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New solutions in control, visualisation and data transfer systems

The article presents the newest products of SEVITEL intended for coalmines. The discussion covers new achievements in the systems of control and visualisation ("THOR" – comprehensive system for dispatcher's support), as well as new solutions applied in the data transfer systems and an innovative method of keeping the register of explosives with the use of the "TRYTON" system.

1. INTRODUCTION

The company of SEVITEL Sp. z o.o. operating on the market since August 2001 has been running business consisting in designing, installation, assembly and service of supply, communications, telecommunications and telemetry systems intended mainly for underground mines, including mainly methane and/or coal dust explosion hazard atmospheres. These applications require the necessity of using the highest security and reliability solutions. Thanks to the highly qualified staff SEVITEL Sp. z o.o. has recently been providing comprehensive services related to audit, repair and maintenance of mining security systems, alarm and broadcasting communication systems and dispatcher's systems, intrinsically safe telephony, gasometric devices and other intended for continuous control and registration of parameters of the atmosphere conditions in mines.

The object of the Company's operation includes also designing and installation of CCTV systems and execution of structural and telecommunications networks with electric power supply. The main recipients of the said services are coalmines, cooper ore mines, and also salt, mineral resources or rock mines, strip brown coal mines and processing plants.

The article presents only a small but very important part of the Company operation focused on modern solutions.

2. NEW SOLUTIONS IN CONTROL SYSTEMS INTENDED FOR COALMINES

Control systems are responsible for correct running of industrial processes. Owing to the nature of the place of their incorporation – underground mines – they need to be adjusted to working in methane and/or coal dust explosion hazard zones. The PSI-1 Intrinsically Safe Programmable Controller presented in the article is an intrinsically safe device of group I category M1, whose inputs and outputs were made to "IA" security level. The main modules used in the construction of the controller are the modules of IMW-1 (Intrinsically Safe Display Module) and MIO-1 (Intrinsically Safe Input Output Module.

The IMW-1 module is intended for visualisation and control of processes. The module is provided with 8-inch digital LCD display, 16-button keyboard and terminals for connecting control buttons, signal LEDs and communication interfaces – two independent CAN buses and two independent RS-485 buses. A PSI-1 controller with IMW-1 display module incorporated is presented in Figure 1.

Fig. 1. PSI-1 Intrinsically Safe Programmable Controller

The IMW-1 module display presents information related to the current status, history of events, configuration and visualisation of the controlled engineering process. The keyboard provided next to the display enables switching of the screen views, browsing the history of events and change of the controller set-up. The "Set-up: menu is secured with a password against unauthorised access. The IMW-1 Intrinsically Safe Display Module is certified and marked as Ex I M1 Ex ia I Ma.

The MIO-1 Input-Output Module (Fig. 2) is used to connect sensors and actuators.

Fig. 2. MIO-1 Input-Output Module

Communication with the module takes place through a CAN or RS-485 bus (Profibus). The module is provided with 32 sockets to be used for the following circuits: galvanically separated inputs, non-galvanically-separated inputs, transmitter inputs, tansoptor outputs, non-separated analogous inputs, non-separated analogous outputs. Analogous inputs may also be set up to count the frequency of impulses, which enables cooperation with inductive sensors used, for example, in speed measurement. The MIO-1 Intrinsically Safe Input-Output Module IO-1 is certified and marked as Ex I M1 Ex ia I Ma.

3. NEW SOLUTIONS APPLIED IN VISUALISATION SYSTEMS, "THOR" – A COMPREHENSIVE DISPATCHER'S SUPPORT SYSTEM

The "THOR" system is a comprehensive solution intended for operation at dispatcher's rooms of such plants as coalmines (Fig. 3), boiler houses, industrial companies and other plants where registration and visualisation of the environment conditions data are important, as well as archiving and reporting enabling the analysis of hazard present at the monitored site.

