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**RESEARCH ARTICLE**

# UTILISATION OF MOBILE COMMUNICATION IN OPENCAST MINES

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***Abstract---- In past several decades, the mining industry has globally shifted thrust from Underground to open cast mining. The use of large capacity Heavy Earth Moving Machinery (HEMM), their extensive deployment and ever growing challenge to increase productivity have led to increased complexity of operation and management. Developments in information and communications technology (ICT) support the collection, connection and analysis of data through sensing and monitoring of trucks in mines. Sensors are parts of all machines that gather data and have an integral role in subsequent processing and transmission of data. Monitoring is a process that observes a state in time or tracks changes in data sets to derive information. Together, sensing and monitoring provide a mechanism for harvesting digital data. This growth in digital data is being used to drive changes in production and distribution processes and the reach of services in the mines. The application of monitoring plays an important role in collecting sufficient relevant information to achieve the desired outcomes of the process in mines. To provide maximum benefit, wireless mining communication networks must offer broadband speeds and form a flexible and reliable foundation to securely support multiple applications on one cost-effective physical infrastructure. A single mining communication network can simultaneously support a range of applications such as, Lower costs by maximizing truck tire life and minimizing unscheduled maintenance Enhance worker safety with improved situational awareness, collision avoidance systems, real-time streams of high wall scans and "man down" systems Improve security using video surveillance and physical access Control Increase efficiency by enabling mine management software (MMS) in the field Improve office staff productivity with high-speed connectivity.***

***Keywords---- Heavy Earth Moving Machinery, Radio-Frequency Identification, Time Domain Reflectometry, Monitoring site***

## I. INTRODUCTION

An advantage of using wireless systems and the Internet-based approach is that mines can remotely monitor their communications links and other systems within the mine. Some equipment vendors and third-party providers already offer services to monitor the systems, thus eliminating the burden of the mine operations personnel of monitoring and troubleshooting the networks. Because mining communications systems are for day-to-day routine use as well as for emergencies, when an emergency occurs, it is essential that a protocol exists to ensure that the dispatcher in the mine operations center immediately recognizes when the nature of the communication is an emergency. An emergency communication generally includes audio alarms for voice communications systems or visual alarms that display on the screen for text systems.

 

## II. WIRELESS VIDEO FOR INDUSTRIAL SECURITY

Video Surveillance over a wireless network provides a highly flexible way of monitoring outdoor areas such as campuses, parking areas, construction sites and industrial plants. Mobile broadband access allows in-field monitoring and distribution of live and recorded video to mobile users. A metro-scale 802.11 wireless network can be deployed faster and can be setup tactically and then moved, with reduced deployment complexity and cost than alternatives. Key benefits of industrial video surveillance over an 802.11 wireless network. Resource multiplier: Provides extra 24x7 virtual eyes in the locations they are needed. Enables simultaneous centralized monitoring and recording of multiple areas and sites with minimum personnel. Mobile security patrols can monitor entire campus areas from one vehicle. Unattended security: Protection of critical equipment during downtime – collects evidence and acts as a theft deterrent. Improved operational communications: In-vehicle or man-carried cameras allow qualified, off-site personnel to see exactly what is going on, improving decision making and reaction times. Video monitoring of critical operations monitors compliance with safety procedures. Video recording provides visual evidence of accidents, improving operational procedures and reducing fraudulent claims. Improved Remote monitoring of operating equipment or processes augments industrial instrumentation and provides an important visual cross-check of operations in real-time.

## III. VIDEO SURVEILLANCE

Video surveillance helps reduce street crime and creates an environment where people of all ages can work and play in safety and security. Freed from the need for and cost of wired infrastructure, wireless broadband networks let you quickly and cost-effectively deploy CCTV cameras in commercial areas, transportation hubs (2), schools, sports stadiums and more. Wireless networks with video surveillance can also support Intelligent Traffic Systems (ITS), enabling cities to deploy bi-directional streaming, with upstream feeds from cameras to control centers and re-streamed to first responders and to traffic websites accessed by commuters. Moreover, wireless networks designed for video surveillance can also be successfully leveraged to provide Internet access and VoIP.

