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Survey paper on MDRZ-OTDM Using MZM Cascaded Receiver

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Abstract: This paper reviews about optical fiber transmission technique in which an advanced and extremely high bit rate communication system is presented. An optical time division multiplexing OTDM system implementation and requirements are discussed. Major theoretical concepts relating to fiber optic communication are also discussed comprehensively. Various modern modulation formats which are utilized for long distance, ultra high bit rate, using low power, immune to dispersion and attenuation are presented. Various optical time division multiplexing techniques which are used for high capacity and long distance transmission are analysed along with their pros and cons. [1].

Keywords: Modified Duo binary Return to Zero MDRZ, optical time division multiplexing OTDM, Quality Factor, Dispersion compensating fiber DCF, Erbium Doped fiber amplifier EDFA, Single mode fiber SMF, laser diode ld, pseudo random Bit Sequence PRBS, and Mach-Zehnder Modulator (MZM), Electrical time division multiplexing ETDM, Bit error rate BER, Return to zero RZ.

I. Introduction

In last few decades revolutionary changes have been noticed in data transmission techniques. Drastically the total communication is switched to optical domain instead of copper wired, or wireless. Optical communication becomes backbone of today's communication network. Continuous extensive researches in optical technology made it a reliable, ultra high speed with no latency, long range, low budget, low power communication network. Due to large data handling capacity and long distance of travelling fiber was adopted was as backhaul for global internet connectivity. To connect lands thousands of kilometre far terrestrial area. Initial installing cost of optical network was very high due to very expensive equipments are used for precise controlling and processing of optical signals. But due to extensive research and development in optical domain cost is reduced. Fiber to the home FTTH is the new network technology almost installed in all countries worldwide. It is only possible due to easy instalment and accessibility, low cost, low maintenance cost. It is used to provide all types of requirements that is internet Tv, data communication, telephone etc [2]. Data carrying capability of optical system is increasing by two and cost decreases by two. Research in coming years will be focused on developing hardware structure for 200-400GBps [3].

II. SYSTEM DESCRIPTION

Block diagram of an optical time division multiplexing OTDM system set up is shown in fig.1 here first of all Source of light continuous wave CW Laser diodes is used to produce clock signal for OTDM System. LDs are monochromatic in nature. Laser diode output contains a particular wavelength. All the particles of Coherent source have single direction and phase. Light of laser diode doesn't scatter due to coherence property so it covers a larger distance with very small amount of dispersion. Laser diodes consume very less power, highly efficient and generate a stable frequency for long time duration [4].

In this project 193.101 THz frequency is used for system. Splitter slices bit rate into four equal parts. This signal supplied to MDRZ modulator or transmitter as a clock and other input to this modulator is data signal that is obtained from PRBS generator transmitter output is in MDRZ format. This modulated signal in optical form with bit rate B_{ch} is supplied to Multiplexer or MUX. Four modulators with above properties are fed to MUX through delay line. Multiplexer combines four channels signal with output bit rate $4xB_{ch.}$ Output of MUX is fed to channel in which single mode fiber is used. To compensate dispersion and attenuation in transmission line dispersion compensation fiber DCF and erbium doped fiber amplifier EDFA is used respectively. Some times for larger distances repeaters or regenerators are also implied. At the receiver end de-multiplexer or DEMUX decompose data into different channels delay lines are used to select a particular channel from OTDM signal. Clock signal generator generates clock signal with the help of clock recovery system. Each channel signal is supplied to receiver which contain optical photo detector

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and de-modulator circuit. Output of receiver is imparted to its application and other to BER analyser for measurement purpose.

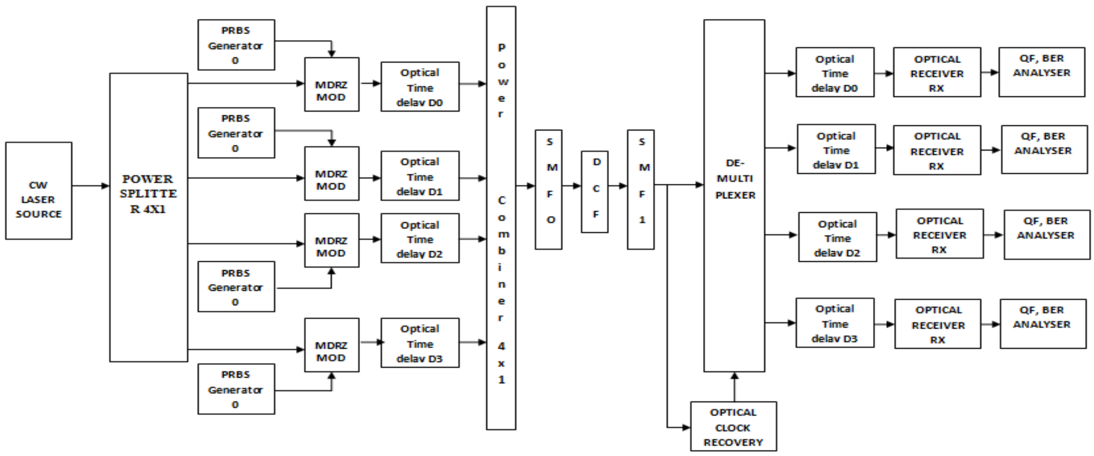

Fig.1 Block diagram of Simulation set up of OTDM system with MDRZ modulation format.

