Retransmission timer

- Used to retransmit lost segments
- Retransmission timeout (RTO) calculation:
  - Calculating measured RTT(RTT_M) → Round trip time
    - In TCP, there can be only one RTT measurement in progress at any time.
    - Measured RTT is likely to change for each round trip.
  - Smoothed RTT(RTT_S), a weighted average of RTT_M and the previous RTT_S is used.
  - Most implementations use RTT deviation, called RTT_D, based on the RTT_S and RTT_M.
- Value of RTO is based on the smoothed round-trip time and its deviation.

Formulas used in RTO calc^n

Initially → no value   ,smoothes out

After first measurement → $RTT_S = RTT_M$

After each measurement → $\boxed{RTT_S = (1-\alpha)RTT_S + \alpha \times RTT_M}$

Initially → No value   ,deviation

After first measurement $RTT_D = RTT_M/2$

$\boxed{RTT_D = (1-\beta)RTT_D + \beta \times |RTT_S - RTT_M|}$

Initially → no value

After any mea- $\boxed{RTO = RTT_S + 4 RTT}$

- Value of α is set to $1/8$
- New RTT_S is calculated as $7/8$ of the old RTT_S and $\frac{1}{8}$ of the current RTT

Persistence timer

When receiving TCP announces a window size zero, sending TCP stops transmitting segments until receiving TCP sends an ACK segments announcing a non-zero window size.
This ACK can be lost : Deadlock.

- ACK segments are not acknowledged and are not retransmitted in TCP.
- No retransmission timer for of a segment containing only an acknowledgement.
- Solution: Persistence timer at sending TCP side.
- If persistence timer goes off, send probe segment.
- Response: resend acknowledgement.
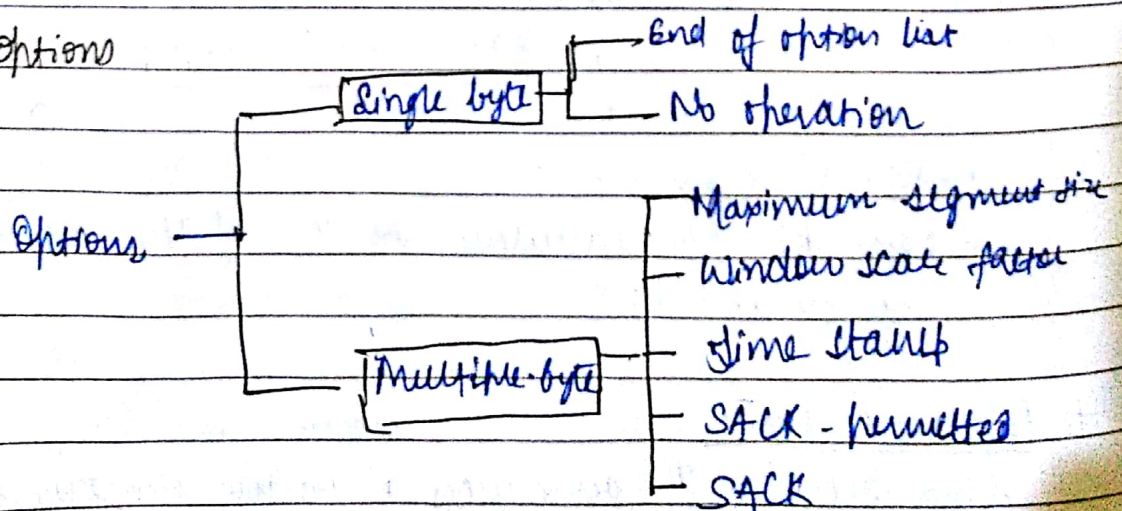- No response continue sending probe segments.

Keepalive timer
- Keep-alive timer is used to prevent a long idle connection b/w two TCPs.
- Each time server hears from a client, it resets the timer. Time-out is usually 2 hours.

TIME-WAIT timer
- The TIME-WAIT (2MSL) timer is used during connection termination.
- Purpose of TIME-WAIT is to allow the networking to distinguish packets that arrive as belong to the old existing connection from a new one.
- The recommendation is to set the TIME-WAIT timer to twice the Maximum Segment Lifetime (MSL).

TCP Options

Options → Single byte → End of option list
                        No operation

         → Multiple-byte → Maximum segment size
                           window scale factor
                           time stamp
                           SACK - permitted
                           SACK

TCP options

- End of options (EOP) – used for padding at the end of the option section.
- Maximum segment size (MSS) – defines size of the biggest unit of data that can be received by the destination of the TCP segments. Value can be 0 to 65,535 bytes.
- Window scale factor – defines the size of the sliding window.
- Window size ranges from 0 to 65,535 bytes.
- Time stamp – measures the round trip time and prevents wraparound sequence numbers.
- SACK permitted – used only during connec² establishment.
- Host sending SYN segments add this option to show that it can support SACK option.
- SACK – used during data transfer only if both ends agree.
- Options include a list for blocks arriving out of order (which can be selectively acknowledged).

User datagram protocol (UDP)

It is a connectionless, unreliable transport protocol.
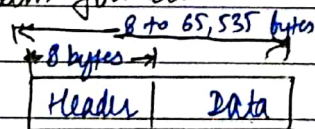It uses port numbers to accomplish process-to-process comm².
UDP has no flow control mechanism
It has no acknowledgement for received packets.
If UDP detects an error in the received packet, it drops it.
It packets user datagram have a fixed-size header of 8-bytes.

User datagram format

```
        |←——— 8 to 65,535 bytes ———→|
        |←8 bytes→|
        | Header |      Data      |
```

Source port addr	Destination port addr
Length	Checksum

UDP header format