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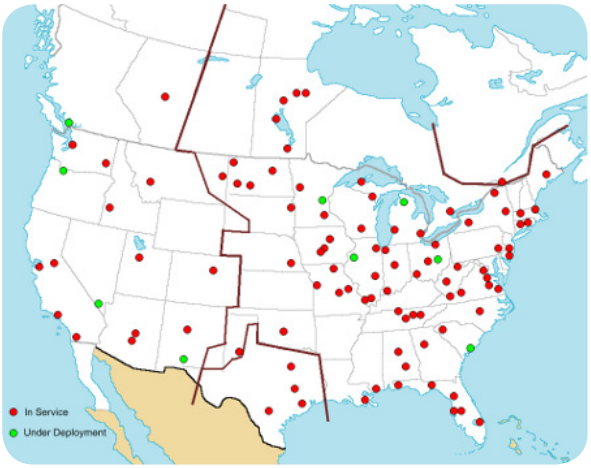
# RESEARCH

## FNET/GridEye System

### Overview

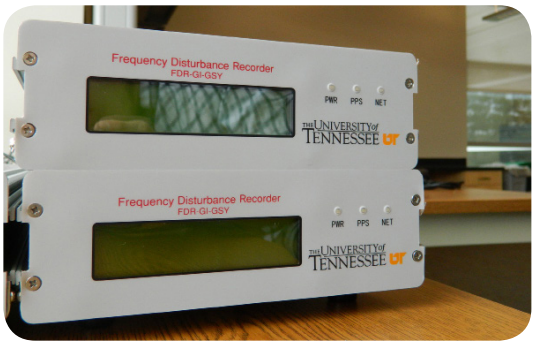
The FNET/GridEye system is a unique wide-area grid monitoring network deployed and operated by the University of Tennessee and the Oak Ridge National Laboratory. It provides independent observation of the entire electrical grid's dynamic performance continuously and in real time.

The project team studies off-normal behavior modes of the bulk electric system and develops and tests beta version algorithms and software tools to accelerate the development of future commercial applications. Currently, the FNET system has approximately 200 sensors deployed across North America.




*FDR Deployments within the United States*

The FNET/GridEye sensors are GPS time-synchronized single-phase phasor measurement units (or PMUs). They capture the dynamic responses (frequency, voltage, and phase angle) of the grids to major disturbances such as generator trips and load shedding, as well as provide insight into inter-area oscillations. Since the sensors (which are referred to as frequency disturbance recorders, or FDRs) are connected at 110V, they do not require extensive installation as is the case for PMUs at high voltage substation. FDR monitors are low-cost, easy to install, and are currently installed in offices, schools and residences.




