Challenges and Solutions for Fiber-to-the-Antenna Networks

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Business White Paper

3M

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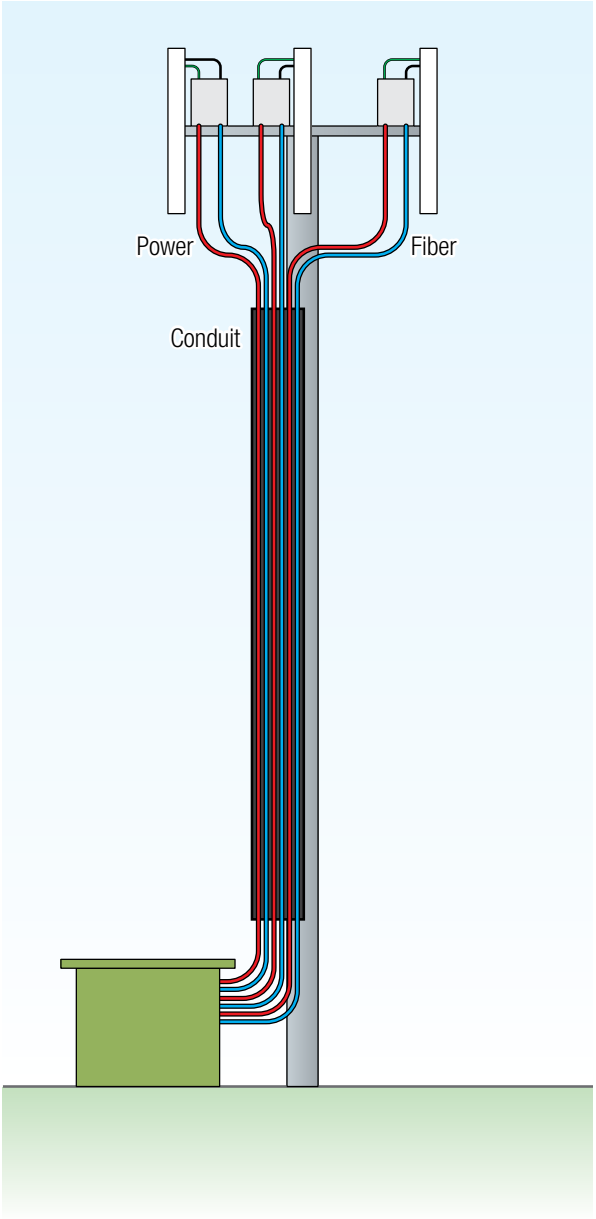
Introduction

In the evolution to advanced 3G and 4G services, wireless service providers are taking fiber to the top of the tower. Next-generation, fiber-fed architectures are quickly becoming the new norm for tower builds and retrofits. These new fiber-to-the-antenna (FTTA) architectures leverage tower-mounted radios to deliver a number of benefits over traditional coaxial-based systems.

However, when it comes to installing fiber networks with an operation geared toward hard-line coax, operators face a new set of challenges, particularly in terms of connectivity. They must weigh the pros and cons of factory-terminated versus field-terminated fiber cable. They have to consider the skill sets of their field technicians. And they should address the increased need for weatherproofing required by many new antenna designs in order to provide advanced services. New solutions from connectivity suppliers are helping operators meet these challenges.



The Case for FTTA

Many operators around the globe have chosen to invest in fiber networks for new builds and retrofits of cell towers. They see it as the best architecture to meet current and future demand, reduce energy consumption and minimize footprint. Among the advantages of FTTA:

- **Better signal integrity:** Conventional systems use coaxial corrugated cables to transmit high-frequency radio signals from the base station on the ground to a passive antenna on the tower. As much as 50 percent of the signal can be lost along the way, according to many industry estimates. These losses increase the signal-to-noise ratio, degrading the quality of the received signal. Signal loss in not a concern when fiber is used. FTTA systems use tower-mounted remote radio units (RRUs) to generate the signal at the top of the tower, near the antenna, with a coaxial jumper cable connecting the two. With a short distance to travel over coax, signal loss is minimal.
- **Increased energy efficiency:** Reducing carbon footprint (and energy costs) has become a ubiquitous goal in the communications industry. Remote radio systems can significantly reduce a tower's energy consumption, according to the 2010 "ATIS (Alliance for Telecommunications Industry Solutions) Report on Wireless Network Energy Efficiency." In a traditional base station design, transmitted radio signal power travels up the coaxial feeder cable to the antenna. As the frequency of the radio signal rises, the corresponding signal losses in the coaxial feeder increase. In the worst cases, twice as much signal must be injected into the feeder coax as is needed to propagate out from the antenna. The radio frequency (RF) power amplifier in the base station is one of the least efficient components of the system, and much of the extra energy required to drive RF power up hard-line coax is simply wasted as heat. This, in turn drives up the energy costs even more because active cooling systems such as A/C are needed to keep the equipment within its operating temperature ranges. Cooling typically accounts for 25 percent of a tower's energy use, according to the ATIS report. With a remote radio system, the RF power amplifier is located in the RRU. The tower-mounted RRU is cooled by ambient air flow, eliminating or decreasing the need for active cooling in the base station and saving energy.
- **Increased capacity and coverage:** Remote radio units often support advanced antenna techniques such as multiple In multiple Out (MIMO) and remote electrical tilt (RET), which enable denser, more flexible coverage with fewer service gaps and higher capacity.
- **Smaller footprint:** FTTA systems consume less space because the fiber cable is many times thinner and carries more signal than coaxial feeder cable. A fiber-fed system lessens – or at least doesn't add to – coaxial congestion and tower loading issues, saving tower real estate, reducing physical complexity and minimizing visual impact. Also, the removal of the inefficient RF power amplifier and its associated cooling systems decreases the need for a shelter or a large equipment storage unit to house the base band unit.

