



# FORCES

## Program Highlights

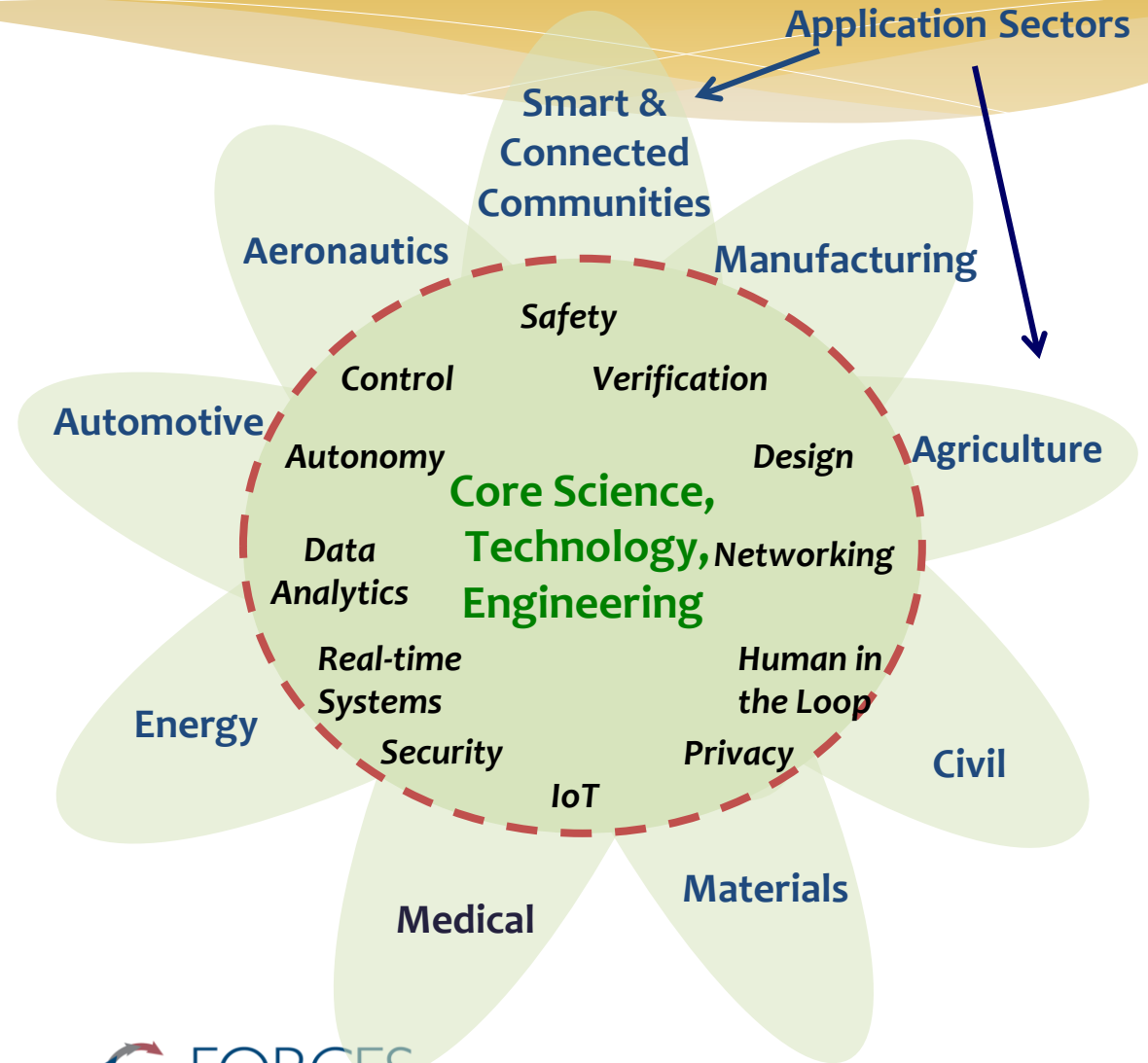
Larry Rohrbough, UC Berkeley

January 25, 2017



# FORCES & NSF CPS Research Model

- \* **FORCES Domains**
  - \* Energy
  - \* Ground transportation
  - \* Air transportation
  - \* Smart cities
- \* **FORCES Science**
  - \* Robust control
  - \* Reliability & safety
  - \* Human-CPS
  - \* Security & privacy
  - \* Systems & analytics
  - \* **Learning in CPS**



# Refinement of FORCES Agenda

**RC+EI**

**Integration  
& co-design**

2013

2014

**New Services  
& Markets:**

**Data, energy,  
mobility**

2015

2017

**Data analytics:**

**Humans + CPS**

**Privacy & security**

**Incentive regulation**

**Learning in  
CPS**

# FORCES Research Presented

- \* Robust control
  - \* Bayen, Hiskens
- \* Reliability & safety
  - \* Karsai, Balakrishnan
- \* Security & privacy
  - \* Amin, Koutsoukos, Teneketzis
- \* Systems & analytics
  - \* Schwartz
- \* Plus Young Researcher Talks...
- \* Learning in CPS
  - \* Sastry
    - \* Active information gathering and state estimation in human-cyber-physical systems (h-CPS)
  - \* Akametalu
    - \* Improved CPS reliability and robustness via learning-based model predictive control (LBMPC)
  - \* Sztipanovits
    - \* Beyond computation, control, and communications to CPS that can learn

