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Performance Optimization of Multipath Routing Protocols using Cross Layer Load Balancing (AODLB Protocol) in Ad Hoc Network

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Abstract-**MANETs are networks capable of communicating in a set of small, low cost, low power sensing devices. A wireless sensor networks is totally based on the limiting factor i.e. energy consumption. A wireless sensor network consists of large number of sensor nodes distributed or scattered in particular network region. MANETs consist of node that is highly mobile, so in particular the range of the nodes is very important. Each device in a MANETs is free to move independently in any direction, and will therefore change its links to other devices frequently. The energy and the bandwidth of such path are of major concern. The lifetime of the network depends upon these parameters. The load balancing is the issue of selection of such optimized paths that are economical, efficient as well as do not allow the network structure to break up in adverse condition. In this paper, we have optimized the performance of the routing protocols using load balancing technique and implementing it using cross layer structure. The results in the paper are compared with the LB-AOMDV, AODV protocol and our own designed routing Protocol; Ad Hoc on demand Load Balancing Routing Protocol (AODLB). The results in the paper have been derived using NS-2 simulator.**

Keywords: **AODLB, LB-AOMDV, AODV, load balancing, cross layer**

I. INTRODUCTION

The network model has different nature as the protocol for this is to be designed in the manner that the infrastructure of the cellular network should be considered [1]. The main challenges regarding this are the mobility of nodes and the scalability of the network [2]. Also the performance measurements in terms of energy and the bandwidth efficiency are unknown [6]. In the wireless ad hoc networks all the nodes transmit data towards the source by passing them through the intermediate relaying nodes. The main concept regarding these relaying nodes is that these nodes require processing energy for their transmission success, thus more the number of nodes more is the requirement of the processing energy [6][3]. Whenever single link situation is considered, there is a tradeoff between the energy efficiency and the bandwidth efficiency for wireless multi hop ad hoc networks [1]. The issue for the multi hop network is regarding the scheduling at the link layer and relaying of data at the network layer. It should always be clear that the data in the network is in the form of packets [6]. The whole network considered to be shared medium between all the nodes that can be source, destination or the relaying nodes. It has also been shown that the per node throughput capacity of ad hoc networks with nodes n decreases with n as $\Theta\ (1/n \log n)^{1/2}$ [3]. The issue regarding this has been shown as the general capacity cost function of channel capacity for arbitrary input alphabets was studied on single link [4]. In the related work the bits per joule capacity of the network is assumed [3]. The tradeoff between energy and the bandwidth has been analyzed under various assumptions on the channel condition and the interference under a linear equidistant relaying network model without considering the energy consumption at the receiver end [5][6][7]. Also the receiver consumption can be improved by using the cross layer design including the effects of the power amplifier used at the transmitter end [8]. The transport efficiency of an ad hoc network was defined considering the transmitter energy and the receiver's processing energy [9] [10]. Thus the energy consumption for the packet transmission and the large number of hops is considered [6]. For the networks that have energy as their limiting resource, the network lifetime related to the energy is one of the significant performance metrics [6]. The transport efficiency measures the bits per second per Hz per Joule of energy need to transport information reliably between source and destination node separated by end to end distance de which is greater than zero [6]. The maximum transport efficiency of the network can be maintained by decreasing the energy consumption for the network and also increasing the bandwidth efficiency of the network at the same time [6]. The relation between maximum transport efficiency of the network is linear function of end to end distance [9]. In [10] it is shown that with help of spatial ruse, we can increase bandwidth efficiency while suffering in the packet successful reception and with increase in number of hops there is decrease in the maximum transport efficiency regardless of the path loss exponents [11].In the paper, we have proposed a routing protocol AODLB which is capable of load balancing by implementing cross layer design. This protocol withstands with all the shortcomings of AODV and LB-AOMDV protocol. The paper shows the analysis carried out using NS-2 simulator

II. SYSTEM DESIGN AND MODEL

The network model consists of k number of hops from source to destination. Therefore, the number of relaying nodes between source and destination will be k-1 [6][1]. Let d_e be the end to end distance between source and the destination. If d_i is the distance between the relaying nodes then the value of d_i is given as: $\alpha_i d_e$ where $0 < \alpha_i < 1$. Note that for k number of hops the summation of $\alpha_i \geq 1$. This determines that it is not necessary that all the nodes are not always in the straight line [6]. The characteristics and the requirements of the nodes are: 1. Has a common power amplifier characteristics, (2) experiences the same propagation environment, (3) transmission is independent of each other that is from node to node, (4) requires energy E_p [J] to process a received symbol

