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MODULAR HIERARCHICAL STRUCTURE OF THE SURVEILLANCE-MANAGEMENT SYSTEM AT THE "BOGUTOVO SELO" OPEN PIT MINE

***Igor Miljanović*[*], *Aleksandar Petrovski*[*], *Tomo Benović*[**]**

[*] *Faculty of Mining and Geology, University of Belgrade, Belgrade, Serbia*
[**] *The Mine and the Power plant Ugljevik, Republic of Srpska*

ABSTRACT: A conceptual solution for the architecture of the integrated and computer supported surveillance-management system at the "Bogutovo Selo" open pit mine, operating within the Mine and Thermal Power Plant Ugljevik, Republic of Srpska, is presented in the paper.

Keywords: Conceptual representation, Architecture, Surveillance, Management, Process Automation, Information-Management technologies

МОДУЛНА ЙЕРАРХИЧНА СТРУКТУРА НА СИСТЕМАТА ЗА УПРАВЛЕНИЕ В ОТКРИТА МИНА „БОГУТОВО СЕЛО"

***Игор Милянович*[*], *Александър Петровски*[*], *Томо Бенович*[**]**

[*] *Минно-геоложки факултет, Белградски университет, Белград, Сърбия*
[**] *Мина и ТЕЦ Углиевик, Република Сръбска*

РЕЗЮМЕ: В доклада е представено идейното решение за архитектурата на интегрирана компютърна система за управление за открита мина „Богутово село", която се експлоатира в рамките на предприятието „Мина и ТЕЦ Углиевик", Република Сръбска.

Ключови думи: Концептуално представяне, архитектура, контрол, управление, автоматизация на процесите, информационни технологии

1. INTRODUCTION

"Bogutovo selo" open pit mine is operating within the Mine and Thermal Power Plant Ugljevik, as a part of the Electric Power Industry of the Republic of Srpska. It is situated near the town of Ugljevik in the Republic of Srpska.

Approximately 2 millions of tons of coal intended for use at the Thermal Power Plant (300 MW) is being excavated annually, at the open pit mine, while minor quantities are being sold at the market. Up to 8.3 millions of tons of overburden is excavated each year. The coal is brown to lignite, with Net calorific value at approximately 9,500 (kJ/kg). The Ugljevik Basin has been an excavation site for a hundred years, while production at the "Bogutovo selo" Open pit mine started some thirty years ago.

A discontinual technology is being used for coal exploitation and overburden excavation. The overburden is excavated and loaded with hydraulic bucket-wheel excavators with bucket volume of 4.5-14 (m^3). The overburden is transported to the waste dump with 75-120(t) capacity trucks, and the material is levelled by bulldozers after the drop from the truck box. Bucket wheel excavators with bucket volume of 4.6-9(m^3) are used for coal excavation. The coal is excavated selectively, due to interlacing of coal with impurities. Processing of coal for the Thermal Power Plant is done in the crushing plant. Crushed coal is afterwards transported to the Thermal Power Plant stockpile by 2 (km) long belt conveyor.

The adequate protection from surface and underground waters is a prerequisite for successful performance of the exploitation at the open pit mine. The dewatering system consists of channels, water collectors, pump stations and pipelines. The system is variable both physically and in time, i.e. adaptive according to the current conditions at the open pit mine.

The existing production process surveillance and control system at the Open pit mine is based on the conventional hierarchical concept, which is, from the functional capabilities aspect, made technically and technologically obsolete. It was the key reason for Mine management to impose a decision for modernisation of the surveillance-management system. The definition of the computer supported surveillance-control system (SCS) concept and development of the Principle Project was assigned to the Department of Applied Computing and System Engineering at the Faculty of Mining and Geology, University of Belgrade. The text below is a review of the conceptual solution for the surveillance-control system.

2. BASIC DEMANDS

It was determined by an analysis, that the processes and data classes at the Open pit mine „Bogutovo selo" can be classified into three surveillance-management functional

entities, i.e. three subsystems. Having in mind the functions and tasks of the SCS and the functional structure of the subsystems on the other side, it has been concluded that it is most suitable to have centralized and selective operation of the surveillance-management processes at several hierarchical levels.

According to the solutions suggested, the SCS should be conceptualized as a distributed system for surveillance and management, with flexible and adaptive integration of hardware, software and information resources, and with hierarchical structure organized through five levels (Table 1).

Table 1. Hierarchical levels of the SCS

Level	Level functions	Functional description of the level	Real system position
I	Measurement-regulation	Measurement and process monitoring, immediate management process actions.	Equipment, machinery, machinery operators.
II	PLC and communication integration	Production, logistic and auxiliary processes data acquisition, local management actions and data transfer.	PLC in the online regime, appropriate services in offline regime (geological, geodetic, ...)
III	SCADA	Executive remote process surveillance and feedback for management actions.	Dispatch (command) centre.
IV	Operational management	Operational management of the Mine, and activities of process monitoring and decision making services.	Mine manager, chief engineer, technical managers of operational entities, specialized services.
V	Central management	Central level of surveillance and decision making.	Manager and MTPP management.

The SCS operation is conceptually based on provision of operational surveillance, aimed for production process data acquisition, and on the possibility of management feedback for technological, logistic and auxiliary processes at the Open pit mine. The overall goal is the achievement of maximum production effects, high level of occupational safety and reliability of production.

3. CONCEPTUAL SCS SOLUTION

The SCS is conceptualized as an integrated and hierarchically distributed computer system for surveillance and management over production, logistic and business related processes at the “Bogutovo selo” open pit mine. As it was already stated, the hierarchical structure of the system is characterized by five surveillance-management levels (Figure 1).

The first level consists of measurement and regulation equipment installed on mobile capital machinery and equipment, at the crushing plant, coal processing plant, meteorological conditions monitoring systems, dewatering and electric power supply systems, and partially on auxiliary machinery.

The second level consists of process logic controllers, which are used for acquisition of signals from the first level (from sensors, actuators, measurement equipment, working elements, potentially loose contacts etc, over standard signals 4-20 mA, 0-10V, 24 VDC), for local management actions and feedback control from the Dispatch centre. The PLC computers were added to the surveyed entities of the Open pit mine technological complex, with adjusted configuration of input/output modules.

Computers with SCADA functions are intended for coverage of technical-technological entities (load-excavator, transport-trucks, auxiliary operations-bulldozers, crushing plant, coal processing plant, dewatering, electric power supply, oil and oil derivatives supply) at the third level in the Dispatch centre. The reference GPS receiver is joined with the computer for the purpose of differential GPS, i.e. the processing of signals for spatial positioning and navigation of machinery and equipment at the open pit mine, and also for geodetic survey.

Mine manager, chief engineer, technical managers of the operational entities and specialized services, at the fourth level, are equipped with PC computers and software applications for production-business and engineering analysis, expert assessment, conclusions bringing, processing, interpretation, data storage, communications etc. This level collects information from level III, level V and from other sources.

The highest level in the management structure – the fifth level (Director and management of Mine and Thermal Power Plant), is equipped with specialized software for interpretation of executive resumes, analysis and decision making. The fifth level is receiving information from the third and the fourth level, and access to communication is enabled hierarchically.

The main communication nod consists of Gateway and Central Server. The Central Server is providing communicational integration of the system at the local level, while Gateway enables the communication of the SMS with external surrounding.

