Energy Efficient Cluster Head Selection Technique for AODV Routing Protocol

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ABSTRACT
Energy is a scarce resource in Wireless Mobile Adhoc networks (MANETs). Adhoc on-demand distance vector (AODV) [6] routing protocol is a reactive protocol used in MANETs. To achieve energy efficiency, Expanding ring search technique is used in MANETs to reduce the network overhead by minimizing the number of Route Request (RREQ) packets broadcasting throughout the network. If the destination node is very far from the source node, Expanding ring search (ERS) [8][9] technique will take much iteration to find the destination node and thus increases the routing overhead. Because of the battery constraints, protocols have to make efficient to conserve the battery. In order to minimize this routing overhead, we propose a new technique called as Cluster Source Initiated AODV routing protocol. Our approach conserves the energy of the nodes by avoiding the redundant rebroadcasting of RREQ by selecting cluster head from each group.

The deployed nodes in the network are sub-divided into number of clusters and each cluster has its own cluster head. The source node is considered as cluster head in that cluster and it broadcasts RREQ to the members of that particular cluster. The cluster nodes which have a shortest path to the next cluster heads will broadcast the RREQ to next cluster head. Then the intermediate cluster head will broadcast the RREQ to its cluster members. This process is repeated till RREQ reaches destination node.

Simulations are performed to study the performance of Cluster Source Initiated AODV routing protocol using Network Simulator – 2 (NS2). The results show the reduced routing overhead and the energy of nodes conserved to a greater extent.

Keywords
Mobile Ad-hoc Networks, Ad-hoc On-Demand Distance Vector Routing Protocol, Expanding Ring Search, Cluster formation, Energy Consumption, Spatial Co-relation.

1. INTRODUCTION
Data communication networks are broadly classified into Wired and Wireless networks. A wireless network [1] provides flexibility and mobility of the devices. Wireless networks are further classified into infrastructure oriented and infrastructure less networks. The Nodes in AdHoc networks [4] are self configuring and they change network topology very frequently. Because of mobility of nodes, power consumption and route establishment are critical factors.

Adhoc On-demand Distance Vector routing protocol (AODV) [2][3] establishes the route between nodes when there is a need of communication without considering the network topology. AODV establishes the route by network wide flooding of RREQ packets and this consumes the battery power to greater extent. ERS [8] technique has been adopted in AODV protocol to overcome the setback associated. Time-to-Live (TTL) value is included in RREQ packets to minimize the network wide flooding of RREQ packets. If Destination node is far away from Source node, RREQ packets have to be sent multiple times with multiple increments of TTL value [7]. Because of this, nodes which are near to the Source have to process these packets many times. This consumes the battery power to greater extent. In this paper, we propose the ideal technique called Energy Efficient Cluster Head Selection Technique for AODV Routing Protocol which divides entire network into number of clusters and also selects cluster heads based on their battery status. Route is established between Source to Destination node through cluster heads.

2. PROBLEM FORMULATION
In this section we discuss about energy based cluster head selection, formation of clusters, selection of new cluster heads and route establishment between nodes.

2.1 Cluster Formation
The deployed nodes constantly send Hello packets to its neighboring nodes along with the energy status. The node which is having maximum energy voluntarily acts as a Cluster Head (CH). The formation of cluster along with the CH is shown in Fig.2.

Following steps explains the formation of clusters:
(i) Every nodes in the network send Hello packets to its neighboring nodes. In these packets we have included the energy status of the respective node which place an important role in the selection of CH. Energy status of nodes is added to Hello packets. Modified Hello packet is shown in Fig. 1.

