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B-Cluster: A Novel Cluster Algorithm for Secured Communication in MANET

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Abstract: The clustering algorithm are widely used to manage the nodes in large scale network. Eventhough, the clustering algorithm is designed to achieve communication stability for a large number of nodes to coordinate and balance the resources and reduce retransmissions and collisions, much of its resource is utilised for the cluster head election which is the frequent procedure in clustering as the nodes constantly move within and outside the cluster. When the cluster head is moved out new cluster head needs to be elected which is a overhead. Inorder to minimize this overhead, a new algorithm B-cluster is proposed which has a principle of electing two head at a time in a single election and have the second cluster head as reserve cluster head. When the first cluster head leaves the cluster reelection is not required in the proposed model as the reserve cluster head is declared as the new cluster head. Moreover, the overhead involved in the existing cluster head selection algorithm is reduced exponentially by giving preference to the Bring Your Own Device (BYOD) node as cluster head. BYOD is a preconfigured with the acees control and hence, is used to establish secured communication amoung the nodes in the cluster. The proposed algorithm is evaluated and the results are tabulated.

Key words: MANET, cluster, BYOD, algorithm, India

INTRODUCTION

MANET's are classified as flat routing (Zhang and Chong, 2009) and hierarchical routing (Torres and Cueva, 2015). In flat routing the node has to perform the role of host by generating its own data and control packets in addition to performing the role of router by forwarding it to its neighbours. Whereas in hierarchial routing nodes are classified into small groups called as clusters and a cluster head is designated in each cluster. The nodes in the MANET are free to move in any direction in any speed and hence, if the cluster head moves out of the cluster a new cluster head shouls be elected and this involves lot of overhead. The algorithm B-CLUSTER is proposed to minimize this overhead.

The contribution of this proposed algorithm B-cluster is a new method to minimize the overhead involved in the election process of cluster head. A new innovative methodology of having a BYOD node as a cluster head. Holding a reserve cluster head to minimize reelection frequency.

Literature review: Many clutering algorithms are proposed by great researchers Hakimifar *et al.* (2015), Agarwal and Motwani (2009), Dhurandher and Singh (2005), Muthuramalingam *et al.* (2010) and Chauhan *et al.* (2011). The Cluster Based Routing Protocol (CBRP) is one of the solution to handle large scale MANETs. CBRP is designed for effective cluster based communication in MANET (Jiang *et al.*, 1999). The nodes in CBRP are divided into small groups called clusters. Each cluster has the Cluster Head (CH) elected by cluster members. The CH is elected based on lowest-ID mechanism. Each node in the cluster possess bi-directional link to its CH. Every node in the cluster is responsible to maintain a Netwotk Neighboring table (NN) having information about its neighbor nodes namely, neighbor node-ID, link state information (bidirectional/unidirectional) and role of node in the cluster (head/member/undecided).

Basu *et al.* (2001) proposed a distributed clustering algorithm, MOBIC for the selection of clusterheads. The researcher demonstrated the stability of the proposed algorithm cluster formation upon than the "least clusterhead change" version of the well known Lowest-ID Clustering algorithm.

Yu and Chong (2005) discussed the recently proposed clustering algorithms classified on the basis of their objectives. This survey provides descriptions of the mechanisms, evaluations of their performance and cost and enlists the discussions of advantages and disadvantages of each clustering scheme.

Yu and Chong (2006) proposed an Efficient Clustering Scheme (ECS) suitabler for large and dense MANETs. Mechanisms for cluster formation and cluster maintenance are discuused. ECS capability to eliminate the frozen period requirement for cluster formation to reduce cluster overlapping and to prolong the cluster lifetime without producing excessive clustering overheads are demonstrated. Many researchers have various cluster methodology

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for MANET (Er and Seah, 2004; Patel and Dubey, 2015; Yadav and Singh, 2015; Singh and Singh, 2015).

MATERIALS AND METHODS

The proposed algorithm B-cluster

Cluster formation: The solution addressed to improve routing performance in MANET's of large scale is clustering. Managing large scale networks is very hectic and hence, they are divided into clusters. The formation of clusters is not by the classical procedure of taking a radius and drawing a circle and all the clusters within the circle boundary belong to the cluster. The drawback of this methodology of forming the cluster is however, close the circles are placed there are many chances that few nodes donot fall into any of the cluster circle. But, if the cluster is formed in the form of a hexagon all the nodes in the large scale MANET fit in any one of the cluster.

Assumptions: The network topology is dynamic; the mobile node has atleast a BYOD node in each of the cluster; side length "T" of the regular hexagon is known; inorder to generate the hexagon the cluster area is defined by the following equation:

$$CA = 3v3/2\ T2$$

Where, 'T' is the length of the regular hexagon if the known T value the hexagon could be generated; the constant function of the node in MANET is changing the physical location to any direction at any time.

Cluster formation algorithm:

- Step 1; fix the optimum cluster size based on the application area as 'r'
- Step 2; identify the Cluster Area CA = $3v3/2\ T^2$ Where 'T' is the length of the regular hexagon

Cluster head selection: After the cluster is formed next task is to identify a head for the cluster. It is generally, named as cluster head. The methodology proposes a new technique to minimize the overhead involved in the classical cluster head selection algorithm. The refinement done to achieve the objective is to identify the BYOD nodes in the cluster. The weight of the BYOD nodes are calculated and updated in the weight table. Based on the weight value, the cluster head is selected. The weight of the cluster denotes the energy of the cluster. Energy of a node is the vital parameter next to BYOD node in determining the cluster head selection.

