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PERFORMANCE EVALUATION OF ROUTING PROTOCOLS IN MANETS

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ABSTRACT

Mobile Adhoc Network (MANET) is a decentralized independent wireless system that is self-configured with a collection of mobile communication node that moves randomly. Challenges such as routing, power management, frequent topology changes, and security are faced by network developers and designers. Routing is one of the core factors that have great influence on network performance, its discovery and maintenance are critical issues. Several studies have been done on the performance evaluation of routing protocols using different evaluation methods. In this paper, we evaluated the performance of DSR, OLSR and GRP, a proactive, reactive and hybrid Adhoc routing protocols respectively using OPNET Modeler Simulator. The performance of these routing protocols is analyzed by Delay, Throughput, Network load, Retransmission Attempts and Data Dropped. The comparison analysis has been carried out about these protocols, simulation results shows that OLSR outperformed both GRP and DSR routing protocols.

Keywords: MANET, Routing Protocol, DSR, OLSR, GRP

INTRODUCTION

A wireless network is a computer network that is not connected by cables of any kind. Wireless network technology allows users to utilize devices that enable access to information at any time in any place (Rackley, 2007). Wireless networks can operate in one of two-mode: infrastructure and infrastructure-less (Ad-hoc). In infrastructure wireless networks all devices communicate with each other through a router, while in Ad-hoc wireless network the devices communicate directly without an access point. Wireless technology has helped to simplify networking by enabling multiple computer users to simultaneously share resources in a home or business without additional or intrusive wiring. These resources might include a broadband Internet connection, network printers, data files, and even streaming audio and video. This kind of resource sharing has become more prevalent as computer users have changed their habits from using single, stand-alone computers to working on networks with multiple computers, each with potentially different operating systems and varying peripheral hardware.

MANET stands for Mobile Ad hoc Network, it is an infrastructure-less wireless network (Harminder Kaur, Singh, & Sharma, 2016). A MANET is a collection of wireless mobile nodes forming a short-lived network without any fixed infrastructure where all nodes are free to move about arbitrarily and configure themselves, with each node acting as a host as well as a router (Nishat & Pothalaiah, 2011; Taneja & Kush, 2010; Pandey & Swaroop, 2011). Nodes in the network can

communicate via a routing protocol that finds the best route from the source node to the destination nodes. Nodes communicate with each other without the intervention of centralized access points or base stations (Olanrewaju& Airehrour, 2014). Routing in MANET means to choose a right and suitable path from source to destination. The routing protocol is required whenever the source needs to communicate with the destination node.

Routing protocols for ad hoc networks can be classified into three main categories proactive, reactive, and hybrid protocols (Gupta & Kaushik, 2012; Karlsson *et al.*, 2012). In Reactive or on-demand, a new route is created based on demand by flooding the network with Route Request or Discovery packets (Mahajan & Chopra, 2013). Protocols such as Ad-hoc On-demand Distance Vector Routing AODV), Dynamic Source Routing (DSR), Associatively-Based Routing (ABR), Signal Stability Routing (SSR) and Location Aided Routing (LAR) fall under this category (Pahal et al., 2011; Kumar & Sharma, 2011). Proactive or table-driven protocols attempt to maintain uniform up-to-date routing information from each node to every other node in the network (Singla & Singh, 2013; Uddin & Zasad, 2010). The paper intends to evaluate the performance of proactive, reactive, and hybrid routing protocols under intense network traffic.

The rest of the paper is organized as follows. Section 2 presents the categories of the routing protocols and discusses one type of each that will be evaluated. In Section 3, a simulation experiment is carried out under various performance metrics using OPNET Modeler version 14.0. Finally, our conclusion is presented in section 4.

Related work

Saleh et al. (2020) investigated the impact of simulating MANET routing protocols using various propagation models. They compared AODV and DSDV. The used NS-3 simulator. Alabdullah et al. (2019) proposed a performance assessment of DSR, DSDV and AODV protocols using network size, mobility and variable network load. NS-2 simulator was used. Result shows that AODV, DSR are more efficient that DSDV and reasonably more proper for ad-hoc applications.

Also, in a paper "Performance Evaluation of Routing Protocols in MANETS" the performance of two on-demand routing protocols AODV and DSR were compared in terms of QoS parameters such as throughput, minimum, maximum and average delay, and packet delivery ratio. The paper performed an extensive simulation using the NS-2 simulator using both conventional TCP and TCP Vegas traffic sources for different node speed. Concluded that both AODV and DSR gave almost the same packet delivery fraction at low node velocities but as the velocity of the node increased DSR gave better PDF with TCP Vegas. Delay was maximum for DSR and minimum for AODV with TCP Vegas. The average end-to-end delay of AODV was less than in DSR. The throughput of AODV was better than that of DSR. Thus, AODV with TCP Vegas traffic source outperformed DSR (Nishat et al., 2011).

