



FORCES

Program Highlights

Larry Rohrbough, UC Berkeley



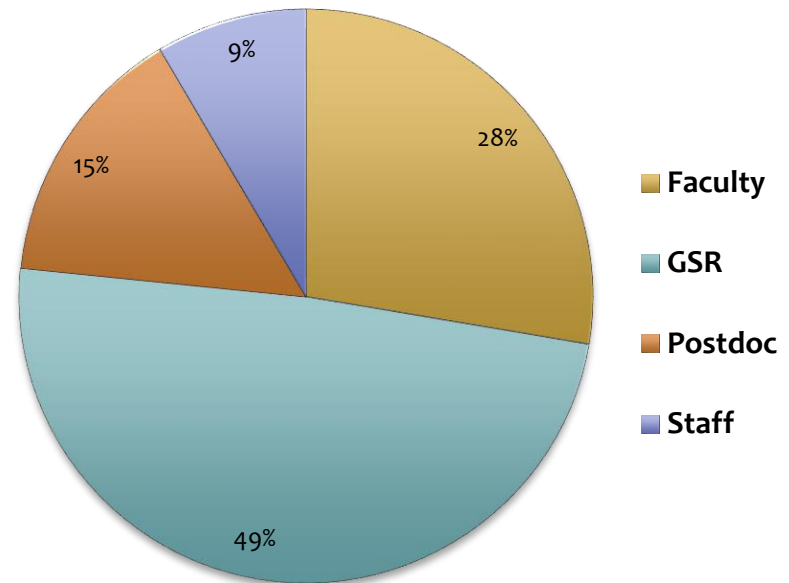
The Overall Team

- * Total Participants = 47
 - * Graduate Students = 23
 - * Faculty = 13
 - * Post Docs = 7
 - * Staff = 4

- * Demographics

- * Female = 26%
- * URM = 4%
- * U.S. Persons = 66%

**FORCES Personnel
(all institutions)**



The Overall Team (cont.)

* New GSRs

- * Jacob Avery (MIT)
- * Kevin Chen (Berkeley)
- * Mathieu Dahan (MIT)
- * Gaurev Kumar (MIT)
- * Jennifer Marley (Michigan)
- * Jonathan Martin (Michigan)
- * Abhishek Sethi (MIT)
- * Chati Yashovardhan (MIT)

