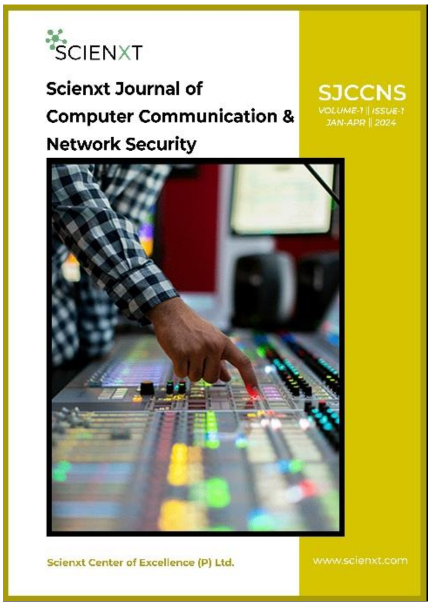

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Wavelength Division Multiplexing

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Abstract:

With the increasing emphasis on the importance of speed and bandwidth in today's communication networks, wavelength division multiplexing (WDM) has emerged as a promising solution. WDM helps to increase the capacity of this fiber network while necessitating new fiber, which becomes a problem when the demand for speed within a transmission line exceeds the present capacities. The difficult part of this decision is figuring out how to maximize savings while increasing network capacity so that all anticipated demand can be met. This Research provides an overview of WDM technology, discussing its history, recent advancements, and the ways in which it can be used to increase the overall capacity of both a communication network.

Keywords:

Bandwidth, multiplexing, optical network unit, OCDM, passive optical network, supervision method.

1. Introduction:

Wavelength division multiplexing is a technique utilized in optical fiber communication systems; it utilizes light of various wavelengths to enable the transmission of multiple optical carrier frequencies over a single optical cable (Fazea, Amphawan and Abualrejal, 2017). One strand or optical fiber can be used for two-way communication and capacity is increased by a factor of four thanks to this method.

When referring to an optical carrier (which is normally characterized by its wavelength), the phrase wavelength division multiplexing is used instead of frequency division multiplexing (which is more often described by frequency). There is a straight inverse relationship between frequency and wavelength, such that the product between frequency as well as wavelength equals (the speed of light in propagation), hence the two terms represent the same thing. Early optical fiber communication networks were relatively straightforward, involving only a single fiber line equipped with a single light source and a single photodetector at each end (Fazea, Amphawan and Abualrejal, 2017). WDM was originally implemented to increase the data-transfer capacity of preexisting point-to-point lines. WDM allows for an increase in fiber's carrying capacity. Transmission of several data streams over a single fiber is the goal of wavelength division multiplexing (WDM), which does this by using numerous light sources of varying wavelengths. This is a picture of a WDM, which is seen in Fig. 1.

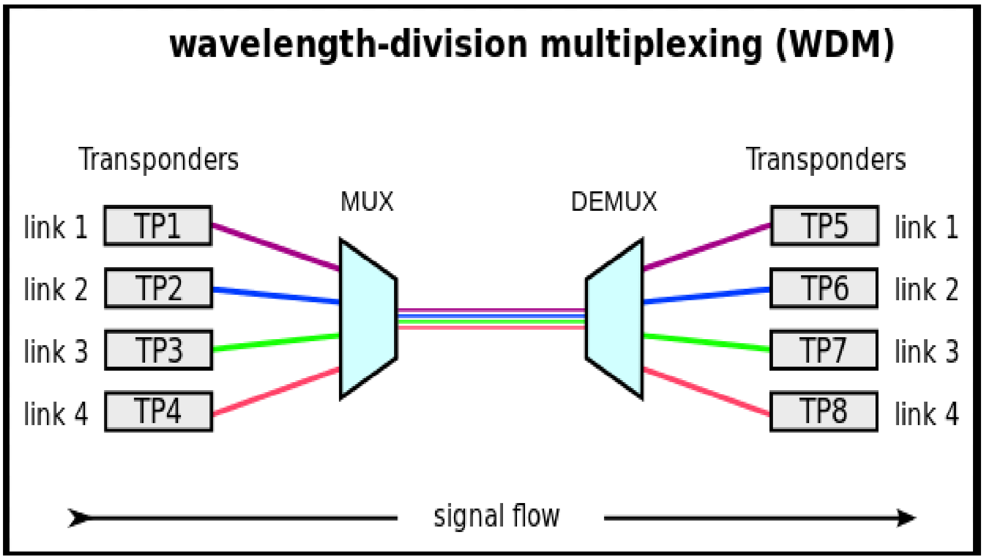

Figure. 1: wavelength division multiplexing

1.1. Aim:

An Optical Time-Domain Reflect meter (OTDR) is still seen as the primary characterization tool for Wide-Bandwidth Monitoring (WDM).

