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Communication efficient protocol for mobile *ad hoc* networks by using cross layer design

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***Abstract*— Cross layer design is an important approach used in Manets for increasing the performance of the network. We focus on some parameters such as delay, PDR, throughput, energy. To reduce energy consumption in MANETs because in today's era energy is an important parameter for mobile ad-hoc networks where devices are expected to work for longer periods of time without the need for charging their batteries. It is a collection of nodes that is connected through a wireless medium forming changing topologies. Continuous change in position of nodes in the network degrades the battery charge of the nodes therefore it is necessary to save the battery power of those nodes so that the network lifetime can be long lasting. It is very much important to maximize the performance of the network and eliminates error in the network. In terms of reducing traffic load, congestion, link breakage and consumption of energy. In data transmission from source to destination if we think the less energy is being used so for that we avoid traffic load, congestion and link breakage and how we avoid this problem by using our proposed protocol uses CLD approach from that we observe consumption of energy. In this paper design, a protocol for network layer and Transport layer that reduces conservation of energy, lifetime of network and congestion control. In this layer, we introduce energy efficient protocol (DERDM) in that layer for having less energy consumption in data transmission and better network lifetime. This protocol is better than existing protocol i.e. AODV protocol. The simulation result shows the proposed cross layer protocol is having a better packet delivery ratio, throughput and less delay, energy than existing protocol.**

***Index Terms*— CLD, MANET, DERDM, AODV, Link breakage**

I. INTRODUCTION

A mobile ad hoc network is a collection of wireless nodes that can transfer data without the use of network infrastructure or administration. In such a network, every node acts both as a host and a router. A major limitation with mobile nodes is that they have high mobility, causing links to be frequently broken and re-established. Moreover, wireless channel is also having limited bandwidth, and nodes operate on limited power, which will eventually be exhausted. Therefore, the design of a mobile ad hoc network is highly challenging, but this technology has high prospects to be able to manage communication protocols of the future.

The nodes that are normally battery-powered, hence, have small transmission ranges and use multihop transmission routes for long distance data transfer. Because of dynamic mobility of the nodes, the MANET routes are often unstable, causing routes to fail frequently and reduce lifetime of network. Another important problem in MANTEs is the dropping of data packets because of congestion in the network. Congestion may occur because of failure of link, queue overflow, or channel or media overloading [2]. The congestion leads to packet losses, reduces throughput of networks, and wastage of energy and time for congestion recovery. In addition, because there is no fixed infrastructure, all nodes in a MANET share a single transmission channel; many nodes may transmit data packets through single channel so that it is increasing packet collisions in the network. In such a situation, the congestion collapse [3] may occur when no node will be able to transmit their data packets. Therefore, achieving reliable, energy-efficient, and timely data delivery is a challenging problem in MANET

Several routing protocols [3–5] have been suggested in decade years to handle route failure and congestion and support reliable data transmission in an energy-efficient way. Some of these protocols [4, 5] use backup route(s) on the failure of primary route. However, the maintenance of multiple alternative paths is difficult, costly, and time-consuming. To improve the network performance some of the protocol uses multiple routes to balance traffic loads on the event of congestion or route failures Several other research works [9, 10] focus on handling link failure of MANTES using local recovery process. However, packets might be lost at the intermediate nodes if the local route discovery takes longer period. Some other parameter focuses on designing energy-efficient routing protocols for MANTES. Some of them consider the remaining energy of nodes and the energy consumption of data transmissions in designing of the routing protocols, whereas others consider balancing traffic load and the proportion of successful data transmissions. However, the design of energy-efficient routing protocol to reduce energy consumption and prolong network lifetime requires consideration of other important factors, such as avoiding critical nodes having low residual energy, ensuring end-to-end data reliability from intermediate nodes other than source, and limiting broadcast messages throughout the network. Recently, cross-layer-based routing protocols are being suggested for MANTES.

