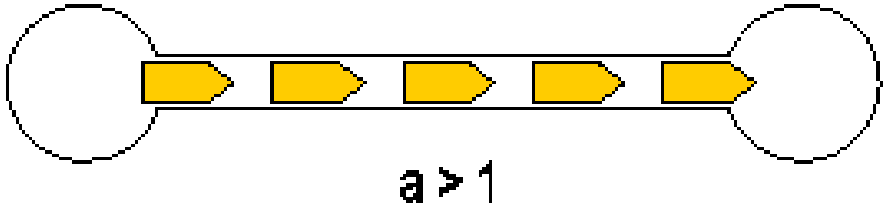
A7B36PSI
Fyzická vrstva

Osnova

- kapacita kanálu
- kódování
- metalická média
- optická média

Rozlehlost

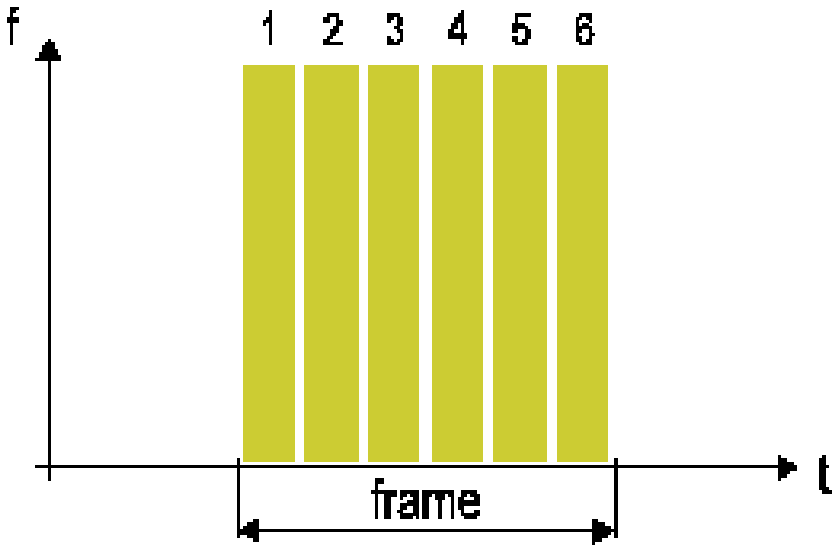


$$a = \frac{t_{odesilani}}{t_{prenosu}}$$

Multiplex

- FDMA
- frekvenční multiplex

- TDMA
- časový multiplex



Kapacita přenosového kanálu

Nyquistova věta

$$C = 2.\mathrm{W}.\log_2(V)[b/s, Hz]$$

Shannonova věta

$$C = 2.\mathrm{W}.\log_2(1 + S/N)[b/s, Hz]$$

W max. kmitočet

C přenosová rychlost

V počet diskrétních hodnot

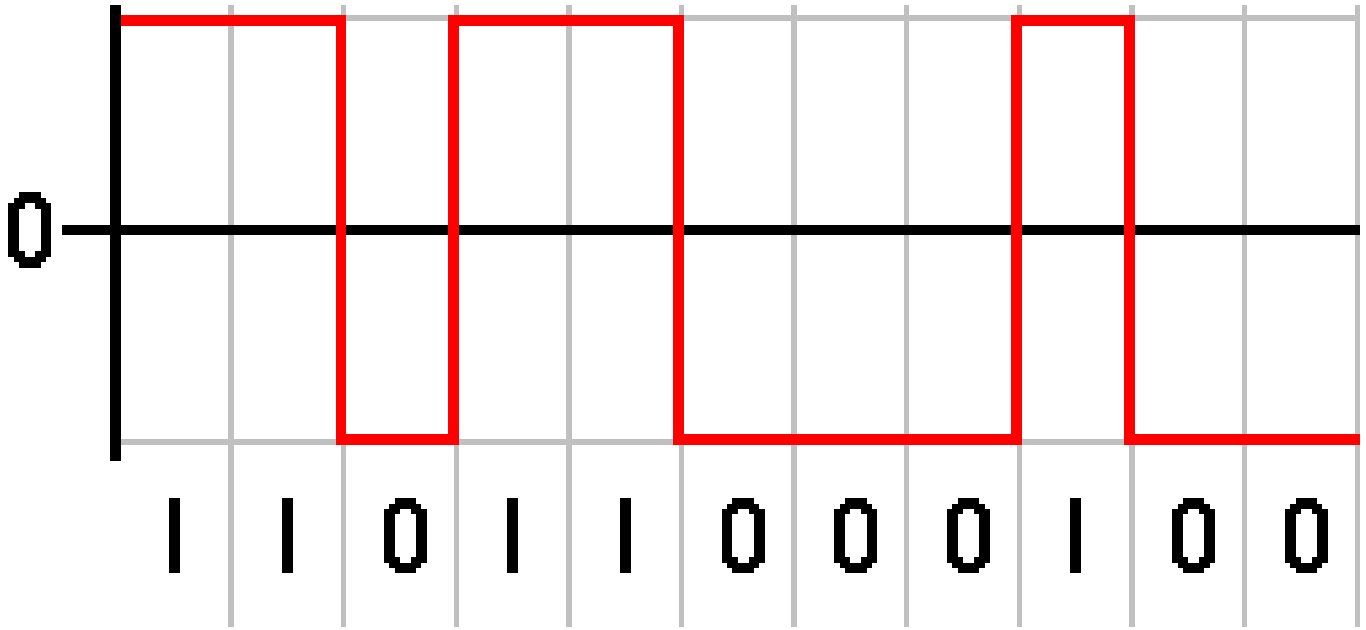
S/N odstup signál-šum

Kódování

- stejnosměrná složka,
- časová synchronizace,
- šířka pásma,
- přenosová rychlost,

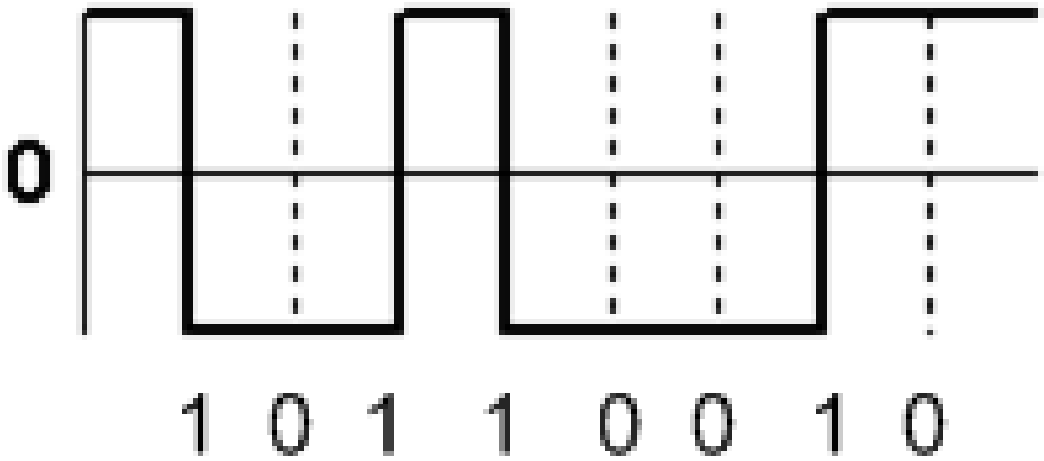
Non Return to Zero

- chybí auto synchronizace (lze doplnit kódováním)



