

COMMUNICATIONS

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VLSI Circuits

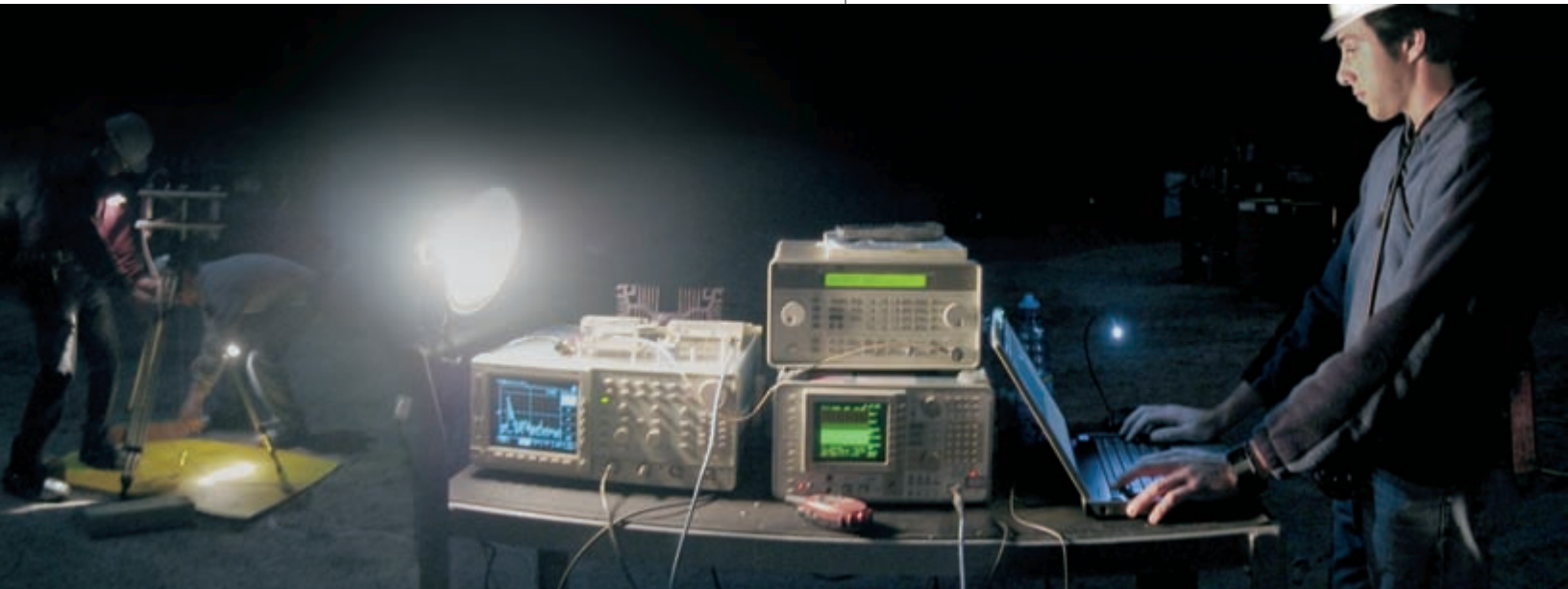
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From left: Chris Anderson (Ph.D. '06), Chris Headley and Haris Volos prepare propagation measurements at the Kimballton limestone mine.

Adapting UWB wireless to mine safety

An ECE research team is investigating UWB-based wireless sensor network technology to boost the safety of mining and improve rescue operations during disasters. “Mining continues to be one of the most dangerous professions due to the possibility of mine accidents,” said Haris Volos, a graduate student on the project.

“We hope to develop the technology that would provide robust wireless notification and coordination under normal operations and during disasters, plus enable rescue teams to track the movements of miners and locate them if they are disabled and unable to communicate.” The team’s goal is a wireless sensor network specifically designed for a mine environment. UWB was selected as the base technology due to its ability to simultaneously provide both

communications and position location data. Initial efforts involve characterizing UWB propagation in mines. “Relatively little information exists on how electromagnetic signals—particularly UWB signals—propagate in a mine environment,” Volos said. Measurement work has begun at the Kimballton limestone mine in western Virginia, where the team took both UWB and narrow-band path loss measurements in tunnels in addition to grid measurements in a room-and-pillar environment.

