

Wide Area Monitoring Technologies For A Reliable Grid

Canadian Electricity Association
Reliability Workshop – Opportunities for
Cross-Border Investment and Cooperation
in Transmission Technology R & D

Washington, D.C.

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by

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Briefing Outline

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- NERC Interconnections
- Elements of a Reliable Electric Grid
- Causes of Major Grid Outages in North America and Europe
- New Transmission Technologies for Efficient and Reliable Grid
- Wide Area Reliability Monitoring Research Needs and CERTS Road Map
- CERTS Research Focus on Real Time Wide Area Reliability Monitoring
- CERTS Grid-3P™ Technology Platform for Real-Time Grid Monitoring
 - ACE-Frequency
 - Eastern Interconnection Phasor Project
- Opportunities for Cross Border Transmission Technology R&D Collaboration

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Introduction

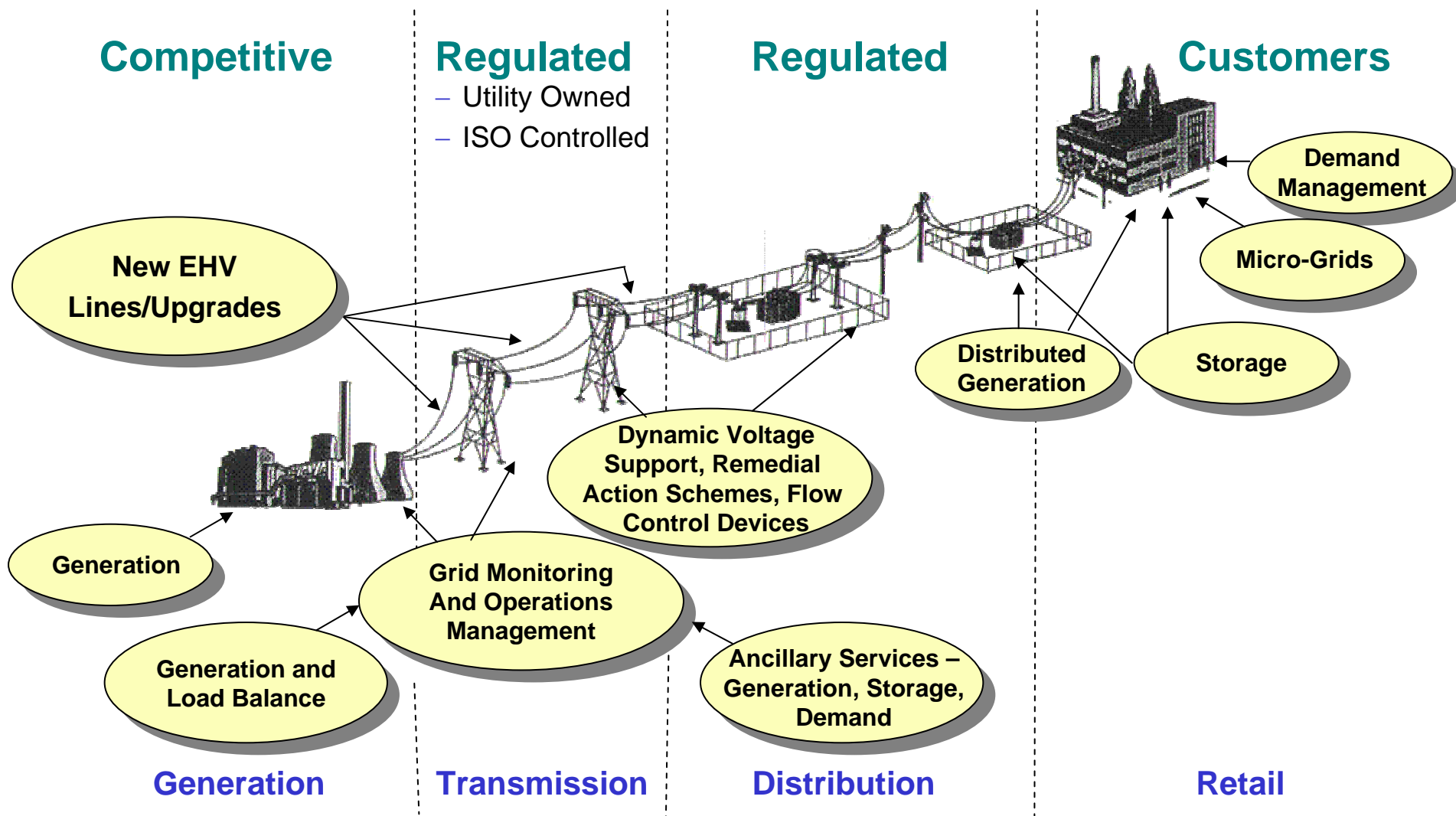
Electric Power Group, LLC

- Provides management and strategic consulting services for the electric power industry
- Focus areas include industry restructuring, competitive electric markets, grid operations and reliability, power technologies, venture investments and start-ups
- Vikram S. Budhraj, President
 - Chair, Consortium for Electric Reliability Technology Solutions (CERTS)
 - Advisor, State of California, Department of Water Resources
 - Formerly President Edison Technology Solutions and Senior Vice President, Southern California Edison Company

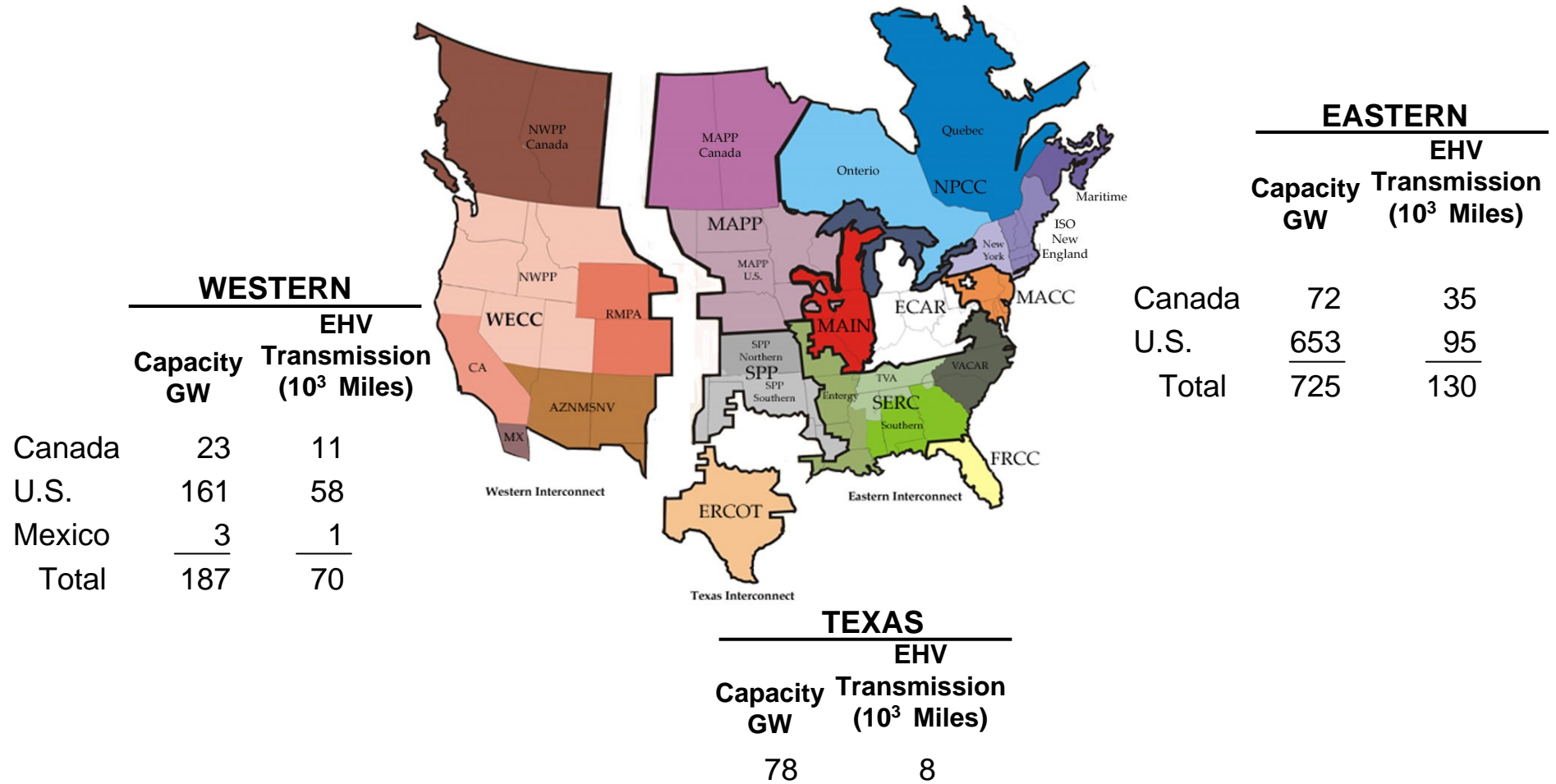
Consortium for Electric Reliability Technology Solutions (CERTS)

