ISSN 2319-2720
Volume 7, No.2, April – June 2018
International Journal of Computing, Communications and Networking
Available Online at http://www.warse.org/ijccn/static/pdf/file/ijccn53722018.pdf
https://doi.org/10.30534/ijccn/2018/53722018

An Approach to Optimized Genetic based Clustering Algorithm in Mobile Ad hoc Network

Arun Biradar[1], Rajappa V [2], Indumathi T S [3], Vijaya R Thool[4]
[1]Professor & Head, CSE, EWIT, Bangalore, India, ambiradar@yahoo.com
[2]Director, PATE Foundation, Bangalore, India, rajuvelur@gmail.com
[3]Professor & Special officer, VTU, Bangalore, India, indumathi_ts@yahoo.co.in
[4]Professor, Dept. of IT, SGGSIE&T, Nanded, India, vrthool@yahoo.com

ABSTRACT

Mobile Ad hoc Network (MANET) are autonomous, distributed, multi-hop routing, reconfigurable Network. MANETs are mainly used for a quick deployment of a cooperative and distributed computing network. Clustering algorithm also plays an important role in MANET. This paper conducts the research on Weighted Clustered algorithm (WC). WC is an on-demand, distributed, weight-based MANET clustering algorithm. It considered ideal node density, battery power and its combination effect, flexible allocation and its weight factor of nodes when choosing head nodes, which will improve the weight and strength of MANET. This paper simulates on WCGA by NS2, the result shows that WCGA is more effectively to form grouping than WC, lowers the information updating expenses of the grouping network, and optimizes the usage of network bandwidth. WCGB effectively improves the MANET accessibility and stability.

Keywords: MANET, Clustering, Genetic algorithm, WC, WCGA.

1. INTRODUCTION

MANET is a self-organizing, infrastructure less network, where each device is able to send and receive data, in addition of independent mobility model. A MANET is a type of ad hoc network that can change locations and configure itself. MANETS are mobile, they use wireless connections to connect to various networks, and this can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission.

For the MANET with flat architecture, function and status of all nodes in network are the same and its biggest advantage is that structure is simple and source node can communicate with destination node as long as there is route between them. However, flat MANET has poor scalability. Some papers [1] pointed out even in an ideal environment, the throughput of each node still decrease with the increasing number of nodes in network. But the using of clustering is a good method to extend MANET. Hierarchical network architecture is capable of dynamically adapt the change of network structure. The head node within a group is responsible for establishing cluster and maintaining network topology, as well as make resource allocation for other nodes within the same cluster. Due to the mobility of nodes in MANET, joining cluster or leaving cluster of a node will both affect the stability of the cluster, but at the same time, frequent changes of head[2] node will affect protocol performance that reply on head node. Therefore, clustering MANET is the main problem for designing hierarchical network architecture. In

1.1 Clustering Alogrithm in MANET

LCA is a groundbreaking clustering algorithm proposed by Baker et al., and it is a clustering algorithm for high frequency communication network of task force. LCA can conveniently construct clustering structure, but will produce excessive cluster head nodes, especially when the node ID is linear ascending order. MinID proposed by Grela and Tsai made some improvements to LCA algorithm and further reduced the number of head nodes. Calculation amount of this clustering algorithm is small and easy to implement.

MAX-Degree referred the methods to choose router in Internet and chose those nodes with highest degree (having most neighboring nodes) as head nodes. When degree is the same, choose the nodes with smallest ID as head nodes, the first hop node of head node becomes ordinary member node of this cluster. Although this algorithm can reduce the number of clusters and the transfer delay of packet, because the algorithm does not limit the number of nodes in cluster, when the number of nodes is excessive, throughput of each customer node will decrease sharply. In addition, when the mobility of node is strong, the update frequency of head nodes will increase sharply, resulting in huge maintenance cost.

Distributed Clustering Algorithm (DCA) is similar to MinID, but DCA chooses head node according to the weights of nodes, which means the greater the weight of node is, the higher priority of node is. With this algorithm, head node can be uniformly dispersed in various parts of the network, but due to the periodicity of algorithm execution[3], single mapping of weights, nodes cannot move especially during the execution of the algorithm and low adaptation to mobility, all those defects limit the application environment and scale of this algorithm. WCA is an on demand distributed generation clustering algorithm. Electoral process of WCA clustering algorithm is

not periodical and update frequency is low, thus it can maintain the stability of network and reduce the cost of computation and communication.

