

# DYNAMICALLY CONFIGURABLE MANET TOPOLOGY FOR WIRELESS NETWORKS USING DCNRPT ALGORITHM

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## ABSTRACT

Mobile Ad hoc Network (MANET) is a collection of mobile nodes that communicate between themselves on wireless links and are different from wireless LAN (WLAN) communications. MANET's mobile nodes are end devices routing information. Mobility of nodes increases near geographical edges of the network clusters. The nodes in a MANET work as both a sender and receiver of information. The basic qualities of reconfiguration and ease in deployment of MANETs make them a suitable candidate for emergency applications. MANET's network topology is based on the relative positions of connecting nodes. Links get created and break when nodes change positions within the network. Node mobility affects source, destination and intermediate nodes, resulting in an extremely volatile topology. The dynamism of MANET topology is a unique challenge and hence a dynamic topology based on ad-hoc position of Mobile nodes is proposed in this paper and also improved packet delivery ratio, throughput, jitter and reduced delay time. The proposed topology DCNRPT is simulated in NS2 for deployment of nodes and an optimized coverage.

**Keywords:** MANET, DCNRPT, WCA, Topology Based Routing, Position Based Routing, Topology Characteristics.

## 1. INTRODUCTION

MANETs are a cluster of nodes which interact without a specific access point or fixed infrastructures [1][2][3]. MANET networks are dynamic in environment and without a static topology. These ad-hoc networks have become popular due to the popularity of mobile devices. Wireless network communications are narrow by a node's communication range and information is passed on in the network using a static topology, while the equivalent is achieved in a MANET using intermediate nodes. Figure.1 represents a MANET Topology.

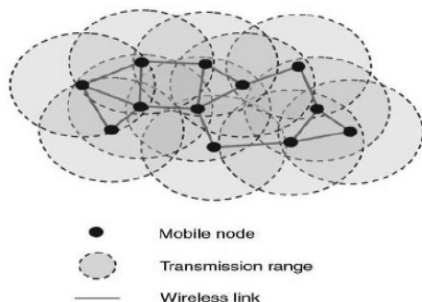


Figure 1: MANET Topology.

MANET is a decentralized network using a dynamic formation of wireless links and not including the need for any cellular infrastructure. MANETs have found use in Military, Rescue operations, Conferences etc. These networks can pass on information in a single hop or use multiple hops. Nodes communicate with further nodes in the transmission range in a single hop MANET. Since MANETs infrastructure is not static, the nodes move freely.

During emergencies like floods caused by natural calamities like floods, fixed infrastructures may malfunction and the dynamic MANET is used for carrying vital information as they can be deployed easily, quickly and in minimal configurations. Though MANETs have advantages during such disasters, they do pose various challenges in topology designs. The expected outcomes of wired networks are more dependable when compared to MANETs information shares. MANET nodes may face delays in propagation due to variations in their node environments. Further, the entire MANET nodes

can send and receive information, reducing the presented bandwidth. MANETs can be created using different networks like Vehicular Ad hoc Network (VANET) or Body Area Network (BAN) or Wireless Sensor Network (WSN). Technologies like IEEE 802.11, Bluetooth and Ultra – Wide Band (UWB) can also be used for realizing MANETs. Mobile Ad hoc Network's dynamic topology makes writing of routing algorithms challenging as nodes are mobile, changing the topology unexpectedly and thereby affecting the availability of routing paths. This paper proposes a new topology design called DCNRPT (Dynamic Configurable Network Routing Protocol based Topology) which segments nodes using clustering for a dynamic topology configuration based on the no. of nodes and their sites in a MANET.

## 2. RELATED STUDIES

MANET's networking technology has inspired substantial research [4] as wireless applications need higher bandwidths and reliability in development. Wireless communications when combined with latest technology increases conventional broadcasting information into direct source-destination signal with cooperative communication [5] [6]. Spectral and power efficiency are regarded as a hopeful approach to network coverage [7] and cooperative protocol relay selection techniques [8]. Selection of proper relay transmission rate can maximize reliability [9]. MANET's cooperative communication has made significant impact on the network topology and network topology control determine deployments. An apt topological network connectivity can optimize performances [10] [11]. MANET's cooperative communication ability is a dynamic channel [12]. Compass Routing and FACE-1 algorithms were proposed in [11] that guaranteed delivery of information in greedy forwarding, in spite of local minimum phenomenon occurs. FACE-2 routing algorithm was proposed in [13] using the edging of the Gabriel Graph (CG) formed at every node. A probabilistic answer called Intermediate Node Forwarding (INF) using a Negative Acknowledgment (NAK) packet for providing feedback on dropped packets to the source was proposed in [14]. A Geographic and Energy Aware Routing (GEAR) proposed in [15] to route a packet toward a region of interest. It worked well for small factions, but its efficiency dropped on larger areas of focus. A participating node's unavailability either due to power shortage or signal strength can create gaps in a network. Gaps means Black holes

