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Design and Realization of the Safety Production Scheduling System

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Abstract: In this study, we have a research of the design and realization of the Safety Production Scheduling System. Urged by the government departments as well as safety supervising institutions, many coal enterprises are embarking on designing and constructing an information system platform for safety production and scheduling. How to establish a systematic, comprehensive, standardized and scientific management platform for the safety production and scheduling has become a hot issue in the coal industry, which is also an important move to integrate various safety management measures in order to prevent major safety accidents and keep up with the international industry status. Taking a successful, large-scale safety production and scheduling system for example, this study elaborates on its overall design and construction. When the system is completed, it will play an important role in strengthening safety production of the coal mines, preventing accidents as well as increasing the overall safety level of the coal industry.

Keywords: Commanding and scheduling, design and realization, information system platform, safety production

INTRODUCTION

In recent years, energy demand in Chinese mainland has been on the gradual increase. Correspondingly, coal as an integral part of energy is also in great need. Coal resources have been exploited a lot and many areas are also on their way to excavate more mines and expand production which to some extent can alleviate the demand for the energy.

However, along with hasty construction of coal mines and the rapid expansion of productivity and scale, many drawbacks and problems occur, among which one major problem is the frequent occurrence of mine accidents. Mine accidents are of frequent occurrence in the coal industry which have claimed many lives and caused great financial losses. Now much attention has been given to mine accidents and safety production is gaining more and more importance. Information construction of safety production and scheduling system in the coal industry as an important aspect of safety production as well as an important measure to keep up with the whole world has been put on the agenda and on its way to popularization and construction.

Constructing a safety production and scheduling system can help to facilitate the information processing and speed the tackling of safety accidents or dangers making the management more transparent. When the system is completed, it will play an important role in strengthening safety production, increasing safety efficiency. A unified and integrated information system platform can combine every information system into a whole implementing a centralized control and management over various safety supervision measures and means. In this way, safety can be under total control and safety accidents or disasters can be well avoided (Tomokazu *et al*., 2010; William, 2010).

In this study, we have a research of the design and realization of the Safety Production Scheduling System. In our research results, when the whole system has been constructed, it can timely display mine's safety production information in an accurate way. When the alarm occurs, the system can inform the relevant personnel through short messages. Besides, it can display production status and environmental monitoring information in the form of graphs, curves, tables possessing a large storage capability and can provide historical data for review. Industrial television images can be directly seen in the general scheduling room. Scheduling and communicating information is provided in 4 ways ensuring its smoothness.

LITERATURE REVIEW

Project background: XX coal company is China's first large-scale coal enterprise that is listed both at home and abroad and also the biggest coal producer in Eastern China having a place among the biggest coal-exporting enterprises. In order to implement the State's safety requirements, respond to the call of "safety first, production second" and strengthen the company's commanding and scheduling for safety production, it is therefore of great importance to construct safety mines.

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By means of constructing an information system platform for the safety production and scheduling, working efficiency can be greatly enhanced through information means. Safety supervising personnel or institutions can learn about the working conditions of 8 mines, the underground environmental monitoring as well as the production and management information using the terminals on the desktops t which will lay a solid foundation for the safety production.

Current situation analysis: As a large-scale coal-producing enterprise, the company has built several producing system platforms, but most of them are scattered and of weak functions. Therefore, it is backward on the whole and cannot satisfy the needs for current safety production:

Status of mines' safety production monitoring system: Each mine is equipped with an independent safety production monitoring system and a beam tube monitoring system. Data in the safety production monitoring system are uploaded to the company in the form of text files. Subsystems of each mine works independently without forming a whole. Therefore, the instantaneity and reliability of the system is relatively weak without a human-machine interface or graphic display. The whole system is relatively weak in functions and network structure lacks safety. The monitoring system of each mine is directly connected to the office network without necessary safety isolation measures.

Status of scheduling, commanding and communication system: The system is mainly composed of a 100 DMY-1 space-division switch and an extension wire of PCM users. The scheduling to the external offices and branch companies can only be realized by telephones. Current scheduling switch system and equipments have serious aging problems and scheduling way is single. Besides, microwave equipments are aging and information channels are unsteady. All these could not satisfy the need for the company's rapid development.

Status of industrial television system: The industrial television system is the earlier analog monitoring system only covering a small geographic area. The monitoring is only confined to the monitoring center with a bad flexibility. All these could not satisfy the need for remote commanding and real-time scheduling. The traditional way of storing cable analog video signals costs a lot of storage media (video tapes for example) making it complicated to review or obtain them and difficult to save and retrieve the data.

Status of production, operation, scheduling and management: The general scheduling room gets the needed data, reports or files from each mine mainly through 3 means, namely, direct dialing, fax or telephone records. The whole process is controlled or half-controlled by hands with a low speed and a low efficiency. The way for transporting scheduling information is rather backward. Besides, each mine has a different way to deal with its daily scheduling information and processing scope for computer auxiliary information also differs from each other. Information processing has not been integrated into the network. There is no analyzing system for the collected data. In addition, data collecting, processing, treatment and analyzing have not been united as a whole.

ACHIEVABLE GOALS AND NETWORK LAYOUT OF THE SYSTEM

Design objectives of the system: It is aimed to build a complete and advanced safety production, scheduling and commanding system by using a variety means such videos, images, figures or text files in order to provide sufficient information for safety production management staff and technicians; to make the business and information exchange of the safety production, scheduling and commanding more systematic, standardized and automatic and to provide information support for making major decisions or formulating policies concerning safety production. The concrete objectives are as follows:

- **Build a safety production monitoring system:** Collect the safety monitoring information from the mining site and gather the data detected by the beam tube. Conduct a collective processing for the information and data and then store them in the industrial database through the monitoring data network. Provide the real-time monitoring information for the company's scheduling room and each specialized department. The real-time monitoring information can be displayed by configuration graphs or tables and illustrated by words. The monitoring information of the system is released through WEB and can be accessed by users through web browsers. At the same time, the real- time data will be saved in the historical database for experts to analyze and retrieve.
- **Build a brand–new scheduling, commanding and communication system:** Form a multiple-pass scheduling and communication network by adopting a series of technologies such as the specialized digital remote control technology, IP telephone, visual telephone and program-controlled

telephone. Make sure the communication between the company and the mines is smooth. Meanwhile, establish communication channels with the external branch companies.

- **Industrial television system:** Make a collection of the mine's industrial television videos and images by using the data network that is being constructed and the streaming media transmission technology. Timely provide them to the company's safety supervising institutions so that safety supervisors can timely grasp the operation information on the mining site.
- **Develop a complete production, operation and scheduling and management system:** Make full use of the data network that is being constructed to ensure the business processing fully connected to the network. Make sure that the company's production and operation information can be timely uploaded the upper department and transmitted to lower department as well. Bring the computer's role in deep and fast information processing into full play. Filing reports can be realized automatically.
- **Update and innovate the scheduling and commanding equipments:** Use the large screen technology with a big picture and high quality to build a central control unit system for scheduling and build a scheduling control center with a high technology level.

Hierarchical structure of the system: Given the safety requirements on industrial control, an independent monitoring data network needs to be constructed on the main transmission platform. The network can only be accessed by workstations in the company's general scheduling room and 8 mines' scheduling rooms for monitoring, collecting and releasing site configuration, the server for collecting database and the maintenance workstation. Other users have no access into the network. The data in the monitoring data network are transmitted to the data Center (IDC) through the firewall. The other users of the company have to visit the websites of the data center using the server to monitor the information or browse and refer to the configuration (Fan *et al*., 2008; Wang *et al*., 2011). Logic diagram of the system structure can be seen in Fig. 1.

Safety production monitoring system is equipped with 2 servers. One is installed within the safety production monitoring network responsible for receiving and saving real-time monitoring data, saving historical data and providing real-time monitoring information to IDC. The other server is installed in IDC responsible for releasing safety production WEB configuration information by means of real-time monitoring data. The safety production WEB configuration information is transmitted to the data network users through the firewall of IDC. The server of industrial television system is directly connected to main switch through a gigabit network interface transferring industrial television images to the data network users in the form of WEB. There are two servers in the production, operation and scheduling and management system. The business server is installed in IDC and database server shares OA server providing information about production, operation and scheduling to the data network users through the firewall of IDC (Luo *et al*., 2009; Zhang and Wei, 2007).

