The University of Georgia

August 18, 2017

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Undergraduate Student Representative – TBA
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Dear Colleagues:

The attached proposal from the College of Engineering for a new Center for Cyber-Physical Systems will be an agenda item for the August 25, 2017, Full University Curriculum Committee meeting.

Sincerely,

Alison F. Alexander, Chair
University Curriculum Committee

cc: Provost Pamela S. Whitten
        Dr. Rahul Shrivastav

Committee on Facilities, Committee on Intercollegiate Athletics, Committee on Statutes, Bylaws, and Committees, Committee on Student Life, Curriculum Committee, Educational Affairs Committee, Executive Committee, Faculty Admissions Committee, Faculty Affairs Committee, Faculty Grievance Committee, Faculty Post-Tenure Review Appeals Committee, Faculty/Staff Parking Appeals Committee, Human Resources Committee, Program Review and Assessment Committee, Strategic Planning Committee, University Libraries Committee, University Promotion and Tenure Appeals Committee

An Equal Opportunity/Affirmative Action/Veteran/Disability Institution

CENTER FOR CYBER-PHYSICAL SYSTEMS

CENTER FOR CYBER-PHYSICAL SYSTEMS (CCPS)

1. MISSION

To foster an interdisciplinary research community in UGA committed to advancing research and education in Cyber-Physical Systems (CPS) and to transitioning CPS science and technology into engineering practice and real-world applications with broad impacts. Integrating with the existing strength of UGA on natural science and engineering, the CCPS will be initially positioned on leading the CPS innovations on the intersecting grand challenges of environment, energy, food, and health. The CCPS will develop collaborative partnerships with academic, government, and industry on integrative research, education, training, and outreach.

2. BACKGROUND AND OPPORTUNITIES

Cyber-Physical Systems (CPS) are smart engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components. CPS technology transforms the way people interact with physical systems -- just as the Internet transforms the way people interact with information. It is well regarded that smart CPS drives innovation and competition in sectors such as agriculture, energy, transportation, building design and automation, healthcare, and manufacturing.

The December 2010 report of the President's Council of Advisors on Science and Technology (PCAST) titled Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology calls for continued investment in CPS research because of its scientific and technological importance as well as its potential impact on grand challenges in a number of sectors critical to U.S. security and competitiveness such as the ones noted above. These challenges and technology gaps are further described in a CPS Vision Statement published in 2012 by the federal Networking and Information Technology Research and Development (NITRD) CPS Senior Steering Group.

Tremendous progress has been made in advancing CPS technology. Researchers have explored foundational technologies that have spanned an ever-growing set of application domains, enabling breakthrough achievements in many of these fields. At the same time, the demand for innovation in these domains continues to grow and is driving the need to accelerate fundamental research to keep pace.

Despite significant inroads into CPS technology in recent years, we do not yet have a mature science to support systems engineering of high-confidence CPS, and the consequences are profound. Traditional analysis tools are unable to cope with the full complexity of CPS or adequately predict system behavior. For example, as the Internet of Things (IoT) scales to billions of connected devices—with the capacity to sense, control, and otherwise interact with the human and physical world—the requirements for dependability, security, safety, and privacy grow immensely. One barrier to progress is the lack of appropriate science and technology to conceptualize and design for the deep interdependencies among engineered systems and the

natural world. The challenges and opportunities for CPS are thus significant and far-reaching. New relationships between the cyber and physical components require new architectural models that redefine form and function. They integrate the continuous and discrete, compounded by the uncertainty of open environments. Traditional real-time performance guarantees are insufficient for CPS when systems are large and spatially, temporally, or hierarchically distributed in configurations that may rapidly change. With the greater autonomy and cooperation possible with CPS, greater assurances of safety, security, scalability, and reliability are demanded, placing a high premium on open interfaces, modularity, interoperability, and verification.

3. CENTER GOALS AND FOCUS AREAS

The center aims to foster a research community at UGA committed to advancing research and education in CPS and to transitioning CPS science and technology into engineering practice and real-world applications with broad impacts. By abstracting from the particulars of specific systems and application domains, the CPS center seeks to reveal cross-cutting fundamental scientific and engineering principles that underpin the integration of cyber and physical elements across all application sectors, where sensing, computing, communication, control, and security play a critical role and need a transformative and integrated study. The CPS center will develop the core system science needed to engineer complex cyber-physical systems that people can use or interact with and depend upon. To expedite and accelerate the realization of cyber-physical systems in a wide range of applications, the CPS center also supports the development of methods, tools, and hardware and software components based upon these cross-cutting principles, along with validation of the principles via prototypes and testbeds.

Federal agencies, foundations, municipalities, and industries have invested and will continue to invest billions of dollars to support research, education/training, and outreach related to cyber-physical systems and security. UGA has yet to develop synergies and significant connections to those opportunities despite a body of individual research activities across campus. As a premier land- and sea-grant university, UGA is active in research and promotion of agricultural and sea-based programs, where cyber-physical systems play a significant role to integrate and transform. The goals of the research center in UGA are to:

- increase the quality and quantity of interdisciplinary research at the interface of cyber and physical systems, and to procure external support for that research;
- integrate with UGA's existing strengths and focuses in responding comprehensively as an institution to significant research and development opportunities;
- proactively develop interdisciplinary publications and modular research proposals focused on cyber-physical technologies for health, food, energy, and environment sustainability;
- enhance the visibility of the University by establishing a national presence in cyber-physical systems and security research and practice;
- attract high-quality students and faculty and provide them with effective mentoring in cyber-physical systems and security research;
- strengthen societal security and sustainability through cyber-physical technology and policy development.

