No point of failure

As mines go digital and robotised, communication networks are having to handle vast quantities of data and analytics meaning new solutions are needed to ensure connectivity is never lost, reports Paul Moore

Trends in the networks market include companies offering "network agnostic" options and increasing influence of network integrators that put together the components in a solution for the mine moving with the times to offer the latest technology; and of course increasing network demands being created by autonomous equipment and the demand for real time machine analytics and machine health monitoring.

3D-P VP CTO Ron White told ***IM***: "Full autonomy is a challenge that only the largest of miners are attacking today. However, most mines are looking into some level of autonomy, typically starting with a simpler solution like remote control for drills or dozers. In any autonomy situation, however, the wireless network is critical to success. The latest wireless solutions offer greater bandwidth, faster roaming, and in some cases, the ability to provide some protection for the network from interference, through licensed spectrum. Predictability becomes one of the largest requirements in these autonomy ready networks. Real-time analytics and safety are two other significant drivers of wireless network improvements, however, to a lesser degree than autonomy as many of today's networks can handle these applications, when the network is properly designed and maintained."

WiFi was never designed for the harsh conditions of open pits and underground mines, so is now struggling to keep pace. This is where LTE networks are coming in. LTE is based on IP, which allows users to host all communications on a single LTE and a fixed IP/Multiprotocol Label Switching (IP/MPLS) network, resulting in substantial design, management and maintenance savings. Previously spectrum access was a big problem for LTE, but private LTE solutions are now being offered by the major players, and crucially, the hardware involved in LTE has become smaller and much less costly. In contrast to WiFi, LTE is based on a tightly scheduled and network-supervised air interface that has better spectrum efficiency and more control over the quality of service offered to application device traffic. Nokia, Ericsson and Huawei are the big providers, but as stated, integrators are taking their technology and implementing it for the mine's customised needs in many cases. LTE started in Australia in mining through a **Nokia** LTE network and **Cisco** core (the LTE was then Alcatel-Lucent before Nokia acquired it) providing a 4G solution for Rio Tinto, which is still operating but LTE is now being looked at by most of the big mining houses. Nokia is currently installing another major LTE network in Chile for a major copper mine. And the first underground solution was recently delivered by **Ericsson** and **Ambra Solutions** at Agnico Eagle LaRonde gold mine in Canada.

Miners can integrate multiple applications directly on one 3D-P Intelligent Endpoint to reduce on-board technology clutter and manage network access and utilisation

Nokia says all the top mining houses are now looking at LTE, it is just a matter of time given the move to autonomous and remote operations

Some argue that the best solution is to deploy LTE but as a hybrid, retaining WiFi for non mission critical comms. White told ***IM***: "LTE promises some significant improvement over traditional Wi-Fi networks, particularly in the area of predictability. The ability to limit possibilities of interference through licensed spectrum provides much of this predictability, but the underlying communication protocol also provides improvements over WiFi in this area. One of the biggest challenges with LTE, however, is in spectrum. In remote regions of Australia, it is possible to acquire private LTE spectrum licenses to operate. However, in North America particularly, all spectrum set aside for LTE is owned by the LTE service providers who have a very different consumer based model for commercialising that spectrum, that typically does not lend itself well to the miner's needs."

If a customer can obtain a license for a chunk of LTE spectrum (the single largest challenge to deploying LTE), it is typically a rather small channel, which limits the throughput available over the LTE network. A hybrid solution helps solve this problem. Using LTE for the communications that truly require the higher levels of Quality of Service, while using another solution, such as standards based WiFi, a client meshing based solution, as well as a true distribution layer network, allows the network to provide the best of both worlds. The distribution layer can be used to connect fixed or nomadic sites, camera's, etc. WiFi access can be used for non-autonomous mobile systems, freeing up all available bandwidth on the LTE network for the critical autonomous communication."

A hybrid solution also is note limited to WiFi as Nokia can offer solutions with a lightly licensed spectrum like CBRS, maintaining a pure LTE solution using carrier aggregation to provide enough bandwidth.

