CS 525M – Mobile and Ubiquitous Computing Seminar

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Credits

- Paper title:
  - Towards Realistic Mobility Models For Mobile Ad hoc Networks
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- Publication date
  - September 2003 (Mobicom '03)

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Related work (existing random models)

Motivation

An Obstacle Mobility Model

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Overview

- *"Simulation provides researchers with a number of significant benefits, including repeatable scenarios, isolation of parameters, and exploration of a variety of metrics."*

- Node mobility directly affects wireless protocol performance

- Existing random mobility models are not realistic enough.

- Solution: Add obstacles to dictate movement and sight lines, and modify node movement to conform.

Introduction

- *“Wireless channels experience high variability in channel quality due to a variety of phenomena, including multipath, fading, atmospheric effects, and obstacles. “While real world tests are crucial for understanding the performance of mobile network protocols, simulation provides an environment with specific advantages over real world studies.”*

- Using a simulation to model a wireless network provides repeatability and ease of rerunning the simulation multiple times with different variables.
- It is generally not feasible to run tests in this manner over a real wireless network.
- The “mobility model” determines how nodes will move once they are placed,

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Related Work

Related work (existing random models)

- Basic mobility model
- Random walk
- Random direction
- Random waypoint
- Edgeless random walk

Mobility Models: Basic

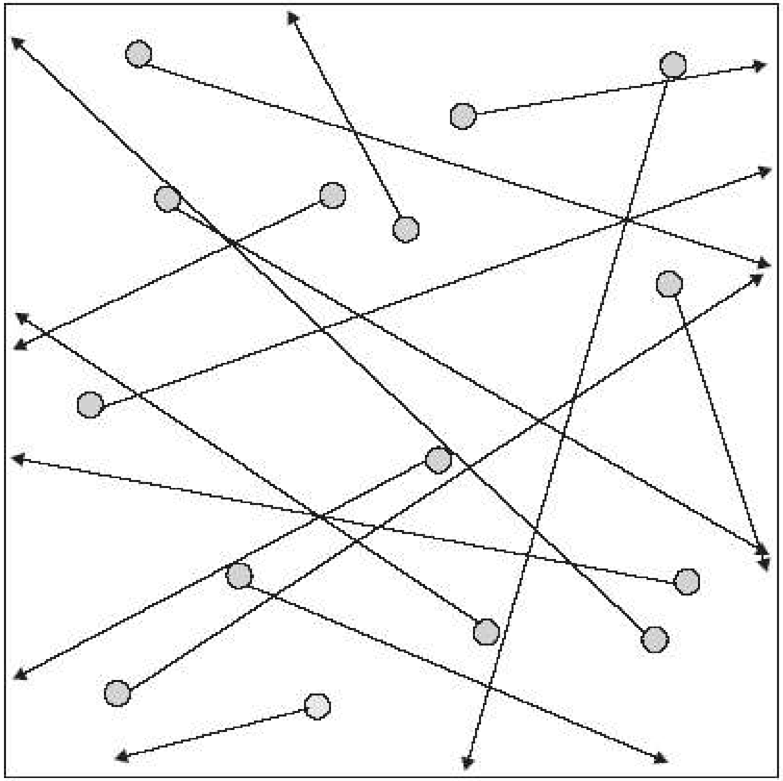
- Basic mobility model
  - Node picks random direction and speed to walk, then walks for *k* time.
  - After *k* time, all nodes pick new directions and speeds.

