ENERGY CONSTRAINT NODE CACHE BASED ROUTING PROTOCOL FOR ADHOC NETWORK

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ABSTRACT

Mobile Adhoc Networks (MANETs) is a wireless infrastructureless network, where nodes are free to move independently in any direction. The nodes have limited battery power; hence we require energy efficient routing protocols to optimize network performance. This paper aims to develop a new routing algorithm based on the energy status of the node cache. We have named this algorithm as ECNC_AODV (Energy Constraint Node Cache) based routing protocol which is derived from the AODV protocol. The algorithm is based on the current energy status of each node and the cached node. The simulation result shows the comparison of ECNC_AODV with AODV protocol with the performance parameters such as energy consumption due to routing control packets, routing overhead and delivery ratio. The result shows the advantages of ECNC_AODV over AODV protocol in terms of energy consumption and routing overhead without affecting the delivery ratio. The simulation is done using Network Simulator NS-2 (Version 2.33).

KEYWORDS

MANET, ECNC_AODV, Energy Consumption, routing overhead, NS-2 simulator.

1. INTRODUCTION

Mobile Ad-hoc Networks (MANETs), is a wireless infrastructure network where nodes are free to move independently in any direction. These nodes do not require any base station for communication among them. Development of energy efficient protocol is needed due to limited battery power of all nodes.

In the related work, Jung et. al. [1] have proposed an approach to constrain RREQ packets based on node caching i.e. the nodes which are recently involved in forwarding the data packets are used to forward RREQ packets. Lee et. al. in [2] have presented workload based adaptive load balancing technique that drops RREQ packets based on the load status of each node. They used different methods instead of flooding to improve packet delivery ratio, average end to end delay and normalized routing overhead.

The flooding method used, in On-demand protocols like AODV [3] and DSR [4], for route discovery process not only increase routing packets but also the energy consumption of each node. Frikha et. al. [5] have proposed an energy constraint routing protocol in which the routing packets are transmitted based on the energy status of the node.

Zygmunt J.Haas et. al. [6] and N.Mahesh et.al. [7] have proposed Gossip technique instead of flooding to increase the delivery ratio of the AODV protocol. The author of the paper [11] and [12] compare energy consumption of various reactive and proactive routing protocols under self–similar traffic. This paper concentrates on the algorithm other than flooding which reduces the energy consumption and hence increases the lifetime of the network. Also it reduces the packet overhead of each node without affecting the delivery ratio.

The present paper is organized as: In section 2, working of AODV and proposed ECNC_AODV routing protocol is explained. The simulation environment and energy model is discussed in section 3. The simulation results are shown in section 4. Sections 5 describe conclusions and future scope.

2. ROUTING PROTOCOL FOR ADHOC NETWORK

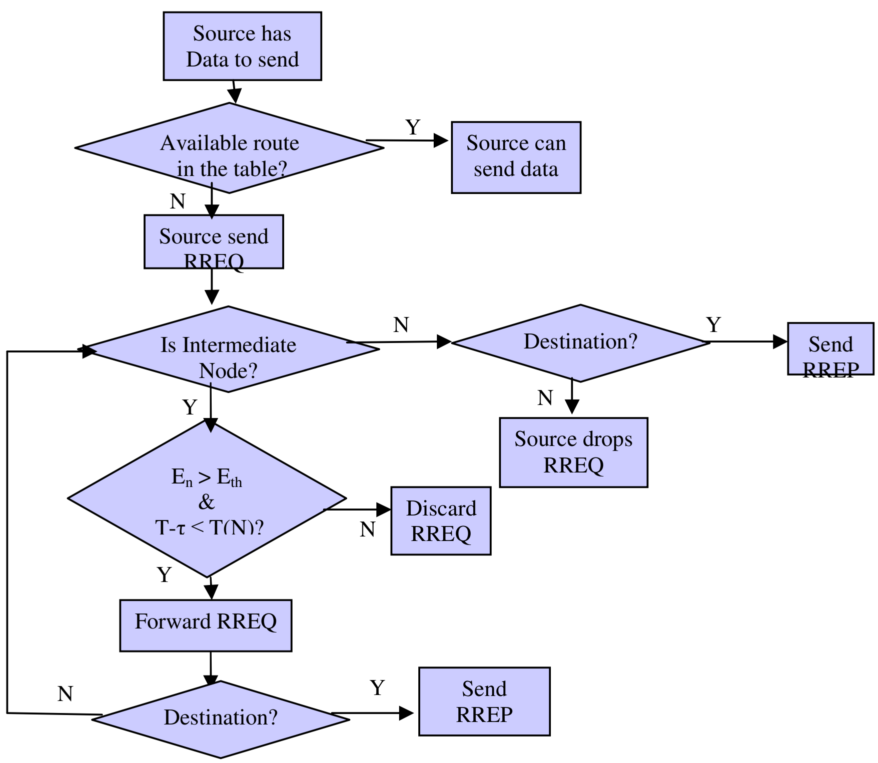
Present paper discusses a new routing protocol ECNC_AODV which is derived from AODV protocol. These can be explained as under:

