Consortium for Electric Reliability Technology Solutions

EIPP Real-Time Phasor Monitoring Prototype

for

EIPP – Real Time Applications Task Team

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by

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Agenda

- Project Objectives
- Phase 1 ‘Interim’ System - Overview
- Functionality and Displays of the Real-Time Phasor Monitoring Prototype Application
- Phase 1 ‘Interim’ System - Project Status
- Current Issues and Concerns

Project Objectives for Real-Time Applications

- Develop a Real-Time Phasor Monitoring **Prototype System** for use by system operators at utilities, ISOs and reliability coordination centers.
- Enable system operators to **gain familiarity** with phasor technology for reliability monitoring and real-time operations.
- Provide system operators with real-time **wide area information** to increase situational awareness to avoid August 14, 2003 type blackouts. This includes stability, system dynamics, grid stress and other key metrics.
- Learn to utilize phasor data to **recognize normal and abnormal conditions**, and assess grid stress
- **Enable system operators to evaluate and provide feedback** on metrics monitored, visualization formats, functionality and displays.

Phase 1 'Interim' System - Overview

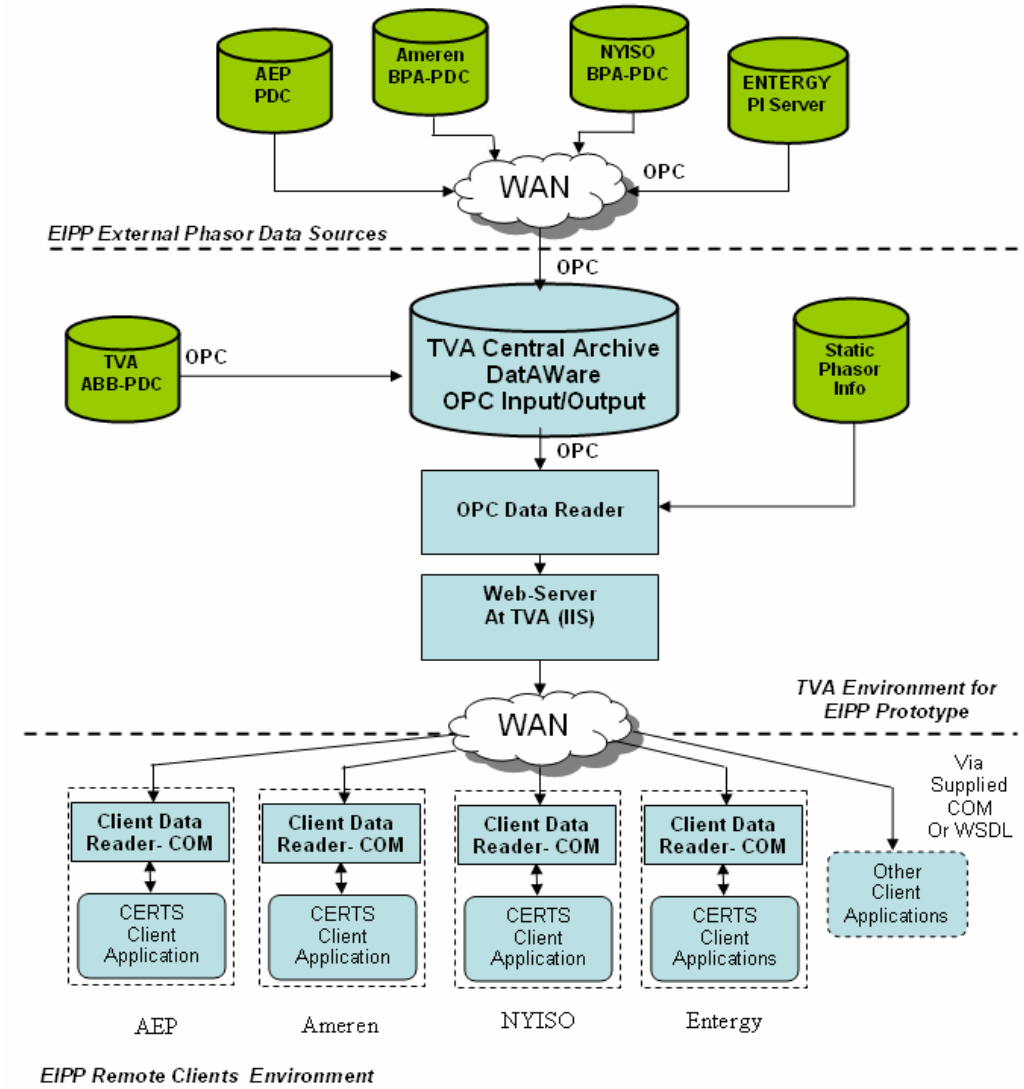
- Real-Time Phasor Monitoring Prototype Application
  - **Functional Specification Approved** by EIPP Real-Time Applications Task Team
- Real-Time Phasor Data will be sent from each utility/ISO to the **Host Site (TVA)**
- Phasor Data is **converted to Standard OPC Format**
- Data is Disseminated to EIPP Remote Clients over **Secure Web Connection –** (SSL, Data Encryption, Digital Certificates, Windows Authentication)
- System **Configurability by End Users** to add or delete PMUs and key transmission corridors.
- Open Architecture Supports **Data Access over Internet** by other Applications using Standard Protocols (Interface Provided)

