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Practical FTTx Approaches with Aerial Fiber Cable

A Guide for Network Operators and Installers

Introduction

Demand for fiber optic technology has never been higher. Between now and 2019, the fiber optic market is expected to grow at a Compound Annual Growth Rate (CAGR) of 5.1 per cent - to reach a value of $3bn. This demand is being largely fuelled by consumers' demand for real-time entertainment, delivered through video and music streaming services like Netflix and iTunes.

According to the Global Internet Phenomena report, **streaming audio and video now accounts for 71 per cent of evening traffic in North American fixed access networks.** Netflix alone accounts for 35.2 per cent of traffic on fixed networks.

And these figures are only likely to increase, as more and more content is streamed rather than delivered through aerials or satellites.

In developing parts of the world, such as Africa, fiber is enabling economic growth. It is allowing people to start and expand their own businesses, sign up for educational courses and learn vital skills to improve their lives, as well as giving them the chance to communicate using free voice over IP (VoIP) services such as Skype.

This growing demand for fiber has put added pressure on network planners and installers. Today's network operators are focused on delivering fiber quickly and cost-effectively - using existing networks wherever possible.

When it comes to deploying buried fiber, challenging geography and crowded (or non-existent) underground infrastructure can often impede progress.

For example, a network operator may need to deal with ground that is undulating, rocky, or both. Or it might find itself in the position of rolling out fiber across a municipality that has no underground telecoms duct network, but is littered with buried routes for electricity, water, sewage, transportation, and other primary infrastructure.

And in some instances, network operators simply don't have the budget for the equipment needed for landscaping and digging trenches.

However, they may have access to a network of existing poles.

A faster, more cost-efficient option

Increasingly, network operators are using aerial cable to address these challenges head-on. Aerial is one of the most cost-effective ways of deploying cable. Instead of digging up roads to bury cables or ducts, operators can use existing pole infrastructures to install cable across urban or rural areas.

Even when faced with no infrastructure, the experience in parts of **Sub Saharan Africa** suggests it can be more cost-beneficial to install and own the pole infrastructure when compared to the costs of going subterranean. Coupled with the fact that aerial cable is typically faster than other options on the market, it is no wonder that over **80 per cent** of FTTx rollouts rely on aerial deployments in some form.

Aerial fiber was the **first choice for British Telecom** (BT) when it began a five-year project in 2010, to roll out high speed broadband to the county of Cornwall in the United Kingdom. Instead of burying cable underground, BT opted to use a 36 fiber, ultra-lightweight aerial cable that could be strung onto existing poles without any additional work. It also chose to use aerial drop duct to blow fiber from the cabinet to the premises.

According to **research from Plymouth University**, more than 12,000 Cornish companies are now connected to the high-speed network, resulting in 2,000 new jobs being created and a further 2,500 safeguarded. When the research was published in July 2015, 95 per cent of Cornwall and the Isles of Scilly had access to fiber.

▼ Over 80 per cent of FTTx rollouts rely on aerial deployments in some form

BT's project in Cornwall vividly illustrates the benefits of aerial cable from both an operator and consumer perspective. In this eBook, we will look at the factors affecting the use of aerial cable, the installation methods available to network operators, and the pros and cons of using particular types of aerial cable - so you can decide whether this solution is right for your business.

Factors Affecting the Use of Aerial Cable

There are a number of factors that affect the deployment of aerial cable. Let's take a look at each of them in turn.

Infrastructure

Each country will have its own regulations, codes, standards and wayleave laws but, generally speaking, before a network operator can install aerial cable, it has to determine whether there are utility poles available in the area that it is surveying. If no poles are present, it will need to talk to the local authority to find out whether or not it is prepared to allow construction. At the same time, the operator will have to evaluate whether it has the budget for a pole installation programme.

If there are existing poles available, the planning team will need to contact the owner to see if they are willing to allow use of their infrastructure. In some cases, the owner will be happy to give the go ahead in return for a fee. In other instances, the poles will be owned by a rival operator, who may not be willing to give access to a competitor.

