Sustavi
za praćenje i vođenje procesa

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Fakultet elektrotehnike i računarstva

Zavod za elektroničke sustave i obradbu informacija

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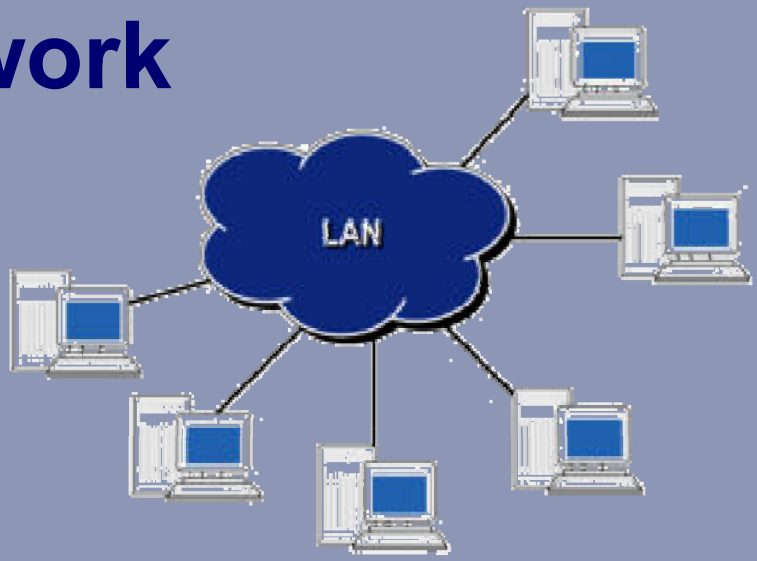
Lokalne računalne mreže

LAN
Local Area Network



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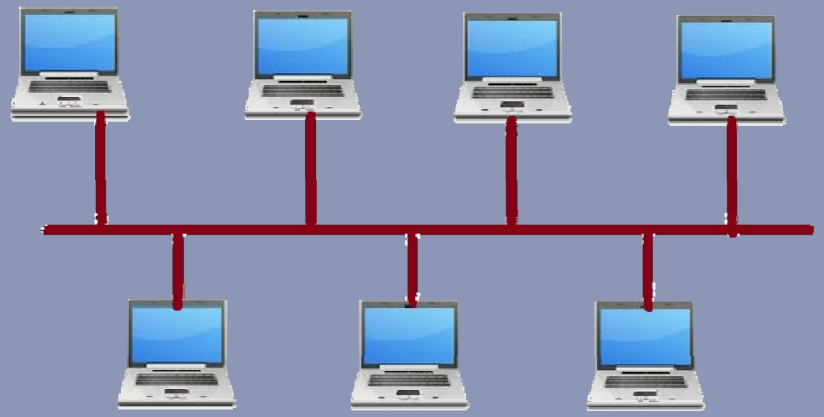
Što su lokalne računalne mreže ?

- **zemljopisno** su **omeđene**
  - jedna zgrada (soba)
  - ili skupina zgrada u dometu vidljivosti (“campus”)
- **jedan vlasnik**
- brzine prijenosa podataka **10 Mbps** i veće
  - iako neki smatraju da je već i 2 Mbps dovoljno



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Što je IEEE 802 ?

- *Institute of Electrical and Electronic Engineers*

- **skupina standarda** za **lokalne** računalne mreže (**LAN**)
  - 802.1 - uvod
  - 802.2 - gornji dio Data Link Layer-a (LLC)
  - 802.3 - CSMA/CD (Ethernet)
  - 802.4 - Token Bus
  - 802.5 - Token Ring

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IEEE 802.1	Bridging (networking) and Network Management
IEEE 802.2	Logical link control
IEEE 802.3	Ethernet
IEEE 802.4	Token bus
IEEE 802.5	Defines the MAC layer for a Token Ring
IEEE 802.6	Metropolitan Area Networks
IEEE 802.7	Broadband LAN using Coaxial Cable
IEEE 802.8	Fiber Optic TAG
IEEE 802.9	Integrated Services LAN
IEEE 802.10	Interoperable LAN Security
IEEE 802.11	Wireless LAN & Mesh (Wi-Fi certification)
IEEE 802.12	demand priority
IEEE 802.13	
IEEE 802.14	Cable modems
IEEE 802.15	Wireless PAN
IEEE 802.15.1	Bluetooth certification
IEEE 802.15.4	ZigBee certification
IEEE 802.16	Broadband Wireless Access (WiMAX certification)
IEEE 802.16e	(Mobile) Broadband Wireless Access
IEEE 802.16.1	Local Multipoint Distribution Service
IEEE 802.17	Resilient packet ring
IEEE 802.18	Radio Regulatory TAG
IEEE 802.19	Coexistence TAG
IEEE 802.20	Mobile Broadband Wireless Access
IEEE 802.21	Media Independent Handoff
IEEE 802.22	Wireless Regional Area Network

IEEE 802.3

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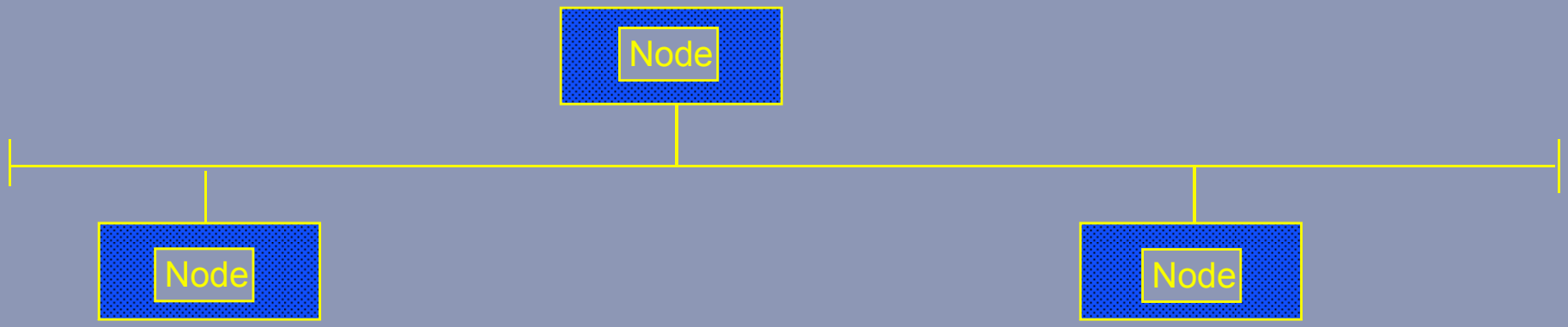
802.3 - CSMA/CD



- sabirnica
- **C**arrier **S**ense **M**ultiple **A**ccess with **C**ollision **D**etection
- ***Ethernet*** je samo jedna primjena (proizvod) 802.3
- standard definira
    - medij
    - konektore
    - električke karakteristike
    - protokol
    - format podataka

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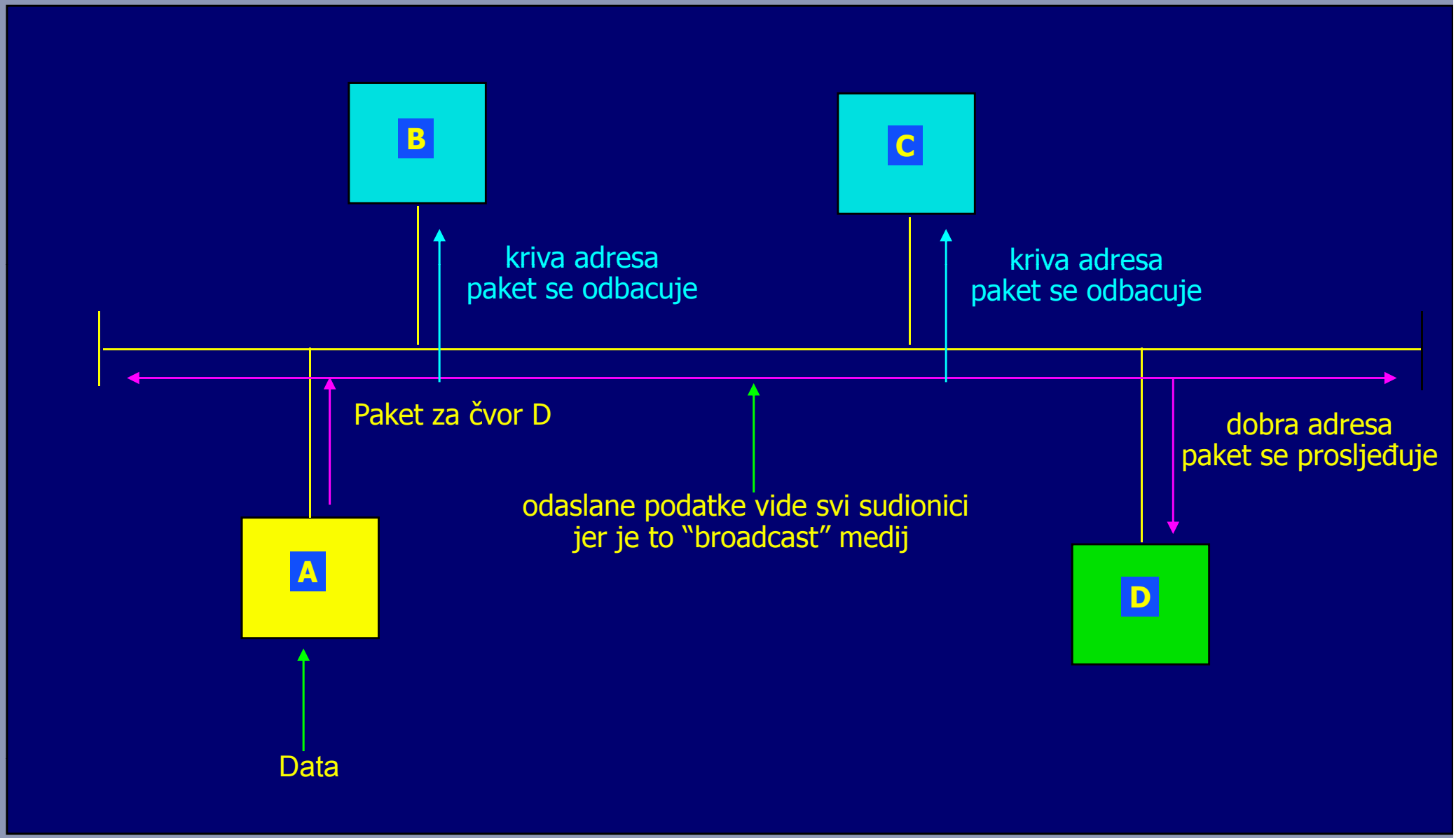
802.3 - kako radi ?



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802.3 - kako radi ?

