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Research Article

Performance Analysis of Various MANET Routing Protocols with Change in Number of Nodes over Different Mobility Models

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Abstract

Due to the change in network topology and high mobility a suitable routing protocol and mobility model should be deployed carefully. In unmanageable and hostile situations the performance of Adhoc networks greatly depends upon the choice of routing protocols and suitable mobility models. Here we examine the performance of two mobility models i.e. Random waypoint and Group over the increasing number of nodes using different routing protocols like AODV, DSR, DYMO and ZRP in realistic scenarios like earthquake prone areas or other disaster affected areas using performance metrics like average end to end delay, jitter, throughput and packet delivery ratio. For implementation of this approach we have considered windows 8 operating system as platform which is compatible with QualNet simulator 6.1. The recommendations of this research will provide better understanding of various routing protocols over varying number of nodes in various real time applications.

Keywords: *MANET, AODV, ZRP, DSR, DYMO, RPGM, RWP.*

1. Introduction

In recent times the development and growth in the areas of portable and wireless communications has increased considerably. Portable and wireless devices are required as the nature of computation has changed from personal to widespread levels. The growing wireless communication availability has created the requirement for supporting real time applications on highly mobile network environments.

MANETS (Mobile Adhoc Networks) are mobile and autonomous systems consisting of hosts and routers linked by random wireless connections. They can be installed anytime and anywhere. MANET deployment covers a variety of applications (e.g. emergency response, disaster relief military applications) as well as providing wireless coverage network areas to inaccessible and remote places.

Mobile nodes in MANETs have limited battery power and bandwidth hence a suitable routing protocol producing low overhead is required. The on demand (reactive) routing protocol provides better results than proactive routing protocols in most infrastructure less situations. In the reactive routing protocols routes are discovered when needed so the choice of suitable routing protocol has a significant impact on the performance of Adhoc networks. Such Adhoc mobile networks have an issue of uncertainty and frequently changing network topology with changing mobility situations. The mobility model chosen must closely match the real time situations. Mobility models can be divided as entity mobility model where nodes are independent and group mobility where nodes are dependent on the movement of the whole group.

The most commonly used mobility model in Adhoc networking is the Random Waypoint (RWP) here each node uniformly chooses a random destination. A node moves to this destination with uniformly chosen velocity at random. The Random Waypoint Group Mobility (RPGM) model gives a path for each group by defining a series of checkpoints along the path corresponding to given time intervals. A group moves from one checkpoint to another and computes a new motion vector from the current one. Here a group must reach a predefined destination within defined time interval to accomplish its task.

The intention of this work is to calculate the impact of various routing protocols such as AODV, DSR, DYMO and ZRP over varying number of nodes in RWP and RPGM models in realistic environment scenarios using performance metrics like average end to end delay, jitter, packet delivery ratio and throughput.

2. Routing Protocols

Routing protocol specifies how routers communicate with each other to select routes between any two nodes on a computer networks. Routing algorithm

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determines the specific choice of route. MANET routing protocols are basically classified in three categories and they are as follows: Proactive protocols: In proactive protocol, each node continuously maintains up-to-date routes to every node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing. Reactive Routing protocols: Reactive routing protocol is a bandwidth efficient on-demand routing protocol for MANET. The protocol comprises of two main function of route discovery and route maintenance. Hybrid routing protocols (HRP): Hybrid routing protocol is a network routing protocol that combines Distance vector routing protocols (DVRP) and link state routing protocol features. HRP is used to determine optimal network destination routes and report network topology data modification. In this paper the performance of four routing protocols has been focused and they are as follows:

Ad-hoc on Demand Distance Vector Routing (AODV) Protocol

AODV routing algorithm is a packet routing protocol used for dynamic wireless network. It is one of most prominent reactive protocol. It is a collection of mobile nodes without any centralized access point or existing infrastructure. It provides loop-free, self-starting and scale large number of mobile nodes. Where, every node maintains the routing information by using routing table which is maintained at every node of the network. In routing table destination address, next hop IP address and destination sequence number is stored. Route request (RREQ), Route reply (RREP) and Route error (RERR) are three types of messages used in AODV mechanism.

