Design of an On-demand Routing Protocol for MANET

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Abstract: An ad-hoc network consists of a set of mobile nodes which are connected with each other by using radio waves. These networks do not need any predetermined structure or central management system and all nodes work as routers. These days the scalability of ad-hoc networks has interested some scholars. Scalability of most of on-demand routing protocols has become limited because of increasing the nodes' population and movement in network. In this paper an on-demand routing algorithm for MANET networks will be presented which aims at creating an algorithm with a high scalability. The effect of network size (number of nodes), nodes' movement, and data traffic on the efficiency of the proposed algorithm and other principal algorithms which have been utilized to create the present algorithm will be studied and their simulation results will be compared. The simulation results show that the proposed algorithm has more efficiency than the present standard algorithms.
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1. Introduction

MANET networks [1-3] are systems of mobile ad hoc networks which are presented dynamically and self-organized in temporary topologies. These networks include a set of mobile routers and hosts which share the same radio canal by using wireless connections and exchange data without using a centralized or broad management. The nodes in these networks can vary regarding the different features such as yield, data sending ability and sources' energy.

MANET networks have several usages. First these networks were devised to be used in military applications. MANET networks are mostly used in survey, helping and saving operations, tracing and following operations, scientific conferences.

In this paper and in order to create proposed on-demand routing algorithm [4-8], we have used adjusted probabilistic flooding [9-10] and AODV [11-12] algorithms which are based on AODV [13-14, 5] routing algorithm. At present, AODV routing protocol is one of pioneering protocols for routing in ad-hoc networks. AODV routing protocol includes a route discovery and a route repair mechanism. Route discovery mechanism [15, 13, 6], is a route demand between a sender and a receiver and route repair mechanism is a new route for a disconnected active route. Disconnection is recognized by connection layer's approval or controlling messages of Hello [13].

If there is not any direct route between source and destination, multi-hop routing is used. Thus, because of limited distribution of nodes in the area, both nodes may need a chain of intermediate nodes to establish the connection. Since these networks have an inconsistent nature, finding and maintaining the route has certain importance. Controlling information is exchanged between the nodes to identify the current status of the network. On the whole, MANET networks' routing protocols are divided into three categories of proactive, reactive, and hybrid protocols. In proactive routing protocols [19] (routing based on table), routing tables are created before sending packets and each node knows the route to other nodes. The problem of this protocol in ad-hoc networks is that maintaining and timing routing tables need a broad bandwidth. Also, most of routing information is never used and consequently the sources are wasted. In reactive routing protocols [13, 6] (on-demand routing), the route is created when there is a need for it. Before sending the packet, route discovery is done and the results are stored in a cache memory. When middle nodes are moved, route repair is done on demand. The advantage of these protocols is that only the routes needed are maintained. The disadvantages include the delay before sending the first packet and the existence of flooding for route discovery. Hybrid protocols [16], are a combination of proactive and reactive protocols.

Scalability of a lot of on-demand routing protocols is limited because of population increase and nodes' movement. When the number of users is increased, ad-hoc routing protocols (like [15-19, 5, 6]) need scalability because of nodes' increase. In this paper the two algorithms of adjusted prob. and AODV-LR will be combined and a new algorithm will be posed in which the main goal is to increase scalability. Scalability for wireless routing protocols is basically depends on extra routing messages [20]. The efficiency of the proposed algorithm will be compared through the results of simulations of routing algorithms of AODV, AODV-LR and Adjusted prob.

2. The Proposed Algorithm

In this part we will introduce a new routing algorithm to improve scalability. Adjusted prob. Algorithm optimizes route discovery by source node and decreases the amount of PREQ in the network. AODV-LR algorithm decreases the number of route rediscovery by source node. For increasing scalability, we integrate adjusted prob. Algorithm with AODV-LR algorithm. In the resulted algorithm, when there is no route for sending the data from source to destination node, the source node performs route discovery and spreads a new PREQ packet including the information below: source address, sequence number, Broadcast id, destination address, destination packet number, number of leaps. Broadcast id increases as the spread by source increases. Broadcast id is a unique couple for PREQs' identification.

