Internet Checksum Example

- Note
  - When adding numbers, a carryout from the most significant bit needs to be added to the result
- Example: add two 16-bit integers

```
  1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0
  1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1
  __________________________
  1 0 1 1 1 0 1 1 1 0 1 1 1 0 1 1
```

- Sum
- Checksum

```
  1 0 1 1 1 0 1 1 0 1 1 0 0 1 1 0
  1 0 0 1 0 0 1 0 1 0 0 1 0 0 0 1
  __________________________
  1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0
```

Stop-and-wait

- Sender: seq # in pkt header
- "window" of up to N, consecutive unack'ed packets allowed
- ACK(n): ACKs all packets up to, including seq # n - "cumulative ACK"
  - may receive duplicate ACKs
- Timer for each in-flight packets
- Timeout(n): retransmit packets n and all higher seq # packets in window

Go-Back-N

- Sender: seq # in pkt header
- "window" of up to N, consecutive unack'ed packets allowed
- ACK(n): ACKs all packets up to, including seq # n - "cumulative ACK"
  - may receive duplicate ACKs
- Timer for each in-flight packets
- Timeout(n): retransmit packets n and all higher seq # packets in window

Selective repeat: sender, receiver windows
Selective repeat

TCP seq. #'s and ACKs
Seq. #'s:
- byte stream "number" of first byte in segment's data
ACKs:
- seq # of next byte expected from other side
- cumulative ACK
Q: how receiver handles out-of-order segments
A: TCP spec doesn't say, up to implementor

Retransmissions

RTT estimation: