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GIS – THE GLOBAL INFORMATION SYSTEM FOR MANAGING ALL ACTIVITIES IN THE REGION

B. Miljkovic, Electric Power Distribution Utility "Elektrovojvodina" – Division "Distribution Utility Sombor", Serbia and Montenegro
V. Strezoski, DMS GROUP LTD Novi Sad, Serbia and Montenegro

INTRODUCTION

The idea of **GIS** has been treated until now through the very small frame of the **G**eographical **I**nformation **S**ystem. The acronym GIS has been developed from this term. The advanced idea of GIS as a **G**lobal **I**nformation **S**ystem (with the same acronym), aimed for management of all activities that are performed in one administratively surrounded room (city, community, region) is promoted in this paper. This idea opens a new dimension of basic concepts, participants and methods of projecting and operation of this information system. The idea that GIS is a system for managing all of activities that are performed in a region guides into the necessity to understand that GIS represents an integration of a huge quantity of data and great number of more or less complex components and applications. The application of such a GIS in all communal activities of the region, impose the necessity for a very high and complex level of hierarchically organized integration of the GIS that is oriented toward the managing of all activities and data of the entire region no matter which region's department asks for them. This complexity is a consequence of a very high number of connections of graphical and alphanumerical data, as well as applications that are used for that purpose. A huge number of utilities and companies are involved in the creation, development and application of the system. The main job of the users of GIS is to define responsibilities of all participants-users of GIS in its operation. Based on the common set of requirements, a unique set of operation standards is established. In this case, mutual rights and responsibilities of all participants of GIS are defined. This provides the full consistency and uniformity of the system. Through the systematization of data and definition of their managing, as well as systematization of functions, activities and users of the system, one achieves the general rules and standards. These standards represent the first step of establishing GIS as necessary system for both users and society.

GIS represents a continual and interactive process of collecting, maintenance, working and distribution (in different forms) of geo-information and alphanumerical data. GIS is useful to everyone who needs particular and/or common information from a certain area. It is used to satisfy all requirements of one who likes not only to be informed bat also of one who likes to act in the field of local or global planning of the region. All activities, which are performed internally in one region, consist of economy, infrastructure, administration, services, etc. All companies and utilities dealing with these activities are more or less intensively related with the same area and the same organization of the certain region. Some of these

Boža Miljković dipl. el. ing., E-mail: boza.miljkovic@so.ev.co.yu

companies are directly a part of the room of the region (electric power distribution, distribution of other energies, post, Telecom, traffic), some of them only use that room (schools, services) and some of them cope with the region administration (state registries, statistical departments). Since the development level of today's information technologies is satisfactory high, all data and information that are necessary for normal providing of activities of all these companies and utilities can be integrated and mutually connected in a unique database. Some of these companies require different data, but some of them have interest for the same ones. E.g., the electric power distribution utility requires the same data about region's citizens as the utility for heating does that, since the most of citizens use simultaneously both the electricity and the heating energy. Contrary, some data, which are of prime interest for a single company, may be of secondary interest for other one. E.g., data about the development of the heating energy network are of prime interest for the heating utility, but they are of secondary interest for the electric power distribution utility. Electric power distribution utility must have information about the disposition of heating network when the power lines and power plants have to be built. However, there are data, which are of interest exclusively for a single company. Those data are ones about, e.g., the internal organization of the company. Saying simply, GIS has to be built by integration of alphanumerical and geographical data of one company and then it has to be integrated (at a higher level) with the data of other companies. In Europe, globally looked, there are two types of organization of GIS, ***, (1):

1. In the first case, only data of common interest for several companies of the region had to be stored into the common database of the "Central Institution". Therefore, in this type of GIS, same data are exchanged over this institution and same ones directly between companies (Western Europe).
2. In the second case, all data of all companies are stored into the database of the "Central Institution"; The "Central Institution" exchanges all necessary data with all companies (these ones do not exchange data directly). Data are updated in each local database and a copy is obligatory provided for the "Central Institution".

The optimal solution of the real organization of a GIS must consist of an appropriate combination of those two radically different cases. In any case, each data, independently on whether it is of prime or secondary interest for certain companies, must be stored into a strictly defined position, and used only by the companies that need it and have rights to manage it. The rest of data (which are of interest for single companies) are stored into corresponding local company's database and managed there. Thus, the groups of data necessary for managing all activities in one region are distributed between the "Central Institution" and individual companies. If those distributed data are accessed by tools for their management, which are correspondingly distributed between "Central Institution" and individual companies, they represent a classical Database Management System – DBMS, ***, (2).