Integrating with the existing focus of UGA on nature and health sciences, this CPS center will be initially positioned on **smart and secure** CPS technologies for the natural and human systems, with the goal of enabling food, energy, and environment security and healthier life. The center's focus areas include food-water-energy systems and security, community health and well-being, infrastructure, and environment sustainability. We will develop collaborative partnerships with academic and industry on integrative research, education, training, and outreach on the following focus areas initially:

1. Controlled-Environment Agriculture and Food Systems
    a. sense and control environmental parameters (such as temperature, humidity, carbon dioxide, light) and soil properties (such as moisture, nutrient concentration, and acidity)
    b. Integrate renewable energy sources with CEA to reduce energy cost and promote green environments, such as deploying solar photovoltaic panels on greenhouse structures for energy production, internal shading benefits for both cooling and heating seasons
    c. minimize the energy cost of lighting, HVAC, and irrigation systems with information from electrical market pricing signals, renewable energy supply, and weather forecasts
    d. provide recommendations on optimized greenhouse design and operations based on local weather conditions, food needs, and energy supply profiles.
    e. optimize food production schedules by connecting with food supply chain and logistics

2. Environment and Infrastructure Security
    a. smart sensor web systems for environment monitoring, such as air or water quality, atmospheric or soil conditions, and can even include areas like monitoring the movements of wildlife and their habitats
    b. sensing, control and security for critical infrastructures (such as power plant, power and water infrastructures, hospitals, airports, and seaports)
    c. structural health monitoring systems for buildings, bridges, water and oil pipe networks
    d. underground security (such as underground tunnels, mines, sinkholes) and sustainability through real-time subsurface imaging
    e. emergency and disaster (like terrorist attack, earthquake, or tsunami) early-warning and mitigation systems that can be used by emergency services to provide more effective aid

3. Smart and Secure Energy Systems
    a. analyzing, designing, and implementing information systems to increase energy efficiency and security
    b. energy harvesting, storage devices and systems, solar, wind, and bio energy, and integration of renewables with grid

c. investigate distributed microgrid energy management and control systems for microgrids

d. monitoring, protection and cyber security of power grid, and automation control

e. advanced oil and gas exploration and production techniques with real-time subsurface imaging

f. energy system machinery health diagnosis and predictive analytics

4. Swarm Robotics for Exploration and Security
   a. design and implement autonomous flying drones, surface vehicles, and underwater vehicles for the engineering autonomy solutions
   b. develop autonomous space, surface, subsurface, and underwater exploration and imaging system for target tracking and homeland security applications
   c. model the coupling of spatial dynamics and information dynamics in exploration and exploitation problems and investigate how the coupled dynamics affect collective behavior
   d. develop feasible motion patterns and control that are inspired by animal behaviors and verify the performance both theoretically and experimentally on engineering systems

5. Smart, Secure, and Connected Healthcare Systems
   a. medical and health sensors and medical robotics systems, human-robot interaction, computer-aided surgery
   b. methods and algorithms for aggregation of multi-scale clinical, biomedical, contextual, and environmental data about each patient (e.g., in EHRs, personal health records, PHR, etc.), and unified and extensible metadata standards, and decision support tools to facilitate optimized patient-centered, evidence-based decisions
   c. underlying socioeconomic and behavioral principles underlying patient participation in healthcare and wellness
   d. parsing and mining the texts of the social media to accurately predict epidemics, such as flu; building statistical models to predict disease occurrence.
   e. protocols and interface standards to enable interoperable, temporally synchronized, medical prosthetic and embedded devices and those devices for continuous capture, storage, and transmission of physiological state and environmental data
   f. interoperable, distributed, federated, secure, and scalable digital infrastructure (such as Blockchain), languages, and tools for effective sharing and use of electronic health record data, data representation, and networked applications that access such data

6. Cyber-Physical Security and Integrity
   a. system, network, and data security mechanisms for cyber and physical systems and their integration
   b. data-driven and physics-based data analytics and security mechanisms

c. bio-inspired immunization and decentralized defense mechanism for cyber and physical attack
d. biophotonic integrated sensors, multispectral and biomolecular biometric identification
e. microwave photonics devices and systems, hybrid photonic-neuromorphic signal processing, and fiber optics sensor for biomedical, robotics, and communication security

Currently, there are great ongoing efforts in all the aforementioned topic areas from the core faculty. The core faculty received the UGA President's Interdisciplinary Seed Grant to develop Cyber-Physical Systems for Controlled-Environment Agriculture, to address the intersecting challenges of food, energy, and environment security and sustainability.

4. ADDED VALUE OF THE NEW CENTER

There are enormous funding opportunities (e.g., billions USD) for research, education/training, and outreach related to cyber-physical systems and security through government agencies and industry. UGA has yet to develop synergies and significant connections to those opportunities despite a body of activities across campus. As a premier land- and sea-grant university, UGA is active in research and promotion of agricultural and sea-based programs, where cyber-physical systems play a significant role to integrate and transform. UGA's diverse strengths are known in agricultural and environmental design and engineering, ecology, earth and atmospheric sciences, public health, business, and the social sciences, the CPS center will cross-cut the nexus of them and advance food, energy, environment, and health technology frontier. This CPS center will also help and promotes AU/UGA medical partnership through integration of cyber systems with medical and health practices.

