Tree structure based Optimized Multicast Routing Algorithm in MANET

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Abstract - *Portable Ad-hoc Network (MANETs) assume a vital part in crisis interchanges where system needs to be built briefly and rapidly. Since the hubs move haphazardly, steering conventions must be very viable and dependable to ensure fruitful parcel conveyance. In view of the information conveyance structure, the majority of the current multicast steering conventions can be arranged into two organizers: tree-based and lattice based. We watch that tree-based ones have high sending effectiveness and low utilizations of transfer speed, and they may have poor power in light of the fact that one and only connection exists between two hubs. As a tree based multicast steering convention, MAODV(Multicast Ad hoc On-interest Vector) demonstrates a great execution in lightweight specially appointed systems. As the heap of system expands, QoS (Quality of Service) is corrupted clearly. We dissect the effect of system load on MAODV convention, and propose an advanced convention MAODV-BB (Multicast Ad hoc On-interest Vector with Backup Branches), which enhances strength of the MAODV convention by joining focal points of the tree structure and the lattice structure. It can redesign shorter tree limbs as well as build a multicast tree with reinforcement branches. Scientific investigation and reproduction results both exhibit that the MAODV-BB convention enhances the system execution over traditional MAODV in substantial burden specially appointed systems.*

Key Words: multicast routing, MAODV, tree structure, backup branch

1. INTRODUCTION

Versatile specially appointed systems (MANETs) are self-arranging remote systems with no altered framework and concentrated administration .All the hubs move haphazardly, which speak with one another through multi-jump remote connections. In the event that two versatile hubs are not inside radio range, the correspondence between them can be built through one or more halfway hubs. Multicast is a productive approach to transmit bundles from one point or multi-focuses to multi-focuses, which can decrease the utilizations of system transfer speed and host control by sending the same information to different beneficiaries. Thus, multicasting assumes an imperative part for correspondence in MANETs, where gathering undertakings are regularly conveyed .Based on the structure utilized for information conveyance, the vast majority of the current multicast steering conventions can be arranged into two classifications, Tree-based and cross section based conventions and network –based conventions .In tree-based multicast directing conventions, all the switches structure a tree structure with the source hub as the root, hence there is stand out single way between every pair of source and beneficiary. Interestingly with tree-based conventions, the cross section based multicast directing conventions keep up more than one way between every pair of source and recipient, and gives a more powerful information conveyance way, it brings on more control overhead to keep up various ways .The key thought of MAODV-BB is to make full utilization of GRPH messages that the gathering pioneer shows intermittently to upgrade shorter tree limbs and develop a multicast tree with reinforcement branches, bringing about streamlined structure and decreased recurrence of tree reproduction. The study surveys the operation of tree based and lattice based multicast steering utilizing MAODV (Multicast Ad hoc On-interest Vector) and ODMRP (On-Demand Multicast Routing Protocol) as cases of tree based and cross section based conventions, individually. Contrasting MAODV and ODMRP, the general pattern we see from the recreation results is that, particularly at high portability, ODMRP shows better (by approximately 10%) parcel conveyance proportions than MAODY. Since MAODV conveys parcel along a multicast tree, a solitary bundle drop upstream can keep countless multicast beneficiaries from accepting the bundle. The nonappearance of repetitive courses influences execution enormously as hub versatility brings about successive connection breakages and parcel drops. In this test, we can likewise infer that ODMRP has a more prominent directing overhead than MAODV because of the cross section structure. Directing convention overhead can be particularly destructive in run of the mill MANET situations where hubs are both transmission capacity obliged and vitality compelled. Considering the benefits of tree-based multicast directing conventions that high sending proficiency and low utilizations of data transmission, a few searchers have figured out how to enhance existing tree-based multicast steering conventions and enhance power of the conventions in different systems. we consider a tree-based case and propose an improved convention MAODV-BB (Backup Branches) to enhance the execution of MAODV in overwhelming burden impromptu systems. The key thought of MAODV-BB calculation is to make full utilization of GRPH (Group-hi) messages that the gathering pioneer telecasts intermittently to overhaul shorter tree limbs and develop a multicast tree with reinforcement branches. The shorter branches diminish the asset involved and the presence of reinforcement branches dodges vast quantities of tree reproductions and upgrades heartiness of the convention. The enhanced convention doesn't bring additional control overhead, as well as guarantees high parcel conveyance proportion and low end-to-end delay. MAODV convention and dissects the effect of system load on MAODV the upgraded convention MAODV-BB in subtle element demonstrates in non-formal systems and determines the scientific presents reenactment results.

