1. Write brief notes on congestion control in Traditional TCP.

Congestion may appear from time to time even in carefully designed networks. The packet buffers of a router are filled and the router cannot forward the packets fast enough because of the sum of the input rates of packets destined for one output link is higher than the capacity of the output link. The only thing a router can do in this situation is to drop packets. A dropped packet is lost for transmission, and the receiver notices a gap in the packet stream. Now the receiver does not directly tell the sender which packet is missing, but continues to acknowledge all in-sequence packets up to the missing one.

The sender notices the missing acknowledgement for the lost packet and assumes a packet loss due to congestion. Retransmitting the missing packet and continuing at full sending rate would now be unwise, (as this mightly (only (Continuing at full sending rate would now b) increase the congestion. Although it is not guaranteed that all packets of the TCP Congesnection take the same way throught the network, this assumption holds for most of the packets. To mitigate congestion, TCP slows down the transmission rate dramatically. All other TCP connections experiencing the same congestion do exactly the same so congestion is soon solved. This co-operation of TCP connections in the internet is one of the main reasons for its survival as it is today. Using UDP is not a solution, because the through-put is higher compared to a TCP connection just at the beginning. As soon as everyone uses UDP, this advantage disappears. After that, congestion is standard and data transmission quality is unpredictable. Even under heavy load, TCP gurantees at least sharing the bandwidth.

2. Compare several enhancements to TCP for mobility. Giving their relative advantages and disadvantages.

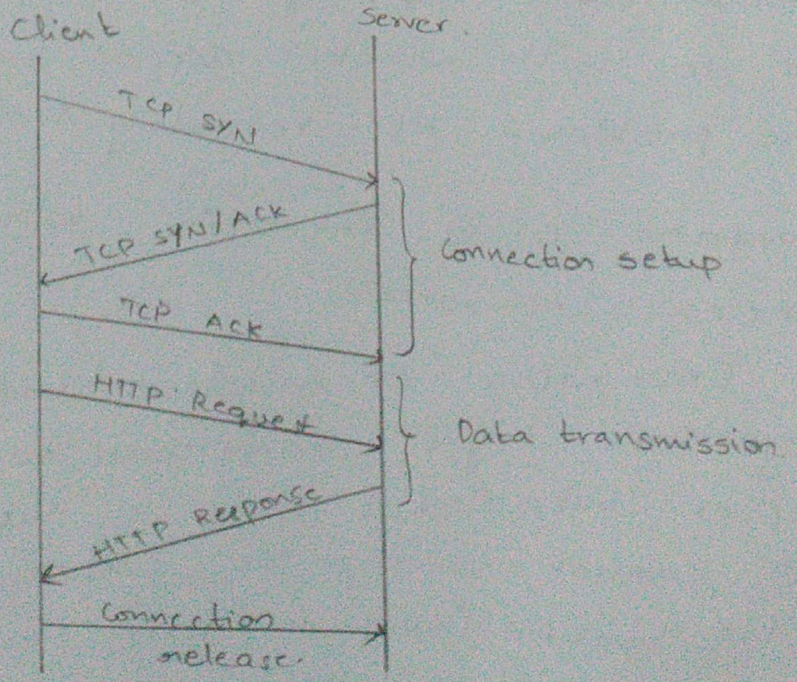
Approach	Mechanism	Advantages	Disadvantages
Indirect TCP	Splits TCP connection into two connections	Isolation of wireless link, simple.	Loss of TCP semantics, higher latency. at handover, security problems.
Snooping TCP	Snoops data and acknowledgements, local retransmission	Transparent for end-to-end connection, MAC integration possible.	Insufficient isolation of wireless link, security problems.
M-TCP	Splits TCP connection, chokes sender via window size	Maintains end-to-end semantics, handles long term and frequent disconnections.	Bad isolation of wireless link, processing overhead due to bandwidth management, security problems
Fast retransmit / fast recovery	Avoids slow-start after roaming	Simple and efficient	Mixed layers, not transparent
Transmission/ time-out freezing	Freezes TCP state at disconnection, resumes after reconnection.	Independent of content (works for longer interruptions	Changes in TCP required, MAC dependent.

