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Performance Analysis of Route Stability in MANET using Hidden Cluster Head (HCH) Algorithm

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Abstract : In this paper proposed new routing algorithm name Hidden Cluster Head (HCH) selection for enhance route stability in Mobile Adhoc Networks (MANET). These algorithm constructed with three phases, first phase is Primary Cluster Head (PCH) selection is based on the combination of high potential score node. Each node calculated its potential score is calculated based on the combination of node mobility, node bandwidth, node energy, and node link quality. Second phase is route node selection process;these route node selections is based on the combination of forward capacity node with in a transmission range and have sufficient transmission power to forward the packet from source to destination. Third phase is select hidden cluster head selection node (another high potential score node) before the primary cluster head go for threshold. First thresholdis warning for search the hidden cluster head selection at the time of less than 20% transmission power. Second threshold primary cluster head is handover the routing process to hidden cluster head at the time of less than 15% transmission power. The same procedure will execute hop1, hop2 and so on until reach the destination. This proposed HCH algorithm provides better performance compare to existing cluster algorithms (Single Cluster Head (SCH), Double Cluster Head (DCH), Load Balancing Clustering (LBC), andWeighted Cluster Algorithm (WCA)) and also improving throughput, remaining residual energy, and reducing end-to-end delay.

Keywords: *Primary Cluster Head (PCH), Hidden Cluster Head (HCH), Node Link Quality, Remaining Residual Energy, Throughput, MANET.*

1. INTRODUCTION

A routing protocol in Mobile Adhoc Networks (MANET) are metrics how the routers to communicate with one another and information that enables to select routes between any two nodeson a wirelessadhoc networks. Routing algorithms in MANET for determine the specific choice of route. Each route only has priorinformation of networks attached to directly it. Routing protocol shares this information first among immediate neighbours, and then throughout the wireless adhoc network.Routing protocols are created for routers. These routing protocols were designed to allow the exchange of routing tables among routers. This router learns about dynamic networks from neighbour routers or from an administrator and builds a routing table. If the adhoc networks are directly connected to the router already knows how to get in to the network. If the networks are not attached, the router must learn how to get to the remote network with either static or dynamic routing which administrator manually enters the routes in the router's table or non-static routing which happens automatically using routing protocols. Hence, to conserve the power consumption, route relaying load, battery life, and reduction in the frequency of sending control messages, optimization of the size of control headers, an efficient route reconfiguration should be considered when developing a routing protocol. The network's topology changes rapidly and unpredictably, due to the limited transmission range of wireless network nodes, multiple network hops may be needed for one node to exchange data with another across the network.

Clustering in mobile adhoc networks has become a most crucial research issue in modern research years, cause clustering can improve the system performance of MANET.Clustering has evolved as an important research topic in mobile adhoc network as it improves the system performance of large MANET. Clustering is one of the approaches for regulation of the routing processthat divides the network into smaller groups called clusters. Each and every cluster has a Cluster Head (CH) as coordinator within the small structure that divided the network into number of interconnected substructures is non-static and unstable nature of the nodes makes it difficult forthe cluster formation and constrained resources restrict the determination of clusterheads for everyone cluster.