# SĀF|ART|INT

- \* Workshop on Safety and Control for Artificial Intelligence (SĀF|ART|INT)
  - \* June 28, 2016, co-sponsored by OSTP and CMU
  - \* <https://www.cmu.edu/safartint/>
- \* Assurance of safety and control as systems interact with humans and their operating environment (operate in a safe and controlled manner)
- \* Focus on sectors such as vehicles, logistics, military systems, healthcare, financial services, and smart cities
  - \* Applications, safety requirements, big ideas
  - \* Algorithms, Intrinsic Safety, Explanations, Evaluations
  - \* Mathematical Models and Reasoning
  - \* Systems and Safety Engineering



**Carnegie  
Mellon  
University**

# Microsoft Faculty Summit

- \* Safe Autonomous Cyber Physical Systems Workshop 2016
  - \* July 15, 2016, part of Microsoft Faculty Summit 2016
  - \* <https://www.microsoft.com/en-us/research/event/safe-autonomous-cyber-physical-systems-workshop-2016/>
- \* Theme was how to define and invent a new level of safety for CPS
- \* Interdisciplinary approach to addressing challenges:
  - \* Perception, Sensing, Modeling
  - \* Controls, Planning, Decision-Making
- \* Industry and academia experts in ML, vision, planning, programming languages, and verification
- \* Talks, group discussions, technical demonstrations



Microsoft

# FORCES Education & Outreach

- \* Undergraduate Research & Education
  - \* Quantitative Sustainability Subject
    - \* Core subject in undergraduate curriculum for systems students
  - \* Mini-UROP CPS Projects
    - \* Hands-on research experience for freshmen
  - \* Capstone Network Resilience Design Projects
    - \* One-two semester long integrative design project (joint with MITLL and MTSI Inc.)
- \* Middle School/High School Education
  - \* Online Security Games @ MIT
    - \* Exploration / Orientation programs for middle school and high school/incoming freshman students (MIT Open House)
  - \* CYBEAR GenCyber Summer Camp
    - \* 2017 camp emphasis on CPS (energy, transportation, smart cities)
    - \* Student-lead instruction, hands-on exercises, capstone projects
    - \* Evaluations to measure impacts of education interventions on student knowledge, engagement, and interest in topics

# FORCES Knowledge Transfer

- \* International Collaborations

- \* Philippines (resilience of societal-scale CPS)
- \* Sweden (Kalle Johansson on sabbatical at Berkeley with Tomlin/Sastry)



- \* Technology Transition

- \* Berkeley – C3 IoT
- \* MIT/Berkeley – UTRC
- \* University of Washington
- \* Google
- \* Facebook





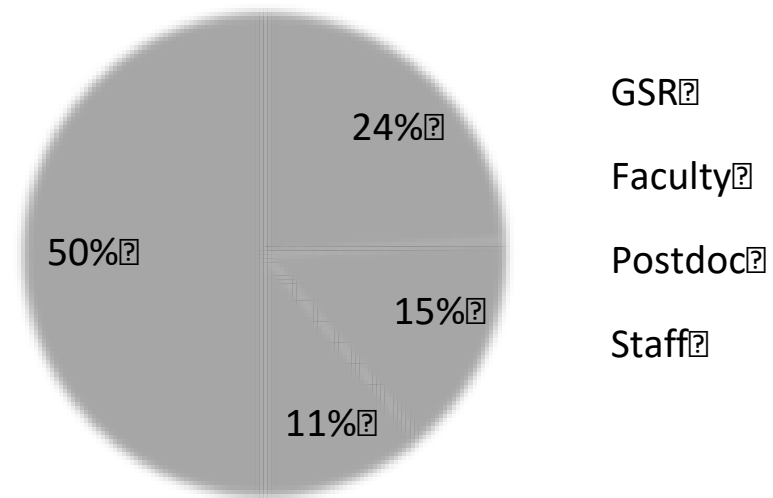
# The FORCES Team

- \* Total Participants = 54
  - \* Graduate Students = 27
  - \* Faculty = 13
  - \* Post Docs = 8
  - \* Staff = 6

- \* Demographics

- \* Female = 22%
- \* URM = 4%
- \* U.S. Persons = 56%

## FORCES Personnel (all institutions)



# FORCES Work Products

## (2016)

94 Total Publications (67 conference/workshop, 27 journal)

### Prominent Conferences...

- \* Control: American Controls Conference (ACC), IEEE Conference on Decision Control (CDC)
- \* Security: ACM Workshop on Moving Target Defense, ACM Conference on Computer and Communications Security (CCS), Network and Distributed System Security (NDSS) Symposium, USENIX Security Symposium
- \* CPS: ACM International Conference on Embedded Systems for Energy-Efficient Building Environments, ICCPS
- \* Other: Allerton, NetEcon, USA/Europe Air Traffic Management Seminar, ICML

### Prominent Journals...

- \* Automatica
- \* IEEE Transactions on Automatic Control
- \* IEEE Transactions on Control of Networked Systems
- \* IEEE Transactions on Control Systems Technology
- \* IEEE Transactions on Dependable and Secure Computing
- \* IEEE Transactions on Human-Machine Systems
- \* IEEE Transactions on Intelligent Transportation Systems
- \* IEEE Transactions on Network Control Systems
- \* IEEE Transactions on Power Systems
- \* International Journal of Electrical Power and Energy Systems
- \* Mathematics of Operations Research
- \* SIAM Journal on Control and Optimization
- \* Water Resource Research