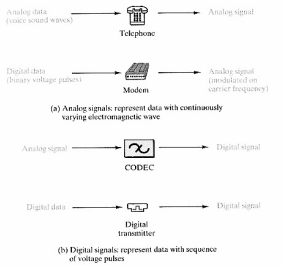
3. Andmed (info) ja signaalid



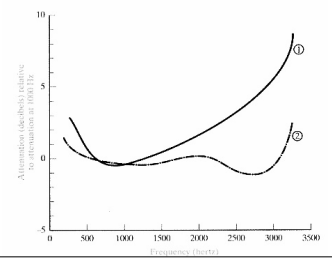
Joonis 12. Analoog- ja digitaalsignaalide kasutamine

source: Stallings

4. Häired andmesides

- Sumbuvus ja sumbuvusest tingitud moonutused
- Hilistumisest tingitud moonutused
- Mürad

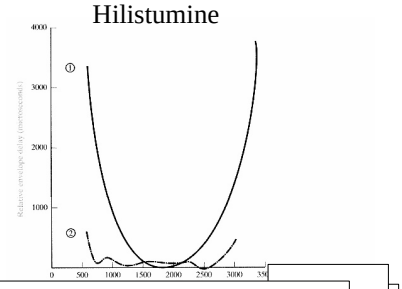
Sumbuvus



Joonis 13. Sumbuvus telefonikanalis

source: Stallings

Hilistumine



Joonis 14. Hilistumisest tingitud moonutused telefonikanalis

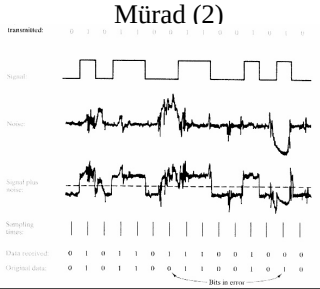
source: Stallings

Mürad

- Termiline müra (“valge” müra)
  - $N_0=kT$
  - $N=N_0B$
- Intermodulatsioonimüra
- Ülekostvus
- Impulssmüra
- Signaali/müra suhe:

$$(S/N)_{dB}=10\log \frac{\text{signaali võimsus}}{\text{müra võimsus}}$$

Mürad (2)



Joonis 15. Müra mõju digitaalsignaalile

source: Stallings

5. Kanali maht

- Kanalimaht C on teoreetilselt maksimaalne andmeedastuskiirus kanalis valge müre tihedusega N_0, mille korral on võimalik saavutada kuitahes väike vea esinemise tõenäosus. [bit/s]

$$C = B \log_2 (1+S/N)$$

- Andmeedastuskiirus R näitab, mitu bitti informatsiooni edastatakse ajaühikus. [bit/s]

$$C \geq R$$

Kanali efektiivsus

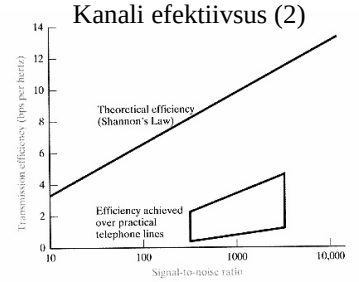
- Kanali efektiivsust väljendab suhe:

$$C / B \text{ [bit/s/Hz]}$$

- Tihti on signaali/müra suhte asemel mugavam kasutada järgmist suurust:

$$\frac{E_b}{N_0} = \frac{S/R}{N_0} = \frac{S}{kTR}$$

Kanali efektiivsus (2)

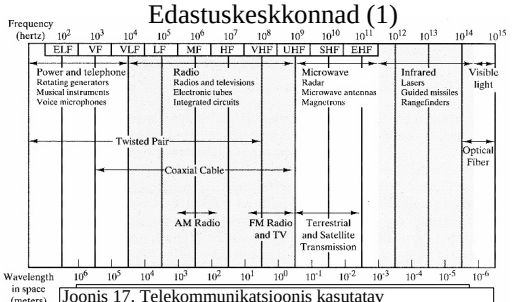


Joonis 16. Teoreetiline ja reaalselt saavutatav kanali efektiivsus

source: Stallings

6. Edastuskeskkonnad

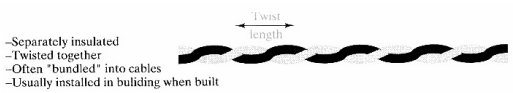
Edastuskeskkonnad (1)



Joonis 17. Telekommunikatsioonis kasutatav elektromagnetiline spekter

source: Stallings

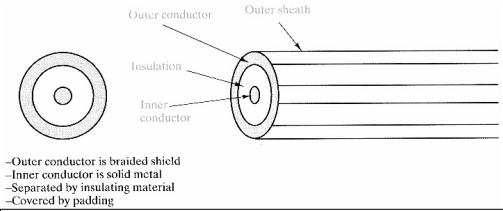
Juhitud keskkonnad (1)



Joonis 18. Keerutatud paar

source: Stallings

Juhitud keskkonnad (2)

