

Energy and Band width aware Multipath Routing protocol

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ABSTRACT: Mobile ad hoc networks (MANET) is a type of ad hoc network that can change locations and configure itself. MANETs is an infrastructure-less, dynamic network consisting of a collection of wireless mobile nodes that communicate with each other without the use of any centralized authority. Due to its fundamental characteristics, such as wireless medium, dynamic topology, distributed cooperation, MANETs is vulnerable to various kinds of security attacks like worm hole, black hole, rushing attack etc. In recent years, routing has been the most focused area in ad hoc networks research. On-demand routing in particular, is widely developed in bandwidth constrained mobile wireless ad hoc networks because of its effectiveness and efficiency. In this paper, we propose a new energy and band width aware routing protocol for wireless Ad Hoc networks. The goal of our proposed routing protocol is not to find more stable paths from a source to a destination node in terms of remaining life time of battery, but it also find multi- paths that satisfy Quality of Service (QoS) requirements.

KEYWORDS: MNETs, SPR, AODV, Energy, Band Width.

I. INTRODUCTION

Network Components in a wireless network communicate with each other using wireless channels. The use of wireless networks has become more and more popular. Based on the type of network infrastructure used for communication, wireless communication network are categorized into two types:

Infrastructured Networks

An infrastructure network consists of wireless mobile nodes and one or more bridges, which connect the wireless network to the wired network. These bridges are known as base stations. A mobile node within the network searches for the nearest base station connects to it and communicates with it.

Infrastructure-less Networks

In Contrast to infrastructure networks, each node in this network acts both as a router and a host. The network topology is dynamic, because the connectivity among the nodes may vary with time due to node improvements. There is no base station or access point. Nodes can communicate with each other by forming a multi hop route as shown in Figure1..Hence there is a need for efficient routing protocol to allow the nodes to communicate over multi-hop paths without access point. Since these networks pose many complex issues, there are many problems for research and contributions. Mobile Ad-Hoc Networks is a type of infrastructure less networks in which nodes are portable devices such as mobile phones and laptops.

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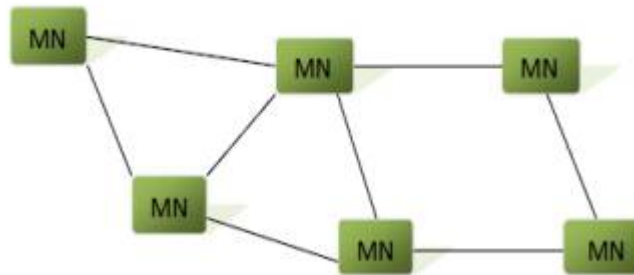


Fig 1. Infrastructure less Network

A Mobile Adhoc Network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. Each of the nodes has a wireless interface to communicate with each other. These networks are fully distributed, and can work at any place without the help of any fixed infrastructure as access points or base stations. Figure 2. Shows a simple ad-hoc network with 3 nodes. Node 1 and node 3 are not within range of each other, however the node 2 can be used to forward packets between node 1 and node 3. The node 2 will act as a router and these three nodes together form an ad-hoc network.

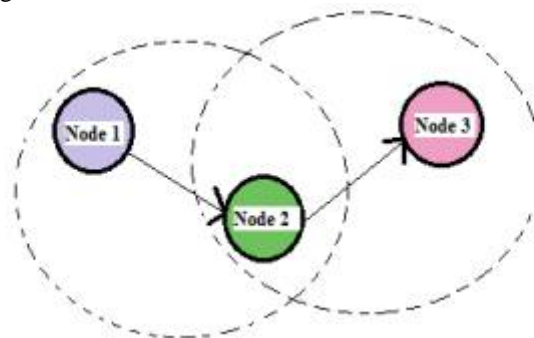


Fig 2. Example of Mobile Ad Hoc Network

MANETs characteristics

- 1) Distributed operation: There is no background network for the central control of the network operations, the control of the network is distributed among the nodes. The nodes involved in a MANET should cooperate with each other and communicate among themselves and each node acts as a relay as needed, to implement specific functions such as routing and security.
- 2) Multi hop routing: When a node tries to send information to other nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.
- 3) Autonomous terminal: In MANET, each mobile node is an independent node, which could function as both a host and a router.
- 4) Dynamic topology: Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable time. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network.
- 5) Light-weight terminals: In maximum cases, the nodes at MANET are mobile with less CPU capability, low power storage and small memory size.
- 6) Shared Physical Medium: The wireless communication medium is accessible to any entity with the appropriate equipment and adequate resources. Accordingly, access to the channel cannot be restricted.

