

PJM Interconnection

Smart Grid Investment Grant Update

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- **PJM Leads:**

- Project Manager: Bill Walker (walkew@pjm.com)
- SynchroPhasor Technical Lead: Mahendra Patel (patelm3@pjm.com)

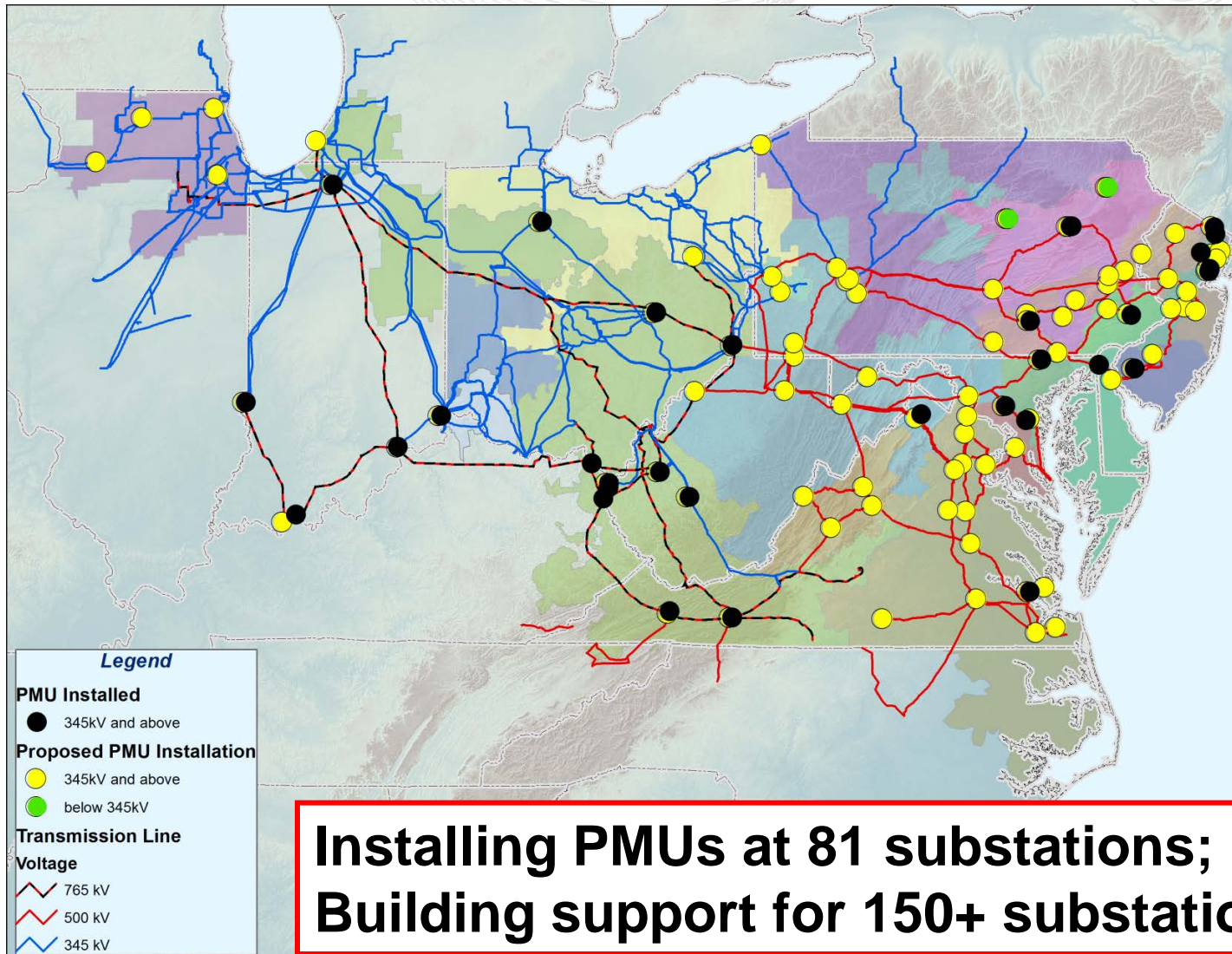
- **Vendor Partners:**

- Electric Power Group (PDC and visualization software)
- Quanta Technology (engineering/project management)
- Virginia Tech University (PMU/PDC device testing)

- 12 Transmission Owners installing measurement devices at 81 substations
 - TO's selected their own vendors
- Transmission Elements Monitored
 - 64 SS > 345kv
 - 17 SS < 345kv
- Approx. 20% of regional footprint monitored
- Installing PMU's, Relays, DFRs, DDRs

