



National Science Foundation
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Cyber-Physical Systems (CPS) Solicitation Frequently Asked Questions

- [What are the primary objectives of the CPS program?](#)
- [What are examples of cyber-physical systems?](#)
- [How can I determine whether a particular topic is suitable as a CPS proposal?](#)
- [What is the relationship between CPS and the traditional CISE and ENG core programs?](#)
- [What is the relationship between the CPS program and Cyber-enabled Discovery and Innovation \(CDI\) program \(NSF 08-604\)?](#)
- [Is it necessary for the PI \(or co-PI\) of a proposal to be from computer science?](#)
- [How substantial does the computer science content have to be?](#)
- [Must a proposal address both cyber and physical systems?](#)
- [Will the proposal review panels consist of both computer science researchers and engineering researchers?](#)
- [Will the CPS program support work on specific applications?](#)
- [I work in area X, which I believe is relevant to cyber-physical systems, but X is not mentioned in the solicitation. Should I submit a proposal to the CPS program to do research in X?](#)
- [I have a Large project to propose. Should I submit to CPS or Expeditions in Computing \(NSF solicitation 08-568\)?](#)
- [How many Large projects will be funded?](#)
- [I would like to be a reviewer for CPS. How can I volunteer to be a reviewer?](#)
- [Can I be a reviewer for the CPS program if I submit a proposal?](#)
- [Do CPS proposals count against the CISE limits of at most 2 CISE core and 2 CISE cross-cutting proposals per year?](#)
- [Will the CPS program fund equipment for experimental research?](#)
- [Can industry be involved in a CPS project?](#)
- [Does CPS allow international cooperation?](#)
- [How do I determine whether my proposal is "Small" or "Medium"?](#)
- [Should I discuss my proposal with NSF program officers?](#)
- [What types of health- and biology-related proposals are allowed?](#)
- [Are Research in Undergraduate Institutions \(RUI\) proposals allowed/encouraged?](#)
- [Why and how was the CPS program created?](#)
- [Where does the funding for CPS program come from?](#)

Additional Information/Links

- [CPS Information Day](#)
- [Other workshops and information meetings relevant to CPS](#)

1. What are the primary objectives of the CPS program?

As stated in the solicitation: "The CPS program aims to reveal cross-cutting fundamental scientific and engineering principles that underpin the integration of cyber and physical elements across all application sectors. The CPS program will also support the development of methods and tools as well as hardware and software components, run-time substrates, and systems based upon these principles to

expedite and accelerate the realization of cyber-physical systems in a wide range of applications. ... Furthermore, the program aims to create a new research and education community committed to the study and application of cyber-physical system innovations."

2. What are examples of cyber-physical systems?

Some examples are listed in the solicitation. Additional examples can be found in the reports of the several CPS Workshops listed at the end of this Q&A list. In particular, several examples of CPS domains and applications are listed in the Executive Summary from the CPS Summit, available on the [CPS Summit website](#). Note that these lists of examples and domains are not meant to be exhaustive, only suggestive. Proposals addressing CPS issues in other domains are welcome.

3. How can I determine whether a particular topic is suitable as a CPS proposal?

A good place to start after reading the solicitation is to review the information presented at the [CPS Information Day](#) on December 15, 2008. The CPS Information Day presentations include examples of the topics and kinds of projects that the CPS program would like to support. These are only examples, however. Some of the Q&A below will help you decide whether to submit your proposal to CPS or other programs. Remember that you are always encouraged to speak with an NSF program officer before submitting your proposal.

4. What is the relationship between CPS and the traditional CISE and ENG core programs?

The focus on cross-cutting fundamental science and engineering to support the tight integration of cyber and physical elements for multiple application domains distinguishes the CPS program from the traditional core programs in NSF. Although advances in CPS will most certainly build in part on concepts and tools from existing disciplines, the CPS program seeks to support the novel, transformative use of these concepts and tools to realize a *new* systems science for CPS. A proposal for research focusing exclusively on a traditional topic that falls within the scope of an existing core program should be submitted to that core program. Such proposals *will not be funded* by the CPS program. If in doubt, consult with one of the CPS program officers.