II. PROPOSED WORK:

In this paper, we propose the protocol use for energy efficient routing and prolong network, network lifetime and less congestion or link breakage by using cross layer design.

Here cross layer approach combining the network and transport layer. In transport layer, we introduce the concept for congestion control, less route failure & link breakage. In network layer we introduce the concept for energy efficient. The proposed concept, where nodes can detect the congestion in the network layer and take the proper decision to decreases the packet dropping. For heavily loaded network, the mobile nodes send alert message to the previous nodes to reduce the data packet delivery rate. So, for the data packet loss, congestion in network or route failure is decreases by using cross layer approach in MANETs proactively.

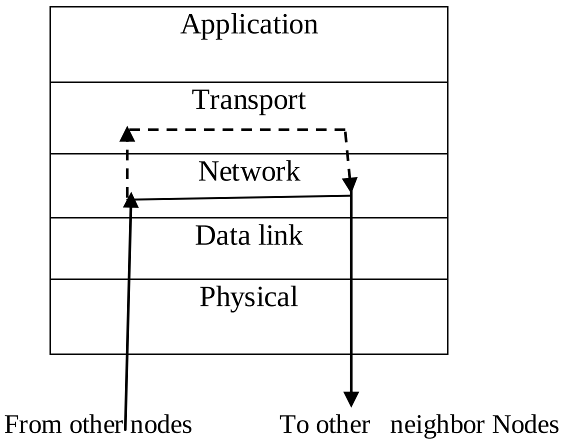

Figure 1. A mobile ad hoc network works both as a host and router

The above figure is of TCP/IP where, in without cross layer approach network we observe that network uses all the layer it will needed or not. But in the cross-layer approach network we observe that for performance of any activity in the network only those layers are used which will required no need to go by all the layer because on this term cross-layer approach perform in the network. So, that it increases the speed of the network and better performance results.

In Figure 1 the host or router in this network is mobile nodes. In this network, the nodes transmit and receive the data packet so when the data is received by the node it's just send to its neighbor node by using the three-layer (i.e., network physical, and data link) layer of TCP/IP model in the normal operation. But in case of link failure, congestion or traffic load the network layer queue uses transport layer queue for reducing packet dropping. This happens only in case of congestion of network or network is heavily loaded. The dotted lines indicate transmission process from local TQ, and solid lines indicate normal data transmission.

Now, why we use transport layer queue or for same node what is the purpose for giving another queue in transport layer. In MANETs many sources transmit data packet to many destination simultaneously. The intermediate nodes work as a forwarder whereas to transmit the data packet from source to destination pairs, and it needed to store the data packet for very small period in a network layer queue. So, when congestion occur or link breakage happen its very hamper to store the data packet in the network layer queue and after some time the buffer get full and packet will dropped so that performance of the network degrades and throughput is also reduces. So, in that condition network layer queue uses transport layer queue for reducing packet loss and increase performance of the network. And in transport layer queue data is stored for longer period and once the route found it get start transmission form transport layer.

In cross layer interface between network and transport layer as shown in Figure2. In this interface have two terms i.e. receive R and delivery D interfaces. In interface R receive the packet from network layer queue and put them into the transport layer queue when a congestion and link failure occur. Similarly, in the intermediate nodes all the data packet buffer in the transport layer queue to decide the destination. When the partial path is found the network, network layer access the transport layer queue and start transmission. Then, the D interface delivers the data packets to network layer and the nodes resume data transmission process.

