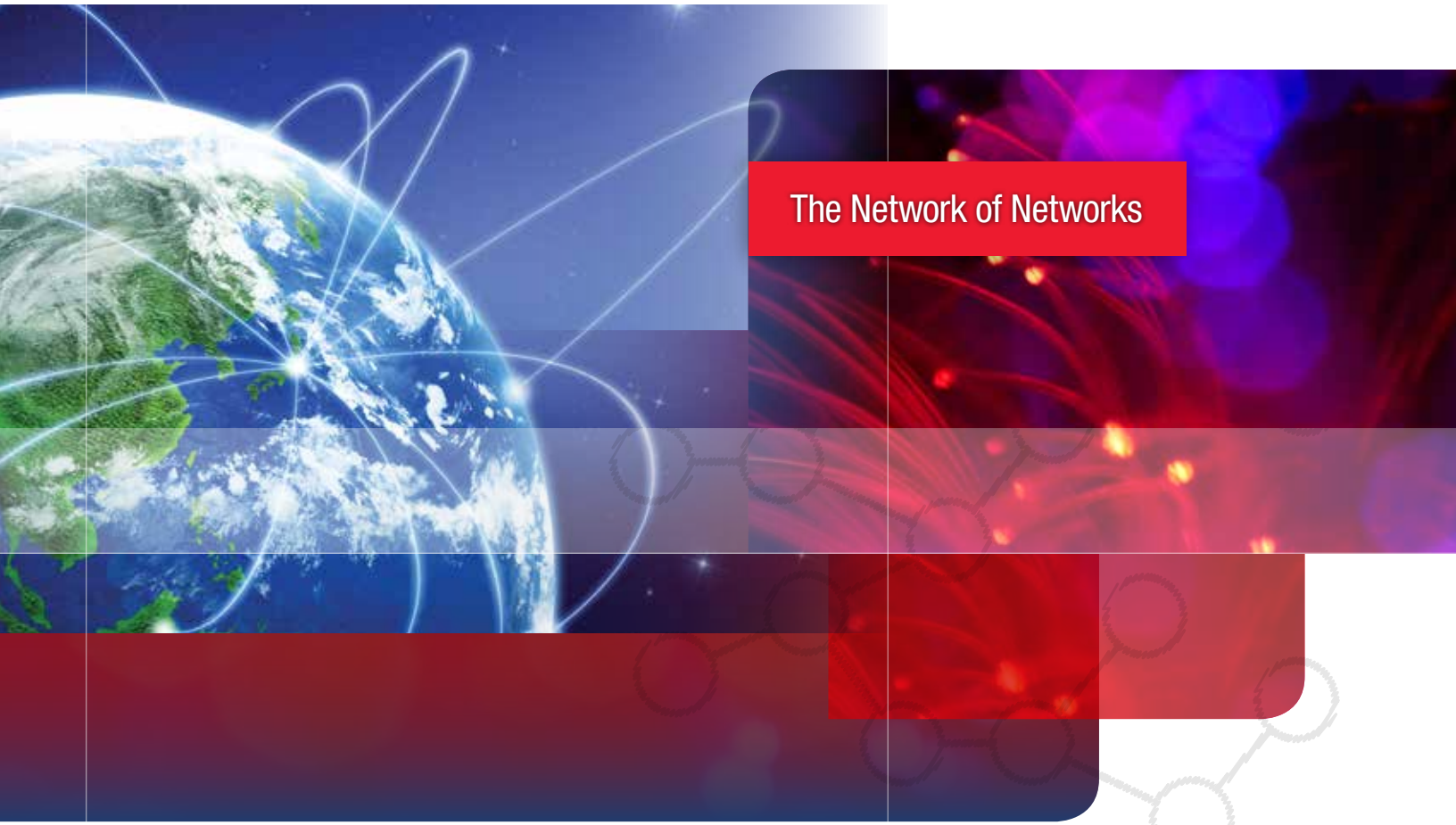
Fiber Management Solutions for the Cell Tower

