Module 3
Network Security

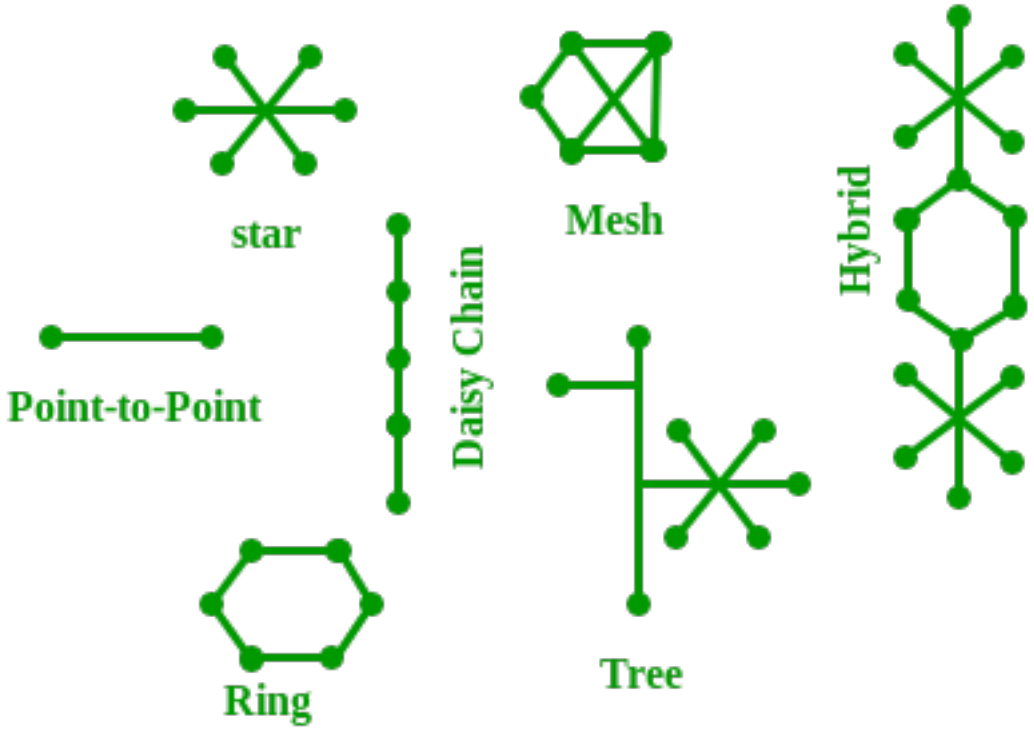
Submodule 1: Networking Basics

Computer Networks

- A computer network consists of two or more computing devices that are connected in order to share the components of your network (its resources) and the information stored.
- The communication between devices is enabled by various networking devices:
  - Router
  - Hub
  - Bridge
  - Switch

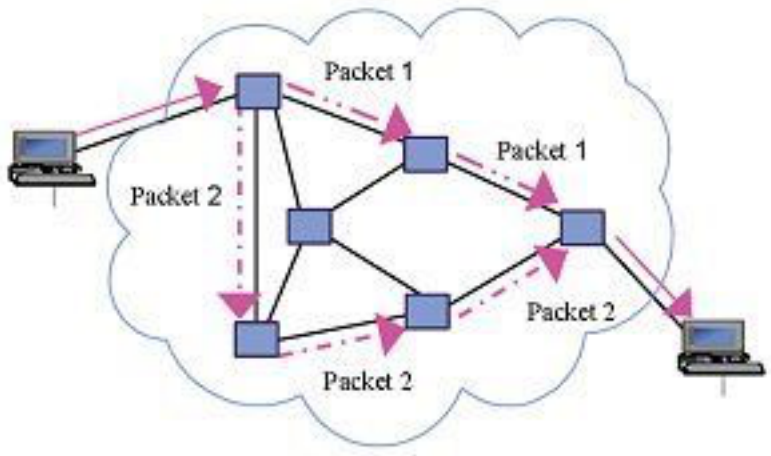
Network Topology

- Network topology defines what layout pattern is used for the devices to be interconnected.



