

Assignment 1

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1. For each application message, the length is M bytes. After encapsulating headers of each layer, each message contains $M+20+30+80+30+20+110 = (M+290)$ bytes to be transmitted, so the fraction of the network bandwidth which is filled with headers is $290/(M+290)$.

2.1) The number of bits of the image $1920*1080*2*10^3*8 = 33,177,600,000$ bits

Transmission Delay = number of bits / bandwidth $= 33,177,600,000 / (56*10^3)$
 $= 592,457.14s$

Propagation Delay = distance / speed of signal $= 10,000/200,000 = 0.05s$

Total Latency = Transmission Delay + Propagation Delay $= 592,457.19s$

2) The number of bits for the image $1920*1080*2*10^3*8 = 33,177,600,000$ bits

Transmission Delay = number of bits / bandwidth $= 33,177,600,000 / (1*10^6)$
 $= 33177.6s$

Propagation Delay = distance / speed of signal $= 10,000/200,000 = 0.05s$

Total Latency = Transmission Delay + Propagation Delay $= 33177.65s$

3. Based on Shannon's theorem: Max. data rate $= B*\log_2(1+S/N)$ bits/sec. $S/N = 2^{(Max.data\ rate/B)} - 1 = 2^{(56*10^3/(4*10^3))} - 1 = 16383$. Converting S/N to SNR from the formula $SNR = 10*\lg(S/N) = 10*\lg(16383)dB = 43dB$. Thus, to support the data rate, the minimum SNR should be at least 43dB.

4.1) The rule of bit stuffing shows that we insert 0 after 5 consecutive 1s, so the stream of bits should be "0111101111100111110101111000" after bit stuffing.

2) According to the relation of n data bits and k check bits using Hamming code: $2^k \geq n + k + 1$, if $n = 16$, the minimal number of k is 5. Hence, we need at least 5 check bits for receiver correcting single error.

5.1) Both layer $k-1$ and $k+1$ will not be affected by layer k in this case, because changing the algorithm is just modifying how the service is implemented, but not changing the service itself. Hence, layer $k-1$ and $k+1$ are not affected.

2) If the service at layer k has a change, it means service provided by layer k will have an impact on layer $k+1$. Since the definition of service tells us service provides set of primitives only to the upper layer, there is no impact on the operations at layer $k-1$.