Becker MineView
A Modern Scalable SCADA System

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ABSTRACT
Current Supervisory Control and Data Acquisition (SCADA) systems are used for a multitude of different applications. They provide remote monitoring and control of equipment and resources. Their main function is to show information and data from a wide range of sources, while making certain that the data integrity and appropriate update rates are sustained.

Becker MineView is a SCADA system primarily developed for the mining industry. MineView is able to show the entire infrastructure, the technical devices and machines, and mobile components on a three-dimensional mine building model using corresponding symbols. In this way, a variety of information regarding the represented equipment and its environment of use can be accessed, device statuses can be tracked. A further essential part of the application includes the different process flow charts and graphics, like trend curves and bar diagrams.

The system comprises of three core units, the MineView Server, the MineView Client, and the MineView Editor. The MineView Server is a redundant server system, which collects and stores all important information and data. It can provide these collected information and data to multiple MineView Clients for visualization. Lastly, the MineView Editor is an aggregation of tools intended for the configuration and maintenance of the whole Becker MineView system.

In addition to the desktop based MineView Client, there is also a web based version. The MineView WebClient. This component allows the access to all charts and three dimensional views with a normal web browser. The used web technologies even enable the use of mobile web browsers, so that it is possible to access the MineView WebClient even with smartphones and tablets.

The Becker MineView system is also deeply integrated with other Becker Mining Systems technologies. One of these technologies is the Becker Mining Systems tracking solution PANTHA. This system provides multiple modules for communication with underground devices, configuration and control of the system components as well as viewing of live and history tracking data. It uses tags and tag reader to track positions. The integration into MineView allows the tracking of individuals, equipment, or vehicles to be visualized on a three dimensional mine model, with tags and tag readers shown on their corresponding location. This paper gives a detailed look at the Becker MineView System, its wide array of features, possible applications, integration into existing Becker Mining Systems technologies, and future developments.
INTRODUCTION
The Becker MineView System is a modern Supervisory Control and Data Acquisition (SCADA) system, developed primarily for the mining industry. It provides all the necessary features you would expect from a state of the art SCADA system, like i.e. a client-server structure, process data logging, data archiving, flowcharts, scripting and a user/group based access system. On top of these basic features, the MineView System adds an easy to use fully integrated three dimensional visualization component which allows the implementation of geolocation based features.

The MineView System can be used in a large variety of different fields. To name a few possible applications:

- General purpose monitoring of:
  - Mine face
  - Belt conveyor
  - Mine ventilation
  - Energy supply
  - Handling systems (conveyors)
  - Communication systems
  - Mine hoists
- Geolocation based applications (using the three dimensional visualization):
  - Mine planning – generation of parts lists and cable lengths
  - Tunneling
  - Tracking and tracing of vehicles, material and persons (collision avoidance, access breaches etc.)
  - Transport / Escape route planning
- Other potential uses:
  - Visualization and/or administration of access points and other IT components
  - Waste water management and freshwater supply

The MineView System is structured into three primary components:

- MineView Server
- MineView Client
- MineView Editor

The communication is based on the Client-Server model. Which means, all the communication data gets processed by the Server. The basics functions of these three components will be briefly described in the remainder of this chapter with a more detailed look at the MineView Client and Editor components in the following two chapters.

The MineView Client is a highly customizable desktop application. The key parts of the MineView Client are the three dimensional mine visualization, chart visualization and log message view. The application can be used as a normal single window application, multi window application, multi monitor application, full screen application or a combination of these.

The MineView Editor is a desktop application for configuring MineView projects. It provides all the necessary tools to create new and maintain projects. These tools include most notably the editors for creating charts, server side scripts and three dimensional mine models. In addition, the MineView Editor features a simulator to test charts.
The MineView Server component is the core component of MineView. Its main duty is to collect and archive all of the desired process data and provide interfaces for accessing this data. Additionally, user-written scripts can be executed on the MineView Server by different triggers. For example, these could be used to check for values that exceed certain limits or generate daily reports of important process data.