Business White Paper



By Stephen C. King
Wireless Applications Engineer
3M Communication Markets Division

3M

Introduction

Fiber optic cable no longer stops at the base of the cell tower. As mobile communication network operators deploy advanced 3G and LTE/4G networks, many are pulling fiber right up the tower. Operators have found that fiber-to-the-antenna (FTTA) architectures offer a number of advantages over legacy coaxial systems, including improved signal integrity, capacity gains, smaller site footprint and significantly lower energy consumption.

However, with the benefits come new challenges. FTTA architectures call for more active components on the tower, resulting in new types of cables to manage, connect and protect. Not all traditional tower connectivity solutions are applicable to FTTA systems.

A newly developed family of tower terminals was specifically designed to meet the challenges of FTTA installations. The new terminals offer a number of advantages over traditional solutions and can help operators simplify cable management on the tower, provide reserve capability for future needs and decrease operating expenses.

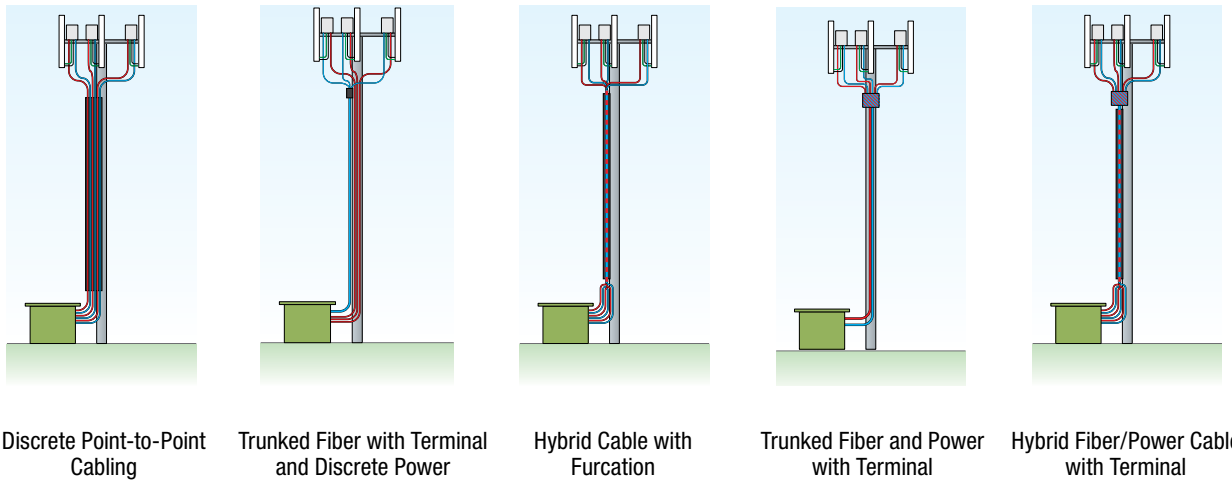
The Emergence of FTTA

The relentless demand for increased wireless network capacity and service reliability has driven the shift from coaxial-based systems to fiber-based FTTA architectures. New antenna technologies such as multiple-in-multiple-out (MIMO) coupled with problematic frequency mixing issues such as passive intermodulation (PIM) distortion make high-capacity wireless communications through coaxial cables difficult, if not impossible, to sustain. FTTA also offers improved energy efficiency, potentially lowering operating costs for mobile network operators. These factors, along with the decreasing cost of fiber optics, have driven the emergence of FTTA architectures.