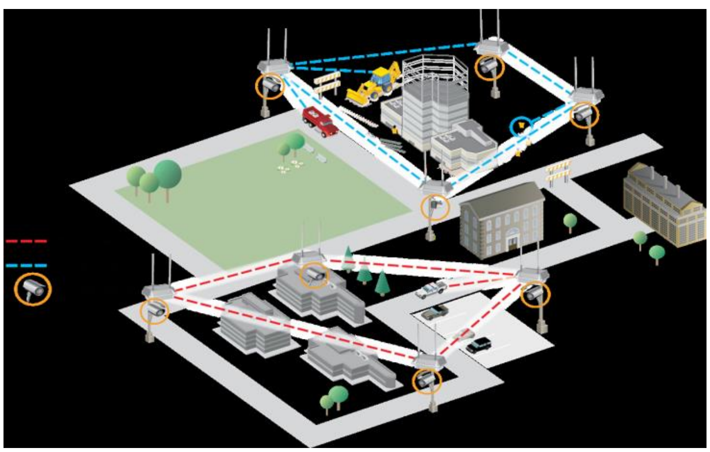

Fig.1: Video surveillance (2)

## IV. TRUCK DISPATCH SYSTEM

Material transportation is one of the most important aspects of open-pit mine operations. The problem usually involves a truck dispatching system in which decisions on truck assignments and destinations are taken in real-time. Due to its significance, several decision systems for this problem have been developed in the last few years, improving productivity and reducing operating costs. According to the literature, material transportation represents 50 per cent of the operating costs for an open pit mine. Dynamic allocation of mining equipment (dumpers, shovels, etc.), thus minimizing the cycle time for open pit mine operations and improving mine productivity. Efficient queue management and monitoring of mobile assets. Effective visualization throughout the operational boundaries within a mine. Trucks are used to haul overburden and ore from the pit to a dump site, stockpile or to the next stage of a mining process. Their use is scheduled in conjunction with other machinery, such as excavators, loaders and diggers, according to the site layout and production capacity. Monitoring of critical parameters of HEMMS and auxiliary equipment's for CBM and safety. Ability to integrate with mine surveys, mine planning and enterprise applications and can be configured with open standard hardware and software platforms such as Microsoft Windows or Linux. Monitoring of the performance of draglines with respect to the swing angle, overload, etc. to maximize operating efficiency.

 

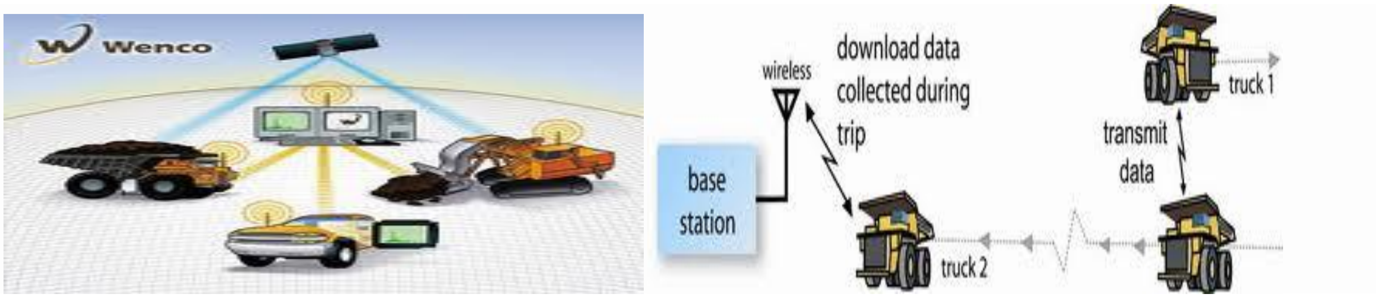


Fig. 2: Truck Dispatch System (7)

