Proposal to discuss optical interface

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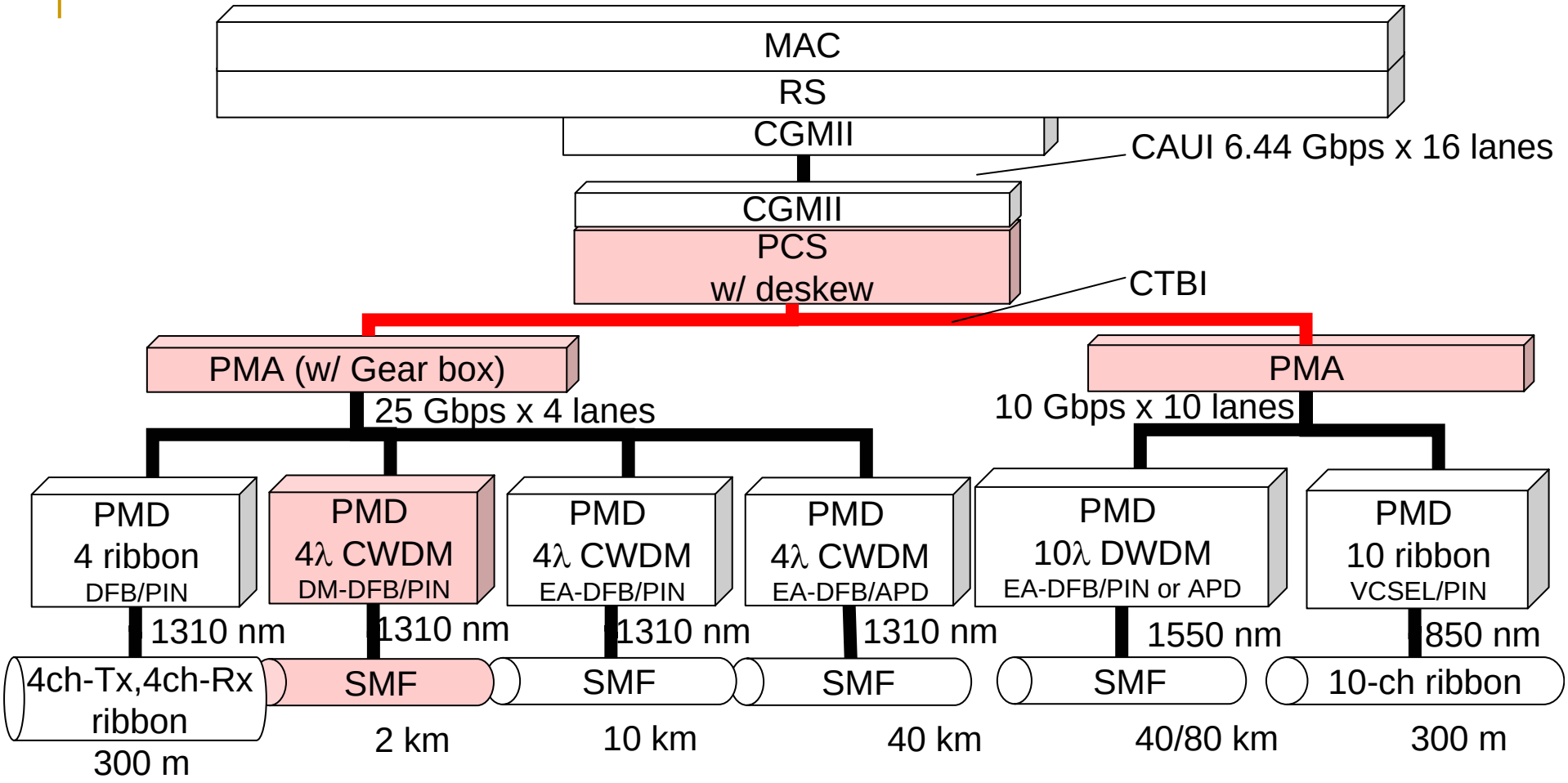
Requirements

