Week 1 – Introduction to Networking

COMP90007
Internet Technologies

Outline

- Computer Networks
- Network Types
- The Internet

- Reading: Sections 1.1-1.3 from our book

Some Basic Terminologies

- A **network device**: refers to PC, Router, Switch, Phone
- **Server**: Provider of a service. Accept requests from clients.
- **Client**: A network device connecting to a server and requesting a service.
- **Computer Network**: A collection of autonomous computers interconnected by a single technology.

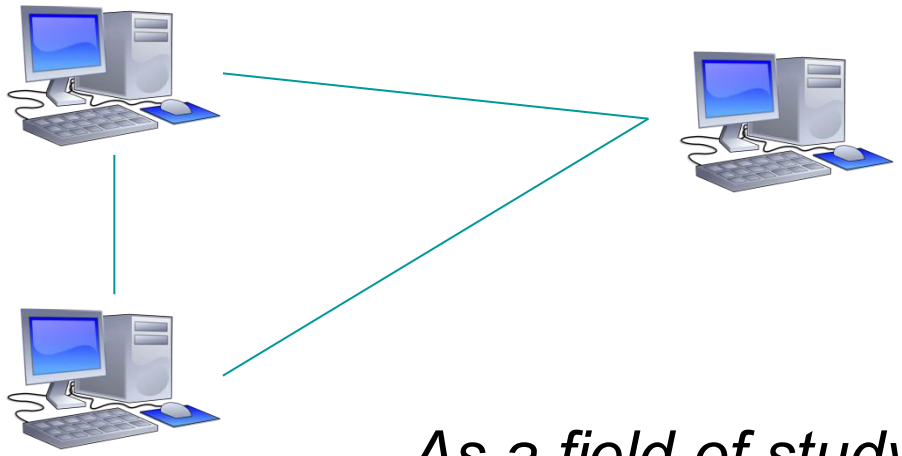
Terminologies Contd.

- **Packet**: A message send between two network devices (more specific definition will be needed as this term actually refers to a particular type of “message”)
- **IP address**: A unique number identifying a network device over the Internet

Network vs Computer Network

- Network (Noun):
  - An intricately connected system of things or *people*
  - An interconnected or intersecting configuration or system of components, *not just computers*
- Computer Network:
  - A data network with computers at one or more of the nodes [Oxford Dictionary of Computing]
  - A collection of autonomous computers interconnected by a *single technology*

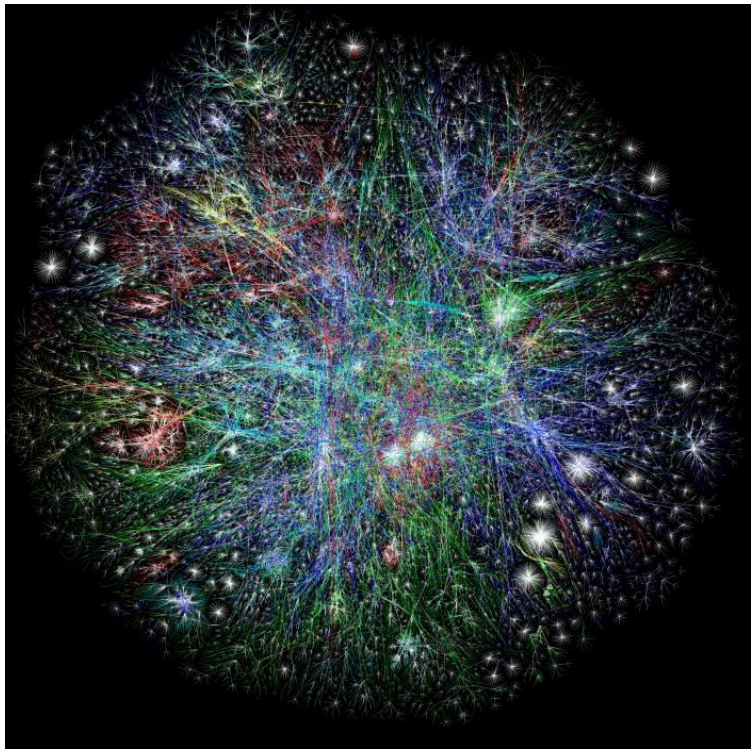
Computer Networks



As a field of study mainly deals with:
How do things scale to large no of devices?
How to deal with distances efficiently?

