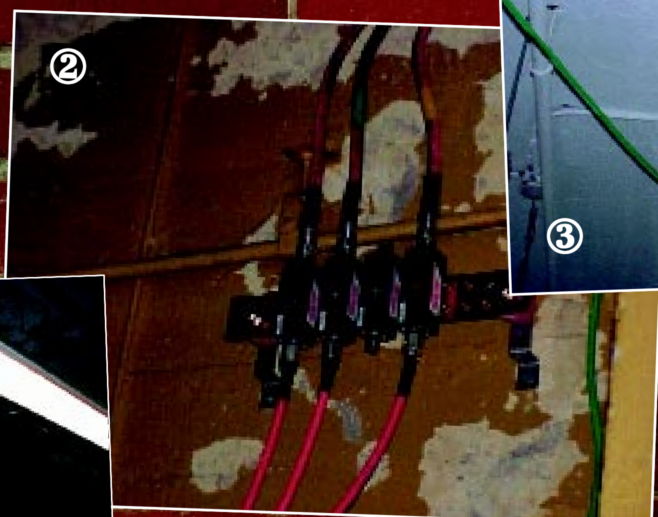


For a radio service provider to take advantage of a rooftop antenna site, a base station had to be located in the basement of a 14-story building and connected to the roof by a run of plenum cables that meet the appropriate codes. Bottom to top: (1) Radio equipment located in a basement cabinet is connected by LMR-400-LLPL cable (orange) to a series of lightning protectors (2), from which runs of LMR-600-LLPL cable (also orange) begin their ascent, crossing the ceiling at the second floor (3) to enter a riser shaft (4) for a straight shot at the roof. The cables exit a hatch at the top of the riser shaft on the 14th floor (5) and are run along an outside wall to the antenna mount (6).

In-building cable installations

As the demand for wireless services increases, more antennas must be installed in less traditional installation environments, such as large buildings. The antenna feeder considerations are different in this type of environment.

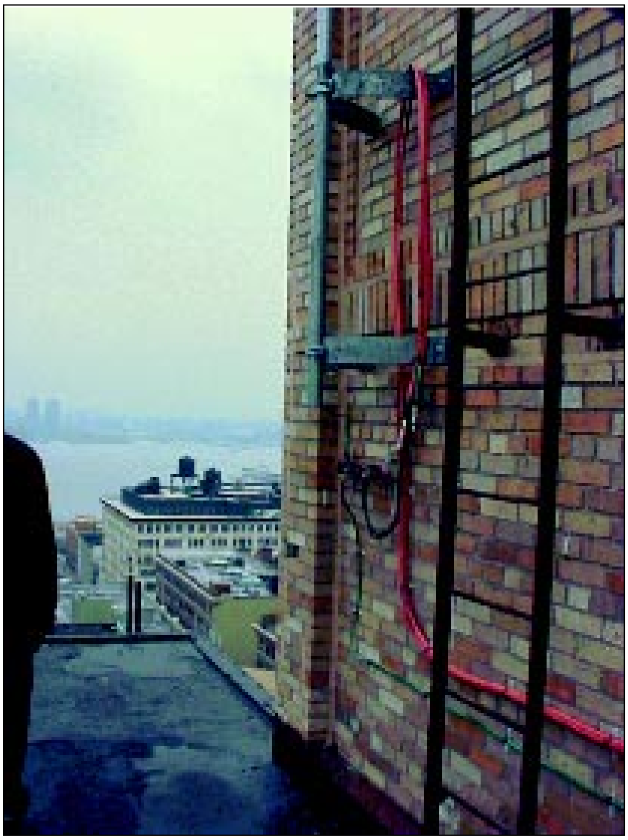
By Robert Perelman

Demand for wireless communications services in urban areas is increasing as the work environment becomes more mobile and the need for constant communications increases. This demand has created the necessity for more antenna installations on building roofs. In addition to the more traditional two-way radio, paging and cellular applications, new services such as local multipoint distribution systems (LMDS), wireless Internet and unlicensed spread-spectrum radio are all being used.

We'll take Manhattan

Antenna siting issues in an urban environment are a major challenge. Clearly, sites with good elevation give the best coverage for omnidirectional systems and clear the most obstacles for point-to-point systems. But real estate at the top of a building is expensive. It is generally not practical to lease space for radio equipment in the penthouse. Instead, a boiler room, garage or other relatively inexpensive area is most likely to be used for radio equipment. Now the challenge for the implementation engineer is to get the signal from the radio room in the basement to the antenna on the roof. As we saw in a recent survey of a site in lower Manhattan, this can be a major challenge, indeed.

The lower Manhattan building where the system was installed is a 14-story, 50-year-old structure, with a riser shaft from the second floor to the 14th floor. The shaft goes up to a secondary structure on the roof where the antenna is mounted. There is no easy access to this shaft, so the cable must survive being pulled through the shaft from the roof to the second floor. This work must be performed by union electricians who are not always familiar with the care required to successfully handle a fragile coaxial cable.



Antenna sites are at a premium in urbanized areas such as New York City. This 14-story rooftop installation is cabled to a base station in the basement.

The system we surveyed requires a maximum 13dB of loss at 900MHz, regardless of run length. Cable needs to be low-VSWR and UV-resistant for the portions of the run that are installed outdoors. On top of this, the cable needs to be plenum-rated in order to meet the requirements of the National Electrical Code (NEC) for indoor installation in an air-handling space in the building. In other installations, riser-rated or general-purpose outdoor cable may be used, depending on the interpretation of the electrical codes in the municipality where the installation is being performed. This combination of requirements limits the choice of cables that can be used for this installation.

