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Performance Analysis of Propagation Structures on DSR Routing Protocol in Mobile Ad-hoc Networks

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Abstract

Propagation structure has a vital role in designing the Mobile ad-hoc networks (MANETs). Propagation structure is employed for computing signal strength about each data packet at the destination. Propagation Structures in MANETs are characterized into three categories such as Free Space structure, Two-Ray Ground structure and Shadowing structure. Here in this paper, the effect of Two-Ray Ground propagation structure and Shadowing propagation structure on the performance of DSR routing protocol is conferred. Propagation Structure has a great impact on the simulation results. The simulation is accomplished using NS 2 simulator and the various Performance Attributes used for the evaluation of the performance of DSR protocol are Average Delay, Packet Delivery Ratio, Energy Consumption and Throughput.

***Keywords**: MANETs; DSR; Two-Ray Ground; Shadowing*

1. Introduction

Mobile, ad-hoc networks (MANETs) repose of moveable nodes which are united through wireless links to exchange information without any centralized base station [1].In MANETs, the random movement of mobile nodes in and out of the transmission range of each other results in frequent connection breaks and variation in the topology of the network [2].MANETs are easy to set up as compared to the wired network and has various applications such as military, battlefield communication, disaster rescue operations, sensor networks and Personal Area Network (PAN).

The categories of routing protocols in the MANETs are: (i) Proactive routing protocols [4] (ii) Reactive routing protocols [4].Proactive routing protocols are also named as Table-driven routing protocols and Reactive routing protocols as On-demand routing protocols. Dynamic source routing (DSR) protocol is an example of Reactive or on-demand protocol.

This paper is arranged into six sections. Section II presents related work. Section III includes the description of DSR routing protocol. Section IV describes the various propagation structures which are put to use for conducting the performance evaluation of DSR routing protocol. Section V presents simulation environment and performance attributes chosen for evaluating the performance of DSR protocol. Section VI comprises the analysis of simulation results. Section VII contains the conclusion of paper.

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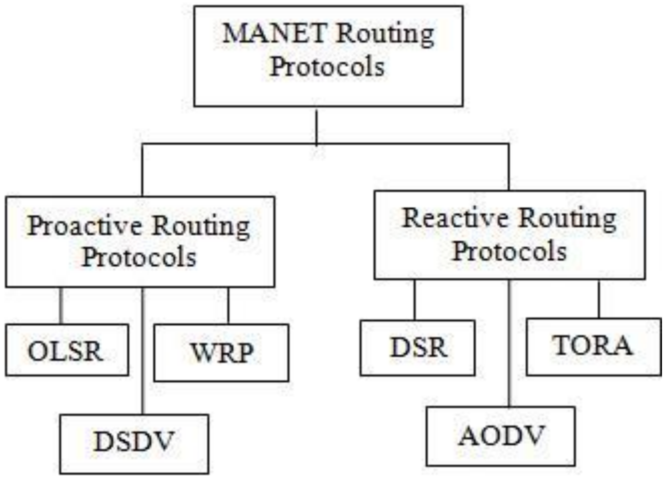

Figure 1. Categories of MANETs

2. Related Work

In MANETs, a number of routing protocols are proposed for wireless communication. Performance evaluation of various routing protocols is done by the researchers. Some of them are AODV, DSR and WRP [5] routing protocols, AODV, DSR, DSDV [12] routing protocols and performance comparison of DSDV, OLSR and AODV [3] routing protocols.

The performance comparison of AODV and DSR routing protocols in Mobile ad hoc networks [1] is done by considering the nodes mobility and the network load. It is concluded that the DSR outperforms AODV routing protocol when the number of nodes and mobility is less. The performance analysis of AODV, DSR and WRP routing protocols [5] is done using FTP, TELNET and CBR traffic conditions under various network scenarios such as the effect of change in pause time, number of source destination pairs and average speed of nodes. A dynamic mechanism for DSR routing protocol [8] have proposed which computes Expected Link Expiration Time which timely removes the stale cache entry from route cache and then evaluated the performance of enhanced DSR protocol using performance metrics such as total route error, end-to-end delay and packet delivery ratio vs. mobility and it is concluded that this enhanced DSR caching scheme improves the performance. The performance comparison of AODV, DSR and DSDV routing protocols [12] is evaluated using varying traffic loads in Mobile ad hoc networks. It is observed that in heavy traffic loads, the performance of DSR is better than the AODV and DSDV routing protocols. The performance evaluation of AODV, DSR and DSDV routing protocols [13] in MANET is done using NS2 simulator and it is concluded that DSR routing protocol is best protocol in terms of packet delivery ratio. The effect of packet size and node mobility pause time [14] is evaluated on the DYMO and AODV routing protocols against the Throughput.

