SIMULATION OF AODV & AOMDV USING SCMAC & PROPOSED SOLUTION TO IMPROVE THROUGHPUT IN MANET

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ABSTRACT

A Mobile Ad-hoc Network (MANET) is a dynamic wireless network that can be formed without the need for any pre-existing infrastructure in which each node can act as a router. In Manet there are two essential issues 1) The design of routing protocols that adopt to the frequent & randomly changing n/w topology.2) The design of MAC protocols .A variety of routing and MAC protocols have been proposed & several of them have been simulated or implemented as well. In this paper we compare & implement two types of on-demand routing protocols, AODV & AOMDV in terms of throughput .On comparing performance we see that AOMDV incurs more throughput. Both protocols are using single channel MAC (SCMAC).In this paper we also proposed a multichannel MAC protocol for MANET to improve throughput of n/w. The IEEE 802.11 standard allows for the use of multiple channels available at the physical layer, but its MAC protocol is designed only for a single channel. A single channel MAC protocol does not work well in a multi channel environment because of multichannel hidden terminal problem .Our proposed protocol enable host to utilize multiple channels, thus increasing n/w throughput. We have compare this multichannel protocol with single channel and proved it more efficient in terms of throughput than single channel.

Keyword: MANET, ROUTING PROTOCOLS, AODV, AOMDV, WIRELESS NETWORK, MAC PROTOCOLS MULTICHANNEL MAC PROTOCOLS, THROUGHPUT.

1. INTRODUCTION

Wireless communication between mobile users is becoming more popular than ever before. There are two distinct approaches for enabling wireless communication between two hosts. The first approach is to let the existing cellular network infrastructure carry data as well as voice. The major problems include the problem of handoff, which tries to handle the situation when a connection should be smoothly handed over from one base station to another base station without noticeable delay or packet loss. Another problem is that networks based on the cellular infrastructure are limited to places where there exists such a cellular network infrastructure.

The second approach is to form an ad-hoc network among all users wanting to communicate with each other. Ad-hoc networks do not rely on any pre-established infrastructure and can therefore be deployed in places with no infrastructure. This is useful in disaster recovery situations and places with no existing or damaged communication infrastructure where rapid deployment of a communication network is needed. Ad-hoc networks have several advantages compared to traditional cellular systems. These advantages include:

- On demand setup
- Fault tolerance
- Unconstrained connectivity

2. WIRELESS NETWORK

A wireless ad-hoc network is a collection of mobile nodes with no pre established infrastructure, forming a temporary network. Each of the nodes has a wireless interface and communicates with each other over either radio or infrared. Nodes in the ad-hoc network are often mobile, but can also consist of stationary nodes, such as access points to the Internet. Wireless networks can be classified in two types.

2.1 INFRASTRUCTURE NETWORK

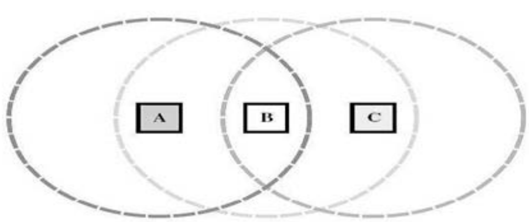
Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

2.2 INFRASTRUCTURE LESS (AD HOC) NETWORKS

In ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. An ad-hoc network uses no centralized administration. This is to be sure that the network would not collapse just because one of the mobile nodes moves out of transmitter range of the others. Nodes should be able to enter/leave the network as they wish.

3. MANET

A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes.



(Fig. 3.1)Example of a simple ad-hoc network with three participating nodes

The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust. In fig. 3.1, nodes A and C must discover the route through B in order to communicate. The circles indicate the nominal range of each node‘s radio transceiver. Nodes A and C are not in direct transmission range of each other, since A‘s circle does not cover C.

4. ROUTING

Routing is the act of moving information across an internetwork from a source to a destination. Along the way, at least one intermediate node typically is encountered.

Routing protocols are protocols that implement routing algorithms.

The routing protocol has two main functions, selection of routes for various source destinations pairs and the delivery of messages to their correct destination. The second function is conceptually straightforward using a variety of protocols and data structures (routing tables).

4.1 ON DEMAND ROUTING PROTOCOLS

On-Demand routing protocols work on the principle of creating routes as and when required between a source and destination node pair in a network topology. Our discussion is limited to two on-demand ad-hoc routing protocols, AODV and AOMDV, as follows.

