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Link Failure Approach to Maintain Quality of Service in Mobile Ad hoc Network

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Abstract: ***Mobile Ad hoc Network is a network in which numerous are contained. These nodes are dynamic in nature and utilize multi-hop communication for communicating with one another. There isn't any central controller included in such a network. These nodes have random mobility and they are allowed to move in any direction due to the infrastructure less quality of this network. DFCP is a routing algorithm using which a path can be established amid source and target. The link failure leads to mitigate the efficacy of this protocol whose enhancement is required for maintaining the QoS. This research work suggests the enhancement of DFCP algorithm to recover the path when the link is failed. NS2 is applied to deploy the suggested algorithm. The simulation outcomes exhibit that the suggested algorithm outperformed the traditional methods concerning higher throughput and lower packet loss.***
Keywords: MANET, Link Failure, DFCP, Quality of Service

I. INTRODUCTION

Mobile Ad hoc Networks (MANETs) have turned out to be one of the most accelerated developing fields of research due to the proliferating inexpensive, smaller and more powerful mobile devices. This new genre of self-organized network integrates wireless communication with high level of node mobility. On contrary to traditional wired networks, this breed of networks has no permanent framework (i.e., base station, central control point and so on). The association of nodes builds a random topology. These networks have pulled the attention of researchers to deploy them in numerous applications, for example, military applications, where there may be rapid changes in the topology of the network to indicate the operational activities of a force, and disaster recovery movements, where present/permanent framework may be non-functional [1]. These networks can be efficiently used for virtual conferences due to their self-organizing infrastructure where establishing a conventional network set-up is a tedious and expensive job. Traditional networks perform fundamental tasks such as packet forwarding, routing, and network management using dedicated nodes. There are two types of mobile ad hoc network (MANET): cellular network (CN) and the mobile network (MN). A CN is contingent upon permanent set-up and supports circuit switching. This network practices single-hop wireless links[2]. They are applicable in the civil and business circles. The distribution of bandwidth is certain and easy. A node applies centralized routing. The cellular network aims at maximizing the call acceptance ratio and reduces the call drop ratio to minimal. It is very expensive to maintain network, however, and it backs the reusage of the frequency spectrum via the geographic channel. What CN is probe to is that it offers constant connectivity. The performance of the cellular network has two categories, time division compound and frequency division compound. Mobile nodes in MANET are smarter than cellular network [3]. Distributed routing is the factor on which packet delivery between source and destination relies upon. In MANETs, packets can be transmitted using both single-hop and multi-hop communication, but the connection is an asymmetrical way. The major objective of routing is to locate the most direct route with least overhead and offer fast packet transmission to the destination with no packet loss[4].

Load represents the traffic or data packets that the node wants to propagate over the suitable link to be delivered to the destination. Balancing implies distributing the load on the nodes in a network in a fair way. This indicates that unless the situation so demands, no node in the network should be burdened to send more packets than other nodes. Load balancing is an indispensable obligation of any multi-hop wireless network[5]. A wireless routing protocol is retrieved on its potential to allocate traffic across network nodes and a good routing protocol obtains this without undesirable delay. The main advantage appears to be in increasing the life of a battery-powered node which can ultimately extend the durability of the whole network. Centre nodes become the well-known pick in attempting to find the shortest distance between any two nodes to transmit data faster [6].Nodes in centre connect multiple sub networks and play the role of gateways for some sub networks which in its absence tend to split from the rest of the network. Therefore, the lifetime of the center nodes becomes a constraint for the connectivity of a sub network before splitting from the remaining network. An unbalanced load may lead to network congestion which affects total throughput, PDR (Packet Delivery Ratio) and average end-to-end delay.

Load imbalance in networks is subject to routing protocols and the way in which they choose legal routes between source and destination [7]. Therefore, a good routing protocol provides good throughput and minimum latency as well as puts effort into fair distribution of load. The imbalanced load causes needless delays in packet broadcast, increases the packet drop ratio, impacts general throughput, reduces the service time of a node, divides the network and introduces congestion. Thus, a routing protocol must emphasize balancing the load besides other challenges. The existent ad-hoc routing protocols are short of load-balancing abilities. Therefore, they generally can't provide good service quality, particularly when the traffic volume is high as the network load is concentrated on a few nodes leading to very congested conditions. The network congestion gives rise to many unwanted effects such as more packet delay, bad packet broadcast, and more routing overhead. It also causes unnecessary exploitation of network resources.

