Study and Performance Comparison of AODV & DSR on the basis of Path Loss Propagation Models

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Abstract

Mobile Ad-Hoc networks (MANETs) are collection of mobile nodes that dynamically forming a temporary network without pre-existing network infrastructure and communicate with its neighbors to perform peer to peer communication and transmission. It offers unique benefits and versatility for certain environments and certain applications. Since there is no prerequisite fixed infrastructure and base stations, they can be created and used anytime, anywhere. Propagation models focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. The accuracy of any particular propagation model in any given condition will depend on the suitability among the constraints required by the model and depend on terrain. A number of propagation models like Free Space and Two Ray ground have been exist. In this paper, we present comparative study on the behavior of various routing protocols with path loss propagation models, various performance metrics used for this comparison such as packet delivery fraction, average jitter, throughput and average end to end delay. The studies would be helpful in choosing the correct protocol for any active operating environment.

Keywords: *Ad-hoc network, AODV, DSR, Free space & Two Ray Ground Path loss propagation model.*

1. Introduction

The development of efficient transmission, operation and management technologies and a progressive reduction in the size of the cells requires a greater suitability on the estimations of the system coverage, which is given by propagation losses, in order to obtain "total coverage" with which the operator attempts to assurance the quality of service. For this reason an accurate and flexible prediction methodologies of coverage with easy implementation is required. [1] It is hard to find a methodology of signal prediction which achieves the precision-complexity-time paradigm. The aim of finding a single methodology for any metropolitan environment is insufficient because it is clear that the performance of a system is closely related to the operation region. In this paper we compare AODV & DSR on the basis of two path loss propagation models i.e. Two Ray Ground model and Free Space Model.

The rest of this paper is organized as follows. Section 2 briefly describes the Routing Protocols in ad-hoc network. In Section 3, overview of propagation model is explained. In Section 4, the simulation Experiment and Parameter Metrics are shown and in Section 5 is simulation results and last Section 6 concludes this paper.

2. Routing Protocols in Ad-hoc Network

For mobile *ad hoc* networks, the issue of routing packets between any pair of nodes becomes a challenging task because the nodes can move randomly within the network. A path that was considered optimal at a given point in time might not work at all a few moments later. Moreover, the stochastic properties of the wireless channels add to the uncertainty of path quality [2].

Traditional routing protocols are proactive in that they maintain routes to all nodes, including nodes to which no packets are being sent. They react to any change in the topology even if no traffic is affected by the change, and they require periodic control messages to maintain routes to every node in the network.

An alternative approach involves establishing reactive routes, which dictates that routes between nodes are determined solely when they are explicitly needed to route packets. This prevents the nodes from updating every possible route in the network, and instead allows them to focus either on routes that are being used, or on routes that are in the process of being set up.

2.1. Dynamic State Routing (DSR)

The DSR protocol [3, 4, 5] requires each packet to carry the full address (every hop in the route), from source to the destination. This means that the protocol will not be very effective in large networks, as the amount of overhead carried in the packet will continue to increase as the network diameter increases. Therefore, in highly dynamic and large networks the overhead may consume most of the bandwidth. However, this protocol has a number of advantages over other routing protocols, and in small to moderately size networks (perhaps up to a few hundred nodes), this protocol performs better. An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery, and if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility, because the routes stored in the route cache will be valid for a longer period of time. Another advantage of DSR is that it does not require any periodic beaconing (or *hello* message exchanges), therefore nodes can enter sleep node to conserve their power. This also saves a considerable amount of bandwidth in the network.

2.2. Ad hoc On-demand Distance Vector Routing (AODV)

The AODV routing protocol [6, 7, and 8] is based on DSDV and DSR algorithm. It uses the periodic beaconing and sequence numbering procedure of DSDV and a similar route discovery procedure as in DSR. However, there are two major differences between DSR and AODV. The most distinguishing difference is that in DSR each packet carries full routing information, whereas in AODV the packets carry the destination address. This means that AODV has potentially less routing overheads than DSR. The other difference is that the route replies in DSR carry the address of every node along the route, whereas in AODV the route replies only carry the destination IP address and the sequence number. The advantage of AODV is that it is adaptable to highly dynamic networks. However, node may experience large delays during route construction, and link failure may initiate another route discovery, which introduces extra delays and consumes more bandwidth as the size of the network increases.

