



## Next Generation Fiber – Back to the LC

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# Legacy Fiber

- Today's data center networks are based on 10GbE
- Mainly use 10GBASE-SR with LC-duplex connectors and OM3 or OM4 fiber



LC-duplex with OM4 fiber



LC-duplex receptacle



Source: Finisar

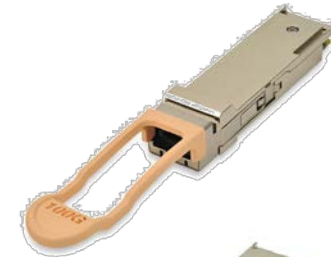
# Alternatives for 40G/100G

- For migration to 40G/100G following alternatives exist:

- LC-duplex via singlemode fiber (LR4)



- Parallel multimode fiber and MPO (SR4)



- Or wavelength division multiplexing for multimode fibers (SWDM4)



Source: Finisar

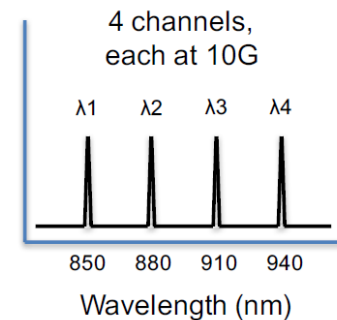
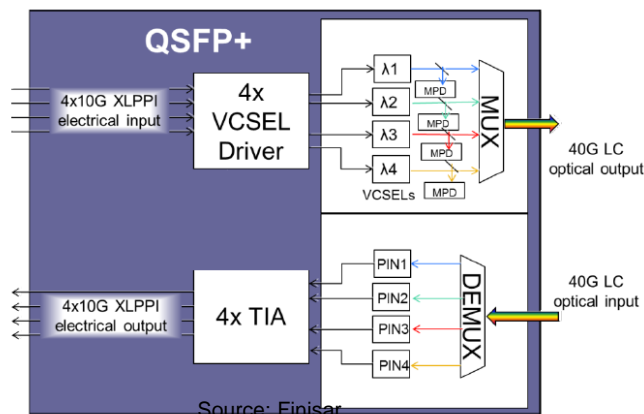
swdm4™



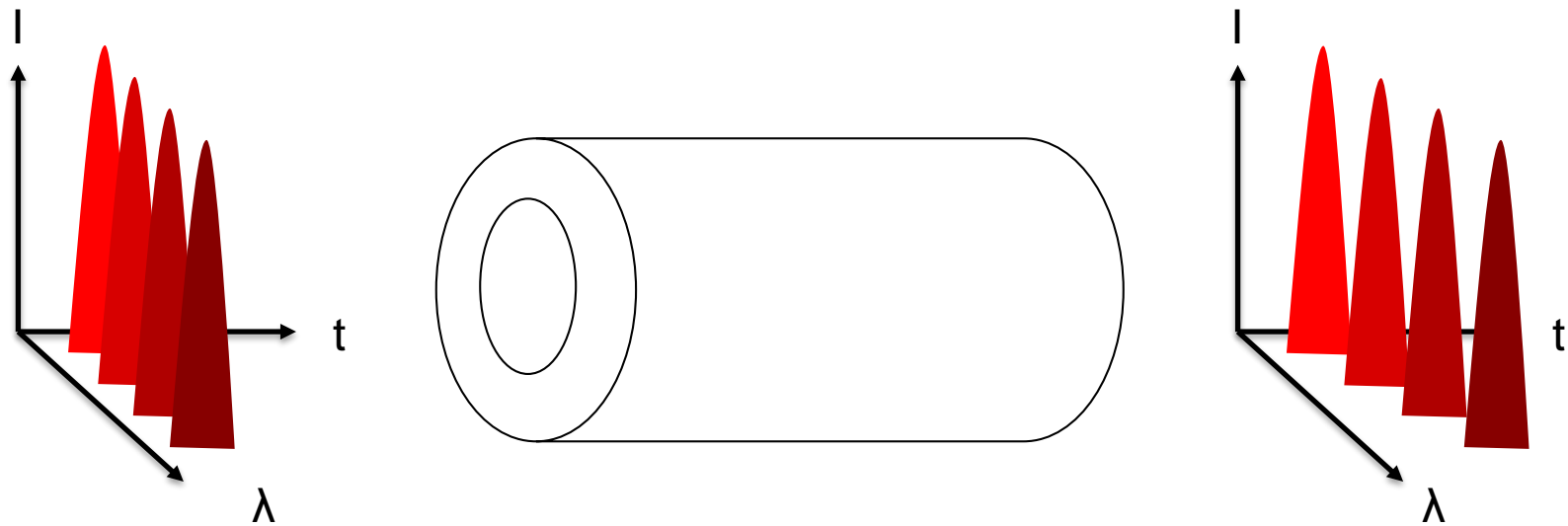
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# Technology behind SWDM4