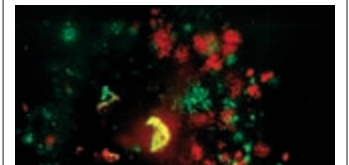
Volos is working with fellow graduate student Chris Headley; Chris Anderson, a post-doctoral associate; ECE faculty members Michael Buehrer and Claudio da Silva; and Antonio Nieto of mining and minerals engineering.

W@VT one of largest wireless groups

Wireless@Virginia Tech is one of the largest wireless research groups in the United States. The center brings together 27 faculty members and more than 100 graduate students, in efforts ranging from circuits to networks. W@VT incorporates eight centers, groups, and laboratories, including the Center for Wireless Telecommunications, the Mobile and Portable Radio Research Group (MPRG) and the Virginia Tech Antenna Group.



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Low-power satellite/sensor system can operate with randomly located packages

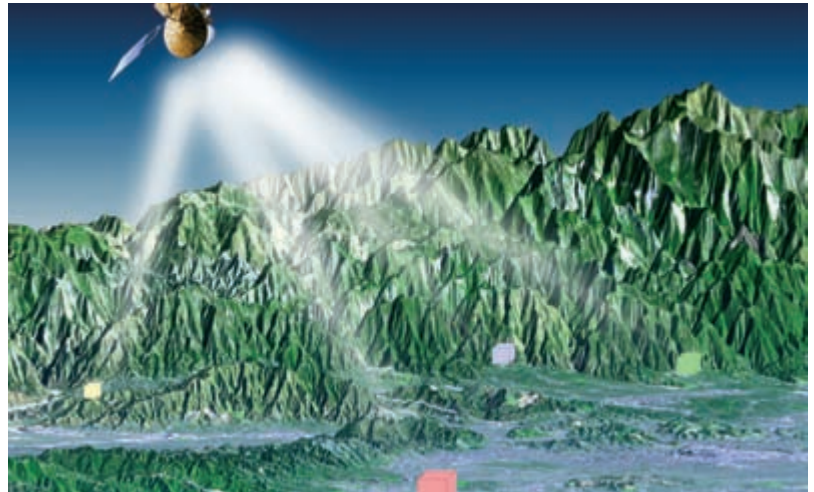
A team led by Amir Zaghoul, an ECE professor, is developing a low-power system for randomly located sensors to communicate with satellites. The sensors can be dropped—and even camouflaged—in uncontrolled or unfriendly environments, making the technique appropriate for disaster situations as well as homeland security, counter-terrorism and combat.

Each sensor in the system operates independently and may relay the same information, which creates a built-in redundancy. “Damage or discovery of the any of the sensor package nodes will not affect the transfer of the required information,” he says.

The sensors use scanning antennas with hemispherical coverage and use small phased arrays with relatively high gain and narrow beam width. The array beam is continuously scanned within the expected angular range of the satellites, with a pre-set dwell time at each scanning position. The coded sensor data is transmitted in all scanning directions.

A geostationary (GEO) or a moving low-earth-orbiting (LEO) satellite then receives the data when the array beam is in the corresponding direction. “This data acquisition by the satellite is performed without the need for satellite tracking by the sensor,” Zaghoul explains. Low-gain hemispherical-beam antennas can also be used for lower frequency operation.

The low-power sensor and antenna are housed in a miniature package along with a sensor processor to translate the sensor information to the RF package. “Initial calculations indicate that, at an information rate of 100 bps, a 3x3 cm phased array of the sensors can link to a LEO satellite at 1400 km altitude with 36 W of RF power at 30 GHz, with a 9 dB link margin,” he says. The low-power system is in the milliwatt range for medium data rates.



Securing SDR devices from hackers, opponents

An ECE research team has been awarded a \$400,000 Cyber Trust grant from the National Science Foundation (NSF) to improve the security of software-defined radio (SDR) technology.

Although software radio technology promises to alleviate the spectrum shortage problem and improve spectrum utilization, it raises new security issues, according to Jung-Min Park, principal investigator, and co-principal investigators Thomas Hou and Jeffrey Reed. “The software may be vulnerable to failure and malicious tampering,” Park said.

“Changes to conventional ASIC (application specific integrated circuit) devices requires technical skills and specialized equipment, which makes unauthorized changes very difficult,” he said. With SDR, user services or RF parameters can be reconfigured via the software. SDR research and standardization efforts focus on cryptosystems securing the download process and preventing tampering of downloaded software.

“That is the first line of defense,” Park said. “We are exploring other measures to secure SDR devices from malicious hackers and military opponents seeking tactical advantages.”

The team is investigating security vulnerabilities in the physical and MAC layers of SDR networks.

