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Real Time On-Demand Distance Vector Routing In Mobile Ad hoc Networks

Sanjeev Jain, Venkateswarlu Pitti and Bhupendra Verma
Department of Information Technology,
Samrat Ashok Technological Institute, Vidisha (M.P) 464001 India

Abstract: The existing Ad hoc On Demand Distance Vector (AODV) protocol do not support the route discovery and route maintenance in the real time traffic of mobile Ad hoc networks A new protocol Real Time On-demand Distance Vector (RODV) protocol has been proposed in this study that deals with the real time traffic such as messages audio and video which are time sensitive. This protocol considers the load field in the Route Request (RREQ) packet of AODV as the factor affecting the performance of the protocol. The load as the parameter in the RREQ decreases the congestion on the node by route discovery mechanism. This will decreases the delay for the transferring the real-time traffic. In this study Route Maintenance is also used, in which if any link is failed or active node is moved from the link, RODV handles the situation, by finding the path between the nodes where the link is failed without transferring the failure information towards the source node. This will reduce the delay in transmitting the data in comparison to AODV routing protocol. It will also help in decreasing the routing overhead in the Ad hoc networks.

Key words: Wireless networking, AODV, RODV, Mobile Ad hoc network, DSR, DSDV

INTRODUCTION

The widespread development of Ad hoc networking and the numerous possible applications of Ad hoc networking, push for the support of real-time applications in Ad hoc networks is very much essential. Since wireless resources are much scarcer than fixed ones, it is necessary to design new schemes to improve support for real-time traffic and optimize network load. Timely wireless Ad hoc networks are essential to allowing Real-time traffic such as audio and video Wireless networking is an emerging new technology that will allow users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types: infrastructured network and infrastructureless (Ad hoc) networks. Infrastructured 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. All nodes of Ad hoc network behave as routers and take part in discovery and maintenance of routes of other nodes in the network. Ad hoc networks are very useful in emergency search and rescue operations, meetings or conventions in which persons wish to quickly share information and data acquisition operations in inhospitable terrain.

Mobile Ad hoc Network (MANET)[1,2] is a network where each of its nodes can act as a router.MANETs tend to be based on wireless mobile nodes and unlike traditional wireless systems such as IEEE 802.11 or GSM, MANETs are not structured around base stations. Instead, nodes communicate directly with each other. When a single hop route between two nodes is not available, neighboring nodes can route packets for their neighboring nodes. Classification of routing protocols[3,4] shown in Fig. 1[1] .

Classification of routing algorithms: Depending on the criteria we can have several classifications of routing

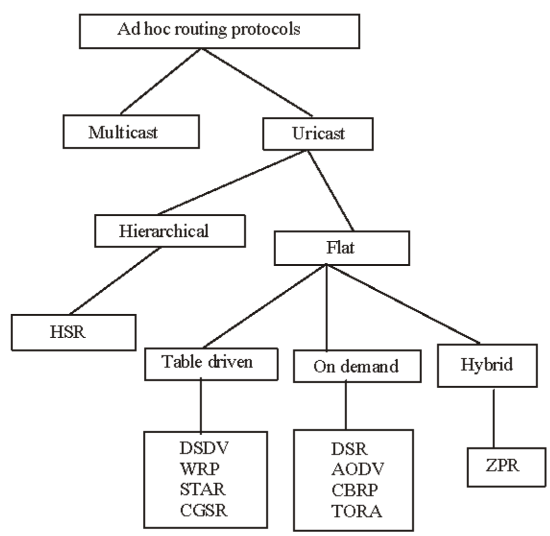

Fig. 1: Classification of routing protocols

Corresponding Author: Sanjeev Jain, Department Of Information Technology, Samrat Ashok Technological Institute, Vidisha M.P 464001 India

algorithms for ad hoc networks in[1]. First, we can clearly distinguish between unicast and multicast routing protocols. The three different points of view lead to sort the protocols in the following way.

