The 19th International Mining Congress and Fair of Turkey, IMCET2005, Izmir, Turkey, June 09-12, 2005

Wireless Lan System For Leg Pressure Monitoring

S. Tadisetty & R.N.Gupta
Department of Mining Instrumentation, National Institute of Rock Mechanics, Kolar Gold Fields, India

K. Matsui & H. Shimada
Department of Earth Resources Engineering, Kyushu University, Fukuoka, Japan

ABSTRACT: The harsh and unpredictable environmental conditions present in an underground coal mine place special demands on equipment and a communication systems. Therefore, the system must be robust, remotely configurable and have the capacity to re-establish itself on power-up without user intervention. The communication link must also support the increasing bandwidth requirements of a modern control system, including data from intelligent sensors and video equipment, which is beyond the capacity of existing serial communication system.

Authors successfully developed the innovative wireless local area network system. It successfully installed at experimental longwall mine. The WLAN was successfully transmitted the underground sensors data. The better data quality and continuity was achieved with this innovative system. Therefore, the powered supports performance was evaluated efficiently in real time. As a result, the management achieved productive mining operations. Besides, this innovative system has many advantages over the conventional systems. In this paper, the discussions mainly focus on wireless data transmissions.

1 INTRODUCTION

The longwall mining is potentially dangerous with human operators exposed to significant risk of injury or death. As longwall equipment has become larger, and safety hazards have increased. Automation of the longwall mining process is therefore seen as highly desirable in order to improve the safety and productivity of longwall mines (Mathur, 2004).

The successful longwall operations are mainly depend on chock shields performance. The continuous monitoring and forecasting of chock shields behaviour is imperative for effective mining operations. The data transmission from underground multiple sensors to surface monitoring system is expensive and need huge maintenance by conventional data cable. Moreover, the signal attenuation and noise influence will be more in long distance cable transmissions. Furthermore, the data quality and continuity will be poor due to signal attenuation and noise. As a result, the conclusions during adverse behaviour will not be reliable and leads to false decisions because of poor data quality. Therefore, the Wireless Local Area Network (WLAN) was successfully implemented for avoiding aforesaid limitations. Thus, this paper will discuss the successful case study of development and application of the WLAN system for achieving data quality and continuity to effective forecasting of the chock shields performance for efficient longwall operations.

2 WIRELESS LOCAL AREA NETWORK (WLAN)

Wireless networks have been around for many years. In fact, early forms of wireless communications include Native Americans waving buffalo skins over a fire to send smoke signals to others over great distances. Also, the use of pulsing lights carrying information through Morse code between ships has been and still is an important form of communications. Of course, cell phones are also a type of wireless communication and are popular today for people talking to each other world wide. The wireless networks use either radio waves or infrared light as a medium for communication between users, servers, and databases. Wireless network fall into several categories, depending on the size of the physical area that they are capable of covering.

The wireless LAN supplies high performance within the specified range. Users in these areas typically have laptops, PCs, and PDAs with large screens and processors that support higher-end applications. The wireless LAN satisfies connectivity requirements for these types of computer devices. The wireless LAN easily provides high level of performance that enables the higher-end applications to run smoothly. The wireless LAN is similar to traditional wired Ethernet LANs in their performance, components, costs, and operation. Because of the widespread implementation of wireless LAN adapters in laptops, most public wireless providers deploy wireless LANs to provide mobile, broadband access to the Internet. The network can be implemented using commercial, off-the-shelf Ethernet components and standard hardware such as optical connectors. IEEE 802.11 is the most prevalent standard for wireless LANs, with versions operating in the 902 MHz, 2.4 GHz and 5 GHz frequency bands. In this development, the wireless operations were successfully implemented in 902 to 928 MHz range. More details are in the following sections (Hargrave et al. 2003).

3 LEG PRESSURE MONITORING

3.1 Pressure **sensor**

Pressure sensor (Figure 1) of strain gage type has a maximum range of 1000 bars. The accuracy was 1% of FSD (Full Scale Division). The pressure sensors were installed at test port of the chock shield rear leg circuit as shown in Figure 1. The sensors have inbuilt signal conditioning facilities. All the underground sensors were interfaced to the wireless data acquisition system through the borehole. The sensors were intrinsically safe. Therefore, the sensors were compatible to underground mining environment.

