Keynote: Scalable Cloud-Edge-Beneath Architectures for City-Scale Internet of Things

Sumi Helal
Professor & Chair in Digital Health
Director, Centre on Digital Health and Quality of Life Technologies
School of Computing and Division of Health Research
Lancaster University, UK

KEYNOTE ABSTRACT

Recent advances in IoT and pervasive and ubiquitous computing provide a glimpse into the future of our planet and reveal exciting visions of smart many things: smart cities, smart homes, smart cars, in addition to smart spaces such as malls, workplaces, hotels, schools, and much more. Driven by a technological revolution offering "low-power many things and wireless almost everything", we could, in only a decade, envision and prototype impressive smart space systems that improve quality of life, enhance awareness of resources and the environment, and enrich users' experience. But prototyping is one thing; actual large-scale deployments are another. The massive scale of sensors and IoT devices that will be deployed in highly populated smart cities of the future will be mind-bugling. Without a carefully-thought ecosystem and a scalable architecture in place, it will be extremely difficult to manage or program such an expanding and massive IoT. In this talk, I will start by raising the thought of how can we estimate the Value of the IoT as we once estimated the value of the network. I will then introduce our recent work - the Cloud-Edge-Beneath (CEB) architecture, and present its salient scalability features. I will also present CEB's bi-directional waterfall optimization framework and show how it leads to "sentience-efficiency" - a new paradigm for realizing aggressive energy-efficiency. I will then present an event-driven programming model based on CEB and show how the model and CEB, combined, foster a much-needed IoT programmability ecosystem. Finally, I will present a validation study demonstrating CEB's scaling behavior in face of IoT expansions (sensors and applications) and under dynamically increasing loads.

SPEAKER'S BIOGRAPHY

Sumi Helal, is professor and Chair in Digital Health at Lancaster University, UK, where he leads interdisciplinary research initiatives in digital health in both the School of Computing and Communications (Faculty of Science and Technology) and the Division of Health Research (Faculty of Health and Medicine). As Director of Lancaster University's Center on Digital Health and Quality of Life Technologies, he leads several active projects on Connected Health Cities, Healthy New Towns design and implementation, suicide prevention using cybernetics and analytics, Airport Accessibility for the hearing impaired, and intelligent primary care GP-Patient interactions. He is a board member and lead of the digital health infrastructure and strategies in the Fylde Whyndyke Garden Village - one of ten NHS England Healthy New Towns development project (a 1400-unit, green grass development which provides for a unique opportunity to embed health elements, by design, in public areas, neighborhoods, and the town community hub (school, wellness center and health care facility), to promote health and wellbeing, active and healthy living and ageing, prevent illnesses and improve people's quality of life.

Before joining Lancaster, Prof Helal was a Computer & Information Science and Engineering Professor at the University of Florida, USA, and Director of its Mobile and Pervasive Computing Laboratory. He co-founded and directed the Gator Tech Smart House, a real-world deployment project that aimed at identifying key barriers and opportunities to make the Smart Home concept a common place (creating the "Smart Home in a Box" concept). His active areas of research focus on architectural and programmability aspects of the Internet of Things, and on pervasive/ubiquitous systems and their human-centric applications with special focus on smart spaces, proactive health/wellness, patient empowerment and e-coaching, and assistive technology in support of personal health, aging, disabilities, and independence. Professor Helal served as the Editor-in-Chief of IEEE Computer (2015-2018), the Computer Society's flagship and premier publication. He currently serves as member of the Board of Governors of the IEEE Computer Society, and Chair of its Magazine Operational Committee. Professor Helal is a Boilermaker (Ph.D., Purdue University, class of 1991), Fellow of the IEEE, Fellow of the AAAS, Fellow of the IET, and the 2020 IEEE Computer Society President-Elect nominee. Contact him at "sumi.helal@ieee.org".