ELEC 3500 (2020)

Question Set -1 (Solution)

1-0. There are no difference between these two terms : "host" and "end system". In the literature quite often they are used interchangeably.

End systems: Computer/laptop, Data terminal, mobile phone, web/mail server, Game console, etc.

Yes, web server is an end system. A web server is a piece of software which hosted on a suitable hardware to offer appropriate service. A web server is connected via a network, acting as an end system.

1-1: Access networks connects the end systems to the internet via the core and backbone networks.

Access technologies: NBN fibre to home, NBN fibre to the node, WiFi network via an access point, Cellular Network (3G, 4G, 5G), University Local Area Network (LAN), Wireless Sensor Network

As mentioned above an access network ~~provide~~ end systems to the internet, allowing these devices to exchange information/data. Access technology consist of number of devices, hardware and software specific to different access networks.

1-2: A rural network is generally characterised by a large geographical area with sparse population density. For such areas either

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a wireless network or a satellite network will be useful to serve ~~th~~ a sparse population distribution. ~~ad~~ ~~an effective cost~~ Cost of fibre or wired network will be very high. NBN offer either ~~ø~~ fixed wireless or satellite based services in rural areas.

1-3: Sutiable physical mediums for Ethenet:

→ Twisted pair copper wire (CAT5/6/7)

→ Optical fibre

1-4: Circuit switched technique offer fixed allocation of transmission resources (Links, ports, slot, etc) to end users for the duration of a call or a data session. Whereas a basic packet switched system allocate transmission resources only ON demand basis, i.e. only when information is ready for transmission.

A circuit switch generally offer a lower transmission delay at ~~a~~ higher cost compared to packet switched system.

(At this moment I don't want to go more detailed discussion)

1-5: Speed of signal $s = 3 \times 10^8$ m/s (Speed of light)

Propagation delay $d_{prop} = \frac{d}{s}$ | d: distance in meter, s: signal speed in m/s

(i) Circuit board, $d = 10$ cm $\Rightarrow d_{prop} = \frac{10 \times 10^{-2}}{3 \times 10^8}$

$\Rightarrow d_{prop} = 3.33 \times 10^{-10}$ sec

(ii) A room, $d = 10$ m, $\Rightarrow d_{prop} = \frac{10}{3 \times 10^8} = 3.33 \times 10^{-8}$ sec

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(iii) A buiding, $d = 100\ m$, $\Rightarrow d_{prop} = \frac{100}{3\times10^8} = 3.33\times10^{-7}$ sec

(iv) A City, $d = 100\ km$, $\Rightarrow d_{prop} = \frac{100\times10^3}{3\times10^8} = 3.33\times10^{-4}$ sec

(v) A continent, $d = 5000\ km$, $\Rightarrow d_{prop} = \frac{5000\times10^3}{3\times10^8} = 0.0166$ sec

(vi) A satellite link, $d = 7200\ km$, $\Rightarrow d_{prop} = \frac{7200\times10^3}{3\times10^8} = 0.24$ sec

1-6:

For the wired network:

$d = 1\ km$, $L = 3000$ byte, $s = 2\times10^8\ m/s$, ~~$R = 2\times10^6$ b/s~~
$R = 100$ Mbs

$$d_{file} = d_{prop} + d_{trans} = \frac{d}{s} + \frac{L}{R}$$

$$= \frac{1\times10^3}{2\times10^8} + \frac{3000\times8}{100\times10^6} = 5\times10^{-6} + 2.4\times10^{-4}$$

$$= 0.245\times10^{-3}\ \text{sec} = 0.245\ \text{ms}$$

For the wireless network

$d = 1\ km$, $L = 3000\ B$, $s = 3\times10^8\ m/s$, $R = 2$ Mbs

$$d_{file} = d_{prop} + d_{trans} = \frac{d}{s} + \frac{L}{R}$$

$$= \frac{1\times10^3}{3\times10^8} + \frac{3000\times8}{2\times10^6} = 3.33\times10^{-6} + 0.012$$

$$= 0.012003\ \text{sec} = 12.003\ \text{ms}$$

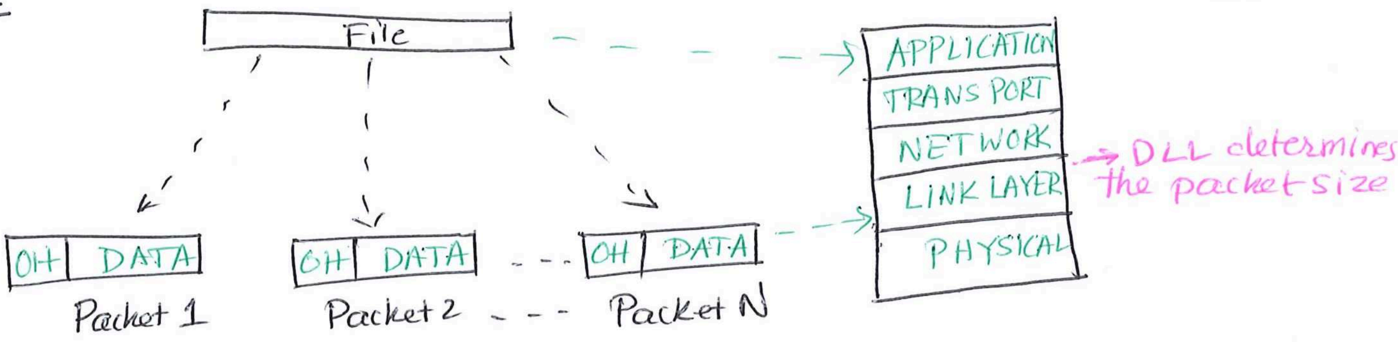
For the above problem equation (1.2) of the texbook used

$$d_{end\text{-}end} = N\left(d_{proc} + d_{trans} + d_{prop}\right) \quad \cdots (1.2)$$

For this problem, $N = 1$, $d_{proc} = 0$

1-7:

TCP/IP Stack

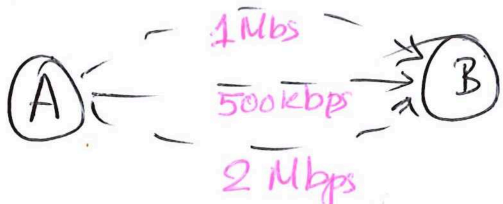


The host A will the protocol stack to support the communication process. The file will be sent from the application layer of the host. File segments will move through the layers by appending header information in each layer. Packets will be produced in the data link layer by including the FCS (Frame check sequence) bits.

The header of packets will inform routers about the link or path it should forward. The IP header contains all necessary information for routing tasks.

Analogy to the road traffic system. Every time a packet reach a router, ~~the~~ a packet will query router about the next path. In this case router reads the IP (network) header information and forward the packet to the appropriate link. The process is similar to ~~showing~~ consulting a guide the address it want to reach where the guide will inform the person how to reach to the next destination.

1-8:



(a) When multiple links exist between the source and the destination, the file could be transmitted by one of the three links (assuming the above three parallel links), or all three links (assuming a three-hop link)

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In absence of any defined link selection policy we can use the following relationship to determine that file throughput which given by (assuming a three-hop link)

$$R_{file} = \min(R_1, R_2, R_3)$$

$$= \min(500 \text{ kbps}, 1 \text{ Mbps}, 2 \text{ Mbps})$$

= 500 kbps

(b) Using the minimum throughput condition

$$L = 4\times10^6 \text{ bytes} = 4\times10^6 \times 8 = 32\times10^6 \text{ bits}$$

Ignoring the propagation delay

$$d_{file} = \frac{L}{R} = \frac{32\times10^6}{500\times10^3} = 64 \text{ sec}$$

Considering the propagation delay

$$d_{file} = \frac{d}{s} + \frac{L}{R} = \frac{100\times10^3}{3\times10^8} + \frac{32\times10^6}{500\times10^3}$$

$$= 64.0003 \text{ sec.}$$

Very minor change when the propagation delay considered

(c) Number of packets generated from the file

$$N_{Packet} = \left\lfloor \frac{4\times10^6}{(20000-60)} \right\rfloor = 201 \text{ packets}$$

The file will be fragmented in to 201 packets and transmitted separately.

$$d_{file} = N_{Packet}(d_{prop} + d_{packet})$$

$$= 201\left(\frac{100\times10^3}{3\times10^8} + \frac{20000\times8}{500\times10^3}\right)$$

$$= 201(3.33\times10^{-4} + 0.32) = 201\times0.3203$$

$$= 64.38 \text{ sec.}$$

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1-9:

Router process : Network/ IP layer ~~(IP + DLL + PHY)~~

Switch process : Data Link Layer

Host process : All five layers

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[2020, S2]