What is the Internet and the World Wide Web in this context?

- Neither the Internet nor the WWW is a computer network!
- Simple answers:
  - The **Internet** is not a single network but a **network of networks**!
  - The **WWW** is a distributed system that **runs on top of the Internet**



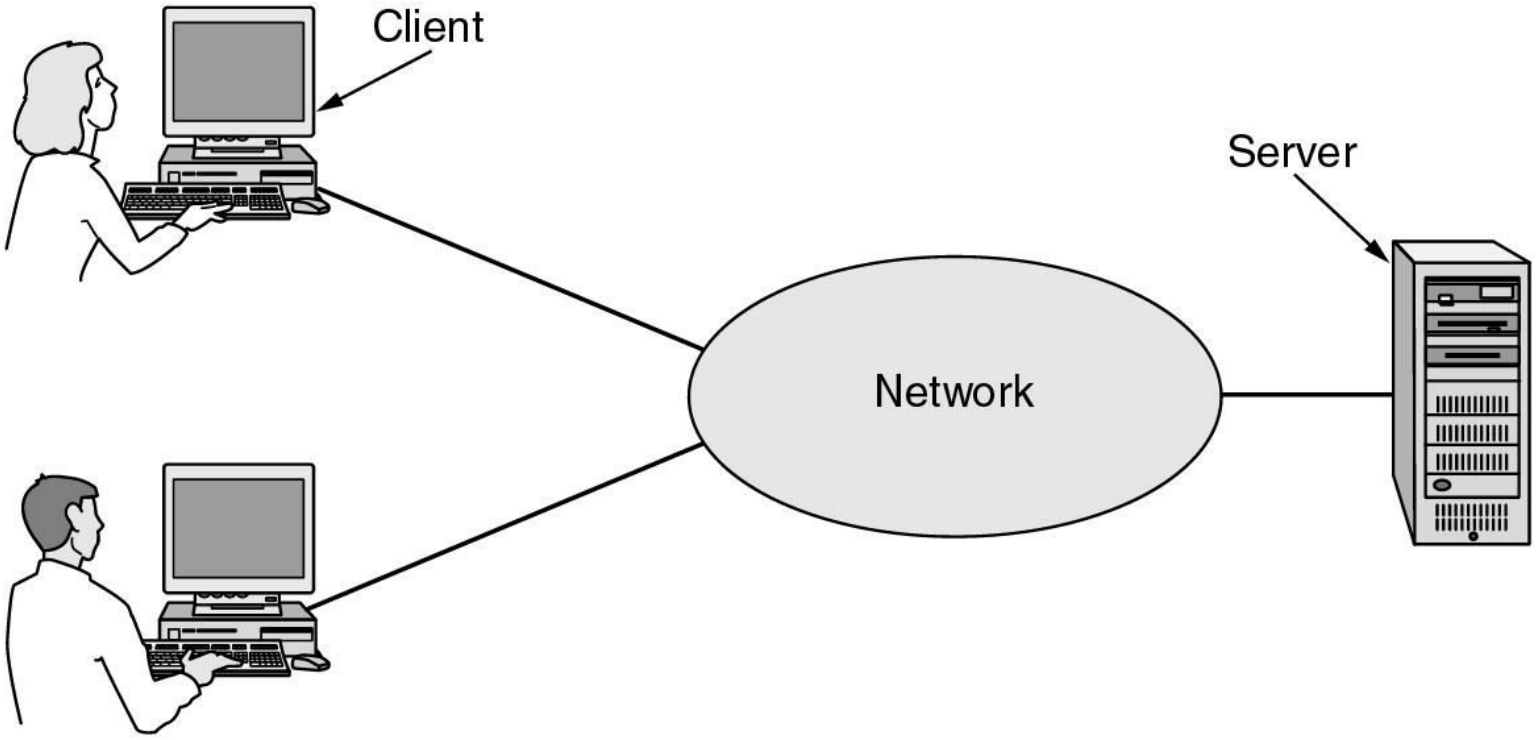
https://mountpeaks.wordpress.com/

Drivers for Computer Networks

- Business Applications
  - Resource sharing (e.g., printer, scanner, files)
- Home Applications
  - Access to remote information
  - Interactive entertainment
  - E-commerce
- Mobile Users
  - Mobility
  - Internet-of-things (e.g., parking, smart-meters, vending machines, etc)
- Social Interactions

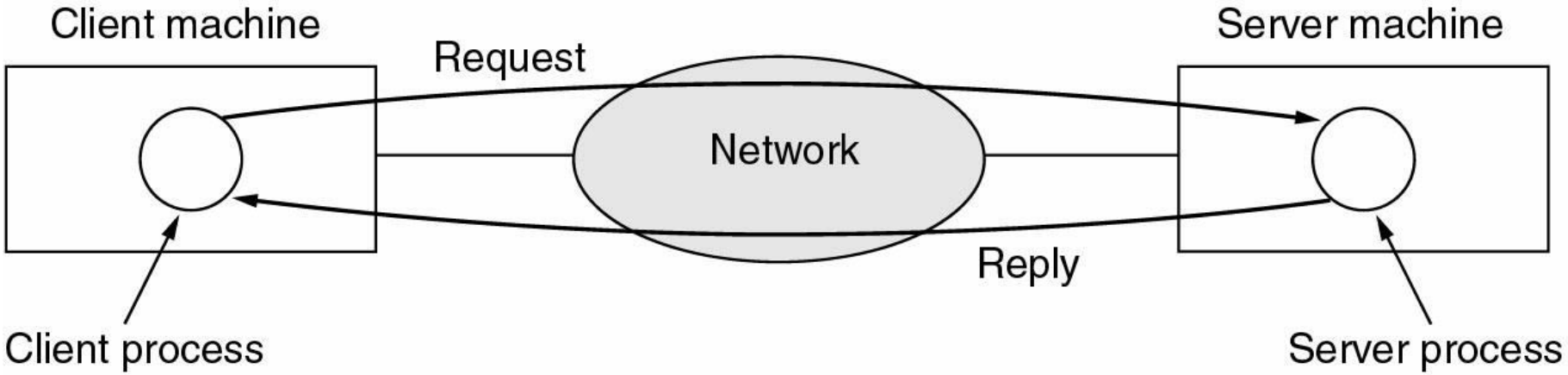
Business Applications

- Origins: Simple Client-Server Network
- A network with two clients and one server



C/S Architecture Contd.

- The client-server model involves requests and replies



Differentiating Factors of Networks

- Types of transmission technology
  - Broadcast link
    - Broadcast networks have a *single communication channel shared by all machines on a network*. Packets sent by any machine are received by all others, an address field in the packet specifies the intended recipient. Intended recipients process the packet contents, others simply ignore it. Broadcasting is a mode of operation which allows a packet to be transmitted that every machine in the network must process.

Differentiating Factors of Networks

- Point-to-point links
  - Data from sender machine is not seen and processed by other machines
  - Point to point networks consist of many connections between individual pairs of machines. Packets travelling from source to destination must visit intermediate machines to determine a route - often multiple routes of variant efficiencies are available and optimisation is an important principle.
  - Unicasting is the term used where point-to-point networks with a single sender and receiver pair can exchange data.
- Multicasting
  - Transmission to a subset of the machines…

Differentiating by Scale

- Classification of interconnected processors by scale.

