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PERFORMANCE ANALYSIS OF ROUTING PROTOCOLS IN MANET WITH STATIC AND MOBILE NODES USING HTTP TRAFFIC

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ABSTRACT

A mobile ad hoc network (MANETs) consists of mobile wireless nodes where inter-node communication is carried out without centralized control. MANETs, therefore requires self organization and self configurability. The mobility feature of MANETs enables nodes to move arbitrarily. Each mobile node can receive and forward packets as a router; therefore routing is one of the critical parts of MANETs. In this paper, the performance of four routing protocols i.e. AODV, DSR, TORA and OLSR is compared to static node and mobile node using delay, data rate and throughput as performance metrics. On the basis of these comparisons the best routing protocol for MANETs has been proposed.

KEYWORDS: Mobile Ad Hoc Network (MANET), Dynamic Source Routing (DSR), Optimized Link State Routing(OLSR), Temporarily Ordered Routing Algorithm (TORA), Ad Hoc on-Demand Distance Vector (AODV), throughput; Delay, Data Rate

INTRODUCTION

Mobile Ad hoc Network is a decentralized autonomous wireless system which consists of free nodes. It is sometimes called as mobile mesh network, which is a self configurable wireless network. It consists of mobile nodes, a router with multiple hosts and wireless communication devices. The wireless communication devices are transmitters, receivers and smart antennas. The term node referred to as a device which is free to move arbitrarily in every direction. These nodes can be a mobile phone, laptop, personal digital assistance, MP3 player and personal computer which can be located in cars, ships, airplanes or with people having small electronic devices.

The ability of self configuration of these nodes makes them more suitable for urgently required network connection, for example in disaster hit areas where there is no communication infrastructure. MANET is the quick remedy for any disaster situation. It is a spontaneous network which is useful when dealing with wireless devices in which some of the devices are part of the network only for the duration of a communication session. The MANET working group within the Internet Engineering Task Force (IETF) works specifically on developing IP routing protocols topologies. To improve mobile routing and interface definition standards for use within the Internet protocol suite.

MANET routing protocol noticed experimental Request For Comments (RFC) since 2003. Implementation and deployment of these protocols have not properly addressed by RFCs, but the routing protocol algorithms proposed were identified as trial technology with the high probability that will result into a standard.

Enormous research work have been focused on different routing protocols such as Dynamic Source Routing (DSR), Optimized Link State routing(OLSR), Temporarily Ordered Routing Algorithm (TORA) and Ad hoc On-demand Distance Vector (AODV), for their development and standardization of routing support by MANET working group of Internet Engineering Task Force (IETF). We have observed the effect of these protocols on MANET performance while using HTTP traffic.

MANET is a self organized and self configurable network where the mobile nodes move arbitrarily. The mobile nodes can receive and forward packets same as a router. Routing is a critical issue in mobile ad hoc network hence the focus of this Paper along with the performance analysis of routing protocols. We compared four routing protocols i.e. AODV, DSR, TORA and OLSR with respect to static node and mobile node. Our simulation tool is OPNET modeler. The HTTP heavy traffic is used over the network designed of our analysis. Performance of these routing protocols is analyzed by three parameters delay, data rate and throughput. All the four routing protocols are explained in a deep way with parameters. 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 MANET. We evaluate the behavior of AODV, DSR, TORA and OLSR routing protocols when implemented in the network. We look that how these protocols affect the network performance, and how they behave in these networks. The algorithm design and analysis of these routing protocols will not be the focus however a detailed explanation of these routing protocols and their effects on the network is discussed.

