



Prenos zvoka prek omrežij IP





Vsebina

- Osnovni pojmi
- VoIP telefonija
- VoIP – prenos zvoka
- VoIP kompresija zvoka – “kodeki”
- Protokolni sklad za prenos medijskega prometa
- Prometna analiza
- VoIP terminalna oprema



Uvod

- **VoIP – glasovna komunikacija prek protokola IP**
 - tehnologija omogoča izvajanje glasovnih klicev z uporabo širokopasovne Internetne povezave
 - namesto regularne (analogne) telefonske linije

- **Zakaj?**
 - VoIP vpliva na cene storitev in zamenjuje distribucijo dodanih vrednosti med ponudniki storitev

- **Zakaj zdaj?**
 - resna alternativna možnost za glasovne komunikacije z dodanimi storitvami
 - ponudniki storitev in proizvajalci opreme dodajajo VoIP v svoje ponudbe



Opredelitev VoIP

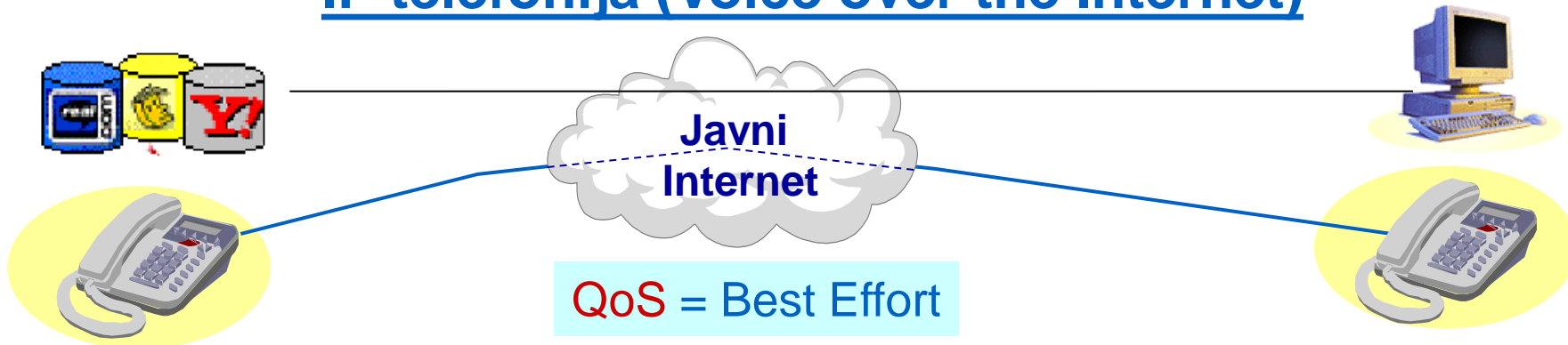
- **IP telefonija**
 - prenos govora, faksov ali podobnih sporočil prek paketnih IP omrežij
- **Internetna telefonija**
 - je del IP telefonije
 - IP telefonija, kjer je osnovno transportno omrežje javni internet
- **Voice-over-IP (VoIP)**
 - je del IP telefonije
 - prenosno omrežje zasebno, upravljano in nadzorovano omrežje IP

- **Analogno pojmom**
 - InternetTV
 - IPTV

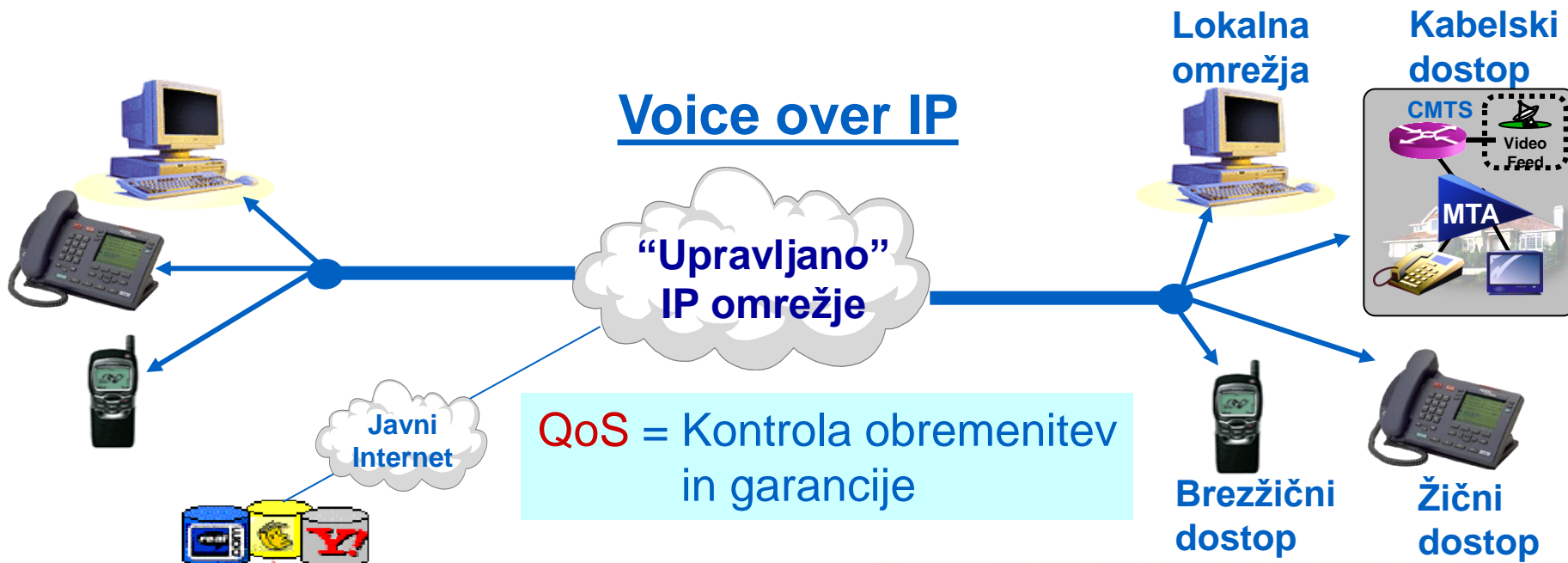


Osnovni pojmi - skica

IP telefonija (Voice over the Internet)



Voice over IP





Telefonija VoIP

- Nosilno storitev predstavlja protokol IP
- Za govorno komunikacijo je namesto tokokrogovnega uporabljen paketni način prenosa podatkov
- Govorna zveza prek
 - tokokrogovnega omrežja (a)
 - paketnega omrežja (b)

PRINCIP DELOVANJA

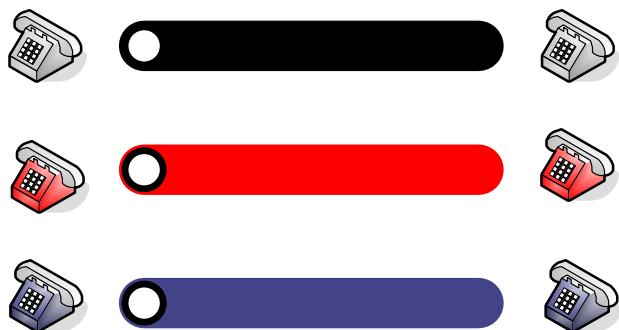
Analogni govorni signal → digitalni podatkovni niz

Oblikovanje IP paketov

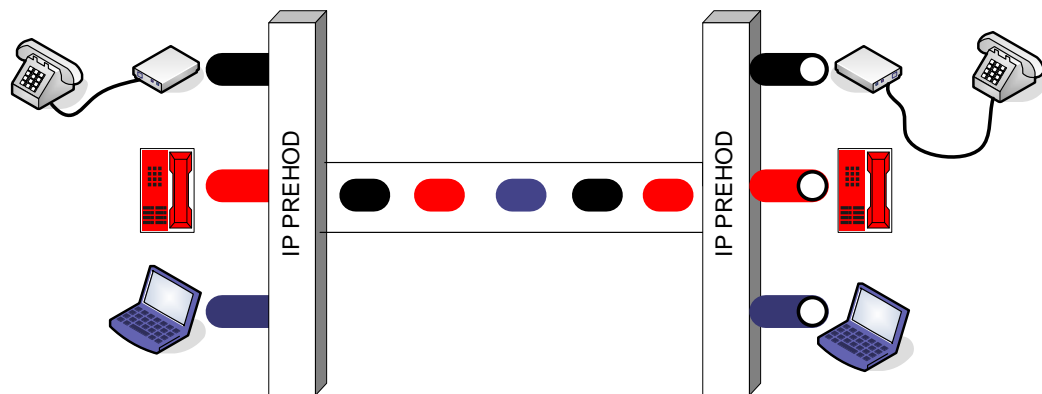
Posredovanje paketov v IP omrežje

Končni terminal: združevanje paketov v digitalni niz

Digitalni podatkovni niz → analogni govorni signal



(a)



(b)

