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EECMRP: ENERGY EFFICIENT CLUSTER MULTIPATH ROUTING PROTOCOLFOR MANETs

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Abstract: The overall performance of the computer network depends on the Quality of service (QoS) parameters such as delay, jitter, variance, bandwidth, throughput, packet delivery ratio etc. In order to further enchance the quality of communication over mobile ad hoc networks (MANETs), this paper proposes an Energy Efficient Clustered Multipath Routing Protocol (EECMRP).Delay being the most important parameter in the transmission of multimedia datacan be minimizedby considering the concept of multipath along with clustering The multipath concept aims at finding more than one path for the transmission of data from the source to the destination. There are two criteria involved one is the stability of the link and the reliability of the link which determines the quality of the link.This provides an efficient measure for cluster retransmission in an energy efficient manner and also reduces delay.Cross layer communication between physical, MAC and routing layers has helped to achieve QoS in the network by establishing more stable and reliable paths, thus reducing the delay.Performance evaluation of the proposed protocol against AODV and QMRP has been conducted using network simulator. Results show that EECMRP outpaces QMRPand AODV in terms of energy efficiency and delay.Routing overhead for QMRP is more than that in AODV as it establishes multipath concept. Further, routing overhead of EECMRP is reduced when compared with QMRP due to the use of clustering concept in each route detection process.

Keyword: QoS; MANET;Clustering; routing protocol; multipath routing; QMRP.

I. INTRODUCTION

MANET is a continuously self-configuring infrastructure less mobile network, in which the communication is carried out through a number of intermediate nodes. The function of an intermediate node is to relay information from one of its neighbor to another neighbor node. In MANET each mobile node not only operates as host but also as a router by forwarding the traffic of mobile nodes in the network. The deployment of MANET makes it attractive for various applications such as defense operations, natural calamities, educational excursions in secluded places and alternative mobile medical units [1]. MANETs have various divergent challenges comprising of security, power management, efficient dynamic routing and QoS guarantees.

In this paper we study QoS routing support, which is one of the challenges in MANETs. The vital characteristics of a network must be studied to design arouting protocol for MANETs. Various characteristics of MANETs are a) Dynamic nature: nodes are peripatetic and unpredictable with respect to their location, the network status changes in a precise short period, b) Distributed operation: the control of the nodes is not centralized. The nodes in MANETs communicate with each other to implement certain specific functions such as routing and security. c) Multi hop routing: The packets are forwarded via multiple intermediate nodes, when one node tries to communicate with another node which is out of the communication range. d) Autonomous terminal: Each node is an independent node in MANET which functions as host and router. e) Light-weight terminals: The nodes in MANET are mobile and withlow power storage and trivial memory size. f) Shared physical medium: The access of the channel cannot be restricted; wireless communication is accessible to any entity with applicable equipment and acceptable resources [2][3]. There are various limitations in MANETs such as security threats, energy constraints, packet loss, hidden terminal problem, limited bandwidth, routing overhead. Therefore the main aim is to develop a QoSaware routing protocol that providesbetter QoSmetrics[4].

Two factors are prerequisite in-order to afford quality assurance for delay-sensitive; real time application in MANETs [4]. Route selection is the primary criteria for the QoS. Instantaneous response is required for the dynamic network, so that route switching is continuous to the user over the lifetime of a session [5]. A route with sufficient resources and links in the path is required to fulfill the path that is stable to meet QoS constraints. Multipath routing is the secondary issue that has gained attention of the research community [5]. Multipath protocol establishes multiple routes between the source and the destination pairs, there are various advantages such fault tolerance, QoS assurance and load balancing [6].

QMRP (QoS-Aware Multipath Routing Protocol) improves the AODV expressively by modifying the phases of the route detection, route selection and maintenance. The QMRP employs multiple paths to reduce the delay. The E2E delay will not be accurate when the network load increases [7].

The rest of the paper is organized as follows. Section II describes related work. Section III presents background information. Section IV defines the problem. System architecture and protocol dynamics are detailed in V. Section VI simulation environment and evaluation. Section VII conclusions.

II. RELATED WORKS

The essential routing protocol proposed for MANETs are single-path routing protocols, which use single paths to communicate between the source and the destination pairs. Multipath routing protocol is based on the single path AODV (Ad Hoc on demand distance vector) which is proposed by Perkins and Royer [7]. Maria et al. proposed anAdhocOn Demand Multipath Distance Vector (AOMDV) as a modified multipath version of AODV [10]. Similar to the AODV criteria, based on the minimum hop count AOMDV establisheslink disjoint and loop free paths. A special flooding mechanism is being used to achieve the link disjoint. In loop freedom the value of node N for the destination D is ensured by using a notion of advertised hop count. The value is used to represent the maximum hop count value of N available for destination D. The alternative path for node D from N is accepted only when the advertised hop count is higher than the lower hop count.

