



Portable Wireless Mesh Networks: **Competitive Differentiation**

Rajant Corporation's **kinetic mesh networking solutions** combine specialized command and control software with ruggedized, high-performance hardware. **Rajant's wireless BreadCrumb® nodes include intelligent routing capabilities** and flexible configuration options, while a redundant, peer-to-peer network design **ensures no single point of failure**. Even when an entire network is in motion, **Rajant ensures consistent and effective communications** at all times.

Flexibility

Rajant's autonomous networks are completely portable and can easily support roving nodes and sensors over areas of hundreds of square miles or more. Operators have full configuration control and the flexibility to customize deployments based on changing field requirements.

Unlike many competitors' solutions, which can best be described as fixed infrastructure networks, the Rajant BreadCrumb® Wireless LAN device can extend communications reach into completely new territories. **Even where no infrastructure previously existed, customers can deploy BreadCrumb® hardware quickly and easily to create a robust and resilient wireless mesh network.**

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Customers trust Rajant products to be **flexible, reliable, and scalable**, and Rajant technology proves its effectiveness daily in customer deployments around the world.

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InstaMesh

InstaMesh® technology powers Rajant's kinetic mesh networking solutions. Relying on a proprietary data routing algorithm, InstaMesh® enables continuous and instantaneous routing of wireless and wired connections. No matter how an operator configures the network, InstaMesh® determines the best pathway between any two points... even when those points are in motion. It provides the most flexibility for customers in remote and often dynamic environments.

In any network, poor routing decisions can result in excessive latency, unacceptable throughput and even random network outages. InstaMesh®, however, constantly discovers and maintains information at each BreadCrumb® node in order to determine the best traffic path. This approach enables robust fault tolerance, high throughput and low latency. When a user changes a device in the network (e.g. moves, disables or adds another BreadCrumb® device), that change only needs to be managed locally. Rajant's architecture design means the change does not need to be propagated throughout the network. This enables Rajant to maintain network availability, regularly adapting to new configurations, devices in motion, and changing environmental conditions to ensure uninterrupted communications.

In many customer situations, there is no existing cellular, advanced mobile broadband or Wi-Fi infrastructure. Using InstaMesh®, Rajant solutions work even without that support by providing any-node to any-node communications. If a wide area link is required, a BreadCrumb® network can easily transmit and receive data through a satellite, point-to-point wireless, or wired link.

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Relying on a proprietary data routing algorithm, **InstaMesh® enables continuous and instantaneous routing of wireless and wired connections – across all nodes.**

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Configuration Control

Rajant BreadCrumb® networks are easy to deploy and require minimal maintenance and administration. Because users of highly mobile networks typically do not have the time and resources to set up and repeatedly reconfigure settings, Rajant offers One Button Operation. Rajant technical teams are available for any additional support needs, and to ensure smooth ongoing operations.

Users also have the option to exercise more administrative control over a Rajant network if desired. BreadCrumb® networks include BC|Commander® software for ongoing operational management. Intuitively designed, BC|Commander® offers standard network control options, as well as many advanced features through a GUI interface including:

- Topology views graphically depicting BreadCrumb® devices, wireless clients, and the connections among them
- A real-time map view of the network with locations reported by GPS-enabled BreadCrumb® nodes
- Peer link information including wireless data rate, SNR, cost, and link distance (for GPS-enabled BreadCrumb® nodes)
- Mesh encryption and authentication settings including AES-256, AES-192, and AES-128 in both Cipher Feedback Mode and Galois Counter Mode
- Bulk BreadCrumb® configuration capabilities
- The ability to configure up to four virtual Access Points per radio, including security settings up to WPA2 Enterprise
- Wireless client access control lists
- InstaMesh and TRoP configuration options
- Capabilities for remote firmware updates
- Options for VLAN configuration, including named VLANs
- A completely customizable user interface allowing for task-oriented screen layouts



To help manage the network, Rajant offers the Rajant Remote Advanced Diagnostic System (RRADS). RRADS leverages Rajant's robust BC|Commander software along with additional tools to provide complete, flexible, and actionable control over the entire network. Additional tools in RRADS include:

- **NACK** – a Rajant-developed customer support tool that analyzes network snapshots taken in BC|Commander. NACK generates an HTML-based report, which allows users to easily analyze BreadCrumb® configuration and interconnectivity, and identify potential network issues. Specific features include:
 - Noise map by frequency
 - Full configuration comparison of all devices
 - Mesh link counts, qualities, and statistics
 - Multiple network graphs for viewing only links with good signal-to-noise ratio, good cost, or both. This can be used to find subnetworks that are only reachable through poor links.
 - Google Earth file export
- **Cacti** – an open source, third-party network graphing software tool that shows BreadCrumb® performance and usage data in an easy-to-read format

Rajant BreadCrumb® networks are easy to deploy and require minimal maintenance and administration.



Reliability

Rajant solutions are built to deliver extreme reliability in extreme conditions. Kinetic mesh networking technology enables distributed control of BreadCrumb® communications routing, which means Rajant networks are unparalleled in redundancy and availability. Many competitive solutions depend on a controller node, which can cause communication interruptions when there is a change in network configuration. In contrast, Rajant BreadCrumb® networks are highly robust – designed specifically to ensure no single point of failure – and perform strongly and reliably even in unstable environments.

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No Single Point of Failure

Many mesh networks rely on a single node to collect and disseminate routing information, which creates a hierarchy in the communications transmission process. Through the use of InstaMesh®, however, Rajant creates a true peer-to-peer network. Each and every node is independent, with full routing capability, and no dedicated backhaul.

In Rajant kinetic mesh networks, there is also redundancy on single and multiple frequencies. In a capability that is unique to Rajant, BreadCrumb® devices actively use multiple radios to perform multiple functions at the same time. Each network node proactively scans the environment and takes corrective action – switching radio channel or frequency – the moment it senses an interference or obstruction. Each radio in a BreadCrumb node can have multiple persistent connections – enabling hundreds of connections on a single node.

Finally, Rajant’s proprietary Automatic Protocol Tunneling (APT) technology allows for multiple ingress and egress points into the wired network – eliminating once again the possibility of a single point of failure.



Rajant Networks
Ensure No Single
Point of Failure

Load Balancing

BreadCrumb® models currently hold up to four radios – 900 MHz, 2.4 GHz, 4.9 GHz, and 5.8 GHz – in a variety of combinations. However, there is the potential to create BreadCrumb® configurations that support more radios with additional frequencies as needed. Again, unique to Rajant is the fact that BreadCrumb® nodes make use of all installed radios for multiple functions at the same time. This capability is crucial, and runs counter to other mesh networking strategies.

Most multi-radio network solutions separate traffic into two types: client access traffic – communication between access points and Wi-Fi clients (mobile equipment, laptops, video cameras, VoIP phones); and backhaul traffic, which connects access points over long distances. The theory is that if at least two radios are performing the “backhaul” function on two different channels, then all traffic can be smoothly transferred from node to node without the need for any retransmission.

Rajant BreadCrumbs®, however, are designed differently. Because the radios in BreadCrumb® devices are capable of simultaneously sending and receiving on different frequencies, Rajant delivers even greater network availability. **Only Rajant has the ability to use**

BreadCrumb® devices actively use multiple radios to perform multiple functions at the same time. This capability is crucial, and runs counter to other mesh networking strategies.

any one of multiple radio frequencies for conducting local-access traffic and backhaul traffic. And if there is interference on any one frequency, a Rajant BreadCrumb® node will automatically switch to another. This feature ensures users maintain critical access to communications applications in the most challenging environments.

In Figure 1, node “C” for example would always use the fastest link available at any given time in communicating to the network, rather than collecting data from one node first and then turning it around and retransmitting it to the other. By focusing on creating no single point of failure, Rajant networks are uniquely capable of balancing traffic loads so that users get the maximum amount of throughput at all times.

