IMPROVED ROUTING PERFORMANCE USING BANDWIDTH ESTIMATION IN MANET

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Abstract - Mobile Ad hoc Networks (MANETs) are dynamically formed, infrastructure-less, flexible networks. The performance deteriorates due to the unstable traffic conditions, network connectivity issues, mobility and limited resources. To increase MANETs performance metrics, various cross-layering approaches are performed where different OSI layer information are exchanged. Studies have shown that AODV is a most suitable distance vector proactive routing algorithm. In my research a modified version of AODV routing protocol, based on route discovery is investigated by using Physical Layer information instead of the minimum hop count method of the default distance vector algorithm. Altering the interactions between layers by cross layering has been shown to increase performance in certain scenarios of MANETs. This makes a way to cross-layer approach. In the proposed scheme, AODV protocol is used to exploit physical information such as bandwidth at the MAC layer in order to find out the suitable route for different application data. It will be proved that cross-layering between MAC and Network layer outperforms much better than using MAC and Network layer in OSI layer separately.

Keywords - Ad hoc on-demand distance vector (AODV) routing, mobile ad hoc networks (MANETs), quality of service (QoS).

I. INTRODUCTION

Mobile ad hoc network (MANET) consisting of mobile hosts only has much more demand recently. In MANET, the nodes themselves are responsible for routing in discovery process and for forwarding of packets. If the topology changes suddenly and if nodes are not able to communicate to each other directly, intermediate nodes are used to make up the network in which the packets are to be transmitted. Examples of MANETs include emergency operations where there is no need of infrastructure and also critical military operations where the existing infrastructure is not secured. The design of efficient routing protocols is a critical issue for MANET having no fixed topology. Therefore, the source-initiated on demand routing protocol, which establishes the route between the source and the destination only when the source demands that, becomes the most popular routing protocol in the MANET. In this paper, we are going to propose the cross layering between MAC and Network layer for estimation of bandwidth of a node in MANET.
Cross Layering between MAC and Network Layer will use Hello and LISTEN bandwidth estimation methods

II. SELECTION OF ROUTING PROTOCOL AND BANDWIDTH ESTIMATION SCHEMES

A. Selecting Routing Protocol: AODV

The table driven proactive routing protocols have the advantage of having an available route always ready to the destination. But it comes with cost of consuming a big part of the bandwidth resource, most of which may not even be used. Thus, an appropriate routing protocol for MANETs should imply a reasonable over-head in order to preserve the limited bandwidth. Message complexity must be kept very low. On the other hand, the reactive routing protocol reduces the overhead traffic by creating a route only when it is required. When a route is no longer used in reactive protocols, it is simply expunged from the routing table. For these reasons reactive protocols are of more interest for the MANET.

B. Selecting Bandwidth Estimation Schemes

In MANET, a host's available bandwidth refers to amount of bandwidth available to the node to send packets to the network. Many researchers have proposed different methods for Bandwidth estimation.

Lei Chen and Wendi B. Heinzelman [7] proposed a QoS-aware routing protocol that incorporates an admission control scheme and a feedback scheme to meet the QoS requirements. This routing protocol use of the approximate bandwidth estimation. There are two phases in QoS routing protocol. The route discovery phase and the bandwidth phase. In the route discovery phase, feasible route is discovered using AODV routing protocol and the minmax approach to choose the route that is most likely to satisfy the QoS requirement. In the bandwidth reservation phase, according to how many neighbouring hosts' free time slots are blocked by this time the weight of each available time slot is calculated by the hosts in the chosen path. There are two scheme in proposed QoS-aware routing protocol, first one is feedback scheme that provides feedback about the available bandwidth to the application and second one is admission scheme that admits a flow with the requested bandwidth. Knowledge of available bandwidth along the route is required for both schemes. So they focused on exploring different ways to estimate the available

bandwidth, incorporating QoS. It is must to know available end to end bandwidth along a route. By estimating the bandwidth QoS can be provided. This can be achieved by finding the minimal residual bandwidth available among the hosts in that route. For bandwidth estimation they used two methods.

- Listen Bandwidth Estimation
- Hello Bandwidth Estimation

III. AODV BASED ON BANDWIDTH INFORMATION

During Route discovery process, source node sends Route Request with the Bandwidth Option in reserved field of Route Request Packet as shown in fig. 1. Intermediate or Destination nodes calculate bandwidth at respective nodes and send the request further by embedding bandwidth calculated in reserved field if required by topology. AODV route reply is sent to those nodes which has maximum bandwidth estimated. Thus, Route Discovery is done using AODV with estimated bandwidth prior to actual packet transmission.

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 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |R|A|    Reserved     |Prefix Sz|   Hop Count   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Destination IP address                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Destination Sequence Number                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Originator IP address                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Lifetime                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Fig. 1. AODV Route Reply Packet Format

C. Listen Bandwidth Estimation

For hosts to listen to the channel and estimate the available bandwidth every second based on the ratio of free and busy times. The IEEE 802.11 MAC utilizes both a physical carrier sense and a virtual carrier sense [via the network allocation vector (NAV)], which can be used to find out the free and busy times. The MAC detects that the channel is free when the following three requirements are met [18] and [19]:

- NAV's value is less than the current time;
- Receive state is idle;
- Send state is idle.

The MAC declares that the channel is busy when one of following occurs:

- NAV sets a new value;
- Receive state changes from idle to any other state;
- Send state changes from idle to any other state.

Bandwidth Calculation:

$$Bav = Bm - Bu \quad (1)$$

Bav is the available bandwidth, Bm is maximum possible bandwidth and Bu is bandwidth used in network utilization. e As 802.11 MAC also utilizes some bandwidth in DIFS, SIFS and back off scheme as over- heads, these must be taken into consideration in calculation of available bandwidth as shown in equation 1. These overheads restrict the MAC scheme to fully utilize the available bandwidth for data transmission.

D. Hello Bandwidth Estimation

The sender's current bandwidth consumption as well as the sender's one-hop neighbours' (from its two-hop neighbours) current bandwidth consumption is piggybacked onto the standard "Hello" message. Each host estimates its available bandwidth based on the information provided in the "Hello" messages and knowledge of the frequency reuse design [18] and [19].

The second neighbouring host's information was proposed by using hop relay to propagate [18]. AODV uses the "Hello" messages to update the neighbor caches. The "Hello" message used in AODV only keeps the address of the host who initiates this message. Modify the "Hello" message, including two fields. The first field includes host address, consumed bandwidth, timestamp, and the second field includes neighbor's addresses, consumed bandwidth, timestamp. Each host finds out its used bandwidth by monitoring the packets it supplies into the network. This value is recorded in a bandwidth-consumption register at the host and is updated periodically.

IV. PROPOSED MODEL

The proposed model determines the channel side information available in terms of calculated bandwidth in packet transmission during the route discovery process and the flow of the proposed model is shown in fig. 2.

The following steps show the route discovery process of the proposed Bandwidth based AODV:

- If there is no route entry, Source node sends RREQ message to its neighbours.
- Node calculates Bandwidth from MAC/Data link Layer and adds value in reserved field of RREQ.
- Destination node receives multiple RREQ and identifies Maximum Bandwidth (MAXBW) index of neighbour and node sends RREP only to those MAXBW node index instead of comparing hop-count

value. So only those paths would have been chosen for which bandwidth is maximum.

- In order to execute above step, each intermediate node will have to acquire the bandwidth information from MAC/ Data link Layer. So information from MAC /Data link layer would be transferred to Network/Routing Layer.
- Finally, the RREP will reach to Source Node and source node start transmission of packets containing data.

