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The Pros and Cons of Dark Fiber

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The number of Internet-connected devices known as the Internet of Things (IoT) is expected to reach over twenty billion by the year 2020. Cloud usage has been escalating at a similar rate, with Amazon AWS, Microsoft Azure, IBM SoftLayer, and Google Cloud leading the charge.

This is driving enterprises to a level of network independence that is fast becoming hyper-critical.

How vital is your network? Fiber optic networks are highly beneficial for companies requiring high bandwidth, scalability, reliability, near-zero latency, and enhanced security. The declining costs of dark fiber leasing makes it even more attractive.

What is Dark Fiber?

Dark fiber is a fiber-optic cable that already has been installed in the ground to be used, but that has yet to be activated. In other words, it remains 'unlit.' When fiber is deployed, excess fibers in a cable or excess cables in a duct are typically installed. Some of the excess optical fibers then can be leased to other operators. A dark fiber network is a privately-operated network that is run directly by its operator over dark fiber that may be leased or purchased from another supplier. This is in contrast to purchasing bandwidth or leased line capacity on an existing network. A fiber that is used is 'lit.'

One enterprising young entrepreneur has purchased multiple dark fibers and is leasing them out to companies that do not want to bother with owning their own networks.

According to a market research report by Credence Research, the global dark fiber network market is set to expand to US$11 billion by 2026, primarily due to growing internet traffic.

Is Dark Fiber Available?

Network Service Providers (NSPs) such as Dark Fiber Optic Network, Crown Castle Provider, and TPG often will install more fiber than is currently needed to fulfill their bandwidth requirements. Most of the planning revolves around determining the route of the cabling and obtaining permission for the construction of the ducts for the fiber itself.

Only when the fiber is in place can other network elements such as switches and repeaters be installed to provide Internet connectivity. Thus, it makes sense that NSPs will install as much fiber-optic cable as they can. The result is that there is an inordinate amount of dark fiber available in certain areas.

For Whom Is Dark Fiber?

Dark fiber can be purchased and operated by anyone who can afford the initial investment. It will greatly benefit those organizations that require end-to-end control of their network and who require near-zero communication latencies.

Advantages and Disadvantages of Dark Fiber

Dark fiber may be the right decision for you, but make sure you are aware of its advantages and disadvantages.

Advantages

Cost control - Dark fiber costs the same regardless of the speed with which you plan to communicate – 1Gb, 10 Gb, 100 Gb. There is no concern that an ISP will raise its costs for the use of the fiber.

Flexibility - You can run any protocol over fiber.

Security – Dark fiber routes are accessible only at the end points. No outside entity can track the data being transmitted through the fiber.

Scalability – Communication capacity may be upgraded as required by simply using higher performance equipment to drive the fiber.

Reliability – Dark fiber networks offer a reliable service that no ISP can match. There is no need for an ISP because you can resolve problems yourself.

Disadvantages

Cost control - If bandwidth requirements are less than 1 Gb, lit services may be less expensive than dark fiber.

Reliability – There is no built-in fault tolerance or connectivity failure protection. This means the purchase of a second dark fiber path may be required between two locations.

Scalability – dark fiber is point-to-point. It does not allow for multiple end points on a network. Multiple paths may have to be provided.

Leasing Dark Fiber

We have discussed the use of dark fiber for communicating between end points. Companies or municipalities often will run fiber cable to support high-speed, low-latency communications, but not all the fibers in the cable will be used. The unused, or unlit, fibers may be leased to other operators.

Once the fiber has been laid, all that is required to increase its bandwidth is to upgrade the equipment powering the fiber. There is no need for concern about sharing the bandwidth with other customers as in normal networks.

Examples of Use

Some companies specialize in deploying dark fiber solely for the purpose of leasing it to others. Some examples of this practice include:

- A data-center provider leased dark fiber for an interconnect to implement data-center mirroring.
- A Philippine operator without its own fiber infrastructure leased dark fiber for its backbone network.
- A hospital leased dark fiber to connect its campus to its data center.
- Mobile operators in several countries are negotiating deals with operators or fiber-optic infrastructure providers to lease dark fiber for 5G mobile backhauling.

Required Equipment

The optical equipment required for dark fiber depends upon the distance to be covered. For short links, all that may be required are transmission systems at the end of the links. For longer distances, optical amplifiers and dispersion compensation may be required.

