



A Systems Engineering Approach to Wireless Network Design

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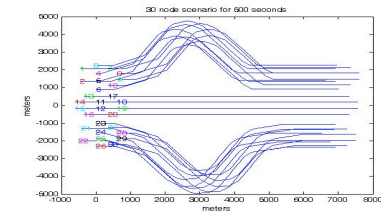
Introduction:

- **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)

Sample Complex Scenarios (courtesy from AIMS Inc.)

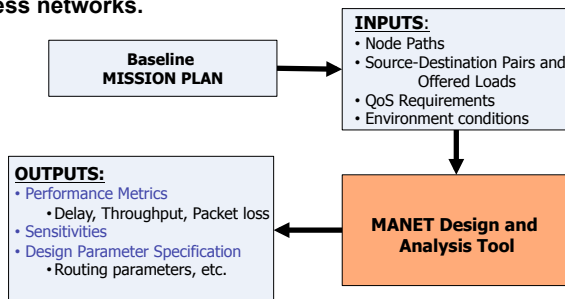
Description:

- 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.



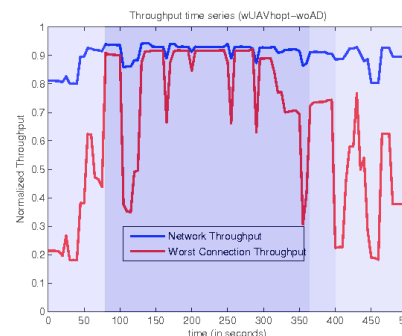
Design and Analysis Framework:

• Our overarching goal is to develop a tool for design and analysis of wireless networks.

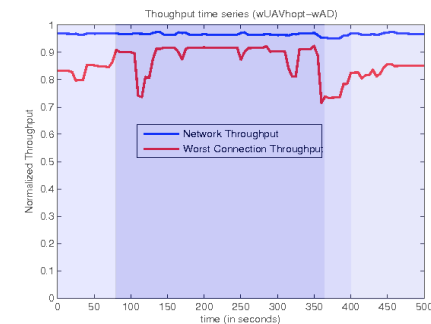


Sample Throughput outputs (courtesy from AIMS Inc.)

Network and worst connection throughput with multiple-path routing



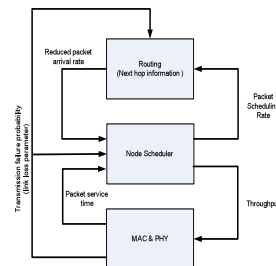
Equal routing probabilities



Optimal routing probabilities using AD

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



Expected delay



Network Throughput as a function of offered load

