Study and Design of Route Repairing Mechanism in MANET

Harendra Kumar, Madhuri Malakar, Sourabh Debnath and Mudassir Rafi

Abstract Mobile Ad hoc Network (MANET) is a frameless, wireless network with no central access point. The network consists of migrant nodes. Topology is highly dynamic, unpredictable, and its probability of link failure is high due to continuous mobility of the nodes. As a result, we find that the nodes are no longer reachable and it moves away from the mobile or active path. This maximizes the dropping estimate, end-to-end delay and also undergoes cut in packet delivery rate thereby leading to degradation of network efficiency. In order to conquer such consequences, our work proposes designing of a route repairing mechanism in MANET. The basic idea of our proposed routing protocol is to find an optimal path based on the minimum hop count in the multipath scenario. Based on the widespread simulation of the proposed mechanism, done by adopting NS2 and by relative study of the same with existing protocol AODV, it was found that the projected routing mechanism helps in enhancing the performance and brings about improvement in ratio of packet delivery, packet loss as well as end-to-end delay.

Keywords Mobile ad hoc network · Ad hoc on-demand distance vector · Route discovery · Route repairing · Optimal path

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1 Introduction

Ad hoc network, a wireless network, lacks well-defined framework. In ad hoc network, each migrant node actions as router. This router discovers, controls routes for other nodes available in network. Within the network topology, these nodes may make a swift in such a way that it may lead to uncertain and frequent changes. There are a number of routing protocols defined for Mobile Ad hoc Networks (MANETs) [1–6]. The two defined categories of protocols, based on the route discovery principle, are proactive protocol and reactive protocol [1]. These two protocols serve different functionalities. In order to update route for every pair of nodes periodically, irrespective of requirements, proactive protocol is used whereas the reactive or on-demand routing protocol uses a broadcasting query-reply, i.e., Route Request–Route Reply (RREQ-RREP) procedure to determine the route, only when there is a need of data packet transmission. There are a number of applications of MANET in the field of civilian environment, law enforcement, military and disaster recovery [7]. To expedite these applications of abundant traffic among nodes, a stable and productive routing protocol is crucial. Figure 1 illustrates the organized communication in MANET. The challenge lies in the persistent change within the network topology, constrained battery capability of the nodes, and uncertain behavior of wireless channels in MANET. Within this network, critical task lies in selection of a long-lasting route [8–11]. Our protocol provides maximum priority route for MANET that may be viewed as a two-stage process, first for route discovery and the second for route recovery.

Characteristic of roving ad hoc network is modification in its topology where serious issue lies in mobile devices in terms of the power limitations [12]. As the network is mobile in nature, devices use battery as their power supply [13]. Therefore, the leading conservation of power technique becomes crucial for designing a system.

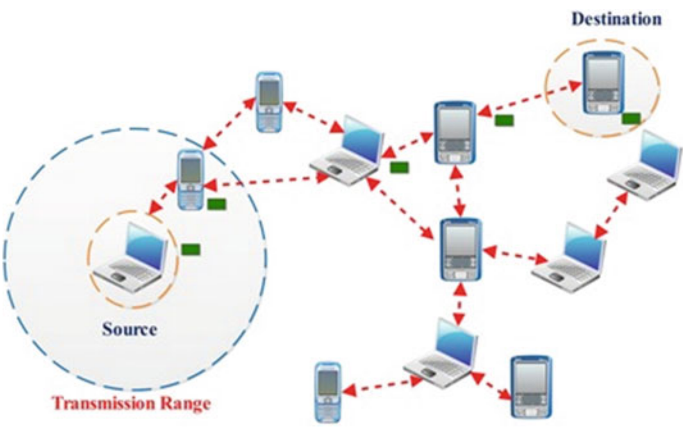


Fig. 1 Mobile ad hoc network

However, the security issue remains in terms of physical aspect. The possibility of attack on mobile network is easy compared to the fixed network.

Overcoming of the new security issues and troubles in wireless network is in high appeal [13]. Other than applications found in the field of military battlefield, commercial sector such as ad hoc mobile communication in between the ships, law imposition, taxi cabs, stadiums, boats, aircrafts, etc. There are a number of other applications found in personal area network such as laptop, cellular phone, Wireless LAN (WLAN), GPRS, and UMTS. Figure 2 illustrates classification of protocols used for routing.

Following are the list of challenges showing the inefficiencies and limitations in a MANET environment [14]:

- Limited wireless transmission range,
- Routing overhead,
- Battery constraints,
- Mobility-induced route changes,
- Potentially frequent network partitions,
- Immense power consumption,
- Depressed bandwidth, and
- Steep error rates.

The other part of our work is formulated as follows: Sect. 2 describes several works. Details of the suggested protocols have been described in third section. Fourth section illuminates results of simulation, comparison with extant protocol. Finally, Sect. 5 provides a conclusion to the paper.

2 Related Work

Route repairing is being extensively studied for the past two decades. Other than the works mentioned in [15], there are several other results which exist in the literature for routing via multiple paths in ad hoc networks. Some of the important works are as follows. The Destination-Sequenced Distance Vector (DSDV) routing protocol, proposed by Park et al. [16], illustrates the perception of classical Bellman–Ford routing algorithm with advancement in making it loop-free. Due to count to infinity and bouncing effect, the distance vector routing is subordinately strong compared to link state routing. Within the network, each of the device maintains a routing table. This routing table consists of entries for all the devices. Each of the devices keeps on broadcasting routing messages at regular interval times to keep the table updated. When the neighboring device packets transmitted routing information and identify ongoing cost of link to device, it tries to correlate the value and its equivalent value stored in its routing table. The value is updated if changes found and recomputation of route distance is done. Ng et al. [17] proposed a protocol named as cluster head gateway switch routing protocol. This is different because rather than using a flat topology, it uses hierarchical network topology. As proposed by Chiang,

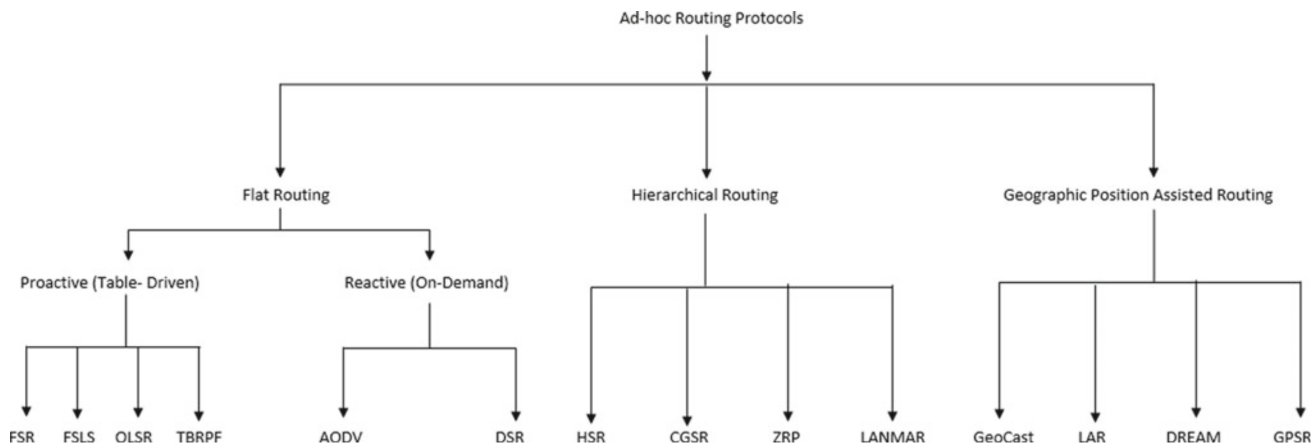


Fig. 2 Distribution of routing protocols in mobile ad hoc network

cluster head gateway switch routing protocol brings about an arrangement of cluster nodes by bringing about a coordination among each cluster member by allocating it to a special node termed as cluster head. In order to elect a node dynamically as a cluster head, an algorithm termed as Least Cluster Change (LCC) is applied. For each mobile node within a network, cluster member table is available to each of the nodes to store target cluster head. Each node broadcasts the cluster member table at regular intervals with the help of DSDV algorithm. CGSR, an expansion to DSDV, is used as underlying scheme for routing. The overhead is similar to DSDV. By using the method of cluster routing, DSDV is adjusted to route traffic from source to target. CGSR brings about an improvement into the routing conduct by routing packets through the cluster heads and gateways. Ad Hoc Backup Node Sets up Routing Protocol (ABRP), proposed by Chung et al. [18], is quite similar when compared to DSR. ABRP stores route substitute data in on-the-route node. Whenever there is failure of link, information is passed to the node acting as backup. In order to replace the ongoing current broken path, the backup node selects a path (if there exists one) by checking in its backup route cache. However, ABRP does not refurbish backup information of route to flash change in the topology. A dynamic route repairing protocol, enlightened by Yu et al. [13], reconstructs a collapsed path by adopting the content given by the nodes on hearing main route communication. Whenever these links steep, the brilliant protocol takes down declined links or nodes with substitute ones, adjoining the main route. A new local repair scheme proposed by Youn et al. [12] uses promiscuous mode. This scheme comprises two important modes: quick local repair scheme and adaptive promiscuous mode. Quick local repair scheme, with the help of related available information, helps in achieving faster local reroute discovery process for alive connection in the local area collected by promiscuous node. Adaptive promiscuous mode helps replay switching process between promiscuous and non-promiscuous mode. This helps conquer energy limits occurring because of promiscuous mode. Bird Flocking Behavior Routing (BFBR) protocol for an extreme mobile ad hoc network is proposed by Srinivasan et al. [19]. The protocol is divided into two parts: an encounter search and direction forward routing. An encounter search is useful in route discovery. Direction forward routing is useful in maintenance of route. Unlike the regular broadcast mechanisms, BFBR protocol preserves the bandwidth bypassing avoidable link traversals. During route discovery, link traversals are diminished by use of encounter search mechanism. Direction forward routing also aids in managing regional surrounding of each node to assure path accordance, thereby bringing about a reduction in overhead in routing. The mechanism is found complex in terms of maintenance of the route. Multi-Route Ad Hoc On-Demand Distance Vector Ant routing algorithm (MRAA) was proposed by Abdel-Moniem et al. [20]. The technique uses AODV to discover routes reactively. AODV discovers route on demand, whereas ACO generates path in between the nodes proactively, regardless of request. However, during data packet delivery, the technique reduces the end-to-end delay. As the technique uses alternate path for delivery of data packets, the forwarding is performed in limited time with minimum overhead. However, storage and maintenance of backup routes add to an overhead. Peer-to-Peer Bee Algorithm (P2PBA), proposed by Dhurandher et al. [21], is designed to provide an effective peer-to-peer (P2P) file exploration in MANETs. The technique utilizes the concept of swarm-based intelligence, explaining foraging behavior of the honeybees. The files are fragmented into small packets. The packets are dispersed over judicious collection of spots. Certain criteria like safeguard of energy, retrieval troubles, and heterogeneous collection of nodes are not taken care of in this technique. Bird Flight-Inspired Routing Protocol (BFIRP) based on energy and position was proposed by Misra et al. [22]. The technique uses the methodology of forwarding the data packets to the destination, keeping into consideration the node's energy and distance from target. Protocol involves the degree of node's closeness to the great circular area, connecting the common as well as the target nodes. However, the protocol suffers from bandwidth problems. A local repair method, removing the pitfalls in ongoing local repair, was proposed by Jain et al. [23]. The improved local repair scheme focuses on end-to-end delay in transference and need of overhead. An ant algorithm is used by the repairing node to look for a new route for next to next node in the link during local repair. The size of F-ANT and B-ANT is reduced as well as it provides significant minimization in overhead. The idea of extant local repair trial method in AODV was proposed by Naidu and Chawla [24]. This was elaborated for broadcasting and minimization of flooding. For easy broadcasting, protocol establishes mobile nodes so that in case of link failure detection, local repair technique is applicable. The technique uses diameter perimeter model to maximize count of intermediate nodes. Our present work presents solution to bring about a reduction in route overheads of AODVLRT as well as investigates the intensified AODVLRT with extant local repair technique. This technique consists of two parts: perimeter routing, which is used for broadcasting; local repair method, which is used to decrease the flooding. However, this maximizes the count of intermediary nodes from origin to target. An on-demand delay and bandwidth-based quality of service (QoS) routing protocol (AODV-D), proposed by Subburam et al. [25], was elaborated for two main reasons: first and the foremost thing to be taken care of was to ensure that delay does not exceed the threshold value and second, to check the least possible bandwidth available for sending the packets. The projected routing protocol follows unicast-type two-hop local route repair protocol reclaiming the lost links accurately while maximizing network accuracy, expanding usage, depreciation in the count of control messages, and decreasing the repair delay. An algorithm to control traffic with the help of local route repair method was proposed by Rao et al. [26]. Whenever there is link failure at intermediary node, the number of hop of target is correlated with origin's hop count and if target is nearer to breakage link than origin, regional improvement is done. When regional repairing is in action, packet is saved in buffered echelon and as soon as an alternate route is found, the packet is passed on to the destination. QoS-aware Routing based on Ant Colony Optimization (QoRA) was proposed by Al-Ani et al. [27]. This technique uses QoRA to calculate QoS parameter locally and helps in avoiding blockage during information transfer with the aid of two architectural components. Each node has a running QORA entity. The QORA entity detects path according to stated QoS needs. The SNMP entity, the other component, consists of Simple Network Management Protocol (SNMP) agent and the Management Information Base (MIB). SNMP finds applicable data for local node. Based on information or values, the QoS parameters are formulated thereby avoiding traffic during data packet transmission. However, this suffers from certain drawbacks such as high end-to-end delay and the technique pauses. AODV-Reliability (AODV-R), bundled by ant colony optimization, is enlightened by Singh et al. [28]. This is based on routing protocol for discovery of the abbreviated path by eliminating traffic. ACO algorithm is used by AODV-R to bring about an improvement in identification of precise path algorithm. Selection of most reliable path is done using AODV-R. It helps in reducing the possibility of link breakages at the time of change in network topology. However, it suffers from certain drawback by not fulfilling the requirements of QoS routing. An advanced method for path selection combined with AODV protocol uses Ant Colony Optimization (ACO) and the concept was enlightened by Sarkar et al. [29], to bring about an improvement in Quality of Service (QoS) in MANETs. The combination of ant colony with AODV helps in selecting best route for data transmission by utilization of path's pheromone value. Pheromone value of route is formulated based on end-to-end reliability, traffic, hop counts, and residual energy. The route with highest pheromone value is selected for data packet transmission. Das et al. [30] proposed a routing protocol for multicast ad-hoc network in order to create an energy effective path from origin to every multicast set built on two vague parameters such as distance and energy, whereas other parameters were not been considered by this proposed work which leads to its limitation. Hence, Yadav et al. [31] stretched the effort placed on multi-constraints method. They have considered three parameters that are delay, bandwidth, and energy. It supports to elect the best route with the help of fuzzy cost. Here too limitations occurred as it is a point-based membership function and fails to hold the fuzziness information. Henceforth, Das and Tripathi [32] proposed an energy-conscious-based routing protocol by considering five parameters such as distance, energy, delay, packets, and hop count. The objective of this routing is to search for an optimal route by considering multi-criteria decision-making and intuitionistic fuzzy soft set. It does not use any optimization method which leads to its limitation. So, by using above techniques several contradictory objectives may not be optimized. Das and Tripathi [33] brought up a routing technique based on nonlinear optimization technique. This nonlinear optimization technique is based on geometric programming which works with polynomial environment instead of polynomial environment. It helps to determine nonlinear parameters efficiently and enhance the network lifetime. A DUCR algorithm for wireless sensor networks was discussed by Mazumdar et al. [34]. This mechanism resolves the hot spot problem. To balance the receiving nodes, DUCR algorithm uses a well-organized approach to distribute the information to its parent nodes. It is scattered in nature and facilitates preferred performance of energy consumption, alive nodes, and lifetime of network. This algorithm is also stationary in nature, and it does not have the property of mobility which may increase the network performance. Mazumdar et al. [35] proposed a distributed fuzzy logic based energy-aware and coverage safeguarding uneven clustering algorithm (DECUC) for wireless sensor networks. While addressing the problems in wireless sensor networks, it intends to create a transition between coverage parameters and energy competence. It uses a fuzzy logic concept by taking parameters such as distance from base station, enduring energy, and CS of a node for electing cluster heads and cluster radii. This algorithm is distributed in nature and facilitates better conduct in coverage preservation, network's lifetime, and energy efficiency. This algorithm is also stationary in nature; it does not have the property of mobility which may increase the network performance. Mazumdar et al. [36] discussed an energy-efficient fuzzy-based uneven clustering and routing algorithm (DFCR) for wireless sensor networks. This mechanism reduces the cluster size that is nearer to base stations which resolves the hot spot problem. This DFCR algorithm provides an efficient approach for cluster head selection and selection of next hop node for routing of information. It is scattered in nature and facilitates superior act in terms of energy consumption and lifetime of the network. Though it is stationary in nature, it does not have the property of mobility which is required for better performance. The directional sensor models, used in the coverage of ROI, was proposed by Chaya et al. [37]. The probability estimation method is used to calculate the threshold value. This was elaborated to directional sensor ratio with respect to omnidirectional sensors. The LP formulation for boosting the coverage area was provided. Fixed count in the number of sensors, different orientation ways were implied and future objective was to achieve the coordinated value of sensors in ROI. The key research work of CLDs was proposed by Sah et al. [38]. It played an important aspect in the past in context to WSNs [39]. Irrespective of layer's collaboration, focus was on minimizing the transference and collecting power, end-to-end delivery improvement, reduction of control packet overhead, and QoS. Apart from this, very small progress was observed in the area of security. Incentive-based replication strategy was proposed by Singh et al. [40] to provide incentive to the participating nodes, so that it does not act selfish. Community-based mechanism was provided for fair incentive to the nodes to carry packets from origin to target. The proposed strategies evaluated in terms of epidemic, prophet, spray and wait, and maxprop routing algorithms. This strategy works better than the existing strategies. Singh et al. [41] say IRS provided better result of delivery ratio when compared to epidemic and prophet routing algorithms. In IRS, incentive policy for selfish nodes was popularized in socially aware DTNs to sacrifice their selfishness and as per incentive value reputation relay nodes can cooperate in replication process and earn incentive value for transferring packets.

3 Proposed Work

Our work delivers a brand-new ad hoc routing protocol with rectifiable path which handles broken-link recovery in a competent way. The present work is an intuitive idea employed behind the proposed protocol. The proposed routing protocol begins by selecting all possible routes from origin S to target node D. This target node also known as terminal node of the network because this is final destination of the data transmission. Among all possible routes, we select maximum priority route on the basis of hop count for packet transmission. As the data packet is sent along the maximum priority route, if there occurs any link failure then node Ni sends route

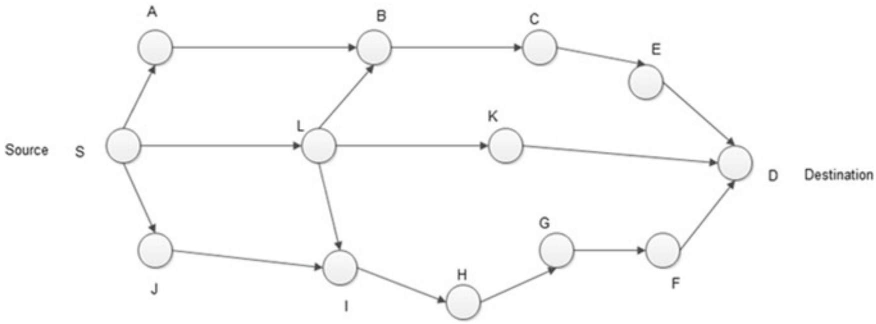


Fig. 3 An illustration showing the idea of proposed protocol

repair (RRP) message to the previous node N_{i-1} and then after node N_{i-1} broadcasts route request (RREQ) message to own neighbor node. After that if there is route from neighbor node to target then node N_{i-1} sends route repair ok (RROK) message to source. Now packet transmission again starts with repair route from source to target. Otherwise, if there is no route from neighbor node to target, in this case, the RREQ packet will be dropped and source node selects the already found route with next maximal priority for data packet transmission. No continual message flow and huge table preservation required. Figure 3 shows an illustration of the idea of our proposed protocol. The proposed work consists of two parts as (i) route discovery and (ii) route recovery.

3.1 Route Discovery

In this section, originating node introduces path detection by broadcasting a route request (RREQ), these route requests contain source node address, request id, source sequence number, destination sequence number, destination address, and hop count.

If destination node D is neighboring source node S, then the packet is sent directly to node D. Else, neighbor's node of S processing and forwarding RREQ packet throughout the network, so we will wait until all the paths between S to D are stored.

Now we calculate priority of each route, after that destination node D sends route replay (RREP) message to the source with maximum priority route, and thus route is established between source and destination. The flowchart for this mechanism is represented diagrammatically in Fig. 4 and algorithm is shown in Algorithm 1.

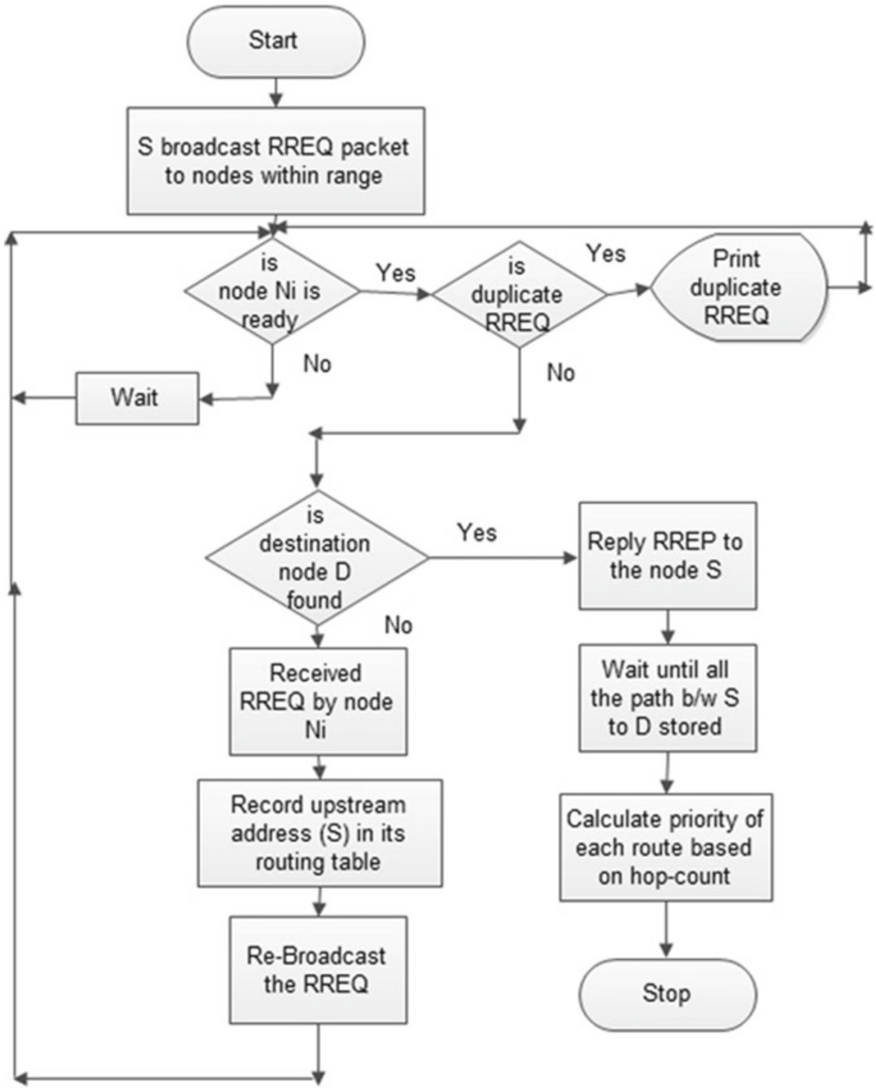


Fig. 4 Flowchart for route discovery

3.2 Route Recovery

In this section, during packet transmission, whenever node Ni finds a broken link in the main route, then node Ni sends route repair (RRP) message to the previous node N_{i-1}.

Then after node N_{i-1} broadcasts route request (RREQ) message to own neighbor node. After that if there is route from neighbor node to destination then node N_{i-1}

sends route repair ok (RROK) message to source, thus new repair route is established from source to destination. Now data packet transmission again starts with repair route from origin to target.

If no route from neighbor node to target, RREQ packet will be dropped and source node finds the route with next maximal priority for data packet transference. The flowchart for this mechanism is represented diagrammatically in Fig. 5 and algorithm is shown in Algorithm 2.

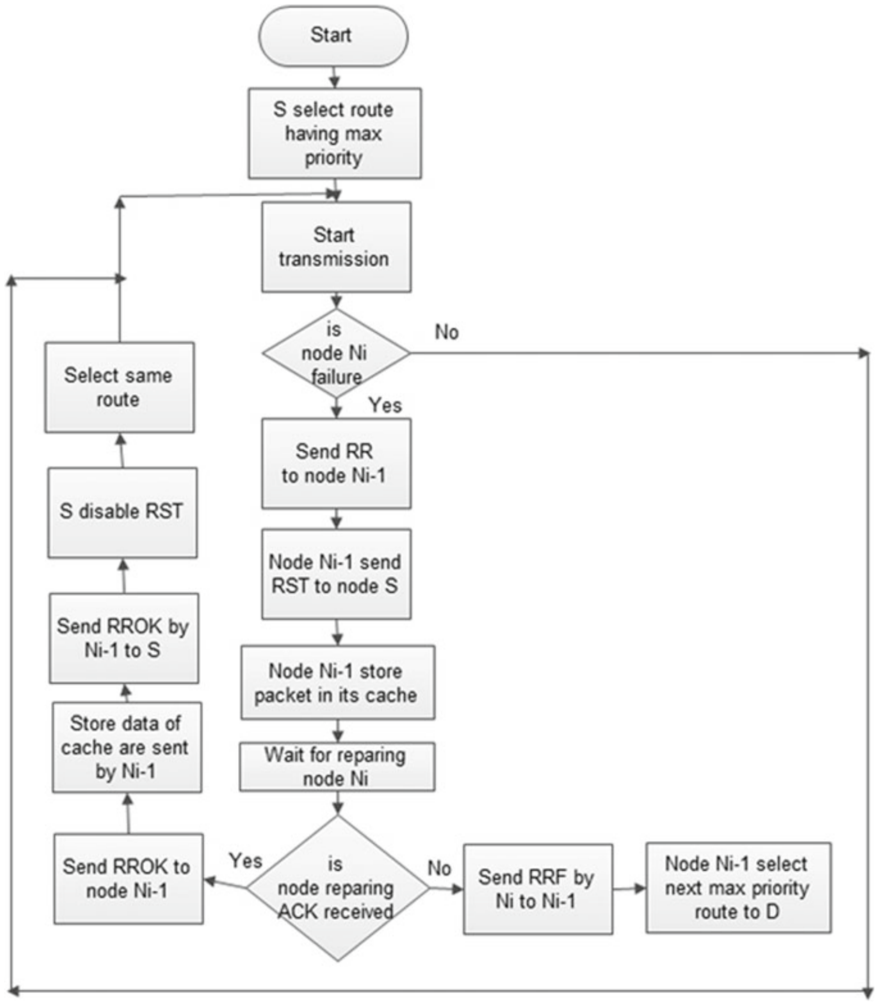


Fig. 5 Flowchart for route recovery

Algorithm 1: Route Discovery.

```
Input: Source node (S), Destination node (D)
Output: An optimal path

Initialization:  i=0, f=0
while (true)
{
if (i==0 )
{
S broadcast RREQ packets to its neighbors;
Neighbor node ( n_i ) accept non-duplicate RREQ packets;
}
if (n_i ==D)
{
f=1
}
else
{
Update R_tableof n_i ; /* R_table is routing table */
Neighbor node n_i re-broadcast the RREQ packet to its neighbor;
i++;
}
if( f==1 )
{
Destination node D send RREP packet based on shortest hop-count path;
break;
}
}
```

Algorithm 2: Route Repairing.

Input: Erroneous Link
Output: Recovery path

```
if (RERR==true)
{
while(true )
{
Node n_i generate and broadcast RREQ packet
to its neighbor   /* n_i is the preceding node of the failure link */
i++;
Neighbor node accept non-duplicate RREQ;
Update Routing table;
if (n_i==D)
{
f=1;
}
if(f==1)
{
Destination node D send RREP packet based on shortest hop-count path;
break;
}
}
}
```

Following is the step-wise representation of how a route is constructed and reconstructed whenever link failure occurs. Once a route is discovered, then information is propagated to destination from source.

Step-1:
An example showing route discovery's triggers route discovery by broadcasting an RREQ has been shown in Fig. 6.

Step-2:
Route discovery, intermediary nodes processing and transferring are shown in Fig. 7.

Step-3:
Shows discovery of route at destination D, and receiving three copies of RREQ in Fig. 8.

1. Through E.
2. Through K.
3. Through F.

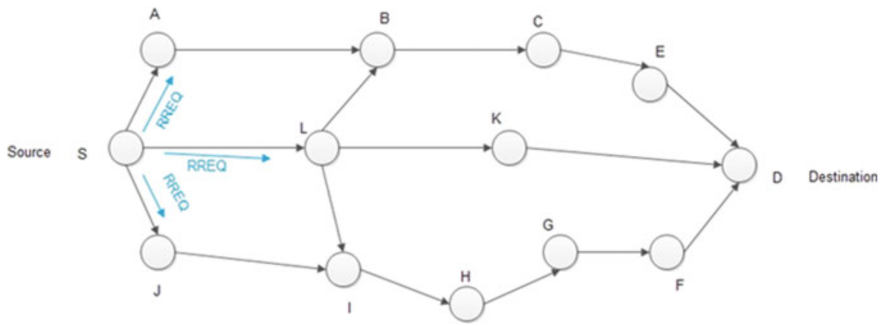


Fig. 6 Route discovery initiates by broadcasting RREQ

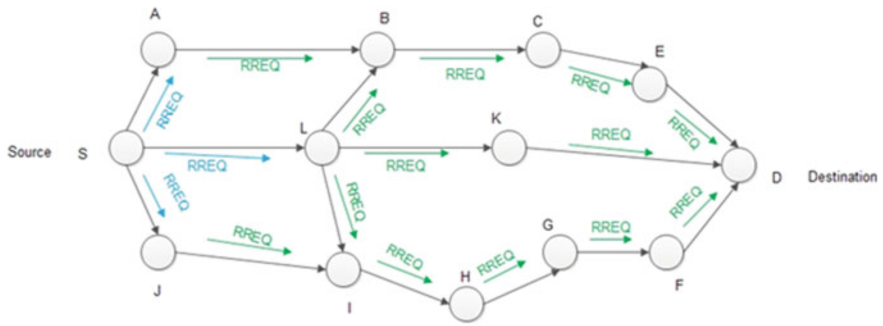


Fig. 7 An example showing route discovery, intermediate nodes are processing and forwarding

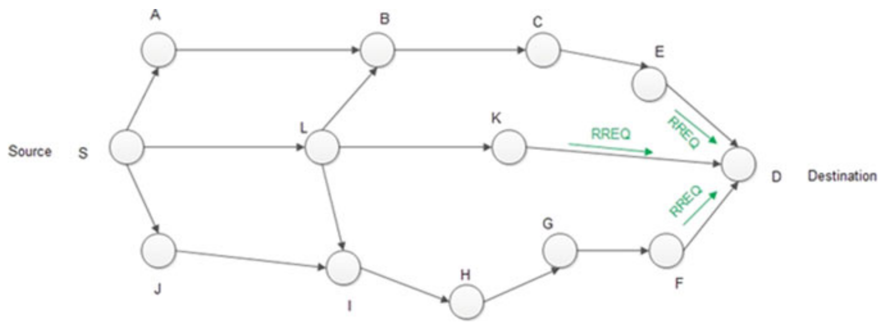


Fig. 8 During route discovery destination node D receiving RREQ

Step-4:
There are five feasible paths from source to destination and is shown diagrammatically in Fig. 9.

1. S->A->B->C->E->D with hop count value (HC1) = 5.
2. S->L->B->C->E->D with hop count value (HC2) = 5.
3. S->L->K->D with hop count value (HC3) = 3.
4. S->L->I->H->G->F->D with hop count value (HC4) = 6.
5. S->J->I->H->G->F->D with hop count value (HC5) = 6.

Step-5:
Destination (D) generates an RREP and forwards it through K which has highest priority route compared to other routes. Minimum hop count shows maximum priority route. Here HC3 < HC1 < HC2 < HC4 < HC5.

So select route with value (HC3) = 3, it is less than compared to other routes. Figure 10 shows route discover, destination D computing highest priority route and generating RREP.

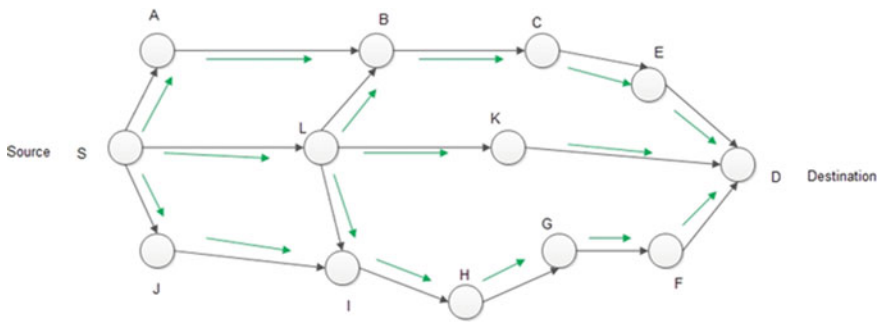


Fig. 9 An example showing route discovery, there are five feasible paths from source to destination

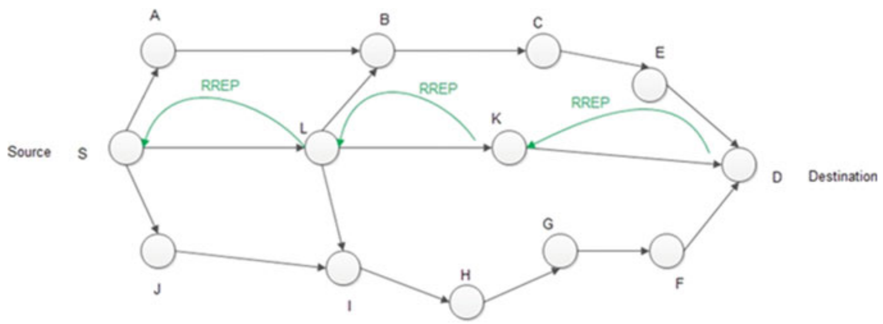


Fig. 10 During route discovery destination node D computing highest priority route and generating RREP

Step-6:
Figure 11 shows route discovery and establishment of maximum priority route between S and D.
Step-7:
How a packet transmission is done from source to destination is shown in Fig. 12.
Step-8:
In case if link fails or breaks during transmission, i.e., route error is shown in Fig. 13.
Step-9:
When a link breaks to continue the transmission process new route or route recovery is done and how it is done is shown in Fig. 14.
Step-10:
For route recovery, the node n_{i-1} broadcasts RREQ to its neighbor shown in Fig. 15.
Step-11:
Node n_{i-1} broadcasts RREQ, if there is a route from node n_{i-1} to destination then node n_{i-1} selects it, with maximum priority. If there are multiple maximum priority routes from node n_{i-1} to destination then node n_{i-1} selects any one route for sending packet. If there are no routes from node n_{i-1} to destination, then again it starts sending packet from source node with maximum priority route as shown in Fig. 16.

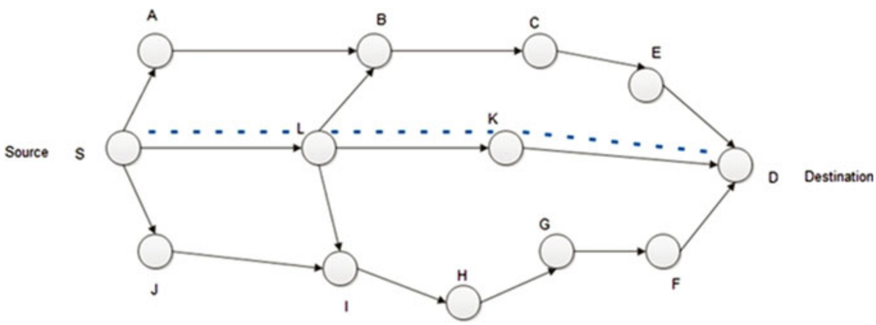


Fig. 11 Route discovery, a maximum priority route from S to D is established

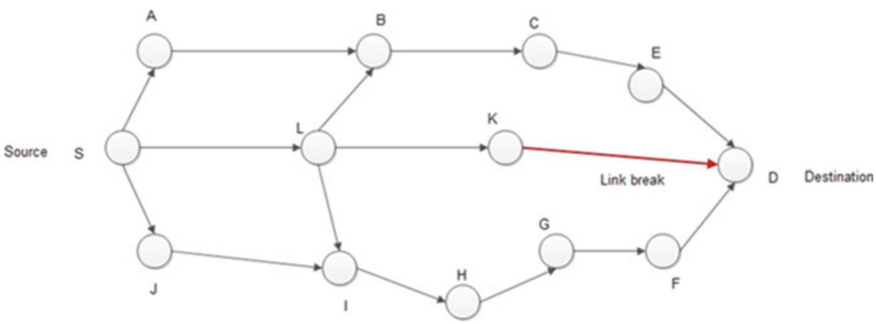


Fig. 12 An example shows transmission of packet from source to destination

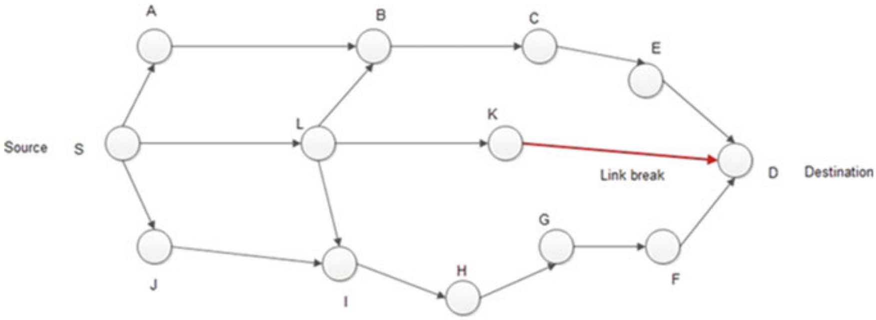


Fig. 13 An example showing route error, if any link is broken

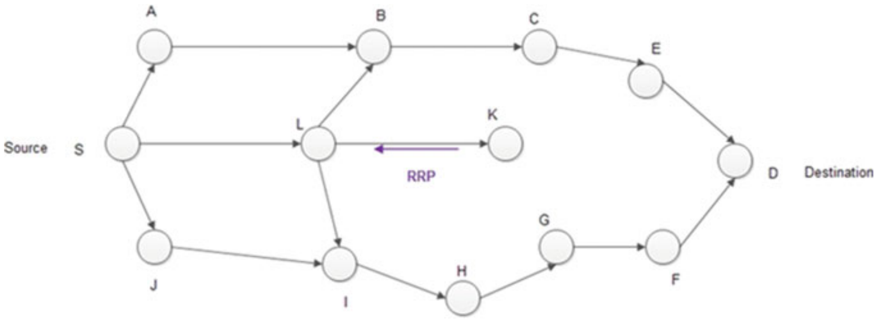


Fig. 14 An example showing route recovery, node n_i sends RRP (Route Repair) message to previous node n_{i-1}

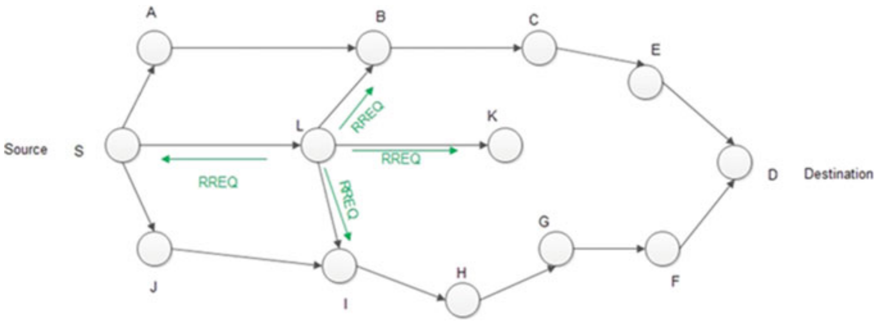


Fig. 15 An example showing route recovery, node n_{i-1} broadcasts RREQ to own neighbor

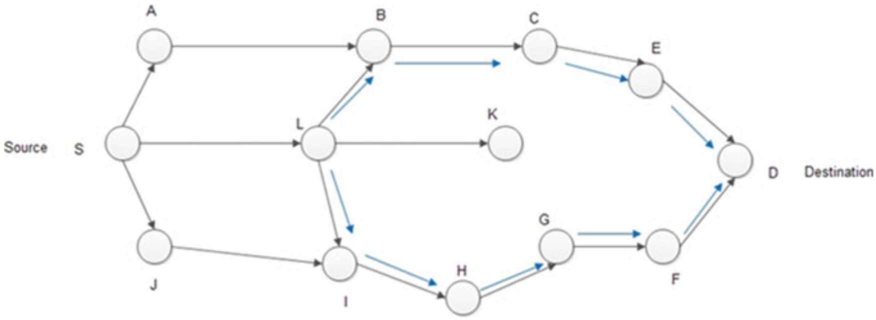


Fig. 16 An example showing route recovery, node N_{i-1} selects maximum priority route

In above example, it shows that there are two routes from node ni-1 to destination, first one is L->B->C->E->D with hop count value(HC6) = 4 and second one is L->I->H->G->F->D with hop count value(HC7) = 5.

Then node N_{i-1} selects maximum priority route for packet transmission to destination. The route is L->B->C->E->D which is more stable compared to L->I->H->G->F->D. Here HC6 < HC7.

Step-12:
In above Fig. 17, node N_{i-1} selects maximum priority route S->L->B->C->E->D with hop count value of 5 as compared to other route which is S->L->I->H->G->F->D with count value of 6 which is high compared to previous route, so node N_{i-1} selects maximum priority route, because lesser hop count shows maximum priority route.

Step-13:
In Fig. 18, repair node N_{i-1} starts sending packet with maximum priority route. Node N_{i-1} sends RROK message to source, then source disables the RST(Route Stop) message and starts to send the packets.

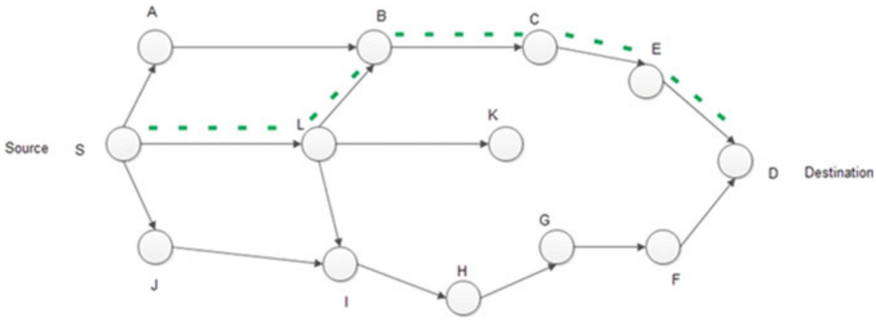


Fig. 17 An example showing packet transmission from repair route to destination

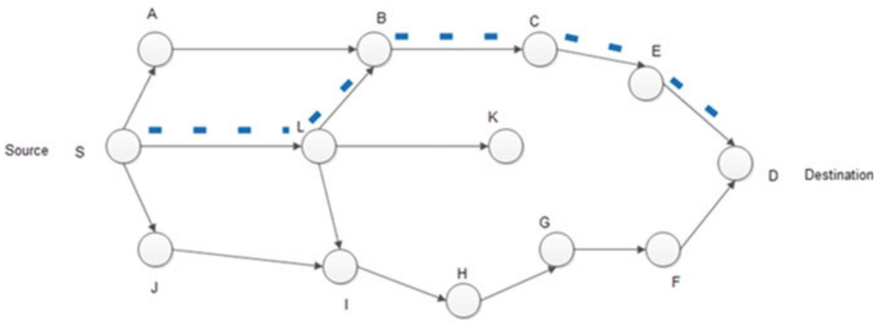


Fig. 18 An example showing packet transmission from repair route to destination

In worst case if node N_{i-1} is unable to repair the route, it delivers back RRF (route repair fail) message to the source. In such scenario, source node will select already found route with highest priority for sending packets to destination.

4 Simulation Results and Analysis

In Table 1, all the parameters that are required for our simulation are mentioned and we have used NS2 as our simulator for simulating our proposed work. The nodes were randomly deployed in a geographical position in the topology 700 × 700 and hence network is established among all the nodes. Number of nodes simulated in each iteration are 10, 20, 30, 40, 50, 60, 70, where transmission range is 550 m and traffic size is CBR. Total packet size is 100 bytes and packet rate is 10 packets per

Table 1 Simulation parameter

Parameter	Values
Topology	700 × 700
Simulation time	150 s
Pause time	10 ms
Number of nodes	10, 20, 30, 40, 50, 60, 70
Transmission range	550 m
Traffic size	CBR
Packet size	100 bytes
Packet rate	10 packet/s
Maximum speed	20 m/s
Routing protocol	AODV
X dimension of topography	500
Y dimension of topography	400

second in speed of 20 m/s. In the proposed technique, the base routing protocol is AODV. Figure 19 shows in which fashion nodes are deployed. In this figure, nodes indicated by MNi where i is the different integer indicating node ID. Node ID of source node is 0 and node ID of destination node is 11 and other nodes are working as hop nodes. Once route generated the packets then it forwarded to in this route, Fig. 20 shows how packets are being sent between nodes whereas Fig. 21 shows the mobility nature of nodes.

Figure 22 shows how packet drops whenever there is a breakage in route link between nodes.