- **Better signal integrity:** As much as 50 percent of the radio frequency (RF) signal can be lost between the radio and antenna in coaxial-based tower systems, according to many industry estimates. FTTA systems use fiber feeder cables for communication between the ground-based controllers and the tower-mounted radios. Optical loss in these digital communication links is insignificant. The tower-mounted remote radio units (RRUs) connect to their antennas through short coaxial jumper cables. Signal loss is minimized because the RF signal only travels a short distance over the coax.
- **Increased capacity and coverage:** Remote radio units often support advanced antenna techniques such as 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 and power cables are much thinner and lighter than coaxial feeder cable. A fiber-fed system lessens—or at least doesn't add to—coaxial congestion, reducing physical complexity and minimizing visual impact. Also, the removal of the inefficient RF power amplifier and its associated cooling system decreases the need for a shelter or a large equipment storage cabinet to house the base band unit at the bottom of the tower.
- **Increased energy efficiency:** FTTA systems can significantly decrease a cell site's energy consumption. RF power amplifiers and cooling systems are the main power thieves in coax-based cabling systems. In FTTA systems, power amplifiers sit on the tower nearer the antenna instead of at the base, so less power escapes along the cable. And, tower-mounted radios are cooled by ambient air flow, decreasing or eliminating the need for active cooling systems and saving operators as much as 25 percent in energy costs.[1]

Cable Management Challenges on the Tower

FTTA cabling architectures differ, but they generally consist of a base band unit (BBU) at the bottom of the tower and multiple fiber-fed remote radio units (RRUs) up the mast. Discrete, trunked or hybrid fiber and power cables run up the tower to the RRUs, which support advanced technologies, such as LTE/4G. Standard half-inch coaxial jumpers connect each RRU to one or more antennas.



Common FTTA cabling architectures.

First-generation FTTA architectures use point-to-point fiber and power cables installed separately on the tower. One fiber and one power cable runs directly from the BBU to each RRU. The initial deployment cost of this cabling method is relatively low, but it provides little flexibility for expansion because new power and fiber cables must be installed every time equipment is added to the tower. As the number of radios grows, this approach becomes more expensive than other alternatives because of the cost of installing, jacketing and reinforcing each individual cable. Also, damaged cables must be replaced in their entirety (as opposed to replacing a short jumper), potentially increasing operating costs.

Operators have learned that multiple-core, trunked fiber cabling and hybrid fiber-power cables can provide greater flexibility for future enhancements while potentially lowering capital expenditure and labor costs over time. However, unlike point-to-point cabling, trunked and hybrid cabling methods involve break-out points on the tower where individual fibers and power conductors split out from the cable to connect to each individual RRU. These vulnerable junctures must be managed and protected from weather in order to ensure reliable service.

Cable management solutions currently used on the tower often prove less than ideal for advanced FTTA systems. Traditional solutions include break-out boots with pre-stretched tubing and metal or plastic box-like enclosures. Break-out boots don't allow easy changes and maintenance (the boot must be cut off and replaced), and square boxes do not provide the most efficient effective projected area on the tower, paving the way for potential wind loading problems. Slack storage and robust cable retention can also be problems with these solutions, often requiring additional infrastructure or support to provide a complete solution.

Domed terminals provide an alternative that addresses many of the issues associated with more basic cable management methods. The rounded shape decreases effective projected area compared to boxes, lowering total tower wind load. They require no special tools, tapes or mastics for installation. And changes and maintenance are generally less expensive because only short jumper cables, leading from the terminal to the RRU, are typically added or replaced as opposed to replacing an entire feeder cable. However, not all products are equal. Most domes on the market today require a heavy mounting bracket and cable retention device, which can counteract any savings in footprint, and they can be clumsy to handle due to the need for tools and multiple parts that must be handled on the tower.

Solutions for FTTA Cable Management

New solutions in tower-mounted terminals have emerged to support varying FTTA architectures. The 3M™ Tower Dome Terminal product family for fiber and power cables provides solutions supporting common FTTA cabling architectures. The terminals are designed to simplify cable management, weatherproof sensitive connections, and enable plug-and-play installations, changes and maintenance. Incorporating the terminals into FTTA cabling designs can help reduce operating costs, improve network reliability, and create a more flexible system that can be easily grown and altered to meet evolving network demands.

