



Problematika vysokorychlostních transceiverů

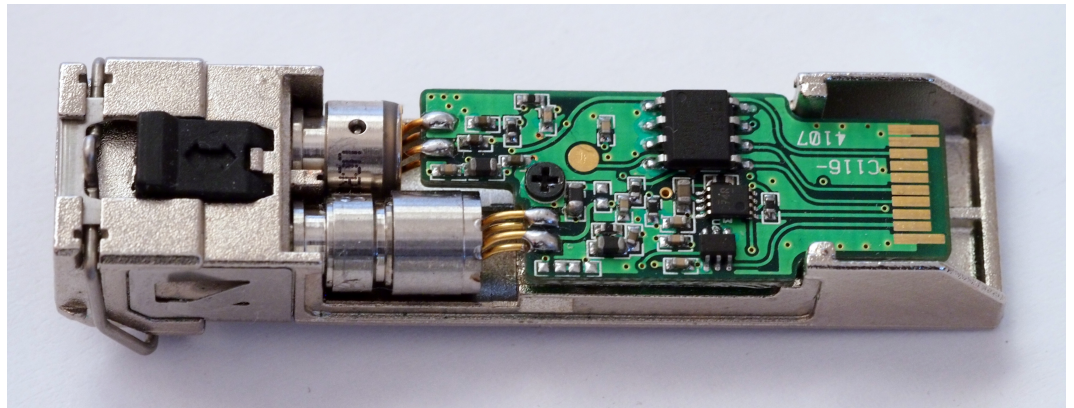
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KKTS Plzeň 2016



Transceiver

- **Transmitter + Receiver = Transceiver**
- **Typy – výměnný / nevýměnný ... pluggable / fix**
 - Např SFP nebo SFF
- **Metalické nebo optické rozhraní**
- **Přenosová rychlost**
- **Typ pouzdra**
- **Typ konektoru**
- **ROSA**
- **TOSA**



Co mne může zajímat?

- Typ fotodiody – PIN, APD
- Typ laseru – VCSEL, FP, DFB, EML
- Vlnová délka
- Rychlost – přenosový protokol

- „Maximální“ vzdálenost
 - Power Budget – vložný útlum k dispozici
 - Disperze

- Příkon (Level I, Level II, Level III, ...)
- „Kompatibilita“

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-SR4** **100/150 m** **OM3/OM4**
- **40GBASE-FR** **2 km** **OS1/OS2**
- **40GBASE-LR4** **10 km** **OS1/OS2**
- **40GBASE-ER4** **30 (40) km** **OS1/OS2**

- **100GBASE-SR10** **100/150 m** **OM3/OM4**
- **100GBASE-SR4** **70/100 m** **OM3/OM4**
- **100GBASE-LR4** **10 km** **OS1/OS2**
- **100GBASE-ER4** **30 (40) km** **OS1/OS2**
- **100GBASE-CWDM4** **2 km SM, mimo standard IEEE**

40GBASE-SR4 a 100GBASE-SR10

Table 86–9—40GBASE–SR4 or 100GBASE–SR10 illustrative link power budgets

Parameter	OM3	OM4	Unit
Effective modal bandwidth at 850 nm ^a	2000	4700	MHz•km
Power budget (for maximum TDP)	8.3		dB
Operating distance	0.5 to 100	0.5 to 150	m
Channel insertion loss ^b	1.9	1.5	dB
Allocation for penalties (for maximum TDP) ^c	6.4	6.5	dB
Unallocated margin	0	0.3 ^d	dB
Additional insertion loss allowed	0		dB

^a Per IEC 60793-2-10.

^b The channel insertion loss is calculated using the maximum distances specified in Table 86–2 and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in 86.10.2.2.1.

^c Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

^d This unallocated margin is not available for use.

100GBASE-SR4

- 4 vlákna v každém směru
- 25,78125 GBd

Table 95–8—100GBASE-SR4 illustrative link power budget

Parameter	OM3	OM4	Unit
Effective modal bandwidth at 850 nm ^a	2000	4700	MHz.km
Power budget (for max TDEC)	8.2		dB
Operating distance	0.5 to 70	0.5 to 100	m
Channel insertion loss ^b	1.8	1.9	dB
Allocation for penalties ^c (for max TDEC)	6.3		dB
Additional insertion loss allowed	0.1	0	dB

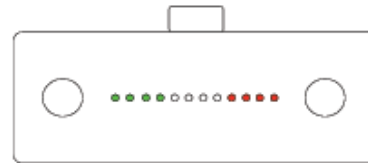
^aPer IEC 60793-2-10.