This outlines just one reason why network regulators play such a crucial role in deciding what is fair and how best to protect infrastructure access. Determining who owns what and how best to access it can seem like no mean feat, so operators will often use consultants to find local policies and relevant directives. In the EU, for example, much of the decision making is driven by the **Digital Agenda for Europe**.

The challenge of dealing with shared access to infrastructure is one that is familiar to the Irish Government. It currently has an ambitious **National Broadband Plan (NBP)** to provide broadband services to 900,000 homes and businesses in rural areas. However, if similar projects in other countries are any measure, the Irish government will struggle to move the plan forward. Putting together an infrastructure database can be an extremely costly exercise. In addition, ensuring co-operation from infrastructure owners is not always straightforward. In many cases, there is no incentive for incumbent infrastructure owners to proactively open their networks to other firms. This may well prove to be the case in Ireland. If the NBP is to be a success in the long term, bidders will have to know what capacity is available on the network and whether or not they can access it, otherwise the programme will fail to gain any traction.

Cost calculations

Then there is the whole matter of cost. If an operator is leasing capacity on someone else's pole network, it will need to get an exact breakdown of costs. It may be the case that the owner only requires a one-off payment. Alternatively, the owner may demand an annual payment over a period of several years. Even if these costs are manageable, the operator will also have to consider maintenance costs when making their calculations.

Lastly, operators need to take into account the challenges posed by different forms of infrastructure. If the existing infrastructure already supports power lines, for example, the operator may need to avoid a cable with metallic support members and instead use one constructed with dielectric materials.

We will look later at the different types of cable available on the market and the locations in which they can be used.

Insight

The Irish Government currently has an ambitious National Broadband Plan (NBP) to provide broadband services to 900,000 homes and businesses in rural areas

▼ A network operator has to determine whether there are utility poles available or not; and if they can use them

Environmental factors

In aerial plant, changes in environmental conditions occur throughout the service life of the cable. Wind and ice loads, as well as seasonal temperature variations, can cause the cable to expand and contract, applying variable forces on the fibers. This is in marked contrast to buried and underground cables where the most severe load a cable is likely to experience is usually applied during installation.

There are a number of factors that can be impacted by environmental conditions. These include:

Tensile strength

Aerial cables are required to be incredibly strong, often with cable specifications calling for minimum tensile loads in the thousands of Newton. Different countries around the world, and different incumbent telecommunication operators, have also adopted their own legislation and specifications covering the breaking strain of the cable.

In the United States, for example, the design of overhead lines is covered by Section 25 of the National Electric Safety Code (NESC). This code divides the country into three storm-load districts – heavy, medium and light – based on the expected ice, wind and thermal loads on aerial cables. Cables used in these districts must have high tensile load strengths, so that they remain on the pole even in the harshest weather conditions.

However, despite the attractiveness of a cable with huge tensile load strength, the perceived benefits need to be weighted against the consequences of things such as vehicle impacts - in which case the cable will likely need replacing whether it is still operational or not.

Operators may also want to avoid damage to other poles in their infrastructure. For example, BT's cables are designed to break at a specific load, so that if a lorry or bus does catch the cable, it will not slice through the vehicle and won't pull down subsequent poles.

Static fatigue

Aerial fiber is also susceptible to static fatigue or the growth of cracks. In order to overcome the effects of cracking, it is advisable to use a cable from a reputable manufacturer who employs only the highest grades of medium or high density polyethylene. The sheath should have a grade that is suitable for outdoor use and provide 20 to 40 years' service life.

In addition, aerial cables must be resistant to the aging effects of the sun and will therefore require an additive to protect them from UV degradation.

Fiber strain

Another hazard for aerial cables is fiber strain. Strains large enough to damage the fibers can occur without any apparent damage to the cable or supporting structure. To avoid this, installers must adhere to the manufacturer's guidelines in terms of recommended cable sag and

tension. Such data can also be calculated using lineman software, allowing the operator to input specific environmental factors such as location, temperature, height of poles and span distances.

For example, the International Electrotechnical Commission (IEC) standard IEC 60794-4-20 states that fiber strain on ADSS optical cables should not be more than 33 per cent of the one per cent proof strain. The IEC also states that the attenuation change should not exceed 0.15dB on a wavelength of 1550nm.

