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Implementation of GPS Telemetry System in the Function of Monitoring and Control in Mining

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Abstract **- The aim of this article is to describe the process of implementation of the GPS system for telemetric monitoring in the mining industry. The paper presents the components of this system, supporting infrastructure and capabilities that can be achieved by implementing such a project. In addition to the opportunities provided by this system, telemetry monitoring is given the possibility of extension with monitoring additional information. Below is the current implementation of the phase, field management, constraints, objectives and estimated time for the implementation of such projects.**

Keyworks: **GPS based telemetry system, Control in mining, Communication infrastructure, Network technology, Monitoring in mining.**

1. Introduction

Global Positioning System navigation is increasingly more and more present in all spheres of human activity: construction, surveying, mining, transport. Below we analyze the possibilities of application and implementation process of GPS system for telemetric monitoring in mining. The exploitation of mineral resources is a dynamic process, in which machinery and equipment change their position over time. Most of the work processes in the surface exploitation of mineral resources in addition to technological compliance has spatial and temporal correlation or causality. In this process, it is not enough just knowing the spatial position of individual elements but also the necessary knowledge and time in which the other relations between individual machines in the planning and control techniques happen[1].

GPS provides the ability to obtain spatial information in real time, which means that in every moment one can know the exact position of machines, equipment, machinery and other moving objects that include the GPS receiver (AVL terminal). These GPS capabilities are opening up a wide field of application in surface mining process of telemetric monitoring to control all the actors in the production process and maintenance, which can significantly affect the revenues and expenditures in these companies [2].

2. Operation of the system for control and monitoring of transport units

Dispatching system is designed so that during normal operation it requires a minimum direct intervention by the dispatcher. The main activity of the dispatchers consists in monitoring the ongoing activities of work machinery and equipment in the open pit, and in the event of unforeseen and unexpected circumstances requires his intervention. The system for control and monitoring of transport units is based on advanced information and telecommunication technologies, the integration of modern applications [3]:

- Global Positioning System (GPS)
- Wireless communication (GSM and GPRS)
- Network technology (Internet, WAP)
- GIS technologies (vector road network) and others.

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Figure 1. The basic scheme of dispatching system

Trucks and other mobile equipment in open pit (excavators, bulldozers, graders, loaders, etc.) are equipped with AVL terminals, which determines the position of the vehicle. Data collection is done in a specified time interval or after a certain distance travelled, depending on where the vehicle in question is. In addition to the GEO position (latitude, longitude and altitude), AVL terminal receives and records the information from the sensor-transmitter on supervised circuits followed by machinery. The data is transmitted to the control center via its own radio network or GSM network of public telecom operator and stored on a central server [4]. User accesses the system to track vehicles and other mobile machinery over the network applications with user name and password, through the server locally, or via your internet connection. Access to the application is designed to be accessed partially by particular group vehicles depending which vehicle we want to observe, as well as what information we want now to follow. It is possible to perform a review and analysis of archived reports for a specific vehicle in a given time period. They can get information about the history of the vehicle, how many hours the vehicle was operational and how much it costs, retention of the vehicle, maximum speed, average speed, the amount of taken and spent fuel (if equipped with sensor in order to control consumption) and so on. Below is the Interface GPS system implemented in RMU Banovići.

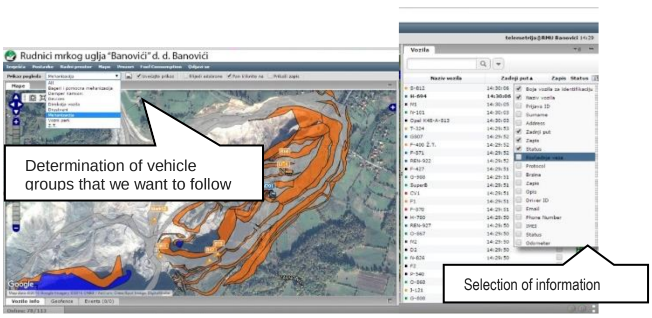

Figure 2. Appearance software, partially determining the group of vehicles and information available

3. Technical description of GPS system and AVL terminal

The system is established on the basis of the platform which is for georeferenced positioning and telemetry control vehicle units. The system is implemented with the following components:

- First AVL terminals,
- Second Servers,
- User Applications for access to the system,
- Communication infrastructure (Ethernet, GPS/ GSM / GPRS)
- Inspection Center for telemetric monitoring,
- Protective Equipment,
- Additional sensors...

