Extending the Range of Wireless Networks Using AODV

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Abstract- A **wireless local area network (WLAN) links two or more devices using some wireless distribution method, and usually provides a connection through an access point to the wider internet. This gives users the mobility to move around within a local coverage area and still be connected to the network. Ad hoc networks are type of wireless LAN comprised of a group of workstations or other wireless devices which communicate directly with each other to exchange information. It may be desirable to extend the range of Wireless Local Area Networks beyond 100 meters. One approach to do this would be to use ideas which arise in ad hoc networks. MANET (mobile ad hoc network) is a wireless mobile network which forms a temporary network without the help of an established infrastructure. If a source node is unable to send a message directly to its destination node due to limited transmission range, the source node uses intermediate nodes to forward the message towards the destination node because each node in MANET acts as a router. This paper presents simulation analysis of the AODV Protocol considering two networks one having various numbers of nodes and other having various pause time effects. Intensive simulation experiments have been conducted on GloMoSim, under different operating conditions and the performance matrix includes delivery fraction and packet loss.**

Keywords – WLAN, AODV, Mobility, GloMoSim.

I. Introduction

The wireless infrastructure networks, also known as cellular network, have fixed and wired gateways. They have fixed base stations, which are connected to other base stations through the wires. The transmission range of a base station constitutes a cell. All the mobile nodes lying within this cells connects to and communicates with the nearest bridge(base station).A “handoff” occurs as mobile host travels out of range of one Base Station and into the range of another and thus, mobile host is able to continue communication seamlessly throughout the network. Example application of this type include office wireless local area networks(WLANs).The office building have fixed base stations at each floor of the building and the persons with mobile nodes can freely move up and down the floor without causing any connections to break [1].

In recent years, we have witnessed the wide-spread deployment of IEEE 802.11-based wireless LAN (WLAN) because of its providing high-speed Internet access to mobile users. In a WLAN, an access point (AP) relays the traffic between the mobile users and the wired network it attaches. This form of setup limits the mobile users at most one hop away from the wired network. In order to extend WLAN coverage to some farther areas of lower popularity and accessibility (such as tennis courts, backyards, and remote villages), cables need to be laid to set up the wired infrastructure, which may be inconvenient or costly. In this paper, we propose a network architecture which does not require every AP to be connected to the wired network, thus able to extend the WLAN coverage cost-effectively.

The other type of network infrastructure less network is known as Mobile Ad-hoc network (MANET).These networks have no fixed routers. All nodes are capable of movement and can be connected dynamically in arbitrary manner. The responsibilities for organizing and controlling the network are distributed among the terminals themselves. The entire network is mobile, and the individual terminals are allowed to move at will relative to each other. In this type of network, some pairs of terminals may not be able to communicate directly to with each Other and relaying of some messages is required so that they are delivered to their destinations. Such networks are often referred to as multi hop or store-and-forward networks. The nodes of these networks function as routers, which discover and maintain routes to other nodes in the networks. The nodes may be located in or on airplanes, ships, trucks, cars, perhaps even on people or very small devices [2].

Mobile ad hoc network (MANET) is a collection of wireless nodes that can be set up dynamically anywhere and anytime without using any pre-existing network infrastructure. Nodes within each other's radio range communicate directly via wireless links, while those that are far apart use other nodes as relays in a multi-hop routing fashion [3]Since their emergence in 1970's, wireless networks have become increasingly popular in the computing industry. These networks provide mobile users with ubiquitous computing capability and information access regardless of the location [4] MANETs have several salient characteristics: i) Dynamic topologies ii) Bandwidth constrained, variable capacity links, iii) Energy-constrained operation and limited physical security etc. Therefore the routing protocols used in ordinary wired networks are not well suited for this kind of dynamic environment. In this paper an effort has been done to evaluate the performance of AODV to extend the range of wlan using Network Simulator GLOMOSIM and results have been analyzed.