Basically, DCFP is a routing protocol that aims to replace a predetermined variable (total number of nodes) of network parameters via a new connectivity metric. Also, it reduces the routing overhead to minimal by omitting additional RREQ packets by means of a new dynamic connectivity factor [8].Basically, AODV, NCPR, and the DCFP have been developed to work under three main phases namely, route discovery, route reply, and route maintenance, as evidenced in Figure 1.

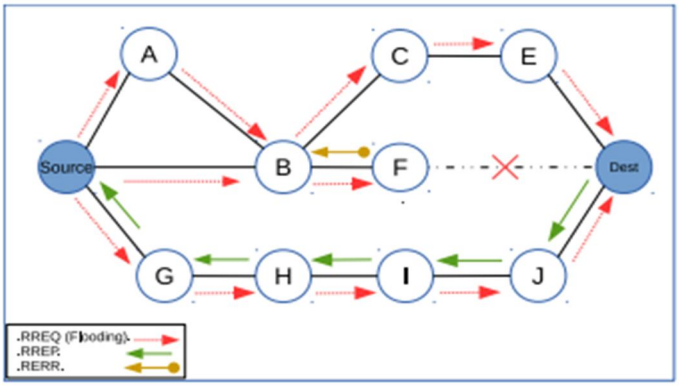

Fig. 1. Three important phases of the DCFP Protocol

For example, any node carrying data to be delivered to another node in the network should verify its routing table for such a destination. If the destination is not discovered, the source node starts sending its data; Or else, it sends RREQ to locate a route to the sink node. In general, the most ideal choice to discover nodes with a route to a destination node is through a flooding approach, in which the RREQ is rebroadcasted by each node that receives the RREQ first-time. Then, the sink node or any node with a route to the destination node responds by sending a Route Reply (RREP) packet [9]. However, due to the regular occurrence of nodes, a link break down may happen, and the node that detects such an event sends a Route Error Message (RERR) to its nearby nodes to notify the breakdown. DCFP only cops up with the issue of flooding in the initial phase (route discovery) by causing reduction in unnecessary RREQ packets. These messages related to flooding mechanisms, such as AODV, and some additional RREQ messages still induce routing overhead since the design of NCPR is inspired from AODV. By The system performance can be improved by reducing these packets and changing pre-set variables. To be more specific, the NCPR does not regard the problem of preset variables, which must be set by the system manager. Also, the additional routing overhead lowers the performance of the network[10].

II. LITERATURE SURVEY

Munshi Navid Anjum, et.al (2019) suggested a technique to balance the load for which load mobile agents were utilized [11]. A mobile agent was considered as a program for migrating among diverse environments at individual level. The agents were appropriate for MANET (Mobile Ad Hoc Network) because the connection of host was not required when the agent was worked on its task. Therefore, mobile agents were more effective for MANET applications in contrast to message passing. The robustness of the suggested technique was proved against attacks on the mobile agents. Aglet platform was applied to execute the suggested technique.

Rafi U Zaman, et.al (2016) presented a novel technique called Adaptive Steady Load Balancing Gateway Selection planned on the basis of balancing the load on path [12]. In order to deploy this approach, the load was computed along the path and the route queue length was considered. The procedure of selecting the gateway was optimized using GA (Genetic Algorithm).

The fitness function of the GA made the utilization of the FL (fuzzy logic) with regard to 3 network metrics. This approach was useful to adjust the periodicity and range of gateway advertisement. NS-2 was utilized to simulate the presented technique and compare the presented approach against traditional techniques.

V. Preetha, et.al (2016) introduced a technique for determining that whether the network was stable in case of implementation of GA (Genetic Algorithm) on the basis of average number of clusters, LB factors and weighted parameters [13]. GA was assisted in assigning the rank to the stability of the network. The experimental outcomes demonstrated that the average number of clusters whose formulation was done under transmission and factor to balance the load of the CH (cluster head) and the weighted metrics were determined to increase the stability of the network effectively.