GIS CARRIERS

GIS as a special geographical and information system has been developed on the basis of cartography, graphics, geography, geodesy and informatics. It is the reality of each economy and administration. The opinion that GIS consists of digital data and graphical lines printed on paper or edited on monitors of PCs is not completed. GIS really consists of a structure of planned digital data, which are hierarchically and rationally connected in the database. These data are defined by their own characteristics in the database and they are located in the certain room. One of the most important issues referenced to GIS is how to find and collect data necessary to built GIS. Generally, data came from classical information systems. These resources are scattered all around each one and they are of different shape and type. Thus, the first step of the realization of GIS is to find and detect sources of data. Some of them are, ***, (3):

1. Geodetic archives
2. Companies for city planning
3. Geodetics companies
4. Cadastres
5. Archive structures of the region
6. Departments for building
7. Statistical departments and computer centers
8. Each company and department which owns any geo-information like:
   - Plans – 1:500 - 5000
   - Maps – 1:1500 - 25000
   - Other geodetical bases and sketches
   - Satellite's photographs
   - Every available and useful statistical data, etc.

The types of data are:

1. Analogous: photographs from satellites or plans, available building bases etc.
2. Digitals: graphical and alphanumerical databases.

The following step of GIS statement consists of four basic phases that determine both the dynamic of realization and application of GIS, Jeff Thurston, (4):

1. Data collecting, entering and modeling;
2. Data processing and conversion and GIS modification;
3. Operation of GIS (queries, analyses, edititing etc.);
4. Maintenance of GIS.

In each phase one uses commercial tools or tools which are developed specially for those who are involved in any of above noted GIS phases. These tools are termed "applications". The applications can be classified into four basic, mutually connected groups, which provides the main functionality of GIS, as a system that is assigned to all aspects of the region's economy and society.

Applications for architecture helps the building designer to draw plans, generate pictures, make very fast calculations and provide designs of the region's buildings.

Applications for cartography consist of all software products aimed for processing of graphics and pictures. Their basic function is the management of locations of objects on different graphical backgrounds.

Applications for infrastructure are tools assigned to corresponding communal utilities. Also, they represent links with other utilities and organizations.

Technical application manages premises, activities and equipment in region's buildings and space. They consist of a set of specialized software modules for maintenance and development, reconstruction, financing and control of infrastructure networks.

These basic applications consist of several software modules for managing groups of activities. E.g., modules for managing in electric power distribution utilities are used for calculations of electrical network's state, minimization of electric energy loss, detections of faults in them and similarly. Each module consists of many sub-modules, which carry out elementary operations. In the same way as data (which depend on their own propose), the applications have been related to universal data that are relevant for every GIS application (citizen's database, streets, parcels), and ones related to specialized data of special departments (e.g., electric network, power plants and other elements of the electric power distribution network).

Establishing of the base and the scale for geographical maps and plans is of fundamental significance for any GIS. They determine the level of details included in any geo-information stored in GIS. Graphical data processing consists of the methodology (vectoring and digitizing) and content (models of topology of infrastructures and layers of graphical background). That is the base of GIS. It is built by computer graphics, which can be classified in two categories – bitmap pictures and vector graphic. Both are equally important and equally used, but for different purposes. E.g., bitmap pictures are very suitable for editing colors and shapes of painted pictures or photographs. Vector graphic is suitable for precise drawing lines on the plans and maps (in proportions) and writing letters on them (also in proportions).

USERS OF GIS AND THEIR PARTICIPATION IN THE SYSTEM

The users-participants of GIS are:

1. City and community's departments (urbanism, statistical and geodetic departments, computer centers, department for building, etc.);
2. Communal and public companies (electric power distribution, post, telecom, water distribution and sewerages, city gardening, distribution of gas, cable TV, etc.);
3. Army and police;
4. Other organizations, companies, associations and departments, which require data from the architecture, building, traffic maintenance etc.;
5. Citizens of each region who use Internet for looking for and getting high-quality and timely information, ***, (5).

Each of those companies, organizations, associations and departments owns some material resources, which they take care of (infrastructures, objects, working room, etc.), or have need for data about them.

Boža Miljković dipl. el. ing., E-mail: boza.miljkovic@so.ev.co.yu

Companies, organizations and institutions, which own material resources, usually own corresponding GIS information as well. They store and update them, apply and delete them according to their needs. They need these data for providing their activities, but also they public them if other companies, organizations, associations and departments ask for them.

Each object drawn in GIS is described in its database by a group of attributes, which make him unique in the database. Also, its position on the maps and plans make him unique in the space. The link between the graphical presentations on any base and descriptions of data by attributes in the database was provided in the phase of projecting of GIS. Thus, using the applications and program modules, one can find directly the graphical representation of any alphanumeric data stored in the database and vice versa. These operations can be done without undertaking special actions either leaving the applications (program modules) at the moment when they are run. In this way, one can quickly supply, effectively check up and find any data.

A great deal of attention is dedicated to the selection of the type of GIS database and its model because it is usual practice to dedicate it to Internet users. The fact that GIS application must have a character of Internet application imposes need for defining and accepting some strict standards when GIS is established. These standards are independent from GIS and must be connected with Internet browser standards, which exist and are accepted by Internet users, (5). If one uses these modules and modules developed specially for GIS (which must be compatible with Internet standards), it can remotely start any procedure on GIS database. The result of these operations is getting strictly defined, processed, uniquely determined and correct graphical and alphanumerical information on the computer of the user who made a query. Time and place of making the query are not relevant.

For the realization of this multi-assigned and multi-user GIS, it is necessary to use all modern information technologies (telecommunication, computer network, Internet technologies, computer software and hardware, graphical tools, modern design methods and projecting tools for graphical and alphanumerical databases), (4). The foundation of the applications on Internet and Intranet technologies provides significant improvements of all segments of human life, especially in the public domain. Development platforms founded on "Web-Based" technologies together with a large pallet of GIS applications bring many advantages for all users of GIS. This is not a consequence only of the fact that these applications are very easy and clear (i.e. they are fully "user-friendly"), but also of the fact they provide that the operation of GIS can be changed and adopted to several different environments and requirements without its reprojecting and systematical changing.

The geography is the base of common interest of all users of GIS. For this reason one can speak not only about "the user" but also about "the user-participant". The reason for introducing the term "user-participant" is that one team or group of specialists provides one layer of graphic (the lowest) – the primary GIS. This layer consists of digitalized and vectorized plans and maps of the region with the basic entities of the considered room. One can add to this base another layer – the layer of the region's infrastructure. With downloading the base layer, the users-participants are provided with conditions for drawing their own infrastructure by themselves. The classical examples of users like these are electric power and water distribution utilities, cable TV network, companies and departments for building, maintenance of roads, railways, metro, taxi services, heating companies, etc. All of them use a unique graphical and alphanumerical base. This base, which is used for more applications, is one of the main integrating components of GIS. GIS is a unique system, which is designed for a large number of users. Such an integrated GIS is presented in Fig. 1. The integrated, open and standard GIS, provides simple and unique data exchange between users-participants. The users-participants are often met not only during the projecting of the growth of their infrastructure, but also when they work in the field. Even then, they retain all specifics of their existing databases. The global characteristics of a modern GIS are the following, (1):

- Compatibility with standard and commercial software and hardware
- Open and sophisticated API (Application Programme Interface) that allows applications building
- ActiveX control
- Web-based platform concept by HTML and JAVA tools
- Environment and standards of GIS which consist of DGN, DWG, DXF, Shape File, MIF/ MID, Oracle Spatial, CAD components that are strictly standardized and available at the market
- Open GIS compatibility
- Object architecture
- Full client / server operation mode
- Full multi-user application and long transaction support (optimistic and pessimistic looking)
- Full CAD environment
- Compatibility with industrial and DBMS standards

Boža Miljković dipl. el. ing., E-mail: boza.miljkovic@so.ev.co.yu

- Presentation of vector and raster data
- Sophisticated tools for acquisition, upgrading and managing of GIS's data
- Support of the event history and memorizing the time of changes of data statuses
- GIS Web solution based on 3-layer architecture.

