IDC TECHNOLOGY SPOTLIGHT

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**Communication service providers must invest continuously to enhance their network infrastructure to meet growing demand. Selecting the ideal optical fiber will not only address deployment and operational challenges, but also help to future-proof the network investment.**

# Innovations in Optical Fiber: Enabling the Evolution of Next-Generation Telecom Networks

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## Driving the Future of Connectivity

Users have been demanding higher bandwidth since the 24x7 availability of internet connectivity has become ubiquitous. The COVID-19 pandemic situation has further spurred the demand for higher bandwidth and stable broadband connectivity to support new lifestyle norms. People are required to stay at home due to COVID-19 lockdowns, and connectivity has given them the flexibility to continue with daily activities such as work, learning and entertainment from their homes.

This situation has created a bottleneck for telecom infrastructure providers since network traffic demand has shifted from business areas to residential areas. Communication service providers (CSPs) must take swift action to solve the network congestion problem. In addition, demand for broadband connectivity has increased since more people are interested in subscribing to high-speed broadband services. At the same time, CSPs are required to expand their fiber network footprint to deliver the high-speed connectivity service to more subscribers, which eventually will expand their coverage and subscriber base.

## AT A GLANCE

### WHAT'S IMPORTANT

Continuous CAPEX investment is required to upgrade existing network capacity to cater for increasing demand for data.

### KEY TAKEAWAYS

Selecting the ideal type of optical fiber for telecom network deployment will:

- Protect network investment
- Increase the lifespan of connectivity infrastructure

Bend-insensitive fiber should be an important consideration in the planning of next-generation connectivity infrastructure.

Based on IDC's 2021 Asia/Pacific Carrier Transformation Survey, 51.1% of the CSPs in Asia Pacific region are already changing their geographical focus to concentrate on areas that have more demand and potential in creating additional revenues for them.

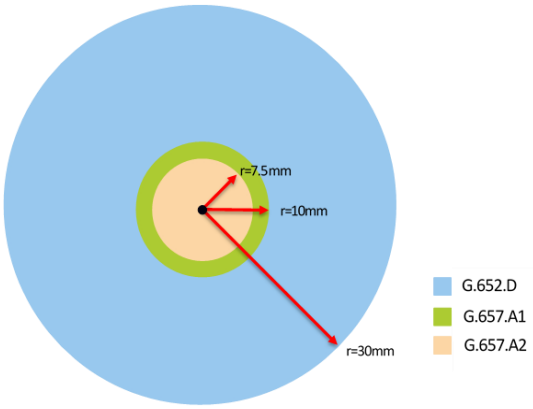
According to IDC, the consolidated global telecom industry capital expenditure (CAPEX) of US$292.7 billion in the year 2020 has been diverted partially from network expansion to upgrade existing network capacity which will cater to increasing demand for data consumption. Furthermore, operators such as AT&T, China Mobile, China Telecom and Verizon have announced additional budgets of up to US$500 million in total to manage evolving demands due to the pandemic. Verizon increased its capital expenditure to 24% year-on-year (YoY) to support high traffic growth across its networks, and has deployed fiber and additional cell sites to expand the its 5G network.

There is on-going investment in optical fiber since next-generation telecommunication technologies like fiber-to-the-x (FTTX) and 5G require this transmission medium to carry terabytes of data. Optical fiber is obviously an enabler in the evolution of the telecommunication network, and it is imperative that CSPs select the ideal optical fiber to protect their network investments and ensure that their networks can deliver advanced telecommunication technologies in the coming future.

## Network Infrastructure Transformation: One Fiber Type for All

The most commonly-used single-mode optical fiber for terrestrial network deployment is ITU-T G.652.D optical fiber, also known as legacy optical fiber. Legacy optical fiber has been deployed in both long-haul transmission and short-haul access networks for almost two decades. As technology evolved, optical fiber applications extended into the customer premise, especially with the introduction of GPON/EPON and Metro-Ethernet technology-related services.

FIGURE 1: ***Minimum Allowable Bending Radius for Each Type of Optical Fiber***




*Sources:*
*1) ITU-T G.652 Characteristics of a Single-mode Optical Fiber and Cable, 2016*
*2) ITU-T G.657 Characteristics of a Bending-loss Single-mode Optical Fiber and Cable, 2016*

Installation of optical fiber into customer premises at both residential and business sites with legacy optical fiber has disadvantages due to its bending limitations. The minimum allowable bending radius of legacy optical fiber is 30mm and sharp bends or corners within customer premises will introduce macrobend, extrinsic optical loss which further increases the total link loss for the network.

ITU-T G.657 optical fiber was introduced to eliminate the bending limitation issue at last-mile installations and due to its bend-insensitive capability, it is known as bend-insensitive optical fiber. The standard types of optical fiber used by CSPs for last-mile installation are mainly bend-insensitive ITU-T G.657.A1 and ITU-T G.657.A2. The former has a bending radius of 10mm, while the latter has a smaller bending radius, of 7.5mm.

Maintaining two different types of optical fiber in telecommunication networks has some drawbacks for CSPs since joining (splicing) of the fibers will create higher splice loss due to mode field diameter (MFD) mismatch. From Table 1, it is evident that different types of optical fiber have different ranges of MFDs and thus, cross-splicing these optical

fibers results in a mismatch between the fibers, which will require additional optical testing to ascertain the exact splice loss.

TABLE 1: ***Mode Field Diameter for Different Types of Optical Fiber***

| Fiber Type | Mode Field Diameter at wavelength, λ = 1310nm | Tolerance |
|---|---|---|
| **G.652.D** | 8.6µm – 9.5µm | ± 0.6µm |
| **G.657.A1** | 8.6µm – 9.2µm | ± 0.4µm |
| **G.657.A2** | 8.6µm – 9.2µm | ± 0.4µm |

*Sources:*
*1) ITU-T G.652 Characteristics of a Single-mode Optical Fiber and Cable, 2016*
*2) ITU-T G.657 Characteristics of a Bending-loss Single-mode Optical Fiber and Cable, 2016*

The concern for the fiber technician is that they cannot distinguish the type of optical fiber with the naked eye, and this will result in them treating all these optical fibers the same way. This practice would increase the chances of cross-splicing occurring between two different types of optical fibers.

Bend-insensitive optical fiber was primarily designed for last-mile installations in access networks, focusing on customer premise installations. Later, applications for bend-insensitive optical fiber extended to both access and transport networks, where legacy optical fiber has been widely used. Designing and deploying telecommunication networks by selecting bend-insensitive optical fiber for both access (short haul) and transport (long haul) networks will not only avoid the MFD mismatch which causes higher splice loss, but will at the same time give better bending performance for the network, and reduce macrobend losses that exist in fiber optic splice closures and other fiber installation boxes.

Moreover, implementing bend-insensitive optical fiber for telecom network infrastructure will extend the lifetime of the network since undesirable optical losses incurred due to macrobend will be drastically reduced. This practice will become a buffer for the additional losses that will be introduced due to any repair works that happen throughout the lifetime of the network.

In summary, deploying access and transport networks with a single type of optical fiber that is bend-insensitive provides the CSP with several advantages:

- Better bending performance and reduced macrobend loss.
- Avoids MFD mismatch and reduces high splice loss.
- Extends the lifespan of network infrastructure.

## Modernizing the Fiber Network

Optical fiber is both flexible and fragile since it is made of silica (glass). The bare optical fiber cannot be installed, especially in outdoor environments, without proper protection. Multiple strands of optical fiber are encapsulated by cables for protection and easy application deployment.

