Abstract: I will present 3 challenge problems where computation and communication are tightly coupled to control large, complex and “messy” plants. These span safety-critical domains of medical devices, energy-efficient buildings, autonomous vehicles and human interaction with the Internet of Things. Medical Devices - From Verified Models to Verified Code: The design of bug-free and safe software is challenging, especially in complex implantable devices that control and actuate organs whose response is not fully understood. Safety recalls of pacemakers and implantable cardioverter defibrillators between 1990-2000 affected over 600,000 devices, 41% of those were due to firmware issues. I will describe our efforts to develop the formal foundations of verified closed-loop models of the pacemaker and the heart to the synthesis of verified medical device software and systems. Energy Systems - Scheduling of Control Systems for Peak-power Minimization: In buildings, heating, cooling and air quality control systems operate independently of each other, often causing temporally correlated energy demand surges. As peak power prices are 200-400 times that of the nominal rate, this uncoordinated activity is both expensive and operationally inefficient. We present approaches for fine-grained coordination of energy demand by scheduling energy control systems within a constrained peak power while also facilitating custom climate environments. Autonomous Vehicles – Co-design of Anytime Computation and Control: Today’s autonomous vehicles require heavy-duty computation for perception, as the hardware is over-engineered to meet the worst case of the run-to-completion algorithms. With the goal to reduce the platform cost and energy by 10x, we investigate anytime computation and control. On the computation side, the control flow graph adapts at runtime to meet a contract time. This is coupled with a robust controller that provides feedback to the computation side in terms of the contract time and minimum estimation quality to maintain stability and tracking performance. I will also showcase new efforts in the future of entertainment, toys and wellness from xLAB.

Biography: Rahul Mangharam is an Associate Professor in the Dept. of Electrical & Systems Engineering and Dept. of Computer & Information Science at the University of Pennsylvania. He directs mLAB: Real-Time and Embedded Systems Lab and xLAB: Experience Design and Technology Lab at Penn. His interests are in real-time scheduling algorithms for networked embedded systems with applications in medical devices, energy efficient buildings, automotive systems and industrial wireless control networks. He received his Ph.D. in Electrical & Computer Engineering from Carnegie Mellon University where he also received his MS and BS in 2007, 2002 and 2000 respectively. He has worked on ASIC chip design at FORE Systems (1999) and Gigabit Ethernet at Apple Computer Inc. (2000). In 2002, he was a member of technical staff in the Ultra-Wide Band Wireless Group at Intel Labs. He was an international scholar in the Wireless Systems Group at IMEC, Belgium in 2003. Rahul received the 2014 IEEE Benjamin Franklin Key Award from the IEEE Philadelphia Section, 2013 NSF CAREER Award, 2012 Intel Early Faculty Career Award and was selected by the National Academy of Engineering for the 2012 US Frontiers of Engineering. He was the Stephen J. Angelo Term Chair Assistant Professor at the University of Pennsylvania from 2008-2013.
Indoor Location Sensing: Where Are We?

**Abstract:** Location sensing is a fundamental service in mobile systems. With people and most things spend majority time indoors, indoor location sensing is the next frontier for location-based services and analytics. However, unlike outdoor location sensing, there is no system like GPS that can provide unified solution for indoor location. In this talk, I will give an overview of typical localization paradigms and representative solutions to derive a view that indoor location sensing is a tradeoff between infrastructure complexity, mobile device complexity, and accuracy. I will then describe our work on using FM signals and direct GPS sensing for indoor localization. Towards the end, I will summarize our experience and observations from the indoor location competition we organized in the past two years, and discuss a few future technical directions.

**Biography:** Dr. Jie Liu is a Principal Researcher at Microsoft Research-NExT, Redmond, WA, and the director of its Project Vesta. His research interests root in understanding and managing the physical properties of computing. Examples include timing, location, energy, and the awareness of and impact on the physical world. He has published broadly in areas such as sensor networks, embedded systems, mobile and ubiquitous computing, and data center management. He also holds more than 70 patents in these fields. He is an Associate Editor of ACM Trans. on Sensor Networks, was an Associate Editor of IEEE Trans. on Mobile Computing, and has chaired a number of top-tier conferences. He received his Ph.D. degree from Electrical Engineering and Computer Sciences, UC Berkeley in 2001, and his Master and Bachelor degrees from Department of Automation, Tsinghua University, Beijing, China. From 2001 to 2004, he was a research scientist in Palo Alto Research Center (formerly Xerox PARC). He is an ACM Distinguished Scientist.