International Journal of Advanced Technology in Engineering and Science
Vol. No.07, Issue No. 01, January 2019
www.ijates.com
ijates
ISSN 2348 - 7550

Energy Evaluation of MANET routing protocols for different Radio Propagation Models

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ABSTRACT

In the wireless network, there is requirement to determine the radio waves targeted coverage area. Targeted radio coverage area has decisive network performance and fiscal impact on the network. This Targeted radio coverage depends on number of parameters such as the emission power. When adhoc network is to be established, emission power defines the number of nodes connected. It also has crucial impact on the energy consumption of nodes. As the large propagation power causes high energy consumption, whereas low propagation power causes less number of nodes interconnected. So there is need to study the behaviour of wireless network under different propagation models. MANET in today's scenarios is most innovative and demanding wireless technology that is the requirement of time. As the nodes of MANET are wireless devices, they have limited battery-life / energy. In this paper, energy consumption of DSR, DSDV and OLSR routing protocols has been evaluated for various radio propagation models such as FreeSapce, TwoRayGround and Shadowing.

Keywords: *DSR, DSDV, OLSR,* FreeSapce, TwoRayGround, Shadowing.

1. INTRODUCTION

Mobile Ad-hoc Network is Infrastructure Less network. It is composed of a set of communicating devices that are able to impulsively interconnect with each other without the requirement of any base stations or any other Nodes of MANET plays the role of both router and host node. Nodes of MANET are wireless nodes having limited energy. Energy consumption in a Mobile Adhoc Networks has been defined as total energy consumed by communication system during transmission of packets from source node to destination [1, 10]. It has been measured in Joules. As nodes are in mobile MANET, topology of network changes with time. Number of

routing protocols has been defined for routing the packets in dynamic topology network of MANET. In this paper, DSR, DSDV and OLSR routing protocols performance has been evaluated [2, 5, 8].

1.1 DSR protocol

Dynamic Source Routing protocol is Reactive Routing protocol. This protocol is the source routing protocol. In DSR while source node transmits data, it inserts in the data packet header the complete information regarding transitional nodes in the route through which the packet has to pass. For load balancing, this routing mechanism allows the source node to select different routes for packets. Intermediate nodes in the path can cache the route information from packet header and can use this information for routing packets in future.

1.2 DSDV protocol

Destination Sequenced Distance Vector routing protocol is proactive routing protocol In DSDV protocol, each node broadcast its routing information to its neighbouring nodes regularly so that routing table of each node provide latest updated routing information during transmission of packets. In DSDV protocol, each node maintains a routing table which consists of destination address, destination sequence number, metrics and next hop address information. Unique sequence number has been assigned to each entry in the routing table for different destination nodes.

1.3 OLSR protocol

Optimized Link State Routing protocol is table driven routing protocol. In OLSR protocol, each node of the network defines its Multipoint Relays by choosing subset of its adjoining nodes. Purpose of defining these MPRs is for reducing the unnecessary re-transmission of same packets to same nodes. Those nodes that are not in the list of MPR of a node, receives the message from source node but it not forward this packet to others. These MPR nodes are only accountable for forwarding the control message of source node into the network. As in case of OLSR protocol only some subset of nodes are forwarding the control packets, total control messages flowing in the network are less in comparison to other protocols, which results reduced number of transmissions in the network.

2. RADIO PROPAGATION MODELS

Radio propagation model, also named as Radio Wave Propagation Model or Radio Frequency Propagation Model, is the mathematical formulation of the characterization of radio wave propagation as a function of distance, frequency, emission power and other surrounding conditions. Single model is usually defined to predict the behaviour of propagation for all similar links under identical constraints [3, 4]. Wireless channel is basically characterised by path loss, Interference, Fading and shadowing, Doppler Shift etc. characteristics of propagation model may change randomly from location to location and time to time. At the physical layer of each wireless node, there is a receiving threshold value defined. If the received packet signal power, is less than

the receiving threshold value then the packet is dropped by the MAC layer. There are number of propagation models defined:

2.1 FreeSpace Model

Free space propagation model represents that there are the perfect propagation state within the sender and receiver. In other worlds, it can be said that this model assumes that there is only one clear line of sight route between the sender and receiver. Following equation defines the receiver signal power strength:

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$

here, P_t is the transmission power, G_t is the Antenna Gain of Transmitter, G_r is the Antenna Gain of Receiver, λ is the wavelength, d is the distance between sender and receiver, L is the system loss factor.