- CERTS was organized in 1999 as a partnership among universities, the private sector, and Department of Energy national labs. Consortium includes four labs (Lawrence Berkeley, Oak Ridge, Sandia, Pacific Northwest), Power Systems Engineering Research Center (consortium of universities led by Cornell), and Electric Power Group.
- CERTS is supported by the Department of Energy, Transmission Reliability Program, Office of Electric Transmission and Distribution, and by the California Energy Commission Public Interest Energy Research Program.
- CERTS focus is to conduct public interest research on reliability technology solutions, tools, technologies, models, systems, and management processes needed in competitive electric markets for reliability management and market efficiency.

The Interconnected Power Grid



NERC Interconnections



Elements of a Reliable Electric Grid

- Plan Adequate System
 - Meet Peak Loads, Provide Adequate Reserves, Balance Supply and Demand at **All** Times

- Build Reliable System
 - Generation, Transmission, Distribution, Controls, Protection

- Operate Within Safe Limits
 - Real Time System Status, Define Safety Margins, Withstand Contingencies, Coordinate Operations

Causes of Major Grid Outages in North America and Europe

- Lack of Data on System Status
- Limited Visibility of System Conditions Beyond Control Area
- Multiple Contingencies
- Operation in Unsafe Zone with Inadequate Safety Margin
- Deficiencies in Communication and Coordination
- State Estimation Model, Not Solving
- Noncompliance with Standards
- Performance Standards Inadequate

New Transmission Technologies for Efficient and Reliable Grid

Transmission Grid

Operations Management

Grid Reliability

Power Quality

Wide Area Reliability Monitoring

- Composites
- Superconductors

- SCADA
- EMS
- Controls
- Protection

- Ancillary Services
- FACTS
- Flow Control
- Voltage – DVAR, Super VAR

- Distributed Generation and Load Control Technologies
- Monitoring-I-Grid

- Wide Area Coordination
- Wide Area System View
- Time Synchronized Data - Phasors
- Visualization
- Decision Tools
- Grid-3P
- New Research Area

