

# Maintenance, management and control of Street-lighting systems with ACSTRE Street-Lighting Geographic Information System

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## Introduction

The main tasks in the exploitation of street lighting systems (SLS) are, as follows:

- Maintenance of the lighting parameters of SLS through timely replacement of the defective components and through regular cleaning of lighting fixtures [1];
- Ensuring the accurate timing for switching on and of the street lighting;
- Execution of emergency works for liquidation of unexpected failures;
- Monthly accounting and analysis of energy costs and realization of programs for energy savings by SLS;
- Reconstruction of morally or physically obsolete SLS;
- Periodic measurement of the voltage and current levels in specific control points;
- Acceptance and commissioning of new SLS;
- Recycling of discarded components – lamps, ballasts, lighting fixtures, etc.

A good opportunity for solving of the above mentioned tasks is the use of the geographic information system (GIS) ACSTRE.

GIS ACSTRE was created in the Central laboratory for computer graphics and GIS at the Technical University - Sofia. Based on this product a family of GIS was developed for creation and operation of installations of the surface and underground cadastre. One of these sub-systems is **GIS ACSTRE -“Street lighting”**, which is a Web based information system for operation of street lighting. By means of it the current technological processes can be controlled on a daily basis and the work of the specialist can be facilitated and automated.

## Operating Capabilities

The proposed system **GIS ACSTRE -“Street lighting”** provides the following operating capabilities:

1. The user gets fully licensed software application – geographical information system, allowing the input and spatial reference of data concerning the parameters of the lines and installations of the enterprise, servicing the street lighting. The cadastre of the settlement shall be presented in a vector format, but it is also possible to work in a raster format.
2. The user can establish a digital model of the street lighting components and underground cadastre of the cable network with the assistance of the system.
3. The program system is open and can be connected with other analogical systems or other functions can be added, allowing the collection of additional information, calculations or dispatcher functions.
4. The program modules can be used for analyses and decision making, as well as for accounting and control of the decision implementation.
5. The system communicates in Internet environment through the TCP/IP protocol stack with the controllers installed in the street lighting boxes, sending commands for switching on and off the individual branches of lighting fixtures, powered from the boxes, receives feedback information about the individual branch loads, load schedule for each branch in the box, alarming for burned lamps, emergency situations or attempts to steal electricity.

## Architecture

The architecture of the information system **ACSTRE-SL** consists of:

1. Specialized geo-information system.
2. Fully integrated application software, which includes :
  - 2.1. Programs for dimensioning of the street lighting components
    - calculation of the voltage loss in a point of the distributing line in operating or emergency duty;
    - calculation of the realized brightness (illumination intensity) for the indicated zone with the existing lights;
    - verification of the realized brightness (illumination intensity) for the indicated zone with lights indicated by the lights catalogue, incorporated in the program;
  - 2.2. Programs for operation of the street lighting components with the following functions:
    - Communication in Internet environment through the TCP/IP protocol stack with the controllers, installed in the street lighting boxes;
    - Sending commands for switching on and off the individual branches of lighting fixtures, powered by the boxes;
    - Reception of information from the street lighting boxes about the individual branch loads, load schedules for each branch in the box and alarms for burned lamps, emergency situations in the distribution line or attempts to steal electricity;
    - Keeping a register of the consumed energy by each box and control of the invoices issued by the electricity distribution companies;
    - Reminder on occurrence of determined events – group replacement of lamps for specified zone, box or street, schedule for cleaning of the lighting fixtures or preventive maintenance of the distribution line.

### The more important tasks, which **ACSTRE-SL** solves, are:

- Maintaining the required set of linear and point symbols for visualization of the street lighting components and equipment.
- Maintaining of database of specifications and passports of the above mentioned equipment.
- Display of lay outs with the routs of the cable lines, indicated in the respective scale.
- Display of listings with specified data for group of cable line elements.

Figures 1 – 7 show screenshots of typical steps in the work with the software product **ACSTRE-SL**, illustrating the operating capabilities described above.

The system operates under MS Windows. The processing of cadastre data for a large city requires processor 1GHz or more. The respective data volume is of the order of 100 MB.

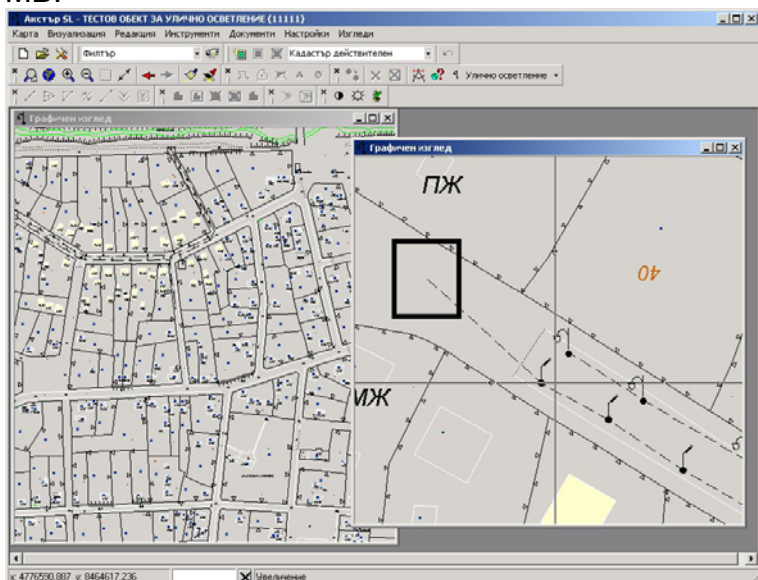


Fig. 1. Working view of ACSTRE - Street Lighting

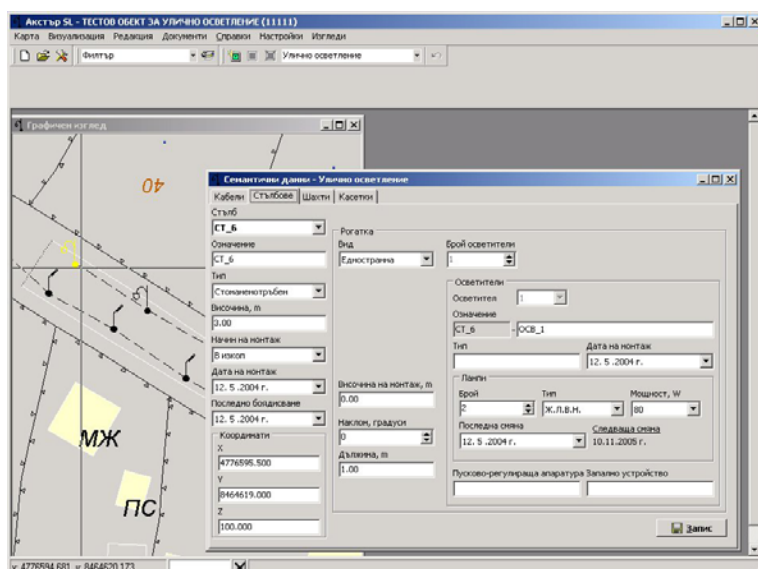


Fig. 2. Screenshot of element “Pole” with possibility for visualization and editing

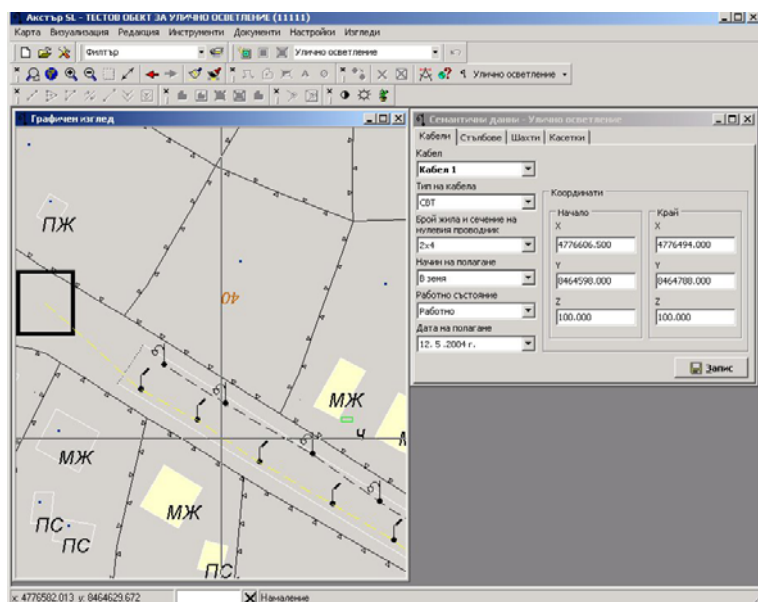


Fig. 3. Screenshot of element “Cable” with possibility for visualization and editing

