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Performance Analysis of Multi-QoS Model of OCDMA System by Adopting OPPM Signalling and Switching

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ABSTRACT
In this paper, optical CDMA which combines the large bandwidth of the fibre medium with the flexibility of the CDMA technique to achieve high speed connectivity has been used. For achieving this purpose, OPPM signalling and switching techniques have been employed. This helps in the achievement of high tolerance to Multiple Access Interference, further resulting in improvement of both the Bit Error Rate and optical channel capacity without the need to decrease the light pulse width. An OPPM scheme to support multimedia services with different transmission rates and Quality of Service requirements is proposed. Packet Switching technique has been employed to help in the transfer of data in the form of packets from the source to the destination via a specified route. The results are calculated by using PPM signalling and switching technology.But switching technology has been found to be far better than the OOK-OCDMA if the average power has been considered as the restraining factor.

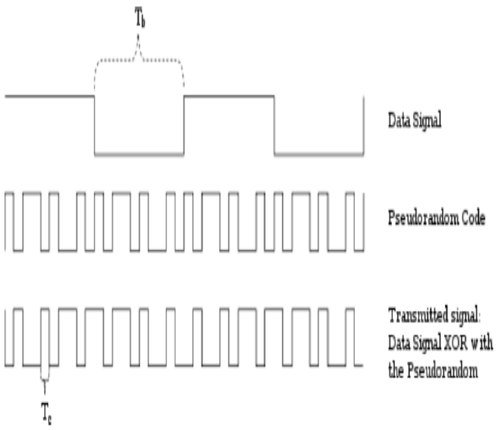
***Keywords**:* CDMA, OCDMA, BER,PPM,OOK, PER,MAI, QoS, Switching.

I.Introduction

Code division multiple access (CDMA)[1] is a channel access method used by various radio communication technologies.

CDMA [4] is an example of multiple access where several transmitters can send information simultaneously over a single communication channel. This allows several users to share a band of frequencies (see bandwidth). To permit this without undue interference between the users,

CDMA employs spread-spectrum technology and a special coding scheme (where each transmitter is assigned a code). CDMA is used as the access method in many mobile phone standards such as CDMA One, CDMA2000 (the 3G evolution of CDMA One), and WCDMA (the 3G standard used by GSM carriers), which are often referred to as simply *CDMA.*



Each user in a CDMA system uses a different codetomodulate their signal. Choosing the codes used to modulate the signal is very important in the performance of CDMA systems. The best performance will occur when there is good separation between the signal of a desired user and the signals of other users. The separation of the signals is made by correlating the received signal with the locally generated code of the desired user. If the signal matches the desired user's code then the correlation function will be high and the system can extract that signal. If the desired user's code has nothing in common with the signal the correlation should be as close to zero as possible (thus eliminating the signal), this is referred to as cross-correlation. If the code is correlated with the signal at any time offset other than zero, the correlation should be as close to zero as possible. This is referred to as auto-correlation and is used to reject multi-path interference.

An analogy to the problem of multiple access is a room (channel) in which people wish to talk to each other simultaneously. To avoid confusion, people could take turns speaking (time division), speak at different pitches (frequency division), or speak in different languages (code division). CDMA is analogous to the last example where people speaking the same language can understand each other, but other languages are perceived as noise and rejected. Similarly, in radio CDMA, each group of users is given a shared code. Many codes occupy the same channel, but onlyusers associated with a particular code can communicate.

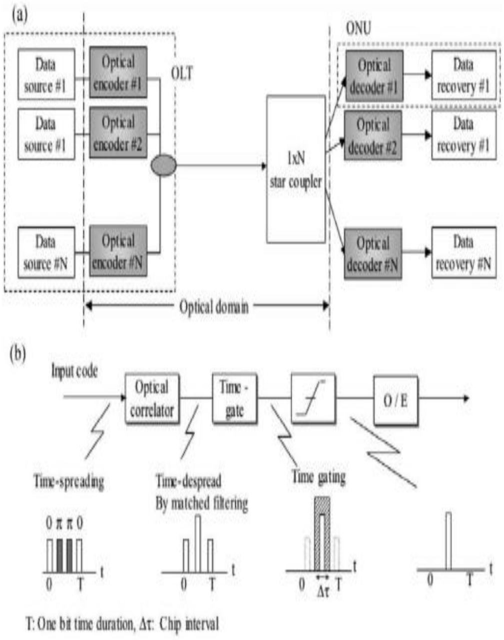
II. Optical Code-Division Multiple-Access

In general, CDMA belongs to two basic categories: Synchronous (Orthogonal codes) and Asynchronous (Pseudorandom codes).