Ansuman Bhattacharya, et.al (2017) developed a novel routing algorithm known as LCMR (Least Common Multiple based Routing) to perform the load-balanced multipath routing in MANET (Mobile Ad Hoc Network) [14]. The initial stage was executed for discovering various paths from source to target. The subsequent stage focused on distributing the data packets along these multiple paths so that the transmitted number of data packets on any such path became inversely proportional to the routing time. The major purpose of this distribution was to balance the load along all the paths in order to alleviate the overall routing time to transmit the data packets. The simulation results exhibited the supremacy of the developed algorithm over the traditional algorithms.

Rafi U Zaman, et.al (2016) projected a modification on the classic solution that had potential to tackle the issues related to discover an effective gateway and balance the load [15]. A GA (genetic algorithm) was adopted with the objective of the optimization of the protocol utilized to balance the load on gateway. NS2 was utilized for simulating the projected technique. The simulation outcomes validated that the projected technique had performed more effectively in comparison with the traditional protocols as well as led to optimize the presented GA.

Gaurav Pathak, et.al (2017) intended an innovative algorithm known as TALB-AOMDV (Traffic aware load balancing in Ad-hoc on Demand Multipath Distance Vector) routing protocol for MANET (Mobile Ad Hoc Network) which was capable of improving the performance of network [16]. For this purpose, the paths were selected with the help of temporal load on the intermediate nodes and the load was distributed among the free nodes when the data was transmitted. The outcomes obtained on NS-2 proved that the intended algorithm provided enhanced resource usage, longer duration of network and lower energy utilized through nodes.

Nor Aida Mahiddin, et.al (2015) focused on constructing an effective technique to balance the gateway load and select the routing so that the robustness of MANET (Mobile Ad Hoc Network) was maximized in disaster scenario [17]. The tasks among gateways were made even and the process to select the route was simplified using the constructed technique. The experimental outcomes revealed that the constructed approach had potential for diminishing the network congestion, minimizing the packet delays and enhancing the throughput fairness. The future work would aim at computing the constructed approach with node mobility.

Sujata V. Mallapur, et.al (2015) designed an effectual routing algorithm recognized as MLBCC (multipath load balancing technique for congestion control) for MANET (Mobile Ad Hoc Network) so as the load was balanced among numerous paths in efficient way for which the congestion was alleviated [18]. The CC technique employed an arrival rate and an outgoing rate for detecting the congestion. The technique to balance the load was concentrated on selecting a gateway node on the basis of link cost and the path cost. Hence, the appropriate paths were chosen for distributing the load. The experimental outcomes on NS-2 indicated the applicability of the designed for enhancing the performance with regard to diverse metrics and balancing the load among the nodes in the network.

Varsha T. Lokare, et.al (2018) investigated a novel routing protocol called OR (Opportunistic Routing) in order to discover the routes adaptively on the basis of existing channel conditions in dynamic wireless environment [19]. The basic operations of OR were utilized and a model to make the decision was put forward so that an optimal route was discovered in the MANET (Mobile Ad Hoc Network). Thereafter, an adaptive algorithm was established for tackling the issue related to Opportunistic Routing as a MDP (Markov decision problem). In the end, the investigated protocol was compared with others concerning throughput, average delay and control overhead. The investigated protocol had generated superior outcomes against the traditional algorithms.

Navinderdeep Kaur, et.al (2017) established MAODV (Modified Ad-hoc On-Demand Distance Vector) protocol to describe all possible routes from source to target node whose maintenance was done when the data was transmitted [20]. If the definite route was dissatisfied, the secondary routes that the routing tables had constructed were utilized to transmit the data packets. These tables were utilized to store various route paths to the destination. MANET (Mobile Ad Hoc Network) was capable of transferring in any direction in the real world. Various metrics such as E2E (End to End) delay, AHC (Average Hop Count) and throughput were evaluated using established protocol on diverse mobility models.

Veronika Szücs, et.al (2018) devised an extended network communication protocol whose enhancement was done using the emergency call coverage to areas [21].

A technique was introduced on the basis of direct communication among network devices in which the potentials of CBRP (Cluster-based Routing Protocol) and BCHP (Bacup Cluster Head Protocol) were employed. The devised protocol made the clustering communication uninterrupted, replaced the missing central nodes in a very short time and presented an innovative and appropriate node in the cluster which allowed the nodes to move.

