NSF CISE CAREER Workshop 2015: (My) CAREER Proposal Writing Process

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Background

- Assistant Professor: Arizona State University (since Oct. 2012)
  - School of Electrical, Computer, and Energy Engineering
  - I teach classes across both power systems and communications systems sub-areas
  - Power systems: cyber-security and privacy
  - Communication systems: data privacy, compression, finite block-length coding, information-theoretic security, …

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- Postdoctoral Fellow and Research Scholar: Princeton University (2007-2010, 2010-2012)
  - Received an (first) NSF grant (as co-PI) in 2010. (On information-theoretic methods for the database privacy problem)

- Ph.D: WINLAB, Rutgers, 2007
  - Capacity analysis of multi-user communication systems with relays

Background: Research Areas

Doctoral: (communication and information theory)

- Capacity of multi-user communication channels
- Game-theoretic incentive mechanisms for enabling cooperation

Postdoctoral:

- transitioned to studying privacy leakage (using information-theoretic lens) associated with publishing electronic databases

- Applied privacy methods to emerging applications in the electric grid

- Steep learning curve in both application areas
- Sufficient prior work on privacy needed to be understood
- Electric power systems is a well defined discipline of EE

Background: CAREER Award

- CAREER award from CIF on Privacy‑Guaranteed Distributed Interactions in Critical Infrastructure Networks
  - first attempt; awarded Jan 2014
  - Spent almost the entire summer of 2013 writing the proposal
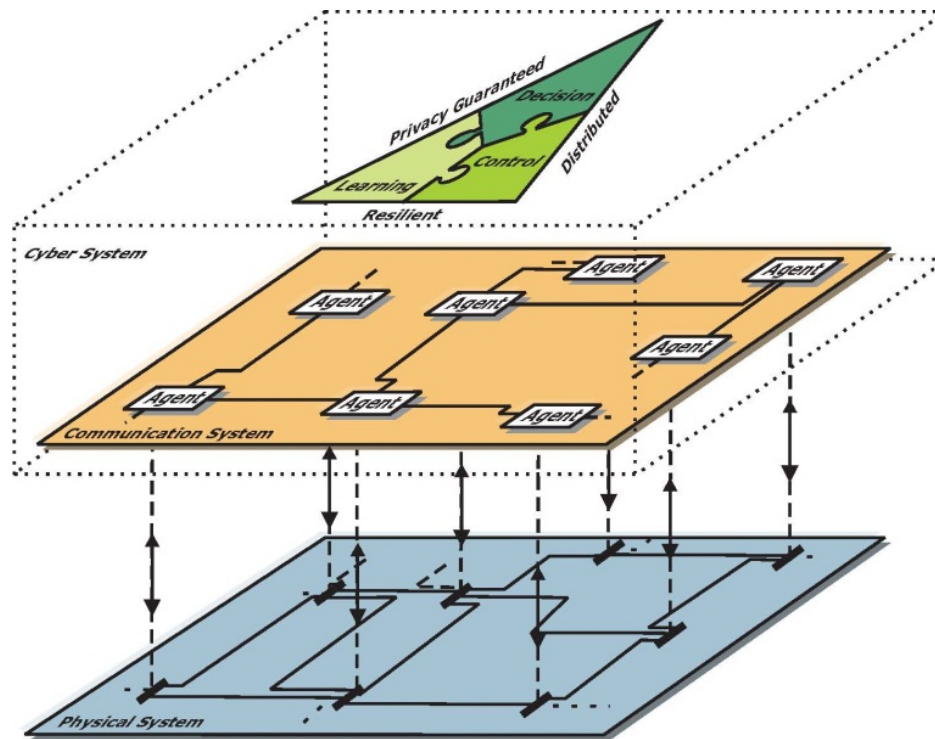
Picking the Problem

- Privacy challenges in the electric grid
  - Simplest example that comes to mind is smart metering systems
  - No! Relatively simple and not much to research for five years.

