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Performance Comparison of AODV & DSR Routing Protocol in a Fading Environment

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Abstract

In most of the performance comparison of routing protocols, the effects of fadings are rarely considered. The protocols are instead compared in terms of traffic intensity, node intensity and mobility etc. In this paper, the performance of two classic routing protocols for adhoc network such as AODV & DSR are compared for Ricean and Rayleigh fading environment. Qualnet Simulator has been used for the simulation and performance analysis. It was found that DSR protocol gives more throughput and less average end-end delay in comparison to AODV for both Ricean & Rayleigh fading environment.

Keywords

MANET, Routing Algorithm, Rayleigh fading, Ricean fading, Qualnet.

1. Introduction

Mobile Adhoc Network (MANET) [1], [2] is a collection of mobile nodes with dynamic topology. Such networks are of interest because they do not require any prior investment in fixed infrastructure. Instead, the network nodes agree to relay each other's packets and hence act as routers and automatically form their own cooperative infrastructure. Wireless Adhoc Network provides lot of flexibility. At the same time, it comes with a whole of research challenges [4], [5]. Node mobility, bad quality of channel, scarcity of resources and many other problems are attracting the attention of the researchers over the last decade. These challenges are responsible for many problems that are still open issues, such as effective routing, effective medium access control (MAC) mechanisms, power management, mobility management etc.

Most widely used On-Demand Routing protocol for Mobile Adhoc Network (MANET) are DSR and AODV. In most of the performance analysis [6, 7], the given routing protocols are evaluated assuming the error less environment. Hence In this paper, we have attempted to compare the performance of DSR and AODV in presence of different fading environment. Qualnet Version- 5.2 has been used to compare the performances. The protocols are evaluated in terms of node density, traffic density in presence of Rayleigh & Ricean fading environment.
This paper is structured as follows. Section 2 gives the introduction to AODV and DSR along with Rayleigh and Ricean fading and Section 3 describes the simulation and results.

2. Literature Review

In this section, two On-Demand Routing protocols DSR [8, 9] and AODV [10] are briefly described. The two commonly fading characteristics such as Ricean & Rayleigh [11] are also introduced.

Dynamic Source Routing (DSR): DSR protocol is based on source routing. When a node in the MANET wants to send data packet to any other node for which it does not know the route, it uses a route discovery method to dynamically determine the route. In the process, the source node broadcasts the RRQ (route request) the packets. All the nodes except the destination node rebroadcast the received route request (RRQ). The destination node replies to the request with a route reply (RRY) packet that is routed back to the source node. The RRQ builds up the path so traversed and the RRY packet routes itself back to the source by traversing this path backward. This path is cached by the source for future use. In case of link failure, the Route Error packet is sent towards the source, which erases the established path entry. If alternate routes do not exist, a new RRQ packet is sent to establish new path.

Adhoc On-Demand Distance Vector (AODV): This protocol is similar to the DSR as it also discovers the route "as on need" basis. But the DSR is a source routing procedure, whereas AODV is a table driven routing mechanism. In order to establish and maintain the routes, it uses Route Requests, Route Replies, & Route Errors messages. Further, it uses a destination sequence number for each route entry in the routing table. Use of destination sequence

numbers helps to solve the looping problem and also knows the freshness of the entry. In this protocol, each node maintains at most one route per destination and hence being a single path protocol, it has to invoke a new route discovery procedure, whenever the only path from the source to destination fails.

Fading: The term fading refers to the time varying received signal power caused by changes in the transmission medium or paths. This is one of the most challenging problems faced by the communication systems engineer in a mobile environment. Two most commonly used fading distributions to describe the statistical time varying nature of the received envelope are Rayleigh & Ricean distribution.

The probability density function (pdf) of Rayleigh distribution is given by [11]

$$p(r) = \begin{cases} \left\{ \frac{r}{\sigma^2} exp\left[-\frac{r^2}{2\sigma^2} \right] (0 \le r \le \infty) \right. \\ 0 \qquad\qquad (r < 0) \end{cases} \quad ----(1)$$

Where, σ is the rms value of the received voltage signal before envelope detection and σ^2 is the time-average power of the received signal before envelope detection.

The cumulative distribution function (CDF) of the Rayleigh distribution at R, is given by

$$P(R) = \Pr(r \le R) = \int_0^R rp(r)dr = 1 - exp\left[-\frac{R^2}{2\sigma^2} \right] \qquad (2)$$

Ricean Fading Distribution: In Ricean distribution a dominant signal component such as line-of-sight (LOS) propagation path exists. In such case, the random the multipath components arriving at different angles are superimposed on the stationary dominant signal. At the output of an envelope detector, this has the effect of adding a dc component to the random multipath.

The probability density function (pdf) of the Ricean distribution is given by

$$p(r) = \begin{cases} \frac{r}{\sigma^2} e^{-\frac{(r^2+A^2)}{2\sigma^2}} I_0\left(\frac{Ar}{\sigma^2}\right), & for\ (A \ge 0,\ r \ge 0) \\ 0, & for\ (r < 0). \end{cases} \quad --(3)$$

Where, A is the peak amplitude of the LOS path and I_0 (.) is the modified Bessel Function of the first kind and zero-order.

