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STATUS OF COMMUNICATION AND TRACKING TECHNOLOGIES IN UNDERGROUND COAL MINES

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STATUS OF COMMUNICATION AND TRACKING TECHNOLOGIES IN UNDERGROUND COAL MINES

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Mining Engineering in the College of Engineering at the University of Kentucky

By

Alexander David Douglas

Lexington, Kentucky

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2014

ABSTRACT OF THESIS

STATUS OF COMMUNICATION AND TRACKING TECHNOLOGIES IN UNDERGROUND COAL MINES

In 2006, Congress passed the MINER Act requiring mine operators to submit an emergency response plan that included post-accident communications and tracking systems to MSHA within three years of the Act. These systems were required to be designed for maximum survivability after a catastrophic event, such as a fire or explosion, and to be permissible (meets MSHA criteria for explosion-proof). At that time, no commercially available systems existed that met these standards. Several companies undertook developing new, or enhancing existing, technologies to meet these requirements. This research presents the results of a study that was conducted to determine the present day types of systems being used, along with their average annual worker hours, coal production, number of mechanized mining units, and type of communications and tracking systems installed. Furthermore, 10 mines were visited to obtain detailed information related to the various technologies. It was found the most influential parameters on system selection include MSHA district, mining method, and number of underground workers.

KEYWORDS: Communication, Tracking, Underground, Coal Mine, MINER Act

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CHAPTER 1: INTRODUCTION

Mining has always had a reputation as a dangerous profession and rightfully so. Mining safety has improved dramatically in the last several decades, but in 2006 the mine disasters at Sago, Aracoma and Darby mines spurred the talk for new legislation to protect miners. The Mine Improvement and New Emergency Response Act of 2006 (MINER Act) created new laws to improve safety in mines and addressed how after disasters it can be difficult to receive accurate information from underground mines. Mine rescue teams had virtually no information on the location, severity, and extent of mine disasters.

The 2006 MINER Act set forth several standards and improvements regarding mine preparedness to disasters. It was determined that at a minimum the last known location of every miner be available and a way of communicating from inside the mine be established. The Act with regards to communication and tracking reads as follows:

> "(i) POST-ACCIDENT COMMUNICATIONS.--The plan shall provide for a redundant means of communication with the surface for persons underground, such as secondary telephone or equivalent two-way communication.
>
> "(ii) POST-ACCIDENT TRACKING.--Consistent with commercially available technology and with the physical constraints, if any, of the mine, the plan shall provide for above ground personnel to determine the current, or immediately pre-accident, location of all underground personnel. Any system so utilized shall be functional, reliable, and calculated to remain serviceable in a post-accident setting.
>
> "(ii) POST ACCIDENT COMMUNICATIONS.
>
> --Not later than 3 years after the date of enactment of the Mine Improvement and New Emergency Response Act of 2006, a plan shall, to be approved, provide for post-accident communication between underground and surface personnel via a wireless two-way medium, and provide for an electronic tracking system permitting surface personnel to determine the location of any persons trapped underground or set forth within the plan the reasons such provisions cannot be adopted. Where such plan sets forth the reasons such provisions cannot be adopted, the plan shall also set forth the operator's alternative means of compliance. Such alternative shall approximate, as closely as possible, the degree of functional utility and safety protection provided by the wireless two-way medium and tracking system referred to in this subpart.

Very few technologies were available that could meet the requirements set forth by MSHA, and even fewer were approved as permissible for use in underground coal mines. The research program established by NIOSH provided the funds to quickly research, develop, and market new systems that meet all requirements; additional companies undertook the tasks without assistance from NIOSH. Two technologies, leaky feeder and node based radio frequency, quickly gained the popularity of the mines, with Wi-Fi technology quickly catching up in the following years.

1.1 Thesis Problem Statement

To better understand how each technology is utilized by the mining industry, a survey was carried out to examine the installation, operation, performance, and maintenance experiences with wireless communications and tracking (CT) systems that have been installed in underground coal mines as a result of the MINER Act. To date, no complete survey and analysis of the use and distribution of underground communication and tracking systems have been conducted and this report aims to compile this information. A comprehensive sample consisting of a variety of sizes, systems, location, and mining methods was chosen for this study. An interview was conducted with maintenance personnel, and when possible a tour and inspection of the installation was included.

1.2 Method

A database of over 500 underground coal mines that were currently in operation in the United States was developed to examine how different communication and tracking technologies have been adopted by the mining industry. The data was collected from various sources, including a freedom of information act request for information from initial emergency response plans from Mine Safety and Health Administration (MSHA), a previous study conducted by Schifbauer (2006), and the annual production reported to MSHA. The data was compiled in early 2013 with the most current information at the time; changes in specific mines could have occurred post compilation and are not reflected in this study.

The information gained from the site visits was used to draw conclusions of the data collected in the data base. Several patterns emerged showing different mine parameters have a significant effect on the selection of communications and tracking technology. The mine parameters with the greatest statistical significance were mine location, mining method, and number of miners.

1.3 Thesis Structure

The thesis is broken into chapters to better organize information. In Chapter 2 the background information for this report can be found. It details the technologies used in underground communication and tracking. Chapter 3 details the site visits conducted and provides information on real world implementation of technologies. Chapter 4 discussed the 500 mine database and compares statistics on the reception of technologies. Finally Chapter 5 will summarize the conclusions of the study.

CHAPTER 2: BACKGROUND INFORMATION

There are several types of communications and tracking systems that comply with the regulations set by the MINER Act in 2006. The following chapter details these systems with reference to the basic setup and signal source. Communications systems are leaky feeder and node mesh. Tracking systems include radio frequency identification (RFID) and received signal strength identification (RSSI).

2.1 Leaky feeder

Leaky feeder cable has been used in underground operations for several decades. It has proven itself as a reliable, cost effective way to transmit radio frequency underground. A basic layout example can be seen in Figure 2-1. The construction of a leaky feeder line makes the entire length of cable behave like an antenna. The cable consists of a special coaxial cable with a solid core and a partial shield; the empty spaces of the shield allow radio signal to "leak out" into the mine area. Two common types of shield are used, perforated holes and stranded wire (the perforated holes can be seen in Figure 2-2). Both cables operate similarly; in-line amplifiers are needed to maintain the signal strength over great lengths because the cable "leaks" out it signal, as a result power is leaked as well. The inner core of the leaky feeder cable provides DC power-supply voltage to the amplifiers. Since the entire cable acts as an antenna, the mine has continuous communication for the length of the cable. Radio waves, however, have very poor propagation characteristics underground, and if the miner is not in line of site with the cable, radio communication is lost.

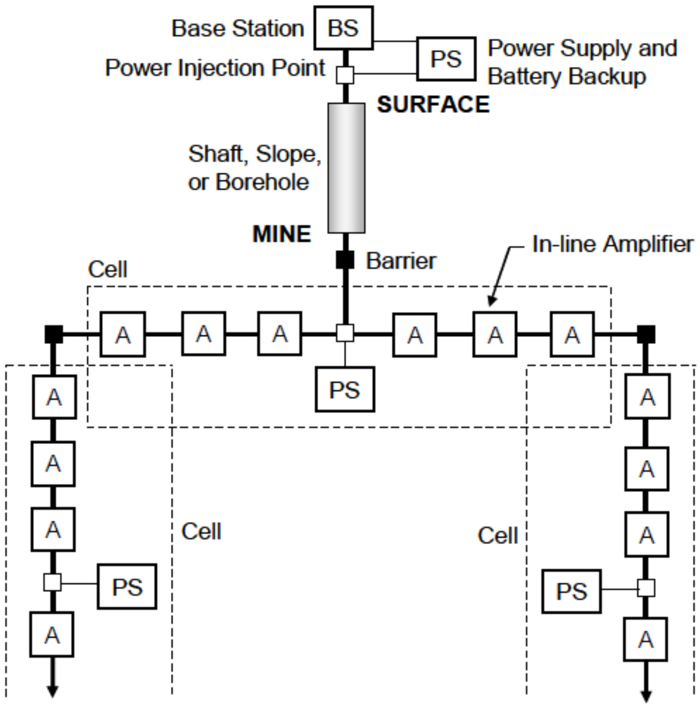

Figure 2-1: Basic Leaky Feeder Layout (Novak, 2010)

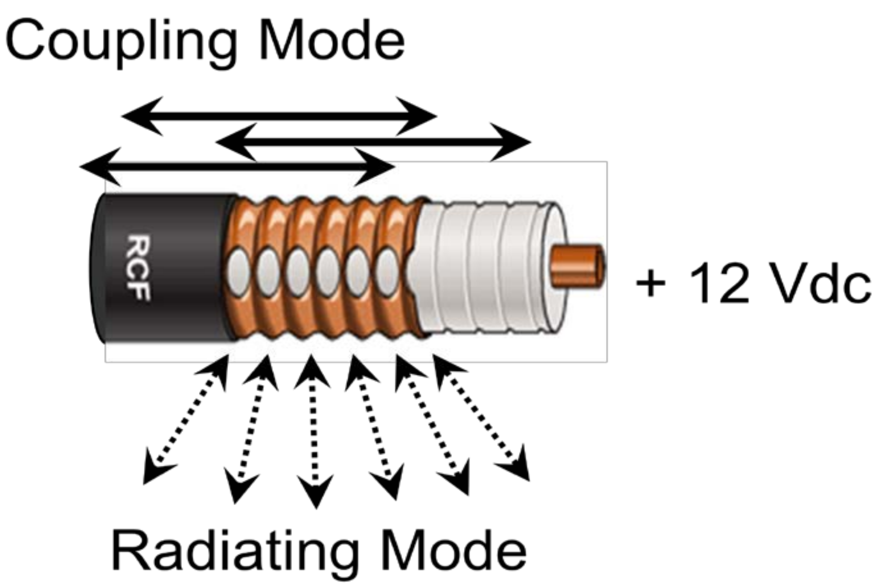

Figure 2-2: Leaky Feeder Cable

Only one cable is used to both send and receive signals. To allow for this, multiple frequencies are used. A radio signal is received on one frequency, travels to the base station, usually on the surface in the mine office, and then is retransmitted at a different frequency on the same cable to broadcast through the mine. With this capability, mines are able to have up to 16 channels of communication, and the base station is able to broadcast to every channel simultaneously in the event of an emergency.

The leaky feeder can also be used as the backbone for tracking. The most notable companies that supply leaky feeder systems to coal mines are: Pyott Boone, Mine Radio Systems, Tunnel Radio Systems, Mine Site Technologies, and Varis.

2.2 Mesh Systems

Several companies developed mesh systems that use discrete signal relay points (nodes) placed throughout the mine that will communicate with hand held devices on miners and with other nodes. In a true mesh system, all nodes would be able to communicate with all other nodes in the system, but in a coal mine this would be impossible due to thousands of feet of rock blocking signal propagation. A more accurate description would be partial mesh, where any node can communicate with any other node in range (Novak, et al., 2010). A major difference, when compared with a leaky feeder, is that the information is transmitted in a digital format and does not have to travel to a central base station. The nodes themselves can communicate among themselves through wire or wirelessly. Every node can communicate with any other node, resulting in multiple redundant paths that can be used in the event of a node failure. A visualization of the node mesh system can be seen in Figure 2-3.

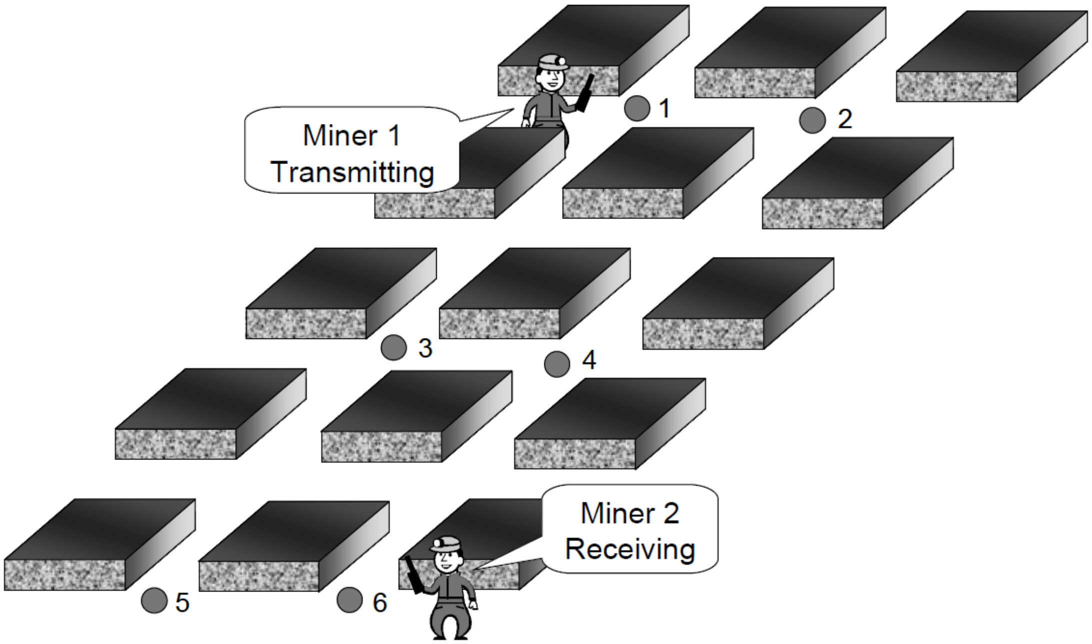

Figure 2-3 Node based system (Novak, 2010)

A node mesh system can be made up of wired, wireless or a combination of both (Figure 2-4). Wireless nodes can transmit information between points without the need for a signal wire. The most common method of wireless node communication is using radio frequency (RF) signals. Wi-Fi is quickly catching up to use of RF technologies due to the increased range and bandwidth of signals. Wireless systems can be either battery or hard wire powered. Battery powered systems require batteries to be changed every few months, while hard wired systems need a direct power connection to a power supply.

Wired systems require a wire to connect two nodes to communicate. Common wire types for data transmission include twisted pair, coaxial, and fiber optic. The fiber optic has the highest bandwidth, but is also the most fragile. As all wired systems require at least a signal wire, the mobility gained by using batteries is negated and thus all wired systems are hard wired to power.

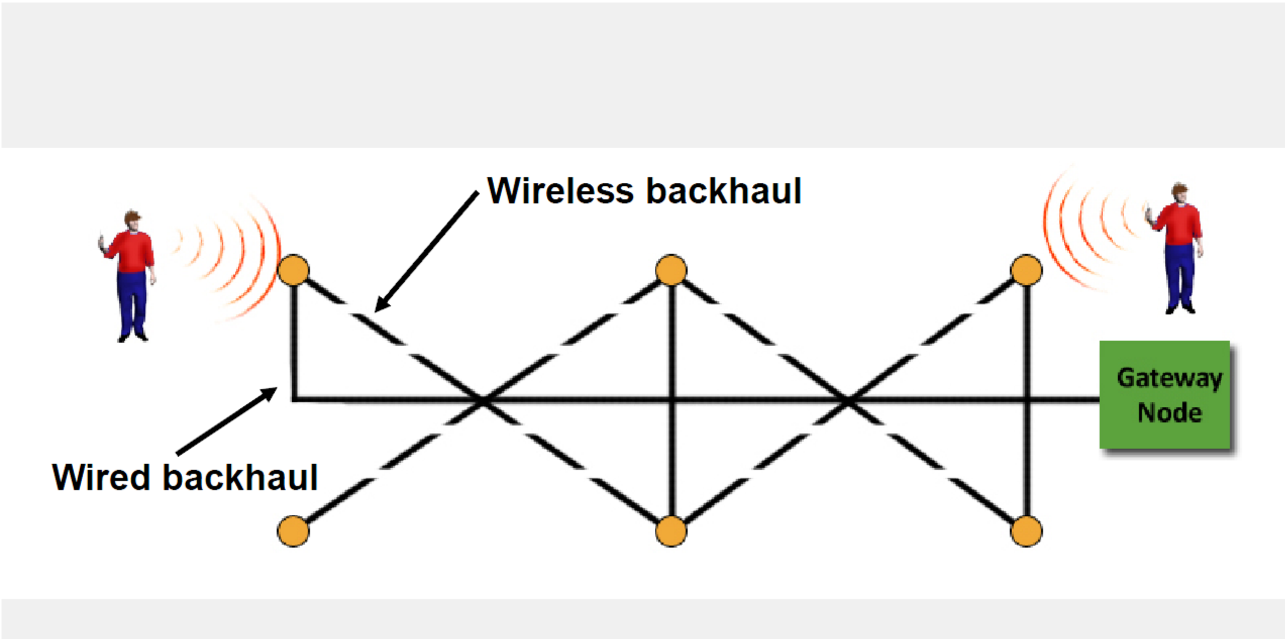

Figure 2-4 Node-Based Systems (Dubaniewicz, 2009)

It is common for companies to combine the advantages of both systems and create a hybrid system. Generally the system is wired from the surface to the feeder breaker, where wireless nodes are used inby. The working section contains several pieces of mobile equipment which increase the risk of damaging communication cables. In this study, if the system is wired to the feeder and wireless in the face, it is considered a wired system. A summary of the classifications can be seen in Table 2-1.

.

Table 2-1 - Wired vs. Wireless

Wired	Wireless
American Mine Research	Active Control
Matrix	American Mine Research
Mine Site Technologies	L-3 Communication
	Strata Safety Products
	Venture Design Group

2.3 Tracking

Tracking of miners allows mine rescue teams to easily narrow the search area in the event of a disaster. The MINER Act requires at a minimum the last known location of every miner at the time of the event to be recorded outside. Miners location must be accurate to 200 ft in the face and have tracking from the portal to the face in both the primary escape way and secondary escape way.

2.3.1 Radio Frequency Identification

The most common mine tracking systems use RFID technology. RFID has two components, a tag and a reader. A tag can be active, passive, or semi-passive (Bai-ping 2008). Active tags contain a battery to power the signal while passive tags capture power from radio waves to transmit its unique ID, semi-passive tags use a combination of these technologies. The only type commonly used in coal mines is active tags. In conventional use, tag readers are hung in strategic locations throughout the mine and recorded on an electronic map outside. When a tag enters the range of the reader, the reader broadcasts the ID of the tag out of the mine, using whatever infrastructure is present, being leaky feeder or wireless node. The key for RFID tracking performance, is maintaining up to date records, including location of readers, reader IDs, and tag owners. Inaccuracies in any of these fields can render the system useless.

An alternative method of RFID tracking, reverse RFID, was developed by L-3 in 2007 as part of a NIOSH contract. In reverse RFID systems, the readers are portable units the miners carry with them, and the tags are installed at fixed locations. The reader transmits the calculated location through the miner's radio. This method allows for accurate tracking because many more inexpensive tags can be hung, compared with the relatively expensive readers. Tags are hung in every other crosscut and take an average of only 3 minutes to install. The system can only update tracking location if the miner is in range of the communication system. This proves troublesome when leaky feeder lines are not in the entry where the miner is working (Milestones in Mining Safety and Health Technology, 2011).

2.3.2 Received Signal Strength Identifier

A lesser used, but highly effective method of tracking is Received Signal Strength Identifier (RSSI). In this method, a tag sends it signal to at least two receivers. The receivers are able to determine the signal strength of the tag and using a ratio of received signal strength and distance between the readers. With this method, the resolution of the system can be several meters instead of several hundred meters. While this method does increase the accuracy considerably, the need for two readers to be able to see the tag is a disadvantage.

CHAPTER 3: CURRENT TECHNOLOGIES – SITE VISITS

To better understand how each technology is utilized by the mining industry, a survey was carried out to examine the installation, operation, performance, and maintenance experiences with wireless communications and tracking (CT) systems that have been installed in underground coal mines as a result of the MINER Act. A comprehensive sample consisting of a variety of sizes, systems, location, and mining methods was chosen for this study. An interview was conducted with maintenance personnel, and when possible a tour and inspection of the installation was included. The questionnaire used in this study can be found in Appendix A.

It is important to note that the reported opinions are site specific to the individual mines and are not necessarily representative of the full range of mine environments for each system. The visits only provide a general idea of how each technology is implemented. Mine names and contact personnel are withheld to maintain confidentiality.

3.1 American Mine Research

American Mine Research provides a wired-backbone, node-based system. The mine visited that utilizes this system, employees 29 underground staff per shift, who operate three mechanized mining units (one super-section and one single section) exploiting the 5.5-9 feet thick coal seam.

