

Tactical Wideband Space-Time (TWiST) Communications

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MITRE Sponsored Research



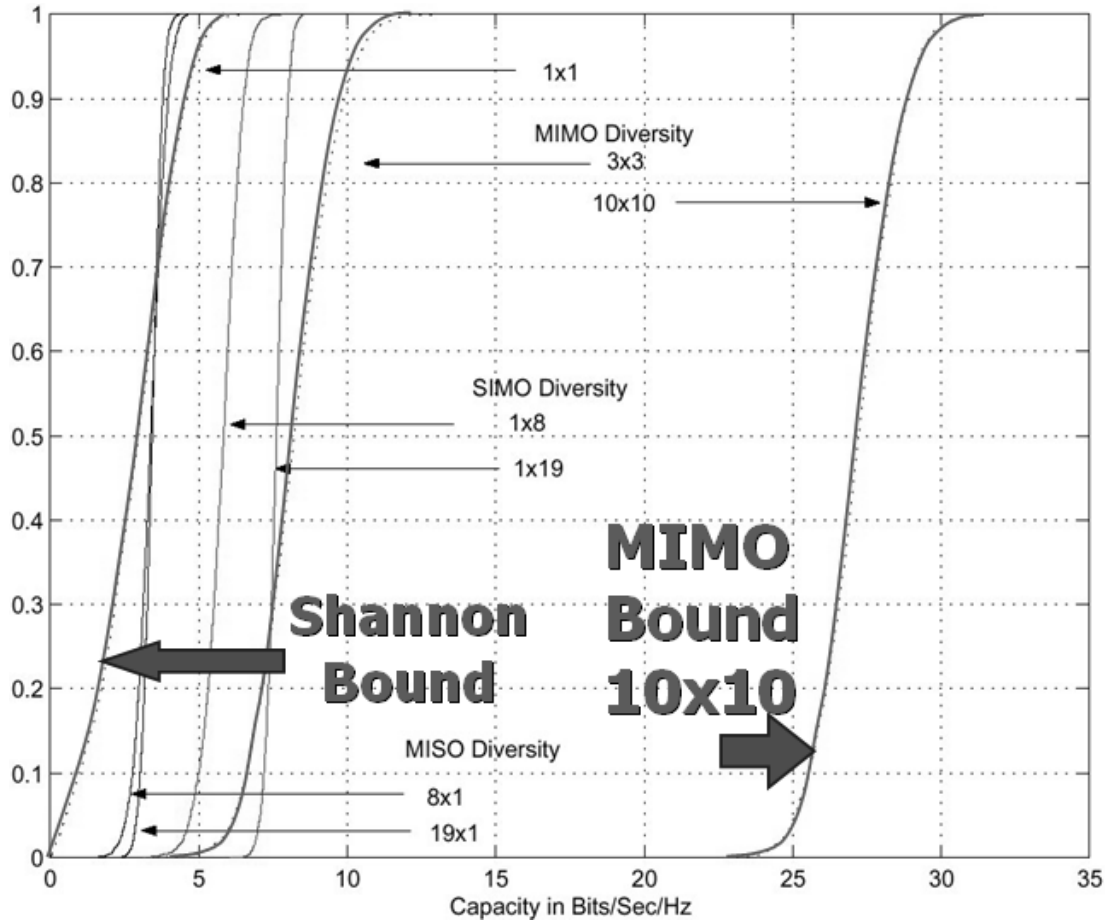
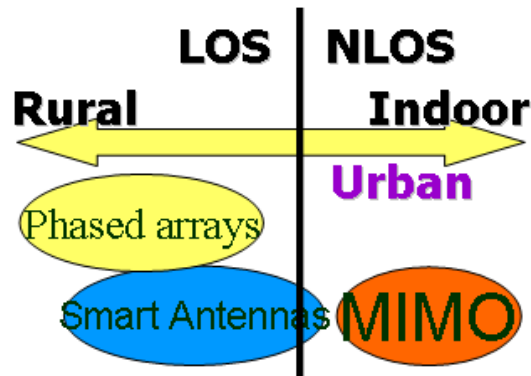
Problem

- Multi-input multi-output (**MIMO**) wireless communications can enable massive increases in information capacity in dense multipath environments such as indoor and certain urban environments.
- However, unless the transmitter is informed of the channel, the MIMO capacity will be severely reduced whenever there is correlated fading, line-of-sight (LOS) transmission, multiple access interference, or jamming – **issues important to a tactical communication network.**

Background

- Open-loop MIMO capacity cumulative distribution curves

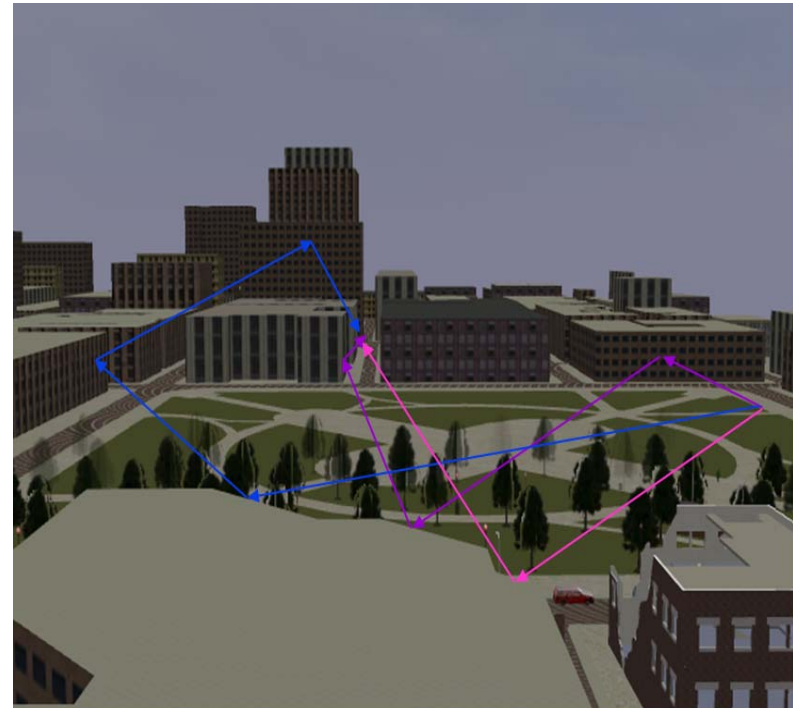
- We desire a way to maintain constant capacity for all channel conditions.



- Open-loop capacity is maintained only when channel is sufficiently uncorrelated.

Objective

- Design wideband space-time algorithms that **exploit a two-way feedback MIMO channel** and are capable of maintaining constantly high capacity in all environments.



- These environments include non-LOS and LOS frequency-selective, space-selective, and time-selective multiuser interference channels.

Activities

- We are analyzing, designing, simulating, and building a two-way MIMO radio that employs space-time algorithms designed to meet the aforementioned objectives.
- We are developing direct-sequence spread spectrum (DSSS) systems and comparing performance to that of orthogonal frequency division multiplexing (OFDM) MIMO systems.
- We focus on multichannel equalization, blind source separation, synchronization, quantization, and gain control.

