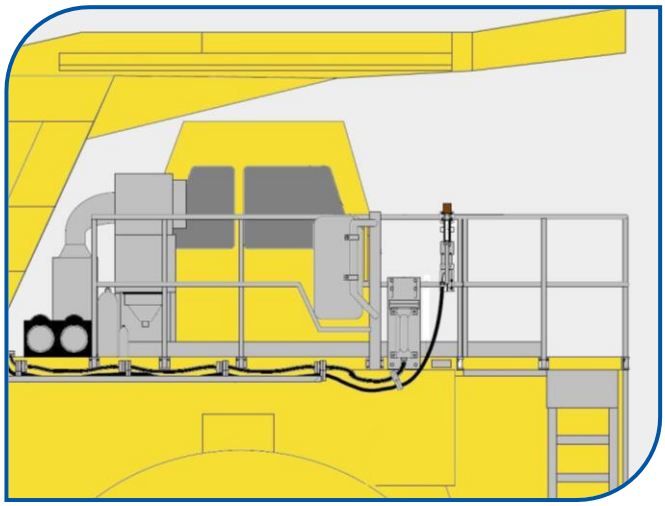
MobileMark
antenna solutions

Extending & Maintaining Wi-Fi Connectivity
Throughout Open-Pit & Underground Tunnel Mines

Mines are increasingly turning to a Wi-Fi network to optimize operations and improve utilization of high capital value equipment. The right Wi-Fi network, particularly with optimum antennas, delivers huge production, OpEx, safety and environmental benefits, allowing to immediately maximize capabilities and achieve gains of up to 10% in productivity. A mine's investment in a wireless network can easily pay for itself in under a year.

BENEFITS AND FEATURES OF A RUGGEDIZED, RELIABLE, HIGH SPEED WI-FI BACKBONE:

- Streamline real-time communications, fleet management and dispatch
- Monitoring and control
- Real-time telemetry data to monitor vehicle health to identify problems before they happen



- Dispatch of vehicles through improved equipment utilization
- Provide GPS data for vehicle location
- Stream video and CCTV
- Manage hundreds of connections from moving or stationary equipment
- Haul road route maintenance and metrics
- Ore Control and load metrics
- Asset management
- Truck payload monitoring
- Productivity monitoring
- Position monitoring, grade control, machine guidance
- Stockpile guidance and control

EQUIPMENT/MAINTENANCE SAVINGS:

- Fuel level
- Tire health and extended life
- Engine and hydraulics health
- Maintenance records

EQUIPMENT/MAINTENANCE SAVINGS:

- Accident prevention & enhanced safety response
- Proximity Detection and Collision Avoidance
- Video camera surveillance
- RFID tagging – miner, equipment location/tracking
- Emergency Response Communications
- Miner tracking
- Operator fatigue and video surveillance

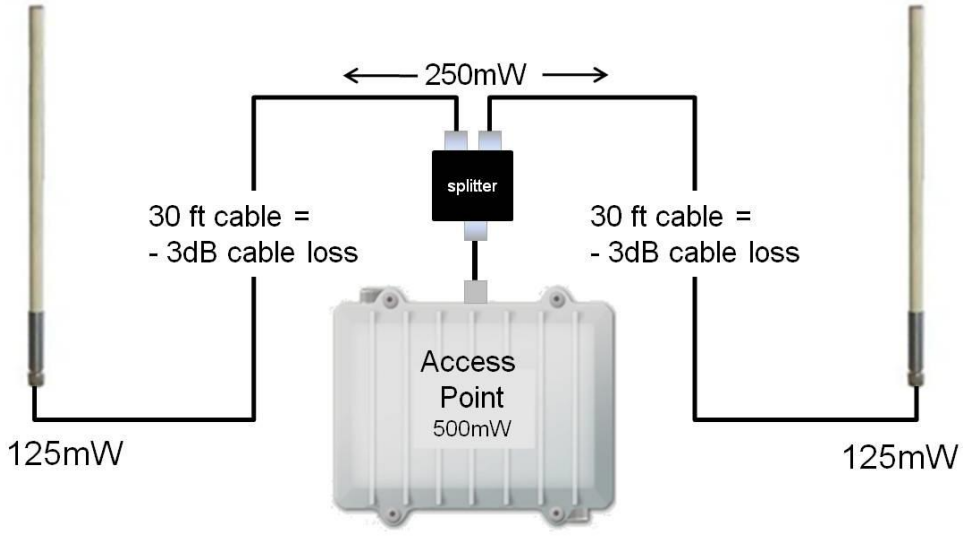
To maintain Wi-Fi connectivity and successfully push data through that connection, you must have a robust Wi-Fi network. Truck size, mine size/type/configuration, distance between connection points, and different elevations, make maintaining Wi-Fi connections exceptionally difficult. Mobile Mark has unique, unmatched antenna solutions that enable mining vehicles to maintain connectivity throughout various mine configurations

