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Use Spare Route and Local Recovery Tree based Approach in MANETs

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Key words: Mobile Ad-hoc network (MANET), routing, DSR, DSR-RRP, QAODV

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Abstract: Mobile Ad-hoc Networks (MANETs), there are no basic network devices, such as routers or access points; data transfer among nodes is realized by means of multiple hops and rather than just serving as a single terminal, every mobile node acts as a router to establish a route. Routing protocols must be highly effective and reliable to guarantee successful packet delivery.Therefore, performed correct routing and rapid restoration of corrupted links is an important issue in mobile ad hoc network that has been discussed. In this study for mobile ad hoc network based on DSR routing protocol and DSR-RRP, a method is provided to quickly create tow path and prevent the packets to be removed or lost. Suggested method is based on tree structure and each node using two tables, one informative table trees and other management of neighbor's information nodes is aware of its own connection and neighbor nodes. During the rapid detection of deterioration according to links on the tables and informative messages, the nearest and most convenient link to the base station quickly discovered and connection will be done. The simulation results by NS2 show that, proposed method (DSR-RRP) comparing with the (QAODV). Outperforms in terms of packet delivery ratio, throughput, packet loss and end-to-end delay. As a result, the Proposed method (DSR-RRP) is obviously better suited for tree based approach in MANETs and can provide better performance for data transmission.

INTRODUCTION

A Mobile Ad hoc Network (no MANET) is a type of wireless networks. This type depends on themobile nodes and there is infrastructure in such type. There are no routers, servers, access pointsor cables. Nodes (mobiles) can move freely and in arbitrary ways, so it may change its locationfrom time to time. Each node may be a sender or a receiver and any node may work as a routerand do all router functions. This means that it can forward packets to other nodes. Many applications of MANET's are implemented and used until today like in: meeting conferences; military operations; search and rescue operations, all of them are examples of MANET networks (Chlamtac *et al*., 2003). To support these applications, many studies have attempted to solve the multicast problem in MANET. The dynamically changing topology of MANET, coupled with relatively low bandwidth and unreliable wireless links makes designing MANET multicast routing protocols significantly more challenging

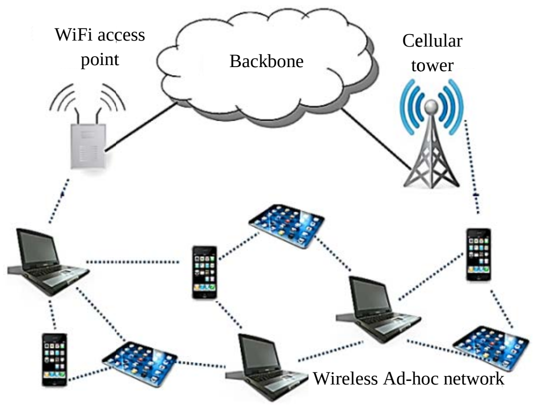

Fig. 1: Mobile Ad-hoc Networks (MANETs)

than those for wired networks do. Current approaches utilized for ad hoc multicast routing protocols can be classified based on multicast topology: tree-based and mesh-based. Simulation studies indicate that tree-based protocols have poor mobility as only one path exists between each source-receiver pair when this path breaks, data are lost until a new branch is constructed. The mesh topology provides multiple paths between a source and receiver which facilitates delivery of multicast data even when a path fails. Therefore, a mesh-based multicast routing protocol is more effective than a tree-based multicast routing protocol in dynamically changing topologies. One approach to increasing the scalability of reliable multicast protocols is distributed recovery-distribute the cost of error recovery, i.e., receivers as well as the source perform error recovery. This helps minimize the implosion problem (Floyd *et al*., 1995). In addition, the scalability increases with local recovery that aims to reduce exposure and bandwidth requirement for retransmission by recovering losses locally (Hofmann, 1996), Fig. 1 Mobile Ad hoc Networks (MANETs).

