Melding Wi-Fi with digital TV 'white space'

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Rice University researchers have won a $1.8 million federal grant for one of the nation's first, real-world tests of wireless communications technology that uses a broad spectral range -- including dormant broadcast television channels -- to deliver free, high-speed broadband Internet service. The five-year project calls for Rice and Houston nonprofit Technology For All (TFA) to add "white space" technology to the wide spectrum Wi-Fi network they jointly operate in Houston's working-class East End neighborhood.

The TFA Wireless network, launched in 2004 with a grant from the National Science Foundation (NSF), today uses unlicensed frequencies ranging from 900 megahertz (MHz) to 5 gigahertz. The new grant -- also from the NSF -- will allow researchers to take advantage of new federal rules that allow the use of licensed TV spectrum between 500 MHz to 700 MHz. The network will dynamically adapt its frequency usage to meet the coverage, capacity and energy-efficiency demands of both the network and clients.

The new grant will pay for the development and testing of custom-built networking gear as well as smart phones, laptops and other devices that can receive white-space signals and seamlessly switch frequencies -- in much the way that today's smart phones connect to the Internet via either Wi-Fi or a cellular network. The grant will also allow Rice social scientists to conduct extensive studies in the neighborhood to find out how people interact with and use the new technology.

"Ideally, users shouldn't have to be concerned with which part of the

spectrum they're using at a given time," said Rice's Edward Knightly, the principal investigator on the project. "However, the use of white space should eliminate many of the problems related to Wi-Fi 'dead zones,' so the overall user experience should improve."

White space is a telecom industry moniker for unused frequencies that are set aside for television broadcasters. Examples include TV channels that are unused in a particular market, as well as the spaces between channels that have traditionally been set aside to avoid interference.

"Engineers often refer to the UHF frequencies between 500 and 700 megahertz as being the beach-front property of spectrum," said Knightly, professor in electrical and computer engineering. "As many Wi-Fi users know, you don't have to move very far before you drop out of a hot spot. Low-frequency TV signals are different. One more wall or one more tree is not going to push you beyond the reach of the network. That's why rabbit-ear antennas served most of the country quite well before cable and satellite came to dominate the market."

White space has become a hot-button issue in recent years, with Congress and the FCC each debating whether to auction or make freely available the broadcast frequencies that were freed up by the 2008 switch from analog to digital TV broadcasting.

Knightly said that one payoff of the five-year NSF grant will be that all the information about the Rice/TFA tests -- how the equipment works, how much it costs to operate, how citizens use it, etc. -- will be freely available. That should make it easier for companies and municipalities to assess the cost of setting up and operating their wide-spectrum network, and it may also help regulators as they compare the pros and cons of auctioning off white-space bandwidth or freeing it for unlicensed, Wi-Fi-style development.

Robert Stein, Rice's Lena Gohlman Fox Professor of Political Science and a co-principal investigator on the grant, said Rice social scientists will work closely with computer scientists and engineers to study how the new technology is used by individuals and groups that have previously been underserved by the Internet and cellular networks.

"The grant also provides extensive research opportunities for undergraduates in the social sciences and humanities to participate in a research project that has the potential to significantly influence public policy concerning the Internet and wireless communication," said Stein, who also serves as faculty director of Rice's Center for Civic Engagement.

The new project marks the latest collaboration between TFA and Rice University. Led by Knightly, researchers from the Rice Networks Group teamed with TFA to build TFA Wireless in 2004. The network uses custom access points to provide free high-speed Internet to more than 4,000 East End residents. It also serves as a technology test bed, a place where Rice researchers can conduct real-world tests on new transmission platforms, custom-built mobile phones, in-home health-monitoring devices and other wireless gadgets.

Lin Zhong, assistant professor in electrical and computer engineering at Rice, has used the network to study cutting-edge smart phones, often by giving them to teenagers who live in the neighborhood. Zhong, a co-principal investigator on the new grant, said his group and Knightly's will study how the combination of white space and Wi-Fi can help users extend battery life and get improved reception. They'll also explore the potential energy savings from powering down Wi-Fi nodes and covering large portions of the network with a small number of white-space transmitters during off-peak hours.

"White space and Wi-Fi have quite complementary characteristics,"

Zhong said. "While a Wi-Fi node can provide a higher data rate, a white-space node can cover a much larger area. The project will study how a dynamic network architecture can combine these strengths."

Provided by Rice University