are shaped due to power exhaustion of the nodes. This results in a heavy resource conflict between neighboring nodes and thus limiting bandwidth or access [16]. Worm hole is one of the denials of service attack [17]. Sensor holes/gaps were determined theoretically with an algorithm called BOUNDHOLE [18]. The study in [19] detected holes and map jammed regions in a antenna network by applying heuristics data like bit-error rates, to discriminate jamming from regular interference. Accordingly, a discrete stochastic optimization problems in topology control MANETs as the problem, and it is a stochastic approximation approach [20] can be solved using [21], which is to prove the optimal solution by converging iteratively to move towards a better solution analysis and simulation in the paper by the one of the advantages of iterative approaches that it dynamically reconfigure the network topology change can track mobile environment.

## 3. CLUSTERING

Wireless sensor network (wireless), progressively more used in many real life environments process data at a minimal cost. This wireless node are deployed, organized and maintained. Topological studies can correspond to networks built from scratch (Greenfield planning) or upgrading existing network infrastructures (Brownfield planning). In a network topology, layer 3 is a router or network or IP level [22]. This is a level where IP addresses are connected referring to the interfaces of nodes. Interconnectivity of logical subnets can also be added to this layer [23] [24] [25]. Layer 2 is a switch level layer, where a single logical link may mock the connections of several other devices like hubs or switches making them appear in a higher degree [26] [27]. The bottom most layer devices may involve a single logical link. Point-of-Presence (PoP) is a insecurely defined grouping of devices and frequently defines a metropolitan area. These level topologies are quite beneficial as they portray the logical structure of networks and implementations in tenures of individual routers. These topologies are best for perceptive connectivity, providing essential information. Network diagrams are repeatedly drawn at this level for easy comprehension. Thus grouping network nodes or links for connectivity is a defined technique. Identifying similarities in data is a fundamental problem in many fields including data analysis, statistics, bioinformatics and image processing. Clustering assigns a groups (Classes or

Categories) based on similarity of a predefined property. Classical clustering dates back to the early 20th century, covering a wide spectrum like centric clustering, connectivity clustering, density clustering, etc. The results of clustering and cluster attributes like average element size, number of clusters, minimum or maximum size etc., generate knowledgeable interest. Many studies have evaluated and compared network clustering algorithms and their performances [28]. Hence, this examine work underlines the use of clustering in identifying and proposing a topology connectivity from a group of nodes for efficiency. Multiplicities of Traffic Patterns exist in wireless communications. Using Local Communication pattern, node information is divided amongst its neighbors and data is transmitted directly between nodes. In a Point-to-Point routing pattern, information is transmitted to another node from an arbitrarily chosen node (Wireless LAN)[29][30]. Compound node information is shared to a one base node in convergence pattern and helps data collection in wireless.

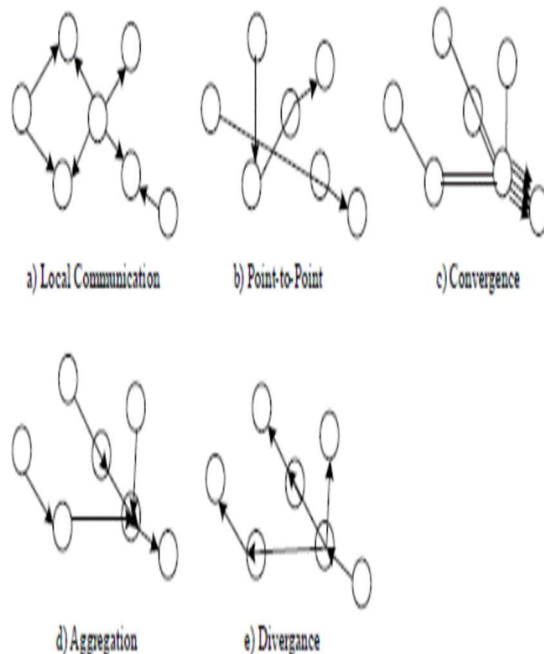


Figure 2: Wireless Traffic Patterns.

