White Paper: Innovative FTTH Deployment Technologies

By the Deployment & Operations Committee

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Fibre to the Home Council Europe

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Introduction

The pace of investment in fibre access networks in Europe has been relatively slow, especially compared to other regions in the world such as Asia Pacific, Middle East and North America. The business case can be particularly difficult to put together in countries that typically have high costs for new network construction.

The debate isn't about whether a fibre to the home network is the best choice – everyone agrees that it is the ideal technological solution. The debate now centres on how to build a network that isn't too costly to deploy or operate.

The investment required can vary considerably depending on the geography being served. Sparsely populated rural areas are the most expensive to connect, because of the long distances to homes. Urban environments are more densely populated, but they also present construction challenges, especially where there is limited space in existing duct infrastructure.

Regardless of geography, the construction (or civil works as they are often called) is the most expensive part of the project. Some estimates put it as high as 80 percent of the overall cost. The construction work therefore offers the greatest scope for reducing the cost of building the network.

The construction costs are loaded into the early years of the business plan. Reducing the construction costs will make the business case more attractive to investors, which will in turn speed up the pace of FTTH deployment.

In this paper we consider innovative methods and equipment that can reduce FTTH deployment costs. The word "Innovative" suggests alternative methods that are being used by the few rather than the many. The deployment methods, equipment, and products described in this paper are not yet in widespread use – although that may well change with time.

Over the last few years, alternatives to traditional trenching methods have emerged. Some, such as micro-trenching and directional drilling, have quickly become accepted and are already considered part of the arsenal of "standard" techniques.

The alternative construction techniques and equipment described in this paper can lower the construction costs of the optical distribution network (i.e. the part of the network outside the home or building). In each case, we shall explain the technique or equipment and identify its advantages and limitations.

The most obvious way to reduce the scope of civil works is to use existing buried infrastructure, such as the duct network of the incumbent operator. In practice, duct sharing has been deployed less often than one might expect, and its application is still quite novel in many countries. We look at the situation in France to see how duct sharing has been enabled there.

Infrastructure belonging to other utilities, such as the sewer system, gas main or water pipes, also provides possibilities for infrastructure sharing both in the feeder part of the network and in the final drop to homes. A method even exists to re-use coaxial cables as conduit for optical fibre.

The speed and ease of installation also has a bearing on the project costs. New equipment has been developed that makes it possible to install cable into ducts more quickly using fewer engineers. Innovative components enable swift installation of ducts, branches and connectors to high standards but without specialised tools.

Finally, we consider a project in a rural area where several novel ideas were applied. These included avoiding construction in highways altogether, instead opting for trenching in farmers' fields, and a self-install pack for the customer, who must make the final connection from a boundary box at the edge of the property to the home itself.

A selection of innovative techniques and equipment will be described, but it is not intended to be comprehensive. For a more complete and thorough overview of the subject of FTTH deployment, please see the FTTH Handbook, also produced by the Deployment & Operations Committee of the FTTH Council Europe.

While cost of fibre deployment is only one aspect of the business case, it is an important one. Reducing the cost of deployment could dramatically speed up the pace of FTTH roll out in Europe.

Innovative Infrastructure Sharing

Duct sharing in France

The sharing of the duct and pole infrastructure of the incumbent telecom operator is an obvious way to drive down the roll out cost of FTTH networks.

In France, the regulatory authority defined rules for duct sharing, and the access process was agreed in 2008. Since then the main alternative operators – Free, SFR, and Numericable – have stopped all civil works to create their own duct infrastructure and started to deploy their cables in the ducts belonging to the incumbent operator Orange (France Telecom).

There are two principles to be observed: cables from different operators in the same duct must be physically separated (which requires sub ducting), and the operator who deploys a cable needs to guarantee there is enough remaining capacity in a given duct section so that his competitor can deploy a cable of the same size in the same section.

Since several operators are now using a duct infrastructure that originally was designed for only one operator, it is important to use the remaining duct capacity in the most efficient way. The fee for renting duct space from Orange is directly correlated with the cross-sectional area of the cable that is installed. This drives alternative operators to use smaller cables that take up less space.

In duct sections with limited remaining space, flexible textile sub ducts can be used. Flexible textile inner ducts take up three times less space than rigid inner ducts, which maximises the number of cables that can be installed. Flexible inner ducts can also be used where rigid ones would normally be used but have failed during installation because the duct was filled with dirt or partially crushed.

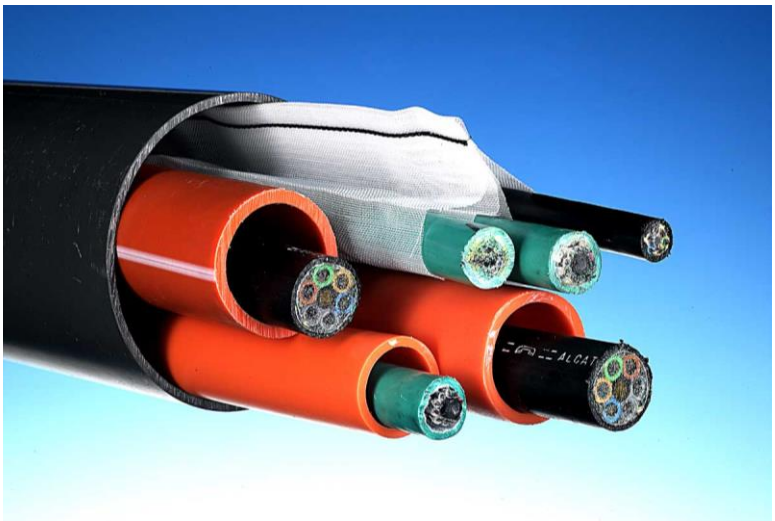

Figure 1: Flexible inner ducts maximize the use of duct space.

In the picture (previous page) is a 100-mm inner diameter duct containing three rigid sub ducts designed to hold three cables, but with a lot of wasted space. The use of flexible inner duct makes it possible to add more cables to this already congested duct -- three in this case, from three alternative operators. Without flexible inner ducts this duct would be full.

It is estimated that about €2.5 billion was saved over five years by eliminating civil works for new cables in France, and similar savings could be made in the coming five years. The huge cost savings from duct sharing can dramatically improve the return on investment for FTTH projects. In some cases projects have been executed that would otherwise not have been possible.