Non Return to Zero Inverted

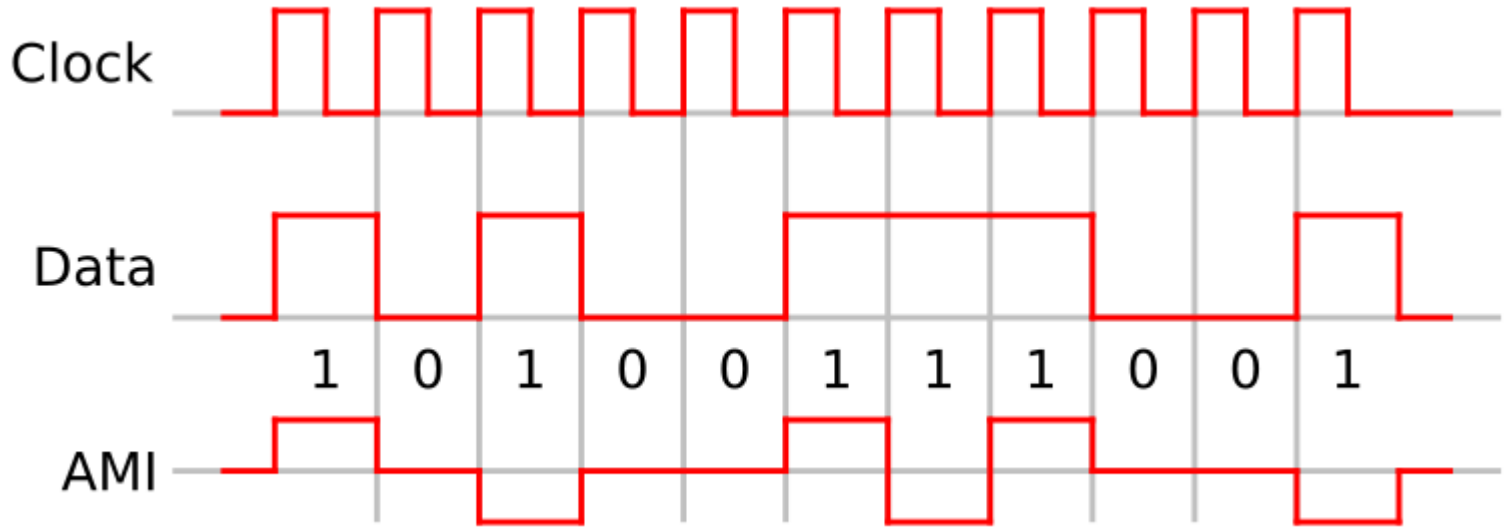
- 1 – změna stavu
- USB



Bipolar

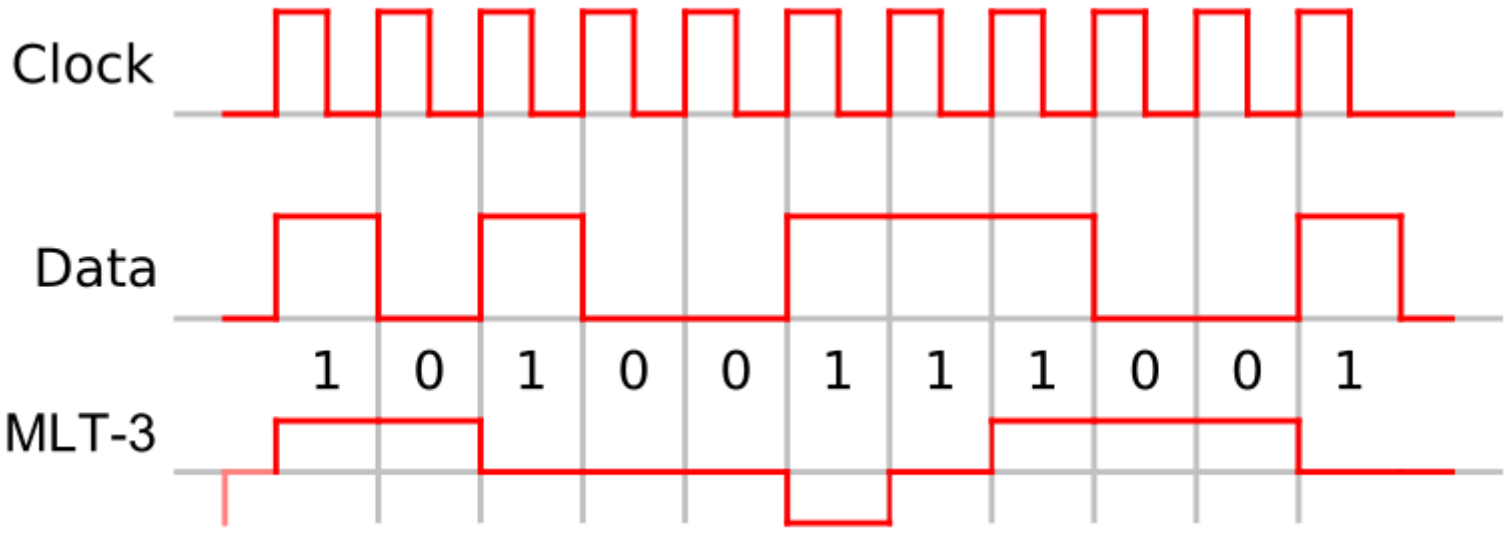
- nemá stejnosměrnou složku

Alternative Mark Inversion



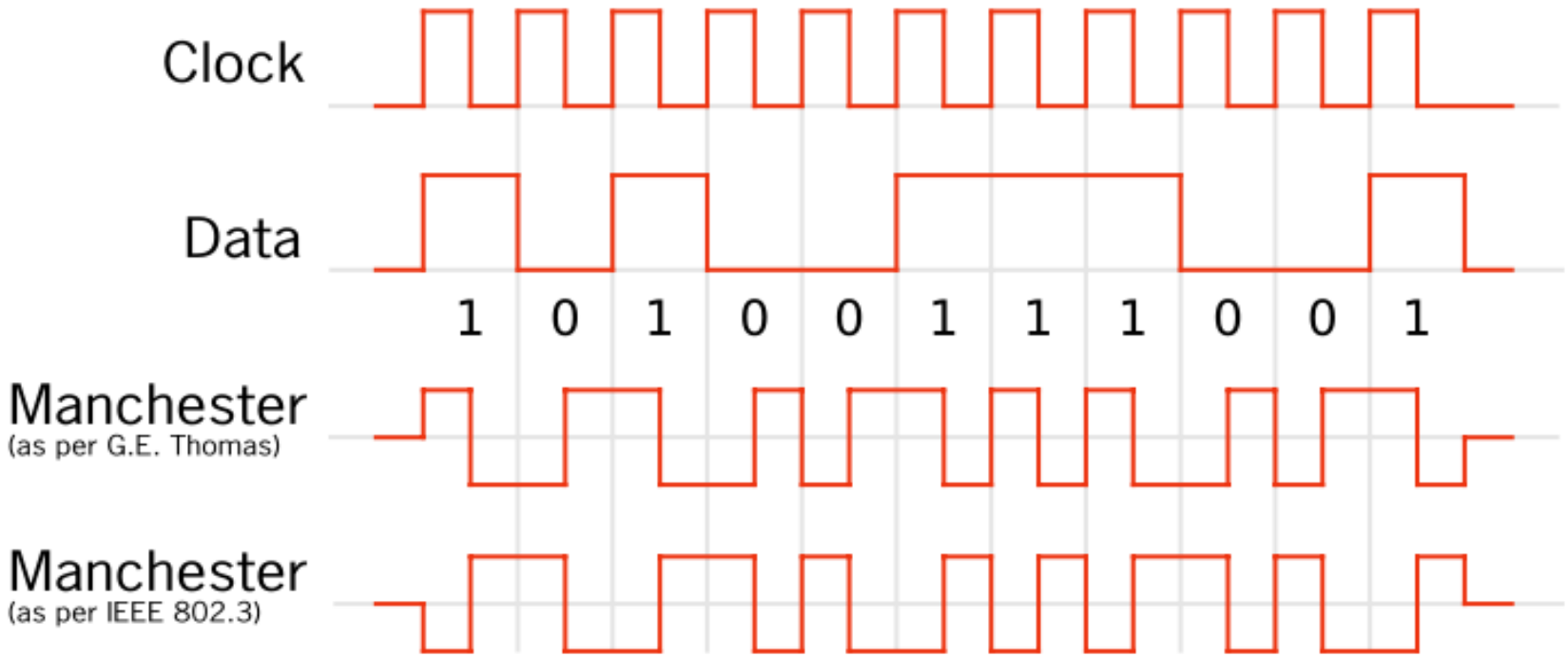
MLT-3

- cyklus -1,0,1,0,...
- FDDI, 100BaseTx



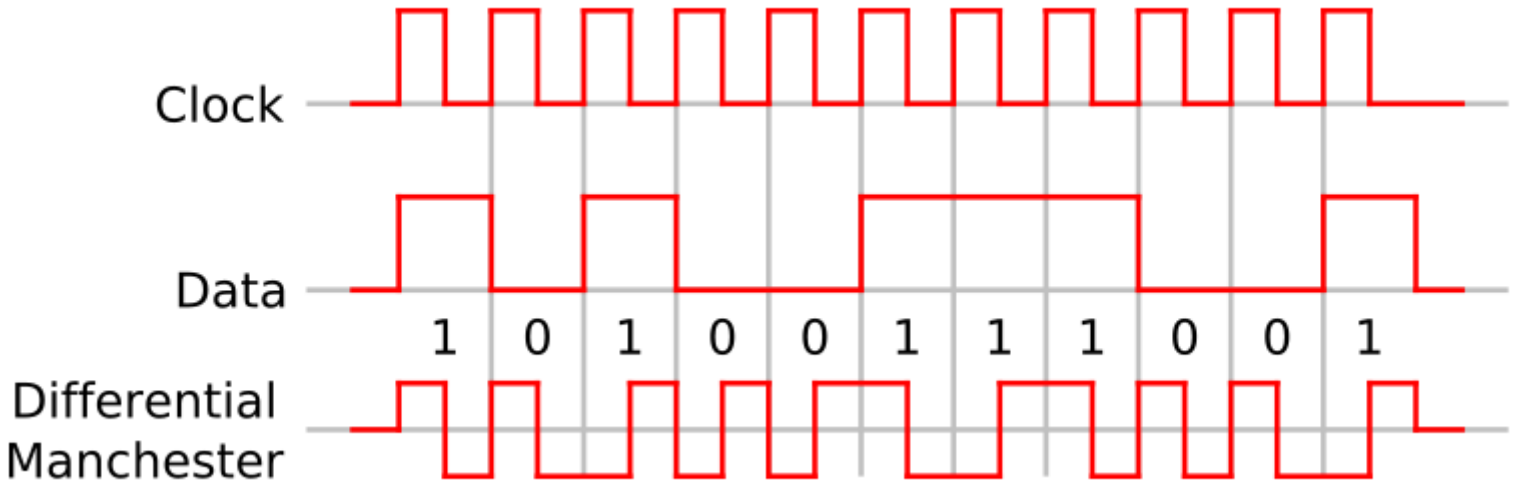
Manchester

- dvojnásobná šířka pásma oproti NRZ,
- IEEE 802.3 – Ethernet,
- IEEE 802.4 – Token Bus



Diferenciální manchester

- 1 – otáčí hranu,
- ignoruje polaritu,
- IEEE 802.5 – Token Ring



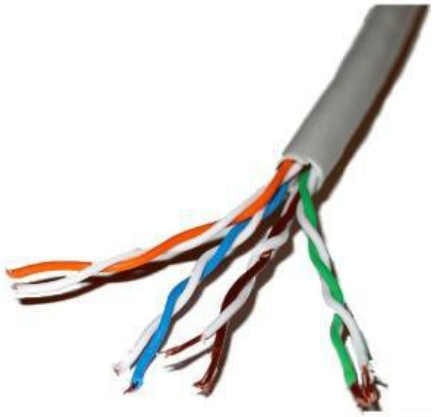
4B5B

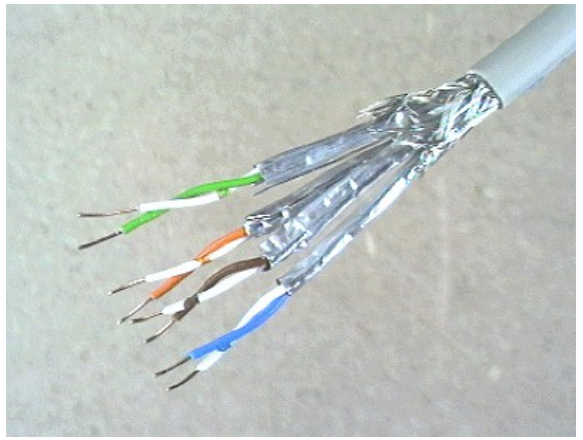
- zajištění hodin,
- 100BaseTx, 100BaseFx