## V. THE PROXIMITY DETECTION SYSTEM

The mine installed a Radio Frequency Identification (RFID) system to track vehicle movement. A RFID is commonly used for tracking objects such as cars on toll roads, public transport patrons and library books. RFID systems involve ‘tags’ which send out a vehicle identification (ID) in the form of electromagnetic waves that are interpreted by ‘readers’ showing the presence of an object. The system was primarily installed at the mine to improve the monitoring of production. However, there was an opportunity to add a proximity warning system to, hopefully, reduce the risk of collision between vehicles. ‘Tags’ were mounted on all vehicles. ‘Readers’ were mounted on heavy vehicles with large blind spots; haul trucks and the loaders. A visual display is provided to the drivers via a touch screen tablet computer. This is mounted on the right of the driver for both haul trucks and loaders. The system detects the presence of any vehicles in range, not just those that are determined dangerous or require action. The driver must still interpret the necessary course of action. The screen shows a text list of the vehicles currently being detected (Figure 3). Part of the text indicates the type of vehicle. A sound of alterable volume occurs on detection and the line with the vehicle ID flashes. Both continue until the screen is physically touched.
When the vehicle is no longer detected, it is removed from the screen, regardless of whether the driver has acknowledged its presence by touching the screen.

## VI. ENERGY ANALYSIS OF TRUCK OPERATIONS (DATA COLLECTION AND MEASUREMENT)

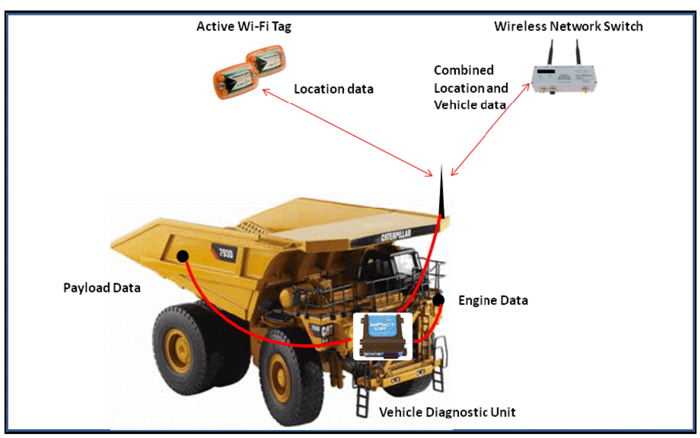


Fig .3: Vehicle Health Monitoring System

There are several data sources that can be used as inputs to an energy efficiency analysis of haul trucks. Mining companies typically maintain records of total diesel use across the mining fleet. In some cases the fuel consumption of individual trucks is measured by recording the amount of fuel that is filled into each vehicle, while other operations simply measure total fuel dispensed to the fleet. Fortes cue was able to acquire data for fuel deliveries to each haul truck from their Fuel management system, and those of their contractors. Many mining vehicles have onboard data collection capabilities. Fortescue’s fleet of Caterpillar 777 trucks used the onboard Vital Information Management System (VIMS) to capture information from sensors and controllers throughout the vehicle, enabling detailed analysis of vehicle performance and engine operating conditions. Fortescue worked closely with Caterpillar to develop a detailed understanding of relevant VIMS parameters. For many of the values recorded, it was important to understand how the VIMS system determined when each mode of the payload cycle started and stopped. In addition to the quantitative data available from fuel and vehicle systems, Fortescue found it useful to also gather qualitative information. Many factors affect the energy efficiency of the trucks, such as the diversity of routes; truck utilization patterns (which can increase the complexity of the analysis); historic information on mine development; site production; and other contextual details that enable a more comprehensive understanding of fuel records and truck utilization data.

