Internet Engineering

241-461

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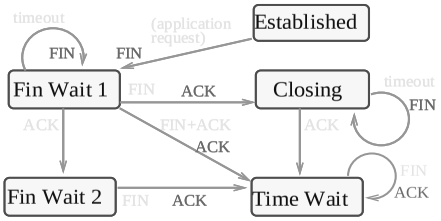
TIME WAIT

- Why TIME WAIT ?



  - Everything has happened?
  - But that is at our system
    - What do we know about other system?
- Other system
  - Received our FIN - ACKnowledged it
  - Sent its own FIN - We ACKnowledged it
    - Did that ACK arrive?
    - How do we know?

TIME WAIT (2)

- Another issue
  - Packets can be delayed
  - Held in network - At a router usually
  - Sometimes for a long time
    - Long by comparison with normal packets
  - What happens if they arrive
    - After connection is CLOSED ?
- In CLOSED state we can open a new connection
  - Same "connection" being used for new purpose
  - Old data might be confused with new data ...
    - Sequence number & window help
    - But are not a guarantee
- TIME WAIT handles this
  - Connection not CLOSED
    - So cannot be re-opened
  - Wait in TIME WAIT long enough for old packets to die

Defining TCP

- Needs
  - Addressing
    - Src & Destination
  - Sequence Numbers
  - Acknowledge received data
  - Inform window size
  - Transmit Segments
    - Data accuracy protection
  - Magic Data
    - SYN & FIN
  - Segment maximum lifetime

Addressing

- Each Connection
  - My Network Address
  - My Port Number
  - Peer Network Address
  - Peer Port Number
- Network Addresses
  - Belong to Network Layer
    - Let Network layer handle those
- Port Numbers
  - Responsibility of Transport Protocol
  - TCP needs to handle them

Addressing (2)

- My vs Peer
  - One segment
  - Exists in Network
    - What is My ?
- Each segment is from one TCP to another
  - Source & Destination
- Each TCP segment needs
  - Source Port Identifier
  - Destination Port Identifier

Information Encoding

- Text vs Binary
  - Human vs Computer
- TCP uses BINARY
  - More efficient
    - Network bandwidth
    - Processing costs
- Binary encoding issues
  - Not all computers the same
  - Bigger problem in the past
    - Still exists today

Port Identifiers

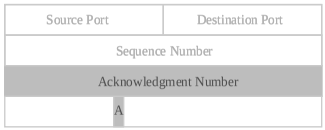
- Identifier just a number
  - An integer
  - 16 bits
    - convenient size
    - big enough
    - not too big
- TCP Header (so far)

Sequence Number

- 32 bit number
  - Needed in every segment

Acknowledgment

- 32 bit number
  - Sequence next expected
  - So must have same value range as SEQ



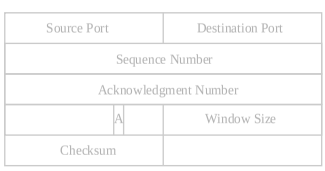
- But not in every segment
  - Cannot send ACK before receiving SEQ
- So, just in most segments

Window Size

- 16 bit number
  - Return to size of window size later
- In every segment

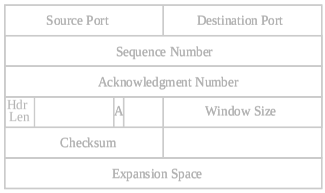
Data Reliability

- Checksum
  - Verifies data unmodified
  - Accidental modifications
    - not deliberate attacks



Future Expansion

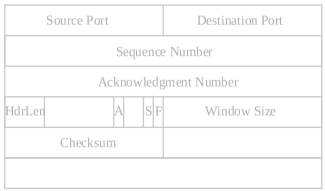
- Protocol might need revision
  - Or data not in every segment
- Add room for expansion
  - Or optional data



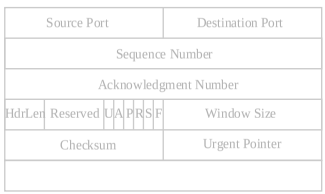
- But how big is this?
  - Need size field

Magic Data

- Need to be able to send
  - SYN
  - FIN
- Those are data
  - but not normal data
- Only ever once in a segment (each)
  - Exist or do not exist

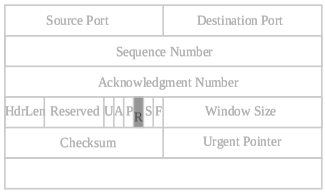


Complete TCP Header



- Sent with every segment
  - Contains some data not examined yet

TCP Header



- ... Contains some data not examined yet

◇ Reset
- The TCP error message
- Sent whenever TCP error occurs
  - Segment in invalid state
  - NOT missing packet
  - NOT out of order packet
  - NOT duplicate packet

TCP Timeouts

◇ Recall ...
- retransmit
- after timeout

◇ How long?
- 1 second ?
- 2 seconds ?
- 3 seconds ?
- Long enough
  - no unnecessary retransmit
- Short enough
  - avoid delays

◇ Time to wait varies
- Different peers (near or distant)
- Different network state (idle or congested)

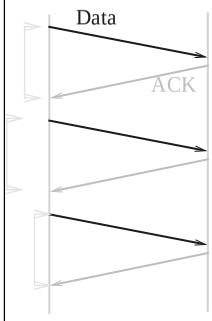
◇ Measure Round Trip Time

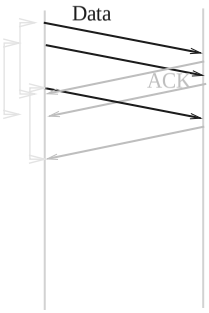
Round Trip Time Estimation

◇ Useful to know when to retransmit
- if have not received ACK within the RTT
  - (plus a bit)
  - then assume packet lost

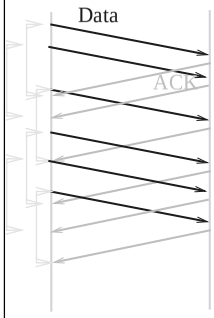
◇ But how to measure the RTT?
- Measure delay between packet and its ACK
  - easy
- But
  - Send packet
    - wait ... wait ... wait (nothing)
  - Retransmit packet
  - ACK arrives
- Which packet was acknowledged?
  - The initial packet
    - acknowledged slower than expected
  - Or the retransmit?

TCP RTT Measurement





TCP RTT Measurement (2)



TCP RTT Measurement (3)