- Bigger challenge in the electric grid: data sharing between different legitimate data collectors (e.g., utility companies, systems operators)
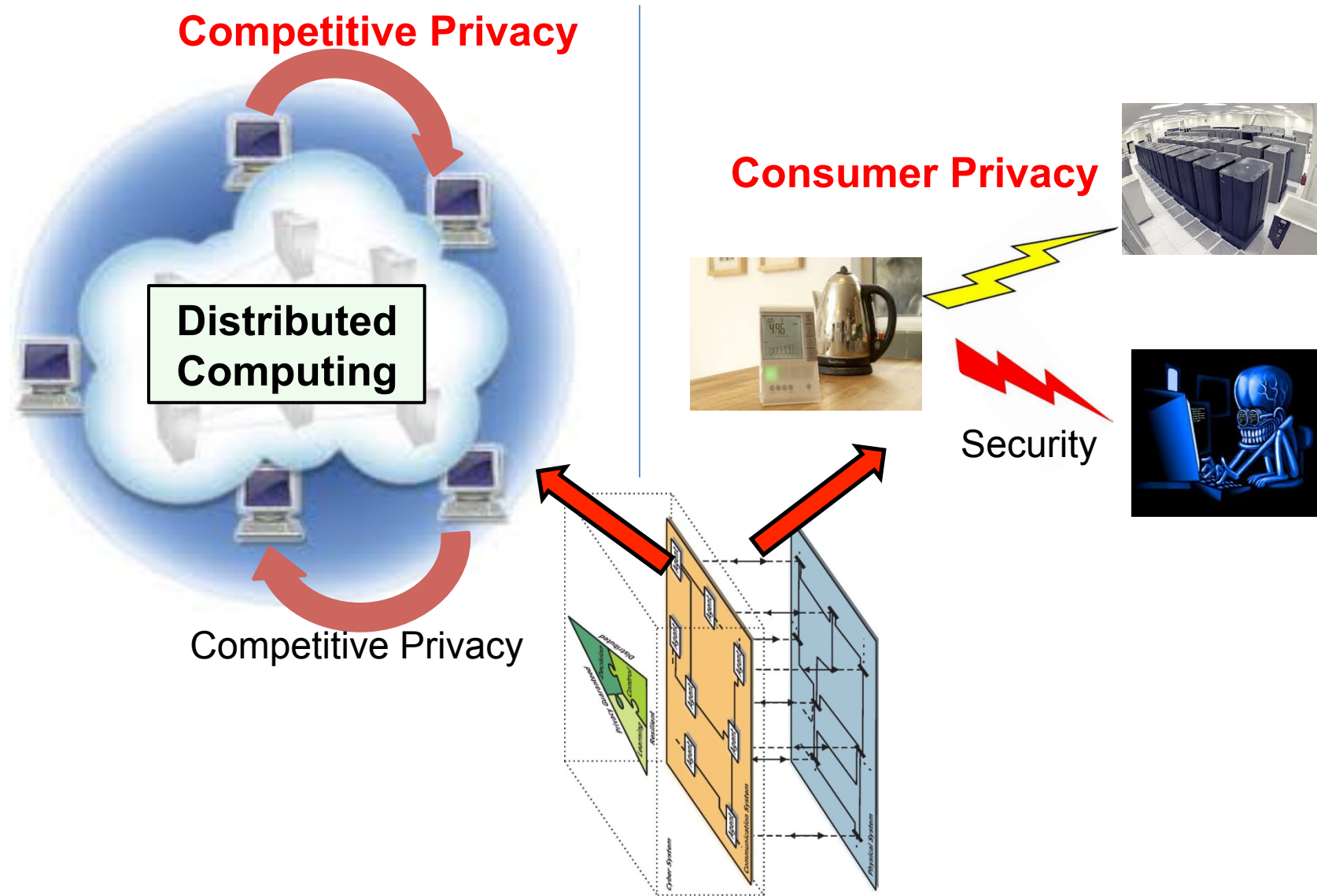
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- Data shared on need-to basis and human-operator interface required
  - Lack of timely sharing leads to catastrophic failures and blackouts

- Problem of competitive privacy: how to enable information sharing and incentivize sharing
  - Problem was recognized as a genuine problem by power systems researchers too.

Privacy

Competitive Privacy

Distributed Computing

Competitive Privacy

Consumer Privacy

Security

Picking the Problem

Wanted to focus on two theoretical underpinnings:

- Develop data exchange protocols that can allow sharing relevant data while ensuring correlated data that needs to be kept private is leaked minimally

- Even with such protocols, need to incentivize non-cooperative parties to share data either for the greater good or for selfish purposes

- Two foundations: information theory and game theory
- Application: electric power system

- Effort: convincing a reader that theory is foundational, applicable and meaningful

Picking the Problem

- Ambitious scope better than not!

- But proving that ambitious scope is within a five year research reach is crucial!

The two foundational problems I proposed had the following components:

- Prior work to establish background
- New problems and applications of information and game theory
- New approaches to studying data sharing problems in the grid

- Each part had sufficient work to do for at least 4 years if not five.

Proposal Writing

Education/Outreach Component

- Prior experience:
  - teaching freshmen at Princeton
  - Introduced a new class on the Fundamental Ideas of the Information Revolution
  - Published papers with freshmen and women
  - Outreach in local elementary and middle schools

- Reached out to ASU's Outreach Office to understand their programs

- Spent sufficient time understanding their outreach programs and finding the right fit

- **Wanted to do something that is different from 'I will work with high school students'**

Education/Outreach Component

- **Wanted to do something that is different from 'I will work with high school students'**

- **Educating middle school (female) students about privacy challenges was my goal**

- Multiple steps to goal:
  - ASU E2 (freshman camp)
  - ASU ECEE high school open house
  - Guest Lectures at ASU 101 (special topics for Freshman)
  - Outreach at local elementary school

  - Girls have IT day at Xaviers High – Middle school girls STEM event

  - ASU BEST 1-2 week summer courses for middle/high school students

Education/Outreach Component

- **Girls have IT day at Xaviers High – Middle school girls STEM event**
  - Working with two ASU Fresh(wo)men on developing an FB-based demo of privacy challenges on social media

