Network Hardware and Software

Computer network consists of two or more computers that are linked in order to share resources, exchange data files or to allow electronic communication. The computers on a network may be linked through cables, telephone lines, radio waves, satellites or infrared light beams.

There are two aspects of computer networks – **hardware** and **software**.

- **Hardware** includes physical connection between two machines by using adaptors, cables, routers, bridges etc.
- **software** includes a set of protocols. Protocols define a formal language among various components. It makes hardware usable by applications.

Network Hardware- Physical Structures

Classifying Networks by Transmission Technology- **Type of Connection**

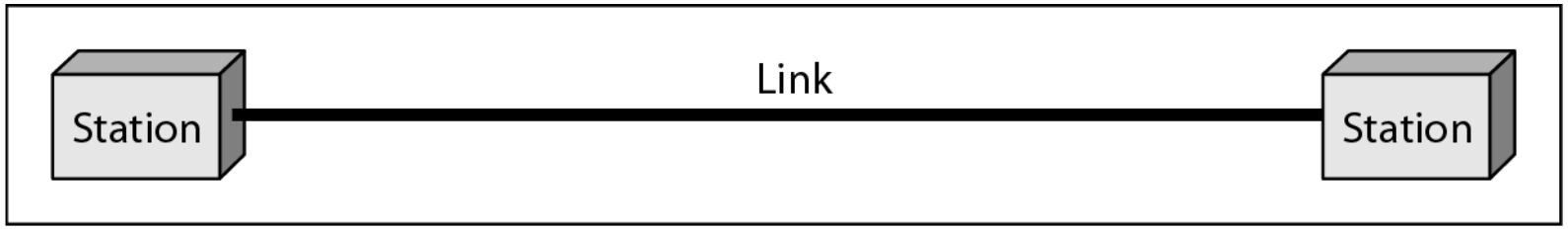
- A network is two or more devices connected through links. A link is a communications pathway that transfers data from one device to another.
- There are two possible types of connections: point-to-point and multipoint.

Point-to-Point

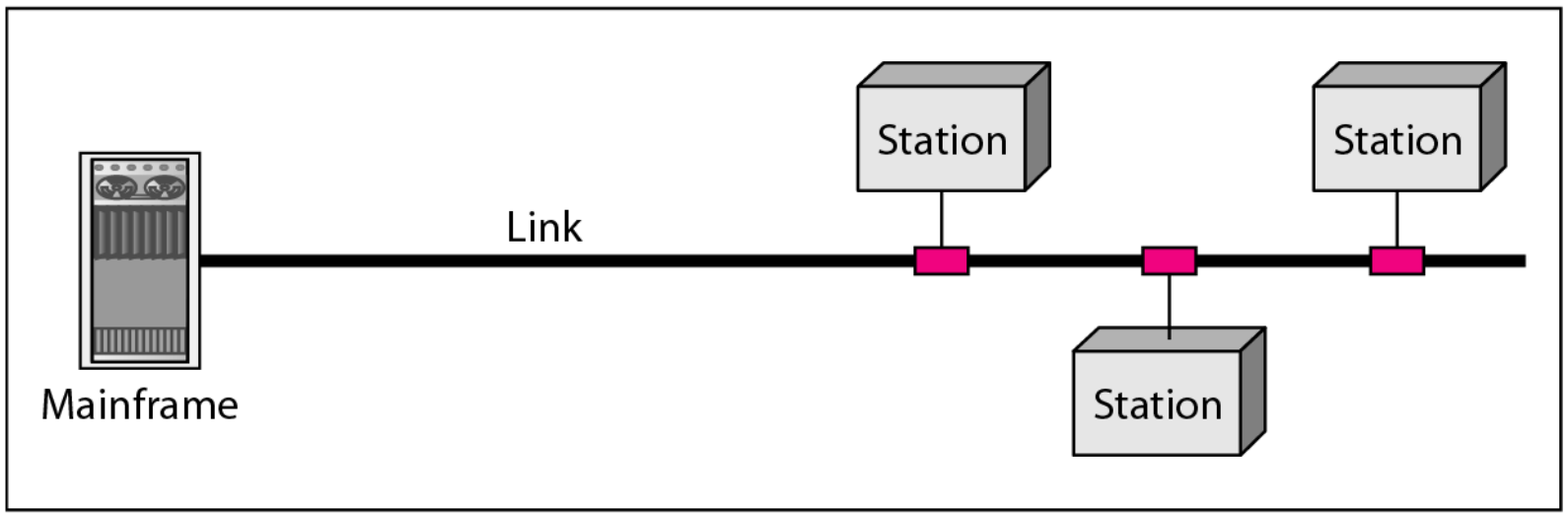
- A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.
- Most point-to-point connections use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible
- When you change television channels by infrared remote control, you are establishing a point-to-point connection between the remote control and the television's control system.

Multipoint

- A multipoint (also called multi-drop) connection is one in which more than two specific devices share a single link
- In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.
- If several devices can use the link simultaneously, it is a *spatially shared* connection. If users must take turns, it is a *timeshared* connection.
- broadcast :: a single communications channel shared by all machines (addresses) on the network.
- multicast :: communications to a specified group.



a. Point-to-point



b. Multipoint

Types of Network based on size

- The types of network are classified based upon the size, the area it covers and its physical architecture. The three primary network categories are LAN, WAN and MAN. Each network differs in their characteristics such as distance, transmission speed, cables and cost.