Intermediate nodes process information and the aggregation is passed on the base node in an Aggregation Traffic Pattern. The Divergence Traffic pattern sends a request or data from a base node to another sensor node. Figure.2 depicts a few traffic patterns used in wireless communications.

#### 4. DYNAMICALLY CONFIGURABLE MANET TOPOLOGY

The following methodology diagram for Figure 3. dynamically configurable manet topology to create a node.

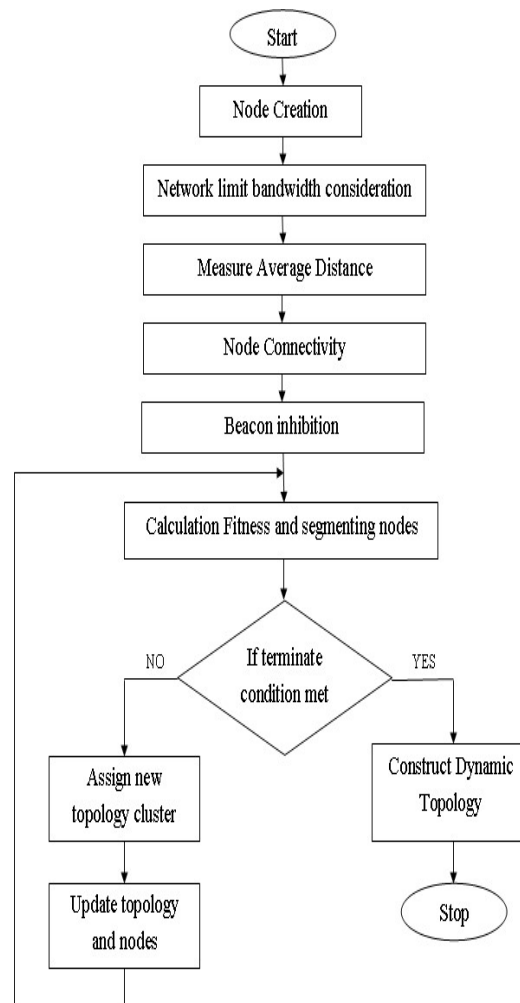


Figure 3 : Methodology diagram for DCNRPT

#### PSEUDO Code

```

Set ns as new simulation
Define Data_Colors=RGB
namTract =out.nam
proc finish ()
begin
  
```

```

        global ns nf
        flush-trace
    end
    close $nf

    Begin
        exec out.nam
        end flush
    End

    Begin node path
        set n0 [$ns node]
        set n1 [$ns node]
        set n2 [$ns node]
        set n3 [$ns node]

        duplex-link $n0 $n2 2Mb 10ms DropTail
        duplex-link $n1 $n2 2Mb 10ms DropTail
        duplex-link $n2 $n3 1.7Mb 20ms
        DropTail

        queue-limit $n2,$n3 = 10

        duplex-link-op $n0 $n2 orient right-down
        duplex-link-op $n1 $n2 orient right-up
        duplex-link-op $n2 $n3 orient right

        duplex-link-op $n2 $n3
        queuePos 0.5

        set sink [new Agent/TCPSink]
        attach-agent $n3 $sink
        connect $tcp $sink
        $tcp set fid_1

    End

    Begin schedule node as agent
        "$cbr start" = 0.1
        "$ftp start" = 0.1
        "$ftp stop" = 4.0
        "$cbr stop" = 4.5

        $ns detach-agent $n0 $tcp ;
        detach-agent $n3 $sink"

        $finish=0.5

    End

    Begin Run simulation
        puts "CBR packet size = [$cbr set
        packet_size_]"
        puts "CBR interval = [$cbr set interval_]"
        $ns run
    End

```

Wireless routing techniques need improvements, due to energy constraints of a node. Optimal routing techniques can help in better utilization of the resources, thus improving the life time of a network. Topology of MANET after deployment decides on its maximized resource usage. The proposed topology, DCMRPT, attempts to identify shortest routing paths and configures MANET connections dynamically. Figure.4 depicts the DCMRPT Architecture,