To be able to have a maximum availability, the server component was designed as a redundant self-organizing system. The MineView Server is physically divided onto multiple computers. By this, all the data can be saved redundant, so that a malfunctioning server computer can’t interrupt the whole service or lead to lost data. By self-organizing these redundant features, it’s also possible, with minimal configuration needs, to add additional server computers into the system without need for a lengthy restart or reconfiguration of the whole system. Another self-organizing feature is the load balancing. Through this, the MineView Server can automatically distribute all necessary tasks to the server computers with the lowest load. This leads to an optimal performance of the overall system.

Figure 1: 3D visualization of mine model

VISUALIZATION CLIENT

The MineView Client is the graphical user interface for the end users of the MineView system. The application supports multiple monitors and its window structure is highly customizable for an optimized and individual visualization of the required information. To use the client, a user has to log in at the server with his username and password. Depending on it’s group membership(s) the assigned project tree(s) are shown in the project browser. This is the starting point to open available 3D views or flow charts, trend curves and diagrams. The main idea of the MineView System is to make all important information, like status messages, warnings or alarms, visible at the 3D model of the mine by easy understandable and more or less self-explanatory symbols. This guarantees an extremely intuitive navigation through the available data. Just by clicking on a desired symbol, a more detailed 3D view (see figure 1) or specific data sheets (see figure 2), animated chart or trend curves will be opened to present all contextual relevant process data.
data to the user. This ordering and linkage between the project elements can be defined in the editor component.

In addition to the real time process values of a mine, the availability of previous values is also very important. The MineView Client contains a history browser, which can generate freely configurable diagrams. By selection any process value of the system and specific a time interval, the historical data is retrieved from the database and then will be graphically presented. In addition, the report generator tool allows the export of diagrams and tables into PDF files, which can also be distributed via email automatically.

Another important component is the logging view. All system messages, warnings and alarms will be displays in this individually configurable window. For each of these logging items a feedback mechanism is supported, to document the status of the processing by the responsible staff.

Figure 2: 2D chart visualization

PROJECT ADMINISTRATION
The MineView Editor is a multifunctional tool for the configuration and maintenance of the whole Becker MineView system. The application has two different modes: In the ‘offline mode’, projects can be loaded and stored only at the local machine. This has no effect on the operating system on site and will mostly be used for the initial setup of a project or for the incremental integration of major changes or extensions to a running system. For the ‘online mode’, the user has to login at the server to get access to available project files. All modifications carried out here will be uploaded to the servers and are immediately available to all clients of the system.

A project consists of a variety of components that has to be set up. In the general settings, the user can configure the servers of the system. For the user this is very simple: He only has to add new entries to a list of available (physical) servers and enter the IP address.
The runtime system will automatically organize and manage the server network under the hood.

In the user and group management section, the important login data can be edited. Each user of the system must have its own user account with login name and password for the identification at the server. In addition, groups can be created to grant different access rights to the system and provide only relevant information to a specific team for example. Therefore, each user can be assigned to one or more groups to inherit all of the group’s access authorities.

The integration and post processing of the process data will be done in the data source editor. The access to process values is done via OPC interface. MineView has a built in OPC-client interface and can connect to available OPC servers in the network. The relevant variables can be selected from the OPC data tree and directly imported into the project. Different handling settings like update interval or storage time can be defined individually. It is also possible to rename internal variables for a better individual ordering and recognition of the data later on. In addition so called ‘virtual variables’ can be added to the project. A virtual variable can either be a constant value that can be useful for later purposes, or it can be used to apply simple filter functions or even complex filter rules to the input signals. Because of the modular system design, other interfaces can be extended easily, to overcome the restriction to OPC.

The modular structure of the system is also reflected in the design of the different graphic editors: To set up graphical windows for the clients, the user has to create so called templates. This can be either a 3D model, a 2D chart or a complex script that will be evaluated by the server at runtime. Even the combination of multiple templates and organization in a tree structure is possible (‘virtual element’).

A fundamental benefit of the MineView system in contrast to other SCADA systems is the 3D data presentation. The import of the mine model, the population of so called ‘information objects’ on the 3D-model and the setup of user (group) defined views can be done in the 3D model view editor. Data import interface is DXF or MineView’s proprietary binary data format. In a 3D view, fundamental basis information about the process conditions will be displayed.

