



## Value of Micro Cabling Systems vs. Traditional Fiber Optic Cabling Systems for Access Networks

*Using micro cabling systems for access networks will better utilize appropriated funding by reducing CAPEX and OPEX, and at the same time significantly reduce our impact on the environment. Blown fiber micro cabling technology is quickly becoming the preferred system solution for access networks based on bandwidth requirements, speed of deployment, network flexibility, future scalability, and of course, the lowest total cost of ownership. When compared to traditional fiber cabling, micro cabling systems provide a much higher return on investment (ROI) due to reduction in material costs, as well as the overall lower cost in labor capitalized by drastic reduction in installation time. Furthermore, significant reduction of plastic materials consumed in the production of both ducts and cables, as well as volume and weight reduction in transportation, considerably reduces the impact on the environment. This paper will provide detailed real-world use case examples and best practice guidelines.*

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### Fiber Micro or Traditional Cabling

While there have been many advances in recent years, blown fiber cable is not a new technology, although it is relatively new compared to conventional cabling methods.

The earliest known version of blown fiber cable (using compressed air to push fiber cabling through tubes) dates back to the 1980's. The technique of installing flexible and lightweight fiber optic units using compressed air was further developed by British Telecom. Over the past decade in particular, micro-cabling system deployments have rapidly gained popularity due to significant advantages this technology offers over conventional fiber optic cabling.

The continuous need to reduce total cost of ownership, and enhance network flexibility and scalability, especially in large Fiber to the Home (FTTH) rollouts, and the emerging deployment of the backbone and access parts required to support 5G networks. Driven by innovation in this space, blown fiber micro cabling systems have continued to evolve and improve over the years, and in almost every aspect, the most up to date air-blown cabling solutions and installation techniques fulfill the needs of today's and tomorrow's networks. So, how is that?

When compared to traditional cabling techniques such as cables pulled in or jetted into large (traditional) conduits, blown cabling systems utilize much smaller micro tubes or microducts to blow (or "jet") lightweight optical fiber bundles or micro cables through predefined pathways at speeds of up to 500 feet per minute (~150 m/min). These micro tubes are manufactured of tough but flexible materials and are sized to

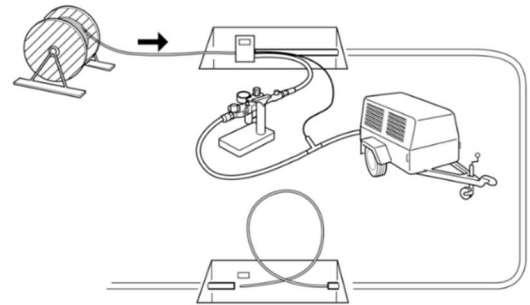


Figure 1. Air blowing of micro cables

accommodate up to 432 fibers or more per micro tube within a microduct which can be installed above ground (aerially) or underground.

### Understanding micro cabling

So, what are the benefits of first laying several small tubes (microducts) in the ground and then blowing in the fiber micro cables in later? It seems to be a two-step operation instead of just laying the cables directly into the ground. To better understand this technology, we need to understand how these microducts are assembled. Multi-way microducts come in a variety of standardized sizes and contain color-coded cells or microducts through which the optical fiber bundles or micro cables are blown. Using couplers, installers connect individual micro cable cells together in tube distribution points, to provide dedicated pathways (routes) through which the fiber cables are blown to achieve a splice-free, point-to-point installation. A splice-free installation saves installation time and improves overall system reliability. System reliability is further enhanced because no strain is placed on the fiber during the installation process.



Figure 2. Microduct assembly for incremental installation of micro cables. The assemblies typical comes in configurations from one to seven microducts.

However, there is so much more to this great story:

The ducts are installed separately and in advance, which means:

- Installation of optical fiber cables may be incremental, adapted to growth in accordance with end user demand.
- Unlike traditional cable pulling methodology, the blown-in fiber cable is not affected by harsh treatment during installation which enable use of slim lightweight cables.
- Minimization of splice points, which reduces installation time and installation cost as well as implications to optical loss budget.
- Easy network upgrade with ability to increase fiber counts or switch to other types of fiber.
- Simplified network design with built-in multi pathway flexibility.



