TCP and UDP headers

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Question 1:
How many bytes is UDP headers? what are the different field? how are those field values set?

Solution:
The User Datagram Protocol (UDP) header is 8 bytes (64 bits) in size. The UDP header consists of the following fields:

- **Source Port (16 bits)**: This field specifies the port number of the sending device. It is optional in some cases; if not used, it is set to 0.
- **Destination Port (16 bits)**: This field specifies the port number of the receiving device.
- **Length (16 bits)**: This field specifies the length of the UDP header and the encapsulated data in bytes. The minimum value is 8 (header length) and the maximum value is 65,535.
- **Checksum (16 bits)**: This field is used for error-checking of the header and data. It is optional in IPv4 but mandatory in IPv6. If not used, it is set to 0 in IPv4.

How these field are set?

- **Source Port**:
  Set by the sender to identify the sending application.
  If the sender does not require a response, it can be set to 0.
- **Destination Port**:
  Set by the sender to indicate the receiving application on the target host.

This value must correspond to the port number of the application/service on the receiving device.

- **Length**:
  Calculated by the sender and includes the length of the UDP header and the length of the data payload.
  The value is set to the total number of bytes in the UDP packet (header + data).
- **Checksum**:
  Calculated by the sender to cover the UDP header, the data, and a pseudo-header. The pseudo-header includes parts of the IP header, ensuring the integrity of the data as it travels across the network.
  If the checksum calculation is not used (allowed in IPv4), it is set to 0.

Question 2:
How many bytes is TCP headers? what are the different field? how are those field values set?

Solution:
The Transmission Control Protocol (TCP) header typically has a minimum size of 20 bytes (160 bits). However, it can be longer if options are included, with the maximum header size being 60 bytes.
The standard fields in a TCP header are as follows:

- **Source Port (16 bits)**: The port number of the sending application.
- **Destination Port (16 bits)**: The port number of the receiving application.
- **Sequence Number (32 bits)**: The sequence number of the first byte of data in this segment. It is used for ordering data segments. It indicates how much data is sent during the TCP session.
- **Acknowledgment Number (32 bits)**: If the ACK flag is set, this field contains the value of the next sequence number that the sender of the segment is expecting to receive.
- **Data Offset (4 bits)**: Specifies the size of the TCP header in 32-bit words. This value is necessary because the size of the options field can vary.
- **Reserved (3 bits)**: Reserved for future use and should be set to zero.
- **Flags (9 bits)**: we also call them control bits. We use them to establish connections, send data and terminate connections. It contains 9 control flags (NS, CWR, ECE, URG, ACK, PSH, RST, SYN, FIN) that manage the state of the connection.
- **Window Size (16 bits)**: Specifies the size of the sender's receive window (buffer space) that is available.

- **Checksum (16 bits)**: Used for error-checking the header and data.
- **Urgent Pointer (16 bits)**: If the URG flag is set, this field is an offset from the sequence number indicating the last urgent data byte.
- **Options (variable, multiple of 32 bits)**: Optional field for various options such as maximum segment size, timestamps, etc.
- **Padding (variable)**: Added to ensure the TCP header is a multiple of 32 bits.

How these values set?

1. **Source Port**:
    - Set by the sender to identify the sending application.
2. **Destination Port**:
    - Set by the sender to identify the receiving application on the target host.
3. **Sequence Number**:
    - Set by the sender to indicate the byte stream position of the first byte in this segment.
    - Initial sequence numbers are often randomized for security reasons.
4. **Acknowledgment Number**:
    - Set by the receiver to indicate the next byte expected from the sender.
5. **Data Offset**:
    - Indicates where the data begins in the segment.
6. **Reserved**:
    - Set to zero by the sender; ignored by the receiver.
7. **Flags**:
    - URG (1 bit): Indicates urgent pointer field is significant.
    - ACK (1 bit): Indicates acknowledgment field is significant.
    - PSH (1 bit): Push function.
    - RST (1 bit): Reset the connection.
    - SYN (1 bit): Synchronize sequence numbers (used in connection establishment).
    - FIN (1 bit): No more data from sender.
    - NS (1 bit): ECN-nonce - concealment protection.
    - CWR (1 bit): Congestion Window Reduced flag.
    - ECE (1 bit): ECN-Echo flag.
8. **Window Size**:

- Set by the sender to indicate the amount of data the sender is willing to accept.

9. **Checksum**:
   - Calculated by the sender to cover the TCP header, the data, and a pseudo-header.
10. **Urgent Pointer**:
    - If URG flag is set, this field is an offset indicating the last urgent data byte.
11. **Options**:
    - Used for various options and settings; padded to ensure the header length is a multiple of 32 bits.