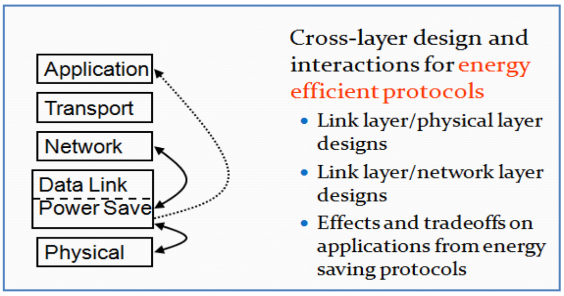


Fig. 1

The factors to be considered for the system model are E_p as already defined is the receiver's processing energy, the power amplifier characteristics is described by two functions f_c and f_o [12]. As assumed in paper [12] P_{in} denote the input power to power amplifier, P_{dc} the consumed power to drive the power amplifier to generate the desired output and P_{out} the desired output power of the power amplifier [6].Now the characteristics can be given as:

$$P_{out} = f_o(P_{in})$$

$$P_{dc} = f_c(P_{in}) \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

Both the above function are strictly increasing function of P_{in} and the difference between the consumed power to drive the power amplifier and the desired output power of the power amplifier is equal to the heat loss in the power from the power amplifier of the transmitter on each node i.e. $P_h = P_{dc} - P_{out}$. Here P_h is considered to be constant [6]. Also the simplifier power amplifier is considered with the following expressions:

$$f_o(P_{in}) = \begin{cases} \rho P_{in}, & 0 < P_{in} < P_1 \\ P_{SAT}, & P_1 < P_{in} \leq P_{max} \end{cases}$$

$$f_c(P_{in}) = f_o(P_{in}) + P_h \ldots\ldots\ldots[6]$$

where ρ and P_h are constants. Also it is considered that $P_{max} = P_1$. The values for the constant are ρ=50(17) dB, P_1=1.5 mW, P_{SAT}=75 mW, and P_h=35 mW.

III. LOAD BALANCING USING CROSS LAYER

A. Cross Layer:

Cross layer is the technique of using the parameter of one layer on the other layer and then using that parameter to optimize the working of routing protocols. In our technique, we are using the technique of load balancing at cross layer. In this, we have generated the values of transmission at physical layer and this value is then transferred to network layer where this is used for efficient routing. This is termed as cross layer implementation. Fig. 1 shows the clear implementation of cross layer between the physical and the network layer. The cross layer allows multiple decision support during routing which optimizes the performance of routing which was earlier carried without any dynamic routing decisions.

B. Load Balancing:

The load balancing is the term of managing the traffic in transmission process efficiently such that the network structure do not enter in the dead state i.e. state of no transmission or delayed transmission. For load balancing consider the Figure. 2.

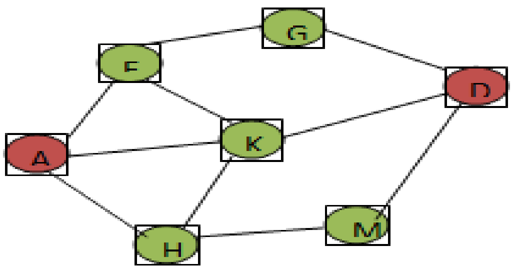


Fig 2

Figure.2 shows the nodal arrangement for ad hoc network. The path is shown to depict the clear joining between the various nodes. Now consider, that data is to be transferred from node A to node D. suppose, that the path chosen for transmission is via K. Since this is the most efficient path, this will traversed more number of times until the whole data is transferred. But there is danger that the node K undergoes excessive data burden and thus might get into dead state as its energy might lowers due to excessive load. Thus to manage this, load balancing has to be implemented which is easily carried out using load sharing with ratio 1:1. Thus, the simultaneous paths such as A-F-G-D or A-H-M-D can also be used to allow proper load balancing in ad hoc network.

C. Combining Load Balancing and Cross Layer (AODLB Protocol)

The two important techniques of load balancing and cross layer is integrated to design a new routing protocol AODLB i.e. Ad hoc on demand load balancing routing Protocol. This protocol manages the working of routing protocol in such manner that performance of the network is optimized to great extent. This protocol as works on cross layer thus, delays are also eradicated. The formula used for delay and efficiency calculation is explained below:

$$B_{k,\,CR} = \sum_{i=1}^{k} (d_i / d_{max})^{\eta} \leq k$$

$$\gamma = E_{tx} \; d_e^{-\eta} / N_o$$

$$\gamma_c = (E_p + P_h Ts)\, d_e^{-\eta} / N_o$$

$$\mathbf{E_{eff} = R_{eff} / \text{ʍ} \, (B_{k,\,CR} \cdot \gamma / k + \gamma_c)}$$

Where k is the number of hops, γ is the signal to noise ratio, γ_c is the efficiency constant, N_o is the noise power spectral density that depends upon the type of physical transmission, E_{tx} is the transmitter energy, E_p is the receiver processor energy, Reff is the effective energy rate i.e. bandwidth, ʍ is mobility and E_{eff} is the modified energy efficiency.

