BWDM
CWDM
DWDM

TRANSITION NETWORKS®

WDM TECHNOLOGY





INTRODUCTION

User's of today's voice, video, and data networks are becoming more complex – requiring more bandwidth and faster transmission rates over ever increasing distances. To meet these demands, network managers are relying more on fiber optics. But the reality that many providers, enterprise corporations, and government entities are facing is that once their available fiber infrastructure is exhausted, laying more fiber is no longer an economical or feasible option. So, now what?

Many groups are turning to Wave Division Multiplexing (WDM) technologies in order to increase capacity on the existing fiber infrastructure. WDM is a technology which multiplexes multiple optical signals onto a single fiber by using different wavelengths, or colors, of light. By utilizing WDM communication methods network managers can realize a multiplication effect in their available fiber's capacity.

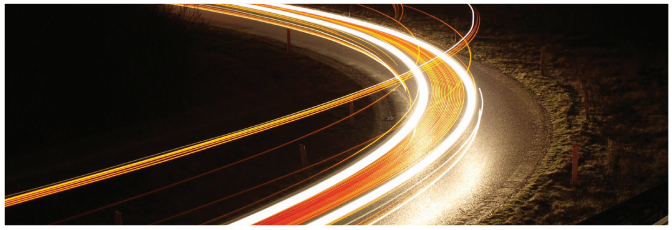
A quick study of WDM yields three options: Bi-Directional Wave Division Multiplexing (BWDM), Coarse Wave Division Multiplexing (CWDM), and Dense Wave Division Multiplexing (DWDM). This article will take a look at the benefits and drawbacks of all three, as well as provide estimated cost comparisons of each technology type.

BI-DIRECTIONAL WAVE DIVISION MULTIPLEXING (BWDM)

BWDM (also referred to as: bi-di, simplex, and single strand) is the least expensive WDM solution. While BWDM offers users the greatest cost savings, it is also the most limiting as far as future proofing for tomorrow's requirements on you network. When examining the pros and cons of BWDM you will find:

Benefits of BWDM:
- Inexpensive
- Requires little or no changes to the general network design
- Doubles the capacity of existing fiber routes

Drawbacks of BWDM:
- Doubling capacity may not be enough
- Requires upstream and downstream spares



While BWDM has the ability to double the amount of fiber capacity in a network, the major question that goes unanswered is: How much time until that extra space is consumed and further steps need to be taken to increase capacity?

Using estimated SFP+ module pricing, the average cost per channel (complete link) cost of a single strand 10 Gigabit SFP+ is:

QTY	PART	PRICE	EXTENDED
8	TN-10GSFP-LRB11	$1,500.00	$12,000.00
8	TN-10GSFP-LRB12	$1,500.00	$12,000.00
	TOTAL		**$24,000.00**
	PER CHANNEL		**$3,000.00**
	FIBER STRANDS NEEDED		**8**

Compared to a similar solution using Duplex SFP+ modules:

QTY	PART	PRICE	EXTENDED
16	TN-10G-SFP-LR	$1,100.00	$17,600.00
	TOTAL		**$17,600.00**
	PER CHANNEL		**$2,200.00**
	FIBER STRANDS NEEDED		**16**

For an average cost increase of 36% per channel, you can effectively double the capacity of your existing fiber infrastructure. If doubling your fiber capacity is not enough future proofing, then moving to CWDM or DWDM is required.

COARSE WAVE DIVISION MULTIPLEXING (CWDM)

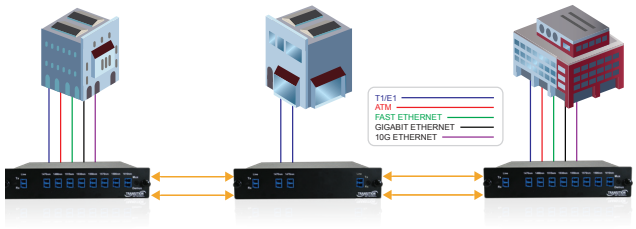
By decreasing the channel spacing between wavelengths, CWDM allows for a simple and affordable method of carrying up to 16 channels on a single fiber. The Benefits and drawbacks of CWDM are:

