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Link Based Bandwidth Aware Multipath Routing Protocol (BWA-AOMDV) in MANET.

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Abstract: *Mobile ad-hoc network (MANET) is wireless network. The Mobile ad-hoc networks (MANET) are having limited battery life and bandwidth. The multipath routing protocols establish multiple routes between the nodes. The construction of multiple routes should be done with minimum overhead and bandwidth consumption. The limited band width of wireless network is the important parameter in mobile ad-hoc network. The main objective of this paper is to develop a bandwidth aware routing protocol for mobile ad-hoc networks. The source select the primary route for data forwarding on the basis of minimal residual available bandwidth for on demand multiple disjoint path. The simulation result show that the performance of AOMDV and BWA-AOMDV using Ns2.34. It reduces the bandwidth aware average end-to-end delay, routing overhead and normalized routing overhead. it also improves packet delivery ratio and throughput.*
Keywords: *AOMDV, BWA-AOMV, Mobile ad-hoc networks, Bandwidth , Multipathcomma*

I. Introduction

The multipath routing protocols are used to provide multiple paths from source to destination. The AOMDV protocol is implemented from AODV protocol. A mobile Ad-hoc network (MANET) is an interconnection of mobile nodes by wireless links and multi hop communications without using much physical network infrastructure. Each mobile nodes are acting as a router as well as a node. The QOS (Quality of service) is important one in MANET. QOS means not only to find a route from source to destination but find a quality route depending upon residual energy and bandwidth. The single path routing protocol such as DSDV and DSR fail to fulfill the above requirements.The MANETs provide multiple routes between sources to destination to transmit the data packet. In case of route break, an alternative route can be used to send the packets towards the destination.

II. Related work

1. Ad-hoc On-Demand Multipath Distance Vector routing protocol (AOMDV)

As the AOMDV is based on static route selection, it could not handle the change of the network. such as congestion and contention. AOMDV is an extension of AODV protocol to find the multipath in route discovery process. These multipath are loop free and disjoint paths. It eliminates the frequent link failures and route breaks due to node mobility, congestion, packet collision and node failure. As the AOMDV select the static route and not change network such as congestion. D.shin et.al.,[17] proposed adaptive AOMDV resolve the problem of AOMDV through dynamic route switching method. A source node find its route dynamically based on the delay of multipath. The destination contains list of next-hop along with the corresponding hop counts in routing table entries. If all the entire next hop have the same sequence number, the advertised hop count is defined as the maximum hop count for all paths.

The route advertisement sends to destination by using the hop count value. If any duplicate route advertisement received by the node then it forwards the packet through alternative path to the destination depend up on the hop count value if it is less than the advertised hop count for the destination. When a route advertisement is received for a destination with a greater sequence number, the next hop list and hop count are reinitialized. The destination sort out all the paths by maximum hop count value. The best route is selected, then the data forwarded through this route. In AOMDV, RREQ (Route Request) propagates from source to destination to find multiple reverse paths. The corresponding RREP(Route Reply) generate and traverse these reverse paths to the source node.

2. Bandwidth Aware and power saving route:

The AOMDV protocol is finding many routes between source and destination in discovery process loop freedom and disjoints alternative Path. The channel bandwidth is utilized in order to improve the network. The power saving during route discovery and power control during data transmission are major classification for wireless ad-hoc network. The total energy consumption is reduced in power saving technique in idle listening mode [11,12] by putting the nodes in to periodical sleep in power control technique. Liang et al., designed an energy multipath routing for wireless network. This algorithm considers the remaining battery capacity. Yumei liu at al.,[20] proposed maximal minimal nodal residual energy[MMRE]in to the existing AOMDV in each route discovery phase.

III. Proposed Routing Protocol: BWA-AOMDV

3.1 Route Discovery

A Bandwidth aware AOMDV protocol is extended by modifying of AOMDV. It reduces energy consumption, maximum available bandwidth, routing overhead and average end-to-end delay. It improves packet delivery ratio and throughput. The main goal is to find energy efficient and maximum available bandwidth shortest path between source to destination.

In the source node the value of min-re-bandwidth should be assigned as maximum value such as node's initial bandwidth. When an intermediate node receive RREQ, If the sequence number of just received packet is greater than this node then it updates its residual bandwidth with min-re-bandwidth of RREQ if it is less then min-re-bandwidth of RREQ of this node.

