Week 1 – Introduction to Networking

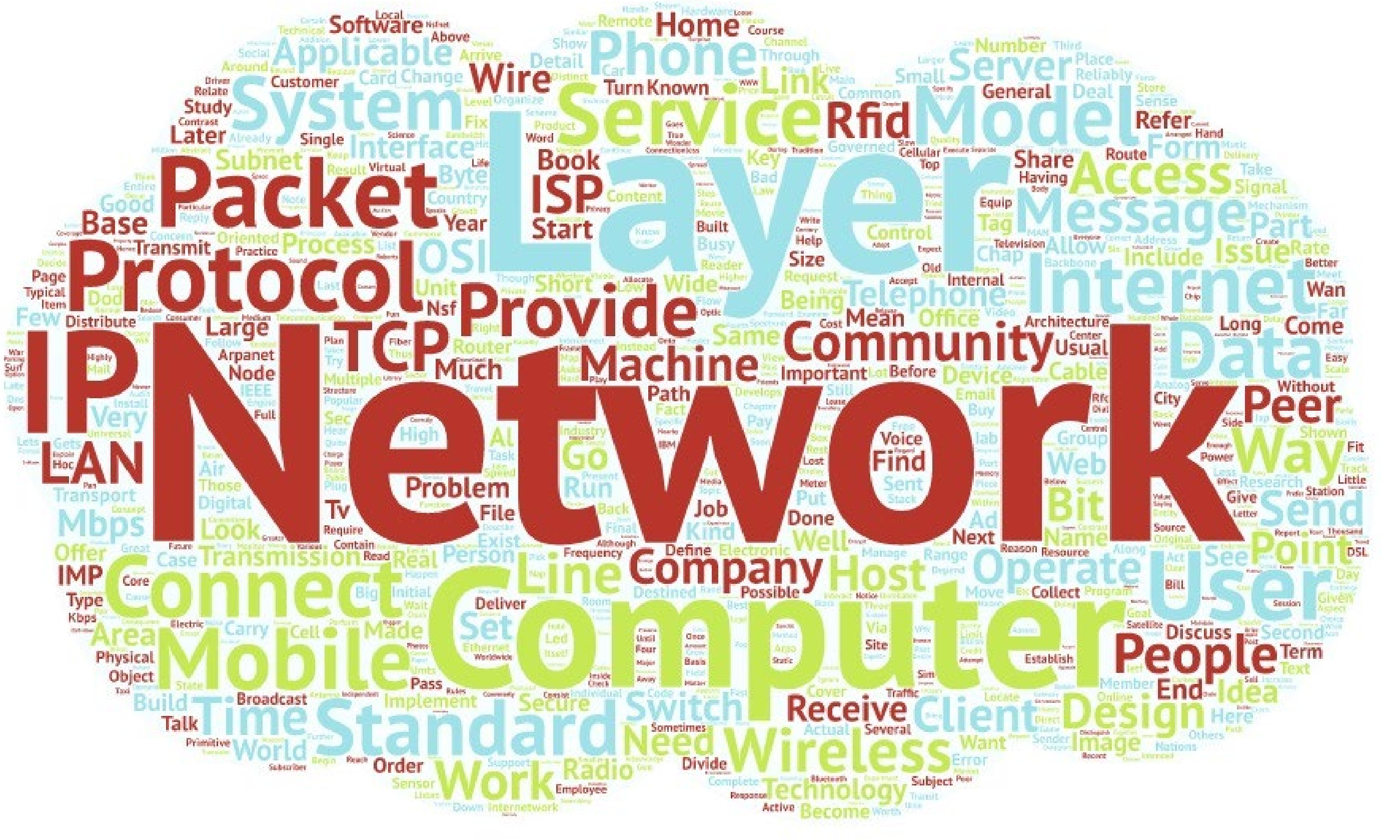
COMP90007 Internet Technologies

Lecturer: Ling Luo

Semester 2, 2020

Outline

- Computer Networks
- Network Types
- Protocols, Layers and Services


Network
Layer
Computer
Protocol
Packet
IP
LAN
TCP
Provide
Machine
Community
Internet
Model
Phone
System
Service
Rfid
Server
Message
Access
Data
User
Peer
Way
Send
Point
Connect
Mobile
Standard
Time
Work
Wireless
Technology
Client
Design
Receive
Company
Host
Operate
Switch
Line
Set
Need
Radio
People
Applicable
Software
Home
Wire
ISP
Book
Start
OSI
Process
Subnet
Interface
Byte
Link
Telephone
Office
Cable
Device
Web
Bit
Find
Voice
Problem
File
Mbps
Area
Transmission
Look
Base
Transmit
Distribute
Large
Arpanet
Node
Very
High
Run
Go
Al
Kind
Well
Done
Put
Sent
Next
Ad
Name
See
Second
Discuss
Term
End
Idea
Image
Here
Want
Error
Place
Number
Share
Control
Part
Issue
Rate
Include
Allow
Tag
Signal
Form
Refer
General
Deal
Small
Known
Turn
Detail
Show
Remote
Course
Through
Channel
Arrive
Change
Card
Customer
Around
Social
Study
Later
Single
Good
Reply
Country
Year
Oriented
Practice
Page
Typical
Few
Mail
Install
Full
Transport
Digital
Those
Air
Offer
IMP
Type
Kbps
Physical
Object
Build
Talk
Broadcast
World
Implement
Pass
Order
Sensor
Down
Internetwork
Employee
Secure
Sometimes
Several
Become
Subject
Establish
Member
Online
Text
Without
Come
Long
Wan
Architecture
Usual
Before
Important
Mean
Same
Being
Size
Request
Short
Wide
Router
Much
Multiple
IEEE
Unit
Nsf
Tv
Require