0	0000	11110	hex data 0	8	1000	10010	hex data 8
1	0001	01001	hex data 1	9	1001	10011	hex data 9
2	0010	10100	hex data 2	A	1010	10110	hex data A
3	0011	10101	hex data 3	B	1011	10111	hex data B
4	0100	01010	hex data 4	C	1100	11010	hex data C
5	0101	01011	hex data 5	D	1101	11011	hex data D
6	0110	01110	hex data 6	E	1110	11100	hex data E
7	0111	01111	hex data 7	F	1111	11101	hex data F

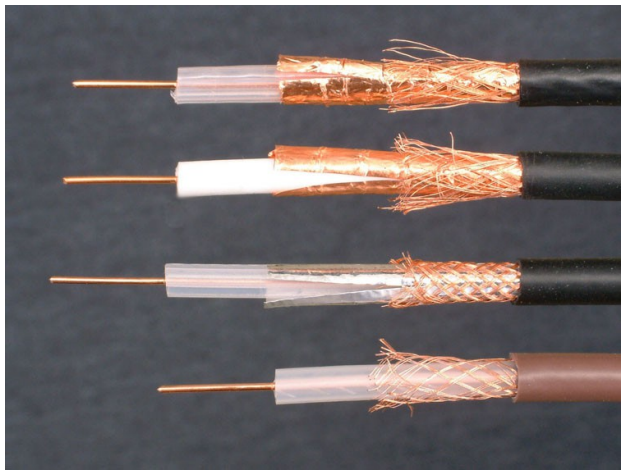
Metalická vedení

- symetrická



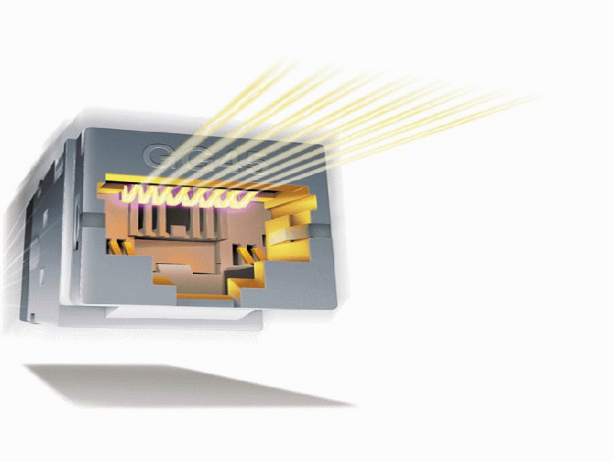


- nesymetrická

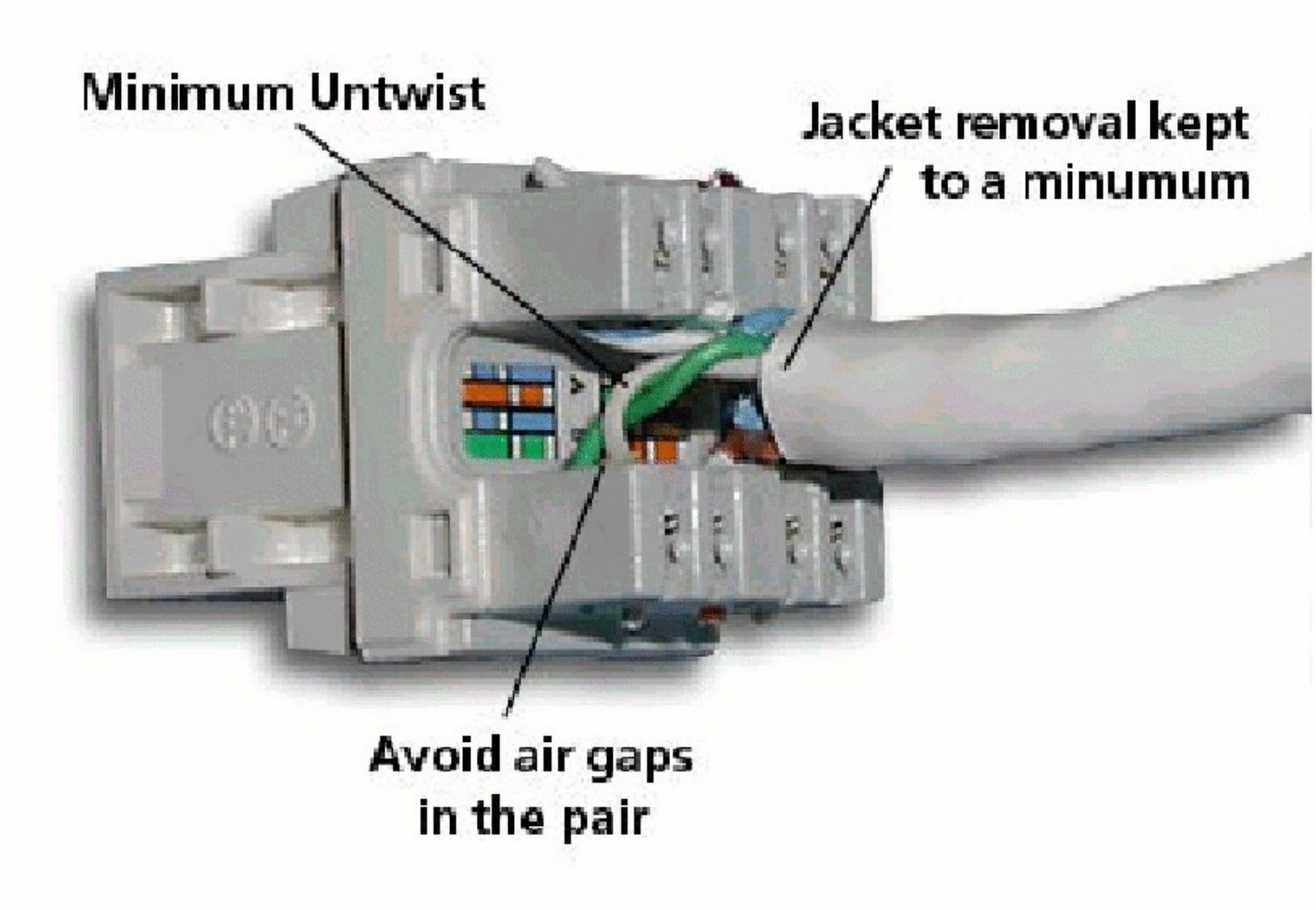


UTP kabely ISO/IEC 11801

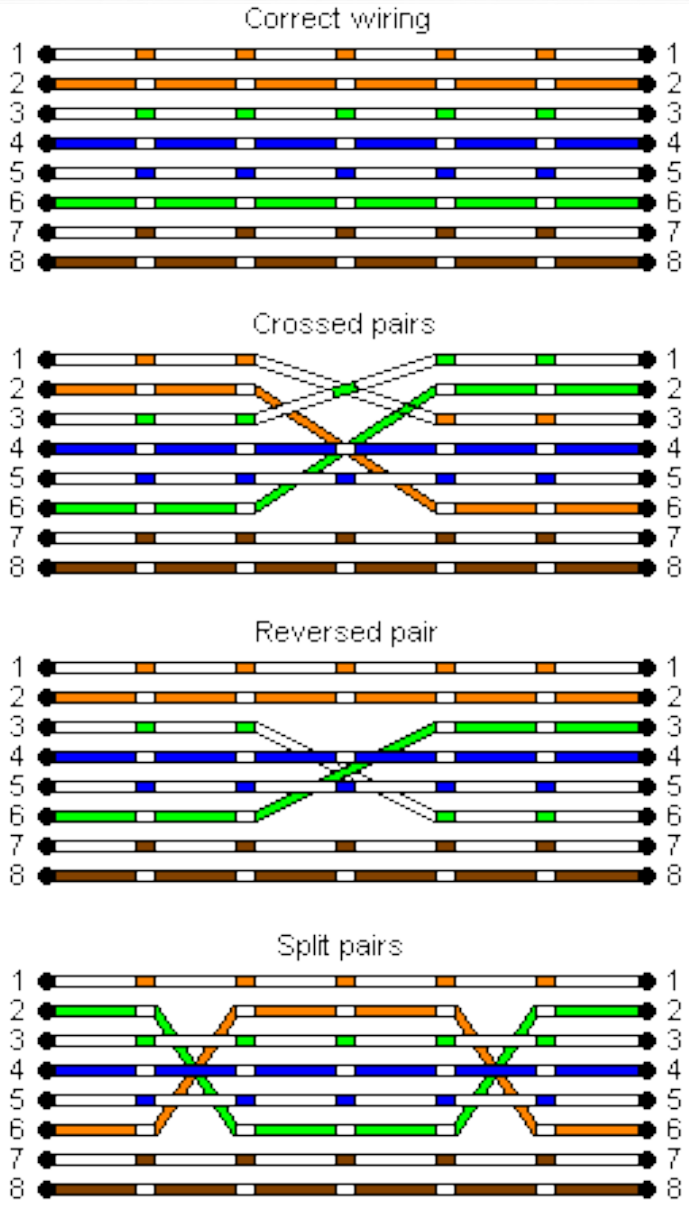
- cat 3 – 16MHz, 10Mbps
- cat 4 – 20MHz, 16Mbps
- cat 5 – 100MHz, 100Mbps (1Gbps)
- cat 5e – 100MHz, 1Gbps (10Gbps – 45m)
- cat 6 – 250MHz, 1Gbps (10Gbps – 55m)
- cat 6a – 500MHz, 10Gbps – 100m
- cat 7 – 600MHz, 100Gbps
- cat 7a – 1000MHz