BACKGROUND LITERATURE ON MANET

Nowadays, the information technology will be mainly based on wireless technology, the conventional mobile networks are still, in some sense, limited by their need for infrastructure, and instance based station, routers and so on. For the Mobile Ad Hoc Network, this final limitation is eliminated and the Ad Hoc Network is the key in the evolution of wireless network and this network is typically composed of equal number of nodes which communicate over wireless link without any central control. Although military tactical communication is still considered as the primary application for Ad Hoc Networks and commercial interest in this type of networks continues to grow. In all applications such as rescue mission in time of natural disasters, law enforcement operation, and commercial as rescue and in the sensor network are few commercial examples, but in this time it's become very important in our life and they become use it. The Ad Hoc Networking application is not new one and the original can be traced back to the Defense Advanced Research Projects Agency (DARPA), Packet Radio Networking (PRNET) project in 1972 which evolved into the Survivable Adaptive Radio Networks (SURAN) program, which was primarily inspired by the efficiency of the packet switching technology for instance the store/forward routing and then bandwidth sharing, it's possible application in the mobile Ah Hoc Networks environments, as well as in the packet radio networking devices like repeaters and routers and so on, were all mobile although mobility was so limited in that time, theses advanced protocol was consider good in the 1970s. After few years, advancement in micro electronics technology made possible to integrate all the nodes and network devices into a single unit Called Ad Hoc Nodes. This advancement in nodes and networks devices introduced flexibility, resilience, mobility and independence of fixed infrastructure, and in that time they so interesting to use it immediately among military battlefield, Ad hoc networks have played an important role in military applications and related research efforts, for example, the Global Mobile Information Systems (GMIS) and the Near Term Digital Radio (NTDR).

Ad Hoc network research stayed long time in the realm of the military, in the middle of 1990s with advice of commercial radio technology and the wireless became aware of the great advantages of MANET outside the military battlefield domain, and then became so active research work on ad hoc network start in 1995 in the conference session of IETF. In 1996 this works had evolved into Mobile Ad Hoc Network, in that time focused to discussion centered in military satellite network, wearable computer network and tactical network with specific concerns begin raised relative to adaptation of existing routing protocols to support IP network in dynamic environments, as well as they make the charter of the Mobile Ad Hoc Network Working Group (MANETWG) of the IETF which also work inside the MANTs relies on other existing IETF standard such as Mobile IP and IP addressing and most of the currently available solutions are not designed to scale to more than a few hundred nodes.

Currently, the research in Mobile Ad Hoc Network became so active and vibrant area and the efforts this research community together with the current and future MANET enabling radio technology. Recently, the Ad Hoc wireless network and computing consortium was established with the aim to coalescing the interests and efforts to use it anywhere such as academic area and industry and so on. And in order to apply this technology to application ranging for the home wireless to wide area peer to remote networking and communications. It will certainly pave the way for commercially viable MANET networks and their new and exciting applications, which began to appear in all fields in this life. More recently, the computer has became spread significantly in all places and after a pervasive computing environment can be expected based on the recent progresses and advances in computing and communication technologies. Next generation of mobile communications will include both prestigious infrastructure wireless networks and novel infrastructure less MANETs.

PERFORMANCE PARAMETERS AND SOFTWARE ENVIROMENT

There are different kinds of parameters for the performance evaluation of the routing protocols. These parameters have different behaviors of the overall network performance. We have evaluated three parameters for the comparison of our study on the overall network performance. The parameters are delay, network load, and throughput for protocols evaluation. These parameters are important in the consideration of evaluation of the routing protocols in a communication network. These protocols need to be checked against certain parameters for their performance. To check protocol effectiveness in finding a route towards destination, we examine the source that how much control messages it sends and it gives the routing protocol internal algorithm's efficiency. If the routing protocol gives much end to end delay so probably this routing protocol is not efficient as compare to the protocol which gives low end to end delay. Similarly a routing protocol offering low network load is called efficient routing protocol. The same is the case with the throughput as it represents the successful deliveries of packets in time. If a protocol shows high throughput so it is the efficient and best protocol than the routing protocol which have low throughput. These parameters have great influence in the selection of an efficient routing protocol in any communication network.