III. RESEARCH METHODOLOGY

Various components are contained in an Improved DCFR (Dynamic Connectivity Factor routing Protocol) that are defined further. The suggested protocol focuses on replacing the variables of the network metrics for which a new connectivity and buffer size estimation metric are employed. Moreover, the extra RREQ (route request) packets were dropped using a new dynamic connectivity factor. This leads to alleviate the routing overhead of the network. The AODV (Ad-hoc On-Demand Distance Vector), the NCPR (Neighbor Coverage-based Probabilistic Re-broadcast) and the suggested improved DCFR protocol are put forward for worked in 3 main phases: route discovery, route reply as well as route maintenance. It is essential to check the routing table for the destination in case of necessity of transmitting the data from among nodes in the network. The data is transmitted amid source and target after recognizing the target. The RREQ recognizes a route to the BS (base station) when the destination is not found [13]. The flooding mechanism is implemented with the purpose of recognizing the nodes which have path towards the target. This mechanism forces every node, to which the RREQ is received for the first time, for rebroadcasting Routing Request in the network. In addition, the BS or any node which requires a route transmits a RREP (Route REPLY) message as a response. But, a link is often broken in the nodes due to their frequent movements. A RERR (Route ERROR) message is created in case any node finds any such event to the neighbours in order to notify about this breakage. The DCFR is effective to deal with flooding issue at primary phase by lessening the redundant RREQ packets. Though, the issue of routing overhead is still faced in the network as messages, which are relevant to the flooding mechanism, are present. This protocol performs ineffectively when the link is failed in the network. Thus, the path is recovered in least time for improving the performance of the system. This research presents diverse protocols that have a number of limitations. These protocols lead to cause extra routing overhead which degrades the performance of network. Hence, a new protocol is projected for tackling these issues faced while discovering the route and recovering the link. Distinct metrics employed in the experiments are defined as:

1) *Check Node Connectivity:* The routing overhead and link recovery are main concerns of several routing algorithms such as AODV and NCPR. Equation (1) expresses the occurrence of these issues in protocols as

$$RO_{aggregated} = RO_{discovery} + RO_{maintenance} \quad \ldots. (1)$$

This research describes the routing overhead in the primary part of process of discovering the route. This is referred as the RREQ overhead and the Equation (2) defines it as:

$$RO_{discovery} = RO_{RREQ} + RO_{RREP} \quad \ldots. (2)$$

In this, RO_{RREP} is the route reply overhead. Moreover, $T_{RO-RREQ}$ denotes the sum of all RREQ overhead for every node which is available in the network. All the nodes are aimed to discover a path in order to transmit the data at particular time (t). Equation (3) describes it as:

$$T_{RO-RREQ} = \sum_{i=1}^{n} RO_{RREQ}(P_i) \quad \ldots. (3)$$

In this, for packet (P_i), n represents the total number of RREQ. The DCFR employs a new connectivity metric for every received RREQ packet(P_i) in accordance with the DCF, $DCF(P_i)$. This metric has impact in the transmission decision of the received Route Request message. The replacement of DCF is done with preset variable of NDPR. This equation is suggested relied on the available number of neighbours in a network. Therefore, average number of neighbours is considered to make the decision regarding the transmitting or dropping the RREQ packets from an extensive run of 30 diverse environments for every point. Then, a new formula for DCF is suggested. Here, the nodes are diverse up to the range of 50 to 300. For all nodes of network, the computation of total numbers of neighbours is done to carry out the experiments. When all these values are computed, the evaluation of average number of neighbours is done. A curve is drawn based on the number of nodes and the information provided through the experiments. The best formula is recognized by evaluating this curve.

Further, in Equation (4), a new variable is computed.

$$NB_{(ni)} = 1 + \left(\frac{N_{(n_i)}}{c}\right)^b \quad \ldots. (4)$$

In this, $N_{(n_i)}$ defines the total number of neighbours that receive RREQ for any node. The variables 'b' and 'c' are fixed.

The DCF is utilized to evaluate the total number of nodes in Equation (5) as:

$$DCF_{(n_i)} = d + \frac{a-d}{[NB(n_i)]^m} \quad \text{.... (5)}$$

In this, the fixed variables are 'a','d' and 'm'. A new connectivity factor called DAF (Dynamic connectivity-Aware Factor) is introduced for recognizing the RREQ redundant packets in NCPR and alleviating the AODV protocols. Equation (6) shows this evaluation as:

$$DAF(n_i) = \frac{DCF(n_i)}{N(n_i)} \quad \text{.... (6)}$$

DCF shows the current node located either within the sparse area or the dense area. For this, the evaluation of the ratio of average number of neighbours to the number of current neighbours for a given node is done. The node having maximum connectivity factor which is calculated by the equation 6 is selected as the node which can recover the path from source to destination.