The reason behind the BYOD nodes being elected as cluster head is they are trust worthy nodes. These are preprogrammed with access control parameters and hence are identified as eligible nodes to compete for cluster head election (Algorithm A).

Algorithm A; cluster head election:

```
Alg_Cluster Head_ Selection

If BYOD nodes are present in the cluster
{
      Broadcast beacon signal to all BYOD nodes in the transmission range
      process the received signals and compute connection Matrix 'c'
      Calculate Weight of Node Wn
      Broadcast Wnto all BYOD Neighbour nodes
      Process the received Signals and establish weights of the Neighbour
      Identify the node with minimum weight and declare it as cluster head
      Identify the node with second minimum weight and declare it as
      Reserve Cluster Head}
else
{
      Broadcast Beacon signal to all nodes in the Transmission Range
      Process the received signals and compute Connection Matrix 'c'
      Calculate Weight of Node Wn
      Broadcast Wnto all Neighbour nodes
      Process the received Signals and establish weights of the Neighbour
      Identify the node with minimum weight and declare it as cluster head
      Identify the node with second minimum weight and declare it as
      Reserve Cluster Head
}
```

Cluster maintanence: Cluster maintanence as discussed earlier involves huge overhead. If the energy of the existing cluster head is less than that of the threshold, the cluster head sends energy down message to all the neighbours to initiate reelection process. The cluster head election is initiated if the cluster head leaves the cluster (Algorithm B).

Algorithm B; cluster maintanence:

```
New_ClusterHead()
{
If (reserve_clusterhead moved out of the cluster)
     calculate Energy of BYOD node in NN Table
    BYOD Nodewith highest Energy is elected as new Cluster_Head
If (Energy<Threshold)
      Cluster head sends ENERGY_DOWN Message to all its
neighbours
      Reelection procedure
      calculate Energy of BYOD node in NN table
      BYOD Nodewith highest Energy is elected as new Cluster_Head
}
```

Node movement has a mandatory role to play in MANET. The cluster head movement initiates the relection process but, if the node moves it also have overhead involved in updating the NN table. The node movement may be classifies as new node leaves the cluster or a new node joing the cluster (Algorithm C).

Algorithm C; Node movement:

```
Node_Movement()
{
If (Node leaves the cluster)
      Update its entry in the network neighbor table
If (CH leaves the Cluster)
      The reserve_cluster head is declared as CH
If (new node sends join request)
      Create an entry in CH_Neighbour Table
If (Another Cluster head joins the Cluster)
      Update its entry in NN table
Calculate its weight and update in Weight Table
}
```

Table 1: The proposed algorithm are composed with the existing algorithm

Performance evaluators	AODV	AOTDV	DSR	CBRP	B-cluster
Packet delivery ratio (%)	41.2	43.4	36.2	58.50	77.3
End to end delay (ms)	26	23.8	22.1	20.00	15.1
Routing packet overhead (%)	1.5	1.72	1.7	1.27	1.7
Number of times CH changes	NA	NA	NA	40.00	21.0
Packet delivery ratio (%)	42.12	50.5	41.8	63.90	87.0
End to end delay (ms)	33.2	31.2	32.7	24.80	14.1
Routing packet overhead (%)	12.1	13.99	11.3	7.30	5.2
Number of times CH changes	NA	NA	NA	51.00	33.0

RESULTS AND DISCUSSION

In this study, the effectiveness of the proposed algorithm B-cluster is provided using the simulation results generated by the simulator Qualnet 4.5.

Environment settings: Simulation software: Qualnet 4.5; simulation area: 10 km^2; number of simultaneous nodes: 50; simulation time: 200 Sec; node mobility: random; data packet size: 2048B (2KB): maximum speed: 20 m sec^{-1}.

Performance parameters: Performance is evaluated for the following parameters:

- Packet delivery ratio
- Average end to end latency (mS)
- Routing packet overhead (%)
- Energy consumption (Joules)

Result analysis: The proposed algorithm B-cluster are compared with the existing algorithms like AODV, AOTDV, DSR, CBRP. The performance is evaluated under two different scenarios by varying node speed and by varying number of nodes (Table 1).

Scenario 1 deals with node velocity and scenario 2 deals with varying number of nodes. The packet delivery ratio is high for both the scenarios in our proposed algorithm and the reason behind this is the choice of BYOD nodes as cluster head as these nodes are trustworthy nodes and hence, result in excellent packet delivery.

End to end delay in our algorithm B-cluster is minimized in both the scenarios. The CBRP has delay of 20 ms whereas the B-cluster has the value further reduced by 5 ms producing 15.1 ms.

Routing packet overhead is highly reduced in the B-cluster. In scenario 1 it is 1.7% in sceanario 2 the routing packet overhead is high for all the algorithms as this scenario deals with varying number of nodes. Many nodes join the cluster and leave the cluster and election and reelection algorithms are executed frequently. But in the B-cluster, the frequency of reelection is reduced resulting in lower routing packet overhead.

Number of times CH changes is less for the proposed algorithm compared to the CBRP. The reason behind this is the energy level of the node is saved as only BYOD nodes participate in the election and much of the energy of the nodes is not wasted in polling several times as reserve cluster head is also selectes in the same election.

CONCLUSION

The proposed algorithm B-cluster outperforms the other existing algorithms incase of packet delivery ratio, average end to end latency, routing packet overhead and energy consumption. Ultimately, the through put of the proposed algorithm is high. The future work involves applying fuzzy to the B-cluster algorithm.

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