- primanje
  - **osluškujem** medij i primam **sve poruke**
  - gledam **adresu** u poruci
  - ako **nije** za mene, **odbacim**
  - ako **je** za mene, **proslijedim**
    - višim razinama softvera

- slanje
  - **osluškujem** da li je medij **slobodan**
  - čim **jest**, **šaljem**
  - dok šaljem, slušam priča li još i netko drugi
  - ako priča, prestanem slati i zagalamim
  - čekam slučajni iznos vremena i krenem od početka

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802.3 - mediji i konektori

- **izvorno** je definiran **koaksijalni kabel**
  - “debeli” , “žuti”
  - “tanki”, “radioamaterski”
- **danas** se uglavnom koristi
  - upletena parica, twisted pair (TP)
    - oklopljena (STP)
    - neoklopljena (**UTP**)
    - “foil” (FTP)
  - svjetlovod

Naziv	Tanki koaksijani	Debeli koaksijalni	Neoklopljena parica	Svjetlovod
Tip žice	RG-8	RG-58	22 - 26 AWG	62.5/125 micron
IEEE Naziv	10BASE5	10BASE2	10BASET	10BASEF
Oznaka standarda	IEEE 802.3	IEEE 802.3a	IEEE 802.3i	N/A
druge oznake	“tanka mreža”	“debela” mreža	UTP	

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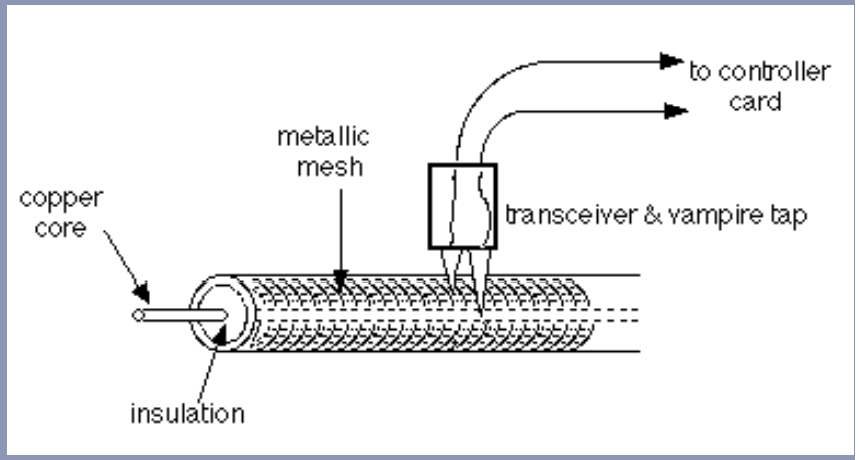
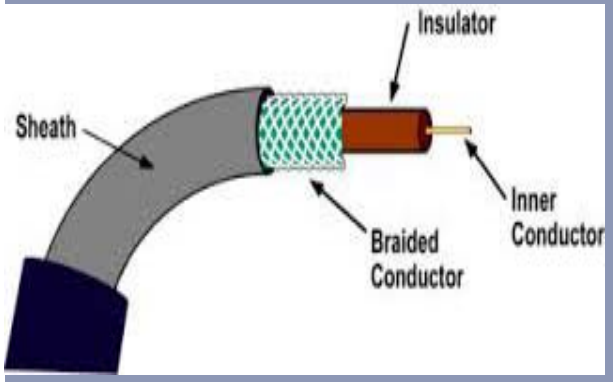
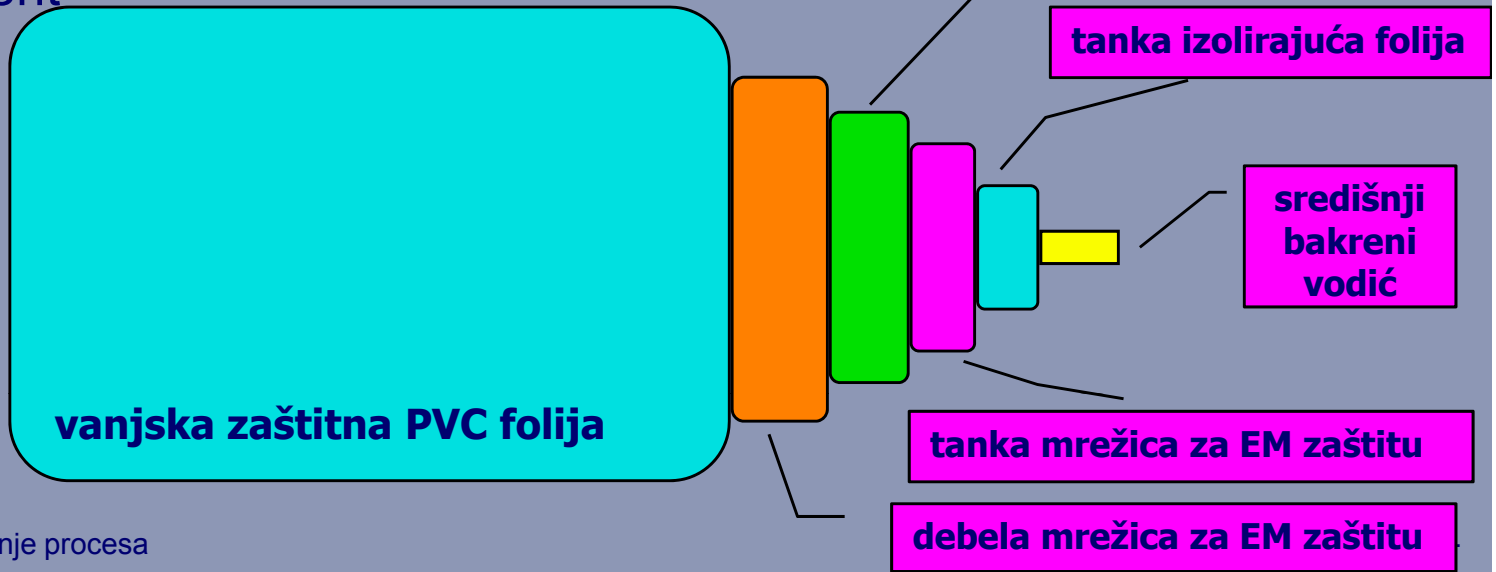
802.3 - koaksijalni kabel

- izvorno je definiran koaksijalni kabel
  - **50 Ohma**
  - zaključenje na oba kraja



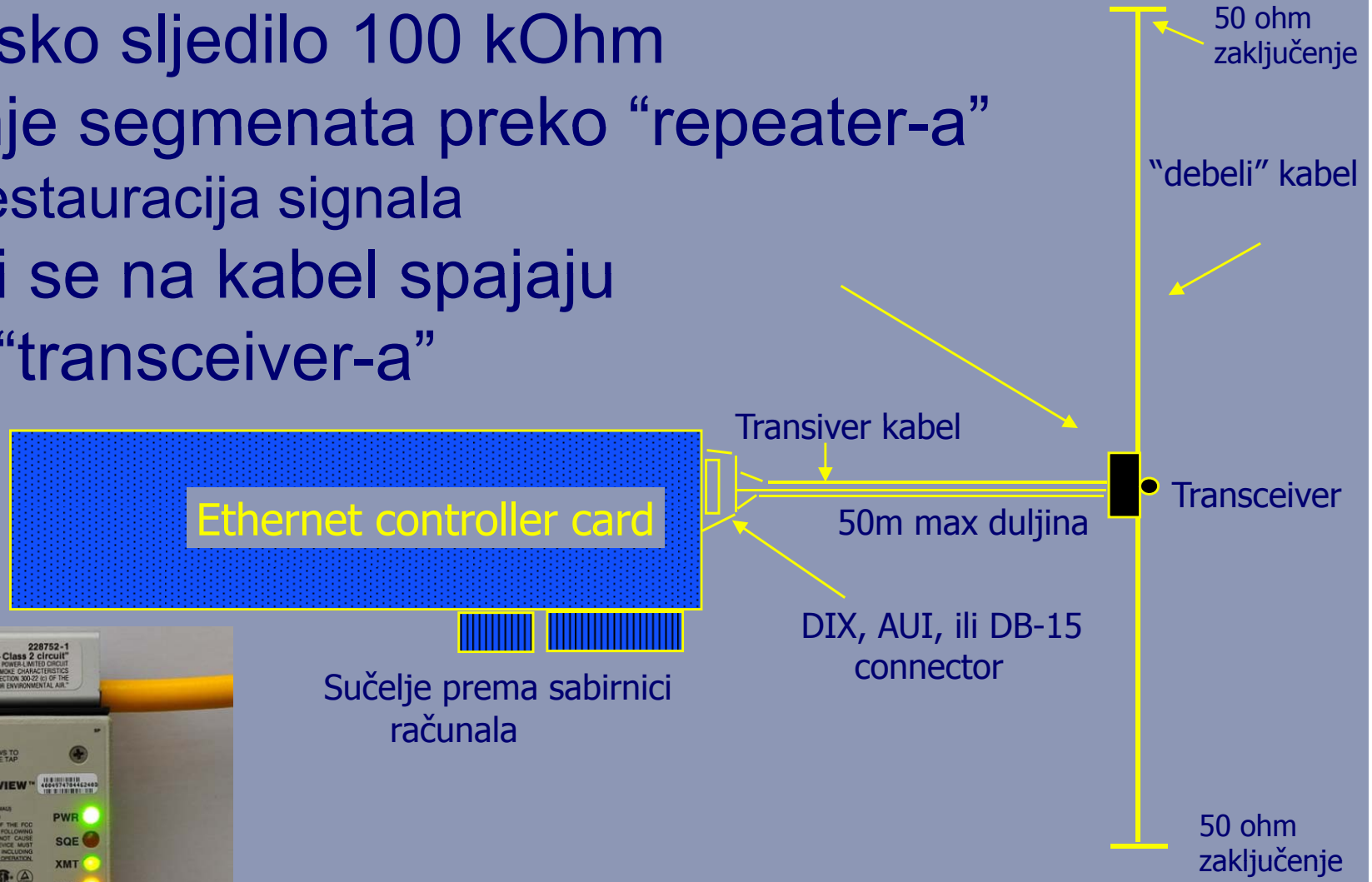
- dvije izvedbe
  - 802.3: “debeli” , “žuti”
    - “vampire-tap”
    - 500 m segment
  - 802.3a: “tanki”, “radioamaterski”
    - BNC konektor
    - 185 m segment





802.3 - električke karakteristike

- 80 mA (na 25 Ohm) = -2V
- naponsko sljedilo 100 kOhm
- spajanje segmenata preko “repeater-a”
  - restauracija signala
- uređaji se na kabel spajaju preko “transceiver-a”



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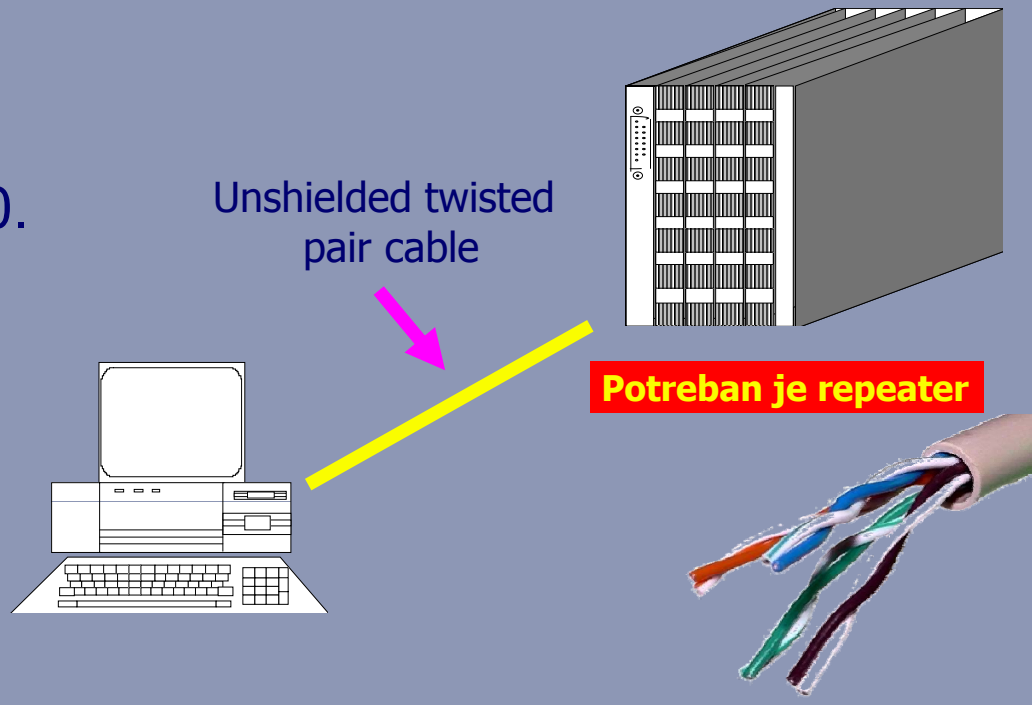
802.3i - UTP kabel

