Delivering100G .....and Beyond

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100G Access/Metro

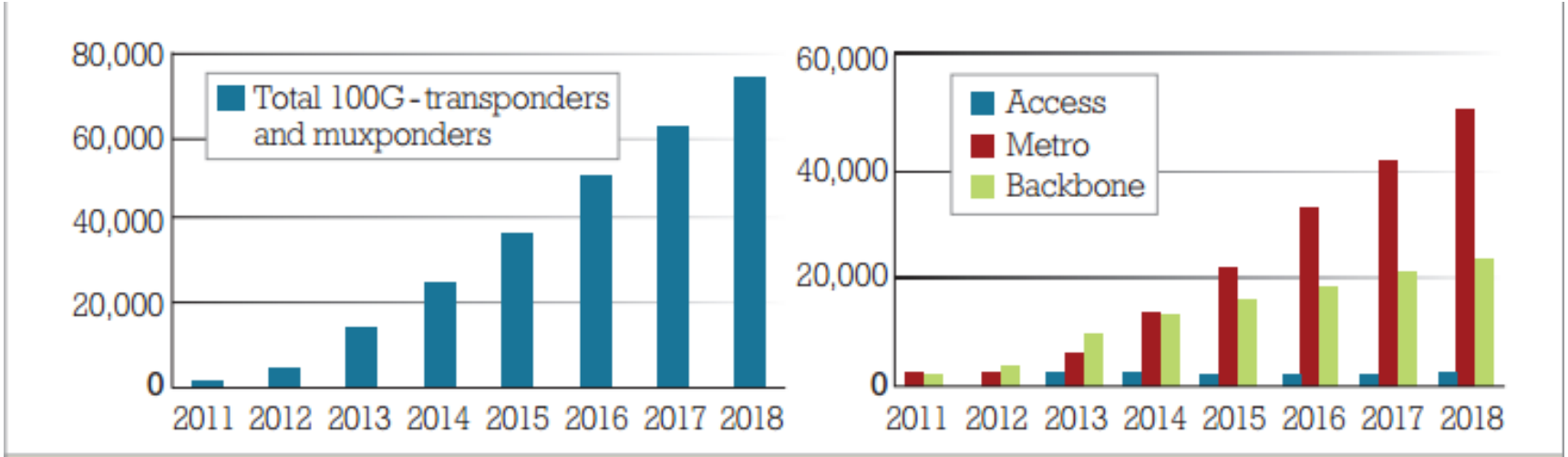
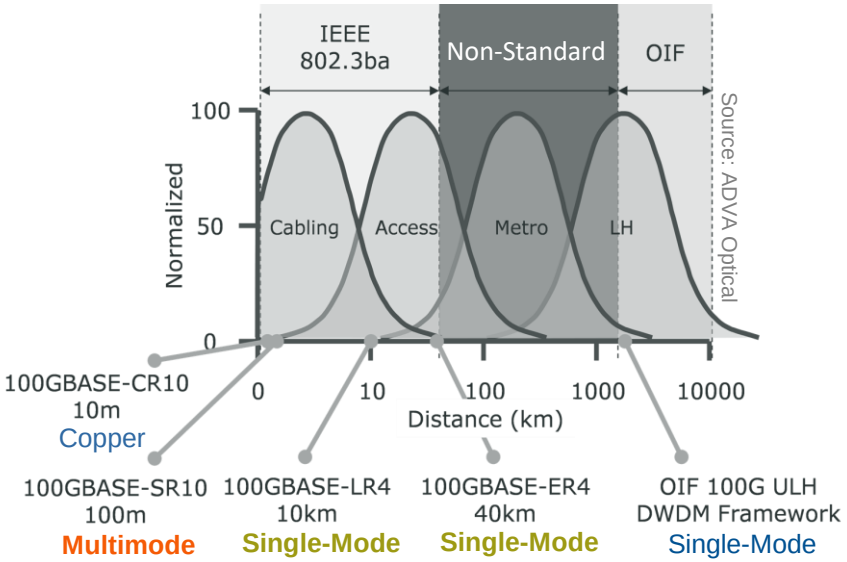


FIGURE 1. The growth of 100G deployments in metro networks is expected to ramp quickly in the next few years.