Benefits of CWDM:

- Passive equipment that uses no electrical power
- Extended Temperature Range (0-70C)
- Much lower cost per channel than DWDM
- Scalability to grow fiber capacity with little or no increased cost
- Protocol Transparent
- Simple to install and use

Drawbacks of CWDM:

- 16 channels may not be enough
- Passive equipment offers no management capabilities
- Optics cost significantly more than BWDM



Since CWDM is a passive technology, it allows for any protocol to be transported over the link, as long as it is at a specific wavelength (i.e. T1 over fiber at 1570nm transported alongside 10Gbps Ethernet at 1590nm). This allows for long-term future proofing of the networking infrastructure because the multiplexers simply refract light at any network speed, regardless of the protocol being deployed.

Another benefit to the passive CWDM technology is that no configuration is necessary, which makes CWDM a low-cost and effortless technology to implement. The most complex step in CWDM integration is aligning and connecting the patch cables from the correct wavelength optic to the correct port on the multiplexers on each end of the link.

CWDM is more expensive than BWDM because of the precision inherent to each optic and because of the transmission power associated with each wavelength. Because the technology is typically used for longer-haul deployments, CWDM 10 Gigabit SFP+ modules come in either 40 or 80km versions. Here is a price comparison between an ER set of SFP+ modules and the equivalent CWDM optics for 40km:

QTY	PART	PRICE	EXTENDED
2	CWDM-M1631LCR	$5,400.00	$10,800.00
16	TN-CWDM-10G-1xx0-40	$3,300.00	$52,800.00
	TOTAL		**$63,600.00**
	PER CHANNEL		**$7,950.00**
	FIBER STRANDS NEEDED		**2**

There is a significant price difference per channel when compared to BWDM, but the shock somewhat fades when the solution is compared to 10 Gigabit ER optics (remember the TN-CWDM-10G-1xx0-40's are for 40km):

QTY	PART	PRICE	EXTENDED
16	TN-SFP-10G-ER	$3,000.00	$48,000.00
	TOTAL		**$48,000.00**
	PER CHANNEL		**$6,000.00**
	FIBER STRANDS NEEDED		**16**

Assuming a deployment distance of roughly 10-40km, the cost increase is 32% to reduce the fiber usage by a factor of 8 (taking 16 strands down to 2). In effect, increasing the capacity of the fiber by 800% for 1.32 times the total cost of the equipment.

DENSE WAVE DIVISION MULTIPLEXING (DWDM)

The last option available is a DWDM solution. DWDM comes in two different versions: an active solution and a passive solution. An active solution is going to require wavelength management and is a good fit for applications involving more than 32 links over the same fiber. In most cases, passive DWDM is looked at as a more realistic alternative to active DWDM. Here are the benefits and drawbacks of a DWDM solution:

Benefits:

- Up to 32 channels can be done passively
- Up to 160 channels with an active solution
- Active solutions typically involve optical amplifiers to achieve longer distances

Drawbacks:

