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Research Article

Performance Comparison of MANET Routing Protocols in Battlefield Disaster Management using QualNet 6.1 Simulator

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Abstract

Disaster situation analyses have been considered to be one important and difficult process which constitutes important phases of experimentations. In these types of situations it becomes difficult for the rescue teams to provide reliefs on existing infrastructures which has high probability of bursting the whole communication backbone. Therefore the establishment of a temporary communication system is required for such purpose. In a temporary or ad-hoc communication system the mobility of the nodes plays a vital role in the proper collection of data. With the involvement of MANET infrastructure this problem can be solved to a higher extend. MANETs are expected to increasingly play an effective role in civilian and military environments. In this article the consideration of mobile ad-hoc network for battle field disaster management is focused, where proper medical facilities to the injured soldiers are difficult in providing. For this purpose various mobility models are considered for the movement of nodes (i.e. Ambulance) and the soldiers in a particular battalion. We have proposed a scenario which consists of soldiers in groups and mobile nodes i.e. ambulance in another group. The Performance of various MANET routing protocols in the considered scenario have been compared.

Keywords: *MANET, AODV, ZRP, STAR, LANMAR, RPGM, RWP*

1. Introduction

Over past few years, the post disaster management problem has important and difficult situations. In these types of issues it becomes quite difficult to provide food relief and medical security by the rescue team in the affected areas, which is generally due to the shutdown of existing networks. With the use MANETs, it is possible to securely manage the network to provide relief and medication by the rescue team. A rapid growth of wireless network has encouraged in the improvement of the network service performance. MANETs is a collection of wireless mobile nodes that communicate with each others. In the case of post disaster management, MANET solves the problem to provide the proper medication to the injured soldiers on the spot. For this purpose the consideration of various mobility models are determined for the movement of nodes in a particular military environment. A better depiction of nodes movement can be obtained through RPGM (Soldiers) and RWP (Ambulance) which have been used in our simulation, (Cardeiro C.M, Agarwal D.P,*et.al* (2005))

In this paper, we analyze and compare the performance of four popular routing protocols: One reactive (AODV), one hybrid (ZRP) and two proactive (LANMAR and STAR). The various mobility models simulate the environment of a battle field scenario, where the soldiers and ambulance (mobile nodes) are connected to each other by CBR and communicate. The soldiers and ambulance are almost always moving due to which the routing process complexity are maximum.

2. Routing protocols

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

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topology data modification. (Kaur .H, sahni.V *et.al* (2013),)

In this paper the performance of four routing protocols has been focused and they are as follows:

Ad-hoc on Demand Distance Vector (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. (Perkins C.E, Royer E.M. *et.al* (2000),)

Zone Routing Protocol: (ZRP)

The Zone Routing protocols combines the advantages of both reactive and proactive protocol into a hybrid scheme, taking advantage of proactive discovery within a nodes 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 work independently of the other and they may use different technologies in order to maximize efficiency in their particular area. (Haas Z.J., Pearlman M.R., Samar .P *et.al* (2002))

Landmark Routing Protocol (LANMAR)

LANMAR borrow the concept of landmark and extend to the wireless ad-hoc environment. The scheme of protocol does not require predefined hierarchical address, but it uses the motion of landmark to keep track of logical subnet in which the members have commonality of interest and are likely to move as a group. Each such logical group has to elected landmark. For each group the underlying scoped routing algorithm will provide accurate routing information for nodes within scope. The routing updates packets are restricted only within the scope. The routing information to remote nodes is summarized by the corresponding landmark. LANMAR runs on the top of the proactive routing information. It requires the underlying routing protocol support the scoped subnet working. The main advantages of LANMAR are that the routing table includes only the nodes within the scope and landmark nodes. Thus the LANMAR scheme largely reduces the routing table size and routing update traffic overhead. It greatly improves scalability. (Gerea.M, *et.al* Hong. X (2002))

Source tree adaptive routing (STAR)

STAR is the routing algorithm for Adhoc network which can be categorized according to the way in which router obtain routing information. In terms of the way in which routers obtain information, routing protocol has been classified as table driven and on-demand. Routing protocol can be classified into link-state protocol and distance vector protocols. Routers running a link state protocol use topology information to make routing decision. Routers running a distance vector protocol use distance or path information to destination to make routing decision. Our characterization of distance vector routing protocol is broader than in other document but is consistent with our prior publications. (Garcia J.J –luna-Aceves (1999),)