A MN-6020 splitter, located every 5000 feet as pairs to provide redundancy (Figure 3-1), create the backbone of the system. Trunk lines extend to the remote stations (Figure 3-2) which in turn connect to Smart Readers (Figure 3-3), that provide four ports for CT antennas. The PVC T-shaped antennas (Figure 3-4) are located every 1000 feet and at every head drive; separate antenna are used for communication and tracking. A Portable Acquisition Device (PAD), as seen in Figure 3-5, is located on the section in every entry for two crosscuts outby the face. The size and number of PADs create obstacles that equipment often knock down, which require re-hanging; this slows production and can result in replacement in areas with poor signal propagation, e.g. in crosscuts with no clear line of site.

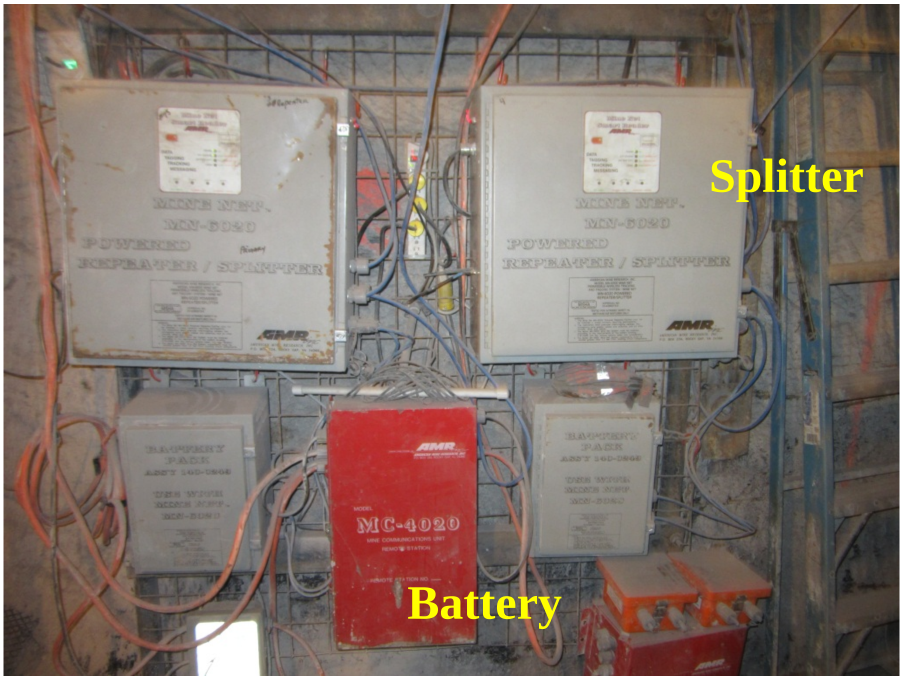

Figure 3-1: Splitter Pair

Figure 3-2: Remote Station

Figure 3-3: Smart Reader

Figure 3-4: Antennas

Figure 3-5: PAD

Communication is only available via text pagers (Figure 3-6), making it difficult and time consuming to enter messages, with several seconds to minutes of lag when transmitting and receiving signals. Vibration, flashing light, and an audible alarm alerts a miner to a message, but when worn on the belt, noise and vibration by equipment hinder their recognition. The text pager antenna can be knocked off when entering and exiting vehicles or using man doors, rendering the device ineffective until noticed, located, and repaired. An active tag (Figure 3-7), worn on various locations including hard hat or suspenders, provides tracking and emergency messaging. False emergency alarms from the tag occur daily due to accidental bumping and pressing of the button.

Figure 3-6: Text Pager

Figure 3-7: Active Tag

The system has two distinct paths for the signal to exit the mine that connect at the face. This allows a signal to reroute in the event of a disturbance, minimizing downtime by ensuring the majority of the system remains operative while repairs are made. This enables a single miner per shift to handle all maintenance requirements of the CT system. Multiple breaks create large dead zones, but repair of a malfunction may be carried out before this occurs. Some malfunctions include: cable wear due to vibrations, corroded connectors, and falling draw rock.

The constant repairs required by communication lines and the lack of voice communication created a desire for the mine to upgrade to AMR's newer Wi-Fi system. At the time of the visit, the mine had begun installation of the new system, but it was not operational. Mine personnel expect the new system will reduce maintenance requirements and improve effectiveness by adding voice communication.

3.2 L-3 Communications

The L-3 Accolade system utilizes wireless nodes. At the time of this mine visit, workers were developing the shaft bottom. The mine currently utilizes two continuous miners (CM) with plans to expand to five CMs and a longwall system with an annual production of 3.2 million clean tons. The coal seam averages 5.5 feet in thickness at a depth of 600 feet. The mine employs 244 underground miners. When full production begins, 320 miners will work underground. Currently an average shift consists of 50 underground employees.

The mine uses the L-3 Accolade System to meet all of the CT requirements established by the 2006 MINER Act. The system supports both voice and text communication. Accolade radios were in the process of being changed to the Innovative Wireless Technologies (IWT) radios. The components of the Accolade system include: a mine operations center, gateway nodes, fixed-mesh nodes, beacons, miner mesh radios, batteries, and antennas. A simplified, general layout of the accolade system can be seen in Figure 3-8.

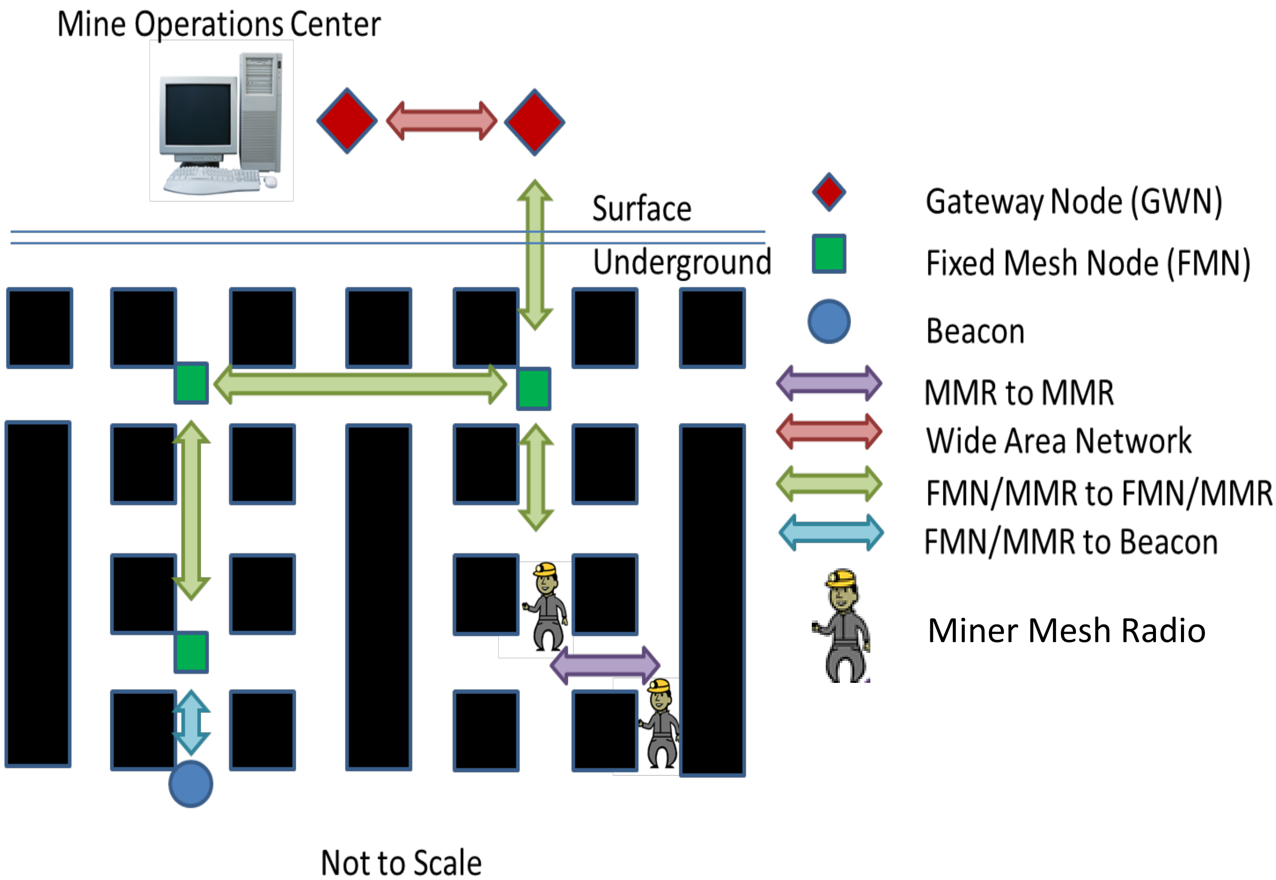

Figure 3-8: L-3 Communications General Layout

Fixed mesh nodes (Figure 3-9) provide the infrastructure backbone of the system, communicating wirelessly with each other and the miner mesh radios (Figure 3-10). Each node requires a battery backup and power supply, located up to 1900 feet away, and each power supply can support up to three nodes. The battery backup is continuously charged by the power supply and is capable of supplying 96 hours of reserve power. If a node fails, the signal is rerouted to other nodes within range, providing a redundant path which allows the CT system in the rest of the mine to remain functional. The paths of communication can be seen on the Pro-V map outside.

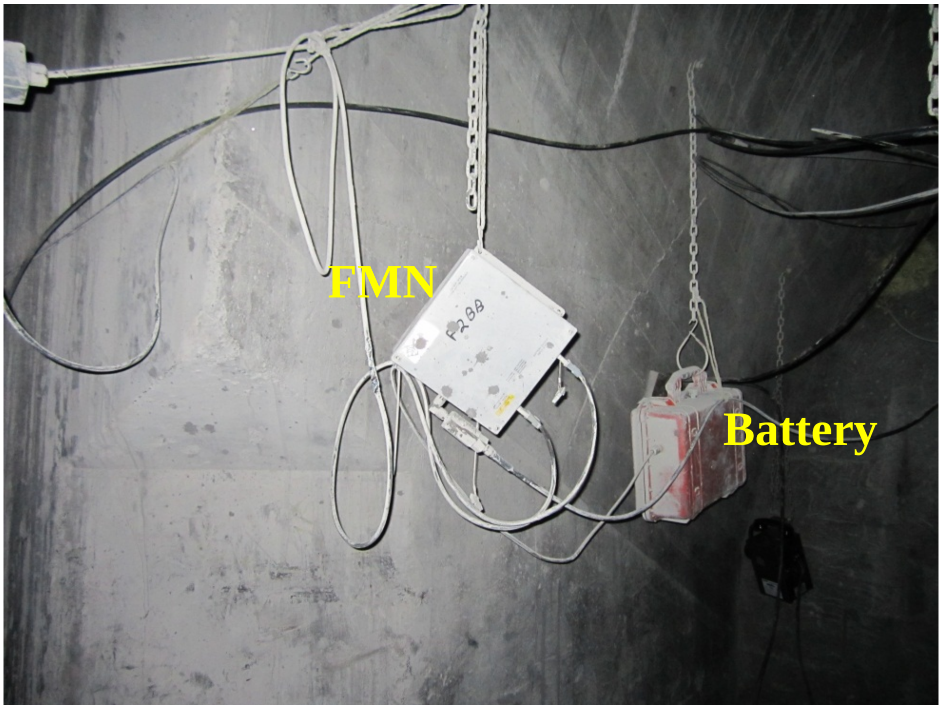

Figure 3-9: Fixed Mesh Node and Battery Backup

Figure 3-10: Miner Mesh Radios

Figure 3-11: Mine Operations Center

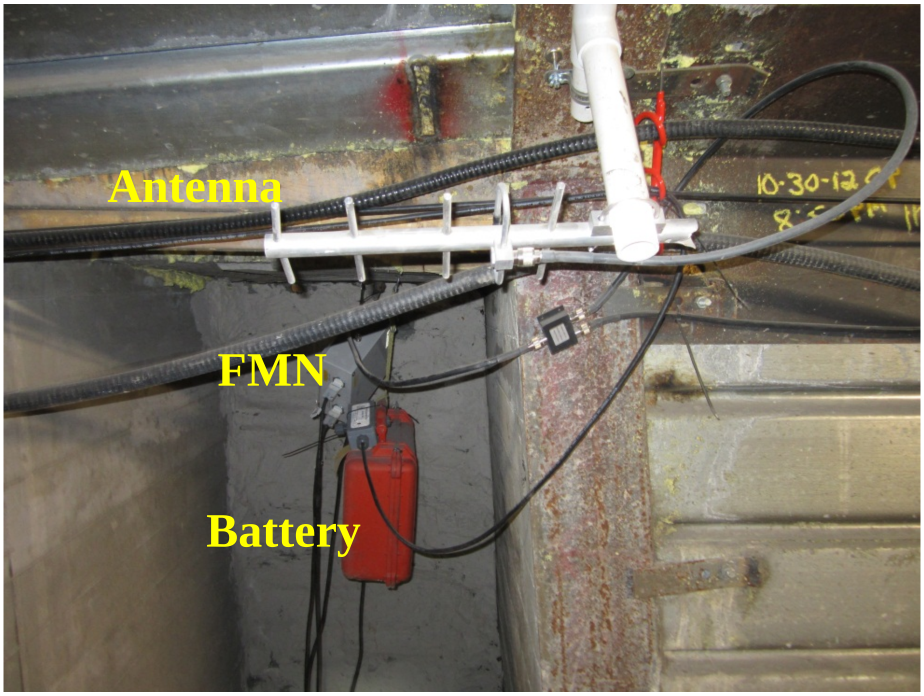

Figure 3-12: Node, Battery, and Antenna

Each fixed mesh node supports up to six antennas (Figure 3-13). Antenna spacing is no greater than 300 feet with closer spacing in areas with poor signal propagation e.g., around pillars where men often work and where dips and crests occur in the coal seam. The antenna connects via a coaxial cable, which comes in lengths of 4 feet to 100 feet. Antennas include magnets in the base to be easily attached to roof bolts and roof-support straps. All six antennas connected to a node are usually placed inby the node. Antenna placement and orientation affect signal strength. An antenna can be orientated both vertically and horizontally, but must remain consistent throughout the mine. If two antennas point at each other, "robbing" can occur, creating a weaker signal.

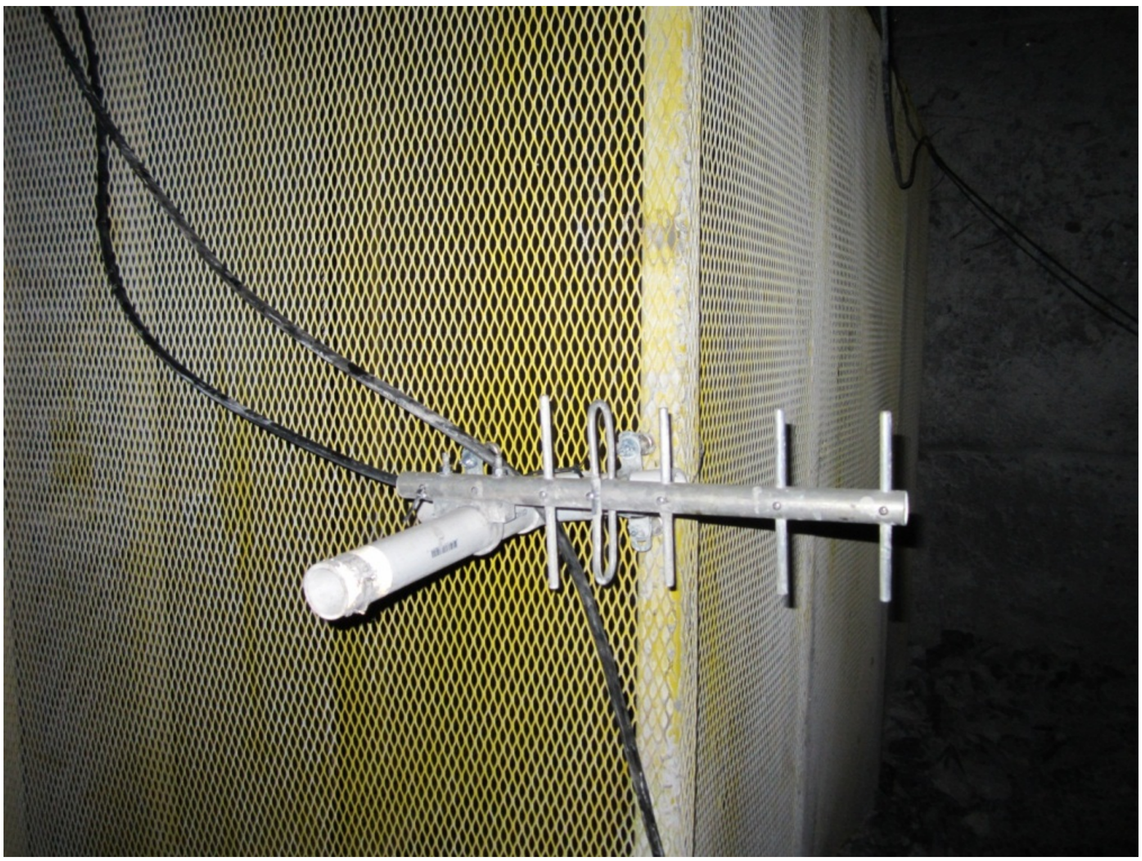

Figure 3-13: Antenna

Beacons are only used for tracking in the face and at rescue chambers, and are powered solely by batteries; they do not support communication systems. A beacon has a smaller antenna, and associated range, allowing placement in every entry for accurate tracking without overlapping signal interference. The tracking location can lag for up to a minute, creating a delay between actual location and reported location.

The general opinion of workers is that the L-3 system is a good CT system that functions well. The installation and maintenance are not difficult, but very time consuming. Currently a single miner carries out the majority of installation and maintenance underground at the mine. When full production begins, the mine estimates that 2-3 employees per shift will be dedicated to the CT system.

When initial training was scheduled to take place, the temporary method for entering the mine was being lowered in a hoist bucket, so the representative from the manufacturer refused to go underground, leaving the workers with only a description of how to install the system and no practical on site instruction. Without receiving the initial support and training necessary, the job was challenging. Issues encountered include: having both horizontally and vertically mounted antennas, antennas robbing signal from each other, and an excessive number of nodes and antennas being installed. Another manufacturer representative resolved most of these issues; however, an additional visit was scheduled for training, after this survey visit.

3.3 Matrix Design Group with Varis

Two mines were visited using a Matrix system in conjunction with Varis; the second visit follows the summary of the first.

The first mine visited uses the Matrix METS 2.1 System, which operates at 433 MHz, to meet the CT requirements established by the 2006 MINER Act. Only text communications are available with this system. A series of hubs are located throughout the mine and are daisy chained to a server in the surface control center, shown in Figure 3-14, via fiber cable. The fiber cable can also be split into separate braches in a junction box as shown in Figure 3-15. Figure 3-16 is a photograph of a monitor displaying the hub arrangement. A simplified, general layout of the system is shown in Figure 3-17. Each hub includes a power supply and battery backup for the wired nodes connected to the hub. The wired nodes are interconnected in a mesh fashion with coaxial cable to provide redundancy and improve survivability. Coaxial cable provides the communication link between the wired nodes (Figure 3-18), as well as supplying their power. The hubs are housed in XP boxes, as shown in Figure 3-19, because of the large number of nodes to which they are required to supply power. In smaller mines with fewer nodes, intrinsically safe systems are possible, and XP enclosures are not required. Wireless nodes, also arranged in a mesh configuration (Figure 3-17), are used in the working section inby the feeder breaker for ease of placement and to eliminate the possibility of face-haulage vehicles damaging or severing communication links. Unlike a wired node, each wireless node (Figure 3-20) is powered by a self-contained battery which has an approximate life between 35 and 75 days. Both types of nodes are readers for a variety of devices, including text pagers, tracking tags, and carbon monoxide sensors.

