Modern mine sites require an integrated approach to external and internal communications to achieve high productivity, security, safety and worker morale.

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The Connectivity Challenge

Modern mining operations rely on a mix of communications solutions for efficient production, safety, site security and remote connection to enterprise services. They also turn to communications for the Internet access and video content that support the morale and retention of miners. The challenge for mining companies is that their operations are usually in remote locations served poorly or not at all by telecommunications providers. The low population density near the mining site usually means that cellular network coverage, broadband access and even land line connectivity is marginal or lacking altogether.

To complicate matters, regional providers will seldom invest in infrastructure to provide adequate service to these locations – there are too few potential subscribers at remote sites to justify the provider’s business case. Thus, it is left to the mining company to provide the services that are required for efficient operations and for connectivity to the outside world.

There are two fundamental communications requirements: reachback communications to the enterprise network, public switched telephone network and the Internet; and mine site communications connecting workers and, increasingly, equipment that is part of machine-to-machine networks.

Reachback Communications

Connectivity to remote sites may be achieved in several ways including satellite communications (SATCOM), line-of-sight microwave communications and fiber. A subset of these approaches or all of these approaches may be used over the lifetime of the site. This type of reachback communications is critical for keeping the site connected to the corporate network, for site management activities, for supply chain management, for site and worker safety, and for heavy equipment lifecycle support.

SATCOM Reachback

Satellite communications (SATCOM) is typically the only practical way to connect a remote site to the outside world – especially during the initial exploration, survey, and mine construction periods. Operators use dedicated SATCOM links with guaranteed data rates, as shown in Figure 1, to support mining communication needs. At the outset, when site exploration and survey are under way, field crews may use satellite phones or small terminals that furnish voice and data services. Here, equipment portability and ease of set up and use are important. The comparatively low data rates available from

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these small L-band frequency terminals suffice for the small field teams. Figure 1 shows Iridium satellite phones and Inmarsat Broadband Global Area Network (BGAN) terminals as the equipment of choice. The figure shows that the L-band SATCOM solution may be practical over the life of the mining operation with use focusing on emergency or backup communications in later phases.

Figure 1. Use of SATCOM for Reachback During Mine Development & Operations – Communications needs scale over time and so should the SATCOM terminal and service approach. Timeline bar height conveys increase in net reachback data rate in different mining phases.

While L-band technology answers many requirements, construction and operation typically demand higher-capacity (depicted as taller timeline bars) and more cost-effective SATCOM solutions. While higher-capacity VSAT equipment costs more than the L-band terminals, users achieve significant operating cost savings over time, because the monthly recurring service cost per Kbps for the VSAT solution is much lower than for the L-band terminal solutions.

Construction involves a considerable increase in personnel on site and therefore the number of users and applications that must be supported by the SATCOM connection. Portable, quick set-up terminals may be ideal for the construction phase. Here, “one-button” terminals, which automatically aim their antennas at the correct satellite, are often the best choice. They offer multi-megabit per
second (Mbps) reachback capability without the need to dispatch a SATCOM field engineer to set up and operate the unit. When site construction is complete, this type of unit can be repackaged in its ruggedized transit cases, stored and later readied for deployment to another construction site.

Figure 1 shows two types of Globecom SATCOM terminals suitable for mine construction and operations phases. Selection of specific terminal design attributes (e.g. antenna size, power amplifier rating, etc.) is made based on thoroughly defining current and projected site communications requirements and on detailed communications link analysis for derived reachback data rates.

Reachback connectivity accomplishes multiple critical objectives. As shown by the blue arc in Figure 2, SATCOM reachback provides enterprise, mobile communications and mining crew support services connectivity. The combination of satellite communications and an interconnection to a global terrestrial network can also connect a mining company with its remote operations anywhere in the world. Connectivity to a mining company facility or corporate WAN is then simply a matter of establishing connectivity to a local peering point via the Internet or leased line services. In most cases, this element of corporate connectivity already exists.

![Diagram of SATCOM Reachback Connectivity for Enterprise, Mobile Phone & Crew Support Services](image)

SATCOM connects the remote site to the corporate network to support day-to-day business functions. Enterprise application support may include email, file sharing and transfer, access to specialized corporate applications, Internet access and enterprise resource planning (ERP) systems. Workers at the mine site are connected to a wired/wireless LAN, which in turn connects via the satellite link with the distant corporate facility or WAN. By combining SATCOM and cellular technologies, using
specialized technologies, it is possible to extend access to SATCOM reachback throughout the mining site while minimizing transmissions costs.

SATCOM is also used to furnish Internet access for workers, who stay at or near the mine site for extended periods. Internet access links separated families through use of VoIP calling, services such as Skype, and instant messaging. Workers have access to a wide range of news, entertainment, music and shopping sources when broadband connectivity is available. This has significant positive impact on crew morale and well-being. In this scenario, worker living quarters are equipped with a wired or wireless LAN and they can use their own or a company-issued tablet or laptop for Internet access.