3. Mobility models in MANET

Mobility models in MANETs 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 (Bai.F, Helmy. A *et.al* (2005),)

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. (Jim.M.Ng and Zhang.Y *et.al* (2003)

Random Waypoint Mobility model (RWP)

Random way point model is a random model for the movement of mobile users and how their location, velocity and acceleration change over time. Mobility model are used for simulation purposes when new network protocol are evaluated. It is one of the most prominent mobility models to evaluate other mobile Adhoc network routing protocol, because of its simplicity and wide availability. The mobile nodes move randomly and freely without any restrictions. In random way point, the destination, speed and direction are chosen randomly and independently of the other

nodes. In this mobility model, the nodes randomly select a position moves towards in a straight line at a constant speed that is randomly selected from a range and pauses at that destination.(Bettstetter.C *et.al* (2003)).

4. 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 bit per second.

Average end-to-end delay

It is an average delay time incurred when data packets are sent from the source to the destination.

Jitter

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

Packet Delivery Ratio

It is the ratios as the number of the data packet delivered to the destination are those generated by the source.

5. Considered simulation setup

The target of the simulation model is to estimate the performance of four routing protocols (AODV, ZRP, STAR, and LANMAR) based on various performance efficiency for MANET. We have considered a simulation model based on the concept of mobility models. Two cases have been considered, nodes taken as a single group and as well as multiple groups. Here in first, the random movement of the nodes in a single group (Ambulance) is considered. As well as second, for the group movement, three groups of equal number of nodes (military) are considered.

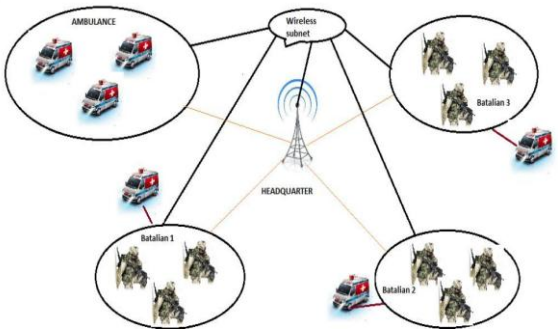

Fig.1 Scenario of battle -field network

In simulation, we creates a scenario considering the area 1500m×1500m, where (50) nodes have been deployed which are divided into two groups. (Single and multiple). These two groups are based on the concept of mobility models. In whole network, the single group (Ambulance) has been considered with randomly movement of nodes, whose speed taken (5-10m/s) and pause time (30sec).Where as the multiple groups (military) have been considered to describe the mobility patterns of the nodes, whose speed taken (1-2, 3-4, 5-6 m/s) and pause time (100sec).Three groups are considered with group mobility with same network condition. One base station model has taken is to be define the 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.

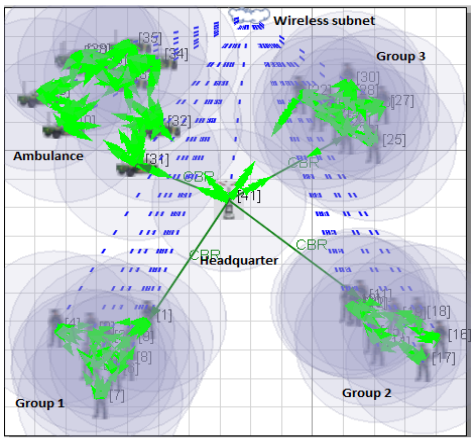

Fig 2: Simulated Scenario of battle-field network

Simulation parameters

Simulation area	1500m×1500m
Number of nodes	50
Mobility model	Group mobility, Random way point
Minimum and maximum speed of single group (Ambulance)	5-10m/s
Minimum and Maximum speeds (Military)	1-2, 3-4, 5-6 m/s
Pause time Single Group (Ambulance)	30 sec
Pau1se Time Multiple Group (Military)	100 sec
Routing protocols	AODV,ZRP,STAR,LANMAR
MAC protocol	IEEE 802.11
Simulation time	1000 sec
Base station model	1
Data traffic types	4 CBR sources
Packet size	512 bytes
Packet rates	4 packets/sec
Radio transmission range	180 m

6. Result and discussion

Effect of nodes considered as single group as well as multiple groups:

Throughput

In two groups with the effect of nodes (constant pause time) the throughput is analyzed. It is observed that AODV perform better than ZRP, STAR, and LANMAR. ZRP performs better than STAR and LANMAR. Here the performance of LANMAR is totally weak in case of throughput.

