PLANET: TRANSMISSION PLANNING IN HUNGARY

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Abstract

The long, medium and short term planning of Hungarian backbone and Budapest trunk networks in Hungarian Telecom are based on the software package PLANET, which covers a wide range of the transmission planning activities. The paper describes the PDH and SDH network planning tools, the planning processes and the resulted networks. Main present features of Hungarian backbone and Budapest trunk networks are summarized, and the first visions of SDH target network structures are presented.

I. INTRODUCTION

Since 1986 the digitalization of the Hungarian transmission network has been carried out. Based on the traffic planning results [1] developed by the Post Research Institute (PKI) a joint planning activity between the PKI and the Technical University of Budapest was initialized and after the common experiences the development of PLANET (PLAnning of communication NETworks) was started in 1989. PLANET has been applied in network planning at the PKI Telecommunication Institute of Hungarian Telecom Company (HTC) since 1991. The implementation of SDH network planning in the frame of PLANET has been carried out since 1992.

PLANET is an integrated tool for transmission network planning. The software provides a flexible frame including databases (for input data and planning results), graphical and numerical input/output interfaces. PLANET package consists of PDH network planning modules for topological optimization, circuit routing and grouping, equipment assignment, hierarchical SDH target network optimizing and dimensioning modules.

In the recent years the optimized network structures with mixed PDH transmission media (fibre and microwave links), several medium and short term development plans of the ongoing network modernization as well as the first SDH target network visions and SDH introduction studies for Hungarian backbone and Budapest trunk network have been elaborated with the help of PLANET.

The paper gives an overview of PLANET and the planning results achieved with the help of PLANET and it is organized as follows. In the next section the transmission planning objectives for different time horizons are given. The third part outlines the elements of PLANET. The general transmission processes are summarized in the fourth part. The PDH and SDH transmission planning steps realized in PLANET are described in Section V and VI. Section VII summarizes the

applications and the resulted networks. Finally the paper is concluded.

II. PLANNING OBJECTIVES

The aim of PLANET is to assist the planners in the determination of the optimal network development taking into account the increase and changing of the circuit demand, the available transmission media and equipment in the given time and in the future, as well as the technical and geographical constraints. This planning aim requires a long-term vision of the network and the determination of a development scenario at the same time. In the planning process the long-term (10-15 years), medium-term (3-5 years) and short-term (1-2 years) plans compose consecutive and consistent activities. The complexity of the network planning necessitates the partition of the planning process in order to have solvable size problems. One of the basic requirements determining the development of PLANET was the realization of the whole planning process in an integrated frame making it possible to improve the planning and analysis methods and tools in a step by step manner.

III. THE ELEMENTS OF PLANET

In order to fulfil the above requirements PLANET consists of five major elements. These elements can be identified as the database of input data, the description of cardinal plans, long-term and short-term planning processes as well as the network analysis. The connections among the elements are visualized in Figure 1.

The database allows the user to define inputs (equipment type and data, cost models of transmission lines, node data, topology, grouping levels, grouping rules, routing rules) that can be generally used in several planning steps. The PLANET frame helps the adequate application of the different input data in every planning and analysis phase.

The planbase defines a hierarchy of plans. This hierarchy and its new elements are stored

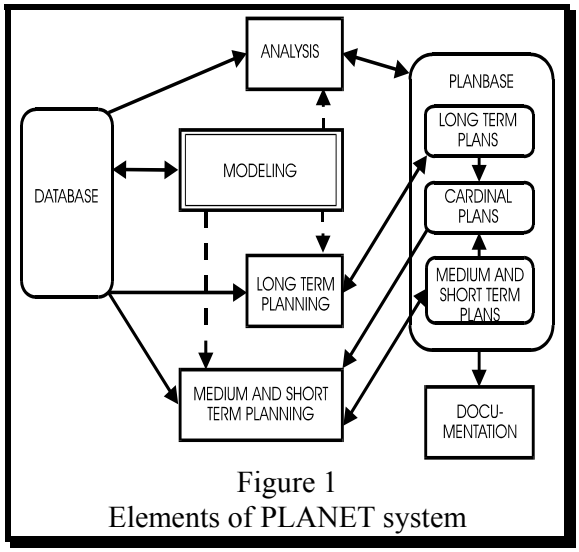


Figure 1
Elements of PLANET system

without user's interaction. Both long and short-term planning have their own part in the planbase. The third part of the planbase, the cardinal plans, contain the information of special significance (e.g. long term network structure, transmission media) and/or the description of the existing networks (realized short-term plans). These plans play important role in the medium and short-term planning activities.

