eBook

Best Practice In-Building Fiber Installation

A Practical Guide for Network Operators and Installers

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Contents

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Introduction

The advantages of fiber optic cable over copper wire are well understood. Fiber can transfer more data, in less time, over longer distances than copper. It does not degrade like copper, requires little maintenance and loses only a fraction of its signal strength over 100 m or 300 ft.

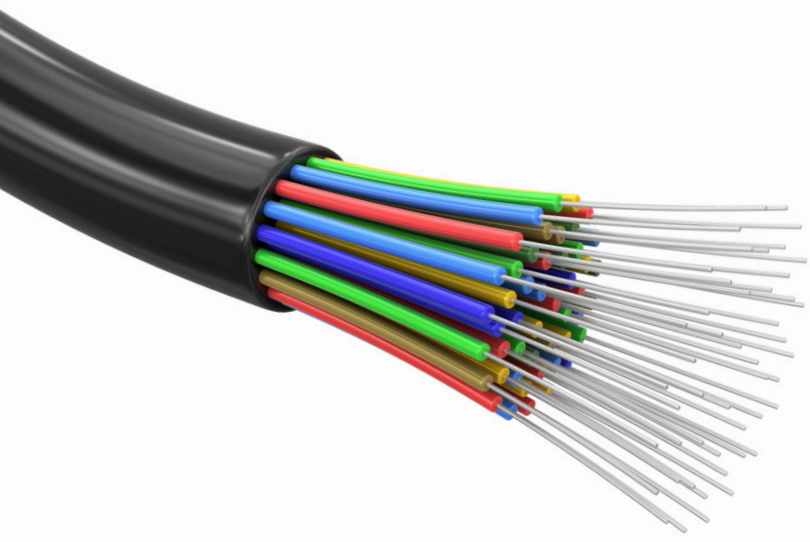
Although fiber is superior to copper in many respects, network operators were slow to embrace the technology. This has changed. The cables that lead from the cabinet to the premises are copper twisted pairs or coaxial cables. Most operators in these markets have chosen to take the interim step of installing fiber to the cabinet and copper/coaxial to the premises because performance is good enough in the early stages, and because it makes sense for them to maximize the value of the existing (and already paid for) infrastructure.

In addition, penetration rates for Fiber to the Premises (FTTP) projects can range from a low of 20 percent in the first few years of deployment to a high of 50 percent when deployments are completed. Over the past decade, cable and telecoms companies have had to operate in a tough, competitive environment. Few have been prepared to invest heavily in fiber or to write off their significant copper infrastructure assets.

Rising demand for superfast broadband

But the commercial landscape has shifted. Consumers demand faster Internet speeds, and this has caused operators to re-think their strategies. To a large extent, this demand is being fueled by video and music streaming services and over the top (OTT) bundles.

According to the Global Internet Phenomena report, Netflix and YouTube now account for 50% of downstream traffic during the peak part of the day in North America. With the growth of Ultra HD TV sets, 4K, and other technologies, this percentage is only likely to increase, particularly as a larger proportion of the content will be streamed rather than delivered through aerials or satellites.



Changing business practices will generate greater demand for fast broadband as information services and data usage continues to rise. Organizations have embraced Internet-based voice and video calling services such as Skype. This trend is likely to continue, with increasing demands for higher definition video solutions that offer a greater quality of service. Operators have also had to change their business models to cater to households with multiple high bandwidth users.

Far sighted network operators are also preparing for the Internet of Things. According to analysts at Gartner, the average family home will contain more than 500 smart, Internet-connected devices by 2022. While each device itself will use only a small amount of bandwidth, the cumulative effect will add to demands on capacity, particularly when combined with smartphones, tablets and PCs.

A growing urban class

In a previous eBook, we investigated the challenge of delivering fiber to a single home. However, a large percentage of FTTP users live in apartment blocks and work in multi-story offices. Over the coming years, their numbers are expected to swell as more people in the developing world move from rural to urban areas.

China is a good case in point. Just over 680 million Chinese citizens now live in cities – 51.27% of the total population. But within 20 years, 75% of the population is expected to be living in urban environments. As more of these migrants enter the middle class they are bound to demand high value services, including superfast broadband.