The rest of the paper is organized as follows: Section II gives the related work of performance evaluation of wireless ad hoc networks. Section III provides an overview of AODV routing protocol used in the study. The simulation environment and performance metrics are described in Section IV and then the results are presented in Section V. Section VI concludes the paper.

II. Related Work

Extending coverage in WLAN through multihop connection has been proposed in [7]– [9], where a mobile station outside the coverage of an AP may connect to the AP using multiple hops through other stations inside the cell. However, such an approach depends on the existence of the relay stations, and hence the coverage extension is not always reliable. Moreover, their Work mainly focuses on the cooperation of the infrastructure mode and ad hoc mode at the relay agent. Chan describes that in WLAN Chan describes that in wireless LAN number of APs may form a wireless mesh and packets are forwarded from one AP to another by means of ad hoc connections to extend the range of the network. They propose a routing scheme to assign the channels among the links [13]. Zhanping Yin and Victor C.M. Leung have proposed two methods that combine to integrate IEEE8 02.11 ad-hoc operations into the infrastructure mode, which improves the performance of WLAN systems with intra-cell packets[10].Nilesh. P and Nitiket.N concluded that the Ad Hoc On demand Distance Vector (AODV) routing protocol performs better than the table-driven protocol and test the ability of AODV routing protocol to react on network topology changes[11]. Mahesh Kumar Yadav states that Broadcasting in MANET poses more challenges than in wired networks due to node mobility and scarce system resources. Due to the mobility, there is no single optimal scheme for all scenarios. They proposed well-known ad hoc routing protocols including AODV to overcome these limitations in an attempt to enhance and promote the quality of the probabilistic schemes. The simulation results show that their proposed approach outperforms its counterparts including the well-known blind flooding, fixed probabilistic and traditional dynamic probabilistic approaches [12].Multi-hop wireless ad hoc network implementation on Windows system based on 802.11 single-hop ad hoc mode have adopted Ad hoc On-demand Distance Vector (AODV) protocol as the routing protocol and then analyze the key implementation problems they have faced. Aiming at those key problems they propose a design framework based on NDIS intermediate driver and discuss some key techniques to solve them[14].G.Vijaya Kumar concluded that as the mobility of nodes in the network increases, reactive protocols perform better and the mobility and traffic pattern of the network must play the key role for choosing an appropriate routing strategy for a particular network[15].

III. Routing Protocols

Routing protocols for Mobile ad hoc networks can be broadly classified into two main categories:

1. Proactive or table-driven routing protocols
2. Reactive or on-demand routing protocols

3.1 Table-Driven Routing (Proactive protocols) –

In proactive routing protocols, the routes to all the destinations (or parts of the network) are determined at the start up, and maintained by using a periodic route update process. In proactive routing protocol each node maintains the information about the other nodes in the tables. Though the numbers of tables used by the different protocols differ. The various proactive routing protocols differ in the way in which they update the routing information in the tables.

On the other hand, the use of periodic routing messages has the effect of having a constant amount of signaling traffic in the network, totally independent of the actual data traffic and the topology changes

3.2. On-Demand Routing (Reactive Protocols) –

In reactive protocols, routes are determined when they are required by the source using a route discovery process. These protocols were designed to reduce the overhead encountered in proactive protocols by maintaining information for active routes only. This means that the routes are determined and maintained for the nodes that are required to send data to a particular destination. Route discovery usually occurs by flooding route request packets through the network. When a node with a route to the destination (or the destination itself) is reached a route reply is sent back to the source node using link reversal if the route request has traveled through the bidirectional links or by piggy-backing the route in a route reply packet via flooding.
Within the last few years the use of Wireless LANs for providing Internet connectivity
has increased. They can be used as an extension of or as an alternative to wired LANs within a building or area. Wireless LANs are infrastructure based wireless networks where the node communicates directly with an access point which is connected to the wired network. The access point acts as a gateway which transmits data between the WLAN and the wired network. A single access point can support a small group of users and can function up to a range of 100 meters. However it may be desirable to extend this range. Ad hoc networking has been put forward as a possible solution to this limitation.

