1. a). If R is with unit of bytes/sec

$$T = \frac{L_1 + L_2}{R} + \frac{2d}{V}$$

If R is with unit of bps

$$T = \frac{8(L_1 + L_2)}{R} + \frac{2d}{V}$$

b). Data link layer is still needed for flow control over the transmission channel and for framing the data. In a multiple access medium such as LAN, the data link layer is required to coordinate access to the shared medium.

c). packet voice : UDP , requires real-time service.

file transfer : TCP requires reliable transfer.

remote login : TCP requires reliable transfer.

2). a). network layer.

The network layer is concerned with the selection of paths across the network.

b). transport layer

The transport layer is concerned with providing reliable service on an end-to-end basis across the network.

c). data link layer

provides the reliable transfer of information between adjacent nodes in a network.

3. $1500 - 20 - 20 = 1460$ bytes

$1.5M / 1460 = 1027.4$. so 1028 blocks are needed

Overhead $= (1028 * 40) / 1.5M = 2.74\%$.

4. CSMA-CD.

$d = 2 * 100 = 200$ m.

$$a = \frac{t_{prop}}{X} = \frac{d/v}{L/R} = \frac{200/2.5\times10^8}{(1500*8)/(100\times10^6)} = 0.00667$$

$$\rho_{max} = \frac{1}{1+6.4a} = 95.9\%$$

so the max throughput is 95.9 Mbps

Slotted ALOHA

$\rho_{max} = 0.368$

So the max throughput is 36.8 Mbps.

5. root bridge: B1

root ports: bridge B2: port 1, bridge B3: port 1

designated ports: LAN1: B1, port1, LAN2: B1, port 2.

LAN3: B2, port2,

port 2 of B3 will be disabled.

If A on LAN1 sends a frame to B on LAN3. It will take path B1→B2

6. a) Assume during a cycle, K stations have messages to send.

The duration of the cycle is:

$$T = \frac{N \cdot m + k \cdot n}{R}$$

since $\overline{K} = N \cdot q$.

The average duration of a cycle is

$$\overline{T} = \frac{N \cdot m + N \cdot q \cdot n}{R} = \frac{N}{R}(m + n \cdot q)$$

b). In a given cycle, on the average, $N \cdot q$ messages are transmitted, among which, $N \cdot q (1-p)^n$ messages are received without error. So the throughput is

$$\frac{N \cdot q \cdot (1-p)^n \cdot n}{\overline{T}} = \frac{n \cdot q \cdot (1-p)^n}{m + n \cdot q} R.$$