IEEE 802.3ah

FEC Cost Effective Parameters for EFM

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Scope

- Parameters to evaluate the cost effectiveness for FEC

Mechanism

- The first goal is to define the parameters for comparison.
- This presentation doesn't include values, which should be added later on.
- Parameters are vendor specific.
- Graphs shows typical behavior.
- Cost is relative – @ as cost tag
- Assuming a revenue model which is not affected from small BW loss or gain

FEC Cost Parameters

Coding Gain

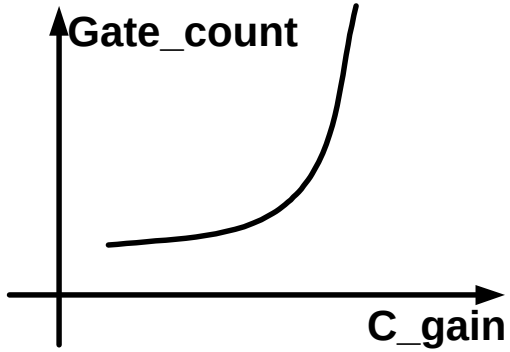
- FEC coding gain – C_gain [dB]
- Different for APD and PIN detectors

- APD_cost – Additional cost for APD receiver [@]

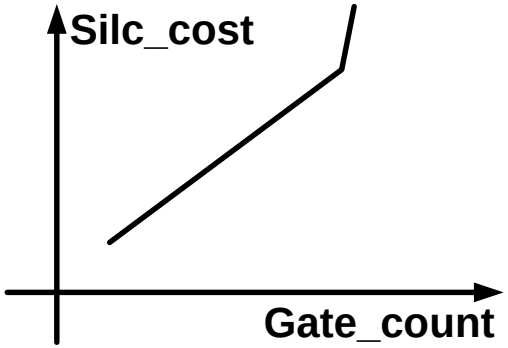
Gate Count

- FEC gate count per coding gain - gate_count[gate/dB]

Gate count increases exponentially as a function of coding gain. The parameter includes the increase in transceiver complexity.



- Silicon cost per gate count – Silc_cost [@/gate]



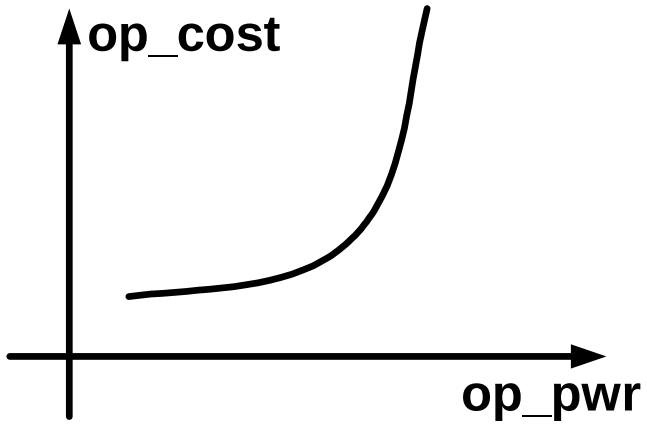
Silicon cost increases linearly to gate count up to technology limits

Power Dissipation

- FEC gate count is in f_{max}
- $P=\rho\eta G\ f_{max}$
- Aggregating ports for P2P OLT:
- $P_{total}=NP$
- High FEC gate count might limit port number in a card.

Optical power

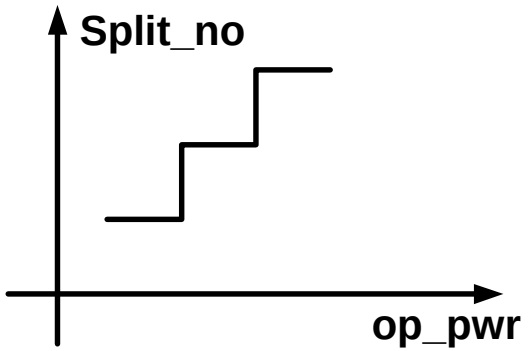
- Optical power cost per dB – op_cost [@/dB]



Optical power cost increases exponentially as a function of gain in optical power

Passive optical Splits

- Split No per dB – $\left\lfloor \frac{\mathbf{C\_gain}}{3.7} \right\rfloor$ [split/dB]



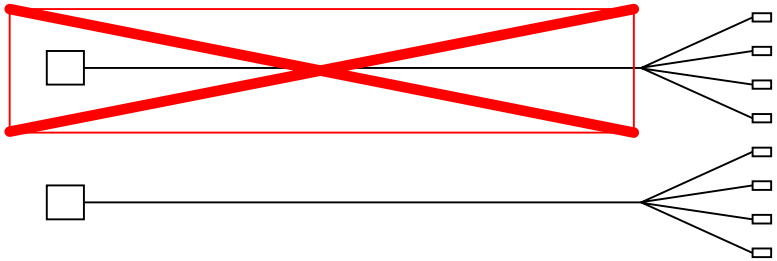
A 2 way optical split decreases optical power on each leg by 3.7dB

