Symmetrical 10Gbps Point-to-Point and Broadcast Service using Centralized Source

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ABSTRACT
In this report, the demonstration of a cost effective bidirectional WDM-PON architecture supporting symmetric data rate for both point-to-point and broadcasting services are presented. To decrease the network cost and increase the end user data rate, utilizing RZ-DPSK for point-to-point (P2P) data and intensity modulation (IM) for broadcast data in downlink direction. Single feeder fiber is used in colorless WDM PON architecture supporting both 10 Gbps point-to-point and 10 Gbps broadcast services data. Error free transmission is achieved with low BER and eye diagrams are verified through simulation at a distance of 25 Km.

Keywords
Passive Optical Network (PON); Wavelength-division Multiplexing (WDM); Differential Phase Shift Keying (DPSK); Bit Error Rate (BER); Intensity modulation (IM); On Off Keying (OOK).

1. INTRODUCTION
WDM systems are trendy with telecommunication companies. Without laying new fiber it expands the capability of the network [1]. In optical communication, WDM technology carries more than one optical carrier signals on a single fiber using different wavelengths of laser light [2]. Bidirectional communication is achieved in the WDM system over one normal fiber with in increased capacity [3]. Paybacks of WDM are capacity upgrade, transparency, wavelength reuse, scalability and reliability [4].

Recently, various multimedia services like IPTV, VOD, HDTV, E-learning get more and more popular, the number of users of the service increases rapidly and each data flow which needs high bandwidth have impelled the bandwidth of access network to increase continually [5]. Therefore, the technique of access network is becoming the holdup of the growth of communication.

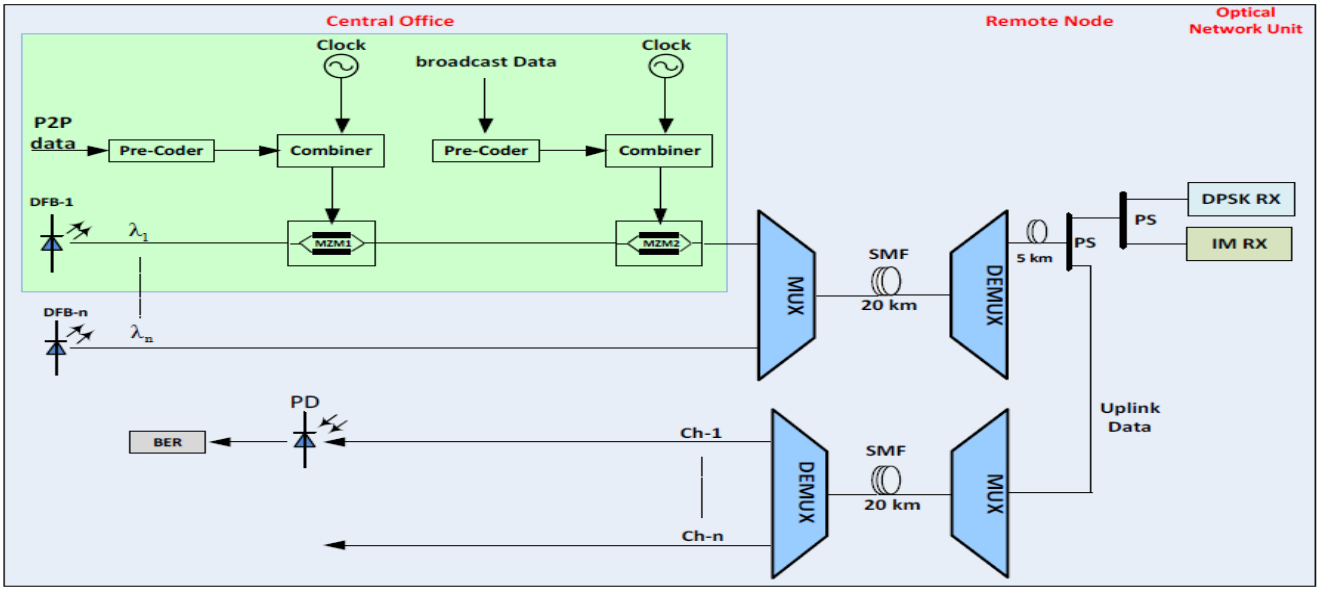

Fig 1: SchematicWDM-PON architecture for P2P and Broadcasting data

In this paper, WDM-PON system has transmitter and receiver end. At the transmitter end numbers of signals are feeds to multiplexer which multiplexes more than one optical signal into a single fiber. At the receiver end demultiplexers are placed to split the signal to many users [6]. An optical signal is converted into electrical signal at the receiver using photo detector [7]. Then the output signal is given to many users.

