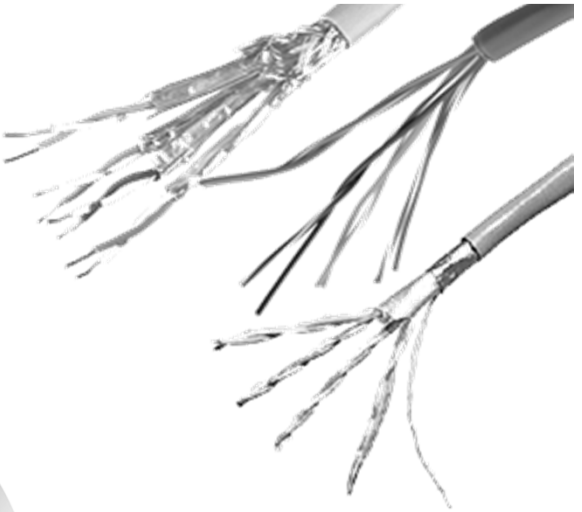
Transmission media

Foundations of computer networks

Classification of media

- Cable



- Wireless

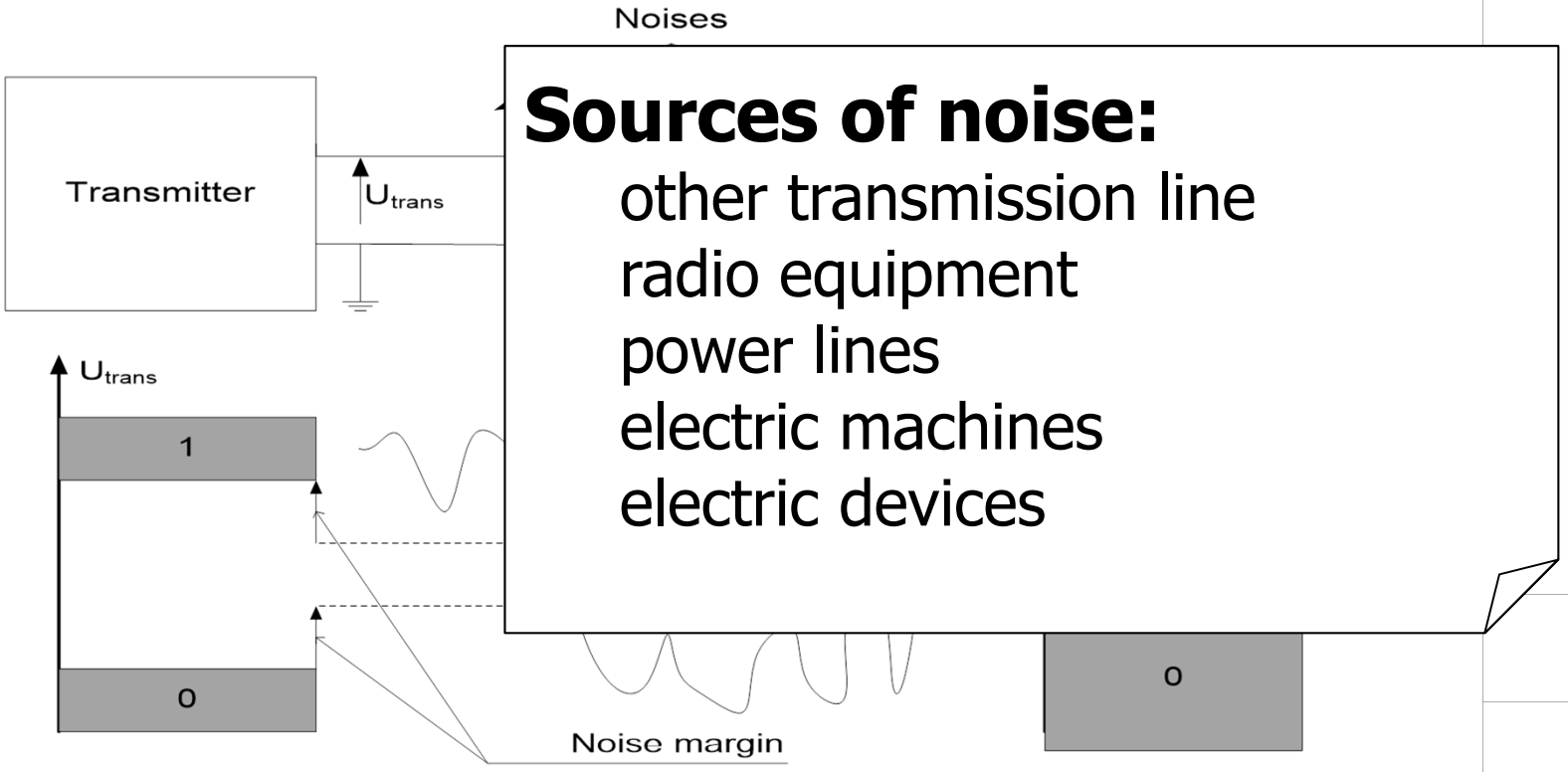
Cables

- Coaxial
- Untwisted pairs
- Twisted pairs
  - unshielded
  - shielded
- Fiber optics