Zone Routing Protocol: (ZRP)

The Zone Routing protocol combines the advantages of both reactive and proactive protocol into a hybrid scheme, taking advantage of proactive discovery within a node's local neighborhood and using a reactive protocol scheme for communication between this neighborhood .In a MANET it can safely be assumed that most communication takes place between nodes close to each other. These local neighborhoods are called zones each node may be within multiple overlapping zones and each zone may be of different sizes. The size of zone is not determined by a geographical measurement but is given by a radius of length where the number of hops to the perimeter of the zone is situated. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area.

Dynamic Source Routing protocol (DSR)

DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless Adhoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. All aspects of the protocol operate entirely on demand, allowing the routing packet overhead of DSR to scale automatically to only what is needed to react to changes in the routes currently in use. The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets. Other advantages of the DSR protocol include easily guaranteed loop-free routing, operation in networks containing unidirectional links use of only soft state in routing, and very rapid recovery when routes in the network change. The DSR protocol is designed mainly for mobile ad hoc networks of up to about two hundred nodes and is designed to work well even with very high rates of mobility.

The DYMO Routing Protocol

The Dynamic MANET On-demand DYMO routing protocol is a newly proposed protocol currently defined in an IETF Internet-Draft in its sixth revision and is still work in progress. DYMO is a successor of the AODV routing protocol. It operates similarly to AODV. DYMO does not add extra features or extend the AODV protocol, but rather simplifies it, while retaining the basic mode of operation. As is the case with all reactive ad hoc routing protocols, DYMO consists of two protocol operations: route discovery and route maintenance. Routes are discovered on-demand when a node needs to send a packet to a destination currently not in its routing table. A route request message is flooded in the network using broadcast and if the packet reaches its destination, a reply message is sent back containing the discovered, accumulated path.

3. Mobility models in MANET

Mobility models in MANET determine the movements of the nodes in the considered ad-hoc network. There are many types of mobility models which have been considered in Adhoc networks, but in this paper we have focused on mainly two prominently used mobility models

Reference point group mobility (RPGM)

In Reference point group mobility model each group has a logical 'center'. The center's motion defines the entire group motion behavior including location, speed, direction, acceleration etc. Thus the group trajectory is determined by providing a path for the center. Usually nodes are uniformly distributed within the geographic scope of a group. To node, each is assigned a reference point which follows the group movement. A node is randomly placed in neighborhood of its reference point at each step. The reference point scheme allows independent random motion behavior for each node in addition to the group motion.

Random Waypoint Mobility model (RWP)

In random waypoint mobility model, nodes are free to move randomly anywhere in the simulation field independent of each other. No restriction is imposed on them. There is random selection of destination, speed and direction with inclusion of pause times between changes in direction and/or speed. After being at a location for certain duration of time, mobile node chooses random destination and speed at pre-defined range and proceeds towards newly chosen destination with velocity chosen. On reaching destination, mobile node pauses for a fixed time period before restarting the same process again. Here, speed and pause time help in defining the mobility behavior of nodes. Low speed and long pause time result in stable network topology whereas high speed and short pause time leads to dynamic topology.

4. Methodology and System Design

The main purpose of the simulation model is to estimate the performance of four different routing protocols (AODV, DSR, DYMO, and ZRP) based on various performance metrics for MANET in realistic environment scenarios. We have considered a simulation model based on the concept of mobility models. A disaster affected area has been considered, three different groups for varying number of nodes are taken. Here in first, the random movement of the nodes in a single group (Rescue relief helicopters) is considered and RWP mobility model is applied. In second and third group people struck under the disaster affected areas are taken and RPGM model is applied.

