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Paper Subject : *Data Communication and Networks (Theory)*

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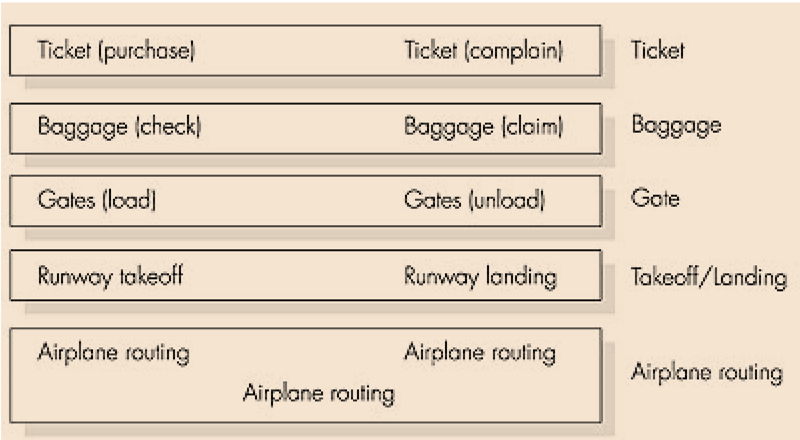
Q1: Protocol layering can be found in many aspects of our lives such as air travelling. Imagine you make a round trip to spend some time on vacation at a resort. You need to go through some processes at your city airport before flying. You also need to go through some processes when you arrive at the resort airport. Show the protocol layering for the round trip using some layers such as baggage checking/claiming, boarding/off-boarding, take-off/landing. (4 marks)

Ans:

One way to describe this system might be to describe the series of actions you take (or others take for you) when you fly on an airline. You purchase your ticket, check your bags, go to the gate, and eventually get loaded onto the plane. The plane takes off and is routed to its destination. After your plane lands, you de-plane at the gate and claim your bags. If the trip was bad, you complain about the flight to the ticket agent (getting nothing for your effort). This scenario is shown in Figure;

Already, we can see some analogies here with computer networking: You are being shipped from source to destination by the airline; a packet is shipped from source host to destination host in the Internet. In a horizontal manner the above figure can be shown as;



Q2: Give some advantages and disadvantages of combining the session, presentation, and application layers in the OSI model into one single application layer in the TCP/IP Protocol Suite (internet model). (3 marks)

Ans:

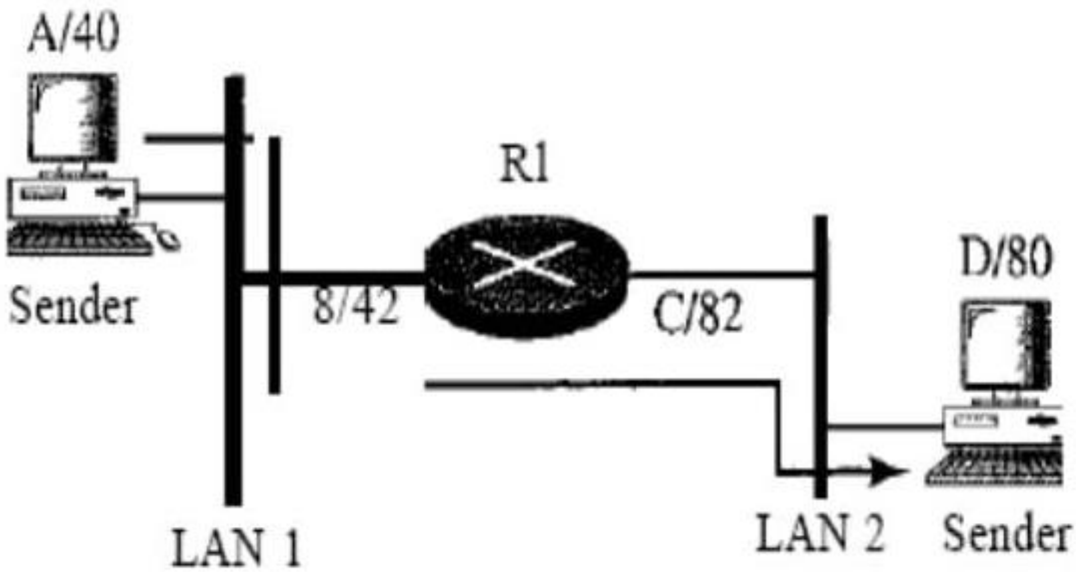
Advantages:

1. By combining these layers the functionality is performed by a single layer and overhead is reduced.
2. Higher Bandwidth as number of layers is reduced.
3. It reflects the real-life separation of application from the TCP-downward sections of the OSI model.

Disadvantages:

1. More functions need to be performed by single layer.
2. Can make reasoning about the architecture of network systems less effective.
3. There will be security issues as the Network security and Application Security will open at a single point which may expose our network open to our threat.

