

Nanoscale Chip Design Enables Future 'Internet of Things'

POSTED BY: DEXTER JOHNSON / THU, FEBRUARY 07, 2013

With each passing day we are becoming more intertwined into the Internet of Things, where each and every object in the world—your clothes closet and every article of clothing in it, your dishwasher and every dish in it, and so on—has its own IP address. Obviously, they will communicate wirelessly. That takes power and, in many cases, frequent battery changes.

Now Peter Kinget, a professor of electrical engineering at Columbia University, and his colleagues have developed a nanoscale chip that requires so little energy in transmitting wireless signals that the batteries may never need to be replaced.

The chip will be presented at the at the IEEE International Solid-State Circuits Conference (ISSCC) meeting in two weeks by Kinget's Ph.D. student Baradwaj Vigraham under the user-friendly title "A Self-Duty-Cycled and Synchronized UWB Receiver SoC Consuming 375pJ/bit for -76.5dBm Sensitivity at 2Mbps."

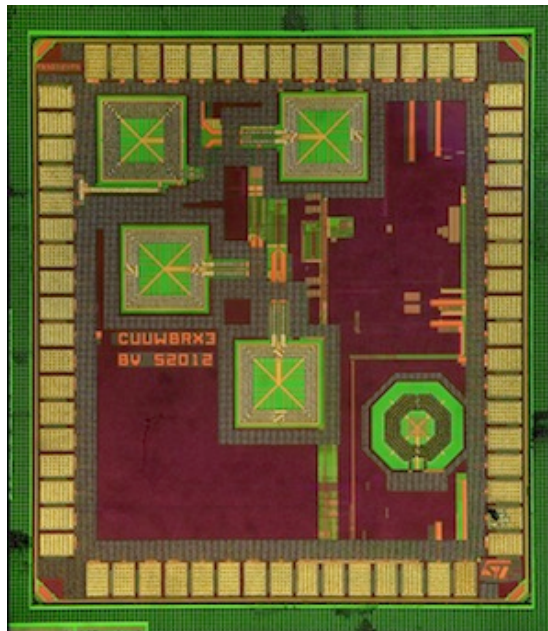
The research is part of a larger, award-winning research program called EnHANTs. "The goal of Enhants is to make thin, flexible, energy self-reliant tags that can be attached to common objects (clothes, furniture, toys, books, walls, windows, shelves, etc.) in our environment for applications such as the Internet of Things, logistics, tracking and search, or disaster recovery," explains Kinget.

To this end the credit-card-size tags Kinget and his collaborators (Gil Zussman and John Kymissis) have developed will collect energy with photovoltaic cells. The photovoltaics will draw energy from artificial light in addition to sunlight since indoor applications are of key interest.

The tags will form wireless mesh networks using ultra-wideband pulse radio wireless communications. Kinget's chip, then, is a receiver for this type of ultra-low power wireless communications.

Pulse radio as a unique solution for short-range, low data-rate, wireless links has been receiving a lot of research interest in the last couple of years, largely in the academic community for applications like tag and sensor networks—connecting biomedical sensors, for example, according to Kinget.

The unique pulsed nature of the signal allows for new ways to communicate with ultra-low power consumption. For example, if you wanted to communicate at a rate of 2Mbit/sec, the chips send 3- to 4-nanosecond-wide pulses 500 ns apart. This means that in between pulses, the electronics can be shut down to save power.



As a result, the Columbia team's latest chip only needs to consume 375 pJ (picojoule) of energy to receive a bit. This is several times lower than the state of the art in research prototypes of pulse radio receivers, according to Kinget. He adds that pulse radio receivers are 10 or 100 times more power efficient than current commercial solutions. In their latest research the team has demonstrated novel techniques to efficiently synchronize and duty cycle the receiver electronics.

"The energy expenditure in these types of tags is largely dominated by the energy needed for wireless

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communications so an important part of the research is focusing on making the wireless communications as low power as possible,” Kinget told me. “We are tackling the problem all the way from devices, to circuits, to communications and networking.

The chip that Kinget and his colleagues have developed is a prototype. “The device is an SoC (system on chip) design which means that it does include a very large part of the required functionality to demonstrate the research ideas we are developing,” says Kinget. “But it is not a fully featured commercial product design.”

While the team has not developed commercial applications yet, it has built and demonstrated various generations of an EnHANTs testbed <http://enhants.ee.columbia.edu/prototype> that uses ultra-wideband pulse radio communications. “The testbed is currently using earlier versions of our chip designs but we are constantly upgrading the test bed with new features including on the wireless links,” says Kinget.

“There is a lot of interest in this type of technology from a wide variety of industries given the broad application opportunities for tag and sensor networks,” says Kinget. “We have received funding or donations through several federal agencies and companies—see the EnHANTs website. For this particular chip, the National Science Foundation, Texas Instruments, and ST Microelectronics have provided support.”

Photo: Baradwaj Vigraham and Peter Kinget/Columbia Engineering

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It would be nice to collect the wireless power and store it instead of using photovoltaic cells.

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Congratulations Baradwaj !

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