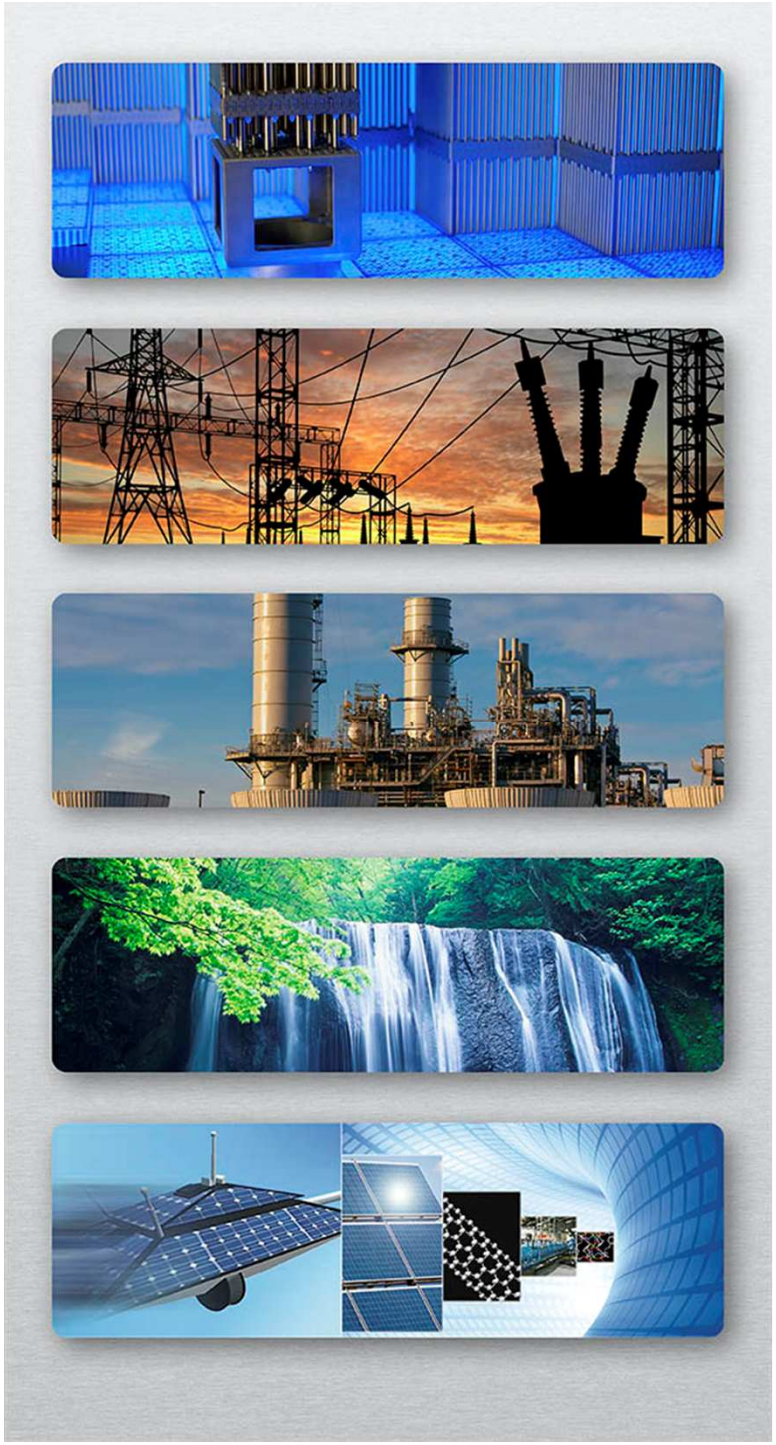

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# Smart Grid Communications Infrastructure