2.1 AODV Routing Protocol

The Ad hoc on demand Distance Vector (AODV) protocol [3] is a reactive also called On-demand routing protocol finds route from source to destination when it is demanded. The protocol undergo: route discovery and route maintenance process. In route discovery process, the source node broadcast RREQ (Route Request) packet to its neighbors, which then forward the request to their neighbors and so on. When the packet reaches the destination node, it generates RREP (Route Reply) packet. In route maintenance process, the source node is being notified by RERR (Route Error) message in case of any link failure. The connectivity between the nodes is maintained using *Hello* beacon.

2.2. Proposed ECNC_AODV

The main aim of the proposed algorithm is to reduce the number of routing packets generated due to flooding method so that there should be reduction in energy consumption; routing overhead and increase in network lifetime could be achieved, without affecting the throughput of the network. The proposed algorithm is explained with the help of flow chart as given below:



The steps involved in the proposed algorithm are:

Step 1: *At source node:*

The source node generates RREQ packet and broadcast it to its neighbours.

Step 2: *At intermediate node:*

Rule 1: If $E_n > E_{th}$ and $T-\tau \leq T(N)$, then n^{th} node will forward RREQ packet.

Rule 2: If $E_n > E_{th}$ and n^{th} node is having one neighbor then it will forward RREQ packet so that destination is not missed.

Rule 3: If $E_n < E_{th}$, then drop RREQ packet.

Step 3: *At Destination node:*

The destination node after receiving RREQ packet will send RREP packet back to the source node. The destination routine is not changed.

Here E_n is the current node energy, E_{th} is the set energy threshold (normal zone is considered), T is the current time, T(N) is the time when last data packet transmitted through node N and τ is another small set time threshold which decides the memory of the node.

3. SIMULATION AND ENERGY MODEL

In simulation model, we have taken 50 nodes that are randomly distributed in a region of 1000m X 1000m and there are 30 numbers of connections. The energy model is same as in [6]. The NIC card includes radio range of 250m, 2Mbps data rate and a frequency of 2400MHz. Initial energy taken is 1000J with transmission and reception power of 1.65W and 1.1W respectively. The traffic model is CBR (Constant Bit Rate) with packet size of 512 bytes and rate 64 packets/s. We have performed experiments for different values of τ = 1, 10, 20, 30, 40, 50 as per our simulation environment and found that τ = 30 will give the throughput equal to AODV protocol.

Table 1.Simulation Parameters

Parameter	Value
Number of Nodes	50
Grid Area	1000m x 1000m
Transmission Range Pause Time	250 meter 100 seconds
Speed	5 m/s
Time threshold (τ)	30
Sending Rate	64 packets/s
Traffic Model	CBR
Data Packet Size	512 bytes
Control Packet Size	48 bytes
Simulation Time	900 seconds

Our main aim is to examine the energy consumption of new algorithm as compared to AODV protocol. Though the delivery ratio (Throughput) can be increases by increasing the value of τ. The energy threshold is also set in normal zone condition. The traffic model is generated using cbreng.tcl and the selected parameters are varied using setdest command [7]. NS-2 simulator version 2.33 is used as the simulation tool [8].The selected simulation parameters are also listed in table 1.