SOURCE: OVUM

Figures based on North America

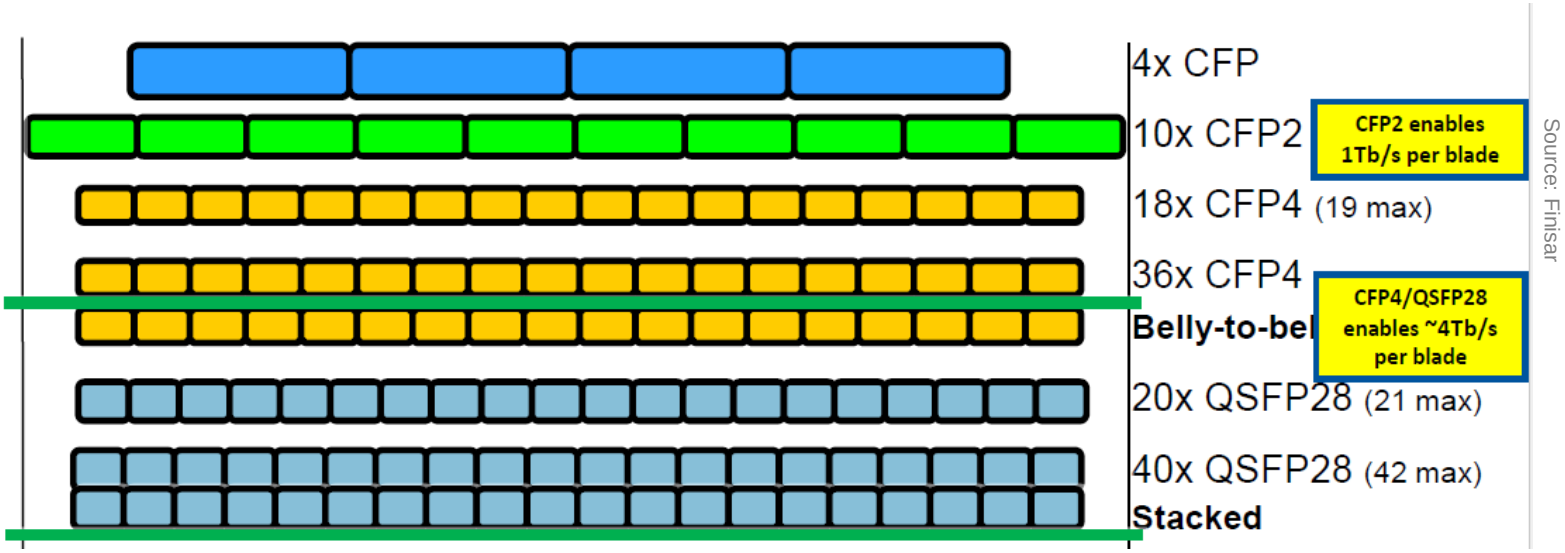
IEEE 100GbE Standards



Media Type	MMF		SMF	
Name	100GBASE-SR10	100GBASE-SR4	100GBASE-LR4	100GBASE-ER4
Standard	IEEE 802.3ba	IEEE 802.3bm	IEEE 802.3ba	IEEE 802.3ba
Electrical	10 x10Gb/s CAUI 10	4 x 25Gb/s CAUI 4	10 x 10Gb/s CAUI 10	10 x 10Gb/s CAUI 10
Reach	100m OM3/ 150m OM4	70m OM3/ 100m OM4	10km	40km
Fiber Count (Tx/Rx)	10	4	1	1
Lanes	1 850nm	1 850nm	4 1295.56nm 1300.05nm 1304.59nm 1309.14nm	4 1295.56nm 1300.05nm 1304.59nm 1309.14nm
Gb/s per lane	10Gb/s	25Gb/s	25Gb/s	25Gb/s
Connector	MPO/MTP	MPO/MTP	LC	LC