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. All the delays in the network are called packet end-to-end delay, like buffer queues and transmission time. Sometimes this delay can be called as latency; it has the same meaning as delay. Some applications are sensitive to packet delay such as voice is a delay sensitive application. So the voice requires a low average delay in the network. The FTP is tolerant to a certain level of delays. There are different kinds of activities because of which network delay is increased. Packet end-to-end delay is a measure of how sound a routing protocol adapts to the various constraints in the network to give reliability in the routing protocol. We have several kinds of delays which are processing delay, queuing delay, transmission delay and propagation delay. The queuing delay is not included, as the network delay has no concern with it. Mathematically it can be shown as equation (i).

$$d_{end-end} = N\left[d_{trans} + d_{prop} + d_{proc}\right] \quad \text{(i)}$$

Where $d_{end-end}$ = End to end delay, d_{trans} = Transmission delay, d_{prop} = Propagating delay and d_{proc} = Processing delay

Suppose if there are n number of nodes, then the total delay can be calculated by taking the average of all the packets, source destination pairs and network configuration.

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). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy. A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation (ii);

$$Throughput = \frac{number\ of\ delivered\ packet * Packet\ Size * 8}{total\ duration\ of\ simulation} \quad \textbf{(ii)}$$

Data Rate

It is the amount of data is moved from one place to another in a given time. The Date Rate can be viewed as the speed of travel of a given amount of data from one place to another.

Software Environment

Designing an efficient network plays an important role in this world and then it is even essential part to check the performance of the designed network, which will be a difficult task in a real time application. For this many network simulators have been designed so far among the most reputed are OPNET (Optimized Network Engineering Tool) Modeler and NS2 (Network Simulator). OPNET modeler is not an open source product it needs license to access it provides GUI and consists of predefined models, protocols and algorithms and supports with lot of documentation it is specially used for commercial purpose. NS2 is an open source simulating tool it is combination of C++ & Otcl with less document support specially used by developers.

We are using the Optimized Network Engineering Tool (OPNET v14.0) software for our simulations. OPNET is a network simulator. It provides multiple solutions for managing networks and applications e.g. network operation, planning, research and development (R&D), network engineering and performance management. OPNET 14.0 is designed for modeling communication devices, technologies, protocols and to simulate the performance of these technologies. OPNET plays a key role in today's emerging technical world in developing and improving the wireless technology protocols such as WiMAX, WiFi, UMTS, etc, design of MANET routing protocols, working on new power management systems over sensor networks and enhancement of network technologies such as Ipv6, MPLS etc. Working of OPNET generally divided into four parts, model design, applying statistics, run simulation and then to view results and to analyze the results, if the results are not correct then it has to be re-modeled and then to apply new statistics. The basic working flow of OPNET is given in figure 1.

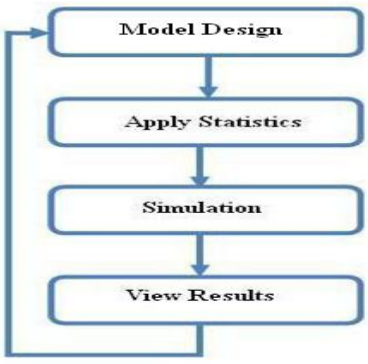

Figure 1: Working flow Chart of OPNET

SIMULATION RESULTS

Category-1

In category-1, a network model is designed with static nodes in OPNET 14.0 modeler for four different routing protocols and we have to observe the impact of these static nodes on MANET routing protocols performance using HTTP heavy traffic. The developed scenario contains18 nodes with the speed of 10km/hr for DSR, AODV, TORA and OLSR routing protocols in the office having the area of 100 x 100 meters. The attributes of nodes and server Ad-Hoc routing parameters are set with respect to required protocol. Simulation results of routing protocols are analyzed with delay, throughput and data rate parameters. The simulation setup time for designed network is 5 minutes as shown in figure 2.