Wide Area Reliability Monitoring Research Needs and CERTS Road Map

Grid of The Future – *Reliable, Efficient, Smart*

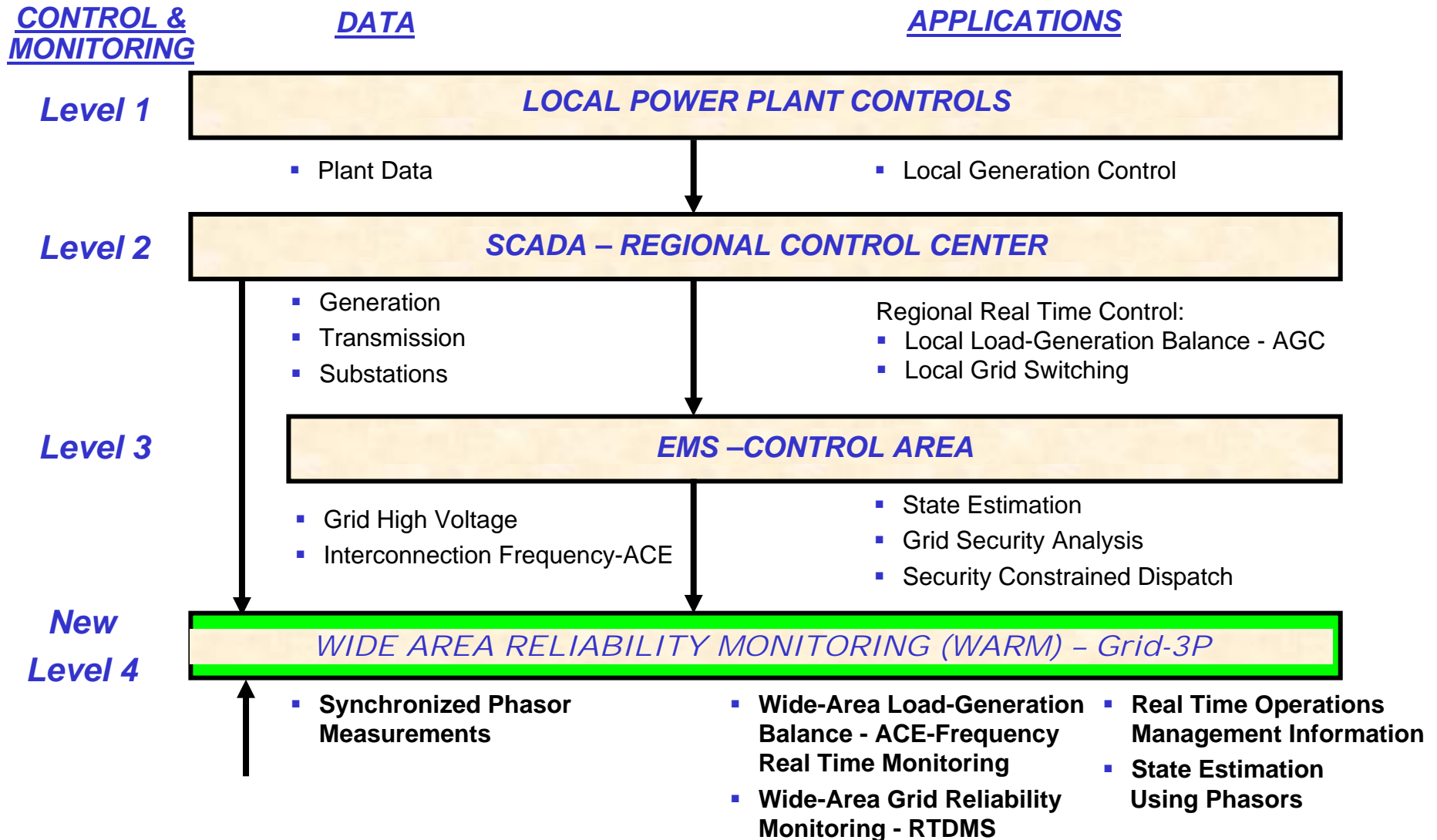
RESEARCH NEEDS

- Coordinated Wide Area Grid Operations
- Wide Area System View
- Time Synchronized Data
- Accurate System Models and State Estimation
- Understanding Market and Reliability Interactions
- Integration of New Technologies

