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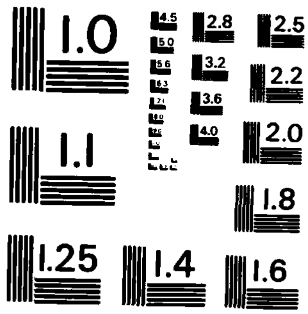

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by

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Modeling a Data Transmission Network by Means of the "Teledacya" Information Subsystem

(Communique)

Krystyna Palmowska

An information subsystem with the title "TELEDACYA"[2] has been developed in the Institute of Telecommunications Networks and in the Departmental Center for Electronic Data Processing at the Institute of Communications[1] for the purpose of facilitating research on data transmission networks.

The concept for this system arose from the need for developing a research tool that would make it possible to carry out rapid assessments of the reasonableness of results from various kinds of prognostication fundamentals and assumptions concerning the development of data transmission networks, important with respect to the extent of loading on a long-distance telecommunications transmission network. This was important because initial evaluations demonstrated that loading determined according to existing prediction methods has essential importance for the planning of an entire telecommunications network.

The programs developed have served, in the first place, for studies on the long-distance data transmission network to be used between provinces scheduled for general use for the period 1990-1995. The working assumption adopted was that the long-distance data transmission network (basic) that was being studied will contain 49 provincial switching centers for the provinces, and that it will have a two-level hierarchical structure.

The network modeling process (Fig. 1) carried out in successive programs in the TELEDACYA system may be presented in the following manner.

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[1]This subsystem is a component part of the so-called "MARS" information system used for modeling and optimalization research on telecommunications networks.

[2]The method and the fundamentals of the "TELEDACYA" subsystem were developed by Engineer K. Palmowska, MS, and the organization of the programs and program composition were carried out together under the direction of E. Szwed, MS.

A set of central offices or switching centers is given and described by their geographical positions, as well as weightings defining their sizes. Each switching center is treated as a noise generator with a certain average value expressed by the average number of bits entering the network over the period of 1 second. The distribution of this noise over the individual relations describes the generation model derived and noise propagation. In accordance with this model, which establishes the total noise generated in the network, a matrix of the interesting inter-junction noise characteristics is described, whose (i,j) element describes the information flow from junction i to junction j.

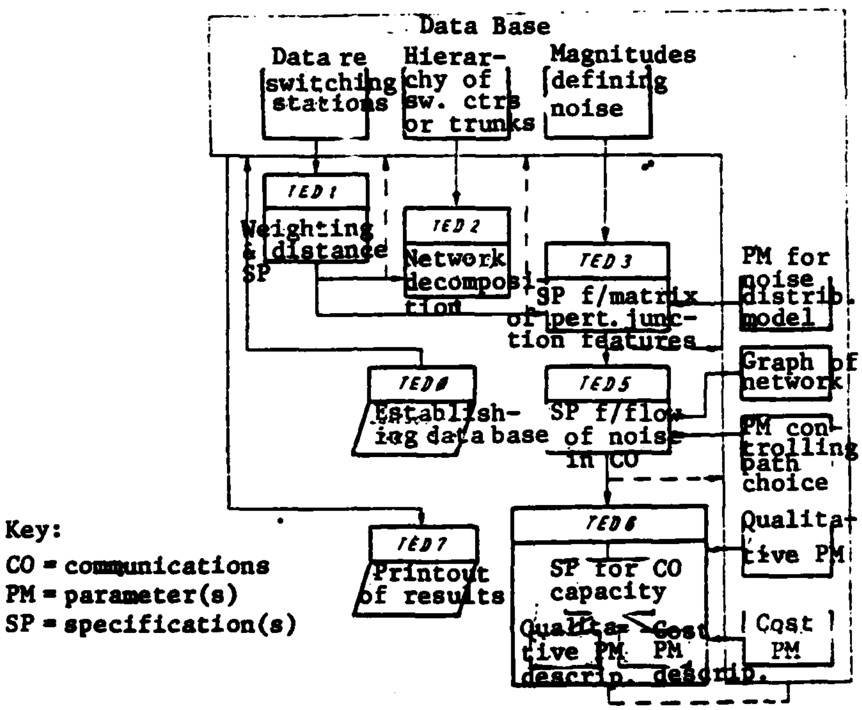

Fig. 1. Simplified diagram of a modeling process for a data transmission network.

Within the set of junctions (central offices, switching centers), there is distinguished a subset of main junctions privileged with regard to weighting or their central positions within the network. The subset of terminal junctions makes up the remainder of the set. We shall introduce an ordering according to which there corresponds one and only one main junction for each terminal junction.

This ordering is specified and assigned during the process of network decomposition.

The topological structure of the network is represented by a graph described by a set of junctions and the trunks connecting them (data transmission links[1]).

