MINE VIEW – MINE INFORMATION AND MONITORING FOR THE FUTURE

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SUMMARY

The MineView Information System provides modern solutions for information management and process monitoring. The three dimensional model of a mine layout, accessible via web browsers throughout the company intranet, presents an easy-to-use interface to complex, heterogeneous information. This can be the mine's geometry, infrastructure, any kind of equipment as well as real-time process data. Additional sources of information may be connected via hyperlinks.

Due to its modular concept, MineView technology can also easily be utilized outside of the web browser. Typical examples include the planning of escape routes, transport simulation or specialized applications for the tracking of underground vehicles.

Moreover, mobile devices like personal digital assistants can be linked to the MineView network. They open up even more alternatives for data acquisition, information retrieval and messaging.

INTRODUCTION

The immediate availability of important operating data plays more and more a decisive role in state-of-the-art plant management. Due to technological advance, nowadays a multitude of data is acquired machine-aided. This leads to a rapidly growing amount of data which has to be collected and stored. Hence, the administration as well as the analysis becomes a great challenge. Certainly this results from the vast amount of the data, but in particular from its heterogeneity: A diversity of data formats results from

- different planning systems,
- control and monitoring devices,
- complex simulation results and
- different database systems

and an outline of the entirety at a glance becomes fairly impractical.

The goal is to design an information system, that provides combined information management as well as process monitoring. The combination of heterogeneous information in one system can help to gain better overview and to understand existing coherences. By means of structured information presentation such a system will lead to more transparency of operating-procedures.

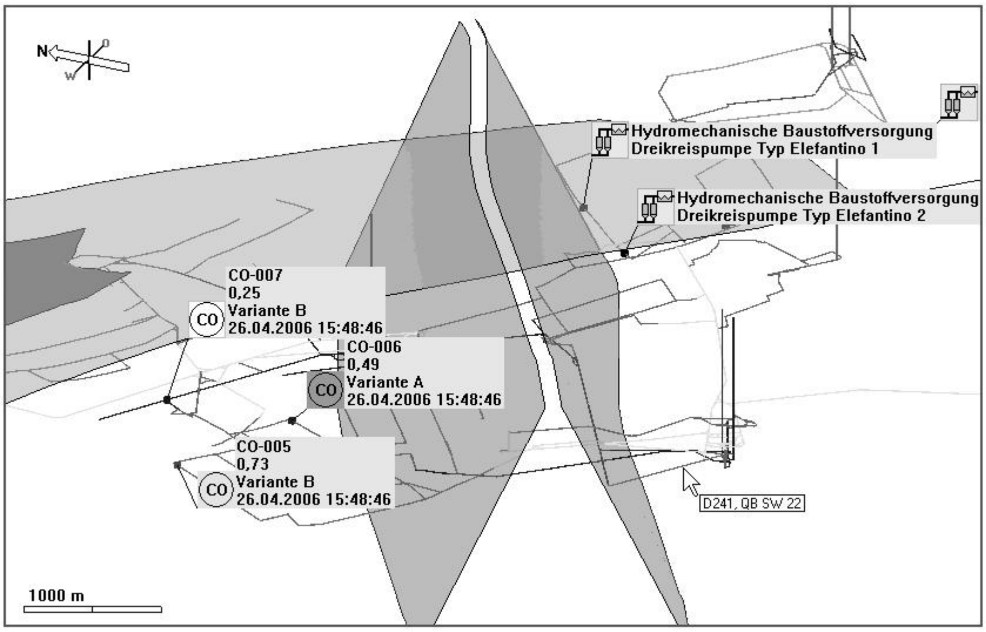

Figure 1: MineView - Heterogeneous information in a mine at a glance

Besides the efficient data management, an essential element is of course a user-friendly presentation of the data. Thus, the basic idea of the system is to make all kind of data available within a three dimensional (3D) visualization module (see figure 1). All information can be accessed directly via the 3D model of the mine and are presented according to the user's need. This intuitive data-offering causes a very descriptive, understandable and user-friendly interface. With its high degree of interactivity, the system provides a form of a "geometric data navigator" to manage the data and to ensure its up-to-dateness.

