

25G upstream power budget

Ed Harstead, Nokia

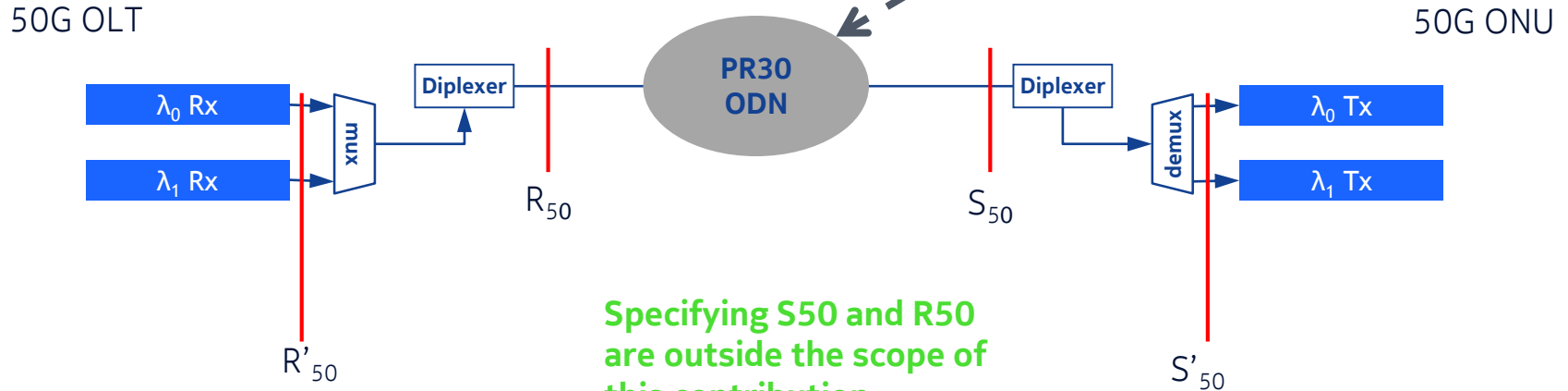
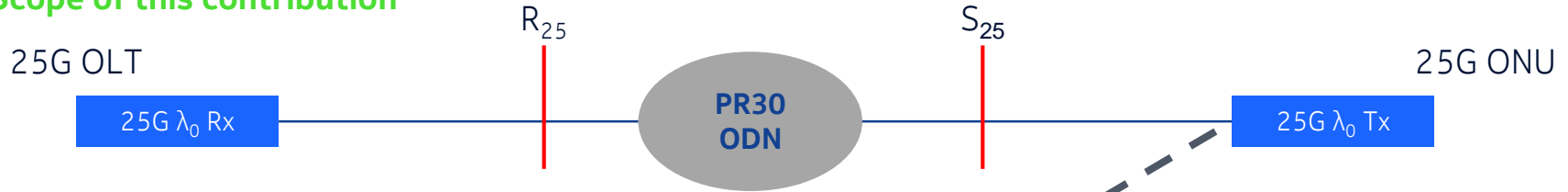
March 2018

Supporters

- Barry Colella, Source Photonics
- Mark Heimbuch, Source Photonics
- John Johnson, Broadcom
- David Li, Hisense
- Hiroshi Miura, Mitsubishi
- Naoki Suzuki, Mitsubishi
- Daisuke Umeda, Sumitomo Electric

Scope: 25G EPON, upstream direction, PR30 loss budget

Scope of this contribution



Specifying S_{50} and R_{50} are outside the scope of this contribution

Methodology

- Derive the 25G OLT receiver sensitivity specification from state-of-the-art 10G PON OLT receivers
 - 10G PON optics have been/are being tested by the market to meet requirements for low cost
 - The specifications already include margins for burst mode, yield, temperature and end-of-life.
- Deriving a specification from measurements of 25G APDs in continuous mode is problematic:
 - Small sample size measurements do not include the margins, in particular burst mode penalty
- Propose to use the same derivation method as for 25G ONU sensitivity in harstead_3ca_4_0117
- As a baseline, propose: **-29 dBm** @10 Gb/s, 1e-3 BER and ER=6. This is state-of-the-art for InP APDs.
 - Aggressive but achievable 10G specification to relax 25G ONU launch power, while
 - Having a viable path to an APD implementation (with no SOA preamp).
- Relax 25G DML ER from 6 dB to 5 dB per harstead_3ca_3_0917

