Load-balancing Approach for AOMDV in Ad-hoc Networks

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ABSTRACT

Routing protocol is a challenging issue in ad hoc networks. It has been studied thoroughly these years. However, most routing protocols in ad hoc network do not consider the problem of load balance. In this paper, we present an effective scheme to balance the load in ad hoc network. Ad-hoc on demand multipath distance vector (AOMDV) selects a path with a lower hop count and discards routes with higher hop count. The new scheme can be applied in most on-demand routing protocols. It is implemented in the process of route request. When route request (RREQ) messages are flooded to acquire routes, only the qualified nodes, which have a potential to serve as intermediate forwarding nodes, will respond to these messages, so that the established path will not be very congested, and the traffic will be distributed evenly in the network. In this scheme, a threshold value, which is used to judge if the intermediate node is overloaded, is variable and changing along with the nodes' interface queue occupancy around the backward path. Therefore, we call it an adaptive load-balancing approach. We apply this scheme in Ad-hoc On-demand Multipath Distance Vector (AOMDV) and simulation results show that the network load is balanced on the whole, and the performance of routing overhead and average end-to-end delay is also improved.

Keywords:

Routing Protocol, AODV,AOMDV, load balancing, Queue Length.

I. Introduction

Ad hoc network is a collection of wireless mobile nodes, forming a temporary network without fixed base station infrastructure and centralized management. The typical areas of mobile ad-hoc network applications include battlefield, emergency, search rescue and data acquisition in remote areas. The network topology changes frequently due to arbitrary movement of the mobile nodes, which act as both hosts and routers. A lot of routing protocols have already been presented for Ad Hoc network. These protocols may generally be categorized as table-driven routing and on-demand routing [1]. The resources to maintain and up-to-date routing information in each node. While on-demand routing protocol does not always maintain routing information at every node, and it only creates route when a packet is desired to transmit.

On demand routing protocols the most prominent ones are AODV [2] and Dynamic Source Routing (DSR) [3]. In this paper, we propose a small but efficient load-balancing approach. AOMDV provides multiple routes to a destination, selects a single route with low hop count and discards higher hop count routes. The proposed new scheme can be applied in most on-demand routing protocols. It is implemented in the process of route discovery. When a RREQ message is flooded in the network, not every intermediate node, which receives the message, will broadcast it. The node will first be judged by a threshold value to determine if it is overloaded. If so, the RREQ message will be dropped, and the established route won't contain this overloaded node. The threshold value used as a criterion is dynamically changing according to the interface queue occupancy of nodes around the backward path.Related work is overviewed. Section Ⅲ describes the adaptive load-balancing approach in detail. Performance evaluation and proposed solution via simulation is presented in Section ⅣVand the conclusion is drew in SectionⅤ.

II. Related works

Routing being a fundamental issue of wired and wireless networks so a range of protocols have been proposed. In this section, we will review some problems in load balance for exiting routing protocols in ad hoc networks. The coupling problem is much more serious in single channel networks, where coupling also occurs when one path crosses the radio coverage area of another path. This problem is discussed in [9]. The load-balancing technique in ad hoc networks can be generally divided into two types. The first type is "Traffic-size" based [10-14], in which the load is balanced by attempting to distribute the traffic evenly among the network nodes. The second type is the "Delay" based [15], in which the load is balanced by attempting to avoid nodes with high delay. In this paper, the proposed scheme is applicable to most on-demand routing protocols, either single-path routing or multi-path routing. It belongs to the "Traffic-size" based type, and will distribute the traffic load evenly among the nodes in ad hoc network.