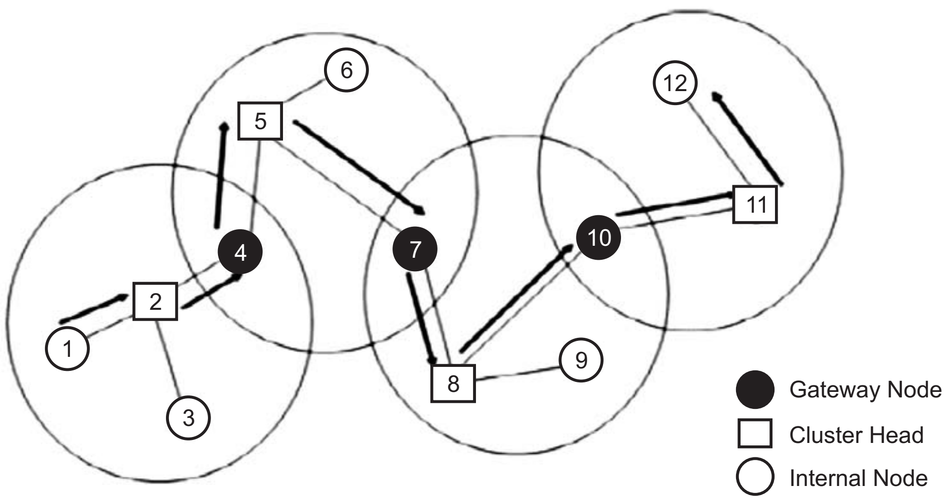

Figure 1: Cluster Formations

In fig.1clustering scheme nodes in a MANET are classified into number of groups are allocated geographically adjacent into the same cluster according to predefined rules with different behaviors for nodes included in a cluster. That cluster structure can be seen as the nodes are divided into a number of virtual groups based on certain rules under a cluster structure; nodes may be assigned a different function, such as cluster head, and cluster gateway or a cluster member. The distance between cluster head and members of the cluster will not be greater than one hop. Thus resource allocation like channel, bandwidth within the cluster is fulfilled by the cluster head. Clusterstructure facilitates the spatial reuse of resources to increase the system capacity.

2. LITERATURE REVIEW

Based on the literature review one can understand the cluster based routing protocol for the route stability in mobile adhoc networks.Route length basedanalyzed link stability for path constrained to improved routability non-static in MANET from Amine Abid, M., and AbdelfettahBelghith. (2011). Comparison of various cluster based self stabilizing algorithms in message passing model were analysed and discussed from Ba, M. and Flauzac, O. et al. (2013).Cluster density based distributed cluster algorithm for mobile adhoc networks were discussed from Christian Bettstetter, (2004).Various weighted based clustering algorithm for mobile adhoc networks were analysed from Chatterjee, M. et al. (2002).A performance analysis of novel networks improving stability and low maintenance based clustering in MANET were discussed from Conceic, L. et al, (2010).Route stability aware based multi metric clustering for mobile adhoc networks in group mobility were discussed and analysed from Hui Cheng, et al. (2008). A clustering service based route discovery protocol for mobile adhoc networks were analysed from Karunakaran, S. and Thangaraj, P. (2011). Non-static clustering algorithm based in mobile adhoc networks for modifying weighted based clustering algorithm with dynamic movement predictions were discussed from Muthuramalingam, S. et al. (2010).Performance analysis of new strategies and extension based weighted cluster algorithm for mobile adhoc networks were discussed from Mohamed Aissa, et al. (2013).Performance analysis of node quality based weighted clustering algorithm for mobile adhoc networks were discussed from Mohamed Aissa, and AbdelfettahBelghith, (2014). Distributed based weighted cluster routing protocol for MANET were studied from Naveen Chauhan et al. (2011).Stable and flexible based weighted clustering algorithm for mobile adhoc networks were studied from PandiSelvam, P. et al. (2011). Performance analysis of various routing protocol for mobile adhoc networks were studied from Prabu, K. et al. (2012). Performance analysis of energy efficient based routing protocol for MANET through edge node selection using energy saver path routing algorithm were analyzed and discussed from Prabu, K. et al (2014). Novel weighted cluster based routing algorithm for mobile adhoc network were discussed from Sunil Pathak, et al. (2015).

3. PROPOSED WORK

The main objective of this research work is to improve the route stability to find the path from source to destination by during the transmission and also increased throughput above 90%, reduced end-to-end delay below 60%, increased remaining residual energy above 50, reduced routing overhead below 60% to find the path from source to destinationbelow and mobility speed, transmission range, number of nodes increased. Our proposed routing algorithm named Hidden Cluster Head (HCH) algorithm for find the path between source and destination to improve the route stability. This proposed algorithm designed with three phases, first phase to find the primary cluster head within the transmission range based on the node high potential score. Each node calculate its potential score combination of node mobility, node link quality, node bandwidth, and node energy. Which node have high potential score compare to all other its neighbour node within the transmission range, it declare the Primary Cluster Head (PCH). Second phase choose the route for each and every hop until reach the destination. This Route Node Selection (RNS) is based on the only forward capacity node within the transmission range (or) same cluster and also maximum distance from the source node, otherwise node will be rejected. Third phase select the Hidden Cluster Head (HCH) is before primary cluster head go for threshold. This PCH set two thresholds (20% and 15% of remaining power). First threshold (20% of remaining power) is warning for search hidden cluster head node. Second threshold (15% of remaining power) is primary cluster head process handover to hidden cluster head node. The same procedure will execute hop1, hop2 and so on until reach the destination for find the path from source to destination.

The Hidden Cluster Head (HCH) algorithm isthe following phases:

Phase 1: Primary Cluster Head (PCH) selection process

A. Primary Cluster Head (P_{CH}) Selection Algorithm

// Primary Cluster Head (P_{CH}) Selection (Same Procedure follow all clusters region)

// (P_{CH}) Mobility is less than compare the other nodes is preferable

// (P_{CH}) is select based on the priority (Top priority, Medium priority, Low priority)

// Top Priority is (High Link Quality, High Energy, High Bandwidth, and Low Mobility)

// Medium Priority is (High Link Quality, High Energy, High Bandwidth, and High Mobility)

// Low Priority is (High Link Quality, Low Energy, High Bandwidth, and High Mobility)

Step 1: Send beacon signal to all neighbour nodes with in a transmission range at time t.

Step 2: All nodes calculate the potential score (N_{PS}) and send it back to all neighbour nodes within the same cluster.

Step 3: Each Node Potential score compare with other neighbour node potential score. Which node have high potential score (P_S) and also have forward node capacity, thatnode declare the primary cluster head (P_{CH}) to all other neighbour nodes with in the transmission range.

$$N_{PS} \leftarrow N_M + N_B + N_E + N_L$$

The steps are execute select the primary cluster head node based on the high potential score node. This high potential score node select based on the combination of node mobility, node bandwidth, node energy, and node link quality. Which nodes have high potential score within a range (or) same cluster compare to all other its neighbour node and also maximum distance from the source node?

Where, N_{PS} = Node Potential Score,
N_M = Node Mobility,
N_B = Node Bandwidth,
N_E = Node Energy,
N_L = Node Link quality,
N_D = Node Degree,
N_R = Node Range,
N_{FC} = Node Forward Capacity,
P_S = Potential Score,
P_{CH} = Primary Cluster Head,
and P_i = Priority of that node

3.1. Node Potential Score (N_{PS})

Calculation: Each node calculates its potential score (combination of node mobility, node band width, node energy and node link quality) mathematically as follows.

$$N_{PS} \leftarrow N_M + N_B + N_E + N_L$$

3.2. Node Mobility (N_M)

Each node calculate its mobility of the node at time T using the mathematical formula as follows,

$$N_M = \frac{1}{T}\sum_{t=1}^{T}\sqrt{(X_t - X_{t-1})^2} + (Y_t - Y_{t-1})^2$$

Where, X = X Co-ordinate,
Y = Y Co-ordinate,
T = Time interval

3.3. Node Bandwidth (N_B)

Each node calculates its bandwidth using the mathematical formula as follows,

$$N_B = CC - UB$$

Where, CC = Channel Capacity,
UB = Utilized Bandwidth

3.4. Node Energy (N_E)

Each node calculates its energy as mathematically follows,

$$N_E = I_E - C_E$$

Where, N_E = Node Energy,

I_E = Initial Energy,

C_E = Consumed Energy

3.5. Node Link Quality (N_L)

Each link between the two nodes calculates its link quality using the mathematical formula follows,

$$N_L = MD_t - MD_{t-1}$$

Where, MD = Mean Distance between a Node,

t = time

Phase 2: Route Node Selection(RNS) Process

3.6. Routing Node Selection (RNS) Algorithm

// Node have Forward Capacity and present within Range or same cluster

// (Node move towards destination is more preferable).

// Node present Maximum distance from Source node and have Sufficient Transmission

// Power of that transmission alone, and that node is already participate in election at any one

// cluster range (to avoid malicious node)

BEGIN

if node N_i have F_C

then {

ifN_i within Range || Same cluster

then {

ifN_i Present Max distance from SourceS

then {

ifN_i have Sufficient T_P

then {

if$N_i$already participate in cluster election in any one cluster

{

Add F_N (N_i)

else

Reject N_i

} } } } }

STOP

Where F_N = Forward Node,
S = Source Node,
N_i = NodeI,
F_C = Forward Capacity,
Max = Maximum Transmission Range,
T_P = Transmission Power

3.7. Forward Capacity Node (F_C)

When a sender broadcasts a packet, then based on the greedy approach, it selects a subset of 1-hopneighbors as its forwarding nodes to forward the packets. Node N1 assigns a weight to each of its neighbor which represents the combination of neighbor's battery lifetime and its distance to N1. For a neighborh1 of N1, the weight can be determined by the following equation:

$$F_C = BL_{h1} + D_{h1}$$

Where, F_C = Forward Capacity Node,
BL_{h1} = is the battery lifetime of h1,
D_{h1} = is the distance of h1 (neigh) from node N1.

