



Technology Innovation

October 4, 2018

Technology and Operations

The Case for Innovation

The Case for Innovation

- **IT as a Budget Opportunity**
 - How do we leverage technology to gain efficiency and reduce business costs?
- **Balancing People and Technology**
 - How do we automate and incorporate machine learning to reduce costs?
- **Technology and Performance**
 - How do we leverage technology and data to be more analytical and predictive?



Technology and Operations

The background of the slide features a dark blue gradient with an abstract, glowing network of interconnected nodes and lines, resembling a molecular structure or a data network. The nodes are represented by small circles, some of which are highlighted with a bright blue glow.

Sensors | Mobility | Monitoring

Industrial Internet of Things

Edge

1. Read sensor data
2. Edge Processing
3. Format and transmit data via radio

Communication

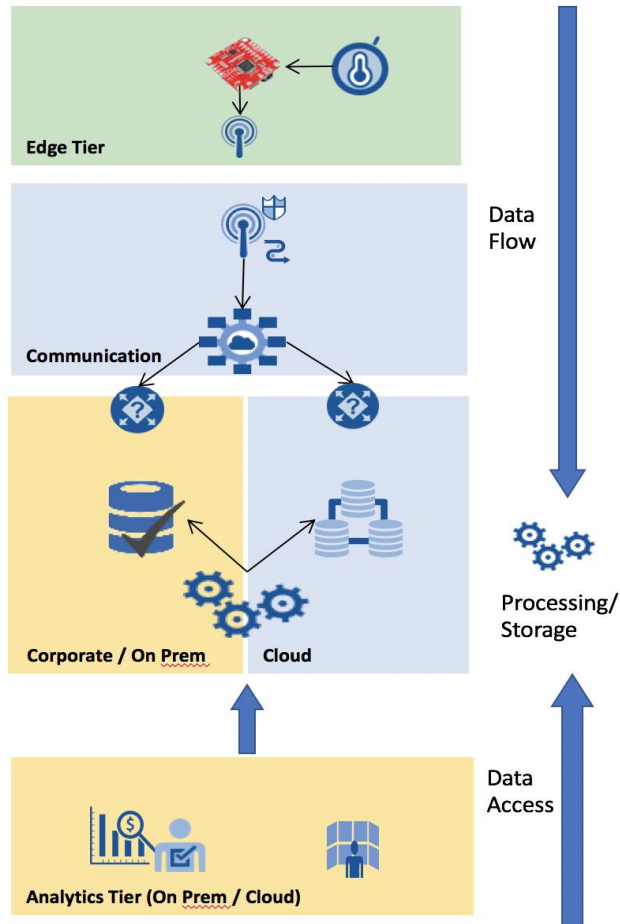
1. 900Mhz / Wifi / Bluetooth / LTE
2. Authentication / Authorization of devices
3. Gateways between networks and radio technologies
4. Connectivity to cloud
5. Connectivity to Corporate