III. Adaptive load balancing in AOMDV

Ad-hoc on demand multipath distance vector is an extension to the AODV protocol for computing multiple loop –free and link- disjoint paths. The protocol computes multiple loop- free and link disjoint paths. To ensure loop-freedom and node only accepts an alternate path to the destination if it has a lower hop count then the advertised hop count for that destination. The proposed adaptive load-balancing approach is carried out in route request procedure. When a source node wants to communicate with a destination node and has no available routing information about the destination, it will initiate a route request procedure to find a route by broadcasting a RREQ message. But not every immediate node that receives the message, will respond to the RREQ. Before broadcasting the RREQ again, the intermediate node itself first makes a decision if it is qualified. If its interface queue occupancy is under the threshold value, the node is qualified and able to broadcast it. the queue occupancy mean the number of packets waiting to be transmitted in interface queue If the node's queue occupancy is over the threshold value, it isn't qualified and will drop the RREQ. By doing so, the overloaded nodes are excluded from the newly created paths, and an on-demand routing protocol using this scheme will distribute the traffic load evenly on the nodes in network

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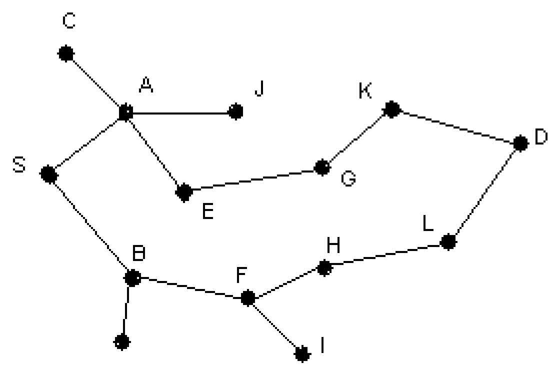
Figure 1.Route Request Process with Adaptive Load Balancing



S - Source node

D - Destination Node.

Here is an example to explain the scheme here. In Figure 1, Node S is a source and D is a destination. When S wants to communicate with D, but without any available routing information, it will initiate a route discovery by flooding RREQ message. Any intermediate node receiving the RREQ will compare its current queue occupancy with its threshold before broadcasting it again. If queue occupancy is greater than the threshold, the RREQ will be dropped simply, such as nodes J and I. They do not broadcast the RREQ so they establish path will bypass these nodes. Otherwise, the node will deal with RREQ normally, such as nodes A, B, E and etc. In above scheme, the threshold value plays a key role in selecting nodes whether or not to forward RREQ. Every time an intermediate node receives a RREQ, it will recalculate the threshold, according to the nodes' queue occupancy around the backward path. Therefore, the threshold is variable and changing adaptively with the current load status of network. Here, we present an algorithm to calculate the threshold for each node.

Step 1: the node calculates the average queue occupancy (*avg_qoc*) using the nodes' current queue occupancy in local area. So the node's *avg_qoc* can be calculated as following:

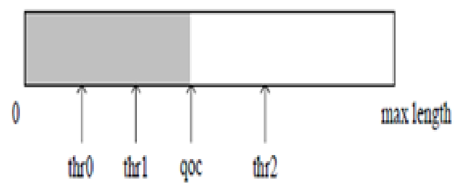
$$avg\_qoc = \frac{qoc + \sum_{i=1}^{n} nb\_qoc_i}{n+1}$$

where *qoc* is the node's own queue occupancy, and *nb_qoci* is the node's neighbor's queue occupancy, and *n* is the number of the node's neighbors. For example, in Figure 1 the *avg_qoc* of node A can be calculated by *qoc* of node A, and *nb_qoc1*, *nb_qoc2*, *nb_qoc3* and *nb_qoc4* of nodes C, S, E and J. *n* equals to 4. the source will calculate its *avg_qoc* and fill it in *sum_qoc* which is an additional field of RREQ. Step 2: the node's threshold (*thr*) is calculated with the *avg_qoc* of all the nodes along the path. With the node's own *avg_qoc* and the received RREQ's *sum_qoc* which records the sum of *avg_qoc* of the nodes along the backward path,

$$sum\_qoc = \frac{\sum_{i=1}^{k} avg\_qoc_i}{K+1}$$

the *threshold* of node G can be calculated by its own *avg_qoc* and the *sum_qoc* of received RREQ which is the sum of *avg_qoc* of node S, A and E. Step3: the node compares its current queue occupancy (*qoc*) with the *thr*.When the node gets its *thr*, it will compare the value with current *qoc*. If *thr* is greater than *qoc*, it will respond to the RREQ as usual. Otherwise, it will simply drop it.

Figure 2.comparing the qoc with thr



In Figure 2, if *thr* = *thr1*, then *qoc* > *thr*. The received RREQ will be dropped. If *thr* = *thr2*, then *qoc* < *thr*. The
received RREQ will be broadcasted again. If *thr* = 0, then *thr* = *thr0*.

