PERFORMANCE OF THE IEEE 802.11 DISTRIBUTED COORDINATE FUNCTION

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ABSTRACT

In this paper, we consider a cluster of N identical IEEE 802.11 DCF (Distributed Coordinate Function) terminals with RTS/CTS mechanism, each of which is assumed to be saturated. For performance analysis, we propose a simple and efficient mathematical model to derive the statistical characteristics of the cluster such as the inter-transmission time distribution of packets and the service time distribution (the inter-transmission time distribution of successful transmissions) of the IEEE 802.11 DCF cluster. We provide simulation results to show the validity of our analytic results and show that analytic results and simulation results are well matched.

INTRODUCTION

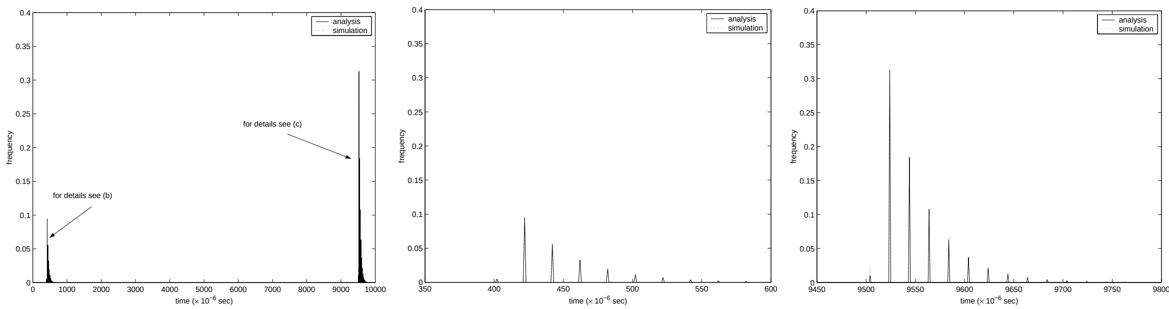
During the past few years we have witnessed an ever-growing interest in wireless technologies and their applications to portable devices. As the number of users of such technologies has increased, the demand for real-time traffic and delay-sensitive applications has become more critical. Along the efforts to satisfy such need, standards for WLANs (Wireless Local Area Networks) have been proposed, and the IEEE 802.11 MAC (Medium Access Control) protocols [2] are the *de facto* standards for WLANs and the most widely used nowadays.

In this paper, we consider a cluster of N identical IEEE 802.11 DCF (Distributed Coordinate Function) terminals with the RTS/CTS mechanism, each of which is assumed to be saturated. For performance analysis, we propose a simple and efficient mathematical model to derive the statistical characteristics of the cluster such as the inter-transmission time distribution of packets and the service time distribution (the inter-transmission time distribution of successful transmissions) of the IEEE 802.11 DCF cluster. While [3–5] have used the PGF to get the service time distributions, our model derives the service time distribution directly, and accordingly is very useful for performance evaluation in practice.

SYSTEM MODELLING AND ANALYSIS

We consider a cluster of N identical IEEE 802.11 terminals with DCF, each of which is assumed to be saturated. For analysis, each terminal is modelled by a discrete time embedded Makov chain as in [1] where the embedded points are the time epochs at which the values of the backoff counter are decremented by 1. Then, from renewal theory we first obtain the inter-transmission time distribution of the cluster.

In the IEEE 802.11 standard, a terminal with positive backoff counter value, detecting a packet transmission should freeze its backoff counter one more slot after the channel busy period [2,5], which is not considered in the above analysis. To capture this behavior, we consider a modified model where we approximate the successful transmission time and the collided transmission time of the RTS/CTS in detail. To check the validity of our modified model, we develop a simulator based on the C++ programming language and simulate a cluster of N identical IEEE 802.11 DCF (Distributed Coordinate Function) terminals with the RTS/CTS mechanism. In simulation studies, we use the system parameters recommended in IEEE 802.11 standard. The result is presented in Fig. 1 where we assume that there are 20 IEEE 802.11 terminals in the cluster.



(a) (b) (c)

Figure 1. The Frequency of Inter-transmission Times ($N = 20$)

Based on our result on the inter-transmission time distribution of the cluster, we then derive the probability distribution of the service times of the cluster of N identical terminals, which are defined by time intervals of successful packet transmissions of the cluster.

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