The routing is an important challenge in MANET networks. According to constant changes in the topology of the network due to the mobility of nodes, routing protocols should adopt a consistent compatible strategy that supports these changes. In way that, the sent data from the source to destination arrive completely. One important method for routing is using a tree structure. In this paper for mobile ad hoc network based on DSR routing protocol and DSR-RRP, a method is provided to quickly create tow route and prevent the packets to be removed or lost. Suggested method is based on tree structure, each node using two tables, one informative table trees and other management of neighbor's information nodes is aware of its own connection and neighbor nodes.

Literature review: In this study related work, we survey some important routing protocols which are attempted to apply into Mobile Ad-hoc Network (MANETs).

To connect multicast members, the Multicast Ad-hoc on Demand Distance Vector (MAODV) routing protocol proposed by Royer *et al*. (1999), Royer (2000) builds and maintains a tree based multicast protocol for each multicast group. Route discovery is achieved on-demand as a request-and-reply process. A node wanting to join the tree floods the networks with a join request and any node on the tree responds with a join reply indicating its distance from the group leader. This message establishes a forwarding path for multicast data packets to follow. The group leader, typically the first member that joined the group, periodically broadcasts group hello packets to announce its status and become aware of reconnections. The MAODV uses a hard-state approach for tree maintenance, meaning that the protocol must keep track of link failures in the tree and perform maintenance operations when required. The MAODV is a tree-based multicast routing protocol that can reduce control overhead. However, the MAODV has poor packet delivery under mobility and congestion along tree links.

Hence, Dong *et al*. (2005) propose two centralized, one distributed algorithm called BAMER, GAMER and DAMER, respectively, claim that they are the first to provide reliable and energy efficient transmission in the unreliable link layer in WMNs. Moreover, little attention is paid in the literature to the issues of protecting the multicast groups against link or node failures. Zhao *et al*. (2006) claim that they are the first to do research on this problem. In order to gain the goal, they propose a resilient 10 forwarding approach called Resilience-Forwarding Mesh (RFM) in which two node-dis joint paths between the source-destination pair by using the advantage of wireless broadcast. Moreover, they propose four heuristic algorithms called Node-Disjoint Tree algorithm (NDT), Revised Node-Disjoint Tree algorithm (RNDT) and Shared Disjoint Mesh algorithm (SDM) and Minimal Disjoint Mesh algorithm (MDM) to find the approximate solutions of RFM. The former two are tree-based algorithms and the latter two are mesh-based algorithms. They claim that RFM can protect the multicast group efficiently in WMNs and MDM is the best one out of all of the proposed algorithms.

The Lantern-Tree-Based (LTB) in Chen and Ko (2004) is a bandwidth constrain QoS multicast routing protocol. A lantern is defined as one or more sub-paths with a total bandwidth between a pair of two neighboring nodes. A lantern path is a path with one or more lanterns between a source and a destination. The multicast tree contains at least one lantern path between any of its source-destination pairs. Lantern tree protocol measures the bandwidth as the available amount of free slots based on CDMA-over-TDMA channel model at MAC layer. One drawback of LTB is the long time needed to find all the paths and to share and schedule the time slots. Another drawback is the use of high number of links which increase the contention at the MAC layer.

QoS Multicast Routing Protocol (QMR) Saghir *et al*. (2005) is a hybrid scheme for supporting QoS routing. It is an on-demand mesh protocol connects group members using QoS paths. QMR define forwarding nodes that provide at least one path from each source to each destination. CDMA-over-TDMA is used to estimate the available bandwidth. A distributed admission control is used to enable intermediate nodes to reject the routes that not satisfy QoS requirement. The forwarding nodes are updated when multiple sources sending to the multicast group simultaneously. This prevents congestion and performs load balancing in the network.

