

The Smart Grid Vision

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What Is A “Smart Grid?”

- There are dozens of national and international initiatives directed toward a “smarter” grid – and many are narrow, focused largely upon the interests of the sponsor
- SCE takes an expansive, inclusive view of the Smart Grid
 - In our view, an advanced grid that doesn’t better serve customers is Showmanship, not Smart!
- A true Smart Grid will integrate advanced intelligence from the customer to the generator - and everywhere in between

What Is A “Smart Grid”?

- A Smart Grid will be:
 - Largely self-healing
 - More flexible
 - More reliable
 - Safer
- A Smart Grid will integrate thousands of Intelligent Electronic Devices (IEDs) sending and analyzing *millions* of pieces of data per minute to produce actionable information -- and using that information to control the electric system

The Self-Healing Grid

- A self-healing Smart Grid will prevent large-scale regional outages by responding much more quickly than humans
- The integrated and interconnected IEDs of the Smart Grid will:
 1. Identify
 2. Analyze
 3. Isolate
 4. Remediate
 5. Report

The Flexible Grid

- By adding much more sophisticated intelligence and control, the Smart Grid will allow:
 - Higher transmission transfer capacity
 - Integration of more renewable/intermittent resources
 - More efficient and effective maintenance practices
 - Faster restoration when outages are unavoidable
 - More customer choice and energy self-determination

The Reliable Grid

- The Smart Grid will improve reliability by:
 - Reconfiguring the system within cycles
 - Isolating unavoidable outages to smaller areas
 - Enabling repair crews to precisely identify and geographically target problems quickly and efficiently

The Safer Grid

- The Smart Grid will be safer for workers and the public by:
 - Detecting many problems before catastrophic failure
 - Replacing oil-filled equipment with solid dielectric (transformers) or vacuum-operated components (fault interrupters)
 - Preventing equipment overloads (e.g., fault current limiters)
 - Placing more failure-prone equipment above ground (e.g., BURDs)
 - Better equipping workers to avoid danger (e.g., PVD, acetylene detection)

Why Now?

- A unique time of convergence between
 - Electrical engineering (e.g., IEDs)
 - High-speed, high-bandwidth communications
 - High-power computing
- The Smart Grid will succeed through an innovative partnership between TDBU and IT
- We can now begin to deploy in the field what we have researched and refined in the lab for over a dozen years

An Overview of the Smart Grid

A Few Component Pieces...

- Smarter Transmission
 - Flexible AC Transmission Systems (FACTS) enable transmission to remain stable over large distances with diverse loads and resources
 - Static VAR Compensation – e.g., Devers SVC helped increase transfer capacity of AZ-CA transmission system by 505 MW. Even more effective when coupled with SPM, as in recent Rector SVC installation
 - Synchronized Phasor Measurement
 - Enable advance identification and remediation of problems over the entire Western Grid
 - Allow use of dynamic nomograms to safely increase transfer capability without adding infrastructure

Components...

- Smarter Transmission (cont.)
 - Centralized Remedial Action Schema (C-RAS) will allow cost-effective and reliable integration of diverse generation without degrading transfer capacity
 - High-tech composite conductors will increase transfers without new towers and scarce rights-of-way
 - High Temperature Superconducting transformers and cables could revolutionize the T&D business – no losses, no heat!
 - Real-time wireless monitors will provide span-by-span information about sag, temperature and loading

