Creating Wireless Multi-hop Topologies on Space-Constrained Indoor Testbeds Through Noise Injection

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WIRELESS INFORMATION NETWORK LABORATORY

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Introduction

- Motivation
  - Create ad-hoc network topologies on space constrained testbeds (ORBIT Grid)
- Challenge
  - Creating multi-hop topologies over a small area
  - Topologies should be repeatable in time
  - Topologies should be easy to generate
- Approach
  - AWGN Generation to compress space
  - Select Interference Fixed Nodes
  - Select Nodes Fixed Interference

Radio Mapping

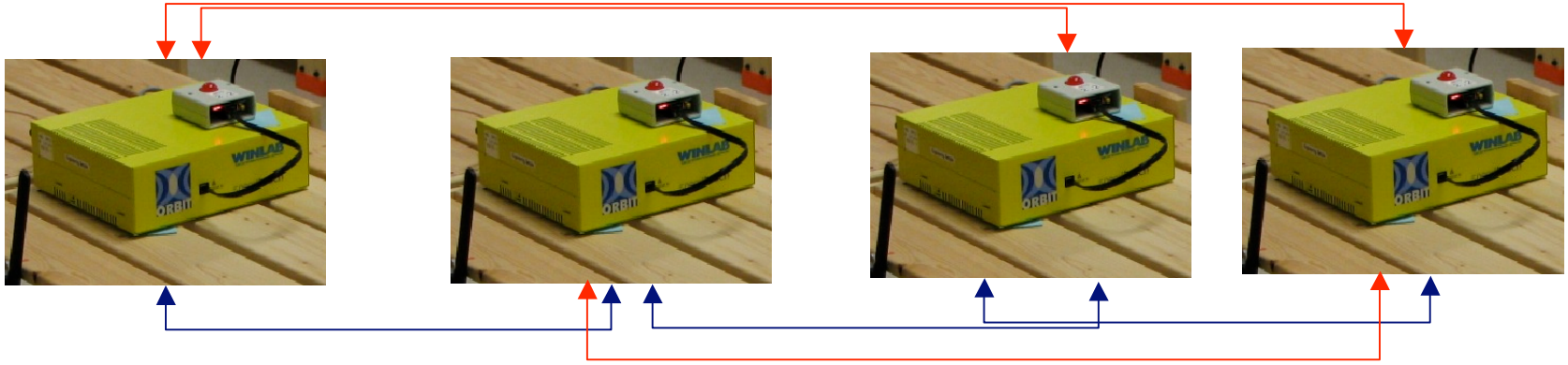
- NS-2 supports
  - Friis free space model
    - Received Power is inversely proportional to square of distance from transmitter
  - Two ray Model
  - Shadowing Model
- Assume Friis free space model
- Likely steps in evaluation of new protocols
  - Simulation Study
  - ***Controlled Indoor testbed with free-space propagation environment***
  - Controlled Indoor testbed with realistic propagation environment
  - Application oriented testbed study

Radio Mapping Problem

Given a set of n two dimensional virtual node positions x1, x2, . . . , xn, configure the testbed so that the packet error rate (PER) on the links between the chosen testbed nodes approximates the PER in the virtual scenario under free-space propagation assumptions (packet collisions are not considered).

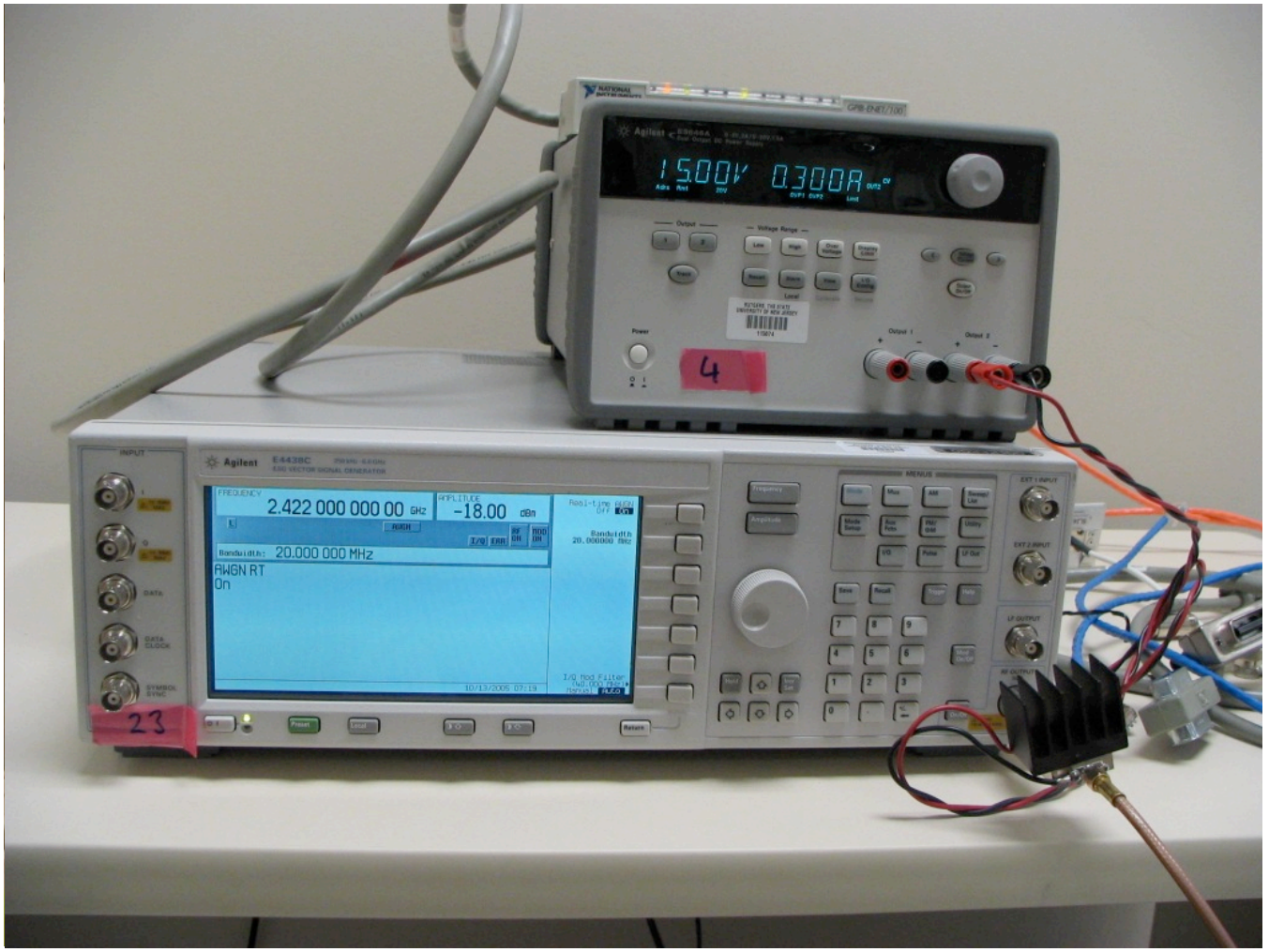
Sample link matrix 4 nodes string Topology