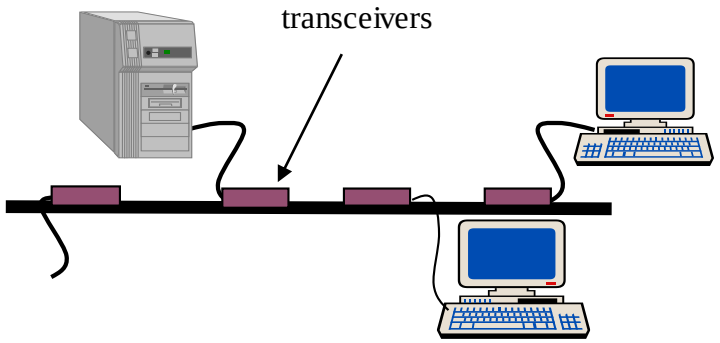
Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Basic types

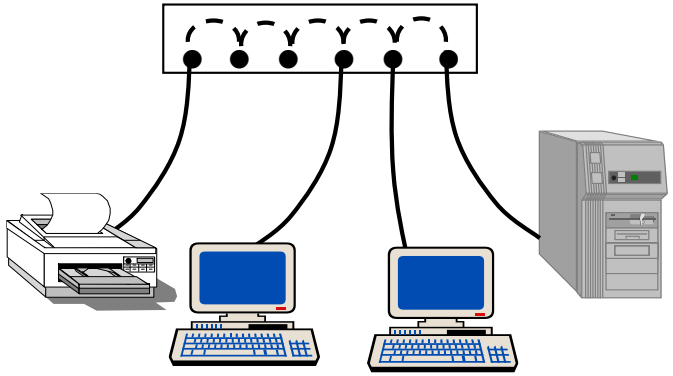
LAN (Local Area Network) – Wired and Wireless LANs

- Group of interconnected computers within a small area. (room, building, campus)
- Two or more pc's can from a LAN to share files, folders, printers, applications and other devices.
- Coaxial or CAT 5 cables are normally used for connections.
- Due to short distances, errors and noise are minimum.
- Data transfer rate is 10 to 100 mbps.
- Example: A computer lab in a college.

Wired LANs



Ethernet bus

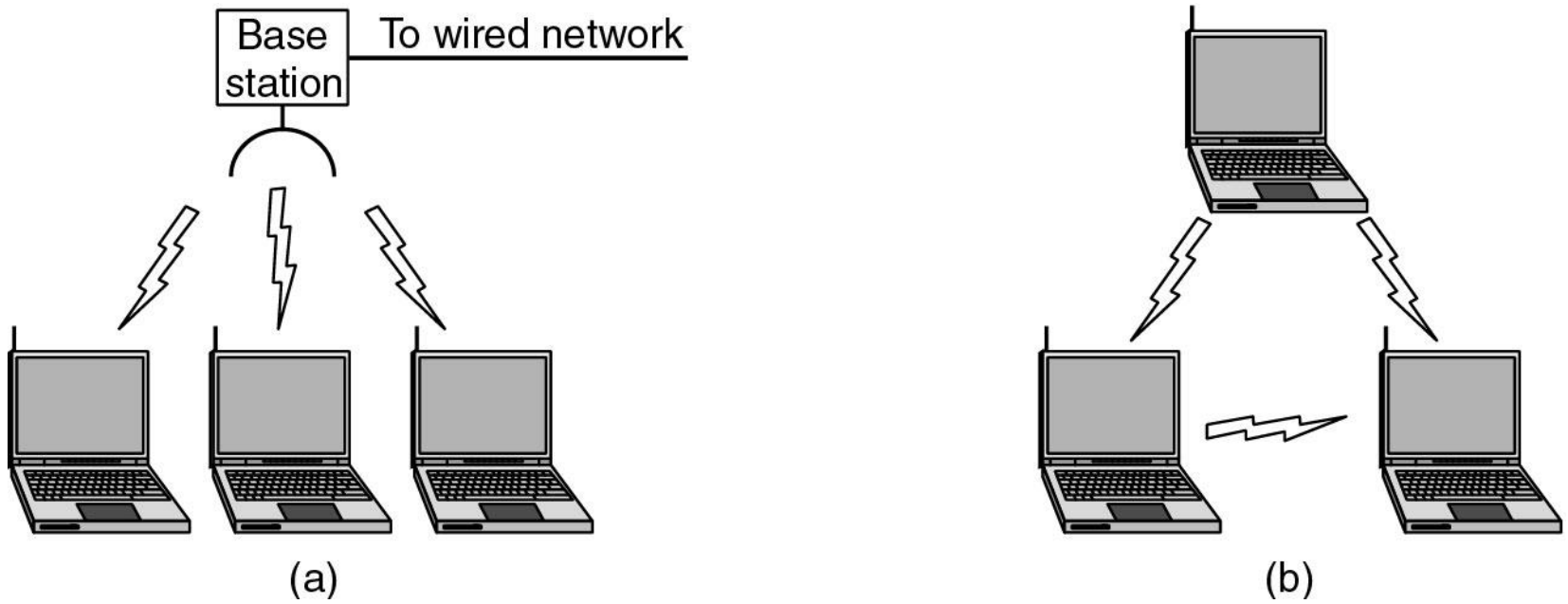


Ethernet hub

Tanenbaum slide

- **WLAN (Wireless LAN)**
  - A LAN that uses high frequency radio waves for communication.
  - Provides short range connectivity with high speed data transmission.

Wireless LANs



(a) Wireless networking with a base station. (b) Ad hoc networking.