3. DSR Reactive Routing Protocol

The Dynamic Source Routing (DSR) is the reactive routing protocol that employs the method of routing by the source i.e. origin node has the entire Multihoping route to the target [5].The DSR routing operation be expressed by two prime phases: (i) Route discovery and (ii) Route maintenance. DSR routing protocol stores various routes in its route cache. The Route discovery phase makes the usage of Route request (Rreq) together with Route reply (Rrep) packets. When a node needs to transmit the data packet towards the target, Rreq packet is simulcast to all of its neighbor nodes to determine the route to the target node. The Rreq packet includes unique identifier, source address and destination address. Each node receiving the Rreq packet does the following [6]:

- If the id of the Rreq packet is similar to the node's id, then the node discards the Rreq packet.

- If the id of the Rreq packet is not similar to node's id, the node appends its own id along the path id and then directs the Rreq packet.

- If the destination id is similar to the node's id, the node loads the packet and follows the Route reply mechanism.

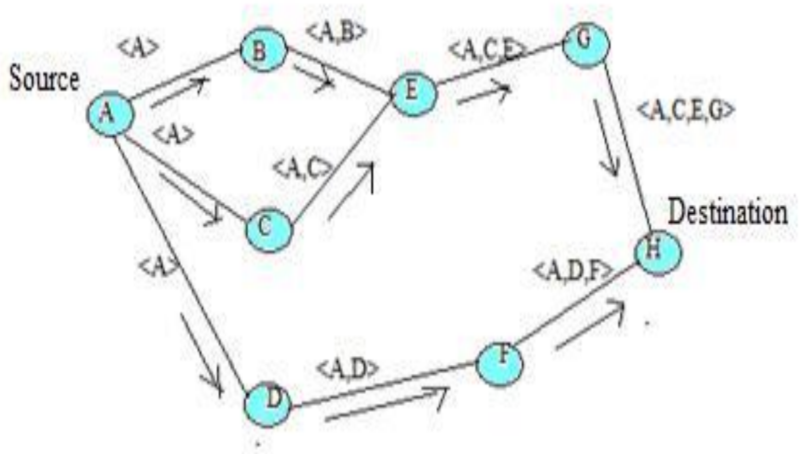

Figure 2. DSR Route Request

In Route reply mechanism, after the Rreq packet reaches the final target, then it use the reversal of the route followed by Rreq packet and routes the Rrep packet to the origin node [7]. In Route Maintenance phase, when there is link breakage or change in topology, the Route error (Rer) information is directed towards source node. The source node subtracts that stale link from its route cache [8].

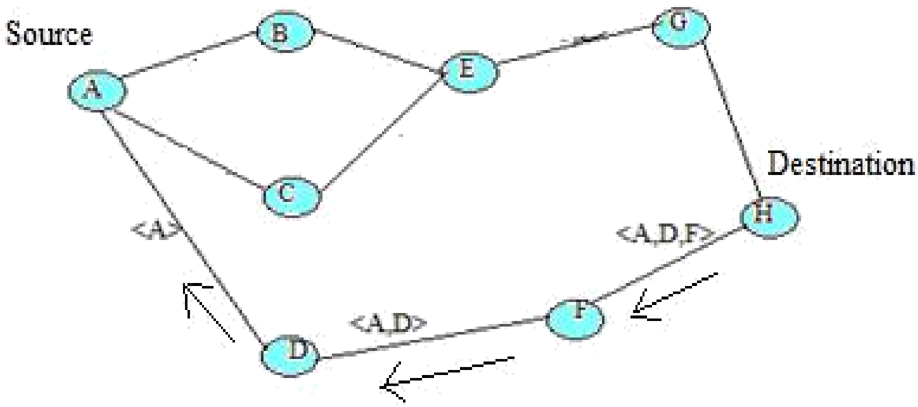

Figure 3. DSR Route Reply

4. Propagation Structures

Propagation Structures are employed to enumerate the strength of the signal of each received packet by the receiver and detect the attenuation amongst the source and the destination. The Propagation Structures [9] are classified as follows:

• Free Space structure: This structure has a one line of sight lane among the transmitting and the receiving antennas. Free Space structure is selected for small-scale distance. In Free Space structure, the signal strength received from the transmitter at the distance d is computed by using the following equation [10]:

$$P_{r(d)} = \frac{P_t G_t \, G_r \, \lambda}{(4\pi)^2 d^2 \, L} \qquad (1)$$

Where, $P_{r(d)}$ - received signal power and its unit is decibel (db). P_t - signal strength that is transmitted. G_t and G_r - transmitter's and receiver's antenna gain respectively. λ - Wavelength. L - System loss, $L \geq 1$.

• Two-Ray Ground structure: This structure consists direct path as well as the ground reflection path. For long distances, it is better to use the Two-Ray Ground structure. The received signal strength in Two-Ray Ground structure is computed by using the following equation [10]:

$$P_{r(d)} = \frac{P_t G_t G_r (h_t)^2 (h_r)^2}{d^4 \, L} \qquad (2)$$

Where, $P_{r(d)}$ - received signal strength at distance d. G_t and G_r - transmitter's and receiver's antenna gain respectively. h_t - height of forwarding antenna. h_r - height of acquiring antenna. L- System loss.

• Shadowing structure: The most realistic structure is Shadowing structure as it concedes the obstruction between the transmitter and the receiver. During the propagation, the hindrance is caused by big buildings or signal may strike with obstacles. An equation used to compute received signal power is as follows [10]:

$$\frac{P_{r(d)}}{P_{r(d_2)}} = -10\lambda \log\left(\frac{d}{d_2}\right) + G \qquad (3)$$

Where, $P_{r(d)}$ – received signal strength. $P_{r(d2)}$ – Received signal strength at closer distance. Λ – Path loss. G – Gaussian Variable.

5. Simulation Environment

5.1 Simulation Attributes

The Simulation is accomplished with Network Simulator 2 (NS 2).The Simulation Attributes are displayed below in Table I.

Table 1. Simulation Attributes

Simulation Attributes	Values
Simulation Tool	NS2
MAC Protocol	IEEE 802.11
Routing Protocol	DSR
Simulation Area	1000 m x 1000m
Number of Nodes	25, 50, 75, 100, 125
Size of Packet	512 bytes
Propagation Structures	Two-Ray Ground and Shadowing Structure
Traffic Condition	UDP and CBR

5.2 Network Simulator (NS 2)

NS 2 [11] is an object-oriented network simulator that is used in performance evaluation of routing protocols in wired and wireless networks. In our work, we used NS 2 to carry out the performance evaluation of DSR protocol with different propagation Structures under different performance Attributes. NS 2 is used for simulating computer networks. NS 2 is written in two languages: OTcl and C++. OTcl is Object oriented Tool Command Language to configure the network and acts as the front end. C++ is used for running the simulation and acts as the back end.

5.3 Performance Attributes

The Performance Attributes used for the performance evaluation of DSR routing protocol are as follow:

• Average Delay: Average Delay is the time that the data packets consume to span the network and then reach the destination. Average Delay is computed by using the following formula:

$$Average\ Delay = \frac{Delay\ Sum}{Total\ number\ of\ Received\ packets} \quad (4)$$

• Packet Delivery Ratio: The ratio of the data packets that are received successfully by the target node and the data packets that are sent by the origin node is defined as Packet Delivery Ratio. The Packet Delivery Ratio is computed as follows [12]:

$$Packet\ Delivery\ Ratio = \frac{Packets\ Received\ by\ Target}{Packets\ sent\ by\ Source} * 100 \quad (5)$$

