WEBINAR:
2014 Cyber-Physical Systems (CPS) Program

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Welcome

- **Farnam Jahanian** – NSF Assistant Director for Computer and Information Science and Engineering

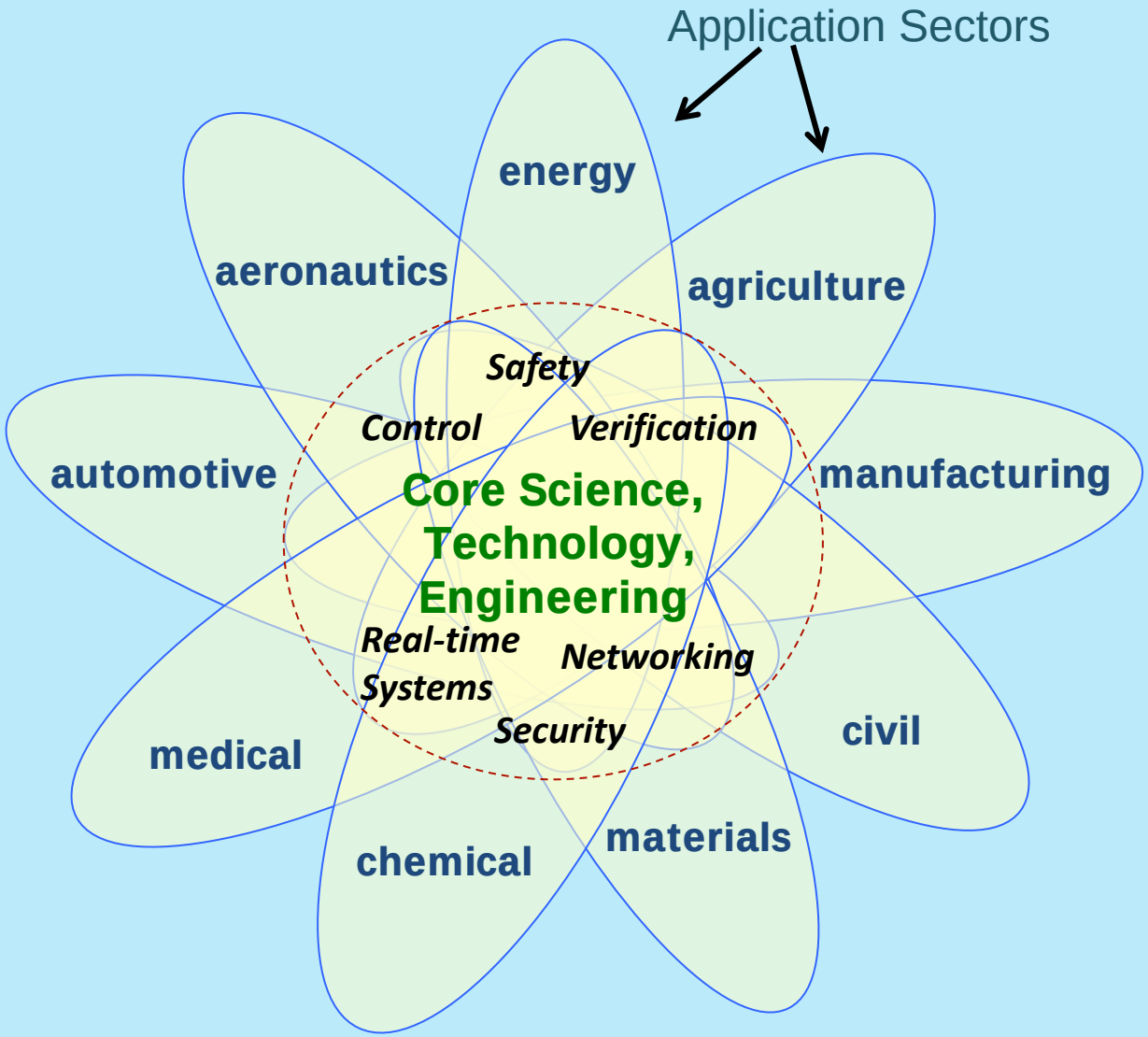
- **Pramod Khargonekar** – NSF Assistant Director for Engineering

