RESEARCH ARTICLE OPEN ACCESS

10-Gb/S Transmission of Wdm Pon for Man with 50km Reach Based On Ftth

Ankit bagga[1] Mr. Kulwinder Singh [2] Bharat rawat[3]
Student[1], Associate professor[2], Assistant professor[3]
Bhai maha singh College of engineering[1,2], Ganpati institute of technology & management Bilaspur[3]

Abstract
The wavelength-division-multiplexed passive optical network (WDM-PON) is considered to be the next evolutionary solution for a simplified and future-proofed access system that can accommodate exponential traffic growth and bandwidth-hungry new applications. WDM-PON mitigates the complicated time-sharing and power budget issues in time division- multiplexed PON (TDM-PON) by providing virtual point-to-point optical connectivity to multiple end users through a dedicated pair of wavelengths. The objective of this paper is proposed a scheme for metropolitan area networks comprising optical components based on arrayed waveguide grating multiplexers, demultiplexers .The Arrayed waveguide gratings based multiplexers and demultiplexers for WDM applications prove to be capable of precise multiplexing and demultiplexing of a large number of channels with relatively low losses.
Keywords- AWGPON. PON, WDMPON, TDMPON

I. INTRODUCTION

Today, telecommunication networks are at the hearth of the information society, allowing billions of people to stay in touch with each other in every part of the world, exchanging data at ever growing speeds. Over the last ten years, the amount of traffic carried by the Internet has been growing at a rate of approximately 70 to 150% per year. The growth can be expected to continue at this rate till at least the end of this decade. In analogy to Moore‘s Law for semiconductors, which states that the processing power and the number of transistors in a microprocessor approximately doubles every 18 months, this trend is often referred to as _Moore‘s Law for Internet traffic‘. Although Moore‘s Law is not a natural law, but results from a complex interaction between technology, sociology, and economics, it has still held with remarkable regularity and for various technologies over many decades. Starting from the seventies, the Internet technology started spreading to a growing number of Universities and companies, as soon as they gained access to computational and networking resources [1]. WDM technology enables network operators to continuously increase the capacity of their networks. (With WDM multiple data channels are transmitted over a single optical fiber enabling network operators to multiply the capacity of their existing infrastructure without installing new fiber which would be very costly.) The additional capacity in turn stimulates innovation of new applications which further increase the demand for more bandwidth [2]. Clearly, WDM will remain the key technology to satisfy the ever increasing demand for more bandwidth within the next years. However, a closer look at the infrastructure of today‘s Internet reveals that it consists of different domains that, besides the need for more bandwidth, all face different limitations and challenges [3]. Most of the metropolitan area networks are based on the Wavelength Division Multiplexing. Metropolitan networks play a critical role in the overall expansion of network services.

II. PON STANDARDS

The following are the various PON standards with a few applications:-
ITU-T G.983 APON (ATM Passive Optical Network).This was the first Passive optical network standard. It was used primarily for business applications, and was based on ATM. BPON (Broadband PON) is a standard [4] based on APON. It adds support for WDM, dynamic and higher upstream bandwidth allocation, and survivability. It also created a standard management interface, called OMCI, between the OLT and ONU/ONT, enabling mixed vendor networks. ITU-T G.984 GPON (Gigabit PON) is an evolution of the B PON standard [5]. It supports higher rates, enhanced security, and choice of Layer 2 protocol (ATM Ethernet) Version is in the process of implementing this. IEEE 802.3ah EPON or GEPON (Ethernet PON) is an IEEE/EFM standard for using Ethernet for packet data. IEEE 802.3av 10GEPON (10 Gigabit Ethernet PON) is an IEEE Task Force for 10Gbit/s backwards compatible with 802.3ah EPON.10GigEPON will likely be based on Wave Division Multiplexing. Even though the EPON or ATM based PON utilizes the bandwidth of

fibre effectively, it has limitations in the increase of transmission speed. WDM-PON becomes more favourable as the required bandwidth increases

