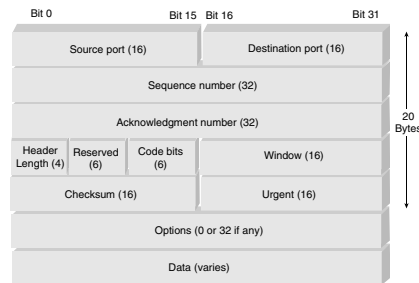


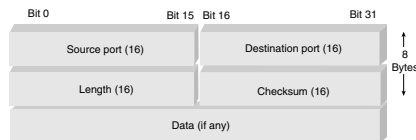
- **Application layer**—Specifications exist for e-mail, file transfer, remote login, and other applications. Network management is also supported.
- **Transport layer**—Transport services allow multiple upper-layer applications to use the same data stream. TCP and UDP protocols at this layer provide the following functions:
  - Flow control (through windowing)
  - Reliability (through sequence numbers and acknowledgments)
- **Internet layer**—Several protocols operate at the TCP/IP Internet layer:
  - IP provides connectionless, best-effort routing of datagrams.
  - ICMP provides control and messaging capabilities.
  - ARP determines the data link layer address for known IP addresses.
  - RARP determines network addresses when data link layer addresses are known.



## TCP

TCP is a connection-oriented, reliable protocol that breaks messages into segments and reassembles them at the destination station (resending anything not received). TCP also provides a virtual circuit between applications.

## UDP



UDP is a connectionless, unreliable protocol used for applications that provide their own error recovery process. It trades reliability for speed. UDP is simple and efficient but unreliable. UDP does not check for segment delivery.

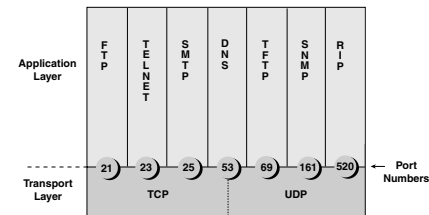
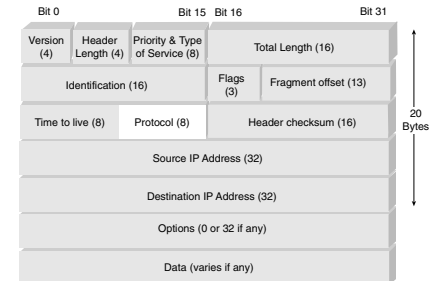
## Connection-Oriented Services

A connection-oriented service establishes and maintains a connection during a transmission. The service first establishes a connection and then sends data. After the data transfer is complete, the session is torn down.

## Port Numbers

Both TCP and UDP can send data from multiple upper-layer applications on the same datagram. Port (or socket) numbers are used to keep track of different conversations

crossing the network at any given time. Well-known port numbers are controlled by the Internet Assigned Numbers Authority (IANA). For example, Telnet is always defined by port 23. Applications that do not use well-known port numbers have them randomly assigned from a specific range.



## Port Number Ranges

- Numbers below 1024 are considered well-known ports.
- Numbers above 1024 are dynamically assigned ports.
- Vendor-specific applications have reserved ports (usually above 1024).