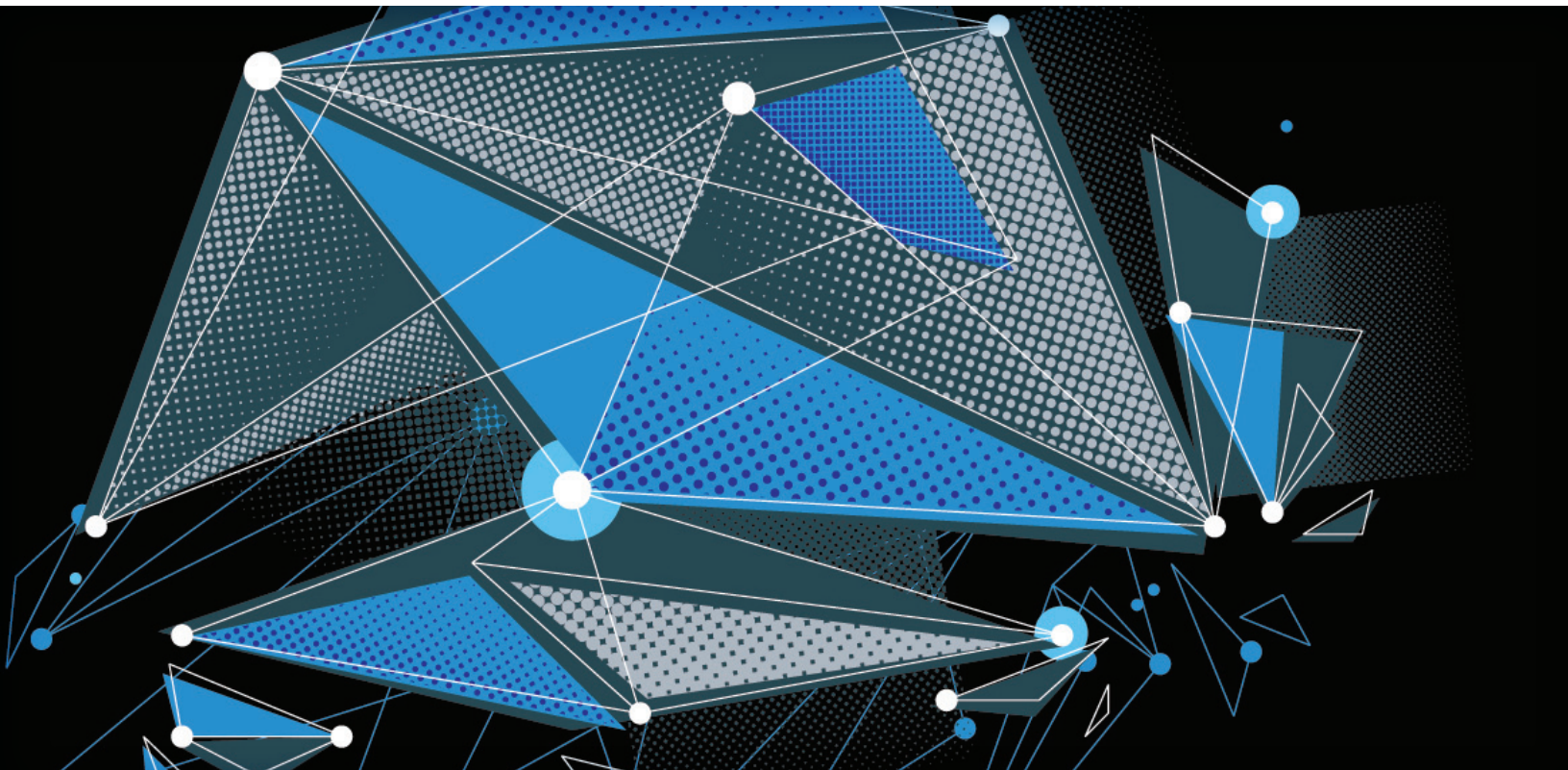




# Network Innovation **on the Move:**

Bringing the Private Wireless Network  
to Life with Rajant Kinetic Mesh Technology



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# Executive Summary

In response to the growing demands for anywhere, anytime communications by organizations and consumers in almost every industry, today's networks—both wired and wireless—are evolving dramatically. A network's success no longer hinges on its ability to provide simple connectivity; it must truly empower those it is serving, removing constraints that hinder accessibility and working intelligently, flexibly, and seamlessly to optimize productivity.

