The objective of this research is to develop new models of computation for multi-robot systems. Algorithm execution proceeds in a cycle of communication, computation, and motion. Computation is inextricably linked to the physical configuration of the system. Current models cannot describe multi-robot systems at a level of abstraction that is both manageable and accurate. This project will combine ideas from distributed algorithms, computational geometry, and control theory to design new models for multi-robot systems that incorporate physical properties of the systems.

The approach is to focus on the high-level problem of exploring an unknown environment while performing designated tasks, and the sub-problem of maintaining network connectivity. Key issues to be studied will include algorithmic techniques for handling ongoing discrete failures, and ways of understanding system capabilities as related to failure rates, geometric assumptions and physical parameters such as robot mobility and communication bandwidth. New metrics will be developed for error rates and robot mobility.

Intellectual merit arises from the combination of techniques from distributed algorithms, computational geometry, and control theory to develop and analyze algorithms for multi-robot systems. The project will develop a new class of algorithms and techniques for their rigorous analysis, not only under ideal conditions, but under a variety of error assumptions. The project will test theoretical ideas empirically, on three different multi-robot systems.

Broader impacts will include new algorithms for robot coordination, and rigorous understanding of the capabilities of different hardware platforms. Robots are an excellent outreach tool, and provide concrete examples of theory in action.