^bThe channel insertion loss is calculated using the maximum distance specified in Table 95–5 and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in 95.11.2.1.

^cLink penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

MPO/MTP konektory pro 40/100GE

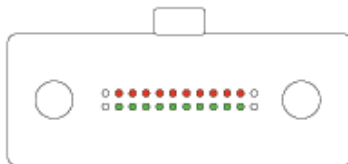
40GBASE-SR4
100GBASE-SR4



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

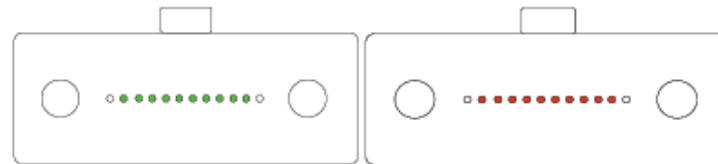


100GBASE-SR10



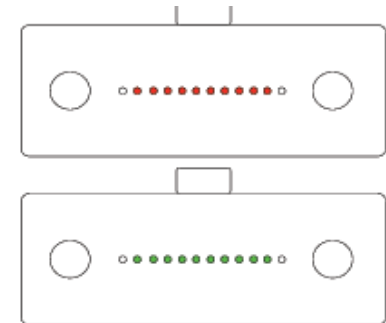
Inner 10 pins, Top Row are Rx
Inner 10 pins, Bot Row are Tx
(outermost pins both rows unused)

Option A
(recommended)



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

Option B



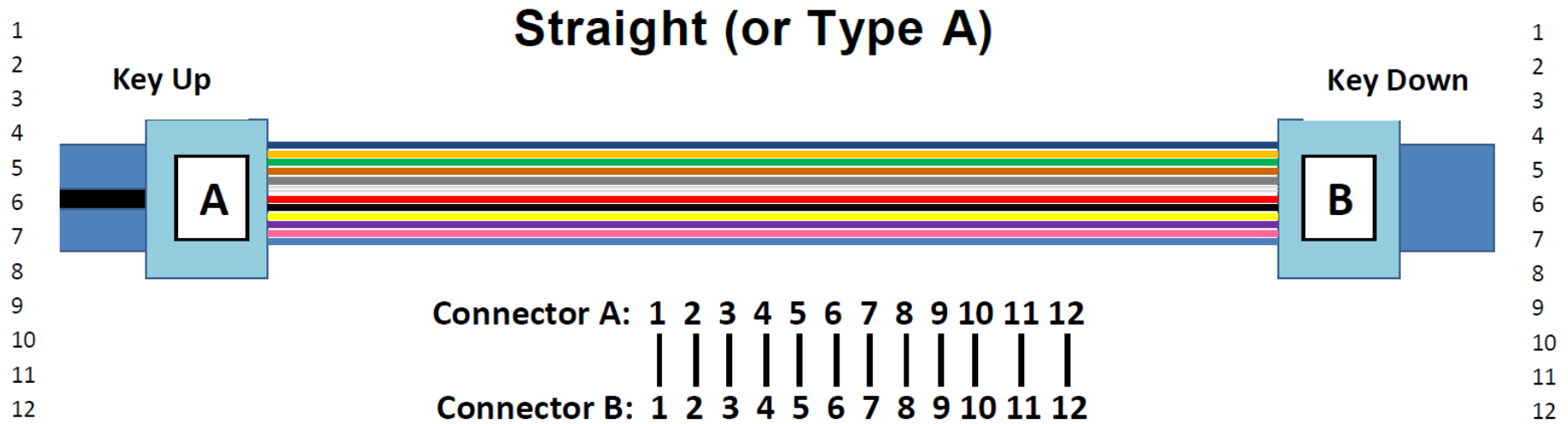
Inner 10 pins, Top are Rx
Inner 10 pins, Bot are Tx
(outermost pins Top & Bot unused)

