A METHOD FOR APPROXIMATELY ESTIMATING THE TRAFFIC-CARRYING CAPACITY OF A TWO-LINK SWITCHING SYSTEM

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Abstract

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A METHOD FOR APPROXIMATELY ESTIMATING THE TRAFFIC-CARRYING CAPACITY OF A TWO-LINK SWITCHING SYSTEM

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1. Queueing theory ([1]) makes it possible to solve analytically problems arising in telephony. Among the telephone problems requiring the application of probability-theory methods, problems of calculating the traffic-carrying capacity of a group of connecting devices are of essential importance for engineering practice. The full-availability group of connecting devices has been studied most completely, both theoretically and experimentally ([1]). The estimation of the traffic-carrying capacity of connecting devices under graded switching is based mainly on experimental data ([2–4]). Groups formed by two-link and multi-link switching systems have been investigated to a considerably lesser extent. In works ([5–7]), approximate methods are given for estimating losses (the probability of refusal) in two-link and multi-link switching systems.

In the present note a method is set forth for approximately estimating the traffic-carrying capacity of a group of connecting devices connected to the outputs of a two-link switching system.

2. Consider a two-link switching system (Fig. 1) having kn inputs and ml outputs, consisting of two stages A and B. Each of the k switches of the first stage contains n inputs and m outputs, and each of the m switches of the second stage has k inputs and l outputs.

The switches of the first and second stages are connected with one another by the usual method of mixing interconnection. Connecting devices are connected to all ml outputs of the switching system under consideration, forming a group of ml connecting devices. All kn inputs of the switching system are assumed to be connected to sources of telephone traffic.

In the switching system under consideration, with variable availability, any output of the system is available to each input of the system so long as there are no occupied connecting paths in the system (for the first call). In the presence of one occupied connecting path, for those inputs of the switching system that can use this connecting path, the availability of the outputs decreases by l and is

Fig. 1

Figure 1: Fig. 1

Fig. 2

Figure 2: Fig. 2

$$a_1 = (m-1)l.$$

With i occupied connecting paths going from a given switch of the first stage, the availability will be equal to

$$a_i = (m-i)l.$$

3. The proposed method for calculating the traffic-carrying capacity of a group of connecting devices connected to the outputs of the switching system under consideration consists in finding a graded group equivalent in traffic-carrying capacity and thereby reducing the calculation, in the presence of variable availability, to a calculation with constant availability of the connecting devices of the group.

Let Y be the telephone traffic load created by kn sources connected to the inputs of the switching system; let v be the number of connecting devices. Then the capacity of the bundle of connecting devices included in the switching system under consideration will be equivalent to the capacity of a graded bundle with availability a_e, if, for the given Y and $v = ml$, the losses are the same.

Fig. 1

4. Let p_i denote the losses at availability a_i; let w_i denote the probability that i cords are occupied (the probability of availability a_i). The condition of equivalence in capacity of the system under consideration and of the graded bundle will then be expressed as follows:

$$\sum_{i=0}^{m} p_i w_i = p_e, \tag{1}$$

where $p_e = P_{Y,v}(a_e) = f(a_e)$ are the losses in a graded-connection bundle with availability a_e, under load Y and with total number of connecting devices v. The nature of the process under consideration defines this function $p = f(a)$ as continuous, monotone, and decreasing.

Fig. 2

5. If the function $p = f(a)$ can be approximated linearly, then

$$a_e = \sum_{i=0}^{m} a_i w_i = \mathbf{M}a, \tag{2}$$

i.e., the equivalent availability coincides with the mathematical expectation of the availability.

6. For a continuous and monotone function $p = f(a)$, within the bounds of the assumptions made in (8), p. 92:

$$a_e \approx \sum_{i=0}^{m} a_i w_i = \mathbf{M}a. \tag{3}$$

7. Relations (2) and (3) are also valid for two-stage switching systems in which the initial availability a_0 is less than the number of outputs of the switching system (Fig. 2).

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Note: Figure translations are in progress. See original paper for figures.