3.8. Transmission Range (T_R)

Transmission range is thus calculated mathematically by using the following formula:

$$T_R = \sqrt{\frac{nd_d / nd_c}{\text{Coverage Area}}}$$

Where, T_R = is Transmission Range,
nd_d = is the desired node degree,
nd_c = is the current node degree,
Coverage area = equals the area covered by the environment.

3.9. Transmission Power (T_P)

Transmission power for transfer the packet from source to destination node at time interval *t* to mathematically calculated as follows:

$$T_P = \frac{T_x}{T_t}$$

Where T_P = is Transmission Power,
T_x = is transmission Energy,
T_t = is time taken to transmit data packet.

In the above methodology diagram process for route node selection based on the forward node capacity within the transmission range and also maximum distance from the source node have sufficient transmission power for find the path from source to destination until reach the destination. Other node will be rejected. The same procedure for route node selection to find the path from source to destination for hop1, hop2, and so on until reaches the destination.

Phase 3: Hidden Cluster Head(HCH) Selection Process

// P_{CH}Need to sleep due to low energy, have very low batter backup, and also need to select supporting node to further transmission.

// P_{CH} act as an Election Coordinator.

// Top Priority is (Low Mobility, High Energy, High Bandwidth, High Link Quality, HighDegree)

// Medium Priority is (High Mobility, High Energy, High Bandwidth, High Link Quality, Low Degree)

// Low Priority is (Low Mobility, High Energy, High Bandwidth, High Link Quality, High Degree)

Step 1: Check P_{CH}Threshold (T_{H1}) is less than 20% Energy.

Then

P_{CH} Send beacon signal to all other nodes present their range at time t.to calculate potential score P_S

Step 2: All nodes calculate potential score $P_{S.}$

$$N_{PS} \leftarrow N_M + N_E + N_B + N_L + N_D$$

and send it back to P_{CH}based on the priority.

Step 3: Check P_{CH} Threshold $T_{H2}$is less than 15% energy & enter into safer mode.Ifannounced Hidden Cluster Head (H_{CH}) to all nodes present in the same cluster in the same range.

Step 4: P_{CH} Go to sleep state.

Step 5: H_{CH} Activated with P_{CH} backup info.

Step 6: Stop

3.10. Pseudo code for Hidden Cluster Head (H_{CH}) Selection

Start

// Check P_{CH} Remaining Energy at time t

if ($P_{CH}E < T_{H1}$)

then

send beacon signal to all nodes in the transmission range. Node calculate N_{PS}

$$N_{PS} \leftarrow N_M + N_E + N_B + N_L + N_D$$

Each node return (N_{PS}) to $P_{CH.}$

// P_{CH} set priority for all nodes with using priority rules (High, High, High, High, Low)

if ($P_{CH}E < T_{H2}$) // P_{CH} E check remaining energy at 'd_t' time.

Then

P_{CH} arrange the remaining node present in the same cluster in descending order using N_{PS}

N_{PA} [Top] ← Max N_{PS} Node

$$H_{CH} \leftarrow N_{PA}[\text{Top}]$$

Announce (H_{CH}) to all Neighbour nodes in same cluster

Active (H_{CH}).

P_{CH} go to sleep mode (or) energy saver mode.

end if.

Call F_{NA} (Forward Node Algorithm).

end if.

Stop.

Where T_{H1} = Threshold 1,
T_{H2} = Threshold 2,
H_{CH} = Hidden Cluster Head,
N_D = Node Degree,
P_{CH} E = P_{CH} Energy

In the above pseudo codewill execute based on the threshold value, first check the remaining energy at time interval *t*. If primary cluster head value is less than first threshold (below 20% of remaining energy) value choose the next high potential score node for select next primary cluster head (*i.e*. hidden cluster head node) node based on the combination of node mobility, node link quality, node bandwidth, node energy, and node degree and also choose PCH based on the priority level (top priority). If primary cluster head less than second threshold (below 15% of reaming energy) primary cluster head handover the process to hidden cluster head based on the top priority within the range and also maximum distance from source node declare that node announce as a hidden cluster head node otherwise node will be rejected. The same process will execute hop1, hop2, and so on until reach the destination.