Also, Ambra Solutions argues on the spectrum issue: "The LTE technology offers one of the best ratio of bits/hertz. It means that with a small carrier, we can achieve a high bandwidth. For example, the new 64x64 Massive MIMO and beamforming technologies allow the transfer of over 430 Mbps down and 128 Mbps up per sector on a single 10 Mhz carrier.

3D-P argues that in the open pit world, and particularly in North America, the driver for LTE has been full autonomy. "Those mines who are not moving to full autonomy within the next five years can be well served by other solutions today, without the additional challenges like

The Ambra/Ericsson LTE solution at LaRonde is now a benchmark for future deep mining LTE

spectrum availability" that LTE creates." 3D-P Intelligent Endpoints (IEP's) were deployed on some of the first LTE deployments in mining, as a rugged client for the LTE network.

LTE deployed at LaRonde

Ericsson and Ambra Solutions have recently worked together to deliver Canada's deepest underground LTE network for the Agnico Eagle mining site, LaRonde in Abitibi, Quebec. Located 3 km below the surface, the LTE network will provide data and voice mobility services across the site and enable several Internet of Things (IoT) use cases to improve safety and mining operations.

LTE cellular networks can provide data and voice mobility services over low frequency bands that allow a better propagation than any other available technology, delivering faster, more advanced wireless technology. The network in LaRonde is utilising band 5 at 850 MHz. Ambra is the only Canadian operator deploying private LTE networks in underground mines.

The solution is based on the latest Ericsson Radio System portfolio of basebands and radio units, software upgradable to provide Massive IoT capabilities for sensor-based applications and support 5G New Radio (NR) capability.

Eric L'Heureux, CEO, Ambra Solutions, says: "The LTE technology is the most cost effective and reliable solution to provide real-time coverage to several kilometres of underground tunnels. A single LTE radio can cover up to 6 km of tunnel, whereas it would take over 60 active Wi-Fi access points to cover the same area."

LTE networks open a new suite of capabilities and possibilities to cost effectively enable smart mining-related tasks for open pits or underground mines. Unlike other options, LTE networks allow the use of IoT sensors and devices to monitor, operate, and collect data throughout the mining site, for example related to air quality monitoring. This includes remote control operation of mining machinery, dispatch systems, emergency notification systems, access control systems, automated collection of data, ventilation fan monitoring and gas detection systems.

In every LTE network Ambra is designing, all the LTE components are fully redundant and deployed in a high-availability mode. Like the big LTE carriers, the mining customer cannot afford downtime and a single point of failure.

Nokia on the LTE future

IM spoke to Jaime Laguna, Nokia Global Program Sales Leader for Mining. He had this to say: "We are a global telecoms company and for mining we had to look at how our technology could help them overcome their challenges. They told us they needed to optimise productivity but also needed to be safe as well as environmentally sustainable."

Laguna agreed on the major driver for mining networks today being automation, offering reliability in a network but also connecting many more devices at the same time. But he also referred to the need for convergence – consolidating different network types into one, such as combining voice and data and removing legacy systems. Nokia technology can provide this offering operational simplicity. "We looked at how to guarantee seamless network evolution and remove the complexity of multiple networks in one mine. LTE is a powerful single network to which more services can be added, allowing existing communications networks to naturally evolve into 5G. We can sometimes achieve this with the legacy products through software changes rather than hardware changes." Nokia also says it is the only LTE manufacturer that is committed to deliver an end to end solution including integration with third parties.

Laguna says that Nokia's offering and technology allows it offer pit to port solutions as well as both open pit and underground LTE. "We understand the need for mission critical mining operations, where real time data back to an ROC makes up to the minute production decisions easier. A powerful single network also helps close the gap between operations and IT. We like to call it 'beyond connectivity.' Nokia's mine of the future vision is a roadmap linked to connectivity but that evolves into other elements beyond just connectivity itself." Other major industries already use LTE and have done for years, and this is helping drive growth in mining as well, as part of a growing LTE ecosystem.