100GbE Form-Factor Evolution

- It is all about rack space, port density and power consumption



100GbE Form-Factor Evolution(2)

	CFP	CFP2		CFP4	QSFP28
Width	82mm	41.5mm		21.7mm	18.35mm
Power	<24W	<12W		9W	3.5W
Electrical	10 x10Gb/s CAUI 10	10 x 10Gb/s CAUI 10	4 x 25Gb/s CAUI 4	4 x 25Gb/s CAUI 4	4 x 25Gb/s CAUI 4
Variants	SR10, LR4, ER4	SR10, LR4, ER4		SR4, LR4, (CWDM4)	SR4, LR4, (PSM4,CWDM4)
Medium	MMF, SMF	MMF, SMF		MMF, SMF	MMF, SMF

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100GbE Non-Standard MSAs

	SWDM Alliance	PSM4 MSA	CWDM4 MSA	CLR4 Alliance	OpenOptics MSA
Form-Factor	QSFP28	CFP4, QSFP28	CFP4, QSFP28	QSFP28	QSFP28
Media	MMF	SMF	SMF	SMF	SMF
Reach	100m OM4	500m	2km	2km	>2km
Fiber Count (Tx/Rx)	1	4	1	1	1
Lanes	4 851nm, 881nm, 911nm, 941nm	1 1310nm	4 1271nm, 1291nm, 1311nm, 1331nm	4 1295nm, 1300nm 1304nm, 1309nm	4 (-32) 1504 to 1566 (200GHz spacing)
Gb/s per lane	25Gb/s	25Gb/s	25Gb/s	25Gb/s	25Gb/s

100G Ethernet Access

Figure 1: Video, Mobility and Cloud are helping to drive around 40% annual growth in internet demand

Cost per bit

Flexibility

Metro-Cloud Interconnect *Requirements*

Reach

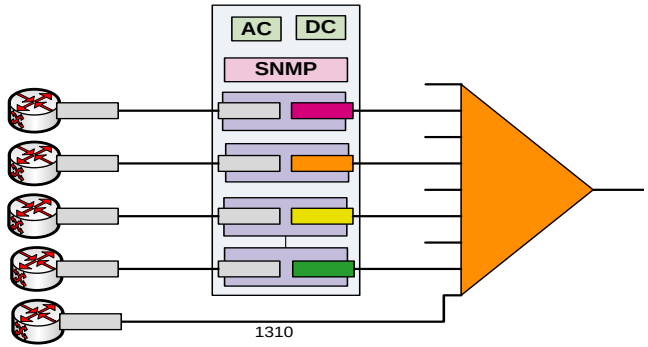
Power

Capacity

Passive 100G Transport

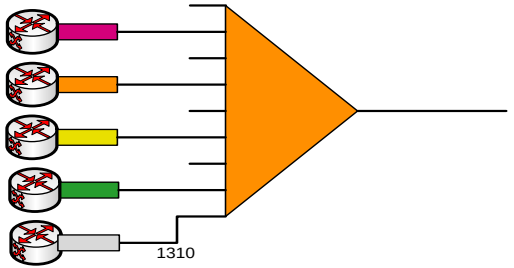
ACTIVE

- Conversion from client (“grey transceivers”) to line (“colored transceivers”) signals by transponder cards
- Since being “active” a chassis with power and management (SNMP) is needed
- Flexible but complex

