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Analyzing Secure Clustering & Maintenance (scm) Algorithm In Mobile Ad-hoc Network (manet)

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Abstract: This paper explains and analyzes the Secure Cluster formation & cluster Maintenance (SCM) Algorithm for the formation and maintenance of mobile Ad-hoc network. If two or more mobile nodes come together for certain reason then these nodes can form a cluster based mobile ad-hoc network. In this algorithm we propose that security can be enhanced by using a better cluster formation and maintenance Algorithm. These nodes can communicate with each other after cluster formation and work together without any extra Infrastructure. For Cluster formation each node will calculate its individual weight. It will form a "Hello message" consisting of five fields. Cluster formation and also maintenance may be done through this "Hello message" only. When needed the process of cluster formation will be initiated by an individual node by initiating a "Hello message". There will be claiming and collection period after this initial "Hello message". If any other node is having more weight then that node will be chosen as cluster head other wise initiating node will continue. There will be four roles for a node (undecided, member, cluster head and Gateway). A node will change its role accordingly. Maintenance process covers the cluster joining process, cluster leaving process, changing the cluster head, cluster dis-integration, cluster re-formation and changing the gateways

Keywords: Analyzing , Maintenance (SCM) , Algorithm , Mobile Ad-Hoc Network .

INTRODUCTION

Mobile stations such as laptops, cell phones, PDAs participate to form a Mobile Adhoc NETwork (MANET). These nodes can communicate directly to each other or indirectly through Cluster Head. Cluster head is the main coordinating node in any cluster for any reason. Gateways can be used to communicate with the nearby clusters14. Clusters must be small and efficient for the sake of better performance. Smaller cluster15 would be beneficial and robust as more Transmission and Reception range is not required. Power (battery) utilization will also be optimum as the nodes are available nearby (at one hop distance). In certain conditions when a Cluster head wants to leave and there is no claiming node then cluster disintegrates. MANET can be used to form the network in emergency especially after natural disasters12 or during wars for Military purpose13.

BACKGROUND:

A great number of clustering algorithm has been proposed for mobile ad hoc networks [1 to 11] especially for cluster formation and maintenance. A brief description of these is as follows:

1. An Innovative Clustering Method for MANET Based on Cluster Convergence1: - This algorithm mainly lay emphasis on the parameter that represents the convergence of the cluster with predicts mobility. In this method three parameters relative speed, node mobility and battery power are used to calculate the primary weight of nodes. Then using the neighbors' signal strength and predicting the node mobility, convergence coefficient can be achieved. Final weight is achieved by multiplying this coefficient with the primary weight calculated. Many mobile hosts are organized into several groups which can communicate with each other; these can move together and work with each other. Members of the same group might have similar mobility patterns and can directly communicate with each other. Members of a group communicate with other nodes outside its group through the group cluster head, which serves as a gateway to other groups. In the group mobility, the cluster head equips with two network interfaces, one is used for local networks and the other is used for external networks. The local networks mean wireless ad hoc networks that are used in a group or between overlapped groups.

2. Highest degree clustering algorithm 2: - This algorithm uses the degree of a node as a metric for selection of cluster head. Among its neighbors the node with highest degree will be elected as cluster head, and others will be cluster members. In this algorithm, as the number of ordinary nodes

in a cluster is increased, the throughput drops and system performance degrades.

3. The Lowest-Identity algorithm (LID) 3: - This algorithm chooses a node with the minimum identity (ID) as a cluster head. The system performance is better than Highest-Degree heuristic in terms of throughput 4. However, since this heuristic is biased to choose nodes with smaller IDs as cluster heads, those nodes with smaller IDs suffer from the battery drainage, resulting short lifetime span of the system.

4. Least Movement Clustering Algorithm 5:- In this algorithm, each node is assigned a weight according to its mobility. The fastest the node moves, the lowest the weight is. And the node with highest weight will be elected as cluster head.

5. The Distributed Clustering Algorithm (DCA) 6:- Distributed Mobility Adaptive clustering algorithm (DMAC) 7 are enhanced versions of LID; each node has a unique weight instead of just the node's ID, these weights are used for the selection of cluster heads. A node is chosen to be a cluster head if its weight is higher than any of its neighbor's weight; otherwise, it joins a neighboring cluster head.

