CLEARFIELD PUSHABLE FIBER DUCT SYSTEM
TOTAL COST OF OWNERSHIP REVIEW

FOR

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I. Overview

Clearfield Communication has new products and techniques for home drop purposes (connection between curb and home) and requested an independent and unbiased view of the total cost of ownership (TCO) using their products and installation methods versus current typical drop methods using direct buried cable. RVA Market Research conducted this analysis focused on single family homes.

Clearfield believes its drop cable products and installation methods have advantages both in terms of initial installation and ongoing maintenance costs.

A. Initial Installation

In the recent past, installing direct buried drop cable has been the most commonly used method to install underground drops to the home, based on information from Clearfield.

Indeed, some drops have been installed with conduit, but using duct with pre-connected fiber often meant requiring conduit as large as three quarter inch. Installing such large diameter duct is considerably more expensive in terms of initial installation cost as compared to direct buried cable.

Utilizing small "microduct" for drops has always been an option, but it often meant fiber was inserted using a "blowing" method, and the need to splice connectors to the fiber in the field. This process also can increase the expense of the process versus direct buried cable and has not become a common practice in North America.

Clearfield has developed a new type of microduct and an accompanying installation method. The company believes the cost of this approach is much closer to the front-end cost of installing direct buried cable than other types of duct used in the past. Lower costs for this type of duct system are based on two stated innovations:

1. A micro-duct that is much smaller than typical duct and yet is large enough to accept fiber with small pre-connectors attached.

2. A way to push the fiber into the duct without expensive equipment or highly trained technicians.

B. Maintenance Costs During The Life Of The Drop

The greatest maintenance cost for buried fiber drops relates to physical cuts in the cable from machinery, hand digging, pet digging, root growth, underground animal activity, earthquakes, etc. Such cuts disrupt service to the customer, of course.

In the recent past, the typical approach to restore service from a cable cut was to install new cable for the entire distance of the drop. (According to Clearfield, other approaches may be utilized infrequently, such as when the cut point is known and occurs close to one end. In this case, it may be possible to expose the cut, and re-splice the cable if sufficient slack can be obtained.)

The largest cost disadvantage of entire replacement of direct buried cable is the cost of reopening an entire trench (or vibratory plowed slot) across the customer's outside premises.

Clearfield has developed what they consider to be a more efficient and cost effective method to repair cut drops than the current process required for direct buried cable. This claim primarily relays on one stated innovation:

1. A new method of cut fiber restoration utilizing ducted installation.

   In this new process, when a duct and internal fiber is cut, the existing fiber is first pulled out of the duct. The distance to the cut in the fiber is measured and the soil is then potholed in one single hole directly above the broken point in the duct. The duct is rejoined with a coupler and a new complete pre-connectorized fiber length is then pushed back through the duct and reconnected on both ends.

II. Background Data

In order to determine the total cost of ownership including ongoing maintenance, the following data was required:

A. Reasonable Timeframe For The Life of the Drop

In order to determine a reasonable timeframe for the life of an average drop, i.e. determine the length of time a drop asset would normally be in continuous use, RVA used existing survey data from past RVA surveys.

RVA determined that a 15 year timeframe would be a reasonable estimate for average continuous utilization of a drop by a FTTH provider via the following discussion. (Average total use would likely be longer given that some churned homes would eventually return to the original fiber provider.)

RVA conducted national consumer studies show that 6.2% of consumers churn from a fiber provider annually because they move to another residence. Slightly less than 1% churn from an FTTH provider for other reasons.

Assuming a FTTH provider retains 60% of the premises that change hands for moving (i.e. the provider resells 60% of the new residents, which should be a reasonable assumption, given recommendations from the home seller, less hassle for the new resident etc.), this means they would lose 2.5% of customers per year because of ownership changes plus the 1% for customers not moving but changing providers. Thus, overall, the provider would lose 3.5% of customers per year. (As noted earlier, this is a conservative assumption because some homes would move to other providers for a time and then move back to the original provider.) With the 3.5% annual loss assumption, the average length of time a FTTH home would be retained by the provider without any interruptions would be just over 15 years.

B. Number Of Cable Cuts Within Life Of The Drop

As mentioned, underground drop cable cuts can occur for various reasons. In order to determine the average number of cuts to underground cable during its lifetime, RVA conducted new consumer research among 2,000 random participants across the U.S.

Based on this August 2014 study, approximately 67% reported living in a single family residence with an Internet or television cable buried to their home. Additionally, among those in single family homes with underground cable, approximately 12.3% reported a cut in the cable within the past 12 months.

Based on this new research, RVA determined that each drop would experience a cut, on average, every 8.1 years – or experience 1.85 cuts during a 15- year period.

C. Initial Installation Costs For Comparative Products

A 150 foot drop is assumed for a typical initial install. To ensure apples to apples comparison, it is assumed both methods use pre-connectorized fiber slightly longer than the drop.