- Up till now, only expensive singlemode lasers could take over WDM functions
- SWDM4 transceivers operate at four wavelengths: 850 nm, 880 nm, 910 nm and 940 nm
- Modulation speed: 10G or 25G
- Electrical form factor will be QSFP+, QSFP28 respectively
- Optical: LC-duplex



# What is OM5?



- Chromatic dispersion due to four wavelengths
- TIA-492AAAE has standardized OM5 – initially known as OM4+ or WBMMF
- Effective modal bandwidth of 4700 MHz·km at 850 nm (like OM4)
- This drops to 2470 MHz·km at 953nm
- Attenuation drops from 2.5 dB/km at 850 nm to 1.8 dB/km at 953 nm

# Benefits of OM5

- Enables future applications such as 40GBASE-SR, 100GBASE-SR, 200GBASE-SR, and 400GBASE-SR4 (this over four fibers), but also 128GFC and 256GFC
- OM5 is backwards compatible to OM4 and OM3
- The OM5 cable distinguishes itself visually from its predecessors by its lime color...



Made popular by...

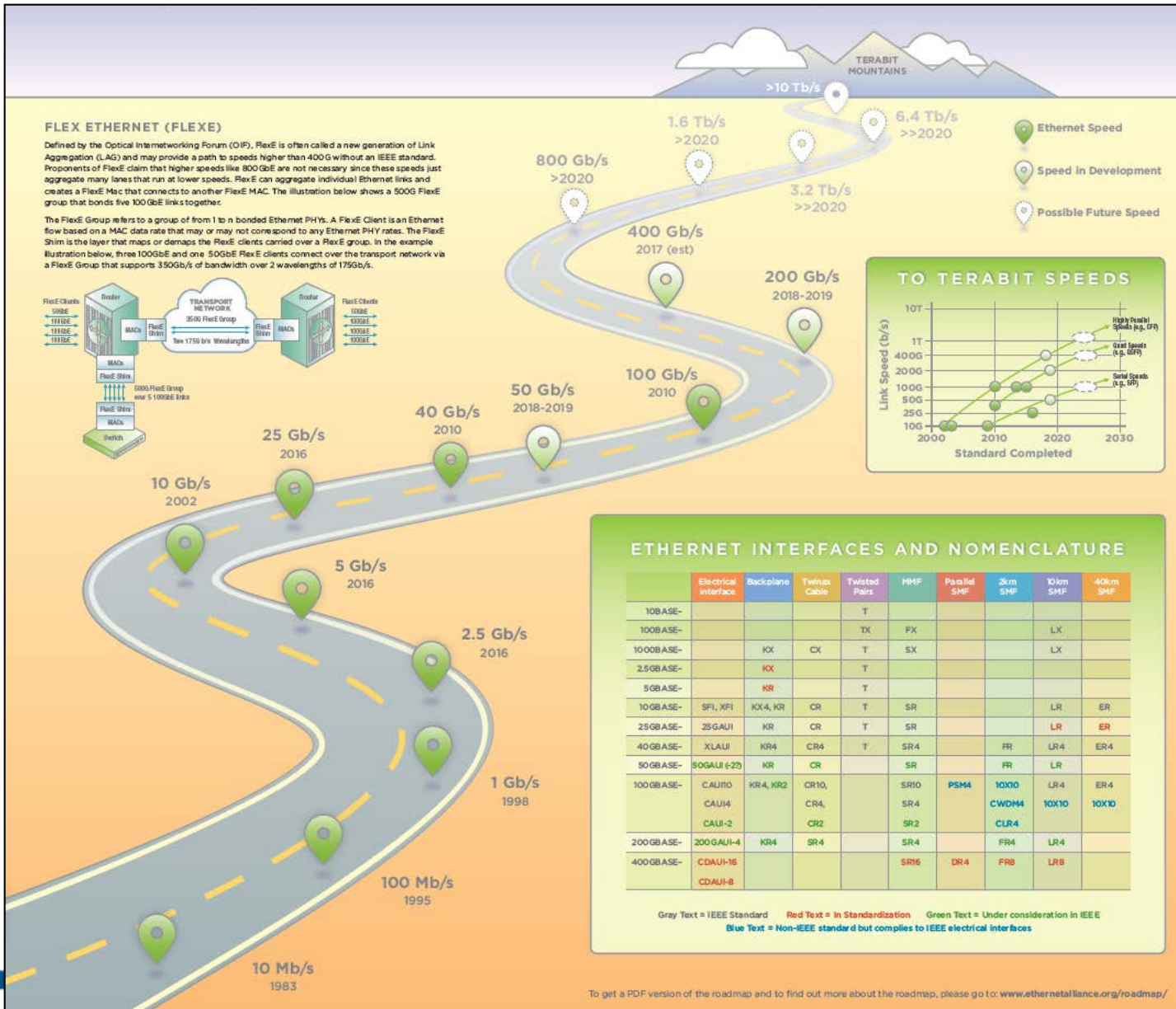


Source: Lamborghini

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# Do you still have the overview?

10Mb/s – 1983  
 100Mb/s – 1995  
 1Gb/s – 1998  
 10Gb/s - 2002





# Applications Roadmap for Ethernet

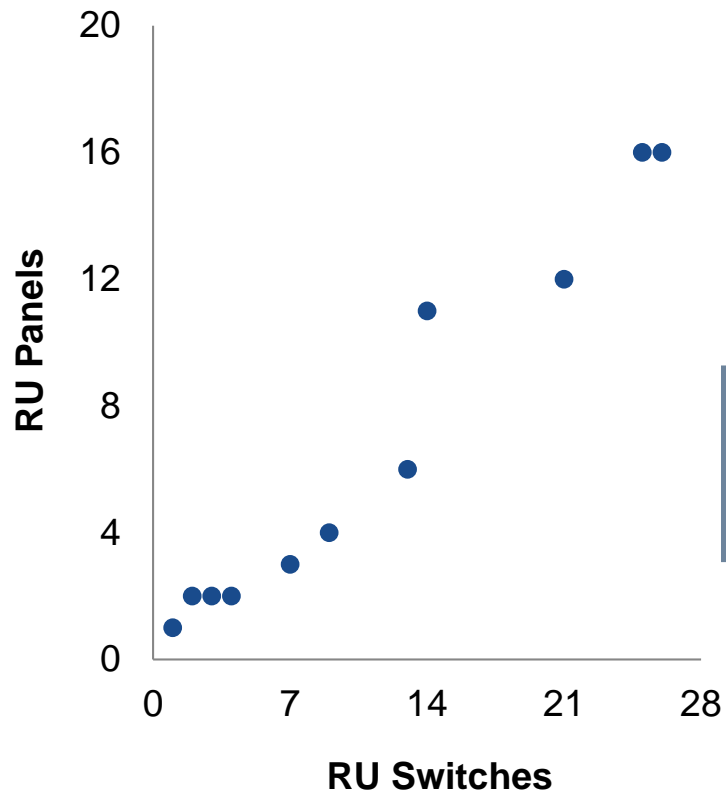
Maturity	Data rate	10G Parallel	25G Parallel	10, 25, 50G WDM	50G WDM & Parallel
2011-2018	40G	MPO		LC-duplex	
2011-2018	100G	MPO24	MPO	LC-duplex	
2018-2020	200G			LC-duplex	
2019-2021	400G		MPO32		MPO



