Belowground DGMS approved I.S. WiFi over Fiber Infrastructure with Tracking and Communications

System installed, operated, maintained under supervision of CMPDIL, Mining Electronics Department for three-and-a-half years at Central Coalfields Ltd.'s Lower Semana Mine in Bhurkunda Project.

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Survivable Intrinsically Safe WiFi based Communications Tracking System for UG Coal Mines

Introduction

When it comes to setting up a WiFi digital network infrastructure in underground coal mines, one would be faced with simple questions like how is it different than a WiFi network setup on the surface?

The basic difference between a WiFi network setup on the surface from that in an Underground Coal mine is that all the electronic components that will be deployed in the underground coal mine needs to be “Intrinsically Safe” (I.S.) certified. “Intrinsically Safe” (I.S.) certified means the power transmitted by these electronic should be within stipulated limits and conforming to International Standards IEC Ex ia.

Hence, worldwide I.S. certified WiFi digital network equipment are deployed successfully, so as to facilitate the underground mine applications such as WiFi voice communications, tracking, environmental monitoring, production monitoring, time and attendance system etc. conforming to MSHA (USA/Canada) / IECEx (Australia/New Zealand) etc.

In India, THE COAL MINES REGULATIONS, 1957 (CMR 1957), under the Mines Act, 1952, states the following among other restrictions and Director General of Mines Safety (DGMS), under Ministry of Labour, has been given the mandate and authority to monitor that all electronic equipment to be deployed in the underground mines adhere to these norms. CMR on page 54 states the following:

Where telephones or electrical signals are provided:

1. Signal wires shall be supported on insulators, and shall not be energised at more than 30 volts;
2. Contact makers shall be so constructed as to prevent accidental closing of the circuit; and
3. In every gassy seam of the second or third degree, all signalling or telephonic communication circuit shall be constructed, installed, protected, operated and maintained in such a manner as be intrinsically safe.

Due to these restrictions most of the popular networking electronic equipment, widely used on the surface, ***like the mobile phones or Cisco Wired or Wireless (WiFi) Networking Equipment cannot be used in the underground coal mines*** as they do not meet the statutory stipulation of Intrinsic Safety.

What CMPDIL has achieved so far?

1. CMPDIL in association with M/S AdCept Technologies Pvt Ltd. has successfully obtained intrinsically safe certification for all the networking equipment that has been used in underground coal mines from CIMFR, Dhanbad (I.S. Certificates enclosed in Annexures).
2. CMPDIL has successfully conducted an extensive field trial for a period of three years in the underground coal mines at Bhurkunda Collieries' Lower Semana Seam, CCL, Ranchi under close supervision and monitoring of DGMS, HQ, Dhanbad.
3. CMPDIL has successfully obtained the DGMS approval for all the network equipment to be used in underground coal mines. (Copy of DGMS Approval enclosed).
4. CMPDIL has successfully demonstrated the functioning of the applications, such as Voice Communication, Miner Tracking etc. whereby one could make a two-way voice call from anywhere on the surface to the underground coal mine and vice-versa and also depict the locations of the workforce on the mine map of the underground mines. The same is also visible from anywhere on the surface.

How does the Underground Mine Intrinsically Safe WiFi based Communication and Tracking System Work?

The setting up of the WiFi digital network in the underground is somewhat similar to a WiFi network installation that we see in large office buildings. Like in buildings, in the underground mine, we also create WiFi hotspots by installing Intrinsically Safe Wireless Network Switches at suitable locations and the Intrinsically Safe wireless clients such as MinePhones, Miner Tags etc. that sends data, voice, etc. to the surface through this network. This is depicted by the following picture:

