The Future of Power System Monitoring and Control Applications

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Outline

- The objectives of the 21st century power system infrastructures and applications
- System monitoring
- Condition monitoring
- Wide area monitoring
- Real-time transmission capacity monitoring
- Control room applications

The 21st Century Power System

- The limitations:
  - The aging infrastructure
    - Most major apparatus are at the end of their designed life
  - Environmental concerns
  - The investment and the incentive for investment
- The trend (answer?)
  - Go green
    - Renewable energy – distributed generation
    - Asset utilization – push more, use/waste less
    - Asset management – no waste/less disposal, defer investment
  - Smart grid
    - Monitoring – system state, asset condition
    - Protection – cascading outage prevention
    - Control – energy market, asset utilization

System Monitoring

- Objective is system state (topology and power flow snapshot)
  - Generator dispatch and power flow control
  - Disturbance identification (Voltage instability, power oscillation, etc.)
- EMS/SCADA infrastructure and applications
  - PT, CT, PMU, RTU
  - Power flow, CB status
  - State estimation
- Fast simulation and modeling (FSM)
  - Faster than real-time
  - Accurate state estimation

Condition Monitoring

- Objective is asset condition
  - Incipient fault
  - Remaining life
  - Real-time ratings (power transformers and transmission lines)
- Infrastructure
  - Standalone systems
  - Advanced substation automation systems
- Characteristics
  - Data intensive
  - Knowledge intensive - smart!!!
  - Information fragmentation and uncertainty

Wide Area Monitoring

- Objective is the marriage between system monitoring and part of condition monitoring
  - PMU based
  - Local voltage instability identification
  - Aid in state estimation improvement
  - Real-time transmission capacity estimation
- Integration with EMS/SCADA has benefit
  - Loose integration
  - Tight integration

Real-Time Transmission Capacity Monitoring

- Objective is for better utilization of transmission asset (power transformers and transmission lines) – green!
- Infrastructure and algorithms
  - Temperature monitoring
  - Load level monitoring
  - Transformer thermal modeling
    - Need a simple way of model setup
- Potential applications
  - A EMS software module to utilize the available transmission capacity in case of emergency?
    - What are the complications?
      - Legal, energy market pricing
    - What else need to be considered?
      - Risk
      - Long term impact on asset life

New Control Room Applications

- Optimal load flow control based on real-time transmission capacity monitoring
  - Trade-off between short term financial gain and long term reliability due to the loss of asset life
  - Consideration of technical, economical and political factors
- Wide area monitoring, protection and control
  - Prevent cascading outages (voltage instability)
  - Damp power oscillations
- Control room visualization techniques
  - Animation on GIS maps


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