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| **This question paper consists of 5**  **printed pages, each of which is**  **identified by ELEC5471M** | **Drawing instruments and electronic calculators may be used.**  **Approved dictionaries may be used** |

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School of Electronic and Electrical Engineering

**January 2015**

**ELEC5471M**

Data Communications and

Network Security

Time allowed: 3 hours

**Attempt any THREE questions.**

**Each question carries the same number of marks.**

**NOTES TO INVIGILATOR AND STUDENT**

To obtain full marks candidates must show how answers are derived

All symbols not specifically defined have their normally accepted meanings

Do not write or draw with red ink or red pencil

This question paper must be attached with a treasury tag to the back of the answer booklets. It is the student’s responsibility to attach the question paper.

**Question 1**

Consider that you have joined a company and have been put on a project to design a communications network. A colleague on this project has little experience of the Internet but has heard of TCP/IP in this context. You need to convince this colleague of the advantages of using a layered protocol architecture.

1. Give four key points that summarize the advantages of using a layered protocol architecture in your design.  *[4 marks]*
2. Using the layered protocol architecture can separate complex problems to several parts, it is easier to solve the complex problems. Different vendors can implement protocols for specific layers within the same framework, promoting standardization.
3. Using the layered protocol architecture can modelized the protocol and thus we can use the same protocol at different network scenarios. Modularity and Easy to design.
4. Using the layered protocol architecture makes network engineers easier to locate the problem since every layer has their own characteristics.
5. Using the layered protocol architecture can let the network engineers implement the network parallel rather than serials since they can implement the different protocol in different layer at the same time.
6. The layered approach provides flexibility by allowing the replacement or upgrading of individual layers without affecting the entire system.
7. Having convinced your colleague of the advantage of using a layered protocol architecture you now need to explain how this works. List four key points of the process of how layered protocols architectures operate. *[4 marks]*
8. Layered protocols architectures divide communication into distinct layers. These layers communicate primarily with the layers above and below it.
9. The communication between layers occurs through defined interfaces. PDU
10. Layers operate as independent entities. Each layer performs particular functions and does not need to affect others.
11. The communication between layers are guided by defined protocols and standards.
12. Your colleague understands your description and asks about the ISO/OSI model layers. Provide the 7 layers of the ISO/OSI communications architecture in the correct order and provide **two** example functions provided by each layer. *[7 marks]*
13. Application layer
    1. Electronic mail Network Services: Provides network services to end-users or applications.
    2. FTP User interface services: Provides the interfaces and services for user interaction with applications.
14. Presentation layer
    1. Encode data of packet Decryption and encryption
    2. Transfer the type of the data to readable.
15. Session layer
    1. Three steps handshake process to establish the session. Dialog control: establish, maintains and terminates communication sessions between applications.
    2. Maintaining the session. Synchronization: coordinates data exchange and maintains synchronization points between devices.
16. Transport layer
    1. TCP Segmentation and Reassembly: breaks data into segments for transmission and reassembles them at the destination.
    2. UDP Flow control: Manages the flow of data to prevent congestion and ensure efficient transmission.
17. Network layer
    1. IP Routing: Determines the optimal path for data packets from source to destination.
    2. MAC Logical Addressing: assigns logical address such as IP address to device on the network.
18. Data Link layer
    1. Ensure the bit stream no error. Framing: Divides the data into frames for transmission, adding headers and trailers.
    2. Detect the bit error. MAC: Manages access to the physical medium, handling issues like collision detection in Ethernet.
19. Physical layer
    1. Wire. Physical Medium Specification: Defines the characteristics of the physical transmission medium.
    2. Wireless. Bit Synchronization: Manages the timing and synchronization of individual bits.
20. Your colleague has more experience of the TCP/IP operation and has heard of network address translation (NAT). Explain the purpose of network address translation (NAT) and how it works. *[4 marks]*

Purpose:

1. The network address translation is a technique used in computer networking to manage the shortage of the IPV4 addresses and enhance the security of the local network.

The Process of the NAT:

1. The NAT devices creates an entry in its translation table, associating the private IP and port with the public IP and port.
2. When the packet arrived from external device, the device will search it in the translation table to determine which device inside should receive the packets.
3. After searching the suitable device, the NAT device switch the public IP and port to private IP and port. It is called DNAT.
4. When the device inside the LAN network want to communicate with the external device, the NAT devices will exchange the private IP and port to public IP and port of the packets. It is called SNAT.
5. Your colleague has heard that NAT addressing contravenes the ‘ISO/OSI layered protocol architecture rules’. Is this the case and if so how? *[1 mark]*
6. Yes, it is. The OSI layered protocol architecture rules define the protocol must serve the certain layer. The NAT is based on transport layer, but it also has close connection with the ports, which is located in the network layer. According to the ideal layered model, each layer should operate independently and transparently to layers above and below.

**Question 2**

You need to design two transport protocols for a communications network to provide respectively an unreliable connectionless service and a reliable connection oriented service; both will be using the services provided by an unreliable connectionless network.

1. Explain what an unreliable connectionless service is offering and how this could be provided. *[2 marks]*
2. Define what a ‘reliable connection oriented service’ is. *[3 marks]*
3. Explain the mechanisms which can provide a reliable connection oriented service when using an unreliable connectionless network. *[5 marks]*
4. TCP is the Internet reliable connection oriented transport layer protocol. In addition to the mechanisms given in part ‘c’, TCP also provides ‘Congestion control’ and ‘Connection setup’.
   1. What is Congestion control aiming to achieve? *[1 mark]*
   2. How does TCP detect congestion and are there any shortcomings in this detection mechanism? *[3 marks]*
   3. When a TCP connection has been established, TCP enters the ‘Slow Start’ mechanism. Describe the Slow Start mechanism. *[4 marks]*
   4. What action is taken by TCP when in the ‘Slow Start’ phase and congestion is detected? *[2 marks]*

**Question 3**

This question is about addressing.

1. By completing a similar table to the following in your answer booklet, describe what (i) MAC addresses, (ii) IP addresses and (iii) Port Numbers are, the size of each in bits, how dynamic or permanent they are, and their purpose and the scope over which they act. *[15 marks]*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Used by: | Bit Size: | Permanence of assignment: | Purpose and scope: |
| 1. MAC address |  |  |  |  |
| 1. IP address |  |  |  |  |
| 1. Port Number |  |  |  |  |

1. Explain how translation is done between MAC addresses and IP addresses and how and why attention is needed to keep the data up to date.  *[5 marks]*

**Question 4**

This question is about routing.

1. Draw the key components of a router and indicate where queuing occurs, describing what causes it and the effects of queuing. *[8 marks]*
2. Two fundamental routing algorithms are ‘Link state routing’ and ‘Distance Vector routing’. Describe how each one works. *[4 marks]*
3. Consider the following network.



With the indicated link delay (additive metric), use Dijkstra’s algorithm to compute the routing table for *x* to all network nodes. Show how the algorithm works by reproducing and completing the following table in your answer booklet (step 0 is given):

*[8 marks]*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **step**  **The End.** | **N’** | **D(y),p(y)** | **D(w),p(w)** | **D(v),p(v)** | **D(u),p(u)** | **D(t),p(t)** |
| 0  1  2  3  4  5 | x | 6, x | 1, x | 3, x | ∞ | ∞ |

Notation in the table:

* D(v): minimum delay of path from the source node to destination v, as of this iteration of the algorithm.
* p(v): previous node (neighbour of v) along the current minimum delay path from the source to v.
* N’: subset of nodes; v is in N’ if the minimum delay path from the source to v is definitively known.

**The End.**