Week 8: Transport Layer Contd

Internet Technologies COMP90007

Lecturer: Tom Drummond

Semester 2, 2021

UDP

- Provides a protocol whereby **applications can transmit encapsulated IP datagrams without a connection establishment**
- UDP transmits in segments consisting of an **8-byte header follow**
- UDP **headers contain sourc ination ports**
- Payload is handed to the process which is attached to the particular port at destination

UDP Contd.

- Main advantage of using UDP over raw IP is:
  - the ability to specify ports for source and destination pairs, i.e., **addressing for processes**

- Both source and - destination allows for incoming seg r outgoing segments

Structure of UDP header: It has ports (TSAPs), length and checksum

Strengths and Weaknesses of UDP

- Strengths: provides an IP interface with multiplexing/de-multiplexing capabilities and related transmission efficiencies
- Weaknesses: pport for flow control, error c bad segments
- Conclusion: where applicatio precise level of control over packet flow/error/timing, UDP is a good choice as application layer can make choices
- **Domain Name System over the Internet is a famous user of UDP**

Another one with UDP: Remote Procedure Call (RPC)

- Sending a message and getting a reply back is analogou ion call in programmin
- Birrell and Nelson modi o allow programs to call procedures on remote hosts using UDP
  - Remote Procedure Call (RPC)

Remote Procedure Call (RPC)

- To call a remote procedure, the client is bound to a small library (the client stub) that represents the server procedure in the client's addr
- Similarly the server is b a procedure called the server stub.
- These **stubs hide the fact that the procedure itself is not local**.

RPC Illustrated

Transmission Control Protocol (TCP)

- Provides a protocol by which applications can transmit IP datagrams within a **connection-oriented** framework, thus increasing reliability
- TCP transport entity manages TCP streams and interfaces to the IP layer - can exist i , library, user process)
- **TCP entity** accepts user data strea **ments them into pieces < 64KB** (often at a size in o he IP and TCP headers can fit into a single Ethernet frame), and sends each piece as a separate IP datagram
- Recipient TCP entities reconstruct the original byte streams from the encapsulation

The TCP Service Model

- Sender and receiver both create **sockets**, consisting of the IP address of the host and a port number, as we saw earlier
- For TCP Ser **connections must be ex between a socket at a sending ho** t, src-port) and a socket at a receiving host (dest-host, dest-port)
- Special one-way server sockets may be used for multiple connections simultaneously

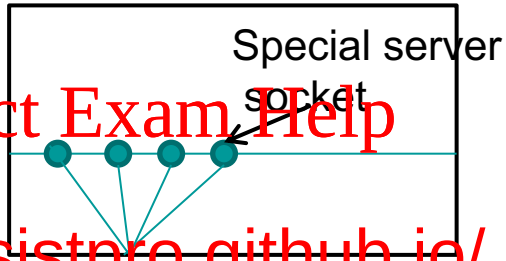
Example

Port Allocations

- Recall TSAPs
- Port numbers can range from 0-65535
- Port numbers are regulated by IANA (http://www.iana.org/assignments/port-numbers)
- Ports are classified into 3 segments:
  - Well Known Ports (0-1023)
  - Registered Ports (1024-49151)
  - Dynamic Ports (49152-65535)

Socket Library - Multiplexing

- Socket library provides a multiplexing tool on top of TSAPs to allow servers to service multiple clients
- It **simulates** the server using a different port to connect back to the client



Features of TCP Connections

- TCP connections are:
- Full duplex - data in both directions simultaneously
- Point to point - exact pairs of senders and receivers
- Byte streams, message boundaries are
- Buffer options - TCP entity can buffer prior to sending or not depending on the context
  - **TCP_NODELAY in Java**
  - **Socket.setTcpNoDelay(boolean)**

TCP Contd

- Data sent between TCP entities in segments - segment has a **20 byte header plus zero or more data bytes**

- TCP entities decide how large segments should be mainly with 2 c
  - **65,515 byte IP p**
  - **Ethernet unit size - generally 150**

- Sliding window - **sender transmits and starts a timer**
- Receiver sends back an acknowledgement which is the next sequence number expected - if sender's timer expires before acknowledgement, then the sender **transmits the original segment again**

The TCP Segment Header

- TCP header includes addressing (ports), sliding window (seq. / ack. number), flow control (window), error control (checksum) and more

The TCP Segment Header

- ***Source port*** **and** ***Destination port*** fields identify the local end points of the connection
- ***Sequence number and Acknowledgement number*** fields perform their usual functions
- ***TCP header*** length tells how many 32-bit words are contained in the TCP header
- ***Window size*** field tells how many bytes may be sent starting at the byte acknowledged
- ***Checksum*** is also provided for extra reliability. It checksums the header, the data
- ***Options*** field provides a way to add extra facilities not covered by the regular header
- ***URG*** is set to 1 if the *Urgent pointer* is in use. The Urgent pointer is used to indicate a byte offset from the current sequence number at which urgent data are to be found

The TCP Segment Header

- ***CWR*** and ***ECE*** are used to signal congestion when *ECN* (Explicit Congestion Notification) is used
- ***ECE*** is set to signal an ECN-Echo to a TCP sender to tell it to slow down when the TCP receiver gets a congestion indication from the network
- ***CWR*** is set to sig uced from the TCP sender to the TC e sender has slowed down and can stop sending the EC
- The ***ACK*** bit is set to 1 to indicate t wledgement number is valid. This is the case for nearly all packets. 0 means ignore ACK number field
- ***PSH*** bit indicates PUSHed data. The receiver is hereby kindly requested to deliver the data to the application upon arrival and not buffer it until a full buffer has been received

The TCP Segment Header

- The ***RST*** bit is used to abruptly reset a connection that has become confused due to a host crash or some other reason. It is also used to reject an invalid segment or refuse an attempt to open a connection
- The ***SYN*** bit is used to establish connections. The connection request has SYN an acknowledgem ction reply does bear CK = 1.
- In essence, the SYN bit is used to **CONNECTION REQUEST and CONNECTION AC** sh the ACK bit used to distinguish between those two p
- The ***FIN*** bit is used to release a connection. It specifies that the sender has no more data to transmit. However, after closing a connection, the closing process may continue to receive data.

TCP Connection Establishment and Release

- Connections established using three-way handshake
- Two **simultaneous connection attempts results in o** (uniquely identified by
- Connections released wi **tric release**
- Timers used for lost connection releases

TCP Connection Management – Full Set of States

- The full TCP connection finite state machine has more states than the simple example from earlier.

TCP Transition Diagram

TCP Transmission Policy

- TCP acknowledges bytes
- Receiver advertises window based on available buffer space