

# **Critical Infrastructure Security: The Smart Grid (4.6)**

**Anurag Srivastava, Carl Hauser,  
and Dave Bakken**

Washington State University  
([asrivast@eecs.wsu.edu](mailto:asrivast@eecs.wsu.edu))



PSERC Future Grid Initiative  
May 29, 2013

# Education Need and Target Audience

- **Need:** The increasing convergence of power, communications, and information network is creating a need for new multi-disciplinary skill sets for the power industry employee. Furthermore, an aging and retiring workforce adds to this challenging problem.
- **Audience:** Students and university-level instructors

# Description of the Offering

- Design a course with multi-disciplinary content integrating topics from data communication, computing, control, cyber-security and power systems that are relevant to secure operations of smart grids.
- Design a course to target audience of senior undergraduate and graduate engineering and computer science students (CS/EE, UG/G).
- Design a course that could be offered to online distance engineering students or engineers from industry as well as in the conventional classroom setting.

# Description of the Offering

- Design course materials to be easily adopted by instructors at other schools.
- Design course evaluations that allow us to assess course outcomes and improve the content
- Team Taught by:
  - Anurag Srivastava – power systems aspects (6 lectures),
  - Carl Hauser – computer networking (6),
  - Dave Bakken – computation and distributed systems (6),
  - Carl Hauser/ Min Sik Kim – cyber security basics (6),
  - Joint: cases (4)
- Take-home group mid-term, final exam, and final project, 2 individual quizzes, 4 homeworks
- Text book: Book chapters and online references

# Learning Objectives

- At the end of this course, student will,
  - 1) Understand the basic principles of smart grid components and operation
  - 2) Understand the principles of communication networks, data management, distributed computing and cyber security
  - 3) Be able to critically analyze the interdependencies of related infrastructure in the smart grid needed to sense, communicate, compute and control in secure way
  - 4) Be able to apply the interdisciplinary principles that you have learned in building secure smart grid infrastructure

# Student Feedback to Date

Offered as 'Critical infrastructure security: the emerging smart grid'

Spring 2012 (29+24=53)

- Pullman Campus:- CptS: UG 7 G 1, EE: UG 4 G 11
- Tri-Cities Campus:- CptS: UG 4 G 2, EE: U 0 G 0
- Online: 24

Spring 2013 (27)

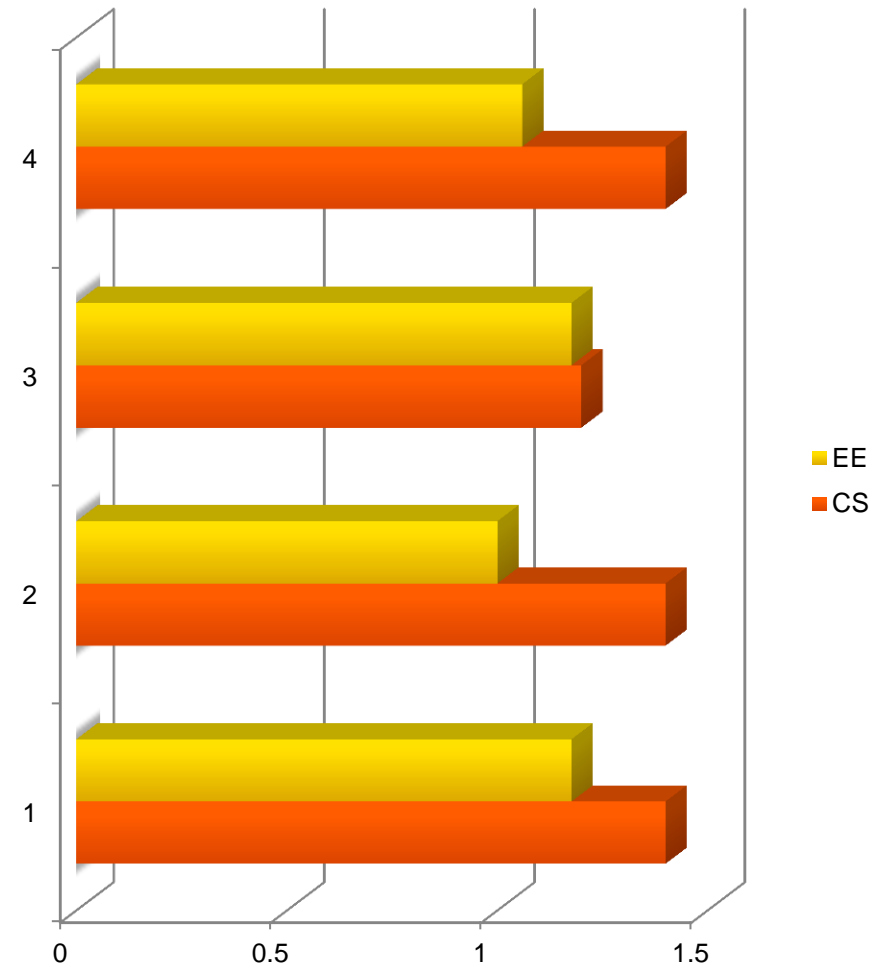
- Pullman Campus:- CptS: UG 2 G 3, EE: UG 3 G 15
- Tri-Cities Campus:- CptS: UG 0 G 0, EE: U 0 G 4

# Student Feedback to Date (2012)

- Evaluations from 15/29 students
- Overall rating
  - 33% excellent
  - 40% good
  - 13% neutral
  - 13% poor or very poor
- Course was well organized
  - 47% strongly agree
  - 47% agree
  - 7% neutral
- I believe I learned in the class
  - 80% very often
  - 7% sometime
  - 13% few times

# Student Feedback to Date (2013)

- Evaluations from 23/ 27 students
- Apply the interdisciplinary principles that I have learned in building secure smart grid infrastructure
- Critically analyze the interdependencies of related infrastructure in the smart grid needed to sense, communicate, compute and control in secure way
- Understand the principles of communication networks, data management, distributed computing and cyber security in context of the smart grid
- Understand the basic principles of smart grid components and operation





# Student Feedback to Date

## Student Feedback

- Too much information per session; cut down and emphasize the basics
- Too many professors – hard to know what is expected
- Group work on exams (not project) was “unpleasant”
- Spend more time on real-world applications

## Faculty Feedback

- It was a very challenging class to design and teach
- Many were bored and others terrified at any given time
- Lectures hard to design to reach both EE/CptS students
- Final projects were actually pretty good and interesting, except in a few cases

# Plans for Future Use

- Try to integrate details about networking/power/computing/security topics around a few case studies that each involve at least two of the topics
  - E.g. Talk about AMI and its smart grid role and couple it with a detailed discussion of IP/UDP, symm. key encryption
  - E.g. Talk about monitoring and control, discuss SCADA, DNP3, and its encapsulation in IP/TCP
- We need our own notes rather than selecting chapters from topic-specific textbooks
- Background reading list – “you should be familiar with this”

# Accessing the Materials

- Course Material will be available in late Summer 2013 (improved one in 2014)
- More Information Available at:
  - Srivastava, Anurag K.; Carl Hauser, David Bakken, and Min Sik Kim, “*Design and Development of a New Smart Grid Course at Washington State University*” IEEE PES General Meeting, San Diego, CA, July 2012.
  - Srivastava, Anurag K.; Carl Hauser, and David Bakken, “*Study Buddies*”, IEEE Power and Energy Society Magazine, vol. 11, issue 1, pp. 39-43, Jan. 2013
- Online offering for certificate (this may change to online degree program in long term). This will be available through WSU global campus in 2014.