Towards Commercial Mobile Ad Hoc Network Applications: A Radio Dispatch System

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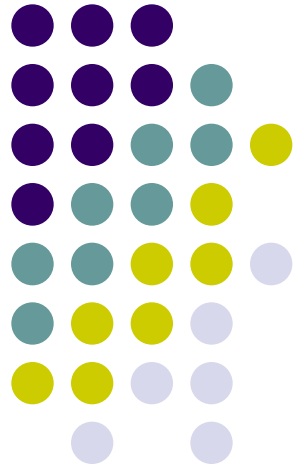


Outline

- Background
- Feasibility study
- Simulation
- Results
- Conclusion

Background

QOS Issues

Significant costs
- radio licensing
- Mobile phones
- Data transfer for GPS

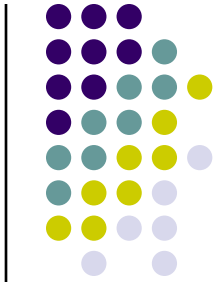
Background: Fundamental idea

Location Info:
- Nearest free taxi

Traffic Info:
- Better communication

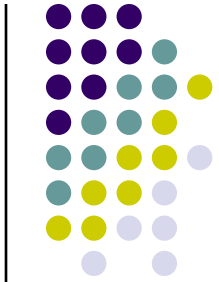
Conflict resolution?
- how much time is available for negotiation?

Feasibility: Financial



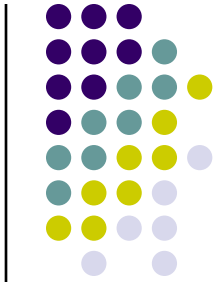
- Customers
  - efficiency
  - ease
- Taxi drivers
  - faster turnover rates
  - accurate info from dispatchers
  - security
- Taxi companies
  - Capacity increase
  - Higher QOS
  - planning
- Significant cost savings

Feasibility: Technical



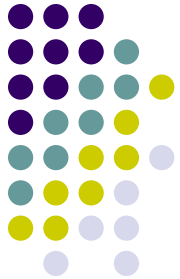
- Mobility Model
  - Manhattan style grid
  - Speed variation
  - Three state:
    - Carrying a passenger
    - Heading for taxi stand
    - Roaming around
  - Real empty cruising estimates
  - 50% probability for taxi stand destination (is this true behavior?)
  - Destination pause time + 30 seconds

Feasibility: Technical



- Propagation Model
  - Based on IEEE802.11b
  - Microcell Model (1.5m omni-directional ant.)
  - Interference (ignored due to low node density)
    - How about other devices?
  - Break distance (100m)
    - 2^{nd} order loss (-20dB/dec)
    - 4^{th} order loss (-40dB/dec)
    - 20dB extra for corners
  - Ricean fading (dominant LOS component)
- Network operations
  - Periodic updates (small data)
  - Periodic outages
  - drive-thru proxy for large data exchange

Simulation: Set up



- 5Km X 5Km Manhattan grid
  - Block size of 100m x 100m
- Central dispatch point at center / taxi stand
- 3hr SIM time runs (1000sec warm up)
- 300 ad hoc enabled taxis
- Connected – if reachable from access point for >=3secs

Results

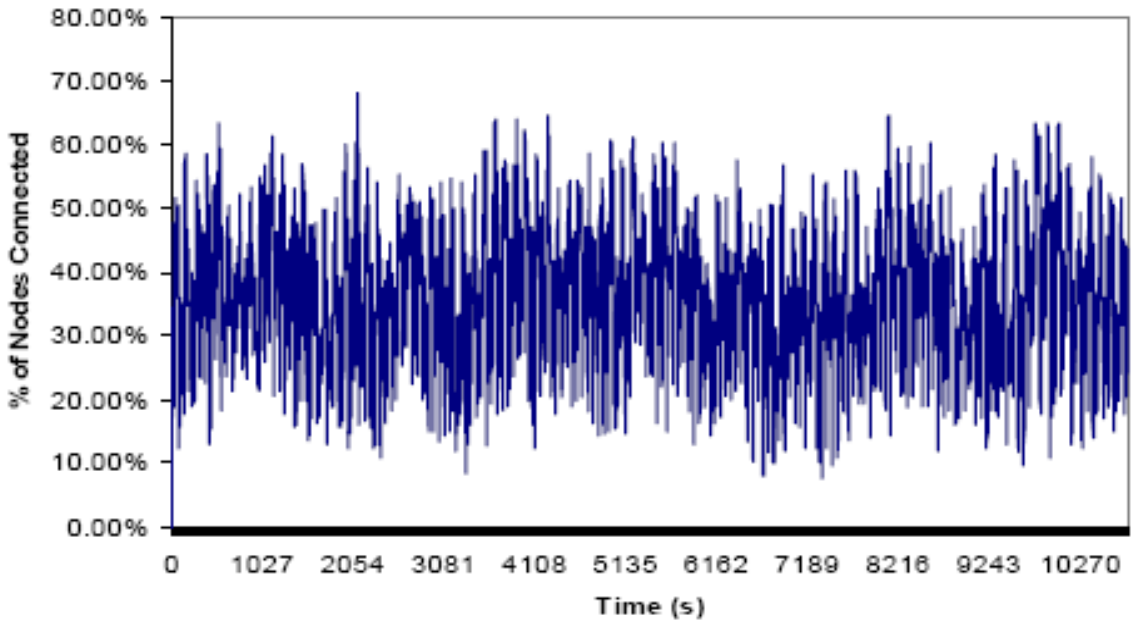


Figure 2: Typical Coverage Under Control Conditions

Fluctuating coverage over time
Mean coverage = 107.7 (35.91%)

