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Review Article

# Dense Wavelength Division Multiplexing - A Review

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***Abstract***

*This paper benchmarks the Dense Wavelength Division Multiplexing Techniques for optical communication network and its principles in optical communication network. Different nature of networks are used at global platform. Conventional and non-conventional techniques are continuously evolved over last few decades for optimum communication across different networks .Inherent nature of nonlinearities for optical communications systems limit the path of communication. In communication system, existing component give birth to new frequency components which will have the impact on the density and the capacity of the system network. Dense Wavelength Division Multiplexing is one of the thrust areas in communication which has been rapidly adapted to enhance the communication capabilities of the model network. It is necessary to dig deep inside this evolving area, its principles and implications in hierarchy fashion to formulate and integrate new design techniques, to upgrade current networks in terms of smooth response, minimized disturbances and achieve high efficiency with reduced cost. In current research, different aspects of the Dense Wavelength Division Multiplexing have been touched and explored to direct the future research into new dimensions.*

***Keywords:*** *Dense Wavelength Division Multiplexing; Metropolitan Area Network; Optical Add-Drop Multiplexer*

## 1. Introduction

The monotonic behavior of modern communications networks is to be in a state of progressive evolution. Parameters such as new applications, dynamic patterns of utilization, and redistribution of information make the definition of networks a work in progress. Nevertheless, we can define the large entities in big picture that make up the global network based on parameters such as transport technology, length, area of applications, and so on. One way of describing the MAN would be to say that it is neither the long-haul nor the access parts of the network, but the area that lies between those two .Different nature of networks are discussed below-

- *Long-Haul Networks*

Long-haul networks are at the root of the global network. Surrounded by a small group of large transnational and global carriers, long-haul networks connect the MANs. Their major thrust of application is transport, so their primary challenge is capacity and strength. In many scenarios these networks, which have conventionally been grounded on Synchronous Optical Network (SONET) or Synchronous Digital Hierarchy (SDH) technology, are experiencing fiber saturation due to requirement of high scale bandwidth.

- *Access Networks*

Access networks are available at the other end of the spectrum. These networks are the nearest to the end users, at the edge of the MAN. They are inherently highlighted by diverse range of protocols and productions, and they scattered a large dynamic spectrum of rates. Target audience is residential internet, large and small corporations, colleges and universities. The predominance of IP traffic, with its inherently volatile, asymmetric, and unexpected in nature, presents many challenges, especially with new real-time usage and applications. At the same time, these networks are required to continue to support legacy traffic and protocols, such as IBM's Enterprise System Connection (ESCON).

- *Metropolitan Area Networks*

MAN is sandwiched between two large and different networking domains. These networks channel traffic within the metropolitan domain and between large long-haul points of presence (POPs). The MANs have many of the same attributes as the access networks, such as diverse networking protocols and channel speeds. Like access networks, MANs have been traditionally SONET/SDH based, using point-to-point or ring topologies with add/drop multiplexers (ADMs). The MAN locates at a critical junction. On the one hand, it must meet the needs

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created by the dynamics of the exponentially increasing bandwidth available in long-haul transport networks. On the other hand, it must direct the growing connectivity requirements and access technologies that are leading to demand for fast-speed, molded data services.

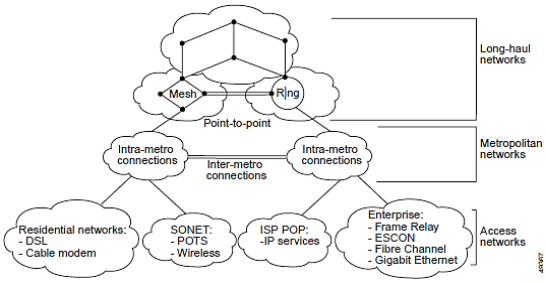


**Figure 1**: Global Hierarchy Network

## 2. Topologies

Dense wavelength division multiplexing (DWDM) networks are scattered into four major configurations: DWDM point-to-point with or without add-drop multiplexing network, fully connected mesh network, star network, and DWDM ring network with OADM nodes and a hub. Each topology demands own requirements and, based on the use of application, major elements may be involved in the respective designs.

- *Point-Point Topology*

Point-to-point topology is primarily adopted for long-haul transport that requires ultrahigh speed (10-40 *Gb/s),* ultrahigh scaled bandwidth (terabits per second), pointed integration of signal, estimated reliability, and fast direction restoration capability. The distance between transmitter and receiver end may be several hundred kilometers, and the number of amplifiers between the two end junctions is typically less than 10. Point-to-point with add-drop multiplexing activates the system to drop and add channels along its route. Number of channels, channel gap, category of fiber signal, modulation technique, and element type selection are all imperative variables in the calculation of the power economy.

- *Ring Configured Mesh and Star Networks*

A variety of proprietary ring DWDM networks have been deployed. In general, a DWDM ring network comprises of a fiber in a ring configuration that completely links nodes; few systems utilize two fiber rings for network protection against any unwanted disturbances. Such a ring may span over a local or a metropolitan area and cover a few tens of kilometers. The fiber ring may contain few(3-5) to many wavelength channels, and few to many nodes. The bit rate per wavelength channel may be 622 Mb/s or lower, or 1.25 Gb/s or higher. One of the nodes on the ring is a hub station where all wavelengths are sourced, terminated, and managed; connectivity with other networks takes place at this hub station. Each node and the hub have optical add-drop multiplexers (OADM) to drop off and add one or more designated wavelength channels. In DWDM ring networks, the hub station may source and terminate several types of traffic. The hub controls all channels subjected to a path between nodes and also the traffic type. At an OADM, one (or more) optical frequency is dropped off and added, whereas the remaining frequencies pass through transparently. However, as the number of OADMs increases, the signal is subject to losses and optical amplification may be required. The number of nodes is typically less than the number of wavelengths in the fiber. In the ring topology, the hub station manages channel (wavelength) assignment so that a fully connected network of nodes with OADM is accomplished. The hub may also provide connectivity with other networks. In addition, an OADM node may be linked with a multiplexer/de-multiplexer where several data sources are multiplexed. All data sources are terminated by the corresponding OADM node, however, since they are on the same channel (and the same wavelength).

- *DWDM Hub*

The area of DWDM node and DWDM hub is currently growing. Different aspects of hub topology are touched here.

- *Transmit Direction*

A hub, in general, takes various (electrical) payloads, such as communications transport protocol, V-Internet Protocol, asynchronous transfer mode and high-speed Ethernet (l Gb/s, 10 Gb/s). Each traffic channel is sent to its directed physical interface, where a wavelength is assigned and is modulated at the electrical-to-optical converter. The optically modulated signals from each source are then optically multiplexed and launched into the fiber.

- *Receive Direction*

When a hub receives a WDM signal, it optically de-multiplexes it to its component wavelengths (channels) and translates each optically modulated signal to a digital electrical signal. Each digital signal then is routed to its corresponding electrical interface: TCPIIP, ATM, STM.

## 3. Faults

Primary objective of DWDM networks is to locate faults on the link or on the ring (broken fiber, faulty port unit, in-operable node) and to isolate a fault on the network to avoid it to propagate across the network. The agenda is to supply continuous transmission with the minimum disturbance possible, as recommended in the different standards. Depending on network topology and architecture, fault avoidance may be accomplished with dual counter rotating rings .When a fault is detected in a

counter rotating ring architecture, the neighboring OADMs avoid the fault by rerouting traffic to optical cross-connect . When the system recovers from the fault or the fault is fixed, the ring network returns to its normal (prior to the fault occurrence) state. Similarly, in point-to-point topology, detected faults will trigger a procedure that either finds an alternative path or trigger alarms. In mesh architecture, faults will search a different path selection procedure that bypasses the fault.

## 4. Challenges

- Density
- Capacity
- Bandwidth
- Fault Detection
- Speed
- Memory Utilization
- Power Consumption
- Synchronization

## Conclusion

Smooth and reliable exchange of information is the target of any communication network. Different architectures and topologies are being generated and developed through various experimental and research studies. Dense wavelength division multiplexing is one of the fastest growing arenas of today's communication system. Standalone and hybrid configurations in this system are being developed to enhance the capacity and speed of information exchange to serve the end customer in reliable fashion without loss of any information. Various contemporary configurations, challenges, usages; and applications have been reviewed in this current study to help future researchers to explore this area to develop new methods to furnish the end customer requirements.

## Future Scope

As the current system is subjected to various pit-falls, a trade-off is to be maintained between different parameters to reach at an optimum solution to serve the users in terms of power consumption, rate and cost involved. Researchers should lead their efforts to new innovations which cost involved is minimum and all the system constraints are satisfied.