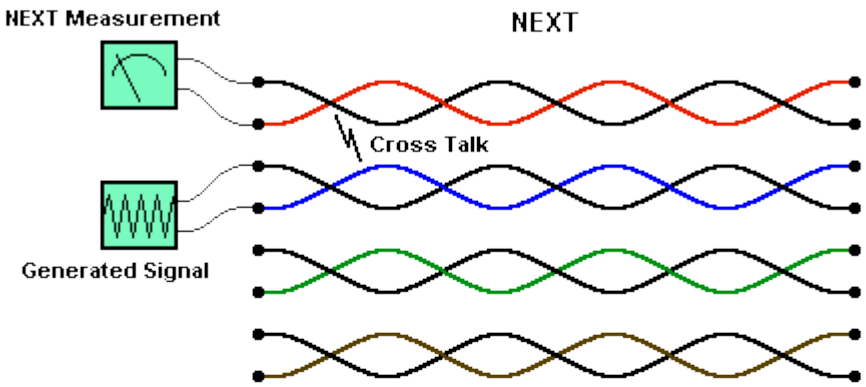
Konektory

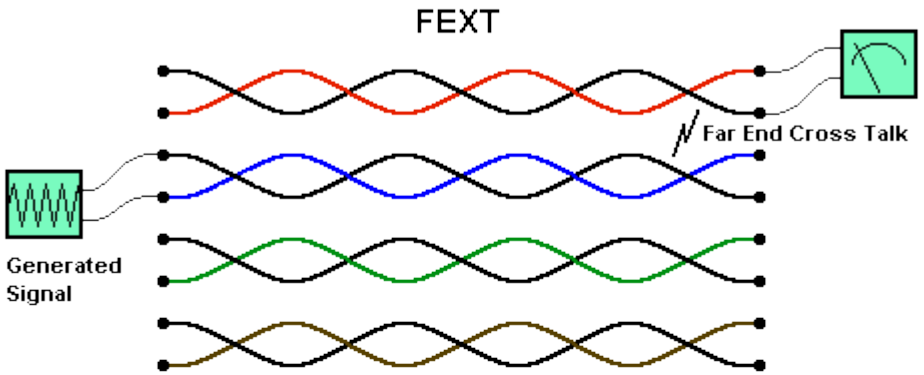


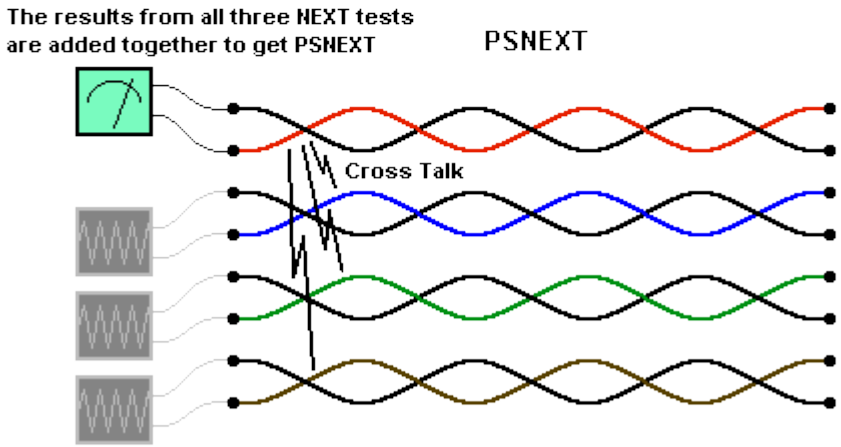
Chyby na vedení

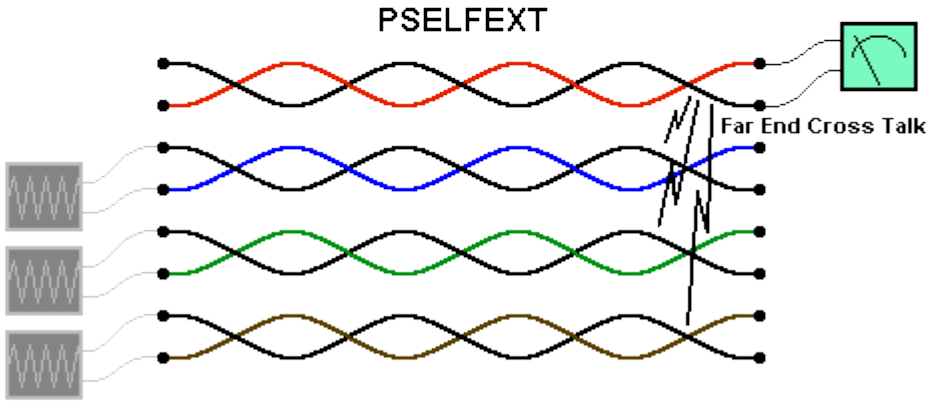


Přeslechy

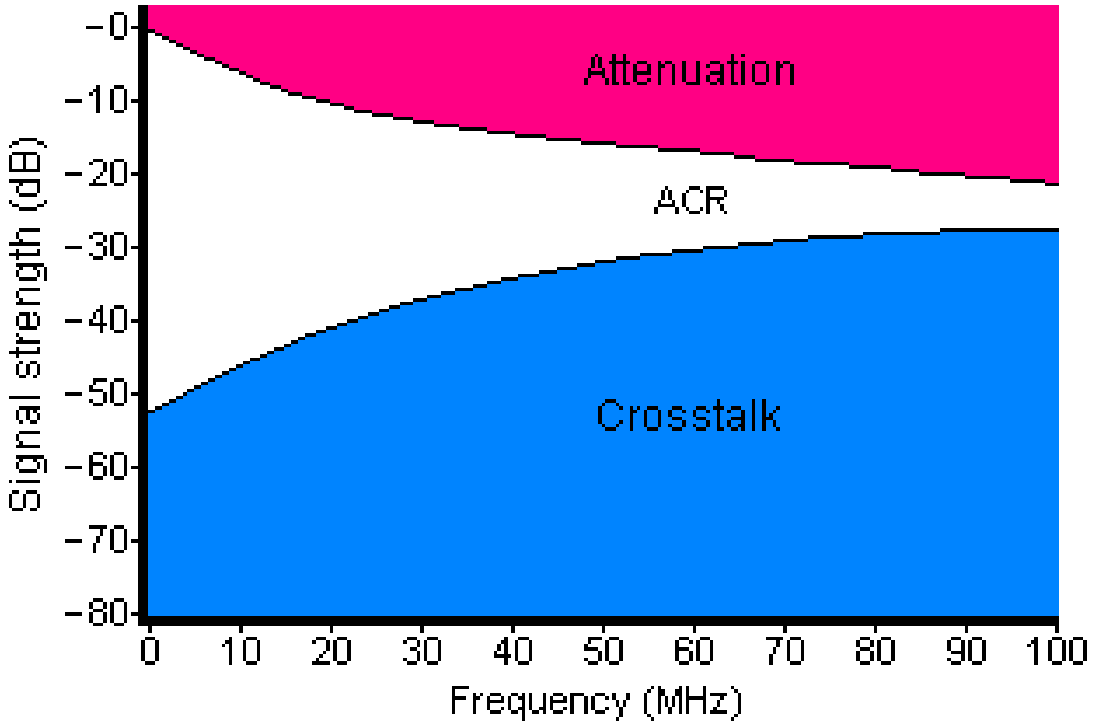




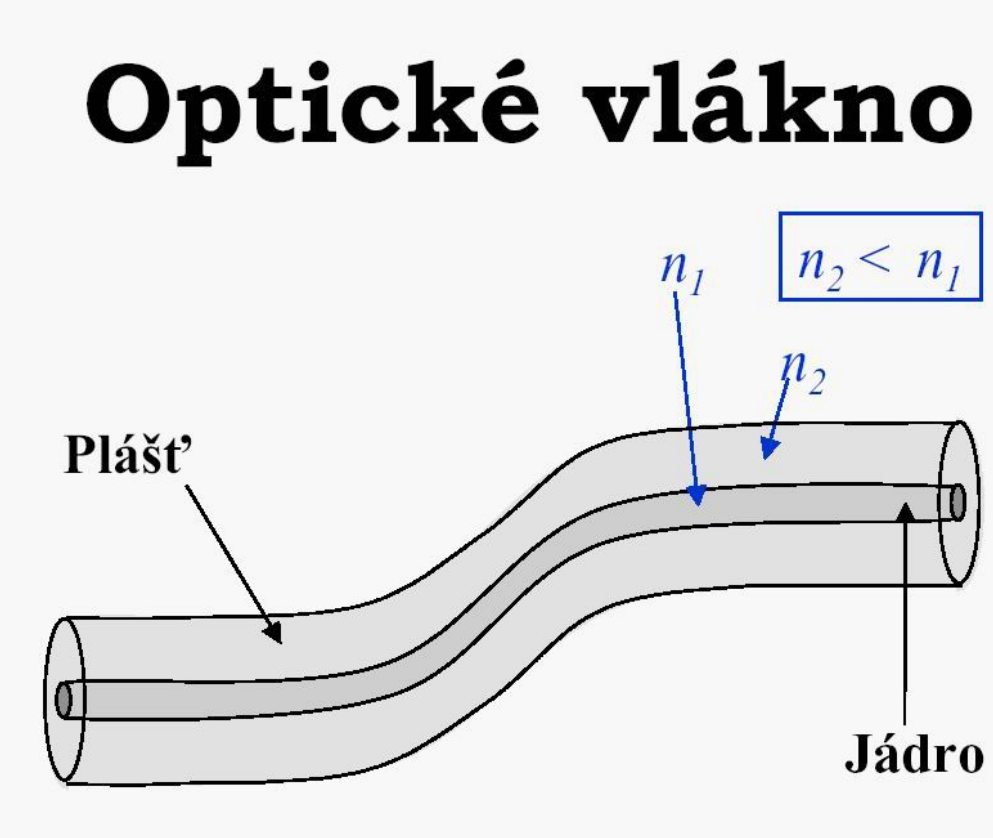




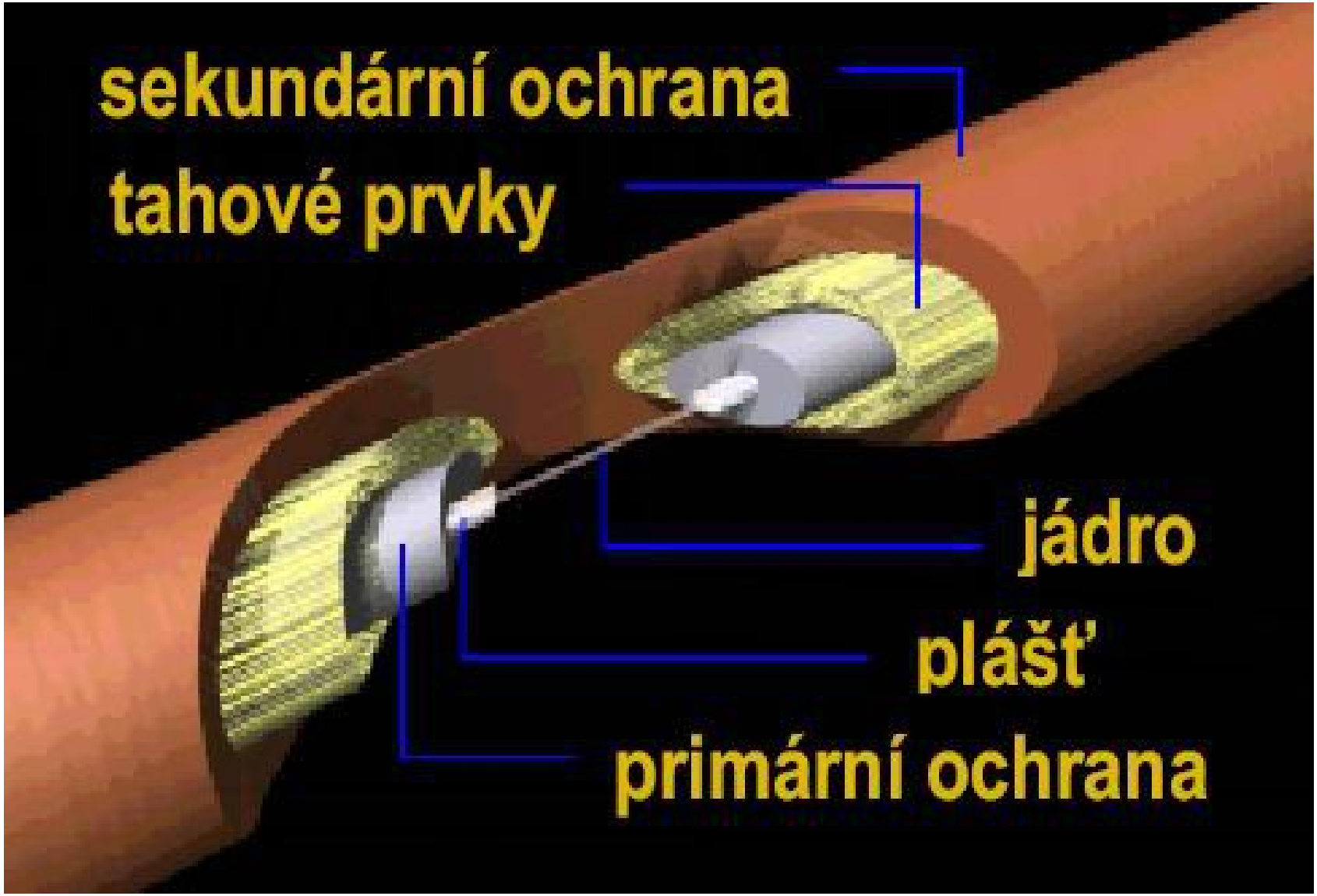
Útlum a přeslech