The long and short-term planning elements are divided into two further subelements named, traffic planning and transmission planning.

In the recent version of PLANET the traffic planning is carried out by other program packages which have not been implemented within the frame of PLANET, so far. However, the results of the traffic planning are introduced into the PLANET planbase, so the further topological and transmission planning steps are based on these input data.

The transmission planning phase comprises the structural and topological optimization, the routing, the grouping and the equipment assignment steps. All the results can be obtained in textual and graphical form as well.

The network analysis tools help to check the results of the planning steps. In the recent version this analysis part is composed of two

elements: the traffic plan evaluation (based on simulation methods [2]) and the reliability qualification of the transmission network [3].

IV. NETWORK PLANNING PROCESSES WITH PLANET

The three main planning processes are distinguished according to the perspective of the activity. However, in the processes implemented in PLANET there are several differences in the planning conditions and in the results, as well.

The aim of the long-term planning process is to determine the optimal target network structure, thus the impact of the existing network is neglected. The implemented planning steps are mainly focused on the topological optimization, although approximate grouping and assignment results can be also obtained. A simplified network model can be used with general routing and grouping rules.

The aim of the SDH target network optimization is to determine the hierarchy and the clustering of the SDH network. In the real size networks a very large number of solutions should be compared in order to find the optimal one. The process contains two phases. In the first phase a subset of candidate network structures is determined with the help of a simplified network model and target function. Having a limited number of variations in the second phase the dimensioning and detailed comparison of network structures can be carried out.

The medium-term planning is subject to the determination of plans for about 5 years. For this period existing and new service demands, technological opportunities and constraints, as well as financial (state and/or company) possibilities are quite well known. The difference between the long-term and medium-term planning processes can be characterized by two aspects. On the one hand, the free development of network is supported, thus basically no limits of capacities and routing solutions have to be