4. SIMULATION RESULT AND ANALYSIS

The performance of the proposed scheme is evaluated using Network Simulator version 2 (NS2). Some of the basic assumptions made for the simulations are the mobile adhoc networks works in a secure environment and thus not prone to any sort of attack, each of the mobile nodes has a maximum battery power that a mobile node in a MANET could offer since it has to be used in the military battlefield which may require a high backup to sustain for a longer duration of each and every node has enough memory to store a copy of the token being circulated. Since any node can become a primary or secondary cluster head has to recover the token and circulate it under situations of token loss. With the assumption of the following parameters are chosen for the simulation environment.

Table 1
Simulation Parameters

Parameters	*Values*
Simulation	NS-2
MAC Layer Protocol	IEEE 802.11
Mobility Model	Random Waypoint
Node Random	Uniform
Terrain Range	1,000 X 1,000 m2
Transmission Range	250 Meters
Examined Routing	HCH
Channel Bandwidth	2 Mbps
Speed	5-25 m/s
Application Traffic	CBR
Simulation Time	1000 *s*
Propagation mode	Free space
Data Packet size	512 bytes
Packet rate	2 packets/*s*
No. of mobile nodes	20 – 100
Contention interval	6 *s*
Hello Packet size	256 bytes
Hello interval	0.2 – 0.8 *s*

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

1. **Throughput :** Throughput is the number of bytes or bits per seconds arriving at the time interval *t*. It is generally measured by (kbps) or (mbps).

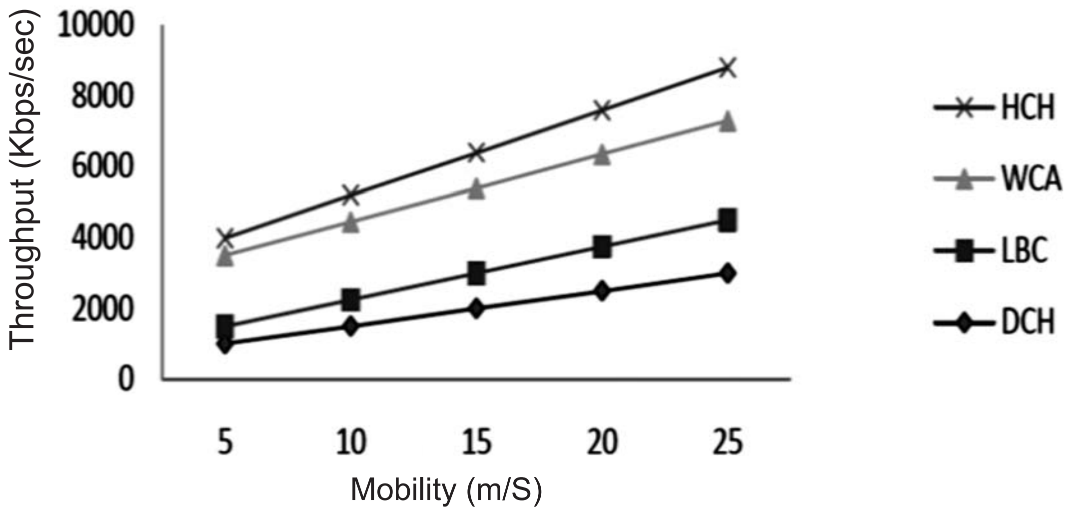

Figure 2: Throughput (Kbps) Vs. Mobility (m/s)

In Fig. 2 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased throughput with mobility is increased.

