ISSN 2229-5518

Optimal Path Selection Routing Protocol in MANETs

Dr. Sapna Gambhir, Parul Tomar

Abstract— An Ad hoc network is a collection of mobile nodes forming a temporary network without the help of any centralized access point or existing infrastructure. In such an environment, routing protocols are required to transfer packets from source to destination as some mobile nodes can act as intermediate nodes to forward a packet to its destination, due to the limited range of each mobile node's wireless transmissions. Dynamic source routing (DSR) is one of the routing protocols used for ad hoc networks. In this, When a node requires a route to a destination, it initiates a route discovery process within the network. Source node broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until a route is found or all possible route permutations have been examined. The main disadvantage of DSR protocol is that source node contains at most one route to destination at any moment of time. So, there is no way for the choice of optimal path for different type of applications like multimedia, voice, mail, etc. In this paper, a new protocol (DSR-A) is proposed which selects route from source to destination depending on bandwidth requirement of source node and battery life of all the nods on a path from source to destination.

Index Terms— Ad hoc networks, Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR), MANET, Power Aware, Performance, OPSR

1 INTRODUCTION

Mobile hosts and wireless networking are prevailing areas of research. Wireless networks are categorized as infrastructure based and infrastructure less networks. Infrastructure less networks are used where it may not be economically practical or physically possible to provide the necessary infrastructure or because the expediency of the situation does not permit its installation viz communication in areas affected by natural disasters, war areas, in meetings and conventions in which persons wish to quickly share information etc. In such situations, mobile hosts within the same vicinity can communicate with each other without the help of fixed wired infrastructure. This type of wireless network is known as an *Ad hoc network*.

In Ad hoc networks, Routing protocols are required to route data packets from source to destination. Routing protocols are basically categorized in to table driven and on demand routing protocols [1]. In table driven routing protocols, up-to-date routing information is maintained by each node in the network. One or more tables are required by each node in order to store routing information, and these tables are modified in response to changes in network topology by propagating updates among all nodes in the network [2]. On the other hand, on demand routing protocols concentrates on creating routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. In this, source node broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until a route is found or all possible route permutations have been examined.

Ad hoc On Demand Distance Vector (AODV) [3] and Dynamic Source Routing (DSR) [4] are on demand routing protocol with the difference that nodes, that are not on a selected path do not maintain routing information or participate in routing table exchanges. In AODV, RREQ packet received by an intermediate node contains information about its immediate source from which a RREQ packet is received whereas in DSR, RREQ packet received by destination contains name of all intermediates nodes through which it traversed from source to destination. The main disadvantage of DSR protocol is that source node contains at most one route to destination at any moment of time. So, there is no way for the choice of optimal path for different type of applications like multimedia, voice, mail, etc.

Various protocols like Ad-Hoc QoS On-Demand Routing (AQOR) [5], Flexible QoS Model for MANET (FQMM) [6], In-band Signaling system (INSIGNIA) [7] have been proposed to provide QoS in terms of bandwidth only. In FQMM, a combinational model of the reservation schema for high priority traffic with a service differentiation of the low priority traffic has been proposed. FQMM is a hybrid schema which take the advantage of both the per flow service granularity in IntServ and the service differentiation of DiffServ. AQOR is a resource reservation based routing and signaling algorithm. It provides end-to-end QoS (bandwidth and delay). AQOR integrates (a) on demand route discovery between the source and destination, (b) signaling functions for resource reservation and maintenance, and (c) hop by hop routing. INSIGNIA is the first signaling algorithm proposed only for MANET. In this protocol, Signaling control information is stored in the INSIGNIA option which is the IP option of the IP data packet. This algorithm is also based on the resource reservation protocol.

Power-aware Source Routing Protocol for Mobile Ad Hoc Networks (PSR) [8] is an energy aware routing protocol which uses the concept of link cost. In PSR, destination node waits for a certain interval of time. When the time expires, destination node selects the path with minimum cost and replies. ODMRP [9] is a mesh based scheme. This protocol makes uses of forwarding group concept. In ODMRP, source node creates group membership and multicast routes whenever there is requirement of data packet transmission. Trust Based Energy Aware AODV (TEA-AODV) [10] is an on demand routing protocol which makes use of two parameters – trust value and battery capacity of a node. TEA-AODV selects path with high reliability.

