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Performance Analysis of QOS Issues on AODV & OLSR Routing for MANETs Applications Using NS-3 Simulator

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Abstract*—Routing protocols are interesting research area in Mobile ad-hoc network. The motivation behind research work is to explain performance evaluation of routing protocol in MANETs. It is quite difficult to determine which routing protocol is best. Each routing protocol has its own advantages and disadvantages. MANET has an open medium, changing its topology dynamically due to these characteristics so it can be accessible both legitimate users and malicious attackers. An ad hoc network is a collection of wireless mobile nodes that forms a temporary network without use of a predefined infrastructure or centralized administration. In this environment it may be necessary for each wireless mobile node to convey other nodes in forwarding a packet to its destination node due to the limited transmission, limited bandwidth and limited battery power of wireless network interfaces. Nodes are connected with each other through a wireless link in ad-hoc network. Each mobile node operates not only as a host but also as a router forwarding packets for other mobile nodes in the network. The nodes are free to join and left the network due to infrastructure less wireless network. Whenever a node in the network is down or leaves the network that causes the link between other nodes is broken. The affected nodes in the network simply request for new routes and new links are established. Routing is playing important role in mobile ad-hoc network (MANETs). Routing is providing paths b/w source and destination by using routing algorithms.

***Index Terms*—MANET, AODV, OLSR, ZRP (Zone Routing Protocol), CBRP, Packet Delivery Ratio, End to End Delay, Routing Overhead, Packet Loss/Drop, NS – 3 Simulator, Quality of Services Issues**

I. INTRODUCTION

All An ad hoc network is basically a collection of wireless nodes not having a permanent network [1]. They are without any fixed infrastructure like access points or base stations. In ad hoc networks every node is willing to forward data for other nodes, and which nodes forward data is decided dynamically based on the network connectivity. The term 'ad hoc' implies that the network is structured for a special, sometimes exclusive service designed for specific applications (eg, disaster recovery, battlefield). Typically an ad hoc network is established for a finite amount of time. They are without any fixed infrastructure like access points or base stations. In ad hoc networks the communication is organized completely decentralized, unlike the communication in infrastructure based networks.

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To regulate or control the traffic there is no central authority. A node can be receiving and origination network traffic, also forwarding traffic on behalf of other nodes. And this kind of act can be performed by all nodes at the same time. The environment may change dynamically and the application can be mobile as well, so it is so obvious that topology also keeps on changing. Due to their flexibility and special nature, ad hoc networks are advantageous in different environments [2].

II. ROUTING PROTOCOL ON MOBILE AD HOC NETWORK

The existing routing protocols in MANETs can be categorized into proactive (table-driven), reactive (on-demand) and hybrid protocols. Proactive/table driven protocols find paths in advance for all source-destination pairs and periodically exchange topology information to maintain paths so that when a route is required, the route is already known and can be immediately used. In on demand/reactive protocols, the routing paths are searched only when needed [3]. A route discovery operation invokes a route-determination procedure. In a mobile ad hoc network, active routes may be disconnected due to node mobility. Therefore, route maintenance is an important operation of reactive routing protocols. Proactive protocols such as OLSR, DSDV and reactive protocols such as AODV, DSR.The hybrid network takes the advantages of each routing style. Hybrid protocols such as CBRP (Cluster Based Routing Protocol) and ZRP (Zone Routing protocol) provide the reactive/ proactive framework and take advantage of the strengths of each of these protocols [4].

A. OLSR (OPTIMIZED LINK STATE ROUTING PROTOCOL)

In a proactive protocol, within the network routes to all destinations are known and maintained beforehand. As the routing tables are available before use, its useful for several network applications as well as systems because there is no additional delay to find a new route. There is no provision for sensing of link included in the original definition of OLSR. It is assumed that a link is present if hello messages have been received form that link. It is also assumed that the links are bi-modal (i.e. working or failed), while in the case of wireless networks it is not necessary [5].

In OLSR, a very huge amount of CPU power and bandwidth is required to compute optimal paths. In the typical networks which generally dont have more than few dozen nodes, where OLSR is used, this is not a problem. Redundancy of flooding process can be a problem in some networks having large packet loss rate. OLSR reduces some redundancy by using MPR flooding.

