



## RFS RADIAFLEX® Radiating Cable Helps Provide Seamless Wireless Connectivity to Millions of Boston's MBTA Subway Riders

One of the primary challenges in designing a solution to offer comprehensive wireless access within the Boston subway system was addressing the city's highly complex system of underground and underwater tunnels. RFS RADIAFLEX® radiating cable was the key to achieving unparalleled technical performance and reliability.



CASE STUDY

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## The Challenge

During the initial phases of the MBTA project, which included eight platforms in four stations all relatively close to each other (¼ mile apart or less, with relatively straight paths), InSite was able to use antennas to provide wireless connectivity. But as the job progressed, the environment began to include more complex environments such as narrow tunnels, long curves, up and down hill areas, sections of track under bodies of water, and more.

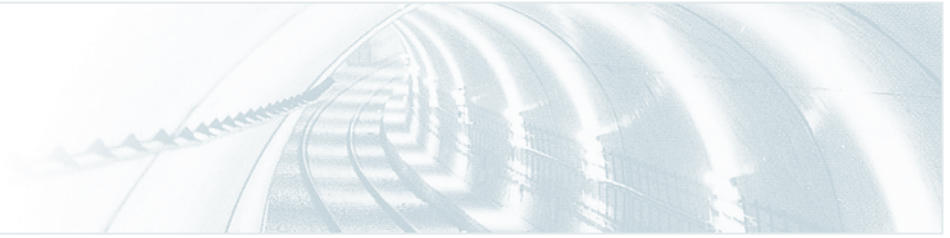
“ Given the nature of the DAS business, you don't want to have to worry about the technology in place, so it is critical to have good components and good vendors... ”

Additionally, there were instances where space to mount the equipment was not available and/or there was limited signal propagation. InSite had also reached a point where it had to work around the massive flood gates on one of the system's Red Line routes. These gates are large doors that allow the tunnels to be sealed to prevent water passage during the construction of highway tunnels.

With all of these factors in play, antennas were no longer a viable option.

**T**he rapid growth of wireless communications has resulted in today's transit passengers demanding a seamless wireless experience for the duration of their commutes. For Boston's subway riders, this quality user experience includes being able to use their wireless devices within the city's **highly complex system** of underground and underwater tunnels. However, the in-tunnel environment is one of the world's most challenging from an RF perspective. The twists, turns and constrained cross-sections of any tunnel, coupled with the large -- and fast-moving -- vehicles it carries, present an onerous RF distribution challenge. Furthermore, the modern wireless communications systems that serve transit passengers must also simultaneously accommodate a wide variety of commercial technologies **from 2G to 3G, 4G and beyond**.

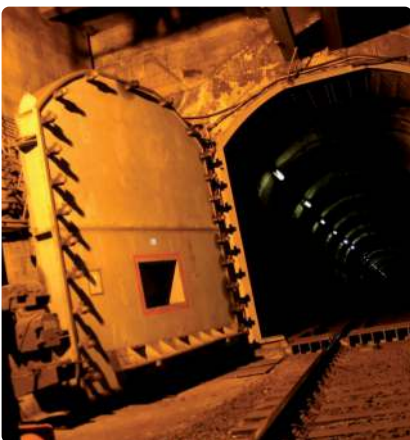
As a result of this growing trend, The Massachusetts Bay Transportation Authority (MBTA), the public transportation system of Greater Boston, initiated a project to provide continuous, end to end wireless coverage in the underground stations and tunnels of its transit system. After a public bidding process, the MBTA awarded a contract to provide and **operate a neutral host wireless distributed antenna system (DAS) in the subway system** to InSite Wireless, a company focused on the design, construction, operation, and maintenance of shared wireless infrastructure for complex indoor and outdoor environments. InSite specializes in neutral host DAS utilized by multiple carriers, specifically targeted at customers who seek seamless wireless coverage in the most challenging of physical environments such as convention centers, casinos, airports and transit systems, where either the quality of wireless signals is impaired by building structures or the signal capacity is insufficient to meet fluctuating occupancies.



