Optical Performance Monitoring for Flexible Optical Networks

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Abstract: Optical performance monitoring for optical OFDM signals in flexible optical networks, including optical signal-to-noise-ratio monitoring, chromatic dispersion monitoring and polarization mode dispersion monitoring, will be discussed.
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1. Introduction

In future optical networks [1], high bandwidth flexibility and high spectral efficiency are the most desirable capabilities to cope with the heterogeneous nature of the traffic demand. The networks have to be equipped with flexible transceivers and bandwidth flexible optical cross-connects to provision the heterogeneous traffic on flexible grid. To date, optical orthogonal frequency division multiplexing (OFDM) format [2] is one of the feasible and promising signal formats to support such flexible optical networks. It has shown superior tolerance to transmission impairments as well as its signal bandwidth can be adjusted by accommodating different number of optical subcarriers to cope with different traffic needs. To assure the quality of the service provisioning, optical performance monitoring (OPM) is an indispensable element in network management. The signal quality and the working status of various network elements can be continuously monitored so as to facilitate the network control. The monitoring information can also be used to enable optimal compensation of various optical impairments, thus assures good signal quality in data delivery. OPM includes monitoring of various common system parameters of the transmission system, including optical signal-to-noise ratio (OSNR), accumulated chromatic dispersion (CD), polarization mode dispersion (PMD), etc. In this talk, the various OPM requirements and techniques for optical OFDM signals in future flexible optical network will be discussed.

2. Optical Performance Monitoring for Optical OFDM Signals

In flexible optical networks, OFDM format would be a feasible and practical signal format to support signal delivery for its flexible bandwidth control and superior transmission performance. To assure good performance of signal delivery across the network, it would be highly desirable to monitor the signal quality at intermediate network nodes so as to provide more information to facilitate impairment-aware routing or scheduling and meet the quality of service requirements of the traffic requests. Therefore, simple OPM techniques for the optical OFDM signals would be of high interest. Recently, we have proposed to employ a pair of coded optical label subcarriers in an optical OFDM signal to realize monitoring of OSNR, CD as well as PMD, without the need of expensive coherent receiver. At the signal transmitter, a pair of coded optical label subcarriers, each carries a unique code sequence, are inserted into the leading and the trailing edges of the signal spectra of the optical OFDM signal. At each intermediate node or the receiver node, part of the signal power is tapped off and directly detected, via a photo-detector. By performing electronic signal correlation to the detected signal with those two designated code sequences, two correlation peaks will be obtained. We have found that the accumulated CD and PMD of the signal can be estimated by measuring the relative temporal delay and the relative power ratio between these two correlation peaks, respectively. Besides, by estimating the electrical SNR of the coded optical label subcarrier through signal correlation, the OSNR of the optical OFDM signal can also be derived.

3. Summary

We have discussed a novel technique to realize OPM for optical OFDM signals, via simple direct detection, followed by electronic correlation procedures with the designated code sequences. The accumulated CD, PMD as well as the OSNR of the optical OFDM signal can be estimated. No expensive coherent receiver is required. This provides a cost-effective monitoring solution for the optical OFDM signals across intermediate nodes in flexible OFDM networks. This project was partially supported by a research grant from Hong Kong Research Grants Council (CUHK410512).

4. References

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