Testing

To meet the NEC, these cables need to be listed by Underwriters Laboratory. To be listed as a plenum cable, the cables must pass the Steiner Tunnel Test that requires several runs of cable be placed in a horizontal chamber. Air is flowed over the cables at a controlled rate. A precisely controlled flame is then introduced. To pass the test, there are limits for both flame spread and smoke generation. This is intended to simulate the situation of a fire in a building. Cables that are installed in air-handling spaces, such as the space above a false ceiling, are especially dangerous in a fire. If they generate smoke, this can make it impossible for occupants of the building to be able to see well enough to exit the building. To pass this test, it is necessary to use special jackets and dielectrics, which are more fire-resistant than polyethylene. Generally fluorocarbon resin-based

Perelman is vice president, commercial sales and marketing, for Times Microwave Systems, Wallingford, CT.
His email is perelman@timesmicrowave.com.

materials, such as Teflon, are the best choice for dielectrics because in addition to being fire-retardant, they have excellent electrical properties and result in cable with low attenuation.

For cables going between floors in a building, there is the somewhat less severe NEC "riser" category. To get this rating, the cables must pass a vertical tray flame test. This simulates resistance to cables spreading the fire from floor to floor in a building fire. To meet this requirement, special jackets can be applied to cables with polyethylene foam dielectrics.

Riser cables can be installed anywhere in a building except air-handling spaces. In large metropolitan areas, the use of plenum cables is mandated for in-building installations.

These ratings form a hierarchy, meaning that plenum cables can be installed anywhere in a building, including risers and air handling spaces. Riser cables can be installed anywhere in a building except air-handling spaces. For this reason, in large metropolitan areas, such as New York City, the use of plenum cables is mandated for all in-building installations.

Cable construction

Two constructions of low-loss plenum cables are available: corrugated copper cables with a helically wrapped Teflon spacer dielectric and flexible cables with an expanded Teflon dielectric. The corrugated copper cables are stiff and difficult to install without damage. The spirally wound spacer does not give full support to the corrugated copper outer conductor. This allows the outer conductor to kink during installation in tight spaces in buildings. Connector installation on corrugated copper cables is also difficult.

Flexible, low-loss plenum cables use expanded Teflon as the dielectric. Similar constructions have been used in high-quality microwave cables for aerospace, testing and other demanding applications for many years. This construction has many advantages. The expanded Teflon has good mechanical strength and fully supports the outer conductor of the cable, resisting kinking and damage to the cable during the installation process. Because the Teflon is expanded, it has both a low-dielectric constant and a low dissipation factor, so the resulting cables have low attenuation. The cable shown in the accompanying photos on page 24 and 25 is Times Microwave Systems LMR-400-LLPL and LMR-600-LLPL. This cable has an orange UV-resistant copolymer jacket, selected to have the smoke and flame properties necessary to allow the cable to pass the UL plenum tests. It is the lowest loss, flexible coaxial cable available and is rugged enough to be installed in difficult building environments without damage.

Installation

In the building that was surveyed, the antennas are located on the top of the 14-story structure. On the roof level, there is a secondary structure that provides the best elevation and is line-of-site to the transmitting antenna, on a building near the World Trade Center. The installation of the cable was accomplished by bringing the reels of cable to the roof and laying out the lengths needed. The cable was pulled down to the second floor. From that point, it had to go about 50 feet down a corridor and then down into the basement. The radio equipment is located in a basement boiler room, not exactly the "high-rent" district, as can be seen from the photographs.

The entire run of cable is 280 feet long. The LMR-600-LLPL is used for most of the run. It has a loss of 2.7dB/ 100 feet at 900MHz, so the loss of the 280 foot run is 7.5dB at 900MHz, well within the requirement for this system. A short run of LMR-400-LLPL is used from the radio to the lightning protector and then to the main feeder run, which adds about 0.5dB, for a total of 8dB, still well within the 13dB specification.

Although a slightly larger, corrugated-copper, plenum rated cable is available with a slightly lower loss (2.5dB/100 ft at 900MHz), the stiffness and fragility of this cable would have made it impossible to install in this building. Only a rugged, flexible cable was possible to use in this installation. Many buildings are similar to this one in the difficult routes through which the cable must be run. The importance of cable flexibility to facilitate installation cannot be overemphasized. The cost of the cable is relatively small compared to the cost of the labor to install it—or *reinstall* it, as is likely with a fragile cable, if it is damaged in the initial installation,

Connectorization of the low-loss, flexible cable is also quicker and easier than for the corrugated copper cables. Tools are available to prepare the cable for connector attachment in seconds. Several styles of connector with different attachment techniques are offered. The quickest to attach is a version with spring fingers for the center conductor attachment and a crimp for the outer conductor attachment. Other versions have pins that solder to the center conductor, and there are also versions that clamp to the outer conductor.

Considerations for antenna feeder selection in large urban areas are different than in a traditional tower-mounted antenna system. Code-adherence and flexibility are required.

Conclusion

With the growing types and numbers of systems required to accommodate the incredibly quickly growing demand of the marketplace for more and varied wireless services, more and more antennas must be installed in ever more untraditional installation environments, especially buildings in large urban areas. The considerations for antenna feeder selection in this environment are different than in a traditional tower-mounted antenna system. Major considerations include meeting the applicable fire codes, sufficient flexibility to allow installation of the cable without damage and low enough loss to meet the system requirements. Only low-loss, flexible, plenum rated cables meet all of these requirements. ■