• Energy Consumption: The high mobility of nodes and forwarding of data packets or control packets are the main causes of the depletion of battery energy of the mobile nodes [13]. The energy consumption of a mobile node for transmitting and receiving packets can be calculated by the following formula:

$$Energy_t = \frac{Transmitted\ Power * Packet\ Size}{2 * 10^6} \quad (6)$$

$$Energy_r = \frac{Received\ Power * Packet\ Size}{2 * 10^6} \quad (7)$$

• Throughput: The average data packets acquired successfully by the target is known as throughput and its unit is bits per second (bps) [14]. Throughput is computed by formula as follows:

$$Throughput = \frac{Received\ Packets * Packet\ Size}{Simulation\ Time} \quad (8)$$

6. Analysis of Simulation Results

The simulation results for the performance evaluation of DSR routing protocol under Two-Ray Ground structure and shadowing structure with as Average Delay, Packet Delivery Ratio, Energy Consumption and Throughput are summarized as follow:

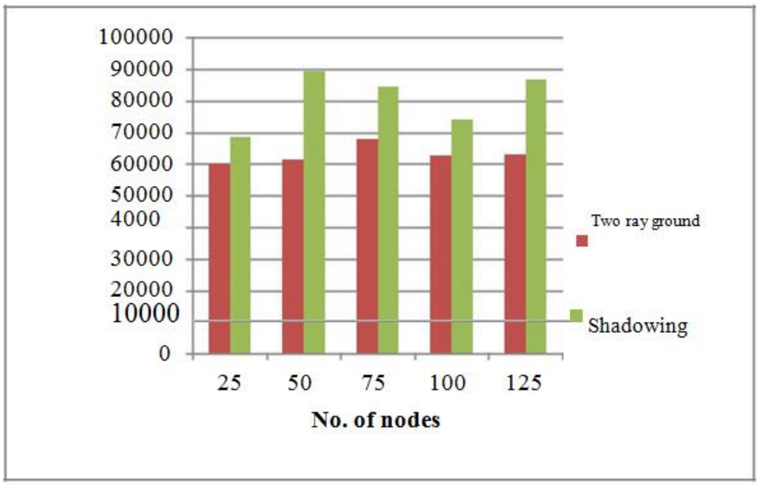

Figure 4. Average Delay vs. No. of Nodes

• Average Delay vs. No. of nodes: Fig.4 displays the simulation results of DSR routing protocol under the Two-Ray Ground structure and Shadowing structure with respect to Average Delay. The Average Delay for DSR protocol is less under Two-Ray Ground structure as related to Average Delay under Shadowing structure with 25, 50, 75,100 and 125 nodes.

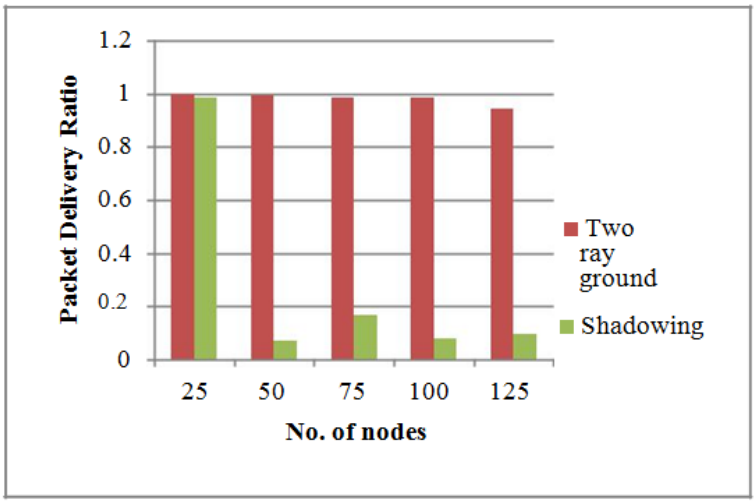

Figure 5. Packet Delivery Ratio vs. No. of Nodes

• Packet Delivery Ratio vs. No. of nodes: Fig.5 displays the simulation results of DSR routing protocol under Two-Ray Ground and Shadowing structure in terms of Packet Delivery Ratio. The Packet Delivery Ratio of DSR routing protocol under Two-Ray Ground structure is much better than under Shadowing structure and it is observed that in the Shadowing Structure, the Packet Delivery Ratio shows a big fall when the number of nodes increases above 25.

