Lecture 18 - Voice Over IP

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?

- UDP does not guarantee in-order delivery. or indication of missing packets
- TCP – too much overhead
  - TCP adds delay to adjust for network congestion (flow control)

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 : 45 : 5 x 4 = 20 bytes for IP

UDP : 2 x 32 bits : 8 bytes for UDP

RTP : " 8 bytes for RTP

36 bytes = headers

20ms x 64 kb/s = 160 bytes = payload

each packet is 196 bytes ; rate $\frac{196 \times 8}{20 \times 10^{-3}} = 78$ kb/s.

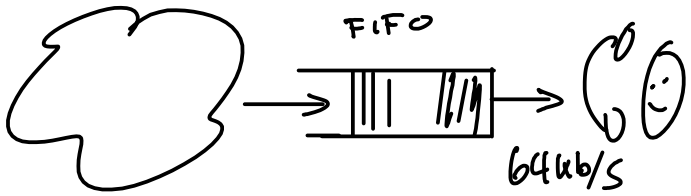
overhead : $\frac{78-64}{78} = \frac{14}{78} \approx 18\%$ overhead.

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

difference = 5 x 4 bytes for TCP − 2 x 2 bytes for RTP

= 3 x 4 = 12 bytes

for a 196 byte packet.



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 bits/sample x 8000 samples/second = 64,000 bits/second

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?

Nyquist rate = 2x bandwidth

max bandwidth = 8 kHz

bit rate = 16 kHz x 10 bits/sample = 160 kb/s

Exercise 6: Why can't trunks be bidirectional?

trunks are long & high loss & need to amplify signal in both directions (this is difficult with full-duplex links)

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