On the other hand, ST-based protocols create a single tree for the entire group which is shared by all the sources. The ST is rooted at a core router that is publicized to all sources by some mechanism. Core-Based Tree (CBT), Protocol-Independent Multicast Sparse Mode (PIM-SM) (Farinacci *et al*., 1998) and Simple Multicast (SM) (Perlman *et al*., 1999) are ST-based protocols. In CBT, each group has a corresponding core which is a router chosen by some election mechanism or hash function. The multicast tree is rooted at the core, which is shared by all the sources. The shared multicast tree is constructed as follows: Each host that wants to join the group sends a join message along the shortest path to the core. The join message stops at the core or a router which is already on the tree. Then, the core or the router sends an acknowledgment to the joining host along the same path that becomes a part of the tree after the joining host receives the acknowledgment. Once the multicast tree is established, a source can transfer the packet by first sending the packet to the core and then, the core sends the packet to the group members along the multicast tree. The PIM-SM protocol is quite similar to CBT but it also allows for creating a source based shortest path tree on behalf of their attached group members. Thus, PIM-SM is a hybrid routing protocol in astrict sense. The SM protocol extends CBT with the major difference that SM identifies a multicast group by the combination of the core node address and the multi-cast address and thus, eliminates the need for the uniqueness of multicast address across the internet.

On-demand QoS multicasting protocol is proposed in (Wu and Jia, 2007). This protocol simultaneously use multiple paths or trees in parallel to meet the required bandwidth of a single QoS request within a delay bound between the source and the destination. The bandwidth is considered as the number of free slots using CDMA-over-TDMA channel model. They propose three multiple path construction strategies to enable the source node to aggregate the bandwidth over the links. The source computes the optimal routes to the destinations and manages the group membership which overload the source with extra processing overhead. Using flooding to discover the paths add the processing overhead for non-member nodes and waste the network resources.

Chen *et al*. (2009) presents an Entropy-based long-life multicast routing protocol in MAODV (E-MAODV). It uses entropy concepts to develop an analytical modeling and selects the long life multicast routing according to entropy metric. This improvement reduces the number of route reconstruction and ensures the route stability in dynamic mobile networks but it increases complexity of route establishments. Furthermore, this paper takes no extra measure to repair broken tree branches.

By Sun *et al*. (2004), a Reliability of the Multicast Ad hoc On-Demand Distance Vector (RMAODV) routing protocol is proposed which is based on a protocol relay concept. The basic schemes for reliable communication can be classified as sender initiated and receiver initiated approaches. In the receiver-initiated approach, each receiver maintains receiving records and requests retransmission via. a negative acknowledgement (NACK) when errors occur. In RMAODV, we use the receiver initiated approach and protocol relays are placed along the multicast tree. Each relay node has only one upper relay to request a retransmission. However, one relay node may have several lower relay nodes. When a relay node detects a loss, it sends a NACK back to its upper relay node. The improved protocol has a better performance for packet delivery ratio and reduces the number of packet re-transmissions but it increases the probability of receiving data duplication to the receivers in a multicast group.

Dynamic Source Routing (DSR): DSR protocol is a reactive routing algorithm designed for mobile ad-hoc network. The process of routing in DSR is composed of two main phases known as route discovery and route maintenance. Routing in DSR is completely carried out in an on-demand method. Route discovery phase is a process under which source node, in order to send data packets, obtains a valid route to the destination node. For this, source node creates a RREQ packet and relays it in the network. All of the sources neighbor nodes will receive such a packet. Each RREQ packet contains an identifier and a list of addresses of intermediate nodes which this packet has passed from them. Such a list is initially empty at the time of creating RREQ by the source node. When a node receives a RREQ packet, creates a RREP regarding information included in the list of addresses inside the packet and sends it back to the source node if only it be the destination node itself or have had a route to the destination. Once source node receives such a RREP packet, it first adds this route to its route cache and then starts to send data packets using the route included in the packet. If the receiver of RREQ has not had a route the destination and has not previously received this RREQ packet, appends its address to the list of nodes inside the packet and rebroadcasts that. When the destination node receives a RREQ, it can create and send back the RREP