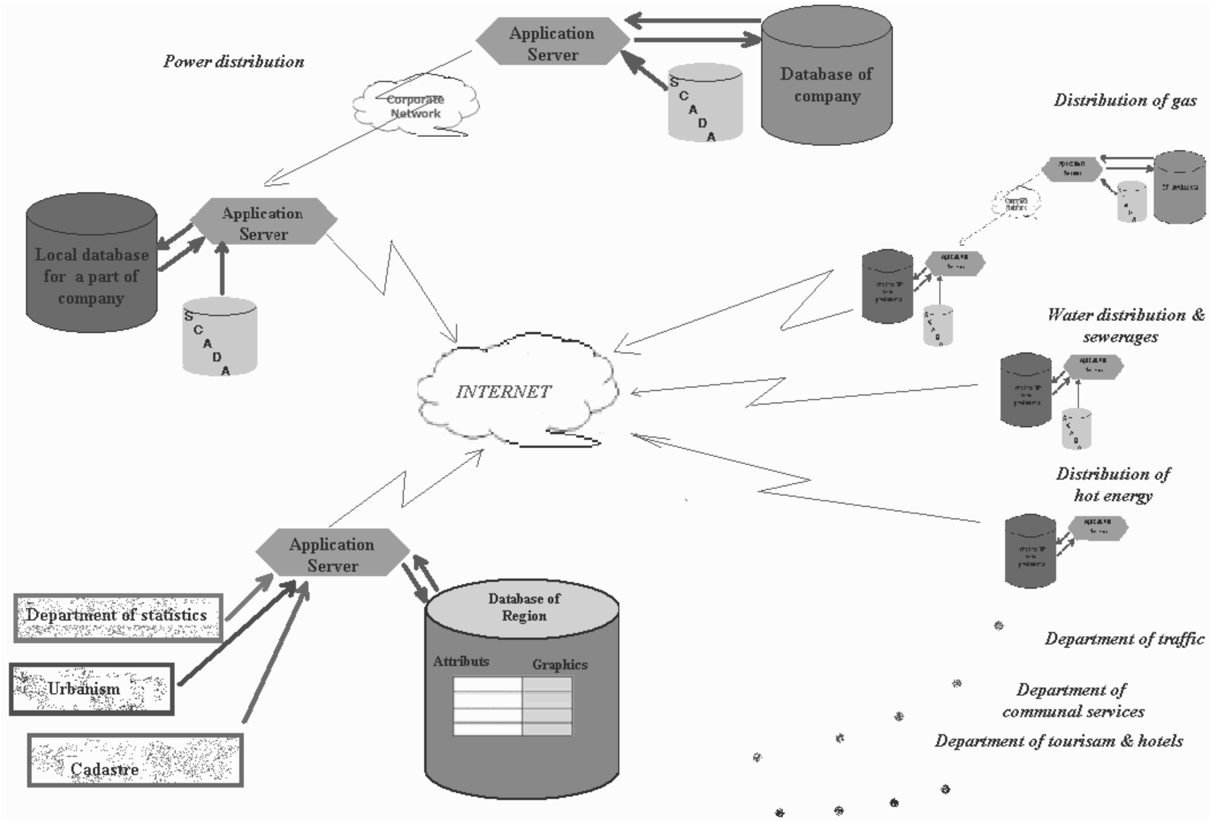

Fig. 1 – The basic GIS and its users-participants.

DMS AS AN EXAMPLE OF THE APPLICATION OF GIS

The efficacy of GIS depends on the quality of its base, statistical data and, especially, on the quality of its applications. Some versions of GIS are very often applied in distribution utilities (electric power distribution, distribution of gas, etc.). Each of these utilities has its own infrastructure network, which covers the region. The specificity of the networks of all distribution utilities is that the direction of the electric energy, water or gas, varies through the same network in different periods. These variations are caused by changes of the operation topologies of the networks, usually performed by system's operators (dispatchers) or automatically by system's protections when faults have been occurred. In these situations, the whole systems depend predominantly on the human factor. The speed of the process of fault cleaning and its repairing depends not only on the quality and flexibility of the system, but also, in the most cases, it depends on both the ability and quality of the dispatchers and their equipage that are on charge with distribution network, and specially on whether they are provided by sophisticated management systems, e.g. GIS.

