



Taking the Bite Out of Broadband

Johnny Hill

An Introduction to FTTH

There are many FTTH deployment technologies with additional ones in development. Service providers must evaluate and determine which technologies are best for them, whether it's BPON, GPON, and Active Ethernet or the emerging technologies of GPON-10GB, WDM-PON, NG-PON, All-IP triple play, and even RFOG. Within this evaluation, the service provider must be aware and carefully weigh the cost associated with these technologies against the insatiable thirst for bandwidth that their subscribers demand.

The FTTH providers are faced with many choices. Do they put in the safe and generally accepted infrastructures – but then worry about the costs and timing of future upgrades? Or should they put in cutting edge technologies and deal with the costs and challenges of being an early adopter? Or do they do something in between? Whatever the choice, the way forward is clear. If the service provider's revenue is not dependent upon fiber now, it will be in the very near future. Advanced services demanded by consumers, and the critical revenue flows associated with them, are the critical elements for long term survival and growth. The foundation of the business is fiber, a long-lived and expensive asset. It only makes sense to address both the upfront costs as well as long term utility with a critical eye.

Regardless of choice, the hard costs of passive connectivity and management are present and will continue to grow as the network evolves – until such point that there is an ubiquitous, broadband, low latency service from the content origination point to each and every home and office. The passives of fiber, connectorization and management are agnostic to the technology yet remain a constant in them all.

The manufacturers of passive connectivity deliver solutions to address the service providers' fiber management needs – and then some. Filtering out what is necessary and what is not can be a challenge as no one wants to pay for features that while interesting, cool and sexy, do not provide additional functionality and reliability. Planners and network designers are constantly walking a fine line between upfront costs, effective day-to-day operations and long term growth.

Fiber management is meant to consolidate, protect and distribute the fiber circuits in a service provider's passive network architecture. A number of consolidation points, depending on network design, connect from one to another until the desired fiber destination is reached. The objective is a single unbroken strand of pure glass from one point to another, often miles apart, and passing through many components. The basic principles of providing protection against bend radius violations, physical fiber protection and proper route paths must exist but must not be overdone. Additionally, workability of the design must include proper access to these circuits and still protect from accidental damage while doing so.

For today's fiber-based telecommunications carriers, the fiber management is fundamental when using sound, logical and simple designs to accomplish the basics. The harder work is to select components with enough added features – without adding to already strained carrier capital budgets – which reduce the operating costs of deployment through ease of maintenance and installation. It starts with the proper design and understanding of network architectures which consider both today's needs and tomorrow's growth to select, specify and order the necessary equipment and supplies. It then shifts to the construction and installation teams to build the network and make it operational. Finally, the network technician has to maintain the infrastructure, enter it to make changes and, over time, install new

facilities. Clearfield addresses these challenges across the entire range of components and across the entire range of carrier circumstances.

A large array of solutions exists in the market. Some are suited for densely populated areas which scale to hundreds if not thousands of fibers, but may not work so well in a Tier 3 carrier or a rural telephone co-op. What's suitable may depend on one's viewpoint. For the transmission engineer looking only from the active component point of view, the simpler the fiber network, the lower the return loss and the better the transmission characteristics, which says, "Splice everything everywhere all the time." On the other extreme, a field engineering supervisor in a high labor cost city would say, "Factory installed connectors everywhere. We just 'plug 'n play.'" Reality comes into the picture and the correct choice, of course, is somewhere in the middle – a sweet spot between the two extremes. Modularity and the ability to use quality connectors are essential for effective, labor-efficient implementations which address the engineering supervisor's concerns. At the same time, reducing the number of splices required simply to transition between cable types will make the transmission engineer a far happier person.

The concept of modularity is critical. Simply put, the components used to consolidate, protect and manage the fiber are designed and fabricated to handle a certain number of fibers, typically some multiple of twelve which has become the industry standard. The service provider should define modularity to match their capital expenditures (CAPEX) and operational expenses (OPEX) reflected in both their immediate as well as long-term plans at any point in the network – be it along Feeder, Distribution or Access. . Simply put, they should have the "choice" to decide how and where they spend their money. Icing on the cake are solutions that can eliminate other hard costs in the network that, until now, were a foregone conclusion – such as direct labor costs and a complex range of splice trays, enclosures, specialized equipment, cables and so on. Labor costs are high and only getting higher over time. What once were "nice to have" features such as factory pre-loaded splice trays or FDH jumper "parking" which can save technicians' time at some point in the product's life cycle, are rapidly becoming a "must have" given increasing emphasis on rapid deployments which treat fiber much more like copper. Working with fiber in the field remains a task with its own set of subtleties and acquired knowledge, however. Technology can only do so much and then the skills of the front line technicians come into play. A well-designed, well-constructed fiber management system simplifies several things, which allows the technicians to spend their time on the hard problems, not the routine ones.