When a node receives PREQ, if it is for several times, it ignores and if it is the first time, creates the route to the source in its routing table. Information such as: destination address, next leap, the number of leaps, destination packet number, and valid time for this route is stored in the node. If a route is not used during a certain time period it would lose its validity. Then the node checks whether there is a valid route to destination node? If the node itself is the destination or it has a valid route to destination and packet's number is greater or equal to destination packet's number in PERQ, a PREP including the following information: source address, destination address, destination packet's number, the number of leaps to destination life time will be spread to the source in a single part. When the middle node receives PREP, it creates the route to destination node in its routing table and sends PREP to the source. On the other hand (if the node itself is not the destination or does not have a valid route to the destination), if the number of neighboring nodes receiving PREQ(x) is less than the average number of the neighbors, the message is spread by a high probability of (p) after adding an extra unit to the number of leaps.

Nodes located in transfer limitation of each other are called neighbors. The number of neighbors is determined by using Hello messages. Each node spreads a Hello message periodically to express its existence. The spread probability of p in each mobile node accords with the number of its neighbors. When the nodes move to another boundary, the amount of p is changes. The average number of neighbors is calculated by formula 1 [9-10]. In this way, at the time of route discovery most of repeated PREQ spreads will be avoided.

$$\bar{n} = (N-1) * 0.8 \frac{\pi r^2}{A} \qquad (1)$$

In the above formula, A is the network circumference, N the number of nodes in the network and r is the boundary for nodes' transfer.

When a connection stops, it is better to devise a new route locally and without discovering route from source. In this way, the sent data is stored in a higher node in order to restore the route locally. By using this method in large networks, the delay will be decreased because a less time is needed to search and achieve a new route.

Thus, when connection stops the higher level node tries to restore the route. A PREQ in which TTL equals the previous distance to the destination in addition to an extra amount, its packet number, destination packet number plus one is created and it is sent to the neighbors. The superior node waits to receive PREP. If it does not receive PREP after a predetermined time, it sends a RERR message to the source and all nodes which use this connection to reach to their destinations update their tables by receiving RERR. Finally, the source receives RERR, then deletes the related routes from its table and then starts the operation to discover a new route.

Figure 1, shows the processing flowchart of the received packet by a node in the proposed algorithm and also the proposed pseudo-code routing algorithm is as follow:

Protocol Receive Request()

On hearing a broadcast packet m at node X
Get the Broadcast ID from the message;
$\bar{n}$ Average number of neighbors (threshold value);
Get degree n of a node X (number of neighbors);
If packet_m received for the first time then
 If $n<\bar{n}$ then
 Node X has a low degree, so set high rebroadcast probability p=p1;
Else if $n \geq \bar{n}$ then
 Node X has a high degree, so set low rebroadcast property p=p2;
End if
End if
Generate a random number RN over [0,1];
If $RN \leq p$ rebroadcast message
Else drop it.

