Researchers develop new wireless technology for faster, more efficient networks

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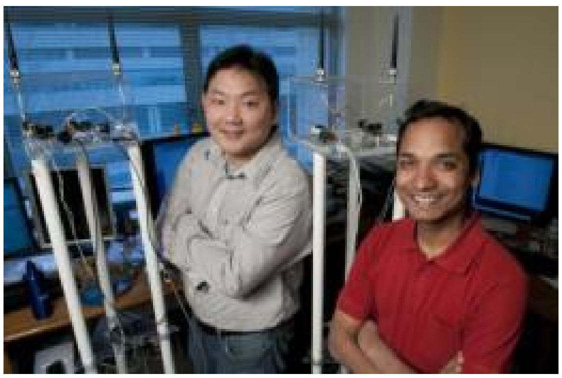

Jung Il Choi left, and Mayank Jain, both electrical engineering graduate students, pose by their demonstration setup used to show that their idea for creating full duplex wireless communication does indeed work, despite what the textbooks say about it being impossible. The third graduate student on the team, Kannan Srinivasan, is not pictured. Credit: L.A. Cicero, Stanford News Service

"Wireless communication is a one-way street. Over." Radio traffic can flow in only one direction at a time on a specific frequency, hence the frequent use of "over" by pilots and air traffic controllers, walkie-talkie users and emergency personnel as they take turns speaking. But now, Stanford researchers have developed the first wireless radios that can send and receive signals at the same time.

This immediately makes them twice as fast as existing technology, and with further tweaking will likely lead to even faster and more efficient networks in the future.

"Textbooks say you can't do it," said Philip Levis, assistant professor of computer science and of electrical engineering. "The new system completely reworks our assumptions about how wireless networks can be designed," he said.

Cell phone networks allow users to talk and listen simultaneously, but they use a work-around that is expensive and requires careful planning, making the technique less feasible for other wireless networks, including Wi-Fi.

A trio of electrical engineering graduate students, Jung Il Choi, Mayank Jain and Kannan Srinivasan, began working on a new approach when they came up with a seemingly simple idea. What if radios could do the same thing our brains do when we listen and talk simultaneously: screen out the sound of our own voice?

In most wireless networks, each device has to take turns speaking or listening. "It's like two people shouting messages to each other at the same time," said Levis. "If both people are shouting at the same time, neither of them will hear the other."

It took the students several months to figure out how to build the new radio, with help from Levis and Sachin Katti, assistant professor of computer science and of electrical engineering.

Their main roadblock to two-way simultaneous conversation was this: Incoming signals are overwhelmed by the radio's own transmissions, making it impossible to talk and listen at the same time.

"When a radio is transmitting, its own transmission is millions, billions of times stronger than anything else it might hear [from another radio]," Levis said. "It's trying to hear a whisper while you yourself are shouting."

But, the researchers realized, if a radio receiver could filter out the signal from its own transmitter, weak incoming signals could be heard. "You can make it so you don't hear your own shout and you can hear someone else's whisper," Levis said.

Their setup takes advantage of the fact that each radio knows exactly what it's transmitting, and hence what its receiver should filter out. The process is analogous to noise-canceling headphones.

When the researchers demonstrated their device last fall at MobiCom 2010, an international gathering of more than 500 of the world's top experts in mobile networking, they won the prize for best demonstration. Until then, people didn't believe sending and receiving signals simultaneously could be done, Jain said. Levis said a researcher even told the students their idea was "so simple and effective, it won't work," because something that obvious must have already been tried unsuccessfully.

But work it did, with major implications for future communications networks. The most obvious effect of sending and receiving signals simultaneously is that it instantly doubles the amount of information you can send, Levis said. That means much-improved home and office networks that are faster and less congested.

But Levis also sees the technology having larger impacts, such as overcoming a major problem with air traffic control communications. With current systems, if two aircraft try to call the control tower at the same time on the same frequency, neither will get through. Levis says these blocked transmissions have caused aircraft collisions, which the new system would help prevent.

The group has a provisional patent on the technology and is working to commercialize it. They are currently trying to increase both the strength of the transmissions and the distances over which they work. These improvements are necessary before the technology is practical for use in Wi-Fi networks.

But even more promising are the system's implications for future networks. Once hardware and software are built to take advantage of simultaneous two-way transmission, "there's no predicting the scope of the results," Levis said.

Provided by Stanford University

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