Performance Comparison of Advanced Modulation Formats for Low-bandwidth optics-based 50-Gb/s/λ PON at O-band
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Abstract
A comprehensive comparison of PAM-4, CAP-16QAM and DMT-16QAM modulations is simulated in 50-Gb/s/λ PON based on bandwidth-limited optics at O-band. The power budget, thermal noise performance and DSP complexity are discussed. The results show that over 29 dB power budget at 3.8 × 10^3 threshold can be achieved.

Introduction
Considering the limited bandwidth of low-cost optics, advanced modulation formats with spectral efficiency and advanced digital signal processing (DSP) are researched in order to reduce the baud-rate of the signal. The performance of multi-level pulse amplitude modulation (PAM), carrier-less amplitude and phase modulation (CAP) and discrete multi-tone (DMT) modulation formats for 50G PON at O-band using 10G-class optics and simple DSP has been simulated and compared in order to reduce the CAPEX and OPEX for both the network operators and the customers.

Simulation Setup
The output of the LPF is directly modulated by a directly modulated laser (DML) with a power output of 17.68 dBm at the central wavelength of 1310 nm. The modulated optical signal transmits 20 km standard single-mode fiber (SSMF) with an average loss of 0.35 dB/km. At receiver side, a variable optical attenuator (VOA) is placed after SSMF to adjust the received optical power for sensitivity measurement. A photodiode (PD) is used for signal detection. An electric 4th order Bessel LPF with a 3 dB bandwidth of 15 GHz is placed after PD in order to simulate the bandwidth limitation of the receiver. After LPF, the detected signal is processed by a 64GSa/s ADC for offline DSP.

Simulation Results
As we can see, 4-bit DAC resolution and 6-bit ADC resolution are enough to achieve below 3.8 × 10^3 threshold after 20km SSMF transmission and there is error floor when both resolutions increase for three modulation formats. It can be seen that PAM-4 has better tolerance at low thermal noise. Besides, PAM-4 and CAP-16QAM have similar computational complexity. DMT-16QAM offers lower complexity than the other two formats.

Conslusion
PAM-4 has the best thermal noise tolerance performance and DMT-16QAM has the largest power budget. The results show that over 29 dB power budget at HD-FEC threshold can be achieved. DMT-16QAM offers much lower computational complexity than PAM-4 and CAP-16QAM.

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