

The following publication K. Zhong, X. Zhou, C. Yu, A. P. T. Lau and C. Lu, "DSP for high speed short reach transmission systems," 2016 Progress in Electromagnetic Research Symposium (PIERS), Shanghai, China, 2016, pp. 4874-4874 is available at <https://doi.org/10.1109/PIERS.2016.7735780>.

DSP for High Speed Short Reach Transmission Systems

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Abstract— In this paper, we review the recent advance on optical short reach transmission systems enabled by DSP. Our recent progress on high-speed short reach transmission systems employing advanced DSP is summarized.

Introduction: In the past 10 years, advanced modulation formats with coherent detection combined with digital signal processing has significantly increased the capacity of long-haul transmission systems. As the increasing in bandwidth demand in high performance computing and data center systems, high speed short reach transmission system at low cost is desired. Considering the system cost, power consumption and footprint, intensity modulation combined with direct detection (IM/DD) system is promising scheme for short reach transmission system. High order modulation formats with low cost direct modulated lasers based transmitter (vertical cavity surface emitting laser (VCSEL), direct modulated DFB laser (DML) and DFB laser integrated with EAM (EML)) with direct detection are promising for optical short reach applications. As high speed and high order signal is applied on low cost transmitter and receiver based optical systems, system performance will significantly degraded by channel impairments, which mainly are bandwidth limitation and chromatic dispersion induced channel fading. Therefore, advanced digital signal processing (DSP) technique can be applied to compensate these impairments and improve system performance.

In this talk, we review our recent progress on high-speed short reach transmission systems employing advanced DSP is summarized.

DD-FTN for Bandwidth Limited Optical Transmission System: Linear equalizer is usually used to compensate the bandwidth limitation of optical transmission system. However, it is well known that the equalizer severely enhance the in band noise in band-width limited optical transmission system. In short reach transmission system, the bandwidth of transmitter and receiver is relative low, which is even smaller than the Nyquist bandwidth of signal. we have proposed a direct detection faster than Nyquist technology (DD-FTN) to recovery severely filtered signal in bandwidth limited short reach transmission systems. First, a post filter was placed after the linear equalizer for enhanced in-band noise suppressing. The coefficient of post filter is optimized to obtain best performance. Then, the strong inter-symbol interference (ISI) induced by the post filter is eliminated by maximum likelihood sequence estimation (MLSE) algorithm. With this DD-FTN technique, 70 Gbaud/s PAM-4 signal over 20 km employing 25 G device was experimentally demonstrated for short reach applications. A total capacity of 500 Gbit/s PAM-4 transmission system employed 25 G EML TOSA and ROSA was demonstrated for 2 km optical inter-connect applications. Enabled by advanced equalization technique, we also demonstrated a 112 Gbit/s SCM-Nyquist 16QAM transmission system, which is the highest bit-rate of such SCM system. More high bit-rate short reach transmission system employing higher order modulation formats and advanced digital signal processing technique are under investigating.

ACKNOWLEDGMENT

This work was supported by project H-ZG3Y of Huawei Technologies Co. Ltd, The Hong Kong Scholar Program (XJ2013026), Hong Kong GRF PolyU152109/14E, PolyU152079/14E, National Natural Science Foundation of China (61435006, 61401020, 61505266), and Beijing Natural Science Foundation (4154080).