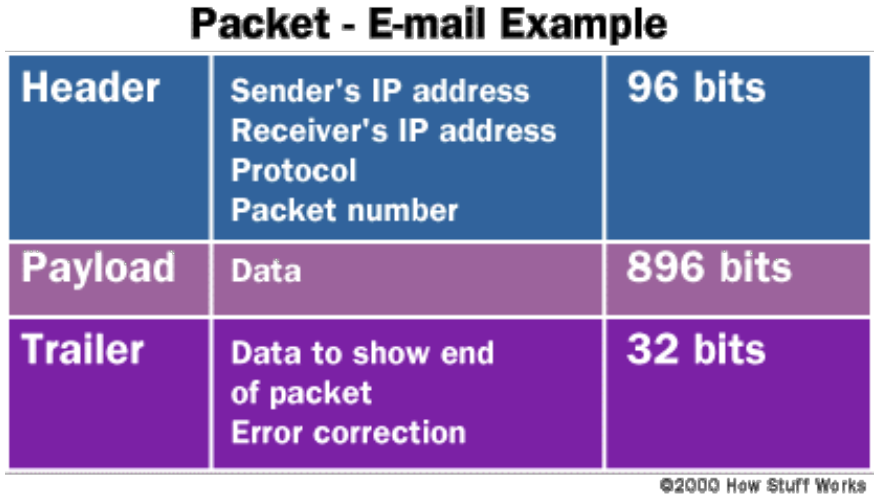
Packet Switching

- Used for the Internet
- Data is split into packets
- Packets are transmitted independently through the network
- Each packet is handled with best effort
- Packets (from the same piece of data) may travel different routes



Inside the Packet

- Each packet is a finite-length set of bits.
- A packet typically consists of:
  - A header: specifies where the packet is going and contains various overhead and bookkeeping details.
  - A payload: the actual information that is to be transmitted.

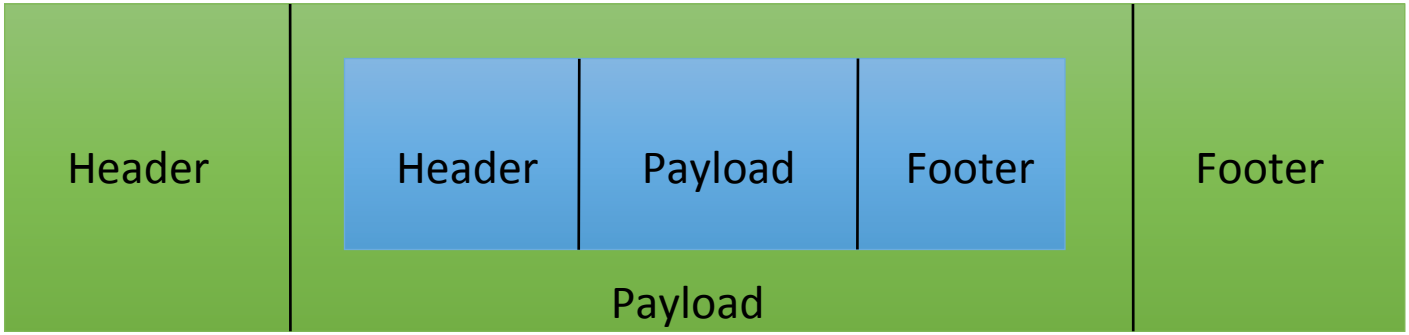


Network Protocols

- A protocol defines the rules for communication between computers.
- Protocols can be broadly classified as:
  - Connectionless protocol
    - Sends data out as soon as there is enough data to be transmitted
    - E.g., user datagram protocol (UDP)
  - Connection-oriented protocol
    - Provides a reliable connection stream between two nodes
    - Consists of set up, transmission, and tear down phases
    - Creates virtual circuit-switched network
    - E.g., transmission control protocol (TCP)

Encapsulation

- The Internet is supported by many different protocols.
  - These protocols need to use services from other protocols.
- Suppose that a network protocol N1 uses services of another network protocol N2:
  - A packet p1 of N1 is encapsulated into a packet p2 of N2
  - The payload of p2 is p1
  - The control information of p2 is derived from that of p1



Internet Protocol Stack-I

- The architecture of the Internet is modeled conceptually as being partitioned into layers, which collectively are called the Internet protocol stack.
  - Each layer provides a set of services and functionality guarantees for higher layers.
  - Higher layers use the services of lower layers via encapsulation.
  - A layer can be implemented in hardware or software
  - The bottommost layer must be in hardware.

