



## Fuzzy Logic based Multi-Metric Route Management for Ad-hoc Networks using a Realistic Mobility Model

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## Challenge & Solution



- ▶ Reduce Control Traffic Flooding
  - ▶ Route/Reply Discovery Process
- ▶ Fuzzy Logic
  - ▶ fuzzy logic system is applied to the route discovery technique
  - ▶ curbs non-optimal network floods
  - ▶ causes a cessation in the generation of low quality routes
  - ▶ only paths with good routing metrics are selected for the rebroadcast of route discovery packets.

## Simulation Mobility



- ▶ Routing protocol performance is correlated to the effectiveness of the routing protocol in adapting to variations in the network topology due to node mobility
- ▶ For modelling ad hoc networks synthetic models are typically used
- ▶ Numerous models have been proposed but do not necessarily represent true-life movement
  - ▶ People do not move in random directions at varying speeds
  - ▶ Consider individuals on a college campus, they trail defined paths through or around buildings to reach specific destination and typically select the shortest path to the terminus

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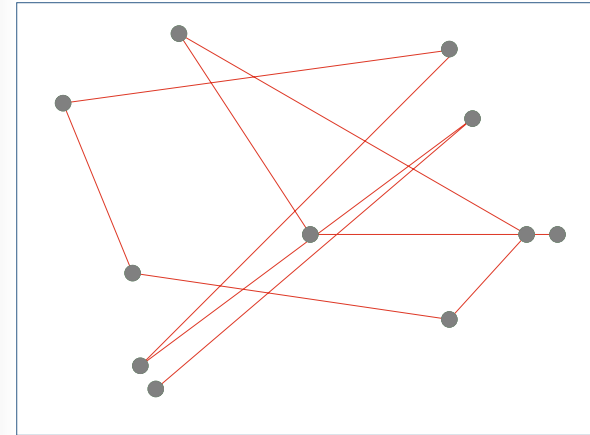
- ▶ Prior research has shown that the mobility model selected for simulation can impact the protocol performance significantly
  - ▶ Hence, it is important to use mobility patterns that accurately characterize the planned scenario in which the protocol is likely to be used
  - ▶ In this way the protocol performance can be more precisely assessed

## Random Waypoint Model



- ▶ Typically used to simulate movement patterns for Ad Hoc networks
- ▶ This model is unrealistic and it does not incorporate movement around or through obstacles.
- ▶ Initially nodes are uniformly positioned
- ▶ Select destination & move along a straight line from source to destination with a constant velocity

## Sample Movement



## Scenario Mobility



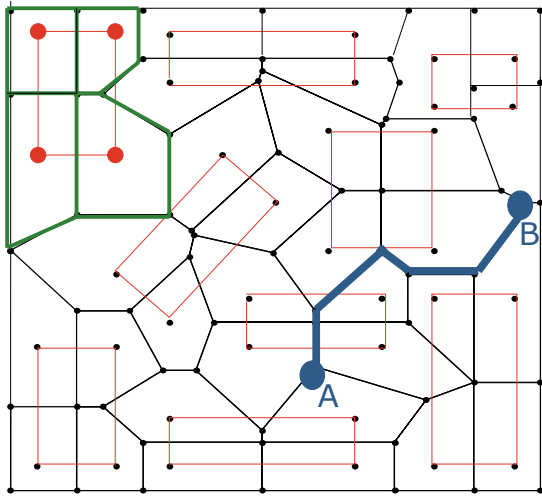
- ▶ Routing Protocols should be evaluated using realistic topologies
- ▶ Voronoi Polygons
- ▶ Partitioning of a plane with  $n$  points into  $n$  convex polygons such that each polygon contains exactly one point and every point in a given polygon is closer to its central point than to any other
- ▶ Construct Voronoi polygons around obstacle vertex points

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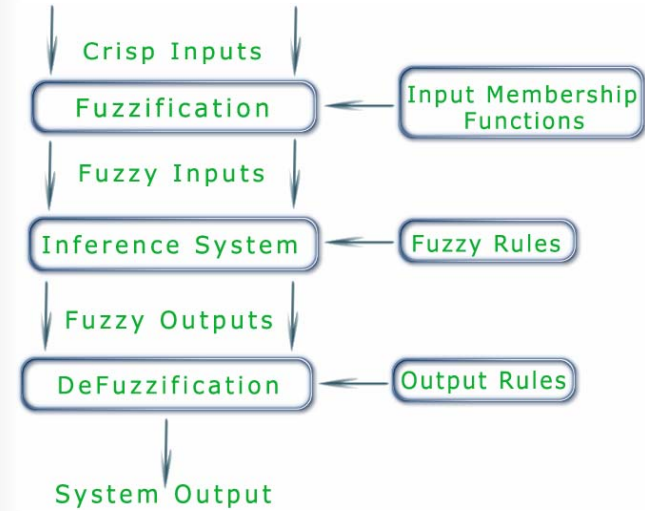