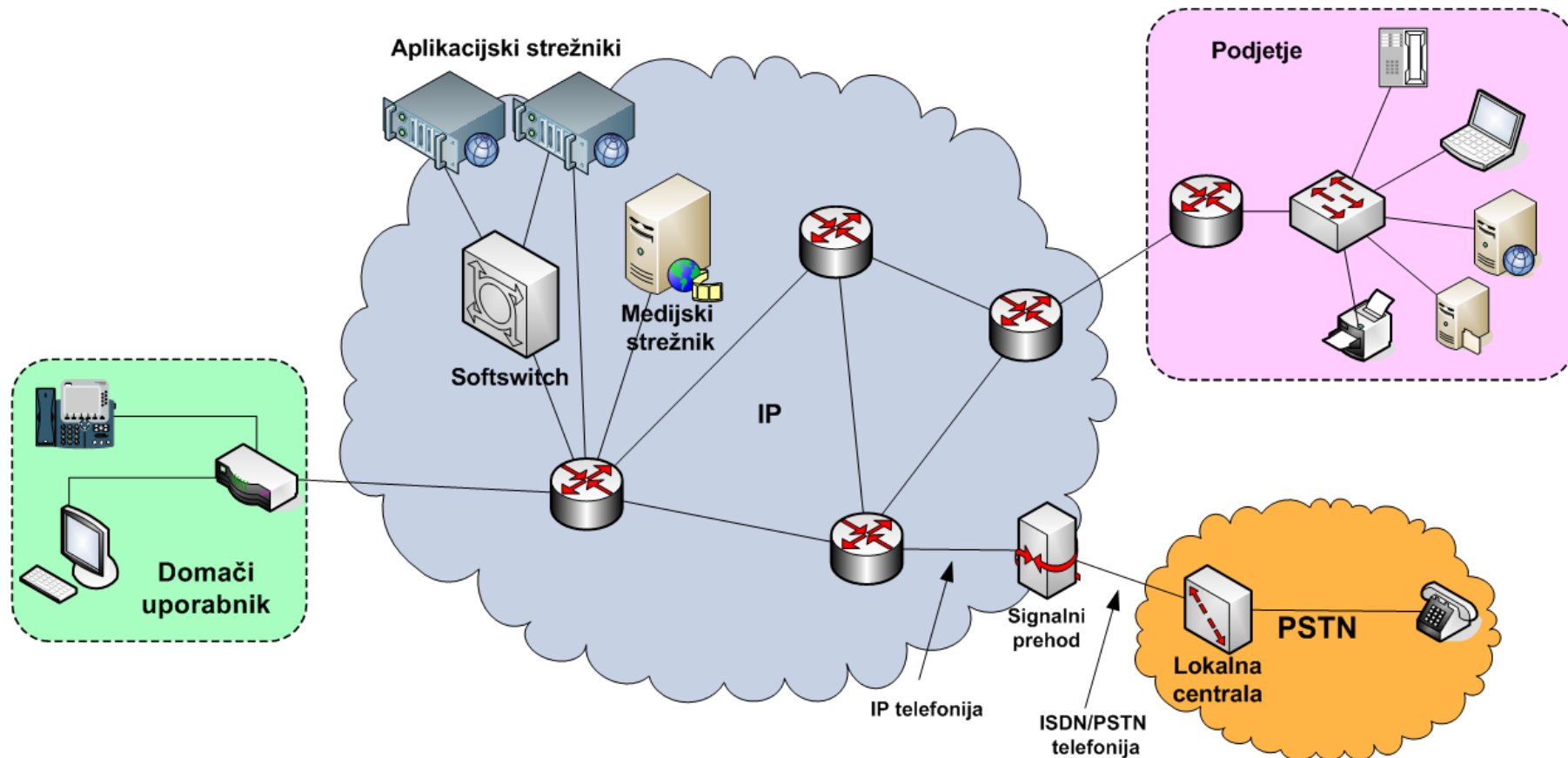


Prenos s protokolom IP

- **Internetni protokol IP**
 - paketni protokol
 - usmerjanje vsakega paketa posebej
 - prenos paketov brez garancij
 - delovanje “best – effort”
 - zakasnitve, izgube
- **Podatkovni promet**
 - asinhron – lahko zakasnitve
- **Glasovni promet**
 - sinhron – stroge omejitve za zakasnitve
- **IP v osnovi ni primeren za prenos zvoka v realnem času**
- **VoIP mora:**
 - doseči zahteve tradicionalne telefonije
 - ponuditi nove in atraktivne zmogljivosti po nižji ceni



Arhitektura VoIP – slika





Protokoli IP telefonije

- **Signalizacijski protokoli**
 - lociranje klicanega uporabnika
 - vzpostavljanje povezave
 - klicanje
 - prevzem zveze
 - preusmeritev
 - nastavljanje začetnih parametrov zveze
 - tip zveze
 - avdio kodek
 - dodajanje / odstranjevanje sogovorcev...
 - spreminjanje parametrov med zvezo
 - zaključevanje povezave
- **SIP**
- **H.323**



Protokoli IP telefonije

- **Protokoli za prenos govora in ostale vsebine (Media Transport Protocols)**
 - digitalizacija vsebine
 - kodiranje
 - dekodiranje
 - paketiranje
- **Protokoli za upravljanje prehodov**
- **IP telefonija uporablja tudi standardne internetne protokole**
 - TCP
 - UDP
 - RTP
 - RTCP
 - ...



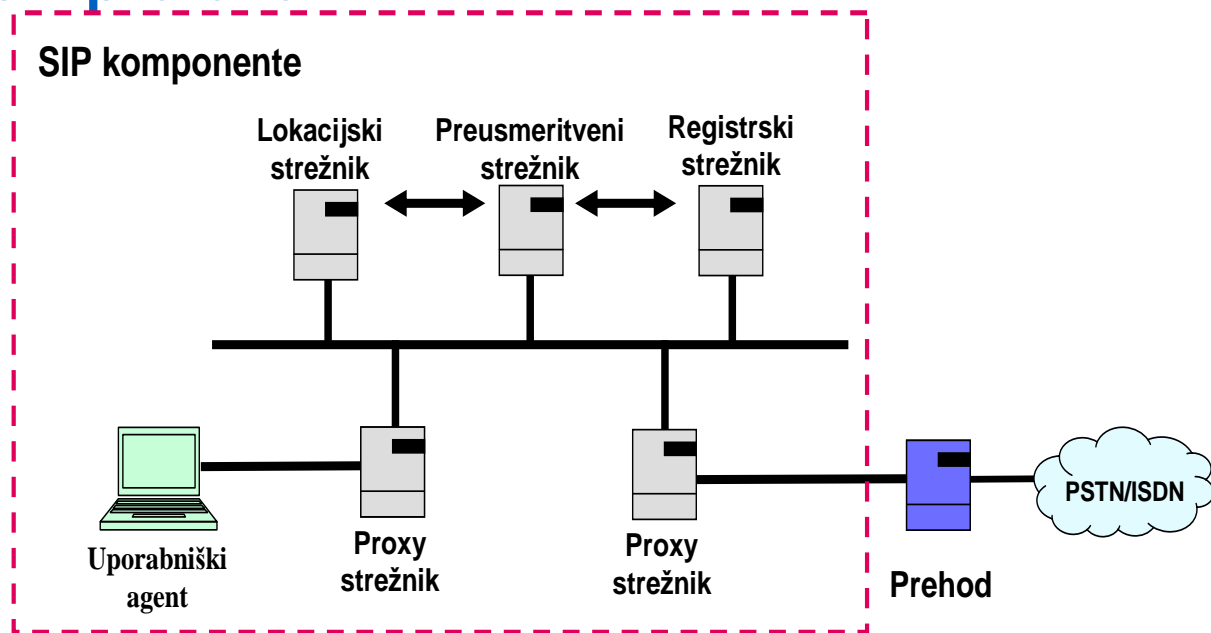
Glavni VoIP standardi

- **Odpri standardi – organizacija IETF**
- **RFC – Request For Comments**
- **IETF**
 - RFC 3261 SIP
 - RFC 2327 SDP
 - RFC 1889 RTP
 - RFC 768 UDP
 - RFC 791 IP
- **ITU-T**
 - H.323: Zgodovina, nadomestil ga je SIP
 - G.700: kodiranje zvoka
 - G.711: 64 kb/s PCM
 - Ostali kodeki, nižje hitrosti (lower rates?)
- **IEEE 802.3 Ethernet**
- **TIA kategorije kablov**



SIP

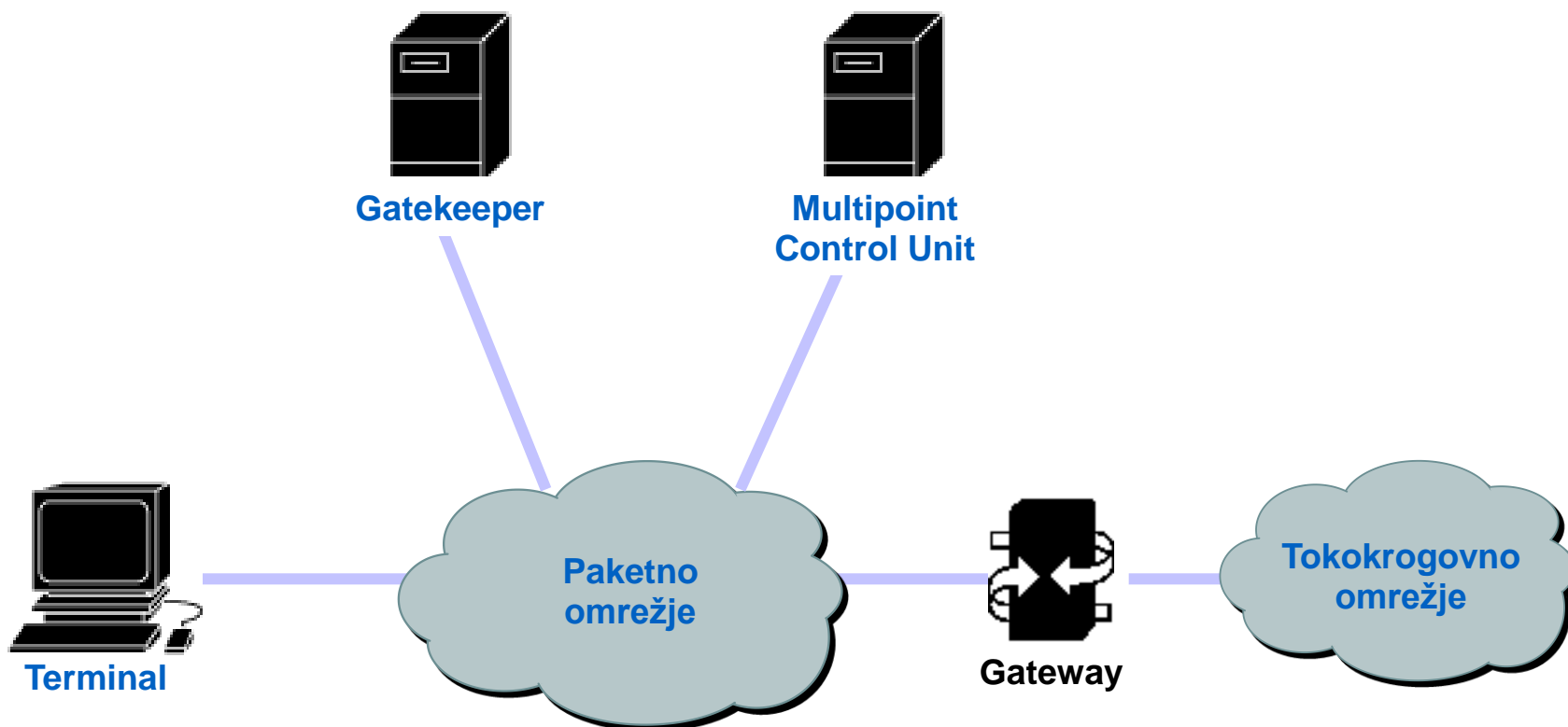
- Session Initiation Protocol (SIP) je protokol za kontrolo aplikacijskega sloja (signalizacija) za:
 - ustvarjanje,
 - spreminjanje,
 - rušenje ...
- ... multimedijskih sej za enega ali več sodelujočih.
- SIP je signalizacijski protokol





