International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Cooperative and Optimized Qos Enhanced Distributed Multipath Routing Protocol in Hybrid Wireless Networks

T.Murugeswari, S.Rathi

***Abstract:** The Hybrid Wireless Networks (HWN) interconnects both mobile networks and wireless networks or combines a cellular and a multi-hopping wireless networks or inter and intra networks. These are networks in which any mobile node in a wireless network may have connectivity either directly or via a gateway node to an infrastructure based wireless network. The quick development of wireless networks has triggered enormous applications. They have been used in various fields such as commerce, emergency services, health care, education, entertainment, etc. In spite of more advantages in HWN, it has some challenges such as to increase data transmitting capacity, to strengthen the network connection, proper bandwidth allocation in Mobile Ad hoc Network (MANET), to maintain a connection during the handover, to reduce the connection failure in between two networks. Here, this research considered to improve the Quality of Service (QoS) by reducing the invalid reservation problem, race conditional problem and link failure. In this paper for guarantying reliable and continuous data transmission and also to ensure that cooperative routing is done faster response and effective packet transmission. Cooperative communications are the most recent fields of research: they combine wireless channels' link quality and broadcasting nature. Ad-hoc mobile networks are successful in communication if routing and transmission of participating nodes are working. A flow is divided into batches of data packets. On departing from source node, every packet of alike batch encloses similar forwarder list. Proactive Source Routing (PSR) protocol offers every node along nodes in networks, the identity of path nodes are enclosed by forwarder list commencing the location of source node. On progressive packets forwarding nodes modifies the forwarder list on any modification notified in network topology. In addition, a few nodes in extra which is not in list of transmitting node may also be transmitted if it is helpful, called small-scale retransmission. Cooperative and optimized QoS distributed multipath routing protocol (COQDMRP) combines the link-quality and broadcasting nature of wireless channels. Thus communication in mobile ad-hoc networks functions properly only if the participating nodes cooperate in routing and forwarding. Also, here the routing utilizes the neighbouring nodes which are basically referred as "Co-operative nodes" that can help transmitting the data from the source and destination. Since many nodes take part in the routing process, it helps to improve the overall throughput and packet delivery ratio. This proposed solution could be deployed in cases where a portion of nodes are in remote areas, packets with varied priority, highly scaled distributed HWN and network with considerable amount of nodes with less battery power. It is designed to achieve high throughput and packet delivery ratio, and low energy consumption. end - to - end delay and packet loss ratio.*

***Keywords:** Link-quality, Proactive Source Routing, QoS small-scale retransmission*

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
T.Murugeswari, Assistant professor, Department of Electrical and Electronics Engineering, Hindusthan College of Engineering and Technology, Coimbatore, Tamilnadu, India. 641032. Email: muvedaven@gmail.com
Dr.S.Rathi*, Associate professor, Department of Computer Science Engineering, Government College of Technology, Coimbatore, Tamil Nadu, India.641013. Email: rathi@gct.ac.in

I. INTRODUCTION

Devices communicate with associated receiver node in conventional wireless communication systems. A source node transmitting information is listened to receiver node along with neighbouring nodes. Interference holding reception of signal information refers the neighbouring nodes receiving the signals that are not achieved by existing approaches. Thus cooperative communications sort out the transmission of information via relay from source to destination along the surrounding node and achieve higher performance of reception. For improving performance, relay of nodes are used in cooperative system of communication system. Several cooperative systems are developed on various deployment and utilization of relays. Several applications are in need of Wireless communication networks. Fundamental constraint limits scalability and quality of applications. Spectrum of sparse radio-frequency, fading in signal propagation and areas of shadowing resulting with limited coverage, minimal energy capacity enhanced factor of mobile devices and antenna diversity are included. Ever demand services mobile in platform of cloud computing and video streaming improve its quality by its robustness and cellular systems throughput. Smart antenna, adaptive modulation and coding, dynamic power control are some of technologies used for cooperation gain. Additional base stations are included for efficiency spectrum improvement. But it fails in effective strategy. Currently, huge demand is required on deployment of purely distributed number of micro-sensors for data processing and collection. Inexpensive Sensors are anticipated and harsh environments in large-scale, implying a usual unattended operation of sensors. Sensor networks can also often suffer high failure rates: node connectivity gets fails on noisy environment and barriers: battery depletion.

Changes to environment or malicious destruction can cause nodes to die. Reliable and energy-efficient data supply in these environments is vital due to low batten power supplied in sensor nodes and wireless channels that are prone to errors.

These sensor network features make it difficult to design a routing protocol. A great deal of research focuses on extending network lifetime through use of energy efficiency, reliability and low cost sensor design to deal with those issues. These objectives, however, are generally orthogonal design goals.

In this study a new communication model was explored, which combines multiple mobile nodes and the base stations. Communication methods are exploited by various cooperating mobile nodes having number of radio interfaces in this work. Wireless communication system's efficiency and robustness are enhanced using general mechanism called co-operation and diversity for many years. On wireless systems having large number of air interfaces are researched with every interfaces unique features. Increased integral hardware, fast computing, high user density make it possible and even necessary to cooperate between nearby devices, given increased bandwidth demand.

The proposed research is sort out as of: section 2 explains the reviews of literature in existing:. Section 3 discusses about energy aware QoS routing and Section 4 estimation of route matrics about cooperative routing. Section 5 gives description about the multipath routing. Section 6 gives hybrid QoS aware multipath routing protocol. Section 7 discussed about cooperative routing. Section 8 best relay selection criteria Section 9 the simulation results and Discussion. Section 10 concludes the contribution of proposed research work.