Todays solutions moving from 4G to 5G need a high bandwidth network, with a first level connecting all the IoT devices at a pit scale, where WiFi is starting to really struggle. Nokia private LTE can either replace WiFi or complement it in a hybrid solution where the LTE handles mission critical applications with low latency and high quality of service. This might include offices, accommodation and catering areas in the mine that don't need to use LTE. Though in these cases an LTE small cell can create a type of local WiFi bubble.

Laguna told ***IM*** that most of the top 40 miners in the world are now actively looking at LTE due the fact they are pursuing elements of automation and teleremote operation and the more automated the site, the more applicable and needed it is. Safety is a big topic as well as asset tracking and video surveillance. Greenfield mines are getting private LTE from the outset, while at brownfield sites, they are still looking at technology revamps, many starting with higher precision and autonomous drilling. Autonomous retrofitting is big business now too but needs the power of an LTE network.

Nokia told ***IM*** that it is working with top suppliers of fleet management systems and autonomous truck manufacturers to ensure the interoperability of the application, the LTE network and machine hardware.

As well as the Chile LTE installation, Nokia has proof of concept studies underway at sites in Asia and Australia including installing smaller scale LTE networks to prove results, especially where a mining customer is trialling autonomous trucks. Even the major equipment OEM test mines are trialling LTE to help them understand its potential. In Canada Nokia is working with a major mining innovation centre on an underground LTE network; allowing customers to conduct visits to see its performance.

In terms of what LTE requires, it has a control base known as a microcore, effectively the core of the network containing all the information on network users. Beyond this depending on requirements you have macrocells, small cells and mini macros (intermediate). But the ratio when compared to WiFi nodes can be 10 times less. Rio Tinto replaced 40 nodes with five LTE cells. In an average mine one macrocell can

cover the whole mine, maybe with one small cell in the base of the pit. The power transmission of the radio equipment is also far better, at 40-60W, whereas WiFi is limited to 250W.

Ambra's LTE journey

Ambra Solutions in Canada is now one of the leading integrators for LTE solutions in mining, as detailed in the recent LaRonde project. The telecoms company started 12 years ago deploying mesh WiFi but has always been hardware agnostic. Uniquely, and what has boosted its growth in the LTE space, is that it is now both an integrator and a carrier, having invested in its own spectrum in Canada. Eric L'Hereux told ***IM***: "We deployed a lot of WiFi mesh in the 2.4 and 5.8 GHz bands, which works fine for the existing FMS and dispatch systems. But with autonomous equipment it really is impossible to create a reliable network with WiFi as it was not designed for outdoor use where there are numerous obstructions. Wireless mesh networks do offer a solution but they are restricted the 802.11 technology and require many more radio nodes and trailers to power them, while using proprietary algorithms. WiFi starts losing bandwidth connectivity at -85dB, whereas LTE goes down to -115dB, a massive difference; meaning LTE antennas can listen to really small frequencies while using far less infrastructure. For an effective open pit LTE network you can use one antenna/cell either side of the pit and cover more than 7 km. These connect to the core, which is a computer than acts like a router interface connecting the antennas and the network. LTE is also highly secure, using SIM cards to authenticate users. It is also the only solution that provides end of end quality of service. While wireless mesh slows down with more users, LTE devices all have their own timeslot to talk meaning synchronised constant latency."

L'Hereux says that most big open pits are still using WiFi but are migrating to LTE to benefit from not having to relocate trailers, as well as having a licenced band and top QoS. "LTE can connect anything – 5G technology and multiple IoT sensors and push to talk; and we see it dominating mining in the near term." Ambra is an integrator, using its own spectrum it takes Nokia and Ericsson technology/cores and tests and configures everything to the mine's need before shipping the solutions as a kit ready for deployment, which most of the big miners can do themselves having their own telecoms departments. Ambra is also working with OEMs like Sandvik and Caterpillar to help them migrate their equipment to LTE via a kit.