Although duct sharing is possible in most of European countries and billions in savings could be realized, as they have been in France, the approach is not widely used. The key factors which resulted in general acceptance and the adoption of infrastructure sharing in France were the French government's clear vision about the need for ultra-high-speed broadband networks and an empowered, independent telecom regulator, ARCEP, which facilitated the whole process and watched over the feasibility and technical and financial balance of the agreement.

Sewer pipes

Waste water pipes are virtually ubiquitous. In the Netherlands, nearly 99% of the population is connected to urban waste water treatment. Other European countries, such as Austria, Germany, Spain and the UK, have connected more than 90% of their populations to waste water treatment. Using the existing sewer system to install fibre-optic cables, it is possible to reach more residents. Sewers are also buried deeply in the ground, making them less vulnerable to accidental damage.

The idea is not exactly new, with robots installing cables in the sewers under Tokyo as far back as 1987 – originally to connect sewer management systems. Today, municipalities are increasingly interested in using sewer management systems to control remote parts of the system, and see some benefit from the installation of fibre-optic cables in their sewer systems. In addition, during the construction process, errors in the sewer system can be detected and mapped.

There are constraints, of course. The installation must be designed not to impede the flow of waste water, and the materials used in the installation must be resistant to toxic gases. The installation also has to withstand traditional sewer cleaning methods. Cable laying equipment may need to pass corners and joints in the sewer system.

Figure 2: The fibre cable is floated through the sewer system on water pressure (10 bar).

Drinking water pipes

Installing cables in the domestic water supply is not a new idea either. Water companies have also put control and data cables inside their drinking and waste water pipes to create networks for their own use. But they did it without publicity – to avoid any public resistance. With the advance of FTTH, there has been a demand for new subterranean paths for the optical distribution network.

Two tools have been developed in Europe over the last few years to install fibre-optic cable in domestic water pipes. These systems provide cost-effective and environmentally friendly ways to run fibre-optic cables through the existing water pipes. Both systems require special adaptors to be installed at the start and end access points in the water supply pipe. Microduct is then installed between the two fittings, creating a gas-tight environment in which fibre can be inserted without coming into direct contact with the water supply.

The first system requires two small access holes to be dug, one at the demarcation point in the footway or road and one at the property wall. Short sections of pipe are removed and replaced by new 'Y'-shaped branches. The branch fittings use standard plumbing screw-fit connections, allowing rapid installation with no special tools. Microduct with 5-mm diameter is then inserted between the two branch fittings, providing a gas-tight route through which fibre-optic cable can be blown either immediately or at a future date.

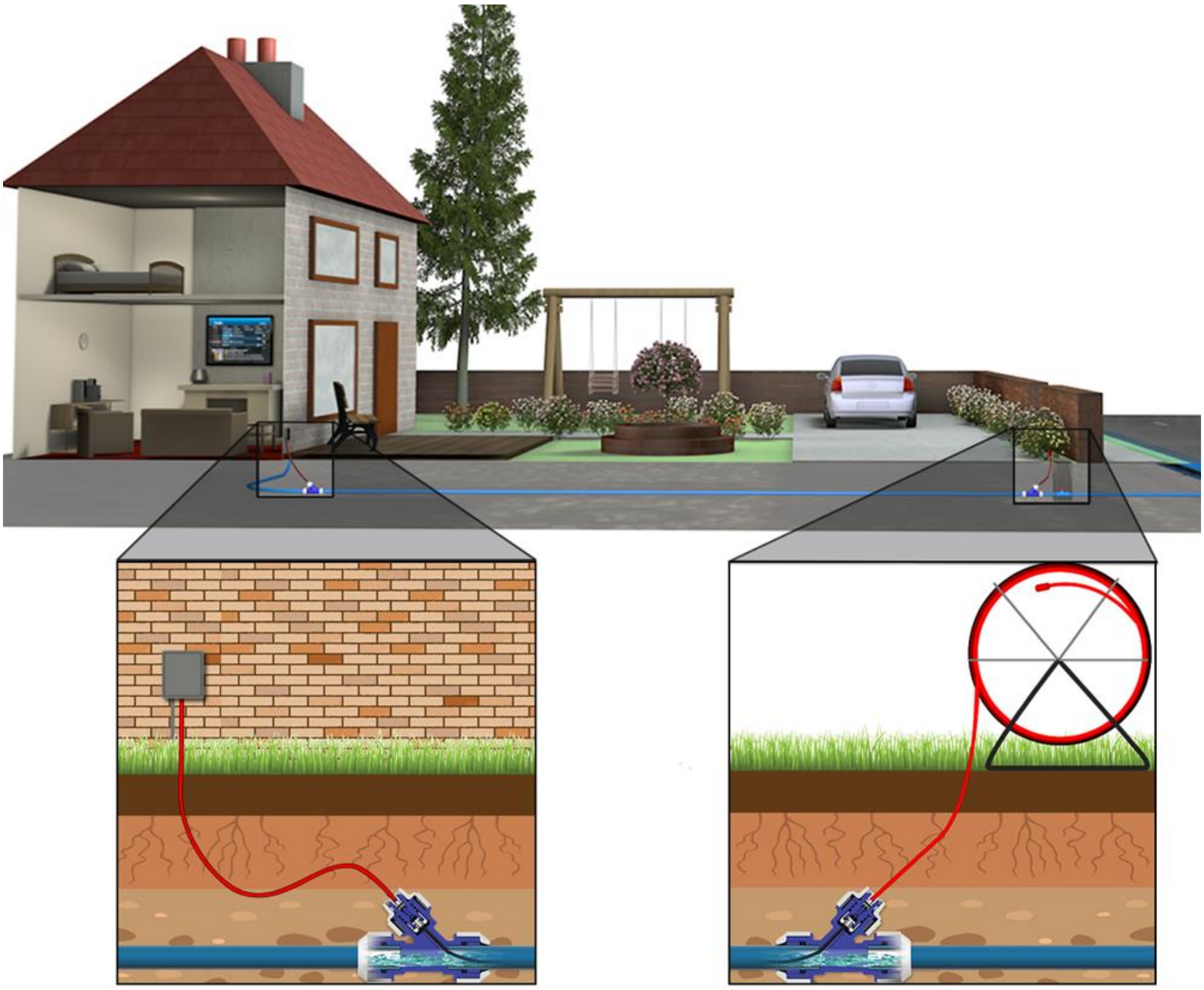

Figure 3: Schematic of fibre-optic cables in water pipes

The company also offers a different product suitable for microduct placement within the higher pressure and larger diameter water distribution mains. This version can be used to provide trunk distribution routes with high-fibre count cables (144 fibres or more).