.2 TwoRayGround Reflection Model

FreeSpace model defines there is only one single direct path, but however in real scenario single direct path between mobile nodes is rarely the only mean of propagation. Signal reaches the receiver through multiple paths which is due to reflection, refraction and scattering. TwoRayGround Reflection model promotes that the signal attains the receiver via true paths i.e. via direct path and a ground reflection path. This model is well suitable for long distance transmission. In TwoRayGround model, the received power is represented by following equation:

$$P_r(d) = \frac{P_t G_t G_r h_t^2 h_r^2}{d^4 L}$$

here, h_t is the height of the transmission antenna and h_r is the height of the receiver antenna.

2.3 Shadowing Model

Both FreeSpace model and TwoRayGround model envisage the received power as a deterministic function of distance. Both these types of models characterize the transmission range as an ideal circle. Shadowing model considers the impact of different scenarios which can affect the radio signal. Shadowing model assumes that the average received signal power decreases logarithmically with distance. Gaussian random variable is added to this path loss to account for environmental influences at the sender and the receiver. The shadowing model is twofold model. The first model is the path loss model represented by $P_r(d)$.

$$\frac{P_r(d_0)}{P_r(d)} = \left(\frac{d}{d_0}\right)^{\beta}$$

here, β is called the path loss exponent.

The second part of the shadowing model reflects the variations of received power at certain distance

$$\left[\frac{P_r(d)}{P_r(d_0)}\right]_{dB} = -10\beta \log\left(\frac{d}{d_0}\right)$$

The overall model is represented by following equation:

$$\left[\frac{P_r(d)}{P_r(d_0)}\right]_{dB} = -10\beta \log\left(\frac{d}{d_0}\right) + X_{dB}$$

here, X_{dB} is Gaussian random variable with zero mean and standard deviation σ_{dB}.

2.4 Rayleigh model

This model has been used in the environments where there is no direct path exists between the sending node and the receiving node. In this model received signal power is the power achieved through distributive path.

3. SIMULATION & RESULTS

To analyze the energy consumption of different MANET routing protocols for different propagation models [1, 11], extensive simulation work has been performed using NS-2 simulator. Here, percentage energy consumption of DSR, DSDV and OLSR routing protocols has been evaluated for varying pause time of nodes such as 0, 5, 10 and 15. Simulation scenario has been specified in table-3.1.

Parameter	**Value**
Number of nodes	50
Maximum speed	20 m/s
Pause time	0, 5, 10, 15
Environment size	1000 x1000 m
Packet size	512 Bytes
Traffic type	CBR
Packet Rate	4 packets/sec
MAC Type	IEEE 802.11
Routing protocol	DSR, DSDV, OLSR
Radio Propagation Mode	FreeSpace, TwoRayGround, Shadowing

Table 3.1: Simulation Scenario

3.1 Energy Consumption under FreeSpace propagation model

Percentage Energy consumption of DSR, DSDV and OLSR routing protocols under varying mobility conditions such as varying pause time of 0, 5, 10 and 15 for FreeSpace propagation model has been shown in fig 3.1. It has been observed from the figure that DSDV protocol is consuming maximum energy due single line of sight between sender and receiver. It has been observed that DSR protocol consumes comparatively less energy from DSDV and OLSR. With increase in pause time of nodes which means nodes are more stable at one location energy consumption of nodes decreases.