Dark Fiber Considerations

Leasing, lighting, and operating a dark-fiber network is a major undertaking that requires a well-trained staff. The most important fiber-optic attributes include attenuation, chromatic dispersion, polarization-mode dispersion, and nonlinear impairments.

Attenuation (or Loss)

Attenuation is a reduction in signal strength as light propagates through an optical fiber. It reduces the distance that can be achieved before an optical amplifier becomes necessary.

Available dark fiber has a wide range of attenuation coefficients. It is incumbent upon the network manager to ensure that the attenuation within the network supports current and future network designs.

Chromatic Dispersion (CD)

The light generated by practical lasers has a distribution of wavelengths (colors). Each wavelength travels at a different speed, causing the pulse to spread. Ultimately, sequential pulses overlap, and the fiber requires dispersion compensation.

The consideration to upgrade to higher data rates should be well understood and a determination made as to whether and where chromatic dispersion compensation is required.

Polarization-Mode Dispersion (PMD)

Polarization-mode dispersion is a form of modal dispersion in which two different polarizations of light in the fiber, which normally travel at the same speed, travel at different speeds due to random imperfections in the fiber. The signal is spread in time because the propagation velocity of the optic signal is not the same for all modes.

The different speeds of light of different polarizations (some horizontal, some vertical) cause random spreading of optical pulses. This signal distortion limits the speed at which data can be transmitted through the fiber.

Network managers must ensure that the fiber is tested and meets the network's design requirements.

Nonlinear Impairments

If signals are transmitted over a fiber at a high-power intensity, the fiber's refractive index can change. This can distort the signal as it transitions from low power intensities to high power intensities.

Transmission over fibers with a large effective cross-sectional area can mitigate such nonlinear impairments. The network manager must know the fiber's effective area and ensure that the fiber can safely carry the intensity of the signals to be transmitted over it. He must understand the potential impact on signal fidelity.

Redundancy

Redundancy is an important requirement to guarantee uptime. An alternate fiber path should be provided to reroute traffic in the event of a network disruption (such as a cable cut).

System and Infrastructure Monitoring

Both the optical infrastructure and the transmission system end points should be monitored for performance. This monitoring can provide signs of problems in time for a network operator to mitigate an issue before it causes a network outage.

Pricing

Most commonly, dark fiber is priced on a per strand per mile basis for a ten to twenty year lease.

For pricing purposes, fiber can be categorized into metro-area pricing and long-haul pricing. Sometimes an urban market will be surprisingly cost-effective because a glut of fiber has had the impact of pushing prices down.

There exist several pricing models:

- Up-front payment plus maintenance: With this pricing model, the cost of fiber is typically USD $750 to USD $3,000 per mile per strand plus USD $150 per mile per year for maintenance.

- Per annum or per month pricing: If paid for monthly or annually, the cost of fiber is typically USD $200 to USD $2.000 per fiber per mile per year.

The price range is dependent upon whether river crossings or similarly complex routing is necessary.

The appropriate pricing for dark fiber will be a balance of attracting customers, realizing sufficient revenue to make it worth the effort, and preserving sufficient fiber for the owner's use.

Riverside, California, Installs Fiber City-Wide

An example of a community taking advantage of dark-fiber communications is Riverside, California. Riverside Public Utilities (RPU) installed 120 miles of fiber to connect office buildings, industrial properties, and data centers. More is planned with the goal of making dark-fiber communications available to industrial and commercial customers everywhere in Riverside. Customers install and maintain their own equipment on both ends of the connection and 'light up' the fiber strands they lease.

RPU charges USD $125 per strand mile per month up the first ten miles, then USD $100 per strand mile per month thereafter. The rate is locked in for the first five years (with a 2% inflation rate).

Summary

A fiber cable contains many strands of fiber. As fiber is laid in a community, many of these strands are initially unused. These 'dark fibers' provide a powerful means for additional communication capabilities in the community.

The declining cost of fiber-optic networks is making them more attractive. With the massive interconnectivity requirements of the looming Internet of Things, fiber may become the preferred means for handling communication between devices.

Optical fiber communications are the wave of the future for data communications. It is capable of incredibly high speeds and is absolutely secure. There is no way for a hacker to gain access to the data that is being transmitted over the fiber.

However, even fiber networks can fail. In an article in the August issue of the Availability Digest, "Gatwick Airport Reverts to Whiteboards," we describe the consequences of a fiber channel outage at Gatwick Airport in the U.K.

Acknowledgements

Information for this article was taken from the following sources:

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