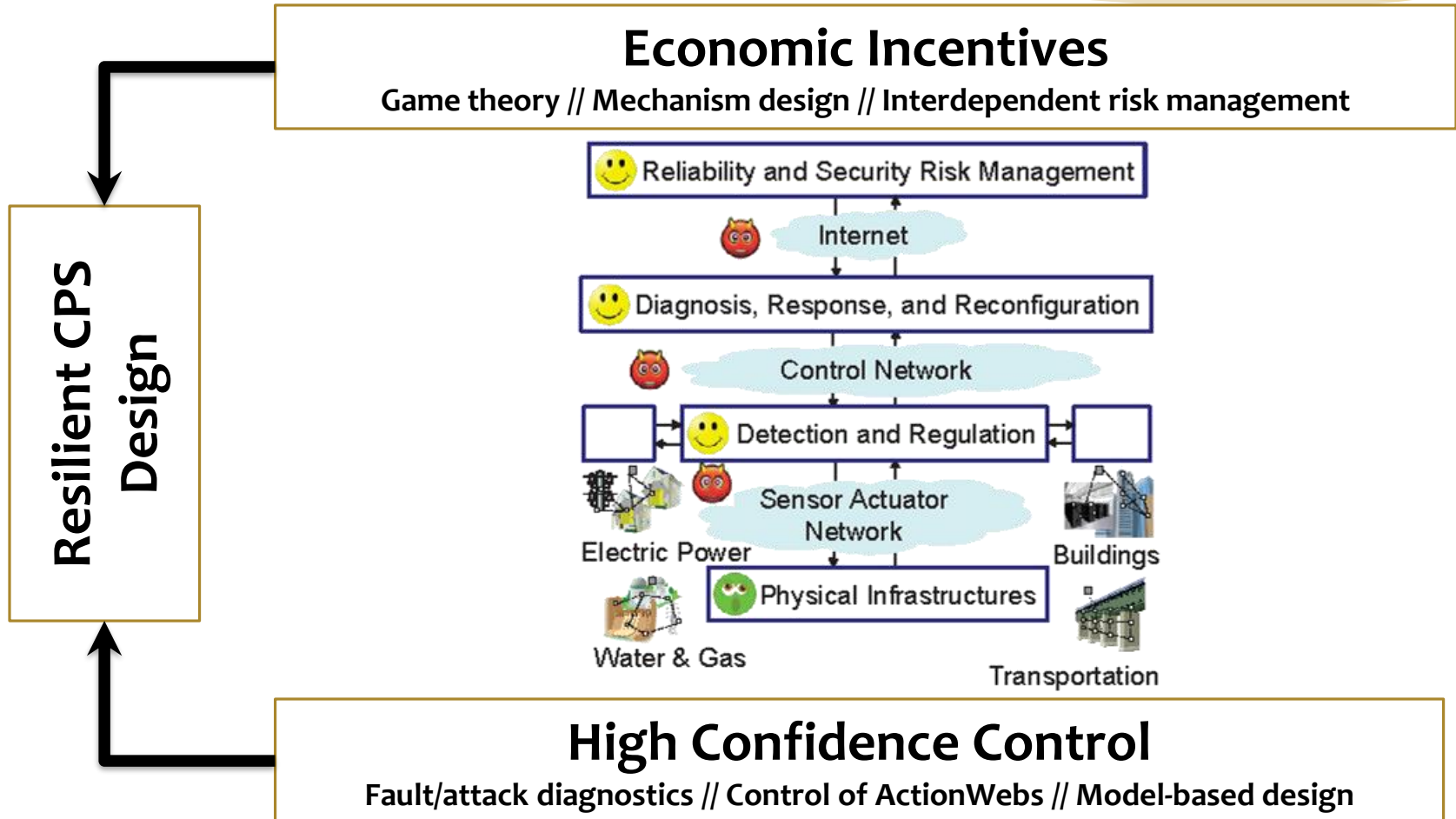
* New Postdocs

- * Ali Kakhbod (MIT)
- * Aron Laszka (Berkeley)

* FORCES Alumni

- * Hoda Bidkhorri (UPitt)
- * Maxim Markov (Roland Berger)
- * David Ogutu (Google)
- * Mathias Payer (Purdue)
- * Lillian Ratliff (Berkeley)
- * Gabor Simko (Google)
- * Insoon Yang (MIT/USC)

FORCES Research Overview & Approach



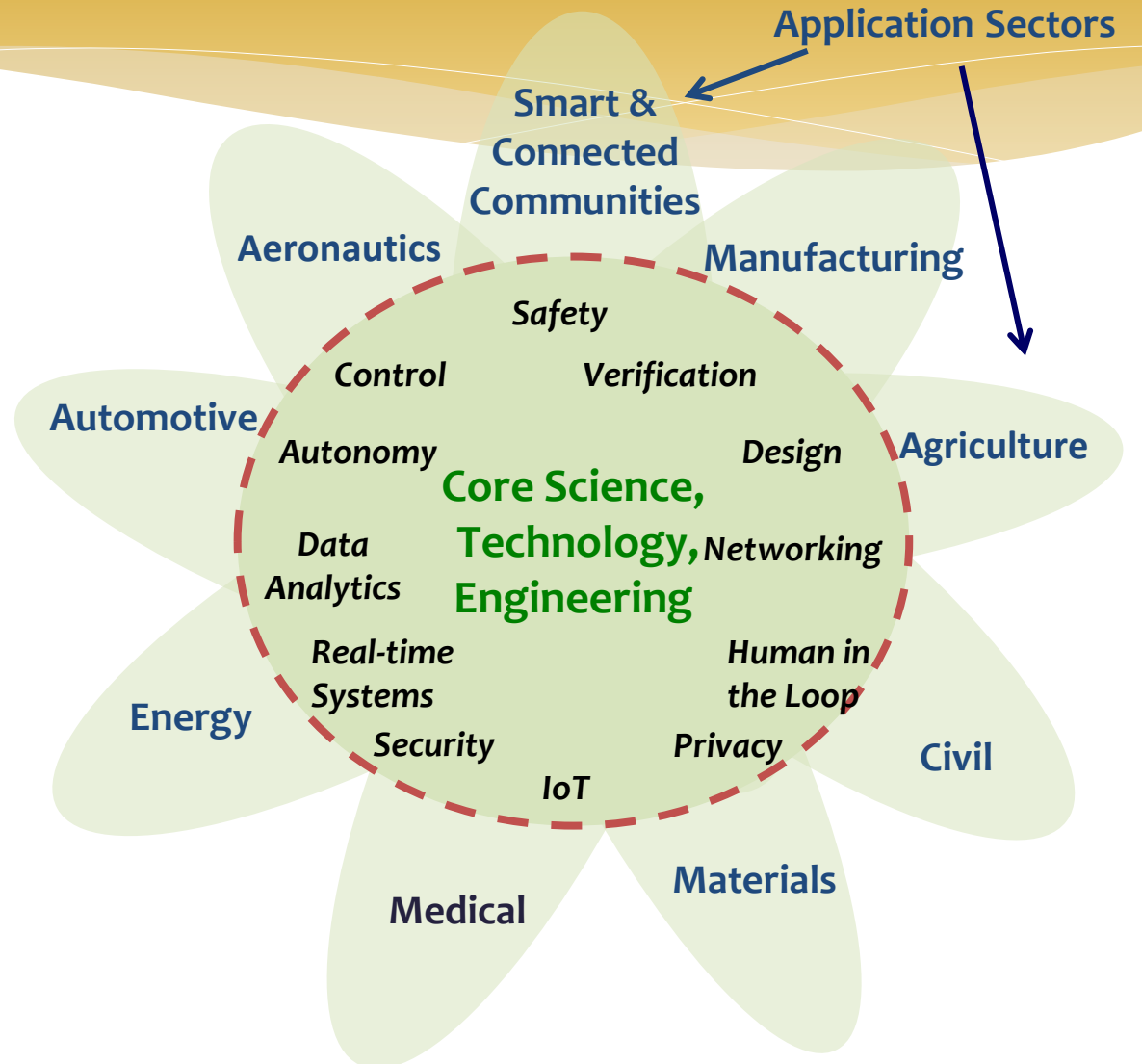
FORCES & NSF CPS Research Model

- * FORCES Domains

- * Energy
- * Ground transportation
- * Air transportation
- * Smart cities

- * FORCES Science

- * Robust control
- * Reliability & safety
- * Human-CPS
- * Security & privacy



Since the Last Meeting...

