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High Speed TDM-PON Beyond 10G

As bandwidth demand keeps on growing, higher capacity access networks will be needed. A passive optical network (PON) based on passive optical power splitting is an important network architecture to provide high data-rate fiber access to the user in a cost effective way. The main challenges of increasing the serial bitrate beyond 10 Gbps are decreased chromatic dispersion (CD) tolerance, increased bandwidth requirements of the optical and electrical components and the resulting reduced optical power budget, fiber reach and higher overall system cost. To address these challenges, alternative low complexity modulation formats have been investigated that require less bandwidth and are more CD tolerant. The target was to use 10 Gbps parts at the cost-sensitive optical network unit (ONU) side where there is no sharing of the cost. Parts selection was limited to more premium parts, like optical amplifiers at the optical line termination (OLT) side where the cost is shared by all the users. Furthermore, initially digital signal processing (DSP) was not used in order to achieve a lower overall system cost. The target serial bitrates are 25 Gbps and 40 Gbps, which are the bitrates of interest for the two PON standardization bodies, FSAN/ITU and IEEE. The contributions have been approved as parts of the IEEE 802.3 25 Gb/s, 50 Gb/s, and 100 Gb/s Ethernet Passive Optical Networks standard.

For more details please see:

[1] D. van Veen and V. Houtsma, "High speed TDM PON beyond 10G," in *Proc. OFC*, paper Tu3C.3., 2016

MIMO Equalization for future multi-Gbit/s chip-to-chip communication

Following the steadily increasing capacity density in access aggregation nodes, the bit rates of chip-to-chip interconnects need to scale accordingly. On the currently used low-cost electrical chip-to-chip interconnects, however, higher signal bandwidths give rise to higher intersymbol interference (ISI) and crosstalk (XT), which severely deteriorate the error performance. In order to combat ISI, most state-of-the-art transceivers apply non-linear decision feedback equalization at the receiver or Tomlinson-Hirashima precoding at the transmitter. In addition to these equalization techniques, a number of XT reduction techniques based on careful interconnect design or signal shaping have been presented. These are often complex and expensive to implement. The XT is expected to dramatically increase because of growing bit rates and reduced circuit dimensions. Consequently, rather than avoiding the XT, it is more advantageous and effective to exploit the useful information in the XT signals. It was recently shown that multiple-input multiple-output (MIMO) equalization enables combining the information from both the direct and the crosstalk channels, and, hence, significantly outperforms conventional single-input single-output (SISO) equalization in future multi-Gbit/s chip-to-chip.

For more details please see:

[1] L. Jacobs, M. Guenach, and M. Moeneclaey,

"Linear MIMO Equalization for High-Speed Chip-to-Chip Communication", IEEE Int. Conf. on Communications (ICC '15), 8-12 June 2015, London (UK)

[2] L. Jacobs, M. Guenach, and M. Moeneclaey, "Application of MIMO DF Equalization to High-Speed Off-Chip Communication", Int. Conf. on Computer as a Tool (EUROCON '15), 8-11 Sept. 2015, Salamanca (Spain)

[3] L. Jacobs, M. Guenach, and M. Moeneclaey, "MIMO Pre-Equalization and DFE for High-Speed Off-Chip Communication", Int. Multi-Conference on Systems, Signals and Devices (SSD '16), 21-24 March 2016, Leipzig (Germany)

Flexible Grid Multi-Domain Optical Networks

Flexible grid optical networks have certain features that allow dynamic arrangements of resources including wavelength channels, bandwidth levels, transmission format, data rate and others. These features enable the optical networks to be more flexible in accommodating changes in demand, traffic conditions, and the quality of transmission. In a software defined environment, an automated control system may leverage this flexibility to reach extra level of efficiencies. One area that was found worth looking at is the statistical capacity sharing at the spectrum level in such optical networks where line rate and modulation format can be changed based on varying traffic loads. The assumption is that each connection can operate either of two rates: a base rate and a peak rate; and is able to switch in between. This assumption, which is made possible by the flexible grid, offers new possibilities of starting all connection requests at a base rate and switching to peak rate on demand, while allowing extra sharing at the base rate. Fujitsu and University of Texas at Dallas have been experimenting with this idea to quantify the gain[1]. Another question that the same group of researchers has been trying to answer was how efficient these bandwidth variable optical transponders, reconfigurable add drop multiplexers (ROADMs), sliceable regenerators and spectrum can be used to realize the virtualization of a flexible grid optical network. Additionally, these resources required for a Virtual Optical Network (VON) may overlay multiple geographic and administrative domains where some constraints may exist. These constraints include the physical differences between inter and intra-domain links that make up the entire physical topology, confidentiality of each domain's internal topology by their own operators, and potentially different policies that have been instituted by the operators and greatly complicate the VON provisioning over multi domain optical networks. The work that answers the efficient provisioning of VONs over multi domain flexible grid optical networks utilizes a framework that keeps the autonomy of each domain and only allows just enough information to be exchanged to aggregate a topology where efficiencies can be realized in a hierarchical way [2].

References:

[1] F.A. Khandaker et al., "Statistical Capacity Sharing for Variable-Rate Connections in Flexible Grid Optical Networks", GLOBECOM 2015

[2] S. Hong et al., "Virtual Optical Network Provisioning over Flexible-Grid Multi-Domain Optical Networks", GLOBECOM 2015.

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