



Information Input about 2-km/ 10-km Applications and Technologies for Link-Budget Increase

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Overview



- **Scope of discussion**
- **Example of 2-km and 10-km applications in telecarrier NW**
- **Example of technologies for link-budget increase**

Discussion scope



Transmission distance: 2km, 10km
 Transmission capacity: 100G, 400G

Ref.) 100 Gb/s per lane optical PHYs SG, CFI_01_1118

	Lanes	500 m	2 km	10 km	20 km	40 km	Up to 80km
1000BASE-	1		LX	LX10 / LH		EX	ZX
10GBASE-	1			LR		ER	ZR
25GBASE-	1			LR		ER	
40GBASE-	4	PSM4		LR4		ER4	
	1		FR				
50GBASE-	1		FR	LR		ER	
100GBASE-	10		10X10				
	4	PSM4	CWDM4 / CLR4	LR4 / 4WDM-10	4WDM-20	ER4 / 4WDM-40	
	1	DR					"ZR"
200GBASE-	4		FR4	LR4		ER4	
400GBASE-	8		FR8	LR8		ER8	
	4	DR4					"ZR"
	1						

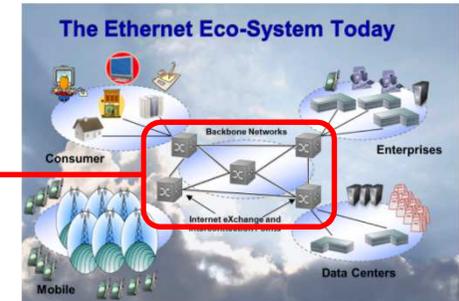


Black Text IEEE Standard
 Red Text In Standardization
 Blue Text Non-IEEE standard but complies to IEEE electrical interfaces

Example of 2-km and 10-km applications



2-km and 10-km reach Interfaces are used for router-to-transport connection and router-to-router direct connection.

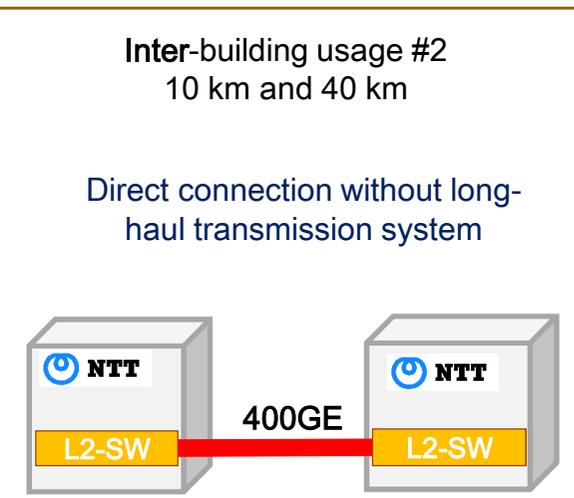
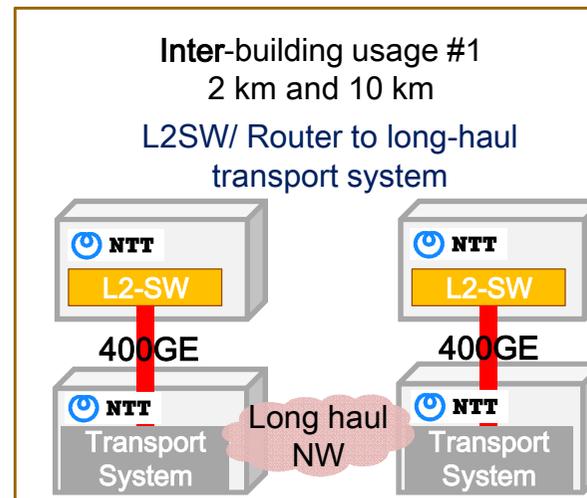
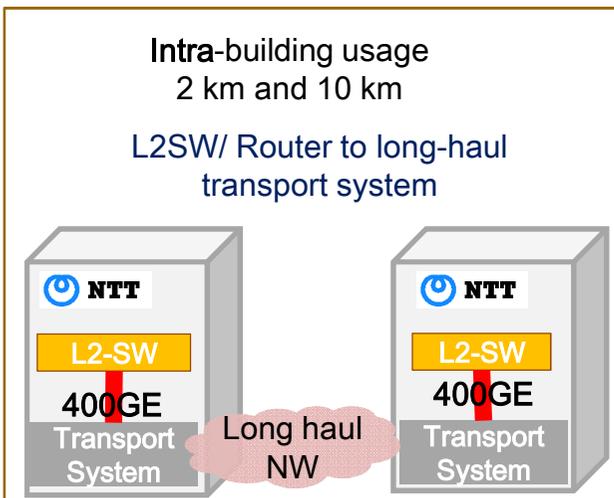


Ref.) 100 Gb/s per lane optical PHYs SG, CFI_01_1118

	Single-mode fiber		
Reach	2 km	10 km	40 km
Application	Intra-building		
	Inter-building usage #1		Inter-building usage #2
802.3bs objectives	✓	✓	-
802.3cn objectives	-	-	✓

2-km/ 10-km reach:
Router-to-transport application

10-km reach:
Covers 50% of inter-building links



Necessity of link-budget increase



- 100G/lane PAM4 requires twice the baudrate compared to 802.3cd or 802.3bs, and it decreases sensitivity in principle.
- Less sensitivity makes link budget decrease.



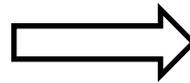
Higher-sensitivity receiver or higher-power transmitter is important for link-budget increase.

802.3cd/ 802.3bs

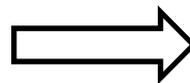
1 x 50G PAM4 2km
1 x 50G PAM4 10km

4 x 50G PAM4 2km
4 x 50G PAM4 10km

50G to 100G



200G to 400G



This Study Group

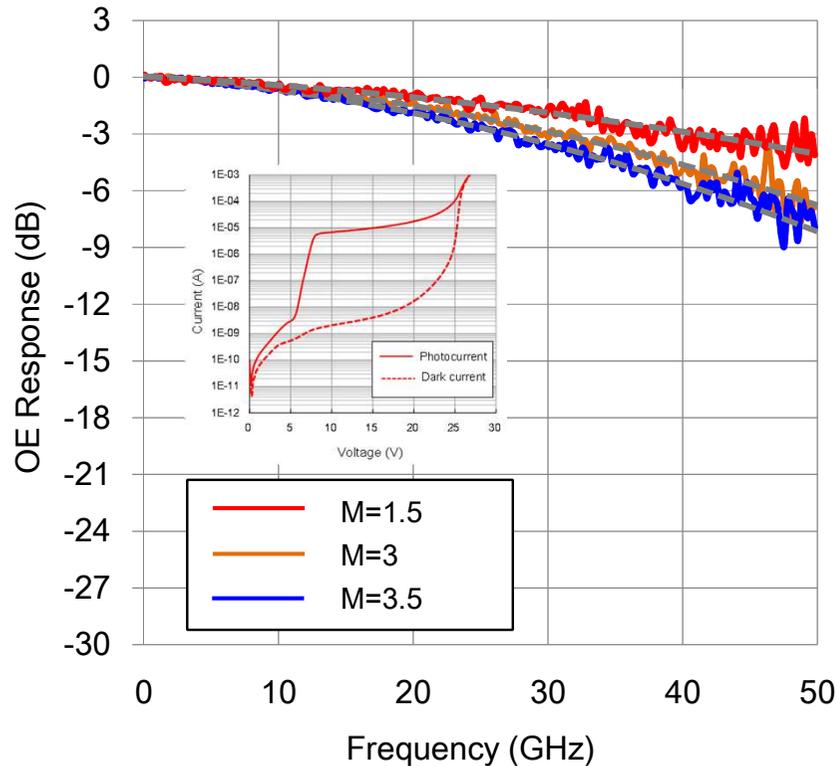
1 x 100G PAM4 2km
1 x 100G PAM4 10km

4 x 100G PAM4 2km
4 x 100G PAM4 10km

50-Gbaud APD-ROSA

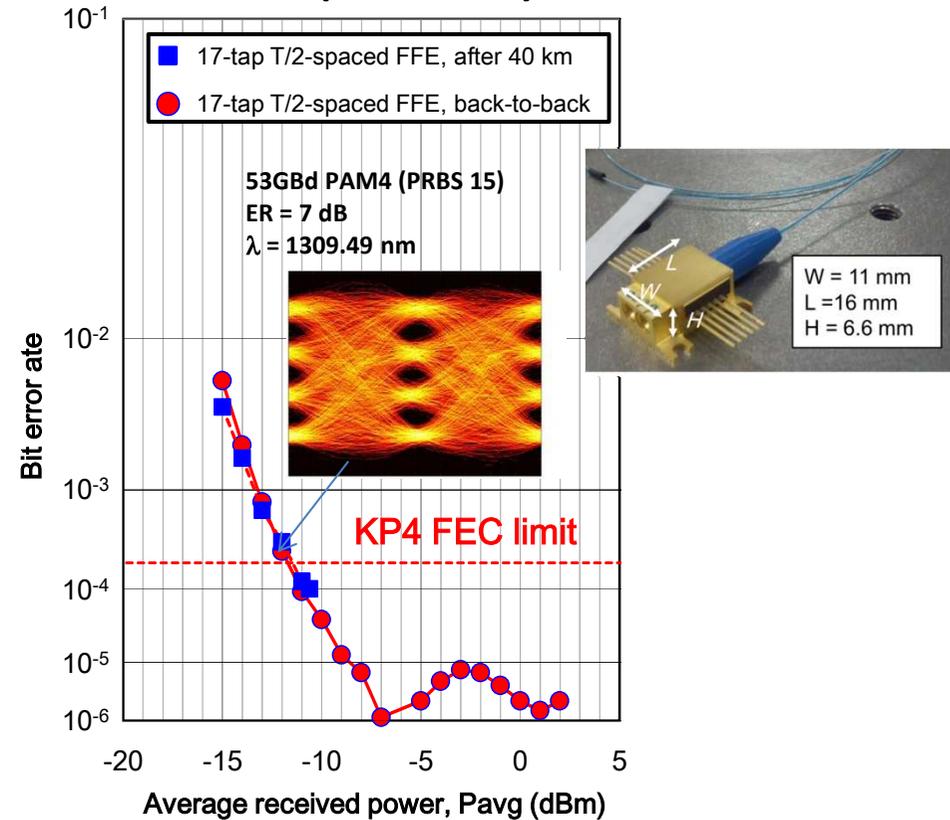


Frequency response (chip)



BER (1ch ROSA)

M. Nada et al. OFC2018 W4D.2



- Vertical illumination structure (Active area: 14 μm)
- Over 30-GHz f_{3dB} for M = 3 (1.5 A/W)
- Minimum receiver sens.: -11.47 dBm after 40-km SMF transmission of which CD is -37 ps/nm



This presentation input information about...

- **Example of 2-km and 10-km applications in telecomm-carrier NW (intra- & inter-building usages)**
- **Example of technology for link-budget increase (50-Gbaud APD)**

Thank you