Bandwidth-Aware AODV based Routing Protocol in MANETs

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***Abstract*— A wireless ad hoc network is a collection of mobile nodes that dynamically form a temporary network and communicate with each other without any physical networking infrastructure . Many real time applications have quality of Service (QoS) requirements like bandwidth, end-to-end delay and jitter. So,to support these applications it is important to have QoS mechanism. In this paper we propose a bandwidth-aware routing protocol, which is based on the reactive ad-hoc distance vector (AODV) routing protocol therefore we named it BA-AODV protocol. In this Protocol, we include one of the important issue of ad hoc networks which is the bandwidth where the bandwidth-aware route discovery process discover a route in which each intermediate node has bandwidth greater than the required bandwidth. We compare our proposed bandwidth-aware AODV routing (BA-AODV) protocol to the existing traditional AODV routing protocol. The simulation results show the effectiveness and correctness of our proposed method in terms of increased network load in the scenarios consisting of mobile nodes as well as static nodes.**

***Keywords*— MANET, QoS, Bandwidth Aware Routing, AODV, SAC, CLM.**

I. INTRODUCTION

A wireless ad hoc network is a collection of mobile nodes that dynamically form a temporary network and communicate with each other without any physical networking infrastructure[1] . Each node can serve as both host and router. MANET is best suited for tactical networking application due to its self forming and infrastructure less nature. MANET nodes rely on multihop communication. That is, nodes within each other's transmission range can communicate directly through radio channels, whereas those outside the radio range must rely on intermediate nodes to forward messages toward their destinations. Whenever Mobile nodes want they can move, leave, and join the network whenever they want, and routes need to be updated frequently because of the dynamic network topology[2]. This is illustrated in Figure 1.Suppose, node C wants to communicate with node A. At time *t*1, the routing path is C→E→A. At time *t*2 (>*t*1), node E moves out of range of node C. Because of this, the changed route for node *B* at time *t*2 is C→B→A.

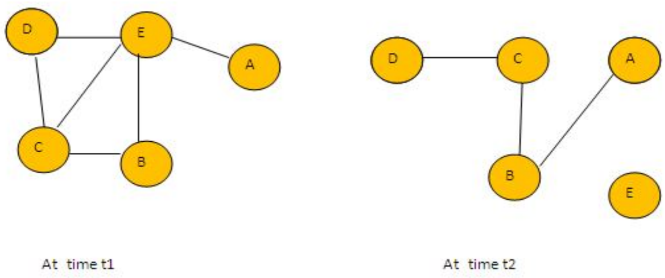

Fig. 1 Mobility of Node's

II. QOS IN MANETS

Due to rapid growth in the use of applications, such as tactical network, online gaming, disaster recovery services, voice-over IP (VoIP), and other multimedia streaming applications in MANETs. These applications have need of Quality of Service (QoS) parameters such as: minimum transmitted energy path, bandwidth, throughput and power for reliable delivery of data[3,4]. It is more challenging to provide the QoS guarantees in wireless networks than in wired networks. Because wireless networks have dynamic topology, interference, multihop communication, and contention for channel access. So for routing protocols, it is important to provide QoS guarantees such as achievable throughput, delay, packet loss ratio, and jitter. A set of service requirements that should be satisfied by the network when routing is performed, is defined as QoS in MANETs. Set of measurable requirements are maximum delay, minimum bandwidth, minimum packet delivery ratio, and maximum jitter. The network has to ensure that the QoS requirements of the data session are satisfied throughout the connection duration by checking all the QoS metrics at the time of connection establishment, and once a connection is accepted. The above-mentioned QoS metrics are used by applications to specify their QoS requirements. QoS requirements can be defined in terms of a set of metrics. For example, a network topology is displaying in which an application at node *A* has certain bandwidth (*BW* >= 5 kbps) and delay (*D* <= 5 ms) requirements. A route (*A*→F→*G*→H→E) is selected by QoS-aware routing protocol that satisfies the QoS requirements of the application instead of selecting the shortest path (*A*→B→D→E). Providing a multiconstrained QoS aims at optimizing multiple QoS metrics while provisioning QoS over MANETs and is, literally, a complex task.