Processing

1. Event hub processing
2. Mapping sensor data to Data Historian points
3. Writing sensor data to Data Historian

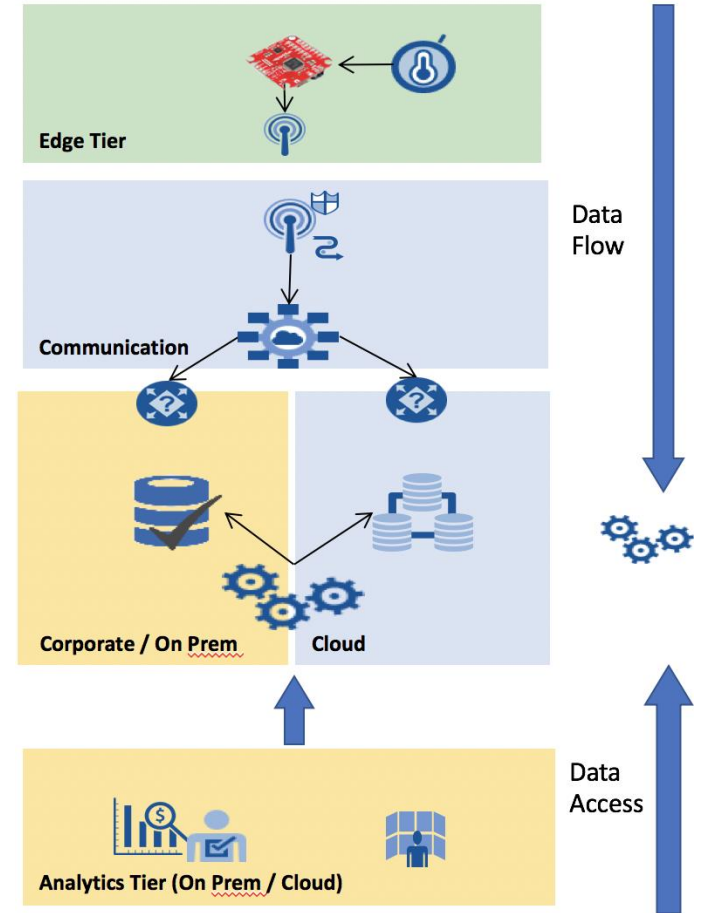
Analytics / Enterprise

1. Streaming Analytics
2. Monitoring Thresholds
3. AI / Reporting

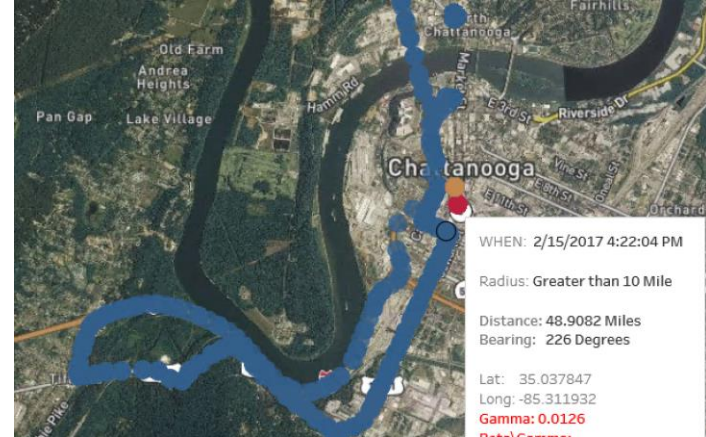


IIoT Challenges

- Remote sensor data collection:
 - Data Lake on Azure Cloud
 - Data Historian on Premise
- Realtime and historical analytics needed
- Pervasive Wi-Fi not available inside plants
- 2.4 Ghz does not penetrate plant equipment
- Crossover between IT, Electro Engineering and 3D Design



Wireless Sensors – In-House Developed



Wireless Vibration Sensors Deployed



Features

- Industrial Grade 3-axis Vibration Sensor with RMS, MAX and MIN g vibration
- Vibration Range $\pm 16g$
- Noise Removal using Low pass filter
- Frequency Range(Bandwidth) up to 408 Hz
- Sample Rate up to 952Hz
- 900Mhz - 2 Mile Range with On-Board Antenna
- Operating Temperature Range -40 to +85 °C
- IP65 Rated Enclosure
- Up to 500,000 Transmissions from 4 AA Batteries



Wireless Vibrations Project



Awards:

- 2018 Nuclear Energy Institute (NEI): Top Innovation Practice (TIP) Award

NCD wireless vibration and temperature sensor:

- 900 MHz Digi Key Mesh network
- 950Hz sampling rate
- Up to 255 sensors per mesh network

Deployments:

- SQN: 96 sensors deployed
- WBN: 96 sensors deployed
- BFN: 108 sensors in the process of being deployed



Nuclear and IT Employees Recognized with TIP Award for Original Wireless Vibration Sensor