He concludes: "We are seeing the largest mines go to LTE first as they are most likely to be testing autonomy and have the largest mine areas to cover. And yes it is mainly open pit for now. But underground, LTE is also better as the low frequencies work better in tunnels – a single LTE access point replaces 60-80 WiFi access points. Underground WiFi cost is about C$70-75/metre compared to LTE at C$30-35 /per metre. WiFi needs optic fibre and more power, while for LTE one cell in a centralised location per level is often enough. LTE is also easy to install and deploy and can be done by non IT professionals. Five years ago LTE cores were expensive and radio units large. Today this has all changed and as in open pit all the underground miners are looking at it. We have had numerous delegations visit LaRonde to see what has been achieved there."

Newtrax solutions leverage any existing UG network infrastructure and enhance network connectivity at the face with the MineHop™ battery-powered wireless multihop mesh network

Newtrax and underground connectivity

Newtrax is primarily an underground specialist, and told ***IM*** it also definitely sees a shift in attitudes towards underground networking technology. Mines are now struggling to access the data they need underground in a timely fashion. While traditionally, the development jumbos and production drills never saw real-time network access, increasingly mines want to know how they are working in real time, while semi and fully autonomous machines are completely network reliant. The lack of real-time access to drilling machine data has actually begun to become a bottleneck in otherwise digitally advanced operations. Using MineHop™, even though it has a low bandwidth to conserve power, allows a subset of the most crucial and important production and availability data to be accessed in real time. This type of information might include, if the drill is working or not, its fuel levels if it is a diesel machine, is it drilling or bolting. The customer can decide the data they want to see.

Newtrax solutions leverage any existing network infrastructure and enhance network connectivity with the MineHop™ battery-powered wireless multihop mesh network and MineProx™ ad hoc peer-to-peer network. Purpose-built to fill the gaps in existing communications systems in underground mines, these unique network extensions can cost-effectively cover all parts of the mining process, including the face, for real-time identification of productivity bottlenecks and early warnings of safety, health and environmental hazards.

But equally, Newtrax is now positioned as

"network-agnostic" and can integrate with and extend any network a mine chooses to implement, whether that be leaky feeder, WiFi or LTE, all of which are in the mix in today's underground market. To fill the gaps of connectivity underground, Newtrax systems' 900 MHz frequency hopping spread spectrum RF links provide an omnidirectional range up to 500 m which can be extended to more than 1 km with directional antennas. There are no wires for power or communication therefore there is no risk of them being damaged by mining activity. The battery-powered wireless nodes are usually hung from the drift roof for easy installation and can be spaced at 100 m or more for many kilometres depending on the customer data needs. Being battery powered means not being dependent on wired power, and the latest batteries mean very long life. The Newtrax Proximity Detection System however uses the MineProx™ ad hoc peer-to-peer network created by the software embedded in miner's cap lamps, so that when they get close to a machine in the working area, the data can be transferred to the network. MineHop™ nodes can also go on machines themselves. The technology is machine OEM agnostic, meaning data from say drills from two or more OEMs can be unified and delivered in the same way to the mine management. This is useful in itself in making it more easy to compare different OEM machine performance. Finally as MineHop™ is extending an existing network, Newtrax works with the network providers and integrators, to ensure a full solution for the customer.

Patrice Corneau, Newtrax Product Owner, told ***IM***: "Mine operators don't have WiFi right up to the working area as electricians and technicians have not had time to implement it. MineHop™ is easy to deploy and provides quick connectivity to working areas, crucial in today's market where operators want real time analytics and are also operating teleremote and increasingly autonomous equipment. To date our system is working in over 85 hard rock mines globally across Canada and the US, Chile, Brazil, Australia, Russia and elsewhere." Recent contract awards include with Gold Fields. A Newtrax Personnel and Equipment Tracking solution, running on the patented MineHop™ network, will be deployed on all of the St Ives Invincible mine underground equipment, and used by all underground miners.

