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Performance Evaluation of MANET Routing Protocols with Scalability and Node Density issue for FTP Traffic

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Abstract-A MANET consists of mobile nodes, a router with multiple hosts and wireless communication devices. The wireless communication devices are transmitters, receivers and smart antennas.This paper aims to compare performance of three routing protocols for Mobile Ad-Hoc networks (MANET's).In present study, a comparison of reactive routing protocols i.e. Ad Hoc On-Demand Distance Vector Routing (AODV), proactive routing protocols i.e. Optimized Link State Routing (OLSR) and hybrid routing protocol i.e. Gathering-based Routing Protocol has been made on the basis of throughput, delay, network load, traffic sent and traffic received by increasing number of nodes in the network. MANET routing protocols are evaluated under different scenarios using file transfer protocol (ftp).We compared three routing protocols i.e. AODV, OLSR and GRP. Our simulation tool will be OPNET modeler. All the three routing protocols are explained in a deep way with metrics. The comparison analysis will be carrying out about these protocols and in the last the conclusion will be presented, that which routing protocol is the best one for mobile ad hoc networks. The final evaluation is presented at the end of this paper.

Keywords— MANET, AODV, OLSR, GRP, OPNET, FTP, Routing Protocols.

1. INTRODUCTION

A mobile ad-hoc network (MANET) is a network formed without any central administration which consists of mobile nodes that use a wireless interface to send packet data. With current technology and the increasing popularity of notebook computers, interest in ad hoc networks has greatly peaked. Future advances in technology will allow us to form small ad hoc networks on campuses, during conferences and even in our own homes. Each MANET node can serve as a router, and may move arbitrary and dynamically connected to form network depending on their positions and transmission range. The topology of the ad hoc network depends on the transmission power of the nodes and the location of the MNs, which may change with time. The presence of wireless communication and mobility make an ad hoc network unlike a traditional wired network, and requires the routing protocols used in an hoc network based on new and different principles. Routing in ad hoc environment is one of the important issues of the most challenging and interesting research areas in MANET. Since mobile ad hoc network change their topology frequently, routing in such network is a challenging task. Generally, the main function of routing in a network is to detect and maintain the optimal route to send data packets between source and destination via intermediate nodes. In this paper, Proactive routing protocols, Reactive routing protocols, Hybrid routing protocols. Proactive protocols, such as Optimized Link State Routing (OLSR) [4] [5] attempt to monitor the topology of the network in order to have route information between any source and destination available at all time. Proactive Routing Protocols are also called table driven routing protocols as all the routing information is usually kept in tables. Reactive routing protocols such as Ad hoc On Demand Distance Vector (AODV) [6][7], find the route only when there is data to be transmitted and as a result, generate low control traffic and routing overhead. Hybrid protocols such as Gathering-based routing protocol (GRP) [8] could be derived from the two previous ones, containing the advantages of both the protocols, using some quality of one type and enhancing it with the participation of the other one. In this paper we evaluate the performance of a Proactive Routing Protocol (OLSR), a Reactive routing protocol (AODV) and a Hybrid protocol (GRP). This paper is organized as follows: Section 2 presents overview of Routing protocols in MANETs. Section 3 describes the Simulation Environment studied. Section 4 analyzes results and discussion. Section 5 concludes this paper.

2. Routing Protocols in MANETs

Routing protocols in MANET [9] [10] are divided into four categories: proactive, reactive and hybrid routing protocols. The most popular ones are AODV, DSR (reactive), OLSR (proactive) and GRP (hybrid). This section describes the main features of three protocols AODV (Ad Hoc On-Demand Distance Vector Protocol), OLSR (Optimized Link State Routing) and GRP (Gathering-based Routing Protocol) deeply studied using OPNET 14.5. An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature. Ad-hoc networks are best suited due to minimal configuration and quick operation.

2.1 Ad Hoc On-Demand Distance Vector Protocol (AODV)

AODV [11] is a reactive routing protocol that minimizes the number of broadcasts by creating routes on demand. The AODV algorithm is an improvement of DSDV [12] protocol. It reduces number of broadcast by creating routes on demand basis, as against DSDV that maintains mutes to each known destination. The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The source broadcasts a route request (RREQ) packet when it wants to find path to the destination. The neighbors in turn broadcast the packet to their neighbors until it reaches an intermediate node that has recent route information about the destination or until it reaches the destination. When a node forwards a RREQ to its neighbors, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet (RREP). AODV uses only symmetric links because the RREP follows the reverse path of the RREQ. An important feature of AODV is the maintenance of timer based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. Another distinguishing feature of AODV is the ability to provide unicast, multicast and broadcast communication.