Sabri et al. (2018) present a performance comparison between DSR, AODV and DSDV protocols. They evaluated the performance of the protocols based on packet delivery ratio, average throughput, average end to end delay and packet loss

ratio metric. The result showed that different protocols performed differently in metrics. Garg et al., (2012) compared the performance study of various on-demand, reactive, and hybrid routing FSR, DSDV, DSR, AODV, ZRP, and ZHLS. Results indicate that AODV keeps on improving with denser mediums and at faster speeds. AODV is still better in Route updating and maintenance processes.

Kaur et al., (2013) conducted a review of OLSR, AODV, ZRP of Routing Protocol in MANETS. The main features of the routing protocols were stated in conclusions, AODV has less connection delay and is loop-free while in OLSR routes to every destination inside the network are known and maintained before use. There is no route discovery delay associated with finding a new route in OLSR and ZRP provides a framework to other routing protocols and each component of ZRP works independently to give an efficient result.

Kampitaki & Economides (2014) used Omnet++, Inetmanet simulator to analyzed the performance of DSR, AODV, OLSR. They used non-specific application traffic (like CBR and burst traffic generators) and FTP traffic at the same time and compared the simulation results to the results of a simulation where FTP was absent and concluded that the protocols have better performance in terms of PDR (packet delivery ratio) and NRO for all the cases studied, while AEED (average end-to-end delay) remains in the same level as when FTP traffic coexists in the network. The NRO of OLSR is not affected by the density of the relay nodes in the network and is slightly affected by the number of FTP flows that are present in the network. Therefore, it concluded that the type of traffic affects the performance, and the mobility pattern does not have any impact on the performance of the routing protocols. Prasanna, Rajakumar & Pitchaikkannu, (2014) Overviewed Proactive Routing Protocols in MANET; DSDV, WRP, CGSR, Deeply discussed the types of proactive routing protocols and concluded that there is definitely need of a routing solution that can not only offer a better routing solution but also address some related issues such as QoS support, Routing overhead, bandwidth constraints and limited power of mobile devices.

Alslaim, Alaqel, & Zaghloul, (2014) conducted a comparative study of MANET Routing Protocols AODV, DSR, DSDV. Simulation results showed that DSR outperforms the other two protocols in ordinary situations. However, DSDV is better in more stressful situations. Therefore, practically speaking, it is better to use DSDV as it has the best performance in a situation similar to the real-life situation.

Shenbagapriya & Kumar (2015) used the Ns-2 simulator to evaluate the performance of LPSR, PSR, DSDV, OLSR, WRP, FSR. Concluded that OLSR is having more overhead since its control message increases during topological changes. DSDV protocol has good performance if a smaller number of nodes and mobility is used. Better end-to-end delay in DSDV since it uses only a small number of nodes. WRP and FSR have high storage complexity which increases the overhead, but FSR supports Multipath routing and QoS routing. There is more end-to-end delay in CGRP because its communication happens only through the cluster head. The PSR outperforms all the baseline protocols but suffers from communication overhead

due to topological change. Finally, LPSR performs some optimization using a tree structure to overcome the communication overhead, but its PDR (packet Deliver Ratio) is less when compared to all other protocols.

(Sah & Saini, 2015) conducted a Review of DSDV, OLSR, AODV, TORA, ZRP Routing Protocols in MANET. The result shows that Proactive protocols are best suited for small networks, but for a dense and large network, reactive protocols are prepared. And hybrid protocols are a combination of proactive and reactive protocols. So, when high performance is required in a large network then hybrid protocols are used.

(Mummadisetty et al., 2015) evaluated the performance using the NS2 simulator of AODV, DSDV, DSR. Results showed that AODV performed well in high mobility and high-density scenarios, whereas DSDV performed well when mobility and the node density were low. DSR performed well in low-mobility scenarios. Concluded that there was no one best protocol for all the scenarios tested. The choice of protocol depended on the network and parameters considered.

Neeraj&Sarita (2017) Reviewed different Routing Protocols in MANET DSDV, OLSR, WARP, AODV, DSR, LAR, CGSR, ZPR and reasoned that MANET routing protocols are outlined based on the application area and condition and it is impractical to plan a single protocol, which is appropriate for all MANETs.

