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 experience of the Internet and has heard of TCP/IP in this context. You need to convince him of the advantages of using a layered protocol architecture.
2. Give four key points you use to convince him of the advantages of using a layered protocol architecture in your design. [4 marks]

[1 mark for each of the 4 reasons (given in lectures) for having layered protocols.]

Having convinced your colleague of the advantage of using a layered protocol architecture you now need to explain to him how this works.

1. List four key points of the process of how layered protocols architectures operate. [4 marks]

[Description of horizontal abstraction and vertical provision of services and hiding of details in vertical realization.]

Your colleague understands your description and asks about the ISO/OSI 7 layer model layers.

1. 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]

[Listing of the layers and suitable examples.]

Your colleague has more experience of the TCP/IP operation and has heard of network address translation (NAT). Explain to him:

1. What is network address translation (NAT) for and how does it work? [4 mark]

[Description of the use of IP addresses augmented with port numbers and the methodology.]

1. He has heard that NAT addressing contravenes the ‘ISO/OSI layered protocol architecture rules’. Is this the case and if so how? [I mark]

[Explanation of use of transport layer info at network layer.]

1. You need to design two transport protocols for a communications network to provide either an unreliable connectionless service or 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]

[Simply a best effort service, i.e. data will be sent with no guarantees on delivery, (in-order or otherwise) or correctness. And there will be no feedback on whether or not data is delivered.]

* 1. Define what a ‘reliable connection oriented service’ is. [3 marks]

[Error free [1], in order delivery [1] of all data[1]. ]

* 1. Explain the mechanisms which can provide a reliable connection oriented service when using an unreliable connectionless network. [5 marks]

[Description of the methods used to enhance performance i.e. Use of error checking, acknowledgment, sequence numbers, timers, and flow control]

* 1. 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]

[Describe purpose of congestion control]

* + 1. How does TCP detect congestion and are there any shortcomings in this detection mechanism? [3 marks]

[Explain basic function of congestion control and problems in modern networks which include wireless links.]

* + 1. When a TCP connection has been established, TCP enters the ‘Slow Start’ mechanism. Describe the Slow Start mechanism. [4 marks]

[Expalin operation of slow start.]

* + 1. What action is taken by TCP when in the ‘Slow Start’ phase and congestion is detected? [2 marks]

[The CongWin threshold is halved, the CongWin is set to 1 MSS and the flow returns to the Slow Start mechanism.]

1. 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, how dynamic they are, and their purpose and the scope over which they act. [15 marks].

[a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Used by: | Bit Size: | Permanence of assignment: | Purpose and scope: |
| MAC address | Link layer  [1 mark] | 48 bit  [1 mark] | No, fixed/permanent; hard wired at manufacture.  [1 mark] | Forwarding frames on a LAN or subnet  [1 mark] |
| IP address | Network layer  [1 mark] | 32 bit (v4)  128 bit (v6)  [2 marks] | Many different solutions exist, especially with v4 to allow for mobility and to extend the range of addresses. With v6 and the vast number of available addresses they are predominantly assigned permanently.  [2 mark] | Routing of packets across an internet.  [1 mark] |
| Port Number | Transport layer  [1 mark] | 16 bit  [1 mark] | Assigned at call link establishment. There are commonly used port numbers e.g. ftp = 20 & 21.  [2 marks] | Addressing a segment to a particular process within a host.  [1 mark] |

Marks as shown for each correctly completed entry – total 15 marks]

* 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]

[Hosts use the Address Resolution Protocol (ARP) to translate. Broadcasting of the entry on the network with a time out period for table entries is used to minimize the traffic generated and ensure information is kept up to date. The translation could change if for example an interface card failed and was replaced. ]

1. Routing.
   1. Draw the key components of a Router and indicate where queuing occurs, describing what causes it. [8 marks]

[Router architecture including input ports, switching fabric, output ports, and routing processor and indication where queueing occurs and what causes it.]

* 1. Two fundamental routing algorithms are ‘Link state routing’ and ‘Distance Vector routing’. Describe each: [4 marks]

[Describe each algorithm and compare them.]

* 1. 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]*

Notation in the table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **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.

Sol:

**The End.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **step** | **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  xw  xwv  xwvu  xwvuy | 6, x  6, x  6, x  6, x  6, x | 1, x  1, x  1, x  1, x  1, x | 3, x  2, w  2, w  2, w  2, w | ∞  4, w  3, v  3, v  3, v | ∞  ∞  11, v  8, u  8, u |

[2 marks for each correct row (to total of 8 max).]

*Place all marks in the LH margin.*

*Totals for each section should be clearly marked with square brackets [ ].*