Research on Multi-band Fiber Transmission System with Multi-carrier and Adaptive Modulation

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Introduction

In order to further improve the capacity of fiber communication system, multi-band fiber transmission (MBT) was proposed. MBT offers a high potential for cost-efficient throughput upgrades of optical networks, as it utilizes more efficiently the existing infrastructures. Multi-band fiber transmission system uses the low loss spectral window of single-mode fiber, and it can greatly expand bandwidth, as shown in Figure 1.

Band	O	E	S	C	L
Wavelength (nm)	1260-1360	1360-1460	1460-1530	1530 - 1565	1565 - 1625
C-band				35nm	
C+L-band				95nm	
All bands	365nm				

Figure 1. The bandwidth for multi-band fiber.

However, MBT has different channel characteristics in each band. These different channel characteristics have different effects on the signal transmission in the channel. We can improve the overall transmission efficiency by performing different modulations and power distributions on different bands.

The introduction of multi-carrier technology in each band can greatly improve the spectral efficiency. It has a certain inhibitory effect on dispersion due to the longer symbol period. The adaptive modulation technology can adaptively adjust the number of transmission bits and modulation format according to the channel condition to improve the system performance.

Scheme

The whole system block diagram is shown in Figure 2. In bit allocation, we use the Hughes-Hartogs algorithm. The Hughes-Hartogs algorithm is to traverse all sub-carriers, select the sub-carrier that requires the least power to place 1 bit, and iterate in this way until the target rate is reached (MA principle). For the MA principle, the Hughes-Hartogs algorithm is optimal.

Optical signal will be damaged when it is transmitted in optical fiber. We mainly consider loss, chromaticity dispersion (CD) and polarization film dispersion (PMD).

At the receiving end, the received signal is processed in the electrical domain through digital signal processing technology. We use FIR digital filters to approximate the all-pass filter to achieve direct compensation of chromatic dispersion in the frequency domain.

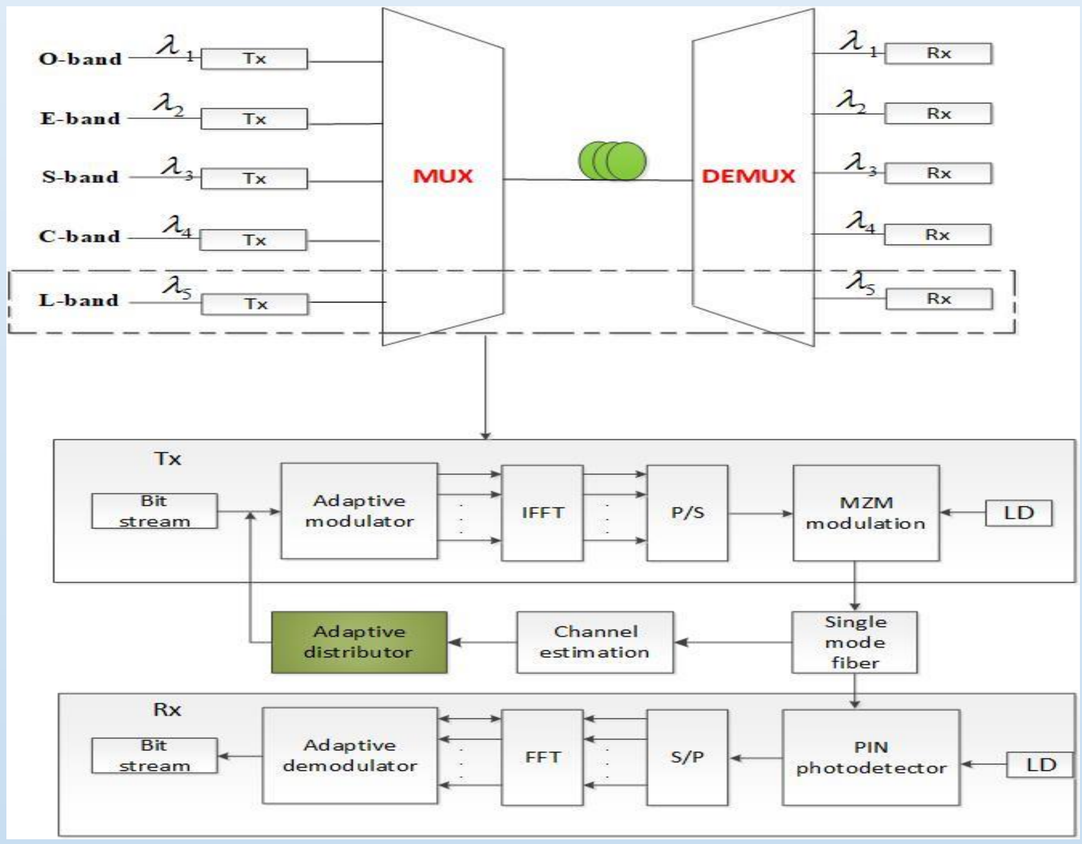

Figure 2. Multi-band system with multi-carrier allocation.

Results and Discussions

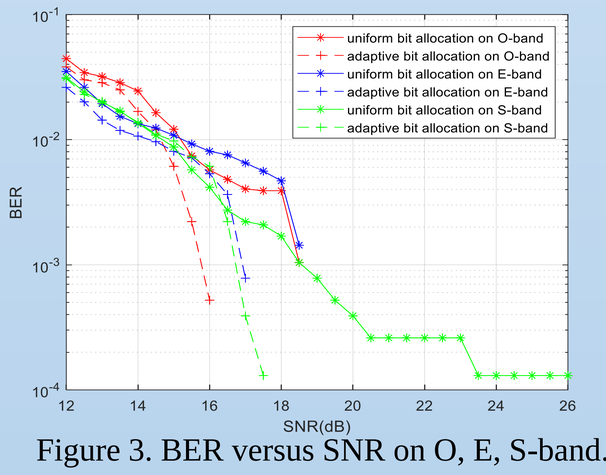

Figure 3. BER versus SNR on O, E, S-band.

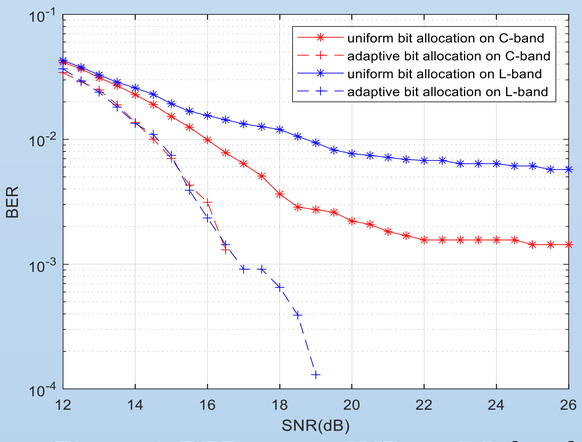

Figure 4. BER versus SNR on C,L-band.

From the simulation results in Figure 3 and Figure 4, it can be seen that the bit error rate has a certain improvement with the adaptive bit allocation. Moreover, the BER performance becomes worse from O to L band because the main effect factor is dispersion, which increases from O to L band.

Conclusion

In this paper, a multi-band optical fiber transmission system based on multi-carrier and adaptive modulation methods is proposed. The adaptive bit allocation in each band is performed in multi-band system. The simulation results show that the method can improve the performance better than that of the traditional uniform bit allocation. In addition, we can see the influence of dispersion on signal transmission more clearly through the bit error rate curve.

Acknowledgements

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