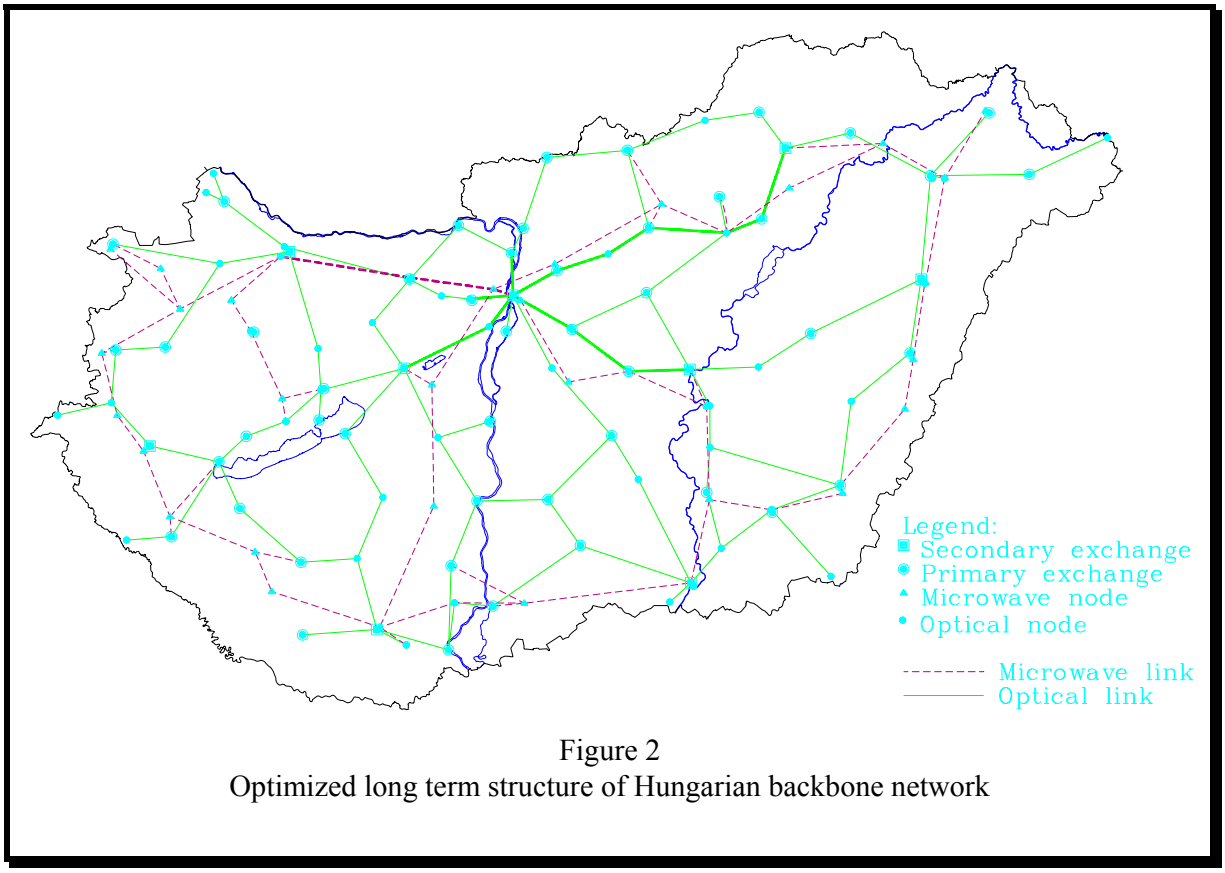


Figure 2
Optimized long term structure of Hungarian backbone network

considered. On the other hand, since these results are planned to be implemented, more sophisticated network models are used with detailed planning restrictions and rules. Recently the process covers all PDH planning activities including the detailed grouping and equipment assignment steps.

The short-term planning is the preparation of the investments for the near future taking into account the actual financial and technological constraints. As far as the long-term and the medium-term planning steps optimize the network from different aspects the short-term planning only gives the dimensions of the network and provides huge and detailed documentation for the installation. In a short-term period the impact of the existing network is very strong, the existing infrastructure, the capacity of links strongly determine the routes that can be used. The unoptimal solutions which are enforced in a short-term phase (in order to minimize the cost of required capacity extension) are (or can be) removed in the next medium-term planning period.

V. PDH TRANSMISSION PLANNING WITH PLANET

There are different network models applied in the different phases of PLANET. Most of them are usual in telecommunication network representation. However, one of the special modeling elements is the so-called connection point that provides opportunity to apply flexible cost models (functions) in the topological planning phase and different multiplexing and demultiplexing models of the different nodes in the grouping step.

The objective of the topological planning phase within the whole planning process is to find the cost-optimal structure of the network fulfilling the circuit demand requirements and taking into account the technological opportunities as well as the technical (e.g. multirouting) and geographical constraints. The implemented method is based on an edge elimination technique, in which different cost parameters of edges are taken into consideration. (An example of the results is illustrated in Figure 2.)

After the determination of the network topology the optimal routing of network demands is derived according to planner defined routing rules and restrictions. The multiplexing capabilities are given for each node in the form of the allowed minimum and maximum module levels of the transmission systems. Considering the circuit demands given in different units and the allowed module levels of the nodes the grouping optimization is carried out from the lowest to the highest level (e.g. from the 2 Mbps to the 140 Mbps module level in PDH networks), subsequently. In every module level different opening and closing thresholds can be specified.

The objective of the assignment step is to define the detailed payload of each equipment. In this step the graphical and textual documentation of the demand assignment and the cross-connect functions are determined .