## The Solution

InSite engineers had to design a system to accommodate the varied geometry of the tunnels and the different types of trains used on each line, as well as a way to get past the flood gates without interfering with their operation. To solve problem installation areas, the designers specified RADIAFLEX® radiating cable from RFS. RADIAFLEX radiating cables facilitate radio communication where the usual free space propagation of electromagnetic waves is hampered, undesired or impossible - in environments such as tunnels, mines, buildings, and large complexes like exhibition grounds or airports.

Radiating cable is similar to regular antenna cable, with slots cut into the outer conductor that allow the cable to work like a sprinkler hose and “spray out” low levels of signal along its entire length. For example, a single radiating cable extending 1,100-1,500 feet will spread an RF signal out to serve a long curve.



Installers had to work around the massive flood gates, which allow the tunnels to be sealed to prevent water passage during construction of highway tunnels. Existing cable sleeves were used to thread RADIAFLEX cable through the gates and into the rest of the tunnel.

To work around the flood gates, the InSite team used existing cable sleeves (used for electricity wiring and other existing cabling) to thread the RADIAFLEX cable through the gates and into the rest of the tunnel – ensuring seamless wireless service.

Time constraints were also a key issue for the cable installation process. Due to the MBTA’s schedule, installers are only able to work when trains are not running. After the process of shutting down power, work trains and other vehicles coming through, the installers get an average of only 2 to 2.5 hours per night to work.

In this kind of installation process, hi-rail vehicles (trucks fitted with special train wheels to allow them to drive on the tracks) are used to put hangers on the wall of tunnels, which tend to be crowded, so installers have to be extremely careful about where to locate them. RFS RADIAFLEX cables include numerous features to simplify installation. To help installers find the correct position, for example, the RADIAFLEX cable jacket is equipped with two guides that fit exactly into the rear open part of RFS standard clic clamps or in the open slots of heavy-duty clamps. This simplification can be critical under tight time constraints.

Furthermore, the highest risk for malfunction, besides cable handling, is poor installation of connectors. RFS one-piece connectors for radiating cable are virtually foolproof, further simplifying the installation process. RFS also offers a wide range of standard and special drums in order to meet specific project needs.



“ We have found RADIAFLEX® to be a technically superior cable, and the quality of product and ease of installation have been critical factors in our success ”

**Joe Mullin**  
Vice President of Engineering and  
Operations at InSite Wireless

CASE STUDY

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Designing a DAS with Unparalleled Technical Performance and Reliability – Now and Into the Future

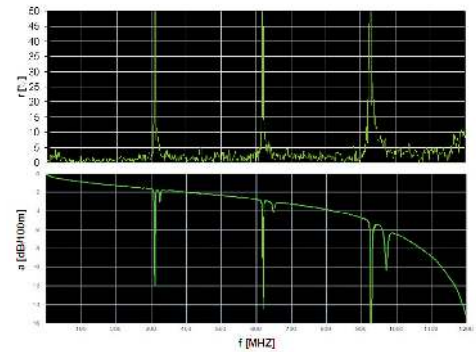
There have been numerous challenges brought on by the rapid growth in wireless usage, and the resulting introduction of new frequency bands. Whereas connectivity needs were once adequately served at 800 MHz and below, technology systems now have to address a wide variety of frequencies ranging from 700MHz up to 2700 MHz.

“ In designing a system such as the MBTA neutral host DAS, it is critical to find a cable that will serve all of the relevant frequency ranges efficiently. RADIAFLEX had the peak performance we needed, while covering all of the required frequencies. ”

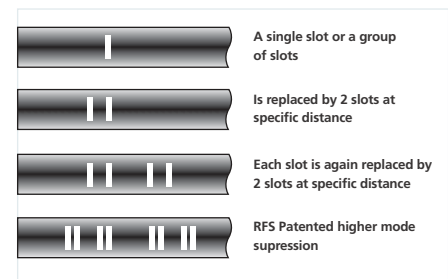
Furthermore, InSite required a radiating cable solution without stop bands to accommodate a high-performance, future-proof design for the MBTA DAS installation. RFS is the only company on the market with the intellectual property and leading-edge technology to suppress stop bands in radiating cables.

