MineView – Web Based 3D Infrastructure and Information Management for Mining

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ABSTRACT
The MineView system is a modern, web based software solution which enables innovative management of complex infrastructure and information using a 3D model. The three dimensional model of the infrastructure (e.g. mine layout) is available in the entire intranet of the company and can be accessed via standard web browsers. The basic concept is the link-up between the 3D model and manifold information, which can be locations of facilities and equipment, current process and measuring data as well as other data sources. The system grants an intuitive access to this information. In addition, the MineView system provides the tracking of vehicles and mobile equipment using WLAN and/or RFID technology. Finally, the integration of mobile devices such as PDAs opens up new opportunities for communication and data exchange.

ZUSAMMENFASSUNG
**INTRODUCTION**

The fundamental of an optimised operation management regarding data processing is the continuous availability of required data and information in correct, updated and understandable form. Whether planning or process monitoring, technical or economic aspects, manifold data from various sources define the operation site.

Nowadays, the acquisition of all these relevant data is usually not a problem. The challenge is rather managing the growing data flood and presenting the resultant information to the recipient in a comprehensible form. The use of 3D models in matters of the visualization of space-oriented data is suitable to achieve this aim.

Three dimensional models of mine layouts, deposits or open pit mines are the basis for an user-friendly navigation through manifold datasets within the innovative web based infrastructure and information management system *MineView*.

The entire technical equipment of a mine can be visualized using significant symbols on a three dimensional model of the mine layout which can be viewed from any perspective. These symbols allow the direct access to manifold information on the represented equipment as well as on its operation area. Furthermore, they show the status of monitored devices and current process and measure data can be accessed easily. Also the tracking of mobile devices is possible.

*MineView* makes data and information from different sources available in one homogenous user interface. Company-wide data access is guaranteed on each network-compatible computer, including mobile devices such as Pocket-PCs/PDAs.
System Structure

The MineView system is designed as a server-client-architecture, which is the basis for the access to relevant information from each with the company’s network connected computer. As apparent from figure 1, MineView consists of the four essential components MineView Server, MineView Database, MineView Administration and the MineView Visualization accessible via web browser.

Figure 1: Architecture of the MineView system

The core of the system is represented by the MineView Server in combination with the MineView Database. These two components are responsible for the central storage and supply of the information on linked objects (sensors, facilities, vehicle etc.), corresponding geometrical data as well as the link-up to external data sources. In order to design the MineView system as independent and portable as possible, the database format Extended Markup Language (XML) is used. The decisive advantages are the easy serialization of any data structures and the possibility to save object-oriented data. The XML format is a world-wide standard that is used in particular for web based applications. Moreover, the service of the MineView Server does not need any special hardware. A “normal” computer with minimal requirements is absolutely capable.
The MineView Administrator is responsible for the administration of the MineView system. An easy-to-use user interface provides the processing of different three dimensional geometries as well as the link-up between the 3D model and the data rather information on the represented infrastructure. One supported file format is the Data Exchange Format (DXF), which is used by many CAD applications in order to store geometrical data. Thus, any three dimensional CAD model in DXF format can be visualized and used as basis for the infrastructure and information management. In addition to that, the MineView Administrator uses a proprietary binary format that allows the space-saving storage and quick loading of complex 3D models. In particular against the background of company-wide access to important data and information, high network transfer rates can be guaranteed in this way.

Furthermore, the user-friendly design of the application enables the intuitive interaction with the 3D model. The user can operate with the model in varied ways – free rotation of the 3D model, zoom in and zoom out as well as moving in all directions. A link-up between the model and information carriers, which represent the particular facilities or technical equipment, can be established easily by using markers to flag the position within the 3D visualization and choosing the right info symbol afterwards. Punctual objects, which mark one location, as well as linear objects can be inserted into the 3D model. Therefore, it is also possible to visualize the course of e.g. electric cables, fibre optics or pipelines as well. Both punctual and linear information carriers will be finally linked to the respective information and the according linkage data will be stored into the MineView Database. The data can thereby consist of text files, images, videos and even external application files.

Finally, the MineView Client represents the end of the information chain. This component enables the visualization of the 3D model as well as the access to linked data and information via the operations system’s standard web browser (e.g. Microsoft Internet Explorer). According to the MineView Administrator, the basis of the client is a 3D visualization module that provides the user interface with the known possibilities of interaction. While the Administrator enables the set-up and editing of new and existing information objects, the MineView Client provides merely the retrieval of stored data and information. The client is based on standardized internet technology and, hence, a platform-independent use is possible. A concrete example could be the application of the MineView Client with e.g. PDAs for the visualization of 3D infrastructures and mobile data retrieval.
Infrastructure and Information Management

*MineView* features ideal specifications for the management of complex infrastructures and manifold information. User-friendly navigation through heterogeneous data means visualization of infrastructure using a 3D model as well as the link to relevant data and information, accessible via information objects within the model.

Figure 2 shows the *MineView Client* with the visualization of a three dimensional mine layout and different linked information objects. The locations of WLAN accesspoints, telephones, monitoring cameras or PDAs can be identified at a glance. Linked data, e.g. the video stream of monitoring cameras or diagrams of current sensor’s measuring data, can be accessed via mouse click on the particular symbol.

![Visualization with the MineView Client](image)

**Figure 2:** Visualization with the MineView Client

A particular example of infrastructure management using *MineView* is the monitoring and administration of WLAN accesspoints in underground mining. Dynamic information carriers mark the location of several accesspoints and visualize the operation status. Additionally, the configuration sites of the accesspoints can be accessed directly over the linked information objects.
Figure 3: Status display of accesspoints within the 3D model

Figure 3 shows the visualization of the accesspoints’ locations and status. Green-coloured symbols signalise the current availability of the accesspoint whereas red-coloured symbols display accesspoints that are temporarily unreachable or out of service.

