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CLUSTER BASED MOBILITY MANAGEMENT ALGORITHMS FOR WIRELESS MESH NETWORKS

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Abstract:
Wireless mesh networks (WMNs) contain the modernadvancementwith attracting additional academicianas well asindustrialiston behalf of their flawless connectivity toward the internet. Radio sourcebeindividualamongst the major resources during wireless network, which belikely to utilizeintoanwell-organizedmannerparticularlyas the mobile nodes beon top of move. Though, on condition thatassured quality of service toward the mobile nodes within the network be a toughproblem. To complete this, we propose 2 cluster algorithms, specifically, static clustering algorithm designed for WMNs with dynamic clustering algorithm meant for WMNs. In these algorithms, we propose a novel weight-based cluster head in addition to cluster portioncollectionprocedure for the development of clusters. The weight of the nodes within WMN be computed allowing for the parametercontain the bandwidth of the node, the amount of node connectivity, and node collaborationaspect. Further, we as wellrecommendimproved quality of service enable routing protocol for WMNs in view of the delay, bandwidth, hopcount, and probable transmission count are the routing metrics. The presentation of the proposed clustering algorithms with routing protocol beanalyze, and outcomedemonstrate high throughput,

high packet deliverance ratio, and low communication chargecomparethrough the existing baseline mobility management algorithms and routing protocols.

1.1 INTRODUCTION

In this paper, to tackle the mobility management issues, static clustering algorithm for WMNs (SCAW) and dynamic clustering algorithm for WMNs (DCAW) are proposed. The objectives of clustering are to utilize the network resources efficiently and reduce the total number of wireless links for the communication especially when the MC is on move. The architecture of cluster based WMN is shown in Fig 1.1. In this approach, the MRs are grouped to form the clusters. One node is chosen as a cluster head (CH) among them. To select the CH, a weight - based mechanism is used.To determine the node's weight, the available bandwidth, degree of connectivity, and cooperation factor are used. If MC moves between MRswithin a cluster, only CH will receive the location update.If MC moves between MRsof different clusters, then GW will receive the location update.

.The proposed SCAW, DCAW and EQER are analyzed and improvement in throughput, packet delivery ratio and communication costs is observed when compared to the baseline algorithms and routing protocols for WMN.

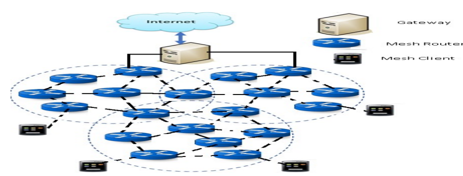

Fig 1.1: Clustering of nodes in WMNs

1.2 PROPOSED MOBILITY MANAGEMENT ALGORITHMS

Management of mobility includes the process of admission control and handoff. The process of admission control monitors and controls new connections to the mesh client in the WMN.The handoff process deals the present ongoing connections of mesh clients and provides the support needed for the already admitted mesh clients to move from one MR to another smoothly. This section describes system model, selection of cluster heads, proposed algorithms for mobility management and protocols for routing.

1.2.1 CLUSTER HEAD SELECTION

The mesh routers begroup into cluster. Cluster member with cluster head selection bebaseon top of node weight.The node weight be calculated as of the node's amount of connectivity, obtainable node bandwidth, with node support factor in addition tobegiven awaywithin Algorithm 1.1.Each WMN node's weight is calculated using the equation (1.1). It's a three - parameter function.

$W(v) = \alpha \times D(v) + \beta \times CF(v) + \gamma \times BW(v)$ (1.1)

The parameter $D(v)$ represents the amount of connectivity of the node also it is the number of connections present with other nodes. The parameter $CF(v)$ represents the cooperation factor of the node and is calculated from the relative amount of quantity of packet forwarded on behalf of other nodes to number packets received. The parameter $BW(v)$ represents existing bandwidth of the node and becompute using equation (1.2). The parameter $W(v)$ represents the weight of the node. The scaling factors are represented by α, $\beta$and γ. The parameter $BW_T(v)$ represents the entire bandwidth assigned to the node with$BW_u(v)$ represents the bandwidth utilized by the node.