The "THOR" system is based on a centralised database server (or a group of servers) enabling data archiving, high availability of data for many workstations, uniformity and homogeneity. The system is highly scalable, which enables its tailoring to the needs of the user and the financial capacity of the company.

The respective applications within the system ensure the possibility of set-up, control and visualisation in the form of plant maps or defined measurement screens (Fig. 4).

The "THOR" system has been designed such as to collect data from various sources, for example any application operating at the plant. The condition is to provide an adequate *driver* to adjust the specifics of the communication protocol to each of the programmes connected to the system.

The particular elements of the "THOR" system have been conceived such as to enable data storage in a uniform and universal manner, i.e. independently of the specifics of other systems. Thanks to that it is possible to continuously monitor the state of measurements, signalling hazard conditions, access to the measuring data archive and creating documents in the form of reports.

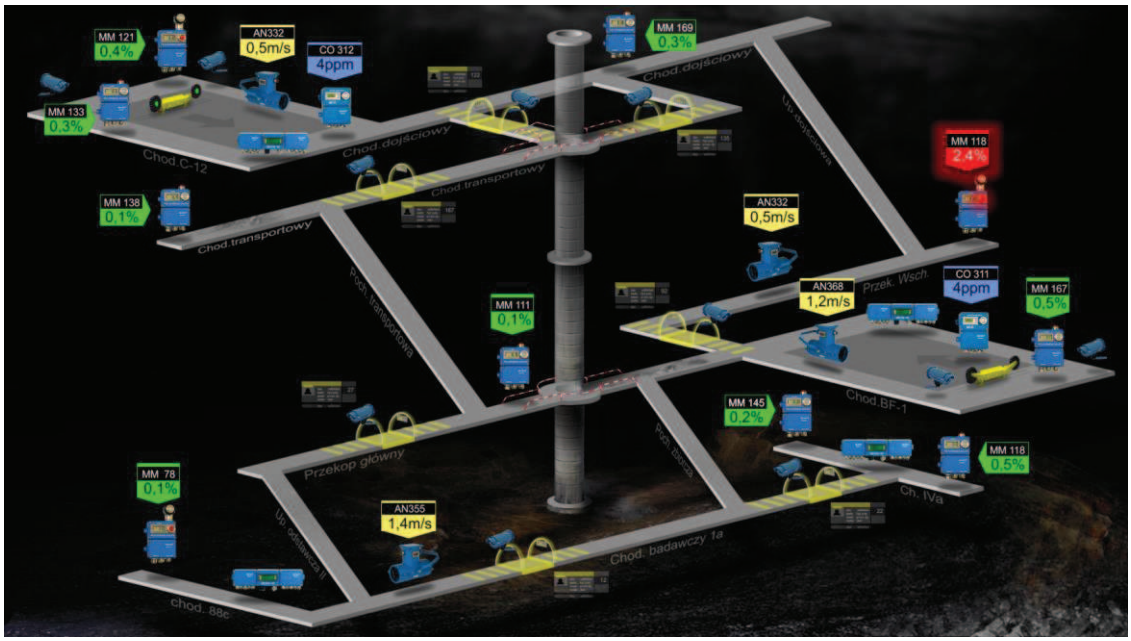

Fig. 3. Specimen sensors visualisation sheet displayed in the "THOR" system

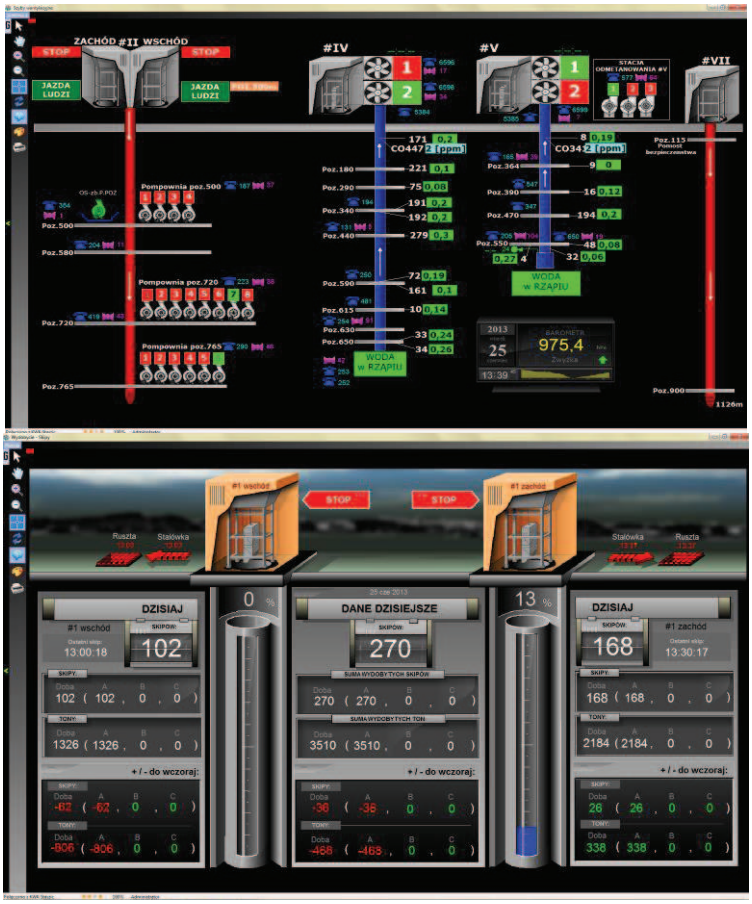

Fig. 4. Specimen visualisation sheet of a plant in the "THOR" system

The basic element of the "THOR" system structure is a centralised database in which all of the data recorded by the communication *drivers* are stored. The data are stored in a uniform manner, independent of the specifics of the supply sources. The communication *drivers* are responsible for adjusting the data collected from the supply source, formatting of the data and recording in the database through a loading

service. An important feature of the system is the possibility of distribution of the particular structural elements and, thus, distribution of the load to many computers ensuring higher capacity.

The system structure may be divided into two parts: data supply and client applications.

The data supply part includes elements responsible for collection of data from various measuring systems and recording them in a specific manner in the database. This part includes also adequate hardware, i.e. computers, telemetric stands, measuring sensors and other elements making up the particular measuring systems.