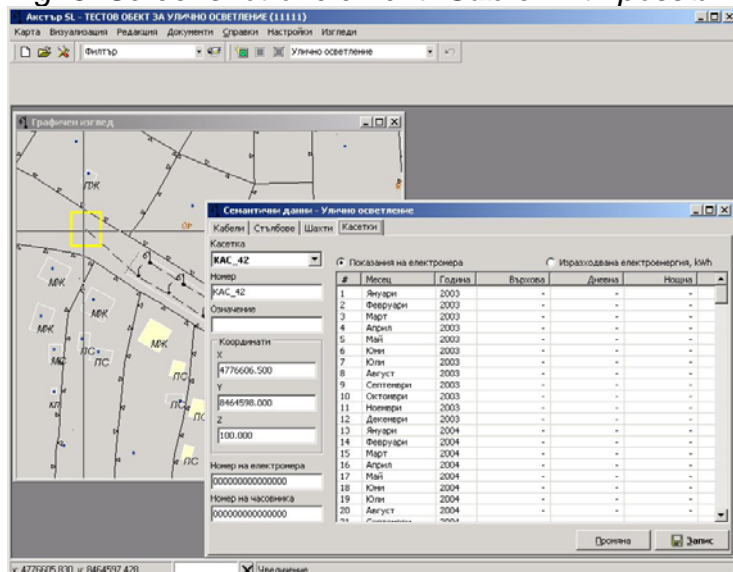


Fig. 4. Screenshot of element “Box” with possibility for visualization of the consumed energy

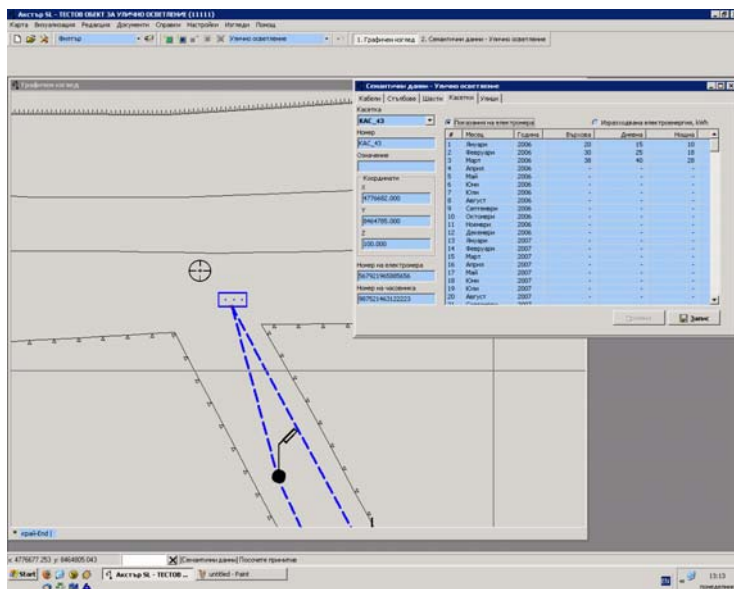


Fig. 5. Screenshot of element **"Box"** with possibility for visualization of data

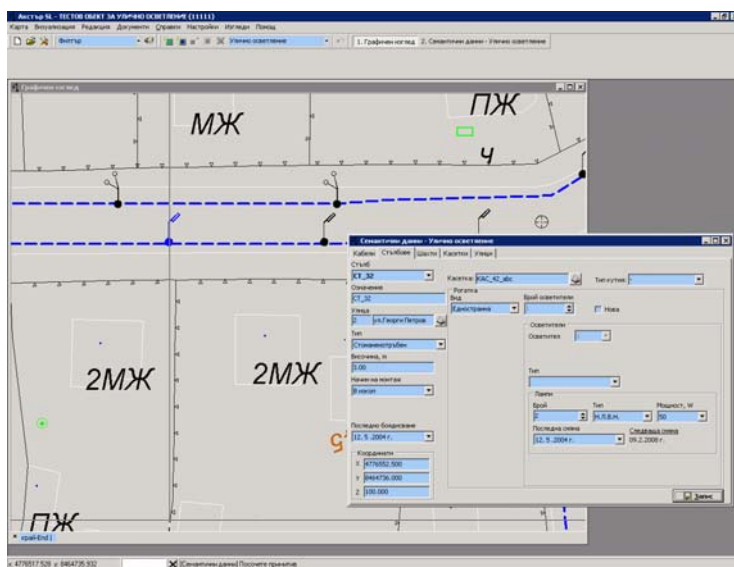


Fig. 6. Screenshot of element **"Pole"** with possibility for visualization and editing