Phasor Monitoring Prototype System Architecture

Data Communication

Central Data Server

CERTS Application for Real Time Monitoring



Real-Time Monitoring Application – What will the System Operator See?

- **Wide Area View** of EI – Key metrics (frequency, voltages and phase angles) at selected locations and transmission corridors.
- **Rapid Changes** in Metrics - Visual alarming and notification
- Violation of Key Thresholds (**defined limits**) – Visual alarming (color coding) and notification
- Voltage **Angle Difference Betweens Major Sources and Sinks** in the EI
- **Replay Capability** of System Events Using Archived Data.
- **System Anomalies**

Real-Time Phasor Monitoring Prototype - Functionality

- Provide Real-Time Monitoring Information on:
  - Interconnection Frequency –
    - Identify approximate point of acceleration or deceleration (loss or load or generation) within the EI.
    - Assess system coherency and its dynamic stress under normal operating conditions.
  - Voltage Magnitude and Relative Angles –
    - Comprehensive profile of EI voltage angles and magnitudes.
    - Identify the high and low voltage regions within the EI grid.
    - Monitor angles relative to a specific location, utility or regions.
    - Operating organizations ability to set threshold limits.
  - Angle Differences across Identified Transmission Flowgates –
    - Provides a birds-eye view of the EI sources and sinks of power.
    - Monitor phase angle differences across key EI flowgates
    - Operating organizations ability to set threshold limits.

Real-Time Phasor Monitoring Prototype – Functionality (cont.)

- Provide Real-Time Monitoring Information on (cont.):
  - Real and Reactive Power Flows Across Monitored Lines
    - Monitor actual MW and MVAR flows at key flowgates
    - Track flows with respect to predefined thresholds
    - Operating organizations ability to set threshold limits.