According to the assumptions adopted here, a terminal junction is connected by means of only one link with a corresponding main junction, whereas a main junction may be connected with many main junctions (in the extreme case, with all of them). The information flow pathway between each pair of junctions is described by the principles of noise control, according to which the shortest channel having a minimum number of intermediate junctions is chosen. The designation of these channels makes it possible to describe the extent of noise flow through individual branches and junctions.

On this basis, and taking into consideration the assumed quality parameters of transmission dependent on the type of commutation (for example, average message delay in message commutation or a noise loss factor in link commutation), the cost and capacity of individual branches within the network are established. In the last phase of description, the set magnitudes are designated for the entire network and their general qualitative and cost indicators are described.

The TELEDACYA system is composed of seven independent programs written in FORTRAN 1900 and PLAN programming languages (Table 1).

The first program, with the name TED Ø, which carries out the role of a data base in this system, has the task of reading in input data and its description on a magnetic tape.

The last program, with the name TED 7, can print out any information contained in the data base and described, at the same time, by network parameters and the parameters of its elements, as well as output data. Each of the other

[1]We take "data transmission link" to be the entirety of means serving for the transmission of data between a given pair of junctions independent of their technical realization. Links can be realized either in digital or analog form and may be multiplexed, either frequency division or time division.

Table 1. List of TELEDACYA subsystem programs

Item No.	Name	Title	Function	Program language
1	TED Ø	DATA READ-IN	Read-in of set of input data and their descriptions in the set TEDA-DAN-WYN, or updating the TEDA-DAN-WYN set	PLAN
2	TED 1	WEIGHTING AND DISTANCE DESIGNATIONS	Designation of inter-junction distances and weightings of normalized junctions	FORTRAN
3	TED 2	NETWORK DECOMPOSITION	Division of the set of junctions into subsets corresponding to regions	FORTRAN
4	TED 3	DESIGNATIONS FOR THE SET OF PERTINENT FEATURES	Designation of pertinent inter-junction and inter-region features according to different variants of the generation model & the noise propagation model	FORTRAN
5	TED 5*	NOISE CONTROL	Designation for noise flow in links	FORTRAN
6	TED 6	NETWORK PARAMETER DESIGNATIONS	Designation of basic parameters concerning the junctions and links, as well as their summing for the entire network	FORTRAN
7	TED 7	PRINTOUT OF RESULTS	Printout of data concerning individual links and junctions, as well as of set data (links and junctions); printout of selected values for fields in the TEDA-DAN-WYN set	PLAN

*TED 4 is a program removed during the carrying out of the subsystem.

programs, designated by names from TED 1 to TED 6, carry out determined tasks in the problem of modeling a network; the data required for this is selected from the data base, and results are also written into the data base. It is also possible to control for the activity of any individual program through a control printout during program operation.

During standard operation, automatic start-up of successive programs from TED Ø to TED 7 is provided for, and because of the independence of the programs, they can be started up in any series or in any group.

This kind of organization facilitates the introduction of optimalizing conjugations when a graph of the best possible parameters is generated in successive iterations. Another element enhancing the elasticity of the control of the flow of calculations is the use of so-called switches that make it possible to choose one of several possible variants of solutions of certain program fragments depending on the control parameters assigned.

All the features of subsystem organization mentioned here assure its all-purpose use and universality (it is also possible to apply it to modeling problems for other networks, such as telegraphic networks), as well as ease in design and development.

The input data used in the successive programs of the system can be divided into the following groups:

- information concerning the junctions (central stations, switching centers) (geographical coordinates as well as weightings),
- conditions imposed on the network's topological structure (junction hierarchy and their links, the graph of the network connecting the main junctions),
- the parameters of noise generation and the parameters for the model of noise distribution (for example, number of subscribers and their division according to category, noise propagation internally and between regions),
- parameters controlling the choice of pathway,
- qualitative parameters, depending on the type of commutation,
- factors for describing link and junction costs,
- as the case may be, factors describing admissible margins of branch capacity.

The output data (results of calculations) also contain set parameters for the entire network -- with a breakdown according to the level emerging from the hierarchical structure of the network -- as well as parameters concerning individual branches and junctions. These are primarily:

- noise flow in the network and in its elements (junctions and branches),
- branch capacity expressed as the number of converted primary groups (or as the case may be, with a breakdown into individual subscriber categories),
- transmission quality parameters,
- cost in relative units.

In addition, it is also possible to print out all the other information derived at individual phases of the modeling operation and contained in the data base.

The structure of the system taken here, characterized by great elasticity, makes it possible, in addition, to use it for optimalization studies of the topological structure of a network, that is, for generating structures which, with given assumptions, will be characterized by the most efficient and economical system of such indicators as the cost of a unit of flow within the network (using conventional units), or average message delay time.

The TELEDACYA system will be used in the Institute of Communications for scientific research work whose object is the development of concepts rationally adapted to our country's conditions for a telecommunications information network for all-purpose use. This kind of network will, in all probability, be built in Poland in the second half of the 1980's and be deployed in the 1990's.

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