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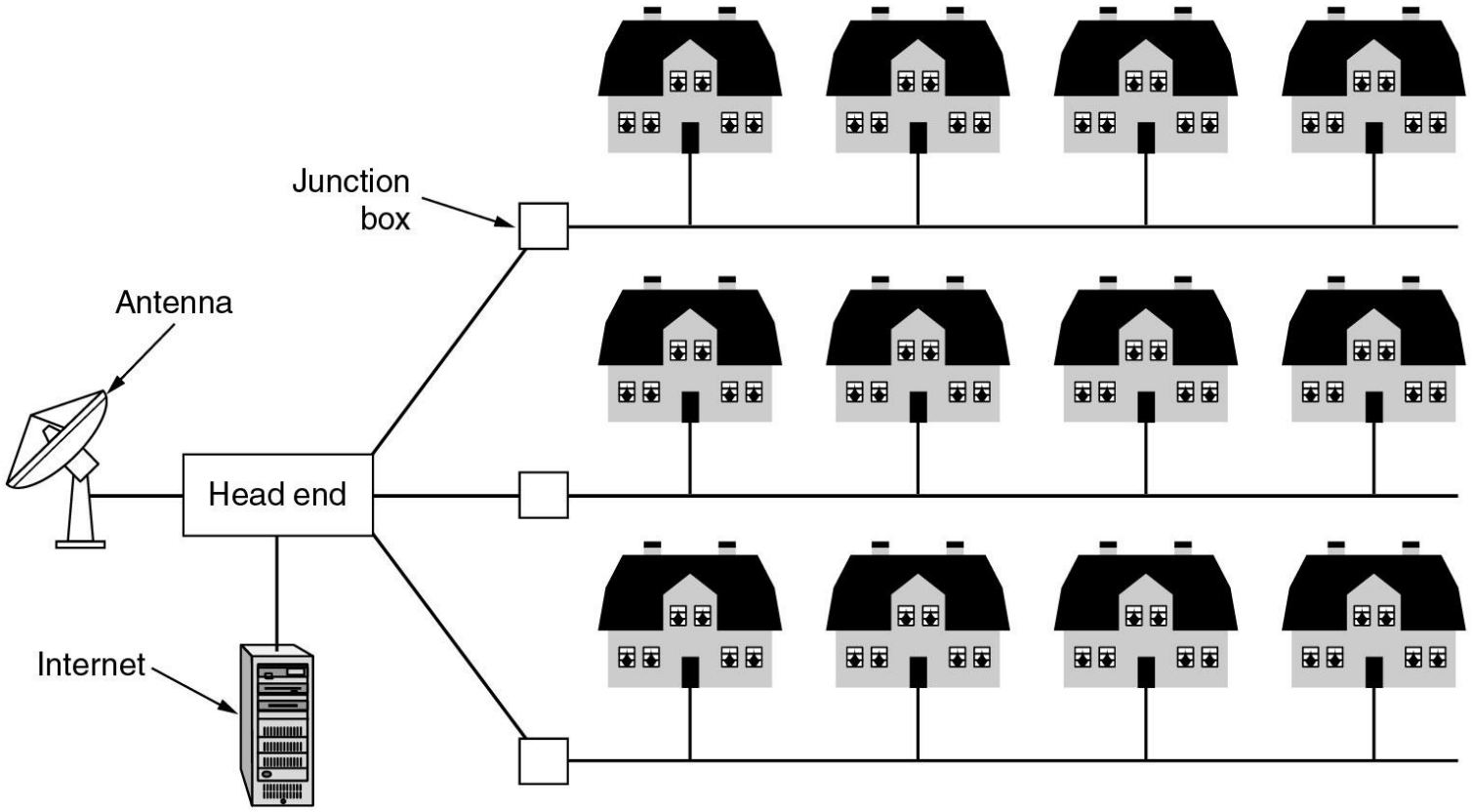
MAN (Metropolitan Area Network)

- Design to extend over a large area.
  - campus networks connecting LANs logically or physically.
  - often have a backbone
- Connecting number of LAN's to form larger network, so that resources can be shared.
- Networks can be up to 5 to 50 km.
- Owned by organization or individual.
- Data transfer rate is low compare to LAN.
- Example: Organization with different branches located in the city.

Metropolitan Area Networks



A metropolitan area network based on cable TV.

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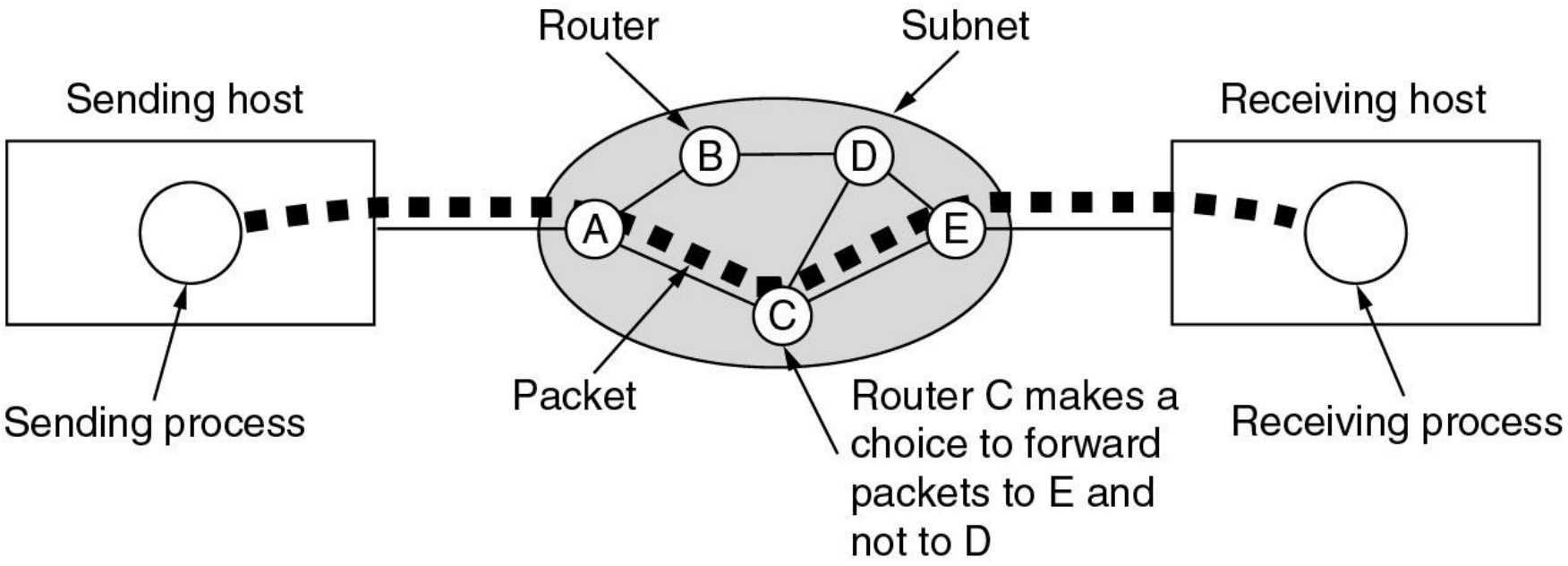
WAN (Wide Area Network)