4. RESULTS

We have evaluated

(i) *Energy Consumption (Joules) due to routing packets:* The energy consumption is converted in Joules by multiplying power with time as shown in the following equations [9]:

Transmitted Energy

T_x Energy = (1.65 * Packet Size)/ $2x10^6$ (1)

Receiving Energy

R_x Energy = (1.1 * Packet Size)/ $2x10^6$ (2)

(ii) *Routing Overhead:* the ratio of number of control packets required for delivery of data packets.

(iii) *Delivery Ratio:* the ratio of number of packets delivered to the number of packets send.

We have evaluate the above parameters as a function of speed = 0, 1, 5, 10, 15 and 25m/s, number of nodes = 30, 40, 50, 60, 70 and 80, number of connections = 10, 20, 30, 40, 50 and grid area = 500mX500m, 750mX750m, 1000mX1000m, 1250mX1250m and 1500mX1500m.

4.1 Energy Consumption:

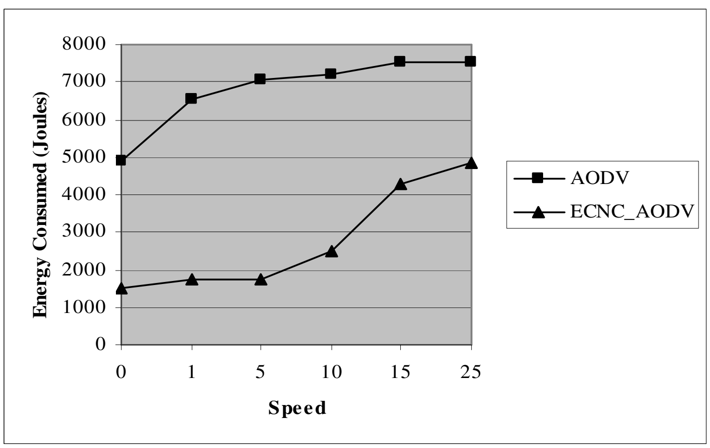


Figure 1a: Energy consumption Versus Speed

Figure 1a, 1b, 1c, and 1d shows the total energy consumed (Joules) due to control routing packets. Results shows that energy consumption is reduce in the range of 10% to 40% using ECNC_AODV in comparison with AODV protocol. This reduction in energy is observes under all scenarios i.e. under mobility pattern, traffic pattern, network size, area shape etc. This reduction in energy consumption is observed due to reduce in the number of routing control packets (RREQ).