As it is a proactive protocol, data about unused routes is propagated by OLSR using power and network resources. Whereas it is not a problem for wired access points and laptops, which make OLSR unsuitable for sensor networks [6].

OLSR is a proactive protocol, which means that the routing information is ready prior to demand. It automatically maintains its tables from time to time. So whenever some information is required, a node does not have to wait for the information repositories to be updated, the fresh information is always ready. So this consumes less time which makes OLSR a widely used ad hoc routing protocol. Since resources like memory are very cheap these days, so memory overhead is not a big issue, the only issue is time, so OLSR fits best for today's scenario[7].

The Optimized Link State Routing protocol is a point-to-point and based on periodically exchange of topology information. The key feature of OLSR uses Multi Point Relays (MPRs) to reducing the overhead of network flooding and the size of link state updates. During topology updating each node in the network selects a set of neighboring nodes those are responsible for retransmission of packets. Node which is not in the set can only read and process but cannot retransmit [8].

OLSR generally uses two types message for route update:

- Hello-Message: A Hello message is used for MPR selection and neighbor sensing procedure.
- Topology control message: A Topology control message is used for route calculation. Topology control message contains the list of the senders MPR selector. Only MPR nodes are forwarding TC message.

Route Calculation

In RFC-3626 a shortest path algorithm has been proposed for route calculation. This algorithm is however trivial. It can be outlined as:

1. Add all 1-hop symmetric neighbors to the routing table with a hop-count of equal to one.
2. For every 1-hop neighbor which is registered as symmetric, add all 2-hop neighbors registered on that neighbor which has:
- Not already been added to the routing table.
- A symmetric link to the neighbor.
- These entries are added with a hop-count two and next-hop as the current neighbor.
3. Now for each node N added in the routing table with hop-count n = 2, add all entries from the TC set where:
- The originator in the TC entry == N.
- The destination has not already been added to the routing table.
- New entries are added with a hop-count of n+1 and next-hop as the next-hop registered on Ns routing entry.
4. Increase n by one, repeat step 3 again and again until there are no entries in the routing-table having hop-count equal to n + 1
5. For all entries E in the routing table the MID set is queried for address aliases. If such aliases exist an entry is added to the routing table with hop count set to Es hop-count, and next-hop set to Es next-hop for every alias address.

B. AODV (Ad hoc on-demand distance vector)

AODV is an on-demand routing algorithm it determines a route to a destination only when a node wants to send a packet to that destination. It is a relative of the Bellman-Ford distant vector algorithm, but is adapted to work in a mobile environment. Routes are maintained as long as they are needed by the source. AODV is capable of both unicast and multicast routing. In AODV every node maintains a table, containing information about which neighbor to send the packets to in order to reach the destination. Sequence number is one of the key features of AODV routing ensures the freshness of route. AODV is a very simple, efficient and effective routing protocol for MANET which do not have fixed topology. This algorithm was motivated by the limited bandwidth that is available in the media for wireless communication. The AODV algorithm is an improvement of DSDV protocol. It reduced number of broadcast by creating routes on demand basis, as against DSDV that maintains routes to each known destination. When source requires sending data to a destination and if route to that destination is not known then it initiates route discovery. To avoid the problem of routing loops, AODV makes extensive use of sequence numbers in control packets. AODV allows nodes to respond to link breakages and changes in network topology in a timely manner. Routes, which are not in use for long time, are deleted from the table. 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. A set of predecessor nodes is maintained for each routing table entry indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node in turn forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link [9].

In AODV when a source node S wants to send a data packet to a destination node D and does not have a route to D, it initiates route discovery by broadcasting a route request (RREQ) to its neighbors. The immediate neighbors who receive this RREQ rebroadcast the same RREQ to their neighbors. This process is repeated until the RREQ reaches the destination node. Upon receiving the first arrived RREQ the destination node sends a route reply (RREP) to the source node through the reverse path where the RREQ arrived. The same RREQ that arrives later will be ignored by the destination node. In addition, AODV enables intermediate nodes that have sufficiently fresh routes (with destination sequence number equal or greater than the one in the RREQ) to generate and send an RREP to the source node [10].