Option C

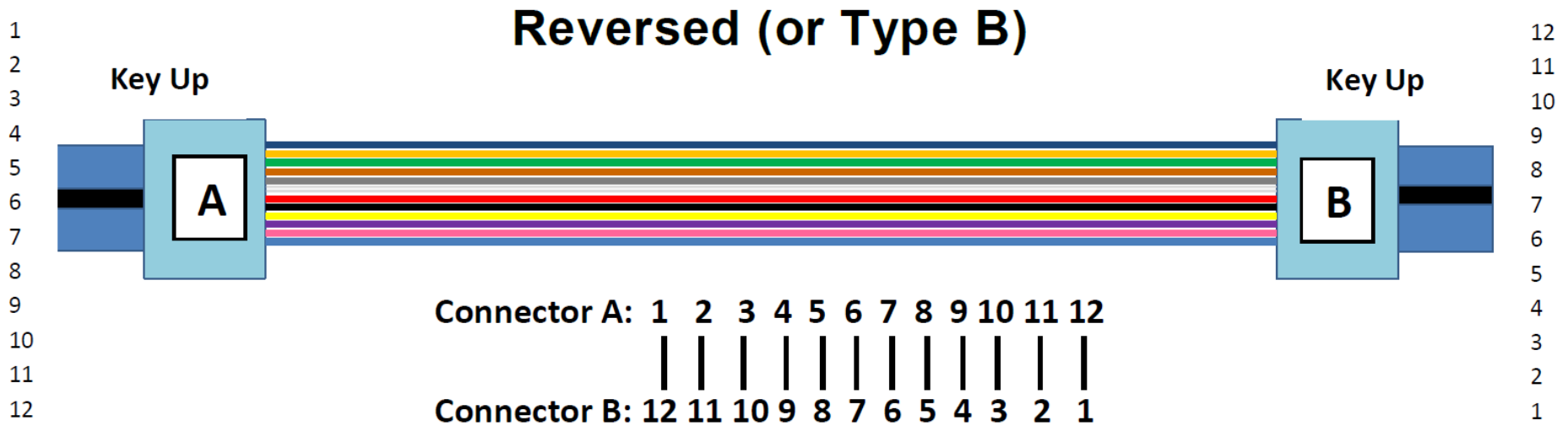
Polarita zapojení MPO konektorů

- **Definováno TIA-568-C**
- **Metoda A**
 - Páteřní kabel zapojen A-A Key Up – Key Down (pin 1 = pin 1)
 - Spojka typ A (Key Up – Key Down)
 - Patchkordy na koncích linky – jeden A-A, druhý A-B
- **Metoda B**
 - Páteřní kabel křížený = zapojen A-B Key Up – Key Up (pin 1 = pin 12)
 - Spojka typ B (Key Up – Key Up)
 - Patchkordy na koncích linky – oba A-B
 - Není možné použít SM APC konektory
- **Metoda C**
 - Páteřní kabel křížené páry = zapojen A-A Key Up – Key Down (pin 1 = pin 2)
 - Spojka typ A (Key Up – Key Down)
 - Patchkordy na koncích linky – oba A-B

Kabel MPO typ A (A-A)

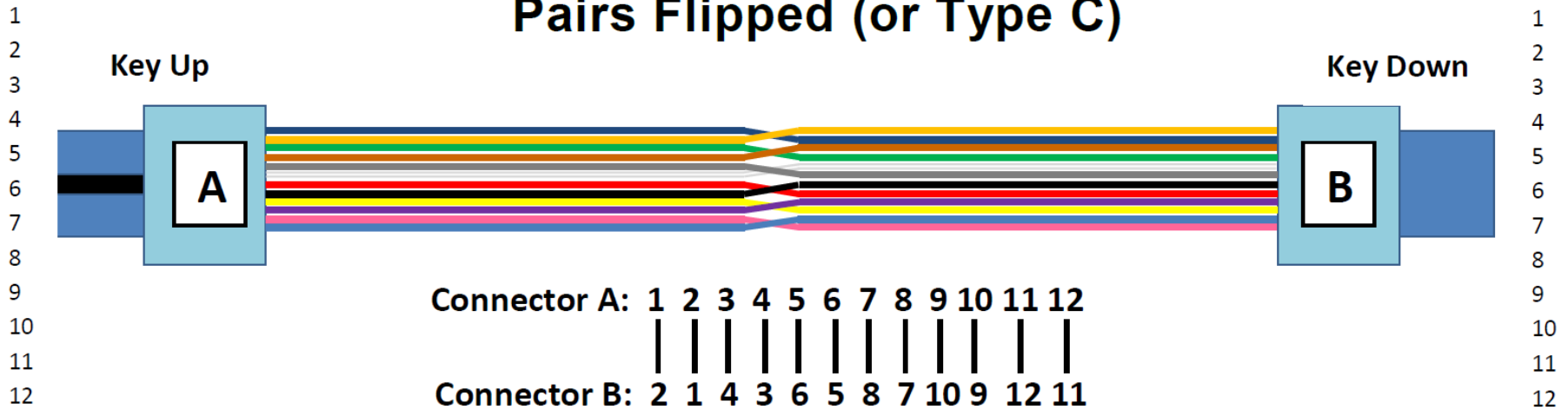


Kabel MPO typ B (A-B)



