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Cluster Based Stretch and Shrink Method for Manet Using Load Balancing, Nearest Neighbor and Rule Mining

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Abstract

Mobile Ad hoc Network is a collection of autonomous wireless nodes, in which each node changes its geographical position frequently and acts as a router to forward packets. The topology stability and network scalability are playing a significant role in mobile ad hoc to determining the network performance. Hence an attempt has been made to analyze the factors such as nearest neighbor and association rule mining in the ad hoc network's bench mark algorithms such as LCA2, load balance, adaptive multi-hop algorithm and Basagni's DCA, and DMAC to form a clustered mobile ad hoc network. Motivated by this understanding, the cluster based stretch and shrink method has been proposed to improve the stability of network.

Keywords: load balanced cluster, nearest neighbor, rule mining, stretch and shrink

Introduction

A Mobile Ad-hoc Wireless Network (MANET) is a collection of autonomous wireless nodes that communicate dynamically and establishes the network to exchange the information. In ad hoc network, every node acts not only as a host but also as a router by creating routing and routing data for other nodes and also it provides pervasive computing environment that support users in accomplishing their tasks, accessing information and communicating anytime, anywhere and from any device. The main characteristics of MANETs are the mobility of nodes, i.e. nodes can move in any direction and at any speed which leads to arbitrary topology and frequent partitioning of the network [1] [2]. Various methods have been used to maintain network topology stability and balance the nodes in clustered based ad hoc network. The following section has analyzed the various techniques such as load balanced algorithms, clustering techniques, association rule mining in mobile ad hoc and nearest neighbor. These are all the techniques have used to minimize the cluster head overload and network partition.

The analysis of node density impact on the network

The high density nodes in the network are making significant impact and its lead to long delay and packet loss. Mainly following two reasons are consider the density: the first reason is when the number of node increased, the network load will be overload, at the same the node decreased, the distance will be increase between nodes, so complex and load balancing methods are needed. Currently the clustering techniques have been deeply researched and try to solve the difficulty of density and dynamic topology problem in mobile ad hoc network environment.

Need for clustering and its techniques

Grouping the network nodes into a non-overlapping cluster and makes possible a hierarchical routing is the idea behind the clustering technique [5]. The cluster has three types of nodes such as Cluster Head (CH), Ordinary nodes (cluster member), Cluster gate way nodes. Cluster Life time can be measured by the time duration between the cluster head formation and cluster head termination. Re-cluster: The ad hoc network require the longest cluster life time and this can be lead to good topology stability. The cluster head carry out its job when all of the nodes are moved from away and try to join as a cluster member in another group. Sometimes, the CH may be moved away, this position lead to call the re-cluster head election [6]. To minimize the re-cluster head election, some of the cluster algorithm uses the redundant (RCH) cluster head technique to handle the absent of CH environment [29]. So the clustering techniques guarantee to improve the load balancing and topology stability in cluster based ad hoc network. The following literature section has discussed the various cluster based load balance algorithms and partitioning technique.

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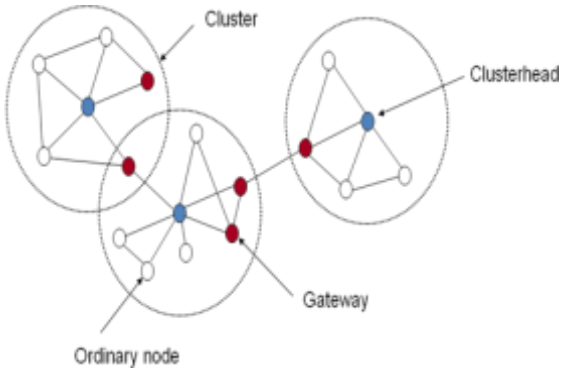
to getting target node [3] [4].To construct the ad hoc network in effective way, an integrated clustering

Figure:



Nodes in cluster structure

Discuss the bench mark algorithms

Linked Cluster Algorithm-LCA and LCA2

The LCA used the TDMA frames to communicate between nodes in the network. The 2n TDMA frames has time slot, each node in the network uses the slots to avoid collisions, where n is a number of nodes. Topology sensing, cluster formation and cluster linkage are primary goal of the LCA. The main task of the Cluster Activation Linkage (LAC) algorithm is to activate the link between the nodes in the ad hoc whereas the routing algorithm covers the routing activities and packet communication. After this, LAC was revised and developed Lowest Id Algorithm (LAC2), this algorithm elects as a cluster head the node with the lowest id among all nodes that are neither a cluster head nor are within 1-hop of the already chosen cluster heads. Both the algorithms were used to construct small network. When the number of nodes increased in the LAC network, the algorithms will force greater delays between node transmissions in the TDMA communication scheme.LCA could not meet certain criteria of the ad hoc network, but could become the base algorithm for other benchmark algorithms [8] [9] [10] [12].