An optical code-division multiple-access (OCDMA) [2] system employing overlapping pulse-position modulation (OPPM) is proposed to support multimedia services with different bit-rate and quality-of-service (QoS) requirements in OCDMA networks. Both wrapped OPPM (WOPPM) and unwrapped OPPM (UOPPM) are considered. The proposed system achieves multi-rate and multi-QoS transmission by using multi-length variable-weight optical orthogonal codes (MLVW-OOCs) as signature sequences and using different values of OPPM modulation parameters. Furthermore, numerical analysis is performed for two different receiver structures, namely, correlation receivers with and without hard-limiters. In our analysis, the multiple-accessinterference(MAI) is considered as the main performance limiting factor. In addition, the performance of the proposed system is evaluated and compared to that of traditional OOK-OCDMA system. Our results reveal that under both pulse width and throughput constraints, the performances of the proposed WOPPMand UOPPM-OCDMA [5] systems are significantly superior to that of OOK-OCDMA system.

In an O-CDMA[3] system, each bit is divided up into *n* time periods, called chips. By sending a short optical pulse during some chip intervals, but not others, an optical signature sequence, or code word, can be created. Each user on the O-CDMA system has a unique signature sequence. The encoder of each transmitter represents each 1 bit by sending the signature sequencehowever; a binary 0 bit is not encoded and is represented using an all-zero sequence. Since each bit is represented by a pattern of lit and unlit chips, the bandwidth of the data stream is increased. O-CDMA is therefore a spread-spectrum technology.

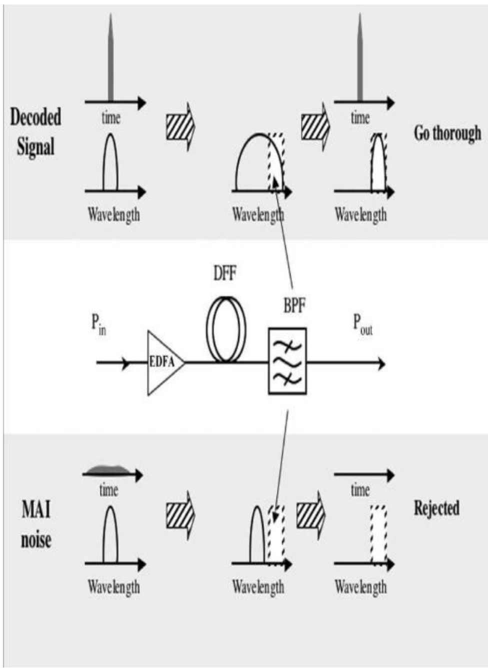
Optical code-division multiple access (OCDMA) provides another dimension for multiple access other than time- and optical frequency domains. Unfortunately, it has long remained outside the main stream of optical communications R&D since its proposal in the mid-1970s followed by experimental demonstrations in the 1980s. This is mainly due to immaturity of optical devices, which are proprietary to OCDMA, such as optical encoder/decoder and optical threshold device. The crosstalk between the different users sharing the common channel, known as the multiple access interference (MAI), and the signal-interference beat noise is the main source of bit errors. The reduction of the MAI and the beat noise are big challenges to make OCDMA a practical option for FTTH systems. Demonstrations of OCDMA system test hasalso been conducted [6]. Being encouraged by the progresses, OCDMA now deserves revisiting as a multiple-access technique forFTTH system[7].In this paper; we will first highlight the OCDMA systems.



Optical Code Division Multiple Access

III. Interference

A phenomenon ofinterference[8] occurs due to the overlapping of spectra from different users at network. Dramatic growth rates in capacity demands in wireless and other broadband systems have resulted in a rise in the use of communication networks in which multiple users share common communication resources. A significant consequence of this trend is the increasing presence of multiple-access interference (MAI), which arises in communication systems employing non-orthogonal multiplexing i.e. in multiple-access systems. This issue arises naturally, for example, in code division multiple-access (CDMA) communication systems using non-orthogonal spreading codes. It also arises in orthogonally multiplexed wireless channels, such as time-division multiple-access (TDMA) and orthogonal frequency division multiple-access (OFDMA) channels, due to effects such as multipath or non-ideal frequency channelization, and in wire line channels such as those arising in digital subscriber line (DSL) systems or power line communications (PLCs) in which crosstalk and other types of interference are major impairments. MAI also arises in optical Wave-Division Multiplexing (WDM) systems due to mode interactions caused by nonlinearities.



Multiple Access Interference
(Decoded Signal, MAI Noise Rejection)

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors.

The **Bit Error Rate (BER)**[6] is the number of bit errors per unit time. The **Bit Error Ratio**[7](also **BER**) is the number of bit errors divided by the total number of transferred bits during a studied time interval. BER is a unit less performance measure, often expressed as a percentage.

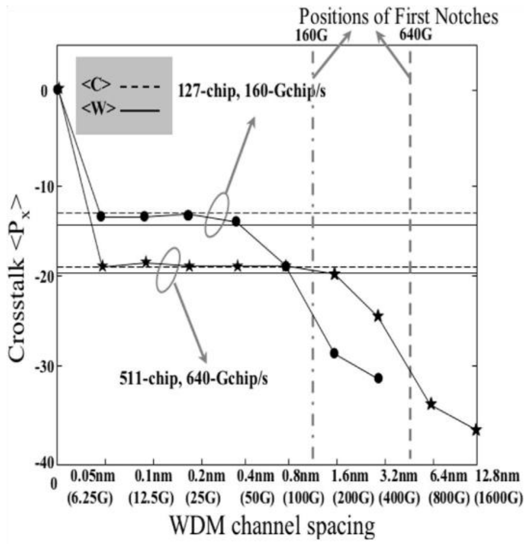
The **bit error probability**[7](Pe)is the expectation value of the bit error ratio. The bit error ratio can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.

The **packet error ratio**(PER) [7] is the number of incorrectly received data packets divided by the total number of received packets. A packet is declared incorrect if at least one bit is erroneous. The expectation value of the PER is denoted **packet error probability**Pp, which for a data packet length of N bits can be expressed as:

$$p_p = 1 - (1 - p_e)^N,$$

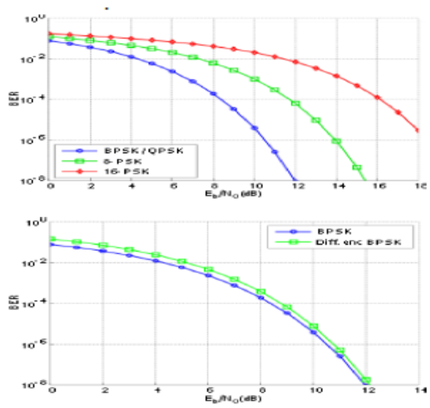
Assume that the bit errorsare independent from each other. For small bit error probabilities, this is approximately,

$$p_p \approx p_e N.$$



In communication system,the receiver BER is affected by the transmission channel noise, interference, distortion, bit synchronization problems, attenuation, wireless multipath fading, etc. The BER may be improved by choosing a strong signal strength (unless this causes cross-talk and more bit errors), by choosing a slow and robust modulation scheme or line coding scheme, and by applying channel coding schemes such as redundant forward error correction codes.

The *transmission BER* is the number of detected bits that are incorrect before error correction, divided by the total number of transferred bits (including redundant error codes). The *information BER*, approximately equal to the **decoding error probability**, is the number of decoded bits that remain incorrect after the error correction, divided by the total number of decoded bits (the useful information). Normally the transmission BER is larger than the information BER. The information BER is affected by the strength of the forward error correction code.



BIT ERROR RATE IN BPSK, QPSK, DIFFERENTIA ENCODED BPSK

IV. Optical CDMA for Access Networks

In an O-CDMA system, each bit is divided up into *n* time periods, called chips. By sending a short optical pulse during some chip intervals, but not others, an optical signature sequence, or code word, can be created. Each user on the O-CDMA system has a unique signature sequence. The encoder of each transmitter represents each 1 bit by sending the signature sequence; however, a binary 0 bit is not encoded and is represented using an all-zero sequence. Since each bit is represented by a pattern of lit and unlit chips, the bandwidth of the data stream is increased. O-CDMA is therefore a spread-spectrum technology.

V On-Off Keying

On-off keying (OOK)[2] denotes the simplest form of Amplitude-Shift Keying (ASK) modulation that represents digital data as the presence or absence of a carrier wave[1]in its simplest form, the presence of a carrier for a specific duration represents a binary one, while its absence for the same duration represents a binary zero. Some more sophisticated schemes vary these durations to convey additional information. It is analogous to unipolar encoding line code.

