THE HIGH CONFIDENCE SOFTWARE AND SYSTEMS COORDINATING GROUP
FEDERAL NETWORKING AND INFORMATION TECHNOLOGY RESEARCH & DEVELOPMENT SUBCOMMITTEE
COMMITTEE ON TECHNOLOGY OF THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

National Workshop for Research on Transportation Cyber-Physical Systems: Automotive, Aviation, and Rail

November 18-20, 2008
Washington, DC (USA)

http://www.ee.washington.edu/research/nsl/aar-cps

CALL FOR POSITION PAPERS

WORKSHOP PURPOSE, OBJECTIVES, AND FOCUS AREAS

Cyber-physical systems (CPS) represent a vision of future systems in which computation and control are deeply and pervasively embedded into physical and engineered components of systems, and networked at every scale, to advance system capabilities and performance. The purpose of this workshop is to provide an open forum for leaders and visionaries from industry, research laboratories, academia, and Government to identify shared development and deployment needs and opportunities for future CPS in the aviation, automotive, and rail sectors. The ultimate goal is to develop a common science and technology research agenda for CPS across and within the transportation sectors, as well as other sectors.

A CPS integrates control, computing, communication, and storage capabilities with physical and engineered entities that possess physical-world dynamics, in order to sense, monitor, and control them. It must do so dependably, safely, securely, efficiently, and in real-time. It may require certification of safety and security. Engineering co-design of the cyber and physical components is central to CPS.

The workshop objectives are: to define a coherent and compelling vision that supports both the shared and separate needs of the sectors, to highlight the technical and scientific challenges, and to identify promising approaches. Although the focus of this workshop is on transportation, representatives of other CPS-intensive sectors, such as medical devices and systems, energy systems, other infrastructures, and environmental systems, are welcome to participate.

The workshop format will be discussion-oriented with specific goals to:

a. Recognize the core limitations in building today's automotive, aviation, and rail CPS—particularly those CPS challenges that are common to all transportation sectors

b. Determine cyber-physical advances that can produce significant societal and economic impact

c. Understand the core technical challenges that must be addressed, and technical infrastructure that must be established, to enable future automotive, aviation, and rail CPS

d. Compare and contrast issues from related domains including transportation/aerospace, medical device, and energy sectors

e. Identify cross-domain (electrical, control, system, mechanical, software) improvements for developing CPS correctly and quickly

f. Pinpoint new applications, innovations, and powerful cross-layer abstractions that will satisfy the challenging requirements of future CPS

g. Identify potentially transformative technologies that will enable yet-to-be determined capabilities

h. Outline the required educational curricula and programs to prepare the workforce to address the cyber-physical challenge in the automotive, aviation, and rail domains

Our aim is to invite all relevant stakeholders, including researchers, developers, and users, who can help to identify emerging systems and assurance needs.

Transportation CPS must be dependable, secure, safe, and efficient and operate in real-time. They must also be scalable, cost-effective, and adaptive. They must seamlessly integrate operations in the cyber-computing and communications domain with actions and events in the physical world.

This workshop will focus on promising solutions (methodologies, techniques and approaches) to satisfy these requirements, with primary emphases on innovations in observation and manipulation of the physical world, novel integration of sensors and actuators with computing and communications hardware capabilities, security, a scalable and reliable software infrastructure tailored to the needs of CPS, application domain-specific advances in control/hybrid systems and signal processing that enable end-to-end operation, and the design and development of high-impact applications. In particular, abstractions and techniques that span multiple layers (including the physical world) are of special interest. A reference architecture that can support a range of CPS is also of interest. A secondary objective is to propose core elements of a new lexicon to capture the new thinking underlying the novel scope and cross-cutting disciplinary nature of CPS to drive future innovation.

In summary, topics of interest include:

- Grand Challenges for transportation Cyber-Physical Systems (common challenges as well as sector specific ones)
- Requirements of common and sector specific Cyber-Physical Systems
- Architectures for common and specific Cyber-Physical Systems
- Technical Challenges associated with interfacing to and interacting with the Physical World
- Innovations, Ideas, Abstractions and Terminology for Cyber-Physical Systems

BACKGROUND

CPS science and technology will allow the rapid and reliable development and integration of computer- and information-centric physical and engineered systems. This represents a new generation of engineered systems that are highly dependable, efficiently produced, and capable of advanced real-time performance in information, computation, communication, and control. Most sectors have not yet taken a CPS view of their systems.

As an example, the automotive sector is a rich target for emerging innovations in CPS. Thanks to tens of electronic control units (ECUs), sensors and actuators now deployed in modern automobiles, features such as adaptive cruise control, lane departure warning, automated parallel parking, and traction control have become feasible. Nevertheless, the design and development of these features tend to be traditional in nature, and extensive testing must be conducted to deliver assurance at a significant cost. Even with extensive advances in mechanical safety and growth in passive safety devices, such as airbags, the auto industry continues to pursue methods to reduce the occurrence of injury. About 42,000 fatalities and 1.5 million injuries occur every year on U.S. roads from automobile accidents representing opportunities for societal improvement. Delays due to traffic congestion waste enormous amounts of user productivity and finite energy resources. Alternative designs and energy sources driven by user demand and new CAFÉ requirements also necessitate complex real-time control. This need to improve how automobiles are designed also applies to how they are manufactured. Automotive manufacturing is a substantial part of the North American economy accounting for close to 2 percent of the U.S. private sector gross domestic product.