Figure 3. Comparison between traditional cabling in duct and micro cable, initial installation and full installation.

## Total Cost of Ownership

Installation cost for any system can be substantial since installing takes time and is labor-intensive. Typically, the cost of materials is a much smaller component of the total installed system cost.

When planning a network, it is common to budget for installation (including material) and then separately budget for operation, including service and maintenance. When budgeting for installation, this cost is divided into:

1. Cost for materials (typically 15-20%)
2. Cost for labor (typically 80-85%)

As such, significant savings can be achieved by using system solutions that are *installation optimized*. So, what is an installation optimized system and how can we show that these methods actually save time and money?

- Use techniques that eliminate or minimize time consuming splice points
- Use cables designed for longest possible installation lengths by blowing
- Use lighter materials (ducts and cables) that facilitate easy handling, faster installation speeds and smaller installation teams, while at the same time lowering the transportation costs for materials as well as work crews.
- Use a system that is easy to upgrade with spare ducts available for future cable installation

## Material and Installation Cost

To be able to analyze the cost difference between traditional cables and micro cables we have studied several scenarios, see table 1. As an example, let's take a closer look at two of these scenarios:

*Scenario 1* - Let's say we want to build a system initially with 288 fiber capacity and want it to be easily upgradable for future expansion.

- A 288-fiber *micro cable* has a diameter of as small as 8.5mm. The cable can be installed in a 4-way 16/12mm (OD/ID) microduct

bundle, which leaves three of the microducts available for future installations.

- *Traditional cable* with the same capacity would be approximately 18mm in diameter and require at least 1.25" conduit or larger. To get the same capacity as the micro cable option with four subducts, three more conduits need to be installed.

Comparing the material and installation cost for the two options above, the traditional cable system would cost 58% more than the micro cable option, see figure 4 and leftmost column in table 1.

*Scenario 2* - Another scenario is to use large conduits in the traditional cabling system together with Maxcell fabric innerduct. The fabric creates sections, or tunnels in the conduit to enable more cables to be installed separately inside one single conduit. Four of the traditional 288f cables can then be installed in a 4" conduit giving a total capacity of 1,152 fibers.

Even in this scenario, the micro cabling system with the same capacity delivers a substantial cost advantage. Specifically, the traditional system is 61% more expensive (see rightmost column in table 1).