With a SATCOM broadband link, it is also possible to provide Internet Protocol TV (IPTV). Here, TV programming is delivered to viewers over the housing facility LAN to set top boxes (STBs) in worker dormitory rooms and common areas. From the STBs, content may be viewed on laptops, tablets, or IP-compatible TVs. IPTV service is particularly beneficial to workers stationed at remote locations for extended periods. Programming content can take the form of channel packages containing a mix of news, sports, movie, and network or cable TV programs, as well as video-on-demand options.

**Microwave & Fiber Reachback**

SATCOM is a viable reachback approach, but it is typically more costly than microwave or fiber. While SATCOM can solve the connectivity problem from day one, communications infrastructure build-out by local providers over time may make lower-cost alternatives feasible. In some areas of the world, extensive microwave radio networks may ultimately reach a remote mining site if the economics to the network provider are favorable. In this case, a remote site operator would switch the bulk of its traffic from SATCOM to microwave to lower operating expenses. Some SATCOM capability may be retained for backup purposes in the event that microwave service is interrupted.

In a similar manner, if a local provider installs optical fiber in the area of the mine site, users typically transition from SATCOM or microwave to this lower-cost, higher-capacity alternative. Again, some degree of SATCOM or microwave service would usually be retained for backup purposes.

Figure 3 illustrates a reachback scenario where initial SATCOM service is first supplanted by lower-cost microwave service. Thereafter, a transition to fiber takes place to again lower OPEX and/or to achieve higher communications throughput. Connectivity at any site over time may use a different mix of these technologies. Other solutions such as WiMax and 3G/4G mobile networks may be available depending upon local conditions.
Mine Site Communications

At the mine site, communications typically depend on a mix of wireless technologies, from Wi-Fi and cellular to mesh radio networks, which combine voice, data and video to support the varied demands of remote sites.

Wireless Communications

To relay production information between surface locations and the site office, mining sites typically establish IEEE 802.11 WiFi networks, and WiFi can also provide the local area networks (LANs) within the site office buildings and in worker living quarters.

WiFi networks are also well suited for site security purposes where perimeter and on-site security cameras and access control systems relay information to a central guard station. Figure 4 illustrates typical outdoor perimeter security sensors and access controllers that support this functionality wirelessly. This type of network can be easily secured to ensure the integrity and confidentiality of company information.
Onsite and Reachback Cellular Communications

Mining sites may be geographically remote, but they do not have to be cut off from the advanced communications services that power business and connect employees to the world. Mine operators have the option of deploying a specialized hybrid satellite-cellular (“SatCell”) solution that doubles as onsite and reachback communications infrastructure.

The SatCell solution places equipment at the mining site that supports local calling and automatically hands offsite and long-distance calls to a satellite link. Offsite calls routed over the satellite are landed at a teleport and routed to the public-switched telephone network (PSTN). The power of this SatCell solution is that the SATCOM link, with its comparatively expensive satellite bandwidth, is only used for offsite calling. Onsite calls stay local.

Mine operators can fully integrate their sites into the global communications network with a remote hosted switching infrastructure that supports the full range of 3G and 4G LTE cellular voice and broadband data. This infrastructure offers the same capabilities and complies with the same service requirements that govern the major cellular communications providers and it supports call routing to users on all provider networks.
Cellular coverage is depicted in Figure 6 by the light-green shaded area. This figure summarizes the types of communications systems that are applicable to the mining environment.

**Mesh Radio Communications**

Personnel managing surface and underground operations, as well as miners on the bench or working a long line, need reliable voice, video and data communications to optimize efficiency and production rates. These requirements can be met most successfully using a mesh wireless network approach.

A full mesh wireless network is characterized by its ability to allow any node in the network to communicate directly with any other node in the network. As shown in Figure 5, this type of network offers a critical advantage: there are usually multiple paths available for communications to pass through the network, which greatly improves the likelihood that communications between nodes will be successful. In some cases, deployed radios may act solely as relays for communications traversing the network.

This capability is important in a complicated mining operation, where environment is constantly changing as the site is mined. This makes self-configuring mesh networks a good choice for this part of the operation. These systems provide broadband capability for voice, data, and video transport.

Given the harsh and potentially explosive underground environment, mine sites require ruggedized, intrinsically safe (IS) radios, cell phones, PDAs and laptops for underground voice and data communications carried by the mesh network. These devices are full featured and certified under the UL 913, ATEX or other international standard for safe use by workers in this environment.