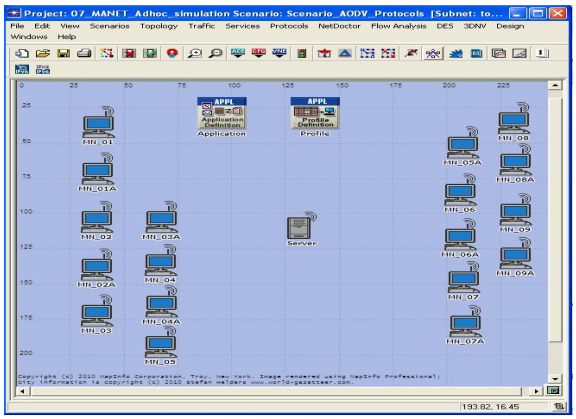

Figure 2: Network Model Design of MANET with 18 Static Nodes

Delay

Delay is one of the three parameters which is used to measure the performance of routing protocols. It is average time taken by the packet in order to transverse the network. In figure 3, we can see the simulation results, reactive protocols DSR, TORA, and AODV showing delay compared to proactive protocols OLSR. The simulation results for reactive protocols DSR, TORA and AODV showing quite high delay compared to proactive protocol OLSR. As the reactive routing protocols the source nodes generally broadcasts the routing requests in the whole network and keeps waiting for responses this makes reactive protocols to show up quite much delay.

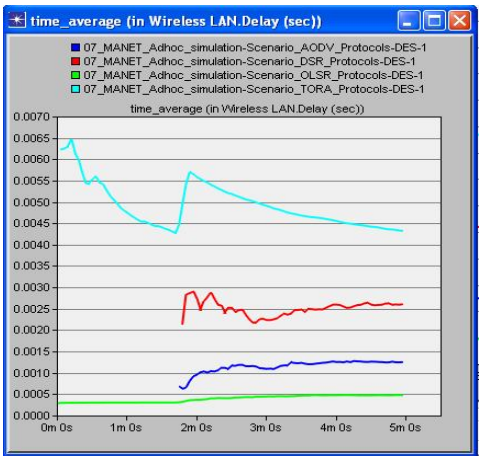

Figure 3: Delay for AODV, DSR, TORA and OLSR with Static Nodes

Throughput

Throughput is second parameter which is used to measure the performance of routing protocols. It is the total amount of the data received by the receiver from the sender until the end of last packet transmission. In figure 4, the simulation results for AODV, DSR, TORA and OLSR protocols over HTTP heavy traffic shows that the throughput for the proactive routing protocol OLSR is higher than that of the reactive routing protocols AODV, DSR and TORA, it is because the OLSR protocol is independent of the traffic and network density compared to AODV, DSR and TORA protocols.

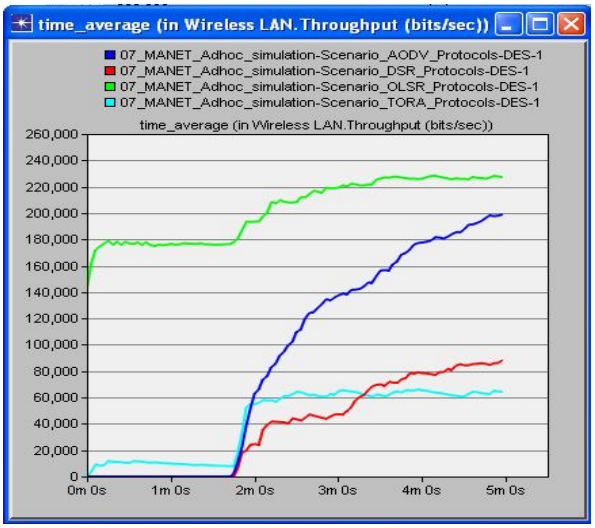

Figure 4: Throughput for AODV, DSR, TORA and OLSR with Static Nodes

Data Rate

Data Rate is also another parameter which is used to measure the performance of routing protocols. In figure 5, the simulation results for AODV, DSR, TORA and OLSR protocols over HTTP heavy load traffic shows that the data rate (data sent) for DSR routing protocol is higher than OLSR, AODV and TORA routing protocols. Because DSR maintain the route cache at every node in the network, it reduces the memory overhead and if the route is found in that node route cache than it will not rebroadcast the RREQ in whole network, this route is considered the shortest path taken by the RREQ packet although the other reactive protocols AODV and TORA show approximately the same data rate as the proactive protocol OLSR.