Lowest Id Algorithm

The lowest Id algorithm uses the simple and fast technique to form a cluster ad hoc and also uses the lowest id node to become head. This algorithm was originally proposed by D.J. Baker and A. Ephremides 1981. Every node in the network exchanges their *id* periodically and selects the lowest id node as head [11]. Since it is biased towards nodes with smaller node-ids, leading to battery drainage and also it does not attempt balance the load for across all the nodes. Ratish Agarwal, and Dr. Mahesh Motwani 2009, defined drawback of lowest ID

Highest-Degree Algorithm

The Highest-Degree Algorithm, also known as connectivity-based clustering algorithm, was originally proposed by Gerla and Parekh 1995. In this algorithm, node becomes a cluster head which is having highest number of neighbor's nodes (highest degree) in the network and the node degree is composed based on its distance from other node. Each node in the network, either acts as a cluster head node or normal node. When the number of nodes increased in the ad hoc, the system performance is getting down as well as the throughput and load handling capacity of the cluster head puts an upper bound on the node-degree, because the cluster head cannot handle a large number of nodes due to resource limitations and does not have any restriction on the upper bound on the number of nodes in a cluster. There is no re-elected to be a cluster head even if it loses one neighbor [11]. Ratish Agarwal and Dr. Mahesh 2009 have specified this system has a low rate of cluster head change but the throughput is low. Typically, each cluster is assigned some resources which are shared among the members of that cluster. As the number of nodes in a cluster is increased, the throughput drops. The re-affiliation count of nodes is high due to node movements and as a result, the highest-degree node (the current cluster-head) may not be re-elected to be a cluster-head even if it loses one neighbor. All these drawbacks occur because this approach does not have any restriction on the upper bound on the number of nodes in a cluster [11] [14] [15] [16].

Node-Weight Algorithm

"The DCA is suitable for clustering "quasistatic" ad hoc networks. It is easy to implement and its time complexity is proven to be bounded by a network parameter that depends on the topology of the network rather than on its size, i.e., the invariant number of the network nodes. The DMAC algorithm adapts to the changes in the network topology due to the mobility of the nodes, and it is thus suitable for any mobile environment. Both algorithms are executed at each node with the sole knowledge of the identity of the one hop neighbors, and induce on the network the same clustering structure [18][19]" .

Basagni et al., 1999 proposed two algorithms, namely distributed clustering algorithm (DCA) and distributed mobility adaptive clustering algorithm (DMAC). The two algorithms are developed for the efficient partitioning of the nodes in the wireless ad hoc network. The weight base method is introduced for cluster formation and each node in the network

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algorithm is that certain nodes are prone to power drainage due to serving as cluster heads for longer periods of time [13] [14].

correctly within a finite time (a step) by all its neighbors, and b) Network topology does not change during the algorithm execution .Results proved that the number of updates required is smaller than the Highest-Degree and Lowest-ID heuristics and computing the cluster heads becomes very expensive and there are no optimizations on the system parameters such as throughput and power control [11] [18] [19].

Weighted clustering algorithm (WCA)

The WCA uses the combined weight metric. For cluster-head election the metrics are used such as the number of neighbors, distance between the neighbors, mobility and cumulative time for which the node acts as the cluster-head [20].

Weighted Clustering Algorithm (WCA) Steps [21]:

1. Compute the *degree* d_v each node v

$$d_v = |N(v)| = \sum_{v' \in V, v' \neq v} \{dist(v, v') < tx_{range}\}$$

Coordinate distance, predefined transmission range.

2. Compute the *degree-difference* for every node

$$\Delta v = |d_v - \delta|$$

-For efficient MAC (medium access control) functioning.

-Upper bound on # of nodes a cluster head can handle.