2) Check Buffer Size of Each Node: DCF assigns the buffer size to each node in the network on the basis of equation (7)

$$\text{Buffer allocated to each node}=\frac{totalbufferspace}{numberofnodes} \text{----- (7)}$$

The total buffer space is the space that is available to perform allocation and the number of nodes is the nodes present in the network.

DCF contains the component for estimating the vacant buffer size on each node to recover the path. To estimate the vacant buffer space on each node the equation 8 is given

$$E_{\text{vacant buffer}}=[\frac{bufferofnodes(n-1)}{totalbufferallocated}]*nn \text{ ----- (8)}$$

The vacant buffer size is calculated, after the division of neighbor node buffer size from the total buffer size. This process will be repeated until vacant buffer size of each node will be calculated. The node having maximum Estimate $_{\text{vacant buffer}}$ which is calculated with equation 8 and maximum connectivity which is calculated with equation 7 is selected as best link recovery node from source to destination.

3) Algorithm 1: Improved DCP Protocol for Link Recovery

a) Initialization:

NN=Number of Nodes over the network

b) Establish path from source to destination

If path exits from source to destination

Else

Source sends route request packets

When node receive route request message

Path established from source to destination

If source receive route error message

Calculate $NB_{(ni)} = 1 + (\frac{N_{(n_i)}}{c})^b$

Calculate $DCF_{(n_i)} = d + \frac{a-d}{[NB(n_i)]^m}$

Calculate $E_{\text{vacant buffer}} = [\frac{bufferofnodes(n-1)}{totalbufferallocated}]*nn$

If $(DCF_{(n_i)} > DCF_{(n_i+1)} \&\& E_{\text{vacantbuffer(ni)}} > E_{\text{vacant buffer(ni+1)}}$

Recovery node=N_i

Else

Recovery node=N_{i+1}

End;

End;

End

IV. RESULT AND DISCUSSION

In the scenario in which such enhancements are performed within the simulation scenario, for each node, the transmission range is 18 m and to generate the dynamics as well as the node position, a random waypoint model is used. The set dest command version 2 from NS-2 is used to incorporate the use of the tool. Uniform distribution is followed and 2 scenarios are selected out of 1300 trails present in the built mobility model. The speed of the node may change between the range (1) to (5),. The pause time involved here is (0), nodes are randomly deployed in an area of 1,000 m X 1,000 m, 512 bytes of packet size and 2 Mbps bandwidth is used.

The value of Constant Bit Rate (CBR) can vary up to 10, 12 and 20 which are applied during the connection of nodes. Table I features the simulation metrics included in the simulation.