AODVM (AODV-Multipath) is proposed by Z.Ye et al. [11], which finds multiple node dis-joint paths without any limit on the number of paths. RREQ (Duplicate Route Request) table is used to record all the RREQ from the source to destination. The destination replies to all RREQ's. The corresponding entry of the transmitting node from RREQ table is deleted when an intermediate node overhears the broadcasting route reply (RREP) message from neighboring nodes. The RREP is received by an intermediate node, it cannot forward any further. Route discovery error message is generated and sent to the node from which it receives the RREP. The node finds up an alternate path from its source to the table.

The shortest path nevertheless of the link quality is used by the shortest multipath routing using labeled distanced (SMLDR) [12]. Limiting distance is introduced by SMLDR; each node knows the minimum distance to the destination. The extension of the AODV with a gridlock route in case of the primary route failure. The link quality is not considered and also been shown that the protocol does not perform well in heavy load conditions, this AODV Backup Route (AODV-BR) was proposed by Lee and Gerla [13]. QoS AODV protocol was proposed by Perkins and Royer, for choosing a route the delay joints along the hop count is considered [14]. The dynamic of MANET is not considered by the protocol such as topology change, node failure that will lead to changes in predicted adjournment.

The caching and multipath (CHAMP) routing protocol was proposed by A.Valera et al [14]. To minimize the packet loss ratio due to the route failure, the joint packet caching and shortest multipathrouting used byCHAMP. SMR (split multi-path routing) protocol proposed by Lee, s.et al [15]. SMR is an extension of DSR (Dynamic Source Routing) [16]. Maximally disjoint path are endeavored by this protocol. The RREQ message is transmitted by the source; the DSR nodes do not send RREP if they have the path to the destination. From the received RREQs destination identifies the multiple dismember paths and sends a RREP packet back to the source for each individual route. Due to source routing nature of the protocol SMR performance is poor in high dense network due to colossal routing overhead. The utilization of cross layer (CL) routing protocol has been increased in MANETs [18],[19],[20]. H.Sun et al. by cross layer corporation proposed an adaptive QoS routing protocol by cross layer cooperation [21],multipath routing and forward error correction(FEC) are used based on the current network condition of QoS requirements. In [24], Cross layer multipath routing protocol (EMRP) is used to exchange information between physical layer, MAC layer and routing layer to utilize the network resources.

QMRP is a node disjoint protocol that considers the channel conditions when establishing multipath between the source and destination pair in wireless ad hoc networks to overcome the limitations of other single path; Effective Path Delay (EPD) is used by QMRP as a metric to choose the route which takes into contemplation the actual data rate from the MAC layer as well as the SNR in the physical layer in accumulation to the nodes average queuing delay to reflect the link quality and the medium utilization around the node, respectively.

Maximum protocols discussed previously,adoptminimum hop count as a criteria in finding and establishing the paths between the source and the destination. But in [19]Draves et al have shown that in case minimum path is considered without taking into consideration the link quality then, the network performance would degrade. As the wireless links that are bad and congested might be included thus causing a degradationin the throughput as well as increase in the delay. As per the work the performance of EECMRP over the network has been studied and compared with QoS-Aware Multipath Routing Protocol and Ad hoc On demand distance vector routing protocol. Actual transmission rate out from the MAC layer is used in-order to dynamically capture the channels to enhance the chances of QoSsupport over MANET. In addition, instead of using the current queue size for delay computation average queuing delay is used. A preemptive handoff mechanism is used to switch paths with lower expected path delay value.

III. BACKGROUNG AND TERMINOLOGY

A. AODV

Ad Hoc On Demand Distance Vector routing protocol uses the RREQ, RREP and RERR packets to establish communication among the different nodes within the network. The route is established only when required. The transmission becomes easy as every intermediate node and the source node store the next hop information corresponding to each flow. Loop free routing is observed in AODV as destination sequence numbers are used. Route request packet is transmitted by the source node when the route to the desired destination does not exist. Several routes can be obtained for a single destination but the appropriate route is found by using the destination sequence number. A RREQ packet includes a Destination Identification (DestID), Source Identification (SrcID), Time To Live (TTL), DestSeqNum, SrcSeqNum and Broadcast Identification (BcastID). Every route will have certain life after which it will be considered as expired. If the destination node is attained then RREP packet is transmitted .if the route breaks then RERR is transmitted. The hop count is set to infinity and sequence number is incremented by nodes by making AODV loop free at all times, further details are given in [7], [10].