- country and worldwide network.
- Contains multiple LAN's and MAN's.
- Distinguished in terms of geographical range.
- Uses satellites and microwave relays.
- Data transfer rate depends upon the ISP provider and varies over the location.
- Best example is the internet.

Wide Area Networks (WANs)



A stream of packets from sender to receiver.

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Other types

- **PAN (Personal Area Network)**
  - Network organized by the individual user for its personal use with technologies that communicate over short ranges.
- **SAN (Storage Area Network)**
  - Connects servers to data storage devices via fiber-optic cables.
  - E.g.: Used for daily backup of organization or a mirror copy

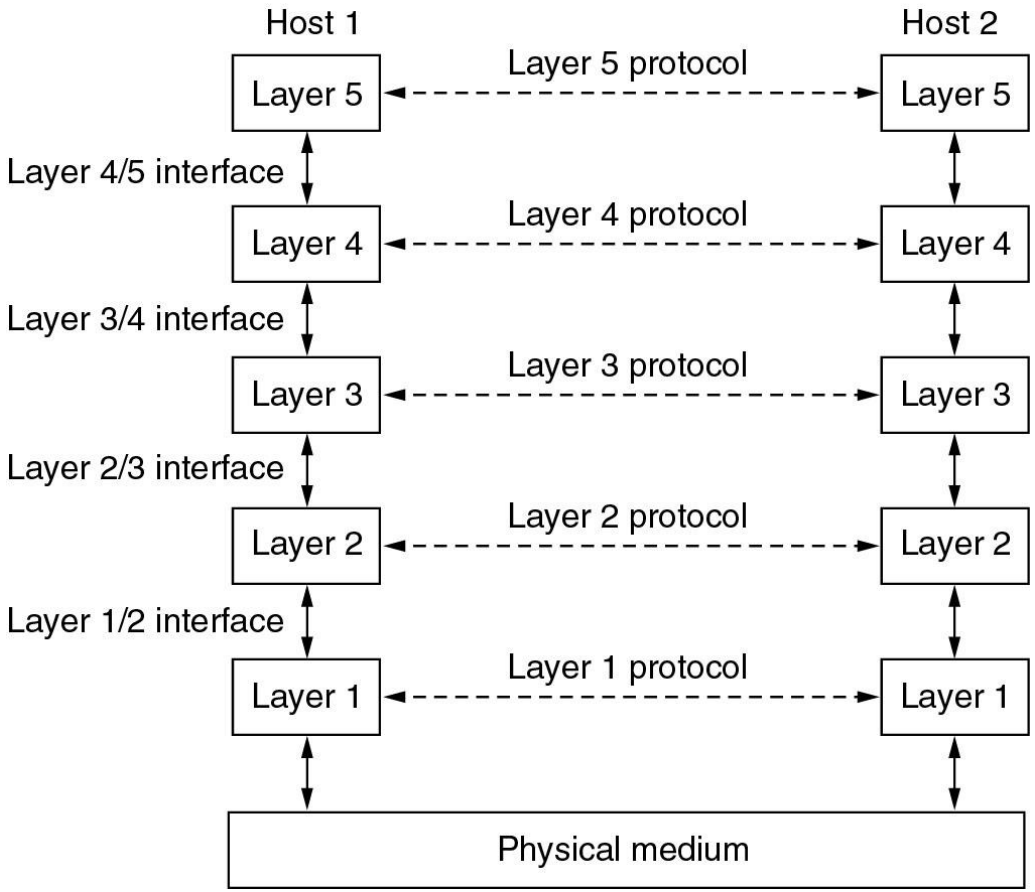
Network Software

- The first computer designed with the hardware as the major concern and the software as an afterthought. This no longer works.
- Network software is now highly structured.
  - Protocol Hierarchies
  - Design Issues for the Layers
  - Connection-Oriented and Connectionless Services
  - Service Primitives
  - The Relationship of Services to Protocols