DMS – Distribution Management System – is a system for managing all activities in electric power distribution utilities. It is one of very important GIS applications, which is very significantly founded on the geography (Fig. 2). In accordance with the usual standards, DMS contains graphical and alphanumerical database. DMS could be applied without a geographic base, but it would achieve its full efficiency when the electrical network is drown on the geographic base, especially when it is applied for electric network development planning purposes, V. Strezoski, (6).

DMS is described in the sequel for the purpose of statement of the following fundamental question: "Could a successful, efficient and economically reasonable DMS be established and applied solely in a distribution utility, outside a GIS (Global Information System) of the region which the utility belongs to?"

DMS is very complex application that represents an integration of a large number of functions – power applications for analysis, control and planning of both the operation and development of the power distribution network. Quickly "moving" across the networks and "working on it" can be performed using the tools for "navigation", which are basic characteristics of GIS's graphical applications. Some of these tools are the following:

1. Scrolling and panning of network diagrams
2. Zooming of network diagrams
3. Selection of network diagrams
4. Selection of the area that is supplied by one or more substations
5. Selection of feeders or group of them, etc., ***, (7).

Fig. 2 – DMS with geographical base

The main property of DMS, as a GIS application, consists of presentation of alphanumeric data of substations and equipment of electric power distribution networks (underground cables, overhead lines, power plants, switchgear etc.), storing of these data and their connection with graphical database, for the purpose of managing and processing them, (7). All necessary data – physical parameters and characteristics (for example line lengths, materials from which they are built, etc.), electrical parameters and network states (impedances, voltages, currents) and geographical parameters (under or over ground, distances from,) are defined in the same database. These data, together with digitalized and vectorized geographic background, represent the space of the electric power distribution network. This space, associated wit the system of DMS analytical functions (power applications), represent the essence for managing of the electric power distribution network, (6). SCADA (Supervisory, Control and Data Acquisition) system provides real-time part of the database. It refers to the measured and telemetered data from the actual network state – voltages, currents … . Other parts of dynamic data are manually entered into the database after periodical reading of measurement instruments installed in the network. These data vary during the time, (6). In this way, the time (x, y, z, time) as the fourth dimension is introduced in DMS. The significance of the fourth dimension consists of the completion of the analyses and reconstruction of the operation events from the past. When the information about the operation events in the power distribution network is associated with information provided by other systems – GIS applications similar to DMS (e.g. meteorological information system), one can reconstruct operation events in both the time and space. Such reconstruction enables one to estimate the events in the future and prevent their negative circumstances. GIS is very often filled by Global Position System – GPS. Thus, one can get real visualization of every detail in the system. In this way, activities in acquisition, measuring and managing in the time are associated with the location in the space, Jeff Thurston (8).

Installation of a modern DMS directly increases the quality of managing all activities in the electric power distribution utilities. This installation comprises equipment for remote monitoring and control of distribution substations, transformers and other power equipment, as well as communication links necessary for completion of technical, business and administration parts of the utility, all ones followed by corresponding software. The cost of this equipment is significantly lower than the financial benefits provided by its application. Such a cost/benefit effect has very significant impact on the modern restructured (deregulated) power industry, L. Philipson, H. Lee Willis (9).

Electric power distribution utilities that do their business at the open electricity market are faced with the problem of significantly decreased budgets for operation of their networks. Therefore, to provide the necessary profit, they must increase their incomes and decrease all types of expenses. This means that they are faced with these two opposite requirements: maximization of profit and minimization of expenses. Delivery of high-quality electric energy necessarily requires a high-quality power distribution network, i.e. a network with small number of supply breaks and wrong operation of the equipment, with standard voltage quality, small power losses and controlled reactive power flows. Such a quality of the electric energy could be provided by investment in both the expensive power equipment (substations, transformers, lines,) and significantly cheaper automation equipment (e.g. SCADA system) and sophisticated DMS. The usual investment policy of electric power distribution utilities is very restrictive in both vertically integrated and restructured power industry. The automation equipment and DMS represent the optimal compromise for minimization of total investments and other expenses in an electric power distribution utility. Thus, basic effects of the implementation of DMS could be seen through new methods for reduction of total expenses of the business of the power distribution utility. Main effects of implementation of DMS are:

1. Decrease of power and energy losses (technical and commercial)
2. Decrease of expenses for operation of the network
    - Increase of the supply reliability – Efficient fault management procedures (fault location, isolation and supply restoration) that implies decrease of damages for undelivered electric energy to consumers
    - Decrease of accidences and damages, that decreases of the life time of the switchgear
3. Decrease of expenses for development of electric power network
    - Optimization of substations building and better operation of all existing power equipment
    - Reserving of substations and thus delaying the capital investments for their building
4. Increase of the revenue / profit of electric power distribution utilities
    - Optimal voltage control to minimize the damage that electric energy customers suffer due to the voltage deviations – the increase of the quality of delivered electric energy
    - Optimal dynamic voltage control for changing of the electric energy consumption depending on the changes of market prices of the electric energy, (2).

The described DMS could be and usually is established in a distribution utility as a single system independent on GISs of the region which distribution utility belongs to. DMS is sometime connected with a classical GIS (like e.g. ArcInfo). The second one provides the geographical background for DMS. GIS is sometime used for drawing electrical lines and substations on the same background necessary for DMS. Thus DMS could take on the electric network from the GIS database. But, an integrated DMS into GIS, with the unique database, cannot be found in the nowadays practice. Like the electric power distribution utility, that has its own management system – DMS, other distribution utilities in the region (water, heating, …) have their own management systems – "XMSs". In the best case all of them are completed like DMS (connected but not integrated with a GIS in the best case). Thus, each of these utilities provides its own geographical background. Furthermore, each of them, including the electric power distribution utility, enters the same lists of citizens (which are their consumers), parcels and buildings (where the measurement equipment is installed), its own network and the networks of all other utilities (to know the disposition of these networks when built its own network) etc. Is such a solution for the region's "XMSs" (each one as a single application aimed for a single utility, with a large amount of data that are of common interest for all utilities) successful, efficient and economically reasonable? Of course not. The unique – integrated **G**lobal **I**nformation **S**ystem is the right solution. The fundamental property of such a GIS is: one data is entered only one time and only in one position, and used only by the companies that need it and have rights to manage it. The idea of such a GIS is promoted in this paper.

CONCLUSION

GIS is an integration of more or less complex hardware and software components, database, applications and users. The basic integration platform of GIS consists of both the unique geographical base and distributed databases, unique tools and applications and unique protocols of GIS's processes.

The high-quality information about the infrastructure and administrative systems, objects and surfaces (spaces) of regions, in both the space and the time, is the basic result of GIS application.

GIS is a system necessary to everybody (persons, groups) who needs a single, grouped or descriptive information about the industry or the administration of the region. Also, it is necessary to all these people who wants not only to be informed, but also to deals with the local or global planning of the region.

The new perspectives and future trends of development of GIS consist of new functions from the environment of the 3-D planning, projecting and managing, as well as generalization of GIS as one Internet service. The technological progress in the field of measurements and sensors has opened a new – time dimension of GIS. As well, the commercialization of GIS has opened new ways of GIS development. GIS is a system of unlimited possibilities, flexible and extendible. The possibilities of GIS are limited by "human fantasy" only. This paper emphasizes the necessity to unify all necessary resources (material, human, organizational, intellectual and economical) for the purpose of providing a high-quality regional GIS in an easiest, fastest and simplest (if not only possible) way as a product of a common interest of all in the region. DMS is only one of the GIS's applications. The basic idea of GIS is to unify all "XMS" in the region. Only such a GIS could provide an adequate support for dealing (management) with data, necessary in the human activities connected to the space planning, managing all activities, analysis, projecting, etc. GIS is the link that today connects and in the future will connect everything in one administratively completed space.

The necessity that DMS must be only an integral part of GIS is given as a proof of the idea of GIS as a **G**lobal **I**nformation **S**ystem. Today, DMS still represents an integration of geographical bases and SCADA system, electrical database, the system of analytical functions etc. Furthermore, DMS is a system for managing not only the technical (electrical) but also all other activities in an electric power distribution utility (e.g. the business activities). Thus, it is an integration of several information systems of the electric power distribution utility. By integration of DMS with the systems for management of all activities in other regions companies and utilities, one can get GIS as the **G**lobal **I**nformation **S**ystem for the considered region. With the integration of GISs of all regions of a country, one can get the idea of the future global information systems.

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Boža Miljković dipl. el. ing., E-mail: boza.miljkovic@so.ev.co.yu