

An Autonomous Network to Power Mobility & Autonomy in Open-Pit Mines

Rajant's Kinetic Mesh is the only wireless network that **autonomously adapts to operational and environmental change**, dynamically evolving to keep applications, equipment, and open-pit mine production running nonstop.

If It's Moving, It's Rajant: Keeping Ever-Changing Open-Pit Mines Covered

Rajant provides a simple but robust solution to modify or expand network coverage dynamically as your mine footprint evolves.

The unique nature of our Kinetic Mesh architecture allows open-pit operations to easily introduce, relocate, or remove network infrastructure – without causing any network downtime – to deliver highly adaptable coverage and continuous connectivity. **Here's how:**

The shape, depth, and configuration of a surface mine is constantly changing as extraction occurs. Equipment and infrastructure must be moved almost daily away from new blast zones, which means network coverage must frequently shift too. This creates a problem for traditional wireless networks that operate from fixed infrastructure, such as Wi-Fi Mesh, Point-to-Multi-Point, and LTE. **Massive towers require significant effort to relocate, and hours of manual configuration to redeploy once they have been moved. The most costly part is the coverage impact that occurs during these transitions;** with the network down, the mine cannot run the real-time applications necessary to maintain 24/7 productivity and site-wide worker safety.

All network nodes can be mobile and create a mesh between moving equipment.

Lightweight BreadCrumb® nodes work peer-to-peer to form a multi-radio Kinetic Mesh network. These nodes can be deployed on fixed infrastructure or moving assets such as trucks and shovels, uniquely enabling vehicle-to-vehicle (V2V) communications between mobile equipment.

Once configured for the mesh, if coverage needs to be shifted, the compact nodes can be easily relocated and will instantly reconnect to begin meshing with nearby nodes.

Multi-radio, multi-frequency redundancy delivers mission-critical reliability.

BreadCrumbs are able to hold multiple connections over multiple frequencies simultaneously, creating hundreds of potential paths over which to direct traffic. Rajant's InstaMesh® networking protocol works in real-time to select the fastest path or paths for delivery. If a path becomes unavailable or blocked, InstaMesh will dynamically route communications via the next-best available path. That means nodes can be relocated without causing any downtime, and interference or signal blockage caused by the changing open-pit environment will not compromise network performance.

Long-term scalability managed with minimal technical resources.

After initial configuration, when new BreadCrumbs are turned on, they automatically begin communicating with other nodes in the area, autonomously and without outside intervention. The network is easily scalable to hundreds of high-bandwidth nodes, and Rajant uniquely offers cross-generational compatibility to ensure you never have to forklift your existing infrastructure investment and have full control over when upgrades are made.

Rajant's solution also includes robust testing and troubleshooting features that further streamline management. For example, you have the ability to run iPerf3 directly from the BreadCrumb; the BreadCrumb can also be used as a packet capture device.

All-in-one functionality, all in one network device.

There is a lot of power packed into every BreadCrumb, which can act as a repeater, client, access point, switch, router, bridge, and gateway. With Rajant, you can greatly simplify your network infrastructure, make it highly portable, and add the power of InstaMesh for autonomously adaptable, continuous mobile connectivity.

The Rajant ME4 BreadCrumb is only 189mm x 95mm x 51mm (7.46" x 3.75" x 2.00") in size.



High Availability for Any Number of Real-Time Mining Applications

The differentiated multi-radio architecture of a Kinetic Mesh network means that Rajant is the only industrial wireless solution that can support continuous mobile connectivity. Wi-Fi clients can only have one live connection at a time, creating loss of connectivity during a handoff. Rajant never breaks for handoff, and creates additional advantages with:

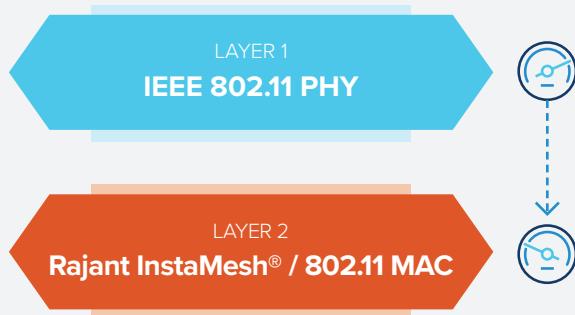
A Layer 2 Network

While InstaMesh leverages a proprietary algorithm and sends packages over Layer 2, it is fully compatible with IEEE 802.3, 802.1q and 802.11 standards. Any third party mining application that can communicate over Ethernet or IP can be transported over the Kinetic Mesh network.

Full Duplex Communication

Multi-radio BreadCrumbs are able to receive and transmit data simultaneously, allowing more data to be moved faster. This enables the network to accommodate more applications at the same time, and Rajant's Quality of Service (QoS) provisioning ensures mission-critical data is delivered before lower-priority application data.

WHERE RAJANT FITS IN THE OSI MODEL



Advantages of Layer 2 over Layer 3: Devices communicate via MAC address vs. having to translate to IP address. This creates significant latency savings when aggregating across an entire network running multiple applications simultaneously and seamlessly integrates into Layer 3 networks.

Dynamic Transmit Power (DTP)

With DTP enabled, BreadCrumbs use less power when communicating with nearby peers vs. distant ones. DTP automatically adjusts the per-peer transmit power based on the Signal Quality required to send information and improves signal to noise ratio (SNR), providing higher throughput in very dense networks by minimizing noise.

DID YOU KNOW?