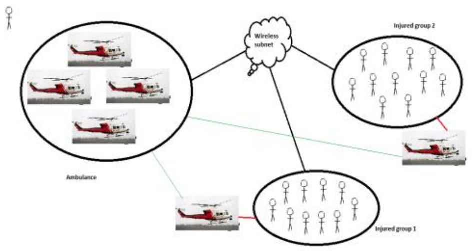

Figure 4.1 Scenario of Earthquake/Disaster affected area

In Simulation, we create a scenario considering the area 1500m×1500m, where (20, 40, 80) nodes respectively have been deployed which are divided into two groups i.e. (10-10, 20-20, 40-40). These two groups are based on the concept of group mobility models i.e. RPGM. In the entire network, a single group (Rescue relief helicopters) has been considered with random movement of nodes as Random waypoint mobility model is applied, whose speed is taken (5-10m/s) and pause time (30sec). Whereas the multiple groups (injured and disaster affected) have been considered to describe the mobility patterns of the nodes, whose speed is taken as (5-6, 5-6 m/s) and pause time (100sec).Two groups are considered with group mobility with same network condition. One wireless subnet is taken to provide wireless routes between single group and multiple groups.

In this simulation, each nodes has a radio transmission range (180m) with MAC protocol as IEEE 802.11b.Data traffic types (CBR) ,maximum packet size used in simulation is 512 bytes and the number of packet send (100). The simulation time is taken (1000sec) respectively.

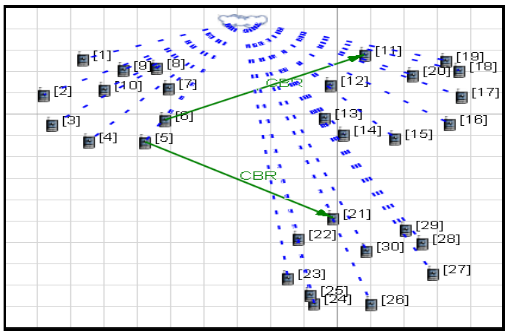

Figure 4.2 Scenario of Earthquake/ Disaster affected network for 20(10-10) nodes

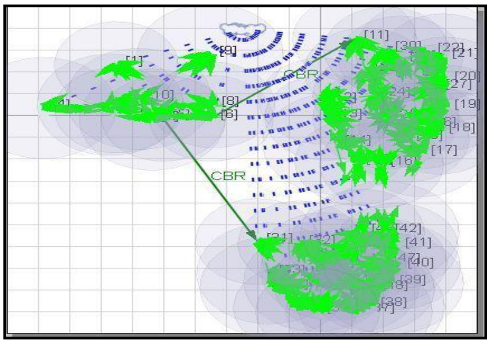

Figure 4.3 Simulated Scenario of Earthquake/ Disaster affected network for 40(20-20) nodes

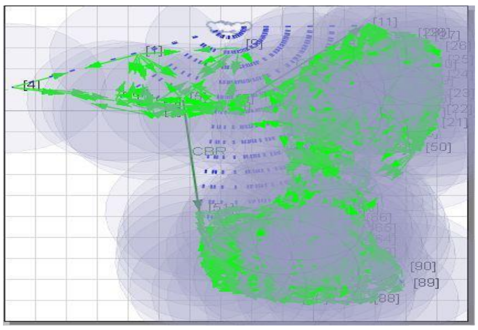

Figure 4.4 Simulated Scenario of Earthquake/ Disaster affected network for 80(40-40) nodes

Simulation Parameters

Simulation area	1500m×1500m
Number of nodes	20,40,80
Mobility model	Group mobility, Random way point
Minimum and maximum speed of (Helicopter Ambulance)	5-10m/s
Minimum and Maximum speeds (Injured people)	5-6,5-6 m/s
Pause time Single Group (Helicopters or ambulance)	30 sec
Pause Time Multiple Group (Injured people)	100 sec
Routing protocols	AODV,ZRP,DSR,DYMO
MAC protocol	IEEE 802.11
Simulation time	1000 sec
Data traffic types	2 CBR sources
Packet size	512 bytes
Packet rates	4 packets/sec
Radio transmission range	180 m

5. Performance Evaluation Metrics

The metrics play a vital role while comparing the four different routing protocols. The various performance metrics that are used to evaluate the performance of routing protocols are as follows.