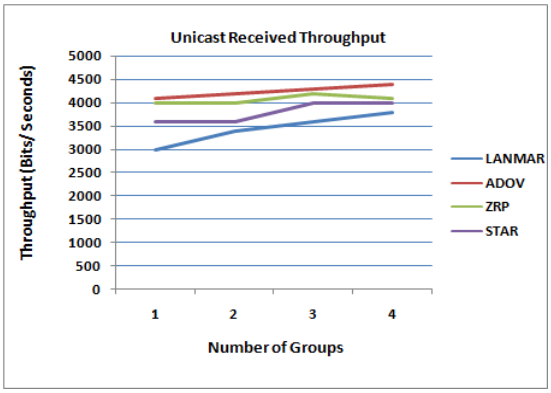

Fig.3: Average Throughput in bits/seconds

End –to –End delay

When a packet is transmitted from source to destination is to be reach in a given interval of time. In this analysis, it is observed that the delays are increasing traffic loads. The average end to end delay is very high in LANMAR than AODV, ZRP, and STAR. AODV has become least end to end delay in comparison to others.

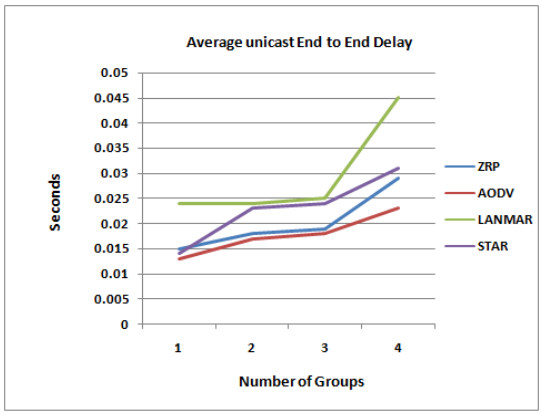

Fig. 4: Average end-to-end delay in seconds

Jitter

In Jitter, the variation of packet arrival of time, it is an important metrics for any routing protocols. It is observed that LANMAR has largest jitter.

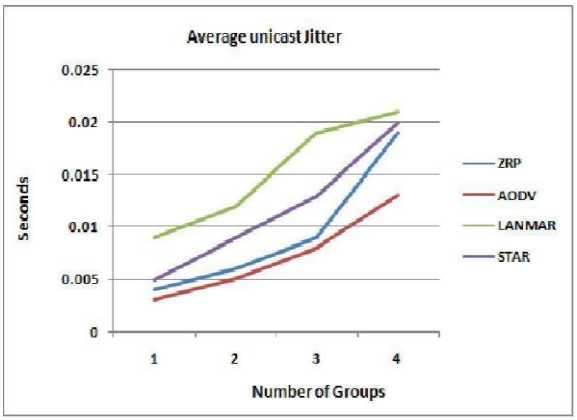

Fig.5: Average Jitter in seconds

Packet Delivery Ratio (PDR)

In Packet delivery ratio (PDR), It is observed that AODV routing protocol perform better than ZRP, STAR and LANMAR. And LANMAR performs inferiors to all these three protocols (STAR, ZRP and AODV) respectively.

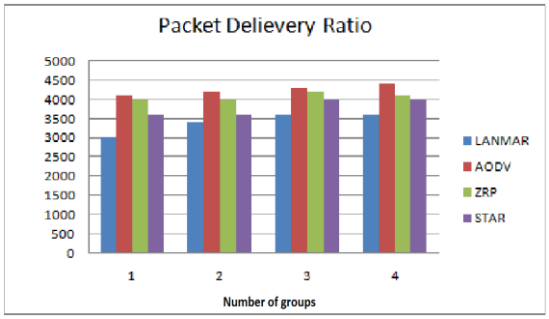

Fig. 6: Average Packets Delivery Ratio

Conclusion and Future Works

According to our simulation, we conclude that, the performance of AODV routing protocols is much better than the others three considered protocols, the performance of AODV is better, because of its dynamic route discovery ability. The performance of ZRP was also better but less than AODV, because of its hybrid ability. The performance of STAR and LANMAR were poor, because of their static ability. LANMAR and STAR were not able to up with the frequent change in the considered network.

In future realistic scenario can also be considered to perform and check the ability of the considered routing protocols.

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