B. *AOMDV:[26] Ad-Hoc On Demand Multipath Distance Vector routing protocol. The entries are made and stored per destination. There is one lifetime value associated with all the routing entries for a destination. Thus all the entries expire at the same time. The unique feature of AOMDV is that multiple routes that are link disjoint are found.*

C. *MAODV:*

The multicast operation of the ad hoc on demand distance vector routing protocol (MAODV) is designed for the use of mobile nodes in an ad hoc network [36]. MAODV offers a quick adaptation to the dynamic condition, low process, memory overhead and low network utilization. In MAODV, a bi-directional shared multicast tree connecting multiple sources and receivers is created. This happens as long as the group members exist within the connected portion of network multicast tree are maintained. In every multicast group, group head maintains the sequence number. Nodes setup the pointers to inaugurate reverse route in the routing table, when a RREQ is broadcasted across a network. Node updates the routing table when it receives a RREQ. When a source node broadcasts a RREQ in a group, it receives more than one reply [37]. The

nodes keep the route received with the greatest sequence number and shortest hop count to nearest member of the multicast tree for a specified time period and other routes are discarded. First member in the group becomes the leader.Hello messages are used by the group leader to broadcast the sequence number within the group. This message contains an extension that indicates the group IP address and sequence number of all multicast group where this node is the leader. The hello message is also used to update the request table [38].

D. *Multipath and Disjointness:*

Because of the limited bandwidth of the mobile nodes multipath routing protocols are exceptional in mobile ad hoc networks. To ensure the QoS requirements between the source and the destination nodes,ad hoc networks permit to initiate multipath routing. Dynamic nature of the ad hoc networks due to mobility, nodes amalgamation, nodes leaving the networks, limited transmission range, limited source power of the nodes, multi path routing is needed to increase network resilience and load balancing which decreases congestion and bottlenecks and increases bandwidth, end to end delay, delay variation and packet loss ratio [26][27][28].

There are two types of multipath routing protocols: node disjoint and link disjoint in the network. Node disjoint paths: paths having no node in common across the network. Link disjoint paths: no link in common across the network. Node disjoint paths provide higher degree of fault tolerance than link disjoints path. Many links fail when a node fails in link disjoints, only a particular link fails when a node fails in node disjoints which means that node fail independently. Node disjoints are harder to find while link disjoints are less profuse [26] [27]. Node disjoint are more effective and can increase the life time of the whole network by avoiding the drain of resource by a node that is located in strategic location. Shown in figure 1.

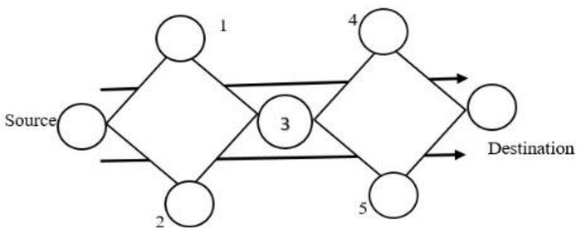


Fig.1. Node, Link Disjointness.

Source node needs a path to destination node. The source node has two link disjoint paths to destination; source-1-3-4-destination and source-1-2-3-5-destination one node disjoint path to destination since 3 is a common node between the two paths. Sine node three is a part of two disjoint path this cause node three to reach its maximum point and cause node three to use the resources available to its node in a precise period of phase which might cause the common node three to fail and hence all the path through the common node three fails, increasing the number of dropped packets and which will lead to cause of longer delay and network partitioning. This is similar when a particular node participating in more than one path moves out of range due to mobility, hence the node disjoint multipath routing protocol is selected.

E. *Cross-Layer Design*

The dependency between the different layers of protocol stack is to maximize the performance and is referred as cross layer design. The cross layered scheme is suggested in [26]. It has both benefit and drawback. It violates the layered architecture embracing the independencies of the protocol design in one layer from other layer.

System durability is reduced due to the failure of the layered approach caused due to many violations [27]. Cross layered design address issues arising from the nature of wireless medium cannot be addressed.

Many studies reported that, without a cross layer design the QoS over the ad hoc networks inspite being aware of the resource availability cannot be accomplished [29]. When compared to the traditional approaches many systems involving the cross layered design have better performance [30] [31] [32].

