Analysis Of Optical Unicast Design Using 1.65Tb/S Overlay System With 40Gb/S Multicast Signal

Shivani Goyal, Akanksha Singh, R.S. kaler

Abstract: In the proposed design, we investigated the optical unicast system using hybrid modulation techniques (NRZ, DQPSK and DP-16QAM) and overlay on multicast system to transmit 13.56Tb/s data rate using OTDM (Optical Time Division Multiplexing). In the design of unicast system, NRZ, DQPSK and DP-16QAM modulation is used to transmit 1650Gb/s data rate and DPSK (differential phase shift keying modulation) is used to transmit 40Gb/s data rate. Similarly total ten unicast signals are generated to achieve the data rate of 1.35Tb/s and overlay it on multicast signal. In the multicast signal DPSK modulation with MZM is used at 40Gb/s data rate. Input power, BER and Q-factor has been observed using Optisystem v 15 software.

Index Terms— BER, Hybrid modulation, MZM, NRZ, QAM, optical multicasting, OTDM.

1 INTRODUCTION

In the recent years, demand of high speed data rate is increasing day by day with efficient utilizationof bandwidth [1]. This large data traffic demand can be fulfilled if optical fiber would allow terabit data transmission. However, it would require numerous types of optical techniques such as hybrid multiplexing like WDM with OTDM [2-3]), WDM with OCDMA [4] and WDM with Nyquist [5] and modulation techniques like RZ+PDM+QPSK [6], DQPSK+DRZ+POLS and NRZ+POLSK+DQPSK [7-8] and multi-dimensional techniques(2-dimensional coding [9-10] and 3-dimensional coding [11-12]). In various research methodologies, different hybrid modulation formats as well as hybrid multiplexing are studied in the last few decades. For efficient utilization of bandwidth the best modulation techniques are NRZ+POLSK+DQPSK. S.Singh[8] investigated a BW efficient system using NRZ+POLSK+DQPSK modulation format at channel spacing of 0.85THz providing each data rate of 105Gb/s for profitable transmission of 35 channels. S.Singh [3] proposed WDM OTDM hybrid multiplexing technique with multicast overlay system at 120Gbps data rate with 0.1THz channel spacing in each super channels and 0.25THz channel spacing in each subchannel. D. Sharma [7] analysed a WDM with Nyquist hybrid multiplexing technique for 9 channels providing data rate of 1.55Tb/s with a channel spacing of 27.75GHz. The design of the system was proposed in such a way to increase the overall system capacity within the available bandwidth.In the proposed model, a new architecture of multicast overlay system with hybrid modulation system as a unicast data is analysed where the unicast data comprises of Polarization shift keying and hybrid modulation to transmit 1650Gb/s data rate as unicast data transmission and 40Gb/s differential phase shift keying as a multicast signal.

The design of the paper is proposed to transmit 13.56Tb/s data rate by using 8x1690Gb/s as unicast data and 40Gb/s multicast data to utilize minimum bandwidth where the channel spacing is of 15GHz or 0.015THz in each subchannel of the proposed hybrid modulation architecture.

2 SYSTEM SETUP

In the proposed setup, the hybrid modulation design is used to modulate ten subcarrier channels which are starting from frequency 193.1THz to 193.25THz with a channel spacing of 15GHz or 0.015THz providing data rate of 1650Tb /s with a delay of one nanosecond (1ns) each in the ten subcarrier design. In this paper, the design of sub channel spacing is being reduced from 27.75GHz to 15GHz [7], moreover using channel spacing of 27.75GHz reduces the spectral efficiency of overall system and bandwidth is not properly utilized. Therefore, an optimized value is set for sub channel spacing to implement the proposed hybrid modulation architecture for unicast data transmission. The system parameters are shown in Table 1. In the proposed hybrid modulation design, the modulation techniques used for unicast transmission are NRZ+DQPSK with parallel combination of DP-16QAM providing data rate of 25Gb/s, 40Gb/s and 100Gb/s respectively. A laser diode is used in the proposed system of hybrid modulation to generate a continuous beam where the output of continuous beam is supplied to LiNb Mach Zehnder modulator and is modulated by 25Gb/s in NRZ modulation case. In the case of DQPSK modulation, there are two phase modulators are used where the first modulator plays the role of modulating the phase of an optical signal at phase deviation of 180^{o} while the second modulator modulates the phase at phase deviation of 90^{o}.