RESEARCH ROAD MAP

- Standards, Metrics and Operations Management System
- Wide Area Visualization and Real Time Monitoring – Grid-3P
- Phasor Network for WECC and EIPP
- Phasor Applications for Model Validation and State Measurement
- System and Market Performance Analysis
- Test Beds, Prototypes, Standards

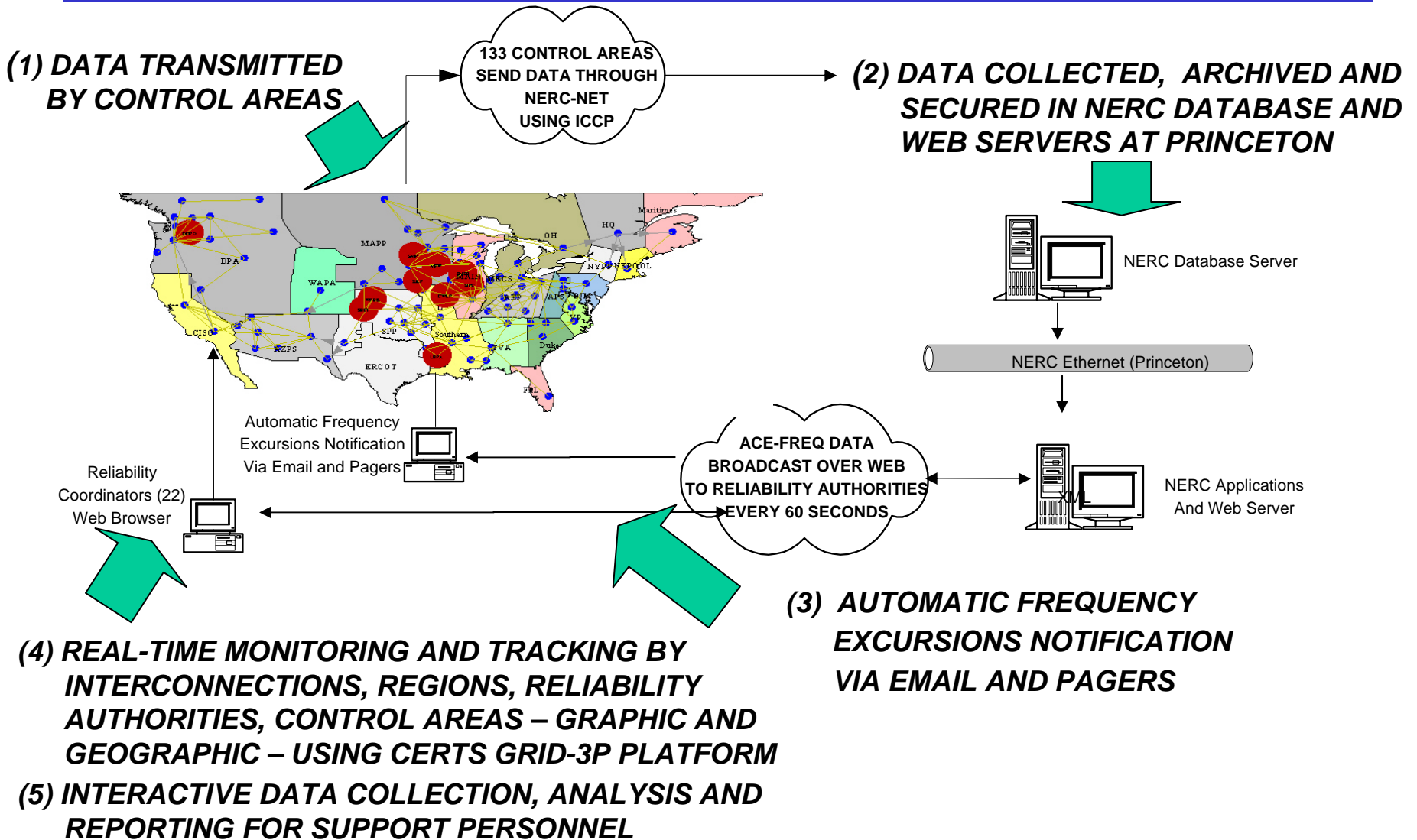
CERTS Research Focus on Real Time Wide Area Reliability Monitoring