Outline

- Welcome
- Overview of the NSF CPS Program
- 2014 Solicitation
- Submitting proposals
- FAQ’s
- Program contacts

CPS Overview: The CPS model

- Abstract from application sectors to more foundational principles
- Apply these principles to problems in new sectors
- Build a new CPS community
- Encourage other communities to join



CPS Overview: Typical characteristics of CPS

- Cyber capability in every physical component
- Networked at multiple and extreme scales
- Complex at multiple temporal and spatial scales
- Dynamically reorganizing/reconfiguring
- High degrees of automation, control loops must close at many scales
- Unconventional computational, physical substrates, or platforms (Bio? Nano?)
- Operation must be dependable, certified in some cases
- Closing the loop – especially at real-time rates in systems that are safety critical

Important factors: Highly networked, cooperative control, multiple spatial and temporal scales. Mixed initiative with varying time scales.

CPS Overview: Program goals and principles

- Develop the core system science needed to engineer complex cyber-physical systems upon which people can depend with high confidence
- Foster a research community committed to advancing research and education in CPS
- Accelerate the realization of cyber physical systems in a wide range of applications through the development of methods, tools, and hardware and software components based upon cross-cutting principles, along with validation of the principles via prototypes and test-beds
- Transition CPS science and technology into engineering practice

CPS Overview: Recent community activities (2013-2014)

- CPS Meetings:
  - CPS PI Meeting (10/2013)
  - CPS Reference Architecture Meeting (3/2014)
- CPS Workshops:
  - CPS Energy Workshop (12/2013)
  - CPS Transportation Workshop (1/2014)
  - CPS Medical Workshop (2/2014)
  - CPS Aspiring PI Workshop (2/2014)
  - CPS Early-Career Workshop (3/2014)
- Information on all CPS community activities can be found on the CPS Virtual Organization at www.cps-vo.org

2014 CPS Program: Solicitation

- 2014 CPS Program Solicitation published on March 5th, 2014
- Submission window: May 19th, 2014 – June 2nd, 2014

2014 CPS Program: Major changes to solicitation

- 2014 solicitation, for the first time is multi-agency:
  - Department of Homeland Security (DHS) – Science and Technology Directorate (S&T) Homeland Security Advanced Research Project Agency (HSARPA)
  - Department of Transportation (DOT)- Federal Highway Administration (FHWA)/ Intelligent Transportation Systems (ITS) Joint Program Office (JPO)
- Identify early-stage CPS research that addresses important needs of mission agencies and has potential for accelerated maturation
- Transition to Practice (TTP) option:
  - Supplemental support to proposed research “whose outcomes at the end of the award are capable of being implemented, matured, applied, experimentally useable, or demonstrated as a useable capability”
  - Available for each class of award
- Page lengths slightly revised (15 pages for Breakthrough and Synergy, 20 pages for Frontier)

2014 CPS Program: Research challenges

The CPS Program seeks to address foundational issues central across CPS applications including but not limited to:

- ***System Design*** -- How do we design CPS to be ***safe, secure, and resilient*** in a variety of unanticipated and rapidly evolving environments and disturbances? How do we integrate privacy and security into CPS design?
- ***System Verification*** -- How do we develop effective metrics and methods to rapidly ***verify and certify*** very large and complex CPS? What technologies enable incremental certification? How can we preserve safety yet dramatically reduce the "test space" when it comes to manned, unmanned, and mixed authority systems spanning a variety of disciplines?

2014 CPS Program: Research challenges

- ***Real-time Control and Adaptation*** -- How do we ***achieve real-time dynamic control and behavior adaptation*** in a diversity of environments such as clouds, as well as in network-challenged spaces? How can CPS leverage "big data" in real-time control?
- ***Producing Integrated software – hardware systems*** -- How can core CPS technologies in communication, computation, and real-time control be harnessed to provide expanded and effective access to means of conceiving of new products, reducing product concepts to realizable designs, and ***vastly reduce timelines for design, build, test, and verify?***

2014 CPS Program: Research interests

A CPS proposal's core research activity should address research challenges in **at least one** of the following "*research target areas*":

- **Science of CPS:** New models and theories that unify perspectives, capable of expressing the interacting dynamics of the computational and physical components; able to support composition, bridge the computational versus physical notions of time and space, cope with uncertainty, and enable cyber-physical systems to interoperate and evolve.
- **Technology for CPS:** New design, analysis, and verification tools; new building blocks, including hardware computing platforms, operating systems, and middleware; enable evidence-based certification, and to maintain certification as the system evolves.
- **Engineering of CPS**: Rethink principles and methods of systems engineering. Attention given to system architectures, designs, and integrations as well as the exploration of design spaces that will produce certifiably dependable systems.