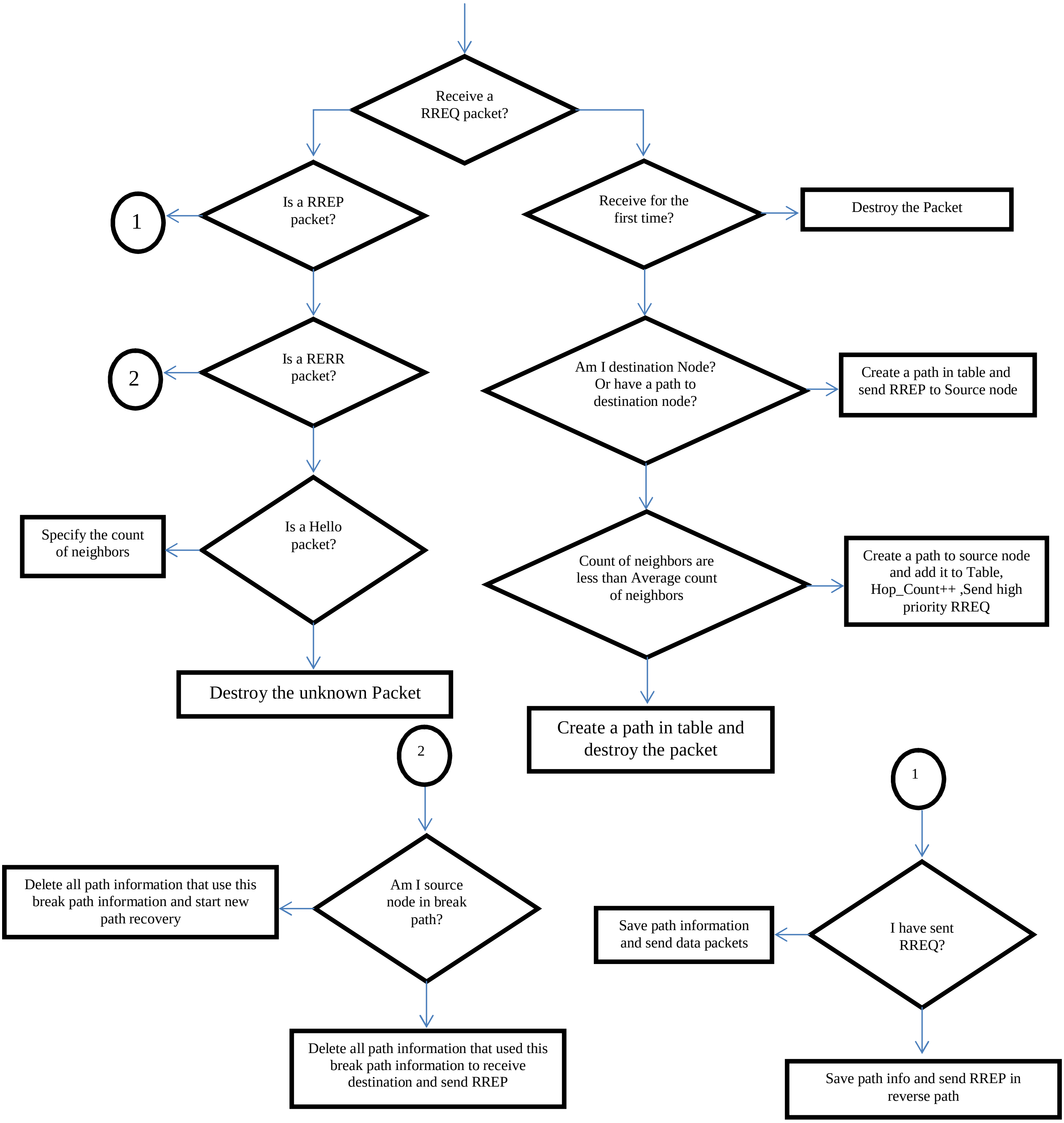


Figure 1. Processing flowchart of the received packet by a node

Protocol route link layer failed()
If the broken link is closer to the destination that source then
Attempt a local repair
Else
Bring down the route.

3- Simulation and performance Assessment

For simulation, we used ns2 [21] version ns2.31 which includes a set of wireless networks' components based on 802.11 [22] and it allows the nodes to move freely in network's environment. A lot of routing protocols which have been observed recently (AODV, DSR, TORA, DSDV) have been simulated in ns2 [23,24, 14].

In this simulation, the data packets were considered to be 512 bytes and CBR traffic has been used. Each node uses random way point model [24] and the speed is random between 0 to 10 m/s.