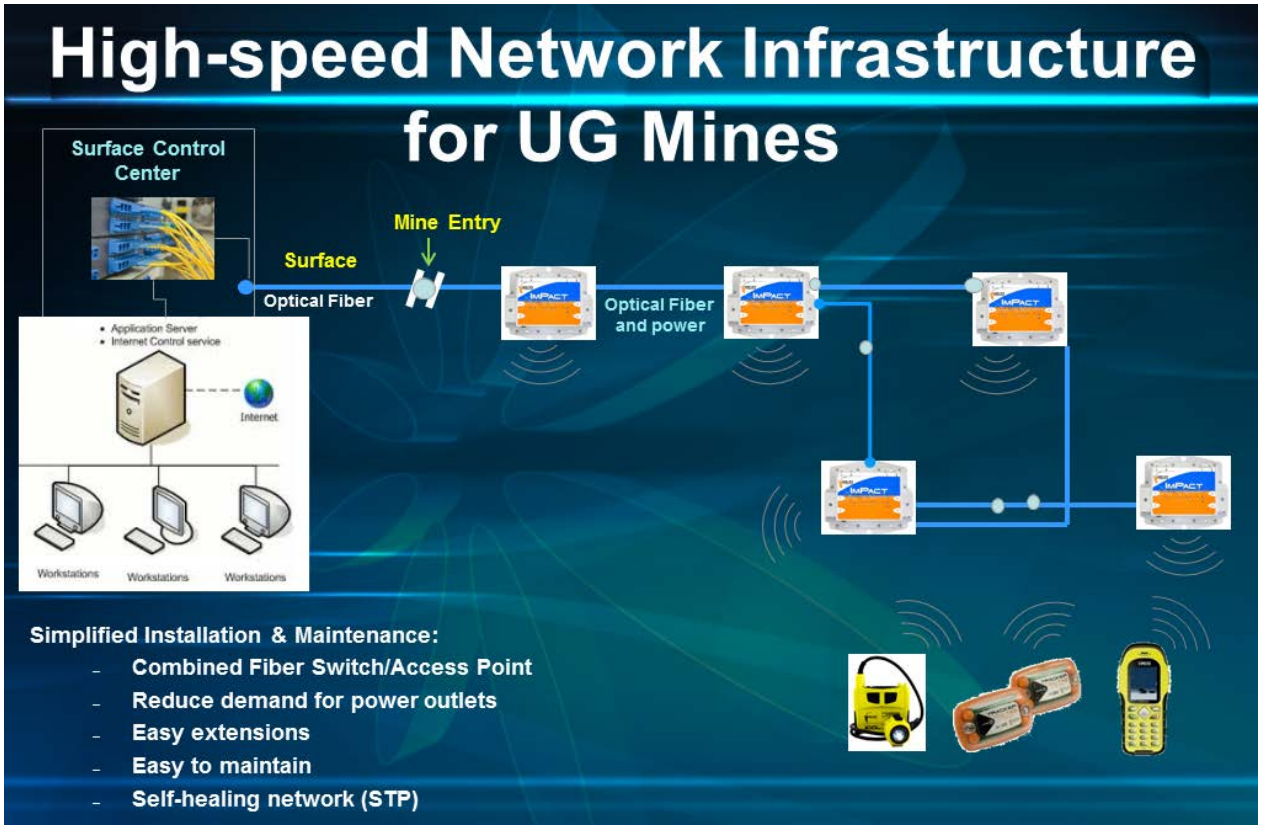

Figure 1: Integrated Intrinsically Safe Network Infrastructure for Degree III U/G Mines

The steps involved are:

1. Create WiFi Hotspots for Voice and Tracking along pre-selected locations in the underground mines. Typical System Layout based on WiFi coverage requirement as shown on Mine Map.

