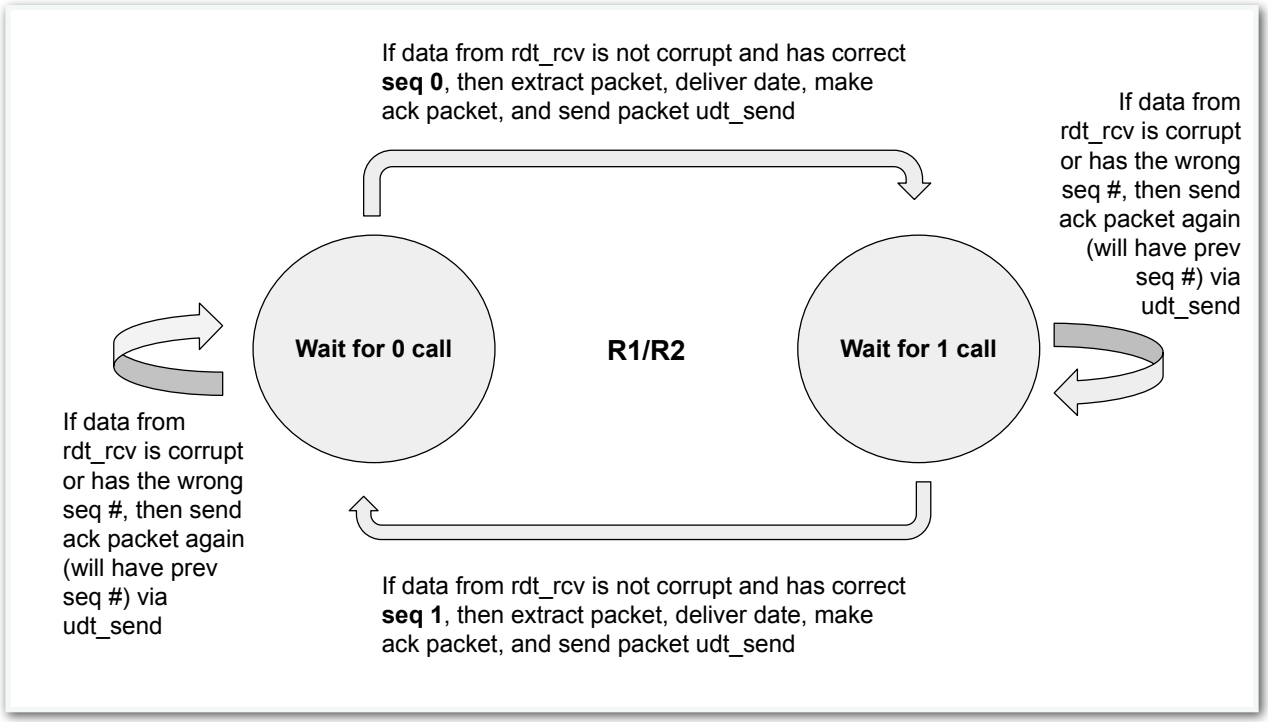

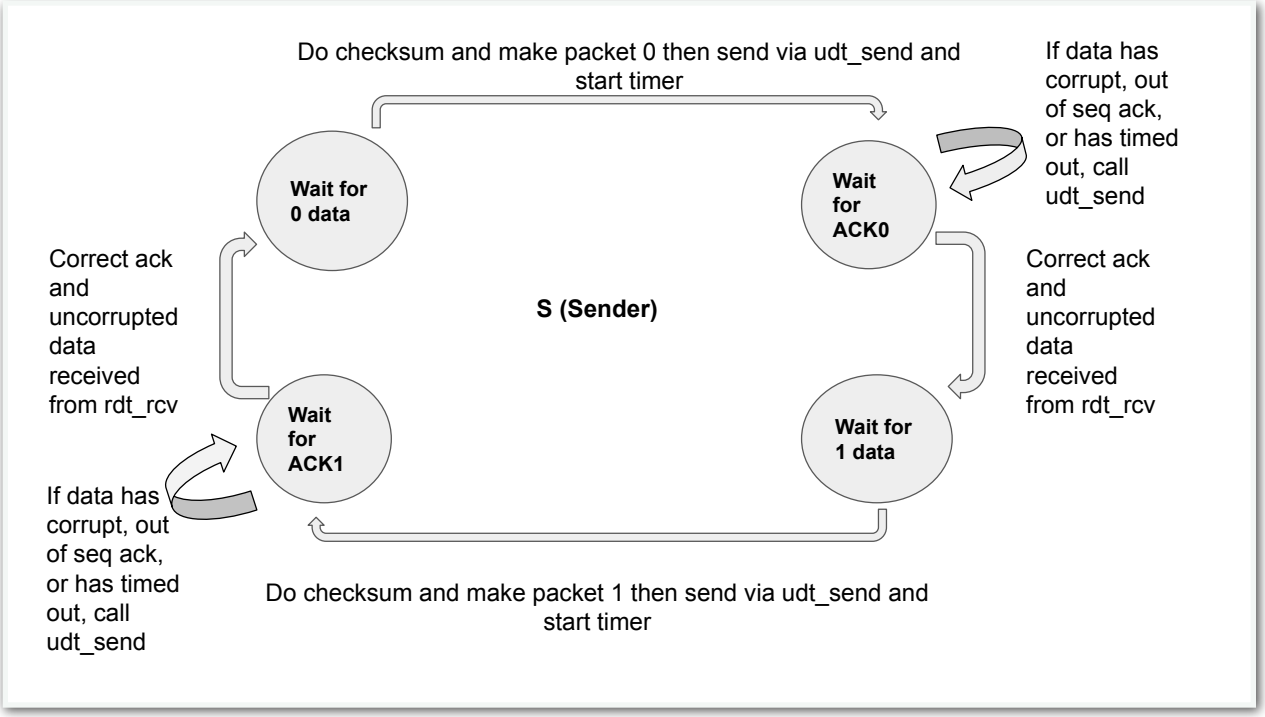

2) Flow control is used in the link layer to make sure that a sender does not overwhelm its receiver when sending data over the network by slowing the rate of transmission. A receiver can become overwhelmed when it is receiving data faster that is is able to process it. TCP implements flow control with the use of a receive window, rwnd. The rwnd is the amount of free space a receiver has in its receive buffer and this information is sent in a packet as part of the

TCP header. The size of the rwnd can change as well. It increases when data is read out of the buffer, and decreases when data is received. Each time a receiver sends an ACK back to the sender, data about the rwnd is sent as well. The sender then uses this information to determine how much data it can send. The sender can never send more data than the last known rwnd value. The last byte sent minus the last byte acked must be less than the rwnd. If rwnd even gets to 0 (aka it cannot receive anymore data), the sender sends 1 byte messages in hopes of soon getting an ack and larger rwnd back.

Flow control doesn't actually care about the network, so this is where congestion control comes in. Congestion control is used to reduce the amount congestion in the network by slowing the rate at which packets enter the network from the transport layer, to enable a better and more fair use of the network infrastructure. A congestion window (cwnd), like the rwnd, though maintained on the source rather than the destination, is used by TCP to help avoid