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25 Gb/s EPON standard

During the March 2018 meeting of the IEEE 802.3ca, the 100G-EPON Task Force adopted standard Draft 1.0 that specifies the 25G EPON standard. This implies that the scope is stable, and that further work within the task force will focus on improving the draft.

25G EPON will support both symmetric 25G/25G ONUs and asymmetric 25G/10G ONUs, where the latter achieve 25 Gbps in downstream and 10 Gbps in upstream. The anticipated deployment of 25G symmetrical services is largely driven by business applications, like mobile front and backhaul. As mobile network operators begin deployment of small cells, PON networks will enable a cost-effective solution for conventional Ethernet backhauling for both future 5G as well as today's LTE. Ongoing efforts to define the 5G C-RAN architecture with relaxed requirements for "midhaul" transport make >10G PON networks utmost suitable and cost-effective for 5G. On the other hand, asymmetrical 10/25G services for residential subscribers is largely driven by headline speed competition and since more content is being stored in the cloud nowadays, residential customers require more downstream bandwidth as well as improved upload capabilities.

Since there are already a large number of deployed PON Optical Distribution Networks (ODNs), and since any changes to the ODN are labor intensive and very expensive, 25G EPON needs to achieve its performance on the existing ODNs designed for a channel insertion loss up to 29 dB. To increase the power budgets for 25G PON without using optical amplification, the standard adopts an 18493 bit LDPC code with a 10^{-2} error correction capability. Differential encoding (precoding) is adopted, which bounds error propagation and allows the use of 10G-class optics for obtaining 25G line rates with duobinary detection. This lowers cost and time to market by enabling the use of existing 10G avalanche photodiodes (APDs) in anticipation of wide market availability of their 25G counterparts.

[1] IEEE P802.3ca draft 1.0, March 2018

[2] V. Houtsma, D. van Veen, and E. Harstead, 'Recent progress on standardization of next generation 25, 50, and 100G EPON,' Journal of Lightwave Technology 35 (6), March 15, 2017

Performance Analysis of Linear Receivers for Uplink Massive MIMO FBMC-OQAM Systems

Offset-QAM-based filterbank multicarrier (FBMC-OQAM) has been shown to be a promising alternative to cyclic prefix-orthogonal frequency division multiplexing. More recently, the use of FBMC-OQAM has been proposed in combination with massive MIMO communications. In this context, it is interesting to study the overall effect of massive MIMO on the FBMC-OQAM intrinsic interference and its interaction with channel frequency selectivity. In [1], the performance of an FBMC-OQAM uplink massive MIMO system is theoretically characterized in terms of the output mean squared error (MSE) of the estimated transmitted symbols and for three types of linear receivers, namely, zero forcer, linear minimum mean squared error and matched filter. Using random matrix theory, the output MSE of these receivers is asymptotically characterized as the number of base station antennas N and the number of users K grow large, while keeping a finite ratio N/K. The obtained expressions allow to draw many conclusions, some of which but not yet theoretically proven [2]. First, the MSE becomes uniform across the frequency band as a result of the channel hardening effect. Secondly, it is shown that a good synchronization of the users is crucial in a massive MIMO scenario. Finally, if the users are well synchronized, the different terms that compose the MSE, such as noise, inter-user interference and the distortion caused by the channel frequency selectivity, become negligible for large values of the ratio N/K. This effect was previously referred to as "self-equalization" in the literature.

[1] F. Rottenberg, X. Mestre, F. Horlin, and J. Louveaux, "Performance Analysis of Linear Receivers for Uplink Massive MIMO FBMC-OQAM Systems," IEEE Transactions on Signal Processing, vol. 66, pp. 830–842, Feb 2018

[2] A. Farhang, N. Marchetti, L. E. Doyle, and B. Farhang-Boroujeny, "Filter Bank Multicarrier for Massive MIMO," in 2014 IEEE 80th Vehicular Technology Conference (VTC2014-Fall), Sept 2014, pp. 1–7.

Exploring field noise on G.fast frequencies

G.fast is the most recent standard in Digital Subscriber Line (DSL) technology. It aims to provide up to 1 Gbit/s on twisted copper pairs. At these data rates and frequency ranges, the noise environment in the copper infrastructure remains largely unexplored. Noise characterization allows performance optimization, a.o. by determining whether a single set of configuration parameters, common to all lines, will be sufficient to guarantee network stability, or if a per-line configuration optimization mechanism such as Dynamic Line Management (DLM) is desired. A homemade low-cost and portable equipment has been built to measure the noise in the G.fast 212 MHz band. An off-line post-processing of the acquired traces was performed to study stationary and impulse noise characteristics using different temporal and spectral analyses. As main results published in [1], beyond measurement and traces analyses methodologies, a spectral kurtosis computation of stationary noise is proposed as a novel tool to derive tone notching requirements due to their probability to exceed the signal-to-noise ratio margin. In addition, in the case of impulse noise, a rare but strong impulsive Power Spectral Density (PSD) content was sporadically observed, also at higher frequencies, contrary to what is commonly admitted, namely that interferences from home appliances are bandwidth limited and tend to decrease with frequency.

[1] B. Drooghaag, J. Maes, M. El Fani, V. Moeyaert, 'Exploring field noise on G.fast frequencies', proceedings of IEEE Globecom 2017. This paper received a TAOS best paper award.

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Editor

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