Wireless media

- Radio
  - terrestrial
  - sat
- Optical
  - infrared
  - laser

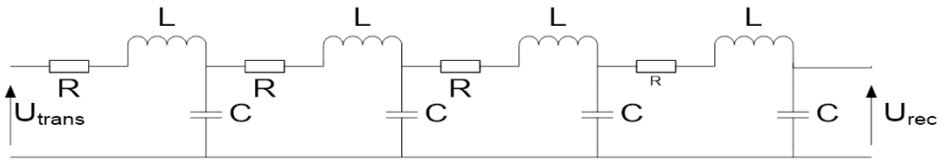
Inferences in electrical circuit

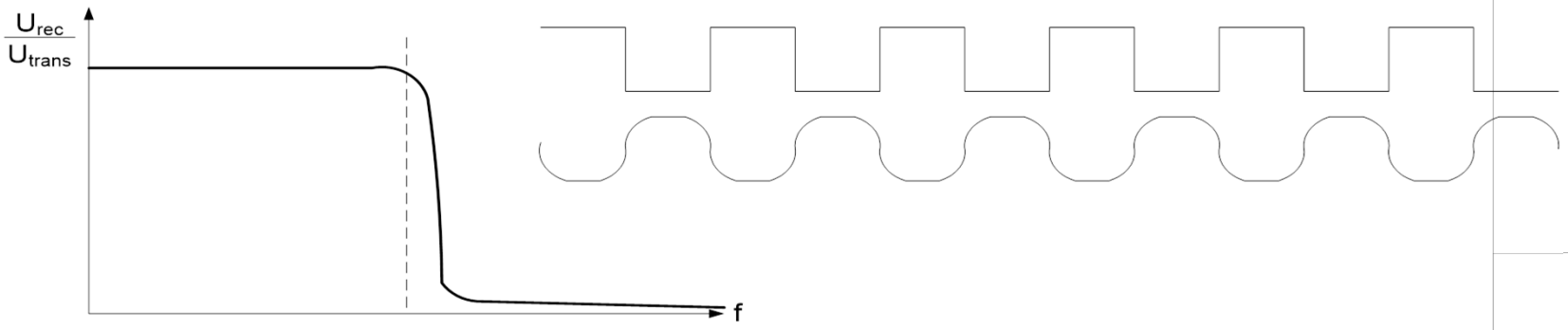


Sources of noise:

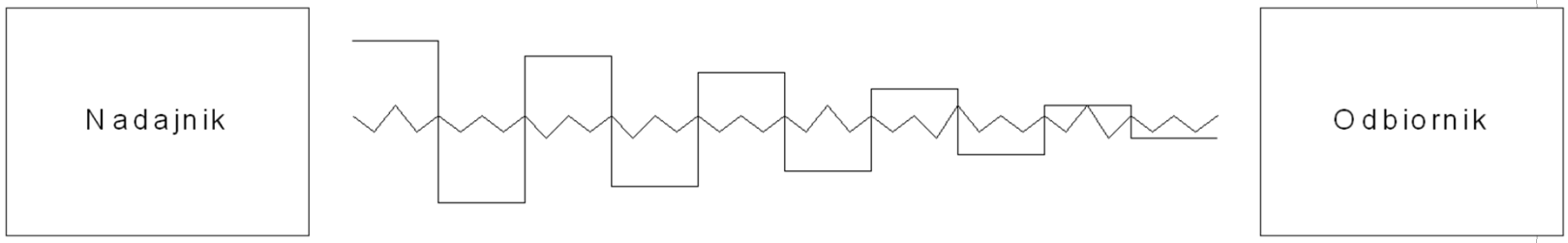
- other transmission line
- radio equipment
- power lines
- electric machines
- electric devices