Throughput

It is defined as the number of packet received successfully to the destination over a particular time. It is measured in bits per second.

Average end-to-end delay

It is the delay involved in arrival of a packet to the destination in MANET. The delay is the time the packet takes to reach the destination after it leaves the source.

Jitter

It is termed as the difference in end to end delay between selected packets in a single connection over time. It is measured in seconds.

Packet Delivery Ratio

It is the ratio of the number of the data packet delivered at the destination to those generated by the source.

6. Results and Discussion

Effect of nodes considered in three groups (20, 40, 80) number of nodes with group mobility:

Throughput

In two groups with the varying (20, 40, and 80) nodes the throughput is analyzed. It is observed that DSR performs better than ZRP, DYMO, and AODV. ZRP performs better than DYMO and AODV. Here the performance of AODV is quite weak in the case of throughput.

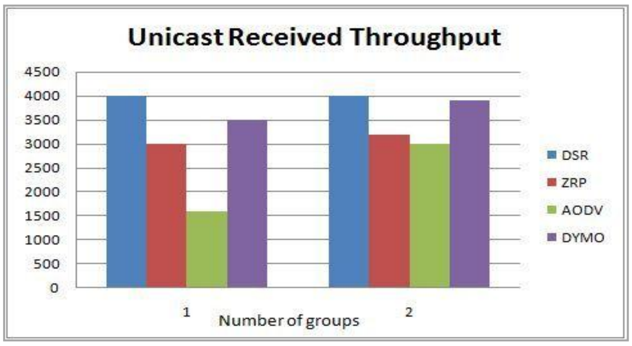

Figure 6.1 Average throughput in bits/seconds in 20 nodes

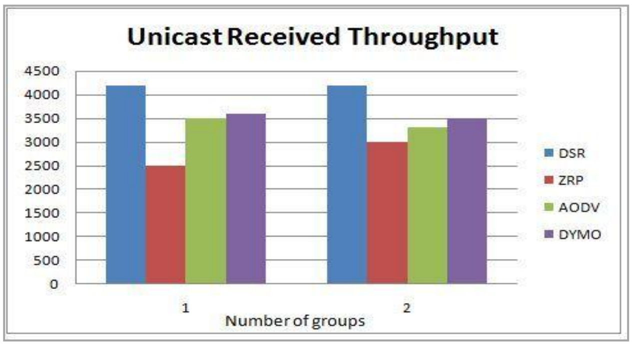

Figure 6.2 Average throughput in bits/seconds in 40 nodes

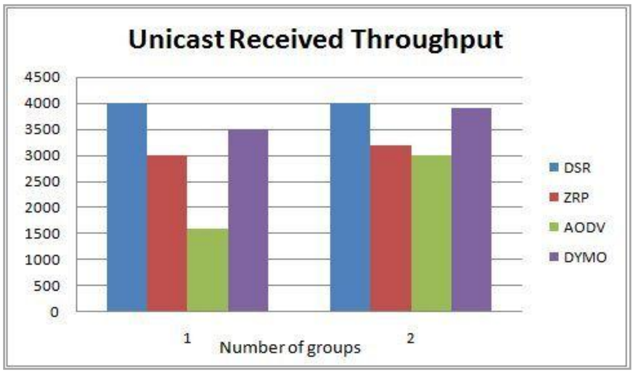

Figure 6.3 Average Throughput in bits/seconds in 80 nodes

End –to –End delay

When a packet is transmitted from source to a destination it is supposed to reach in a given interval of time. In two groups with the varying (20, 40, and 80) nodes the average end to end delay is analyzed, it is observed that the delay increases traffic load. The average end to end delay is the least in DSR than DYMO, ZRP and AODV. DSR has the least end to end delay in comparison to others.