The client application part covers applications enabling access to the database and the entries made therein. Through the software supplied the user receives a set of equipment set-up and control functions, as well as the functions of browsing, analysing and reporting data or other solutions enabling the system operation. The application part may be developed depending on the user requirements, whereas the provided system functionality may be dynamically extended. The basic software should be treated as a tool for setting up the system by the user in accordance with the user requirements and specifics of the plant.

The most important elements of the system are:

- database including a properly prepared data structure,
- data distribution service, which records data collected from the respective *drivers*,
- communication *drivers*,
- user applications enabling the proper use of the system,
- other elements extending the system capability in accordance with the user requirements.

The other elements, e.g. applications, services, etc. cover for various user needs and through adequate extensions increase the system functionality. An example here may be the "SAT" system alarm matrix servicing, which is possible thanks to an additional functionality and set-up application.

In the "THOR" system many functions and capabilities have been designed such that the user may decide upon the method of their use and, therefore, the operator must set up the system in accordance with their needs. For that purpose it is important to remember that the available applications are only tools and the manner of use of the tools depends mainly on the user.

The following applications make up the "THOR" system, as required for the correct system use:

- "ODYN" – system set-up software for the user to enter data to the database and adjust the system to their requirements;
- "LOKI" – design edition software enabling the creation of the particular viewing sheets, maps, drawings and downloading data from the database for the purpose of visualisation; the application has a set of tools for drawing, conversion from other formats and inserting objects available in the database, with simultaneous determination of the method of operation;
- "SKADI" – data visualisation software providing data access functions.

There are also available additional applications to extend the system capability, e.g. the "SAT" system alarm matrices set-up software, virtual sensors set-up software, or application for the measurement results presentation in the form of charts (Fig. 5).