Structure

Uniform protocols: All the nodes have the same roles in the routing schemes, so there is a flat routing structure.

Non-uniform protocols: To limit routing complexity by decreasing the number of nodes involved in a route computation. They turn out to be an attempt to achieve scalability and reduce overhead.

State information

Topology-based protocols: The nodes maintain large-scale topology information. Link state based protocols are representative among these routing protocols.

Destination-based protocols: The nodes keep some local topology information, like distance vector based protocols do by storing a distance (whatsoever metric employed) and vector (next hop) to the destination.

Scheduling

Table driven (proactive) algorithms: Store the needed information for routing purposes in tables, which are repeatedly updated through control packets that are sent by each node. The updates can also respond to topological changes of the network.

On-demand (reactive) protocols: In contrast to table driven routing protocols, compute the route to a specific destination only when needed, so a routing table containing all the nodes as entries does not have to be maintained in each node. When a source wants to send to a destination, it invokes a route discovery mechanism to find the path to the destination. The route remains valid till the destination is reachable or until the route is no longer needed.

We are developing a Routing Protocol on the basis of Ad hoc On Demand Distance Vector (AODV) Routing. Many researchers[5-7] says that the routing algorithm is quite suitable for a dynamic self starting network as required by users wishing to utilize ad hoc networks. AODV provides loop free routes even while repairing broken links. Because theprotocol does not require global periodic routing advertisements the demand on the overall bandwidth available to the mobile nodes is substantially less than in those protocols that do necessitate such advertisements. This algorithm scales to large populations of mobile nodes wishing to form Ad hoc networks.

The algorithm's primary objectives are:

- To broadcast discovery packets only when necessary
- To distinguish between local connectivity management neighborhood detection and general topology maintenance.
- To disseminate information about changes in local connectivity to those neighboring mobile nodes that are likely to need the information.

AODV uses a broadcast route discovery mechanism as in the Dynamic Source Routing (DSR)[8,9] algorithm. Instead of source routing, AODV relies on dynamically establishing route table entries at intermediate nodes. This difference pays off in networks with many nodes where a larger overhead is incurred by carrying source routes in each data packet. To maintain the most recent routing information between nodes, they borrow the concept of destination sequence numbers from Destination Sequence Distance Vector (DSDV)[10]. Unlike in DSDV however each Ad hoc node maintains a monotonically increasing sequence number counter which is used to upersede stale cached routes. The combination of these techniques yields an algorithm that uses bandwidth efficiently. By minimizing the network load for control and data traffic is responsive to changes in topology and ensures loop free routing. The path discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. Every node maintains two separate counters, a node sequence number and a broadcast id. The source node initiates Path discovery by broadcasting a route request (RREQ) packet to its neighbors.

Proposed routing algorithm is a modification of the basic AODV routing protocol. We are likely to over come the limitations which are pointed out in the previous study. The basic routing mechanisms in present proposed routing protocol are Route Discovery and Route Maintenance as in AODV routing protocol with modifications, to improve the performance of the routing protocol.

Route discovery: The route discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. The source node initiates Route Discovery by broadcasting a route request (RREQ) packet to its neighbors. The RREQ contains the following fields as mentioned in Table 1

We have added the Load (L) field to the Routev Request (RREQ) message. This Load (L) field specifies the load on the nodes. When a node receives the RREQ