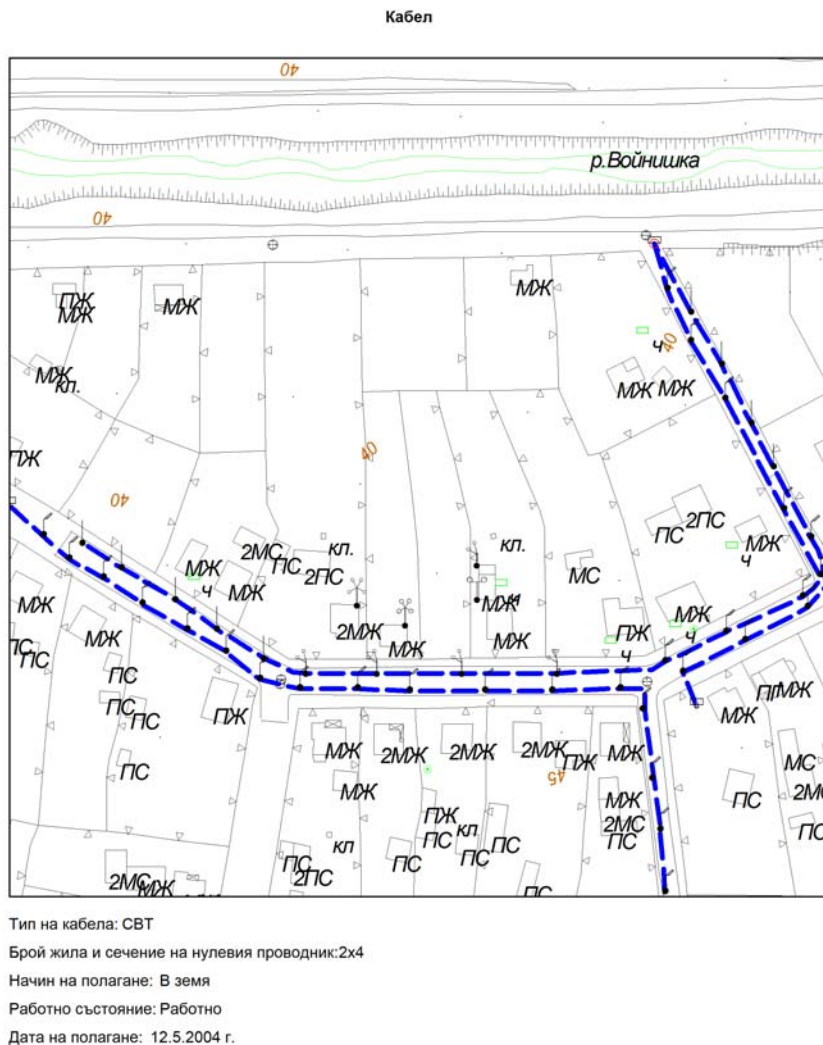


Fig. 7. Displaying of document for specified area

### Technology for management and control of street lighting

The street lighting in Bulgaria is powered by network, separate from the communal network, consisting of separate boxes. Up to 4 three-phase loops come out from each box. The box is powered by the nearby transformer post. A middle-sized town has about 100 – 150 boxes, powering 3000 – 4000 lighting fixtures and the exploitation of lighting requires considerable efforts, if conventional means are used. In this specific case a system is used for street lighting control and collection of information, related to the condition of the operating duty of the individual branches through Web controllers, mounted in the boxes and connected to GSM/GPRS devices [4, 5]. Each controller can command independently the switching on and of the individual branches in the boxes, in accordance with a predetermined program or a signal from dispatch station and to receive information about the condition of the equipment through current measuring devices. The loads in the separate branches are recorded and the data is transmitted back to the dispatch station through GSM/GPRS devices. The current information can signal about electrical installation failures or thefts of electricity.

Figure 8 shows schematically the management and control of the street lighting, powered by two boxes. The commands to the box are sent by controller through actuation of the contactors in the existing box.

Standard for the Internet environment TCP/IP protocol stack is used to transmit the data. The connection of the controller to Internet can be realized in two ways:

- through a specialized module of the system LonWorks, presenting GSM with a standard SIM card;
- through the LAN, existing in the town.