The initial installation cost is computed as follows for both the current direct bury method and the new pushable duct method:

INITIAL COSTS	DIRECT BURY CABLE	PUSHABLE/ DUCT
150' Undergrounding	$282 Plowing	$282 Plowing
160 ' Fiber connectorized both ends	$78 Direct bury cable - pre terminated	$62 Pushable fiber - pre terminated
Micro duct	$0 NA	$45 10 mm duct
Connecting fiber	$40 1 hour level 1 tech (loaded)	$40 1 hour level 1 tech (loaded)
Total	**$400**	**$429**

D. Maintenance Costs For Comparative Products

The cost of maintenance to repair cuts appears to be significantly lower for the pushable duct method versus direct buried cable for the following reasons:

1. The entire direct buried cable must usually be replaced, requiring re installing the cable underground.

   By contrast, pushable duct system repair does not require complete replacement as described in section I, B above.

2. The direct buried cable must usually be spliced at one end, because the greater mass and larger workable bend radius of direct buried cable makes coiling significant slack fairly impractical and often requires special housings for the slack. This also requires a higher level technician.

   By contrast, bare fiber used in the pushable fiber system can be pre-connectorized on both ends and coiled tightly in existing housings.

MAINTAINANCE /RESTORATION COSTS	DIRECT BURY CABLE	PUSHABLE/ DUCT
Truck roll 1, Troubleshooting, temporary drop	$80 1 hour level 3 tech (loaded)	
Truck roll 2, Plowing in cable	$282 Plowing 150' (contractor)	
Truck roll 3, Final drop installation /splice one end	80 1 hours level 3 tech (loaded)	
Truck roll 1, Troubleshooting, temporary drop		$80 1 hour level 3 tech (loaded)
Truck roll 2, Potholing, duct splice, push/ connect new fiber		$40 1 hour level 1 tech (loaded)
Total Per Event	$442	$120
Total Per 15 years (1.85 events)	**$818**	**$222**

(The net present value of future costs is not used in this comparison, for simplicity, and because while there is a lower present value of future costs, it is assumed that labor costs will increase at a faster rate. If net present value concepts are included, however, the same basic gap in costs exists.)

III. Total Cost Of Ownership

Based on the data developed above, the total cost of ownership for the Clearfield pushable duct system was developed:

A. Base Case Cost Of Ownership Comparison

The TCO for the pushable duct system in this scenario is only 53 % percent of the traditional direct buried drop cable.

TOTAL COST OF OWNERSHIP	DIRECT BURY CABLE	PUSHABLE/ DUCT
Initial Installation	$400	$429
Maintainance/restoration 15 years	$818	$222
Total	**$1,218**	**$651**

B. Additional Factors That Could Further Widen Cost Of Ownership Comparisons

As noted earlier, there are other potential advantages to pushable duct fiber that are more difficult to quantify and therefore not included in this analysis. These factors would almost certainly make the actual gap in total cost of ownership greater than the preceding analysis.

1. More fiber cuts with direct buried cable

   In our comparative case we assumed the same number of cuts for both direct buried cable and ducted fiber. In actuality, there would likely be more cuts with direct buried fiber without the additional protection afforded by conduit. (Duct is unlikely to withstand a hit with a backhoe, but more likely to withstand a hit from a shovel or activity from underground rodents, etc.)

2. Higher underground costs with direct buried cable

   If obstacles are encountered in drop placement such as sidewalks or driveways, the cost of undergrounding may be increased for direct buried fiber – which may be installed under obstacles via horizontal directional drilling or pneumatic piercing tools. (Micro duct can often be installed by cutting a narrow cut or grove in the obstacle, installing the conduit, and then grouting the groove.)

   Further, for the base case, we assumed that both comparative methods use fiber pre-connectorized on both ends for initial installation. In actuality, the direct cable method is often is spliced on one end so the drop cable can be precisely sized. Splicing requires an additional level 3 technician and more cost.

3. More costs related to customer churn with direct buried cable

   Given that reconnecting direct fiber could take more time because of more work and more steps (especially scheduling someone to re plow the entire distance to lay a new cable, etc.), the typical service

disruption would be longer and there would be more noticeable disruption to the consumer's yard and landscaping –first in terms of a temporary line laid on top of the yard, and second in terms of undergrounding the final drop. This would typically cause more consumer dissatisfaction with the provider. Based both on past RVA studies (and common sense) lower satisfaction is correlated to increased customer churn and increased marketing costs to replace churned customers.

IV. Conclusion

While RVA LLC does not directly recommend or endorse any particular telecom equipment vendor, it appears the concept of small drop conduit with pushable connectorized fiber and a well thought out system to repair fiber cuts in the field does have potential total cost of ownership advantages. The advantages appear to be statistically significant as compared to methods commonly used today.

This conclusion is based on both new market research conducted by RVA to determine the number of fiber cuts likely over a TCO period, and from general deployment assumptions provided by Clearfield. (RVA has not independently verified all these assumptions.)