

Lower VHF Networking in Harsh Environments



**S&T Campaign: Information Sciences
Networks and Communications**

**Brian M. Sadler 301-394-1239
brian.m.sadler6.civ@mail.mil**

Research Objectives

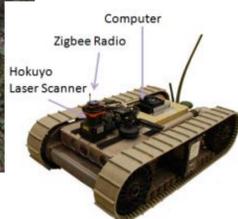
- Exploit penetration and low signal distortion for short-range low-power comms @ low VHF
- Develop palm-sized tunable antennas $\sim \lambda/125$
- Characterize short-range low-power propagation in harsh environments
- **New capability: persistent connectivity, network control and healing, geolocation**
- Integration with autonomous agents

Challenges

- Traditionally large aperture antennas (40 MHz, $\lambda = 7.5\text{m}$)
- Lacking low-power short-range phase coherent low-VHF studies
 - Virtually all channel modeling based on long range high power path loss
 - Large scale channel measurements cumbersome
- EM modeling limited to small scale scenes
- Phase coherent processing requires very fine calibration
- Commercial radios not suitable for tactical network experiments

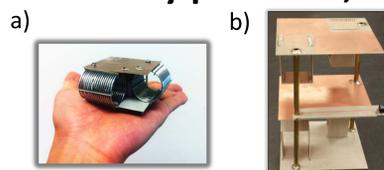


LeJeune MOU site experiment



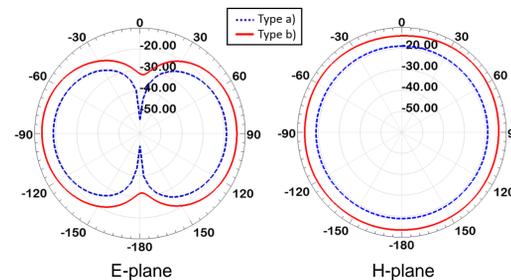
ARL Facilities and Capabilities Available to Support Collaborative Research

- Miniaturized Antennas
 - Vertically polarized, omni-directional, w/ UMICH



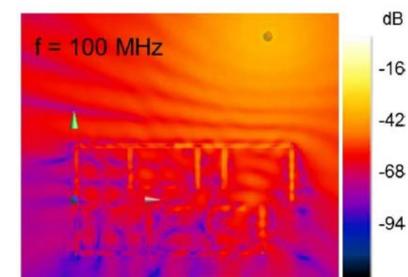
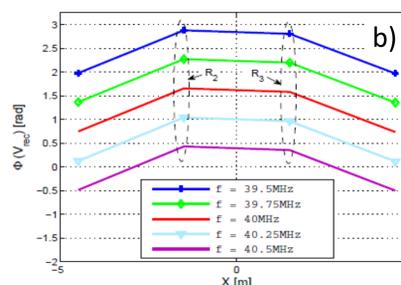
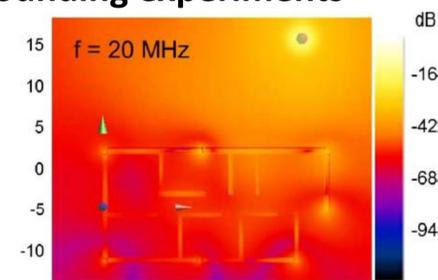
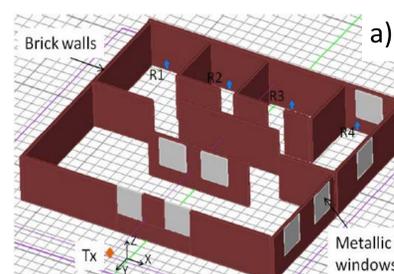
Antenna type	a)	b)
$f_{resonance}$	39.1MHz	39.4MHz
Bandwidth	0.1MHz	0.5MHz
Peak gain	-21dBi	-13dBi

< Antenna performance comparison >



- a) 6cm X 6cm X 3cm, 18.5 grams
- b) 10cm X 10cm X 10cm X 15cm, 98 grams

- Experiments & Signal Processing
 - Integration with software define radio (SDR) and robotic operating system (ROS)
 - Geolocation, array processing, distributed estimation
- High Fidelity EM simulations on HPC's
 - Solve Maxwell's equations for realistic tactical scene
 - Modeling spatial phase and received signal strength (RSS) variation at HF/VHF
 - Quantifying multipath as a function of frequency and environment
 - Validation with channel sounding experiments



Full wave indoor/outdoor simulations characterize penetration, onset of multipath, and spatial coherence

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- EM modeling & experimentation
- SDR

Publications:

- [J1] F. T. Dagefu, G. Verma, C. Rao, P. Yu, B. Sadler and K. Sarabandi, "Wireless Channel Characterization in the lower VHF band" *IEEE Trans. Ant. & Prop.*, submitted
- [J2] F. T. Dagefu, J. Choi, M. Sheikhsoufa, K. Sarabandi and B. Sadler, "Near-ground Indoor Wave Propagation Measurements in the VHF band" *Radio Science*, submitted
- [J3] J. Oh, J. Choi, F. Dagefu, and K. Sarabandi, "Extremely small two-element monopole antenna for HF band applications," *IEEE Transactions on Antennas and Propagation*, vol. 61, no. 6, June 2013.
- [J4] F. Dagefu, J. Oh, K. Sarabandi, "A sub-wavelength RF source tracking system for GPS-denied environments," *IEEE Transactions on Antennas and Propagation*, vol. 61, no. 4, April 2013.