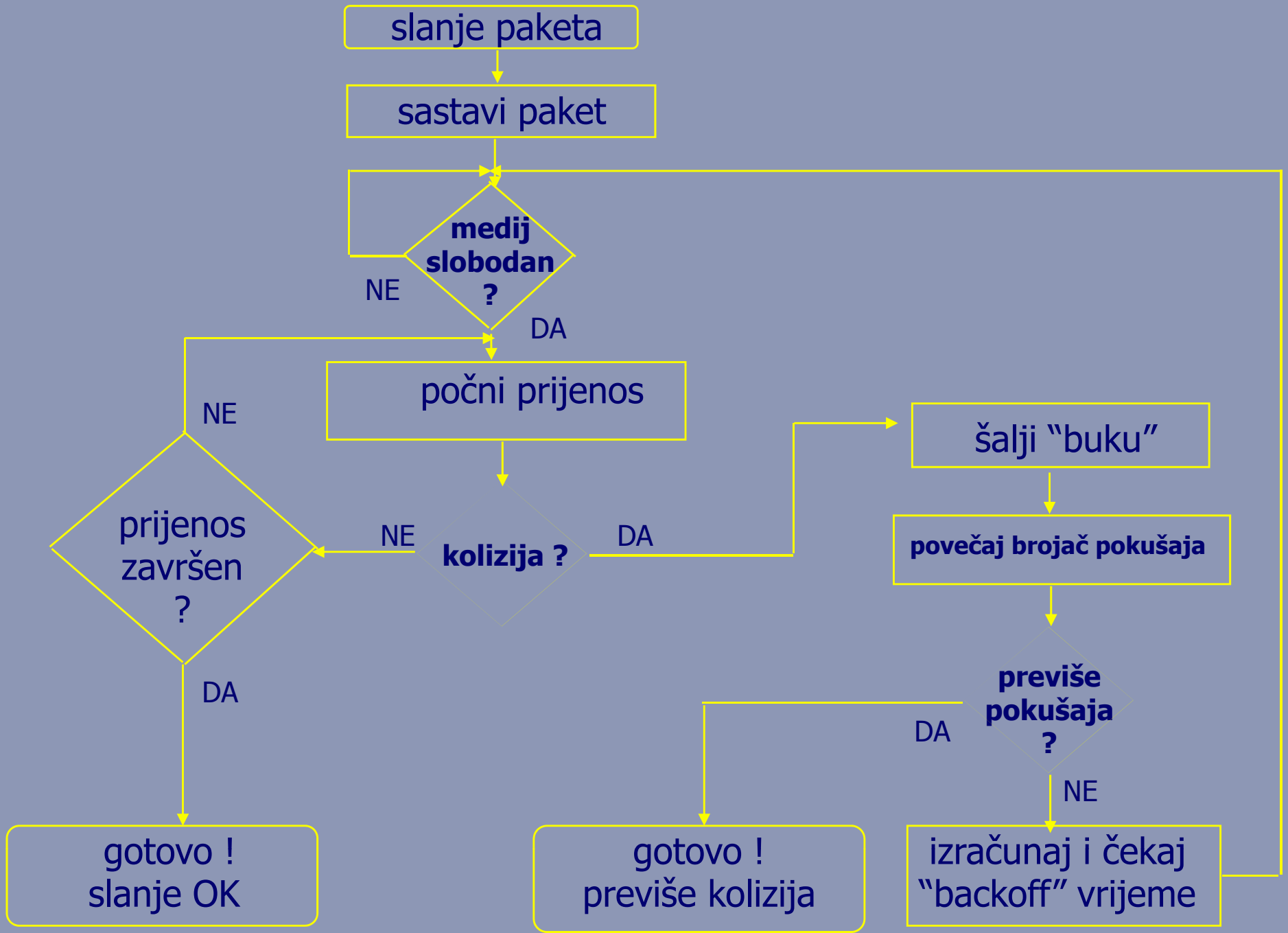
- UTP je standardiziran od 1990.
  - EIA standard TIA 568A
  - ISO/IEC 11801
- 8 vodiča
  - upletena parica
- tri kategorije kabela



Kategorija	Primjena	Brzina	Pin
Cat 3	LAN	10 Mbps	1,2,3,6
Cat 4	LAN	16 Mbps	1,2,3,6
Cat 5	LAN	100 Mbps	1,2,3,6
Cat 6	LAN	1 Gbps	svi
Cat 6a	LAN	10 Gbps	svi
Cat 7	LAN, Telefon, CCTV	10 Gbps	svi
Cat 7a	LAN, Telefon, CCTV	10 Gbps	svi
Cat 8	LAN, Telefon, CATV	40 Gbps	svi
Cat 8a	LAN, Telefon, CATV	40 Gbps	svi

Pin	Signal Name	Description	cable wire color	Name	Pin
1	TX+_D1	Transmit Data+	White with orange stripe	TX+_D1	1
2	TX-_D1	Transmit Data-	Orange with white stripe or solid orange	TX-_D1	2
3	RX+_D2	Receive Data+	White with green stripe	RX+_D2	3
4	BI+_D3	Bi-directional+	Blue with white stripe or solid blue	BI+_D3	4
5	BI-_D3	Bi-directional-	White with blue stripe	BI-_D3	5
6	RX-_D2	Receive Data-	Green with white stripe or solid	RX-_D2	6
7	BI+_D4	Bi-directional+	White with brown strip	BI+_D4	7
8	BI-_D4	Bi-directional-	Brown with white stripe or solid brown	BI-_D4	8

802.3 - protokol (slanje)



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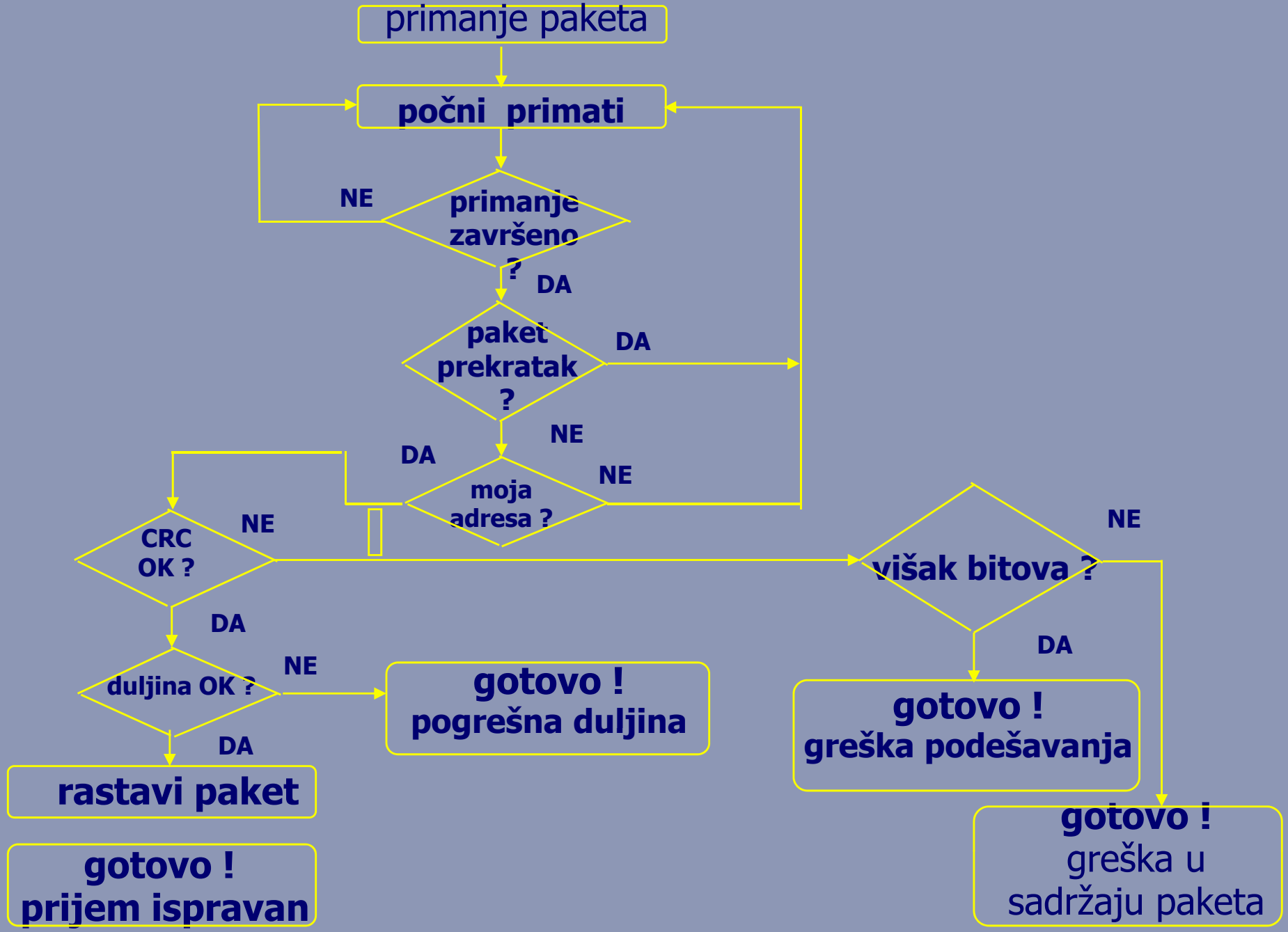
802.3 - protokol (prijem)



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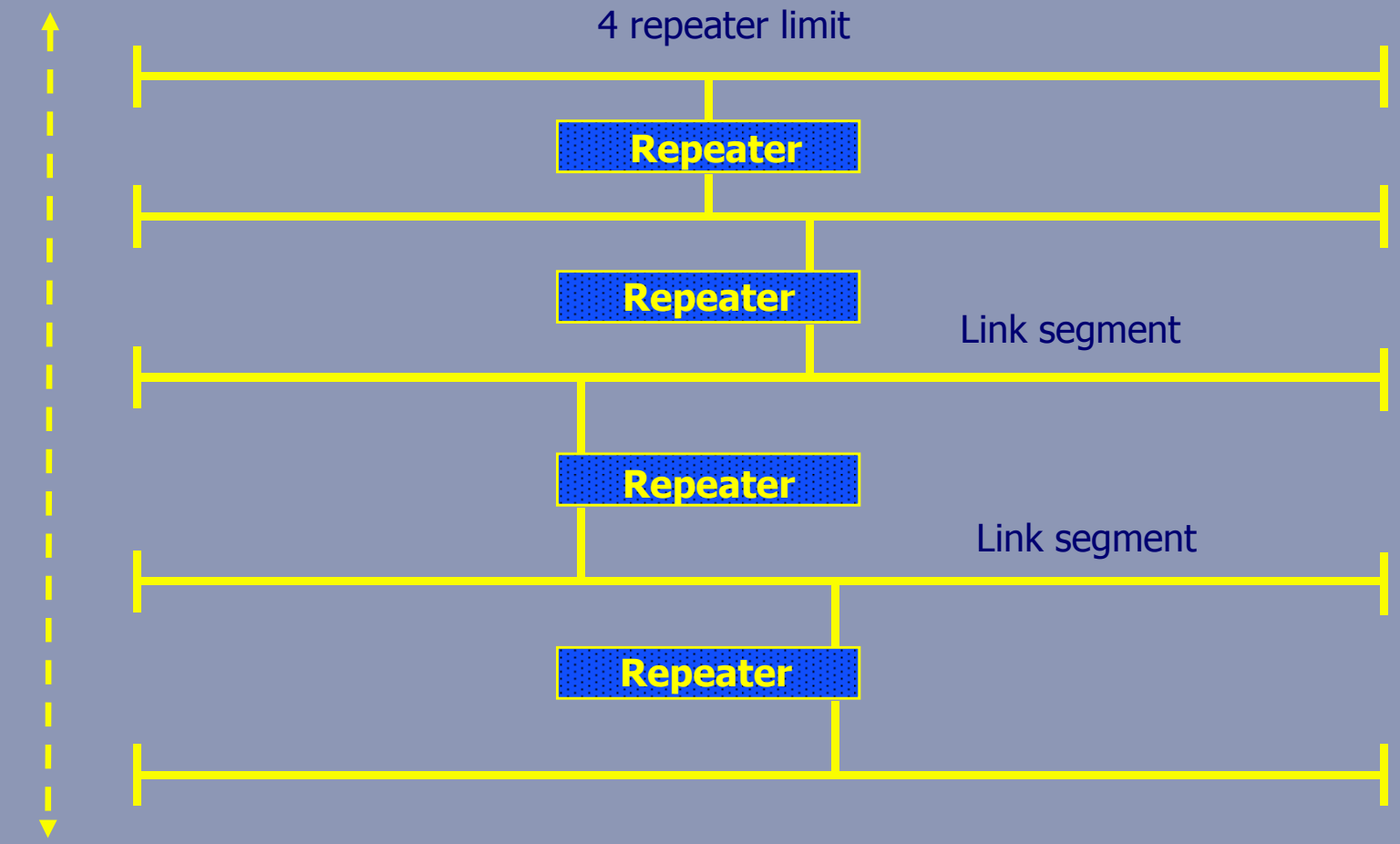
802.3 - topologije