AODV Hello Pkt	Hop count	Dest Addr	Dest Seq	Life Time	U ID	Energ y Status

Fig.1. Modified Hello Packet

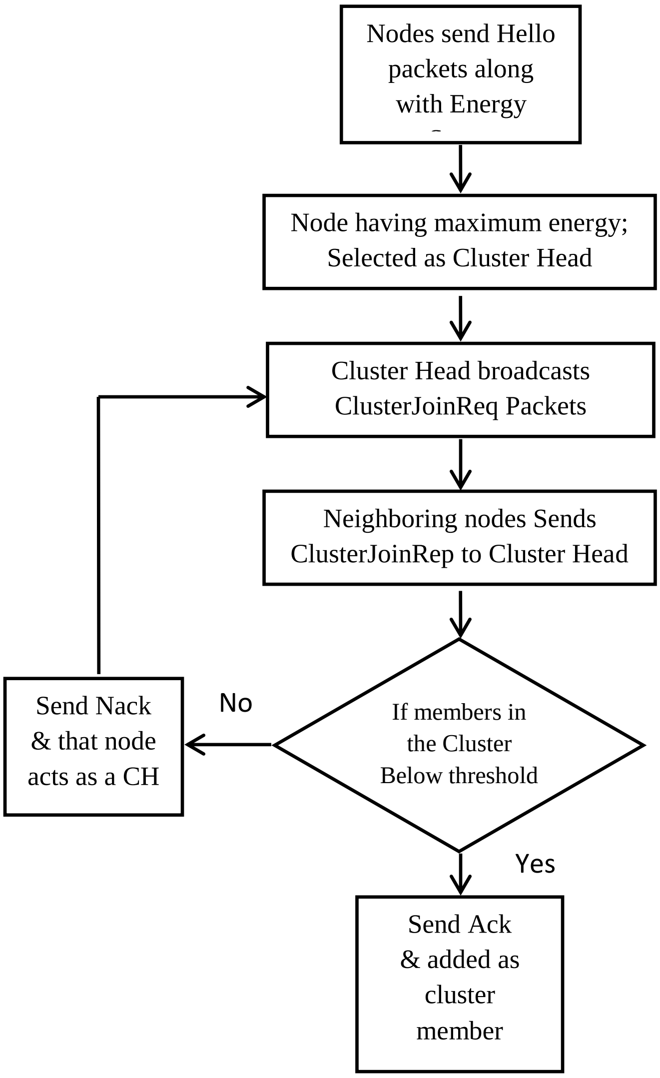

Fig. 2 Formation of Cluster.

(ii) All the nodes in the network, receives Hello packets from neighboring nodes and compare its energy status. Node which is having energy status more than neighboring nodes, acts as CH.

(iii) CH sends ClusterJoinReq (CJRQ) packets to its neighboring nodes.

(iv) Nodes which receives CJR packets, sends ClusterJoinRep (CJRP) to CH node.

(v) CH compares member count with threshold value. If count is below, it adds node as its member by sending an acknowledgement (ACK). Otherwise it sends Negative acknowledgement (NACK) to indicate cluster has reached its threshold value. A threshold value is maximum allowable nodes in a cluster.

(vi) Nodes which receives the NACK, acts as another CH and repeat process from (iii).

2.2 Selection of new Cluster Head

CH broadcast energy status at regular intervals. Cluster members compare their energy (N_E) status with energy status of CH (CH_E). If CH_E greater than N_E, member node becomes CH. Fig. 3 shows process of re-selection of CH.

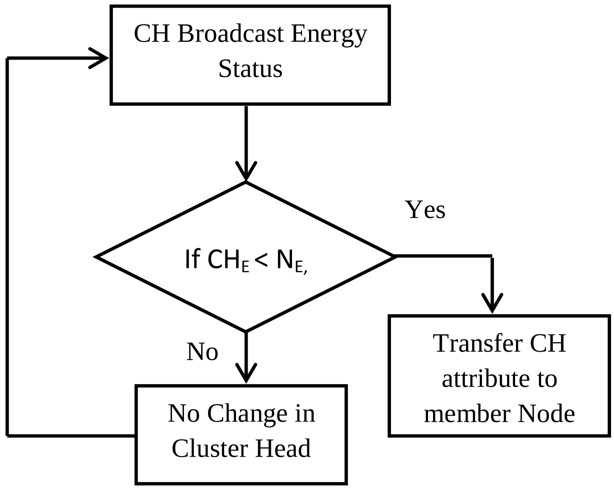

Fig. 3.Selection of new CH

2.3 Route Establishment

Before sending Route Request (RREQ) packets, a new field is added, called as CH_{Count}. When RREQ passes through a CH, this count is incremented. Modified RREQ packet format is shown in Fig. 4 along with other fields.