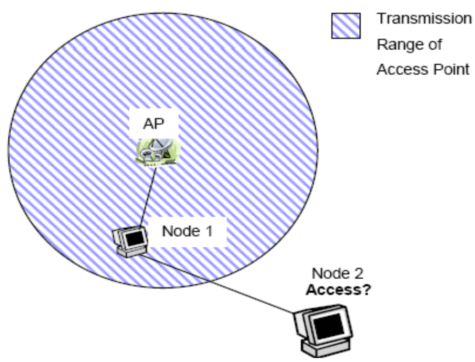

Figure 1 : Transmission Range

As Fig. 1 illustrates, Node 2 is outside the transmission range of the access point. However by using ad hoc routing protocols Node 2 can obtain Internet connectivity by using Node 1, which is within the range of the access point, as a relay node to forward packets to the access point. This route is maintained for as long as Node 2 requires it. Although, this new approach of networking offers great flexibility to the world of wireless communications and raises some new challenges among the research community as far as routing, QoS, and security issues are concerned.

In this report we will be concentrating on the routing area and the effect of traffic loads on the ad hoc network. The objective of this study is the implementation, documentation and evaluation of simulation models for ad hoc networks. The commercially available simulation software GloMosim was used for this purpose.

The routing protocol which seemed the most appropriate for the simulations was the Ad hoc On-Demand Distance Vector (AODV). It is arguably most mature in standards development process. As well as this an implementation was readily available in the GloMosim [5] simulator. The next section will explain how AODV works.

3.3 Ad-hoc On Demand Distance Vector Protocol (AODV)

Ad hoc On-Demand Destination Vector, (AODV) is a distance vector routing protocol that is reactive. The reactive property of the routing protocol implies that it only requests a route when it needs one and does not require that the mobile nodes maintain routes to destinations that are not communicating. AODV guarantees loop free routes by using sequence number that indicate how new, or fresh, a route is. AODV requires each node to maintain a routing table containing one route entry for each destination that the node is communicating with. Each route entry keeps track of certain fields. Some of these fields are:

source address	broadcast ID	source sequence no.	destination address	destination sequence no.	Hop count

Figure 2: Structure of an RREQ packet

Source IP Address: The IP address of the source which generate the RREQ.
Destination IP Address: The IP address of the destination for which a route is supplied.
Destination sequence number: The destination sequence number associated to the route.
Next Hop: Either the destination itself or an intermediate node designated to forward packets to the destination.
Hop Count: The number of hops from the originator IP Address to the Destination IP
Address Lifetime: The time in milliseconds for which nodes receiving the RRE consider the route to be valid
Routing flags: the state of the route; up (valid), down (not valid) or in repair.

(a) *Path Discovery of AODV*

Whenever a source node desires a route to a destination node for which it does not already have a route, it broadcasts a route request (RREQ) message to call its neighbors. The neighbors update their information for the source and create reverse route entries for the source node in their routing tables. A neighbor receiving a RREQ may send reply (RREP), if it either the destination or if it has unexpired route to the destination. If any of these two cases is satisfied, the neighbor unicast a RREP back to the source. Along the path back to the source, intermediate nodes that receive the RREP create forward route entries for the destination node in their routing tables. If none of the two cases mentioned is satisfied, the neighbor rebroadcasts (forwards) the RREQ. Each mobile node keeps a cache where it stores the source IP address and ID of the received RREQs during the last PATH_DISCOVERY_TIME seconds. If a mobile node receives another RREQ with the same source IP address and RREQ ID during this period, it id discarded. Hence, duplicated RREQs are prevented and not forwarded.