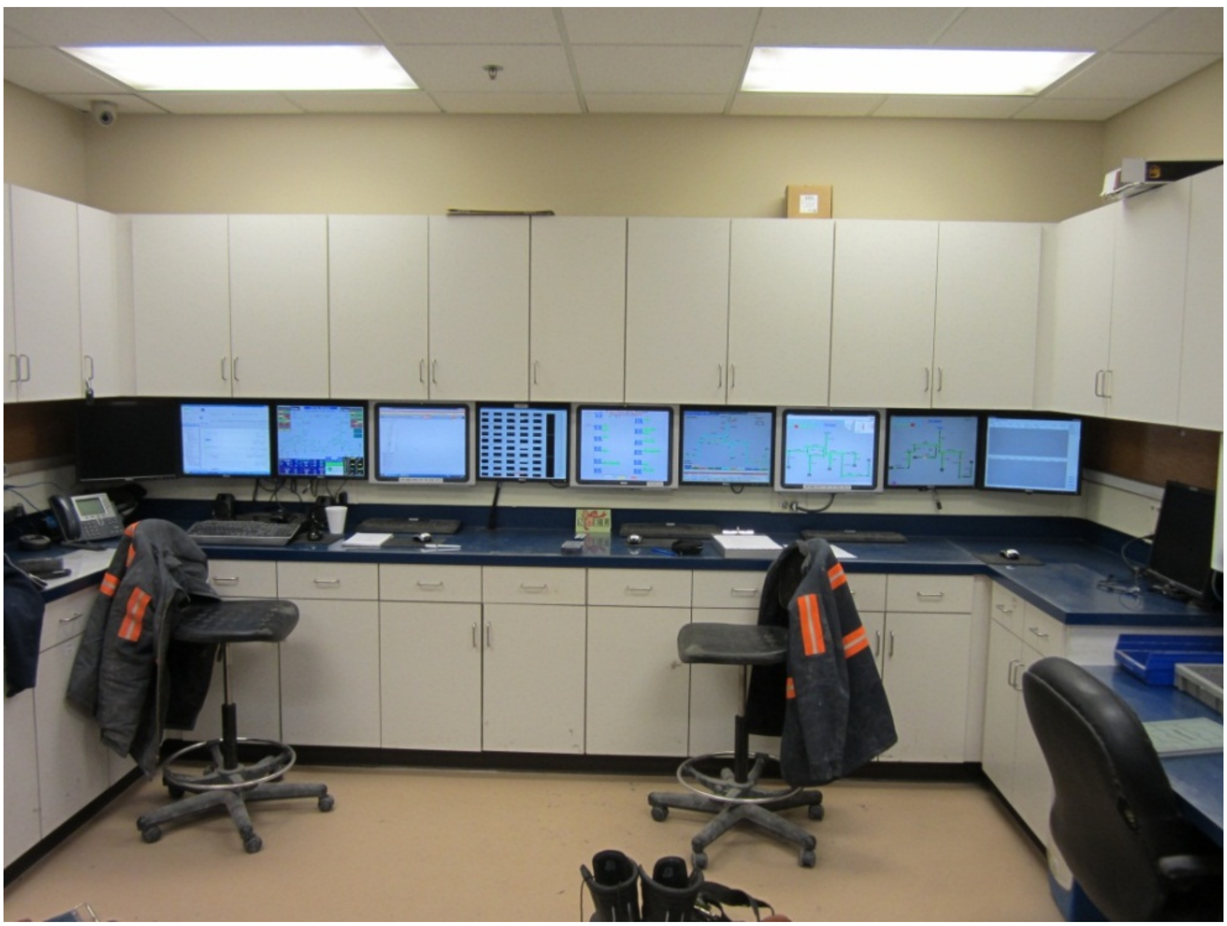

Figure 3-14: Surface Control Center

(a) Front view. (a) Side view.

Figure 3-15: Fiber Cable Junctions

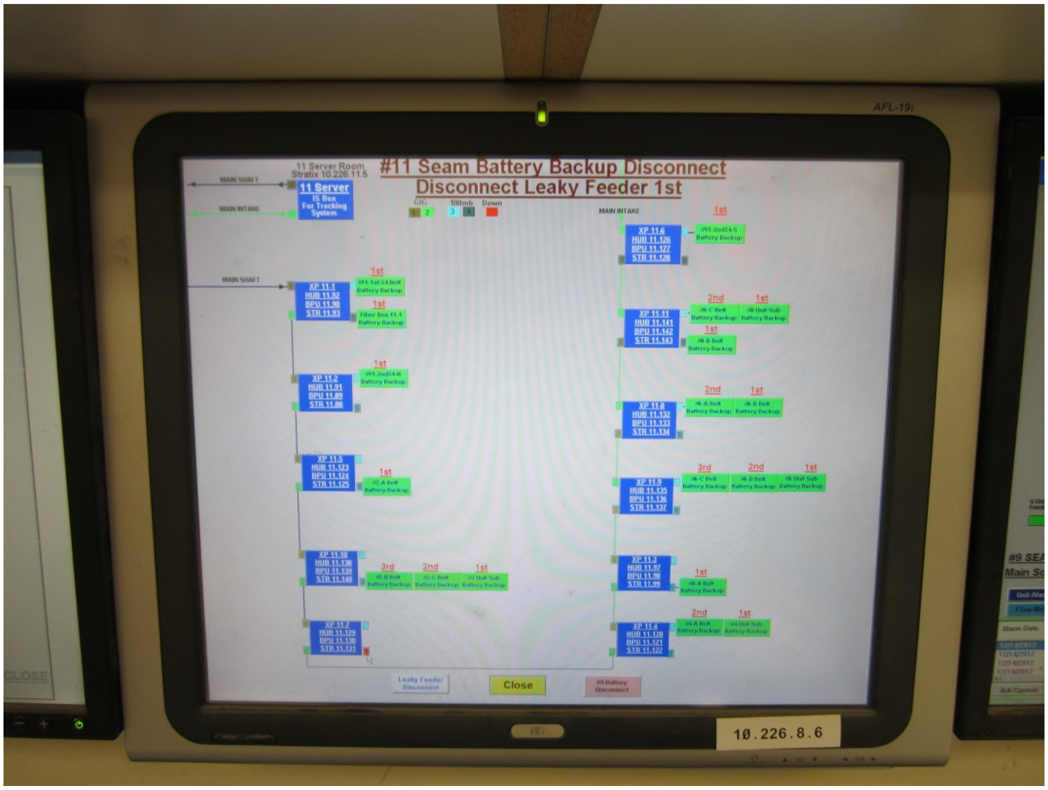

Figure 3-16: Display of Hub Arrangement

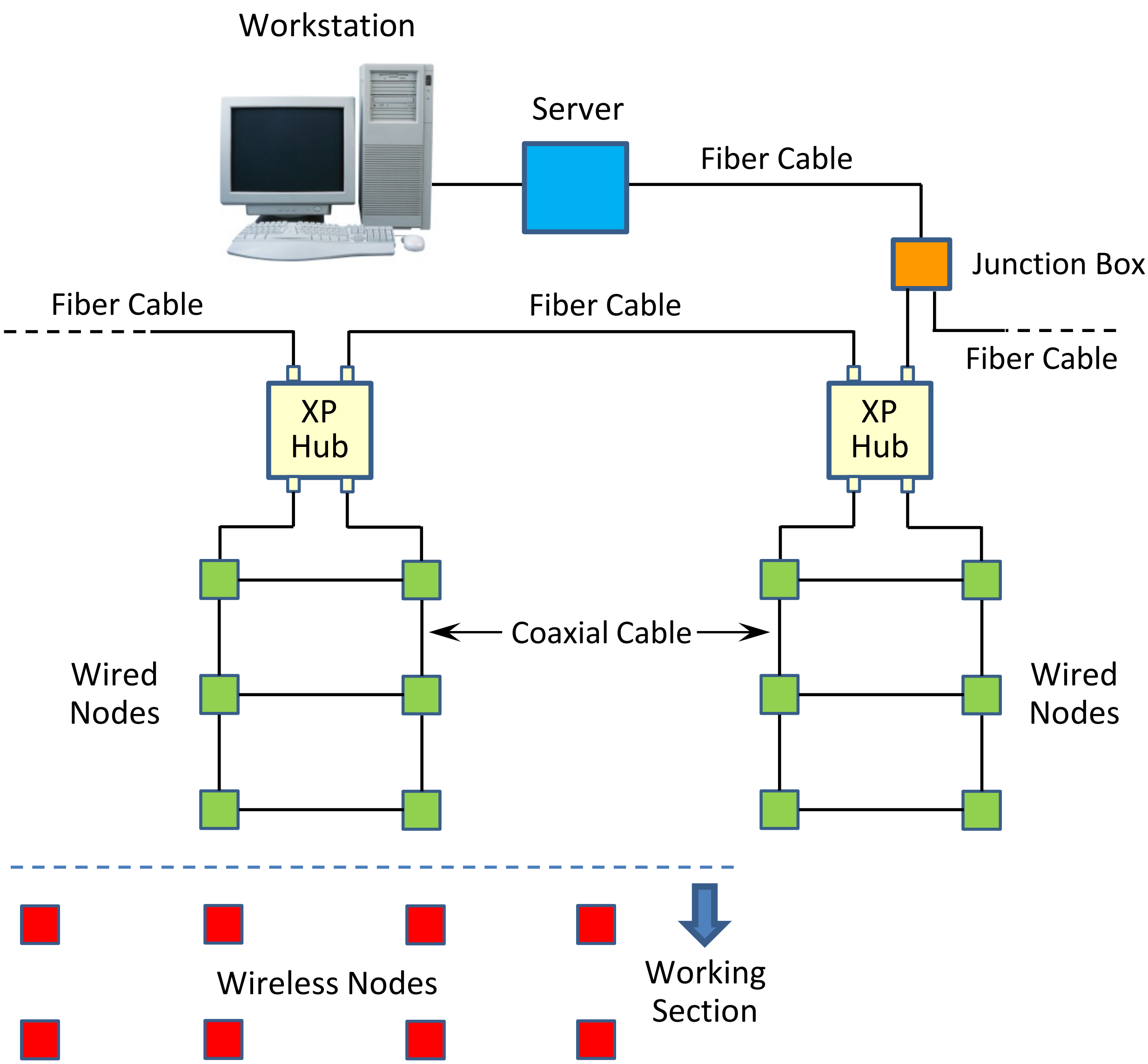

Figure 3-17: Matrix General Arrangement

Figure 3-18: Wired Node

Figure 3-19: EP Enclosure - Communication Hub

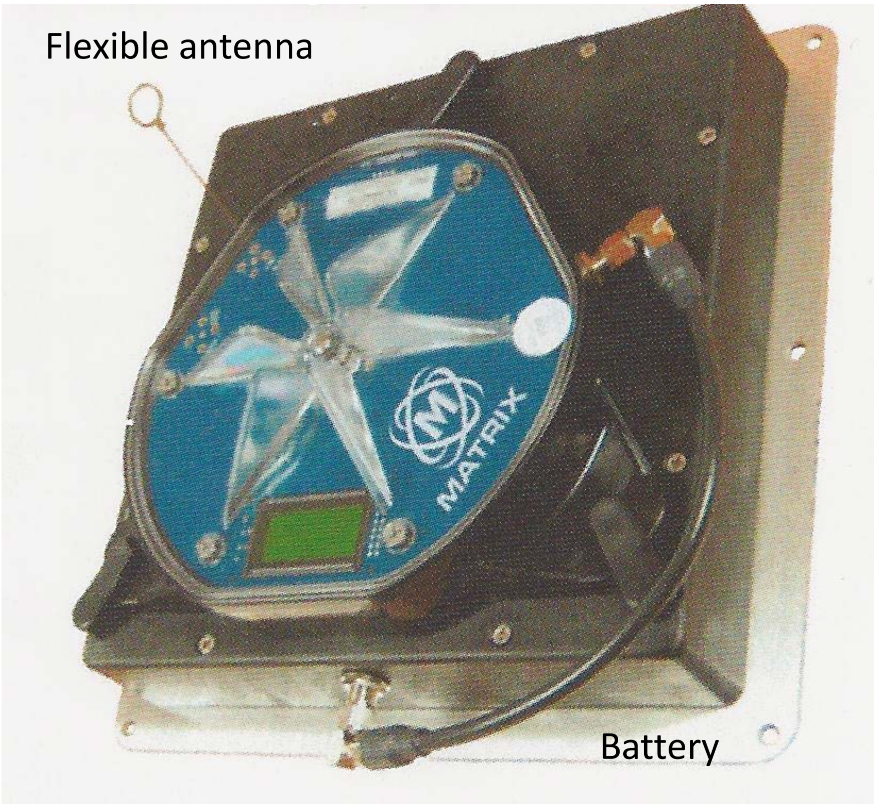

Figure 3-20: Wireless Node

Each underground employee carries two devices for communication and tracking. A tracking tag is worn on the mineworker's hardhat (Figure 3-21), and a text pager (Figure 3-22) is worn on his/her belt. (The text pager is used for both tracking and communications.) Each device transmits a unique code that identifies the miner wearing the tag. The system assigns the mineworker to the closest reader (node) for tracking purposes, as shown in the display of Figure 3-28.

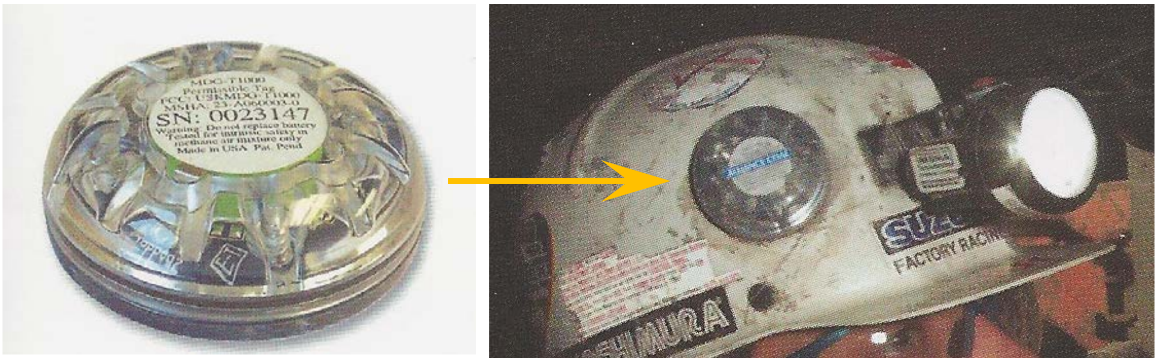

Figure 3-21: Tracking Tag

Figure 3-22: Text Pager

In addition to the text pager, a Varis leaky feeder system is used to supplement the Matrix system with voice communications. Each mineworker wears a leaky-feeder handset. The Varis radio has five channels – one outside, two for the different seams, and two extra. If two workers need to have an involved conversation over the radio, they could switch to the extra channels to avoid tying up a channel.

The Matrix text pagers can be used to text individuals or groups of workers, e.g., maintenance or workers on a specific section. All messages are stored on the computer outside. The text pagers can also be used to find the location of people underground.

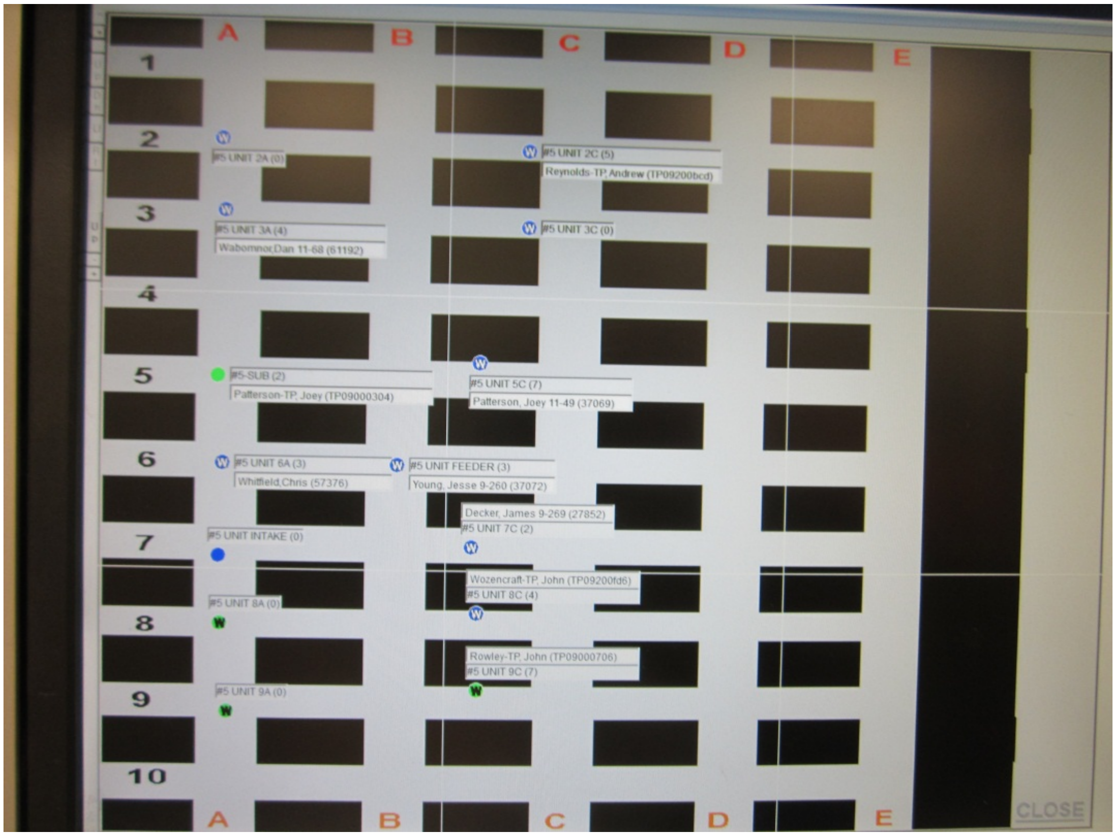

Figure 3-23: Tracking Display - Working Section

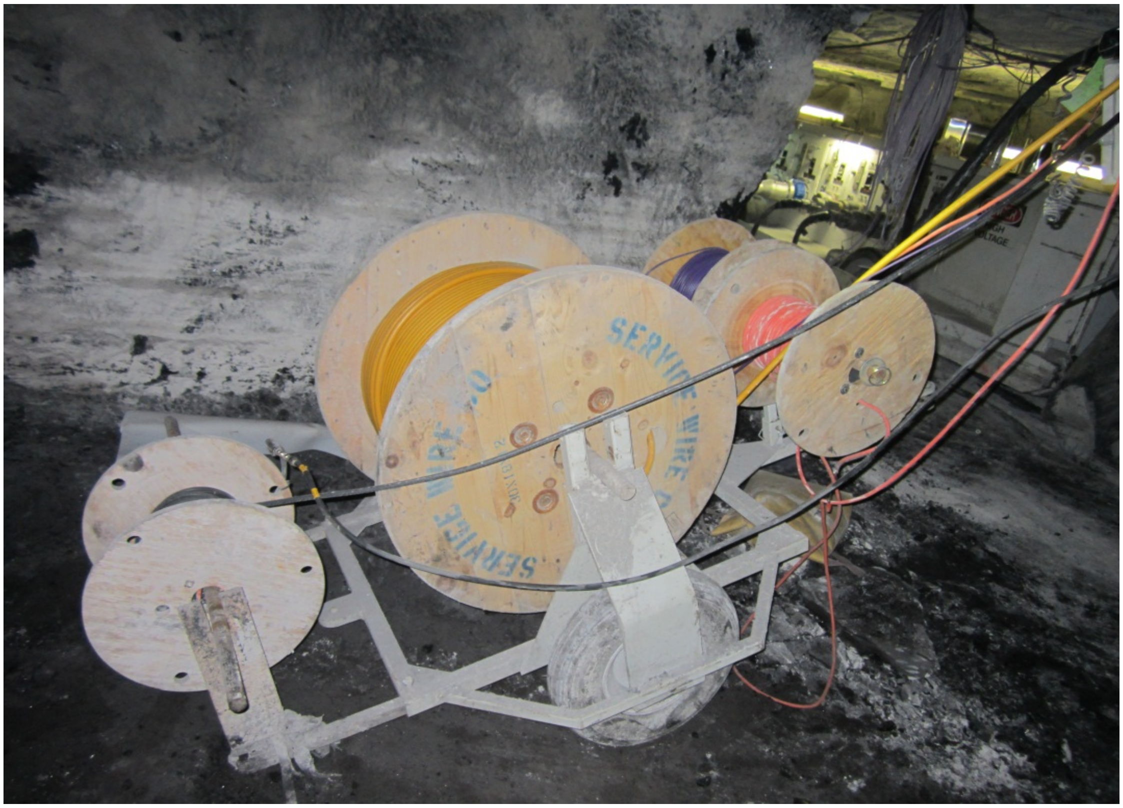

Figure 3-24: Cable Spools

The installation and maintenance of the CT system is done in-house. Eight employees (total of all three shifts) are dedicated to the maintenance of the system. Other employees know how the system operates and can do basic tasks, such as plugging in loose cables and extending cables. Nodes at the working section are advanced during third shift. A cart with all the cable spools (Figure 3-24) is pulled forward to assist in the advance. Whoever moves the tag readers underground is responsible for updating the mine map of the tag locations at the surface control center.

