DATA COMMUNICATION AND NETWORKS
MID SEMESTER ASSIGNMENT

Course code: 102002090 ID: 13002
Course Title: Data Communication and Networks Name: Nusratullah
Instructor: Engr. Ghassan Husnain
Program: BS Computer Science

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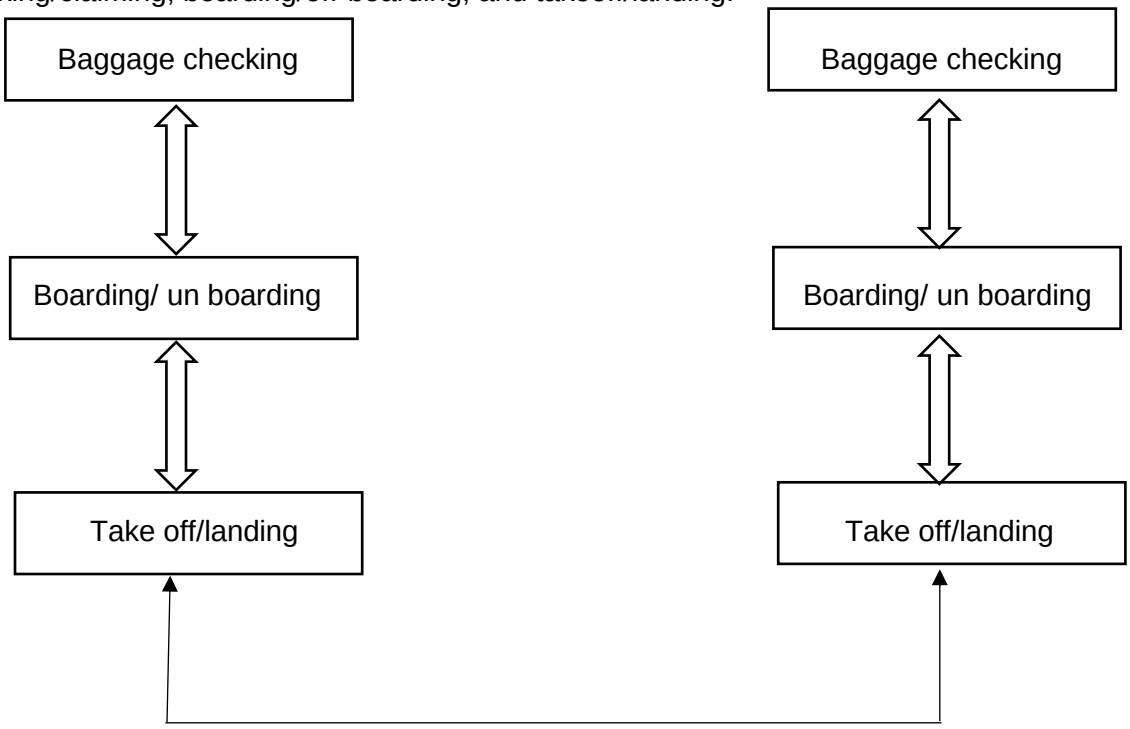
1. **Protocol layering can be found in many aspects of our lives such as air travelling. Imagine you make a round-trip to spend some time on vacation at resort. You need to go through some processes at your city airport before flying. You also need to go through some process at your city airport before 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, takeoff/landing.**

Ans: Protocol is defined as the set of rules. In protocol performs different functions as pre-requisite. The following diagram explains the protocol layering in airport that include baggage checking/claiming, boarding/off-boarding, and takeoff/landing.



2. **Give some advantages and disadvantages of combining the session, presentation and application layer in the OSI model into one signal application layer in the TCP/IP protocol suite (Internet mood).**

Ans: **Advantages and disadvantages of incorporating the OSI approach into TCP/IP:**

OSI Model vs TCP/IP Model

OSI Model

I. In the OSI model, the transport layer is only connection-oriented.
II. OSI model provides a clear distinction between interfaces, services, and protocols.
III. Session and presentation layers are a part of the OSI model.
IV. It is defined after the advent of the Internet.

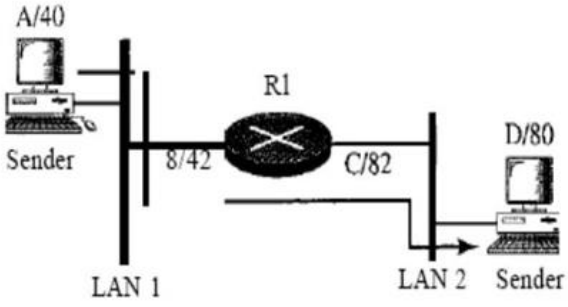
Advantage:

- It helps you to standardize router, switch, motherboard, and other hardware
- Reduces complexity and standardizes interfaces
- Facilitates modular engineering
- Helps you to ensure interoperable technology
- Helps you to accelerate the evolution
- Protocols can be replaced by new protocols when technology changes.
- Provide support for connection-oriented services as well as connectionless service.
- It is a standard model in computer networking.
- Supports connectionless and connection-oriented services.

