

GeoTT Geographic Information System Support for Telecommunication Network Planning and Design

Dragan H. Stojanović, Slobodanka J. Đorđević-Kajan, Zoran H. Stojanović, Leonid V. Stoimenov

Abstract - Planning and design of the telecommunication network using Geographic Information System, with their great performance and qualitative improvements and benefits are presented in this paper. GeoTT-Project, a specialized GIS module developed as integral part of GeoTT GIS for Telekom Company of Serbia with the purpose of scheduling, planning, design and management of telecommunication networks is described along with its main features and useful functions.

Keywords - Telecommunication network, GIS, spatial database, planning and design

I. INTRODUCTION

Telecommunication networks are widely dispersed networks. The key parameter for planning, design, development, maintenance and management them is their geography, which means the exact spatial information of networks' objects. Till the near past, telecom managers and operators have handled their networks by large-format, manually drafted paper drawings presenting schematic plans of telecom network and sketches of important objects on them, coupled with thousands of paper documents containing network qualitative and quantitative information. Efficient handling of large, traditional paper based documentation and keeping it up-to-date and consistent is nowadays enabled by using modern computer and Geographic Information System (GIS) technology. GIS represents the specialized, non-standard information system dedicated to the storing, retrieval, analysis, processing and visualization of geocoded (i.e. referenced to geographic coordinates) information. Management of the telecommunication cable network using GIS technology, with great performance and qualitative improvements and benefits in all management activities have been clearly presented and well established [1, 2]. This paper is dedicated to GeoTT-Project module developed to support all creation activities needed for telecommunication network planning, design, construction and implementation.

II. GEOTT - A GIS IN TELECOMMUNICATION

To improve the quality of services and management of telecommunication network in Telekom Company of Serbia,

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the specialized geographical information system GeoTT is developed for the purpose of computerized management of telecommunication cable network [1, 3]. GeoTT system was developed at the Computer Graphics & GIS Lab, Faculty of Electronic Engineering Niš, on top of GiniNT [4] - a scalable, object-oriented GIS platform. GeoTT GIS supports all activities, processes and technologies which have to be performed on telecommunication network, from telecom network planning and design, via network construction and implementation, to network operation and maintenance, which include performing suitable spatial and non-spatial network analyses, inventory management, fault management, administration of network documentation, etc.

GeoTT system consists of several software modules, which form a complete tool set to support, all telecommunication network management phases (figure 1):

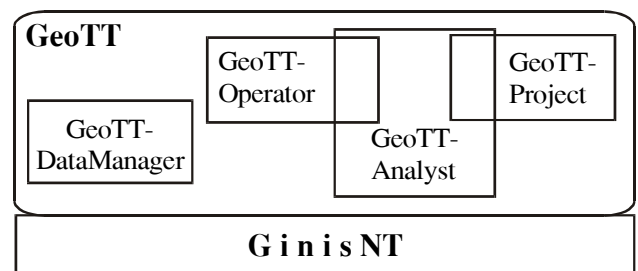


Fig. 1. Architecture of GeoTT system

- ♦ GeoTT-DataManager [5] - Accurate and up-to-date recording, updating and manipulating of telecommunication network data, both its geographic component (the map content specifying the location and geometry of network elements) and alphanumeric one (types, properties, quantities, codes, etc.), blending them into integrated GeoTT database.
- ♦ GeoTT-Operator [1, 2, 3] - Efficient evidencing, analyzing, maintaining and operation of telecommunication network, improved customer care and appropriate worksheets and plots generation.
- ♦ GeoTT-GeoAnalyst [6] - Interactive, efficient and user-friendly querying, retrieval and analysis of geographic and attribute data, based on specific spatial, temporal, thematic and hybrid conditions and criteria.
- ♦ GeoTT-Project - Faster and optimized network planning and design (using up-to-date spatially referenced data, information on spare capacities, etc.).

GeoTT system and its modules, having the support of

GinisNT's advanced GIS features, enable distributed and multiple access of network data to all producers and users of telecom network data throughout the Company. This data can be viewed, edited, analyzed and processed simultaneously by all authorized operators in Marketing, Strategic planning, Network design, Construction, Network maintenance, Customer service and other Telekom company departments.