CONCRETE IMPLEMENTATION AND MANAGEMENT

Mine's safety production monitoring system: Information collection system adopts the system mode of CS framework and database belongs to the in SQL industrial database. Each data collection terminal uses INTOUH software and the maintenance terminal adopts IAS maintenance software. The releasing system uses BBS framework and adopts CV (WEB) releasing system. The client terminal can be accessed by IE6.

Three types of monitoring information can be integrated through data collection design (monitoring information about environmental safety, monitoring information about major production status and beam tube analytical data) and then stored into a unified industrial database. The company's scheduling room, each specialized department and each producing mine can look for their real-time monitoring information. The real-time monitoring information can be displayed by way of configuration graphs or forms. Monitoring information of the system can be released through WEB and users can have access to it through the browser. At the same time real-time data can be saved into the historical database for other system to retrieve:

- **Network structure of the system:** In order to ensure the reliable operation of the system, each mine should arrange data collection module and real-time configuration display so that the system can operate even when the network breaks down and can automatically upload the historical data to the historical database when the network restores. During the normal operation, the system can realize balanced load among all the terminals through IAS. Network structure of the system can be seen in the Fig. 2.
- **Data collection:**
  - Three types of information need processing

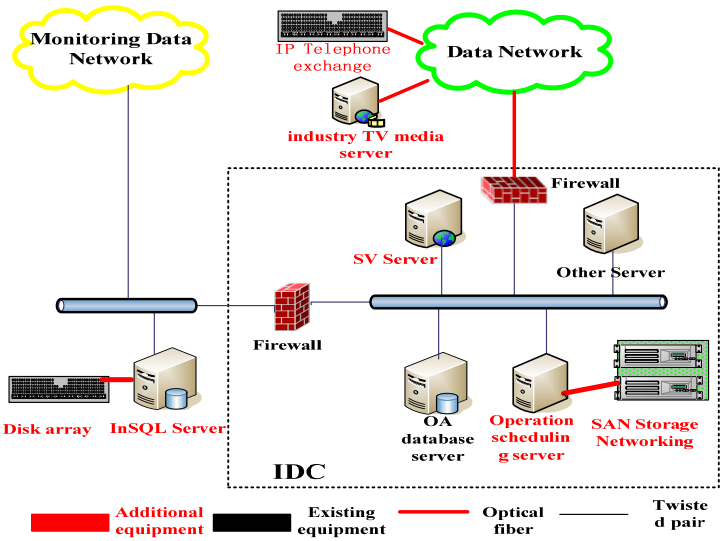

Fig. 1: Logic diagram of system structure

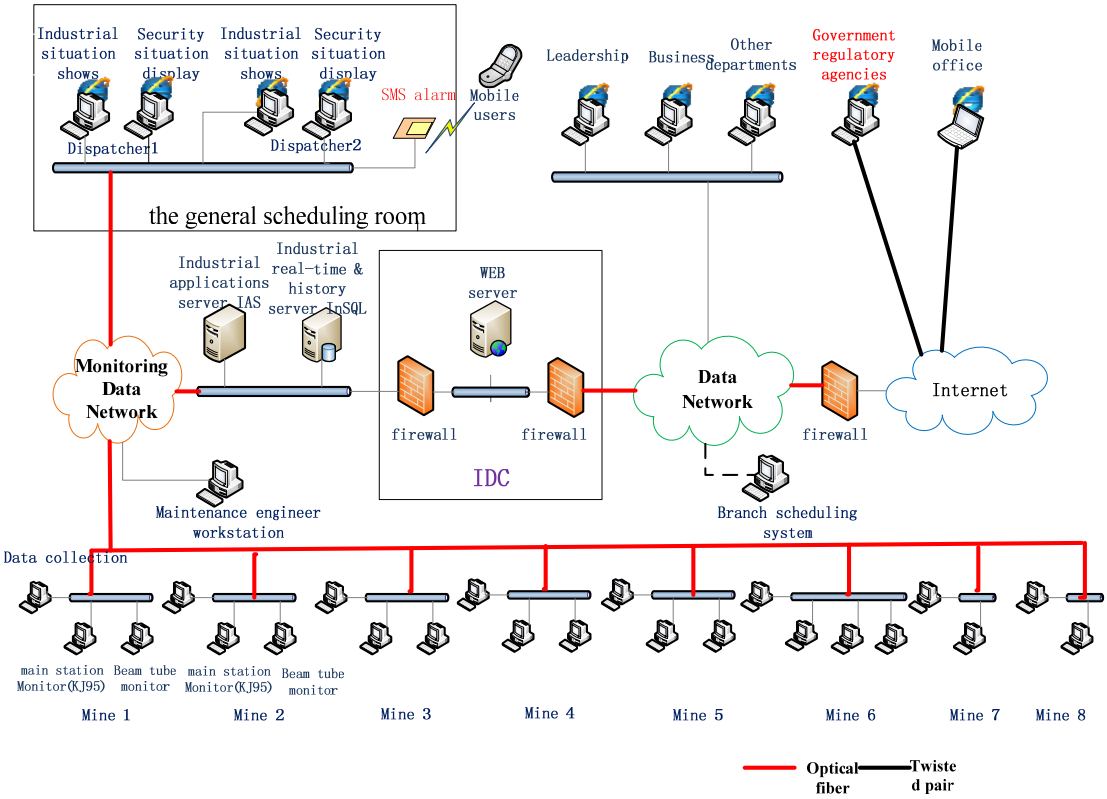

Fig. 2: Network structure of the system

- Monitoring information about environmental safety CH_4, CO, wind speed, temperature, pressure, the state of the air door, the state of the fan
- Monitoring information about major production status

The state of major producing facilities (coal winning machine, tunneling machine, ventilator, air compressor, hoister, water pump, belt), fundamental quantity of the equipment, real-time information of electric protection; voltage, current, electric quantity,

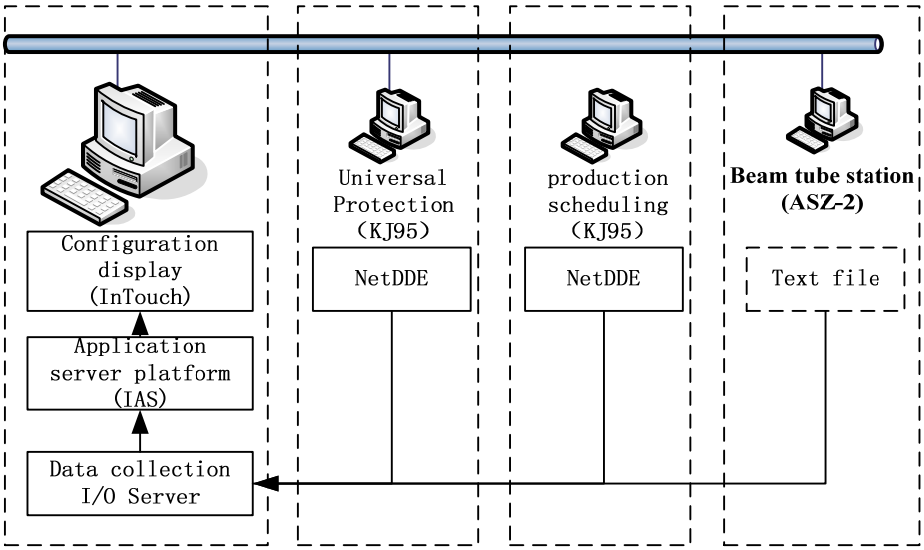

Fig. 3: Logic diagram of data collection

active and reactive power of the ground substation and underground central substation; the state of the switchboard and real-time monitoring information about relay protection; coal level and water level.