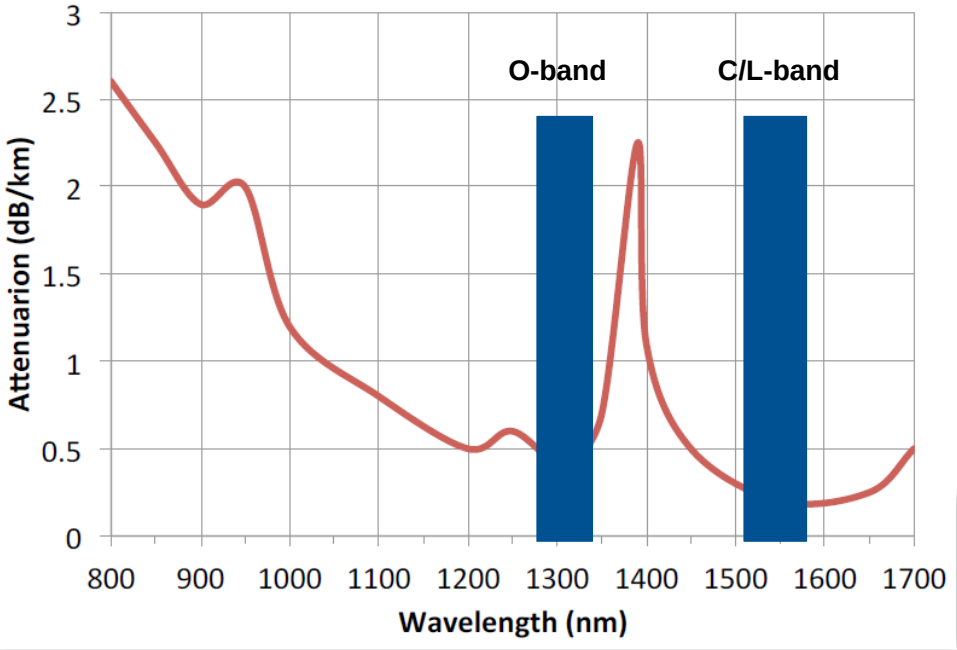


PASSIVE

- No conversion, transport transceivers are plugged straight into terminal equipment
- Less active elements => higher reliability, less latency
- Transceivers are managed by terminal equipment (Switch, DSLAM, etc.)