Company-wide information retrieval is another essential element of the MineView-System. For an optimized set-up of the operating schedule, straightforward access to important data is essential. Due to the fact that the implementation comprises a communication platform which allows information access via Internet/intranet, data-queries are feasible from all over the company and even beyond.

In the following at first the general system structure is described and the components of which the system consists of are explained. Then some practical experiences and examples of use are given. Finally the paper concludes with a summary and an outlook on some ideas which could be of interest during further developments.

METHODOLOGY

System Structure

The MineView-System is designed as a Server-Client-Architecture to provide a company-wide available information system. As apparent from figure 2, the core of the system is the MineView-Database (MVDB). Here, information on existing objects (sensors, equipment, vehicles, mobile devices, ...), as well as links between different objects, to specific geometry or external data sources are stored.

In order to design a system that is as independent and portable as possible, the favoured database-format is the Extended Markup Language (XML). Major advantages are the easiness of serialization of nearly all kind of data structures and the option to store object oriented data. XML is accepted world-wide and is especially used in web-based-applications.

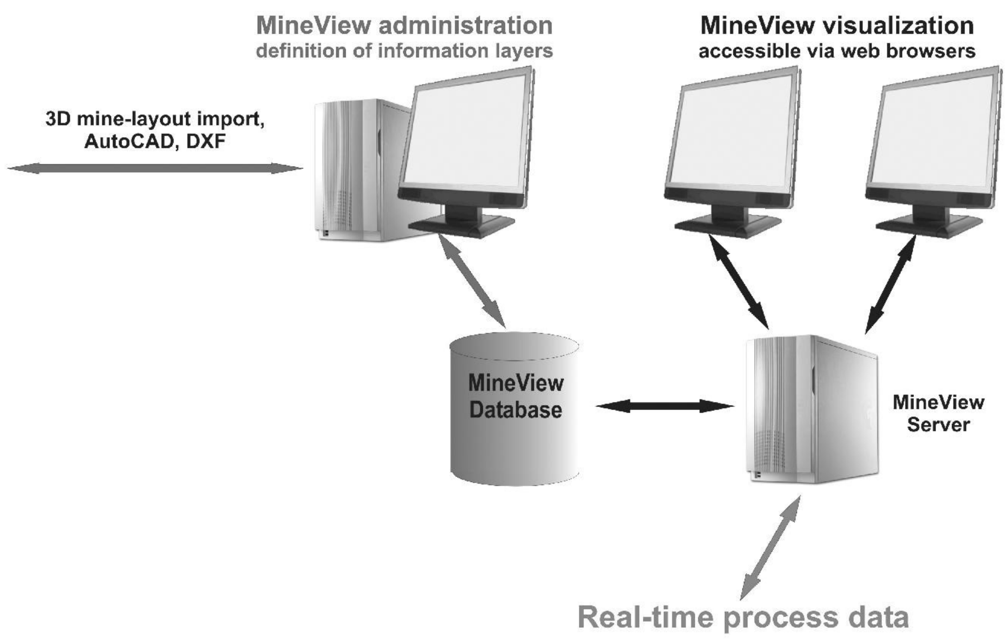

Figure 2: MineView-System structure

The content of the database can be edited via the MineView-Administrator (MVA), another important component of the system. The MVA is a standalone application for the interactive data and information layer administration. Through a simple interface, the user is able to load existing geometric data into the 3D visualization module. One of the supported formats is the Data Exchange Format (DXF), a quasi-standard that is supported by most CAD-applications. Besides those standardized exchange formats, the MVA supports a proprietary data format. This binary format has the advantage of smaller file-size. First and foremost this is important due to the server-client structure in order to make quick network-transmission possible.

Once the MVA has loaded a model, the user has full interactive control over the model and can perform standardized transformations like rotation, translation or zoom. First and foremost, he is able to load already existing object and information-layer data and link it to the 3D mine layout model. Basically there are two different kinds of object types. Static ones exhibit fixed data and normally have a fixed position. Examples for static objects first-aid stations, fire extinguishers or telephones.