II. LITERATURE REVIEW

Khandani, Jinanae, Modiano, Lizhong [2005] "Co-operative routing in wireless networks" studied in wireless networks about combined issue of transmission-side diversity and routing. Single antenna with omni-directional network is equipped every node and transmission-side diversity is achieved by coordinating even many nodes transmissions. Formulation of route with minimum energy is found by this setting. Regular line network and grid network topology are obtained with energy saving setting for lower bounds. 39% energy savings is achieved in a regular line topology, 56%for grid topology and 30% — 50% is achieved in arbitrary networks to the base of simulations accordingly.

S.S Iyengar, et al [2007] implemented a Biologically Inspired Co-Operative Routing for Wireless Mobile Sensor Networks based on important mechanisms inclusive of biologically inspired and its associations on Ant-based and genetic methods to resolve routing technique. In addition, biological computations incorporating mathematical theory is applied sensor networks and in turn a generalized routing framework is presented for sensor networks. Ant-based and genetic techniques achieves by biological computations diffusion. New biologically computational framework in different modes is observed in several research directions.

Chen, M., Kwon, T., Mao, S., Yuan, Y., & Leung, V. C. (2008) proposed a reliable energy efficient routing (REER) with benefit in geographical information including maximum node density and offers data in collective efforts in many cooperative nodes independent of specific. Nodes of source and the sink are chosen. Every RN performs selection by multiple co-operative nodes (CNs). Cooperative routing achieves reliability: multiple CNs is maintained by every hop to receive data transmission in hop without obstacle. A control buckle for the robustness exchange, cones energy cost and latency of end-to-finish that refers distance among two adjacent RN.

Huang X., Zhai. H., & Fang Y. (2008) implemented aCooperative relay carried out at every hop is therefore necessary only local knowledge. Cooperation between multiple nodes involves coordination with lower levels. Cross-layer design based Routing with robust collaboration relies on, IEEE 802.11 MAC protocol with anchoring of the MAC layer. Nodes of source and destination after the trajectory has been established and temporary and permanent path breakdown are prevented by robust cooperative routing in reliable package delivery. The consequent breakage of path is permanent when a node moves away. Temporary path failure can cause interference and deterioration. Substantial road maintenance attains its robustness in routing and use distributed approach for updating and repair control overhead. During routing in robust, only light overhead occurs. Cooperation between nearby nodes also enhances energy efficiencies, as consistent and constant routing connections are chosen. Selecting out links with consistency reduces transmission potential, thereby reducing energy and reducing late transmission.

Maalej M., Cherif S., &Besbes H. (2013), used opponent modelling reinforcement learning technique, the optimization of a RSSI based collaborative communication protocol, and competitive energy node consumption that is, a protocol of the co-operation communication routing based on knowledge of energy and service quality.

Rani S., Malhotra J., &Talwar R. (2015), studied multi-hop data aggregation which is deployed using hierarchical clustering. It achieves less time of transmission and less consumption of energy in coordination formulation. High density deployments and extended circumstances, Novel algorithm achieves better result in wireless sensor network. Area factorization into clusters collects information from inaccessible areas and produce cluster head in concern subarea. Each and every node is being served by local nodes cooperation and coordination using relay nodes of local cluster. New transmission algorithm is deployed for routing in predefined path. Inter cluster communication inclusive of cluster coordinators performs transmission distance to reduce relay nodes within the cluster.

Yuan Chai, Wenxiao Shi, Tianhe Shi (2017) proposed a load-aware cooperative hybrid routing protocol (LA-CHRP).It protects load in routing and also routers and clients characteristics. Routers of Mesh and clients are assigned with various levels of load and in turn traffic based on Gateway and client are tackled dynamically. The load levels are considered for cooperative mechanism in the mesh routers and mesh clients with load level are notified in node-aware routing metric based on priority.

Adequate of energy is retained with less load client for packet transmission. LA-CHRP attains in hybrid WMNs of low latency, maximum better performance of throughput and less packet loss rate.

Daijavad S., Davari B., Naughton B. P., &Verma, D. C. (2017) proposes to amplify and forward (AF) technology on Rayleigh faded UWSN channels, a Regional Cooperative Routing (RBCRP) Protocol.The sensed signal is being sent from source node to target and follows in relay nodes and checks the Bit error rate (BER) by positive and negative (ACK or NACK) recognition. Techniques of mobile sinks and energy collection used to increase the output and life of network.

Hee-won Kim, Tae Ho Im, Ho-Shin Cho [2018] proposed a "Cooperative Medium Access Control (MAC) Protocol for Underwater Wireless Sensor Networks" (UWSNS) named UCMAC. It is used in cooperative communication by identifying co-operators in source and enlists the destination co-operators and delineating their proximity. Transmission of data packets in case of error requests for retransmission in co-operators destination in a closest-one-first manner. From the source or other co-operators, the buffered data packet gets transmitted in a designated co-operator. That stem from cooperation is addressed carefully with signalling procedure and various nodes waiting times. UCMAC is evaluated by computer simulation of parameters likeenergy efficiency, single-hop packet delivery ratio (PDR), latency and system throughput. Proposed is optimized than prevailing systems of MACA-U and CD-MACA.

Tran AnhQuang Pham, Kamal Deep Singh, Juan Antonio Rodríguez-Aguilar, Gauthier Picard, KandarajPiamrat, Jesus Cerquides, César Vihol [2018] presented a "AD3-GLaM:Fast convergence is attained by cooperative optimization schemes in distribution with highlight of AD3 efficiency. A factor graph is plotted with original problem encoding and exchanged messages in optimization and thus partially distributed routing method is proposed via OLSR and AD3; in addition, a feasible solution is obtained by decoding algorithm. Experimental results get benefited via proposed scheme.