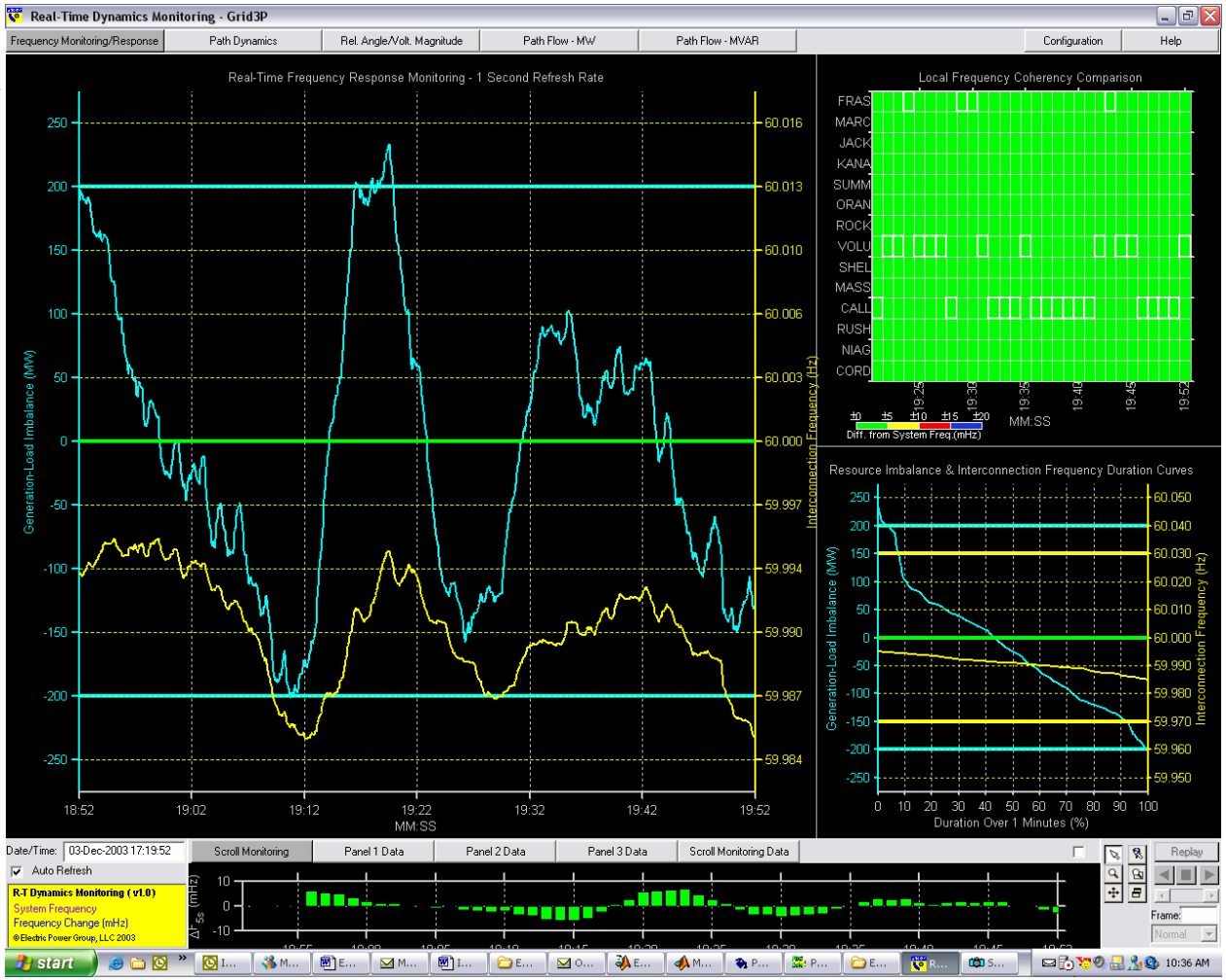
- Application Displays Offer Local and Wide Area Monitoring of EI Dynamics

- Interactive Client Configuration Utility Enable Users to Define:
  - Visualization Subsets
  - New Monitoring Paths and Alarming Thresholds

Real-Time Phasor Monitoring Application
Frequency Monitoring Display

Monitor : Interconnection Frequency Deviation and the Associated Generation/Load Imbalance

- delta (Δ) in frequency measured in millihertz.



