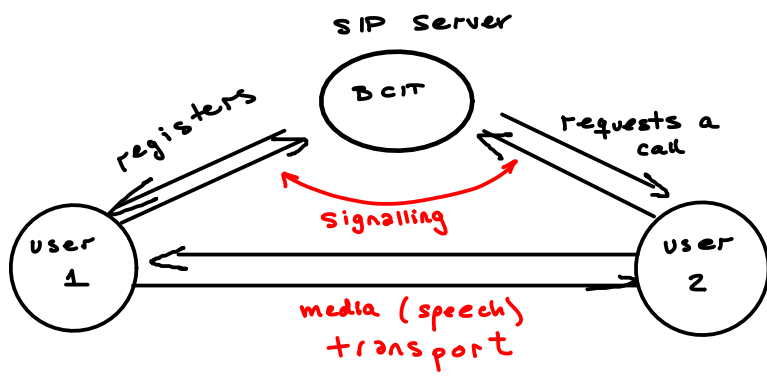
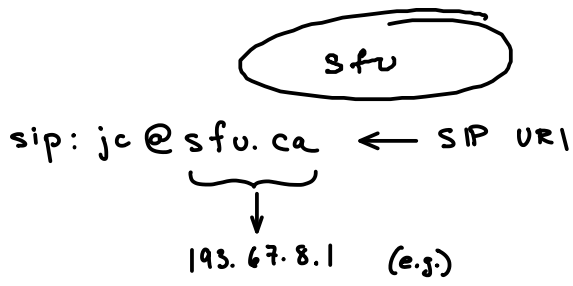


Lecture 24

Exercise 1: Why can't the speech and video stream be transmitted using only UDP? Why might we want to avoid transmitting them over TCP?

- would not be able to detect missing or out of order data
- TCP may not send out frames at the rate we supply them (due to congestion control & retransmissions)



Exercise 2: How many bytes of header overhead are added to each packet assuming the smallest possible IP, UDP and RTP headers? If 64 kb/s PCM is being transmitted in 20 ms frames, what is the total data rate, including both headers and speech data? What fraction of that is for headers?

IP = 20 bytes
 UDP = 8 bytes
 RTP = 12 bytes

 40 bytes of headers.

$$64 \text{ kb/s} \times 20 \text{ ms} = 160 \text{ bytes/packet}$$

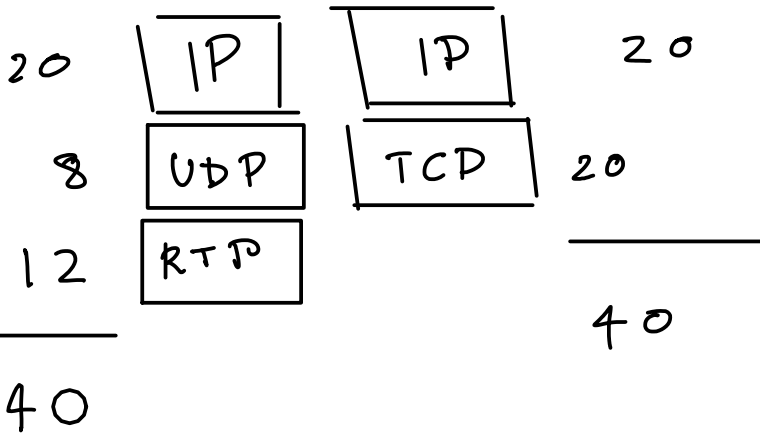
$$= 8 \text{ kBytes/s} \times 20 \text{ ms} =$$

$$\text{data rate} = \frac{\text{bits}}{\text{time}} = \frac{\text{voice headers } 160 + 40}{20 \text{ ms}} = \frac{200}{20} = 10 \text{ kBytes/s} = 80 \text{ kb/s}$$

$$\text{fraction} = \frac{\text{header bytes}}{\text{total bytes}} = \frac{40}{200} \approx 20\% \text{ overhead.}$$

Exercise 3: Assuming the minimum header lengths, which has less overhead, TCP or RTP?

TCP header overhead = 20 bytes for IP
 + 20 bytes for TCP
 = 40 bytes



Exercise 4: If the sample rate is 8 kHz and each sample is quantized with 8 bits, what is the bit rate in each direction?

$$8 \text{ kHz} \times 8 \text{ bits/sample} = 64 \text{ kb/s}$$

Exercise 5: What is the maximum bandwidth and the bit rate if the sampling rate is 16 kHz and there are 10 bits per sample?

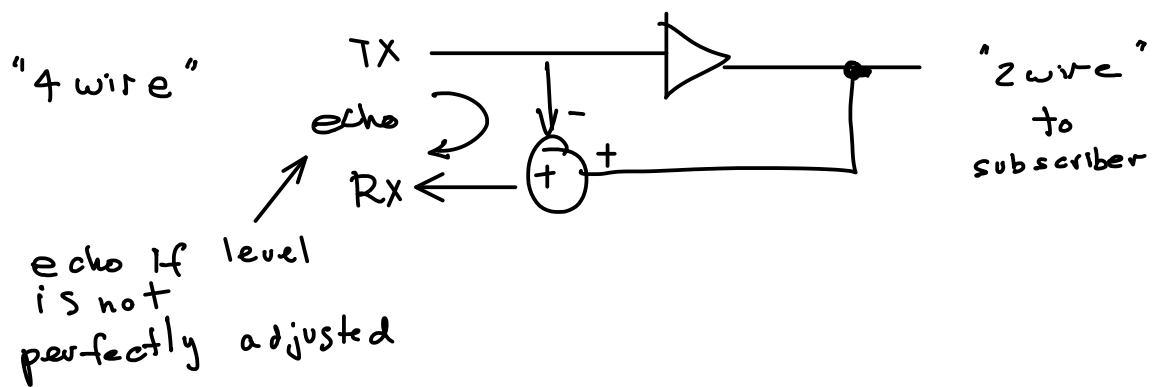
$$16 \text{ kHz} \times 10 = 160 \text{ kb/s}$$

20 kBytes/s.

Exercise 6: Why can't trunks be bidirectional?

- A/D & D/A output / input are separate bit streams
- need independent digital links in each direction

hybrid or 2-to-4 wire conversion:



Exercise 7: Which customer-facing interfaces provide which of the three services?

telephone	RJ-11 jack	POTS
data	RJ-45	Ethernet
TV	Co-ax F-connector	digital TV channels.
	HDMI	