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Re-use of Low Bandwidth Equipment for High Bit Rate Transmission Using Signal Slicing Technique

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Abstract: Massive fiber-to-the-home network deployment requires never ending equipment upgrades operating at higher bandwidth. We show effective signal slicing method, which can re-use low bandwidth opto-electronical components for optical communications at higher bit rates.
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1. Introduction

Internet is the most important communication system in modern society. Associated with new internet applications like online gaming, video streaming, social media, e-health systems, video conferencing and online data storage services, global internet data traffic has fivefold during the last five years [1]. The increased bandwidth demand forces network operators to continuously upgrade their networks, which in turn introduces many new challenges [2]. Common network upgrades are costly, as they are achieved by replacing low bandwidth electronics or optical equipment with wider bandwidth equipment. Considering desirable technical features, future optical access networks need to be flexible in terms of providing dynamical bandwidth on customer's request.

A possible solution to re-use low bandwidth equipment and provide flexible bandwidths are signals slicing transceivers, described in this paper [3]. Signal slicing technique portions the bandwidth of an electrical high bit rate signal in certain amounts of low frequency bandwidth slices. These slices are modulated on an optical carrier, transmitted, and stitched back after direct detection. Signal slicing enables sustainable transmission of wide bandwidth signals via low bandwidth equipment.

In this paper, we will first describe the signal slicing concept and then present experimental results of a scalable sliceable transceiver for low complexity intensity modulated optical access networks.

2. Signal slicing technique

Signal slicing technique transmits wide bandwidth signals (high data rate) at lower bandwidth by slicing the electrical spectrum into several slices. These slices are transmitted via one wavelength channel, known as time division multiplexing (TDM) or in parallel over separate wavelength channels, known as wavelength division multiplexing (WDM). TDM transmission has the benefit of using less network resources. On the other hand, the transmission of the entire signal takes more time and introduces a time delay in the system. Furthermore, a buffer is needed to avoid data loss. Therefore, TDM fits best for non-real time applications like online file storage. These applications have already a buffer included usually. In case of WDM, transmitting slices in parallel gives the opportunity to transmit wide bandwidth signal in real time without any significant time delay. However, used network resources are increased by the number of slices needed for transmission of the entire signal bandwidth. For TDM, as well as for WDM transmission, the bandwidth is scalable by adjusting the number of slices or the modulation format.

In signal sliced transceiver the electrical bandwidth of necessary equipment is at least twice smaller than the original bandwidth of the baseband signal. Fig. 1 shows the principle of signal slicing. A high bit rate signal is sliced into at least two slices in frequency domain. Each slice of the signal has half of the original signal bandwidth. To match the bandwidth of the used electrical equipment, the slice at higher frequencies is down-converted to baseband. Next, both slices are transmitted using TDM transmission principle (one after another in time) and received by direct detection. The initial waveform is reconstructed by transforming the received time signal into frequency domain, up-converting the second slice to its original frequency band and stitching both slices together. Slicing and Fourier-transformations are performed in a digital signal processor (DSP). Transmitted data rate can be increased using more complex intensity modulation formats, like multiple pulse amplitude modulation (M-PAM), duobinary or polybinary [4].