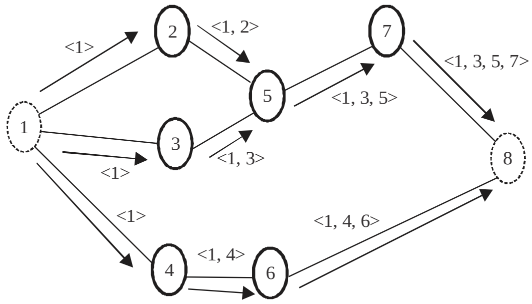

Fig. 2: Depicts a discovery route in DSR protocol (All-over distribution)

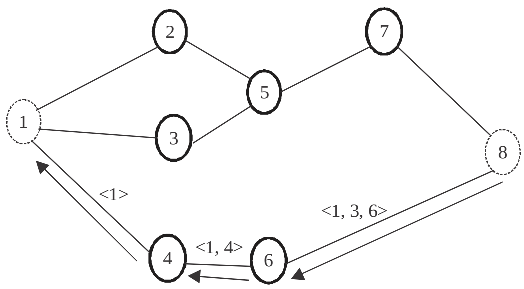

Fig. 3: Depicts a discovery route in DSR protocol (All-over distribution)A sample of route discovery in DSR protocol

to the source node using the route which can be computed by inversing the list of addresses inside the RREQ packet. Route maintenance is a mechanism by which as source node is using a route to send its data packets can discover changes of topology and send remainder of its packets through an alternative route if it be convinced that the current route has been broken and not usable anymore (Johnson *et al*., 2007) (Fig. 2 and 3).

MATERIALS AND METHODS

Proposed method (over view): The routing is an important challenge in MANET networks. According to constant changes in the topology of the network due to the mobility of nodes, routing protocols should adopt a consistent compatible strategy that supports these changes. In way that, the sent data from the source to destination arrive completely. One important method for routing is using a tree structure. Since, in the MANET networks due to rapid changes and constant movement, the trees links will be changed, so, they need a tow path to send data and not being stopped. The project aims to design routing path to discover a tow path and retrieve the path with the help of tree structure using DSR protocol.

Keeping track of the DSR protocol: In DSR protocol damaged link will be discovered by examining the periodic HELLO messages by nodes on any activated rout in DSR. Other nodes have to use link layer mechanism in order to explore damages of each link and reducing the control overhead use. If upstream of a node does not have any HELLO messages from its downstream neighbor node that links its pre-defined gates, it indicates that the invalid route used by neighboring nodes. Then, a RERR message used to inform the other nodes and nodes along the path and source nodes regarding of failure. When a closed node receives RERR, relevant routes gets annulled and abandoned the sources that received from nodes and forward the RERR packet to direction of resources. After receiving a RERR message, the source can do the discovery process from the start.

The (DSR-RRP) proposed approach: In the proposed DSR-RRP method, to manage network each node has two tables. One table for information of the tree and other table management information of neighbors which will be, explain more in the following text. The information table tree will stores the information regarding the topology of the tree which has particular node that is aware of its information, the structure of this table is described in Table 1.

In addition, the information of the managing neighbors regarding neighbor's nodes is expressed in Table 2. For maintaining the updated information of tree structure, each node finds the information of the children, parents and neighbors at their disposal to update the information found in the two tables above. The nodes find the children at their disposal with sending HELLO packets. If at a certain distance, no packets have send from children node to the parents, one HELLO public packet will be send for informing the parents regarding the availability. Children nodes will be notifying by ACK the availability of their parents. Each Hello packet formed by few parameters (node ID, parent's ID, number of steps) which will be included in the header of the packet. The nodes also extract this information from the messages that send from the neighbor nodes. With this information, each node can update the information of the trees and tables of their neighbors. For example, data of the tree and the neighbors table in node (1) in Fig. 4 in Table 3 and 4 has been showed.