2.2 Optimized Link State Routing (OLSR)

OLSR [13] is a modular proactive hop by hop routing protocol. It is an optimization of pure link state algorithm in ad hoc network. The routes are always immediately available when needed due to its proactive nature. The key concept of the protocol is the use of "multipoint relays" (MPR). Each node selects a set of its neighbor nodes as MPR [8]. Only nodes, selected as such MPRs are responsible for generating and forwarding topology information, intended for diffusion into the entire network. The MPR nodes can be selected in the neighbor of source node. Each node in the network keeps a list of MPR nodes. This MPR selector is obtained from HELLO packets sending between in neighbor nodes. These routes are built before any source node intends to send a message to a specified destination In order to exchange the topological information; the Topology Control (TC) message is broadcasted throughout the network. Each node maintains the routing table in which routes for all available destination nodes are kept. Control traffic in OLSR is exchanged through two different types of messages: “HELLO” and “TC” messages. HELLO messages are exchanged periodically among neighbor nodes, in order to detect links to neighbors, to detect the identity of neighbors and to signal MPR selection. TC messages are periodically flooded to the entire network, in order to signal link-state information to all nodes. The best working environment for OLSR protocol is a dense network, where the most communication is concentrated between a large numbers of nodes.

2.3 Gathering-based Routing Protocol (GRP)

Gathering-based Routing Protocol [14] [15] combines the advantages of Proactive Routing Protocol (PRP) and of Reactive Routing protocol (RRP). PRP are suitable for supporting the delay sensitive data such as voice and video but it consumes a great portion of the network capacity. While RRP is not suitable for real-time communication, the advantage of this approach is it can dramatically reduce routing overhead when a network is relatively static and the active traffic is light. However, the source node has to wait until a route to the destination can be discovered, increasing the response time. The function of Gathering-based Routing Protocol (GRP) for mobile ad hoc network is to gather network information rapidly at a source node without spending a large amount of overheads. It offers an efficient framework that can simultaneously draw on the strengths of Proactive routing protocol (PRP) and reactive routing protocol (RRP) [16] collects network information at a source node at an expense of a small amount of control overheads. The source node can equip promising routes on the basis of the collected information, thereby continuously transmitting data packets even if the current route is disconnected, its results in achieving fast (packet) transfer delay without unduly compromising on (control) overhead performance.

3. Simulation Environment

The simulation mainly focuses on the performance of the routing strategies to react on the different scenarios in MANET [17]. Because the three protocols (AODV, OLSR and GRP) cover different routing strategies mentioned above, we will discuss these routing strategies based on the simulation results of the three protocols. In this paper, we evaluate the performance in terms of network throughput, delay and load.We carried out simulations on Opnet simulator [18] [19].
The simulation parameters are summarized in table 1. Modeler is commercial network simulation environment for network modelling and simulation. It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability.

Table 1: NETWORK PARAMETERS

Statistic	Value
Simulator	OPNET 14.5
Routing Protocols	AODV,OLSR and GRP
802.11 data rate	11 Mbps
Node	75

Scenario Size	3.5*3.5 km
Application Traffic	FTP and HTTP
Simulation Time	300 second
Channel Type	Wireless channel
Network Interface Type	Phy/WirelessPhy
Performance Parameter	Throughput, Delay, Network Load, Traffic Sent, Traffic Received

