Error characteristic and test in XGPON system (Ber=1e-2)

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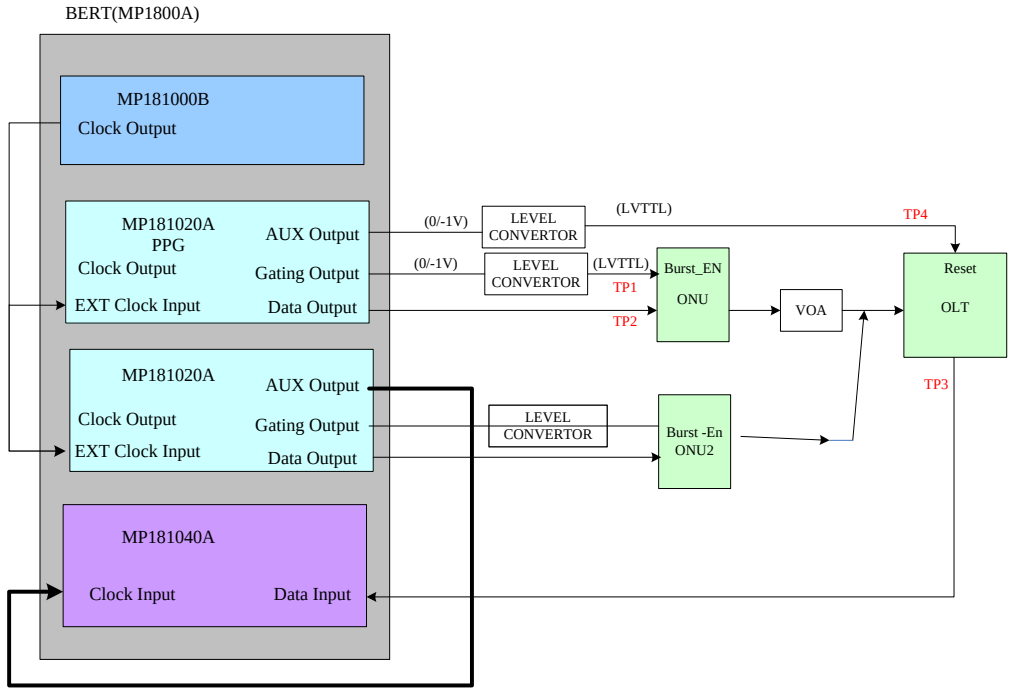
Introduction

Enhanced FEC with input BER =1e-2 is considered for improved power budget in 25G channel ;

Some factors affecting performance after FEC were introduced in vanveen_3a_1a_0317.pdf , Especially, some significant reduced FEC gain due to non-random error distributions from BM receiver effects were shown.

In this contribution, we present a statistics of XGPON system errored bit distribution with input BER =1e-2.

Test Environment



Fiber length : 20 km

Data rate : downstream 10G bps

upstream 2.5G bps

Data pattern : downstream: prbs 15

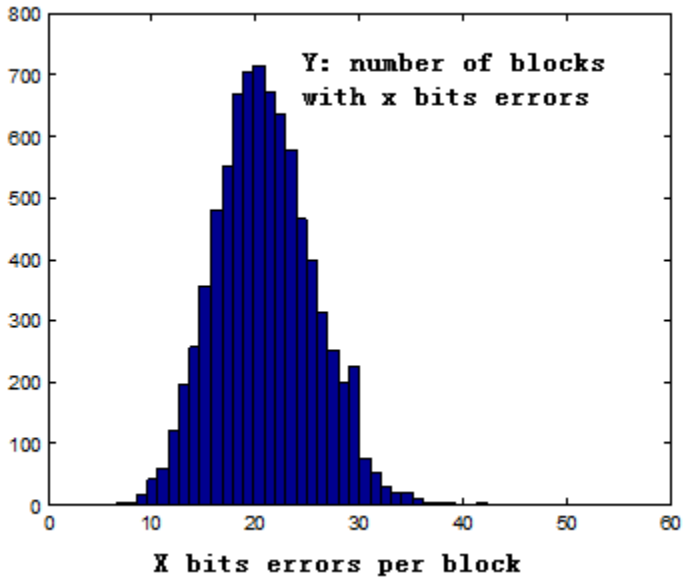
upstream : preamble (1984bits) + delimiter(32 bits)+ payload (4360 bits)

Preamble pattern : 0x AAAA ……AAAA; Delimiter pattern : 0x A566 79E0;

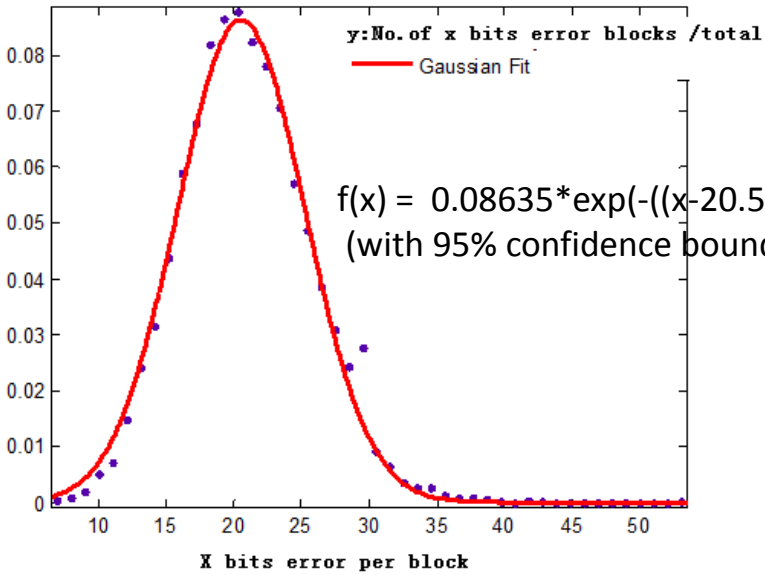
payload pattern :prbs 15

Statistics of downstream 1

Histogram



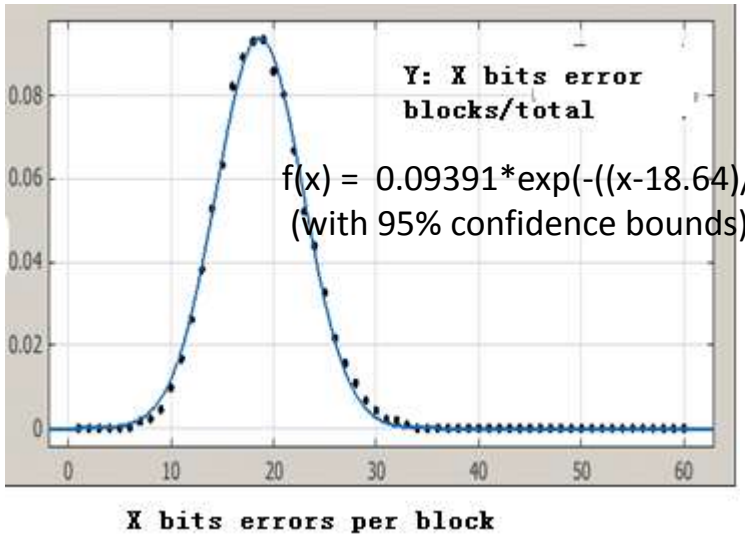
Probability Density Distribution



BER= 1e-2 ;

Total statistics : 10000 blocks with 1984bits /block

The error distribution of XGPON down stream fits that of an ideal AWGN channel well.



Statistics of a ideal AWGN channel

Statistics of downstream 2

Statistic of consecutive errors：

Total statistics： 2020456 bytes

Errors： 168352 bits

Theoretic value： 161636 bits

Statistic of consecutive errors as follows：

Consecutive errors number	6	5	4	3	2
Test value	1	7	78	898	12282
Theoretic value (assume random distribution)	0.4	5.56	71.9	931.6	12059

In 202046bytes ,

Consecutive 6 bytes occurred errors appeared once ;

Consecutive 5 bytes occurred errors appeared 7 times ;

Consecutive 4 bytes occurred errors appeared 78 times ;

。 。 。 。 。 。

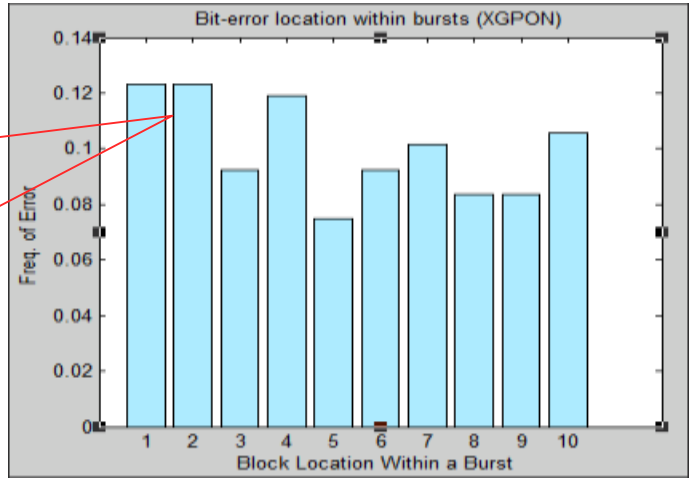
The test value of consecutive errors fits to that of theoretic calculation well.