6. MOBIC 7:- It uses a new mobility metric Instead of static weights.

7. The Weighted Clustering Algorithm (WCA) 4:- It is based on the use of a combined weight metric that takes into account several parameters like the node-degree, distances with all its neighbors, node speed and the time spent as a cluster head. Although WCA has proved better performance than all the previous algorithms, it lacks a drawback in knowing the weights of all the nodes before starting the clustering process and in draining the cluster heads rapidly.

Proposed Work: Mechanism:
Phase I: Cluster Creation Algorithm:
Step1: Any one node will start the procedure of cluster formation
Step2: Each node will calculate weight on the following parameter. Essentially individual node calculate its own weight depending on the following 10 parameters, using 1 to 10 scale-
.
Processor speed will be calculated on 1 to 10 scale.(1 to 4 GHz is divided in 10 discrete levels)
RAM (Random Access Memory) will be calculated on 1 to 10 scale.(128 MB to 6 GB)
OS (operating system) will be calculated on 1 to 10 scale. (Linux, Window - xp, window-7,window-8, Android will be rated accordingly)
TX (transmitting) range will be calculated on 1 to 10 scale.
RX (receiving) range will be calculated on 1 to 10 scale.
Degree of connectivity will be calculated on 1 to 10 scale.
Stability in cluster will be calculated on 1 to 10 scale.
Battery Backup will be calculated on 1 to 10 scale.
Lowest ID (IP address) will be calculated on 1 to 10 scale.
Age as CH (Cluster Head) will be calculated on 1 to 10 scale.

Average of all these parameters will be the weight of individual node.

Wi=(w1+w2+w3+w4+w5+w6+w7+w8+w9+w10)/10

Step 3: Each node would prepare its "Hello packet" consisting of 171 bits. Hello Packet would consist of five fields as below
a.ID (IP Address (32 bits) + MAC Address (48 bits).
b.Weight (Wi) is calculated on 1-10 scale (8 bits).
c.It's role (0 for Undecided, 1 for Cluster Head16, 2 for Member and 3 for Gateway17 consisting of 2 bits, default value will be undecided =0).
d.It's Cluster Head ID (IP Address (32 bits) + MAC Address (48 bits), default value will be 0 i.e. no Cluster head) as it has not yet joined a cluster.
e.Low resource field for low battery, low Transmission range or low receiver range will be Boolean type (either yes (1) or no (0). If any of three resource i.e. battery back up, transmitting range and reception range is lower then a threshold value then a node resets its LOW RESOURCE Boolean field as yes=1. If low resource then station will assume it self as discarded from cluster and reset its ROLE as UNDECIDED =0. If it is having the post of cluster head, cluster gateway or cluster member respectively then its ROLE will be reset to UNDECIDED =0 step by step. if it is a cluster head then after handing over its responsibilities to best claiming node its status will be changed to member and further to undecided. Same way if it is a Gateway then also it hands over its responsibility to best claiming node and reset its ROLE as member and further to undecided. This type of node would not claim to join any cluster even after hearing a "Hello message" until its Low resource constraint is cleared.

ID	**Weight**	**ROLE**	**CH-ID**	**Low resource**
(32 bit IP + 48 bit MAC)	1 to 10 scale (1 byte)	Undecided-0 cluster head -1, member – 2, gateway – 3 (2 bits)	(32 bit IP + 48 bit MAC)	No – 0 Yes – 1 (1 bit)

Fig -1: Frame Format of "HELLO" Packet

Step 4: A node must initialize its ROLE as UNDECIDED=0 and CLUSTER HEAD ID (CH-ID) = 0, as it has not yet joined a cluster.
Step 5: Initiating node broadcasts a "Hello message" consisting of above discussed fields.
Step 6: All nearby nodes hearing this broadcast, will compare its weight with this node. If a node finds its weight less than the INITIATING node then it assume itself as member of this cluster and set its ROLE as member and CH-ID field as the ID of INITIATING node, but if this node finds its weight more than initiating node then it waits for the claiming period. Claiming period would start just after, initial "Hello message" transmission with a beep (1 bit frame) from INITIATING node. This period will be the period to claim for the post of Cluster Head if any node feels that it has more weight.
Step 7: In the claiming period if a node wants to claim as cluster head then it would transmit a "Hello message" with its ROLE field as UNDECIDED and CH-ID field as ID of INITIATING NODE. This means that although the node is