Results

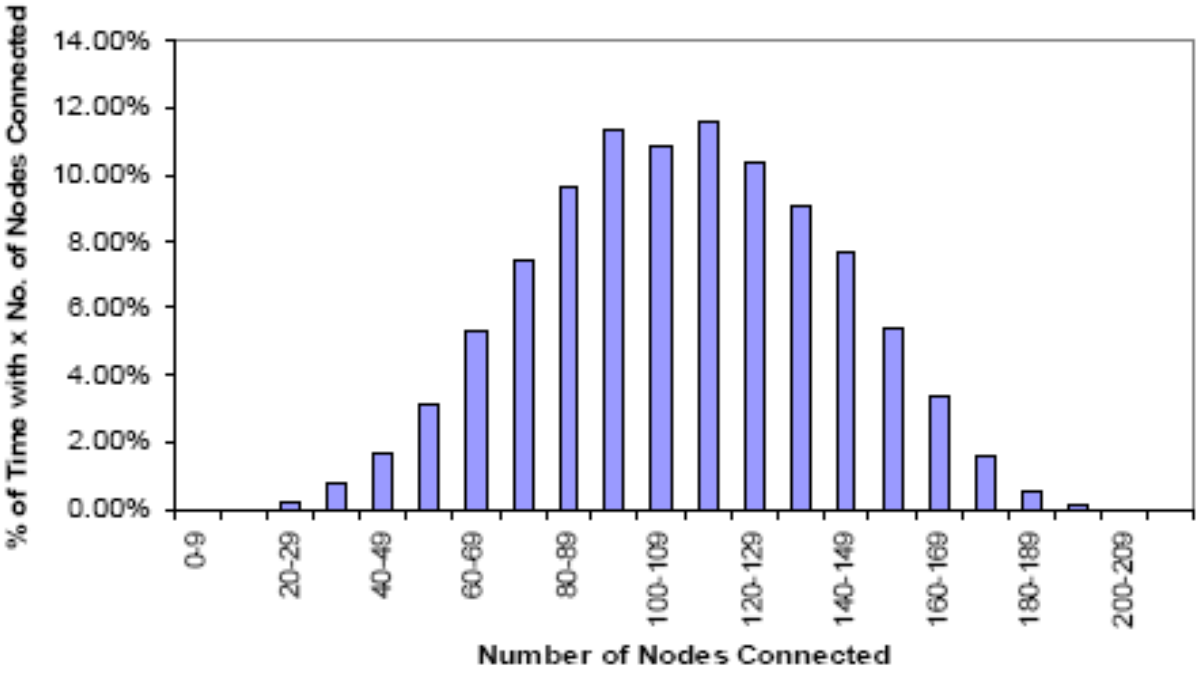


Figure 3: Typical Distribution of Coverage

Gausiian distribution
-median = 35.84%
-std. Dev. = 0.6%

Results

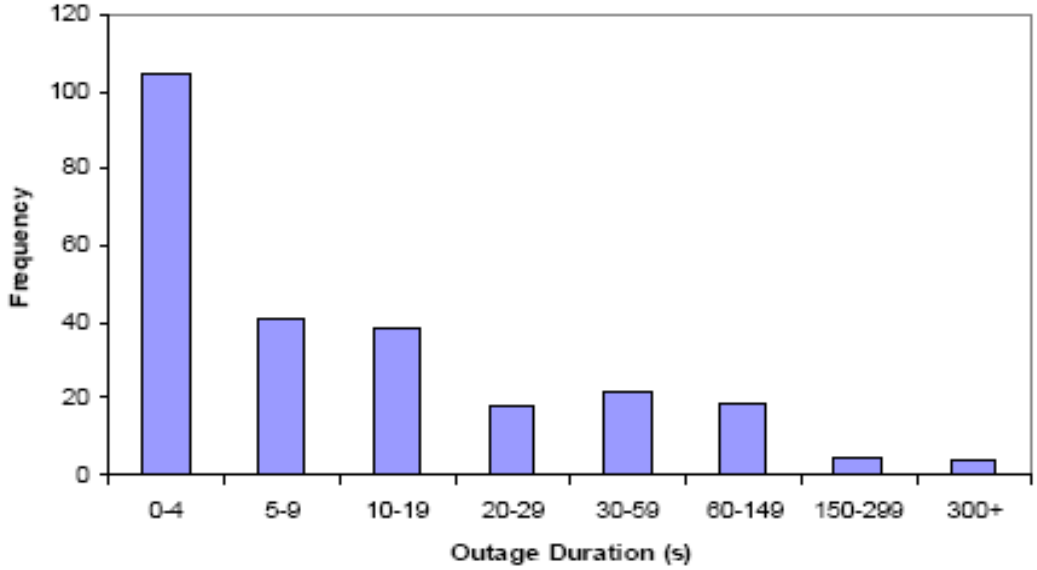


Figure 4: Typical Distribution of Outage Durations

Average outage time = 28.47s (95% confidence lvl of 0.15s)
Max time = 11mins
Longest time observed = 46min (perhaps lunch break?)
Unsuitable for real time communication

Results: Node Density

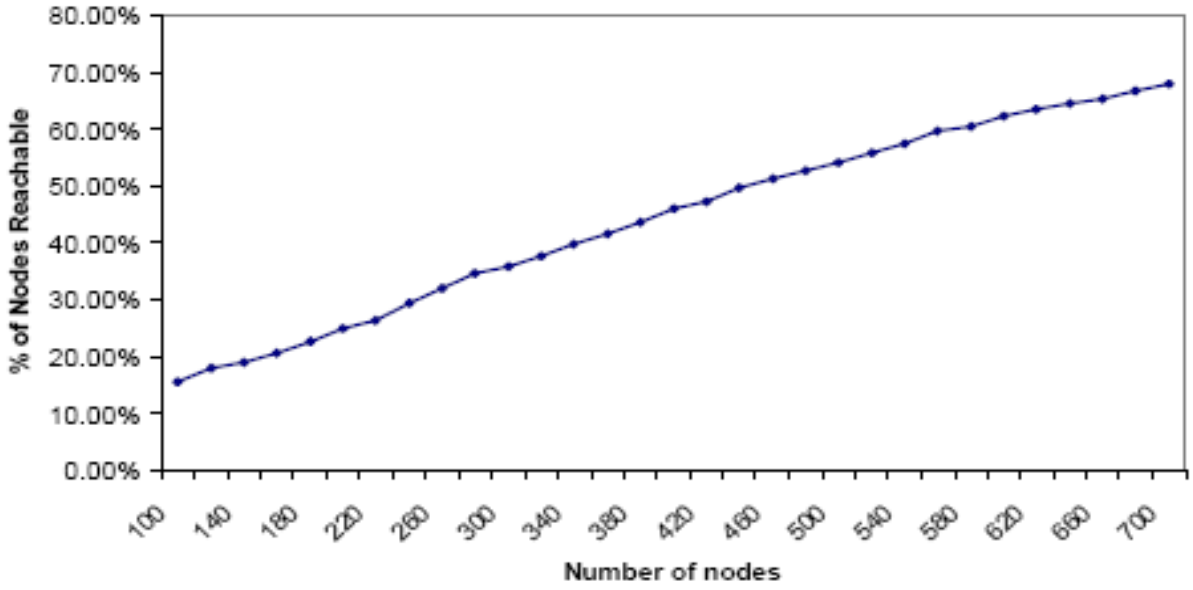


Figure 5: Percentage of Nodes Reachable as a Function of the No. of Nodes

Increase node density from 100 to 700

Results: Node Density

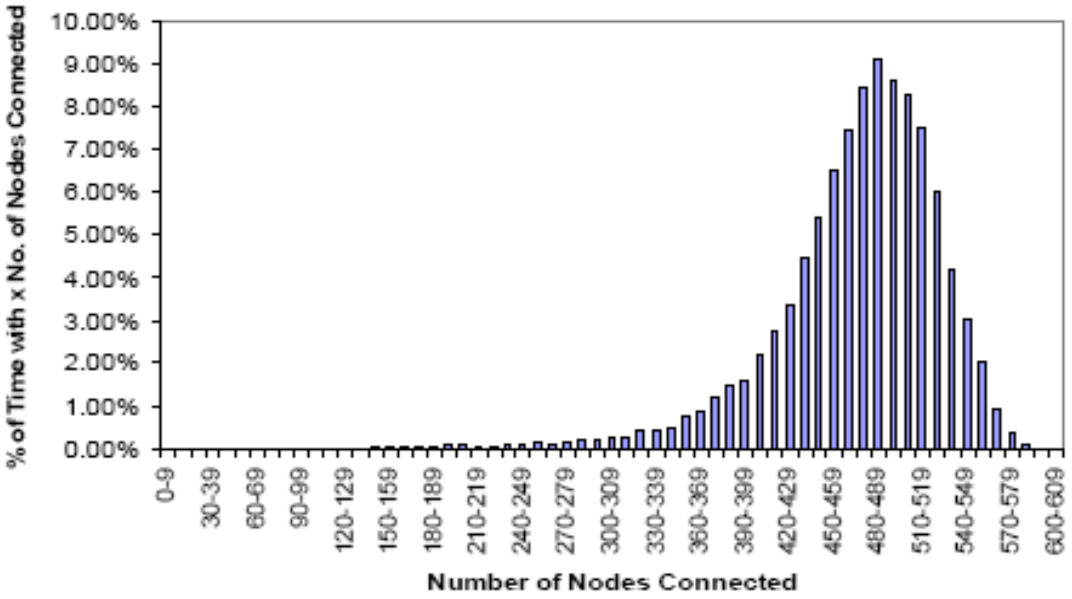


Figure 6: Typical Distribution of Coverage with 700 nodes

More nodes connected, hence right shift from prev. figure

Results: Node Density

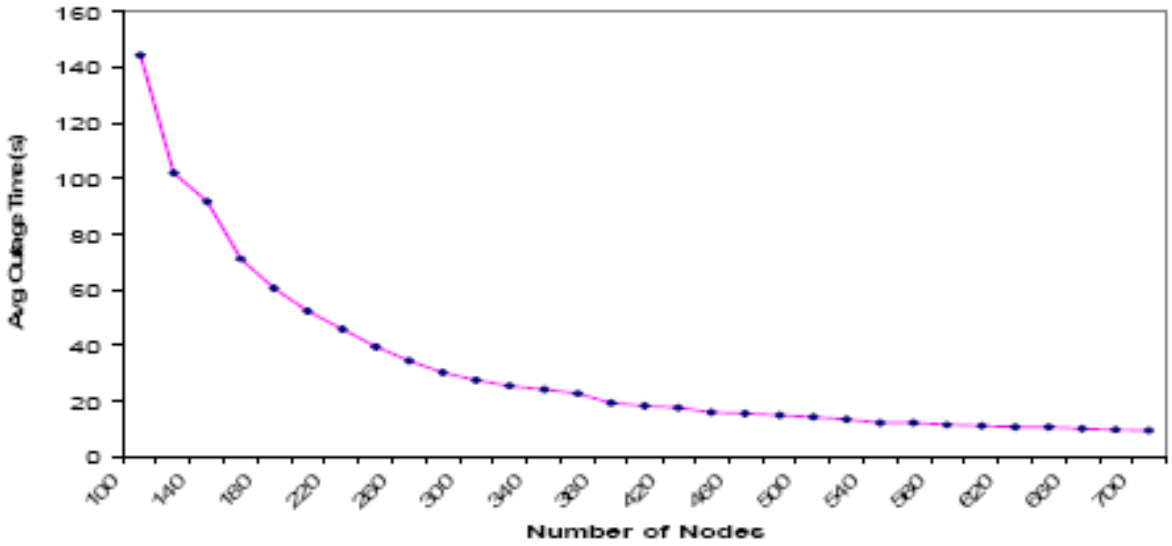


Figure 7: Average Outage Time as Function of No. of Nodes

Results: Node Density

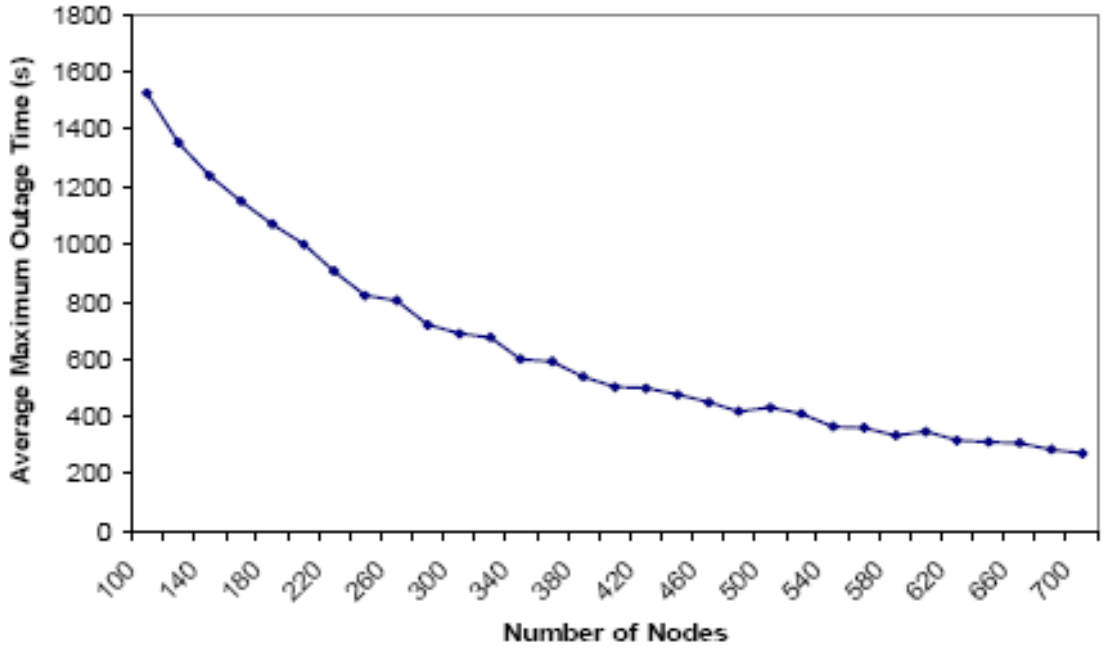


Figure 8: Average Maximum Outage Time as a Function of the No. of Nodes

Avg Max outage time = avg of all max outage times of all nodes over each sim. run