Different kinds of cables have been designed for various applications and installation scenarios. The contemporary types of cables that are used by CSPs for their telecommunication networks are:

- All-dielectric self-supporting (ADSS) cables
- Micro cables
- Ribbon fiber cables

ADSS cables have been introduced for applications on the electrical grid since they do not have any metallic components as part of the cable structure. ADSS cables can also be used in both overhead and underground telecom network infrastructure, especially in brownfield areas. Applications of this cable in both scenarios will simplify inventory management since one type of cable could be used for both aerial and underground installation. Furthermore, there is no need to ground such cables for aerial installation since they lack metallic parts. This saves costs for network infrastructure providers during the network deployment stage.

While ADSS cables have been widely applied in brownfield scenarios, the miniature version of loose tube cables – micro cables – are designed to be considered for greenfield areas. A greenfield area like a new township could have proper infrastructure planning that includes microduct installations as part of town planning. With proper planning and availability of microducts, micro cables can be installed at a relatively fast pace and additionally, provide easy scalability to the network when the time comes for expansion of the connectivity infrastructure. Blowing machines and skilled technicians are required to conduct micro-cable installations.

It is very common to see the optical fiber come in a single strand. Jointing a 96-optical fiber cable requires 96 splices at each jointing point. For long-haul transport network deployment, this effort could be very time-consuming and costly. Ribbon fiber, where the optical fibers are aligned and bonded together in a group of 4, 8, 12, or 16 optical fibers, will help CSPs to complete the splicing work much faster.

If there are any cable-cut issues, the maintenance team could minimize the time needed to restore the network, reducing network downtime. Feedback received from network contractors regarding ribbon fiber cable deployment is that they need to invest in ribbon splicing machines, but it is a one-time investment and they will recover the cost quickly as they can do more installations in a day.

Total cost of ownership (TCO) calculations during the planning stage will assist CSPs to decide the right cable and optical fiber type for their network infrastructure. Understanding the features of available optical fiber cables and the selection of the cable based on applications and deployment scenarios during the planning stage will help CSPs to optimize their network installation cost.

TABLE 2: ***The Advantages and Typical Applications of Various Optical Fiber Cables***

| CABLE TYPE | ADVANTAGES | APPLICATION |
|---|---|---|
| ADSS | Used for both aerial and underground installations<br>No grounding required | Brownfield areas |
| Micro cables | Faster installation<br>Scalable<br>Higher duct utilization | Brownfield areas<br>Greenfield areas |
| Ribbon fiber cable | Faster splicing work<br>Reduces time for restoration work | Long-haul transport networks<br>FTTX |

## *Future-Proofing Telecom Infrastructure*

When it comes to optical fiber and cabling, Sterlite Technologies Limited (STL) is one of relatively few players whose portfolio is positioned as future-proofed telecom infrastructure. The company provides integrated 5G ready end-to-end solutions, ranging from wired to wireless, design to deployment, connectivity to compute through core capabilities in optical interconnect, virtualized access solutions, network software and system integration.

The company designs and manufactures optical fiber and optical fiber cable solutions. With expertise ranging from optical fiber and cables, hyper-scale network design, as well as deployment and network software, the company is the industry's integrated solutions provider for global data networks.

### *Stellar optical fiber*

STL's Stellar fiber is the next-generation optical fiber that blends the benefits of both legacy and bend-insensitive optical fibers. It has a MFD that matches the MFD of legacy optical fiber while at the same time, features similar bend-insensitivity characteristics to ITU-T G.657A1 and G.657A2 optical fiber.

Deploying Stellar optical fiber will solve the MFD mismatch problem since it is legacy-compatible optical fiber and will enable CSPs to maintain legacy optical fiber in their networks. In other words, there will be no high-splice loss in the fiber network due to a MFD mismatch using Stellar optical fiber.

Furthermore, Stellar has better bend-insensitive performance compared to legacy optical fiber, and its minimum allowable bending radius is 7.5mm. Utilizing bend-insensitive optical fiber like Stellar will reduce potential macrobend loss – fiber loss that is not anticipated or considered during network link loss calculations.

