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Performance Evaluations of MPEG-4 Video Traffic Services over Fading Channel-based MANETs

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Abstract

The wireless communication links in the mobile ad-hoc networks are very unreliable and are easily and frequently broken because of mobility, erroneous channel, and the lack of infrastructure. However, applications such as video streaming service over wireless ad-hoc networks require the higher bandwidth and reliability. In this paper, we evaluate the performances of video streaming services with two ad-hoc routing protocols; AODV and DSR in the presence of Ricean fading channel. Through the extensive simulations and analysis, AODV protocol is recommended for delay-constraint services while DSR protocol is for services with high reliability.
Key Words- Wireless Personal Area Network (WPAN), Wireless MAC, Link Adaptation, Piconet.

1. Introduction and Motivation

To route data efficiently in Mobile Ad hoc networks (MANETs), we need routing protocol that can effectively react to the dynamic environment of the network. Dynamic Source Routing (DSR) [1] is the example of reactive routing protocol that is based on the concept of source routing. It is designed specially for the use in multi-hop ad-hoc networks of mobile nodes. Ad hoc On Demand Distance Vector (AODV) protocol [2, 3] is another example of reactive protocol. It is confluence of both Destination Sequenced Distance Vector (DSDV) [4] and DSR protocol [1]. It shares DSR protocol's on-demand characteristics and as a consequence discovers routes whenever it is needed via a route discovery process. However, AODV protocol adopts the concept of the traditional routing tables; one entry per destination. This is in contrast to DSR protocol, maintaining multiple route-entries cached for each destination.

Multimedia applications are expected to become more prevalent over MANETs in the near future. Moving Picture Expert Group version 4 (MPEG-4) gives better performances in terms of video streaming application by comparing to MPEG-1 and MPEG-2. Therefore authors in [5] evaluate the performances of multimedia services over MANETs using DSR protocol. Simulation results show that DSR protocol performs well with low mobility and low traffic intensity. However, when considering the high traffic intensity (i.e. 40 traffic sources), its performances noticeably decrease, especially in the presence of the multimedia traffic. However, the evaluations in this paper have been conducted over error-free channel. In [6], authors study the effects of node densities, packet lengths, and mobility on four routing protocols: Optimized Link State Routing (OLSR), AODV, DSR, and Temporary Ordered Routing Algorithm

(TORA). It is studied over IEEE 802.11b standard-based MANETs. The simulation results in the paper show that, node density and mobility have a significant impact on underlying routing protocols. However, all simulation works have been conducted over error-free channel. Therefore, the results might not be realistic. In [7] authors examine the performance of two MANET protocols i.e. AODV and DSR protocols based on the variation of node density and mobility using Random Way Point (RWP) and Random Way Point with Attractions (RWP-ATTR) mobility models. The result shows that RWP mobility has negative effects on both AODV and DSR protocols while compared to RWP-ATTR, which is immune from non-uniformity of node distribution. However, evaluation works have been conducted over error free channel. Therefore the result might not be realistic.

Wireless channels are mostly suffering from the low bandwidth and high bit error rate due to noise, interference, unpredictable user mobility, and multipath fading channels. However, none of the aforementioned papers evaluates the performances of multimedia traffics such as MPEG-4 over MANETs with the multipath fading channels and routing protocols. Therefore, we are motivated to evaluate the performances of MPEG-4 streaming services over the multipath fading channels in MANETs.

The rest of the paper is organized as follows. Section II discusses simulation environment. After the simulation environments are illustrated in Section II, the simulation results are evaluated and analyzed in Section III. Finally, conclusion and future works are provided in Section IV.

2. Simulation Environments

All simulations are performed in Network Simulator 2 (NS2) version 2.29 [8], with the additional patch of Ricean fading obtained in [9] and publicly available library of traces in [10]. IEEE 802.11-based protocol defined in [11] is used for the MAC layer protocol. In addition, IEEE802.11a-based physical layer is used, which is standardized in [12]. For the reliable transmissions, the lowest data rate, 6Mbps, is used. Ricean fading channel model is used for the simulations. The probability density function of Ricean random variable, *r*, is given by:

$$P(r)=\begin{cases}\frac{r}{\sigma^2}e^{-(\frac{r^2.A^2}{2\sigma^2})}I_0(\frac{A_r}{\sigma^2}), for(A\geq 0, r\geq 0)\\ 0, \quad for(r\prec 0)\end{cases} \quad , \tag{2.1}$$

where A is the peak amplitude of the dominant signal, σ is the strength of all other components, and I_0 is the zeroth order Bassel function. Ricean distribution can also be described in term of parameter, K, called Ricean factor as defined: $K=\frac{A^2}{2\sigma^2}$. K in term of db is as follows:

$$\mathrm{K(db)} = 10\log\left(\frac{A^2}{2\sigma^2}\right)db \tag{2.2}$$

When K = 0 the channel is Rayleigh fading channel, and when K $=\infty$, the channel is Additive White Gaussian Noise (AWGN) channel.

