

ECE 5332 Communications and Control in Smart Grid

Department of Electrical & Computer Engineering
Texas Tech University

Spring 2012



Course Overview

- Graduate Course on [Introduction to Smart Grid](#).
- [No Official Pre-requisites](#):
 - Background in the following fields would help:
 - Power Systems
 - Computer and Communication Networks
 - Probability and Random Variables
 - Linear Algebra
 - Convex Optimization
- [Lectures](#): TR, Holden Hall 109, 9:30 AM – 10:50 AM.

Course Overview

- Instructor: Dr. Hamed Mohsenian-Rad
 - E-mail: hamed.mohsenian-rad@ttu.edu
 - Office: ECE Room 206
 - Office Hour: [Tuesday \(11:00 AM – 12:00 PM\)](#).
[Or by appointment]
- Course material: Will be posted on Blackboard
 - <http://www.blackboard.ttu.edu>

Course Overview

Grading:

- Test 1 – 20% [Early February – in Class]
- Test 2 – 20% [Early March – in Class]
- Test 3 – 20% [Early April – in Class]
- Test 4 – 20% [Late April - Early May]
- Final Project Report and Presentation – 20%

*One page (single-sided) cheat-sheet is allowed

Course Overview

Final Project:

- Individual
- Topic Related to Smart Grid / Your Choice / My Approval
- One Page Project Plan [Due on March 21, 2012]
- Final Project Report [Due on May 8, 2012]
- Final Project Presentation [10 min, Last Week of Classes]

Course Overview

No Textbook!

Main Source: Class Handouts [Download from Blackboard]

Plus Several Recent Papers, e.g., Those Published in:

- IEEE Transactions on Smart Grid
- IEEE Innovative Smart Grid Technologies Conference
- IEEE International Conference on Smart Grid Communications

Course Overview

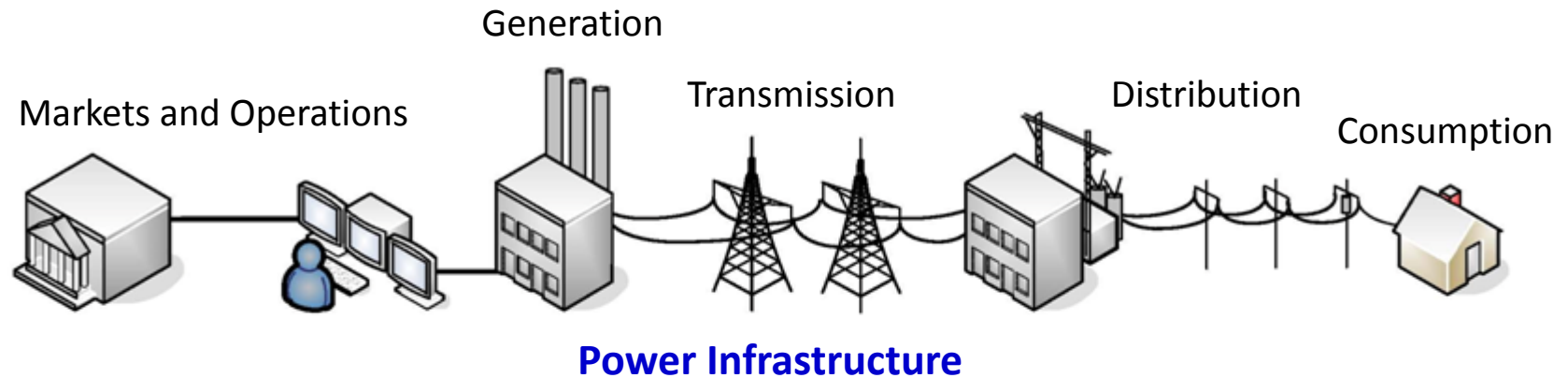
Q: What is Smart Grid?