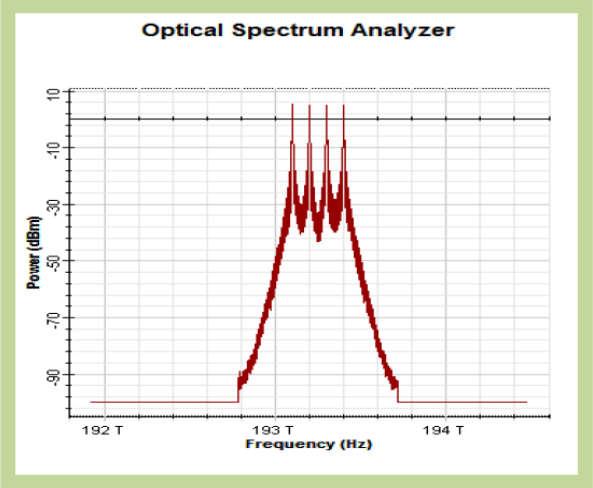

Fig 2: Four downlink multiplexed DPSK signals

2. WORKING PRINCIPLE AND NETWORK ARCHITECTURE

A full duplex WDM-PON network architecture is shown in Fig 1 delivering P2P and broadcast data. Base station (central office) contains four laser diodes which generates downstream wavelength from λ_1 to λ_4. When light passed through Mach-Zender-Modulator (MZM) to achieved DPSK modulation the two complementary output 10Gbps precoded superimposed electrical signals clock and data which is driven by MZM [8] [9]. Other additional MZM is driven by broadcast 10Gbps data, and then both P2P and broadcast data are multiplexed. This united downstream signal is transmitted on single strand fiber over distance of 20 km. At the access node downstream signal is demultiplexed where half power splitter is used to tape first half power for remodulation technique and fed to intensity modulator (IM) in turn to generate 10Gbps upstream data signal [10]. The other half power is transported through distribution fiber up to 5 KM, where signal is further by 3dB power splitter at ONU. Balance-Photo-Diode and 1-bit delayed inferometer is used to demodulate the downstream DPSK signal.

Table 1: General settings

Parameters	Values
Dispersion parameter for fiber	16.75ps/nm/km
Dispersion slope for fiber	0.075ps/nm^2/km
Attenuation coefficient	0.2dB/km
Core area of fiber	80um^2
Photo dectector Responsitivity	1A/W
Dark current of photo detector	10nA

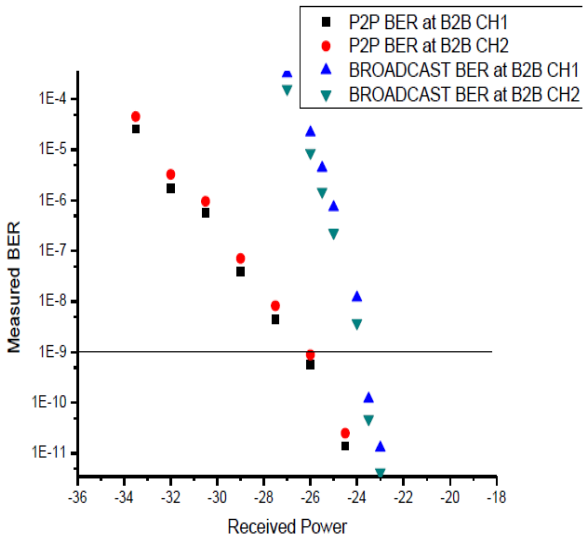

Fig 3: BER Graph for P2P and Broadcast data at B2B for Channel 1 and Channel 2

3. SIMULATION SETUP AND OPERATION

The proposed WDM-PON architecture for both broadcast data and point to point data was discussed and successful simulation is done by using OptiSystem 7.0 without use of pulse curve [11] shown in Figure-2. A 10Gbps bit stream of order 2^7 is superimposed by 5GHz clock with help of combiner. First MZM modulator is used for point to point data signal very much modulate to create DPSK downstream data signal. Second MZM is intensity modulated by 10Gbps broadcast data. Both signals are multiplexed and transmitted over 25 KM single feeder. A downstream signal is divided in two parts at remote node by 3dB optical splitter. Intensity modulation OOK technique is used to re-modulate first half signal to generated upstream data signal. The second half signal is transmitted through 5KM distribution fiber. Here balance diode and MZDI is used to extract P2P data while intensity demodulator received broadcast data from received signal. General settings for proposed system are given in Table 1.

4. PERFORMANCE ANALYSIS AND RESULTS

Bit error rate (BER) is main criteria for performance assessment of network. Both broadcasting and P2P transmission for channel-1 and channel-2 on back to back scenario are shown in Fig 3. In downstream direction -26dBm optical power is received at 10^{-9} BER for 10Gbps P2P data signal, similarly -23dBm power received at 10^{-9} BER for 10Gbps OOK broadcast data signal.

Fig 4 illustrate BER graph for both broadcast and P2P after transferring data over 25KM (20KM fiber + 5KM distribution fiber). In downstream direction -24dBm optical power is received at 10^{-9} BER for 10Gbps P2P data signal, similarly -19dBm power received at 10^{-9} BER for 10Gbps OOK broadcast data signal over traversing 25km fiber. Miniature power penalties for P2P data 2.0dB and for broadcast data 4.0dB were measured during B2B scenario and after traversing 25km fiber.