On-off keying [5]is most commonly used to transmit Morse code over radio frequencies referred to as CW (continuous wave) operation, although in principle any digital encoding scheme may be used. OOK has been used in the ISM bands to transfer data between computers.

For example OOK is more spectrally efficient than frequency-shift keying, but more sensitive to noise when using a regenerative receiver or a poorly implemented super heterodyne receiver. For a given data rate, the bandwidth of a BPSK (Binary Phase Shift keying) signal and the bandwidth of OOK signal are equal.

In addition to RF carrier waves, OOK is also used in optical communication systems (e.g. IrDA). In aviation, some possibly unmanned airports have equipment that let pilots key their VHF radio a number of times in order to request an Automatic Terminal Information Service broadcast, or turn on runway lights.

VI Qualityof Service

Quality of service (QoS)[8] is the overall performance of a telephony or computer network, particularly the performance seen by the users of the network.

To quantitatively measure quality of service, several related aspects of the network service are often considered, such as error rates, bit rate, throughput, transmission delay, availability, jitter, etc.

Qualityof service (QoS)[10]is particularly important for the transport of traffic with special requirements. In particular, much technology has been developed to allow computer networks to become as useful as telephone networks for audio conversations, as well as supporting new applications with even stricter service demands.

In the field of telephony, quality of service[12]was defined by the ITU in 1994. Quality of service comprises requirements on all the aspects of a connection, such as service response time, loss, signal-to-noise ratio, crosstalk, echo, interrupts, frequency response, loudness levels, and so on. A subset of telephony QoS is grade of service (GoS) requirements, which comprises aspects of a connection relating to capacity and coverage of a network, for example guaranteed maximum blocking probability and outage probability. In the field of computer networking and other packet switching telecommunication networks, the traffic engineering term refers to resource reservation control mechanisms rather than the achieved service quality. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed. Quality of service guarantees are important if the network capacity is insufficient, especially for real-time streaming multimedia applications such as voice over IP, online games and IP-TV, since these often require fixed bit rate and are delay sensitive, and in networks where the capacity is a limited resource, for example in cellular data communication.

The performance of encoded overlapping pulse position modulation (OPPM)[1] with at most two pulse positions per pulse width is investigated for an optical direct-detectionchannel under communication constraints. It is shown that under bandwidth and throughput constraints OPPM, with two pulse positions per pulse width, outperforms PPM when the overlap is chosen properly and the throughput is greater than 0.2 nats/slot. This makes it possible to increase the throughput and/or decrease the energy of the OPPM system,while maintaining the same performance as PPM. The energy saving when using OPPM[12] instead of PPM to transmit reliably a given amount of information is determined for different values of overlapping indices. The maximum throughput that can be achieved under average power and bandwidth constraints (with error probability not exceeding 10^{-5}) is also determined.

VII. Switching System Fundamentals

Telecommunications switching systems generally perform three basic functions: they transmitsignals over the connection or over separate channels to convey the identity of the called (and sometimes the calling) address (for example, the telephone number), and alert (ring) the called station; they establish connections through a switching network for conversational use during the entire call; and they process the signal information to control and supervise the establishment and disconnection of the switching network connection.

In some data or message switching when real-time communication is not needed, the switching network is replaced by a temporary memory for the storage of messages. This type of switching is known as store-and-forward switching.

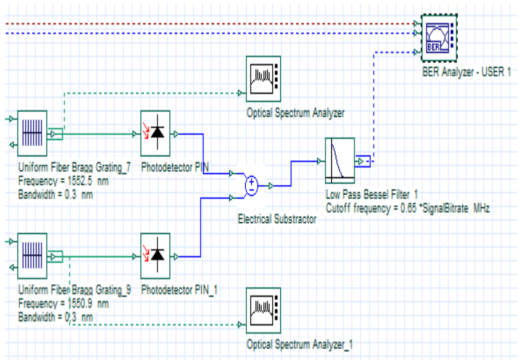
Signalling and control: The control of circuit switching systems is accomplished remotely by a specific form of data communication known as signalling. Switching systems are connected with one another by telecommunication channels known as trunks. They are connected with the served stations or terminals by lines.

In some switching systems the signals for a call directly control the switching devices over the same path for which transmission is established. For most modern switching systems the signals for identifying or addressing the called station are received by a central control thatprocesses calls on a time-shared basis. Central controls receive and interpret signals, select and establish communication paths, and prepare signals for transmission. These signals include addresses for use at succeeding nodes or for alerting (ringing) the called station.

Most electronic controls are designed to process calls not only by complex logic but also by logic tables or a program of instructions stored in bulk electronic memory. The tabular technique is known as translator. The electronic memory is now the most accepted technique and is known as stored program control (SPC). Either type of control may be distributed among the switching devices rather than residing centrally.

VIII. Simulation and Description

In this circuit, optical CDMA which combines the large bandwidth of the fibre medium with the flexibility of the CDMA technique to achieve high speed connectivity has been used. For achieving this purpose, OPPM signalling and SWITCHING techniques have been employed. This helps in the achievement of high tolerance to Multiple Access Interference, further resulting in improvement of both the Bit Error Rate and Optical channel capacitywithout the need to decrease the light pulse width, by using BER Analyser and optical spectrum Analyser for various signal bandwidths.



Circuit and Waveform Analysis inOptisystem**13.0**

Components used: Uniform Fibre Bragg Grating, Photo detector PIN, Electrical Subs tractor, Low Pass Filter, Optical Spectrum Analyser, BER Analyser.

Simulation parameters

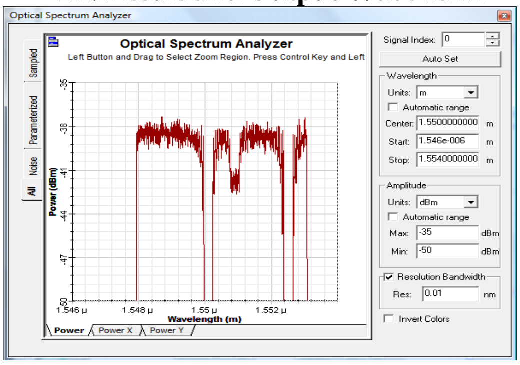
Uniform Fibre Bragg Grating_7, Uniform Fibre Bragg Grating_9

Frequency= 1552.5nm, Frequency =1550 nm

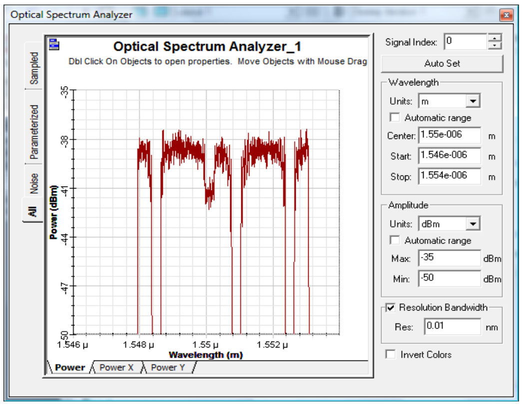
Bandwidth= 0.3nm,Bandwidth=0.3nm

Low pass Bessel Filter: Cut off Frequency= 0.65 *Signal Bitrate MHz's

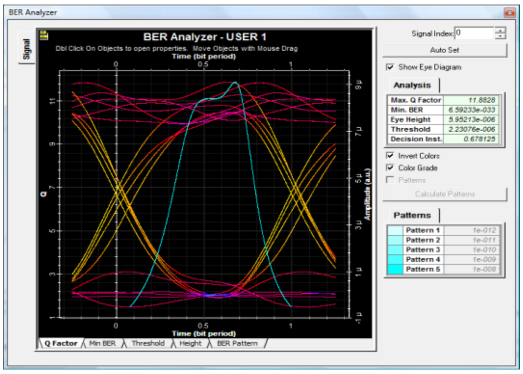
IX. Result and Output Wave form



Output Waveform – Optical Spectrum Analyzer



Output Waveform – Optical Spectrum Analyzer_1



Bit Error Rate Analyzer

X. Conclusion

In this paper, a multi rate and multi Quality of Service transmission system has been proposed using OPPM techniques and SWITCHING techniques. When the OCDMA system is being modulated using OPPM then it is found to be than OOK. The switching technique used is PACKET switching in which the data is being sent in packets from the source to the destination via a specified route (VIRTUAL PACKET SWITCHING). In this technique a large amount of data can be easily transmitted. The results have been validated using the Optisystem 13.0 simulator.

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