Table 1. Basic Characteristics of DSR & AODV

Protocol	Multiple Routes	Route Metric Method	Route Maintained In	Route Reconfiguration Strategy
DSR	Yes	Shortest Path or Next path available	Route Cache	Erase Route then Source Notification.
AODV	No	Freshest & Shortest path	Route Table	Erase Route then Source Notification or Local Route Repair

3. Overview of Propagation Model

A propagation model is a set of mathematical expressions, diagrams, and algorithms used to represent the radio characteristics of a given environment [9]. Propagation model are three types empirical model, semi deterministic model, deterministic model Empirical models are based on measurement data, simple, use statistical properties, and not very accurate. Semi-deterministic models are based on empirical models and deterministic aspects. Deterministic models are site-specific, require enormous number of geometry information about the cite, very important computational effort, accurate.
Path loss can be expressed as the ratio of the power of the transmitted signal to the power of the same signal received by the receiver, on a given path. It is a function of the propagation distance. Estimation of path loss is very important for designing and deploying wireless communication networks. Path loss is dependent on a number of factors such as the radio frequency used and the nature of the terrain [10].

3.1. Free Space Model

The free space propagation model is the simplest path loss model. The received power is only dependent on the transmitted power, the antenna's gains and on the distance between the sender and the receiver. It accounts mainly for the fact that a radio wave which moves away from the sender has to cover a larger area. So the received power decreases with the square of the distance. The free space propagation model assumes the ideal propagation condition that there is only one clear line-of-sight path between the transmitter and receiver. H. T. Friis presented the following equation to calculate the received signal power in free space at distance d from the transmitter [11, 12].

$$P_R = P_T . G_T . G_R . (\frac{\lambda}{4\pi d})^2$$

Where P_T is the transmitted signal power G_T and G_R are the antenna gains of the transmitter and the receiver respectively. λ is the wavelength. The path loss for the free space model when the antennas are assumed to have unity gain is provided by the following equation.

$$\frac{P_T}{P_R} = \left(\frac{4\pi d}{\lambda}\right)^2 = \left(\frac{4\pi d f}{c}\right)^2$$

Expressed in dB as:

$$L(dB) = 10\log\frac{P_T}{P_R} = 10\log\left(\frac{4\pi d f}{c}\right)^2$$

$$L(dB) = 32.44 + 20\log(d_{km}) + 20\log(f_{Mhz})$$

One is able to see from the above free space equations that 6 dB of loss is associated with a doubling of the frequency. This same relationship also holds for the distance, if the distance is doubled, 6 dB of additional loss will be encountered.

3.2. Two Ray Ground Model

One more popular path loss model is the two-ray model or the two-path model. The free space model described above assumes that there is only one single path from the transmitter to the receiver. But in reality the signal reaches the receiver through multiple paths (because of reflection, refraction and scattering). The two-path model tries to capture this phenomenon. The model assumes that the signal reaches the receiver through two paths, one a line-of-sight path, and the other the path through which the reflected wave is received. According to the two-path model, the received power is given by [11]:

$$P_R = P_T \cdot G_T \cdot G_R \cdot \left(\frac{h_t h_r}{d^2}\right)^2$$

Where P_T is the transmitted power, G_T and G_R are the transmitter and receiver antenna gains, respectively, in the direction from the transmitter and receiver, d is the distance between the transmitter and receiver, and h_t and h_r are the heights of the transmitter and receiver, respectively.

