Dual Architecture Uplink Demonstration of a 7×622 Mbps SAC-OCDMA PON Using a Burst-Mode Receiver

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Abstract: We demonstrate experimentally the uplink of an incoherent spectral amplitude-coded optical code-division multiple-access passive optical network (PON) using a burst-mode receiver. Error free transmission is achieved for local sources and centralized sources PON architectures.

(a)

In Fig. 2(b) we plot the worst case PLR versus the number of users, with and without CPA (at -18 dBm received power). The worst case PLR is the PLR measured at phase shift between packets, *i.e.*, half the bit period. At this phase shift, the CDR samples exactly at the edge of the eye diagram. We consider that all packets are correctly received when $PLR<10^{-6}$ corresponding to a $BER<10^{-10}$ as in [3]. Packets have zero preamble bits; use of a preamble would improve PLR, but at the cost of reduced throughput. In the case of CDR without CPA, the worst case PLR is near 1. In contrast, the phase picking algorithm samples each bit twice and significantly enhances the performance. Therefore, we achieve a zero PLR for up to four users, and two orders of magnitude improvement for a fully loaded system despite the nonideal sampling of the CDR. There is degradation in performance passing from LS to CLS architecture. This is easily explained by the corresponding degradation in the BER, since packets are declared lost either if the payload is incorrectly received (poor BER performance) or if the delimiters are not received properly.

The power budget of a PON is an important parameter in the design, as it helps the fiber-to-the-home (FTTH) service providers to select appropriate light sources and convenient receivers. Splitting is the major source of losses in TDM and OCDMA PONs. In LS architectures, the uplink signal travels only from the ONU to the OLT, therefore, for N ONUs we have $10\log(N)$ dB splitting losses. In the CLS architecture, the uplink signal travels from the OLT to the ONU and then back to the OLT after modulation, therefore a CLS PON experiences twice the splitting losses as a similar LS architecture PON. Obviously, the propagation losses for the upstream direction are also doubled in CLS architectures compared to LS architectures. For a 1:8 splitting ratio and for a 20 km reach PON, the total uplink losses in the LS and CLS configurations were roughly 39 dB (excluding the losses through the 1×8 splitter incurred for LS experimental convenience) and 52 dB, respectively. The 13 dB difference is the contribution of an additional 9 dB coupling loss, and an extra 4 dB propagation loss over the 20 km link.

4. Conclusion

We achieved error free transmission for an incoherent 7×622 Mbps uplink of LS and CLS SAC-OCDMA PONs using a standalone burst-mode receiver providing a coding gain of more than 2.5 dB at $BER = 10^{-9}$. We reported a zero PLR for up to four simultaneous users (for any phase difference between packets), and more than two orders of magnitude improvement for a fully loaded system when using the CPA module. In LS architectures, splitting losses are only in one direction, whereas in CLS architectures, there are splitting losses in both directions. Therefore, doubling the number of users while maintaining the same distance and source power imposes an additional 3 dB loss in LS architectures, whereas doing the same for CLS architectures imposes an extra 6 dB loss.

5. References

[1] J. Penon, et al., JLT 2007, vol. 25, no. 5