May 24, 2018

Nuclear News



NEI Awards

Technology and Operations

Sensors | **Mobility** | Monitoring

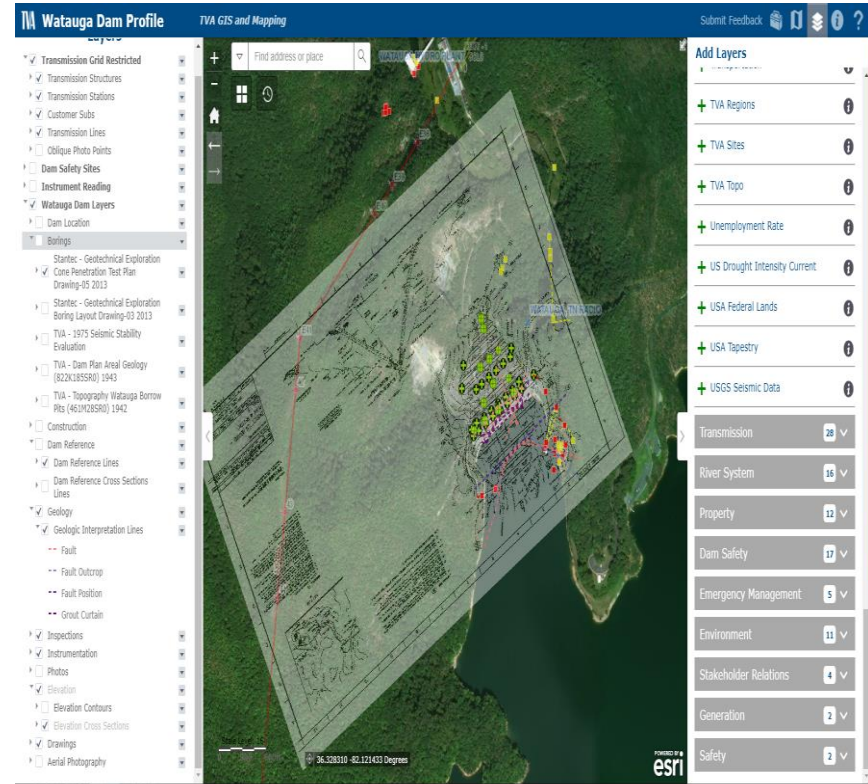
Dam Records And GIS ONLINE (DRAGON)



- Consolidates instrumentation readings into one central system
- Eliminates the use of spreadsheets
- Mobile application eliminates travel time for error rechecks
- Automates reporting

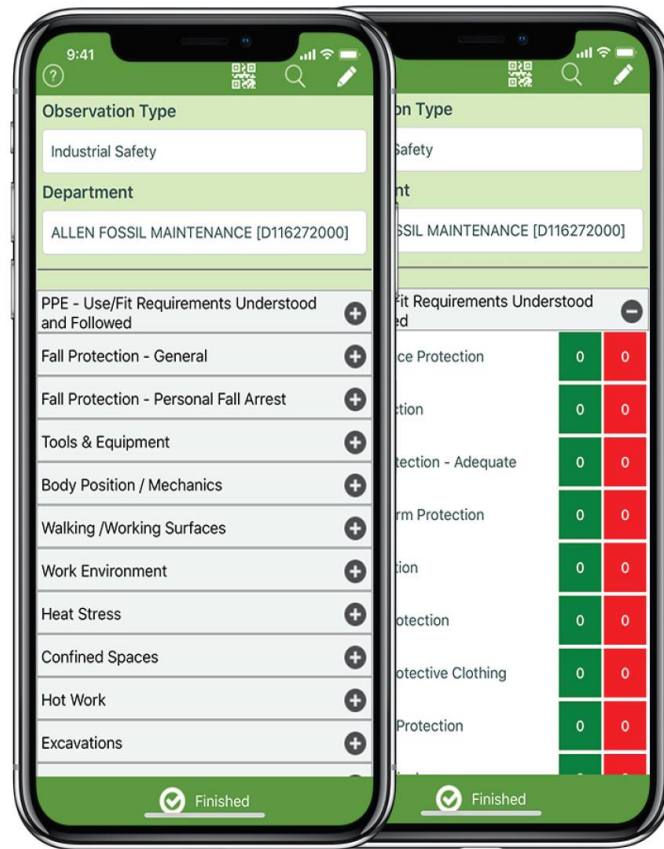
Benefits:

- Providing a mobile solution for 193 inspections scheduled for 2019
- Estimated hours saved for 2019 is over 1000 man-hours



SafetyNet

- Improves efficiency and accuracy of TVA's safety observation program by allowing personnel to submit observations in real time
- Provides a user friendly interface for assigning safe vs. at-risk conditions and behaviors
- Includes ability to submit photographs
- Enables trending
- Leading indicators based on behaviors and conditions
- Red Flag predictive modeling / analytics
- Externally linked to Union leadership
- TVA hosted demonstrations for over 20 peer companies and presented at 2 industry conferences



Safety Dashboard

Safety Dashboard

[Key Indicators](#) | [Incidents](#) | [Observations](#) | [Body Map](#) | [HR Hours](#) | [Weekly Report](#)

Show Filters

Save Filters

View/Refresh

Clear Filters

[Filters]

1 of 1

100%

Find | Next

Key Safety Indicators Dashboard			
Date	Fiscal Date: 2018	Risk Severity	All
Department	Current: BOARD OF DIRECTORS	Observed Org	All
Contractor	False	Observer Org	All
Incident Classification	All	Observation Type	All

Top 5 Injured Body Parts

Knee 27

Lower Back Area 23

Wrist(s) 23

Shoulder(s) 17

Lower Arm 14

Body Family Injuries

40

26

21

67

Serious Injury Rate

0.06

6

Rec Injury Rate

0.36

39

First Aid Rate

0.59

64

Obs. Rate

1033.30

94,368

YTD Incidents & Observations					
Incident Counts				Observation Counts	
Date	Recordable Injuries	Recordable Injuries YTD	First Aid Injuries	First Aid Injuries YTD	Observations
2018	40	40	69	69	102,158

Incident Risks by Date					
Date	EXTREME	HIGH	MEDIUM	LOW	#Rated
2018	0.13%	1.17%	21.96%	76.75%	3,088

Num. Incidents Per Category For last 7 Days

Good Catch (24)

Safety Suggestion (18)

Near Miss (6)

Injury/Illness (4)

Motor Vehicle Accident (3)

Equipment Property Damage (0)

Top 5 At-Risk by Fundamental

Good Catch (24)

Safety Suggestion (18)

Near Miss (6)

Injury/Illness (4)

Motor Vehicle Accident (3)

TVA Safety Statistics

FYTD thru Aug 2018

Injury / Illness

Recordable Injuries

39

FY18TD - 39

FY17TD - 47

Nature of Injury

11 Strain or Te...

7 Fracture

5 Contusion

4 Laceration

4 Sprain or Te...

8 All Other

Body Part

7 Knee

6 Finger(s)

5 Lower Back A...

3 Shoulder(s)

2 Soft Tissue

16 All Other

Total # Injuries

Down 13%

47

39

81

64

105

94

Serious Injuries FYTD

6

FY18 - 6

FY17 - 4

Lost Time FYTD

11

FY18 - 11

FY17 - 10

Restricted Time FYTD

11

FY18 - 11

FY17 - 15

Leading Indicators

Good Catch

Near Miss

Safety Sug.

Observation

6%

↓

Top 5 At Risk By Fundamental

Aging and obsolescen... (4 / 4)

8. Performance L... (2 / 2)

Do not release the w... (2 / 2)

Never park propane o... (2 / 2)

A communicator to ma... (1 / 1)