**Mobility is a key driver shaping these network requirements, as well as the applications that they must effectively run.**

Organizations with personnel and equipment that are remote, geographically dispersed, and/or constantly on the move need a mobile infrastructure that allows all of their assets, whether fixed or in motion, to connect and communicate in real-time, at all times. This also means that it must be intelligent enough to adapt quickly to changing network topologies, dynamically shifting data to best available routes without interference, interruption, or manual intervention.

Unfortunately, many solution providers have claimed this level of mobility and autonomy in their networks but have fallen short. A thorough understanding of the strengths and weaknesses of common approaches will help you avoid investing heavily in technology unfit for dynamic environments that are challenging to navigate, and select the solution that delivers on the promises above.

This white paper evaluates the commonly considered network offerings—from public networks to traditional mesh—in **contrast to Rajant Kinetic Mesh technology, a fully mobile connectivity solution built from the ground up to excel in today's diverse, mobility-driven marketplace.**

## Market Insight

Gartner's top two strategic technology trends among organizations for 2014 were identified as **Mobile Device Diversity & Management** and **Mobile Apps & Applications**.<sup>1</sup>

## Market Insight

Accenture's recent High Performance IT study revealed that high-performing CIOs identified their top business objective as **providing the right information to the right person at the right time**.<sup>2</sup>

# Part I: Network Technology Options

There are multiple approaches that organizations can take to construct a workable network, but many options become less and less viable as scalability, throughput, ruggedness, self-management, cost efficiency—and particularly mobility—demands increase.

Clearly, the decision whether to implement a private wireless network or use a public wireless network needs to be made early in the planning process. Today, many organizations prefer to deploy private

wireless networks so they can maintain control over network access, traffic, security, and capacity while achieving high levels of availability, redundancy, speed, and agility for their mission-critical applications.

Network strengths and weaknesses should be carefully evaluated based on connectivity requirements as well as the applications that will need to run effectively on top of the network, both today and as part of future growth.

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Below are a few of the common types of network options that could be considered in industrial and municipal environments where mobility must be addressed.



**Cellular networks** use fixed-location transceivers to create 'cells' of wireless coverage over land areas, and relay data via 'handovers' to neighboring cells as users travel into new cell geographies.

- **Pros:** Often available in areas where other types of networking like LANs and WLANs cannot reach; 3G delivers data rates equivalent to broadband networks; enables mobility while in transit.
- **Cons:** Short tower range (1 to 2 mile radius) leads to likelihood of 'dead spots' between cell tower ranges; signal strength degradation in high traffic, bad weather, etc; limited capacity for simultaneous clients per cell; the need for extensive backhaul engineering; mobility restricted to only clients; high overhead for client hand-off management.



**LTE (Long-Term Evolution) technology** enables wireless communication of high-speed data, and was built to increase the capacity and speed of wireless data networks by leveraging new digital signal processing (DSP) techniques and modulations.

- **Pros:** Increased bandwidth for advanced tasks such as video conferencing; mitigates access bottlenecks; supports deployment on different frequency bandwidths.
- **Cons:** New technology, still fully untested; connectivity limited to certain specified carriers and regions; users forced to switch to 3G or Wi-Fi connectivity in areas without LTE coverage; high start-up costs for equipment installation; limited capacity for simultaneous clients per cell; the need for extensive backhaul engineering; mobility restricted to only clients; high overhead for client hand-off management.

# Part I: Network Technology Options



**Satellite** is most often used to provide broadband access in areas with little or no existing network infrastructure.

- **Pros:** Provides high-availability to remote environments spanning large distances.
- **Cons:** Low bandwidth; high latency; interference caused by topographical and weather conditions; very expensive.




**Traditional mesh networking** creates large-scale, resilient wireless local networks capable of multiple concurrent connections. Each mesh 'node' has redundant links to other nodes, which creates inherent redundancy.

- **Pros:** Very little wiring needed to deploy across large areas; fast and flexible set up; self-adjusting to best traffic paths; high bandwidth; resilient.
- **Cons:** All data routes are determined by a single controller node (failure there affects entire network); heavy bandwidth use must be reserved for overhead (up to 50%); ineffective at higher node volumes (as little as 50).