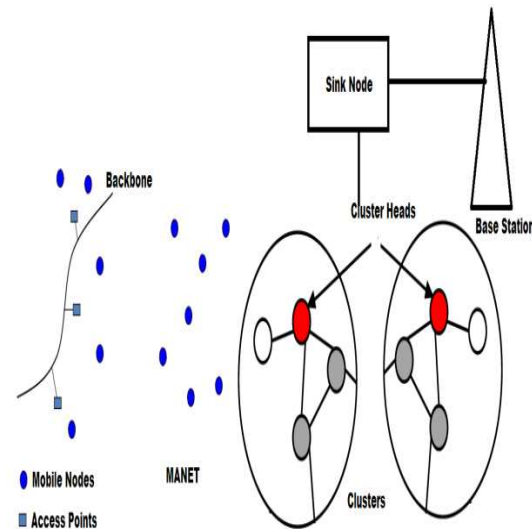
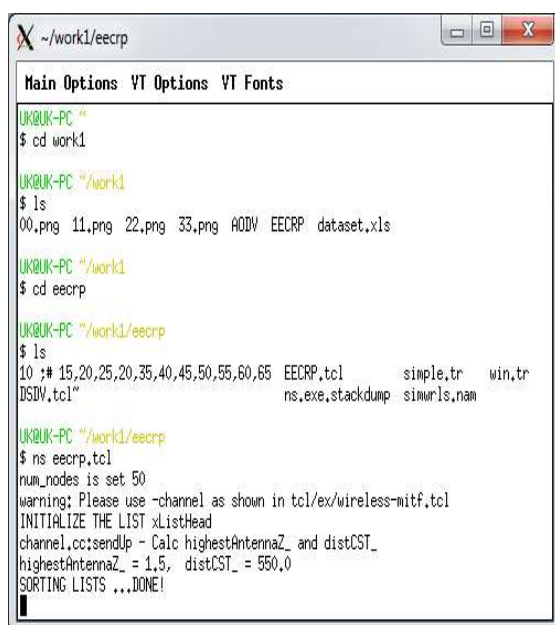


Figure 4: DCMRPT Architecture.

DCMRPT in the first step creates a predefined number of nodes based on the requirement or implementation. Each node communicates with other nodes directly or indirectly and the required number of nodes for deployment is specified as an input to DCMRPT. IPv4 Routed /24 Topology Dataset is used in implementation of DCMRPT on NS2 for simulating the proposed topology. The number of nodes taken in the requirement phase was 100 nodes to be grouped into five clusters. Figure.5 depicts a screen shot of requirements given to DCMRPT.



```

~/work1/ecdnp
Main Options VT Options VT Fonts
UKBUK-PC ~
$ cd work1

UKBUK-PC ~/work1
$ ls
00.png 11.png 22.png 33.png ADDV EECRP dataset.xls

UKBUK-PC ~/work1
$ cd eecrp

UKBUK-PC ~/work1/ecdnp
$ ls
10 :# 15,20,25,20,35,40,45,50,55,60,65 EECRP.tcl simple.tr win.tr
DSOV.tcl ns.exe,stackdump simwrls.nam

UKBUK-PC ~/work1/ecdnp
$ ns eecrp.tcl
num_nodes is set 50
warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl
INITIALIZE THE LIST xListHead
channel.cc:sendUp - Calc highestAntennaZ_ and distCST_
highestAntennaZ_ = 1.5, distCST_ = 550.0
SORTING LISTS ...DONE!

```

Figure 5: DCDNRPT Requirements.

DCDNRPT takes into account network limitations in the second step and the range of the wireless deployment is decided. Figure.6 depicts DCDNRPT's node creation.

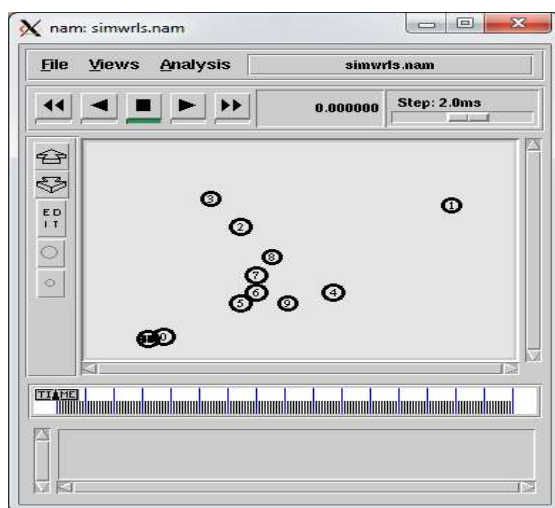


Figure 6: DCDNRPT Node Creation.

DCDNRPT created nodes are then clustered for defining cluster heads in the wireless network and defines the parameters X,Y which denote the source and destination Ranges of a wireless. This is followed by defining the height of the wireless network. It then finds the average distance between nodes by using the Dijkstra's Algorithm for construction of shortest routing paths dynamically

and in an ad-hoc manner based on the wireless nodes. Figure.7 depicts DCDNRPT's Active Distance Measure.



