TCP Wrap-up

TCP Timers

Selective Acknowledgements

TCP Timers

- TCP maintains four (4) timers for each connection:
  - **Retransmission Timer:**
    - The timer is started during a transmission. A timeout causes a retransmission
  - **Persist Timer**
    - Ensures that window size information is transmitted even if no data is transmitted
  - **Keepalive Timer**
    - Detects crashes on the other end of the connection
  - **2MSL Timer**
    - Measures the time that a connection has been in the TIME_WAIT state

Retransmission Timer (RT Timer)

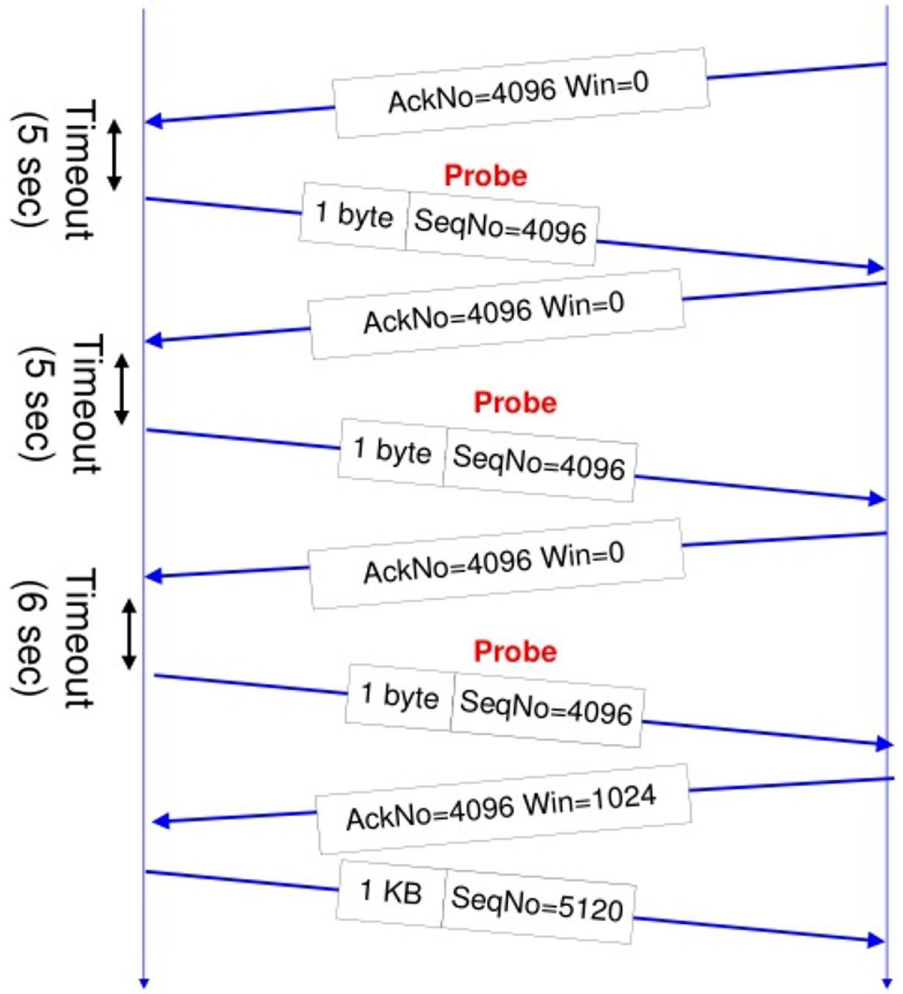
Setting the RT timer

- When a segment is sent and RT timer is not running, start RT timer with RTO value
- Turn off RT timer, when all data is acknowledged
- When an ACK is received for new data, reset the RT timer to RTO value