## VII. COLLISION WARNING SYSTEMS FOR TRUCKS

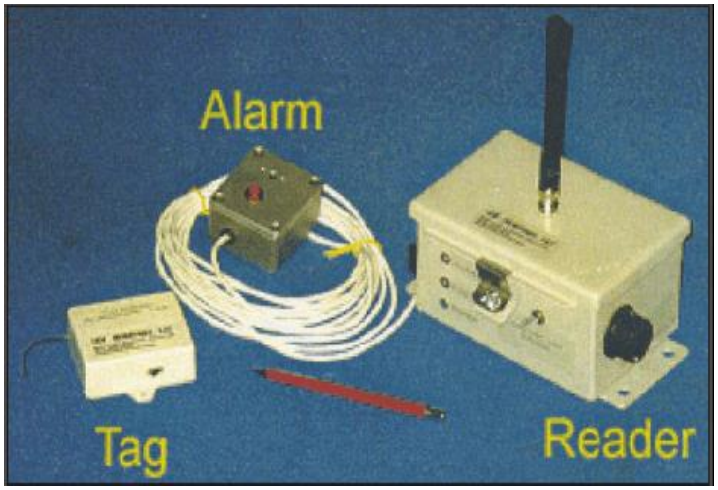


Fig.4: Prototype RFID-based collision warning system built by ID International**.**

An average of 13 mine workers are killed each year by being run over or pinned by mobile mining equipment. At surface mines, these accidents commonly involve large dump trucks that drive over a smaller vehicle or a person that is in the dump truck's blind spot. One method of detecting a person or another vehicle in a blind spot is to use some type of sensor technology such as radar or radio-frequency identification (RFID).RFID-based collision warning systems are commercially available for use on surface mining equipment at this time, some of the systems tested show promise for this application. One advantage of these systems is that they do not generate false alarms. Either a tag is in the reading range of the tag reader or it is not. If the system detects a tag and sets off an alarm, the dump truck operator can be sure that there is an obstacle in his or her blind spot. Attaching tags to objects that are to be avoided assures that only objects of interest will generate an alarm. Rocks, berms, or a high wall will not cause the system to alarm.

## VIII. DATABASE MANAGEMENT SYSTEMS

An Instrumentation Database Management System (IDMS) incorporates those components required to store, transmit, analyze and present the readings obtained from the various instruments. In order to achieve this number of specific sub-systems were developed including the Data Acquisition System, Data Transmission System (DTS), and the Database Systems (DS).

### *A. Data Acquisition and Initial Storage:*

The primary control mechanism for the collection and initial storage of the monitoring data was achieved through the installation of a number of data loggers. Programming of the devices was undertaken using proprietary software to set both the monitoring and data transmission frequencies.

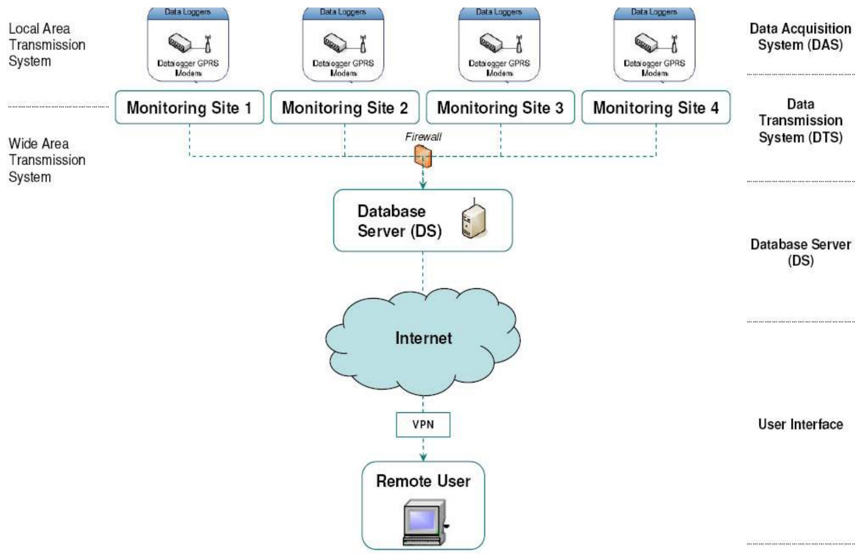


Fig.5: Database Management Systems

***B.Data Transmission System:***

The data transmission system in use for the four monitoring sites consists of a Wide Area Transmission System This system transmits the monitoring data directly from clusters of instrument at various locations throughout the sites back to the monitoring database typically by means of GPRS (General Packet Radio Service) modems. Separate GSM (Global System for Mobile Communications) and SMS (Short Message Service) modems are also being used for data from the groundwater monitoring devices due to the provision of a total system provided, incorporating the transducer, data logger and GSM transmission system(4), by the Instrument manufacturer.

