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10GEPON Power Budget in IEEE Formalism

based on 3av_0705_takizawa_01.pdf

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IEEE Definition

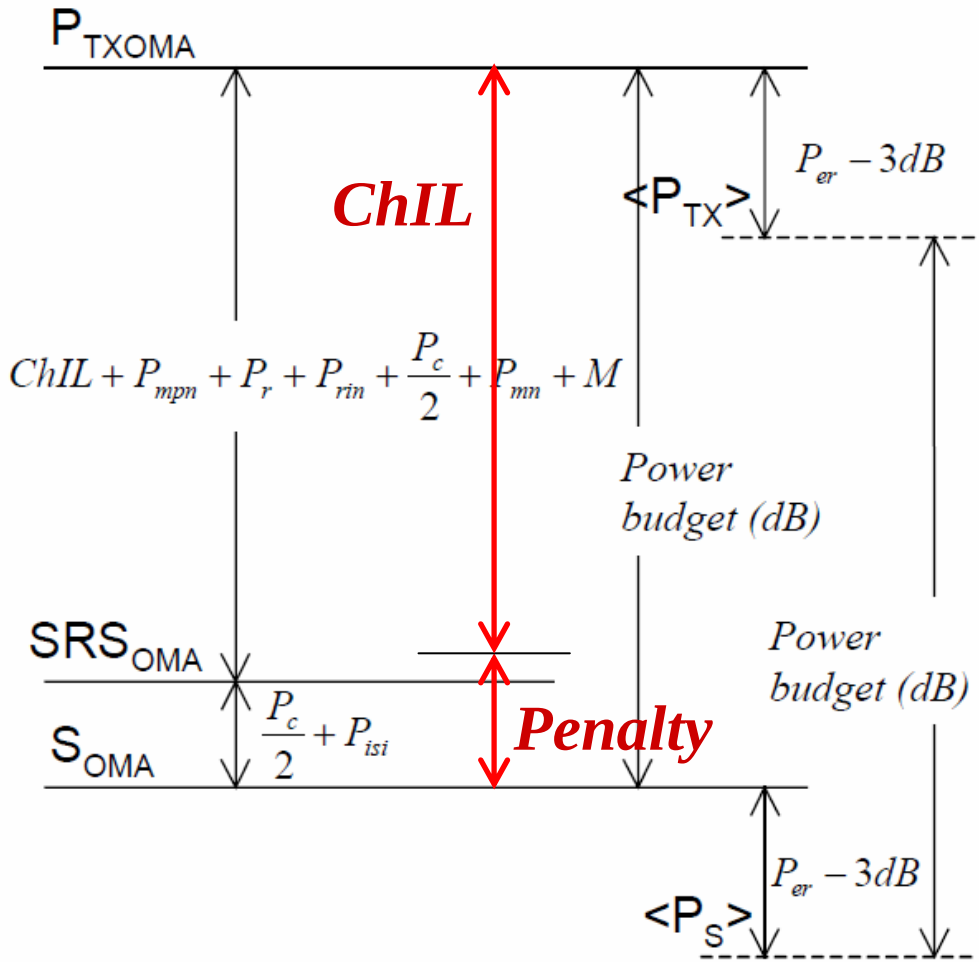

Figure 2. The 10Gigabit Ethernet power budget

Power Budget

= P_{TXOMA} - S_{OMA}

= ***ChIL + Penalty***

- SRS_{OMA} : Realistic sensitivity using the practical TX

  Close to ITU RX sens. including Path Penalty

- S_{OMA} : Nominal RX sensitivity using the ideal TX

  Not a practical sensitivity indicator

Review of the 10Gigabit Ethernet Link Model, ONIDS2002, White Paper

10G Consideration

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$$Penalty = Pmpn + Pr + Prin + Pc + Pmn + Pisi + M$$

Negligible with 10G optics ??

