ATCO Electric | Transmission Division

SCADA

The Heart of an Energy Management System

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What is SCADA/EMS?

- **SCADA**: Supervisory Control and Data Acquisition
  - Retrieves data and alarms from remote sites
  - Enables control of devices or machines at remote sites

- **EMS**: Energy Management System
  - Uses SCADA data for real-time decision making
  - Uses SCADA data in advanced applications for real-time analysis
  - Archives data for future analysis

What did we do before SCADA?

- Rare sites had data acquisition systems (DAS)
  - Typically only analog data and slow update times
- Some critical sites were manned 24/7
  - Generators - Substations - Pumping Stations
- Some sites were checked on a periodic basis
  - Manned during the day or checked daily on key sites
  - Monthly/weekly checks on lower priority stations
- Some sites were visited on request
  - Switching of voltage control devices
  - Switching of devices to isolate equipment

What has made SCADA affordable?

- Communications
  - Technology advancements
  - Cost of communications
  - Bandwidth availability
- Information Technology
  - Use of common operating systems
  - Switched networks
  - Off the shelf hardware (no longer proprietary)
  - Processing power

Processors - Then and Now

1980's

Today

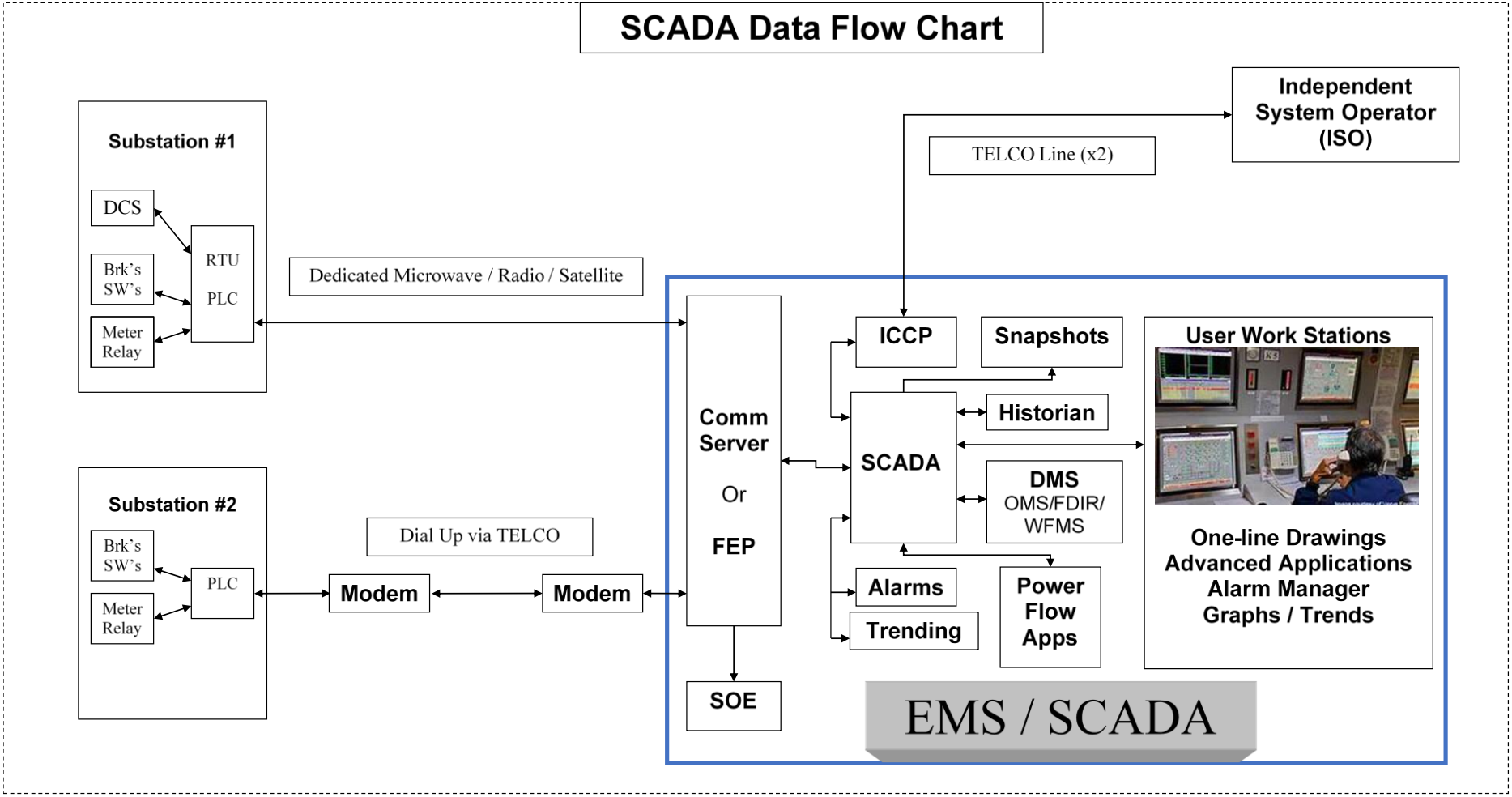
Why do we need SCADA?

