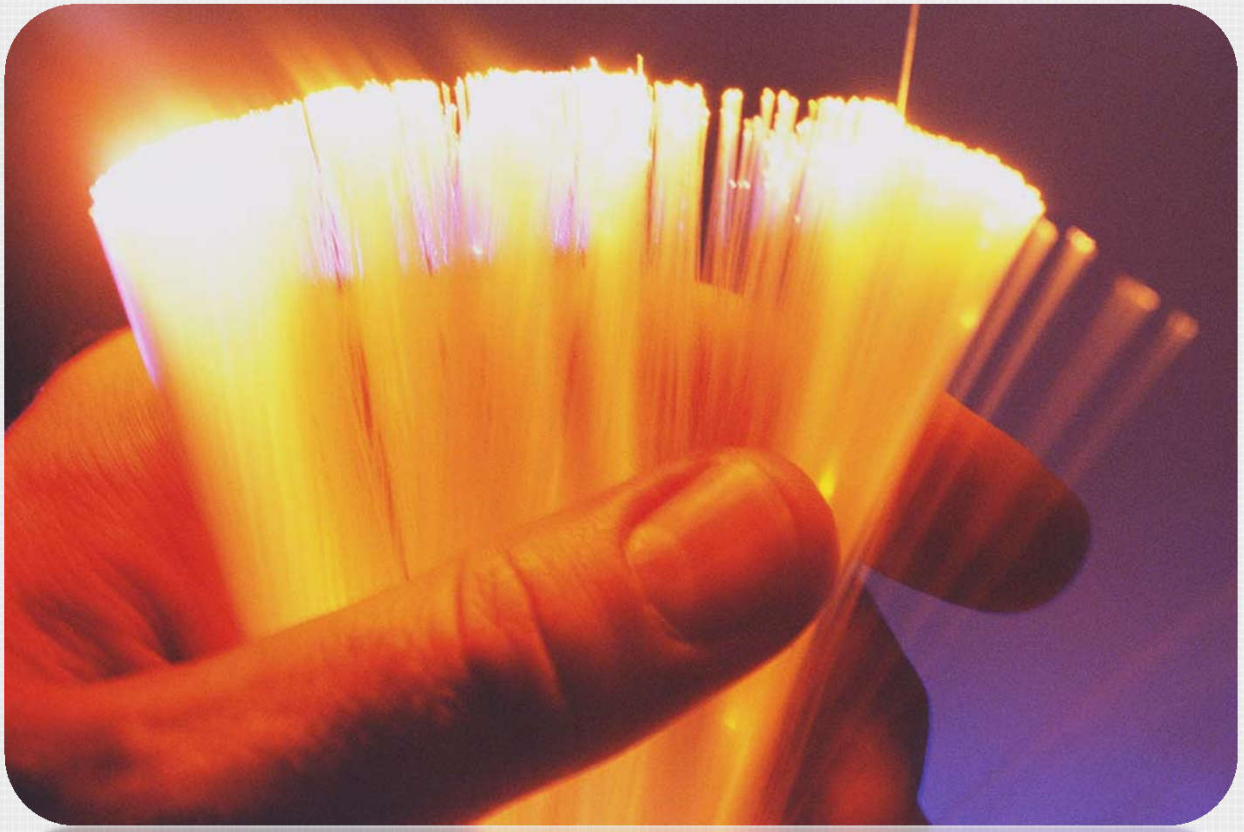
University of Idaho, ECE 421
22 October 2015



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POWER ENGINEERS

Utility SCADA & Automation

- Chris Dyer, P.E.
- BSEE University of Idaho, 1997
- POWER Engineers, Inc., SCADA and Analytical Services (SAS) Department Manager, Boise, ID
- SCADA & Automation Engineer for 17 years

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What is SCADA?

- S.C.A.D.A
  - Supervisory
  - Control
  - And
  - Data
  - Acquisition

What is SCADA?

- Transmitting and receiving logic or data (telemetry)
- Monitoring of processes
- Monitoring of equipment health
- Remote control

Why SCADA?

- Ability to manage large systems efficiently
- Area control and balance
- System reconfiguration
- Automation
  - Load shedding
  - Load transfer
  - Reactive compensation

What data?