Similarly, the aviation sector is challenged by the need for a Next Generation airspace, in which many classes of air vehicles can interoperate safely with increased autonomy, and new airspace capacity and operational models can enable decentralized airspace management. These innovations will require dependable software for the aircraft avionics as well as the airspace management system. If the physical limitations of the behavior of the aircraft are known, they can inform the software development as well as the required distance separation between aircraft. Communication between aircraft will be paramount in a decentralized system, and emphasizes the dependencies on networked systems as well as their security.

Both freight and passenger rail systems are seeing increased demands for service because of their inherent fuel efficiency and safety. Because it is not probable that significant new track lines will be laid in the foreseeable future, the current infrastructure will see an increased density of usage. This increase poses significant challenges to the logistics of operation and to the safety, durability and integrity of the system. The most effective means of dealing with these issues is to create a multi-domain CPS that integrates dispatch centers, maintenance operations, track, signals, individual cars and trains as a unified dynamic system that operates optimally according to real-time conditions. Such a system is essential if passenger, commuter and freight rail systems are to continue to operate at increasing densities on overlapping infrastructures. Trains should be capable of communicating track condition to centralized control centers that could then determine optimal speeds for trains in the system to avoid bottlenecks at sidings on single track lines, locomotive power and braking should synchronize with individual car braking to optimize train dynamics and reduce power consumption and wear on track and wheels. Careful monitoring of the train-track dynamics together with real-time simulation of system performance can provide the guidance needed to achieve zero reactive maintenance, stable train dynamics and reduced damage during derailments.

The synergies between the automotive, aviation, and rail CPS have led to this transportation workshop to continue the momentum produced by prior automotive (see http://varma.ece.cmu.edu/auto-cps) and aviation (see http://chess.eecs.berkeley.edu/hcssas) meetings, and to provide a forum to exchange new research and development results by the emerging community of researchers, developers, regulators, users, and manufacturers.

POSITION PAPER PREPARATION AND SUBMISSION INSTRUCTIONS

Due to the workshop's ambitious schedule, position papers are requested by **OCTOBER 21, 2008** (extended)**.** Notifications will be sent by **OCTOBER 28, 2008**. Position papers should be at most three pages in length and printed in a 12-point font on 8-1/2x11 inch paper. Each position paper should address two to four of the workshop topics listed above. Each topic should address one or more of the following questions:

1. What are three fundamental limitations in the design and implementation of today's automotive, aerospace and rail CPS?
2. What are the three most important research challenges?
3. What are promising directions?
4. What innovations and abstractions should be considered for future transportation CPS?
5. What are possible milestones for the next 5, 10 and 20 years?

In addition, each position paper should include at most a half-page bio, organization/affiliation, email address, and phone number for each author. The bios are included in the 3-page limit.

Submissions are accepted in the PDF format using the submission page on the workshop website, by OCTOBER 21, 2008. Please use corresponding author's last name as the filename for the uploaded file. Please note that submitted position papers will be available on-line, and authors are advised not to include any proprietary information that they do not wish to be publicly disseminated.

ATTENDANCE AND PARTICIPATION

Workshop attendance is by invitation only. Anyone interested in participating in the workshop is encouraged to submit a position paper addressing the questions outlined above by **October 21, 2008**. The position papers will be used to identify session topics and some of the speakers as well as report writers. Notifications will be sent by **October 28, 2008** and will include information of the roles they will be asked to play. Government representatives interested in being invited to attend as participants or observers are asked to submit a brief biography with a few sentences describing past or current interests in CPS.

DELIVERABLE

The workshop will result in a comprehensive report capturing prioritized research challenges (findings), research needs to address challenges, prioritized recommendations, and suggested input to the development of a roadmap to determine what, when, and how these priorities should be addressed over an identified time frame. The organizers will deliver a report to the National Science Foundation that summarizes the workshop's findings, and that will be made widely available through the workshop website. Invitees will have the opportunity to provide additional inputs that may be of use in preparing the report, beyond white papers.

IMPORTANT DATES

October 21, 2008:	Submission Deadline (extended)
October 28, 2008:	Notification of Acceptance/Rejection
November 18-20, 2008:	Workshop

VENUE

The workshop will be held at the Sheraton Premiere at Tysons Corner located at 8661 Leesburg Pike, Vienna, Virginia 22182, (703) 448-1234. (See http://www.starwoodhotels.com).

WEBSITE INFORMATION

The workshop Web site http://www.ee.washington.edu/research/nsl/aar-cps/ provides up-to-date information. If you wish to be put on the workshop mailing list, please contact the workshop organizers at king@nitrd.gov.

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