AN EFFICIENT APPROACH FOR ROUTING IN WIRELESS AD HOC NETWORK USING ARTIFICIAL INTELLIGENCE

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Abstract: MANETs are the set of small, low infrastructure communication setup that operates by consuming the energy of batteries. Thus, it is very much important for MANETs to perform efficiently. For efficient transmission, routing is of much concerned and should be performed intelligently. For this, artificial intelligence can be used to select the most optimized path. In this paper, optimized path is termed to path with no congestion. Thus, in the paper, we have proposed an artificial intelligence based on demand routing protocol (AIBODR) that eliminates the congestion in MANETs and applies the concept of artificial intelligence for selection of optimized path and also it solves the issues regarding congestion. We have used the NS-2 simulator for performing simulation regarding routing and MATLAB for artificial intelligence analysis.

Keywords: AIBODR; AODV; artificial intelligence; congestion; link capacity; virtual state.

I. INTRODUCTION

Mobile ad hoc networks (MANETs) are networks composed of set of communicating devices able to spontaneously interconnect without any pre-existing infrastructure. Devices in range can communicate in a point-to-point fashion. Taking a great part in the military issues and as well as in the business the work on Ad hoc networks is locking to be as the necessity of the world. The wide spread of lightweight and low-cost mobile devices-we are talking about mobile phones, PDAs, Pocket PCs, etc-which now embedded Bluetooth and Wi-Fi (IEEE 802.11) network adapters enable the spontaneous creation of city-wide MANETs. The ad hoc network is the network structure that requires routing decisions to be taken with utmost care as energy efficiency is concerned with transmission of each packet. The routing protocol must have the ability to manage the frequent topology changes caused by the mobility of nodes and these need to be efficient as compared on basis of efficiency in terms of bandwidth and power as well as on basis of load transmission [11]. With the advent of On-demand routing, the tables are not maintained and the topological views are also rescued and the routing totally becomes dynamic [11]. Existing on demand routing protocols such as DSR (Dynamic Source Routing), AODV (Ad-hoc on demand distance vector routing) are the shortest path based routing protocols, also these don't consider the packet size and the antenna range of the nodes as a performance metric due to which there is a problem of long delays and congestions in the routing path and the whole set up of the nodal structure enters in to the dead state [10]. Also, on demand protocols that use the shortest paths as performance metric suffer from performance degradation as the network traffic increases [10]. We have opted for AODV protocol as our base for improving the performance of the ad hoc structure and improving the same for efficient routing by eliminating the factors and the issues regarding congestion. Unlike other network structure, ad hoc networks suffers more with congestion problem as the routing is dynamic and there is always danger of selection of wrong path to transmit the packet between the source and the destination. The reason for not considering the DSR protocol is that it cannot be applied to large network areas and also, the header part of the packets contains the address of each routing node. Thus, this makes the packets size heavier than actually expected which ultimately increases the delays that act as source for congestion. So, if congestion of the network has to be optimized, the delays should be managed or vice versa. The ideology for solving the congestion originated in our work has been derived from the concept of artificial intelligence. Artificial intelligence is the technique of thinking and making decisions efficiently with the help of machines or software. Artificial intelligence can be integrated as decision making parameter for selection of optimized path. This technique can be used for removal of congestion and also, it can prevent a network structure from entering into the state of no transmission. Thus, in this paper, we have proposed a routing protocol that has its basics derived from artificial intelligence and is capable of performing routing with zero delays and no congestion. We have termed this protocol as AIBODR i.e. artificial intelligence based on demand routing protocol for MANETs.

II. SYSTEM MODEL AND PROBLEM DEFINITION

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][13]. 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 [13]. 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. 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 [13]. As assumed in paper [13] 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:

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

$$P_{dc} = f_c(P_{in}) \text{................ [13]}$$

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 [13]. Also the simplifier power amplifier is considered with the following expressions:

$$f_o(P_{in}) = \rho P_{in},\ 0 < P_{in} < P_1$$

$$P_{SAT},\ P_1 < P_{in} \leq P_{max}$$

$$f_c\,(P_{in}) = f_o(P_{in}) + P_h \quad \text{...[6]}$$

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. The attenuation of the transmitted signal power along distance d is given by:

$$P_r = \beta\, P_{out} / d^{\eta}, \quad \text{where } d > 0.$$

The related work that has been carried out in elimination of congestion is done by packet counter at each node. Some of the routing techniques involve the acknowledgements exchange between the transmitter and the receiver. But the problem regarding this technique is that these are applicable to downlink only whereas the problem of congestion makes larger impact over the uplink transmission in MANETs. Also, some work has been carried out using parameter of received signal strength but again this parameter can help in taking routing decision towards shortest distance nodes but can’t be applied to large scale deployments. Thus, this has been the major issue we opted for artificial intelligence modelling for selection of congestion free path in MANETs.

