TCP Examples

Timing Diagrams
TCP “Iceberg Analogy”

Application View
- Connect
- Bind/Listen/Accept
- Read/Write
- Close

Transport Protocol View
- Attributes
  - Reliable Delivery
  - In-order Delivery
  - Flow Control
  - Congestion Control
- Mechanisms:
  - 3-way handshake - ISN
  - Sequence Numbers
  - ARQ: Automatic Repeat Request
  - Retransmission Timeout
  - Timeout Calculation
  - Receiver Window Size
  - Sliding Window
  - Fast Retransmission
  - Tear-Down
  (Congestion Control & others discussed later)
Case 1:
window size = 4
all ok
Packet Loss
How & When to Retransmit

- **RTO (Retransmission Timeout)**
  - Each packet sent gets a timeout
  - If the timeout expires, resend that packet

- **Cumulative ACK**

- **Fast Retransmit**
  - Resend the packet after 3 duplicate ACKs
  - Does NOT replace timeouts, just enhances the capability
  - Needs lots of packets in flight (window size) to be effective
**Case 2:**
- window size = 2
- packet 1 gets lost

RTO drives retransmission

Diagram:
- Packet 0
- Packet 1
- Packet 2
- Ack 0
- Ack 1
- Packet 1 again
- Packet 2 again
- Timeout
- Sender
- Receiver
- discard
**Case 3:**
- Window size = 4
- Packet 2 gets lost

Sender:
- Packet 0
- Packet 1
- Packet 2
- Packet 3
- Packet 4
- Packet 5

Receiver:
- Ack 0
- Ack 1
- Ack 1
- Ack 1
- Ack 1

1\textsuperscript{st} dup ACK
2\textsuperscript{nd} dup ACK
3\textsuperscript{rd} dup ACK

Retransmit Packet 2

Ack 5