Derivation of 25G PR30 OLT receiver sensitivity specification

Not including FEC improvement

④ 25G OLT Rx Sens_{max} = -24 dBm @ ER=6 dB , BER = 10⁻³

Adjust for ER = 5 dB: **-23.4 dBm**

③ 25G APD vs. 10G APD performance margin = 1 dB*

② 25G vs. 10G APD
noise penalty = 4 dB*

10G InP APD + EDB
Rx Sens_{max}

② 25G vs. 10G
EDB penalty = 5 dB*

① Baseline: 10G OLT
receiver sensitivity= -29 dBm
@ER = 6 dB, BER = 1e-3

*Similar derivation method as for 25G ONU sensitivity in harstead_3ca_4_0117

Additional sources of risk/loss

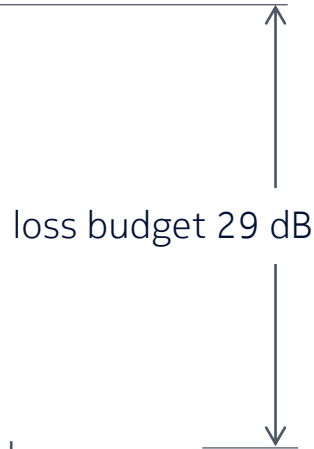
- There may be some risk associated with translating 10G APD performance to 25G APD performance.
- There will be somewhat greater risk of meeting spec at I-temp (required for remote OLTs) vs. C-temp.
 - The APD sensitivity difference is about 0.3 dB from 10G experience (D. Umeda).
- There will likely be a market need for combo modules.
 - Additional filtering can add 0.5-1 dB insertion loss (D. Umeda)
- **To mitigate the above, propose to add an extra 0.5 dB of margin: -22.9 dBm @1e-3 BER, ER= 5 dB.**
- Further risk mitigation:
 - Ge/Si APD per pan_3ca_1_0317.
 - SOA preamp (last resort, hopefully only necessary for initial deployments, at most)

TDP and FEC improvement

- For upstream 25G DML TDP, assume 2 dB per tanaka_3ca_1_1116
- 25G US FEC improvement = 1.5 dB, per powell_3ca_1a_0118 (via laubach_3ca_1b_0118: GE model, with interleaver, precoder on, minimum value).

25G upstream loss budget, PR30

ONU AVP_{min} = 6.6 dBm, ER=5 dB



OLT Rx Sens_{max} -22.9 dBm
@ ER=5 dB , BER = 1e-3

TDP = 2 dB

OLT Rx Sens_{max} = -24.4 dBm* @ ER = 5 dB

25G US FEC improvement = 1.5 dB.

*BER = 1e-2 nominally

Check proposed specification for 25G ONU DML

- Per vendor survey harstead_3ca_3_0917

cooled DML	number	mean	σ
AVPmin (dBm)	6	6.5	0.5
ER (dB)	6	5.2	1.0

uncooled DML	number	mean	σ
AVPmin (dBm)	5	4.7	1.0
ER (dB)	5	4.6	0.7

ONU AVP_{min} = 6.6 dBm, ER=5 dB is confirmed to be feasible for cooled DMLs.

ONU AVP_{min} = 6.6 dBm, ER=5 dB may be feasible during the life of 25G PON with future improvements in technology.

Notes:

- “number” = number of responses
- “mean” = the average value of the responses. When a vendor gave a range for a value, the midpoint of that range was used.
- “ σ ” = the standard deviation of the responses.

Motion

The 25G-EPON PR30 specifications proposed in harstead_3ca_2_0318 page 6

- 25G OLT receiver sensitivity: -24.4 dBm at BER= 1e-2 and ER=5 dB
 - 25G ONU transmitter: AVPmin = 6.6 dBm and ER min = 5 dB
- shall be adopted.