accepting to enter the cluster but wants to claim for the cluster head.
Step 8: If so many node does this at a time than collision will occur and it would be dealt with adaptive tree walk Algorithm.
Step 9: All the hearing nodes would make entry of all these types of transmissions in a table of same fields and compare their own weight with these, immediately after this transmission. If it appears to a node that its weight is low then it assumes it self as member and sets it's ROLE as member and waits for the collection period.

ID	Weight	ROLE	CH-ID	Low resource
192.168.2.1.0011010.. (Initiating node)	9	1	192.168.2.1.0011010..	0
196.160.2.13.100011..	8	0	192.168.2.1.0011010..	0
192.120.22.15.110011..	7	0	192.168.2.1.0011010..	0
202.160.200.13.101010.	6	2	192.168.2.1.0011010..	0
.168.2.1.	5	2	192.168.2.1.0011010..	0
192.168.2.1.	7	2	192.168.2.1.0011010..	0

Every member has to make a list of cluster members in its memory including CH (Cluster Head) during collection period.
Step 10: After the claiming period each node will have all information about claiming nodes. A node with higher overall calculated weight would assume itself as CH (Cluster Head). Immediately after the claiming period, this node will broadcast a "HELLO message" after setting its ROLE as CH and CH-ID as its own ID. Hearing this rest all nodes update their role as MEMBER node and also broadcast "HELLO message" as a reply. This period will be called collection period. If weight of claiming node is equal to INITIATING NODE then it would not claim to be CH i.e. if condition is Wi >= Wj (where Wi = weight of Initiating node and Wj is weight of claiming node) then it will not claim to be CH. So according to this condition if the weights are equal then it will not claim for the CH.
Step 11: All the nodes which have just joined the cluster including Cluster Head update their CH (Cluster Head) field as ID of CLUSTER HEAD (CH-ID) which was a sequence of '0' initially.
Step 12: Collision will occur but again it will be dealt by Adaptive tree walk Algorithm. The benefit of this Algorithm is that if the Joining node is only one, then there will not be any collision, but as the nodes increases they will be given time to transmit as per the tree walk. So it can have benefits of both collision and contention free protocols.
Step 12: Cluster Head and all other member would maintain a table of members of cluster in their memory. They will be listening all the transmission during collection process and update their tables accordingly.
Step 12: All the station after updating their CH field (after joining a cluster) will keep mum until a change occur.
Step 13: Now if any node enters in cluster, leaves the cluster or change its role, it would transmit a "hello message".
Step 14: If a node wants to join a cluster its role field would be UNDECIDED, again.
Step 15: This process will form a cluster initially. All the operation performed in this cluster after this initial formation will be categorized as cluster maintenance operations.

Phase II: Cluster Maintenance: - Once a cluster is formed any node entering or leaving cluster has to take permission from CH (Cluster Head).
Process I: Cluster Joining Process: - If cluster is already formed and a node wants to join the cluster then it will proceed in the following manner
Step 1: In this system mobile stations will maintain frequencies as in the AMPS system. There will be 832 full duplex channels each consisting of a pair of simplex channels. There are 832 simplex transmission channels from 824 to 849 MHz and 832 simplex receiving channels from 869 to 894 MHz. Each of these simplex channels is 30 KHz wide. Thus this system uses FDM to separate the channels. The 832 channels are divided into four categories:

a.Control (CH to member) to manage the system – 21 channels are reserved for control
b.Paging (CH to member) to alert mobile users to calls for them. -
c.Access (bidirectional) for call set up and channel assignment.
d.Data (bidirectional) for voice, fax, or data.

Every node will maintain all four categories of channels.

