1. The definition for point-to-point connection is that a source can be connected only to a single destination and, to a certain destination, only one source can be connected. The definition for multicast connection is that a source can be connected to one or more destinations and, to a certain destination, only one source can be connected. In a switch source is an input port and destination is an output port.

   (a) What is the number of possible point-to-point connection patterns in N $\times$ N switch if all ports are connected?

   (b) What is the number of possible point-to-point connection patterns in N $\times$ N switch if there can be non-connected ports?

   (c) What is the number of possible multicast connection patterns in N $\times$ N switch?

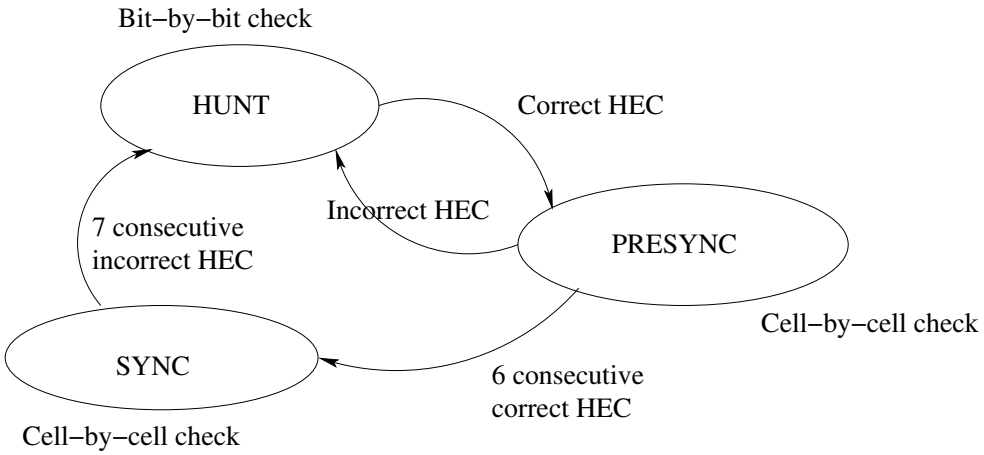
2. Information is transferred in fixed size (N bit) packets either as datagrams or using virtual connections. In the first case one needs n_d bits for the address. In the latter case the length of the VCI field is n_c ($< n_d$) bits. In addition the set up of the connection takes a time equal to that of transmitting D bits. When is the transmission of an M bit long message faster using a virtual connection than using a datagram?

3. (a) How much information is in transit ("on wire") on a 1000 km long transmission cable if the transmission speed is a) 10 Mbit/s b) 155 Mbit/s? Use $2 \cdot 10^8$ m/s as the propagation speed of the transmitted signal.

   (b) How long is transmission time of one ATM cell on transmission line operating at 155 Mbit/s?

   (c) How long does it take to fill the payload of one ATM cell from a source with transmission speed of 64 kbit/s?

4. ATM cell delineation process is based on three state state-machine (see the figure below). The SYNC state is the normal operation state, HUNT state is used in start-up and error situations to find a correct cell header, and PRESYNC is used to make sure that the correct cell delineation is really found. In this case a correct header is considered to contain no bit errors.



   (a) What is the probability of SYNC $\rightarrow$ HUNT transition, i.e., getting 7 consecutive incorrect HECs, when bit-error rate $p_e = 2.4 \cdot 10^{-3}$?

   (b) How long, on the average, a 155.520 Mbit/s ATM system would remain in SYNC state (assuming the same bit-error rate)?

5. (a) In certain transmission link 1 packet in every 2500 packets has an error. What is the probability that there are less than 9 invalid packets in a sample 15000 packets?

   (b) Certain switching unit is known to fail and unable to recover from error once is each 400 days on the average. What is the probability that the switching unit does not fail in 600 days? What is the probability that it fails within 150 days?