The second approach targets fibre connections to multiple occupancy buildings. This method only requires a single access hole to be excavated. From an access point, typically located in the basement or utility connection room of the building, a 7-mm-diameter conduit is fed into the domestic water pipe until it reaches the access hole in the street. Joints are integrated into the pipe by electrofusion welding. Single fibre-optic cables are then fed through the conduit from the street directly into the basement without any further excavation.

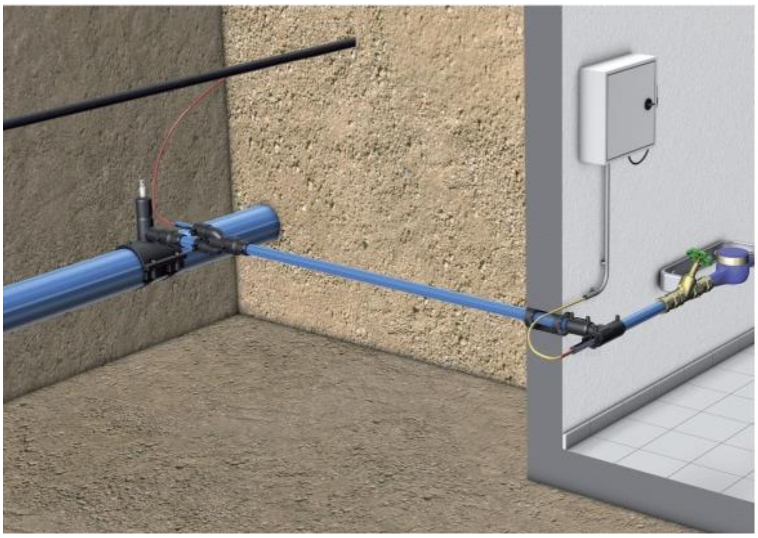

Figure 4: The duct containing the fibre cable enters the building inside the drinking water pipe.

Figure 5: Drinking water pipe connection, in an installation in Adenau, Germany.

Both solutions can significantly reduce deployment costs, by minimising the need to excavate and reducing the time taken to deploy the cable. Another benefit is the minimal impact on the established ground surfaces and entry points to the existing property.

The systems have been designed to not to have any appreciable impact on the hydraulic performance of the water pipe and no “stagnation zones” (areas of poor flow). Components that come into contact with drinking water must also comply with local water regulations.

Residential gas pipes

Another alternative infrastructure is the domestic gas supply connection. In Germany, for example, about 60% of all buildings are supplied with natural gas.

A conduit can be integrated into the connecting service pipe in a similar manner to that used in drinking water pipes. Depending on the required capacity, fibre cables can be pushed mechanically or conveyed under compressed air through the conduit. This can take place at any time after the conduit has been installed. The interfaces for the conduit and fibre cable lead-outs/lead-ins are integrated reliably and permanently into the gas supply pipe using electrofusion welded fittings, a tried and tested procedure practised by utilities companies.

This approach always requires two access holes (in contrast to the drinking water solution) because local regulations stipulate that the adaptors in the gas pipe must be located outside the building. The fibre must then enter the building through a separate opening in the building wall.

Figure 6: The d16 x 3.0 mm conduit is threaded into the gas service pipe through the branch.

Figure 7: The conduit forms a homogeneous and gas-tight bond in the service pipe.

All of the components, pipe, fittings, conduits, and connectors must comply with the technical requirements of the local gas supply regulations and standards and be certified accordingly. To be used in the gas main, the materials must be resistant to natural gas and its admixtures. Impediments to supply capacities caused by the main's smaller cross section at the conduit are generally negligible. The pressure drop and the throughput can be calculated to verify suitability.

Innovative Fibre Installation Methods

Handheld fibre blowers

The usual method for installing cables in structured networks is to deploy cables through conduits or ducts using pulling, pushing and blowing techniques. Installers must take great care and skill neither to exceed the manufacturer's specified maximum strain for cables when pulling, nor to exceed the minimum bend radius when pushing or blowing. If adequate care is not taken, the cable can easily be damaged during installation, which could result in damage to the fibre. The damage may not be immediately obvious and could lead to failure later in the life of the cable.

In the early years of fibre deployment in network backbones, and particularly on long-distance routes, cables had high fibre counts and were heavily armoured. Heavy duty equipment is required to install these large, heavy cables, providing a substantial push force whilst using compressed air for lubrication. These machines typically require at least three people to operate, although more people may be required in situations with less skilled operators and long cable runs.

