Network architecture
  - Layering
    - Network functionality is partitioned into N layers
    - Layer n offers services to layer n+1 and uses services of layer n-1
    - Hardware in bottom layer (i.e., the physical layer), applications in top layer (i.e., the application layer)
  - Why layering?
    - Decomposes the complex problem of building a network into more manageable components
    - Easy to add a new service in a layer: can reuse services at the lower layers
  - Protocols
    - Each layer contains a set of protocols.
    - A protocol provides a communication service that higher-layer objects (i.e., applications processes and higher-layer protocols) use to exchange messages.
    - A protocol defines two interfaces
      - The service interface defines the operations that higher-layer objects can perform on the protocol
      - The peer interface defines the format and the meaning of messages exchanged between protocol peers to implement the communication service
  - Message transfer between protocol peers
    - Encapsulation at sending side: Sender encapsulates upper layer’s message by attaching a header, which contains control information
- Decapsulation at receiving side: Receiver interprets the header and passes the body of the message to the upper layer

- Example network architectures
  - ISO’s Open Systems Interconnection (OSI) architecture
    - There are 7 layers
    - **Application Layer** contains protocols for network applications, such as FTP for file transfer, SMTP for email, and HTTP for Web
    - **Presentation Layer** provides independence from data representation by translating between application and network formats
    - **Session Layer** provides the mechanism for opening, closing and managing a communication session between application processes
    - **Transport Layer** implements a process-to-process communication channel
    - **Network Layer** handles routing among nodes within a packet-switched network
    - **Data Link Layer** is responsible for reliable frame transfer between adjacent nodes
    - **Physical Layer** handles the transmission of raw bits over a communication link
  - Internet architecture
    - There are 5 layers: no session and presentation layers
      - The session layer functionality is included in the transport layer
      - The presentation layer functionality is included in the application layer
- Key Internet protocols
  - The Internet Protocol (IP) in the Network layer
    - IP supports the interconnection of multiple networking technologies into a single, logical internetwork
  - TCP and UDP in the Transport layer
    - TCP provides a reliable byte-stream channel to application programs
    - UDP provides an unreliable datagram delivery channel to application programs