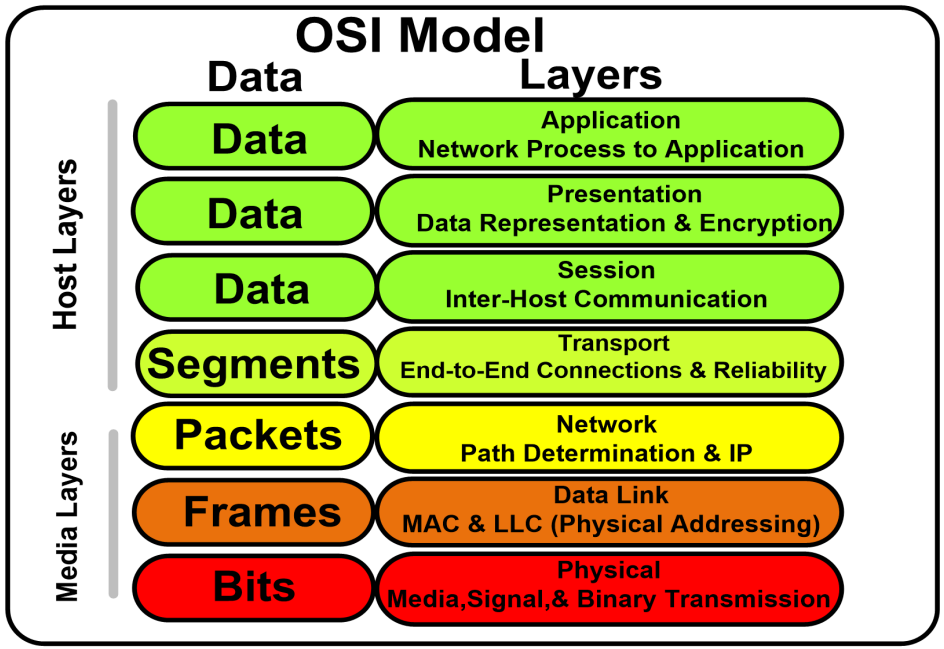
Internet Protocol Stack-II

- A network device may implement several layers
- A communication channel between two nodes is established for each layer
  - Actual channel at the bottom layer
  - Virtual channel at higher layers
- The exact number and names of the layers of the Internet protocols vary, depends on the source of your model.

The OSI Model

- The OSI (Open System Interconnect) Reference Model is a network model consisting of seven layers

- Created in 1983, OSI is promoted by the International Standard Organization (ISO)



Internet Protocol Layers-I

- Here we use five layers as follows:
  - Physical layer
  - Link layer
  - Network layer
  - Transport layer
  - Application layer
- Physical layer:
  - Move the actual bits between nodes
  - Connection is created using various media: copper wires, coaxial cables, optical-fiber cables, or wireless radio

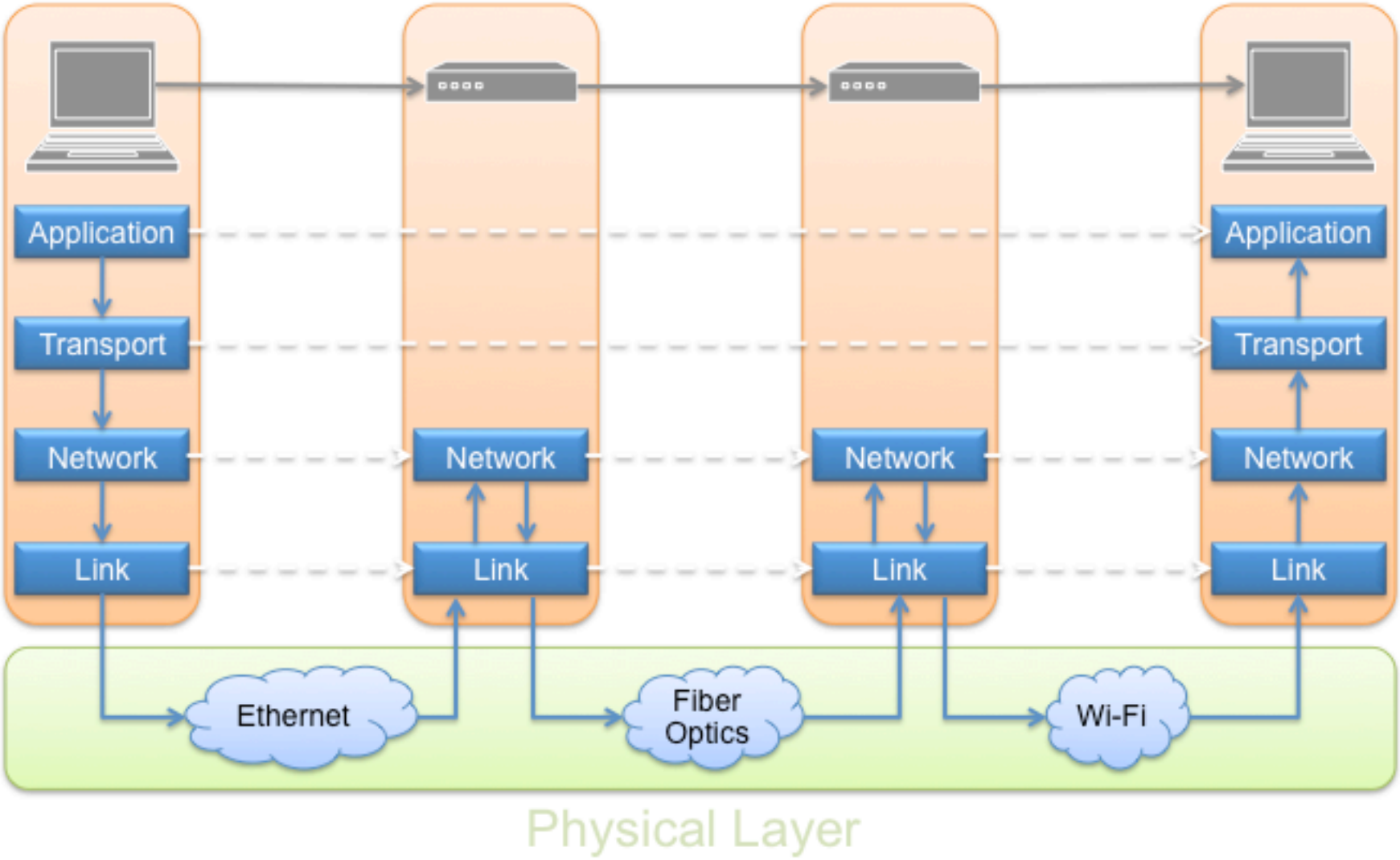
Internet Protocol Layers-II

- Link layer
  - Transfer data between pair of nodes and detect errors occur at the physical layer
  - Uses 48-bit media access control (MAC) addresses
  - Packets called frames—ordered records of bits

- Network layer
  - Also known as the Internet layer, moves packets between two hosts. Internet-wide communication
  - Best efforts—no guarantee of delivery
  - Main protocol used in this layer is Internet Protocol (IP)
  - Use IP address to address each host:
    - 32-bit internet protocol (IP) addresses in IPv4
    - 128-bit IP addresses in IPv6

Internet Protocol Layers-III

- Transport layer
  - Support communication and connections between applications, based on IP addresses and ports.
  - Port is a 16-bit addresses for application-level protocols to use
  - Connection-oriented transmission layer protocol (TCP—transmission control protocol)
  - Connectionless user datagram protocol (UDP—user datagram protocol)
- Application layer
  - Provide protocols to support useful functions on the Internet.
    - HTTP, SMTP, IMAP, SSL—use TCP
    - DNS, VoIP-use UDP


Application
Transport
Network
Link
Network
Link
Network
Link
Application
Transport
Network
Link
Ethernet
Fiber Optics
Wi-Fi
Physical Layer

Internet Packet Encapsulation