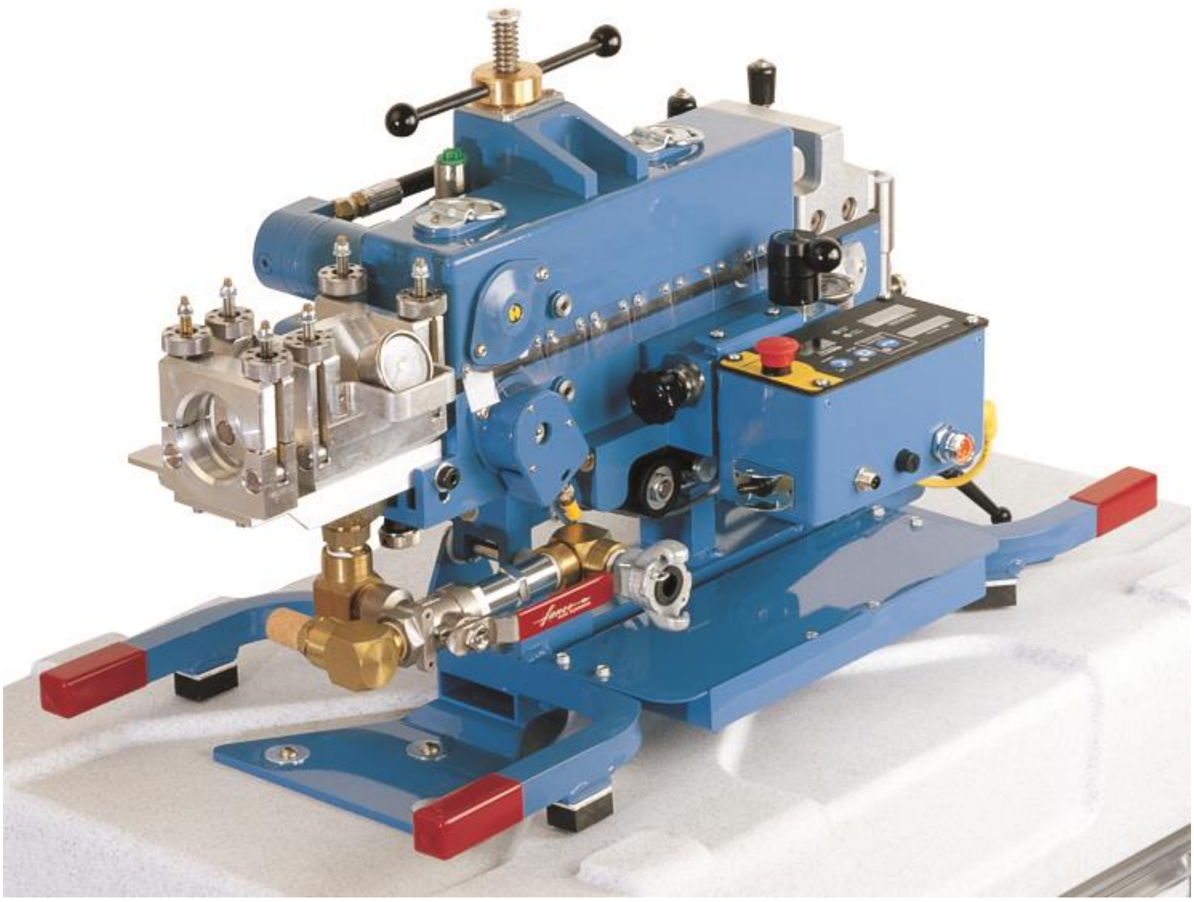

Figure 8: Example of fibre-optic cable blowing equipment.

FTTH has created a requirement for smaller diameter, high-fibre-count cables suitable for installation in increasingly crowded ducts and sub-ducts. Operators need to install more fibre, more quickly although often over less arduous distances. Installation equipment is therefore not required to be of such a heavy duty nature since the push forces and air requirement are far less. However, there is still a need for skilled operators, and it can be argued that smaller cables require more care than larger ones if they are to be deployed without damage.

New installation machines have recently been launched onto the market that attempt to address these requirements in a cost-effective manner. Machines capable of offering long-distance blowing up to 1 km, at high speed and with minimal risk of damage to the fibre are becoming more common. Light-weight equipment that can be hand held, operated by one hand and used up telegraph poles, in underground chambers and in buildings, will help to keep costs and risk down whilst enabling technicians to install the maximum amount of cable in a given time.

Figure 9: Handheld fibre blowing equipment

Pushable fibre

Over the past twenty years, much has been accomplished with blown fibre. A new derivative of this technology, pushable fibre, offers even greater ease of use and greater cost containment for both new and existing environments.

In its simplest form, pushable fibre assemblies are pushed through a ruggedized microduct to deliver fibre to the desired end point. When used with a pushable connector on a single-ended assembly, half the labour is eliminated. When used with a pushable connector on one end and industry standard connector on the other, all splicing and termination labour can be eliminated. With skilled splicing labour averaging over €55 per hour, labour cost savings can quickly add up.

Pushable fibre pathways are established either aerially or buried, or they are placed in new or existing conduit that often is otherwise thought of as exhausted (no room left for traditional conduits or cable). The pathway can transition from an outside plant (aerial or buried) to an inside plant environment with a simple airtight and watertight coupler that requires minimal tools to install allowing for a single and continuous pathway from A to B.

Additionally, the restoration capabilities of a "cut" or "severed" fibre should not be overlooked. Should a fibre be cut, the pushable fibre can be located and pulled from the duct – and it serves as a "tape measure" so that the distance required for a replacement product is easily calculated. The ruggedized microduct can then be accessed at that point, quickly repaired with airtight and watertight couplers to make the pathway whole again. The replacement assembly is pushed back in – all without rolling a splicer and all with unskilled labour.

Figure 10: Examples of pushable fibre assemblies.

Cable de-coring

A proprietary technology has been developed that allows the inner core of buried copper telephone, coaxial or electrical distribution cable to be extracted without excavation. This leaves an open conduit ready for fibre-optic installation.

Instead of digging up the entire cable, the route only needs to be accessed at two points, which gives a substantial reduction in the cost and duration of the work. Routes up to 1500 ft (450 m) have been successfully de-cored.

The patented process makes it possible to pull out the core of existing, deployed cable, leaving the outer sheath in the ground. This is done by injecting a specially engineered fluid at high pressure down the length of the cable. The lubricating fluid breaks down the chemical bonds between the cable's outer jacket and inner core. Once the fluid emerges from the other end of the cable, a winch is used to extract the copper core – which can then be recycled.

The technology has been used in a number of projects across Europe, and is being trialled in other countries around the world.

Figure 11: Cable de-coring in progress.

Innovative FTTH Components

Flat microduct systems

Microducts are small ducts, typically between 7 and 20 mm in diameter, intended for the installation of fibre-optic cables. They can be used either as single pipes or grouped as bundles in either a round or flat configuration with a sheath to hold the bundle together.

Thin-walled microducts provide minimal protection, and are intended for installation in existing duct infrastructure. Thick-walled microducts have a 2-mm wall thickness that provides protection from crush, distortion and corrosion and are suitable for direct burial (providing that they are installed correctly - duct bundles should be covered by sand before backfilling and compression.) With thick-walled designs, the sheath doesn't need to provide protection, its purpose is to fix the microducts in the bundle and to carry a colour or stripe for identification.

Flat microduct bundles are a more recent development. The flat configuration is resistant to twisting, which enables smoother installation.

Figure 12: Single thick-walled microducts

Figure 13: Microduct bundles in a round design

Figure 14: Microduct bundles with flat design

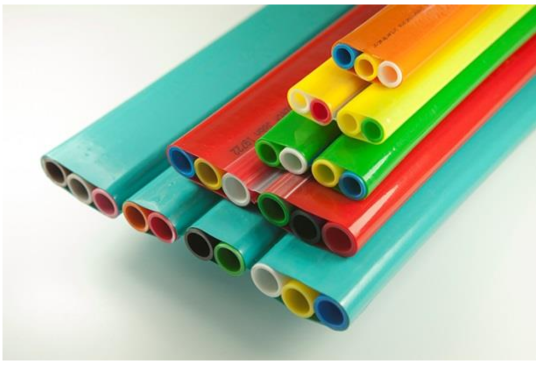

Figure 15: Microduct bundles in a flat design

Another advantage of working with flat microduct systems is that they don't need any further protection in the ground, so no additional housings or closures are required. Instead, individual microducts can be accessed simply by cutting a slot in the sheath. A branch is then created by mating one tube to another using a suitable push-fit connector. This process of "slot cutting" and "branch off" is quick and easy to do, which is important when there are many locations to be accessed and homes to be connected. The simple process helps to keep costs down.