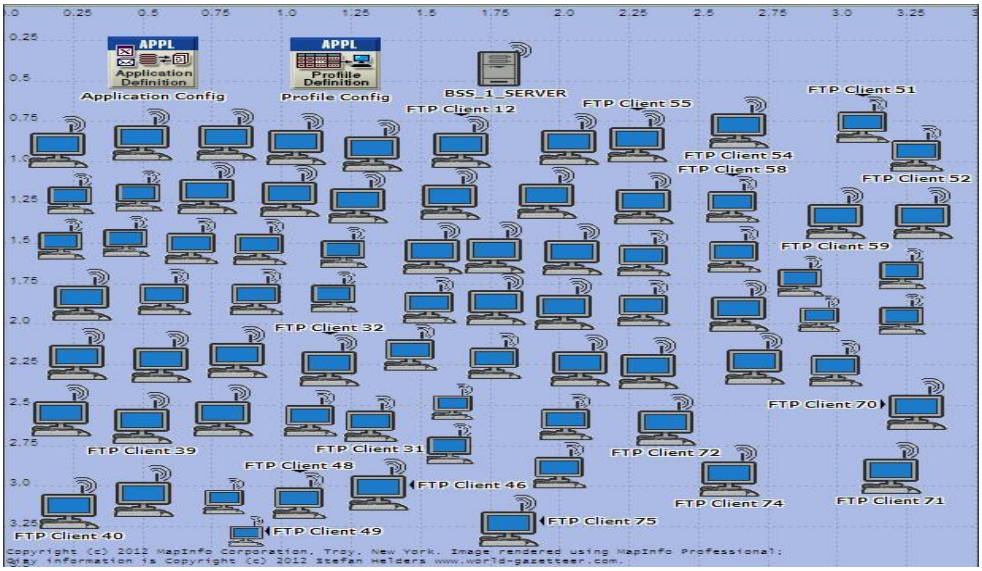

Figure 1.1: Network Topology Used

Figure1.1 shows a sample network created with 75 Nodes, one static FTP server, application configuration and profile configuration for the network in which FTP and HTTP has been chosen as an application. Figure 2 depicts a network with 75 fixed nodes whose behaviour has to be analyzed nodes in the network with respect to time to determine the effecting features of each protocol. OPNET modeler 14.5 is used to investigate the performance of routing protocols AODV, OLSR and GRP with varying network sizes, data rates, and network load. We evaluate three parameters in our study on overall network performance. These different types of parameter show the different nature of these Protocols, the parameters are throughput, delay and network load etc.

3.1 Parameters used in the network

There are different kinds of parameters for the performance evaluation of the routing protocols. These have different behaviours of the overall network performance. We will evaluate three parameters for the comparison of our study on the overall network performance. These parameters are delay, network load, and throughput for protocols evaluation.

3.1.1 Delay: The packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network. This time is expressed in sec.

3.1.2 Network Load: Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load. The efficient network can easily cope with large traffic coming in, and to make a best network, many techniques have been introduced.

3.1.3 Throughput: Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec).

4. Result Analysis And Discussion

We carried out simulations on Opnet simulator 14.5. The results show differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based. We carried out our simulations with 75 nodes. Figures 3,4 and 5 depicts the throughput, delay and network load of this network with respect to total simulation time which is taken as 5 minutes for which the simulation was run.

In this simulation, the network is set to 75 nodes, the traffic is FPT and HTTP mode, the data transmission rate is 11 Mbps and the simulation time is 5 minutes.

4.1 AODV Performance

The first scenario is simulated and it gives the required results shown in the below Fig. 1.2. In this scenario, 75 mobile nodes are simulated. The Ad hoc On Demand Distance Vector protocol was checked by three parameters such as delay, network load and throughput. First graph shows number of hops per route. Average number of hops is 3. Second graph shows route discovery time and it keeps on increasing. Here in the given graph the 3rd window shows delay in sec. The x-axis denotes simulation time in min and y-axis denotes delay in sec. With time delay increases gradually and reaches 22 sec at end of simulation. The 4th window shows the network load in bits/sec. In this network load remains constant at a value of 0 bit/sec for 1m 30s and afterwards gradually increases to 11,00,000 bit/sec and then becomes constant at around 10,00,000 bits/sec. The 5th graph shows the throughput where x axis represents time in sec and y axis denotes bits. With sudden rise throughput becomes constant. This throughput remains 0 bit/sec for 1m 30sec and with sudden increase it becomes constant at 5,00,000 bits/sec.