From studies, it is clear that either bandwidth or energy awareness is the consideration parameter in existing work but none of the protocol has taken these two parameters together to find the optimal path. Also, the existing power aware routing protocols do not take care of the loop created by the data packet while searching the optimal path.

A new routing protocol (DSR-A) is proposed in order to remove these disadvantages. At any moment of time, source node can have multiple routes to destination. Source node selects the optimal path based on various parameters like type of applications, bandwidth and current battery life status of all nodes on a route to destination.

Organization of the paper is as follows: Basics of DSR protocol, its disadvantages and proposed protocol DSR-A is discussed in section II. Section III concentrates on experimental analysis which reflects the benefits of using DSR-A protocol. The work is concluded in section IV.

2 Proposed work

The main objective of DSR-A is to find out the best available route from source to destination depending on the type of data packet like voice, multimedia data etc sent by the source. For the proposed protocol, the base protocol is DSR where every node has a route cache in which it caches source routes that it has learned. When source is ready to send data packet to destination, it checks its route cache for a route to destination. If route is there then it uses this route to transmit the packet otherwise it broadcasts RREQ packet towards the destination in order to find out the route from source to destination. Each intermediate node checks its route cache for route availability. If route is available at the intermediate node then it transmits route reply (RREP) packet towards the source. At last, Destination receives only one RREQ packet with same sequence number and ignores the other copies of RREQ packet with same sequence number. RREQ packet received by the destination contains all information of intermediate nodes through which it traversed.

In the proposed (DSR-A) protocol, two new fields, required bandwidth for transmission and battery life of the node itself, are added to RREQ and RREP packet respectively which helps to select optimal path from source to destination. Structures of RREQ and RREP packet are shown in Table 1 and Table 2. In the proposed protocol, following considerations are there:

1. Bandwidth requirement depends on the type of data like voice data and multimedia data to be sent.
2. Battery life at any movement of time reflects the future time for which respective node is activated for sending and receiving packets and information.

Table 1

Structure of RREQ Packet

Pid	Source	Destination	Sequence no.	Required Bandwidth	Nodes traversed

Table 2

Structure of RREP Packet

Source	Destination	Battery	Nodes traversed

Three variables are required for the working of DSR_A protocol.

1. **MAX_H_COUNT:** Each intermediate node calculates hop count with the help of node traversed field in the RREQ packet. If count is more than MAX_H_COUNT then it drops the RREQ packet immediately otherwise add its identity in the node traversed field of RREQ packet and broadcast it further.
2. **TIMER_DES:** This variable consists of amount of time for which destination node waits for RREQ packets of same sequence number.
3. **TIMER_SRC:** This variable consists of amount of time for which source node waits for RREP packets of same sequence number in order to select optimal path from source to destination.

Steps followed by the proposed protocol (DSR_A) are explained in Algorithm 1 and Algorithm 2.

Step 1 Source node, having data packet for the destination, checks its route cache for the destination.
Step 2 If entry is not present in route cache then go to step 3 else go to step 11.
Step 3 Source broadcasts RREQ packet towards the destination on every possible path.
Step 4 Each intermediate node compares the required and available bandwidth at the node, if required bandwidth id greater than available bandwidth then drop the RREQ packet immediately.
Step 5 Each intermediate node calculate hop count with the help of node trace. If count increases to MAX_H_COUNT then drop the RREQ packet immediately otherwise add its identity in the node trace field of RREQ packet and broadcast it further.
Step 6 For amount of time stored in TIMER_DES, Destination sends Request Reply packets against all RREQ packets of same sequence number.

