Comparative Performance Analysis of AODV, DSR, TORA and OLSR Routing Protocols in MANET Using OPNET

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Abstract

Mobile Ad Hoc Networks (MANETs) are receiving a significant interest and are becoming very popular in the world of wireless networks and telecommunication. MANETs consist of mobile nodes which can communicate with each other without any infrastructure or centralized administration. In MANETs, the movement of nodes is unpredictable and complex; thus making the routing of the packets challenging. As a result, routing protocols play an important role in managing the formation, configuration, and maintenance of the topology of the network. A lot of routing protocols have been proposed as well as compared in the literature. However, most of the work done on the performance evaluation of routing protocols is done using the Constant Bit Rate traffic. This paper involves the evaluation of MANETs routing protocols such as Ad hoc on Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporary Ordered Routing Algorithm (TORA), and Optimized Link State Routing (OLSR) using Http Image Browsing traffic. The performance metrics used for the evaluation of these routing protocols are delay and throughput as a function of the load. The overall results show that the proactive routing protocol (AODV) performs better in terms of delay and throughput .

Keywords: Manet, AODV, DSDV, OLSR, TORA, Routing Protocol, simulation, OPNET.

1. Introduction

daily- life, we can access the internet using these devices where the physical connectivity between devices is not possible like airplanes, cars and taxies. Manet represent a distributed peer-to-peer network in which each node acts as both as an end system and as a router to process and forwards the data packets towards the destination.

Development of Ad-Hoc networking focuses on multi-hop relaying due to limited radio range of individual nodes.

Wireless Ad-Hoc networks are easy to deploy without using any infrastructure by using radio waves as transmitting medium. In such a network nodes can moves freely in any direction but still the rapid growing technology pay attention in many areas such as routing, bandwidth, security, power consumption, simulation and topology control due to moving node [1, 2]. The main target of mobile Ad-Hoc networking is to facilitate efficient communication mechanism in wireless technology by adopting routing strategies between moving nodes.

The remaining part of the paper is organized as follow: Section II includes the definition of Manet, classification of routing protocols. Descriptions of three protocols which are used in research study are presented in section III. Section IV gives details of simulation environment and performance metrics and the results and analysis part of the work done are presented in section V. Section VI concludes the paper and future scope the related work are presented in section VII.

2. Mobile AD-HOC Networks

Manet denotes a complex distributed peer to peer system of mobile nodes creating a temporary network without aid of fixed infrastructure. In Manet participating node can leave and join the network arbitrarily and network topology change over time. The nodes in Manet are generally come with limited capacities including mobile phones, laptop PDA's etc.

2.1 Routing in Manet's:

Manet is a collection of nodes with high degree of mobility without centralized point of observation. Each node work as an end system as well a router to process and forward data packets. Due to this highly dynamic nature designing of routing protocol in Manet is a complex task. It requires a routing protocol capable to handle topological changes and functional problems of nodes. If a node either leaves the network or goes out of its range and causes to link breakage, affected nodes can easily request for new routes and will get another available path.

2.2 Classification of routing protocols:

Routing protocols in Manet can be classified on the basis of many factors but most of routing classes dependent on routing methodologies and network structure. According to the routing methodologies routing protocols are of two types.

1. Proactive (table-driven) routing protocol
2. Reactive (On-demand) routing protocol

A. On-Demand or Reactive protocols:

A network using reactive nature of routing protocols, does not maintain prior routing information on all nodes to all times. When a sender node want to transmit data to a desired node, a route discovering procedure is performed to gaining the route availability information. It means we can say that the reactive protocols works on on- demand approach. To use already maintained route a route maintenance step is performed using hello messages to check the nest hop availability, route maintenance is required due to node mobility that leads the topological changes and to ensure the validity of maintained route. Reactive protocols are bandwidth efficient because it
reduces the control overhead that are generated only when they are needed, but it suffers from high latency compare than proactive protocols due to route discovery mechanism [3]. Examples of some reactive protocols are

1) Dynamic Source Routing Protocol (DSR).
2) Temporarily Ordered Routing Algorithm (TORA)
3) Ad-Hoc on-Demand Distance-Vector Routing Protocol (AODV)

B. Proactive protocols or Table-driven protocols:

Proactive protocols maintain all routing information on all nodes at all times before start to communication. This can be performed in various ways, thus protocols are categorized into two subclasses: Event-driven and periodic updated protocols.

