Saturation Throughput Analysis of IEEE 802.11 Wireless LAN under the Rayleigh fading channel

Hong-Il Cho [1] , Gang Uk Hwang [1]

1) *Dept. of Mathematical Science, KAIST, Korea*

Corresponding Author : Hong-Il Cho, hammol@kaist.ac.kr

ABSTRACT

In this paper, the saturation throughput of IEEE 802.11 DCF (Distributed Coordinate Function) under the Rayleigh fading channel with basic access mechanism is analyzed. We propose the Markov chain of the backoff counter and backoff stage for a tagged node in an IEEE 802.11 LAN network under the Rayleigh fading channel. Using parameters obtained from that Markov chain, the throughput of IEEE 802.11 DCF under the Rayleigh fading channel id derived. It is shown that results from our analysis fit well to the results from the simulation with the network simulator ns2.

INTRODUCTION

IEEE 802.11 Wireless LAN is widely accepted as a wireless network for local area communications. It has two access mechanisms, Distribution Coordinate Function (DCF) and Point Coordination Functions (PCF). In specification [1], DCF is mandatory. So, the analysis on DCF is quite important to analyze the performance of IEEE 802.11 wireless LAN. Several works [2,3] which analyze IEEE 802.11 DCF are presented.

In this paper, we consider a network of identical IEEE 802.11 DCF nodes under the Rayleigh fading channel, each of which assumed to be saturated. For the analysis, we construct two different kind of discrete time Markov chains. From that Markov chains, a saturation throughput of IEEE 802.11 DCF under Rayleigh fading channel is derived. While [3] does not consider the effect of time correlation of the Rayleigh fading channel, our model uses the speed of a mobile node, and accordingly consider the effect of time correlation of the Rayleigh fading channel.

SYSTEM MODELLING AND ANALYSIS

We consider finite number, say N, of mobile nodes in network, each of which assumed to be saturated. The backoff counter and backoff stage of each node's DCF is modelled for the analysis. We construct another discrete time Markov chain to model the behavior of the Rayleigh fading channel. Using the stationary probabilities and state transition probabilities obtained from Markov chains both for backoff stages and the Rayleigh fading, the saturation throughput of IEEE 802.11 DCF under the Rayleigh fading is derived. Since the transition probability of Markov chain for the Rayleigh fading channel is used in our derivation, we capture the effect of time correlation of the Rayleigh fading channel ,which is not considered in [3].

We validate our results from analysis using the network simulator ns2 [5]. The simulation is done for ad hoc network topology under both the ideal and Rayleigh fading channel. Most of the parameters used in simulation is from [1].

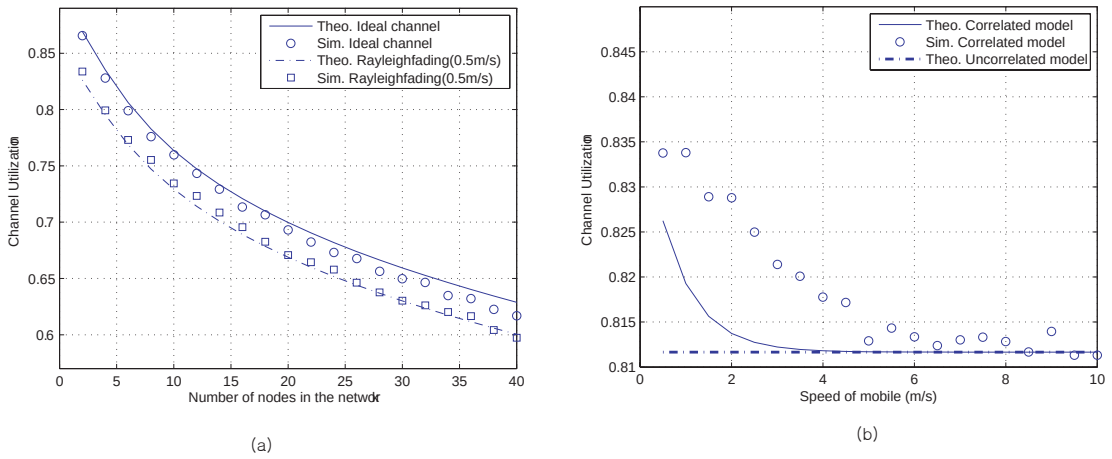

Figure 1. The channel utilization of IEEE 802.11 DCF

The results are presented in Fig. 1. The channel utilizations from analysis and simulation are shown in Fig. 1 (a) under the Rayleigh fading channel and ideal channel. The speed of mobile nodes are fixed to $0.5m/s$, since the nodes in IEEE 802.11 WLAN might be pedestrian users. The effect of mobile speed to channel throughput is presented in Fig. 1 (b). The number nodes in the network id fixed to 2 for the latter simulation.

REFERENCES

1. IEEE 802.11 Working Group, *Part 11: Wireless LAN medium Medium Access Control(MAC) and Physical layer(PHY) specifications*, ANSI/IEEE Std 802.11, 1999 Edition.
2. G. Bianchi, “Performance Analysis of the IEEE 802.11 Distributed Coordinate Function”, *IEEE JSAC*, Vol. 18, no. 3, 2000, pp. 535-547.
3. P. Pham, “Comprehensive Analysis of the IEEE 802.11”, *Springer, Mobile Networks and Application*, 10, 2005, pp. 691-703.
4. R.J. Punnoose, P.V. Nikitin, D.D. Stancil, “Efficient simulation of Ricean fading within a packet simulator”, *Proc. Veh. Technol. Conf.*, Vol. 2, pp 764-767, Sep 2000.
5. The VINT Project, *The ns Manual*, 2005.
6. G.L. Stuber, *Principle of Mobile Communications*, Kluwer Academic Publisher, 2001.
7. X.J. Dong, P. Varaiya, “Saturation Throughput Analysis of IEEE 802.11 Wireless LANs for a Lossy Channel”, *IEEE COMM Letters*, Vol. 9, no. 2, Feb 2005.