The research and graduate programs of UGA engineering college are organized along three interdisciplinary programs that enable crosscutting scholarship that address societal needs. These crosscutting programs are Engineering Secure, Resilient, and Sustainable Systems; Advancing Human Wellness, Cognition, and Learning; and Developing Advanced Materials, Devices, and Cyber Tools. The proposed center aligns well with the engineering college's vision and will strengthen the nexus of those three interdisciplinary programs.
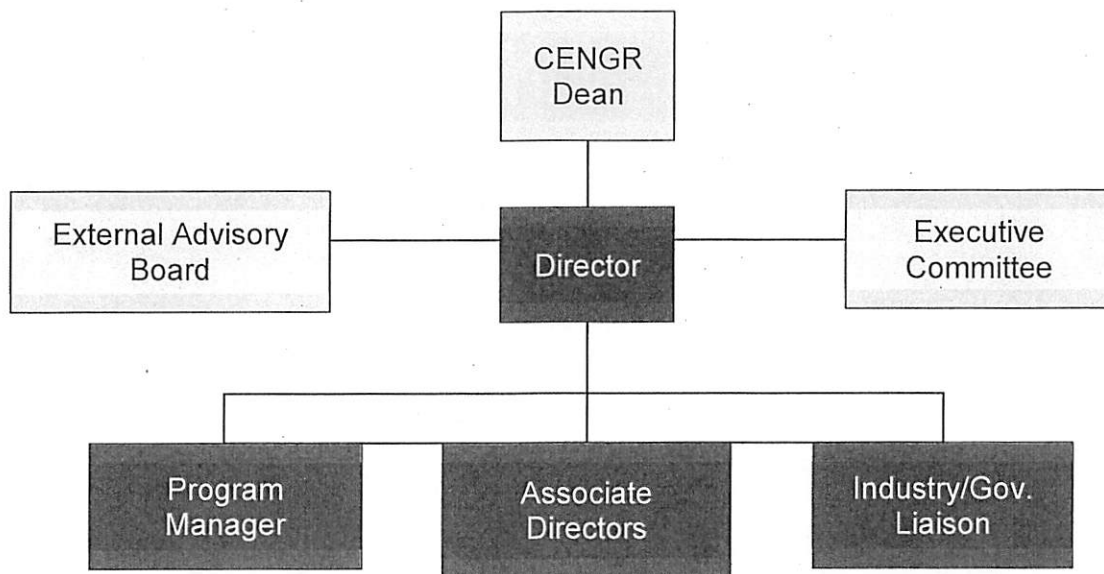
5. ORGANIZATIONAL STRUCTURE

The center will be located administratively in the CENGR Dean's Office and will report to the Dean of Engineering. The Director will be appointed by the Dean of Engineering. The appointment of the Director will be reviewed annually. The Center will be independent but organizationally affiliated with the Georgia Informatics Institutes. The Center Director will work with the Director of the GII's director as appropriate and through the Center's research focus in Cyber-Physical Systems, contribute to GII's research mission.

Participation of faculty in the center will be voluntary and by agreement with the center Director. UGA faculty members with relevant research interests can apply for affiliation with the center by completing a web-based application form. Faculty applications will be evaluated by the Executive Committee (described below). Participating faculty will maintain their existing appointments in their home academic units. Responsibilities of participating faculty representing the participating units are to:

- attend center meetings and proposal development retreats;
- collectively discuss and recommend center strategic directions;
- actively participate in specific center research and development activities;
- provide knowledge and guidance on societal priorities and relevant areas in their field of expertise; and
- promote the strengths of the center in supporting future decisions to their sponsors and collaborators.

A diagram depicting the basic organization of the center is provided below.

Center Organization Structure

The founding Director of the center is Dr. WenZhan Song. The Director is responsible for providing both scholarly and administrative leadership for the center such that the value of the center grows for all its constituencies. The Director chairs the internal and external advisory groups and is responsible for establishing the leadership team of the center (e.g., Associate Director, Program Manager, etc.) as the center matures and grows. The Director is also responsible for all internal reporting and reviews required of the center.

The center Associate Directors are faculty members who lead research thrusts leading CPS for agriculture, energy, health, etc. If the maturity of the center does not yet warrant it or there is no

faculty member suitable for this role, the Director may choose to establish an Executive Manager instead of the Associate Director, who will be a staff member dedicated to working with the Director in executing the mission of the center.

The Executive Committee will be responsible for recommending and codifying the policies of the center, providing input on priorities for center research activities, and recommending spending priorities based on input solicited from all faculty affiliated with the center. The Executive Committee consists of at least five faculty members broadly representing the diverse academic units participating in the center. The Executive Committee is convened and chaired by the Director. Responsibilities of the Executive Committee include:
- establishing policy for the center (the Director has final say for policy; disputes between the director and the executive committee may be taken to the CENGR dean);
- evaluating faculty applications for membership in the center; and
- advising the Director.

The Advisory Board will be comprised of representatives of municipalities, businesses, and other center partners. The Board will meet collectively as a group twice each year to advise the leadership team and to review collectively funded projects. The Board will annually prepare and present a written Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis. The Board will have a chair who organizes the board's activities in coordination with the Industry/Government Liaison and the Director.

The Industry/Government Liaison is a staff member responsible for developing the center's innovation ecosystem, marketing the center to industry and government, garnering their financial support, developing and coordinating industrial/municipal involvement with faculty and students, and managing the center's translation of research for the public good. This position will be filled by Dr. Crystal Leach, UGA Director of Discovery and Innovation Partnerships.

The Program Manager manages research projects; supports the center's web and social media presence; large proposal preparation; coordinates research, outreach and oversight meetings, and writing retreats; and coordinates regional, national, and international scientific meetings and conferences. This position will be established as project portfolio and external funding growth warrants and is able to support it.

6. BUDGET AND FUNDING SOURCES

The center will increase externally funded research in the areas stated, enable expanded world recognized scholarship, increase diversity, and expand engagement in a critically needed area. Anticipated revenue streams include contracts and grants, member fees from government and industry partners, sponsorships and gifts from various sources, and registration fees for workshops and trainings. Member fees from industry and government partners will provide funding of a portfolio of shared projects that leverage resources and provide value-added benefits.

Center Start-up Support

The College of Engineering will support the center in its launch and work with the Director as needed to expand that support as programs grow. The center is expected to become self-sustaining in three years based on estimated costs and projected revenues from voluntarily returned indirect costs, fees for continuing education, cooperative agreements with government and industry partners, and sponsorships and gifts from various sources. Startup support provided by the College of Engineering will be through existing programs and personnel. This will include either direct or matching support for proactive publication and proposal writing activities, developing industry, government, and interinstitutional partnerships, travel for program development and outreach, and staff support for the center until it becomes self-sustaining. Support for other positions will be gradually procured via the self-supported activities of the center.

In April 2017, some of the core faculty of this proposal received the President's Interdisciplinary Seed Grant to develop Cyber-Physical Systems for Controlled-Environment Agriculture. This project assembles an interdisciplinary team of engineering, agricultural, information systems, and computer science researchers to tackle the intersecting grand challenges of food security and energy and environmental sustainability. Besides the $140K grant support from OVPR, each college/department contributes 5%-10% matching to support this synergetic effort. This pool of funding and synergy will help support a good launch of the center.