The purpose of this eBook is to outline the choices available to network operators that want to install fiber in apartment blocks and multi-story offices. There are typically three phases to installing fiber in a Multi-dwelling Unit (MDU) or commercial building. First, the fiber has to be taken from the curb into the building. Then it needs to be routed from the basement to each floor in the building. In the final phase – which is similar to the last drop in FTTP installations – the cable has to be brought into individual apartments. Different techniques can be applied at any stage in the process.

Over the coming pages we will investigate the pros and cons of each technique. Our intention is to give you a complete overview of the technical landscape so you can make the right choices for your business.

> “Within 20 years, 75% of the Chinese population will be living in urban environments.”

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Fiber to the Premises

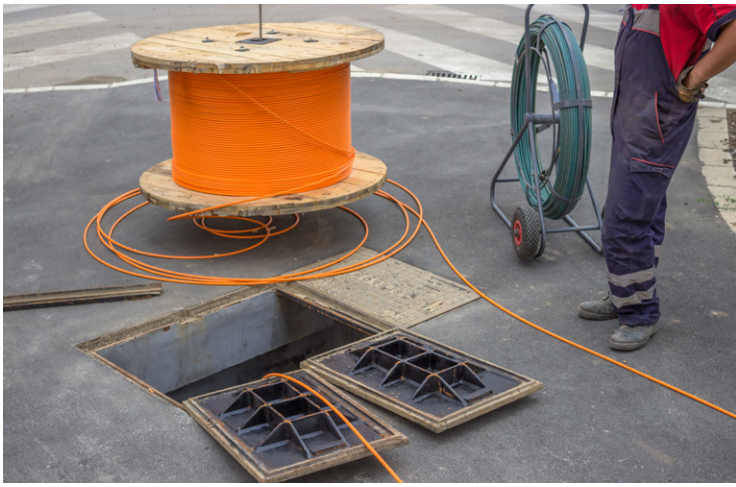
The first phase of an in-building fiber installation typically involves bringing fiber cable from the curb to an Outside Distribution Box.

In most cases, the fiber is then brought inside the building. However, in some parts of the world – like the Middle East – it is common practice for operators to install single fiber cables from the Outside Distribution Box directly to the individual apartments in Point-to-Point (P2P) cable runs through ducts and on the exterior walls of the building. The fiber is first connected to the Distribution Box. It is then inserted into an outdoor microduct, which is used to carry the fiber up the outside of the building into an individual apartment.

For apartment blocks with four to six apartments, or small commercial buildings with a few offices, the above P2P cable run system can be cost-effective. However, it is challenging and often not cost-effective to scale this method for medium and high density complexes. In these scenarios, the preferable method of installing fiber requires a staged approach throughout the building.

One potential downside of this approach is that it can require considerable upfront expenditure. Depending upon the architecture, Indoor Optical Distribution Boxes or Distribution Frames need to be purchased and installed. In most cases, floor level or buddy boxes have to be bought and positioned on separate floors. It is not uncommon for operators to spend many thousands of dollars on upfront equipment for an apartment block before signing up a single subscriber. However, in most cases, this method proves to be more economical than a P2P approach over the medium to long term.

> “For medium and high density complexes, point-to-point installations are not cost effective.”



> “The preferable method for bigger buildings takes a staged approach, bringing fiber into the building, then each floor, then into each apartment.”

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Taking the Cable Inside

To get fiber into a premises, a cable has to be routed from the point of presence (the Outside Distribution Box, in this instance) into the building through the wall, and plugged into a further distribution box or distribution frame in the basement or a comms room.

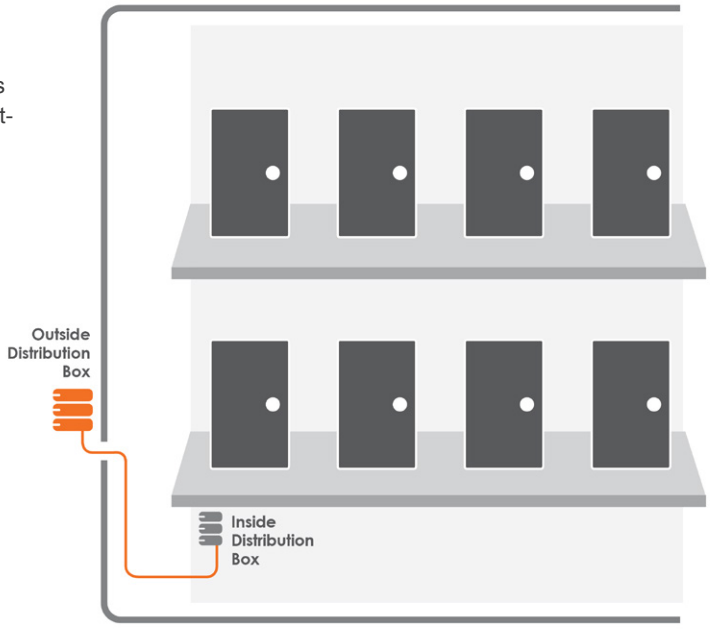
It is good practice to use cable that is UV resistant and suitable for deployment indoors. Most optical fiber regulations allow for a short length of outdoor rated UV cable to be installed within a building (check local regulations) of between 2 to 15 m (7 to 49 ft), however if the cable needs to be routed further in order to reach the distribution box or frame, then a suitable LSZH, flame retardant or indoor rated conduit/ microduct should be used (varies according to region).

There are a number of benefits to having the fiber distribution point inside a building. First of all, it extends the network lifecycle by increasing its protection – the fiber terminals and other passive equipment are no longer at risk of being damaged by harsh weather, negligence or vandalism.

Secondly, it speeds up the whole process of installation. As we shall see later in this paper, it is common practice for network operators to route fiber cable from the basement of an apartment or office block up to floor boxes on each landing. This allows operators to break out fiber quickly and cost-effectively when a resident demands it.

Choosing cable connectors irrespective of whether the network architecture is PON, P2P, or some other configuration, once the fibers have been brought onto the distribution frame (or, for small scale MDUs, the distribution box), they will then need to be connectorized.

The most popular connectors used here are SC and LC with angled end faces, however with larger buildings the scope for multi- ferrule connectors such as the MTP / MPO becomes more attractive - particularly in multi-floor P2P scenarios where each floor level box connects up to 12 subscribers. For further analysis on connector options, see “Fiber Connectors – what’s the difference.”



At this point it is worth looking at the different ways in which operators can connect the distribution box or frame to the floor level boxes. There are three main options available. Operators can use pre-terminated indoor drop cables; use mechanical or fusion splice connectors, or thirdly they can fusion splice onto pigtails. Each method has its positives and negatives.

Many small to medium network operators choose to use pre-terminated cable because it eliminates the capital expenditure, cost and required skills for time-consuming fusion splicing. As it is factory fitted and tested, a pre-terminated cable offers good, certified signal performance and, on top of this, no specialist staff or equipment is needed to install the product. However, the main drawback to using pre-terminated cable is that there may be excess cable during installation that needs to be coiled and stored within the route, although if a proper site survey has been conducted this can be kept to a minimum.

There has been a rapid expansion in the use of mechanical and fusion splice connectors in recent years. This is due to the lower initial capital expenditure (mechanical only) compared to fusion splicing. The major disadvantage to using the mechanical connector is the high signal losses in comparison with fusion spliced or polished fiber connections.

Fusion splice connectors offer better performance verses mechanical splice connectors but will require an expensive machine and the necessary components to adapt that machine to accept fusion connectors. Added to this, the technician needs to validate field-assembled connectors using a suitable ODTR or light source and power meter, which adds extra time to the process.

Fiber will inevitably need some form of connector at the end, capable of repeat mating and with an outer protection rugged enough to allow repeat patching and switching. Splicing on pigtails therefore fulfils the networkability requirement but can add a vulnerable weak spot to the network; therefore operator are advised to source only high quality pigtails if they choose this approach.

Increasingly operators are using pre-terminated cable in multiple dwelling installations to remove weak spots, as well as the requirement for highly trained engineers, and to reduce installation times. As the uptake of FTTP services increases, the demand for efficient, effective and high quality solutions will equally start to drive the business case.

> “Many small to medium sized network operators choose to use pre-terminated cable because it eliminates cost and required skills for splicing.”

SC

MTP/MPO

LC

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Fiber to the Floor

There is an important preliminary step that every installer needs to navigate before they can bring fiber into an apartment.

They have to find some means of getting the fiber cable from the basement of the building to each floor. In new build apartment blocks and commercial buildings, this step is relatively straightforward as usually the architect will have designed the building with fiber in mind and installed a microduct from the basement to each of the floors. The network operator then has the option of blowing, pushing or pulling the fiber cable from the basement to each floor.

However, there are pros and cons to each approach. Blown fiber is a tried and tested method but is certainly not optimized for in-building deployments. Heavy gasoline driven compressors are not ideal in basement applications and some developers simply don't allow compressed air, which might carry dirt and water, to be blown into their buildings. The advantage with blowing, of course, is distance. In some high-rise deployments it may be the only viable option.

	New Duct		Existing Duct		Populated		None		Max Installation Distances
	Time	Cost	Time	Cost	Time	Cost	Time	Cost	
Pushed (hand)	🕒🕒	$	🕒🕒	$	🕒🕒	$			25-100m
	no tools, no skills		no tools, no skills		no tools, no skills, distance < 25m				
Pulled	🕒🕒	$	🕒🕒	$	🕒🕒🕒	$$			25-500m
	no tools, no skills, pull-cord can be specified		no tools, no skills, but pull-cord may not be present		some tools, no skills, rod/fish tape pre-install				
Pushed (machine)	🕒	$$$	🕒	$$$					50-300m
	Machine required, can be air assisted		Machine required, can be air assisted						
Blown	🕒🕒🕒	$$$$	🕒🕒🕒	$$$$					<1km
	specialized tools and skills required		specialized tools and skills required						
Drop							🕒🕒	$$	<1km
							basic tools and skills required		

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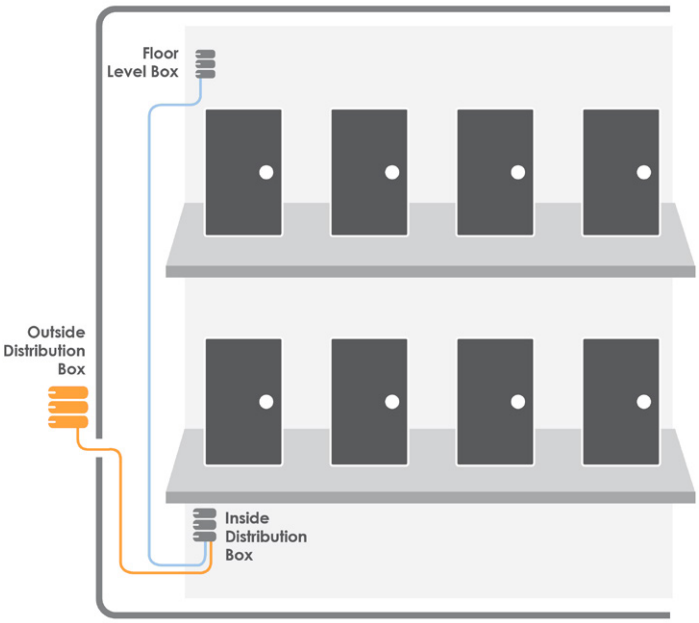
Pullable cable is a cost-effective option because it requires little extra equipment and has a proven track record in most regions. However, it is a labor-intensive practice unless a pull-cord is already in place. Some installers adopt a cable rodding approach, which despite working well is prone to over-stressing the cable. Damage to the fiber can be caused by excessive tensile load being placed on the cable during the pulling process. The cable can also be damaged by encounters with obstacles along the route.

Pushable cable can be pushed manually up to 100 m (328 ft) or further using inexpensive pushing equipment. If done in conjunction with pre-termination, the process is quick and efficient (See 'Solving the Fiber to the Premises Challenge with Pushable Fiber' eBook for further details).

In older buildings, there may only be PVC electrical conduits in place. In most instances they are pre-populated with other types of existing infrastructure. While a well-routed microduct path might allow 50 to 100 m (164 to 328 ft) of cable to be pushed and/or pulled through it, a congested and ill-planned conduit might only accept 15 to 25 m (49 to 82 ft) of cable inside. And sometimes there will be no obvious means of getting the fiber to the floor at all. So what options do operators have in these circumstances?

In this situation, or when there is no pre-existing infrastructure in place to transport the cable, operators should use whatever spaces are available in the building. There might be an elevator shaft to which the cable can be dropped down from the floors above. Or it may be possible to tack or glue the cable to walls, ceilings and plenum spaces. A slightly more aesthetic approach is to use cable trunking or to otherwise hide the cable wherever possible.



> "Pullable cable is a cost-effective option because it requires little extra equipment and has a proven track record. However, it is a labor-intensive practice unless a pull-cord is already in place."