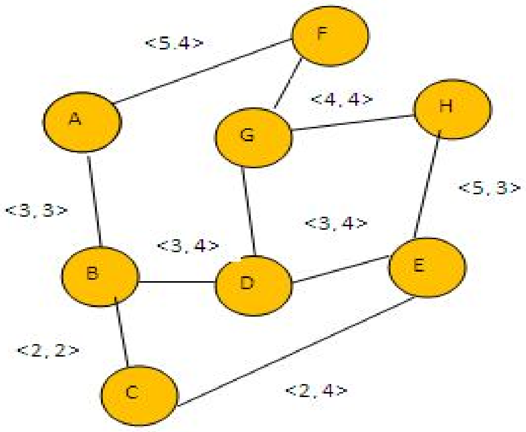

Fig.2 Bandwidth aware routing in MANET

Tuple <BW,D>

III. AODV PROTOCOL

Perkins and E. Royer [5] proposed Ad hoc On Demand Distance vector Routing (AODV).It is table-based and reactive routing protocols. AODV uses a broadcast route discovery mechanism. AODV relies on dynamically establishing route table entries at intermediate nodes. Each Host works as a router and obtain routes as needed. There is no requirement of periodic routing advertisements. So AODV provides loop free routes even while repairing broken links. This protocol uses bandwidth efficiently by minimizing the network load for control and data traffic is responsive to changes in topology and ensures loop free routing. They maintained most of the advantages of basic distance vector routing mechanism. AODV avoids problems with previous and has the following features:

- the routes are stored only when needed
- Reduces memory requirements and needless duplications
- Quick response to link breakage in active routes

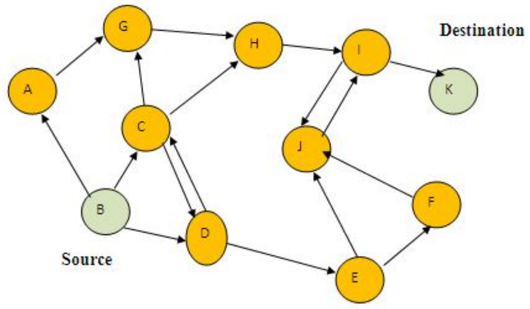

fig 3 AODV route discovery(Propagation of RREQ)

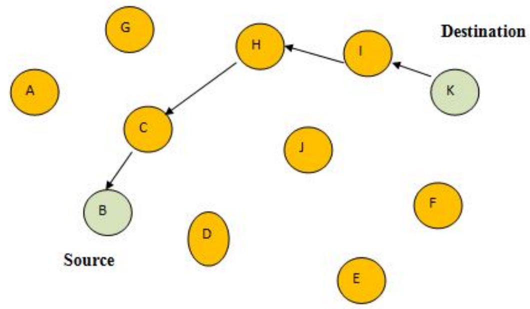

Fig 4 AODV route discovery(Propagation of RREP)

IV. PROPOSED METHODOLOGY

Our proposed bandwidth-aware routing protocol is based on the reactive ad-hoc distance vector (AODV) routing protocol therefore we named it BA-AODV protocol. The proposed methods also uses two components called Session Admission Control (SAC) and Cross-layer Communication Module (CLM) that works together for the correct working of the proposed BA-AODV routing protocol. The MAC specification[6,7,8,9] used for the formation of MANETs is 802.11.

A. Session Admission Control (SAC)

The SAC process is used to admit or deny the admission of a requesting data session with specified bandwidth requirement into the network based on the current bandwidth of the underlying wireless network. The SAC process only admits a flow into the network if the network has enough bandwidth to support the given bandwidth requirements of the requesting flow and the admission of this flow will not degrade the performance of already admitted data sessions in the network. Figure 5 shows the working of a SAC process in the proposed BA-AODV routing protocol.