However, it is worth noting that this standard relates only to ADSS optical cable. Network planners and installers are advised to consult with industry and government bodies about all of the fiber strain standards in their localities prior to implementation.

Other factors

Network installers and planners should be aware of other, less obvious factors before embarking on an aerial fiber deployment.

There are unique things that need to be considered when installing fiber on a power line; there are also issues that arise from wildlife damage; and there are factors involving cable break away limits that need to be assessed before any rollout.

At times, operators will have no option but to install aerial cable in an environment that contains power lines. In this situation, network installers have no choice but to use cables that are resistant to electricity. There is a specific type of cable that fits this profile – all-dielectric self supporting (ADSS) cable. This can be placed on transmission lines, enabling the re-use of existing poles, which helps reduce installation costs and speeds up deployments. It should be noted, however, that operators are under an obligation to consult with and abide by the regulations of local authorities and utility providers when planning this kind of installation.

Animals as diverse as squirrels, cicadas, ants and woodpeckers can cause damage to aerial cable. Operators should take counter measures to ensure that their infrastructure is not damaged by wildlife.

Besides damage from wildlife, operators need to be aware of cable break away limits when planning aerial implementations. Different countries will have different policies in this area and it is worth checking with local regulators and incumbent operators on the situation. For example, in the US, lower ultimate tensile strengths and clean-breaking cables are not typically required and network planners aim to save the cable in favour of breaking the pole or other infrastructure.

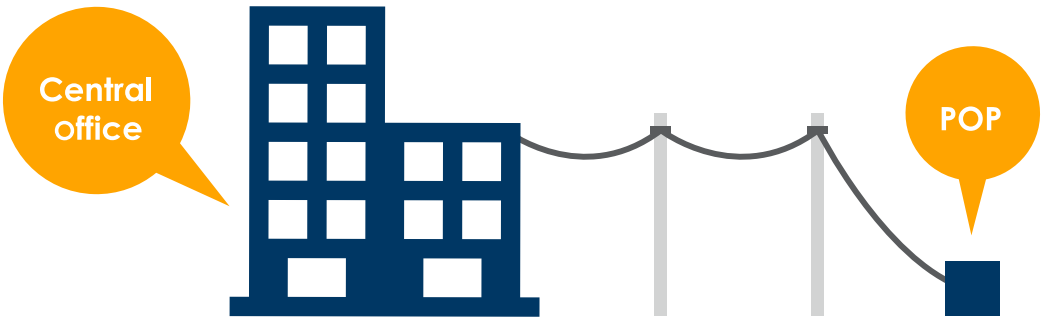
Finally, operators need to take into account local planning permission factors. In some countries, local authorities won't allow aerial cables beyond a certain diameter to be installed as they are deemed to be unsightly.

Use of Aerial Cable in the Network

Aerial cable can be used right across a telecommunications network. It can be used separately in the backbone, the last mile, the last drop or in any combination of these.

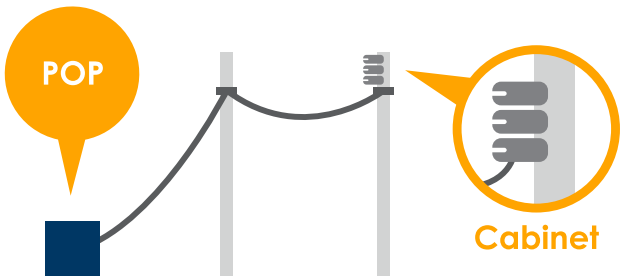
The backbone

The backbone is a large transmission line that carries data gathered from smaller lines that interconnect with it. At the local level, a backbone is a line or set of lines that local area networks connect to for a wide area network connection.