In the end, it comes down to costs and revenue. While Clearfield's products are only indirectly linked to the revenue side of the carrier's business; they are certainly a potential positive contributor on the cost side by addressing the entire range of factors in the "total cost of ownership" (TCO) concept. Direct costs – be they out-of-the-box costs or direct labor for installation and commissioning – are critical. Indirect costs, such as the engineering time for design and planning of a complex network both for first build and expansions, inventory carrying charges for multiple vendor's equipment, technician training time, consumables, what's kept on the trucks, building and hut floor space, etc. add up as well. Thinking about the fiber plant in TCO terms takes work, but the effort may well pay off, especially if the TCO approach is used consistently across the entire spectrum of the fiber optic infrastructure, from inside the main office all the way to the most distant residential customer.

Clearfield studied the lessons cited in a recent (August 2009) independent study of fiber optic network infrastructure* regarding practices and recommendations for carriers looking to deploy new FTTH

*"Meeting the Challenges of FTTH: planning and passive infrastructure", Beta Partners, LLC www.beta-partners.com

networks. The paper's overall thrust confirms and strengthens Clearfield's approach to fiber cable management. The study's comprehensive look at the various TCO elements, some of which are well out of the passive infrastructure for which Clearfield is known, does lead to answers to many of the questions we get asked by our customers. The study's approach to TCO, and the Clearfield solution to the matter, is taken up later in this paper. (See: "The Big Picture")

Passives in the Inside Plant

The central office, head-end, or remote hut is often the largest consolidation point of fiber in a network. It is where the issues of scale with large fiber counts begin to make a significant difference. It's also where much of the day-to-day 'touches' on the fiber network take place, since it's the network hub and the focal point for new service deployments. Typically, racks or frames are used to mount active communication equipment and fiber management panels. Outside Plant (OSP) cable, if more than 50 feet inside a structure must meet and be spliced to intra-facility cable (IFC or distribution style) which introduces another consolidation point. There are two methods for splicing these two different fiber types: off-frame splicing or on-frame splicing. Off-frame indicates that a separate closure, typically called a Fiber Entrance Cabinet (FEC), is placed on a wall or floor at the point where the OSP cable enters the building. The IFC cable is pulled to the FEC where both cables are prepped, spliced and slack-stored in the FEC. These entrance cabinets can prove to be quite costly and once "designed-in" can grow complex and dense with cables since often only one outside wall penetration point is really feasible given the building design and interior layout.

On-frame splicing is the same method but done in a different area – on the frame. If the building is small or the communication frames with their active equipment are within allowable distance, the service provider may choose to use this method by pulling the OSP cable directly to the frame and into a separate splice deck that acts as a smaller version of the FEC, but one mounted on the frame. The splicing of IFC tails, coming from the patch panel to OSP cable is done in the same way as off-frame but on a much smaller scale. This method does have the drawback of using additional vertical real estate, but a lower modularity of 12 ports for the basic Clearview™ Cassette means that only what is needed can be installed; there is no wasted vertical real estate. With the tremendous amount of fiber now in these facilities, space on the frame is tough to give up, but can also be counterbalanced by the increasing density of the active equipment available today. From a TCO viewpoint, first costs for installation and scaling costs become the driving factors, along with a strong consideration towards easy entry for changes and expansion.

The Simpler Alternative

The Clearfield design team evaluated the traditional methodology used in environments of less than 50 feet and set out to eliminate the costs of an FEC entirely via an off-frame deployment while simultaneously eliminating the costs of additional splice decks in an on-frame deployment. The solution is the core building block of the FieldSmart product line, which is the Clearview™ Cassette (see attachment to this whitepaper). By integrating fiber management inside of a 12-port building block and then using that same building block to house splicing, these cost saving goals are accomplished, not only at the main central office and head-ends, but anywhere where an on-frame OSP cable termination may be

used, such as in widely dispersed equipment huts in FTTH deployments where the elimination of the FEC could well result in a smaller hut.

In addition, the material cost of expensive IFC cabling is eliminated. Because the cassette provides the physical fiber protection of the 2-meter 12-fiber 900 μ m assembly, the protective outer jacketing is no longer required. Because space is saved on the frame, in slack storage pileup of the 7.5mm jacketed sub-unit, the frame can be used for other necessary equipment thereby reducing the physical footprint required in the CO and minimizing the amount of expensive per-square-foot real estate. Shorter patch cables or jumpers, maybe even entirely on the same frame, may be used, saving both in material cost for the jumpers themselves as well as for storage and routing troughs. The savings by using the Clearview™ Cassette and on-frame splicing can be realized both in existing CO buildings as well as in new designs. While migration from an FEC-based office to one which uses an on-frame Clearview™ Cassette approach may be more complex, it may prove feasible and cost effective whenever a new service is being planned, be it trunking, metropolitan networks or even an FTTH network deployment. Whatever the technology, the conservation of frame real estate remains a key consideration. FTTH, with its new active components and dedicated OSP cabling is especially attractive, and may well be implemented with little or no additional frame space, just what is needed for the patch panel itself. For new offices or huts, the reduction in size, network-wide standardization on components (resulting in fewer unique parts count) and complexity is a strong driver to consider the Clearfield approach.

Moreover, additional cost savings can be realized if optical components (splitters and multiplexers) are part of the configuration. With the Clearfield design, optical component modules can be packaged into Clearview™ Cassettes. This provides the customer additional choices: either to dedicate optical component space in a dedicated chassis, which may have advantages in scale or operations, or to mix fiber terminations and components in the same chassis thereby saving space and valuable real estate on the frame. Again, for the smaller CO buildings and remote hubs, the reduction and simplification of the network and standardization of practices across the network is always a benefit in the TCO equation.

Take the Bite out of Passive in the Inside Plant

Using the simpler deployment methodologies made possible through the Clearfield design, service providers can save on an 864-port count frame between seven and eight thousand dollars – that’s anywhere from \$9.35 to \$9.68 per port solely in material reductions. Additional costs savings through a reduction in real estate will also be substantial but are difficult to calculate.

Cost Saving Potential (through material reductions) in a 864 *On-Frame* splicing using FieldSmart from Clearfield

	Qty	Price Ea.	Ext.
Splice Deck, 23", 144 splice capacity, 6", splice trays loaded	6	\$1,300.00	\$7,800.00
Distribution Cable, 12 Tight Buffered, 72 x 3 Meters	216	\$1.30	\$280.80
Total			\$8,080.80

**Note - 24" of rack space saved eliminating splice tray*

Cost Savings Potential (through material reductions) in a 864 *Off-Frame* splicing using FieldSmart from Clearfield

	Qty	Price Ea.	Ext.
Fiber Entrance Cabinet, 864 total splice Capacity	1	\$2,695.00	\$2,695.00
Splice Trays - 24F	36	\$30.00	\$1,080.00
Distribution cable, 144 Tight Buffered, 100'	6	\$765.00	\$4,590.00
Total			\$8,365.00

Passives in the Outside Plant – Distribution

With the advent of higher fiber counts in the distribution network driven by FTTH deployments, the focus on the Fiber Distribution Hub (FDH) becomes critical to long term cost effective fiber infrastructure design. As the FDH often has considerable fiber counts (576 or even higher) to manage, yet must be placed in the field and thus be small enough to fit into a right-of-way without sacrificing ease of entry, the balance between first cost, operations and longer term growth are particularly challenging. Unlike the CO where – however expensive it may be – there is usually a way to fit in another frame, in an FDH, there is no other place to go. Change-out of an in-service FDH is very expensive. Getting it right the first time is critical.

Traditionally, service providers use a “patch only” method where the splicing of cabinet tails to distribution and feeder fibers of pre-stubbed cabinets was done in a splice case which is then stored in a grade level hand-hole either directly underneath or further away, often as far as 300 feet. In the case of aerial distribution, the riser cables from the pole are usually buried to the FDH and thus are treated in much the same way as fully buried plant. On rare occasions, the FDH itself may be pole mounted and splicing up on a ladder or in a bucket is to be avoided if at all possible and finding a way to neatly store slack becomes an issue, either by simply using coils or snowshoe on-strand storage. While there are many reasons for this method, the most common is that it provides the ability to pull the tails of the feeder and distribution cables up and to a dedicated splicing area along with the stubbed tails from the cabinet. This enables the installer to take advantage of a controlled environment such as a splice trailer where good, clean and consistent splicing results can occur.

Furthermore, many FTTH deployments using Passive Optical Network design (PON) may choose to locate the splitters within the FDH to lower cable count at the CO or active hub location. The FDH, while still entirely passive, must perform multiple functions.

The cost advantages of a “patch & splice” alternative motivated design engineers to consider that methodology, but it also has its limitations. The biggest issue is that in a conventional patch & splice deployment, the user cannot pull the pre-stubbed distribution tails into a trailer or other controlled environment. The reason for this is the stub lengths need to equal the prep strip lengths of the OSP buffer tubes. OSP cable manufacturers typically recommend a length no longer than 20 feet. The challenge is that the buffer tube will change in length as the temperature fluctuates due to thermal expansion/contraction issues. Another reason for limited splicing distance is that historical patch and splice methods in fiber distribution cabinets incorporate splicing hardware that is captive to the cabinet (and often times limited only to ribbon). This limits the ability to splice anywhere other than close to the cabinet since all splicing is done in the same splicing chamber where all the splice trays are consolidated into one chassis located in the cabinet. The combined buffer tube slack and pre-terminated distribution slack needs to be stored together in the cabinet and the 15-20 foot range is not long enough to pull out of the cabinet and into the splice trailer.

Given that even a modest sized 288 fiber count FDH, which in a new FTTH deployment may well have over half – 150 or more – of its fiber active upon network turn up, it’s not unreasonable to expect to spend considerable skilled technician time at each FDH. Anything which reduces time-on-site, improves quality and reliability, and reduces the total number of parts needed, will only benefit the TCO equation.

Add to this the need to for easy entry as the network expands. It's no wonder the FDH is frequently the designer's single biggest headache.

As networks deploy to more and more areas particularly lower density ex-urban and rural locations, planners are beginning to get away from the "tyranny of the three digit numbers" – the 576, 288 and 144 count locations. Solutions effective at 576 may not be so at 48 or 72, especially if there is wasted space, unused sheet metal and other hangovers resulting when a vendor attempts to downsize on the cheap. The Clearview™ Cassette with its lower 12 port modularity provides a solution while still retaining the ability to scale.

The Simpler Alternative

The Clearfield design team evaluated the traditional "patch only" and conventional "patch & splice" methodologies and set out to enable all the advantages of patch only configurations along with the traditional cost reductions in labor and materials that patch & splice affords. With field technician's time running \$50 per hour, and often much higher, spending less time at an FDH bringing up new service, even avoiding a next-day return and truck roll, adds to considerable cost savings.

Because the splice trays nest inside the Clearview Cassette and because the cassettes are not captive to the cabinet, the device becomes portable. During the construction phase, the customer can pull the distribution and feeder tails up and through the cabinet into the splice trailer mirroring the techniques with patch only. The difference comes in the mechanics: at this point, the service provider pulls the correct number of cassettes out of the cabinet (if staged at the factory) or from field stock (since they are all the same), carries them to the splice trailer and performs their splice work in the comfort and convenience of a conditioned environment. Once the cable sheath has been fully spliced to the cassettes (6-72, 12-144, 24-288), the cassettes can be ganged together with simple zip-ties. This creates a solid and compact fiber management device where the port count equals the sheath that was just spliced. This is then transported back to the cabinet for installation. The technician then moves on to the next sheath matching OSP fiber to the correct number of cassettes. The allocation of the cassettes into the cabinet is determined at the design stage, but can easily be modified as long as the FDH itself has adequate space. Splitter components, if used at the FDH, are also easily integrated into the Clearview™ Cassettes at the time of commissioning the network and the resulting patch panels for service drops installed and ready to deliver services.

With Clearfield's simpler alternative, the service provider can eliminate the cost of the OSP stub and costs of terminating this cable in exchange for a more cost-effective 900µm assembly integrated into and protected by the Clearview Cassette. The user has eliminated the expensive sealed underground splice case (and the labor involved) used in patch only methods because splicing occurs in the cassette. Additionally, the service provider can reduce the size of the grade level hand-hole because it has to be only large enough for the feeder and distribution slack that has been brought to the hand-hole – no more splice cases. Time is further saved in post-installation re-entries as access is better in the cabinet than entering a hand-hole. For the rare aerial mounted FDH, the advantages of the Clearview approach are evident...less work on ladders or buckets, with time saved and improved safety.