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

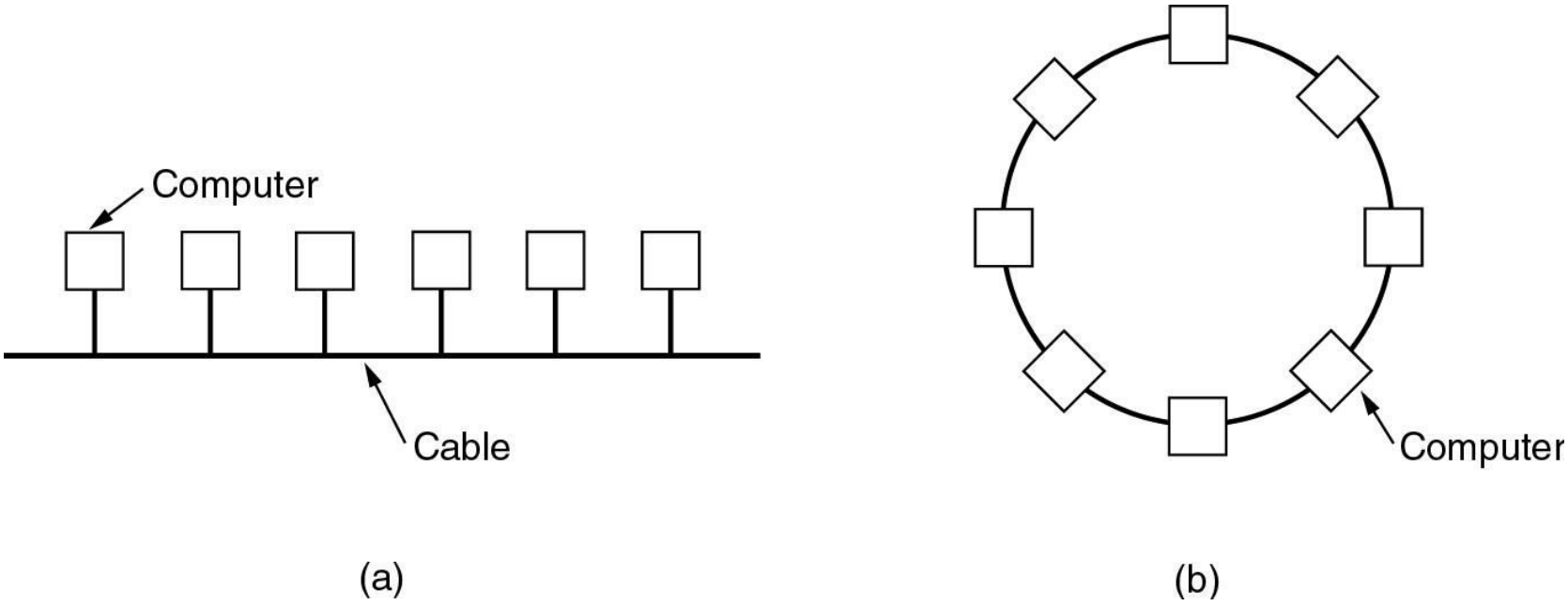
Other Differentiations Exist…

- E.g., Speed, etc.
- Many taxonomies exist today and they can be considered together as they are commonly orthogonal to each other as they look at different aspects.