Figure 3-25: Military Connector - Wireless CO Monitor

Interviewed employees liked the computer interface at the surface control center. The employees working on the CT computers at this mine are very experienced with computers in general, but they also indicated that other miners felt comfortable with the interface. They feel the system allows them to add as much information as they want, including photos, emergency contacts, and medical records, without having an overabundance of information on the screen.

The overall opinion of the mine employees is that Matrix has a very good product. The initial installation was relatively simple after an installation pattern was developed. Daily maintenance requirements are very manageable. The system has self-diagnostics and displays low battery warnings. Most employees who see a loose cable will re-plug the quick-connect cables (Figure 3-25). If a cable or other piece of CT equipment is damaged, an employee will call outside and inform the maintenance department.

The mine plans on upgrading to the new Matrix system when its development is finished. The employees are happy with Matrix. The new features and improvements is the reason for the upgrade, not dissatisfaction. The same cables can be used with the new system, but the tag readers will need to be changed. Finally, it should also be noted that the CT system is used as the communications backbone for the Carbon Monoxide (CO) monitoring system along the belt conveyors. Matrix manufactures a wireless CO monitor, which is shown in Figure 3-25.

The second mine using a combination of Matrix and Varis employs 62 underground miners, averaging 20 per shift, exploiting the 12 feet coal seam with two single continuous miner sections.

Unlike the previous mine, the Matrix system only uses the trackers, not the text pagers. The outby nodes are wired together at intervals of no more than 2000 feet with additional nodes placed at head drives and intersections. These are cross tied at every head drive to provide redundancy in the arrangement. Tracking in the face area is provided by five nodes spaced in the entries, three of which are wireless.

The Varis leaky feeder system provides the communications to meet the MINER Act. The roadway and primary escape way have a leaky feeder line running the distance from the portal to the face area. The line connects near the feeder providing two paths for signal to travel in the event of a failure. The mine averages 15 hand-held mine radios underground, with one channel primarily being used; 55 radios are owned and are capable of broadcasting on three channels.

The maintenance is done in house; four miners are trained, but the majority of the work is done by one man on third shift. The problems encountered with the Matrix system include: F connector ends oxidizing and losing connection and thunderstorms take out the tracking system. Mine personnel theorize that an electric storm induces noise in the copper wire running underground, and they would like to try the use of fiber cable instead. The Varis system is also difficult to maintain in working conditions. The lines are often broken by falling rock and moving equipment. Signal interference with the communication radios have also set off CO sensors and shut down continuous miners.

The mine does not like the CT system. They claim the increased maintenance offsets any benefit to having communications on a non-emergency basis. They feel the tracking requirements are pointless in the event of an emergency, as miners may move or try to escape on their own. The last know location shown on the computer would be meaningless to a mine rescue team, but an investigative team could use the location to assign blame and write citations.

3.4 Mine Site Technologies

Mine site technologies is a wired node based technology. A total of 300 employees, averaging 100 per shift, operate six continuous miners on three sections at the visited mine that uses this system. The seam height averages six feet, and the mine utilizes 50 feet pillars. The farthest distance to a face is approximately four miles.

Mine Site Technology's system delivers both the communication and tracking for the mine. The hand held radios (Figure 3-27) allow both text and voice communication. The text is most useful when an individual is outside the coverage range and cannot be reached by phone; a text message can be sent that will be delivered when the miner reenters signal range. The process of entering a text message can be time consuming due to the old cell phone style entry method, multiple presses of the same button for different letters, and a small delay between button press and device response. The tracking tag (Figure 3-26) can be placed on a hardhat, in a way that is virtually unnoticeable to the wearer and has a battery life of three to six months.

Figure 3-26: Tracking Tag

Figure 3-27: Hand-held Radio

A simple layout of the system can be seen in Figure 3-28. Access Point (AP) boxes throughout the mine (Figure 3-29) are daisy chained with a composite fiber cable which provides power and signal transfer. An Access Point located in the intake/primary escape way is connected and powered by an Access Point in the roadway. Bread-Crumbs in the face extend the coverage wirelessly. Redundancy is provided by a fiber cable connected at the face which runs uninterrupted to the surface computer.

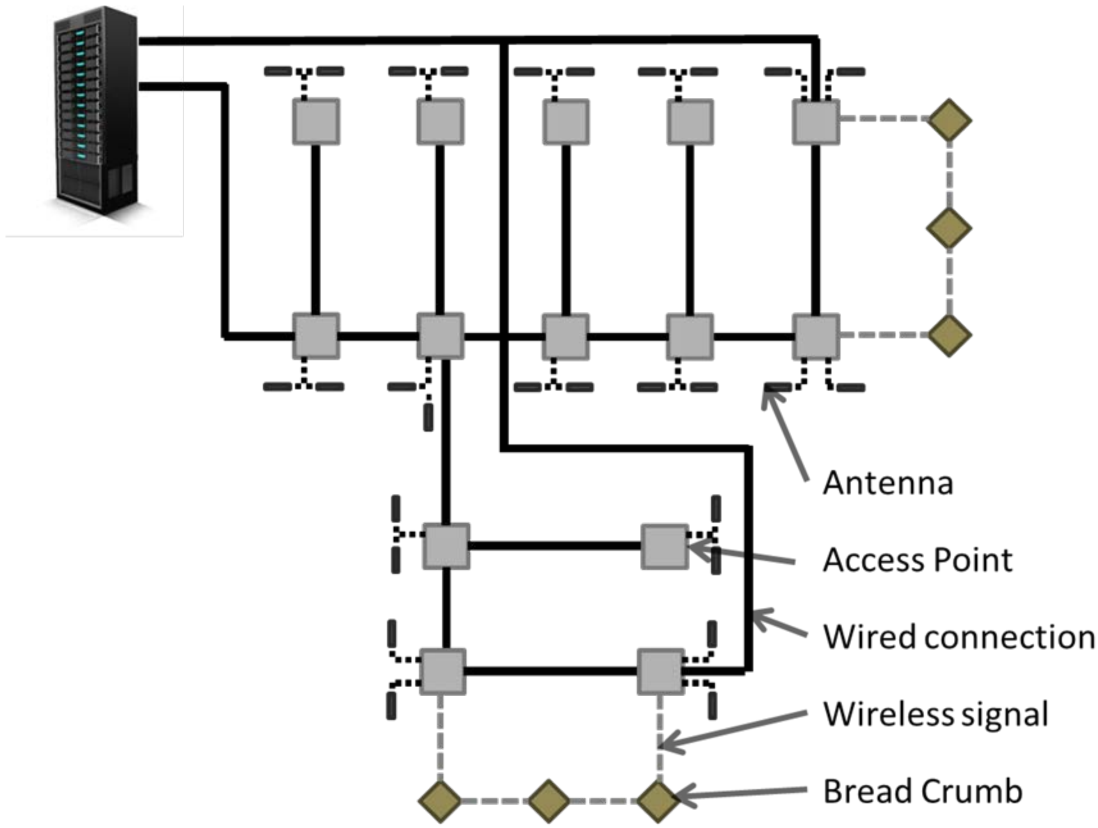

Figure 3-28: Mine Site Technologies System Layout

The AP has four ports for fiber and two ports for coaxial cable. The fiber transmits the signal out of the mine and provides power for the AP in the intake. The coaxial ports connect to the antenna. The majority use one port with a coaxial splitter to connect to the two antennas. This is done so if in the future a cache or other area requires CT, it can quickly and easily be installed. The directional antennas are placed facing opposite directions down the entries. The distance between access points is 1500 feet. A signal does not travel well beyond the entry in which the antenna is installed. A signal can be lost between the two APs briefly while traveling.

Figure 3-29: Access Point

In the face bread-crumbs are used to extend and enhance the tracking capabilities. A total of six are placed in the last open crosscut. The batteries last 72 hours and are replaced and recharged on the section, every day. The extra coaxial port on the closest AP has an antenna calibrated to accept the breadcrumb signal.

Every pair of APs has a battery, generator, and power supply contained in a single unit (Figure 3-30). These units weigh 350 pounds each and create the majority of the problems encountered with the CT system. The computer chip inside becomes covered in dust and stops the generator from charging the battery. After the battery is drained the AC power will not power the AP. The difficulty in dust proofing the enclosure has come from internal fans and vents that are used for dissipating heat. A foam insert has been put in place to reduce the dust accumulation, but even after the fix, dust remains troublesome. Every couple of weeks a power supply needs to be sent to the manufacturer to be repaired.

Figure 3-30: Battery Backup

The computer interface outside was well received by the miners. Adding an AP to the map is easy and quick with the ability to drag and drop existing nodes. Clicking on a node is an easy way to trouble-shoot if a node is communicating or not. A number of nodes can be grouped together to form a zone, e.g., “Main South.” The computer system has a feature to diagnose system health, but the number of false positives renders this feature useless. Three different programs are used for the system: to set node and cell locations, to see how the cells communicate with each other, and a console to add/edit phones, tags and zones. The computer does not report the battery level of nodes or breadcrumbs. The mine must send the mine map to Mine Site Technologies to update the display map.

3.5 Pyott Boone

Pyott Boone's Minecom and Tracking Boss systems are used to provide voice communication throughout the mine and tracking at discrete nodes, via a leaky feeder cable. The system serves the three and a half mile travel and escape ways to two single unit CM sections in the six feet coal seam in the visited mine.

The backbone of the system is the leaky feeder cable (Figure 3-31). It hangs in the primary and secondary escape ways from the portal to the face, with a maximum cable length of 1000 feet. In-line amplifiers (Figure 3-32) are used to maintain signal quality and allow for transmission along the entire length of cable. The tracking tag data is relayed to the leaky feeder cable through wireless gateways (Figure 3-33). These nodes are located at every head drive, and no farther than 1000 feet apart. In areas with several gateways, additional amplifiers are installed to maintain signal integrity.

Figure 3-31: Leaky Feeder Cable

Figure 3-32: In-Line Amplifier

Figure 3-33: Wireless Gateway

The installation of the system is critical for effective system operation. It took this mine two months to get the system fully operational when first installed. The leaky feeder cable should be spaced a few inches below the roof to permit a good signal. The signal will travel through crosscuts, but when traveling parallel in adjacent entries, only 10 feet or less of travel is permitted before losing signal. The gateway nodes should be placed as close to the cable as possible. In most situations, this requires having the antenna of the gateway actually touch the leaky feeder cable, as seen in Figure 3-34. The face uses the same leaky feeder cable and gateways; the tracking at the face is accurate to 200 feet, which, "… can pretty much only tell if you are on the right or left of the section."

Figure 3-34: Antenna Touching Cable

Figure 3-35: Cable Trailer

Maintenance of the system is a daily occurrence. Two men are dedicated to work on the system, one on first and one on second shift. Additional maintenance personnel are sometimes required to help if the work load gets too much to handle. The daily downtime for the system could be anywhere between 30 minutes and 4 hours. This almost exclusively relates to the leaky feeder cable. Rock falling from the roof can cut cables, pull wires out of boxes, and pinch cables. Moving equipment can also damage the cable. A reliable self-diagnostic feature is non-existent. Finding a bad spot in the cable can take hours of searching.

Despite the maintenance issues, the mine is relatively satisfied with the Pyott Boone system. The computer interface outside is easy to use and integrates with the other Pyott Boone programs already in use by the mine. The mine has no plans on changing the system and is looking at future technologies coming out to augment the current system (methane and airspeed monitoring).

3.6 Strata Safety Products

Strata's system is a completely wireless node based system. The mine visited has a total of 100 employees, averaging 25 per shift, and operating two CMs on a single section. The seam averages a 48 inch height, and the mine utilizes both 70 and 50 feet pillars. The distance from the portal to the face is 850 feet.

Strata's system utilizes battery powered nodes (Figure 3-36) for tracking and communication throughout the mine, including the face area. A node battery will last at least ten months, and at the time of the visit, the mine had not needed to replace a battery. The bags are small and several can be carried by a single miner. The mine has been very happy with the system. There is virtually no maintenance requirement and installing new nodes is as simple as hanging a bag. A single miner is dedicated to maintaining the system, but only has to work a half shift every other day on the system.

Figure 3-36: Wireless Node

To increase battery life, packets of information are sent every 10 seconds that contain all CT data. Miners say that no delay can be noticed when the signal needs to travel across several nodes. Strata uses signal strength to track miners and claims an accuracy to within 20 feet. A face map can be seen in Figure 3-37.

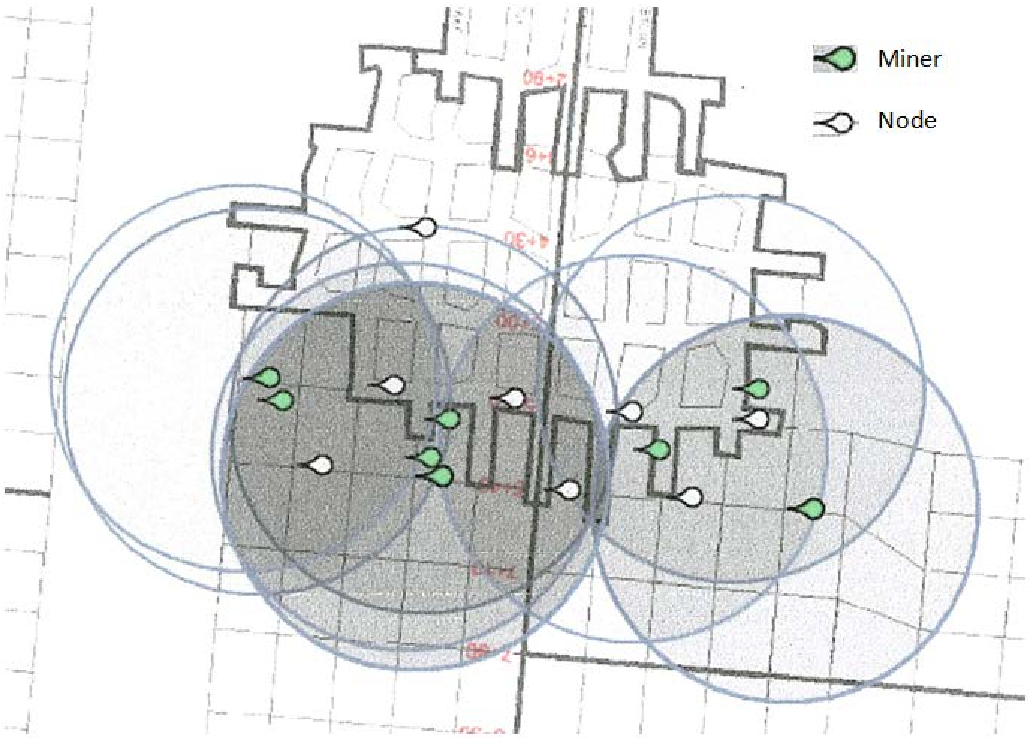

Figure 3-37: Mine Map

Communications and tracking are done with the same device (Figure 3-38), with the main disadvantage of the system being the communication limitations. No voice communication is available and only preprogramed text messages can be sent. This may be an issue in emergency situations when specific information is required (medical need and allergies, roof and rib condition, and an active damaged electrical wire). The device only has a visible alert when a message is received, no vibration or audio, thus the device must be clipped on the outside of clothes or periodically checked if in a pocket. Accidental "pocket calls" do not occur very often, but enough to be considered a small annoyance.

Figure 3-38: Handheld CT Unit

The computer system outside, set up by Strata, has a user friendly interface and provides sufficient information without cluttering the screen. The computer shows battery levels of all devices, handheld and nodes, and indicates when batteries need to be charged or changed. The tags turn on and off when removed and placed in the charger (Figure 3-39). This allows easy detection if a miner leaves with the device not charging; miners sometimes leave them in their locker or not completely in the charger. Gateway nodes connect the surface computer to the mine infrastructure (Figure 3-40).

Figure 3-39: Charging Station

Figure 3-40: Gateway Node

To supplement the Strata system, the mine uses Kenwood portable radios in the face area to communicate. No mine-wide infrastructure is in place, thus only line of sight from radio to radio communication is available.

3.7 Tunnel Radio

Tunnel Radio's system is used to provide voice communication throughout the mine and tracking at discrete nodes, via a leaky feeder cable. The system serves 5.5 miles of travel and escapeway entries, allowing the average shift of 23 miners to communicate at the continuous miners and longwall face at the visited mine.

The Tunnel Radio leaky feeder line is installed in lengths of 1500 feet. In-line amplifiers keep the signal consistent along the cable length. The cable is advanced every crosscut using a spool hung on the back of trucks. The longwall face uses a different type of cable that is more expensive, but provides greater flexibility, moving as the longwall moves. The tracking boxes, located every 1000 feet, use three antennas each to cover the primary, belt, and return entries. The same box used outby is used in the face for tracking.

The initial installation of the tracking system took three days. The beginning tracking was very spotty. The mine was an early adopter of the system and made suggestions to Tunnel Radio who listened and made necessary upgrades to create a system that functions "very nice" today. The system requires little effort to maintain; no single person is dedicated to upkeep, instead whoever is closest can do repairs. The usual tasks include changing batteries every few weeks or doing the weekly inspection for line breaks. The most common unscheduled maintenance issues arise from when haulers hit the cables.

The computer system is hosted online, needing internet access to work. This creates both advantages and disadvantages: any computer can see data and no software license is required, and there is no tracking if the internet goes down. The system uses server that can trigger alarms to Allen Bradley plcs but cannot send the alarm type. If the tracking server goes down, Tunnel Radio has a manual tracking feature where an operator can tag people at locations and automatically keep records of personnel locations.

3.8 Venture Design Services Supplemented with Varis

The visited mine of 145 miners (100 underground) operates three shifts averaging 40 workers exploiting the 5.5 feet thick coal seam at a depth of 515 feet. The mine installed the Venture system for tracking and text communication, supplemented with the Varis leaky feeder allowing voice communication for select people. The mine has – nearly depleted its mining reserves, with only a longwall operating, and all continuous miner development has ceased.

Venture's system uses a wired backbone that connects five subnet controller cabinets (Figure 3-41) located throughout the mine. From each of the boxes, three separate subnets, or areas, can be used. Each subnet consists of Wireless Access Points (WAPs) that communicate wirelessly and are spaced every 500 feet, as seen in Figure 3-42. A node is wired to provide power to the unit. A diagram of the basic layout is seen in Figure 3-43 below. The face is completed by using wireless nodes that can operate for 30 days and be as far as 800 feet from the last wired node.