5. What is the relationship between the CPS program and Cyber-enabled Discovery and Innovation (CDI) program ([NSF 08-604](#))?

Although the CPS and CDI solicitations share some common themes, they are distinct in purpose and emphasis. The CDI program seeks to support research that leads to innovative advances in computational thinking to realize novel methods for discovery and innovation in any domain. In contrast, the CPS program seeks proposals that address the tight integration of cyber technology (computation, communication, control) and the physical world. This includes new computational models and methods that enable innovation and lead to next generation natural and engineered systems that truly meld the cyber and physical and result in systems that "our lives can depend on." CPS proposals must address one or more of the three CPS themes: Foundations; Methods and Tools; and Components, Run-time Substrates, and Systems.

6. Is it necessary for the PI (or co-PI) of a proposal to be from computer science?

No, there is no such requirement. The particular departmental affiliations of the PIs are not the important point. What matters is the background and expertise of the PIs relative to the proposed work and the objectives of the CPS program.

7. How substantial does the computer science content have to be?

Clearly computer science expertise is important to many issues in CPS, but the degree to which the proposal draws on computer science will depend on the problems being addressed and the approaches to be taken. One of the objectives of the CPS program is to address the gaps between the cyber and physical. Therefore, it is expected that every proposal will address the interplay between these two. To this end, each proposal needs to make its case about the relevance of the proposed research to CPS and the expertise of the PIs to undertake the proposed project.

8. Must a proposal address both cyber and physical systems?

Yes. Successful CPS proposals must focus on the integration of cyber and physical elements. Proposals focusing exclusively on cyber systems or exclusively on physical systems *will not be funded* in the CPS program. For example, a proposal for building software to study/analyze/design strictly physical systems or strictly software systems is not appropriate for a CPS proposal. Software for CPS would support computational and communication resources that are tightly conjoined and coordinated with physical resources in a variety of CPS application domains.

9. Will the proposal review panels consist of both computer science researchers and engineering researchers?

Review panels will be comprised of individuals with the expertise appropriate to evaluate the merits of the proposals assigned to the panel. Panels will include reviewers with expertise in appropriate areas of computer science and engineering and relevant application domains.

10. Will the CPS program support work on specific applications?

A proposal to do research in any application domain should explain why the domain is relevant to cyber-physical systems, how the proposed research contributes to the broader CPS agenda, its potential to advance the state of the art toward realizing a new systems science for CPS, and what the anticipated innovation consequences will be. As mentioned above, research focusing exclusively on a topic covered by an existing NSF core program should be submitted to that program. For example, a proposal focusing exclusively on kinematics for robotics may be appropriate as a core program proposal, not a CPS proposal. A CPS proposal should advance the fundamental science and engineering combining cyber and physical components and lead to systems ideas/architectures that are applicable to a variety of CPS sectors (i.e., not just in one application sector, in this case robotics, but also to some other application sector, e.g., transportation or the power grid).

11. I work in area X, which I believe is relevant to cyber-physical systems, but X is not mentioned in the solicitation. Should I submit a proposal to the CPS program to do research in X?

Specific examples of cyber-physical systems mentioned in the solicitation are only offered as suggestions and illustrations. The list is not meant to be exhaustive. Proposals in areas not mentioned in the solicitation are welcome and strongly encouraged (subject to the guidelines given in other Q&As).

12. I have a Large project to propose. Should I submit to CPS or Expeditions in

Computing ([NSF solicitation 08-568](#))?

Investigators must make their own decision about whether or not to submit their research ideas to a particular solicitation. Make sure your proposal addresses the aims of the program you choose. Crucial issues to consider are the size, scope, and aims of the proposed effort. In particular, determine whether your project fits better with the aims and constraints outlined in the CPS solicitation.

13. How many Large projects will be funded?

The Large proposal category is anticipated to be extremely competitive, consequently only the highest quality proposals that address the objectives and scope of CPS will be awarded.