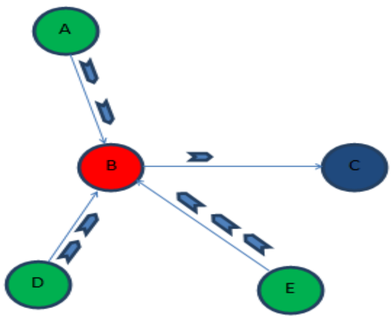


Fig. 1 INITIAL STRUCTURE

Consider the fig.1, it can be noticed that node B is selected for relaying between the source and the destination nodes. But, as B is the node chosen on basis of shortest path, thus it is traversed more number of times and is the relaying node for more than one source. Therefore, it receives packets from multiple nodes that make huge impact on routing them towards next uplink; this causes the receiver processing energy of node B to lower down the actual value resulting in blockage or no transmission of packets. Thus, due to inability of routing protocol to think intelligently, the congestion occurred. Thus, an efficiently designed artificial intelligence model can be applied for routing in MANETs which is the exact work carried out by us in this paper. The extensions and the working of the proposed model and protocol have been suggested in the next section.

III. PROPOSED MODEL

Our proposed model is an application of artificial intelligence for the purpose of routing in ad hoc network. The system we suggested in the paper is capable of performing routing efficiently resulting in no congestion. The artificial intelligent system proposed by us is formula based analyzing system that computes the various parameters before actual routing is performed and thus prevents the system from being attacked by congestion. The proposed work can be clearly understood by analysing the following figures.

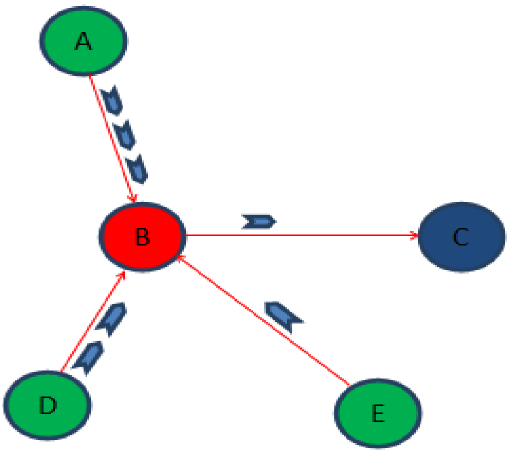


Fig. 2 CONGESTION STATE

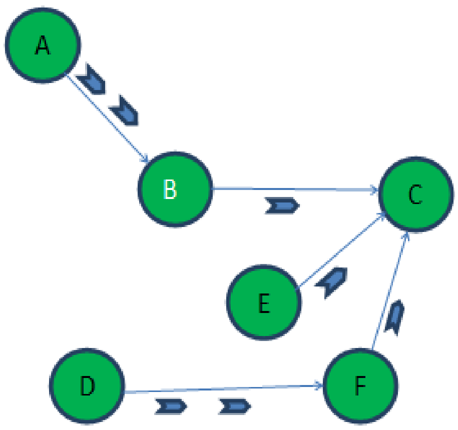


Fig. 3 NO CONGESTION

The fig2 explains how exactly congestion occurs. The node A, D, E transfers data simultaneously and thus, the traffic at node B becomes heavy and there is blockage of data and no or minimum transmission towards the destination node C. This is the major problem. For optimizing this, we considered parameters like: Peak value of packets acceptance by relaying node, number of packets actually transmitted, remaining capacity, initial receiver processing energy, tolerance and by using these parameters we developed an intelligent routing system which is capable of pre determining of congestion sate and carries re routing and route discovery for selection of next optimized path towards destination. This can be explained with the help of example: consider that the peak value of the node B is 300, the receiver processing energy of this node is 0.32 micron J, and number of packets actually transmitted is calculated by use of packet counter which counts the number of packets transmitted by node B towards the destination node C. Therefore, the remaining capacity can be calculated as:

REMAINING CAPACITY= PEAK VALUE - ACTUAL PACKET TRANSMITTED

Thus, the signal containing the remaining capacity of the node B is transmitted towards the node A, D, E. Thus, this will create a virtual intelligent system that computes the routing decisions and allows detecting the state of congestion. Now, the next step is to choose the optimum path for transition of data towards the destination C. This is shown in fig. 3. The feature of MANETs i.e. mobility is taken as a problem solving parameter. When, the nodes get awareness signal or the warning message, they all either starts moving towards the destination and selecting the next optimized path or the nodes start RREQ and RREP process and performs re-routing and route discovery process thus selecting the next best optimized path. But the only condition in this case will be that one node will interact with only one relaying node. This technique of optimized re-selection of path is the main feature of AIBODR protocol. So, in summary, it can be stated that routing before the danger state will be carried out on dynamic basis but with intelligent system integrated with it and on detection of danger state, the routing will be performed using AIBODR protocol. The algorithm for the above stated technique is defined as follows:

A. Artificial Intelligence Based On Demand Routing (AIBODR) Protocol

```
While (ring search_node)
{
 Route_discovery
 Perform transimisison
 Increment packet_counter
 Remaining capacity= peak value - actual packet transmitted

 If (packets to be sent>=remaining capacity)
   {
   Mobility_initiate
```

RERQs, RERPs
Re-Routing (ringsearch_node)
}
Start_transmission
}

B. Equations used for congestion/delay evaluation and Performance Measurement

Congestion ∞ 1/link speed.. (1)

Congestion ∞ packet size.. (2)

Congestion ∞ average delays...................................... (3)

Thus, from (1), (2) and (3)

Congestion rate= β * delays * (1/ ʍ)

Where ***delays=1/ (link speed) ((Np-N_t)+ (D_I-1))N.***

Where 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 and ʍ is the mobility.

IV. SIMULATION RESULTS AND GRAHICAL ANALYSIS

A. Performance Metrics:

For the simulation to be performed using NS-2 simulator, we have considered the following scenarios.

TABLE 1 PARAMETERS VALUES

Parameter	**Value**
Dimensions	1000X1000 sq. m.
Number of Nodes	25, 50, 70, 100
Simulation Time	300 s
Source Type	CBR/UDP
Number of Connections	10
Packet Size	512 bytes
Mac Layer	IEEE 802.11 b
Buffer Size	300 packets
Propagation Radio Model	Two Ray Ground
Physique layer	Band width as 2 Mb/s
Maximal Speed	10 m/s
Pause Time	10 s
Interval Time To send	2 packets /s

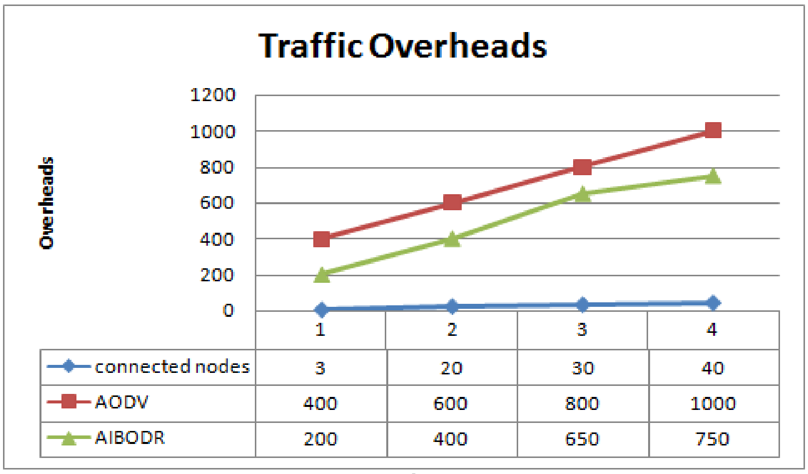
The various metrics that have been improved under this technique are as follows:

- **Congestion Rate:** it is defined as the number of times the congestion state appears during the process of transmission of data between the source and the destination.
- **End to End delay:** it is defined as the average delays that a network suffers during the transmission. It is the gap between the actual time of received packets and the expected time

- **Traffic Overhead:** it is the amount of breakage in the link during the transmissions and it also includes the number of re-transmissions.
- **Packet Delivery ratio:** it is the ratio of number of packets received to the number of packets lost at the destination end.
- **Buffer Size:** it is the capacity that defines the limit of the packet holding capacity of various nodes in the network structure involved in the process of transmission.

