Barbara Wagner, Innovative Wireless Technologies Inc., USA, explores the rise of wireless networks in underground mining.

he mining industry has seen a significant transformation in how data and communications are managed over the past decade. The industry has shown a shift towards digitalisation to operate more efficiently, improve worker safety, and make informed, real-time decisions. Internet of Things (IoT) devices, combined with wireless communication technologies, in particular, have revolutionised underground mining, providing unprecedented levels of connectivity and streamlining operations even in the most remote locations.

## The digital shift in mining communications

Traditionally, mining operations depended on manual reporting, paper logs, and legacy communication systems that limited data accessibility and responsiveness. Over the past two decades, though, the need for greater efficiency and safety has led to the adoption of modern digital communication networks. At the same time, today's mines are deploying IoT real-time monitoring systems to track operations as they happen. Remote monitoring and automation have also become integral, allowing operators to control equipment from centralised locations, reducing human exposure to hazardous environments. Data is now centralised and analysed, enabling operators to optimise productivity and make data-driven decisions that enhance operational outcomes.

Mining environments present unique challenges that often require a combination of wired and wireless network solutions. Fiber and Ethernet remain necessary in centralised control areas, providing stable, high-speed connections. But, for the last mile, legacy leaky feeder systems have been shown to be substandard and are being supplemented with more modern and efficient solutions. Wireless networks have gained popularity due to their flexibility and ability to adapt to changing mine layouts. Wi-Fi and cellular networks are widely used in surface facilities, while underground operations increasingly rely on mesh networking for scalable, resilient connectivity. The choice of network infrastructure is influenced by site location,



Figure 1. The SENTINEL<sup>™</sup> WGM+ enhances safety and efficiency with real-time gas monitoring and communication in one device.



Figure 2. Integrated wireless systems allow instant gas alerts and communications for faster, safer response.

mining conditions, cost considerations, and the necessity for real-time data. Wireless solutions have become a preferred choice due to their adaptability, reliability, and speed and ease of deployment in dynamic underground settings.

# The growing shift toward wireless technologies

Wireless mesh networks are rapidly becoming the backbone of underground mining operations. Unlike wired systems, they eliminate the need for extensive cabling, allowing for faster deployment and easier integration of new sensors and equipment. These networks also improve safety by enabling real-time tracking of personnel and machinery, allowing for quick responses to emergencies. The ability to support IoT-enabled sensors ensures seamless data transmission, facilitating predictive maintenance and enhanced operational efficiency. As mines continue to embrace automation and remote operations, wireless communication technologies will remain at the forefront of innovation.

Safety is the top priority in mining, and wireless mesh networks, like those developed by US-based Innovative Wireless Technologies (IWT), are making a significant impact in protecting workers and improving operational awareness. Continuous connectivity ensures that safety-critical information is communicated instantly, enabling better coordination between workers and emergency response teams.

Advanced wireless sensor monitoring within the network detects potential hazardous gas levels, ventilation issues, or equipment malfunctions, providing real-time alerts that allow for immediate action. In emergency situations, rapid communication and automated alerts minimise downtime and improve incident response. Data analytics further contribute to safety by offering predictive insights, helping mine operators implement proactive measures to mitigate risks before they become critical.

A key advantage of wireless networks in underground mining is their ability to support a diverse range of critical services within a single, unified infrastructure. Unlike traditional systems that require separate networks for voice communication, data, equipment monitoring, and safety sensors (such as gas monitoring and proximity detection), an integrated wireless solution consolidates these functions into one seamless platform. This not only reduces the complexity and cost of deploying multiple networks, but also enhances reliability and efficiency. A single, scalable network can support real-time communication between workers, automate machinery controls, enable predictive maintenance through IoT sensors, and provide continuous tracking for personnel safety. By streamlining operations and eliminating communication silos, an all-in-one wireless network creates a more cohesive, responsive, and future-proofed mining environment, ensuring that operations remain agile as technology and industry demands evolve.

One example of this is IWT's SENTINEL<sup>™</sup> WGM+, which combines critical communication services and hazardous gas monitoring into a single, wireless device. Traditionally, mines relied on separate systems for voice communication and atmospheric monitoring, often leading to inefficiencies and gaps in data collection. The WGM+ streamlines these functions by providing seamless, real-time voice and text communication while continuously monitoring gas levels for potential hazards. This integration not only enhances safety by ensuring miners receive immediate alerts about dangerous conditions, but also simplifies deployment and maintenance by reducing the need for multiple devices.

### Innovations in mining communication

The demand for reliable underground communication has led to the development of specialised solutions tailored to the mining sector. Companies like IWT have introduced platforms which integrate wireless communication with real-time monitoring, location tracking, and enhanced safety features. Future advancements in mining communications will incorporate high-speed wireless mesh data networks, advanced proximity detection, and improved analytics for predictive maintenance and hazard prevention. IoT sensor networks will continue to evolve, allowing for more precise data collection and analysis, further optimising decision-making and operational efficiency.

The future of mining communications is driven by emerging technologies that will further enhance safety, efficiency, and automation. Advanced IoT sensor networks are improving environmental monitoring, predictive maintenance, and automated reporting. Additionally, edge computing is playing a crucial role in reducing latency and enhancing real-time decision-making capabilities by processing data closer to the source. Autonomous systems, supported by wireless networks, are revolutionising mining operations by enabling self-operating machinery that reduces human exposure to hazardous conditions. Proximity detection technologies are also evolving, providing enhanced tracking solutions that improve worker safety and underground navigation.

#### Expanding beyond mining: Wireless networks in other industries

The benefits of integrated communication networks extend beyond mining. Similar technologies are being deployed in oil and gas operations, maritime industries, and other sectors that require reliable, real-time data transmission in remote or hazardous environments. The ability to provide continuous monitoring and automation across various industries highlights the growing influence of wireless communication solutions in enhancing safety and efficiency across multiple applications.

#### Future-proofing network investments

The adoption of wireless mesh communication networks is transforming underground mining, enabling real-time monitoring, improved decision-making, and enhanced worker safety. Furthermore, wireless mesh networks increase in value as additional services are deployed over a common backbone. As digitalisation continues to reshape the industry, the role of advanced communication solutions will become even more critical. With continuous advancements in wireless technology, automation, and Al-driven analytics, the future of underground mining communications promises to be more efficient, connected, and secure than ever before. **GNR**