- ▶ The vertices of the Voronoi polygons and bounded simulation area provide pathways
- ▶ Intersection of a Voronoi vertex and an obstacle edge are used as a means of traversing a building - doorways
- ▶ Set of available node positions are derived from the points of intersection of the Voronoi vertices with the simulated area boundary and obstacles

# Sample Topology



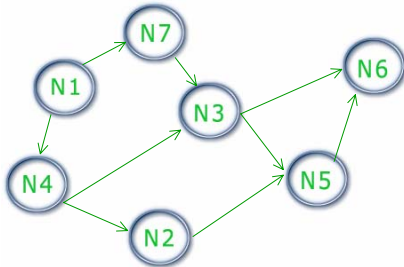
# Fuzzy System



# Fuzzy DSR



- ▶ Applying Fuzzy System to Dynamic Source Routing Protocol in route discovery process



- ▶ Fuzzy Metrics SNR, Node Energy, number of hops & Queue level
- ▶ Fuzzy system determines if a node should rebroadcast a route discovery packet

# Tests & Results

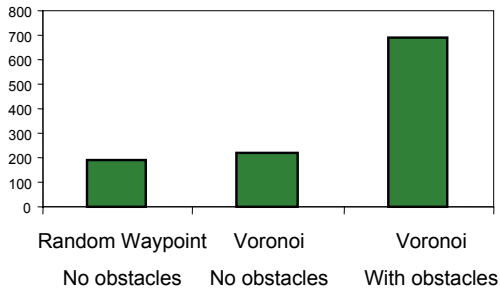


- ▶ Effect of Mobility Model on Simulation
  - ▶ Control Traffic Generation
- ▶ Fuzzy Versus Non Fuzzy
  - ▶ Control Traffic Generation
  - ▶ Path Quality

# Mobility



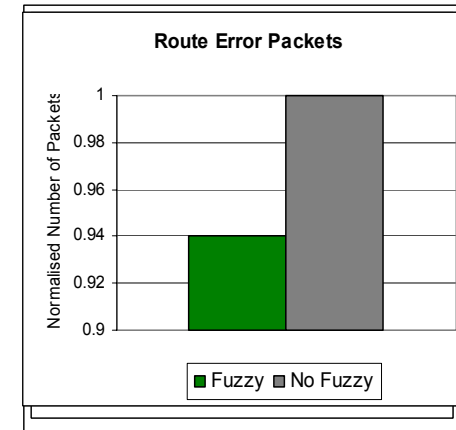
### Control Traffic Generation



# Fuzzy Versus Non Fuzzy



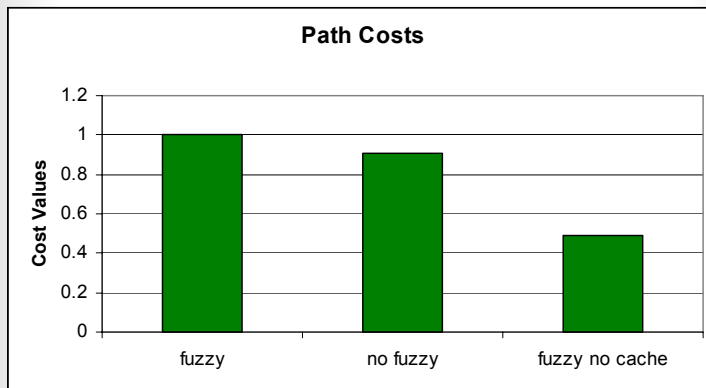
### Control Traffic Overhead



# Path Quality



### Path Costs



# Conclusion



- ▶ Mobility model can dramatically effect protocol performance
  - ▶ Necessary to use realistic model
- ▶ Fuzzy logic can be used to limit network broadcasts in the route discovery process
  - ▶ Thereby limiting control traffic generation
  - ▶ Creating better quality routes for caching