F. *QMRP*

Based on the feedback from the physical layer and MAC layer QMRP protocol computes multiple disjoint paths. By modifying the different phases of routing such as the route discovery, route selection and route maintenance QMRP improves significantly than AODV. The route propagation packets refer to RREQ/RREP. Multiple node disjoint path that will experience lowest delay when QMRP protocol establishes it. Current delay or history of estimated end to end delay is been used as a metric by most of the delay aware routing protocols. However, this need not be an accurate measure of the delay that will getting to be proficient by the route-requesting node since this node can intensify the aggregate network load. Once the network load proliferates, E2E delay that was attained through route broadcasting is no longer precise. Introducing the projected increase in load into the reckoning of delay an additional correct delay price are obtained once the node starts injecting its traffic into the network.

IV. PROBLEM STATEMENT

The objective is to develop an Energy Efficient Clustered Multipath Routing Protocol (EECMRP), which would satisfy the QOS requirements for ad hoc networks. The prominence on providing QoS for applications rather than on obliging several connections and not full filling the QoS needs. The dynamic and limited resources of MANETs in addition to the wireless medium randomness makes the assignment harder to triumph. There are two parts of question a) approach to take b) how to apply it.

A multipath approach will be taken. The aim of the multipath is to find more than one path between a particular source and the destination to maintain the Qos assurance until the connection has been recognized. The reliability of the network has been increased, congestion will be reduced by load balancing, bandwidth is increased, end to end delay has been reduced, packet loss ratio and delay variation. Addition benefits of the multipath routing include reduction in computation time that CPU needs, high call admission ratio in voice application [1] [3].

The main quality deficiency for a voice application is delay. One way communication time between 0-150 ms is acceptable for a voice application as per ITU-T G.114 [30]. The end to end delay is defined as the time when a frame is generated at the source until it reaches the destination. End to end delay consists of play our relay, queuing, transmission, propagation. The time when a packet is send in the buffer at the destination for smooth play out is shown in figure2. [32].

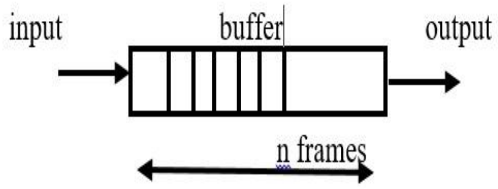


Fig.2.Play Out

Bit error rate (BER) as a function of signal to noise ratio (SNR) translates into modulation reflects the link quality and stability which is known as function of distance. Five digital modulation schemes between the BER and SNR are shown in figure: binary phase shift keying, quadrature phase shift keying, quadrature amplitude modulation with various bit rate per symbols.

Cluster process is been used when the data is transmitted in a multipath network.A collection of nodes, interconnected by a LAN or a high-speed switching network, all nodes can be used individually or collectively as a cluster. All nodes in the cluster are combined together with middleware support for collective usage as a single computing resource, in addition to the traditional usage as individual computers.

Multipath concept isused in order to accomplish the desired QoSby using the cross layer design approach. The interaction between the layers is established by extracting some crucial parameters from the physical and MAC layers and the output is given into the routing layer. Cluster retransmission is been used over the network in order to maintain the QoS.

V. SYSTEM ARCHITECTURE AND PROTOCOL DYNAMICS

The proposed architecture and the work with an application as well as the routing protocol support over the multipath network is shown in the Fig.3. SNR is extracted from the physical layer and given to the MAC layer by EECMRP and the actual transmission rate out from the node and the queue size. These values are passed into the routing layer where the delay computation is calculated to find the path with the lowest delay between the source and the destination pair to reassure the QoS based on the link eminence. Fig.4 shows the fflowchart of the protocol.