III. ENERGY-AWARE QOS ROUTING

For MANET, a hybrid QoS richer protocol of routing in multi-path is suggested here. This approach proactively performs discovery in topology as well as reactivates discovery in route. Every node learns of topology discovery phase the residual bandwidth, length of queue and power of battery and moreover TIT stored information. Nodes exchanging the TIT determine the topology. The link metric is computed using data of TIT for data transmission using TIT from source. Nodes in source choose minimal LM nodes and begin the transfer of the packet via 2-hop selected node. Data gets transmitted using the Dijkstra algorithm for nodes with paths in multiple holding low metric connection. If the intermediate node is not recognizing next 2-hop TIT then AOMDV helps in message propagation with Route Request (RREQ) of every nodes efficiently with reactive protocol of routing in multi-path. Subsequently Route response messages (RREP) are forwarded along source with routes in reverse for setting best route toward target node. TIT gets updated on source every time of new entry of route.

IV. ESTIMATION OF ROUTE METRICS

A. Estimation of Residual Battery Power:

Computation of consumed power is as P(t) in sequence to time t,

$$P(t) = DP_{tx} * \lambda + DP_{re} * \eta \quad (1)$$

while,

DPtx - total transmitted packets as a result in node sensor later than t time

DPre - total packets received in node sensor later than t time,

λ and η - constants $\in$ [0, 1].

Node power is denoted by Pi, then the PR residual power is computed as equ. 2 with node time t,ode at time t, can be formulated as:

$$P_R = P_t - P(t) \quad (2)$$

Where Pt is termed as total power.

B. Estimation of Queue length:

Demonstration of mobile node along with known packet numbers at the queue on the traffic load is done. If excess traffic runs through mobile nodes, there are more packets available at the interface queue. the average queue size is determined by the node's load traffic.

$$QL = \delta\, QL_O + (1-\delta) * QL_C \quad (3)$$

Where, length of Average queue is represented as *Ql*, length of New queue is represented as *QLc*, length of Old queue is represented as QL_0, constant is represented as δ which lies between 0to 1.

C. Estimation of Residual Bandwidth:

Range of intrusion in every node has enough bandwidth to congestion free transmission of the data. Thus, it requires to familiarize neighboring as well as local nodes in the range of interference. Nodes requires to transmit an information should range of interference and local bandwidth into account. Following are procedures used to predict the bandwidth of local and nearby nodes. The nodes calculate a bandwidth based on an idle and busy time ratio for a predetermined time interval (t) as the bandwidth among neighboring nodes is distributed by channel. The bandwidth in local B_1 is computed from (4)

$$B_1 = C_{ch} * (t_i / t) \quad (4)$$

Where, capacity of channel is represented as C_{ch}, in t idle time is reprensted as t_i,range of transmission is identifiable for bandwidth in minimum (B_{min}) of all nodes information are considered on neighboring node sourcing is collected previously. Residual bandwidth (B_R) will be defined in residual bandwidth register, as the difference between the (BW_{min}) and B_1.

$$B_R = BW_{min} - BW \quad (5)$$

V. MULTIPATH ROUTING

A multipath algorithm of data transmission among Source (S) and destination (D) hold loops freely with N routes free. The source node includes an updated Z_i flag to recognize the validity of node-related routes in the multi-path link state routing protocol which is optimized for all possible nodes in the network.

In first place, false answer is assigned for Z_i that predicts no route among destination node. The constraint obtains any node n_i for multiple paths
If false is set to Z_i,
Dijkstra multi-path algorithm implemented for node in getting of the paths in multiple on neither, place them in the table of multi-path routing and renew them to be true. Else, a valid route to i is indicated b the node of multipath routing table.
End if
Return (P_1. P_2, P_3,…, P_N)
Return (P_1. P_2, P_3,…, P_N)

Multipath Dijkstra Algorithm
Let ST = source tree.
Let w_a=arc w's opposite edge.
Let h (w) = vertex edge to w points.
F (ST, D) = function used to compute shortest path from STto D.
W's cost is increased using Fpwhich is derived from previous path (P_i).
W's cost is increased usingFwwhich leads to verticesof Pi.
Graph G = {ψ, τ, σ} is applied with is algorithm for computing N routes in G to Dfrom S.
Where, ψ represents set of vertices
τ =ψ*ψ represents set of arcs
σ :ψ →K^+ represents positive cost function.
σ1 = σ
G1 = G
For i ←1to N do
Do
ST_i ← Dijkstra (G_1, S)
P_i ← F (ST_i, D)
For all arcs w in τ
If w is in P_i or Reverse (w) is in P_i Then
σ_{i+1} (w) ← Fp (σ_i (w))
Else if the h(w) is in P_i Then
σ_{i+1} (w) ← Fw (σ_i (w))
Else
σ_{i+1} (w) ← σ_i (w)
End if
End for
G_{i+1} ← (ψ, τ, σ_{i+1})
End for

RETURN (P_1. P_2, P_3,…, P_N)

VI. HYBRID QOS AWARE MULTIPATH ROUTING PROTOCOL

Reactive and proactive protocol's features are mingled in the proposed hybrid protocol and it has two phases.