It is important to mention that, although, node 4, 5 and 6 are in range of the movement of node 1, they are not in neighbors table of node 1 because they are already on the table tree of node 1. The status of a node means it is whether this node is part of a tree. If the node is part of a tree or have a connection to the base station, it is connected, otherwise it is not connected.

How to connect a node to the network: Each node has an automated network configuration software. Nodes often search for BS that are to them. If they found a station, they communicate with that BS. BS dedicate the ip address to the nodes, the internet connection to the

Table 1: Table of tree information

Field name	Explanation
Parent	Parents node keeps (ID)
BS	Base station that provides internet connections to nodes (the network can find several BS development)
Number of Hop	The number of hop each node to the destination BS
List of children{}	List of children which are directly connected to the node
Status	Connected or disconnected

Table 2: Table of Tree information

Field name	Explanation
Node ID	Neighboring nodes (ID)
Hop count	Number of hop count withe (ID) specify the to a destination (BS)
Similar (BS)	(Yes/no) is this Nodes The BS similar or not
Status	connected or disconnected

Table 3: Information of node (1) in the tree

Field name	Data
Parent	Base station
Hop count	(1)
List of children{}	{4,5,6}
Status	Connected

Table 4: Sample table neighbors nodes (1)

Field name	Explanation
Node ID	(2)
Hop count	(1)
Similar (BS)	(Yes) neighboring nodes with ID number 2 to a base station connected to the nodes (1)
Status	Connected

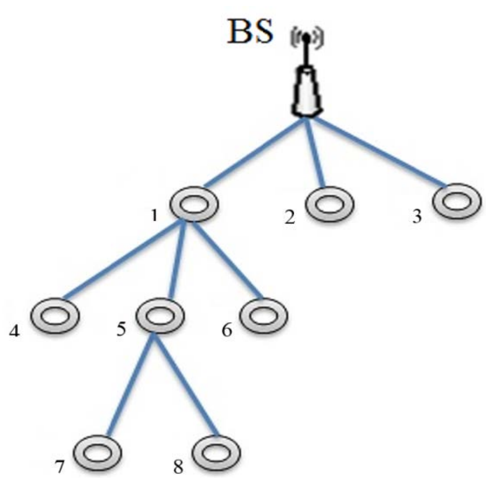

Fig. 4: Sample of a few steps tree-based network

nodes and provides network topology information of the node. As a result, each node knows its real station, parents and the number of steps to BS which added to the tree node information. When a node has successfully connected to their parents, they make their own table.

Identify and repair broken link with DSR-RRP method: In the normal mode when DSR protocol find a fault RERR path it will send to the origin, then exploring a new path begins by origin which leads to significant production of slag control, packet loss and delays in the system. To provide support for QOS, we need a mechanism of retrieve/store that be faster and more efficient. In the proposed DSR-RRP method, a node can receive or recognize a lower links fault (links to their children) on the basis that the HELLO messages or data messages with a predefined threshold at specified time T. Links also detects upper links through failure of receiving ACK with interval T. Thus, the detection of link failure is determined. In case of failure of a link at the bottom, parent nodes can easily remove nodes related to list of their children. But in case of failure of the upper link which causes the parent's relationship cut the base station, that node will be invalid for the bottom trees of it. For example, if the link between nodes 1 and BS (Fig. 5) fails, all nodes in the node 1 tree, means from node 4-8, cannot connect to the base station. Therefore, an effective mechanism is needed to identify and repair broken links quickly. The proposed DSR-RRP method, each node in the active path, maintains ID of each children node and his parents at their own table and this information is updated according to the local routing processes. Our approach is based on the observation that when a link goes down, there are still some upstream neighbor nodes, which through other nodes available with 2 steps and these nodes can quickly create a new link. When a node detects failure of one of the neighbors, it can repair the broken path using extra nodes in its neibouring. Hence, a few of extra controlling overheads will be created and repairing path will be created much sooner than making a new path. In case of failure of upper links, nodes are trying to create an alternative connection, for example, handovers a part from a tree to replace a node. In our proposed DSR-RRP method is suitable for repairing damaged links. A node that explore the failure of the upper links, do not have entire route to restored BS. But simply hand over part of the tree to neighboring nodes which got the lowest number of step with the same base station and has similar situation can quickly create a new link. When the parent node realizes the failure on its link, its status is changed to non-connected mode and their children will be aware of its status. So, a DIS message will be send to its children about the restoration process of links. So, these children nodes chooses nearest neighbor with the same BS as parents and the request will be connected to the control message LRREQ (local route repair requests) and will be sent. Neighboring nodes, which received this message will send Lrrep message and the nodes will connected to this parent node and will update their tables. An example of a link failure and tow path shown in Fig. 5. When node 1 in Fig. 5 to move out

