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A New Efficient and Reliable On-Demand Routing Protocol for MANET (ERORPM)

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Abstract- Mobile Ad Hoc Networks (MANETs) belongs to a class of wireless network that is a spontaneous network can be formed dynamically and randomly without the need for infrastructural setups; therefore the mobile hosts communicate over multi-hop wireless links. In addition to the high degree of mobility, MANET nodes are distinguished by their limited resources such as power, processing, bandwidth, and memory. This paper introduces a New Efficient and Reliable On-demand Routing Protocol for MANET (ERORPM) that uses the general technique called breadth first search which gives the shortest path for data transmission and routing. The algorithm is based on the routing discovery phase, packet forwarding phase and route maintenance phase. The main aim of ERORPM is find out the best possible available route from source to destination depending upon data packet like voice-data, multimedia type data etc. sent by source. This protocol provides the higher data packet rate, efficient routing but also cope with efficient loop free routing. It also reduces the number of data packet drop and saving the battery life of nodes. It avoids the problem of limited memory space and complex table formation.

Keywords─ Mobile Ad-Hoc Networks (MANET), BFS, ERORPM, RIT, and Routing.

I. Introduction

An ad hoc network is a collection of wireless mobile nodes (or routers) dynamically and randomly forming a transitory network not including the use of any existing network infrastructure or centralized management in which users wanting to communicate with each other [1]. In these types of networks mobile nodes (or routers) communicate directly with each other. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. For this purpose, a routing protocol is needed. The nodes in an ad-hoc network can consist of mobile, laptops, computers and personal digital assistants and having very limited resources such as CPU capacity, storage power, battery power and bandwidth. This means that the routing protocol must try to decrease control traffic, such as periodic update messages. Due to the frequency and structural changes in the network, ad hoc networks are divided into mobile ad hoc networks (MANETs) and wireless sensor networks (WSN). Mobile ad hoc networks (MANETs) are self-directed and interconnected systems consisting of mobile hosts (called nodes) that are connected by multi-hop and bandwidth constrained wireless links. MANETs are decentralized networks that develop through self organization where network organization and message delivery must be executed by the nodes (or routers) themselves i.e. routing mechanism should be applied on mobile nodes (or routers). These are often called infrastructure-less networking since the mobile nodes (or routers) in the network dynamically set up routing paths among themselves. If two mobile nodes need to communicate with each other in the mobile network, they can communicate directly if they are within the transmission range of each other, otherwise intermediary nodes (nodes in between) should forward the packet from one of them to the other. MANETs routing protocol has to be able to deal with the new challenges that a MANET creates such as nodes mobility, security preservation, quality of service, limited bandwidth and limited power supply. There are many major applications of MANETs [1] such as military battlefields operations, emergency search, and rescues sites, disaster recovery operations and convocations where participants share information dynamically using their mobile devices etc.

Routing protocols plays a very vital role in MANET. It has become clear that routing mechanism in MANET is fundamentally unlike from conventional routing established on infrastructure networks. Routing in MANET depends on many factors including topology, selection of routers, and beginning of request, and specific basic characteristic that could serve as a heuristic in discovery the path rapidly and efficiently[2]. Routing protocols are used to forward or route the data packets which depends upon the path conditions or Routing is the mechanism of moving information from a source to a destination in an internetwork. During this process, at least one intermediate node within the internetwork is encountered. The designing of network protocols for MANETs is a complex problem. Message or packet routing in a decentralized network where network topology fluctuates is not a definite problem. The routing idea basically involves, two activities: firstly, determining best possible routing paths and secondly, transferring the information groups (called packets) through an internetwork [3].

A routing protocol must have a loop-freedom property that avoid the problems such as, a small fraction of packets spinning around in the network for random time periods, but a more structured and well-formed approach is generally

desirable as it usually leads to improved overall performance. Another performance issue for a routing protocol is that it having a demand-based operation [4]. The dynamic topologies will lead to the routing algorithm adapt the traffic pattern on a demand basis, instead of using a uniform traffic distribution within the network. Due to this operation the energy and bandwidth resources are utilized more efficiently, at the cost of increased route discovery delay. A routing protocol having another performance issues such as security i.e. the main problem for Mobile ad hoc networks and many protocols will be more susceptible to many forms of malicious attacks.

The paper proposes a new efficient and reliable on-demand routing protocol for MANET (ERORPM) using general technique called Breadth First Search. Protocol contains three phases: route discovery, data forwarding and maintenance phase. Route discovery phase is implementing with RIT and BFS. Route is discovered according RIT (which contains route information of all nodes with their neighbor node). BFS is applying at staring node for traversing and issue for all nodes one by one [5]. Data packets are sending through the determined path at destination node. And acknowledgement is send via same reverse path at source node. The maintenance phase (improvement phase); if a node moves from its location due to mobility problem and route is broken, then we uses the another path because we have list of available paths for data transmission. If one is not capable of data sending we use another stored path. This protocol provides the efficient routing but deal with efficient loop free routing. It helps in reducing the no. of packet drop and minimizes the power consumption and provide optimal path for data transmission and having less time and less memory space. The working of algorithm is shown below with the help of different examples and algorithm is written in pseudo code discussed later in section 3.

II. RELATED WORK

Many protocols have been proposed in order to provide efficient routing and managing the energy level. Some protocols have been proposed in order to provide power aware routing.

Efficient Routing Protocol for MANET has been proposed in [6].This paper present a new routing protocol which not only provide QoS (Quality of Service) but also deal with efficient loop free routing in terms of bandwidth and tries to solving the problem of network partitioning. The protocol checks for the availability of required bandwidth at the time of route discovery process. Nodes having available bandwidth equal or greater than the required bandwidth will take part in route discovery process. This helps in reducing the number of packet drop due o discharge of battery, also nodes need not to maintain large tables, and thus the problem of limited storage space can be easily overcome.

Adaptive Velocity and Distance based Routing Protocol for MANETs has been proposed in [7]. The paper presents an improvement of AODV protocol called mobility aware modified AODV (MDAODV).In AODV routing protocol, the shortest path between source and destination nodes in always selected without collecting the topology information. But in new improved routing protocol, presents a new algorithm that finds an optimum path based on distance, relative velocity between two nodes and hop count. The simulation results show that this improvement has higher packet delivery ratio than standard AODV routing protocol.

Probabilistic Routing Using Queuing Theory for MANETs [8]. This paper gives the idea of an improved algorithm, which uses probabilistic approach for the stability of the adjacent nodes in discovery and maintaining the routing paths in Mobile Ad- Hoc networks. The probability of a node being stable in the path is modeled by queuing theory, where the stability of a node is calculated by number of packets arrived at a node and number of packets being serviced by the node per unit time. This shows the major enhancement over the traditional Ad-Hoc on-demand distance vector routing protocol analyzed in the result analysis section.

On Demand Route Routing Protocol (ODRRP) for MANET [9]. This paper presents a on demand route routing protocol with broadcast reply which combines the merits of both proactive and reactive approach. ODRRP takes advantage of broadcast nature in MANET for route finding and store maximum information in the routing tables at each node.

An Enhancement of Routing in Mobile Ad Hoc Networks for Increasing the Speed of Reliable Data Transmission for MANET has been presented in [10]. The objective of this paper is to calculate the required energy and reliability pair factor, based on values assign the priority to multiple paths. Based on priority and data rate the better path is chosen.

A New Proactive Routing Algorithm for MANET [11] .The authors have proposed a new proactive routing algorithm for MANET called NPR, which is stimulated by a modified Ant Colony Optimization (MACO) framework and uses "ants" for route discovery, maintenance and improvement.

A Robust and Efficient Data Transformation in Ad Hoc Networks has been proposed in [12]. The authors address a cooperative caching method to improve data accessibility in Ad Hoc networks. Proposed solution is based on the size of the cache in nodes. For large-sized caches, nodes take decision independent of each other whether to cache some data and how long. A data replacement policy allows nodes to store recently received data while maintaining the better performance in data delivery system in small sized caches.

A Stable On-Demand Routing Protocol for Mobile Ad Hoc Networks with Weight-Based Strategy [13]. In this paper author proposed a weight-based, stable and on-demand routing protocol for mobile ad hoc networks. The proposed protocol may warfare against link failure due to mobility, link failure in network due to the exhausting node energy is a aspect that also be required to be accounted for when computing weights for established routing.