2. WEIGHTED CLUSTERING ALGORITHM

WCA is an on-demand, distributed, weight-based MANET clustering algorithm. It considered ideal node density, battery power and its combination effect, flexible allocation and its weight factor of nodes when choosing head nodes. WCA can dynamically adapt to the continually change of MANET topology and limit the number of member nodes that head nodes deal with, which makes MAC function not decline. WCA will be executed only when needed, which means when node is neither head node nor belongs to any cluster[4], WCA will be executed, in order to reduce the computation and communication cost.

Every element is associated with a real valued weight, representing its "mass" or "importance". Traditional clustering algorithms can be readily translated into the weighted setting by considering their behavior on data containing element duplicates

A weight function w: X →R+ defines the weight of every element. A dissimilarity function d: X x X →R + u {0} is the dissimilarity defined between pairs of elements

(w[X],d) denotes weighted data A Partitional Algorithm maps

Input: (w[X],d,k) to Output: a k-clustering of X

Range(A(X, d)) = {C | ∃ w s.t. C=A(w[X], d)} The set of clusterings that A outputs on (X, d) over all possible weight functions.

Range(A(X, d)) = {C | ∃ w such that A(w[X], d) = C}

Weight-robust: for all (X, d), |Range(X,d)| = 1.

Weight-sensitive: for all (X, d),|Range(X,d)| > 1.

Weight-considering: 1) ∃ (X, d) where |Range(X,d)|=1. 2) ∃ (X, d) where |Range(X,d)|>1

Weighted k-means objective function

$$\sum_{i=1}^{k} \sum_{x \in Ci} w(x) \| x - c_i \|^2 \quad (1)$$

$$c_i = \frac{1}{\sum_{x \in Ci} w(x)} \sum_{x \in Ci} x w(x) \quad (2)$$

3. CLUSTERING ALGORITHM WITH GENETIC BASED

Genetic algorithm is recognized as one of the effective method to solve NP problems and is widely applied in combinatorial optimization, machine learning, signal processing, self-adaptive control and artificial life, and made many remarkable achievements. Applying genetic algorithm into MANET to optimize clustering can achieve better results.

In order to improve the searching speed to head node of this algorithm , before the formal formation of cluster, build a virtual cluster from a certain node and its neighboring nodes within two hop and head node is not decided. In clustering process of GA-WCA, use genetic algorithm to search in a virtual cluster and at the same time, also hope that this algorithm can converge as soon as possible in order to save the battery energy of node and improve the surviving ability of clustering.

Data where Average Linkage responds to weights:

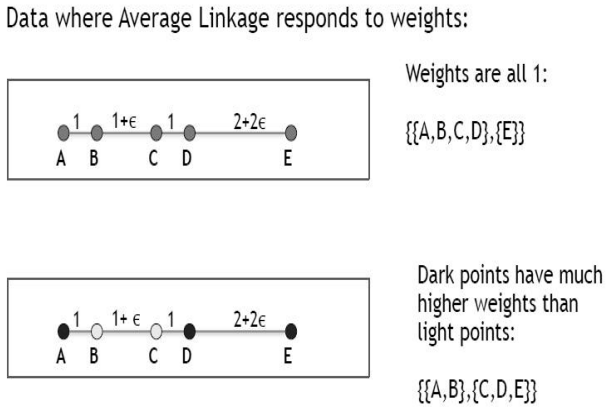

Figure 1: Adaptation of weights in linkage

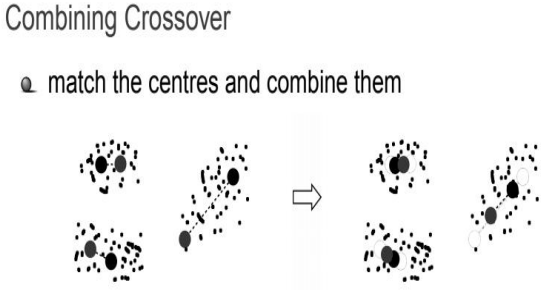

Figure 2: Adaptation of Cluster crossover and linkage

The **pseudo-code** (Algorithm) for crossover is as follow:

BEGIN

Input a pair of chromosomes, calculates its length If NON cluster Create Cluster Intialize Cluster Node

If Cluster = Genetic Cluster

While common points in two parents

If node have common point

Construct a set of crossing point

Apply crossover process between current parents

While keeping the start and end nodes without change in the population

END WHILE

4. SIMULATION STUDIES

4.1 Simulation Experiment

The NS-2 is a discrete event driven simulator developed at UC Berkeley. NS-2 is suitable for designing new protocols, comparing different protocols and traffic evaluations. It is an object oriented simulation written in C++, with an OTcl interpreter as a frontend. Simulation experiment adopts the NS-2 tool to establish the RW and RWP mobile scenes, which are denoted as the scene 1 and scene 2 respectively. the three dynamic characteristic of mobility model, such as link connection ratio, topology varying ratio and Ad Hoc network topology lifetime.