*Frequency Disturbance Recorders (FDR)*

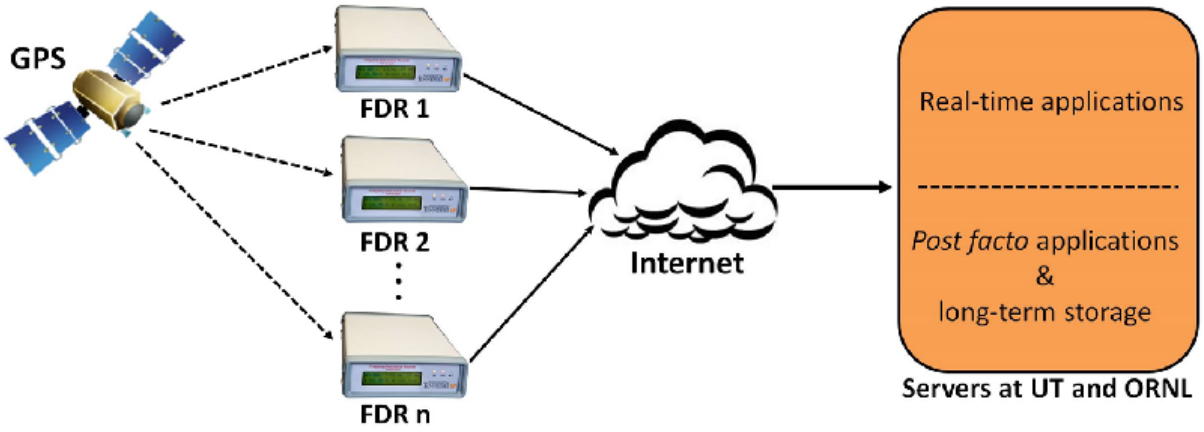
### FNET/GridEye Tools and Applications

- **Event detection** detects generation tripping, load shedding and line tripping in real-time.
- **Event size and location estimation** Estimate MW based on the frequency change. Estimation the location in real-time based on the propagation of the frequency.
- **Automatic oscillation alert and analysis** Provide oscillation mode information and automatic e-mail alerts.
- **Online ambient oscillation mode display.**
- **Online angle change display.**
- **Visualization tools** provide a means for synchrophasor data to be easily assimilated and interpreted by the human senses.

FNET GridEye

OAK RIDGE National Laboratory

research funding provided by

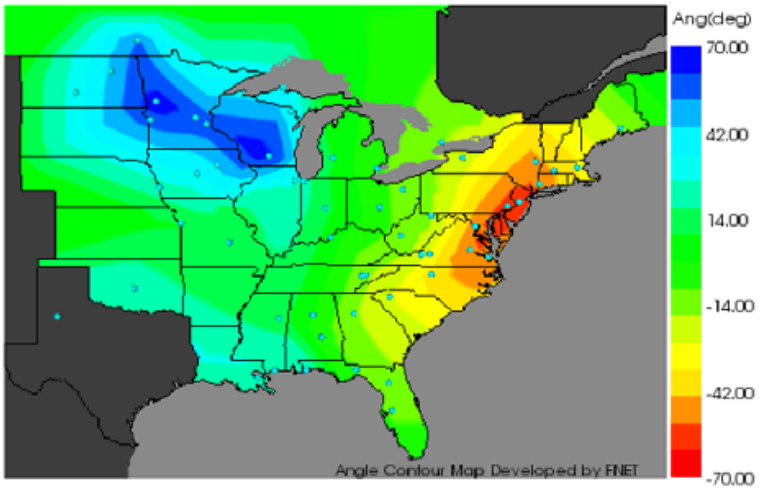



## FNET/GridEye Architecture

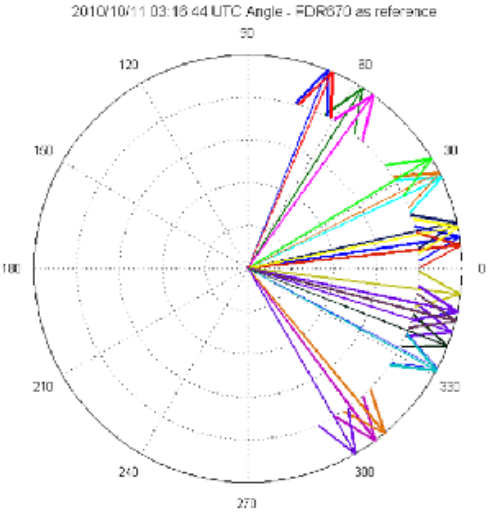
Each FDR calculates phasors based on voltage measurements taken 1,440 times per second, applies GPS time synchronization within a micro-second, and streams 10 phasors per second to servers located at the University of Tennessee in Knoxville, TN and Oak Ridge National Laboratory in Oak Ridge, TN.

## Example: Phase Angle Measurements

Real-time dynamic power angle measurements can be used to assess stress points in the electric grid and give an indication of the stability of the system. Greater phase angle differences imply larger static stress across that interface; larger stress could move the grid closer to instability.




Phase Angle Visualization




Phase Angles

## Research Interests in the Distribution Sector

- Many large-scale renewable energy sources will be connected at the distribution level. An expanded FNET/GridEye system can establish a baseline of dynamic behavior before renewables are introduced and track changes afterwards.
- FNET/GridEye sensors are also useful for detecting certain power quality anomalies and phase unbalance issues at the distribution level.
- Participating in the FNET/GridEye research program helps host distribution system operators maintain situational awareness of conditions of the wider electric grid.

POINT OF CONTACT

Yilu Liu
865.974.4129 (ph.)
865.974.9723 (fax)
liu@utk.edu

THE UNIVERSITY OF TENNESSEE KNOXVILLE

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