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Performance Analysis of AODV & OLSR for MANET

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Abstract

Mobile Ad-hoc Network (MANET) is a collection of wireless mobile nodes which dynamically forms a temporary network without the use of any existing network infrastructure or centralized administration. Recently a tremendous growth in the sales of laptops, handheld computers, PDA and portable computers and mobile devices. These smaller computers nevertheless can be equipped with megabytes/gigabytes of disk storage, high-resolution color displays, pointing devices and wireless communications adapters. Moreover, since many of these small computers operate for hours with battery power, users are free to move without being constrained by wires. To support such type of scenario MANET has been designed. MANET has several characteristics such as, dynamic topologies, bandwidth-constrained, variable capacity links, energy constrained operation and limited physical security. There are three types of routing protocols in MANET such as Proactive, Reactive, and Hybrid. This paper presents a performance comparison of proactive protocol such as OLSR(Optimized Link State Routing Protocol) and reactive protocols such as AODV(Ad Hoc On-demand Distance Vector) based on metrics such as packet delivery ratio and average end-to-end delay and routing overhead by using the NS-3 simulator.

Keywords: *MANET, AODV, OLSR, packets delivery ratio, end-to-end delay, Routing overhead.*

1. INTRODUCTION

In ad hoc networks the nodes themselves are responsible for routing and forwarding of packets. If the nodes have moved out of range from each other, and therefore are not able to communicate directly, intermediate nodes are needed to make up the network in which the packets are to be transmitted. A mobile ad hoc network (MANET) is a collection of wireless nodes that can be set up dynamically anywhere and anytime without using any pre-existing network infrastructure. In mobile ad hoc networks where there is no infrastructure support as is the case with wireless networks, In order to make that multi hop network operational the self-configuring and self-organizing mechanisms must be introduced to the routing protocols. The basic idea of routing protocol for ad hoc network is to announce a new node presence and listen to broadcast announcements from its neighbors. The way how the node learns about new neighboring nodes it based on the path discovery algorithms and characterizes particular routing protocol. To be effective, routing protocols have to keep the routing table up-to-date and reasonably small, choose the best route for given destination by using in terms of number of hops, reliability, and routing overhead and converge within an exchange of a small amount of messages. When link failures occur in MANET, it important for the routing protocol to detect and restore routing paths to minimize packet loss. MANETs provide an emerging technology for civilian and military applications.

Though traditionally wired network used to get network or internet access the use of wireless technology has become a more popular technique currently to access the Internet or connect to the local network for a corporate, educational or private Users. It is much easier and less expensive to organize a wireless network compared to a conventional wired network, as the required effort and cost of running cables are negligible

One of the important research areas in MANET is establishing and maintaining the ad hoc network through the use of routing protocols. Though there are so many routing protocols available, this paper considers AODV and OLSR for performance comparisons are analyzed based on the important metrics such as packet delivery ratio, average end-to-end delay and routing overhead presented with the simulation results obtained by NS-3 simulator [1].

2. Description of ad hoc routing protocols

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 [5]. In on demand/reactive protocols, the routing paths are searched only when needed. A route discovery operation invokes a route-determination procedure. [3] 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.

2.1 Ad hoc on-demand distance vector (AODV)

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.[2] 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 does 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. [2]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.

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.

2.2 Optimized Link State Routing (OLSR)

The Optimized Link State Routing (OLSR) is a table-driven, proactive routing protocol developed for MANETs. It is an optimization of pure link state protocols in that it reduces the size of control packet as well as the number of control packets transmission required. OLSR reduces the control traffic overhead by using Multipoint Relays (MPR), which is the key idea behind OLSR routing. [3]A MPR is a node's one-hop neighbor which has been chosen to forward packets. During each topology update, each node in the network selects a set of neighboring nodes to retransmit its packets. This set of nodes is called the multipoint relays of that node. Any node which is not in the set can read and process each packet but do not retransmit. To select the MPRs each node periodically broadcasts a list of its one hop neighbors using hello messages. From the list of nodes in the hello messages, each node selects a subset of one hop neighbors which covers all of its two hop neighbors.

Generally, two types of routing messages are used in the OLSR protocol a HELLO message and a topology control (TC) message. A HELLO message is the message that is used for neighbor sensing and MPR selection. In OLSR each node generates a HELLO message periodically. A node's HELLO message contains its own address and the list of its one-hop neighbors [4]. By exchanging HELLO messages each node can learn a complete topology up to two hops. HELLO messages are exchanged locally by neighbor nodes and are not forwarded further to other nodes. A TC message is the message that is used for route calculation. In OLSR each MPR node advertises TC messages periodically. A TC message contains the list of the sender's MPR selector. In OLSR, only MPR nodes are responsible for forwarding TC messages. Upon receiving TC messages from all of the MPR nodes, each node can learn the partial network topology and can build. In case there are multiple choices the minimum set is selected as an MPR set.

3. Performance Evaluation of Routing Protocol

Routing concepts is basically includes two process first determining the optimal path and second is forwarding information. It is difficult to say which routing protocol is efficient and optimal under different network scenario such node density, traffic load and mobility speed [2]. Here I have evaluated the performance of AODV and OLSR by using different performance metrics such as Routing Overhead, Packet Delivery Ratio, Average End-to-End Delay and Packet Loss via simulation. I have created a network with following Simulation parameter for performance evaluation of routing protocol shown in table 3.1.

3.1 Performance Metrics

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 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.

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.

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.

3.2 Simulation Parameters:

Parameter	Value
Simulator	NS-3
Number Of Nodes	30
Simulation Time	100 sec
Traffic Type	CBR(Constant Bit Rate)
Simulation Area	1000X1000
Packet Size	1000 Bytes
Mobility Model	RandomWayPointMobilityModel
Routing Protocol	OLSR, AODV
Application used	On Off Helper
Speed, Pause	10 m/s,2 sec

Table 3.1: Simulation Parameter Setup

3.3 Simulation Results and analysis:

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.

3.3.1 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. MPR feature in OLSR that reduces unnecessary retransmissions in the network.

Routing overhead of AODV and OLSR shown in table 3.2

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

Table 3.2: Simulation results of AODV and OLSR

3.3.2 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 is 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 make route. Average end-to-end delay of AODV and OLSR shown in table 3.2.

3.3.3 Packet Delivery Ratio: Packet Delivery Ratio higher represents the better communication reliability. 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.

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

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

4. 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, Routing overhead. From this comparison each routing protocol has its own advantage and disadvantage .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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