Example: Local Area Network
Immediately 3 factors come to mind

- Size
- Transmission Technology
  - Such as physically wired network
- Topology
  - Bus
    - only a single machine on the network can transmit at any point in time requires a negotiation mechanism to resolve transmission conflicts: Ethernet is the most common bus network
  - Ring
    - Each transmission bit is propagated individually
    - Requires access control to resolve propagation queuing
    - E.g., Token Ring

Local Area Network Examples

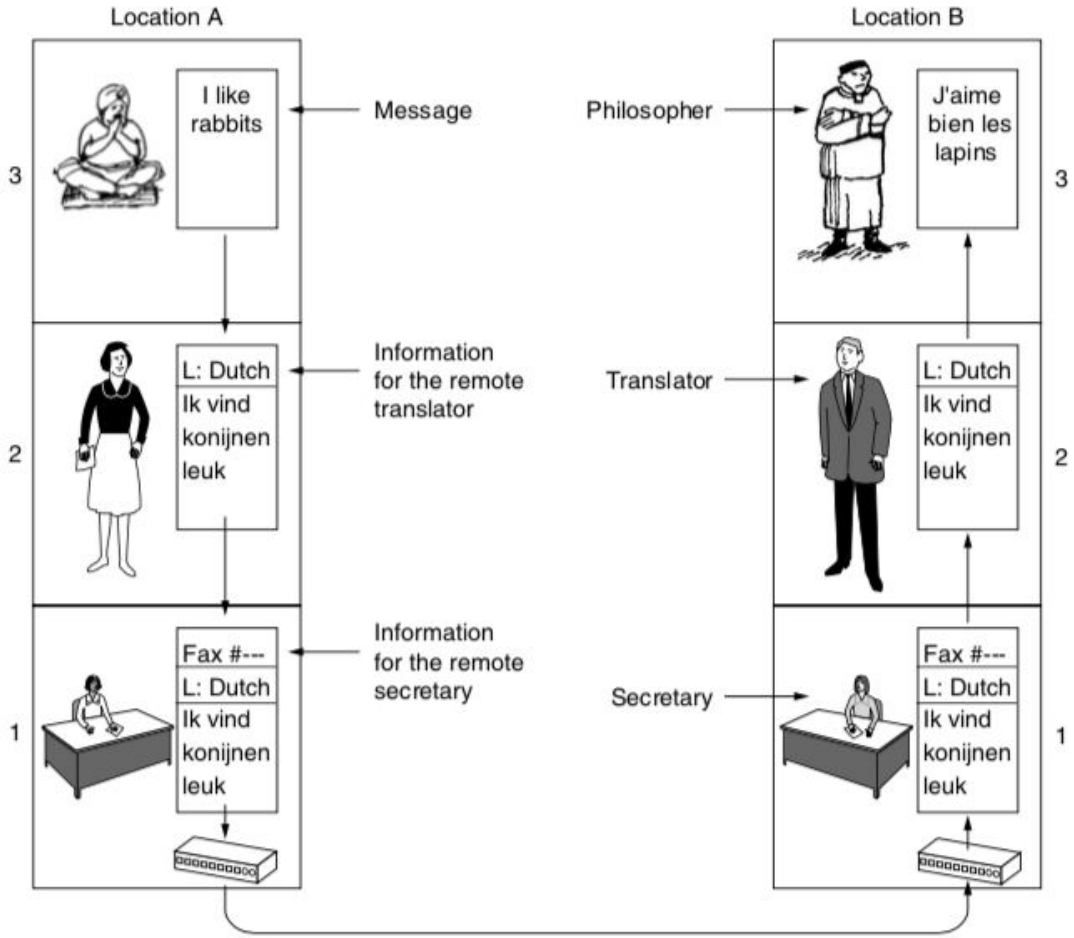


- (a) Bus
- (b) Ring

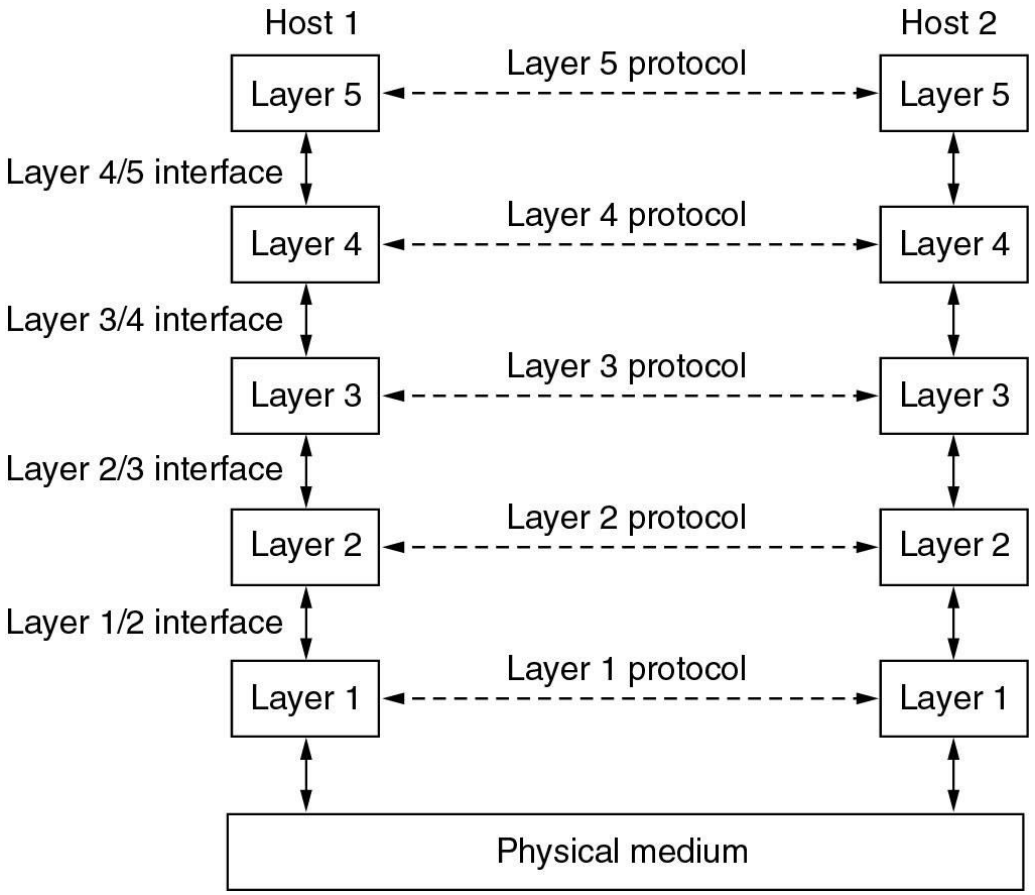
What Makes the *Internet* Work

- Network Reference Models
  - Open Systems Interconnect
  - TCP/IP
- Network Standards
- Models >> Protocols, Layers and Services
  - Design of Layer Models
  - Protocol Hierarchies
  - Connection-Oriented and Connectionless Service Types
  - Services Primitives
  - Services
  - Protocols

