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Neural Network Model Based Sleep down Power Control for Mobile Ad-hoc Network

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***Abstract*—Power control is needed to exchange messages between any pair of neighboring nodes. Mobile ad-hoc network capacity is increasing by reducing the transmit power level of nodes in network. Transmit power control depends on the protocol from physical to transport layers, including the three important parameters like data transfer rate, switching time and energy consumption. This paper is focus on energy consumption by transmitter and receivers. Power is consumed by nodes during switching in mobile ad-hoc network. Neuron network model concept is based on simulation result. This concept is more helpful as compare to other algorithm to solve power control problem in mobile ad-hoc network.**

***Index Terms*– Power, Control, Energy, Protocol and Network**

I. INTRODUCTION

MOBILE Ad-hoc Network is a wireless, self-organized network, which involves a set of mobile computing devices are equipped with wireless communication and networking facilities. There is no system administration, no base stations and no routers. Networks have the advantage of being deployable in non-infrastructure environments, such as disaster areas and battlefields [1]. Most wireless ad-hoc networks consist of mobile devices which operate on batteries. Power consumption in this type of network therefore is paramount important [2]. To maximize the lifetime of an ad-hoc network, it is essential to prolong each individual node life through minimizing the total transmission energy consumption for each communication request. Hence there is a need for designing minimum energy consumption routing protocols that ensure a longer battery life. For such a protocol design, the existing minimum-hop routing scheme cannot be applied, and a new, power aware routing scheme that takes the transmission energy into consideration explicitly is urgently needed.

In this paper Section A describes the related work Section B describes energy consumption models for mobile ad-hoc networks and concludes.

II. RELATED WORK

Optimal policy is minimizes the total energy spent for each successful packet transmission. Adarsh et al. have introduced the desirable controlling transmission power in a time-slotted

wireless network. Transmission power control scheme is not effective for long range communication due to signal loss [3].Transmission power control scheme presented by Muqattash et al, in which signal is transmitting over a transmission channel in radio range without any loss. This scheme is used to determining the performance and energy consumption of network. Transmission power control scheme could not improve throughput for mobile ad-hoc network [4].

Krun et al. have presented a power-controlled protocol called power medium access protocol, which achieves a significant throughput. Power medium access protocol uses an access window in exchange of information. Access window is used to allow for a series of request-to-send/clear-to-send in simultaneously data packet transmission. Data transmission is effected by interference of nodes [5]. Random vs. fixed power controls schemes have been studied by Tae et al., in which randomizing transmission power has positive effect of reducing high interference to the other nodes, and improves network connectivity. Fixed power control is more suitable for small size local network. Random power control is made by randomizing transmission power for nodes in a network. The signal quality was not guaranteed in network [6].

Ruffini et al. have described a transmission control scheme in which higher transmission rate increases the link throughput, while on the other side, requiring higher transmission power. This scheme is increasing the interference in a network. Quality of received signal was improved in a network. Transmission control scheme could not improve traffic carrying capacity of network [7]. Zhitang et al. have stressed on novel medium access protocol in which power control for wireless ad-hoc networks is to facilitate the negotiation of transmission power between the source node and receiver node. Protocol can improve the traffic carrying capacity. Quality of signal is low in a network [8].

Kaojung et al. have focused on minimum-energy multicast problem in wireless ad-hoc networks. Multicasting mean nodes are communicating with multicasts or different links in a network. Each link has minimum energy for transmission of data. Branch and cut or cutting planes techniques are used to know the shortest path with minimum transmission power. Power control problem was not improved due to multicasting in a network [9]. Low-energy routing is often the main objective of the various topology control algorithms that have recently been used for MANET [20]. J.Haas et al. have proposed a new technique called Gossip to increase the performance of routing protocols for Ad-hoc network [14]. They have selected packet delivery fraction, average delay and normalized routing load as there performance parameters. M.Frikha et al. have suggested a routing protocol based on the current energy status of the node [15].

There is an increase in the control packets such as Route Request, Route Reply in all reactive protocol such as AODV and DSR, as flooding technique issued in route discovery process. Neural network with directed convergences achieves better results when the transmission radius is short [16].