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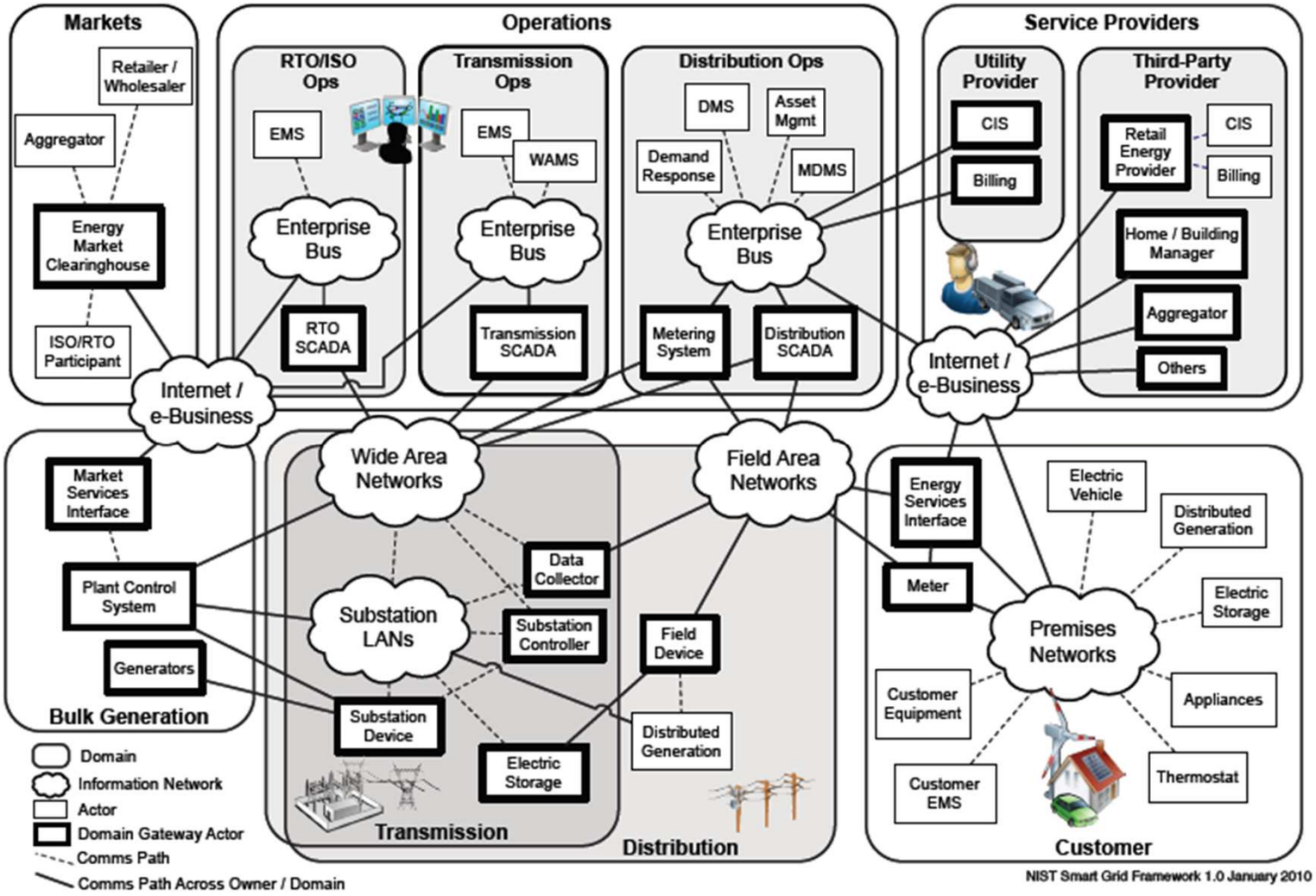
# Smart Grid Communications – Overview (DOE)