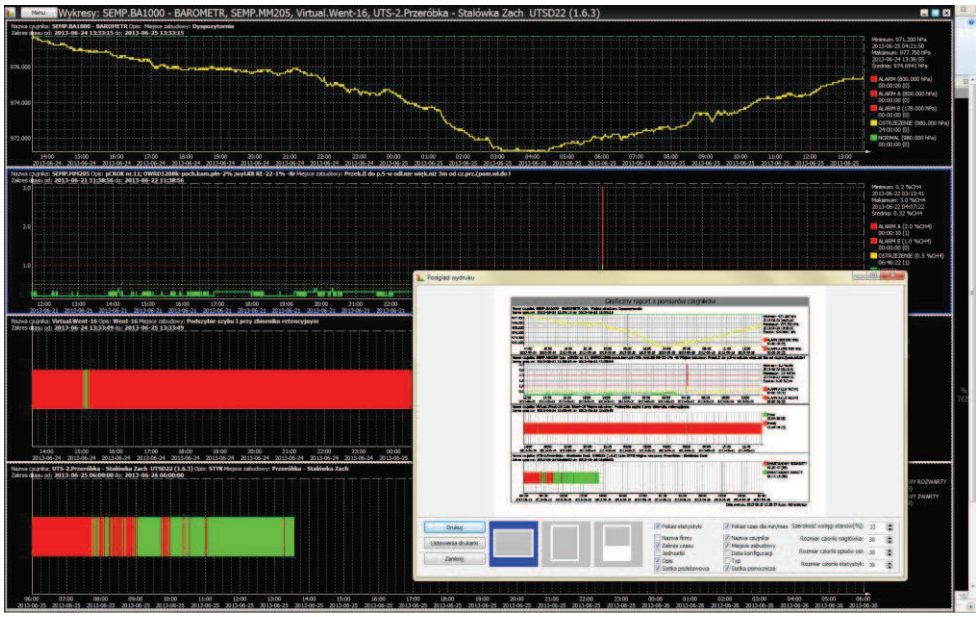

Fig. 5. Specimen chart presentation screen in the "THOR" system

4. NEW SOLUTIONS APPLIED IN DATA TRANSFER SYSTEMS

Data transfer systems used in coalmines must fulfil the intrinsically safe construction requirements. The products presented further herein fulfil the requirements for group I category M1 device requirements, thanks to which the devices may operate in a continuous manner, regardless of explosive gases concentration. Additional challenges for such devices are the speed of transmission and the maximum distance of transferring the data. Owing to the necessity of sending a growing quantity of information, a new line of products – KTE has been designed, consisting of transmission converters, switches and media converters. The devices enable the creation and extension of the underground Ethernet network infrastructure.

KTE-1 Ethernet Transmission Converter (Fig. 6) is a device intended for sending data from R-485 or CAN serial interfaces through the Ethernet.

Fig. 6. KTE-1 Ethernet Transmission Converter

KTE-1 converters may be produced as incorporating an RJ-45 socket used in connections through twisted-pair cables – 10/100Base-TX, or fibre optic modules enabling transfer of data in fibre optic networks – 100Base-FX/LX. KTE-1 converters are certified and marked as Ex I M1 Ex ia op is I Ma.

KTE-1-SW network switch (Fig. 7) is a device intended for extension of the Ethernet network. The unique feature of the switch is that the number of fibre optic interfaces (100Base-FX/LX) and RJ-45 sockets (10/100Base-TX) may be determined depending on the type of the device.

Fig. 7. KTE-1-SW Ethernet Network Switch

The solution enables the avoidance of the necessity to use additional media converters, as would be needed in the case of switches provided solely with RJ-45 sockets. KTE-1-SW switches are certified and marked as Ex I M1 Ex ia op is I Ma.