In contrast to this, dynamic objects exhibit time-variable data. Mostly such data my be referred to as process data. Some examples for common object-types are:

- all kind of sensors like temperature, pressure, carbon monoxide and so on,
- machine or equipment status and position or
- wireless-LAN (WLAN) access points.

The most important feature of the MVA is to enable the user to define new information layers and objects, or to edit existing ones which have been loaded before or recently placed. An important fact is, that this can be done directly on the 3D-model of the mine. For example, figure 3 shows the definition of a new carbon monoxide sensor: First, the user activates the “marker-positioning-mode” and selects the desired object position by simply clicking on the 3D model with the mouse. Next, he opens the “object definition dialog” and selects an object-type. Here a new carbon monoxide sensor with identifier “COS-004” is defined. This ID is also assigned by the user, and is needed to link the dynamic object to the real-time process-data later on. To complete the definition/editing process, the user has to save his changes into the MineView-Database.

To make the information from the MVDB available to the clients, the MineView-Server (MVS) is used. This may be a standard personal computer (PC), so there are no special hardware requirements or other restrictions. Just as the server reads the requested data from the MVDB, it is responsible for the dynamic process data interface. After the real-time-values are transmitted, the server resolves given assignments (as already mentioned above) and makes these information available to the clients.

Referring to figure 2, it's obvious that the MineView-Clients (MVC) form the end of the chain of information-flow. Just like the MVA, all clients are based on a 3D visualization module which offers the standard user interfaces as mentioned above. Main differences are, that a user may not define new objects or change existing ones like the administrator can do. Furthermore, the MVC runs in web browsers, therefore the data is accessible from nearly everywhere.

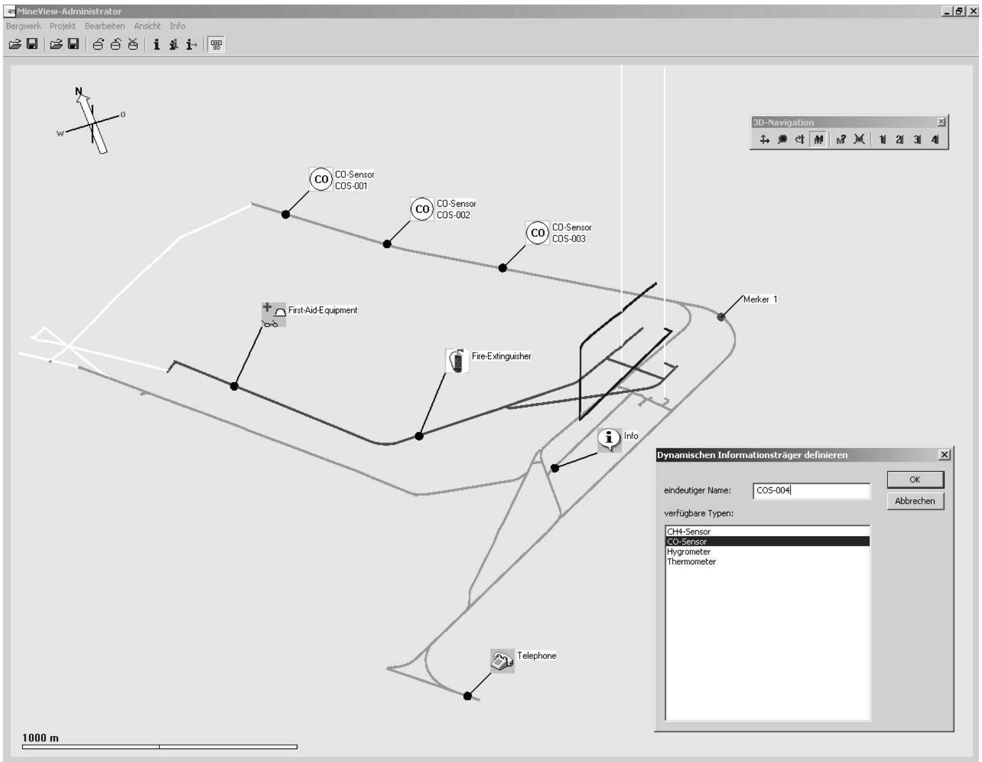

Figure 3: Definition of information objects and sensors in MineView-Administrator

The user can interact with the 3D-model perform the following actions:

- rotate, translate and zoom the 3D mine-layout,
- show different information layers,
- keep track of dynamic objects (sensor values, WLAN-access points status),
- save and restore user-defined views and
- invoke further functionality offered by context menus.

