

Instructor: Stefan Savage

Due Monday 10/10 at the beginning of class

1. Viasat-1

Viasat-1 is a Ka-band satellite recently launched by Viasat corporation (a local company with headquarters in Carlsbad). Its aggregate data capacity, across all of its transponders, is 130Gbps (for simplicity, we will assume that this bandwidth is all made available for a single user). The satellite is in geostationary orbit, roughly 37,000 km above the surface of the earth (covering most of north America). Assume that a radio signal can travel at the speed of light (roughly 3×10^8 m/s).

a. Calculate the minimum round-trip time (RTT) for the link.

$$\sim 250\text{ms} \quad (37\text{km} / (3 \times 10^8 \text{ m/s}) = 0.1233 \times 2 = .2466 \text{ seconds})$$

b. Calculate the bandwidth * delay product for the link. (use RTT for delay)

$$250\text{ms} * 130\text{Gbps} = 32.5 \text{ gigabits}$$

c. Suppose I ask you to take a collection of photos I have on a USB drive here at UCSD (total size 100GB) and send them to Viasat corporation in Carlsbad. You have two choices: 1) use an on-campus satellite uplink to transmit them to Viasat corporation via the Viasat-1 satellite. 2) drive the USB drive up to Carlsbad. For the sake of this experiment, assume that there are no bit errors on the satellite link and that the travel time from La Jolla to Carlsbad is 15 minutes.

2. ATSC HDTC TV

ATSC is US standard for High-Definition Television. It is defined around channels of 6Mhz, with a minimum S/N ratio of at least ~16db. Note: it is common to use the logarithmic decibel scale for SNR. To convert between the decibel scale and the raw S/N ratio: $\text{SNR}_{\text{db}} = 10 \log_{10}(\text{S/N})$ (i.e., 16db = a S/N of ~40). Based on what you know of Shannon's law, what is the maximum bandwidth we could expect from such a channel.

$$6\text{Mhz} * \log_2(1 + 40) = 6M * 5.35755200462 = 32,145,312 \text{ Mbps} (\sim 32\text{Mbps})$$

(in practice we only get ~20Mbps, in part because we don't use some of the bandwidth at each side of the 6Mhz band to prevent interference and because we have significant overhead from forward-error correction encoding to help the receiver tolerate bit errors)

3. Stuffing

Suppose you are using a byte-level sentinel framing protocol where STX = 0x93, ETX=0x92 and DLE=0x14.

- a) What is the worst-case encoded frame length (in bytes) for a 5 byte input message?

12 bytes

- b) Show such an example message and its encoded version

0x14 0x14 0x14 0x14 0x14

0x93 0x14 0x14 0x14 0x14 0x14 0x14 0x14 0x14 0x14 0x92

(note, this is true for any five byte message composed entirely of any combination of 0x93, 0x92 and 0x14 bytes)

- c) Describe how many bytes this maximum sized message will consume using consistent overhead byte stuffing (remember, the first byte will indicate how many bytes to the first zero or 0xff if there is no zero in the first 254 bytes).

6 bytes

- d) Show the COBS-encoded version of this message:

0xff 0x14 0x14 0x14 0x14 0x14

(note this should be the first message from part 6 with an 0xff preceding it).

Also, will accept 7 bytes for part c if they put a final 0x00 in part d (not strictly necessary for COBS, but sometimes people get confused)