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

HIGH RELIABLE NETWORKS

V.A.GARMASH, L.A.SHOR, A.I.ABRAMOVICH

Institute for Problems of Information Transmission
USSR Academy of Sciences Moscow, USSR

ABSTRACT

The paper considers methods to detect single and binary short duration failures in networks and to improve the reliability in the class of networks Σ when switching elements refuse. The paper is based on and develops further the authors' report on the 10th International Teletraffic Congress (ITC-10) in Montreal.

Two methods to improve the reliability of one-switching network is considered. The first method is to apply a built-in device to test and to self-regenerate rearrangeable networks. The constructing of such arrangement we shall illustrate by an example of threestage one-switching network $\gamma(n,r)$, where r is the number of quadratic nxn switches in the first and the third stages. Ennumerate inputs and outputs in i-th switches of stages 1 and 3 by numbers from n(i-1)+1 to ni and imputs and outputs of j-th switches of stage 2 by mumbers from r(j-1)+1 to rj. To the pair of numbers (i,j) where $1 \le i \le nr$, $1 \le j \le 2n+r$ corresponds a swit ching element (SE) from $\gamma(n,r)$, determined according to the following rule;

- if $1 \le j \le n$, the SE connects in the first stage input number i with output number $\lfloor (i-1)/n \rfloor n+j$;
- if $n+1 \le j \le n+r$, the SE connects in the second stage input number i with output number $\lfloor (i-1)/r \rfloor r+j-n$;
- if $n+r+1 \le j \le 2n+r$, then SE connects in third stage input number i with output number $\lfloor (i-1)/n \rfloor n+j-n-r$.

Let on $\gamma(n,r)$ be given a realization of mapping of a set of inputs to a set of outputs, that should be written as a matrix of nr x (2n+r) size, in which element a_{ij} is equal to one, if SE (i,j) is blocked, and to 0 otherwise.

Determine fro all i, $i=\overline{1,nr}$, $j=\overline{1,2n+r}$, $k=\overline{1,nr}$

$$b_i=\sum_{\alpha=1}^{2n+2} a_{i\alpha},\quad c_k=\sum_{\alpha=1}^{2n+2} a_{\lfloor k/n \rfloor \alpha},\quad d_j=\sum_{\alpha=1}^{nr} a_{\alpha j} \qquad (*)$$

where all the sums are taken with respect to module 2. Denote by B,C,D the control sums, i.e. sets of numbers $\{b_i\}$, $\{c_k\}$, $\{d_j\}$ found according to (*) to realize mapping without mistake.

Theorem. If during the mapping realization on $\gamma(n,r)$ short duration failures in one or two SE take place, then, knowing sets of indexes I,J,K for which control sums B,C and D were changed, it can be determined simply, in which SE were short duration failures.

The other method is to introduce auxiliary SE into the reconstructed network that makes possible loss probability decrease.

Optimization is also taken into account, that consists in the following. Among all the networks with given level of reliability one should be constructed such thet has less number of auxiliary SE. In the report the problem of optimal synthesis is resolved in class of networks Σ in which reliable characteristics and the number of SE is determined by finite (and not very large) number of integer parameters.

The networks of class Σ are built as follows. Let R be a one-switching network with N inputs and N outputs. Denote by Σ_2 the network in which each SE of network R is replaced by a hammock with parameters r_2, l_2. We call hammock of length l and width r a network of rl SE that has one input and one output connected by chains of length l and to break all the paths of whic it is necessary to disconnect no less that r SE.

Networks, consisting of N unconnected hammocks each we denote by Σ_1 and Σ_3. All the parameters of Σ_1 and Σ_3 are the same. Network S with N inputs and N outputs is obtained by consequent connection of networks $\Sigma_1, \Sigma_2, \Sigma_3$. Denote by M a class of networks, obtained of (1,2N) polars by replacing all their SE by hammocks. Hammocks 1,2,...,N have the same parameters r_4 and l_4 and hammocks N+1,...,2N - the same parameters r_5, l_5. Denote by Σ_4 a circuit consisting of m networks $M_1, M_2, \ldots, M_m$ of class M with inputs and outputs switching in parallels. Denote by Σ a circuit obtained by parallel connection of networks S and Σ_4. Changing integer parameters r_i, $i=\overline{1,5}$ and integer m we obtain the class of networks Σ.

Synthesis algorirtm of the networks optimal on auxiliary SE number from class Σ is given, i.e. solving algorithm of integer non-linear optimization task. The algorithm consists of subsequent elimination of such values of psrsmeters r_i, $i=\overline{1,5}$ and m that do not solve the problen due to fault probability limitation.