Produljena sabirnica



2500 m max za "debeli" Coax
1000 m max za "tanki" Coax

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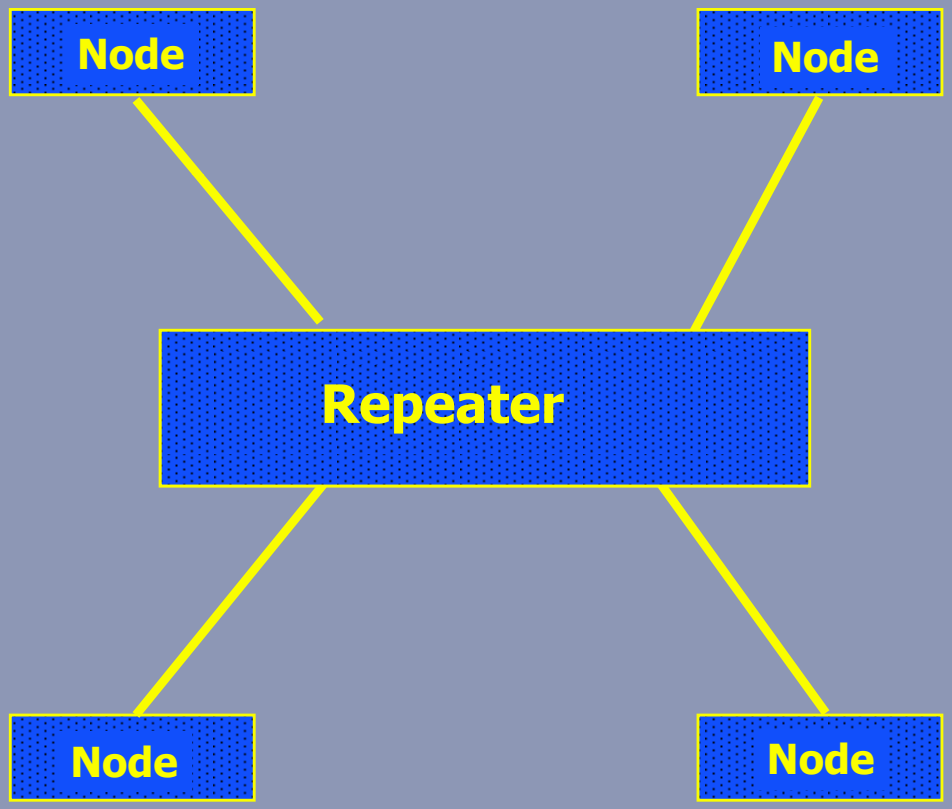
802.3 - topologije

Zvijezda



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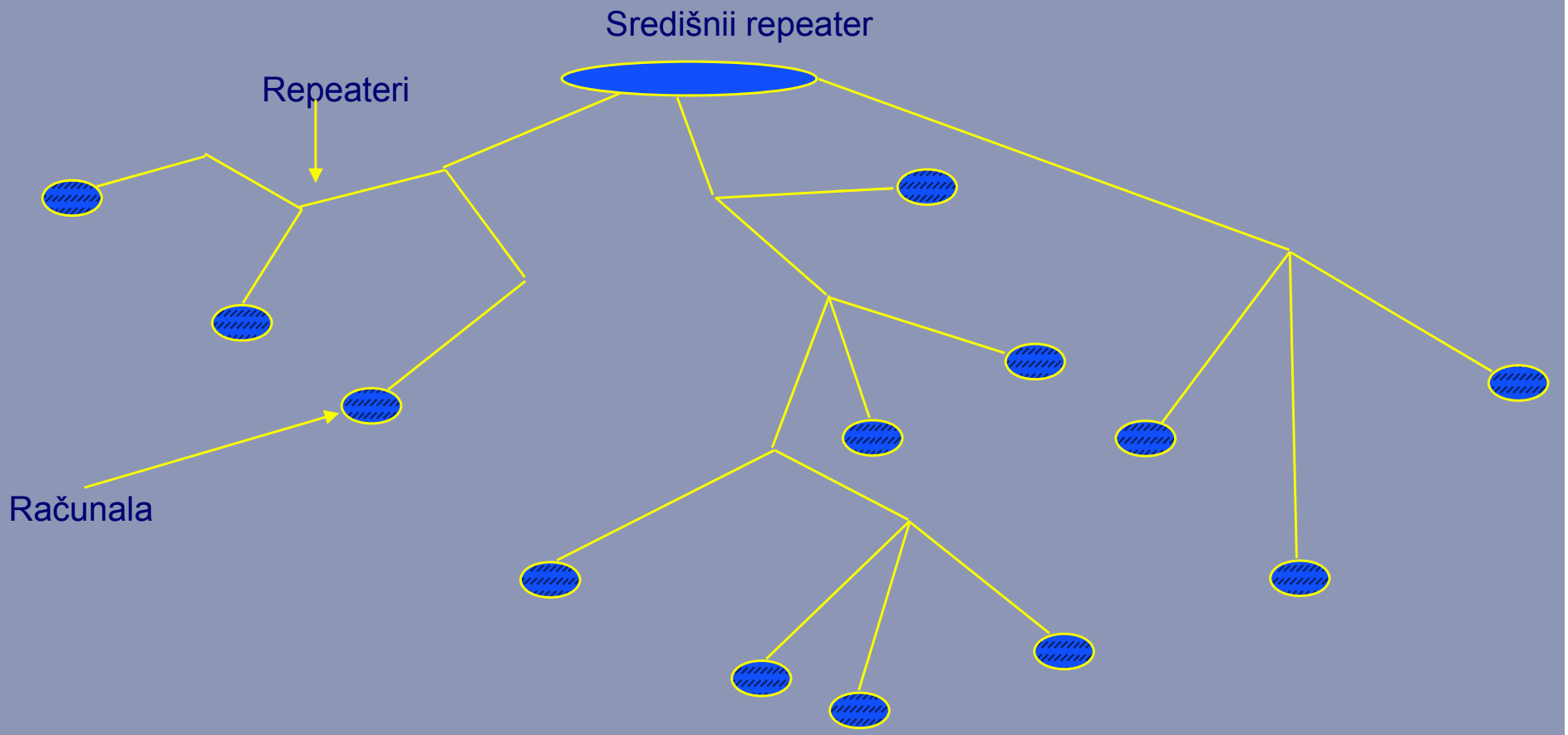
802.3 - topologije
Stablo



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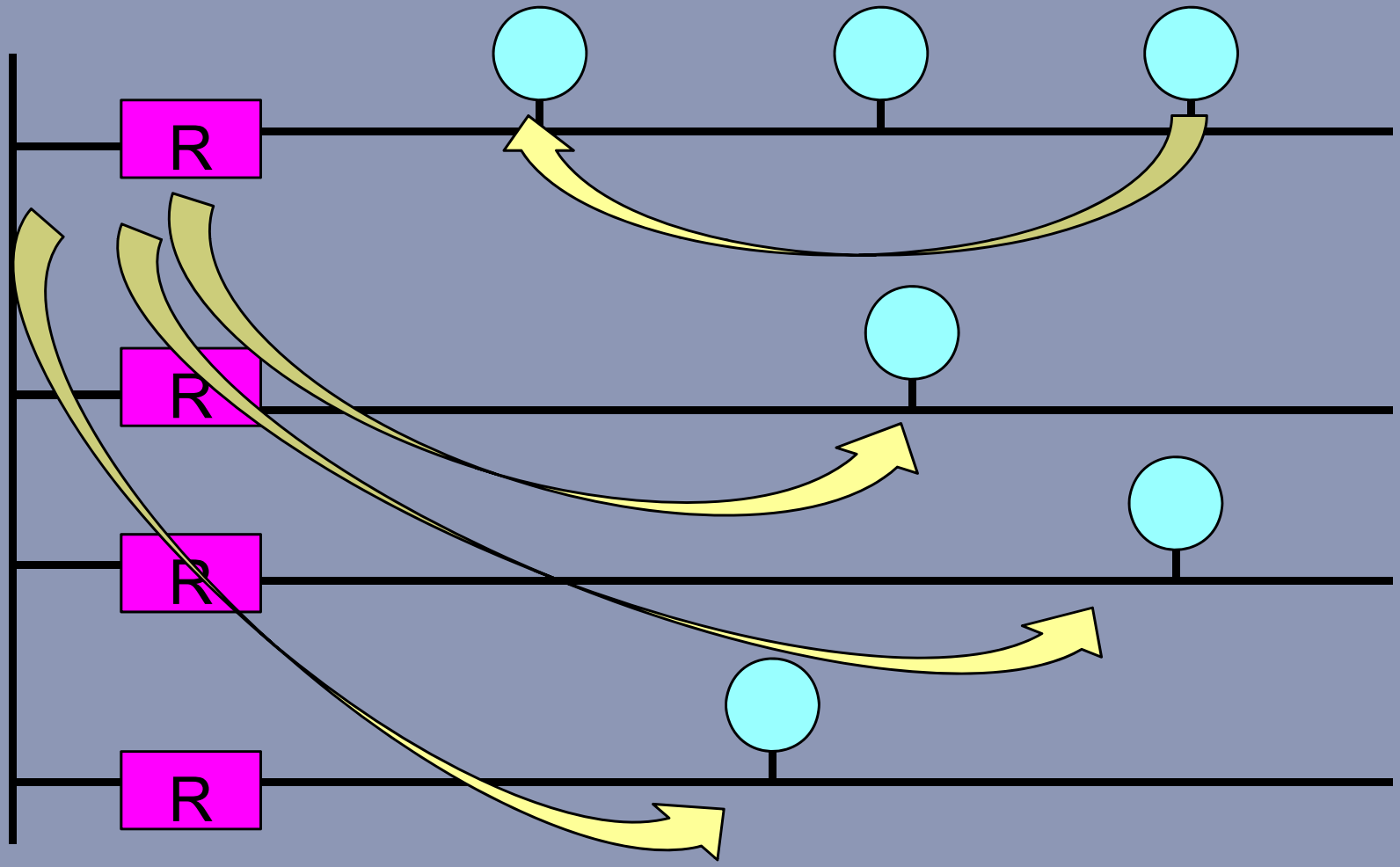
Mreža s repeaterima



