Serial 10G EPON Downstream using FEC

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FEC Advantages in Optical Networks 1/2

- A common approach to improve optical link budget is use of FEC
- FEC effectively adds a significant gain to the optical power budget
- FEC advantage is twofold: reducing the transmission power whilst increasing link budget
- Employing FEC allows:
  - Accept relatively high BER (>10E-3)
  - Robust network
  - Relax transmitter and receiver requirements
  - reduce the optical output power level
  - Increase split ratio
  - Increase link distance
- ITU-T G.975 recommends FEC in systems operating at 2.5 Gbps and higher.

FEC Advantages in Optical Networks 2/2

- FEC provides up to 5.5dB gain to optical components depending on receiver type
- APD Photodiode is limited by the ***shot noise,*** coding gain is close to Electrical gain
- PIN Photodiode is limited by the ***thermal noise,*** coding gain is about ***half*** of the Electrical gain

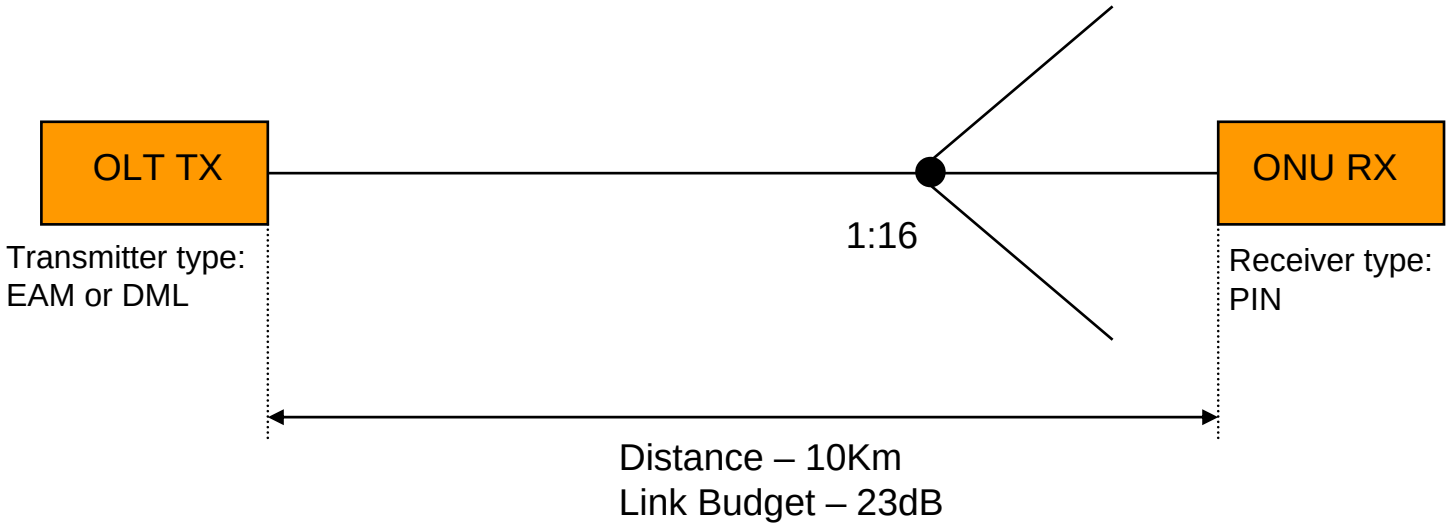
FEC lower cost and higher performance

Transmission Classes

3 optical budget classes

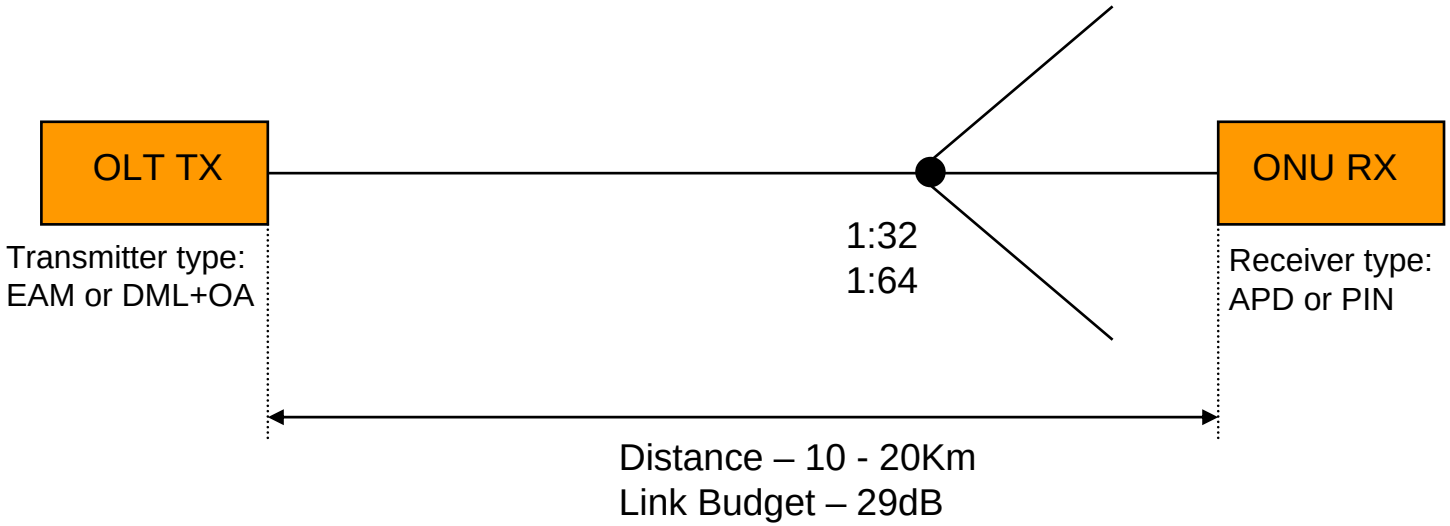
Class	Split Ratio	Distance [Km]	Loss Budget [dB]
I	1:16	10	23
II	1:32	20	29
	1:64	10	
III	1:128	20	35

Class I



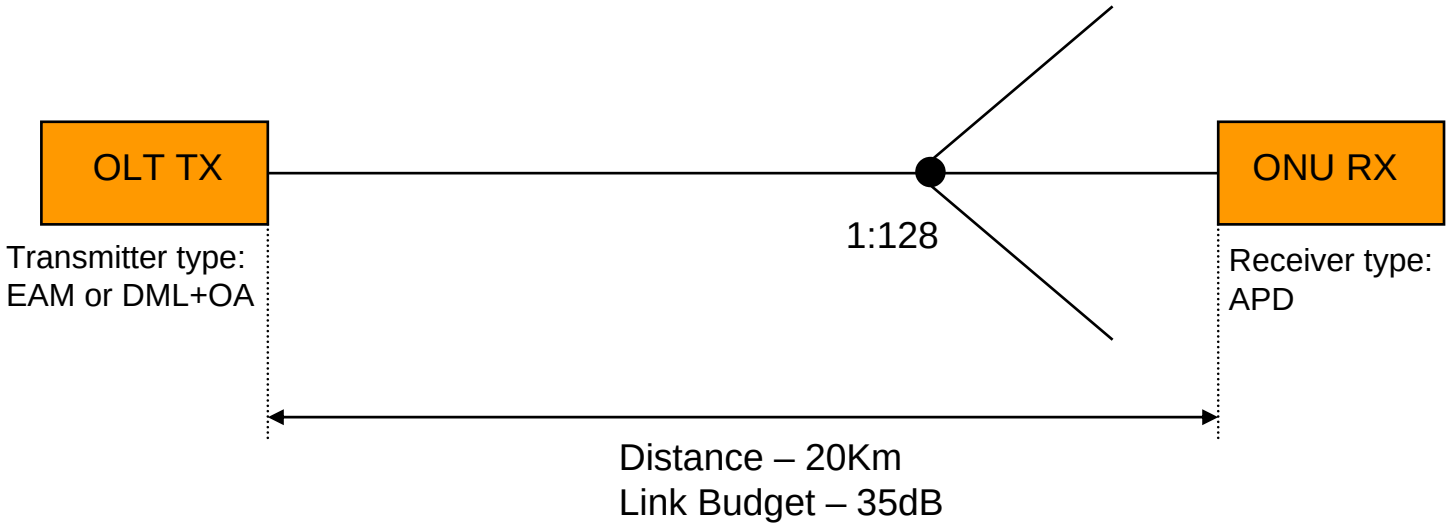
	FEC Type	FEC Gain [dB]	OLT TX	ONU RX	Actual Link Budget [dB]	Cost Saving [%]
Class I	w/o FEC	0	EAM + OA	PIN [-17dBm]	23	0
	RS FEC	3	EAM [+3dBm]	PIN [-17dBm]	23	20
	Enhanced FEC	**4-5**	**DML [+2dBm]**	**PIN [-17dBm]**	**>23**	**>30**