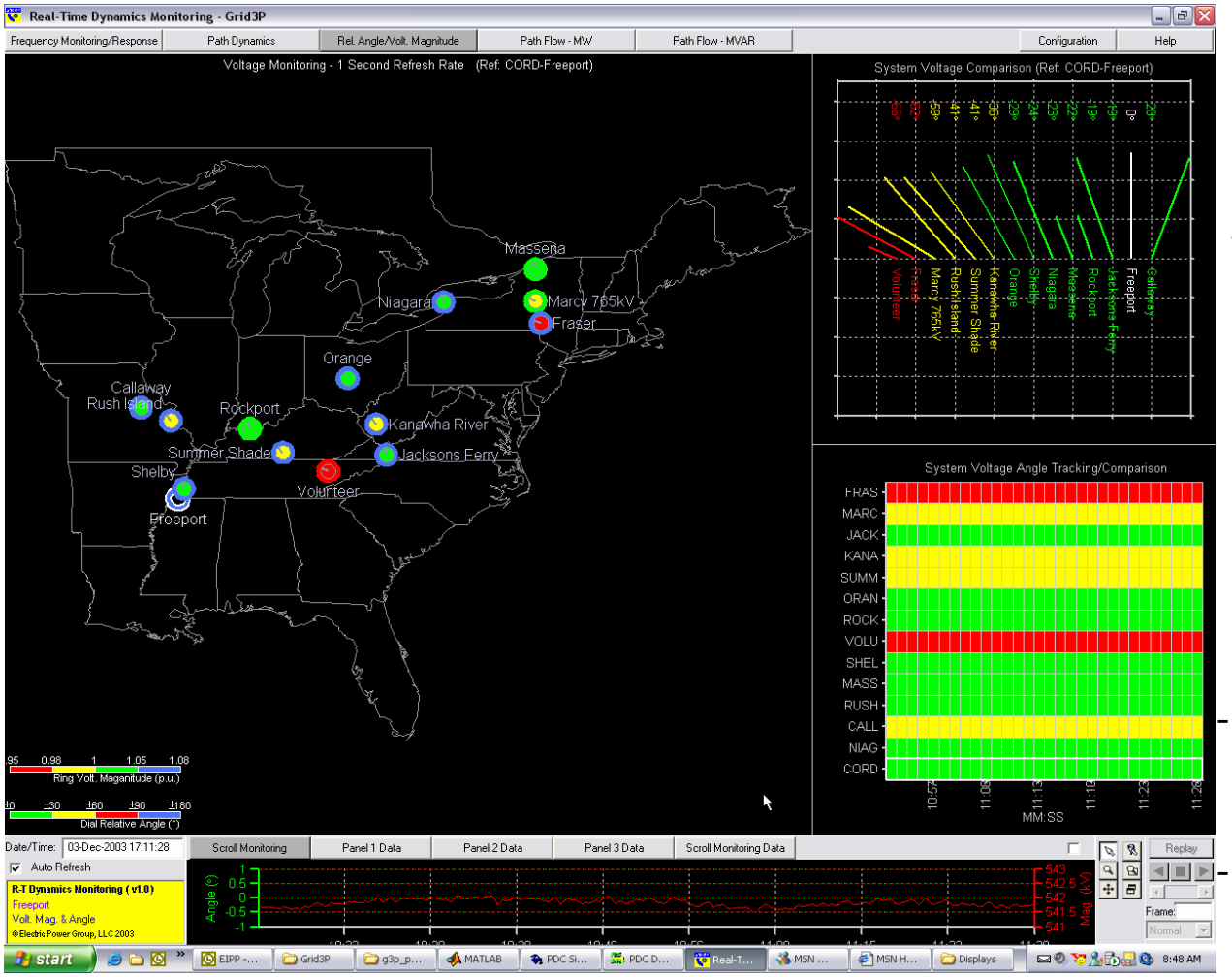
- local frequency deviation from interconnection frequency
- color coded to quantify dynamic stress
- estimate the point of acceleration or deceleration

frequency histogram to assess performance

Real-Time Phasor Monitoring Application
Relative Angle/Voltage Magnitude Display

Monitor :

- **voltage angles and magnitudes**
- **color coded**
- **quickly identify low or high voltage regions**