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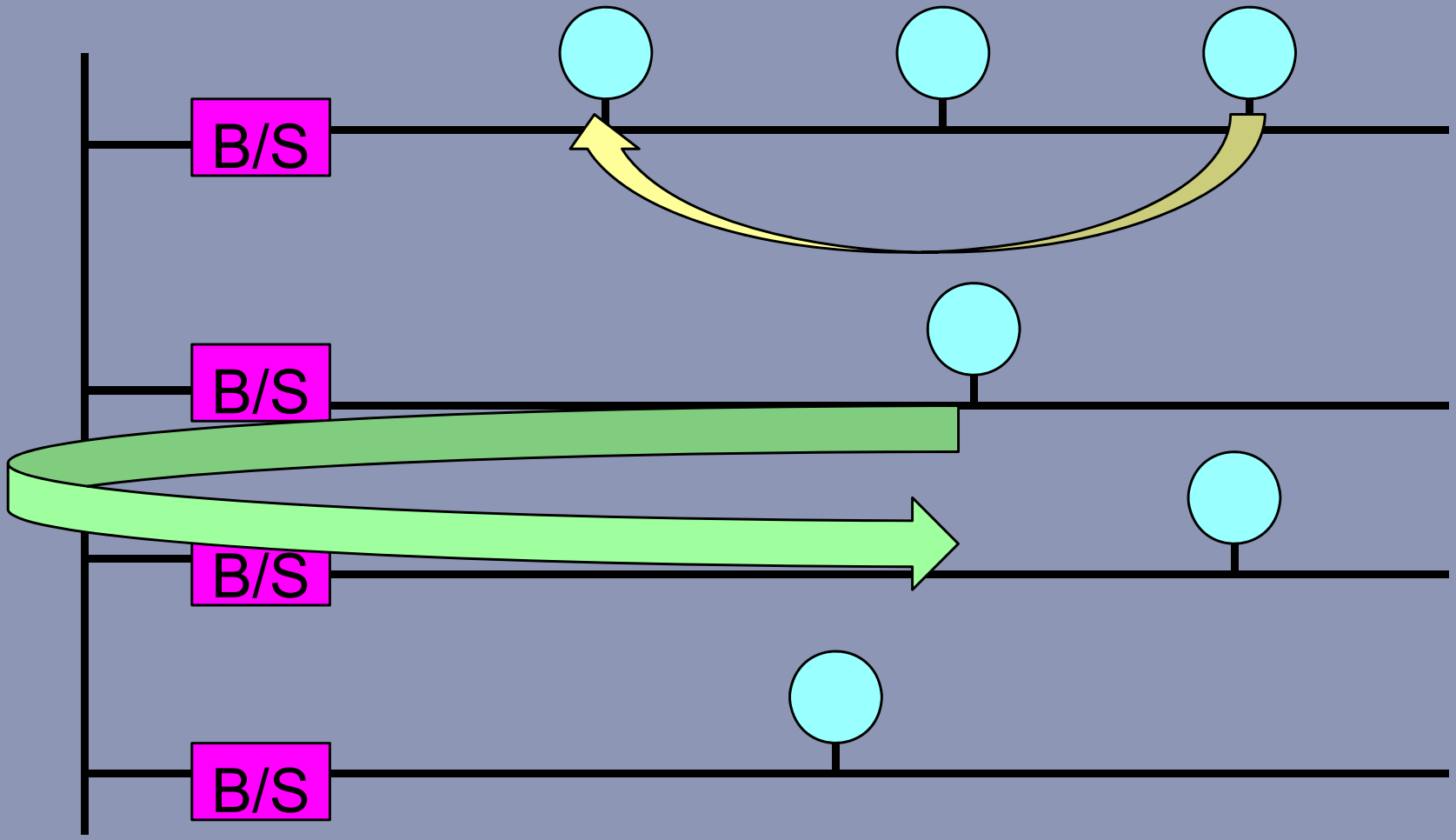
Mreža s preklopnicima



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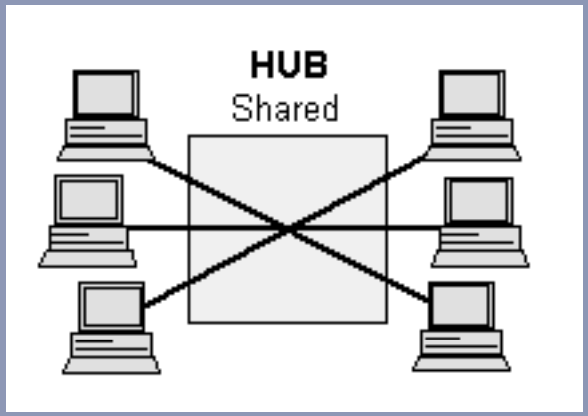
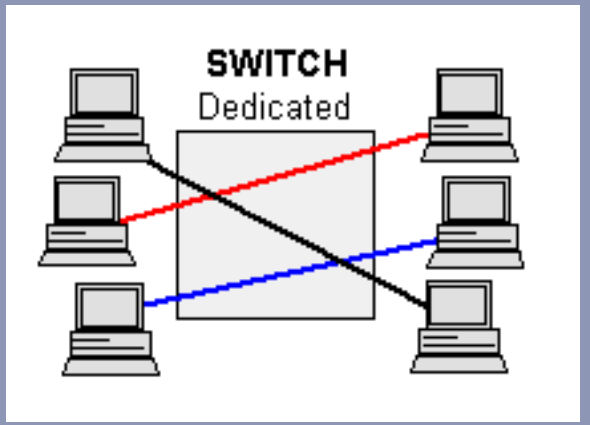
Hub, repeater, switch

- HUB
  - spojište, koncentrator
  - u praksi se koristi za repeater
    - ali i za switch
- Repeater
  - električki pojačava signal
  - s jednog prosljeđuje na sve ostale priključke (eng. port)
- Switch
  - čita cijeli paket
  - ponovno ga šalje
    - samo na onaj port kojem je namijenjen
  - povećanje efektivnog prijenosnog kapaciteta





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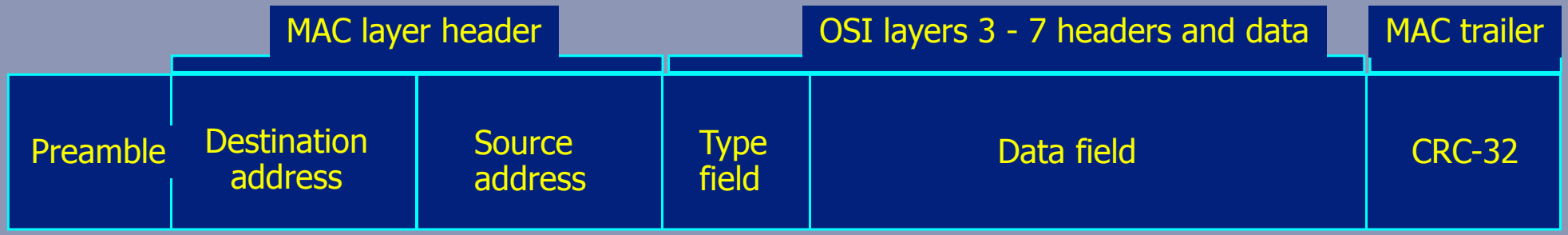
802.3 - format paketa



- MAC – Media Access and Control
  - opći naziv za OSI Layer 2
  - odnosi se na više tehnologija
    - Ethernet, TokenRing, …

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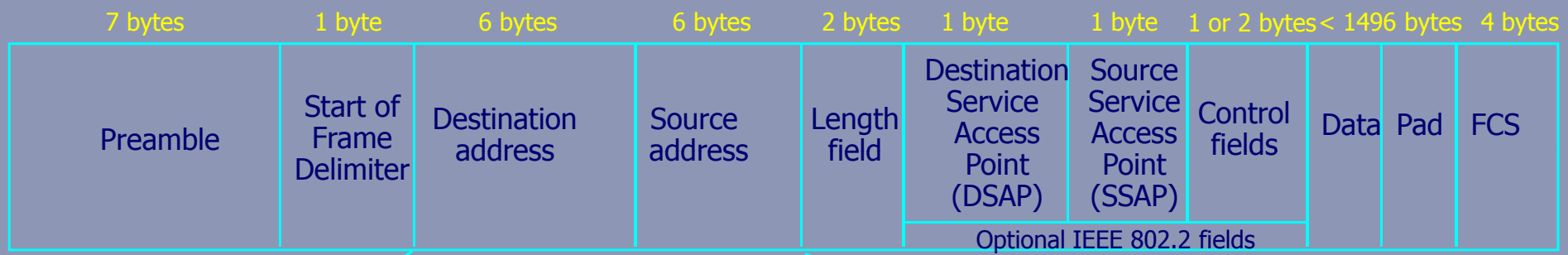
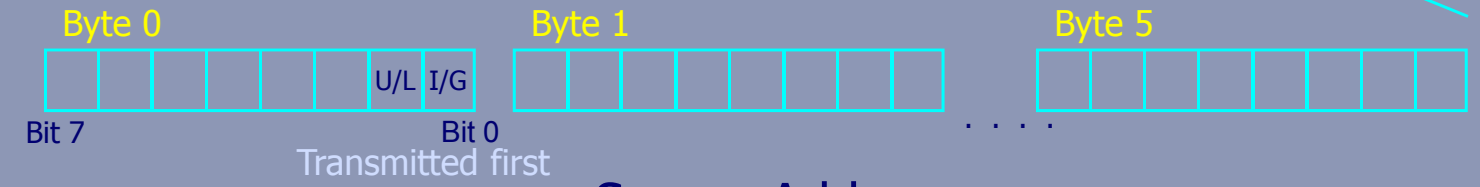
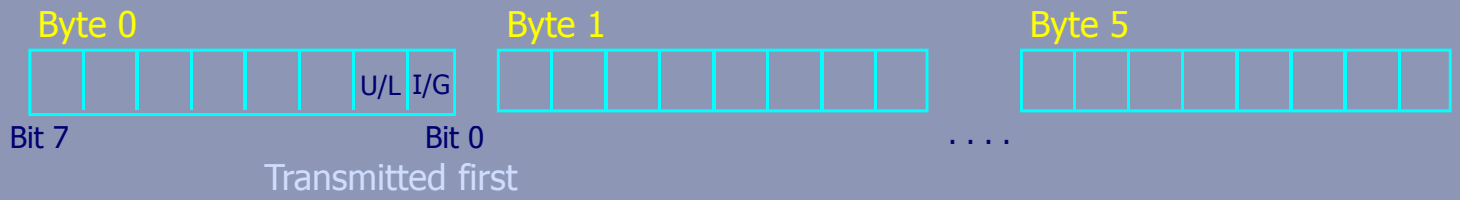
802.3 - format paketa



Destination Address



Source Address



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802.3 prednosti i nedostaci

- **prednosti**
  - **nema kontrolera**, svi su **ravnopravni**
  - **jednostavno** uključivanje i isključivanje
  - visoka **učinkovitost** prijenosa
  - velika **raširenost**
    - **niska cijena**
    - **jednostavna primjena**

- **nedostaci**
  - **nema potvrde** prijenosa
    - *eng. unreliable transport*
  - **nedeterministički** odziv
  - **nema prioritete**
    - jedna vrsta prometa, jedan korisnik
    - **može zauzeti cijeli resurs**

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Token Bus

IEEE 802.4

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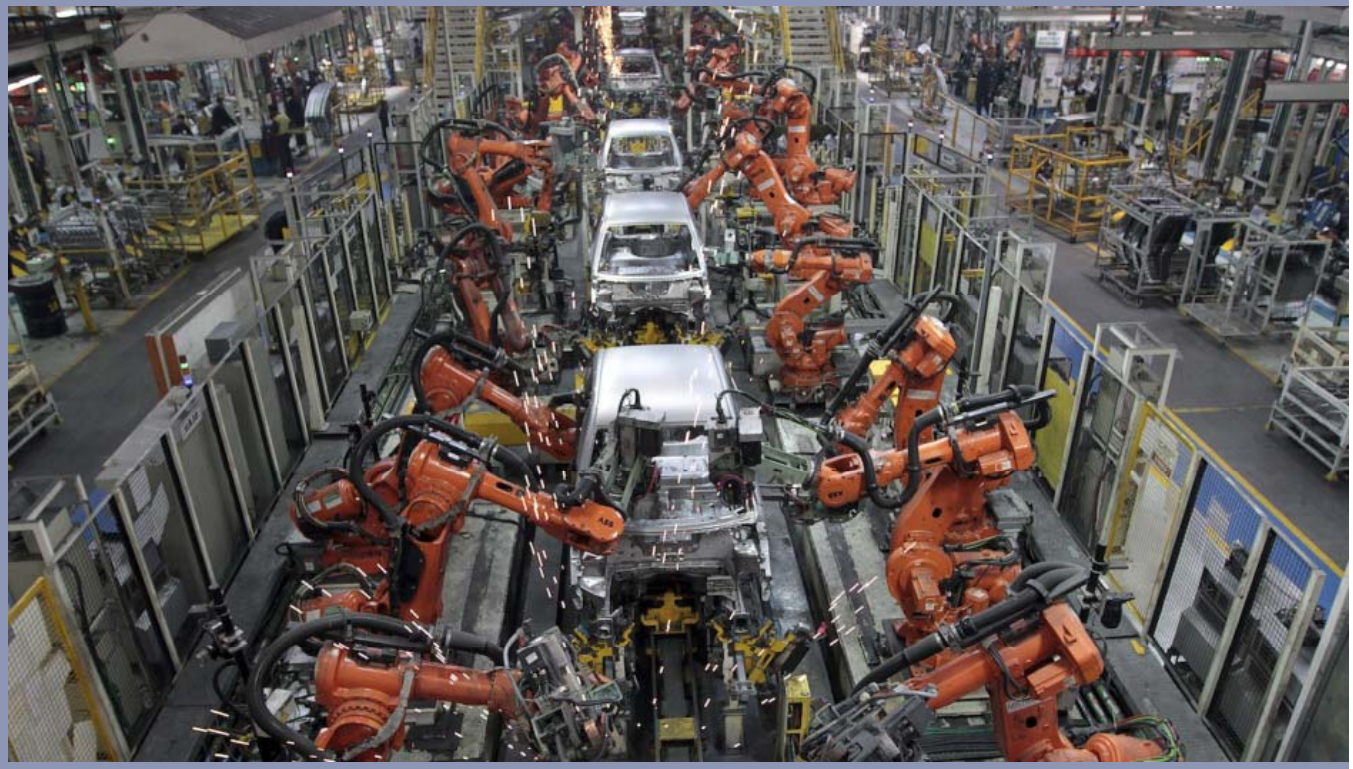
802.4 Token Bus

- sabirnica za industriju
- potreba za **determinističkim odzivom**
- potreba za linijskom topologijom: **sabirnica**
- potreba za prijenosom i drugih informacija
- definiran u General Motors



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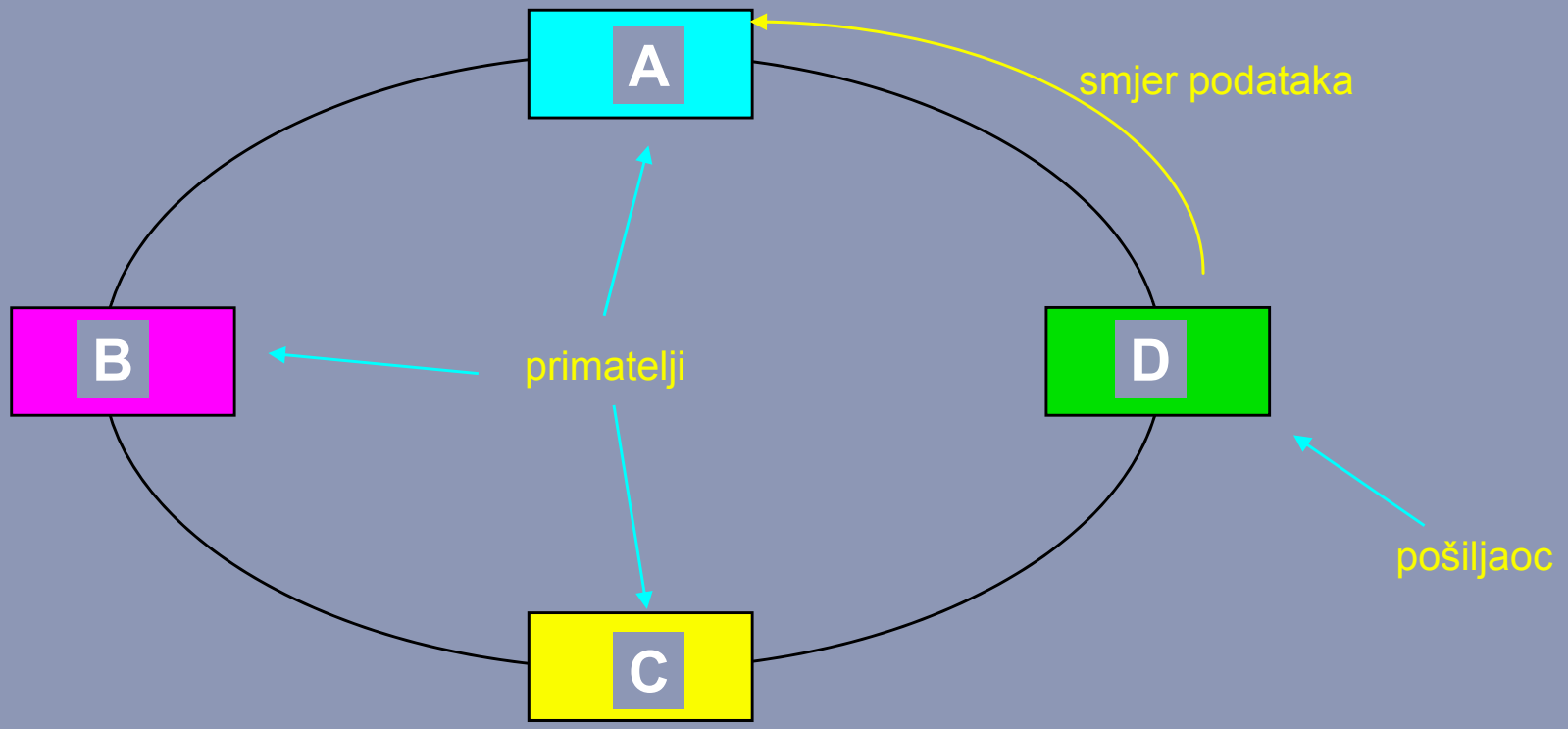
802.4 ideja prstena



- **nadzor** nad komunikacijom se **ciklički prenosi** uvijek istim redoslijedom

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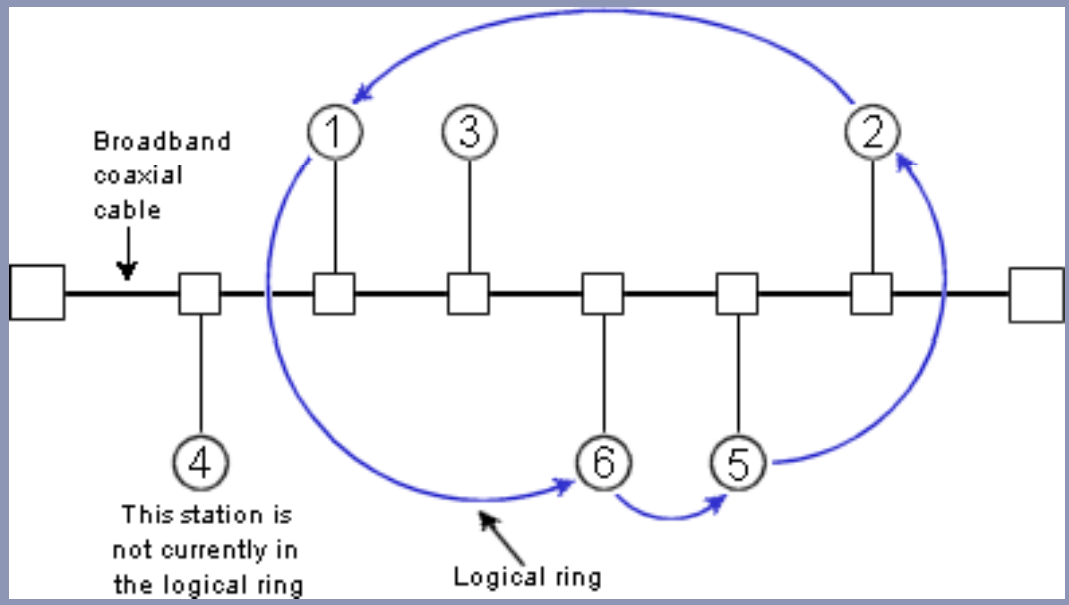
802.4 kabel i modulacija

- koaksijalni **75 Ohm**a (TV)
- amplitudna modulacija (TV)
- frekvencijski multipleks
  - video i audio signali u ostalim kanalima
- definirane brzine prijenosa:
  1, 5, i 10 Mbps



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802.4 signali

- modulacija omogućava prenošenje više signala (simbola):
  - “0” i “1”
  - slobodno
  - tri simbola za kontrolu
- fizički sloj nekompatibilan s 802.3

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802.4 problemi protokola

- uključivanje
  - čeka da bude prozvana
  - ako ih je više, slijedi “aukcija”
- isključivanje
  - mora se odjaviti
  - bdije i onaj tko je predao token
- “zadržani” token
  - štoperice
  - aukcija

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802.4 prednosti i nedostaci

- **prednosti**
  - fizička sabirnica
  - jedan medij za mrežu, audio i video
  - determinizam
  - jeftini medij

- **nedostaci**
  - složeni SW
  - mala rasprostranjenost
    - skup
    - teško se primjenjuje

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Token Ring

IEEE 802.5

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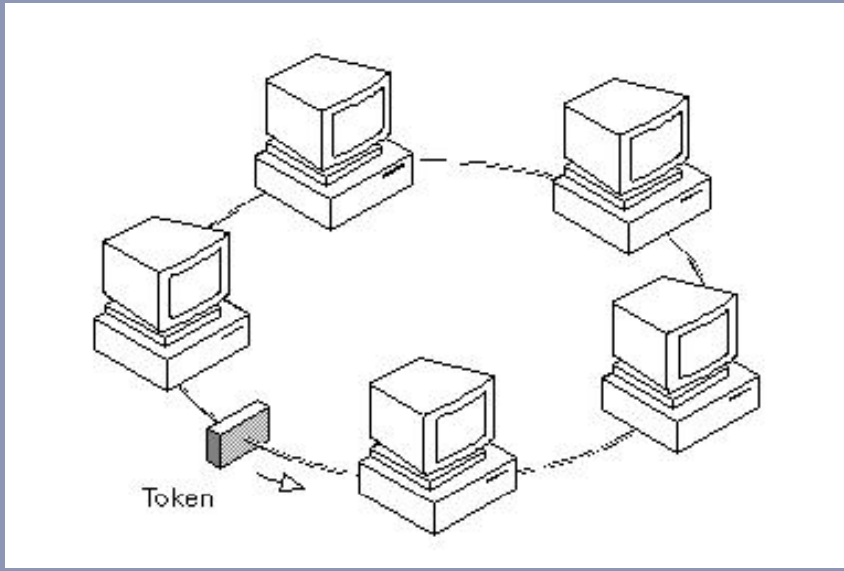
802.5 Token Ring

- potreba za **determinističkim odzivom**
- **prstenasta** topologija
  - point-to-point veze
  - **nepostojanje broadcast medija**
  - sustav je broadcast
- **digitalni** prijenos