2. RELATED WORK

To give solid multicasting suitable to portable impromptu systems, a few specialists have continued attempting to improve existing multicast steering conventions. The fundamental ways to deal with enhance the power of tree-based multicast directing conventions are the improvement of selecting course component, hub versatility forecast, the foundation of various trees, the usage of multipath steering et cetera. Presents an Entropy-based long-life multicast steering convention in MAODV (E-MAODV)[8]. It utilizes entropy ideas to build up a systematic demonstrating, and chooses the long life multicast steering as indicated by entropy metric. This change diminishes the quantity of course remaking and guarantees the course solidness in element versatile systems, however it expands multifaceted nature of course foundations. Besides, this paper takes no additional measure to repair broken tree limbs. NMP-MAODV[9] (Node Mobility Prediction-MAODV)guarantees non-separation correspondence by dynamic connection switch before versatile hub splits far from upstream hub's sign extent. The multicast bunch individuals set the brought together cycle and compute the anticipated flight time.

On the off chance that the outcome is not as much as limit, then swing to the dynamic connection switch process. On the off chance that the connection switch methodology comes up short, it will start the MAODV repair process. The enhanced convention can work legitimately in profoundly portable system, however it builds extra control overhead because of MACT messages. In (RMAODV) [10] a Reliability of the Multicast Ad Hoc On-Demand Distance Vector directing convention is proposed, which is in light of a convention transfer idea. The essential plans for solid correspondence can be named sender launched and beneficiary started methodologies. In the collector launched methodology, every beneficiary keeps up accepting records and appeals retransmission by means of a negative affirmation (NACK) when slips happen. In RMAODV, we utilize the collector launched methodology and convention transfers are set along the multicast tree. Every hand-off hub has one and only upper hand-off to demand a retransmission.

Then again, one hand-off hub may have a few lower transfer hubs. At the point when a hand-off hub identifies a misfortune, it sends a NACK back to its upper transfer hub. The enhanced convention has a superior execution for bundle conveyance proportion and decreases the quantity of parcel re-transmissions, however it builds the likelihood of accepting information duplication to the beneficiaries in a multicast group.MT-MAODV[11] presents an improved steering convention (Multiple Tree-MAODV which focuses on issue identified with feature multicast over versatile specially appointed systems. To keep up nonstop feature spilling, it propose an augmentation to MAODV to develop two very disjoint trees.

In MT-MAODV, the feature is isolated into two free sub-streams and is transmitted independently along these trees. In light of this, the feature source must have an association with both trees so that the activity allocator can part the movement in like manner. On the other hand, if a hub that endeavors to join the multicast gathering has one and only choice to be joined with the multicast bunch, which is through another hub u, considering that network is giving higher concern than tree disconnection, hub u must turn into the sending hub for both tree-1 and tree-2. Clearly, this technique can altogether lessen the relationship of bundle misfortune if the multicast trees are very disjoint. Anyway, if an abnormal state, the execution of enhanced convention will be under the confinements. MP-MAODV[12] (Multipath Routing-MAODV) stretches out MAODV to make two hub disjoint courses to enhance system productivity and offsets the system loads. It includes two additional control messages MACT-S (multicast initiation with the banner S) and RREP-S (course answer the banner S) for selecting and securing disjoint ways. Really, the reinforcement way is assembled from the source hub to the multicast tree, so it has nothing to do with the adequacy of the multicast tree structure. Be that as it may, it is still one and only connection between two on-tree hubs. Besides, when the structure of multicast tree is an expansive scale, the issue of substantial system load can't be fathomed viably. Most importantly, no compelling change concentrating on the tree structure itself has been taken to streamline tree-based multicast directing conventions. To overcome such wastefulness, we consolidate focal points of the tree structure and the lattice structure to advance the multicast tree structure, including redesigning shorter tree limbs and developing a multicast tree with reinforcement branches to enhance unwavering quality of the convention.

