

## APPLICATION OF GPS TECHNOLOGY FOR MANAGEMENT WITH MOBILE MINING MACHINERY IN COPPER MINE "BUČIM"

### PRIMENA GPS TEHNOLOGIJE ZA UPRAVLJANJE MOBILNOM RUDNIČKOM MEHANIZACIJOM U RUDNIKU BAKRA "BUČIM"

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**Abstract:** The development of the Global Positioning System (GPS) allow its use for positioning, mobile surveillance for the equipment and monitoring of technological parameters in production units and processes in mining operations. This paper presents the system for monitoring and surveillance of mobile load and transport machinery in the copper mine "Bučim". In this paper are also presented the benefits of application system SkyLinks.

**Key words:** GPS, SkyLinks, System, Load-transport machinery

**Apstrakt:** Razvoj sistema globalnog pozicioniranja (GPS) je omogućio njegovu primenu za pozicioniranje i nadzor mobilne opreme i za praćenje tehnoloških parametara u proizvodnim jedinicama i procesima u rudarstvu. U radu je prezentovan sistem praćenja i nadzora mobilne utovarne i transportne mehanizacije u Rudniku bakra "Bučim". Takođe su prezentovani benefiti primene sistema SkyLinks.

**Ključne reči:** GPS, SkyLinks, sistem, utovarno-transportna mehanizacija

## 1. INTRODUCTION

Based on the identified mineral reserves of copper, the Council of Radoviš in April 1972, issued the decision on registration of enterprises for producing and processing of copper, called "Bučim" mine. In November 1976, the foundations of the mine are set, and in less than three years later mine started with active work. In 1988 are produced the first quantities of gold. Within ten years period the mine produced 32.3 million tons of copper ore and 55.7 million tons of overburden. Overall is processed 31.8 million tons of ore, of which 383,000 tons is copper extracted

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concentrate and with that we get: 67,500 tons of copper, 6,500 kg of gold and 6,300 kg silver.

With the privatization the copper mine "Bučim" is purchased from Russian company "Solvej management". Today the copper mine "Bučim" is active on exploration of new mineral reserves and their exploitation with surface mining.

In this mine are applied discontinuous technology of loading and transportation of the excavation ore. Two years ago from the Bulgarian company "NOAK" in the copper mine "Bučim" is installed sophisticated SkyLinks dispatching equipment for monitoring and surveillance of mobile mining machinery.

## 2. DESCRIPTION OF THE SYSTEM SKYLINKS FOR DISPATCH THE MINING MACHINERY

Algorithm of the system SkyLinks is shown in Figure 1, and it consists of the following parts:

- Dispatch station;
- Controllers installed in mobile facilities;
- Radio resources.