- Breaker status
- Analog data
  - Voltage
  - Current
  - Real/reactive power
  - Load tap changer position
- Critical apparatus alarms
- Controls

SCADA Evolution – Early History

- Pre-SCADA
  - Limited Technology
  - Local control limiting system size
  - Manpower required
  - Coordination became difficult
  - Slow response
  - Conservative operation
  - Longer, more frequent outages

SCADA Evolution – Early History

- "Homegrown" custom
- Proprietary systems
  - Distributed
  - Energy Management Systems (EMS)
  - Remote Terminal Units (RTU)
- Discrete hardwired components
  - Auxiliary contacts, DC inputs, AC current/voltage transducers with A/D converter

SCADA Evolution – Recent History

- Open (non-proprietary) RTUs
- Local Human Machine Interface (HMI)
  - Traditional annunciator/mimic
  - PC based
  - Web based
- Communication Infrastructure owned or leased
- EMS & associated systems
- Data repository

SCADA Evolution - Communications

- 1200 baud “Bell 202” standard lease-lines
  - Low bandwidth, high availability
- Traditional serial (RS232/RS485)
- Ethernet
- Microwave (and other RF communications)
- Owned Fiber Optic Networks (OPGW)
- Leased broadband circuits

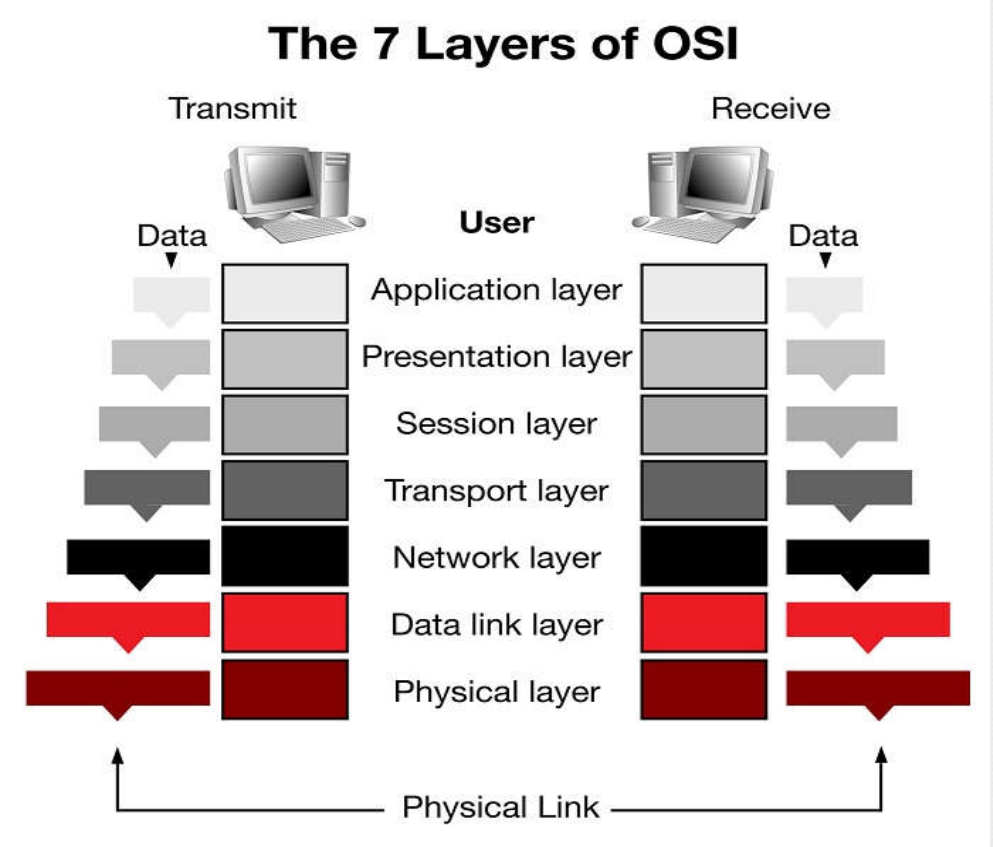
SCADA Evolution - Protocols

- Set of rules defining the exchange of information utilizing digital data transmission between intelligent devices
- Software communication “languages”
- Hardware “handshaking”
  - RTS/CTS/DSR/DTR

SCADA Evolution - Protocols

- Proprietary based on manufacturer
- MODBUS industrial communications
- DNP V3.00 developed as an “open” protocol
  - Heralded in an era of “interoperability”
- UCA
- IEC-61850
  - GOOSE
  - MMS
  - Sampled Values