**Rajant Kinetic Mesh Networks** differ from traditional mesh in that they provide extremely scalable, fully mobile-enabled, wide-range, and reliable connectivity, allowing all nodes and clients to be in motion all the time. When needed, the network instantaneously redirects data packets over more available frequencies, to avoid interference or obstructions while assuring the fastest possible delivery.

Rajant Kinetic Mesh enables full network motion and flexibility, with no master or controller node to create a point of failure. Instead, it employs multiple frequencies and any-node to any-node capabilities to continuously and instantaneously route data via the best available traffic path and frequency, all with extremely low overhead.



**POWERING THE  
LIVING NETWORK**  
RAJANT KINETIC MESH

Rajant recognized early that with rapidly proliferating mobile applications would come growing connectivity complexities for enterprises, businesses, and organizations of all types. Through its Kinetic Mesh technology, Rajant brings to life an extremely agile and adaptable wireless broadband solution that thrives in today's diverse, ubiquitously mobile environments: **the Living Network.**

The Living Network is entirely mobile and mobile-enabled, highly scalable, and intelligent in its ability to self-manage and self-optimize. These powerful attributes make it a strategic asset in any industry dealing with highly mobile, challenging or hard-to-connect environments.

# Part II: A Closer Look at Rajant Kinetic Mesh Technology

Unlike any other offering on the market today, Rajant Kinetic Mesh technology provides fully mobile wireless broadband connectivity, allowing all nodes to be in motion at any time. While this unique functionality makes it a natural fit for operations with demanding mobility requirements, it brings an array of other equally compelling technological features for any organization seeking to intelligently connect diverse assets across large-scale environments.

These environments may be highly remote and span hundreds of square miles, where existing cellular, 3G or Wi-Fi infrastructure may not yet be established. In those cases, **Kinetic Mesh networks can be readily deployed using any number of Rajant BreadCrumb® wireless network nodes.** Easy-to-install BreadCrumbs rapidly self-configure to route communications peer-to-peer or through any satellite, point-to-point wireless, or wired links.

In addition to remote locations, **Kinetic Mesh performs in high density environments.** Many traditional mesh networks become unusable once they reach a set node capacity, which can be as little as 50. However, Kinetic Mesh networks can operate in full form in networks supporting hundreds of nodes. In fact, these networks actually grow stronger as density increases, since new nodes provide additional paths for data routing.

In remote or high-density environments, network traffic is orchestrated by Rajant InstaMesh® technology. InstaMesh is a patented protocol that dynamically evaluates and determines the best pathways between any wired or wireless points, even when points are in motion. It can redirect data packets to faster unused frequencies or switch channels the moment it senses an interference or obstruction. This approach mitigates bottlenecks and provides robust fault tolerance, high throughput and low latency.

## 🔍 Market Insight

According to Ericsson's 2014 Mobility Report, **increasing requirements for high performance and data capacity** has led operators to invest in network modernization and adopt new technologies.<sup>3</sup>

## 🔍 Market Insight

A recent article from Enterprise Networking Planet noted, "As 2G is phased out, and 3G and 4G are proving to be highly expensive and highly burdened options for 'always-on' IoT devices, **developing a distributed mesh system... is becoming an attractive cost-saving measure.**"<sup>4</sup>

In the following sections, the primary functionalities of Kinetic Mesh will be explored in more detail.



## Total Mobility

While traditional meshing technologies rely on a single stationary access point which acts as the root node / controller managing other radios as clients, every node in a Kinetic Mesh network can act independently and with full routing capabilities. Its underlying InstaMesh protocol allows a Kinetic Mesh network to become a true peer-to-peer network, and enables its full mobility. BreadCrumbs can be placed on fixed equipment, moving vehicles, and even devices to instantly connect them into the fluid network.



## Intelligent Autonomy

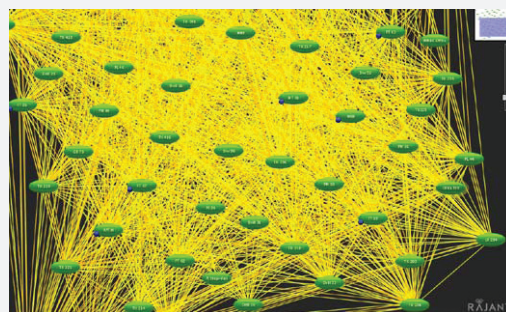
A Kinetic Mesh network requires very little manual configuration or maintenance due to its self-learning and self-healing capabilities. BreadCrumbs can be spun out quickly, as they automatically find peers and begin routing instantly through best-available paths. Any-node to any-node communication capabilities ensure no single point of failure. If a node does go down the network seamlessly reroutes data in real-time.

