

Creating New Paths of Opportunity with WDM

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Introduction

Long an important optical networking technology for transport and FTTP networks, communications service providers (CSPs) of all sizes are finding new applications for wave division multiplexing (WDM). CSPs turn to WDM to meet growing demands for bandwidth across existing networks, adding capacity where needed and extending the life of existing fiber networks.

At its basic level, WDM allows a network operator to increase bandwidth through the use of simultaneous data streams, or wavelengths, across a single optical fiber. By multiplexing multiple wavelengths, or colors, across an optical fiber, WDM helps maximize and optimize fiber capacity. WDM equipment combines these wavelengths, transmits them, and then separates them. Coarse WDM (CWDM) offers up to 18 channels per fiber pair. Dense WDM (DWDM) can support 40 or 80 channels per fiber pair, depending on spacing.

CWDM applications tend to be shorter range and have a more metro network focus. A common application for WDM exists with traditional cable systems. Cable operators use different wavelengths in CWDM to combine narrowcast and broadcast traffic across hybrid fiber coaxial networks (HFCs). Other applications can include supporting FTTP architectures and supporting enterprise applications across a metro ring network.

DWDM has historically been used for more dense, long-haul transport networks. The growing demand for bandwidth on the edge, from both enterprise and consumer applications, requires much higher-capacity transport networks to meet that demand. These networks are migrating to 400G and even 800G transport capacity.

Other than transport capacity, the density of devices, or circuits, connected on a common infrastructure is increasing (i.e., mobile small cells or CATV nodes), which can be serviced with discrete wavelengths vs. dedicated point-to-point fiber pairs.

Emerging Applications

There is a growing interest in leveraging WDM for targeted growth opportunities for CSPs with existing fiber networks. As CSPs look to business, enterprise, and wholesale customers to maximize business opportunities, WDM can play an increasingly important role in supporting those opportunities.

Business and enterprise customers have growing demands for bandwidth. The need for robust and secure connections to the cloud is one example of unique requirements for fiber connectivity. Enterprises are increasingly turning to applications such as SD-WAN as well. The market research firm Dell'Oro Group is forecasting a compound annual growth rate of 24% over the next five years for SD-WAN, reaching \$4 billion in market activity.¹

Wholesale customers need fiber connectivity for backhaul and fronthaul applications to power next-generation wireless networks. Beyond public wireless networks where demand for fiber backhaul is well documented, CSPs should also recognize the growing private wireless trend, where enterprises are building their wireless networks. According to market research firm Mobile Experts, private LTE and 5G networks are expected to grow at 20% annually over the next five years to reach \$10 billion in market activity.²

To maximize their opportunity with these trends, CSPs need excess fiber capacity, which may prove to be challenging, as many are approaching or already suffering from dwindling capacity or fiber exhaustion. For smaller Tier 2 and 3 CSPs, this issue may be acute. The aforementioned fiber business opportunities are hugely attractive but may not be enough in smaller markets to justify new fiber builds. What's needed are strategies to leverage existing fiber networks for additional capacity to meet specific bandwidth demands, allowing CSPs to take advantage of a targeted opportunity where it exists.

WDM is proving to be just the solution needed to meet this demand. While WDM has historically been seen as a transport or long-haul application technology, it's considered an access network solution for fiber-to-the-business and wholesale bandwidth demand.

Using WDM to Get Creative in the Access Network

In a perfect world, CSPs would prefer point-to-point fiber connections to meet these business, enterprise, and wholesale bandwidth needs as it's less complex and provides flexibility for growth. But fiber network exhaustion may prevent this preferred solution. Building new facilities is expensive, time-consuming, and could be prohibitive as a result. Yet distinct business opportunities exist and need to be leveraged for top-line revenue growth.

By adding WDM capability, much less fiber is required to deliver the bandwidth necessary to meet this growing demand. Through transceivers and filters in WDM architecture, CSPs can leverage their existing fiber network to add the capacity needed to meet these requirements and not have to forgo business opportunities.

For CSPs that have built an FTTP network with separate sheaths that segregate fiber pairs serving residential and business customers, leveraging WDM can be fairly simple. By adding passive WDM filters and "colorized" WDM transceivers to fiber pairs in the business sheath, CSPs can dramatically increase bandwidth delivered to business and enterprise customers. This addition helps save on the expense of building new facilities that might otherwise be required due to fiber exhaustion.

Another option is to use WDM on an existing GPON network as a migration strategy to 10 Gbps-capable XGS-PON. This is a "coexistence" strategy that introduces a WDM element to the distribution network. With this strategy, GPON and XGS-PON wavelengths can coexist across the existing PON network. The WDM element allows a CSP to transmit XGS-PON wavelengths, with customer premises equipment determining whether signals received are XGS-PON or standard GPON signals. A coexistence strategy can also be applied to other 10G or future options (NG-PON2, 25G EPON, etc.)

Ideally, CSPs would add XGS-PON capability using separate feeder fibers. If that excess capacity is available, XGS-PON would be delivered to its own independent splitter in the field. Both XGS-PON and GPON fibers would be in the same sheath and deliver separate services and capabilities to end customers. However, excess feeder fibers are not always available, so the coexistence element becomes a viable option.

Another option is full network convergence in the core of the network. With this option, a PON network and WDM (CWDM or DWDM) signals are all converged in the core through WDM filters. All services are collapsed onto a single pair of fibers (or even a single fiber) and delivered to the distribution network, where the signals are "deconverged" or split out. The PON signals are

redirected to a feeder cable towards a 1x32 splitter and ultimately to homes. The WDM traffic is redirected to a demultiplexer, serving enterprise or wholesale customers with high-bandwidth services.

Conclusion

It's critically important for smaller Tier 2 and 3 providers to maximize business services opportunities. According to RVA Research, which does market research for the Fiber Broadband Association, smaller fiber CSPs generate 2.1x more revenue from the average business customer than a residential customer. Today's CSPs must juggle many factors and variables to determine how to best address this reality. They have a growing number of opportunities on the business, enterprise, and wholesale segments that should not be ignored. They may also have network constraints that limit their ability to take advantage of all the available opportunities.

WDM technology can provide CSPs with much-needed options. Historically viewed as a long-haul transport technology, WDM today enables CSPs to get more creative with their existing access network. CSPs should first determine the needs and applications of end customers and evaluate whether their current network capacity can support those needs. If not, the introduction of WDM offers several options, allowing CSPs to leverage their existing fiber network to maximize important business, enterprise, and wholesale opportunities.

¹ SD-WAN Market to Grow at 24 Percent Compounded Annual Growth Rate over Next Five Years, <https://www.delloro.com/news/sd-wan-market-growth-will-accelerate-in-2021/>

² Private LTE and 5G market to triple by 2025: Report, <https://www.rcrwireless.com/20200212/5g/private-lte-and-5g-market-to-triple-by-2025-report>

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