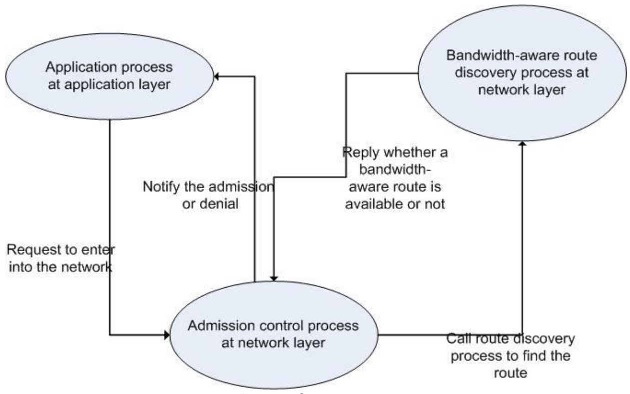

Fig .5 Working of a SAC process

B. Cross-layer Communication Module (CLM)

On the other hand, the CLM process is used to perform the cross-layer communication between the different layers which is required to perform the correct session admission control and also provide the required information from the various other layers to the layer that requires that information. In our proposed method the cross-layer communication module is used for two cross-layer communications that are as follows: a) The CLM asks the required bandwidth from the application process that wants to admit into the network. This is done so that now the route discovery process can use this information to find the routes between the source-destination pair so that all the nodes on the discovered route have the bandwidth greater than the given required bandwidth of the requesting application. b) The CLM process also communicates with the physical layer to calculate the local available bandwidth (band_local) of a node and sent this information to the route discovery process so that it can search for the routes that have enough bandwidth to take part into the route discovery process. Figure 6 shows the working process and role of cross-layer communication process in our proposed routing protocol i.e., BA-AODV

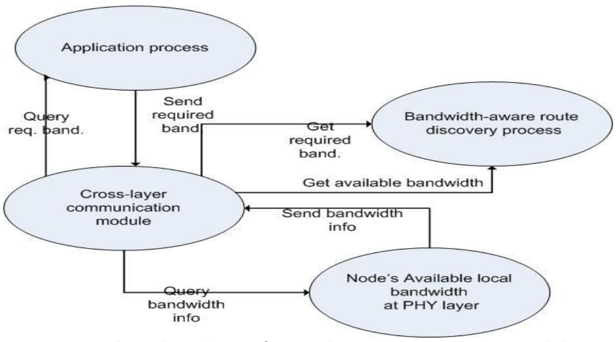

Fig. 6 Role and working of Cross-layer communication module

C. Proposed Algorithm

Algorithm 1 Working process of proposed bandwidth-aware routing protocol

Variables Used
S = Source Node
D = Destination Node
I = Intermediate Node
RT = Routing table of a node
TBW_req = Total required bandwidth of a requesting application
Band_local = Local available bandwidth of a node
IF1 (S receives a DATA packet)
S has a bandwidth-aware route in its RT, S transmits the data packet
ELSE1
S initiates the route discovery process by initiating the RREQ message
ENDIF1
IF2 (I receive a non-duplicate RREQ message)
IF3 (I (band_local) > REQ_bwd1)
I rebroadcast the RREQ message
ELSE3
I discard the RREQ message
ENDIF3
ENDIF2
IF4 (D receives a RREQ message)
D initiates a RREP message by setting REQ_bwd2 = REQ_bwd1 and BWD_OK = TRUE
ENDIF4
IF5 (I receives a RREP message)
IF6 (I (band_local) > REQ_bwd2)
I forward the RREP
ELSE6
I set the BWD_OK = FALSE and forward the RREP
ENDIF6
ENDIF5

V. SIMULATION RESULTS

We present the details of the simulations that we perform to evaluate the performance of our proposed protocol which refers to the BA-AODV protocol. We use Qualnet as a network simulator. The following results were obtained from the simulation.

A. Average End –to – End Delay

Figure 7 shows the average end-to-end delay with the increase in network data load over MANETs consist of static nodes only for AODV and BA-AODV routing protocols. The end-to-end delay is calculated at destination node by adding the delay of each individual data packet and divide it with the total number of data packets received at the end of the data session. As it can be seen from Figure 7 that the delay of both the routing protocols increases with the increase in the network load. Although the delay of our proposed BA-AODV routing protocol is smaller than AODV protocol

In figure 8, we can see the results for end-to-end delay for both the comparing protocols i.e., BA-AODV and AODV with the increased network load in a mobile scenario. As it can be seen from Figure 8 that the delay of both the protocols is increased as compared to their delay in the static network.