Traditional mesh networks eat up bandwidth with overhead messages to determine best paths, but InstaMesh learns from its analysis of user data flowing through it how to optimally route each packet it sees, keeping overhead traffic to a bare minimum.

## A Closer Look:

### Rajant InstaMesh® Routing Technology

Relying on a patented data routing algorithm, InstaMesh enables continuous and instantaneous routing of wireless and wired connections across the Kinetic Mesh network.



It does so by constantly discovering and maintaining information at each BreadCrumb node to determine the best path and frequency on which to send each packet. When a user changes, moves, or disables a device in the network, that change will be detected by its neighboring BreadCrumbs and does not need to be propagated throughout the network.

This enables operators to make significant productivity gains and maintain high network availability with minimal maintenance and administration, as InstaMesh auto-adapts to new configurations, devices in motion, and changing environmental conditions to ensure uninterrupted communications.



## Dynamic Frequency Utilization

Many wireless network systems now have nodes capable of utilizing multiple simultaneous frequencies. However, these frequencies are almost always segregated between backhaul, client access, hand-off coordination and other functions. Rajant's Kinetic Mesh system dynamically utilizes all available frequencies for any and all functions. Nodes support up to four transceivers simultaneously and in a wide variety of combinations, with ability to access 900 MHz, 2.4 GHz, 4.9 GHz, 5 GHz as well as military, licensed, public service and other proprietary frequencies. If there is interference on any one frequency, the node will redirect the data packet to one of the other available frequencies to complete its transmission. This capability provides robust fault tolerance, high throughput and low latency.



## Rapid Scalability

Rajant Kinetic Mesh networks are able to seamlessly scale with changes in density and distance requirements. As BreadCrumbs are added, they automatically discover and maintain mesh links, allowing operators to quickly and easily scale the network with little manual intervention. Whereas, traditional mesh networks degrade as nodes are added, Kinetic Mesh networks grow stronger with each additional node.

### A Closer Look:

## Rajant BreadCrumb® Wireless Network Nodes

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 as part of a fully mobile, high bandwidth network.



Multiple radio configurations support comprehensive applications and deployment environments, including 900 MHz, 2.4 GHz, 4.9 GHz, 5 GHz and others. These nodes can securely support IEEE standards for compatibility with millions of commercial-off-the-shelf (COTS) client devices such as laptops, smartphones, IP cameras, sensors, VoIP phones and other IP devices.

Considered the most ruggedized mesh networking hardware on the market, BreadCrumbs have been proven to operate reliably across challenging terrain and the most extreme conditions.



# Part II: A Closer Look at Rajant Kinetic Mesh Technology



## Extreme Ruggedness

When Kinetic Mesh networks were introduced to the market nearly 14 years ago, they were primarily used in military and mining applications. As such, Rajant's hardware was built to withstand the most punishing environments and extreme vibrations. Constructed of hardened materials made for rugged conditions, nodes meet stringent ingress protection standards and are IP67 rated, making them completely dust-tight and waterproof. They have proven to provide consistent, reliable performance in temperatures ranging from -30 °C to 80 °C (-22 °F to 176 °F), and vastly outperform in durability compared to any outdoor enclosure competitive offering.



## Extreme Security

From its military and defense roots, Kinetic Mesh networks also support extremely high security. BreadCrumbs provide multiple configurable levels of encryption and authentication to provide confidentiality, data and network integrity, replay protection, and protection from traffic-analysis attacks. Standard wireless client security protocols including WPA2 Enterprise are also supported, along with many other Layer 2 and Layer 3 client/server and peer-to-peer security solutions.



## High-Performance Applications

Customer applications are dictating the type of network they need, and many of these have become both mobile and bandwidth-intensive. Kinetic Mesh network nodes can seamlessly integrate with any Wi-Fi or Ethernet-connected device to deliver low-latency, high-throughput data, voice and video for remote monitoring, tracking, surveillance, and virtually any other number of operational applications.



