RAJANT

CASE STUDY

Rajant's Kinetic Mesh® Technology **Boosts Speed and Efficiency for Class I Railroad's Intermodal Railyard**

Freight railyards are a dynamic environment in which all assets—cargo, people and vehicles—are constantly on the move.

For this complicated operation to run smoothly requires reliable access to real-time data, but the rugged environment of an intermodal railyard makes constant connectivity a difficult goal to achieve.

When a Class I railroad's intermodal yard decided to purchase additional heavy equipment to help increase speed and efficiency, management quickly realized their basic Wi-Fi solution was no longer robust enough. Vehicle locations, the dynamic nature of stacked containers, and trains coming in and out of the yard meant the yard needed higher availability than the Wi-Fi could offer. **The railyard needed a new solution.**

The Challenge

The railyard itself is a major intermodal yard, approximately 1 mile wide and half a mile long, covering 118 acres, with trains, trucks and other vehicles entering and exiting at all times of day, and thousands of sealed cargo container stacks being moved from trucks to trains, and vice versa, every day. The intermodal yard uses a variety of vehicles to pick and move containers, including approximately 30 hostlers and 9 reach stackers.

One of the railyard's goals was to improve container movement efficiency, so that containers only required one to two moves, versus the five to six moves (based on a three-containers-high stack) currently required to reach the correct container. With this reduction in container moves, the yard would increase efficiency; reduce wear and tear on the moving vehicles; reduce lane blockages and congestion; and speed up the truck-to-stack, stack-to-truck, train-to-stack and stack-to-train times. The last two are especially critical around the December holidays, when cargo shipping skyrockets.

Company Profile

- Class I intermodal railyard operation spanning approximately 118 acres
- Operating a variety of vehicles and equipment including 30 hostlers and 9 reach stackers

Solution Components

- Rajant Kinetic Mesh® private wireless network consisting of the following BreadCrumb® nodes:
  - 4 LX5s as access points
  - 2 LX5s and 2 ME4s installed on rubber-tired gantry cranes
  - 10 ME4s installed on reach stackers
  - 30 JR2s installed on hostlers and other yard vehicles

Kinetic Mesh Partner (KMP)

- Future Technologies: wireless integrator specializing in the assessment, planning, design, implementation, and support of innovative communications solutions.

Outcome and Impact

- Improved speed and efficiency and streamlined stack management
- Increased reliability with fully redundant, low latency network with no single point of failure
- Enables real-time, end-to-end view of intermodal operations for timely analysis and decision-making
- Provides railyard ability to support future applications including yard management software and stack management system

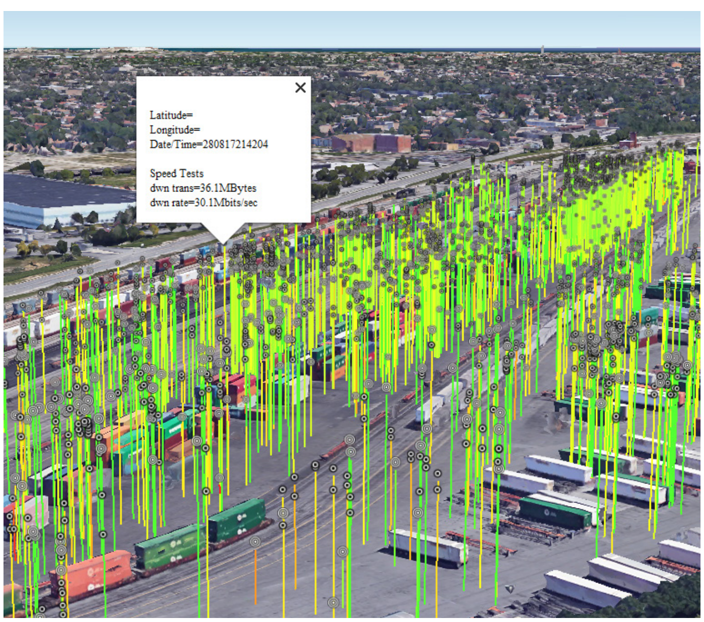
To meet that goal, the railroad planned to purchase two 30-ton overhead cranes and install them in the center of the yard, straddling the container stack, to speed up container movement. The railyard also began exploring the implementation of a stack management application to track the contents of the container stack and manage all cranes, vehicles, containers and devices.

Previously, in addition to the Wi-Fi, the intermodal yard utilized vehicle-mount computers and two-way radios to determine vehicle and personnel locations, and to support some of the outbuildings in the yard, but this was not enough to support the new stack management application in development. Site constraints meant that access points could not be installed in the areas that most needed them, and there was no logical place to put additional vertical infrastructure like towers. The yard needed a different type of network.