H.323

- **Osnovne funkcionalnosti H.323**
 - vzpostavljanje in prekinjanje klicev
 - avdio, video ali multimedijske konference

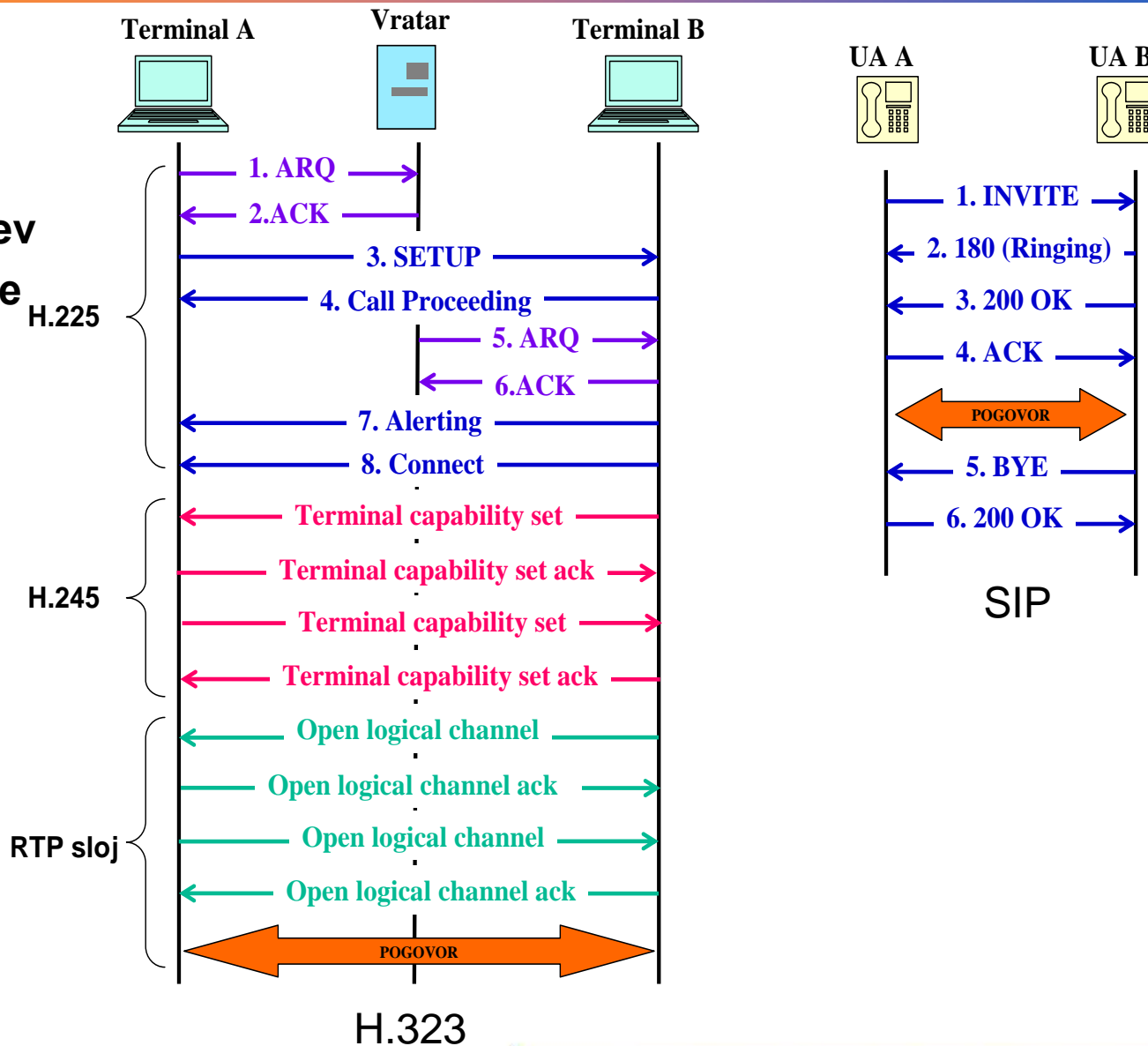




H.323 vs. SIP

■ Zveza

- vzpostavitev
- vzdrževanje
- rušenje



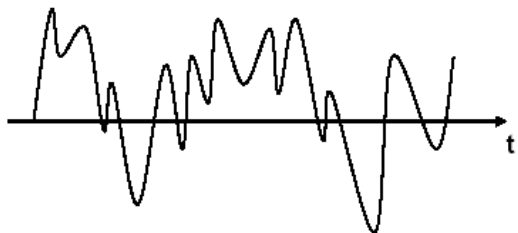


Prenos medijskega prometa

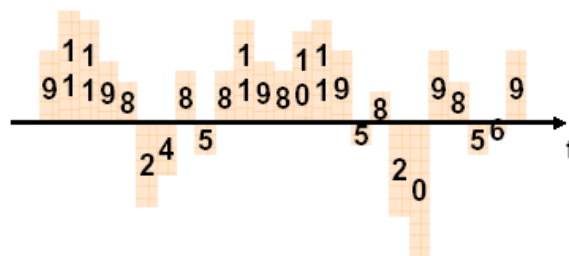


Paketizacija govornega signala

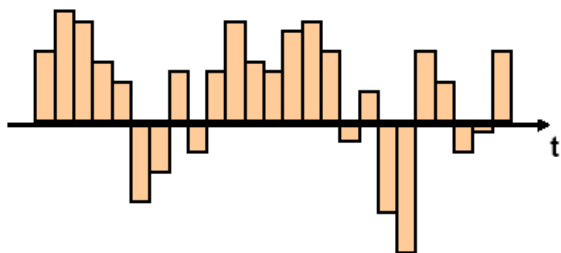
■ Analogni signal



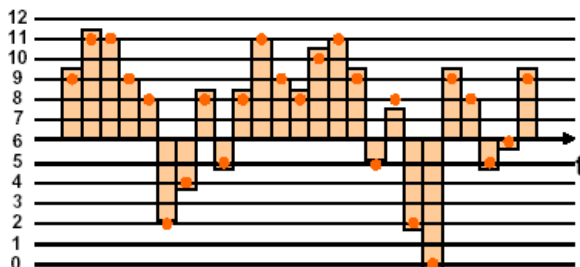
■ Digitaliziran signal



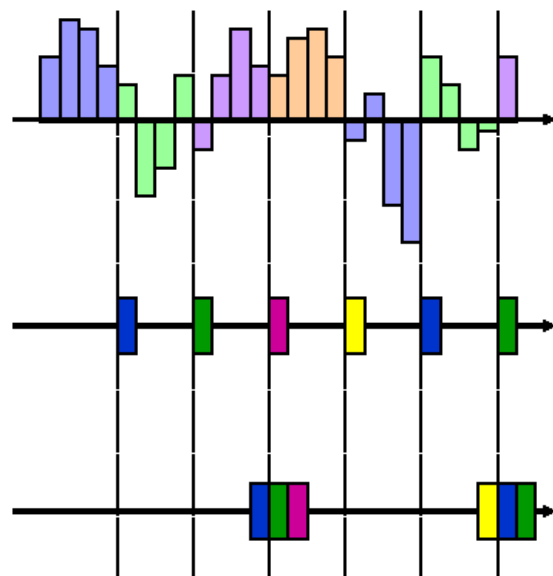
■ Vzorčeni signal



■ Kvantizacija



■ Kompresija / paketizacija okvirjev v pakete





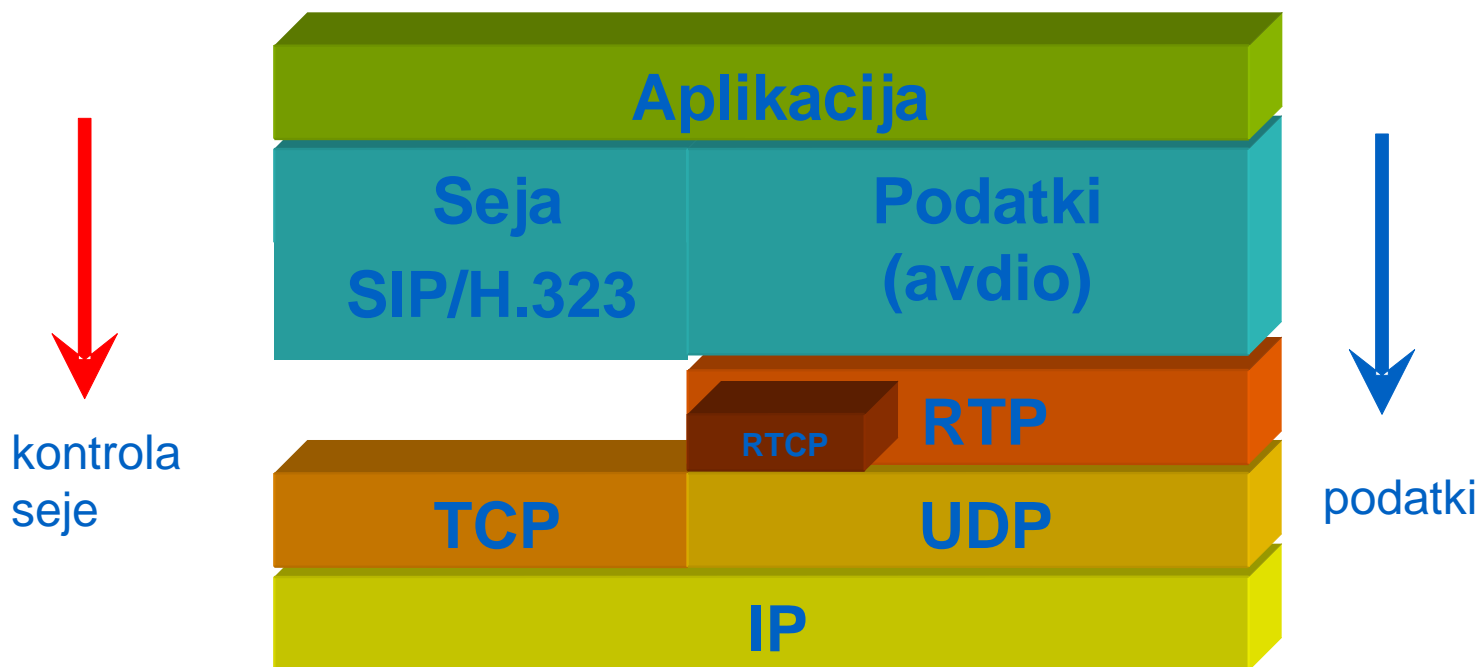
Protokolni sklad za prenos A/V vsebin

■ Kontrola seje

- SIP
- H.323
- (RTSP za video vsebine)