Optimal Path Selection Routing Protocol in MANETs [14]. This paper presents, a new protocol (DSR-A) which selects route from source to destination depending on bandwidth constraint of source node and battery life of all the nods on a path from source to destination. This protocol gives the best result as compare to traditional DSR. If the Nodes in Network are move far away (due to mobility) from each other more energy are wasted for calculation of bandwidth.

III. PROPOSED WORK

The main purpose of this proposed work is to provide efficient and reliable routing over Mobile Ad Hoc network. Our proposed work introduces a new efficient and reliable on-demand routing protocol for MANET (ERORPM) that based on the general algorithm called Breadth First Search (BFS).The general idea behind this algorithm is that the search is begin at a starting node. First we examine the starting node and then we examine all the neighbors of that node. After that we examine all the neighbors of neighbors of that starting node and so on. There we need to keep track of the neighbors of a node and we need to guarantee that no node is processed more than once. This is accomplished by using a queue to hold nodes that waiting to be processed, and by using a field which tells us the status of any node. The working of our proposed algorithm is shown with example in below:

Working of algorithm with Example:

In proposed work, we deals with three phases: first is route discovery phase, second packet forwarding phase and third is maintenance (improvement) phase. This protocol uses "hello" beacon signals to determine which nodes are capable of direct communication. These beacon signals are broadcast periodically after some time period in the network. When a node receives beacon signal is considered a neighbor and added to the neighbor list.

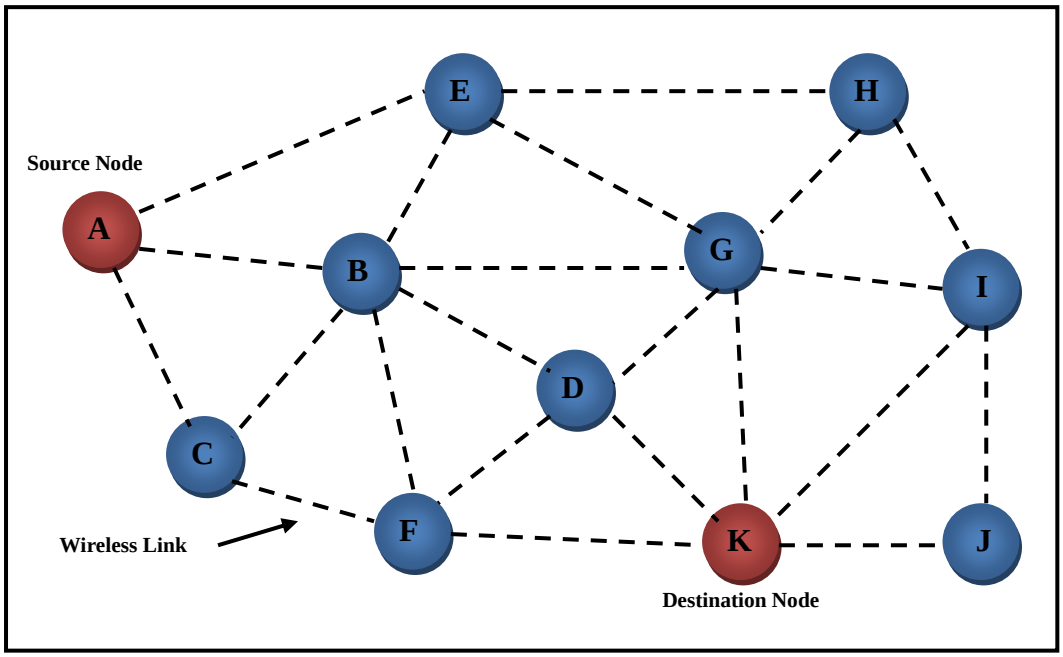

Fig.1 Network Topology (Mobile Ad Hoc Network)

So we determined which nodes are within transmission range and those nodes are within transmission range they join the network and form a network topology.

