# MOVE THROUGH EVERY PHASE OF YOUR MASS TRANSPORTATION ROADMAP WITH RAJANT

The *Only* Network that Powers Fully Mobile
Mass Transit Broadband Connectivity

RAJANT

# ACCELERATE YOUR JOURNEY
## TO A FULLY INTEGRATED, 'SMART' MASS TRANSIT SYSTEM

Shaped by ever-growing passenger volumes and increased competition, your mass transit technology roadmap must account for an array of needs – from heightening safety, to improving capacity, to creating a differentiated customer experience. As such, operators need a robust and flexible network infrastructure that can adapt to support both short- and long-term priorities: one that's rapidly implemented today, but easily scaled to the plans for the future.

As you lay out your roadmap of objectives to meet new regulatory demands, revenue milestones, and discerning passenger expectations, you must ask yourself — "is my network infrastructure ready?" The advanced applications needed to support these initiatives often require uninterrupted connectivity, high-capacity bandwidth, dynamic speed, and most of all, robust mobility.

Because of this, tomorrow's smart transportation cities are not built on wired infrastructures alone. Let's explore the core building blocks your network will need to enable the operational gains, revenue increases, and levels of customer delight that mass transit operators are striving to achieve today.

# The **4 Vital Network Components** of Mass Transit Systems

The plethora of sensors, cameras, and handheld devices on and around trains and tracks provide invaluable insight into everything from passenger behavior to vehicle and equipment health, exact speeds and locations, fuel consumption, traffic, security concerns, and more. But the only way for operators to effectively utilize this information is by having a communications network that can connect these hundreds of moving assets simultaneously, and bring data to command centers in real time.

This is made harder by the fact that trains often travel across vast, remote, or underground areas where no, or limited, cellular, 3G/4G, or Wi-Fi infrastructure is available. Even in such cases, complete reliability to non-negotiable. That means that a mass transit network infrastructure must account for:



## Train to Trackside Connectivity

The first critical link your network must provide is **constant** connectivity between your high-speed trains and the broader fixed trackside infrastructure it travels past, giving onboard wireless clients the uninterrupted ability to support applications running on the train and along the wayside.

The robustness of this component is especially important when implementing capacity- and safety-enhancing applications like Communications-Based Train Control (CBTC), as well as regulatory-driven initiatives like Positive Train Control (PTC), which critically require continuous, redundant connectivity.



## Cellular and Wayside Aggregation and Load Balancing

It is an extremely expensive, and often off-the-table, proposition for mass transit operators to build out wayside infrastructure across the expanse of their train lines to support private wireless network build-out. This is particularly true as lines stretch out past city hubs to more remote areas.

As such, the network should be able to take advantage of infrastructure that already exists, with the ability to seamlessly 'toggle' between wayside, which is more prominent in densely populated urban centers, and cellular, which is common in more suburban environments.



## Car-to-Car Connectivity

High-capacity distribution of connectivity between train cars is another vital need for mass transit operators today, and one that traditional communication control units (CCUs) struggle to do effectively. These solutions take capacity hits with each car they carry connectivity to, so that one car may have access to 100 Mbps, while a car five lengths down the line may only experience 10 Mbps.
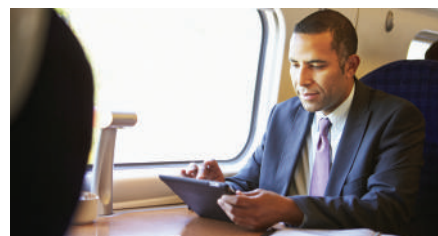
To keep up with the bandwidth demands of next-gen onboard sensors, cameras, and other operational applications, as well as customer expectations for consistent in-transit connectivity, operators require a solution that can deliver similar levels of capacity across all cars, no matter where the signal originates.



## Onboard Wi-Fi Distribution

The customer experience is a rapidly growing concern for today's passenger rail systems. While it may not be a direct way to increase revenues, discerning commuters have growing expectations for Wi-Fi service, and offering this amenity is part of an effective customer retention and ridership growth strategy.