Although a MineView-Client user can’s define new objects, he is able to add links to existing ones. These links can be opened by simple mouse clicks later on. Examples for the connection of external data to information objects are simple text files, tables, pictures, videos, speech notes, web-sites or even external databases.

RESULTS AND DISCUSSION

Real-Time Process Data Monitoring

Figure 3 shows how to define new information objects like static symbols and sensors using the MVA. On the client's side relevant information about positions, sensor-types, identifiers and so on now is available, as well as dynamic sensor-data from the MineView-Server. The visualization component shows current values and all relevant data (name, unique identifier, current measurement value and time-stamp) next to the sensor's symbol (figure 4).

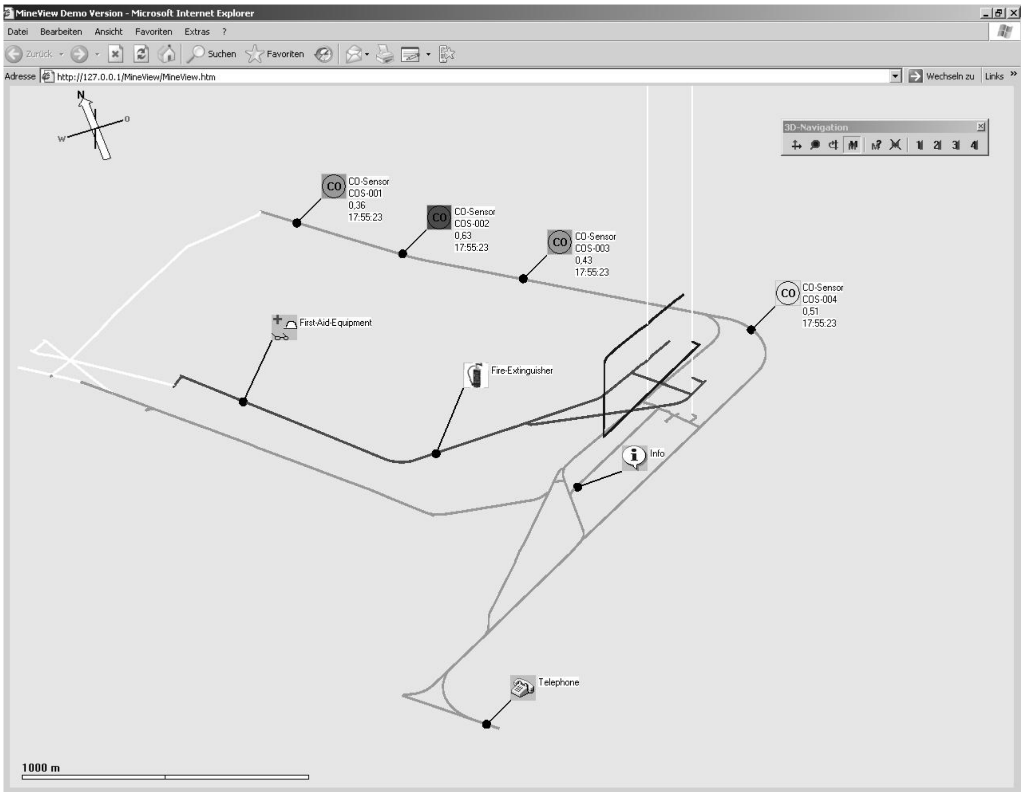

Figure 4: Real-time process data monitoring in a MineView-Client

If thresholds for dynamic sensor objects are defined, the system will choose the dynamic object's symbol accordingly. A simple example is a color change from white (sensor is not active) to green (sensor is active and its status is good), yellow (values are critical) and red (alarm). If critical values are reached, alerts are raised. Emergency procedures might also be induced automatically.