Protocol Hierarchies

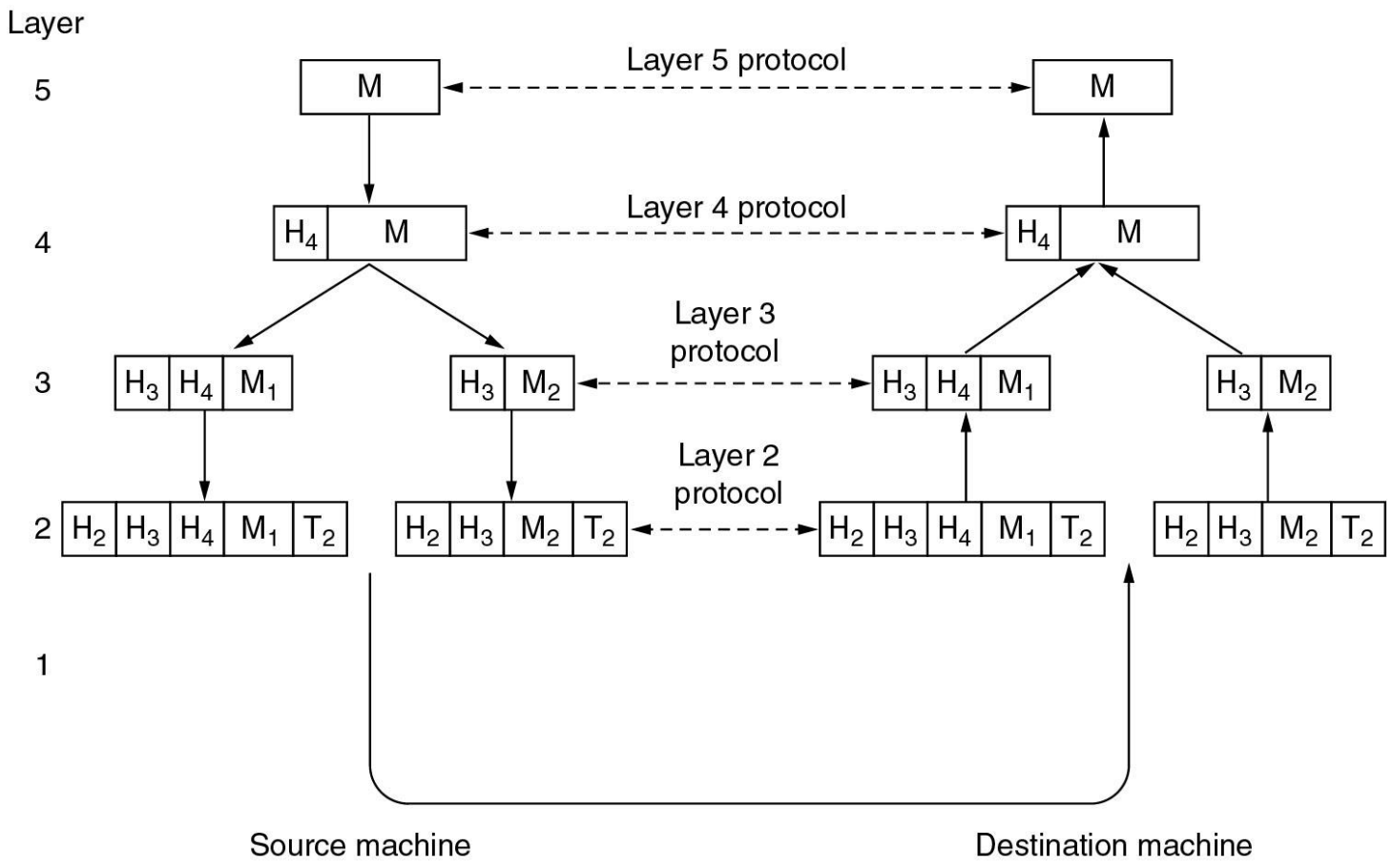
- To reduce the design complexity, most networks are organized as a series of layers or levels. Each one built upon the one below it.
- The number of layers, name of each layer, contents of each layer and the function of each layer differ from network to network.
- Layer *n* on one machine carries on a conversation with layer n on another machine. The rules and conventions used in this conversation are collectively known as the layer n **protocol.**
- Basically, a protocol is an **agreement** between the communicating **peers** on how communication is to proceed.

The layering Principle



- Between each pair of adjacent layers there is an **interface.**
- A set of layers and protocols is called a **network architecture**.
- A list of protocols used by a certain system , one protocol per layer, is called a **protocol stack**.

The layering Principle



Design Issues for the Layers

- Addressing – each layer needs a mechanism for identifying senders and receivers.
- The rules of data transfer – simplex, half-duplex, full duplex
- Error Control – error-correction and error-detection
- Flow Control - The communication channels must preserve the order of messages sent on them – disassembling, transmitting, and then reassembling.
- Multiplexing – inconvenient or expensive to set up a connection for each pair of communication process.
- Routing – multiple paths between source and destination, a route must be chosen

Connection-Oriented vs. Connectionless

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

Service Primitives

- A service is formally specified by a set of primitives (basic operations) available to a user or other entity to access the service.

