The Internet of Things Is Here

The Internet of Things (IoT) is a topic that engenders excitement, skepticism, and anxiety. Supporting these feelings are expectations regarding the potential value that the IoT can create today and into the future, the “hype-cycle” considerations, and the risks regarding security and privacy. Yet the fact is, the Internet of Things is here. Now. Higher education thus has an opportunity to support the development and deployment of the technical and business model innovations for an IoT-enabled economy, to build the leaders of the IoT-enabled economy today and into the future, and to address the TIPPSS risks related to the IoT: Trust, Identity, Privacy, Protection, Safety, and Security.

The current reality of the IoT is already staggering, not even considering the expectations and hype about the future: billions of physical devices, across the world, that have digital sensors and are interconnected by leveraging the Internet or other network technology. An estimated 13.4 billion devices were connected in 2015, representing more than twice the human population on the planet at the time, and this number is projected to nearly triple, to 38.5 billion devices, by 2020.1 Connecting the physical to the digital world can encompass a wide range of objects: vehicles, appliances, lighting, health and wellness devices, manufacturing systems, buildings, bridges, water pipes, food containers, electric meters, security systems, cameras, wearable devices, drones, and many more. These objects are connected through a digital sensor that collects and transmits data to other devices or to a centralized management system. The public Internet or private networks connecting these devices provide the communications between these devices—or “things.”

A report recently published by Internet2 highlights the IoT at the top of the “Key Information and Communications Technology Trends for the Research and Education Community” through 2025.2 According to some estimates, the IoT could create $11.1 trillion in global economic value by 2025, representing 11 percent of global gross domestic product (GDP).3 This economic value reflects both the upside revenue potential for IoT-related devices, applications, and services and also the efficiencies and cost reductions generated through the IoT. This multi-trillion-dollar opportunity not only attracts investments but also requires innovation in technology and business models to be enabled. The risk factors of the IoT require additional research and development.

The higher education community can lead the development of the technologies, business models, ethics, and leaders of the IoT-enabled world. For example, professors of engineering and computer science are directing IoT labs for the improvement of IoT technologies, including security design. They can work with business schools to design curricula and form IoT clubs to create new business models. Law schools can teach IoT ethics, privacy, and policy. Medical schools can enable the “Internet of Medical Things.” Informatics programs can teach how to leverage the volumes of IoT data, with TIPPSS. Through such efforts, the higher education community can work across disciplines to develop the technologies, business models, and leaders for the IoT-enabled economy of the future.

The Importance of the IoT to Higher Education

1. The IoT is on campus now. Whether we’re ready or not, the IoT has already infiltrated the university experience. Students are coming to college with an average of seven unique IoT devices.4 Since students are arriving on campus with so many devices, higher education institutions can leverage this opportunity to enhance the student experience on several fronts. For instance, they can use students’ smartphones and smartwatches as a communications mechanism. At Virginia Tech, the VT Alerts (https://wwwalerts.vt.edu/) system notifies students, staff, and faculty of a campus emergency situation. Starting at the University of Washington, a student-developed app—OneBusAway (http://onebusaway.org)—provides real-time information for metro-area bus systems not only in Puget Sound but also in other cities across the country. Leveraging the IoT, smart campuses can be test beds for early IoT innovations to inform decision making for the surrounding cities and communities and can serve in public-private partnerships.

2. The IoT needs discovery and development—which researchers, educators, and students in higher education can lead. Higher education researchers, educators, and students are in a unique place to lead the discovery and development of IoT devices, applications, systems, and services. At the 2016 South by Southwest (SXSW) interactive festival, U.S. President Barack Obama said he was there to recruit attendees to develop new platforms and ideas across disciplines and across skill sets to solve some of the big problems we’re facing today.5 IoT and analytics technology can be leveraged to capture and analyze data and provide actionable insights to improve health and wellness with the connected “Internet of Medical Things,” to improve efficiencies on campus and across communities, to reduce energy use, and to improve information capture to address public safety issues. This will require working across skill sets and disciplines to build a system view. Researchers can create end-to-end TIPPSS solutions for the IoT, including for life-critical applications such as connected health devices and connected vehicles. Researchers, educators,
3. Higher education needs to build the leaders of the future IoT economy.

The sophisticated talent within higher education systems will envision, develop, and lead the new business model and technology innovations. The future of the IoT economy can be shaped by experts and leaders in higher education and by the students they are educating. For example, the University of Wisconsin–Madison Internet of Things Lab (http://www.iotlab.wisc.edu/) is shaping technical innovation skills as students are learning to create IoT apps and end-to-end systems from devices speaking with other local devices such as in a smart home, communicating over a network to centralized management systems (e.g., building management systems), and to applications in the cloud. The UW-Madison IoT lab has become a campus hub for multidisciplinary education, research, and university-industry collaboration to learn, explore, and innovate with IoT technologies and applications in various domains. Beyond technical innovations, leaders in higher education can also guide new business model innovations, using IoT-enabled systems to create new services, improve client service, and integrate and analyze data from disparate but related systems to increase efficiencies and add value to businesses and consumers. Higher education has the opportunity to shape the future leaders of an IoT-enabled economy by designing curricula for technical and business leaders and by facilitating students and researchers to build new business processes that leverage IoT technologies in a multidisciplinary way.

Join the IoT Journey

In February 2016 the IEEE, the National Science Foundation (NSF), and Internet2 cosponsored a workshop, “End to End Trust and Security for the Internet of Things,” followed by an IEEE Experts in Technology and Policy Forum at George Washington University in Washington, D.C. These workshops attracted IT, research, academic, industry, government, lab, agency, and network leaders, resulting in a series of technical considerations and a discussion on IoT policy and ethics. The ease of developing an IoT application can lead to risks of device and individual TIPSS. As noted above, law and business professors are beginning to consider how we might design a point of view and curriculum regarding IoT ethics.

To enable higher education leadership, discovery, and development for the IoT, Internet2 offers several initiatives that campuses can join, including the IoT working group and the end-to-end trust and security working group. The IoT working group convenes higher education, industry, and government agency leaders to advance technology and ongoing innovation, ushering in a new era of the IoT. Internet2 has also launched a Smart Campus Initiative—led by a higher education CIO advisory council—to identify, develop, and enable the scaling and securing of IoT solutions across colleges and universities. Higher education leaders will be working together to create and share experiences regarding new IoT-enabled systems that improve efficiencies, energy use, the student experience, and the athletic fan experience and that integrate systems across a campus and community for a better quality of life. As part of the smart campus and IoT initiatives, Internet2 also established a task force on IoT systems risk management to identify the IoT-related risks and suggest recommendations for risk mitigation.7

Higher education has the resources and talent to develop and shape the future of the IoT, especially since it is already on our campuses. This is a topic that should be top-of-mind for college and university presidents, CIOs, researchers, educators, and technical staff as they build and position their institutions for future success.

Notes
4. “College Students Own an Average of 7 Tech Devices,” MarketingCharts, June 18, 2013.
7. For more information on these initiatives, see Internet2: “Collaborative Innovation Community”; and “April CINO Update,” April 13, 2016. If you are interested in joining the Internet2 initiatives, e-mail CINO@Internet2.edu.

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