	1	2	3	4
1		up	down	down
2	up		up	down
3	down	up		up
4	down	down	up	



The 64 Node Orbit Grid (sb9)

Noise Generating Equipment



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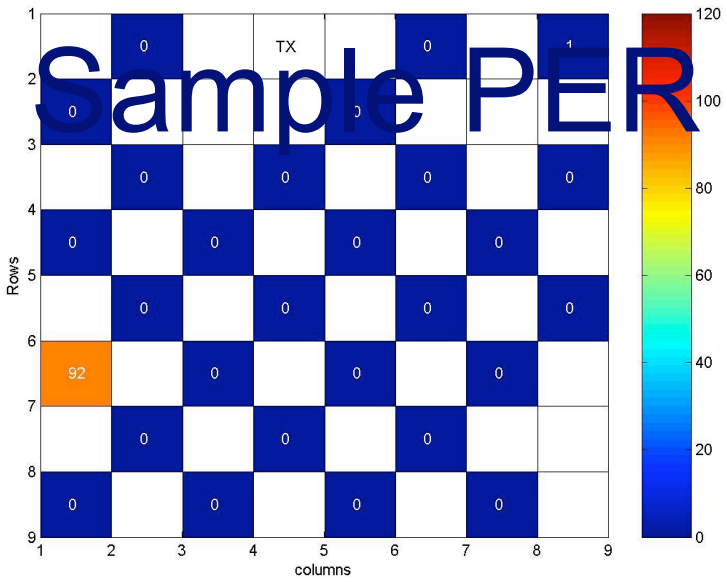
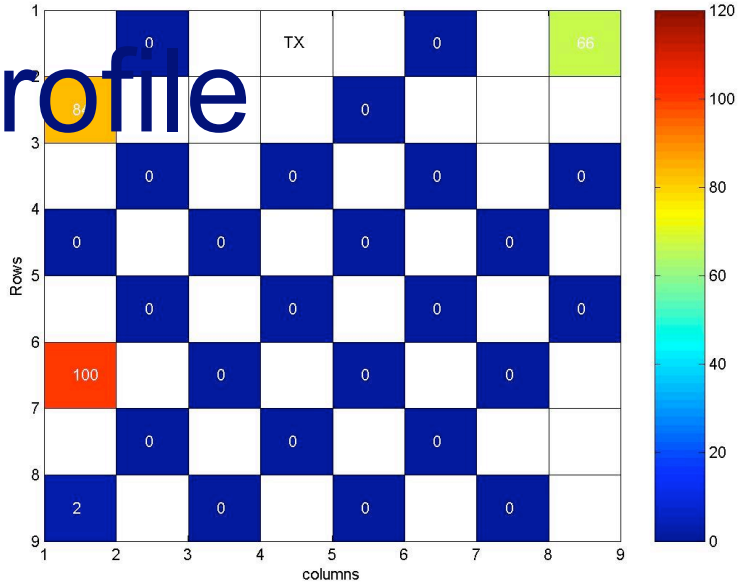
Grid PER RSSI Profile

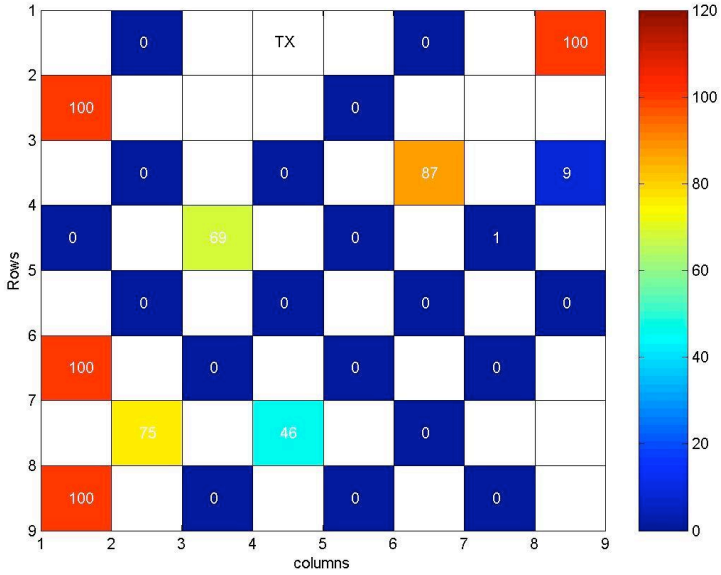
- Approach
  - Select a node on the grid and activate beacon transmission
  - Measure PER and average RSSI at all other nodes
  - Get the measurements selecting each node on the grid as a transmitter.
  - The above could be repeated for a range of noise levels