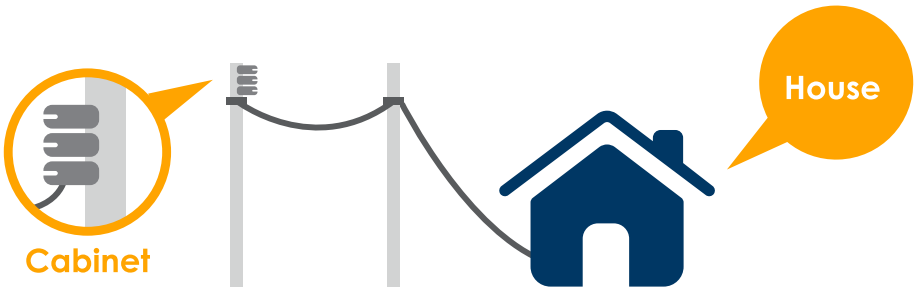
The last mile

The last mile refers to the connection from the exchange throughout the local area, connecting up street cabinets and ultimately homes and businesses.



The last drop

The specific connection from the cabinet or curb to the individual premise is often referred to as the "last drop."



Installing Aerial Cable

Before an operator embarks on an aerial cable installation, it should instruct its engineering and construction staff to carry out a thorough survey of the route.

Route surveying will dictate the most suitable installation method for the site, as well as the necessary equipment and materials. Representatives of each organisation potentially affected by the installation should be present during the route survey.

Once the site survey has been completed, the network operator should ensure that the right-of-way is free of obstacles like guy wires and trees. In all likelihood, the operator will also need to set up equipment on private property. It is essential for the operator to obtain permission from property owners and authorities before taking any action.

Working with optical fiber requires specific skills and training - and performing that work at height is no exception. Aerial linemen should not only be competent and safe at height work, but they should also have permits for working near electricity cables and in a range of weather environments. Having a good understanding of the nature of the aerial environment and the additional precautions it demands will also stand them in good stead. Some of these factors include cable sag, strain, tension, galloping and aeolian vibration – but they are not limited to this list.

Training for telecommunications engineers can be performed in-house but is most likely to be provided by a specialist training body who meets the national requirements, or is accountable to the authorising body in that region. Failure to verify that the appropriate level of training has been attained will prohibit any access to the aerial architecture and, if not properly dealt with, might incur fines, delays and even prohibition orders. Network operators must both do their homework and respect the laws of the land before making any assumptions about the intended aerial installation.

Insight

Some of the factors affecting aerial deployment include cable sag, strain, tension, galloping and aeolian vibration

▼ A good understanding of the nature of the aerial environment and the additional precautions it demands will stand aerial linemen in good stead

Stationary reel placing method

Providing permission is granted, the operator can move to the next stage of installation. At this point, they will need to decide whether they want to install the cable using moving reels or fixed reels.

The stationary reel placing method is generally used when cable is installed above existing lateral cable and other obstructions. The choice may also depend on the types of vehicles and placing equipment that are available to the installer.

First of all, a series of temporary cable supports, chutes or tangent blocks are installed at each pole along the route. Next, a pull line is threaded through the cable supports and attached to the outside of the cable using a breakaway swivel and a cable pulling grip. The pull line is then used to pull the cable through the cable blocks into position.

If the cable is pulled with a winch, the pulling rope or winch line must be installed through the cable supports. A non-metallic rope or winch line should then be used to pull the cable.

It is vital that the pulling winch be calibrated to stop the operation when the installation tension exceeds the maximum rated cable load (MRCL). If this type of winch isn't available, a dynamometer can be used to monitor installation tension. The dynamometer must be equipped with an audible alarm or visual display that allows the pulling operation to be stopped when the installation tension reaches the MRCL.

After the cable has been pulled into its final position with slack for building access or for splicing, the cable should be tensioned until the correct sag level is reached. It should then be terminated at each dead-end pole along the route.