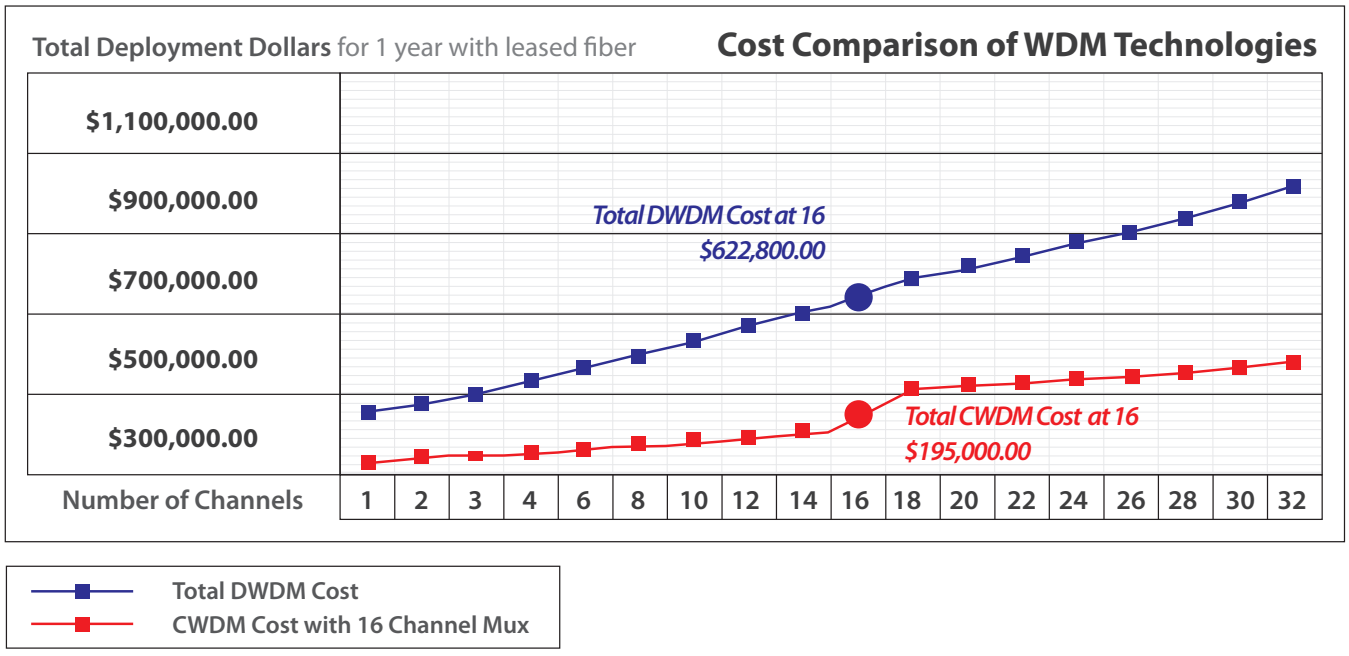
- DWDM is very expensive
- Active solutions require a lot of set-up and maintenance expense
- "Passive" DWDM solution still requires power

DWDM offers essentially the same benefits of CWDM, especially when evaluating a passive solution. An active DWDM solution, on the other hand, is very labor intensive and complicated to design and configure. The extra distance capabilities of optical amplifiers and the immense amount of channels make active DWDM an attractive solution for large capacity optical rings that are servicing hundreds of customers or locations.

The downside to a passive DWDM solution that needs to be taken into account is that rarely are the extra channels provided actually being used. If the full 32 channels are not being lit, a lot of unnecessary cost is being incurred per channel with no offsetting gain. Here is an approximate price model of a 32 channel passive DWDM solution configured to provide 16 channels:

QTY	PART	PRICE	EXTENDED
2	ONS-15454	$3,250.00/ea	$6,500.00
2	15454-32MUX-O	$28,875.71/ea	$57,751.42
2	15454-32DMX-O	$28,875.71/ea	$57,751.42
16	DWDM-SFP-xxxx	$4,000.00/ea	$64,000.00
16	F2F802L7-02M	$28.95/ea	$463.20
		TOTAL	**$186,466.04**
		PER CHANNEL	**$23,308.25/ea**
		FIBER STRANDS NEEDED	**2**

