

Duke Energy Carolinas Smart Grid Investment Grant

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NASPI *North American
SynchroPhasor Initiative*

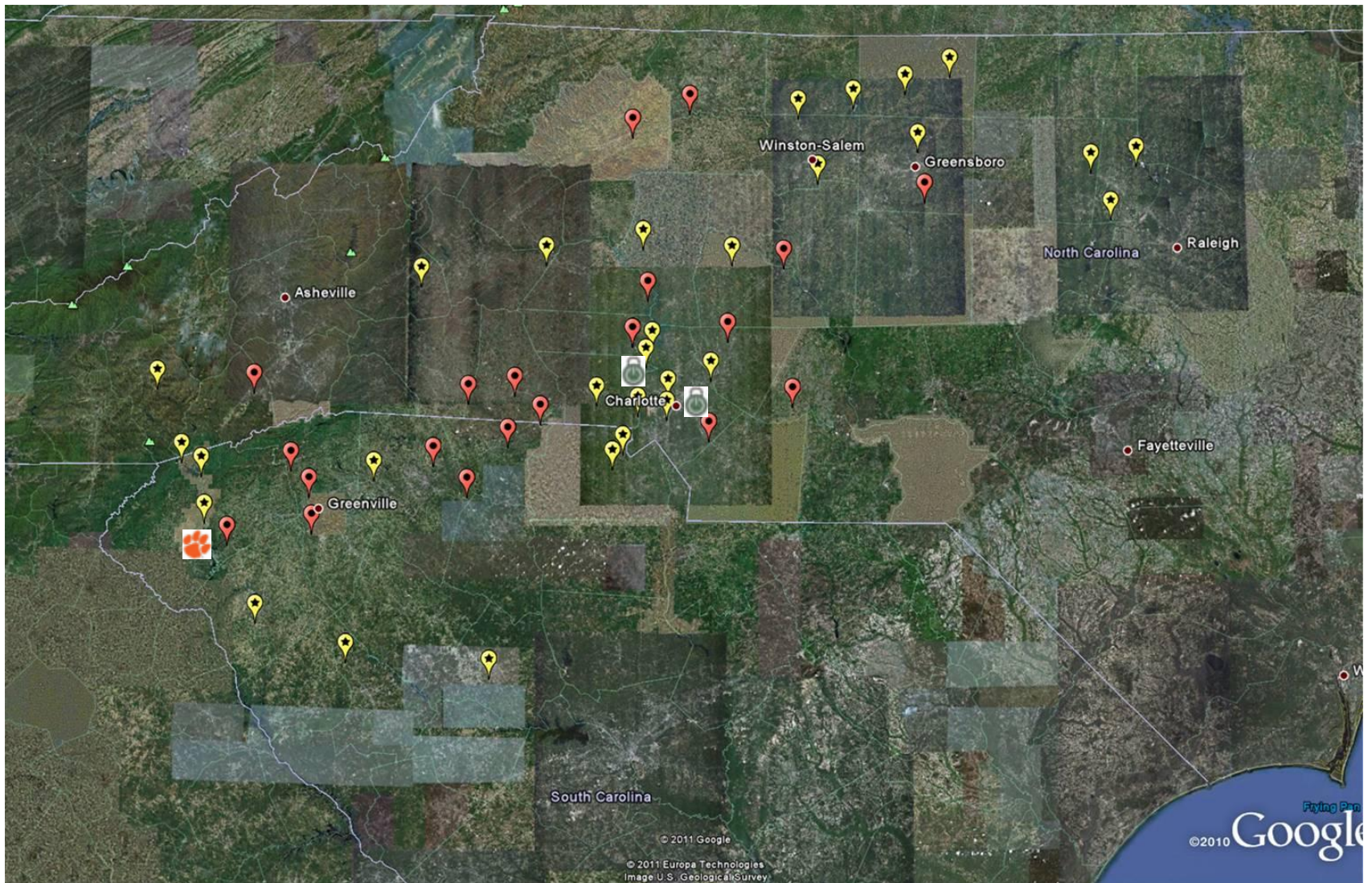
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Project participants