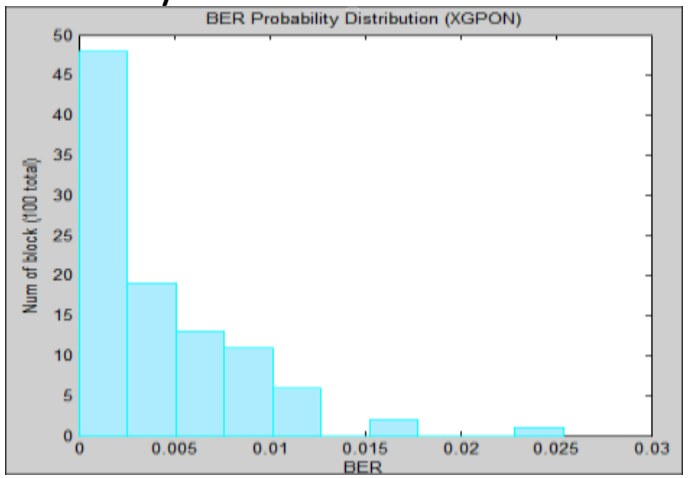
Statistics of upstream 1

Histogram showing bit-error locations within bursts

Histogram showing Probability Density Distribution

Burst error at start of burst. This factor is consistent with public result [1]

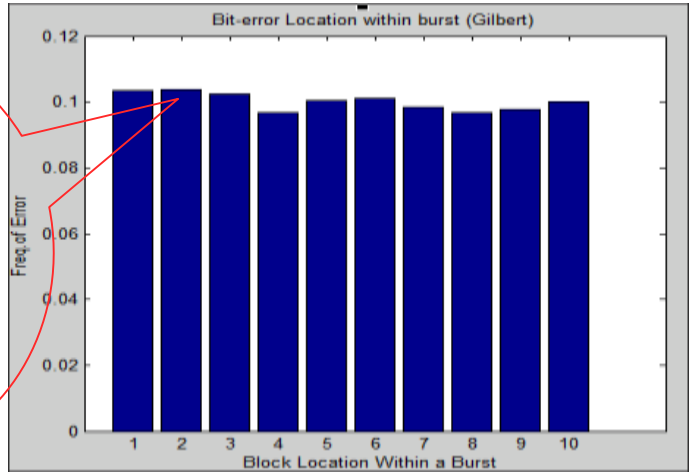


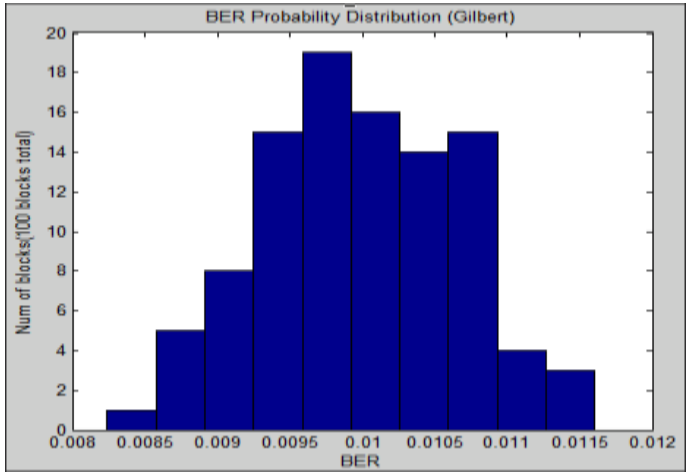


XGPON System

XGPON System

Error is independent of location in Gilbert model





Gilbert Burst Error Model

Gilbert Burst Error Model

[1] D. Brunina. et.al. Analysis of Forward Error Correction in the Upstream Channel of 10Gb/s Optically Amplified TDM-PONs OFC 2015 Th4H.3

