1. **Viasat-1**

Visat-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 3x10^8 m/s).

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

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

c. Suppose I ask you to take a large collection of photos I have on a disk drive here at UCSD (total size 10TB bytes) 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 disk drive up to Carlsbad via car. 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. Explain which method will be quicker.
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.

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?

   b) Show such an example message and its encoded version

   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).

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