■ Prenos podatkov

- RTP/RTCP
- SRTP/SRTCP/ZRTP
- TCP/UDP





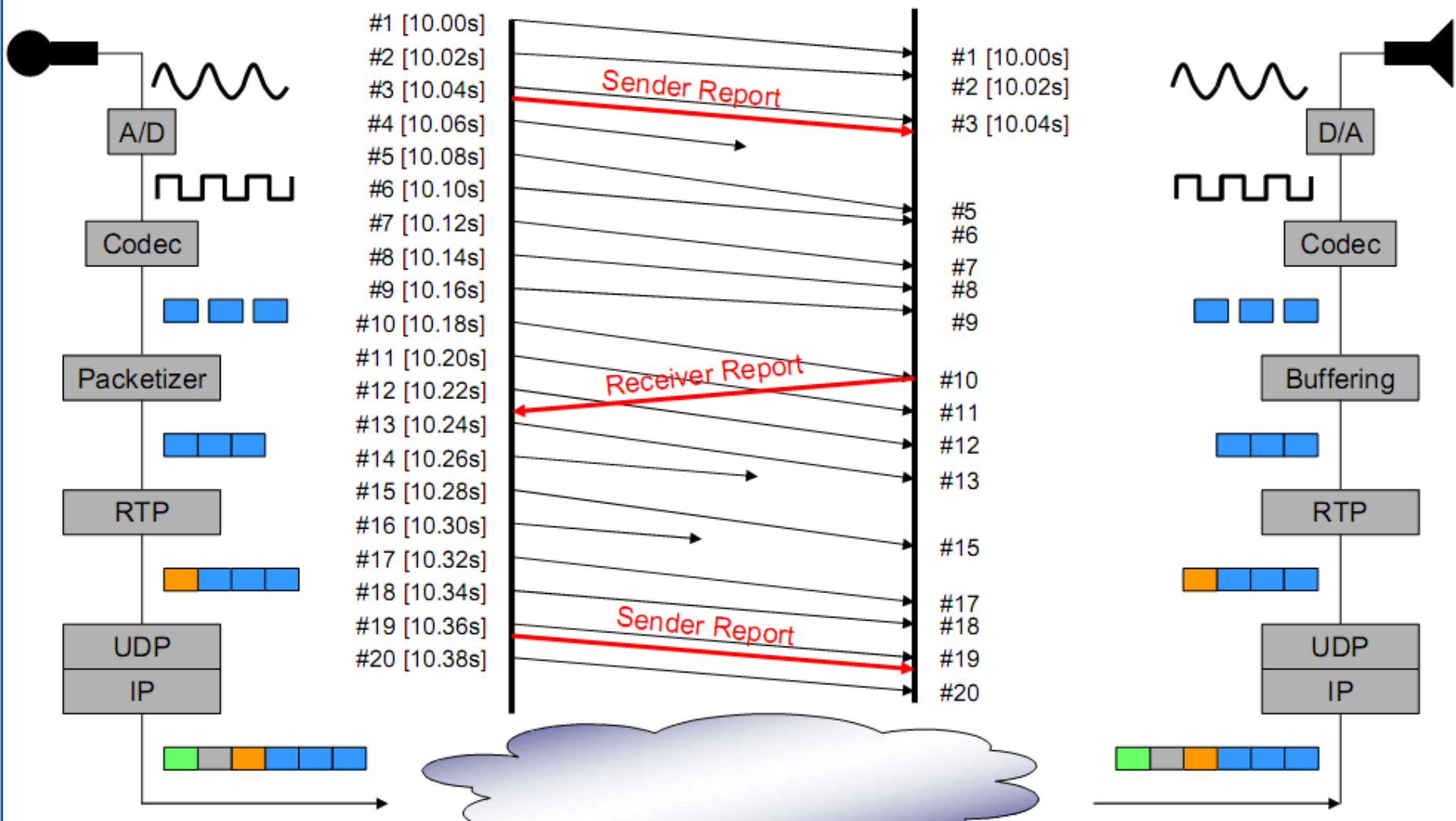
Avdio “kodeki”

- **Kodeki se razlikujejo po**
 - potrebni pasovni širini
 - potrebni procesorski moči za kodiranje in dekodiranje

Kodek	Algoritem	Bitna hitrost
G.711	Pulse-Coded Modulation (PCM), μ -Law ali A-Law	64 kb/s
G.721	Adaptive Differential Pulse Code Modulation (ADPCM)	32 kb/s
G.726	Razširjen ADPCM	40, 32, 24 ali 16 kb/s
G.728	Low-Delay Code Excited Linear Prediction (LD-CELP)	16 kb/s
G.729	Conjugate-Structure Algebraic-Code-Excited Linear Prediction (CS-ACELP)	8 kb/s



Primer: Avdio prek RTP/RTCP





VoIP kodeki – pasovna širina

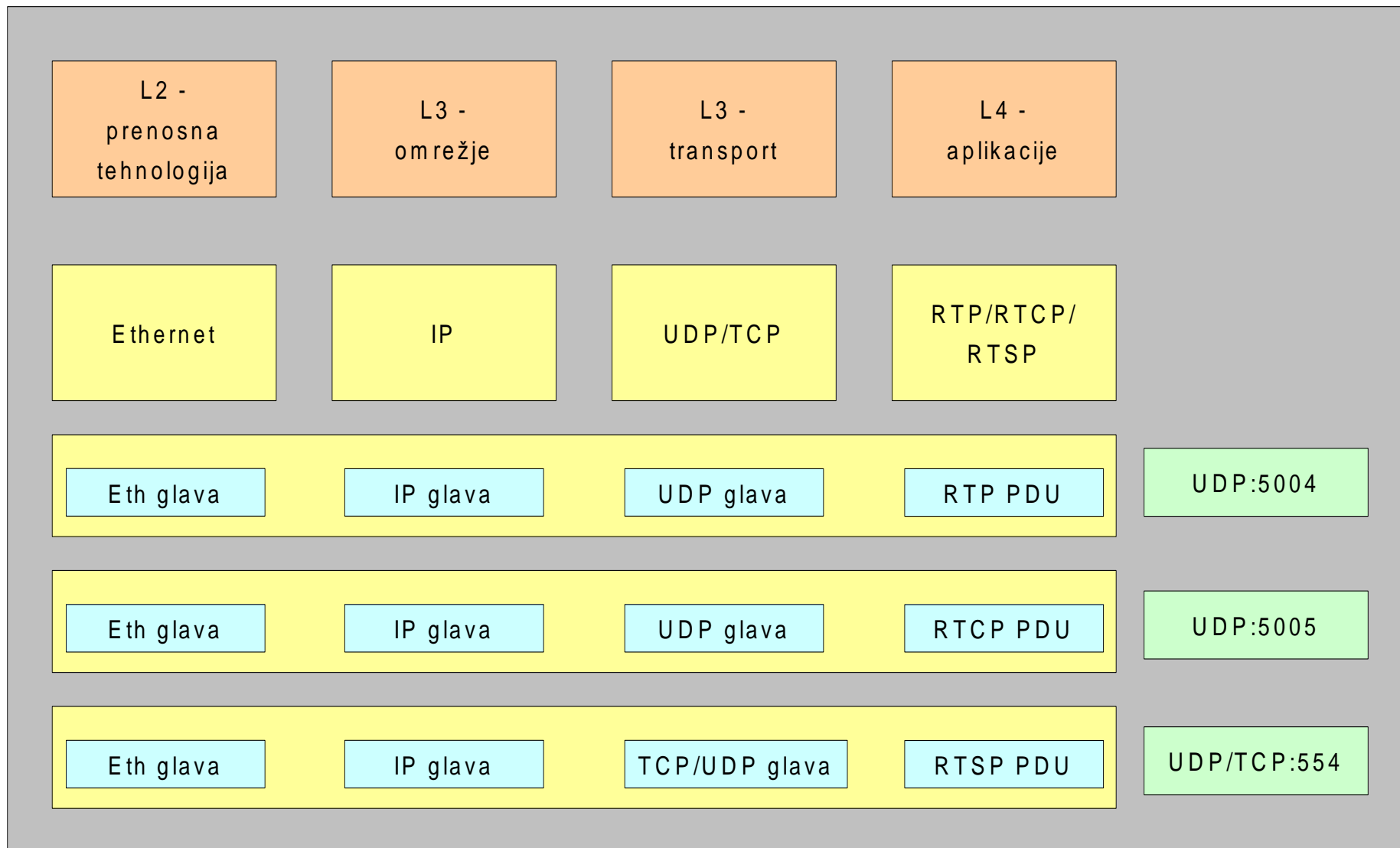
■ G.711 - Ethernet

- **BW: 64kbit/s**
- **vzorčenje: 20ms->50 paket/s**
- **64kbit/s / 50 paket/s = 1280 bit/paket = 160 byte/paket**
- **režija: Ethernet (18 byte) + IP (20 byte) + UDP (8 byte) + RTP (12 byte) = 58 byte**
- **skupno: 160 byte/paket + 58 byte/paket = 218 byte/paket**
- **bruto BW: 218 byte/paket * 50 paket/s = 10900 byte/s = 87.2 kbit/s**
- **režija: 87.2 kbit/s - 64kbit/s = 23.2 kbit/s**

Codec Information				Bandwidth Calculations					
Codec & Bit Rate (Kbps)	Codec Sample Size (Bytes)	Codec Sample Interval (ms)	Mean Opinion Score (MOS)	Voice Payload Size (Bytes)	Voice Payload Size (ms)	Packets Per Second (PPS)	Bandwidth MP or FRF.12 (Kbps)	Bandwidth w/cRTP MP or FRF.12 (Kbps)	Bandwidth Ethernet (Kbps)
G.711 (64 Kbps)	80 Bytes	10 ms	4.1	160 Bytes	20 ms	50	82.8 Kbps	67.6 Kbps	87.2 Kbps
G.729 (8 Kbps)	10 Bytes	10 ms	3.92	20 Bytes	20 ms	50	26.8 Kbps	11.6 Kbps	31.2 Kbps
G.723.1 (6.3 Kbps)	24 Bytes	30 ms	3.9	24 Bytes	30 ms	34	18.9 Kbps	8.8 Kbps	21.9 Kbps
G.723.1 (5.3 Kbps)	20 Bytes	30 ms	3.8	20 Bytes	30 ms	34	17.9 Kbps	7.7 Kbps	20.8 Kbps
G.726 (32 Kbps)	20 Bytes	5 ms	3.85	80 Bytes	20 ms	50	50.8 Kbps	35.6 Kbps	55.2 Kbps
G.726 (24 Kbps)	15 Bytes	5 ms		60 Bytes	20 ms	50	42.8 Kbps	27.6 Kbps	47.2 Kbps
G.728 (16 Kbps)	10 Bytes	5 ms	3.61	60 Bytes	30 ms	34	28.5 Kbps	18.4 Kbps	31.5 Kbps



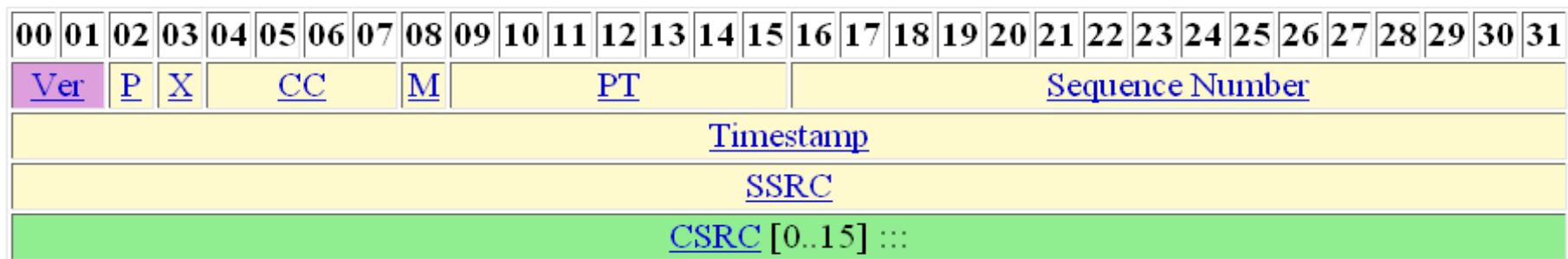
Osnovne značilnosti RTP/RTCP/RTSP





RTP (Real-time Transport Protocol)

- RFC 3550, RFC 3551
- Namenjen prenosu vsebin v “realnem času”
- Prenos v unicast in multicast načinu
- Protokol RTP zagotavlja storitve
 - časovno žigosanje in rekonstrukcijo
 - detekcijo izgub
 - identifikacijo vsebin
- Polja
 - Verzija – 2
 - Tovor (ang. Payload)
 - Časovni žig (ang. Timestamp)





RTCP (RTP Control Protocol)

- RFC 3605, RFC 3611, RFC 3711, RFC 3550
- Komplementaren protokol, ki dopolnjuje protokol RTP
- Udeleženci RTP seje periodično pošiljajo RTCP sporočila za izmenjavo informacij o kvaliteti prenosa in o identiteti udeležencev
- **Naloge**
 - nadzor kakovosti storitev in prenosa podatkov, informacije lahko koristijo tako oddajniki, sprejemniki ali nadzorni sistemi
 - identifikacija izvorov omogoča enolično globalno označevanje – kanonična imena
 - sinhronizacija med mediji (avdio, video).
 - prilagajanje kontrolnih informacij med udeleženci

MAC header | IP header | UDP header | RTCP header | Data :::

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
<u>Version</u>		<u>P</u>	<u>Count</u>				<u>Type</u>					<u>Length</u>																			
Data :::																															



RTSP (Real Time Streaming Protocol)

- RFC 2326
- Nadzorni protokol namenjen za učinkovito strujanje večpredstavnih vsebin
- Prenos prek transportnih protokolov TCP (tipično) in UDP, privzeta št. komunikacijskih vrat je 554 (8554)
- Strežba vsebin na zahtevo in oddajanje v živo
- Omogoča inicializacijo in VCR funkcionalnosti: pavza, hitro predvajanje naprej in nazaj, absolutno pozicioniranje
- Možno tuneliranje podatkov (RTP) v okviru protokola RTSP
- Komplementaren po funkcionalnosti H.323
- Razvili: RealNetworks, Netscape Communicatios, Columbia University

MAC header	IP header	TCP header	RTSP message
MAC header	IP header	UDP header	RTSP message



Analiza prometa – H.323 - signalizacija

h323test1.pcap - Wireshark

Filter: [ip.addr eq 192.168.99.23 and ip.addr eq 192.168.99.2] Expression... Clear Apply

No. -	Time	Source	Destination	Protocol	Info
5	4.100470	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [SYN] Seq=0 Len=0 MSS=1460 WS=0 TSV=5742188 TSER=0
6	4.102517	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [SYN, ACK] Seq=0 Ack=1 win=8192 Len=0 MSS=1460 WS=0 TSV=37199255 TSER=57
7	4.103758	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [ACK] Seq=1 Ack=1 win=8192 Len=0
8	4.235365	192.168.99.23	192.168.99.2	H.225.0	CS: setup OpenLogicalChannel
9	4.236847	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [ACK] Seq=1 Ack=334 win=7863 Len=0 TSV=37199256 TSER=5742188
10	4.363940	192.168.99.2	192.168.99.23	H.225.0	CS: setupAcknowledge
11	4.369757	192.168.99.2	192.168.99.23	H.225.0	CS: progress OpenLogicalChannel
13	4.430233	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [ACK] Seq=334 Ack=179 win=8067 Len=0
91	6.697797	192.168.99.2	192.168.99.2	H.225.0	CS: information
96	6.816400	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [ACK] Seq=179 Ack=386 win=8192 Len=0 TSV=37199261 TSER=5742188
343	13.809884	192.168.99.23	192.168.99.2	H.225.0	CS: releaseComplete
344	13.811030	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [ACK] Seq=179 Ack=440 win=8142 Len=0 TSV=37199275 TSER=5742188
345	13.815489	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [FIN, ACK] Seq=179 Ack=440 win=8192 Len=0 TSV=37199275 TSER=5742188
346	13.816605	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [ACK] Seq=440 Ack=180 win=8192 Len=0
347	13.822151	192.168.99.2	192.168.99.2	TCP	1038 > 1720 [FIN, ACK] Seq=440 Ack=180 win=8192 Len=0
348	13.822748	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [ACK] Seq=180 Ack=441 win=8192 Len=0 TSV=37199275 TSER=5742188

+ Frame 8 (387 bytes on wire (387 bytes captured)
 + Ethernet II, Src: Iskratel_50:09:60 (00:d0:50:09:60), Dst: Iskratel_00:4f:8f (00:d0:50:00:4f:8f)
 + Internet Protocol, Src: 192.168.99.23 (192.168.99.23), Dst: 192.168.99.2 (192.168.99.2)
 + Transmission Control Protocol, Src Port: 1038 (1038), Dst Port: 1720 (1720), Seq: 1, Ack: 1, Len: 333
 + TPKT, Version: 3, Length: 333
 + Q.931
 + H.225.0 CS
 - H323_UserInformation
 - h323-uu-pdu
 - h323-message-body: setup (0)
 - setup
 - protocolIdentifier: 0.0.8.2250.0.4 (itu-t(0) recommendation(0) h(8) h225-0(2250) version(0) 4)
 - sourceAddress: 2 items
 - sourceInfo
 - destCallSignalAddress: ipAddress (0)
 - 0... .. activeMC: False
 - conferenceID: 0058791b-3f33-0a1f-0ca8-33f069ee8f1d
 - conferenceGoal: create (0)
 - callType: pointToPoint (0)
 - sourceCallSignalAddress: ipAddress (0)
 - callIdentifier
 - guid: 0058791b-3f33-0a1f-0ca7-33f069ee8f1d
 - fastStart: 4 items
 - Item 0
 - Item: 25 octets
 - OpenLogicalChannel
 - forwardLogicalChannelNumber: 1
 - forwardLogicalChannelParameters
 - dataType: audioData (3)
 - audioData: g711Alaw64k (1)
 - multiplexParameters: h2250LogicalChannelParameters (3)
 - Item 1
 - Item: 25 octets
 - OpenLogicalChannel
 - forwardLogicalChannelNumber: 1
 - forwardLogicalChannelParameters
 - dataType: audioData (3)
 - audioData: g711Alaw64k (1)
 - multiplexParameters: h2250LogicalChannelParameters (3)

0060 ee 8f 1d 71 04 19 00 00 0c 20 1d 80 11 14 00 ...q....
 00c0 01 00 c0 a8 63 17 4a 38 00 c0 a8 63 17 4a 39 1d ...c.J8 ...c.J9.
 00d0 40 01 42 06 04 01 00 4c 20 1d 80 11 14 00 01 00 ...B...L
 00e0 c0 a8 63 17 4a 38 00 c0 a8 63 17 4a 39 19 00 00 ...c.J8...c.J9...
 00f0 01 0c 60 1d 80 11 14 00 01 00 c0 a8 63 17 4a 38 ...c.J8...c.J8
 0100 00 c0 a8 63 17 4a 20 1d 40 01 42 06 04 01 00 4c ...c.J9...B...