- Discovery of proactive topology
- Discovery of reactive Route.

a. Proactive topology discovery

Step 1: A topology message is exchanged by every node in the network with periodic interval among nodes in neighboring.
Step 2: Data are being gathered in each nodes on other nodes and perform QoS metrics in a TIT (Topology Information Table) subsequent to measuring. In TIT, residual bandwidth (BR) along with neighborhood data of 2 hops, queue length (QL), PR, 1 hop and 2 hop adjacent node ID andID of source node are sorted.

Table I Topology Information Table (TIT)

Source node ID	1-hop neighbor node ID	2-hop neighbor node ID	Residual energy	Queue length	Residual Bandwidth

Step 3:Updated node information supports in discovery of nodes and nodes' TIT values are shared.

b. Reactive Route Discovery Phase:

If the routes of D is in need for S then intermediate nodes performs in a route detection phase. The subsequent steps are deployed in the route discovery.
Step 1: Initially, TIT are checked if S requires a data packet to be forwarded to D.
Step 2: After validation, S gathers every data about the nodes towards D.
Step 3: The connection metric (LM) is computed by S deploying TIT values.

$$LM=\frac{\eta * Q_l}{(\alpha * P_R)+(\beta * B_R)} \quad (6)$$

Where the normalization factors are represented by α, β and η.
Step 4: Minimum LM nodes are chosen by S and do packet transferring for selected 2-hop node. With minimal connection metric nodes, transfer of data over several paths are done by Dijkstra Multipath Algorithm.

VII. COOPERATIVE ROUTING

Cooperation of MAC layer can be used to improve system performance on a network layer in MANETs. MAC cooperation performs route selection to destination from source unlike existing routing protocol. Cooperative routing is therefore activated whenever there are opportunities for cooperation.

The route from node V_i to node V_j are discovered b means of V_{i+1} and V_{i+2} is in discovery phase of proposed routing scheme.

In V_i and V_{i+1} exchange of packet data, if R is better in nodes of relay for supportive cooperative transmission, then nodes V_i and V_{i+1} route table are updated along extra entry in nodes of relay. Two adjacent nodes are relayed b route layer that execute cooperative link metrics. route table helps to select next better hop by route layer. The possible route from node V_i to V_j can be V_i—R_i—V_{i+1}–V_{i+2}— V_j. Thence, network performance are improved by the cross-layer mechanism deploying cooperative diversity.

Cooperative Routing (CRCPR) sub layer based on Constructive Relay exist in network layer and it will not affect Open Systems Interconnection model's functions and original architecture. Multihop ad hoc mobile communication is supported by need of CRCPR. Else, ordered IP traffic over remaining wired or one-hop wireless networks is still supported. In CRCPR framework, Routing function, CRCPR Control Packet and CRCPR table parts are available.
1) CRCPR tables: Cooperative Neighbour, Relay and COP Table.

2) CRCPR control packets: Cooperative Confirm (CCON), Cooperative Route Reply (CREP), Cooperative Route Request (CREQ), Cooperative Hello (CHLO) Packet. 3) Routing functions: Routing Discovery, Route Reply, Route Enhancement, Cooperative Data Forwarding.

A.Discovery of Neighbor

(i) Creation of Table for Cooperative Neighbor:The Table for Cooperative Neighbor is built on the base of the data collected following to a CHLO packet received in a node as of its neighbours. Addition of two new items is done in Cooperative Neighbor table likely to the existing neighboring table: Addr List (NSN) area and B/U area (Browsing/Unicast). Every neighbour's neighbors are attached to the respective NSN AddrList field to facilitate COP Table building andCOP topology maintenance. B / U indicates if a B / U packet has been received from a incoming CHLO that updates a certain entrance. Relationship broadcasts are a common method of transmission for hello packets, like most classic MANET, whereas unicast is used in the COP and relay tables created by CRCPR only through cooperative nodes and relay nodes.

(ii) COP Table Creation: Unless a node, the COP algorithm of algorithms *5.1* (via Neighbor Addr / NSN addr lists) also forms a four-node COP topology, a common neighbour to another node, by means of its Cooperative Neighbor table. While COP topology with more than four knots can lead to better output, a four-node scheme for COP topology is a compromise between the complexity of the algorithms and MAN ET's network efficiency. The diversity of transmissions to save energy is not easy to use for a three node topology. For a 4-node topology it is not very difficult to develop and maintain this topology, also offers better concert with regard to the reduction of connection breakage and consuming energy. In case of greater than four nodes inside topologies it is difficult to maintain its complexity. The design and execution of such an algorithm in dynamic MANET is not realistic. In addition, it well understands the mechanism of the layer at lower in cooperative transmission mode as well as discusses techniques of co-operative communication synchronization. In addition, the approach is not restrictive, since there may be several COP four-node topologies inside MANET. Thence sufficient chance is provided in consumption of energy as well as strength improvement.

Algorithm:COP Possibility Detection Algorithm
//Let NA_i be neighbor addresses in every IN.
//Let NSN_j be every neighbors' neighbor addresses list.
//Let L(i,j) be each neighbors' neighbor addresses in one NSN_j .

1. begin
2. For each i in NA_i
3. begin
4. For each j in NSN_j
5. *Find neighbors' neighbor address*
6. Obtain L(i,j)
7. begin
8. For eachi + 1 in NA_i
9. begin
10. In NSN_j, for every k,
11. *Neighbors' neighbor address is computed*
12. ComputeL(i+1,k)
13. *Neighbors' neighbor address are compared*
14. if (L(i,j) == L(i+1,k))
15. *New incoming is added in COP Table*
16. In COP Src, own IP address is added
17. In COP Dest, L(i,j) or L(i+1,k) is added
18. In Node C, two NA_i are added
19. else (L(i,j) == L(i+1,k))
20. *Start next loop*
21. continue
22. end
23. end
24. end
25. end

(iii) Relay Table Creation: An algorithm is developed by every IN runs for COP detection. Thus it updates a COP table or removes invalid entries if there is no further COP topology when a CHLO package updates a Cooperative Next table. When an item removed from COP table, C nodes remain nearby, it will create a Relay Table. Relay table, Relay neighbors 1 has IP addresses IN I and 2 has IP addresses 1N2.