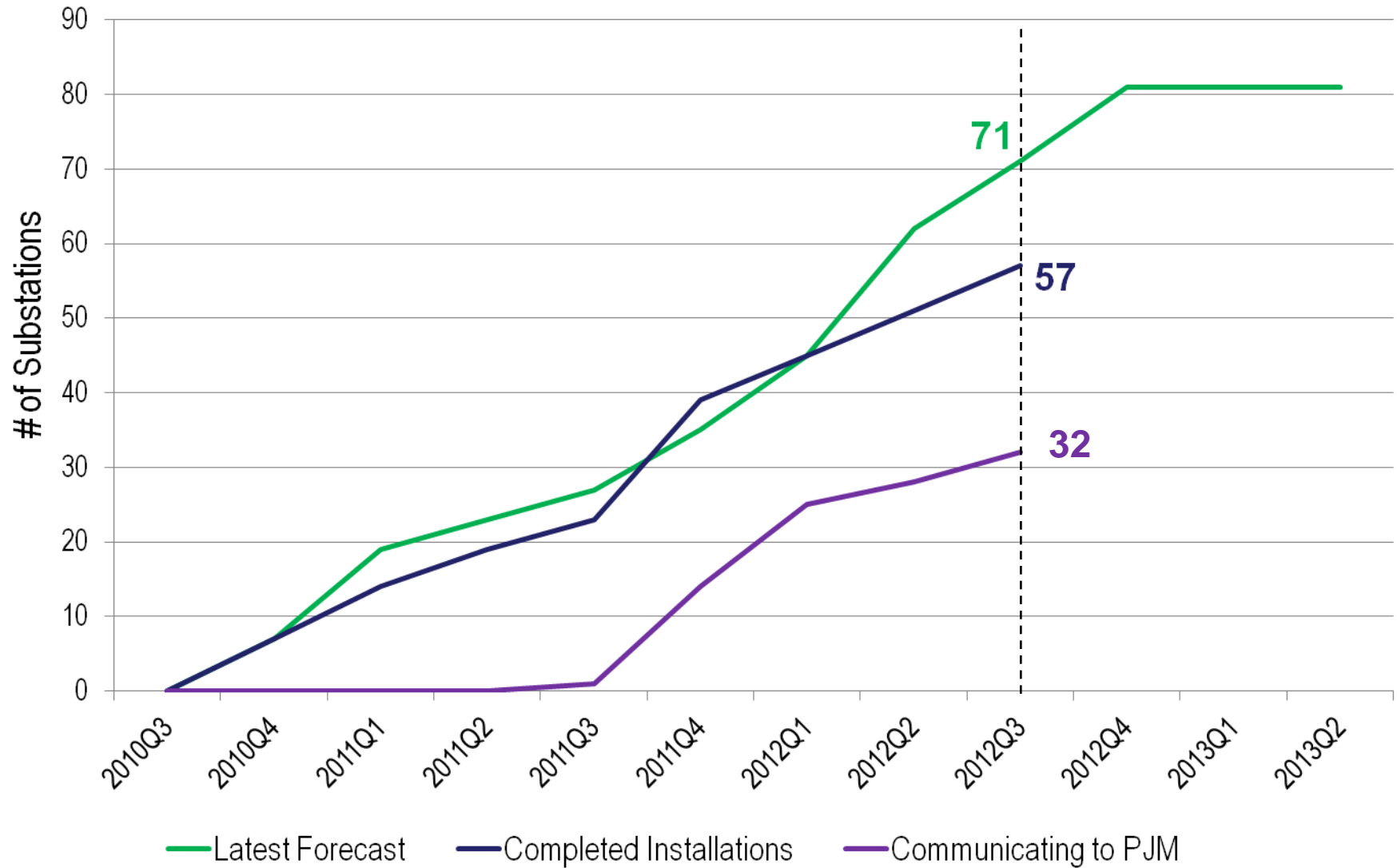
Participating Transmission Owners

Transmission Owner	# of Substations with PMU Installations	# of Central PDCs
Allegheny Power	8	0
American Electric Power	15	1
Baltimore Gas & Electric	2	2
Commonwealth Edison	4	1
Duquesne Light	2	2
FirstEnergy Services	7	2
PECO Energy	3	1
PEPCO Holdings Inc.	4	2
PPL Electric Utilities	12	2
Public Service Electric & Gas	12	2
Orange & Rockland Electric	1	1
VA Electric & Power (Dominion)	11	2
NEW Duke Ohio	3	1