Rajant's network is **deployed with virtually every open-pit mining fleet management system used today**. In fact, Rajant networks are running more than 30 different applications in use at the world's largest mines, including:

Fleet & Asset Management

- Fleet Guidance Monitoring
- Real-Time Asset Tracking
- Equipment Health Monitoring
- Telemetry from Remote Sensors
- Predictive Maintenance

Safety Applications

- Driver Fatigue Management
- Anti-collision
- Video Surveillance
- High Wall Monitoring
- Tailings Dam Monitoring

Next-Gen Applications

- Vehicle-to-Vehicle (V2V) Communications
- Pit-to-Plant-to-Port Communications
- Autonomous Drones (UAVs)
- Unmanned Ground Vehicles (UGVs)
- Autonomous Fleets (trucks, dozers, drills, etc.)

An Autonomous Network Made for V2V and Autonomy

The single biggest requirement for open-pit mining networks today is an ability to support autonomy.

Rajant delivers on this demand with an autonomous network. InstaMesh dynamically optimizes Kinetic Mesh performance as network characteristics change, without the need for a controller node or human intervention.

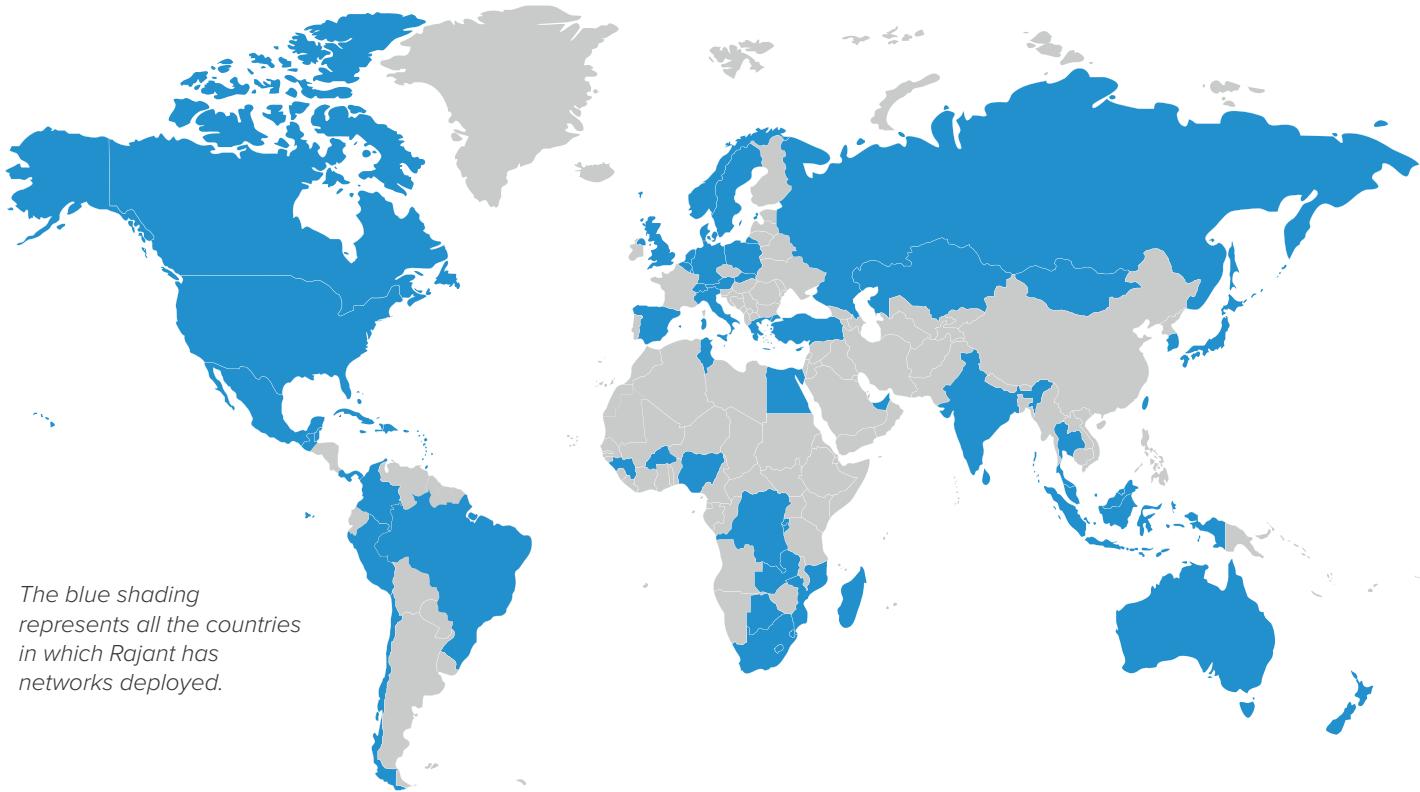
Mobile nodes can communicate directly with each other to enable V2V communications between both manned and unmanned vehicles.

Unlike any other industrial wireless solution available, it adapts on the fly with evolving conditions and makes multiple connections over multiple frequencies per node for resilient, never-break mobility: a mandate for V2V and particularly for autonomy. In any other network, intermittent breaks in connectivity occur which cause autonomous systems to stop running. Rajant provides the mission-critical link needed to communicate with and tele-operate these systems, keeping them moving nonstop so production efficiency never wavers.



Relied Upon by the World's Leading Mines

Kinetic Mesh networks are **deployed throughout more than 200 of the largest open pit mines across 60 countries today, and over 99% of BreadCrumbs ever deployed are still operational today.** They are helping mines across the globe—from small operations with several trucks to the largest open-pit mines in the world—to overcome application performance and reliability issues that stem from their always-changing environment, and to capitalize on new efficiency, safety, and productivity gains.



**Interested in learning how
Rajant can connect your
open-pit mine to new value?**

Learn more how Rajant can connect your mine to the value of a mission-critical wireless network solution at rajant.com/mining.

Tel: 484.595.0233 | www.rajant.com

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