

project objectives

... how far, how long ...

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working towards TF

- » One of the major goals for SG is to isolate and bound the problem we are set to explore.
- » This SG is looking at providing support for loss budgets for EPON exceeding what is currently specified for 1G-EPON (24+dB) and 10G-EPON (29dB+dB)
- » What we need to do
 - > Bound link loss / power budget values we are planning to work on and deliver to 802.3 WG in the future
 - > Clearly identify goals and deliverables for the project to drive development during TF process

bounding the problem

- » The problem we are going to solve involves guaranteeing interoperability at physical layer between ONU and OLT devices, connected to ODN with specific loss budget
- » Here is how past projects (802.3av/802.3ah) went about bounding the problem to be solved:
 - > define nominal distance and nominal split ratio to be supported (... *Define up to 3 optical power budgets that support split ratios of 1:16 and 1:32, and distances of at least 10 and at least 20 km ...*);
 - > no target values for optical power budgets were defined in the objectives (see e.g. [10gepon objectives 0706.pdf](#) for 10G-EPON);
 - > required power budgets were derived from nominal distance / split ratios as well as techno-economic considerations for optical modules during the course of the TF work.

how should we bound the problem

- » Follow a similar path already tried by 802.3ah and 802.3av i.e. define minimum nominal distance / split ratios to be supported by the newly defined power budgets ...
- » ... but combine them with the specific supported power budgets to clearly delineate the goals to be achieved by the project
- » For example:
 - > Define optical power budget for 1G-EPON, supporting channel insertion loss of 29dB and a nominal split of at least 1:32 at the distance of at least 20 km
 - > Define three optical power budgets for EPON (one for 1G-EPON, one for 10/1G-EPON, and one for 10/10G-EPON), supporting channel insertion loss of at least 32 dB and a nominal split of at least 1:64 at the distance of at least 20 km
- » The actual supported distance / split ratio may be higher than the nominal values used for link modelling purposes (see slide 7+)

29dB loss for 1G-EPON - motivation

- » Support for 29dB loss budget for 1G-EPON is already defined for upstream – see 802.3av, Clause 75
- » To have a complete, fully functional PHY we need also downstream link specification – currently missing in 802.3 (both 802.3-2008 as well as 802.3av)
- » The workload expected with development of the associated PMD specifications is limited, especially considering already demonstrated technical feasibility and manufacturing capabilities (ExEPON_1109_li_1.pdf)

32dB loss for EPON - motivation

- » 10G-EPON currently supports 20, 24, 29 dB loss budgets, with:
 - > 4 dB difference between PR(X)10 and PR(X)20 PMDs,
 - > 5 dB difference between PR(X)20 and PR(X)30 PMDs.
- » The next “bump” in loss budget for EPON should provide at least additional 1:2 split in the ODN (3dB increase from currently specified 29dB loss budget)
- » Discussion is needed whether 3dB is considered a sufficient increase from existing loss budgets, or whether 4dB would be more acceptable.

Loss budget examples

» Derived from Excel spreadsheet tool used to verify the design of 802.3av power budgets, available at:

<http://www.ieee802.org/3/av/public/tools/>

» Here are the main parameters used for link loss calculations:

- > Fibre_Attenuation_Curve: G652AB
- > Fibre_Attenuation_Curve_Type: max / min
- > Fibre_Attenuation_Base_Value: 0.35
- > Fibre_Attenuation_Base_Wavelength: 1310nm for US, 1550nm for DS
- > Fibre_Attenuation (max): 0.298 dB/km for DS, 0.418 dB/km for US
- > Fibre_Attenuation (min): 0.232 dB/km for DS, 0.356 dB/km for US
- > Splitter_Loss_Curve: max loss curve based on 802.3av findings
- > Splice / coupler loss: 2 dB per ODN (very conservative)

29dB loss budget EPON

split [1:N]	PSC loss [dB]	distance US [km], min	distance US [km], max	distance DS [km], min	distance DS [km], max
4	7.99	45.47	53.35	63.79	81.89
8	11.46	37.17	43.61	52.15	66.94
16	14.93	28.87	33.88	40.50	52.00
32	18.40	20.57	24.14	28.86	37.05
64	21.87	12.27	14.40	17.22	22.10
128	25.34	3.97	4.66	5.57	7.16
256	28.81	NA	NA	NA	NA

- » 1:32 split at 20 km can be supported under the worst-case ODN design scenarios without any problems.
- » 1:128 split can be supported at around 4 km distance.
- » Even maximum distance is very conservative (fiber loss, ODN couplers etc.)

32dB loss budget EPON

split [1:N]	PSC loss [dB]	distance US [km], min	distance US [km], max	distance DS [km], min	distance DS [km], max
4	7.99	52.65	61.77	73.85	94.81
8	11.46	44.35	52.03	62.21	79.87
16	14.93	36.05	42.30	50.57	64.92
32	18.40	27.75	32.56	38.93	49.97
64	21.87	19.45	22.82	27.28	35.03
128	25.34	11.15	13.08	15.64	20.08
256	28.81	2.85	3.34	4.00	5.13

- » 1:64 split at 20 km can be supported under the worst-case ODN design scenario. US direction may require further optimization (19.5 km) be seems feasible.
- » 1:128 split can be supported at around ~11 km distance (WCS).
- » Even maximum distance is very conservative (fiber loss, ODN couplers etc.)

Proposed project objectives

- » Support subscriber access networks using point-to-multipoint topologies on SM optical fiber
- » EPON PHY(s) to have a BER better than or equal to 10^{-12} at the MAC/PLS service interface
- » Provide physical layer specifications:
 - > for 1G-EPON supporting channel insertion loss of 29dB, with the split of at least 1:32 at the distance of at least 20 km, and supporting channel insertion loss of at least 32 dB, with the split of at least 1:64 at the distance of at least 20 km;
 - > for 10G-EPON, supporting channel insertion loss of at least 32 dB, with the split of at least 1:64 at the distance of at least 20 km;

Guidelines for FT work

- » Maintain upgrade path from 1G-EPON to 10G-EPON on the same ODN i.e. support the same loss budget classes for 1G-EPON and 10G-EPON.
- » Support the upgrade path from existing EPON to ExEPON without affecting already deployed ONUs (no changes to fielded ONU).
- » Maintain PCS (Clause 65/76) and MPCP (Clause 64/77) definitions for 1G-EPON and 10G-EPON unchanged.
- » Maintain existing EPON ONU PMD specifications as much as possible i.e. restrict changes to the OLT side PMD specifications, improving their performance.