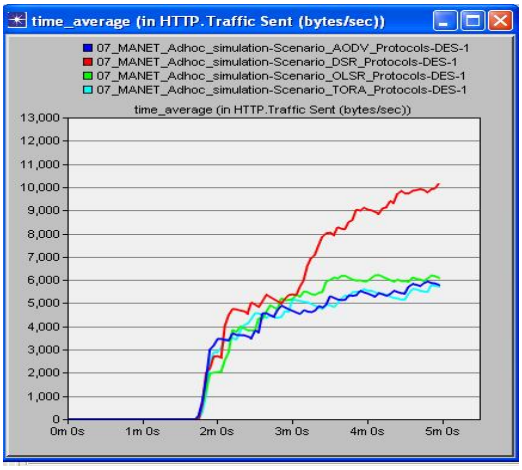

Figure 5: Data rate for AODV, DSR, TORA and OLSR with Static Nodes

Category-2

In category-2, a network model is designed with mobile nodes in OPNET 14.0 modeler for four different routing protocols and we have to observe the impact of these mobile nodes on MANET routing protocols performance using HTTP heavy traffic. The developed scenario contains18 nodes with the speed of 10km/hr for DSR, AODV, TORA and OLSR routing protocols in the office having the area of 100 x 100 meters. The attributes of nodes and server Ad-Hoc routing parameters are set with respect to required protocol. Simulation results of routing protocols are analyzed with delay, throughput and data rate parameters as observed in category-1. The simulation setup time for designed network is 5 minutes as shown in figure 6.

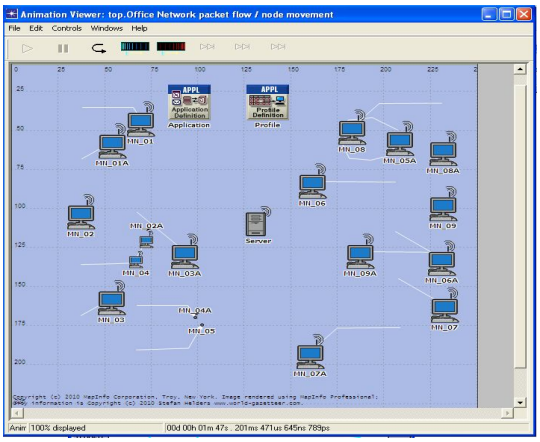

Figure 6: Network model design of MANET with 18 Mobile Nodes

Delay

In figure 7, we can see the delay for AODV, DSR, TORA and OLSR protocols for the nodes moving with the speed of 10km/hr. On comparing the graphs we can observe that delay in OLSR routing protocol is quite low as compare to reactive protocols AODV, DSR and TORA. Because the OLSR protocol will maintain and update its routing table frequently, due to this reason OLSR protocol maintain consistent paths. OLSR protocol exchanges HELLO messages with its neighboring nodes and form symmetric links though there is variation in nodes speeds and by this it can make successful routing, therefore mobility of nodes show less impact over the performance of OLSR protocol.