The system uses GPS / GSM services for the exchange of telemetry data and control instructions. The GPS module which is located in the AVL terminal performs computing their positions every second time or for a specific traveled section [5]. These readings are variable parameters and can be changed, so that the AVL terminals in the mine set to read the position of a certain number of seconds, or a number of passed meters. These data may be adjusted depending on the needs of specific types of machinery. Also, the configuration parameters are set with the terminal and the period of delivery of the collected data in the internal memory to the server via a GPRS signal. This period is from 1 minute to 24 hours.
The internal memory of the terminal that was the subject of research can store up to 100,000 records GEO position followed by machinery.

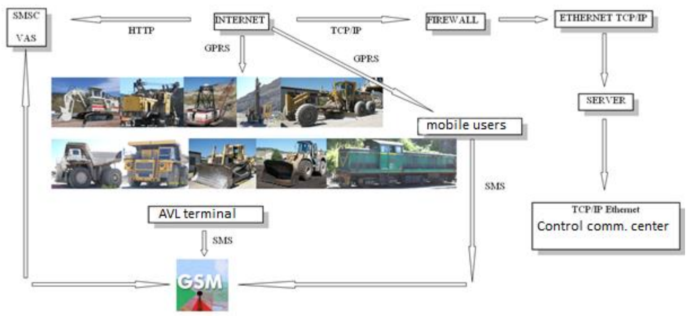

Figure 3. Relationship of elements in the dispatching system

AVL terminal is a set of integrated electronic components required for georeferenced and telemetry control of mobile units. The mine Lancaster uses several types of AVL terminals from different vendors. These terminals should be a highly reliable and sophisticated GPS / GSM terminals exclusively intended for installation in loading and transportation equipment, passenger vehicles and other equipment that are the subject of telemetry control.
Essentially AVL terminal includes GPS / GSM module, internal processor and memory and operating

system [6]. This configuration represents a complete computer that provides unlimited ability to define the parameters. In addition to these basic components AVL terminal should include:

- A combined GPS / GSM antenna that is used for receiving GPS signals and also provides high-quality communication in the GSM network,
- Its own battery which is powered from the installation of the supervised equipment,
- Hands-free kit speaker and microphone for voice communication during operation,
- Various sensors that are activated when a change in the status of the monitored parameters:

    - Fuel consumption sensor,
    - Sensor monitoring the engine speed,
    - Load sensor electric motors etc.

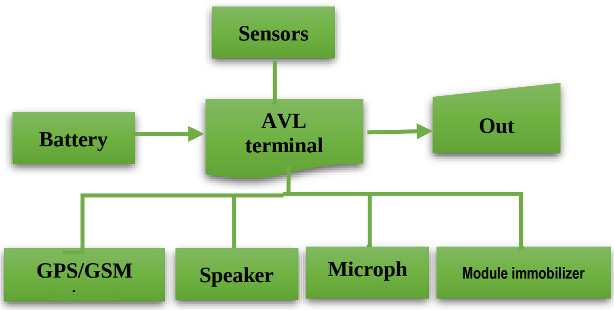

Figure 4. Block diagram of AVL terminal

Protection against short-circuit and overload is carried out by fuses and for surge protection it is necessary that a tracking device has an integrated surge protection.

4. Technical description of the server

Server should include adequate hardware performance and a set of software solutions that run on a particular operating system and should have the following basic elements:

- module for TCP / IP communication with the monitored equipment via GPRS,
- module for SMS communication with the monitored equipment through VAS / SMSC,
- module for displaying user environment (HTTP and WAP server),
- appropriate database for "logging" complete communication.