When an intermediate node receives RREQ if the sequence number of just received packet is equal to this node, It updates its bandwidth. The route with maximum available bandwidth for any source to destination.

3.2 Route discovery algorithm

The AOMDV route update rules are illustrated in algorithm1, when a node i receives a RREQ or RREP, it updates its advertised hop count for a destination d if its sequence number is less than the sequence number of RREQ or RREP of node j.

Algorithm 1: Update the Route Rule of BWA-AOMDV

Algorithm 1 Route Update Rule of BWA-AOMDV Routing Protocol

if ($seqnum_i^d < seqnum^d_j$) **then**
$seqnum_i^d := seqnum^d_j$;
if ($i \neq d$) **then**
if ($re\_bandwidth_i < min\_re\_bandwidth^d_j$) **then**
$min\_re\_bandwidth^d_j := re\_bandwidth_i$;
end if
$advertised\_hopcount_i^d := \infty$;
else
$advertised\_hopcount^d_i := 0$;
end if
$route\_list_i^d = NULL$;
insert (j, $advertised\_hopcount^d_j + 1$, $min\_re\_energy^d_j$, $min\_re\_bandwidth^d_j$) **into** route $\_list^i_d$;
else if ($seqnum_i^d = seqnum^d_j$) **and** (($advertised\_hopcount_i^d$,i)>
($advertised\_hopcount_j^d$,j)) **then**
$min\_re\_bandwidth^d_j := re\_bandwidth_i$;
else if (($advertised\_hopcount_i^d$,i) <= H_{TM}) **then**
$min\_re\_bandwidth^d_j := re\_bandwidth_i$;
else
$min\_re\_bandwidth^d_j := re\_bandwidth_i$;
end if
else if ($min\_re\_bandwidth^d_j >= BW_{TM}$) **then**
$min\_re\_bandwidth^d_j := re\_bandwidth_i$;
end if
insert (j, $advertised\_hopcount^d_j + 1$, $min\_re\_bandwidth^d_j$) **into** route $\_list^i_d$;
end if

In route discovery process to find the minimal residual Band width of each route between source and destination node. Each RREQ and RREP carry an additional field called minimum bandwidth which gives the information about the path BWA path of multipath stored in route list.

The band width of route is The RREQ and RREP packets consist of existing information of available bandwidth of forwarding in it. The source is able to identify the bandwidth of the multipath during the discovery process by using maximum minimum approach. The path with the greatest available bandwidth as its primary path for transfer data. The source node will change its path from current primary path to alternative path if the available bandwidth is higher than the predefined to wait for its primary path break. We also proposed to modify the route request as well as route reply packet.

RREQ(proposed) = RREQ(AOMDV) + ABW (node)
where,
ABW (node) = MIN [ABW (RREQ received) , Bavail (node)]

3.3 Hello packets

In AOMDV the hello packets used to keep the address of the node .We modify the Hello packet for the new solution by adding the bandwidth information of the node sending the hello packet and neighbors of the node with their bandwidth information. Each node broadcast this hello packet periodically and update its neighbors depend up on its bandwidth.

IV. Simulation Result:

4.1 Simulation Environment

The performance of Bandwidth aware AOMDV (BWA-AOMDV) and AOMDV routing protocols are evaluated by using NS 2.34 [15] illustrate the simulation model and simulation parameters respectively.

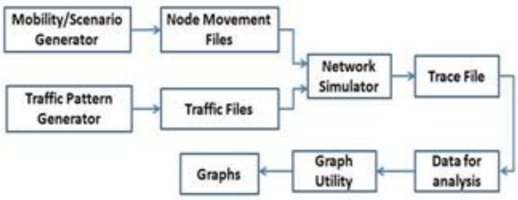

Fig.1. Simulation model

Table:1 Simulation parameters

Parameters	**Values**
Simulator	Ns 2.34
Traffic Type	CBR
Number of Nodes	100
Simulation time	100 seconds
Pause Time	50,100,150,200,250,300
Network load	4 packets/sec
Packet size	512 byte
Mobility Model	Random way point model
Routing protocols	EE-BWA-AOMDV,AOMDV
Antenna Model	Omni
Radio propagation Model	Two Ray Ground
Dimension	1000m*1000m
Speed	5,10,15,20,25
Channel Type	Wireless Channel
MAC Type	802.11
Initial Energy	100 Joules

4.2 performance Metrics Using speed.