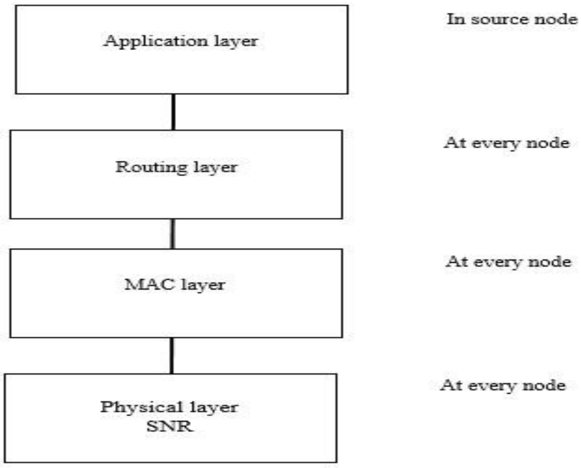
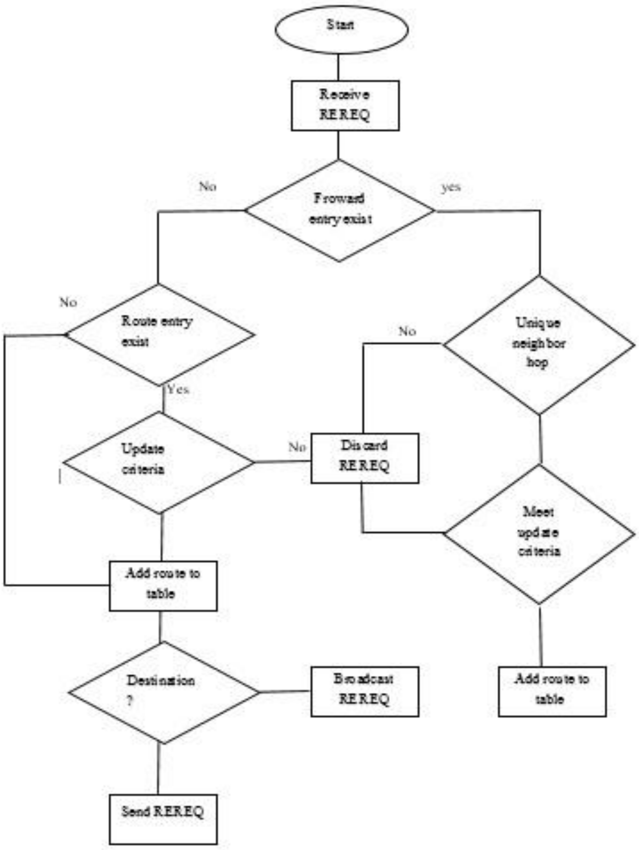


Fig.3. System architecture

A. Protocol Overview

This section describes the details of EECMRP protocol which calculates node disjoint path based on the response from the MAC and physical layer. EECMRP improves QMRP expressively modify the phases of clustering. Route discovery, route reply, route maintenance, clustering are the phases of EECMRP. There are four phases in clustering process. They are a) head selection b) gateway creation c) cluster formation d) cluster retransmission. In this work the route broadcasting packets are referred as REREQ and REREP. The EECMRP protocol uses various node disjoint paths which exhibit the least delay. Current delay or the history to estimate the end to end delay is used by the most of the delay aware routing protocol. Though it is not an accurate measure of the delay that will be experienced by the route requesting node, since this node will increase the overall load of the network. Once the load of the network increases then the E2E delay that was obtained through the route broadcasting will not be accurate. An accurate delay value is obtained by introducing the projected increase in load into reckoning of delay which has been obtained once the traffic is injected into the node. There are various protocol phases that are given below.