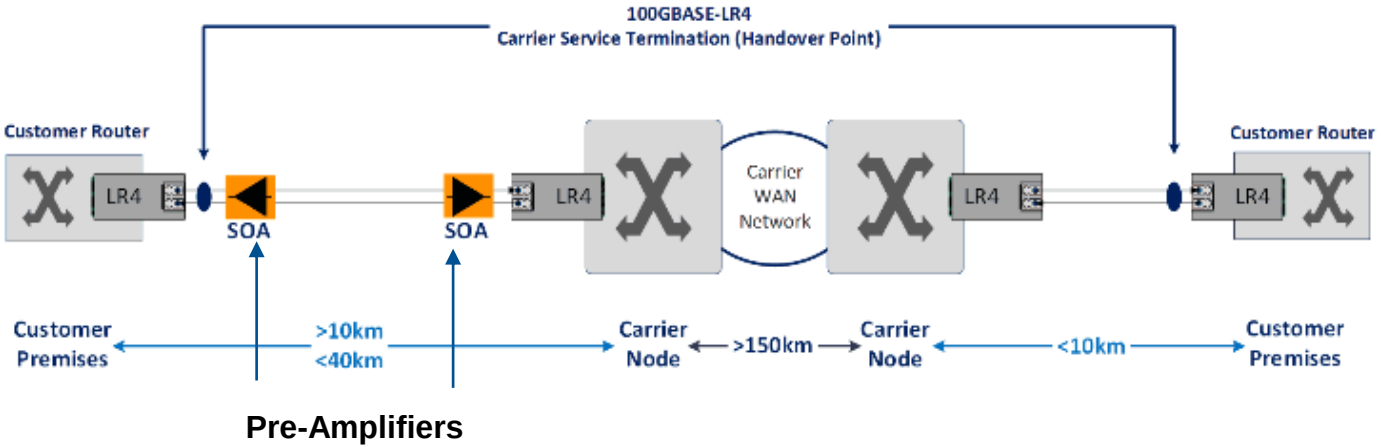


Transmission Windows

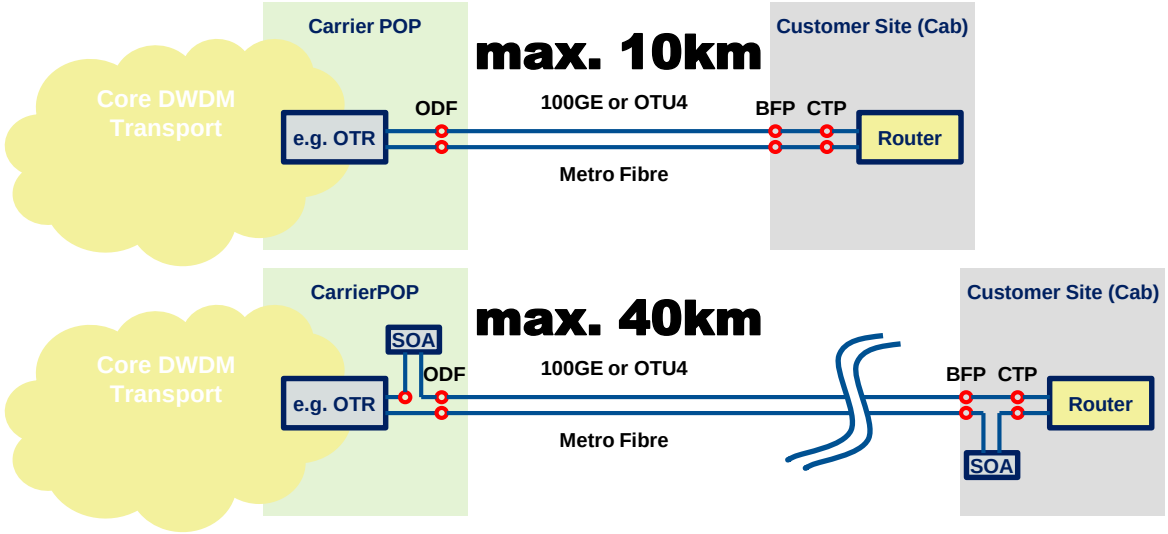


You can also pre-amplify in O Band

Extend Reach 100G



…but some issues



Can use wideband 1310nm pre-amps to go up to 40km but:

- Often there are too many patches/connectors in the path which results in failure or biterrors
- Customers expect up to 10km (at least few km) reach from CTP handover point, but that‘s not feasible as SOA is a Pre-amp and need to sit very close to Rx Transceiver input!
- SOA can only deliver LR4, but not other 100GE (OTU4) interfaces like SR4, CWDM4 etc.

Causes Delay =

Extra cost

Alternatives

- For 1G and 10G Ethernet there are good – and affordable! – solutions on the market:
- They have a rich flavor of OAMP functions, can be managed out- or in-band, can be used for traffic monitoring, statistics, troubleshooting, and many more functions.
- For a reason they are called the Swiss Army Knife of Ethernet working...

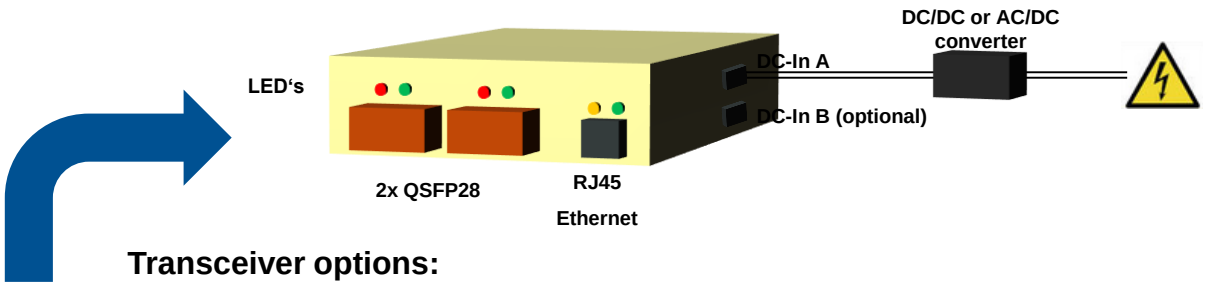
- But to be considered, these are Layer2 devices. L2 switching/bridging at reasonable cost is possible at 1G and 10G level.
- **No 100G versions on the horizon in next 2...3 years.**
- non-Ethernet interfaces like OTU2/2e (11G) or OTU4 (112G) not supported.

For 100G, pizza boxes are available from Adva, Ciena, Coriant, Infinera etc.

