小测1 答案及解析

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Question 1

A system has an 7-layer protocol hierarchy. Applications generate messages of length 1000 bytes. At each of the layers, a 25 byte header is added. What fraction of the network bandwidth is filled with headers? (**round to integer**)

Solution

7层结构，每层(at each of the layers)引入一个25字节的头部，共$25 \times 7 = 175$字节。发送一条1000字节的报文，需要消耗$1000 + 175 = 1175$字节，头部开销为$175/1175 \approx 0.1489$，舍入后为15%。

Question 2

A client-server system uses a satellite network (client -- satellite -- server), with the satellite at a height of 50000 km. What is the best-case delay **in response to a request**? **(msec, round to integer)**

Solution

使用卫星通信，从请求到响应需要经历客户端给卫星发送请求、卫星将请求转发给服务器、服务器给卫星发送响应、卫星将响应转发回客户端四个步骤，共$50000km \times 4 = 200000km$，卫星系统使用电磁波通信，速度为光速$300000km/s$，因此总时延为$200000km/300000km = 0.666...s$，舍入后为667毫秒。

Question 3

Which of the following description about OSI layers is **incorrect**?

- The physical layer is concerned with transmitting raw bits over a communication channel
- The data link layer is a true end-to-end layer, all the way from the source to the destination
- The network layer controls the operation of the subnet and determines how packets are routed from source to destination
- The application layer contains a variety of protocols that are commonly needed by users

Solution

数据链路层是负责点对点（point-to-point，相邻节点，例如交换机和主机、交换机和交换机）的通信。作为补充，网络层负责主机对主机(host-to-host)通信，传输层负责负责端对端(end-to-end，进程之间)通信。

Question 4

A noiseless 2-k Hz channel is sampled every 1 msec. What is the maximum data rate?

Solution

根据奈奎斯特定理，

$$数据率 = 2Blog_2M$$

题中给定了带宽$B = 2k$Hz，而未指定码元和位的关系（未给出M），因此数据率无法确定，可能有非常大。

Question 5

Television channels are 16 MHz wide. How many bits/sec can be sent if 64-level digital signals are used? Assume a noiseless channel. (Mbps)

Solution

64个电平的数字信号可以传递$log_264 = 6$位信息，根据奈奎斯特定理$2 \times 16 \times 6 = 192$ Mbps。

Question 6

A CDMA receiver gets the following chips: (-1 +1 -3 +1 -1 -3 +1 +1). Assuming the chip sequences defined in figure(a), which bit did **Station D** send?


```
A = (−1 −1 −1 +1 +1 −1 +1 +1)
B = (−1 −1 +1 −1 +1 +1 +1 −1)
C = (−1 +1 −1 +1 +1 +1 −1 −1)
D = (−1 +1 −1 −1 −1 −1 +1 −1)
            (a)
```

Solution

在CDMA中，判断一个码片向量发送了什么信息，需要将该向量和结果向量做点积并除以向量长度，如果为+1代表发送了1，如果为−1代表发送了0，如果为0代表未发送消息。题中

$$(-1 + 1 - 3 + 1 - 1 - 3 + 1 + 1) \cdot (-1 + 1 - 1 - 1 - 1 - 1 + 1 - 1)$$
$$= (-1) \times (-1) + (+1) \times (+1) + (-3) \times (-1) + (+1) \times (-1)$$
$$+ (-1) \times (-1) + (-3) \times (-1) + (+1) \times (+1) + (+1) \times (-1)$$
$$= 8$$

又$8 \div 8 = 1$，因此D发送了1。

Question 7

A noisy channel has a bandwidth of 7 KHZ its signal-to-noise ratio (S/N) is 30dB. To send binary signal, what is the maximum data rate of this channel? (kbps)

Solution

①香农定理：信噪比$30dB$对应1000倍，根据香农定理可以算出$7 \times log_2(1 + 1000)$约为70 kbps。

②奈奎斯特定理：由于题中强调了"binary signal"，表明了码元和位的关系，根据奈奎斯特定理$2 \times 7kHz * log_2 2 = 14$kbps。

二者取小值为14kbps。

Question 8

What is the remainder obtained for a frame 1101011111 using the generator polynomial G(x) = x^4 + x + 1?

Solution

计算CRC校验码，需要先在原数末尾填充比G(x)长度少1位的0，再使用模2除法（异或运算）计算。

$G: 10011$，5位 $\Rightarrow$ 补4位

$$
\begin{array}{r}
110000111 \\
10011\,\big)\,11010111111\,0000 \\
\underline{10011} \\
10011 \\
\underline{10011} \\
00001 \\
\underline{00000} \\
0001 \\
\underline{00000} \\
00111 \\
\underline{00000} \\
01111 \\
\underline{00000} \\
11110 \\
\underline{10011} \\
11010 \\
\underline{10011} \\
10010 \\
\underline{10011} \\
00010
\end{array}
$$

$00010 \Rightarrow 0010$

Question 9

What is the maximum sending window size of the selective repeat protocol when use 4 bits for frame serial number?

Solution

选择重传协议的最大窗口大小为2^{n-1}，题中$n=4$，故最大大小为8。

Question 10

After the sender first sends frames from 0 to 6 and at the end of timeout receives the acknowledgements for frame 1, 3, and 5, the next frame it will re-transmit is frame _?_ . (assume the protocol is go-back-n, which utilizes cumulative acknowledgment)

Solution

在回退N协议中，累积确认表示收到了这一序号及以前的所有帧。接收方最后确认了5号帧，说明5号帧及以前都已经收到。此时发生超时，接下来应当重传6号帧。