Education/Outreach Component

- **Used the ASU Outreach Evaluation office to evaluate my outreach**

- Budgeted 10K for this outreach evaluation
  - Surveys, IRBs, independent evaluation and confirmation of activities
  - Materials

- Do not know of prior such efforts

- Maybe overkill

- Has worked well for me thus far including developing surveys for my outreach activities

Education/Outreach Component

- Also leveraged my outreach/community efforts in the Information Theory Society
  - Student volunteer and chair of IT Society
  - Helped organize panels and talks at IT society conferences

- Devoting proposal pages to Outreach:
  - Reviewed proposals suggested 1-2 at most
  - That was my rule of thumb
  - Include all relevant details but succinctly

Educational Component: Teaching

- First semester at ASU: introduced a special topics class on Cyber-security and Privacy in the Electric Power Grid
  - **Tough but forced me to learn more**
  - **Gained a broader and deeper understanding of an application area (power systems) for my CAREER award**
  - **Such a course not taught before**

- Leveraged it in my CAREER educational/outreach part

- Also hired two (MS) students (via class) and began working (learning) with them over summer

- **What I learned: educational component needs to standout**

Integration with Research

- Teaching the special topics class directly connected to my research on two fronts:
  - Privacy (data sharing) challenges in electric power systems
  - Cyber-security challenges in electric power systems

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My proposal included:

- One-page overview to the reviewers on the electric grid, its computing systems and the data sharing challenges
  - Teaching helped integrate these ideas succinctly and clearly

- Crucial to have a background section to place proposal in context
  - Both for inter-disciplinary and core proposal topics

- Just received an NSF CPS award for cyber-security research

Mentor, Friends, Well-wishers

- My faculty mentor at ASU was extremely helpful in encouraging me, reading my proposal, and telling me honestly what was missing
  - In fact a few weeks before the deadline the proposal was barely done
  - He felt more details were needed
  - Friends in the IT community had similar feedback
  - Advisers and other senior mentors shared feedback too

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- Important to find at least a small set of folks who are willing to help

- Introduction, Summary, Overview/Timeline: most important to review or read

Proposal Efforts: Timeline

- Started thinking about writing in Jan. 2013
- Need to identify sufficiently ambitious topics and leverage prior/related work

- Requested to sit on an NSF CIF panel (thank you, Dr. Regalia!)
  - Very valuable in understanding the review process

- Began writing in earnest in May-June.
  - Spent enormous amounts of time writing Introduction, Outreach, Outline of Thrusts, and Background
  - Spent similar amounts of time identifying proposed problems going well beyond preliminary work
  - Summer largely devoted to writing CAREER award

Example Proposals

- I asked all those I knew well in my research community (IT) and read 8-10 proposals carefully (throughout the process)
  - Very grateful to those who shared; invaluable to read high quality funded proposals

- **Ask those you know well first**
  - They are more likely and willing to share
  - Seemingly hard to share one's proposal even if unrelated to others' research with relative strangers

- Take a mix of successful grants: senior faculty and relatively recent awardees
  - Review outreach, proposal writing style, flow of ideas
  - It is a test of one's writing skills

Example Proposal

Project Summary.

Information sharing between operators (agents) in critical infrastructure systems such as the Smart Grid is fundamental to reliable and sustained operation. However, despite its importance, data sharing in such systems is stymied – sometimes with known catastrophic consequences – due to the lack of a framework that addresses the competitive interests and information leakage concerns of agents. There is a tension between sharing data for system stability and reliability (utility) and withholding data (privacy) for competitive advantage. This problem of privacy-constrained interactions in distributed systems, identified by the PI as a competitive privacy problem, appears in a number of complex systems involving agent interactions. A key feature of this proposal is a foundational approach for this problem grounded in an information leakage based privacy model.

NSF Sub-Division and PD

- **This was not an easy decision**
  - It is better to approach ECCS where reviewers may not know me?
  - SaTC since it is related to privacy?
  - Or my core group CIF since the ideas are based on information and game theory foundations?

- Answer: ?

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- Answer: CIF
  - Theoretical basis of the research
  - Relatively well-known in the community
  - My outreach efforts are well-known to the community too

- Met CIF PD (Regalia) and spoke to him about what his division funds

Final Thoughts

- Organize ideas first

- Have a rock solid outreach effort (but realistic)

- Reach out to NSF PDs and talk to members in community

- **Read, re-read, re-re-read proposal**
  - If tired, ask someone else to read – ask for honest critical comments

- Few questions you need to address:
  - Why is the proposed problem/research important?
  - Who cares and why should they care?
  - Why is it worth funding?

- Introduction and Summary should address these questions clearly, precisely, and set the stage for your credibility

Final Thoughts

- Highlight collaborative work
- Indicate if some of your work will be collaborative

- Not everything should be collaborative

- Distinguish your work (even if new) from related prior work

Read, re-read, re-re-read proposal