CCPS Anticipated Operating Cost

Expense Category	FY19	FY20	FY21
Staff support	$0	$20,000	$50,000
Workshop series	$2000	$2000	$2000
Travel funds	$5000	$8000	$8000
Total	**$7,000**	**$30,000**	**$60,000**

CCPS Anticipated Revenue

Revenue Source	FY19	FY20	FY21
Registration fees	$2000	$2000	$2000
Industrial donation and membership	$5,000	$30,000	$60,000
Total	**$7,000**	**$32,000**	**$62,000**

The faculty participating in the center may elect to voluntarily contribute their portion of returned indirects from center projects. Given the uncertainty in the amount of return from this source, it is not included in the revenue of the center. The indirects recovered will be mainly used to support students and build research infrastructure.

Federal Funding Opportunities

The research and development of Cyber-Physical Systems have enormous funding opportunities from many federal agencies[1], including the National Science Foundation (NSF), U.S. Department of Defense (DOD), U.S. Department of Energy, U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T); the U.S. Department of Transportation (DOT) Federal Highway Administration (FHWA), and through FHWA, the U.S. DOT Intelligent Transportation Systems (ITS) Joint Program Office (JPO); the National Aeronautics and Space Administration (NASA) Aeronautics Research Mission Directorate (ARMD); several National Institutes of Health (NIH) institutes and centers [including the National Institute of Biomedical Imaging and Bioengineering (NIBIB), Office of Behavioral and Social Sciences Research (OBSSR), National Cancer Institute (NCI), and National Center for Advancing Translational Sciences (NCATS)]; and the U.S. Department of Agriculture-National Institute of Food and Agriculture (USDA-NIFA, hereafter referred to as NIFA).

The National Science Foundation (NSF) is announcing over $35 million in Smart Cities-related grants and planning new investments in FY16. With a new foundation-wide effort devoted to Smart and Connected Communities, NSF will bring academic researchers and community stakeholders together to unlock transformational progress on important challenges—including health and wellness, energy efficiency, building automation, transportation, and public safety—through research to integrate new digital tools and engineering solutions into the physical world. NSF announcements in support of this agenda include the following: $11.5 million in new awards to develop and scale next-generation Internet application prototypes that leverage gigabit speeds to achieve transformative impact in areas ranging from healthcare to public safety. $10 million in new Cyber-Physical Systems Program research awards focused on Smart and Connected Communities. These awards support research in the integration of computing, networking, and physical systems, such as in smart agriculture and energy. The research awards being announced today help to establish the foundation for Smart Cities and the "Internet of Things." $7.5 million in proposed FY16 spending for urban science that will support research that integrates advanced digital tools with the physical world to improve quality of life, health and well-being, and learning in communities. A new Dear Colleague Letter (DCL) encouraging Early-Concept Grants for Exploratory Research proposals, as well as supplemental proposals to existing grants, to grow a Smart and Connected Communities research community and pilot early-stage efforts. Yet another DCL encourages I/UCRC (Industry-University Cooperative Research Center) on Cyber-Physical Systems or Internet of Things. We will have a very good opportunity for this, because we are the inaugural member of OpenFog consortium[2] involving over 60 industry and university members. The mission of OpenFog is to drive industry and academic leadership in fog computing architecture, testbed development, and a variety of interoperability and composability deliverables that seamlessly leverage cloud and edge architectures to enable end-to-end IoT scenarios.

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[1] https://obamawhitehouse.archives.gov/the-press-office/2015/09/14/fact-sheet-administration-announces-new-smart-cities-initiative-help

[2] OpenFog Consortium: https://www.openfogconsortium.org/

The Department of Defense (DOD) has enormous funding opportunities on cyber-physical systems and security through its subordinates Army, Navy, Air Force and Defense Advanced Research Project Agency (DARPA). For example, DARPA's High-Assurance Cyber Miltary Systems (HACMS) program is to create technology for the construction of high-assurance cyber-physical systems, where high assurance is defined to mean functionally correct and satisfying appropriate safety and security properties. Achieving this goal requires a fundamentally different approach from what the software community has taken to date. Consequently, HACMS will adopt a clean-slate, formal methods-based approach to enable semi-automated code synthesis from executable, formal specifications. In addition to generating code, HACMS seeks a synthesizer capable of producing a machine-checkable proof that the generated code satisfies functional specifications as well as security and safety policies. A key technical challenge is the development of techniques to ensure that such proofs are composable, allowing the construction of high-assurance systems out of high-assurance components.

The Department of Homeland Security (DHS) is announcing plans to invest $50 million over five years to develop cutting-edge emergency response technologies for Smart Cities. Through the Next Generation First Responder Apex Program, the DHS Science and Technology Directorate is developing and integrating innovative technologies to ensure first responders are protected, connected, and fully aware—helping to better prepare them for threats and disasters of all sizes. As part of this effort, DHS is also collaborating with NIST to leverage Smart Cities data, analytics, and predictive modeling to give responders the right information at the right time, increasing responder operational efficiency and safety.

The Department of Transportation (DOT) is announcing over $40 million in new funding to advance transportation for Smart Cities, building on a broad base of existing research and outreach to spur the development of next-generation transportation systems. DOT is announcing awards today of up to $42 million in its first wave of Connected Vehicle Pilots, including $20 million for the installation of this technology in midtown Manhattan, and $17 million to address congestion in downtown Tampa. A new funding opportunity of approximately $4 million focused on how mobile telecommunications and travel data integration can make traveling easier and more efficient, as well as how incentives can help promote safer travel. Past research has explored the potential for automated vehicles, dynamic ridesharing, and integration of sensor data to assist navigation for blind and vision impaired pedestrians. This new opportunity from the Federal Highway Administration Exploratory Advanced Research Program will build on these results in further areas related to smart cities. Gathering input on integrating vehicle data, technologies, and applications with other systems across a city.