3. MAODV PROTOCOL INTRODUCTION

MAODV is an on-interest steering convention in view of separation vector, which is suggested by IETF MANET. In this area, we firstly give a brief depiction of course system in MAODV and afterward talk about the effect of system load on the MAODV convention.

3.1 Route system

MAODV is a steering convention outlined particularly for impromptu systems. Notwithstanding unicast steering, MAODV bolsters multicast and telecast also. MAODV convention develops an imparted conveyance tree to bolster different senders and beneficiaries in a multicast session. The course component in MAODV essentially comprises of course foundations and course systems of support. Television S-checked MACT and M-denoted the tree incoherence can't be kept up at MACT message. As a tree-based multicast steering convention, MAODV depends on flooding through the entire system to find the directing way and secure the multicast tree. At the point when a source hub needs to join a multicast aggregate or has information to send to the multicast bunch, it will show a course ask for (RREQ) message. Moderate hubs build converse course and forward the RREQ message. In the wake of accepting a RREQ message, the individuals from multicast gathering answer a course reply(RREP)message to setup a forward way. In the event that the source hub gets one or more RREP messages from the destination hubs before timeout, it picks one of the courses with the biggest grouping number and the littlest bounce check.

In MAODV, when an on-tree node detects a link broken, it will start the route recovery immediately. Firstly, it needs to determine whether the broken link is upstream or not. If it is, the node will delete the upstream node in its next-hop list, drop multicast data packets which should be sent and then send RREQ message with the flag J to reconstruct anew tree branch. Otherwise, the node will delete the downstream node in its next-hop list and then set pruning timer.

3.2 Impact of network load on the MAODV protocol

In light load ad hoc networks, the above mechanism of multicast route recovery is effective. Because most applications allow a small amount of packets lost before the multicast route recovery is completed. However, when the network is highly loaded, large number of packets will be discarded and poor robustness of the tree-based protocols appears. Therefore, only depending on the original route maintenance in MAODV cannot ensure the network performance. As shown in figure 1, in order to illustrate the impact of network load, we simply set two source nodes to send multicast packets. Node S I and node S2 both establish the routes to the multicast tree. When any one of multicast group members receives multicast packets, it will broadcast along the multicast tree branches. Due to mobile nodes moving randomly, the structure of established multicast tree may be destroyed partly. It needs to take some time to repair the broken link. During this period, large amounts of multicast data packets arrive in the multicast tree continuously. As a result of the invalid link, the multicast group member C cannot receive any multicast packets from node A and cannot forward multicast packets successfully to other group members, which results in packet delivery ratio decreased.

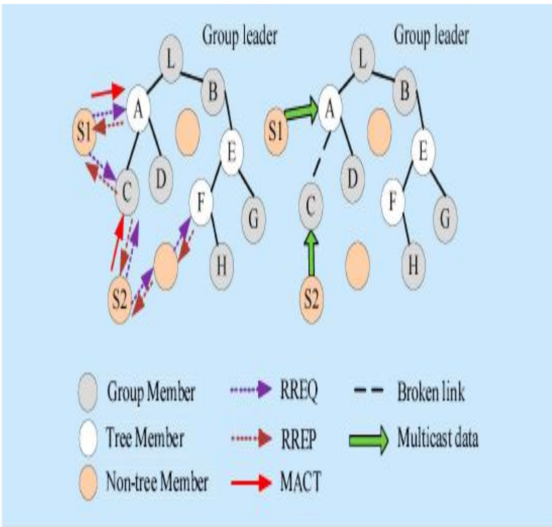

Fig.1 Impact of network load on MAODV

4. Change OF MULTICAST ROUTING

To defeat the effect of system load and enhance strength of the MAODV convention, we stretch out MAODV convention to build a multicast tree with reinforcement branches from two perspectives. One is the methodology of reinforcement branches choice and expansion, the other is the instrument of multicast tree support.

4.1 GRAPH message development

In MAODV, the gathering pioneer occasionally shows GRPH messages to redesign or keep up the multicast bunch data. Keeping in mind the end goal to choose and include reinforcement branches effectively, we broaden unique GRPH (Group-hi) messages with the quantity of dynamic downstream branches in MAODV-BB (Backup Branches).In our tests, we set a maximum farthest point with the estimation of three. Practically speaking, when the quantity of downstream branches is bigger than as far as possible, the execution of conventions won't be enhanced further. The configuration of the augmented GRPH messages is demonstrated in Table 1.