Kabel MPO typ C

Pairs Flipped (or Type 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:

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

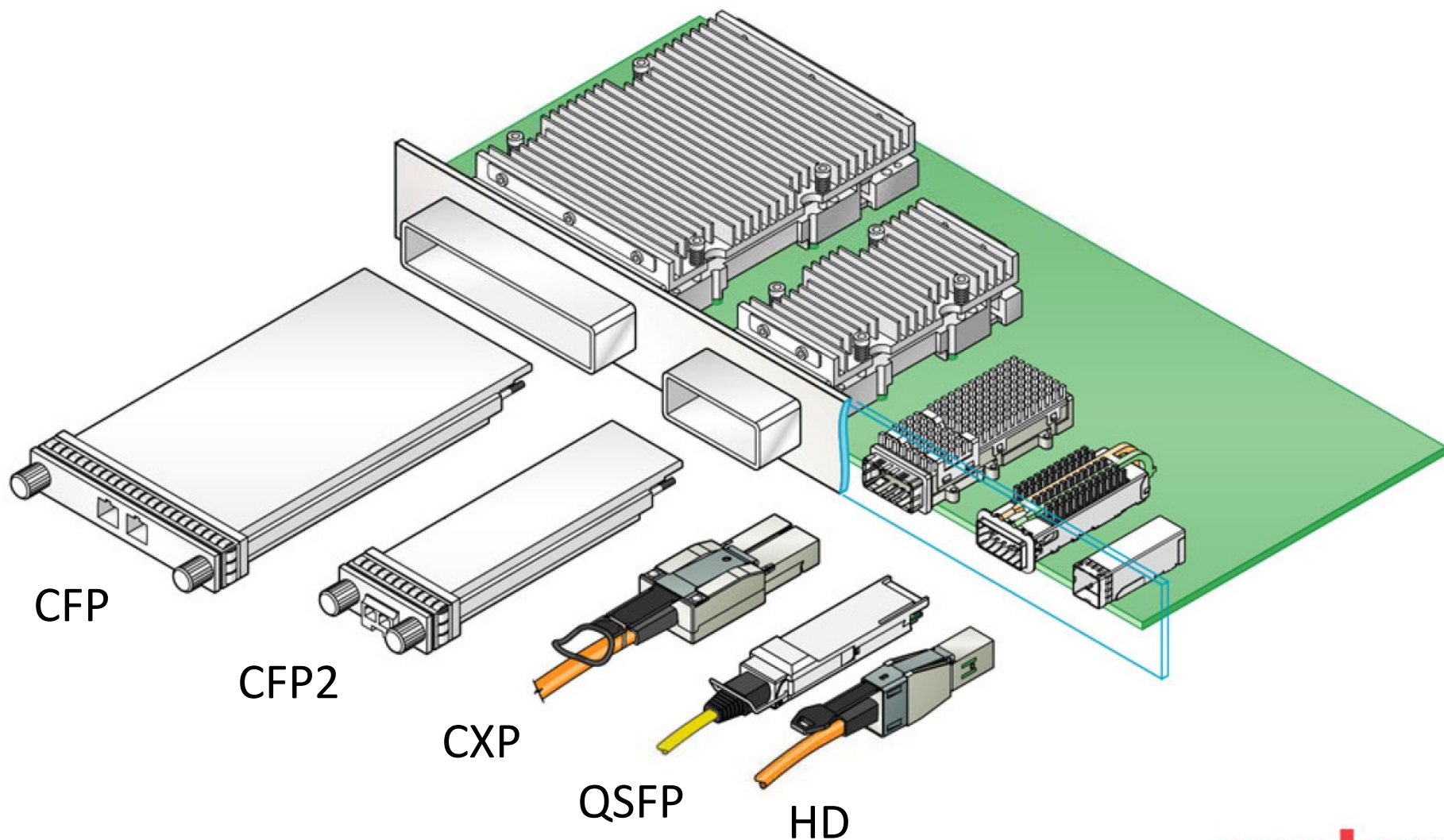


Zdroj:

Další vývoj Ethernetu ?