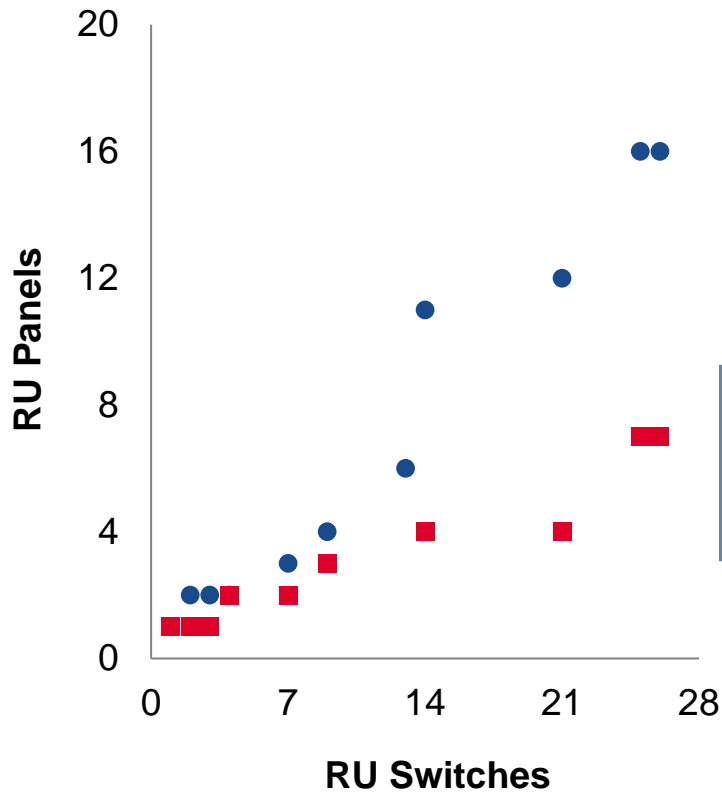
# Applications Roadmap for Fibre Channel

Maturity	Data rate	14G	28G	56G	28, 56G WDM	28, 56G Parallel
2011	16GFC	LC-duplex				
2016	32GFC		LC-duplex			
2019	64GFC			LC-duplex		
2016	128GFC				LC-duplex	MPO
2019	256GCF				LC-duplex	MPO

# Space consumption for cabling



# Space consumption with UHD LC Panel (100+ LCD in 1RU)

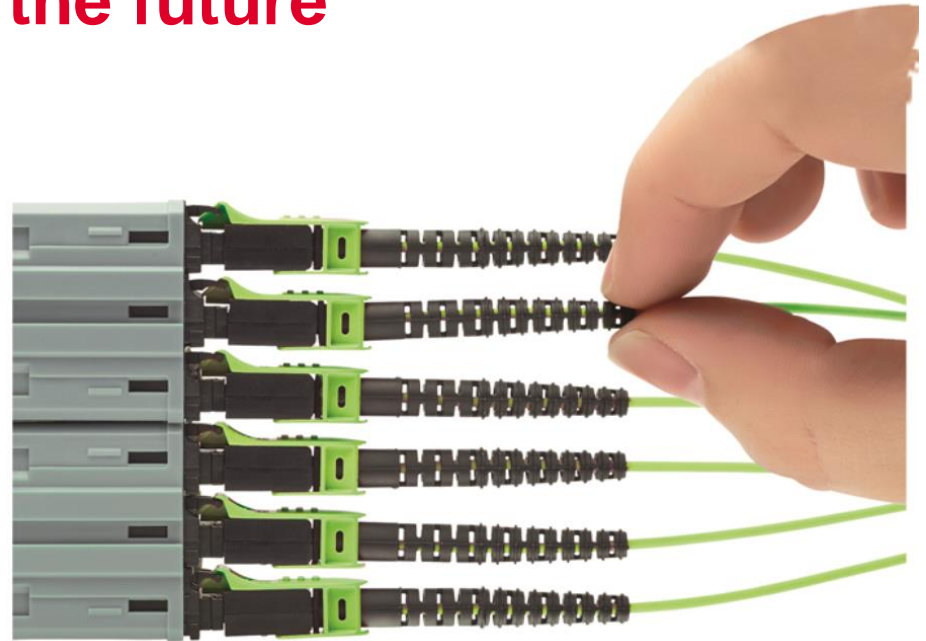


Up to  
60% less  
rack space

# Modularity with Ultra High Density Panel



# The connector of the past – now also available for the future



- Push-pull mechanism
- Uniboot 1.4mm twin-fiber cable
- Quick and easy polarity conversion

# IEC 61300

Definition IL/RL at R&M	Grade A*/1	Grade A*/2	Grade B/1	Grade B/2	Grade C/1	Grade C/2
Insertion loss (IL) 97%	≤ 0.15 dB	≤ 0.15 dB	≤ 0.25 dB	≤ 0.25 dB	≤ 0.50 dB	≤ 0.50 dB
Insertion loss (IL) typical value	≤ 0.07 dB	≤ 0.07 dB	≤ 0.12 dB	≤ 0.12 dB	≤ 0.25 dB	≤ 0.25 dB
Return loss (RL)	≥ 80 dB	≥ 50 dB	≥ 65 dB	≥ 45 dB	≥ 60 dB	≥ 45 dB
Typical	≥ 90 dB	≥ 55 dB	≥ 85 dB	≥ 55 dB	≥ 80 dB	≥ 55 dB
Laser power, inserted IEC61300-2-14, 500h, 23° C	≤ 2 W	≤ 300 mW	≤ 1 W	≤ 300 mW	≤ 500 mW	≤ 300 mW
Definition IL/RL at R&M	Grade D/3	Grade M/4				
Insertion loss (IL) 97%	≤ 1.00 dB	≤ 0.75 dB (100%)				
Insertion loss (IL) typical value	≤ 0.50 dB	≤ 0.35 dB				
Return loss (RL)	≥ 35 dB	≥ 26 dB				
Typical	≥ 45 dB	≥ 35 dB				

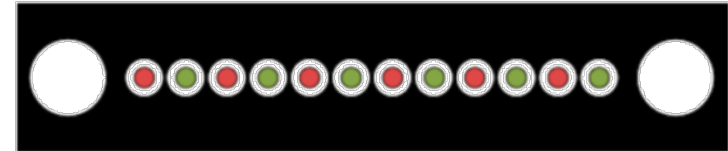
*IL test according to IEC61300-3-34, RL test according to IEC61300-3-6.*

# MPO is still good

## ..... Trunking

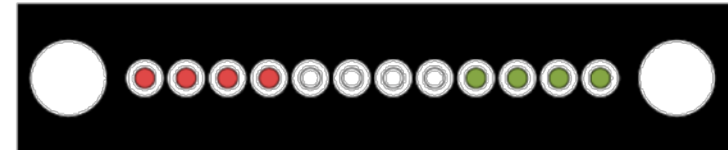
- **Multiple 10G**

- Used: 6x duplex per row
- Fiber arrangement of Rx & Tx depends on type of MPO-LC module – A, B or S