No extra margin can be allocated in 10G Class B++ tight power budget

	10GEPON Targets	Exclude
Optical Source	DM-DFB (DML) EML	FP-LD
Fiber	SMF (G.652)	MMF

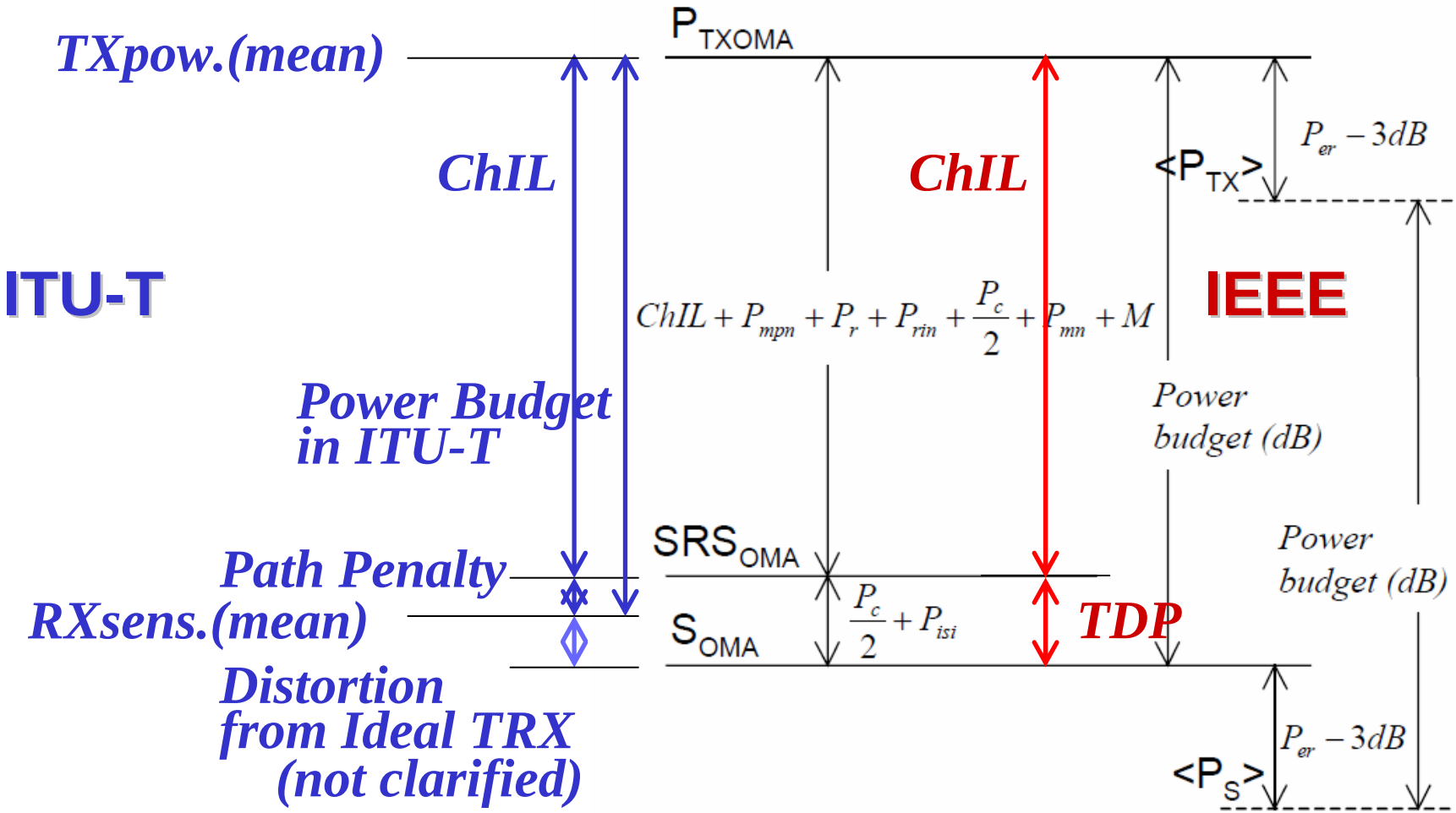
Pmpn : mode partition noise power penalty
Prin : power penalty due to RIN
Pmn : power penalty due tomodal noise
M : power margin

Pr : reflection noise poewr penalty
Pc : correction due to penalty interactions
Pisi : power penalty due to ISI

Penalty ~ Pisi ??