- Wider bandwidth: ~ 100 Gbps
- Longer reach: 100 m - 80 km
- Low cost:
  - Small number of optical components
  - Compact CMOS-ICs
- Low power consumption
- Low latency
- High reliability (BER: < 10^{-15})

PMD architectures



- 10-ch architectures (technically easy)
  > 4-ch architectures (cost effective)

EA-DFB: DFB integrated with electroabsorption modulator, DM-DFB: Direct modulated DFB, CTBI: 100G Ten bit interface

Module objectives

- *Low cost*
- *Low power consumption*
- *Compact footprint*
  - *Especially optimizing SR (100 m) and LR (10 km) application*

Module configurations

	10-lane		4/5-lane
Optical link configuration	10 Gbps x 10 fiber	10 Gbps x 10 λ	25 Gbps x 4 λ 20 Gbps x 5 λ
Transmission length	100m MMF (Ribbon)	80 km SMF (DWDM)	10 km / 2 km SMF (CWDM)
Technology level	Current 10 Gbps + multi-port integration	Current 10 Gbps + DWDM integration	Down grade 40 Gbps + CWDM integration
Optical device	850-nm VCSEL	1550-nm EA-DFB	1310-nm EA-DFB/ 1310-nm DM-DFB
Interface IC	CMOS	CMOS	SiGe BiCMOS or CMOS (65 nm)
Driver/TIA	CMOS, SiGe or GaAs	SiGe or GaAs	InP HBT or HEMT or SiGe
Cooler	Without	With	Without

In this presentation, mainly 4/5λ CWDM are discussed.

Estimate: 4 λ and 5 λ

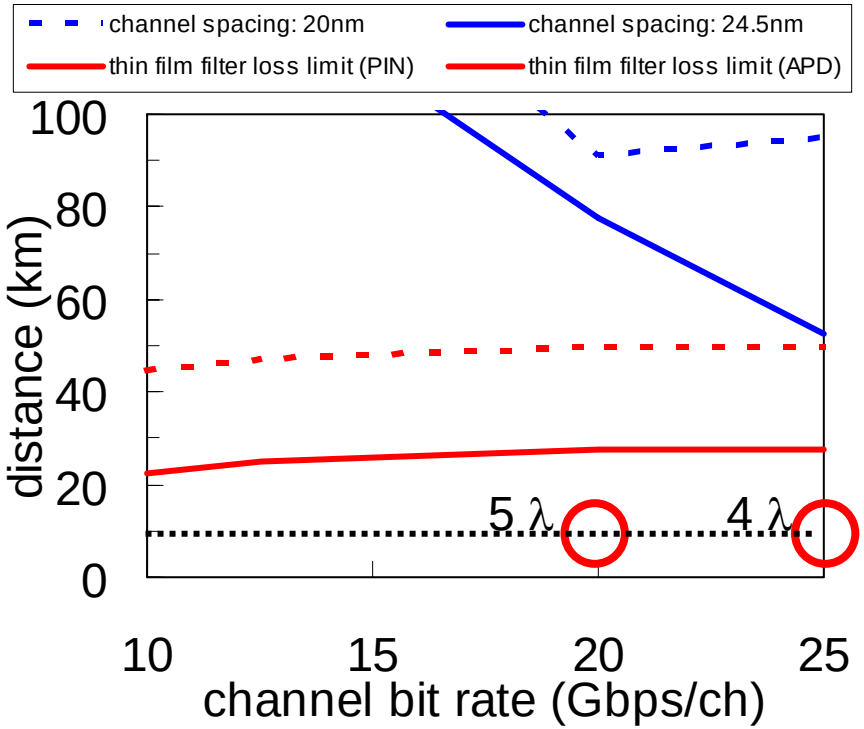


Fig. TX: uncooled EA-DFB

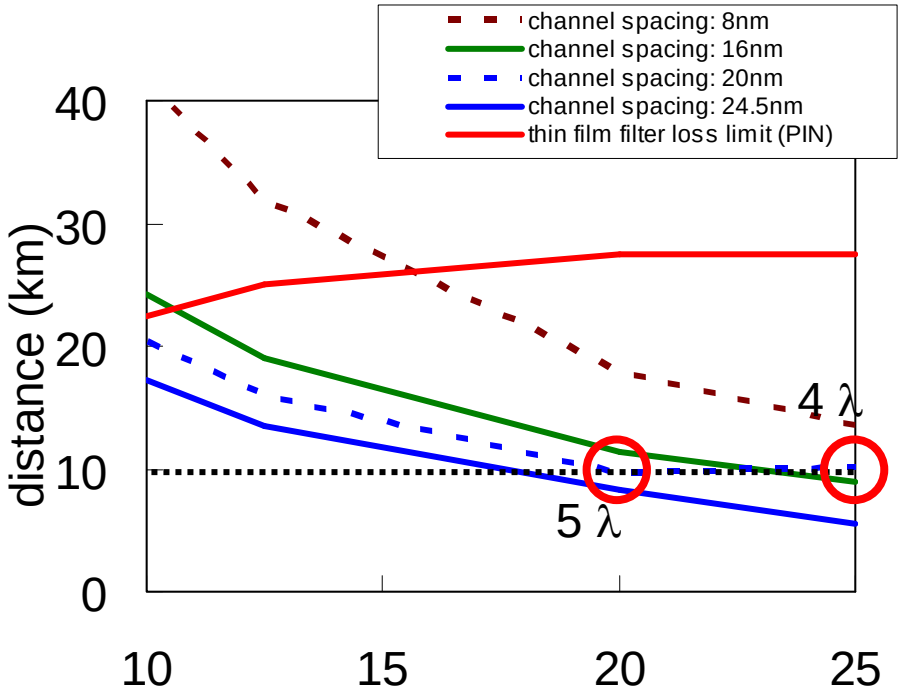


Fig. TX: cooled DM-DFB

- **EA-DFB dispersion tolerance: 1600 nm/ps, DM-DFB: 170 nm/ps**
- **Minimum output power (Pave): 2 dBm**
- **Minimum optical receiver power @ 25 Gbps; PIN: -14 dBm, APD: -23 dBm**
- **WDM thin film filter loss: 0.5dB/ch**
- **2dB penalty at BER 10^{-10}**

4 λ or 5 λ ?

EA-DFB can be used for both 4 λ and 5 λ solutions.
DM-DFB has no margin over 10 km.

	4-lane	5-lane
Optical link configuration	25 Gbps x 4 λ	20 Gbps x 5 λ
Wavelength pitch	20 nm (*)	
Transmission length	10 km SMF (CWDM, without cooler)	
EA-DFB	Loss limit: 28 km	Loss limit: 27 km
DM-DFB	Dispersion limit: 10 km	Dispersion limit: 9.6 km
DQPSK (near future)	Easy	Difficult
Gearbox 10 ch v.s. n-ch	Slightly complex	Easy

(*) Transmission length is around 5.5 km with DM-DFB (4 λ: wavelength pitch of 24.5 nm)

4 λ or 5 λ ?

4 λ is expected to be cheaper and use less power than 5 λ.

		4λ CWDM	5λ CWDM
Power consumption	Tx / Rx AC (*1)	1	1
	Tx / Rx DC (*2)	1	1.25
Cost	Total OSA (*3)	1	1.25

(*1) Assume 10 Gbps AC power = 1.0

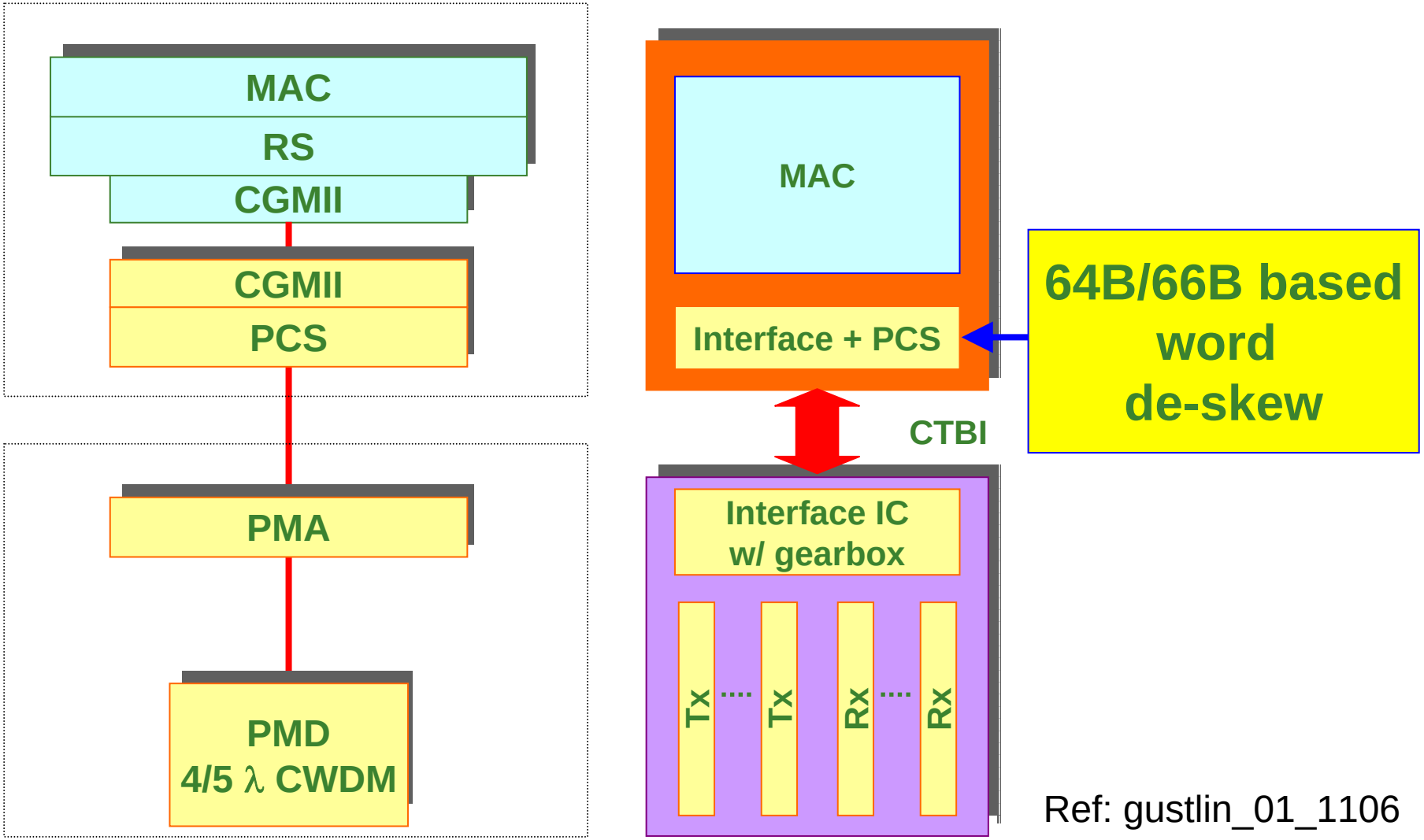
➔ 4 x 25 Gbps AC power = 2.5: Total AC power 2.5 x 4 = 10.0

➔ 5 x 20 Gbps AC power = 2.0: Total AC power 2.0 x 5 = 10.0

(*2) Laser bias current, EA bias voltage, etc.

(*3) 20-Gbps laser and 25-Gbps laser are almost same cost.