The RADIAFLEX suite of radiating cables feature RFS’ patented “higher order mode suppression technique” that allows RFS to offer cables that support current and future in-tunnel and in-building commercial and private radio services from 698 MHz to 2700 MHz for valuable cost savings. As a result of this patented higher mode suppression, selected RADIAFLEX cables have no stop band from 698-2700 MHz. RADIAFLEX cables are future-proof with respect to RF spectrum re-banding / re-farming, ensure low insertion loss and excellent coupling performance, and feature halogen-free, non-corrosive, low-smoke and flame-retardant jacket material for safe and reliable long-term cable operation.

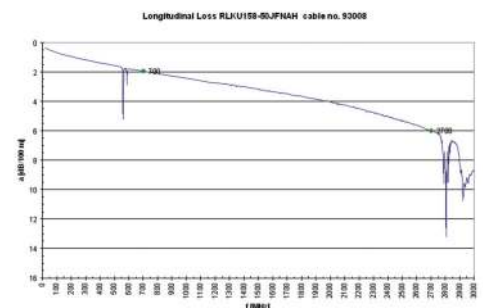
“ There are a number of cable manufacturers; the challenge is finding one that offers consistent technical performance and reliability, while also providing an economical solution. RFS excelled in all of these areas. ”



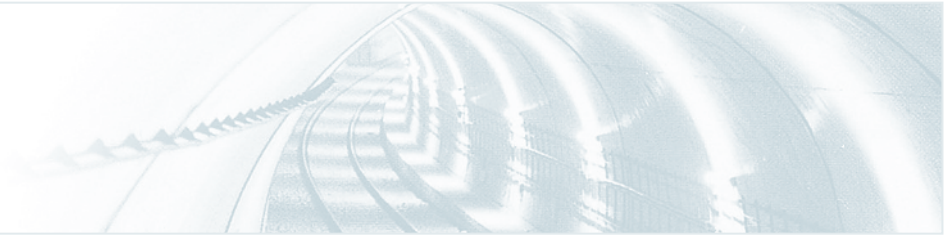
The periodic repetition of the slot or slot group causes resonances and harmonics



The theory behind RFS’ higher order mode suppression technique



RFS patented higher mode suppression with no stop bands

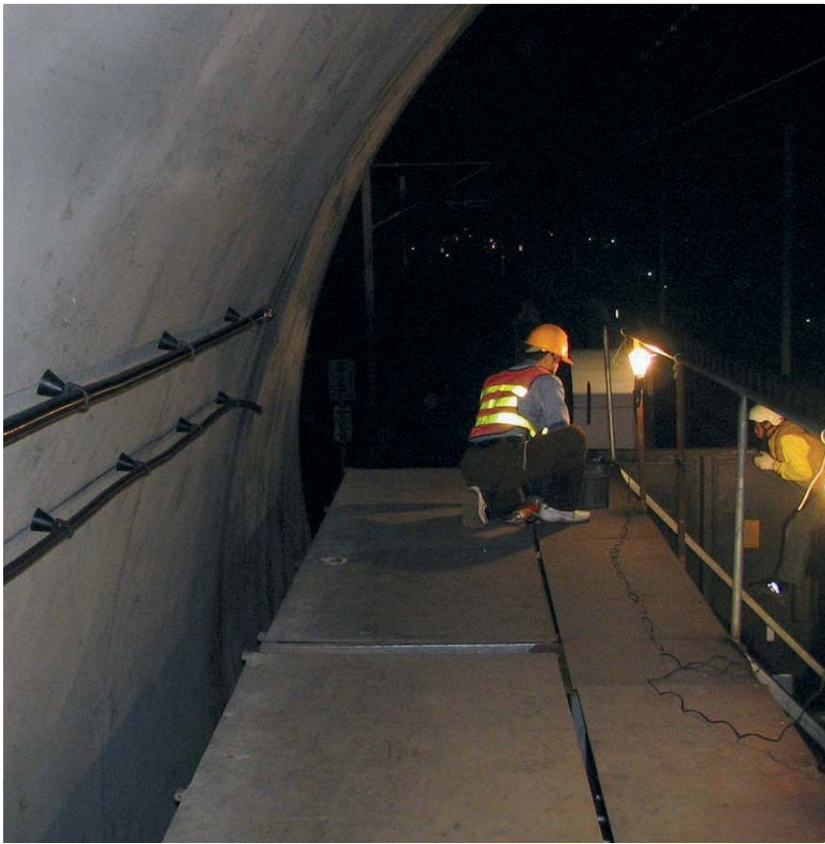


## Conclusion

To date, InSite Wireless has used close to 30,000 feet of RADIAFLEX cable for the MBTA project, with plans to use approximately 30,000 feet more in the project's final phase of completion. Upon its anticipated 2012 completion, the MBTA installation will be the first neutral host DAS offering end-to-end coverage throughout the entire subway — including 35 underground stations and 19 miles of connecting tunnels.