Table 1 *System parameters*

System Parameters	Value
Channel Spacing	15GHz
CW laser Frequency	193.1THz
Total Fiber Length	50Km
No. of loops	10
Unicast Modulation	NRZ+DQPSK+DP-16QAM, POLSK
Multicast Modulation	DPSK

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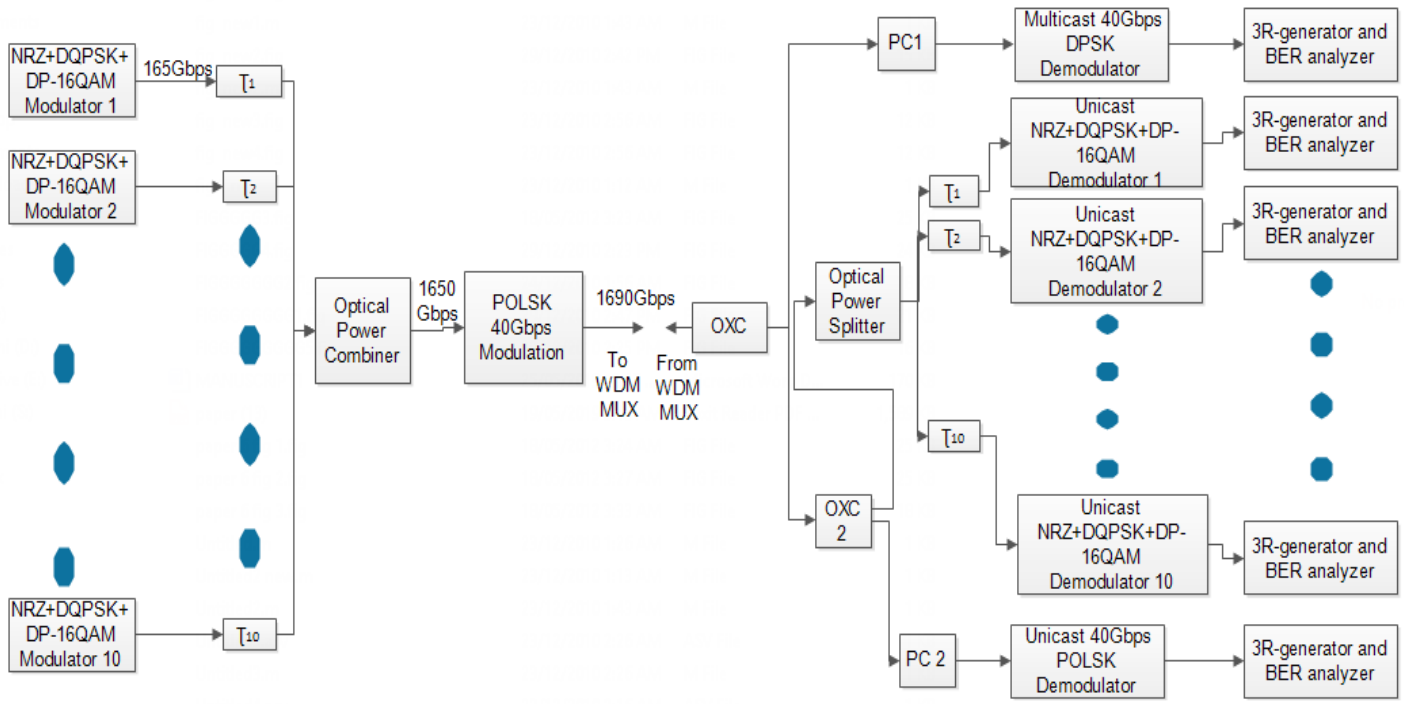