Rajant – optimised wireless mesh

Rajant Corporation is well known in the industry for its wireless mesh networks, used at many large open pit mines. High functionality, easy-to-install BreadCrumb® nodes work in concert with InstaMesh® to enable voice, video and data communications that operate over a common wireless infrastructure. Hundreds can be quickly linked, self-configuring as part of a fully mobile, high bandwidth network.

The Rajant LX5 is a rugged, wireless device that forms a mesh network when used in conjunction with other BreadCrumb systems

Kinetic Mesh® networks utilise Rajant's patented peer-to-peer InstaMesh networking technology to perform real-time evaluation and direct traffic via the fastest pathways between any wired, wireless, or in-motion points. InstaMesh is able to dynamically optimise performance as network characteristics change, whether nodes are added or subtracted, frequencies are opened or blocked, or the assets it connects are moved over large areas. When a user changes, moves, or disables a device in the network, that change only needs to be managed locally, not propagated throughout the network.

As a completely distributed protocol, InstaMesh® responds rapidly to network topology changes to ensure robust fault tolerance, high throughput and low latency. Unlike traditional meshing technologies, which rely on a single stationery controller node to manage decisions across the network, every node in a Kinetic Mesh® network can act independently. The InstaMesh protocol seamlessly connects fixed, wireless, and mobile nodes together and will dynamically redirect traffic between the next best available points if any one peer is compromised or obstructed.

This self-healing capability not only provides for no single point of failure, but enables network nodes to seamlessly switch between available radio frequencies based on best-path analysis at the node level.

"InstaMesh® always prefers the fastest path to any destination, based on the state of the network at the time at which each packet needs to be transmitted. Each node learns and constantly reevaluates the best link to use for each destination in real time by analysing every packet flowing through it. This approach allows the Kinetic Mesh® network to make extremely fast decisions and react immediately to changing network conditions, without consuming excessive bandwidth for overhead messages."

Finally, while InstaMesh® leverages a proprietary algorithm, it is fully compatible with 802.11 standards. The protocol sends packages over Layer 2. If your voice, video, and data communications can be sent over Ethernet, it can be sent over the Kinetic Mesh® network.

Chris Mason, Rajant Director of Sales for Europe, Middle East, and Africa told ***IM***: "We are seeing consistent pressure on mine efficiencies and a desire to spend less dollars per tonne along with an increasing focus on safety, which includes keeping people safe but also avoiding safety related stoppages. Technology and digitalisation are helping take people out of the equation and all the big miners are looking at forms of digital operations, particularly trying to achieve 100% guaranteed connectivity to data. There has been a huge increase in personnel tracking system installation as well as far more video surveillance both above and below ground. This all means much more pressure on mine networks." Mason says Rajant now actively works against a product roadmap that assists miners on their journey to more remotely operated, digitised and autonomous operations. From Rajant's point of view this means that a mission critical network with no point of failure is critical. Rajant's solution is not dependent on WiFi, its wireless mesh is a multiple radio node to multiple radio node design. Mines can maintain multiple routes to connectivity in a way that WiFi cannot. Rajant argues that legacy WiFi mesh and even LTE in the mining area still have to communicate with a central connector/switch which can become a point of failure, whereas it is running a multi frequency network with no point of failure, while LTE uses much fewer nodes in an environment with many potential obstructions to signals. Rajant provides a mine area system, that then links to whatever onward connectivity is in place, but Rajant still believes it is unequalled for reliability in the defined InstaMesh® network.

Rajant technology is offered to the mining market directly but also through integrators such as 3D-P who incorporate the Rajant hardware and software into their overall customer solution, often with enhanced functionality and ruggedised housings. Finally, the company is conducting extensive trials of InstaMesh® underground both with mines themselves and equipment OEMs; all part of the same drive for more efficiency that has been seen in surface mining.