- * Energy

- * Machine learning and econometrics for residential demand response
- * Strategies for responsive load control
- * Stochastic storage control to reduce price volatility

- * Ground Transportation

- * Attacks on mobility-as-a-service (MaaS) systems
- * Attack-resilient design for traffic signal systems
- * Resource management solutions for urban parking

- * Air Transportation

- * State and dynamics of networks to quantify impacts on air traffic delay
- * Taxonomy of vulnerabilities and mitigation strategies for next-gen air traffic control systems

Since the Last Meeting... (cont.)

* Security

- * Quantifying threats to security and privacy of CPS/IoT
- * Integrating intrusion detection systems into CPS
- * Network modeling, analysis, and management tools to detect and mitigate DoS/DdoS attacks
- * Resilient supervisory control system for CPS cyber-attacks

* Economics

- * Metrics and tools for valuing data and a data market for sharing (and quantifying the usefulness of) information
- * Framework for economically evaluating the security of large-scale networked CPS

FORCES Work Products

- * Publications (2014-2015): 51 conference papers, 25 journal articles

Prominent Conferences...

- * Control: American Controls Conference (ACC), IFAC World Congress, IEEE Conference on Decision Control (CDC)
- * Security: ACM Conference on Computer and Communications Security (CCS), Network and Distributed System Security (NDSS) Symposium
- * CPS: ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)
- * Other: Allerton Conference on Communication, Control, and Computing

Prominent Journals...

- * IEEE Transactions on Automatic Control
- * IEEE Transactions on Control Systems Technology
- * IEEE Transactions on Human-Machine Systems
- * IEEE Transactions on Network Control Systems
- * IEEE Transactions on Smart Grid
- * IEEE Transactions on Intelligent Transportation Systems
- * International Journal of Electrical Power and Energy Systems
- * SIAM Journal on Control and Optimization
- * Water Resource Research

FORCES Awards & Recognition

* Students

- * Michigan: Hamid Tavafoghi – Dow Sustainability Doctoral Fellowship
- * MIT: Li Jin, Jeff Liu, and Devendra Shelar – Schoettler Fellowships
- * MIT: Jacob Avery – ACRP Graduate Research Award on Public-Sector Aviation Issues



* Faculty

- * MIT: Amin – NSF CAREER Award, Google Faculty Research Award, Robert N. Noyce Career Development Professorship, and Siebel Energy Institute Award



FORCES Awards & Recognition (cont.)

- * Best Papers

- * Goncalo Martins, Sajal Bhatia, Xenofon Koutsoukos, Keith Stouffer, Chee Yee Tang, and Richar Candell. “Towards a Systematic Threat Modeling Approach for Cyber-Physical Systems,” *3rd International Symposium on Resilient Cyber Systems (ISRCS 2015)*, Philadelphia, PA, August 18-20, 2015.

FORCES Industrial Advisory Board

- * May 2015 Meeting Participants
 - * Shaunak Bopardikar, UTRC
 - * Karen Fireman, Fireman Consultants
 - * Jim Paunicka, Boeing
 - * Bill Streilein, MIT Lincoln Labs
 - * Matt Wakefield, EPRI

Select IAB Feedback

- * Dr. Jim Paunicka
 - * Using the data to characterize performance, create models, system identification for privacy/IP protection
- * Dr. Shaunak Bopardikar
 - * Most applications are related to critical infrastructure. How would the fundamentals change if these concepts were to be applied to non-critical applications.
 - * For CPS privacy (or even security), it would be nice to understand why existing (or naïve) approaches would not apply or not work.
 - * It would be nice to see some performance versus security (or privacy) tradeoffs for such applications.

Select IAB Feedback (cont.)

- * Dr. Bill Streilein
 - * Consider more work to characterize the actual cyber threats in a quantitative way such that risk can be assessed
 - * Consider more work to explore how analytics on multi-modal data, potentially outside the normal domain of a CPS system can be leveraged to interpret data and potential discount compromised sensors
 - * While autonomy is very important as a goal, I think there should continue to be work on how humans interact with CPS systems, either for use or control

Select IAB Feedback (cont.)

- * Karen Fireman

- * Metrics – at some point we need to codify metrics that will help to define the matrix of probability vs. severity of attacks
- * Military – leverage concepts of attack and defense
- * Relate to the research presented about Waze & Google impacts (i.e., negative impacts) and the prevalence of the Nash Equilibrium

- * Matt Wakefield

- * Consider having each presentation include some perspective on how their research could be applied or will be applied would be helpful for the audience and also for the students to think about