III. WAVELENGTH DIVISON MULTIPLEX PON

Among the various solutions to the FTTH realization, the wavelength-division-multiplexed passive optical network (WDM-PON) has been considered as an ultimate next-generation solution because of its large transmission capacity, network security, and data transparency. The option of using WDM in the PON has been studied in the literature for many years [6]. In a very representative example of such WDM PON architectural proposals, each ONU is assigned a separate wavelength channel, and these channels are routed by a passive arrayed waveguide grating (AWG)-based router. Note that the AWG, which is a passive device (and needs little maintenance in the field), has essentially replaced the passive splitter of the traditional PON. However, unlike the passive splitter which fully broadcasts all information it receives on the fiber from the OLT to all the ONUs, the AWG has a fixed (cyclic) routing matrix which determines which incoming wavelength on which of its incoming ports will be routed to which output port. That is, the AWG allows spatial reuse of wavelength channels, and this can increase the information-carrying capacity of the PON manifold. In a WDM PON, different ONUs can be supported at different bit rates. Each ONU can operate at the full bit rate of a wavelength channel; and, therefore, it does not have to share the available bandwidth with other ONUs in the network. Moreover, unlike TDMA PON, the WDM PON does not suffer power-splitting losses. However, for the practical deployment of WDM-PON systems, the optical network terminal (ONT) placed in the subscriber premises should be wavelength-independent or wavelength-free, in addition to being cost-competitive to existing technologies. For the practical deployment of WDM-PON systems, the optical network terminal (ONT) placed in the subscriber premises should be wavelength-independent or wavelength-free. To this end, many noble solutions have been proposed. One successful scheme is the injection-locking WDM-PON, where the Fabry Perot laser diode (FP-LD), a multimode laser intrinsically, can be transformed to a single mode laser by injection of external light of which wavelength is aligned to one of its multiple modes. The WDM-PON of this scheme with a couple of broadband light sources (BLSs) being used as multiple-channel external injector by slicing the broadband spectrum has been deployed to Fiber To the Curb (FTTC) network by Korea Telecom (KT), the biggest telco in Korea, and successfully provided 100Mbps per wavelength and 16 wavelengths multiplexed on a fiber. However, this scheme requires BLSs to have a high optical power enough to turn the FP-LD at the ONT into the injection-locked mode. It would not be easy for the scheme to provide higher data rates beyond 1.25 Gbps over longer than 20Km distance due to the optical power fluctuation of spectrum-sliced lights out of the BLS.

Although the injection locking scheme has been already commercialized, further efforts have been made to increase transmission speed per wavelength and to eliminate the additional light sources such as BLSs beside the light sources for carrying the data, so that the optical link architecture can become simpler. This issue has been taken into account seriously because the main barrier to a larger penetration of WDM-PON into the optical access networks has been of course the higher equipment cost as compared to that of the TDMA PON. The re-modulation scheme developed by ETRI has a distinctive feature such that the optical signal modulated with downstream data is re-used to carry the upstream data through the Reflective Semiconductor Optical Amplifier (RSOA) equipped in the ONT or ONU, where the modulated downstream optical signal is flattened out, reflected at the rear facet of the RSOA, and then re-modulated with upstream data. The major advantage with the re-modulation scheme would be enabling us to realize the simplest WDM-PON optical link structure, which is directly reflected on cost-effectiveness of the network both in equipment and maintenance costs.

IV. TIME DIVISON MULTIPLEX PON

TDM-PON (Time division multiplexing) is a point-to- multipoint architecture, and data are broadcasted to each optical network unit (ONU) by the shared downstream trunk. The upstream packets from the ONUs are time- interleaved at the power splitting point. At the optical line terminal (OLT), a burst mode receiver is needed which can synchronize quickly to packets coming from different ONUs, and which also can handle the different amplitude levels of the packets. The average capacity per ONU decreases when the number of ONUs grows . Bandwidth allocation is a critical issue for TDM-PON performance [7]. A TDM-PON uses a passive power splitter as the remote terminal. The same signal from the OLT is broadcast to different ONUs by the power splitter Signals for different ONUs are multiplexed in the time domain.

PON DESIGN ISSUES

PONs are envisaged to provide high-speed broadband access over much longer distances than can be supported with current copper based access technologies. The physical properties of available equipment have a strong impact on the possible performance, available bandwidth and network reach.

These parameters determine the network architecture and must be considered in the process of designing and testing any efficient bandwidth allocation algorithm.