## Ease of Network Management

Rajant's BC|Commander® network management software makes Kinetic Mesh networks very easy to administer. It establishes secure, encrypted links to each node that allow administrators to gain a graphical, real-time view of network topology. The tool enables point-and-click BreadCrumb configuration (including radio settings, mesh encryption and authentication, VLANs, and InstaMesh settings), provides RF status information for mesh and client links, and generates network analysis and configuration reports. Through its BreadCrumb Application Program Interface (BCAPI), customized management and monitoring applications can be developed with minimal overhead. As such, administrators gain global control and anytime insight into network performance.

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This combination of technical functionality infuses Kinetic Mesh with the adaptability, flexibility, intelligence, and mobility that make it more than just a tool for connectivity. It becomes a value-add asset to improve operational effectiveness, enhance quality of service, drive productivity, and generate increased ROI.

The following pages show how Rajant Kinetic Mesh networks can be applied in different industries to overcome mobility-driven connectivity challenges.

# Part III: Kinetic Mesh In Context: Industry Examples

## Kinetic Mesh in Mining

Mining operations must monitor and manage large fleets of vehicles, equipment and personnel, all remotely dispersed across rugged terrain – and all of which require constant, reliable high-bandwidth connections while on the move. Continuous production and safety mandates call for unwavering availability, with 24x7x365 uptime in all areas of the mine.

Rajant Kinetic Mesh networks can be easily implemented to reliably cover people and assets across all remote mining operations, even in landscapes where no existing cellular, 3G or Wi-Fi infrastructure is available.

- **Assure IP traffic uptime with virtually no manual intervention, even in extreme conditions.**

Rajant Kinetic Mesh networks rapidly adapt to changes in network topology, whether nodes are moved, disabled, or added. If an obstruction is encountered or interference occurs at one node across the mine, InstaMesh provides smart self-healing functionality by redirecting packets to alternative links in real-time.

- **Continuously monitor high-value equipment, from loader trucks to shovels and pumps.** Rajant Kinetic Mesh technology helps mine operators reduce downtime by bringing them the data needed to proactively identify maintenance issues and remotely manage equipment health.

- **Give site workers a remote network that acts like a private network.** Rajant Kinetic Mesh technology autonomously optimizes to assure that mining personnel have seamless communications and instant access to critical data and applications, whenever and wherever they need them.

### Market Insight



\$47.5M

#### Mining is a machine-intensive industry.

An industry model for an open pit mine producing 80,000 tons of ore per day estimates the cost of the required machinery to be in excess of \$47.5M.<sup>5</sup>



\$1.4M

#### Equipment health monitoring is critical.

Mines can potentially lose up to \$1.4M an hour in downtime every time a conveyor belt must be stopped.<sup>5</sup>



30%

#### Condition-based maintenance is key.

Using a time-based preventive maintenance model, about 30% of maintenance effort is wasted, and another 30% is actually harmful. Real-time condition monitoring optimizes maintenance efforts.<sup>5</sup>

## Case In Point: Kinetic Mesh Gives Mine-Wide Network an Upgrade—with Zero Downtime

### The Challenge:

A global leader in clean coal solutions urgently needed to upgrade its network to support its growing number of dispatch, operations and equipment health monitoring applications—without disrupting the mine's 24x7x365 operations.

### The Solution:

Rajant Kinetic Mesh technology was selected for its ability to quickly and reliably connect the mine's many fixed and moving assets, which included a 1,300-person workforce covering nearly 44 square miles (114 square kilometers). The transition occurred seamlessly, with 165 nodes deployed to reliably support the entire mine's mission-critical operations.

### The Results:

The migration to this unified network resulted in zero downtime and 100% application availability. Soon after initial deployment, mine operations expanded, and an additional 110 BreadCrumb nodes were deployed, primarily by mine personnel—attesting to the Kinetic Mesh network's ease of scalability.

## Kinetic Mesh in Municipalities

While a mining network must connect extremely large but sparsely-built areas, municipal networks need to effectively support the high-traffic volumes inherent in their densely populated cities and towns. The solution must satisfy a wide range of users and applications, all of which are becoming more mobile. In addition to providing connectivity for personal, business, and governmental applications, municipal networks must support broad-reaching public safety initiatives.

Rajant Kinetic Mesh technology provides a fully mobile solution which is capable of seamlessly integrating with existing communications infrastructure to support these highly varied users and needs in a self-managed fashion, to lower cost, maintenance, and complexity while driving economic growth.