Mobility Models: Random Walk

- Random walk
  - Node picks random direction and distance to walk, then walks

Mobility Models: Random Direction

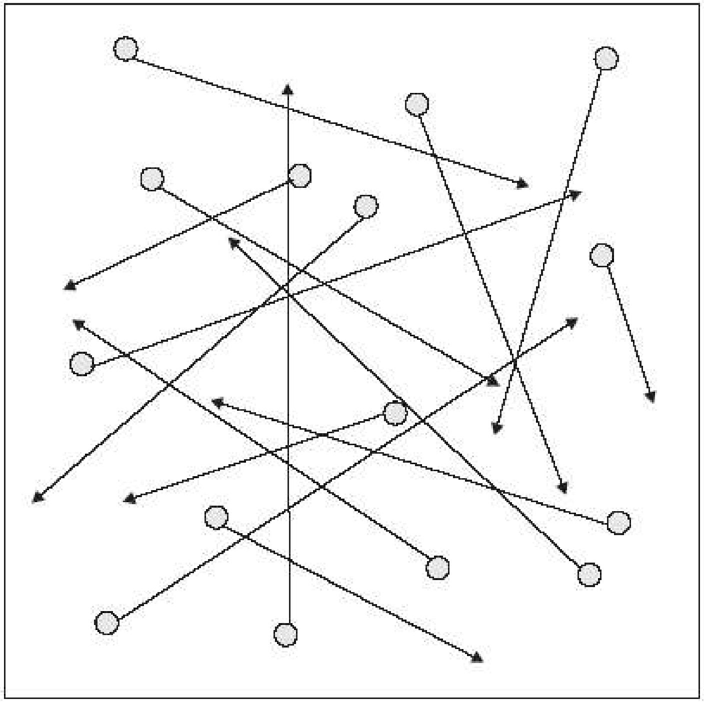
- Random direction
  - Node picks random direction, then walks until boundary encountered.



(b) Random Direction Mobility

Mobility Models: Random Waypoint

- Random waypoint
  - Node picks random destination point, then walks in that direction.
  - Random waypoint is one of the most popular models.



(a) Random Waypoint Mobility

Mobility Models: Edgeless

- Edgeless Randon Walk
  - Like Random Walk but with the environment modeled as a torus.
  - Left edge connects to right, and top to bottom.

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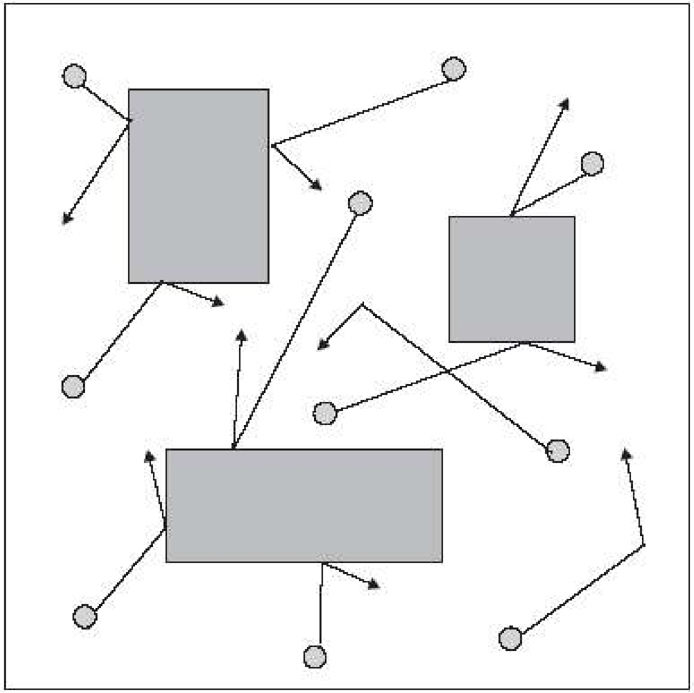
- All of the previous models have dealt with unobsruncted movement in open environments.
- These models do not take into account the effect of obstacles on the movement of the nodes or the ability to broadcast from one node to another.

Motivation

- Simple Solution: Movement with Obstacles
  - Insert polygonal objects into environment for Random Walk/Distance
  - Reflect direction of movement off of any encountered edge.
  - Does not model the way that people would realistically move in this environment.
- A better solution would more realistically model movement as well as environments.