MATERIALS AND METHODS

Network Model and Simulation Set-up

The simulation was carried out with Opnet Modeler 14.0 with Throughput, Delay, Network load and Retransmission Attempts as the measure parameters. The scenario was run, with 20 numbers of mobile nodes.

Table 1: Simulation environment

Simulation parameters	Values
Area	1000m x1000m
Number of nodes	20
Mobility Model	Random waypoint
Simulation time	3600s at 10m/s
Protocols	DSR, OLSR, GRP
Node speed	11Mbps
Pause Time	100s

Performance Parameters

Delay

This is the time from the generation of the packet by the sender up to their reception at the destination's application layer and is expressed in seconds. The end-to-end delay is therefore a measure of how well a routing protocol adapts to the various constraints in the network and represents the reliability of the routing protocol.

Throughput

The ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet. It is expressed in bits per second or packets per second.

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 (Suhaimi Bin Abd Latif,2013).

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 the best network, many techniques have been introduced. High network load affects the MANET routing packets and slow down the delivery of packets for reaching to the channel and it results in increasing the collisions of these control packets. Thus, routing packets may be slow to stabilize.

Retransmission Attempts

This is the total number of retransmissions attempts by all WLAN MACs in the network until either the packet is successfully transmitted or it is discarded as a result of reaching a short or low retry limit.

RESULT

The result of simulation of 20 nodes in Opnet Modeler 14.0 is presented according to the four measure parameters.

Throughput

OLSR by far outperformed DSR and GRP. GRP shows a medium throughput. DSR with the minimum throughput as it is a reactive protocol; it must take some time to generate the route each time a route request is made. OLSR is a proactive routing protocol thus paths are readily available for traffic (Figure 1). OLSR maintains consistent paths in the network causing a low delay.

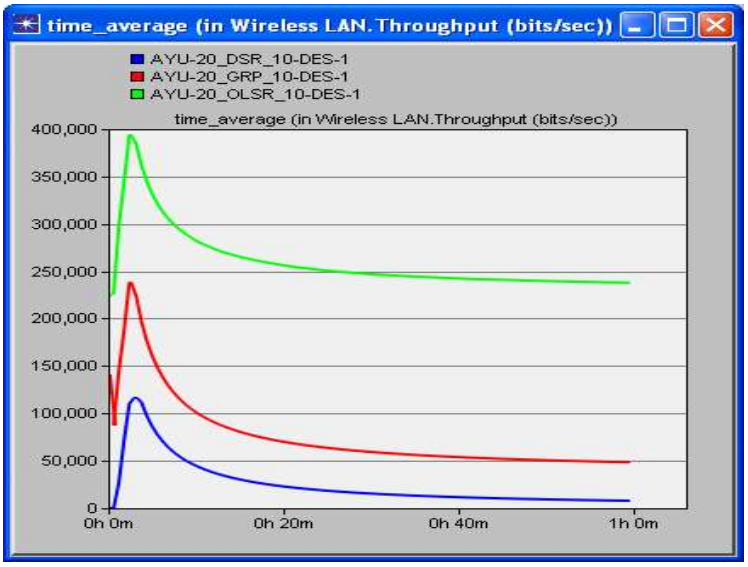

Figure 1: Throughput- 20 nodes

Network load

GRP showed a peak value of 184689bits/second, OLSR overlapped with GRP within the first 10minutes of the simulation and after that GRP slightly move below OLSR and maintain its hybrid nature. DSR shows the least network load Figure 2).