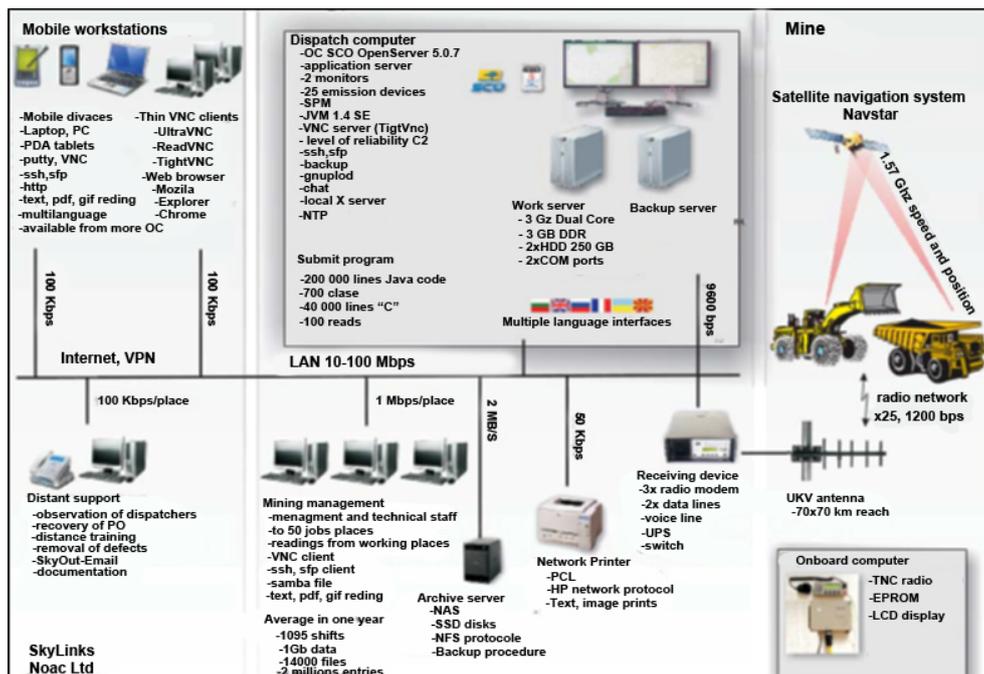


Figure 1 - Algorithm of system SkyLinks

These objects are linked in a common radio network. Data is sent by the protocol AH.25 with speed of 1,200 points. System is connected with local network via TCP/IP protocol. Dispatch computer is running from the application server mode.

Access to information from working places are analysed through emulation of the graphics terminal.

The data can be presented on screen, can be printed or saved in text files with different encodings, or presented like files in MS Excel or PDF format. Access to information is controlled by the operating system and the system for accessing to the program.

The dispatch station, Figure 2, is equipped with the following devices:

- Computer for workings in industrial environment;
- Radio modem;
- Radio stations for transmitting data;
- Radio communication with the participants in the process;
- Printing device;
- RF device and
- Power supply with electricity.



**Figure 2** - Dispatch station

The system does not require additional equipment at the gates or paths. The positions of loading and unloading stations, the system is detecting them based on the transmitted and received information from the transporting vehicles. Each route is followed if is located in an area that is covered by the system. Dispatcher can give new routes and new tasks on the drivers of the trucks. Excavators are equipped with controllers that serve to position the station, sending short text messages, and voice connection between dispatcher – operator of machine.

Mobile tools are equipped with a controller, GPS receiver for position, various sensors and radio which works on UKV area. Radio station is running on two channels, the first channel is for exchanging data, and the second is used for voice connection with the dispatch station.

GPS receiver operates on the basis of satellite global positioning system. Each second receiver sends to controller navigational information for positioning, with an accuracy of 10 to 15 meters of position and 0.1 km/h for speed. Sensors of measurement

for: mass peak, oil pressure in the engine, the amount of fuel in the tank, the temperature of the engine, are sending information to the controller, which then sends them to the system and simultaneously displayed in the cabin of the truck.

### 3. INCOME EFFECTS WITH APPLICATION OF GPS TECHNOLOGY FOR DISPATCH OF MINING EQUIPMENT

The effects from application of GPS technology for dispatch of mining equipment can be divided into: explicit and implicit.

#### 3.1. Explicit effects

Explicit or immediate visible effects is perceived with the surveillance system SkyLinks which is generating real-time data on the position of machinery (Figure 3), routes and dynamics of movement, loading, time effective operation, the duration of individual phases (Despodov, 2002) (maneuvering, loading, driving of loaded truck, driving of empty truck), fuel consumption, delays, the number of delays and mode of operation of the machine, all this allows the achievement of higher new tracking and information system for the functioning of the real production system in copper mine "Bučim".