1.2. Objective:

- Possibility of not having to employ a tunable OTDR, that is both time-consuming and costly to maintain.
- To reduce the impact of a monitoring signal just on data transfer process.
- The speed with which the issue is detected and localized thanks to the effectiveness of the monitoring system.
- The sensitivity and dynamic range of the OTDR.

1.3. Research questions:

1. Possibility of not having to employ a tunable OTDR, that is both time-consuming and costly to maintain.
2. To reduce the impact of a monitoring signal just on the data transfer process.
3. The speed with which the issue is detected and localized thanks to the effectiveness of the monitoring system.
4. The sensitivity and dynamic range of the OTDR.

2. Literature Review:

An overview of the most useful sources used to compile the research is shown here. The several subsections of this chapter cover every significant aspect of the study.

2.1. WDM:

WDM increases the capacity and adaptability of complex communication networks (WDM). Data channels might have been injected and retrieved. Add–drop multiplexers add or eliminate data channels based on wavelengths. Current systems can handle up to 160 data, allowing a normal 10 Gbit/s network to be scaled to 1.6 Tbit/s only using one fiber pair. WDM systems are popular within the telecom industry because it allows capacity expansion without adding fiber. Most WDM systems use 9 m only one fiber for transmission. Some WDM systems support multi-mode fiber lines with core diameters of 50 to 62.5 meters (Keiser, 1999). This approach uses the huge opto-electronic bandwidth mismatch to multiplex WDM channels from diverse end users onto a single fiber. WDM networks split the optical transmission band into multiple non-overlapping wavelengths (or frequency groups), each of which supports a distinct channel of communication working at the greatest electronic speed. Multiple WDM channels must coexist on such a single cable to maximize fiber bandwidth. This condition requires an efficient internet protocol, algorithms, as well as infrastructure. WDM wavelength division multiplexing is a technology used during fiber optic communication systems that allow for increased capacity and bidirectional communication over a single fiber. The signals in a WDM system are combined by a multiplexer just at the transmitter and separated by a demultiplexer now at the receiver. The correct fiber allows for a device that serves as both an optical add-drop multiplexer and a transceiver, all at once (Guelbenzu, Calabretta and Raz, 2018). The WDM building block is depicted in Fig. 2.