$BW(v) = BW_T(v) - \sum_{v \in D(v)} BW_u(v)$ (1.2)

Algorithm 1.1: Cluster head selection

Step1: if node v have the utmost weight then

Step2: choose v as CH

Step3: modify cluster head IP by node v IP

Step4: transmit Hello message {IP_v, CH-IP_v , W(v), BW_u(v)}

Step5: end if

1.2.2 CLUSTER FORMATION

Each node sends Hello messages at regular intervals to their neighbors in order to know the neighboring node information. This information about the neighboring node is important for the clusters to form. The Hello message packet format is shown in Figure 1.2. With this Hello messages nodes can know their neighbors and keep their information like QoS parameters, weight etc.

Sender Node IP	QoS requirement	Weight of the node

Figure 1.2: Format of Hello message

The format of the neighbor table is shown in Figure 1.3.If the node meets the QoS requirements, it will forward this Hello message to its neighbors and continue this process until it meets the ETX requirements and distance requirements and is represented by equation (1.3) and (1.4).

Node IP	Weight of the node	QoS parameter

Figure 1.3: Format of neighbor table

The nodes so as to meet these QoSconstraintbe chosen as cluster member. As a cluster head, the cluster member with the maximum node weight be selected.

$\sum_{n=1}^{N} d(MR_{i,} MR_{i+1}) + d(GW + MR_i) \leq d_{max}$ (1.3)

$\sum_{n=1}^{N} ETX(MR_{i,} MR_{i+1}) + ETX(GW + MR_i) \leq ETX_{th}$(1.4)

1.2.3 STATIC CLUSTERING ALGORITHM MEANT FOR WMNS:

The mesh routers of communications WMN begroup to form static clusters. Each node should be at least one cluster member. A node through the maximum weight be chosen like a head of the cluster.To manage mobility and simplify routing, every cluster beheadvia a node call the cluster head. The cluster - based WMN architecture

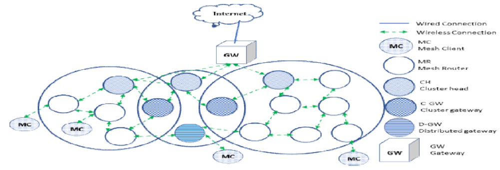

Figure 1.4: Cluster management in WMN

Consider an internet flow in a cluster based WMN infrastructure to illustrate the mobility management and routing process. If MC requests an internet session, the request to which it is attached will be forwarded to MR first.The MR in turn relays this request to CH. Then CH forwards this request to GW. As GW stores the addresses of all CMs and their CHs, it finds the path between the GW and CH of MR satisfying QoS requirements. The GW sends the data packets to CH of the requested MR. CH is now responsible for delivering the data packets via multi - hop communication to the intended MC.

1.2.4 DYNAMIC CLUSTERING ALGORITHM MEANT FOR WMNS

Dynamic clustering algorithm forms virtual clusters with MRs, unlike static clusters in SCAW. Assume that a mesh customer raises an internet service request under the MR to which it is currently connected.Now, the MR is sending this internet access request to GW and informing the GW to update its status as MC's cluster head.

For the first time, the information packetproposedused for MC beintercepthrough GW and forwarded to CH for delivery to MC.The weight of the novel MR and the previous MR, the ETX with the distance values of the paths between the GW - CH - MR and GW - MR are compared when MC is moving and there is a change in the attachment point.Based on MR weight, ETX and path distance values are performed either by CH registration or by GW registration. If the equations from (1.5) to (1.8) are satisfied, the GW registration will be triggered.