In the wake of the certification of WLAN accesspoints in German hard coal mining, nowadays, mobile data acquisition and wireless communication via PDAs are state of the art in underground mining too. The integration of network compatible PDAs into the MineView system makes efficient mobile communication as well as company-wide access to information possible. In addition to the position indication of PDAs in the range of accesspoints the direct communication with these devices can be realised via mouse click on the particular information symbol within the MineView’s visualization. Text messages, images, videos or even VoIP messages can be send straight to the recipient’s PDA. One application example is the support of underground personnel by providing access to digital documents in situ, which are necessary for maintenance purposes.

Visualization of Process Data

Visualization and monitoring systems, which are reliable and operated intuitively, play an important role in particular in safety relevant areas such as mine ventilation. Measurement equipment and sensors can be integrated in the MineView system via appropriate interfaces. So, measuring data can be displayed in real-time within the 3D model. Corresponding information carriers mark the location of the particular device/sensor and provide the direct access to updated measuring data. If
the measured value exceeds a predefined threshold the information symbol change the colour. The signal colours green, yellow and red are representative for the status “OK”, “Not dangerous, temporary exceeding or undercut” and “Critical value”. The deviation from thresholds can be recognized at a glance and, therefore, necessary actions can be initiated promptly. Figure 4 shows the example of a 3D model with linked CO sensors as well as the possible visualization of the measured values.

**Figure 4: Visualization of process data**

Moreover, *MineView* provides the combined visualization of different data types. An example is the tracking of monorails in addition to the monitoring of CO sensors. Negative changing of measured values, which is caused by a passing monorail, will be identified quickly and can be distinguished from critical measurement errors. In conclusion, not only the visualization of measuring data but also the increase of safety is focused.
Detection of Smouldering Fires

With regard to safety the early detection of smouldering fire in particular close-by belt conveyor systems plays an important role. In the context of a R&D project fibre optics are used as temperature sensors along belt conveyors in one German hard coal mine. The MineView technology provides the modeling of sensor courses within the three dimensional mine layout and the simultaneous analysis and visualization of measured data.

Figure 5: Visualization of the sensor and display of alarms within the mine layout
Pipeline Networks

The visualization of compressed air or fresh water networks in the 3D model of the mine layout is a further application range of MineView. Measured values from sensors will be monitored directly in the 3D model using rule-based analysis methods and alarm messages to visualize threshold exceedings. Figure 6 shows the model of a pipeline network together with the locations of measuring devices. The symbols change its colour subject to current measured values and the particular analysis rule.

Figure 6: Visualization of a pipeline network and sensor status

The administration software provides the implementation of the pipeline network as well as the according sensors into the 3D model and the defining of monitoring rules. Several types of rules can be distinguished. Predefined, basic rules can be used e.g. for the monitoring of threshold exceeding with display of warnings or alarms. Complex rules provide the combination of several sensor values with additional information.
Tracking and Tracing

A further field of application of MineView is the tracking of vehicles and mobile devices using WLAN technology. The combination of WLAN signal strength measurements and the knowledge of the accesspoints’ locations is the basis for the tracking (display of the current position) of mobile devices which are connected to the network. The visualization of the covered distance within a specific time interval (Tracing) or the point-related representation (when was which device in the range of a particular accesspoint) is possible as well. In addition to the use of WLAN technology, the integration of RFID components as well as alternative sensor networks for tracking of vehicles and mobile devices is also supposable.

Figure 7: Tracking of a monorail and display of machine data as well as covered distance

An example of tracking using MineView technology and WLAN components is the implementation of a graphical user interface for monitoring an autonomous monorail system of RAG. The position of the monorail as well as current machine data is continuous visualized within the 3D model and so the system provides the complete supervision of the driverless vehicle. The communication between the user interface and the machine server is based on IREDES (International Rock Excavation Data...
Exchange Standard), an international standard for data exchange between mining equipment and office computer systems.

**Routing**

MineView has routing functions that enable the automatic determination of the shortest-path between two or more locations within the 3D model. In addition to the modeling of connecting paths, the accurate distance between these locations will be calculated. Therefore, MineView is also applicable for planning purposes – e.g. for the planning and calculation of escape routes as well as the determining of required cable and pipeline lengths regarding the mine’s environment.

![Routing within the MineView Administrator](image)

**Figure 8:** Routing within the MineView Administrator
MineView Technology for Different Fields of Application

The use of MineView for the purpose of visualization and management of underground infrastructure in mining is only one possible application of that system. The visualization component enables the processing of user-defined CAD models as well as the link-up to individual, customized to the specific field of application, information carriers. In reference to the use of open standards, MineView is applicable for visualization of manifold data from different sources. This maximum of flexibility turns the MineView system into a multifunctional tool for infrastructure management in various industrial sectors. Figure 9 shows the use of MineView for the visualization of open pit mines, for sensor supported monitoring of buildings and rooms as well as for a guidance system.

Figure 9: Example of using MineView technology; Visualization of open pit mines (top left), sensor supported monitoring of rooms (top right), monitoring of buildings (bottom left), 3D guidance system (bottom right)
SUMMARY

The MineView system provides the user-friendly and reliable administration and visualization of the mine’s infrastructure and manifold other information in the entire intranet of a company. The specific system architecture, the use of standardized web technology as well as the minimal requirements of the hardware turns MineView into a cost-efficient multifunctional tool for different fields of application. The basic idea of MineView is representing the mine’s infrastructure by a 3D model of the mine to which relevant information are linked. Thus, an intuitive and fast access to important data can be guaranteed. Moreover, the system can be used for monitoring of sensitive areas as well as company-wide communication through the integration of sensors and mobile IT components.