h245.AudioCapability (h245.audioData), 3 bytes

P: 351 D: 16 M: 0



Analiza prometa H.323/RTP – podatki

h323test1.pcap - Wireshark

File Edit View Go Capture Analyze Statistics Help

Filter: Expression... Clear Apply

No. -	Time	Source	Destination	Protocol	Info
5	4.100470	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [SYN] Seq=0 Len=0 MSS=1460 WS=0 TSV=5742188 TSER=0
6	4.102517	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [SYN, ACK] Seq=0 Ack=1 win=8192 Len=0 MSS=1460 WS=0 TSV=37199255 TSER=57
7	4.103758	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [ACK] Seq=1 Ack=1 win=8192 Len=0
8	4.235365	192.168.99.23	192.168.99.2	H.225.0	CS: setup openLogicalChannel
9	4.236847	192.168.99.2	192.168.99.23	TCP	1720 > 1038 [ACK] Seq=1 Ack=334 win=7863 Len=0 TSV=37199256 TSER=5742188
10	4.363940	192.168.99.2	192.168.99.23	H.225.0	CS: setupacknowledge
11	4.369757	192.168.99.2	192.168.99.23	H.225.0	CS: progress openLogicalChannel
12	4.404744	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=0, Time=200, Mark
13	4.430233	192.168.99.23	192.168.99.2	TCP	1038 > 1720 [ACK] Seq=334 Ack=179 win=8067 Len=0
14	4.436666	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=1, Time=440
15	4.468615	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=2, Time=680
16	4.500622	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=3, Time=920
17	4.532613	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=4, Time=1160
18	4.564612	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=5, Time=1400
19	4.580658	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=6, Time=1640
20	4.612629	192.168.99.2	192.168.99.23	RTP	PT=ITU-T G.711 PCMA, SSRC=0xc7ab4a0, Seq=7, Time=1880

Frame 17 (294 bytes on wire, 294 bytes captured)

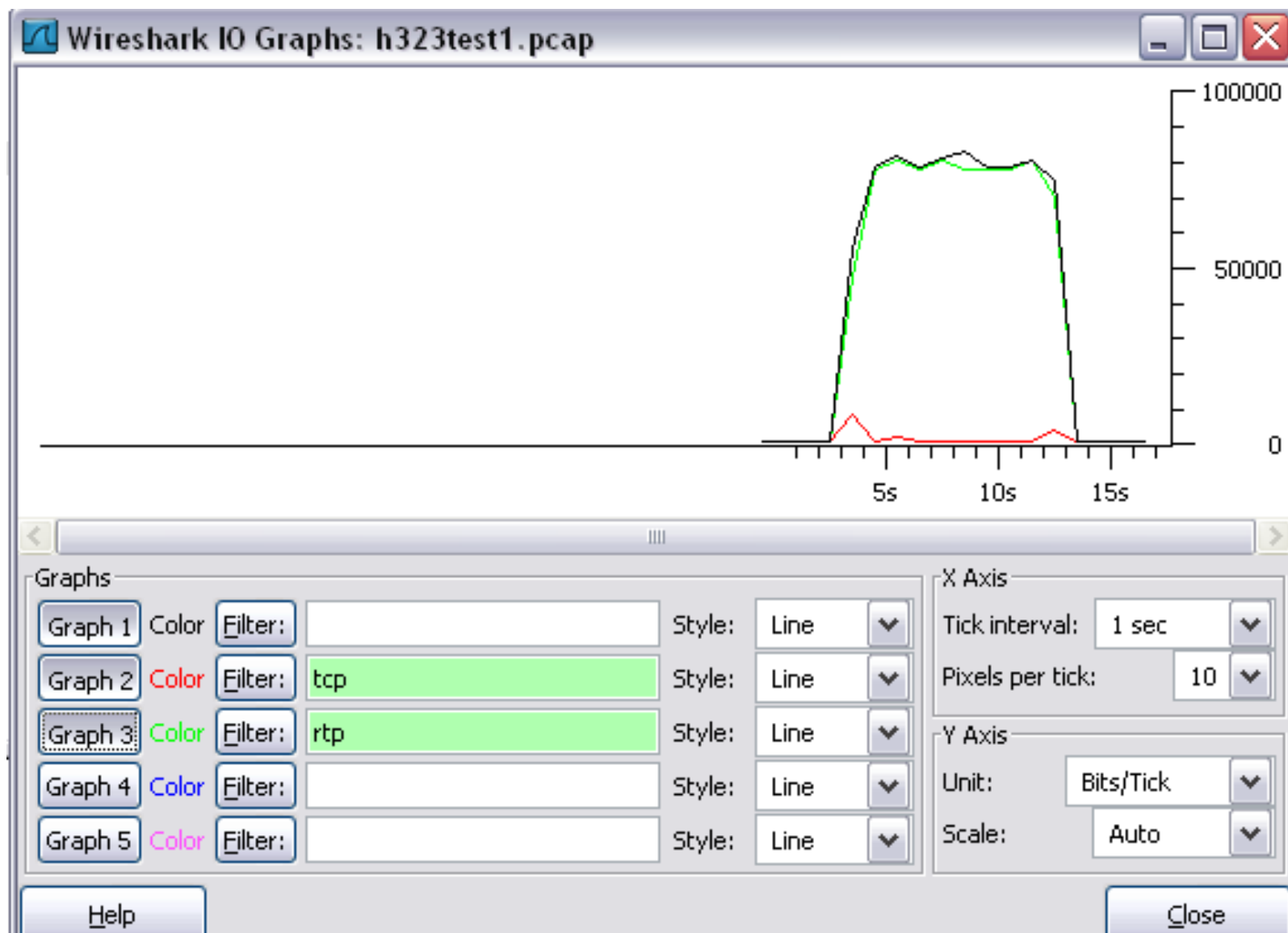
- Ethernet II, Src: Iskratel_00:4f:8f (00:d0:50:00:4f:8f), Dst: Iskratel_50:09:60 (00:d0:50:09:60)
- Internet Protocol, Src: 192.168.99.2 (192.168.99.2), Dst: 192.168.99.23 (192.168.99.23)
- User Datagram Protocol, Src Port: 17948 (17948), Dst Port: 19000 (19000)
 - Source port: 17948 (17948)
 - Destination port: 19000 (19000)
 - Length: 260
 - Checksum: 0x0000 (none)
- Real-Time Transport Protocol
 - [Stream setup by H245 (frame 11)]
 - [Setup frame: 11]
 - [Setup Method: H245]
 - 10.. = Version: RFC 1889 Version (2)
 - ..0. = Padding: False
 - ...0 = Extension: False
 - 0000 = Contributing source identifiers count: 0
 - 0... = Marker: False
 - Payload type: ITU-T G.711 PCMA (8)
 - Sequence number: 4
 - [Extended sequence number: 65540]
 - Timestamp: 1160
 - Synchronization Source Identifier: 0xc7ab4a0 (209368224)
 - Payload: B8A5BABB183C106363F3A2538320B11938ABDB8A5BABFB7...

```
0020 63 17 46 1c 4a 38 01 04 00 00 80 00 04 00 00 c.F.J8... ..
0030 04 88 0c 7a b4 a0 b8 a5 ba be b1 83 c1 06 36 3f ...z.....6?
0040 3a 25 38 32 0b 11 93 8a bd b8 a5 ba bf b7 87 71 :%82.... .q
0050 02 31 9e 3a 3a 39 33 0e 6c 9b b4 bc bb a3 bb bc .1>:93. |.....
0060 b4 9b 6c 0e 33 39 3a 3a 3e 31 02 71 87 b7 bf ba ..1.39: >1.q....
0070 a5 b8 bd 8a 93 11 0b 32 38 25 3a 3f 36 06 c1 83 .....2 8%:76...
0080 b1 be ba a5 b8 b3 89 eb 1e 35 3d 3b 25 3b 3c 34 ..... .5=;%;<4
0090 05 e1 8c b0 b9 ba ba b9 b0 8d fb 04 37 3f 3b 25 ..... .7?:%
00a0 3b 3d 35 1c 94 88 b2 b8 a5 ba be b6 80 55 00 36 ;=5..... .U.6
00b0 3e 3a 25 38 32 08 14 9c b5 bd bb a5 bb bf b7 84 >:%82.... .
00c0 7b 0d 30 39 3a 3a 39 30 0c 61 85 b4 bc bb a5 bb {.09:190 .a.....
00d0 bd b5 9e 6b 09 33 38 25 3a 3e 31 03 41 86 b6 bf ...k.38% >1.A...
00e0 ba a5 b8 b2 8b 91 13 0a 3d 38 25 3a 3f 37 07 f1 ..... =8%:??..
00f0 82 b1 be ba ba b9 b3 8e ec 1b 34 3c 3b 25 3b 3c ..... .4<:;%;<
0100 34 1b ec 8e b3 b9 ba ba be b1 82 f1 07 37 3f 3a 4..... :%??.
0110 25 38 3d 0a 13 91 8b b2 b8 a5 ba bf b6 86 41 03 %8..... .A.
```

