CS8601 –MOBILE COMPUTING

UNIT 4

MOBILE TRANSPORT AND APPLICATION LAYER

4.1. Mobile TCP

There are several mechanisms of the Transmission Control Protocol (TCP) that influence the efficiency of TCP in a mobile environment.

Traditional TCP improvements

Improvement in TCP: TCP was initially designed for wired (traditional) networks

4.1.1 Slow start

4.1.2 Congestion Avoidance

4.1.3 Fast retransmit/fast recovery

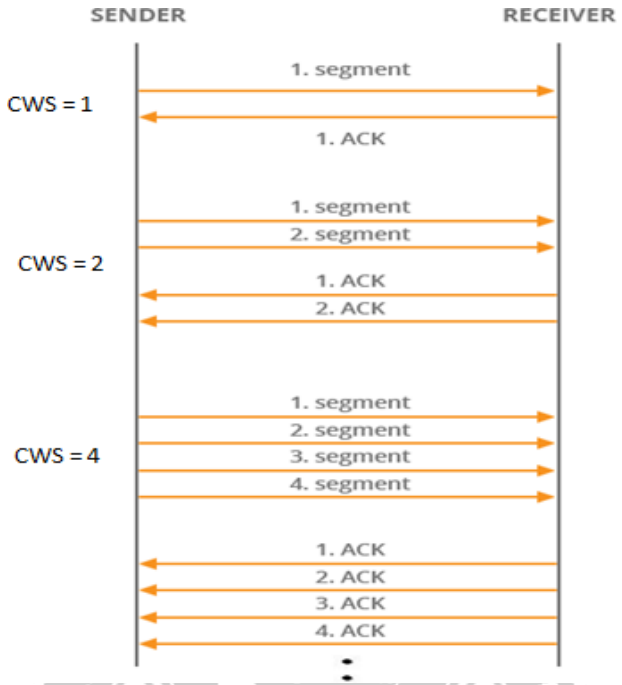
4.1.1 Slow start

The behaviour TCP shows after the detection of congestion is called slow start .Instead of starting transmission at a fixed transmission window size, the transmission is started at the lowest window size and then doubled after each successful transmission.

If congestion is detected, the transmission window size is reduced to half of its current size.

The sender always calculates a congestion window for a receiver.

1. The start size of the congestion window is one segment.
2. The sender sends one packet and waits for acknowledgement.
3. If this acknowledgement arrives, the sender increases the congestion window by one, now sending two packets.
4. After arrival of the two corresponding acknowledgements, the sender again adds 2 to the congestion window, one for each of the acknowledgements.
5. Now the congestion window equals 4.
6. This scheme doubles the congestion window every time the acknowledgements come back, which takes one round trip time (RTT). This is called the exponential growth of the congestion window in the slow start mechanism.

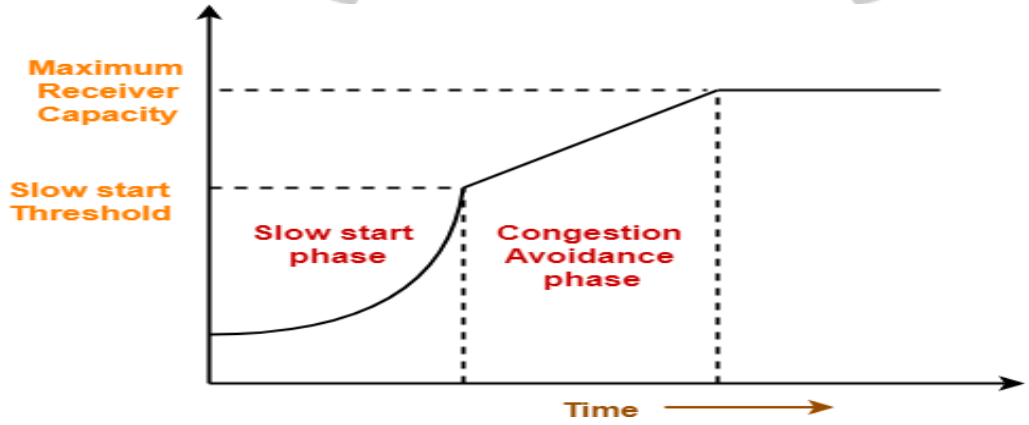


4.1.2 Congestion Avoidance

Congestion avoidance start when slow start stops. Drawback in slow start: It is too dangerous to double the congestion window each time because the steps might become too large.