(a) Movement with Obstacles

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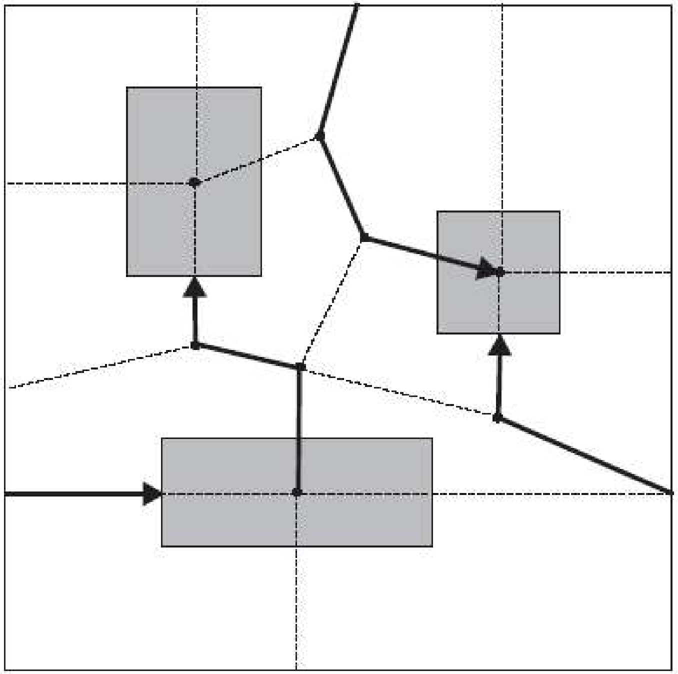
An Obstacle Mobility Model

An Obstacle Mobility Model

- Two major components to model
  - Placement of polygonal obstacles in simulated environment.
  - Rectangular obstacles used in example.
- Construction of paths as a Voronoi diagram, dependent on obstacle placement.



(b) Movement with Obstacles and Pre-Defined Pathways

The Voronoi Diagram

- Any point on a path in a Voronoi diagram is equidistant from its two closest reference points, or “location points.”
- This method also divides the area into a number of cells equal to the number of location points.
- Each cell is the area of influence of a location point.
- The paths split adjacent areas of influence.
- Location points in the mobility model are the corners of the model obstacles.
  - This is the “geometry-based” approach.
- Vertices, or “sites,” of a Voronoi diagram occur when an edge intersects:
  - Another path
  - The edge of an obstacle
  - The boundary of the simulation region.

Voronoi Diagram: Movement

- The movement model in the Voronoi diagram has each node take the shortest path from its current site in the Voronoi diagram to a random site, at a random speed, then pause for a random interval.

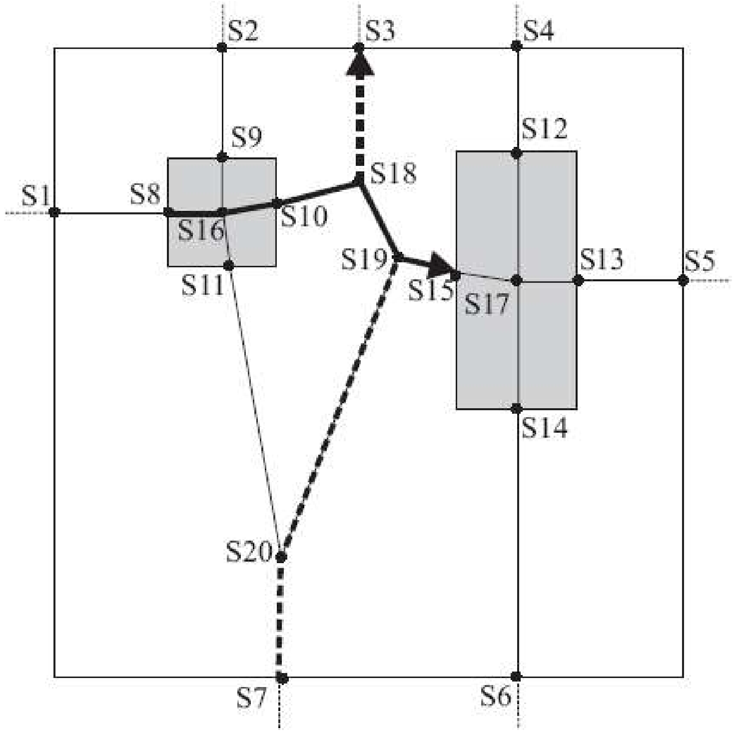


Figure 5: Example Movement Paths.