One of the peculiarities of PLANET is the semi-automatic generation of the graphical documentation of the grouping and assignment results.

VI. SDH TRANSMISSION PLANNING WITH PLANET

The basic planning steps are mainly identical for PDH and SDH networks. The definition of circuit demands, the network topology and architecture, the determination of the main and stand-by routes, the grouping of the circuit demands, the definition of the applied network elements, the equipment assignment and the approximate cost of the network can be implemented for the PDH and SDH network planning process in the same frame.

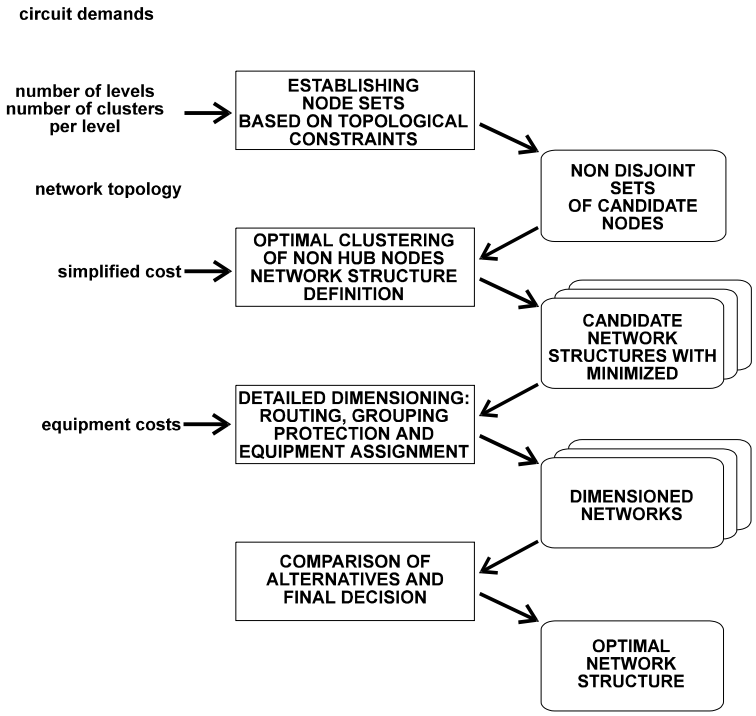
However, in the realization of SDH network planning steps some important new

features should be taken into account. The circuit demands can be defined in different level of SDH or PDH units.

The network topology is given as in case of PDH networks, while the architecture is considered as a multilevel hierarchical structure. The elements of the architecture can be rings, mesh networks and point-point connections on different levels.

The structural optimization processes are totally different from the PDH, only the basic approch is similar (optimization in two phases with refined model). As an input the demand sources, demands, and the topology (consisting all possible links) are given. The aim of the process in the first phase is to determine a subset of candidate network structures, and in the second phase to compare them in details in order to find the optimal one. The main steps of the first phase are as follows.

Before starting the optimization process



the planner should decide the number of hierarchical levels, the number and type of clusters on each level and the points (*hub*s) providing the connections between clusters. A statistical analysis of the demand structure helps the planner in these decisions.

Then non-disjoint sets of demand sources are dedicated to the *hub* pairs taking into account the distance between demand source - *hub* pairs (Several implementation of "nearest *hub*s pairs" are realized.)

Based on these sets the optimal clustering of the network is determined. The size of clusters can be limited by technological reasons (e.g. STM-4 ring). The combined target function takes into account two factors: the total amount of demand leaving the lowest level clusters and the total load of the higher level. The realized version of the method handles two-level hierarchies with dual-homing, rings on the lower level and with mesh or ring on the higher one.

The last step in the preselection of the candidate structures is to determine the optimal connection order and topology for the ring structures. In these step the preferred (existing) and the non-existing links of the network topology have different cost functions.

The second phase of the structural optimizations is the detailed network dimensioning (routing, grouping).

In the routing and grouping phase the routing rules and protection techniques as well as the possible local cross-connect functions are taken into consideration. The planning and dimensioning of SDH based rings required new methods. The routing, grouping and stand-by net-