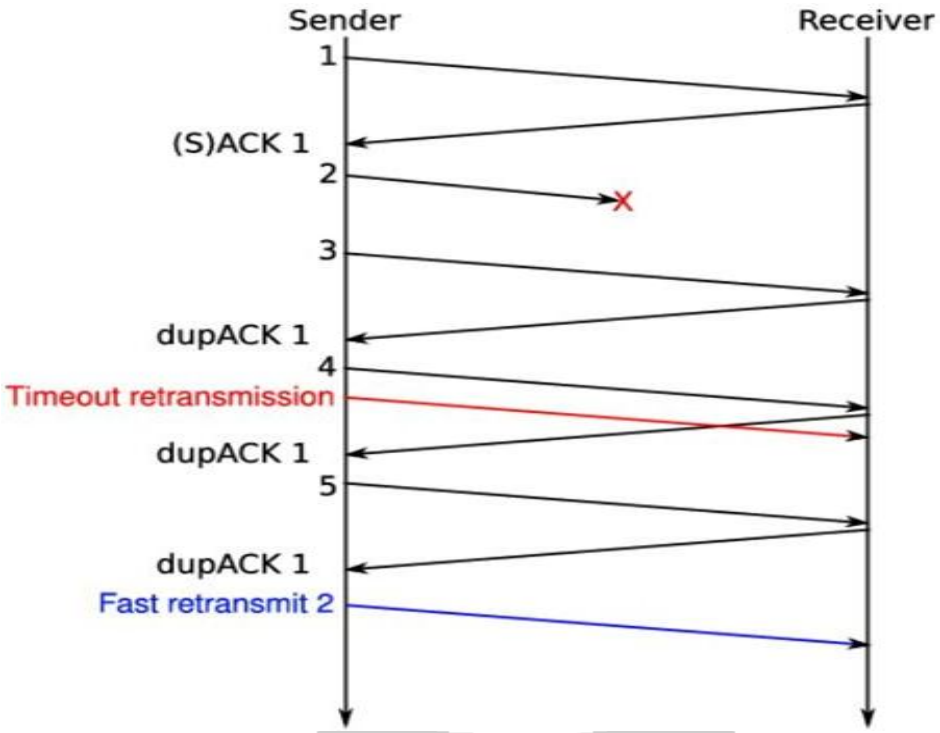
Solution:

- Window size is doubled until it reaches a threshold level.
- When it reaches a threshold level, then window size is increased linearly.
- If congestion is occurred, then the window size is reduced to half of its size.
- If it reaches zero then again slow start begins



4.1.3 Fast retransmit/fast recovery

- The sender can retransmit the missing packet(s) before the timer expires.
- It does not wait until the timer expires it retransmit a packet whenever sender is getting 3 duplicate acknowledgements.
- After retransmitting a packet it sets the window size is reduced to its half



Classical TCP Improvements For Wireless NETWORK

Mechanisms to increase TCP's performance in wireless and mobile environments:

- Indirect TCP (I-TCP)
- Snooping TCP (S-TCP)
- Mobile TCP (M-TCP)
- Fast retransmit/fast recovery
- Transmission/time-out freezing
- Selective retransmission
- Transaction-oriented TCP (T-TCP)

i)Indirect TCP (I-TCP)

Two competing insights led to the development of indirect TCP:

1)TCP performs poorly together with wireless links

2)TCP within the fixed network cannot be changed

Working:

- I-TCP segments a TCP connection into a fixed part and a wireless part.

- 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.

- Standard TCP is used between the fixed computer and the access point.

- The foreign agent (access point) acts as a proxy and relays all data in both directions.

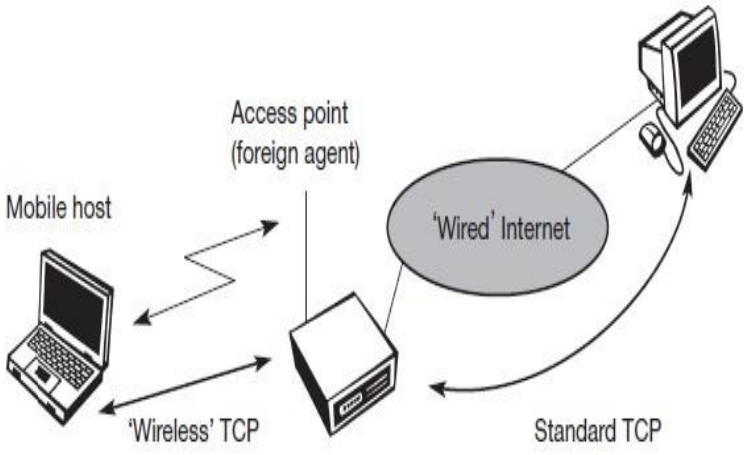


Fig. I-TCP segments a TCP connection into two parts

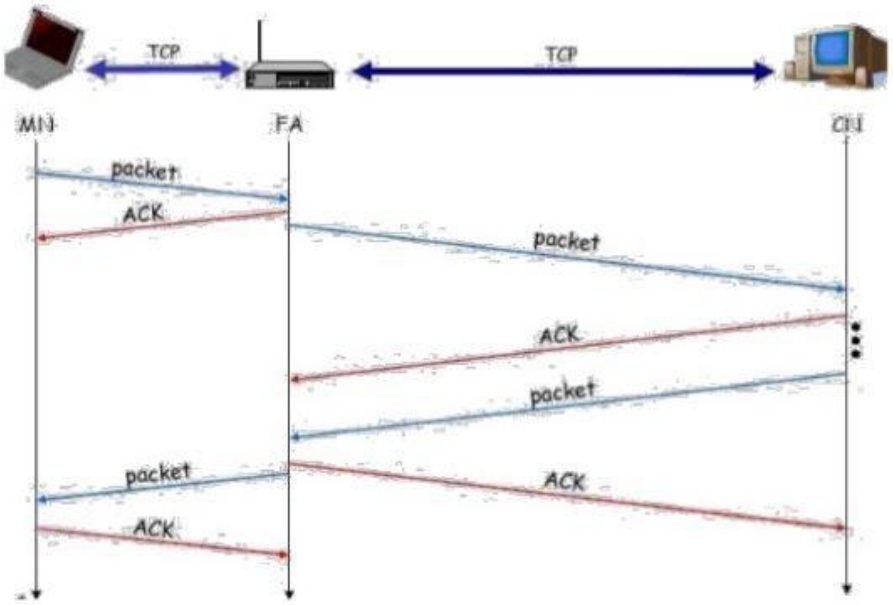
Packet delivery:

- If CN sends packet, FA acknowledges packet and forwards packet to MN

- If MN receives packet, it acknowledges

- This acknowledgement only used by CN

- Similarly if MN sends packet, FA acknowledges packet and forwards it to CN



Packet Loss:

Case1 : If a packet is lost on the wireless link due to a transmission error:

•Then the CN would not notice this.

•The FA tries to retransmit this packet locally to maintain reliable data transport.

Case2:If the packet is lost on the wireless link:

•The MN 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 FA.

Advantages with I-TCP:

1.TCP does not require any changes in the TCP protocol as used by the hosts in the fixed network.

2.Due to the strict partitioning into two connections, transmission error cannot propagate into the fixed network.

3.Partitioning into two connections allows the use of a different transport layer protocol between the FA and the MN.

4.Different solutions can be tested or used at the same time without disturbing the stability of the Internet.

Disadvantages of I-TCP:

1.The loss of the end-to-end semantics of TCP might cause problems if the FA partitioning the TCP connection crashes:

2.Increased handover latency may be much more problematic

3.The FA must be integrated into all security mechanisms.

ii)Snooping TCP (S-TCP)

The segmentation drawback of I-TCP is eliminated by Snooping TCP."The FA buffers all packets with destination MN and additionally 'snoops' the packet flow in both directions to recognize acknowledgements".Reason for buffering: To enable the FA to perform a local retransmission in case of packet loss on the wireless link.

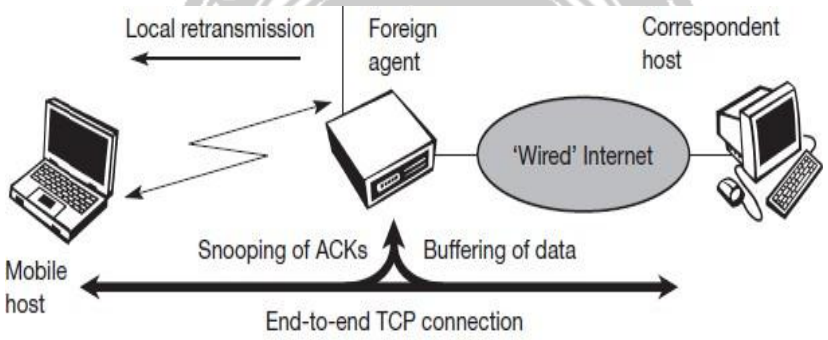


Fig. Snooping TCP

Data transfer to the MH (Mobile Host)