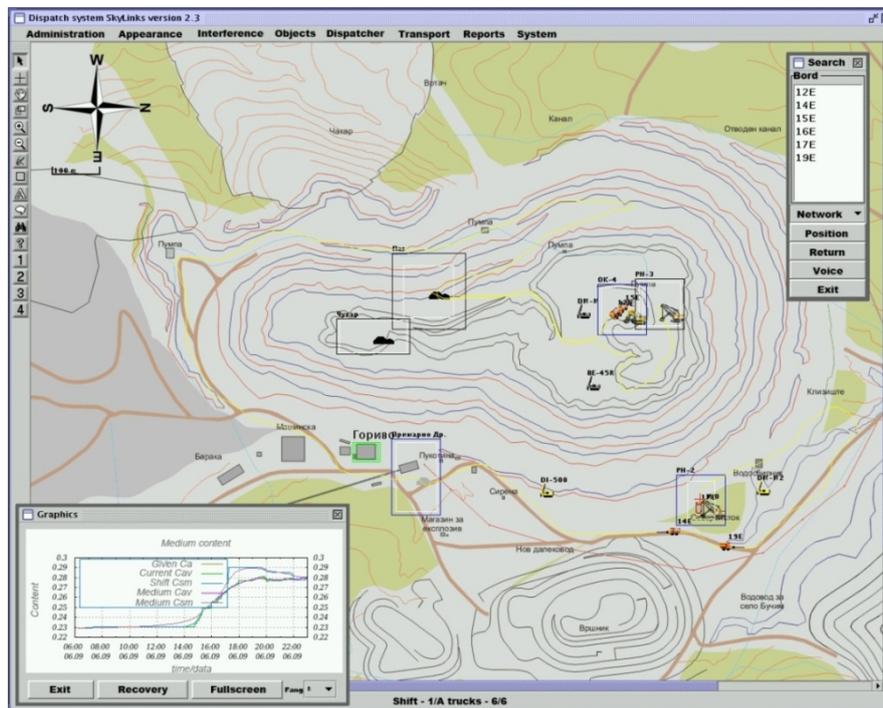


Figure 3 - Main menu for dispatch system SkyLinks

The main menu of the SkyLinks system for dispatch of the equipment is shown in Figure 3 and the system for positioning the trucks is shown in Figure 4.

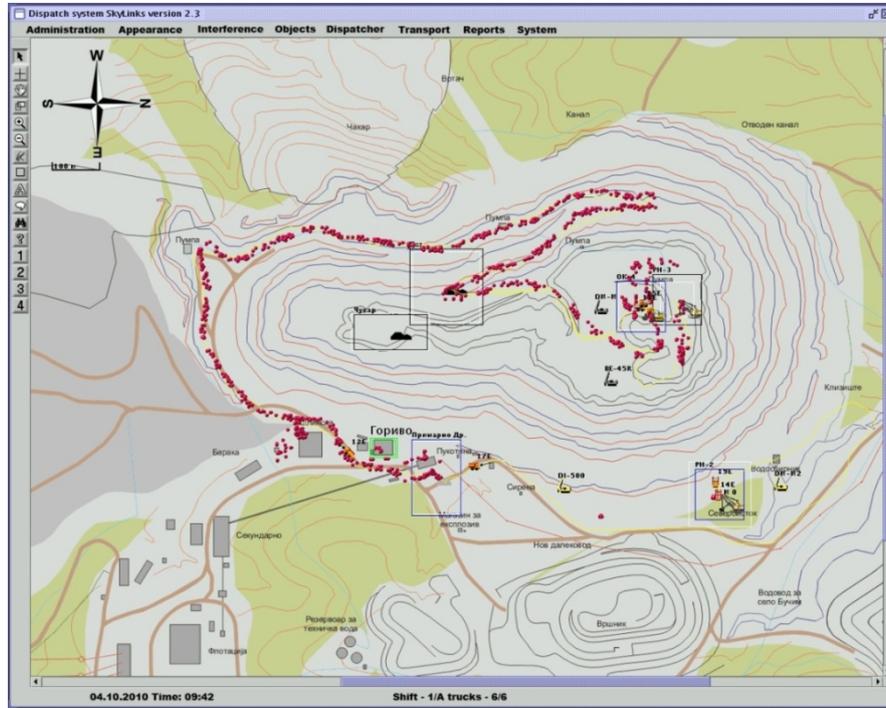


Figure 4 - Positioning of the trucks in copper mine "Bučim"

On Figure 5 is shown the form for setting the parameters of the reports on the technological parameters of mining machinery, and the whole mine completely.