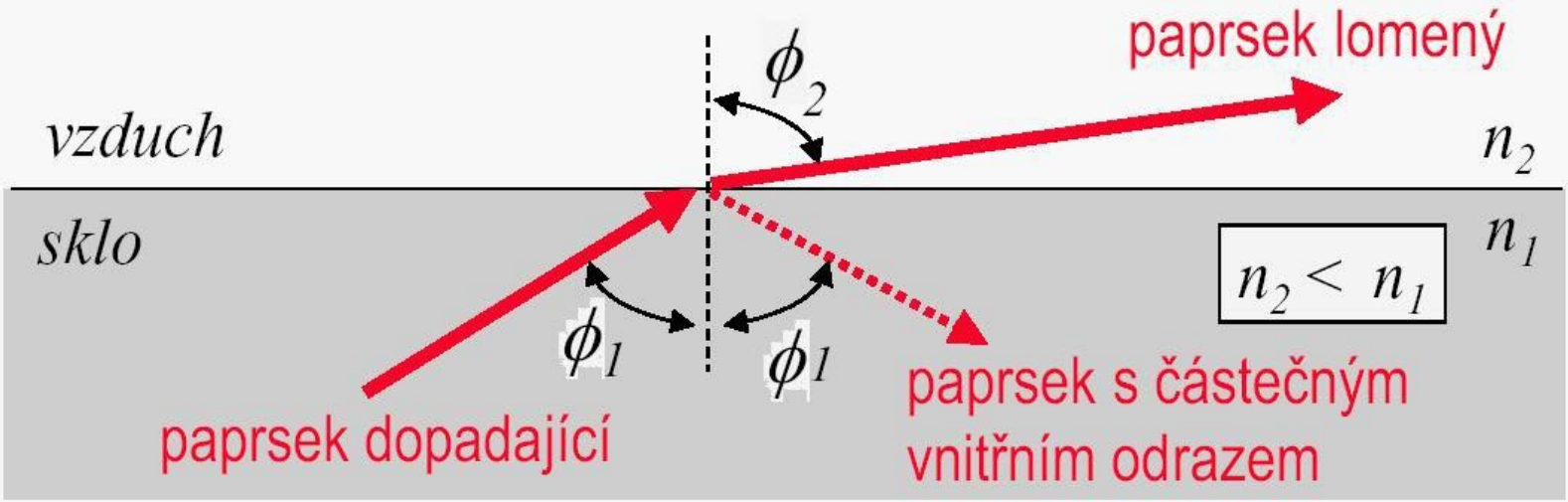
Optická vedení



Řez vláknem


sekundární ochrana
tahové prvky
jádro
plášť
primární ochrana

Snellův zákon lomu

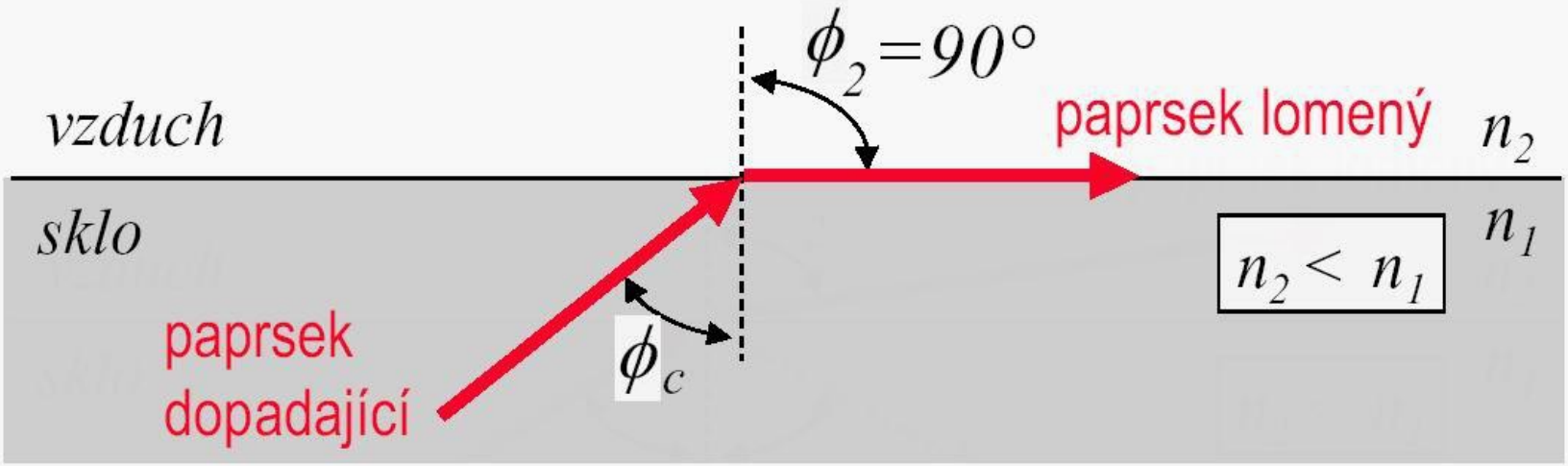


$$n_1 \sin\phi_1 = n_2 \sin\phi_2$$

nebo

$$\frac{\sin\phi_1}{\sin\phi_2} = \frac{n_2}{n_1}$$

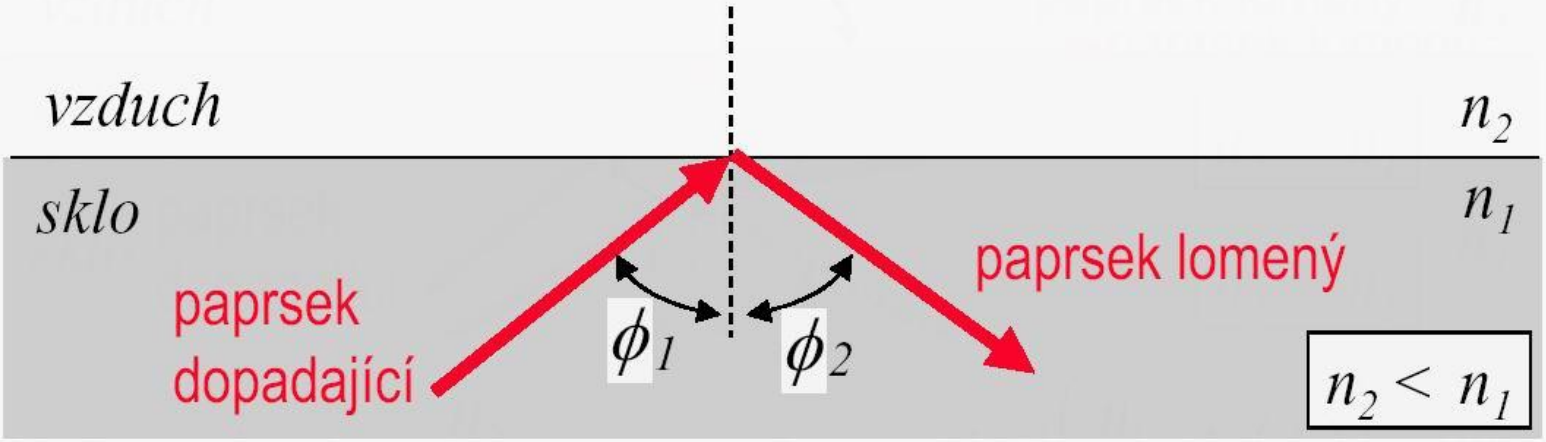
Kritický úhel lomu