Rajant says it recently received some insightful feedback from a customer in South America who decided to switch to LTE last year for multiple technologies they use in the pit. Rajant believes this customer's inputs are particularly relevant especially as they see more mines in Peru and Brazil that are choosing LTE yet have not had a

single successful installation. Their key points were the following: "Investments in LTE in Latin America are being analysed and scrutinised carefully resulting in further delays in these investments due to two primary factors – low bandwidth and hidden costs. For example, for every 20 MHz of spectrum that is obtained, the estimated traffic for a mining topology with the associated geography is between 40 and 80 Mbps of upload traffic. This fact alone demonstrates that LTE on its own cannot be the sole solution for mining companies but will be a component of an overall mine-wide connectivity solution. In all likelihood, there will be two or possibly three networks running in parallel. Second is the cost factor and we know how significant that is for all mines who feel the productivity pressure to deliver more with less every day. In this same example, the initial cost for this LTE investment for a fleet of 100 is $3.5 million to $4.5 million plus an annual cost of $400,000-500,000 in support service. These networks are not only mission critical and complex to support and with carrier class equipment that requires specific services to ensure the guarantee. There are technical aspects of the infrastructure required for this network which contribute to the additional costs making it even more expensive resulting in the need to build out an MPLS type network over the LTE access network. And with growing demands for surveillance and remote monitoring on the rise, a complete LTE network with even six thermal video cameras that each consume 14 Mbps becomes too much of an investment. However, today LTE is gaining strength and by 2020-2022 will be in most of the mining companies; but not as a sole connectivity solution but running in parallel with other networks and segmenting the services."

3D-P and mine customised solutions

3D-P is a radio agnostic systems integrator and focuses on choosing the appropriate technology for its customers through the following lenses. First understand the challenges of the environment, including ruggedisation requirements, the effects of mobility and the mining environment on RF requirements, etc. Second, understand the requirements of the application. "Mining applications are significantly different beasts as compared to typical applications used in office or consumer environments. The communication requirements for these applications demand that the network be designed differently than those networks that are designed for those more typical applications. These design requirements change depending on not only the applications the mine will utilise, but also the technology chosen. With this information we then choose the appropriate technology for the mine, ensuring they will get the performance, maintainability, and scalability they require."

On the continuing role for mesh technology, Ron White told ***IM***: "There is absolutely a place for client meshing solutions such as Rajant's Kinetic Mesh even when a customer decides LTE is the right choice for their mobile fleet. When 3D-P designs networks that will utilise a client meshing solution, the customers' requirements are first taken into consideration. Many smaller mines, with limited technology requirements are able to take full advantage of a client meshing solution, with very limited infrastructure deployed. Other customers may require nearly 100% coverage and a high bandwidth requirement. For these customers, our designs are always a multi-layered (hybrid) network, which allows us to keep the traffic on the mobile links dedicated for mobile devices, and other traffic to take advantage of solutions that are more appropriate to that traffic type. As far as that client meshing layer goes though, the overall network design is focused on one-hop connectivity (client to infrastructure), even when client meshing is available. In other words, the network is designed in such a way that the mobile fleet will be able to communicate directly to infrastructure, rather than relying on meshing through neighbouring clients to find the network."

He adds: "Deploying a client meshing solution in this manner may seem counter intuitive, although in the end, it provides extremely high reliability and performance, while solving a few of the challenges typical wireless networks have in the mobile open pit environment. For example, a few of these challenges include communication around shovels, particularly in drop cuts, and in deploying nomadic (typically solar trailer) repeaters in an area that can cover this section of the pit, without the frequent moves required by blasting. Client meshing allows the solar trailer to be placed in an area that will limit the requirement to frequently relocate it, and also allows the equipment working around the shovel, which would often be blocked from connectivity by the shovel itself or from the terrain in a drop cut area, to mesh through the shovel, or other queueing trucks, to establish connectivity. It is a critical piece of the puzzle that raises overall network connectivity and performance to the highest level."