OSI Seven Layer Model



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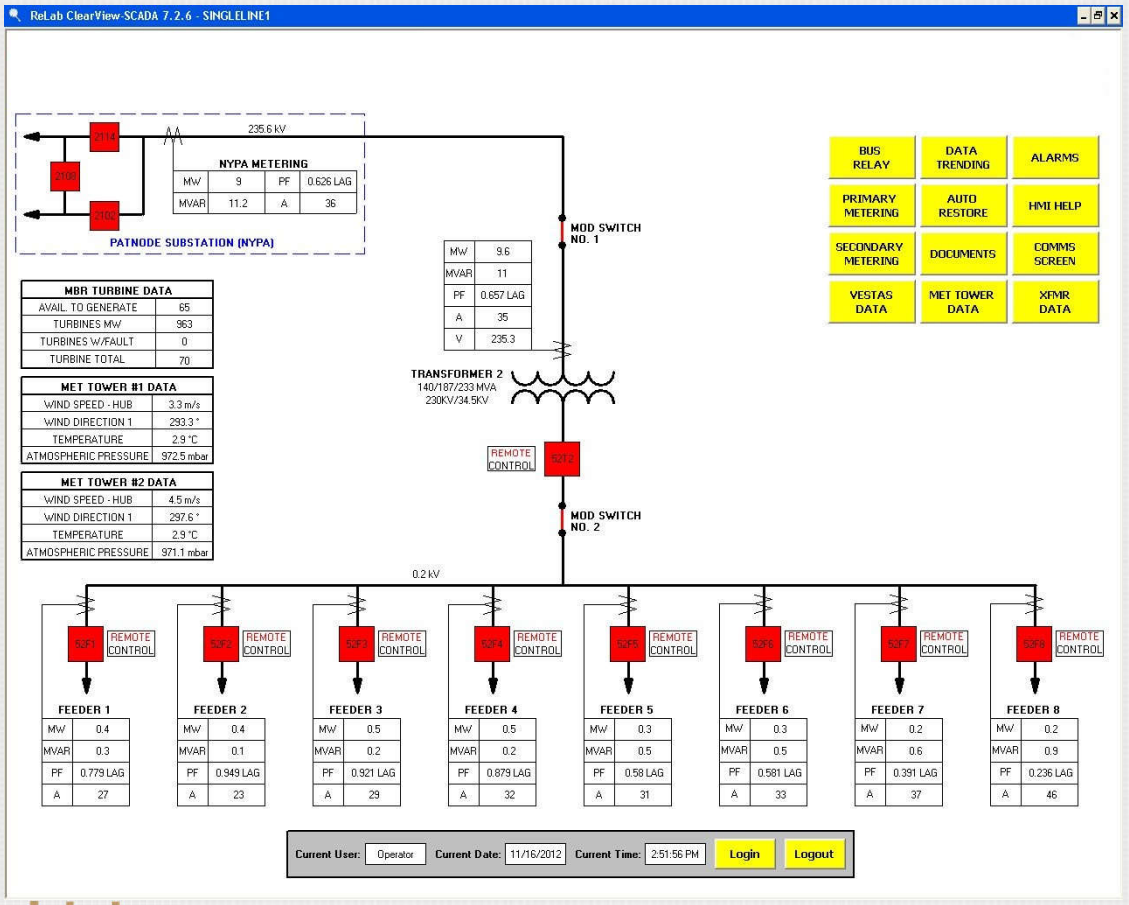
SCADA Evolution – Modern Era

- IED (Intelligent Electronic Device)
- Digital microprocessor relays
- Additional microprocessor based IEDs
- Moore's Law as applied to SCADA
- Communications and database additions

SCADA Evolution – Modern Era

- Communications systems advancement
  - Broadband technologies
  - Multiplexing
  - Interoperability
- Bandwidth capabilities
- Data analytics