Step 2: Nearby clusters will not use the similar set of frequencies (in four categories of channels) alike cell technology.
Step 3: Cluster head (CH) would always listen to all 21 control channels. All other members of a cluster will not listen to control channels continuously.
Step 4: If a node wants to join some cluster for some reason it scans a preprogrammed list of 21 control channels to find the most powerful signal. It notes down the most powerful signal and then tries to join this particular cluster.
Step 5: It switches over to this particular frequency and transmits a "Hello message". It sets CH field of its "Hello message" as the ID of most powerful signal received.
Step 6: Every new node joining new cluster has to authenticate itself by its old cluster (ID of old cluster) and threshold share update from all the members of old cluster (only when more secure environment is required). A node must authenticate or it has to make a new cluster for its existence.
Step 7: Hearing this CH accepts this node as a member vice-versa this node accepts this CH as its cluster head.
Step 8: If weight of CH is less than the new entering node then it will claim to be CH after joining the cluster. This will be dealt in "changing the cluster head Algorithm" separately.
Step 9: After joining the cluster this node changes over to access channel of cluster and transmits the "Hello message", hearing this every member and CH updates the list of members in the cluster.

Process II: Cluster Leaving Process for a member
Step 1: There may be so many reasons to leave the cluster e.g. if a node is low on resources (If any of three resources i.e. battery back up, transmitting range and reception range is

lower then a threshold value then a node resets its LOW RESOURCE Boolean field as yes=1), it must leave or if a node wants to change its location or if it wants to leave the cluster explicitly.
Step 2: If a node wants to leave a cluster, it will change its role as UNDECIDED but do not change CH-ID field. Transmit a "Hello message" with Role as UNDECIDED and CH-ID as original value.
Step 3: Hearing this every node including CH updates its member list and deletes this node from list.

Process III: Changing Cluster Head: - A cluster head may be changed due to many reasons e.g.
a.A better node with higher weight claims to be CH
b.Existing CH deteriorates on resources and hits LOW RESOURCE field to 1.
c.Existing CH wants to leave Cluster for some reason or it wants to change its location despite higher weight.

a. A better node claims (new or existing)
Step 1: Any node improving its weight can claim to be CH (Cluster Head) or any new NODE joining cluster may also claim to be the cluster head (CH) but final authority for changing cluster head (CH) lies with the present Cluster Head (CH). He can declare to leave the post of CH if he experiences low resource, if he is loosing weight or wants to leave the cluster for some reason despite having higher weight.
Step 2: Any Cluster Head (CH) if loses its weight by 25 %, will be discontinued as CH (Cluster Head). It will hand over its charge to an efficient and authenticated node.
Step 6: Every node before claiming to be CH (Cluster Head) has to have maximum weight.
Step 7: If any node wants to claim to be CH, it will transmit a "HELLO message" again.
Step 8: Present CH will store this ID of claiming node and any other node claiming to be CH.
Step 9: Any node claiming to be CH if desires to change its claim to be CH, can do this by changing its choice.
Step 10: This change will not effect immediately but after a spell of waiting period.
Step 9: After waiting period, If a CH desires to Hand Over his responsibility to any other claiming node then at that time he calculates the best among all the claiming nodes and hands over charge to him by sending a "Hello Message" broadcast. In this "Hello Message" it changes the CH field to the ID of new calculated CH.
Step 10: Hearing this "Hello Message" all member nodes change its CH field.

b. Existing Cluster Head (CH) deteriorate
Step 1: if cluster head deteriorate on resources then it follow the same process of handing over the post of CH.
Step 2: it looks the list of claiming nodes and then calculates the best amongst them.
Step 3: It then prepares a "Hello Message". In this "Hello Message" it changes the CH field to the ID of new calculated CH.
Step 10: Hearing this "Hello Message" all member nodes change its CH field.

c. Cluster Head intends to leave the cluster despite higher weight
Step 1: if cluster head intends to leave despite higher weight then also it follow the same process of handing over the post of CH.
Step 2: it looks the list of claiming nodes and then calculates the best amongst them.
Step 3: It then prepares a "Hello Message". In this "Hello Message" it changes the CH field to the ID of new calculated CH.
Step 10: Hearing this "Hello Message" all member nodes change its CH field.