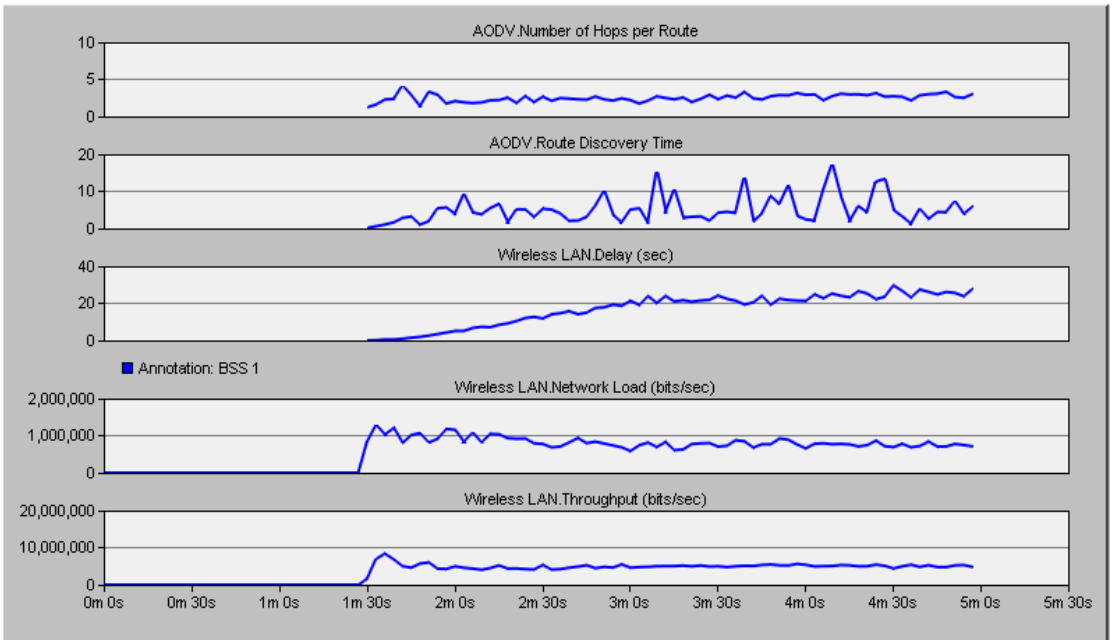

Fig. 1.2: Delay, Network Load, Number of hops per route, Route discovery time and Throughput of AODV 75 Nodes

4.2 OLSR Performance

The below given images show Optimized Link State Routing protocol for the following three parameters Delay, Network Load, hello traffic sent and Throughput. The numbers of mobile nodes were still kept as 75 and one WLAN fixed server. In the given Fig. 1.3,

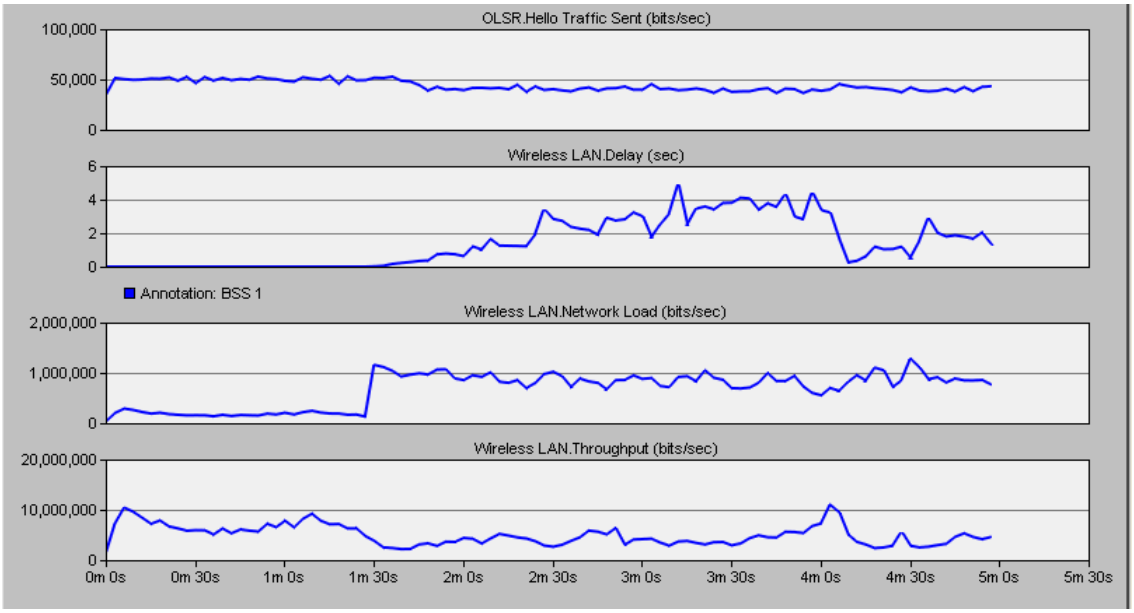

Fig. 1.3: Delay, Network Load, Hello Traffic Sent & Throughput of OLSR 75 Nodes

1st graph shows amount of hello traffic sent in bits/sec. As the amount of load in network increases hello traffic drops from 50,000 bps to 40,000 bps and becomes non-variable. Second graph shows the network delay. Peak delay is 4.5 sec but remains low for most of time. In 3rd figure amount of network load is non-variable reaches 10,00,000 bps at end of simulation. The last graph in the given Fig. 6.3 is for the throughput of OLSR 75 nodes. The peak value of the throughput in OLSR is 11,00,000 bits/sec. This value gradually drops to 5,00,000 bit/sec for a small interval and usually runs above 6,00,000 bps.