Insight

A pulling winch must be calibrated to stop the operation when the installation tension exceeds the maximum rated cable load (MRCL)

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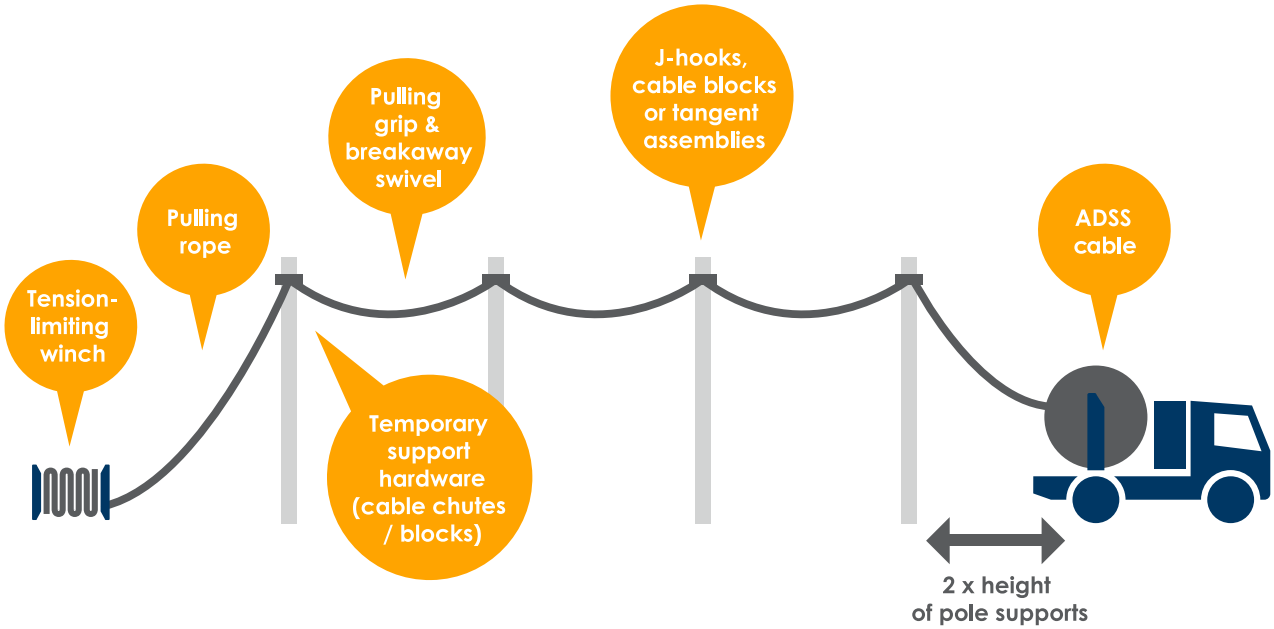
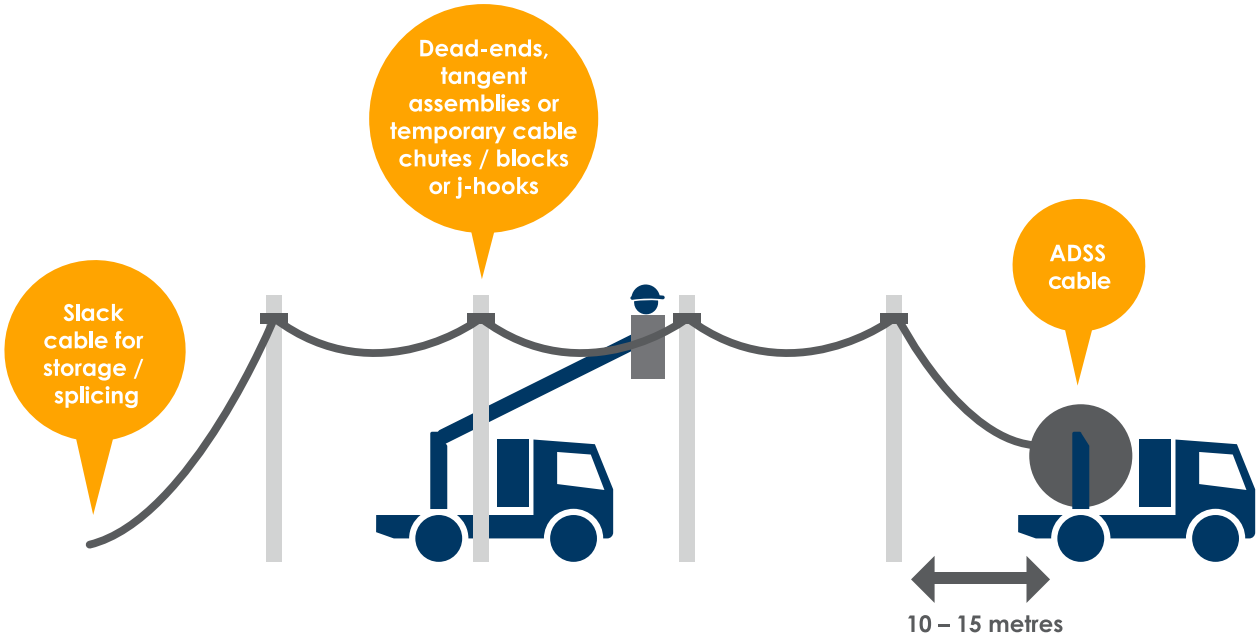