CERTS Grid-3P Technology Platform for Real-Time Grid Monitoring

- Grid **P**erformance Monitoring and **P**rediction **P**latform (Grid-3P) for Real-Time Monitoring of Grid Reliability Metrics is designed to:
 - Integrate with existing grid control and communications infrastructure;
 - Enable real-time monitoring of the grid;
 - Monitor grid parameters impacting reliability, including transmission, generation, grid interconnections and markets; and
 - Convert real-time data into meaningful metrics, tracking and visual displays.

ACE-Frequency Architecture and Utilization

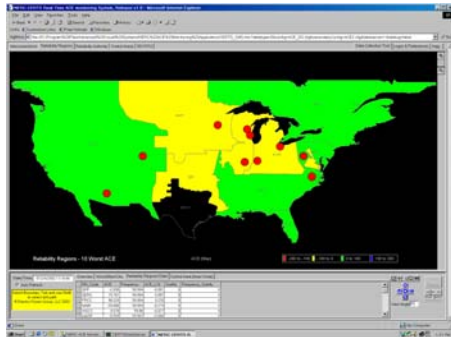


Sample Display – Cont'd

Grid-3P Displays for ACE Monitoring

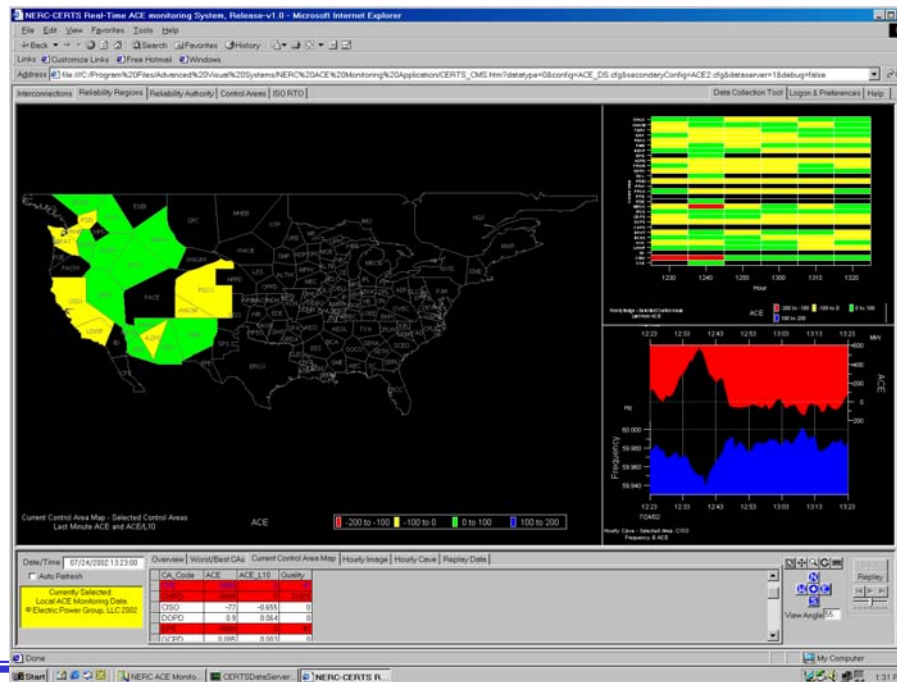
LONG-TERM: Western 7/18/2002 9:32:40 AM(EST) -
Rolling Frequency Hourly Average for last 61 minutes
was 0.024Hz >= 0.016Hz.

