

TELE3118 Tutorial 1: Introduction and Physical Layer

Q1: [Protocol stack]

Consider the “Internet protocol stack” consisting of Physical, Link, Network, Transport and Application layers, and a client application (e.g. web browser) that sends a request to a server.

- (a) In what way is the server different from the client?
- (b) If the path from client to server passes through an Ethernet switch and then a router, then list the names of the protocol stack layers that the request would pass through, in order of passage, at client, switch, router and server.
- (c) List the encapsulations (at each layer) that the message from the client to the server will have to go through.

Q2: [Statistical Multiplexing]

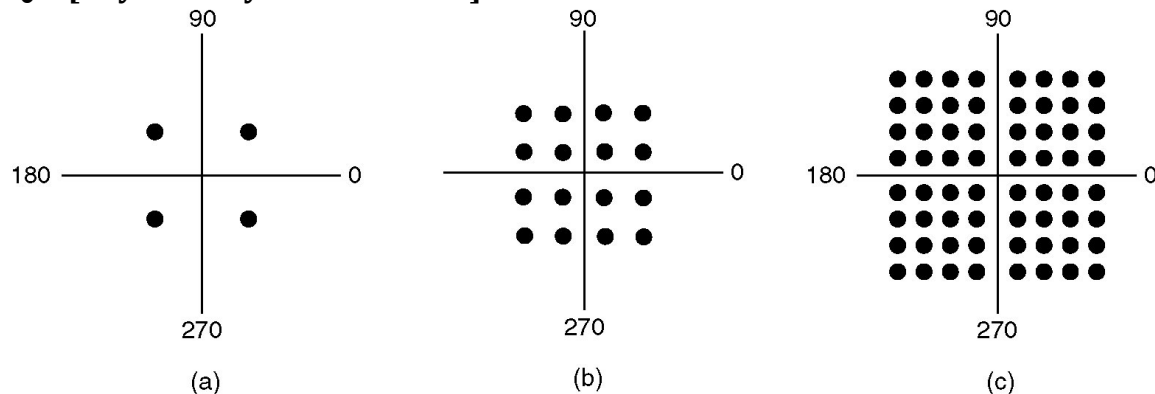
Suppose users share a 10 Mbps link. Also suppose each user requires 1 Mbps when transmitting, but each user transmits only 10 percent of the time.

- a. When bandwidth is dedicated for each user (as in circuit switching), how many users can be supported?
- b. For the remainder of this problem, suppose that bandwidth is not allocated to users, instead bandwidth is statistically multiplexed using packet switching. Suppose there are 50 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (*Hint: Use the binomial distribution.*)
- c. Find the probability of congestion, namely that more than 10 users are transmitting simultaneously.

Q3: [Delays]

Consider a packet of length $L=1500$ bytes which begins at end system A and travels over two links to a destination end system B. The packet thus travels from A over the first link of length 4000 km to a switch, and from there over a second link of length 1000 km to destination B. Both links operate at 2 Mbps, the switch takes 3 msec to process each packet, and assume that there are no queuing delays. What is total end-to-end delay for the packet from A to B? Assume that signals propagate at $2 * 10^8$ m/s on the links.

Q4: [Physical Layer Modulation]



What is the function of a “modem”? For the same baud rate (i.e. symbols-per-second), what data rates (i.e. bits-per-second) are achieved by the modulation schemes (a) QPSK, (b) QAM-16, and (c) QAM-64 shown above?