Those units are designed for a different application:

- DataCenter to DataCenter interconnect – not for Operator use with extended fibre
- Muxponder/Transponder, but not simple/pure interface conversion or demarcation
- Typical 1x Line and 1x or Nx Client, but not Client/Client
- Usually work in back2back only i.e. 2 devices required
- On the line side usually coherent 100G nowadays, with reach of >1000km
- Capacity usually 200G or 400G minimum today (1x/2x 16QAM)
- Not optimised for simple 100G extensions – technical and commercial overkill
- Issues with space & power in the node, as well as at customer premises/demarc site
- **Cost are too high – 40...60k€ or more**

A simple 100GE Access NID



Transceiver options:

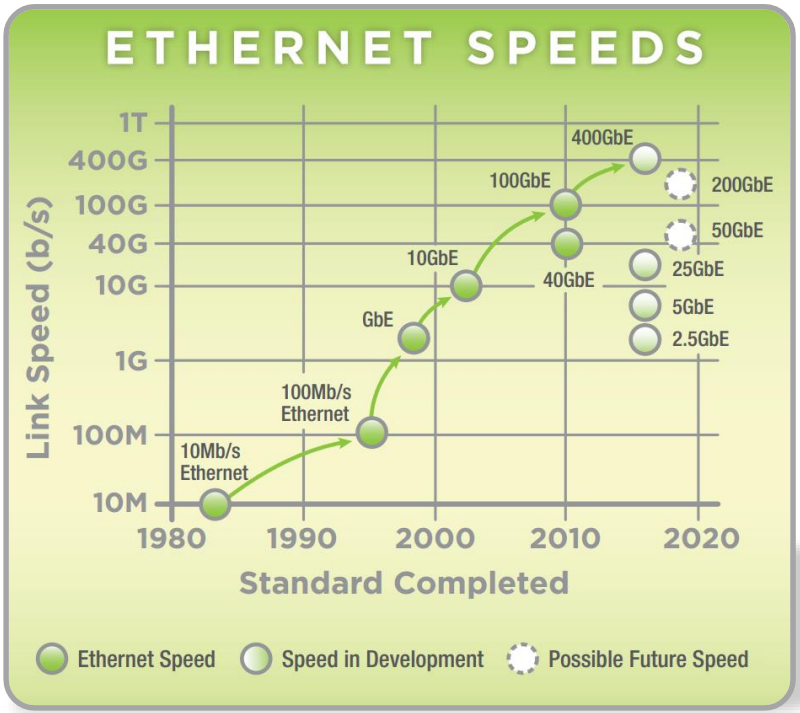
1) 100GBase-LR4 / OTU4 Multirate – day1 support for most use cases without SOA (10km) or with SOA (40km)

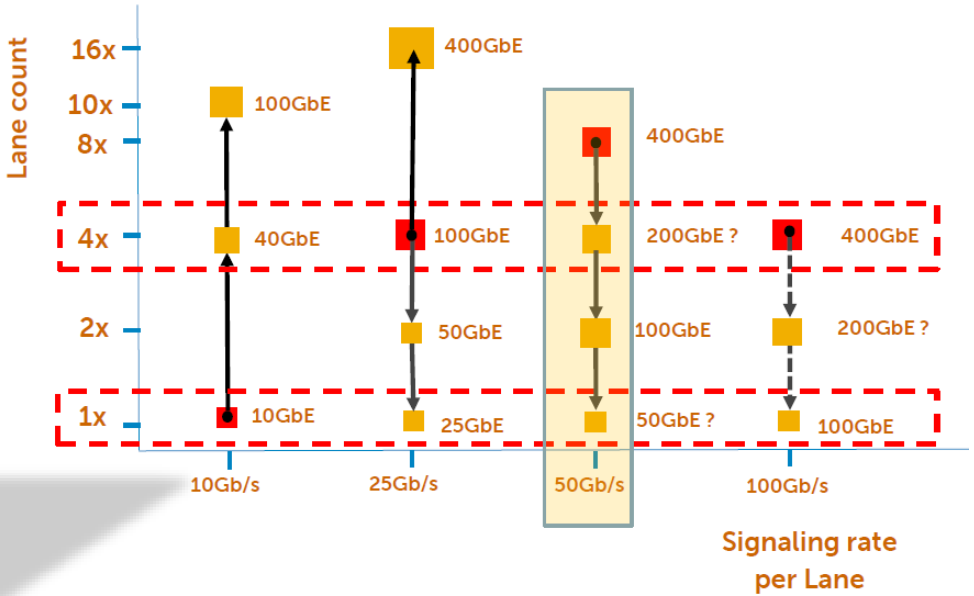
2) 100GBase-SR4 (Single- or Multirate) – for interface conversion or low cost interconnect with system hardware (short reach ~100m ribbon MM)