Moving reel placing method

The moving reel method can be used in situations where a cable reel trailer or aerial lift truck can be moved along the pole line and there are no obstructions to prevent raising the cable. It should be noted that the moving reel method is a one-pass operation and does not require the use of cable blocks or pull lines.

In the first place, the cable reel should be mounted on a reel carrier off a cable trailer or aerial line truck. Next, the reel carrier should be driven along the cable route. As it advances along the route, the cable ought to be paid off the reel with no back tension on the reel, guided to the pole, and supported with appropriate hardware.

When using the moving reel method, operators must ensure that the aerial line truck or cable truck is about 10 to 15 metres ahead of the first pole position. This ensures that there is sufficient slack cable available for splicing and slack storage.

During the operation, the installer should fit the appropriate dead-end support to the cable, raise it to the correct support level and mount the dead-end to the pole.

The placing vehicle must then be driven parallel to and as close to the pole line as possible, while maintaining constant speed and tension. Once the cable pay-off is 10-15 metres past the next pole in the route, the cable should be raised to the required pole height and placed into a J hook or temporary support.

The cable installation should then continue span by span until the entire run is completed and the final dead-end pole has been reached. At this point the cable should be tensioned to the correct sag level using suitable chain hoist equipment at the "free" end of the cable, before it is dead-ended to the pole.

Once this has been done, the cable can be lifted out of the temporary J hooks or temporary supports and permanently fixed using tangent assemblies.

▼ The moving reel method is a one-pass operation and does not require the use of cable blocks or pull lines

The selection of attachment hardware for aerial cable is vast and solutions exist to reduce vibration, coil excess cable, to provide mid-span drops and tangent support. Perhaps the most widely used hardware though, will be the dead-end attachments. Broadly speaking, this category can be split between a formed wire design and the wedge anchor clamp type.

The formed wire dead-ends function by gripping the cable uniformly over the length of the support, typically two to four feet in length. For this reason they are often seen as the strongest solution for long spans. The alternative wedge clamp dead-end works by anchoring the cable between opposing wedge blocks, gripping a shorter distance of cable; perhaps only six to 12 inches. Wedge supports are perhaps better suited to scenarios where strain is less of an issue and spans and below 300ft.

The other major factors in selecting the correct attachments include, but are not limited to:

- Can it be metal or is an all dielectric design required?
- What is the span distance between attachments?
- Are there specific loading requirements - e.g. wind/ice?
- What is the outer diameter of the cable being supported?
- What size is the overall budget for pole attachments?
- Is space prohibitive at the pole head?

Cable termination

Aerial cable is no different from other fiber cables when it comes to termination, and can be field spliced or deployed pre-terminated. Each method has its pros and cons. For the last drop especially, many network operators choose to use pre-terminated aerial cable because it eliminates the need for time-consuming and expensive fusion splicing. The main drawback to using pre-terminated cable is that there is almost always excess cable left over from installations.