4. Simulation Environment

4.1 Table 2. Parameter Values for Simulation

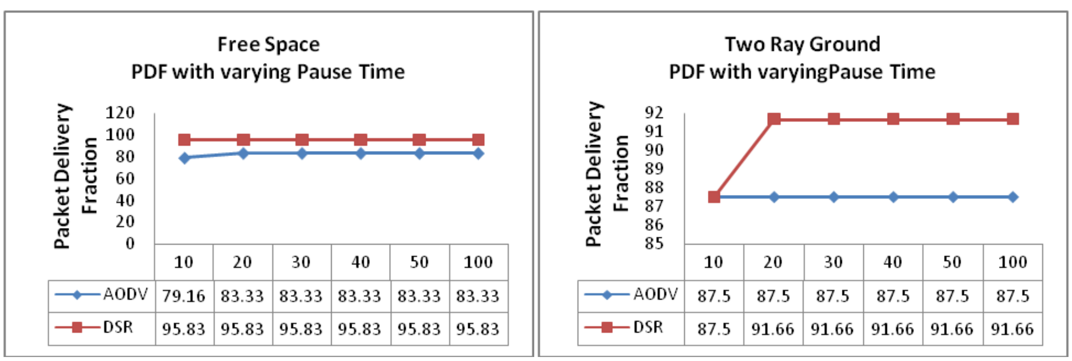
Maximum Simulation time	200 Seconds
Physical Terrain-Dimensions	1000 X 1000
Number of nodes	75
Mobility Model	Random Way Point
Routing Protocol	DSR, AODV
Propagation model	Free space, Two Ray Ground
Shadowing Model	Constant
MAC layer Protocol	IEEE 802.11
Traffic type	Constant Bit Rate
Node Placement	Random
Maximum Speed	30mps
Seed	1
Pause Time	10,20,30,40,50,100 Seconds

4.2. Simulation Model

The overall goal of this simulation study is to analyze the performance of DSR& AODV wireless routing protocol on the basis of two path loss propagation models. The simulations have been performed using QualNet version 5.0[13], a software that provides scalable simulations of Wireless Networks and a commercial version of GloMoSim. It is a comprehensive suite of tools for modeling large wired and wireless networks. It uses simulation and emulation to predict the behavior and performance of networks to improve their design, operation and management. To evaluate the performance of routing protocols, both qualitative and quantitative metrics are needed. Most of the routing protocols ensure the qualitative metrics. Therefore, we use four different quantitative metrics to compare the performance. They are:

- **Packet Delivery Ratio:** The fraction of packets sent by the application that are received by the receivers.
- **Average Jitter: Jitter** is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes.
- **Average End-to-end delay:** End-to-end delay indicates how long it took for a packet to travel from the source to the application layer of the destination.
- **Throughput:** The throughput is defined as the total amount of data a receiver R receives from the sender divided by the times it takes for R to get the last packet.

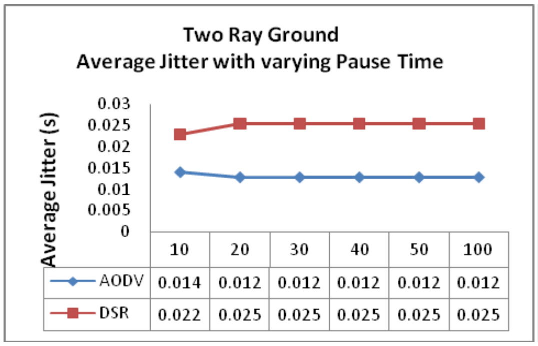
5. Simulation Results



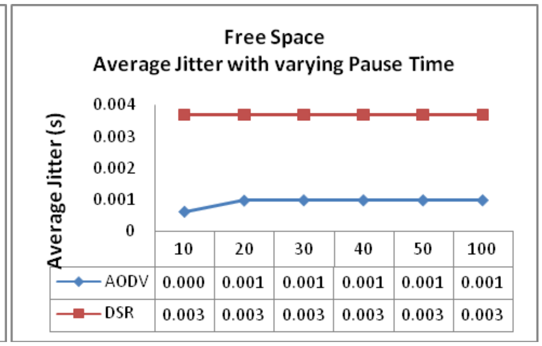
(a) **(b)**

Figure 1. (a) PDF with Varying Pause Time in Free Space Model. (b) PDF with Varying Pause Time in Two Ray Ground Model

Figure (a) & (b) are the Packet delivery Fraction of AODV & DSR in Free Space & Two Ray Ground model respectively, as it seen in from both the figures DSR perform better in both the models, in Free Space model it is 95.8%. And in Two Ray ground model it is 91.6%. If we talk about AODV, which is 83.3% in Free space and 87.5%in Two ray ground model which means, more percent of packets received at destination is more in DSR.



