A novel method for optical subcarrier label generation

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Fig. 3. Spectra of (a) the generated label with the suppressed carrier

Fig. 3. (b) the generated signal consisting of payload and label

Fig. 3. (c) the extracted label after first OADM

Fig. 3. (d) the payload with the residual label after second OADM.

induced by the labeling and transmission are about 0.3dB for both the label and payload.

(a) 2ns/div

(b) 2ns/div

(c) 25ps/div

(d) 25ps/div

Fig. 4. Eye-diagrams of (a) original label before multiplexing (b) extracted label (c) original payload before multiplexing (d) extracted payload.

Fig. 5. Measured BER curves

4. Conclusions

We have proposed and demonstrated a novel method to generate an optically labeled signal by using the carrier suppression technique. The generated signal consists of a 10Gb/s payload and a 156Mb/s label, and shows good performance in a 50km transmission link.

References

1. D.J. Blumenthal et al, "All-optical label swapping networks and technologies" *J. Lightwave Technol.*, v. 18, 2058-2075 (2000).
2. B. Meagher et al, "Design and implementation of ultra-low latency optical label switching for packet-switched WDM networks," *Journal Lightwave Technol.*, v. 18, 1978-1987 (2000).
3. Y.M. Lin et al, "A novel optical label swapping technique using erasable optical single-sideband subcarrier label," *Photon. Technol. Lett.*, v. 12, 1088-1090 (2000).
4. T. Koonen et al, "Optical packet routing in IP-over-WDM networks deploying two-level optical labelling," *THL2.1, ECOC'01* (2001).
5. R. Montgomery et al, "A novel technique for double sideband suppressed carrier modulation of optical fields," *IEEE Photon. Technol. Lett.*, v. 7, 434-436 (1995).

All-Optical Wavelength and Time 2-D Code Converter for Dynamically-Reconfigurable O-CDMA Networks Using a PPLN Waveguide

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We demonstrate all-optical wavelength and time code conversion for O-CDMA networks at 2.5-Gbit/s with 10-Gchip/s. Difference-frequency generation provides wavelength-shifting and fiber-Bragg gratings introduce cyclic time-shifts to the incoming code, generating a new time/wavelength code with less than 0.7-dB power penalty.

1. 2-D OCDMA networks utilizing code-converters

There has recently been much renewed interest in optical code-division-multiple-access (O-CDMA) due to its potential for enhanced data security and spectral efficiency, especially when considering the fine granularity of traffic in local-area-networks (LANs) [i,ii]. However, a key drawback for O-CDMA has been the necessity of generating, propagating, and detecting extremely short chip times (i.e. the time-domain subdivisions of a bit) such that there are sufficient orthogonal codes [iii]. One approach for alleviating the small chip time has been the introduction of a two-dimensional O-CDMA architecture, in which each bit is subdivided into a combination of chip times and a discrete set of wavelengths [iv, v]. Even with a time/wavelength approach, a reasonable number of wavelengths and chip times cannot accommodate many simultaneous users. Therefore, it may be of great value for an O-CDMA network to re-use a finite set of 2-D codes across different parts of the network. Moreover, such code re-use, which is analogous to wavelength re-use in a WDM network, should be reconfigurable in order to account for changing traffic patterns and to alleviate congestion.

In general, a 2-D code converter would need to redistribute the optical energy in both dimensions, namely, the chip times and the wavelengths. A brute-force electronic approach for code conversion would be to decode the O-CDMA signal using autocorrelation and threshold detection, change the code in the electronic domain, and then re-encode the data on an optical signal [vi]. A potentially more rapid, efficient and transparent approach for high-data-rate signals is to perform the code conversion in the optical domain.

Although there were generic demonstrations of all-optical wavelength conversion for wavelength routing in WDM networks and separate demonstrations of all-optical time shifting for time slot routing in TDM networks [vii], there has been no reported demonstration of an all-optical O-CDMA 2-D code converter.

We demonstrate all-optical, wavelength and time, code conversion for OCDMA networks at a user data rate of 2.5 Gbit/s with 4 chips/bit and 2 wavelengths/code. Difference frequency generation (DFG) in a periodically-poled lithium-niobate (PPLN) waveguide enables wavelength conversion [viii] and fiber Bragg gratings (FBGs) are used to provide cyclic time shifts [vii] to the incoming code to generate a new time/wavelength code. We also demonstrate switching of input frames to code-converted frames to resolve code contention between 2 LANs sharing the same particular code. Our technique for code conversion introduces less than 0.7 dB power penalty.

2. Time/wavelength O-CDMA structure and code conversion

Figure 1 explains the method of our time/wavelength 2-D O-CDMA code conversion. Interconnectivity between multiple O-CDMA LANs can be made efficient by incorporating code re-use. To provide this functionality, a code converter acts as