- Reduce requirement for 24/7 on-site manpower
- Closer monitoring of system conditions
  - Quick response to outages, leaks, equipment issues
  - Proactive actions to maintain system stability
  - Reduce equipment damage
- Early detection of equipment failures
  - Notification of a problem (gassing) can save big $$'s
- Field techs better informed of failure cause
  - Have the right equipment and parts on the truck
  - Have the appropriate manpower on site

How does SCADA differ from a DCS?

- DCS is typically within a closed environment
  - Chemical Plant
  - Power Plants and Boiler Controls
  - Water Management Systems
- Communications is direct to the end device
  - Proprietary protocols
  - Standard protocols (Modbus)
- Built in automation logic
  - Automatically operates devices based on pre-defined conditions

Typical SCADA Communication Path



What are the key field components?

- End Devices
  - IED's (Meters-Relays) -Transducers -DCS
- RTU – PLC – DCS
  - Collect data from IED's and transducers
  - Interface to communication system
  - May have a built in SOE recorder with remote access
- Local HMI
  - Allows monitoring and control locally
- Communications Interface
  - Connects RTU, PLC or DCS to communications network

What are the key components of SCADA?

- Front End Processor
  - Communications protocol interface
  - Point mapping to RTU or PLC
  - Sequence of Events (SOE) recording
- SCADA Database
  - Mapping to FEP or Communications Server
  - **Data Types**: Analog, Status, Setpoint, Accumulator
  - **Controls**: Setpoint, Binary, Pulse
  - Data Type Configurations:
    - Status: Normal/Abnormal States
    - Analog: Violation limits, Rate of Change (ROC) limits
    - Setpoint: Min/Max limit

Key components of SCADA (cont)

- SCADA Data Type Examples
  - Status
    - Breaker, valve, switch, relay, gate, door, alarm, level limit, remedial action scheme, generator, fire, etc.
  - Analog
    - Power flow, product flow, temperature, pressure, voltage, distance to fault, transformer tap position, etc.
  - Setpoint
    - Generator output, set voltage, DC convertor output, stacking order,
  - Accumulator
    - Energy metering, product metering

Key components of SCADA (cont)

- SCADA Control Examples
  - Breakers, Switches, Relays, Valves, Pumps, Protection Schemes, Flow Gates
  - **Transformers**: Auto/Manual - Tap Raise/Lower – Independent/Parallel
  - **Turbines**: Start/Stop, Emergency Shutdown, Generator Exciter Raise/Lower, Gas On/Off
  - **DC Convertor**: On/Off, Power Direction, Power Flow, AC Voltage
  - **Static VAR Compensators**: Voltage Setpoint, VAR Setpoint

What do we do with this data and functionality?

- Monitor system and equipment health
  - Voltage monitoring
  - Equipment loading
  - Equipment status (oil level, temperature, fault type)
  - Site security and video feedback
- Maintain system security and stability
  - Instantaneous switching of multiple load devices
  - Sequential switching of devices
  - Remedial Action Scheme (RAS) status
  - Protection Scheme status
  - Switching of voltage control devices

What do we do with this data and functionality? (cont)

- Start/Stop machines
  - Turbines/Generators
  - Motors/Pumps
- Monitor asset maintenance requirements
  - Isolated generator hours of operation
  - Device operations versus scheduled maintenance
- Pass data to advanced applications
  - System stability and contingency analysis
  - State estimation
  - Trending
  - Disturbance monitoring and playback