Q3: In figure below, assume that the communication is between a process running at computer A with port address *m* and a process running at computer D with port address *n.* Show the contents of packets and frames at the network, data link, and transport layer for each hop. (3 marks)



Ans:

Computer A:

Contents of segment at Transport layer;

Data	Header

Contents of Packet at Network layer;

A	D	Data	Header

Contents of Frame at Data Link layer;

4240	A	D	m	n	Data	H2	T2

Computer D:

Contents of segment at Transport layer;

Data	Header

Contents of Packet at Network layer;

A	D	Data	Header

Contents of Frame at Data Link layer;

8082	A	D	m	n	Data	H2	T2

Q4: What is the theoretical capacity of a channel in each of the following cases;

a. **Bandwidth: 15 KHz SNR_{dB} = 30**
b. **Bandwidth: 100 KHz SNR_{dB} = 2**
c. **Bandwidth: 0.5 KHz SNR_{dB} = 10** **(6 marks)**

Ans:

a. **Solution:**
SNR(dB) = 10 * $\log_{10}$(SNR)
SNR = $10^{(SNR(dB)/10)}$
SNR = $10^{(30/10)}$
SNR = 10^3 = 1000
As we know that;
Capacity = bandwidth * $\log_2$(1 + SNR)
Capacity = 15 KHz * $\log_2$(1 + 1000)
Capacity = 15 KHz * $\log_2$(1001)
Capacity = 15 KHz * 9.97
Capacity = 149.55 Kbps

b. **Solution:**
SNR(dB) = 10 * $\log_{10}$(SNR)
SNR = $10^{(SNR(dB)/10)}$
SNR = $10^{(2/10)}$
SNR = $10^{0.2}$ = 1.6
As we know that;
Capacity = bandwidth * $\log_2$(1 + SNR)
Capacity = 100 KHz * $\log_2$(1 + 1.6)
Capacity = 100 KHz * $\log_2$(2.6)
Capacity = 100 KHz * 1.38

Capacity = 138 Kbps

c. **Solution:**

SNR(dB) = 10 * log_{10}(SNR)

SNR = $10^{(SNR(dB)/10)}$

SNR = $10^{(10/10)}$

SNR = 10^1 = 10

As we know that;

Capacity = bandwidth * log_2(1 + SNR)

Capacity = 0.5 MHz * log_2(1 + 10)

Capacity = 0.5 MHz * log_2(11)

Capacity = 0.5 MHz * 3.46

Capacity = 1.73 Mbps

Q5: A digitized system is operated at 4800 bps. If a single element encodes an 8-bit word, what is the minimum required bandwidth of the channel? (3 marks)

Ans: Solution:

Using Nyquist's equation: **C = 2 * B * log_2M.**

We have C = 4800 bps

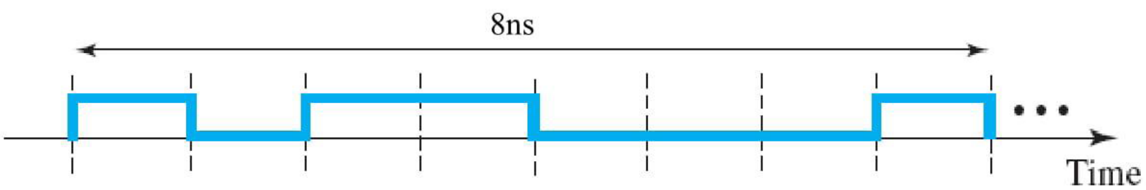
log_2M = 8, because a signal element encodes a 4-bit word. (So, actually M=256).

Therefore, C = 4800 = 2B □ 8,

16B = 4800

and we have **B = 300 Hz**

Q6: What is the bit rate for the signal given below? (4 marks)



Ans:

Solution:

Here number of bits = 8 bit, and Bit Duration = 8 ns

So;

Bit rate = 8 bit/8 ns

Bit rate = 1 bit/ns

Bit rate = 1 * 10^9 bit/sec

Bit rate = 1 Gbit/sec

OR

Bit rate = 1 Gbps

Q7: A capacity of the channel is given as 40 Mbps, the bandwidth of the channel is 6 MHz. Assuming white thermal noise, what signal-to-noise ratio is required to achieve this capacity? (3 marks)

Ans:

Solution:

As we know that;

Capacity = bandwidth * $\log_2(1 + SNR)$

Here Capacity = 40 Mbps, and bandwidth = 6 MHz, putting in above equation;

40 Mbps = 6 MHz * $\log_2(1 + SNR)$

$40 * 10^6$ bps = $6 * 10^6$ Hz * $\log_2(1 + SNR)$

$\log_2(1 + SNR) = 40/6$

$\log_2(1 + SNR) = 6.67$

$1 + SNR = 2^{6.67}$

1 + SNR = 102

SNR = 101

Q8: A composite signal that is non-periodic contains frequencies from 20 to 40 KHz. The peak amplitude is 10 V for the lowest and the highest signals and is 30 V for the 30 KHz signal. Assuming that the amplitudes change gradually from the minimum to the maximum, draw the frequency spectrum. (4 marks)

Ans:

Solution:

Frequencies = 20 to 40 KHz

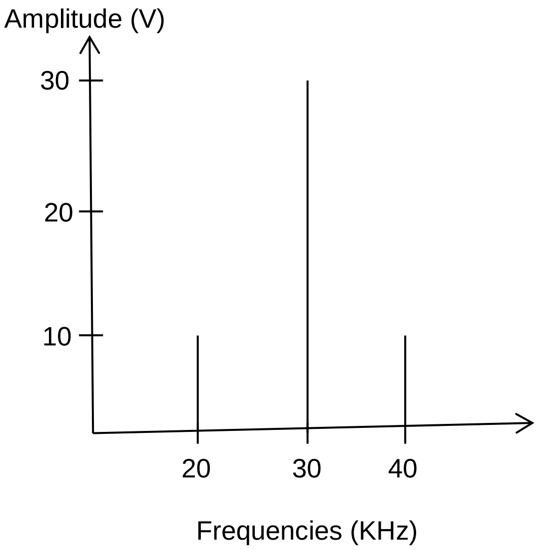
So Bandwidth = 40 KHz – 20 KHz

Bandwidth = 20 KHz

Amplitude = 10 V for the lowest and the highest signals,

30 V for the 30 KHz.

Frequency Spectrum:



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