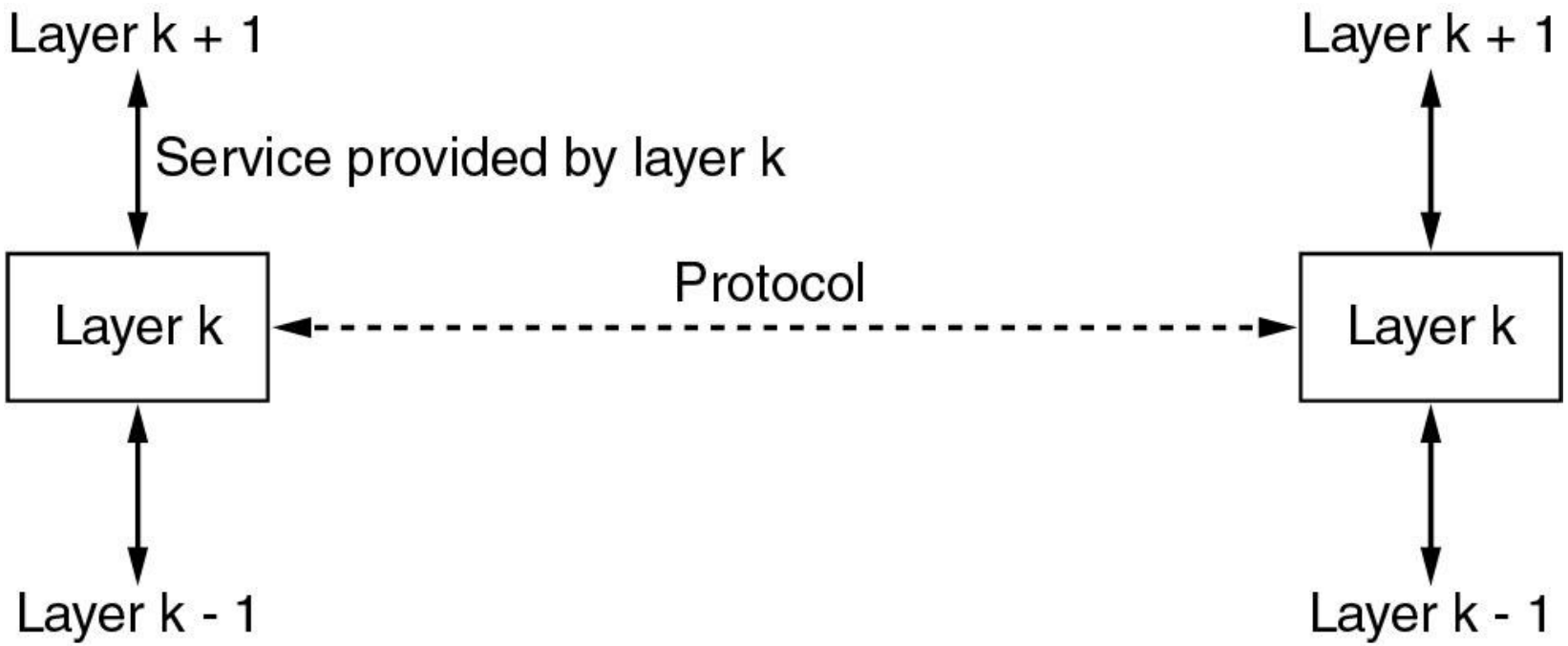
Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection

Example: five service primitives for implementing a simple connection-oriented service.

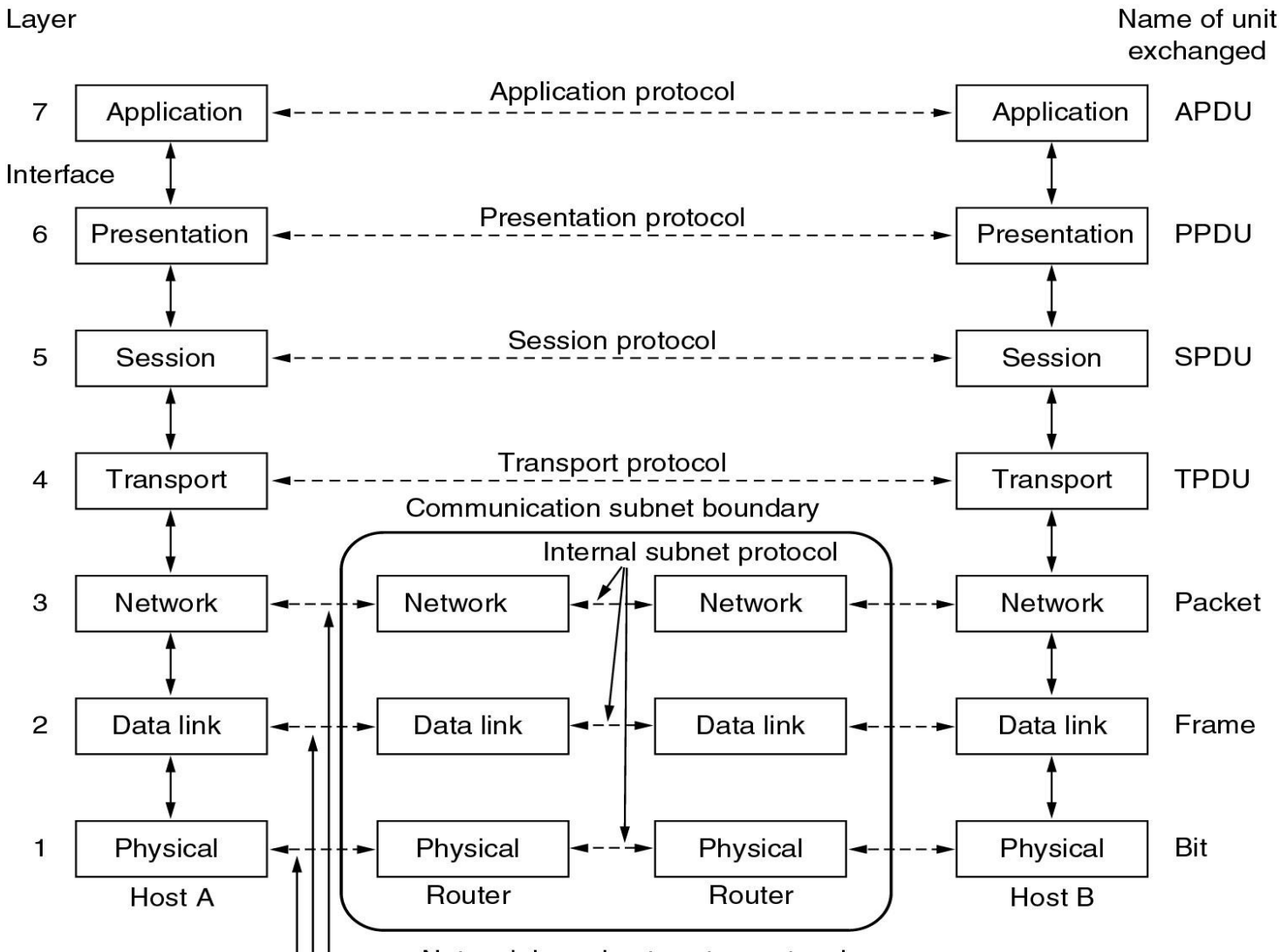
Services to Protocols Relationship

- The relationship between a service and a protocol.
- A service is a set of primitives(operations)that a layer provides to the layer above it
- A protocol is a set of rules governing the format and meaning of the frames, packets, or messages that are exchanged by the peer entities within the layer

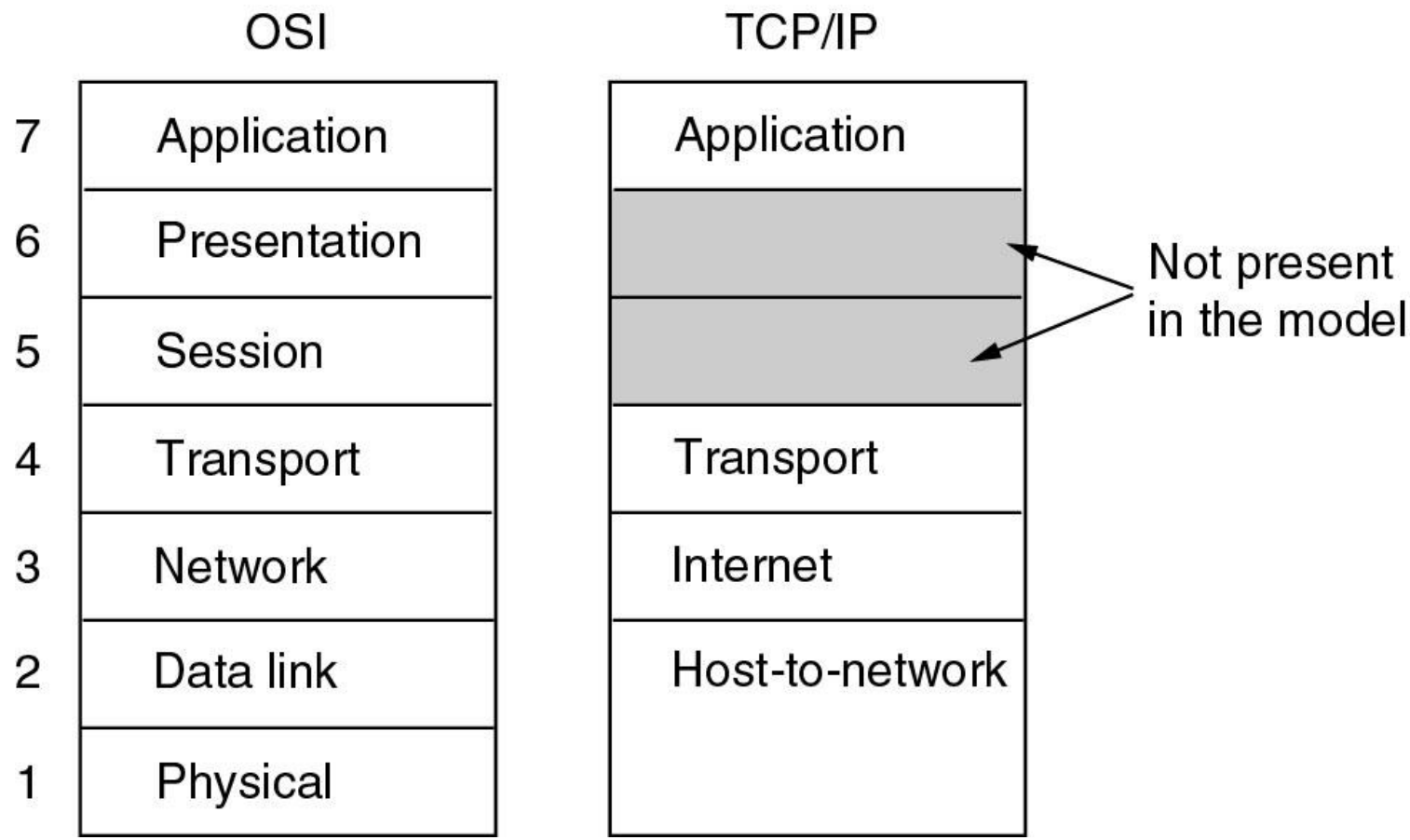
The relationship of Service



The OSI Reference Model



The TCP/IP Reference Model



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