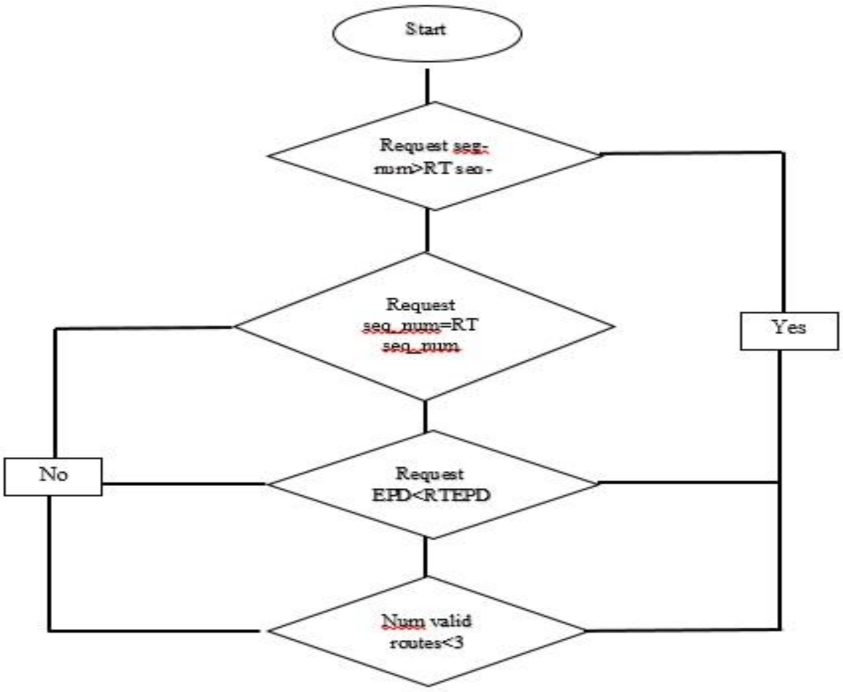


Fig.4. Protocol dynamics

B. Route discovery

When the source node wants to communicate with another node the route discovery process ofEECMRP is initiated. If source node does not have path to the destination node, source node broadcasts a REREQ with a sequence number to triumph limited flooding in the REREQ. In AODV each node receives the REREQ and increments the hop count by one. First copy of REREQ is being used to form the reverse path when a particular node receives multiple copies of same REREQ and all the other duplicate copies that are received will be discarded. The goal is to find several paths, these duplicate route broadcasting is utilized to initiate multiple path. Multipath guarantees loop freedom and node disjointness will be used to establish reverse path.Two addition fields are introduced by EECMRP to the route broadcasting packet Expected path delay field and load field.

C. Route reply

If the node and the destination receive a RREQ, the node updates the entry in its routing table and generates a RREP. The EPD field of the RREP is initialized to zero and unicasted back to source node. According to condition specified successive nodes maintain the routing table when they receive the RREP. With their computed delay EDP field of RREP is incremented and the node is included. The RREP is forwarded to the next hop towards the source node which was discovered through the reverse path during the route discovering process based on minimum EPD. The RREP is forwarded to hop with the lowest EDP once the node checks the RREQ. The RREQs received by the destination form different last hop it generates a RREP to each distinct last op and per unique neighbor hop. One copy of the RREP per source and per destination sequence number are forwarded by the all the intermediate nodes, it's used to specify the node disjointness of the path. If no reverse path is available RREP is discarded. When the source receives all RREPs back from the destination by three paths, it uses the lowest EDP value and saves the other two as a snarl path in case the primary path fails for any reason.

D. Route maintenance

Route maintenance in EECMRP is an extension to that of QMRP and is achieved by generating the route error packet (RERR). When an intermediate node discovery a link node failure due to mobility. Undetected hello packet it generates RERR packet. The RERR packets propagates towards all nodes that have a path through failed node and invalidates all available path in all nodes along the way that have a path through the failed link. When the RERR packets reaches the source it need a path for the destination. It switches the second available path list in the source node. If the source need a path to the same destination when all the paths are invalid then the source stars a new route discovery process.

E. Clustering

Clustering is an important technique for protracting the lifetime of the network. It comprises with grouping of sensor nodes into cluster and choosing cluster head (CHs) for all the clusters. Various number of protocols have been used in order to improve the energy efficiency.

- *Head selection:* Cluster head collects the data from the corresponding clusters nodes and forward the collected data to the base station. Fuzzy decision is used to select the cluster head.

1. for k = 1 to NR do // 'NR' number of regions
2. fori = 1 to SN do // 'SN' number of nodes
3.for j = 1 to SN do
4. $dis_k(i, j)$ = distance from i to j
5. end
6. end
7. fori = 1 to NR do
8.for j = 1 to SN do
9. $D_k (i) = \sum dis_k (i, j)$ // Total distance
for 'i'
10. end
11. end
12. end
13. for k = 1 to NR do
14. fori = 1 to SN do
15. $M_k (i) = \min\{D_k (i)\}$ //minimal distance of grid 'k'
16. if RE(i) >TE
17. $CH_k (i) = M_k (i)$
18. else
19. $M_k (i)$ = next_min{Dg(i)} goto step 16.
20. end
21. end

The cluster head selection is done from this algorithm. The value of K is chosen from the total number of regions and the value of I is chosen from the sensor nodes. Total distance is calculated $D_k(i)$ is calculated and the minimum distance $M_k(i)$ is calculated. When the RE (i)>TE the minimum distance of grid is chosen as cluster head.

- *Cluster formation*
  The mobile host with the highest weight among the neighbor broadcast the message cluster head to the neighbors, the node declares itself as the cluster head. If the mobile host does not cliques the largest weights among the neighbors, the node waits for the decision of all the mobile host having the larger weight than its own and decides its role. The mobile host receives at least one cluster head messages when it joins the cluster of the cluster head which has the highest probability of being neighbor in the future in comparison to other cluster head that sends the cluster head message. The mobile head broadcast message to communicate with the neighbors. If the mobile host receives only the join message from the neighbor nodes with the larger weights, defines that all the mobile host have deferred to other cluster head. Mobile host is free to become the cluster head and thus it transmits the cluster head message to neighbors.The communication between the nodes in the network are done through the gateway. The inter communication between
  the clusters are performed through the gateway.
- *Cluster retransmission*
  In a multihop network when the cluster is flooded or if the energy of the cluster head is low then the cluster head retransmits the data. Data aggregation is done by cluster.