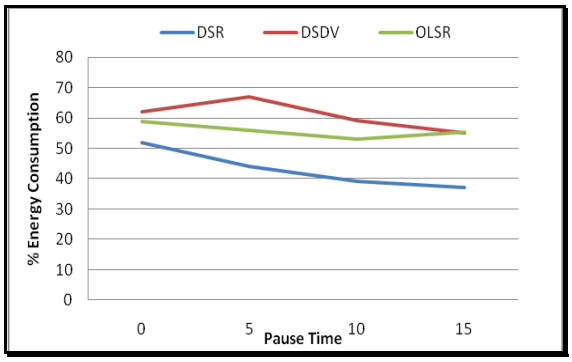

Fig 3.1: Energy Consumption Analysis for FreeSpace propagation Model

3.2 Energy Consumption under TwoRayGround propagation model

Fig 3.2 elaborates the Percentage Energy consumption of different MANET routing protocols for varying pause time under two path propagation model such as TwoRayGround. It has been observed from the figure there is slight reduction in percentage energy consumption of all routing protocols. It has been noted that with varying pause time percentage energy consumption of DSDV protocol increases whereas it decreases for DSR and OLSR routing protocols.

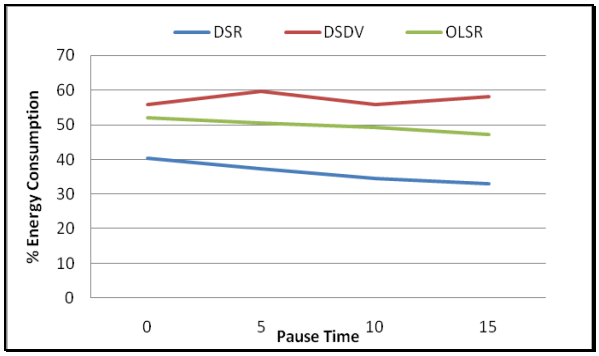

Fig 3.2: Energy Consumption Analysis for TwoRayGround propagation Model

3.3 Energy Consumption under Shadowing propagation model

Percentage Energy consumption various MANET routing protocols under varying mobility conditions Shadowing propagation model has been shown in fig 3.3. It has been observed that under shadowing model percentage energy consumption is least in comparison to that under Freespace and TwoRayGround propagation models. It has been further noted that percentage energy consumption of DSDV and OLSR routing protocols increases with varying pause time conditions.

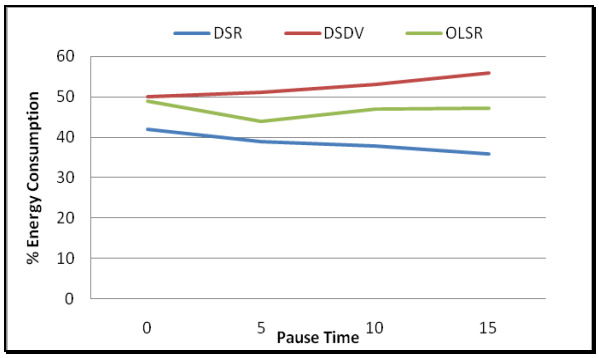

Fig 3.3: Energy Consumption Analysis for Shadowing propagation Model

4. CONCLUSION & FUTURE SCOPE

This paper analyzed the percentage energy consumption of DSR, DSDV and OLSR protocols under FreeSpace, TwoRayGround and Shadowing propagation models. It has been concluded from the analysis that change in propagation model has no impact on the basic behaviour of routing protocols. However, it has been concluded that in case of FreeSpace model due to single line of sight between sending node and receiving node, there is more consumption of energy. It has been also observed that DSDV protocol consumes maximum energy due to its proactive routing behaviour, whereas DSR protocol consumes least energy. In future, to optimize the energy utilization of nodes, modified version of routing protocols or new propagation model can be proposed.

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