3. Simulation & Results

The performance evaluation of the two routing protocols DSR & AODV are carried out in fading environments. The Qualnet version 5. 2 have been used for simulation. The Simulation parameters are given in Table-1 & Table-2.

The two routing protocols are evaluated in terms of node density. Initially, within the given area of 1500X1500 there were only 25 active nodes and gradually the nodes were increased to 50, 75 and then 100 nodes. Further, the number of CBR connections among the nodes within the same area was gradually increased as shown in Table 2, to evaluate the performance of the routing protocols in terms of traffic density. Finally, the performances of the protocols are also evaluated assuming the statistical nature of the channel to be of Rayleigh & Ricean.

Table 1: Simulation Parameters

PARAMETERS	VALUES
No. of nodes	25,50,75,100
Placement of nodes	grid structure
Terrain	1500 X1500
Data traffic	CBR
MAC protocol	802.11
mobility	Two ray ground reflection model
Routing protocol	AODV and DSR
Fading	Rayleigh and Ricean

Table 2: Specifications for different nodes

No. of nodes	Simulation time	No. of CBR connections		
25	1500s	3	10	18
50	2000s	8	24	42
75	2000s	10	40	55
100	3000s	11	34	84

In this paper, the received throughput, average end-to end delays are used as performance metrics to evaluate the performance of the protocols.
Figure-1 shows the throughputs (in bit/sec) of AODV & DSR routing protocols under ideal environments, i.e. without considering the fading. It may be observed that the throughput of the DSR is always

larger than the AODV for any number of active CBR connections. Figure -2, shows the average end-to-end delay (in sec) for the two protocols & without taking fading of the environment into consideration. The AODV offers less delay when the number of active cbr connections are between 20 to 60.and the approximately same for rest of the cases. Figure-3 & 4 shows the throughput comparison of both the protocols in Ricean and Rayleigh fading environment respectively. In both the cases, the performance of DSR is better in comparison to the AODV in terms of throughput irrespective of the number of active CBR connections (traffic intensity).Figure-5 and Figure-6, shows the average end-to-end delays(in sec) for various fading environment. In both the Rayleigh & Ricean fading environment, the AODV has more average end-to-end delay in comparison to DSR routing protocols. Hence we have seen that the performance of DSR routing protocol is better in comparison to AODV for most of the fading environments. That means DSR offers more throughput and less delays in comparison to DSR for all fading environment.