III. PERFORMANCE EVALUATION OF OLSR AND AODV ROUTING PROTOCOL

OLSR and AODV Routing Protocol is simulated on NS-3 Simulator for MANET Environment. Here we have calculated the performance of AODV and OLSR by using different performance criteria of Quality of Services issues such as Routing Overhead, Packet Delivery Ratio, Average

End-to-End Delay and Packet Loss viaNS-3 simulation as shown in table 3.1.

A. Quality of Services Issues

Packet Delivery Ratio/Packet Delivery Fraction: Packet Delivery ratio is measured by dividing the total received packets to the destination by total sent packets. It describes packet loss rate. When more PDR it means routing is efficient [11].

Routing Overhead: The routing overhead describes how many routing packets for route discovery and route maintenance need to be sent. Routing overhead is the total number of routing packets divided by total number of delivered packets

Packet Loss/Drop: Packet loss calculated by subtracting total receives packets from total send packets. Some packet may be dropped any error condition in the network

Average End-to-End Delay: Average end-to-end delay is measured by subtracting sending time from receiving time for each received packets. End-to-End delay includes all the possible delay such as buffering for route discovery process, queuing processing at the interface queue, propagation and transfer times[12].

B. Simulation Results

I have calculated Packet Delivery Ratio, Routing Overhead and Average End-to-End Delay for AODV and OLSR via simulation.

Parameter	**Value**
Number Of Nodes mobile node	30
Traffic Type	CBR(Constant Bit Rate)
Simulation Area	1000X1000 meter
Size of Packet	1000 Bytes
Mobility Model used	Random Way Point Mobility
Routing Protocol	OLSR, AODV
Speed of mobile node	10 m/s
Pause of node at a random walk	2 sec

Table 3.1: Simulation Parameter Setup

Routing Protocol	Data Packets	Control Packets	Routing Over Head (%)	Average Delay(sec)
AODV	99	495	83.33	.0013
OLSR	99	1701	94.50	.0009

Table 3.2: Simulation results of AODV and OLSR

Speed(m/s)	AODV (PDR %)	OLSR (PDR %)
20	100	100
40	97.92	96.46
60	97.76	94.90
80	98.38	97.45
100	98.93	98.70

Table 3.3: Simulation results of PDR with speed(m/s)

A. Analysis of Results

Performance Evaluation of routing protocol gives applicability and helps to identify which protocol is best suitable for a given scenario. I have calculated Packet Delivery Ratio, Routing Overhead and Average End-to-End Delay for AODV and OLSR via simulation.

1) Routing Over Head

AODV routing protocol has less routing overhead comparison to OLSR because AODV only maintains active route information in the network. While nature of OLSR is proactive and each node maintains topology information of other nodes in the network. OLSR routing has more control traffic volume. AODV has less routing overhead comparison to OLSR because OLSR uses Multi Point Relay (MPR) for transmission. We need more requirement bandwidth, power and storage for OLSR comparison to AODV.

2) Average End-to-End Delay

Average End-to-End Delay tells possible Delay in the network b/w source and destination node and also provides quality of communication. OLSR routing are proactive nature it means all routes are available at all times. While in AODV routes are determined when needed. So OLSR has low delay than AODV. Because AODV takes time to decide the route.

3) Packet Delivery Ratio

Packet Delivery Ratio higher represents the better communication reliability. We can see AODV routing has more PDR comparison to OLSR. Because re-routing is less in AODV routing. When we increase mobility speed the lots of links are breaks and affect the packet delivery ratio.

IV. CONCLUSION

We have examined the performance of AODV and OLSR by varying different simulation parameter and measuring the performance metrics such as Packet Delivery Ratio, Average Delay, and Routing overhead. From this comparison each routing protocol has its own advantage and disadvantage. For proactive routing protocol such as OLSR, each node maintains up-to-date routing information in the network. So connection setup times are fast. But these routing protocols have large amount of routing overhead in the network due to periodic update message. On demand routing protocol such AODV reduces the traffic needed for routing but introduces delay due to route discovery process on demand. AODV routing protocol is highly adaptable in changing network topology.

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