The line of KTE products consists of group I devices intended for continuous operation in coalmines, provided with output security to "IA" and "OP IS" standard. The presented devices, which are furnished with intrinsically safe interfaces, may also be incorporated in safe zones (on ground of mines, inside fire-safety casing). In such situation fibre optic interface is an output intended for entering the explosion hazard zone.

In order to enable the connection of wireless communication devices to the underground Ethernet network, a GPD-3 Mining Access Point (Fig. 8) has been designed.

Fig. 8. GPD-3 Mining Access Point

The device may be attached to the Ethernet cable network through fibre optic interfaces or RJ-45 sockets. Communication with wireless devices is made to 802.11b/g standard. Inside the device directional

antennas are incorporated, thanks to which the reach of the wireless network in mining headings has been significantly enhanced. The device enables current monitoring of the activeness of wireless stations, gathering of statistics and shaping the network traffic. In the places where no wire Ethernet infrastructure is present, it is also possible to connect GPD-3 points in wireless manner.

A useful solution to increase safety of the works performed in a mine is a monitoring system enabling registration of the current situation in the place of incorporation and remote sending of information (image) to the authorised units. Intrinsically safe IKE-1 Ethernet Camera (Fig. 9) is an intrinsically safe device ensuring image registration at the speed of 25 frames a second with 640×480 pixels resolution.

Fig. 9. IKE-1 Intrinsically Safe Ethernet Camera

The camera may be connected to the Ethernet network through a fibre optic interface or RJ-45 socket. The device is certified and market either as Ex I M1 Ex op is I Ma – fibre optic interface or Ex I M1 Ex ia I Ma – RJ-45 socket.

5. REGISTRATION OF EXPLOSIVES WITH THE USE OF THE "TRYTON" SYSTEM

The "TRYTON" system has been created in order to fulfil the requirements of the Commission Directive 2008/43/EC of 4 April 2008 setting up, pursuant to Council Directive 93/15/EEC, a system for the identification and traceability of explosives for civil uses.

The presented solution ensures comprehensive service in relation to managing explosives, starting from delivery acceptance and booking and ending with the turnover of explosives stored in the Explosives Warehouse.

The "TRYTON" system is based on explosion-proof devices, which ensures high safety of work in direct contact with explosives. Figure 1 shows a specimen of underground and over ground part of the system. The information originating from computer registration stations is sent through a transmission line to the ground and recorded on server.

The register kept may be also supervised on ground. The information from the server is rendered to the network clients who possess adequate authorisations and software. Thanks to such structure there may be a large number of computer stations, without detriment to homogeneity and security of the data stored.

The system consists of the following devices:

- mobile terminal with code reader,
- stationary terminal – SEVPC computer,
- telecommunication infrastructure devices.

All of the devices are made to explosion-proof standard.

Additionally, the system may also include an alphanumeric transparent to inform about the status of the Explosives Warehouse status of operation.

The "TRYTON" system consists of two parts. The over ground part is made up by data servers in which the registration data from the particular Explosives Warehouses are stored. Access to the servers is possible through the software installed in stationary terminals located underground a mine, or through supervising application installed on ground.

The software installed on computer stations supports the dispatcher in the explosives turnover (release, return, stock taking) as well as generation of specifications and reports of consumption based on such criteria as name of the shotfirer, name of heading and date. It is worth mentioning that the report may be generated and displayed in the form of currently used turnover sheets, which enables easy preparing of the staff to work with the new system.

Through the software installed therein, the mobile terminal exchanges the scanned bar codes of the explosives and other information gathered by the dispatcher (e.g. shot firer's ID) with the stationary terminal. Such collected data are then assigned in the stationary terminal to the particular purposes (e.g. headings where the explosives are to be used).

Moreover, the system enables operation in power failure conditions. Thanks to the mobile terminal the current turnover is recorded in the internal memory and after the failure removal the data are synchronised with the server. The mobile terminal uses a wireless 801.11b/g Wi-Fi network for communication.