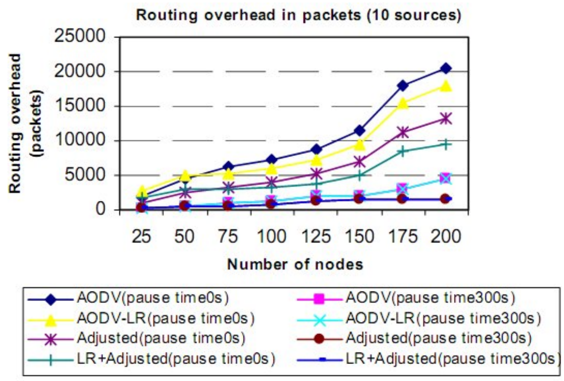
In this model, the node chooses a random destination and moves towards it with a speed which has been predetermined regarding its minimum and maximum speed. When the node reaches the destination, it stops there for predetermined pause time, and then it randomly chooses another destination and moves towards it. The ground size is 750m*750m and the nodes' number is changed from 25 to 200. Each simulation takes 300s. According to previous experiments and studies, in scenarios with high movement the difference in protocols' efficiency is clearer. In static networks, we can examine the power of a protocol in rapid discovery of a route and effective delivery of the data. In these networks because the nodes are fixed, no route is stopped and thus the administrative burden is minimum and the delays are not long or data packets are not lost. In this way, we can execute and report nodes of 25 to 200, and scenarios with fixed movement (pause time, second), while nodes are not working (pause time of 300 seconds). Also, we can study with 75 nodes, the movement effect on protocols' efficiency. We executed each experiment with 10 or 20 CBR traffic sources and with this number of sources, the protocols' scalability will be studied with traffic load.

We used two metrics of ROP and PDF to obtain the efficiency of routing protocols. ROP is the sum of transferred routing packets' number during the simulation and each leap in one route is calculated separately. PDF is a ratio of sent data packets which have been delivered by each routing protocol. Next we will study the effects of nodes' number and movement on protocols' efficiency.

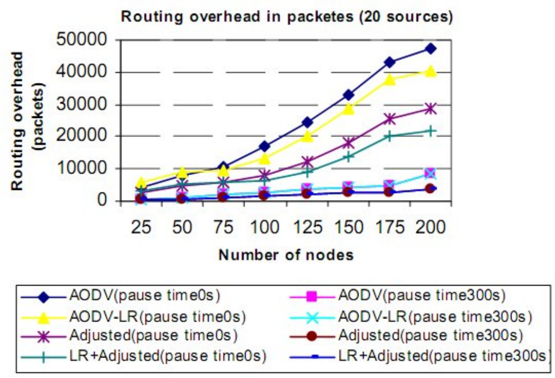
3.1. The effect of nodes

Figure 3, shows ROP protocols with static scenarios (pause time 300 seconds) and high movement scenarios (pause time, 0 seconds) as a function of nodes' number and network load for different numbers of traffic sources. In static mode, ROP is the same for the proposed algorithm and adjusted prob. Because the nodes are fixed and it is better than the two other algorithms because of less PREQ spread. In high movement scenario (more than 50 nodes), the proposed algorithm has less ROP because of spreading less PREQ while route discovering and locally restoring the disconnected route.

Figure 4 shows the measured PDF. In static scenario (pause time 300 seconds), the protocols have better scalability compared with the increase of nodes' number.