VI. SIMULATION ENVIRONMENT AND EVALUATION

A. *Simulation Environment*

NS2 [39] simulation package is used to calculate the performance of the proposed EECMRP protocol and compare with QMRP. Random way point mobility model is been used. 512 bytes each plus header of different layer has been generated as constant bit rate. The results of the simulation environment is given in the table.

Parameter	Values
E2E	0.15-0.18
Energy variation	180k-380k
Energy consumption	6k-16k
Packet delivery	98-96.5
Delay	0.420-0.44
Packet loss	2.928-3.198
Routing overhead	50900-51300
Throughput	0-80

B. *Evaluation*

The following metrics are being evaluates

- Average delay: Is the difference in time between the source and the destination.
- E2E delay: time taken by a packet to transfer over a network from source to destination.
- Loss: packet loss occur when more number of packets travel over a network or if a network fails or if there is congestion in network. Packet loss are calculated by percentage of packet sent.
- Packet delivery: To send a packet the sender must know the full, IP address of the receiver. Network topology is used to give the MAC address of the packet.
- Throughput: the successful rate of message delivery.
- Routing overhead: the metadata and the network routing information send by an application. A portion of available bandwidth is been used.

C. *Results and Discussion*

In fig.5 the number of connection and the average time delay occurring in a multi a\cast network is been calculated. The result of our proposed protocol EECMRP is compared with QMRP protocol. In EECMRP when the number of nodes are less than 20 the delay time calculated is 0.047 and in QMRP the delay time calculated is 0.0456. The average delay time is reduced when compared with the results of QMRP.

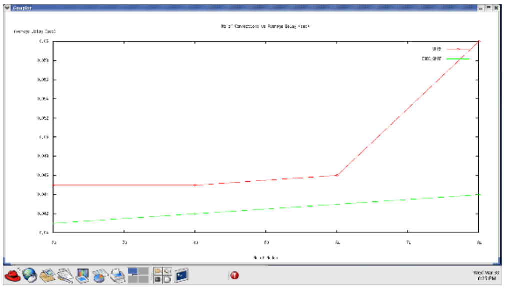


Fig.5. no of connection vs average time delay

In this Fig.6. Energy consumption is compared with simulation time. The result of our proposed protocol is compared with QMRP, AODV, and MAODV. The simulation time taken when the protocol was initiated is taken as 10 ms.The energy consumption is 160k nj. The energy consumption is reduced when the simulation time of the EECMRP protocol increases.

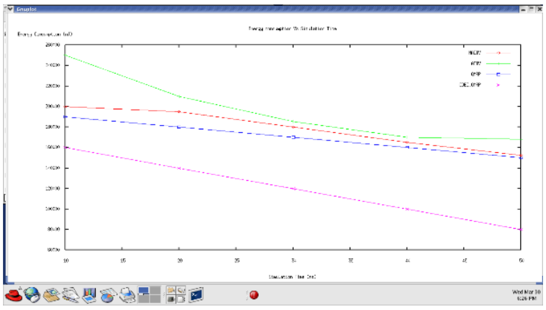


Fig.6.Energy Consumption Vs Simulation Time.

Similarly fig.7. The simulation time of the protocol EECMRP increases the end to end delay time of the protocol also increases. The EECMRP protocol is more efficient when compared with the QMRP, AODV, and MAODV.

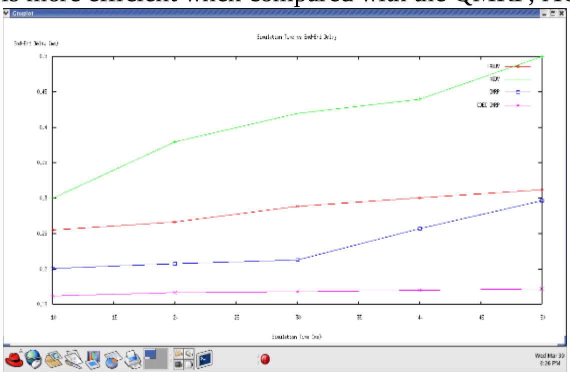


Fig.7. Simulation Time Vs End To End Delay

From the fig.8. The simulation time and the variation of the energy utilized is given. Variation of energy is given by nj and the stimulation time is given in ms. The EECMRP protocols variation of energy is low when compared with the protocol like QMRP, AODV, MAODV. When the simulation time is 10ms the variation of energy varies from 100k to 200k.