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Transmission Behavior

- Transmissions in the model are affected completely by line of sight
- Transmissions are blocked:
  - between indoor and outdoor nodes
  - between buildings
  - outdoors when an obstacle blocks the line of sight.
  - in the same building if the perimeter blocks the line of sight.
- Transmissions are unobstructed otherwise.
- The position of each node (outdoors or within a specific obstacle) is maintained through use of a position tag.
- Ad hoc network routing will not occur between two nodes when the wireless transmission is blocked.

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Simulations

- Performed using GlomoSim network simulator
- Simulation model is a representation of a 1km square section of UCSB campus.
- Between nodes, a maximum transmission range of 250m is assumed.
- Data derived from average of ten simulation runs.

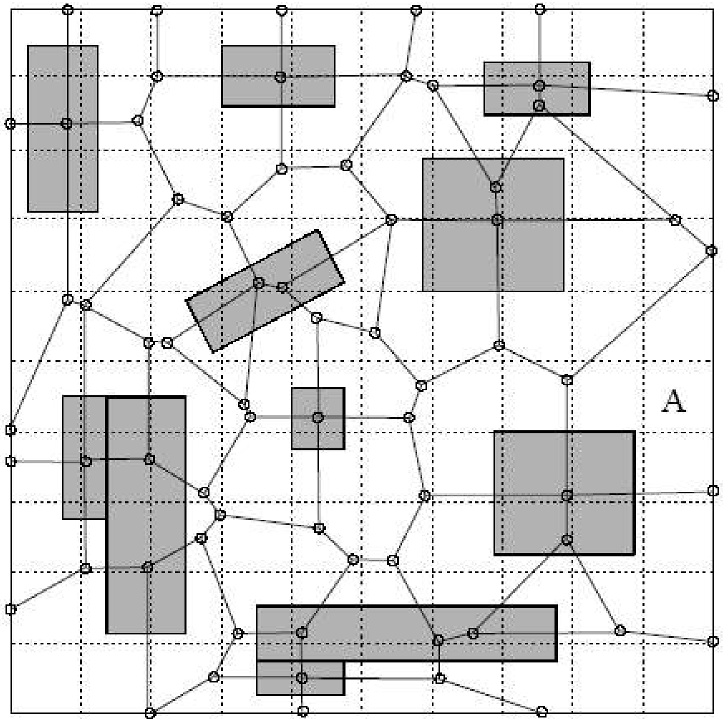

Figure 8: Simulated Terrain

Results: Node Density

Node Density

- Measure of average number of nodes within range.
- Note that the line at the top is a result of running the simulation in the obstacle model while ignoring the effect of obstacles