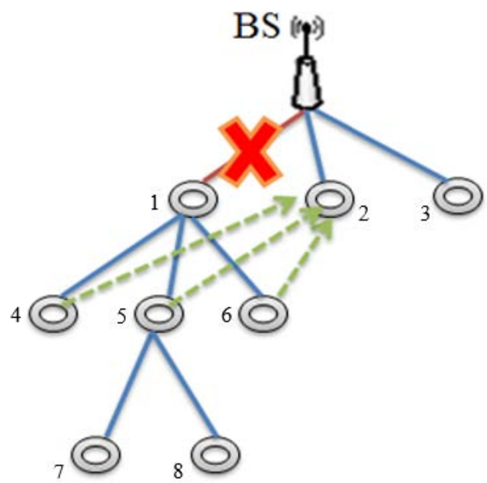

Fig. 5: Link failure

of range, the link between nodes 1 and BS disappears. Node 1 cannot establish a replaying connection with node 2 because it is farther away from its previous neighbor node 2. Node 1 has changed its status to non-connected mode and children (4, 5 and 6) aware of a definite connection with DIS message. Children of starts the repair process, resulting in that neighbor nodes number 4, 5 and 6 joint will be connected with their neighbor parent which is connected to the mutual parent, means node 2. Example of failure and repair link in DSR-RRP methods.

RESULTS AND DISCUSSION

Simulation model and parameter: This section deals with investigating the results of this paper. A system domain similar to real world should be offered by simulation process. Taking after this thought, we try to characterize practical situations where Mobile Ad-hoc Networks (MANETs) might be conveyed. Use Spare Route and Local Recovery Tree based Approach in MANETs the effectiveness of the proposed method (DSR-RRP) was evaluated using NS-2.34. Afterwards, we introduce the trial set up considering the parameter settings for both, the met heuristic algorithms and the ns-2.34 simulation. Moreover, we evaluate it in terms of performances end-to-end delay and packet delivery ratio, packet loss, throughput. Finally, we compare it to Comparison (DSR-RRP) With (QAODV). Simulations have been carried out by Network Simulator NS2 Version 2.34. To see the simulation parameter are show in Table 5 the metrics used to evaluate the performance.

Table 5: Simulation parameter

Simulator	Values
Simulator	NS-2 (Version 2.34)
Area	1000 X*1000
Number of mobile node	100
Network interface	Wireless Phy
Propagation type	Two ray ground
Transmission range	250 m
Antenna	Omni antenna
Simulation time	200-1000 sec
MAC layer	802_11
Application layer protocol	CBR
Transport layer protocol	UDP
Buffer size	150 packet
Type queue	Drop tail
Node placement	Random
Mobility	Random way point
Chanel type	Wireless channel
Simulation methods	DSR-RRP, QAODV

Performance metric

Packet Delivery Ratio (PDR%): Determined as the ratio of the number of data packets actually delivered to the estinations to the number of data packets supposed to be received. Because packets are routinely dropped from a network:

$$PDR = \frac{\text{Packet recived}}{\text{Total packet transmitted}} * 100$$

where, PDR is the package delivery rate, total packet transmitted is the number of sent packages and Packet Recived denotes the number of received packages.