The Department of Energy (DOE) will invest almost $10 million to expand efforts to support the emergence of smart, energy-efficient and low-emission cities that are leveraging Smart Cities technologies. These new steps include the following: Creating a new SMART Mobility consortium, with $5 million in new research funding. DOE will launch a Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility consortium to examine the nexus of energy and mobility for future transportation systems. The Department will also lead a new collaborative effort

with multiple private sector groups to leverage the work of the existing Better Buildings Energy Data Accelerator to promote better access to building energy data in new cities across the country. A Smart Grid Integration Challenge for Cities, offering at least $1 million in funding. DOE's Office of Electricity Delivery and Energy Reliability will launch a new challenge competition in 2016 to support city efforts to implement sensing, data sharing, and data analytics to achieve city goals for reducing energy consumption. The competition will be open to city governments that have already developed a roadmap or an action plan with clearly defined targets for energy consumption reduction for the entire city.

The Department of Commerce's Economic Development Administration (EDA) is planning a new $10 million round of its Regional Innovation Strategies funding opportunity, with a new focus on catalyzing regionally-grown solutions to communities' most pressing problems. As part of the 2016 Regional Innovation Strategies (RIS) program, which helps build regional capacity to support entrepreneurs and growing young companies, EDA will conduct directed outreach to programs that support early-stage companies that use technologies to solve communities' most pressing problems, such as companies in the Smart Cities sector, which can have a significant positive impact on a community's or region's economic growth and resiliency. As part of the 2017 RIS Program, EDA plans, where appropriations allow, to include the i6 Impact Challenge and the Conscious Seed Fund Support (C-SFS) Grants program, which will support high-growth companies that solve these pressing problems to help make cities and communities smarter and more economically resilient.

The National Institute of Standards and Technology (NIST) plans to invest $5 million in Smart Cities in FY16 and is launching a new round of the Global City Teams Challenge. Proposed FY16 investments will foster collaborations with communities and industry to demonstrate the capabilities of Internet of Things technologies to benefit local communities, while developing related performance standards and measurement tools. In addition, NIST is launching the next round of its Global City Teams Challenge (GCTC), using a new approach that will challenge teams of cities to set Smart City goals and then work with innovators to develop, deploy, and evaluate standards-based Smart City technologies that measurably improve residents' quality of life.

The Environmental Protection Agency (EPA) is announcing new steps to unlock Smart Cities approaches to environmental monitoring and analysis. These new steps are designed to help communities undertake innovative sensor-based approaches to improve data collection and analysis of environmental condition and risk. Up to $4.5 million in new grant funding to conduct innovative air quality pilot studies in several cities using low-cost portable air pollution sensors. The grants will empower communities and individuals with new data to help them understand their air pollution exposure at a more granular level, while improving our understanding and management of data quality from distributed sensors. Deployment of EPA's Village Green Project air monitoring stations to pilot test in three new cities over the next year: Oklahoma City, OK, Hartford, CT, and Chicago, IL. Building on four already successful deployments, the Village Green Project enables researchers and citizens to monitor and analyze local air quality, unlocking a better understanding of local variations and air quality trends.

Industrial Consortium and Partnership

The Internet of Things (e.g., Cyber-physical Systems) has been recognized by the industry and will lead to the next business boom. There are multiple industry and university consortiums formed to drive industry and academic leadership in CPS architecture, testbed development, and a variety of interoperability and composability deliverables that seamlessly leverage cloud and edge architectures to enable end-to-end IoT scenarios.

The UGA CPS center will explore a consortium framework to work with industry. In this framework, each industry partner donates $50K per year to the consortium, and the consortium will use it to support graduate and undergraduate students on the CPS research that may have a direct or indirect benefit to the industry partners. We are an inaugural member of OpenFog Consortium and have built good connections with IoT industry. Large companies are interested to engage universities in testing of their products and conduct research years ahead of industry, while small and medium companies can increase the cost-effectiveness of their efforts by combining resources with university research centers in support of transferable research conducted by the center.

7. PROGRAM REVIEW

To ensure that the center is fulfilling its mission and stated goals, periodic reviews will be performed by internal and external evaluators. The center will be reviewed internally every three years by the Dean of Engineering. As part of this review process, the center will produce a report describing all research and funding efforts in the center, including the scholarly productivity of the faculty participating in the center. Measurable outcomes to be quantified by the center and evaluated in the triennial review are listed below. Baseline values for the metrics will be established and agreed to by Dean and Director with the formal establishment of the center.

- Number of research projects in the center and level of involvement by center faculty
- Number of interdisciplinary grants related to cyber-physical systems
- Research productivity of core faculty based on indicators of scholarly activity such as numbers of journal articles published, conference presentations, invited presentations, books and book chapters, reports, software, and other artifacts
- Number of grant and contract proposals submitted
- Number of grant and contract proposals awarded
- Amount of external funding received
- Number of M.S. and Ph.D. students supported
- Number of partnerships created with municipalities/government, industry, and universities
- Number of memberships in the center received

Review of the center will also include an assessment of the following broader questions:
- Has the center become a catalyst for interdisciplinary research development?
- Is the center successfully cultivating and growing a national and international reputation?

- Has the center met its original milestones or adaptively moved to seize opportunities to establish and achieve new milestones?
- Has the center become self-sustaining?

In addition, an external review of the center will be conducted not less than every seven years by members of an external review panel appointed by the Dean of Engineering. The external review panel will utilize the same measurable outcomes and evaluation criteria described above.

Each internal and external review will address any changes in strategy, resources, commitments, and/or operating agreements, and ultimately recommend or not recommend continuation of the center. If continuation is not recommended, the Dean of Engineering will decide the process for dissolution.