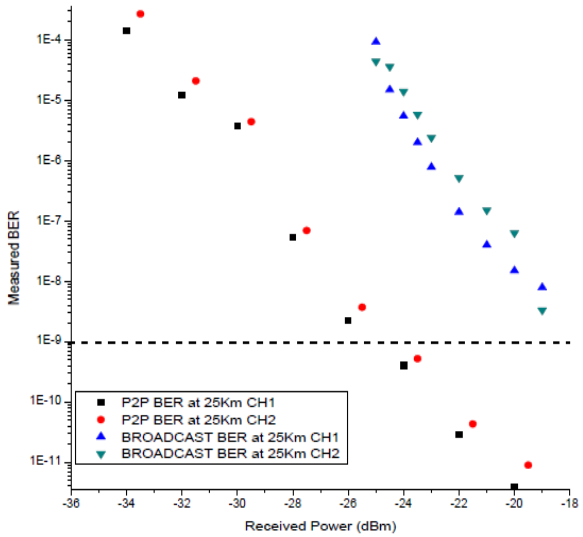

Fig 4: BER Graph for P2P and Broadcast Data at 25km for Channel 1 and Channel 2

Such a miniature power penalty possibly will largely be accredited to chromatic dispersion, yet the continuous performance of the downstream signal evidently shows the applicability of such a lucrative DPSK transmitter for the implementation in upcoming WDM-PONs. Figure-5 shows the resultant optical eyes diagram for both downlink and uplink channels. These eyes are wide open and transparent.

5. CONCLUSION

In this paper, a lucrative WDM-PON architecture supports both broadcast and point to point services at a rate of 10Gbps in full duplex mode is demonstrated. Remodulate the downstream signal for uplink data by using On off Keying (OOK) technique save more resources like light source and extra modulator. Error free transmission is verified through software at a distance of 25KM with low BER. Low power penalties 2.0dB for Point to Point and 4.0dB for Broadcast services are measured at 10^{-9} BER. Successful transmission is achieved for both downlink/uplink P2P data and broadcast service for more than on channel.

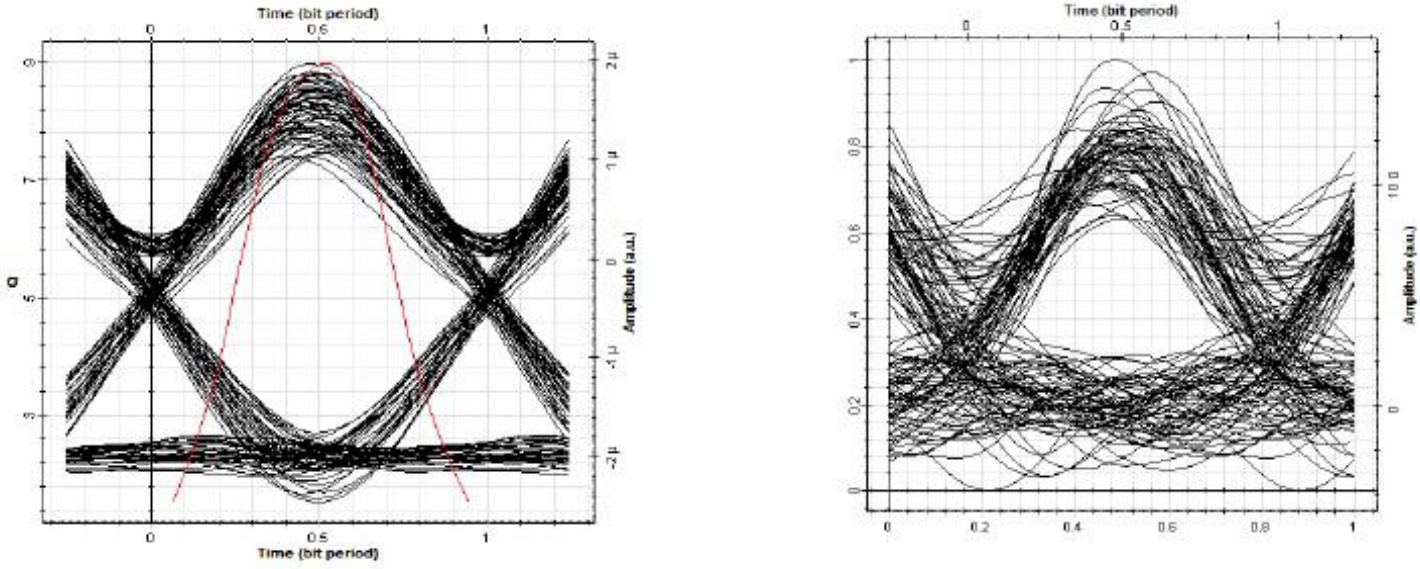

Fig 5: Eye Diagram for Point to Point and Broadcast Signals

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