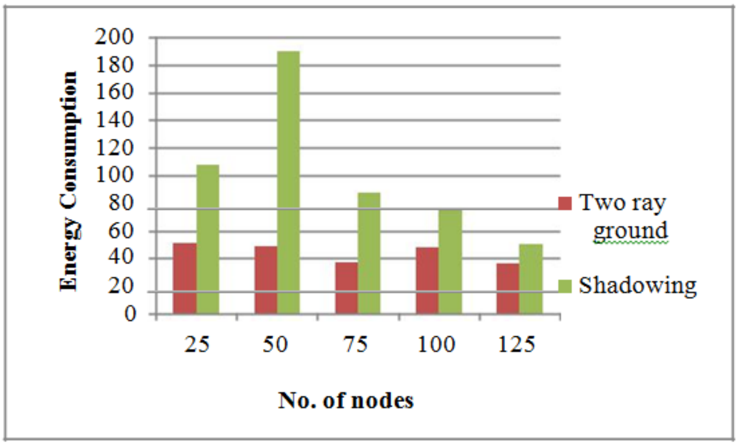

Figure 6. Energy Consumption vs. No. of Nodes

• Energy Consumption vs. No. of nodes: Fig.6 displays the simulation results of DSR routing protocol under Two-Ray Ground and Shadowing structure in terms of Energy Consumption. The Energy Consumption for DSR routing protocol is less under Two-Ray Ground structure than Shadowing structure

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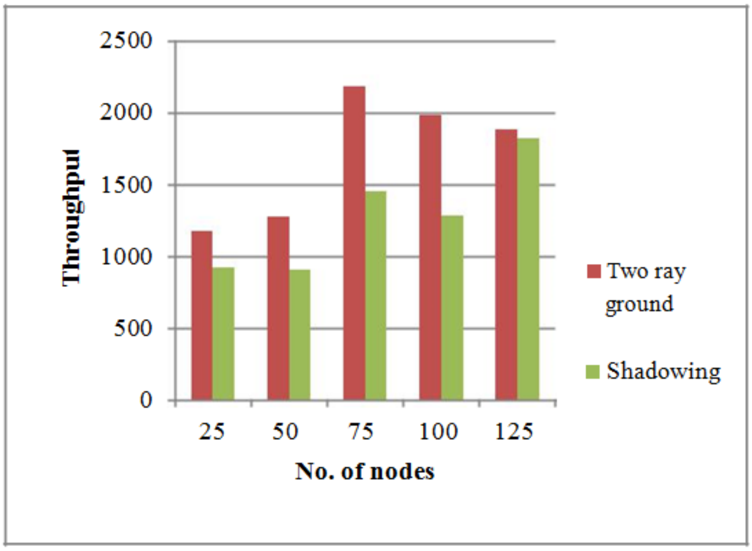

Figure 7. Throughput vs. No. of Nodes

• Throughput vs. No. of nodes: Fig.7 displays the simulation results of DSR routing protocol under Two-Ray Ground and Shadowing structure in terms of Throughput. The Throughput for DSR routing protocol is more in Two-Ray Ground structure than in Shadowing structure.

7. Conclusion

In this paper, the effect of Two-Ray Ground and Shadowing structure against the performance of DSR routing protocol is shown. The simulation outcomes show that the nature of propagation structure affects the performance of DSR routing protocol. It has been concluded that for DSR routing protocol, the Two-Ray Ground structure gives better results than the Shadowing structure in terms regarding Average Delay, Packet Delivery Ratio, Energy Consumption and Throughput. In the future, the performance of several routing protocols i.e. OLSR, AODV, DSDV can be compared under the Two-Ray Ground structure as well as Shadowing structure.

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