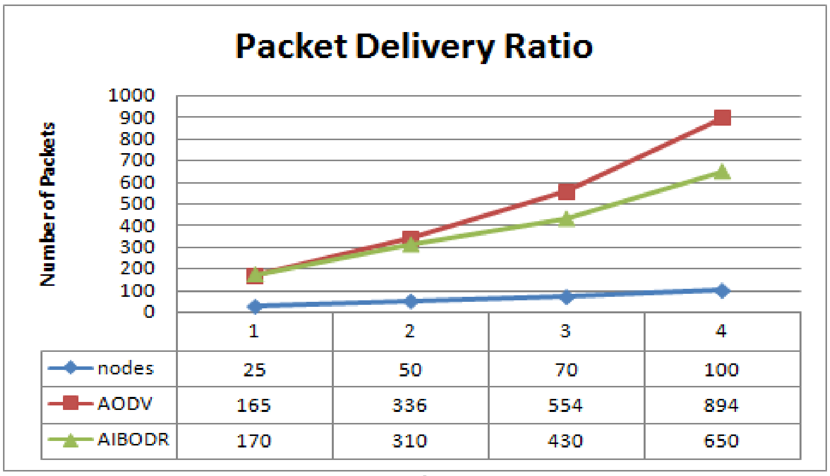
B. Graphical analysis:

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 and MATLAB for artificial intelligence check of the routing protocol. The graphs taken by us are as follows:



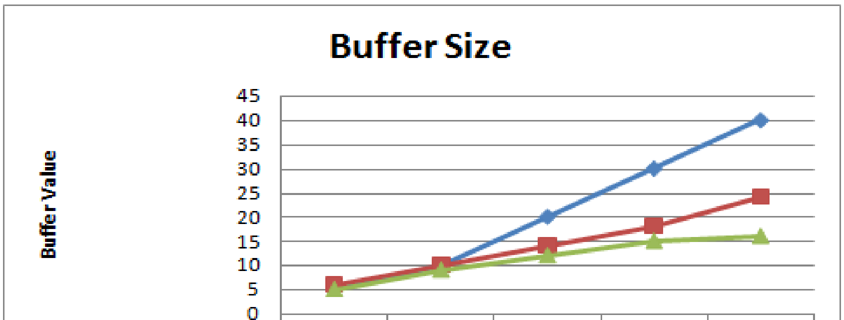
Graph 1

Graph 1 shows the comparison of the AODV protocol and the AIBODR protocol on the basis of traffic overheads and clearly our technique shows improvement by 18.75 percent approx.



Graph 2

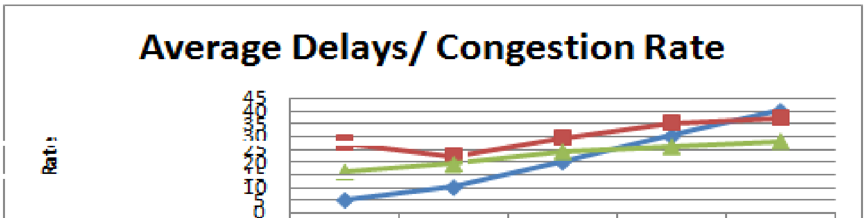
Graph 2 shows the comparison of the AODV protocol and the AIBODR protocol on the basis of packet Delivery Ratio and clearly our technique shows improvement by 22.38 percent approx.



	1	2	3	4	5
connections	5	10	20	30	40
Buffer Size (AODV)	6	10	14	18	24
AIBODR	5	9	12	15	16

Graph 3

Graph 3 shows the comparison of the AODV protocol and the AIBODR protocol on the basis of buffer size and clearly our technique shows improvement by 16.66 percent approx.



	1	2	3	4	5
connections	5	10	20	30	40
Average Delays /Congestion Rate (AODV)	27	22	29	35	37
Average Delays/Congestion Rate (AIBODR)	16	19	24	26	28

Graph 4

Graph 4 shows the comparison of the AODV protocol and the AIBODR protocol on the basis of congestion rate and clearly our technique shows improvement by 25.71 percent approx.

V. CONCLUSION

Thus, from the paper, it is noticed that in order to increase the performance of the network, congestion should be minimized. In this paper, we have proposed AIBODR protocol. We claim that the proposed model have been able to show improvement by 20.25 percent on average. Also, the network reliability has also improved. The concept of artificial intelligence strengthened the formation of routing protocol and showed tremendous improvement. In the future, the concept can be applied to the practical scenario and also, the artificial intelligence based system can be more efficiently integrated with the concept of routing in MANETs. Also, the cost of implementation can be made more economical.

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