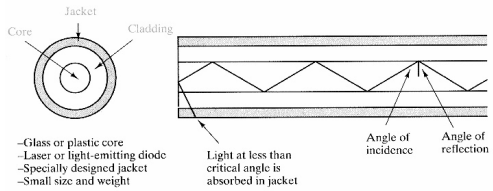


–Outer conductor is braided shield
–Inner conductor is solid metal
–Separated by insulating material
–Covered by padding

Joonis 19. Koaksiaalkaabel

source: Stallings

Juhitud keskkonnad (3)



–Glass or plastic core
–Laser or light-emitting diode
–Specially designed jacket
–Small size and weight

Light at less than critical angle is absorbed in jacket

Joonis 20. Fiiberoptiline kaabel

source: Stallings

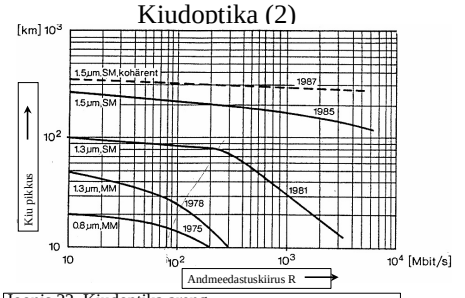
Kiudoptika (1)

Fiber type	Core diameter (μm)	Cladding diameter (μm)	Attenuation (dB/km) (Max) 850 nm	1300 nm	1500 nm	Bandwidth (MHz/km) (Max)
Single Mode	5.0	85 or 125	2.3			5000 @ 850 nm
	8.1	125		0.5	0.25	
Graded-index	50	125	2.4	0.6	0.5	600 @ 850 nm 1500 @ 1300 nm
	62.5	125	3.0	0.7	0.3	200 @ 850 nm 1000 @ 1300 nm
	100	140	3.5	1.5	0.9	300 @ 850 nm 500 @ 1300 nm
Step-index	200 or 300		380 or 440	6.0		6

Joonis 21. Kiudoptiliste kaablite karakteristikud

source: Stallings

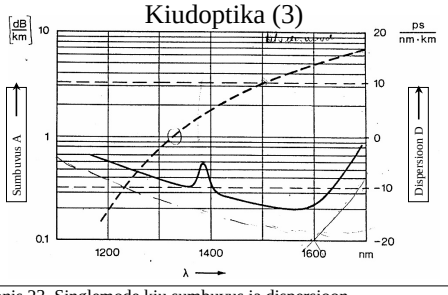
Kiudoptika (2)



Joonis 22. Kiudoptika areng.
MM: Multimode-kiud; SM: Singlemode-kiud

source: Leuthold

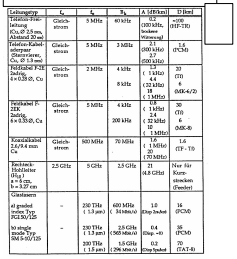
Kiudoptika (3)



Joonis 23. Singlemode kiu sumbuvus ja dispersioon
——— sumbuvus; – – – dispersioon

source: Leuthold

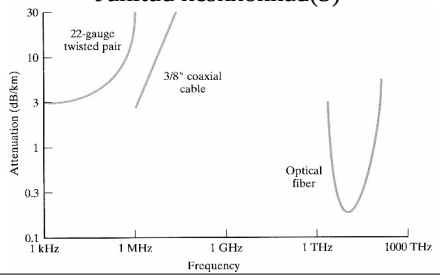
Juhitud keskkonnad(4)



Joonis 24. Mõnede oluliste kaablitüüpide parameetrid
(L = 1km)

source: Leuthold

Juhitud keskkonnad(5)



Joonis 25. Sumbuvus erinevates kaablitüüpides

source: Stallings

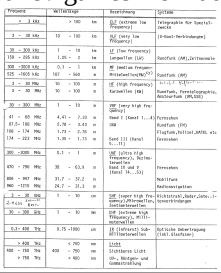
Vaba leviga keskkonnad (1)

Frequency band	Name	Analog data Modulation	Analog data Bandwidth	Digital data Modulation	Digital data Data rate	Principal applications
30–300 kHz	LF (low frequency)	Generally not practical		ASK, FSK, MSK	0.1–100 bps	Navigation
300–3000 kHz	MF (medium frequency)	AM	To 4 kHz	ASK, FSK, MSK	10–1000 bps	Commercial AM radio
3–30 MHz	HF (high frequency)	AM, SSB	To 4 kHz	ASK, FSK, MSK	10–3000 bps	Shortwave radio CB radio
30–300 MHz	VHF (very high frequency)	AM, SSB; FM	5 kHz to 5 MHz	FSK, PSK	To 100 kbps	VHF television FM radio
300–3000 MHz	UHF (ultra high frequency)	FM, SSB	To 20 MHz	PSK	To 10 Mbps	UHF television Terrestrial microwave
3–30 GHz	SHF (super high frequency)	FM	To 500 MHz	PSK	To 100 Mbps	Terrestrial microwave Satellite microwave
30–300 GHz	EHF (extremely high frequency)	FM	To 1 GHz	PSK	To 750 Mbps	Experimental short point-to-point

Joonis 26. Vaba levi lainealade karakteristikud

source: Stallings

Vaba leviga keskkonnad (2)



Joonis 27. Vaba levi lainealade rakendusvaldkonnad

source: Leuthold