d. Cluster disintegration
Step 1: If a node deteriorates on resources or wants to leave for some reason and there is no claiming node then cluster disintegration process is invoked.
Step 2: In this process existing CH transmit a "Hello Message" by setting all the fields to "0".
Step 3: Listening this all the nodes clear their memory and act as if they are not the member of any cluster.
Step 4: This process invokes again the process of new cluster formation

Architecture:

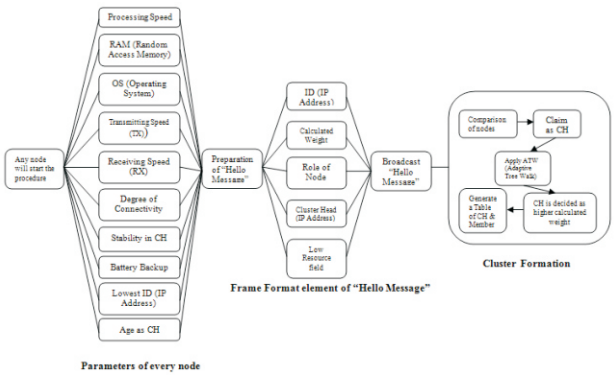

Figure 1: Architecture of Cluster Formation

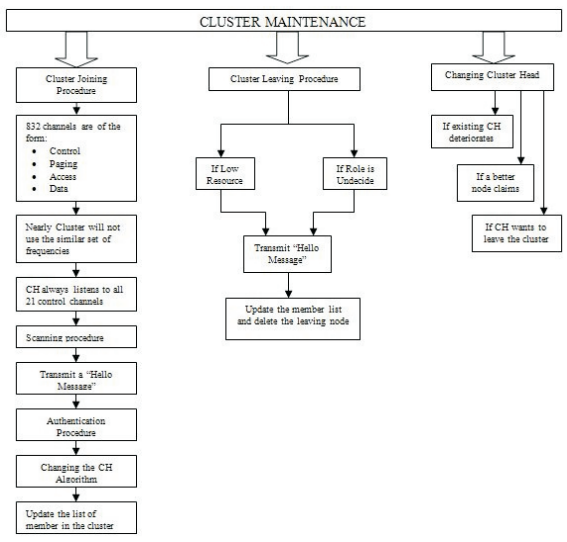

Figure 2: Architecture of Cluster Maintenance

CONCLUSION:

Improvement over Innovative Clustering Method for MANET Based on Cluster Convergence: - Our SCM algorithm is an improvement over Innovative Clustering Method. Innovative Clustering Method uses only three parameters whereas our SCM algorithm uses 10 parameters based on 10 point scale. Neighbors signal strength and predicted node mobility is used to calculate the convergence coefficient and further it is multiplied with primary weight to calculate final weight which is a complex method of calculating the weight whereas our SCM algorithm have all these parameters in the 10 parameters to calculate the final weight. Complexity remains less because computation is direct and easy. Members of cluster communicate with each other directly and to members of other clusters indirectly through cluster head which acts as a gateway. In our algorithm we suggest direct communication with members but with proper authentication to enhance security and indirect communication with the members of other clusters but with the help of gateways. Here in our algorithm cluster head is not working as gateway because it will increase the burden of processing and routing on the cluster head. Cluster head is already overloaded with so many processing, so we should avoid giving him extra processing burden. Two network interfaces are also not required for cluster head for internal and external communication because it will also increase the complexity of a cluster head node. In our algorithm a single interface will suffice for cluster head. Two interfaces (internal and external) are only required for gateway nodes because these only will be doing work of routing and communication to other clusters.

Future Scope:

This Algorithm is aiming to have fewer burdens18 on the cluster head and robust cluster formation. In this Algorithm all the nodes in the cluster are at one hop distance from the CH. Smaller clusters are more robust19 then the bigger clusters as they can work better in low resource conditions and more efficient in routing then bigger clusters. As the burden of processing is less on CH it will last longer. By providing authentication process while entering or leaving a cluster, the security of cluster is enhanced. In future these small cluster can form a big cluster by acting as sub-clusters of a bigger one, but there will not be any central node to play as CH. These small clusters will come together to form bigger clusters and it will also increase the efficiency of routing in bigger clusters

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