Motor Vehicle Accidents

MVA Total

Driver Controllable

2%

↑

FYTD 207

4%

↑

FYTD 77

FY18 vs FY17

100.0%

100.0%

100.0%

100.0%

Four Vital Behaviors

1. Identify hazards before every task.

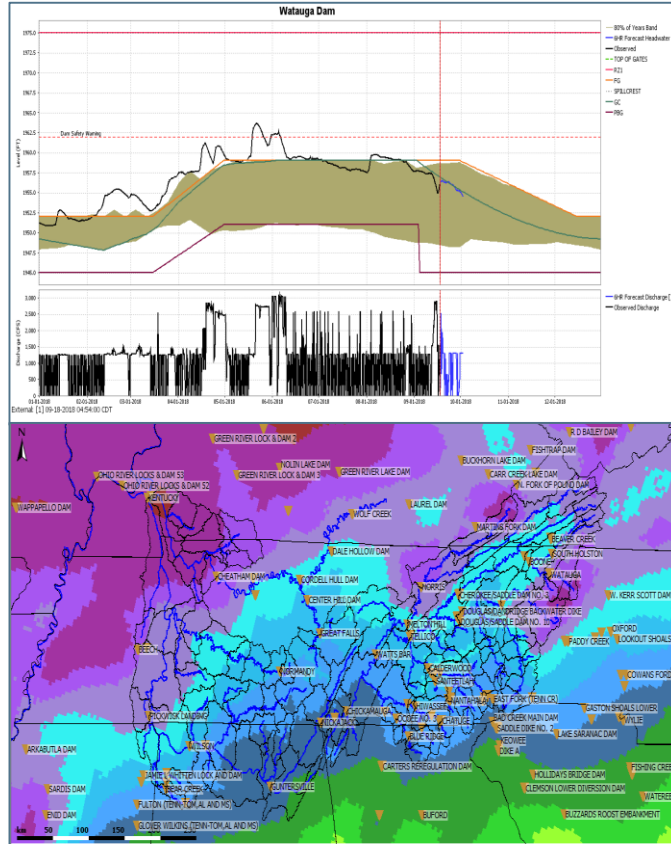
2. Take action to remove hazards and reduce risk.

3. Protect yourself and others; intervene when necessary.

4. Take pride in safety and be involved.

TECHNOLOGY INNOVATION | 14

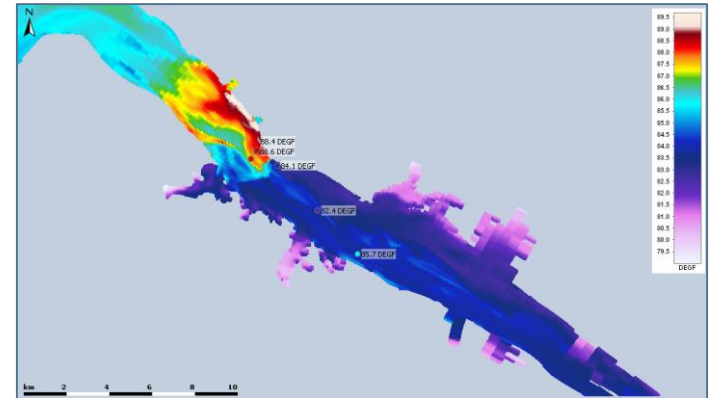
River Forecast Verification System



- River Forecast Center forecasts water supply, flooding, navigation, lake levels, generation, etc.
- Improved forecasting leads to optimized river operations at lower cost
- Determines where error exists and how to address it
- Supports future enhancements and hydro projects through data-driven inquiries
- Provide training opportunities
- National and International benchmarking has occurred against TVA's river systems
- Will be highlighted at International FEWS User Conference in the Netherlands this November

Hydrothermal System

- Reduction in forecast uncertainty will save an estimated \$1M/Year
- Better data allows for less conservative steady-state river operations
- Solutions provided:
 - Created 3D thermal modeling for more fine-tuned optimizations
 - Upgraded Browns Ferry and Sequoyah Nuclear Plant models
 - Developed Wheeler, Chickamauga, and Melton Hill Reservoir models
 - Upgraded Kingston, Gallatin, and Cumberland Fossil models



