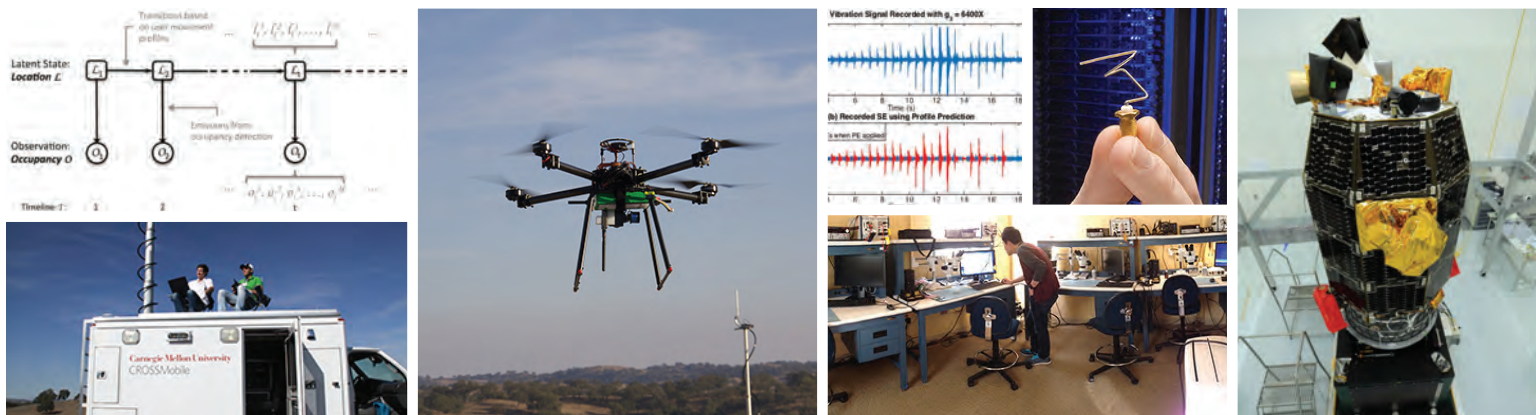


# Mobile Systems

## Electrical & Computer Engineering



Mobile computing is transforming societies and economies, and the Internet of Things may well become the single largest system the world has ever known. Hundreds of billions of devices will be connected in ways that will encourage creativity and inspire decades of innovation.

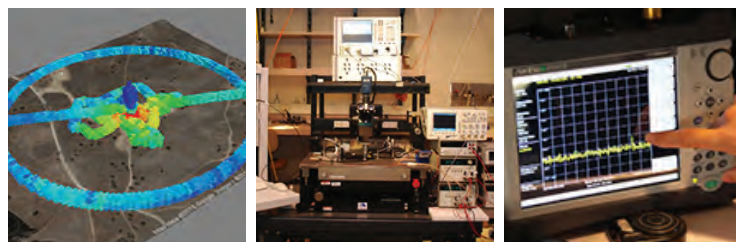
While it may seem that the mobile revolution is well underway, we are only just beginning to explore deep integration of connected computing into our lives. For the IoT, we have barely started thinking about large-scale systems, how they will be composed, and what we will be able to do with them.

With this in mind, we are actively exploring core technologies and systems-level issues, including; cellular networks as a platform for wide-area cyber-physical systems; survivable and resilient mobile systems; antenna system synthesis; mobile network and device security and privacy; power- and energy-optimized devices; federation of IoT systems; context and situational awareness; cloud-connected embedded computing; and mobile and sensor systems in the third dimension, or IoT-in-the-sky.

Mobile systems research includes deep investigations into essential elements of mobility. In addition, mobile systems research seeks to understand how reliable, secure, trustworthy systems can be composed out of wirelessly-connected elements. In doing so, we actively collaborate across areas of specialization to define and pursue across

areas of specialization to define and pursue research challenges that demand a systems perspective.

