trend new SCADA system state and performance
- Increased reporting accuracy
- Decreased support needs



# Contact Information

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Duke Energy





## Questions

Please wait for the **microphone** before asking your questions



State your **name & company**

## Please don't forget to...

complete the Post  
Event Survey

감사합니다

谢谢

Danke

Merci

Gracias

**Thank You**

ありがとう

Спасибо

Obrigado

Engage, Plan, Standardize, then Deploy