Overcoming the "Fear of Fiber"

While FTTA architectures boast many advantages, operators face a number of new practical challenges when it comes to installing fiber on towers. Operators realize that fiber is generally better suited than coax to achieve advanced 3G and 4G data rates and to prepare their networks to meet future demand. However, a number of stumbling blocks stand in the way of implementation.

The so-called "fear of fiber" has been coined to describe concerns that operators face as they consider next-gen architectures. The term alludes to the fact that fiber is relatively fragile and requires some care during installation. But the real reluctance to switch from coax to fiber is steeped in fundamental unfamiliarity with the media. Indeed, installing fiber requires a new skill set. That means retraining technicians or hiring new ones, a time-consuming and costly proposition. Companies can sidestep the training issue by purchasing factory-terminated fiber. However, factory-termination adds to the cost of the cable and requires various lengths to be stocked. Additionally, because it comes in pre-defined lengths, factory-terminated cable may create either a slack storage situation or turn-up delays when the cable is too short, adding cost.

Those issues have fueled the emergence of field-terminated fiber connectors in the FTTA space. Field termination fits well with the prevailing practices used for hard-line coax. Specifically, hard-line coax is always cut and terminated on-site to ensure a proper fit. New field-mount fiber connectivity solutions allow the same paradigm to be used for fiber deployments – simply roll out a spool of fiber, field terminate at the site, and you have a custom installation every time with no messy slack storage or missed deadlines due to inadequate cable lengths.

To make fiber more craft friendly, connectivity suppliers have developed solutions to help mitigate the cost and complexity of installing fiber in the field. For instance, the 3M™ No Polish Connector (NPC) allows quick and easy termination of fiber cables at the site. For the small fiber counts used in FTTA installations, the NPC connector is faster than fusion splicing because only one end of the fiber needs to be prepped and the installation tool requires no power or care. For installations requiring integrated strain relief, the 3M™ Tool Less Connector (TLC) series makes the process even simpler with an innovative fiber cable strength member capture mechanism. Proven solutions, NPC and TLC connectors are currently deployed in environmentally demanding applications around the world.

3M™ No Polish Connector LC SM 250/900 8830

Likewise, the 3M™ Fiber Dome Tower Terminal allows quick and easy connection of the RRU fiber jumper to the tower fiber cabling in a trunked-fiber tower architecture. Rugged and hermetically sealed, the terminal protects against weather, yet is re-enterable for easy maintenance. As the centerpiece of a fiber-fed remote radio system, the Fiber Dome Tower Terminal from 3M provides plug-and-play simplicity.

3M™ Fiber Dome Terminal Closure FDTC 08M

Guarding Against the Weather

Wireless operators must also address new weatherproofing challenges when installing next-gen tower networks. Emerging designs, such as MIMO, incorporate multiple connection points and higher density connections than traditional 2-port antenna designs. These connection points require effective weatherproofing to ensure reliability. However, traditional solutions for weatherproofing, such as tapes and mastics, are often too cumbersome to apply on tightly spaced connectors.

Proper weatherproofing of RF connections tops the list of essentials to ensure network reliability – and it is relatively inexpensive. A small investment in weatherproofing can help safeguard against expensive service interruptions. The importance of weatherproofing cannot be overstated. Even connectors with internal gaskets/weatherproofing are not fail-safe. Moisture build up around the connector can cause corrosion, allowing RF signals to mix and generate passive intermodulation (PIM) distortion. PIM can interfere with neighboring frequencies, prompting a host of legal and regulatory headaches for the operator. It's no small wonder that major cellular antenna manufacturers recommend external weatherproofing around their "sealed" RF connectors. The security in performance and reliability for minimal spend is simply too high to ignore.

3M developed the One Step Closure for Wireless (OSCW) for weatherproofing critical coax connections on the tower. The smaller OSCW-J-1/2 closure is used at the jumper to antenna connection. The larger OSCW-F-7/8 closure is used at the feeder to jumper connection. Used extensively on towers worldwide, the closure locks out moisture, helping preserve signal integrity. The closure's sealing gel provides an effective barrier against moisture and water, yet does not stick to the connector. Its compact, one-piece design and tool-less, single-handed closing and opening allow quick and easy installation and maintenance.

Later this year, 3M anticipates the release of a small form factor closure designed specifically for high-density antenna connections. Based on proven technology, the closure will be designed to protect the coaxial cable jumpers between remote radio units and next-gen antennas. The closures will be easy to install and reusable.

3M also offers a full spectrum of weatherproofing solutions ranging from tapes and mastics to cold shrink insulators. Additional 3M solutions to help providers transition to next-gen tower architectures include fiber distribution units, high-density copper blocks, jumper assemblies, tower top cable routing enclosures, site support cabinets and more.

3M™ One Step Closure for Wireless (OSCW)

Summary

Next-generation, fiber-fed networks enable the 3G and 4G services that subscribers demand. However, wireless operators accustomed to coaxial-based systems face new challenges when installing fiber on cell towers. Regardless of the type of architecture chosen, operators must consider installation method (field versus factory termination) and new weatherproofing needs. Solutions newly available on the market can help wireless operators resolve those issues and assist them in building reliable fiber networks, from base station to antenna.

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