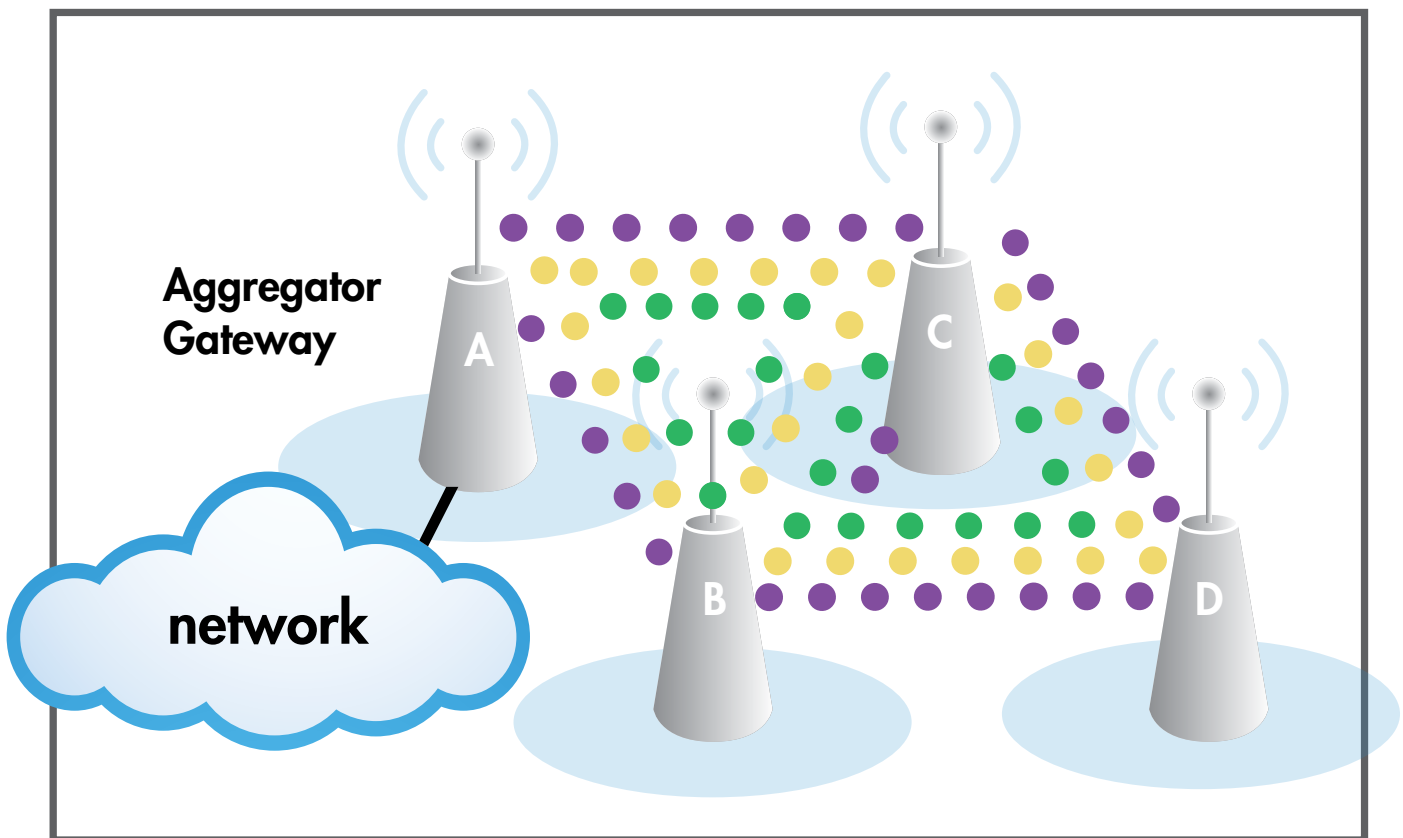


Figure 1. Multi-Frequency Mesh Network

Power Source Options

BreadCrumb® devices are designed to operate in a variety of conditions, including situations where access to power is limited. Rajant BreadCrumb® models support multiple power sources including A.C., vehicle D.C., and battery power for one or multi-day usage on a charge.

Scalability

In addition to flexibility and reliability, Rajant solutions offer customers the ability to scale wireless networks as demand and distance requirements change. Greater network efficiencies – including lower administrative overhead and optimizations for managing high-bandwidth applications – help extend the power of Rajant networks and ensure customers stay connected even as demand on those networks increases.