Parameters of transmission line





Noises and damping



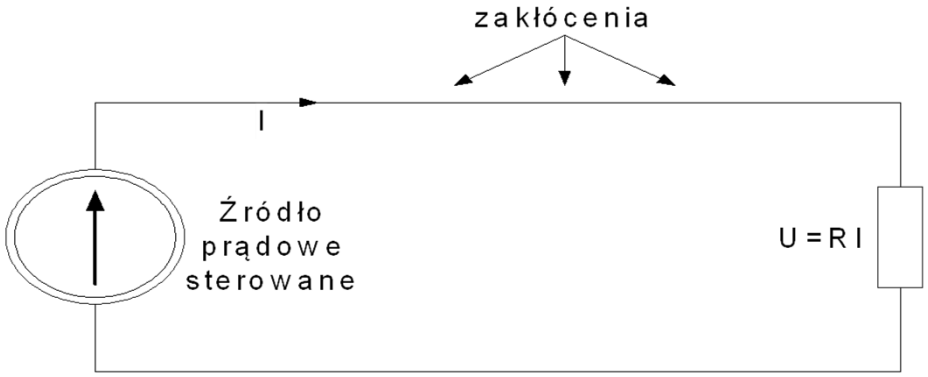
Bandwidth

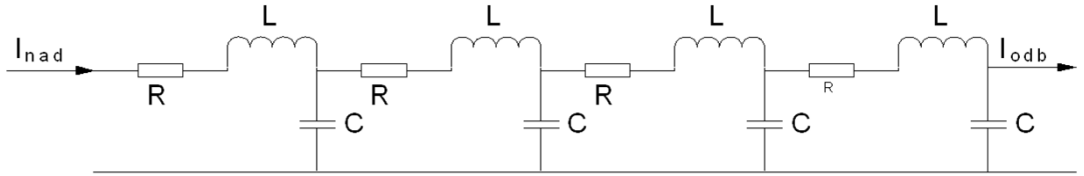
$$W = f_g - f_d$$

Shannon law

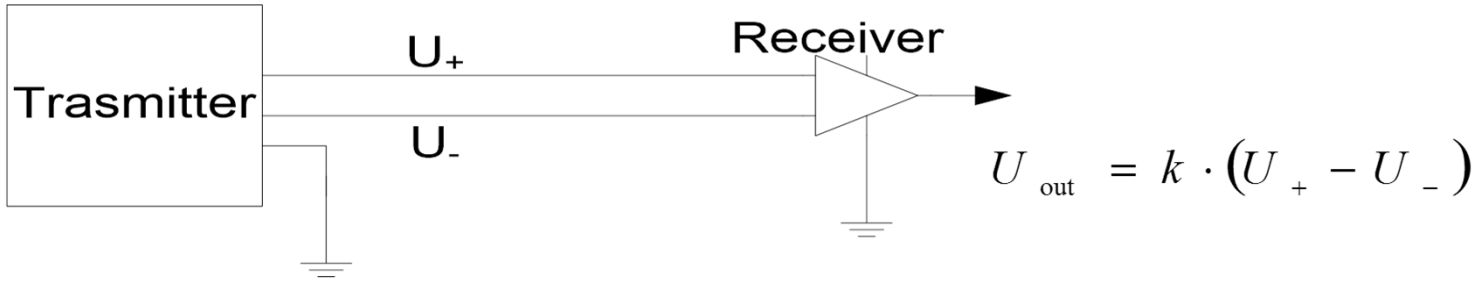
$$P = W \cdot \log_2\left(1 + \frac{S}{N}\right) \left[\text{bit/s}\right]$$

Current transmmission

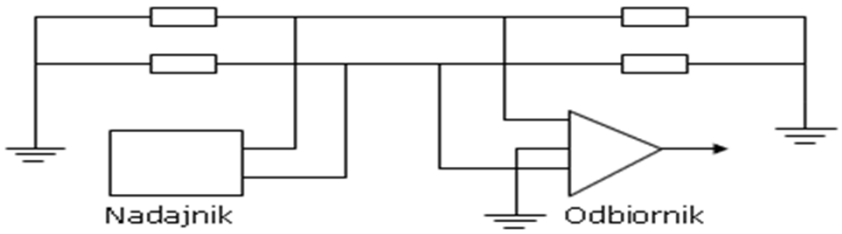




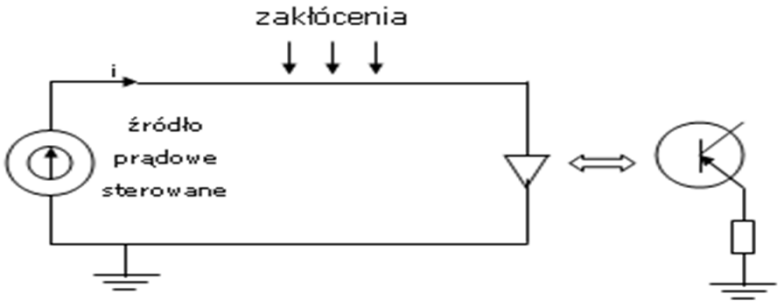
Symetric transmission



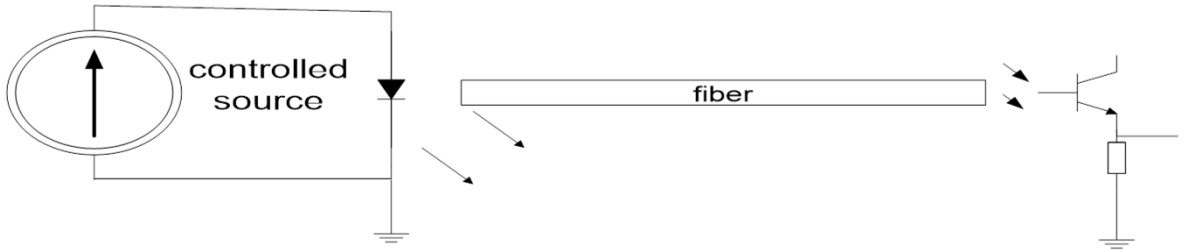
Symetric current transmission



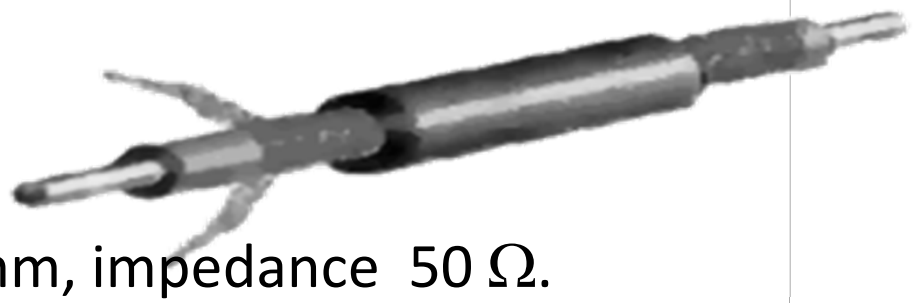
Galvanic isolation



Fiber as medium



Coaxial cables



- 10Base5
  - Fat Ethernet – diameter 10mm, impedance 50 Ω. Maximal length of segment 500m. The both ends of cable must have suppressor. Nowadays not in use.
- 10Base2
  - Thin Ethernet – diameter 5 mm. Maximal length of segment 185m. Also called as RG 58. Nowadays not in use.
- RG 62
  - Had been applied in ARCNET at the beginning of ’90.

