**WHITE PAPER**

**3D-P Relaces a Masterlink®
Network with Mine-Wide 802.11n
Document Number 040512-01
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## TABLE OF CONTENTS

**Overview**

3D-P, a leading provider of technology products for the mining industry, recently upgraded a US mine site from a Masterlink® 11 network to a high speed 802.11n network. The mine realized a drastic improvement in available network throughput with possible data rates increasing from 11 Mbps to 130 Mbps, and a significant reduction in latency. The mine also realized benefits stemming from 3D-P's onboard open computing and networking platform that allows connectivity and management of all third party applications through the same high bandwidth network.

## The Decision to Upgrade

The mine has utilized a Modular Mining® Masterlink® (802.11b) network for several years. In 2010 a decision was reached to find a network that could continue to provide connectivity for their Modular product, while also providing additional throughput for in-pit applications such as machine health. Mine officials sought a safe, secure, cost-effective network that had the capability of providing connectivity and appropriate throughput to multiple applications. After performing market research, including interviewing and visiting several other mine sites and reviewing available networks, it was determined the upgrade would be provided by 3D-P, through the use of 3D-P's Intelligent Endpoint (IEP) product line, and Motorola's 7181 802.11n meshing infrastructure.

The Motorola 7181 802.11n meshing infrastructure has several features that would be of benefit to the mine. The first is the capability to utilize 802.11n and its inherent high throughput. The 7181 is designed for outdoor deployments and doesn't rely on the multipath available in indoor environments for the MIMO connectivity of 802.11n, but rather creates both horizontal and vertical polarized data streams. The 3D-P Intelligent Endpoint is able to differentiate these data streams at distances over 1km, making MIMO 802.11n throughput a reality in an outdoor environment.

The 3D-P Intelligent Endpoint product line is a radio agnostic, open computing and networking platform. It allows integration of an appropriate radio for the chosen infrastructure. In this case the chosen radio is a Ubiquiti 802.11n card working with the 7181 network. The combination of these products, when compared to all other 802.11n products on the market, can obtain 802.11n speeds at much greater distances in the outdoor environment, due to the ability to differentiate dual data streams at distances over 200 meters.

The IEP product line allows management of the wireless network from the client side. This allows breakthrough network management in the form of packet shaping and bandwidth limiting for individual applications based on geographic location, application/data type, etc. IEPs also allow integration with 3rd party applications, allowing the mine to keep all its appropriate machine data on one network, rather than having each application vendor setup another network or client.

With the Intelligent Endpoint being an open platform, 3rd party applications can even be run directly on the IEP. In addition to Modular Mining Dispatch, the mine selected Matrikon™ as their solution for machine health. The 3D-P Intelligent Endpoint's open architecture enabled the mine to run the Matrikon software directly on the IEP, alleviating the need for additional hardware installations, while reducing hardware and maintenance costs.

## Deployment

**Phase 1, Infrastructure Replacement**

The Modular Masterlink network was up and running at the time of the upgrade. The first phase of the upgrade was to replace all the existing Masterlink infrastructure radios, while allowing existing Masterlink clients to continue with uninterrupted service.

The Motorola 7181 network utilizes a Meshing network layer on a 5.8 GHz radio. This allows remote 7181s to be connected to the network, without direct connectivity via Ethernet. Proper Mesh topology requires several "Mesh Point Root" (MPR) radios be deployed throughout the network. A MPR can be considered a Mesh Endpoint, as it is a Mesh radio with physical connectivity to the wired network, in this case an Ethernet connection. It is the "jumping off point" for data going to or from the Mesh network. Having several MPRs deployed throughout a Mesh network allows redundancy for the network. If there is a problem with one MPR, data can still get on and off the network by "Meshing" to one of the other available MPRs.

At the mine, several MPRs were deployed at infrastructure locations that had existing network connectivity via Ethernet. Other MPRs were deployed at remote locations with Motorola Cambium Networks Point to MultiPoint radios providing the network connectivity to these locations.

"Mesh Point" (MP) radios (7181s not connected directly to the backhaul, but rather meshing over the 5.8 radio to MPRs) were deployed strategically in areas necessary to complete the network coverage. Careful consideration was given to all of these locations in order to create proper coverage zones for clients. These coverage zones are designed to ensure proper overlap between access points, allowing both high throughput and high connectivity throughout the mine. More information on creating coverage zones can be found in the 3D-P document "112911-Network Design".

During the initial deployment phase of this network, the 7181s were deployed with the same 802.11b network ID, and security settings as the pre-existing Masterlink infrastructure. Once the 7181s were up, all Masterlink infrastructure radios were removed from the network. The Masterlink client radios continued to function with connectivity through the 7181 network.

## Phase 2. Deployment of Intelligent Endpoints

Over time, the mobile fleet was upgraded, with the Intelligent Endpoint replacing the Masterlink radio. The Intelligent Endpoint was deployed with the capability of communicating on either an 802.11bg network, or an 802.11n network. The 7181s were configured to allow communication from either client type, initially.

