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ON A TWO PHASE MODEL FOR BURSTY TRAFFIC AND ITS APPLICATION TO TDMA NETWORKS WITH SERIAL NODES

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Abstract

In this paper, the performance of nodes in particular TDMA networks is investigated. For the calculation of the loss probabilities of nodes with multiple random inputs and of nodes with two bursty inputs (generated by two preceding nodes), exact methods are presented. Furthermore, an approximation method for nodes with two bursty inputs is derived which is well suited for practical application in dimensioning whole networks. Nodes with random input and nodes with bursty input, as well as networks with several nodes have also been investigated by means of traffic simulations. The approximation values are in good agreement with exact calculations and simulation results.

A queueing problem in a special TDMA network is investigated. In the considered system all subscribers are connected to a network of time division multiplex (TDM) highways. This system represents a decentralized switching system with a branched network containing no closed loops (1). The branches of the network are connected by means of nodes. As each subscriber may be connected to the network at an arbitrary point, all blocks arriving at a node must be transmitted through the whole network. If more than one information block arrives in a node at the same time slot, only one block can be transmitted to the outgoing highway whereas the other(s) must be stored. For this purpose a finite number of waiting places is provided. When all waiting places are occupied a store overflow may occur and information blocks get lost.
Formulae for the calculation of the probability that an arbitrary block is lost when arriving at a node are known for the special case of a network in which at most three pairs of highways are connected at each node and for the case that the blocks are distributed at random within the frames (2). In the present paper a method has been derived for the exact calculation of the loss probability of a general node with an arbitrary number of incoming and outgoing trunks (in case of very large frames).
The random distribution of blocks is only fulfilled in nodes which are situated in marginal districts of a TDMA network where the arriving information blocks have not yet passed any further nodes (and, of course in networks with only one node). If the blocks arriving at a node already have passed further nodes before, the outgoing traffic contains longer series of occupied time slots (bursty traffic). This results in an increased loss probability in nodes with bursty incoming traffic. A node with two bursty inputs (generated by two preceding nodes) has been investigated by means of exact calculations with the aid of the succesive overrelaxation (SOR) method.
Furthermore, an approximation formula for the calculation of the loss probability of nodes with bursty incoming traffic is presented. The incoming traffic is modeled by means of a two phase model. In the bursty incoming traffic two phases are distinguished: one phase with clustered arrivals (bursts) and another phase with arrivals distributed at random within the frame.
The transition probabilities between certain states of the phases are calculated from the output process of the preceding nodes. An approximation formula for the loss probability is derived, which is based on the two phase model for bursty traffic.
From the results it can be seen that the loss probability of a node with bursty incoming traffic is much higher than in a node in which the arriving blocks are distributed at random within the frames. By means of the new approximation method it is now possible to calculate the loss probabilities in all nodes of networks of the type considered here. In this calculations the properties of bursty traffic can be taken into account.

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