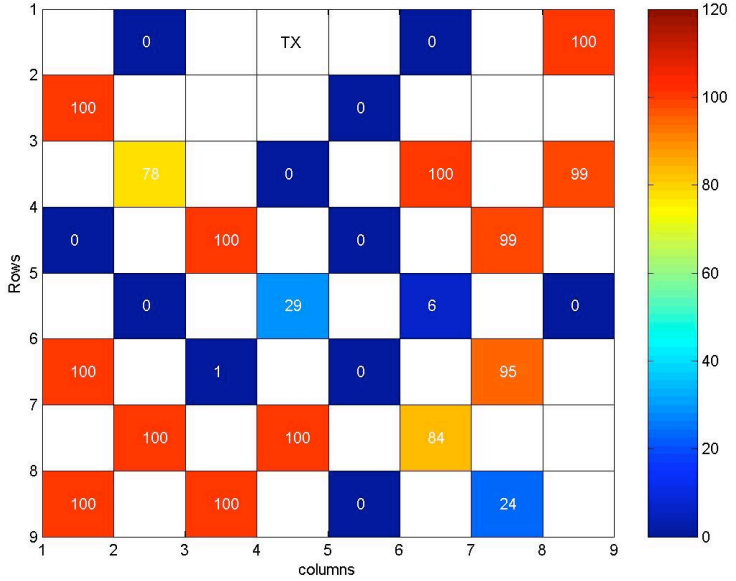
- What we get..
  - We have a link matrix involving all nodes on the grid for different noise levels
  - The link matrix will be an input to SNFI and SIFN along with a desired link status matrix

Sample PER profile









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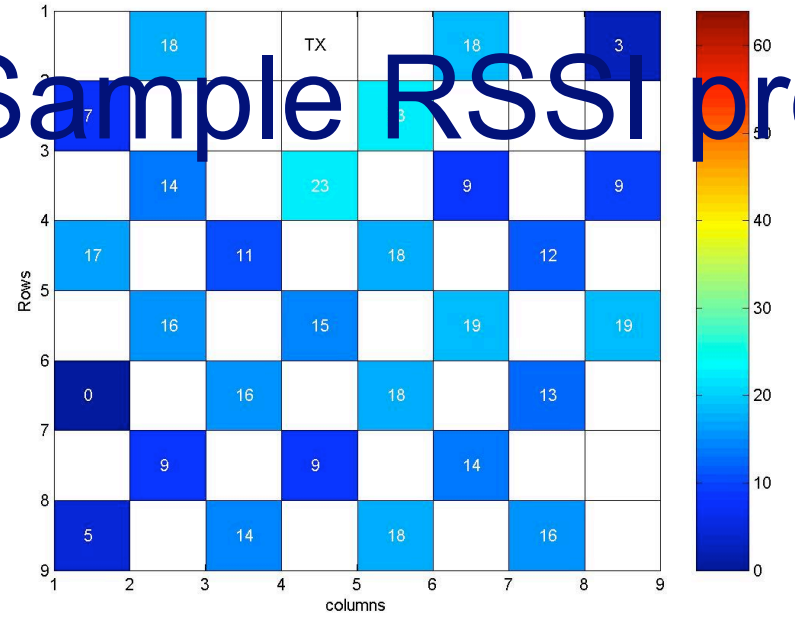
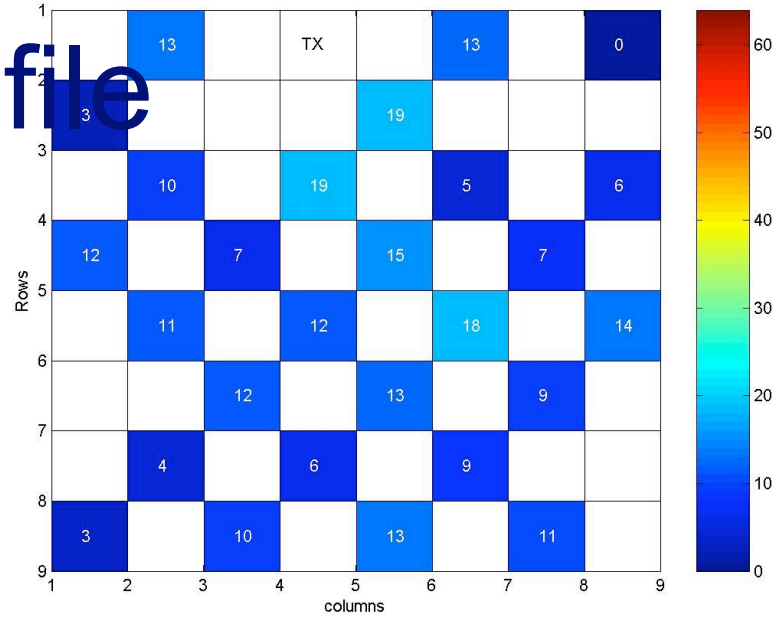
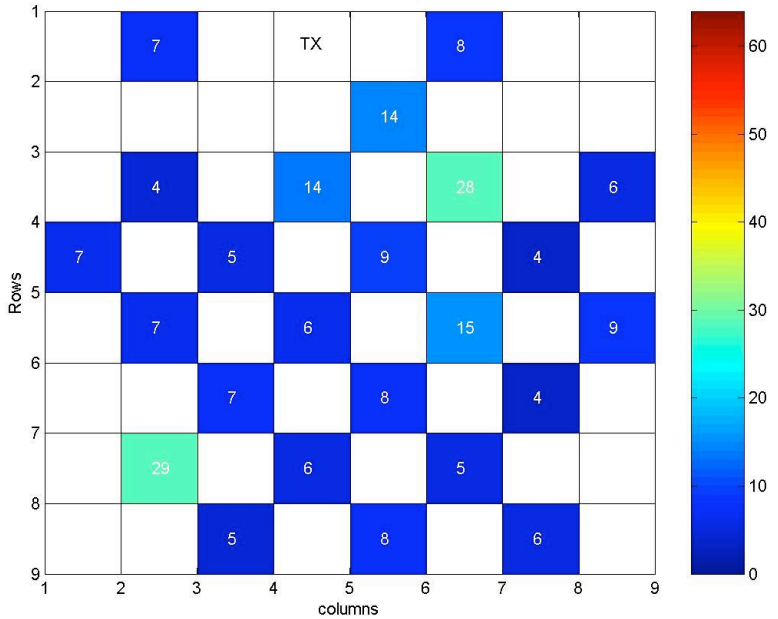
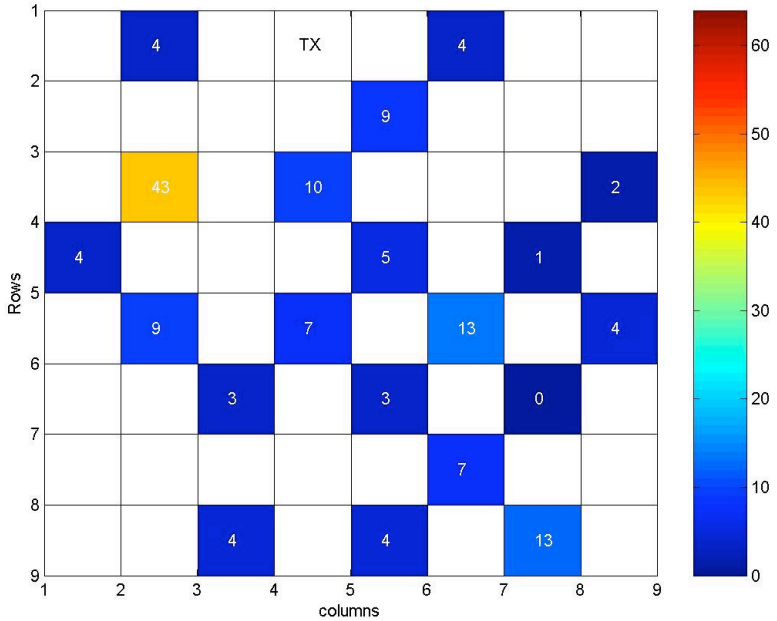
Sample RSSI profile

