Module 3 Tutorials & Solutions
Transport Layer (Forouzan Chapter 13)

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13.1 A sender sends a series of packets to the same destination using 5-bit sequence of numbers. If the sequence number starts with 0, what is the sequence number of the 100th packet?

A: Sequence numbers have 5 bits and start from zero. They will cycle from 00000 to 11111 and then the sequence repeats. So packets 1-32 will have sequence numbers from 0 to 31, then this is repeated for 33-64, 65-96, and then 97, 98, 99, 100 will be 0, 1, 2, and 3. Therefore, the sequence number is 3. You can also just calculate (start sequence number + packet number - 1) modulo 2^{nbits}, in this case this is (0 + 100 - 1) modulo 32 = 3.

13.3 Show the finite state machine for an imaginary machine with three states: state A (starting state), state B, and state C; and four events: events 1, 2, 3, and 4. The following specify the behaviour of the machine:

A:

1. When in state A, two events may occur: event 1 and event 2. If event 1 occurs, the machine performs action 1 and moves to state B. If event 2 occurs, the machine moves to state C (no action).
2. When in state B, two events may occur: event 3 and event 4. If event 3 occurs, the machine performs action 2, but remains in state B. If event 4 occurs, the machine just moves to state C.
3. When in state C, the machine remains in this state forever.

A: See Figure 1

13.5 Redraw Figure 2 with 5 packets exchanged (0, 1, 2, 3, 4). Assume packet 2 is lost and packet 3 arrives after packet 4.

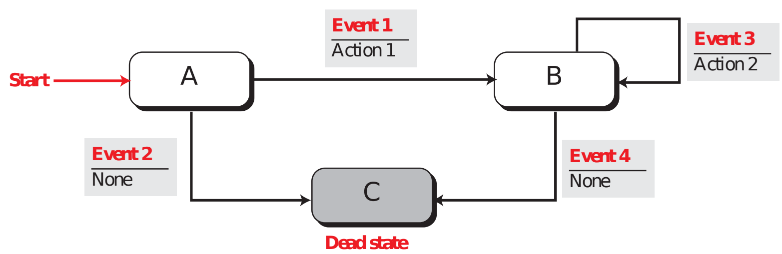

Figure 1: Foruzan problem 13.3

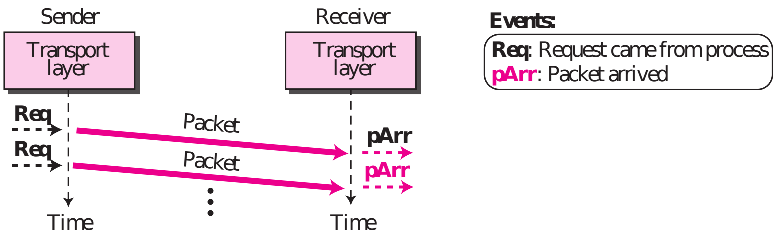

Figure 2: Figure 13.18 (Foruzan problem 13.5)

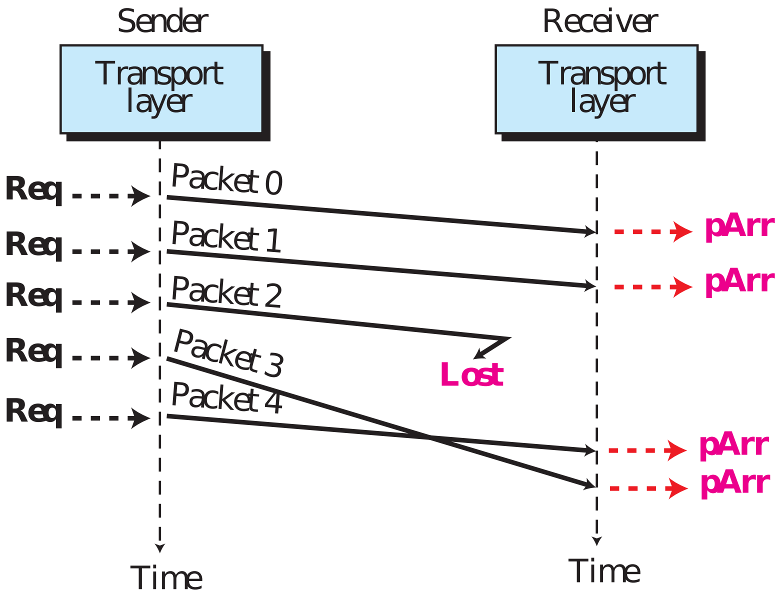

Figure 3: Foruzan problem 13.5

A: Figure 3 shows the outline. Note that since the simple protocol provide no error control, if a packet is lost, the receiving process is responsible to find a solution. The transport layer is not even aware that this has happened.The packets may also be delivered out of order to the receiving process. The responsibility again is on the receiving process to reorder the packets.