Statistics of upstream 2

Statistic of consecutive errors：

Total statistics： 1000*248=248000bytes

BER = 9e-3

Errors： 17821 bits

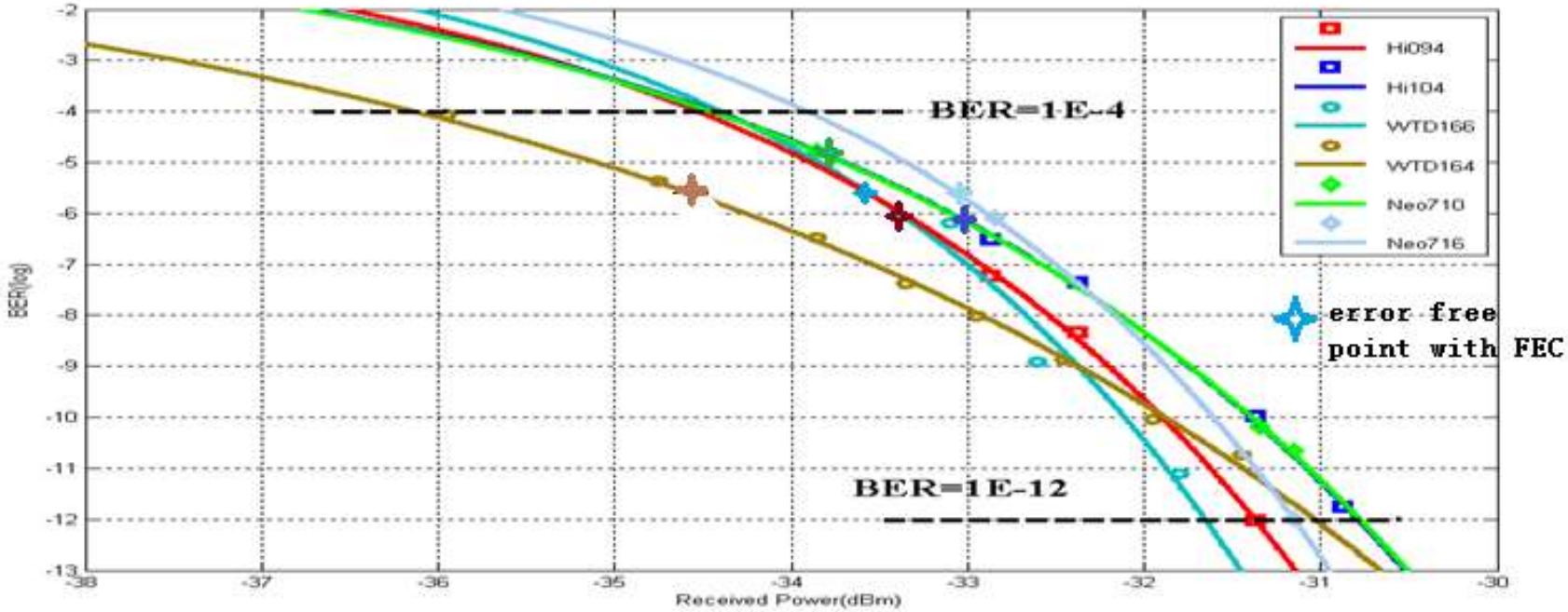
Theoretic value： 17856 bits

Statistic of consecutive errors as follows：

	6	5	4	3	2
Test value	2	8	45	210	1592
Theoretic value (assume Random distribution)	0.54	4.75	41.7	366	3216

The error distribution deviates from the AWGN distribution

BER curve Vs FEC gain (upstream)



Transceiver	measured from BER curve (dB)	FEC gain test in system (dB)
Xcvr A	5.11	3.6
Xcvr B	3.67	3
Xcvr C	3.65	2.9
Xcvr D	3.16	2.1
Xcvr E	2.74	1.8
Xcvr E	2.5	1.7

- The test covers 6 vendors with 6 OLT optical transceivers
- It shows that the smoother BER curve , the larger GEC gain
- The input BER with error free is around 1e-5~le-6 instead of 1e-4

Conclusion

- The error distribution of XGPON is counted , including upstream and downstream .
- The error is consistent with the random distribution characteristics in down stream with continuous receiver.
- Gilbert burst model did not correctly reflect the error location in a burst .
- FEC gain in system shows very large difference for different vendors' receiver
- The input BER with error free is around 1e-5~le-6 instead of 1e-4
- Further research and discussion is needed to employing Enhanced FEC with input BER =1e-2 for improved power budget in 25G channel

Thank you

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