Results: Node Density

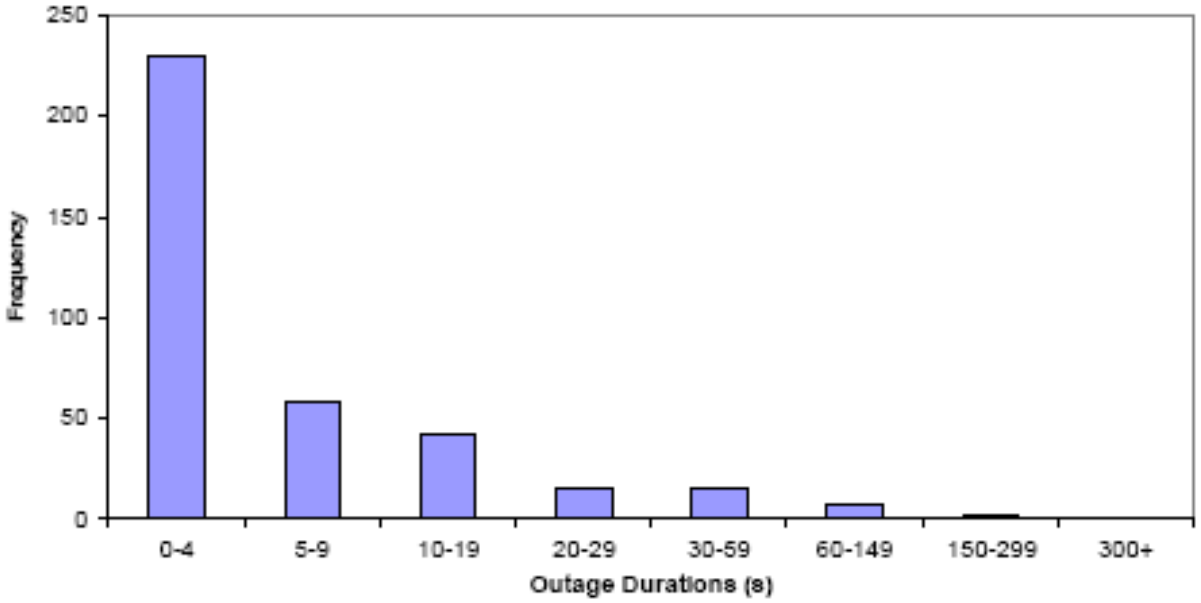


Figure 9: Typical Distribution of Outage Durations with 700 nodes

Results: Node Density

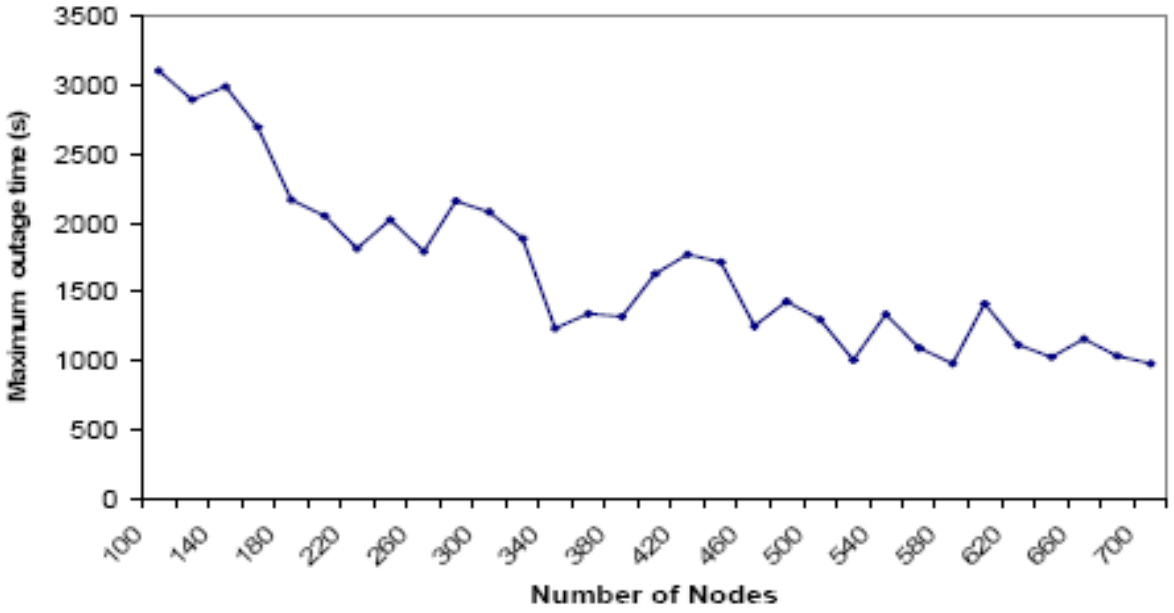


Figure 10: Maximum outage time

Randomness attributed to variation in sim runs

Results: Connection Time

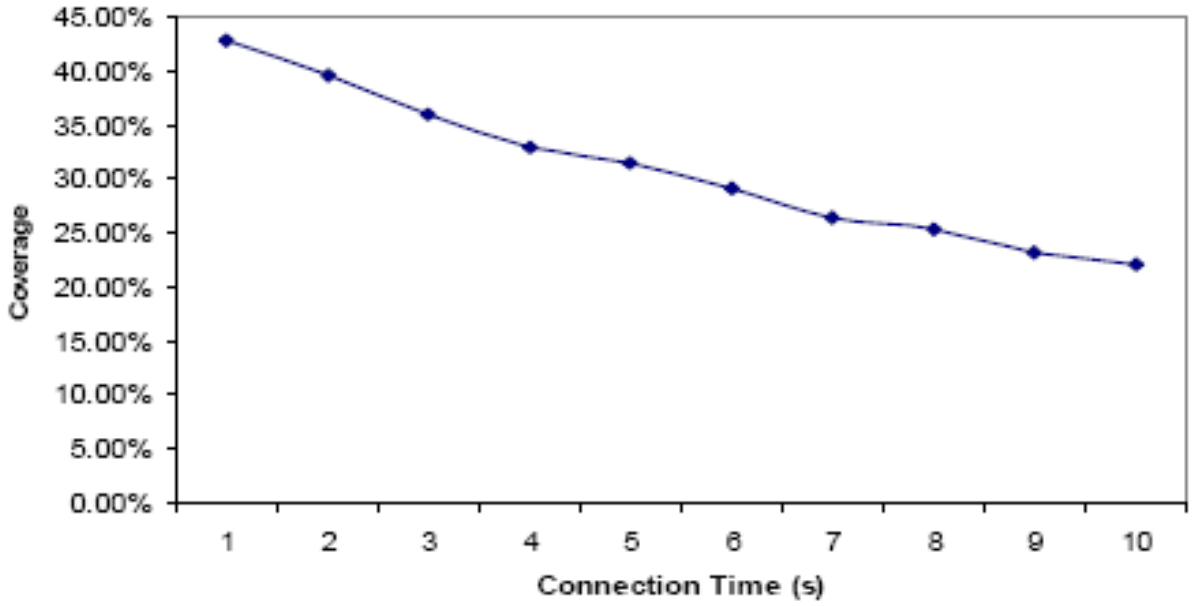


Figure 11: Coverage Variation with Connection Time

Connection time = Time to set up links & transmit data