Figure 7: DCDNRPT Active Distance Measure

Nodes are then grouped for connectivity using the previously calculated average distance measure. Transportation networks with many nodes rise in complexity and their comparisons become difficult. A node's accessibility is not evident easily and measures and indices are needed to evaluate network efficiency. After nodes are created the average distances between the nodes are measured. DCDNRPT's active distance measures helps in its efficient topology proposals based on time. A network with higher active distance tends to be less linked and active distances are reduced for higher connectivity (Planar networks have larger active distances due to intermediary ends between two distant nodes). DCDNRPT then finds the threshold of each neighborhood as a validation measure using the Beacon inhibition mechanism and given in eq.(1)

$$T = \frac{\text{Range of Beacon (R)}}{\text{Time taken to send a beacon (t)}} \dots\dots\dots (1)$$

The nodes are segmented further based on the minimum sensing threshold range of the network. In the final step a dynamic structure is then mapped and proposed based on the homomorphism of node similarity. DCDNRPT's connects links based on the minimum average distances between nodes for constructing the cluster groups and eventually the connectivity pattern. Figure.8 depicts DCDNRPT's node connectivity pattern



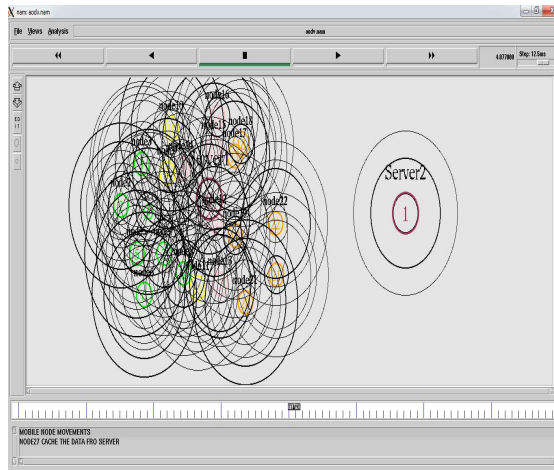


Figure 8: DCDRPT Node Connectivity Pattern.

The following DCDRPT (Dynamic Configurable Network Routing Protocol based Topology) algorithm is used to create the dynamic network topology for data points (nodes) in the proposed method using node energy.

### DCDRPT Algorithm

**Input** : Set Maximum limit of X,Y from network land; Set Height coordinate system

**Output** : Create Dynamic Configurable Network Topology

/\* Initialization\*/

Step 1: Initialization of time  $T=0$

Step 2: For node= 1 to n do

Step 3: Randomly select the end point destination node

Step 4: Launch exploring point

Step 5: End For

/\* The exploring and reaches the destination\*/

Step 6: Launch backward node

Step 7: For each backward node do

Step 8: Track backward and exploring node

Step 9: Update routing tables

/\* Process data packet \*/

Step 10: Initialization time  $T=0$

Step 11: Receive packets p from Media Access Control layer

Step 12: For each p do

Step 13: Select next node j among neighbor nodes

Step 14: Update routing tables

Step 15: Processing data packet {delivery, forward or discard}

Step 16: End For

Step 17: Remove expired packet Receive new packet

Step 18: Compute network statistics

Step 19: End For

**DCDRPT Advantages:** DCDRPT's generated clustered pattern uses the threshold value based on eq. (1) for beacons. The use of beacon inhibition mechanism helps in the reduction of collisions and increases transmission efficiencies. Any node can emit multiple messages based on its threshold value. DCDRPT attempts to overcome issues in topological segmentation of other methods. Since it uses clustering, nearest nodes are identified to form cluster heads. The major advantage of using cluster heads is to reduce load on the sensing nodes. The traffic to the sink nodes are reduced by the cluster heads as they take charge of a set of sensor nodes. The information from these nodes are transmitted to the cluster heads which then forwards it to the sink nodes. DCDRPT's clusters helps in better productivity. Moreover, since the messages that are flashed are dependent on the threshold values, the information flow within the network is optimized. The commonly used weight function, avoids the randomness problems of k-means clustering method. The performance of the proposed technique shows that it can work well even on complex networks. Since, DCDRPT is based on mutual information sharing between neighbors; it increases segmentation robustness and drives DCDRPT architecture towards a more rational topological/semantic map.

## V. SIMULATION RESULTS AND ANALYSIS

MANETs have numerous intrinsic characteristics (eg. dynamic topology, time-limited and bandwidth-limited wireless channels, multi-hop routing, and disseminated control and management). The design and performance study of routing protocols for MANET networks is currently an active area of research. In order to moderate the values of routing protocols, qualitative and quantitative metrics are needed to measure their applicability and performance in Weighted Clustering Algorithm(WCA). Specifically, the

performance of the proposed DCNRPT routing protocol can be evaluated in the following performance metrics: packet transfer rate, performance, latency, and jitter.