AODV RREQ Pkt	Bcast ID	Dest Addr	Dest Seq	Src Addr	Src Seq	Last Addr	**CH Count**	Hop count

Fig. 4. Modified RREQ Packet

(i) Initially source send modified RREQ to its CH.
(ii) CH checks for the destination within a cluster. If it is present, send RREQ to destination. If not, broadcast RREQ to its member nodes.
(iii) The member nodes which are nearer to next CH, forwards RREQ to next CH and informs its CH that it has path to the next CH.
(iv) Once RREQ reaches next CH, CH_{count} is incremented.
(v) If destination is present in that cluster, send RREQ, else broadcast RREQ to its member nodes.
Above process repeats till RREQ reaches destination node. Destination node receives many RREQ from different paths. Destination checks for the minimum CH_{Count}, selects that path as active path and removes that entry from routing table. Destination sends Route Reply (RREP) packet in the same path of RREQ selected. Process of sending RREP is as shown in Fig. 6.

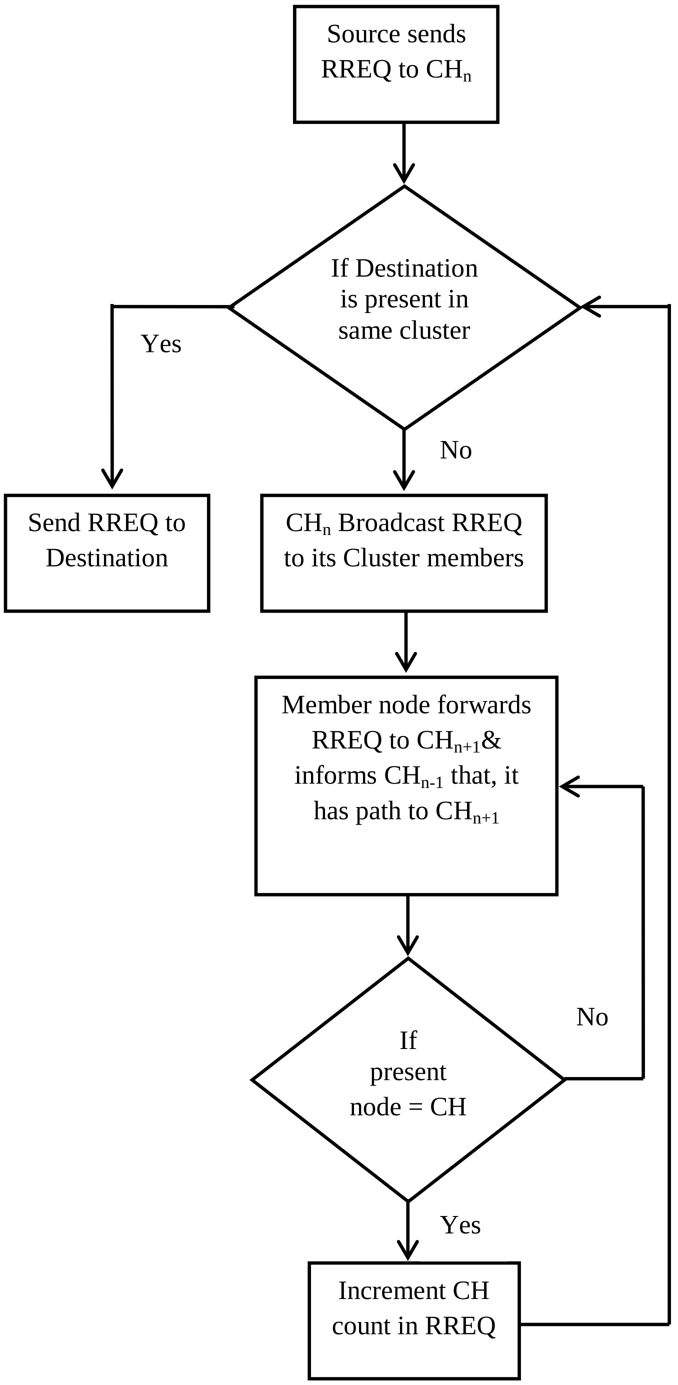

Fig. 5. Broadcast of RREQ

The CH_{Count} is included in RREP packet to ensure the delivery of RREP.