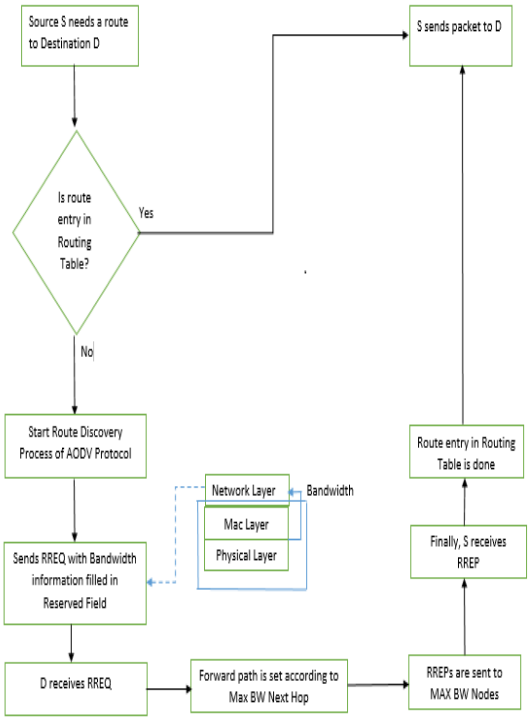

Fig. 2. Flow of the Proposed Model

V. SIMULATION AND RESULTS

Network Simulator NS2 tool was used for the simulation purpose of the research. Different traffic scenarios were simulated to observe the performance of the Bandwidth based AODV. Some of the simulation scenarios are presented in this section.

TABLE I. MANET Simulation parameters

Parameters	Value
Nodes	50
Traffic	UDP
Protocol	AODV (default and Proposed)
MAC	IEEE 802.11
Hello Interval	1ms

The NS2 simulation done for both standard AODV protocol and Proposed model of AODV using bandwidth estimation. Following test results show the performance increase in various network parameters such as packet delivery ratio, delay, packet retransmission and throughput.

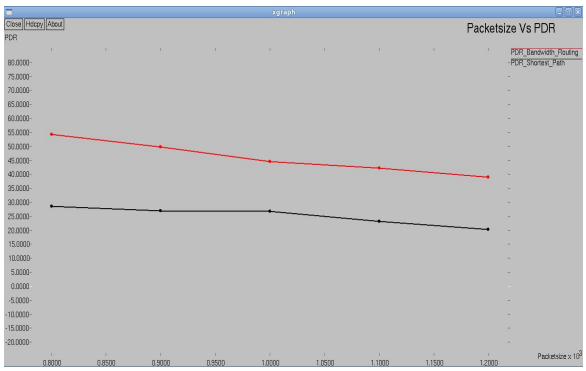

Fig. 3a. Comparison for Packetsize Vs PDR

PDRcan be defined as the ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the source. As we can see in the following graph in Fig.3a. that PDR increases in Bandwidth Routing more than Shortest Path Routing.

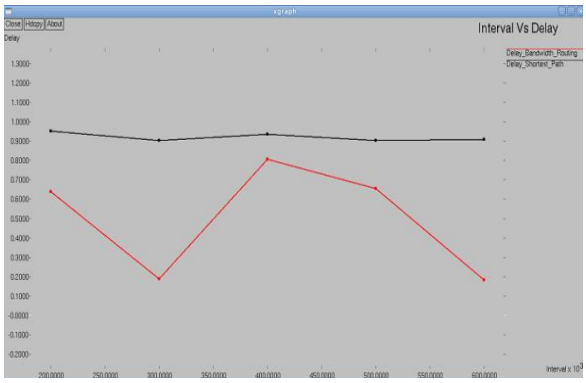

Fig. 3b. Comparison for Interval Vs Delay

Delay is calculated at various Routing intervals and it can be seen from the below graph in Fig.3b. that Packet delay in Bandwidth Routing is much smaller than Packet Delay of the Shortest Path Routing.