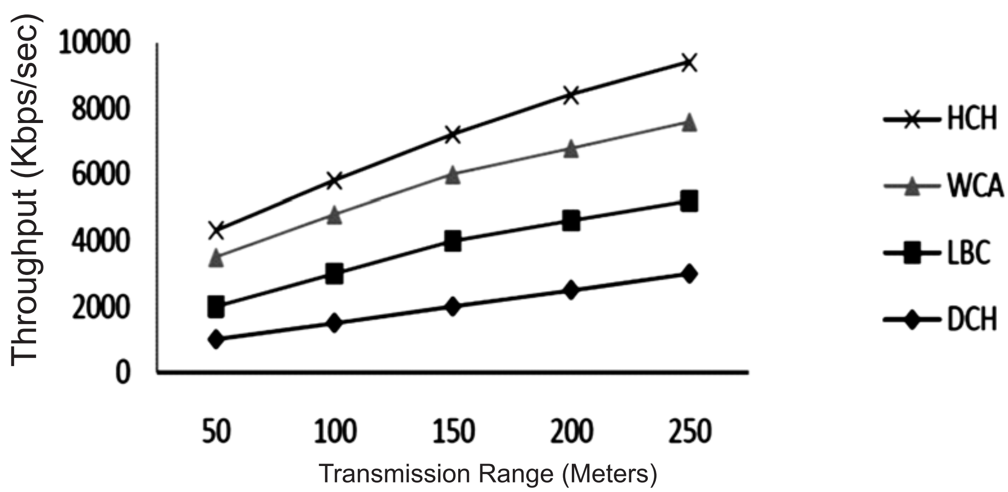

Figure 3: Throughput (Kbps) Vs. Transmission Range (Meters)

In Fig. 3 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased throughput with transmission range is increased.

In Fig. 4 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased throughput with number of nodes increased.

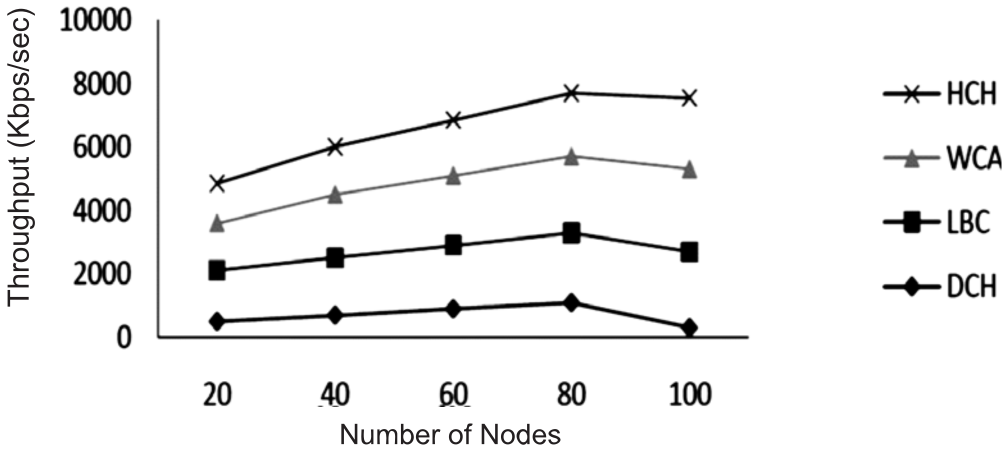

Figure 4: Throughput (Kbps) Vs. Number of Nodes

2. End-to-End Delay : Delay is number of bytes or bits per seconds at time interval *t*.

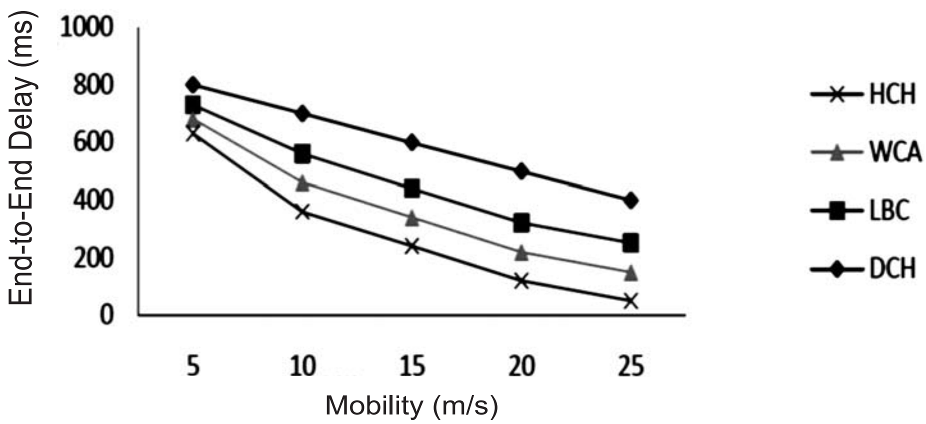

Figure 5: End-to-End Delay (ms) Vs. Mobility (m/s)

In Fig. 5 the proposed HCH algorithm provides better performance compare to existing algorithm and also reduced end-to-end delay with mobility is increased.