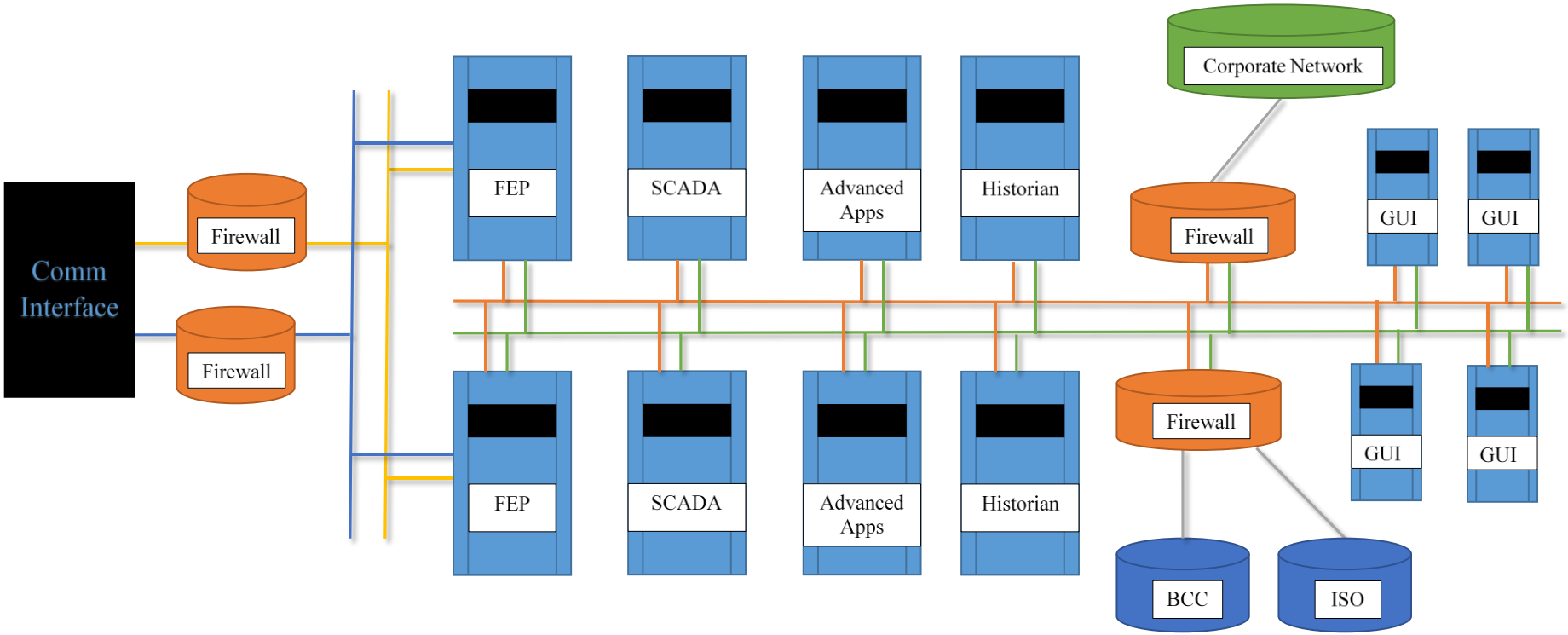
What do we do with this data and functionality? (cont)

- Pass data to advanced applications (cont)
  - Distribution Management System
    - Outage Management System (OMS)
    - Fault Detection, Isolation and Restoration (FDIR)
    - Workforce Management System (WFMS)
  - Data historian (PI, Oracle, Sybase etc.)
    - Outage or fault analysis
    - PMU data **not** provided via SCADA
  - Operator training simulator
- Exchange data with other entities (ISO)
- Pass data to backup or regional control centers

System Criticality

- A SCADA system is often deemed critical
- Outage time is unacceptable (.9999 availability)
- All servers are redundant with dual power supply
- All network devices are redundant
- All firewalls are redundant
- There is no single point of failure internally
- North American ISO's abide by NERC CIPS
- Electrical utilities in Alberta abide by AESO CIPS
- Driven by 9/11 and 2003 Northeast Blackout

A typical EMS hardware configuration



Break Time

I need a donut!!!!!

SCADA/EMS System Procurement

- There are not many SCADA vendors out there
  - The number you get to choose from depends on your system requirements
- SCADA vendors have different market focuses
  - Some are strictly oil, gas and water
  - Some are strictly electrical utility
  - Some will claim they do all of the above
  - Some target large systems requiring customization
  - Some target small systems requiring minimal change
  - Some have specific applications they promote

SCADA/EMS System Procurement

- Ensure you pick an appropriate project team
  - Include the designers, maintainers, data users and MOST IMPORTANTLY the **end users**
  - You don't need a cast of thousands
- Clearly define your SCADA needs
  - Have vendors come on site to present their systems
  - Invite multiple vendors as all systems have different functionalities
  - Ensure that what they show you isn't **vapour ware**
  - Develop functional spec from your needs and what vendors presented