$W(new\ MR) > W(old\ MR)$ (1.5)

$ETX(MR, CH) \geq ETX(GW, MR)$ (1.6)

$ETX(MR, CH) + ETX(GW, CH) \geq ETX_{th}$ (1.7)

$d(MR, CH) \geq d(GW, MR)$ (1.8)

For instance, it is assumed that MC is under MR1. So, MR1 is considered as cluster head. If MC moves to MR2 it checks the equations from 1.5 to 1.8. If they are not staisfied, then MR2 is set as cluster member and MR1 continues as a cluster head for MC. This process continued to MR3 and MR4. If MC enters into MR5 and if the equations from 1.5 to 1.8 are satisfied, then MR5 is elected as cluster head for the MC. The dynamic clustering algorithm be presened within algorithm 1.2

Algorithm 1.2: Dynamic clustering algorithm for WMN	
Step1:	if (mesh clients go in vicinity of original MR)
Step2:	if $\{W\ (new\ MR)\ >\ W\ (old\ MR)\}$
Step3:	if $\{ETX\ (new\ MR, CH)\ >\ ETX\ (GW, new\ MR)$ &

$ETX\ (new\ MR, CH)\ >\ ETX\ (GW, CH)\ \geq\ ETX\ thresh\ \}$

Step4: if $\{d\ (GW,\ new\ MR)\ >\ d\ (GW, new\ MR)\}$
Step5: execute GW update
Step6: Reset Cluster Head throughoriginal MR
Step7: else
Step8: place the new node like CM
Step9: end if
Step10: end if
Step11: end if
Step12: end if

1.3 PROPOSEDQoSBASED ROUTING PROTOCOL FOR WMNs

A QoS - enabled routing protocol based on Ant colony called enhanced QoS enabled routing protocol (EQER) is also proposed in this work.To determine the best path between source MR and destination MR, the proposed routing protocol considered bandwidth, end - to - end delay, hop count and ETX as QoS parameters.If a source MR wants to send the data packets to destination MR, source MR will generate Forward Ants (FANTs) to determine the multiple paths to destination MR that meet the QoS requirements.The source only broadcasts the FANTs to the neighbours selected. The selection of neighbours is based on the availability of Next Hop (NHA). A node's NHA is determined by its factor for cooperation.The source broadcast the FANTs to the nodes with $NHA \geq\ NHA_{Th}$. The value NHA_{Th} represents the threshold value of NHA. The NHA is calculated from the equation (1.9).

$$NHA =\ \ C \quad (1.9)$$

The cooperation factor is calculated from the number of packets sent on behalf of other nodes to the number of packets received. The FANTs broadcast message fields is shown in Figure 1.5.

Figure 1.5: Packet format of FANT

SA: Source address
DA: Destination address
SN: Sequence number
HC: Hop count
BW: Bandwidth
ST: Start time
PF: Path field

SA	DA	SN	HC	BW	ETX	ST	PF

At the intermediate node, destination MR address is checked. If found discard the FANTs broadcast message. If not, add its address field in the path field of broadcast message and retransmit to the next node which satisfy the NHA criteria. When FANTs passing through each intermediate node, the information such as link delay, processing delay, link ETX, link bandwidth, path bandwidth and the number of hops visited. During this process FANTs set a pheromone of the path based on the QoS parameters. From the collected QoS information the parameters of the paths are calculated as follows. The sum of each ETX of link that constitute the path is called total $ETX$of the pathand is given by equation (1.10)

$$ETX_{p(i,j)} = \sum_{k=i}^{j} ETX(k) \quad (1.10)$$

The parameter end to end interruption of the path 'i' is determined since the equation (4.11)

$$d_{p(i,j)} = \sum_{e \in p(i,j)} d_e + \sum_{n \in p(i,j)} d_n \qquad (1.11)$$

Where $BW_{p(i,j)}$ represents the bandwidth of a path between node i with j, the parameter BW_erepresents the link bandwidth. The path ' i ' hop count be determined as of the equation (1.13) and be the amount of nodes within the path

$$.h_{p(i,j)} = \sum_{i=1}^{j} n_i \quad (1.13)$$

Bandwidth parameter is a concave metric. The parameters end to end delay, hop count and ETX be additive metrics. The integrity of these parameter is determined from equations (1.14) during (1.17)