3. Compute the sum of the distances D_v with all neighbors

$$D_v = \sum_{v' \in N(v)} \{dist(v, v')\}$$

4. Compute the average speed of every node; gives a measure of *mobility* M_v

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

Where (xt, y_t) and (xt_{-1}, y_{t-1}) are the coordinates of the node v at time t and (t-1) Component with less mobility is a better choice for clusterhead.

5. Compute the total (cumulative) *time* P_v a node acts as cluster-head

assigned a real number as ID (based on its weight). In the network, which node is getting higher weight than the other nodes of its neighbor becomes a cluster head and other nodes treated as cluster members.

Common operational assumptions of DCA is made by Basagni: a) A message sent by a node is received

$Wv = W1.\ \Delta v + W2.Sdv + W3.Mv + W4.Pv$

6. Calculate the combined weight $\mathbf{W_v}$ for each node

7. Find min $\mathbf{W_v}$; choose node v as the cluster head, remove all neighbors of v for further WCA

8. Repeat steps 2 to 7 for the remaining nodes

The disadvantage of WCA is, if a node moves into an area that is not covered by any cluster-head then the cluster set-up procedure is invoked again which causes re-affiliations. A Hello message contains its ID and position. Each node builds its neighbor list based on the Hello messages received. Each node calculates its weight value by following algorithm [20].

Load-Balancing clustering

"Load-balancing clustering algorithms believe that there is an optimum number of mobile nodes that a cluster can handle, especially in a cluster head-based MANET. A too-large cluster may put too heavy of a load on the cluster heads, causing cluster heads to become the bottleneck of a MANET and reduce system throughput. A too-small cluster, however, may produce a large number of clusters and thus increase the length of hierarchical routes, resulting in longer end-to-end delay. Load-balancing clustering schemes set upper and lower limits on the number of mobile nodes that a cluster can deal with. When a cluster size exceeds its predefined limit, re-clustering procedures is invoked to adjust the number of mobile nodes in that cluster [22]".

Load Balancing Factor (LBF)

It is desirable to balance the loads among the clusters. Load balancing factor (LBF) has defined as [20,5]

$$LBF = \frac{n_c}{\sum_i (x_i - \mu)^2}$$

Where

$$\mu = \frac{(N - n_c)}{n_c}$$ is the average number of neighbors of a cluster-head (N being the total number of nodes in the system), where, n_c is the number of cluster-heads, x_i is the cardinality of cluster i.

Degree- Load Balanced Algorithm (DLBC)

The degree load balanced algorithm has proposed by Alan D. Amis and R.Prakash 2000. It uses the different load balancing method that is degree load balance heuristic. Two heuristic approaches have

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Battery drainage = Power consumed
Weighing factors are chosen in such a way that
W1+ W2+ W3+ W4 = 1
Combined weight of a node *Wv* is calculated as follows

the DLBC can reduce the rate of cluster head change because a cluster head does not need to relinquish its cluster head status whenever it has a member node with a higher node degree. However, since the cluster head change is still based on node degree, DLBC likely will cause frequent re-clustering because the movement of mobile nodes and consequent link setup/break results in dynamic variation of mobile node degree. In addition, how to select a cluster head is not addressed in DLBC if in a local area no mobile nodes can satisfy the degree difference requirement between *ED* and its current node degree (2-hop) [9][22].

Adaptive Multi-hop Clustering (AMC)
AMC has proposed by Tomoyuki Ohta et al., in this algorithm, two important features have consider, the first one is each node autonomously constitutes the cluster and each cluster autonomously maintains itself. Five types of node state can be classified in AMC i)NSN(Normal State Node) cluster member, (ii) CN(Control Node) cluster head, (iii)BN(Border Node) border node, (iv)BCN(Border and Control Node) plays both CH and gateway node. (v) ON (Orphan Node) Node with state of *ON* does not have any cluster ID. Note that, when a node is newly added, a state of the node becomes *ON*. The five types of node performs the two types of following action (i) A node exchanges the information with the neighboring nodes periodically by using *hello packet*. (ii) If a node is a cluster member, the node broadcasts its information to all cluster members in the some cluster periodically by using control packets called *periodic notification packet*. The nodes in the cluster have maintained by cluster head and each node in a cluster broadcast its unique node ID, a cluster ID and the above state. By such message swap, each mobile node gets the topology information of its cluster. Each gateway also periodically exchanges information with neighboring gateways in different clusters and reports to its cluster head. Thus, a cluster head can recognize the number of mobile nodes of each neighboring cluster. The AMC uses the upper bound and lower bound (U and L method) to balance the load in an each cluster. In each cluster, the CH tries to merge the cluster with one another when the cluster members are less than L as well as tries to split the cluster when the member is greater than L. In this AMC, clearly mentioned the L and U bound node mobility and node states but without any justification the L value and U value parameter has passed to the simulation [22, 23].