B. Route Discovery

MANET path is determined for a CREQ packet if a node is in need of a path to a destination. COP topology data is allowed by an innovative packet handling CREQ process to a destination. Like AODV. CREQ management is simple in normal topology. It concentrates on COP topology. If a CREQ packet is received from the IN and it detects that the last hop upstream node is COP Dest of COP table, the IN replaces its own IP address for the last hop IP from the CREQ IP List. This allows the COP Dest to be placed closer to its destiny and reduces the last hop on the last route.

VIII. BEST RELAY SELECTION CRITERIA

On packet transmission of node, the next hop is randomly chosen on candidates forwarding amongst neighbors. The list of forwarder encloses nextI hop and the candidate list. Figure 1 depicts the procedure for selection and prioritizing list of the forwarder in flow diagram. Packet header enlists the candidate and steps of hop by hop. The chosen nodes in list of candidates will transmit the candidate.

Here ND indicates the final or destination nodes represented by ND and its distance of current node is represented by its base. The distance of ND and its n neighbour nodes are denoted by ND_n and if it is greater than base indicates that the distance of nodes among neighbour and destination node is greater than distance of nodes of current and destination. In sequence, candidate list insert neighbour node.

In sequence of packet transmission, nodes of candidate list concur the forwarding node. Following of packet received with time-slots in sending of packets by acknowledgements (ACKs). Forwarding candidates are done by ACKs along with packet header. Every ACK encloses senders ID along with recipient of maximum priority, duplicate forwarding is reduced by slotting the candidates list to forward a packet as of rippling candidate-sub network. Simple ExOR stage is considered on choosing the forwarding node i.e., packet receiving along with acknowledgements support in selecting nodes for forwarding. Forwarding of packets are carried if ACK-ID is less than or equal to node ID itself.

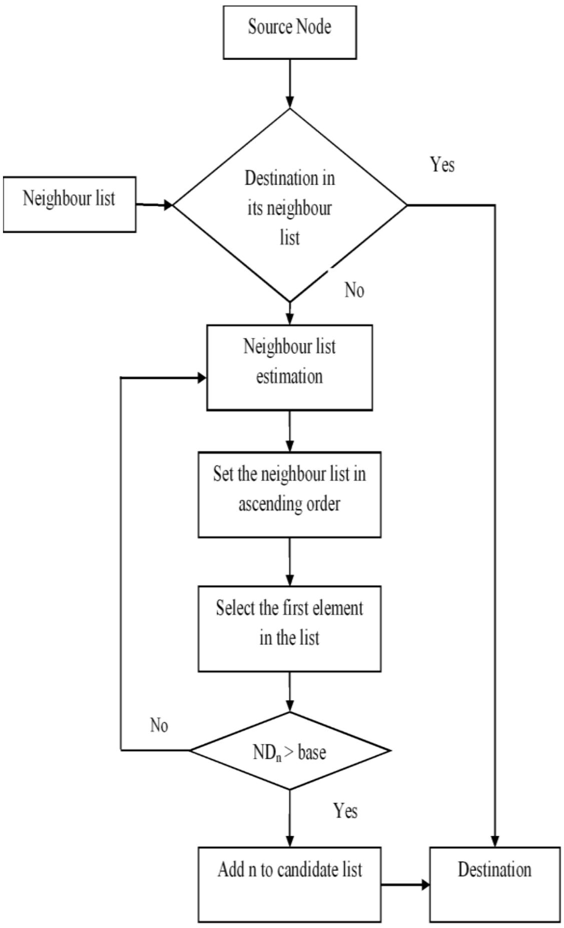

Figure 1 Flow diagram of selecting forwarding candidates

IX. RESULTS AND DISCUSSION

This phase uncovers the experimental results of proposed and existing methods implemented in NS2 simulation with certain parameter metrics. The developed algorithm reach out improved result than existing work with low performance. Better experimental results are achieved in developed incorporated algorithms of Enhanced QoS Oriented Distributed routing protocol (EQOD), Priority and Interference aware Multipath Routing Protocol (PIMRP) and Co-operative and Optimized Quality of service enhanced Distributed Multipath Routing protocol (COQDMRP) against existing method like qos-Oriented Distributed routing protocol (QOD). The network configuration values installed during the experiments can be found in Table II. Optimisation and value gets varied on multiple applications. Table II explicates the scenario of interval time values on notifying time of testing in this case study.

TABLE II: EXPERIMENTAL VALUES FOR SETTING

PARAMETER	VALUE	UNIT	DESCRIPTION
N	30	NODES	NODES COUNT
C	3	CLUSTERS	CLUSTERS COUNT
$T_{Radioon\_CH}$	600	MS	MAXIMUM ON TIME OF CH RADIO FOR TRANSMISSION
T_{sample}	500		SENSING'S SAMPLE TIME
$T_{recluster}$	30000		RE-CLUSTERING TIME
T_{cycle}	5000		TIME INTERVAL BETWEEN TWO DATA TRANSMISSION
$T_{Dataagg}$	50		DATA AGGREGATION TIME AT CH
T_{DataRx}	500		CH DATA RECEPTION TIME
$T_{Radioon_{CM}}$	100		MAXIMUM ON TIME OF CM RADIO FOR TRANSMISSION
ΔV_{th}	100	MV	DEAD NODE'S THRESHOLD VOLTAGE

a. Packet Delivery Ratio

Ratio between numbers of data packets arrived to total data packets transmitted defines Packet Delivery Ratio.