Figure 3-41: Subnet Controller Cabinet

Figure 3-42: Wireless Access Point

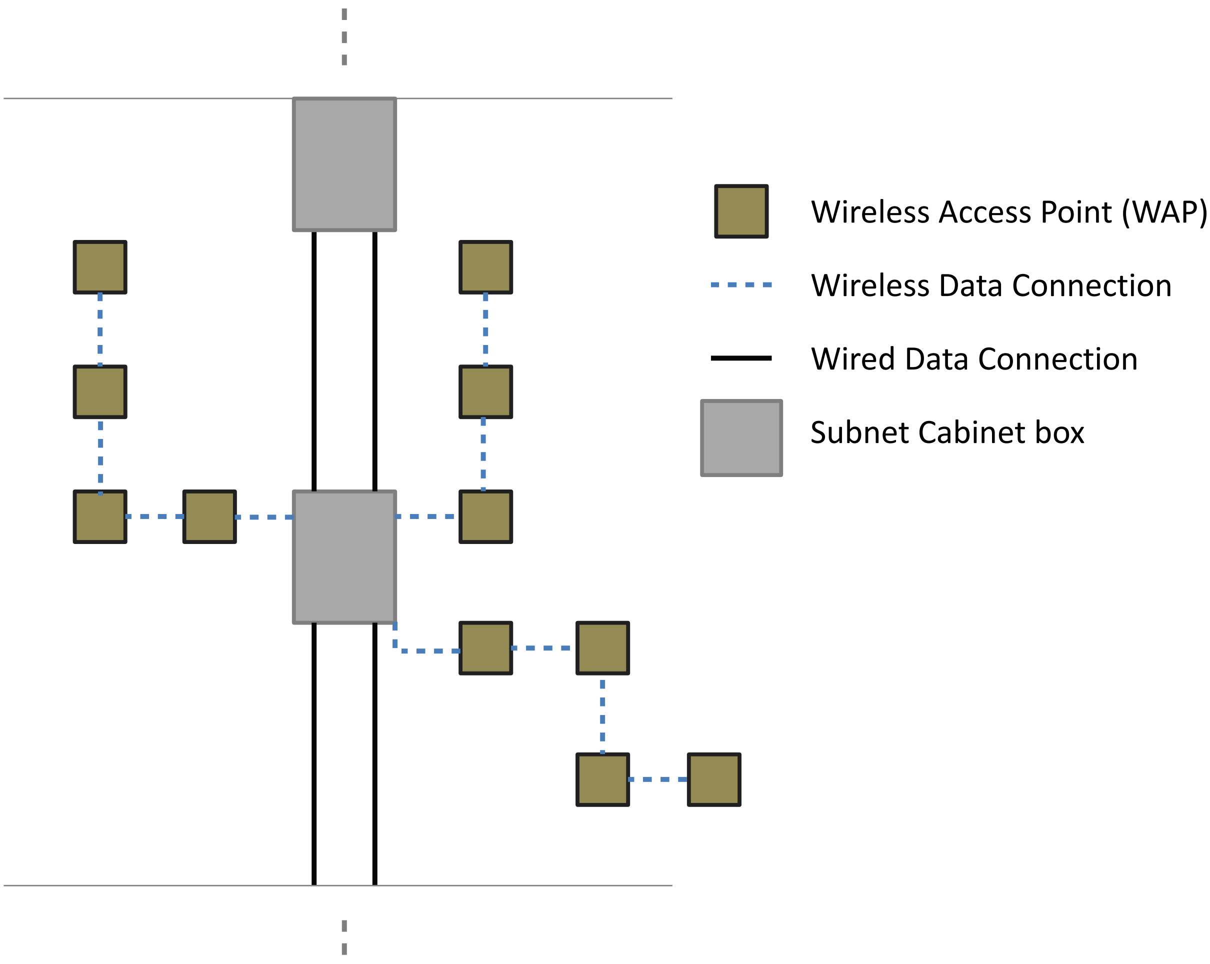

Figure 3-43: System Diagram

The text messaging is all preloaded and can only communicate outside; no radio to radio communication exists. The outside operator must relay all messages if they are meant for others underground. The subnet cabinet can store all text and location information in the event of a power failure or communication line break. The WAPs flash a bright light when a tag is alarmed nearby, along with the immediate inby and outby nodes. Accidental alarms are an occurrence that happen often enough to be an annoyance, but nothing more.

The system allows for a unique tool to be used by mine rescue teams. The tag reader (Figure 3-44) can detect the RFID tags and a relative strength of signal, allowing for accurate hand held location of miners. The mine rescue team on site trains by finding buried tags hidden underground.

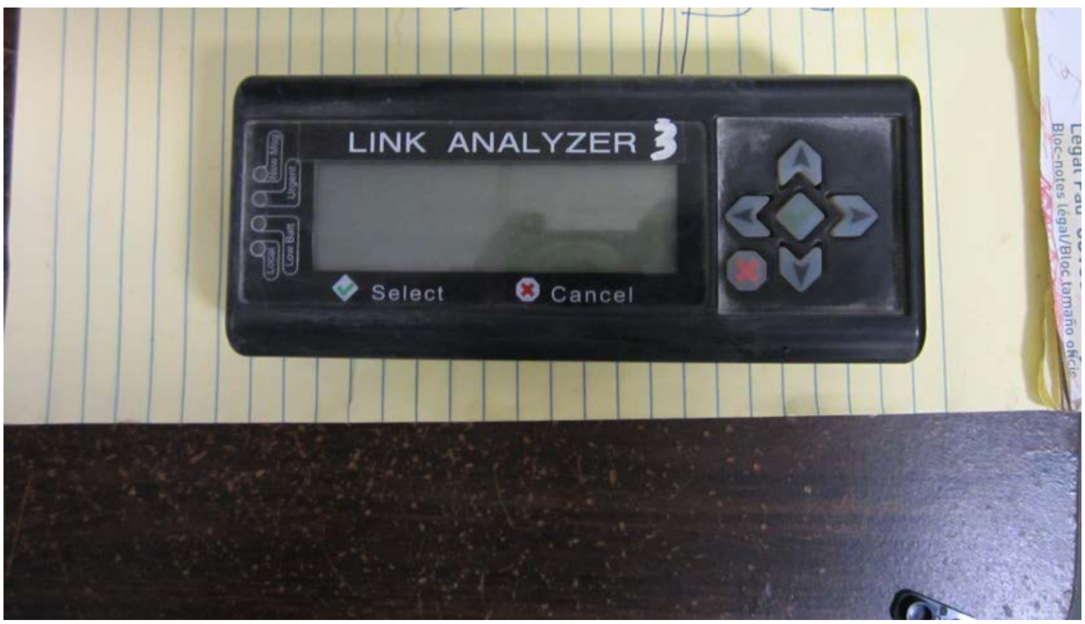

Figure 3-44: Link Analyzer

The maintenance is very minimal and the major reason for the selection of the system. It is "plug and play" with the power cable being the only labor intensive part. For installing nodes, a laser light was used to ensure line of sight between nodes. The leaky feeder is more work but is still very manageable with the same team of workers.

CHAPTER 4: RECEPTION OF TECHNOLOGIES

A complete list of mines and the CT systems in use was constructed to compare the reception of technologies in the industry. This data came from a study Shifbaur did in 2009 and a freedom of information act request for the emergency response plans of mines from MSHA. The data was merged and updated wherever it was found to be inaccurate, because of mines changing systems. The 2011 mine production summary from MSHA was used to compare technologies across several fields, including, number of employees, location, production, and number of mechanized mining units. A discussion of each of these follows. For all graphs unless otherwise stated, the technology used for communications is used.

4.1 Leaky Feeder vs Node Communications

The most basic comparison available is the comparison of the number of leaky feeder systems in use compared of node based systems. From Figure 4-1 one can see that node based systems are slightly better represented, but the total number is very close, being 47% leaky feeder and 53% node based.

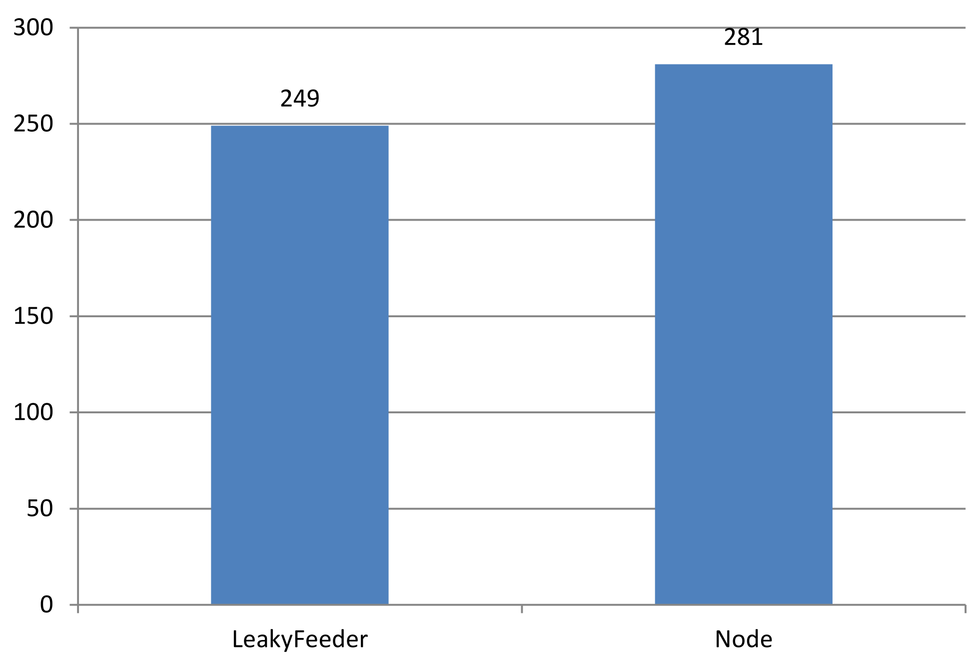

Figure 4-1: Leaky Feeder vs. Node Mesh

4.2 Node-Base Systems –Wired vs Wireless

Node based systems can be further subdivided into the categories of wired and wireless. In Figure 4-2 the node based systems are compared based on the technology used. Like the comparison between leaky feeder and node based technology, there is little difference in the number of wired compared with wireless systems, with a slight edge going to wired systems. This figure also details the functions available with each system: voice only, text only, or both. It is interesting to note that a larger number of wired systems only offer text based communication as wires provide greater bandwidth with less signal loss. Additionally, no wired system offers only voice communication. A possible explanation is that if the bandwidth allows for voice, the addition of text is rather simple, and the few mines that only have voice use a cheaper third party radio that does not have text capabilities.

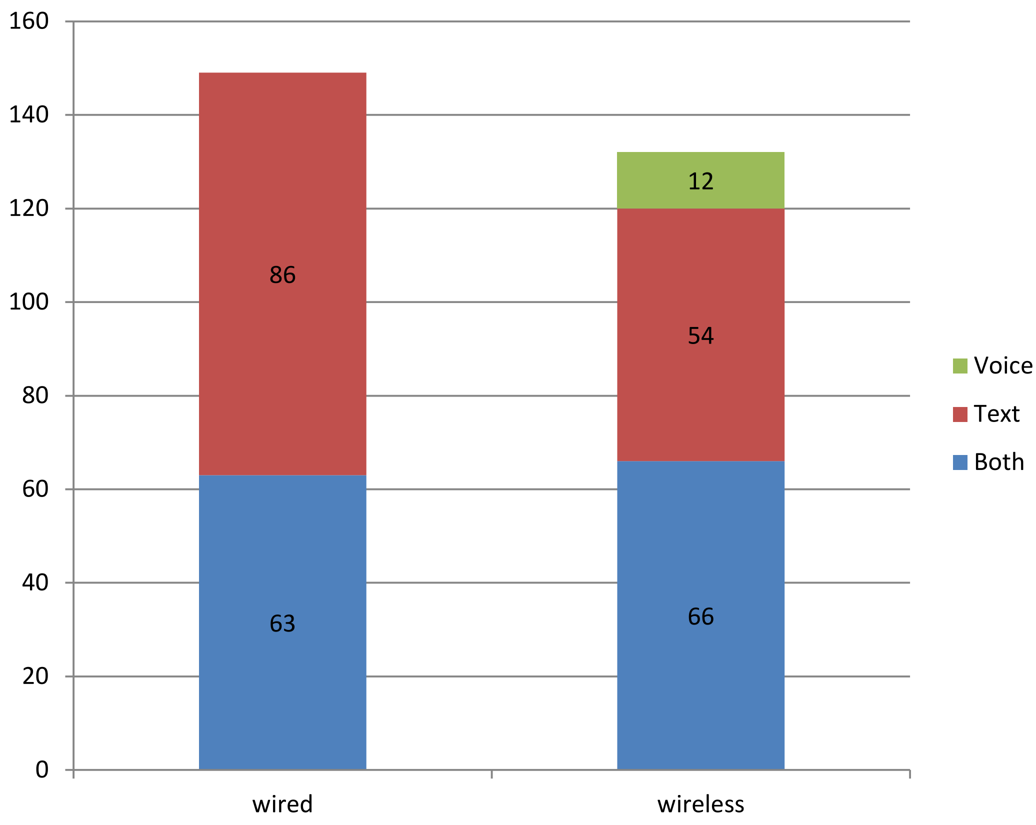

Figure 4-2: Wired vs. Wireless

4.3 Large vs. small mines

The classification of mine size was a difficult metric to decide. The size of a mine could be based on annual production, length from portal to face, number of sections, and so on. The focus of this study is on communication and tracking systems, so the metric for mine size was chosen to be number of things communicating and being tracked -- workers. The numbers of workers at each mine were divided into three categories approaching an even distribution of mines per size category. See Table 4-1 for a summary of this calculation.

Table 4-1: Size of Mine

	Employee Count	Number of Mines	Percentage
Large	69+	169	33.33
Medium	28-68	165	32.54
Small	0-27	173	34.12

In Figure 4-3 the comparisons between technologies are made. It is evident that the large mines are equally split between the technologies, but small and medium mines are significantly different. Small mines prefer node based systems, this could be because these systems require less man power and are generally easier to recover when moving to new panels. The medium sized mines can take a hit to man power to allow the generally cheaper leaky feeder systems to be used.

The next graph (Figure 4-4) shows how the communication options are divided between mines. Small mines prefer the text only option. It is theorized that this is because it is much cheaper than voice. The medium and large mines rely more on voice communication to help organize workers on a daily basis; where it is much easier to relay in information in small mines.

The final comparison in mine size is represented in Figure 4-5: Size Comparison - Company. The most interesting points in this graph is that Mine Radio Systems and Mine Site Technologies are not installed in any medium sized mines. Also, Active Control is not installed in any small mines.

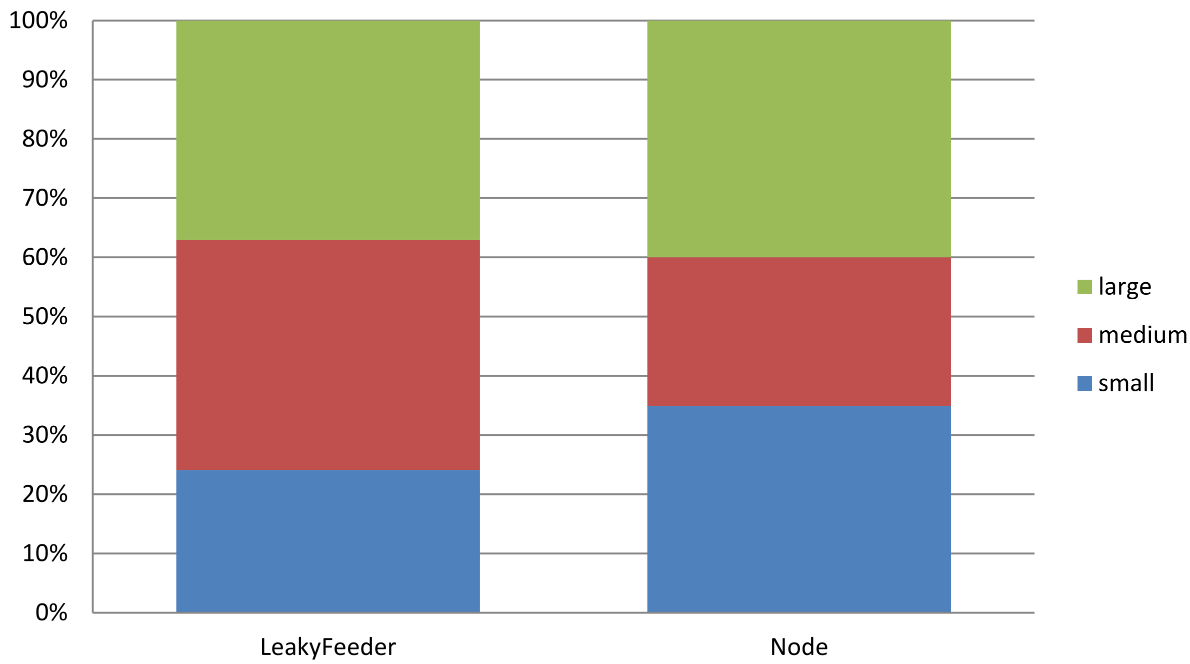

Figure 4-3: Size Comparison - Technology

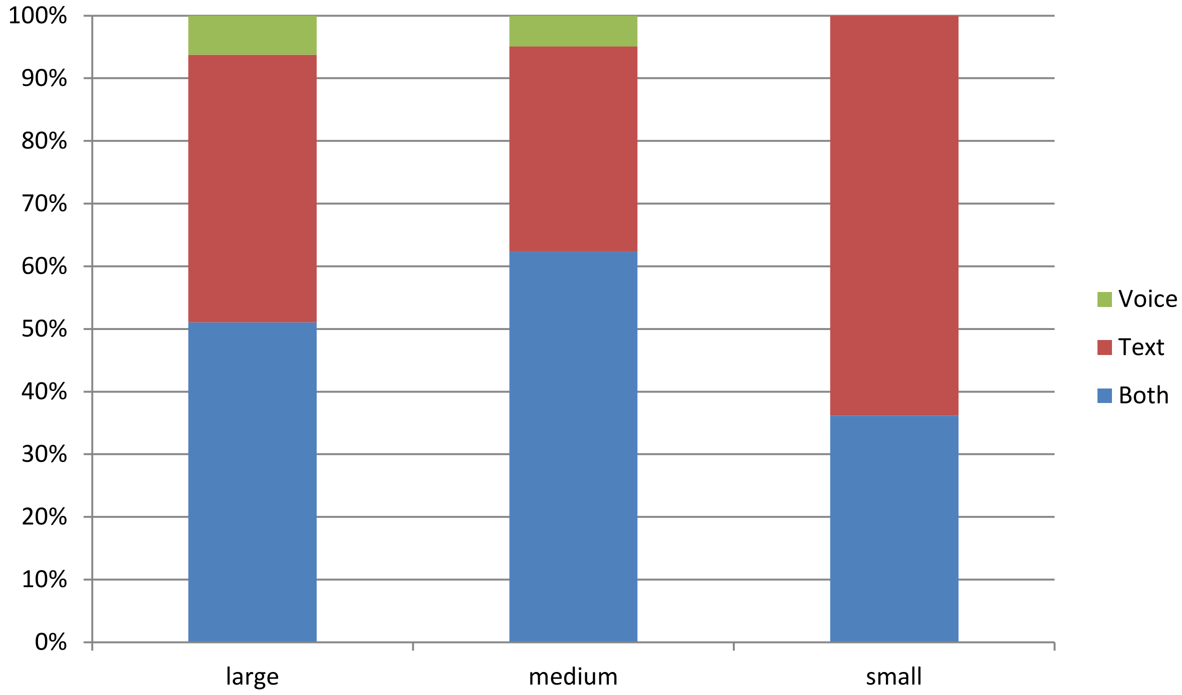

Figure 4-4: Communication vs. Size of Mine

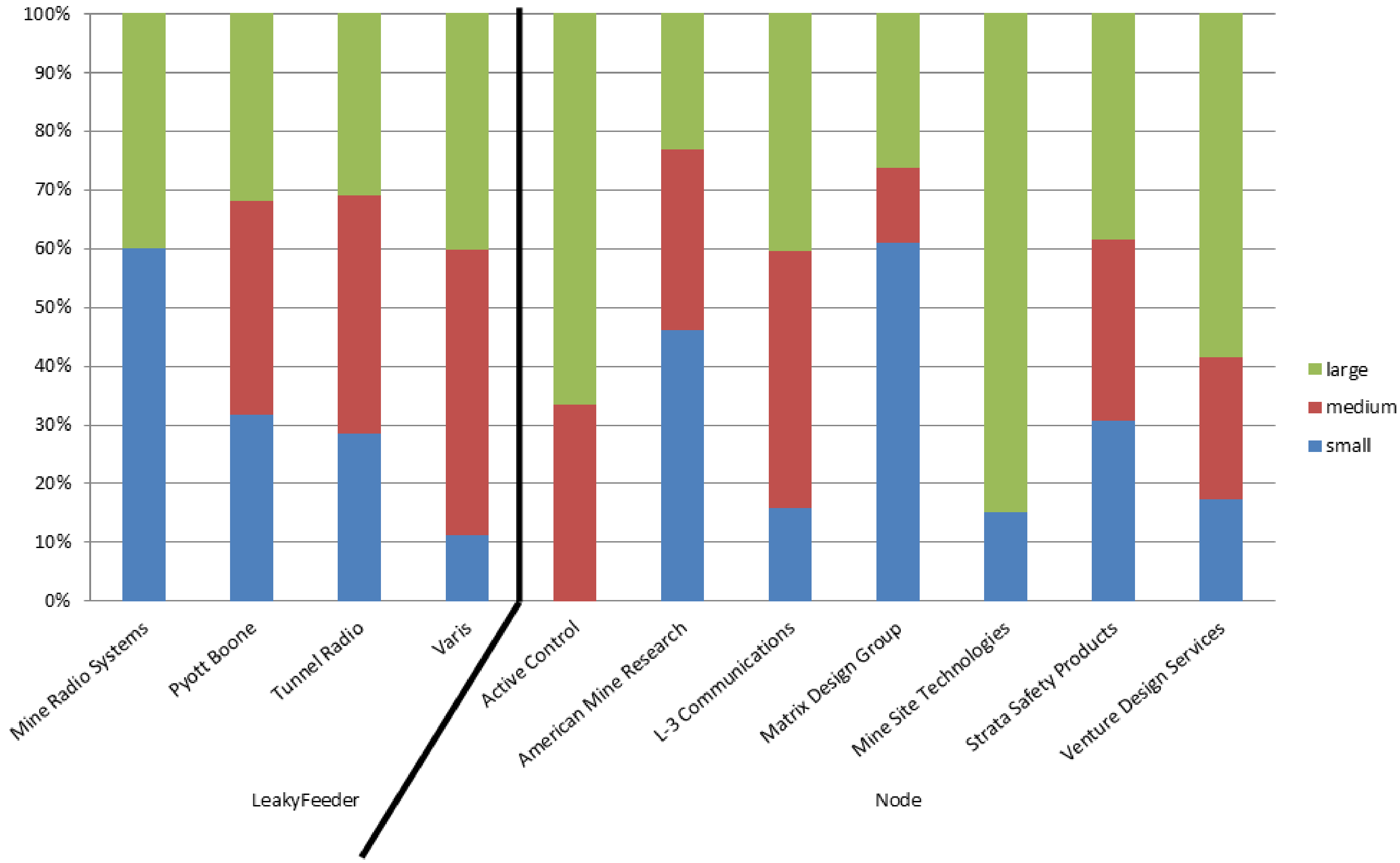

Figure 4-5: Size Comparison - Company

4.4 Geographical Location

The location of a mine seems to play a role in the selection of systems. In Figure 4-6 the various MSHA coal mining districts are displayed. The districts are determined by type of coal, number of mines in the area, and state borders. Figure 4-7 shows the number of mines and the size of mines by MSHA district. The majority of mines can be found in southern West Virginia, eastern Kentucky, and Virginia. These have a fairly normal split of small, medium, and large mines. The western mines, as well as the Illinois coal basin and southern Appalachian mines are heavily skewed to large mines.