developed to handle balanced nodes in ad hoc network. The first one is for election heuristic to form a cluster and the second one is CH heuristic to select a cluster head in each cluster. This method uses the ED (Elected Degree) to handle the optimum number of nodes in a single cluster. So the cluster head can maintain the average number of nodes in each cluster. Jane Y. YU et al. compared the DLBC with HCC [15]; clearly defined and in AMC the L and U values are not defined. When the number of mobile nodes exceeds the max_Delta value, current cluster head de-promote to an ordinary node in a cluster, so the DLBC cluster head is based on the node degree. The AMC uses the division and merger method to form a cluster in ad hoc network [22].

Approaches Used In Cluster Based Stretch And Shrink Method

Cluster Based Stretch and Shrink method using the following methods to form a cluster based ad hoc network.

MANET Mining (Association Rule Mining)
Association rule mining of data mining can be implemented in mobile ad hoc network to improve the network stability as well as the routing.

Convergence of MANET with data mining: Data mining, in reference to transactions is similar, to a large extent, to mining packets in MANET in the following aspects [24, 30].

- *Each transaction in data mining is a set of items (attributes). In case of MANET, the nodes are the attributes and the transaction is the transmission of one packet.*
- *Data mining is applicable to a database with a large number of transactions. MANET mining is applicable to traffic with a large number of packets.*
- *The purpose of mining association rules in a database is to discover all rules that have Support and Confidence (predictability) greater than or equal to the user-specified minimum Support and minimum Confidence. In case of MANET, the rules represent the most likely patterns among the cooperating/routing nodes.*
- *Each Frequent Set FS in data mining is equivalent to the common nodes of different paths in MANET.*

The Manet mining algorithm is used to mining techniques is applied with a threshold to the mining procedure and some of the possible enhancements and extensions of ad hoc using the rule mining: Security

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Summary of AMC and DLBC

Both AMC and DLBC algorithms are uses the cluster based load balancing method to balance the number of mobile node in each cluster. AMC uses multi-hop clustering scheme and DLBC uses 2-hop scheme for high mobile ad hoc network. In DLBC, the ED (Elected Degree) and max_Delta values are not

x ,y are scenarios composed of N features, such that $x=\{x_1\ldots..,x_n\}$, $y=\{y_1\ldots\ldots\ldots\ldots..,y_n\}$.Two distance functions are used to calculate the distance: Absolute distance measuring, Euclidean distance measuring [25] [26].

Enhancement, maximizing the Network Life Span, routing and Multicasting [24].

Nearest Neighbor

The k-nearest neighbor is simple classifier algorithm of all machine learning methods. It is used to divide the node points into several groups (cluster) and finds the group of new sample point. If k=1, then the new node is assigned to the group of that single neighbor. The learning process of KNN is simpler than other models. Compute the distance between two scenarios using some distance function d(x,y) , where

The Propose Stretch and Shrink Method

The nearest neighbor method is used in the ad hoc network to divide the nodes in to number of groups or clusters.