Limited Power at the Antenna = Limited Coverage

The conventional Wi-Fi network in a large mining truck has very limited power at the antenna due to:

- Radio Power – typically less than 500mW
- Splitters – cut power by half
- Long Cable Runs – power attenuation through cable loss

Industrial strength wireless access points can have 500mW as opposed to 100mW found in standard indoor access points. The additional power is meant to provide greater coverage, but that extra power is still insufficient in providing the needed coverage and connectivity. Due to the large size of mining trucks, multiple antennas per truck are required for coverage, typically at least

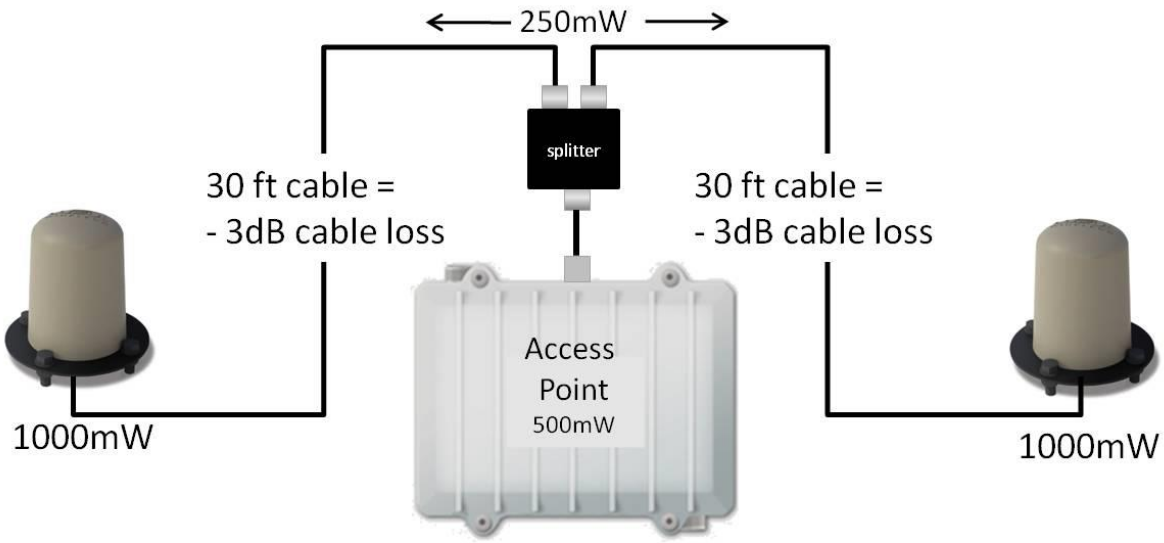


one per side (two total). As seen in the graphic above, the 500mW is reduced to approximately 125mW in a typical implementation, rendering it ineffective due to insufficient power to provide the needed

range. With only 125mW of power at the antenna, operators are left with no other option than to use a high-gain antenna to get the reach. Antenna gain, reach, and beam width are discussed in the next section.

The Mobile Mark Tactical Mesh Antenna (TMA) makes up for inefficiencies of using splitters and long cable runs to provide nearly 10 times the power. The standard system provides 1000mW (30dBm) of power directly at the antenna, giving it the ability to provide range and coverage that far exceeds the 125mW powered 8dBi antenna.