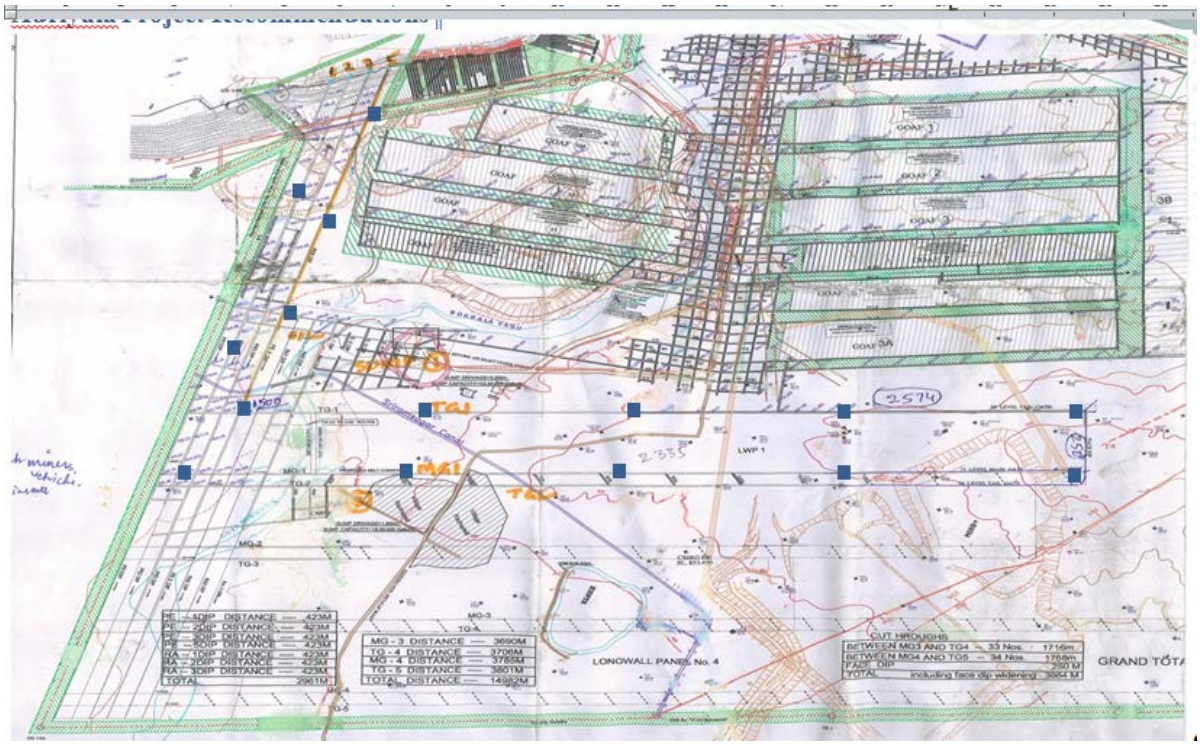

Figure 2: Mine, I. S. Wired / Wireless Network Infrastructure at CCL Bhurkunda Mines

2. After deploying the underground coal mine communication infrastructure, the value-added applications such as wireless telephony, miner / equipment tracking, environmental monitoring, production monitoring, longwall tracking, etc. are rolled out.

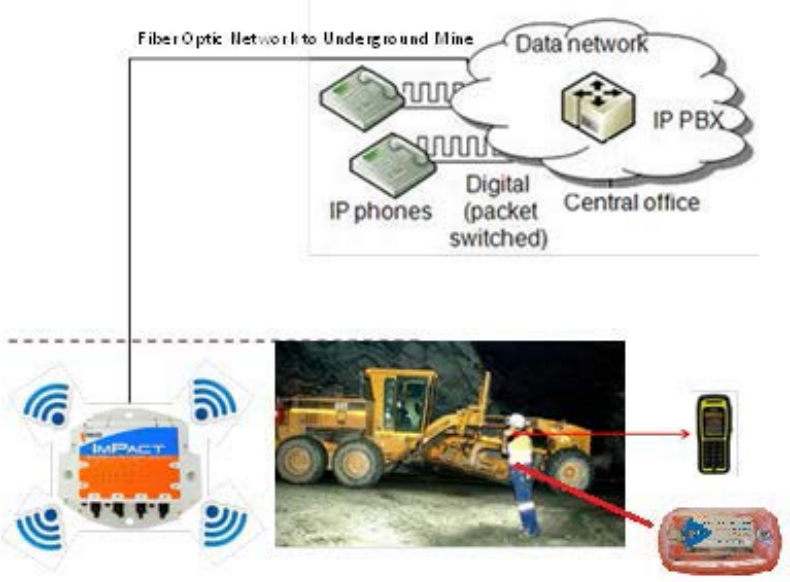

Figure 4 I.S. Wireless Voice Communications

Figure 3. Longwall Powered Roof Support Active RFID

Some applications that run on the Intrinsically Safe WiFi Infrastructure for Voice & Tracking Communications are shown below:

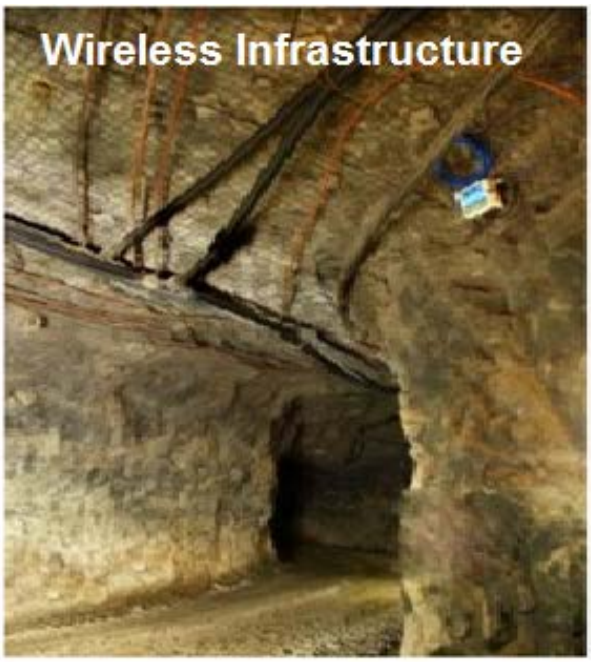

Figure 5 I. S. WiFi Voice and Tracking System

3. The concept of WiFi Tracking in U/G Coal Mines, as the I.S. Wireless Network Switches have the capability to read the miner WiFi tags, in addition to provide wireless connectivity for

WiFi MinePhones. The I.S. Wireless Network Switches are deployed per the requirement of the specific mine.

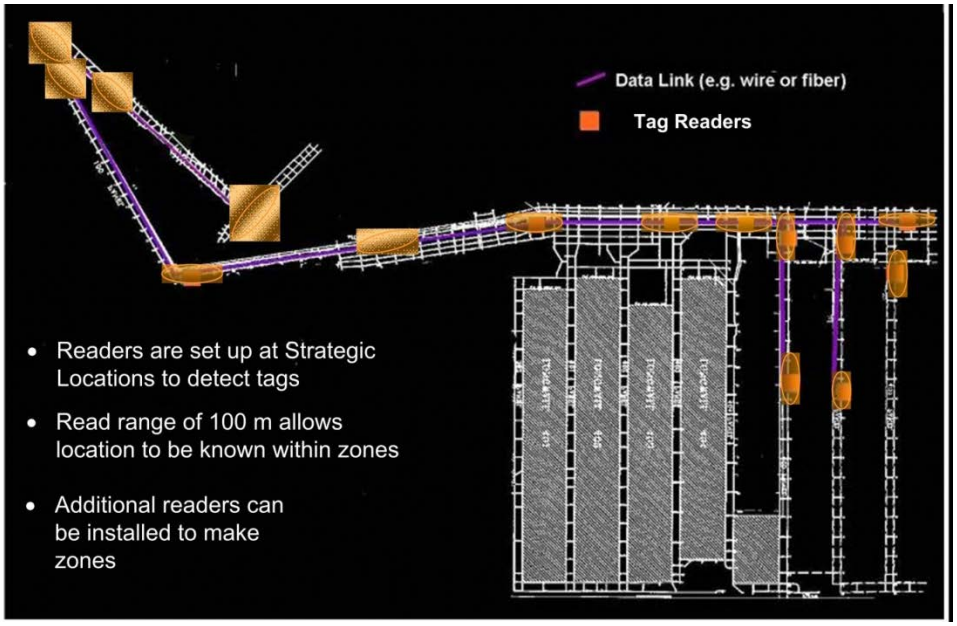

Figure 6 Underground mine Tracking System

4. On the Surface Control Room Screen – Miner and Equipment Location shown in real-time, this information can be shared anywhere, depending on the customer's specific requirements.