(i) Destination node send modified RREP to its CH.
(ii) Once RREP packet reaches CH, decrement CH_{Count} and forward RREP to node which is present in next cluster.
(iii) This process repeats till CH_{Count} reaches zero.
(iv) IfCH_{Count} = 0, search for the source node in that cluster.

Best path between source and destination is established when source receives RREP packet. In case of link failure between data transferring, destination select next RREP which is having less CH_{Count} and send RREP to source. This will establish new path between source and destination.

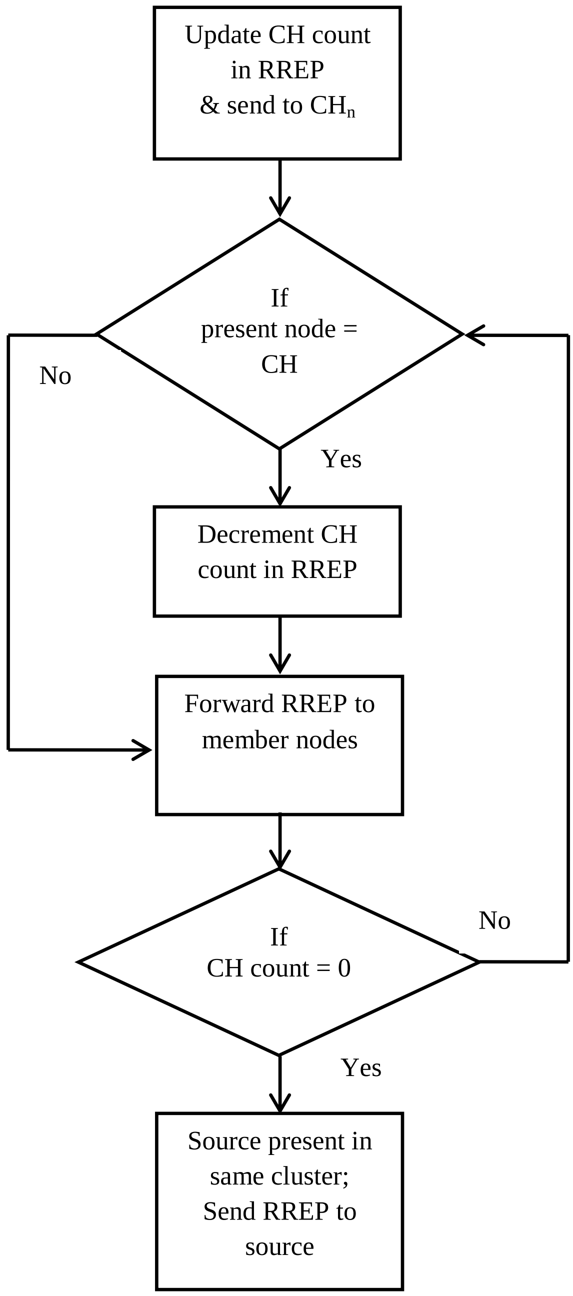

Fig. 6. RREP Path to Source

3. PERFORMANCE EVALUATION

We used NS-2 simulator [10] for the implementation of the proposed technique. This includes many changes to existing system. The work is simulated using ns-2.34 tool. EECH AODV protocol is implemented in C++ programming language and executed through Tcl scripts. The EECH AODV protocol in ns-2.34 is modified in various.