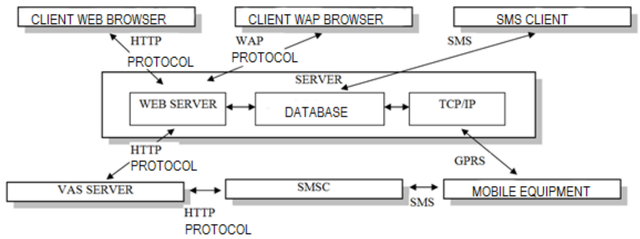

Figure 5. Scheme server module

The module for TCP / IP communication with the machinery via GPRS should be implemented as a TCP port listener to which AVL terminal connects to a predetermined IP address via TCP protocol for GPRS communication channel. The module for SMS communication with the monitored equipment and machinery by VAS / SMSC is implemented as a set of 'ASP' scripts to be run on the Web server and the VAS to a mine and communicate with the HTTP protocol with whichit is receiving and sending (delivery) SMS message to the AVL terminal.

Figure 6. Communication between servers and dispatching workstations

The module for displaying user environment will be implemented as a modern application that is server-side consisted of static HTML elements and graphic elements, while dynamic content is created using the 'ASP' scripts that are delivered to the same Web client in the form of XML. Client side (Web browser) with the use of modern technology will be carried out "rendering" elements of the user interface. A special element of the user interface will be implemented through the presentation of maps and satellite images depicting the disclosure or georeference position of loading and transport and other equipment [7]. The system that allows the use of publicly available map servers (Google, VirtualEarth), as well as your own server.

The same scenario will be used for WAP clients, and the restrictions that have its own WAP platform in terms of user interface elements.

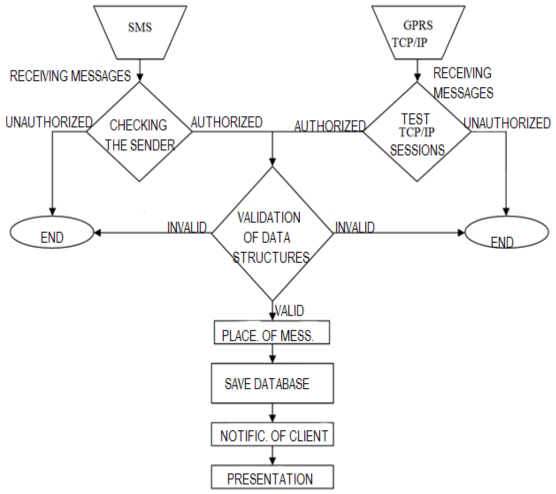

Figure 7. Block diagram of the data flow in the server

SMS client module is responsible for delivering information in a monitored and watch mechanization on request by SMS to the pre-defined GSM numbers.

Through this environment will be received the basic parameters of the equipment at the open pit of archived readings. It will use the server database to archive all relevant parameters that pass through the system. It will be used to store configuration parameters and system AVL terminal, basic information about the traceable components, consumer rights of operators and administrators.

5. Installation of sensors for monitoring additional parameters

In addition to monitoring the GPS location where a certain machine is located, there is a need for monitoring of some other parameters (fuel consumption, monitoring engine speed, load and drive the electric motor and the like). This can be achieved by installing the appropriate sensors that send data to a tracking device. In order that this tracking device could collect information, it must have a sufficient number of analog and digital inputs.

The minimum number of inputs that a tracking device must have has 3 digital inputs and 2 analog inputs, which will take the data from the sensor as to how much is needed in the production process.

Hands free set

At the command-control panel followed by machinery, a key can be installed by which the machine operator can perform the activation of a telephone call to a predefined phone number control center. Verbal communication in this case is accomplished by using the installed “hands free kit”. The set contains a microphone and active speaker with a direct connection to the KA13, KA15 audio cable. This collection provides quality voice communication vehicles with dispatching center.

Figure 8. Hands free set

Control of fuel consumption

Control of fuel is done by monitoring the fuel level in the tank. The control includes the following statistics:

- ✓ Fuel in the beginning of the day (shift)
- ✓ Fuel at the end of the day (shift)
- ✓ Total spent fuel
- ✓ Average consumption per hour (l / h)
- ✓ Average consumption per 100 kilometers (l / 100 km)
- ✓ Input fuel (scattering)
- ✓ The output of fuel (extraction from the reservoir).