Table III. Number of nodes vs Packet delivery ratio values

Number of nodes	Packet delivery ratio			
	QOD	EQOD	PIMRP	COQODMRP
100	0.756	0.788	0.806	0.824
200	0.754	0.786	0.803	0.822
300	0.753	0.785	0.802	0.821
400	0.752	0.784	0.801	0.82
500	0.751	0.783	0.8	0.81

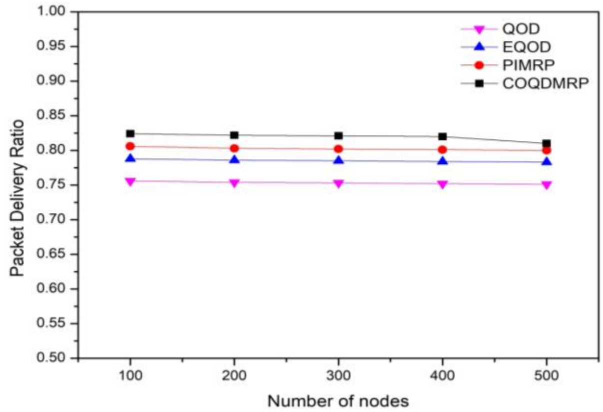

Fig 2. Number of nodes vs Packet delivery ratio vs

Figure 2 illustrates the ratio of packet delivery on comparison of developed system and stems. In x-axis, nodes in number are represented and in y axis, packet delivery ratio value is represented. Proposed method performs effective detection as shown in results. Hence the figure depicts that developed algorithm achieves improved result performance than existing result.

Comparison of packet delivery ratio for sum of the proposed, methods EQOD, PIMRP and COQODMRP with existing method QOD are shown in figure 3.

b. Throughput

Over a message channel, successful delivery of packet's ratio defined throughput of a network and is measured in bits per second (bit/s or bps). High value of throughput corresponds to better performance.

Table IV Number of nodes vs Throughput values

Number of nodes	Throughput in kbps			
	QOD	EQOD	PIMRP	COQODMRP
100	0.93455	1.01455	1.11455	1.24914
200	1.08213	1.18213	1.29213	1.44109
300	1.14559	1.30558	1.41558	1.56106
400	1.2345	1.4254	1.6457	1.74568
500	1.39688	1.59688	1.70688	1.88015

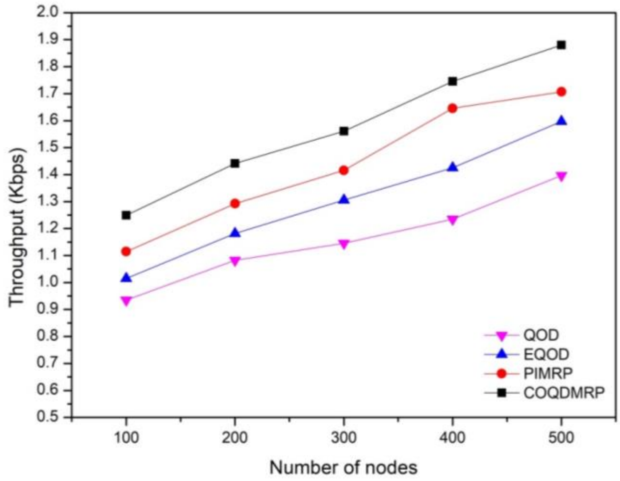

Fig 3 Number of nodes vs Throughput vs

Figure 3 expose the throughput value among developed and prevailing approaches with nodes in number plotted in x-axis and values of throughput in y-axis. High result of throughput value is seen in COQDMRP system indicating good performance in efficient detection as of proposed method.

Comparison of throughput for sum of the proposed, methods EQOD, PIMRP and COQDMRP with existing method QOD are shown in figure 4.

c. Energy Consumption

Energy required for successful completion of transmission of data by entire network defines energy consumption.

Table V. Number of nodes vs Energy consumption

Number of nodes	Energy consumption in Joules			
	QOD	EQOD	PIMRP	COQODMRP
100	0.97955	0.90955	0.78955	0.65412
200	1.19232	1.10232	0.90232	0.79013
300	1.33521	1.21521	1.16897	0.98157
400	1.52469	1.38135	1.20124	1.13606
500	1.66245	1.40025	1.31245	1.23456

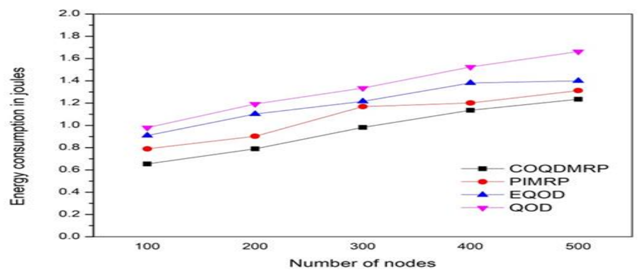

Figure 4 Number of nodes Vs Energy Consumption

Comparison of energy utilization for sum of the proposed, methods EQOD, PIMRP and COQDMRP with existing method QOD are shown in figure 2

d. End to End Delay

Across a network, time required to transmit a packet to destination from source defines end to end delay. Queuing of packets and retransmission of packet due to collision increased the end to end delay.