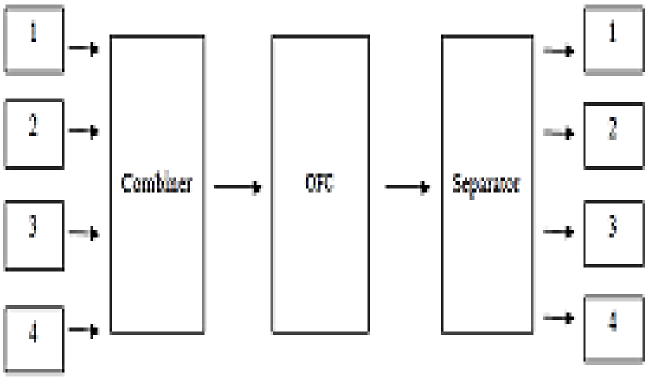

Figure. 2: WDM building block

2.2. Recent advancements in WDM:

Various WDM-based communication networks are among the most promising technologies for increasing the total capacity of communications systems (Goldfarb, Li and Taylor, 2007). Have been presented and further investigation into improving these network models (Zhou, Mao and Agrawal, 2015). WDM passive optical network (PON) was proposed and deployed to provide triple-play services. This 125 Mbps, 32-channel method uses Fabry-Perot laser diodes that are amplified by spontaneous emission injection (Park et al., 2004). In this paper, we present a packet-switched unidirectional and bidirectional ring WDM system that achieves higher capacity by the strategic utilization of available spatial wavelengths. The highest possible throughputs were attained on average for transmission, reception, and multicast. Eventually, writers came up with the idea of a wavelength division multiplexing (WDM) local area network, which sets up four distinct optical fibers to facilitate rapid fault isolation and data transmission (Scheutzow, Reisslein, Maier and Seeling, 2008). A light-wave central hybrid bidirectional network which integrates WDM-OFDM-PON with ROF was presented. It relies on the creation as well as reuse on various providers (Wang and McNair, 2011). Using distinct downlink and uplink frequencies reduces Rayleigh backscattering (Hsueh, Huang, Fan and Chang, 2011). A ring-based WDM-PON with less Rayleigh backscattering was introduced. Upstream and downstream traffic is supported by a separate optical network. WDM-PON provides unicast and broadcast services using polarization multiplexing with offsetting (Yeh and Chow, 2011). We successfully transmitted a 10 Gbps upstream unicast or broadcast utilizing differential phase shift typing and a 2.5 Gbps upstream ON-OFF message across a 20-kilometer standard fiber. And with wavelength division multiplexing – wireless via fiber optical network, both wired as well as wireless Internet connections are feasible. This network uses carrier-suppressed return-to-zero QPSK with polarization multiplexing (CSRZQDPSK). Our network bandwidth was thus better used (Xiong, Zhong and Kim, 2012). A portable Optical Network Unit (ONU) communicates upstream without wires or wiring. ONUs can eliminate the need for a laser source by employing semiconductor optical amplifiers as well as recycling network light, rendering WDM-PON colorless (Xiong, Zhong and Kim, 2012). The network permits both online and offline channels, even though the ONU has no RF emitters (Ji and Chang, 2013). WDM access network with FSO distribution link was shown.

3. Methodology:

3.1. Data collection:

Secondary sources of information, such as newspapers and the Internet, have long been relied upon. WDM-PON analysis by means of supervision techniques. We also present an architectural perspective on WDM-PON management. Furthermore, in this step, the fundamentals and characteristics of a WDM coupler (i.e., AWG), as well as the monitoring equipment (including OTDR as well as Optic Frequency Domain Reflectometry, OFDR), were investigated. Current research articles and patents are analyzed to learn more about the key problems and obstacles in WDM-PON supervision. Some promising methods are also evaluated in light of the need for effective WDM-PON supervision at this point.

3.2. Data analysis:

There are three essential components of a WDM-PON Supervisory Approach. Minimal impact of a supervision process on normal data transmission.

(1) The ability to rapidly detect and localize fibre events in order to 32 reduce downtime;

(2) Not requiring a tunable OTDR to preserve the cost-efficiency of a PON system; and

(3) Avoiding the need for frequent manual inspections.

As far as we are aware, none of the described approaches can concurrently fulfill all three requirements. Here, we provide a straightforward approach to supervision that meets those criteria. Its fault localization sub-system and the wavelength division multiplexed passive optical network transmission system make up the bulk of the system. Finally, a WDM coupler sends the multiplexed signals down the feeder fiber to the far-flung node. After passing via a second WDM coupler, the signals are demultiplexed using an AWG at the far end of the network. After traveling via a 2x1 multiplexer as well as an optical filter, each wavelength channel is sent down a separate drop fiber and eventually received by ONU.

4. Findings and Discussion:

This supervision method is simple. The supervision method won't affect the transmission procedure for a reflecting element. There are still downsides. This strategy isn't suitable for a WDM-PON network for various reasons. Using an optical splitter instead of an AWG in the remote node causes insertion loss. The system's reflecting component adds cost. For add insult to injury, the mirrored monitoring signal carries no information well about breakdown's location, making problem localisation impossible.

This supervision strategy is superior because it pinpoints errors. Finding the problem's source takes longer than identifying it. Separating localization from defect detection can enhance system efficiency.

5. Conclusion:

As WDM technology emerges as a potential way to solve communication network difficulties, more effort remains to be done to deliver cost-effective solutions. Existing and new networks can be optimized to solve communication network difficulties. An overview of WDM technology shows how it increases network capacity.

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