Table 1 : Simulation parameters

Parameters	Value
Simulation	NS-2
MAC Protocol	IEEE 802.11
Protocol Name	DCNRPT, WCA
Mobility Model	Random Waypoint
No. of Nodes	100
Transmission Range	250meters
Size of Network	500m * 500m
Pause Time	25s
Hello Interval	5.0s
Simulation Duration	500 times

The following performance metrics to evaluate through networks simulation (NS2):

### 5.1 Packet Delivery Ratio

The packet transfer relationship is computed by separating the no.of packets received by the destination by the number of packets initiated by the application layer of the source. Specify the packet failure rate, which limits the highest performance of the network. The better the transfer relationship, the more complete and correct the routing protocol.

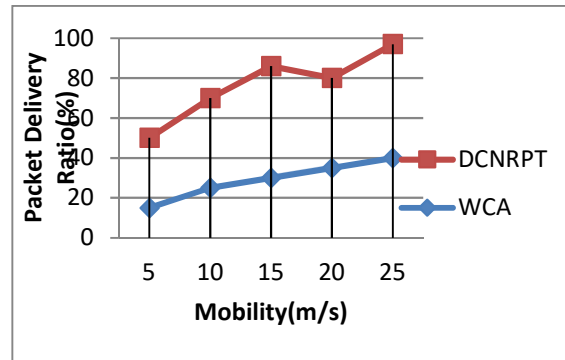


Figure 9: Packet Delivery Ratio(%) Vs Mobility(m/s)

In Figure.9 the proposed DCNRPT algorithm provides better performance compared to existing WCA algorithm and also increased packet delivery ratio with mobility is increased.

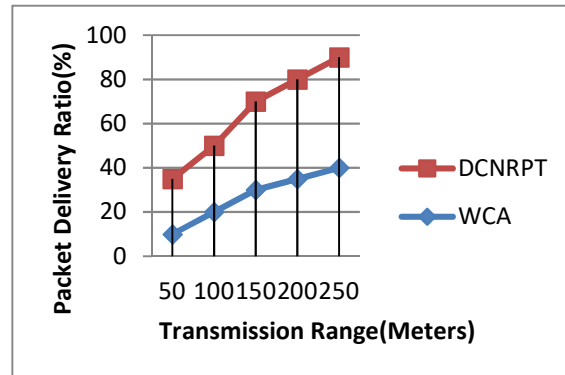


Figure 10: Packet Delivery Ratio(%) Vs Transmission Range(Meters).

In Figure.10 the proposed DCNRPT algorithm provides better performance compared to existing WCA algorithm and also increased packet delivery ratio with transmission range is increased.

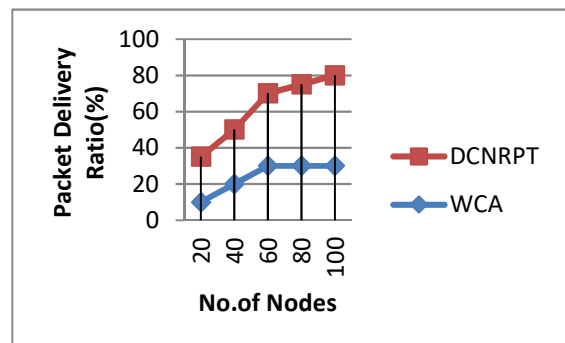


Figure 11: Packet Delivery Ratio(%) Vs No.of Nodes.

In Figure.11 the proposed DCNRPT algorithm provides better performance compared to existing WCA algorithm and also increased packet delivery ratio with number of node is increased.

## 5.2 Throughput

The performance of the protocol can be defined as the percentage of packets received by the receiver between packets transmit by the source. It is the quantity of data per unit time passed from one to another over a communication link. Performance is calculated in bits per second and it is generally measured by kbps or mbps.

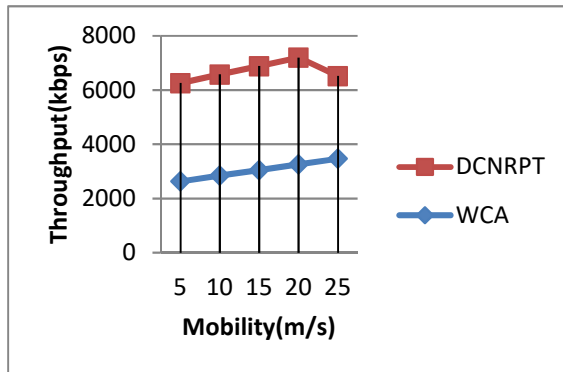


Figure 12: Throughput(kbps) Vs Mobility(m/s)

In Figure. 12 the proposed DCNRPT algorithm provides better performance compared to existing algorithm WCA and also increased throughput with mobility is increased.

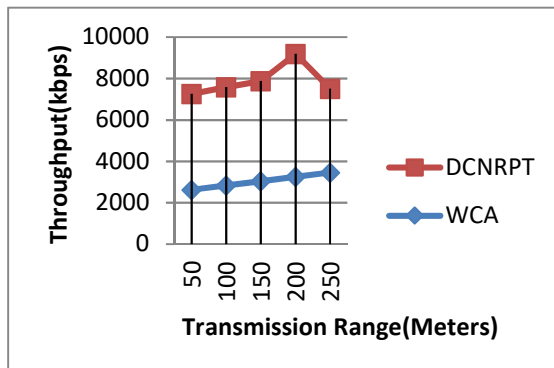


Figure 13: Throughput(kbps) Vs Transmission Range(Meters)

In Figure. 13 the proposed DCNRPT algorithm provides better performance compared to existing WCA algorithm and also increased throughput with transmission range is increased.

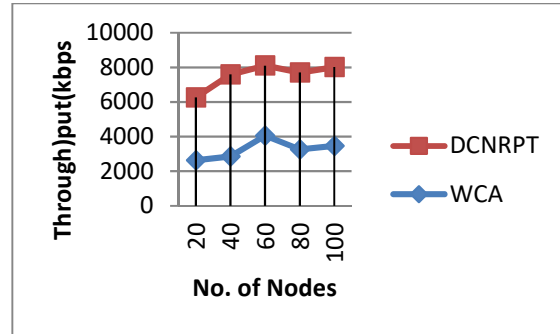


Figure 14: Throughput(kbps) Vs No.of Nodes

In Figure. 14 the proposed DCNRPT algorithm provides better performance compared to existing WCA algorithm and also increased throughput with number of node is increased.

## 5.3 Jitter

It is the time variation between the arrivals of the packet. The stability of the response of measurement algorithm to structural changes. It is the deviation of the ideal delay and caused by network congestion, sudden changes in network topology, or routing changes.

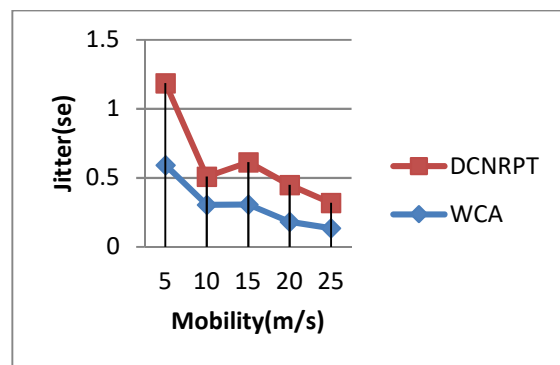


Figure 15: Jitter(sec) Vs Mobility(m/s).

In Figure.15 the proposed DCNRPT algorithm provides better performance compared to existing algorithm WCA and also increased jitter with mobility is increased



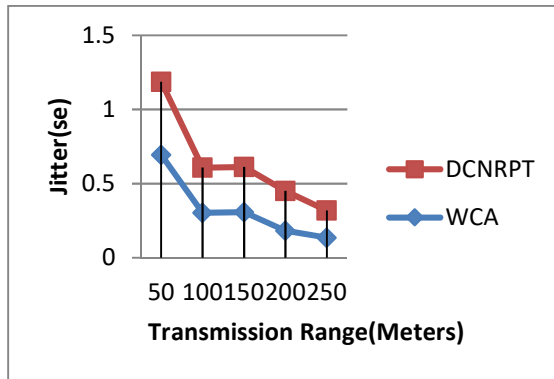


Figure 16: Jitter(sec) Vs Transmission Range(Meters).

In Figure.16 the proposed DCDNRPT algorithm provides better performance compared to existing algorithm WCA and also increased jitter with transmission range is increased.

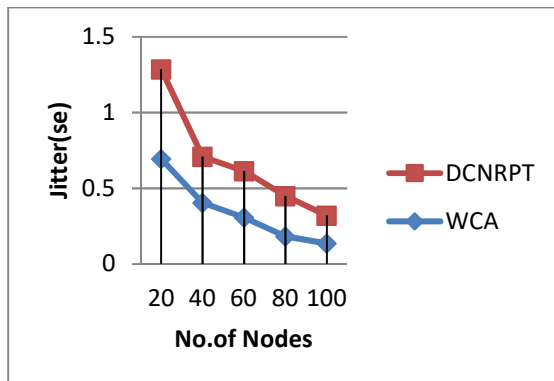


Figure 17: Jitter(sec) Vs No. of Nodes.

In Figure.17 the proposed DCDNRPT algorithm provides better performance compared to existing algorithm WCA and also increased jitter with number of node is increased.

#### 5.4 Delay

The end-to-end delay of a packet is the time at which the originating node generates the packet until it reaches the destination node. This is the time it taken packet to pass through the network. This time is expressed in seconds. Therefore, all network delays are known as packet-to-end delays, such as buffer queues and broadcast times. Sometimes this delay can be called a delay. Some applications are sensitive to packet delays because speech is a latency-sensitive application. Therefore,

voice requires a lower average delay in the network.

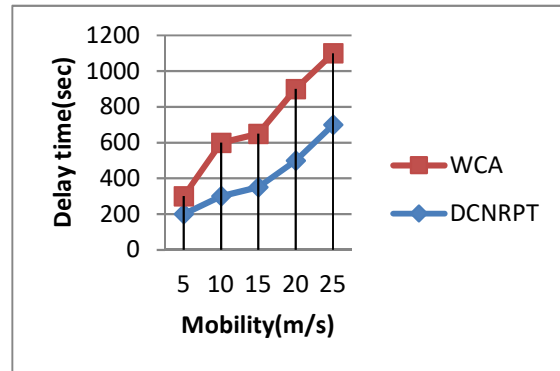


Figure 18: Delay time(sec) Vs Mobility(m/s).

In Figure.18 the proposed DCDNRPT algorithm provides better performance compared to existing WCA algorithm and also reduced delay time with mobility is increased.

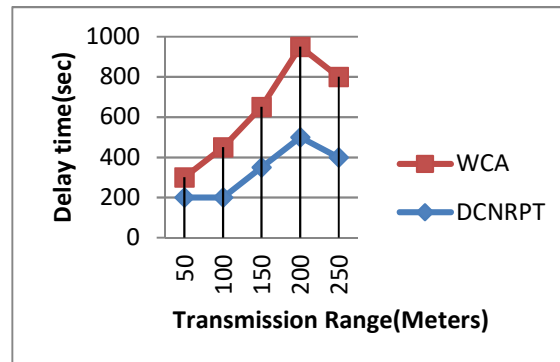


Figure 19: Delay time(sec) Vs Transmission Range(Meters).

In Figure.19 the proposed DCDNRPT algorithm provides better performance compared to existing WCA algorithm and also reduced delay time with transmission range is increased.

In Figure.20 the proposed DCDNRPT algorithm provides better performance compared to existing WCA algorithm and also reduced delay time with number of node is increased.

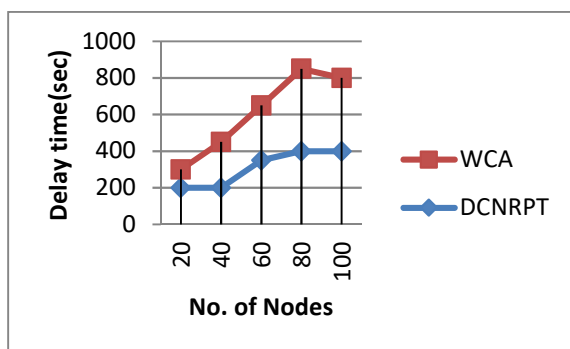


Figure 20: Delay time(sec) Vs No. of Nodes.

## VI. CONCLUSION

The implementation of MANET network maintenances is a difficult task suitable to the mobility of the nodes. This paper has proposed and demonstrated a topology generation approach that can adapt to changing mobile locations while maximizing speed, efficiency and be implemented in complex MANET networks. Analysis and results imply that DCNRPT algorithm used to better performances in the dynamically changing MANET networks compared to weighted clustering algorithm. It can be used as a base for future expansions in dynamically configurable topology designs for MANETs. Though simulated on NS2, it can be adapted to real time MANETs for increasing energy efficiency and speeds. It can be also concluded that DCNRPT is a viable technique that able to be applied to existing WCA in MANETs for upgrades and also improving packet delivery ratio, throughput, jitter and reduced delay time.

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