## 第三次作业：（英文版教材第三章 1，2，3，4，6，7，9，11，14，15，16, 17, 18, 20, 27, 28, 29, 30, 31, 32, 33，补充题1-5）

1. An upper-layer packet is split into 10 frames, each of which has an 80% chance of arriving undamaged. If no error control is done by the data link protocol, how many times must the message be sent on average to get the entire thing through?
2. The following data fragment occurs in the middle of a data stream for which the byte stuffing algorithm described in the text is used: A B ESC C ESC FLAG FLAG D. What is the output after stuffing?
3. What is the maximum overhead in byte-stuffing algorithm?
4. When bit stuffing is used, is it possible for the loss, insertion, or modification of a single bit to cause an error not detected by the checksum? If not, why not? If so, how? Does the checksum length play a role here?
5. To provide more reliability than a single parity bit can give, an error-detecting coding scheme uses one parity bit for checking all the odd-numbered bits and a second parity bit for all the even-numbered bits. What is the Hamming distance of this code?
6. An 8-bit byte with binary value 10101111 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?
7. One way of detecting errors is to transmit data as a block of *n* rows of *k* bits per row and add parity bits to each row and each column. The bit in the lower-right corner is a parity bit that checks its row and its column. Will this scheme detect all single errors? Double errors? Triple errors? Show that this scheme cannot detect some four-bit errors.
8. Suppose that data are transmitted in blocks of sizes 1000 bits. What is the maximum error rate under which error detection and retransmission mechanism (1 parity bit per block) is better than using Hamming code? Assume that bit errors are independent of one another and no bit error occurs during retransmission.
9. What is the remainder obtained by dividing x 7 + x 5 + 1 by the generator polynomial x 3 + 1?
10. A bit stream 10011101 is transmitted using the standard CRC method described in the text. The generator polynomial is x 3 + 1. Show the actual bit string transmitted. Suppose that the third bit from the left is inverted during transmission. Show that this error is detected at the receiver’s end. Give an example of bit errors in the bit string transmitted that will not be detected by the receiver.
11. Data link protocols almost always put the CRC in a trailer rather than in a header. Why?
12. In the discussion of ARQ protocol in Section 3.3.3, a scenario was outlined that resulted in the receiver accepting two copies of the same frame due to a loss of acknowledgement frame. Is it possible that a receiver may accept multiple copies of the same frame when none of the frames (message or acknowledgement) are lost?
13. A channel has a bit rate of 4 kbps and a propagation delay of 20 msec. For what range of frame sizes does stop-and-wait give an efficiency of at least 50%?
14. A 3000-km-long T1 trunk is used to transmit 64-byte frames using protocol 5. If the propagation speed is 6 μsec/km, how many bits should the sequence numbers be?
15. Consider the operation of protocol 6 over a 1-Mbps perfect (i.e., error-free) line. The maximum frame size is 1000 bits. New packets are generated 1 second apart. The timeout interval is 10 msec. If the special acknowledgement timer were eliminated, unnecessary timeouts would occur. How many times would the average message be transmitted?
16. In protocol 6, MAX SEQ = 2n − 1. While this condition is obviously desirable to make efficient use of header bits, we have not demonstrated that it is essential. Does the protocol work correctly for MAX SEQ = 4, for example?
17. Frames of 1000 bits are sent over a 1-Mbps channel using a geostationary satellite whose propagation time from the earth is 270 msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used. What is the maximum achievable channel utilization for

(a) Stop-and-wait?

(b) Protocol 5?

(c) Protocol 6?

1. Consider an error-free 64-kbps satellite channel used to send 512-byte data frames in one direction, with very short acknowledgements coming back the other way. What is the maximum throughput for window sizes of 1, 7, 15, and 127? The earth-satellite propagation time is 270 msec.
2. A 100-km-long cable runs at the T1 data rate. The propagation speed in the cable is 2/3 the speed of light in vacuum. How many bits fit in the cable?
3. Give at least one reason why PPP uses byte stuffing instead of bit stuffing to prevent accidental flag bytes within the payload from causing confusion.
4. What is the minimum overhead to send an IP packet using PPP? Count only the overhead introduced by PPP itself, not the IP header overhead. What is the maximum overhead?

补充题1：已知数据位流为1101 0110，采用CRC 校验，G(x)=x3+1，计算出校验位。

补充题2. 采用3 比特序号的选择重传（SR）协议，若接收窗口为5，则发送窗口的最大值是多少?

补充题3. 50-kbps 的卫星信道，往返时延为 500ms，帧长为 1000 位，使用捎带确认（搭载ACK）的SR协议，若使效率达到50%，序号的比特数至少是多少?

补充题4. 数据链路层采用GBN（回退N步） 协议，发送方已经发送了编号为0-7 的帧，当计时器超时时，若发送方只收到0，4，5 号帧的确认，则发送方需要重发的帧数是多少?

补充题5. 两台计算机的数据链路层协议实体采取滑动窗口机制利用16kbps 的卫星信道传输长度为128 字节的数据帧，信道传播时延为270ms。

1) 计算使用停等协议的信道利用率；

2) 计算使用发送窗口为7 的GBN 协议的信道利用率；

3) 计算使用发送窗口为15 的GBN 协议的信道利用率；

4) 为使信道利用率达到最高，使用GBN 协议时序号的比特数最少为多少位？