4D ANTENNAS SECURE WIRELESS COMMUNICATIONS

EVEN IN HIGHLY directional antenna arrays, side-lobe radiations exist. These can be received by highly sensitive antenna systems. Creating antenna arrays without side lobes is difficult, as systematic and random errors in antenna arrays induce stray radiation. To disable eavesdropping and enhance wireless-communications security, a technique using time modulation has been developed by Quanjiang Zhu, Shiwen Yang, Ruilin Yao, and Zaiping Nie of the University of Electronic Science and Technology of China.

The group uses a switching technique that doesn't compromise the directivity of the antenna. Several of the outer elements of the antenna array are switched from on and off states in alternating patterns. This approach induces time modulation for the signal transmission from the side lobes. Yet it does not influence the primary lobe.

As long as the signal bandwidth is greater than the time-modulated frequency, the primary lobe signal can be restored using simple filtering. A LeCroy oscilloscope was used in the testing of an amplitude-modulation (AM)-based test to distort time modulation. The results demonstrated significant distortion of the AM signal from the side lobes and a restored AM signal post-filtration.

A simulated test of a BPSK demonstrated a recoverable primary signal with distorted side lobes. In a bit-error-rate (BER) simulation using the binary-phase-shift-keying (BPSK) signal method, the BER is found to be consistently low at the primary lobe and consistently high at the side-lobes. See "Directional Modulation Based on 4-D Antenna Arrays," *IEEE Transactions on Antennas and Propagation*, Feb. 2014, p. 621.

TIME-SLOT DIVISION STRATEGY
ENABLES EFFICIENT SIMULATION

MODERN-DAY COMMUNICATIONS SIGNAL streams pass through digitally assisted RF nodes, which rely on advanced digital signal processing. This heterogeneous system becomes difficult and computationally expensive to simulate during pulse-width-modulated on and off states. Energy stored in RF components, like resonators, needs classical time-step integration methods for simulation. Accordingly, David Ferreira, Jorge F. Oliveira, and Jose C. Pedro have developed an automatic time-slot division technique at the University of Coimbra in Portugal.

Their strategy automatically switches between envelope-following techniques and time-step integration, depending upon factors involving the signal stimulus. The simulation process is then broken down into regions where either envelope or SPICE-like techniques would be more computationally viable. Simulations are run using a self-oscillating RF power amplifier and an on-off amplitude-shift-keying wireless transmitter.

A comparison of the new method, SPICE-like engines, and multiple-rate time-step integration techniques was performed. The new method showed notable increases in computational speed compared to the other methods with significant increases over SPICE approaches. According to the researchers, greater time efficiency is possible with circuits that have a larger discrepancy between the carrier period and the on-state duration when compared to simulated circuits. See "A Novel Time-Domain CAD Technique Based on Automatic Time-Slot Division for the Numerical Simulation of Highly Nonlinear RF Circuits," *IEEE Transactions on Microwave Theory and Techniques*, Jan. 2014, p. 18.

RF MEMS SWITCHES DELIVER
HIGH POWER IN A COMPACT PACKAGE

THANKS TO RECENT technology advances, some microelectromechanical-systems (MEMS) switches now outperform micro-relays or solid-state switches. In fact, MEMS technology has the potential to overtake conventional technologies in terms of linearity, power consumption, and insertion loss. Yet challenges must be overcome to implement viable RF MEMS switches—particularly in the handling of significant power levels and reliability. In order to find design topologies that could offer these benefits, an RF MEMS switch using radial cantilevers in an SPST and SP4T configuration was designed by Hosein Zareie and Gabriel M. Rebeiz of the University of California at San Diego.

Overcoming drawbacks of certain material properties is critical in the implementation of MEMS devices. To solve the high contact-resistance issues surrounding reliable and hard metals, these switches are designed with multiple contact points and high contact force. The SPST is fabricated with a gap of 0.9 µm and a 5-µm gold beam. The cantilever sections are connected to form an eight-contact design. A sliding anchor is used to limit displacement to a single axis.

The SP4T typology boasts four independent actuation electrodes at the output ports of each quadrant. For fabrication of a 500-µm high-resistivity silicon substrate, the UCSD process is used. The SPST typology is capable of handling power levels beyond 2 W while the SP4T typology can handle upwards of 10 W over 100 million cycles. See "Compact High-Power SPST and SP4T RF MEMS Metal-Contact Switches," *IEEE Transactions on Microwave Theory and Techniques*, Feb. 2014, p. 297.