Synchrophasor Education for Students and Professionals

PSERC

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Overall Objectives

• Develop comprehensive educational package that will reach out to educators, students, practicing engineers, managers, legislators, public officials, etc.

• Write a text book and prepare a set of presentations that may be used to

a) Help educators in guiding students at different levels of education in their research efforts

b) Help instructors in offering university courses ,tutorials and short courses for practicing engineers and managers

c) Help public officials in presenting the issues to legislators and public at large (customers)

Targeted Audience

The practicing engineers, students, managers, and non-technical persons need to master these new technologies in a way that corresponds to their role in the overall process of making such technologies a reality.

Deliverables

• **First year**: *Book outline, first revision of PP slides sets, initial drafts of book chapters.*

• **Final**: *Final version of the book, complete course package, including lecture notes and sets of PP slides.*

Synchrophasor and synchronized sampling (outline)

1. Introduction (Kezunovic)
   - *Definitions*   - *Motivation*
   - *History*   - *State-of-the-art*
2. Technology background (Meliopoulos)
   - *Standalone PMUs*
   - *PMU-enabled IEDs*   - *PDCs*
   - *System Architecture and Visualization*
3. Time Synchronization (Sprintson)
   - *GPS receivers*   - *Local time synchronization*
   - *Time synchronization over a communication network*
   - *Time synchronization interface protocols*
4. Communications (Sprintson)
   - *PMU-PDC communications*
   - *Routers and gateways*
   - *NaspiNet*   - *Quality of service*
5. Stability monitoring (Venkatasubramanian)
   - *Requirements*   - *New algorithms*
   - *Implementation*   - *Benefits*
6. Stability assessment and control applications (Vittal)
   - *Requirements*   - *New algorithms*
   - *Implementation*   - *Benefits*
7. Protection and fault analysis (Kezunovic)
   - *Requirements*   - *New algorithms*
   - *Implementation*   - *Benefits*
8. Energy management systems (Meliopoulos)
   - *Requirements*   - *New algorithms*
   - *Implementation*   - *Benefits*
9. Deployment issues (Kezunovic)
   - *Standards and interoperability*   - *Testing*
   - *Upgrades and maintenance*   - *Cybersecurity*
10. Conclusion

Background

The use of synchronized measurements, particularly synchrophasors, has a history of over thirty years of research and development. In the last few years the effort of deploying and demonstrating variety of applications that can benefit from synchronized measurements has been accelerated through the DOE funding and other related industry efforts.

The deployment of the Intelligent Electronic Devices (IEDs) for substation synchronized measurement applications has two approaches: a) use of Phasor Measurement Units-PMUs, and b) use of PMU-enabled IEDs (Digital Fault Recorders-DFRs, Digital Protective Relays-DPRs, Digital Disturbance Recorders-DDRs, etc. that have PMU measurement capability). The number of installed units in the US power grid will pretty soon go over 1000 with even more to be installed in the next 5-10 years.

Learning Outcomes

We propose to develop instructional artifacts that will cover new technologies and will describe new system solutions, and related benefits in a way that fits user needs for information in the best way. The outcome will be an increased knowledge of the individuals that play critical role in the process of development, deployment and public acceptance of the smart grid solutions.