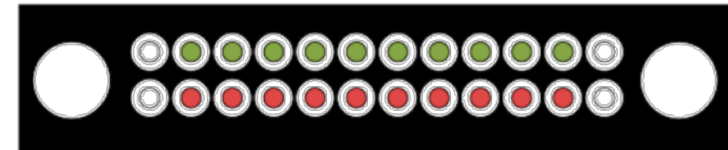
- **40G or 100G**

- Used 4x 10G or 4x 25G
- Fiber arrangement is standardized



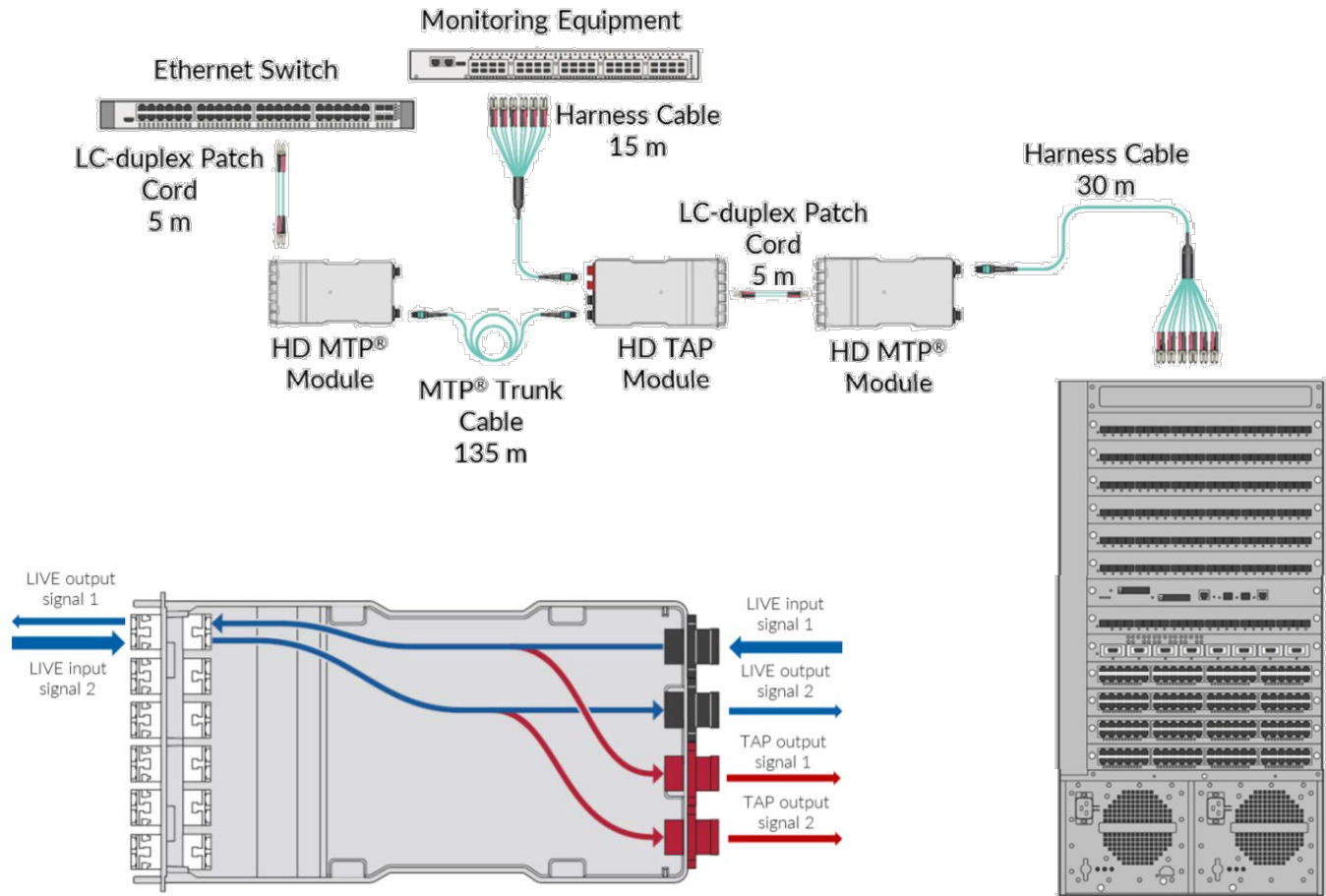
- **100G**

- Used 10x 10G
- Fiber arrangement is standardized





# MPO is still good ..... TAPs





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