3. Result and Comparative Analysis

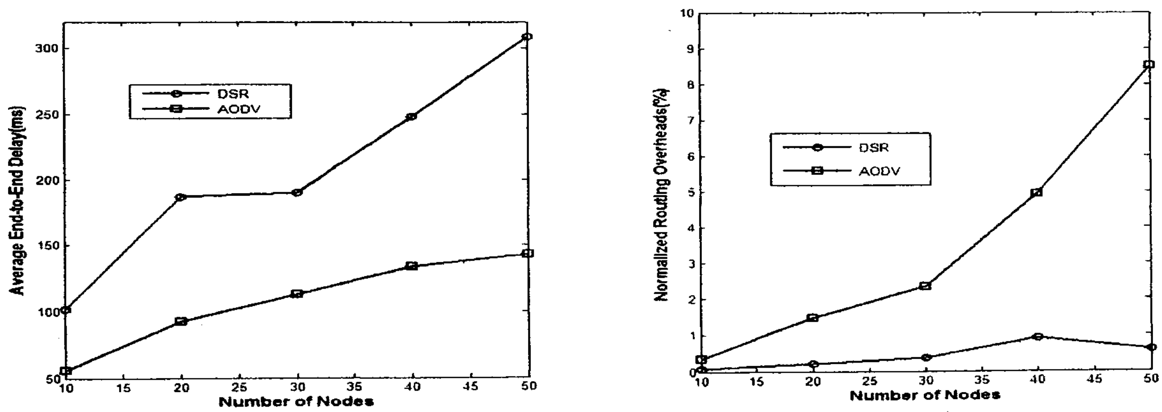
3.1 Impact of the Number of Streams

1). *Impact on End-to-End Delay in Fading.*

The first analysis is based on varying the number of nodes from 10 to 50 in the fixed communication area of 1km x 1km. As the number of nodes increases, the number of traffic sources also increases with the factor of n/5, where n is the total number of nodes in the simulation environments. Table 1 shows the minimum requirements in the throughput, the maximum end-to-end delay, and the maximum percentage of the packet loss for delivering the multimedia traffics. The International Telecommunication Union (ITU) specifies them in [13]. These performance metrics are commonly used by applications to specify the QoS requirements to the routing protocol, as they may be used as constraint on route discovery and selection.

Table 1: QoS Requirement for each class of traffic

Metrics	VOICE	VIDEO	DATA
End-to-End Delay (Sec)	0.150	0.150	0.150
Percentage of Packet loss (%)	0. 5 %	0. 5 %	0%
Throughput (Kbps)	64	384	28.8



(a) (b)

Fig 1. (a) Average End-to-End Delay and (b) Normalized routing overheads of AODV and DSR protocols as a function of the number of nodes.

As shown in Table 1, having larger end-to-end delay than 150ms is not appropriate for MPEG4 applications. It means that the end-to-end delay for MPEG4 streaming service should be less than 150ms. As the number of nodes increases in Ricean fading channel, the end-to-end delays using AODV and DSR protocols are shown in figure 1(a). It is observed that AODV protocol provides consistent behavior on MPEG-4 streaming service. On the other hand, the delays with DSR protocol are not acceptable in most of cases except the case with 10 nodes.

As evaluated in [7], if there is no fading, DSR protocol causes higher delay performance than AODV protocol does as the node density increases. The first reason is that, in DSR protocol, the route information is embedded in the packet header so that it increases packet size, as well as increase the transmission time. The second reason is that, although DSR protocol stores the stale routes in cache, it does not have any explicit mechanism to expire the stale routes. Therefore, sending of traffic on to stale routes causes unnecessary retransmissions and it leads to excessive delays.

