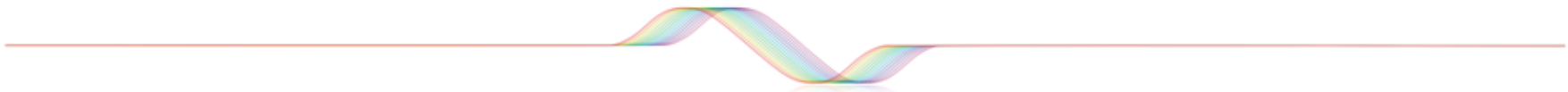
„Když desítka nestačí“

Když 10 Gbit/s v metropolitní síti nestačí

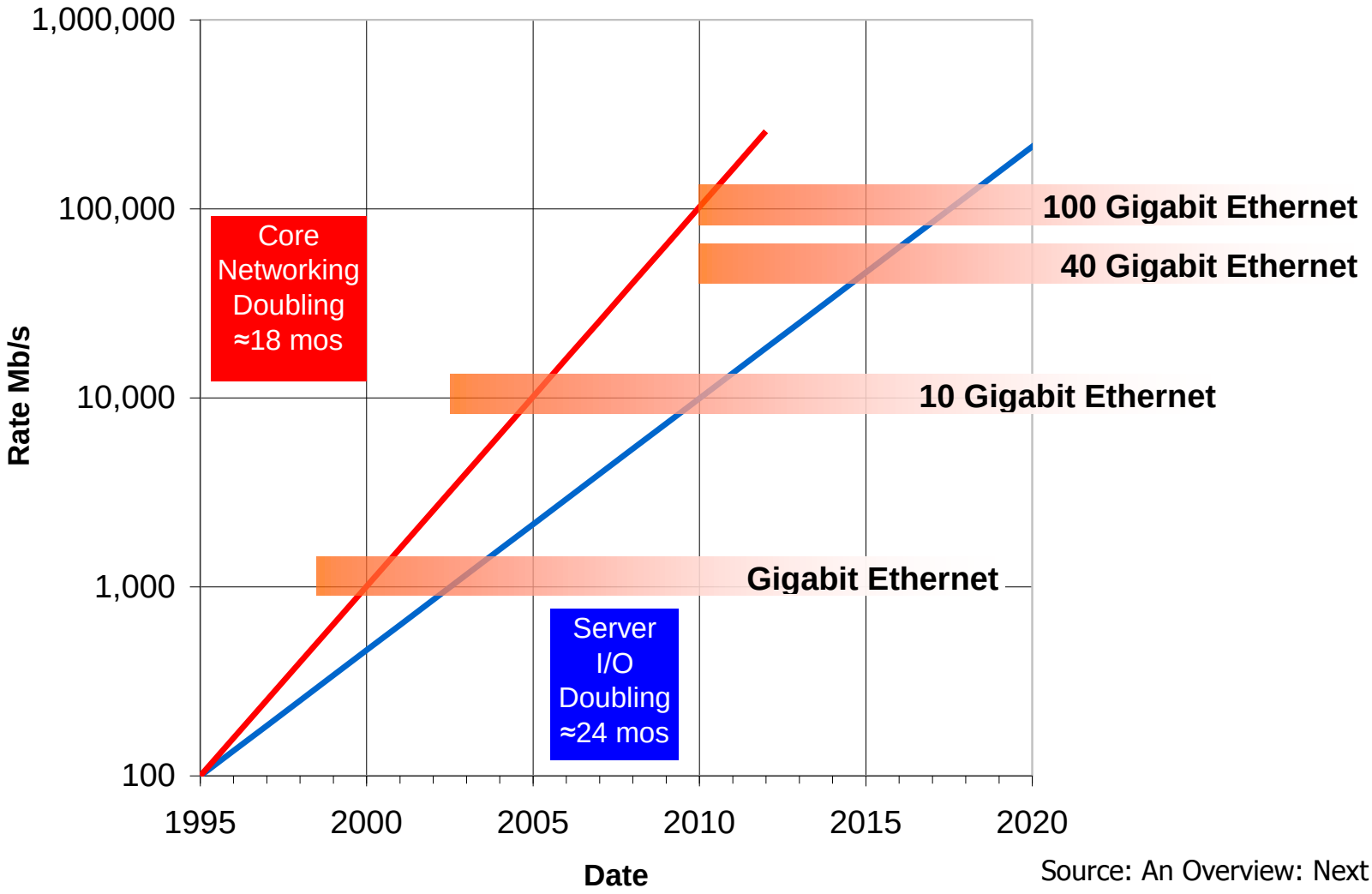
Parametry rozhraní 40G a 100G

Ing. Jaromír Šíma

FTTx 2016 Brno



Potřebujeme 40/100Gbit/s ?