▼ Aerial cable can be field spliced or deployed pre-terminated

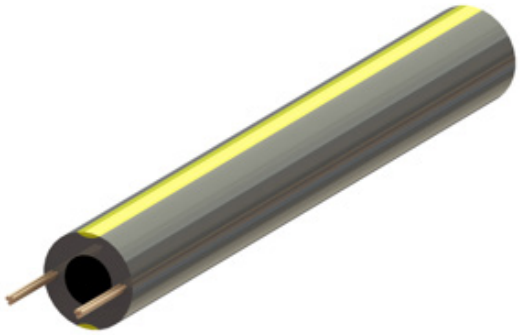
Fusion splicing offers a high quality connection and little excess cable is left over once the process is complete. However, it is a time-consuming process and specialist equipment and experienced engineers are needed to carry it out. The whole process of preparing and splicing the fibers is made more difficult when the network access point is mounted at pole height.

Cable Considerations

We've examined the environmental and infrastructural factors that affect aerial cable usage. And we've looked at the different installation methods available to operators. But there is one factor that we haven't considered yet – cable type.

There are a wide variety of cables that can be used in aerial deployments. Each type has its strengths and weaknesses. Some cables are particularly robust and capable of withstanding extremes in temperature. Others are lightweight and easy to install. The construction of the cable will also vary from a loose tube or tight buffered design.

Let's take a closer look at the main cable types.



Blown fiber

A considerable proportion of fiber to the home (FTTH) is installed by blowing. The technique involves using compressed air to blow a fiber or a cable down a small duct. Blowing fiber is popular because it is a fast process, and the blown fiber can be installed over great distances.

However, the costs involved in using blown fiber can be comparatively high because a microduct must be deployed before the fiber can be blown. The additional time and cost of using a blowing head and compressor makes this an unattractive solution for most operators unless they have their own plant or equipment.

Following the microduct and fiber deployment, the fibers must be spliced by a trained optical engineer, which, again, can consume time based on availability. Blowing fiber certainly still has benefits. And if the planner is looking to build a future-proof network where fibers can be more easily replaced with minimum disruption, a cable in duct solution would be the best option.

Pushable fiber

Similar to blown fiber, this is a two stage installation process that first requires microduct to be installed using one of the two methods outlined above. It is the second stage where the cost comparisons can be made, since the fiber is pushed or pulled rather than air blown. Installation speeds are comparable to blown fiber, ranging from between 20 to 50 feet per minute by hand, or with the aid of an electric pushing machine, in excess of 100 feet per minute.

Insight

Some cables are particularly robust and capable of withstanding extremes in temperature

▼ There are a wide variety of cables that can be used in aerial deployments and each type has its strengths and weaknesses

In FTTH installations it is also possible to pre-terminate a connector onto the pushable fiber cable, reducing the need to splice the fiber at both ends of the drop cable. This has the potential to reduce installation costs, as well as rollout speeds in instances where one or two fibers would traditionally need field splicing.

On the downside, pushable fiber is only really suited to last drops and short metropolitan area networks. If there is slack cable left after deployment, it may need to be managed. And it can take longer than other options to deploy because there are two distinct installation phases - albeit the skill requirement is greatly reduced.

Constructed cables

Sometimes operators want to use aerial cables with high fiber counts. In these instances, the most common approach is to use a constructed cable, either loose tube or tight buffered. Both types have a similar design, utilising either a figure-of-eight messenger support or a central strength member, surrounded by fiber tubes or buffers with a skin of black polyethylene. Manufacturers may also include ripcords, steel armouring and other features to make installations easier.

However, constructed cables are large, stiff and inflexible, which may cause difficulties in certain installations. For final drops and other instances where accessing and terminating the fiber needs to be quick and easy, they are ill-suited.

Cables with integrated strength members

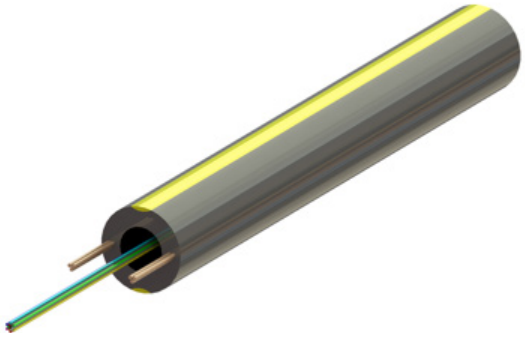
As previously noted, aerial cables are subject to tensile loads, static fatigue and fiber strain. In a bid to counteract these factors, some manufacturers have produced cables with integrated strength members. Incorporating tensile reinforcing rods often mean that the cable design is "flat", or with a central reinforcing element, separate to the cable sheath.