Highlight

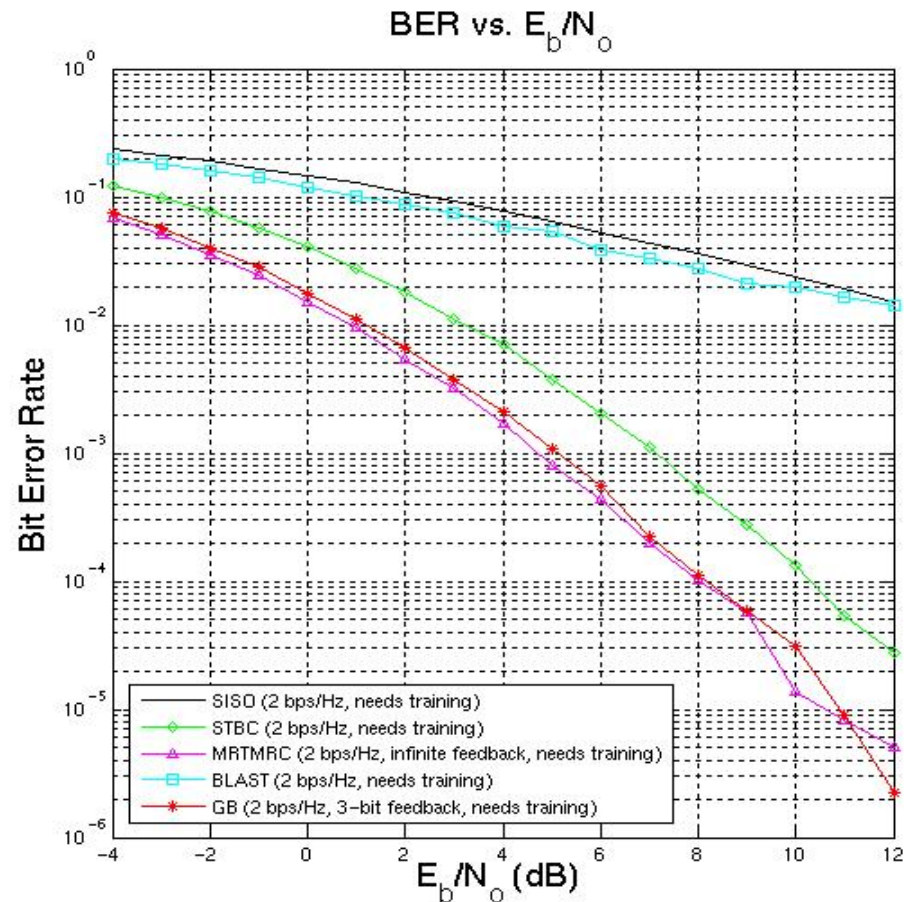
Simulation Performance of 2x2 MIMO algorithms operating in a Rayleigh Flat-Fading Channel with spectral efficiency=2bps/Hz

Open-Loop MIMO

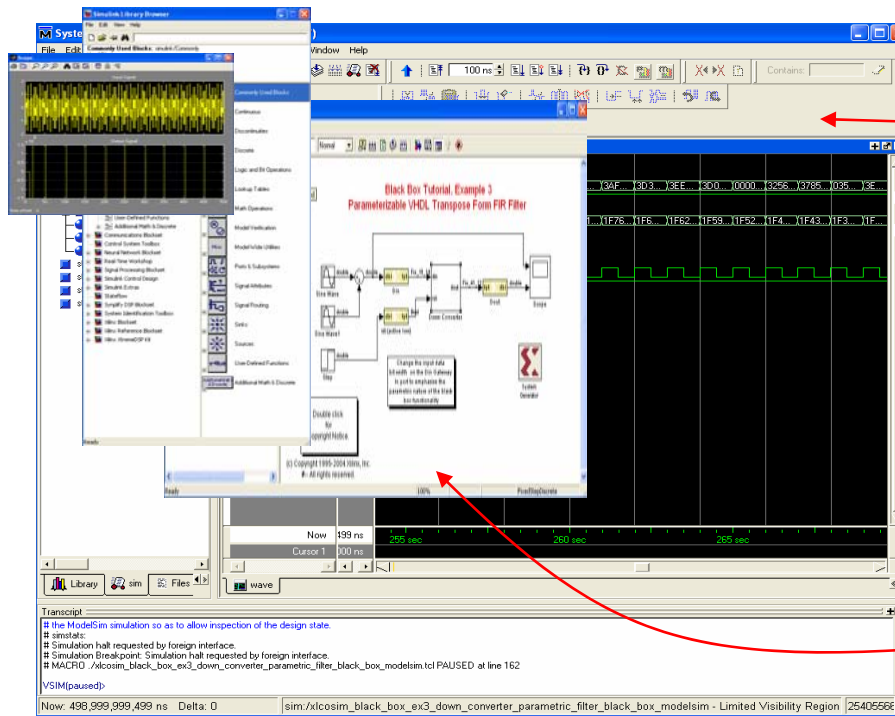
- Bell Labs Layered Space-Time (BLAST)
- Space-Time Block Coding (STBC)

