A RELIABLE NODE CLUSTERING ALGORITHM FOR MOBILE AD HOC NETWORKS

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Abstract

Wireless technologies gained great popularity for the past two decades. Laptop and smart phones are some wireless devices and being essential for our daily lives. Wireless Adhoc Network(WANET) or Mobile Adhoc Network(MANET) is a decentralized type of Wireless Network whereas mobile nodes joined without having any pre-established infrastructure or any other kind of fixed stations. Due to this nature of mobility and lack of authorization facilities, MANET may compromise by any malicious activities easily. Therefore handing over reliable and efficient data transfer is very crucial. Clustering is a process where nodes are divided into several groups as to increases scalability and to decreases network overhead. This paper proposed an algorithm namely Weight Based Clustering Algorithm (WBCA) towards to form reliable clusters of trusted nodes only as to sustain stability and flexibility of the network. Experiment results expose that the proposed clustering algorithm produces reliable clusters than Weight Clustering Algorithm (WCA) over some set of simulation scenarios.

Keywords: AdHoc Networks, Clustering, Clustering Algorithms and NS2

1. Introduction

MANETs are an autonomous system of wireless networks and gaining much attention in recent years. There is no such infrastructure exists in this network and hence mobile nodes are highly dynamic. Due to this unstable nature, nodes may change their topology independently and unpredictably [1]. As a result MANETs are more prone to physical security than wired networks. However, ad hoc network suitable for variety of real world applications such as emergency rescue, law enforcement, disaster relief, mobile conferencing and battle field communications. Generally, flat routing structure requires excessive information and may introduce delay for large network[2]. These spontaneous issues affect network performance predominantly. Such problem can be reduced while big networks divided into small clusters. Clusters are small virtual logical groups for providing stability to the network in an efficient manner. Clustering is a hierarchical structure plays an effective technique for node management in a MANET[3][4]. Each cluster comprised with Cluster Head(CH), Cluster Gateway(CG) and Cluster Member(CM). CH is a superior node and acts as administrator of the cluster. A cluster can have only one CH at a time as to maintain data forwarding, intra-cluster transmission and managing CMs are major role of CHs. A CG is a member of the cluster which responsible is to concatenate two or more clusters. Rest of the

nodes is members of the clusters they can communicate with each other through its corresponding cluster head. Due to the irregular fashion of nodes and hence unpredictable mobility, nodes may dynamically change their structure frequently. Therefore, developing reliable clusters for long duration is a difficult and critical task [5][6][7]. In this paper, Cluster formation involves by using Weight Based Clustering Algorithm (WBCA) to elect suitable node as CH and to control all other nodes in the network. In our approach reliability characterization divided into three categories such as Reliability on Cluster formation, Reliability on Mobile Coverage and Reliability on Communication [17-20]. The rest of this paper is organized as following subsections. Section 2 talks about the related works that are proposed recently. In section 3 the proposed clustering algorithm explained in detail. Simulation environment study is contented in section 4. Obtained results and its discussions are in illustrated Section 5 and conclusion and future betterment are conferred in section 6.

2. Related Works

Pallavi Khatri et al. [8] proposed a methodology to form a trusted cluster by using nodes trust value, remaining energy and weight of each node to elect the CH. This trust based clustering approach is compared with classical AODV protocol to show this minimal packet drops and hence better packet delivery ratio. TaoWang et al. [9] conducted probabilistic analysis for reliable clusters also used scatter search optimization algorithm towards to improve robustness and for performance metrics. Experimental results shows that the clustering results produce further reliability than existing approaches. M. Ashwin et al. [10] developed weighted clustering trust model algorithm to investigate the impact of maliciousness and to cluster head selection algorithm. Simulation results indicate that without malicious node the proposed trust model improves packet delivery ratio and reduced end to end delay due to its cluster numbers. Mehdi Maleknasab et al. [11] discussed about various hybrid trust-based clustering schemes with their properties and features. This is mainly focused to discuss trust management mechanisms and its related issues in the cluster formation and maintenance. This paper also compared all the previous trust computation methods and issues. Raihana Ferdous et al., [12] presented a cluster head election algorithm to elect reliable cluster heads to provide secure communication. Node based Trust Management Scheme (NTM) modified and formulated by considering mobility of nodes. Results reveal that the proposed algorithm efficiency as increasing its trust values over that LEACH algorithm. R. Raja and P.Ganeshkumar[13] offered an improved trusted clustering based routing protocol (QoSTRP) to provide secure communication. Simulation results illustrate its better achievements in terms of packet delivery ratio, energy consumption, throughput and delay of number of nodes deployed in the network. Haidar Safa et al., [14] suggested a cluster based trust-aware routing protocol (CBTRP) to ensure the passage of packets trusted nodes only i.e. preserve forwarded packets from doubtful malicious nodes. Simulation results are prove that the CBTRP trustworthiness of cluster head election than the CBRP.R. Pandi Selvam and V.Palanisamy[15] suggested a weight based clustering algorithm to sustain the stability and flexibility against topology changes of the network. Results are demonstrating the algorithm efficiency than the weighted clustering algorithm. Also, clustering is protected from malicious nodes in mobile ad hoc network is proposed by Pandi Selvam et al.,in [16].

3. Proposed System

(i) ***Reliability on Cluster formation:*** Forming reliable cluster is an NP-hard problem in MANETs due to dynamic nature and hence unpredictable topology changes. For each cluster, we pick a node to be local coordinator of the cluster to manage its nearby

members. If the elected CH is inactive it cause to reclustering process. Therefore we elected trusted cluster with CH, gateway and members.

(a) Cluster Head Election

Cluster head election is done based on weight of its each node. Nodes are exchanging request and reply message with its neighbors to update the cluster information. In this paper, we assume that the highest hop distance is two between cluster head and cluster members. Each node, weight function *w(p)* is defined as follows

$$w(p) = x \times a(p) + y \times b(p) + z \times c(p)$$

Where, *a(p)* is number of multicast member nodes in one-hop, *b(p)* denotes number of multicast member nodes in two-hop and *c(p)* represents both number of multicast members and cluster members are within two-hops. The assigned variables *x, y* and *z* are depends with number of hops. Where, we taken as *x = 3, y = 2* and *z = 1*. After weight calculation done by each node, compares its weight with its neighbors within two hops. The node with largest weight declares as cluster head. After that it sends the announcement message to the neighbors as to intimate its responsibility. Once a normal node receives message from cluster head it sends back response message to the corresponding CH as to join with the cluster.

(b) Cluster Gateway Election

A normal node which has largest weight elected a cluster head all the others may join with the cluster head and become members of the clusters. If a cluster members join with more than one cluster than its chosen as gateway node. In this situation gateway nodes have to send request message to all corresponding cluster heads for allowing as to gateway of the cluster.

(c) Cluster Member Election

Nodes who are receiving announcement message from elected cluster head send the response message to CH. Before allowing a node to be CM, the trust value is verified by CH then only normal node could be member of the cluster.

(ii) *Reliability on Mobile Coverage:* Due to dynamic and arbitrary nature, nodes may move far away from transmission range of the CH. It will cause to reclustering and hence induce to affect the performance of network like bandwidth utilization and packet losses. Therefore, we give solution for nodes wish to join newly in cluster, moving a node from a cluster to cluster, resigning cluster heads its role, leaving a node from a cluster.

(a) New Node joining

During that the node joins to the network, it broadcasts hello message to all neighbors in the neighborhood list. Any CH that receives it sends reply message consist the number nodes and trust value of the cluster head. After receiving this reply that the new node sends join message to the CH. If there is no response from any one cluster head that the new CM declares itself as cluster head and inform to all the members in the cluster.

(b) Moving or leaving cluster member node

When CM moves from one cluster to another cluster, it sends a leave message to its cluster head and members. After receiving the reply message from the cluster head, node can remove from the cluster and from the neighbour list.

(c) Cluster head resigned its role

When a cluster head decided to resign its role, it sends an announcement regarding it's absconding to the entire cluster members. These cluster members have to select a new CH or join with nearby clusters. By this time, cluster head chooses subsequent highest weight

among the cluster members. Then new head sends announcement message containing the new CH's identity.

(iii) Reliability on Communication: Communication link must be reliable during network communication. Unreliable link drops data packets and it can be reduce the delivery ratio. Hence, we considered some situation when there is new link in cluster, new link between clusters, link failure in cluster and link failure between clusters to maintain the reliable communication in the network.

(a) New link between cluster

Two nodes affix with a fresh link from distinct cluster. Among these two, one node may affix with neighboring cluster if which is within minimum hops. Otherwise it will act as gateway of the clusters without changing the cluster head.

(b) New link in a cluster

When a new link occurs between two nodes in a cluster, the minimum hop and next hop nodes may change its topology. Therefore, nodes should update cluster status for ensuring the cluster head to know up-to-date link state of the cluster.

(c) Link failure between clusters

Link failure may take place between two different cluster nodes. In this case nodes have to examine whether which is between gateway or not. If failure occurs between gateways, nodes must overhaul their cluster information and inform to their cluster head. Else, there is nothing to do.

(d) Link failure in cluster

Link failure may also occur between nodes in same cluster. Hence, nodes should check their statuses recurrently. If they are within two hops, they just inform the change to its corresponding CH to update the link status. Else, node may leave from the cluster and can stick together with neighboring cluster.

4. Simulation Environment

Our simulation environment composed with 50-300 nodes within 0-200 meter transmission range. At every time unit, nodes were randomly moved in 250 * 250 meters square space towards all possible directions. 10 number of simulation was carried out on 200 sec with 5 sec pause time.