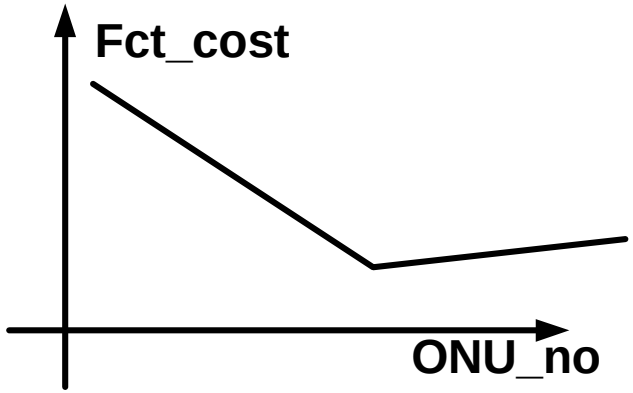
- ONU_no = $\mathbf{ONU\_no}_{\mathbf{Last}} \cdot 2^{\left\lfloor \frac{\mathbf{C\_gain}}{3.7} \right\rfloor}$
- The benefit from FEC is proportional to the increase in the number of ONU's it enables

Facility Cost for P2MP

- Facility cost/ ONU_no - Fct_cost [@/ONU_no]

Facility cost goes down when there are more ONUs per PON since there are less OLTs and fibers. The reduction is up to a limit of negligible OLT cost:



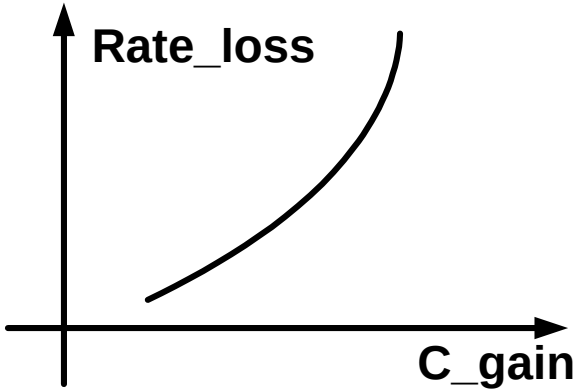


- Increasing the number of ONU to a PON may also affect revenues of BW distribution in some deployment scenarios.

Rate Loss

- Rate loss of code
- Rate loss due to increasing sync. time in P2MP uplink receiver

Rate_loss [%]



Rate loss grows up non-linearly when increasing coding gain.

- Assuming reasonable BW loss, the effect of the BW loss on most deployment scenarios is negligible since the system is not deployed in full BW capacity.

FEC Saving for P2MP

- FEC saving factor for P2MP is :
- The saving in the system cost, due to the increase in ONU number +
- + the saving in the optical power cost from the remaining gain –
- - silicon cost for FEC (including in transceiver) –
- - APD cost (if using an APD)

FEC Saving for P2MP

$$\mathbf{FEC\_save\_p2mp} = \Delta\left[\mathbf{Fct\_cost}\right] +$$
$$+ \Delta\left[\mathbf{op\_cost}\left(\mathbf{C\_gain\_remain}\right)\right] -$$
$$- \Delta\left[\mathbf{gate\_count}\left(\mathbf{C\_gain}\right)\right] \cdot \mathbf{silc\_cost} -$$
$$- \mathbf{APD\_cost}$$

FEC Saving for P2P

- FEC saving factor for P2P is :
- the saving in the optical power cost -
- - silicon cost for FEC (including in transceiver) –
- - APD cost (if using an APD)

FEC Saving for P2P

$$\mathbf{FEC\_save\_p2p = \Delta[op\_cost(C\_gain)]-}$$
$$\mathbf{- \Delta[gate\_count(C\_gain)] \cdot silc\_cost -}$$
$$\mathbf{- APD\_cost}$$

Analysis – Putting in Numbers

- In order to reduce analysis complexity:
- Choose 3 FEC codes defines sets of 3 points of:
  - Coding gain
  - FEC gate count
  - Silicon cost
- choose 3 points of optical power defines:
  - Optical power cost

Total Analysis

- A matrix of 9 points of the following elements:
  - Number of splits
  - Facility cost per ONU
  - FEC save for p2mp
  - FEC save for p2p

Conclusion

- Parameters for FEC cost effectiveness.
- Parameters cost tag may be different for each vendor