8. FACILITIES

The work of center faculty and students will initially draw upon a number of existing facilities, including computing and mechanical facilities in Engineering and the Franklin College, and controlled agriculture environments in the College of Agricultural and Environmental Sciences. The center does not currently control any physical resources and will utilize existing space and facilities. Proposals for space and physical resources will be considered in accordance with the growth and success of the center over its first three years of activity. The collaborative labs and institutes include, but are not limited to, the following:

- Sensorweb Research Lab
- Horticultural Physiology Lab
- Complex Systems Control Lab
- Network System and Security Lab
- Big Data Analytics Lab
- Cortical Architecture Imaging and Discovery Lab
- Virtual Experiences Lab
- Medical Robotics Laboratory
- Bio-sensing and Instrumentation Lab
- Lightwave and Microwave Photonics Laboratory
- Biophotonics/Bioimaging Lab
- Data Intensive Pervasive Systems Lab
- Institute for Disaster Management
- Georgia Informatics Institutes

9. INITIAL CORE AND SUPPORTING FACULTY

AU/UGA Medical Partnership:	Engineering:	Horticulture:
Jonathan Murrow	Mable Fok	Marc van Iersel
	Mark Haidekker	
Business:	Larry Hornak	**Public Health:**
	Kyle Johnsen	
Rick Watson	Sung-Hee Sonny Kim	Cham Dallas
Maric Boudreau	Thomas Lawrence	
	Charlie Li	**Statistics:**
Computer Science:	Ke Li	
	Leidong Mao	Ping Ma
Yi Hong	Javad Mohammadpour	Wenxuan Zhong
Kang Li	Ramana Pidaparti	
Tianming Liu	WenZhan Song	
Lakshmish Ramaswamy	Zion Tse	
	Paul Xie	

All faculty listed above are the initial affiliated members with the center. The executive committee will start with the following members: WenZhan Song (committeee chair), Marc van Iersel (agriculture), Tianming Liu (computer science), Ping Ma (statistics), Cham Dallas (public health), Jonathan Murrow (medical), Rick Watson (business).

10. SUPPORT LETTERS

In the appendix, please find the support letters from:
- College of Engineering
- College of Business
- College of Arts and Sciences (Computer Science, Statistics)
- College of Agricultural and Environmental Sciences
- AU/UGA Medical Partnership
- Georgia Informatics Institutes
- Institute for Disaster Management

UNIVERSITY OF GEORGIA
College of Engineering

TO: Office of Curriculum Systems
FROM: College of Engineering
RE: Proposal on Center for Cyber-Physical Systems
DATE: August 8, 2017

The College of Engineering (CENGR) authorizes the submission of the proposal on creating Center for Cyber-Physical Systems (CCPS) in CENGR with the mission statement as follows:

To foster an interdisciplinary research community in UGA committed to advancing research and education in Cyber-Physical Systems (CPS) and to transitioning CPS science and technology into engineering practice and real-world applications with broad impacts. Integrating with the existing strength of UGA on natural science and engineering, the CCPS will be initially positioned on leading the CPS innovations on the intersecting grand challenges of environment, energy, food and health. The CCPS will develop collaborative partnerships with academic, government and industry on integrative research, education, training and outreach.

_____
Donald J. Leo, Ph.D.
Dean
UGA Foundation Professor in Engineering

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WenZhan Song, Ph.D.
Georgia Power Mickey A. Brown Professor in Engineering

UNIVERSITY OF
GEORGIA
College of Engineering

July 26, 2017

Dr. WenZhan Song
Georgia Power Mickey A. Brown Professor
College of Engineering
University of Georgia

Dear Dr. Song,

I am pleased to provide this letter of support from the College of Engineering for the proposed Center for Cyber-Physical Systems. Your proposed center has the potential for campus-wide interdisciplinary research impact in Cyber-Physical Systems (CPS) which are of critical national importance and represent significant extramural funding opportunity. The proposed center's affiliation with the GII enables it to serve as the first formal center of research focus for the institute and connect with domain expertise unique to UGA that is critical to meeting the interdisciplinary challenges that next generation CPS pose. For these reasons and in the ways outlined in this letter of support, the College of Engineering commits to serving as administrative home of the Center for Cyber-Physical Systems and looks forward to helping you achieve the center's research goals.

Cyber-physical systems are central to 21st century engineering. CPS link cyberspace to action in our physical world through a closed loop of sensing, computation and analytics, control, and physical actuation. From smart systems, to the Internet of Things, cutting edge CPS is essential to the viability and competitiveness of nearly every sector including agriculture, energy, transportation, building design and automation, healthcare, and manufacturing. Consistent with CPS' strategic importance, federal government mission agencies (NIH, DoD, USDA, NASA, etc.) have established research programs to advance CPS specific to their missions and collaborate with NSF to support fundamental CPS science and engineering research.

The College of Engineering looks forward to the proposed center serving as a nucleation point for concept and faculty proposal team development linking UGA's broad domain expertise with that of engineering, computer science, and industry partners to achieve grant success and leadership in niche areas of the CPS field. Your initial success with award of the Presidential Seed Grant *Cyber-Physical Systems for Controlled-Environment Agriculture* is indicative of the leveraging of expertise from engineering and colleges across campus that can differentiate UGA and achieve growth in the extramural funding of CPS research.

The College of Engineering will provide startup support for the Center for Cyber-Physical Systems through the College's existing programs and personnel for its first three years after which time it is expected to become self-sustaining. College startup support will include either direct or matching support for proactive publication and proposal writing activities; support from our Office of Research and Office of Industry Collaborations for developing industry, government, and interinstitutional partnerships; travel for program development and outreach;

and staff support for the center until it becomes self-sustaining. In addition, the College will coordinate with other units on campus as needed for large-scale cooperative research activities.

I look forward to the establishment of research Center for Cyber-Physical Systems as a formal UGA Center.   The College is committed to working with you and your team for the benefit of the College and campus as you shape the organization into a nationally recognized center.

Sincerely,

Donald J. Leo, Ph.D.
Dean
UGA Foundation Professor in Engineering

Terry College of Business
Office of the Dean

Benjamin C. Ayers, *Dean*
Earl Davis Chair in Taxation

July 6, 2017

Office of Curriculum Systems
University Curriculum Committee
319 New College
Athens, Ga 30602

Dear Committee Members:

As dean of the Terry College of Business, I support the proposal submitted to the University Curriculum Committee for the creation of a Center for Cyber-Physical Systems.