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Short Answer: Smart Grid = IT + Electric Grid

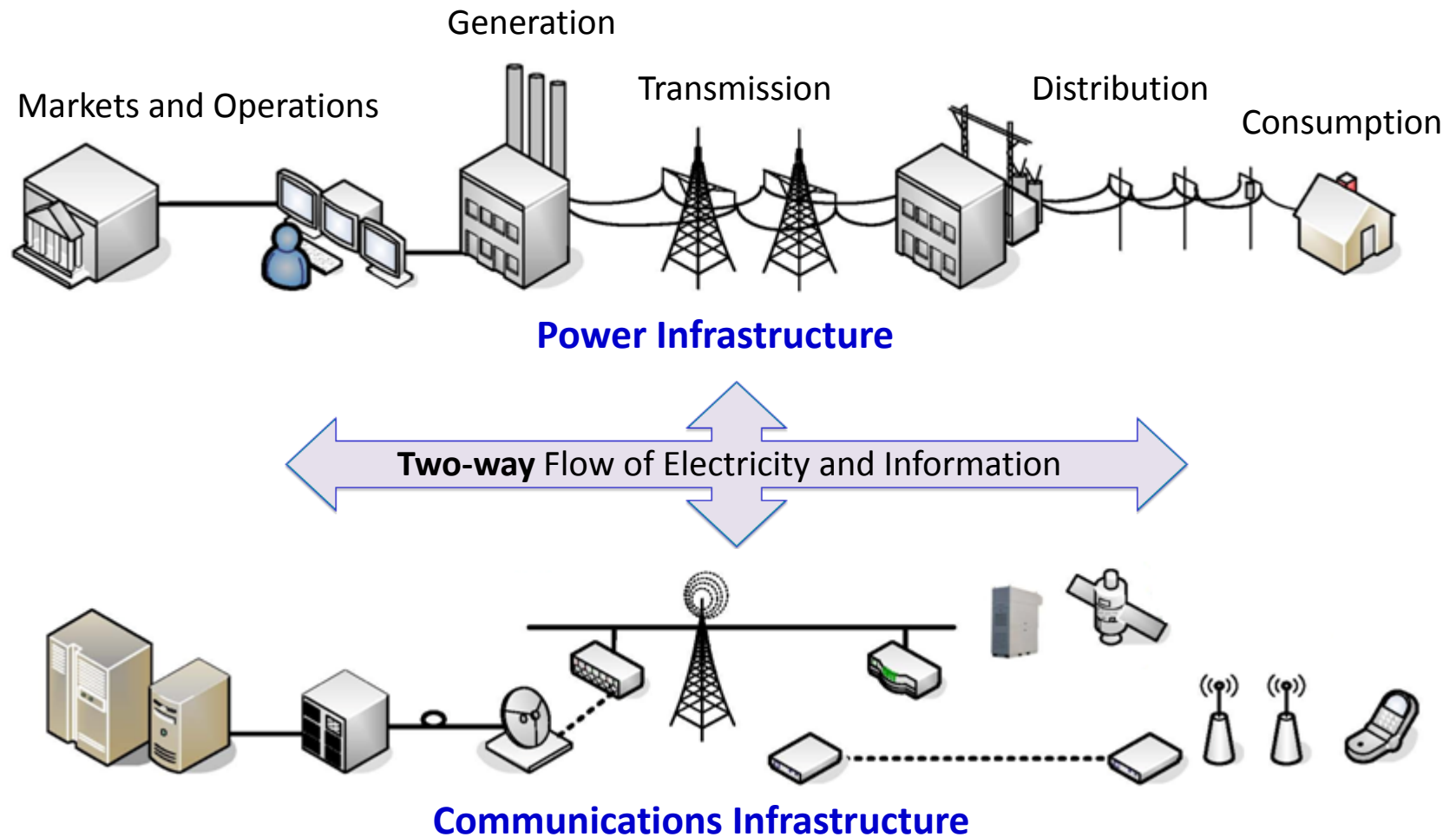
What is Smart Grid?

- Traditional Power Grid:



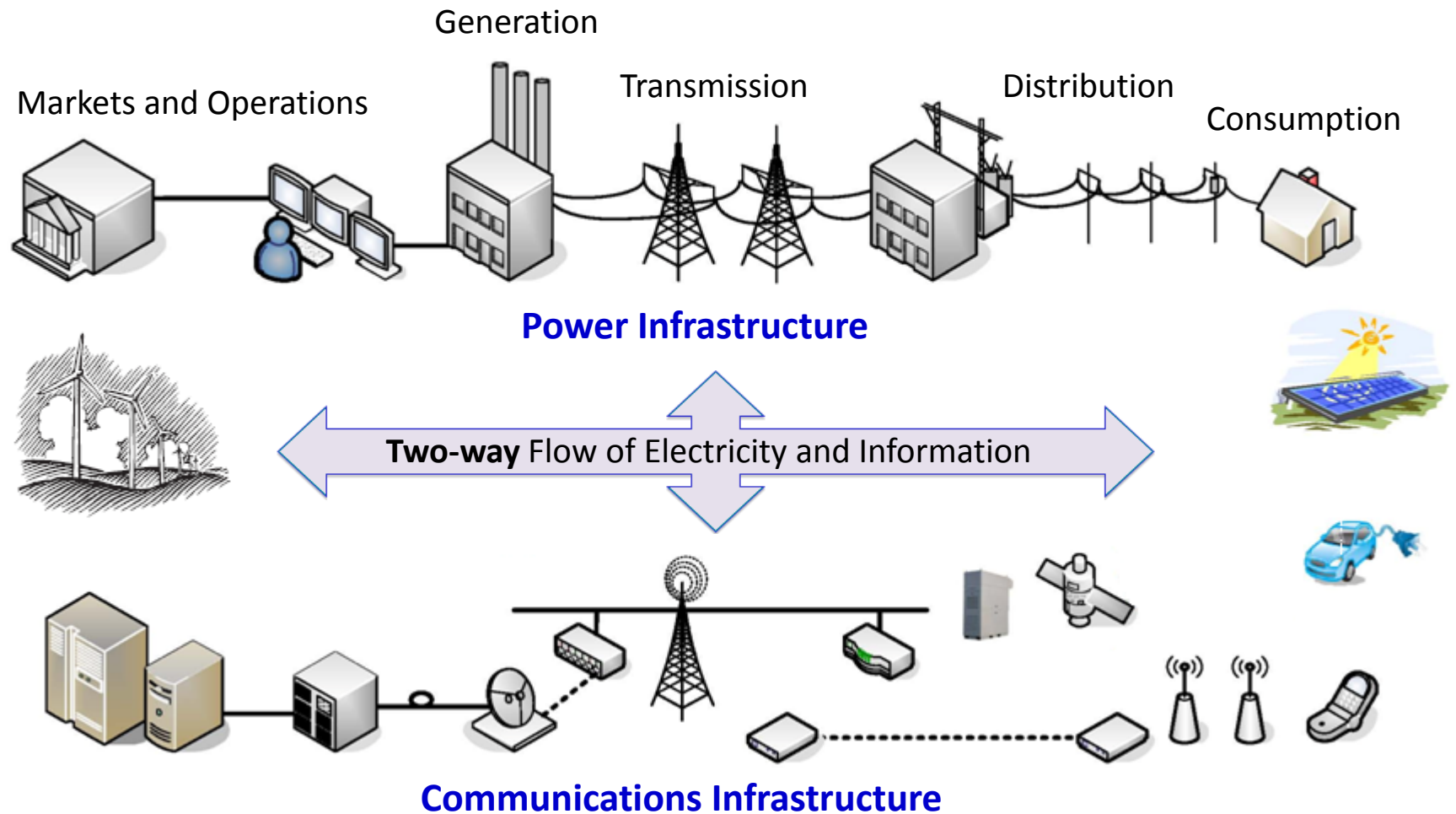
What is Smart Grid?

- Future Smart Grid:



What is Smart Grid?

- Future Smart Grid:



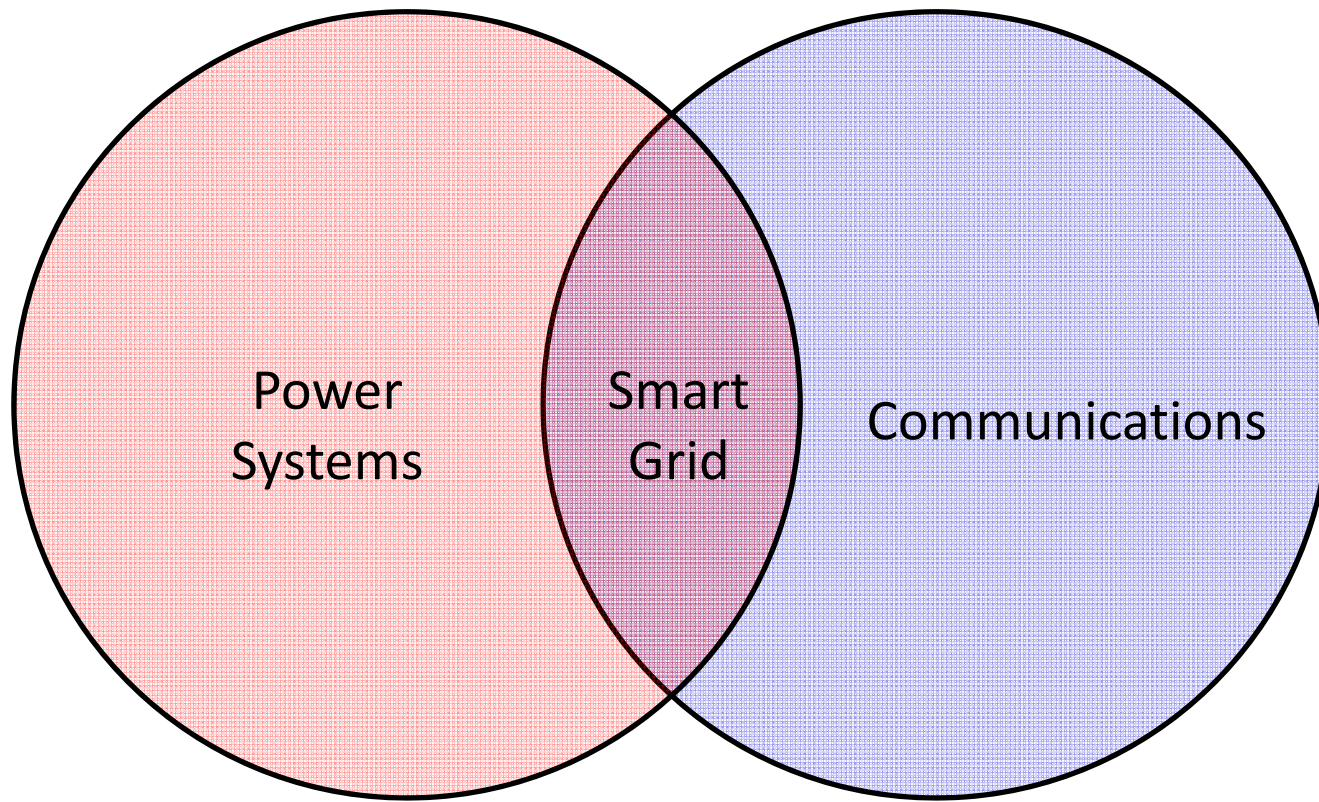
What is Smart Grid?

- Brief Comparison between Existing Grid and Smart Grid:

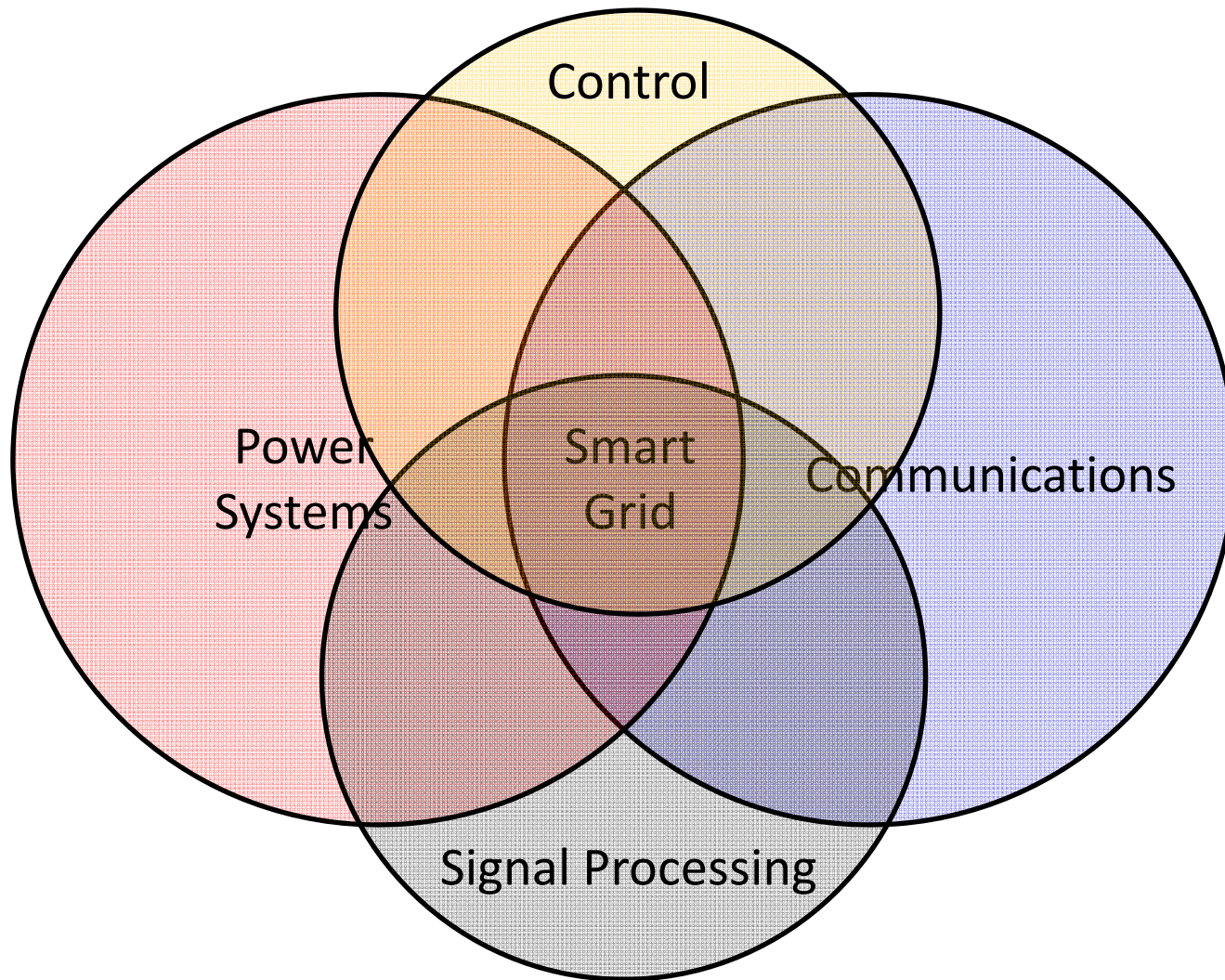
Existing Grid	Smart Grid
Electromechanical	Digital
One-way communication	Two-way communication
Centralized generation	Distributed generation
Few sensors	Sensors throughout
Manual monitoring	Self-monitoring
Manual restoration	Self-healing
Failures and blackouts	Adaptive and islanding
Limited control	Pervasive control
Few customer choices	Many customer choices

Ref: Farhangi 2010.

A Multi-disciplinary Field



A Multi-disciplinary Field



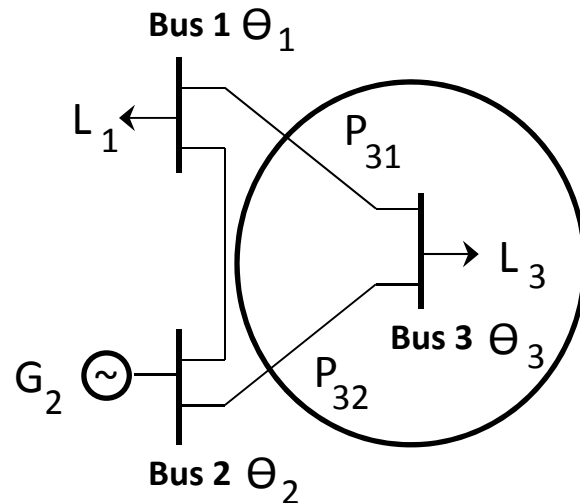
Topics Covered

- Basics of Power Systems
- Basics of Smart Grid
- Smart Grid Communications
- Demand Response
- Renewable Generation
- Wide Area Measurement
- Security and Privacy
- Economics and Market Operations

Diverse Topics!

Topic 1: Basics of Power Systems

- Load and Generation
- Power Flow Analysis
- Economic Dispatch and Unit Commitment



$$P_{31} + P_{32} - L_3 = 0$$

$$P_{31} = B_{31}(\theta_3 - \theta_1)$$

$$P_{32} = B_{32}(\theta_3 - \theta_2)$$

(B_{31} and B_{32} are obtained from Y - Bus Matrix)