Když $\sin\phi_1 = \frac{n_2}{n_1}$ potom $\phi_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin(\phi_1)\right) = 90°$

Takže, kritický úhel lomu je definován $\sin\phi_c = \frac{n_2}{n_1}$

Jev totální vnitřního odrazu

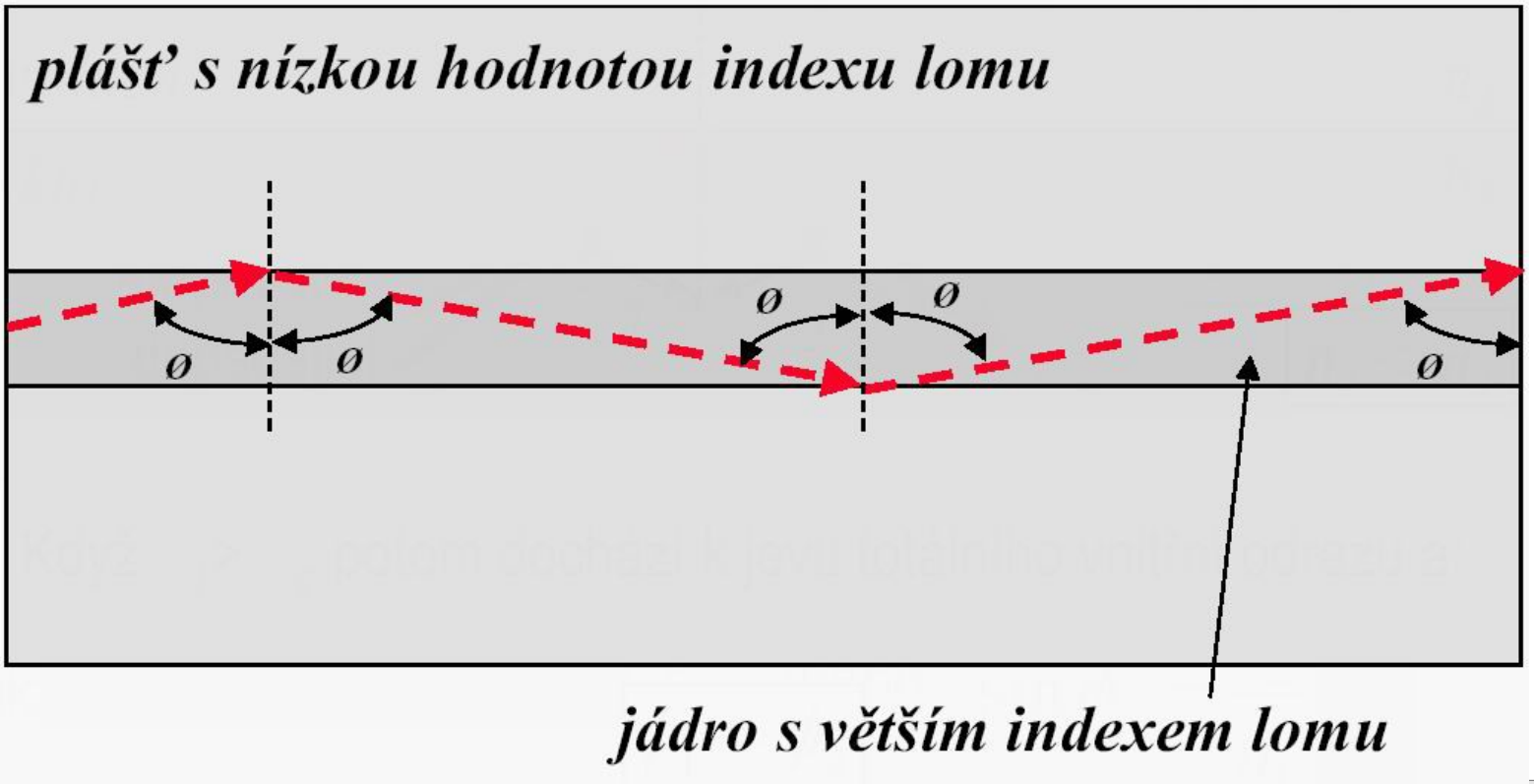


Když $\phi_1 > \phi_c$ potom dochází k jevu totálního vnitřní odrazu a:

$$\phi_1 = \phi_2$$

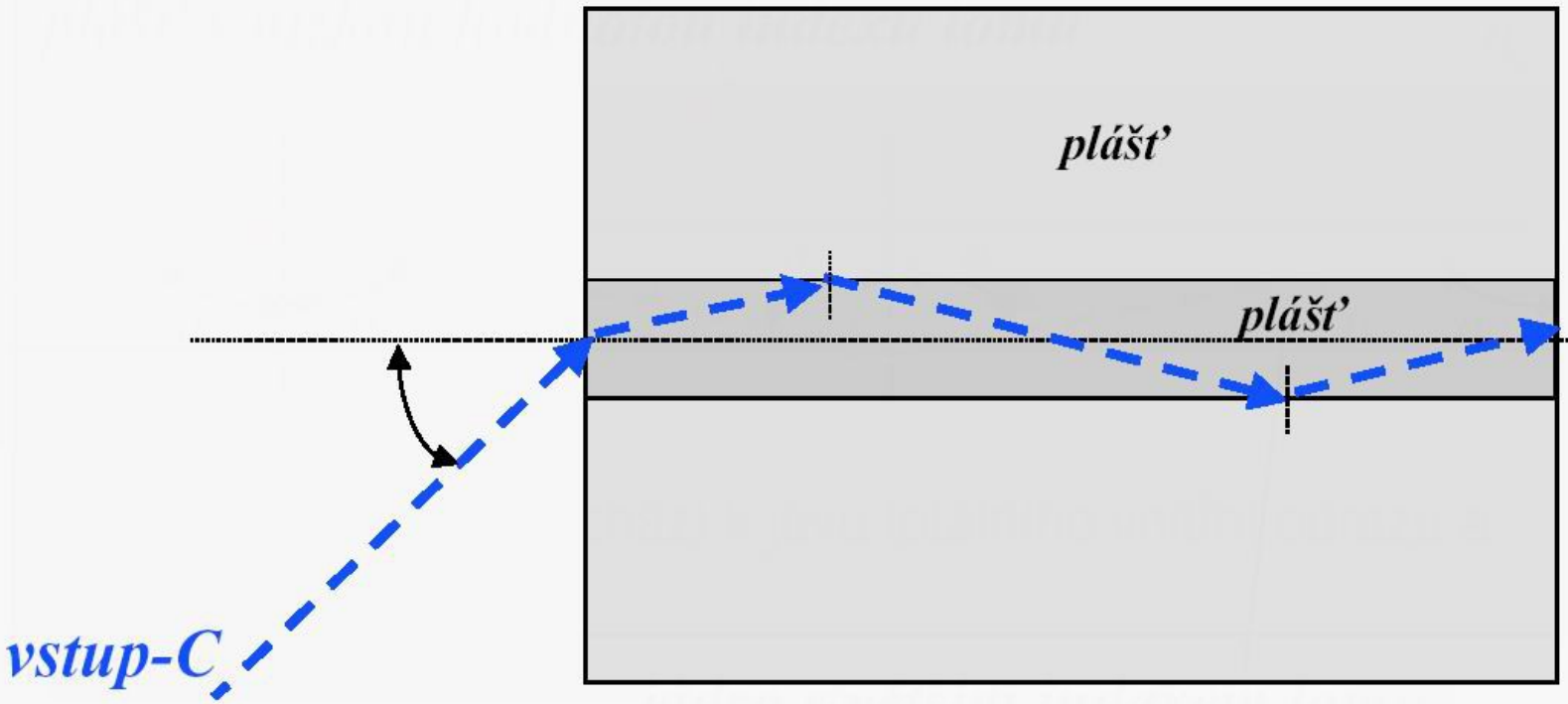
Princip šíření světla 4

Přenos paprsku v ideálním optickém vlákně



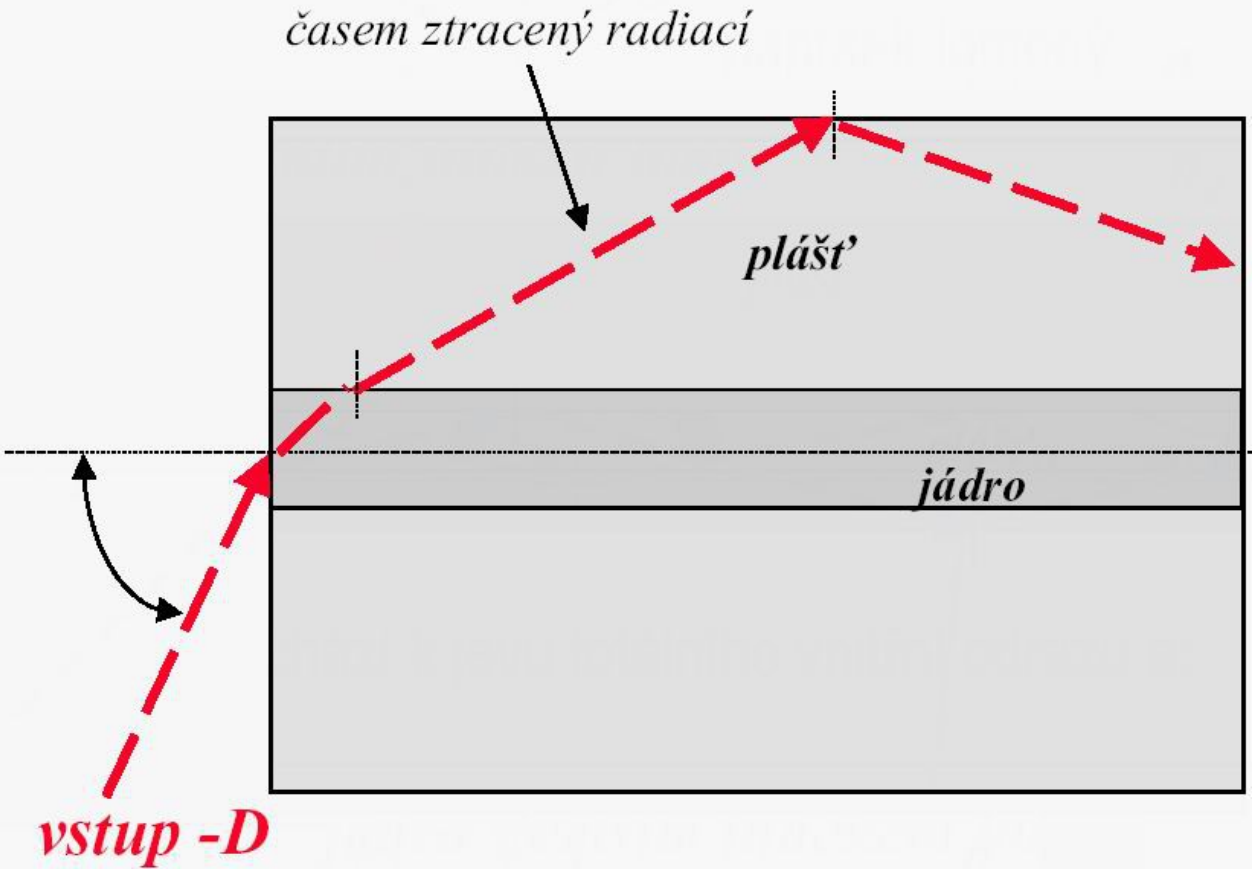
Princip šíření světla 5

Maximální úhel navázaní

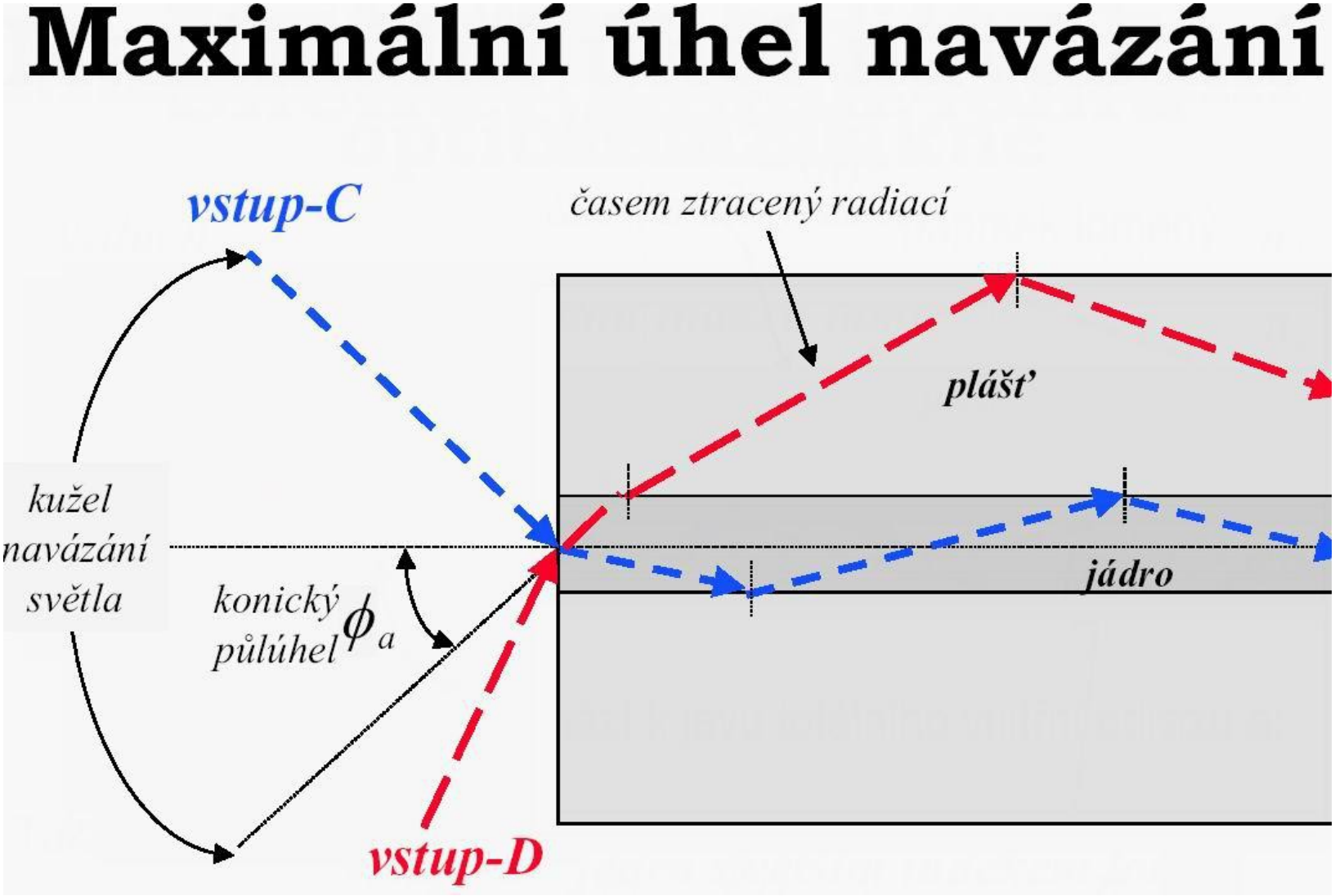


Princip šíření světla 6

Maximální úhel navázaní



Princip šíření světla 7



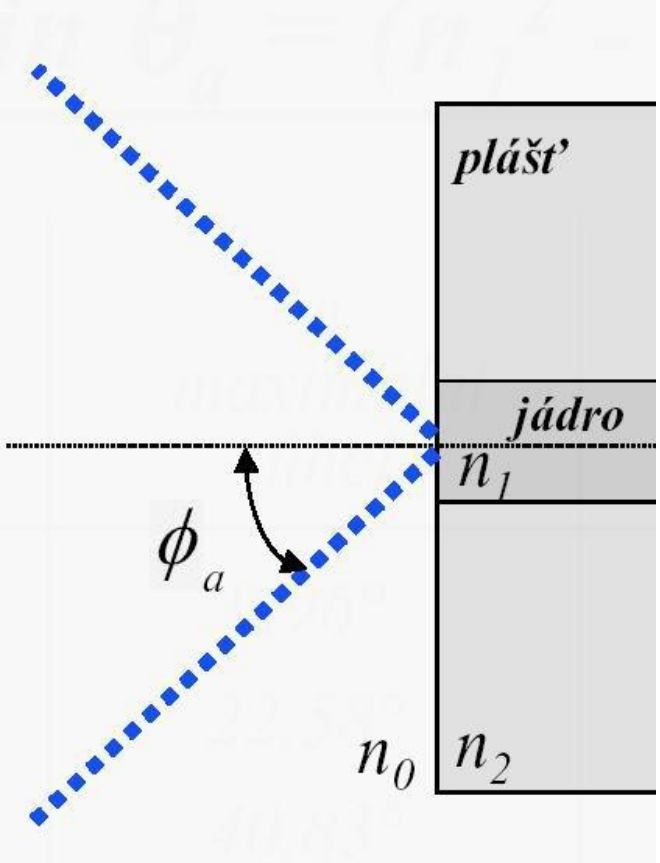
Numerická apertura

- míra schopnosti vlákna navázat paprsek do jádra
- závisí na okolí

$$NA = n_0 \cdot \Phi_a$$

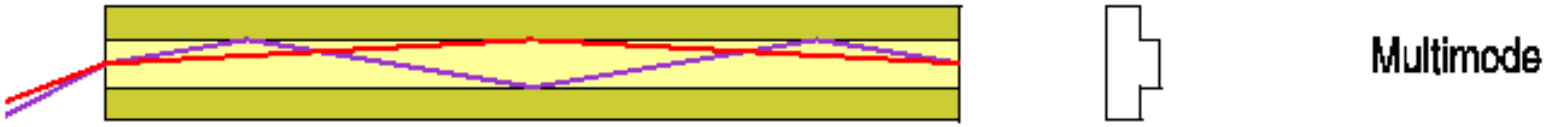
$$NA = (n_1^2 - n_2^2)^{1/2}$$

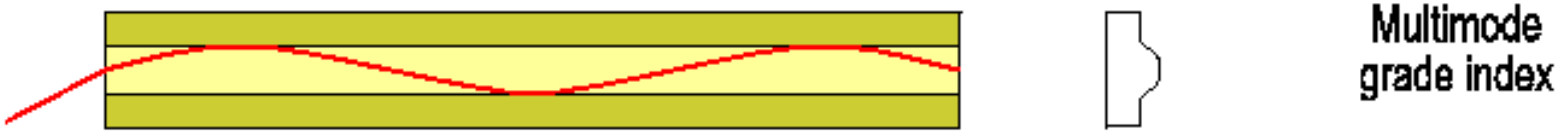
- n_0=1 pro vzduch
- Φ_0 maximální úhel navázání