The experimental result shows EECH AODV is better compared to ERS technique in AODV [5] in terms of computational power that reduces energy consumption of nodes. CH is changed periodically by comparing energy status with member nodes, their by avoiding dead nodes. Another advantage is selection of best path on the basis of CH_{Count}..

The simulation area is a square field of 1200m x 1200m size, where nodes are placed uniformly. The random way point model is used, where each node chooses a random point and move towards that point with a random speed chosen between minimum and maximum values specified. The bandwidth of shared wireless channel is assumed to be 2 MHz The nodes use the 802.11 as MAC protocol and IP as network protocol with output queue size of 200. The transmission range of all the nodes in the network is set to be around 280m. The parameters considered for the simulation are listed in the Table 1

Table 1:Simulation Parameters

Parameters	Values
Terrain Size	500 X 500 Sq. meters
Simulation Time	500 Sec
No. of Nodes	50, 100
Node Placement	Uniform
Transmission Range	280 meters
Bandwidth	2MHz
Propagation Model	TwoRay Ground
MAC Protocol	802.11
Network Protocol	IP
Transport Protocol	TCP
Routing Protocol	AODV, EECH AODV
Application	CBR

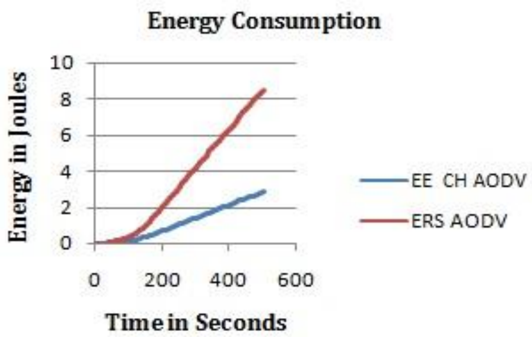

Fig. 7 Energy Consumption Graph

Fig. 7 shows the energy consumption in terms of computational power. The energy consumption in EECH AODV is less than ERS AODV.

4. CONCLUSION

This paper proposes Energy Efficient Cluster Head Selection for AODV Protocol which uses CH_{Count} in both RREQ and RREP packets to minimize energy consumption of nodes in the network. In future if multiple nodes are nearer to the next CH, the node which is having maximum energy will actively participate in the route establishment.

5. REFERENCES

[1] D.P.Agarwal and Q-A Zeng, Introduction to Wireless and Mobile Systems, Brooks / Cole Pulishing, ISBN No. 0534-40851-6,436 pages,2003.

[2] PadminiMisra, Routing Protocols for Ad Hoc Mobile Wireless Networks, http://www.cse.wustl.edu/~jain/cis788-99 /ftp/ adhoc_routing.

[3] ElizabethM.Royer and C.K.Toh,"A Review of current Routing Protocol for Ad-Hoc Mobile Wireless Networks ", 2003.

[4] C.E.Perkins, "AdHoc Networking", Addison-Wesley Publication, Singapore, 2001.

[5] WoonkangHeo and Minseok Oh, "Performance of Expanding Ring Search Scheme in AODV Routing Algorithm", Second International Conference on Future Generation Communication and Networking, pp : 128-132, China, 2008.

[6] Working of AdHocOndemand Distance Vector Routing Protocol (AODV) https://www.ietf.org/rfc/rfc3561.txt

[7] D.N.Pham and H.Choo, "Energy Efficient Ring Search for Route Discovery in MANETs" ,IEEE International Conference of Communication, Turkey, 2008.

[8] D.N.Pham,V.D.Nguyen, V.T.Pham, N.T.Nguyen, X.BacD, T.D.Nguyen, C.Kuperschmidt and T.Kaiser, "An Expending Ring Search Algorithm For Mobile Adhoc Networks", International Conference on Advanced Technologies for communication, Vietnam, 2010

[9] S. Preethi and B. Ramachandran,"Energy Efficient Routing Protocols for Mobile AdHoc Networks", International Conference on Emerging Trends in Networks and Computer Communications (ETNCC), Udaipur, 2011

[10] The Network Simulator - ns-2, http://www.isi.edu/nsnam/ns/