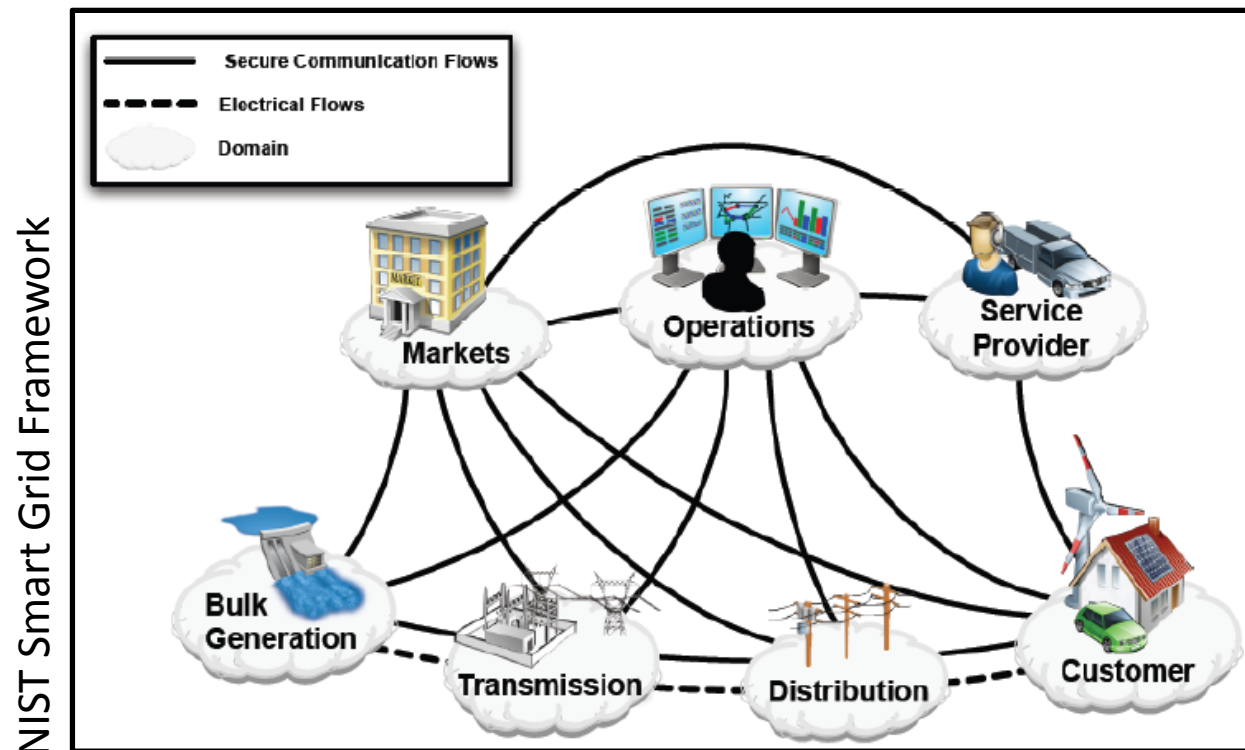
Topic 2: Basics of Smart Grid

- Definition and Applications
- Government and Industry
- Standards and Test-beds



Topic 3: Smart Grid Communications

- Two-way Digital Communications Paradigm
- IP-based and Power Line Communications Architectures
- Smart Meters