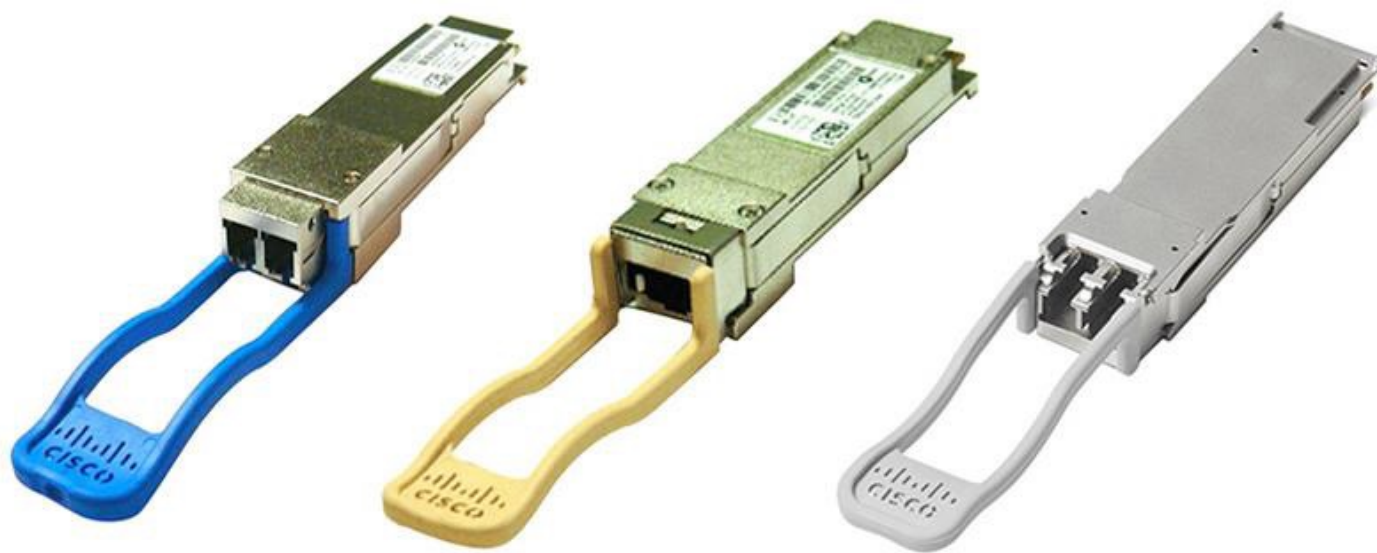
- Další typy rozhraní pro 40G a 100G Ethernet (25G, 50G, 200G, ...)
- IEEE P802.3bq 25G/40GBASE-T Task Force
- IEEE P802.3by 25 Gb/s Ethernet Task Force
- IEEE P802.3ca 25 Gb/s, 50 Gb/s, and 100 Gb/s Ethernet Passive Optical Networks Task Force.
- **400 Gbit/s Ethernet**
 - IEEE P802.3bs 400 Gb/s Ethernet 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 Terabit/s Ethernet**
 - 16x 100G, 8x200G, 4x400G, ... ??

Transceivers 40G a 100G



QSFP+ Transceivers

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



Zdroj:

40G a 100G Transceivery AOC

QSFP / QSFP+ / QSFP28



CXP



Active Optical Cables

Transceivery pro 100/200/400G

I/O	10x10	10x10 4x25	4x25	16x25	8x50	4x100
CFP MSA	CFP	CFP2	CFP4	CDP	CDP2 (= CFP2)	CDP4 (= CFP4)
Other MSA	CXP			CDFP		
SFF			QSFP28			QSFP56
Cisco		CPAK				

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



CISCO CPAK transceivers

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



Zdroj:

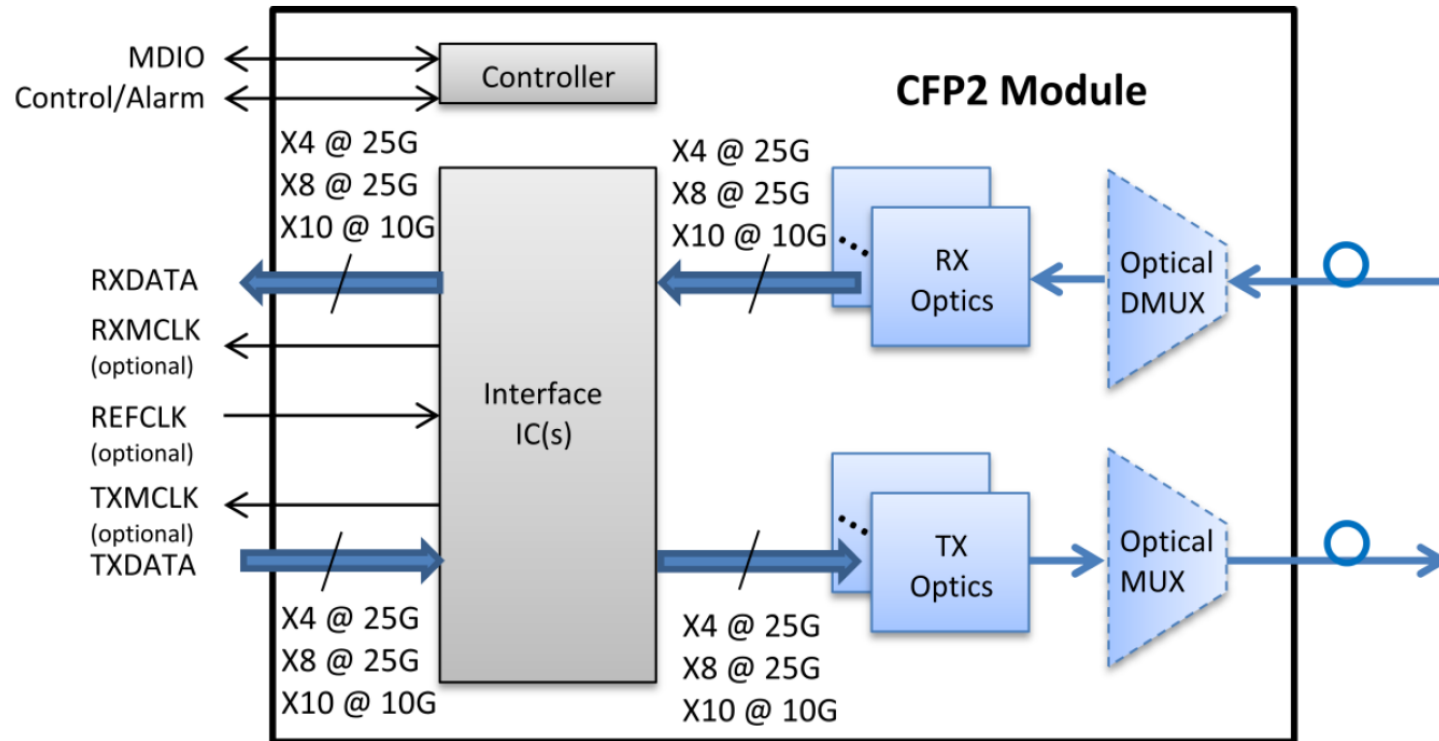
CFP transceiver

- Verze 40Gbit, 100Gbit
- Multimode nebo Singlemode
- DWDM CFP 10x10Gbit, cca 40 km
- 100G 4x28G Metro Tunable DWDM 30km (500km+ po zesílení)
- DWDM CFP 100Gbit, C-band tunable, koherentní, > 800km



CFP 2 transceiver

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



Finisar DWDM CFP2 transceiver

- 200G/100G Tunable C-Band CFP2-ACO Coherent Optical Transceiver
 - ACO (Analog Coherent Optics)
 - DCO (Digital Coherent Optics)
- 100G DP-QPSK / 200G DP-16QAM



Problém kompatibility rozhraní

- **Optické rozhraní transceiveru**
 - 100GBASE-SR10
 - 100GBASE-SR4
 - 100GBASE-LR4
 - 100GBASE-LR4 lite
 - 100GBASE-ER4
 - 10x10GBASE-LR
 - 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 XLPPPI)
 - 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

Digital Diagnostic Monitoring Interface

- DDMI – Digital Diagnostic Monitoring Interface (DMI)
 - <ftp://ftp.seagate.com/sff/SFF-8472.PDF>
- 2x 256-byte memory EEPROM (addresses 0xA0 and 0xA2)
-
- **Monitoring**
- Received power monitoring (Power nebo OMA)
- Transmitted power monitoring
- Bias current monitoring
- Supply voltage monitoring
- Temperature monitoring
- Případně i Laser Temp/Wavelength, TEC current
- Případně i Alarm a Warning thresholds

Náš tým je Vám k dispozici!

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