4.1.1 Ad-hoc On-Demand Distance Vector Routing (AODV)

AODV is a reactive protocol that discovers routes on an as needed basis using a route discovery mechanism. It uses traditional routing tables with one entry per destination. Without using source routing, AODV relies on its routing table entries to propagate an RREP (Route Reply) back to the source and also to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers. AODV maintains timer-based states in each node, for utilization of individual routing table entries, whereby older unused entries are removed from the table. Predecessor node sets are maintained for each routing table entry, indicating the neighboring nodes sets which use that entry to route packets. These nodes are notified with RERR (Route Error) packets when the next-hop link breaks. This packet gets forwarded by each predecessor node to its predecessors, effectively erasing all routes using the broken link. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves. The advantages of AODV are that less memory space is required as information of only active routes are maintained, in turn increasing the performance, while the disadvantage is that this protocol is not scalable and in large networks it does not perform well and does not support asymmetric links.

4.1.2 Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV)

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are nodedisjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link disjointness. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.

5. Performance Evaluation

Implementation of wireless ad-hoc networks in the real world is quite hard. Hence, the preferred alternative is to use some simulation software which can mimic real-life scenarios. Though it is difficult to reproduce all the real life factors such as humidity, wind and human behavior in the scenarios generated, most of the characteristics can be programmed into the scenario.
To compare two on-demand ad-hoc routing protocol, it is best to use identical simulation environments for their performance evaluation.

5.1 Simulation Environment

Network simulator	NS-2.34
Network size	800m*800m
Pause time	0 s
No. of nodes	30,50,100
MAC layer	802.11
Mobility model	Random way pt. model
Traffic Model	Continuous bit rate(CBR)
Routing protocols	AODV , AOMDV
Simulation time	10 sec
Transmission range	250m.

Our simulation is based on simulation of varying nodes (30, 50, 100) moving about over a square (800* 800) flat space for 10s of simulated time .A square space is chosen to allow free movement of nodes with equal density. In our simulation, we use random way pt. model. Node chooses a random destination in 800m* 800m simulation space and moves there at a uniform speed. A pause time of 0sec. correspond to continuous motion & a pause time of 10 sec corresponds to no motion.

5.2 Performance Evaluation Metrics

Throughput: It is a measure of how fast the data sent from source to destination without loss.

Throughput is defined as (∑node throughputs of data transmission / total no. of nodes)

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5.3 Simulation Results:

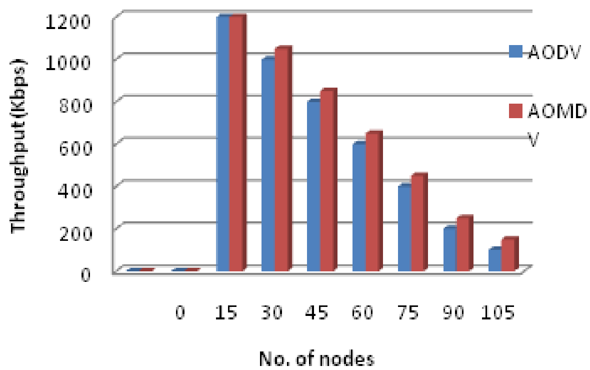

Fig. 5.3 Throughput Comparison

We ran the simulation environment for 10 sec. with varying no. of nodes (30, 50,100) & throughput is calculated in each case for both protocols. The result is summarized above with graph shown in fig. We note that AOMDV incurs more throughputs in comparison to AODV. But in both cases throughput is decrease with increase in no. of nodes as shown in (Fig. 5.3).

6. Proposed Solution

In above evaluation, we see that AOMDV incurs more throughput but both protocols are using single channel MAC. We can get better throughput or can improve throughput of network by providing multichannel MAC support for MANET. As we know that a single channel MAC protocol does not work well in multichannel environment because of multichannel hidden terminal problem. Thus, here we proposed a protocol enable host to utilize multiple channels to improve throughput.

Medium access control (MAC) protocols play an important role in the performance of the mobile ad hoc networks (MANETs). A MAC protocol defines how each mobile unit can share the limited wireless bandwidth resource in an efficient manner. The MAC protocol is the primary factor determining the network capacity. MAC protocols has to deal with several issues like Bandwidth efficiency, Real-time traffic support, shared broadcast medium, Lack of central coordination, hidden terminal problem, exposed terminal problem, mobility of nodes.

The challenge for MAC protocols for MANET is to find satisfactory tradeoff between two primary objectives of minimizing delay and maximizing throughput. It has studied that several MAC protocols are designed for wired network like CSMA, CSMA/CD but these protocols can't be directly used in wireless network because of hidden & exposed terminal problem in wireless. So, several MAC schemes are designed to overcome these problems.