Selective transmission	Retransmits only lost data	very efficient	slightly more complex receiver software, more buffer space needed
Transaction-required, oriented TCP	Combines connection setup/ release and data transmission	Efficient for certain application.	changes in TCP required, not transparent, security problems.

3. Describe Transaction-oriented TCP.

Assume an application running on the mobile host that sends a short request to a server from time to time, which responds with a short message. If the application requires reliable transport of packets, it may use TCP ..

Using TCP now requires several packets over the wireless link. First, TCP uses a three-way handshake to establish the connection. At least one additional packet is usually needed for transmission of request, and requires three more packets to close the connection via a three-way handshake.



The obvious advantage for certain applications is the reduction in the overhead which standard TCP has for connection setup and connection release. However T/TCP is not the original TCP anymore, so it requires changes in the mobile host and all correspondent hosts, which is a major disadvantage. This solution no longer hides mobility.

4.

a) Why mobility results in packet loss.

Mobility itself can cause packet loss. There are many situations where a soft handover from one access point to another is not possible for a mobile end-system. For example, when using mobile IP, there could still be some packets in transit to the old foreign agent while the mobile node moves to the new foreign agent. (while the mobile node moves to the) The old foreign agent may not be able to forward those packets to the new foreign agent or even buffer the packets if disconnection of the mobile nodes takes too long. This packet loss has nothing to do with wireless access but is caused by the problems of rerouting traffic.

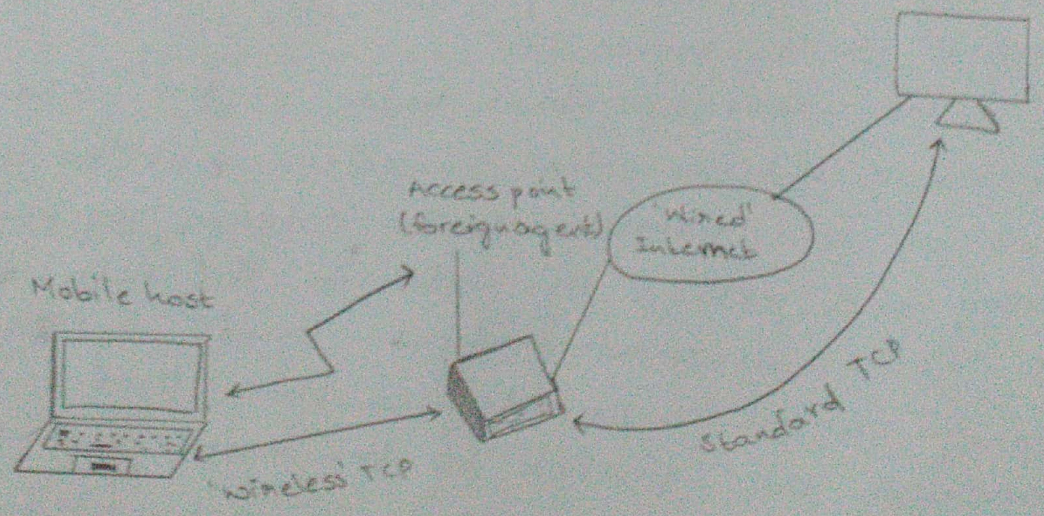
b) Compare error rates in wired networks and wireless networks.

Error rates on wireless links are orders of magnitude higher compared to fixed fiber or copper links. Packet loss is much more common and cannot always be compensated for by layer 2 retransmissions (ARQ) or error correction (FEC). Trying to retransmit on layer 2 could, for example, trigger TCP retransmission if it takes too long. Layer 2 now faces the problem of ~~re~~transmitting the same packet twice over a bad link. Detecting these duplicates on layer 2 is not an option, because more and more connections use end-to-end encryption, making it impossible to look at packet.

c) Why we cannot change TCP completely just to support mobile users. What are the consequences of it.

One cannot change TCP completely just to support mobile users or wireless links. The same arguments that were given to keep IP unchanged also apply to TCP. The installed base of computers using TCP is too large to be changed, and, more important, mechanisms such as slow start keep the internet operable. Every enhancement to TCP, therefore, has to remain compatible with the standard TCP and must not jeopardize the cautious behaviour of TCP in case of congestion.

5. How indirect TCP hides the problems of wireless links from fixed host.



Two competing insights led to the development of indirect TCP (I-TCP). One is that TCP performs poorly together with wireless links; the other is that TCP within the fixed network cannot be changed. I-TCP segments a TCP connection into a fixed part and a wireless part. Figure shows an example with a mobile host connected via a wireless link and an access point to the 'wired' internet where the correspondent host resides. The correspondent node could also use wireless access. The following would then also be applied to the access link ~~t~~ of the correspondant host.

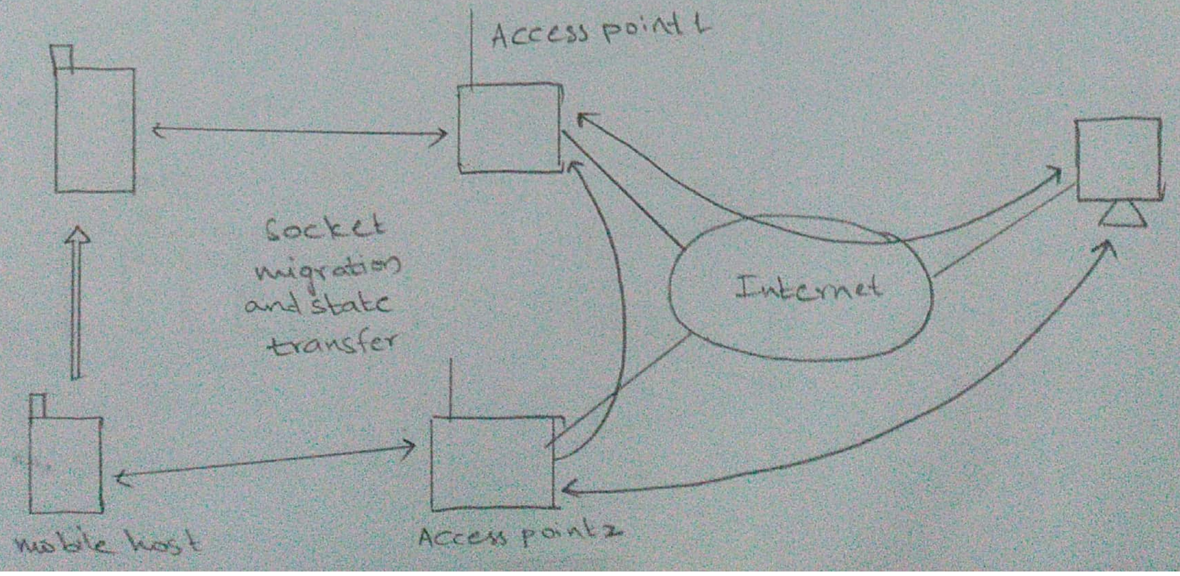
Standard TCP is used between the fixed computer and the access point. No computer in the internet recognizes any changes to TCP. Instead of the mobile host, the access point now terminates the standard TCP connection, acting as a proxy. This means that the access point is now seen as the mobile host for the fixed host and as the fixed host for the mobile host. Between the access point and the mobile host, a special TCP, adapted to wireless links, is used. Changing TCP for the wireless link is not a requirement. Even an unchanged TCP can benefit from the much shorter round trip time, starting retransmission much faster. A good place for segmenting the connection between mobile host and correspondant host is at the foreign agent of the mobile IP. The foreign agent controls the mobility of the mobile host anyway and can also hand over the connection to the next foreign agent when the mobile host moves on.

The correspondant host in the fixed network does not notice the wireless link or the segmentation of the connection. The foreign agent acts as a proxy and relays all data in the both directions. If the correspondent host sends a packet, the foreign agent acknowledges this packet and tries to forward the packet to the mobile host. If the mobile host receives the packet, it acknowledges the packet. This acknowledgement is only used by the foriegn agent. If a packet is lost on the wireless link due to a transmission error, the correspondent host would notice this. In this case, the foriegn agent tries to retransmit this packet locally to maintain reliable data transport.

6. The foreign agent can act as a gateway to translate b/w different protocols in indirect TCP Com-
-ment.

If the mobile ~~no~~ host sends a packet, the foreign agent acknowledges this packet and tries to forward it to the correspondent host. If the packet is lost on the wireless link, the mobile hosts notice this much faster due to the lower round trip time and can directly retransmit the packet. Packet loss in the wired network is now handled by the foreign agent.