V. KEY COMPONENTS

The key components for an 10Gb/s WDM PON the transmitter, Tx, at the optical line terminal, OLT, side and receiver, Rx, at the optical network termination, ONT, side. In case of XG-PON2 also the OLT Rx and ONT Tx. Especially the burst-mode OLT Rx is technically challenging. The GPON power splitter needs to have a low uniform insertion loss across the whole single-mode band (1260 -1625 nm). For WDM-PON is the wavelength splitter (typically arrayed waveguide grating, AWG) critical, especially in 1-fiber applications where so called cyclic AWG are needed to carry both DS and US wavelengths on each port. The most critical WDM-PON component is the colourless ONT transmitter (i.e. wavelength adaptive transmitter) since only one type of ONT is desirable. Two main types can be identified, seeded reflective semiconductor optical amplifiers (RSOA) and tuneable lasers. The line rate for 10GPON is as stated above 10G in the DS and 2.5G or 10G in the US. Although both 100M and 10G are possible for WDM-PON, the main-stream is currently towards 1G (or actually 1.25G with 8B/10B line coding of 1 Gigabit Ethernet). When it comes to the split ratio (N, i.e. number of subscribers per feeder fibre), 10GPON is designed to co-exist with GPON where typical split ratios are 32, 64 and 128. For WDM-PON the split ratio equals the number of wavelengths: a typical value of 100 GHz ITU-T spacing makes 32 split possible but also 64 splits are being discussed5. The bandwidth (BW) available per subscriber is more difficult to place a number on: for 10GPON just dividing the line rate with the split could be a valid number for the US (e.g. 78 Mbps for 2.5G US and 32 split) while the subscriber BW in the DS depends onthe relation between broadcast and unicast traffic. In the extreme case of all subscribers just consuming broadcast (e.g. IPTV), all would have 10G capacity! In the other extreme with all subscribers just having unicast, the BW would be 10G/N (e.g. 312 Mbps for 32 split). In a triple-play scenario, the DS BW would be something between these values depending on the service mix. For WDM-PON, the subscriber BW is simply the line rate, i.e. 1G. It should however bepointed out that for both 10GPON and especially WDM-PON, the uplink capacity from the first active equipment in the central office (i.e. OLT) in relation to the access side capacity, sometimes referred to as oversubscription or aggregation factor, will put a limit to the available subscriber bandwidth. For example for a WDM-PON OLT with 32 1G port and 10G uplink, the subscriber BW is the same as for a 10GPON with 32 split. The advantage for WDM-PON in this case is however that the subscriber BW can be upgraded by increasing the OLT uplink. For unlimited uplink, the WDM-PON used would have 1G capacity, which would allow just a 10 split on a 10GPON to reach the same capacity. The system reach is in the 10GPON case determined by the split. For example for a 32 split (~18 dB insertion loss) and a 28 dB link budget, 10 dB is left for connectors, margin and fibre attenuation, typically equating to about 20 km. For WDM-PON, reach is one of the strong points since the AWG has much lower loss that a power splitter. It is typically stated that WDM-PON with tuneable laser ONTs reach longer than RSOA-based; 50 km looks achievable2. Both 10GPON and WDM-PON can be adapted to long-reach scenarios by introducing mid-span reach extenders. For 10GPON either opto-electric-optic (OEO) or SOA extenders can be used to reach up to 60 km (limited by GPON protocol) whereas WDMPON in C/L-band using erbium-doped amplifiers could reach up to 100 km. Finally, in the case GPON is already deployed on a particular fibre and the operator wish to place the NGPON as an overlay, a co-existence band plan is needed. For XG-PON, FSAN has placed much effort in assuring co-existence while it for WDM-PON still is an open question if this is achievable.

VI. WDM FTTH PON

We proposed the basic architecture of the network based on an AWG multiplexers and AWG demultiplexers is shown in Fig.1 Each node is connected to the network via two fibers i.e. one for transmission and the other for reception.

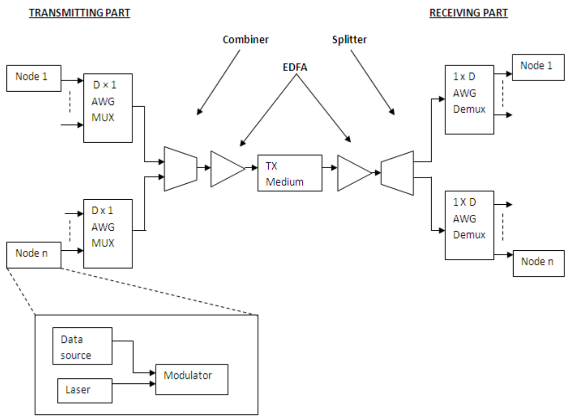

Fig.1 Block Diagram of the optical AWG multiplexer and AWG Demultiplexer.