- Duke Energy Carolinas
 - Megan Vutsinas, Megan.Vutsinas@duke-energy.com, 704-382-0855
 - Tamara Harrison, Tamara.Harrison@duke-energy.com, 704-384-7723
 - 104 PMUs and 2 PDC systems to be installed
- Vendors: Alstom Grid, SEL, Cisco, OSIsoft

Project Map



Project Timeline

	2009	2010				2011				2012				2013	
	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr
STIP Implementation															
2010 Sites			█												
2011 Sites						█									
2012 Sites										█					
2013 Sites														█	
EMS Upgrade(Revised)															
Design and Purchase						█									
Install and Test									█						
Visualization(Revised)															
Design and Purchase												█			
Install and Test														█	
Super PDC															
Design and Purchase			█												
Install and Test						█									

PMUs

[Total (completed) project data except for installation pace]

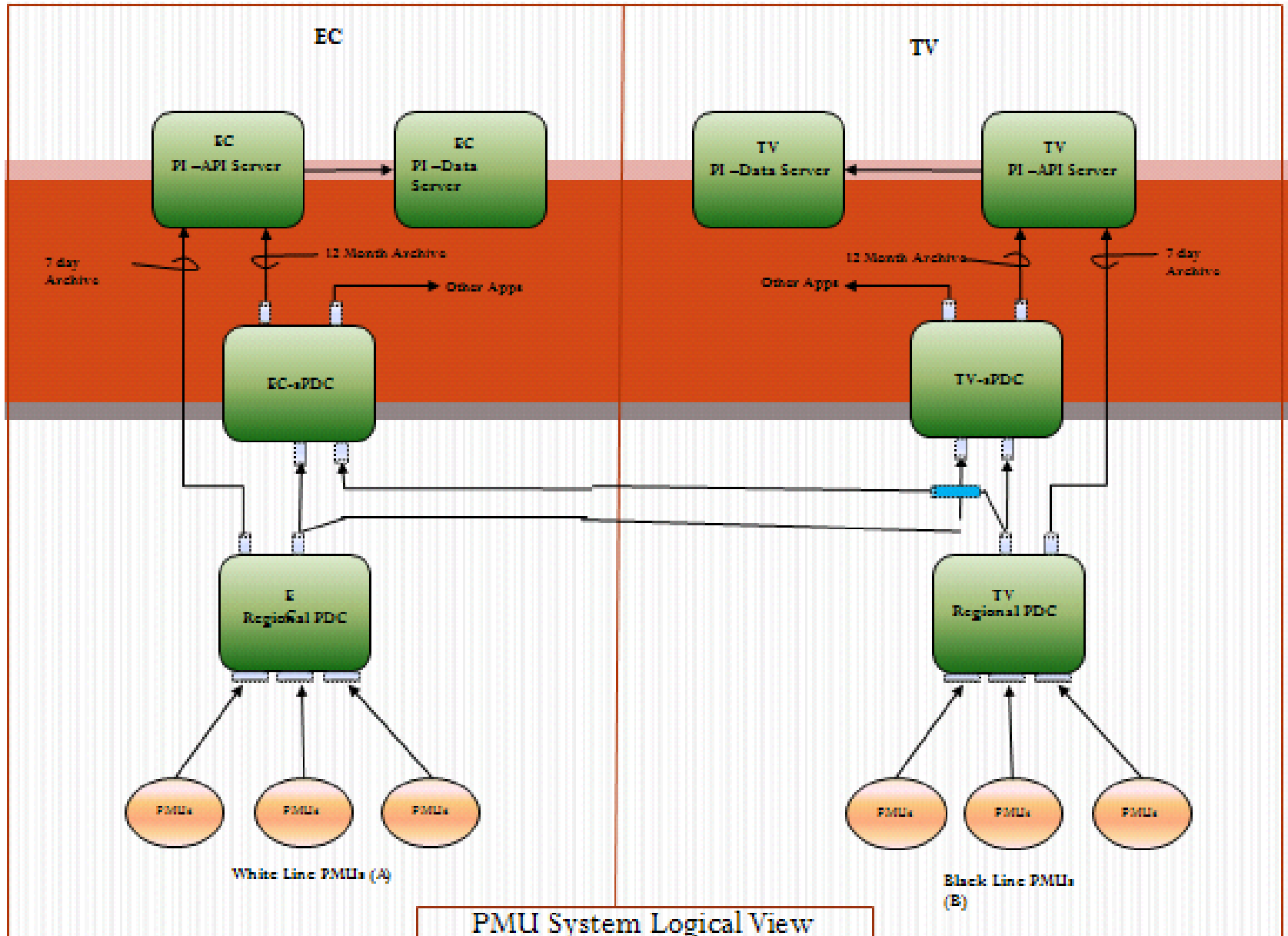
- 1 transmission owner in project and 104 PMUs
- Transmission elements monitored by PMUs
 - 12 elements >345 kV (500 kV)
 - 92 elements \geq 230 – 345 kV (230 kV)
 - 0 elements < 230 kV
- 100% of TOs regional footprint monitored by PMUs (based on load)
- 52 substations with PMUs
 - 2 PMUs/substation monitoring different elements
- 30 Samples/second PMU sampling rate
- Stand Alone SEL 351A
- PMU installation rate (stations)
 - # installed: 14 total, 13 new, 1 replacement by 9/30/11
22 total, 20 new, 2 replacement by EOY 2011
 - # installed: 48 total, 45 new, 3 replacement by EOY 2012
 - # installed: 52 total, 49 new, 3 replacement by May 2013