“ T-Mobile currently provides 13 miles of coverage to 26 underground stops on the MBTA subway line. As a result, our customers are now able to carry on conversations, text and use the Web while traveling underground in Boston as seamlessly as they are able to above ground, with no interruption to their wireless service. Ensuring this quality user experience for our customers is critical, and it would not be possible without the technologically advanced DAS system installed within the MBTA subway system. ”

**Tom Ellefson**  
Northeast Vice President of  
Engineering at T-Mobile



RADIAFLEX cables include numerous features to simplify installation. Cable jackets are equipped with two guides that fit exactly into the rear open part of RFS standard clic clamps, or in the open slots of heavy-duty clamps, and RFS one-piece connectors for radiating cable are virtually foolproof.

## About InSite Wireless

InSite Wireless specializes in the design, installation, operation, and maintenance of shared wireless infrastructure solutions that enhance the quality and capacity of wireless voice and data services in public facilities and complex environments. InSite built and launched its first DAS at the Moscone Center in San Francisco in 2001, and has developed and currently operates additional projects in convention centers (including the Boston Convention and Exhibit Center), casinos, airports, sports stadiums, and transit systems like the MBTA subway system. InSite's parent company, InSite Wireless Group, LLC, also owns InSite Towers, LLC, which develops, manages, and owns nearly 600 telecommunications towers and sites for wireless carriers.

# Why RFS?



**Radio Frequency Systems (RFS) is a global designer and manufacturer of cable, antenna and tower systems, plus active and passive RF conditioning modules, providing total-package solutions for wireless outdoor and indoor infrastructure.**

**RFS serves OEMs, distributors, system integrators, operators and installers in the broadcast, wireless communications, land-mobile and microwave market sectors. As an ISO compliant organization with manufacturing and customer service facilities that span the globe, RFS offers cutting-edge engineering capabilities, superior field support and innovative product design. RFS is a leader in wireless infrastructure.**

**For over 35 years, RFS has provided total-turnkey RF solutions for the world's metros, railway and road tunnels. RFS is the globally acknowledged expert in tunnel RF coverage systems, with worldwide experience and know-how spanning six continents and many hundreds of installations.**

## Serious about services

Customers know they can count on RFS for comprehensive logistical capabilities, flawless execution and outstanding technical skills and support. The company's dedicated shipment coordinators, hotline staff and on-site engineers go well beyond mere technology, striving to offer tailored solutions to meet even the most complex site-engineering and delivery challenges.

RFS' value-added services match the exact needs of business partners large and small.

## Ever-present quality guarantee

From design to manufacture, ISO 9001 and ISO 14001 certification standards encompass all aspects of RFS' business worldwide. Every product RFS ships has stood up to the most stringent technical, environmental and quality control tests, continuously meeting and surpassing the expectations of a long list of wireless carriers, transportation and utility operators, and broadcasters.

RFS backs every product bearing its name with a quality guarantee that is unrivaled in the market.

## A tradition of innovation

For over a century, RFS has been at the forefront of the wireless communication industry through its unwavering commitment to design and develop the world's most advanced technology in the field. Dedicated R&D teams, along with a privileged partnership with Bell Labs, are at the source of breakthroughs that are ensuring the mobility of an increasingly wireless world.

RFS is at the frontier of wireless technology innovation, sustaining the boldest ventures to enhance the way people communicate and live.

## A truly global company

With on-the-ground personnel in more than 20 countries and on every continent, RFS always delivers on its commitments, providing a comprehensive range of premium products, systems and services. Its clients benefit from all the advantages of a global supplier, while relying on dedicated support from RFS' local engineering, manufacturing and shipping teams.

RFS' products, systems and personnel can be found in every corner of the planet. As a global group, RFS is committed to upholding the most stringent environmental, health and safety standards, and seeks to integrate green initiatives in every aspect of its business.

