Progress in real time, DSP assisted, coherent optical transmission (invited)

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Abstract
Ready high speed digital signal processing , DSP, has ushered in a new epoch of commercial coherent optical transmission. We present recent progress in this area.

Introduction
For some years, the speed of ready DSP has been capable of addressing the equalization requirements long haul transmission at the highest capacities on existing fiber plant. These requirements include a channel memory of order one hundred bits, minmum loop delay of 10's of nanoseconds and a data troughput > 10 Gb/s.
Recently we reported transmission of 46 Gb/s over long haul distances using polarization mutiplexed Quadrature Phase shift Key, DP-QPSK, modulation and coherent detection [1,2]. The transmission is supported by a CMOS receiver ASIC outfitted with four, six bit wide, analog to digital converters, ADCs, and a 20 Mgate DSP engine. The ASIC is shown in Figure1. Each ADC converts signals proportional to the in-phase and quadrature fields arriving on the x and y polarization directions with respect to Rx site reference phase and polarization . These are translated using DSP to the same signal categories but with respect to the transmit side phase and polarization reference. In so doing chromatic dispersion and and PMD are equalized while carrier phase and signal clock are recovered. PDL The total processing amount to 12 Tops/sec and ASIC power dissipation is 21W.

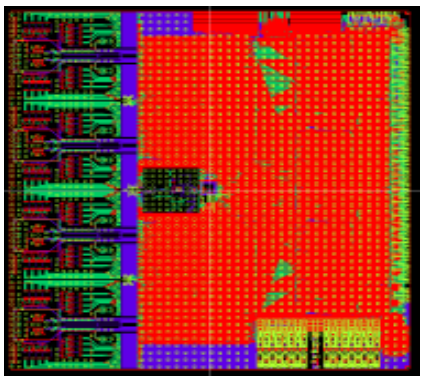

Figure 1 photograph of 46Gb/s receive ASIC

Coherent detection affords the opportunity of using the receiver's electrical filter to separate channels incident on the same detector as long as the channel separation greater than the receiver bandwith. Under these conditions the local oscillator is tuned to the desired channel such that substantially all of the mixing products with other channels are extiguished by the receiver filter. Using coherent single ended detection, and DP-QPSK modulation we have found it to be practical to support two carriers, each carrying 56 Gb/s of data, within a wavelength management window of the 50GHz ITU grid. Hence a total throughput of 112 Gb/s and a network spectral efficiency of 2. This 112 Gb/s frequency division multiplexed, Co-FDM, transceiver is shown in Figure 2.

Figure 2 112 Gb/s, 50 GHz ITU grid compliant Co-FDM transceiver

Both 46 Gb/s and 112 Gb/s tranceivers rely of the same opto-electronic and DSP architectures and address similar fiber plant.

We present recent measurements of the tolerance of these transceivers to static and dynamic PMD and PDL. Also, the nonlinear performance of this class of tranceiver will be examined by means of measurement and analysis.Recent examples of field performance will be discussed.

References

1. H. Sun, K.-T. Wu, and K. Roberts, "Real-time measurements of a 40 Gb/s coherent system," *Opt. Express*, vol. 16, no. 2, pp. 873–879, Jan. 2008.
2. M. O'Sullivan "Measurement of inter-channel non-linear effects in a real-time, phase modulated, coherent transmission system" COCS, 2008.