3) CWDM4 optics – low cost interconnect and data center applications Supported by carrier system vendors (short reach 2km single mode)

4) ER4-lite – medium cost for up to 25km links without SOA, interesting option back2back or – if system vendor supports it – in conversion mode

Future Ethernet Speeds





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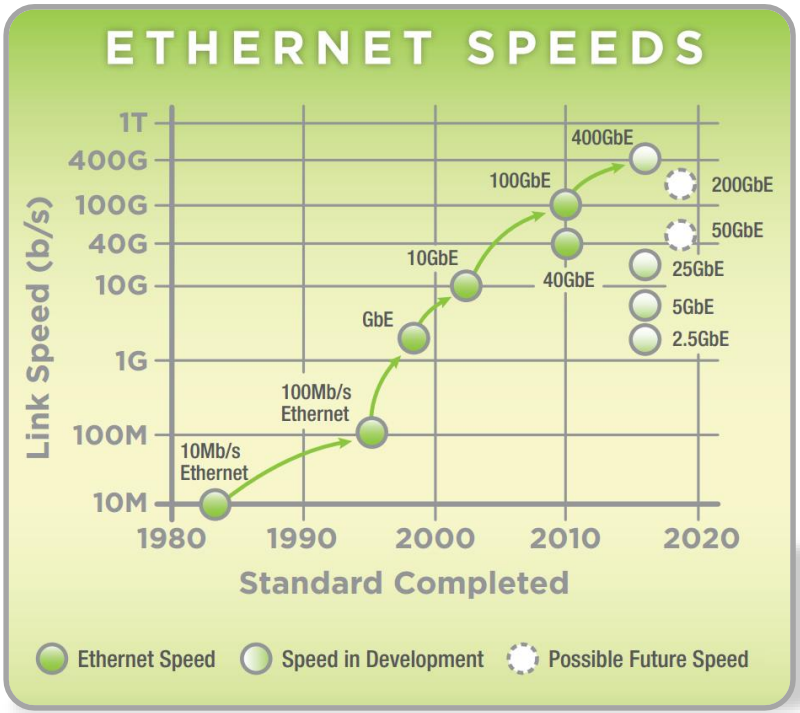
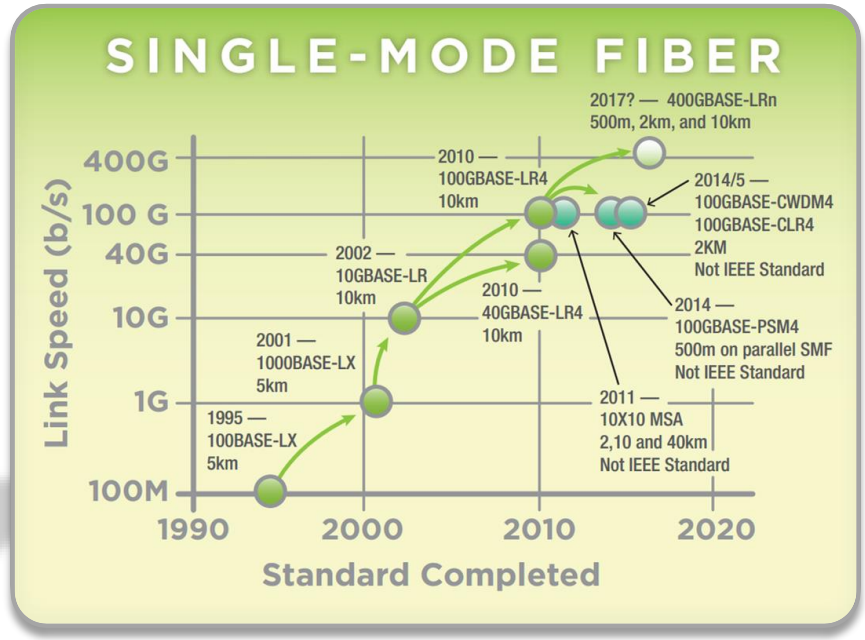
Future Ethernet Speeds(2)