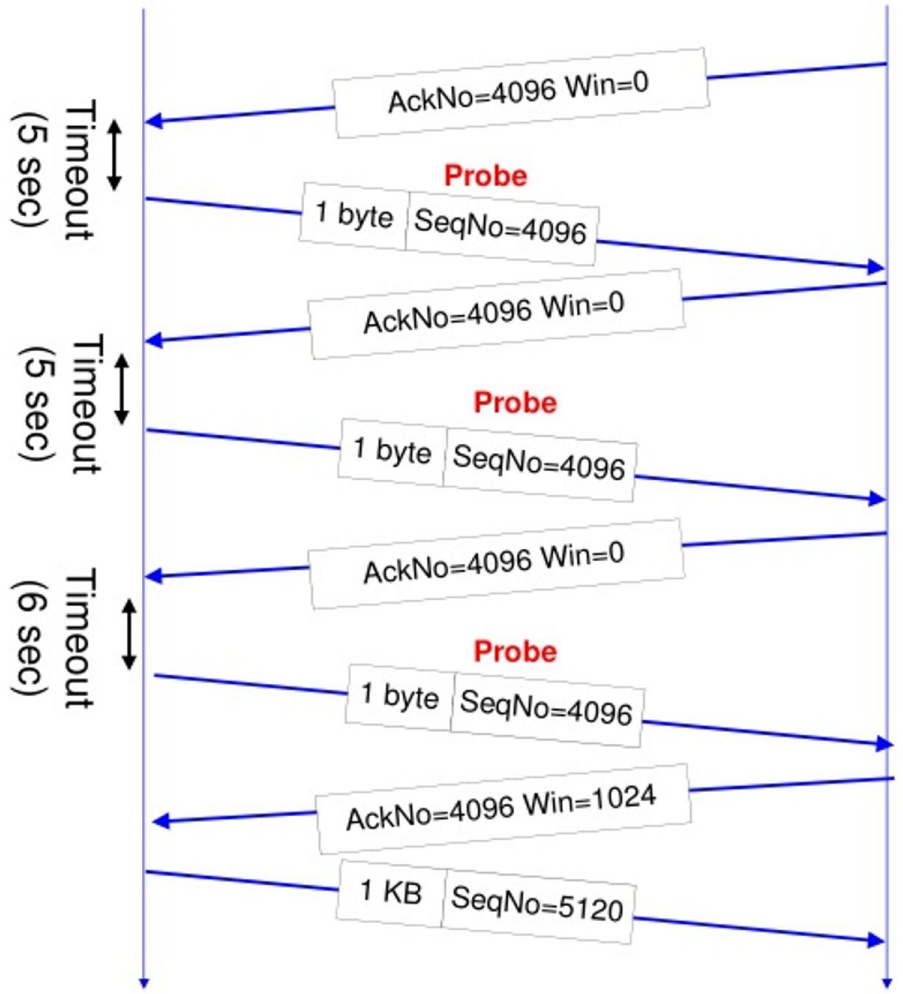
RT timer expires

- Retransmit the earliest segment that has not been acknowledged
- Double value of RTO (see Karn's rule)
- Start the RT timer with RTO value

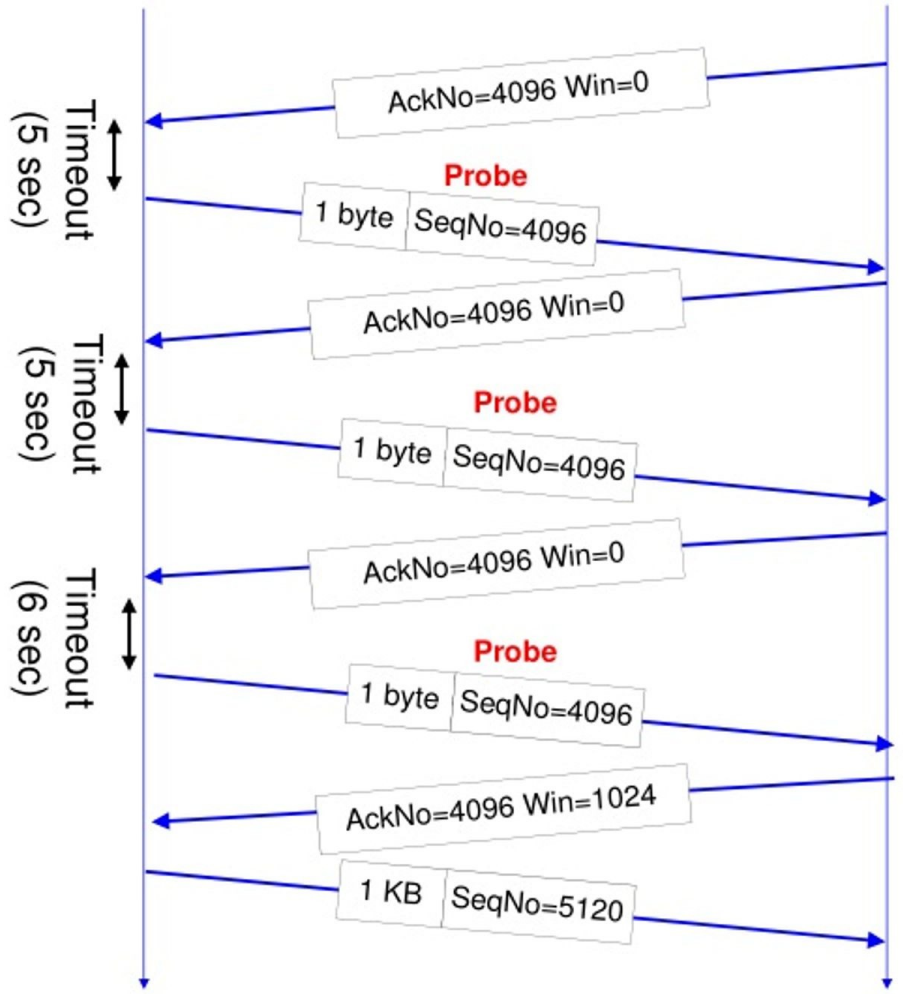
TCP Persist Timer



TCP Persist Timer



TCP Persist Timer



TCP Keepalive Timer

- When a TCP connection has been idle for a long time (1 min – 2 hours), a **Keepalive timer** reminds a station to check if the other side is still there.
- A segment wihtout data is sent if the connection has been idle for 2 hours
- Assume a probe has been sent from **A** to **B**:

(1) **B** is up and running:	**B** responds with an ACK
(2) **B** has crashed and is down:	**A** will send 10 more probes, each 75 seconds apart. If **A** does not get a response, it will close the connection
(3) **B** has rebooted:	**B** will send a RST segment
(4) **B** is up, but unreachable:	Looks to **A** the same as (2)

Background on ARQ Error Control

All retransmission schemes use all or a subset of the following procedures:

- Positive acknowledgments (**ACK**)
- Negative acknowledgment (**NACK**)
- All retransmission schemes (using ACK, NACK or both) rely on the use of **timers**

The most common ARQ retransmission schemes are:

Stop-and-Wait ARQ
Go-Back-N ARQ
Selective Repeat ARQ

Error Control in TCP

- Retransmission scheme in TCP
  - Mainly a variation of Go-back-N ARQ
  - Mainly uses ACKs
- **But:**
  - Duplicate Acks (see congestion control) serve as NACK
  - Selective Repeat is allowed as an option

Selective Acknowledgements (optional)

- **Selective acknowledgments (SACK):** The receiver can acknowledge non-continuous blocks of data

- SACK is an optional feature
  - Negotiated during setup
  - SACKs are sent in options of TCP header
  - SACK is sent when an ACK does not include the last received sequence number