NIST Smart Grid Framework 1.0 January 2010





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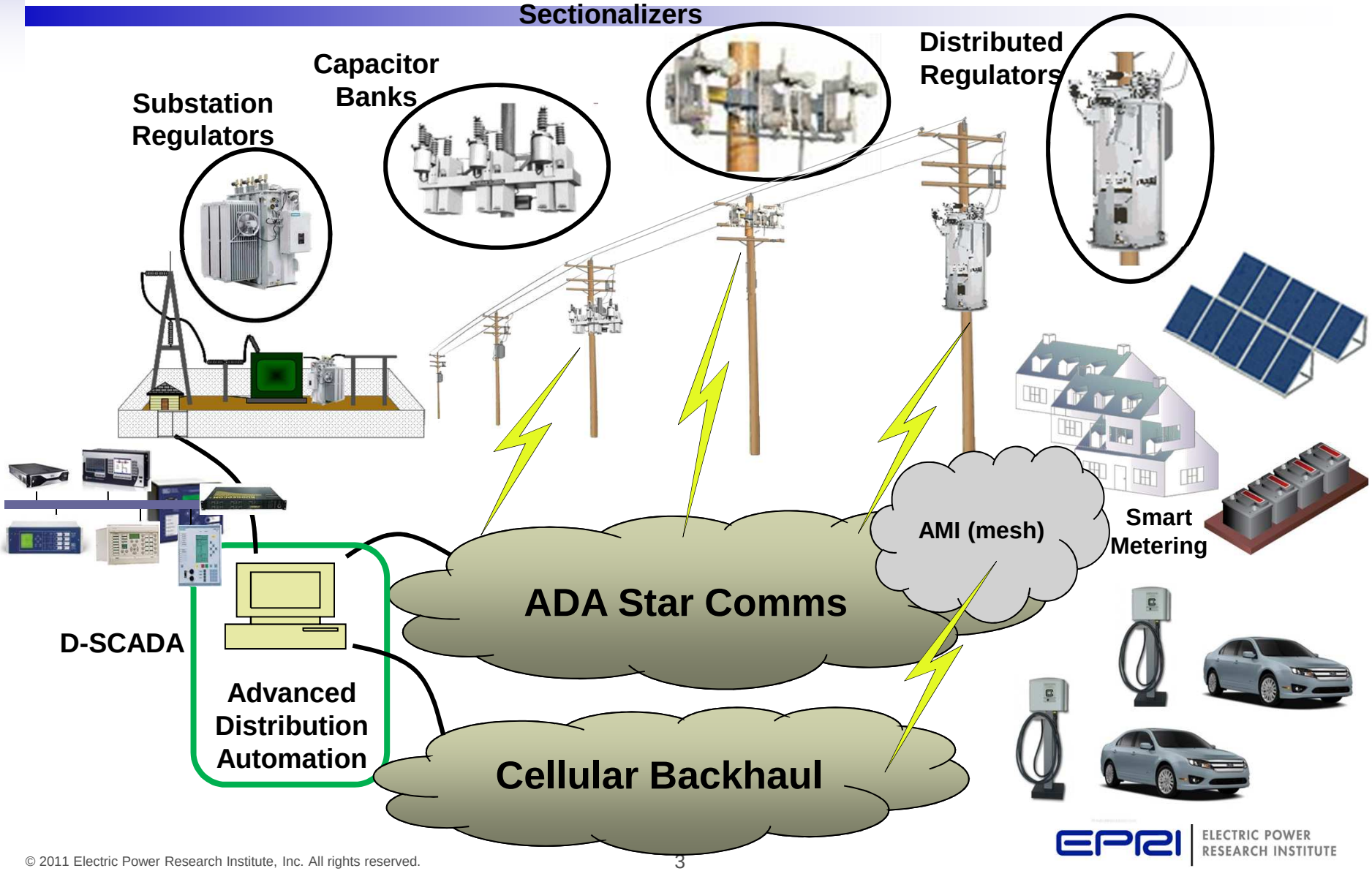
# Background





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# 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 sq mi)
- 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 into 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 such functionality be distributed? benefit from comms-based open-loop control?

# Wide-Area Situational Analysis

- Communications **between Phasor Measurement Units (PMUs), Phasor Data Concentrators (PDCs), and central monitoring/control**
- Applications: **grid (voltage, frequency, phase) stabilization, real-time state estimation, predictive modeling**
- Driving high-bandwidth, low-latency WAN/MAN requirements
- Requirement: very accurate (~1 usec) time source
  - Currently using GPS clocks
  - Could benefit from distributed SW implementation (IEEE 1544, NTP, PTP)
- Current efforts: NASPI-Net, multiple ARRA projects

# EPRI Smart Grid Communications R&D

- AMI and HAN focus
  - SEP2 Application Interoperability testing
  - Modular HAN Communications Interface
- AMI/FAN “Network Edge” focus
  - Wireless standards gap analysis
  - AMI/FAN routing/switching architecture
- Field Area Network (FAN) focus
  - High Reliability FAN architecture, requirements, and standards
  - Unlicensed “Industrial Wi-Fi®” FAN analysis and trials
  - Licensed 4G Wireless based FAN analysis and trials
  - Industry-wide HR-FAN Demonstration Initiative (from 2012)
- Wide Area Network focus
  - Smart Grid Substation laboratory
  - Wide Area Situational Awareness architecture requirements
- Electric Transportation focus
  - PLC requirements, architecture, standards, and testing
  - Telematics application integration

# EPRI Smart Grid Integration R&D

- IEC 61968 Test Development
  - Conformity test development
  - Interoperability test development
- MultiSpeak® - CIM harmonization
  - Semantic based harmonization
  - Translator for network model and AMI
- Architectural Development
  - DoDAF – Department of Defence Architecture Framework
  - TOGAF – The Open Group Architecture Framework
- IntelliGrid(SM) Methodology
  - Process documentation
  - Requirements gathering
  - Project Planning
  - System Acceptance Testing
  - Governance

# Today's Panel

- Larry Plumb, Verizon, Emerging Issues & Technology Policy
- Manal El-Ramly, ZE PowerGroup Inc - Smart Grid Integration and Communication Challenges
- Rich Lechner, IBM GTS Cloud Computing
- Sandy Bacik, NIST/Enerex - Update on NIST Cyber-Security
- Steve Kalland, N.C. Solar Center
- Barry Kuehnel, FERC