$$d_g = \frac{D_T - D_C}{D_T} \times 100 \qquad (1.14)$$

$$BW_g = \frac{BW_C - B_{WT}}{B_C} \times 10 \qquad (1.15)$$

$$h_g = \frac{h_T - h_C}{h_T} \times 100 \qquad (1.16)$$

$$ETX_g = \frac{ETX_T - ETX_C}{ETX_T} \times 100 \quad (1.17)$$

The destination MR till it receives all the FANTs over a time T_w. Destination MR segregates the received information of different paths between source MR and destination MR. The destination MR calculates the path preference probability $P(i)$ for the path ' i ' on the basis of these values and is represented in the equation (1.18)

$$P(i) = \frac{(h_g\, BW_g\, d_g\, ETX_g)_i}{\sum_{j \in p_i} (h_g\, BW_g\, d_g\, ETX_g)_j} \quad (1.18)$$

The destination MR generates Backward Ants (BANTs) for paths with a path preference probability greater than the threshold value. The BANTs packet format is displayed in Figure 1.6.

Destination address	Original Source address	Start time	Received path field	Path preference probability

Figure 1.6: Packet format of BANT

The pheromone chargebemodernized as $T_{j,i}$in the reverse path from destination MR to source MR, as of node $j$towards$i$ at the intermediary node (m) and given in equation (1.19)

$$T_{m,i} = \left(1 + T_{m,i}\right) P(i) \quad (1.19)$$

The value of pheromone is decreased by ρ if data transmission is not successful over a finite time interval T_{deacy}. and it is given in equation 1.20.

$$T_{ij} = \begin{cases} (1-\rho) & if\ 0.1 < (1-\rho) T_{ij} \le 1 \\ 1 & if\ (1-\rho) T_{ij} > 1 \\ 0.1 & Otherwise \end{cases} \quad (1.20)$$

If the link be broken or lost, then the pheromone value of the link is considered as zero.

1.4 SIMULATIONS & RESULTS DISCUSSION

The proposed algorithms and routing protocol are analyzed using the NS2 simulator. Table 1.1 shows the simulation parameters. Network performance is tested for parameters such as throughput, total communication costs, packet delivery ratio, number of HELLO messages, route request messages, route response messages and route discovery time.

Table 1.1: Simulation parameters for EQER, SCAW,DCAW

Parameters	**Value**
Simulation Time	400s
Number of nodes	25

CBR packet size	512 bytes
CBR packet interval	20 ms

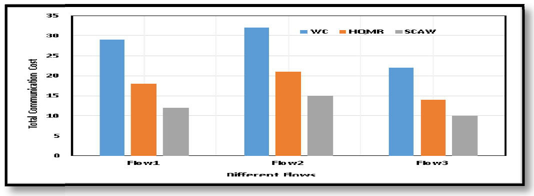

Figure 1.7.The total communication cost of the SCAW

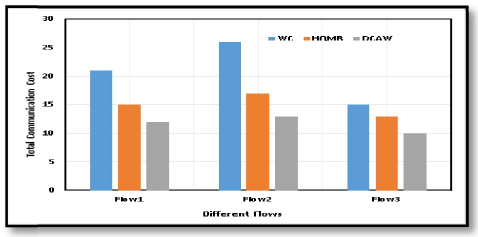

Figure 1.8.The total communication cost of the DCAW

Hello messages, throughput and packet delivery ratio.RREQ messages with number of nodes is shown in Figure 1.9. It is observed that the RREQ messages are increased with the increase in number of nodes. In EQER, many RREQ messages are sent towards the objective MR to locatefinest path. But, in the proposed EQER protocol, merely the objective MR is authorized to transmit the RREP point.