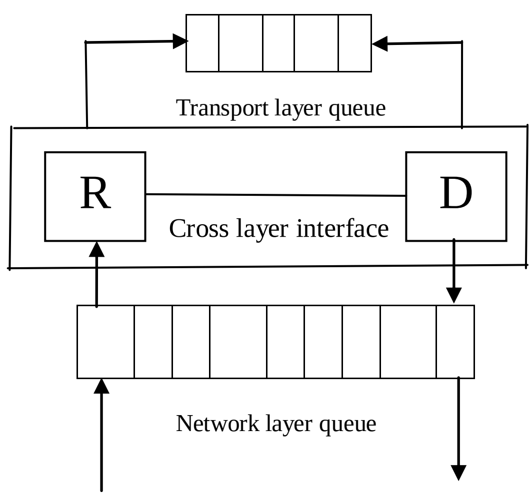

Figure 2. Interface between network and transport layer

III. SIMULATION RESULTS

This section describes the simulation environments and presents the simulation results. The network simulator [NS2] used to stimulate the AODV protocol and our proposed DERDM protocol. In the MAC layer used the adopted protocol IEEE 802.11 DCF protocol.

In our simulation, we consider a square area of size 1000 x 1000 m, where 50 mobile nodes are deployed randomly. The simulation time is set to 200 s. Each node has the transmission range of 250 m initially had 100 J of energy. The source nodes of our network generate constant bit rate data streams. This helps to measure performance for various traffic load at each mobile node. The size of each data packet is 2000 bytes, link bandwidth is kept at 11 Mbps, and the underlying transport and MAC layer protocols are UDP and IEEE 802.11 DCF, respectively.

Table1 also illustrate the complete parameters used with their respective values as shown below.

TABLE 1 SIMULATION PARAMETERS

Parameters	**Value**
Topology size	1000 x 1000 m
Simulation time	200 s
Number of nodes	50
Radio propagation model	Two ray model
Transport type	IEEE 802.11 DCF
Queue size	50
Traffic model	CBR
WLAN standard	IEEE 802.11b
Data rate	11,5.5,2 & 1 Mbps
Control rate	1 Mbps
Frequency	2.47e9
Bandwidth	11 Mbps
Data size	2 Mbyes/flow
Packet size	2000 bytes
Data generation rate	(0.2/0.4/0.6/0.8/1.0) Mbps

Once all the parameter of the network is set and the simulation is run the results shows that the packet delivery ratio, throughput is increased & delay, energy are decreased. When DERDM is used instead of AODV and hence overall the energy consumption is less and network becomes more efficient.

In fig3. Shows the NAM window of MANET (Network animator). We took 50 mobile nodes in the network. Data transmission is between source to destination. Packet drop occur when buffer is full or link is break. So, we focus on less energy to be required for the mobile nodes and network prolong lifetime. In this network, all the 50 mobile nodes set at different value and different position. In our proposed protocol, we observe that DERDM has less energy consumption and congestion. Also, packet dropping is less, transmission rate is better, packet delivery ratio, throughput, delay, energy is better than existing protocol i.e. AODV

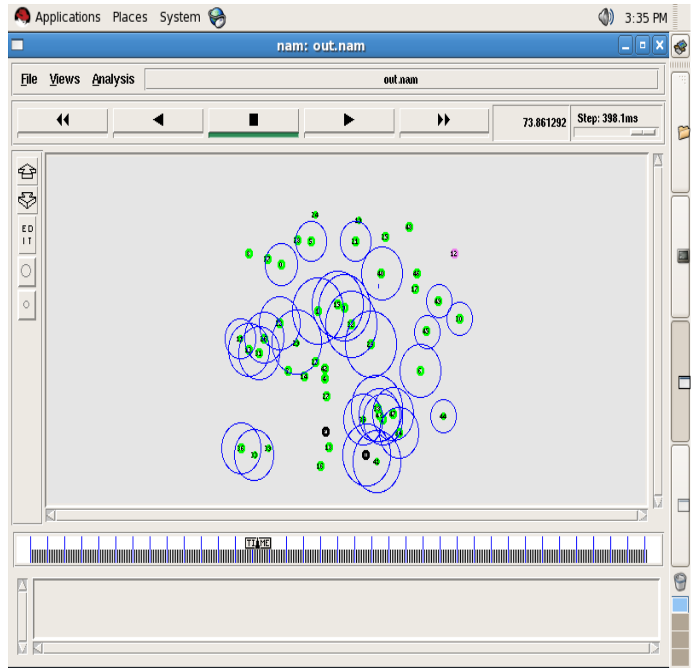

Fig3. The NAM window of the proposed protocol

A] Packet Delivery Ratio

PDR is defined as the percentage of ratio between the number of packets received at the destination and the number of packets sent by source.