(a) Proposed solution

The proposed protocol will make the following changes to the existing AOMDV protocol

1.Paths are selected depending on the hop count and queue length.

2. Load is to be balanced via alternate paths if queue length process a certain threshold value.
3. RREQ packets are to forwarded or discarded depending on the queue length.

NODES	IQO	LA_IQO	THRESHOLD
S	12	10.33	10.33
A	10	7.4	11
E	8	8	10
G	6	6	9
K	4	4	8
D	2	3	7
B	9	9.3	10.1
F	7	6.5	8.5
H	5	5	8.2
L	3	3.3	7.1
I	5	6	8.1
J	4	7	8.6
C	3	6.5	8.3

IV. Performance evaluation

In this session we apply load balancing approach in AOMDV which is called AOMDV-LB and evaluate the performance of AODV with AOMDV-LB in the simulation environment. Aomdv on demand multipath distance vector selects a path with a lower hop count and discards routs with higher hop count.

(a) Simulation environment

Here NS-2 is used to conduct the simulation for 25 mobile host with transmission range of 250 meters.

(b) Parameters

- Transmission range 250 meters
- Topolgy size 800mX800m
- Number of nodes- 25
- Number of destionation-1
- Traffic type-constant bit rate
- Packet size-512bytes
- Packet rate -5 packets per second
- Mac layer-802.11
- Bandwidth-2 megabits per second
- Node placement- uniform

Under this simulation environment three performance metrics have been evaluated

- Packet loss rate
- End to end delay
- Load distribution

(c) Performance results

Figure 3 shows the packet loss rate. With light load on the network, the packet loss ratio of AOMDV-LB is almost the same as AODV. As the interface queue is occupied very few, the threshold is often equal to zero. Then the initial threshold is used, which is set to 5 packets in this paper. In this case, most nodes' queue occupancy won't exceed 5 packets.

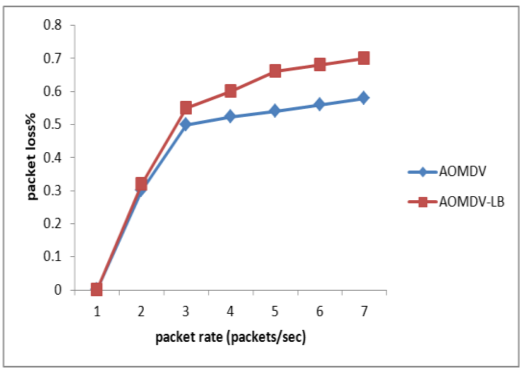


Figure 3: packet loss rate

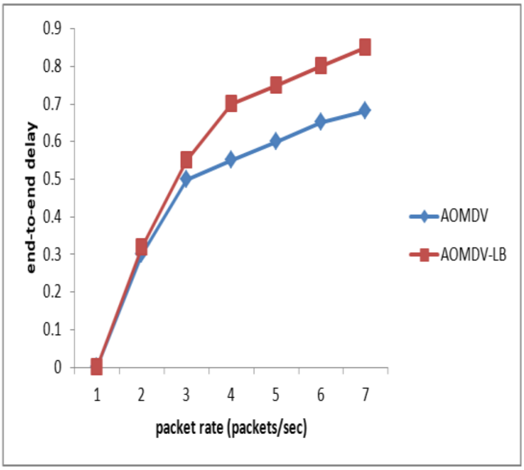


Figure 4: average end-to-end delay

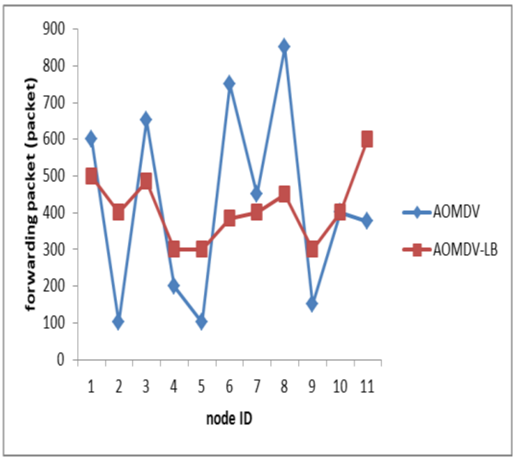


Figure 5: load distribution

Figure 4 presents average end-to-end delay. When the traffic load becomes heavy in the network, the end-to-end delay will increase. It is induced by congestion. AOMDV-LB can find path with low traffic load but AODV hows poor performance and traffic is heavily loaded .Therefore the average end to end delay will be reduced in AOMDV-LB.