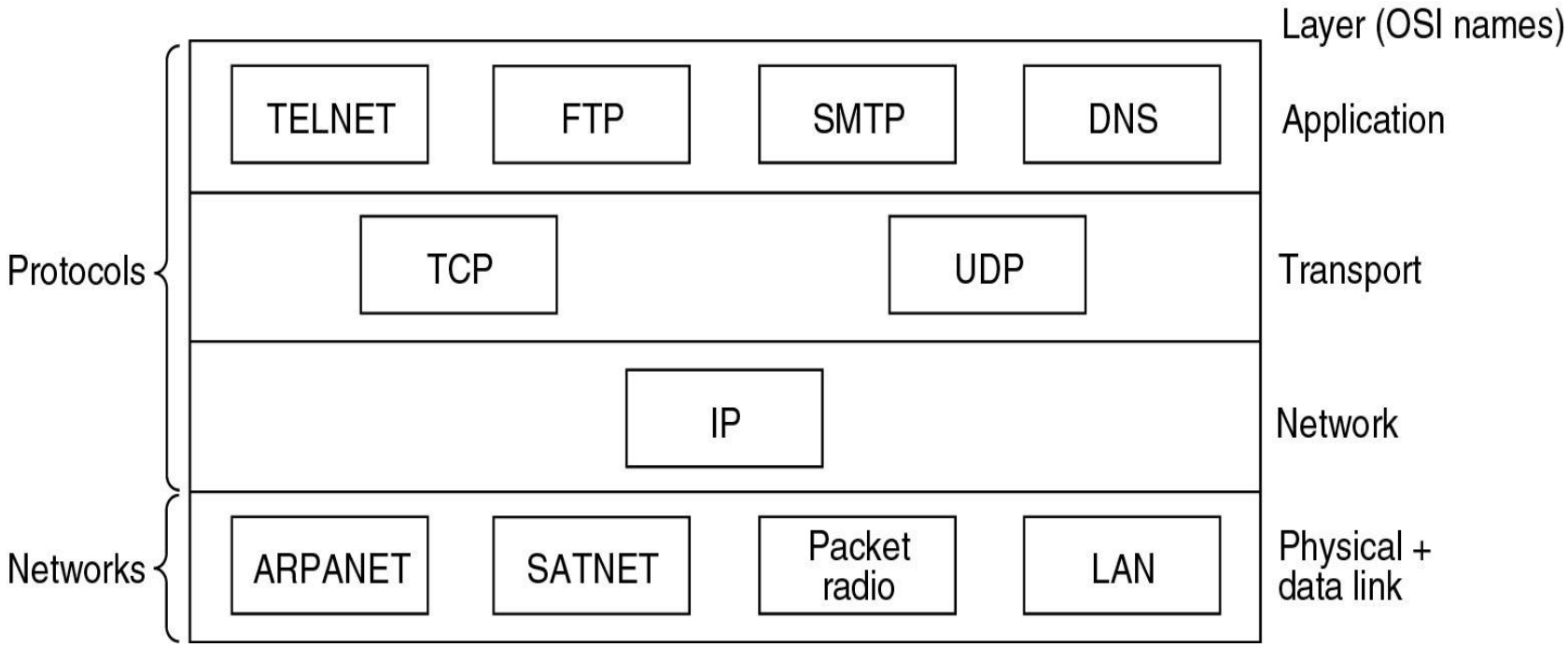
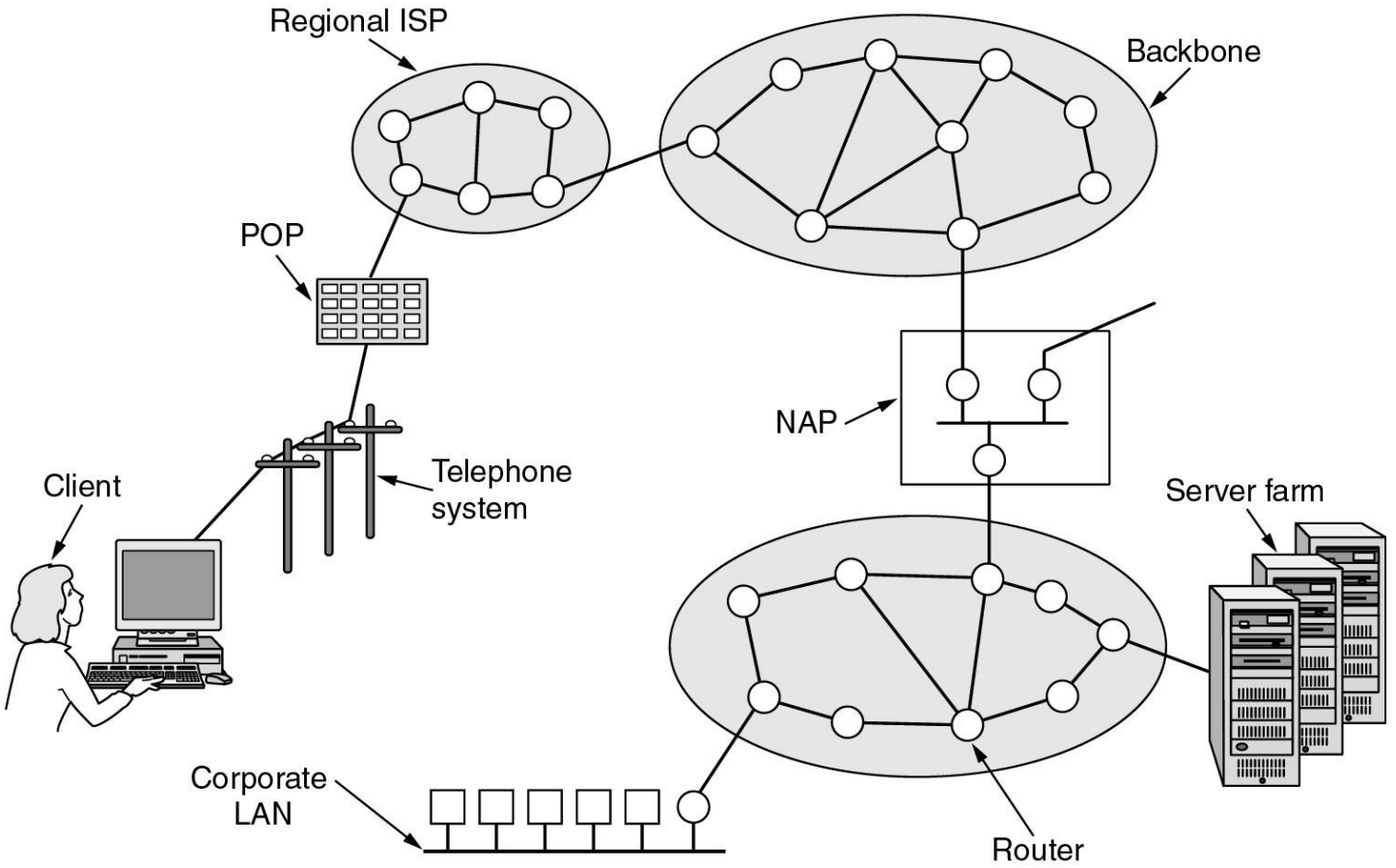


Protocols and networks in the TCP/IP model initially.

The TCP/IP Reference Model



Overview of the Internet.