- **Beam tube analytical data:** CH_4, CO, O_2, CO_2, N_2, C_2H_2, C_2H_4, C_2H_6, olefin-alkyl ratio.

Data collection mainly deals with the software interface between each mine's safety production monitoring system and the company's safety production monitoring system as well as the software interface between each mine's beam tube analyzing system and the company's safety production monitoring system. Data collection software first obtains the mine's safety production monitoring data and then sends the data to the application server. Configuration display interface will obtain the data that have been processed by the application server. Logic diagram of data collection can be seen in Fig. 3.

Scheduling, commanding and communication system: In order to ensure smooth scheduling, commanding and communication to all the subsidiaries by the general scheduling room, form a multiple-pass, multiple-means and large-scale scheduling and communication network by adopting a series of technologies such as the specialized digital remote control technology, IP telephone, visual telephone and program- controlled telephone. Make full use of current communication network and data network supplemented by various means to ensure the reliability and expansibility of the system providing real-time information.

The company's general scheduling room can communicate to all the subsidiaries by videos or voicing which has several functions such as one-key dialing, group calling, team calling, abrupt interruption, abrupt disconnection, group faxing, recording, voice amplifying and voice playing. Logic diagram can be seen in Fig. 4.

Industrial television system: The general scheduling room transfers the industrial videos and images of 8 producing mines to the Head Office each mine having 2 circuits with a total 16. Embedded digital industrial television transmission and display system based on IP network can realize the above function by means of data network and at the same time provides the authorized users the right to check real-time images.

Embedded equipments are adopted to conduct digital compression for each mine's industrial television images so that the images can be transmitted on the IP network thus combining the industrial television of the scheduling system with the company's data and information platform. The system is mainly composed of 3 parts: forward monitoring point, system control center and monitoring workstation of scheduling room (client terminal).

Videos and images of industrial television are transmitted through digital network videos. At the bandwidth of 512 kbps, the images can be well restored. Embedded digital network video system can provide high-quality videos and images required by

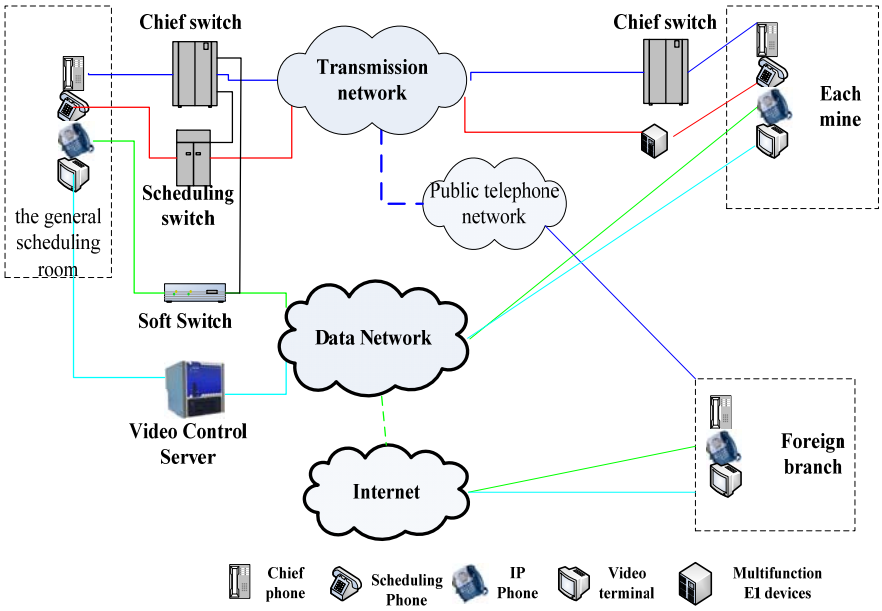

Fig. 4: Logic diagram of scheduling commanding and communication system

the industrial television. In addition, the system possesses good security and stability.

Scheduling and commanding equipment system: As the company's information accumulates, the scheduling and commanding center needs more and more large and high-quality images so that it can conduct efficient and reliable scheduling and commanding.