Take the Bite out of Passive in the Outside Plant – Distribution

Using the simpler deployment methodologies made possible through the Clearfield design, service providers can save more than \$900 per cabinet – at 288 ports per cabinet, that’s more than \$3 per port solely in direct material and labor reductions. The benefits start at the design phase, by reducing part count and projected labor expense in the project planning documentation and continues through the purchasing, staging, construction, commissioning and operations. Direct costs savings are shown below. Indirect costs, while harder to quantify in a whitepaper example, can be readily identified in the example provided above.

Cost Savings Potential (Through material reductions) in a 288-port count fiber distribution cabinet using Field Smart from Clearfield

	Qty	Price	Extended
OSP Cable	100	\$1.35	\$135.00
Splice Closure	1	\$350.00	\$350.00
Fiber Splice Trays - Distribution	4	\$20.00	\$80.00
Fiber Splice Trays – Feeder	1	\$10.00	\$10.00

Material cost savings through size reduction

	Qty	Price	Extended
Hand-hole - 60 inch	1	\$1,075.00	
Hand-hole - 48 inch	1	\$817.00	
<i>Difference between the two:</i>	1	\$258.00	\$258.00

Labor savings using Field Smart from Clearfield

	Qty	Price	Extended
Cable Prep	1 hour	\$65.00	\$65.00
<i>*Estimated Labor savings for OSP prep. Strip, buffer tube access, Clean 250UM. 60 minutes factory environment</i>			
Trouble shooting entry of splice closure	0.33 (conservative)	\$65.00	\$21.45
<i>*Estimated at minimum 1 entry during lifetime</i>			
Total Material and Labor Savings using Clearfield Patch & Splice			\$919.45

Passives in the Outside Plant: Access – The Last Mile

The last mile to the home (often referred to as the Access Network) is where the access point or “drop” is accomplished within FTTH networks. In contrast to the CO, hub and FDH areas which share common costs over a base of revenue, drop costs scale virtually in step with service deployments. Not only are the access costs very visible on a first cost basis (‘customer acquisition costs’) they are also typically a significant area for operational costs: moves, adds, changes, repairs, etc. To add to the complexity of the equation, it is in the drop where the carrier must leave its own property and the reasonably well controlled right-of-way and venture onto customer’s property, crossing streets, driveways, landscaping and ending up somewhere on the side of a building. Every deployment comes with its own set of complexities.

The critical element of the access network is the “drop” which is simply the last piece of carrier-owned fiber network. Normally, a drop cable is not installed until needed; that is, the customer at the home or building has ordered service and a team has been dispatched to install a drop cable, whatever electronic equipment is needed at the customer’s premise (often called the Optical Network Terminal or ONT) and performs whatever splicing and connecting is required.

The access point, providing splicing or interconnect functionality between the drop cable and the installed distribution network, can be placed aerially in pole or strand-mount closures, pedestals on the ground, or below grade in small hand-holes with closures. While the aerial or ground-mount options may or may not be sealed, the below grade option must be sealed to ensure against moisture entering the closure. Whatever access method is chosen, all must provide a reliable but easily installed physical connection between it and the customer premise. Extra work adds to customer acquisition costs and is highly visible and scrutinized constantly by the carrier’s financial organization.

Drop cable assemblies used today have one of several termination methods. Whether single or double-ended, the drop cable is usually of a flat construction with two strength members running parallel to a single buffer tube of 1 to 12 fibers or of a single tight buffered cable with outside diameter around 2.0mm and comes with or without a tracer for locating purposes. The widely promoted termination standard for this drop cable assembly is the HFOC (Hardened Fiber Optic Connector) which provides an environmentally protected and hardened interface for a conventional SC or connector body. Choosing this interface locks the user into providing the mating adapter either at the access point or at the ONT or both.

This mating function with HFOC at the access point is accomplished through a hardened termination distribution system where the distribution cable is spliced into it at the access point or a pre-terminated stub is interconnected somewhere into the distribution cable in another hand-hole with a splice enclosure away from the access point with a hardened multi-fiber connector. Both methods provide the physical link to the upstream distribution network, typically the fiber distribution hub (FDH), discussed previously.