III. SLEEP DOWN MODE APPROACH

This transmission power control approach is used to determine the optimal routing path that minimizes the total transmission energy required to deliver data packets to the destination.

Sleep-down mode approach is focus on inactive time of communication. Since most radio hardware supports a number of low power states, it is desirable to put the radio subsystem into the sleep state or simply turn it off to save energy. For example, Lucent's Wave LAN-II based on IEEE 802.11 wireless LAN standard consumes 250mA and 300mA when receiving and transmitting, respectively, while consumes only 9mA in sleep mode [10]. However, when all the nodes in a MANET sleep and do not listen, packets cannot be delivered to a destination node.

One possible solution is to elect a special node, called a master, and let it coordinate the communication on behalf of its neighboring slave nodes. Now, slave nodes can safely sleep most of time saving battery energy. The nearest with forward progress algorithm was proposed by Hou and Li and requires a node to transmit to the nearest neighbor which will result in forward progress, If the nearest such node is not reachable with the maximum available power, the node does not transmit. If the node does transmit, it does so with the minimal power required to reach the receiving node [18].

Liang and Bruck propose several topology control algorithms based on cone angles and study their properties, each node chooses its transmit range to be the minimum value, subject to the constraint that its cone angles are all smaller than π. Each slave node periodically wakes up and communicates with the master node to find out if it has data to receive or not but it sleeps again if it is not addressed. Network throughput under the multipath fading and shadowing is far less than that under the free space path loss model, which is used in the majority of existing studies. But it can be greatly improved by using the cross-layer architecture [19].

Path loss is derived from the Friis transmission equation and is defined as:

$$\text{Path Loss} = 20\log(4*p*r/\lambda) \text{ db} \quad (1)$$

Where r is the distance between the transmitter and receiver, and λ is the wavelength.

For example 900 MHz transmitters (λ=0.33 meters).The path loss equation represents path loss (signal attenuation) as a function of distance between the receiver and transmitter and the wavelength of the operating frequency. The Friis transmission equation can be used to represent the path loss as the sum of the other system factors leading to the following equation:

$$\text{Path Loss} = P(t) + G(t) + G(r) - R(s) - F(s) \text{ db} \quad (2)$$

Where P(t) = transmitted power ,G(t) = gain of transmit antenna ,G(r) = gain of receive antenna ,R(s) = sensitivity of receiver ,F(s) = fading margin, (experimentally determined to be 22dBm) These two equations can be used to calculate the maximum range of RF modules.

Case1:

Consider the range of 1W RF module:
λ = 0.33 meters (for f=900 MHz)
From Equation 1. , Path Loss = 122 dB = 20 * log (4*π*r/λ)
From Equation 2. , Path Loss = 30dBm + 2dB + 2dB - (-110dBm) - 22dBm= 122 Db, r = 33, km = 20 miles transmitting range.

Case 2:

Consider the range of 18W RF module: This give r = 133 km = 82 miles transmitting range.

Performance Metrics

The packet delivery ratio, average end-to-end delay, and routing overhead ratio were used as performance metrics. The packet delivery ratio is the ratio of the correctly delivered data packets to total packets transmitted and is obtained as follows:

1). Packet Delivery Ratio = No. of packets (message delivered)/No. of packets (message) sent

The number of delivered data packets is the sum of total delivered data packets received by all nodes. The number of sent data packets is the sum of total numbers of data packets/message sent by each node [11].

2). The average end-to-end delay is the average of all end-to-end delay of transmission.

IV. SIMULATION RESULT

Simulator is used for this experiment. Fifty nodes are connected in self configured network. Node has Operating Frequency: 868.35 MHz, Modulation Types: ASK, Power Supply: 0-4V, Transmitting range 100m

Simulation Parameters: Number of Nodes,Sim-time-limit, CPU-time-limt, Total-stack-kb, Data Transfer Rate, Pay Load, Byte sent, Minimum Node Energy.