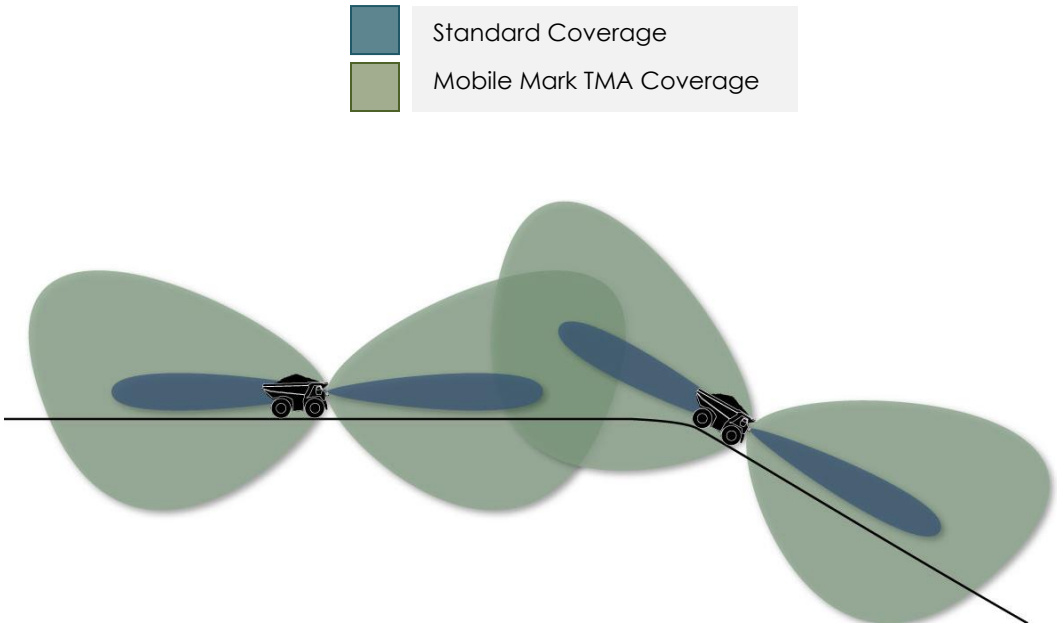
Bi-Directional Amplification. Wi-Fi is a bi-directional exchange and so is our amplification process. Coupled with the 30dBm of transmit power is 18 dB of receive gain, making the amplification process bi-directional. This is critical to the success of any Wi-Fi implementation. See the section on receive gain below. (Many operators choose a higher gain antenna to maximize reach, but with that higher gain comes a narrower beam width as shown below.)



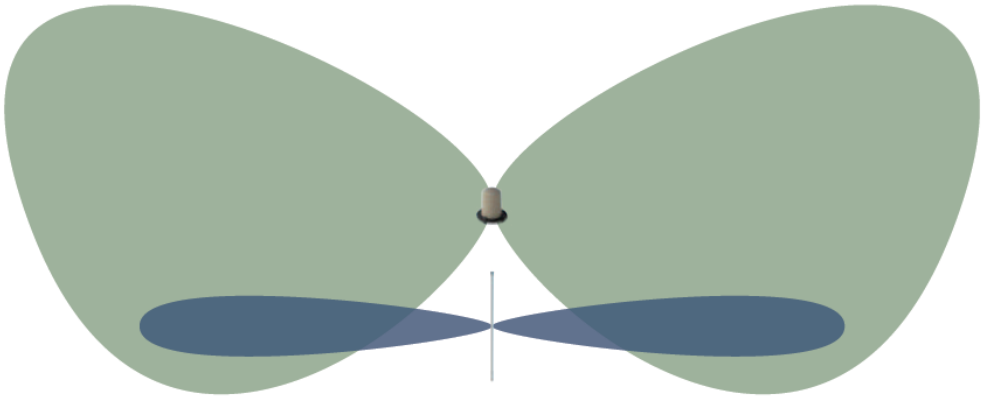
Selecting the Right Antenna

To maximize horizontal reach in a mine, operators typically use a high-gain (8-10dBi) omni-directional "stick" antenna. Antenna gain and beam width are inversely related: the higher the gain, the narrower (and less forgiving) the beam width. The graphic below illustrates the narrow "pancake-like" beam width of an 8dBi omni antenna, shown in blue.