## References


Dutton, Harry J. R(1998),Understanding Optical Communications. Research Triangle Park: IBM Corporation; 1998.

Goff, David R. (1999),Fiber Optic Reference Guide, 2nd edition. *Boston: Focal Press*.

Goralski, Walter J.(2000), SONET, *2nd edition. New York: McGraw-Hill*.

Kaminow, Ivan P., and Koch, Thomas L.,eds.(1997) Optical Fiber Telecommunications. *San Diego: Academic Press*.

S.V. Kartalopoulos(1999), Understanding SONETISDH and ATM: Communications Networks for the Next Millennium, *IEEE Press, Piscataway, NJ*.

B. Furht(1999), Handbook ofInternet and Multimedia : Systems and Applications, IEEE Press, Piscataway, NJ.

L.G Raman(1999), Fundamentals ofTelecommunications Network Management, *IEEE Press, Piscataway, NJ*.

J.e. Palais(1992), Fiber Optic Communications, *3rd ed., Prentice-Hall, Englewood Cliffs, NJ*.

A. Borella, G. Cancellieri, and F. Chiaraluce(1998), Wavelength Division Multiple Access Optical Networks, *Artec House, Boston*.

B.T. Doshi, S. Dravida, P. Harshavardhana, O. Hauser, and Y. Wang(1999), Optical Network Design and Restoration, *Bell Labs Technical Journal*, vol. 4, no. 1, pp. 58-84.

L.Y. Lin, E. Karasan, and R.W. Tkach(1998), Layered Switch Architectures for High-Capacity Optical Transport Networks *IEEE Journal on Selected Areas in Communications*, vol. 16, no. 7, pp. 1074-1080

M. Koga et al(1998), Large-Capacity Optical Path Cross-Connect System for WDM Photonic Transport Network, *IEEE Journal on Selected Areas in Communications*, vol. 16, no. 7, pp. 1260-1269.

D. Banerjee, 1. Frank, and B. Mukherjee(1998), Passive Optical Network Architecture Based on Waveguide Grating Routers, *IEEE Journal on Selected Areas in Communications*, vol. 16, no. 7, pp. 1040-1050.

S. Chatterjee and S. Pawlowski(1999),All-Optical Networks, *Communications of the ACM*, vol. 47, no. 6, pp. 74-83.

S.V. Kartalopoulos(1990), A Manhattan Fiber Distributed Data Interface Architecture, *Globecom'90*, San Diego, CA, December 2-5.

S.V. Kartalopoulos(1993), Disaster Avoidance in the Manhattan Fiber Distributed Data Interface Network, *Globecom'93*, Houston, TX, December 2.

S.R. Johnson and V.L. Nichols(1999), Advanced Optical Networking-LUCENT's MONET Network Elements, *Bell Labs Technical Journal*, vol. 4, no. 1, pp. 145-162.

L.D. Garrett et al(1998), The MONET New Jersey Network Demonstration, *IEEE Journal on Selected Areas in Communications*, vol. 16, no. 7, pp. 1199-1219.

R. Gaudino et al.(1998), MOSAIC: A Multi wavelength Optical Subcarrier Multiplexed Controlled Network, *IEEE Journal on Selected Areas in Communications*, vol. 16, no. 7, pp. 1270-1285.

D. Cotter, J.K. Leek, and D.D. Marcenac(1997), Ultra-High-Bit-Rate Networking: From the Transcontinental Backbone to the Desktop, *IEEE Communications Magazine*, vol. 35, no. 4,pp.90-96.

S.F. Midkiff(1992), Fiber Optic Backbone Boosts Local-Area Networks, *IEEE Circuits and Devices Magazine*, vol. 8, no. 1, pp. 17-21.

E. Traupman, P. O'Connell, G. Minnis, M. Jadoul, and H. Mario(1999), The Evolution ofthe Existing Infrastructure, *IEEE Communications Magazine*, vol. 37, no. 6, pp. 134-139.

A.G. Malis(1999), Reconstructing Transmission Networks Using ATM and DWDM, *IEEE Communications Magazine*, vol. 37, no. 6, pp. 140-145.

R.K. Snelling(1991), Bringing Fiber to the Home, *IEEE Circuits and Devices Magazine*, vol. 7, no. 1, , pp. 23-25.