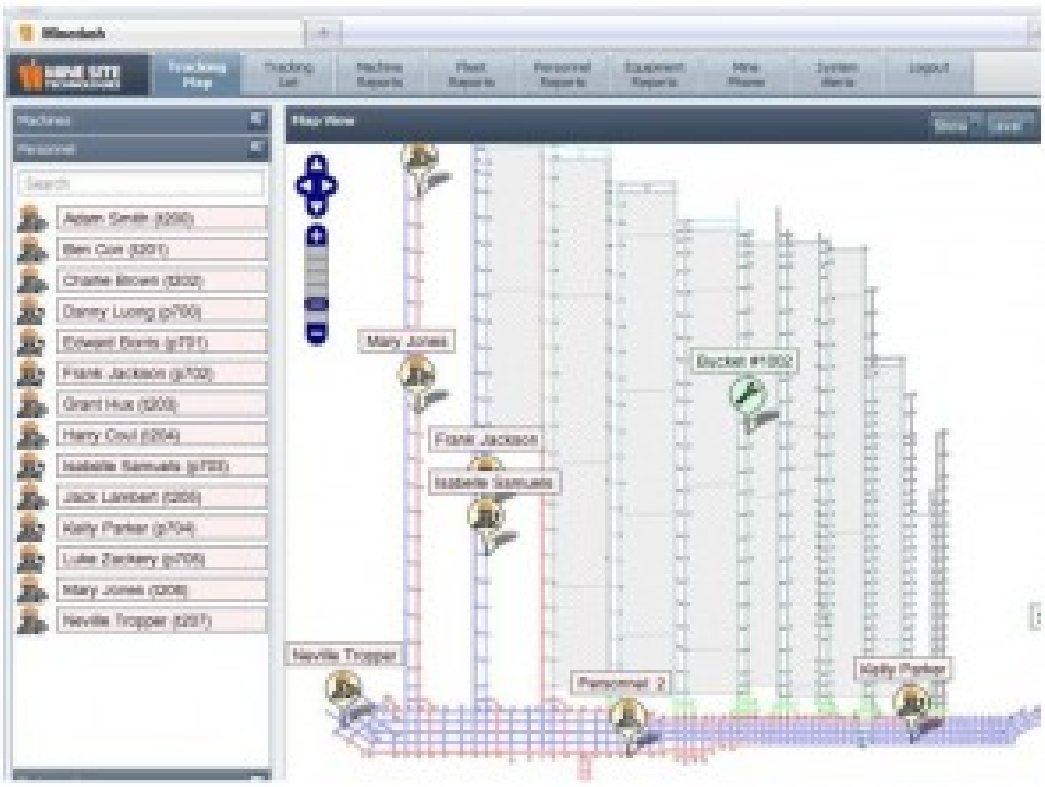

Figure 7 Manpower & Equipment Tracking Dashboard

Benefits realized from the I.S. Communication Network Communication and Tracking System

Now the benefits of "on-the-go" wireless connectivity available to all of us on the surface could be experienced by the workforce in underground coal mines. The underground miner:

1) Can call another miner, a group of miners, anyone around the world from his MinePhone
2) Can send Text Messages from his MinePhone
3) Can be tracked on the mine map of the surface at all times
4) The Miner Tracking System can send alerts of workers approaching pre-designated danger zones

This basically facilitates extending the communication facilities available on the surface to the belowground coal mines, hence extending Digital India into the coal mines.

Adoption of such productivity and safety enhancing technology typically would result in attaining efficient, effective workforce mobilization and utilization, besides reduction of equipment downtime. Furthermore, the system helps attract attention of nearby miners or mine control center operator on the surface, for timely rescue using the "SOS" or "Mandown" feature of the MinePhone. This is possible due to the locationing feature of the MinePhone on the mine map by the surface operator.