SCADA/EMS System Procurement

- Clearly define your SCADA needs (cont)
  - Do we require a test and development environment
  - Do we require an off site backup system
  - Do we need a training simulator
  - What type of redundancy do we really need
  - What are our cyber security requirements
  - Seek an external consultant to help define your needs
- Have vendors demo their cyber security features
  - Do they use encryption between third party software
  - How do they establish an ESP and DMZ

SCADA/EMS System Procurement

- Have vendors provide you with a customer list
  - List should include:
    - New customers with a recently installed system
    - Long term customers who have experienced upgrades
    - Customers with needs similar to yours
- Spend the $$'s to go to customer sites for a visit
  - Be sure to interview designers, maintainers, end users
  - Ask what the upgrade experience was for each group
  - Ask what they like/dislike about the system
  - Ask about cutover process from old to new
  - Would they buy this system again
  - Are they happy with the vendor support/training

SCADA/EMS System Procurement

- Have vendors provide a detailed training plan
  - Does it include training for designers, maintainers and end users
  - Ensure that it is hands on training
  - What are their training options (on-site, online, vendor site)
- What additional training does your staff need
  - Are the maintainers well versed in the OS
  - Are there any hardware training requirements
- Ensure your contract has clear milestones

SCADA/EMS System Procurement

- Licensing
  - Ensure your system is sized appropriately at purchase
    - You don't want to increase your system size right after installation and pay increased licensing costs
    - Increased sizing is often cheaper at purchase
    - You don't want to pay for a system size you don't need
  - How are the system/databases/applications licensed
    - Some vendors charge extra for point additions
    - Some charge extra for adding additional stations
    - Some charge extra for increasing the size of a database
  - What are the licensing costs for adding another GUI
  - Does a licensing change require any system down time

SCADA/EMS System Procurement

- Maintenance Contracts
  - Find out the details of the maintenance contract
    - Are multiple types of maintenance contracts offered
    - Is it limited by the number of problems reported
    - Does it include the cost of release and version upgrades
    - How often are new releases and versions available
    - Does vendor test and certify OS patches
    - Does patch testing meet the local regulatory rules
    - Does the vendor provide 24/7 support
  - What is the cost of a maintenance contract
    - Does the cost increase if database sizing is increased
    - Include a multi-year maintenance contract if possible
    - Are there triggers that will cause the cost to increase

SCADA/EMS System Procurement

- System Upgrades
  - How often are system upgrades available
  - How does the vendor manage version control
  - How does the vendor track customizations
  - How are system upgrades completed
    - Are vendor staff required on site to do the upgrade
    - How long does a typical upgrade take (days/weeks/months)
    - How much down time is required during an upgrade
    - Can applications be upgraded without a system upgrade

SCADA/EMS System Procurement

- System Cutover Plan
  - Have the vendor provide a detailed cutover plan if you have an existing system
  - Plan should include a detailed back out plan
  - Ideally have the two systems run in parallel
    - Have the new system run in a monitor mode
    - Can validate data on the new versus old
    - Have new and old consoles side by side if possible
    - Users feel more comfortable if they see the new one working and can get some hands on experience

SCADA/EMS System Procurement

- Customized System versus Shrink Wrapped
  - Customized system pros and cons
    - **Pro**: You should get exactly what you want
    - **Pro**: System is customized to your needs
    - **Con**: Upgrades can be challenging (months vs days)
    - **Con**: Higher cost for initial purchase
    - **Con**: Higher maintenance contract costs
    - **Con**: Your system may be the only one with a bug
    - **Con**: Proprietary hardware (avoid if possible)

SCADA/EMS System Procurement

- Customized System versus Shrink Wrapped (cont)
  - Shrink Wrapped pros and cons
    - **Pro**: Initial cost is lower than customized
    - **Pro**: Upgrades are usually less painful
    - **Pro**: Maintenance contract costs are typically lower
    - **Pro**: Someone else's enhancement is in your upgrade
    - **Pro**: If you have a bug so does everyone else
    - **Con**: May not get all the functionality that you want
    - **Con**: May have to do some of your own customization
    - **Con**: Proprietary hardware (avoid if possible)

SCADA/EMS System Procurement

- Additional considerations
  - Confirm that vendor is not using third party software
    - Third party software problem leads to finger pointing
    - Problem resolution may not be given a priority by third party
    - Mitigate this by adding protection into your contract
  - Be cautious where vendor is using VMware
  - Avoid doing your own customizations
    - Customer is responsible for customized software during upgrades
    - Vendor system changes may impact your customization
  - What about your HVAC, UPS and power supply

Questions Anyone?