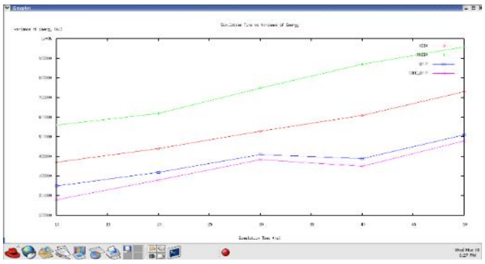


Fig.8. Simulation Time Vs Variation Of Energy

Initially when the size of the packet increases the loss will be reduced. In QMRP protocol when the packet size is given between 0-10bytes the loss ratio is as high as 3.9. When the packet size increased to 60 bytes the loss is reduced to 3.5. When EECMRP protocol is used in multicast routing the loss ratio is decreased to 3.2 for packets of size 0-10 bytes and the loss ratios is reduced to 2.9 when the packet size is increased. EECMRP protocol is effective when compared to QMRP.

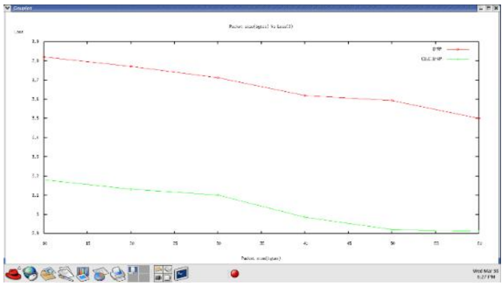


Fig.9. Packet Size Vs Loss

From the fig.10. The packet delivery ratio has been calculated. There is gradual loss in delivery of data when the simulation time increases. By using EECMRP protocol the PDR value varies between 96.7%-98% when the stimulation time varies from 10to50ms. When compared with QMRP PDR percentage is lower in EECMRP.

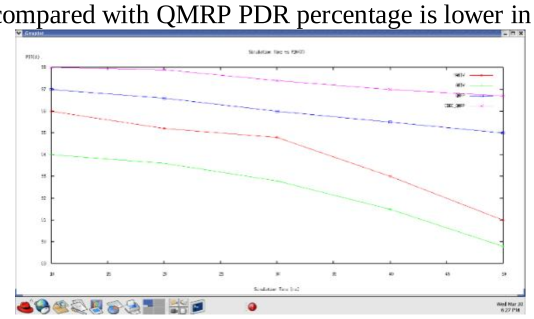


Fig.10.Simulation Time Vs PDR.

From the Fig.11. Number of connection is compared along with the routing overhead. In EECMRP when the number of connection increases the overhead of routing increases. When compared with QMRP the EECMRP is effective.

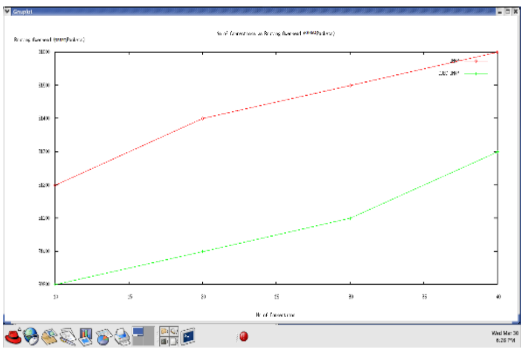


Fig.11. No.Of Connection Vs Routing Overhead.

Form the fig.12. Throughput is calculated the in Kbps in EECMRP protocol the throughput increases when the protocol simulation time is increased. The throughput calculatedis in in Kbps and stimulation time is given in ms. EECMRP protocol throughput is high when compared with other protocols QMRP, AODV, MAODV.

VII. CONCLUTION

In a vibrant environment like MANET on demand multipath routing protocol can achieve aims such as lower delay, load balancing, network resilience through the fault tolerance network and increase packet delivery section. This paper proposes EECMRP (energy aware clustered multipath routing protocol) a disjoint protocol that considers the channel conditions when establishing multipath between the source destination pair in wireless ad hoc network to overcome the limitations of other single paths. EECMRP uses the EPD to choose the route which takes SNR into consideration at the physical layer QMRP extracts the SNR from the physical layer and passes it to the MAC layer where the later computes the actual transmission rate out from the node and the queue size then pass these values to the routing layer where delay computation takes place to find the path with the lowest delay between source-destination pair to assure QoS based on link quality.Without the loss of generality EECMRP introduces the retransmission in which the energy is efficiently utilized and the energy consumption is being reduced. As a result the EECMRP protocol outperforms QMRP protocol in terms of delay, packet delivery and route discovery.
Future work can be carried on algebraic analysis for EECMRP with the other routing protocols.

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