Such a Center would have synergy with the Energy Informatics initiatives that the MIS department has put forward in the past few years. Moreover, it would further support the UGA Interdisciplinary grant that faculty from the department have received ("Smart Cyber-Physical Systems for Controlled-Environment Agriculture"). As emphasized in this grant, the knowledge and skills of UGA researchers involved in cyber-physical systems will be of great use to businesses, which are among the top adopter of IoT (Internet of Things) solutions.

We anticipate that this research center, via its workshops, seminars, and grant writing activities, will provide many opportunities for our faculty and students to obtain and contribute knowledge on how cyber-physical systems impact businesses. We thus fully support this initiative.

Sincerely,

Benjamin C. Ayers

/abg

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University of Georgia

Franklin College of Arts and Sciences
Office of the Dean

August 7, 2017

Dr. WenZhan Song
Georgia Power Mickey A. Brown Professor
College of Engineering
University of Georgia

Dear Dr. Song,

On behalf of the Franklin College of Arts and Sciences, I write in support of your proposed Center for Cyber-Physical Systems. The proposed center has the strong potential for collaboration across colleges, including several units in the Franklin College, and the prospect of securing new sources of extramural funding.

Franklin College departments and centers provide unique expertise that can directly address computational and theoretical challenges associated with cyber-physical systems. In addition, the college offers expertise that can integrate across both social and technological research dimensions, which is critical in a number of funding opportunities related to Smart Cities and Communities.

The college is committed to support our faculty and students who are engaged in research on cyber-physical systems. We will encourage their participation in center activities, grant proposals, workshops, and seminars. I offer my full support to your proposal to establish the Center for Cyber-Physical Systems.

Sincerely,

Alan T. Dorsey, Dean

cc: Dr. Ping Ma, Department of Statistics

Department of Computer Science
415 Boyd Graduate Studies Research Center
200 D.W. Brooks Drive
University of Georgia
Athens, Georgia 30602-7404
TEL 706-542-2911 | FAX 706-542-2966
www.cs.uga.edu

Franklin College of Arts & Sciences
Department of Computer Science

July 07, 2017

Dear Members of the Curriculum Committee:

On behalf of the Computer Science Department at UGA, I strongly support the establishment of the Center for Cyber-Physical Systems (CPS) at UGA lead by Professor WenZhan Song. The interdisciplinary nature and the stated goals of the proposed Center are much needed at UGA, and it will have a high impact on research funding. Professor Song has an excellent research record in the proposed area of research of the Center, and he has chosen an excellent core faculty, including four members from the Computer Science Department. Moreover, Prof. Song is an Adjunct faculty in our CS Department and has already worked with a number of our faculty and graduate students.

I believe that the proposed Center has the potential to be a successful one, and the establishment of such Center is timely. I do strongly support the establishment of such Center.

Best regards,

Thiab Taha
Professor and Head

July 12, 2017

Dr. WenZhan Song
College of Engineering
University of Georgia

Dear Dr. Song,

On behalf of the Department of Statistics at UGA, I strongly support the creation of the Center for Cyber-Physical Systems (CCPS) at the University of Georgia. Your proposed center has great potential to build new interdisciplinary collaborations between various disciplines at UGA. We will be glad to encourage and support our faculty and students to participate in the activities organized by the Center.

As a multidimensional and complex system, I understand that Cyber-Physical System (CPS) is a comprehensive cyber, network and physical environment, and by combining technologies related to computing, communication, and control, one can realize close integration of the information and the physical world. I also understand that with foundations rooted in statistical methods, big data analytics play a crucial role in many data-intensive CPS systems. As you know, the Department of Statistics has strong statistics and data analytics research and education programs, and our faculty and students are also involved in developing fundamental statistical methodologies and algorithms that are useful in various applications of CPS. Since many cyber-physical systems require real-time fast decisions and decentralized data analytics, we will believe that there will be ample opportunities to develop new statistical methodologies to tackle problems in the big data and CPS regime.

I am also pleased to learn that two statistics faculty members, Drs. Ping Ma and Wenxuan Zhong, are already collaborating with you in this important research direction and will participate as core faculty of the Center. Over the past three years, Drs. Ma and Zhong have established diverse extramurally funded research programs to overcome the computational and theoretical challenges arising in big data analysis. We hope that this research center will also provide opportunities for several other faculty and students of Statistics to obtain and contribute knowledge on cyber-physical systems and its impact on statistics and analytics.

We would like to reiterate our full support for the creation of the Center for Cyber-Physical Systems. We are optimistic that CCPS will succeed in building new interdisciplinary collaborations, which will benefit a variety of units at UGA.

Sincerely,

T. N. Sriram
Professor and Interim Head
Department of Statistics
University of Georgia

July 10, 2017

College of Agricultural and Environmental Sciences

Office of the Dean and Director

Dr. WenZhan Song
Georgia Power Mickey A. Brown Professor
School of Electrical and Computer Engineering
College of Engineering

Dear Dr. Song:

I would like to express my support for the proposed Center for Cyber-Physical Systems. Such systems have the potential to develop important applications in agriculture. The proposed center can strengthen existing collaborations, as well as result in new linkages, between our College and Engineering.

The College of Agricultural and Environmental Sciences (CAES) has strong programs in areas such as Controlled Environment Agriculture and Precision Agriculture. These programs are good fits for Cyber-Physical Systems and already rely on collaborations between CAES and Engineering. The traditional concepts of control, sensing, and real-time behavior will require new perspectives on modeling, performance prediction, and control to account for the spatial, temporal, and environmental considerations fundamental to agriculture. We are interested in new CPS technologies that can be developed and demonstrated in the context of agricultural challenges, and then rapidly converted into capabilities that will transition into practice. The proposed CPS center is a timely initiative and can strengthen existing collaborations with engineering and attract other faculty members with relevant expertise.