Payload type (rtp.p.type), 1 byte P: 351 D: 351 M: 0



Analiza prometa H.323 – BW





Analiza video prometa pri strujanju – RTSP

(Untitled) - Ethereal

File Edit View Go Capture Analyze Statistics Help

Filter: ip.addr == 193.2.90.101

No. -	Time	Source	Destination	Protocol	Length	Info
47	4.999376	10.0.3.130	193.2.90.101	TCP	62	3173 > 554 [SYN] Seq=0 Ack=0 Win=65535 Len=0 MSS=1460
49	5.000253	193.2.90.101	10.0.3.130	TCP	62	554 > 3173 [SYN, ACK] Seq=0 Ack=1 Win=16384 Len=0 MSS=1460
50	5.000464	10.0.3.130	193.2.90.101	TCP	54	3173 > 554 [ACK] Seq=1 Ack=1 Win=65535 Len=0
51	5.003124	10.0.3.130	193.2.90.101	RTSP	485	DESCRIBE rtsp://193.2.90.101/harry.wmv RTSP/1.0
52	5.036928	193.2.90.101	10.0.3.130	RTSP/S	1514	Reply: RTSP/1.0 200 OK, with session description
53	5.037141	193.2.90.101	10.0.3.130	RTSP	1514	Continuation
54	5.037284	10.0.3.130	193.2.90.101	TCP	54	3173 > 554 [ACK] Seq=432 Ack=2921 Win=65535 Len=0
55	5.037471	193.2.90.101	10.0.3.130	RTSP	89	Continuation
57	5.173464	10.0.3.130	193.2.90.101	TCP	54	3173 > 554 [ACK] Seq=432 Ack=2956 Win=65500 Len=0
58	5.229027	10.0.3.130	193.2.90.101	RTSP	414	SETUP rtsp://193.2.90.101/harry.wmv/rtx RTSP/1.0
59	5.235884	193.2.90.101	10.0.3.130	RTSP	628	Reply: RTSP/1.0 200 OK
60	5.237333	10.0.3.130	193.2.90.101	RTSP	482	SET_PARAMETER rtsp://193.2.90.101/harry.wmv RTSP/1.0
61	5.237958	193.2.90.101	10.0.3.130	RTP	1512	Payload type=Unknown (96), SSRC=2407692578, Seq=8017, Time
62	5.238135	193.2.90.101	10.0.3.130	RTP	1513	Payload type=Unknown (96), SSRC=2407692578, Seq=8018, Time
63	5.238196	193.2.90.101	10.0.3.130	RTP	1514	Payload type=Unknown (96), SSRC=2407692578, Seq=8019, Time
64	5.238271	193.2.90.101	10.0.3.130	RTSP	301	Reply: RTSP/1.0 200 OK
65	5.374636	10.0.3.130	193.2.90.101	TCP	54	3173 > 554 [ACK] Seq=1220 Ack=3777 Win=64679 Len=0
66	5.499908	10.0.3.130	193.2.90.101	RTSP	441	SETUP rtsp://193.2.90.101/harry.wmv/audio RTSP/1.0
67	5.502250	193.2.90.101	10.0.3.130	RTSP	635	Reply: RTSP/1.0 200 OK
68	5.502516	10.0.3.130	193.2.90.101	RTSP	441	SETUP rtsp://193.2.90.101/harry.wmv/video RTSP/1.0
69	5.504099	193.2.90.101	10.0.3.130	RTSP	635	Reply: RTSP/1.0 200 OK
70	5.676389	10.0.3.130	193.2.90.101	TCP	54	3173 > 554 [ACK] Seq=1994 Ack=4939 Win=65535 Len=0
117	8.498841	10.0.3.130	193.2.90.101	RTSP	468	PLAY rtsp://193.2.90.101/harry.wmv RTSP/1.0
118	8.502907	193.2.90.101	10.0.3.130	RTSP	820	Reply: RTSP/1.0 200 OK
119	8.506884	10.0.3.130	193.2.90.101	RTSP	647	SET_PARAMETER rtsp://193.2.90.101/harry.wmv RTSP/1.0
120	8.507459	193.2.90.101	10.0.3.130	RTSP	189	Reply: RTSP/1.0 200 OK
121	8.548514	193.2.90.101	10.0.3.130	RTP	1426	Payload type=Unknown (96), SSRC=12025892, Seq=61551, Time
122	8.548733	193.2.90.101	10.0.3.130	RTP	1426	Payload type=Unknown (96), SSRC=12025892, Seq=61552, Time
123	8.548785	193.2.90.101	10.0.3.130	RTP	1403	Payload type=Unknown (96), SSRC=12025892, Seq=61553, Time

Frame 51 (485 bytes on wire, 485 bytes captured)
Ethernet II, Src: 00:03:47:fe:6e:e6, Dst: 00:16:46:b6:a8:40
Internet Protocol, Src Addr: 10.0.3.130 (10.0.3.130), Dst Addr: 193.2.90.101 (193.2.90.101)
Transmission Control Protocol, Src Port: 3173 (3173), Dst Port: 554 (554), Seq: 1, Ack: 1, Len: 431
Real Time Streaming Protocol
DESCRIBE rtsp://193.2.90.101/harry.wmv RTSP/1.0\r\n
User-Agent: WMPlayer/10.0.0.364 guid/3300AD50-2C39-46C0-AE0A-500F44282979\r\n
Accept: application/sdp\r\n
Accept-Charset: UTF-8, *;q=0.1\r\n
X-Accept-Authentication: Negotiate, NTLM, Digest, Basic\r\n
Accept-Language: sl-SI, *;q=0.1\r\n
CSeq: 1\r\n
Supported: com.microsoft.wm.srvppair, com.microsoft.wm.sswitch, com.microsoft.wm.eosmsg, com.microsoft.wm.predstrm, com.micr\r\n\r\n

Real Time Streaming Protocol (rtsp), 431 bytes

P: 1697 D: 1335 M: 0



Analiza prometa RTSP seje

Čas

amino103-a_mpg-ociscen.trace - Ethereal

File Edit View Go Capture Analyze Statistics Help

Filter: (ip.addr eq 10.0.5.20 and ip.addr eq 10.0.1.78) and ...

Time	Source	Destination	Protocol	Length	Info	
1	0.000000	10.0.5.20	10.0.1.78	TCP	74	2059 > 554 [SYN] Seq=0 Ack=0 Win=
2	0.000621	10.0.1.78	10.0.5.20	TCP	74	554 > 2059 [SYN, ACK] Seq=0 Ack=1
3	0.000942	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=1 Ack=1 Win=
4	0.102013	10.0.5.20	10.0.1.78	RTSP	255	SETUP rtsp://10.0.1.78/Video/a.mp
5	0.102148	10.0.1.78	10.0.5.20	TCP	66	554 > 2059 [ACK] Seq=1 Ack=190 Wi
6	0.110499	10.0.1.78	10.0.5.20	RTSP/S	496	Reply: RTSP/1.0 200 OK, with sess
7	0.110811	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=190 Ack=431
8	0.209260	10.0.5.20	10.0.1.78	RTSP	170	PLAY rtsp://10.0.1.78/Video/a.mpg
9	0.222411	10.0.1.78	10.0.5.20	RTSP	241	Reply: RTSP/1.0 200 OK
10	0.222725	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=294 Ack=606
6338	15.424355	10.0.5.20	10.0.1.78	RTSP	150	GET_PARAMETER rtsp://10.0.1.78/vi
6342	15.431080	10.0.1.78	10.0.5.20	RTSP	163	Reply: RTSP/1.0 200 OK
6343	15.431373	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=378 Ack=703
18899	45.424179	10.0.5.20	10.0.1.78	RTSP	150	GET_PARAMETER rtsp://10.0.1.78/vi
18903	45.431506	10.0.1.78	10.0.5.20	RTSP	163	Reply: RTSP/1.0 200 OK
18904	45.431774	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=462 Ack=800
18970	50.810103	10.0.5.20	10.0.1.78	RTSP	145	TEARDOWN rtsp://10.0.1.78/Video/a
18971	50.817397	10.0.1.78	10.0.5.20	RTSP	132	Reply: RTSP/1.0 200 OK
18972	50.817711	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [ACK] Seq=541 Ack=866
18973	50.983272	10.0.5.20	10.0.1.78	TCP	66	2059 > 554 [FIN, ACK] Seq=541 Ack
18974	50.983433	10.0.1.78	10.0.5.20	TCP	66	554 > 2059 [RST, ACK] Seq=866 Ack

Frame 1 (74 bytes on wire, 74 bytes captured)

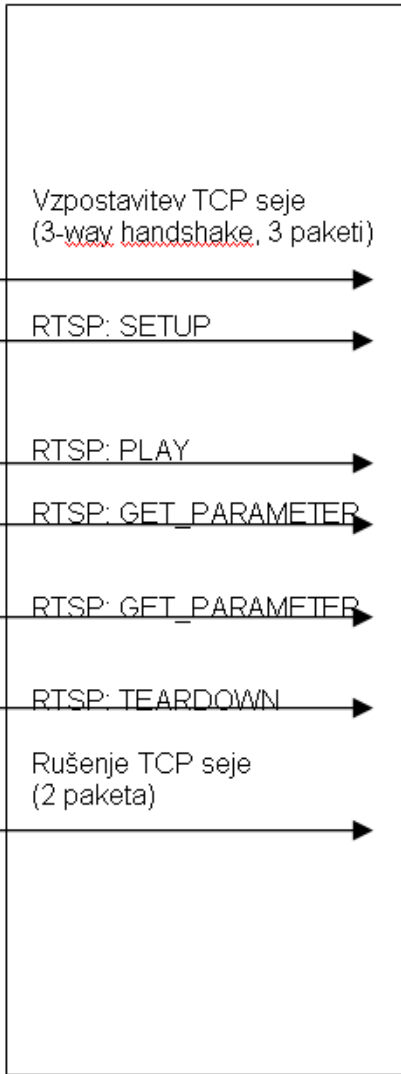
- Ethernet II, Src: 00:02:02:00:33:8b, Dst: 00:30:48:84:dc:5a
- Internet Protocol, Src Addr: 10.0.5.20 (10.0.5.20), Dst Addr: 10.0.1.78 (10.0.1.78)
- Transmission Control Protocol, Src Port: 2059 (2059), Dst Port: 554 (554), Seq: 0, Ack: 0, Len: 0

```

0000  00 30 48 84 dc 5a 00 02 02 00 33 8b 08 00 45 00  .0H..Z.. ..3...E.
0010  00 3c 89 8d 40 00 40 06 96 cd 0a 00 05 14 0a 00  .<.@.@. ....
0020  01 4e 08 0b 02 2a b0 4e 08 32 00 00 00 00 a0 02  .N...*N .2.....
0030  16 d0 d2 60 00 00 02 04 05 b4 04 02 08 0a 00 00  ... ..