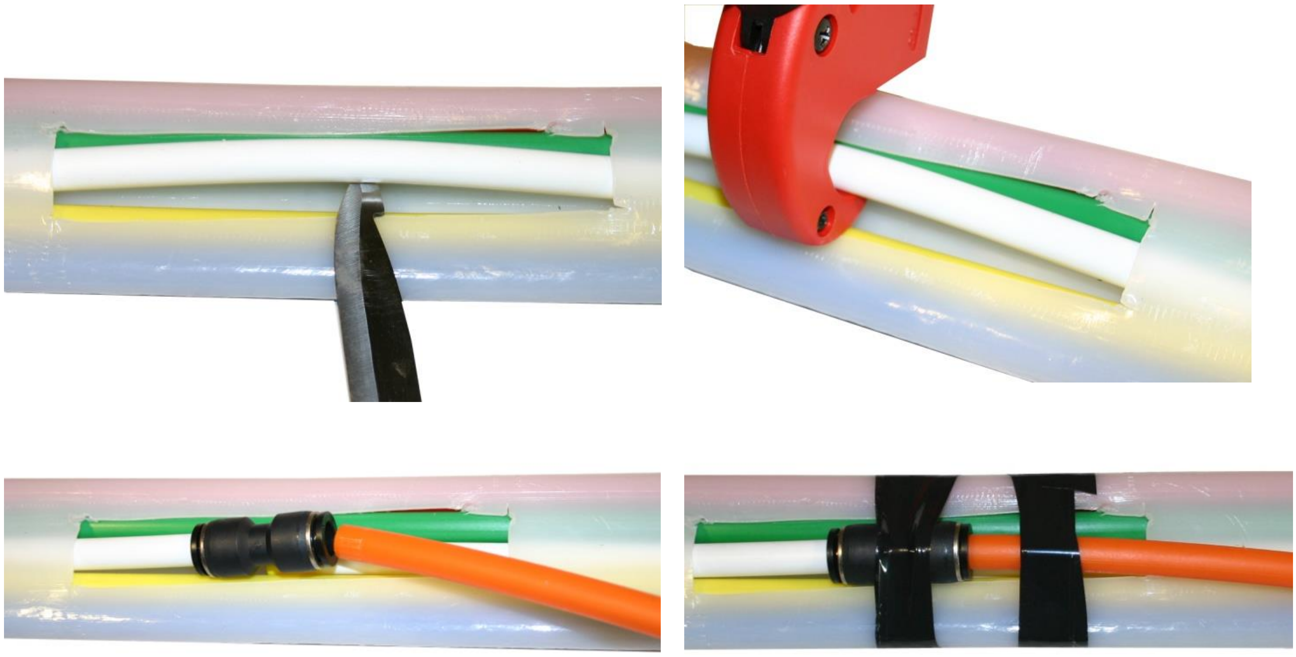

Figure 16: Creating a branch in a flat microduct system.

Figure 17: Flat microduct bundles in the ground.

No epoxy, no polish connectors

Termination of optical fibre in the field has, until recently, relied upon three main techniques, either fusion splicing (fibre to fibre or fibre to pigtail), mechanical splicing or jointing via an epoxy and polish connector. Each of these methods has advantages and disadvantages:

Parameter	Fibre-fibre splice	Fibre-pigtail splice	Mechanical splice	Epoxy and polish
Performance	< 0.2 dB	< 0.5 dB	< 0.5 dB	< 0.5 dB
Skill level	High	High	Low	Medium
Time to joint	2 mins	2 mins	4 mins	> 5 mins
Capital Investment	High	High	Low	Medium
Reliability	High	High	Medium	Medium
Product cost	Low	High	Medium	Low
Environmental resistance	High	High	Medium	Medium

Ideally, installers want the best of all worlds: a low loss connection with high reliability, but that is also quick and easy to assemble. The recent launch of no- epoxy and no polish (NE/NP) field-fit connectors offers this possibility. These connectors have an installed loss of better than 0.5 dB coupled with a completion time of about two minutes. They require minimal tools and capital investment can give an environmentally stable connector that is potentially highly reliable. In effect, the work has been factory-completed for the installer which inevitably means the unit cost of these products is a multiple of a standard connector.

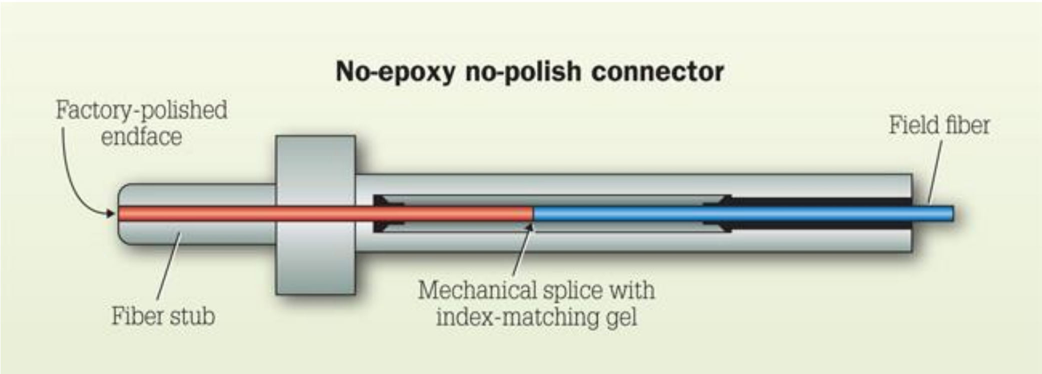

Figure 18: No-epoxy, no polish connector

Passive optical networks (PONs) generally require a good return loss (RL) from the connector. RL is not normally a field-measurable parameter and requires specific measuring equipment normally only found in the factory. Thus pigtails give excellent RL performance, but with the significant

associated costs of running fusion splicing equipment. It can be difficult to estimate RL with an epoxy and polish or mechanical splice. The NE/NP connector above can give excellent RL with little up-front investment.

The nature of NE/NP connectors means that the retention of the field fibre at the back of the unit may not be as great as in a conventional pigtail connector. If this parameter is important, specific product designs should be evaluated.

Pre-terminated cable

Where installation times are very tight and available installer skills are at a premium, it may be desirable to deploy pre-connectorised cables. These products can be supplied with a certified performance from connector end-face to connector end-face.