When all vehicles are on the same level plane, a narrow beam width can work well, but as soon as varying elevations and angles are introduced, the narrow beam width limits connectivity. Vehicles with a broader beam width, such as a Mobile Mark TMA, shown in green, will more easily connect to other vehicles across a mine, in tunnels, or on a different elevation or grade, as illustrated below:



A Mobile Mark TMA has even greater reach than a 8dBi stick antenna, but it has the broader beam width of a 2dBi antenna, as illustrated below. The extra beam width allows the signal to reach higher and lower elevations to maintain connections at most angles encountered in a mine.



Receive Gain. Bi-Directional Signal Boosting: The Mobile Mark TMA incorporates a patented bi-directional Signal Boosting technology that cleanly amplifies the signal and further enhances the ability to maintain a strong connection with mobile clients on the network. In addition to delivering 20dB of transmit gain, 15dB of receive gain pulls the signal from low-powered client devices, delivering a more reliable and stable connection.

Form Factor. While high-gain omni-directional antennas are often 15" tall or more, the Mobile Mark TMA has a low profile at only 5" tall. This makes it ideal for tight spaces, and far less prone to breakage. Additionally, it is built for heavy industrial and military use, and it will withstand the harsh environment of a mine.

Mobile Mark Tactical Mesh Antenna (TMA) in Action

Escondida Mine, Chile

The Escondida Mine located in northern Chile is currently the world's highest producing copper mine. Mobile Mark's partner Protab, based in Santiago, Chile, was charged with setting up a high-performance Wi-Fi network in the mine, connecting each vehicle to the network. After significant field testing, Protab selected Mobile Mark's TMA, because of superior performance and ruggedized design, to provide unparralled client connectivity. Static, pole-mounted access points placed strategically throughout the mine provide the network backbone, with subscriber units in each vehicle connecting to that network. Smaller trucks were outfitted with a single omni-directional antenna, but due to the size of large haul trucks, two antennas were needed. Using two antennas means implementing a splitter followed longer cable runs out to the antenna.

Protab found that the signal strength and reach of a standard 8 dBi antenna did not provide adequate connectivity throughout the mine. Protab then tested the Mobile Mark TMA with nearly 180 degrees of horizontal beam width, and 30 dBm at the antenna. The TMA easily outperformed the standard stick antenna. In addition to extra power, a TMA has 33 degrees of vertical beam width, which turned

out to be a huge advantage when needing to reach up or down to connect to the closest access point.

As an alternative, deploying two subscriber units per truck, one to each antenna, was investigated, but not only did it present a problem in tracking a single vehicle with two subscriber units, it also didn't have the same reach as the Mobile Mark TMA system.

Mobile Mark offers not only TMAs for vehicles, but also helical and panel directional antennas to transmit signals down long shafts and tunnels, and point-to-point. These Mobile Mark antennas are currently in use in mines in North and South America. Mobile Mark offers both circularly polarized and linearly polarized antennas to get maximum penetration in difficult environments.

FCC Notice: The use of all radio equipment is subject to regulations in each country. To comply with FCC part 15 rules in the United States, radio equipment must only be used in systems that have been FCC certified. It is the responsibility of the user/professional installer/operator to ensure that only approved equipment/systems are deployed. To ensure FCC part 15 compliance, Mobile Mark amplifier products should only be installed in certified systems by licensed professionals. Mobile Mark also offers FCC certification assistance and engineering support for qualified OEM's interested in certifying complete amplified WLAN systems. Please contact Mobile Mark for details.

Mobile Mark, Inc. designs and manufactures site, mobile and device antennas for 30 MHz – 6 GHz. Applications include GPS Tracking & Fleet Management, Cellular 4G LTE & 5G Ready, Wi-Fi, RFID, Public Safety FirstNet, M2M & IoT, Smart City Networks and Autonomous & Connected Cars. Engineering and custom design services are available. Mobile Mark's global headquarters, research facilities and manufacturing plant, are located near Chicago, IL. An additional manufacturing and sales facility is located near Birmingham, UK.

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