Meeting fire protection regulations

Whatever type of cable is used for this stage of an in-building installation it needs to meet local fire regulations. Fire regulations for fiber cable protection vary across the world, meaning that a cable suitable for use indoors in one country may very well not be allowed in the same building structure elsewhere in the world.

The U.S. approach is based on the idea that it is better to control the release of heat since this causes fire to spread. Therefore the primary requirement for fiber cables is that they shouldn't propagate fire and can self-extinguish. In Europe, controlling smoke density and toxicity is often believed to be more important than flame propagation.

Installers should check the fire regulations wherever they are operating before installing fiber in a building. Failing a building inspection can prove costly both in money and reputation.

Routing cable to a floor level box

Whether the cable is routed through an existing conduit or not, it will invariably terminate at a box on the floor. Again, network operators then have the choice of splicing fibers at the box or using a pre-terminated wall box. As we saw in the previous section, there are positives and negatives to each approach.

Whether the network architecture demands one or more fibers per dwelling or inversely, multiple occupants are allocated to a single fiber, generally the same rules and constraints apply in terms of routing these cables to the floor boxes and then onto subsequent customer Optical Network Terminal (ONT).

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Fiber to Apartment or Office

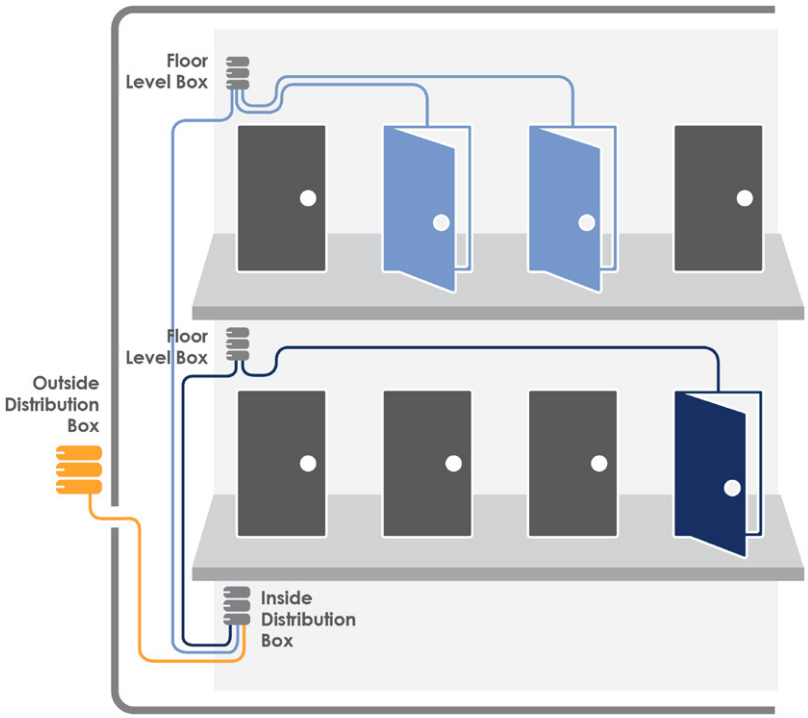
There are several viable options that work for the last leg of an in-building fiber installation project – namely direct fixing, pulling and pushing.

In select cases, blowing may be an option if there is a duct leading from the floor into each apartment. However, very few apartment or office blocks have this kind of infrastructure in place and it may not be an acceptable install method for reasons mentioned previously.

It is also possible to use a pull-back method to connect each room. This involves deploying a multi-fiber feeder cable from the comms room in the basement, up to each floor and then along the corridor/ hallway, passing each room. The feeder cable can then be window-cut and a single 900u fiber accessed, for onward routing to each subscriber/user.

Although the pull-back approach is space efficient and can negate the need for floor boxes, it still requires a skilled technician to handle the bare fiber, which is manually pulled out of the cable and threaded though into the dwelling space via a lead-in access box.

Once installed, the fiber will then require field termination. The pull-back method is therefore better suited for applications where skilled labor is available and a fast installation time is not critical. The comparative cost is also high, both in terms of labor, equipment and fiber wastage.



Blowing fiber may be an option if there is duct leading into each apartment. However, very few apartment or office blocks have this kind of infrastructure in place and it may not be an acceptable install method for reasons mentioned previously.

For pulling, the ideal scenario is to source microducts with pulling rope or cord pre-installed. In this case the cable is simply tied to the pull-cord or secured inside a pulling sock before being pulled through the microduct. Pulling is often preferred by installers because it's quick and reliable, with comparable distances to blown fiber and none of the mess.