congestion. The amount of data that can be sent if the whatever is smaller between the rwnd and cwnd. In TCP, there are 3 parts to the congestion policy. The slow start phase is used first by sending a single segment at a time, and increments the cwnd each time a segment is acked, leading to exponential growth. If a packet is lost, then ssthresh is set to half of cwnd. If cwnd is greater then ssthresh we switch to part 2 of the protocol - congestion avoidance mode. Here the transmission rate is increased more slowly by incrementing the cwnd (MSS/cwnd) * MSS. If there is ever triple duplicate ack we switch to fast recovery, which is part 3 of the policy. Here we are just dealing with a lost packet, so as soon as we get a new ack, we go back to congestion avoidance.

3)

	Src Address	Src Port	Dest Address	Dest Port
From A to X behind NAT	10.0.0.1	1025 - 65535	1.2.3.4	80
From B to X behind NAT	10.0.0.2	1025 - 65535	1.2.3.4	80
From A to X between the NAT and X	5.6.7.8	1025 - 65535	1.2.3.4	80
From B to X between the NAT and X	5.6.7.8	1025 - 65535	1.2.3.4	80
From X to A between X and the NAT	1.2.3.4	80	5.6.7.8	1025-65535
From X to A between the NAT and A	1.2.3.4	80	10.0.0.1	1025-65535

The translation table gives the private IP address and then what the will be on the public network:

Private	Public
10.0.0.1:8080	5.6.7.8:8080
10.0.0.2:3000	5.6.7.8:3000

4)

a) There are 6 subnets: A, B, C, A&B, A&C, B&C. The smaller prefix that can be used is 31.

b) 21 bits is the cheapest prefix that the company could have purchased.

c)

Network	Port
1.1.1.0/24	1
1.1.2.0/24	2
1.1.3.0/24	3
Everything else	D

5)