Table VI. Number of nodes vs End to End delay values

Number of nodes	End to End delay in ms			
	QOD	EQOD	PIMRP	COQDMRP
100	0.21011	0.15011	0.05011	0.04199
200	0.53236	0.42236	0.32236	0.21092
300	0.84004	0.75004	0.65004	0.53129
400	0.92135	0.78565	0.72346	0.58123
500	0.97365	0.88365	0.78365	0.61023

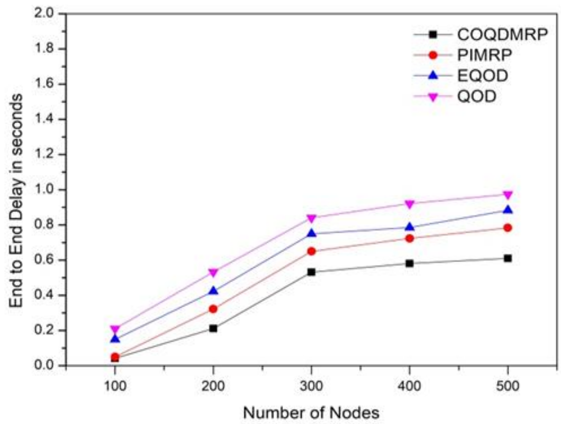

Figure 5 End to End Delay vs number of nodes

Figure 5 explores End to End Delay comparison among proposed and prevailing methods. X-axis denotes nodes in number and y-axis plots metrics of end-to-end delay values. Higher experimental result and efficient detection is attained in proposed of COQDMRP method than the existing.

Comparison of end to end delay for sum of the proposed, methods EQOD, PIMRP and COQDMRP with existing method QOD are shown in figure 5.

e. Packet Loss Ratio

It is the ratio between number of packets lost during the data transmission to the total number of packets sent by the source. The packet loss ratio numerical values are shown in the following table VII.

Table VII. Number of Nodes vs Packet loss ratio values

Number of Nodes	Packet loss ratio values(x10^{-3})			
	QOD	EQOD	PIMRP	COQDMRP
100	78.32	75.82	73.32	66.18
200	82.48	79.94	76.44	68.35
300	85.2	82.18	78.85	72.01
400	87.34	83.26	80.25	74.12
500	88.38	84.18	82.08	76.9

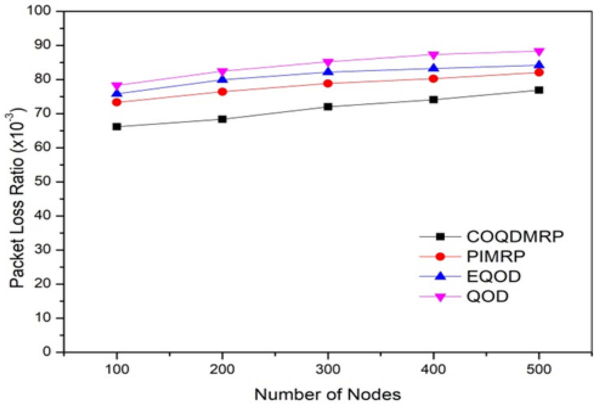

Figure 7. Number of nodes vs Packet Loss Ratio vs

Performance Analysis of the Proposed Methods compared with existing method QOD

Parameters	Increased in Efficiency with respect to QOD		
	EQOD	PIMRP	COQDMRP
Packet Delivery Ratio	4%	6%	9%
Throughput	5%	7%	8%
Energy consumption	3.5%	4.5%	7%
End-to-End Delay	4.5%	5.5%	7.5%
Packet loss ratio	5.5%	7.5%	8.5%

X. CONCLUSIONS

This research work ensures the efficient data transmission by focusing on the enhanced distributed multi path data transmission. It analysed and schemed efficient methods to solve invalid resource reservation problem by efficient node selection, race conditional problem by distributed multipath routing and link failure by cooperative node selection, that are inherent challenges in HWN. It is the latest research area. Quality of link and its broadcast in wireless channels are incorporated is referred as latest arena of Cooperative

Communication. Proper functioning of node routes and node forwarding leads to success of mobile ad-hoc networks communication. Experimental result exhibits the improved cooperative routing is achieved by developed method than the existing methods. Against existing cooperative routing, developed method's effectiveness is shown using enhanced throughput and packet delivery ratio and reduced end-to end delay and energy consumption. Proposed COQDMRP shows better performance than existing method QOD, where 9% increased packet delivery ratio, 8% increased throughput, 7% energy saving, 7.5% reduced end to end delay, Packet Loss Ratio 8.5%. It shows better performance than EQOD method, where 5% increased packet delivery ratio, 3% increased throughput, 3.5% energy saving, 3% reduced end to end delay, Packet Loss Ratio 3%, It shows better performance than PIMRP method, where 3% increased packet delivery ratio, 1% increased throughput, 2.5% energy saving, 2% reduced end to end delay, Packet Loss Ratio 1% Hence COQDMRP is more effective than existing QOD, EQOD and PIMRP in terms of QoS parameters and also it resolves invalid resource reservation problem, race conditional problem and link failure.