(1) Abnormal Event Notification



(2) Root Cause Assessment -- Regions and Control Areas with Ten Worst Area Control Errors (ACEs)

(4) Control Area Frequency ACE Display



(5) ACE-Frequency Analysis

(3) Drill-Down to Pinpoint Root Cause

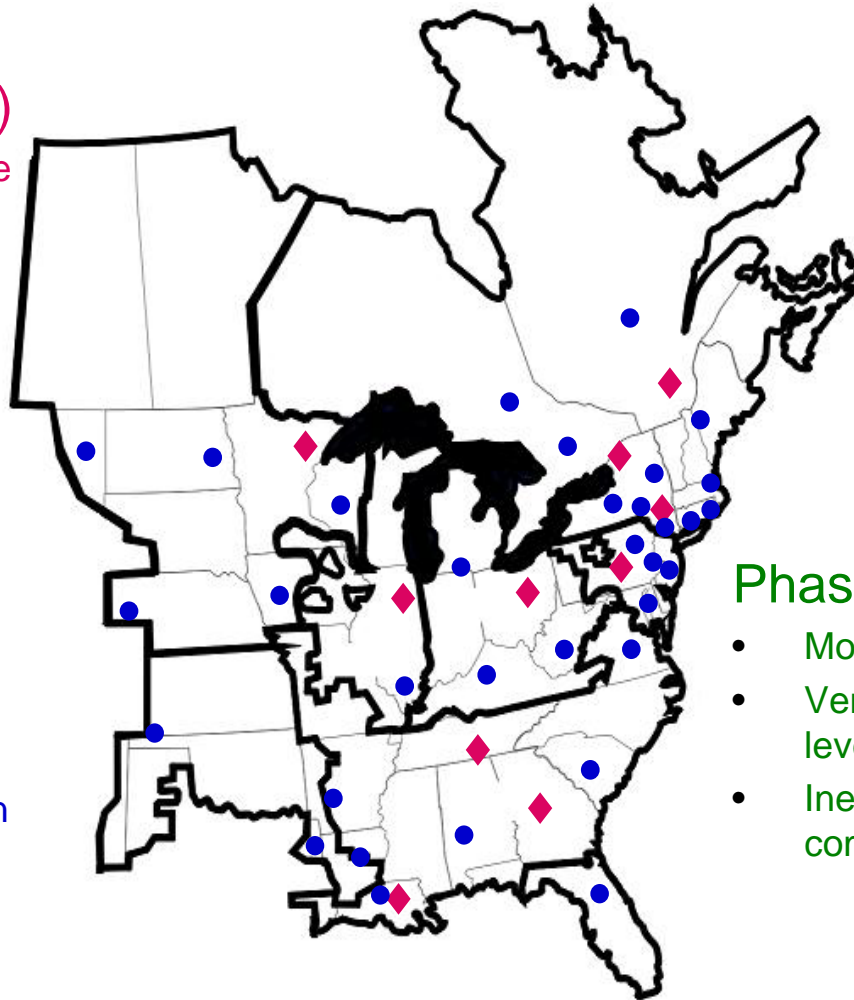
Eastern Interconnection Phasor Project

Phase Ia (summer '04)

- 10-12 Instruments, most are already installed but not connected
- Work out communications issues
- Transfer software tools to users
- Establish relationships

Phase Ib (late 2004)

- ~50 Instruments
- All major corridors covered
- Data available to research community to begin work on projected benefits



Phase II (2005-)

- More than 350 Instruments
- Vendors participating at all levels
- Inexpensive instruments and communications available