III. TELECOM NETWORK PLANNING AND DESIGN

The telecommunication networks are permanently evolving, especially in urban areas: new cables are laid, new exchanges are put in operation, the new subscribers' telephone numbers are added, new external terminal blocks are built, and so on. This makes telecom network planning and design very important and critical activities within network telecom management, and a good candidate for

appropriate GIS solution. Also, a standard GIS contains only up-to-date information, thus the sense of telecom network spatial and thematic changes, and development dynamics through time, in planned, future and past temporal domain is not evidenced, maintained and represented within it.

The importance of maintaining temporal dimension of spatial and thematic telecom network information in network development management was considered and appropriate temporal GinisNT extension has been developed. It is based on SPATEMP [7, 8], spatio-temporal data management system developed to enable unified and integrated processing and management of spatial, temporal and attribute data about geographic entities. The SPATEMP has been significantly improved the effectiveness and management power of GinisNT, as well as GeoTT system being rebuilt on top of extended GinisNT, in the management of specific dynamic geographic aspect of interest.

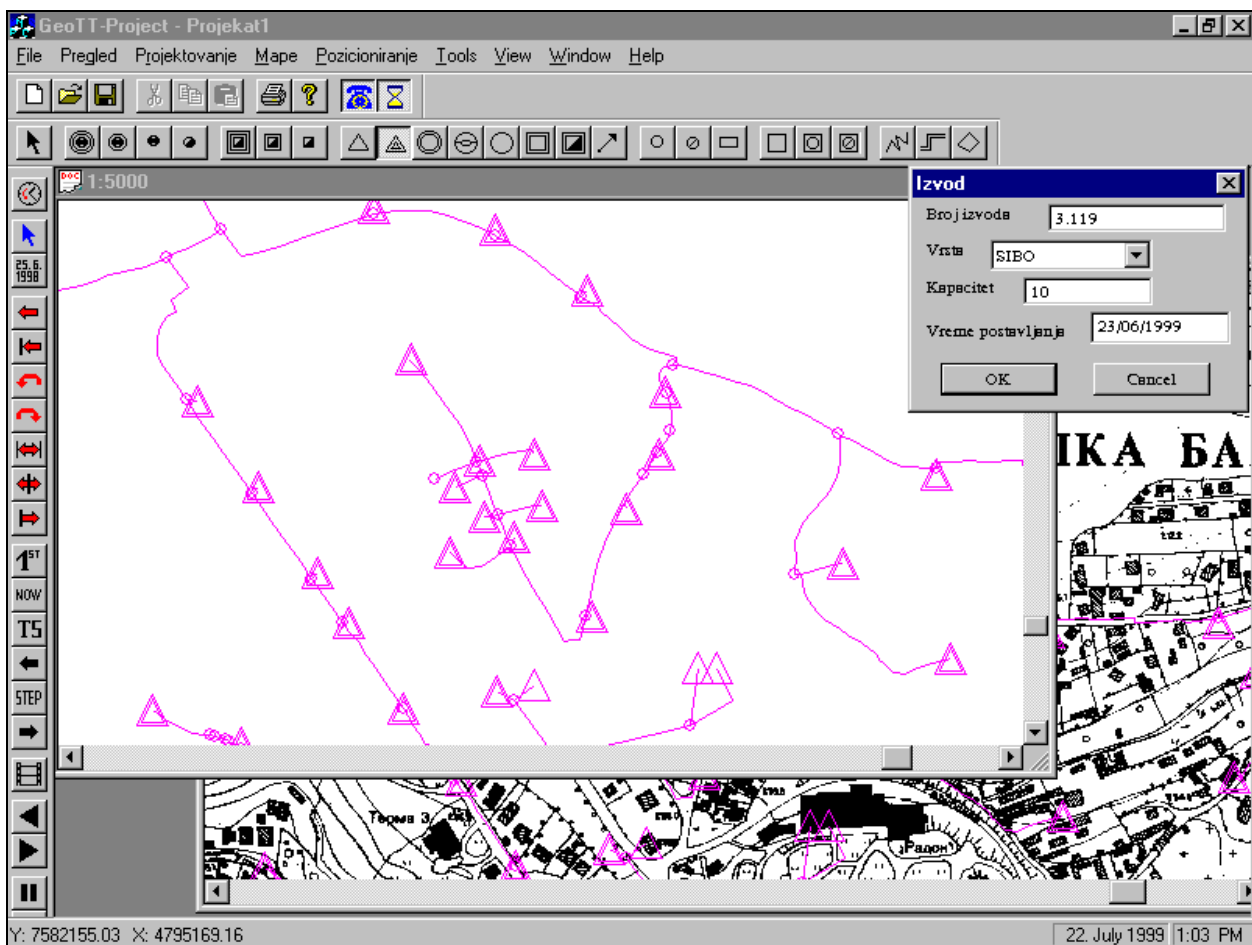


Fig. 2. GeoTT-Project - a module for telecommunication network planning and design