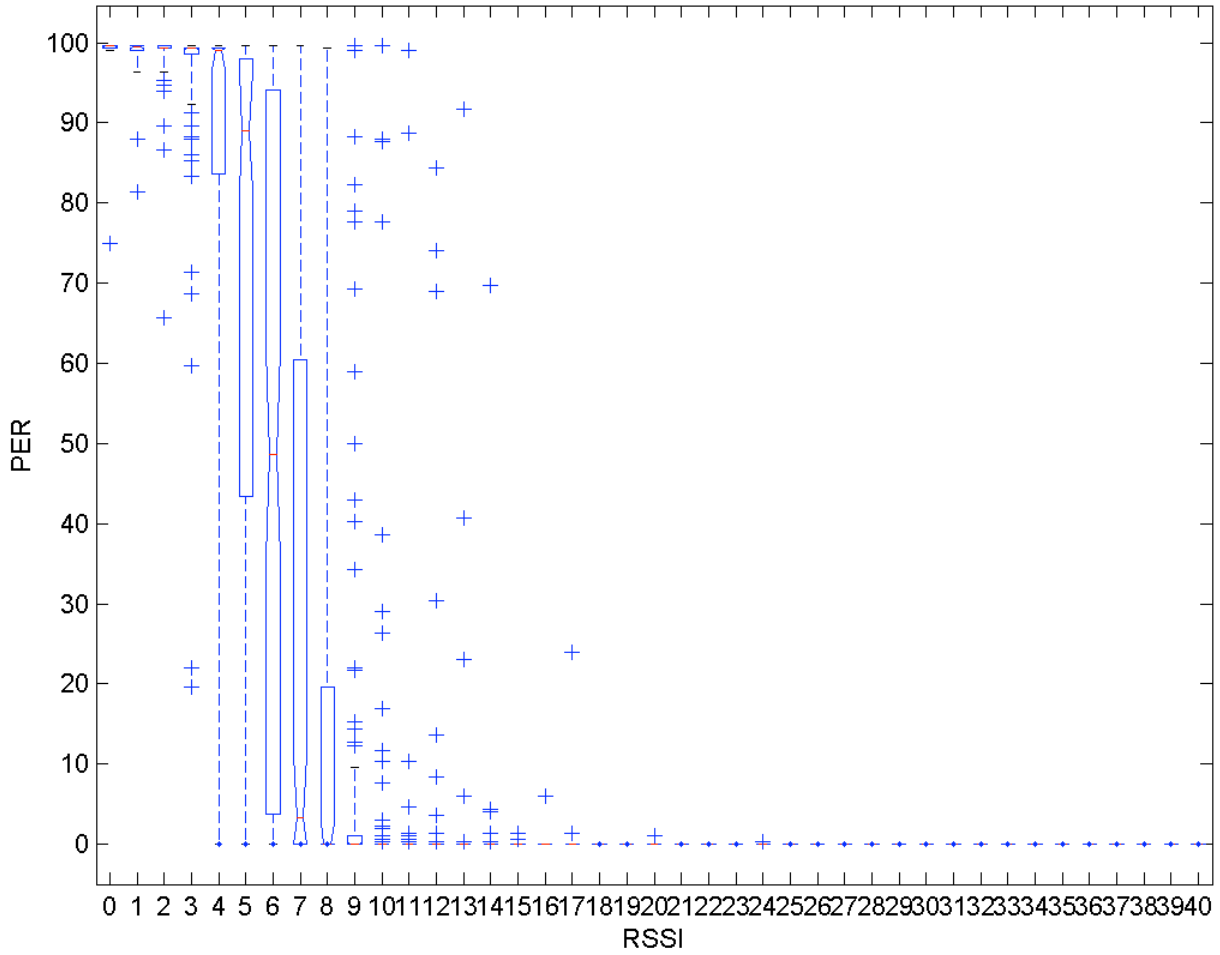








RSSI PER Correlation



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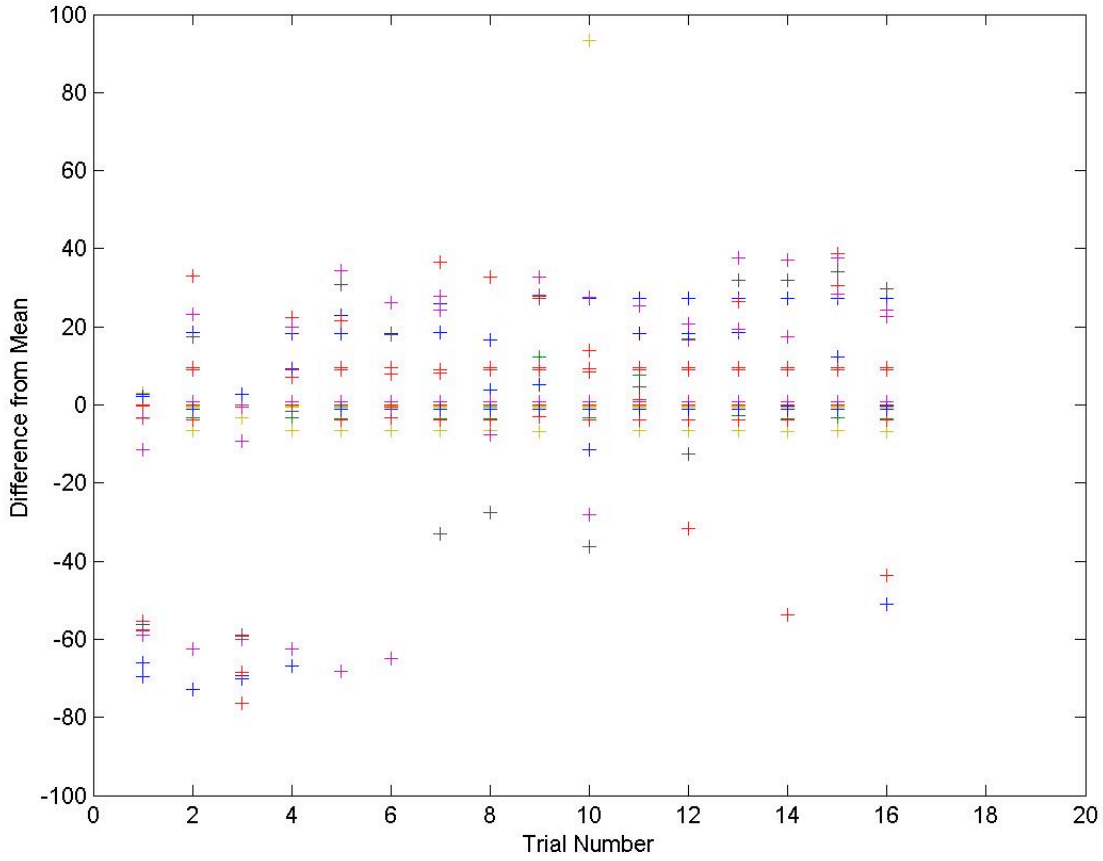
Relative Node Behavior