Table 1. The arrangement of GRPH message in MAODV-BB.

Type	Flag	Reserved	Hop count
Multicast group leader IP address			
Multicast group IP address			
Multicast group ID			
The number of downstream branches for previous node			

4.2 Backup branches selection and addition

In MAODV convention, when an on-tree hub firstly gets a GRPH message with the same multicast bunch pioneer location and multicast gathering location, it overhauls the multicast bunch data in its gathering pioneer table and multicast steering table. Normally, the GRPH message is distinguished as the multicast bunch pioneer address and the multicast gathering location. We include one reinforcement steering table for each on-tree hub to spare the data of its reinforcement tree limb in MAODV-BB. To perform the change, the operation in the wake of accepting a GRPH message is changed as taken after:

(a) lf it is the first run through for the on-tree hub to get the GRAPH message, then swing to b, generally dispose of the GRPH message;

(b) Determine whether the GRAPH message is gotten from its upstream hub or not. In the event that it is, the hub needs to perform the same operations MAODV, generally swing to c);

(c) If the bounce to the gathering pioneer in the GRPH message is not as much as that in multicast steering table and the quantity of dynamic downstream branches is under the point of confinement, then redesign the tree limb, generally swing to d);

(d)Judge whether there is an accessible reinforcement branch or not. On the off chance that there is, swing to e), generally include another reinforcement branch in the reinforcement steering table.

(e)If the jump to the gathering pioneer in the GRPH message is not as much as that in the reinforcement steering table, then upgrade its reinforcement branch, generally surrender the GRPH message. For instance, in figure 2, hub K firstly gets a GRPH message from hub B and afterward confirms that the bounce to the gathering pioneer in the GRPH message is not as much as that in multicast directing table.

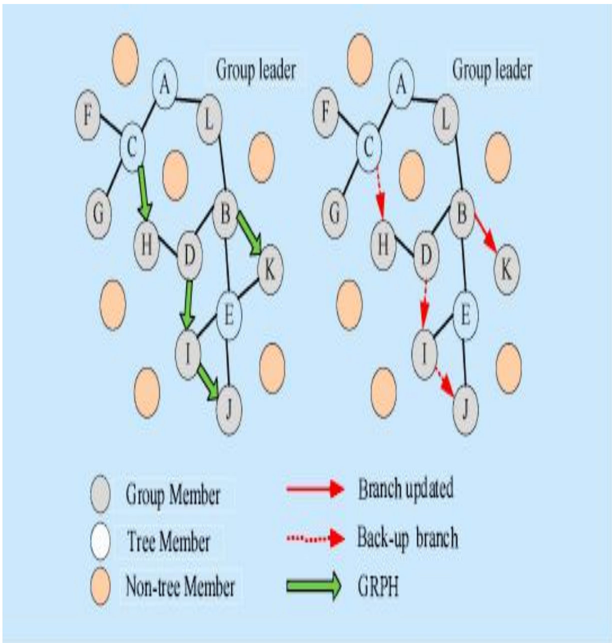

Fig. Backup branches selection and addition

Hub K upgrades the shorter tree limb and replaces hub E with hub B as the new upstream hub. The shorter tree limbs can diminish control movement and normal deferral. Besides, hub H, hub I and hub J separately include reinforcement branches in their reinforcement steering tables. Without harming the tree structure, the expansion of reinforcement branches enhances heartiness of the system and guarantees the system execution.

4.3 Multicast tree upkeep

Amid the period of multicast tree upkeep, when the upstream hub distinguishes the connection broken, it will erase the downstream hub in its next-jump rundown and set pruning clock. At the point when the downstream hub distinguishes the connection broken, it needs to figure out if there is an accessible reinforcement branch in its reinforcement steering table. In the event that there is, the downstream hub sends a multicast initiation message with the banner J to empower the reinforcement branch. In the meantime, the downstream hub needs to send a multicast enactment message with the banner P to prune the first upstream and erases the first upstream hub in its next-bounce list. The presence of reinforcement branches maintains a strategic distance from the methodology of course recuperation and guarantees multicast information parcels to transmit consistently.

