Pervasive Computing and the Internet of Things

Maria R. Ebling, IBM T.J. Watson Research Center

This issue marks a change that has been in the works for 18 months. In case you didn’t notice, our subtitle has changed from “Mobile and Ubiquitous Computing” to “Mobile Systems | Ubiquitous Computing | Internet of Things.” How does IoT differ from pervasive computing, and why did we add it to our subtitle?

INTERSECTING COMMUNITIES

According to Webopedia.com, pervasive computing, also called ubiquitous computing, “is the idea that almost any device, from clothing to tools to appliances to cars to homes to the human body to your coffee mug, can be imbedded [sic] with chips to connect the device to an infinite network of other devices…. in such a way that the connectivity is unobtrusive and always available.”

The origins of IEEE Pervasive Computing are in realizing the vision outlined in Mark Weiser’s seminal Scientific American paper, “The Computer for the 21st Century,” published in 1991. This vision is summarized by his famous opening statement: “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.” Mahadev Satyanarayanan outlined this origin in our inaugural issue, and we revisited our progress toward Weiser’s vision in a special issue recognizing the 20th anniversary of Weiser’s seminal article.

Webopedia.com defines IoT as “the ever-growing network of physical objects that feature an IP address for Internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.” It goes on to say that IoT “extends Internet connectivity beyond traditional devices … to a diverse range of devices and everyday things that utilize embedded technology to communicate and interact with the external environment, all via the Internet.”

Like pervasive computing, the origins of IoT date back to a visionary researcher from the 90s. In 1999, just eight years after Weiser’s seminal article, Kevin Ashton, the head of the Auto-ID Center at MIT, made a presentation to Procter & Gamble entitled, “Internet of Things.” In fact, numerous overviews of IoT explicitly reference both Weiser’s article as well as Ashton’s presentation (also see http://postscapes.com/internet-of-things-history). According to Friedemann Mattern and Christian Floerkemeier,

The Internet of Things represents a vision in which the Internet extends into the real world embracing everyday objects. Physical items are no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. An Internet of Things makes computing truly ubiquitous—a concept initially put forward by Mark Weiser in the early 1990s.

Pervasive computing and IoT examine similar problems and face similar challenges. Some might argue that pervasive computing focuses more on HCI issues—on making the connected things disappear from human attention—while IoT focuses more on connecting the devices. Yet the IoT community also focuses on HCI issues, and the pervasive community thinks about connecting devices too. Both communities are interested in issues beyond just technology, such as privacy, security, and ethics. Both communities are pur...
suing similar use cases, including smart cities, environmental monitoring, agriculture, home automation, and health and wellness monitoring.

The communities behind pervasive computing and IoT share the same (or at least largely overlapping) technical interests and goals, so I encourage our readers to participate in IoT forums, and I welcome submissions from the IoT community. I hope that our subtitle change will help our communities join forces and collaborate. We will all make faster progress if we work together toward our common goals.

IN THIS ISSUE
One topic of interest to both communities is that of smart vehicles, so it is highly appropriate that smart vehicle spaces is the theme of our first special issue under our new subtitle. Steve Hodges, Brian Noble, and Venkatesh Prasad have done a tremendous amount of work on this issue, arranging for an interview and a spotlight column in addition to the themed articles. I want to thank them all for their efforts in bringing you this special issue.

In addition to our theme articles, we also have four feature articles and several departments, many of which should be of interest to both the pervasive and IoT communities. In “Soft Actuation: Smart Home and Office with Human-in-the-Loop,” Jaroslaw Domaszewicz, Spyros Lalis, Alexander Pruszkowski, Manos Koutsoubelias, Tomasz Tajmager, Nasos Grgropoulos, Michele Nati, and Alexander Gluhak present a system focused on “soft actuation” in which the smart home or office infers a context switch that requires an actuation and triggers its human-in-the-loop to make the actuation. The authors focus on ensuring that the soft actuation remains “calm” by paying careful attention to when to interrupt the user and by providing nonintrusive hints that are easily ignored and sometimes undetected.

Next, Sarah Clinch, Nigel Davies, Mateusz Mikusz, Paul Metzger, Marc Langheinrich, Albrecht Schmidt, and Geoff Ward present “Collecting Shared Experiences through Lifelogging: Lessons Learned.” This article describes their Grasmere House experience, in which they collected lifelogging data in an immersive environment that included instrumenting the house as well as deploying wearable, connected cameras over a period of almost three days. One really interesting aspect of this experiment is that they had almost two dozen lifeloggers living in one house. They outline the experiment and explain the many lessons learned. I encourage anyone interesting in lifelogging to have a look at this study.

In “Crowdsensing in the Wild with Aliens and Micropayments,” Manoop Talasila, Reza Curtmola, and Cristian Borcea describe two crowdsensing experiments that they recently completed at the New Jersey Institute of Technology. The two experiments involved a mobile, first-person-shooter game—in which users complete sensing tasks by defeating aliens around...
the campus—and a micropayment system—in which participants are paid to complete specific sensing tasks around the campus. The authors describe the two experiments and offer lessons learned about these different approaches to crowdsensing incentives. This article addresses a situation in which the world is not fully instrumented with connected sensors and in which you need to incentivize mobile agents (in this case humans) to augment the sensor network.

Finally, in “Software Support for Multitouch Interaction: The End-User Programming Perspective,” Andrea Bellucci, Marco Romano, Ignacio Aedo, and Paloma Diaz present a survey examining the state-of-the-art of software development tools that support the creation of multitouch sensing interactions by end-user programmers. They examine tools ranging from software developer’s kits provided to support various mobile devices to libraries designed to support touch-based interactions in Web applications.

In our Smartphones department, Ella Peltonen, Eemil Lagerspetz, Petteri Nurmi, and Sasu Tarkoma discuss their work in understanding and characterizing the energy consumption of a wide variety of system settings available to smartphone users with a technique that leverages crowdsourcing. The authors provide useful tips for readers as well as access to their data, which others can use in their own research.

Our Wearable Computing department focuses on watches. Kent Lyons, in “Smartwatch Innovation: Exploring a Watch-First Model,” examines the different types of disruptive innovations and asks whether a smartwatch falls into each type of disruption. He examines whether a smartwatch is an innovation for the smartphone, an innovation for a watch, or a disruptive innovation of its own. He then examines the movement toward “watch first” and what it would take for a watch to be an independent platform of its own. His analysis is well worth reading!

Mary Baker and Justin Manweiller discuss drones, robots, and IoT in Notes from the Community. I haven’t followed the developing drones market closely, and I am amazed at the types of drones becoming available. On the robot front, I was surprised to learn that household robots (aka roombas) outnumber industrial robots almost 10 to 1. I particularly liked the discussion of the IoT-enablement of the sushi conveyer-belt restaurants! And the ability to detect depression from a person’s smile seems like important progress for diagnosing mental health issues.

Our Innovations in Ubicomp Products column examines how cloud-based AI APIs can be used to enhance your pervasive computing products and prototypes. These APIs include capabilities around speech recognition, computer vision, text analytics, machine learning, and more. Albrecht Schmidt shows readers how to make a sample call to three different AI services and then shows the sample output produced by each. He concludes that incorporating basic AI capabilities into your pervasive applications is relatively simple and requires only minimal programming skills, but that complex capabilities might require someone with expertise in computer vision, speech, or the like, depending on your needs.

In Pervasive Health, Stephen Intille discusses the Precision Medicine Initiative (PMI), which was announced by President Obama approximately one year ago. The PMI, which has also been called personalized medicine, has significant implications for pervasive health research and presents numerous challenges for the pervasive computing community to address in the years to come. Imagine collecting all the health and behavior data for a cohort of more than one million individuals and following those individuals longitudinally for decades. Those of you working in the healthcare space will want to read this article carefully; those of you concerned about your own or your loved ones’ health and wellness will find the initiative interesting.

Our upcoming 2016 editorial calendar includes topics that should be of interest to both the pervasive and IoT communities, with special issues on Domestic Pervasive, Pervasive Displays, and Energy Harvesting and Power Management (see the sidebar for more information). I hope that our colleagues in the IoT community will join us in our explorations of these, and future, topics.

REFERENCES


Maria R. Ebling is a director at the IBM T.J. Watson Research Center. She manages a team building systems capable of supporting a Smarter Planet while not forgetting about the people who use such systems. Ebling received her PhD in computer science from Carnegie Mellon University. She’s a member of the IBM Academy of Technology, a distinguished member of the ACM, and a senior member of IEEE. Contact her at ebling@us.ibm.com.

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