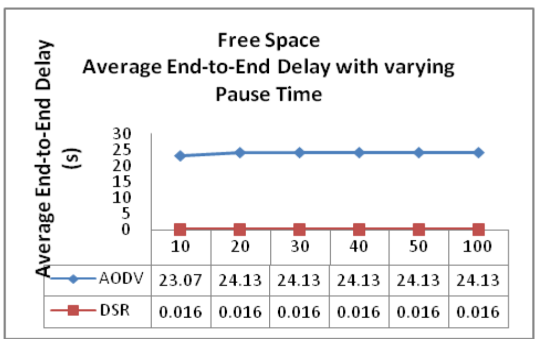
(c)



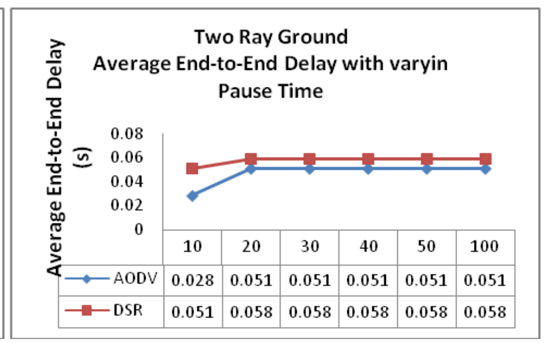
(d)

Figure 2. (c) Average Jitter with Varying Pause Time in Free Space Model. (d) Average Jitter with Varying Pause Time in Two Ray Ground Model

From fig (c) & (d), Average jitter of DSR is more in both the models, i.e. variation in the time between packets arriving, caused by network congestion, timing drift, or route changes is more in DSR. AODV is better as it takes less time in both the models, in Free space it is .98 mili seconds, in Two ray ground 12.842 mili seconds. Whereas DSR takes 3.69 mili seconds in Free space and 25.396 mili seconds in Two ray ground.



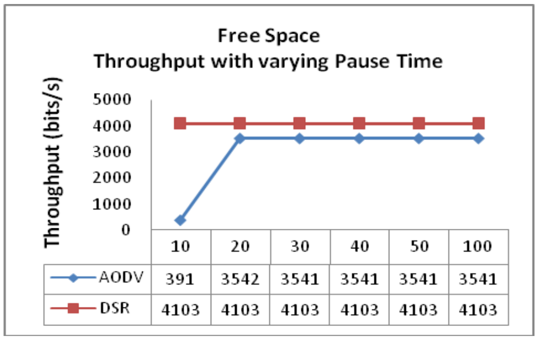
(e)



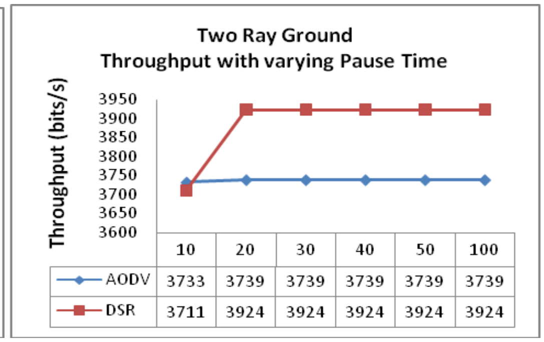
(f)

Figure 3. (e) Average End-to-End Delay with Varying Pause Time in Free Space Model. (f) Average End-to-End Delay with Varying Pause Time in Two Ray Ground Model

Fig (e) & (f), are the Average end-to-end delay of Free space and two ray ground model respectively, as from both of the figures avg end-to-end delay of AODV is more in Free space around 24.1343 seconds and in Two ray ground DSR delay is more i.e. around 58.9 mili seconds. Hence DSR better in Free space and AODV better in Two ray ground as they take less time to travel packets from source to the destination respectively in the model.