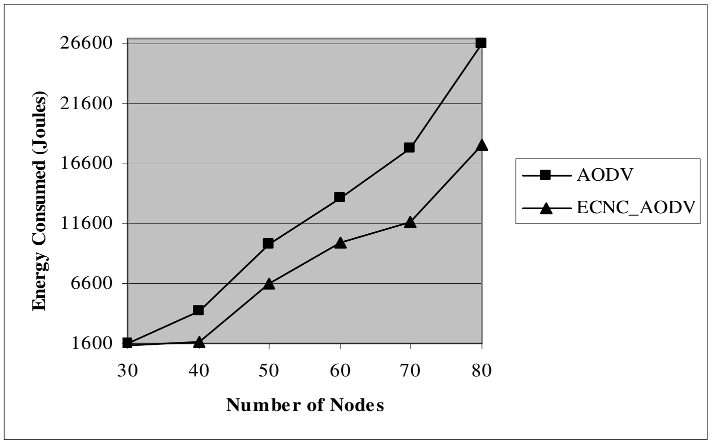


Figure 1b: Energy consumption Versus Number of Nodes

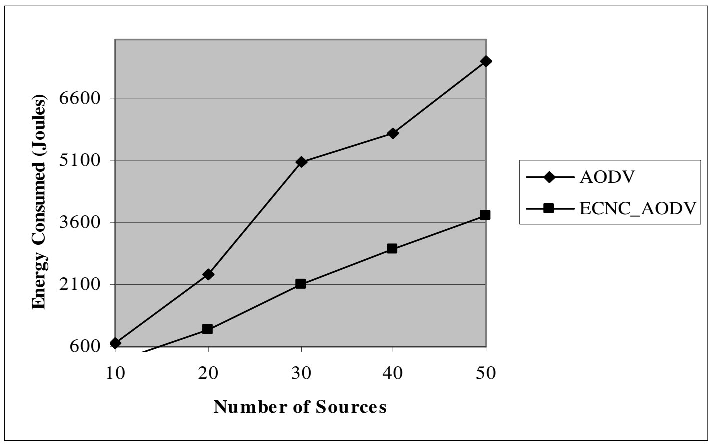


Figure 1c: Energy consumption Versus Number of Connection

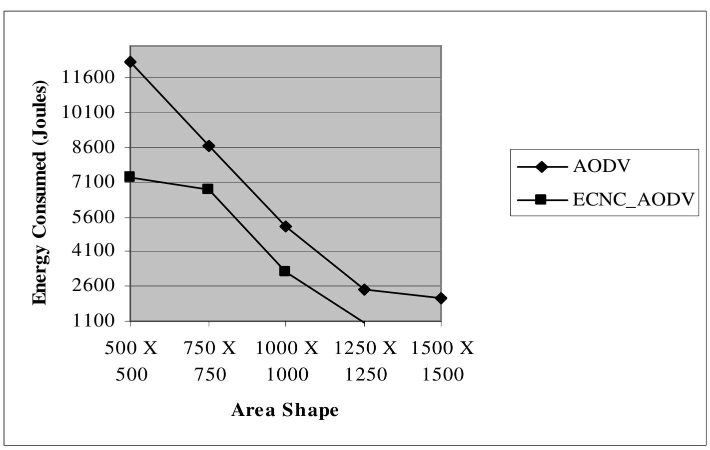


Figure 1d: Energy consumption Versus Grid Area

4.2 Routing Overhead:

Graph of figure 2a, 2b, 2c, and 2d shows the normalized routing overhead. Again there is 10% to 30% reduction in the routing overhead for ECNC_AODV is observed by varying speed, number of nodes, number of sources and grid area as compared to AODV protocol.