- **Optimize existing network investments while adding critical mobile functionality.** Rajant Kinetic Mesh networks can fully interoperate with point-to-point, microwave, and traditional mesh networks, allowing municipalities to retain their current infrastructure and add to it a powerful mobility solution to address growing mobile demands.

# Part III: Kinetic Mesh In Context: Industry Examples

- **Speed emergency response rates and improve situational awareness for public safety.** A Rajant Kinetic Mesh network enables police, firefighters, and emergency units to take their data and communications anywhere, for real-time response. The network also enables high-bandwidth data transmission for security and surveillance monitoring.
- **Create new economic opportunities through communication innovation.** Rajant Kinetic Mesh enables municipalities to increase the speed and quality of service delivered by their departments to all constituents, to make their 'smart city' a draw for businesses, residents and visitors alike.

## Case In Point: Kinetic Mesh Brings Wireless Access to Philadelphia Folk Festival

### The Challenge:

The Philadelphia Folk Festival needed a way to provide reliable mobile broadband access to staff and 10,000+ event attendees gathered at an 80+ acre campground for its multi-day festival.

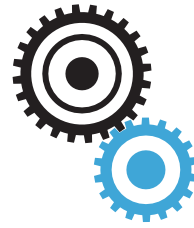
### The Solution:

Leveraging Rajant Kinetic Mesh technology, a self-establishing, high-bandwidth wireless network consisting of 14 BreadCrumb nodes was quickly deployed across the entire festival grounds.

### The Results:

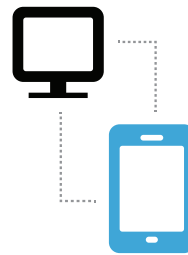
In addition to providing broadband access to festival goers anywhere they traversed throughout the event site, the Rajant network powered the festival's numerous applications, including ticketing systems, Wi-Fi camera installations, and real-time communications between trailers and among volunteers, management staff, and security.

## Market Insight



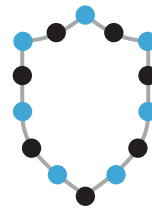
### Smart cities are the future.

According to Frost & Sullivan, the smart city market will be valued at \$1.565 trillion in 2020. Smart cities are built on 'intelligent' solutions and technology that drive innovation in 8 key areas, including smart mobility and smart connectivity.<sup>6</sup>



### Smart cities are fully interoperable.

The need for complex and integrated citywide solutions will foster convergence in the smart-city space, with network providers offering collaborative networks to create an ecosystem of intelligent services.<sup>6</sup>



### All constituents are better served.

In a smart city, government entities can use intelligence to make better decisions and plans; workers can deliver services that operate in coordination across the city; and citizens will live in a safe community, with full access to useful services.<sup>6</sup>

# Conclusion

The evolving communications landscape is prompting organizations across a wide variety of industries to look differently at their networks and how they use them. Simple, static, stationary solutions are no longer viable for those seeking to create and operate in highly productive, mobility-driven environments. Instead, they need a network that is 'living'—able to easily adapt, smartly optimize, and freely move to meet changing business and connectivity demands..

Rajant Kinetic Mesh technology is unlike any other network offering in its ability to provide dynamic, smart, productive, and fully mobile private wireless networks made for today's marketplace. The innovation behind Kinetic Mesh technology enables the network to work autonomously to provide optimal connectivity across an organization's dynamic environment of fixed and mobile assets while delivering the real-time applications they need to enhance productivity, quality of service, and ROI. **In modern industrial and public markets where anywhere availability for communications and real-time delivery of business intelligence via private networks are critical, this network lives up to demands.**

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## About Rajant Corporation

Rajant Corporation is the exclusive provider of private wireless networks powered by patented Kinetic Mesh technology, BreadCrumb® network nodes, and InstaMesh® routing software. With Rajant, customers can rapidly deploy a highly adaptable and scalable network that leverages the power of real-time data to deliver on-demand, critical business intelligence from the field. Rajant BreadCrumbs can seamlessly integrate with any Wi-Fi or Ethernet connected device to deliver low latency, high throughput data, voice and video applications across the meshed, self-healing network. With the ability to take private network applications and data everywhere, Rajant networks are used across a broad array of industries including military, industrial, transportation, utilities, telecommunications, and all level of governments. For more information, visit [www.rajant.com](http://www.rajant.com).

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