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IMPACT

Making wireless communications more energy efficient

While most wireless communications devices consume relatively modest amounts of electricity, the proliferation of such equipment is leading to significant energy usage. And the growing capability of wireless data exchange, which increasingly uses high-speed, large volume content like streaming video, means that the energy demands of this technology will also continue to grow.

Dr. Fadhel Ghannouchi (right), Dr. Leonid Belostotski (centre), and PhD student Saeed Rezaei (left) and as well as a larger multidisciplinary team of academic and industrial researchers are developing intelligent RF radio systems with improved energy efficiency for emerging wireless and satellite communications.

For Dr. Fadhel Ghannouchi, Canada Research Chair in Intelligent RF Radio Technology and Professor in the Department of Electrical and Computer Engineering at the University of Calgary, this prospect represents an opportunity rather than a problem. He foresees a warm welcome for the next generation of high frequency electronics and radio systems, which could handle a number of different applications on a single hardware platform, using far less energy.

Known as software defined radio, or intelligent radio, this approach opens up entirely new possibilities for devices that would combine many of the functions now being handled separately by hardware found in places like cell phone towers.

According to Ghannouchi, radio equipment accounts for as much as half of the energy used by this wireless systems architecture. As opposed to the current design of base stations dedicated to a single operator, stations incorporating intelligent radio could be shared by a number of operators at the same time, reducing the total number of stations required, along with the power those stations would consume.

He adds that such progress will call for progressive expertise in creating the new communications protocols that will drive this technology. CMC Microsystems is helping him cultivate the highly qualified people who will realize this progress and some of these individuals are already being recognized for their outstanding contributions.

Saeed Rezaei, a PhD student working under the co-supervision of Dr. Ghannouchi and his departmental colleague Dr. Leonid Belostotski, won the Teledyne Dalsa Componentware/CAD Award at the TEXPO Research Competition and Exhibition in Gatineau, Quebec during the fall of 2011. And he was similarly honored at the 2012 International Solid-State Circuits Conference (ISSCC) conference in San Francisco early in 2012 where he received the Analog Devices (ADI) Outstanding Student Designer Award for distinguished student integrated circuit design work.

In each case, Rezaei's research has been cited for the novel use of Gallium Nitride (GaN) technology in designing broadband amplifiers. These amplifiers have the potential to replace several narrow band types presently being produced by industry using CMOS or GaAs-based technologies.

He recalls that CMC initially supported his research by allocating him space in an early-access GaN fabrication run through the Canadian Photonics Fabrication Centre. The research resulted in a broadband Class J integrated GaN amplifier. "This kind of relationship is very valuable for us," he observes. "It keeps us all fresh." And that freshness has enabled Rezaei to join the pioneers of a particular type of linear amplifier, known as Class J.

"Compared with other amplifier classes, Class J achieves high efficiency over a broader bandwidth while maintaining a certain level of linearity," Rezaei explains. That advantage means these amplifiers can meet the standard's requirements for a range of applications, including Code Division Multiple Access (CDMA), Global System for Mobile Communications (GSM), Wimax and Wi-Fi. In other words, a device outfitted with a single piece of hardware can accommodate all of these standards and platforms, using less energy consumption in the process of signal amplification.

Dr. Belostotski, a colleague of Ghannouchi's, sees the knowledge gained during this work eventually expanding from base stations to portable devices by migrating the design to CMOS technologies. This migration will reduce the cost and enable single-chip designs of the fully integrated, efficient broadband CMOS transceivers that have become integral to the capabilities of multi-standard smart phones and other wireless devices.

These technologies combined with the R&D efforts of collaborators and students are competitive ingredients needed to resolve energy management challenges facing the communications industry.*cmc*