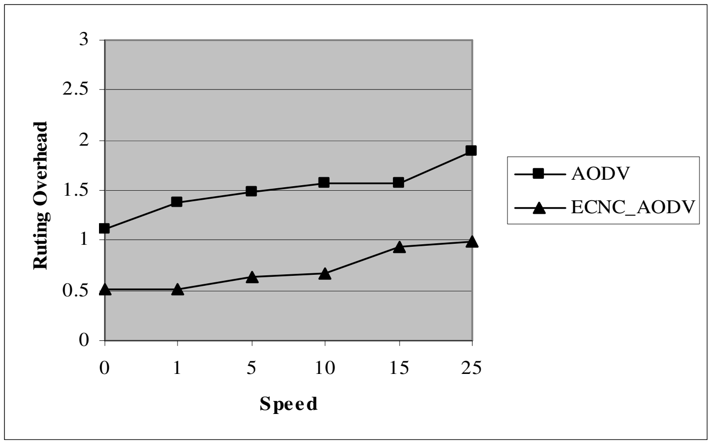


Figure 2a: Routing Overhead versus Speed

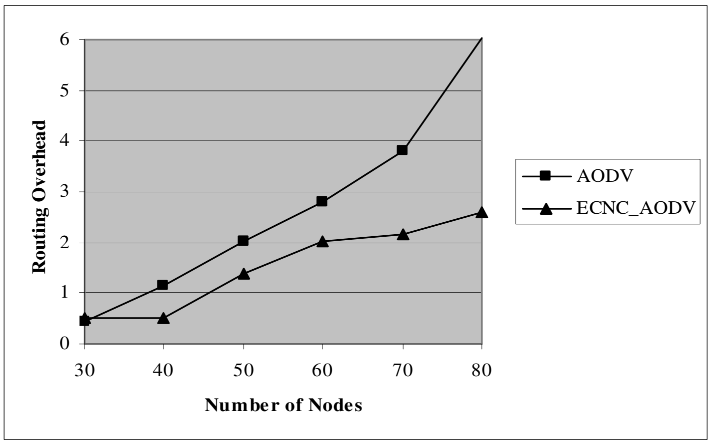


Figure 2b: Routing Overhead versus Number of Nodes

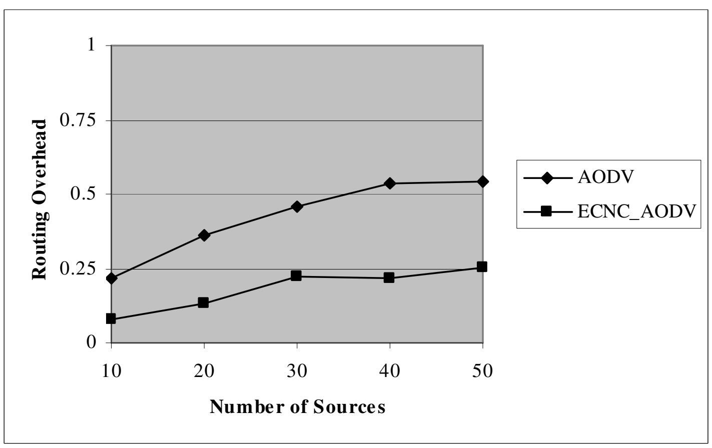


Figure 2c: Routing Overhead versus Number of Connection

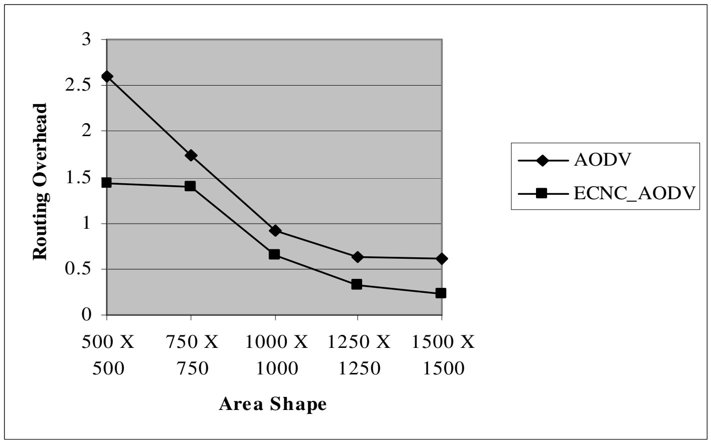


Figure 2d: Routing Overhead versus Grid Area

4.3 Delivery Ratio:

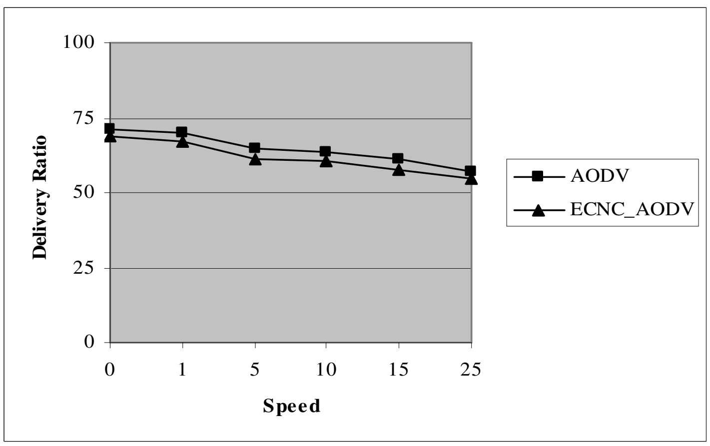


Figure 3a: Delivery ratio Versus Speed

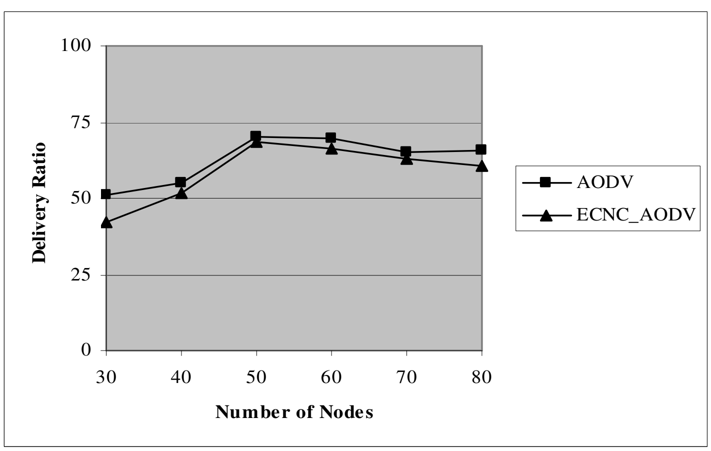


Figure 3b: Delivery ratio Versus Number of Nodes

Graph of figure 3a, 3b, 3c, and 3d shows the delivery ratio (Throughput) as a function of mobility pattern, traffic pattern, network size and area shape. The delivery ratio of ECNC_AODV is within ± 5% to that of AODV. Our main aim is to reduce the energy consumption under all scenarios without affecting the delivery ratio (throughput). The throughput can be increased by varying the value of τ to higher side. The delivery ratio of both the protocols is almost same.