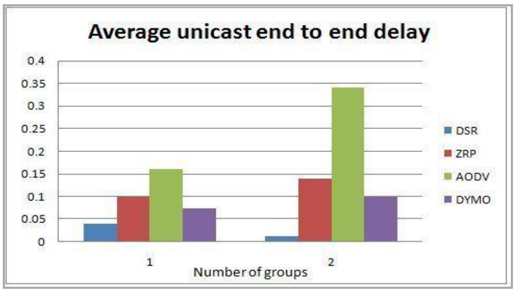

Figure 6.4 Average end –to-end delay in seconds in 20 nodes

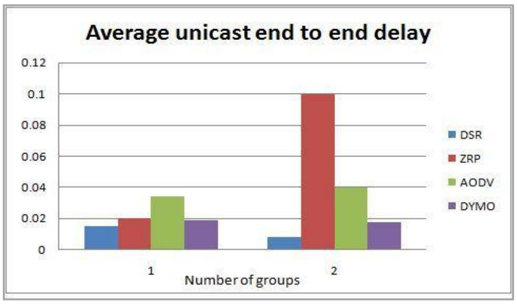

Figure 6.5 Average end-to-end delay in seconds in 40 nodes

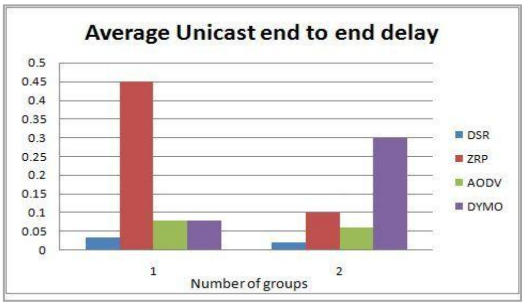

Figure 6.6 Average end-to-end delay in seconds in 80 nodes

Jitter

Jitter is the variation in the time of packet arrival; it is an important metrics for any routing protocols. In two groups with the varying (20, 40, and 80) nodes the jitter is analyzed It is observed that DSR performs best as it has the lowest jitter. DYMO performs better than ZRP.AODV has the largest jitter.

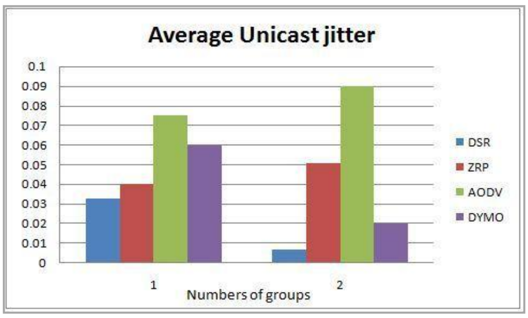

Figure 6.7 Jitter in seconds in 20 nodes

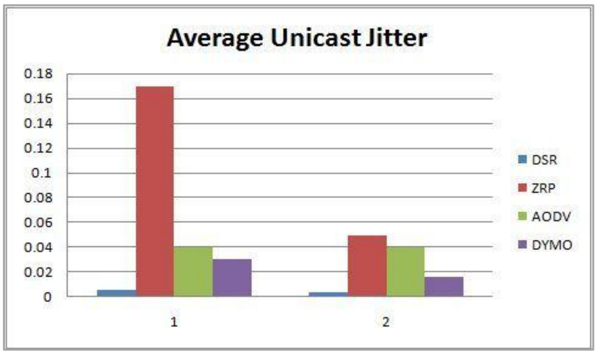

Figure 6.8 Jitter in seconds in 40 nodes.