5. Numerical PROVING AND DERIVATION

In this session, we firstly demonstrate that gathering individuals own littler bounces to the multicast bunch pioneer in MAODV-BB, because of including the overhaul operation of tree limbs. The littler the bounce is, the less asset is possessed. Also, we derivate the mathematic model to demonstrate that the interim time between two course recuperations clearly increments in the multicast tree with reinforcement branches.

5.1 The redesigning operation of tree limbs.

Here we take non-formal routines to demonstrate. Hypothesis 1. The redesign operation of tree limbs can guarantee a fitting way from a gathering part to the gathering pioneer. Evidence. There is no vital distinction in the course system between the enhanced convention MAODV-BB and MAODY. Just amid the procedure of multicast tree systems of support, we add a jump component to figure out if to redesign a shorter tree limb. The redesign operation can give a shorter way from a gathering part to the gathering pioneer. Therefore, a fitting way from a gathering part to the gathering pioneer can be guaranteed. Hypothesis 2. The jumps from gathering individuals to the gathering pioneer in other course instrument enhanced conventions are at least that in MAODY. In the wake of including the redesign operation of tree limbs, the bounces from gathering individuals to the gathering pioneer in MAODY-BB are not exactly or equivalent to that in MAODY. Evidence. Use decrease to foolishness. We expect that the bounces from gathering individuals to the gathering pioneer in other course system enhanced conventions are not as much as that in MAODY.Base on the guideline of MAODY, we can presume that it is a base bounce convention. Anyhow, this is in inconsistency with the suspicion .In MAODV-BB, if a shorter way to the gathering pioneer is recognized amid the procedure of multicast tree systems for upkeeps, the hub will overhaul the multicast tree limb. Subsequently, the enhanced convention MAODY-BB upgrades the tree structure with shorter branches amid the period of multicast tree support

5.2 The current of reinforcement branches

The scientific model is determined as takes after: We depict versatile specially appointed systems as a diagram G=(N, E), where N and E individually speak to the hub et s and the connection sets .Assume that a branch P from anon-tree hub to the multicast bunch pioneer comprises of n remote connections.

The i-th link in the branch is denoted by Lj and its lifetime is defined as Xr. If any one of the wireless links in the branch breaks, the on-tree node will break away from the multicast tree. So the lifetime of a branch P considering of n wireless links can be expressed as Xp, where Xp=min{XLI ,xL2 ..... XL) .It is well known that XI' is an exponentially distributed random variable. Therefore, its probability density function and cumulative distribution function are expressed as:

$f x_{p(t)=ke^{-kt}}$

(1)

$F x_{p(t)=\int_0^t f x_{p(t)\,dt=1-e^{-kt}}}$

(2)

where k is a parameter associated with n .

Consider an on-tree node which has an available backup branch to the multicast group leader, where the lifetime of the tree branch is denoted by Xp1, and the lifetime of the backup branch is denoted by Xp2,. Assume that Xp1, and Xp2 are independent. Then the interval time between two route recoveries in the multicast tree is described as a random variable T, where

T=max{Xp1,xp2}. The probability density function of T is calculated as

$$f_T(t) = P(T \le t) = P(\max\{X_{p1,}X_{p2}\} \le t)$$

(3)

Where kl and k2 are the parameters respectively associated with the tree branch and the backup branch, further Then we can derive1 the mathematical expectation of T.

$$E[T] = \int_0^{+\infty} t f_T(t)\,dt = \frac{1}{k1} + \frac{1}{k2} - \frac{1}{k1+k2} \ge E[X_{p1}] = \int_0^{+\infty} t f_{xn}(t)\,dt = \frac{1}{k1} \qquad (4)$$

According to Eq. (4), it is not difficult to conclude that the existence of backup branches makes the interval time between two route recoveries in the multicast tree longer. It not only reduces the frequency of tree reconstruction but also ensures high packet delivery ratio in heavy load ad hoc networks. The addition of backup branches improves robustness of the tree-based multicast routing protocols and shows the advantages of both tree-based and mesh-based protocol.

6. SIMULATION RESULTS AND EVALUATION

We run simulations with NS-214 to analyze and compare MAODV-BB with MAODV in heavy load ad hoc networks. NS-2 provides substantial support for simulation of T CP, routing and multicast protocols over wired and wireless networks.