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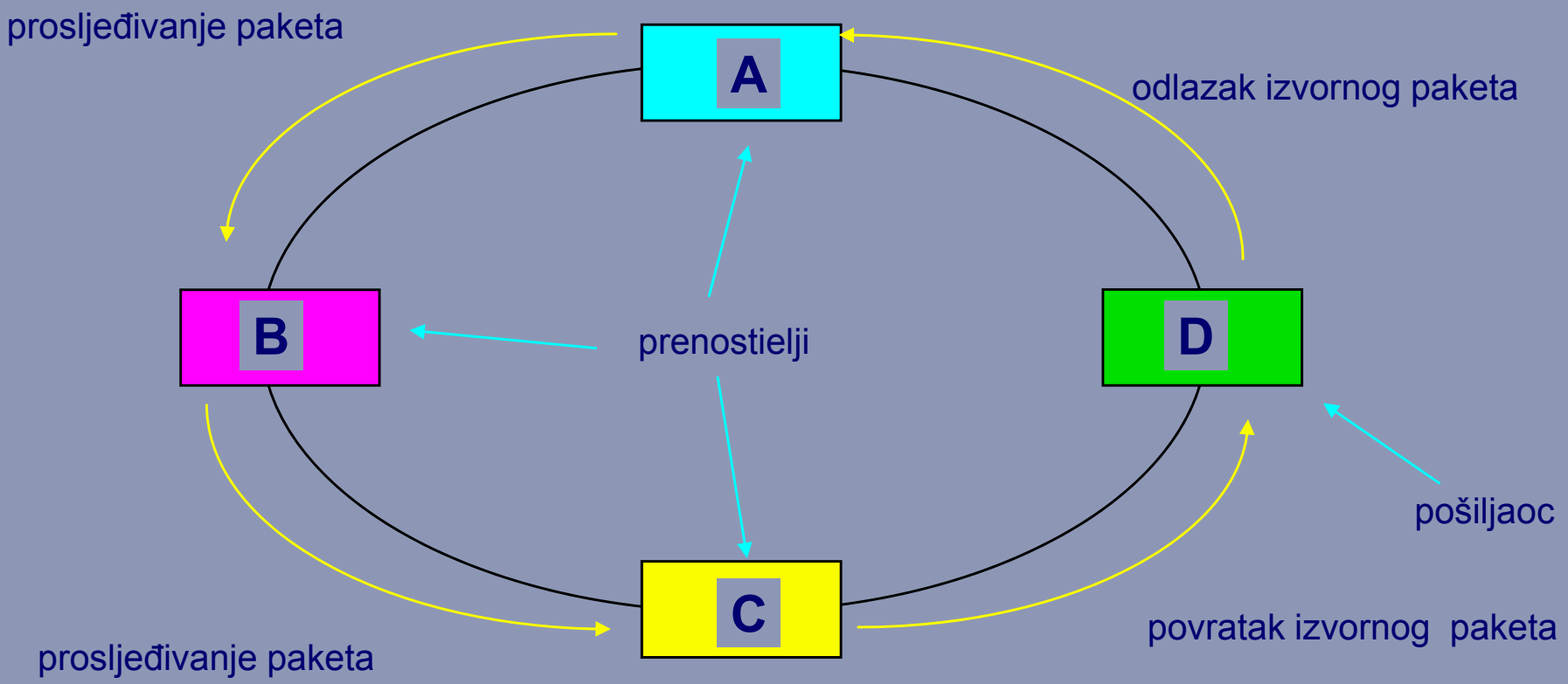
802.5 ideja prstena



- **podaci** se ciklički prenose **kroz** stanice

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802.5 povezivanje

- **point-to-point** veze
  - svaka stanica je povezana s dvije susjedne
  - digitalne veze
- standard propisuje **oklopljenu paricu**
- konektori
- brzine prijenosa 4 i **16** (1989.) **Mbps**
- stanica mora **osigurati fizički prospoj** ako ne radi
- moguća **zvjezdasta konfiguracija**
  - putem “wire center-a” (Multistation Access Unit)

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802.5 kabeli

- standard propisuje oklopljenu paricu
- mogu se koristiti i:
  - neoklopljena parica (4 ili 8 žica)
  - svjetlovod
- kategorija 3 za 4 Mbps
- kategorija 4 za 16 Mbps
- preporučena **max. udaljenost 100 m**

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802.5 konektori

- Universal Data Connector (UDC) za STP
- RJ-11 za UTP

- RJ-45 ili DB-9

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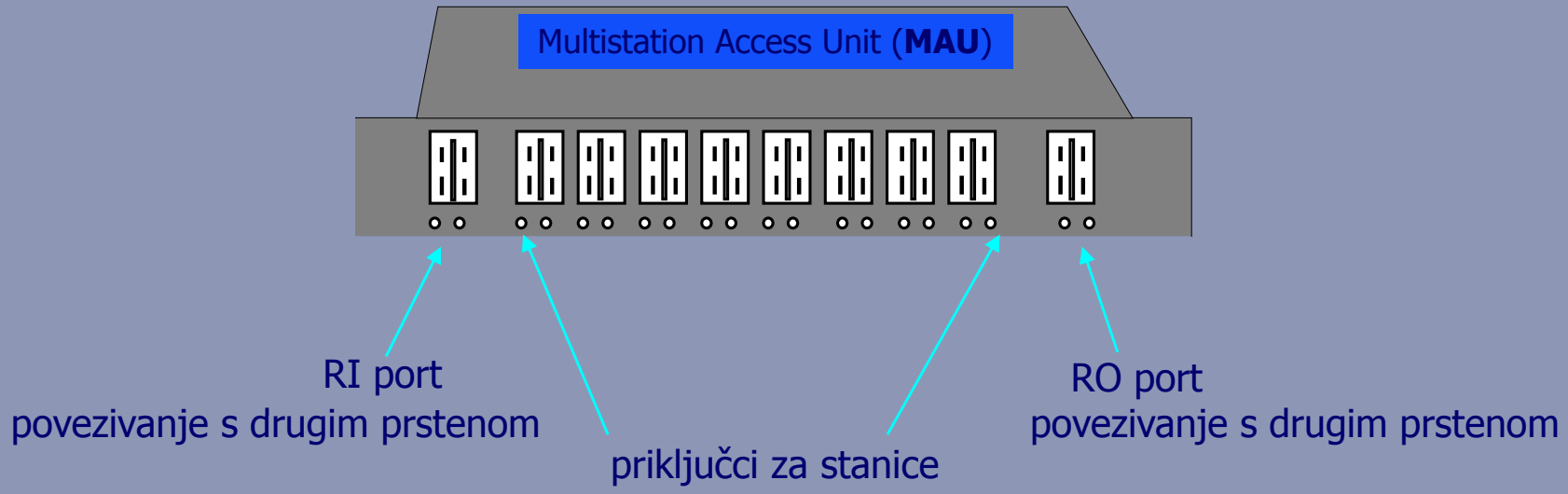
802.5 povezivanje



- **zvjezdasto**, preko središnjeg uređaja
- max. udaljenost za stanice je **100 m**

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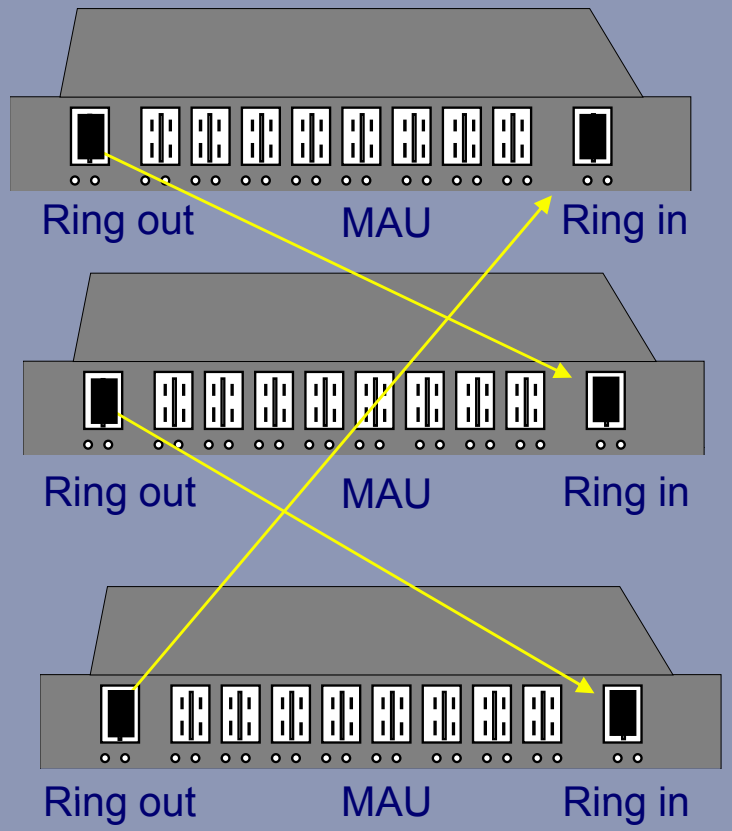
802.5 povezivanje



- moguće je više prstenova spojiti zajedno
- max. je 260 stanica

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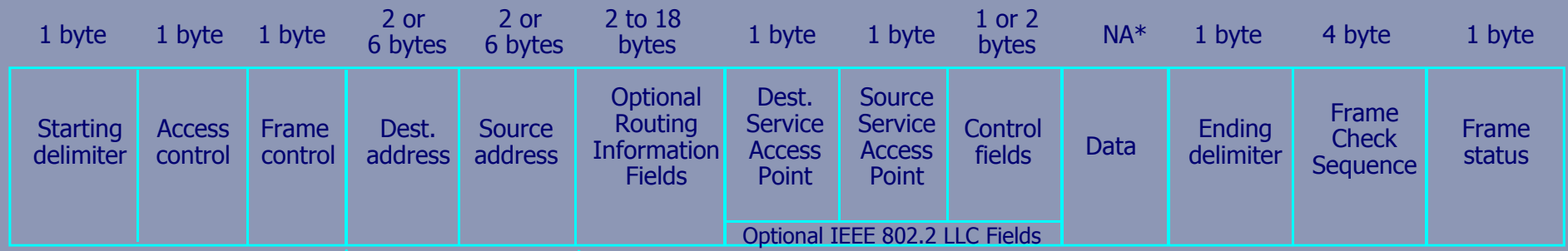
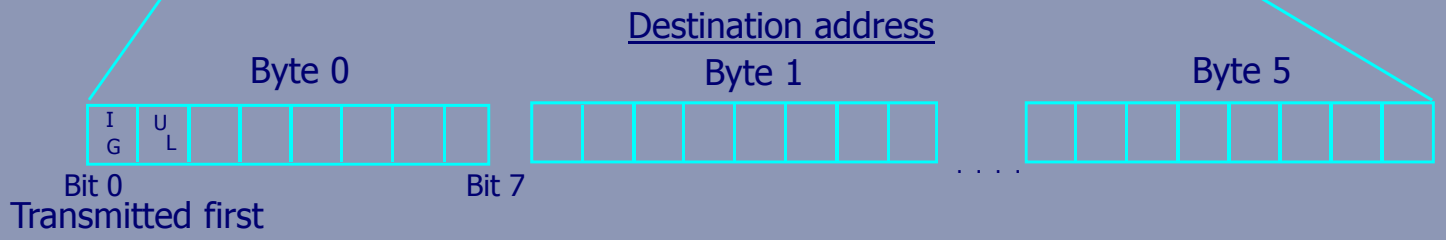
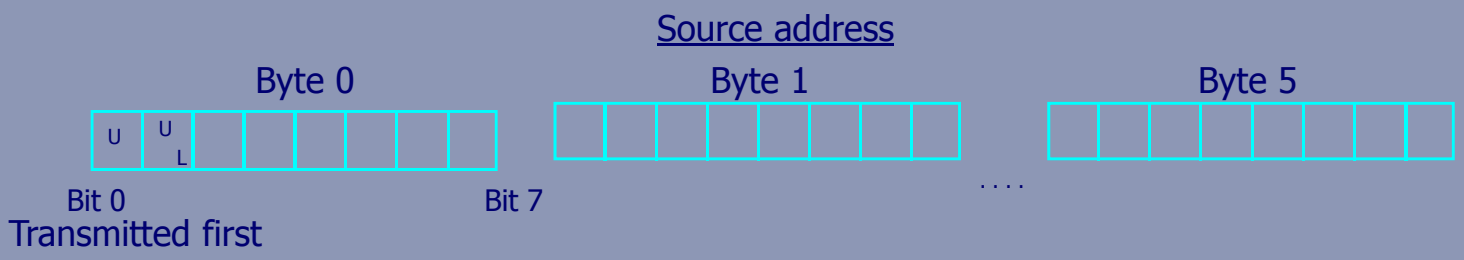
802.5 format podataka