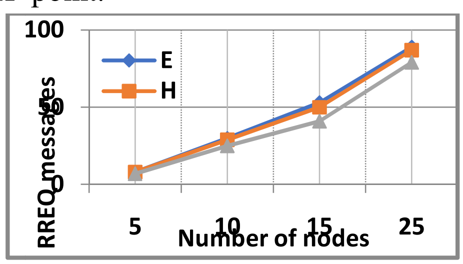

Figure 1.9: RREQ messagesof EQER

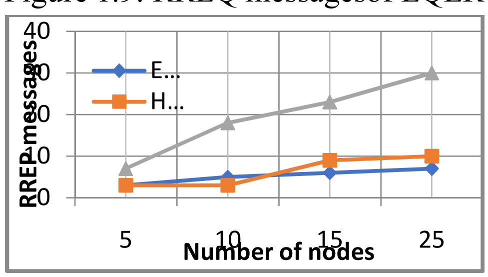

Figure 1.10: RREP messagesof EQER

Figure 1.11 shows EQER's Hello messages. Compared to AODV and HQMR, the proposed EQER is recorded with low Hello messages.In AODV, a new route that causes more generation of Hello messages should be determined whenever MC changes its attachment point. In the proposed EQER protocol, the formation of clusters with MRs reduces the number of Hello messages.

Route discovery time is analyzed as the number of nodes increases and is shown in Figure 1.12. It increases as the number of nodes increases.Compared to base line routing protocols HQMR and AODV, the proposed EQER spends a little bit of time finding the path between source MR and destination MR.Network throughput is analyzed as the number of nodes increases and is shown in Figure 1.13. It decreases as the number of nodes increases. Compared to base line routing protocols HQMR and AODV, the proposed EQER records high throughput.

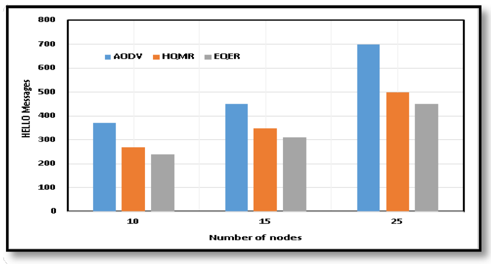

Figure 1.11: HELLO messages of EQER

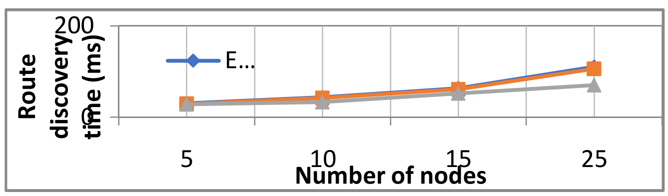

Figure 1.12: Route discovery time of EQER

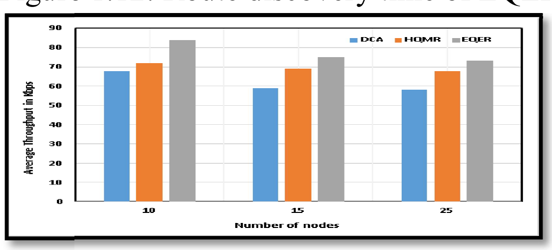

Figure 1.13: Average throughput of EQER

The packet delivery ratio is analyzed as the number of nodes increases and shown in Figure 1.14. It decreases as the number of nodes increases. It is high compared to base line routing protocols HQMR and AODV, the proposed EQER.