The performance of new protocol BWA-AOMDV is evaluated using following metrics to compare the performance with the existing protocol of AOMDV. We evaluate the following metrics.
I) packet delivery fraction: The ratio of data packets delivered to the destination generated by the sources.
II) Throughput: The total amount of bytes received by the destination per unit time.
III) Normalized routing overhead: The number of routing packets transmitted per data packet towards the destination.
IV) End-to-end Delay: The average time of data packet to be sent transmitted from source to destination includes buffering, latency and interface queue etc.
V) Total Energy consumed-The summation of energy consumed by all nodes during the simulation.

Table2: Routing Overhead of AOMDV and BWA-AOMDV

Max.Speed(m/s)	AOMDV	BW-AOMDV
5	69	65
10	72	65
15	60	57
20	68	65
25	68	63

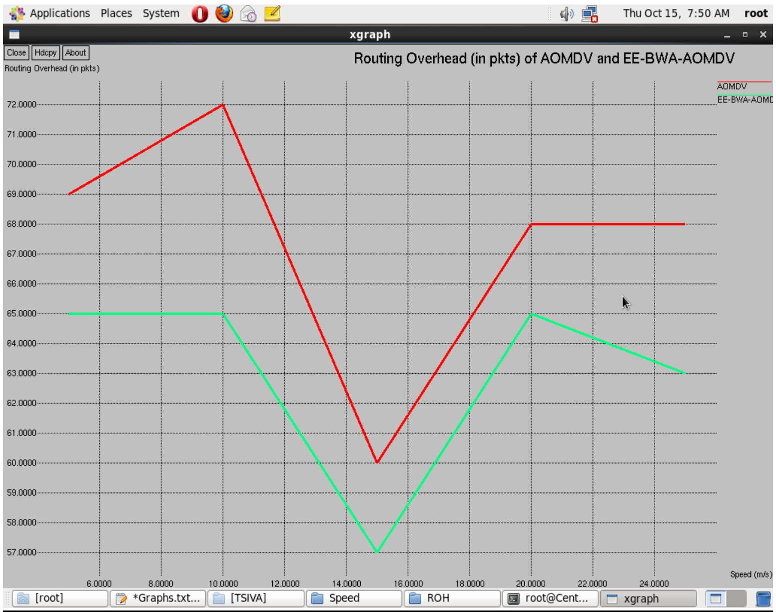

Fig:2 Routing overhead of AOMDV and BWA-AOMDV

Table 2 fig 2 represent the Routing overhead of AOMDV and BWA-AOMDV protocols. The BWA-AOMDV protocol reduces the energy and hop count routing packets.

Table3: Packet Delivery Ratio(%) of AOMDV and BWA-AOMDV

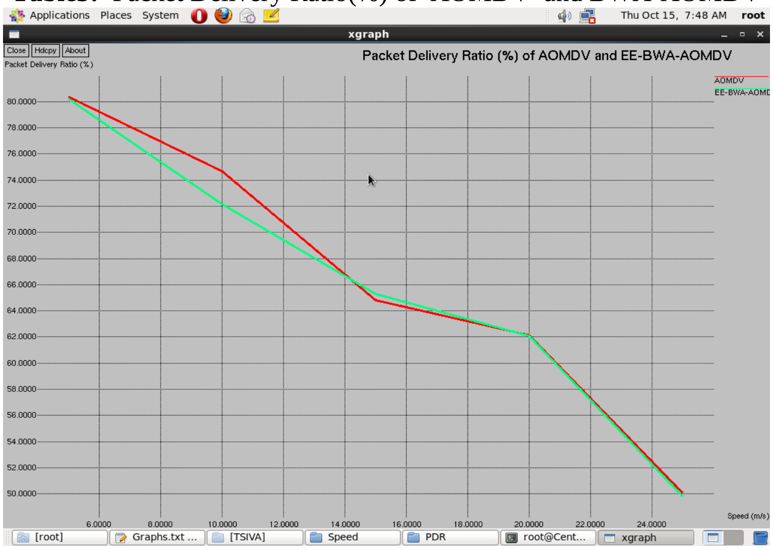

Fig:3 : Packet delivery Ratio(%) of AOMDV and EE-BWA-AOMDV

Table 3 fig 3 represents the Packet delivery Ratio (%) of AOMDV and EE-BWA-AOMDV protocols. The EE-BWA-AOMDV protocol given the better packet delivery ratio compare to AOMDV.