~ ***TDP*** ?? (*Transmitter & Dispersion Penalty*)

Simplified Diagram



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Simplified Model

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$P_{TXOMA} - SRS_{OMA} = \boldsymbol{ChIL}$

$SRS_{OMA} - S_{OMA} = \boldsymbol{TDP}$

Power Budget = $P_{TXOMA} - S_{OMA} = \boldsymbol{ChIL} + \boldsymbol{TDP}$

- Most IEEE specs. look close, but with slight differences
  - 802.3ae : 10GBASE-L (DFB), -E (EML)
  - 802.3ah : PX20-U/S, -D/S (DFB)

- IEEE vs ITU-T "Receiver Sensitivity" definition differs

Receiver Sensitivity	IEEE	$S_{OMA} = SRS_{OMA} - \boldsymbol{TDP}$
	ITU-T	$\boldsymbol{RXsens.} = SRS_{OMA} - \boldsymbol{Path\ Penalty}$
Power Budget	IEEE	Power Budget = $\boldsymbol{ChIL} + \boldsymbol{TDP}$
	ITU-T	Power Budget = $\boldsymbol{ChIL} + \boldsymbol{Path\ Penalty}$

TDP for 10GEPON

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	802.3av (Proposal)	802.3ae
D/S	**1.5 dB**	**3.0 dB** (10GBASE-E)
Wavelength Distance Source Type (ER)	1574-1580 nm 20 km EML (9dB)	1530-1565 nm 40 km EML (3dB)
U/S	**3.0 dB**	**3.2 dB** (10GBASE-L)
Wavelength Distance Source Type (ER)	20nm in 1260-1360 nm 20 km DFB (6dB)	1260-1355 nm 10 km DFB (3.5dB)

- Proposal reflects current XFP product results
- U/S TDP
  10G DFB waveform-oriented penalty should be allocated ; resonance, dull falling edge, and baseline wandering
- D/S TDP
  Smaller path penalty (<1dB) is assumed in contrast to 10GBASE-E
- TDP may be important for evaluating TX profiles esp. DFBs

D/S Power Budget (PIN@ONU)

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	PX10	PX20	B++	λ : 157x nm
CH IL (dB)	20	24	29	
Path Penalty (dB)	1	1	1	EML-Tx, <20km
ER (dB)	9	9	9	
ONU Sensitivity	-20 (-19)	-20 (-19)	-20 (-19)	BER<10^{-2} or 10^{-3} (BER<10^{-4})
OLT Launch (min)	+1 (+2)	+5 (+6)	+10 (+11)	
OLT Launch (max)	+4 (+5)	+8 (+9)	+13 (+14)	
ONU Overload	-1 (0)	-2 (-1)	-2 (-1)	

S OMA	-18.6 (-17.6)	-18.6 (-17.6)	-18.6 (-17.6)	ONU
TDP	1.5	1.5	1.5	~Pisi ??
SRS OMA	-17.1 (-16.1)	-17.1 (-16.1)	-17.1 (-16.1)	w/ E-FEC (w/ FEC)
Launch OMA	+2.9 (+3.9)	+6.9 (+7.9)	+11.9 (+12.9)	OLT

D/S Power Budget (APD@ONU)

FUJITSU

	PX10	PX20	B++	λ : 157x nm
CH IL (dB)	20	24	29	
Path Penalty (dB)	1	1	1	EML-Tx, <20km
ER (dB)	9	9	9	
ONU Sensitivity	-26 (-25)	-26 (-25)	-28 (-27)	BER<10^{-2} or 10^{-3} (BER<10^{-4})
OLT Launch (min)	-5 (-4)	-1 (0)	+2 (+3)	
OLT Launch (max)	-2 (-1)	+2 (+3)	+5 (+6)	
ONU Overload	-7 (-6)	-8 (-7)	-10 (-9)	

S OMA	-24.6 (-23.6)	-24.6 (-23.6)	-26.6 (-25.6)	ONU
TDP	1.5	1.5	1.5	~Pisi ??
SRS OMA	-23.1 (-22.1)	-23.1 (-22.1)	-25.1 (-24.1)	w/ E-FEC (w/ FEC)
Launch OMA	-3.1 (-2.1)	+0.9 (+1.9)	+3.9 (+4.9)	OLT

U/S Power Budget

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	PX10	PX20	B++	λ : 1310 nm
CH IL (dB)	20	24	29	
Path Penalty (dB)	1	1	1	
ER (dB)	6	6	6	
OLT Sensitivity	-20 (-19)	-26 (-25)	-26 (-25)	BER<10^{-2} or 10^{-3} (BER<10^{-4})
ONU Launch (min)	+1 (+2)	-1 (0)	+4 (+5)	
ONU Launch (max)	+6 (+7)	+4 (+5)	+9 (+10)	
OLT Overload	+1 (+2)	-6 (-5)	-6 (-5)	

S OMA	-21.2 (-20.2)	-27.2 (-26.2)	-27.2 (-26.2)	OLT
TDP	3.0	3.0	3.0	~Pisi ??
SRS OMA	-18.2 (-17.2)	-24.2 (-23.2)	-24.2 (-23.2)	w/ E-FEC (w/ FEC)
Launch OMA	+1.8 (+2.8)	-0.2 (+0.8)	+4.8 (+5.8)	ONU

Note : APD parallel PMD (ATT inserted) is assumed for 1G/10G dual-mode Rx.

Summary

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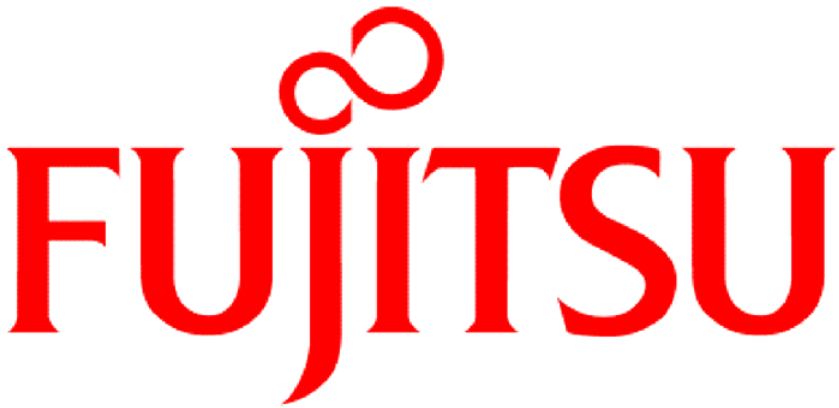
10GEPON power budget in IEEE formalism was indicated based on 3av_0705_takizawa_01.pdf

- Diagram simplification was made considering 10G optics
- TDPs were proposed based on current XFP product results

Concern still exists about the spec. numbers, especially TDP

- TDP logical definition may not be clearly indicated
- TDP test may not be well normalized
- Model may be too much simplified and underestimate TDP
- Spread sheet consistency was not verified

Comments and discussions will be appreciated !!



THE POSSIBILITIES ARE INFINITE

802.3ae 10GBASE-L (DML)

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Launch	-3.2 dBm (@worst TDP)
ChIL	6.2 dB (max.)
Budget	9.4 dB (max.)
SRS	-10.3 dBm (max.)
	2.3 dB
S	-12.6 dBm (max.)
TDP	3.2 dB (max.)

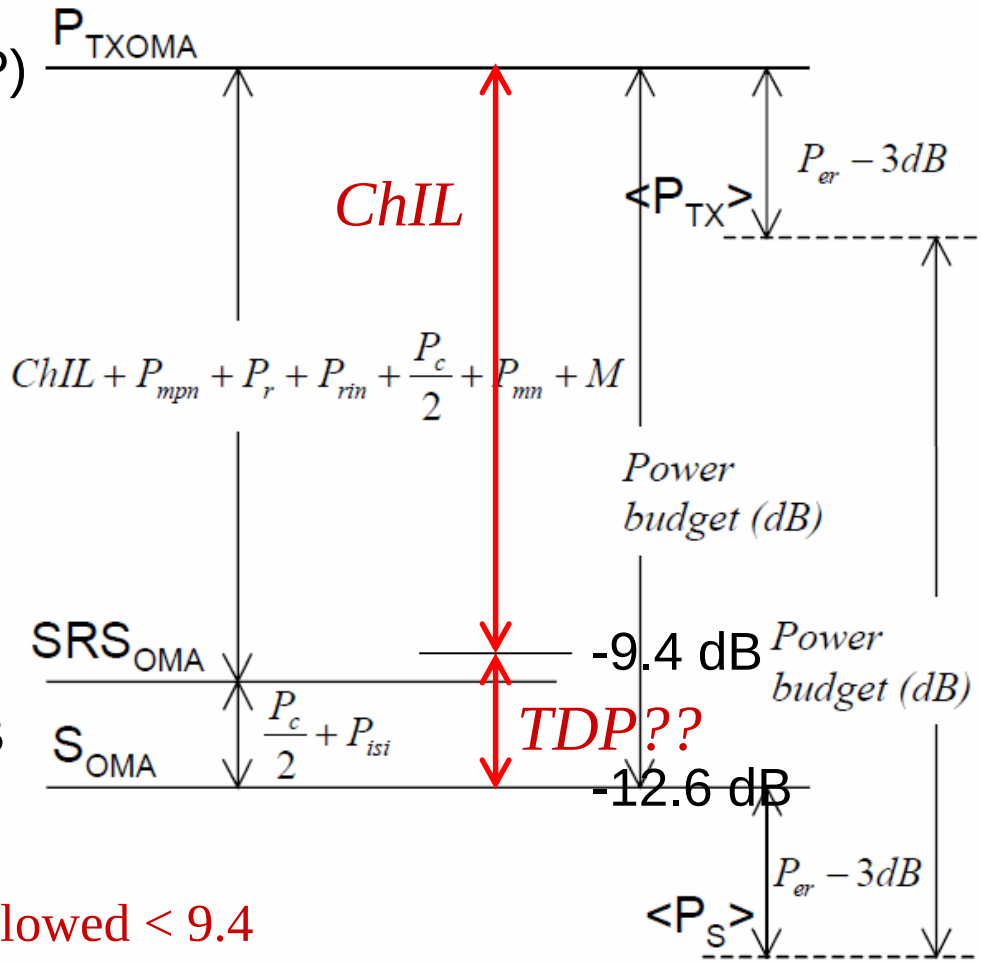

Figure 2. The 10Gigabit Ethernet power budget

If ***TDP*** < 3.2, then smaller Budget allowed < 9.4

0.9 allocated for LD mode penalty??

Review of the 10Gigabit Ethernet Link Model, ONIDS2002, White Paper

802.3ae 10GBASE-E (EML)

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Launch	+0.9 dBm (@worst TDP)
ChIL	10.9 dB (max.)
Budget	15.0 dB (max.)
SRS	-11.3 dBm (max.)
	2.8 dB
S	-14.1 dBm (max.)
TDP	3.0 dB (max.)

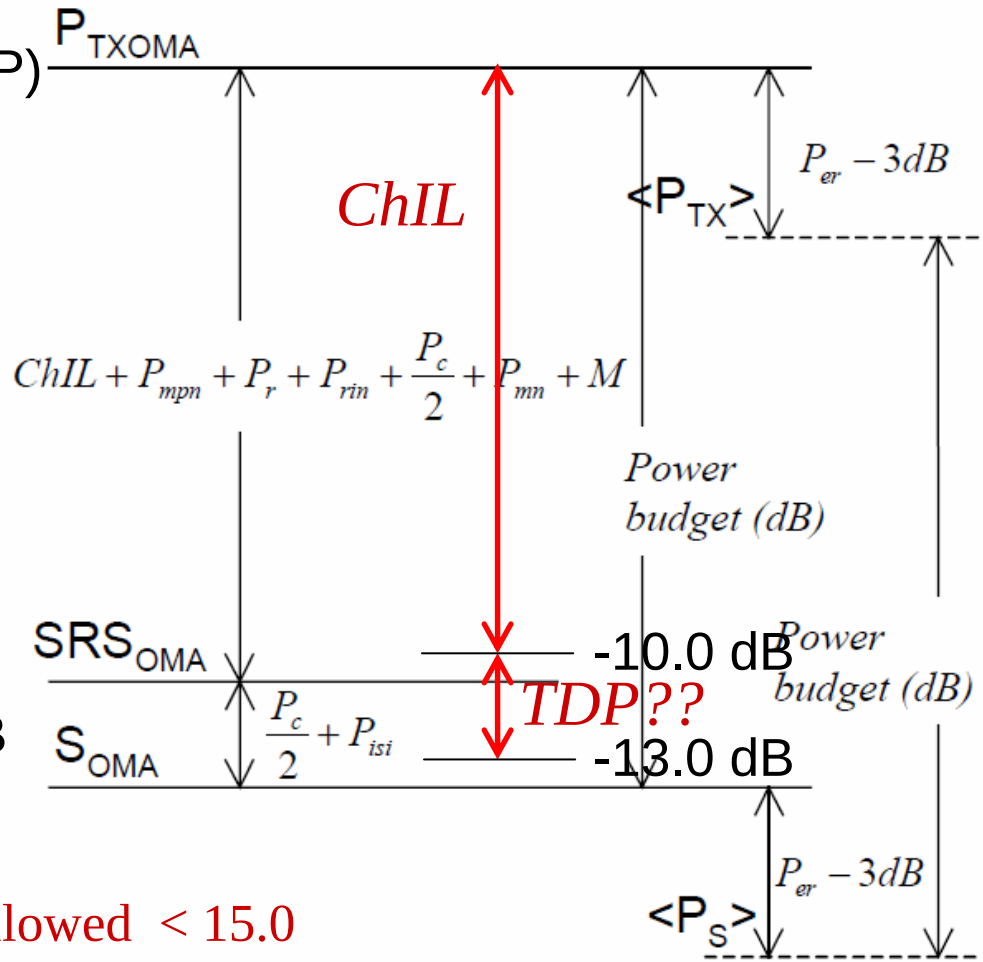

Figure 2. The 10Gigabit Ethernet power budget

If ***TDP*** < 3.0, then smaller Budget allowed < 15.0
1dB margin seems to be allocated

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802.3ah PX20 (U/S)

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Launch -0.22 dBm

ChIL 24.0 dB (max.)

Budget 26.0 dB (max.)

SRS -23.6 dBm (max.)??

2.6 dB

S -26.2 dBm (max.)

TDP 1.8 dB (max.)

Launch - SRS < ***ChIL***??

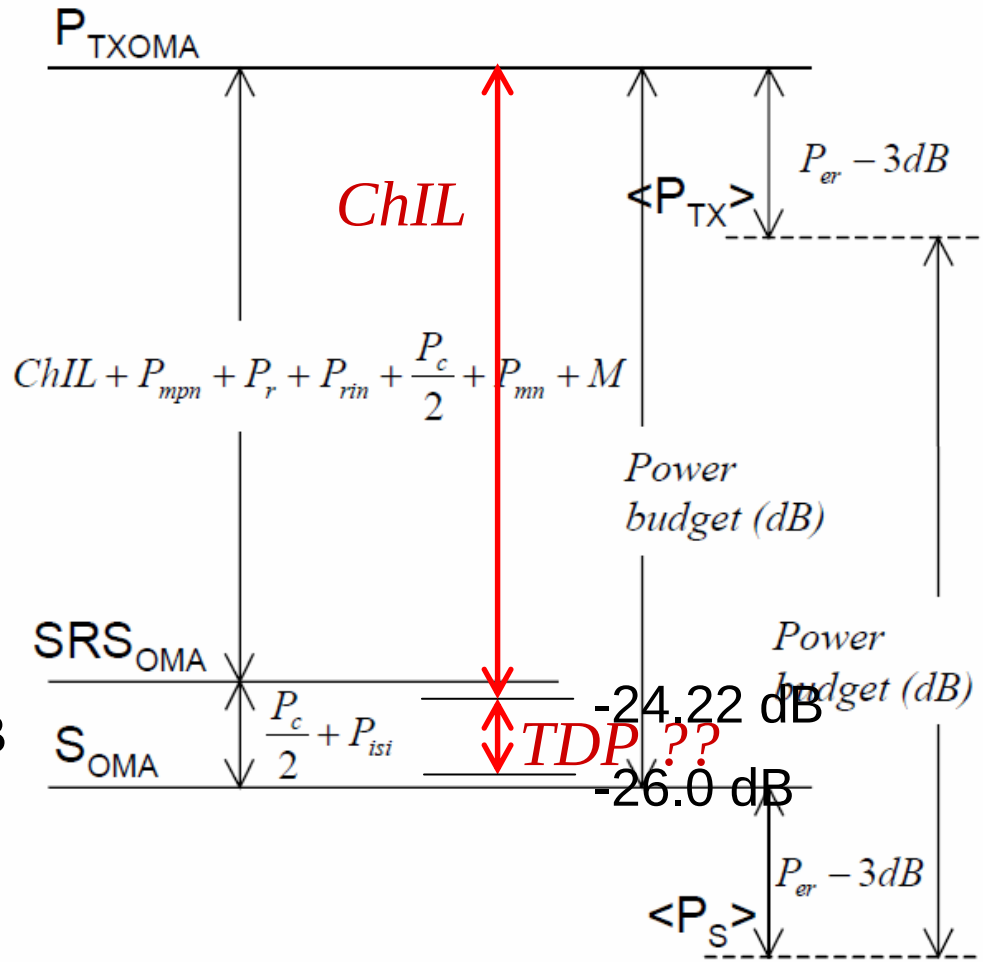

Figure 2. The 10Gigabit Ethernet power budget

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802.3ah PX20 (D/S)

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Launch +2.8 dBm

ChIL 24.0 dB (max.)

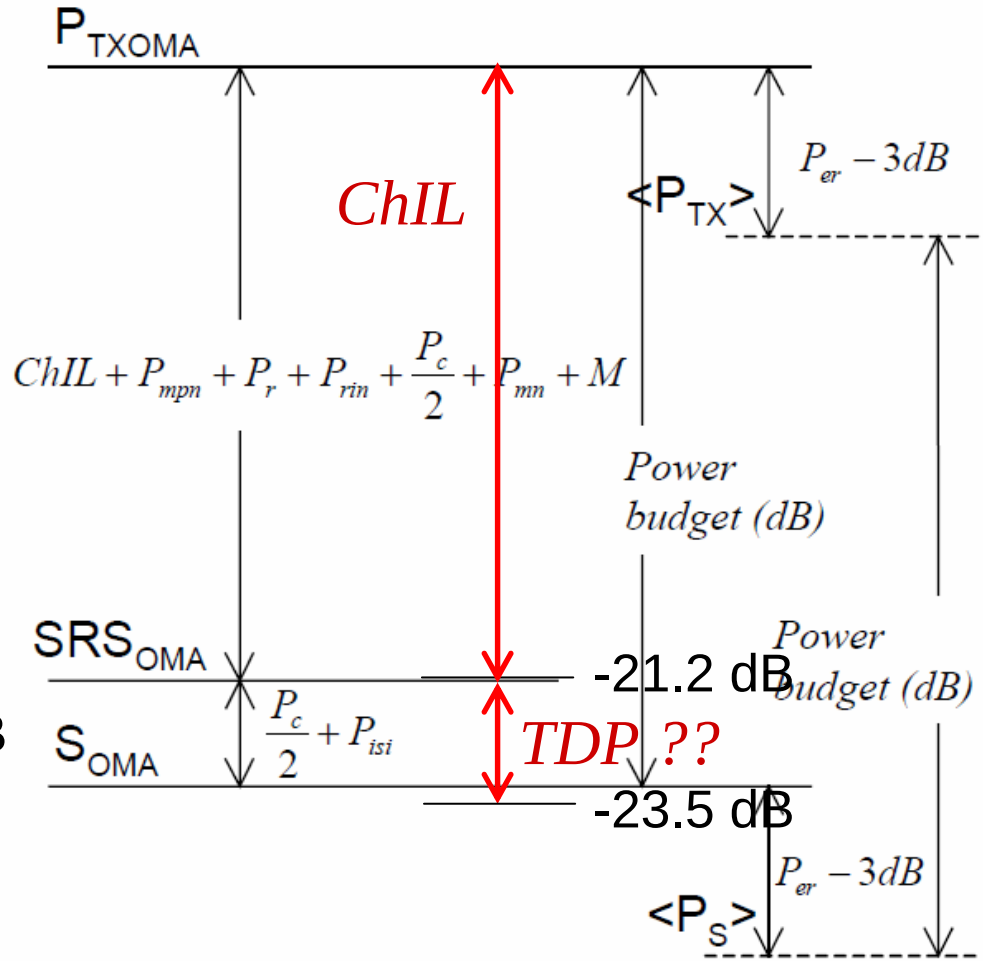
Budget 26.0 dB (max.)

SRS -21.3 dBm (max.)

1.9 dB

S -23.2 dBm (max.)

TDP 2.3 dB (max.)



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