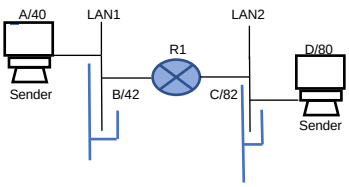
Disadvantage:

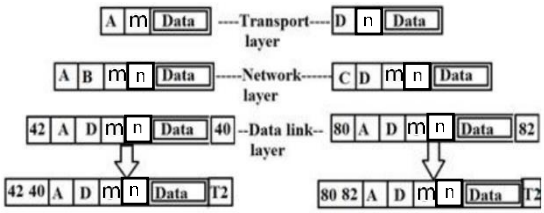
- Fitting of protocols is a tedious task.
- You can only use it as a reference model.
- It doesn't define any specific protocol.
- In the OSI network layer model, some services are duplicated in many layers such as the transport and data link layers

3. **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 content of packet and frames at the network, data link, and transport layer for each hop.**



Ans:





From above figure shows two computers communicating. Assume 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.

The sending computer is running one process at this time with port address m and another computer running one process at this time with port address m. The packet from the transport layer is then encapsulated in another packet at the network layer with local source and destination addresses (A and D). Given physical address from figure 40 sends a frame to anode with physical address 42. The two nodes are connected by a link. At the data link layer, this frame contains physical address in the header. Similarly, this way applies to 80 and 82 from computer B. Finally, this packet is encapsulated in a frame with the physical source and destination addresses for the next hop.

4. **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 MHz $SNR_{db} = 10$**

Ans: Formula:

The theoretical channel capacity (C)= B* SNR_{dB} / 3

Here, C = channel capacity

B = Bandwidth

SNR_{dB} = Signal-to-noise ratio in decibel units

a) Given data:

B = 15KHz

SNR_{dB} = 30

Therefore, the theoretical channel capacity C = 15* 30/3

= 150 Kbps

a) Given data:

B = 100KHz

SNR_{dB} = 2

Therefore, the theoretical channel capacity C = 100* 2/3

= 66.67 Kbps

a) Given data:

B = 500KHz

SNR_{dB} = 10

Therefore, the theoretical channel capacity C = 500* 10/3

= 1666.67 Kbps

5. **A digitized system is operated at 4800 bps. If a signal element encodes an 8-bit word, what is the minimum required bandwidth of the channel?**

Sol: Formula:

In Signal Processing for a noise-free channel, Nyquist's equation is expressed as follows:

$$C = 2B \log_2 M$$

Where, *C* is upper bound for the data rate of a transmission system, *B* is the bandwidth (in Hz), and *M* denotes the number of signal levels.

Given data:

Now for this problem, we know C = 4800 bps

And $\log_2 M = 8$, as the signal element encodes an 8-bit word

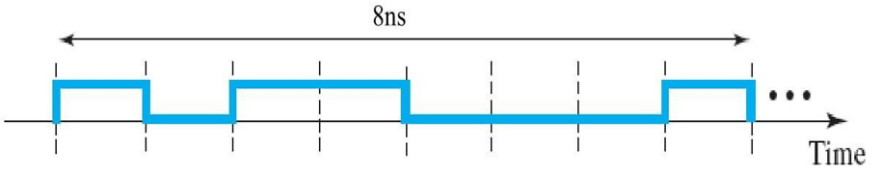
So, $2B \log_2 M = 4800$

$2B * 8 = 4800$

$B = 4800 / 8*2$

$B = 300$ Hz

6. **What is the bit rate for the signal given below?**



Ans: The total number of bits = 8

The time = 8 nanosecond

The bit rate = $\frac{8}{8 \times 10^{-9}} = \frac{8 \times 10^9}{8} = 1 \times 10^9$ b/s

7. **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?**

Ans: Given data:

Bandwidth (B) = 6 MHz

Intended capacity of the channel (C) = 40 Mbps

Solution: As we know that,

$C = B \log_2 (1+SNR)$

$40 \times 10^6 = 6 \times 10^6 \times \log_2(1+SNR)$

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

$\log_2(1+SNR) = 6.6667$

$1+SNR = 2^{6.6667}$

$= 101.82$

$SNR = 101.82 - 1$

$SNR = 100.82$

8. A composite signal that is non-periodic contains frequencies from 20 to 40 KHz. The peak amplitude is 10V for the lowest and highest signals and is 30V for the 30Khz signal. Assuming that the amplitudes changes from the minimum to the maximum, draw the frequency spectrum.

Sol: frequencies = 20 to 40Khz
Bandwidth = highest frequency – lowest frequency
= 40 – 20
= 20 Khz
Amplitude = 10v for the lowest and the highest signals 30v for the 30Khz

Frequency spectrum: