New Software Alleviates Wireless Traffic

University of Michigan

Ann Arbor—The explosive popularity of wireless devices—from WiFi laptops to Bluetooth headsets to ZigBee sensor nodes—is increasingly clogging the airwaves, resulting in dropped calls, wasted bandwidth and botched connections.

New software being developed at the University of Michigan [1] works like a stoplight to control the traffic and dramatically reduce interference.

The software, GapSense, lets these devices that can't normally talk to one another exchange simple stop and warning messages so their communications collide less often. GapSense creates a common language of energy pulses and gaps. The length of the gaps conveys the stop or warning message. Devices could send them at the start of a communication, or in between information packets to let other gadgets in the vicinity know about their plans.

"All these devices are supposed to perform their designated functions but they're using the same highway and fighting for space," said Kang Shin [2], the Kevin and Nancy O'Connor Professor of Computer Science at U-M. "Since they don't have a direct means of communicating with each other because they use different protocols, we thought, 'How can we coordinate them so that each can perform their functions while minimizing interference with the others?'"

The researchers tested GapSense and found that it could reduce interference by more than 88 percent on some networks with diverse devices. Shin and Xinyu Zhang, a former doctoral student in electrical engineering and computer science, will present the work April 18 at the IEEE International Conference on Computer Communications in Turin, Italy.

To get a sense of how many wireless devices exist today, in 2013, CTIA, the Wireless Association counted more than 321 million WiFi-enabled cell phones, laptops and tablets in the United States. That's more than one device per person, and it's just the items that use WiFi, the protocol that transmits big chunks of data over relatively long distances.

Bluetooth and ZigBee use the same wireless spectrum as WiFi, but they all speak different languages. Bluetooth, shorter range and less powerful, can connect headsets and keyboards to phones and computers, for example. ZigBee, the lowest powered of the group, links networks of small radios to automate home and building systems such as lighting, security alarms and thermostats. It's also found in hospitals, where it gathers medical data from patients.

All these devices are already equipped with the standard "carrier sense multiple access," or CSMA, protocol that programs them to listen for radio silence before they send their own transmissions. But often it doesn't work.

ZigBee takes 16 times longer than WiFi to gear up from its idle state to transmit information, so sometimes it might sound to WiFi that the coast is clear when a ZigBee packet is on its way out.

"The little guy might be talking, but big guy cannot hear it," Shin said. "So the little guy's communication will be destroyed."

That's just one of several potential problems GapSense can help remedy. The researchers tested the software in a simulated office environment. With moderate WiFi traffic, they detected a 45 percent collision rate between ZigBee and WiFi, and GapSense reduced that to 8 percent.

The software could also address the so-called "hidden terminal" problem. Newer WiFi standards allow for faster data rates on wider bandwidths than the standard 20 megahertz, but devices on different bandwidths can't hear one another's communications to avoid talking over them. GapSense could enable these devices on different standards to talk in turn. At moderate WiFi traffic, the researchers detected around 40 percent collision rate between wider- and narrower-bandwidth devices and GapSense reduced it to virtually zero.

GapSense could also reduce energy consumption of WiFi devices by 44 percent. It would accomplish this by allowing the WiFi receiver to operate at low clock rates. With the software, the faster-clocked WiFi transmitter could send a wake-up message to the slower-clocked receiver in time for it to synch and catch an information packet.

"The impact of GapSense is huge in my opinion," Shin said. "It could be the Tower of Babel for the increasingly diversified world of wireless devices."

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The paper is titled "Gap Sense: Lightweight Coordination of Heterogeneous Wireless Devices." The work is funded by the National Science Foundation. The university is pursuing patent protection for the intellectual property and is seeking commercialization partners to help bring the technology to market.

IEEE Infocom conference: http://infocom.di.unimi.it [3]

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