Table 4: Normalized Routing Overhead(%) of AOMDV and BWA-AOMDV

Max.Speed(m/s)	AOMDV	BWA-AOMDV
5	80.386	80.213
10	74.666	72.179
15	64.831	65.280
20	62.117	62.090
25	50.081	49.970

Max.Speed(m/s)	AOMDV	BWA-AOMDV
5	3.162	3.170
10	3.715	3.846
15	4.549	4.647

20	5.108	5.056
25	7.265	7.281

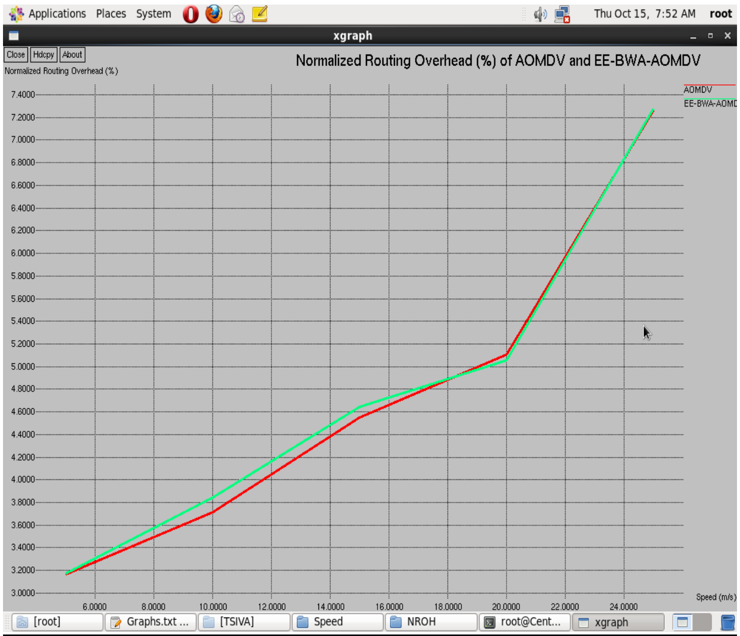

Fig 4: Normalized Routing Overhead (%) of AOMDV and BWA-AOMDV

The figure 4 represent the Normalized Routing load of AOMDV and proposed routing protocol of EE-BWA-AOMDV. The new protocol given less normalized routing load.

Table:5 Total Energy Consumed(in joules) of AOMDV and BWA-AOMDV

Max.Speed(m/s)	AOMDV	BWA-AOMDV
5	3893.9910	3631.6410
10	3670.6015	3413.3515
15	3420.2020	3065.5820
20	3162.6225	3028.2725
25	2851.333	2672.6300

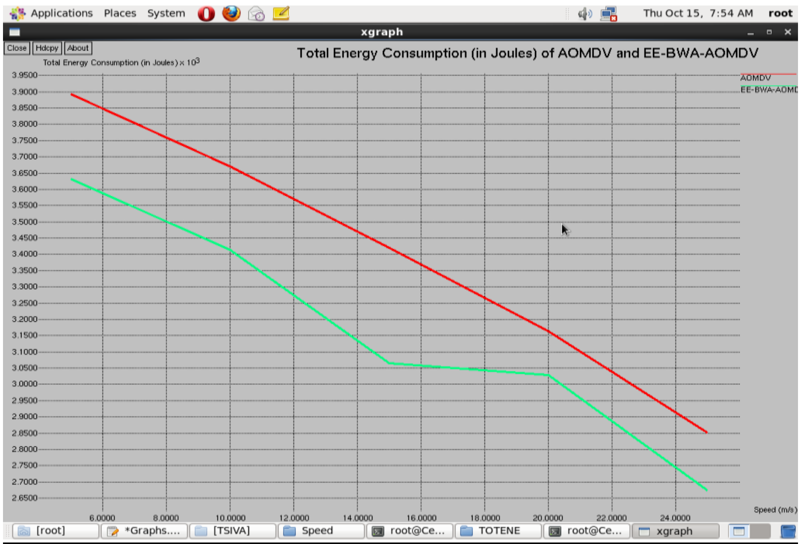

Fig :5 Total Energy Consumed(in joules) of AOMDV and BWA-AOMDV

The graph represent total energy consumption of EE-BWA-AOMDV PROTOCOL is very less compare it with the AOMDV protocol as shown in fig 5.