A study conducted by STL found that using Stellar fiber can potentially increase the life span of networks by an additional 10 years since the network will have a buffer against future optical losses due to network repair work.

### *Challenges*

Building telecommunication network infrastructure is considered a huge challenge and involves significant expenditure from CSPs, which can make them cautious about investing in relatively new albeit innovative technologies, even if there is proven return on investment (RoI). CSPs also fear a scenario of 'overbuilding' passive network capacity to cater for projected future network demand in case of those predictions go awry. While STL will have to face this hesitancy from potential customers, the opportunity for the company lies in highlighting the:

- **Availability of alternative types of optical fibers and cables:** Most of CSPs' attention during network planning has been focused on the active elements in the network. Conducting exploration and trial sessions with different types of optical fiber and cables would help to show them the advantages of bend-insensitive optical fibers and various types of optical fiber cables.
- **Building future-ready networks:** Optical fiber cable accounts for about 10 % to 15% of a typical network infrastructure cost, other cost components being CAPEX for cable installation, electronic hardware and software. Deployment of higher fiber count cables with the right choice of optical fiber today will require a marginal increase in the network investment cost at the current rates but will deliver the twin benefits of not only making networks ready for future demand, but also enable significant savings in future network upgrade costs.
- **Impact of optical fibers and cables on the lifetime of the network:** Settling for lower-price optical fiber and cables to reduce the CAPEX component of network infrastructure cost will result in the procurement of poor-quality optical fiber and cables that will reduce the lifetime of the network in the long run. This will also increase the OPEX of the network as frequent maintenance work will be needed.

## Essential Guidance

IDC recommends that CSPs select their optical fiber and cable construction of choice carefully. They should consider the ideal optical fiber and type for:

- **Faster network deployment:** Quick installation will allow CSPs to accelerate their go-to-market strategy within their coverage area.
- **Ease of maintenance:** Reduces the impact of downtime during any breakdown or repair of the network, and eventually maintains customer satisfaction of the connectivity service rendered to subscribers.
- **Future-proofing telecommunication networks:** Provides scalability for the network when infrastructure upgrade work is required in future.
- **Protecting network investment:** Increasing the life expectancy of the network will reduce the operational expenses (OPEX) for network maintenance.

Careful consideration on selecting the ideal optical fiber and type of cable will future-proof telecommunication networks and protect CSPs' investment.

# About the Analysts

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Nikhil Batra is the Associate Research Director for the regional telecommunications team in IDC Asia/Pacific. Based in Australia, Nikhil focuses on Telecom Service Provider and tech vendor strategies, along with enterprise services across the A/P region. In his role, Nikhil works with the regional telecom teams to produce intelligence reports, market insights, and contributes to various consulting projects for leading regional telcos and tech vendors.

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## MESSAGE FROM THE SPONSOR

**STL - Digital Networks Integrator**

With experience spanning over two decades in leading the evolution of optical fibers, introducing game-changing products and solutions, and steering global enterprises through their digital journey, STL is a pathbreaker not only in identifying all the challenges CSPs face but also in driving innovation to build adequate and agile solutions. In the current times of dramatic increase in data consumption and rapidly transforming lifestyles, STL's research team is continuously building integrated network infrastructure solutions to drive network optimization and agility for CSPs. Their focus is on optimum capital outlays and shorter turnaround timelines on one hand, and network interoperability and efficiency on the other. Additionally, their constant goal is to make networks smarter, enable faster deployment using cost-effective processes and technologies.

Stellar™ is one such breakthrough technology that allows CSPs a smart solution to densify the network with superior performing cables, improving capacity and coverage thereby making it future-ready and facilitating 5G / FTTX deployments. It optimizes costs and negates/minimizes future redundancies. It, therefore, builds both for the present and for the future.

Click here to know more about Stellar™.

IDC Custom Solutions

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