Performance Analysis of IEEE 802.11 Non-Saturated DCF

Yun Han Bae 1 Kyung Jae Kim 1 and Bong Dae Choi 1

1) Department of Mathematics, Korea University, Seoul 151-742, KOREA

Corresponding Author: Yun Han Bae, unani96@korea.ac.kr

ABSTRACT

In the IEEE 802.11 MAC layer protocol, the basic access method is the Distributed Coordination Function which is based on the CSMA/CA. In this paper, we investigate the performance of IEEE 802.11 DCF in the non-saturation condition. We assume that there is a fixed number $n$ of competing stations and packet arrival process to a station is a Poisson process. We model IEEE 802.11 DCF in non-saturation mode by 3-dimensional Markov chain and derive the stationary distribution of the Markov chain by applying matrix analytic method. We obtain the probability generating function of packet service time and access delay, and throughput.

INTRODUCTION

Recent years Wireless Local Area Networks have brought much interest to the telecommunication systems. IEEE 802.11 standards define a medium access control protocols. IEEE 802.11 MAC includes the mandatory contention-based DCF (Distributed Coordination Function) and the optional polling-based PCF (Point Coordination Function) [1]. Most of today’s WLANs devices employ only the DCF because of its simplicity and efficiency for the data transmission process. The DCF employs CSMA/CA (Carrier-Sense Multiple Access with Collision Avoidance) protocol with binary exponential backoff. The DCF is relatively simple while it enables quick and cheap implementation, which is important for the wide penetration of a new technology.

We may classify arrival pattern of packets to the station into two modes: saturation mode and non-saturation mode. Saturation mode means that stations always have packets to transmit. Non-saturation mode means that stations have sometimes no packets to transmit. Most of analytical models proposed so far for the IEEE 802.11 DCF focus on saturation performance.

Unfortunately, the saturation assumption is unlikely to be valid in most real IEEE 802.11 networks. We note that most works ignore the effect of the queue at the MAC layer. There have not been many analytic works in the non-saturation mode due to mainly analytic complexity of models. The necessities of analytic performance of IEEE 802.11 in non-saturation mode are mentioned several recent papers [2, 3, 4].

In this paper, we deal with the performance of IEEE 802.11 DCF with considering protocol details in the first case of non-saturation condition at packet level. We assume that there is a fixed number $n$ of competing stations and packet arrival process to a station is a Poisson process with rate $\lambda$. We construct 3-dimensional a Markov chain based on Bianchi’s model and adding the queue length information. The one step transition probability matrix $P$ has the form of upper block Hessenberg, which is called Markov chain of $M/G/1$ type. We derive the stationary distribution of the Markov chain by applying the well-known matrix analytic methods. We obtain the probability generating function of packet service time and channel access delay,
and throughput.

REFERENCES