The Philosopher-translator-secretary Architecture at the Core



Network Software: Protocol Hierarchy



Consider the network as a stack of layers

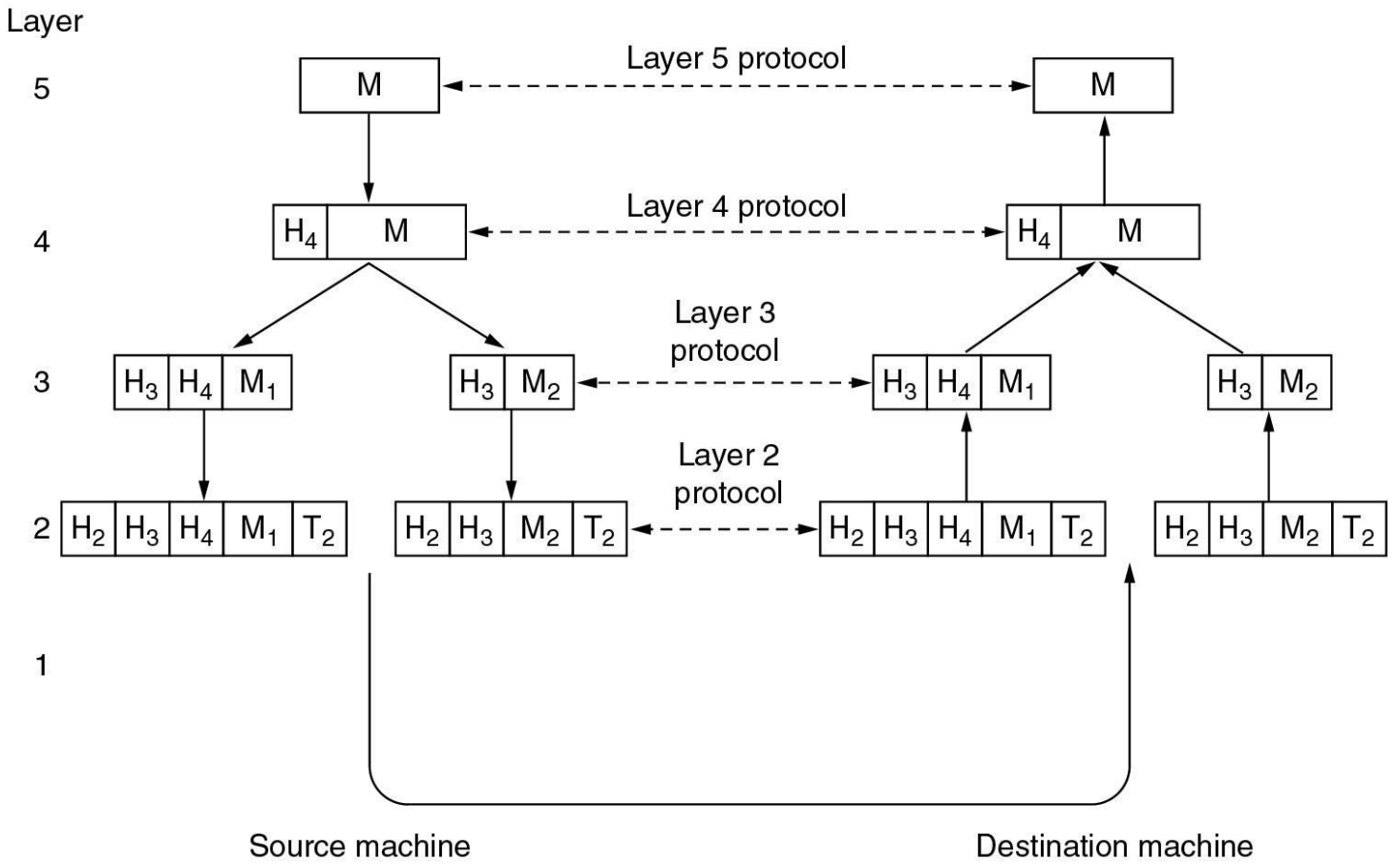
Each layer offers services to layers above it through an interface

Inter-layer exchanges are conducted according to a protocol

- Layers, protocols, and interfaces

Protocol Hierarchies Contd

- Example information flow supporting virtual communication in layer 5



Design Issues for the Layers

- **Connection Oriented**: connect, use, disconnect (similar to telephone service)
  - Negotiation inherent in connection setup
- **Connectionless**: just send (similar to postal service)
- Choice of service type has a corresponding impact on the reliability and quality of the service itself

Connection-Oriented and Connectionless Services

- Six different types of services

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

Service Primitives

- Primitives are a formal set of operations for services
- The number and type of primitives in any particular context is dependent on nature of service itself - in general more complex services require more primitives service

