Performance Monitoring by sub-carrier multiplexing in optical label switching network

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Abstract: This paper proposes a new optical layer performance monitoring method based on the correlation between payload and sub-carrier label Bit-Error-Rates (BERs). Experiment results show that the payload BER can be estimated by the sub-carrier BER. © 2003 Optical Society of America
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1. Introduction

Optical layer performance monitoring is a key requirement for a successful deployment of all-optical IP networks. Previous research work on optical layer performance monitoring proposed methods utilizing optical signal histogram or Q-factor based BER estimations [1], and using sub-carrier to monitor dispersion and other impairments [2]. This paper proposes a new optical layer performance monitoring method based on the correlation between optical sub-carrier label and base-band payload BERs in optical-label switching networks. Strong correlation between label and payload BERs implies that each optical node can conduct performance monitoring while reading the label without monitoring the data payload. This method is simple, efficient and suitable for real-time performance monitoring.

2. Experiment and results

The proposed optical-label switching network utilizes optical sub-carrier multiplexing in which the optical sub-carrier carries the label and the base-band optical carrier carries the data payload [3]. Since the label and the payload data are on the same wavelength traveling the same path in the network, there will be a correlation between the signal quality of the label (sub-carrier) and the payload (base-band) channels. The label BER can be easily monitored in real-time using an error-checking field such as bit interleaved parity (BIP) check. Fig. 1 shows the experiment set-up for investigating the correlation between the label BER and the payload BER.

![Sub-carrier multiplexing performance monitoring experiment setup](image)

The pattern generator (PG) unit generates the 2.5Gbps payload and the 622Mbps label data. Both of them are $2^{11}-1$ pseudo-random bit sequences (PRBS). The label signal modulates the 14 GHz sub-carrier
amplitude. The wavelength of the laser diode (LD) is 1550.7 nm. The setup includes a variable optical attenuator (VOA) and an Erbium-Doped Fiber Amplifier (EDFA) for adjusting the signal-to-noise ratio (SNR) at the receiver. A fiber bragg grating (FBG) with central wavelength at 1550.7 nm reflects the payload signal and allows the sub-carrier label signal to pass through. The band-pass filter (BPF) reduces the noise introduced by the EDFA. At each attenuation level (different SNR level), the payload BER and the label BER are measured simultaneously. Fig. 2 (a) and Fig. 2 (b) show the BER curves of the payload and label respectively. The 3dB bandwidth of the band-pass filter is 1nm, but the 3dB bandwidth of the FBG is only 0.1nm, so the label channel will experience more noise impairment than the payload channel. The label signal has larger power penalty than the payload, which is actually beneficial for sensitive performance monitoring. Fig.3 shows the strong correlation in the two BER measurements over relatively a wide dynamic range (0 dB to 15 dB attenuation).

3. Conclusion

The strong correlation between the data payload BER and the label BER indicates that each network node can achieve very effective optical performance monitoring simply by monitoring check sum errors on the label.

4. References