Packet Loss Ratio (PLR) (%): Packet loss can be caused by a number of factors including attacker over the network medium due to multi-path fading, packet drop because of channel congestion, corrupted packets rejected in-transit, faulty networking hardware, faulty network drivers or normal routing routines (among DSR in mobile ad hoc networks), packet loss can be caused by the black hole attack:

$$\text{Packet loss} = (\text{Send packet-Received packet})/\text{Send packet} \quad (2)$$

End to end delay: Delay constraint is one of the most important QoS parameters that many applications require with less bound. Timely transmission of safety applications in mobile ad-hoc networks environment is of significant important:

$$D = \frac{\sum_{i=1}^{n} D_i}{n} \quad (3)$$

Throughput: It measures the total rate of data sent over the network, including the rate of data sent from cluster head to the sink and the rate of data sent from the nodes to their cluster head:

$$T = \frac{\sum_{i=1}^{n} T_i^r}{\sum_{i=1}^{n} T_i^s} * 100 \quad (4)$$

Where:

T_i = The average receiving throughput for the application
T_is = The average sending throughput for the application
n = The number of applications

Performance analysis: This section investigates the performance of the proposed protocol (DSR-RRP) and compares it with (QAODV) routing algorithms. The performance metrics evaluated in all the figures in this section have been calculated by taking the average results of at least twosimulation time.

In Fig. 6 show, that the protocol (DSR-RRP) has better packet delivery ratio than (QAODV) protocol the reason for this is using routing tree and sending packets on a stable direction and we know these nodes are connected. Another reason is rapid restoration routes that have been destroyed and it causes the immediate replaced by a new link to be delivered to the destination. However, (DSR-RRP) improves the packet delivery ratio compared to (QAODV), at different times of the simulation However, our proposed protocol (DSR-RRP) outperforms (QAODV) in terms of packet delivery ratio.

Figure 7 show that the delay in 600-1000 that end-to-end delay, proposed method (DSR-RRP) compared to (QAODV). Is better performance. Because the proposed method (DSR-RRP) use spare route and local recovery tree based transforms a multicast group tree and one member is assigned at most two transmission tasks. The protocol then averagely distributes transmission tasks among the members and multicast data will not generate a bottleneck at any member. Therefore, transmission tasks can be completed quickly even under heavy traffic. The efficiency of networks is thus enhanced. Because use (DSR-RRP) Use Spare Route as an efficient optimization method to solve routing problems.

Figure 8 show that the delay in 600-1000 that end-to-end delay, proposed method (DSR-RRP) compared to (QAODV). Is better performance. Because the (DSR-RRP) has the second-route for transmitting tree multicast paths. In (QAODV) curve decreases because route repairs become easy when a network has many members. Therefore, transmission tasks can be completed quickly even under send tree and quickly discover the tow route the efficiency of networks. However, (DSR-RRP) improves the average throughput compared to (QAODV), at different times of the simulation However, our proposed protocol (DSR-RRP) outperforms (QAODV) in terms of average throughput.

Figure 9 shows the packet loss ratio of proposed method (DSR-RRP) at the different time 200 to 1000 than the (QAODV) is better, the algorithm DSR-RRP with the rapid restoration of corrupted packets are not lost link and immediately transferred via. links to trailers. Proposed method (DSR-RRP) method quickly discovered routing. Improved routing and packet delivery ratio between mobile ad-hoc networks. However, (DSR-RRP) improves the packet loss ratio compared to (QAODV), at different times of the simulation However, our proposed protocol (DSR-RRP) outperforms (QAODV) in terms of packet loss.