Action or event-driven protocols will not generate and exchange any routing updates until no change is occurring in network topology. If a node receiving a message related to the topological changes in network, through its neighbor-set, it informs the other nodes as per the methodology adopted by routing protocols [6]. Some event-driven protocols are:-

1) Estimation-Sequenced-Distance–vector routing protocol (DSDV)D
2) Cluster-Based routing protocol (CBRP)

Periodic updated routing protocols always send their topological information to other nodes after a specified interval of time. Examples of periodic updated routing protocols

1) FSR (Fish-Eye-Routing protocol)
2) OLSR (Optimized-Link-State Routing Protocol

3. Description of AODV, DSDV AND OLSR

A. Ad-Hoc on-demand Distance-vector (AODV) routing protocol:

An Ad-Hoc On-Demand Distance Vector (AODV) employ multi-hop routing between participating nodes in the network willing to communicate to each other and maintain an ad-hoc network. It is a reactive protocol based upon the distance vector algorithm, conceptually, AODV is an improved version of DSDV routing algorithm. It inherits the properties form both DSDV and DSR, periodic updates from DSDV and hop by hop routing from DSR. AODV routing mechanism provides a robust and secure transmission of data packets in Manet. Due to reactive nature AODV discover a route only when it is required and does not maintain routes to destination that are not active in the communication process [4].

The algorithm uses different messages to route determination and maintain links. When a node wants to transmit data and does not have the route information, it broadcasts Route Request (RREQ) to all its neighbors. The RREQ flow throughout the network until it reaches to the destination or a node with route information to the destination. Then the route is established by unicasting a RREP back to the sender [5].

The algorithm uses hello messages that are periodically broadcasted among the immediate neighbors set. These hello messages are used for neighbor sensing and identify the link breakages in the network. if hello are not received from a particular node, the neighbor can assume that the node has moved away and mark that link to the as broken and inform all the affected set of nodes by sending a RERR error message. The key steps followed by AODV are

Route Discovery:

When a node has some data to send it check own routing table for route to desired destination, it route is available it start the transmission. If destination is unknown and previous route is not valid it broadcast a Route Request (RREQ) to find the route to destination. After broadcasting it wait for a Route Reply (RREP). If it not received the reply packet within a specific time period, the node may rebroadcast the RREQ or assume that there is no path available for the intended destination.

When the RREQ reaches a node that either the destination or a node with enough route information to destination, a RREP is generated or unicasted to the source node back. While the RREP is forwarded, a route is created to the destination and when the RREP reverted back to the original sender a path is established from source to destination [7].

Route Maintenance:

When a node found that a particular route to a neighbour is no longer available, it delete that routing entry from the routing table and send a error notification(RRER) ,a triggered route reply message to all those neighbours that use stale routes actively informing them that this route is no longer available. AODV uses an active neighbour list to keep track the routes using by the neighbours. The nodes receives error messages repeat this procedure for the removable of invalid routes and alert them to request new routes using RREQ.

Merits of AODV:

1) No loop formation
2) Less routing overhead
3) Optimal multicast

Demerits of AODV:

1) Bi-directional connection required to support unidirectional link
2) Introduce delay during route discovery

B) Destination-Sequenced-Distance-Vector (DSDV) routing protocol:

DSDV is a proactive protocol and use the bellman-ford algorithm to find the best shortest path among the all the available paths. Each node periodically exchange own routing information with the all neighbour node sets in the network. The advantage of DSDV over wired distance vector protocols is that it guarantees routes with no loop formation. DSDV uses the concept of sequence number to indicate the freshness of a route. Each node received the route update message from one of its neighbour and update own routing information according to the sequence number, updates are made only when the sending node have the higher sequence number than receiving node. If the sequence numbers are same then route with minimum hop count is considered as fresh route and make changes in its routing table [8].

In order to reduce the amount of overhead generated due to periodic updates there are two types of update packets are used, Full dump and incremental dump. the full dump packets all the available routing information whereas incremental dump packet stores the information changed since last full dump. DSDV basically is distance vector with small degree of adjustments makes it suitable for Ad-hoc networking [7,9].