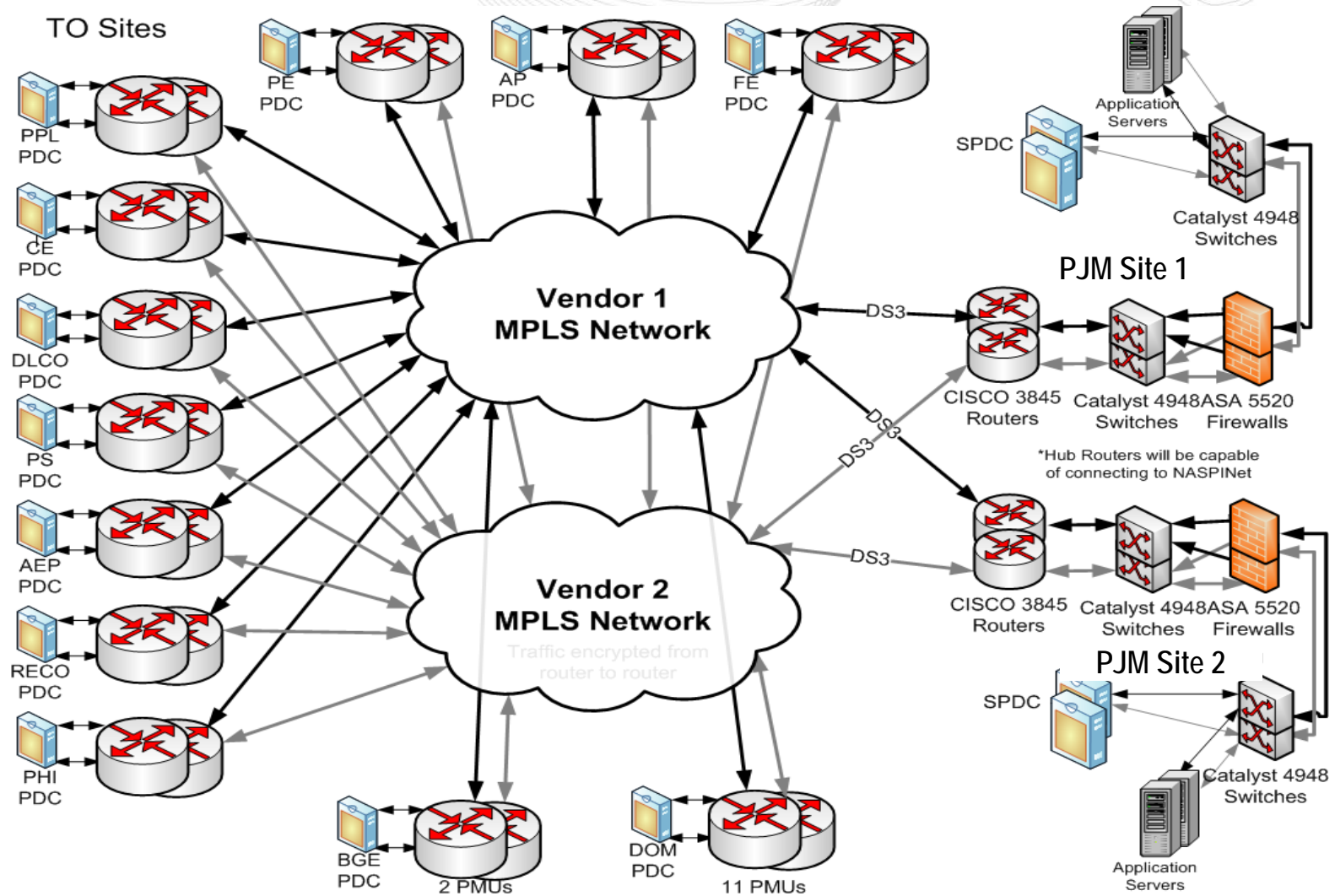
**Installing PMUs at 81 substations;
Building support for 150+ substations**

PMU Installations (Substations)



- PDCs
 - 11 (+5) TO Control Centers with Central PDC
 - Archive Database Status
 - Storage Size – 220 TB (approx 3 years retention)
 - Data archive considerations
 - 90 days real-time; 1 year near-real-time; 7 year archive
 - PDC Availability: 99.99%
- Communication System
 - 11 (+5) dedicated links to TOs (T1 lines)
 - 2 dedicated MPLS Clouds; 1 Verizon and 1 AT&T
 - System Availability: 99.99%

Telecommunications Network



- Q4 2012
 - Complete initial TO connections (final 5)
 - Data Quality and Availability
 - TO Operator Training
 - Production Hardware/Software installation
 - System Testing



- Q1 2013
 - “Go Live” with Production hardware/software
 - Implement backup communications network
 - Deploy visualization & analysis software to TO's
- Q2 & Q3 2013
 - Additional PJM and TO Operator Training
 - Full Transition to Operations Support
 - Initiate pilot projects to gain insight
 - Test EMS/SE Modifications

SynchroPhasor Applications

Data Analysis

- Use recorded data
- Verification of operations
- Analyze dynamic performance
- System model maintenance

OFF-LINE

Wide Area Monitoring

- Situational awareness display & alerts
- Visual status displays
- Interface into EMS
- Limit alarms
- State measurement

