A Systems Engineering Approach to Wireless Network Design
Senni Perumal, Kiran Somasundaram, Punyaslok Purkayastha, Vahid Tabatabaee, John S. Baras

Introduction:
- Objective: Analyze and design MANET with predictable performance for a baseline scenario so as to satisfy mission requirements.
- Problem: Develop models that estimate the performance of a MANET fast - design for predictable performance bounds (specifications).
- Inputs: network topology (could be time varying), neighbouring relations (channel conditions), traffic demand (source-destination pairs, data rates, number of paths).

Design and Analysis Framework:
- Our overarching goal is to develop a tool for design and analysis of wireless networks.

Approach:
- We define three sets of equations:
  1. MAC & PHY: loss parameters and service time of a link in terms of the incoming rate (throughput) of a link and its neighboring nodes.
  2. Scheduling: node scheduling rate and throughput as a function of incoming rates and loss parameters.
  3. Routing: loss parameters and scheduling rate of nodes to obtain the arrival rate of the next-hop nodes.
- Fixed point iterations: equations coupled iteratively on entire network till convergence to find a consistent solution.
- Sensitivity analysis and robust/optimal design using AD maximize the total network throughput.

Sample Complex Scenarios (courtesy from AIMS Inc.)
Description:
- 30 ground nodes (3 groups with 10 nodes each) moving with speeds 22-60 mph for 500 seconds.
- 2 Aerial Platforms (AP) will join the network to maintain connectivity.
- 17 source-destination pairs: 12 intra-cluster loads of 100 Kbps (4 in each cluster); 5 inter-cluster loads between 20 and 100 Kbps.

Sample Throughput outputs (courtesy from AIMS Inc.)
Network and worst connection throughput with multiple-path routing.

Expected delay
Network Throughput as a function of offered load.