Shortest Path Computation And Escape Route Planning

The MineView-System provides 3D routing functionality, based on user defined source and target positions. On the one hand this is interesting for the calculation of shortest paths, for example to estimate the length of cables and pipelines. On the other hand this functionality can be used to compute escape routes, which are security relevant.

As shown in figure 5, source and target points are defined on the 3D model of the mine. Using the MVC, a user sets at least 2 markers and the algorithm will compute the optimal (shortest) path from the first to the last position. Besides the 3D-visualization of the path, all junction-nodes along the path with corresponding distances are listed (box on the lower right).

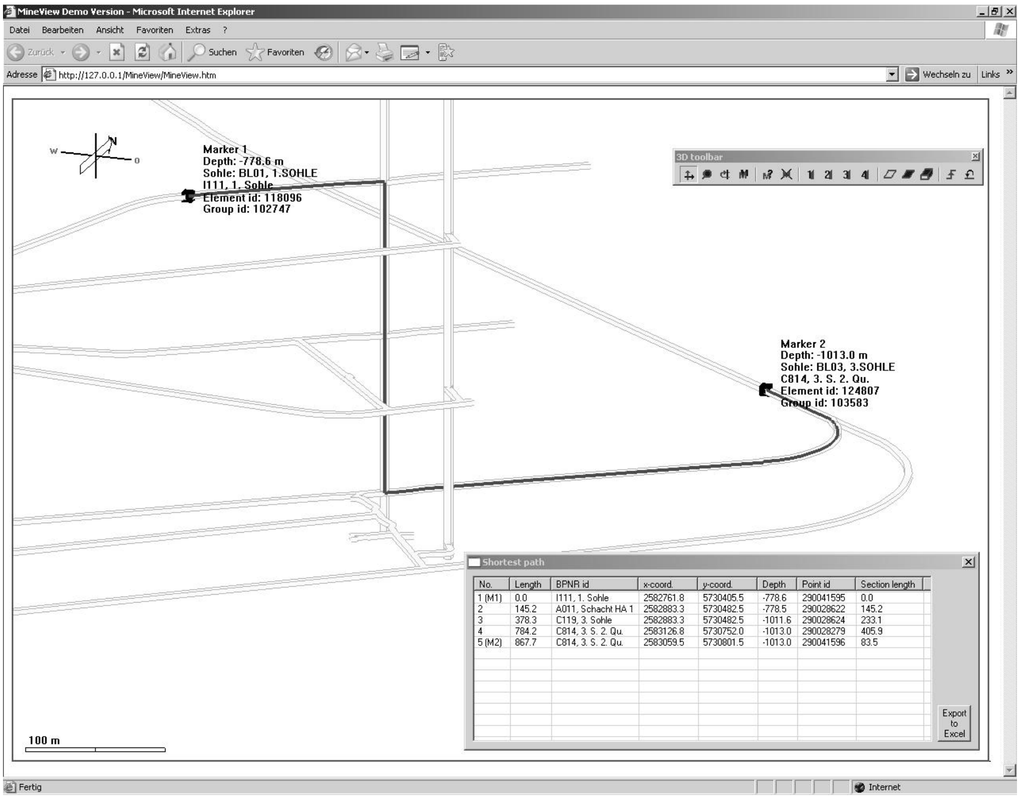

Figure 5: Calculation and visualization of the shortest the path

Monitoring Of Mine Ventilation And Pipeline Networks

The monitoring and control of mine ventilation networks is another important aspect in regard to mine safety. Improved monitoring of pipeline networks (e.g. for compressed air or fresh water), also leads to energy savings and reliable operation of those networks. The geometry of the networks is visualized directly on the 3D model of the mine. By dint of self-explaining symbols for pressure and flow-rate sensors, as well as trend charts or diagrams, a user-friendly and intuitive access to all relevant process-data is possible. An automated report-generator simplifies subsequent data interpretation. Based on a better tranparency, first results of energy saving are already guaranteed. The 3D-visualization is fundamental for automated recognition of leakages and network regulation, too. Via the administration tool graphic network administration is possible.