A large-screen comprehensive display system can provide clear images for the general scheduling room showing the scheduling and commanding personnel information about the production status, safety monitoring, operation and scheduling, industrial television as well as the cable television in the mines. Central control unit of the scheduling room can operate on the touch screen realizing the comprehensive control by the general scheduling equipments. Besides, display interfaces on the large-screen, plasma television can realize free switching. Audio system, indoor lights as well as other electric equipments can be controlled and adjusted.

- **Components and functions of the system:** The system is composed of 3 parts: a large-screen splicing-wall, a plasma television and an audio-video matrix. The large-screen image-splicing is made up of DLP splicing-wall and an image-splicing controller. The audio-video matrix includes AV matrix and VGA matrix.
  Production status information, safety monitoring information, management scheduling information is output through the corresponding computer terminals and then switched to DLP splicing-wall, plasma television wall and scheduling meeting room for display through VGA matrix. The industrial television of each mine is transferred to the general scheduling room through company's data network and then received by the video decoder for decoding. The decoding information then enters AV matrix and then is switched to DLP splicing-wall, plasma television wall and scheduling meeting room for display.
- **Central control unit of scheduling room:** The scheduling room is equipped with DLP splicing-wall, plasma television, sound accompanying equipments and lights. In order to control and operate these equipments in an easy and centralized way, a central control unit is needed to connect the control interfaces of these equipments which can provide a unified control interface to keep a single or combined control over several equipments. The central control unit is composed of a main controller, a touch screen, a RS-232 expansion box, volume controlling box, a relay heavy-current controlling box. The main controller is connected to the corresponding electric equipment though the interfaces and is responsible for the whole control process. The RS-232 expansion box is connected to the large screen, plasma television, audio-video matrix, projector and other equipments. The volume of the sound box is controlled by the volume controlling box. Relay heavy-current

controlling box is connected to the light and the switches of heavy-current equipments.

Production and operation scheduling and management information system: The system adopts a BBS framework pattern. The backstage uses the ORACLE database and the interlayer uses J2EE middleware. The client terminal adopts IE6 browser.

The production, operation, scheduling and management information system is used to gather the data about each mine's production scheduling, safety scheduling, management scheduling, transportation and distribution scheduling and process these data. Besides, the system is used to transmit company's files, safety information and scheduling data and at the same time produce production report thus standardizing the entry of report data and making it easier to analyzing and processing the data.

CONCLUSION

The construction of the coal mine's safety production, scheduling and commanding system is a systematic infrastructure project. It is also an important measure to increase the production safety, comprehensive management as well as the market competitiveness.

When the whole system has been constructed, it can timely display mine's safety production information in an accurate way. When the alarm occurs, the system can inform the relevant personnel through short messages. Besides, it can display production status and environmental monitoring information in the form of graphs, curves, tables possessing a large storage capability and can provide historical data for review. Industrial television images can be directly seen in the general scheduling room. Scheduling and communicating information is provided in 4 ways ensuring its smoothness.

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REFERENCES

Fan, Q., K. Xiao-Hong and L. Yi-Hui, 2008. Complete isolation of scrambled networks based on VPN technology. Comput. Appl. Software, 25(8): 111-113.

Luo, J.Z., H. Zhi-Geng and W. Liang-Min, 2009. Trustworthy and controllable network architecture and protocol framework. Chin. J. Comput., 32(3): 391-404.

Tomokazu, N., Y. Taniguchi and S. Tamaki, 2010. A TCP communication performance improvement method considering congestion status of network. Inform. Int. Interdisciplinary J., 13(1): 123-136.

Wang, S., W. Hui-Ju, Q. Xiong-Pai and Z. Xuan, 2011. Architecting big data: Challenges, studies and forecasts. Chin. J. Comput., 34(10): 1741-1752.

William, S., 2010. Data and Computer Communications. 9th Edn., Prentice Hall, NJ, pp: 888, ISBN-10: 0131392050.

Zhang, H. and S. Wei, 2007. Fundamental research on the architecture of new network--universal network and pervasive services. Acta Electr. Sinica, 35(4): 594-598.