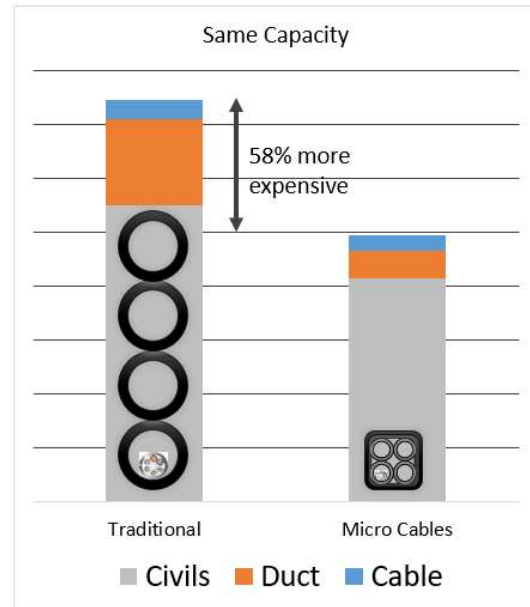


Figure 4. Comparison between traditional and micro cabling cost

MICRO CABLE	288f	288f	576f	864f	1,152f
288f micro cable	2.00	2.00	2x2.00	3x2.00	4x2.00
4-way 16/12 mm microduct	0.64	0.64	0.64	0.64	0.64
Maxcell	N/A	N/A	N/A	N/A	N/A
Duct installation (trenched)	4.50	4.50	4.50	4.50	4.50
Cable Installation (blown)	0.60	0.60	2x0.60	3x0.60	4x0.60
<b>Total cost (\$/ft):</b>	<b>7.74</b>	<b>7.74</b>	<b>10.34</b>	<b>12.94</b>	<b>15.54</b>
TRADITIONAL CABLE	288f	288f	576f	864f	1,152f
Conduit size (standard sizes)	4x1.25"	1x1.5"	1x2"	1x3"	1x4"
288f Cable (non-armored loose tube)	3.00	3.00	2x3.00	3x3.00	4x3.00
Conduit	4x0.32	0.33	0.62	1.34	2.44
Maxcell (in duct, least cost)	N/A	N/A	0.50	0.70	1.00
Conduit installation (trenched)	7.00	4.50	4.50	5.18	5.63
Cable installation (pull)	1.00	1.00	2x1.00	3x1.00	4x1.00
<b>Total cost (\$/ft):</b>	<b>12.28</b>	<b>8.83</b>	<b>13.62</b>	<b>19.22</b>	<b>25.07</b>
<b>DELTA % (Trenched)</b>	<b>+58 %</b>	<b>+14%</b>	<b>+32%</b>	<b>+48%</b>	<b>+61%</b>

Table 1. High level comparison of total cost between micro cabling and traditional cabling (unit costs are typical USD/Foot)

## CO<sub>2</sub> Emissions – Too Big to Ignore



Figure 5. Comparison of standard duct cable and micro cable

In addition to cost savings, there are substantial environmental benefits realized when using solutions that consume less materials and generate less volume. When comparing a traditional cable with a micro cable, the diameter is normally 2 to 2.5 times larger for a traditional cable. This relates to a volume and weight difference of 4 to 6 times, see table 2.

A traditional cable, when installed in a duct, requires much larger ducts than micro cables so the materials savings (plastic) as well as the related transportation implications, will be further enlarged.

The total material consumption related to cables and ducts at 4-6 times greater, is directly proportional to a much higher environmental impact. However, this impact is not only related to the manufacturing process and use of raw materials. Shipping, handling and installation are

also, a major part of CO<sub>2</sub> emissions. The CO<sub>2</sub> emissions implicated here are related to fuel consumption incurred during the transportation of cables, ducts or conduits from production facilities, to distribution warehouses, to installation sites. This also includes the delivery of raw materials from the suppliers of plastic raw materials to the manufacturing plants.

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CABLE	Diameter [mm]	Weight [lbs/ft]	Weight [delta]	Length per truck load [ft]	Length per truck load [delta]
288 fiber micro cable	8.5	0.038	-	104,986	-
288f traditional	18.0	0.188	+395%	236,220	+125%

Table 2. Comparison of a 288f micro cable and 288f traditional cable.

DUCT and CONDUIT	4-way 16/12mm	1.25" SDR9	1.5" SDR9	2" SDR9	3" SDR9	4" SDR9
Plastic mass [lbs/ft]	0.368	0.372 (+1%)	0.488 (+32%)	0.762 (+107%)	1.655 (+349%)	2.737 (+643%)
Length per truck load conduit [ft]	102,000	102,000 (0%)	78,000 (-24%)	36,000 (-65%)	18,000 (-82%)	6,600 (-94%)
Increased fuel consumption	-	-	+31%	+183%	+467%	+1445%

Table 3. Comparison of 4-way 16/12mm microducts and SDR9 conduits.

Let us look at our two scenarios again and compare the CO<sub>2</sub> emissions:

*Scenario 1* - This scenario compared 4x1.25" conduits with a 4x16/12 microduct assembly. As seen in table 3, this gives us *up to 4 times (+300%)* higher fuel consumption and CO<sub>2</sub> emission with traditional cables/conduits compared to a microduct solution, see Figure 5.