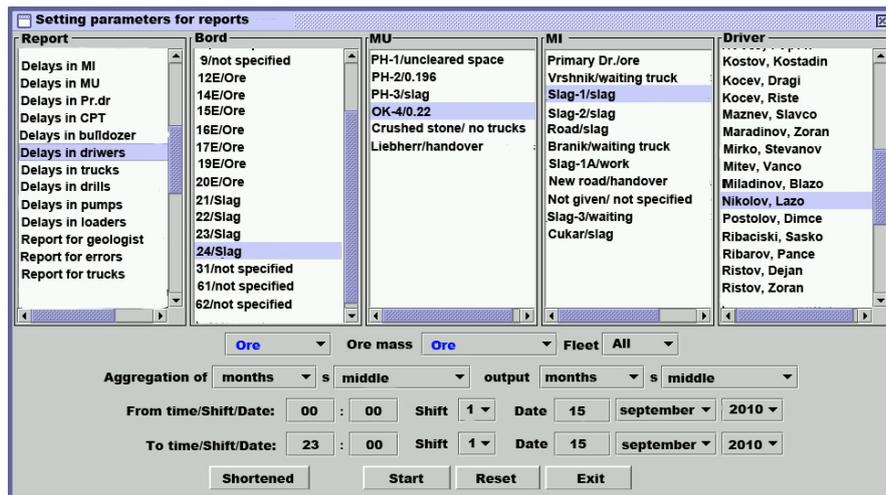


Figure 5 - Positioning of the trucks in copper mine "Bučim"

Besides the information mentioned earlier in this paper, some parameters to improve the mining transport in copper mine "Bučim" are also shown in the papers (Čekeroški et al. 2011a, 2011b, 2011c). The Figure 6 shows that the system also provides information about the content of useful components or copper ore and is plotted a graph of the average content.



Figure 6 - Diagram of copper content in the ore over specific time

### 3.2. Implicit effects

Implicit beneficial effects of the introduction and application of GPS dispatch system in copper mine "Bučim" are made with the influence of the operators on machines (they know they are under surveillance), and this results in a more responsible attitude towards the execution of the tasks, better work discipline, and proper and careful handling machines.

With this kind of workings comes to reducing the cost of operation, reduce fuel consumption, reduce maintenance costs of machinery, increasing the availability of machines for work and so on.

The results of experimental research on the application of GPS surveillance-control systems in surface mining exploitation (Vujić, 2006; Vujić et al. 2012), suggest that can be expected for: reduction of exploitation costs of 10% to 15%, increase of the total time available from 12% to 17%, increasing the energy efficiency of the production system from 5% to 7% and increase labor productivity by 25% to 30%.

#### 4. CONCLUSION

In the management of large-scale mining enterprises is very important to obtain prompt information on the production system and based on this information making the right and timely management decisions to undertake specific activities.

An important step in this regard was made in copper mine "Bučim", with the implementation of GPS surveillance-control systems for dispatch of mobile mining machinery. Reports on technological parameters which are generated from the dispatching system provide opportunities for timely, fair and accurate assessment of the actual production results. The data which will be obtained over a long period of working of the system it will be of great benefit for improving the working process of surface mining of copper ore.

Implementing the system SkyLinks entirely in copper mine "Bučim" will improve the quality and safety of production work.

The use of natural gas is becoming increasingly popular due to economic, environmental and other constraints which can occur with other conventional energy sources. One of the limitations posed by the introduction of natural gas use is the security aspect. A model for a choice of heating system in the urban area, which is presented in this paper, is based on an analysis of factors which affect human lives safety and material resources when natural gas is used. A similar approach could be used in the situations where the choice can be made between two possibilities, for example, by choice of a pipeline route or a location for pressure reduction station. Combining safety factors with economical, ecological and other important factors, a new model could be created, and it would enable more qualitative choice.

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