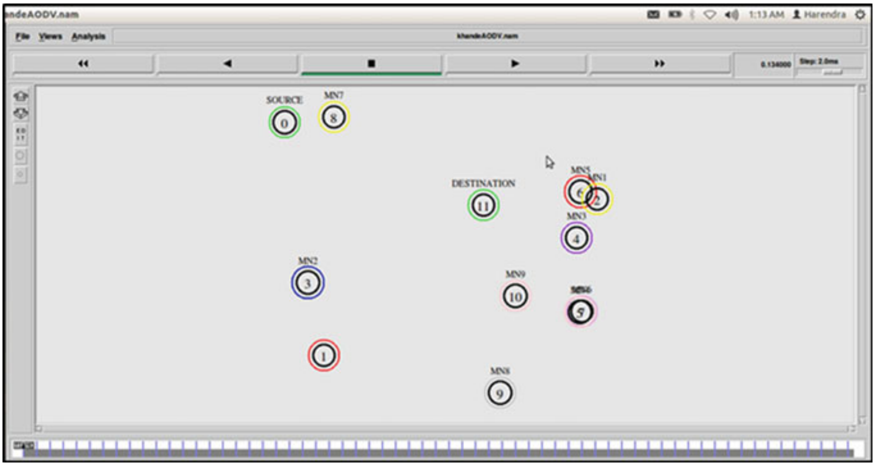


Fig. 19 Network topology

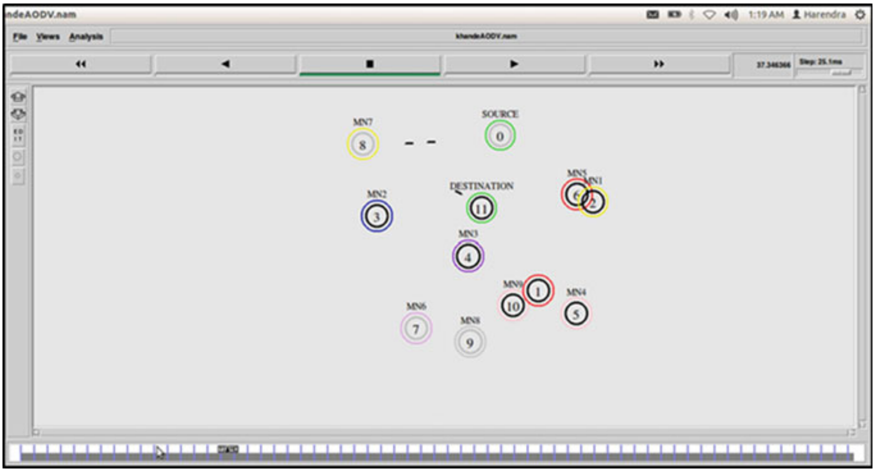


Fig. 20 Packet sent between routes

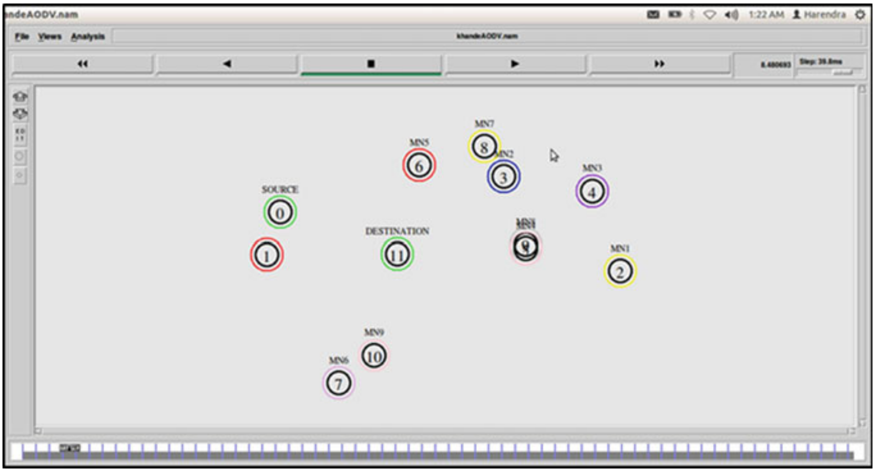


Fig. 21 Mobility of node

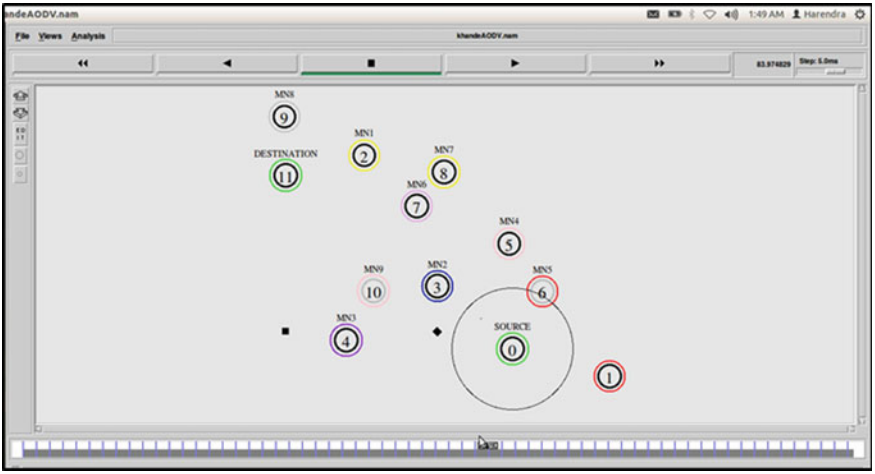


Fig. 22 Link breakage and packet dropping

Hence, they will find an alternate path to transmit their packets from origin to target as shown in Fig. 23, and trace file system is shown in Fig. 24. This figure contains different columns such as event, time, from node, to node, packet type, packet size, flags, fid, source address, destination address, sequence number, and packet id.

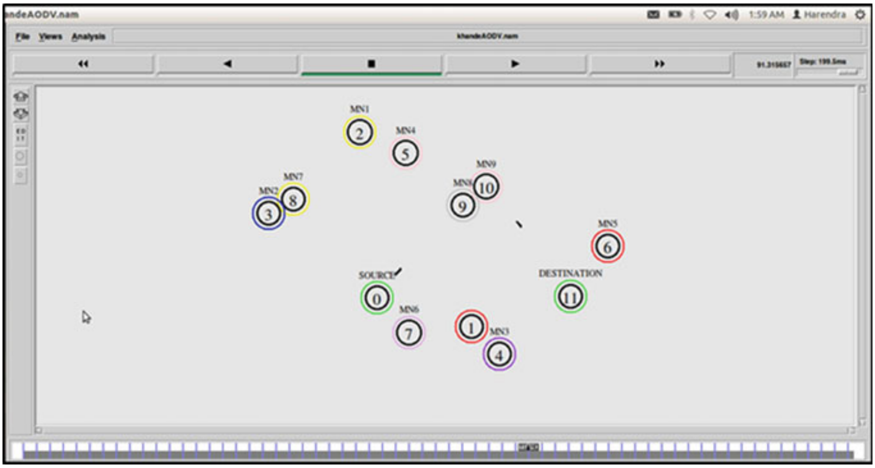
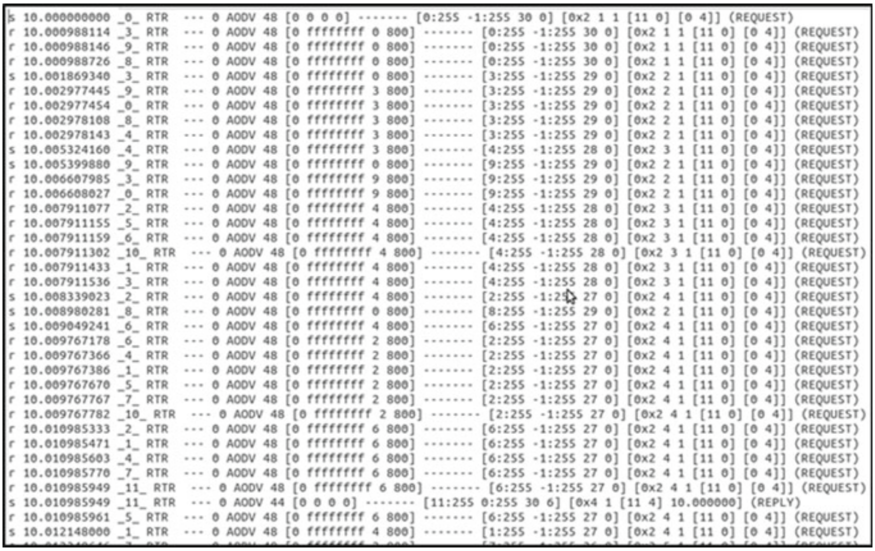