Three types of pre-terminated cables exist on the market today: (i) long haul, high fibre count, multiple connector products, (ii) Simplex or duplex fibre cables with single or double SC or LC ends and (iii) pre-connectorised blown fibre units.

High-count multi connector cables are not common in the FTTH environment. Usually, these products contain a harness and shroud at either end of the cable to hold and shield the connectors (the connectors themselves may be environmentally hardened), and a pulling eye.

Figure 19: High count multi-connector cable

Low count, final drop cables are more common in FTTH installations. The cables can be double-end terminated or single-end terminated. Single-end terminated cables are usually spliced at the field node and plugged-in at the customer end connection. Double-end terminated cables require a field node that is has a connector patch field:

Recently, pre-ferruled cable products have been introduced that enable 2- or 3-mm cables to be installed inside microducts with the connector housing being fitted after the cable exits the microduct. This enables the microducts used to have a bore of 6mm or less which gives rise to a more aesthetically pleasing appearance of the installed product.

Figure 20: examples of pre-ferruled cable products.

The use of double-end pre-terminated cables requires careful route and stock planning. If installing from the final node towards the customer, care must be taken to avoid leaving a large excess of cable at the entry to the building. A minimal amount of slack cable can be stored, but even with this provision, product will be required in a variety of stock lengths at intervals of 10 to 20 m.

The final product type that is commonly pre-terminated is blown fibre. Blown fibre cables, or more properly fibre units, are the smallest and lightest fibre products. They are designed to be installed only in their protective microducts. Typically fibre units have an outer diameter of 1.0 to 2.0 mm and contain from 1 to 12 optical fibres.

It is generally not desirable to connectorise the leading end of a blown fibre unit, since the unit is not sufficiently rugged to withstand the extra load imposed by the connector when installing. In this case the fixed, near end is usually connectorised while the leading end is ready to be fusion spliced or connectorised with a field-fit product. In many cases this means blowing needs to take place from the customer location back to the node.

The choice between the options will depend on the nature and length of the route, whether the route comprises duct or microduct, the direction of installation, the required installed product performance and the type and number of connectors needed.

Innovative Project Design

Multiple novel installation techniques and equipment can be applied simultaneously in the same project to help drive down costs as far as possible. Novel approaches are particularly important for projects in rural areas, where the total deployment costs are likely to be higher, but the opportunities to be innovative are arguably greater. The following case study provides a real-world example of innovative project design.

Case Study: Parham, UK

Parham is a fragmented village in a broadband "not spot" in rural Suffolk, UK. Rural areas such as this often do not have existing infrastructure such as ducts and sub-ducts in place, the distance between properties is often much greater, with rights of way not necessarily following the shortest route, and there are fewer customers to connect. In this particular case, there are about 80 houses in the village, spread over three geographically separate areas covering approximately a 4-km radius. It would be highly challenging to connect this community with fibre.

In 2012, a public sector organisation issued an invitation to tender for the design, installation, and operation of a FTTH network in Parham. A local design company, NGA Connect Ltd., responded to the tender with a methodology and product set that would simplify the installation process and reduce the costs, to meet the challenges of this very rural fibre deployment.

The project had a restricted budget of £150,000, mainly from public funding, to cover planning, civil engineering, infrastructure and consumables. With the limited funding available, it was clear from the outset that standard installation and deployment models were not going to be feasible.

The proposed solution followed the "tractor broadband" model, similar to that used in the Broadband for the Rural North (B4RN) project in Cumbria, UK, which would utilise consenting landowners' field boundaries to avoid costly highways-related civil engineering costs.

The equipment and installation innovations were bespoke to this install, yet made to be adaptable for further network rollouts. Specifically, to keep costs down, a method where the customer self-connects themselves to the network was developed in conjunction with partners, as from a splicing and maintenance point of view, the most costly part of the installation was the drops to customers. We developed a solution where we would run standardised connection boxes to the boundaries of customer properties and then they would have responsibility for laying microduct provided as part of a kit through their gardens and to their property, with connection either done completely by the customer, or with the assistance of an appointed village expert.

Avoiding highways and associated costs

Routing the fibre via roads and verges was not an option due to high charges by the Highways Agency. While roads would have been convenient (it is rare for a rural property not to be connected to the road network) a charge of £61/metre for roads and £10/metre for verges, before civil engineering and traffic management costs, ruled out using these options for deployment.

Key Point 1: Route the cable via field boundaries to avoid the cost of digging in the highway.

Field boundaries, which are common in the majority of rural areas, were identified as the key to keeping rural fibre installation costs down. The strip of land at the edge of fields is relatively undisturbed, and does not command a monthly lease from the Highways Agency. The land can be accessed by large civil engineering equipment without closing any roads, which would be both expensive and cause significant disruption to local residents.

The support of local landowners is obviously the key to this approach, and consideration has to be made for any impact the trenches might have. Field boundaries at the tops of fields are the best location because they are the least likely to affect the landowner's drainage (mole drains).

Field boundaries surround the majority of the properties in the village of Parham, so routing through the village at the rear of properties along the field boundaries was identified as the cheapest and least disruptive option