REFERENCES

1. G Chai, Y., Shi, W., Shi, T., & Yang, X, "An efficient cooperative hybrid routing protocol for hybrid wireless mesh networks," Wireless Networks, 23(5), 2017, 1387-1399.
2. Daijavad, S., Davari, B., Naughton, B. P., & Verma, D. C. U.S. Patent No. 9,838,108. Washington, DC: U.S. Patent and Trademark Office, 2017.
3. Paruchuri, S., & Awate, S., "Organizational knowledge networks and local search: The role of intra-organizational inventor networks," Strategic Management Journal, 38(3), 2017, 657-675.
4. Fiatal, T. U.S. Patent No. 9,712,986. Washington, DC: U.S. Patent and Trademark Office, 2017.
5. Balasubramanian, V., & Karmouch, A., "Managing the mobile Ad-hoc cloud ecosystem using software defined networking principles," In Networks, Computers and Communications (ISNCC), IEEE, 2017, pp. 1-6.
6. Holur, B. S., Shannon, M. L., & Davidson, K. W. U.S. Patent No. 9,814,086. Washington, DC: U.S. Patent and Trademark Office, 2017.
7. Hinton, H. M., Angwin, A. J., & Pozefsky, M. U.S. Patent No. 9,825,916. Washington, DC: U.S. Patent and Trademark Office, 2017.
8. Tran, T. X., Hajisami, A., Pandey, P., & Pompili, D., "Collaborative mobile edge computing in 5G networks: New paradigms, scenarios, and challenges," IEEE Communications Magazine, 55(4), 2017, 54-61.
9. Blanco, B., Fajardo, J. O., Giannoulakis, I., Kafetzakis, E., Peng, S., Pérez-Romero, J., & Sfakianakis, E. "Technology pillars in the architecture of future 5G mobile networks: NFV, MEC and SDN," Computer Standards & Interfaces, 54, 2017, 216-228.
10. Dückers, M. L., Witteveen, A. B., Bisson, J. I., & Olff, M. "The association between disaster vulnerability and post-disaster psychosocial service delivery across Europe," Administration and Policy in Mental Health and Mental Health Services Research, 44(4), 2017, 470-479.
11. Arrighi, C., Rossi, L., Trasforini, E., Rudari, R., Ferraris, L., Brugioni, M., & Castelli, F. "Quantification of Flood risk mitigation benefits: A building-scale damage assessment through the RASOR platform," Journal of environmental management, 207, 2018, 92-104.
12. Zhou, C., & Ding, L. Y., "Safety barrier warning system for underground construction sites using Internet-of-Things technologies," Automation in Construction, 83, 2017, 372-389.
13. Kumar, N., & Khan, R. A. "Emergency Information System Architecture for Disaster Management: Metro City Perspective," International Journal of Advanced Research in Computer Science, 8(5), 2017.
14. Burke, E., Pinedo, M., Zografos, K. G., Madas, M. A., & Androutsopoulos, K. N., "Increasing Airport Utilisation through Optimum Slot Scheduling: Review of Current Developments and Identification of Future needs," Journal of Scheduling, 20(1), 2017,103-113.
15. Fadi Al-Turjman, Cognitive routing protocol for disaster-inspired Internet of Things, Future Generation Computer Systems, Volume 92, 2019, Pages 1103-1115.
16. Funai, C., Tapparello, C., & Heinzelman, W., "Enabling multi-hop ad hoc networks through WiFi Direct multi-group networking," In Computing, Networking and Communications (ICNC), 2017 January, International Conference on(pp. 491-497). IEEE.
17. Aggarwal, D., "A Study on the Role of Mobile Adhoc Networks (MANETS) in Disaster Management," International Journal of Advanced Research in Computer Science, 8(5), 2017.
18. Xu, X., Chen, A., & Yang, C., "An optimization approach for deriving upper and lower bounds of transportation network vulnerability under simultaneous disruptions of multiple links," Transportation Research Part C: Emerging Technologies, 2017.
19. Rani, S., Malhotra, J., & Talwar, R., "Energy efficient chain based cooperative routing protocol for WSN" Applied soft computing, 35, 2015, 386-397.
20. Huang, X., Zhai, H., & Fang, Y., "Robust cooperative routing protocol in mobile wireless sensor networks," IEEE transactions on wireless communications, 7(12), 2008, 5278-5285.
21. Chen, M., Kwon, T., Mao, S., Yuan, Y., & Leung, V. C., "Reliable and energy-efficient routing protocol in dense wireless sensor networks. International Journal of Sensor Networks, 4(1/2), 2008, 104.
22. Maalej, M., Cherif, S., & Besbes, H., "QoS and energy aware cooperative routing protocol for wildfire monitoring wireless sensor networks," The Scientific World Journal, 2013.

AUTHORS PROFILE

Murugeswari.T received the AIME in Electronics and Communication Engineering, The institution of Engineers (India), Calcutta and M.E. Power Electronics & Drives in Sri Ramakrishna Engineering College, Coimbatore, (Anna University, Chennai). At present, she is perusing Ph.D., in the field of networking in Anna University, Chennai. She has about 19 years of teaching experience and 6 years of experience in industrial field. She has published about 9 technical papers in various international journals. She has presented various technical papers in 8 international and 17 national conferences. She has organized a seminar, a conference and two guest lectures. She is now Assistant professor in Electrical and Electronics Engineering, Hindusthan College of Engineering and Technology, Coimbatore, Tamil Nadu, India from 2005.

Rathi.S is Associate Professor in Department of Computer Science Engineering, Government College of Technology Coimbatore, Tamilnadu, India. She did her Ph.D. in Mobile Computing (Anna University, Chennai). Her fields of interests include Computer Networks, Mobile Computing, Wireless Security & the Fault Tolerant system Design. She received her Master degree, in CSE from Government College of Technology, Coimbatore. She also leads and teaches modules at both B.E, M.E. levels in Computer Science. She published 22 technical papers in the national & international journals and 24 conferences. She has organized 2 conferences for students and faculty, 7 training programmes for faculty and 12 training programmes for students.