BNC

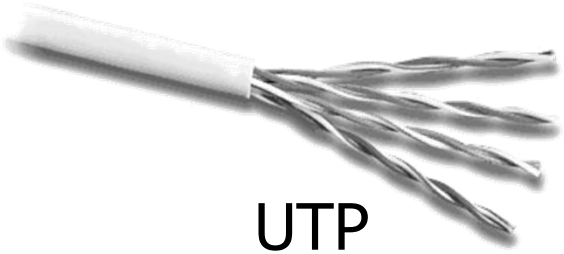
Twisted pairs

- Unshielded Twisted Pair - UTP
- Foiled Twisted Pair - FTP
- Shielded Twisted Pair - STP

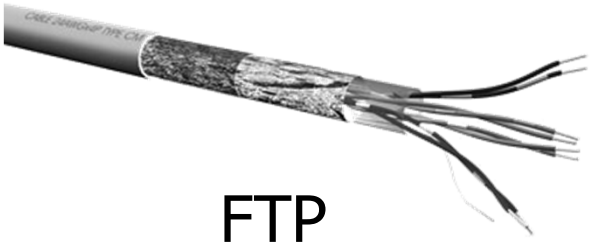
Classes (categories)

- A (cat.1) – telephone services to 100kHz
- B (cat.2) – voice and terminal services to 1MHz, four pairs UTP (IBM) 4Mb/s
- C (cat.3) – LAN to 16MHz, 10Mb/s (Ethernet), 4Mb/s (Token Ring)
- cat.4 – 16Mb/s (Token Ring)
- D (cat.5) – LAN to 100MHz, 100Mb/s (Fast Ethernet)
- D extended (cat.5e)
- E (cat.6) – 250MHz (Gb ethernet, ATM 622Mb/s)
- F (cat.7) – 600MHz (STP, >1Gb/s)