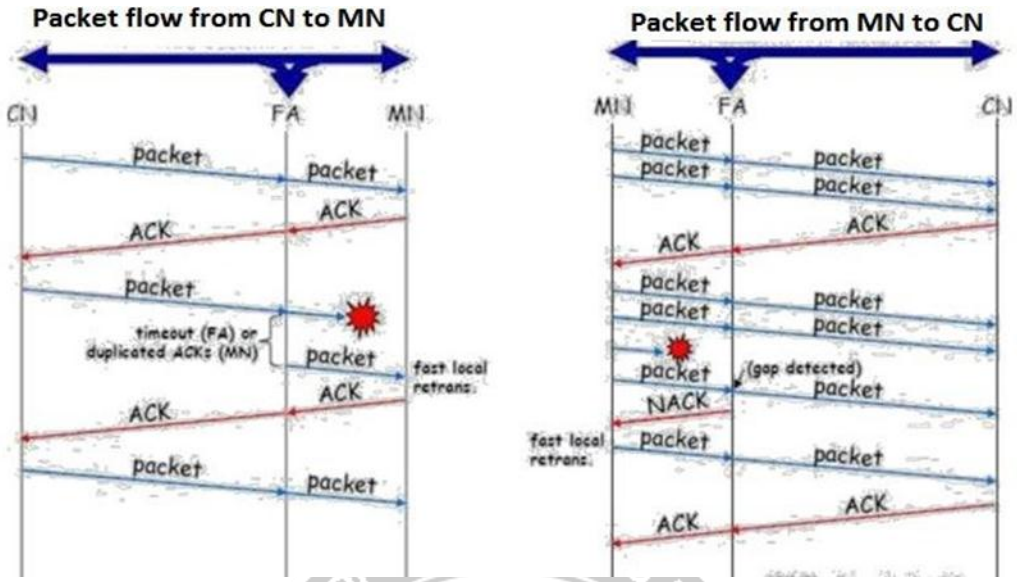
•FA buffers data until it receives ACK of the MH

•FA detects packet loss via duplicated ACKs or time-out

Data transfer from the MH (Mobile Host)

•FA detects packet loss on the wireless link via sequence numbers, FA answers directly with a negative acknowledgement (NACK) to the MH

•MH can now retransmit data with only a very short delay



Advantages:

1.The approach automatically falls back to standard TCP ifthe enhancements stop working.

2.The CN does not need to be changed since most of the enhancements are in the FA.

3.It does not need a handover of state as soon as the MH moves to another FA.

4.It does not matter if the next FA uses the enhancement or not. If not, the approach automatically falls back to the standard solution.

Disadvantages:

1.Snooping TCP does not isolate the behaviour of the wireless link as good as I-TCP.

2.Additional mechanism for negative acknowledgements (NACK) between FA and MH.

3.Snooping and buffering data may be useless if certain encryption schemes are applied end-to-end between the correspondent host and mobile host.

iii)Mobile TCP (M-TCP)

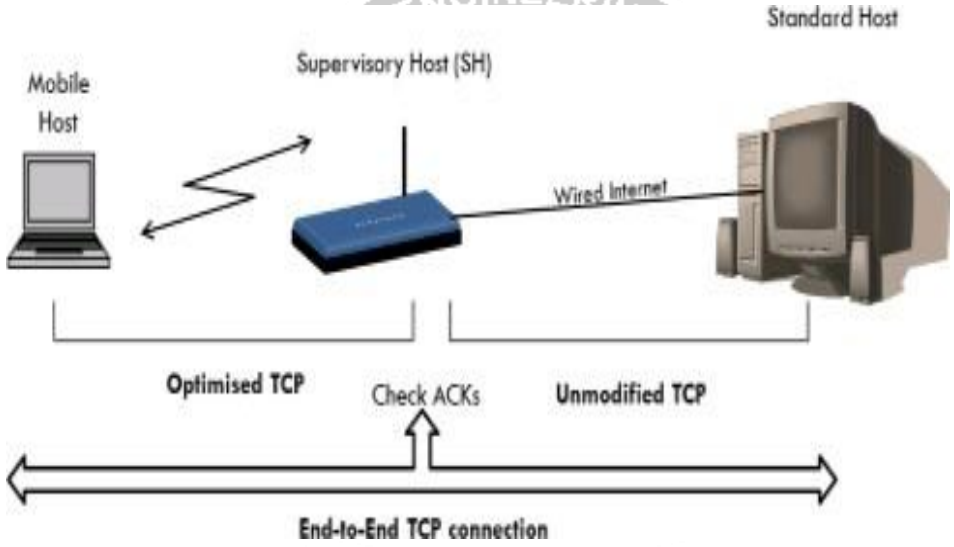
I-TCP and S-TCP does not work well, if a MH is disconnected.The M-TCP has the same goals as I-TCP and snooping TCP

Goals of M-TCP:

- ✓ Prevent the sender window from shrinking if bit errors or disconnection.
- ✓ Improve overall throughput
- ✓ Lower the delay
- ✓ Maintain end-to-end semantics of TCP
- ✓ Provide a more efficient handover
- ✓ Adapted to the problems arising from lengthy or frequent disconnections

The M-TCP splits up the connection into two parts:

- ❖ An unmodified TCP is used on the Standard host-Supervisory Host section
- ❖ An optimised TCP is used on the Supervisory Host- Mobile Host section.