Multiple Radios and Frequencies Enable Multiple Simultaneous Functions

900 MHz

2.4 GHz

3.65 GHz

4.9 GHz

5.8 GHz

CUSTOM Frequencies

Rajant networks scale easily to hundreds of high-bandwidth nodes.

Layer 2 vs. Layer 3

Rajant's approach to wireless mesh networking differs from many other providers in that the kinetic mesh networking technology is based on a Layer 2 type system. While Layer 3 networks use IP addresses to track each client device, Layer 2 networks rely on Mac addresses. An IP address is assigned based on when and where a device joins a network, but a Mac address never changes. For mobility purposes, this makes a Layer 2 network far more efficient. Operators don't have to reconfigure the network or worry about disruption every time a device is on the move.

A Layer 2 system also lets customers run as many IP sub-networks on top of a Rajant-deployed network as needed. Because these sub-networks are created based on IP number ranges, they are effectively transparent to a Rajant BreadCrumb®. Customers can use any protocol on top of a Rajant network as well, from encrypted Ethernet packets, to IPv4 or IPv6, to non-IP protocols.



High-Performance Applications

The best test of a network is the performance of the applications that run on top of it. The concept of scalability goes beyond the geographic reach of a network. It also addresses how well a network can perform even as the usage of applications with heavy bandwidth requirements increases. For example, Voice over IP (VoIP) communications that rely on Wi-Fi connections draw a significant amount of bandwidth. Rajant has found that traditional VoIP architectures are particularly difficult and inefficient to manage in remote network environments for a variety of reasons. Because of this, and the fact that voice communications are often critical in remote and mobile operations, Rajant developed Tactical Radio over IP (TRoIP) to avoid shortcomings in standard VoIP protocols.

Common implementations of VoIP networks require a centralized SIP (Session Initiation Protocol) registration server in order to map a user's VoIP domain contact, such as a telephone number or username, to an IP network address. Common voice conferencing systems require a centralized conference server to receive voice streams from individual conference members and deliver the combined conference stream to all conference members. The Rajant BreadCrumb® TRoIP system, however, requires no central database of network contact information, and is designed specifically to be decentralized and fault tolerant. Instead of a central conferencing server, TRoIP picks a BreadCrumb® on the network to be the voice conferencing server. This ensures higher application performance, and lower bandwidth demand on the network. Because any BreadCrumb can act as the voice conferencing server, Rajant networks have redundant failovers.

Like voice, video is a bandwidth-intensive application. While Rajant mesh networks can transmit video using any encoding, Rajant also works with hand-selected partners to facilitate greater efficiency at the encoding and transport layers. Rajant video and voice efforts are examples of how they address the interplay between application and network operations to ensure the highest performance levels even as customer demands grow.



Proven in the Field

From mines to military and beyond, Rajant has proven the success of BreadCrumbs® and kinetic mesh networking technology in mobile environments. A combination of real-world experience and continuous optimization of the InstaMesh® algorithm is delivering unparalleled performance in the most remote, rugged and dynamic regions on Earth. This includes some of the world's largest mines, and military sites throughout Afghanistan. **Where there's a need for flexible, reliable, and scalable networking, even when and where other networks fail... Rajant connects.**

The Rajant BreadCrumb® TRoIP system requires no central database of network contact information, and is designed specifically to be decentralized and fault tolerant.





“We tasked our development team with anticipating the future needs of Rajant users across multiple industries. The result is a routing technology and network management platform that is flexible, secure, and allows for the rapid deployment and management of Kinetic Mesh Networks.”

- **Paul Hellhake, CTO**, Rajant Corporation

About Rajant Corporation

Based in Malvern, PA, Rajant Corporation enables secure communications-on-the-move through a portable meshed wireless network that can rapidly reconfigure and adapt in real-time. Rajant's BreadCrumb® Wireless solutions provide networks for Military, Mining, Oil and Gas, Homeland Security, First Responders, Telecommunications Service Providers and Public Safety and provide voice and data communications across a meshed, self-healing network. Rajant's BreadCrumb network nodes communicate with IP based client devices such as laptops, PDAs, video cameras, satellite terminals, networked radios, RFID's and sensor devices. Please visit www.rajant.com or call (484) 595-0233.

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