Results: Connection Time

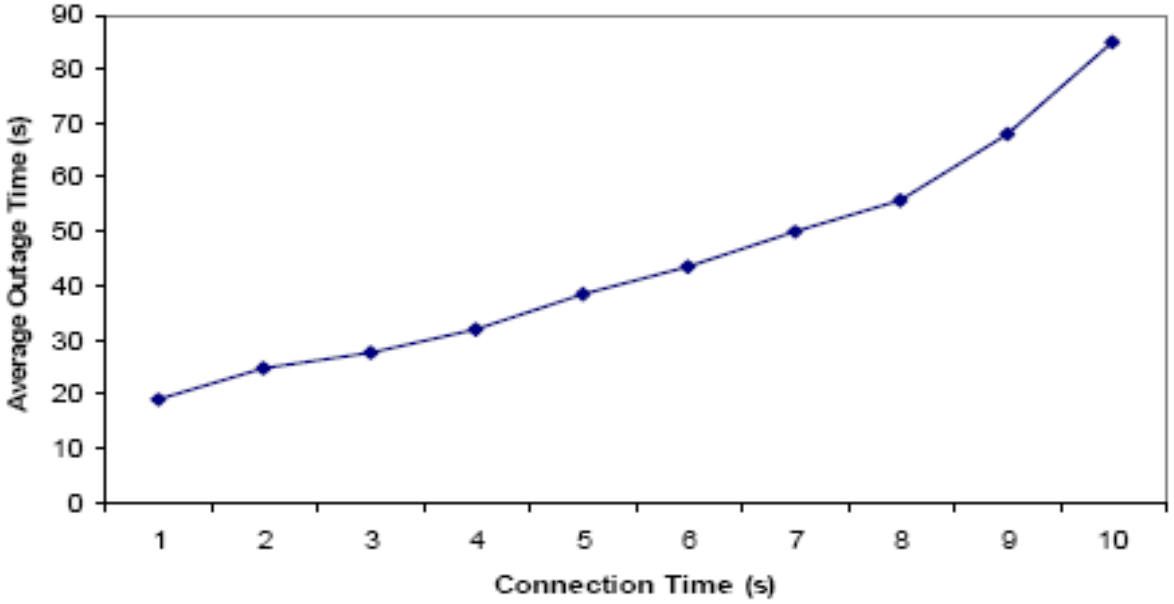


Figure 12: Average Outage Time vs. Connection Time

Results: Connection Time

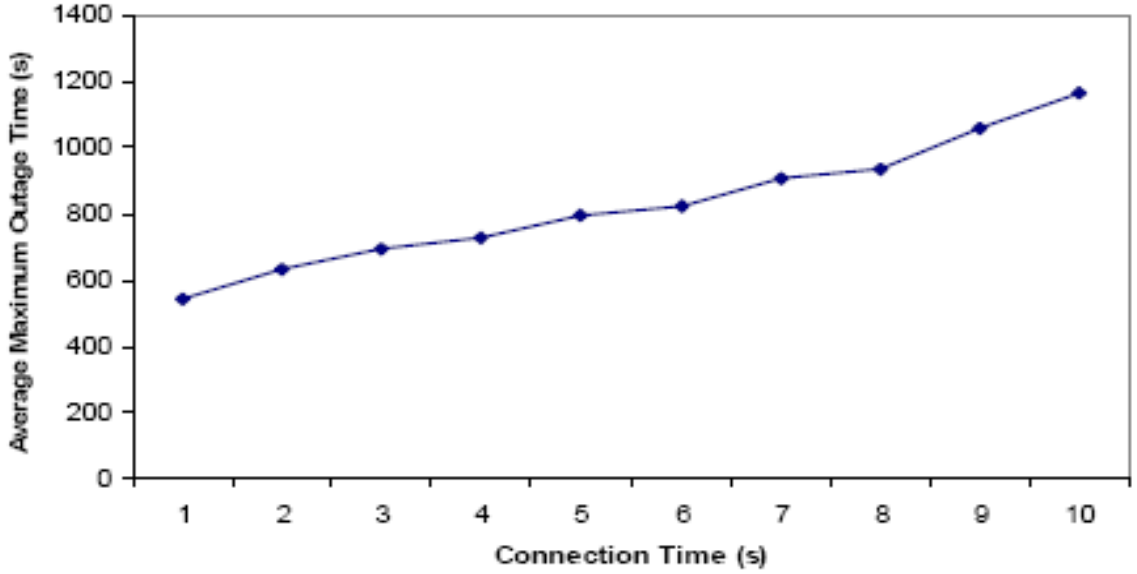


Figure 13: Average Maximum Outage Time vs. Connection Time

Results: Effects of Larger networks sizes and shorter connection time

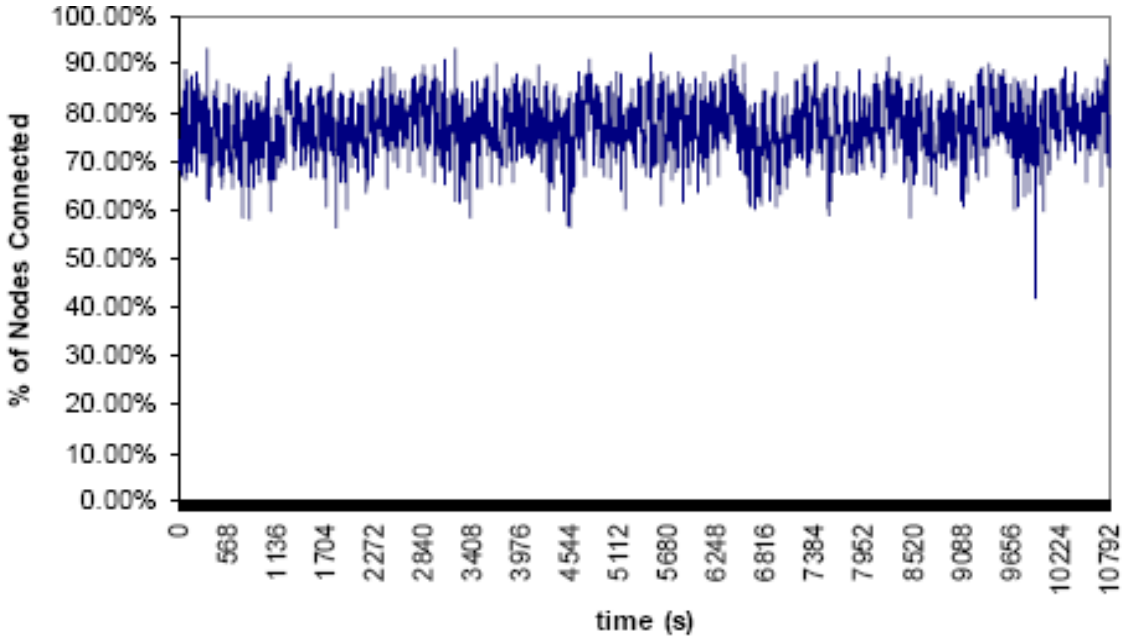


Figure 14: Typical Coverage with 700 Nodes and a 1s Connection Time