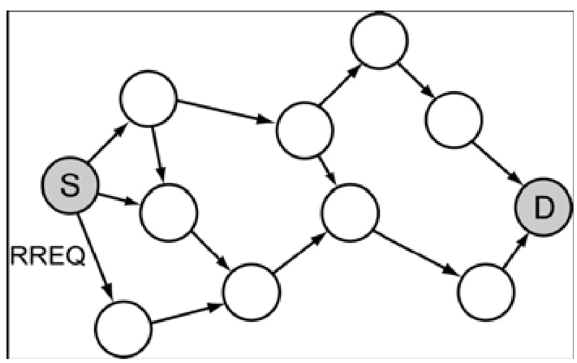

Figure 3(a) Source node S initiating the path discovery process

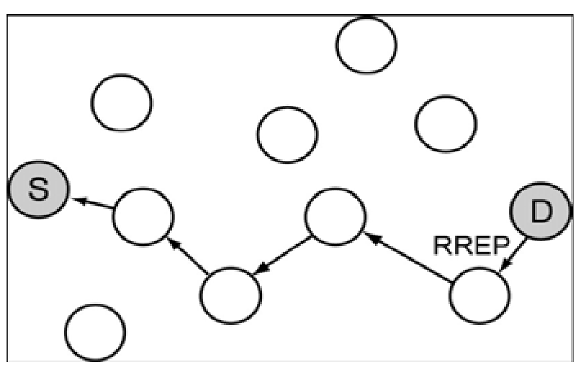

Figure 3(b) A Root reply packet being sent back to the source.

Figure 3 :Path Discovery of AODV

When searching for a route to the destination node, the source node uses the expanding ring search ring technique to prevent unnecessary network-wide dissemination of RREQs. This is done by controlling the value of the time to live (TTL) field in the IP header. The first RREQ message sent by the source has TTL=TTL_START. The value of TTL defines the maximal number of hops a RREQ can move through the mobile ad hoc network, i.e. it decides how far the RREQ is broadcast by the source, is received only by mobile modes TTL hops away from the source (and of course all mobile nodes less than TTL hops away from the source). Apart from setting the TTL, the timeout for receiving a RREP is also set. If the RREQ times out without reception of a corresponding RREP, the source broadcasts the RREQ again. This time TTL is incremented by TTL_INCREMENT, i.e the TTL of the second RREQ message is TTL_START +TTL_INCREMENT. This continues until a RREP is received or until TTL reaches TTL=NET_DIAMETER, which disseminate the RREQ widely, through the MANET. Broadcasting a RREQ with TTL=NET DIAMETER is referred to as a network-wide search. If a source node does a network-wide search and still does not receive a RREP, it may try again to find a route to the destination node, up to a maximum of RREQ_RETRIES times.

(b) Route Maintenance of AODV

When a link in a route breaks, the node upstream of the break invalidates all its routes that use the broken link. Then, the node broadcasts a route error (RERR) message to its neighbors (TTL is set to one). The RERR message contains the IP address

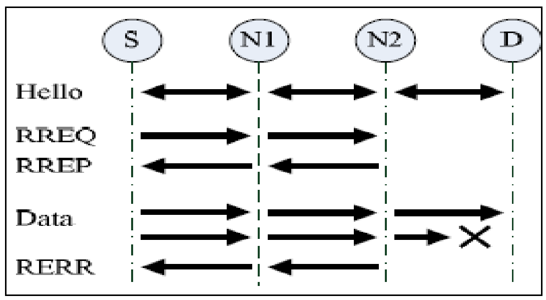

Figure 4: Route Error of AODV

of each destination which has become unreachable due to the link break. Upon reception of a RERR message, a node searches their routing tables to see if it has any route(s) to the unreachable destination(s) (listed in the RERR message) which use the originator of the RERR as the next hop. If such routes exist, they are invalidated and the node broadcasts a new RERR message to its neighbors. This process continues until the source receives a RERR message. The source invalidates the listed routes as previously described and reinitiates the route discovery process if needed.