Step 7 Each intermediate node which receives RREP packet attach its bandwidth and battery capacity and forward it further.
Step 8 For amount of time specified in TIMER_SRC, source, node receives multiple RREP packet with same sequence number.
Step 9 Call **O_Path(RREP packets at source node, Y_{th},)** algorithm in order to find out optimal path from source to destination and start sending data packets to destination through that optimum path.
Step 10 If source generates new sequence no. before receiving the first RREP packet for the same source and destination pair. It must ignore all Request Reply having old sequence no. and go to step 1.
Step 11 Use route cache entries to send data packets to destination

Algorithm 1: DSR-A Routing Algorithm

Let us consider an Ad hoc network as shown in Fig. 1 where various nodes are linked with each other. Source node A wants to send packets to destination node G. Fig. 2 shows the RREQ packets that can be received by each node. In this Fig., we assume that node G received all the four packets during the time specified in TIMER_DES. Fig. 3 shows the status of RREP packets at each node in the network. Here, we assume that all the four packets are received by the source node during the time stored

Algorithm O_Path(RREP packets at source node, Y_{th},)
{
m= count (no_request_reply_packets);
For (j=0; j<m; j++)
{
n= count (no_nodes_visited);
x=1;
initialize the counter to 0;
For(i=0 ;i<n ;i++)
{
If (Y_i<=Y_{th});
{
x=0;
break;
}
}
If (x<>0)
{
Y_{avg}[j] =Sum_of Y_i/n;
Increment the counter;
}
Else
Y_{avg}[j]=0;
}

If (counter==1)
send data packets to the selected path;
If (counter>1)
{
Y_{max}= Max(Y_{avg}[1],Y_{avg}[2],…..Y_{avg}[m]);
select corresponding channel with the Y_{max} value;
}
If (counter==0)
Retransmission of RREQ packet.
}

Algorithm 2: Optimal Path Routing Algorithm

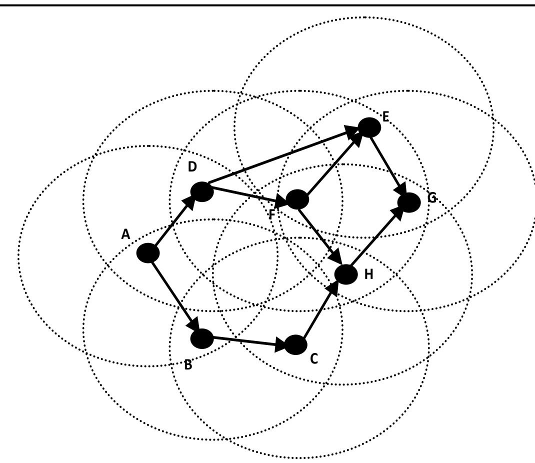

Fig. 1. Ad Hoc Network

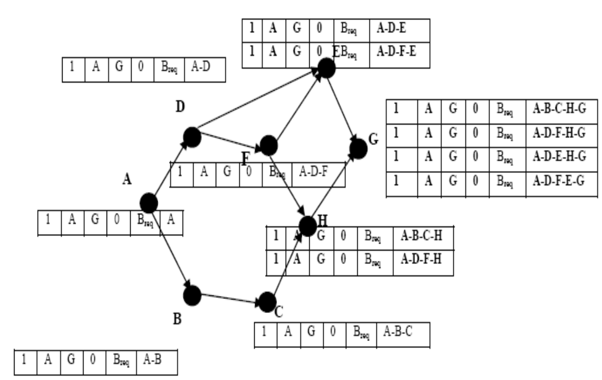

Fig. 2. A RREQ Packets from Source to Destination Node d Hoc Network

---

- *Dr. Sapna Gambhir is currently working as an Associate Professor in CE Deptt. Of YMCA University of Science and Engineering, Faridabad,India. E-mail: sapnagambhir@gmail.com*
- *Parul Tomar is currently working as an Assistant Professor in CE Deptt. Of YMCA University of Science and Engineering, Faridabad,India. E-mail: ptomar_p@hotmail.com*

