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Smart Grid Requirements

on

MAN infrastructure

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Selected utility MAN-based applications

Not exhaustive – to illustrate a range of requirements.

- Advanced Metering Infrastructure (AMI)
- Distributed Energy Resources (DER) Integration
- SCADA and Distribution Automation (DA)
- Advanced DA (“Self-Healing Circuits”)
- Wide-Area Situational Awareness (WASA)

Advanced Metering Infrastructure

- Links to/from fixed Smart Meters (SMs)
  - One SM per Utility Service Point = customer premise
  - Can be numerous in sub/urban grid (>5K per 3-segment BS)
- Traffic characteristics (per SM)
  - Typically low BW (256 Kbps UL&DL), low latency (1–10 sec E2E)
  - Can burst to higher BW (0.5-1+ Mbps), faster rate (100-500 msec E2E)
- Applications
  - Metering: revenue, supply & demand (intervals)
  - Monitoring: voltage/current, VAR, outage, tamper
  - Manage device configuration, health, etc.
  - Interface to HAN (DR, PH/EV Charging)
- Main requirements
  - Security
  - Reliability, robustness
  - Scalability, aggregate performance

Large-scale DER Integration

- Exchanges between DERs (PV arrays, Micro-Wind, Small-scale Storage, PH/EVs) and other SG devices and central applications
  - Monitor delivered active/reactive power, fluctuations, stability
  - Monitor inverter performance (i.e. voltage, frequency)
  - Monitor EV charging impact on distribution system
  - Detect aging/degradation, failure; manage islanding and reconnection
- Example motivation: passive anti-islanding protection
  - IEEE 1547-2003 requires 2 sec shut-off (DGs <= 500kW)
  - >10 of DGs in parallel => anti-islanding algorithms too slow
  - Drives case for a comms-based transfer trip implementation
- Main requirements
  - Similar to AMI
  - Potentially higher performance, i.e. for intentional islanding
    - To maintain power quality (voltage and frequency within range)
    - To co-ordinate distribution system and DG reclosing and restoration

SCADA and Distribution Automation

- Communications between utility control center and
  - SCADA devices (largely based in substations)
  - DA devices (situated on distribution feeders)
- Applications
  - Operations (grid monitoring, analysis, simulation, configuration, protection, maintenance, …)
  - Capacity planning, load modeling and forecasting
  - Asset management, work management
- Main requirements
  - Security (!!!)
  - Scalability, manageability
  - Support for legacy protocols (tunneling, translation, termination)
  - Integration of legacy devices into multi-device schemes

Advanced DA

- Pushing DA towards fully autonomous behavior
- “Self-healing circuits”
  - i.e. aggressive sectionalization for improved reliability
  - i.e. fine-grained power/voltage/frequency stabilization
- Some applications/devices operate at “sub-cycle” speeds
  - Static VAR Compenstors (SVC), Dynamic Voltage Restoration (DVR), D-STATCOM (Distributed Static Compensator)
  - Currently closed-loop sensor-controller architectures
  - Could these benefit from MAN support?

Wide-Area Situational Analysis

- Communications between Phasor Measurement Units (PMUs), Phasor Data Concentrators (PDCs), and central mointoring/control platforms
- Applications: grid (voltage, frequency, phase) stabilization, near-realtime state estimation, “grid MRI”
- WASA driving high-bandwidth, low-latency requirements
- Requirement: very accurate (~1 usec) time source
  - Currently using GPS clocks
  - Could benefit from distributed SW implementation (IEEE 1544, NTP, PTP)
- Current efforts: NASPINet, ARRA projects

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