13.7 Create a scenario similar to figure 13.21 in which the sender sends two packets. The first packet is received and acknowledged, but the acknowledgement is lost. The sender resends the packet after time-out. The second packet is lost and resent.

A: See Figure 4

13.9 Redraw Figure 13.34 if the sender sends 5 packets (0, 1, 2, 3, and 4). Packets 0, 1, and 2 are received in order and acknowledged, one by one. Packet 3 is delayed and received after packet 4.

A: See Figure 5

13.11 Answer the following questions related to the finite state machines for the Go-back-N protocol with $m = 6$ (Figure 6):

1. The sending machine is in the ready state with Sf = 10 and Sn = 15. What is the sequence number of the next packet to send?
2. The sending machine is in the ready state with Sf = 10 and Sn = 15. A time-out occurs. How many packets are to be resent? What are their sequence numbers?

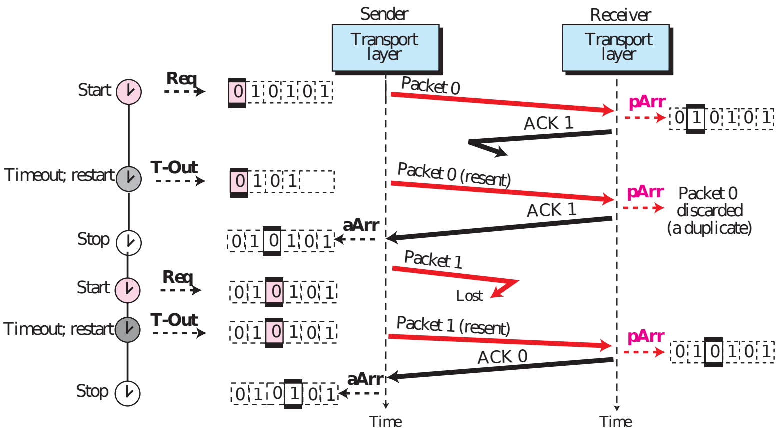

Figure 4: Foruzan problem 13.7

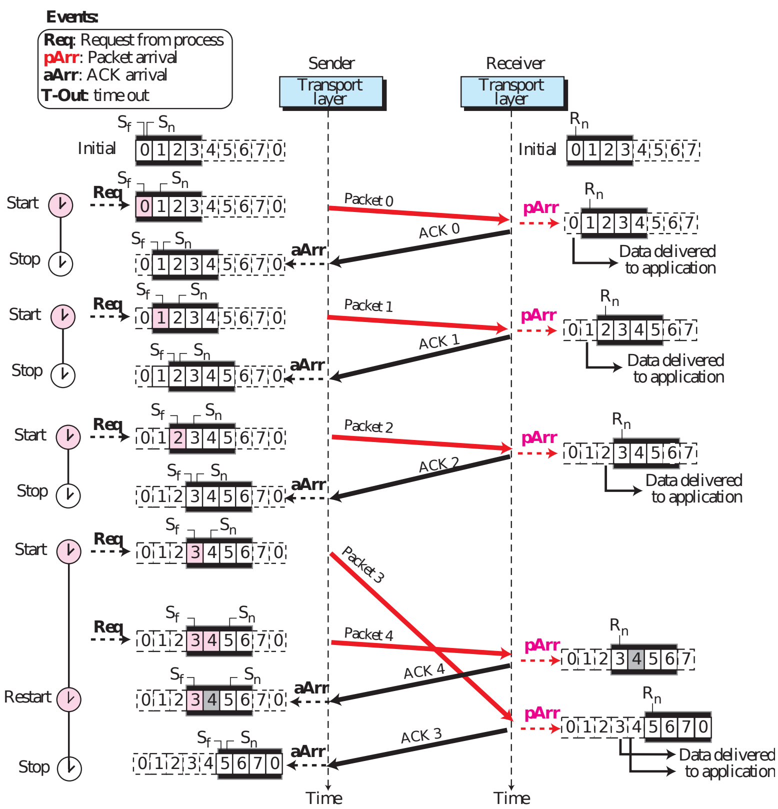

Figure 5: Foruzan problem 13.9

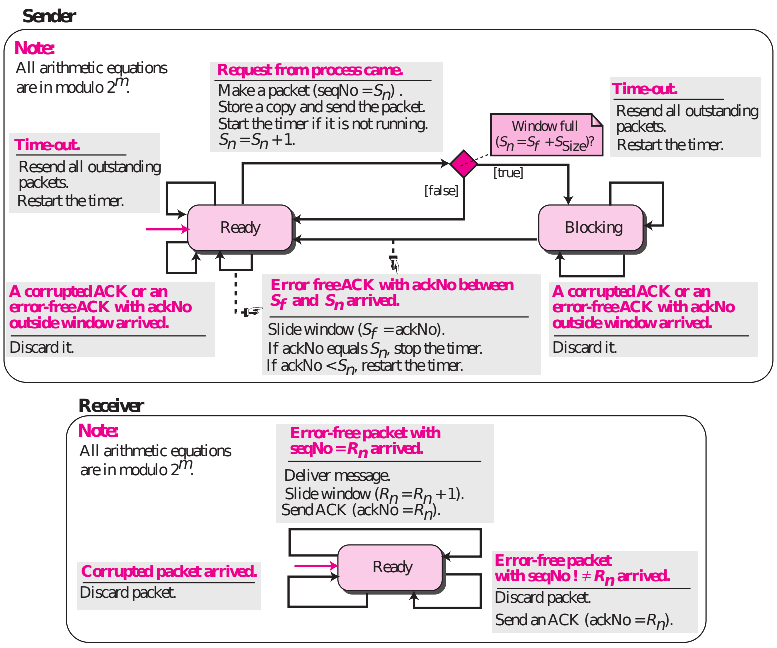

Figure 6: Foruzan problem 13.11

3. The sending machine is in the ready state with Sf = 10 and Sn = 15. An ACK with ackNo = 13 arrives. What are the next values of Sf and Sn?
4. The sending machine is in the blocking state with Sf = 14 and Sn = 21. What is the size of the window?
5. The sending machine is in the blocking state with Sf = 14 and Sn = 21. An ACK with ackNo = 18 arrives. What are the next values of Sf and Sn? What is the state of the sending machine?
6. The receiving machine is in the ready state with Rn = 16. A packet with sequence number 16 arrives. What is the next value of Rn? What is the response of the machine to this event?

A:

1. seqNo = 15.
2. Five packets with seqNo set to 10, 11, 12, 13, and 14 are to be resent.
3. Sf = 13 and Sn = 15.
4. The size of the window remains the same. Max Wsize = $2^6 - 1 = 63$.
5. Sf = 18 and Sn = 21 Next state = ready