Fig.1. *Schematic Design for transmission and reception of single unicast and multicast sub channels*

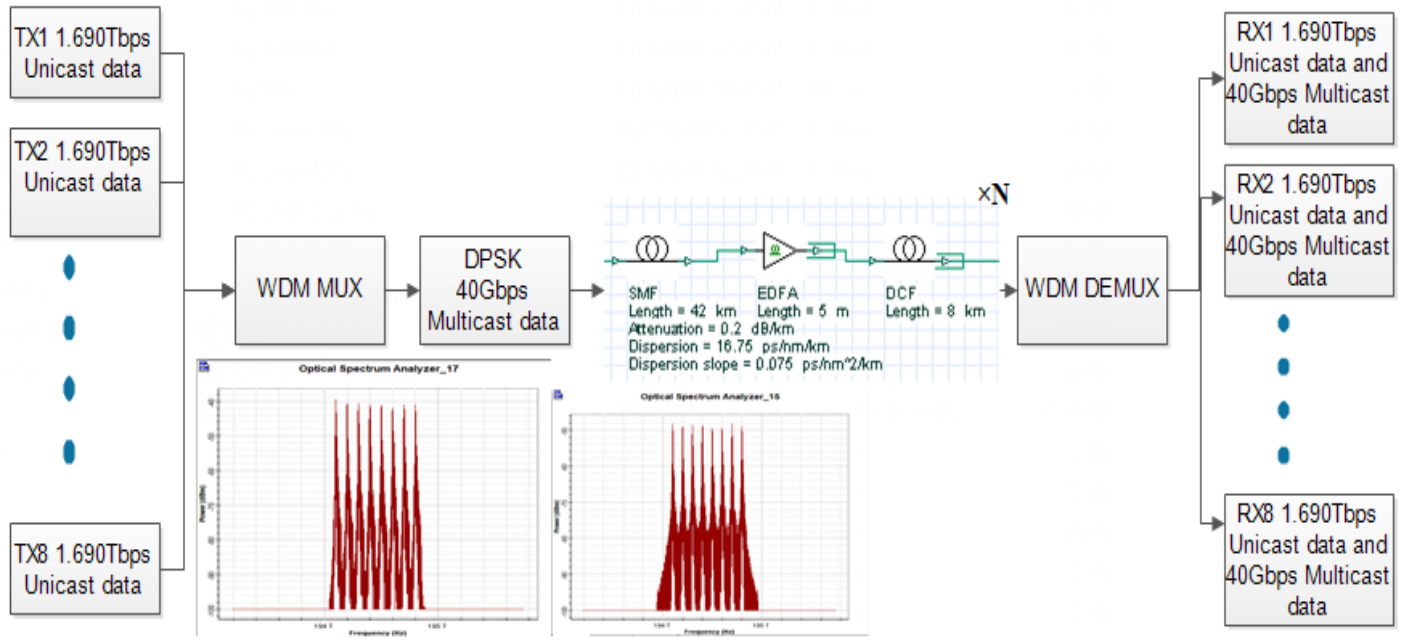

Fig.2. *Schematic design of unicast signal overlay multicast signal*

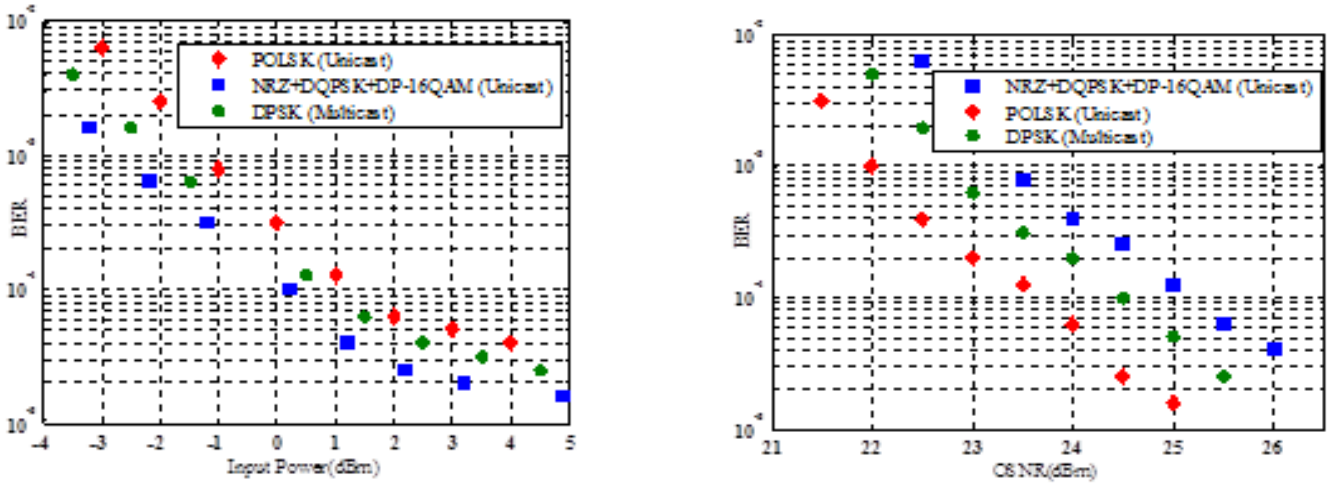