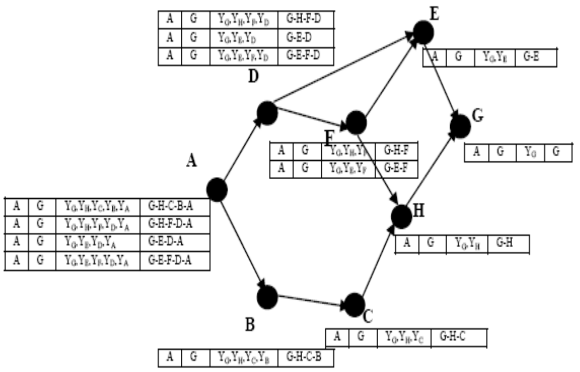

Fig. 3. RREP Packets from Source to Destination Node

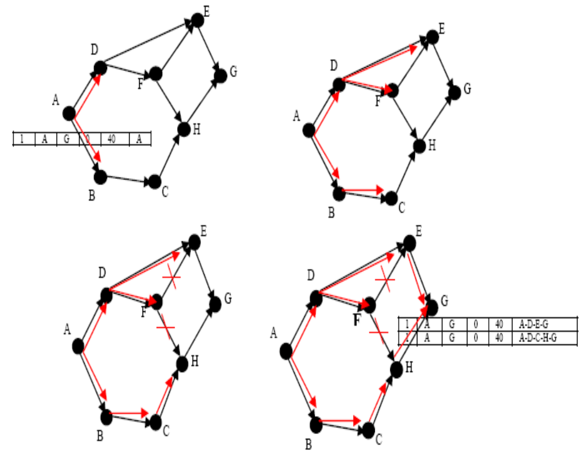

Fig. 4. RREQ packets towards Destination with the Condition of Bandwidth Requirement

3 EXPERIMENTAL ANALYSIS

For the Ad hoc network shown in Fig. 4, if source node A wants to send packets to destination node G with the bandwidth requirement of 40 Mbps. The available bandwidth at each node is shown in Table 3. Fig. 4 shows various steps to transfer RREQ packets towards destination with the condition of bandwidth requirement. Last step shows only two RREQ packets received by destination node with in the time specified in TIMER_DES.

TABLE 3

AVAILABLE BANDWIDTH AT NODES IN THE NETWORK

Nodes	Available Bandwidth (in Mbps)
A	45
B	55
C	45
D	50
E	60
F	30
G	70
H	40

In this section, we discuss how to calculate the total time required in order to send packets from source to destination using basic DSR routing protocol and proposed DSR_A protocol. Various abbreviations used for this purpose are shown in Table 4.

For the calculations, two situations are considered. First situation (best case) is when all the intermediate nodes between source and destination fulfill the requested bandwidth requirements. Second situation (worst case) is when one node on a path between source and destination does not fulfill the requested bandwidth requirements even after the k number of attempts.

TABLE 4

ABBREVIATION USED

S.no.	Abbreviation	Description
1	Tp	Processing Time
2	N	Number of packets
3	M	Minimum number of Intermediate nodes on a path between source & destination
4	Tt	Propagation Time
5	TRREQ	Route request Packet time from source to destination
6	TRREP	Request Reply Packet time from destination to source
7	Tw	Waiting Time
8	K	No of attempts in case of failure

Situation I: Best Case

Total Time)$_{DSR}$ = $T_{RREQ}+T_{RREP}+ m^* T_p+ T_t *(m+1)$ (1)

(Total Time)$_{DSR-A}$ = $T_{RREQ}+T_{RREP}+ m^* T_p+ T_t *(m+1) + T_w$ at destination node+ T_p at source node
(2)

Situation II: Worst Case

$(\text{Total Time})_{DSR} = k*\{T_{RREQ} + T_{RREP} + ((m/2+1) + 1)*T_p\} + T_{RREQ} + T_{RREP} + m*T_p + T_t*(m+1)$ (3)

$(\text{Total Time})_{DSR\text{-}A} = 2*T_t*(m+1)* + T_w + T_p$ (4)

For the calculation, some values of the parameters are considered whose details are shown in Table 5.After substituting these values in equations 1-4, resulted total time for basic DSR and proposed DSR_A protocols are shown in Table 6 and corresponding graph representation is shown in Fig. 5.