4.3 GRP Performance

The below given images show Gathering based Routing Protocol for the following three parameters Delay, Network Load and Throughput.

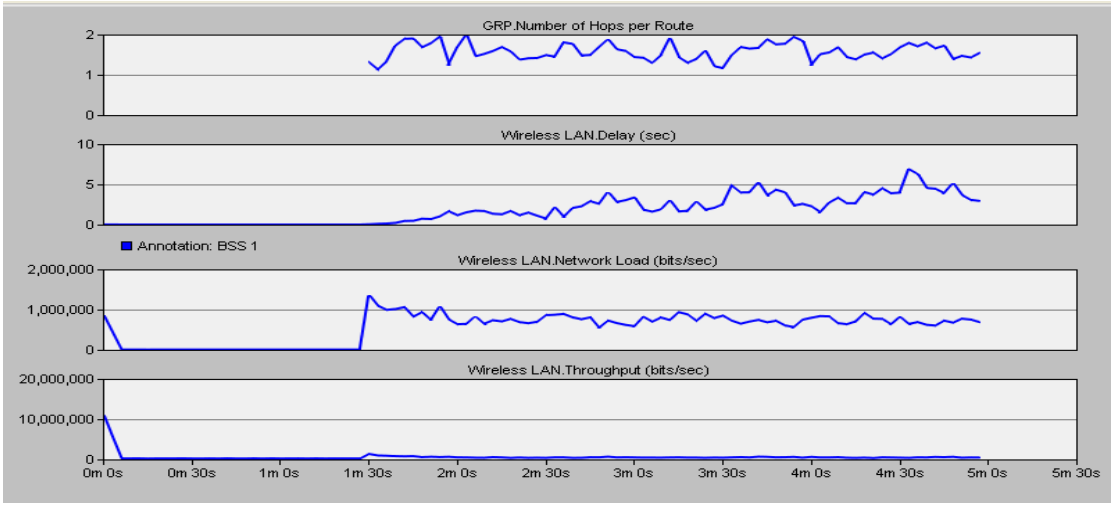

Fig. 6.4: Delay, Network Load and Throughput of GRP 75 Nodes

The numbers of mobile nodes were still kept as 75 and one WLAN fixed server. In the given Fig.1.4, 1st graph shows number of hops per route and value shows continuous fluctuations between 1.5 and 2. 2nd graph gives network delay in bps. For 1m 45s value remains at value of 0 bit/sec and after that delay gradually increases but with a slow rate. At the end of simulation it reaches 6 sec. Network load is shown by the 3rd graph in the given Fig. 6.4. Peak value of network load is 10,00,000 bit/sec at 1m30s. The network load value gradually drops to 5,50,000 bit/sec and remains there for most of time. The throughput of this network is shown by 4th graph. The first peak value of throughput is 10,12,987 bit/sec. The throughput value gradually decreases to 1,56,789 bit/sec in 1 min and afterward value of throughput remains constant .

5. CONCLUSIONS

In this paper, we discussed in the three routing protocols (AODV, OLSR and GRP), based on OPNET simulations. Our motive was to check the performance of these three routing protocols in MANET in the above mentioned parameters.

The simulation study of this paper consisted of three routing protocols AODV, OLSR and GRP deployed over MANET using FTP and HTTP traffic analysing their behaviour with respect to five parameters i.e. delay, network load, throughput, traffic sent and traffic received. Our motive was to check the performance of these three routing protocols in MANET in the above mentioned parameters. The selection of efficient and reliable protocol is a critical issue. In a similar fashion to HTTP, we also investigated the literature on models covering E-Mail and FTP traffic. At the end we came to the point from our simulation and analytical study that the performance of routing protocols vary with network and selection of accurate routing protocols according to the network, ultimately influence the efficiency of that network in magnificent way.

So proactive protocol OLSR outperforms in terms of throughput and gets the same low delay as OLSR. Further study could also look at voice over IP traffic for the evaluation of MANETs under the same conditions as the ones used in this paper.

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