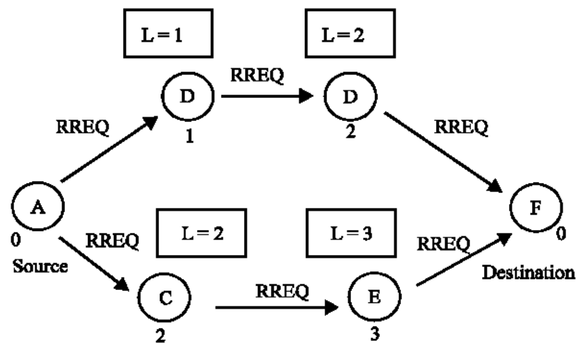

Fig. 2: Route request (RREQ) message formate

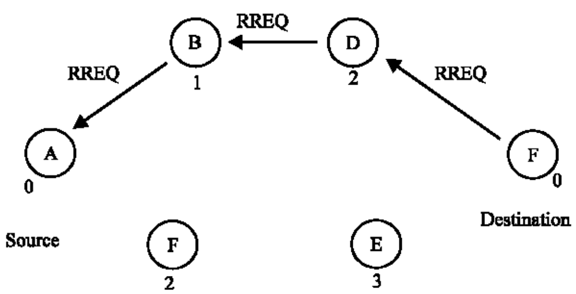

Fig. 3: Propagation of RREQ from source to destination

message,the node will replace with its load if the load value is less than the load it is having otherwise it will not change the Load (L) field in the RREQ message format as shown in Fig. 2.

The number below the nodes specifies the load on that node as shown in the Fig. 2 and the L = 3 specify that the node E has replaced the L field with its load.

Figure 3 shows the destination field will get two RREQ messages with the same hop count = 2 and with two different Load values 2 and 3. Now, the destination will select the optimal path based on the values in the Load on the nodes. Hence the A->B->D->F path will be selected and the destination F will unicasts the RREP message to the source in the selected optimal path (Fig. 4.) By selecting the routes in this manner we are able to overcome the limitation that the nodes with more load will come in the active route. This will indirectly support for the real time traffic. If we select the optimal path with the nodes with fewer loads, the congestion and the load in the network will be decreased.

Data transmitting: While transmitting data, the source will set the priority to the transmitting data, such as, real time or non-real time traffic. The intermediate nodes in the active root will be having the priority queues, by which the priority for the real time traffic will be more than the non-real time traffic.

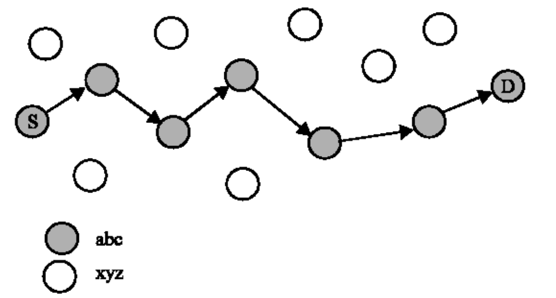

Fig. 4: Data transmission using the active route

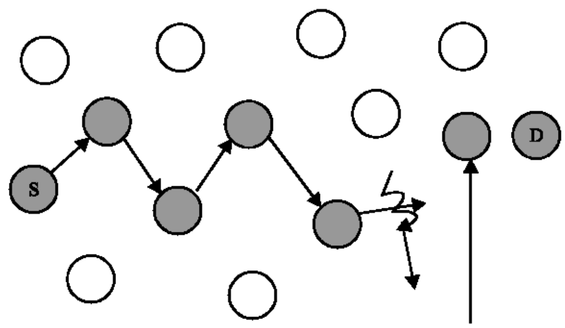

Fig. 5: Link break in active route

Table 1: Route Request (RREQ) mesage fomate

Route Request (RREQ) message formate
0 1 2..7 8 9 0 1 2..8 9 0 1 2 3 4 5 ... 9 0 1

Type	D	G	L	Reversed	Hop count
RREQ ID					
Destination IP address					
Destination sequence number					
Originator IP address					
Originaror sequence number					

Route maintenance: The treatment of link failures will be of two cases in present proposed protocol. Case 1, if the intermediate or destination node moves (or link failure occurs) and Case 2, if the source node moves.The recovery from the first case is as follows. In the AODV routing protocol, when a link break in an active route occurs (Fig. 5), the node upstream of the break creates a Route Error (RERR) message listing all the destinations which have become unreachable due to the break. It then sends this message to its upstream neighbors till the source node. Then the source node re-initiates the Path Discovery process, which leads to delay in transmitting the data. Instead of sending an Route Error (RERR)