*Scenario 2* – Here we compare a 4" conduit with Maxcell fabric. Again, in table 3 (rightmost column), we see that the emission is almost outrageous, more than *15 times larger (+1445%)* compared to a microduct solution!

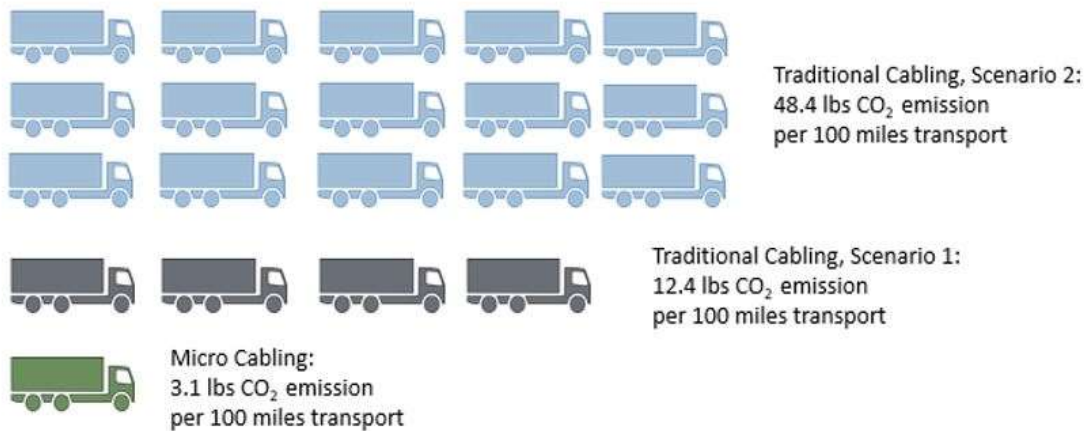


Figure 6. Comparison of CO<sub>2</sub> emission per 1000 ft 4" conduit, 4x1000 ft 1.25" conduits and 1000' 4-way 16/12mm microduct.

## Let Us Compare

When focusing on the savings in cost, the Total Cost of Ownership (TCO), and the environmental benefits in lower CO2 emissions, we can summarize the following:

### Conclusion

We have demonstrated that micro cabling systems deliver the lowest total cost of ownership and the highest level of scalability and flexibility relative to traditional cabling systems. Furthermore, micro cabling systems have a substantially lower carbon footprint by using less plastic materials and burning less fuel during transportation, making this technology much more environmentally friendly over the legacy technology of pulling cables through standard conduits.

Every network owner and system installer strive for lowest *Total Cost of Ownership (TCO)* and highest level of network futureproofing. Blown fiber cabling techniques were specifically developed to provide exactly this functionality

Consideration	Traditional Cabling	Micro Cabling	
<b>TCO</b>	Materials Cost	Larger cables require larger, more expensive ducts	Reduced size enables smaller ducts at lower cost
	Installation Cost	Heavy, bulky materials handling, and short installation lengths combined with time consuming fiber splicing	Installation cost reduced by 30 to 50% due to more efficient installation in shorter time, and with fewer personnel required
	Transport Cost	Very high due to large volume on cables and ducts	4-6 times lower than traditional
	Upgrade Cost	Not possible, unless very expensive ducting installed day one	Very low cost since microduct installations usually involves spare ducts for future installation
<b>CO<sub>2</sub></b>	Material Usage	High weight and volume, high usage of polymers	Extremely efficient materials usage, 4-6 times lower than traditional
	Transport Emission	High weight and volume	Extremely efficient, 4-6 times lower than traditional

for branched networks such as FTTH. Recently, this technology has gained more interest in other applications, such as long haul, datacenters and 5G since the cost benefits are substantial for almost all applications.

In addition, the environmental impact using micro cabling systems is just a fraction of comparable traditional cabling systems. In a straightforward comparison, it is therefore hard to argue for traditional cabling techniques in favor for air-blown micro cabling.

### Authors:

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