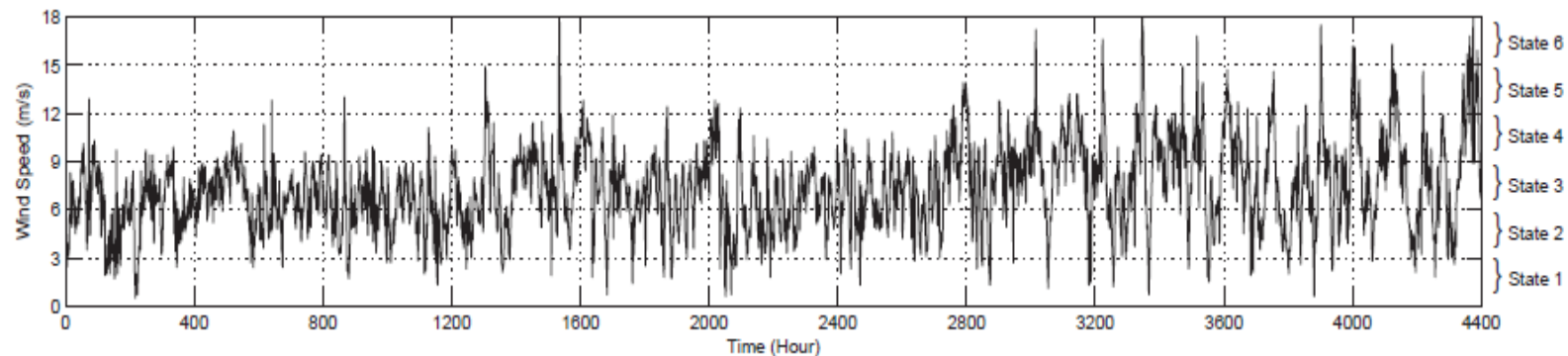
Topic 4: Demand Response

- Definition, Applications, and State-of-the Art
- Pricing Models and Energy Consumption Scheduling
- Controllable Load Models, Dynamics, and Challenges
- PHEVs and Vehicle-to-Grid Systems, Ancillary Services



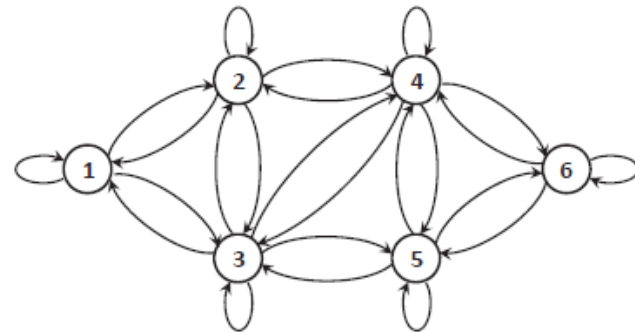
Topic 5: Renewable Generation

- Carbon Footprint, Renewable Resources
- Microgrid Architecture, Distributed Storage and Reserves
- Tackling Intermittency, Stochastic Models and Forecasting