2014 CPS Program: DOT-FHWA program interests

- DOT-FHWA is interested in foundational technologies that can accelerate innovation, reduce cost, and lower risk of technology adoption.
- Two primary areas are of interest where a coordinating investment with NSF would best advance both the fundamental science of CPS and speed the application of scientific advances into the highway industry: **Enabling technology** and **scaling cyber-physical highway systems**.

2014 CPS Program: DHS S&T - HSARPA program interests

DHS S&T - Homeland Security Advanced Research Agency (HSARPA) is interested in **security technologies** relevant to cyber-physical systems. Particularly:

- CPS security technologies related to transportation, emergency response, energy, and healthcare
- Relevant technologies include:
  - Cybersecurity approaches for guarding against malicious attacks on CPS as well as diagnostics and prognostics that aim to identify, predict, and prevent or recover from faults
  - Validation, verification, and certification that speed up design cycles while ensuring high confidence in system safety and functionality

2014 CPS Program: Proposal types

- **Breakthrough** - significant advance in fundamental CPS research with potential to change the field. New approaches to bridge computing, communication, and control.
  - Up to $500,000 over 3 years.
- **Synergy** - innovation at the intersection of multiple disciplines, to accomplish a clear goal that requires an integrated perspective spanning the disciplines.
  - Up to $1,000,000 over 3 to 4 years.
- **Frontier** - clearly identified critical CPS challenges that cannot be achieved by a set of smaller projects.
  - Up to $7,000,000 over 4 to 5 years.
- CPS **CAREER** grants considered as part of NSF CAREER solicitation (NSF 14-532).