Merits of DSDV:

1) Guarantees loop free paths reduce the count-to-infinity problem.
2) Use of incremental update packets reduces the network overhead.
3) DSDV maintains the best single path to destination that saves the space in the routing table.

Demerits of DSDV:

1) Does not support multipath routing.
2) Tedious to estimate delay for routes advertising.
3) Unnecessary route advertising consumes bandwidth.

C) Optimized-Link-state-Routing (OLSR) protocol:

The proactive OLSR works on the traditional link state protocols concept for wireless Ad -Hoc networking. Due to its proactive tendency, it uses periodic updates to maintain the topological information at each node. In the link state routing methodology, the link state packet contains entire database of its neighbour list that leads large amount of control overhead, furthermore, broadcasting of these packets throughout the network which does not suit the bandwidth - constrained feature of wireless network.

One key idea is to reduce the generated overhead by limiting the number of broadcasts as compared with pure flooding process. The basic concept to employ this idea is the use of multipoint relays (MPR). MPR indicate the specific routers that can

OLSR perform three functions they are, packet forwarding, neighbour sensing and topology determination. Packet forwarding and neighbour sensing are used to gaining information about neighbours and offer an efficient way of message flooding using MPRs in the OLSR networks.

The neighbour sensing operation spread out the local information to the entire network by using routers. Topology discovery operation is carried out to calculate the routing tables and find the topological structure of the network. To handle all over routing forward broadcast messages during the flooding process. In order to reduce the size of broadcast messages, Each MPR maintains a small set of neighbours.

The protocol is scalable and suitable for dense networks. [10].

OLSR uses four types of messages they are, Hello messages, Topology Control (TC), Multiple Interface Declaration (MID) and Host and Network Association (HNA) message. Hello messages are used to collect the information about the neighbours and link stability. Control messages (TC) used to broadcast own advertised neighbours information that include at least the MPRs selector-list. Hello messages are broadcasted to only one-hop neighbour whereas TC messages are broadcasted to the entire network.MID messages are for informing to other hosts that the announcing host can contain multiple OLSR interface addresses. HNA messages provide the information regarding external routing like network and netmask addresses, so that OLSR host can consider that the announcing host can work as a gateway for the specified set of addresses [11].

Merits of OLSR:

1) Overcome the generated overhead by using the MPRs concept**.**

2) Suitable for large and dense networks.

3) Easy to integrate with existing operating systems.

Demerits of OLSR:

1) Bandwidth consuming due to constant use.

2) No guarantee of shortest path due to use of MPRs.

3) The size of routing tables increase nonlinearly and the actual packets can be blocked by control packets.

4. Simulation Setup

The performance evaluation of the routing protocols mentioned earlier was done using the discrete even simulator OPNET (Optimized Network Engineering Tools) version 14.0 [13].The simulation models in this paper were run with 30 nodes randomly distributed in an area of 1000 m × 1000 m. The nodes moved following the random waypoint mobility model with a speed of 10 meters per second and a pause time of 100 seconds. The protocols that were studied in the simulation are: DSR, AODV, OLSR,TORA .

In this paper, one profile was modeled:

Http : Image Browsing

The nodes in the MANET modeled supported a data rate transmission of 11Mbps with a power of 0.005 Watts. the profile created was applied to each of the protocols during the simulation. Figure 1 shows the simulation arrangement used in this paper.

