Introduction

Given population density and economies of scale, the multi-dwelling unit (MDU) category of housing has long been identified as an important growth opportunity for communications services providers. Yet, a large portion of subscribers who reside in brownfield MDUs remain unconnected to high speed broadband service.

This white paper reviews the evolution of key network components that have influenced methods of bringing fiber optic media to the living unit. Further, the paper will present a full-fiber MDU broadband solution, developed by 3M, that helps resolve many of the challenges faced by service providers in delivering their product to consumers.

Barriers to Deploying Fiber in Brownfield MDUs

Increased engineering, longer installation times and higher costs associated with fiber deployment in brownfield MDUs have hindered and slowed the ability of service providers to fully realize the financial promise of the MDU category of housing. Deploying fiber in existing apartments and condominiums is challenging, on many fronts.

When it comes to existing MDUs, no two are alike and no single solution fits all. These basic truths can immediately create physical and financial impediments for service providers. Engineering challenges arise when attempting to retro-fit existing structures for fiber. They can slow the installation process and add to its cost.

Outside plant (OSP) solutions don’t translate easily into an MDU environment, where overcoming space restrictions and aesthetic objections are significant challenges. Older buildings are already wired with multiple cable media, creating congestion both in riser and horizontal applications.

Adding conduits and pulling new fiber cables within walls or above ceilings and creating new cable pathways add more cost. These necessary additions can also require access to customer living space prior to a service activation request, and some tenants or homeowners may perceive the service provider as unnecessarily intrusive.

Perhaps not surprisingly, building owners and homeowner associations (HOAs) have been barriers, too. They have been hesitant to approve installations of apparatus and cable that, due to aesthetics, might permanently reduce the value of their properties and homes. From a short-term perspective, building owners and HOAs understandably want to avoid construction noise and keep other disruptions to a minimum. Complaints from tenants and homeowners are not good for business.
Drop Cable Evolution

In MDUs, installing standard fiber cable within the acceptable bend radius limitations often proves difficult. The architecture of such buildings requires cable placement to accommodate more, tighter bends than other categories of housing. Standard singlemode fiber, due to its 30 mm minimum bend radius limitation, cannot be installed flush to the wall or baseboard tightly around corners, producing unsightly gaps. Also, technicians sometimes ignore the minimum bend requirement in order to get a job done quickly and/or improve installation aesthetics, and that kind of judgment call during installation can lead to service complaints.

In 2002, the first bend-insensitive fiber cable was launched in the U.S. It was capable of a 10 mm bend radius without affecting signal performance. Since then, manufacturers have improved upon first-generation bendable fiber, developing fiber with an allowable bend radius of 7.5 mm and even as little as 5 mm, which can easily achieve a tight, 90-degree bend.

Initially, the most common MDU bend-insensitive drop cable had a 3 mm cable jacket. These cable assemblies were produced at various lengths ranging from 50 to 200 feet and typically pre-connectorized on one end. Their size and ability to achieve bend radii as small as 7.5 mm made them rugged enough for use in MDU applications entailing multiple bends.

Demand led to the emergence of a 5 mm ultra bend-insensitive fiber (UBIF) drop cable. UBIF cables were quite rugged and could easily be stapled to walls for quick installation in apartments. But there were problems. The cables were impractical in settings where concrete walls existed. And although able to maintain an even tighter bend radius than their bend-insensitive brethren, UBIF cable drops were more bulky and difficult to conceal from consumers.

Cable Pathway Alternatives

In new construction, communications cables are planned for in advance and often hidden behind the walls of the building. Older buildings, however, require the creation of cable pathways for concealing cables for an aesthetically pleasing solutions for owners and tenants. Durable, long lasting installations and high-quality service are paramount. Plus, from a service provider perspective, these cable pathways must be cost-effective.

One common cable pathway creation method involves the use of rigid crown moldings off-set about one to two inches from the ceiling. This allows jacketed drop cables to be tucked behind them and concealed from view. While often the most aesthetically pleasing option, it is also one of the most costly and disruptive to install. See image to the right.
Another alternative is to use two-piece plastic square latch molding consisting of a base and a cover. These products are somewhat lower cost, but still require significant custom fitting during installation since the molding is sold in standard lengths. To place cables inside, removal and replacement of the covers is required. In a 300 foot or greater hallway, the time and effort involved is considerable. See an example of latch molding in the figure to the right.