V. Conclusion

In the scheme each node checks its interface queue occupancy to determine whether it responds to the received RREQ or not. The criterion for the decision is a threshold value, which is calculated by each node when a RREQ is received. It is a variable along with the queue occupancy of the nodes around backward path. Therefore, the threshold is adjusted adaptively according to the load status of the network this scheme can distribute the traffic evenly among thenodes in an ad hoc network.

References

[1] Abolhasan, M., Wysocki, T., and Dutkiewicz, E., "A review of routing protocols for mobile ad hoc networks," Ad Hoc Networks 2, pp. 1-22 (2004).

[2] Perkins, C., Belding-Royer, E., and Das, S., "Ad hoc On-Demand Distance Vector (AODV) Routing," rfc3561.txt (2003).

[3] Johnson, David. B., Maltz, David. A., and Hu, Yih-Chun, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)," draft-ietf-manet-dsr-10.txt, (2004).

[4] Lee, S. J. and Gerla, M., "AODV-BR: Backup Routing in Ad hoc Networks," Proc. of IEEE Wireless Communications and Networking Conference, pp. 1311-1316 (2000).

[5] Li, X. F. and Cuthbert, L., "On-demand Node-disjoint Multipath Routingin Wireless Ad hoc Networks," Proc. of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04).

[6] Marina, M. K. and Das, S. R., "On-demand Multipath Distance VectorRouting for Ad Hoc Networks," Proc. of 9th IEEE Int. Conf. On Network Protocols, pp.14-23 (2001).

[7] Jiang, M. H. and Jan, R. H., "An Efficient Multiple Paths Routing Protocol for Ad-hoc Networks," Proc. of the 15th International Conference on Information Networking, pp. 544-549 (2001).

[8] Higaki, H. and Umeshima, S., "Multiple-Route Ad hoc On-Demand Distance Vector (MRAODV) Routing Protocol," Proc. of the 18th Internation Parallel and Distributed Processing Symposium (IPDPS' 04).

[9] Pearlman, M. R., and etc, "On the Impact of Alternate Path Routing for Load Balancing in Mobile Ad Hoc Networks," IEEE, pp. 3-10 (2000).

[10] Lee, Y. J. and Riley, G. F., "A Workload-Based Adaptive Load-Balancing Technique for Mobile Ad Hoc Networks," IEEE, pp. 2002-2007 (2005).

[11] Altalhi, A. H. and Richard, G. G., "Load-Balanced Routing through Virtual Path: Highly Adapative and Efficient Routing Scheme for Ad Hoc Wireless Networks," IEEE, pp. 407-413 (2004).

[12] Yoo, Y. and Ahn, S., "A Simple Load-Balancing Approach in Cheat-Proof Ad Hoc Networks," IEEE, pp. 3573-3577 (2004).

[13] Zheng, X. Q., and etc, "A New Dynamic Load-aware Based Load-balanced Routing for Ad Hoc Networks," IEEE, pp. 407-411 (2004).

[14] Pham, P. and Perreau, S., "Multi-Path Routing Protocol with Load Balancing Policy in Mobile Ad Hoc Routing," IEEE, pp. 48-52 (2002).

[15] Zhang, L. F., and etc, "Load Balancing of Multipath Source Routing in Ad Hoc Networks," IEEE, pp. 3197-3201 (2002). 0-7803-

[16]Mahesh K.Marina and Shamir R Das "On demand Multipath distance vector Routing in Ad-hoc networks" in IEEE proceedings 2001

[17] An adaptive load-balancing approach for ad hoc networks by Y.H.Yuan,ChenHui-min,Jia,School of Communication & information Engineering,Shanghai university