- **angle spread across all monitoring points**

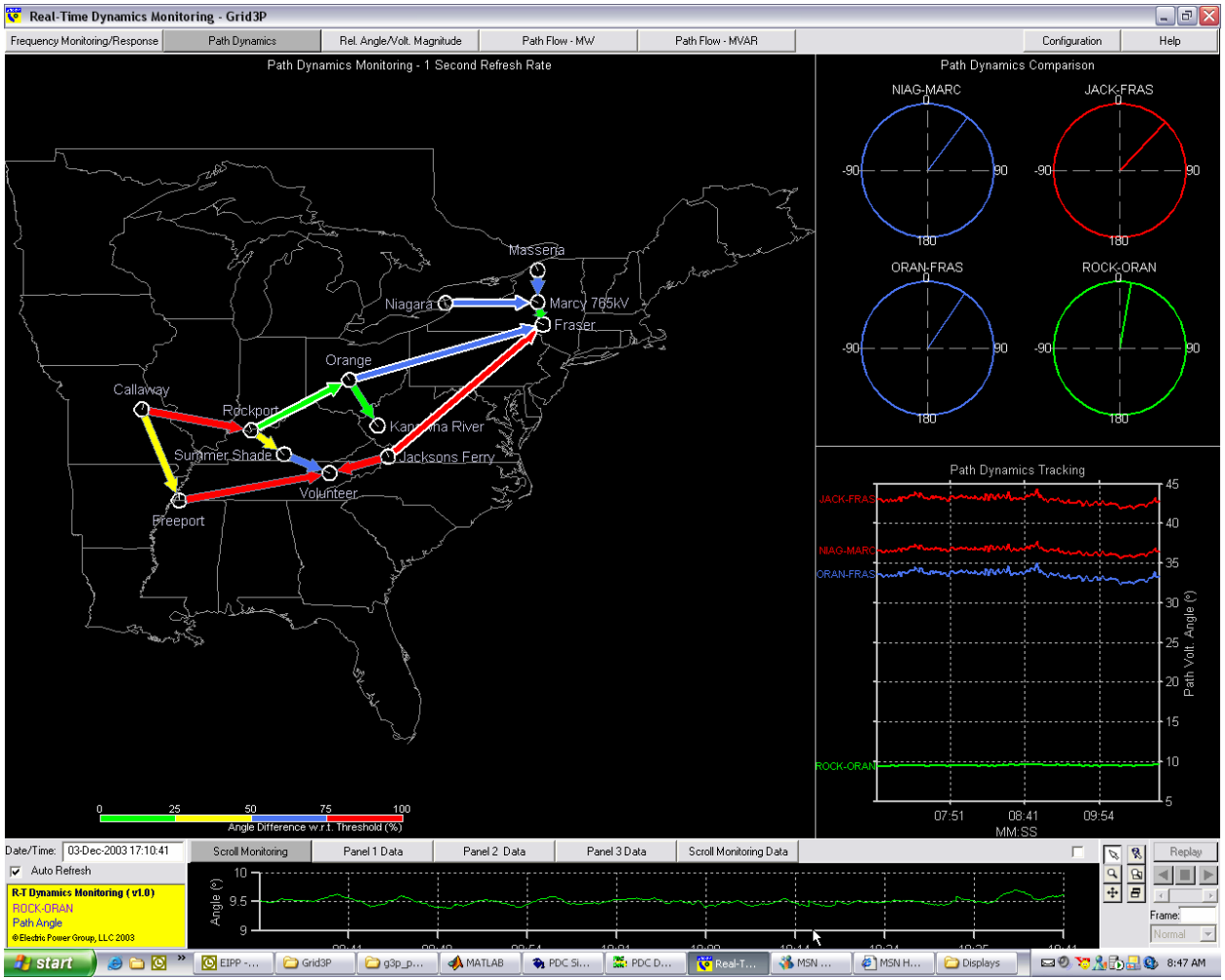
- **voltage angle and magnitude tracking at selected location**

- **comparison of angle distribution over specified time duration**
- **quickly identify changing conditions**

Real-Time Phasor Monitoring Application
Path Dynamics Display

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**

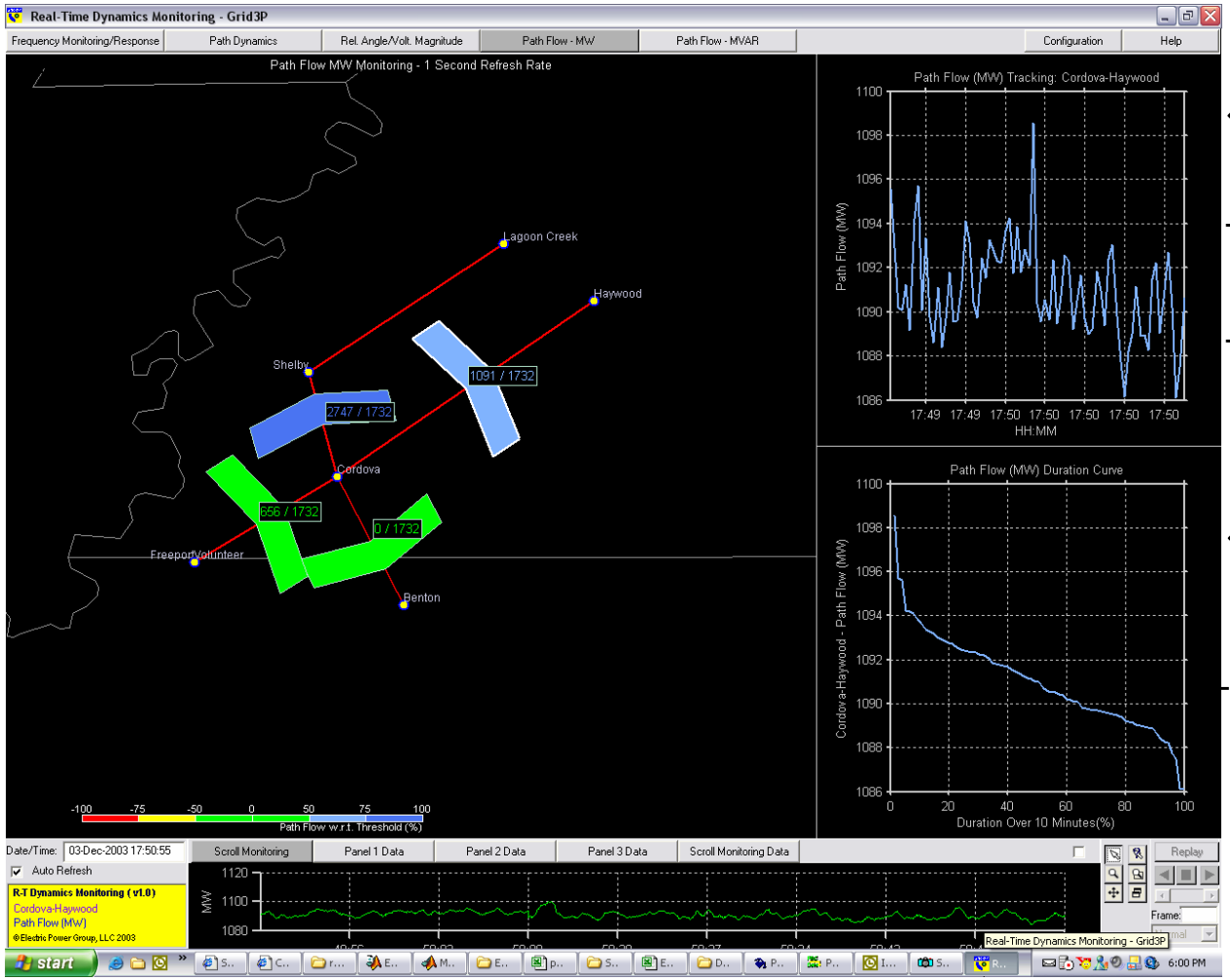
Real-Time Phasor Monitoring Application
MW/MVAR Path Display

