

1. How many pixels per second are encoded from a video source with resolution 640 x 480 pixels and 30 frames per second (fps) ? What is the required data rate if color information is encoded with 24 bits (8 bits per color component)? How many bits are needed per pixel on the average if the data stream is encoded using JPEG with a data rate of 20 Mbit/s? How are the results affected if the resolution is 320 x 240 with 15 fps or 1280 x 960 with 10 fps?
2. Data packets are adapted to the ATM layer either by using AAL 3/4 or AAL 5. What is the data rate utilization in both cases if the packet size is a) 20 bytes, b) 50 bytes or c) 500 bytes?
3. Consider a 3-stage circuit-switched Clos switching matrix with 1024 input lines. Each input line has a load (probability that the line in question is in use) of $p = 0.7$.
 - a) The input is divided into 32 block of type $32 \times k$, where k is number of second stage blocks. Determine k such that the switch internal blocking probability is < 0.001 using Lee's approximation. What is the total number of switching points in the switch ?
 - b) The same situation as above, but now there may not be any blocking.
 - c) What are the optimal (minimal) numbers of 1st and 2nd stage blocks with non-blocking switch. How many switching points are there?
4. We have an $N \times N$ ATM switch (packet switch) which is internally non-blocking. Let's assume (unrealistically) that there are no buffers: for all cells destined to the same output only one gets through (others are discarded). Assume further that cells arrive to the inputs with the same probability p , so that arrivals to different inputs and different time slots happen independently with this same probability (Bernoulli arrivals). Arrivals are assumed to happen simultaneously (synchronized with one cell sized buffers). The cell destinations are independently distributed evenly between all outputs.
 - a) Determine the switch throughput as a function of the load p . (Probability that there is a cell in a randomly chosen time slot of an output line).
 - b) What is the limit of the throughput when the switch size N increases without limit? Calculate the maximum throughput and the corresponding cell loss rate when $N = 2$ and $N \rightarrow \infty$.