Comprehensive Educational Tools for Reliability Modeling and Evaluation of the Emerging Smart Grid

Chanan Singh
Texas A&M Univ.
(singh@ece.tamu.edu)

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Quantitative Reliability in Perspective

- With increased complexity and uncertainty, the potential for possible failures with a significant impact on industrial complexes and society increases.

- In these circumstances maintaining the grid reliability and economy is an important objective.

- An important step in maintaining grid reliability is to model, analyze and predict the effect of design, planning and operating decisions on the reliability of the system – before implementation.

Quantitative Reliability in Perspective

- To implement the process, we need to define quantitative measures of reliability and have methods to calculate these.

- A substantial body of techniques does exist on this topic.

- Quantitative measures can be used:
  - As a constraint
  - Reliability worth included in overall cost optimization
  - Multi-objective optimization with reliability as one of the objectives

Education Needs and Target Audience

- This task develops educational material for teaching reliability modeling and evaluation of the emerging power grid with heavy penetration of renewables and massive deployment of computer and communication technologies.
- Audience: University-level instructors, Graduate students and other professionals.

Description of the Offering

- Two courses are developed, one semester long course that can be offered at the graduate level and a short course that can be offered in about six hours.

- The semester long course has been now fully developed and has been offered twice.

- Power points of the short course have been completed but videos for explaining these power points are being developed using Camtesia.

Semester Long Course

- Introduction to quantitative reliability analysis.
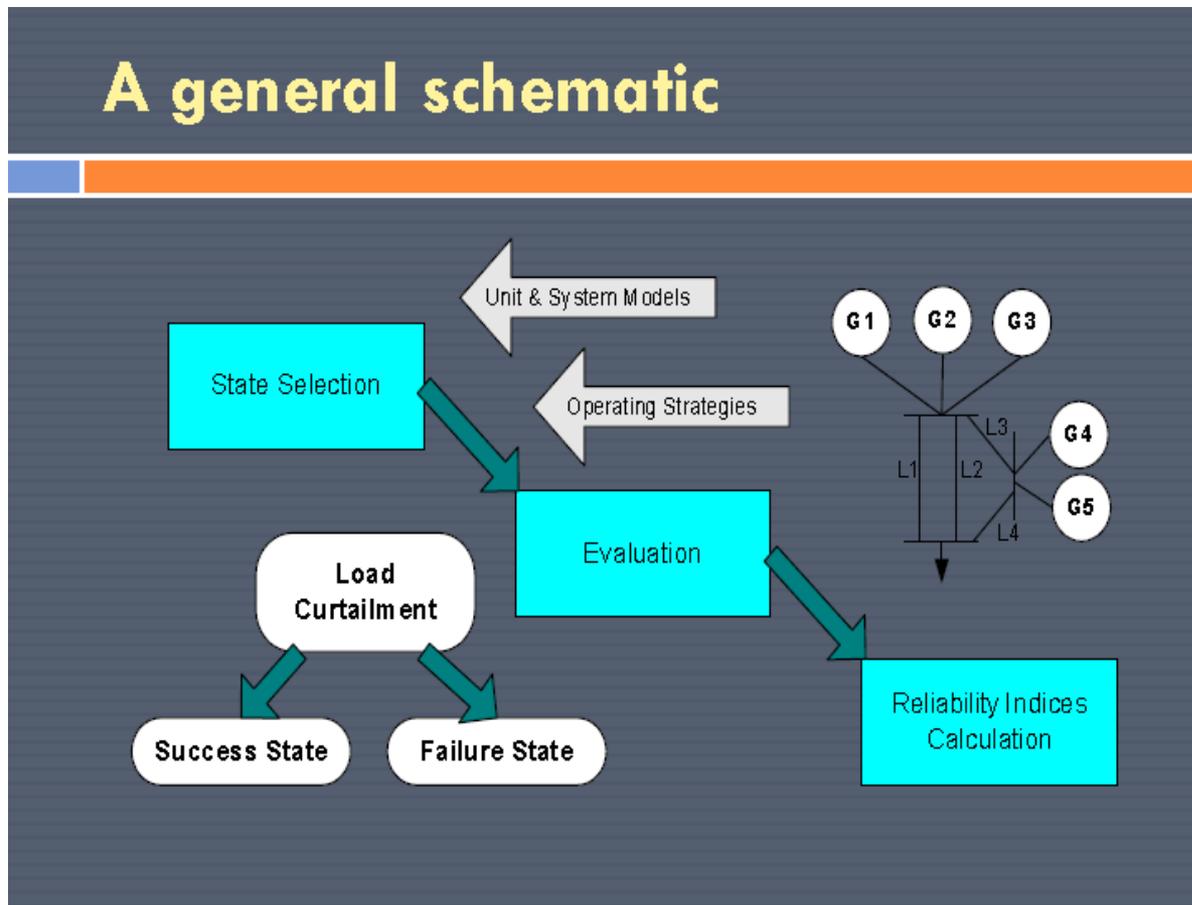
Topics

- Review of probability theory and stochastic processes: combinatorial methods, and discrete time and continuous time Markov process.

- Frequency balance approach: an alternative to stochastic processes.

- Methods of quantitative reliability analysis
  - State Space Approach
  - Network reduction
  - Min cut set method
  - Monte Carlo simulation

Topics

- Introduction to power system reliability
- Single area generation reliability
  - Static reserve
  - Spinning reserve
- Multi-area reliability analysis : analytical methods & Monte Carlo
- Composite system reliability analysis: Monte Carlo & Contingency analysis

Topics

- Integration of renewable sources: models for wind farms and integration into grid considering correlation and diversity.

- Reliability of cyber-physical power systems: A general approach to integrating the cyber and physical in reliability analysis.

Short Course

- Introduction to quantitative reliability
- Review of probability theory
- Introduction to power system reliability
- Single area reliability
- Multi-area reliability
- Monte Carlo Simulation
- Composite power system reliability

Student Feedback to Date

- Semester long course has been taught in Fall 2012

- Feedback was excellent: The students reported:
  - Important for engineers and they expect it will help them in the future
  - Well structured.
  - Some said this was the most important material they had and they learnt something new they never saw before.

- **Short course in somewhat different version was taught at NE-ISO and was attended by the engineers and some board members. Well received.**

Plans for Future Use

- Semester long course will be taught every year.
- Short course will be taught on demand
- The short course will have accompanying videos
- If future funding is available videos will be developed for the semester long course.

Accessing the Materials

- Both courses will be made available through Texas A&M Website and linked to PSERC Website