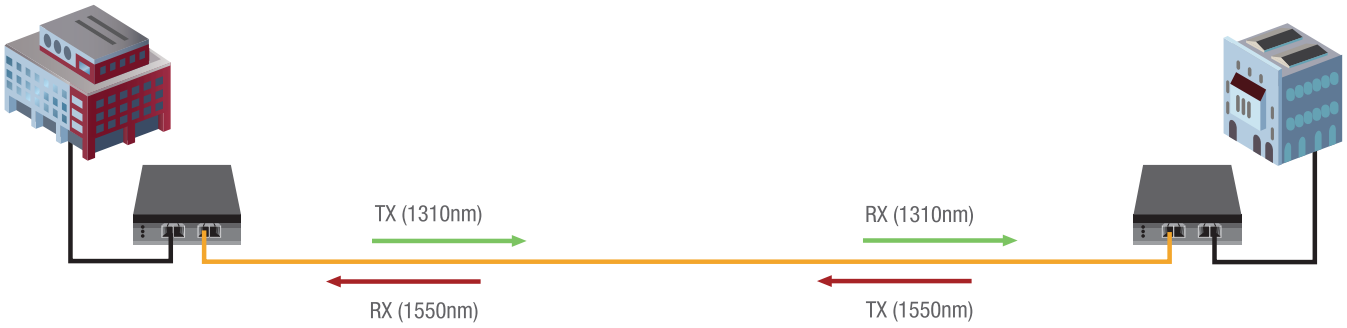
Often times it is a difficult proposition to compare passive DWDM and CWDM solutions against one another. With the benefits and drawbacks of each being nearly identical, the true differentiators end up being the number of channels needed by the customer and the cost associated with deploying each system. The graph below takes into account the cost per strand ($1.00/m) for leasing 10km of fiber over the course of one year. As you can see, the graph illustrates that at 16-channels and below, CWDM is clearly more economical to implement.



TRANSITION NETWORKS' WDM APPLICATIONS

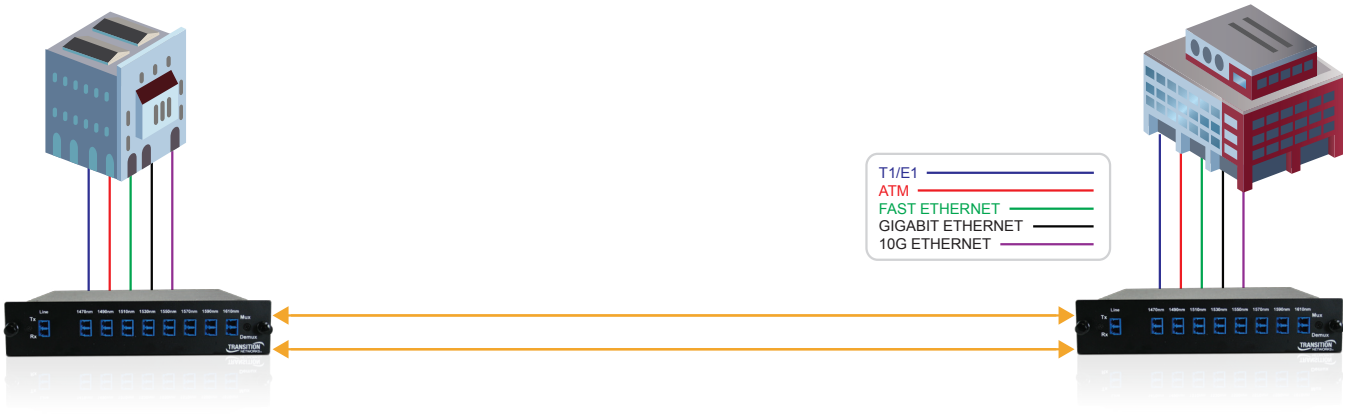
BWDM

Transition Networks offers a variety of products with bi-di optics on them, or the ability to use a bi-di SFP, to double your fiber capacity. Typically a BWDM deployment will use the 1310nm and 1550nm wavelengths. BWDM products are deployed in pairs to ensure the TX and RX of each device are not using the same wavelengths. In the example below the products could be Ethernet, T1/E1, DS3/E3 or any other protocol.