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Underground mesh networks also support automated, machine-to-machine (M2M) data communications between heavy equipment and an integrated monitor and control (M&C) system. This capability is important for monitoring how well machines are performing their jobs. Performance monitoring is critical in obtaining targeted yields over time, and in being diligent and proactive about maintenance. The right M&C solution will alert maintainers to upcoming scheduled maintenance and more importantly, about potential equipment problems before they become critical and costly. M2M capability is also useful for tracking heavy equipment at the site. Equipment asset tracking is particularly important for managing traffic, so that work flow at the site can be scheduled to minimize equipment idle time.

The self-configuring mesh wireless network also provides a good underground communications solution for mine safety equipment. These communications are critical in the event of an incident where access to any mine area may be restricted and miners are unaccounted for. Enough of the multi-node mesh network may be intact to permit communications from emergency shelters located in the mine, and additional radios can be quickly brought to bear in re-establishing communications if additional assets are needed. Mesh network connectivity and applications for mining are illustrated by the light blue shading and the callout text in Figure 6.
Systems Integration – Putting It All Together

The mesh radio, WiFi, cellular and SATCOM communications systems must be integrated into an overall solution in order to be effective. Globecomm specializes in exactly this demanding work for complex networks. As a major SATCOM services provider, we offer a full range of global SATCOM terminals, onsite communications infrastructure, our unique SatCell system, and global service solutions. We engineer our SATCOM solutions to be highly efficient, and we use specialized equipment to optimize the amount of information that can be transported in a given amount of satellite bandwidth.

The mine site solution utilizes a converged Internet Protocol (IP) architecture in order to optimize performance and to achieve interoperability of communication services. Thus, all communications between disparate systems or between on-site and off-site points ultimately generate IP traffic that is
routed over the mine site LAN. Depending upon the types of communications devices present at the site, this may require use of dedicated radio over Internet Protocol (RoIP) interoperability platforms, use of special-purpose interface hardware configured within mine site routers, and use of a dedicated voice over IP (VoIP) system. The IP network equipment suite also includes routers, switches, accelerators and firewalls. Our capabilities extend to implementing the on-site wired or wireless LAN and provision of user desktops, laptops, VoIP phones and peripheral equipment.

We architect the overall system and integrate the required equipment in one or more equipment racks installed in the mine site office, as well as provisioning terminals, radios, cellphones, PDAs and laptops ruggedized for underground operation. If such a facility is unavailable, a container-based equipment-room solution may be viable. Here, all IP and communications network equipment is integrated into ruggedized equipment racks installed in purpose-built ISO shipping containers. External masts, towers and antenna/RF systems are connected to the rack-mounted equipment in order to realize on-site and reachback communications capability. Rack-mounted equipment also supports the on-site LAN. This approach offers the advantages or rapid fielding after initial factory integration and scalability for capabilities growth over time.

System integration is followed by rigorous testing to ensure that all site communications systems are operating to predicted performance levels. Successful testing results in commissioning the network into service and turning operations over to the on-site operators.

**Summary**

This paper has described various types of communications that may be used to conduct essential operations at a mining site. SATCOM is typically used to connect the remote mining site to the outside world. Mesh radio based communications using self-configuring radio technology are ideal for the ever-changing below and above-ground environments at these sites. Mesh communications may be used for a variety of functions and may carry voice, data, and video information. Secure wireless communications based on WiFi and/or WiMax technology are well-suited for broad area site coverage for general communications needs and for site security and surveillance. Wireless technology is also applicable to establishing site office LANs and, where applicable, worker living quarters networks. Cellular capability based on SatCell technology provides economical on-site voice and data connectivity and the ability to connect via SATCOM backhaul for long-distance calling purposes.

**About Globecomm**

Globecomm is a leading global provider of managed network communication solutions. Employing our expertise in emerging communication technologies, we are able to offer a comprehensive suite of system integration, system products, and network services enabling a complete end-to-end solution for our customers. We believe our integrated approach – offering in-house design and engineering expertise...
combined with a world-class global network and our 24x7 network operating centers – provides a unique value to customers. As a network solution provider, we leverage our global network to provide customers managed access services to the Internet backbone, video content, the public switched telephone network or their corporate headquarters, or government offices. We are currently providing such services to customers in the US, Europe, South America, Africa, the Middle East, and Asia.

- We offer a wide range of hosted and managed communications services that leverage our global transmission capacity and our network of data center, content management and switching facilities.
- Our expert teams can also advise you on the best ways to meet your critical communications needs, while our specialized laboratories evaluate broadcast, IP and other technologies for customers.
- We can engineer and integrate individual systems or complex networks, and then support them through the lifecycle.
- Our engineering expertise has also produced a wide range of satellite and wireless terminal products ready for quick and cost-effective deployment.

Globecomm makes one vital commitment to our customers: that the solutions we provide will work, no matter what. Globecomm provides services and products supported by one of the industry's largest in-house engineering staffs. When we build components into our services and products, we test them exhaustively for reliability, compatibility and cost-effectiveness. That's why suppliers have come to rely on us for improvements to the products they provide.