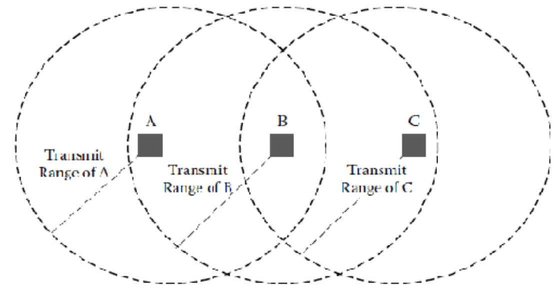

Fig. 6.1 Hidden & Exposed terminal problem in wireless network

Several MAC protocols are designed to avoid Hidden and Exposed terminal problem like MACA, FAMA, And IEEE 802.11. But these protocols cannot work well in multi channel environment because of multichannel Hidden terminal problem

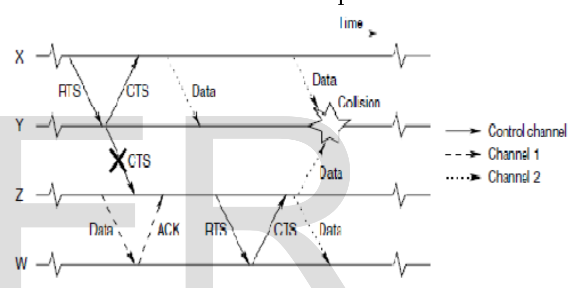

Fig. 6.2 Multichannel hidden terminal problem

7. Multichannel MAC Solution

MMAC protocol solves the multiple channel hidden terminal problems by using just a single transceiver. MMAC borrows the idea of Ad hoc Traffic Indication Messages (ATIM) from the power saving mechanism (PSM) of IEEE 802.11. ATIM windows are used by IEEE 802.11 to put nodes into doze mode, where the node consumes much less energy by not sending or receiving packets. MMAC adopts this concept by periodically sending beacons to divide time into beacon intervals. The nodes are synchronized so that their beacon intervals begin at the same time. Each beacon interval starts with an "ATIM window" which is used by the communicating nodes to exchange control information. One of the N data channels is chosen as the default channel and all nodes listen to this channel during the ATIM window of each beacon interval. The control packets are sent during the ATIM window on the default channel only. Thus instead of having a separate channel just for control

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traffic, MMAC uses one of the data channels for a fraction of the time. This technique is especially useful when the number of available channels is low and allocation of a separate control channel would be wasteful.

In MMAC, each node maintains a data structure called Preferable Channel List (PCL) to record the usage of different channels in its neighborhood. Each channel is categorized based on its preference as:

(1) HIGH: This channel is being used by the node in the current beacon interval. Only one channel can be in this state at a time.

(2) MID: This channel is not being used by any of the node's neighbors.

(3) LOW: This channel is already being used by one or more nodes in this node's vicinity.

The state of the channel, in the PCL, is changed as follows (shown in Fig. 7.1): All the channels in the PCL are in MID state at the start of each beacon interval. If two nodes choose a channel for communication, that channel is moved to HIGH state. If a node overhears control messages that specify that a particular channel is used by some other node in this node's vicinity, then this node moves the chosen channel to the LOW state.
When node X has packets for node Y, it will send an ATIM packet to Y that contains the PCL of X.
On receiving this information, Y chooses a channel for communication based on the received PCL and its own PCL. The chosen channel information is included in an ATIM–ACK and sent to X. If the chosen channel is acceptable to X, it sends an ATIM–RES packet to Y to reserve the channel and also to let other nodes in its neighborhood know that the particular channel has been reserved. This information is used by its neighbors to update their PCLs. After the ATIM window, nodes X and Y switch to the chosen channel and start data transfer. On the other hand if the chosen channel is not acceptable to X, it will have to wait until the next ATIM window and renegotiate. Since node Z also tunes to the default channel during the ATIM window, it hears the control exchange between X and Y. So if it receives an ATIM packet from some other node during the ATIM window, it chooses another channel and avoids collision. Random backoff is used to resolve collision of ATIM packets when multiple nodes contend for the control channel.