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B .MANETs Challenges

- 1) Limited bandwidth: Wireless link continue to have significantly lower capacity than infrastructured networks. In addition, the realized throughput of wireless communication after accounting for the effect of multiple access, fading, noise, and interference conditions, etc., is often much less than a radio's maximum transmission rate.
- 2) Dynamic topology: Dynamic topology membership may disturb the trust relationship among nodes. The trust may also be disturbed if some nodes are detected as compromised.
- 3) Routing Overhead: In wireless adhoc networks, nodes often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead.
- 4) Hidden terminal problem: The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the sender, but are within the transmission range of the receiver.
- 5) Packet losses due to transmission errors: Ad hoc wireless networks experiences a much higher packet loss due to factors such as increased collisions due to the presence of hidden terminals, presence of interference, uni-directional links, frequent path breaks due to mobility of nodes.
- 6) Mobility-induced route changes: The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes; hence an on-going session suffers frequent path breaks. This situation often leads to frequent route changes.
- 7) Battery constraints: Devices used in these networks have restrictions on the power source in order to maintain portability, size and weight of the device.

II. RELATED WORK

In [2], Chen and Heinzelman proposed a Quality of Service (QoS)-aware routing protocol that incorporates an admission control scheme and a feedback scheme to meet the QoS requirements of real-time video or audio transmission. This QoS-aware routing protocol proposes a new method of the approximate bandwidth estimation to react to network traffic.

In [3], Chen et al. presented a congestion-aware routing protocol (CARP), which uses a metric incorporating data-rate, Medium Access Control (MAC) overhead, and buffer delay to combat congestion. These parameters are utilized to select maximum throughput paths, avoiding the most congested links. The CARP route discovery packet is similar to that in Dynamic Source Routing (DSR) [4] where every packet carries the entire route node sequence.

In [5], Zafar et al. proposed a Shortest Multi-paths Source (SMS) routing protocol which is based on DSR and Split Multi-paths Routing (SMR) [6]. This proposed protocol increases the number of selected routes between the source and the destination by requiring. The selected routes have to be partially disjoint. However, these algorithms listed above may result in a rapid depletion of the battery energy in the nodes along the most heavily-used paths in the network. Indeed, routing of packets is a significant power consuming activity since it involves packets forwarding by many intermediate nodes. The general consensus is that routing protocols should optimize energy consumption for routing activity given the limited battery power available in wireless nodes.

To minimise the energy consumption and increase the network's consistly, in [7], Dhurandher et al proposed an energy-efficient routing protocol for Ad Hoc network. This protocol balances energy load among nodes in the network. This lead to maintain the minimum energy level among these nodes and so to increase the network life.

In [8], Kumar et al. focused on providing power -aware routing protocol. This proposed protocol provides better performance in terms of link failure. Indeed, it finds path between the source and the destination in terms of remaining power of each node. In [9], Sharma and Kush proposed a power-aware routing protocol. This protocol is incorporated with the Ad hoc On-Demand Distance Vector (AODV) protocol [10], which will be discussed in the next section. The proposed protocol allows a mobile node to maintain route to a destination with more stable route selection. It insures fast selection of routes with faster recovery and minimal efforts. In [7], [8] and [9], the authors take into account the

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aspect of energy of each node when a source discovers a path to a destination, but they do not take into account other aspects such as QoS requirements in terms of delay and bandwidth as in [2] and [5].

AOMDV is an on-demand routing protocol for mobile ad hoc networks [10]. This protocol uses three types of messages to discover and maintain route: Route Requests (RREQs) and Route Replies (RREPs) messages are used for route discovery. Route Errors (RERRs) messages are used for route maintenance.