Owing to the temporal extension, GeoTT system is now able to trace dynamics and changes of telecom network states, which resides in the study area and store historic telecom networks states into integrated spatio-temporal database. Management and analysis of historic network states based on temporal telecom network information are integrated into

GeoTT-Analysis module. In addition to evidencing the history of network spreading and development, the spatio-temporal database can store anticipated, future network states. It enables designing future plans and current schedules in telecom network development within GeoTT-Project module (figure 2). GeoTT-Project module supports all creation

activities needed for telecommunication network planning, design and construction. It can offer dynamic monitoring and control of the network design and development, providing daily accurate data for all sectors and departments in the Telekom Company involved in and responsible for telecom network development management.

GeoTT-Project module support all activities in scheduling, planning and design of future telecom network development and those are:

- Site selection and dimensioning of telecom network nodes (terminal blocks, connection boxes, distribution points, cable cabinets, front-end switches, central offices) using digital geographic map of specific area and efficient graphical user interface techniques (direct manipulation, drag&drop, etc).
- Storage and processing of all relevant network objects' qualitative and quantitative parameters

- The geographical tracing of cables, laying them in cable ducts, connecting specific network nodes, using the digital geographic map as design background (figure 3).
- Specification of construction parameters (laying depth, type and diameter of tubes, planned occupation of the tubes with cables).
- Geographic site selection of manholes and specification of their construction parameters (dimensions, cross-sections).
- Specification of planned occupation of manholes and the routing of cables inside.
- Automatic calculation of the running lengths of trenches, ducts, cables, etc using the geographic coordinate information of the underlying digital geographic map.
- Generation of the bill of quantities for materials and services for planned telecommunication network, so the ordering and provisioning can be carried out perfectly coherent to the construction plans.