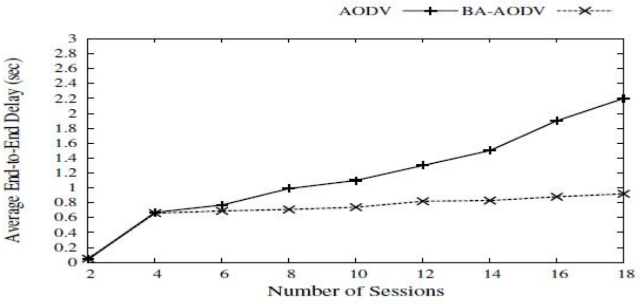

Fig. 7 Average end-to-end delay with increased network load (Static networks)

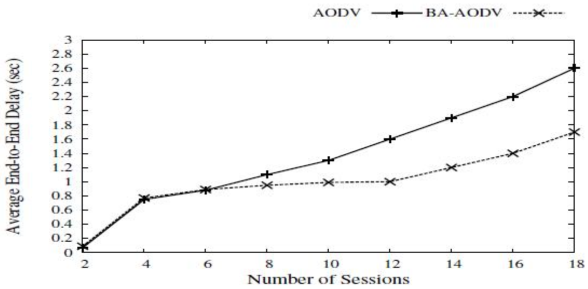

Fig.8 Average end-to-end delay with increased network load (Mobile networks)

B. Average Packet Delivery Ratio

The packet delivery ratio (PDR) of the BA-AODV and AODV routing protocols with the increased network load on both static as well as mobile networks are shown in Figures 9 and 10. It can be observed from Figures 9 and 10 that the PDR of both the comparing routing protocols decreases with the increase in the network node. Although, the PDR of our proposed BA-AODV routing protocol is not much affected with the increase in the network loads because the admission control process of BA-AODV will not allow data sessions to enter into the network if the source node is not able to find routes during the route discovery process that supports the bandwidth requirement of the requesting application.

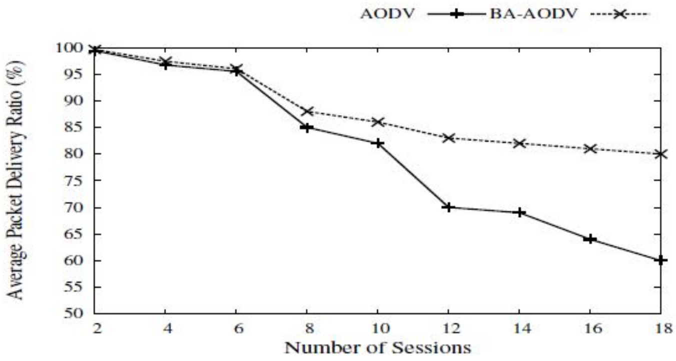

Fig. 9 Average Packet Delivery Ratio with increased network load(Static Network)

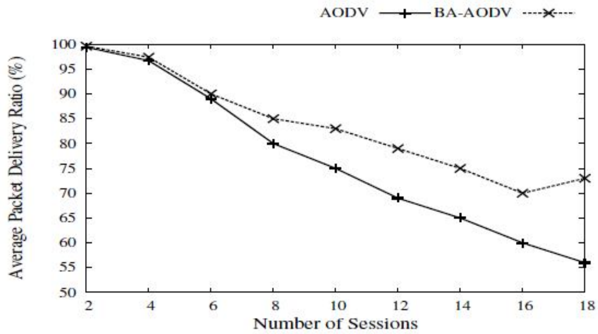

Fig.10 Average Packet Delivery Ratio with increased network load (Mobile networks)

VI. CONCLUSION

In this paper, we have presented a reactive routing based bandwidth-aware routing protocol that discover routes during the route discovery process which consists of the nodes that have local available bandwidth greater than the required bandwidth of the requesting application. Based on the results of our bandwidth-aware route discovery process a proposed session admission control process will either admit or deny a requesting application from entering into the network. In this way our admission control function makes sure that a data session is not admitted into the network if the network has not enough bandwidth to support the flow and this way the admission process also stop the degradation in the quality of the existing data flows in the network which will be degraded if a flow is entered in the network for which the network did not have enough bandwidth. The simulation results shows the effectiveness and correctness of the proposed work in terms of various metrics that includes the end-to-end delay and packet delivery ratio. Both the simulation results that are developed for the static as well as mobile wireless ad hoc network has are satisfactory for the moderate mobility network and moderate sized network.

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