Typically, these components are separate core competencies of vendors and their infrastructure solutions — meaning that mass transit operators must deal with multiple third parties to implement each aspect in their move toward a fully integrated digital railway. **Until now, with the Rajant Kinetic Mesh™ network.**

# Rajant Kinetic Mesh Networks:

## 3 Critical Network Components in One Fully Mobile Solution

Rajant Kinetic Mesh networks are transforming the way people and assets move by offering the ONLY fully mobile solution with the robust capabilities to support train to trackside connectivity, car-to-car connectivity, and cellular and wayside aggregation and load balancing with a single SKU — the Rajant BreadCrumb®.

BreadCrumb wireless nodes work in concert with Rajant's patented InstaMesh® networking software to deliver data via the best available path on a packet by packet basis, seamlessly integrating with each other, LTE networks, and third-party satellite, wired, point-to-point wireless, and Wi-Fi devices to form a complete wireless networking solution. Every BreadCrumb can act independently, making it a true peer-to-peer network that is completely mobile-enabled.

For mass transit operators, this makes Rajant Kinetic Mesh networks a simple, nearly all-in-one private wireless network solution for their extremely mobile, hard-to-connect environments.

**BreadCrumb LX5**      **BreadCrumb ME4**      **BreadCrumb JR2**

# What Makes Kinetic Mesh Unique:

## Complete Mobility vs. Fixed Manipulation

Many networking solutions claim full mobility, but in reality require a fixed backbone where a single controller node manages network movement, creating a vulnerable point for failure. In a Rajant Kinetic Mesh network, each BreadCrumb can move independently and free from a controller node, using multiple connections to ensure there will always be a viable pathway to deliver your information. As nodes are added, moved, or removed, InstaMesh automatically adapts to the changes, establishing new links in real-time to keep the network available, intact, and secure, with no single point of failure. This technology combination is what gives Kinetic Mesh its total mobility, and is the core of what makes Rajant's network so different from competitive offerings.
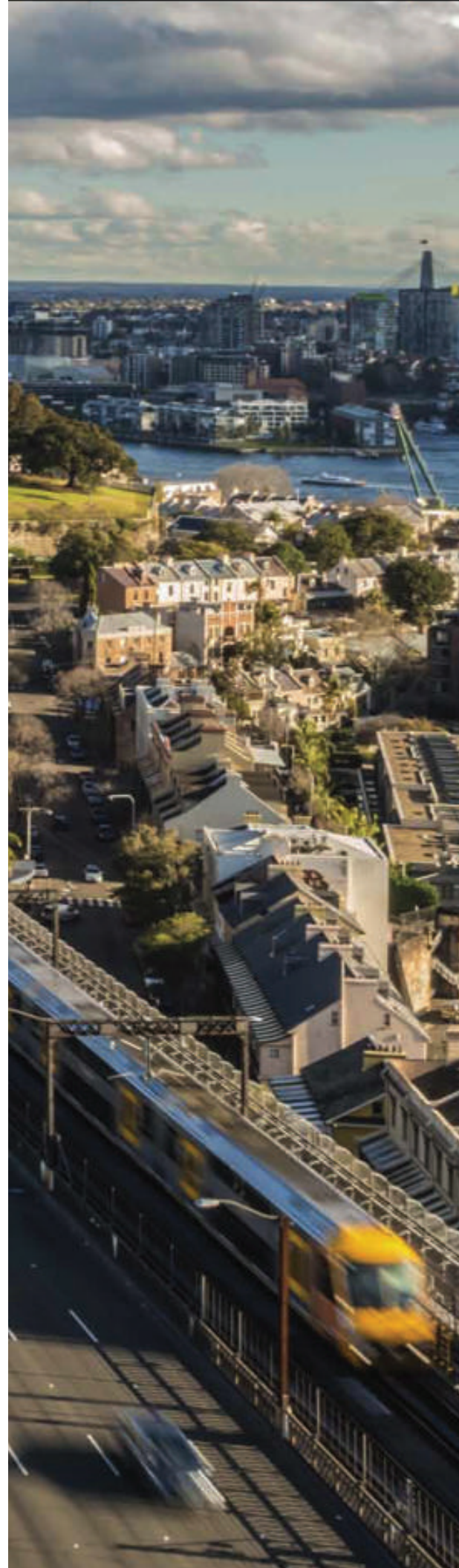
# "Make Then Break" Connectivity from Train to Trackside

The innovation behind Kinetic Mesh technology enables its ability to maintain connectivity without handover. In contrast to fixed manipulated PtP and PtMP solutions, which use a "break then make" approach to move connectivity forward to the next access point the train travels past, Kinetic Mesh uses a "make then break" paradigm whereby it establishes connection with its next access point before disconnecting from the previous point. This ensures that there is never a break in connectivity as the train moves along.