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802.5 prednosti i nedostaci

- prednosti
  - ima potvrdu prijenosa
    - *eng. reliable transport*
  - deterministički odziv

- nedostaci
  - koristi dio resursa čak i kad drugi nemaju što slati
    - manja učinkovitost prijenosa
  - mala raširenost
    - skuplji od 802.3
    - teža primjena

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FDDI

Fiber Distributed Digital Interface

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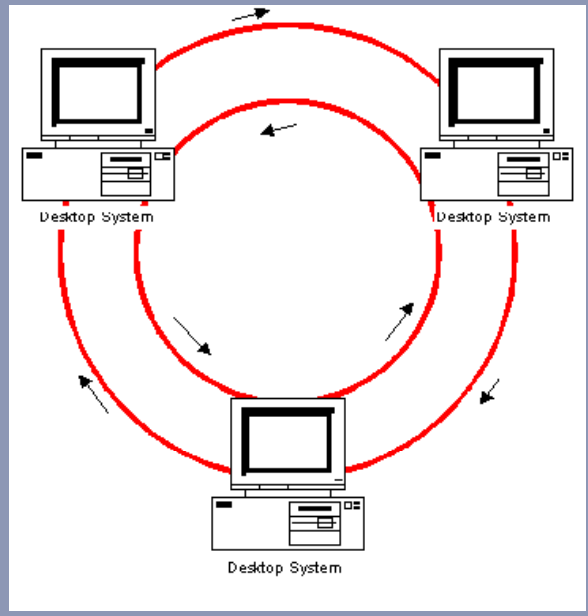
FDDI

- FIber Data Distributed Interface
- **prstenasta** topologija
  - **dva prstena**
  - DAS i SAS stanice
- 500 - 1000 stanica
- **100 Mbps**
- fiber (singlemode, multimode)
- **2 - 20 km**



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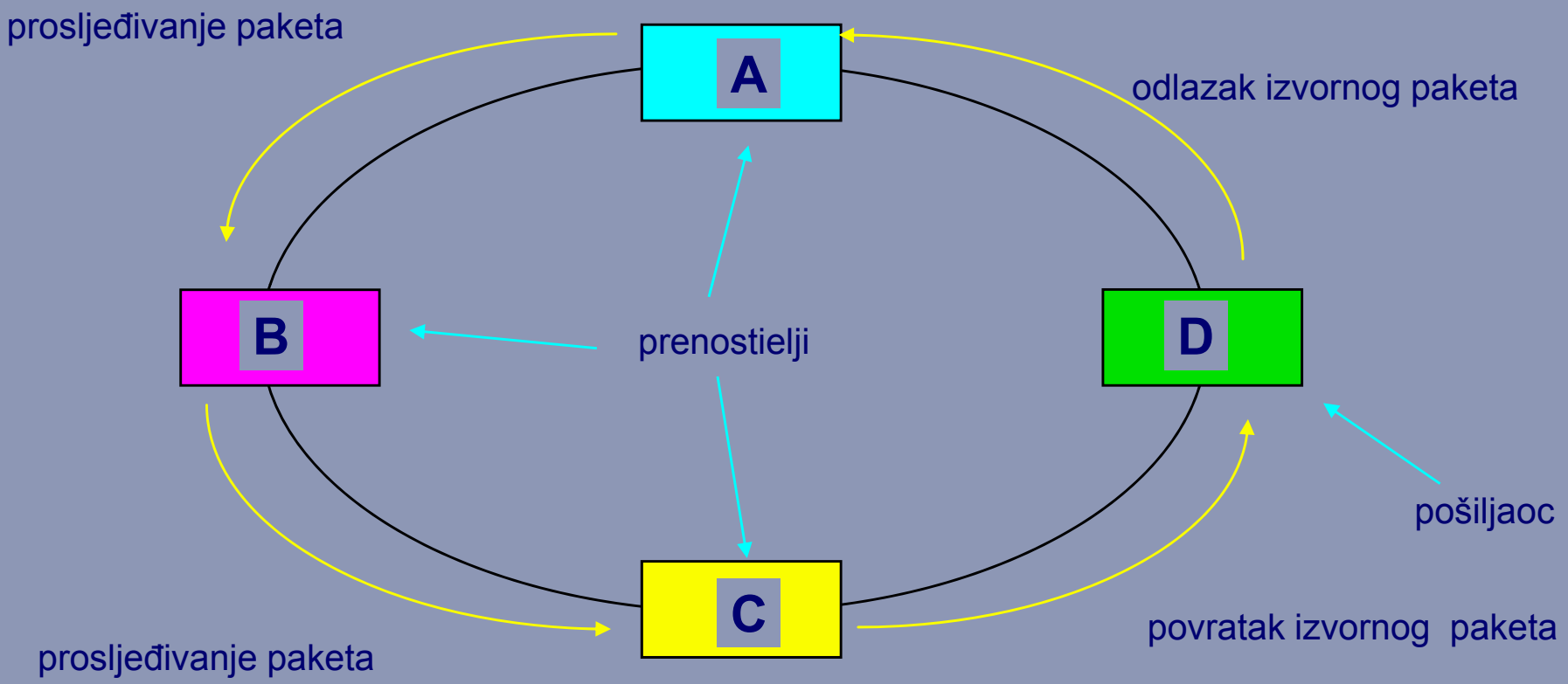
FDDI ideja prstena



- **podaci** se ciklički prenose **kroz** stanice

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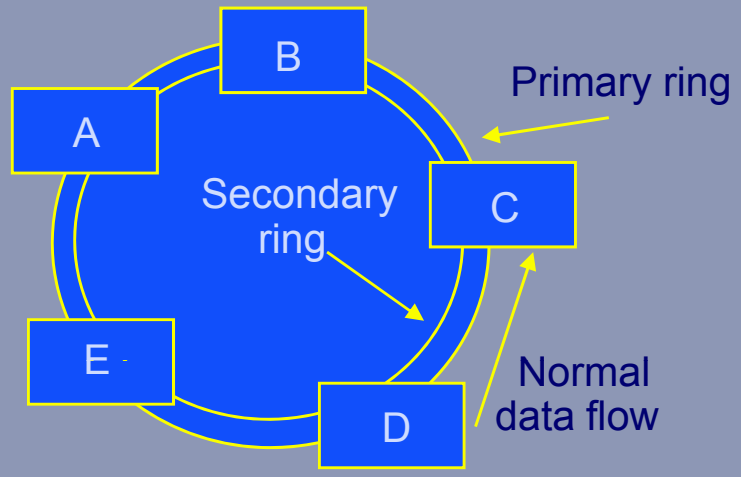
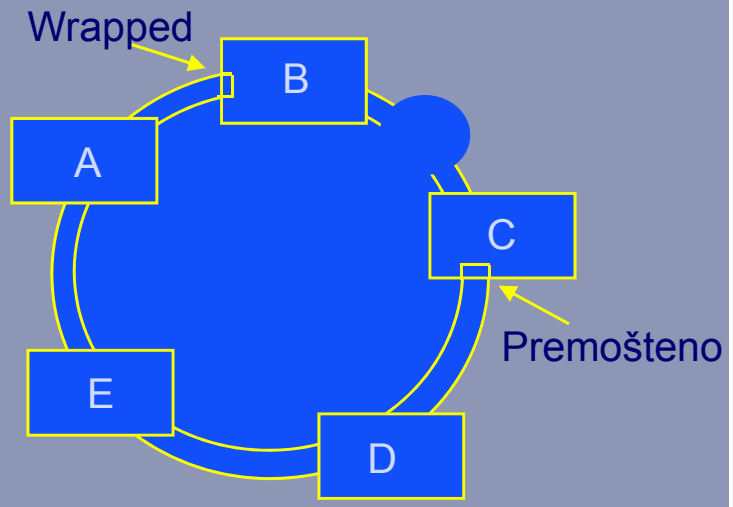
FDDI povezivanje

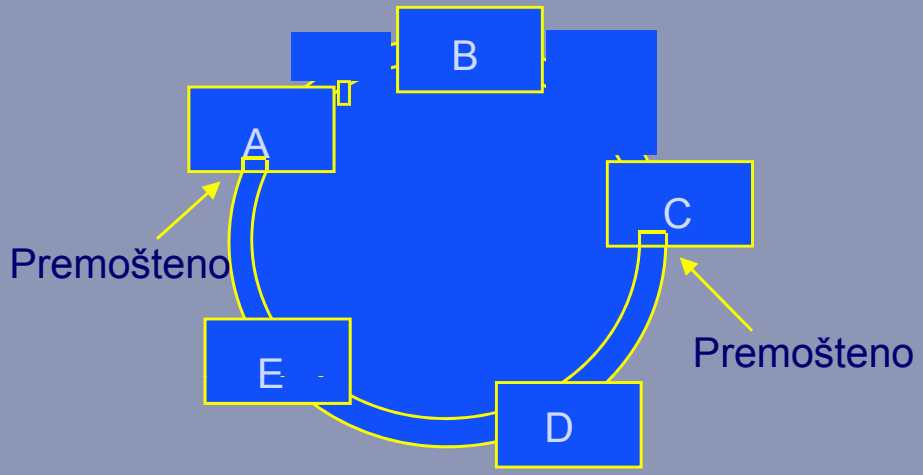


Normalni rad

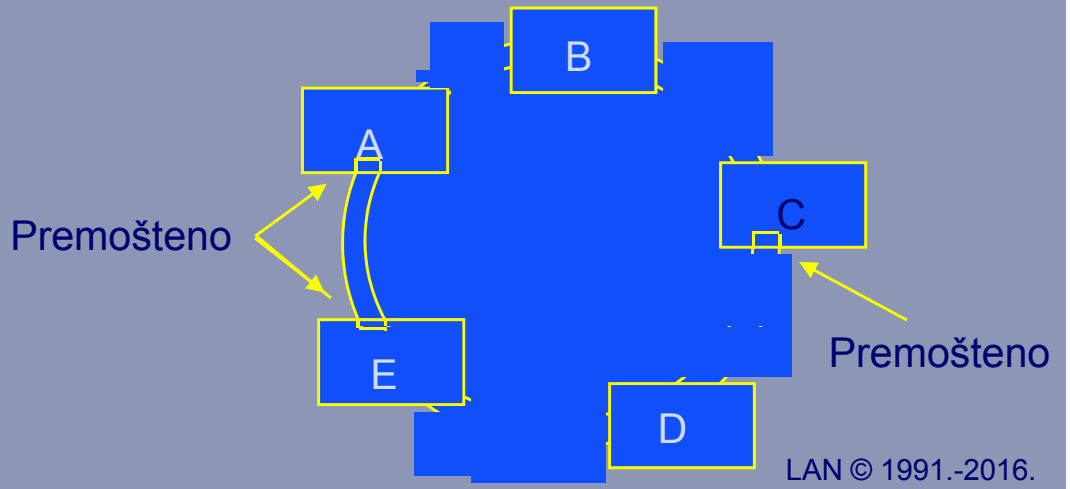


Fiber prekid između C iB

Node B u prekidu



Node B and D u prekidu



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Sustavi za praćenje i vođenje procesa

SPVP.zesoi.fer.hr

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