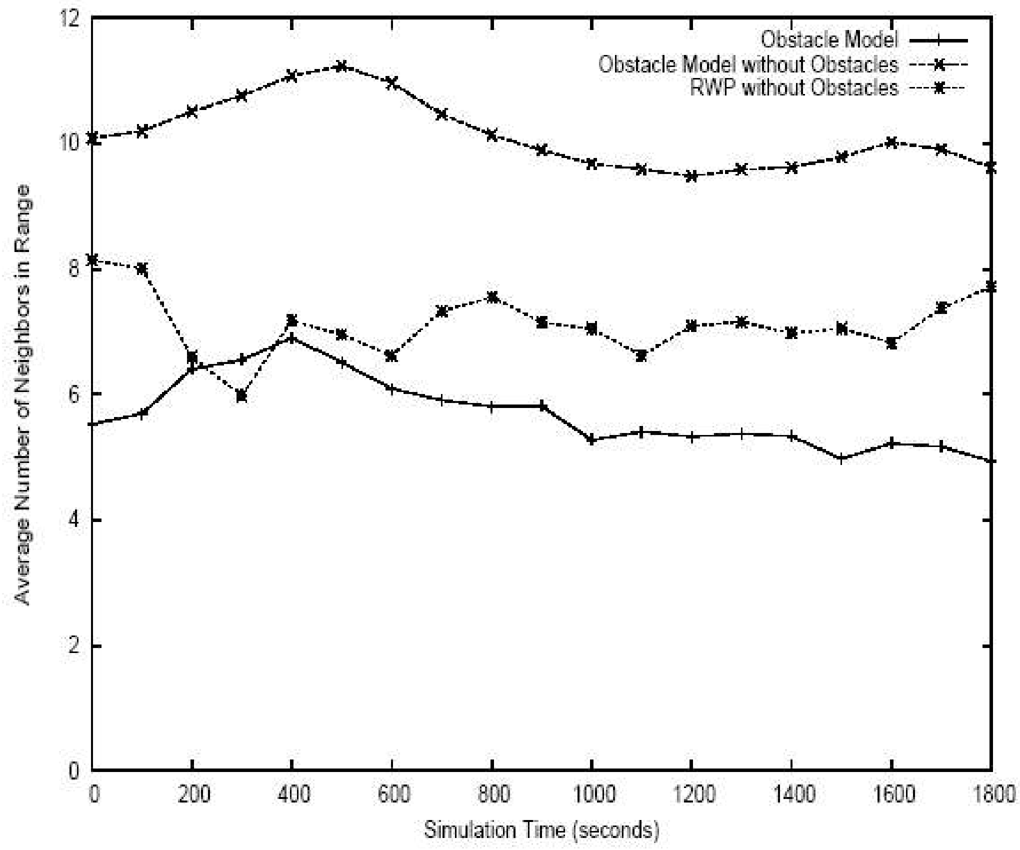

Figure 9: Node Density.

- Of special importance is the decrease over time of density in the obstacle model, contrasted with the increase in RWP

Results: Path Length

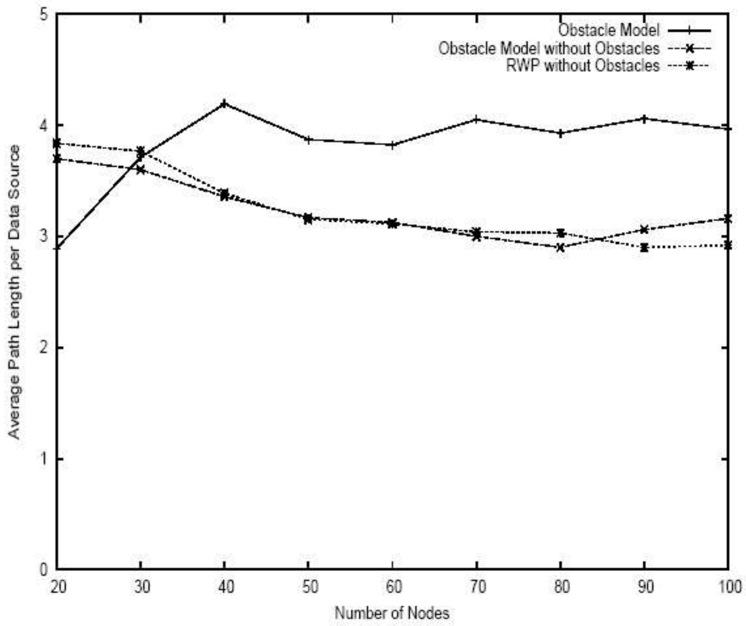

Figure 11: Path Length versus Number of Nodes.