Source: An Overview: Next Generation of Ethernet – IEEE 802 HSSG_Tutorial_1107

100G bit/s standardizace

- **IEEE 802.3ba – 100G Ethernet**
  - 2006 založena pracovní skupina IEEE HSSG (Higher Speed Study Group) , dále od 2008 IEEE 802.3ba
  - Práce na 40G Ethernet a 100G Ethernet rozhraních
    - http://www.ieee802.org/3/ba/public/index.html
- **Ethernet Alliance**
    - http://www.ethernetalliance.org/
- **OIF**
  - **OIF 100G DWDM Transmission Project**
  - OIF's The Physical and Link Layer (PLL) Working Group
- **ITU-T**
  - Study Group 15 (SG 15)
  - Nové verze OTN rozhraní OTU-4, OTU-5, …

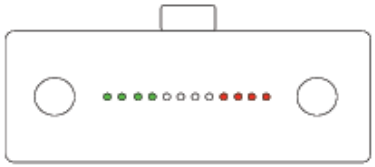
IEEE 802.3 40G a 100G

• 40GBASE-KR4	1 m	backplane
• 40GBASE-CR4	7 m	copper cable
• 40GBASE-SR4	100/150 m	OM3/OM4
• 40GBASE-FR	2 km	OS1/OS2
• 40GBASE-LR4	10 km	OS1/OS2

• 100GBASE-CR10	7 m	copper cable
• 100GBASE-SR10	100/150 m	OM3/OM4
• 100GBASE-SR4	70/100 m	OM3/OM4
• 100GBASE-LR4	10 km	OS1/OS2
• 100GBASE-ER4	40 km	OS1/OS2

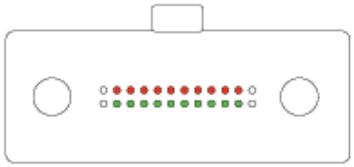
MPO/MTP konektory pro 40/100GE

40/100GBASE-SR4



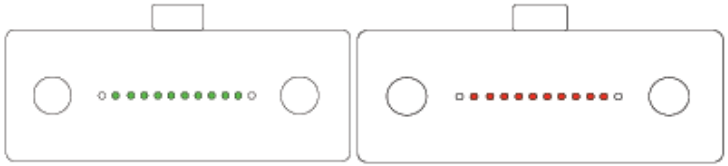
Left 4 pins are Tx
Right 4 pins are Rx
(inner 4 pins unused)

100GBASE-SR10



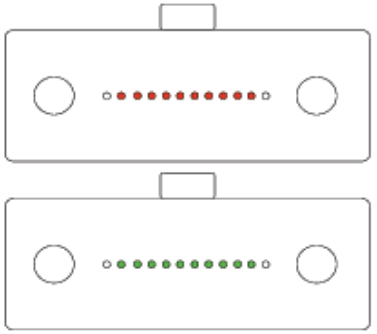
Inner 10 pins, Top Row are Rx
Inner 10 pins, Bot Row are Tx
(outermost pins both rows unused)

Option A
(recommended)



Inner 10 pins, Left Side are Tx
Inner 10 pins, Right Side are Rx
(outermost pins each side unused)

Option B



Inner 10 pins, Top are Rx
Inner 10 pins, Bot are Tx
(outermost pins Top & Bot unused)

Option C

Ethernet singlemode 40G

- **40GBASE-LR4 2 m až 10 km**
  - Čtyři vlnové délky á 10 GBit/s
  - CWDM rastr 1270/1290/1310/1330 nm

87.6 Wavelength-division-multiplexed lane assignments

The wavelength range for each lane of the 40GBASE–LR4 PMD is defined in Table 87–5. The center wavelengths are members of the CWDM wavelength grid defined in ITU-T G.694.2 and are spaced at 20 nm.