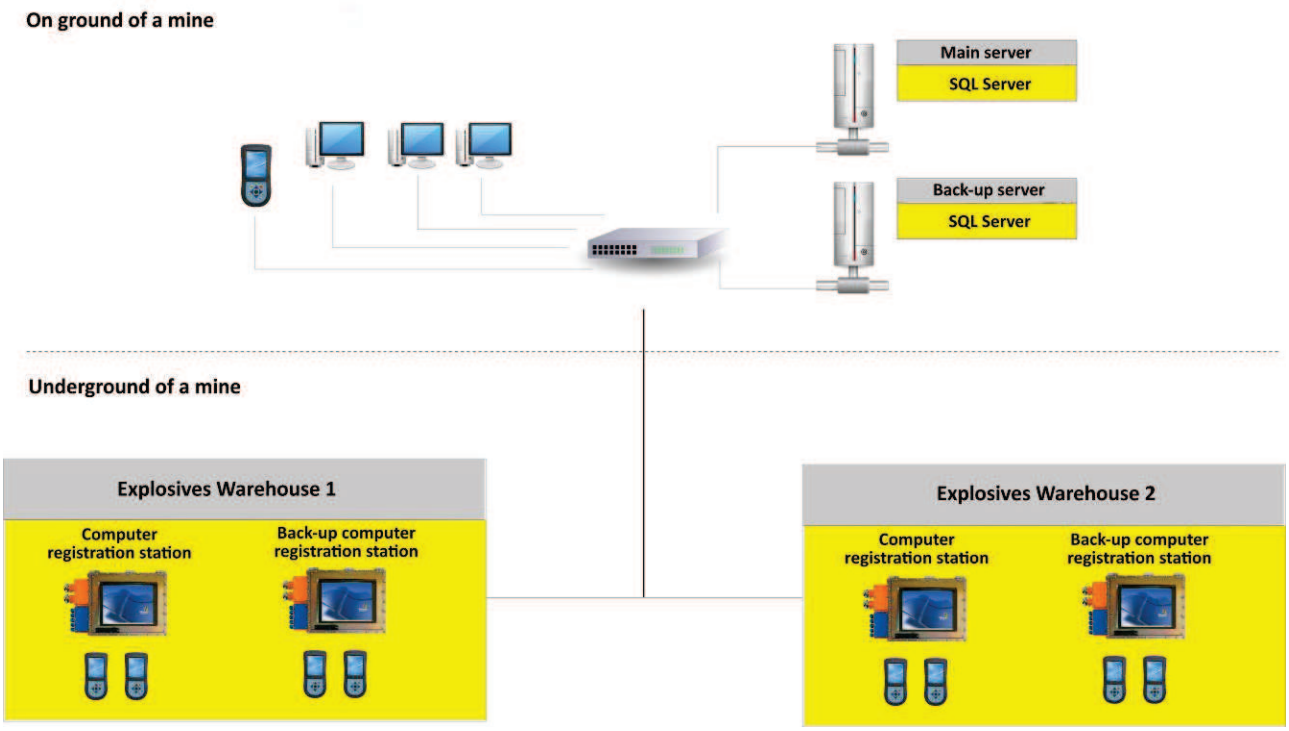

Fig. 10. Structure of the "TRYTON" system

With the use of supervision software installed at the explosives division office, the authorised person may control access of staff to the explosives present on site. Additionally, new areas of shot firers work may be created and recorded in the system. There is also a possibility to browse the history of each explosive at the request of the police or public prosecutor.

The presented system structure is not the only possible solution. The system has a flexible structure and is fit for both large mines where a lot of explosives are used and also for minor plants where explosives are used occasionally.

6. SUMMARY

The long years of SEVITEL Sp. z o.o. operation and the experience gathered in that time make it possible to recognise the needs of mines as regards solutions combining state-of-the-art IT technologies and methods.

The solutions presented in the article with regard to control, visualisation and data transfer systems show that work optimisation and improvement of work safety are possible with the use of the same.

The descriptions of the discussed solutions as well as the photos and drawings provided have been derived from the presented products' documentation.