Closed-Loop MIMO

- Grassmannian Beamforming (GB)
- Maximum Ratio Transmission Maximum Ratio Combining (MRT/MRC)



Highlight/Demonstration



ChipScope Pro
JTAG



Real Time DATA Transfer
PCI

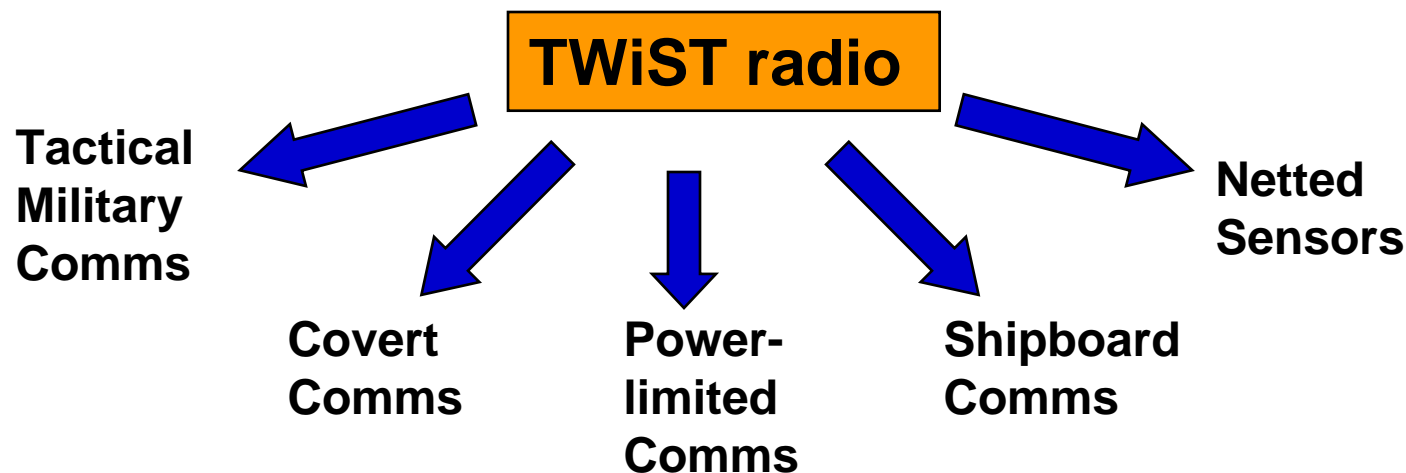
We rapidly prototype MIMO algorithms on FPGA systems (using Matlab/Simulink and Xilinx or Alterra block sets). We develop multi-antenna RF interfaces to test the algorithms with real channels.

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Impacts

- This project will produce a robust, spectrally efficient multiuser tactical radio system that will give our military and intelligence forces constant high-speed wireless network connectivity that is insensitive to dynamic unknown environments (be they rural, urban, or indoor).



Future Plans

- **Implement newly developed duplex channel estimation and exploitation algorithm**
- **Design second-generation RF interface, which will be two 8x8 MIMO transceivers composed of analog integrated circuits**
- **Compare MIMO-OFDM system to MIMO-DSSS system for link reliability and multiuser capacity under varying channel conditions**