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Nuclear Power Plant Tests DAS

An initial test of a distributed antenna system (DAS) shows promise for addressing nuclear power plant coverage challenges. **By Danny Ramey**

About four years ago, the Electric Power Research Institute (EPRI) began testing how maintenance workers at nuclear power plants could use tablets in the field in lieu of traditional paperwork packages. That tablet study exposed a need for greater connectivity and coverage in power plants.

"The objective was to make the work execution process more efficient while enhancing the mobility of maintenance workers," says Nick Camilli, senior technical leader at EPRI.

Founded following the Great Northeast Blackout in November 1965, EPRI is a non-profit organization that conducts research into both long-term and short-term solutions for making power systems more flexible, resilient and connected.

Many nuclear power plants have at least some level of Wi-Fi available, but numerous factors limit or reduce RF coverage in areas of the plant. Most nuclear power plants are in fairly remote areas, and they are complex and robust with many components and concrete, making it difficult to get RF signals to and through most areas.

An idea for improving connectivity in nuclear plants came to Camilli while reading a case study that detailed a project to implement a distributed antenna system (DAS) for cellular coverage and connectivity throughout the underground tunnel network of the Boston subway system. The subway tunnels posed similar issues to connectivity and coverage as a nuclear power plant, giving Camilli the idea to explore using DAS to improve connectivity inside a power plant.

Testing the System

A utility offered to allow EPRI to test the DAS concept at a nuclear power plant in Florida. Because the plant was in the early stages of decommissioning, EPRI was able to test the DAS system in conditions approximating an operational plant.

"It was as near real-life conditions as we could get," Camilli says. "It was really the perfect scenario."

Camilli reached out to two vendors that had worked on similar subway projects about participating in a test of the DAS technology in a nuclear power plant. SOLiD supplied the active DAS headend and radio equipment, while Radio Frequency Systems (RFS) provided its leaky feeder coaxial cable solution. The project required a radiating cable without stop bands to accommodate a high-performance, future-proof design and fewer shadow areas, and RFS' cable made it possible to enable Long Term Evolution (LTE) technology for data management. The cable's higher-order mode suppression technique allows some cable variations to have no stop band from 698 MHz to 2.7 GHz.

"Our radiating cables act as distributed antennas, making them an ideal fit for the uniquely challenging environment of a nuclear power plant," says Suzanne Kasai, RFS business development manager.

Officials secured floor plans of the power plant and used radio planning software to engineer the network and document cable routes, RF propagation and heat maps. With that initial work done, the project team performed baseline testing at the power plant and measured several specified test points. This round of testing allowed the team to fine tune its design by providing insight into factors such as wall thickness and wall material that were not evident in the floor plans.

While the nuclear power plant environment bears similarities to a subway system, there are several challenges specific to the power plant. The biggest difference is how the RF signal propagates through the area. In a subway system, the signal bounces off the walls of the tunnels to provide the coverage. Propagation in a nuclear power plant is more difficult because of the large number of pipes, equipment and other components that congest the area and bounce signals in unpredictable ways.

"It's probably the most congested place I've seen," says David Culpepper, SOLiD sales engineer.

Understanding how that congestion factors into frequency propagation and how it affects coverage were key goals of the project. EPRI chose to test the system in two areas of the power plant: the auxiliary building and the containment area. Those two areas are generally the most remote buildings at a plant, tend to be underground or partially underground, and have components and concrete that can block signals. EPRI staff hypothesized that if the system could provide decent coverage in either of those areas, it would work anywhere else in the power plant, Camilli says.

EPRI wanted the system to achieve the same threshold standard as cellular companies, aiming for -95 dBm or higher signal strength. The team tested the DAS system at both 730 MHz and 2.13 GHz to see how the system performed on both high-end and low-end spectrum. The lower frequency provided about twice the coverage of the higher frequency — a result the team was hoping for when the project first started. The lower frequency lessens concerns about RF interference and electromagnetic compatibility, making it more ideal from a performance and installation perspective, Camilli says.

On the lower frequency test, the

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Photo courtesy EPRI

A wireless network can support productivity gains and reduced costs for power and utility plants by enabling on-site consultation, data entry and communications, as well as remote equipment monitoring.

system generated an acceptable signal with about 80 percent coverage at the target threshold of -95 dBm or higher through as many as three walls. The higher frequency test only reached about 35 percent of the target level. The test results also indicated that 100 percent coverage is possible by rerouting the cable and/or using antennas to boost signal strength in poor coverage areas.

"The radiating cable provided the advantage of a uniform distribution of RF energy over the entire distance of the cable, which can improve coverage in all frequencies," Kasai says.

Next Steps

The test in Florida was a feasibility study to see if the technology could potentially help power plants. After completing the test, EPRI shared the results with its member organizations and received positive feedback on the idea. One nuclear energy company interested in the technology volunteered one of its active power plants for deploying and testing a full-scale system.

This next phase of testing will look at a variety of factors not considered in the initial testing, including focusing on coverage on all elevations in a building instead of just one, tracking network speeds, installing online monitoring sensors to see if they can sync with the system and others.

"Basically, we're taking it to the next level," Camilli says. The utility that volunteered its site for the next level of testing has indicated it would be interested in deploying the technology in all of its plants throughout the country should the next phase of testing go well.

"There's so much opportunity in this industry for DAS," Culpepper says. "There are a lot of eyes on this approach, and I think the chances for this to go nationwide are very big." ■

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