At each AWG multiplexer input port data is collected from attached nodes. At each AWG multiplexer output port, a wavelength-insensitive combiner collects data from multiplexers out ports. After the amplification by EDFA the data is transmitted through single mode optical fiber. EDFA‘s gain is 5 dB. Similarly, after the transmission fiber data is amplified by the EDFA and the signals are distributed by a wavelength-insensitive splitter. After that the signal is distributed to nodes by AWG demultiplexers. Each node is equipped with a laser diode (LD) and a photodiode (PD) for data transmission and reception, respectively.

Transmitter section

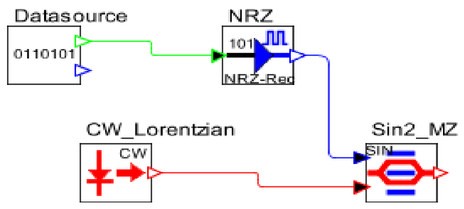

Fig.2 Transmitter section

Data source generates a binary sequence of data stream. Data source is customized by baud rate, sequence, logical signal level and the period length.
Laser block shows simplified continuous wave (CW) laser. In our model considered we have set 193.0 THz center emission frequency, 1553.32 nm wavelength, 1mw CW power, ideal laser noise bandwidth, 10 FWHM linewidth and laser random phase. The output from the driver and laser source is passed to the optical amplitude modulator. **Modulation driver** generates different types of data formats such as NRZ Rectangular, NRZ Raised cosine, RZ Rectangular, RZ raised cosine and RZ super Gaussian.

The pulses are then modulated using MZ modulator at 10 Gb/s bitrate. Amplitude Dual-Arm Mach Zehnder Modulator is used to modulate optical signal of desired form at having the following parameters: offset voltage corresponding to the phase retardation in the absence of any (on both arms) electric field is 0.5V, extinction ratio =20 dB and average power reduction due to modulation is 3dB. The optical signal from the EDFA i.e. after combiner is passed through the optical link section composed of SMF.

Receiver section

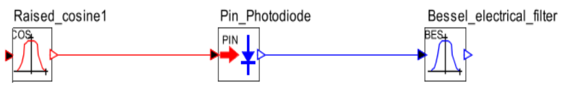

Fig.3 Receiver section

Single receiver is composed of optical raised cosine filter indicated by the component Raised cosine1 in Figure, PIN photodiode indicated by the component name Pin Photodiode and low-pass Bessel filter indicated by the component name Bessel electrical filter. Electrical scopes with Gaussian filter are used to observe change in performance.

VII. PERFORMANCE EVALUTION

In this section we will study the performance of the proposed AWG WDM PON scheme for its Quality factor, bit error rate, input & output power spectrum.

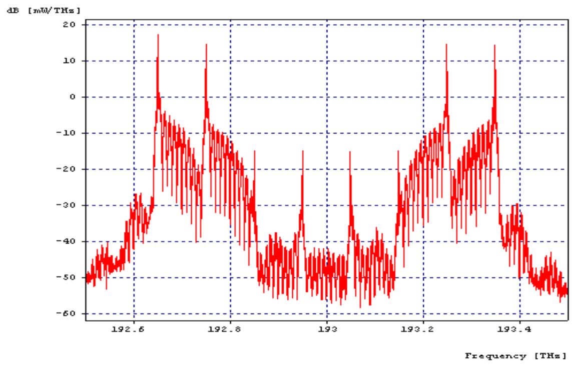

Fig.4 Input power spectrum

Fig.4 shows the input optical power spectrum of AWG multiplexer and demultiplexer based network, it is observed at transmission end.

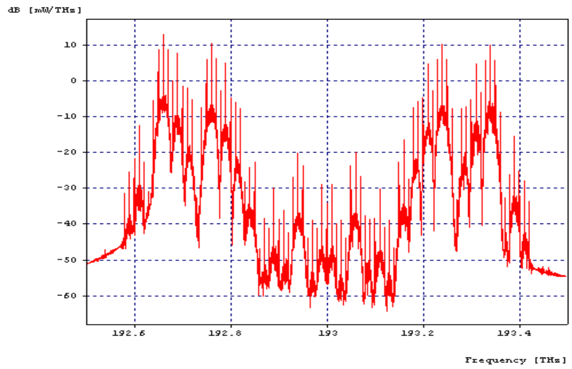

Fig.5 output power spectrum

Fig.5 shows the output optical power spectrum which is observed at the receiver end.

