Degree Proposal
Master of Science in Internet of Things
Institute for the Wireless Internet of Things
Department of Electrical and Computer Engineering
College of Engineering
Khoury College of Computer Sciences

Executive Summary

Within the last two decades, major breakthroughs in the field of electronics, embedded systems and wireless communications have paved the way for the development of the Internet of Things (IoT) as we know it today. The IoT defines a truly cyber-physical system in which all sorts of physical devices, ranging from standalone sensors and actuators to home appliances and vehicles, are interconnected and able to autonomously interact with each other. This new form of seamless connectivity is the enabler of many diverse applications in the fields of smart healthcare, home monitoring and automation, environmental monitoring and pollution control, smart grid and infrastructure management, real time monitoring of industrial processes, and intelligent transportation of people and goods, among many others. Not surprisingly, it has been predicted that by 2023 there will be over 14.7 billion machine-to-machine (M2M) connections or half of the total global connected devices and connections over the Internet (up from 33% in 2018). While IoT devices are and will be used in all types of industry verticals and consumer markets (including healthcare, manufacturing, and retailing), connected home applications will have nearly half or 48% of M2M share by 2023, and connected car applications will grow the fastest at 30% compound annual growth rate over the forecast period (2018–2023). While IoT devices are and will be used in all types of industry verticals and consumer markets (including healthcare, manufacturing, and retailing), connected home applications will have nearly half or 48% of M2M share by 2023, and connected car applications will grow the fastest at 30% compound annual growth rate over the forecast period (2018–2023). To enable and sustain that growth, both public agencies and the private sector are making multi-billion-dollar investments, resulting also in an unprecedented demand for IoT engineers. To develop such a highly qualified workforce is the goal of this program.

The Institute for the Wireless Internet of Things (WIoT) and the Department of Electrical and Computer Engineering (ECE) in the College of Engineering (COE) together with the Khoury College of Computer Sciences (CS) propose a new Master of Science (M.S.) in IoT. The MS in IoT is an interdisciplinary program that will provide students with the necessary theoretical and practical skills to contribute to the IoT revolution and growth. These include sensors, RF and embedded system design; wireless communication and networking; machine learning, artificial intelligence and data analysis; security; and business and entrepreneurship. This will be achieved through highly interdisciplinary coursework spanning multiple colleges at Northeastern University.

The program responds to a pressing request from the leadership of the COE that in late Fall 2021 charged its departments to increase the size and scope of their graduate education plans through updated and new M.S. programs. The leadership team at WIoT replied promptly by designing the new M.S. program in IoT (among others), with the further aim to expand educational and research opportunities by reaching out to colleagues in the Khoury College of Computer Sciences. Colleagues in other colleges, including D'Amore-McKim School of Business (e.g., developing business models for IoT applications), the School of Law (e.g., relating to legal and ethical aspects of pervasive data-collecting IoT systems), and the Bouvé College of Health Sciences (e.g., focused on medical IoT and health informatics), were also contacted to craft a program that is truly interdisciplinary. The program also responds to the WIoT educational and workforce development plans, which include increased involvement with industry partners and direct leverage of the unique experimental resources available

at WIoT. The proposal for a new M.S. in IoT was presented and unanimously approved by the ECE chair, by the ECE, and both COE and Khoury Graduate Affairs Committees (GACs) and at the university level within set deadlines for new program approval.

Program Description

The Master of Science in IoT is structured as follows: a total of 32 credits are required, which students can obtain by following one of two tracks, namely, *course-only* and *Master's Project*. All students are required to complete 28 *semester hours* (SH) in *core courses*. Course-only students will complete their requirements by taking 4 SH in *elective courses*, whereas project students will complete their requirements by taking 4 SH in *project credits*. As mentioned, the program is highly interdisciplinary, with core courses from three Northeastern colleges, and electives from five different colleges.

The program favors co-op experiences as well. WIoT and Khoury have strong relationships with several companies in the IoT, wireless, defense, computing, and manufacturing areas, which are sponsoring research or partnering in various ways with faculty and researchers. These companies, which include AT&T, Raytheon, Verizon, MITRE, Interdigital, Mavenir, Dell, NVIDIA, Qualcomm, Draper, Facebook, Red Hat, Mathworks, JMA Wireless, VIAVI, Keysight, National Instruments, US Ignite, Intelligent Automation, Andro Computational Solutions, Airanaculus, will be targeted as co-op partners for students in the new program.

Through the combination of courses, industry training through co-op, and research experience at the WIoT, students who complete the M.S. in IoT will be able to 1) Understand the state-of-the-art solutions relating to the building blocks from the IoT, from sensors and embedded systems, through communication and networking, to data application and analytics; 2) Design, implement and orchestrate IoT systems, utilizing theoretical, numerical, and experimental tools; and 3) Anticipate and adapt to new distributed data application requirements, networking architectures and communication techniques. These will be the three outcomes that will be used to pursue accreditation of the program.

Program Contribution to the University's Mission

The proposed program is well aligned with university objectives. At the **department level**, the program builds on the strengths of electrical engineering (nanoelectronics, embedded systems, communications, signal processing and control), computer engineering (computer networking, security and data science), and computer science (security) and offers an integrated path for students who want to cover the three key components of the IoT, namely, the Internet (communication networks), the Things (embedded systems) and an overlaying pervasive intelligence (AI, data analytics and optimization). Traditionally, this has not been the case as students are asked to select a concentration either within the Internet component of the IoT, usually Communications, Control and Signal Processing (CCSP) or the Computer Networks and Security (CNWS), or within the Things component, usually Microsystems, Materials, and Devices (MSMD). This program will prepare students to think at the system level (Internet) while being able to contribute at each individual level, starting from the devices (Things). At the **colleges level**, the program builds on the existing strengths and international leadership of our faculty in research initiatives that continue to shape the future of our hyperconnected society. At the **institute level**, the WIoT is at the forefront of IoT research in the country, including next generation wireless and wired communication networks, the use of machine learning for network orchestration and management, and, overall, large scale experimental research. All these will be key components of the proposed program. At the **university level**, the program contributes to the mission of providing an innovative, experientially driven education to students who can make a positive impact on society. Students graduating from this program will be equipped with theoretical and experimental tools to address critical societal needs, such as the development of technologies at the basis of smart homes, cities and transportation networks, transformative healthcare applications, and climate change studies.