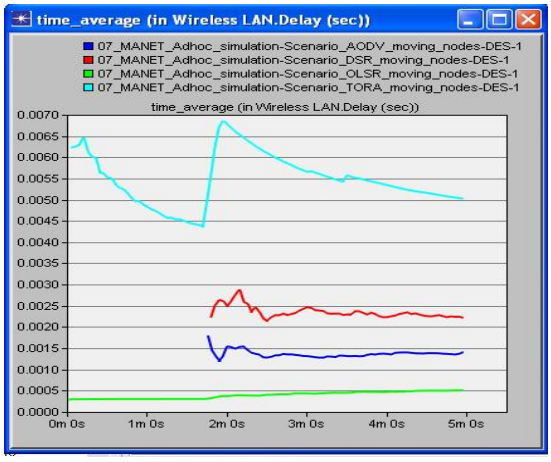

Figure 7: Delay for AODV, DSR, TORA and OLSR with Mobile Nodes

Throughput

In figure 8, we can observe that the throughput for the reactive protocol AODV shows good throughput as compare to other reactive protocols DSR and TORA. But the proactive protocol OLSR shows even better performance than reactive protocols, this is because of the proactive nature it will always maintain and update its routing table therefore OLSR protocol follow it's routing in order to direct the traffic to the destination efficiently even in the mobility condition.

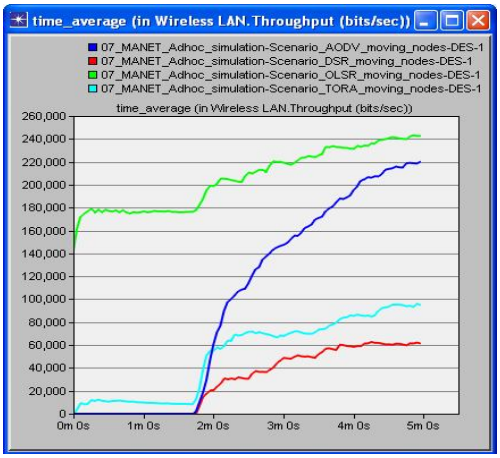

Figure 8: Throughput for AODV, DSR, TORA and OLSR with Mobile Nodes

Data Rate

In figure 9, the simulation results for AODV, DSR, TORA and OLSR protocols over HTTP heavy traffic shows that the data rate of TORA is higher than DSR,AODV and OLSR routing protocols because TORA establishes route quickly in the case of mobility, it also minimize the overhead by reaction to the topological changes in moving nodes case. TORA is proposed for highly dynamic mobile multi hop wireless networks. It is also observe that the data rate of OLSR routing protocol is also good as compare to DSR and AODV routing protocols.

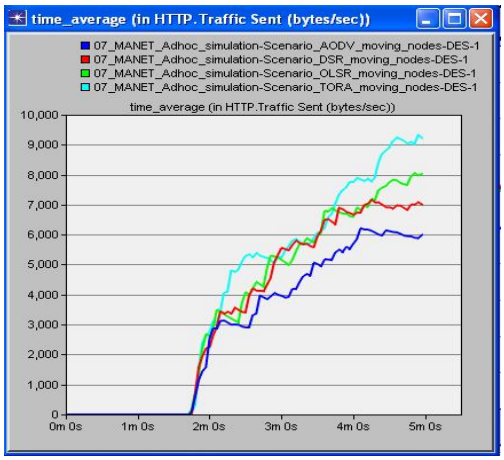

Figure 9: Data Rate for AODV, DSR, TORA and OLSR with Mobile Nodes

CONCLUSIONS

In this work we have performed performance analysis on MANET routing protocols (DSR, OLSR, TORA and AODV) with respect to the static nodes and mobility nodes. Delay, Throughput and Data rate parameters are used to analyze the protocols over HTTP heavy traffic. Our simulation results of static routing protocol in analyzing the

performance of our chosen protocols conclude that the proactive routing protocol OLSR outperforms reactive routing protocols AODV, TORA and DSR protocols. But it is not necessary that OLSR perform always better in all the networks, its performance may vary with different parameters as we observed in the case of data rate the performance of the DSR routing protocol is better than all other three protocols. In the case of mobility, it is also observed that the proactive routing protocol OLSR outperforms reactive routing protocols AODV, TORA and DSR protocols. But again in the case of data rate the performance of the reactive routing protocol TORA shown better result even from the OLSR. At the end we came to the point from our simulation and analytical study that the performance of the routing protocols vary with network and selection of accurate routing protocols according to the network and the routing protocols also depend on the performance parameter.

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