Given the rapid pace of innovation in the commercial marketplace, mobile systems research at CMU has vital ties to industrial partners and has also been the genesis of new companies. ECE research in mobile systems is well-connected to related work in Engineering and Public Policy, the CyLab Mobility Research Center, and Computer Science.



# ECE expertise

## Wireless sensor networking



We are now beginning to see practical wireless sensor network deployments making their way to industry. ECE researchers in this space are tackling the next set of challenges associated with ultra low-power networking, system architectures and ontologies for accessing, storing and analyzing sensor data streams at scale. *Contact: Pei Zhang*

## Wireless emergency alerting



When severe weather, terrorist threats, or other emergencies occur, government officials alert the public by sending text messages to smartphones and other mobile devices. The current delivery and targeting system is ineffective to the point that individuals disable the messages, reducing the effectiveness of the system. ECE researchers are applying new technologies and system architectures for accurate targeting and more effective use of the alerting system. *Contact: Hakan Erdogmus*

## Wireless network security



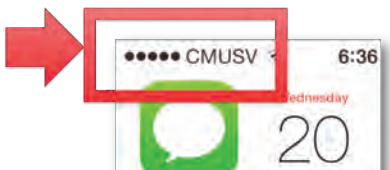
We are actively investigating performance, security, and privacy in wireless communications, networking, and mobile systems, including modeling and evaluating vulnerabilities in wireless ad-hoc, mesh, and sensor networks; designing robust networking protocols for ad-hoc networks, wireless embedded systems, cognitive radio networks, and cyber-physical systems; and developing robust and secure services for smartphones and other mobile platforms. *Contact: Patrick Tague*

## Mobile computing, visual coaches, and cloudlets



A confluence of technologies including miniature electronics, digital communications, human-computer interaction, robotics, and machine learning makes possible the creation of intelligent systems that monitor and communicate with users, infer their context, understand their needs and goals, and compensate for diminished cognitive and physical capabilities. Termed "virtual coaches," these systems can monitor physiological parameters, identify trends, provide guidance, correct errors, and motivate. The computational demands for these capabilities are provided by cloudlets located in local access points reducing latency while provisioning light weight wearable systems. *Contact: Dan Siewiorek*

## Mobile network architecture



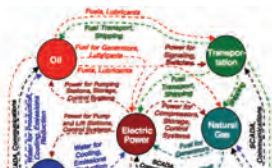
Commercial mobile network architectures emerged from their wired counterparts in an evolutionary manner. Market pressures fueled upgrades in bandwidth and functionality. Decades later, these networks maintain historical artifacts from wired networks, and the artifacts work against fundamental needs of mobile systems. We are creating the CROSSMobile architecture as an alternative, emphasizing openness and programmability at every level. *Contact: Bob Iannucci*

## Antenna system design



As antenna systems become more complex and support ever-increasing communication requirements, it becomes crucial to have automated tools assist engineers in designing such systems. We are studying and developing advanced stochastic search algorithms that can automatically design and optimize antenna systems, to achieve increased performance, lower cost, smaller form factors, and improved reliability. *Contact: Jason Lohn*

## Robust and optimal design of interdependent and multi-layer networks



Complexity is now the limiting constraint in the design, engineering, and operation of large-scale communication and engineering systems that often consist of multiple inter-connected networks. A direct consequence of this complexity is the increased vulnerability against component failures and adversarial attacks. ECE researchers actively work on novel approaches on modeling, design, and optimization of robustness in complex, multi-layer networks. *Contact: Osman Yagan*

## Integrated circuits for next-generation communications



Wireless communication is undergoing a revolution in order to meet emerging demands that are dictated by new applications, high data rates and low energy consumption. In order to meet such demands, ongoing research within ECE is focused on developing integrated circuits and systems that can operate at high frequencies while consuming little energy, can be reconfigured to meet a wide variety of communication scenarios, and adapt dynamically to the mobile spectral environment. *Contact: Jeyanandh Paramesh*