Failing a pull-cord being present, a conduit must first be rodded before the cable can be pulled. This can be a lengthy process because the rod has to push past obstacles in the conduit before it can be attached to the cable, effectively enacting twice the installation time and effort in a push and pull process.

> "With pushing, the cable should be flexible enough to push around corners yet stiff enough not to buckle. In many respects, pushing is much simpler - there is only one step in the process."

With pushing, the selected cable should be flexible enough to push around corners, yet stiff enough not to buckle in long routes where high levels of friction are generated. In many respects, pushing is much simpler – there is only one step in the process. In addition, pushing the cable into a microduct or conduit applies zero tensile load to the cable, reducing the instances of damaged cable or strained fiber.

When rodding/ pulling seems like the only option, pushing can be a viable alternative solution, provided the cable has the right characteristics. It may take one to two hours for an operator to rod a conduit and pull cable from the floor into an apartment.

The same operation will take a fraction of the time with pushing. One network operator was able to save more than 45 minutes per installation per apartment using pushable cable in a recent project in Qatar. Over ten buildings, they were able to save in excess of 2,200 hours – equivalent to 93 days.

The Final Connection

The final step of the process involves connecting the fiber to the media-converting equipment in the apartment.

Typically, the fiber has been pushed, pulled or fixed as far as a wall box terminal in the apartment or office entrance. If the fiber has been pre-terminated (e.g. with a SC/APC connector) it will then simply connect to the service provider's equipment (media gateway) either directly of via a short fiber patch lead. If the fiber is bare however, it will first require the splice technician once more, to furnish the fiber with what is typically an SC or LC format connector. From there the data is translated by the gateway into a range of different signals for both copper and wireless communications used in and around the home or office.

If the preferred location for the gateway is not where the fiber has currently been installed to, a longer patch cord can be used to move the point of presence, often referred to as the Optical Network Terminal (ONT). Depending on the application this might involve installing the patch cable within existing conduit beneath wall screeds, routing it inside capping or trunking or even fixing it directly to the wall. Reasons for repositioning the gateway are typically aesthetic but can vary widely, including instances where there are no power sockets near or around the standard telecommunications wall box terminal (gateways require a DC power supply).

If the fiber cable has been pre-terminated, particularly with a pushable connector; the cable can quickly and easily be pushed the short distance to the gateway location. In such instances the primary wall plate can be used as a slack storage box for the pre-terminated cable, solving the problem of excess fiber and allowing for margin of error in the preliminary site survey.

> "Reasons for repositioning the gateway are typically aesthetic but can vary widely, including lack of nearby power sockets."

Conclusion

The global market for FTTP is far from mature. In the European Union, there are currently 20 million FTTP subscribers in a continent of more than 500 million people. In the developing world, operators are bypassing the copper stage and moving straight to fiber deployment for their new networks. And in the Middle East, the scale of building is accelerating, with whole new cities springing up in many countries. Fiber is an integral part of these new builds, providing residents and companies with high-speed access to services, from video on demand to IPTV.

Many of these new networks are being installed in multi-story offices and apartment blocks right now. We hope this guide has given you a comprehensive overview of the challenges involved in installing fiber in a MDU or office complex.

In-building fiber installations don't need to be painful experiences. If managed properly, they can be carried out quickly and cost-effectively with minimum disruption to the customer. Most importantly, they can deliver what an operator values most – a genuine return on investment.

If speed is of the essence, then whichever installation method is chosen, the cable type will invariably be pre-terminated at one or both ends. In reality, the time spent managing and splicing fibers in each and every dwelling, and potentially further connectorization after that (such as patch cord links to active equipment) will be the rollout bottleneck.

> "In-building fiber installations don't need to be painful experiences. If managed properly, they can be carried out quickly and cost-effectively with minimum disruption to the customer.

About PPC

PPC is a global leader in connective technology. We're committed to innovation, value, quality and reliability, and are dedicated to bringing new and enhanced products to market.

We have manufacturing locations spanning five continents and boast a diverse product portfolio that supports network architectures and applications from the headend to the premises. Through our focus on innovation for more than 75 years, we have delivered a number of industry firsts and hold more patents in connector technology than any other company worldwide.

If you would like to discuss any of the topics in this eBook, please contact us directly.

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