III. Different Multiplexer Systems used in optical communication

Many techniques are available for combining several low bit rate streams into high bit rate for single mode fiber communication for example Electrical time division multiplexing ETDM, code division multiplexing CDM, wavelength division multiplexing WDM, optical time division multiplexing OTDM. OTDM is most suitable for optical fiber communication.

A. Electrical Time Division Multiplexing

Electrical time division multiplexing is the transmission method to send several individual channels of information from source to destination over a single very high capacity channel. In this method time slots are assigned to every channel in the frame system.

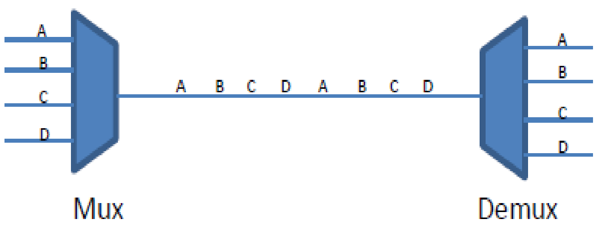

Fig. 4 Optical time division multiplexing system

B. Dense Wavelength Division Multiplexing

In ITU-T G.964.1 specifications, in dense wavelength division multiplexing technique separation between each channel is 0.1nm (12.5GHz), 0.2nm (25GHz), 0.4nm (50GHz) and 0.8nm (100GHz) and more and available may reach to 80. It is very efficient and high capacity multiplexing technique with high cost. In this technology very sharp cut off filter, large bandwidth EDFA are required.

C. Polarization Division Multiplexing

Polarization division multiplexing PMD is a way of combining two signals on a single carrier wave, but the condition is that two signal waves are made orthogonally polarised to each other. Its application is in satellite TV channels but now it is also used in optical communication. It has a limitation that only two channels can be transmitted at a time and sometime cross talk between to orthogonal signals is noticed [5].

D. Optical Time Division Multiplexing

For OTDM there are two techniques synchronous and asynchronous, in case of synchronous fixed time slots are used cyclic manner. Other hand flexible time slots are used according to need in asynchronous [6].

E. Wavelength Division Multiplexing

In case of WDM several different low bit stream are assigned different wavelengths with some channel spacing 20nm. Different channels are modulated and combined by using WDM multiplexer [6].

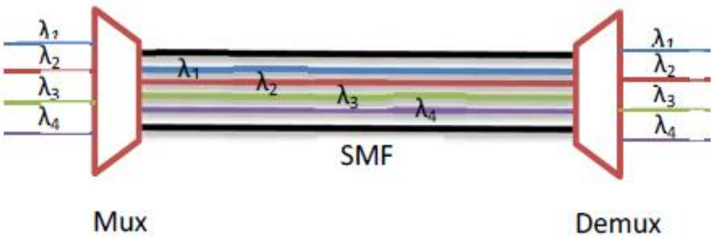

Fig. 4 Wavelength division multiplexing system [6].

F. Code Division Multiplexing

Code division multiplexing CDM uses many bit streams concurrently at a single frequency, in time sharing manner. Every bit stream uses definite code string [6].

G. Coarse Wavelength Division Multiplexing

CWDM is same as dense wavelength division multiplexing but in CDWD without the use of very precise optical amplifier and inexpensive active and passive components are used. In this multiplexing technique a specific grid is allocated by ITU G.692, it defines eighteen wavelength channels in low loss optical spectrum. Each channel is allocated a bandwidth greater than 200nm. One of its applications is in multichannel television distribution [7].

IV. Literature survey

1. **U.Feiste et. al** introduced a optical transmission system of 160GBps using return to zero format. This experiment is carried out on G.652 ground installed fiber. In the receiver side DEMUX of 160GBPS to 40GBPS is used its output is supplied to an electrical signal processor ETDM. At the receiver side De-multiplexer is based on cross phase modulation XPM in semiconductor amplifier SOA. Clock pulse is generated by Tune able mode locked laser. It produces a train of 10GHz at a wave length of 1552nm. A pulse width of 1.2ps is intensity modulated with PRBS source. An external Mach-Zehnder type modulator is used for intensity modulator.