**Figure 1** below shows an example of how Rajant Kinetic Mesh's 'always on' connectivity works along a track, compared to the disruption caused in PtP / PtMP handovers, show in **Figure 2.**
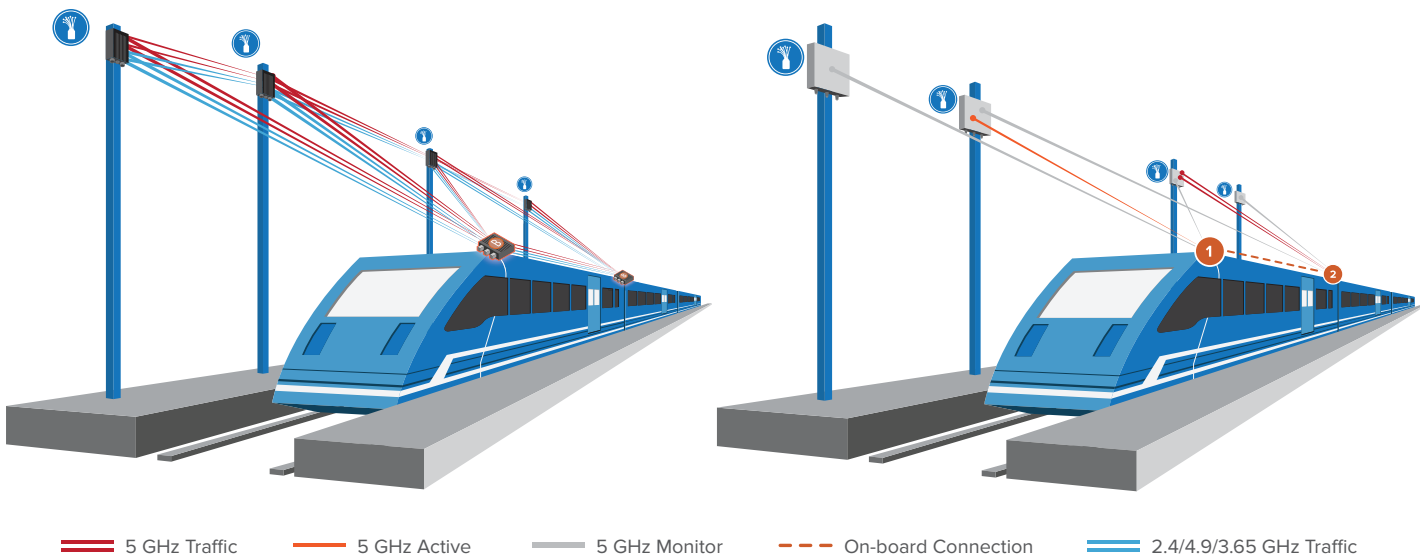


| ▬▬ 5 GHz Traffic | ▬▬ 5 GHz Active | ▬▬ 5 GHz Monitor | --- On-board Connection | ▬▬ 2.4/4.9/3.65 GHz Traffic |

**Figure 1.** Rajant Kinetic Mesh requires no handover and provides simultaneous car-to-car connectivity.

**Figure 2.** PtP / PtMP requires two types of handover and an additional onboard requirement for intra-car connectivity.

Additionally, BreadCrumbs have the flexibility to act as repeaters when fiber or other connectivity is absent, while fixed manipulated solutions require pre-existing connectivity at every infrastructure location.