Table 87–5—Wavelength-division-multiplexed lane assignments

Lane	Center wavelength	Wavelength range
L_0	1271 nm	1264.5 to 1277.5 nm
L_1	1291 nm	1284.5 to 1297.5 nm
L_2	1311 nm	1304.5 to 1317.5 nm
L_3	1331 nm	1324.5 to 1337.5 nm

Zdroj: IEEE

Ethernet singlemode 100G

- **100GBASE-LR4** **2 m až 10 km**
- **100GBASE-ER4** **2 m až 30 (40) km**
  - Čtyři vlnové délky á 25 Gbit/s
  - DWDM rastr, odstup 800 GHz

88.6 Wavelength-division-multiplexed lane assignments

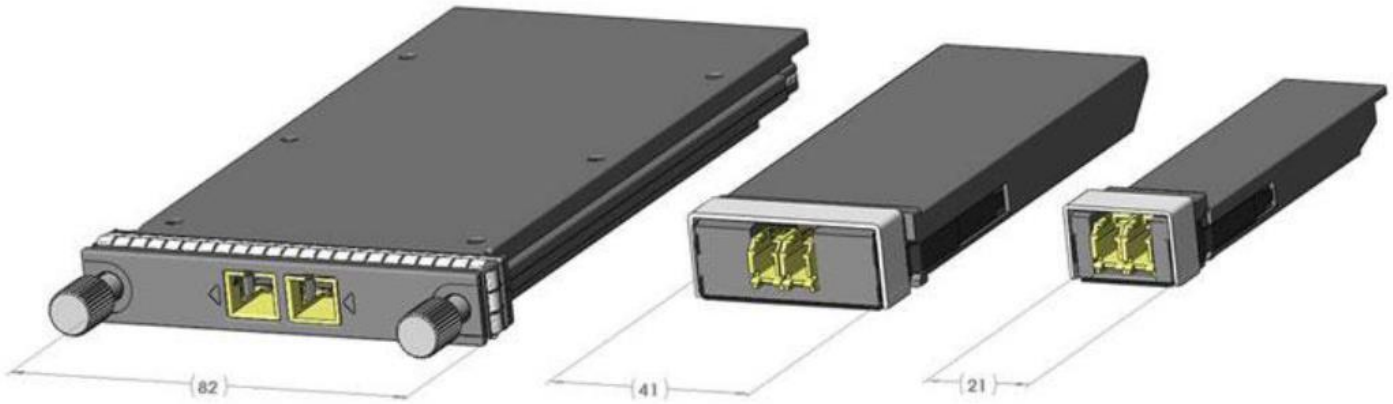
The wavelength range for each lane of the 100GBASE–LR4 and 100GBASE–ER4 PMDs is defined in Table 88–5. The center frequencies are members of the frequency grid for 100 GHz spacing and above defined in ITU-T G.694.1 and are spaced at 800 GHz.

Table 88–5—Wavelength-division-multiplexed lane assignments

Lane	Center frequency	Center wavelength	Wavelength range
L_0	231.4 THz	1295.56 nm	1294.53 to 1296.59 nm
L_1	230.6 THz	1300.05 nm	1299.02 to 1301.09 nm
L_2	229.8 THz	1304.58 nm	1303.54 to 1305.63 nm
L_3	229 THz	1309.14 nm	1308.09 to 1310.19 nm