One characteristic of the 802.11n protocol is that 802.11bg clients attempting to communicate to 802.11n capable infrastructure drastically reduce the throughput of the 802.11n clients, lowering their available throughput to the same level possible on the 802.11bg clients. When the entire network changeover is completed, 802.11bg clients can be blocked on the 7181, which allows the 802.11n equipped IEPs to achieve their full potential 802.11n speeds. This changeover occurred at the mine. When all Masterlink radios were removed, the 7181 infrastructure was re-programmed to accept only 802.11n traffic, and a drastic increase in throughput was achieved. A simplified diagram of the final network topology is shown below:
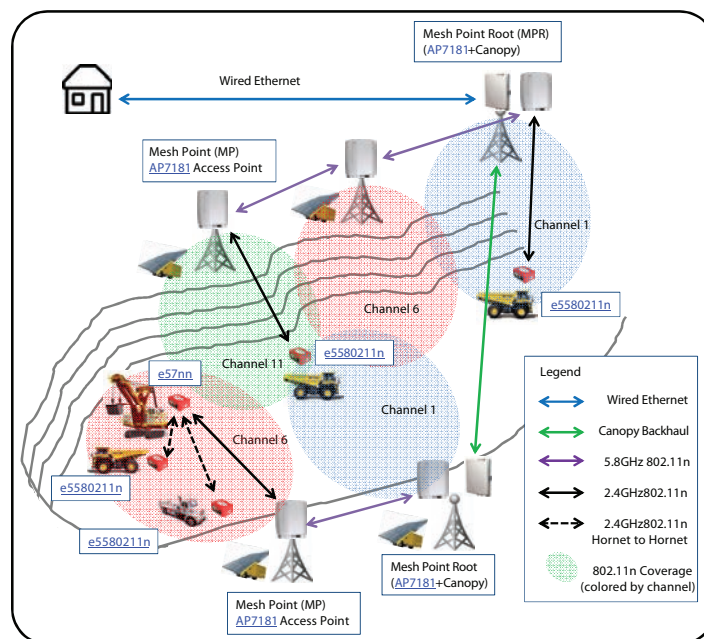
## Results

### Overall Network Coverage

Network coverage at the mine is tested both by a ping test, conducted by IEPs driving throughout the mine, and as reported by the Modular "No Talk" report. In both cases network coverage is over 99%. After the initial deployment, a few coverage blind spots were found. However, these were easily addressed by relocating trailer mounted Mesh Points to adjust coverage.

### Overall Network Throughput

Maintaining consistent throughput in a mobile network is challenging, with factors such as mobility, shadowing, number of neighboring clients, etc. changing the reported throughput at any given area and at any given time. 3D-P stands by its ability to adjust the available throughput in an outdoor 802.11n network to a degree through proper design of coverage zones. 3D-P can also manage the required throughput from applications behind their Intelligent Endpoints using their smart network management tools, such as bandwidth limiting based on location, etc.

The throughput necessary for any given network must be determined from the required applications, and the network designed appropriately to ensure adequate throughput for all such applications. This network is not an exception, and the required throughput is relatively low at this point, with the primary applications being Modular Dispatch, Modular HPGPS, Caterpillar® CAES™, and Matrikon. This being said, the available throughput of this new network gives the mine the scalability it requires to add other applications that might be integrated in the future, such as proximity awareness, video, etc.

Managing the mobile network to maintain optimum performance is vital for every mine operation to ensure their mobile applications achieve maximum uptime. 3D-P has developed a tool called Heatmap which can be installed on any IEP and provides data that can be used to report on network coverage, throughput, signal strength, connected AP, direction of travel, etc. all tied to GPS position throughout the network as the IEP moves. Heatmap is a valuable monitoring tool designed to assist the mine operators in maintaining optimum performance of the network over time. 3D-P also utilizes Heatmap to baseline the performance of all networks during the commissioning phase of new installations.

In this case, 3D-P ran the Heatmap software on several Haul Trucks for 24 hours, with the tests being run every 60 seconds. Heatmap reports consistent throughput throughout the coverage areas, averaging 10.5Mbps, and reachi-ng peaks of over 53Mbps. It's important to understand these throughput numbers represent actual payload data the IEP was able to push during the Heatmap test, not just the reported data rate which is much higher. Average latency for the network is 16.3ms, with latency under 5ms when talking directly to an MPR. Handoffs from AP to AP can be as good as a few milliseconds when IAP zones provide proper overlap. When compared to the pre-existing network with data rates of 1 or 2Mbps, and throughputs maxing out in the kbps range, the improvement is significant.

**Conclusion**

Outdoor 802.11n in a mobile environment is now a reality. The Motorola 7181 Meshing infrastructure radio, when matched with the 3D-P Intelligent Endpoint client solution can provide 802.11n speeds to mobile clients, even in the harsh RF environment of an open pit mine. The IEP also makes it possible to utilize this new network for multiple client applications, including dispatch systems, machine health systems, machine guidance systems, etc. The IEP also includes the capability of managing the bandwidth utilization of these applications, making addition of other applications like safety systems, etc. possible.

Contact 3D-P at 1-800-955-9337, or www.3d-p.com in order to learn more about upgrading your network to 802.11n.

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