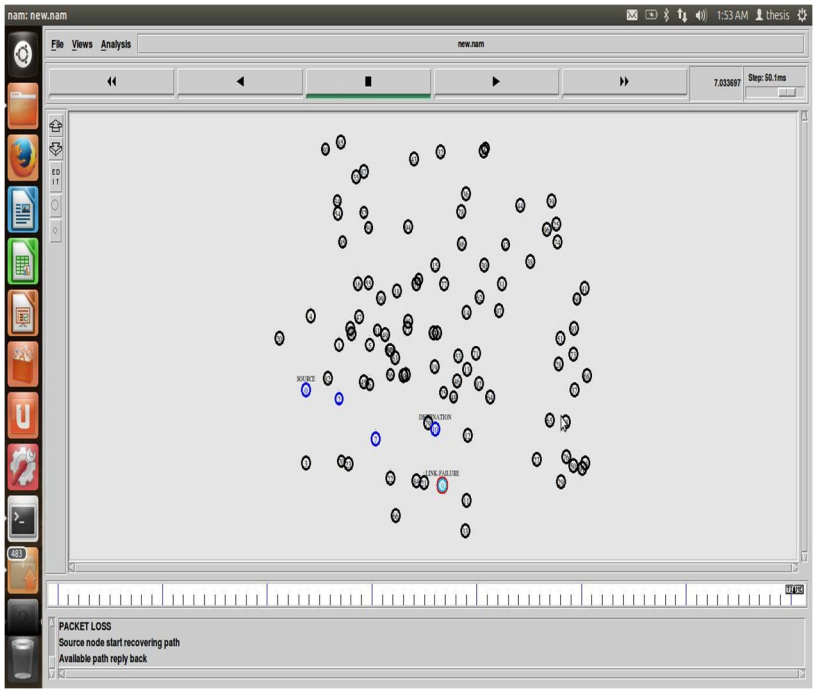

Fig 1: Data Transmission

Figure 2, the path is recovered between source and destination post link failure. The data is broadcasted from source to destination via recovered route.

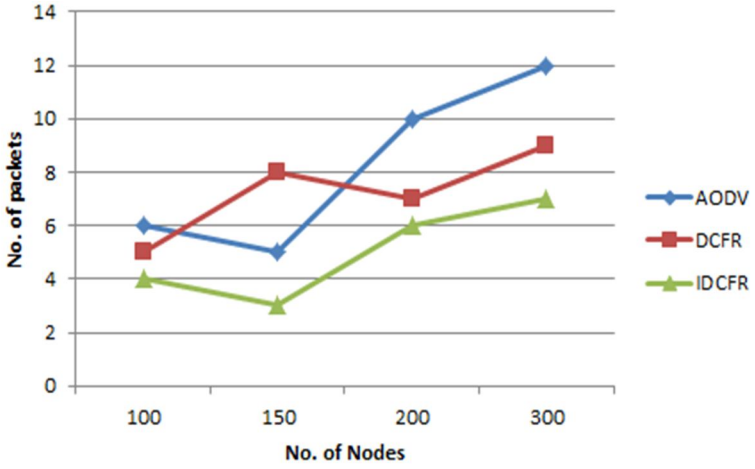

Fig 2: Packetloss Comparison

Figure 2 evidences comparison between AODV, DCFR and IDCFR protocol in terms of packet loss. In contrast to AODV and DCFR protocols, the packets loss of IDCFR protocol is less.

Table 2 Packet loss Comparison

No of Nodes	AODV	DFCP	IDFCP
100	6	4	4
150	7	8	3
200	10	7	6
250	12	9	7

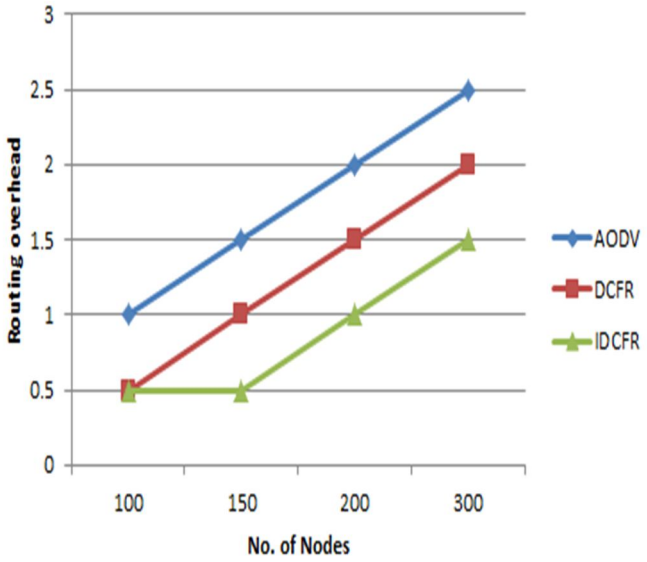

Fig 3: Overhead Comparison

Figure 3 evidences comparison between improved DCFR and IDCFR protocol in terms of routing overhead. In contrast to DCFR protocol, the IDCFR protocol has less overhead. This figure also shows comparison between all considered protocols in terms of nodes' volume.