Fig.3. *Observed Simulation results for Unicast over Multicast system (a) Input Power w.r.t BER (b) OSNR w.r.t BER*

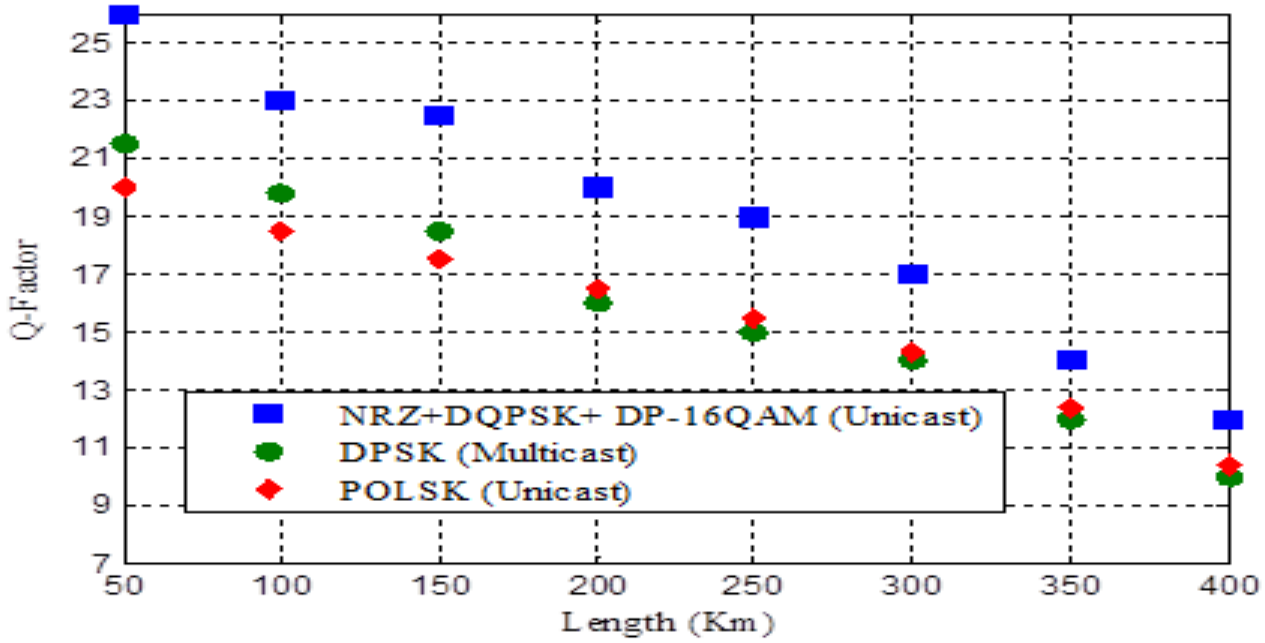

Fig.4. *Performance Analysis of Quality-Factor w.r.t length for each channel using Unicast (NRZ+DQPSK+DP-16QAM and POLSK) and Multicast modulation (DPSK)*