14. I would like to be a reviewer for CPS. How can I volunteer to be a reviewer?

Review panelists are crucial to the NSF award process, and we definitely appreciate hearing from volunteers. The best way to get involved is either to send a message indicating your interest in being a reviewer to one of the NSF CPS program directors or to respond promptly to any emails asking for reviewers and days of availability. Invitations to serve on a CPS review panel will be based on the expertise needed for each panel, conflict of interest rules, and other factors as relevant.

15. Can I be a reviewer for the CPS program if I submit a proposal?

The CPS management plan allows the *possibility* (assuming no other conflicts of interest exist) that proposers in one CPS category (e.g., Small) may serve as reviewers for CPS proposals submitted in other categories (e.g., Medium and Large).

16. Do CPS proposals count against the CISE limits of at most 2 CISE core and 2 CISE cross-cutting proposals per year?

CPS is an NSF cross-cutting program (rather than a CISE-only cross-cutting program), so the limits for CISE-only solicitations are not applicable. However, the CPS solicitation does state the following limitation for proposals to the CPS program: "An individual may participate as PI, co-PI, or Senior Personnel in no more than 2 proposals submitted in response to this solicitation in any annual competition."

17. Will the CPS program fund equipment for experimental research?

Funding for equipment for experimental research can be included in the budgets for CPS proposals. CPS is not an infrastructure program, however, so proposals and budgets that are primarily for the purpose of buying equipment *will not be funded* in the CPS program. Equipment requests must be well justified for the proposed research and the amount of money allocated for equipment should be reasonable relative to the overall size of the budget. In any case, the budget total must fall within the specified limits for the type of project being proposed (Small, Medium, or Large). Proposals for experimental work that requires equipment should justify the particular experimental platforms being proposed, including a justification for the cost. Proposals should also explain why the equipment needs to be purchased under the budget for this project rather than being available through other sources.

18. Can industry be involved in a CPS project?

Although industry participation is *not required* and the lack of industry participation

will not be a negative factor in the review process, the CPS team recognizes the importance of industry involvement, particularly in CPS challenge applications, and strongly encourages collaboration with industry. Not only does CPS encourage industry involvement with research projects, the CPS program also hopes to fund a CPS Virtual Organization (CPS-VO), which will recruit industry participants and support activities to provide industry perspectives on emerging CPS applications and identify opportunities for industrial collaboration and technology transfer. It is important to note, however, that the [CPS solicitation](#) does not provide funding for the support of industry participants; the solicitation points in [Section II](#) to *other* NSF programs that provide such support.

19. Does CPS allow international cooperation?

Yes. NSF encourages interaction with the international research community. The NSF routinely supports collaborative research efforts with other nations around the world. For such international collaboration, NSF normally supports the U.S. participants and the international participants are supported by their respective countries. Requests for funds for international collaboration must be justified, including the scope and relevance to CPS objectives.

20. How do I determine whether my proposal is "Small" or "Medium"?

Project teams must identify their own proposal types, based on the guidelines given in the solicitation. It is anticipated that Small awards will support efforts up to a level roughly comparable to: summer support for one or two investigators (generally with complementary expertise); one or two graduate students; and their collective research needs (e.g., materials, supplies, travel) for three years. Medium awards are anticipated to support larger efforts up to a level roughly comparable to: summer support for two to three investigators, normally with complementary expertise; three graduate students; one or two senior personnel (including post-doctoral researchers and staff); and their collective research needs (e.g., materials, supplies, travel) for three years. The integrative contributions of the Medium team should clearly be greater than the sum of individual researchers working on their own.

21. Should I discuss my proposal with NSF program officers?

It is recommended that you discuss your planned proposal for CPS with a program officer. The discussion will be limited to the *suitability* of the proposal for the CPS solicitation, and not on the intellectual merit and broader impacts of the proposal. Furthermore, once submitted, proposals may not be discussed with NSF officers, as this would constitute unfair competition, or the perception thereof.