I.S. WiFi Based Communications and Tracking - A Quantum Leap in Communications Technology

As of now the only communication technology used in the underground mines in India is an age-old copper wire based analog telephony system. These systems have channel limitations requiring the wired sets to be interconnected along the gallery. The miners in order to use the system have to walk 1Km or so at times, just to make a call and more often than not there is lot of noise. Furthermore, being a proprietary analog, having very low bandwidth, often times supporting just simplex communication. Since this is a wired connection, there is no scope of wireless communication or for that matter cannot support other value adds such as miner / equipment tracking, duplex real-time wireless voice communications, environmental monitoring, transfer of production data etc.

Features	**I.S. WiFi based Digital Wireless Communication and Tracking Infrastructure**	**Copper wired Analog channel based Communication System.**

Coverage Area	Wider coverage per node	Limited to fixed points where wired telephone instrument is installed.
Channel Limitation	No limitations on channels	Limited to a few channels.
Bandwidth	1 Gigabits per second	Analog voice channels only
Scalability with regard to deployment	Unlimited options to extend coverage	Not possible, only limited to drawing wiring to wherever the telephone instrument needs to be fixed
Redundancy – Accident proof	Possible, by multiple parallel routes through the mines to the surface control center	Not possible, only a single line, if damaged then no communication is possible. Very vulnerable in emergency situations.
Presence at mine face	Possible as the MinePhone and Tags are both wireless.	Not possible
Communicate all over the world from any phone, landline or mobile	Possible. One can make a call from anywhere in the world to the underground mine and vice versa.	Not possible, communication restricted to analog telephone in the mines.
Same infrastructure supports many applications	Possible, **Miner Tracking**, **Environment Monitoring**, **Time and Attendance**, **Longwall Tracking, Trip Counting, Conveyor belt monitoring, etc.**	Not possible
Worldwide Use	Prevalent in use worldwide; in line with improved communications technologies on the surface, like cellular phones, Internet etc. Enables digital communications in the underground.	Proprietary copper wire system only limited to use in India and have become obsolete worldwide.

Conclusion

Since last decade, there has been a sea change in the technological environment the world over, and India is no exception. Mining, more particularly underground mining in the Coal sector, is highly challenging as far as the safety, security of miners, and using real-time communication technologies to improve productivity are concerned. This is because of the hazardous gaseous environment in the coal sector and also because of its vulnerability due to inundation, roof-falls/slides, etc. Hence our endeavour is to bring down the hazards by all available technological and communication means so as to minimize the fatality of accidents by creating an effective communication and tracking technology in order to save precious lives of our miners in addition to enhancing improvements in productivity.

Statutory Steps Taken by Government in the field of Adopting Communication and Tracking Systems in Underground Coal Mines

The 10th Conference for Safety in Mines had recommended belowground Communication and Tracking System. **Recommendations of 11th conference on Safety in Mines** held on 4th & 5th July, 2013 at New Delhi included initiatives for establishment of appropriate communication system for below ground mines including to locate the trapped miners.

With the main focus now being to increase coal production from underground coal mines, at the same time eliminating or minimising the risk of disasters in mines, and in this context of prevention of accidents and fatality, keeping the inherent benefits of such communication systems in mind, it is necessary that all underground coal mines install a DGMS approved Intrinsically Safe IP based switched wireless communication and tracking system.

It is an irony that despite being one of the largest producers of coal globally, India has not adopted till date such proven IP based wireless communications and tracking systems in the underground coal mines to improve productivity, accountability, and safety of miners/equipment. It is also an irony despite revolutionary development in mobile communication technology, our Indian underground mining workforce are deprived of even establishing a contact with their family members for a long stretch of working hours in the most hazardous, gaseous, humid working conditions. More so, when the same technology is widely deployed (in 100+ mines abroad) and accepted to improve productivity, efficiency and safety at the same time, all through robust communication and effective tracking of men and machinery.