The two ways of communication are illustrated in Fig. 8

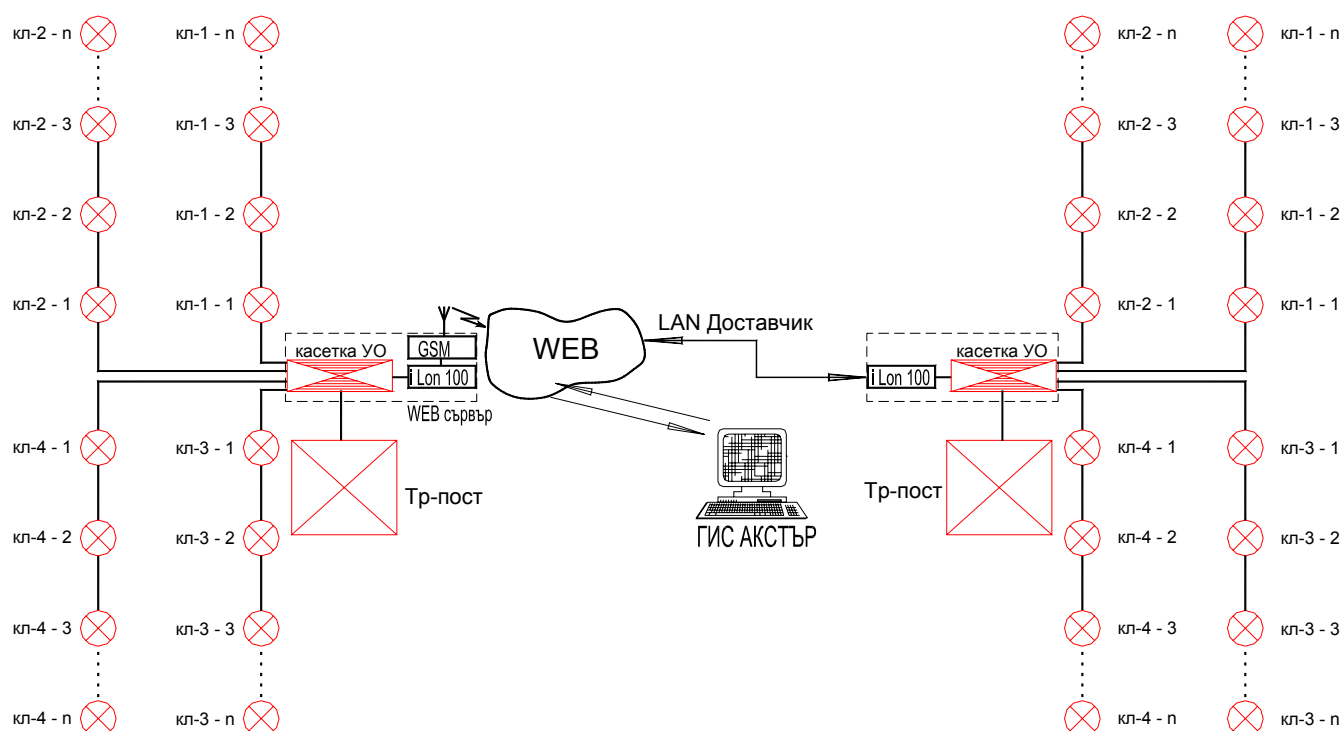


Fig. 8. Transmitting data and commands through GSM and LAN connection

The information received about the condition of the lighting installation can be stored in the dispatch station, using to this end the geographic information system for control of the street lighting GIS ACSTRE-S.

### Implemented systems:

Since the beginning of 2006 the present system assists the operation of the street lighting in the town of Blagoevgrad (Bulgaria) [3].

### REFERENCES

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3. Velinov K. Y. Rubenov, Application of GIS ACSTRE in the exploitation of the street lighting in the town of Blagoevgrad. Transactions of XIII National Conference on lighting with international participation Lighting' 2007, Varna, Bulgaria.
4. Velinov K., O. Kishkilov, APPLICATION OF LONWORKS TECHNOLOGY FOR MANAGEMENT AND CONTROL OF LIGHTING INSTALLATIONS, Transactions of XIII National Conference on lighting with international participation Lighting' 2007, 12 – 13 June 2007, International home of scientists "F. J. Curie", Varna, Bulgaria, p. 73-78
5. Velinov K., O. Kishkilov, Systems for management, control and exploitation of street lighting., National Seminar "Management of Street Lighting", Varna, 20 November 2008