6. Rn = 17 Action: an ACK with ackNo = 17 is sent.

14.1 In cases where reliability is not of primary importance, UDP would make a good transport protocol. Give examples of specific cases.

A:

- Interactive voice / video over IP (Skype etc.)
- Broadcast TV over IP - multicast

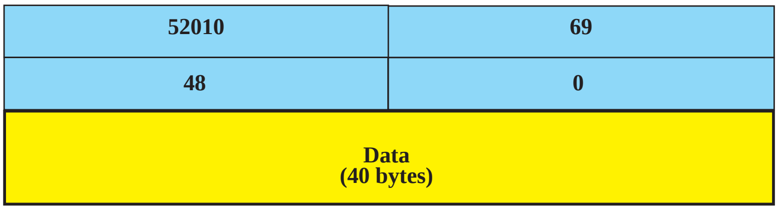

Figure 7: Foruzan problem 14.3

- Real-time gaming (e.g. multiplayer FPS)
- Local file distribution over a reliable network (or network filesystem)

14.3 Show the entries for the header of a UDP user datagram that carries a message from a TFTP client to a TFTP server. Fill the checksum field with 0s. Choose an appropriate ephemeral port number and the correct well-known port number. The length of data is 40 bytes. Show the UDP packet using the format in Figure 14.2.

A: See Figure 7

14.5 A TFTP server residing on a host with IP address 130.45.12.7 sends a message to a TFTP client residing on a host with IP address 14.90.90.33. What is the pair of sockets used in this communication?

A: The server would use the IP address 130.45.12.7, combined with the well-known port number 69 for its source socket address and the IP address 14.90.90.33, combined with an ephemeral port number as the destination socket address.

14.7 A client uses UDP to send data to a server. The data length is 16 bytes. Calculate the efficiency of this transmission at the UDP level (ratio of useful bytes to total bytes).

A: Efficiency = (16 bytes of data) / (24 bytes of total length) = 0.666 = 66.6 percent.

14.8/9 Redo Exercise 14.7, calculating the efficiency of transmission at the IP level. Assume no options for the IP header.

A: Efficiency = (16 bytes of data) / (16 (data) + 8 (UDP) + 20 (IP)) = 0.364 = 36.4%.

14.9 Redo Exercise 14.7, calculating the efficiency of transmission at the data link layer. Assume no options for the IP header and use Ethernet at the data link layer.

A: Efficiency = (16 bytes of data) / (64-byte minimum frame size) = 0.25 = 25%.