6.1 Simulation environment

In the following simulation, 20 nodes move randomly in a square area about 500 x 500 meters. Select 6 nodes to join the multicast Radio propagation range for each node is 250 meters and channel capacity is 2 Mbps. Each simulation is executed for 910 seconds of simulation time. A traffic generator is developed to simulate CBR sources. The size of the data payload is 512 bytes. Each source node sends out 5 packets per second. In order to test the influence of network loads on the protocol performance, load of network is set to 5, 10, 15 and 20 packets per second respectively. Two-ray ground propagation model is used in our experiments, and the MAC layer protocol is IEEE 802.11. Table 2 lists the simulation parameters.

6.2 Impact of network load

and average end-to-end delay to evaluate As a tree-based multicast routing protocol, MAODV shows an excellent performance in light load ad hoc networks. However, as the load of network increasing, QoS is degraded obviously. In order to illustrate the impact of network load on the performance of MAODV, we select packet delivery ratio, control overhead e the performance of protocols. Packet Delivery Ratio Measure related to the reliability of communication, the delivery ratio R is defined as:

$$R = n_{data-r} / n * n_{data-s} \qquad (5)$$

Where n_{data-r} is the number of multicast data packets received at all multicast group members, and n_{data-s} is the number of multicast packets that a source node generated, besides n is the number of multicast group members.

Control Overhead Control overhead reflects the degree of network congestion and the efficiency of protocols, the control overhead C is defined as:

$$C = n_{ctrl-s} / n_{data-r} \qquad (6)$$

Where nn_{data-s} data-s is the number of transmissions of control packets in the whole network, and n_{data-r} is the same as abovementioned.

End to end average delay End to end average delay is usually used to evaluate the effectiveness

of routing. Furthermore, it concludes whether the routing is easy to be built. The end to end average delay T is defined as.

$$T = t_{total} / n_{data-r}$$

Table II .Simulation parameters.

Number of nodes	20
Scene range	500m×500m
Load of network	5,10,15,20 packet/s
Number of group members	6
Channel bandwidth	2 Mbps
Data payload	512 bytes/packet
Node pause time	0-10 seconds
Transmission range	250 m
Simulation time	910 seconds
Propagation model	Two-ray ground

where t_{total} total is the total time which multicast data packets take from the source node to multicast group members, and n_{data-r} is the same as abovementioned. In the simulation, load of network is set to 5, 10, 15 and 20 packets per second respectively. Furthermore, three curves in figure 3, 4 and 5 respectively represent simulation result with the speed of 1m/s, 5m/s, 10m/s. Obviously, as network load increases, the MAODV's packet delivery rate decreases. Moreover, as network load increases, routing overhead also decreases due to the total number of data bytes received by MAODV receivers increasing. However control data transmitted, remains fairly constant with increased network load there by reducing the routing overhead.