3.2 Wireless data **transmissions**

The distance between the underground sensors to surface monitoring system was around 10 km. The eight powered supports were selected for continuous monitoring based on preliminary field investigations. They were four from centre of the panel and two each from main and tail gate. The total number of pressure sensors interfaced to chock shields was 8. The data cable required for transmitting 8 sensors data to 10 km was of around 100 km length or more for implementing conventional method. Moreover, the data continuity and quality will be poor in conventional long distance cable data transmissions because of signal attenuation, frequent cable cuts and so on. Therefore, wireless data transmissions were successfully implemented. The abounded borehole was located on surface over the longwall workings (Figure 1(b)). All the sensors data cable was taken out from the borehole and interfaced to the data acquisition system. The radio modem was received data from data acquisition system as shown in Figure 1. The radio modem was interfaced to the wireless antenna. The wireless antenna was commissioned on top of the tower to maintain the line of sight with the receiver (Srinivasulu tadısetty et al. 2003).

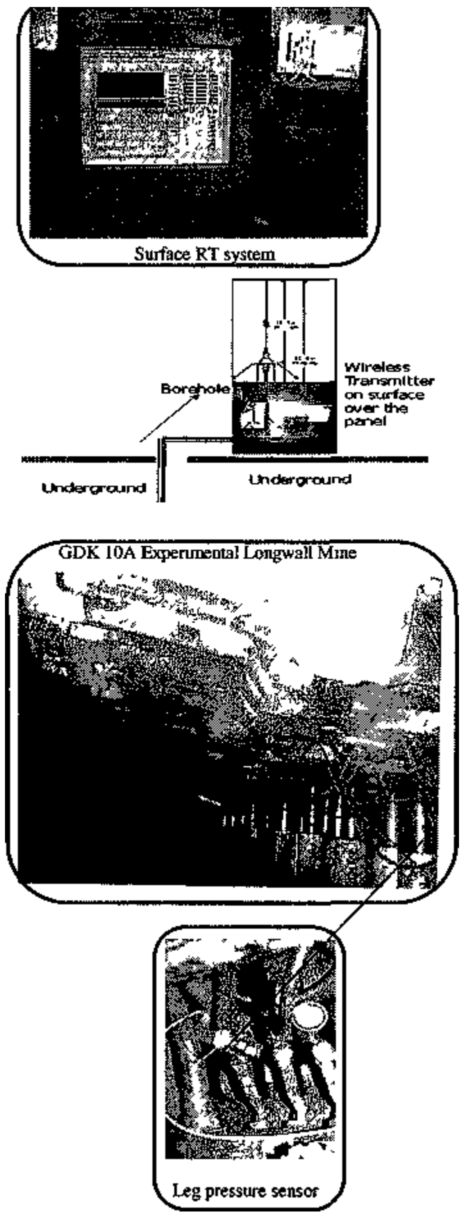

Figure 1(a) Leg pressure sensor interfaced to surface RT system via WLAN

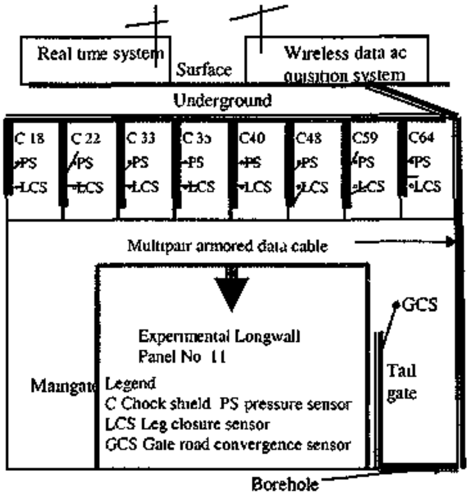

Figure 1(b) Instrumentation Layout at experimental panel

Consequently the wireless operations were successfully implemented for transmitting the underground multiple sensors data in real time However, the wireless operations can be implemented in underground rather than rooting through borehole Furthermore, the transmission range will reduce due to many problems like signal attenuation, absorption, obstacles, line of sight and so on

The main important task was to maintain line of sight in underground Therefore, it needs more wireless modules, complex operations and expensive Thus, the simple and economical solution was to locate the old or abounded borehole for implementing wireless data transmissions as discussed above