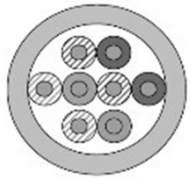
Cat 5 and 5e

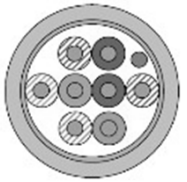


UTP

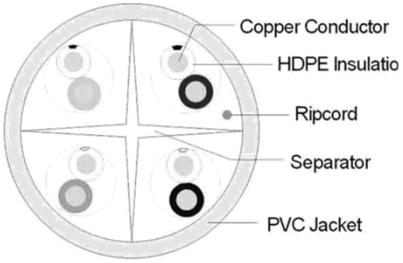


FTP

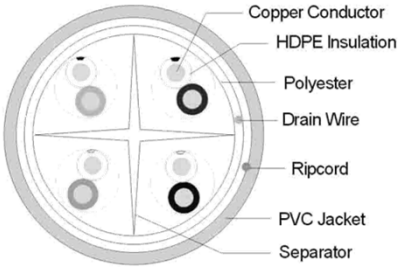




Cat 6

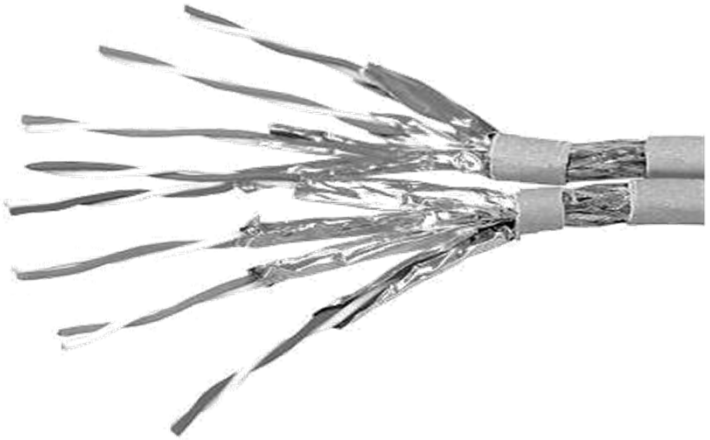


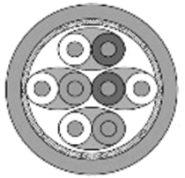
UTP Cat 6

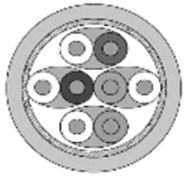


FTP Cat 6

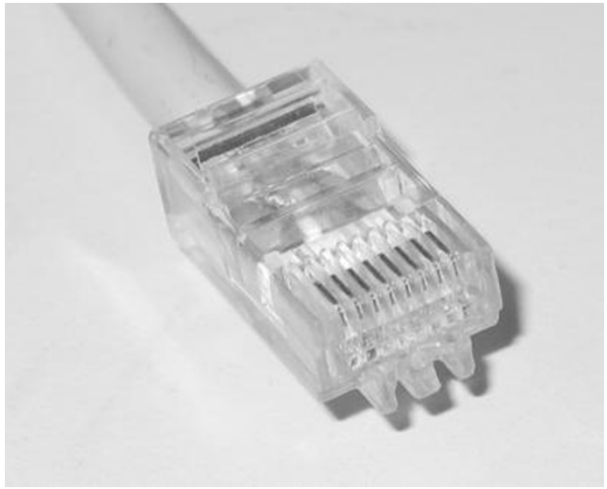
Cat 7

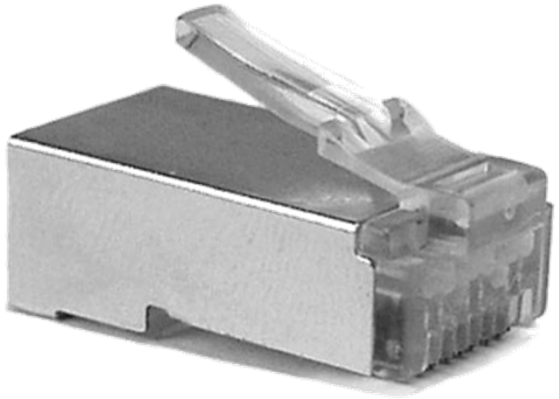






RJ-45





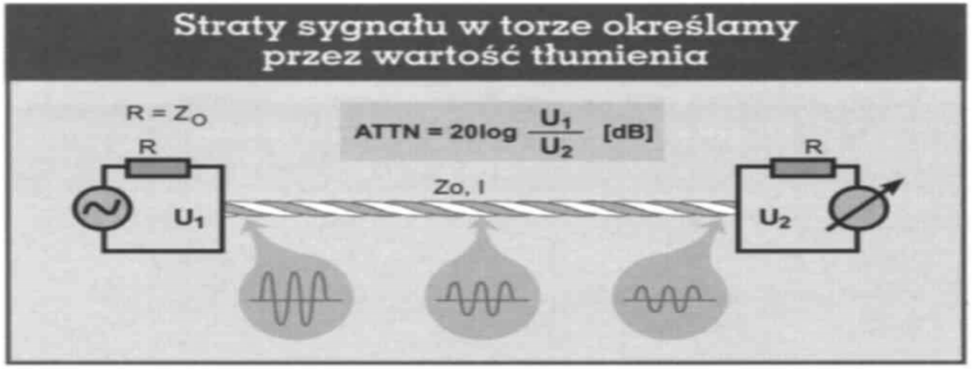
Attenuation

The decrease in the signal level on the road - defined in dB / 100m. This causes a reduction in signal-to-noise ratio, and thus the throughput.

Dopuszczalne wartości tłumienia w kanale (w dB)

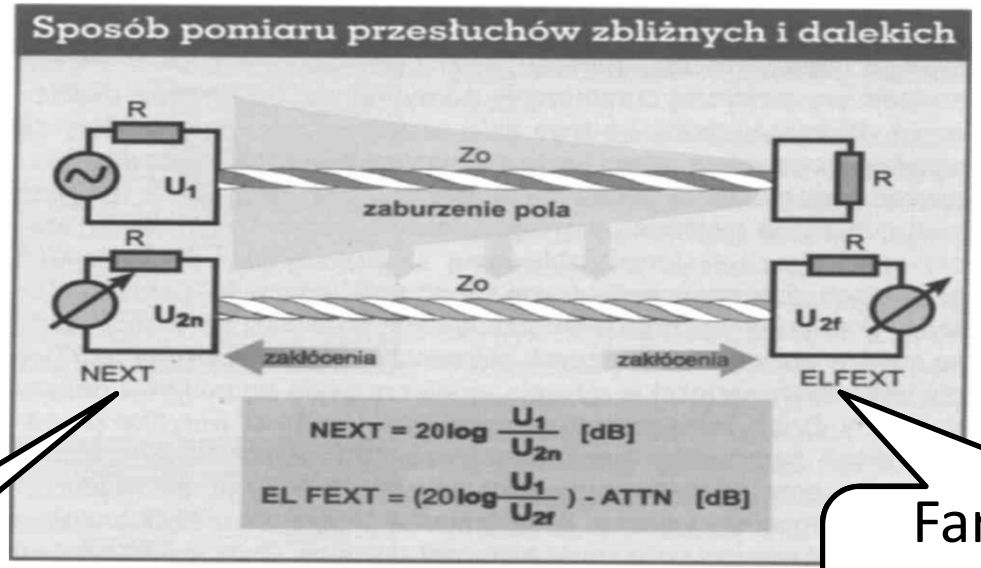
Częstotliwość	Klasa D	Klasa E	Klasa F	1000BASE-T
100 MHz	24,0	21,1	20,8	24,0
250 MHz		35,9	33,8	
600 MHz			54,6	