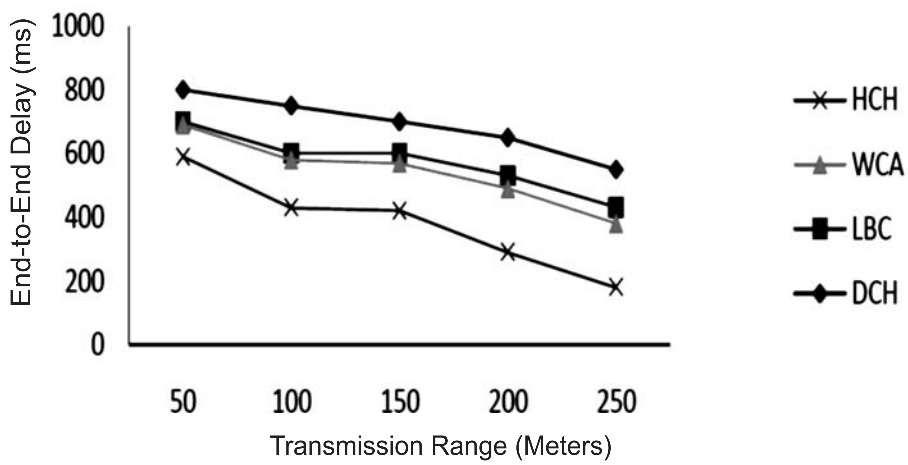

Figure 6: End-to-End Delay (ms) Vs. Transmission Range (Meters)

In Fig. 6 the proposed HCH algorithm provides better performance compare to existing algorithm and also reduced end-to-end delay with transmission range is increased.

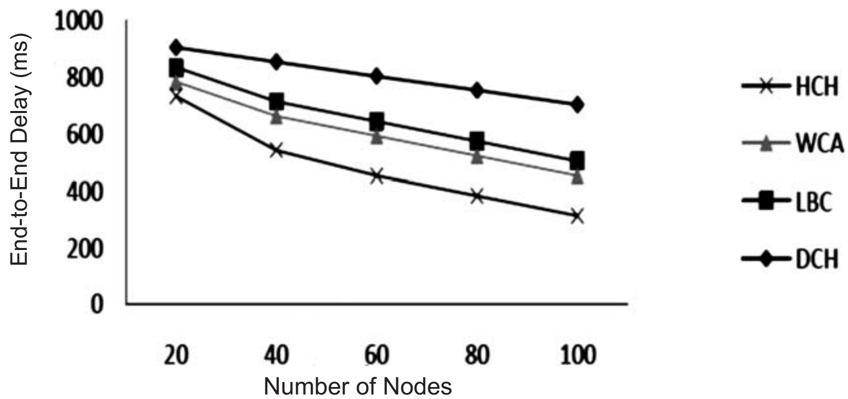

Figure 7: End-to-End Delay (ms) Vs. Number of Nodes

In Fig. 7 the proposed HCH algorithm provides better performance compare to existing algorithm and also reduced end-to-end delay with number of nodes increased.

3. **Remaining Residual Energy:** Remaining energy will be calculates at the time interval *t*.

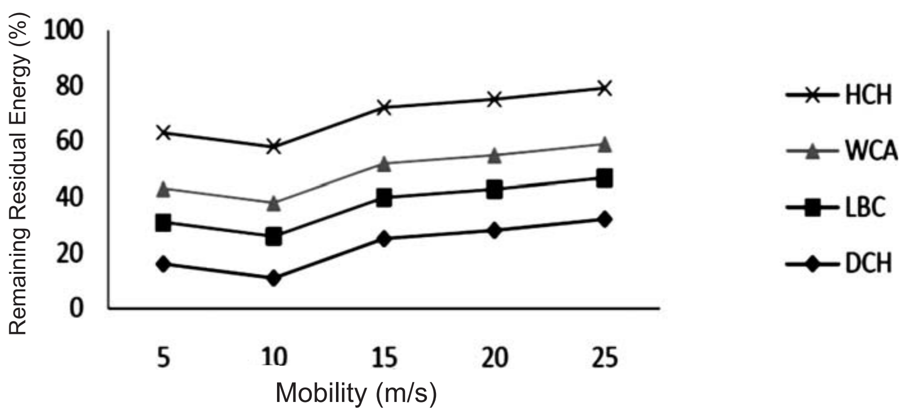

Figure 8: Remaining Residual Energy (Kbps) Vs. Mobility (m/s)

In Fig. 8 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased remaining residual energy with mobility is increased.