Route Discovery in ERORPM: Whenever a node want to transmit data to another node in the network then the data transmitting node becomes a source node and receiving node becomes destination node. The source node maintain a table called routing information table (RIT) which contains the route information about all the nodes with their neighbor nodes in the network. The route discovery phase is started in which we choose the starting node (source node) from the route information table and apply the breadth first search technique and traverse the node with its neighbors. This search technique is implementing for all the nodes in the network and traverses all nodes one by one. When all nodes are traversed then we get a traversed path, these may be more than one and keep these all in descending order and choose a path for data transmission according this scheme. Using above fig.1 we create a route information table which contains node route link information with their neighbor nodes shown below in the table:

Table1. Route Information Table (RIT)

	Number of Nodes with their neighbor information										
Node	A	B	C	D	E	F	G	H	I	J	K
A	x	1	1	0	1	0	0	0	0	0	0
B	1	x	1	1	1	1	1	0	0	0	0
C	1	1	x	0	0	1	0	0	0	0	0
D	0	1	1	x	0	1	1	0	0	0	1

E	1	1	0	0	x	0	1	1	0	0	0
F	0	1	1	1	0	x	0	0	0	0	1
G	0	1	0	1	1	0	x	1	1	0	1
H	0	0	0	0	1	0	1	x	1	0	0
I	0	0	0	0	0	0	1	1	x	1	0
J	0	0	0	0	0	0	0	1	1	x	1
K	0	0	0	1	0	1	1	0	1	1	x

In the above table data is represented in the bit (0 or 1) form. If a node having further link with its neighbor node then it is represented by 1 and if there is no connection then it is shown by 0. The route information table is updated periodically when nodes receives the beacon signals. After table formation, now choose first node i.e. is the source node and traverse using BFS. This technique is applied for all the nodes in the network and no node is repeated more than one time. In BFS we use the Queue to hold nodes that are waiting to be processed and using a field STATUS which tells us the current status of any node. When we eliminate the front node from Queue the front is incremented by one (FRONT: =FRONT+1) and add to Queue the neighbors of that processing node. The origin maintains a path of each boundary by using an array Origin with the array Queue. Initially add node A to Queue as shown below:

Process node A, Queue: A, Origin: (Ø)

Process node A: (B, C, E), [Queue: (A, B, C, E), Origin: (Ø, A,)]

Process node B :(A, C, D, E, F), [Queue: (A, B, C, D, E, F), Origin: (Ø, A, B)]

No node is processed more than one time so, node A is not process.

Process node C: (A, B, F), [Queue: (A, B, C, F), Origin: (Ø, A, B, C)]

Process node F: (B, C, D, K), [Queue: (A, B, C, F, D, K), Origin: (Ø, A, B, C, F)]

Process node D: (B, F, G, K), [Queue: (A, B, C, F, D, G, K), Origin: (Ø, A, B, C, F, D)]

Process node G: (B, D, E, H, I, K), [Queue: (A, B, C, F, D, G, E, H, I, K), Origin: (Ø, A, B, C, F, D, G)]

Process node E: (A, B, G, H), [Queue: (A, B, C, F, D, G, E, H, I, K), Origin: (Ø, A, B, C, F, D, G, E)]

Process node H: (E, G, I), [Queue: (A, B, C, F, D, G, E, H, I, K), Origin: (Ø, A, B, C, F, D, G, E, H)]

Process node I: (G, H, J, K), [Queue: (A, B, C, F, D, G, E, H, I, J, K), Origin: (Ø, A, B, C, F, D, G, E, H, I)]

Process node J: (I, K), [Queue: (A, B, C, F, D, G, E, H, I, J, K), Origin: (Ø, A, B, C, F, D, G, E, H, I, J)]

After traverse all nodes, we maintain a table named as list of available path in route cache. Theses all traversed path are kept in descending order and used for sending data at destination.

Table No.2 List of Available Path Stored

List of Available path (In descending order) in route cache	(A-B-C-F-D-G-E-H-I-J-K) (A-B-C-F-D-G-E-H-I-K) (A-B-C-F-D-G-K) (A-B-C-F-D-K)

Data Packet Forwarding in ERORPM: Now we have the entire best path for data transmission. Once the route has been established, the source node starts sending the data packets to the destination. Source node send data at intermediate node and intermediate node further forward the data packet at destination node.