## Applications Enabled

Rajant Kinetic Mesh provides superior train to trackside networking to support applications which require unwavering, redundant mobile connectivity, including:

- **CBTC**
- **PTC Backhaul**
- **Real-time CCTV**
- **Stations View and Train Door Monitoring**
- **Signaling Intelligence**
- **Vehicle Health Monitoring**

## Full Capacity for Evenly Distributed Car-to-Car Connectivity

By placing compact, ruggedized BreadCrumbs on each train car, operators instantly establish robust intracar connectivity. Unlike traditional CCUs—which degrade in capacity as signals are distributed, resulting in sometimes drastic discrepancies in service quality across cars—BreadCrumbs ensure even coverage from end-to-end. Because this capability is supported by the same SKU that handles trackside connectivity, BreadCrumbs provide the benefit of simultaneous increases in aggregate capacity from the trackside, while increasing overall network redundancy. In contrast, traditional CCUs do nothing to aid capacity or redundancy, and are an equipment add-on to a fixed manipulated PtP / PtMP network.

**Figure 3** shows how car-to-car connectivity is made possible with a Rajant Kinetic Mesh network.
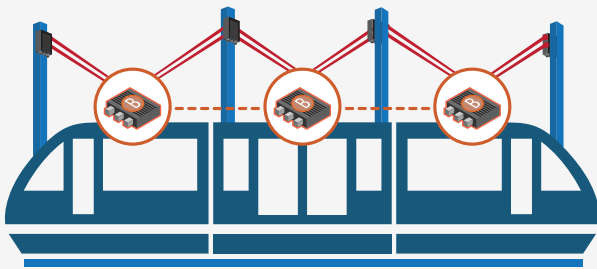
**Figure 3.** The Rajant Kinetic Mesh network enables simultaneous car-to-car and train to trackside connectivity.

### Applications Enabled

The reliable, predictable bandwidth provided by Rajant Kinetic Mesh across train cars ensures proper, continuous functioning of applications including:

- **Onboard CCTV**
- **Passenger Information Systems**
- **Digital Advertising**
- **Automated Ticketing**

## The InstaMesh Enabler for Cellular Aggregation and Load Balancing

InstaMesh is the advanced, patented protocol developed by Rajant that directs the continuous forwarding of network traffic, always determining the most efficient pathway between any two points—even when those points are in motion. Its ability to seamlessly network between fixed, wireless, and mobile nodes is what makes Rajant the perfect solution for transit operators to create a 'hybrid' network that saves significant infrastructure costs.

InstMesh is able to make decisions on a packet by packet basis, depending on its best-path analysis, and will dynamically switch between cellular and wayside in microseconds – eliminating the latency often seen with traditional CCU load balancing. Aircards can be installed directly into onboard BreadCrumbs, also removing the need for additional third party equipment.

**Figures 4 and 5** below show how Rajant BreadCrumbs perform cellular and wayside aggregation and load balancing, compared to traditional CCU solutions.
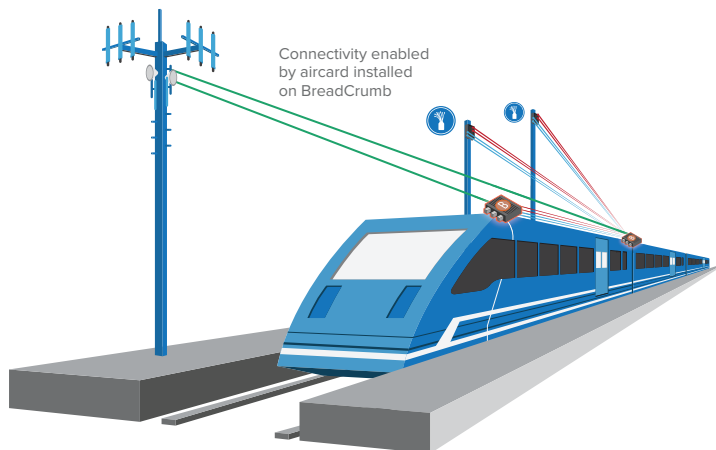