Table:6 Average End-to-end delay of AOMDV and BWA-AOMDV

Max.Speed(m/s)	AOMDV	BW-AOMDV
5	2.820	2.872
10	3.170	3.425
15	3.289	3.134
20	3.531	4.018
25	5.752	4.752

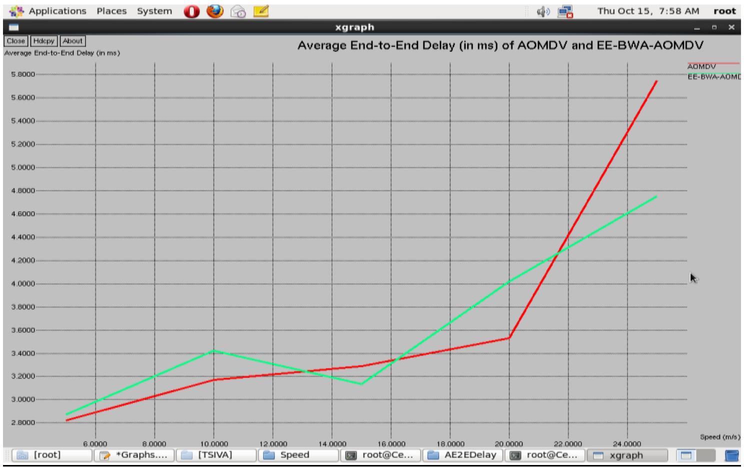

Fig:6 Average End-to-end delay of AOMDV and BWA-AOMDV

The table 6 and fig 6 represent the Average End-to-end delay of AOMDV and EE-BWA-AOMDV routing protocols. The EE-BWA-AOMDV is reducing the end to end delay whenever the speed of node is increased.

Table: 7 Throughput of AOMDV and BWA-AOMDV

Max.Speed(m/s)	AOMDV	BWA-AOMDV
5	202.675	202.688
10	187.860	181.660
15	163.849	164.542
20	156.868	155.911
25	126.612	125.721

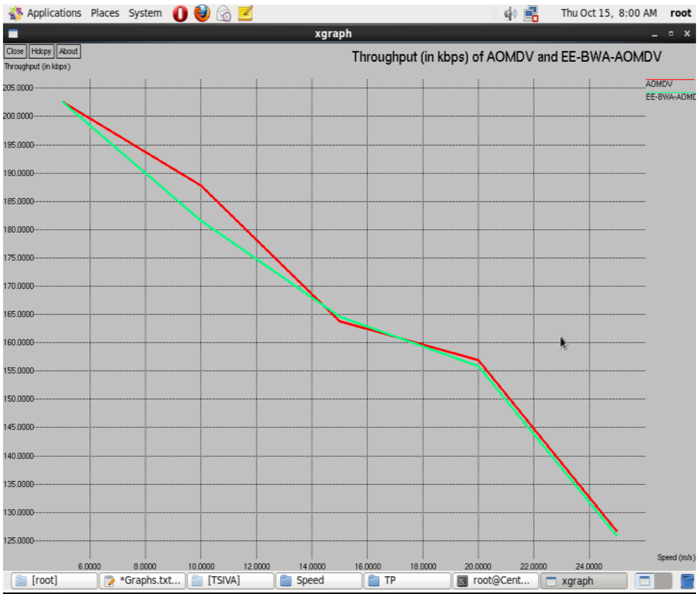

Fig 7: Throughput of AOMDV and BWA-AOMDV

The BWA-AOMDV gives the better throughput compare to AOMDV protocols as shown in the figure 7.

V. Conclusion:

In this paper, we proposed a BWA-AOMDV protocol to reduce the energy consumption, routing overhead, minimum bandwidth and average-end-to-end delay. It also improves the packet delivery ratio and throughput by using random way point model. The simulation result of BWA-AOMDV routing protocol is very better than AOMDV. In future research will focus on to improve overall performance of the new metrics associated with the network.

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