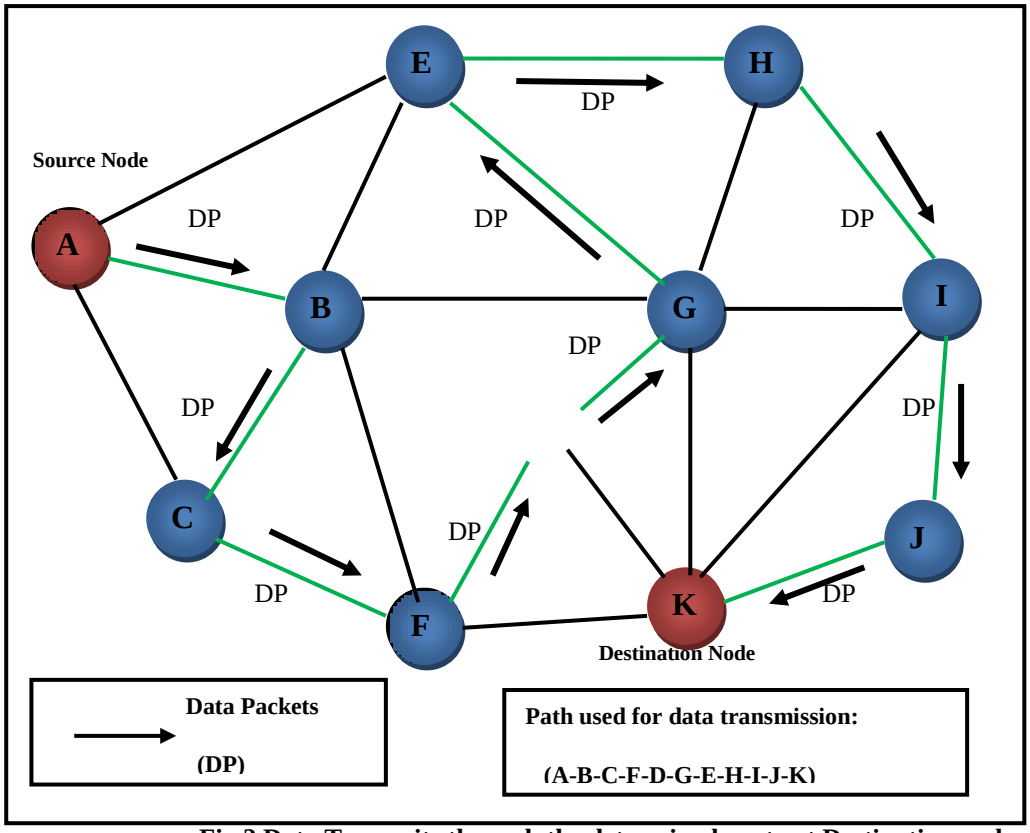

Fig.2 Data Transmits through the determined route at Destination node

This phase is called packet forwarding phase, in this phase source node transmit the data packet through the determined path along with <packet sequence number>, <source address>, <source sequence number> and <destination address> avoiding the flooding attack and send to the destination. The destination node sends back acknowledgement to source node through same reverse path with <source address>, <destination address> and <destination sequence number>.

Route Maintenance in ERORPM: The last phase is route maintenance, in this phase all nodes maintains the routes in the network. If there is any link failure between the nodes, then intermediate node send back the RERR (Route error message) to the source node to notify it to unreachable destination.