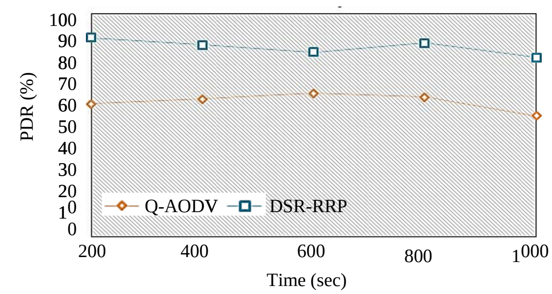

Fig. 6: Packet delivery ratio vs. simulation time

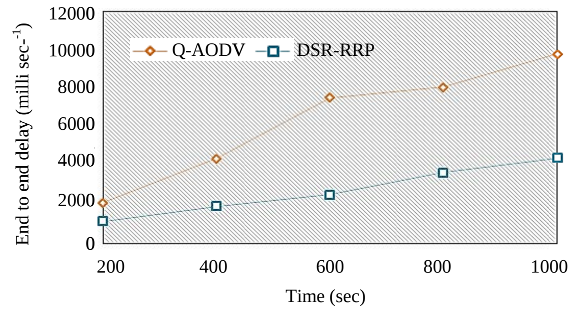

Fig. 7: End to end delay vs. density

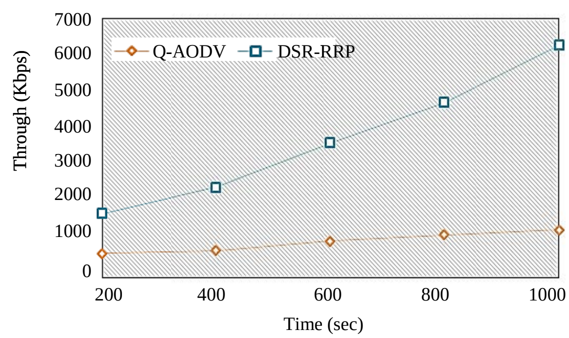

Fig. 8: Throughput vs. simulation time

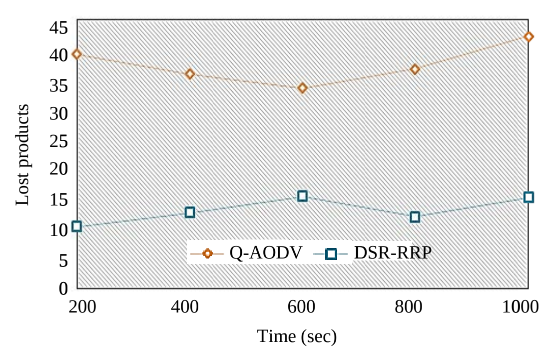

Fig. 9: Packet loss ratio vs. simulation time

CONCLUSION

Mobile Ad-hoc Networks (MANETs) play an important role in emergency communications where network needs to be constructed temporarily and quickly. Since, the nodes move randomly, routing protocols must be highly effective and reliable to guarantee successful packet delivery. Many techniques routing protocols for improving is proposed route use the hop count vector to a group of anchors for packet forwarding. Due to the discrete nature of hop count, based coordinates, without an effective recovery mechanism, these protocols will frequently encounter failures at network local minimum sites. In this study, a new method has been introduced on the basis of DSR routing protocol with the (DSR-RRP) name. This method was based on tree and the routing from each node to the base children base station, children transfer their packets to the parent and then the parent will send to the BS. In the proposed method to maintain connection and communication between child and parent awareness, each node has two tables, one table tree information and other neighbor's management information table that holds all the information in these tables. In the proposed methods after detecting the link failure through the HELLO message threshold or ACK HELLO message, the repairing process is done and quickly tow path will be created. The simulation results by ns2.34 show that, proposed method (DSR-RRP) comparing with the (QAODV). Outperforms in terms of packet delivery ratio, throughput, packet loss and end-to-end delay. As a result, the proposed method (DSR-RRP) is obviously better suited for MANET and can provide better performance for data transmission.

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