Avg connec. = 77%

Results: Effects of Larger networks sizes and shorter connection time

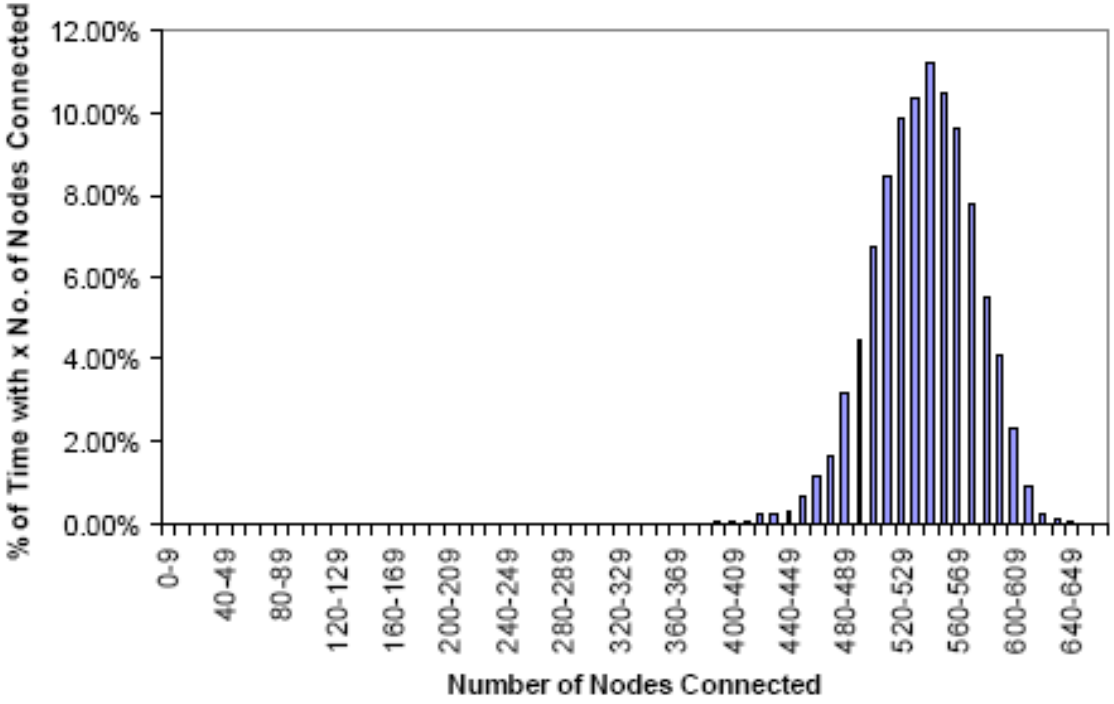


Figure 15: Typical Coverage with 700 Nodes and a 1s Connection Time

Results: Effects of Larger networks sizes and shorter connection time

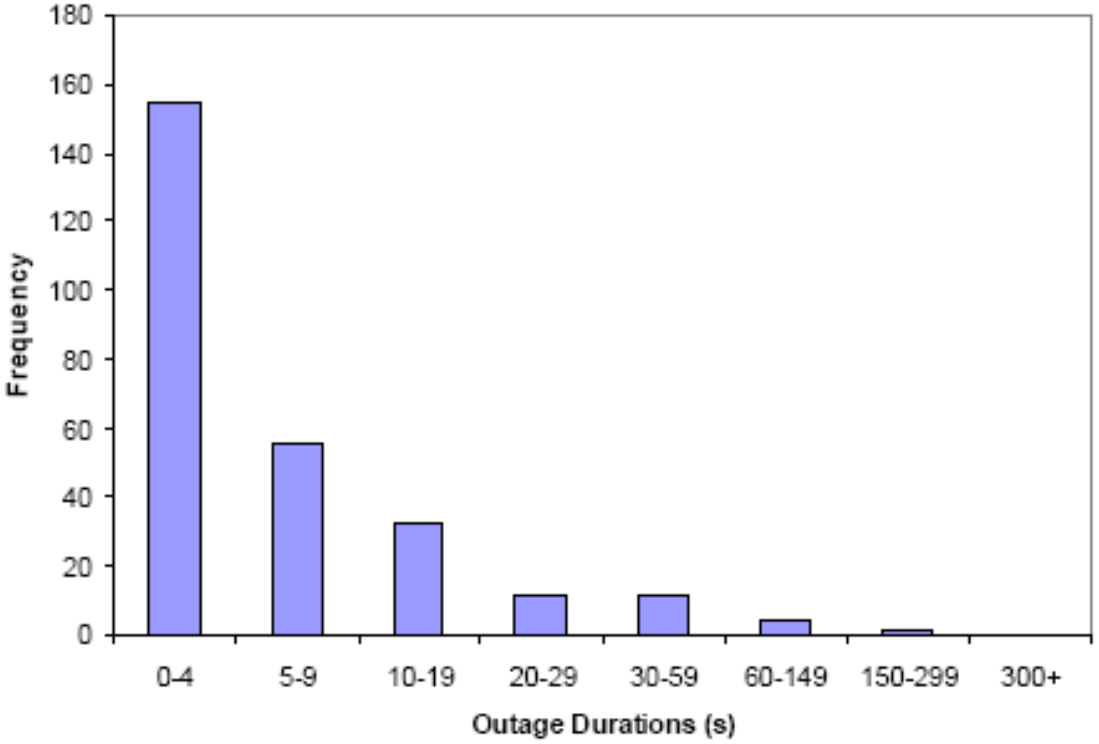


Figure 16: Typical Distribution of Outage Durations with 700 Nodes and a 1s Connection Time