3M Tower Dome Terminals offer the following advantages:

- Faster, easier installations and changes:
  - The terminal's External Cable Assembly Module (ECAM) system, designed by 3M, is optimized for true plug-and-play installation. The ECAM assembly allows cables to be prepared on the ground. On the tower, the ECAM assemblies containing the cables snap into the dome's terminal ports. Technicians spend less time in the air performing cumbersome tasks, such as sealing and securing cable ports.
  - A tool-less latching mechanism for the dome itself allows quick sealing and re-entry for easy installation and maintenance.
  - Dedicated jumper ports for each RRU allow the tower hand to add or replace the jumpers to one RRU without disturbing or breaking the seals of any other RRU jumpers.
- Supports network reliability:
  - The IP68-rated closure (with integrated, fixed O-ring) provides a highly reliable, weather-tight seal and reduces the chance of installation error. Designed to enhance performance and ensure signal integrity, the terminals reinforce standard fiber bend radius specifications. Separate fiber and power routing paths keep the feeders and jumpers apart to prevent interference and accidental damage to the fiber.
  - Optional sensors warn of intrusion or unacceptable moisture levels. With the inclusion of sensors, 3M is paving the way for intelligent passive infrastructure to provide network operators with information about the state of their networks, enabling corrective action before failures occur.

Installation of 3M™ External Cable Assembly Module (ECAM) 27 mm.

- Decreased tower load:
  - The terminals require a smaller, lighter mounting bracket than many competitive dome terminals. The terminal's ECAM assembly incorporates a torsion-spring design with a pull-out force of 100 pounds, enabling the low-profile bracket and virtually eliminating the need for external cable retention hardware. The terminals offer a special combination of pullout strength and excellent sealing to ensure a simpler, more robust tower installation.
  - Integrated slack storage virtually eliminates the need for a separate housing for excess cable. The terminals can provide slack storage for up to 16 meters of 5 mm fiber cable per eight-inch dome or 60 meters of 5 mm fiber cable per 10-inch dome.
- Greater system flexibility:
  - Modular DIN-rail design allows the addition of a mix of power components, including surge protection devices, terminal blocks and circuit breakers.
  - The terminals can store and protect unused fiber and power conductors for later use.

A Terminal for Every FTTA Application

The 3M™ Tower Dome Terminal product family offers a group of solutions for common FTTA cabling applications.

Trunked Fiber and Discrete Power

3M Tower Dome Terminals for fiber are designed for use with FTTA architectures fed by a trunked fiber cable and separate, point-to-point power cables. The fiber feeder terminates in the dome terminal, and fiber feeders connect the terminal to each RRU. The terminals can accommodate up to nine RRUs and fiber feeder cables up to 25 mm O.D.

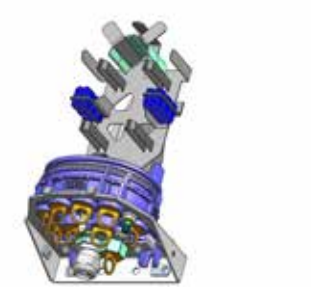
3M Tower Dome Terminals for power are designed to complement the tower fiber terminals. Optimized for power cable routing and incorporating a DIN rail for mounting power components, such as surge protection devices, circuit breakers and terminal blocks, these compact units provide an excellent alternative for completely separated fiber and power FTTA architectures.

Ultra Compact Designs

3M Tower Dome Terminal compact solutions are designed for quick, three-sector installations. They offer minimal footprint with complete FTTA power and fiber connectivity support for up to three RRUs. Incorporating an industry-standard DIN rail for flexible power management and up to eight duplex LC adapters for fiber feeder connectivity, these ultra-low profile domes embody minimal size and maximum functionality.