When looking at the technology used, West Virginia mines have a heavy preference for leaky feeder systems. Districts that are at least partially located in West Virginia are the only districts that have a percentage of mines using leaky feeder greater than 50%. The next two districts that use the highest percentage of leaky feeder border West Virginia.

The major contributor to West Virginia using leaky feeder is a state regulatory law. The majority of the mine disasters that lead to the MINER Act occurred in West Virginia, and as a result, legislators required voice communication, and an earlier installation date. This caused leaky feeder, already established with voice communication, to have a strong position in the market. The newer node based voice systems had not completed development when most communications systems were placed in West Virginia.

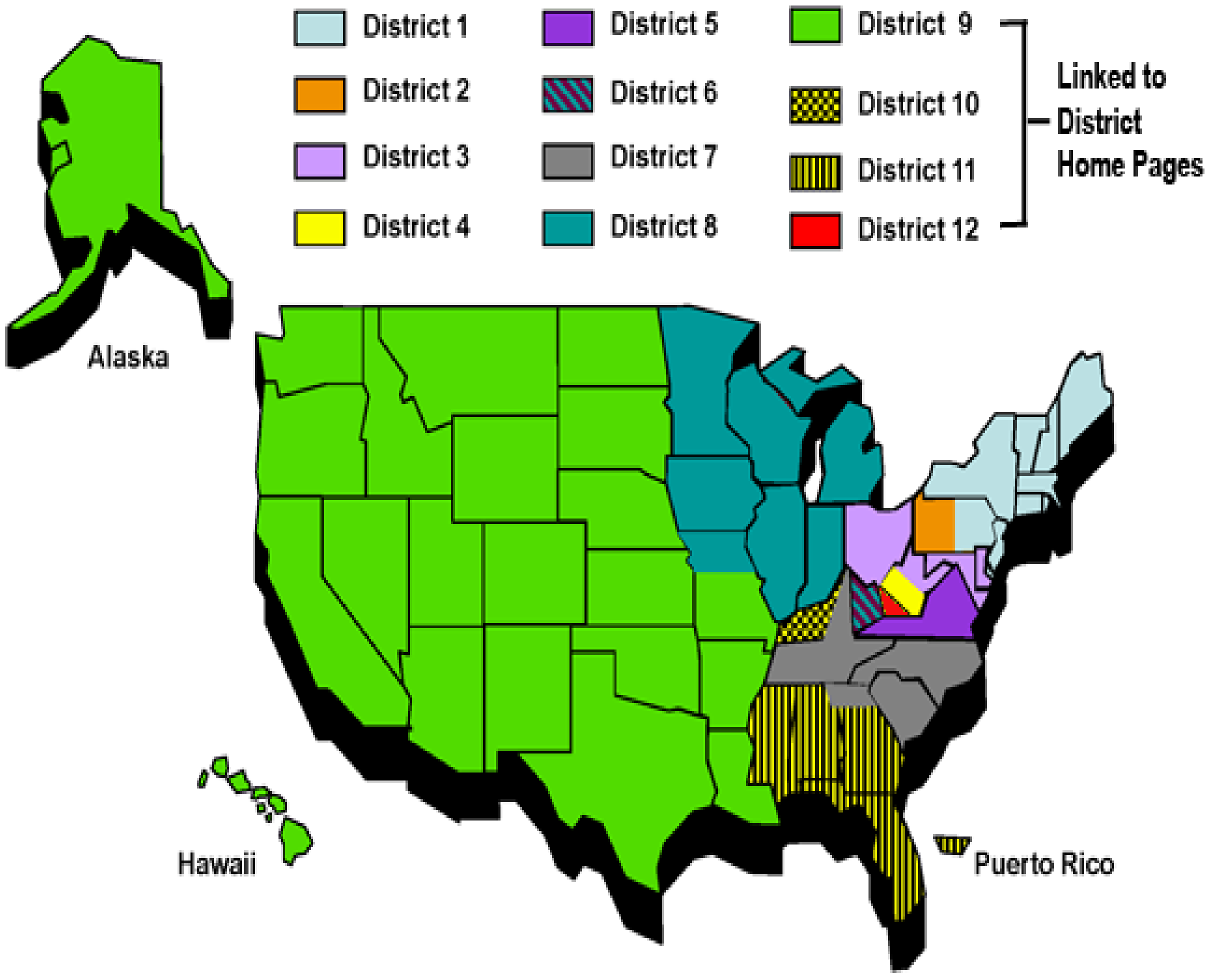

Figure 4-6: Map of MSHA Districts (MSHA Website)

District 1 Anthracite coal mining regions in Pennsylvania

District 2 Bituminous coal mining regions in Pennsylvania

District 3 Maryland, Ohio, and Northern West Virginia

District 4 Southern West Virginia to include the following counties - Boone, Braxton, Clay, Fayette, Greenbrier, Kanawha, Monroe, Nicholas, Pocahontas, Putnam, Raleigh, Summers, Webster

District 5 Virginia

District 6 Eastern Kentucky

District 7 Central Kentucky, North Carolina, South Carolina, and Tennessee

District 8 Illinois, Indiana, Iowa, Michigan, Minnesota, Northern Missouri and Wisconsin

District 9 All States west of the Mississippi River, except for Minnesota, Iowa, and Northern Missouri

District 10 Western Kentucky

District 11 Alabama, Georgia, Florida, Mississippi, Puerto Rico, and the Virgin Islands

District 12 Southern West Virginia to include the following counties - Cabell, Lincoln, Logan, McDowell, Mercer, Mingo, Wayne, Wyoming

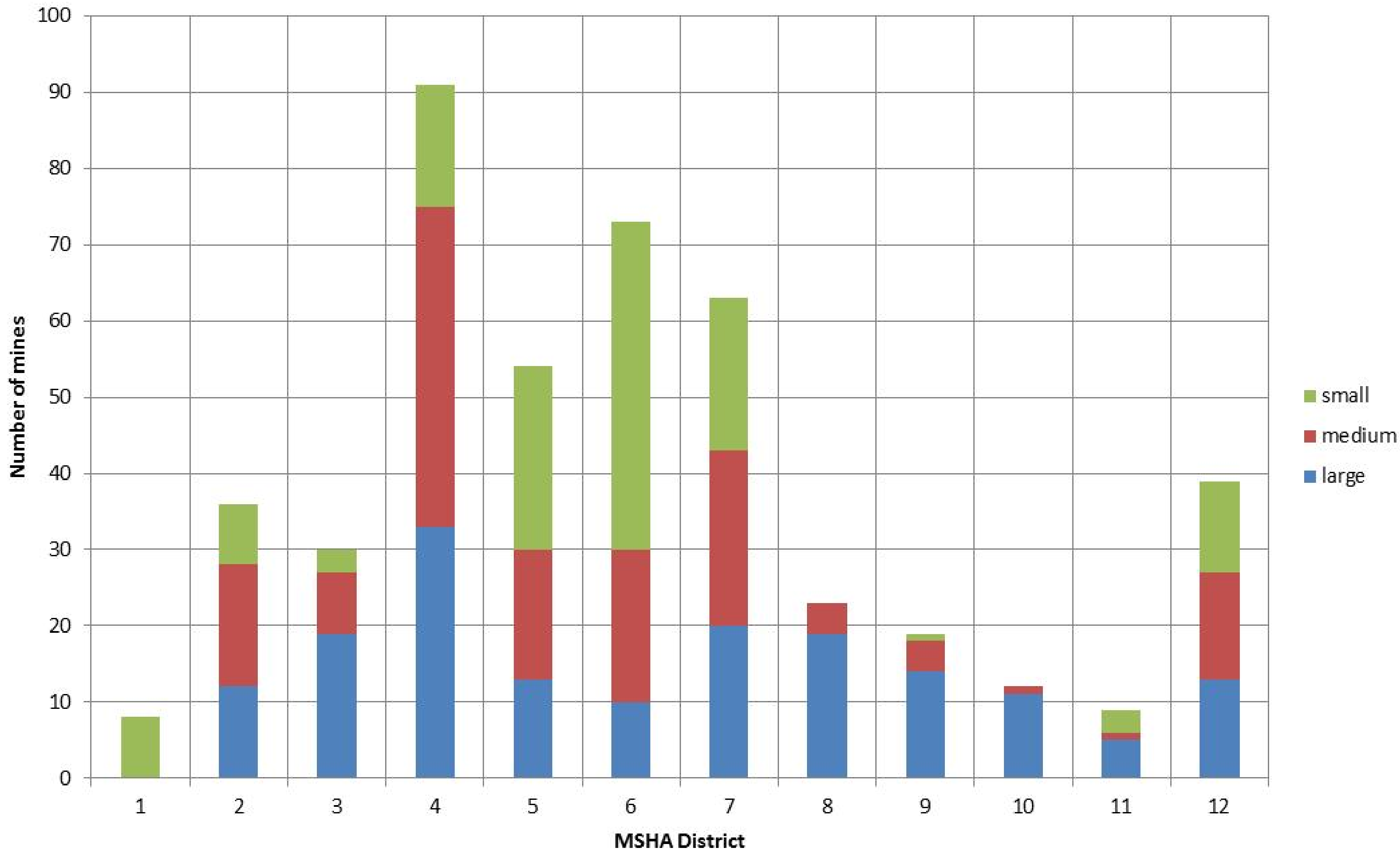

Figure 4-7: Mine Size by District

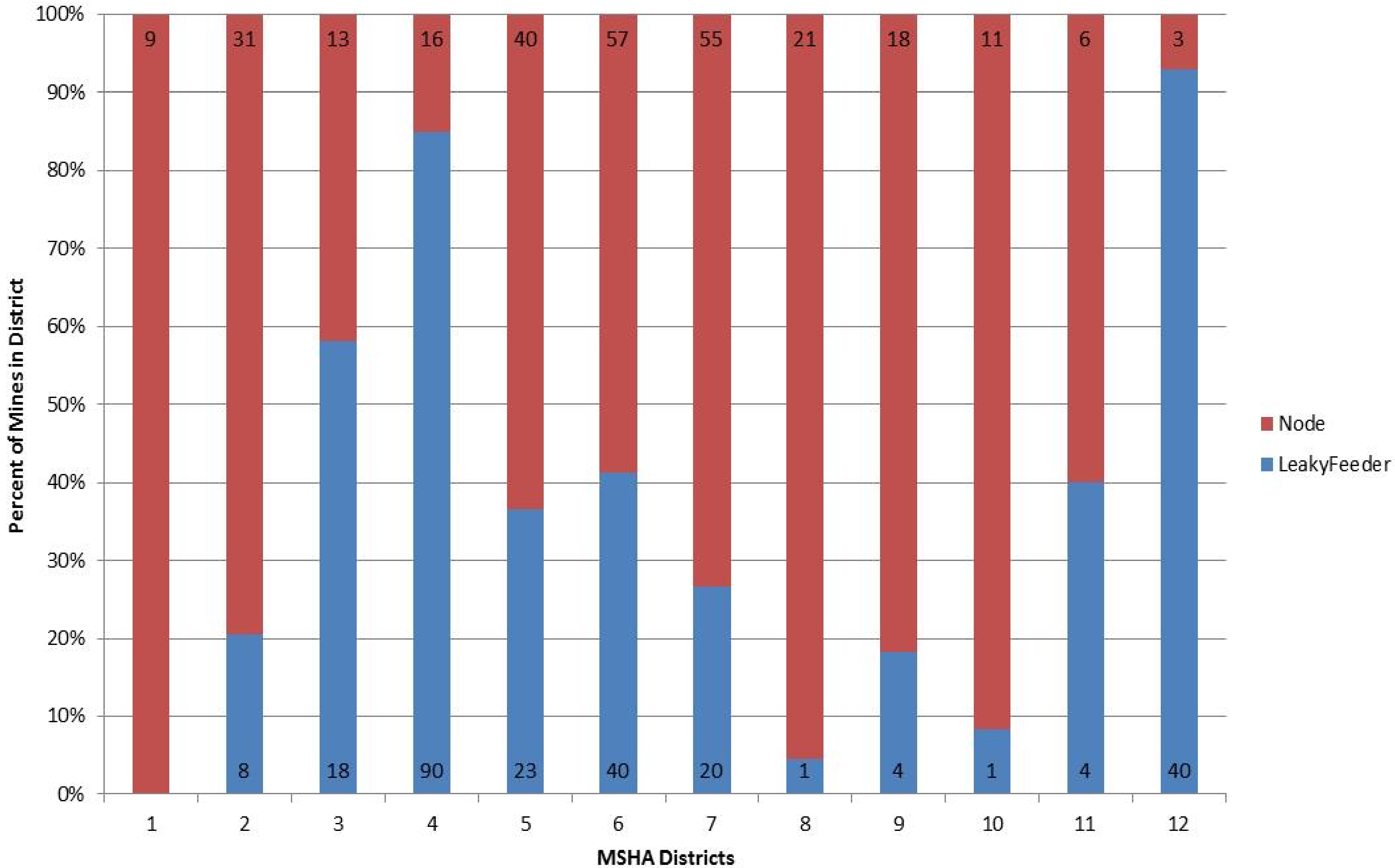

Figure 4-8: Technology Comparison by District

4.5 Type of mining

The two types of mining analyzed with this data were continuous miner (CM) and longwall (LW). The mines that operate only continuous miners are split evenly between node and leaky feeder usage. A strong preference for longwall mines is to use node based systems. This is hypothesized to relate to the recovery of equipment while retreat mining.

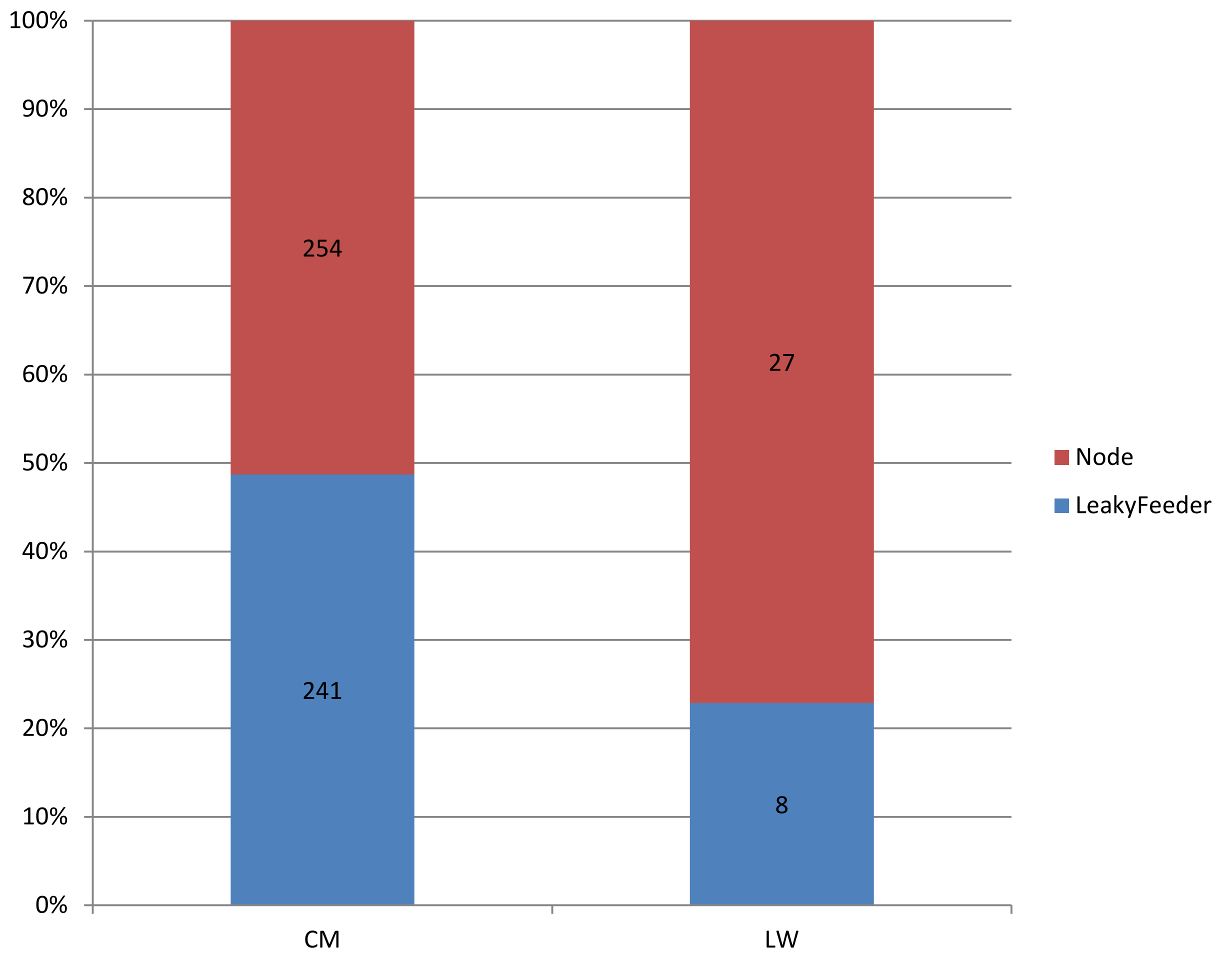

Figure 4-9: Mining Method Comparison

CHAPTER 5: CONCLUSIONS

A series of mine disasters in 2006 led to the creation of the MINER Act to help the health and safety of miners in disaster scenarios. One part of the act includes the requirement for wireless communication and tracking of underground coal miners. At the time no system existed that met all the requirements of the act, and several companies undertook the challenge of developing these systems.

Two main technologies emerged to supply communication to miners: leaky feeder and node mesh systems. The leaky feeder provides continuous voice communication along a leaky feeder cable, which acts like a giant antenna. The node mesh systems can provide voice, text, or a combination of both to miners from discrete points throughout the mine.