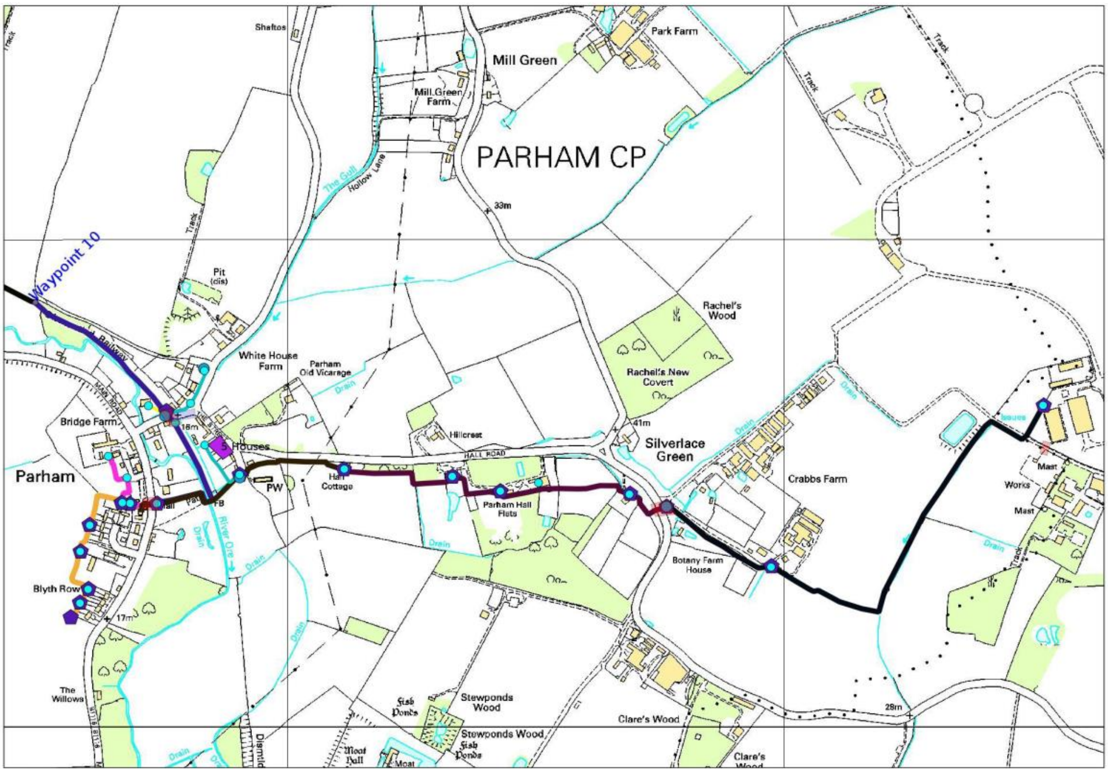

Figure 21: The route follows field boundaries at the rear of properties

The cable route connected to a point of presence in a serviced office building in the nearby small town of Framlingham. This location was chosen as there was access to backhaul fibre infrastructure and generator-backed power supplies, which also helps to keep costs down.

The route to Parham was carefully chosen to minimise road crossings and their associated costs. Part of the route followed a disused railway line. Road crossings were to be handled with either horizontal boring or directional drilling.

Ducting and fibre was to be laid with trenching equipment and mini-diggers as the route allowed, using local contractors and, where necessary, an agricultural drainage specialist, who has significant expertise in laying piping similar to telecoms duct in local farmers' fields.

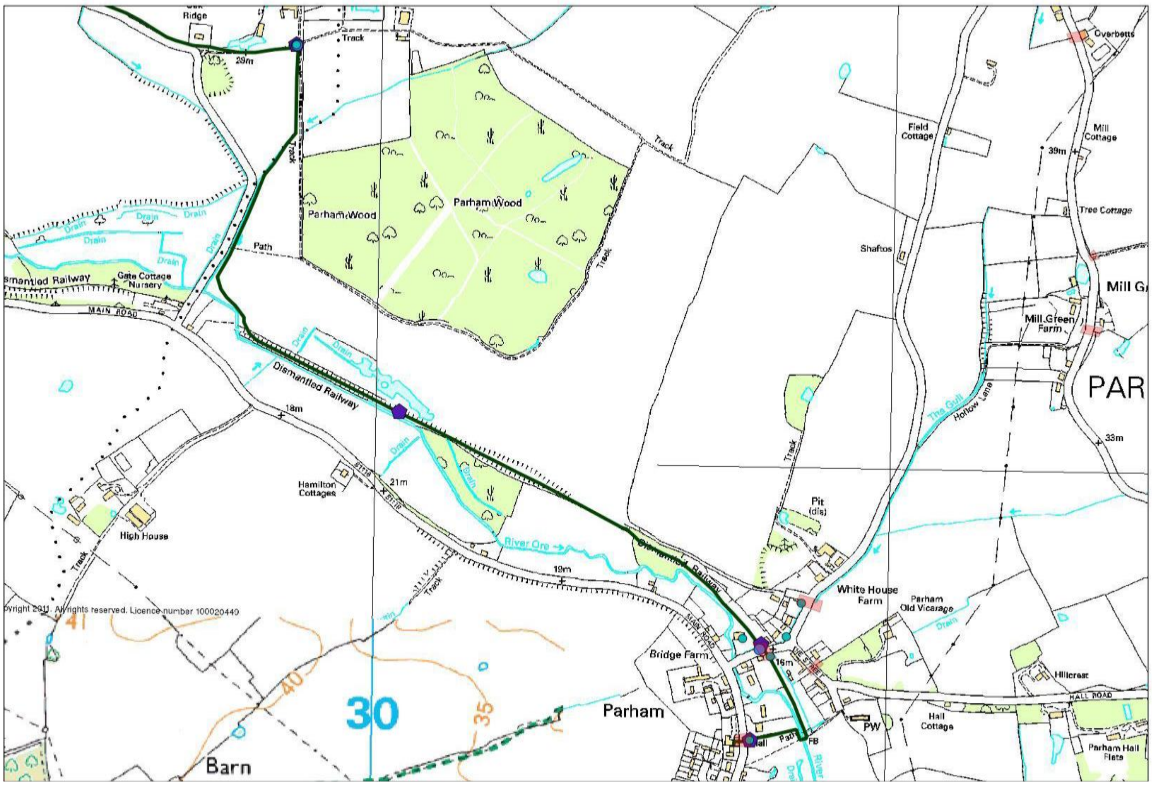

Figure 22: The route follows a disused railway line as it enters Parham

Design for customer self-connection

Unless 100% of the homes passed sign up to services prior to the installation of the network, the addition of any customers to the network traditionally requires installers to return to site, incurring additional costs. It was decided the best solution was to leave a customer "self connect box" at the boundary of every property. This keeps the cost to pass the home to a minimum as no works are carried out on customer property.

Key point 2: Install “plant pots” at the boundary of every passed property.

The customer boundary box is the point of connection between the network and the customer. It consists of an IP68-rated standard enclosure box with connection ports specially configured for the connectors supplied as part of the self-install pack. The customer can make their own connection here using a plug-n-play spliceless connector. This box is contained within an IP65 container and is only part buried so that the box may be accessed. The boxes are situated at the boundary of every customer premise passed.

Key Point 3: Provide a pack of products that enable customer to connect themselves to the network when they are ready by providing “Customer Install Packs”.

The final stage of the customer connection was identified as the most expensive in terms of cost per metre. The solution was to allow the customer to undertake this stage themselves. The method needs to be suitable for the customer to use without the need for trained assistance and must be rugged in design, to protect the fragile fibre.