To make available more detailed information about specific areas or certain machines in the mine, so called 2D charts can be designed (see figure 3). These consist of 2D flow diagrams with animated texts and colored graphical elements as well as different kind of graphs to display trend curves or historical values. The editor comes with an integrated library of established symbols for a simple chart creation via drag and drop. This library can be easily extended by the user with individually created elements. For the most common Becker equipment, the editor has pre-built chart templates to minimize the configuration effort.

As already mentioned above, filter functions or complex rules can be applied to input signals. With the built-in programming interface, those filter scripts or complex rules for data analysis can be created. The programming is done in C# and the user has access to different kind of functions like message logging, email sending or writing of OPC values (see figure 4).

The report generator is based upon this scripting module to create PDF files for technical documentation. The report generation can be done by simple mouse click or automatically by scheduled script execution. In addition, the documents can be sent to the desired recipient directly by email.
The idea of the template concept is to have universal and especially data independent patterns, that can be used later to create individual views. Wherever a data input is required, a so called mapping name can be defined. This name will be looped through all nested template elements and retroactively used later to assign real time process data values to template elements. To create a real client window, the user has to instantiate the templates by mapping the template’s wildcards to real process values. This will be done by assigning the project variables to the corresponding mapping names of the template. Usually a project will consist of a variety of views and include hundreds or even thousands of variables. To minimize the effort of instantiating, the editor is capable to perform this mapping more or less automatically (see figure 5).

![Figure 3: 2D chart editor](image)

Finally, the admin can define the project structure for the visualization in the clients. Different project trees consisting of different instances of 3D views or 3D charts can be created. For each tree, the access right with respect to the user group can be defined to make available specific views only to appropriate users.

Another important feature of the editor application is the opportunity to test all of the 2D charts with the built-in Chart Simulator. In a separate window, all available mappings of a chart can be assigned user defined values to test all functionalities like text changes, animations, color changes and so on before the project is uploaded to the server.
Figure 4: Rule programming interface

Figure 5: Variable mapping for a project instance
Integration: Becker Mining Systems Technologies
For the enhancement of the productivity and safety of a mine, wireless detection and position tracking of moving objects has become very important. Due to rapid evolution of technology, tracking and tracing offers a wide range of gainful application: Position monitoring of mobile machinery, observation of material transport, localization of persons or area access control, to name only a few. This is made possible by the provision of personnel and machinery with special transponders and the installation of appropriate readers, alternatively or in addition by the availability of wireless networks.

Becker’s Pantha system was designed as Centralized Asset Tracking System and provides TCP/IP communication to the Becker Wireless Router Access Points (WRAP) as well as Becker UHF tags and Wi-Fi clients to cover personnel, vehicles and assets. Important modules are the blast/shaft clearance as well as the generation of tip production reports. MineView’s capability of combining position-dependent data with the 3D model of a mine makes possible an intuitive presentation and exploration of Pantha’s tracking data. The system provides full integration of Pantha’s functionalities and data access via 3D visualization:

- management of various (security) zones and assignment of access permissions for the different zones (group-based or individually for single mobile units or individuals)
- storage and representation of the time when entering or leaving an area
- alerts for breaches of access authorizations
- knowledge of the last known location of missing persons in an emergency (for example in case of fire and / or explosion)

Mine View has it’s own symbol library that contains templates for all relevant Becker hardware. Predefined flowsheets for WRAPs oder UATRX tag readers for example, as well as semi-automatic data linkage simplify the handling of the system.

Outlook
As web applications get more and more important, there is currently a MineView web component in development. This new component will be called MineView Web. It will allow access on a MineView project through a normal web browser (for example Google Chrome). All of the different views and visualizations available inside the desktop MineView Client application will then also be available with MineView Web. By only using modern technologies like HTML 5 and WebGL, it will be also possible to access MineView Web with smartphones or tablets (see figure 6).

In contrast to other systems, it won’t be necessary to change anything in already existing MineView projects to use the new MineView Web components.
Figure 6: MineView web client running on a tablet

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