Monitor :

- **MW/MVAR flows on monitored lines**

Alarming:

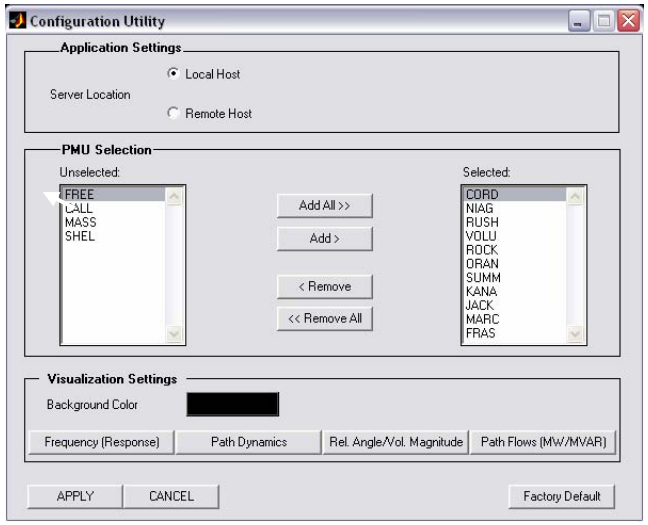
- **color coded on proximity to transfer limits as established by offline studies**
- **quickly identify heavily loaded lines**



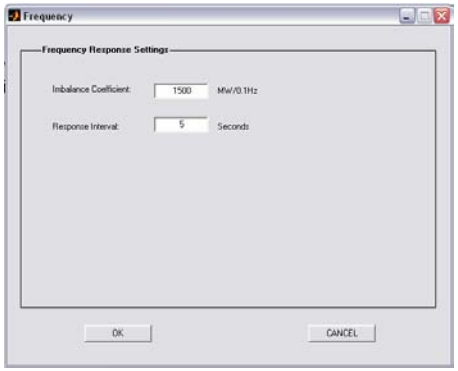
- **historical tracking over specified time duration**
- **track changing flows on selected line**
- **MW/MVAR histogram over specified time duration**
- **track flows on a selected line**

Configuration Utility

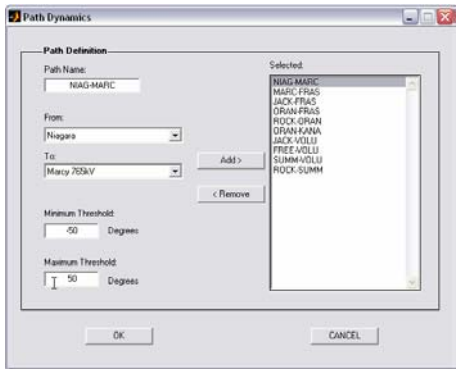
Allow Easy Scalability as New Monitoring Devices are Added to the System