**Figure 4.** Achieving cellular and wayside aggregation and loading balancing with Rajant Kinetic Mesh is made simple by plugging an aircard directly into the onboard BreadCrumb node.
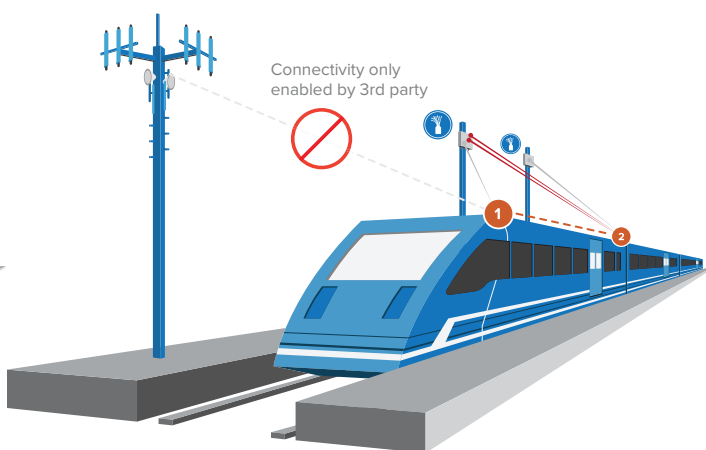
**Figure 5.** Traditional CCU solutions require add-ons from third party vendors to achieve cellular and wayside connectivity.

As you can see, a Rajant Kinetic Mesh network provides full mobility in sharp contrast to any modified fixed technology on the market today, delivering multiple key network building blocks needed for a 'smart' mass transit system in one single solution.
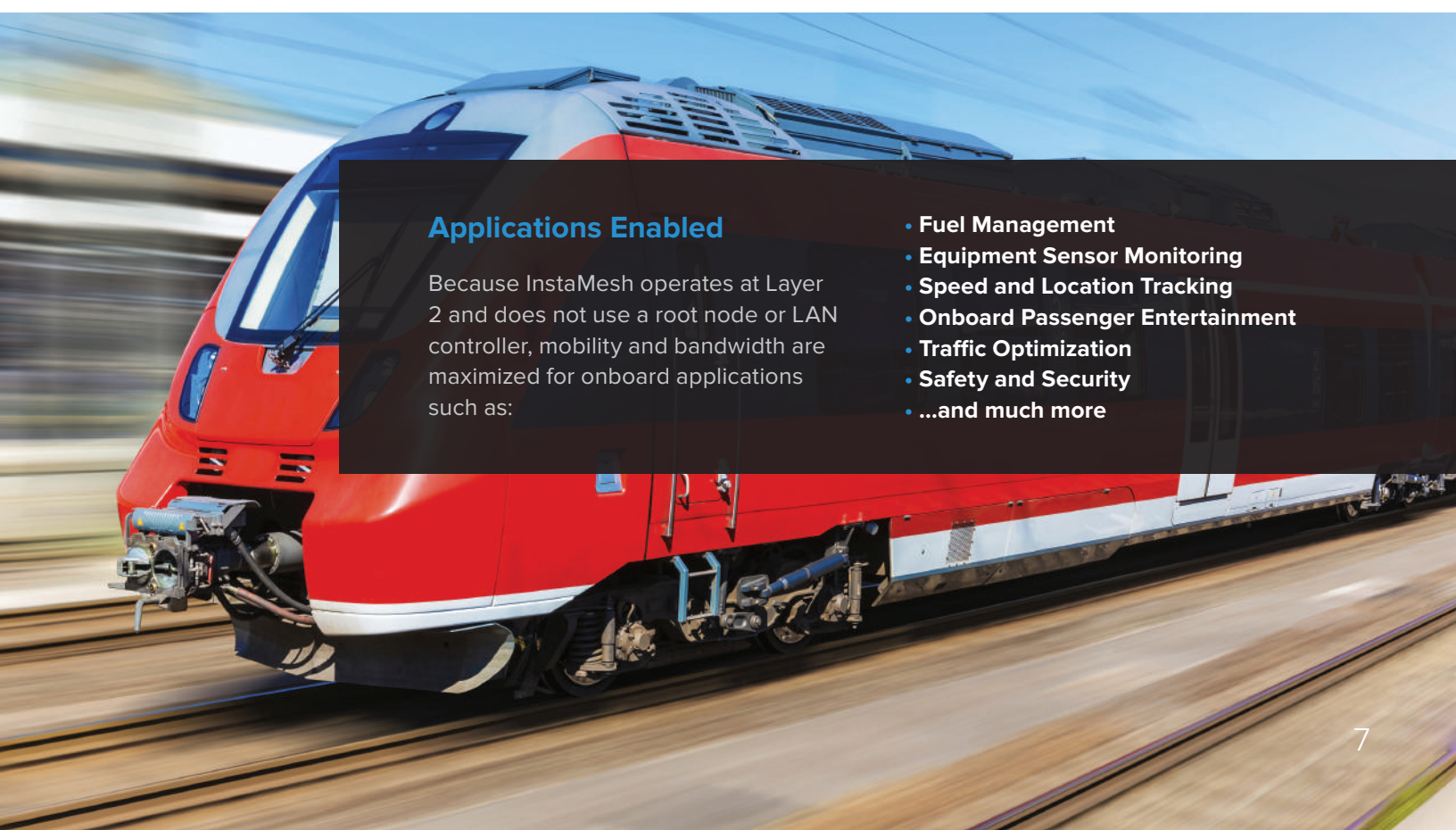


## Applications Enabled

Because InstaMesh operates at Layer 2 and does not use a root node or LAN controller, mobility and bandwidth are maximized for onboard applications such as:

- **Fuel Management**
- **Equipment Sensor Monitoring**
- **Speed and Location Tracking**
- **Onboard Passenger Entertainment**
- **Traffic Optimization**
- **Safety and Security**
- **...and much more**

# The **Rajant Difference**

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 to mass transportation operating, who are dealing with highly mobile, hard-to-connect environments.

POWERING THE
**LIVING NETWORK**™
RAJANT KINETIC MESH

## Fixed Manipulated PtP / PtMP
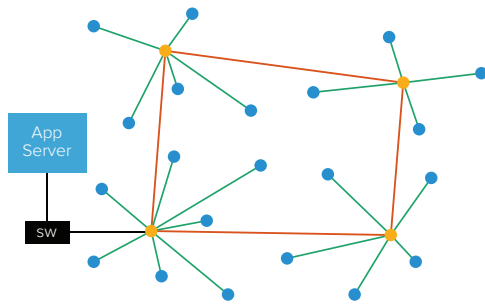


- Handover
- No Intra-Car Connectivity Options
- PtP Capacity
- 3rd Party Required for Cellular/Wayside Load Balancing and Aggregation
- Frequency Reuse Limitations

## Rajant Kinetic Mesh Network
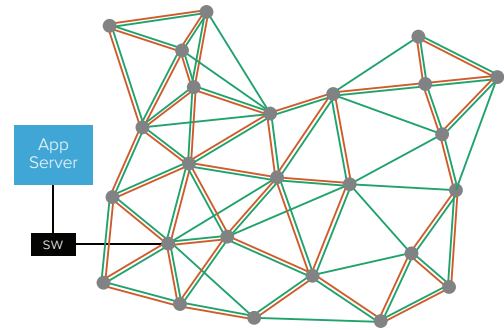


- ✓ Always Connected
- ✓ Simultaneous Intra-Car and Wayside Connectivity
- ✓ Aggregate Capacity
- ✓ Cellular/Wayside Load Balancing and Aggregation Built In
- ✓ Automatic Transmit Power

# SET YOUR MASS TRANSIT ROADMAP IN MOTION TODAY WITH RAJANT

Gain a network with the agility and adaptability you need to respond to new opportunities in the mass transportation market. Rajant Kinetic Mesh is the powerful solution you need to support next-generation applications for improving safety and security, increasing operational efficiency, and maximizing revenue generation—and are proven in real-world scenarios to provide exceptional reliability and performance across diverse, mobility-driven environments.

Talk to the Rajant Transportation team today to learn how a Rajant private wireless network can meet and exceed your transportation system's unique requirements.

**www.winn-marion.com**

**A Rajant partner since 2019, Winn-Marion customers can leverage the power of real-time data to deliver on-demand, mission-critical business intelligence.**

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