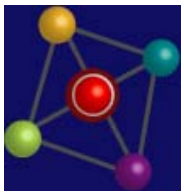

Proposal Outline

"Use of synchronized sampling in substations and system-wide applications"

I. Introduction

Improved reliability of power system operation heavily depends on the ability of utility personnel to closely monitor power system operation on-line. Legacy solutions use Supervisory Control and Data Acquisition (SCADA) systems to collected data utilizing Remote Terminal Units (RTUs) located in substations. The necessary information is then extracted and passed to the operators through Graphical user interface (GUI) of Energy Management System (EMS). The existing technology has limitations when it comes to an ability to monitor disturbances, determine fault location, and provide precise time stamping of fault clearing and switching sequences. Emerging technology of Intelligent Electronic Devices (IEDs), such as Digital Protective Relays (DPRs), Digital Fault Recorders (DFRs), Digital Fault Locators (DFLs), etc enables far closer monitoring of power system operation than what is available with SCADA systems, but the data collected with IEDs is not readily available for on-line use by utility personnel. Time synchronization of data collection is still not widely used, which further limits an ability to provide effective monitoring of power system disturbances.

II. Project description with linkages to wires company, high tech and university objectives (identify type of project—study, demonstration, commercialization or combination). Also, identify location (by company, if demonstration or commercialization, and geography).

This project will demonstrate how IED data is used to enhance EMS functionality and operator ability to better deal with fault disturbances and other system contingencies if the time-synchronization of data sampling is utilized. The project will also demonstrate how the time synchronization of both samples and phasors, as well as automation of data collection and processing will benefit both local and system-wide applications.

The expected benefits for ERCOT ISO will be the improved reliability and operational awareness. Demonstration test beds for evaluation of the benefits coming from the use of the technology and related services will be implemented. The software and hardware that will come out of this project will enable new and existing businesses in Texas to engage in new commercial activities related to product development, engineering and consulting in this area.

III. Detailed list of tasks that lead to deliverable(s), including the calendar period of time for completion. Identify critical Stop/Go decision points. Identify annual budget for each task that sums to a total cost per deliverable.

Task #1. Further development and demonstration of new field equipment ($175k)

- *Task#1A. Development of GPS-enabled Circuit Breaker Monitor (A project currently supported by DOE and demonstrated at CNP will be extended to include more demonstration sites and additional functionalities),* ***$100k.***

  Deliverables: A "beta" prototype of a low cost CBM that will be installed in the field at the base of a circuit breaker.

  Benefits to utilities: Automated monitoring of CB status and historical performance of switching actions improves: a) ability to confirm with great confidence the topology and switching status over what can be "seen" through SCADA, which will enhance operators' awareness of the topology changes and interpretation of associated alarms leading to savings in the restoration time, b) capability to explain detailed timing of switching actions during transmission line fault clearing that cannot be captured through traditional monitoring of "a" and "b" contacts, which will enhance protection engineers' understanding of the equipment performance leading to savings in the analysis time over what is needed to perform manual analysis, and c) possibility to perform on-line diagnostics of CB operations leading to just-in-time scheduling of maintenance actions, which will improved maintenance response and asset management planning leading to cost savings in manpower and spare parts.

- *Task#1B. Development of Test Set for field testing and evaluation of GPS-enabled IEDs (The development will be an extension of the high-precision test equipment commercially offered by TLI, Inc and currently used in a test lab configuration at CNP),* ***$75k****.*

  Deliverables: A prototype of the GPS-enabled high precision test sets for field evaluation of GPS-enabled IEDs

  Benefits to utilities: Testing capability will make sure the synchronized sampling applications will provide accurate results. Without this capability there could be significant loss of accuracy associated with benefits of synchronized sampling. For example, the deterioration in the fault location accuracy due to the lack of field testing of the improved solution that uses synchronized sampling can ultimately lead to the loss of time in patrolling the line and delay in restoring the line.

Task #2. Deployment of software for new applications ($1,121.8k)

- *Task #2A: ERCOT-related implementation of new software applications based on phasor measurements using existing IEDs (Several phasor-measurement projects currently supported by DOE and implemented using Phasor Measurement Units-*

*PMUs will be complemented by an ERCOT field demonstration experience and deployment of new applications using other GPS-enabled IEDs),**$450k***

Deliverables: Software applications, as well as the application guidelines and test procedure for phasor measurement implementation using commercially available GPS- enabled IEDs (other than PMUs).

Benefits to ERCOT and its operating companies: All the benefits are directly tied to better performance of ERCOT operators. In general, any savings in this area have a direct financial gain since the operator ability to estimate the system capability to support energy transactions directly improves the market efficiency (revenue) of energy transactions. In particular, reliability will be increased through better monitoring of the operating limits, which in turn leads to increased ability to transfer more power. The operator system awareness and better ability to schedule the transactions is also facilitated by more precise information about the maintenance scheduling, which can be improved as discussed in Tasks #1A, 2B and 2C. All of this is achieved using existing IEDs rather than purchasing additional PMUs.

- *Task #2B: New software applications for automated disturbance monitoring and relay performance assessment utilizing GPS-synchronized sampling. (A project currently supported by EPRI and demonstrated in one substation at CNP will be extended to include additional substation and functions),**$310k***

  Deliverables: Fault analysis and fault location software based on GPS-synchronized samples from IEDs located in switching stations and substations

  Benefits to utilities and ERCOT: As a result, more timely analysis of the equipment operation following faults will be performed leading to multiple savings in the utility operations, maintenance and protection groups as follows: a) reduced restoration time, b) increased productivity of engineers that are responsible for the analysis, and c) improved utilization of data from IEDs to enhance performance of line patrolling crews in the utility. The ERCOT savings are again tied to the ability to run more efficient and reliable energy transactions. Further details of the benefits are described in the EPRI project SOW.

- *Task #2C: New graphical visualization interface software for various utility groups (a project presently funded by DOE for development of the conceptual design will be leveraged by deploying demonstrations at selected locations at CNP,**$178.4k***

  Deliverables: Interface software for graphical visualization and presentation of information from the application software that uses time-synchronized measurements coming from GPS-enabled IEDs

Benefits to utilities: The benefits of this development are closely related to the benefits already discussed for Task 2B, except in this case an additional benefits comes from effective transfer of information to the various utility groups using dedicated graphical user interfaces, which in general is associated with increase in personnel productivity and effectiveness.

- *Task #2D: Implementation of field demonstration sites. (A project currently supported by EPRI and demonstrated at CNP will be extended to include one more field demonstration site at CNP),* ***$183.4k***

  Deliverables: Software deployment at two switching stations and/or substations in the CNP system including related graphical visualization interfaces

  Benefits to utilities: The main benefit is that field deployment of new solutions will bring experience to all participating utilities enabling them to make decisions about the benefit of new technology deployments in much more informed way than otherwise. This will allow measurement of the gains in cost savings in various areas such as: a) personnel productivity, b) effectives of improved time response in operator decisions, c) quality of performance in power system control actions, d) impact on the restoration time, e) reduction in maintenance cost, etc.

Task #3. Exploration of new services and study of economic benefits ($150k)

- *Task #3A: Development of advanced calibration and product certification lab for characterization of GPS-enabled IEDs used for the synchronized sampling and phasor measurement application,* ***$100k.***

  Deliverables: Lab set-up at a Texas university that will be used for calibration and certification of GPS-enabled IEDs and GPS-enabled test sets.

  Benefits to utilities: The calibration lab will be available locally at Texas A&M University and the cost of using it would be minimal. Being able to verify IEDs before purchase can lead to huge savings by avoiding purchase of large number of devices with inferior performance, which may not be detectable without certification tests. Being able to calibrate test sets allows maintenance of high precision applications avoiding losses due to degradation in the application accuracy.

- *Task #3B: Economic Assessment of the benefits from the use of synchronized sampling based technologies in transmission system,* ***$50k***

  Deliverables: The cost-benefit analysis report.

  Benefits to utilities and ERCOT: This study will spell out the benefits and means of measuring them in the future. This will lead to development of empirical data

needed to re-evaluate existing business models affected by the improvements and perhaps devise more cost-effective models.

IV. Cost of development and status of products at the end of Year I:

- Prototype design of a new GPS-synchronized circuit breaker monitor for on-line assessment of the CB performance. **$100k**
- Prototype design of a new high precision test set for field evaluation and testing of synchronized sampling features of IEDs. **$75k**
- Demonstration software for automated phasor measurements processing and collection for system-wide (ERCOT) uses based on the PMU capabilities embedded in protection relays. **$450k**
- Demonstration software for automated analysis of faults and other disturbances using GPS- synchronized IED data for individual utility uses. **$310k**
- Prototype design of stand alone graphical user interfaces for each new software package developed for the uses at CNP sites and ERCOT ISO. **$178.4k**
- Software demonstrations strategically deployed at two CNP substations in the ERCOT service area. **$183.4k**
- Prototype design of the high precision calibration and certification lab to be located at a selected TxCEE university, and to be used for evaluation of GPS-enabled IEDs. **$100k**
- Study of economic benefits of the use of synchronized sampling technology in Transmission systems. **$50k**

V. Proposed CCET member funding and participation (in-kind, professional contribution).

Duration and cost. Two years, ($1,446.8k for the first year)

Requested Funding (for the first year). *The State ETF*: $500k; *CCET members* Utilities ($33.4k cash, $100k in TC contribution, $43.4k in-kind), *EPRI* ($100k in TC matching),HydroOne ($50k in TC and $50k from EPRI matching), *DOE* ($350k); *ERCOT* ($100k cash, $25k in-kind), *TAMU* ($35k in-kind), *TLI Inc* ($60k in-kind)

Note: Detailed breakdown of the co-funding contribution and allocation is available upon request

VI. Management structure and professional team

Overall Project Oversight: CCET's TAG and CCET Board

Project Management: Management Board consisting of representatives of contributing CCET members, TEES Project manager, EPRI project manager, DOE project manager, and ERCOT project manager.

Project Technical Advising and Supervision: An Advisory Group consisting of technical staff from CCET member organizations

Project Fiscal Management: Texas Engineering Experiment Station (TEES)

Project Manager and Lead Investigator (name and affiliation): Dr. Mladen Kezunovic, Texas Engineering Experiment Station, Department of Electrical and Computer Engineering, College Station, TX 77843-3128, Tel. 979-845-7509, email: kezunov@ece.tamu.edu

Project participants (names and affiliations). Mack Grady, UT Austin; Surya Santoso, UT Austin; Wei-jen Lee, UT Arlington; Garng Huang, Texas A&M University; Ovidiu Crisan, U of H. The role of each professor will be further defined in future revisions to this project description.

The role of industry participants (TLI) will be added in the future SOW revisions.

VII. Identify prospects for match funding.

Prospects for funding are very good since it would only require discussion with EPRI and DOE/CERTS to expand their on-going projects.