długość toru 100 m



Crosstalk

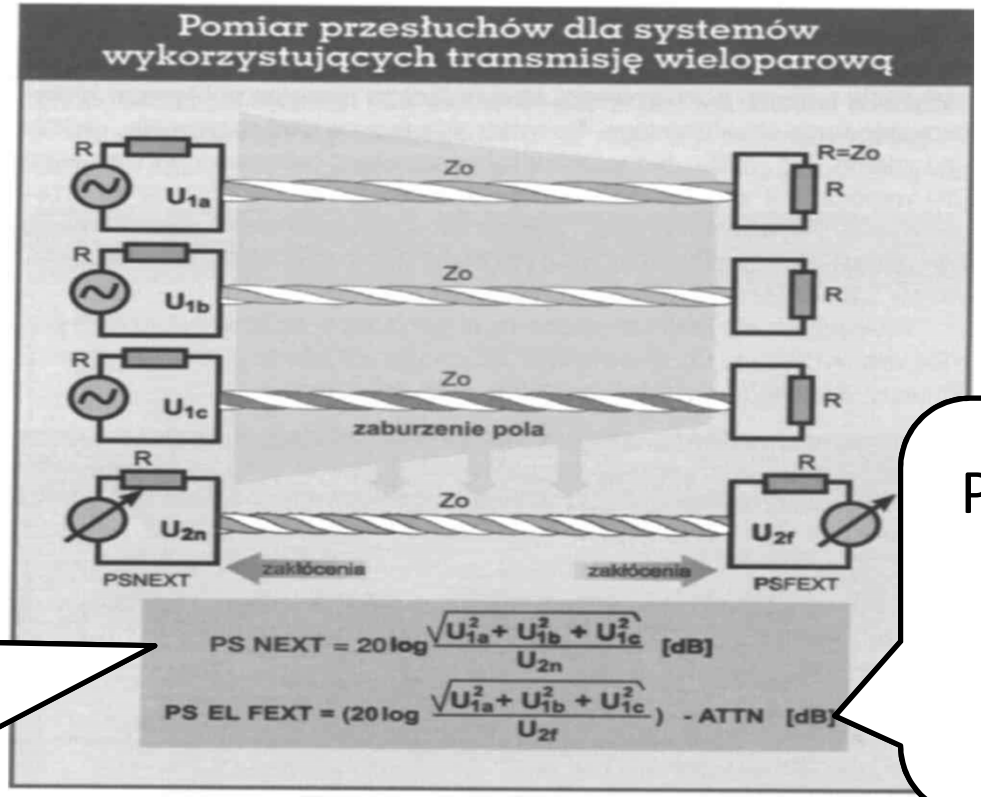
The penetration of the signal from one pairs to another. It is referred in [dB].



Near End Crosstalk

Far End Crosstalk with Attenuation Compensation

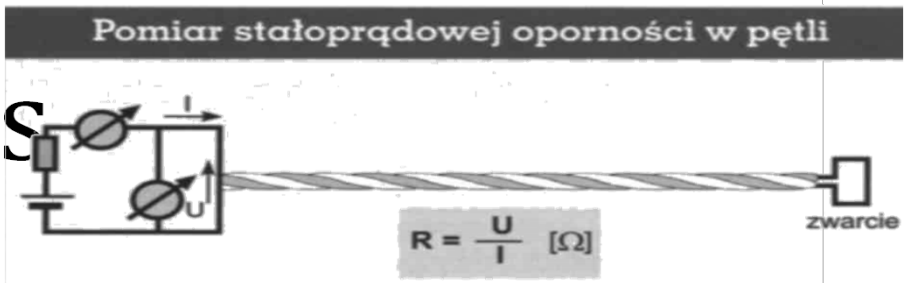
Power Sum Crosstalk



Power SumNear End Crosstalk

Power Sum Far End Crosstalk with Attenuation Compensation

Other parameters



- Unit capacity
  - capacity between pair of wires or between wire and sheld
- Impedance
  - It depends on the design of the cable and not the length of it; the typical values for coaxial cables are 50, 75, 93Ω, and for twisted cables are 100, 150, 300Ω

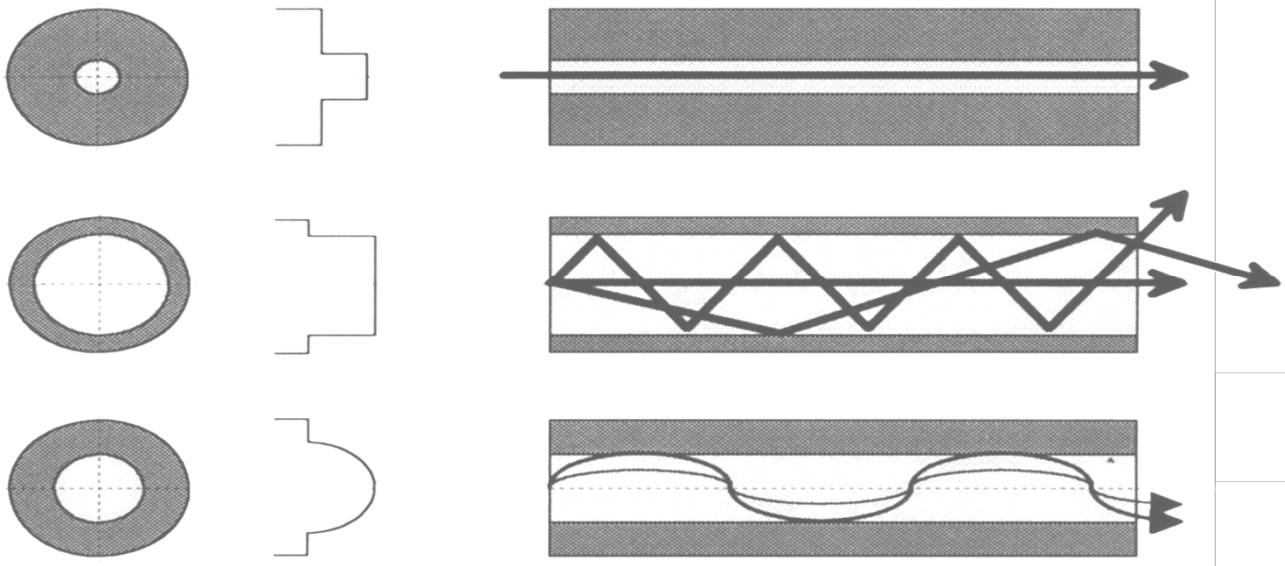
Other parameters

- Backround noise
  - Voltage rising intrinsically in wire matarial, not as the result of transmitter activity. It occurs due to thermal move of electrons and external inference.