In the case of POLSK modulation the signal gets modulated at phase angle of 45°. The modulated signal from Hybrid modulation system generates the signal with the data rate of 1650Gb/s. The output from ten hybrid modulation systems each at data rate 1650Gb/s is fed to optical power combiner with a delay of 1nec. After the signal is passed through optical power combiner, the signal with data rate 1650Gbps is overlaid with multicast DPSK. The integrated signal of unicast and multicast signal is conveyed to recirculating N loops which consist of DCF (Dispersion Compensated Fiber), EDFA (erbium-doped fiber amplifier) and SSMF (standard single mode fiber). Since noise is random in nature and 100% of it cannot be removed from any communication system and to make the system more realistic, in each channel white Gaussian noise is added. After that, these eight unicast signals at 1690Gb/s data rate and multicast signal at 40Gbps data rate is fed to the de-mux and received by the receiver that is presented as the right side of the Figure 1. The 3dB optical cross coupler 1 (OXC1) is used to distribute the power of unicast and multicast signal equally and further the unicast data is received optical cross coupler 2 (OXC2) and polarization controller 2 (PC2) and multicast data is received polarization controller 1 (PC1). PC1 is used to change the state of polarization at 45°. Now at the receiver side of POLSK modulator the signal with data rate of 1690Gb/s is generated and conveyed to WDM demultiplexer. Likewise, the total eight transmitters of unicast signals are transmitted where each unicast data generates 1690Gb/s data rate starting from frequency 193.1THz to 193.22THz and fed to WDM multiplexer In order to receive 165Gb/s unicast data, there is a requirement of hybrid demodulators. Before the process of demodulation takes place, the ten demodulator of unicast data is divided by optical power splitter and the delays gets nullified. To receive back the transmitted signal, the hybrid

demodulators comprises of NRZ+DQPSK+DP-16QAM modulators part. After successfully receiving the unicast hybrid data, multicast DPSK data and POLSK data, all three are connected to 3R generator and BER analyzer in order to observe the performance of multicast overlay system.

3 Simulation Results

The design of the proposed system is carried out on opti-system v15 simulation software to investigate the performance of present hybrid modulation with multicast overlay system From the above mentioned Fig.3(a) represents the input power versus Bit Error Rate (BER) for multicast overlay system and it has been analyzed that as the input power increases till 5dBm the performance of BER improves parallely for multicast overlay system and BER decreases as input power goes below 0dBm. For input power the acceptable BER limit has been analyzed from 0dBm to 5dBm in the proposed research work. The Fig.3(b) shows the optical signal to noise power(OSNR) versus BER for each individual channel of POLSK unicast data, hybrid modulation(NRZ+DQPSK+DP-16QAM) unicast data and multicast DPSK data and it is analyzed that the unicast system has best BER as compared to the multicast system. The best acceptable limit of OSNR in case of unicast data (NRZ+DQPSK+DP-16QAM) comes out to be 26dBm at 6.8×10-4. From Fig 4.the relation between Q-factor and length of each channel for the case of NRZ+DQPSK+DP-16QAM,multicast DPSK data and PolSK data can be observed and and it can be mentioned that Distance and Q-factor are inversely propositional to each other reason being the multicast data is overlaid on unicast data data due to nonlinearities present in fiber. Finally from the proposed design, the length of the optical fiber used in the setup is 50Km and the number of loops present is 8 so, the total distance covered by the overall system is 400Km.

4 Conclusion

In this design, we have investigated a unicast signal transmission over multicast signal with efficient utilization of bandwidth for total data rate of 13.56Tb/s. In the unicast system, NRZ+DQSK+DP-16QAM and PolSK are used. From the simulation design and observed results input power, best BER and Quality factor have been analyzed for unicast-multicast proposed system, which is superlative of other previous research for unicast and multicast design.

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