Integration Of Mobile Minicomputers

Access to information via mobile devices, as well as the ability to broadcast real-time process data, for example, is of great interest. Through the integration of mobile minicomputers (Personal Digital Assistants, PDAs) into the MineView-network, company-wide communication and information access can be further improved. There are lots of examples for reasonable usage of PDAs within the company's intranet. The bidirectional exchange of text messages, pictures, video-files or even live streams may be mentioned here.

Due to the fact that modern mines are more and more equipped with WLAN-access points and intrinsically safe PDAs, new potentials are at hand. Besides the mentioned communication within the (wireless) intranet, tracking of mobile devices is possible, too: Based on the currently measured

WLAN signal strengths, an estimate of the position of the device is possible. Different kinds of computation-approaches are working fine for aboveground applications. For subsurface adoption, the analysis of given signal strengths is best qualified. This method is based upon the fact, that the signal strength decreases with a growing distance from the WLAN-access point. A special mapping is used to estimate the distances for given signal strengths. The combination of two or more signals allows the position-estimation.

As already mentioned, the MVC shows the position, status (well reachable, low signal or turned off) and further important information about the access point configuration directly at the 3D minelayout (figure 6). Furthermore the MVC can visualize the PDAs at their corresponding positions, thus extending all features of the MineView-System to mobile devices, too. Messenger application are also accessible via the 3D MVC user interface.

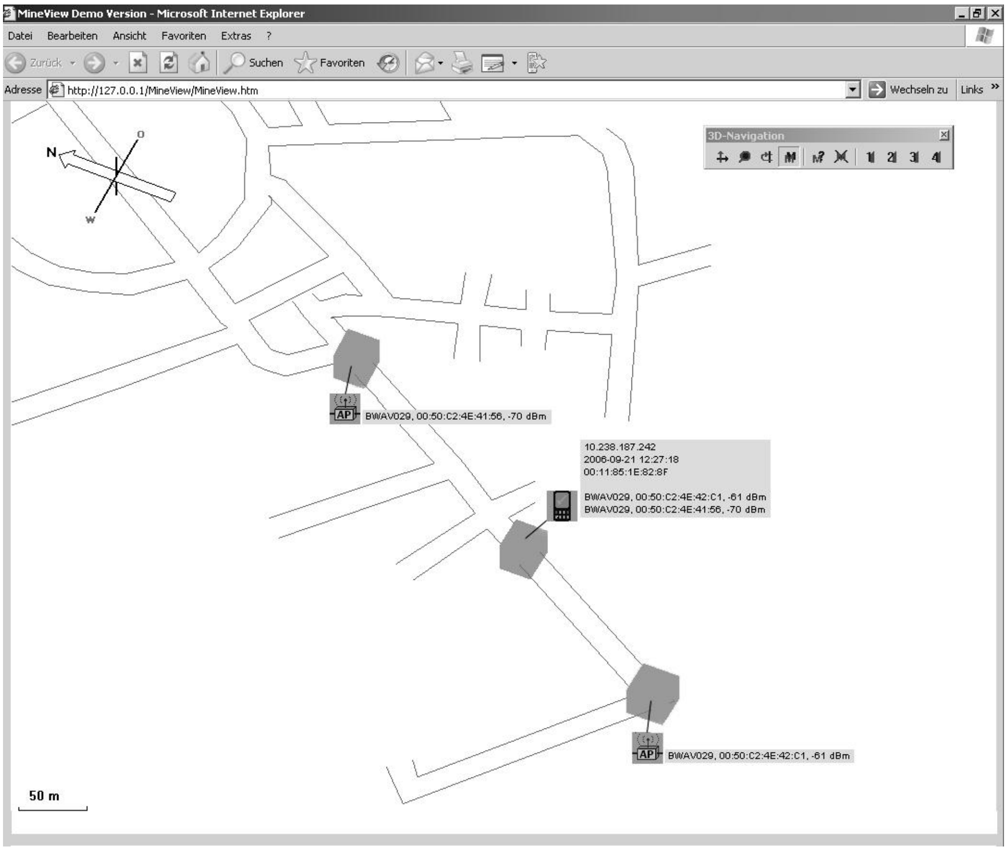

Figure 6: PDA-Tracking via the analysis of signal strengths of all reachable access points and „online visualization“ at the min's geometry model

