Preface to the Special Issue: Toward an Efficient and Effective Internet of Things for Cyber-Physical Systems

(Part I)

We are pleased to present this special issue of the *ACM Transactions on Cyber-Physical Systems* entitled “*Internet of Things*.” This special issue is presented to commemorate the 10th anniversary of the CPS research program and the inauguration of *ACM Transactions on Cyber-Physical Systems*.

Cyber-Physical Systems have been a critical driving force for economic development during the 21st century. An organized effort to define CPS research and development and to establish a funding program commenced 10 years ago. In summer 2006, the Computer and Network System Division (CNS) of the U.S. National Science Foundation (NSF), reviewed its research programs and decided to focus on engineering systems that are built from and depend upon the integration of computational and physical components. Consequently, the Computer System Research (CSR) program of CNS was revised, with CPS becoming a thematic research area in the CSR program. With the support from the NSF Directorate for Computer & Information Science & Engineering (CISE), the first call-for-proposal of this new research program was announced in fall 2006 (NSF 07-504).

This first CPS research program received enthusiastic responses from all academic, industrial, and governmental sectors. The very first workshop on CPS research and development was held in Austin, Texas, in October 2006, with a mission to define the agenda of CPS research and development for the Nation. The effort was quickly recognized by the U.S. President’s Council of Advisors on Science and Technology (PCAST). In PCAST’s 2007 report, CPS was given a top priority for substantial research investment. In 2008, the NSF elevated its support for CPS research by launching a full-fledged research program (NSF 08-611), which has now become a core NSF program jointly supported and managed by multiple agencies. Many other countries and organizations have since launched similar efforts, triggering a large-scale, globally organized effort to pursue CPS research, education, and development.

The Internet of Things (IoT) is expected to become a global networking infrastructure for cyber-physical systems. Technically, the IoT is an emerging paradigm that seamlessly integrates a large amount of smart objects interlinking the physical and the cyber worlds and keeps them in a close and continuous interaction. As such, while the envisioned paradigm will need to address significant complexity, the IoT is an exciting, broad, and nascent area spanning a multitude of scientific research communities as well as several areas of applied industrial research and development. With the introduction of this exciting new paradigm, a variety of new problems and challenges present themselves. Traditional Internet approaches are insufficient at solving these unprecedented issues. This special issue covers recent advances on addressing issues related to design, analysis, and implementations of the IoT.

A total of 14 papers have been accepted for this special issue. This month is Part I of the special issue, comprised of seven papers. Part II will be presented in the issue April, 2018. Given the operational nature of cyber-physical systems, the IoT must meet various stringent requirements of CPS applications (e.g., privacy, security, timing correctness). The paper entitled “*Quantifying the Utility-Privacy Tradeoff in the Internet of Things*” addresses the tradeoff between the quality

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of collected data and an adversary's ability to infer a consumer's privacy. Security issues and proposed solutions are discussed in two papers, entitled "*Switching and Data Injection Attacks on Stochastic Cyber-Physical Systems: Modeling, Resilient Estimation, and Attack Mitigation*" and "*Dynamic Security Analysis of Power Systems by a Sampling-based Algorithm*," respectively. CPS applications are usually time-critical and hence IoT must ensure time-soundness. This issue is addressed in the paper entitled "*Time-Soundness of Time Petri Nets Modelling Time-Critical Systems*." Application programs in the CPS/IoT environment are different from traditional ones. The paper entitled "*A Self-Stabilizing Publish/Subscribe Middleware for IoT Applications*" deals with middleware support for IoT applications, while papers entitled "*Building Rules: A Trigger-Action Based System to Manage Complex Commercial Building*" and "*Long-Term Event Processing over Data Streams in Cyber-Physical Systems*" address programming models for IoT applications.

We would like to thank the authors of these papers for their hard and diligent work to produce excellent quality contributions. Our appreciation is extended to the reviewers of the papers for their in-depth reviews and great efforts in improving the quality of the papers. A special thanks is due to Editor-in-Chief Tei-Wei Kuo for his vision, guidance, and trust. We appreciate Ms. Ada Leong at the University of Macau for her dedicated management of the review process. We are also indebted to the editorial office at Taiwan National University and the publishing and production teams at ACM for their assistance in the preparation and publication of this issue. All the aforementioned efforts were very important in making this special issue a success.

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