Trunked Fiber and Power Cables

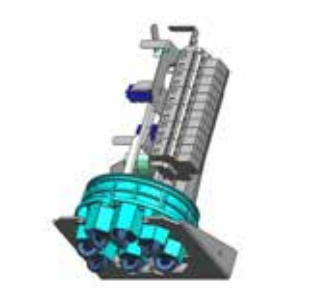
3M Tower Dome Terminals for fiber and power support tower architectures with separate trunked, multi-core fiber and power feeder cables. Both feeders terminate in the same housing to reduce footprint and tower load. Physical separation of the fiber and power connections helps ensure minimum crossover and maximum access security. These larger terminals support power and fiber for up to six RRUs.



3M™ Tower Dome Terminal for fiber only.

3M™ Tower Dome Terminal for power only.

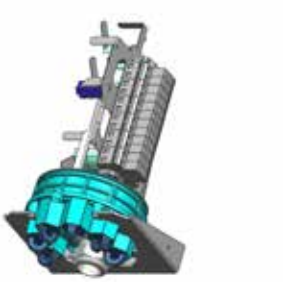
3M™ Tower Dome Terminals are unique for their compact design.



3M™ Tower Dome Terminal for fiber and power.

Hybrid Cable

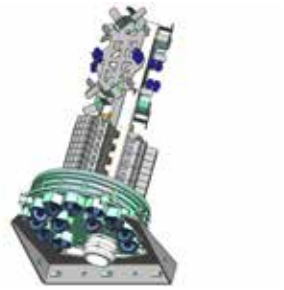
3M Tower Dome Terminals for hybrid cable are designed specifically for use with hybrid fiber-power cable. The connector field in the housing terminates all the fibers and power conductors in the hybrid construction and provides slack storage. Optional power connection and surge protection devices can be added on the industry standard DIN rail. The terminals can accommodate up to six RRUs. They also support many emerging tower architectures, such as coax reuse and active antenna systems as well as roof-top configurations.



3M™ Tower Dome Terminal for hybrid cable.

Multi-Sector/High RRU Count

3M Tower Dome Terminals for high RRU counts are designed for lower effective projected area and higher connection and port density, supporting up to 12 RRUs. This configuration supports dense coverage models where four sectors with three radios each are used. The radial design improves installation access and serviceability while maintaining minimum overall size. For areas where service continuity is a primary consideration while new radio technologies are added, the multi-sector terminal, with its high port count, can be used to provide fiber and power feeds for both older and newer generation technologies simultaneously.



3M™ Tower Dome Terminal for high RRU count.

Conclusion

As wireless service migrates from 3G to LTE/4G, the future is fiber. 3M offers a full family of solutions for managing, connecting and protecting fiber and power cables at the cell site. 3M Tower Dome Terminals enable fast, easy installs and potentially substantial savings on labor, inventory, operating expenses and maintenance costs. No matter what the tower cabling system, 3M has a solution. Learn more about 3M Tower Solutions at 3M.com/Wireless.

[1]ATIS (Alliance for Telecommunications Industry Solutions) Report on Wireless Network Energy Efficiency, January 2010.

The Network of Networks

The 3M Network of Networks is a world leader in communication technology, connecting products, people and companies by harnessing the power of more than 45 technology platforms to create customer-centric innovations. From FTTX to xDSL to wireless. The Network of Networks connects smart grids to smart phones, wind farms to server farms, greenfield to brownfield, wireline to wireless and customers to their goals. To get the Network of Networks working for you, visit 3M.com/Telecom.

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

Warranty; Limited Remedy; Limited Liability.
This product will be free from defects in material and manufacture for a period of 12 months from the time of purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any loss or damage arising from this 3M product, whether indirect, special, incidental or consequential regardless of the legal theory asserted.**

Communication Markets Division
6801 River Place Blvd.
Austin, TX 78726-9000
800/426 8688
Fax 800/626 0329
www.3M.com/Telecom