When a source node needs to communicate with a destination node for which it does not have a route, it broadcasts an RREQ packet across the network. When an intermediate node receives this packet which it does not have seen before, it creates a reverse route to the source. Then, it checks the destination address, if the intermediate node does not have a fresher route to the destination, it increments the hop-count and re-broadcasts the RREQ packet. Otherwise, it generates a RREP packet and sends it to the source node. When the source receives the RREP packet, it saves the route and begins data transmission. When a node detects a link break in an active route, it sends a RERR packet to notify the other nodes about this problem. An active route is used to forward data packets.

The format of RREQ packet for AOMDV protocol is shown in Figure 3

Type	Flags	Reserved	Hop-count
RREQ ID			
Destination IP Address			
Destination Sequence Number			
Originator IP Address			
Originator Sequence Number			

Fig 3. RREQ packet format for AOMDV

Protocol Here:-

- ☐ Type: It represents the type of the packet and it is set to 1
- ☐ Flags: It represents a set of flags each flag indicates a state of the packet
- ☐ Reserved: It is set to 0 and it is ignored on reception
- ☐ Hop Count: Represents the number of hops from the source node to the node handling the request
- ☐ RREQ ID: It represents the sequence number uniquely identifying the particular RREQ when taken in conjunction with the source nodes IP address
- ☐ Destination IP Address: It represents the IP address of the destination for which a path is desired
- ☐ Destination Sequence Number: It represents the latest sequence number received by the source for any path towards the destination,
- ☐ Originator IP Address: It represents the IP address of the node which originated the route request,
- ☐ Originator Sequence Number: It represents the current sequence number to be used in the route entry pointing towards the source of the route request.

The sequence number ensures loop freedom and allows nodes to determine fresh routes. This latter is a valid entry for the destination which is associated with a sequence number greater than that contained in the RREQ packet.

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III. EBMRP

• SPR

The goal of the SPR protocol is to find an optimal route from a source to a destination in MANET networks. This route is stable in terms of remaining life time of battery. Moreover, it satisfies QoS requirements in terms of bandwidth. On request for data transmission, the source node broadcasts a RREQ packet. This RREQ packet will determine the path from the source node to the destination node. The format of the RREQ packet is shown in Figure 4.

RBW	ML	TTL	Seqnum
Source Address			
Destination Address			
Adress 1			
.....			
Adress n			

Fig 4: RREQ packet format for SPR

Protocol Here :-

- ☐ RBW: It represents the required bandwidth for data transmission
- ☐ ML : It represents the minimum remaining life of the route
- ☐ TTL : It represents the time to live
- ☐ Seqnum: It represents the sequence number that uniquely identifies the RREQ packet
- ☐ Source Address: It represents the address of the source node
- ☐ Destination Address: It represents the address of the intended destination node,
- ☐ Address i: It represents the address of an intermediate node of the route.

When an intermediate node receives an RREQ packet, it compares its own address with the destination address. If it is the destination, it sends back a RREP packet along the reverse route. Otherwise, it checks first the availability of the required bandwidth. If the required bandwidth is not available, it drops the RREQ packet. If there is sufficient bandwidth for data transmission, the intermediate node decrements the time to live (TTL) of the packet. The TTL is the maximum number of hops that a packet can make before reaching its destination. If the TTL becomes zero, the intermediate node drops the RREQ packet and sends an error message to the source node. After that, the node calculates the minimum path life by comparing its own remaining life with the value of the ML Field. This field in the RREQ packet has always to contain the minimum life of all nodes crossed by the path. Before rebroadcasting the RREQ packet, the node adds its address in this packet, and maintains in its routing table some information such as the source address, the destination address, the sequence number and the minimum life of the route.

Description of our proposed protocol

In order to exceed the limits of the SPR protocol, we propose a new routing protocol called Energy and Band Width aware Multi-path Routing Protocol. The goal of our proposed protocol is to select multi-paths with the longest lifetime in the network without performance degradation in terms of delay time and Band Width. To achieve this goal, we need first to compute the Cost (called C) of each route by using the following equation:

$$C = ML / NH \text{-----} (1)$$

Where NH represents the number of hops in the path.

Our scheme has basically the same principle of the SPR protocol, but we modify some steps as follows:

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- When an intermediate node receives more than one RREQ packet from the same source, it computes for each RREQ packet the value of C using equation (1) and it check with the required condition is satisfied in terms of energy and bandwidth. It re-broadcasts the packet when it satisfies the required condition otherwise it will discarded.
- After receiving the first RREQ packet, the destination node waits the reception of other RREQ packets from different paths for a predefined time. Then, it sends back the RREP of each corresponding RREQ packet to the source node. This will help the source node in finding the shortest and the most stable path and keeping alternative paths that can be used when the primary path does not becomes functional (for example when link or node failure occurs),
- When receiving all RREP packets, the source selects the primary route with the greatest C value. Then, other routes are considered as secondary routes. Initially, the data transmission uses only the primary path and in case there is any kind of fault in this path, the source node can rapidly switch to the next shortest and most stable route.

IV. SIMULATION AND EVALUATION

To evaluate our proposed routing protocol (EBMRP), an extensive simulation study is performed using the NS-2 simulator [12]. We compare this proposed protocol with modified AODV (AOMDV) routing protocols. The simulation is carried out for 100 seconds and using a topology size of 1000 meter * 1000 meter. We use the two Ray ground as a model of propagation and the Constant Bit Rate (CBR) as a traffic type. The main parameters of our simulation model are given in Table I.

Parameters	Value
Protocol	EBMRP,AOMDV
No of Nodes	50
Simulation Time	200 sec
Traffic Type	CBR
Simulation Area	1000m*1000m
MAC Protocol	MAC/802.11
Mobility Model	Two Ray Ground

Table 1. Parameters for simulation evaluation

Throughput is the ratio of the data packets received at the destination to the data packets sent out from the source. Result from Figure 5.shows that EBMRP is better than AOMDV. Throughput increases when simulation time increases, even then throughput of EBMRP is higher for complete simulation duration. For a better data transmission in MANETs we want higher throughput, these proposed protocol give higher throughput than existing protocol.

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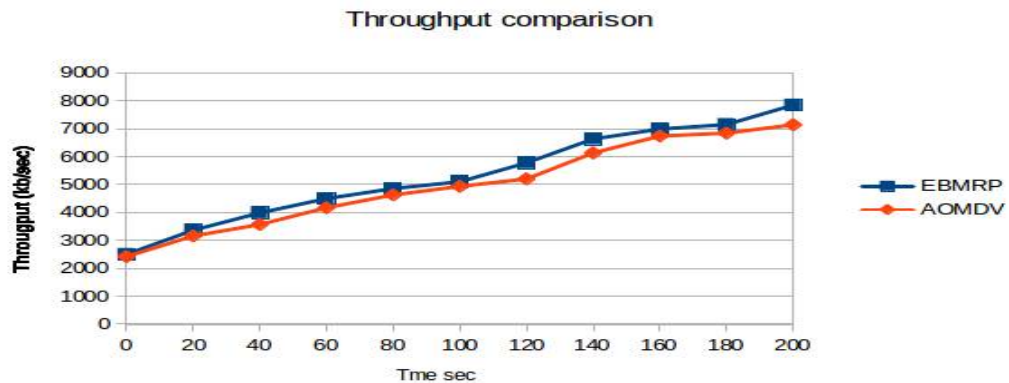


Fig 5.Throughput comparison

Average end to end delay is based on the source to destination and is compared between EBMRP and AOMDV. Result from Figure 6. Shows that EBMRP is better than AOMDV throughout the simulation. In MANETs for efficient data transmission we want to reduce delay, which leads to increase the QoS service in terms of delay.

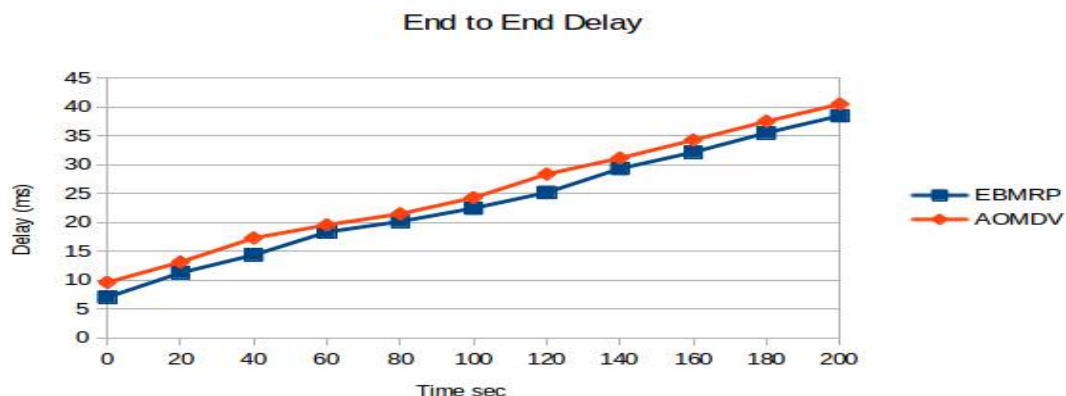


Fig 6. Delay Comparison

Figure 7. Shows the remaining energy during progress of simulation. This gives a better performance based on energy for EBMRP over AOMDV. This is mainly because of the energy details with the routing. In mobile networking Energy in nodes is challenging characteristic because of that it is more energy conserved than other network ,due to that nature transmission will be breaks due to inefficient energy of nodes. We want to increase the energy level for better transmission of data in mobile networks. These protocol gives higher energy life than existing protocols.

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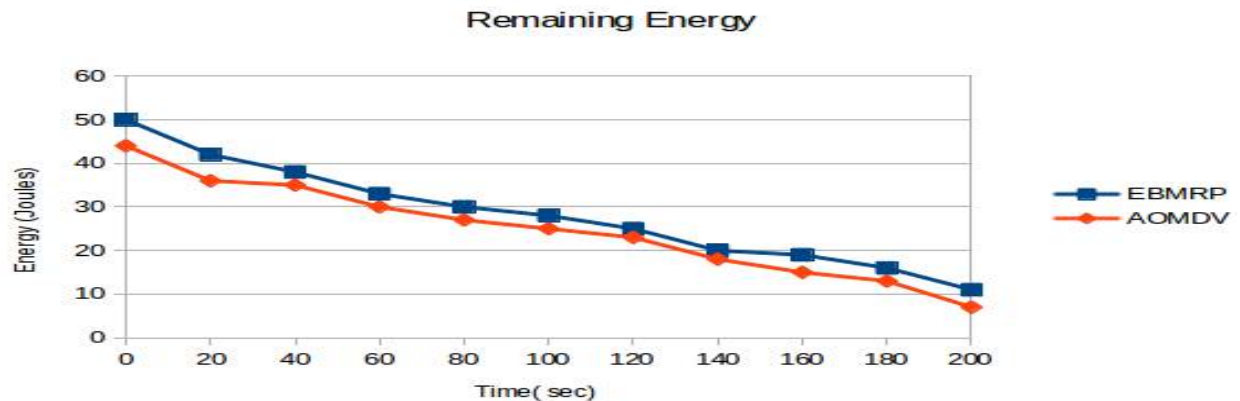


Fig 7. Remaining Energy Comparison

V. CONCLUSION

The energy is a major constraint in ad hoc networks since the nodes operate with limited battery life. Hence, the routing protocols in this type of networks must be developed to consider power aware as a primary objective. Also, the support of QoS requirements in terms of delay and bandwidth becomes a challenge due to the dynamic nature of ad hoc networks.

In this paper we proposed a new routing protocol for ad hoc networks. Our proposed protocol does not consider only the battery power as a major challenge, but it also aims to satisfy QoS requirements (delay and bandwidth). Moreover, our routing protocol keeps backup paths in order to rapidly switching to operational routes when problems occur. The simulation results show that the proposed protocol significantly outperforms MAODV protocols in terms of throughput, end-to-end delay and energy. Indeed, EBMRP provides the shortest end-to-end delay because it considers the number of hops when selecting the primary path. Further, our proposed protocol performs better in terms of throughput and packet loss as it takes into account the battery life of nodes and therefore chooses a stable path. Moreover, it can rapidly uses secondary paths when a node or a link fails. It is also interesting to improve EBMRP in a manner that the source can use all or part of the selected multi-paths to communicate with the destination in order to increase the throughput while extending the battery life of different nodes.

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