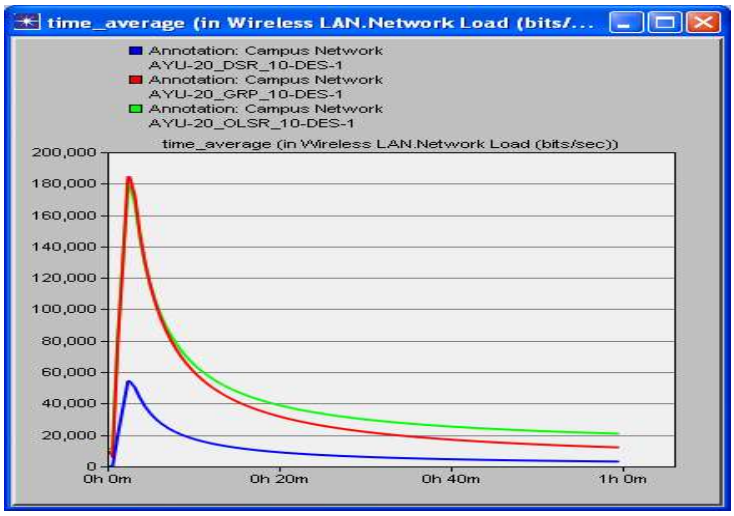

Figure 2: Network Figure Load for 20 nodes

Delay

GRP showed a higher delay with a peak value of around 0.0022 seconds initially and drastically drop and stood in between OLSR and GRP, DSR shows the highest delay, and OLSR still showed the least delay. From the result, both GRP and OLSR showed better performance in terms of end-to-end delay in packet delivery. OLSR is a proactive routing protocol that maintains a predetermined route before the route request. The absence of high latency induced by the route discovery processes in OLSR explains its relatively low delay. GRP is a hybrid protocol with some proactive attributes. DSR as a reactive protocol must take some time to search for the route each time a route request is made (Figure 3).

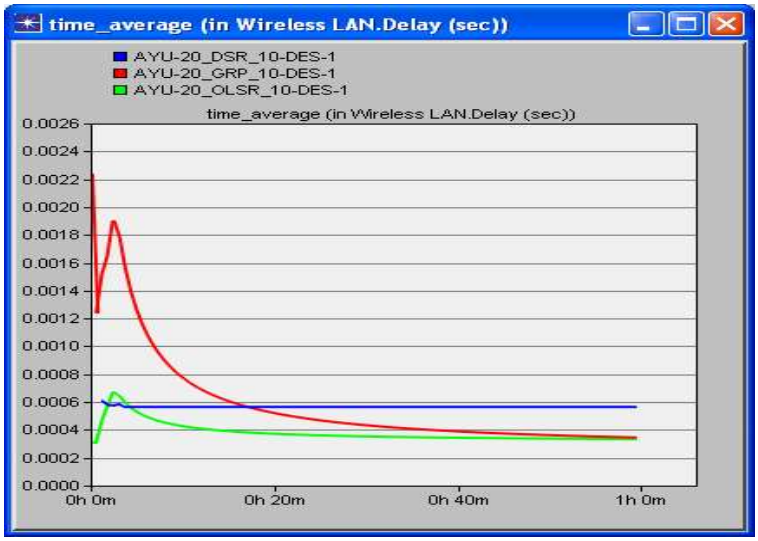

Figure 3: Delay for 20 nodes

Retransmission Attempts

With 20 nodes, GRP retransmission attempt was above OLSR, both moving at a constant rate. DSR shows the highest attempt of almost 0.20 packets (Figure 4).

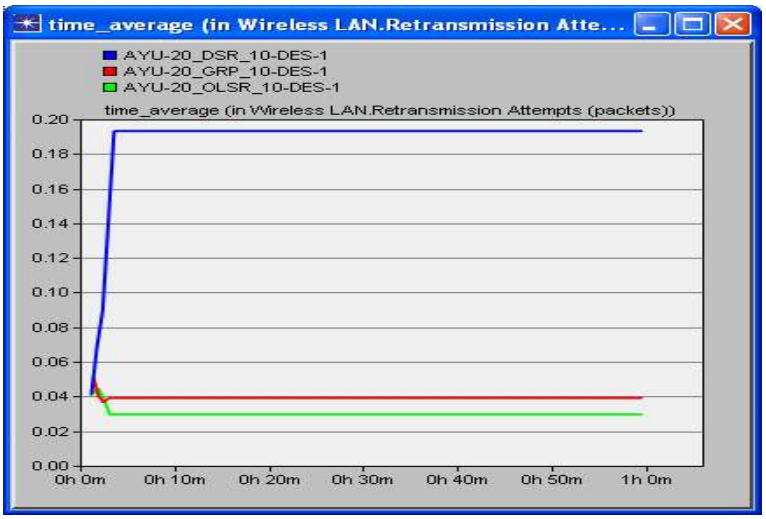

Figure 4: Retransmission Attempts for 20 nodes

DISCUSSION

In this paper, three different routing protocols were analyzed with respect to throughput, network load, Delay, and Retransmission on the OPNET simulator. The objective was to check their performance. The selection of efficient and reliable protocol is a critical issue. The results used are the simulation graphs and the time average statistical values from these graphs. From the study, it is clear that due to the random behavior of the node, changing topology and security attacks routing becomes complex. Many routing protocols used in the MANET, each have its unique features, advantages and disadvantages, and performance parameter combinations where they outperform their competitors based on network environments. In the end, it comes to point from the simulation study that the selection of accurate routing protocol depends on the intended use of the network, as observed from the graphs that OLSR outperformed both GRP and DSR routing protocols. With OLSR being better in MANET according to our simulation results but OLSR doesn't always perform better in all situations across various networks.

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