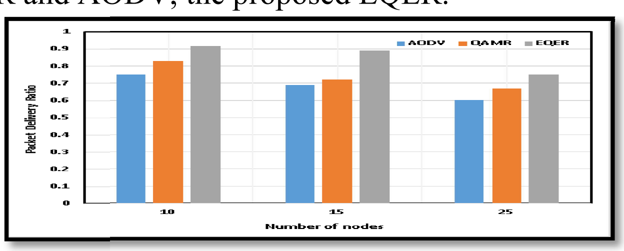

Figure 1.14: Packet delivery ratio of EQER

1.5 SUMMARY

two clustering algorithms are proposed for mobility managingspecifically, static clustering algorithm used for WMNs along with dynamic clustering algorithm used for WMNs. An ant colony based routing protocol called improvedQoSenable routing (EQER) protocol meant forWMNs is also proposed. In the proposed algorithms, a weight based cluster head selection is presented. A node by means ofelevated weight is electedwhen a cluster head as well as the other nodes are cluster members. The node weight is computeallowing for the parameters such as the available bandwidth of the node, the degree of node connectivity, with node collaborationfeature. The parameter such asdelay, ETX, hop count and bandwidth are consideredon the way tolocate the most excellent path in the proposed routing protocol.Improvement in route discovery time, route request messages, route reply messages, packet delivery percentagewithstandard throughput is observed ascompare to the WC, DCA, HQMRalong with AODV protocols. The average total communication cost of DCAW
(9.66) is reduced by 35.6% compared to HQMR (15). The average throughput of EQER (77.33 Kbps) is increased by 11.5 % compared to HQMR (69.33 Kbps). The average packet delivery ratio of EQER (0.85) is increased by 16.43 % compared to HQMR (0.73).

REFERENCES:

Amir, Y., Danilov, C., Hilsdale, M., Musˇaloiu-Elefteri, R., and Rivera, N.,"Fast handoff for seamless wireless mesh networks", MobiSys'06: Proceedings of Fourth international conference on Mobile systems, applications and services, pp. 83–95, 2006.

Aoun Bassam, Raouf Boutaba, Youssef Iraqi, and Gary Kenward. "Gateway placement optimization in wireless mesh networks with QoS constraints", IEEE Journal on Selected Areas in Communications, Vol.24, no. 11, pp. 2127-2136, 2006.

M. Sabeur, G. A. Sukkar, B. Jouaber, D. Zeghlache, and H. Afifi. "Mobile party: A mobility management solution for wireless mesh network", Third IEEE International Conference on Wireless and Mobile Computing, Networking and Communications, pp.45–53, 2007.

Zhao, W. and Xie, J. "IMeX: Intergateway Cross-Layer Handoffs in Internet-Based Infrastructure Wireless Mesh Networks", IEEE Transactions on Mobile Computing, Vol. 11, Issue 10, pp. 1585-1600, 2012.

Majumder, A. and Roy, S., "A Forward Pointer Based Mobility Management Scheme for Multi-Hop Multi-Path Wireless Mesh Network", International Conference on-Data-Science & Engineering (ICDSE),pp.194-197, 2012.

Majumder, A., Roy, S. and Kumar Dhar K. "Design and Analysis of an Adaptive Mobility Management Scheme for Handling Internet Traffic in Wireless Mesh Network", Annual International Conference on Emerging Research Areas and International Conference on Microelectronics, Communications and Renewable Energy,pp.1-6, 2013.

Abhishek Majumder and Sudipta Roy, "Design and analysis of a dynamic mobility management scheme for wireless mesh network", The scientific world journal, vol.7, no.5, pp.546-556, 2013.

Majumder, A. and Roy, S, "A Tree Based Mobility Management Scheme for Wireless mesh network", Second International Conference on Emerging Technology Trends in Electronics, Communication and Networking, 2014.

A.Majumder, S.Roy, "Implementation of enhanced forward pointer-based mobility management scheme for handling internet and intranet traffic in wireless mesh network", Telecommunication Systems, Vol. 66, No. 2, pp. 1-24, 2017.

George Athanasiou and Leandros Tassiulas, "Design and implementation of distributed load balancing and fast handoff for wireless mesh networks", Transactions on Emerging Telecommunications Technologies, vol. 26, no. 4, pp. 630-649, 2013.

Yin, H. , Haibo Ni, Liang Sun, Mingxuan Wang and Xun Zhou, "A caching-list based fast handoff mechanism in wireless mesh networks", 2013 International Conference on-ICT-Convergence (ICTC), pp.402-407, Jeju, 2013.

Khasawneh, F.A., BenMimoune, A., Kadoch, M. and Osama, S.B. "Intra-Domain Handoff Management Scheme for Wireless Mesh Network", Proceedings of the 12th ACM International Symposium on Mobility Management and Wireless Access, pp. 9-13, 2014.