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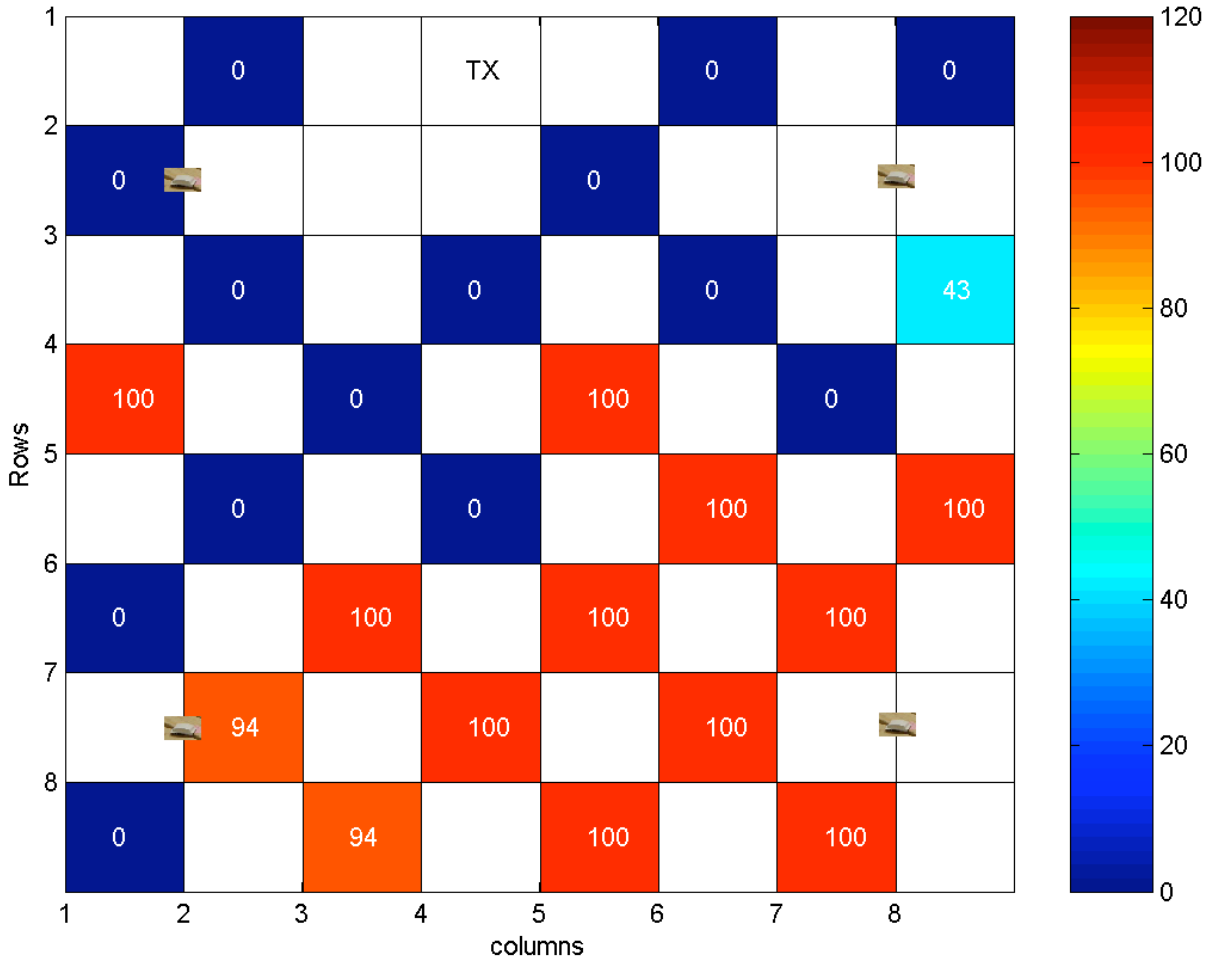