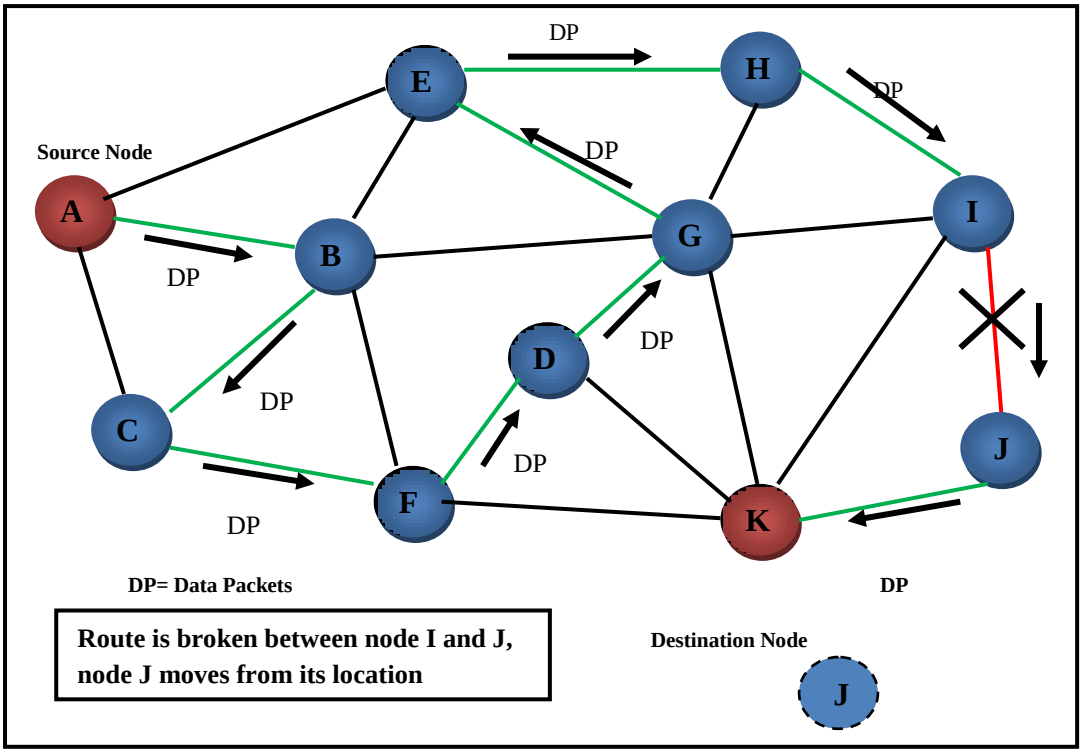

Fig.3 After data transmission Node J moves from its location and route link Between node I and J is broken.

If any node moves from its location or route link is broken with its neighbor. Then that case we choose another stored path from the table (list of available path in route cache) and start data transmission process in a new route. No node moves so far in the network, if a node moves from its location then that nodes will be moves towards to another neighboring node in the network and it may be possible that we find out the another shortest path for destination than the previous.

In above fig.3, if node J moves from its location and moves to another location in the network then we use another available path for data sending shown in fig.4. We use the path (A-B-C-F-D-G-E-H-I-K) for data packet sending. This new path is better than the previous. We choose another best path because there is different path available in the list of available path. Use that path for data transmission. Suppose if destination node moves from its location before data transmission, than according to that we create the route information table. And if after transmission a node moves from its location then we only use another stored path for data sending.

The path used for data transmission is in descending order as stored in the list of available path in route cache from the table. This leads to reducing the data packet drop in the Mobile Ad hoc networks and also consumes less time. The Route maintenance phase deals with two conditions discussed in the algorithm section. Rather than finding another route and repeating the whole process use the stored path is the best way. This is the main advantage of this protocol that it provides reliable and efficient routing. It also deals with loop free routing and having fewer messages overhead and consume less time for calculation. In this protocol we found more stable paths and reducing the no. of packet drop.