TABLE 5

VALUES FOR CONSIDERATION

	T_p	n	T_t	T_w	k
Values (in msec.)	0.25	5	1	4	4

TABLE 6

COMPARISON TABLE OF TOTAL TIME FOR DSR AND DSR-A

	Best Case (in msec)	Worst Case (in msec)
Basic DSR Protocol	9.5	36.5
DSR_A Protocol	13.5	13

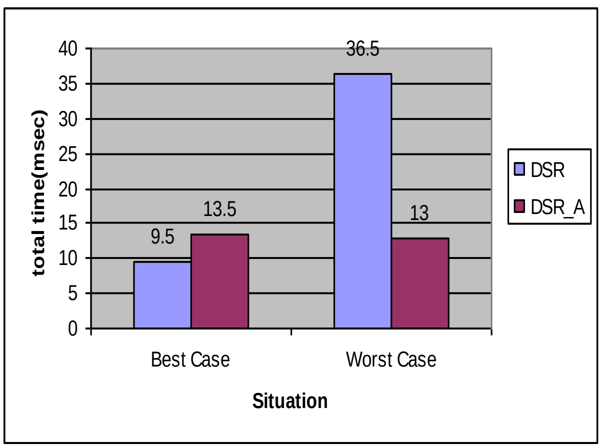

Fig. 5. Graph Representation of total time for DSR and DSR-A

In order to calculate percentage of saving of total time when using DSR-A routing protocol, following equation is used. The result shows 64.38% of saving in total time to send packets from source
to destination.

$$\%\ \text{saving (Total Time)} = 100 - \left(\frac{(\text{Total Time})DSR - A}{(\text{Total Time})DSR} * 100 \right)$$

The result shows 64.38% of saving in total time to send packets from source to destination.

4 CONCLUSION

This paper has presented a protocol (DSR-A) for routing packets between mobile nodes in an ad hoc network. Unlike routing protocols like dynamic source routing and ad hoc on demand distance vector routing, our protocol considers various parameters like bandwidth requirement of source node and battery life of all the intermediate nodes on a path to destination. Bandwidth requirement depends on the type of data used for transmission like voice, multimedia data etc. Battery life reflects high probability of path usage for transmission. Based on results of numerical analysis, DSR-A protocol is better when mobile nodes on a path between source and destination do not fulfill the requested bandwidth requirements even after many attempts. In this situation, our protocol saves 64.38% of total time to send packets to destinations.

REFERENCES

[1] Elizabeth M. Royer, C-K Toh. A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks, IEEE Personal Communications, Vol. 6, April 1999,pp. 46-55.

[2] C. E. Perkins and P. Bhagwat. Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers Computer Communications, Review, pp. 234-244, October 1994.

[3] C. E. Perkins and E. M. Royer, Ad Hoc On Demand Distance Vector (AODV) Routing, IETF Internet Draft, draft-ietf-manet-aodv-02.txt, November 1998

[4] J. Broch, D. B. Johnson, D. A. Maltz, The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks, IETF Internet Draft draft-ietf-manet-dsr-01.txt, December 1998.

[5] Qi Xue , Aura Ganz. Ad hoc QoS on-demand routing (AQOR) in mobile ad hoc networks , Journal of Parallel and Distributed Computing,(63), 154-165, 2003.

[6] Hannan XIAO, Winston K.G. SEAH, Anthony LO and Kee Chiang CHUA. Flexible Quality Service Model for Ad-HOC Networks, In proceedings of the IEEE Vehicular Technology Conference, Tokio, Japan, May 2000.

[7] [ACLZ99]G-S. Ahn, A.T. Campbell, S-B. Lee, and X. Zhang. INSIGNIA, Internet Draft, draft-ietf-manet-insignia-01.txt,Oct 1999.

[8] Morteza Maleki, Karthik Dantu, and Massoud Pedram. Power-aware Source Routing Protocol for Mobile Ad Hoc Networks, ISLPED'02, August 12-14, 2002, Monterey, California, USA.

[9] B. Venkatalakshmi1 and S. Manjula. Power Aware On Demand Multicast Routing protocol.

[10] M. Pushpalatha, Revathi Venkataraman, and T. Ramarao "Trust Based Energy Aware Reliable Reactive Protocol in Mobile Ad Hoc Networks", World Academy of Science, Engineering and Technology 56 2009.