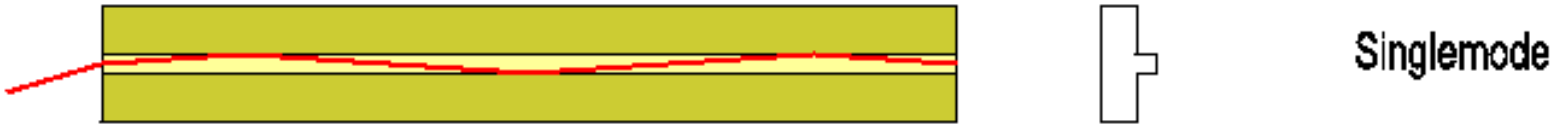
Typy vláken

Multimode 50/125, 62.5/125, 100/140 μm

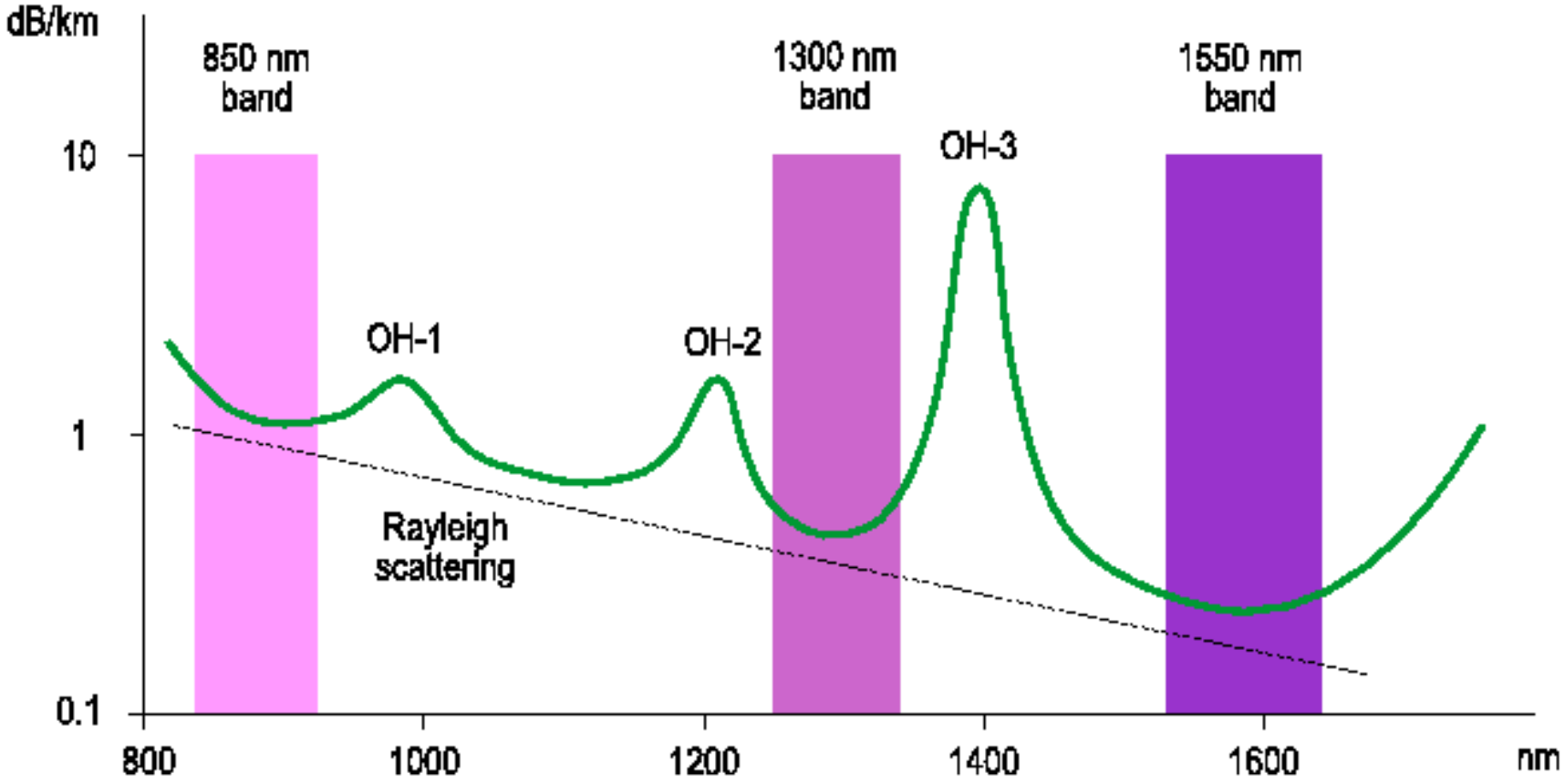




Singlemode 9/125 μm



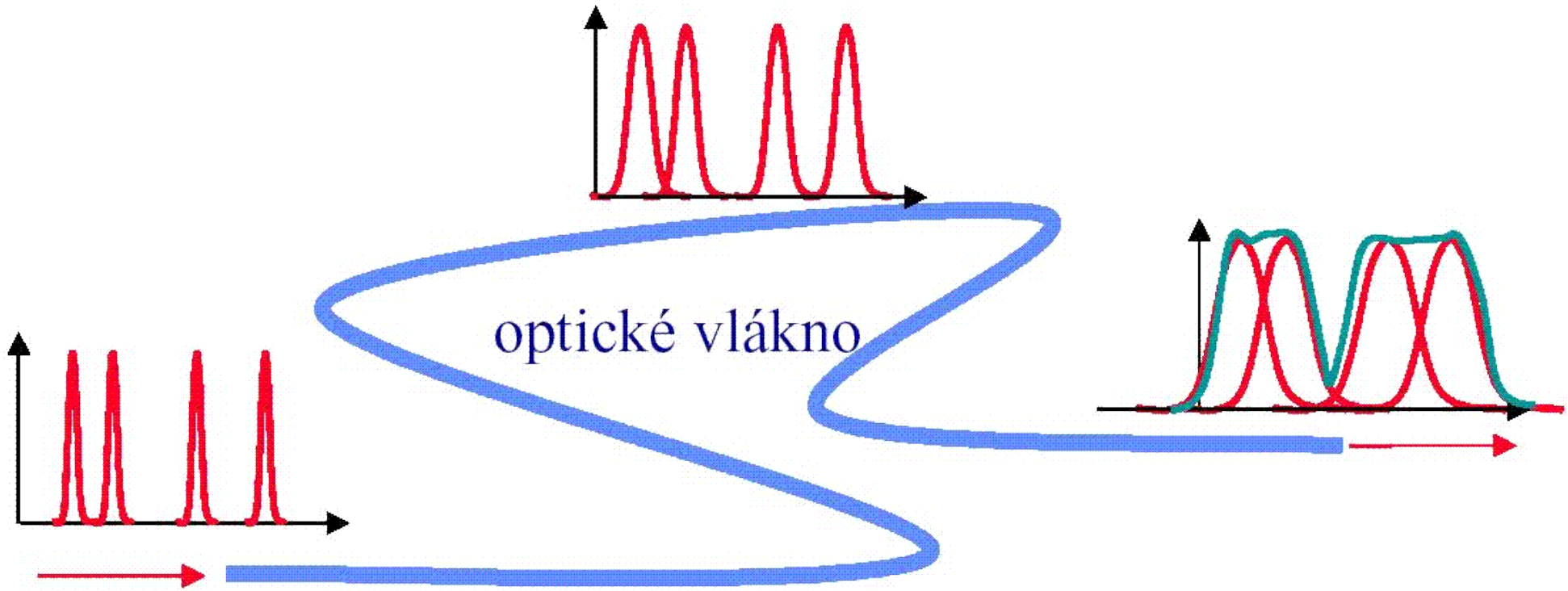
Útlum


dB/km
850 nm band
1300 nm band
1550 nm band
OH-3
10
OH-1
OH-2
1
Rayleigh scattering
0.1
800
1000
1200
1400
1600
nm

Disperze

- vidová
- chromatická

Mezisymbolová interference



Parametry vláken

- útlum, měrný útlum,
- šířka přenosového pásma

	vlákna				rozměr
	50/125	50/125	62.5/125	100/140	um
útlum 850nm		2,6	3,4	3,7	dB/km
útlum 1300nm	0,3	0,48	0,63	0,67	dB/km
bandwidth	~100000	1400	1000	500	MHz.km

Konektory


ST


FC/PC

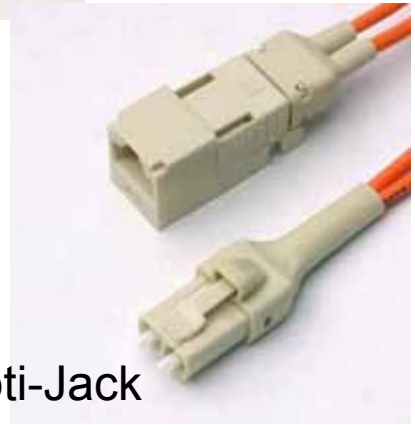

Volition


E2000/LX-5


LC


MU


MT


Opti-Jack


MT-RJ


SC

Poděkování

Děkuji Jiřímu Hájkovi a Janu Janečkovi za poskytnuté materiály využité v této přednášce.