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Increasing transmission efficiency with advanced signal processing

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Extended Abstract

Today widely used Dense Wavelength Division Multiple Access (DWDM) in data and telecom networks offers many advantages. However, in DWDM systems the number of network users is govern by the number of wavelength channels available and therefore must be supported by the equal number of wavelength sources. The effect is called hard limit on the number of simultaneous users.

Code Division Multiple Access (CDMA) is another very advanced approach to data transmission which is widely used in the wireless (mobile) networks world wide, including the USA. Its optical version Optical CDMA (OCDMA) has been intensively studied since the mid-1980s but until recently, the interest into practical application of Optical CDMA has been limited primarily due to the unavailability of cheep complex photonic components and by the lack of adequate optical technologies. However, recent improvements in fiber optic and photonic technologies substantially helped to advance the OCDMA practicality.

In our demonstrated approach to incoherent OCDMA we have developed advanced and highly flexible scheme which offers superior scalability, suppresses Multi Access Interference (MAI) noise while at the same time improves the overall system power budget and therefore is more energy efficient.

By simulations and experimentally, we have demonstrated that introduction of advanced photonic signal processing in conjunction with proper OCDMA code selection will dramatically improve overall system performance, will help to increase number of simultaneous users and on other hand will keep the original hardware count unchanged, thus will deliver energy more efficient approach to data transmission. Also the OCDMA soft blocking property offers several advantages over traditionally used DWDM or OTDM - since these two suffer from hard blocking limitations.

Our demonstrated 1.25Gbit/s incoherent CDMA system has superior scalability and a significantly improved power budget. The increase in the system scalability offers significant improvements in number of simultaneous users and was achieved by elimination of Multi Access Interference (MAI) noise by using all-optical signal processing in conjunction with traditional OCDMA receiver. The theoretical performance analyses of the system which uses two dimensional frequency-hopping time-spreading incoherent coding scheme was also carried out. Two cases were examined. One with data detection done by a conventional OCDMA receiver and second when a 2ps-TOAD-based all-optical demultiplexing technique was implemented in conjunction with the conventional OCDMA receiver. Error-free operation with a BER less than 10^{-12} was demonstrated. Obtained experimental results show that such an advanced receiver can not only eliminated the MAI noise but at the same time will improve overall system power budget by as much as 3dB. The use of this type of receiver significantly increases number of simultaneous users (by nearly tree times), all without any degradation of BER performance. In addition, if a Forward Error Correction (FEC) technique to improve 10^{-4} raw BER is implemented to achieve targeted level of BER say 10^{-9}, then the number of simultaneous user will further increase nearly three times from eleven to thirty.

By comparing these results to a currently used DWDM approach, these increases in number of simultaneous users does *not* require any additional wavelength laser sources and could be implemented by using only *three* communication wavelengths.

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