- Moved: Ed Harstead
- Seconded:

- For:
- Against:
- Abstain:

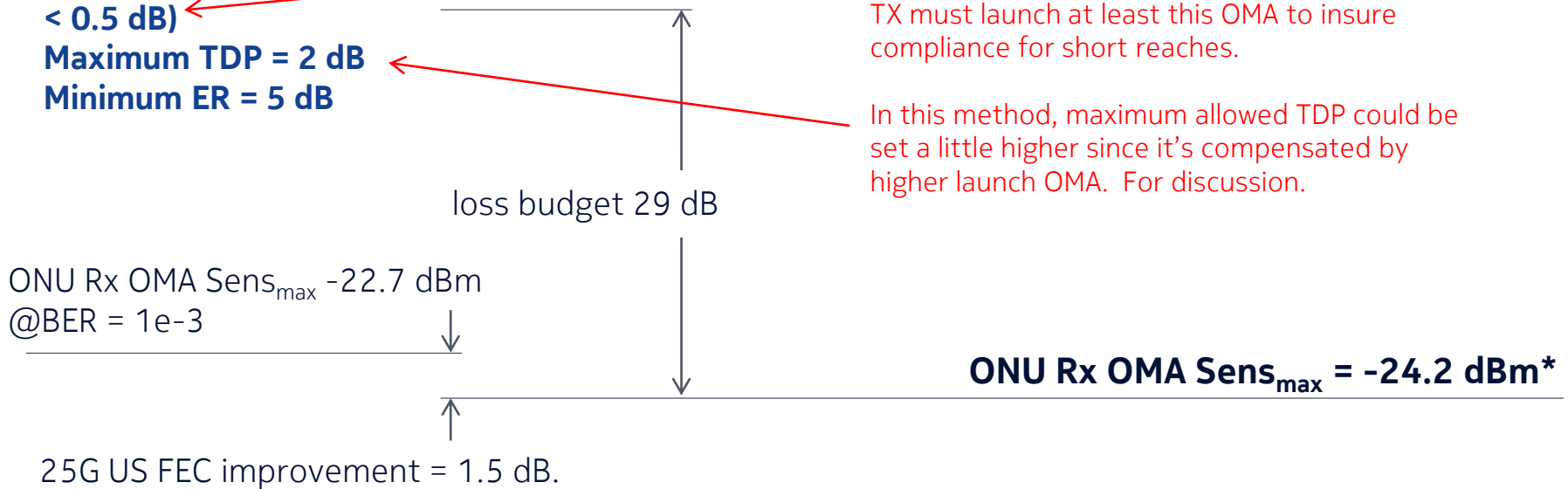
Example: Converting to OMA and OMA minus TDP (John Johnson)

Min ONU OMA-TDP = 4.8 dBm

Minimum OMA = 5.3 dBm (even if TDP < 0.5 dB)

Maximum TDP = 2 dB

Minimum ER = 5 dB



Choice of 0.5dB reference TDP is representative of the expected TP of a good DML TX. Value is open to discussion. Interpretation: Even if DP<0dB over 20km, all TX must launch at least this OMA to insure compliance for short reaches.

In this method, maximum allowed TDP could be set a little higher since it's compensated by higher launch OMA. For discussion.

*BER = 1e-2 nominally

NOKIA

Reason to avoid a 25G specification that will never be realizable with APD

- The 100G Ethernet ER4 (40 km) receiver specification was initially based on a PIN+SOA.
- Ever since, they have been working to correct this mistake, with APD-friendly ER4f/ER4lite and now [4WDM MSA](#).

18 October 2016

Chris Cole, Finisar

100G 10km, 20km & 40km 4x25G NRZ WDM Optical Specifications Proposal, Draft 04

Specification	10km WDM4-10 w/ FEC 100G LR4 loss	20km WDM4-20 w/ FEC	40km WDM4-40 w/ FEC
Rate \pm 100 ppm Gb/s	25.78125	25.78125	25.78125
Reach km (RX type)	10 (PIN)	20 (PIN)	40 (APD)

- The cost of the SOA+PIN will depend on volumes, and it's now unlikely to have any significant volume from 100G Ethernet. Therefore it is likely to be high cost.
- The SOA+PIN will have significantly higher power dissipation than the APD. This will degrade OLT port density
- **Therefore a 25G OLT specification requiring SOA+PIN will be a liability for 25G EPON market success**