The use of micro ducts behind walls and above ceilings is also a common method for concealing communications cables. Micro ducts first must be installed and later, cables fished or routed through them. Often times the use of micro ducts requires core drilling, the process of boring holes through one or multiple floors of a building. This is not only expensive and time consuming but, when done through stacked closets in multiple apartments on multiple floors, requires tenants to be at home during the installation process – an inconvenience. The benefit of micro duct, however, is that cables and the ducts can be almost completely concealed. See micro ducts placed in a riser closet to the right.

In each of the cable pathway solutions described above, the installation of cables involves a time-consuming, costly, two-step process that usually requires two installation crews – one to build the cable pathway and one to lay the cable. Most of the work involves carpentry, and can take a two-person crew an entire day or more to finish a single floor. The resulting costs can be enormous.

In other circumstances, particularly in apartments with more complex layouts consisting of a greater number of bends and turns, ultra bend-insensitive cables, capable of maintaining a bend radius as small as 5 mm (ITU G.657.B3), are often simply stapled to the walls. While generally considered optically acceptable if this classification of fiber is used, a special crowned staple is needed.

When it comes to existing MDUs, no two are alike and no single solution fits all.
And while stapling cables to walls is quick and easy, many apartment walls are concrete, making stapling virtually impossible. In general, stapling is noisy, creates dust, and looks industrial, at best. Visually, most high-end building owners and homeowners are unlikely to accept such a solution.

**Connectivity Methods**

For MDU applications, service providers have traditionally deployed either factory-terminated patch cords or fusion-spliced pigtails/connectors. Both of these technologies have excellent optical performance with good performance in the field after installation.

Patch cords are advantageous as a connectivity method because no tools or splices are required in the field to make the termination. Terminations are completed in the factory. The simple plug-n-play installation also minimizes the skill set required to make the connection, which can reduce installation time and labor costs.

But there are some potential downsides, including cable management issues, that can arise during deployment. These include the need for boxes to store cable slack, the requirement of carrying a wide variety of different cable lengths in inventory, and the possibility of discovering a particular cable is too short for the job once the installation is in progress. In addition, there is the potential for cable waste if a long patchcord is used on a much shorter job and increased installation time when a connector is damaged, which requires that the entire patch cord be replaced.

Fusion-spliced pigtails can alleviate these issues, but fusion splicing comes with its own challenges. Acquiring a fusion splice machine requires a rather large, up front expense, and specialized training and expertise is required to operate the equipment and perform the splices accurately and in a high quality manner. The fusion splicer also requires electrical power, a mandatory element that can often limit its use in places like MDU hallways where power outlets aren’t readily available.
Because of the expense and training required, not all technicians in the field may have a fusion splicer, which slows deployment and creates installation inefficiencies. Advancements in mechanical fiber connectivity have combined the fusion splicing benefits of field customized cable lengths and reduced cable inventory with a simple, easy-to-use tool set that is low cost.

Mechanical connectors are installed with a simple handheld tool that does not require an electrical power source. Terminating fiber cable using the connectors is fast, easy and requires little training. A single-fiber termination can be completed in less than three minutes with a no polish connector incorporating mechanical splice technology greatly decreasing installation time compared to fusion splicing.

Yet, mechanical splicing has not been popular because many providers share a concern that the index matching gel inside the splices can yellow or dry out, resulting in service failures. However, over the last 20 years, great strides have been made across the industry in improving gel performance and longevity. Testing shows that the gel can perform well in temperature extremes from -40 °F to 167 °F.

In fact, global service providers have deployed more than 20 million mechanical splices and connectors in indoor and outdoor environments with proven reliability. For these drop cable applications, mechanical splicing can reduce initial tool capital expenditures up to 90 percent, decrease installation time up to 50 percent, and decrease total installed costs up to 50 percent relative to fusion splicing.

**Introducing the 3M Total Package**

The 3M Total Package is the full-fiber MDU broadband solution for both inside and outside the living unit. It combines the 3M™ One Pass Mini Fiber Pathway for living units with the 3M™ One Pass Fiber Pathway hallway solution and is connected by the easy-to-install 3M™ No Polish Connector (NPC).