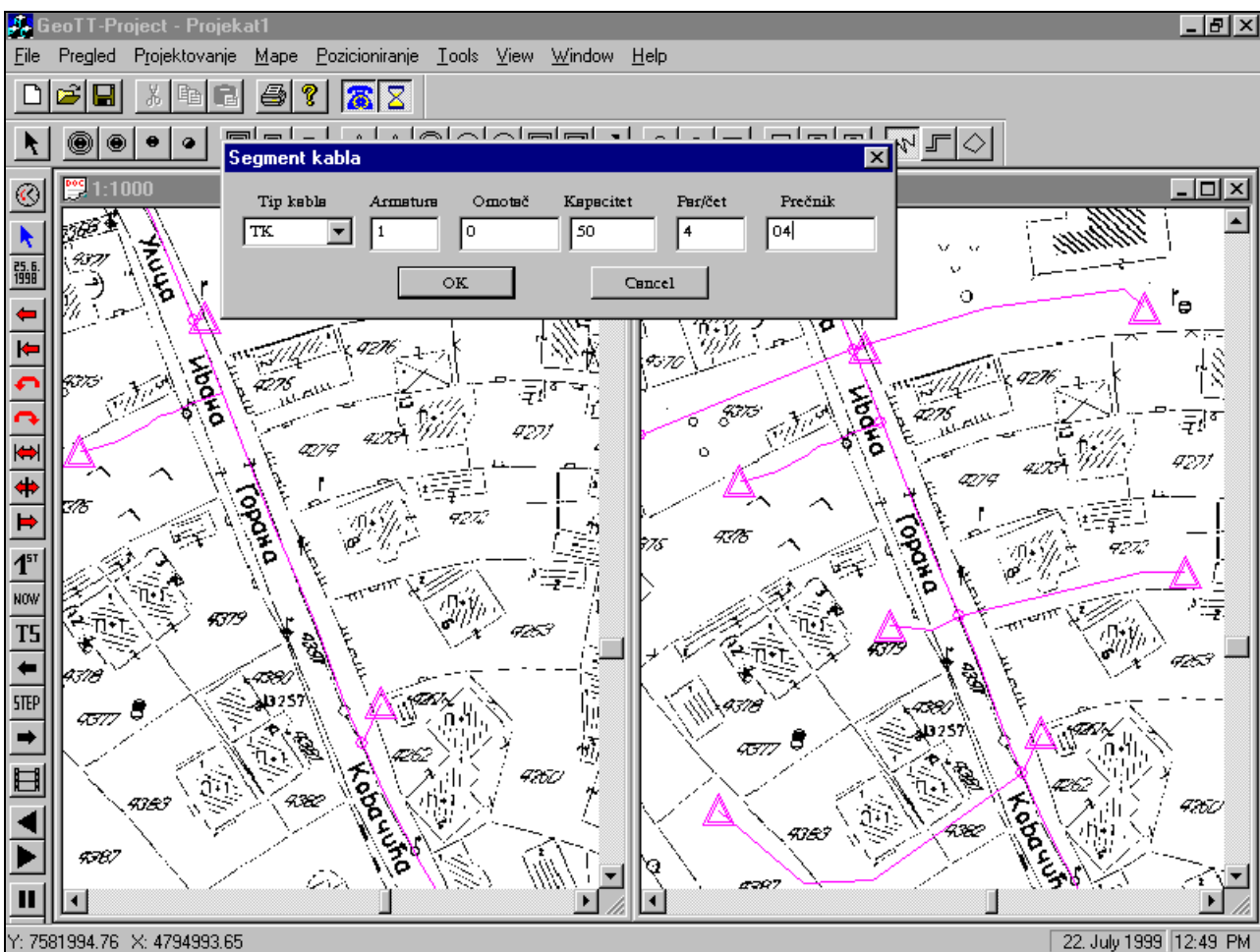


Fig 3. Current and planned state of telecom network during the network design

Since all telecom network data (geographic, attribute and temporal) is stored in a single, integrated GeoTT-Project database, generation of all conventional engineering drawings, schematic and construction plans, as well as reports, both in electronic form (data and displays) and on paper sheets are provided. The common database guarantees

strict congruency among these different types of “views” on the telecommunication network.

GeoTT-Project is able to perform a time schedule of network development and temporal planning of its progress. Besides, it provides support for maintenance of various telecom network design alternatives within single, integrated

GeoTT database. Based on analysis and comparison of main features and important characteristics of these alternatives the support for decisions making is provided to chose the most satisfied solution for network development.

During telecom cable network construction and implementation, planned and constructed network information is moved to GeoTT database. If change of design occurred, network re-engineering enables overwriting "planned" values with "as-built" ones. After this process, this data is accessible for network maintenance and operation within GeoTT-Operator, GeoTT-GeoAnalyst and GeoTT-DataManager.

Further improvements of GeoTT-Project will enable advanced design activities based on appropriate algorithms and artificial intelligence technologies:

- ♦ automatic and optimized cable route tracing,
- ♦ computer-assisted selection and dimensioning of cables, computer-assisted generation of splicing tables,
- ♦ computer-assisted management of cable cabinets,
- ♦ computer-assisted site selection and dimensioning of electronic equipment.

GeoTT-Project module and GeoTT system can be easily integrated with the Telekom company's other Information Technology solutions as well with appropriate IT solutions of government, public and private institutions. For example, spatio-temporal information from regional development GIS, based on temporally extended GinisNT, accessed from GeoTT-Project could provide evaluations of alternate locations for telecom facilities given demographic forecast, urban development and local behavior patterns.

Also, it is planed to extend GeoTT-Project to planning and design of CATV network, by including much higher and more sophisticated demands and requirements in planning and design processes. The key functionality which would have to be supported is to help the network designer keep the signal levels within specified limits (in order to fulfill noise and distortion specifications) and to meet power requirements of all active devices without compromising their reliability. The higher level sensitivity of CATV with respect to telephony makes the parameter "distance" (i.e. GIS functionality) even more crucial.

IV. CONCLUSION

In order to improve all activities and operations in development, management and maintenance of the telecommunication network, the traditional paper and document-based solutions must be drastically reduced or completely left. Geographic Information Systems offer invaluable performance benefits and improvements in all phases of telecommunication network life cycle, from its planning and design to its management and maintenance.

GeoTT open, object-oriented, GIS is effectively used for telecommunication network management and maintenance in Telekom Serbia. The temporal GeoTT extension incorporated into GeoTT-Project module offers many benefits in telecommunication network management, with emphasis on its planning and design. GeoTT-Project is currently in its prototype, testing and refinement phase, and can be easily and efficiently integrated in the latest version of the GeoTT software on the Telekom Serbia responsible person's request.

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