Mobility & Cognitive 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

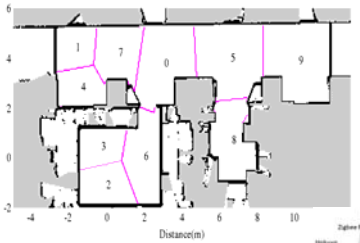
- Enhance tactical network availability, reliability, and capacity through cognition and smart mobility
- Integrate cognitive radio and autonomous networking
- Develop robust link quality and network connectivity metrics
- Develop algorithms for autonomous and collaborative mobility for network healing

Approach

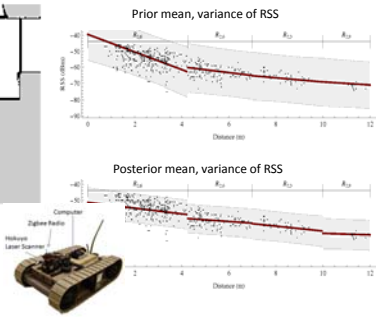
- Graph theoretic methods for multi-agent networks
- Multi-wavelength communications (low VHF, UHF, microwave, optical)
- Exploit spatial statistics of received signal strength (RSS)
- Bottleneck discovery and healing via autonomous agent control
- Parsimonious models for connectivity and mapping

Autonomous Exploration, Mapping, and Connectivity

- Integration with software define radio (SDR) and robotic operating system (ROS)
- Simultaneous physical and connectivity mapping



Environment segmented into regions



Online learning of mobile-to-mobile channel

Challenges

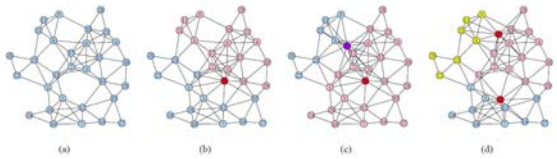
- Integration of cognition & control in complex distributed systems
- Network overhead, computational tradeoffs
- Geolocation
- Hybrid network modeling (multi-wavelength, human & autonomous nodes)

ARL Facilities and Capabilities Available to Support Collaborative Research

- Expertise in SDR, Low VHF channel modeling & RSS spatial gradient theories
- Access to robotic vehicles & ARL Autonomous Assets Test Facility

Graph Theoretic Bottleneck Healing

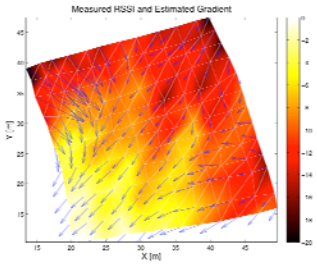
- Cheeger constant to identify bottleneck
- Autonomous agents for enhanced connectivity



Network partitions and relay node placement (red nodes)

Exploiting Received Signal Strength

- Estimation of RSS spatial gradient
- Incorporate into control for network healing
- RSS at low VHF yields direction of arrival
- Experiments with autonomous agents



Track RSS Gradient to inform mobility decisions

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Distributed control & cognition
- Hybrid network modeling

Publications:

[1] Y.-L. Chow, M. Pavone, B. M. Sadler, S. Carpin, "Trading safety versus performance: rapid deployment of robotic swarms with robust performance constraints," *Journal of Dynamic Systems, Measurement, and Control,* 2014.
[2] J. N. Twigg, J. R. Fink, P. L. Yu, B. M. Sadler, "Efficient base station connectivity area discovery" *International Journal of Robotics Research,* 2013.
[3] M. Cheng, Y. Ling, B. M. Sadler, "Wireless ad hoc networks connectivity assessment and relay node deployment," *IEEE Global Communications Conference (GLOBECOM), 2014.*
[4] J. Fink, J. Twigg, P. Yu, B. M. Sadler, "A parsimonious model for wireless connectivity in robotic networks," *1st IEEE Global Conference on Signal and Information Processing, (GlobalSIP), invited, December* 2013.