SCADA = Visibility



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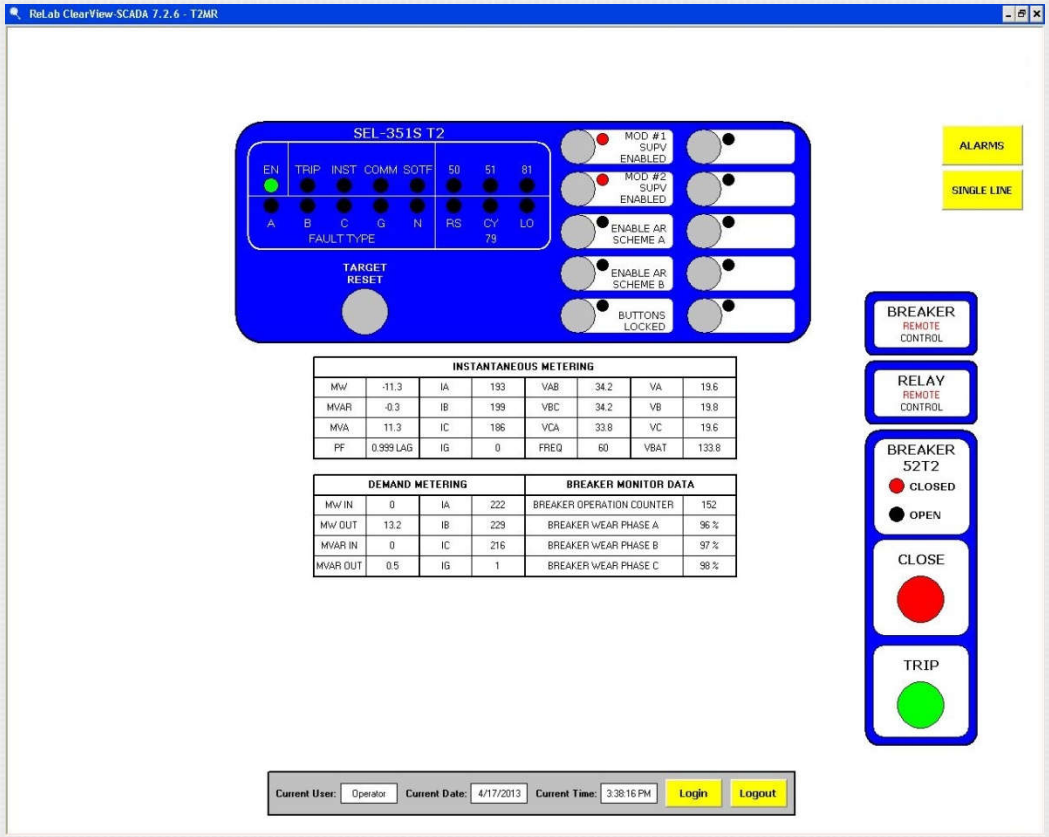
SCADA = Visbility



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SCADA Evolution – The Future

- Where do we go from here?
  - "Smart Grid"
  - Data analytics & Condition based maintenance
  - IEC-61850
  - Synchrophasors
  - Cybersecurity

The Smart Grid

- Many definitions driven by marketing
- Demand side data for customer use ("smart" meters)
- Distribution Automation
  - Load transfer
  - Load shedding/recovery
  - Volt/VAR control

The Smart Grid

- Distributed Generation
  - Distribution system design
  - Protection & stability
- Digital Substation
  - “Fly by wire”
  - Networked
  - High data availability
  - Redundancy

Condition Based Maintenance

- Definition
  - Real time monitoring of apparatus
  - Evaluation of data
  - Notification
  - Automated correction
- Traditional methods
  - Time based
  - Performance based (failure)

Condition Based Monitoring

- Example: Power Transformer
  - High cost, long lead
  - IED monitoring of:
    - Dissolved gases
    - Partial discharge
    - Cooling fan operation
    - Operation & stress
  - Trend analysis
  - “Uprating”

Condition Based Monitoring

- Benefits
  - Equipment expenditures
  - Labor & resource expenditures
  - Operational data
  - Event analysis

IEC-61850

- International Electrotechnical Commission
- Set of standards
  - System & project management
  - Engineering tools
  - Data modeling
  - Hardware requirements
  - Product lifecycle
  - Communication structure

