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Wireless Networks Improve Safety, Efficiency

By Paul May

The MINER Act of 2006 marked a significant turning point for wireless communications and tracking (C&T) networks for the mining industry, initiating a 20-year cycle of ongoing product and technology development. The results of these efforts, such as C&T networks that have been installed and are operational in mines, have led to documented improvements in mining safety, efficiency, and overall productivity.

The original intent of the Act was to improve emergency responses at coal mines by being able to locate and communicate with every miner underground. However, wireless equipment providers for the mining industry have continued to enhance the wireless C&T technologies and are now offering networks that include additional communication modes, asset tracking, environmental monitoring, wireless alarms and notifications, and wireless broadband backhaul to improve production methods.

Networks Initiate Change

These improvements have had a transformative effect on mining operations, allowing mines to easily install remote monitoring sensors, install wireless ventilation and energy controls, and collect data for predictive analytics. They were also the beginning of an evolutionary process for the miners that adopted them and also for the industry in general.

The MINER Act is best known for defining the improvements needed in wireless infrastructure and handheld devices to meet safety requirements for miner tracking and post-incident communications. But another provision in the Act, the establishment of National Institute for Occupational Safety and Health (NIOSH) research grants for projects related to miner safety, has had an equally significant long-term impact for the min-



Wireless mesh communications equipment can be easily deployed (and re-deployed) to meet the changing coverage requirements in a mine. (Photo: IWT)

ing community. These grants, which jumpstarted the needed technology research and product development efforts, have provided the mining industry with commercial sources for C&T networks.

Since 2006, NIOSH grants have resulted in the four major C&T product developments for the mining industry.

Wireless Mesh Networks

First was the commercialization of intrinsically safe wireless mesh networks optimized for the challenging underground mining domain. Mesh networks intercommunicate using multiple redundant paths so that signals are automatically rerouted when obstructions or disruptions occur.

Redundancy means that a properly constructed mesh network eliminates single points of failure, ensuring that wireless voice and tracking communications are reliably transmitted from one end of the network to the other.

Wireless Environmental Sensing and WGMs

Other NIOSH grants helped fund the development of battery powered monitors for atmospheric gases (carbon monoxide, carbon dioxide, and methane) and absolute air pressure, air temperature and humidity. The pressure data can be used for ventilation monitoring, and the ventilation data gathered from the wireless gas monitors (WGMs) can be used for ventilation planning.

One key requirement for these devices is the use of C&T networks for data transport and alarm notification to users both underground and in administrative dispatch hubs.

Smart Battery Technology

Also partly developed with NIOSH money was maintenance analytics capabilities to remotely monitor battery health for intrinsically safe backup batteries installed in C&T network infrastructure. Due to the specialized na-

ture of intrinsically safe batteries, the existing commercial technology could not accurately predict the degradation of those batteries, which, in turn, lead to batteries that would “silently fail.”

Today, the smart battery technology in the C&T equipment will alert mine maintenance to replace the batteries before a failure will adversely affect the overall safety provided by the network.

Mine Safety Data Analytics Engine

There is a growing market need for a data analytics engine that can collect, parse, measure, analyze, and present big data at mine sites as actionable information to mine managers. The data can come from a variety of sources, but one key origin is data collected from users and equipment on the C&T network.

The correlation of personnel location and environmental data, along with additional telemetric data from mining equipment, will allow mine operations to have a comprehensive, real-time picture of operations. The analysis and correlations from historic data can then be fed into predictive analytics to predict potential safety risks, resulting in recommendations for proactive safety measures.

Leveraging New Tech to Augment Old Tech

While NIOSH grants have been successful as a kickstarter for the development of communications technology in the mining industry, wireless communication vendors have also made significant investments on their own to expand the capabilities of the original C&T networks. One example is leveraging the deployment of high-bandwidth fiber optic and ethernet cabling used to carry wireless voice and tracking to aboveground operations centers.

New intrinsically safe wireless broadband mesh equipment, developed specifically for the mining industry, provides convenient Wi-Fi access points for a wide range of data collection and dissemination. These

hotspots can also collect telemetric data from equipment passing by, or from fixed equipment in the coverage area. Because the mining hotspots use wireless mesh backhaul, the network can easily grow or move with advances in the working section.

Additional customer-driven C&T enhancements are currently being released by wireless equipment vendors. The Internet of Things (IoT) continues to generate new control, sensor, and data collection devices for mining extraction and material handling equipment.

In cases where IoT equipment generates alarms, C&T networks can route the alarms to individual or group handsets or to section alarms for mass notification. C&T networks have also expanded the interoperability capabilities for voice communications, allowing the voice transmissions to be interconnected to legacy aboveground analog and digital LMR networks, cellular push-to-talk networks, and phone systems.

Geofencing for Additional Safety

Finally, C&T real-time location services are being augmented with high-precision ultra-wide-band sensor networks for geofencing of hazardous areas and equipment. These high-precision location services can be used for stand-alone proximity detection or integrated into vehicular controls to protect miners from accidental pinning or crushing.

The high-precision location service can also be integrated with C&T communications networks to provide real-time equipment status updates using mining tracking and visualization software in the operations office.

High precision location services, combined with wireless broadband mesh, can support a variety of emerging technologies as well. For example, with these integrated technologies, mines will be able to adopt virtual-reality and augmented-reality technologies to train new miners by simulating complex procedures or emergency conditions.

While today’s wireless broadband mesh products can support limited video streaming, ongoing developments will increase this capability. The wireless broadband mesh technology will also provide the network access for advancements in tele-remote and autonomous longwall, continuous mining, and haulage equipment.

The net result of the improved communication networks combined with advanced data collection and back-end data analytics provides the basis for the digital transformation of the mining industry. Mines will be able to replace manual information-collection processes, estimates, and intuition with data-driven decisions to meet safety standards, production goals, and efficiency improvements.

Mines that have embraced data automation and analytics are seeing measurable improvements in productivity because exceptions, such as equipment failures, are reported and corrected on a real-time basis. Combining the real-time data with analytics on maintenance records and regulatory compliance issues drives additional efficiency gains by eliminating issues, such as equipment failures, before they occur.

The Miner Act of 2006 has had a profound impact on the mining industry’s approach to communications and tracking systems. The mandated upgrades and subsequent technological advancements have resulted in safer working conditions for miners.

The integration of advanced communication networks, real-time tracking, and data-driven monitoring has transformed underground mining operations from isolated environments to interconnected and safer spaces. This digital transformation brings data-driven solutions to enhance operational efficiency, safety, and sustainability. And, as technology continues to evolve, the communications backbone provided by the C&T networks will support further innovations to enhance miner safety and operational efficiency.

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