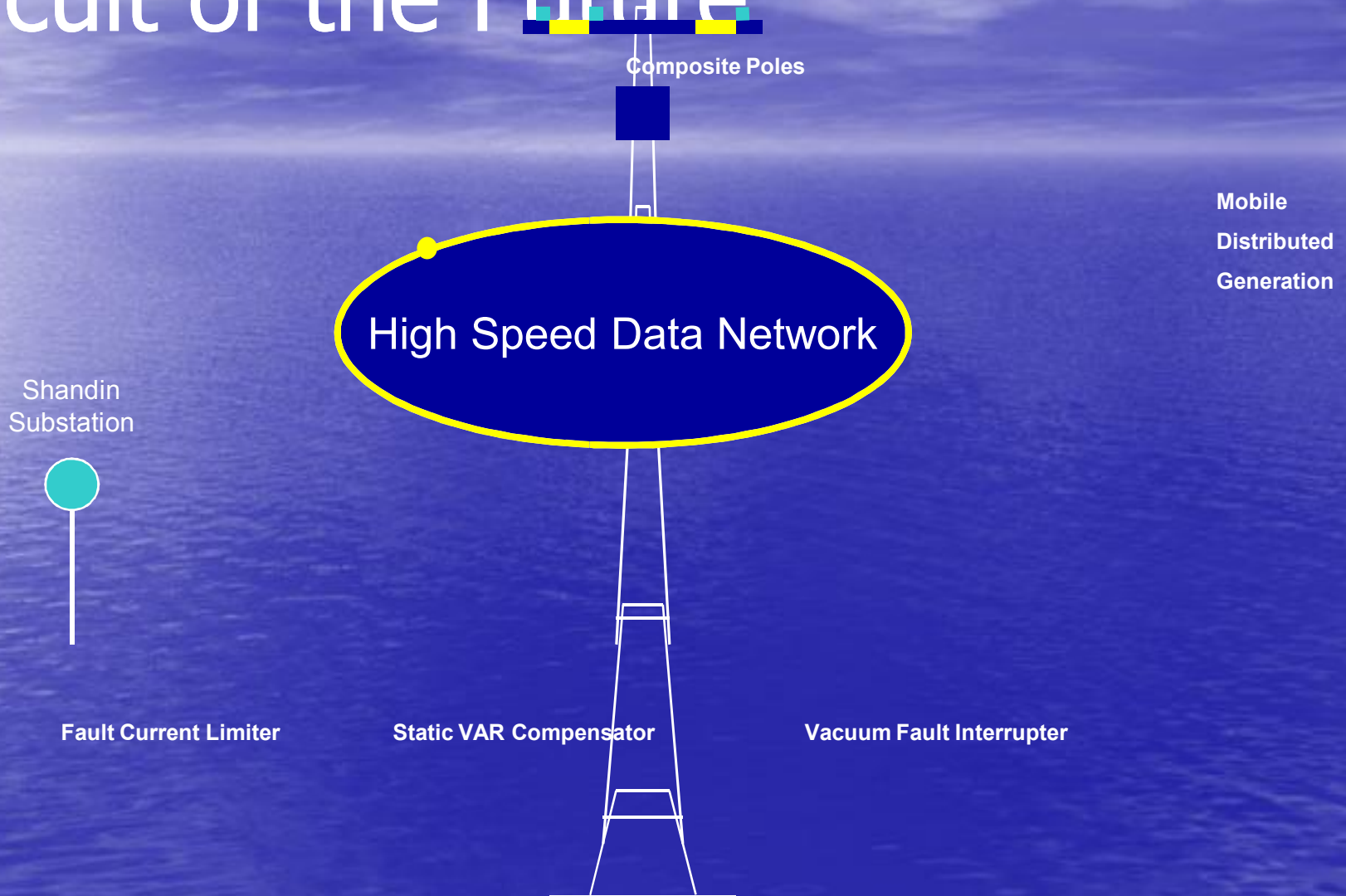
Components...

- Smarter Substations
 - Real-time monitoring of equipment conditions will allow higher loading, targeted maintenance and fewer failures
 - Remote Transformer Dissolved Gas (DGA) Analysis
 - Faster load-rolling and circuit reconfiguration via interconnected “smart” relays and switches

Components...

- Smarter Distribution Circuits
 - *Avanti* is the first real-world test bed for many of the “best of breed” distribution technologies

Circuit of the Future



Mobile Distributed Generation
Substation
Fault Current Limiter
Static VAR Compensator
Vacuum Fault Interrupter

Components...

- Smarter Worker Tools
 - The Lineman of the Future tools may include:
 - Wearable computers
 - Wireless communications with a central data base and live SMEs
 - Wireless video transmission
 - Heads-up displays
 - RFIDs
 - Video recognition and diagnostics
 - High-tech PPE (e.g., PVDs)

Our Development Philosophy

- SCE's advanced engineering credo is "Adapt and Adopt."
 - We take the best developed by others in the industry and **adopt** it once proven
 - We take the best from other industries and **adapt** it to our business
 - We intentionally do very little "creating"
 - Risky
 - Expensive
 - Long lead-times
 - **Never** technology just for technology's sake

When Will the Grid be “Smart Enough”?

- Never!
- The Grid is now becoming a vast network of interconnected, special-purpose computers and sophisticated algorithms. It will never again be “just wires and transformers”
- The relentless progress of digital electronics technology will cause rapid change to our Grid just as it does to our computing environment!
- The \$64,000 Question: How do we evolve our strategies to accommodate the imminent transition of the Grid from the “mechanical world” to the “digital world” of rapid obsolescence and Moore’s Law?