Average outage dropped to 8.8s

Results: Traffic Congestion

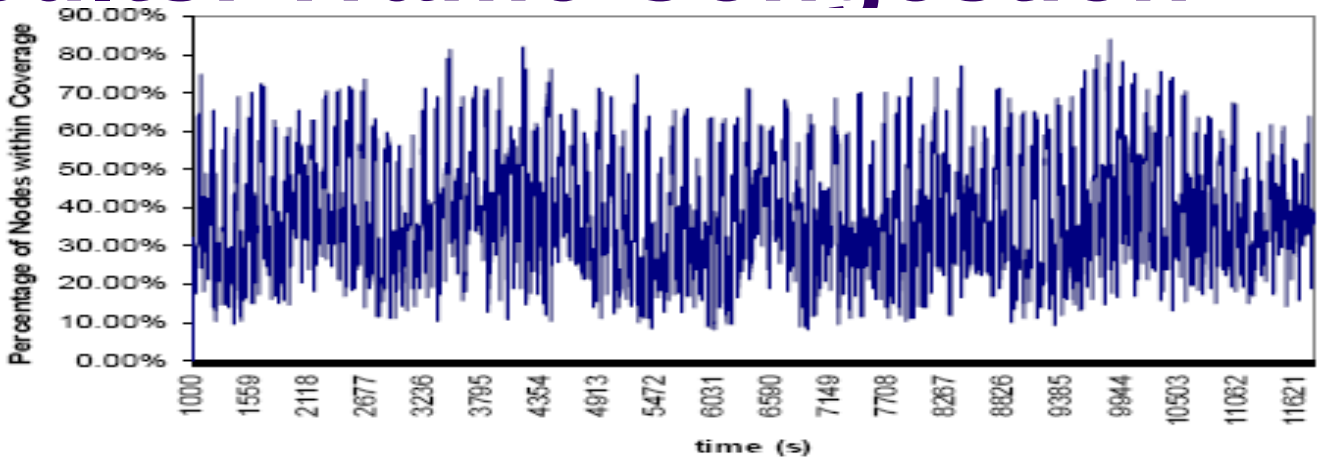


Figure 17: Typical Coverage with Congestion (30,000 cars)

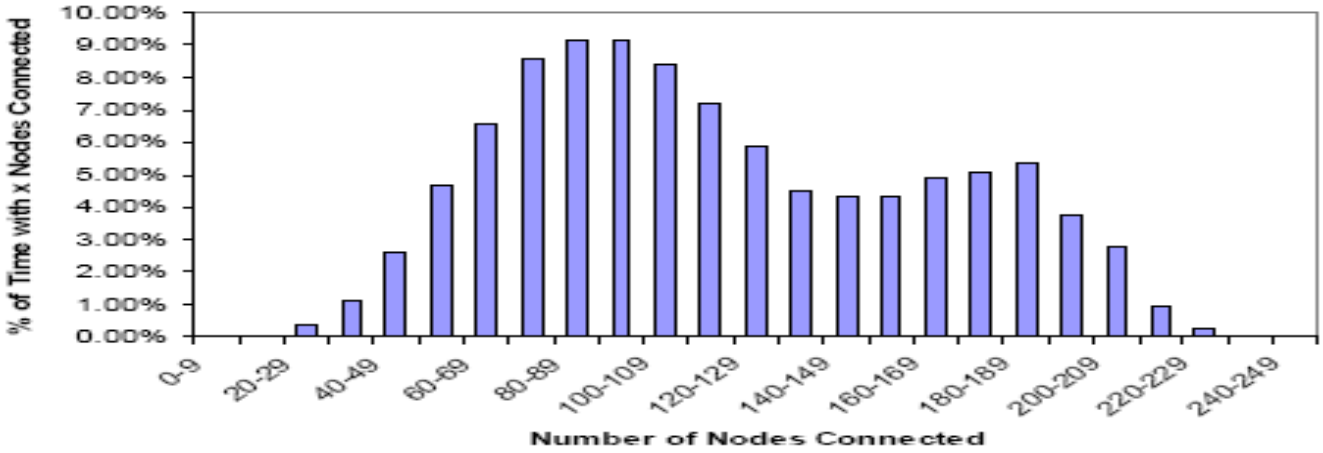


Figure 18: Typical Distribution of Coverage with Congestion (30,000 cars)