```

File: amino103-a_mpg-ociscen.trace 25 MB 00:00:50 | P: 18974 D: 21 M: 0



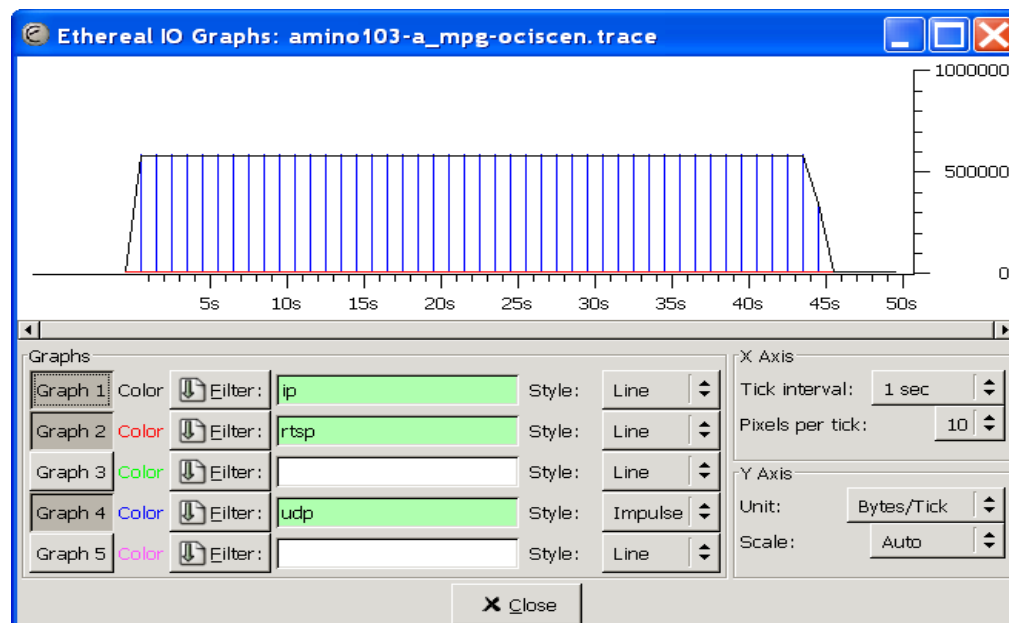


Prometne značilnosti

■ Protokolna hierarhija

Protocol	% Packets	Packets	Bytes	Mbit/s	End Packets	End Bytes	End Mbit/s
▼ Frame	100,00%	18974	26120041	4,099	0	0	0,000
▼ Ethernet	100,00%	18974	26120041	4,099	0	0	0,000
▼ Internet Protocol	100,00%	18974	26120041	4,099	0	0	0,000
▼ Transmission Control Protocol	0,11%	21	2807	0,000	11	742	0,000
▼ Real Time Streaming Protocol	0,05%	10	2065	0,000	9	1569	0,000
Session Description Protocol	0,01%	1	496	0,000	1	496	0,000
▼ User Datagram Protocol	99,89%	18953	26117234	4,098	0	0	0,000
Data	99,89%	18953	26117234	4,098	18953	26117234	4,098

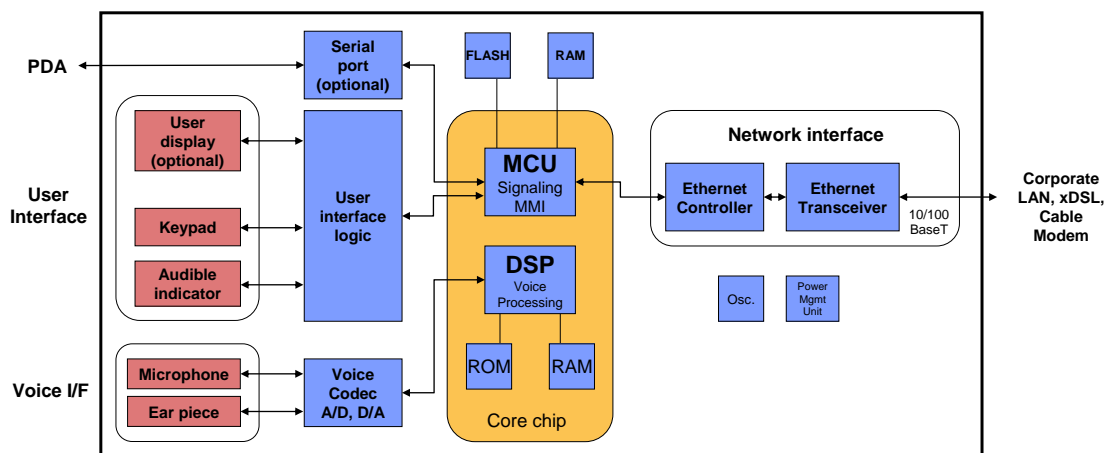
■ Primerjava količine prometa (RTSP, UDP)





Terminalna oprema VoIP

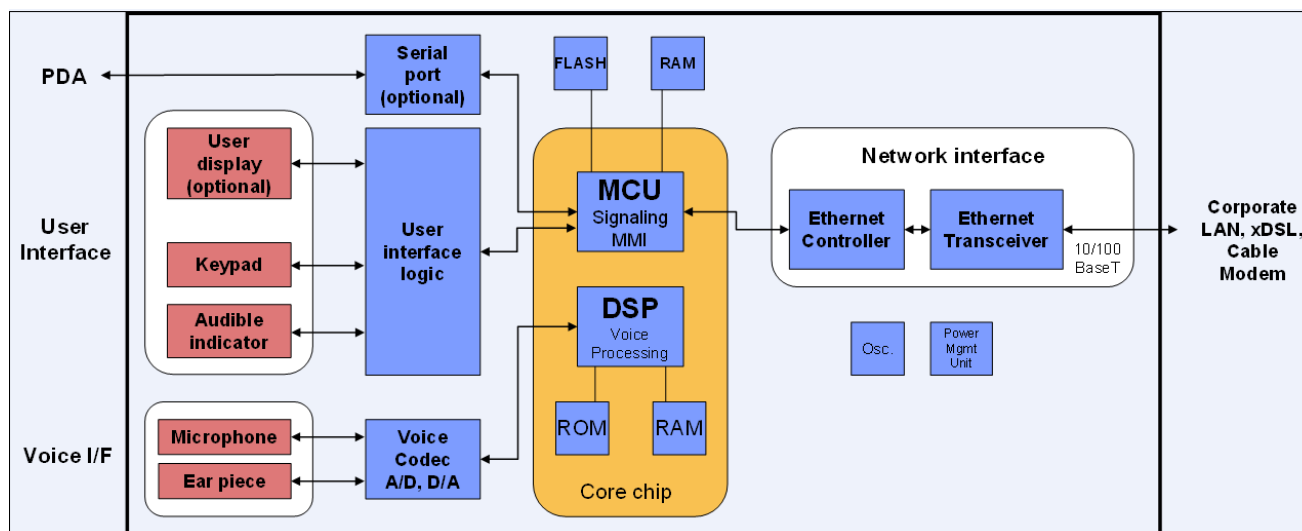
- Načelno IP terminale delimo v dve večji skupini
 - strojno osnovani VoIP terminali oziroma IP telefoni in
 - programsko osnovani VoIP terminali
- IP telefon sestoji iz sledečih referenčnih komponent
 - uporabniški vmesnik
 - govorni vmesnik
 - omrežni vmesnik
 - procesorsko jedro s pripadajočo logiko





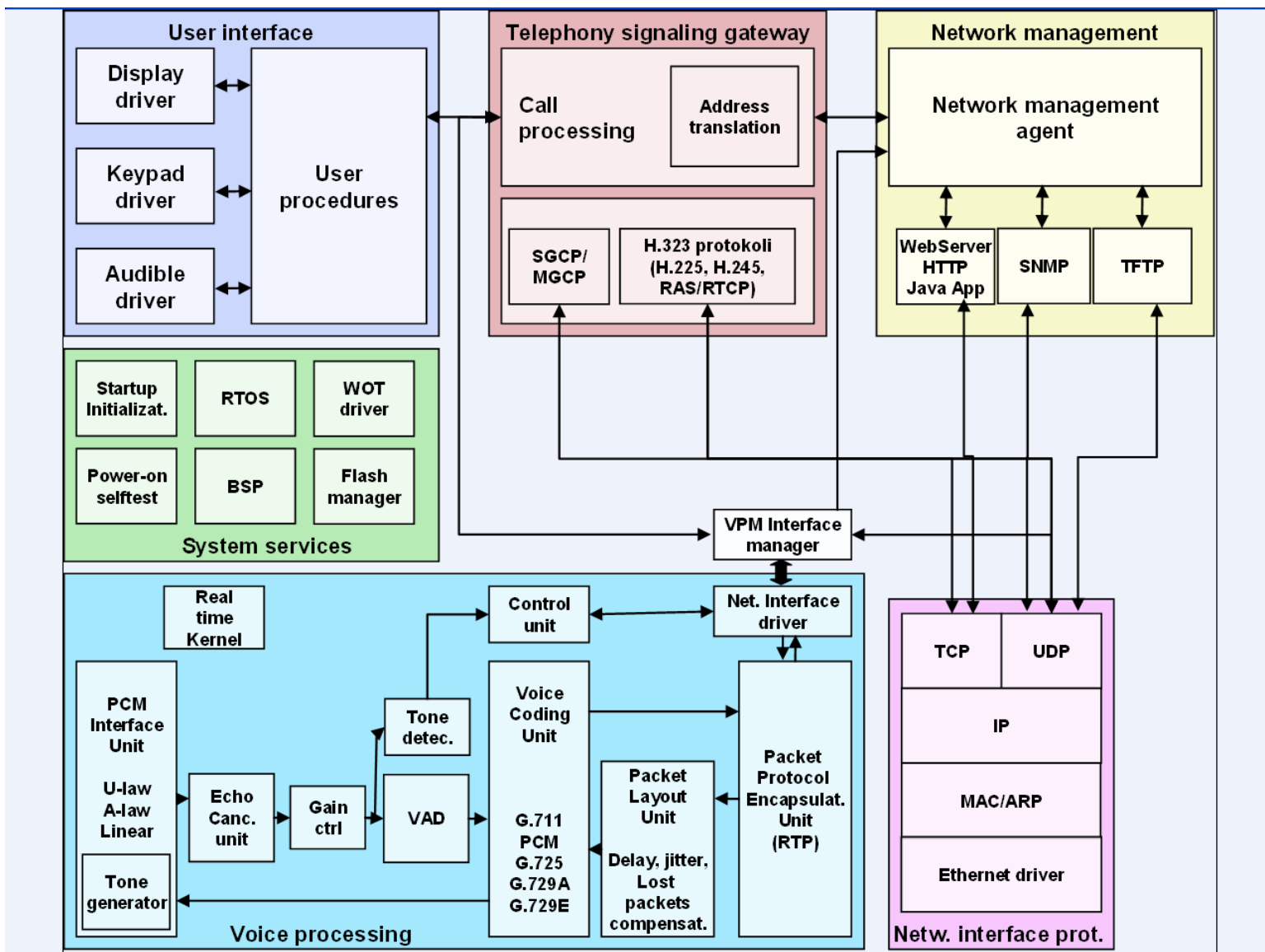
IP telefon – strojna zasnova

- **Uporabniški vmesnik**
 - tipkovnica
 - prikazovalnik
- **Avdio vmesnik**
 - digitalizacija in formatiranje audio signala
- **Mrežni vmesnik**
 - omrežna komunikacija
- **Procesor (DSP, MCU)**





IP telefon – programska zasnova





IP telefon – IskraTel IP10S





“Soft Phone”