Technologies developed to track miners include RFID and RSSI. Discrete tag readers in the mine can read the tags worn by miners. With the simple RFID, where a reader identifies a tag that has entered its zone, the miner associated with the tag is determined to be in that zone. RSSI can improve the resolution of RFID by comparing the signal strength found at multiple readers.

A survey along with information gathered by mine site visits has identified the factors that play a role in deciding the system utilized at a mine include: mine size, geography and mining method. Medium sized mines mainly use leaky feeder based systems for communications. This may be due to having enough workers to maintain the system, but not enough revenue to fund a mesh based system. Mines in West Virginia show an increased number leaky feeder based systems due to legislation written exclusively in the state requiring voice communication several months before the national requirement for any communication. Longwall mines use more node based systems due to the ease of recovery as the longwall retreats.

APPENDIX A – MINE SURVEY

Mine Information

Mine Name ____

Location ____

Company____

Contact Person____

Total Employees ____

Underground Employees____

Average underground employees per shift______________________________

Annual Production____

Seam Height and Depth____

Pillar Size____

Linear Feet covered my CT system_________________________________

Number of underground employees with radios________________________

Number of Sections____

Mining Method____

No. Maintenance employees______________________________________

Type of System Used____

Standardization of CT systems for multiple mines operated by a single company

CT SYSTEM GENERAL

Leaky Feeder

Manufacturer

Is it used to meet the MINER Act requirements?

VHF or UHF

Number of handheld radios

Number of radios channels

Cable installation lengths

Node Based System

Manufacturer

Is it used for both tracking and communications?

If used for communications – voice and/or text?

Type of system – wired, wireless, or hybrid (wireless at face)

Number of nodes

Node Spacing

Operating frequency

Number of radios and/or RFID tags

Radio's number of channels

Method of extending the CT system as working face advances

____

____

Integrated CT system or separate backbones (atmospheric monitoring included?)

____

CT system installation – vendor, contractor, or in-house?

____

CT system maintenance - in-house or external contract

____

Methods for addressing survivability (redundancy or component protection)

____

Future plans for changing or upgrading the system

____

TECHNICAL

Plan for interfacing with CT systems of mine rescue teams or reliance on separate mine rescue CT systems

____

____

Issues with interference with any other radio source e.g. remote control continuous miners or wireless sensors

____

Secondary Communications system

Interest in medium frequency or through-the-earth communications

____

System implementation – stand alone or integrated with primary system

____

Future plans for changing or upgrading the system

____

OPINIONS

System Experience

Installation effort

____

Startup and Initial operation

____

Maintenance requirements

____

Occurrence and extent of system outages

____

Experience with surface computer interface – e.g. report generation, availability and clarity of required information, overabundance of information, system and display compression, system maintenance/health information, and status of backup batteries

____

____

Overall opinions of the CT system

____

____

____

Section layout (rough map) (dimensions of pillars and entries)

Main entries and escape-way layout

Photos of surface controls and underground nodes and/or leaky feeder

APPENDIX B – MINE DATA

MINE ID	MINE NAME	STATE	MSHA District	AVG EMPLOYEE CNT	Total MMUs	Technology Communication	wired or wireless mesh	Voice or Text	Manufacturer of Communications System specified in ERP	Manufacturer of Tracking System Standardized	Mining Method
100759	North River #1 Underground Mine	AL	11	299	3	Node	wireless	Text	Venture Design Services	Venture Design Services	LW
100851	Oak Grove Mine	AL	11	403	4	Node	wired	Text	Matrix Design Group	Matrix Design Group	LW
101247	No 4 Mine	AL	11	507	5	Node	wireless	Text	Strata Safety Products	Strata Safety Products	LW
101401	No 7 Mine	AL	11	757	8	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
102901	Shoal Creek Mine	AL	11	542	4	LeakyFeeder		Voice	Varis	Matrix Design Group	LW
103002	Corinth Mine	AL	11	12	1	LeakyFeeder		Voice	Mine Radio Systems	Mine Radio Systems	CM
103389	Carbon Hill Mine	AL	11	10	1	LeakyFeeder		Voice	Mine Radio Systems	Mine Radio Systems	CM
103419	Maxine-Pratt Mine	AL	11	20	1	LeakyFeeder		Voice	Mine Radio Systems	Mine Radio Systems	CM
103422	Clark No 1 Mine	AL	11	45							CM
301736	Sebastian Mine	AR	9	52	1	Node	wired	Both	American Mine Research	American Mine Research	CM
500296	New Elk Mine	CO	9	102	1	LeakyFeeder		Voice	Mine Radio Systems	Mine Radio Systems	CM
503013	Mc Clane Canyon Mine	CO	9			LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
503505	Deserado Mine	CO	9	116	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	LW
503672	West Elk Mine	CO	9	274	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
503836	Foidel Creek Mine	CO	9	363	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
504591	Bowie No 2 Mine	CO	9	264	3	Node	wired	Both	American Mine Research	American Mine Research	LW
504674	Elk Creek Mine	CO	9	286	4	Node	wireless	Text	Strata Safety Products	Strata Safety Products	LW
504864	King II	CO	9	59	1	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1100726	Shay #1 Mine	IL	8	86	3	Node	wireless	Text	Venture Design Services	American Mine Research	CM
1102408	Gateway Mine	IL	8	214		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1102632	Crown III Mine	IL	8	184	4	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1102664	Viper Mine	IL	8	260	4	Node	wireless	Text	Venture Design Services	Matrix Design Group	CM
1102752	The American Coal Company New Era Mine	IL	8	405	7	Node	wired	Text	Matrix Design Group	Matrix Design Group	LW
1103054	Willow Lake Portal	IL	8	483		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1103058	Pattiki	IL	8	283	4	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1103141	Mach #1 Mine	IL	8	124	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	LW
1103147	Prairie Eagle-Underground	IL	8	105	2	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1103156	Wildcat Hills Mine-Underground	IL	8	116		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1103162	Royal Falcon Mine	IL	8			Node	wireless	Text	Venture Design Services		CM
1103182	Deer Run Mine	IL	8	65							CM
1103189	MC#1 Mine	IL	8	126		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1103193	Lively Grove Mine	IL	8	156	1	LeakyFeeder		Voice	Varis	Venture Design Services	CM

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1103205	Prairie Eagle South Underground Mine	IL	8	39	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1103232	New Future Mine	IL	8	320							CM
1202010	Air Quality #1 Mine	IN	8	191		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1202215	Gibson Mine	IN	8	269	8	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1202249	Prosperity Mine	IN	8	290	5	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1202295	Francisco Underground Pit	IN	8	258		Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1202316	Freelandville Underground	IN	8	51	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1202349	Carlisle Mine	IN	8	254	5	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1202394	Oaktown Fuels Mine No 1	IN	8	214	4	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1202423	Freelandville West Underground	IN	8	32	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1502057	Advantage #1	KY	6	126	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1502132	Dotiki Mine	KY	10	370	10	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1502263	Darby Fork No 1	KY	7	103	3	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1502709	Highland 9 Mine	KY	10	424	6	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1507082	Freedom Energy #1	KY	6		3	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1507201	C-2	KY	7		1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1507475	Mine #1	KY	6	45	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1508079	Mine No 3	KY	6	252	8	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1509636	#77	KY	7	73	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1510753	Clean Energy #1	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1512564	Straight Creek #1	KY	7		3	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1512753	Calvary No 81	KY	7	113	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1512908	No 1	KY	6	11						Not Specified	CM
1515215	#3	KY		13							CM
1516457	K-4 Mine	KY	7	8	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1516583	Sam #14	KY	6	24	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1516663	Eagle Coal #22	KY	6			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1516801	#1	KY	6	11	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517077	RB #5	KY	7			Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1517110	ICG Knot Calvary Mine	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1517141	Mine #1	KY	7								CM
1517165	Mine No 1	KY	7	104	3	Node	wired	Both	American Mine Research	American Mine Research	CM

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1517216	Cardinal	KY	10	397	10	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517228	Black Star Energy #2	KY	6							Not Specified	CM
1517232	Richland No 9	KY	10	28	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
1517234	Huff Creek No 1	KY	7	111	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1517266	#10	KY	6	14	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1517478	#75	KY	7	105	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1517497	#68	KY	7	124	3	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1517587	Freedom	KY	10	157	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517610	No 3	KY	6	16	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517651	Mine #1	KY	6	94	3	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1517691	Mine #3	KY	7	17	1	Node	wired	Both	Mine Site Technologies	Pyott Boone	CM
1517720	#2	KY	6	26	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
1517741	Paradise #9	KY	10	206	5	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517874	No 18	KY	7	8	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517898	Mine #1	KY	6	9	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517903	Mine No.2	KY	7	33	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517917	No 2	KY	6	8	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517924	Bee, B & B#1	KY	6							Not Specified	CM
1517935	Clean Energy Transport Mine	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1517979	Mine No. 8	KY	6	11	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517982	Woodman 3 Mine #7	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1517993	#7	KY	6	17	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518001	#4	KY	6	21	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518058	Coal Creek	KY	7			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518161	Panzer Coal Inc. No.2	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518182	D & C Mining Corporation	KY	7	18	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518196	Highsplint	KY	7	18	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518197	Jarisa Cave Spur Mine	KY	7	50	2	Node	wired	Both	American Mine Research	American Mine Research	CM
1518198	Mine No. 1	KY	7	94	2	Node	wired	Both	American Mine Research	American Mine Research	CM
1518233	Black Light Energy	KY	6	8		LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518241	Mine No. 1	KY	7	82	2	Node	wired	Both	American Mine Research	American Mine Research	CM
1518250	Mine #16	KY	6	51	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518264	Cawood Mine #1	KY	7			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM

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1518277	K-3	KY		12							CM
1518316	White Star #1	KY	6		1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518335	Dodge Hill Mine #1	KY	10	146	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518340	Mine No 4	KY	7	97	2	Node	wired	Both	American Mine Research	American Mine Research	CM
1518368	CAM Mining #23	KY	6			Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1518369	Inspiration Resources Inc #3	KY	6	12	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518376	Beechfork Mine	KY	7	112	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518381	Taylor Fork Energy	KY	6	85	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518393	ICG Knott County Clean Energy	KY	6							Not Specified	CM
1518436	S. A. M. #10	KY	6	32	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1518452	White Cabin #7	KY	6	14	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518466	F-M #4	KY	7	17	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
1518472	No.11	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518507	Mine #8	KY	7	52	1	LeakyFeeder		Voice	Pyott Boone	Mine Site Technologies	CM
1518516	No 1	KY	7	33	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1518522	Classic Mine	KY	6	58	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518547	Onton #9	KY	10	243	3	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518552	Big Run Mine	KY	10	90	4	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1518565	E4-1	KY	7	141	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1518569	Deane #1	KY	6	25	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
1518575	No. 1	KY	6	201	5	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518589	Jones Fork E-3	KY	6	21	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518595	B & K Coal Inc #4	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518626	Mine No. 2	KY	6	27	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518647	Clover Fork No 1	KY	7	114	3	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518659	LA Energy #3	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518660	Coalburg Mine #6	KY	6			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518662	E3-1	KY	7	161	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1518699	Red Bird Coal No. 2	KY	6		1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518705	Band Mill 2	KY	7	56	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518710	Raven Mine #2	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518711	# 1	KY	6	20	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518721	Mine #23	KY	6	111	4	Node	wireless	Both	L-3 Communications	L-3 Communications	CM

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1518725	RB #11	KY	7					Both	n/a	Venture Design Services	CM
1518732	Mine No 5	KY	7	55	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518734	Mine #1	KY	7	53	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518747	Fools Gold Energy No. 16	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518763	Simpson Br	KY		14							CM
1518771	RB #12	KY	7	29	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1518775	Mine #15	KY	6	139	4	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1518782	Sandlick II	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518792	#1	KY		10							CM
1518826	Elk Creek Mine	KY	10	324	8	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518839	Van Lear Mine	KY	6	197	8	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518854	Liggett #3	KY	7	41	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1518864	Mine #2	KY	6	9	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518869	Mine No 2	KY	7	85	2	Node	wired	Both	American Mine Research	American Mine Research	CM
1518870	Mine No 1	KY	7	16	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518881	#9	KY	6	15	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518884	Coal Diggers Inc #1	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1518911	Mine #28	KY	6	105	3	LeakyFeeder		Voice	Tunnel Radio	Mine Site Technologies	CM
1518924	Butcher Branch	KY	7	5	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518936	No. 1	KY	6	18	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1518943	Mine No 5	KY	6	13	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1518949	Raven Mine #1	KY	6	57	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1518964	Mine #30	KY	6	21	1	LeakyFeeder		Voice	Tunnel Radio	#N/A	CM
1518984	Mine No 9	KY	7	16	1	Node	wireless	Both	L-3 Communications	American Mine Research	CM
1518987	Clark Mining Inc, #1	KY	6							Not Specified	CM
1518991	Flint Ridge Mine #2	KY	7	124	3	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519015	E4-2	KY	7	192	4	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1519018	No. 3	KY	7	9	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519029	Jet Coal Company Eagle Mine	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519039	Coal Hollow Mine	KY	6	11	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519048	Mine #15A	KY	6	29	1	Node	wireless	Both	L-3 Communications	#N/A	CM
1519051	Timber Tree #9	KY	7	18		Node	wired	Both	American Mine Research	American Mine Research	CM
1519063	Panther Mine #4a	KY	7			Node	wired	Both	American Mine Research	American Mine Research	CM

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1519094	Center Creek Mine	KY	6	16	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1519097	No 1	KY	6	88	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519102	P-1	KY	7	38	2	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1519113	Marion Branch	KY	7		1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519114	C-5	KY	7	25	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519116	Mine #9A	KY	7	94	2	LeakyFeeder		Voice	Pyott Boone	Mine Site Technologies	CM
1519117	K-6	KY	7			Node	wireless	Voice	Active Control	Active Mine	CM
1519129	No. 15	KY	6	35	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519132	Abner Branch Rider	KY	7	73	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519153	#1 Mine	KY	6	13	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519159	Jasper Coal LLC #1	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519178	South Akers Mining SAM#17	KY	6			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519180	No 1	KY	6	42	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519188	Grapevine Mine No. 1	KY		9							CM
1519191	Deane Mining Love branch	KY	6		1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
1519193	Voyager #7	KY	6	59	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519196	#2	KY	6	18		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519208	Hubble No 6	KY	6	8	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519224	#2	KY		17							CM
1519228	Blue Ridge No 1	KY	7	27	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519242	Redhawk #1	KY	6	35						Not Specified	CM
1519246	TLT Reseources Company #1	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519252	Mine No. 8	KY	7	17	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1519253	Viper Coal LLC 6#	KY	6	4						Not Specified	CM
1519256	#1	KY	6	31	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519258	Ember Contracting J&T #1	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519260	D-5	KY	7	44	2	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1519261	Viper Coal LLC, #2	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519262	Mine #4	KY	7		1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519263	Mine No 5	KY	7	34	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1519266	Hubble No. 7	KY	6	18	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519269	#2	KY	6	39	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM

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1519270	Love Branch South	KY	6	46	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519280	No 4	KY	6	24	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1519282	Mine No 2	KY	7	31	1	Node	wireless	Text	Venture Design Services	Matrix Design Group	CM
1519290	Infinity #4	KY	7	29	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1519292	C1	KY	6	31	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519294	5 Star Energy, LLC #1	KY	6			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519296	No 24	KY	6	56	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519297	UZ No. 2	KY	6	61	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519308	Victory	KY	7			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519309	#3	KY	6	8	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1519313	Mine #29	KY	6	11	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519314	Mine No. 12	KY	6	21	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519318	Garmeda #2	KY	7	33	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519323	Slone Branch	KY	6	66	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519325	Mine No. 7	KY	6	12	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519327	Mine #2	KY	6	9	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1519333	No 7-D	KY	6	12	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519336	Jellico #1	KY	7	68	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519347	Inner Mountain Mining #2	KY	6		1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519357	No. 2	KY	6	18	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519358	Parkway Mine	KY	10	126	3	Node	wireless	Voice	Active Control	Active Control Technologies	CM
1519374	River View Mine	KY	10	527	16	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519384	Oldhouse Branch	KY	7	66	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519390	#7	KY	6	15	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1519394	No. 1	KY	6	7	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519395	Cloverlick #2	KY	7	31	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519400	#88	KY		38							CM
1519408	Hance Mine No. 1	KY	7	28	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519410	Tantrough	KY	7	37	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
1519418	Mine No. 3	KY	7	71	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
1519422	South Akers Mining SAM #18	KY	6	16	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519430	Mine # 1	KY	7	27	1	Node	wired	Both	American Mine Research	American Mine Research	CM
1519433	Eagle 2	KY	6	15	2	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM

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1519438	Mine #17	KY		7							CM
1519447	Kathleen	KY	6	64	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519460	No 2	KY	6	18	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519462	Liggett #7	KY	7	35	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1519486	Engle Hollow Mine #1	KY	7			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1519488	No. 25	KY		27							CM
1519492	#31	KY		34							CM
1519494	No. 8	KY	6	30	1	Node	wireless	Both	L-3 Communications	#N/A	CM
1519497	Lige Hollow	KY	6	57	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
1519501	Mine No 11	KY		6							CM
1519514	D-1 Mine	KY	7	19	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
1519517	#1	KY	7	8	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1519528	Laurel Fork #2	KY		8							CM
1519531	White Cabin #9	KY		32							CM
1519532	Access Energy	KY		29							CM
1519533	Trace Fork 1	KY		36							CM
1519534	Eagle 3	KY		10							CM
1519535	Kronos Mine	KY		52							CM
1519539	Mine No 5	KY		17							CM
1519541	7-E	KY		20							CM
1519563	Redhawk #2	KY		31							CM
1519565	Hubble 12	KY		8							CM
1519567	Liggett #8	KY		30							CM
1519575	No 1	KY		11							CM
1519579	Miniard Branch Mine	KY		10							CM
1519598	Poundmill Mine No 90	KY		27							CM
1519605	No. 1	KY		5							CM
1800748	Taylor # 1	MD	3	52	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
1800761	Steyer II	MD	3	57	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
1800780	Casselman Mine	MD	3	22		LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
2401950	Bull Mountains Mine No 1	MT	9	213	3	Node	wireless	Text	Strata Safety Products	Strata Safety Products	LW
2902170	San Juan Mine 1	NM	9	263	3	LeakyFeeder		Voice	Mine Radio Systems	Mine Radio Systems	LW
3300968	Hopedale Mine	OH	3	135	5	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM

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3301070	Century Mine	OH	3	454	6	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
3301159	Powhatan No. 6 Mine	OH	3	475	6	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
3304509	Tusky	OH	3	67	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3304520	Buckingham Mine No 7	OH	3	90	2	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
3304526	Buckingham Mine #6	OH	3	113	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
3304565	Bergholz 7	OH	3	35	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3304591	Shean Hill Mine	OH	3	32	1	LeakyFeeder		Voice	Tunnel Radio	Pyott Boone	CM
3304595	Yellowbush Mine	OH	3	69	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3304605	Carroll Hollow #6	OH	3	39	1	LeakyFeeder		Voice	Tunnel Radio	Pyott Boone	CM
3402080	P8 North	OK	9	38	1	Node	wired	Both	American Mine Research	American Mine Research	CM
3600958	Mine 84	PA	2		0	Node	wireless	Text	Venture Design Services	American Mine Research	CM
3601818	R S & W Drift	PA		4							CM
3602022	Buck Mountain Slope	PA	1	2		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3602203	N & L Slope	PA	1	3	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3605018	Cumberland Mine	PA	2	560	3	Node	wireless	Text	Venture Design Services	Venture Design Services	LW
3605466	Emerald Mine No 1	PA	2	575	6	Node	wireless	Text	Venture Design Services	Venture Design Services	LW
3607230	Bailey Mine	PA	2	875	11	Node	wireless	Text	Venture Design Services	American Mine Research	LW
3607416	Enlow Fork Mine	PA	2	657	2	Node	wireless	Text	Venture Design Services	American Mine Research	LW
3607741	Rock Ridge No 1 Slope	PA	1	6		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3607838	Harmony Mine	PA	1	24	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3608135	Darmac No. 2 Mine	PA	2	28	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608346	Primrose Slope	PA	1	14		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3608525	Tom's Run Mine	PA	2	40	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608571	Sarah	PA	2	10		Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3608603	Tracy Lynne	PA	2	43	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608622	Miller Mine	PA	2			Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3608636	Agustus	PA	2	56	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3608637	#1 Slope	PA	1	6	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3608645	Geronimo	PA	2			Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3608701	Dutch Run	PA	2	30	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608704	Dora 8	PA	2	36	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3608725	Beaver Valley	PA	2	17		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608746	Quecreek #1 Mine	PA	2	124		Node	wireless	Text	Venture Design Services	Venture Design Services	CM