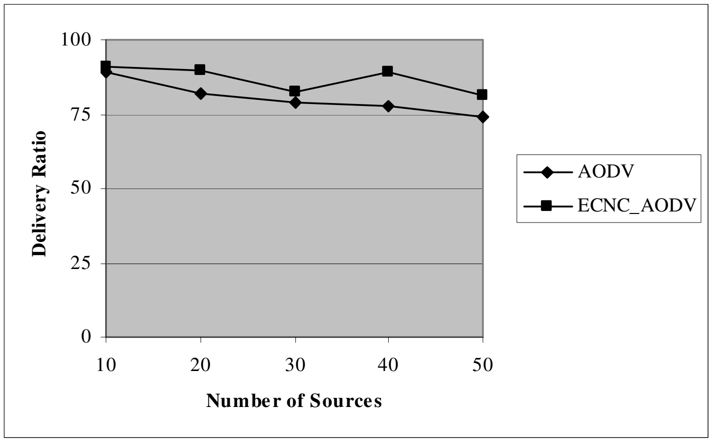


Figure 3c: Delivery ratio Versus Number of Connection

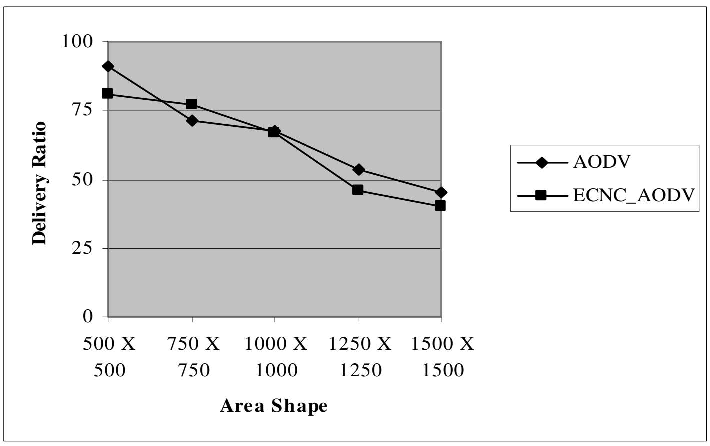


Figure 3d: Delivery ratio Versus Grid Area

5. CONCLUSION

On the basis of critical evaluation of all the results discussed above, following conclusions can be made about the better performance of ECNC_AODV over existing AODV protocol under all scenarios.

(i) There is 10% to 40% reduction in energy.

(ii) There is 10% to 30 % reduction in routing overhead.

(iii) The delivery ratio of both the protocol is almost same.

In future both the protocols can be examined under self-similar traffic like Pareto and Exponential traffic. Also one can analyze these protocols to find the optimal value of set energy and time threshold to optimize their performances.

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