When monitoring fuel the two possible scenarios are as follows:

- The connection and control of fuel to the already existing sensor (original if any) and integrating it with the system of monitoring,
- Installation of a special capacitive sensors.

When connecting to an existing sensor each tank is calibrated specifically to name regardless of the production of vehicles in the fleet which enables precision measurement to 4%. The lack of original sensor is generally what is not measured from the bottom 10% and 10% from the top of the tank, and we have non-linearity of the inverter so we get no real information. In order to have more precise measurements , special capacitive probe for fuel are installed that are connected to the device for GPS and in this way we enable permanent monitoring of fuel level in the tank regardless of the on / off status of the motor. This type of monitoring fuel probe proved to be the most accurate measurements with an accuracy of 1-2%.

In this way, we continuously monitor fuel consumption, and it is almost impossible expropriate fuel. In dispatching center of the application, it is possible to separate graphs track the status of fuel and observe any irregularities. It is possible to combine the multiple sensors on a single mobile unit for data transfer, if there are more fuel tanks.

Video surveillance work excavator

The purpose of the video surveillance using broadband camera mounted on excavators is transferring images from the excavator dug in the dispatching center in order to provide visual control room within excavator operation, greater operator safety and equipment and increasing productivity software. Due to the specific conditions under which it operates, all equipment used in the system for video surveillance of vehicles should have protection against vibration and shock (shock absorber system) and water resistance moisture and dust class IP 66. Advances in information technology enabled the customer system CCTV to via Wi-Fi or 3G / 4G network has access to the status of the machine and position (picture and sound) in real time.

6. Implementation of project GPS system

In the initiation phase of the project it would be necessary after the research to create documents confirming the economic viability and technical feasibility, after which it would be required at the planning stage to create project's documentation [8] and the necessary permits that will be planned, the scope, resources, constraints such as cost, time, risks and performance management changes [9].

The implementation phase that occurs after the signing of the agreement is necessary to start with the implementation, procurement of the necessities, supervising them and the entire flow of implementation and management using GPS-based telemetry system (contextual and behavioral competence) in the function of the objectives within the given limits [10]. After the implementation should be left in trial operation to remove the perceived execution lack, receiving equipment and works and archive documents which represents the final stage. The time for such projects in all of these phases is 20 months.

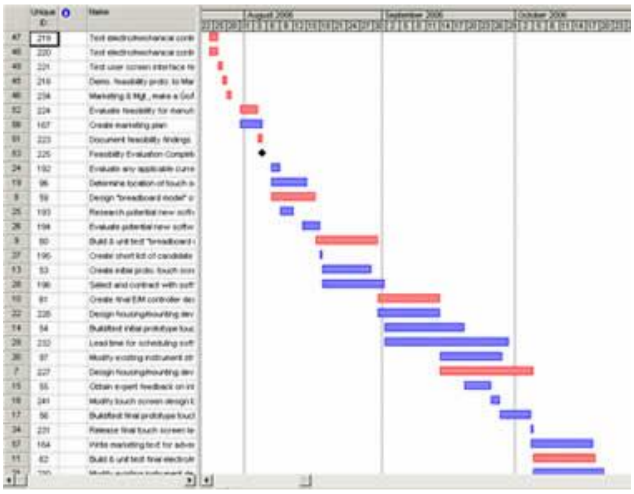

Figure 9. Implementation of project GPS system

7. Conclusion

The use of GPS systems in mining gives wide possibilities of improvement and optimization of management processes of production, maintenance, better communication, people' security, reducing abuse of the use of resources and potential expropriation which has the potential to positively affect revenue and reducing expenditure, as well as improving security conditions in these companies.

Implementation of these projects involves interdisciplinary access to and knowledge of how the process of production in mines, as well as knowledge of a wide range of areas of information and communication technologies. Terms of implementation are complex, and the process of exploitation involves the use of equipment that will be exposed to high level of dust, vibration, shock, water, and equipment and installations must be made within the standards that ensure this.

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