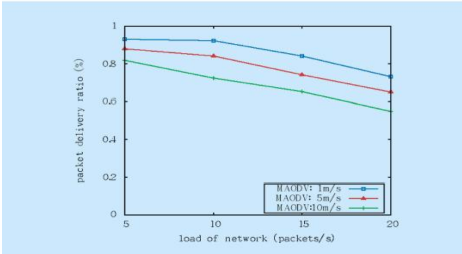

Fig. Impact on packet delivery ratio

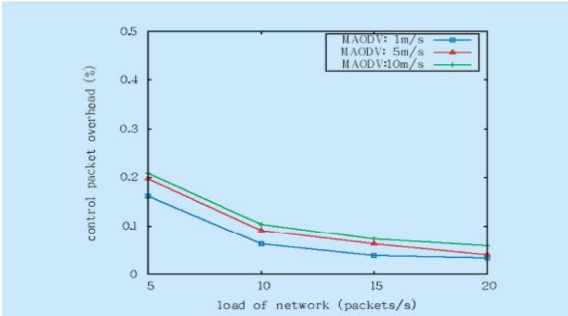

Fig. Impact of control overhead

6.3 Simulation results and performance evaluation

At first, we simulate to prove that packet delivery ratio will not be improved further when the number of downstream branches is larger than the upper limit, as is shown in figure 6.In our experiments, we set an upper limit with the value of three. The average hop from group members to the group leader reflects the optimization of the multicast tree structure. Figure 7 shows the comparison of average hop from group members to the group leader. We observe from the simulation result that MAODV-BB owns the smallest average hop. On one hand, the updating operation of tree branches optimizes the tree structure. On the other hand, backup branches can provide more effective routing information for group members. The load of network nearly has no effect on the multicast tree structure, so the average hop under different load of network remains almost the same. As follows, we analyze and compare MAODV-BB with MAODV in heavy load ad hoc networks by using packet delivery ratio and average end-to-end delay. Figure 8 shows the impact of network load on packet delivery ratio. With the increasing of the network load, the MAODV's packet delivery rate has descended obviously. When the load of network is 20 packets per second, the packet delivery rate of MAODV is about 10 percent lower than that in the network with 5 packets per second. Only adding the updating operation to MAODV improves the packet delivery ratio when the network load is light. However, MAODV-BB's packet delivery is always maintained at a high level even when the network load is heavy. In MAODV-BB, the existence of backup branches reduce the frequency of tree reconstruction and ensures high packet delivery ratio in heavy load ad hoc networks .The average end-to-end delay of MAODV-BB is least, as is shown in figure 9. As the increasing of the network load, the packet delivery delays become longer. This is because that the recovery procedure takes a long time to repair the partition and makes a bad effect on data transmitting. It is obvious to see that the delay of MAODV-BB is always lower than MAODV's. The update operation of tree branches optimizes the tree structure and reduces delay.

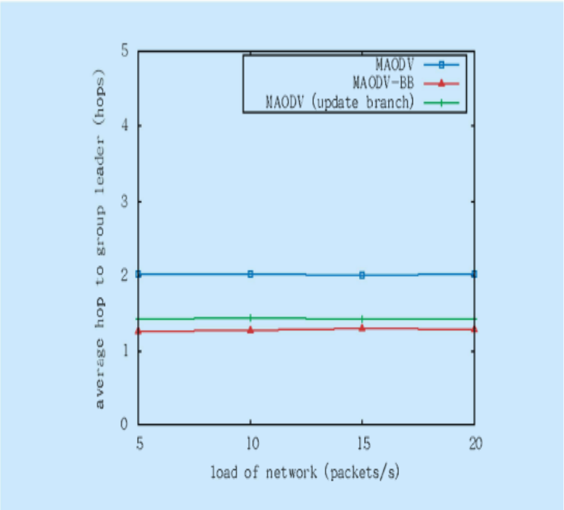

Fig. Average hop to group leader

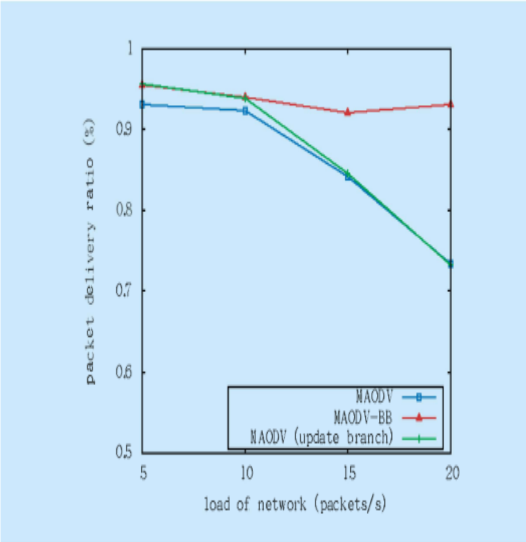

Fig. Comparison of packet delivery ratio

7. CONCLUSIONS

In this report, we have first given an introduction to optimised protocol MAODV-BB based on MAODV, which improves robustness of MAODV protocol by combining advantages of tree structure with the mesh structure. The kye idea of MAODV-BB is to make full use of GRPH messages that the group leader broadcasts periodically to update shorter tree branches and construct a multicast tree with backup branches. It not only optimizes the tree structures but also reduces the frequency of tree reconstruction. Mathematics modeling derivations and simulation results both demonstrate that MAODV-BB protocol improves the network performance over conventional MAODV in heavy load ad hoc networks which meets Qos requirements for communication in MANET.

As further work ,it intend to study the reliability of tree-based multicast routing protocols in varying condition such as node mobility, group size. It also consider enhancing our protocol with a global congestion control mechanism to solve the data rate of the senders when the network is highly loaded.

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