This solution simplifies the process of drop cable routing through MDU hallways and interior spaces. The 3M Total Package is a complete fiber-to-the-premises broadband solution.

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<tr>
<th>3M™ One Pass Fiber Pathway</th>
<th>3M™ No Polish Connector</th>
<th>3M™ One Pass Mini Fiber Pathway</th>
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<td>One crew to install one floor of fiber in just one pass for up to 35% in savings per floor.</td>
<td>Replaces the need for expensive fusion splicing machinery with a convenient, easy-to-use field termination that connects to each pathway in two minutes or less.</td>
<td>Like the One Pass hallway solution, the One Pass Mini, designed for use inside the apartment, is easy to install on virtually any wall surface – including painted concrete.</td>
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The 3M™ One Pass Fiber Pathway hallway solution is a flexible, adhesive-backed, surface-mount indoor drop cable and cable pathway system that is installed simultaneously in just one pass around the perimeter of an MDU hallway. The low-profile duct combines the pathway and fiber drop cable in one solution, eliminating the two-step process of building a cable pathway and pulling cable. This results in a savings to service providers of up to 35% per floor when compared with traditional raceway or crown molding methods.
Two-person crews easily install the system using a handheld, pole-mounted tool that removes the liner from the adhesive backing on the duct and places the pathway containing the internal fibers, all in one quick and easy motion. An exclusive 3M adhesive bonds the product to virtually any wall surface, including painted concrete. The duct itself is also paintable, allowing it to blend into just about any décor. Since adhesive is used to mount the pathway to the wall, installation is less disruptive than traditional methods. No stapling, hammering, sawing, or carpentry work is needed.

The 3M™ One Pass Duct is not required to be hidden inside conduit, riser, or plenum spaces. See the installation images to the right.

The 3M™ One Pass Fiber Pathway addresses many of the challenges of traditional horizontal optical cabling solutions. Because the pathway uses bend-insensitive 900 µm fiber as the medium to distribute fiber optic services, the pathway itself can be made smaller than traditional optical cable pathway solutions designed to contain multiple 2, 3 or 5 mm jacketed cables. This makes the system more discreet and less noticeable to tenants and homeowners.

The evolution of key network components has led to a game-changing solution that makes fiber-to-the-home deployment in brownfield multi-dwelling units fast, easy, and low cost.
3M™ One Pass Mini Fiber Pathway delivers triple-play services inside a residence and can be used with or without the 3M™ One Pass Fiber Pathway hallway solution. Like the One Pass hallway solution, it’s easy to install on virtually any wall surface, including painted concrete.

Because the fibers are factory-installed, installation of the 3M™ One Pass Pathways are completed in one simple step. Specially designed installation tools enable a quick, easy installation. Because adhesive is used to mount the pathway to the wall, installation is less disruptive than traditional methods.

**3M™ No Polish Connector Provides Speed, Flexibility, and Less Waste**

The 3M™ No Polish Connector consists of a factory polished connector assembly with an integrated mechanical splice, enabling fast, onsite installation of the 900 µm fiber. It utilizes a simple, low-cost, handheld tool that comes in every box of 60 connectors.
The connector performance is excellent, with a typical insertion loss less than 0.3 dB and reflections less than -60 dB. A proven solution for both indoor and outside use, the connector can be installed in temperatures from -23°F to 114°F and has been designed and tested to maintain stable optical performance from -40°F to 176°F.
Summary

As service providers increased their emphasis on passing MDUs with fiber optic services, suppliers responded with the evolution of key network components which in turn influenced FTTH deployment methods, specifically in brownfield MDUs. The evolution of key network components has led to a game-changing solution that makes fiber-to-the-home deployment in brownfield multi-dwelling units fast, easy, and low cost. Best of all, some solutions make it virtually invisible.

The 3M Total Package consists of product innovations that resolve pain points faced by service providers in delivering their products to consumers in a brownfield MDU environment. Installing 3M™ One Pass Fiber Pathways is almost as easy as placing adhesive tape. With the 3M™ No Polish Connector, connections are quick and easy.


The Network of Networks

The 3M Network of Networks is a world leader in communications 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.