The drop cable is then aerially lashed, pulled through conduit, or direct buried to the customer home and mated with a terminated end. The most expensive method is where a pre-terminated distribution cable is connected at the access point and a pre-terminated HFOC interconnects at the home. This is, generally, the most costly method for deploying drops, but avoids field splicing altogether. Additionally, expensive engineering resources are used and the design must be done to very tight tolerances to ensure

that everything “reaches.” A mistake in length at an access point can result in delays waiting for the correct assembly (if it’s too short) or having to find a place to safely store a long loop of cable (if it’s too long). A drop cable with HFOC at both ends also limits the ability to install a drop with a new or existing conduit run if it is less than 1” diameter as the HFOC connector is physically large and requires at least a 1” diameter duct. Though once the duct is properly sized, the pull itself is easy.

A more widely deployed method is to use a pigtail with a single pre-terminated end using an industry standard connector. The un-terminated end is then cut to length and field terminated, either to an industry standard connector or in a hard splice to an industry standard pigtail. There are two possibilities: one is to have the pre-terminated end, such as an HFOC, at the access point where the mating connector is already spliced back to the HFC, in which case the pigtail is spliced into a connector or pigtail at the ONT; the second, is to have the connector ready to go at the ONT and the splicing is done at the access point. The advantage of this methodology, in both flavors, is that it allows for exact lengths for slack storage to be accomplished at each and every drop. For the field crew, it is readily adaptable to aerial, direct buried, conduit, and any combination thereof. Pre-terminated pigtails may be stocked in various lengths on the truck (some vendors provide up to 1000’ foot lengths) and the excess is simply cut off. This is a cost-effective and simple method that does not increase the risk of excess inventories of cables pre-terminated at both ends. The argument that splicing is expensive and difficult to do infield is negated with today’s efficient handheld splicing machines designed for this application as well as the use of mechanical splicing hardware that yield high performance on par with traditional splicing.

Other cost elements come into play as well. Drop cables are the most likely to be damaged and thus simplifying the repair process is something to consider both in terms of technician time, the need to have one truck roll to fix the problem (not two: one to diagnose then another to come back with the right components), as well as the number of spare assemblies in the warehouse with their own inventory carry charges. Furthermore, in harsh climates, drops are temporarily done via aerial and then buried when the ground thaws or may simply be spooled out along the ground and protected as much as possible.

The Simpler Alternative

Use of pre-terminated cable, be it HFOC or standard, has demonstrable advantages. Clearfield customers have used the HFOC as well as the standard connector in their deployments. Clearfield recommends the use of the standard connector as it is far easier to deploy than the HFOC and we have witnessed minimal to no reduction in reliability through its use.

To expand upon this ease of use, cost savings and reliability, the Clearfield design team set out to design a solution that incorporate splicing within the pedestal – and then goes a step further by incorporating the protection of a Clearview™ Cassette. With a Clearview™ Cassette inside a pedestal of the service providers’ choice, a pre-terminated pigtail-style drop cable can then be mated to the cassette adapter outputs and finished off at the customer home with a splice to a terminated SC or LC pigtail which then is stored inside the ONT. Since the Clearview™ Cassette is the identical fiber management protection used in other parts of the outside plant as well as the central office, the packaging is familiar to the technician and install times are reduced. The pedestal can easily accommodate toneable cables as well as plain dielectric only. (While splicing of pigtails at the ONT is cost-effective, care should be taken to use jacket material that responds well in harsh environments. Clearfield’s ruggedized patch cords or pigtails are

designed with a MIL-SPEC rated cable that remains flexible down to 40 degrees below zero ensuring that the cable will be routed correctly and will perform through hot and cold temperatures.)

There are many opinions about whether to use flood proof, sealed, or non-sealed pedestals at the access point. All Clearfield solutions have a full range of environmental options while providing the ability to provide mid-span access: larger count cable can enter and leave a pedestal while handing off the necessary fiber to serve the desired homes at the access point. The flexibility for the network designer means easier route designs and the added advantage of lower profile pedestals in residential areas. Of course, fully buried and sealed enclosures are another option. Service repairs and temporary drops are readily accomplished in all types of circumstances. Interconnect or splice only options are available to suit the customer need.