22. What types of health- and biology-related proposals are allowed?

NSF CISE and ENG Directorates fund bio-engineering, biomedical-engineering and health informatics research. Applications to medicine (e.g., embedded medical devices, robotic- and tele-surgery) and healthcare (e.g., operating rooms of the future, patient monitoring) are important CPS challenges. The specific guidelines from the NSF Grant Proposal Guide (NSF 09-1) are: "Research with disease-related goals, including work on the etiology, diagnosis or treatment of physical or mental disease, abnormality, or malfunction in human beings or animals, is normally not supported. Animal models of such conditions or the development or testing of drugs or other procedures for their treatment also are not eligible for support. However, research in bioengineering, with diagnosis- or treatment-related goals, that applies engineering principles to problems in biology and medicine while advancing engineering knowledge is eligible for support. Bioengineering research to aid persons with disabilities also is eligible."

23. **Are Research in Undergraduate Institutions (RUI) proposals allowed/encouraged?**

RUI proposals are encouraged, but require special documentation. See the "Supplementary Documents for Institutions that have RUI Eligibility" in [Section V.A.](#) (Proposal Preparation Instructions) of the solicitation for more details.

24. **Why and how was the CPS program created?**

The program was the result of a series of NSF and inter-agency studies and workshops that considered gaps and research needs in the cross-cutting science and technology required for innovation in capable, safe, and assured cyber-physical systems. Many of these workshops are listed below, at the bottom of this Q&A list. NSF Directorate, Division, and Program officials provided a summary overview of the aims of the CPS program and its history as part of the public CPS Information Day held on December 15, 2008. For your information, these presentations are available at the [CPS Information Day website](#).

25. **Where does the funding for CPS program come from?**

CPS is being jointly funded through the CISE and Engineering Directorates.

ADDITIONAL INFORMATION/LINKS

CPS Information Day

- "[CPS Information Day](#)," December 15, 2008, Arlington, VA.

Other workshops and information meetings relevant to CPS

- "[High Confidence Medical Device Software and Systems \(HCMDSS\)](#)" Workshop, June 2-3, 2005, Philadelphia, PA.
- National Workshop on "[Aviation Software Systems: Design for Certifiably Dependable Systems](#)," October 5-6, 2006, Alexandria, TX.
- NSF Workshop on "[Cyber-Physical Systems](#)," October 16-17, 2006, Austin, TX.
- National Meeting on "[Beyond SCADA: Networked Embedded Control for Cyber Physical Systems](#)," November 8-9, 2006, Pittsburgh, PA.
- National Workshop on "[High-Confidence Software Platforms for Cyber-Physical Systems \(HCSP-CPS\)](#)," November 30 - December 1, 2006, Alexandria, VA.
- NSF Industry Round-Table on Cyber-Physical Systems, May 17, 2007, Arlington, VA.
- "[Joint Workshop On High-Confidence Medical Devices, Software, and Systems \(HCMDSS\) and Medical Device Plug-and-Play \(MD PnP\) Interoperability](#)," June 25-27, 2007, Boston, MA.
- National Workshop on "[Composable and Systems Technologies for High-Confidence Cyber-Physical Systems](#)," July 9-10, 2007, Arlington, VA.
- National Workshop on "[High-Confidence Automotive Cyber-Physical Systems](#)," April 3-4, 2008, Troy, MI.
- "[CPSWeek](#)," April 21-24, 2008, St. Louis, MO.

- "[CPS Summit](#)," April 25, 2008, St. Louis, MO.
- "[The First International Workshop on Cyber-Physical Systems](#)," International Conference on Distributed Computing Systems (ICDCS), June 20, 2008, Beijing, CHINA.
- "[Workshop on Security and Privacy in Cyber-Physical Systems](#)," sponsored by the Army Research Office, June 26-27, 2008, University of California at Irvine, Irvine, CA.
- "[Robotics and Cyber-Physical Systems](#) Special Sessions" at the IEEE/RSJ 2008 International Conference on Intelligent Robots and Systems (IROS 2008), September 24, 2008, Nice, FRANCE.
- [Workshop on Cyber-Physical Systems: Closing the Loop](#), Embedded Systems Week 2008, October 23, 2008.
- National Workshop on "[Research on Transportation Cyber-Physical Systems: Automotive, Aviation, and Rail](#)," November 18-20, 2008, Washington, DC.