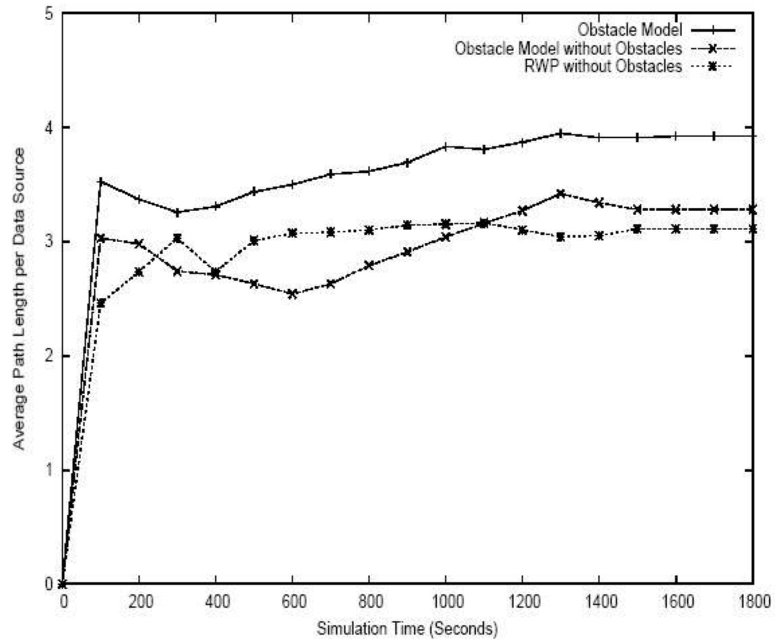

Figure 10: Path Length versus Time.

- Path length deviates by one whole hop between the obstacle model and RWP.
- Since the obstacle model without obstacles closely resembles RWP in these graphs, routing around obstacles is probably the reason for this variance.

Results: Data Packets

- Packet reception is greatly affected by the obstacle model.
- Here, the intermediate simulation is one with no node movement inside of obstacles
- The upper line is the result of RWP simulation.
- The source of the rift between the two is obstacles causing transmissions to be aborted and not subsequently re-established.

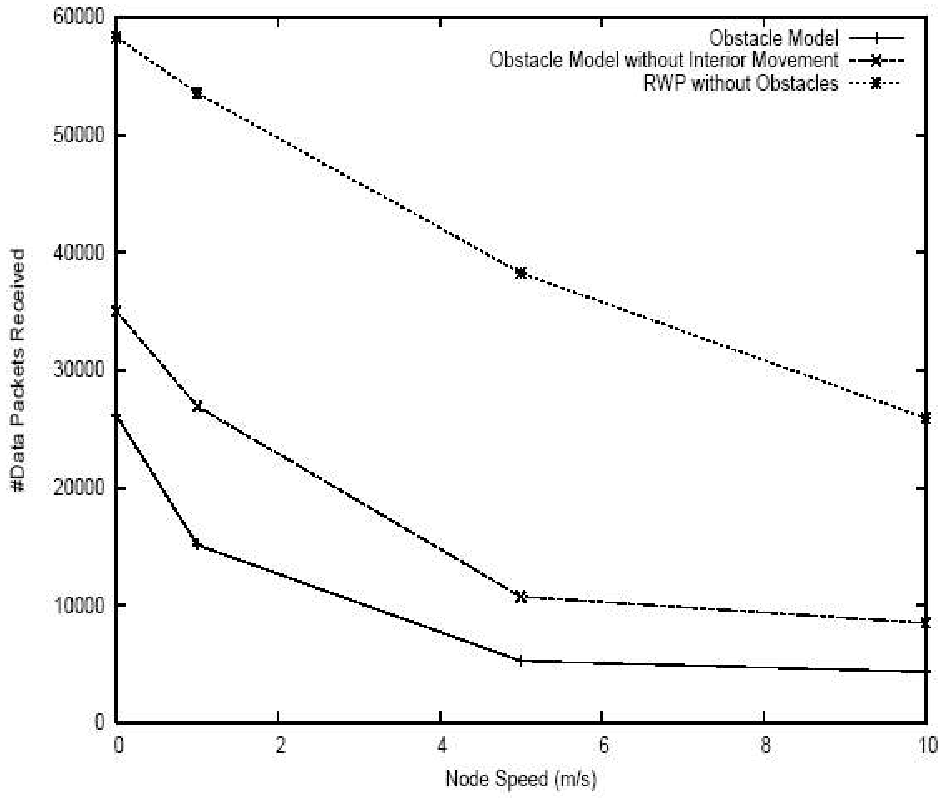

Figure 12: Data Packet Reception.