Zdroj: IEEE

Transceivery 40G a 100G

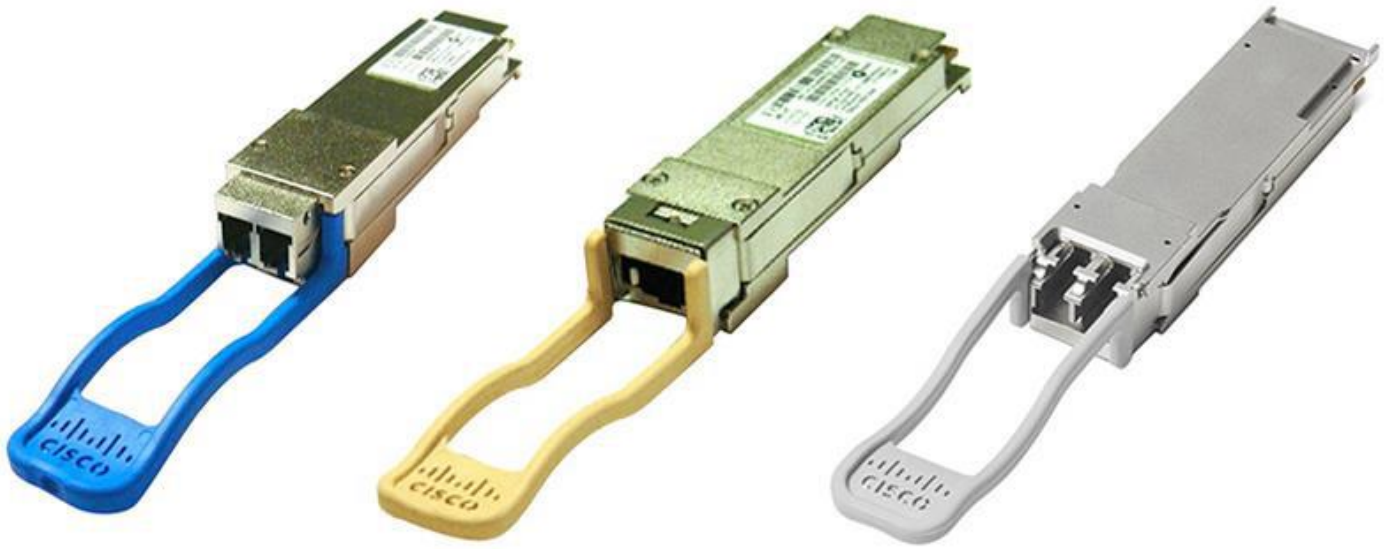


Module Type	CFP	CFP2	CFP4	QSFP28
LC port electrical I/O	10x10G	10x10G 4x25G	4x25G	4x25G
1 RU slot 100G ports	4 (single row)	8 (single row)	32 (belly-to-belly)	36 (double row)
MPO ports electrical I/O		8x50G	4x50G	
1 RU slot 100G ports		32 (single row)	64 (belly-to-belly)	

Zdroj: Finisar

QSFP+ Transceivery

- **Cisco 40GBASE-SR4**
- **Cisco 40GBASE-LR4, LR4 Lite - 2 km**
- **Cisco 40GBASE-cSR4 300m/400m OM3/OM4**

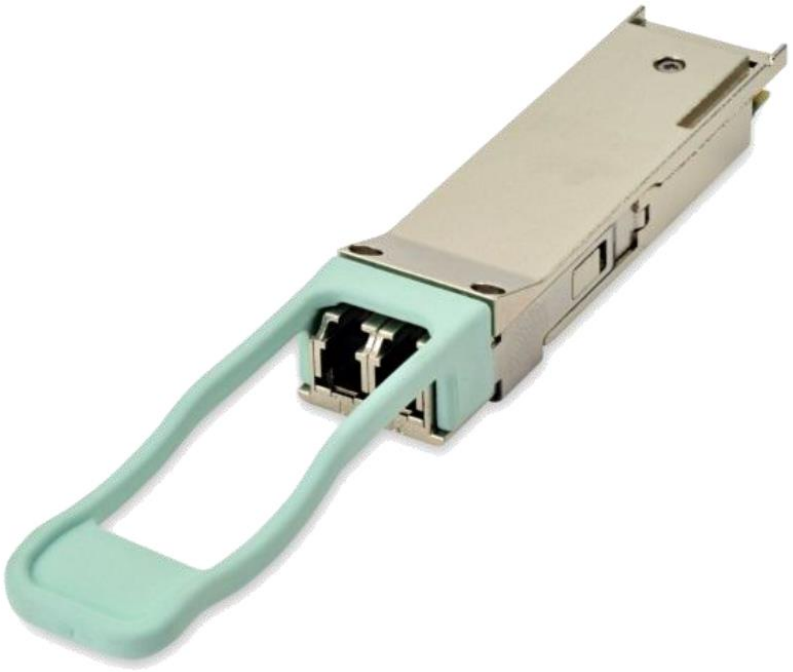


Zdroj:

Finisar univerzální QSFP+

- 40GE Universal LM4 QSFP+ Optical Transceiver Module

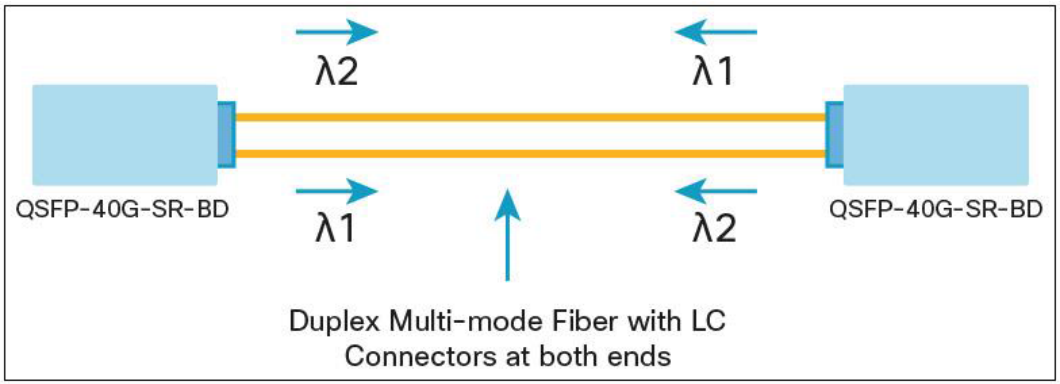
- **4x 10G CWDM**
- **140 m OM3**
- **160 m OM4**
- **1 km SMF**



Zdroj: Finisar

Cisco Bidi 40G QSFP+ transceiver

- **Cisco QSFP BiDi Transceiver (QSFP-40G-SR-BD)**
- **Bidi = 2x 20G, 2 vlákna, 850/900 nm**
- **100m OM3, 150m OM4**



Zdroj:

CFP transceiver

- **Verze 40GBit, 100Gbit**
- **Multimode nebo Singlemode standard (SR10, LR4, ER4)**

- **DWDM 10x10Gbit, cca 40 km**
- **DWDM 4x28G Tunable 30km (500km+ po zesílení)**
- **DWDM 100Gbit, C-band tunable, koherentní, > 800km**

Zdroj: Finisar

Finisar DWDM CFP2 transceiver

- 200G/100G Tunable C-Band CFP2-ACO Coherent Optical Transceiver
- 100G DP-QPSK / 200G DP-16QAM

Zdroj: Finisar

4x 100G passive cable QSFP28

Finisar CXP transceiver

- 300m OM3
- 100GBASE-SR10 100G Ethernet
- OTU4/OTU2e
- 12x 10G Ethernet (compatible)
- PCIe Gen1/2/3
- SATA/SAS3