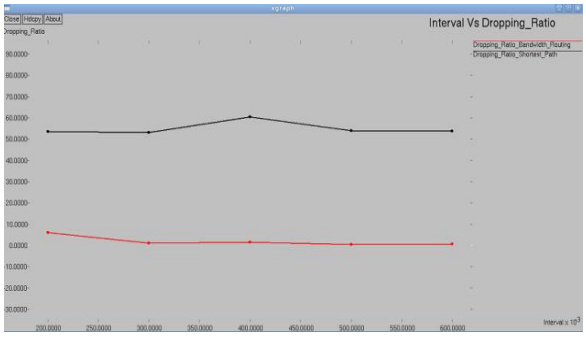

Fig. 3c. Comparison for Interval Vs Packet Dropping Ratio

Packet Dropping Ratio is calculated at various Routing intervals and it can be seen from the below graph in Fig. 3c. that Packet Dropping Ratio in Bandwidth Routing is much smaller than that of the Shortest Path Routing.

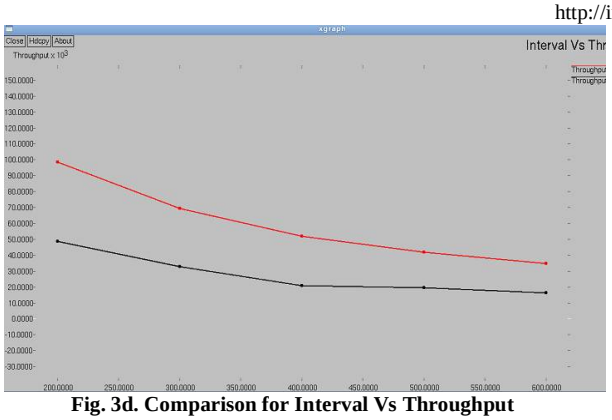

Fig. 3d. Comparison for Interval Vs Throughput

Throughput is calculated at various Routing intervals and it can be seen from the below graph in Fig. 3d. that Throughput in Bandwidth Routing is much greater than that of the Shortest Path Routing.

Finally, Considering various packetsize, final performance is plotted as shown in following Bar Graph in Fig. 4. which clearly shows that network peformance in terms of routing parameters such as PDR, Dropping ratio, Routing overhead and Throughput increases using proposed Bandwidth Routing as compared to traditional Shortest Path Routing using AODV.

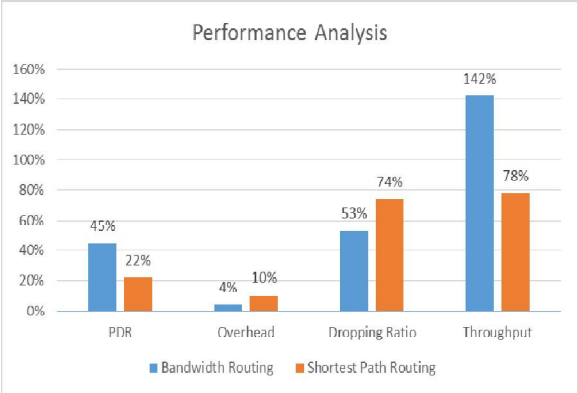

Fig. 4. Overall Performance Analysis

CONCLUSION AND FUTURE WORK

MANETs are flexible networks where all the nodes act as host as well as routes to deliver data. By the nature and the architecture, the performance is affected by various channel conditions, network connectivity, mobility and resource limitations. Various cross-layering approaches are implemented to improve the performance of MANETs and their associated routing protocols. Our research investigated a modified version of AODV routing protocol utilizing Physical Layer information in terms of Bandwidth. The proposed model uses the calculated bandwidth to find its route instead of the default AODV protocol where minimum hop count is considered. The simulation of proposed AODV shows performance improvement than default AODV.

We will do further research in the system as, to provide user an efficient, QoS oriented network which has strong security mechanism for sensitive information. In further research we will also consider link feedback of MAC which will help us to decrease the bandwidth usage at MAC layer which could be utilized by an application.

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