Optic fiber

- single-mode
- multi-mode
- gradient

Modal dispersion Specifies the usefulness of the fiber for transmission over long distances. It causes the distortion of the output optical fiber due to different time of arrival of each ray to the receiver.



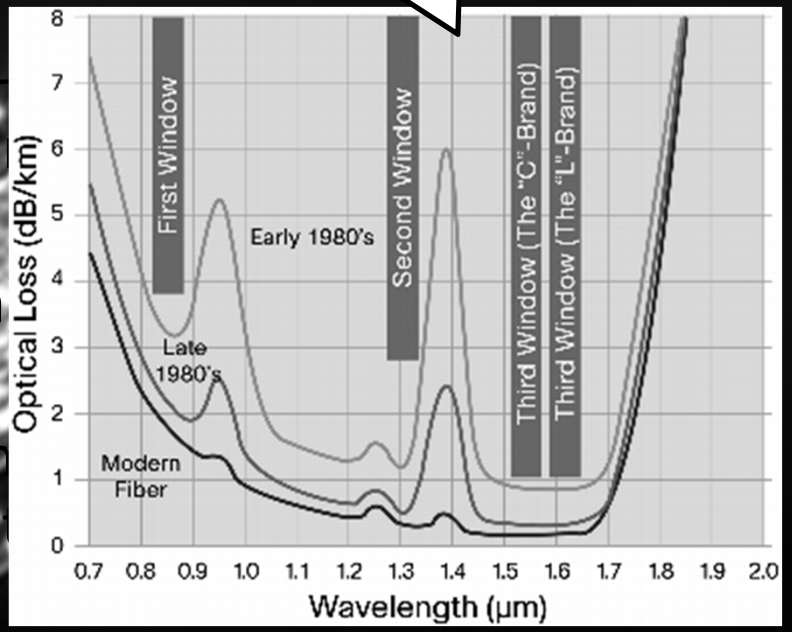
Light sources:

- LED
- laser

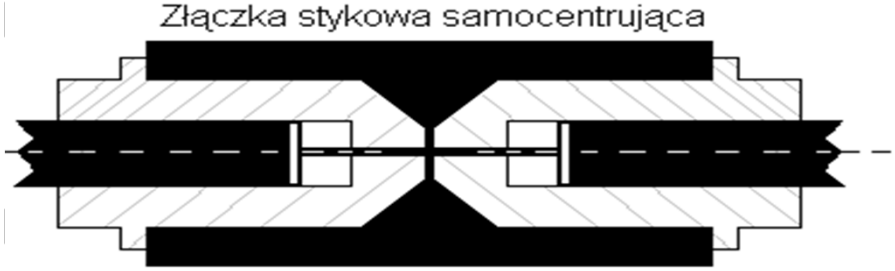
Optic fiber generations

- I (transmission window 850nm) - Glass) multi-mode fiber, the atte bandwidth 50Mb/s
- II (transmission window 1300nm attenuation 0,4dB/km
- III (window 1550nm) attenuation dB/km, dystance between repea dispersion
- IV – applying wideband optical amplifiers EDFA, commutation wave multiplication WDM
- V - SOLITONS 360 Tb/s/km = 10 Gb/s – 36000km