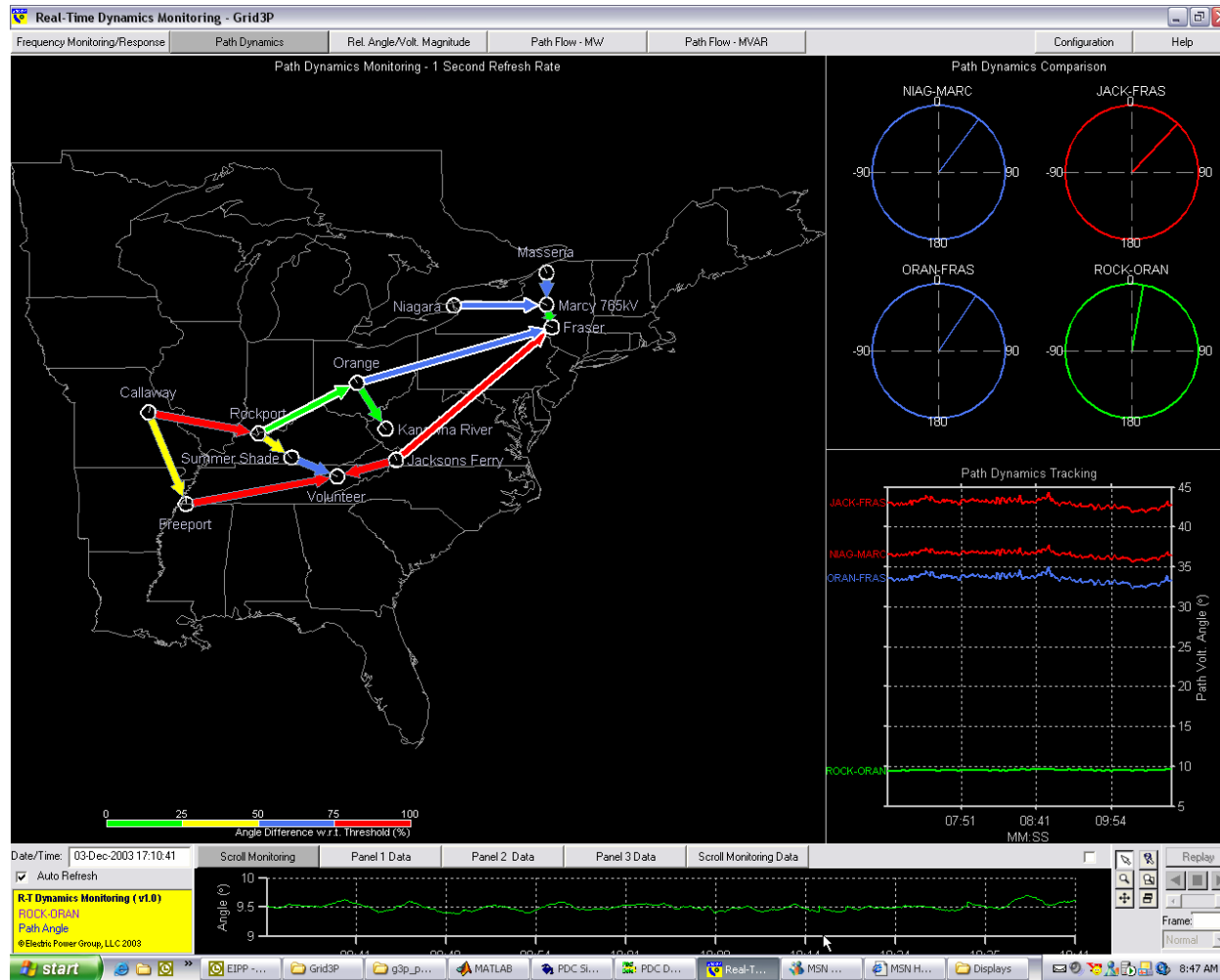
Synchronized Phasor Technology Applications

Monitor :

- angles across predefined flowgates or interfaces

Alarming:

- color coded on proximity to alarming thresholds
- immediately identify areas of stress



- compare angles across selected interfaces

- historical tracking and comparison over specified time duration
- quickly identify interfaces affected by an event

- track angle across a selected interface

Opportunities for Cross Border Transmission Technology R & D Collaboration

Common Interconnection Standards and Platforms for:

- Time Synchronized Measurement
- Wide Area Monitoring
- Control
- Protection
- Performance
- Operations