2) Normalized Routing Overhead

Figure 1(b) shows the normalized routing overhead using AODV and DSR protocols. When we increase the node density, it also increases the neighbor count defined in [14] as follow:

$$\text{Neighbour\_Count} = \left\lceil \pi r^2 \Big/ \frac{wh}{n} \right\rceil, \tag{3.1}$$

where r is the radio propagation distance, wh is the square meter area of topology where w is width and, h is height, πr^2 is the area covered by the node's transmission, and n is the number of nodes. That is, Neighbor_Count represents the number of neighbor nodes based on transmission and simulation area. Increasing Neighbor_Count implies more neighbors are around the source and as a consequence the number of collisions increases. That leads to the more retransmission attempts and the increase of the wireless routing overheads. When we increase the number of nodes, the normalized routing overheads with AODV protocol increase much more than that with DSR protocol. There is also an increase in the routing overheads with DSR protocol as increasing the number of nodes. However, in all cases it is less than that of AODV protocol.

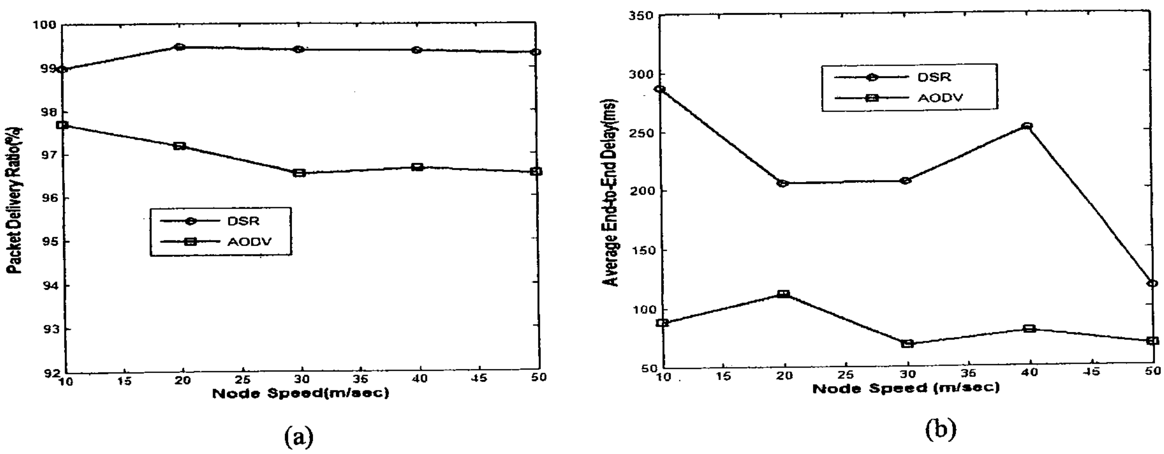


Fig 2. Impact of the node speeds on (a) packet delivery ratios and (b) average end-to-end delays using AODV and DSR protocols.

The first reason of less normalized routing overhead in case of using DSR protocol is that, during single query-reply cycle for finding a route, a source learns routes to each intermediate node along the path to a destination. Furthermore, each intermediate node also learns the route information to other nodes on the route. That is, the greed listening of nodes using DSR protocol also helps to learn the routes to every node on the route. In AODV protocol, there is no source routing or greed listening. Therefore, it causes AODV protocol for nodes to search a route more often, which generates more routing overheads. Secondly, DSR protocol aggressively uses route caching and replies to all requests reaching a destination from a single request cycle. Therefore, a source learns many alternative routes to the destination, which is useful when the primary route fails. This saves overheads due to discovery flood.

3.2 Impact of the Speeds of Nodes

In this section, we explore the effect of varying nodes speed. In the presence of high node speeds, link failure can happen frequently. Link failures trigger new route discoveries in AODV protocol, because it has at most one route per destination in its routing table. The reaction of DSR protocol to link failure in comparison to AODV protocol is mild and cause route discovery less often. This reaction of DSR protocol helps to increase in a Packet Delivery Ratio than AODV protocol. Figure 2(a) shows the Packet Delivery Ratio as the node speed increases from 10 to 50 m/s. In the case of AODV protocol, the Packet Delivery Ratio decreases as the node speeds increases from 10 to 30 m/s. However, for the speed from 40 to 50 m/s, there is no change in the Packet Delivery Ratio. DSR protocol provides better performance in the MPEG4 streaming service than that AODV protocol does for all the cases. Figure 2(b) shows the impact of node speeds on the end-to-end delay. In general, DSR protocol provides higher end-to-end delay in MPEG4 packet deliveries than AODV protocol does in all cases.

4. Conclusion and Future Work

In this paper, we study the impact of Ricean fading channel on the performance of video streaming service with AODV and DSR protocols over MANETs. The simulation results show that AODV protocol provides shorter end-to-end delay in MPEG4 streaming service than DSR protocol does, and as a consequence, it can be better choice if the delay is an important factor for the application. On the other hand, DSR protocol provides higher Packet Delivery Ratio in multimedia streaming service than AODV protocol does.

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