I-TCP requires several actions as soon as a hando-
-ver takes place. Not only the packets have to be redirected using ; e.g; mobile IP. In example shown, the access point acts as a proxy buffering packets for retransmission. After the handover, the old proxy must forward buffered data to the new proxy because it has already ackn-
-owledged the data. After registration with the new foreign agent, the new foreign agent can inform the old one about its location to enable packet forwarding. Besides buffer content, the sockets of the proxy, too, must migrate to the new foreign agent located in the access point. The socket reflects the current state of the TCP connection, i.e; sequence number, addresses, ports etc. No new connection may be established for the mobile host and the correspondent host must not see any changes in connection state.

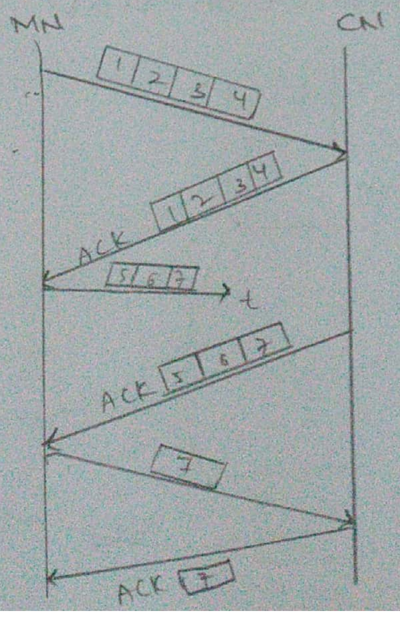


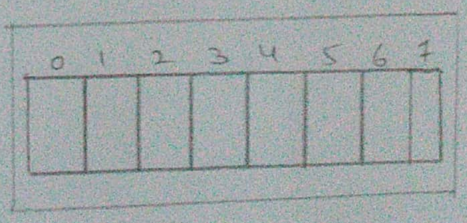
7. How does selective transmission improve the transmission efficiency? What are the modifications required in the TCP receiver.

A very useful extension of TCP is the use of selective retransmission. TCP acknowledgements are cumulative, i.e., they acknowledge in-order receipt of packets up to a certain packet. If a single packet is lost, the sender has to retransmit everything starting from the lost packet (go-back-n retransmission). This obviously wastes bandwidth, not just in the case of a mobile network, but for any network (particularly those with a high path capacity, i.e., bandwidth-delay-product).

TCP can indirectly request a selective retransmission of packets. The receiver can acknowledge single packets, not only trains of in-sequence packets. The sender can now determine precisely which packet is needed and can retransmit it.

The advantage of this approach is obvious: a sender retransmits only the lost packets. This lowers bandwidth requirements and is extremely helpful in slow wireless links. The gain in efficiency is not restricted to wireless links and mobile environments. Using selective transmission is also beneficial in all other networks.





8. What are the applications in which packet delay is equivalent to packet lost? Explain.

Wireless systems suffer from large delay variations or 'delay spikes'. Reasons for sudden increase in the latency are: link outrages due to temporal loss of radio coverage, blocking due to high-priority traffic, or handovers. Handovers are quite often only virtually seamless with outrages reaching from some 10ms to several seconds. handover. e.g.; from a WLAN to a cellular system using Mobile IP without using additional mechanisms such as multicasting data to multiple access points.

Packets might be lost during handovers or due to corruption. Link-level retransmissions the loss rates of 2.5G/3G systems due to corruption are relatively low. However, recovery at the link layer appears as jitter to the higher layers.

9. What are the applications for which packet loss can create severe problems? Explain.

Link congestion, video conferencing, Device performance, software issues on a network device. and faulty hardware or cabling in which packet loss can create severe problems

Packet loss can cause several issues which leads to the severe problems:

Out-of-date information:- A few micro seconds of delay can be the difference of a win or lose in case of a video game and is similar to the information transfer in any application.

slow loading times, loading interruptions, closed connections, missing information. Can cause packet loss.

The severe problem is caused in TCP and UDP which use these packets to transfer information. TCP or UDP may face problems if there is a packet loss. In some cases the whole process must be repeated in order transfer the whole information.