An Exact Combinatorial Analysis for the Performance Evaluation of Framed Slotted Aloha Systems with Diversity Transmission over Erasable Wireless Channels

鍾英漢,顏名慶
Electrical Engineering
Engineering
ihchung@chu.edu.tw

Abstract

Framed Slotted Aloha (FSA) protocols have been widely used in various multiple access communication systems. In this paper, we investigate the performance of FSA systems that employ diversity transmission (DT) techniques over erasable radio channels. Two DT schemes, DT-SWIR and DT-SWOR, differentiated by the underlying channel sampling procedures, i.e., sampling with replacement (SWIR) and sampling without replacement (SWOR), are proposed. Modified versions of the two schemes, MDT-SWIR and MDT-SWOR, in which different diversity factors are granted to new users and backlogged users are also presented. To further exploit the advantages of using DT and enhance the system performance, we introduce a new concept that associates diversity factors with transmission power levels in the MDT-SWIR. In this scheme, which we call PMDT-SWIR, the transmitting power of a packet in a slot is proportional to the multiplicity that this slot is selected. Using a probabilistic retransmission model over erasable wireless channels, we develop an exact combinatorial analysis to evaluate the throughput and the activity factor of all schemes. Characteristics of all schemes are comprehensively investigated through numerical examples. For a dynamically controlled system, in which the retransmission probability for a backlogged packet can be dynamically varied, the optimal retransmission probabilities that can result in maximal throughput for the MDT-SWIR, the MDT-SWOR, and the PMDT-SWIR are determined. All mathematical analyses are validated via computer simulations. Apart from characterizing of various DT schemes suitable for FSA systems, analytical method presented in this paper can be applied to the performance evaluation of other communication techniques.

Keyword：Keywords: activity factor; diversity transmission; erasable channels; framed slotted Aloha; sampling with/without replacement