(g)



(h)

Figure 4. (g) Throughput with Varying Pause Time in Free Space Model. (h) Throughput with Varying Pause Time in Two Ray Ground Model

The throughput is defined as the total amount of data a receiver R receives from the sender divided by the times it takes for R to get the last packet. From both the figures (g) & (h) it is clear that throughput of DSR is more comparatively AODV.

Hence, if we talk about the overall performance, then it is clear DSR perform much better in both the Path loss propagation models. Whereas AODV average end-to-end delay is less which means it takes less time in transmission of packet to their final destination successfully in Two Ray Ground model.

6. Conclusion

In this paper, we present comparative study of AODV & DSR with path loss propagation models (Free Space & Two Ray Ground). The comparative analysis was carried out for the simulated results by varying the Pause Time. Various performance metrics used for this comparison such as packet delivery fraction, average jitter, throughput and average end to end delay. This model based study results into the conclusion that overall performance of DSR is better in both of the propagation models, whereas AODV perform better in average end-to-end delay in Two ray ground model.

References

[1] Casaravilla J., Dutra G., Pignataro N. & Acuña J. "Propagation Model for Small Macro cells in Urban Areas"2009.

[2] Magnus Frodigh, Per Johansson and Peter Larsson "Wireless ad hoc networking-The art of networking without a network" Ericsson Review No. 4, 2000

[3] D. B. Johnson and D. A. Maltz, "Dynamic Source Routing," in *Ad Hoc Wireless Networks, Mobile Computing,* T. Imielinski and H. Korth (Eds.), Chapter 5, pp. 153–181, Kluwer Academic Publishers, 1996.

[4] D. B. Johnson, D. A. Maltz, and J. Broch, "DSR: The Dynamic Source Routing Protocol for Multihop Wireless Ad Hoc Networks," *In Ad Hoc Networking, C. E. Perkins (Ed.)*, pages 139–172, Addison-Wesley, 2001.

[5] David B. Johnson and David A. Maltz, "Dynamic source routing in ad hoc wireless networks," *In Mobile Computing,* Imielinski and Korth (Eds), chapter 5, pages153–181, Kluwer Academic Publishers, 1996.

[6] E. Perkins and E. M. Royer, "The Ad Hoc On-Demand Distance-Vector Protocol (AODV)," In Ad Hoc Networking, C. E. Perkins (Ed.), pages. 173–219, Addison-Wesley, 2001.

[7] C. Perkins, "Ad hoc On Demand Distance Vector (AODV) Routing," *Internet draft, draft-ietfmanet- aodv-00.txt.*

[8] Charles E. Perkins and Elizabeth M. Royer, "Ad-Hoc On Demand Distance Vector Routing," *In Proc. 2nd IEEE Workshop on Mobile Computing* 147 *Systems and Applications*, pages 90–100, IEEE Computer Society, February 1999.
[9] A. Neskovic, N. Neskovic, and G. Paunovic. Modern approaches in modeling of mobile radio systems propagation environment. *IEEE Communications Surveys*, http://www.comsoc.org/pubs/surveys, 2000.
[10] Ayyaswamy Kathirvel, and Rengaramanujam Srinivasan "Analysis of Propagation Model using Mobile Ad Hoc Network Routing Protocols" International Journal of Research and Reviews in Computer Science (IJRRCS), Vol. 1, No. 1
[11] James Demetriou and Rebecca MacKenzie "Propagation Basics" September 30, 1998.
[12] Ibrahim Khider Eltahir "The Impact of Different Radio Propagation Models for Mobile Ad hoc NETworks (MANET) in Urban Area Environment" (AusWireless 2007)
[13] Scalable Networks Technologies: QualNet simulator 5.0, http://www.scalable-networks.com

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