Class II



	FEC Type	FEC Gain [dB]	OLT TX	ONU RX	Actual Link Budget [dB]	Cost Saving [%]
Class II	w/o FEC	0	EAM [+5dBm]	APD [-24dBm]	29	0
	RS FEC	4	EAM [+1dBm]	APD [-24dBm]	29	10
	Enhanced FEC	**4-5**	**DML+OA**	**PIN [-17dBm]**	**>29**	**>15**

Class III



	FEC Type	FEC Gain [dB]	OLT TX	ONU RX	Actual Link Budget [dB]	Cost Saving [%]
Class III	w/o FEC	0	EAM + OA	APD [-24dBm]	35	0
	RS FEC	4				
	Enhanced FEC	**4-5**	**DML+OA**	**APD [-24dBm]**	**>35**	**>20**

Conclusions

- Employing FEC with an effective Coding Gain G means:
  - Transmitter power may be reduced by G [dB]
  - Receiver sensitivity may be increased by G [dB]
- Accept data at High BER (>10E-3)
- By Enhanced FEC we can achieve high performance in “noisy” network
- Enhanced FEC allows using ***PIN Photodiode*** instead of ***APD***
- Enhanced FEC allows using ***DM DFB Laser*** instead of ***EAM Laser***
- FEC
  - Reduce power consumption
  - Relax requirements
- FEC → Cost

FEC parameters should be chosen as a trade-off between Hardware complexity and performance

PMC-SIERRA

Q&A

FEC Types

FEC codes with 7% overhead (rate 0.93)

Examples: (NCG @ 10^{-16})

Classical FEC:

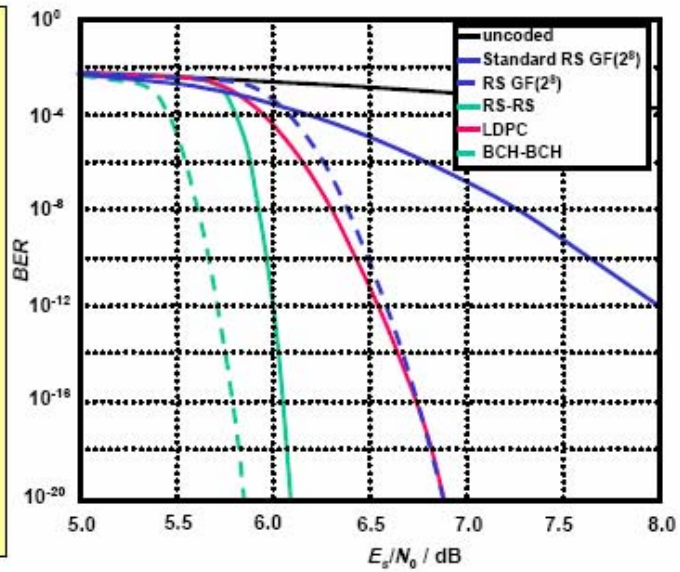
RS(255,239): NCG = 6.3 dB
RS(2720,2550): NCG = 8.2 dB

LDPC codes:

LDPC: NCG = 8.2dB

Concatenated codes:

RS(255,245)xRS(246, 240):
NCG = 9.0dB
BCH(2040,1930)xBCH(3860,3824):
NCG = 9.3dB
...



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RS(255,239) – Optical Coding Gain (APD)