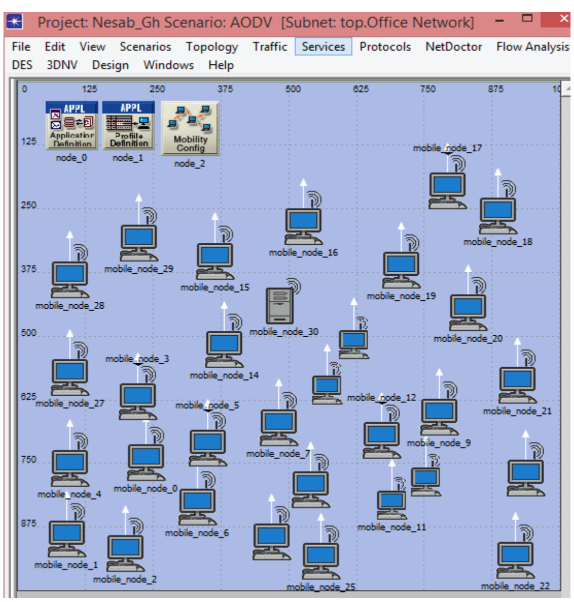

Fig.1. Simulation setup used in this study

5. Results and Discussion

In this section, the experiments results are presented and discussed. the performance analysis of the routing protocols AODV, DSR, OLSR and TORA are done according to the performance metrics cited earlier; that is based on the delay and the throughput. In terms of delay, TORA experiences oscillations due to the slow route reconstruction after a connection has been lost between nodes. Also in terms of delay, all the reactive routing protocols start to generate traffic only after a certain amount of time (simulation time); that is due to the route discovery mechanisms of reactive protocols in MANETs.

A. Delay

The performance in terms of delay of AODV, DSR, OLSR and TORA routing protocols is respectively shown Figure 2 .

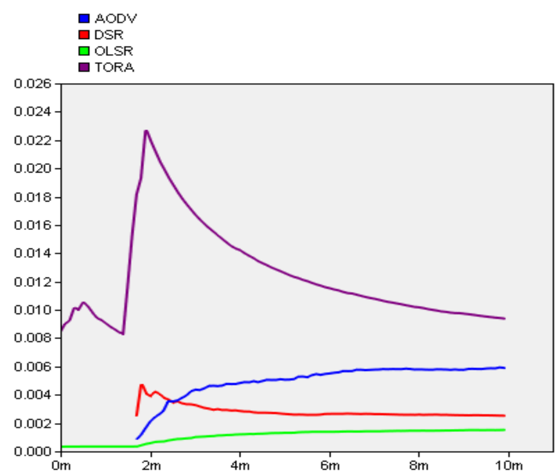

Figure 2 : Delay

Figure 3 indicate that image browsing loads, the OLSR and AODV protocols are competing for the shortest delay. The poor performance of TORA in terms of delay under image browsing load is due to fact that route rebuilding after a connection is lost may not occur as fast as in other reactive routing protocols[12] . This is due to the potential oscillations that may occur during this period. This is the basis behind the probable long delays encountered while waiting to determine the new routes. The AODV protocol has the second longer delay behind TORA; the potential long delay experienced by AODV may be the result of wrong updates that could occur if its cache does not have the exact route to the destination node.

B. Throughput

The performance in terms of throughput of the MANETs routing protocols AODV, DSR, OLSR and TORA over image browsing is respectively shown in Figure 4.

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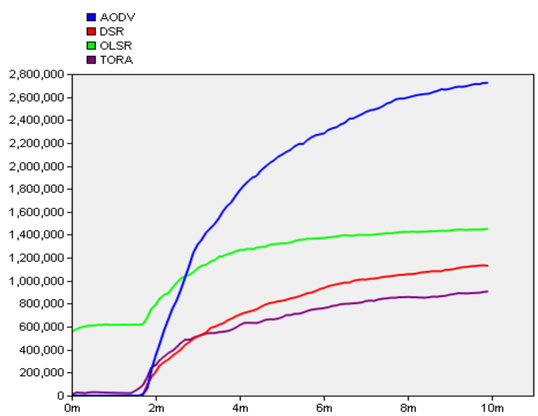

Fig.3. Throughput

Figure 3 show that the routing protocol AODV outperforms the routing protocols OLSR, DSR and TORA respectively under image browsing traffics.

6. Conclusions

From the results generated above, it can be concluded that:

- In terms of delay, OLSR competed with DSR for the shorter delay. AODV had the second longest delay behind TORA which had an extremely long delay. Still in terms of delay, it was observed that TORA oscillates and that was due to the time that TORA takes to rebuild the route after a link failure.
- In terms of throughput, AODV outperformed OLSR, DSR and TORA in all the scenarios. TORA had the lowest throughput. This is due to its route discovery process.

Future Work

The MANET modeled and designed in this paper uses the Random Waypoint as a mobility model. Further study could be done by modeling the Reference Group Point mobility model and using it as a mobility model under the same conditions as the ones used in this paper. 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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