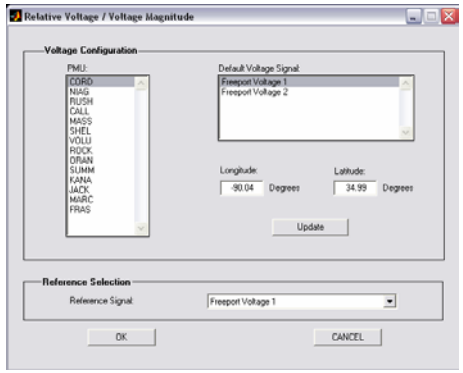
User-Defined Clusters



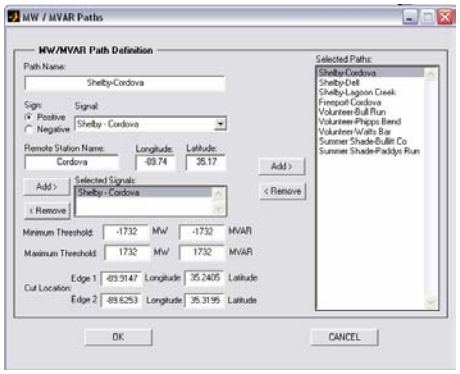
Frequency Monitoring Display



Path Dynamics Display



Relative Angle / Voltage Magnitude Display



MW / MVAR Path Monitoring Display

Project Status

- Data Sources to Host Site (TVA):
  - **Early October** - TVA, AEP, NYISO and Entergy
  - In the near future - Ameren
- Development of **Data Source Converters**
  - **DataWare to OPC** – work in progress
  - BPA to DataWare – work in progress
  - OPC to DataWare – work in progress
- **Prototype Development Completed**
  - (OPC reader, web server and visualization clients)
- System Integration and Testing – work in progress
- Interface for internet Open Architecture Data Access
- **System Deployment Scheduled for Early October, 2004**
- Application availability to EIPP Participants via CDs
- **Training Dates -TBD**

Current Issues/Concerns

- Growing the data infrastructure
- Data Quality
- Latency of the integrated system
- Ongoing data management at TVA (significant storage requirements)
- Display updates and maintenance – client or central control?

Real-Time Application Plan

Functionality Being Tested for WECC and will be incorporated in EIPP prototype by first quarter 2005

- **Event detection logic based on frequency and voltage swings** to detect onset of transient disturbances
- **Email notification** on threshold violation alarms and alerts
- **Disturbance archiving and event logging** capability

User Defined Functionality

- **Trending analysis** for instability prediction (example, frequency oscillations and voltage decline)
- **Island identification**
- **Propose corrective control actions** for given set of alarms or anomalies
- **User feedback**

Action/Decision Items

- Display access
  - Suggestion – Since the information can be used to enhance grid reliability all EIPP participants who have reliability authority and have signed the NERC NDA should ultimately have access to information. **Near-term need for core Real-Time team**. Next would be Reliability Coordinators an major Transmission Operators.
- Web library and **information base** (Operations, IT, Planning)
  - FAQ and discussion forum
  - Technical documents
  - Path to learn about and integrate with project and tools
- Determine training requirements and dates
  - Suggestion – Training sessions to be conducted via an internet webcast, with archive capability.
  - Need to agree on date(s) and times.
- How best to disseminate application to EIPP Participants?
  - Suggestion – Electric Power Group to send out a CD with the application and a users guide.
  - Need input on who in each organization should receive the CD.
  - E-mail Manu Parashar at parashar@electricpowergroup with the name and address of person to receive the CD.

Long Term Vision

- **Grow the Suite of Tools** Over Time
  - Users (Implied need for a users' group)
  - Vendors
  - DOE-sponsored
- Have **Standardized (yet configurable)** Real-Time Phasor Monitoring Displays for Reliability Coordinators and other grid operators
- Combine Phasor Data with SCADA for a More Comprehensive Understanding
- Incorporate Phasor Measurements to Improve **State Estimation** Process
- Utilize the Phasor Network for Real-Time Automatic Control and Special Protection Schemes