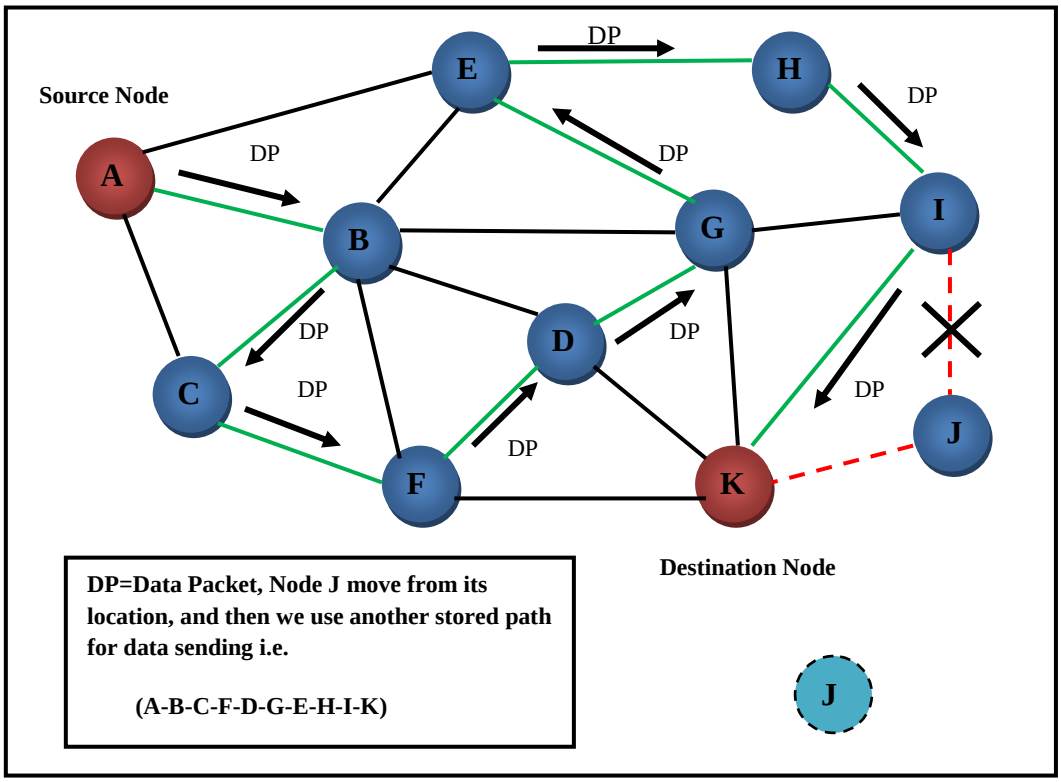

Fig.4 List of available stored path used for data transmission (when one route is failed)

The algorithm steps involved in a new efficient and reliable on-demand routing protocol for MANET (ERORPM) is:

For the formation of Network Topology:

Step1. Broadcast "HELLO" beacon signals in the network periodically and when a node receives this signal, add to neighbor list.

Step2. Once all nodes receive "HELLO" beacon signal, and then these nodes form a network topology.

Step3. If a node not receives a beacon signal, then go to step 1.

For Route Discovery Process:

Step4. [Route Discovery Phase] Select the SOURCE and DESTINATION node and start formation of RIT (Route Information Table).

Step5. If a node having further route link with its neighbor, add its information in RIT and Else

If not then, add only node without having the neighbor information (It is shown as null).

Step6. Select the first node (Source node) from RIT and apply BFS for traversing.

Step7. Call BFS for all nodes in the network one by one.

Step8. Store all traversed path in a table named as list_ of _available _path in route cache (in

For Data Packet Forwarding:

Step9. [Data Packet forwarding] Start the Data Packet Forwarding Process. Route is found out; now data forwarding process is started between SOURCE and DESTINATION.

Step10. SOURCE node sends DATA PACKET at intermediate node along with <packet_ sequence _no.>, <source address>, <source sequence number> and <destination address> through the determined path at destination node.

Step11. DESTINATION node sends ACK (Acknowledgement) through the reverse path with <source address>, < destination sequence number> and <destination address>.

Step12. Repeat the process until the data transmission is completed from step 9 to step 11.

For Route Maintenance:

Step13. [Route Maintenance Phase] At Maintenance phase, if any link failure then, sends the RERR message to source node. Two cases are possible:

i. If a node move from its location before RIT formation,

Else

Maintain the node information according to that movement of a node in RIT. No node move so far in the network.

ii. If a node move from its location after data transmission,

Else

Choose another stored path from the table <list of available path in route cache> and start data transmission process in a new route.

Go to step 8

Step14. If it is not happened in the network, then go to step 11.

Step15. Path selection at destination based on BFS and the updation occurs in RIT periodically according to beacon signals. Go to step 1.

Step16. End.

IV. CONCLUSION

The proposed paper described a novel approach known as a new efficient and reliable on-demand routing protocol for MANET (ERORPM) using BFS, finding the shortest and resilient path for routing but also provide the efficient and reliable routing, which handles the various issues related to Mobile Ad hoc network along with loop free environment. In our proposed work the source node send data to destination according to determined path. The determined path is calculated according to route information table which having the information of nodes. Breadth first search is applying

on all nodes and store the traversed path. If a node changes its location and route broken then used stored path for transmission. This will help in reducing the number of packet drop and also avoiding the battery discharge. There is no need to maintain complex tables, therefore the problem of limited storage apace can be easily solved and provide efficient method along with the guaranteed services to the end user. In future the routing for MANET is done with other general techniques.

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