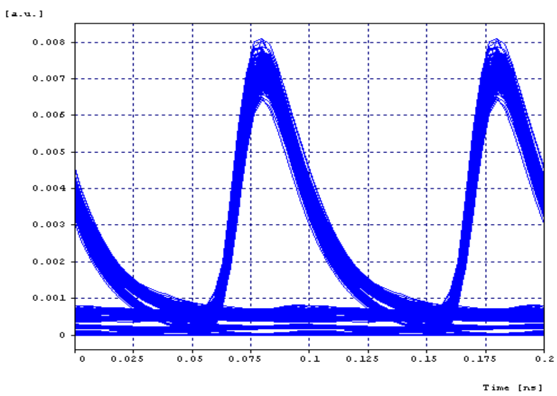

Fig.6 Eye diagram

Fig.6 shows the eye diagrams for RZ Raised cosine data formats .

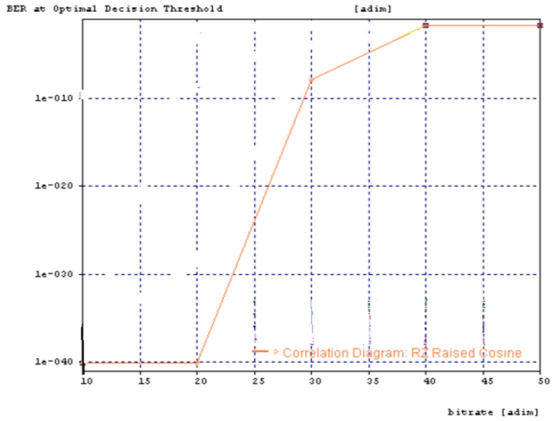

Fig.7 Bit Error Rate plot

Fig.7 shows the BER rate plot for RZ cosine data formats.

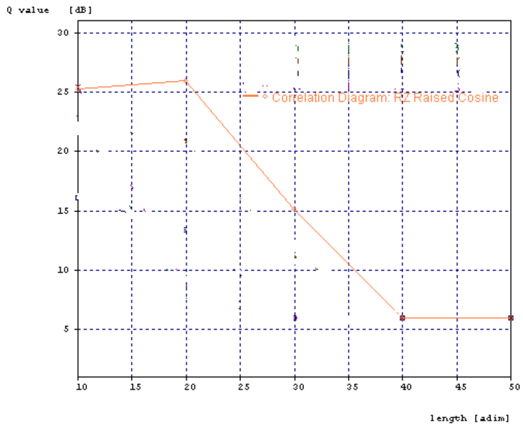

Fig.8 plot for Quality factor

Fig.8 shows the Quality factor plot for different lengths

VIII. CONCLUSION

In this paper we investigate the performance of the AWG multiplexer and AWG Demultiplexer based 10 Gb/s network. Moreover, this network is scalable and cost-effective. Here, we observed that Arrayed Waveguide Gratings multiplexers and Demultiplexers for WDM applications have proven to be capable of precise Multiplexing and Demultiplexing of a large number of channels with relative low losses and with a very low BER of 1 x10-40 for a transmission distance of 50 km. This distance can be further increased by using optical amplifiers in the network. Hence, this network is a good choice for either upgrading or installing a new metropolitan area network .The data format RZ raised cosine its highest value of Q (26.33dB**),** good eye opening, lowest BER and its non-susceptibility at different chirps makes it the best choice.

REFFERENCES

[1] R. Ramaswami, N.J. Sivarajan *Optical Networks, a practical perspective, second edition*, Elsevier Science and Technology books, November 2001.

[2] G.P. Agrawal, *Fibre-optic communication systems‖, third edition*, John Wiley and Sons, May 2002.

[3] Diptish Dey, *Theory towards an all optical WDM slotted ring MAN with support for optical multi casting,* Ph.D Thesis, University of Twente, June 2003, available at http:/www.tup.utwente.nl.

[4] ITU-T, "*G.983.1 Broadband Passive Optical Networks (BPON): General characteristics,"* June 1999.

[5] ITU-T, "*G.984.1 Gigabit-capable Passive Optical Networks (GPON): General characteristics*," Mar. 2003.

[6] A. Banerjee, G. Kramer, Y. Ye, S. Dixit, and B.Mukherjee, "*Advances in Passive Optical Networks (PONs),"* Optical WDM Networks: Past Lessons and Path Ahead (Eds: K. Sivalingam and S. Subramanium), Kluwer Academic Publishers, 2004.

[7]. Biao Chen, Jiajia Chen and Sailing He "*Efficient and fine scheduling Algorithm for Bandwidth Allocation in Ethernet Passive Optical Network*" IEEE Journal of selected topics in Quantum electronics July/August 2006