Introducing the Clearview™ solution to a network deployment is also more readily accomplished in the access part of the network, where new techniques and technology can be evaluated at much lower cost and risk. In the CO or even an FDH, where engineering decisions taken months, if not years ago have driven the choice of components, any change, however desirable, is incremental. In the access network, especially where an FTTH deployment with new construction is not as tied to existing practices, the Clearview solution is an ideal place for a trial.

Take the Bite out of Passive in the Outside Plant – Access

Using the simpler deployment methodologies made possible through the Clearfield design, service providers can save more than \$28 per cabinet – serving four homes per pedestal, that’s a savings of \$7 per home connected in direct costs. Indirect costs, as discussed above, are readily identified as to type (lower labor costs, reduced inventory, etc.) but are harder to quantify.

Cost of the Simpler Alternative

	QTY	Price Ea.	Ext.
Pedestal, splice – Avg. feed 2-4 Homes	1	\$125.00	\$125.00
Ruggedized SC APC, Single fiber flat drop, toneable, Pigtail, 100'	4	\$38.00	\$152.00
Total			\$277.00

Traditional Costs

	QTY	Price Ea.	Ext.
Pedestal - closure within closure	1	\$145.00	\$145.00
HFOC SC APC, Single fiber flat drop, toneable, Pigtail, 100'	4	\$40.00	\$160.00

\$305.00

Cost Savings per Pedestal

\$28.00

Clearfield provides the access pedestal products to fit the environmental comfort level of the customer using simple and cost effective designs that are its trademark.

The Big Picture

The phrase "Total Cost of Ownership" or TCO has been used extensively in this paper. The Beta Partners, LLC study referenced earlier provides an interesting chart representing a comprehensive view of the TCO factors relating to a FTTx deployment, with the "x" representing fiber to the "node", "curb", "premise" or "home".

The following chart is used with permission from Beta Partners, LLC, with the final column added by Clearfield. Note that many of the TCO factors are, indeed, well beyond the physical layer, but represent the entire range of factors needed to be considered.

Life Cycle Cost Stage	Elements or Components	Clearfield Advantage
Plan	Engineering & Planner staff and direct costs	Simplified design, one component across all areas
	Marketing & Sales staff and direct costs	
	Marketing & Sales activities including customer surveys, literature, advertising	Clearfield RUS listed
	Legal (permits, environmental studies, taxes and fees, licenses and FAA clearance for radio towers, if used)	
	Financing (RUS, BTOP, etc.)	Simple to understand and use, especially suited for trial and evaluation use
	Vendor and contractor evaluation work	
Purchase	Test and integration planning	Use of standard connector means test equipment need not accommodate HFOC types
	Capital costs – direct for hardware and materials	Cost competitive across all applications
	Consultants and contractors	
	Capitalized expenses for labor and related costs	Simple to understand and use, especially suited for trial and evaluation use
	Shipping, storage, warehousing, carrying costs for inventory	
	Spare parts initial buy	Ease of use, both at installation and long term, fewer parts needed due to high commonality
	Finance charges and costs for loan closing, legal services, insurance riders	
		Again, fewer parts means less inventory now

Life Cycle Cost Stage	Elements or Components	Clearfield Advantage
Deploy	<p>Installation labor and consumables</p> <p>Inside wiring and carrier-supplied CPE</p> <p>Right of way restoration</p> <p>Upstream Internet connectivity, routing, firewall</p> <p>Testing and systems integration, new test equipment</p> <p>Technician training and certifications</p> <p>Customer service and customer support training</p> <p>Updating corporate web site</p> <p>Migration of existing customers to new platform(s)</p> <p>Upgrade of computer or IT infrastructure, software licensing</p> <p>Changes / modifications or installation of OSS and BSS systems and components</p> <p>Security, network integrity and reliability evaluation, case testing and remediation work, security key Certificate Authority (if needed)</p> <p>Content licensing, Conditional Access and Digital Rights Management</p> <p>Increasing UPS capacity, portable gen-set purchase</p>	<p>Clearfield can demonstrate its superiority</p> <p>Conventional F/O test equipment is all that is needed</p> <p>Once trained on the cassette, it becomes familiar and routine and takes less time on the job site</p> <p>Simplified drop installations at customer's homes with minimal installation of OSP pedestals and construction</p>
Maintain	<p>Ongoing routine maintenance for equipment and service restoral</p> <p>Spare part acquisition</p> <p>Moves / adds / changes and new service orders</p> <p>Ongoing licenses for software and content</p> <p>Security audit and remediation, patch management</p> <p>Licenses and permits, content use audits</p> <p>Financial audit and accounting charges</p> <p>Increasing recurring costs for power, water, insurance, utilities, facility maintenance</p>	<p>Clearfield's components are tested to the highest standards and commonality assures availability for years to come</p> <p>Already a Clearfield strong point</p> <p>Smaller footprint, lower leases</p>