TABLE I. SIMULATION PARAMETERS

Parameters	*Values*
Routing Protocols	AOMDV,DSDV
Number of nodes	50
Simulation Time	100sec
Pause Time	0,5,10,15,20 ms
Environment Size	500*500
Transmission range	250m
Traffic Type	CBR(Constant Bit Rate)
Packet size	512 Bytes
Packet Rate	4 packets/sec
Maximum Speed	2,4,6,8,10m/s
Queue Length	50
Mobility Model	Random waypoint
Antenna Type	Omni-Directional

In this model maximum speed of moving node is varied and rests of parameters are kept constant. The value of speed is varied from 2 to 10m/sec and Pause time is kept constant at 0sec. When trace files are generated then it is needed to analyse these files using the *awk* or *perl script.* To analyse the files awk or perl scripts are written according to the performance metrics which are to be used in the performance evaluation. This simulation is performed to evaluate the performance based on the three metrics namely Packet delivery ratio, Average and to end delay and Normalized routing load. So three awk files are used for this Simulation.

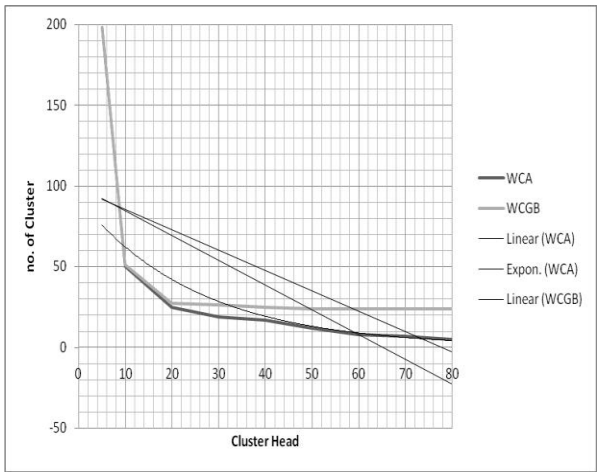

Figure 3: Adaptation of Cluster crossover and linkage

the average number of nodes as the cluster transmit distance increases and decreases, as the WCA does not limit the size of the group, so that a sharp increase in the load of the cluster head in a relatively large radius, and WCGB group size is not restricted, but the first node of each cluster is the strongest overall performance in nodes, therefore, it can achieve an ideal result. With increasing radius, reducing delete nodes, the rule set update rate decreases, WCGB algorithm can enhance the stability of the cluster.

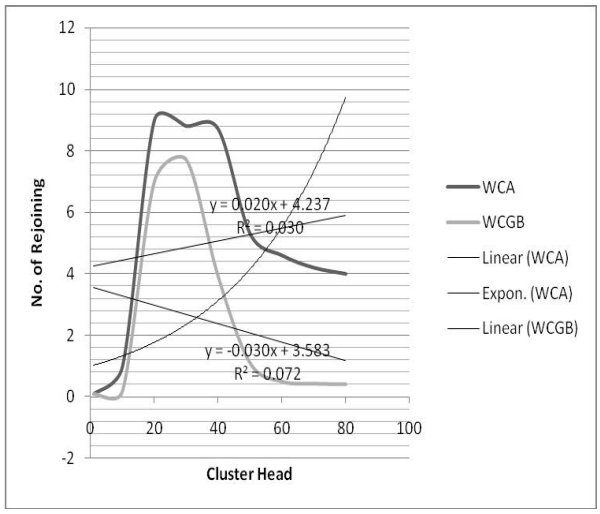

Figure 4: Adaptation of Cluster crossover and linkage

Figure 4 show a comparison of clustering stability

In the above figure the cluster breaks help in radius increases, the node delete reduces, the rule set update rate decreases, WCGB algorithm can enhance the stability of the cluster.

5. CONCLUSION

Clustering in MANET plays a important role in maintaining the node cluster head. Genetic Algorithm is an evolutional technique where each cluster is treated as cluster chromosomes which increase the performance of cluster and optimizes the network. WCA is also helps in proper clustering but WCGB conducts clustering optimization from MANET perform more rejoining. The simulation result indicates that WCGB is better on WCA, but is prior to it.

ACKNOWLEDGEMENT

I would like to thank East West Institute of Technology for their continuous support and encouragement for making this paper flourishing and completion.

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