REAL TIME

System Dynamics Monitoring

- Visual displays and Alarm Processing
- Dynamic operation limits (oscillations, mode shapes...)
- Parameter estimation
- Oscillation detection

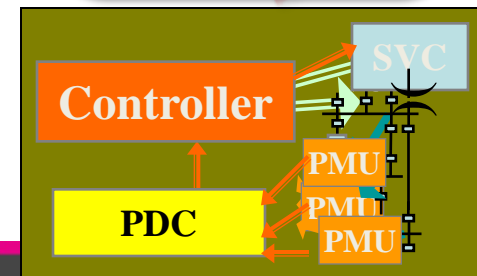
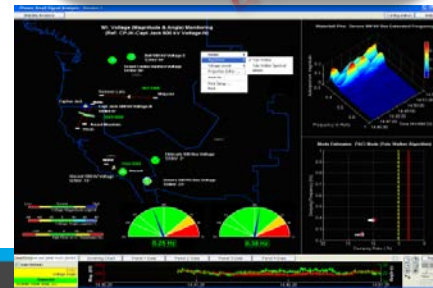
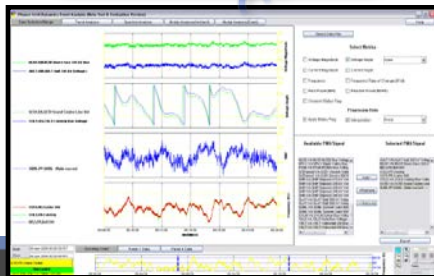
REAL TIME

System Control, Protection & Reliability

Control Actions For:

- Wide area problems
- Out-of-step detection
- Excessive power flow, high phase angles
- Both low and high speed operation

REAL TIME



Application Assessment - Future Deployment

Synchrophasor Application Prioritization for Implementation Roadmap			
Implementation Requirements & Risks	High	Special protection system design; System operating limits evaluation and design	Fault location
	Medium	Renewable resources output monitoring and alarm;	Controlled system separation; System restoration; Real-time transfer limits; Real-time reactive power and voltage control
	Low	Frequency monitoring	Grid stress
			Transient stability monitor
		Low	Medium
		High	
		Business Benefits	

DEFER

Long Term

Medium Term

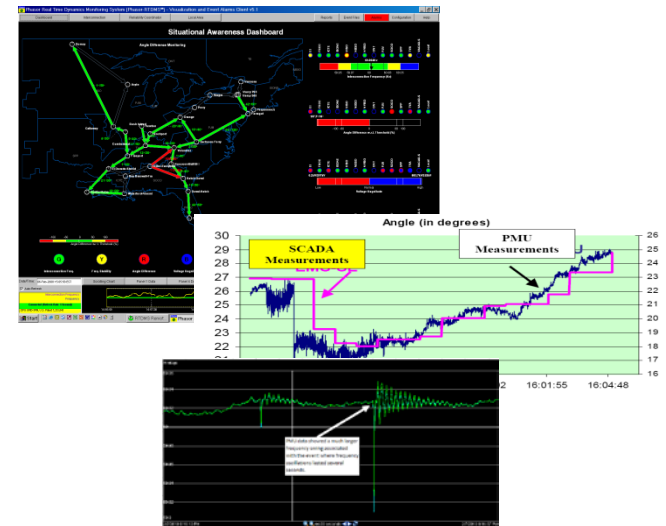
Short Term

- 71% of PMUs with “Good” (or better) rating
- 45% of PMUs delivering Timely data
 - With latency under .5 seconds
- 35% of PMUS are both “Good” and “Timely”
- Poor Quality – Root Cause
 - PMU Calibration
 - GPS Clock issues
 - Data Name limitations
 - Loose cables
 - Loss of telecom connection
 - Server overload
 - Aliasing at PDC
 - PDC configurations

- RTO/ISO Data Sharing
 - MISO (send/receive)

- Application Outputs
 - 12 PJM TO's (target Dec/Jan)

- Research Projects
 - Multiple planned



- High-level Project Challenges
 - TO Installation Schedule Changes
 - Data Quality and Availability
 - Coordination of all project stakeholders
 - TOs, Vendors, ISO/RTOs, DOE
 - Expanding scope to use available funds
 - Ensuring the architecture is scalable
 - Storage, Storage, Storage
 - R&D approach vs. “touch it once” approach
 - Data Exchange with other RTO/ISO’s

- Future Roadmap
 - Data Sharing with other RTO/ISO's
 - Integrate Phasor Data into existing applications/tools
 - Determine data archival/retention requirements
 - “Big Data” Analysis
 - Data Mining Applications
- Research Needed
 - Transient Stability
 - Dynamic Model Derivation
 - Bad Data Detection (near real-time)
 - Data Storage Efficiencies

Thank You