Introduction

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Communication

Transferring information over a distance

Human Communications:

- auditory (language, music)
- visual (body language, smoke signals, writing)

Machine Communications:

- Requires a shared symbol set that can be encoded and transmitted as an electromagnetic signal in a medium, received and understood
  - Symbol set: 0/1, Morse Code
  - Encoding: the physical forms of symbols
  - Medium: copper wire, fiber, radio wave

Networking

Facilitating the communications among multiple (potentially a large number of) parties

Solutions

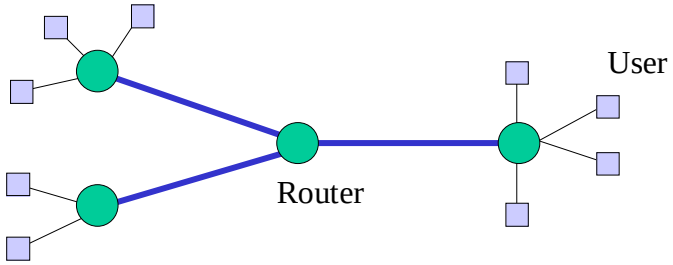
- Complete mesh
  - All users connected back-to-back with one another
  - Infeasible
- Broadcast
- Switching

Broadcast Based Networks

- All users share a broadcast medium, which is used even for one-to-one communications
- Examples: Ethernet,Token ring.
- The main issue is **Medium Access Control (MAC).**
  - When two nodes wish to broadcast at the same time, who gets “right of the road”?
- Scalability problem
  - # of users limited by the bandwidth of the shared medium

Switching

- Uses intermediate nodes, called **switches** or **routers**, to relay messages.
- One main issue is **routing**, the task of finding a path form the source of a message to the destination.



LAN vs WAN

- **Local Area Networks (LANs)**
  - Small Area (e.g., a building)
  - Privately owned media
  - Typically based on broadcast, but switching is emerging (ATM LANs, switched Ethernet)
- **Wide Area Networks (WANs)**
  - Large Area (country or global)
  - Due to large areas and large numbers of users, WANs must use switching technologies.

Standards

- Reasons for networking standards
  - allow different computers to communicate
  - decrease price through economies of scale
- Disadvantages of standards
  - Tend to freeze technology: by the time the standard is developed, reviewed, agreed upon, and distributed, better technologies become available.
  - Often multiple, conflicting standards for the same thing.

Standard Organizations

- ISO (International Organization for Standardization)
  - a voluntary organization that produces standards for "everything" including network protocols.
  - Well known for its OSI networking model.
- ITU (International Telecommunication Union)
  - U.N treaty organization comprising primarily the PPT (Postal, Telegraph, and telephone) authorities of member countries.
  - Example: H.323, the videoconferencing standard used by MS NetMeeting.

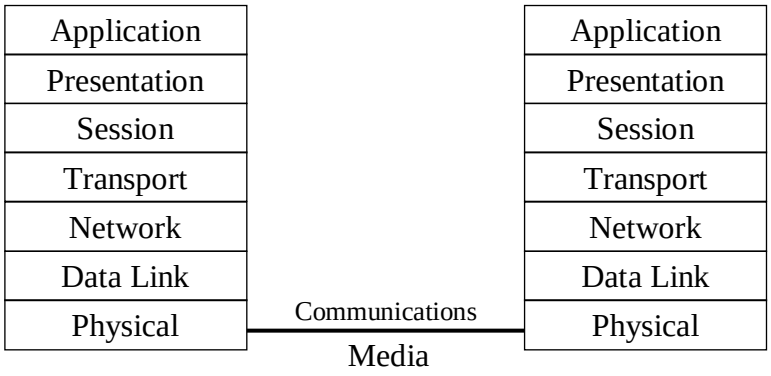
- ANSI (American national Standards Institute)
  - non-profit ,non-governmental organization composed of manufacturers, users and carriers
  - C/C++ languages
- IEEE (Institute of Electrical and Electronic Engineering)
  - professional society and member of ANSI
  - known for standards for LANs
- IEFT (Internet Engineering Task Force)
  - Responsible for the development of Internet protocols

Networking Layers

- Network functions are organized as a series of layers, in order to reduce complexity.
  - Each layer builds upon the one beneath it and provides services to the one above it.
  - Between each layer is an interface.
  - Well-defined layering minimizes information flows across layer boundaries and encourages modulization.

OSI Reference Model

- ISO has defined a seven layer model: **Open Systems Interconnection** (**OSI**) reference model.



Physical and Data Link layers

- **Physical Layer:** Transmit and receive bits on physical media
  - analog and digital transmission
  - a definition of the 0 and 1 bits
  - bit rate (bandwidth)
- **Data Link Layer:** Provide error-free bit streams across physical media
  - Error detection/correction
  - reliability
  - flow control

Network Layer

Controls the operations of the network

- **Routing:** determining the path from the source of a message to its destination
- **Congestion Control:** handling traffic jams
- **Internetworking** of both homogeneous and heterogeneous networks.

Transport Layer

Provides end–to–end (host–to–host) connections

- **Packetization:** cut the messages into smaller chunks (packets)
- An ensuing issue is **ordering**: the receiving end must make sure that the user receives the packets in the right order
- Host–to–host flow control

Upper Layers

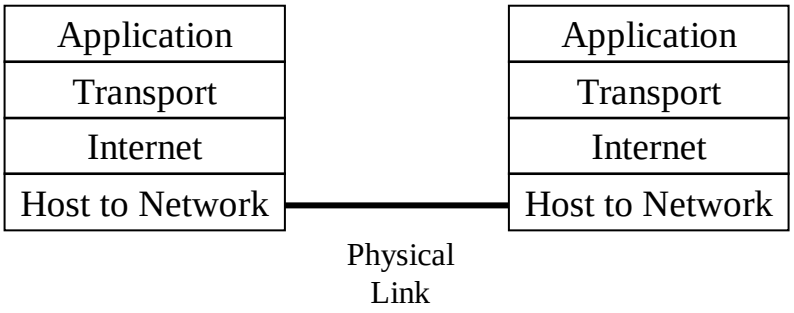
- **Session Layer**
  - user–to–user connection
  - synchronization, checkpoint, and error recovery
- **Presentation Layer**
  - data representation/compression
  - cryptography and authentication
- **Application Layer**
  - file transfer, email, WWW, and so on

Shortcomings of the OSI Model

Just because someone says it is a model/standard does not mean you have to follow it

- All layers do not have the same size and importance
  - session and presentation layers seldom present
  - data link, network, and transport layers often very full
- Little agreement on where to place various features
  - Encryption, network management
- Large number of layers increases overheads

Internet Reference Model



Comparing the Two Models

- There are no presentation and session layers in the Internet model.
- The internet layer is the equivalent of the network layer in the OSI model.
- The physical and data link layers in the OSI model are merged to the “Host to Network” layer.