The Solution

TESSCO, one of the railroad's partners, learned of the challenge the railroad was facing, and referred the railroad to one of its own partners, Future Technologies, a wireless integrator providing turnkey installs for specialized projects. Future Technologies began to examine options for a better wireless solution to accommodate the new equipment and software.

"Initially, the railroad was asking us for point-to-multipoint (PtMP) products as a solution," said David Rumore, Executive Vice President of Future Technologies. "After further analysis and a deeper understanding of this customer's railyard environment, we soon realized that PtMP was not an optimal solution at all, and, in fact, would fail to meet the customers' requirements altogether."



Custom testing data gathered over 24 hours show upload and download speeds as well as latencies, demonstrating the network's high availability and low latency.

Future Technologies VP of Engineering Kyle Purintun added that being unable to install towers in the center of the site would require perimeter access point installation locations, meaning PtMP was not the right solution because subscriber devices only make one connection back to network infrastructure at any moment.

"There would be many times in a day where a vehicle would not have line-of-sight to any access point," he said. "The railyard needed a system that could relay data around the obstructions and seamlessly handle hand-offs."

In the ever-changing environment of a railyard, vehicle and container movement can create interference and restrict signal range for many wireless communication systems because radio frequency (RF) waves cannot penetrate the metal containers.

"Thousands of containers are being moved every day, and line-of-sight issues crop up constantly as stacks of containers move around and are piled higher," Rumore said. "That was the biggest challenge in designing infrastructure."

Additionally, the railyard required a network with high bandwidth and low latency. The yard is surrounded by dense residential and commercial zones and can see hundreds of individual Wi-Fi access points. The yard's bandwidth requirements were a minimum of 15 MB/250 ms latency.

The yard needed high availability, so that sent UDP packet streams are always received, to ensure the current method of tracking equipment and containers as well as the new stack management application can function properly. If a packet is missed, the system will not record the location of a container, and disrupt the entire process.

"Antennas on the reach stackers are mounted on the 'head' or 'grabber' part, which might be stuck far into the stack and lose line-of-sight," Purintun said. "But this is the critical moment when the location is being recorded, and it was crucial that the network could handle total loss of line-of-sight to an access point, and still keep packets moving."

Knowing the railyard's specific requirements, Future Technologies recommended Rajant Corporation's Kinetic Mesh® wireless network, a type of wireless network that has been successfully deployed in other harsh environments such as ports, oil and gas, mining and military operations.

In a Kinetic Mesh network, there is no static infrastructure; each radio, or node, serves as singular infrastructure, which enables all devices and the network itself to be mobile—a critical component for a railyard, where people, devices, vehicles and equipment are constantly on the move. The network employs multiple radio frequencies and any-node-to-any-node capabilities to continuously and instantly transmit data in real time via the best available traffic path and frequency.

Rajant's BC|Commander mapping tool uses real-time GPS coordinates from the wireless radios to show the current links.

Because there is no central control node—and thus no single point of failure—routes are built automatically, and are evaluated for quality and performance with every received and sent packet. If a certain path becomes unavailable for any reason—due to a vehicle moving out of coverage, or an object that moves in and obstructs coverage, for example—nodes on the network use an alternate route to deliver data.

This allows the network to adapt to node location, local interference and congestion dynamically, eliminating downtime even in the most rugged conditions. All infrastructure components transmit and receive real-time information, enabling an end-to-end view of intermodal operations and allowing timely analysis and decision-making. The network can be redeployed in multiple ways simply and easily by repositioning the nodes.

Purintun added that another concern was the subscriber part of the path calculation. Wi-Fi-based laptops and tablets generally have battery-sipping Wi-Fi radios that are not meant for distance, as well as very small internal antennas and a plethora of chipsets covering different standards (A/B/G/N/AC, MIMO variants, etc.).

"Using Rajant allowed the access points and subscribers to act more effectively and have the same high-performance radios and antennas as the access points," he said. "This allowed the up-link and down-link path calculations to be nearly identical. We were also able to mount the radios in the best possible location, rather than inside the computer, which would likely be in the vehicle and at driver height."

The subscriber part of the path calculation was important, as the "upload" is more important than the download, and the railyard needed very significant reliability—especially important when the reach stacker is placing or pulling items from the stack.

"This is the moment the data is the most critical, and when the radio is placed into its most challenging environment: surrounded by containers on almost all sides," Purintun said.