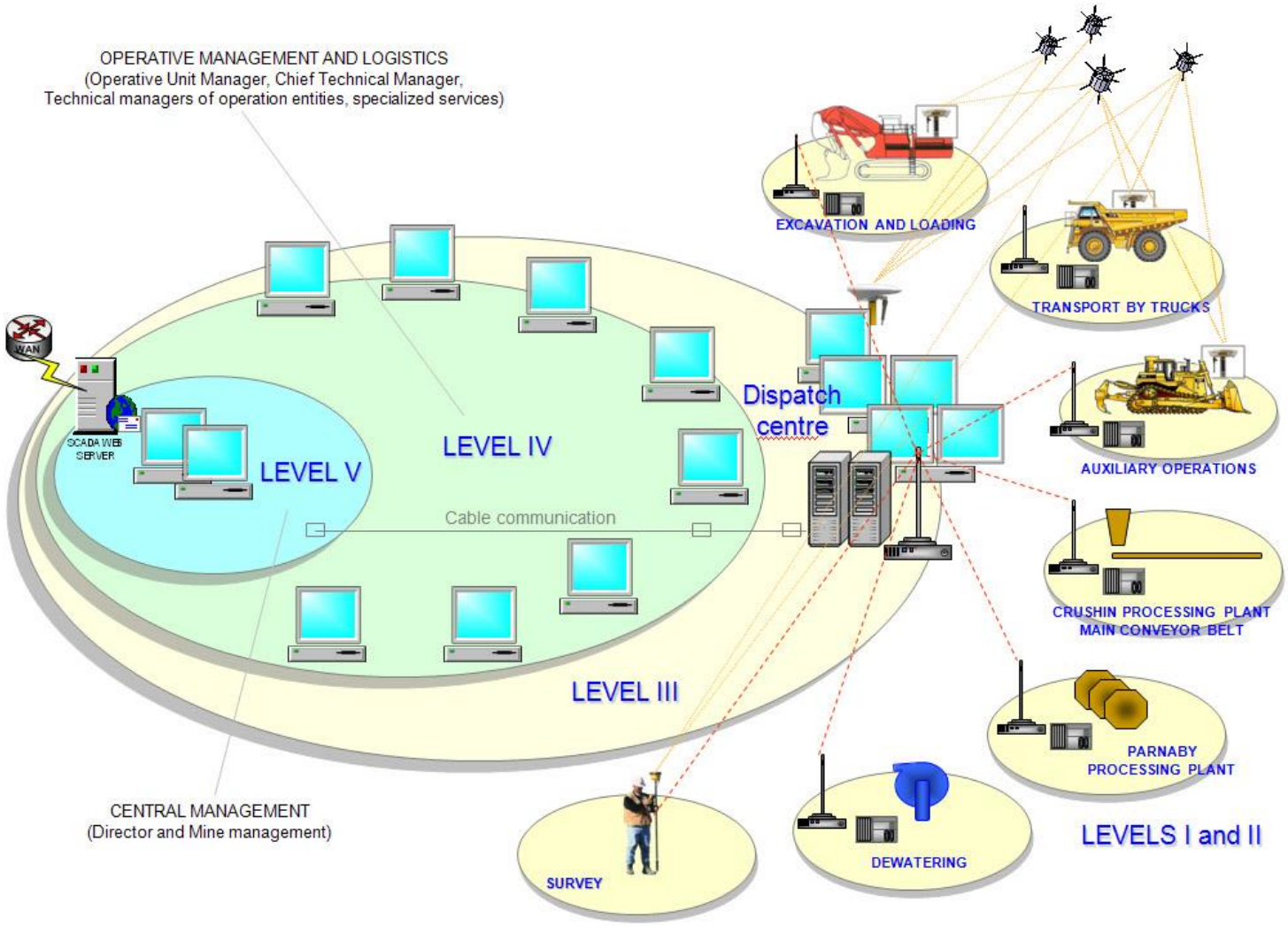

Fig..1. SCS configuration at the Open pit mine "Bogutovo selo"

System distribution was accomplished via production, logistic and auxiliary functional entities, with five hierarchical information-management levels of the real system.

The integration of the SMS entities is assured via communication connections. The computer network of the SMS is physically realized by cable and radio transfer. The cable connects the stationary entities of the SMS. Radio connection is established between the stationary and non-stationary or between the non-stationary entities themselves. This communication integration is appropriate for needs and conditions; it enables fast and secure communication between all members of the system.

The system is conceptualized as a modular, meaning that it can be expanded, upgraded, transformed and innovated without obstacles both in functional, hardware and software sense.

4. INSTEAD OF CONCLUSION

All the necessary prerequisites for Project implementation exists. The machinery structure at the Open pit mine is providing favourable technical and technological environment for SCS implementation. Construction of the system by phases and less strain in investment dynamics during the construction are enabled by the flexible architecture and topology of the SCS. The financial resources required for the construction and maintenance of the SCS are relatively modest when compared to capital equipment investments. The cost-benefit analysis based on the Conceptual Project (Vujic, 2007), shows that the investment in SMS can be returned in full in less than two years, by means of increased productivity, energetic efficiency and other direct savings at the open pit mine.

Recommended for publication of Editorial board

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