Fig 3 Overhead Comparison

No of Nodes	AODV	DFCP	IDFCP
100	1	0.5	0.4
150	1.5	1	0.4
200	2	1.5	1
250	2.5	2	1.5

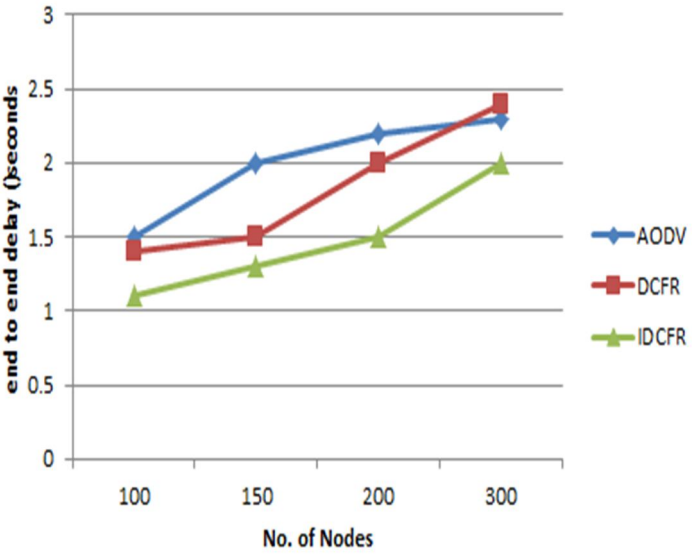

Fig 4: Delay Comparisons

Figure 4 evidences comparison between improved DCFR and IDCFR protocol in terms of delay. In contrast to DCFR protocol, the IDCFR protocol has less delay due to route preservation feature. This graph is plotted based on number of nodes.

Fig 4 Delay Comparison

No of Nodes	AODV	DFCP	IDFCP
100	1.5	1.4	1
150	2.5	2.4	2
200	3.6	3.2	3
250	5	4.2	3

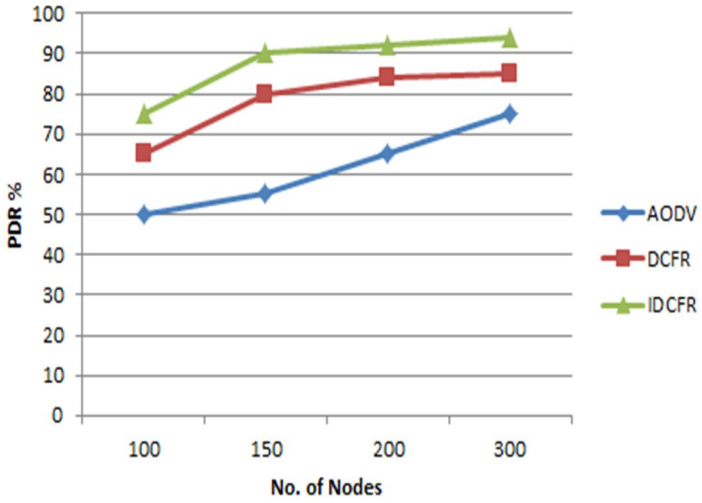

Fig 5: Packet Delivery ratio

Figure 5 shows comparison between AODV, DCFR and IDCFR protocols in terms of the PDR. As per analysis, the performance of IDCFP protocol is better than other two protocols. Also, graphs are drawn versus no. of nodes.

Fig 5 PDR Comparison

No of Nodes	AODV	DFCP	IDFCP
100	40	45	50
150	46	52	60
200	56	59	65
250	63	68	72

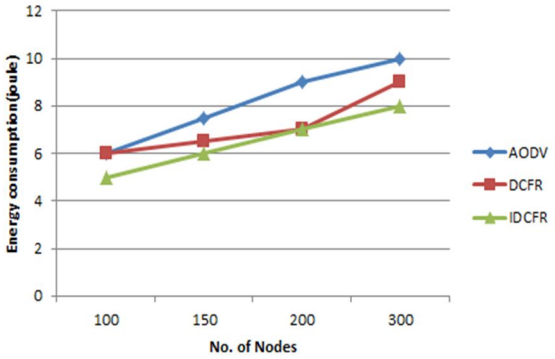

Fig 6: Energy consumption

Figure 6 shows comparison between AODV, DCFR and IDCFR protocols in terms of energy exhausted. As per analysis, the IDCFP protocol exhausts less power than other two protocols.