3.3 Real Time System

The intelligent dump terminal was interfaced to RT system The RT system interfaced to radio modem and wireless receiving antenna as shown in Figure 1 The display of intelligent dump terminal can be called as real time display The real time system has 40 channels Furthermore, the number of channels can be increased as and when required The acquisition time was selected one minute All the operations were menu driven and user friendly The RT system was automatically analysed acquired data of underground sensors and displayed the chock shields performance as shown m Figure 1 The chock shield behavior was displayed m graphical form on real time display The rate of change in chock shield pressure was displayed in numerals In addition, comprehensive information of various sensors like type of sensor, units, location, exicitaion, and calibration status was displayed The complete data was stored in standard format to retrieve quickly and easily

The real time system was successfully recorded periodic falls, hydraulic leakages, periodic weights, goaf falls, face falls and gate roads convergence The display was updated with latest information for every minute Therefore, the continuous information of the chock shield performance was available for quick decisions to implementing precautionary measures during adverse behaviour for achieving effective and efficient longwall operations

4 DATA ANALYSIS AND INTERPRETATION

The RT system was generated a very big data base because of the data continuity The setting and yield pressure of powered support was 345 and 434 bars respectively The powered supports performance was grouped into six categories as per the support resistance They are type 'A', 'B', 'C, 'D\ 'E', and 'F' (Peng & Chiang, 1984) The type of support behaviour was successfully forecasted m real time The data analysis and interpretation of the RT system records are as follows

The support setting pressure of C35 chock was 380 bars at 8 23 hrs on 20lh March 2003 (Figure 2) It was advanced at 12 24, 16 25, 19 25 and 20 25 hrs The support resistance was always less than the rated setting pressure The support pressure was reduced to 150 bars at 14 24 hrs due to hydraulic leakages The support was in the centre of the panel

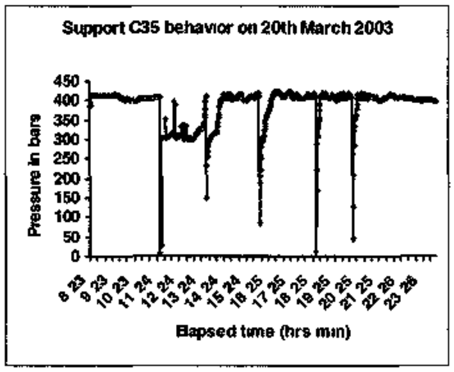

Figure 2 Chock Shield C35 behavior on 20th March 2003

The support was not offered adequate resistance due to deteriorated roof conditions The roof condition was deteriorated due to severe face cavities The face operations were disturbed frequently with the continuous face spalling Therefore, the powered support C35 behaviour was a 'type E' (Peng & Chiang, 1984) as per the discussions Furthermore, the management was successfully implemented various preventive/precautionary measures for avoiding major disaster Subsequently, the management was alerted the maintenance staff for preventing further deterioration of hydraulic leakages As a result, the productivity and safety of mining operations maintained The RT system was successfully recorded and forecasted hydraulic leakages and periodic weightings Eventually, The RT system was successfully forecasted the powered supports performance in real time

5 CONCLUSIONS

The WLAN system was successfully developed and installed at experimental longwall mine The geo mechanical data from underground leg pressure sensors was successfully transmitted The innovative WLAN system was avoided the requirement of expensive data cable and its huge maintenance The better data quality and continuity was maintained for reliable analysis of strata and supports performance It was an economically viable system due to indigenous development Besides, it was fully compatible to underground environment

At present, the WLAN is in application for transmitting data from underground leg pressure sensors The system can be used for transmitting to any type of geomechanical parameters This new WLAN system was helped the Indian mining industry for achieving better productivity

Acknowledgement

The SCCL (Singarem Collieries Company Limited) management and Department of Coal, Government of India was strongly acknowledged for supporting field experimentation and providing necessary funds respectively Further, acknowledged the Japan Society for Promotion of Sciences for approving fellowship to carry out the research at Kyushu University The views expressed in this paper are those of the authors and not necessarily of the organization they represents

REFERENCES

Chad Hargrave, Ron Mcphee, Jonathon Ralston, David Hainsworth and David Reid 2003 Wireless Ethernet for Longwall Coal Mme Automation, *International conference on computer applications in mineral industry,* Canada

Mathur, R B 2004 Technology for tomorrow and equipment selection for Indian coal mines, *International conference on mining science and technology* October 20-22, China

Snnivasulu Tadısetty, Kıkuo Matsuı, and R N Gupta 2003 Frequency hopping techniques for reliable geomechanical data transmission, *Journal on instrumentation* Vol 33 No 1 pp 10 15

Peng S S and H S Chiang 1984 powered supports *In Lonqwall mining,* ed A Wiley Interscience, 188 192