Zdroj: Finisar

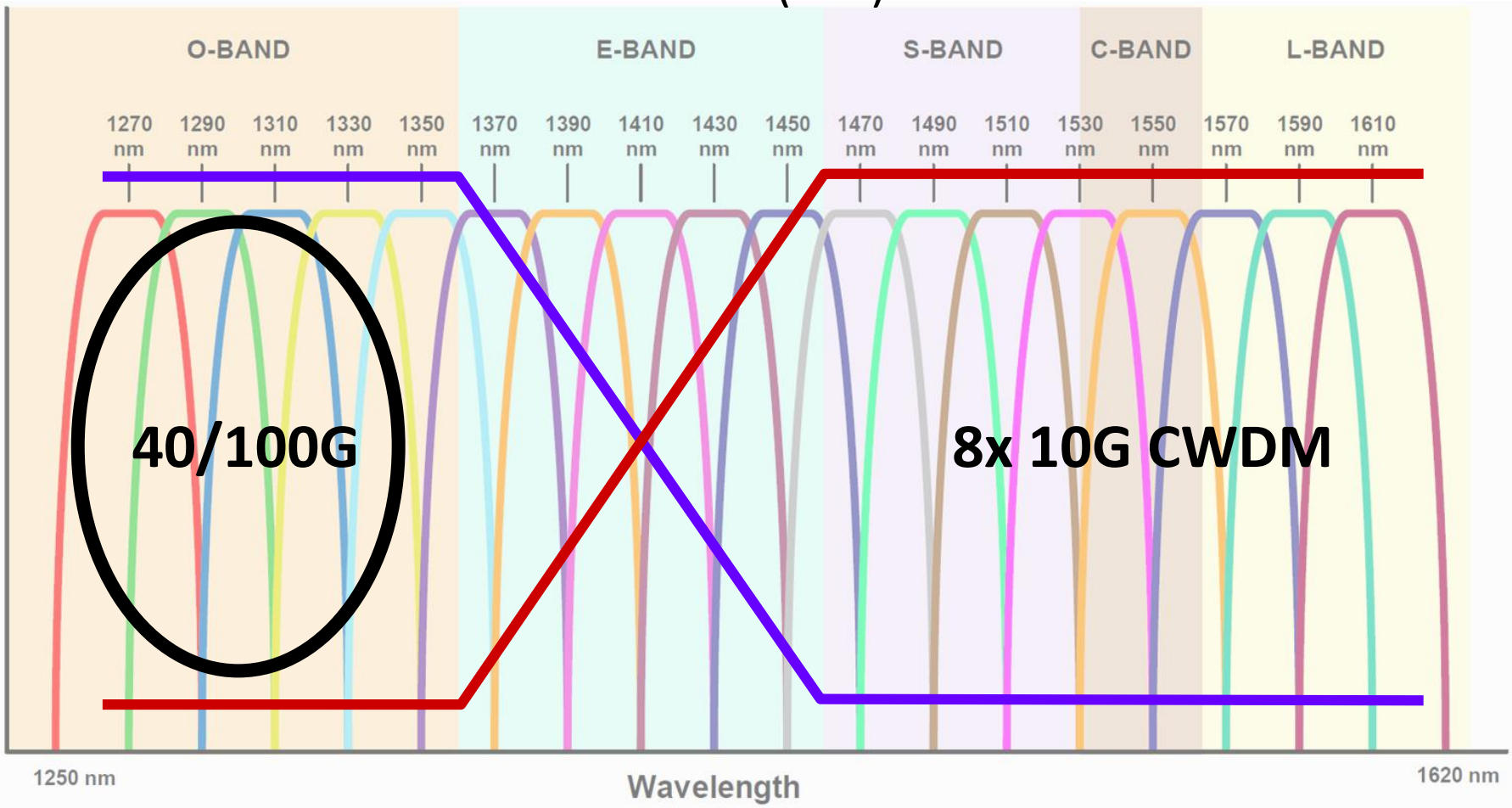
CISCO CPAK transceivery

- **Cisco CPAK 100GBASE-SR10 Module** — **150/100 m OM3/OM4 (2x 10 vl.)**
- **Cisco CPAK 100GBASE-LR4** — **10 km OS1/2**
- **Cisco CPAK 100GBASE-ER4 Lite** — **25 km OS1/2**
- **Cisco CPAK 10x10GBASE-LR** — **10 km OS1/2 (2x 10 vláken)**

Zdroj:

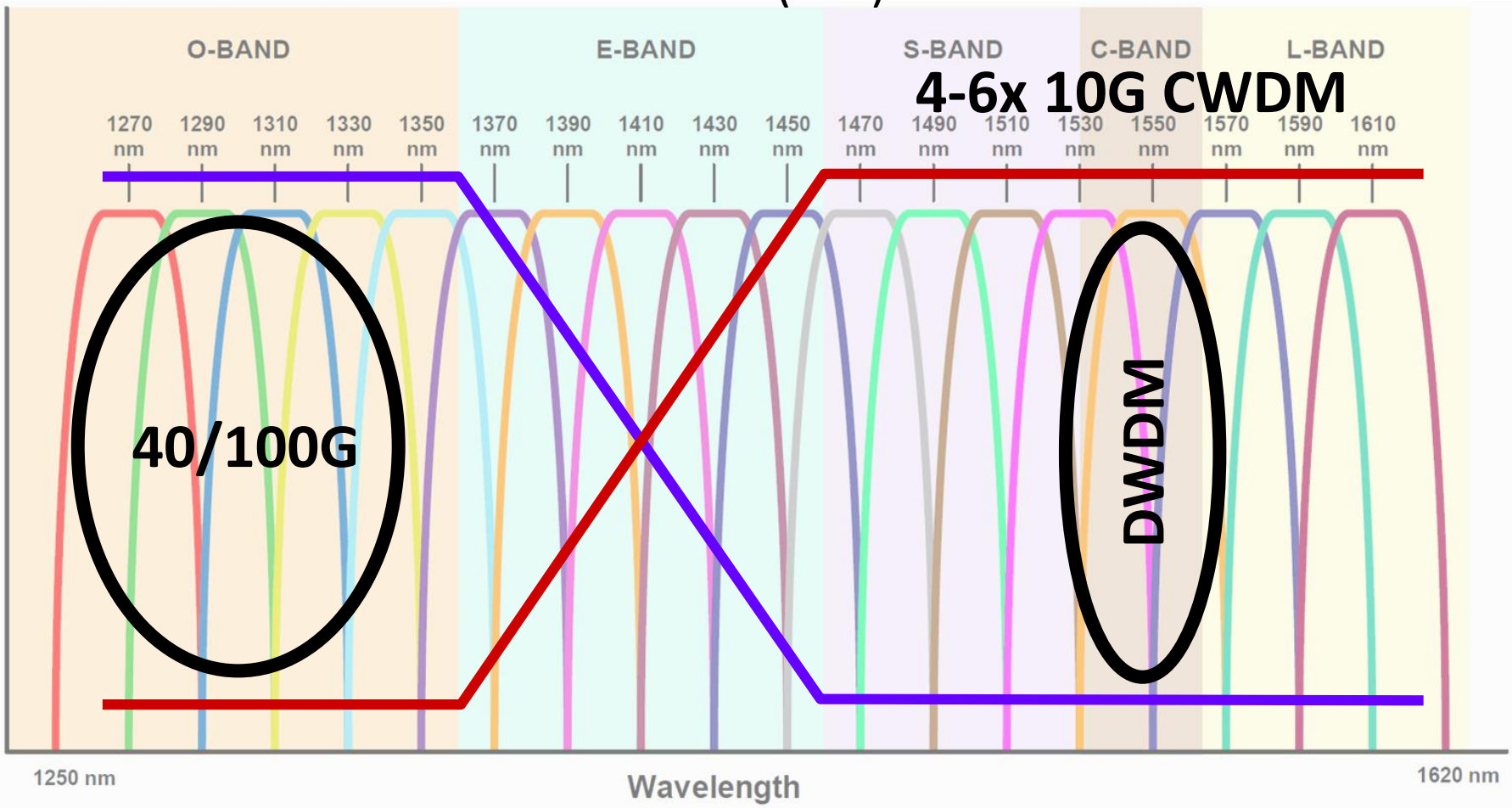
Aplikace 8x CWDM + 40/100G LR4

CWDM Filtr 1310 band (5ch) + 8ch



Aplikace C/DWDM + 40/100G LR4

CWDM Filtr 1310 band (5ch) + 8ch



Problém kompatibility rozhraní

- **Optické rozhraní transceiveru**
  - 100GBASE-SR10
  - 100GBASE-SR4
  - 100GBASE-LR4
  - 100GBASE-LR4 lite
  - 100GBASE-ER4
  - 100G DWDM 4x28G
  - 100G DWDM 10x10G
  - 100G DWDM DP-QPSK

