Homework 3 Solutions

Problem 1: Aloha Throughput Formula

Frame transmission time is $\frac{1500}{1{,}000{,}000}\frac{b}{b/\text{sec}} = 1.5$ msec.

If the system generates 1000 frames per second, then $\frac{G}{0.0015 \text{ sec}} = \frac{1000}{1 \text{ sec}}$, which implies $G = 1.5$. The throughput is therefore $1.5 \times \exp(-2G)$, or 0.0747 or 7.47%. This means that 74.7 frames will survive.

If the system generates 1500 frames per second, then G = 2.25 and the throughput is 2.5%. Only 37.5 frames will make it.

If the system generates 500 frames per second, then G = 0.75 and the throughput is 0.167 or 16.7%. Then 83.7 frames will make it.

Problem 2:

The vulnerable time is twice the signal propagation time over the maximum distance, i.e. 100 m. This is twice 3.3356×10^{-7}sec or 667.12 nano-seconds. At 600 Mbps, a single bit takes $\frac{1}{600{,}000{,}000}$ seconds or 1.667 nanoseconds. A minimum sized frame has $\frac{667.12}{1.6666666666666667}$ or at least 401 bits in it. This corresponds to 51 bytes minimum.

Problem 3:

Since ATM cells do not fit perfectly into an SPE, we need to calculate how much user data fits into a STS-3 frame. An ATM cell has 53 Bytes (48B payload and 5B header). An SPE can carry 44 cells, each with 48B of AAL data. Per frame, this is $44 \times 48 \times 8 = 16{,}896$ bits. At 8000 STS-1 frames per second, we get 135168000 bits per second or 135Mbps. We multiply this by three because STS-3 has three times as many frames, to get 405 Mbps.