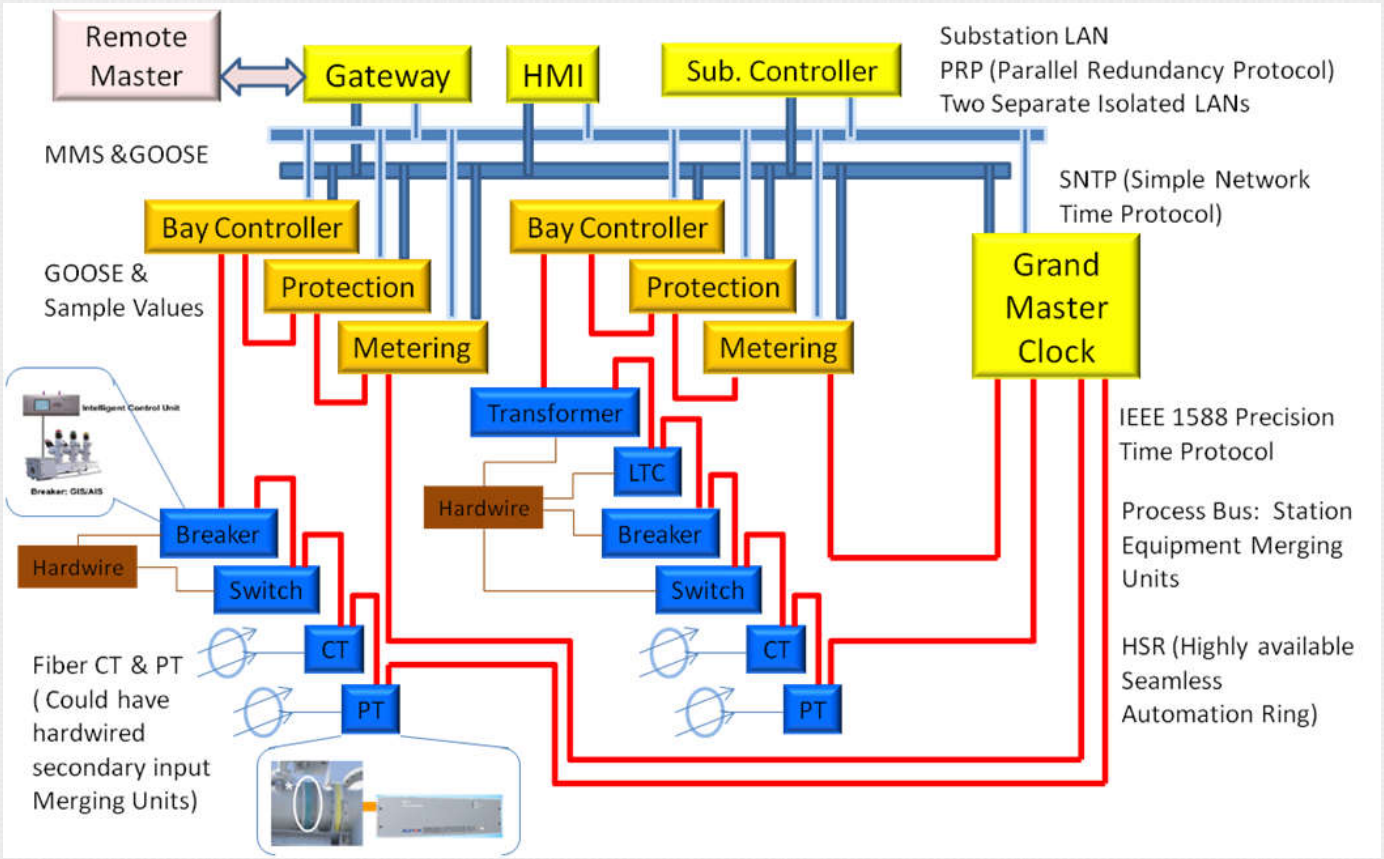
IEC-61850 Cont'd

- Station Bus
  - SCADA Protocols (MMS)
  - Protection Protocols (GOOSE)
- Process bus
  - Measured or Sampled Values

IEC-61850 Cont'd

- Object oriented standard for modeling substation and apparatus
  - Example:
    - Logic Node: Circuit Breaker (XCBR)
      - Data Object: Position (Pos)
        - » Data Attributes:
          - Control type, time
          - Status
          - Operations counter
          - Quality
          - Time stamp

IEC-61850



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IEC-61850

- Factors impeding adoption
  - Room for interpretation of standards
  - Complex with integration of other standards
  - Integration of different skills sets
  - Limited interoperability
  - Brownfield site complexity
  - Training
  - Testing & Commissioning
  - Documentation (logic diagrams, etc)
  - Trust & confidence
- Technology and standardization will drive the implementation

Synchrophasors

- High frequency data sampling
- Time stamped voltage & current phasor measurements
- Synchronized utilizing GPS
- Instability detection
- Post mortem sequence of events
- Potential to allow dynamic power flow monitoring

Micro-grids

- What is a Micro-grid?
- What does a Micro-grid consist of?
- How is the operation different?
- Special considerations
  - Communications
  - SCADA

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Cybersecurity – The Threat

- Stuxnet virus – the danger is real
- NERC CIP-14
  - Central California physical security attack
- Recent hacks
  - Retail industry (Target)
  - Sony Studios
  - Federal government (OPM)
- Is your local utility next??