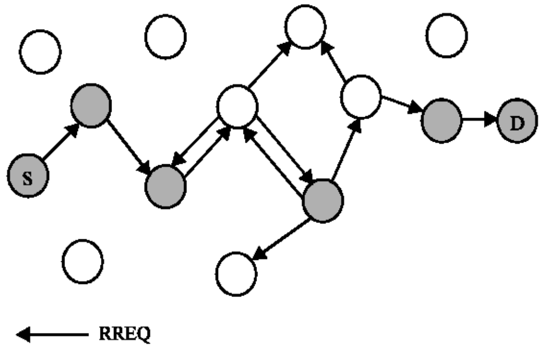

Fig. 6: Broadcasting RREQ with small TTL

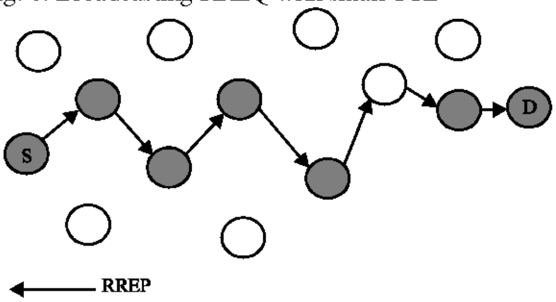

Fig. 7: Propagation of route request

message to the source node.A node upstream of a link break that attempts to repair the route, broadcasts a RREQ with a TTL set to the last known distance to the destination, plus an increment value (Fig. 6).

This TTL value is used so that only the nearer nodes of the destination will be searched, which prevents flooding the entire network. The upstream node places the sequence number of the destination, incremented by one into the RREQ (Fig. 7).

After the upstream node attempts to repair the broken link itself, fewer data packets may be lost and the link can be repaired without the source node and other upstream nodes being disturbed (Fig. 8).

If a route to the destination is not located on the first attempt, a RERR message is sent back to the source node and Route Discovery continues as described in Route Discovery process.If the source node moves away from its neighbor, then the source node will re-initiate the Route Discovery process. This is about Route Maintenance in present proposed routing protocol.

Simulation: The most recent version 2.27 of the network simulator NS_2[11] is used for the simulation study. Each mobile host uses an omni-directional antenna. The IEEE 802.11 Distributed Coordination Function (DCF) is used as the MAC layer protocol. The implementation uses Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol. We have simulated AODV, DSDV

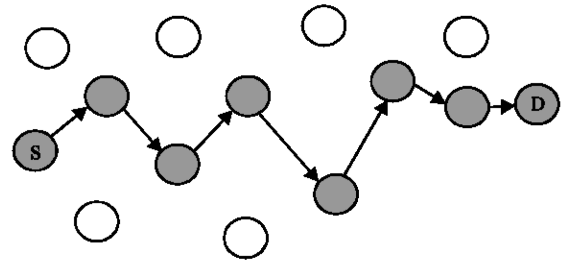

Fig. 7: Reversed route

and Route Maintenance of present proposed routing protocol in NS_2. For present results we assumed 50 mobile nodes communicating via IEEE 802.11. The nodes move inside a simulation area of 1000×1000 m. The simulation time is 300 sec. The nodes move with a maximal velocity of 20 m s^{-1} and with the pause time of 10 sec. In this model, a node randomly chooses a point in the simulation area and a speed for the next move which is uniformly distributed between 0 and the maximal velocity. Subsequently, the node drives to the selected point at constant speed. After arriving at the end point the node remains there for a certain time. Subsequently, the node repeats the operation by selecting a new end point and a new speed.The Constant Bit Rate (CBR) traffic is used in the simulation with 20 sources (or mobile connections). Eachconnection is specified as a randomly chosen source destination pair. The packet sizes are fixed as 512 bytes. The packet sending rate is 4 packets per sec. Each connection starts at a time randomly chosen from 0 to 100 sec.