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

- Six service primitives for implementing a simple connection-oriented service

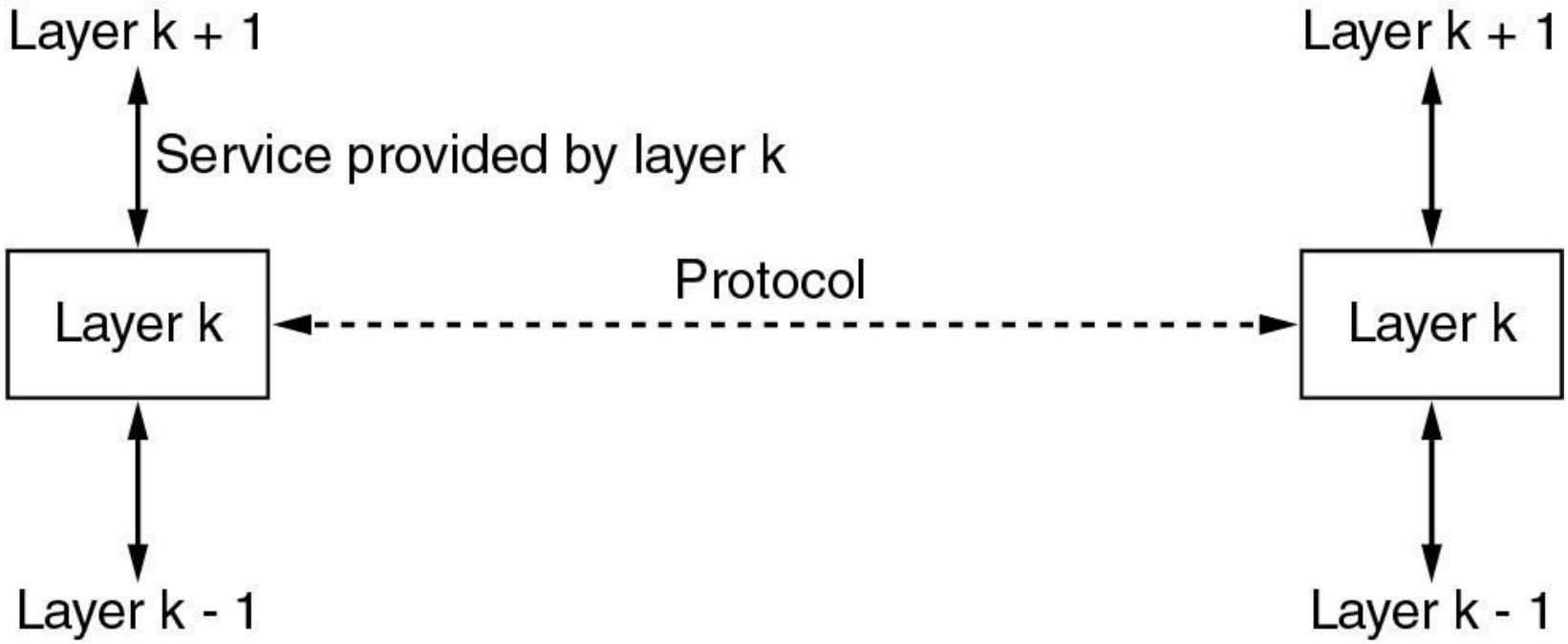
Relationship of Services and Protocols

- **Service = set of primitives that a layer provides to a layer above it**
  - Defines what operations the layer is prepared to perform on behalf of its users
  - It says nothing about how these operations are implemented
  - interfaces between layers (service provider vs service users)

- **Protocol = a set of rules governing the format and meaning of packets that are exchanged by peers within a layer**
  - Packets sent between peer entities

Services to Protocols Relationship

- The relationship between a service and a protocol in detail



Focus: Reference Models

- The **OSI Reference Model**
- The **TCP/IP Reference Model**
- A Comparison of OSI and TCP/IP
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model

Why do we need a network reference model?

- A reference model provides a ***common baseline for the development*** of many services and protocols by independent parties

- Since networks are very complex systems, a reference model can serve to ***simplify the design process***

- It's engineering *best practice* to have an ***"abstract" reference model***, and corresponding implementations are always required for validation purposes