Packet delivery ratio = No. of received packet at destination/ No. of packet sent by source) *100

Fig. 4 shows packet delivery ratio vs packet size. In this figure shows the existing protocol AODV and our proposed protocol DERDM. The existing protocol is having the average packet delivery ratio 92.4% and our proposed protocol having approximately 96.8% packet delivery ratio which is better than AODV protocol.

Table 2 shows the analysis of data delivery ratio from that we conclude that the DERDM protocol is better as compare to AODV protocol.

TABLE 2 PACKET DELIVERY RATIOS

packet size	600	700	800	900	1000
AODV (%)	91.2	93.8	95.1	90.6	91.3
DERDM (%)	92.5	94.3	95.8	95.2	96.3

B] Average End-to-End Delay

It is measured as the average time in milliseconds required by all the data packets that are received by the destination nodes.

Fig. 5 shows average end to end delay vs time in sec. In that the existing protocol AODV is having more delay as compare to proposed protocol. The result shows X-graph of end to end delay. The average end to end delay of AODV is more than 351ms and our proposed protocol having approximately 263ms less delay. DERDM gives a better result, the speed of data transmission is more and hence traffic load is less.

Table 3 shows the analysis average end-to-end delay from that we conclude that the DERDM protocol is better as compare to AODV protocol. So, the delay is less of proposed as compare to AODV protocol.

TABLE 3 AVERAGE END-TO-END DELAY

Time (s)	60	80	100	120	140
AODV (ms)	310	290	378	454	327
DERDM (ms)	296	254	286	230	252

C] Throughput

It is measured as the average amount of data bits received per unit time by all the destination nodes in the network.

Fig 6 shows throughput vs packet size. In this figure shows the existing protocol AODV and our proposed protocol DERDM so in this the existing protocol having the throughput 31 Kbps and our proposed protocol having 34Kbps throughput which is always better than AODV protocol.

Table 4 shows the analysis of throughput from that we conclude that the DERDM protocol is better as compare to AODV protocol.

TABLE 4 THROUGHPUTS

packet size	600	700	800	900	1000
AODV (Kbps)	20	22.5	26	28.5	31
DERDM (Kbps)	21	23.5	27	30	34

D] Energy Consumption

It is measured as the total consumed energy divided by the total number of packets received.

Fig 7 shows Energy vs Nodes. In this figure shows the existing protocol AODV and our proposed protocol DERDM so in this the existing protocol having the energy 23.40 J and our proposed protocol having 12.88J energy which is always better than AODV protocol.

Table 5 shows the analysis of throughput from that we conclude that the DERDM protocol is better as compare to AODV protocol.

TABLE 5 ENERGY

Nodes	10	20	30	40	50
AODV (Joule)	12.11	17.03	26.28	24.84	36.76
DERDM (Joule)	8.60	9.96	12.90	12.80	20.16