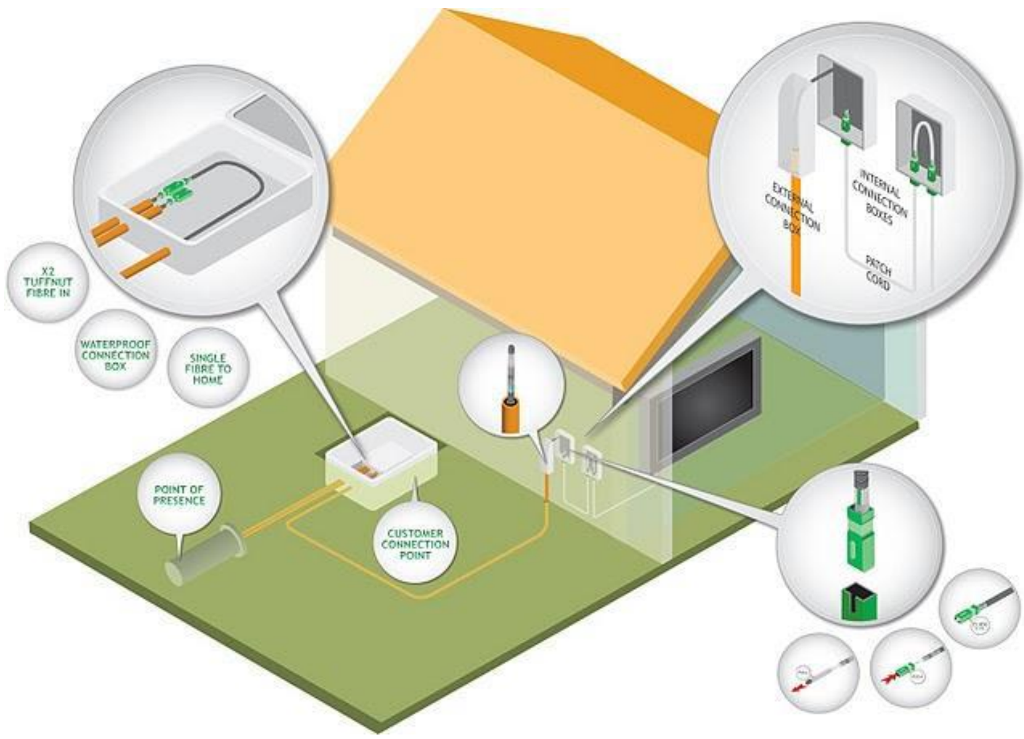

Figure 23: Details of the customer self installation.

The self-install pack would be sold to the customer at the point of their request for connection. This meant that the scope of the network could be maximised and the customer understands what their connection fee pays for. The pack enables the customer to connect to the network at the boundary box simply by plugging in a standard connector.

Customer Install Pack (paid by customer): £250.00 ex VAT
1x 150ft Black Corrugated UV Stable duct
1x 150ft QuikPush cable (SC Terminated)
1x Waterproof Connector
1x Instruction Booklet
1x SC clip-on connector
1x ONT (Fibre Media Converter, Telephone Capable)
1x External Wall Box
1x Internal Wall Box
1x Patch Lead

Cost breakdown of the Parham FTTH Project

With the approach described, the project was able to realise network deployment costs almost 50% lower than the projected cost of £300,000 based on standard deployment methods. Shown below is the complete product requirement from the project plan. The project planners have shared this information to illustrate that substantial cost savings can be achieved in the rural environment through the use of non-standard techniques.

Main Delivery Equipment: £29,990
1 x Rack 36u with power attachments
1 x Uninterruptable Power Supply
9 x 48 Port SC Optical Fibre Patch Panels (with Pigtails)
1 x Cisco Catalyst Switch with line cards
2 x Network Monitoring Computer
4 x 1000 Base -T SFP Pluggable Transceivers
3 x 1000 Base – Lx SFP Pluggable Optics
1 x Secure Rack
1 x OLT Chassis
1 x Set of Batteries and a rectifier
3 x (1 X 32) Fibre Splitters
1 x Uplink Card 4 x 1GB Ethernet
1 x GPON Line Card
1 x Active Line Card 20 Port of up to 1GB

3 x GPON SFP
5 x Active SFP’s
100 x 1m Patch Leads

Cable, Microduct and Closure Equipment: £24,000
1x 8km of 12x8 Pre-fibred 96 core Tuffduct
25x 8 Connection IP68 Domed SNACs
12x 16 Connection IP68 Domed SNACs
164x 100ft Tuffduct 8x6
164x 100ft QuikPush Cable with SC Connector

Other Delivery Equipment & Costs: £28,930
82x “Plant Pot” – Customer Delivery Connection
1x Splice Machine
8x Handholes
3x Splice Closures
Maps
Backhaul Installation Cost

Labour and Civil Engineering: £78,052
13x 1 Day professional splice engineer
Civil engineering including trenching, cable laying, back-filling, road crossings, permissions and traffic management.

Total install cost for 80 residents: £160,972

Summary

The Parham template for cheaper, efficient rural broadband connections is:

- Use field boundaries instead of roads and verges to reduce licensing costs.
- Use local civil engineers and agricultural contractors to lay ducting and fibre, utilising a product set designed for rough handling.
- Plan for minimal splicing, and only at key points, enabling splice labour to be greatly reduced.
- Avoid blowing fibre, as this is costly and inconvenient; use pre-fibred ducting for major routes and push/pullable fibre for drops.
- Plan for customer self-connection using a product set specifically designed for this purpose.

Conclusion

The investment requirements for FTTH have already decreased substantially in recent years. The growing maturity of the industry and its supply chain certainly helps. Increased purchasing volumes help to drive down prices, and fixed costs can be allocated across a larger customer base.

A major contributor to the reduction in investment requirements for FTTH has been the use of efficiency improvements by service providers through improved procedures, innovative tools and components, and use of labour-saving methods.

There is still scope for innovation to further drive down the cost of FTTH deployment, especially in rural locations. Standardised methods and products are designed for network backbones, which are shared by many subscribers, and urban environments, where distances between subscribers are short. Reaching and connecting communities in rural locations will require novel approaches to drive down the "cost per metre" of fibre cable installation.

The innovative solutions described in this paper are designed to drive down the cost per metre through de-skilling, ruggedisation, simplification and using the right tools for the rural landscape.

No single innovation can solve all FTTH cost issues. Indeed not all of the novel methods described here may be suitable or appropriate in any given situation. For example, installing cables in water or gas pipes requires co-operation from utility companies, and that isn't always a given.

However, it is important that every project consider that there are alternatives to the standard methods of carrying out the installation. Reducing the deployment cost can improve the FTTH business case, which will help to speed up the pace of FTTH roll out in Europe.

Notes

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