Table 1. Summary of clustering schemes in ad hoc topology stability

Author and proposed scheme	No. of node (s)	Simulation area (m)	Mobility model	Simulation Time (s)	Transmission Range (m)	Max speed (s)	Logic used	Compared with	Conclusion
Alan D. Amis Ravi Prakash., 2000	600	200* 200	Random way point	2000			The degree load-balancing heuristic, much like the LCA2 heuristic, does not allow for adjacent cluster head	LCA,LCA2, Max-Min	This mechanism tries to make all cluster heads almost serve the same and optimal number of member nodes
Mainak chatterjee et al., 2002	20-60			200	70		degree-difference, sum of the distance with all neighbors, average moving speed and cluster head serving time	Lowest-ID, Node-Weight heuristic, Highest-Degree	The number of re-affiliations for WCA is about 50% of that obtained from the Lowest-ID heuristic.
Tomoyuki Ohta et al., 2003	200	750* 750	Random way point		100, 200, 300	20	U and L bound used to divide and merge the cluster		When the mobility(m/s) 20, the no. of cluster range 3.75(0.48) and cluster member 53.60(7.82)
Yi Xu and Wenye Wang,2006	120 - 240	2000 * 2000	Random way point		250	1,9 - m/s	U and L bound used to divide and merge the cluster using threshold value	Lowest Id	Longer lifetime cluster heads and better scalability. No. of nodes in cluster:4-5
Tomoyuki Ohta et al., 2007	150	2000 * 2000	Random way point	300	250	1-20	U and L bound used to divide and merge then cluster, Autonomous clustering	1-Hop clustering (1HC).	AC has high adaptability and provides more stable route.
Sahar Adabi, 2008	N	800* 800	Random way point		250	30 ms	Fuzzy Score-based Clustering	WCA, FCM	Better end-to-end throughput, longer lifespan and smaller number of clusters.
Yi Xu and WenyeWang, *2009*	240	L=2000	Random node mobility		250		Designed MEACA and CNORP	Lowest Id	Maximize the stability of hierarchical networks.

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AbdelRahman H. Hussein et al., 2009	300	250* 250	Random way point	200	200		Load balanced cluster and using threshold value to form a cluster	Lowest Id, highest degree, WCA	20%-70% more stability than original WCA. No. of nodes in cluster:5
Abdelrahman H. Hussein et al., 2010	60	100* 100 m^2	Random way point	100	10-100		weighted distributed clustering algorithm, called CBMD	WCA	When the transmission range increased (30-70), 57.15% and 63.68% less re-affiliation than WCA. No. of nodes in cluster:10
Fereydoun Ramezani Zangi1et al., 2012	10-50	100* 100	Random way point		30-40	5-10 m/s.	The stability of the cluster is increased through solving the problem of node density in a cluster.	WCA	The transmission range of every node is 30m, the LBF between 0 and 0.923 and for the WCA; it is between 0 and 0.686.
Ratish Agarwal et al., 2014	100	1000* 800	Random way point	100	200	10	U and L bound, Threshold value=6, using cluster merge and division (*join_cluster)* to manage cluster load.	WCA	The PDF, E2E, throughput, load balance are better than WCA.

The clustered network can be shrinking (split) or stretch (merge) based on the threshold value and association rule mining. If the current cluster's node density is greater than the threshold value, the cluster can be shrinking as well as the cluster can be stretch when the cluster node density is smaller than the threshold (pre-defined) value. The above two process of stretch and shrink can be done by using the nearest neighbor method. Threshold is a predefined value that a cluster can cover. The threshold value decides whether to add a new node to the existing cluster or not. The load balancing cluster concept in ad hoc network is accomplished by determining a pre-defined threshold on the number of nodes that a cluster head can cover ideally. So the threshold helps to balance the nodes in the network and none of the cluster heads are overloaded. Abdel Rahman H et al., 2009, uses the pre-defined threshold value as 5 nodes in each cluster [11] [27]. The load balancing method plays an essential role in ad hoc network to minimize the cluster head overhead and make topology stability and the bench mark algorithms (DCA, DMAC, DLBC, ACM) has been used in this method by setting the upper threshold limit and lower threshold limit in each cluster to maintain the balanced nodes in ad hoc network [31].

each cluster. So the cluster head overload is minimized as well as the topology change.

Conclusion And Future Research

In this research exposition, three data mining techniques and ad hoc load balanced bench mark algorithms have been analyzed and proposed cluster based stretch and shrink method, which uses the load balance method, cluster, nearest neighbor, rule mining and threshold value to form a balanced clustered ad hoc network. The proposed method used to improve the network performance, such as topology stability and scalability. By using the nearest neighbor to form an effective cluster in ad hoc and the rule mining, threshold predefined value techniques have to maintain the balanced nodes in *organization of a mobile radio network via a distributed algorithm", IEEE Transactions on Communications COM- 29, pp. 1694-1701, 11(Nov.1981).*

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