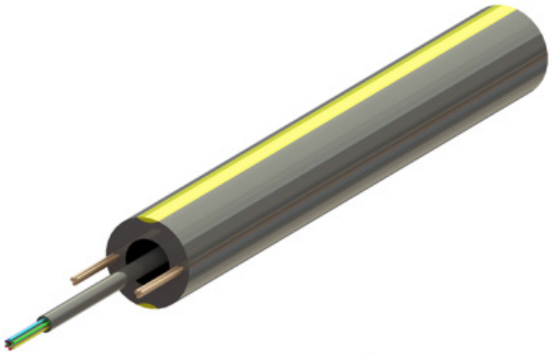
This adds new challenges to fiber termination and supporting the cable. Thankfully, some manufacturers have incorporated the strength rods inside the sheath wall (jacket), allowing the cable to be suspended using standard "round" termination and supporting accessories. Cable and duct designs with this feature are not prone to splitting; where the strength element becomes detached from the main sheath and the tensile integrity is compromised.

Insight

Pushable fiber is suited to last drops and short metropolitan area networks

▼ Aerial cables are subject to tensile loads, static fatigue and fiber strain





Loose tube cables

Loose tube cables are highly suited to long deployments, up to and beyond what is traditionally feasible with blown fiber. Depending upon the pay-off capabilities of the installation crews and the landscape, continuous lengths of 30,000 feet (+ 5 miles) are not uncommon. This makes aerial loose tube fiber cable ideal for building backbone networks or long metropolitan area trunk lines.

Compared to cable in duct practices, a loose tube cable will be faster to deploy, since it requires just one truck roll. However, as with blown fiber, the cable will still need preparation and field splicing. Unlike pushable fiber, it is not compatible with pre-termination because the arrangement of the loose tubes does not support industry standard connectorisation.

Tight buffered cables

These typically follow the same design and construction as loose tube cables, with the obvious exception that the fiber sets (normally 12 fibers each) are sheathed and not able to move freely. However, the fibers will be at higher risk once the cable is stripped for termination. As with pushable cables, tight buffered drops can be ordered pre-terminated. Unfortunately, tight buffered cables are not best suited to long hauls (over 1km) since the processing of the fibers can potentially add stress to the glass. It is therefore a viable and cost-effective alternative for metropolitan area or FTTH drop cables but less suitable for backbone fiber.

Insight

Aerial tight buffered cable is a viable and cost-effective alternative for metropolitan area or FTTH drop cables but less suitable for backbone fiber

▼ Aerial loose tube fiber cable is ideal for building backbone networks or long metropolitan area trunk lines

Conclusion

Aerial deployments are on the rise across the globe as consumer demand increases and operators seek to offer faster fiber networks in response – in a way that is timely and cost-effective.

However, these deployments require careful planning if they are to be successful and fulfil requirements.

Network planners and installers need to take into account a range of environmental and infrastructural factors when planning a deployment, while potential damage from birds and other creatures should also be factored into the equation.

Different installation methods need to be investigated. And, lastly - but most importantly - the right type of cable needs to be selected for the job.

But providing these factors are adequately addressed, aerial fiber can offer network operators an economical solution that can be deployed relatively quickly - with an immediate return on their investment.

Insight

Aerial deployments are on the rise across the globe as consumer demand increases and operators seek to offer faster fiber networks in response

▼ **Aerial fiber can offer network operators a timely and cost-effective solution**

About PPC

PPC is a global leader in connective technology with a worldwide reputation for technical leadership. We have developed many industry firsts including pushable fiber, universal crimp and compression connectors, continuity connectors, integrated weather sealing connectors, among our many innovations.

As a Belden brand, PPC also accesses Belden's powerful position within the signal transmission solutions space to offer a very unique end-to-end solution to its customers.

If you would like to discuss your FTTx challenge or any of the topics in this eBook, please contact us directly. We'd be delighted to hear from you.

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