IWT Wireless – adapting to the customer need

As a company, Virginia-based **Innovative Wireless Technologies** (IWT) is over 20 years old now, and over its history has offered all kinds of wireless solutions to industrial customers, from Bluetooth to private mobile radio options. This diversity of experience saw the company enter the mining business in 2007, primarily to address the requirements for IS comms and tracking systems laid out in the MINER Act passed in 2006. This led to the development of the ACCOLADE® wireless miner mesh radio system and later the development of SENTINEL™, which is an ad-hoc wireless digital network for communications and tracking but which was designed and optimised for underground coal mines. Today, IWT argues that SENTINEL continues to outperform and has a lower cost of ownership than WiFi and leaky feeder based systems. Key attributes are that it is relatively low in power usage but also low in bandwidth, which means in terms of the main goal of one network for voice/texting and continuous tracking of people it offers good redundancy. The IWT solution differs from wired solutions in that all of the tracking and comms data is handled (transmitted) wirelessly. The IWT mesh nodes, which act like repeaters and are installed in the escapeways, can run on AC lines with battery backup to allow the system to remain functional if main power is lost, or can be battery-powered. Infrastructure for the working section is battery-powered. The use of portable, battery powered devices also means the system can easily keep pace with even a rapidly advancing mine development area.

SENTINEL is a single network that provides voice communications, texting, and tracking using wireless communications but can also handle data for tasks such as longwall moves, critical machine health data, environmental data and mine rescue. And while underground coal remains a major part of the IWT business, it has now taken this model into salt, trona and limestone mines as well as the tunnelling market, which do not require an IS solution but in mine design operate in a similar way to coal. However, they will tend to employ many fewer miners, so not as many radios are needed. Many large metallic hard rock mines have optic fibre extensively in the mine, and some of the advanced coal longwalls do as well – these mines send a lot of machine data directly via fibre. But the majority of coal mines using room and pillar and other methods many have limited underground networking infrastructure, so an IWT solution offers them a lower cost but just as effective option. The same is true of many smaller metallic mines. And a number of mid-tier gold mines have poor wired networks for the last mile before the working face. These customer challenges have led IWT into new markets like Mexico both for its coal and metallic mining industries. IWT Vice President Phil Carrier tells ***IM***: "A lot of our time is spent trying to understand each customer's use case – what data, tracking and services are they trying to get where in the mine."

To enable handling of more machine data, IWT says its new HDRMesh™ solves many of the data retrieval issues facing underground operations today. "Traditional Wi-Fi-based solutions do not

reliably transmit in non-line-of-sight conditions, and lack the range for continuous coverage. Traditional wired data solutions are difficult to maintain, difficult to advance and often do not survive the mining process." IWT's data solution is composed of a series of rugged High Data Rate (HDR) wireless nodes that 'hop' data from mine equipment to the mine's fibre backbone. Information critical for the mine's productivity and safety is communicated in real-time to decision makers at the surface. Each node contains IWT's proprietary high data rate mesh component and a Wi-Fi Client Access Point. Superior range allows for fewer nodes for a cost efficient system.

Finally, legislative rulings over the last few years have not specifically addressed the communication capability of mine rescue practices. Teams still face the challenge of communicating among themselves in apparatus areas and by relaying messages through the briefing officer to/from a command centre. This process of relaying information from the team to the fresh air base and then to the command centre and back again is prone to errors. With IWT's patented mesh network communication technology, the SENTINEL system provides a solution to this unmet need by connecting rescuers tying in and eliminating or reducing the need to relay messages along the command structure. IWT's SENTINEL system inherently supports reverse RFID tracking. This capability provides the command centre personnel locations inside the mine as the effort progresses. It affords the command group a real time picture of the positions and status of rescuers. And as working teams advance and retreat when conditions become unsafe, leaving permissible methane and CO monitors behind provides the command structure insight into conditions rescuers will face upon return. This information gives the command group more data to base decisions about re-entering the mine. The SENTINEL Mine Rescue system has the intrinsic ability to provide the infrastructure for remote, permissible, battery powered sensing. The IWT system has now become the standard for US Federal and State mine rescue teams as well as in many mining company mine rescue operations. Going forward, IWT says it is looking at how LTE is evolving, and it does see options for example to incorporate LTE small cells underground, to provide something similar to a local 5G network, similar to a WiFi hotspot.

Maestro launches Plexus Powernet

Maestro Digital Mine has recently introduced Plexus Powernet, which uses copper coaxial cable to get data from the mine face to surface faster. As mines rely more on real-time information and advanced diagnostics, the need for pervasive connectivity has become more

Maestro recently introduced Plexus Powernet, which uses copper coaxial cable to get data from the mine face to surface faster

critical. Maestro says it has come up with a solution that borrows from an old method of delivering TV channels and the Internet to the home: a copper coaxial cable network. As outlined in March 2018 in *Northern Ontario Business*: "Currently, modern mines use fibre-optic communication networks underground for voice, data, video and autonomous vehicle applications. The fibre cable is fragile and prone to breakage from blast concussion and damage from mobile equipment. Fibre splicing and termination is very delicate and requires an ultra-clean environment and expensive equipment. In short, getting fibre-optic networks in the 'last mile' of the mine is difficult, time-consuming and expensive. The Plexus PowerNet is the latest creation from Maestro that is being touted as yet another way for mines to incorporate digital innovation. It is the world's first coaxial gigabit network designed to be a simple and efficient means of getting data from the underground workings back to the command centre."

Data and power are combined on the same cable, so the network powers the end point devices to eliminate additional infrastructure and reduce installation cost and time. The cable and fittings are already designed to withstand a lot of punishment. VP of Development and Technology, David Ballantyne, said while working on this problem he was looking at coaxial cables, which had been designed to transfer information over long distances. Those same cables can also withstand a wide range of temperature and weather conditions, making them ideal for mines, where blasting happens almost daily and temperatures become increasingly hotter as they go deeper into the mine. Mine operations can now add devices on the same cable without adding another separate power to each device. This approach also reduces capital costs by 40 to 70%. Along with high bandwidth requirements, it is important for the network to have ultra low latency and jitter so that autonomous vehicles can be safely operated underground. The network can also be installed and maintained by any internal tradesperson, eliminating the need for costly outside fibre-optic contractors, an internal specialist, or expensive tools. The network is fully Cisco compliant so that the client can use all their existing software tools to support it from surface or even remotely in another city or country. Maestro expects to have 50 installations by the end of 2018.

Matrix and N-Connex

Last year, **Matrix Design Group**, LLC announced a distribution partnership agreement with Northern Light Technologies (NLT) for distribution and service of the N-Connex system. Matrix N-Connex is an award-winning networking system designed specifically for harsh environments, integrating voice and high-speed data communications, asset and personnel tracking, control and automation, video surveillance, condition monitoring and other solutions into a single modular, Wi-Fi and Ethernet based platform. The network is a simple, high-speed network suitable for underground metal/non-metal mines, tunnels, prep-plants and other heavy industries. "N-Connex is fast. It delivers gigabit data throughput speed. Run all the data through it you want – including teleops, autonomous vehicles and video. N-Connex is easy to maintain. If a module fails, you can plug in a spare to minimise downtime and do this with existing personnel. N-Connex is easy to expand and repair, and offers a lower total cost of ownership to operators." It is fully compatible with 802.3 and 802.11 Ethernet and WiFi devices for voice, tracking, atmospheric monitoring (AMS), data and video systems. Wi-Fi solutions include voice and data support for private calls, PTT broadcasts, tablets, laptops and smartphones. Matrix is now the exclusive sales and service distributor of NLT N-Connex in the US, Europe and Africa.

Matrix N-Connex is an award-winning networking system designed specifically for harsh environments