PDCs and Communications

[data below for completed project]

- PDCs
 - 2 BA/TO control centers with PDCs (using *openPDC*); each center has 1 primary and 2 regional clusters (see next slide)
 - Archive/database status
 - 70 terrabyte
 - 12 months of data to be readily accessible
- Communications system
 - Communication across TO's private network
 - Utilize fiber or microwave for high bandwidth (≥ 512 kbps)
 - Primarily owned by TO with some leased circuits
 - Interested in Phasor Gateway

PDC System Design



Major operational applications using phasor data

- Plan to share data with external RCs & TOs as requested
- Wide-area situational awareness*
 - Proposal is to use Alstom e-terravision
 - Would integrate into the Alstom EMS
 - Evaluating options to ensure tool(s) implemented increases SA
 - Spring 2013 operational date
- State estimation*
 - Alstom EMS being upgraded to allow PMU data to be used in State Estimation
 - Fall 2012 operational date
- Near term (less than three years) applications
 - Post-Event Analysis*
 - Model Validation
- Long term (beyond three years) POTENTIAL applications
 - Angle and Voltage Stability
 - Other applications not yet mature, but will be monitored and revisited

*Applications that we are focused on and feel provide the greatest initial benefit

Challenges and lessons learned

- What have been your biggest technical challenges to date?
 - Overwhelming amounts of data
 - Data hard to read when raw, needs to be scrubbed for users to look at
 - Getting the data into our historian (PI)
- What have been your biggest programmatic or execution challenges to date?
 - Dealing with unfamiliar regulations (e.g. Davis-Bacon)
 - Mechanics of metrics reporting
- Other lessons or insights about
 - PMU performance, installation experience or cost
 - Sometimes difficult to tell if getting bad data or event occurred
 - Signals dropping randomly, determined happened when train went by
 - Communications system design and performance
 - Hard to have full redundancy with the amount of data & bandwidth required
 - Interoperability
 - Clock and PMUs need same parity, or firmware update required
 - Data extraction in a format that can be used as input to other apps
 - Physical or cyber-security
 - Stand alone PMUs because of cyber
 - Deployment slowed because tie to communications upgrade
 - In-the-field inspections after install lead to some changes for better security
 - Data archiving
 - What to archive (raw vs. compressed, compression settings, duration, etc)

Other things we should know about your project?

- Finalizing agreement with university and data analytics company for data manipulation and advanced applications (e.g. visualization, baselining, event detection, stability)
- Evaluating best support of the openPDC