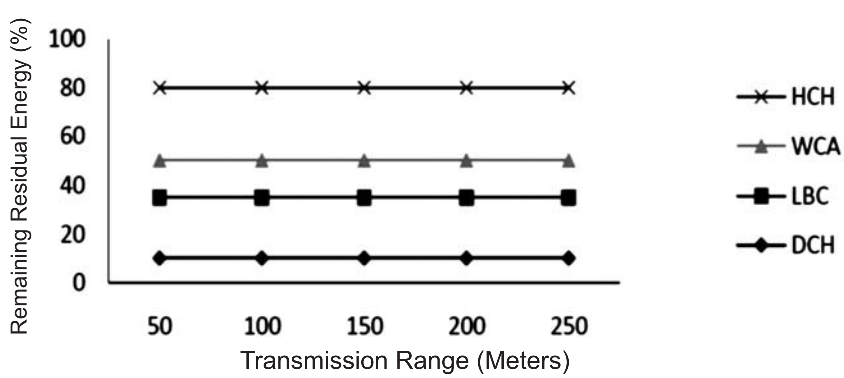

Figure 9: Remaining Residual Energy (Kbps) Vs. Transmission Range (Meters)

In Fig. 9 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased remaining residual energy with transmission range is increased

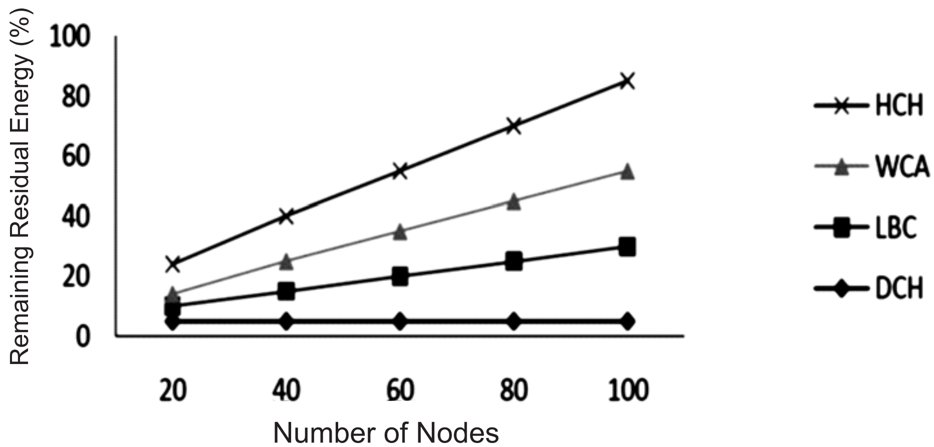

Figure 10: Remaining Residual Energy (Kbps) Vs. Number of Nodes

In Fig. 10 the proposed HCH algorithm provides better performance compare to existing algorithm and also increased remaining residual energy with number of nodes increased.

5. CONCLUSION

In this paper proposed new routing algorithm named Hidden Cluster Head (HCH) selection to enhance the route stability for MANET. This HCH construction is based on the three phase. First phase is select the Primary Cluster Head (PCH) is based on the combination of node mobility, node bandwidth, node energy, and node link quality. Second phase is route node selection is based on the forward capacity node within the transmission range and has maximum transmission power for each and every hop until reach the destination. Third phase is select HCH node, another high potential score node compare to its neighbour node before primary cluster head go for threshold. This HCH is set two thresholds, first threshold is warning for search HCH node at the time of less than 20% of transmission power. Second threshold is handover the routing process to HCH node at the time less than 15% of transmission power. This proposed HCH algorithm provides better performance compare to existing cluster algorithms (Single Cluster Head (SCH), Double Cluster Head (DCH), Load Balancing Clustering (LBC), and Weighted Cluster Algorithm (WCA)) and also improving throughput, remaining residual energy, and reducing end-to-end delay.

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