Comparison metrics

Packet delivery ratio: The ratio between the number of packets originated by the CBR sources and the number of packets received by the CBR sink at the final destination..

Routing overhead: The total number of routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet (each hop) counts as one transmission.

Average end-to-end delay: The average time it takes for a packet to reach the destination. It includes all possible delays in the source and each intermediate host, caused by routing discovery, queuing at the interface queue. Only successfully delivered packets are counted.

RESULTS

We simulated the result using network simulator version 2.27 software by taking the parameters (Maximum speed, pause time, number of nodes) on x-axis and performance metrics (Packet delivery ratio, normalized overhead, average end to end delay) on the Y-axis.

Packet delivery ratio vs maximum speed: present proposed routing algorithm (RODV) is showing better performance than the other two simulated routing protocols (AODV and DSDV) as shown in Fig. 9.
speed. We simulated the routing protocols at different speeds (0 to 30 m s^{-1}).

Average end to end delay vs maximum speed: The difference between DSDV line and RODV is more because we have taken values when the mobile nodes are moving. In present proposed routing protocol we have decreased the delay of the recovery from the link failure that is the reason why present proposed protocol line is giving better performance than other protocols (Fig. 10).

Packet delivery ratio vs pause time: Pause Time is the idle time for which the mobile nodes in the Ad hoc Network are in stable position. After Pause Time the mobile nodes will move and will be steady for the given pause we have taken different Pause Time (0 seconds to 900 seconds) for which the performance are almost same for both the AODV and present proposed routing protocol (Fig. 11).

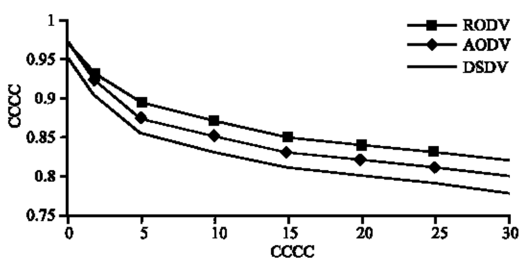

Fig. 9: Packet delivery ratio Vs maximum speed

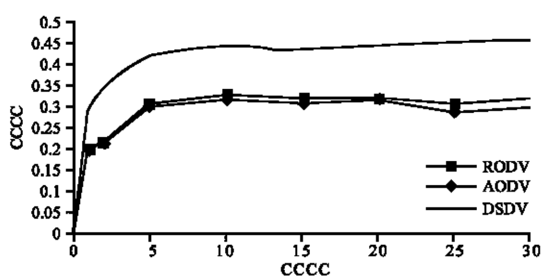

Fig. 9: Average end-to-end delay Vs maximum speed

Normalized routing overhead vs pause time (sec.): The Routing Overhead is more for AODV and RODV (our proposed Routing Protocol) when compared with DSDV at Pause Time is 0. As we increase the Pause Time the performance of AODV and RODV are increasing. The