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3608836	Twin Rocks Mine	PA	2	42		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608841	Logansport Mine	PA	2	65	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608847	Little Toby Mine	PA	2	15		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608850	Nolo	PA	2	84	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3608862	Clementine Mine	PA	2	36	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3608893	7 Ft Slope	PA	1	2		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3609005	Ondo Extension Mine	PA	2	41	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3609033	Gillhouser Run Mine	PA	2	51	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3609075	Rossmoyne No. 1 Mine	PA	2	21	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
3609127	Madison Mine	PA	2	72	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3609224	Cherry Tree Mine	PA	2	87	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609260	Roytown Deep Mine	PA	2	87		Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3609287	Lowry Mine	PA	2	24		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609326	4 West Mine	PA	2	206		Node	wireless	Text	Venture Design Services	Strata Safety Products	CM
3609342	Barrett Mine	PA	2	23		LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
3609355	Penfield Mine	PA	2	37		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609371	Mine 78	PA	2	72	2	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609394	Knob Creek	PA	2	24		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609407	Heilwood	PA	2	44		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609464	T.J.S. No. 6 Mine	PA	2	38	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
3609468	Long Run	PA		11							CM
3609475	No 13 Slope	PA	1	3		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3609477	Harmony Mine	PA	2	35		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609491	Bottom Split Slope	PA	1			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
3609549	Kimberly Run	PA	2	164	4	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3609637	Starford Mine	PA	2	24		Node	wireless	Both	L-3 Communications	L-3 Communications	CM
3609666	Horning Deep Mine	PA	2	49	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
3609706	T.J.S. No. 7 Mine	PA	2								CM
3609963	Buck Drift #2	PA		4							CM
4002750	Rex Mine No.1	TN		9							CM
4003143	S & H # 10	TN	7	29	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4003177	Valley Mine #1	TN	7			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4003272	Mine No. 14	TN	7	17	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM

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4003328	Premium #5 Deep Mine	TN	7	20	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4003333	No. 1	TN	7	27	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4003365	Double Mountain Mine	TN	7	46	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4200079	Emery	UT	9			Node	wireless	Text	Venture Design Services	American Mine Research	CM
4200089	Sufco	UT	9	250	5	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
4200121	Deer Creek Mine	UT	9	291	3	Node	wireless	Both	L-3 Communications	L-3 Communications	LW
4201566	Skyline Mine #3	UT	9	225	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
4201890	Dugout Canyon Mine	UT	9	180	3	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
4202074	Horizon Mine	UT	9	110	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4202233	West Ridge Mine	UT	9	264	4	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	LW
4202241	Lila Canyon	UT	9	20	1	Node	wired	Both	Mine Site Technologies	Mine Site Technologies	CM
4202263	Castle Valley No. 3	UT	9			Node	wireless	Both	LifeStream Resources	LifeStream Resources	CM
4202335	Castle Valley Mine #4	UT	9	54	1	Node	wireless	Both	LifeStream Resources	LifeStream Resources	CM
4202356	South Crandall	UT	9					Both	Not Specified	Not Specified	CM
4401486	Meridian #2	VA	5	10	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4403317	Apple Jacks No. 7	VA	5		1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4404856	Buchanan Mine #1	VA	5	669	9	Node	wireless	Text	Venture Design Services	American Mine Research	LW
4405411	Beehive	VA	5	14	2	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4405559	Mine No 1	VA	5	48	1	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
4405815	Mine No. 4	VA	5			Node	wired	Both	American Mine Research	American Mine Research	CM
4406195	Mine No 3	VA	5			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4406444	Laurel Mountain	VA	5	88	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4406499	Dominion No 7	VA	5	83	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4406643	Mine No 2	VA	5			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4406685	Paw Paw Mine	VA	5	85	3	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4406718	Mine No. 26	VA	5	36	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4406748	Mine No. 30	VA	5	39	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4406759	Mine No. 36	VA	5	81	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4406782	6C Mine No 1	VA	5			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4406791	Mine #2	VA	5			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4406804	Tiller No 1	VA	5	90	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4406816	Band Mill Mine	VA	5			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4406836	Mine No. 1	VA	5	12	1	LeakyFeeder		Voice	Pyott Boone	Matrix Design Group	CM

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4406839	Mine No. 34	VA	5	22	1	LeakyFeeder		Voice	Pyott Boone	Matrix Design Group	CM
4406859	Big Fork Mine	VA	5			Node	wireless	Text	Venture Design Services	American Mine Research	CM
4406864	Cherokee Mine	VA	5	97	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4406868	No 6	VA	5	15	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4406876	Mine No. 3	VA	5	9						Not Specified	CM
4406907	Mine No. 1	VA		12							CM
4406920	Hiram Fork	VA		9							CM
4406929	Deep Mine #26	VA	5	254	5	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4406947	Wilson Deep Mine #1	VA	5	27	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407045	Mine No 1	VA	5	11	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4407046	Mine #2	VA	5	43	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407047	Mine # 1	VA	5	12	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4407052	Mine No. 4	VA	5	84	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407074	Dogwood #3	VA	5	10	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407081	No. 2	VA	5	39	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407082	Mine #3	VA	5	5		Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407087	Mine No 2	VA	5	61	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407104	Hatfield Mine #1	VA	5	18	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407123	Deep Mine #35	VA	5	62	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407127	Derby Wilson Mine	VA	5	54	2	Node	wireless	Text	Strata Safety Products	Strata Safety Products	CM
4407129	Deep Mine #25	VA	5	98	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407137	No. 2	VA	5	42	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407138	Mine No 5	VA	5	45	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407146	Roaring Fork No 4	VA	5	33	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407150	Mine No. 1	VA	5	81	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407154	No. 5	VA	5	9	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407156	#3	VA	5	64	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407159	No 9	VA	5	12	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407167	LMM	VA	5	12	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407179	No. 2	VA	5			Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407186	Looney Creek Taggart Mine	VA	5	45	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407187	Mine No. 3	VA	5	19	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407188	#2	VA	5	26	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407189	Low Splint A Mine	VA	5	42	1	Node	wired	Both	American Mine Research	American Mine Research	CM

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4407205	Integrity	VA		8							CM
4407207	Middle Splint	VA		20							CM
4407211	No 2	VA	5	23	2	Node	wired	Both	American Mine Research	American Mine Research	CM
4407214	No 8	VA	5	11	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407217	No 10	VA	5	10	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407220	Mine No. 44	VA	5	58	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4407223	Deep Mine 41	VA	5	90		LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407224	Pine Branch 1	VA	5	69	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4407231	Deep Mine 37	VA	5	45	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4407237	Marker Portal Mine	VA	5			Node	wired	Both	American Mine Research	American Mine Research	CM
4407241	Dogwood #4	VA	5	12	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407251	Looney Creek Marker Mine	VA	5	41	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407252	#1	VA	5	10	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
4407261	No 1	VA	5	14	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4407262	Phillips Rider No. 1 Mine	VA	5	7	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4407269	Middle Fork Hagy	VA		12							CM
4407275	Wilson #2	VA		36							CM
4407277	Dogwood #4-C	VA		12							CM
4601271	Harris No 1	WV	4			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4601318	Robinson Run No 95	WV	3	531	3	Node	wireless	Text	Venture Design Services	American Mine Research	LW
4601433	Loveridge #22	WV	3	608	6	Node	wireless	Text	Venture Design Services	American Mine Research	LW
4601436	Shoemaker Mine	WV	3	621	5	LeakyFeeder		Voice	Varis	American Mine Research	LW
4601437	McElroy Mine	WV	3	900	8	LeakyFeeder		Voice	Varis	American Mine Research	LW
4601456	Federal No 2	WV	3	470	4	LeakyFeeder		Voice	Varis	Matrix Design Group	LW
4601537	Farley Eagle Mine	WV	12	51	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4601544	Road Fork #51 Mine	WV	12	93	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4601816	Pinnacle Mine	WV	12	406	3	LeakyFeeder		Voice	Varis	Matrix Design Group	LW
4601968	Blacksville No 2	WV	3	504	4	Node	wireless	Text	Venture Design Services	American Mine Research	LW
4604168	Sentinel Mine	WV	3	276	6	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4604236	Maple Eagle No. 1 Mine	WV	4	188	3	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4604387	Prime No. 1 Mine	WV	3	150	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4604955	Lightfoot No. 2A Mine	WV	4	64	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4605071		WV	4			LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4605121	Camp Creek Mine	WV	12	316	10	LeakyFeeder		Voice	Varis	Matrix Design Group	CM

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4605130	Silver Oak No. 1	WV	4	32	1	Node	wireless	Voice	Active Control	Active Control Technologies	CM
4605252	Beckley Pocahontas Mine	WV	4	240	6	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4605315	Caymus Mine	WV	4			Node	wireless	Voice	Active Control	Active Control Technologies	CM
4605437	American Eagle Mine	WV	4	301	4	Node	wireless	Both	L-3 Communications	L-3 Communications	LW
4605589	Crawdad No 1 Mine	WV	3	40	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4605978	Bronzite III	WV	4	40		Node	wired	Both	American Mine Research	American Mine Research	CM
4606263	Wyoming No 2	WV	12	54	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4606265	Sewell Mine B	WV	4	44	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4606558	Highland Coal Handling Facility	WV	12			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4606618	Gateway Eagle Mine	WV		67							CM
4606843	No 2 Mine	WV	12	25	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4607009	Castle Mine	WV	4	69	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4607191	Josephine No 2 Mine	WV	4	58	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4607273	Justice #1	WV	4	133	2	Node	wireless	Both	L-3 Communications	L-3 Communications	LW
4607366	No 1	WV	12	11	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4607908	Big Mountain No 16	WV	4	205	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608019	No 1	WV	12								CM
4608131	Mine No. 35	WV	12	43		LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608159	Stockton Mine	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608194	Pleasant Hill Mine	WV	3	124	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608224	No 6	WV	12					Both	N/A		CM
4608266	Josephine No 3 Mine	WV	4	39	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608268	No. 6	WV	12	50	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608297	White Queen Mine	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608305	Campbells Creek 11B Mine	WV	4	51	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608309	Upper Cedar Grove Mine No 3	WV	4	8	2					Pyott Boone	CM
4608315	Brushy Eagle	WV	4	92	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608365	Grassy Creek No 1	WV	4	96	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608384	Seng Creek Powellton	WV	4	83	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608402	Black Knight II	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608436	Upper Big Branch Mine-South	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM

MINE ID	MINE NAME	STATE	MSHA District	AVG EMPLOYEE CNT	Total MMUs	Technology Communication	wired or wireless mesh	Voice or Text	Manufacturer of Communications System specified in ERP	Manufacturer of Tracking System Standardized	Mining Method
4608444	No 1	WV		17							CM
4608551	Marsh Fork Mine	WV	4	59	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608553	Black King I North Portal	WV	4	42	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608570	Coalburg No 2 Mine	WV	12	26	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
4608577	Jims Branch No 2	WV	12	16	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608581	Mine No. 1	WV	4	9	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608610	Matewan Tunnel	WV	4			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608625	Kingston No 1	WV	4	91	4	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608636	No. 2	WV	12	49	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608637	Campbells Creek No. 10 Mine	WV	4	64	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608642	Mine No 3	WV	12								CM
4608646	Mine No 3	WV	12	20	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608650	No. 13-A Mine	WV	4								CM
4608655	Tunnel Mine	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608659	Mine No. 32	WV	12		1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608676	Lick Branch Mine No 2	WV	4	41							CM
4608715	Pond Creek Mine No. 1	WV	4	16	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608730	Mountaineer Alma A Mine	WV	12	93	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608731	Sugar Camp Mine	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608735	Allegiance Mine	WV	4	66	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608738	Diamond Energy	WV	12	36	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608756	Plum Mine	WV	3	20	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608758	Eagle #1	WV	4	66	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608759	Eagle Mine	WV	4	115	4	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608762	Powellton Tunnel	WV	4								CM
4608763	Fork Creek No 1	WV	4	129	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608772	Deep Mine No 7	WV	12	48	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608778	No 3	WV	12	51	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608787	Jerry Fork Eagle	WV	4	61	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608801	Aracoma Alma Mine #1	WV	12	154	6	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608802	Hernshaw Mine	WV	12	45	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608808	Ruby Energy	WV	12	114	3	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608811	No 56	WV	4			LeakyFeeder		Voice	Varis	Matrix Design Group	CM

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4608812	Upper Cedar Grove No 4	WV	4	17	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608829	Beckley Crystal	WV	4	42	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608837	Coon Cedar Grove Mine	WV	4			LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608863	Mountain Fork No 1	WV	12								CM
4608864	Tunnel Ridge Mine	WV	3	171	1	Node	wired	Text	Matrix Design Group	Matrix Design Group	CM
4608878	Affinity Mine	WV	4	67							CM
4608884	No 58	WV	4	67	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608885	Poplar Ridge No 1 Deep Mine	WV	4	114	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608890	Rivers Edge Mine	WV	4	28	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608892	Bronzite	WV	12					Both	N/A		CM
4608909	Midland Trail Mine No. 2	WV	4	65	1	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4608932	Kingston No. 2	WV	4	91	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608949	Winifrede 12 Mine	WV	4	40	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608955	Mine No. 2	WV	12	7	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4608959	Mine No. 2	WV	12		1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608976	No 4 Mine	WV	12			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608993	Coalburg No 1 Mine	WV	4	45	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4608994	Deep Mine No 8	WV	12	75	3	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4608999	Mine No 1	WV	4	35	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609017	Mine No. 37	WV	12	24	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609018	No. 8	WV	12	106	4	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609020	No 65	WV	12	110	3	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609028	Mountain View Mine	WV	3	206	5	LeakyFeeder		Voice	Varis	Matrix Design Group	LW
4609029	Mountaineer II Mine	WV	12	337	6	Node	wireless	Both	L-3 Communications	L-3 Communications	LW
4609042	Fork Creek Mine No 3	WV	4	49	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609048	Slip Ridge Cedar Grove Mine	WV	4	101	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609060	#4 Mine	WV	3	70	1	LeakyFeeder		Voice	Tunnel Radio	Matrix Design Group	CM
4609065	Sweet Birch	WV	4			LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609066	Cucumber Mine	WV	12	72	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609069	Mine No. 6	WV	12	13	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609073	Sugar Maple Mine	WV	4	48	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609082	Coalburg No 1 Mine	WV	4	57	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609084	Laurel Fork Mine	WV	4			Node	wireless	Text	Venture Design Services	American Mine Research	CM

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4609086	Brody Mine No 1	WV	4	345	9	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609091	Horse Creek Eagle	WV	4	83	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609092	Allen Powellton Mine	WV	4	47	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609093	Mine No. 7	WV	12	17	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609097	Brier Creek No 1	WV		7							CM
4609099	Coon Hollow Tunnel Mine	WV	4			Node	wireless	Both	L-3 Communications	L-3 Communications	CM
4609100	Mountain Fork No 2	WV	12	26	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609103	Mine No 5	WV	12					Both	N/A		CM
4609107	Campbells Creek No 7 Mine	WV	4	55	2					Matrix Design Group	CM
4609108	Mammoth #2 Gas	WV	4	75	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609115	Imperial Mine	WV	3	102	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609126	Saylor Mine	WV	4	47	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609129	Jolo Mine	WV	12	11	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609136	Broad Run Mine	WV	3			LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609148	Laurel Coalburg Tunnel Mine	WV	4	44	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609150	Dorothy No 3 Mine	WV	4	70	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609152	Black Oak Mine	WV	4	175	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609154	Pocahontas Mine	WV	4	94	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609163	Roundbottom Powellton Deep Mine	WV	4	146	6	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609171	Rocklick Coalburg Deep Mine	WV	4	79	2	Node	wireless	Text	Venture Design Services	American Mine Research	CM
4609172	Mountaineer Pocahontas Mine No 1	WV	4	192	6	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609173	Mine No 1A	WV	4	4		LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609177	Big Branch No. 1 Belt Mine	WV	4			Node	wireless	Text	Venture Design Services	Venture Design Services	CM
4609180	Apache Mine	WV	4		1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609187	No 2 Deep Mine	WV	4	27	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609188	Westchester Mine	WV	4	25	1	Node	wired	Both	American Mine Research	American Mine Research	CM
4609192	Leer Mine	WV		32							CM
4609193	Parker Peerless Mine	WV	4	75	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609194	Mine No 3	WV	4	33		LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609198	Caretta #3 Mine	WV	4	6	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609201	Eagle #2 Mine	WV	4	23		LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM

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4609207	Mine No 2	WV	12	16	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609209	Deep Mine No 15	WV	4			LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609210	Mountaineer Pocahontas Mine No. 3	WV	4	31		LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609213	Beckley No. 3	WV	12	36	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609215	Upper Cedar Grove Mine No 5	WV	4	27	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609217	Powellton #1 Mine	WV	12	210	6	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609221	Slabcamp	WV	4	80	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609222	Green Ridge #2	WV	4	28	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609225	Mine No 4	WV	4	32	1	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609227	Double Camp No. 1	WV	4	41		LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609230	Winchester Mine	WV	4	125	4	Node	wireless	Voice	Active Control	Active Control Technologies	CM
4609231	Coalburg No. 2 Mine	WV	4	54	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609237	Alloy Powellton	WV	4	86	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609243	Jims Branch No 3B	WV	4	21	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609244	Randolph Mine	WV	4	107	6	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609245	Isaban Deep Mine No. 3	WV	4	53	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609254	Hatfield Energy Mine	WV	12	37	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609261	Mine No. 39	WV	4	133	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609266	Hominy Creek Mine	WV	4	51	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609269	Mine No 8	WV		27							CM
4609271	Mine No 3	WV	4	15	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609275	Shadrick 5 Block	WV	4	14	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609279	No. 3-A Mine	WV	12	53	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609280	Dingess Chilton Mine	WV	12	127	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609282	Tralee Mine No. 1	WV	4	15	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609289	Black Pearl Underground Mine	WV	4	12	4	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609291	Mine No 1	WV	4	11	1	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609293	Hunter Peerless Mine	WV	4	83	4	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609296	Mine No. 2	WV	4			Node	wireless	Voice	Active Control	Active Control Technologies	CM
4609297	BC No. 1 Deep Mine	WV	4	93	1	Node	wireless	Voice	Active Control	Active Control Technologies	CM
4609298	Mine No. 40	WV	4	47	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609299	Cedar Grove #1 Mine	WV	12	50	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM

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4609301	Still Run No 3	WV		49							CM
4609302	Arco No. 1 Mine	WV		15							CM
4609304	Twin Bridges 2	WV	3	23	1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM
4609307	MT-41	WV	12	44	2	Node	wireless	Text	Venture Design Services	American Mine Research	CM
4609319	Lower War Eagle	WV		24							CM
4609325	Fork Creek No 10 Mine	WV	4	85	2	LeakyFeeder		Voice	Varis	Matrix Design Group	CM
4609328	Cook Mine	WV	4	34	2	LeakyFeeder		Voice	Pyott Boone	Pyott Boone	CM
4609329	Mine No 11	WV	4	61	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609343	Workman Branch Deep Mine	WV		52							CM
4609348	Horse Creek No 1	WV	4	42	2	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609369	Bismarck Mine	WV	3	44	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609371	Saylor B	WV	4	49	1	LeakyFeeder		Voice	Tunnel Radio	Tunnel Radio	CM
4609373	Left Fork No. 1 Deep Mine	WV		29							CM
4609378	Mine No. 42	WV		23							CM
4609383	Mine No 1	WV		13							CM
4609389	Spider Ridge	WV		29	3	Node	wireless	Both	L-3 Communications	L-3 Communications	CM
0103245	Thompson No. 1	AL	11			Node	wireless	Text	Venture Design Services	Venture Design Services	CM
0103422	Clark	AL	11		1	Node	wireless	Text	Venture Design Services	Venture Design Services	CM

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