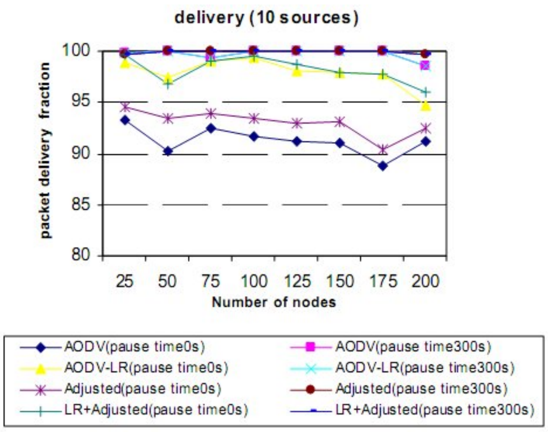


(a) Source number =10

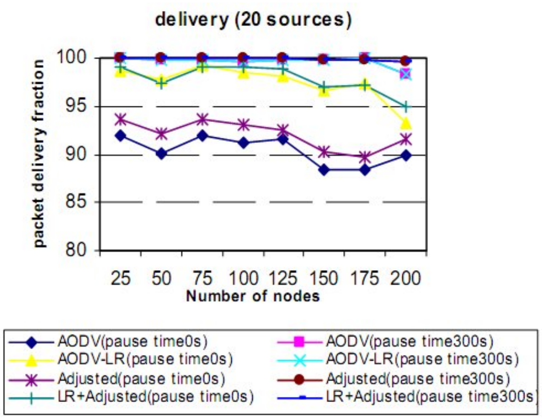


(b) Source number=20

Figure 3: the sum of transferred routing packets' number while simulating



(a) Source number =10



(b) Source number =20

Figure 4: A ratio of sent data packets which have been delivered by each routing protocol

In high movement scenario, the proposed algorithm and AODV-LR have a better PDF than the other two algorithms because the proposed algorithm and AODV-LR do not remove data packets and thus packets' delivery is more in these two algorithms. As you can see in the figure, in high movement, the PDF with 20 traffic sources is less than the PDF with 10 traffic sources.

PDF is low because a lot of data packets fail to reach to their destinations. When the number of traffic sources increases, the protocols start to delete most of data packets in the source. When a data packet (CBR) is produced, it is labeled as a send-buffer agent. Here the data packet waits to find its route. When the route is discovered, the data packet is removed from send-buffer and is sent to connection layer and is located in IFQ. If there is a route to destination, the packet enters IFQ directly and avoids going into send-buffer. MAC layer takes the packet from IFQ and sends it onto the channel. If send-buffer is full or the packet has been preserved for a long time and waits for a route, the data packet can be deleted in source node. The other reason to delete data packet in source node, is the overcharge of IFQ. IFQ works in FIFO mode. When it becomes full, the entrance of a new packet, deletes the old packets because of IFQ overcharge.

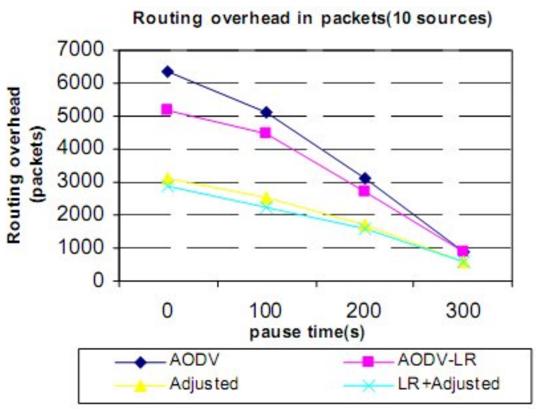
We considered send-buffer size for all protocols to be 64 packets and sending speed to be 4 packets per second. In summary, the reasons for data packets' deletion in source node are IFQ overcharge, packets' time finish, or overpopulation or collisions in which MAC layer is unable to transfer the packet. Also, administrative packets' spread, benefits a higher priority over data packets.

3.2. The effect of movement

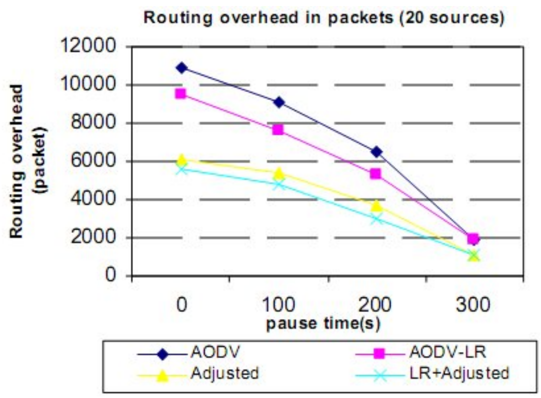
In order to understand the movement effect and the number of traffic sources on protocols' efficiency better, the number of nodes in scenarios is kept fixed and the results of experiments will be presented.

Figure 5, shows ROP is a function of pause time and network load for different numbers of traffic sources. According to figure 5, when the pause time increases, ROP becomes less because the connections stop less and thus routing overcharge decreases.

Figure 6, shows that measured PDF for 75 nodes is a function of nodes' movement with different traffic sources. You can observe that, the ratio of packets' delivery increases by increasing pause time because the longer pause time means less movement. The proposed routing algorithm is able to deliver more data packets to destination in comparison to other algorithms. AODV and Adjusted prob. Routing algorithms remove data packets easily when a route stops and thus the ratio of packets' delivery in AODV and Adjusted prob. becomes worse in comparison to other protocols.

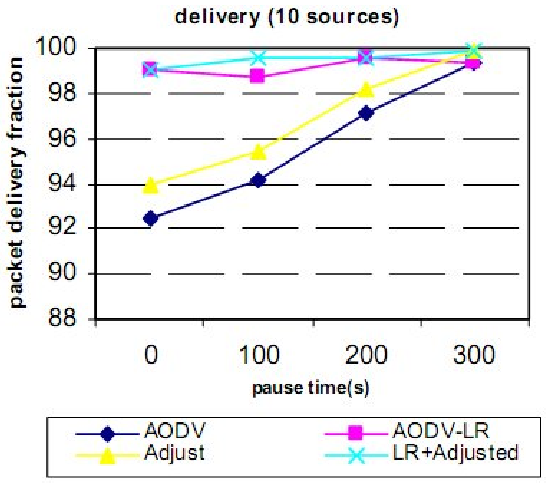


(a) Source node =10

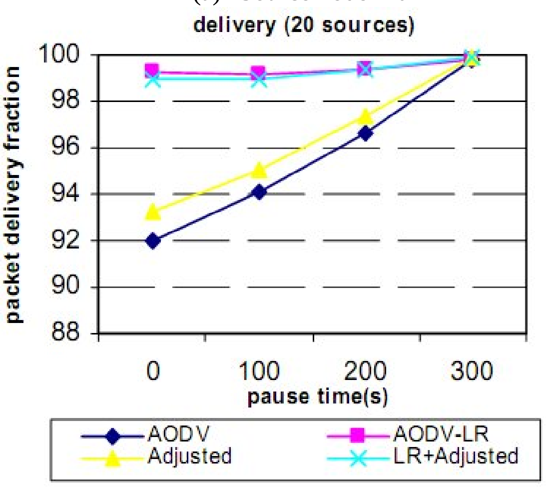


(b) Source node= 20

Figure 5: ROP with 75 nodes



(a) Source node=10



(b) Source node=20

Figure 6: ROP with 75 nodes

4- Discussions

In this article, the scalability of on-demand routing protocols was studied by choosing some protocols from among the set of protocols (AODV, AODV-LR, adjusted prob.), and a new algorithm was suggested to enhance the efficiency in big networks. The scalability of AODV, AODV-LR, adjusted prob. protocols were studied considering different aspects of the issue. We noticed that how the efficiency of these protocols depends on the number and movement speed of the nodes and data traffic load. When the movement and population of nodes increases the routing overcharge increases and it halts data packets' delivery. You observed that local restoring is beneficial in increasing data packets' delivery to the destination. Also adjusted prob. algorithm is effective in decreasing the overcharge amount of routing while route discovering.

Thus, to increase scalability, we proposed a new algorithm which in fact integrates the advantages of the two algorithms of ADOV-LR and adjusted prob. with each other and regarding the results of the simulation presents a better routing algorithm for big ad-hoc networks.

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References

1. Macker. J and Corson. S, Mobile ad hoc networks (MANET), 1997, http://www.ietf.org/html.charters/manet -charter.html.
2. Perkins.C.E., Ad Hoc Networking, Addison Wesley 2001.
3. Toh.C-K., Ad Hoc Mobile Wireless Networks: Protocols and Systems (Prentice-Hall, New York, 2002).
4. Maltz.D., Broch.J., Jetcheva.J., and Johnson.D., The effects of on-demand behavior in routing protocols for multihop wireless ad hoc networks. IEEE Journal on Selected Areas in Communication, 1999.
5. Perkins.C.E., Royer.E and Das.S., ''Ad Hoc On-Demand Distance Vector (AODV) Routing,'' Internet Draft, draftietf-manet-aodv -13. txt, February 2003.
6. Johnson. D.B., Maltz. D.A., Dynamic source routing in ad hoc wireless networks, in: Mobile Computing, Kluwer Academic Publishers, 1996.