Module structure and de-skew



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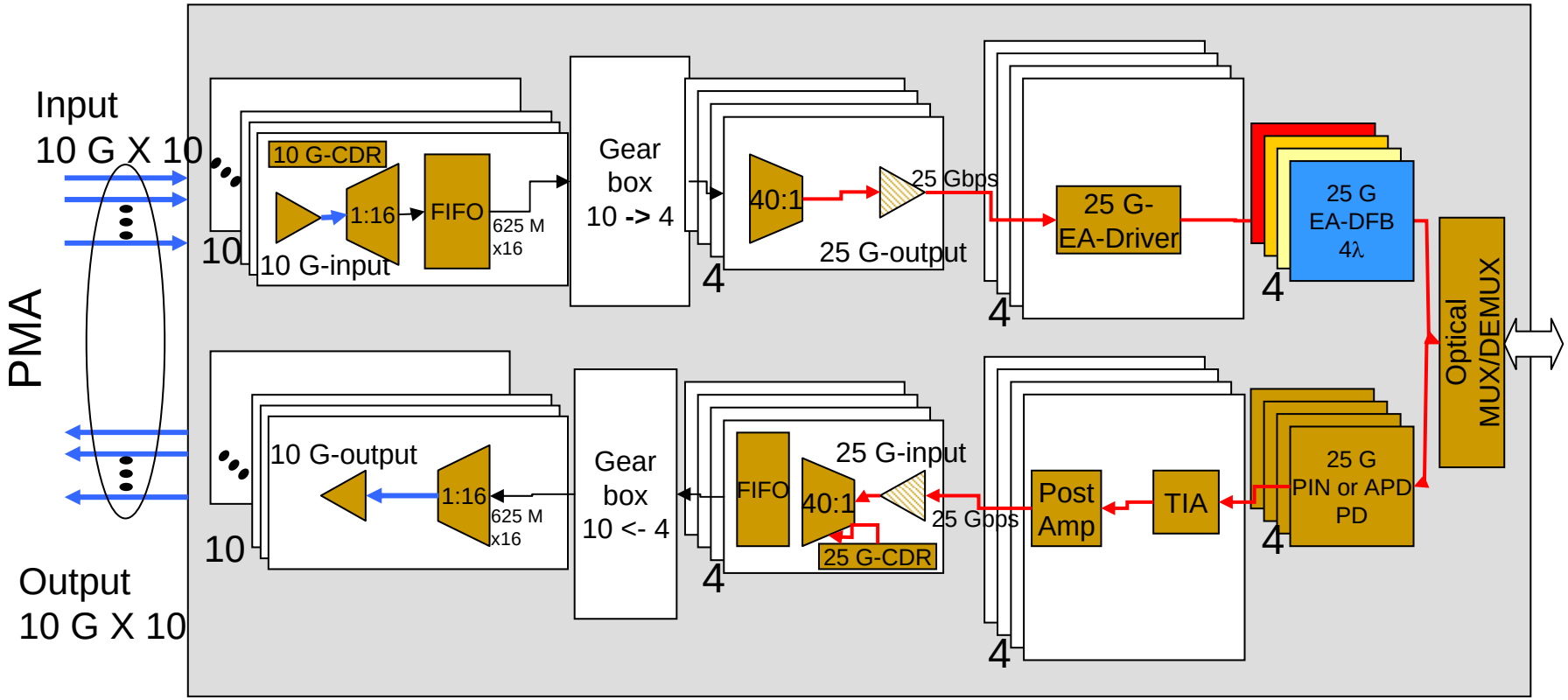
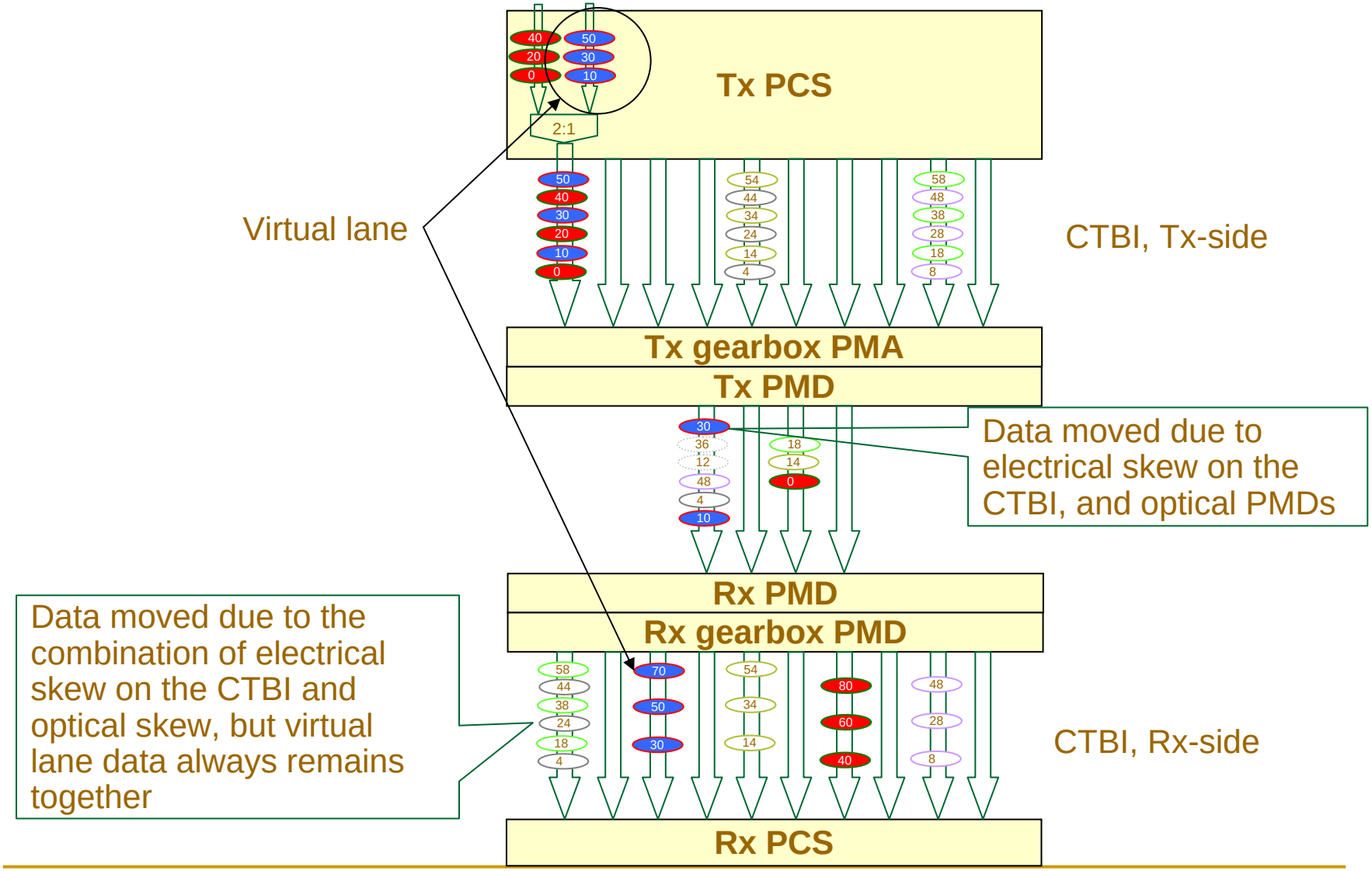
Plan of PMD module structure plan



De-skew mechanism



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Future challenges

- Package:
  - Size (power consumption)
  - Number of pins
- Electrical interface of optical module:
  - 10 x 10 Gbps
  - 8 x 12.5 Gbps, 16 x 6.25 Gbps or 4 x 25 Gbps
  - Pluggable electrical connector
- Skew compensation in PCS and PMA
- Forward error correction

Summary

- Parallel link
  - 25 Gbps x 4 ch (CWDM and ribbon)
  - 10 Gbps x 10 ch (DWDM and ribbon)

- 4 λ CWDM or 5 λ CWDM?
  - 4 λ: Low power consumption and
    cost effective in optical modules