Problém kompatibility rozhraní

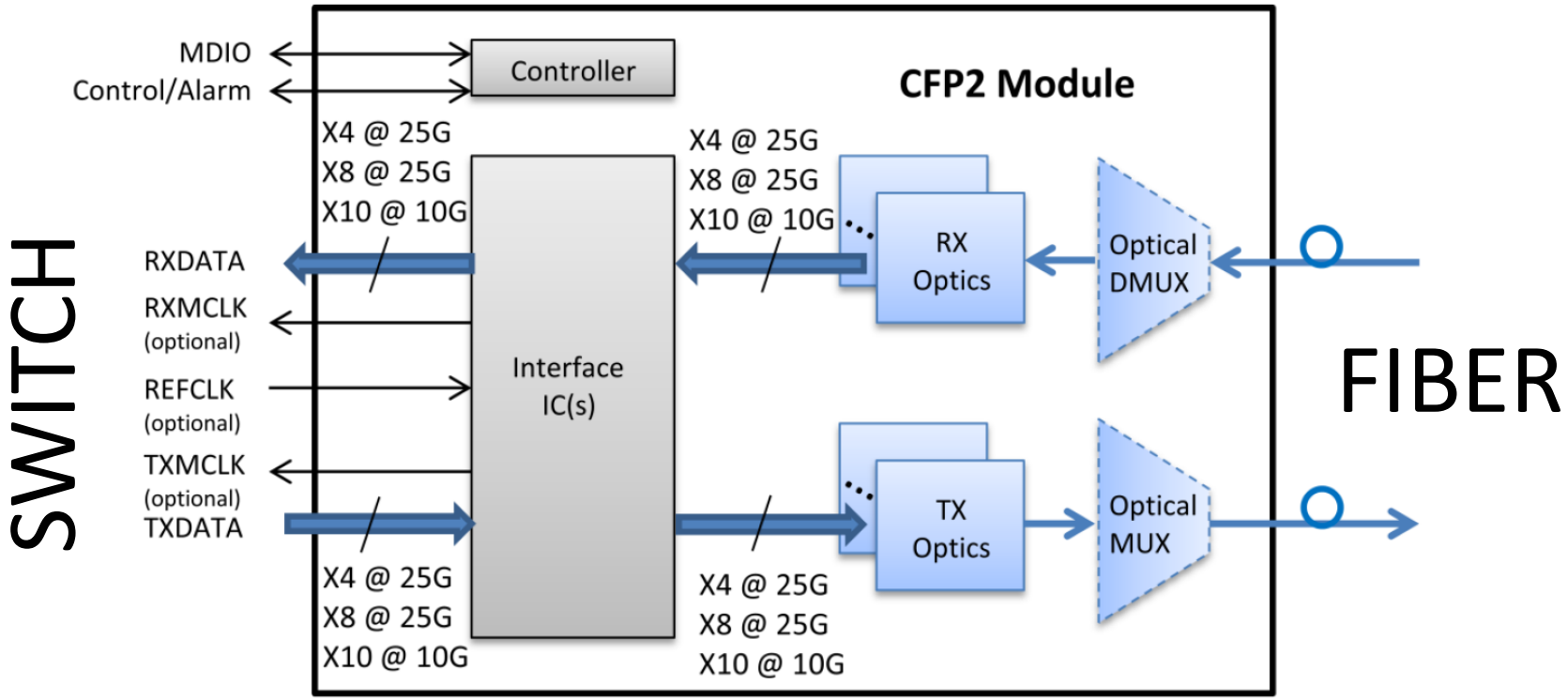
Transceiver	elektrické rozhraní (typu AUI nebo PPI)
QSFP+	4x10G
QSFP28	4x25G (CPPI-4 nebo také XLPPI)
CFP	10x10G, 4x10G (CAUI)
CFP2	4x 25G, 8x25G, 10x10G, 4x50G a 8x50G
	rozhraní CAUI-4 retimed, CPPI
CFP4	4x25G, (4x10G)
CFP8 (jako CFP2)	16x25G, 8x50G, 4x100G
CFP16 (jako CFP4)	8x50G

- CDP, … – pravděpodobně budou nahrazeny CFP8 a CFP16

- AUI – Attachment Unit Interface, PPI Parallel Peripheral Interface

CFP 2 transceiver

- **El. rozhraní 4x 25G, 8x25G, 10x10G, 4x50G a 8x50G**



Další vývoj Ethernetu ?

- **Další typy rozhraní pro 40G a 100G Ethernet (25G, 50G, 200G, …)**
- **IEEE P802.3bq 25G/40GBASE-T Task Force**
- **IEEE P802.3by 25 Gb/s Ethernet Task Force**
- **IEEE P802.3ca 25 Gb/s, 50 Gb/s, and 100 Gb/s Ethernet Passive Optical Networks Task Force.**
- **400 Gbit/s Ethernet**
  - IEEE P802.3bs 400 Gb/s Ethernet Task Force
  - http://www.ieee802.org/3/bs/
  - Očekávaný standard v roce 2016/2017
  - Verze 8x50G, 4x100G, 2x200G, …
  - Další typy transceiverů – CFP8, CFP16, CDP, CDP2, CDP4, CDFP, QSFP56
- **1 Terabit/s Ethernet**
  - 20x50G, 10 x 100G, … ??
- **1,6 1 Terabit/s Ethernet**
  - 16x 100G, 8x200G, 4x400G, … ??