Federal funding agencies increasingly require interdisciplinary approaches to address societal challenges. The faculty involved in the proposed center has a wide range of expertise. As a result, the center can help bring together teams that will effectively compete for large federal grants. This includes NSF programs like 'Cyber-physical Systems', 'Smart & Connected Communities' and 'Innovations at the Nexus of Food, Energy and Water Systems', and many other federal agency programs (such as USDA, NASA, DOE, NSF).

Our college will support our faculty and students involved in this center and encourage them to participate in workshops, seminars, and grant writing activities. I look forward to working with you and the proposed center. The center can strengthen existing programs and will likely result in new collaborative efforts. A new UGA Center for Cyber-Physical Systems will benefit both the College of Agricultural and Environmental Sciences and UGA as a whole.

Sincerely.

Dr. Samuel L Pardue
Dean and Director

SLP/alc

cc: Allen Moore
    Marc van Iersel

July 7, 2017

Dr. WenZhan Song
College of Engineering
University of Georgia

Dear Dr. Song:

This letter is to support the proposal for the creation of the **Center for Cyber-Physical Systems (CCPS)** at the University of Georgia. From a biomedical research perspective, developing programs in cyber physical systems represents a tremendous opportunity to improve health care delivery. The Medical Partnership is in the process of developing a strategic plan around research. Smart and connected health through cyber-physical systems represents one domain where our existing clinical and research relationships can be leveraged into meaningful scholarship.

Medical device industry is undergoing a rapid transformation, embracing the potential of embedded software and network connectivity. Instead of stand-alone devices that can be designed, certified, and used to treat patients independently of each other, we will be faced in the near future with distributed systems that simultaneously control multiple aspects of the patient's physiology. The combination of embedded software controlling the devices, networking capabilities, and complicated physical dynamics that human physiology exhibits makes modern medical device systems a distinct class of cyber-physical systems, which we refer to as medical CPS. Development of safe and effective medical CPS will require new design, verification, and validation techniques: the devices, and communications and analytics among them, but also patients, caregivers, and clinicians. Thus, we see tremendous collaboration opportunity between Medical Partnership and CCPS and are excited with the potential.

Faculty from the Medical Partnership have already engaged in collaborative research relationships seeking to develop scholarship around existing medical sensor systems, mobile health technology, and health informatics. Lacking is a center that would facilitate interaction, cultivate research proposals, and foster competitive funding applications. Accordingly, I am pleased to support the effort to consolidate efforts into a discrete center and support our faculty to participate in its workshops, seminars, and grant writing activities of this Center.

Sincerely,

Jonathan R. Murrow, M.D.
Campus Associate Dean of Research
Associate Professor of Medicine (Cardiology)
AU/UGA Medical Partnership
jmurrow@uga.edu | 404.695.3451

July 21st, 2017

Dr. Pamela Whitten
Senior Vice President for Academic Affairs and Provost
University of Georgia
Athens, GA

Dear Dr. Whitten,

The Georgia Informatics Institutes for Research and Education (GII) is pleased to support Dr. WenZhan Song's proposal to establish the Center for Cyber-Physical Systems (CPS) as one of our core partners alongside the Institute of Bioinformatics , the Health Informatics Institute, and the Institute for Cybersecurity and Privacy. The Center for CPS should be well positioned to cultivate the immense physical and data resources at UGA, such as those within the robotics, medical, agricultural and energy sectors, helping to meet the demand for innovative research that fulfills the ever-growing societal needs for food, health, and security.

These activities will be facilitated by the co-growth of the GII and its partner network through shared sponsorship of interdisciplinary activities, increased overall focus on cyber/data-driven research, and raised knowledge/skills of UGA students and faculty in related areas.   For example, students earning the new undergraduate certificate in informatics would be ideal students to join research laboratories associated with the CPS center. As is the case for our current partners, many of the GII members are already listed as prospective members of the CPS, but this new center also engages faculty in key areas of science and engineering that will help to grow the overall interdisciplinary activity on campus. Furthermore, raising the overall public profile of UGA in CPS should increase our opportunities to participate in collaborative research projects with other institutions.

In summary, we believe that the Center for CPS is a vital new addition to our network of informatics research and education. We are happy to work with Dr. Song as both a GII member, and as director, and are committed to supporting its activities as they align with the mission of the GII.

Sincerely,

Kyle Johnsen, PhD
Director, Georgia Informatics Institutes
Associate Professor, College of Engineering
University of Georgia
Athens, GA

College of Public Health
Institute for Disaster Management

July 7, 2017

Dr. WenZhan Song
Georgia Power Mickey A. Brown Professor
College of Engineering
University of Georgia

Dear Dr. Song:

I am writing this letter in support of the establishment of the Center for Cyber-Physical Systems at the University of Georgia. The critical need for transitioning science and technology in this field into real world applications has been emphasized by multiple federal and private institutions, such as the President's Council of Advisors on Science and Technology. Indeed, the vulnerability of multiple national assets in the public and private sectors will likely insure significant and growing federal funding opportunities for this Center.

I would be glad to serve as a core faculty member in this endeavor, and look forward to the participation of the Institute for Disaster Management in research and education in Cyber-Physical Systems (CPS). As you know, the Institute has many years of experience in preparing healthcare systems for high impact events, including extramurally funded mass casualty management curricula development, peer-reviewed research publications, and full-scale exercises. In Georgia alone, we have over 700 institutional stakeholders with whom we have a productive research and training relationship that would be ideal for collaborative work with this proposed Center in the healthcare, security, and logistical support communities. Internationally, the Institute has extensive past experience and future collaborative opportunities now in development that could be of utility to CPS endeavors. The faculty, staff, and students at the Institute for Disaster Management look forward to working with the proposed Center for Cyber-Physical Systems in extramural research grants, research and education, and service to local, state, national, and international communities in this critical field.

Sincerely,

Cham Dallas, Ph.D.
University Professor
Professor & Director,
Institute for Disaster Management
College of Public Health

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