ITC 11, Minoru Akiyama (Editor)
Elsevier Science Publishers B. V. (North-Holland)

THE OPTIMIZATION OF INTEGRATED DIGITAL NETWORKS WITH VOICE AND DATA

Tatsuki WATANABE and Masayuki MATSUMOTO

Department of Electrical Engineering, Toyo University
Kawagoe-Shi, Japan

1. INTRODUCTION The heuristic procedure to generate the optimized or near optimized structures of integrated voice/data networks as well as the comparison of two arrangements for voice, i.e., packet switching and line switching is presented. The load curves used to estimate the trunk capacity are shown that give greater capacities to the packet-switching for voice. The heuristic procedure used here is based on the similar principle to that developed by S.Lin, et. al. for the travelling-salesman problem [2].

2. PROCEDURE As shown in Fig.1, two kinds of terminals, telephone and data, are considered in the integrated voice/data exchange. Telephone calls are switched to one of VOCODER's connected to the CCU which generates voice-packets consisting of 240 bits each at every 90 ms during the talk-spurts for each telephone call. Data terminals are assumed to be sources of data packets having 1024 bits each generated randomly from infinite number of sources. These voice/data packets are transmitted to the respective digital trunks together with the tandem-switched packets. The following two kinds of integration arrangements have been considered.

(A1)Packet switching with packetized voice and data: The required trunk speeds are dimensioned using the load curves produced on the basis of single-server model of pre-emptive-repeated-identical-priority queues [1], incorporating the traffic simulation results (Fig.2).

(A2) Hybrid witching where telephone calls are circuit-switched while data are packet-switched on the fixed boundary basis: The required transmission capacities are dimensioned using Fig.2 in which the load curves are produced using Erlang B formula (B=0.001) for voice taking the bit-rate of 2.667 kb/sec as one voice channel.
In either arrangement, the data packet queueing delays are calculated as less than 50 ms.

The optimization problem here is to find the optimized or near-optimized network having the minimum total cost estimated by the given cost functions when the traffic matrices required for voice and data, locations of switching nodes, etc. are given. The fully connected mesh network is taken as the starting solution. The algorithm is to find the optimized solution through repetition of a procedure such as to re-route the traffic carried through the edge (direct trunk) between the randomly selected pair of nodes to a selected tandem switching node (exchange)as shown in Fig.3.

3. RESULTS As the example, the results in the case of six different exchanges located uniformly on a circle whose radius is 200 km long are shown in Fig. 4. The following tendencies have been observed from the trials.

If no other constraint such as protective measures is incorporated,networks that are close to those of full tandem tree or star type tend to be generated as the optimum. The degree of cost reduction is usually greater for A1 arrangement than A2 and the absolute cost value for A2 is greater than A1. If two kinds of traffics are out of balance, by-path trunks dedicated to one of two kinds of traffics tend to appear especially in A2 arrangement.

REFERENCES

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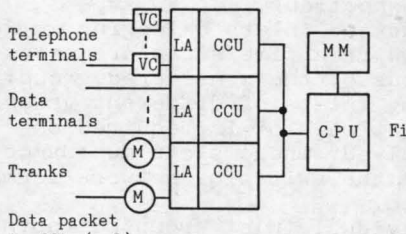

Fig.1 Integrated voice/data exchange

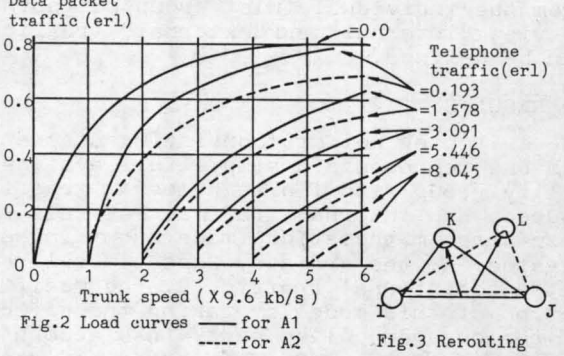

Fig.2 Load curves —— for A1 ----- for A2

Fig.3 Rerouting

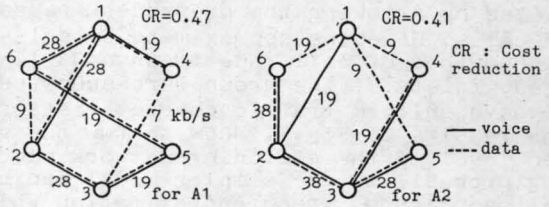

Fig.4 Optimized networks
(ratio of data to total packet traff. : 0.9)