第四次作业：（英文版教材第一章 15，22，教材第三章 17，18，20，27，28，29，30，31，32，33，补充题 2-4）

1-15. (Retransmission with Possibility of damage) In some networks, the data link layer handles transmission errors by requesting that damaged frames be retransmitted. If the probability of a frame's being damaged is p, what is the mean number of transmissions required to send a frame? Assume that acknowledgements are never lost.

1-22. (ACK for packet vs. ACK for whole file) When a file is transferred between two computers, two acknowledgement strategies are possible. In the first one, the file is chopped up into packets, which are individually acknowledged by the receiver, but the file transfer as a whole is not acknowledged. In the second one, the packets are not acknowledged individually, but the entire file is acknowledged when it arrives. Discuss these two approaches.

17. (Reason of duplicate frames) 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?

18. (Performance of Stop-and-wait) 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%?

20. (Performance of Go-back-N) A 3000-km-long T1 trunk with bandwidth 1.544Mbps is used to transmit 64-byte frames using protocol 5, which uses a short ACK frame as acknowledgement. If the propagation speed is 6 μsec/km, how many bits should the sequence numbers be?

27. (Idea of protocol 6) 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?

28. (Idea of protocol 6) In protocol 6, MAX SEQ = $2^n - 1$. 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?

29. (Performance of 3 ARQ protocols) 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?

30. (Performance of different sending window sizes) 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.

31. (Bandwidth Delay product) A 100-km-long cable runs at the T1 with data rate 1.544Mbps. The propagation speed in the cable is 2/3 the speed of light in vacuum. How many bits fit in the cable?

32. (Idea of PPP) 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.

33. (Idea of PPP) 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 2. (Performance of Selective Reject) 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 3. (Performance of Go-back-N) 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，则发送方需要重发哪些帧?

补充题 4. (Performance of Stop-and-wait and Go-back-N) 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。若采用捎带确认（搭载 ACK）方式，且传输不会出错，

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？