Results: Traffic Congestion

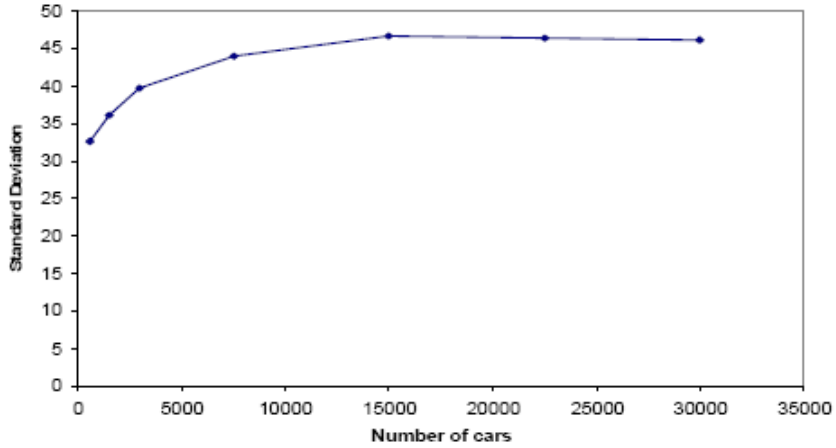


Figure 20: Standard Deviation of the coverage as Function of Congestion

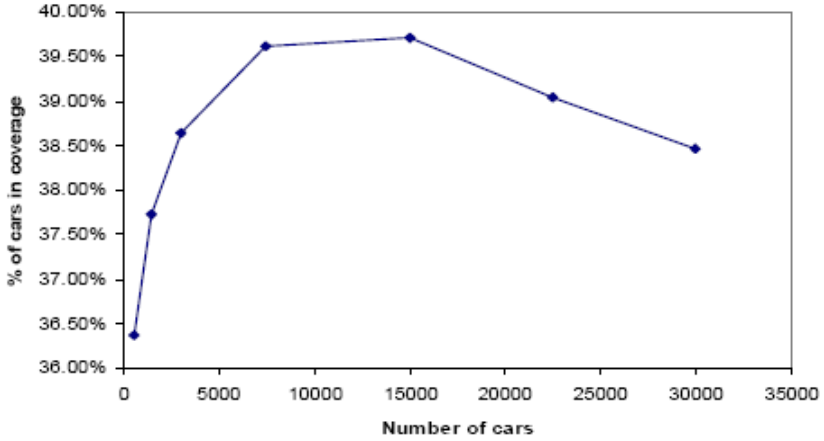


Figure 21: Coverage as Function of Congestion

Results: Traffic Congestion

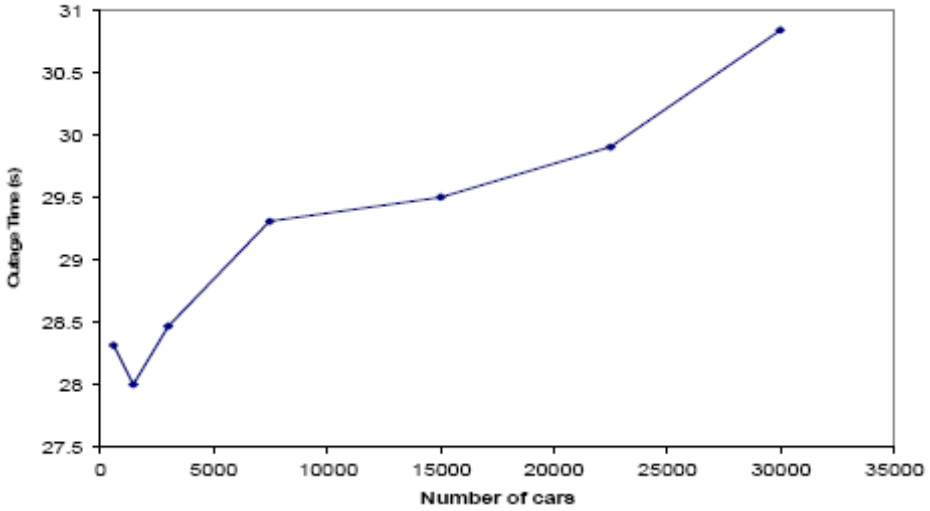


Figure 22: Average Outage Time

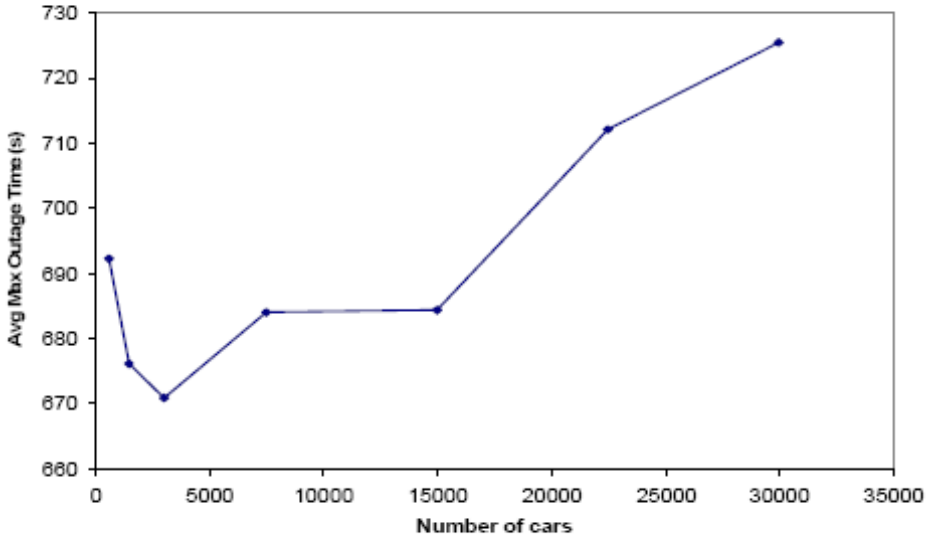


Figure 23: Average Maximum Outage Time

Results: Traffic Congestion

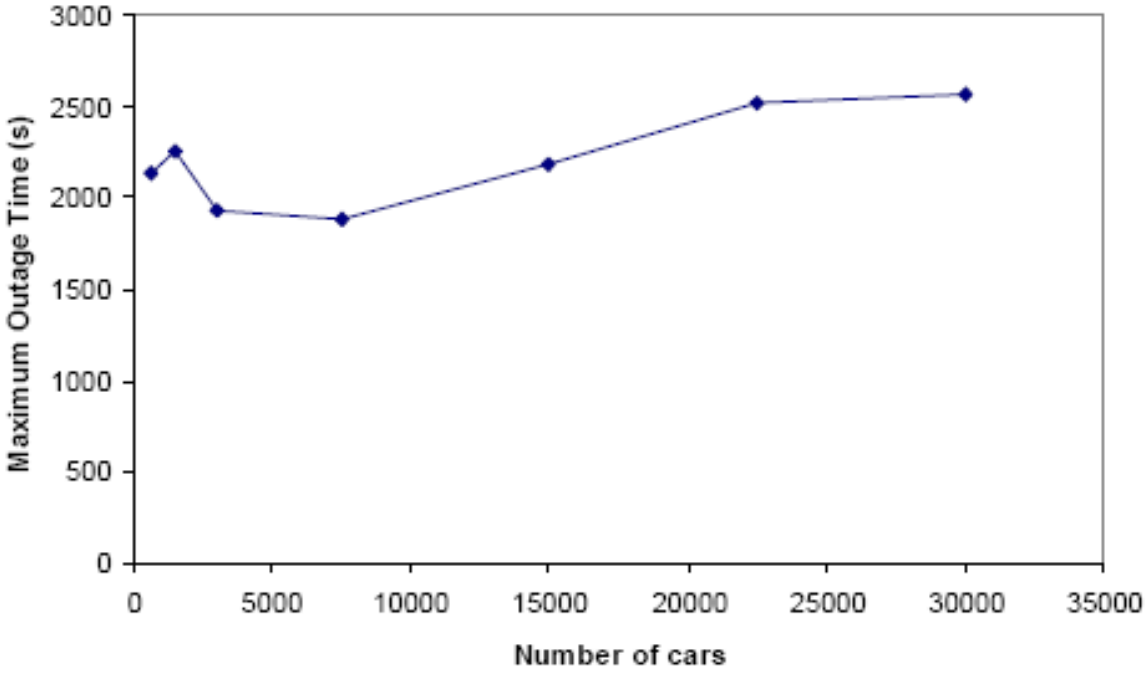
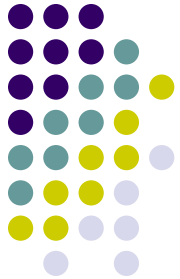


Figure 24: Maximum Outage Times

Results: Conclusion



- Focus on only low layers
- Routing protocols are assumed to work
- Need for a back up system
- Seamless handoff betw LAN and radio
- Security concerns, no eavesdropping
- Scalability and Interference
  - Use adaptive radios
  - New unlicensed bands