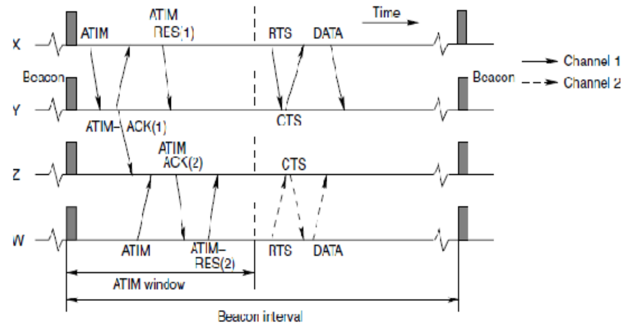

Fig. 7.1 Channel negotiation in MMAC protocol

7.1 Multichannel MAC Protocols with Dynamic Channel Selection

Multichannel MAC protocols can also improve the throughput performance due to the following reasons:

1. **Fewer bakeoffs:** If contending transmitters in a given neighborhood distribute their transmissions over different channels so as to gain better access to free channels independently, the need for backoffs is reduced. This automatically improves the channel utilization due to smaller idle periods in the channel.

2. **Reduced interference:** Because of the spatial distribution of interference and the option of transmitting on one of several available channels, transmissions can be distributed on appropriate channels so that each transmission experiences the lowest possible interference. This can lead to lower probabilities of packet collisions and better quality of transmissions on the average.

The assumptions that differentiate the conditions under which multichannel MAC protocols can be implemented over that used by the traditional 802.11 standard may be stated as follows:

• (N<n) N nonoverlapping data channels are available, all having identical bandwidths and propagation characteristics. And N is assumed to be arbitrary.

• Each node has a single half-duplex transceiver that can operate on any of the N channels. The MAC can dynamically select the channel that is to be used by the network interface card.

• Each node is capable of sensing the carriers on all channels. The CCA is performed sequentially over all channels to identify the free and busy channels. The channel switching time is usually less than 1 μsec, which is negligible compared to packet transmission times.

These assumptions create a framework where a sender first determines a free-channel list, comprising of the channels in which the carrier strength is found to be smaller than TCS. The sender can choose any one of these free channels for transmitting its data using an 802.11-like mechanism to take advantage of the combined bandwidth available on multiple orthogonal channels. However, higher channel utilization can be achieved if each packet is transmitted on the channel which would have the lowest collision probability. Determination of the best channel would typically require additional information. Various different schemes for channel selection have been proposed that are based on the past and current channel usage in the vicinity of the sender and the receiver.
Since wireless signals are location-dependent, the information available at the sender is not sufficient to determine the most appropriate channel for transmission. The usage of MAC-layer control packets, such as RTS and CTS, is a typical solution for exchanging relevant information between a sender and the intended receiver.
There is a multichannel MAC protocol that use dynamic channel selection as follows:

7.2 The MMAC with Soft Reservation (MMAC-SR)

This protocol tries to reduce contention on the channels by confining the transmissions from a particular node on the same channel whenever possible. This protocol follows some steps:

1. Each node determines the set of free channels whenever it needs to transmit a data packet.
2. It selects the channel that it has used most recently without experiencing a collision, if that channel is free.
3. If the last used channel is not free, the node chooses another free channel randomly.
4. If there are as many channels as the number of nodes that are active in transmission in a given neighborhood.
5. If the number of transmitting nodes exceeds the number of free channels, then some nodes will occasionally seek alternative channels, which will result in the access and backoff.

Then this procedure leads to a situation where each active node continuously uses the same channel for data transmission, thereby eliminating contention and the need for backoffs. This results in a "soft" reservation of a channel for every node, much like the distribution of non over lapping channels among users in a cellular network.

8. Conclusion

In this paper, we have compare and analyze two routing protocols AODV & AOMDV (both are using single channel MAC) in terms of throughput through simulation & have seen that AOMDV incurs more throughput .We have also presented a multichannel MAC protocol which utilizes multiple channels with dynamic channel selection strategy to improve throughput in MANET. In order to avoid multichannel hidden terminal problem, we require nodes to be synchronized, so that every node starts each beacon interval at about the same time. At the start of each beacon interval, every node listens one common channel to negotiate channels in the ATIM window.
After the ATIM window, nodes switch to their agreed channel and exchange messages on that channel for the rest of the beacon interval. Because, Nodes cannot exchange data packets during the ATIM window, even if they already finished exchanging the ATIM packets. So it is desirable to change the size of ATIM window dynamically, based on the traffic condition. Here we have introduced the concept of dynamic channel selection to overcome this problem.

Theoretically, we have proved that MMAC successfully exploits multiple channels to improve total network throughput over IEEE 802.11 single channel. We have also provide an algorithm for (MMAC-SR) MMAC with soft reservation, Which will provide better network throughput in comparison to MMAC.

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