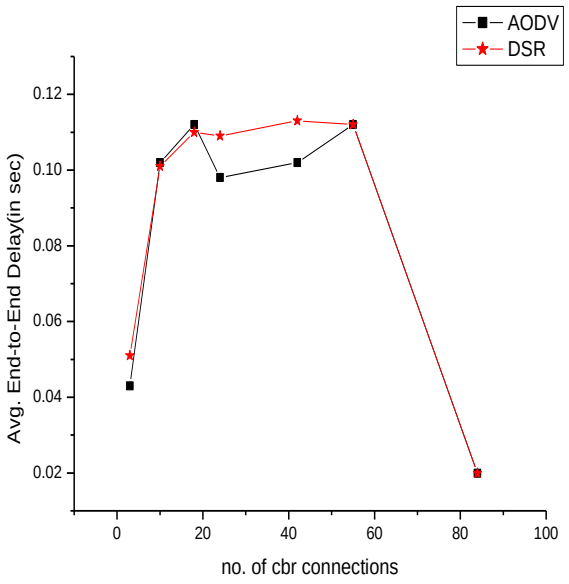

Figure 2: Average end-to-end delay of AODV and DSR in ideal environment

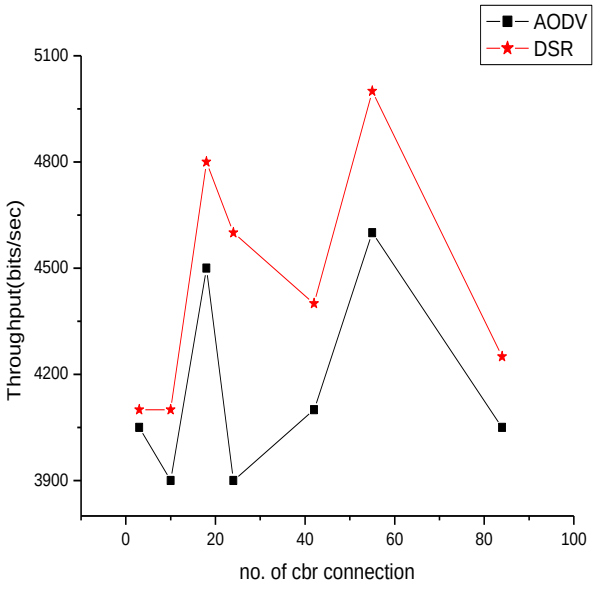

Figure 1: Throughputs of AODV & DSR in ideal environments

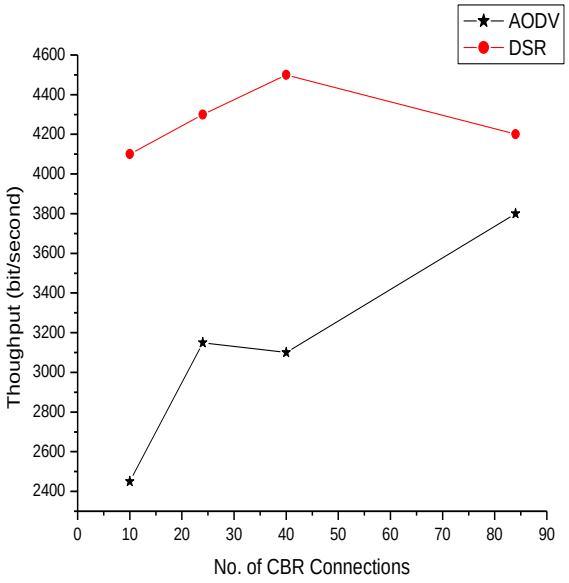

Figure 3: Throughput Vrs no. of active cbr connection with Ricean fading

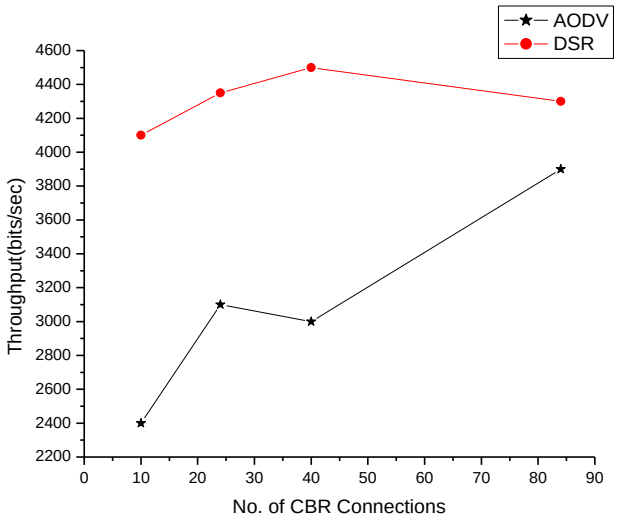

Figure 4: Throughput vrs no. of active cbr connection with Rayleigh fading

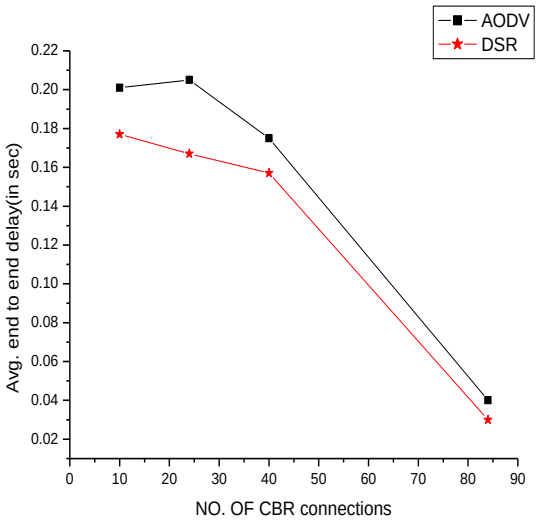

Figure 6: Average End-to-End Delay Vrs no. of active CBR connections in Rayleigh fading environment

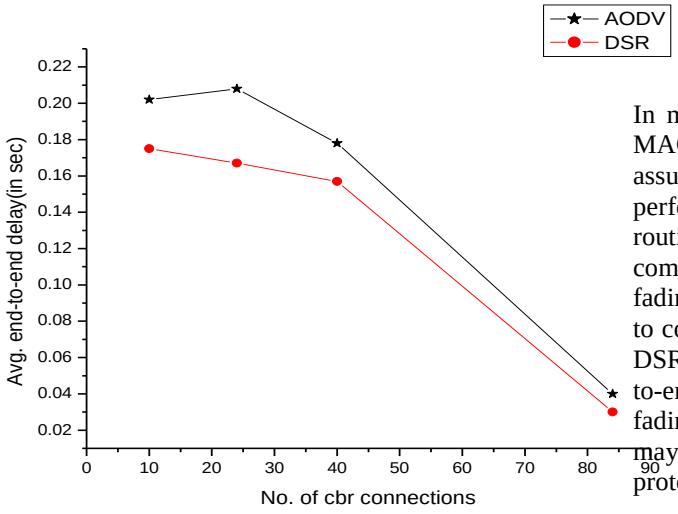

Figure 5: Average End-to-End Delay Vrs No. of active CBR connections in Ricean fading environment

4. Conclusion

In most of the performance analysis of routing and MAC protocols, the communication environment is assumed to be non fading or ideal. In this paper, a performance comparison of two classic on-demand routing protocols such as AODV and DSR are compared considering the Ricean and Rayleigh fading environment. Qualnet v5.2 simulator was used to compare the performance. It was observed that the DSR protocol gives higher throughput and less end-to-end delays in comparison to AODV for all cases of fading environment. The poor performance of AODV may be due to the table-driven principles of the protocol.

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