Life Cycle Cost Stage	Elements or Components	Clearfield Advantage
Refresh	Change out of older components driven by capacity, function, end of life by vendor, damage, wear & tear [Repeat plan, purchase, deploy, maintain cycle for new network components]	Highly modular and with 12 port granularity, inevitable moves and changes can go easier and faster

Summary of Cost Savings

At Clearfield we set out to enable service providers to build the most reliable fiber networks possible. That's why our fiber management and other passive connectivity solutions are designed to the full suite of Telcordia Standards and listed with the RUS. But we also recognize that the delivery of broadband connectivity is a business – and a business in which costs to subscriber ratios are constantly scrutinized and every penny per home spent must be evaluated for the return on investment.

Through the use of simpler design principles made possible by the Clearview™ Cassette and the FieldSmart product line, this whitepaper documents how it is possible to save more than \$9 per home in the central office, \$3 per home at the outside plant cabinet and \$7 per home at the pedestal – that's \$19 per home served.

No matter the size of your network those numbers really add up. Small communities of no more than 5,000 homes can recognize savings of nearly \$100,000 while nearly a million dollars of savings is possible for larger communities of 50,000.

Access Network Savings	Savings	Homes	
	\$19	5000	\$95,000.00
	\$19	25000	\$145,000.00
	\$19	50000	\$950,000.00

Conclusion – Clearfield, your new Best Friend

From the central office to the customer home, from conditioned to non-conditioned environments, service providers are looking for significant cost savings in their passive connectivity budgets. By using simpler yet innovative methods and techniques that take the bite out of passive network deployments, FTTH can be cost-effective without sacrificing performance or reliability of the network.

Introducing Clearfield technology to existing network architecture does take time and effort, but can be well rewarded by favorably influencing many of the key Total Cost of Ownership factors for the entire lifecycle of a physical infrastructure. The Clearfield product design, application engineering and field support teams are experts at both introducing Clearfield products into networks designed to a wide variety of practices and vendor-specific solutions. While a greenfield project may be the easiest way to test-drive the Clearview™ Cassette, any fiber infrastructure which is changing and growing – which would be almost all of them – are candidates to demonstrate the modularity, capability and usefulness of the system.

Introducing Clearview™

Traditional fiber management has been designed from the outside in. All hardware that provides the necessary protection is designed into the box in terms of sheet metal chassis, connector panels and splice trays, placing a hard limit on the scalability that can be achieved. In order to provide the most flexibility and scalability in the industry, Clearfield design engineers believed that fiber management needed to be designed from the inside out. They sought to establish a building block that would protect 12-fibers at a time supporting all cable constructions. They felt a “Lego®-like” approach that incorporates all of the design considerations of protection, portability, and modularity could offer service providers a simple, cost effective and rapidly delivered solution that could offer a level of scalability from as small as 12 ports to any port count desired. They sought to ensure the same device could be used throughout the network – from the central office through the distribution and access networks – all the way to the home. Such a design would allow for fewer inventories, would create familiarity thereby establishing shorter learning curves, and cost reductions from volume and shorter network installation times.

The result is the Clearview™ Cassette.

The Clearview Cassette is a system composed of just five carefully engineered parts that fully nest together to support any application in the inside or outside plant. Parts are added or removed to support the configuration element desired for the environment that it is being deployed into. All types of fiber construction can be integrated into the cassette. The cassette can support all patch only, patch & splice, passive optical component hardware, and plug n’ play scenarios with small form factor multi-fiber connectors.

From here, the cassette will populate, up to desired densities, into various fiber management housings ranging from:

Inside Plant – Central Office, Head-end, remote hut

- Patch Only Panels

- Patch & Splice Panels

- Tie-Panels

- Indoor rated wall boxes

OSP Distribution

- PON cabinets

- Cross – Connect cabinets

OSP Access

- Pedestals

- NEMA 4 Wall boxes

 - MDU wiring systems

 - Customer Premises

 - Business Parks, Multi-tenant commercial buildings