7. Abolhassan.M.,Wysocki.T., and Dutkiewicz. E., A review of routing protocols for mobile adhoc networks.Ad Hoc Networks, 2004.
8. Lai. W., Hsiao. S., Lin. Y., Adaptive backup routing for ad-hoc networks, September 2006.
9. Bani-Yassein. M., Ould-Khaoua. M., Mackenzie. L. M. and Apanastasiou.S., Performance Analysis of Adjusted Probabilistic Broadcasting in Mobile Ad Hoc Networks ,International Journal of Wireless Information Networks, Vol. 13, No. 2, April 2006.
10. Bani Yassein. M. and Ould Khaoua. M. ,Applications of Probabilistic Flooding in MANETs, Ubiquitous Computing and Communication Journal,2006.
11. Lee.S., Belding-Royer.E. and Perkins. C., Scalability Study of the Ad hoc On-Demand Distance Vector Routing Protocol. ACM/Wiley International Journal of Network Management ,2003.
12. Pan.M., Chuang.S. and Wang.S., Local Repair Mechanisms for On-Demand Routing in Mobile Ad hoc Networks. 11th Pacific Rim International Symposium on Volume , Issue , 12-14 Dec. 2005.
13. Perkins.C.E., Royer.E., Ad hoc on-demand distance vector routing, Proceedings of IEEE WMCSA 1999.
14. Perkins.C., Royer.E.M., Das.S.R, and Marina. M.K, Performance Comparison of Two On-demand Routing Protocols for Ad Hoc Networks, IEEE Personal Communications, pages 16-28, Feb. 2001.
15. Toh.C.-K., “Associativity-Based Routing for Ad-Hoc Mobile Networks,”Wireless Personal Communications Journal, vol. 4, no. 2, pp. 103-139, Kluwer Academic Publishers, March 1997.
16. 16] Pearlman.M.R. and Haas.Z. J., “Determining the Optimal Configuration for the Zone Routing Protocol,” IEEE Journal on Selected Areas in Communications, vol. 17, no. 8, pp. 1395-1414,August 1999.
17. Sinha.P.,Sivakumar.R. and Bharghavan.V.,“CEDAR: a Core-Extraction Distributed Ad hoc Routing Algorithm,” Proceedings of the IEEE INFOCOM’99, pp. 202-209, New York, NY, March 1999.
18. Corson.S., Macker.J., Mobile ad hoc networking (MANET): routing protocol performance issues and evaluation considerations, RFC.2501 ,1999.
19. Perkins. C.E., Bhagwat. P., Highly dynamic destination sequenced distance-vector routing (DSDV) for mobile computers, Proceedings of the ACM SIGCOMM. 1994 .
20. Ni.S., Tseng.Y., Chen.Y., and Sheu.J., The broadcast storm problem in a mobile ad hoc network, Wireless Networks, Vol. 8, No. 2, pp. 153–167, 2002.
21. The Network simulator ns-2, http://www.isi.edu/nsnam/ns/ ns-man.html.
22. LAN MAN Standards Committee of the IEEE Computer Society. Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. IEEE Standard 802.11. Technical report, 1999.
23. Naumov. V. and Gross. T., Scalability of routing methods in ad hoc networks. Performance Evaluation. (Elsevier Science), October 2005.
24. Broch. J., Maltz. D. A, Johnson. D. B., Hu. Y-C.and Jetcheva.J. A performance comparison of multi-hop wireless ad hoc network routing protocols. In Proceedings of the 4th International Conference on Mobile Computing and Networking (ACM MOBICOM’98), pages 85–97, October 1998.

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