TABLE I

SIMULATION PARAMETERS

Meaning	Value
Number of Nodes (N)	50 – 300
Simulation Area (X * Y)	250 * 250 m
Transmission Range(R)	0-200 m
Maximum Displacement (MD)	0-10 m
Simulation Duration	200 sec
Pause Time	5 sec
Mobility Model	Random way point
Number of simulation	10

5. Results and Discussion

To analyze the outcome, we have plotted the relation between average number of clusters as to increasing transmission range, number of nodes and displacement in Fig.1, Fig.2 and Fig.3 respectively.
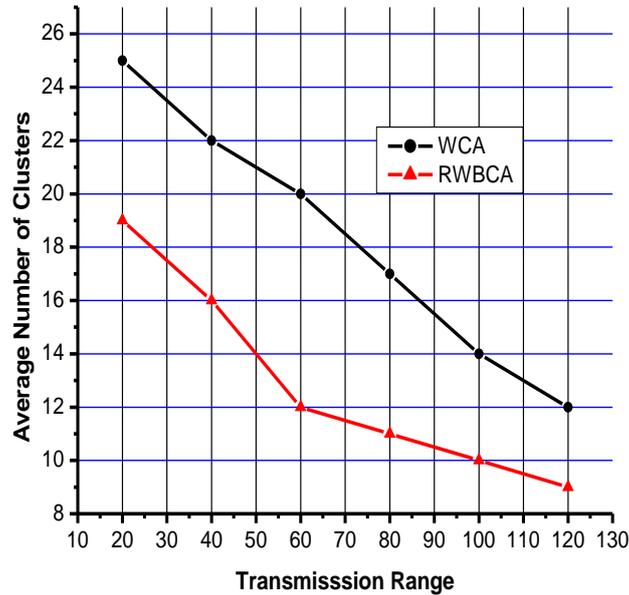

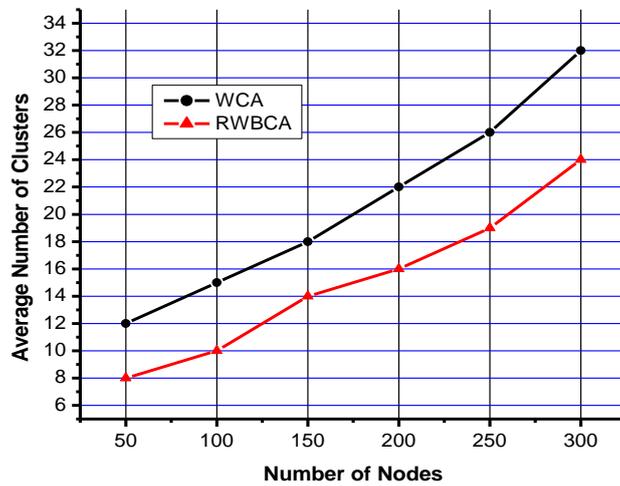Fig.1 Transmission Range Vs Average Number of Clusters
when N = 300 and MD = 10

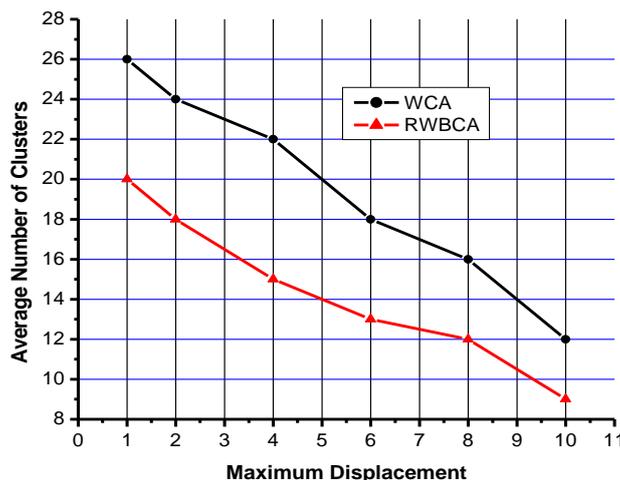Fig.2 Number of Nodes Vs Average Number of Clusters
when R = 100 and MD = 10

Fig.3 Maximum Displacement Vs Average Number of Clusters
when N = 300 and R = 80

From experiment results, we could conclude that our RWBCA has the smallest number of stable clusters than the WCA. Since, in order to ensure reliability our proposed clusters are formed by only trusted cluster head, gateway and cluster members. Also, we have focused to maintain the reliability on mobile coverage and communication in the network. These are all for minimizing resource utilization such as bandwidth, cluster head change and cluster heads re-affiliation.

6. Conclusion

Improving Ad hoc network environment requires a reliable MAC protocol. This could be achieved improving stability and flexibility of the network. This paper suggested a Reliable Weight Based Clustering Algorithm (RWBCA) with some reliability metrics in node clustering against frequent topology changes. The algorithm is being compared with classical Weighted Clustering Algorithm (WCA) running under the similar environment and the results were proved that the benefit of this proposed clustering algorithm. From experiment results, we can deduce that from the entire three environments, the proposed approach RWBCA produced reliable clusters than prior approach WCA. Although several clustering schemes and algorithms have been done on clustering for ad-hoc networks, still there are some difficulties to implement in hostile and trusted environments. Hence, designing such scheme and to provide high security in hostile conditions considered as our future studies and enhancements.

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