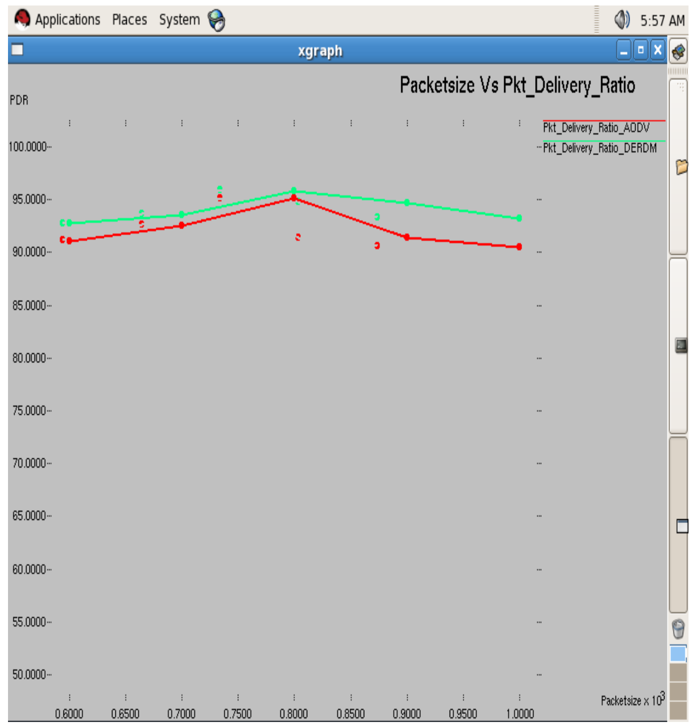

Fig. 4 Packet delivery ratio

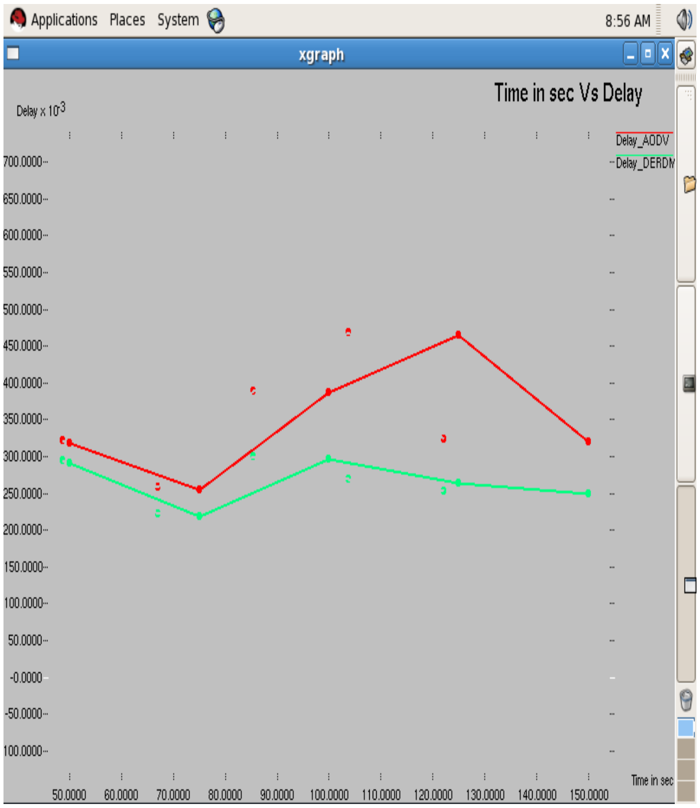

Fig. 5 Average end-to-end delay

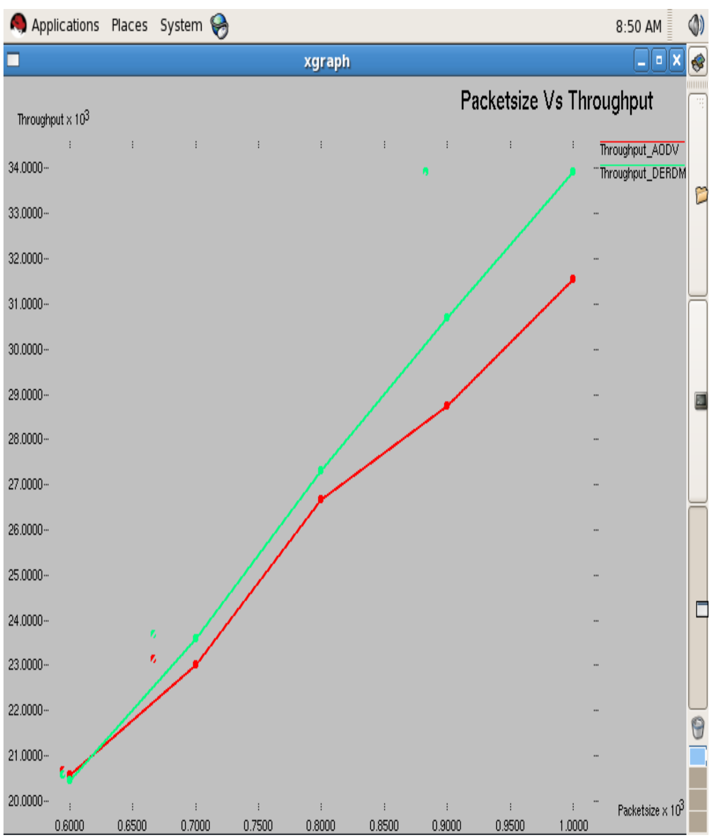

Fig. 6 Throughput

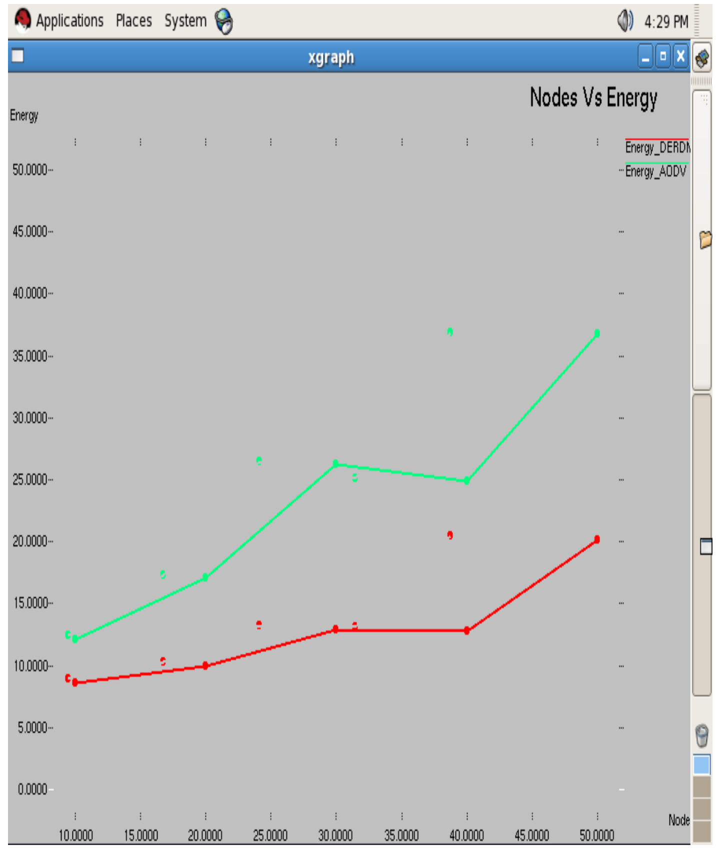

Fig. 7 Energy

IV. CONCLUSION

In this paper, we introduced cross layer design protocol for route failure, congestion & link breakage energy efficient protocol for MANETs. This protocol combining the network and transport layer by using CLD approach. In the transport layer, the concept of local buffering to store the incoming data packet when the route failure and link breakage occur and once the route established it start transmission frequently. In the network layer, the concept of energy efficient is introduced whereas the energy consumption is reducing throughout the network as well as consumption of energy by limiting the broadcasting messages. So, this paper shows increase in the packet delivery ratio, throughput & decrease in the delay, energy and hence it reduces the energy consumption and prolong the network lifetime.

We got the stimulation result from that we analyzed that energy consumption throughout network is reduces in the proposed protocol as compare to the existing protocol. For simulation, we have used NS2 stimulator. This paper contributed the data transmission successful and reduces traffic load on the nodes and it also reduces link breakage and link failure that energy applying in DERDM and comparing with existing protocol AODV.

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