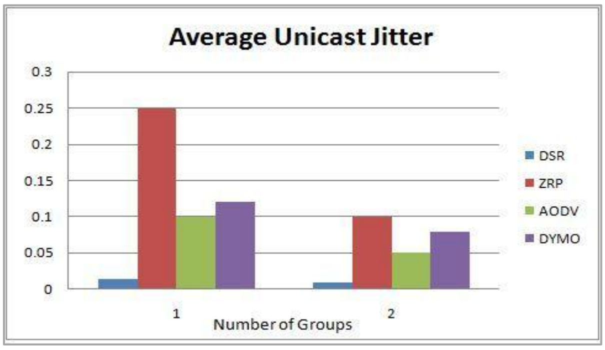

Figure 6.9 Jitter in seconds in 80 nodes

Packet Delivery Ratio (PDR)

In Packet delivery ratio (PDR) it is observed that DSR routing protocol performs better than Demand ZRP. AODV performs inferior to all the three protocols (DSR, DYMO and ZRP) respectively.

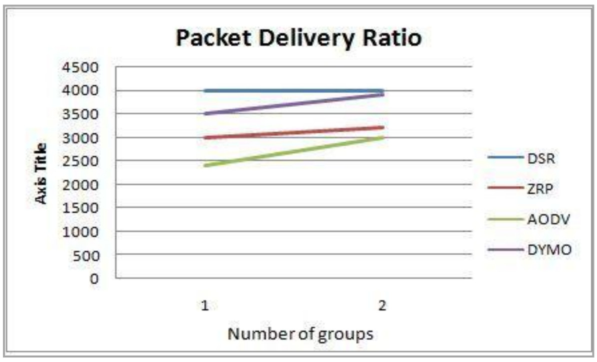

Figure 6.10 Average Packet Delivery Ratio in 20 nodes

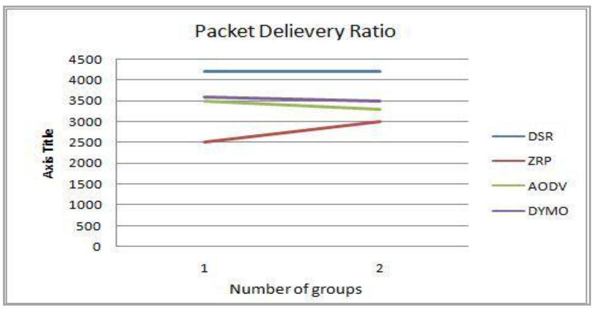

Figure 6.11 Average Packet Delivery Ratio in 40 nodes

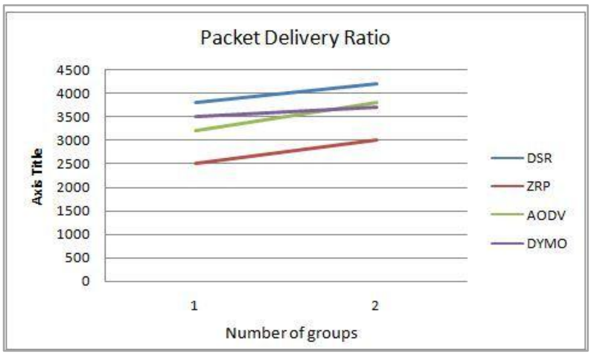

Figure 6.12 Average Packet Delivery Ratio in 80 nodes

Conclusion and Future works

In this research work the performance metrics i.e. (average end to end delay, jitter and throughout) of various routing protocols (AODV, DSR, DYMO and ZRP) were examined with the increasing number of nodes in each group. Realistic environmental conditions like earthquake prone or any other disaster affected areas were taken into consideration. The results illustrated that in the rescue operation scenario, with the increase in number of nodes for all the above stated protocols the performance of DSR (on demand routing protocol) was the best, because on increasing the number of nodes in a group the average end to end delay and jitter was the least and the throughput was good comparatively. On further analysis it was observed that there were very little variations and fluctuations in the performance metrics of DYMO for the increase in number of nodes, the throughput were better than ZRP and AODV. ZRP performed with more variations as the average end to end delay and jitter was more compared to DSR and DYMO. The performance of AODV was quite poor as there was a significant amount of variation in its performance metrics, the average end to end delay and jitter was the highest and the throughput was very less.

In future we are interested in analyzing other performance metrics like normalized routing load etc. of these routing protocols for various other realistic scenarios.

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