ECE professor receives $620,000 to research cognitive radio and dynamic spectrum access

CLEMSON — Many who have attempted to use a cell phone within or near a college football stadium during a homecoming game have experienced the frustration of repeated busy signals or dropped calls, which are two of the undesirable consequences of having too many communications devices attempting to use the same frequency spectrum at the same time.

Overcrowded frequency spectrum is also responsible for disruptions in wireless connections for laptop computers. An article in the Washington Post a few years ago described the frequent loss of internet access by laptop users in some urban neighborhoods, which proved to be caused by too many Wi-Fi access points in close proximity. The problems are even more complicated for Wi-Fi than for cell phones, because Wi-Fi frequency spectrum is shared with Bluetooth devices, cordless telephones, bar scanners, and microwave ovens.

The consequences of overcrowded spectrum are more serious for U.S. forces engaged in peacekeeping operations in foreign countries. Not only is it critical for our troops to communicate promptly and reliably among themselves, they must also communicate with allied units from other nations. Coalition forces from other countries may use frequencies that conflict with U.S. equipment, and civilian communications in the host country may interfere with U.S. communications devices.

The solutions being pursued for future commercial and military communications rely on intelligent communications devices, known as cognitive radios, that choose their own frequency bands rather than use the fixed allocations of spectrum that have existed since the early days of radio. In the new paradigm, a cognitive radio is permitted to search for unused spectrum instead of being confined to a predetermined frequency band. Unused spectrum exists, for example, as a result of broadcast TV channels that are idle in many parts of the country. Because different channels may be idle in different regions, a cognitive radio must automatically locate the idle channels in its neighborhood and then use them effectively without disturbing other communications receivers.

Each cognitive radio will be able to gather information about its environment, modify its operation in response to the information, and share what it has learned with other cognitive radios. These smart communications devices of the future are required to make intelligent decisions and learn from the consequences of their past behavior. In many situations, a cognitive radio will be required to detect the emergence of a new signal in the frequency band it is using and then vacate the band if the signal has higher priority.

Clemson Professor Michael Pursley, holder of the Milton and Betty Holcombe Endowed Chair in Electrical and Computer Engineering, has been awarded basic research grants totaling approximately $620,000 from the Army Research Office and the Office of Naval Research to support long-term basic research in cognitive radio and dynamic spectrum access communications. Additional support for the research is being provided by MIT Lincoln Laboratory.

The Army is sponsoring investigations of new techniques that will enable a cognitive radio to automatically adjust its communication signal as the radio's operating frequency is changed and then, while the radio is transmitting, adapt the signals to overcome increases in propagation loss and interference that often occur during a communications session. The Army-funded research will also devise methods by which a radio will learn from its past experience and communicate in ways that preserve scarce communications resources for use by other devices.

Research on rapid design and evaluation methods for cognitive radio protocols is being conducted under Navy sponsorship. Such methods will eliminate the need for time-consuming computer simulations of radio receivers. The Navy is also supporting research on novel techniques that will permit a cognitive radio to simultaneously communicate in a frequency band and search for higher priority signals in the band. Previous methods require the communication device to cease communication while it checks to see whether another signal has entered the band.

Assisting in the research are Clemson graduate students Steven Boyd, Jason Ellis, Michael Frye, and Michael Masse. Thomas Royster of MIT Lincoln Laboratory is collaborating with the Clemson team.