Simulation result for Node 2:

Table I: Total energy for node2

Pay Load Value	Energy Data TX(J)	Energy Switch--ing (J)	Energy Sleep(J)	Energy Tx (J)	Energy Rx(J)	Total Energy (J)
63	0.0108	0.0022	0.00099	0.0118	0.04896	0.0640
127	0.2176	0.0022	0.00098	0.0226	0.05149	0.0772
255	0.0435	0.0021	0.00096	0.0444	0.05912	0.1066
511	0.0793	0.0021	0.00093	0.0802	0.07346	0.1568
1023	0.1587	0.0021	0.00087	0.1596	0.10520	0.2678

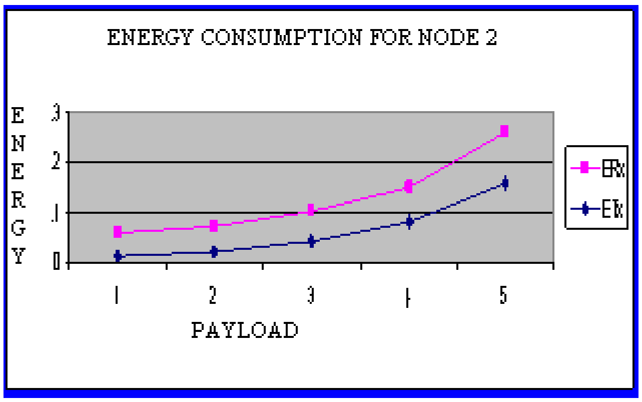

Fig.1. Energy Vs Payload for Node2

From graph and table, it is clear that amount of energy is used in Switching, Sleeping, Transmission, Receiving. Node battery life is depending on the energy consumption. Node consumes more energy in case of large data size. Sleep down mode approach is more effective as compare to other protocol to save energy in transmission of data for mobile ad-hoc network.

V. PROPOSED NEURAL NETWORK BASED SLEEP DOWN POWER CONTROL PROTOCOL

McCulloch and Pitts worked out the scheme of the neuron in 1943 and it was created as a building imitation of the biological nervous cell [12-13]. Input signals xi coming from external receptors (for the input layer) or from the previous neurons layer (for hidden layers and exit layer) are attached to the network inputs. Every signal is multiplicities by numerical value wi, which is interpreted as weight of the given neuron, ascribed to the neuron. This value has the influence in creation of the output value. The value of the weight can stimulate the neuron to operate, when its sign is positive, or can also hold on the neuron inactive, when the sign is negative. The sum of entrance signals multiplied through appropriate weights is the argument of the neuron's activation function. The diagram representing the structure of single neuron is presented in Fig. 2.

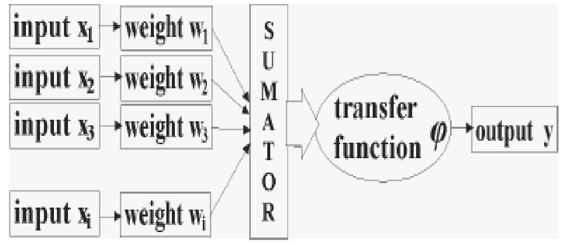

Fig. 2. Neural Network Model

The model of artificial neuron describes the mathematical model, where *m* is a number of input signals of a single neuron

$$y = \varphi\left(\sum_{i=1}^{m} w_i x_i\right) \tag{3}$$

θ = Threshold of Threshold Unit, X = Input Vector, W = Weight Vectors, s=X·W

Conditions- If s≥θ, op=1, if s< θ, op = 0

Evaluation of node energy consumption with neural network based mathematical model

Three inputs (X1, X2, X3) for Node-3 are given below:-

X1= ED Tx -Energy Data TX, X2 = E Switching, X3= E Sleep, Weight (W1, W2, W3) =1,

θ =0.009, S=X·W=(X1…X3).W (W1, W2, W3),

Output(y) = 0.63863

Simulation trained neural network model gave almost instantaneous result. In case of dead node, Energy consumption by network is zero, only active nodes are used in network.

VI. CONCLUSION

In this paper**,** Sleep down power control approach put the radio subsystem into the sleep state or simply turn it off to save energy, Neuron network model is more helpful as compare to other method to solve power control problem in mobile ad-hoc network. Proposed neural network model is design on the basis of simulation parameters and result. It is easy to operate, design network and understand the nature of network. Neural network model is alternative concept of simulator.

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