***C.Monitoring Database System:***

At the heart of the instrumentation project is the monitoring database system (MDS), which was designed and installed with all the necessary software and hardware to collect, store, analyze and present the monitoring data automatically. The total storage capacity of the MDS is such that it can handle monitoring data from an additional six monitoring sites (i.e. 10 sites in total), each with an average number of 60 instruments installed. The MDSnormally collects data at 15 minute intervals but is capable of retrieving data at a maximum frequency of 5minutes, although the instruments themselves have far higher frequency capabilities should this be required.

Data security is implemented by means of physical and environmental security, network and communication security, and the built-in security features of the relational database management system (RDBMS). The MDS is located in a secure server room, which has strict control on temperature and humidity, and can be accessed by, authorized persons only.

***1) Monitoring site 1:***

Real-time access to meter data increases billing accuracy Centralized monitoring enables quick detection of problems reducing time for service restoration Centralized ability to turn service on/off reduces truck rolls, saving operating costs Improves conservation of resources with the ability to more accurately monitor and analyze usage.

***2) Monitoring site 2:***

Safety is a major concern as pit slopes and benches are being shaped with the use of explosives and heavy equipment. Wireless broadband enables data from Doppler radar systems to be streamed directly to headquarters in real time. An alarmist immediately sounded should there be an unexpected slump or collapse in the pit wall, keeping workers out of danger.

## IX. WIRELESS SYSTEM FOR MONITORING OF SLOPES

Monitoring of slope movement using wireless communication can be an effective Approach for pre-warning/alarming of many unstable or potentially unstable slopes. Such as fall, topple, slide, spread, and flow, can occur in a variety of materials and degrees of slopes. Specific types of landslides, such as rock fall, earth slump, and debris flow, can occur depending upon the types of geologic materials and movement. Available electronic instrumentation includes vibrating wire piezometers, wire line extensometers, bore hole extensometers, electrolytic bubble Inclinometers, tilt meters, and time domain Reflectometry (TDR) for sensing changes in slope conditions, besides widely practiced total station monitoring(1). Wireless Data Transmission System uses advanced antennas at respective slope instruments in opencast mines or natural slopes. By installing the wireless sensor nodes at respective slope stability points in mines, data from slope instruments and Data Acquisition System can be acquired and interpreted online(3)**.** The basic principle of TDR is similar to that of radar. The cable tester sends an electrical pulse down a coaxial cable grouted in a borehole, when the pulse encounters a break or deformation in the cable, it is reflected. The reflection shows as a “spike” in the cable Signature. The relative magnitude and rate of displacement and the location of the zone of deformation can be determined immediately and accurately. The size of the spike increase correlates roughly with the magnitude of movement, although there is limited research on exact correlations. A laptop computer is connected to the tester and cable signatures are transferred to disk for future reference. By deploying wireless sensor network to TDR we can send the slope movements to control room by using wireless network.

## X. CONCLUSION

A profitable open pit mine operation depends on effective communication efficiency and safety. A high capacity wireless broad band network is the key to achieving this objective. Wireless technology enables continues online planning and real time monitoring of the geological and production activities throughout the operation. The hazards of explosives Wireless communications can significantly enhance the efficiency, productivity, safety Increased safety with increased automation of mining operations. Lower maintenance costs with improved condition-based monitoring .Lower labor costs with the reduction in repetitive tasks with automation. Significant operational efficiencies with the transfer of best practices and supply chain execution enabled by a remote operations center. Wireless network can cost-effectively provide voice and high speed data service to field facilities even in areas that lack cellular coverage. Wireless systems offer the fast, reliable and always available connectivity that is essential for efficient communication and productivity for the industry. Fast, secure Data transfer, VoIP telephony and video surveillance are all supported by a single wireless communication platform. By deploying the wireless Data Transmission System using advanced antennas at respective slope instruments in underground or opencast mines we can collect data without any physical connections.

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