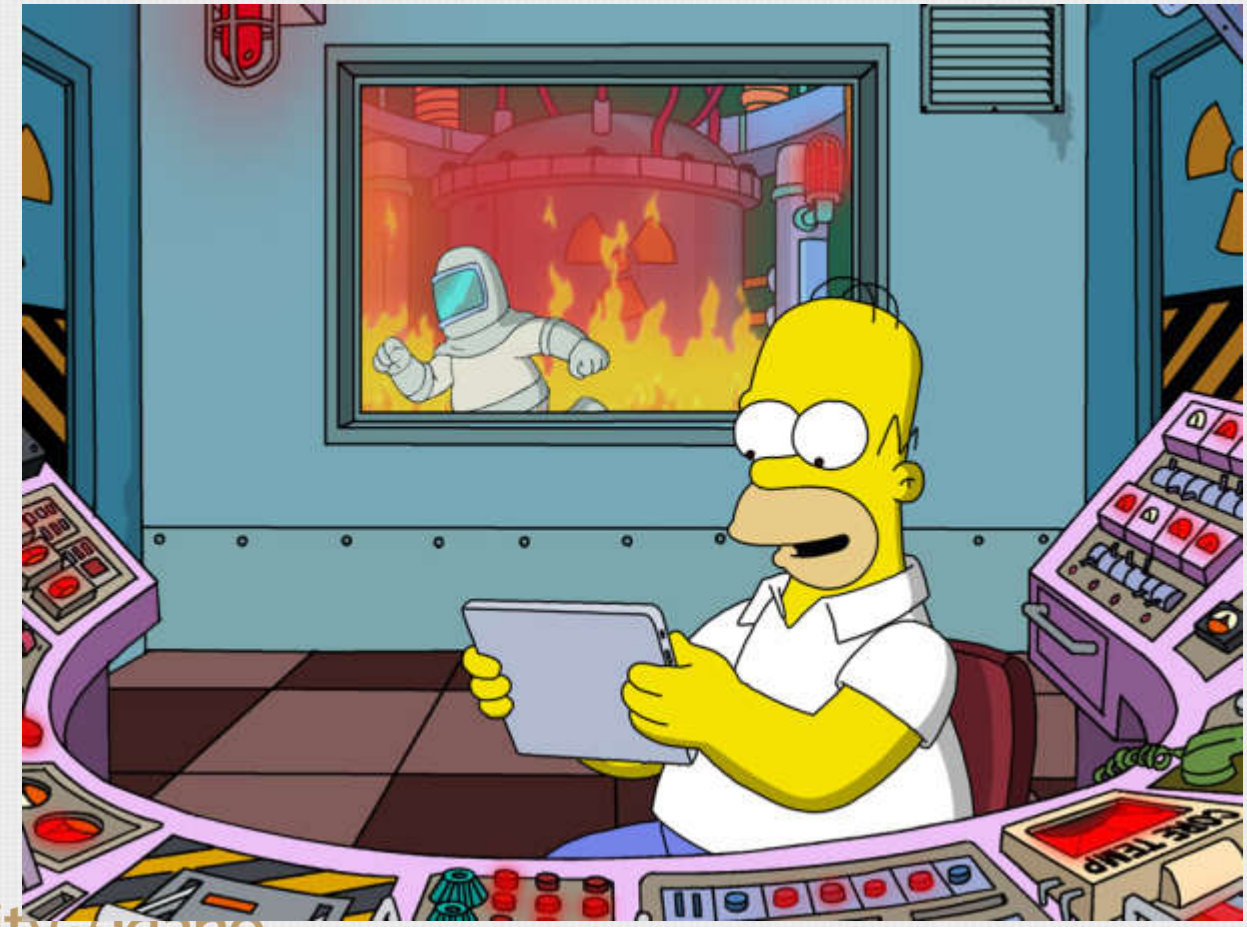
Cybersecurity – Response

- NERC (North American Electric Reliability Corporation)
- CIP (Critical Infrastructure Protection)
- Reliability & security
- Critical Assets Definition
- Compliance & penalties

Cybersecurity – Actions

- Policies & procedures
- Training
- Situational awareness
- Configuration management
- Monitor & detection
- Response and recovery

Substation of the future??



Questions?

- Thanks for your attention.
  - Chris

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