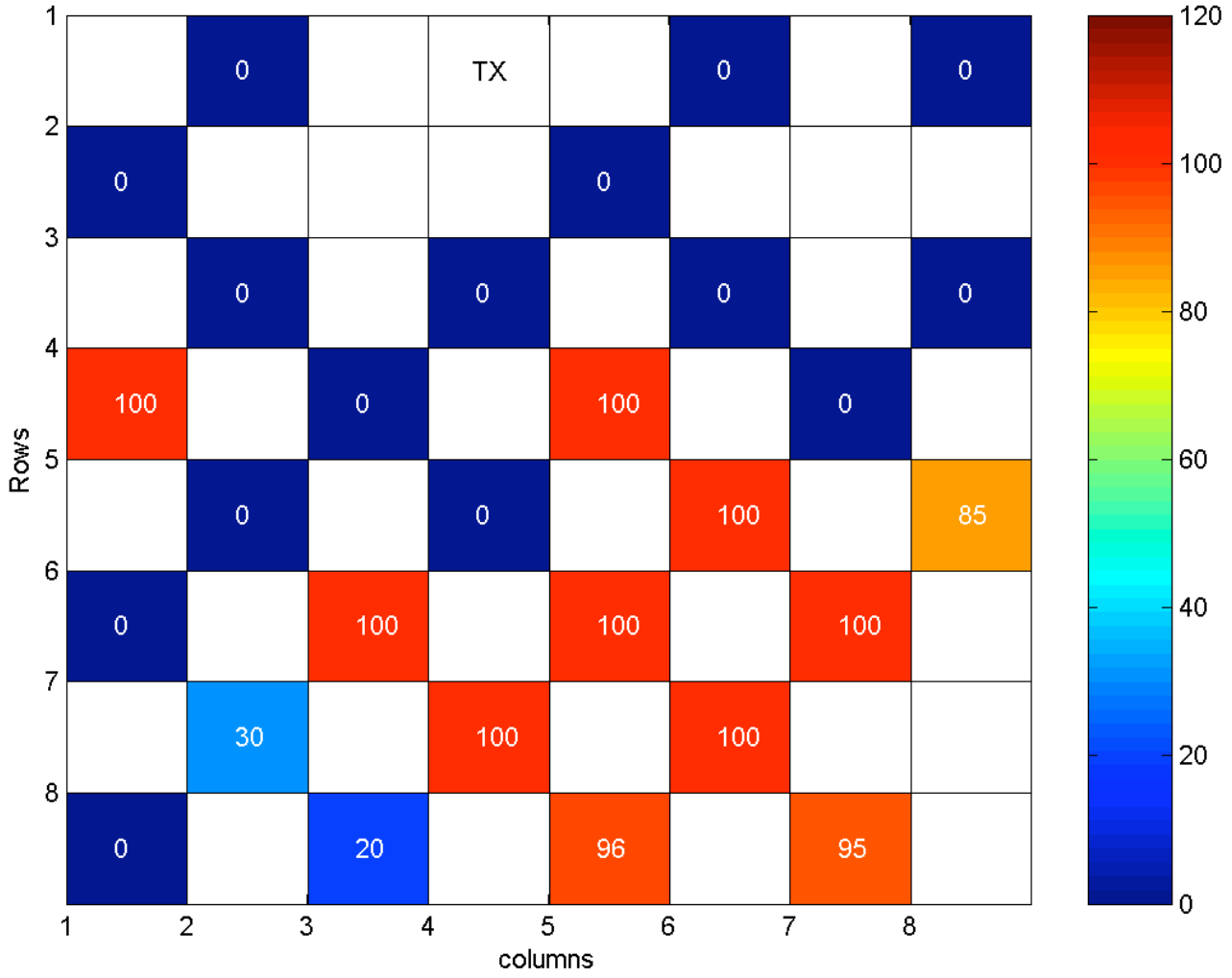
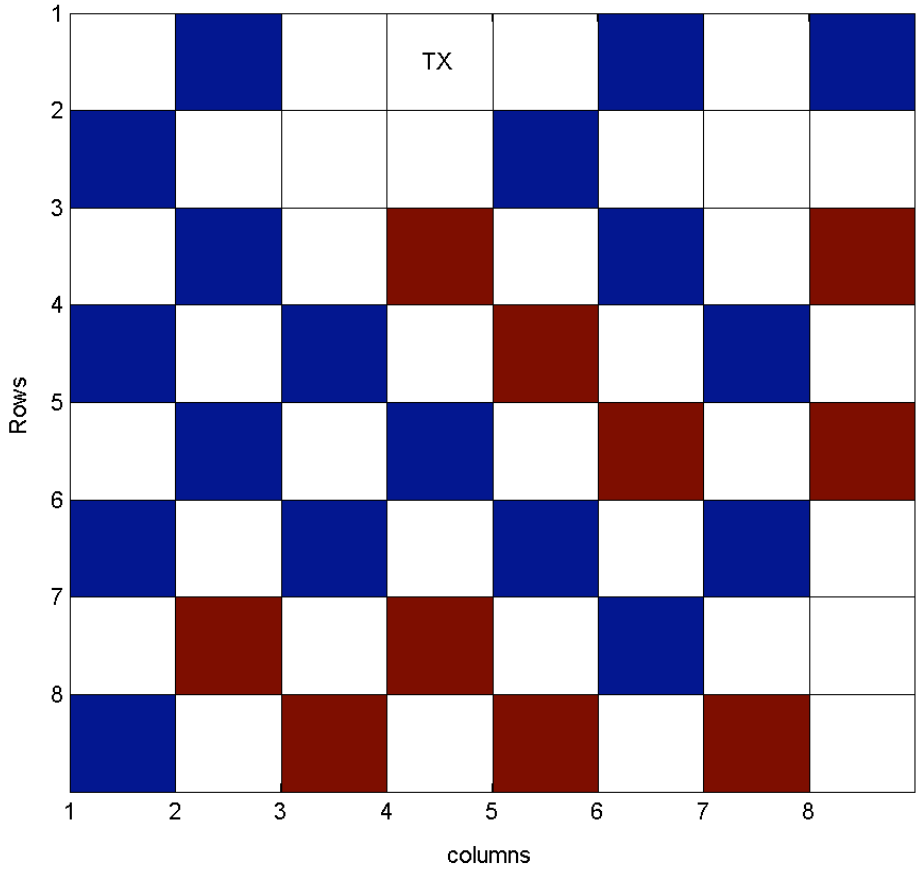
PER Plot Trial I



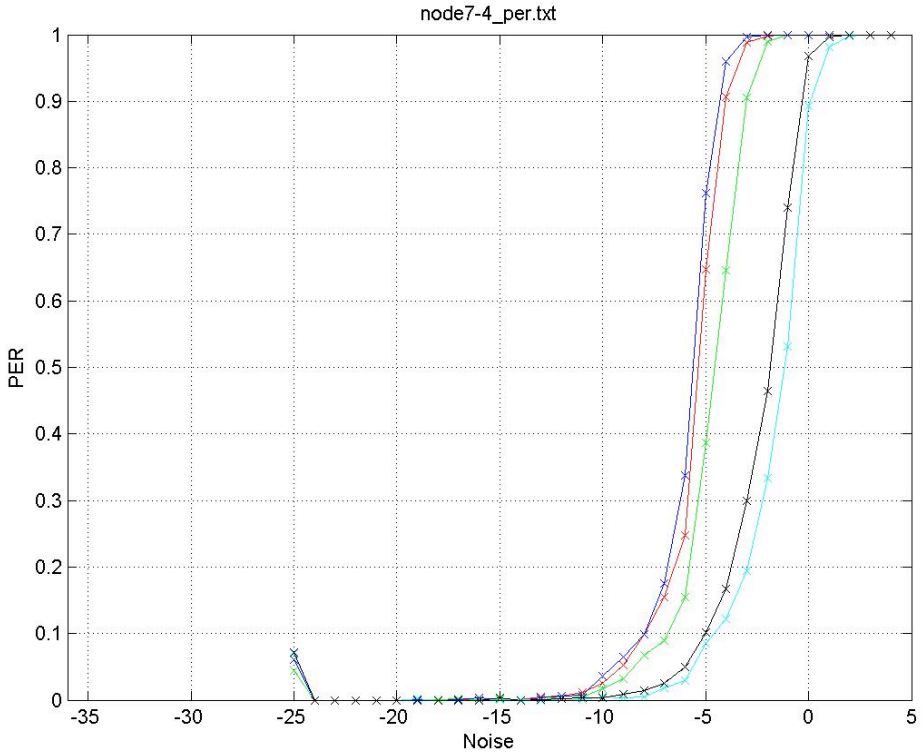
PER Plot Trial II



Variance Over VIII Trials



PER With Gradually Increasing Noise



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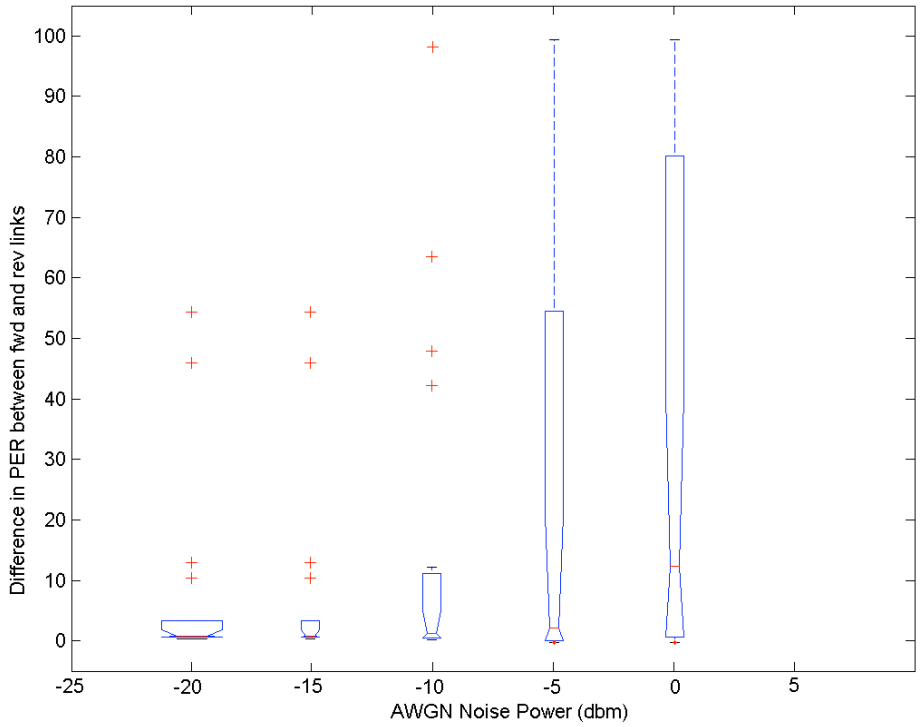
Link Asymmetry – PER metric



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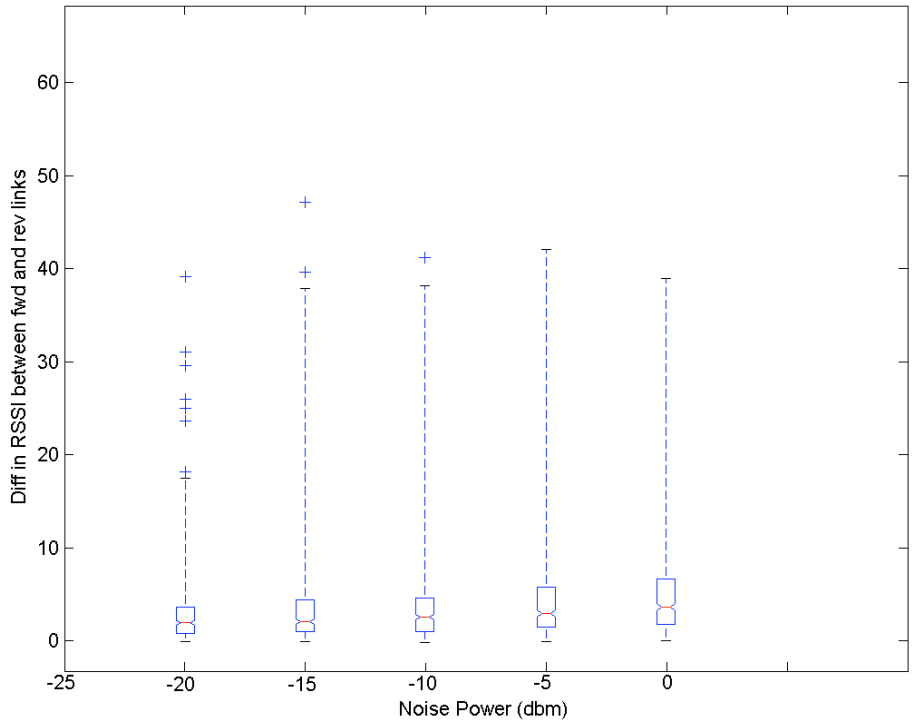
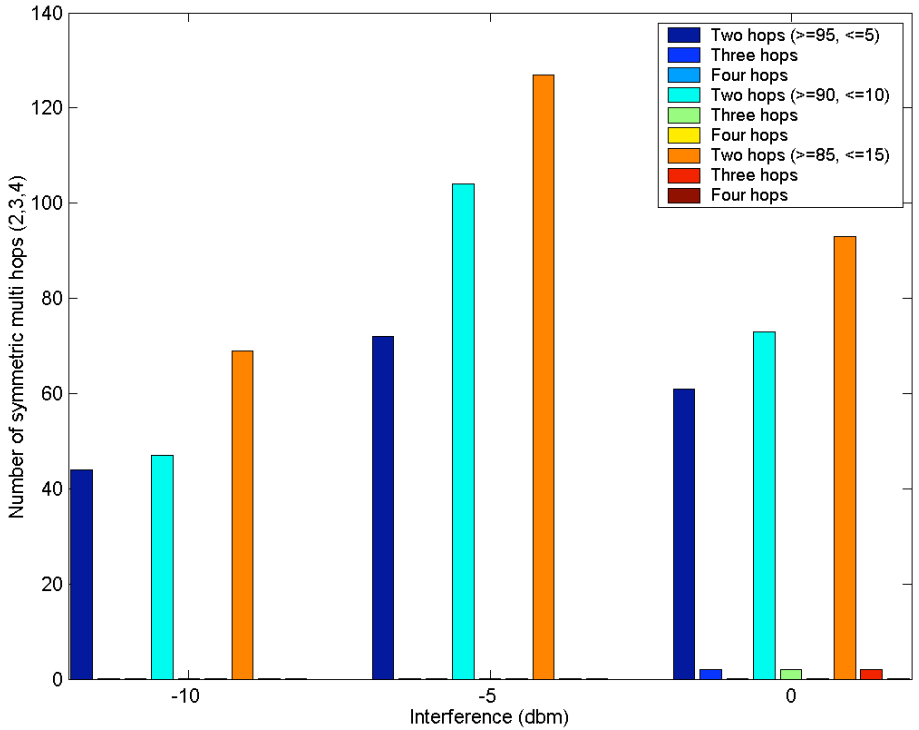
Link Asymmetry – RSSI metric



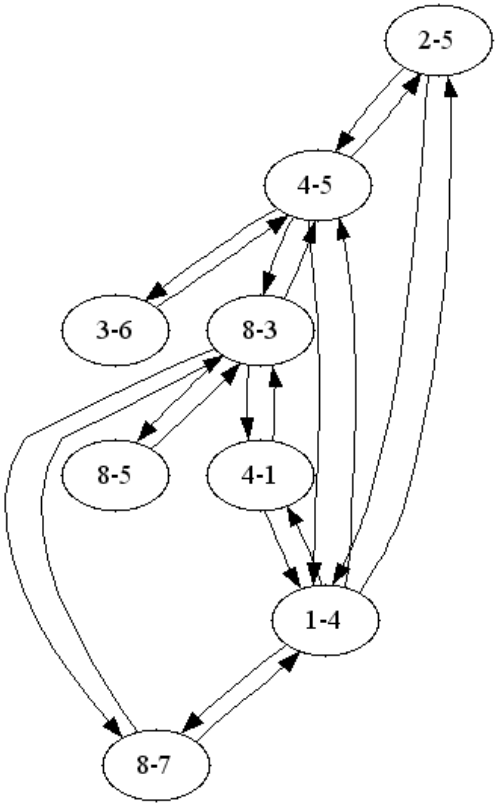
SIFN – Three Hop Topology (9ft)

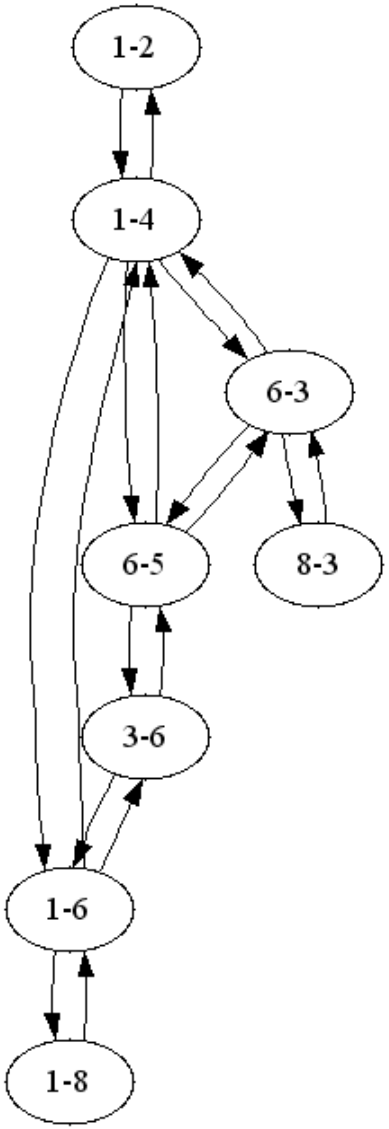
1-1	TX	1-3	0	1-5	100	1-7	100
1-1	0	1-3	TX	1-5	1	1-7	100
1-1	100	1-3	0	1-5	TX	1-7	0
1-1	98	1-3	100	1-5	0	1-7	TX

SNFI – Two, Three & Four String Topologies



Complex Topologies





Conclusion

- The hops are there and they are symmetric too!
- SNFI
  - No manual intervention
  - Limited antennae
  - Can generate number of 2 or 3 hop topologies. A few complex topologies give up to four hops at high interference of 0dbm.
- SIFN
  - Could be automated via variable attenuators for each antenna.
  - Will allow greater control with one antenna per node.
  - May allow greater repeatability of created topologies.