Delay= 1/ (link speed)((Np-N_t)+ (D_I-1))N

Where link speed is the actual bandwidth for transmission between the receiver and the transmitter and N is the number of nodes and the N_t is the number of retransmissions, Np is the packet size and D_I is the average delay that is measured taking into account the ideal conditions for transmissions and its value is computed to be 6 bms.

VI. SIMULATION RESULTS AND ANALYSIS

A. Performance Metrics Result:

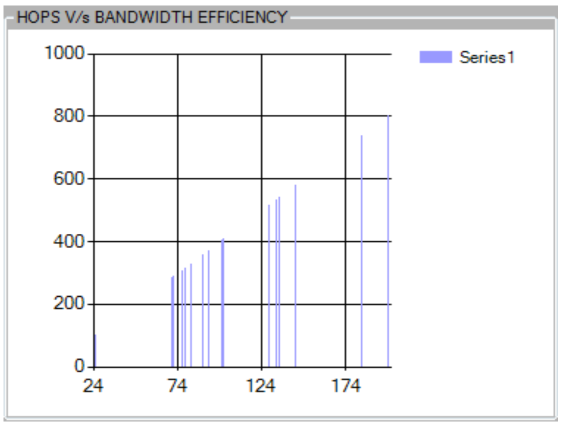
Table 1.Our Simulator results

Parameters	**Improvement**
Transmitter Energy	45%
Reveiver Procesing Energy	45%
Energy Efficiency	50%
Bandwidth Efficiency	50%
Delays	Reduced By 70%
Working Efficiency	85%

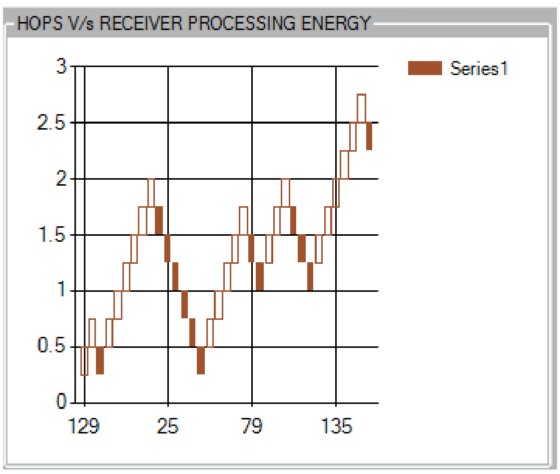
B. Graphical Analysis:

The graphical analysis is carried out by comparing the trace file of the newly designed and previous version of protocol. The comparison is carried out by use of files present in the x graph of NS-2. The graphs taken by us are as follows:

Graph 1

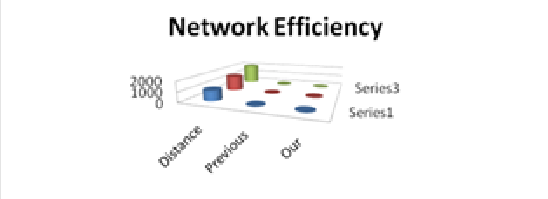


Graph 1 is the relation between the bandwidth efficiency and hops of AODLB routing protocol.



Graph 2

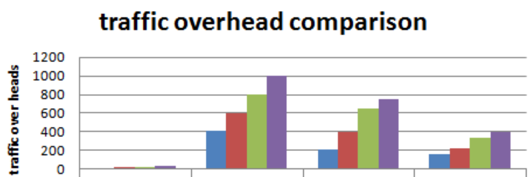
Graph 2 shows the relation between the hops and receiver Processing Energy for AODLB routing Protocol.



	Distance	Previous	Our
Series1	1000	0.00216	0.00433
Series2	1500	0.00323	0.00646
Series3	2000	0.00433	0.00866

Graph 3

Graph 3 shows the network efficiency comparison between the AODV before use of AODLB and after user of AODLB. There has tremendous improvement in the life time of the network on use of our proposed algorithm.



	connected nodes	AODV	LB-AOMDV	AODLB
Series1	3	400	200	150
Series2	20	600	400	230
Series3	30	800	650	340
Series4	40	1000	750	400

Graph 4

Graph 4 shows the overall improvement in efficiencies of AODLB routing protocol as compared to LB-AOMDV and AODV protocol as network overheads decreases tremendously in AODLB.

V. CONCLUSION

From, the paper, it is noticed that the AODLB protocol is very much capable to optimize the working of the routing protocol. The results show the tremendous increase in the efficiency of the network also, the network life increases tremendously. The protocol is also capable to handle delays. Further, work can be carried out to distribute load over the remote nodes with dynamic source allocation and acknowledgement based routing.

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