Automation And Tracking Of Underground Vehicles

Within the scope of a R&D (research and development) project at Deutsche Steinkohle AG (DSK, Germany), MineView technology was used to implement a graphical user interface for an autonomous monorail system. In addition to the 3D-visualization of the train positions and system

status, the user interface allows the initiation of driving-jobs and the processing of teach-in data (figure 7).
The interprocess communication between the user interface and a central application server is based on IREDES online, an information exchange standard that has been developed in cooperation with XGraphic. Utilizing state-of-the-art technologies like XML, SOAP (Simple Object Access Protocol) and HTTP (Hypertext Transfer Protocol), IREDES online provides an adequate basis for the platform-independent exchange of process data over Internet/intranet connections and perfectly matches the MineView infrastructure.

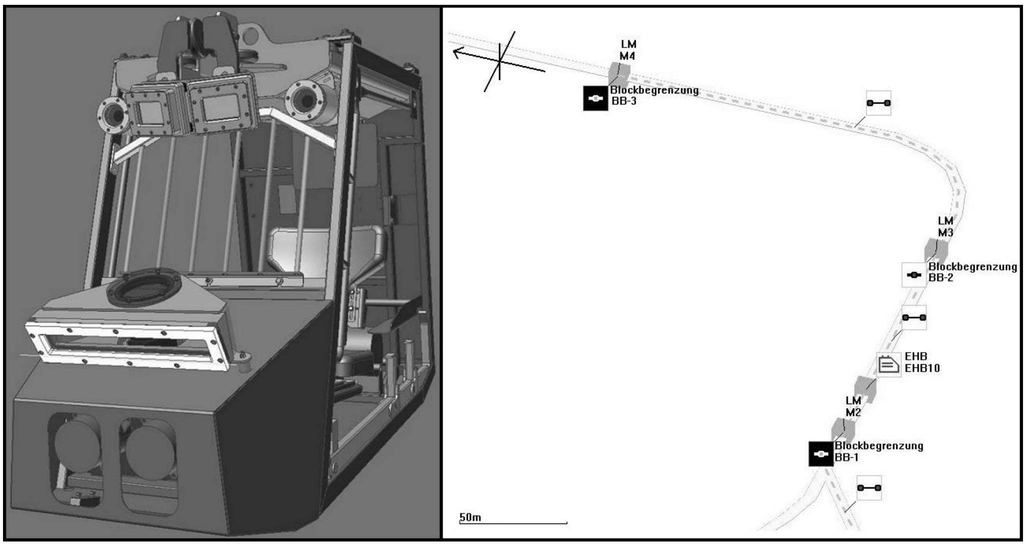

Figure 7: Sketch of an automated monorailcar and operation-monitoring

A preliminary version of the user interface is presently being investigated (October 2005). Readiness for production will be achieved during 2006.

Without doubt, such a sophisticated automation-solution is not restricted to underground monorails. Autonomous material transport in industrial facilities or tracking applications in facility management systems are other fields of application.

CONCLUSIONS

The MineView-System provides information management and process monitoring via a user-friendly graphical interface throughout the company intranet. The fundamental idea is to attach all kinds of information to the 3D model of the mine. This model is displayed by the MineView-Client where the user may select different information layers. The interactive 3D data-exploration is very intuitive, easy to learn and much more convenient then the traditional analysis of abstract tables. Besides static information like infrastructure, equipment and other points of interest (telephones, first-aid stations, ...) the system links real-time process data to the model and visualizes them at a glance.

The usage of common hard- and software (standard PC for the MineView-Server and web browsers for the clients) results in a simplification and homogenisation of the deployed system structure. Utilizing standard Internet technology leads to a saving of costs and improves company communication as well as the transparency of operating-procedures. The availability of WLAN-access points in underground mines extends the MineView-System to mobile devices, too.

Further developments are especially focused on the enhanced integration of mobile devices like PDAs. Emphasis is put on the tracking of mobile devices by the analysis of WLAN signals. Another topic is the integration of Voice over IP (VoIP) into the MineView-System, thus further improving underground communication.

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