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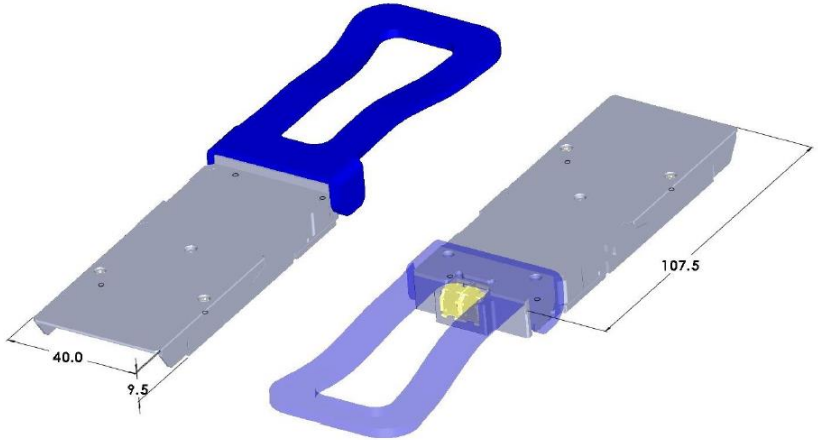
Future Spectrum of 200G and 400G Optics

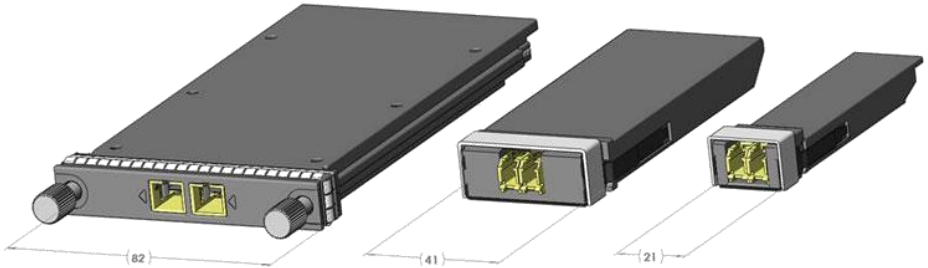
Media	MMF				SMF					
Name	200G SR4	200G SWDM4	400G SR4.2	400G SWDM8	200G-PSM4	200G LR4/FR4	400G PSM4.2	400G LR8/FR8	400G PSM4	400G FR4
Reach	150m	100m	100m	70m	500m	10km/2 km	500m	10km/ 2km	500m	2km
Fiber Count (Tx/Rx)	4	1	4	1	4	1	4	1	4	1
Lambda	1	4	2	8	1	4	2	8	1	4
Gb/s per lane	50Gb/s	50Gb/s	50Gb/s	50Gb/s	50Gb/s	50Gb/s	50Gb/s	50Gb/s	100Gb/s	100Gb/s

* Still in discussion

400GbE New Form Factors

400GBASE-FR8/LR8 SMF Duplex LC CFP8





CFP | **CFP2** | CFP4

Conclusion

- 100Gbps will be here sooner than you think
- 100G switches moving towards higher port density with CFP2, CFP4 and QSFP28 optics
- 200G and 400G Ethernet speed in development to meet the continuous traffic demand
- It‘s a fragmented market, with no clear winner.

Talk with Huber+Suhner Cube Optics and feel…….

Thank you for your attention.

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