The SH is responsible for exchanging data to both the Standard host and the Mobile host. In this approach, we assume that the error bit rate is less as compared to other wireless links. So if any packet is lost, the retransmission has to occur from the original sender and not by the SH.

1.The SH monitors the ACKs being sent by the MH.

2.If for a long period ACKs have not been received, then the SH assumes that the MH has been disconnected.

3.If so the SH blocks the sender by setting its window size to 0.

4.Then the sender goes into persistent mode i.e. the sender will not try to retransmit the data.

5.Now when the SH detects a connectivity established again with the MH, the window of the sender is restored to original value.

Advantages of Mobile TCP:

1.M-TCP maintains the TCP end-to-end semantics.

2.If the MH is disconnected, it avoids useless retransmissions, slow starts or breaking connections by simply shrinking the sender's window to 0.

3.M-TCP does not buffer data so, no forwarding.

Disadvantages of Mobile TCP:

1.The SH does not act as proxy

2.M-TCP assumes low bit error rates, which is not always a valid assumption.

3.Requires new network elements like the bandwidth manager.

iv)Fast retransmit/fast recovery

Change of FA often results in a packet loss. TCP reacts with slow start although there is no congestion.

Solution: Fast retransmit method.

Fast retransmit method: When a MH moves to a new FA, it transmits the ACK of the last packet was received. It is indication for the CN to continue transmission at the same rate it did before MH moves to another FA. This approach puts the CN to fast retransmission mode.

Advantages:

1.It is simple.

2.Only minor changes in the MN software results in performance increase.

3.No FA or CN host has to be changed.

Disadvantages: Increased time delay in the retransmitted packets to move from CN to MH.

v)Transmission/time-out freezing

In normal TCP, a disconnection takes place when the connection is lost for a longer time.

Example: When a MN moving through a tunnel or passing black out areas, the connection is lost and it needs to make connection once again, when it comes back.

TCP freezing:

- MAC layer is often able to detect interruption in advance
- MAC can inform TCP layer of upcoming loss of connection
- TCP stops sending, but does not assume a congested link.
- MAC layer signals again if reconnected.

Advantages:

1.Offers a way to resume TCP connection even after longer interruptions of the connection.

2.Independent of any other TCP mechanism, such as ACKs, sequence numbers etc.

Disadvantages:

(i)The software on the MN and CN needs to be changed.

(ii)Depends on MAC layer

vi)Selective retransmission

TCP acknowledgements are cumulative. ACK n acknowledges correct & in-sequence receipt of packet up to n. If a single packet is lost quite often a whole packet sequence beginning at the gap has to be retransmitted. Bandwidth wastage.

Solution: Selective Retransmission

•Allows the receiver acknowledge a single packets

•Now the sender can retransmit only the missing packet.

Advantage:

•The sender retransmits only the lost packets.

•Much higher efficiency. Lowers bandwidth requirement

Disadvantage: More complex software on the MH.

vii)Transaction-oriented TCP (T-TCP)

TCP requires several trans reception of packets for:

- Connection setup
- Data transmission
- Connection release.

(-) Even a short message needs minimum of 7 packets leads to connection overhead.

Solution: T-TCP

Connection setup,Data transmission,Connection release can be combined,thus only 2 or 3 packets are needed.Reduces the total overhead.

Advantage: Reduction in overhead.

Disadvantage: Requires changed TCP, Mobility not longer transparent.

COMPARISON OF VARIOUS TCP

Approach	Mechanism	Advantages	Disadvantages
Indirect TCP	Splits TCP connection into two connections	Isolation of wireless link, simple.	Loss of TCP semantics. Higher latency athandover, 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 Retransmission /Fast Recovery	Avoids slow start ate roaming	Simple and efficient	Mixed layers, nottransparent.
Transmission / Time out freezing	Freezes TCP state at disconnection, resumes after reconnection	Independent of content, works for longer interruptions	Changes in TCPrequired, MAC dependent
Selective retransmission	Retransmits only lost data.	Very efficient	Slightly more complex receiver software, more bufferspace needed
Transaction oriented TCP	Combines connection setup-/ release and data retransmission	Efficient for certain applications	Changes in TCPrequirednot transparent, security problems.