Characteristics of AODV

1) All routes are loop-free through use of sequence numbers.
2) On-demand route establishment with small delay.
3) Use of Sequence numbers to track accuracy of information.
4) Only keeps track of next hop for a route instead of the entire route.
5) Use of periodic HELLO messages to track neighbors.
6) Unicast, Broadcast, and Multicast communication.
7) .Multicast trees connecting group members maintained for lifetime of multicast group.
8) Link breakages in active routes efficiently repaired.

IV. SIMULATION

The simulations have been performed using GLOMOSIM Simulator [5]. The traffic sources are CBR (continuous bit–rate). Destination pairs are spread randomly over the network. The mobility model uses ‘random waypoint model’ [6] in a rectangular filed of 1000m x 1000m with varying no. of nodes. Different network scenarios for different number of nodes and pause times are generated. The model parameters that have been used in the following experiments are summarized in Table 1.

Table 1: Simulation Parameters

Parameter	Value
Simulation Time	100 seconds
Terrain Size	1000 X 1000 meters
Mobility Model	Random Waypoint
Node Placement	Nodes.input File
Nominal traffic type	Constant Bit Rate (CBR)
CBR Packet Size	512 Byte/Packet
Network Protocol	Internet Protocol
MAC Layer Protocol	802.11
Routing Protocols	AODV
Bandwidth	2 mbps
Mobile Nodes	6,12,18,24
Pause Time	10,20,40,60,80

V. SIMULATION RESULTS & OBSERVATIONS

The simulation results are shown in the form of line graphs. Graphs show performance of AODV by varying different numbers of nodes and varying pause times on the basis of the Packet delivery ratio and loss packet percentage as metrics.

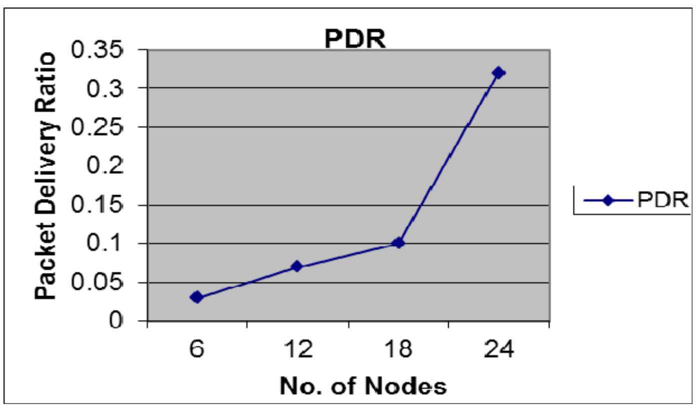

Figure 4: Packets Delivery Ratio vs No. of nodes

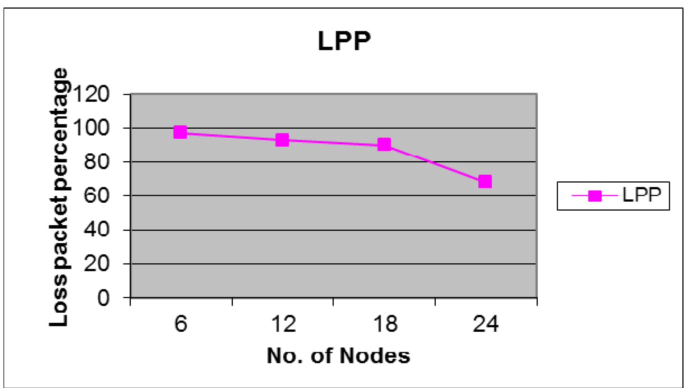

Figure 5: Loss Packet Percentage vs No. of nodes

Figure 4 and Figure 5 show the effects of no. of nodes on packet delivery ratio, it shows that as the number of nodes are increased the PDR increases and a loss of the packets is decreases to reach the destination node . This is due to the fact that many routes are available because of mobility nodes can move along the access point and provide the proxy to the neighbor node and a number of nodes that are part of the mesh transmit data packets.

