

## RESEARCH BRIEF

# CODING TECHNIQUES FOR BROADBAND WIRELESS COMMUNICATIONS

### The potential

As new emerging broadband applications demand reliable wireless communication at higher and higher data rates, new transmission and reception technologies need to be developed to meet this demand. Evolving wireless standards, such as the mobile WiMax (IEEE 802.16e), WLAN (IEEE 802.11a,b,g), and IEEE 802.11n standard or the Super 3G (3.9 G) standard, are likely to employ multiple transmit and receive antennas with OFDM modulation for increased spectral efficiency and improved performance.

Consequently, the development of coding methods and signal processing techniques that can fully exploit the potential of multi-antenna OFDM systems will make a serious impact on the direction in which future wireless systems and standards evolve.

### The challenge

The wireless transmission medium is very hostile: it attenuates and distorts the transmitted signal. This makes recovering the sent data an extremely challenging task. The applied coding and decoding methods must take into account the complex interaction between the transmitter, the propagation environment and the receiver, so advanced mathematical tools are needed to model the impact of a given coding scheme on the system performance. Further constraints, such as code design complexity, flexibility and decoding complexity, make the problem even harder to solve.

### The research

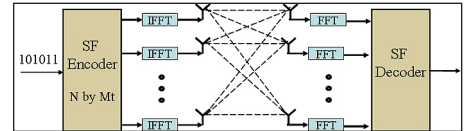
Professor K.J. Ray Liu (ECE/ISR), ISR postdoc Dr. Weifeng Su and ISR alumnus Dr. Zoltan Safar invented three space-frequency (SF) code design methods that can guarantee reliable data transmissions at high data rates in broadband wireless communications. This is the first coding scheme to guarantee both full rate and full diversity in such communications. No other technology demonstrates the same functionality.

This technology has potential applications in the design of the next generation of broadband wireless communication systems. Novel features include:

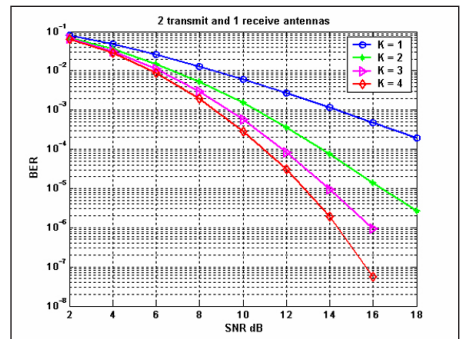
- The inaugural design of full diversity SF codes from space-time (ST) codes;

- The first systematic SF code design method that can guarantee both full rate and full diversity in multiple-input-multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) wireless communication systems;

- A space-time frequency (STF) transmission scheme, capable of coding across multiple OFDM blocks, to further exploit all the available diversity in MIMO-OFDM systems; and
- SF/STF code designs that are applicable to the most general channel model that has been used in practice.



The MIMO-OFDM system model



Performances of the full-rate STF code over K=1,2,3,4 OFDM blocks, with TU channel model.

### 2005 Invention of the Year

This research won the University of Maryland's 2005 Invention of the Year Award in the Information Science category.

### Patent information

A U.S. patent application is pending.

## **Research team**

Professor K.J. Ray Liu (ECE/ISR)

ISR postdoc Dr. Weifeng Su

ISR alumnus Dr. Zoltan Safar

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