2014 CPS Program: Transition to Practice (TTP) Option review criteria

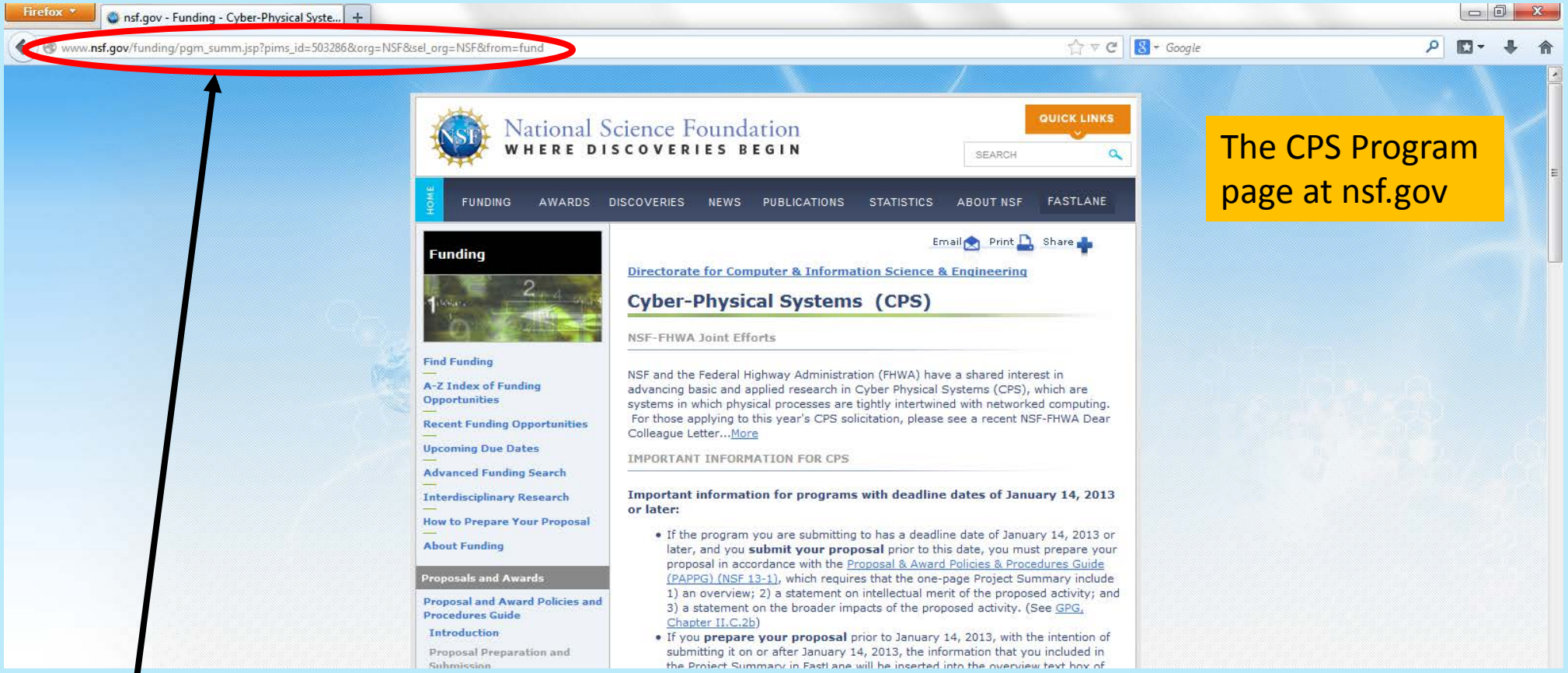
- Expected impact on the deployed environment
- Extent to which the value of the proposed CPS research and development is described in the context of a needed capability and potential impact
- Feasibility, utility, and interoperability of the capability
- Plan for accomplishing the transition
- Tangible metrics to evaluate the success of the capabilities developed, and the steps necessary to take the system from prototype status to production use
- The appropriateness of the budget

CPS Proposals: Formulating your research ideas

Is your idea a good fit for the CPS program?

- CPS research must involve both the cyber (sensing, communication, computing) and physical (sensing, control).
- Essential to include a control component - i.e., close the loop, at real-time if possible, otherwise close to real-time.
- Idea can start from an application, but CPS research must be in the foundational science (i.e., applicable in multiple domains).
- Vice-versa, research idea can begin by answering difficult theoretical problems, but a successful CPS proposal must be able to identify a motivating application (i.e., how the results can benefit society).
- Read the solicitation including the additional review criteria carefully!

CPS Proposals: Resources at nsf.gov



The CPS Program page at nsf.gov

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503286&org=NSF&sel_org=NSF&from=fund

CPS Proposals: Resources at nsf.gov

Useful links at the bottom of CPS Program page

"What Has Been Funded (Recent Awards Made Through This Program, with Abstract"

Questions may also be e-mailed to:
cpsquestions@nsf.gov

Thank you for listening!

FAQ's

- Question:
  - How can industry participate in a CPS proposal beyond their support through a letter of commitment?

- Answer:
  - Industry can participate in a university proposal as a sub-awardee.
  - Industry cannot submit a separate proposal.

FAQ’s

- Question:
  - Can my proposal fund international collaborators?

- Answer:
  - Under most circumstances, no.
  - Please contact a Program Director for additional information.

FAQ's

- Question:
  - What does multi-agency solicitation mean for proposal review process?

- Answer:
  - All proposals still submitted to NSF
  - Agencies will contribute panelists
  - NSF panel review process will continue unchanged.
  - Inter-agency transfer of funds will take place.

FAQ's

- Question:
  - Can we submit a domain specific proposal? E.g., Smart Grid?

- Answer:
  - Proposals need to consider holistic, integrative approaches to cyber-physical systems that are applicable to more than one application domain.

CPS Program: Points of contact

Agency	Point of Contact	Email Address
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Final words

- Check the NSF CPS program webpage for program updates: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503286.

- Please consider serving on CPS review panels. If you know of individuals who may be willing and able to serve on CPS Panels, please send us their names.

- E-mail questions to cpsquestions@nsf.gov.