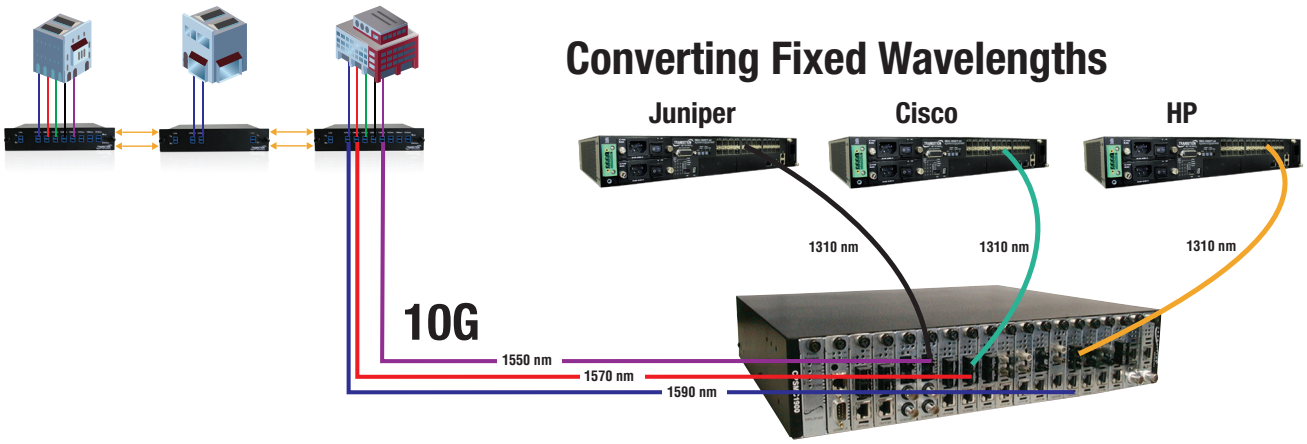


CWDM Mux / Demux

Using CWDM multiplexing technology paired with wavelength specific optics inserted into Transition Networks' complete link of modular fiber optic devices and switching products allows you to realize the full benefit of CWDM technology. The modular approach that Transition Networks takes toward CWDM deployments makes scaling a project to fit your exact needs easy and affordable. Transition Networks also offers products that allow you to take advantage of standard fixed optic wavelengths on existing products where we can convert them to the appropriate CWDM "color" or wavelength.

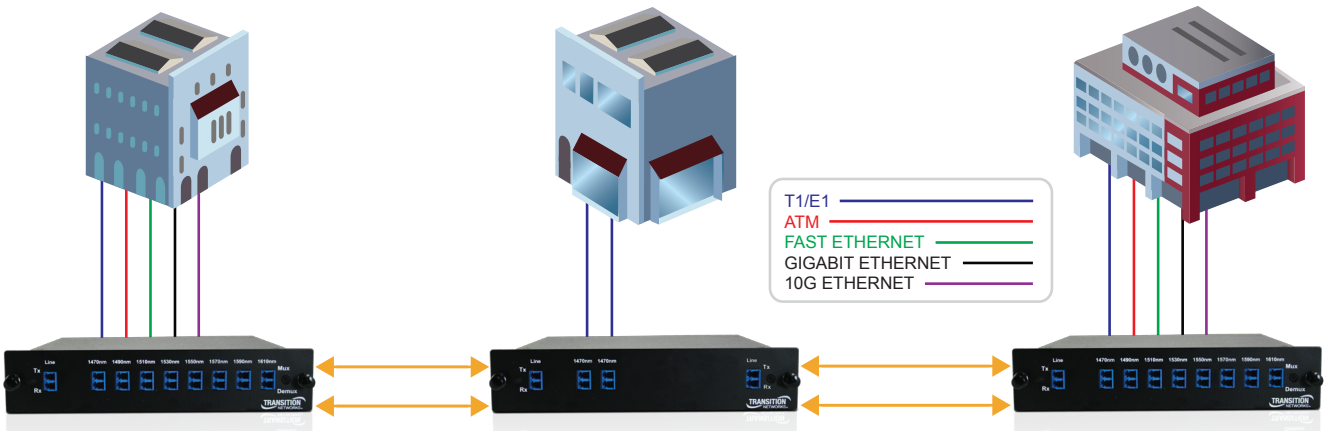


Optical Wavelength Conversion for CWDM Mux / Demux



CWDM Add/Drop Modules

The optical add/drop modules provide you with a means to insert or remove a single wavelength of light from a fully multiplexed group. Add/drop technology allows for intermediate locations to easily access the common fiber segment linking all the network nodes together. Wavelengths that are not specifically added or dropped simply pass through the add/drop modules and continue on to the next network node. Additional add/drop modules can be added in the event that more than one intermediate location exists or if multiple wavelengths are required at one location.