Fig. 23 Alternate path for sending packet



```
s 10.000000000 _0_ RTR  --- 0 AODV 48 [0 0 0 0] ------- [0:255 -1:255 30 0] [0x2 1 1 [11 0] [0 4]] (REQUEST)
r 10.000988114 _3_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [0:255 -1:255 30 0] [0x2 1 1 [11 0] [0 4]] (REQUEST)
r 10.000988146 _9_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [0:255 -1:255 30 0] [0x2 1 1 [11 0] [0 4]] (REQUEST)
r 10.000988726 _8_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [0:255 -1:255 30 0] [0x2 1 1 [11 0] [0 4]] (REQUEST)
s 10.001869340 _3_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [3:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.002977445 _9_ RTR  --- 0 AODV 48 [0 ffffffff 3 800] ------- [3:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.002977454 _0_ RTR  --- 0 AODV 48 [0 ffffffff 3 800] ------- [3:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.002978108 _8_ RTR  --- 0 AODV 48 [0 ffffffff 3 800] ------- [3:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.002978143 _4_ RTR  --- 0 AODV 48 [0 ffffffff 3 800] ------- [3:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
s 10.005324160 _4_ RTR  --- 0 AODV 48 [0 ffffffff 3 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
s 10.005399880 _9_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [9:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.006607985 _3_ RTR  --- 0 AODV 48 [0 ffffffff 9 800] ------- [9:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.006608027 _0_ RTR  --- 0 AODV 48 [0 ffffffff 9 800] ------- [9:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
r 10.007911077 _2_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
r 10.007911155 _5_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
r 10.007911159 _6_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
r 10.007911302 _10_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
r 10.007911433 _1_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
r 10.007911536 _3_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [4:255 -1:255 28 0] [0x2 3 1 [11 0] [0 4]] (REQUEST)
s 10.008339023 _2_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
s 10.008980281 _8_ RTR  --- 0 AODV 48 [0 ffffffff 0 800] ------- [8:255 -1:255 29 0] [0x2 2 1 [11 0] [0 4]] (REQUEST)
s 10.009049241 _6_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767178 _6_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767366 _4_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767386 _1_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767670 _5_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767767 _7_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.009767782 _10_ RTR  --- 0 AODV 48 [0 ffffffff 2 800] ------- [2:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.010985333 _2_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.010985471 _1_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.010985603 _4_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.010985770 _7_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
r 10.010985949 _11_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
s 10.010985949 _11_ RTR  --- 0 AODV 44 [0 0 0 0] ------- [11:255 0:255 30 6] [0x4 1 [11 4] 10.000000] (REPLY)
r 10.010985961 _5_ RTR  --- 0 AODV 48 [0 ffffffff 6 800] ------- [6:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
s 10.012148000 _1_ RTR  --- 0 AODV 48 [0 ffffffff 4 800] ------- [1:255 -1:255 27 0] [0x2 4 1 [11 0] [0 4]] (REQUEST)
```

Fig. 24 Trace file

4.1 Packet Delivery Ratio

It is the ratio of number of packets received to the number of packets sent. It illustrates the level of delivered data to the destination. The greater value of packet delivery ratio signifies better performance of protocol.

From Fig. 25, we find that the packet delivery ratio increases with increase in the number of node counts. Hence, it can be said that, in terms of rate of data delivery, our protocol outstands AODV.

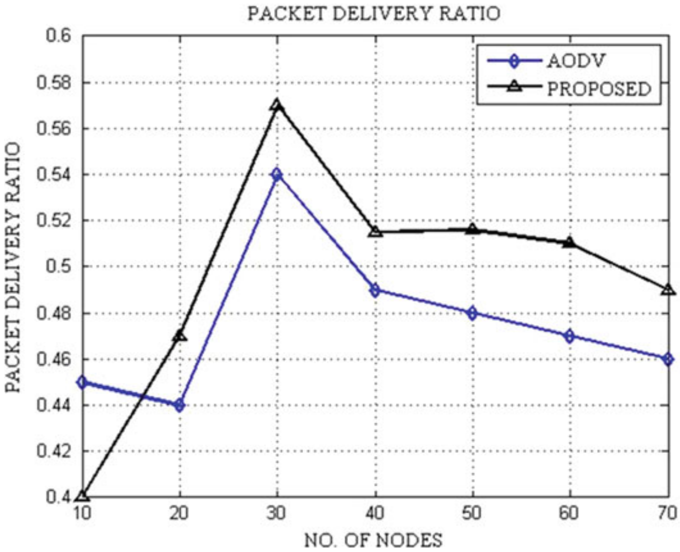


Fig. 25 Ratio of packet delivery versus nodes count

4.2 End-to-End Delay

End-to-end delay is transmission delay in data packets. Buffering during route discovery latency, queuing at interface queue, retransmission delays at the MAC, and transfer time may cause such delays. The minimized value of end-to-end delay represents improved conduct of protocol.

Hence, from Fig. 26, we can say that there is an approximate end-to-end delay with number of nodes. When the number of nodes is scarce, i.e., then the end-to-end delay is near about the same, but when the number of nodes is more than 40 then end-to-end delay maximizes. This shows that our protocol performs better than the AODV.

4.3 Packet Loss

It is defined as the difference between the number of packets transmitted by the origin and pocket by the target. The minimal value of the packet lost means better conduct of protocol.

From Fig. 27, we find that the packet loss rate of AODV and our protocol is approximately same for a less number of nodes. The loss in the rate of packets is increasing when the number of node is more than 10 nodes. So through this result we can conclude that for more number of nodes, the rate of packet loss of our protocol is lower than the AODV.

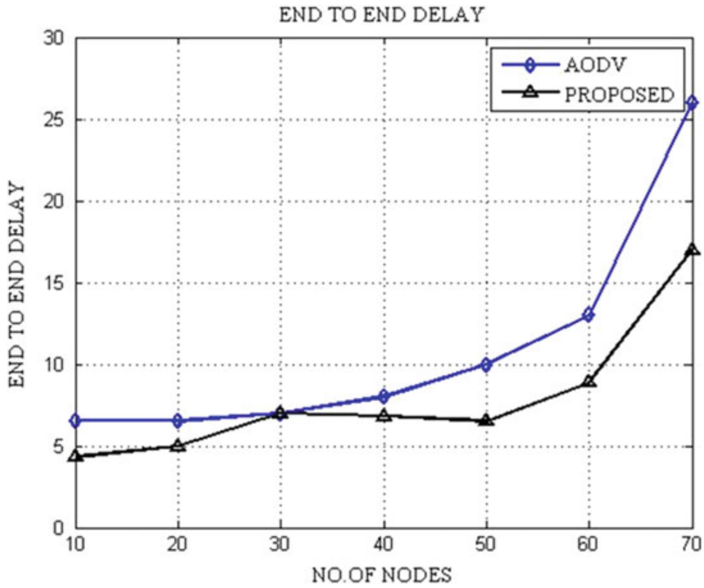


Fig. 26 End-to-end delay versus number of nodes

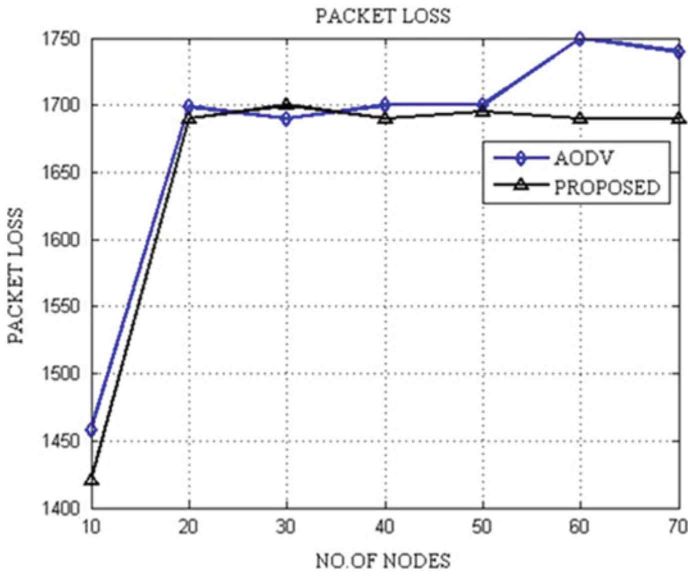


Fig. 27 Packet loss versus number of nodes

5 Conclusion

Changes in network topology limited the capacity of battery nodes. The unreliable behavior of wireless channel is a threat for descent routing in MANET. Selection of a long-lasting route is a demanding task in MANET. Our work explains a brand-new routing mechanism. When a route request message is added to the priority field, it refrains selection of unstable paths during establishment of a fresh path detection and adds the method of path repair to the route request message rather than beginning with a new routing discovery. NS-2 simulator is used to carry out the simulation. The simulation work shows improvement in the rate of packet loss, end-to-end latency, and throughput as well as network resources are utilized effectively.

Most of the enlightened routing protocols used for ad hoc networks are uni-path in nature. In uni-path routing, single route is used between origin and target node. In MANET, two protocols extensively used are DSR and AODV protocols. AODV and DSR are both on-demand protocols. In this paper, we used AODV protocol for route repairing mechanism. Future work includes identifying the route repairing mechanism using other existing protocol such as DSR, DSDV, OLSR, CGSR, TORA, etc.

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