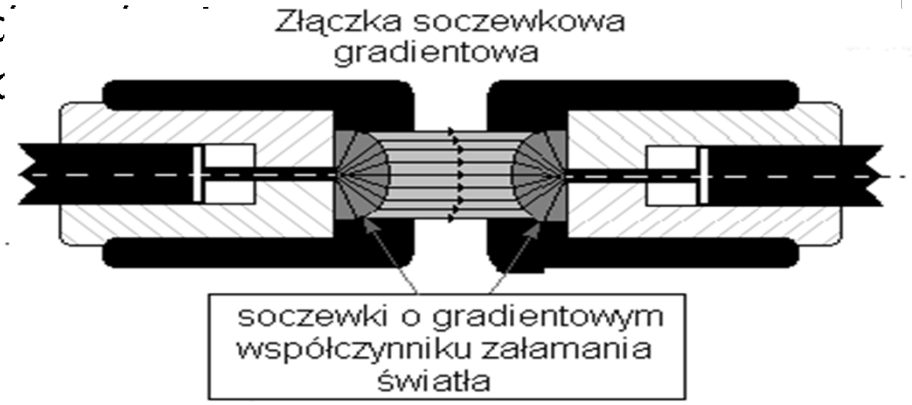
Source: cisco.com



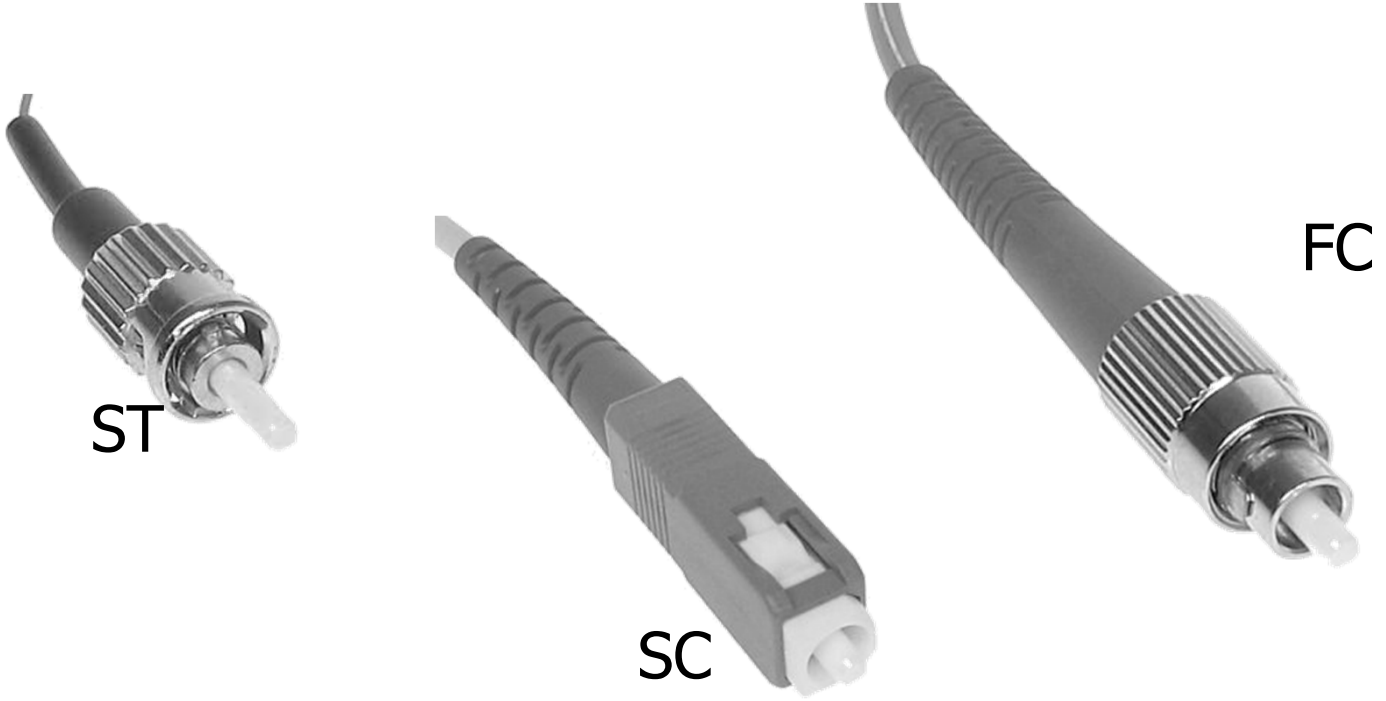
Connections of fibers

- 

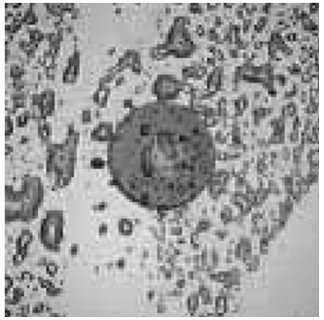
  n roztopieniu włókna w
  0,1 dB na spaw
-
  - do krosowania w sieciach w postaci krótkich odcinków zakończone są złączkami patc
    samocentrujące lub soczewk

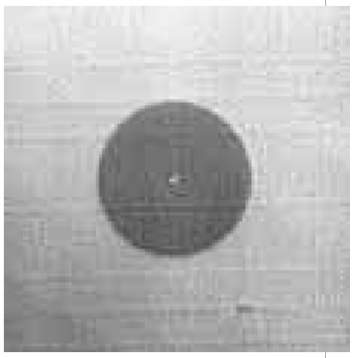


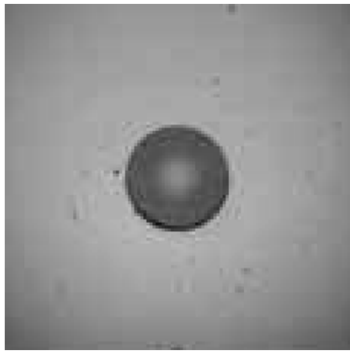
Fiber connectors



Tester złącz i wtyków optycznych FT300







Ranges of radio connections

GSM – 900 MHz

DCS – 1800 MHz

DECT – 1890 MHz

VSAT – 12,5 GHz

Bluetooth - 2,4 GHz

ZigBee - various

Standard IEEE	Szybkość transmisji	Pasmo częstotliwości
802.11	1 Mb/s 2 Mb/s	2,4 GHz
802.11a	do 54 Mb/s	5 GHz
802.11b	5,5 Mb/s 11 Mb/s	2,4 GHz
802.11g	do 54 Mb/s	2,4 GHz

802.11n 2,4/5GHz do 600Mb/s

Modulation

$$S(t) = A(t)\sin\left[2\pi f(t) + \Phi(t)\right]$$

- AM – amplitude
- FM – frequency
- PM – phase

❖analog modulation

❖digital modulation (switching)