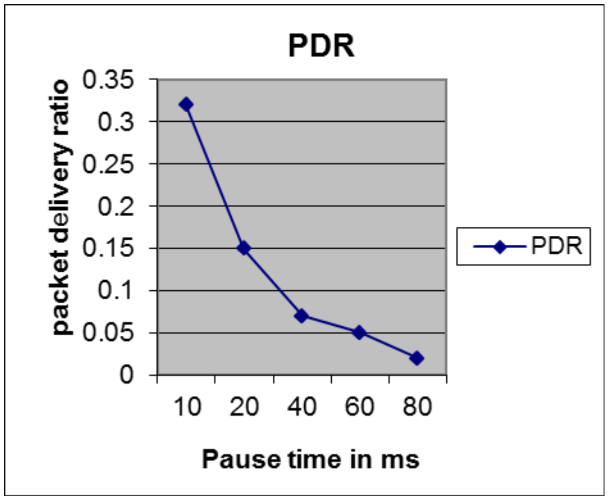

Figure 6: Packets Delivery Ratio vs Pause Time

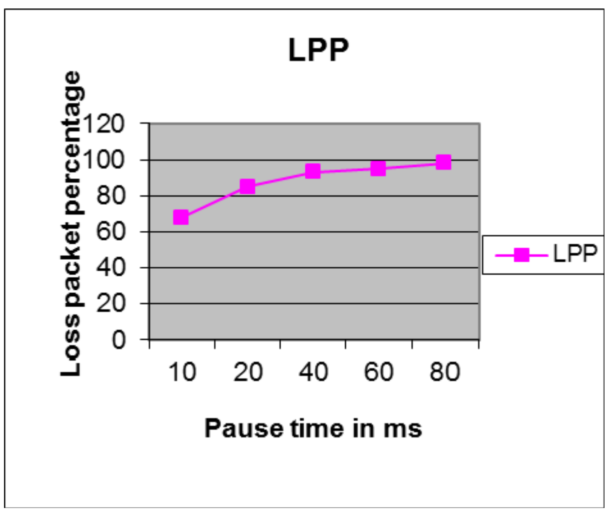

Figure 7: Loss Packet Percentage vs Pause Time

Figure 6 and Figure 7 show the effects of various pause times at fixed no. of nodes on packet delivery ratio, it shows that as the pause time increased the PDR decreases and a loss of `the packets is increased to reach the destination node . This is due to the fact that maximum time is used to find the route along the access point and provide the proxy to the neighbor node and a number of nodes that are part of the mesh transmit data packets.

VI.CONCLUSION

The goal of this performance evaluation of AODV routing protocol is to extend the transmission range of wlan networks. AODV in the simulation experiment shows the performance for different scenarios. Table-1 represents a summary of evaluations. Efforts are on to simulate the two schemes, packet-delivery ratio and loss packet percentage as well. The simulation of these protocols has been carried out using GloMoSim simulator on Linux Redhat-7.2 operating system. Two different simulation scenarios are generated and other network parameters are kept constant during the simulation.

So, conclusion is that in a mobile ad hoc network, nodes move arbitrarily, therefore the network may experience rapid and unpredictable topology changes. Because nodes in a MANET normally have limited transmission ranges, some nodes cannot communicate directly with each other. Hence, routing paths in mobile ad hoc networks potentially contain multiple hops, and every node in mobile ad hoc networks has the responsibility to act as a router. This paper is a survey of active research work on AODV routing protocol for MANET. As the mobility of nodes in the network increases, multiple routes will be there. Mobility and traffic pattern of the network play the key role for choosing an appropriate routing strategy for a particular network. It is also seen the ad hoc network should be restricted two hop distance outside the access point range. As the node density increased, the efficiency increased dramatically with a significant delivery of packets.

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