2. **Hans-Georg Weber et. al** suggests an ultra high speed optical arrangement using OTDM. Ultra high speed network essentials at transmitter end, receiver end and optical link are discussed. In this outcome of other researchers are discussed. It also presents discussion on different modulation formats, multiplexer, de-multiplexer, Different types of fiber and its properties, DPSK modulation formats in detail. Dependency of OTDM on ETDM and vice-versa is discussed.
3. **J.P. Turkiewicz et. al** presented optical time division multiplexed arrangement of 160GBps with switching and de-multiplexed by an installed fiber. In this 16 time interleaved channels are used to obtain 160GBps by 10Gbps data rate of each channel. Addition or drop of a channel in OTDM is achieved by a Semiconductor optical amplifier SOA. Clock recovery is done by electro-optical phase locked loop or an electro absorption modulator EAM. Dispersion of chromatic and polarization mode is analysed using fiber. Data of 160GBps is transmitted at fiber length of 550km and 275km, at this length adding and dropping a channel, clock recovery and transmission is presented with good results.
4. **R. Ludwig et. al** shows experimental arrangement consist of differential phase shift keying using DPSK transceiver. At transmitter 10.75 GHz tuneable mode-locked laser (TMLL, 1553 nm) and a phase correction setup Supply a 43GHz clock signal having pulse width of 1.8 Pico second. Continuous signal of 43GHz is DPSK modulated by Mach-Zehnder modulator as push pull arrangement at Transmit/Receive setup. The setup consists of DPSK pre-coder with an advanced FEC pre–coder (UFEC). For stable operation and control loops are used. The fiber link consists of three spans with a length of 160 km. A loss of 36db is noticed in every spam so EDFA is used to compensate. At 160GBps with ultra long repeater spacing of 160km length can be increased up to 1000 km.
5. **Ghafour Amouzad Mahdiraji et. al** in this paper discusses basic optical technology. It explains different type of advance modulation formats RZ, MDRZ, DRZ and multiplexing techniques used in optical technology. In this paper comparison of various modulation formats has been given.
6. **Divya Dhawan et. al** in this paper demonstrated experimentally with pictures, results using dispersion compensating fibers DCFs. DCFs with inverse dispersion properties are used to mitigate the effect of dispersion. Their position in link that is Pre, post and symmetric schemes are employed for dispersion compensation. RZ and NRZ Modulation formats are used. The investigation is done on detailed simulative analysis. Results are obtained from the contour plots for different number of spans. Pre-compensation scheme is a bit better than post because eye opening is wider but pre compensation decreases the signal power faster.
7. **Bhumit P. Patel et. al** In this paper evaluates different modulation formats for WDM setup operating at data rates 320GBps. The performance is the study of Non return-to-zero NRZ, Return-to-Zero RZ, Carrier-suppressed return-to-zero CSRZ, Duo binary -RZ DRZ and Modified Duo binary-RZ MDRZ. Optimum modulation format is obtained for a 40GBps bit rate optical communication system. The performance of WDM system is measured by changing applied power at input ranging from -15dBm to 10dBm with fixed length of 300 km at spacing more than 100 GHz and 200 GHZ in each channel.
8. **S.J. Zhang et. al** proposed in the work a clock recovery scheme without a phase comparator, it works on summing with phase modulator to OTDM signal and base rate of clock. In this clock recovery of 10GHz for 160 to 40GBps is performed without any error. In OTDM for Channel dropping, adding,

regeneration and de-multiplexing a clock pulse is required. The problem At ultrahigh capacity is that a very high resolution is required for phase comparator.

9. **Simranjeet Singh et. al** In this paper demonstrates with the help of graph and table, difference between various modulation schemes. Results obtained from simulator are compared in EDFA, Raman amplifier and ytterbium amplifier. MDRZ scheme shows best results than CSRZ and DRZ. MDRZ could perform best in long haul communication. With the increase in length performance of every format decreases. In case of Raman amplifier CSRZ shows better results than DRZ. MDRZ is highly immune to fiber non-linearity because it has capability to suppress pulse interaction and ghost pulses. It is finally suggested that MDRZ format is the best candidate for communication over distances covering many hundreds of km.
10. **Tajinder Kaur et. al** in this paper suggests on the basis of result obtained from 160Gbps bit rate (four channel with data rate of 40Gbps each) by using RZ and NRZ signal pulses. Dispersion is managed with the help of Dispersion Compensating Fibers DCFs. In this 343km distance is successfully covered with the help of single mode fiber, result for RZ shows Q-factor 11.60 and bit error rate 1.39×10^{-31} and for NRZ format Q factor 10.13 and bit error rate 1.47×10^{-24}.

V. Conclusion

To conclude, we have studied and reviewed various techniques and research progress in the field of optical time division multiplexing. Various modern modulation formats which are utilized for long distance, ultra high bit rate, using low power, immune to dispersion and attenuation are presented. Different optical time division multiplexing techniques which are used for high capacity and long distance transmission are analysed along with their pros and cons. We have also proposed a design for optical time division modules that form the basis for further development in the optical time-domain technology. In literature survey various research papers are studied and analysed to find the space for further research. In future, we propose a base technique for All-optical network design with the combination of WDM and OTDM, for flexibility of adding and dropping a channel offered by OTDM as well as to increase the capacity of optical link by using different wavelength in WDM.

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