Wind Speed in Lubbock, TX

Markov Chain Model

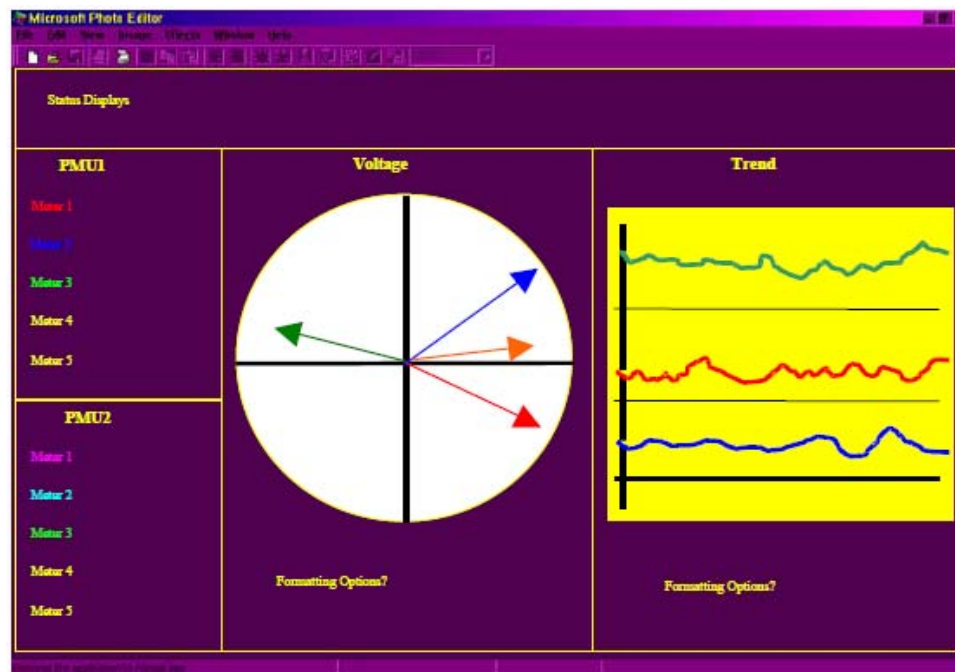


Topic 6: Wide Area Measurement

- Sensor Networks
- Phasor Measurement Units
- Fault Detection and Self-Healing



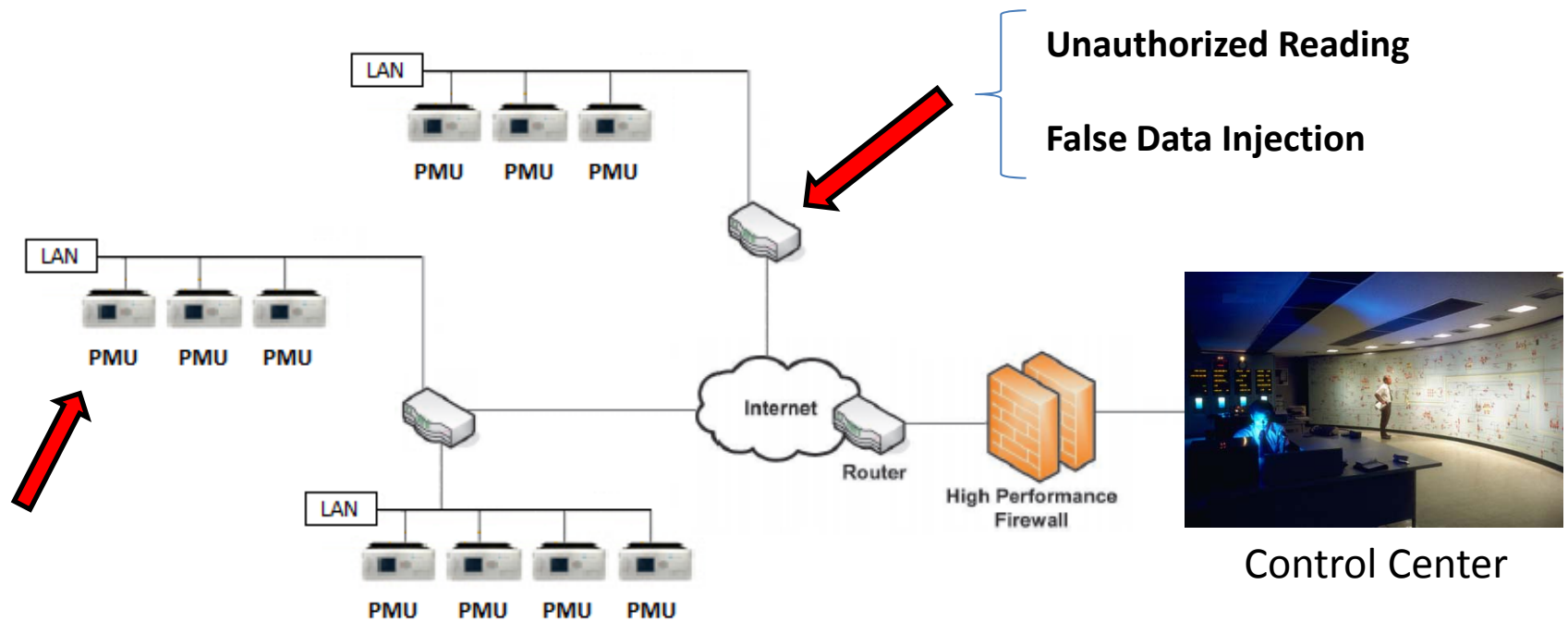
PMU



Collected Data

Topic 7: Security and Privacy

- Cyber Security Challenges in Smart Grid
- Load Altering Attacks, False Data Injection Attacks
- Defense Mechanisms



- **Q:** What if I am interested in one or two topics only?
- **A:** You can pick those topics for your final project.
- **Q:** Is there any other topic on smart grid that we don't cover?
- **A:** Maybe, smart grid is a very diverse field.
- **Q:** Why should I care about this new field anyways?

Smart Grid Job Market

- You may want to take a look at this website:
 - <http://www.smartgridengineerjobs.com/>
- It currently has 395 smart grid engineering job postings.

SR. WIRELESS ENGINEER

Infrax Systems - Pinellas Park, FL 33781

Created on Nov 15, 2011

Job Description

Infrax, Inc., based in St. Petersburg, Florida, is focused on developing new solutions for the Smart Grid space. The position requires the successful candidate to take a lead role in the design and development of new wireless based products/applications in the smart grid space, primarily in the demand response and distribution automation areas. . This is a key role in defining the overall wireless architecture. Design activities will include preparation and participation in design reviews, component selection, schematic creation, layout optimization and hardware evaluation.

Course Overview

- Before we conclude this overview, let us watch this video:
 - http://www.youtube.com/watch?v=YrcqA_cqRD8
- There are many other interesting videos that you can watch:
 - <http://www.youtube.com/watch?v=N8jqbKd8hVg>
 - <http://www.youtube.com/watch?v=ipB1n-yCUgc>
 - http://www.youtube.com/watch?v=yGk13U_kgGM