Results: Overhead

- Y-axis here is raw control packet count.
- In RWP [upper line], there is little to no occurrence of unreachable paths.
- The obstacle model results correlate with the lack of data throughput.
- With fewer maintained links, the obstacle model sends fewer overall control packets

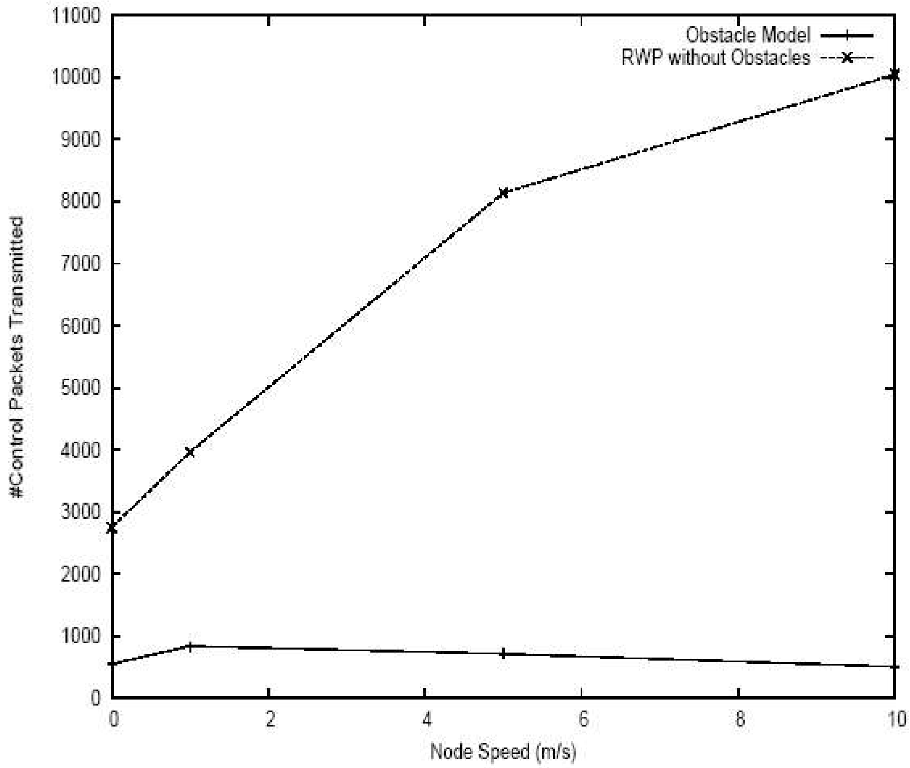

Figure 13: Control Packet Overhead.

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Conclusions

Conclusions made by the authors:

- Network performance is heavily dependent on the shape and layout of the area in an obstacle model.
  - Protocol behavior will vary based on the topography, so network simulations must be carried out with diverse layouts to get an accurate estimation of a routing protocol's effectiveness.
- A basic improvement that needs to be addressed is how nodes choose destinations.
  - In the model, nodes chose destinations randomly and without weight towards any particular set of sites.
  - In reality, the current location of a node affects the likelihood of moving to particular nodes. For example, short paths, as in between adjacent buildings or departments, are more likely than long ones.

Conclusions

My conclusions, especially as related to the authors':

- Throughout the paper, the team has conveniently paid little more than lip service to the fact that binary routability as implemented in their model has a strong effect on the outcome.
- In the real world, buildings have windows and walls may reflect signals; rarely will building walls block out 100% of signals, especially outdoor transmissions not in LOS.
  - The effects of this are chaotic and difficult to model, but if they hope to achieve a “realistic” model, these things must be taken into consideration.
- Until these simulations are simulated in real-life, we won't know whether the obstacle model is more realistic in terms of effect on data rates and hop counts.
  - It's expected, but it cannot be assumed with certainty.

End of slideshow

- Thank you. ☺