CWDM ORDERING INFORMATION

Transition's CWDM devices are available in two main configurations: Optical Add/Drop Multiplexer (OADM) modules and Multiplexer/Demultiplexer (Mux/Demux) modules. Each module is a pluggable device that slides into a one rack unit (1RU) chassis that can hold 2 modules and mount into a 19" equipment rack.

CWDM OPTICS:

100BASE-X/OC-3 CWDM SFP
- 18 wavelengths from 1270nm to 1610nm
- 80km and 160km options
- Cisco compatible and MSA options

1000BASE-X CWDM SFP
- 18 wavelengths from 1270nm to 1610nm
- 80km and 160km options
- Cisco compatible and MSA options

10G CWDM XFP
- 18 wavelengths from 1270nm to 1610nm
- 10km, 40km, 70km and 80km options
- Cisco compatible and MSA options

10G CWDM SFP+
- 8 wavelengths from 1470nm to 1610nm
- 40km and 80km options
- Cisco compatible and MSA options

To see Transition Network's complete portfolio of CWDM SFPs and XFPs, along with our standard SFPs and XFPs, please scan the QR code or follow the URL below to download our SFP products brochure:

www.transition.com/SFPproducts

MULTIPLEXERS:

Part Number	Description
CWDM-M451LCR	4 Ch. 1510/1530/1550/1570nm w/LC*
CWDM-M453LCR	4 Ch. 1530/1550/1570/1590nm w/LC*
CWDM-M455LCR	4 Ch. 1550/1570/1590/1610nm w/LC*
CWDM-M551LCR	5 Ch. 1510/1530/1550/1570nm + 1310 w/LC*
CWDM-M553LCR	5 Ch. 1530/1550/1570/1590nm + 1310 w/LC*
CWDM-M555LCR	5 Ch. 1550/1570/1590/1610nm + 1310 w/LC*
CWDM-M847LCR	8 Ch. 1470 ~ 1610nm w/LC*
CWDM-M947LCR	9 Ch. 1470 ~ 1610nm + 1310 w/LC*
CWDM-M1631LCR	16 Ch. 1310 ~ 1610nm w/LC

1-CHANNEL ADD DROP MULTIPLEXERS:

Part Number	Description
CWDM-A2A831LCR	1310nm Add/Drop with E/W Lines w/LC
CWDM-A2A833LCR	1330nm Add/Drop with E/W Lines w/LC
CWDM-A2A835LCR	1350nm Add/Drop with E/W Lines w/LC
CWDM-A2A837LCR	1370nm Add/Drop with E/W Lines w/LC
CWDM-A2A839LCR	1390nm Add/Drop with E/W Lines w/LC
CWDM-A2A841LCR	1410nm Add/Drop with E/W Lines w/LC
CWDM-A2A843LCR	1430nm Add/Drop with E/W Lines w/LC
CWDM-A2A845LCR	1450nm Add/Drop with E/W Lines w/LC
CWDM-A2A847LCR	1470nm Add/Drop with E/W Lines w/LC
CWDM-A2A849LCR	1490nm Add/Drop with E/W Lines w/LC
CWDM-A2A851LCR	1510nm Add/Drop with E/W Lines w/LC
CWDM-A2A853LCR	1530nm Add/Drop with E/W Lines w/LC
CWDM-A2A855LCR	1550nm Add/Drop with E/W Lines w/LC
CWDM-A2A857LCR	1570nm Add/Drop with E/W Lines w/LC
CWDM-A2A859LCR	1590nm Add/Drop with E/W Lines w/LC
CWDM-A2A861LCR	1610nm Add/Drop with E/W Lines w/LC

Accessory *(sold separately)*

CWDM-MB19R1
19" Rack Mount Bracket, 1RU High, holds 2 CWDM Modules

* SC connectors available

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CWDM Mux/DeMux & Add/Drop Modules


SFP, SFP+ & XFP Modules


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