Example of enhanced 3D river modeling near Nuclear intake

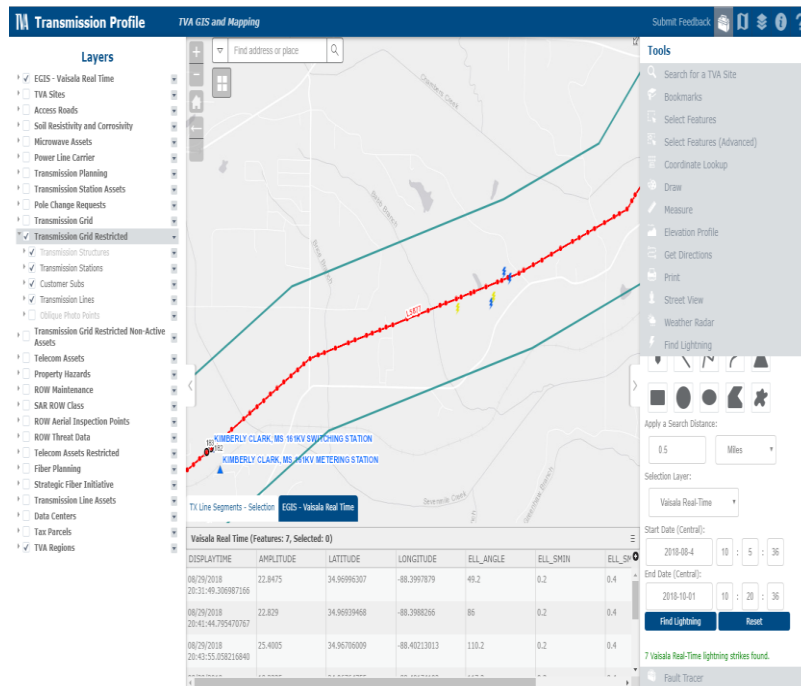
River and Reservoir Compliance Monitoring

- TVA aquatic biologists track the health of rivers and reservoirs by counting fish and benthic populations on a periodic basis for environmental and compliance purposes
- More efficient and accurate field surveys
- Consolidation of data sets
- Moved historical data from spreadsheets to database
- Enhanced reporting capabilities



GIS Situational Awareness

- Modernized Enterprise GIS platform services at TVA and consolidated disparate data sources while allowing for greater system scalability and system integration
- Some business problems solved through use of the platform:
 - Transmission Line Maintenance
 - Transmission Line Planning
 - Load Coordination Planning
 - Power Quality Lightning Strike Insurance Management
 - Disaster Response Management
 - Dam Safety Analysis



Continuous Emissions Monitoring System

- Meeting EPA requirements to capture emissions data via continuous emissions monitoring systems
- Upgrades to data loggers
- Virtualization of all physical servers
- Single points of failure removed
- Server storage and network uplifts
- Software uplifted to latest versions at all sites
- Greatly reduces travel time, speed to problem resolution, and support costs through virtualization



Technology and Operations

Sensors | Mobility | **Monitoring**

Monitoring in an Operational Environment

Challenges faced:

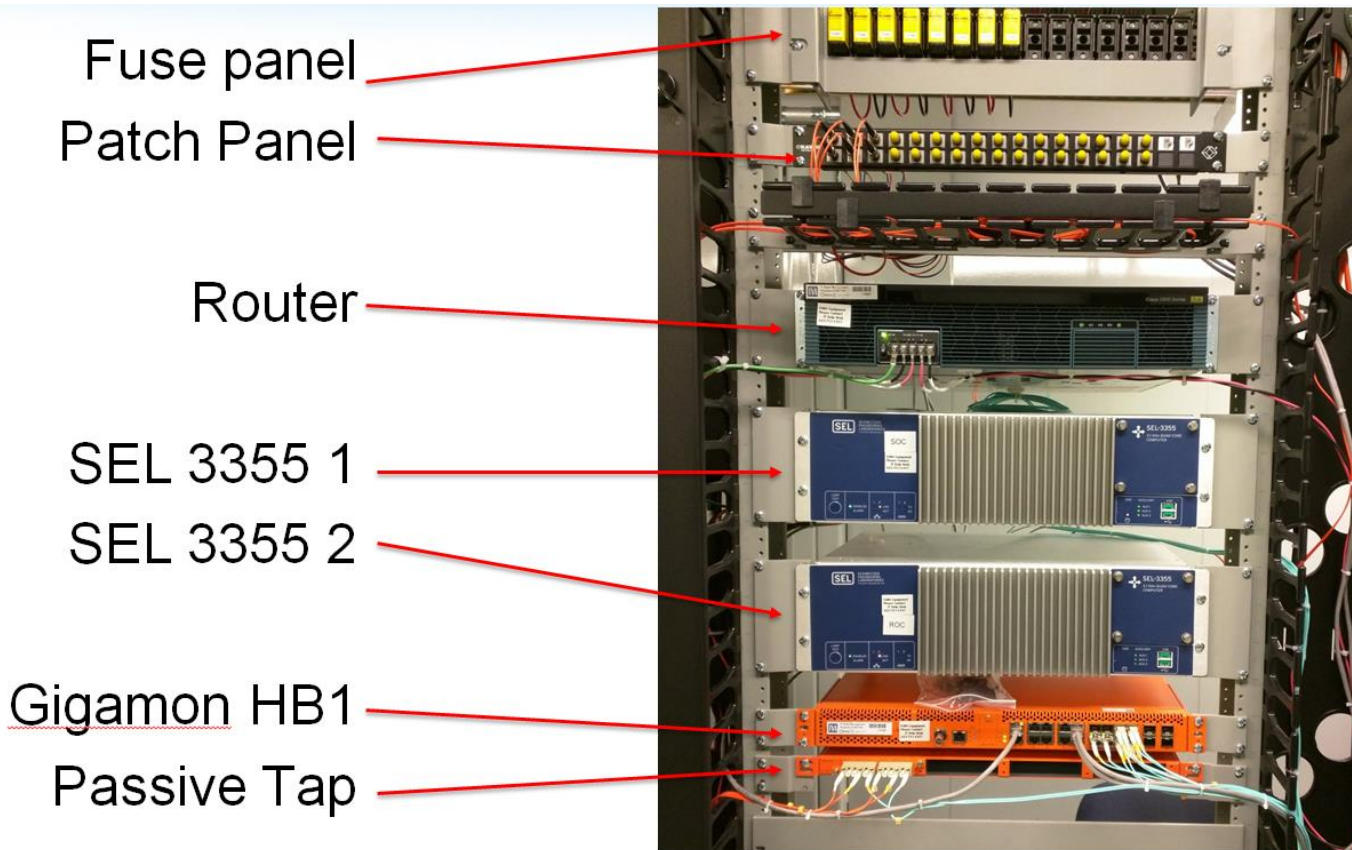
- **Non-Interference**
 - Operational systems had to be monitored with no potential to impact the bulk electric system
- **Power**
 - Plant equipment runs on DC power, while commercial monitoring equipment utilizes AC power
- **Security Landscape**
 - Techniques of threat actors change so the platform had to be adaptable and flexible
- **Non-Standard Device Types**
 - Commercial security tools do not have an 'out of the box' ability to process logs from plant equipment

Monitoring in an Operational Environment

Solutions implemented:

- **Non-Interference**
 - Utilized a network tap and syslog through tap
- **Power**
 - Used hardened telecommunications and ICS components designed for DC power
- **Security Landscape**
 - Developed a custom virtual ICS platform that can be updated remotely
- **Non-Standard Device Types**
 - Utilized a customizable solution to process any text-based data from any source or type

Monitoring in an Operational Environment



Innovation Challenges

Sensors | Mobility | Monitoring



Innovation Challenges

- **Technology Sources**
 - How to maximize return on investment through creative sourcing
- **Emergence of Cloud (SaaS, PaaS, IaaS)**
 - Risk and reward
 - Corporate versus operations
- **Workforce Development and Retention**
 - Developing quality and depth of talent
 - Changing approach to labor