Fig 6 Energy Comparison

No of Nodes	AODV	DFCP	IDFCP
100	4	3	2
150	8	7	4
200	8	7	5
250	9	6	3

V. CONCLUSION

To conclude, mobile ad-hoc networks are auto-configured networks that allow mobile nodes to roam freely anywhere without any restrictions. Being a routing protocol, DCFR helps in route formation and route preservation based on node connectivity. The buffer size parameter is further added in this research project to recover route. The node with highest connectivity factor and smallest buffer size is picked up as the most ideal node for path retrieval between source and destination. The comparison of existing DCFP and AODV protocols is performed in this work with respect to certain metrics (such as packet loss, routing overhead, delay and energy consumption). The results of extensive simulations illustrate an escalation up to 10 to 15 percent in the new improved DFCR protocol as opposed to the standard DFCP protocol.

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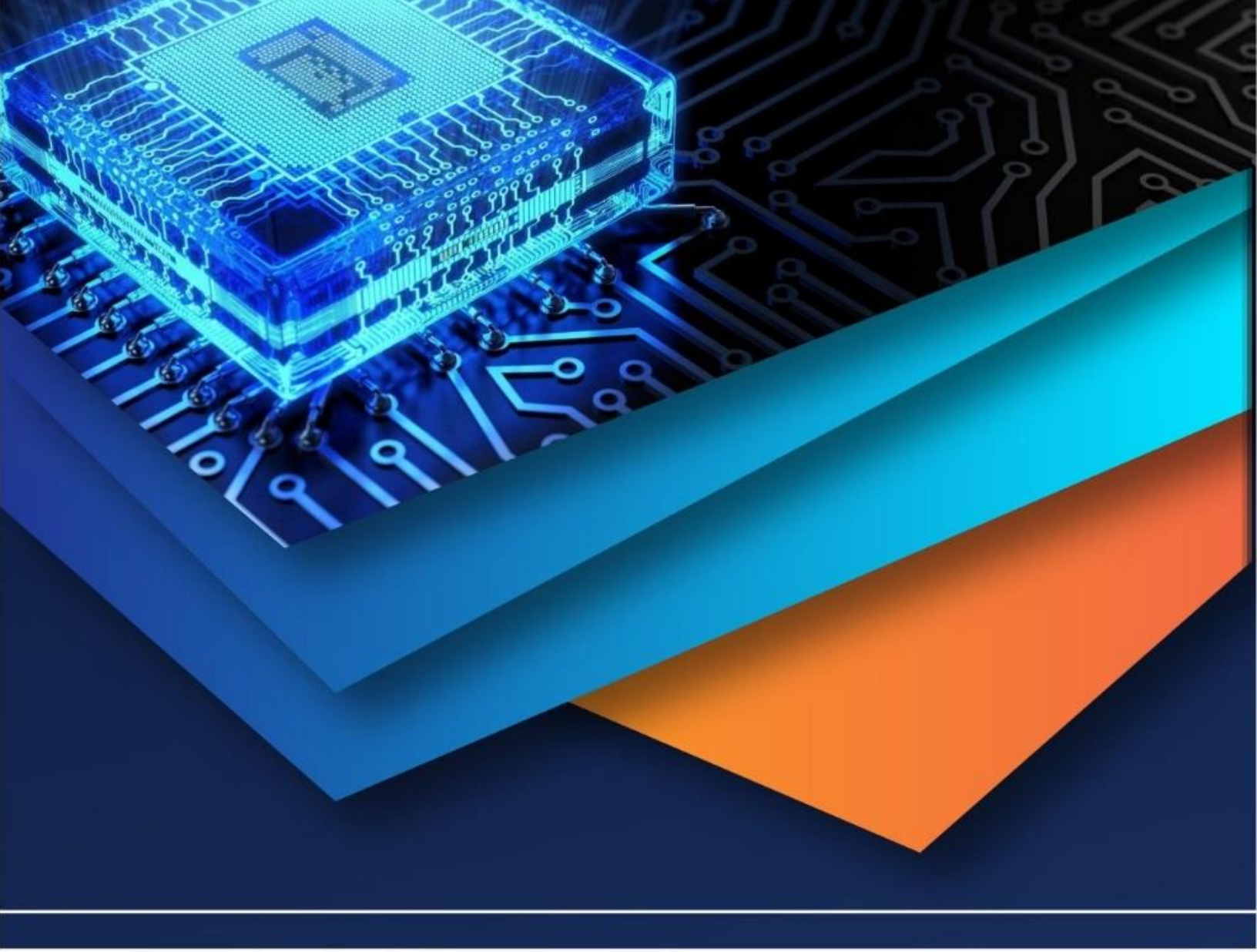

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