The Installation

The railroad made initial contact with Future Technologies in fall 2015, and Future Technologies formulated the Rajant solution in the first quarter of 2016. Future Technologies conducted a site survey in June 2016, with additional surveys conducted later as the railroad adjusted its scope and expanded coverage areas, before finalizing the design.

The railroad awarded Future Technologies the contract in March 2017. Deployment kicked off one month later, with a civil crew installing fold-down towers and other personnel installing devices on reach stackers and other vehicles.

To meet the railyard's ambitious goals of improved speed and efficiency and streamlined stack management, the following Rajant BreadCrumb® nodes are being installed: four LX5s as access points; two LX5s and two ME4s on the rubber-tired gantry cranes; 10 ME4s on the reach stackers; and 30 JR2s on the hostlers and other yard vehicles.

The installation team encountered a few challenges, including the same ones that eliminated the possibility of traditional Wi-Fi—lack of vertical infrastructure and the dynamic nature of the environment—but the Kinetic Mesh® network solved these easily.

The Rajant wireless nodes could not be mounted in the middle of the required coverage area, even on existing light poles, because the railyard needed to be able to lower the halo lights to perform maintenance. Instead, Future Technologies placed the BreadCrumbs at the periphery of the operating area, looking in toward where containers and vehicles move.

"That's where the mesh came into play," Rumore said. "We had to have backhaul capability and had to have capacity injection capability at multiple sites without building a whole lot of infrastructure to support that, which isn't possible with traditional Wi-Fi solutions."

Likewise, Kinetic Mesh was able to support the dynamic environment of the railyard. Future Technologies designed the network infrastructure to have some fixed locations to give coverage in areas that would routinely have open lines of sight. The company then added Rajant BreadCrumb LX5 and ME4 nodes to the equipment itself. The cranes, which will sit above the containers and all infrastructure, will have radios attached to "look" down into the container stacks. The reach stackers will also be equipped with BreadCrumbs.

"All these nodes add to the mesh and to the robustness of the network," Rumore said. "This gives us constantly moving nodes that are also moving in and out of areas where we need coverage, which fixed infrastructure wouldn't be able to do."

Purintun added that the radios were ideal for the railyard's rugged environment.

"The installation and radios need to be very durable, as these components will endure hundreds of shocks a day as the grabber connects to containers," he said.

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— David Rumore
Executive Vice President, Future Technologies

And a wireless network is important to the company, as it wants to utilize applications on equipment to pull data. For example, a proximity application could keep workers informed of where equipment and operators are, promoting safety and productivity. Executives are also interested in establishing voice communication throughout the entire mine for all employees, using a cell phone with an application enabled for this purpose. In order to accomplish all of the above, the organization needs a robust, high bandwidth, low latency network in the mine.

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Results

The complete installation is still ongoing, as delivery of the 30-ton cranes was delayed, but the existing network is already exceeding railyard personnel's expectations.

"The railyard project manager's prior experience was related to Wi-Fi and other mesh products that did not handle the 'make-before-break' hand off very well, and they had some preconceived notions on what networks could and couldn't do," Rumore said. "We initially got some pushback when we told them what the network would be capable of, but we used RF planning and modeling tools to show them what they could expect, and they have been pleasantly surprised and pleased with the network performance they've seen so far."

"Proper meshing and make-before-break are mission-critical," Purintun added. "This is the only radio that makes and maintains multiple connections to access points and other subscribers to make split-second decisions on packet flow. Additionally, the number of mobile vehicles that were outfitted with these radios will expand the network capability, not impede it, which is important because the number of access point locations had to be so few."

Applications being developed for the railyard include the stack management system and yard management software. The upgraded yard management system will be a total yard solution and is three to five years from completion. These systems will organize all movement based on location data, using the most logical routes for the highest efficiency. Some of the vehicles will have tablets inside them to enable even speedier information transfer.

After the large cranes are delivered, the rest of the network will be deployed—in plenty of time for the railyard to streamline container movement and meet its improved speed and efficiency goals before the busy holiday season.

The railyard will use Rajant's BCICommander® monitoring and management application, which establishes secure, encrypted links to each node in the Kinetic Mesh® network, allowing operators to gain a complete view of their BreadCrumb®-based network topology. Real-time node mapping allows administrators to see exactly where and how their network is connecting, even as devices move through the environment, and provides real-time RF status informatio for mesh and client links.

Purintun said that this will be a valuable way to manage the network.

"BCICommander is a complete tool for configuring, testing, monitoring and maintaining the Rajant network, allowing users to visualize the network using real-time GPS

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