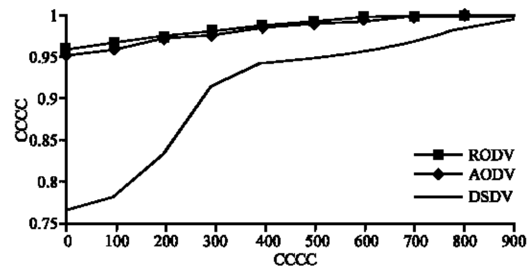

Fig. 11: Packet delivery ratio Vs pause time

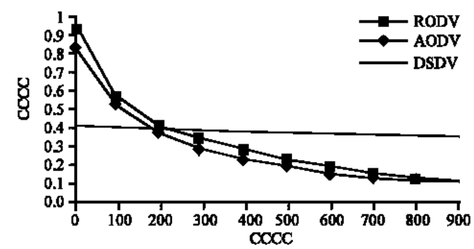

Fig. 12: Normalizing routing overhead Vs pause time

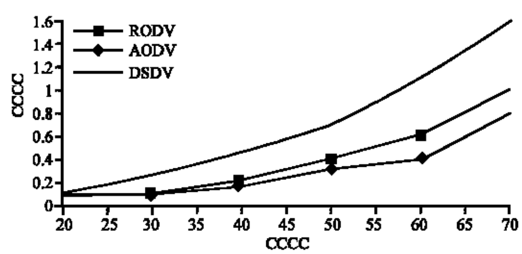

Fig. 13: Normalizing routing overhead Vs No. of nodes

performance of DSDV is constant for all Pause Time (Fig. 12).

Normalized routing overhead vs number of nodes: As the number of nodes is increasing the performance of the DSDV is decreasing when compared with AODV and present proposed routing protocol. The performance of AODV and RODV is same at start but as the number of nodes increased, the gap between the AODV and RODV is also increased. This will prove that present proposed protocol is more scalable than AODV (Fig. 13).

CONCLUSION

Proposed Real time On demand Distance Vector (RODV) routing protocol is an efficient means to support real-time traffic and to avoid congestion in Mobile ad hoc networks. In Route Maintenance, if any link is failed or active node is moved from the link, RODV handles the situation, by finding the alternate path between the nodes where the link is failed. This reduces the delay in transmitting the data when compared with AODV routing protocol. The routing overhead in the network is also decreased in the Ad hoc Network. The simulation results show that the performance of present proposed routing protocol is better when compared to AODV and DSDV routing protocols. The proposed routing protocol increases the Packet Delivery Ratio while simultaneously decreasing the Average End to End Delay. Routing Overhead is reduced as compared to the basic AODV routing protocol. The future work of this paper is to modify the Route Discovery process to suite Real-time traffic in Ad hoc Networks. We have to analyze the results of present proposed routing protocol with the basic AODV routing protocol.

REFERENCES

1. Charles, E.P., E.M. Royer and S.R. Das, 2003. Ad hoc On-Demand Distance vVector (AODV) routing. IETF Internet Draft, Manet Working Group.
2. Sung-Ju, L., E.M. Royer and C.E. Perkins, 2003. Scalability study of the Ad hoc on-demand distance vector routing protocol. In ACM/Wiley Intl. J. Network Manage., pp: 97-114.
3. Broch, J. and D.A. Maltz, 2002. A performance comparison of multi-hop wireless Ad hoc network routing protocols. In: Proceedings of the 4th Ann. ACM/IEEE International Conference on Mobile Computingand Networking (MobiCom'98), Dallas, Texas, USA Internet Draft.
4. Broch, J., D.B. Johnson and D.A. Maltz, 1998. The dynamic source routing protocol for mobile Ad hoc networks. Internet Draft.
5. Elizabeth, M.R. and C.K. Toh, 1999. A review of current routing protocols for Ad hoc mobile wireless networks. IEEE Personal Communications., pp: 46-55.
6. David, B.J. and D.A. Maltz, 1996. Dynamic Source Routing in Ad Hoc Networks. Mobile Computing, T. Imielinski and H. Korth, Eds., Kulwer, pp: 152-181.
7. Elizabeth M.R. and C.E. Perkins, 2000. An implementation study of the AODV routing protocol. In: Proceedings of the IEEE Wireless Communications and Networking Conference, Chicago, IL.
8. Charles, E.P. and P. Bhagwat, 1998. Highly dynamic Destination Sequenced Distance Vector routing (DSDV) for mobile computers. In: Proceedings of the SIGCOMM '98 Conference on Communications Architectures, Protocols and Applications, pp: 234–244.
9. Perkins, C., 2000. Ad Hoc Networking. Addison-Wesley Publishing Company. 1st Edn.
10. Agarwal, D.P. and Z. Quin-An, 2003. Wireless and Mobile Systems Thomson Asia Pte Ltd., Singapore, 1st reprint.
11. http://www.isi.edu/nsnam/ns/s.