Contain
Real
Person
Exist
Deliver
Frequency
Define
Electronic
Possible
Destined
Collect
Move
Manage
Range
Email
Buy
Group
City
Power
Research
Give
Source
Bill
Goal
Satellite
Station
Little
DSL
Given
Session
Scale
Easy
Far
Meet
Better
Television
Backbone
Internal
Old
Reader
Busy
Built
Content
Bad
Key
Top
Cellular
Hand
Route
Take
Having
Equip
Address
Chap
Path
Fact
Task
Still
Pay
Chapter
Lab
Stack
Job
Back
Final
Ethernet
Code
Cover
Traffic
Actual
Site
Via
Sim
Complete
Support
Primitive
Subscriber
Category
Reach
Response
Active
Hardware
Above
Local
Technical
Driver
Relate
Contrast
Science
Result
Virtual
Organize
Product
Word
Fix
Level
Life
Entire
Note
Concern
Item
Dod
Ad Hoc
Lets
Gets
Universal
Sec
Hear
Plug
Speed
Future
Case
Great
Core
Big
Initial
Wait
Made
Carry
Cell
Electric
State
Individual
Itself
Led
Fast
Basis
Divide
Hold
Cost
Lot
Develops
Fiber
Plan
Follow
Try
Quality
Thing
Sense
Store
Music
Delivery
Mechanism
Fit
Track
Shown
Letter
Report
Thousand
Act
Clear
Along
Resource
Reason
Depend
Program
Others
Notions
Sender
Locate
Direct
Recent
Third
Reliably
Common
Main
Live
Governed
Tradition
Expect
Adopt
Accept
Flow
Optic
Higher
Lost
Meter
Media
Memory
Process
Small
Bluetooth
Worth
Though
Private
Allocate
Low
Instead
Right
Travel
Structure
Popular
Medium
Consumer
Certain
Addition
Already
Abstract
Premise
Million
Keep
Particular
Bandwidth
Apply
Concept
Function
Pan
Suff
Highly
War

Terminologies

- A **network device**: eg. 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

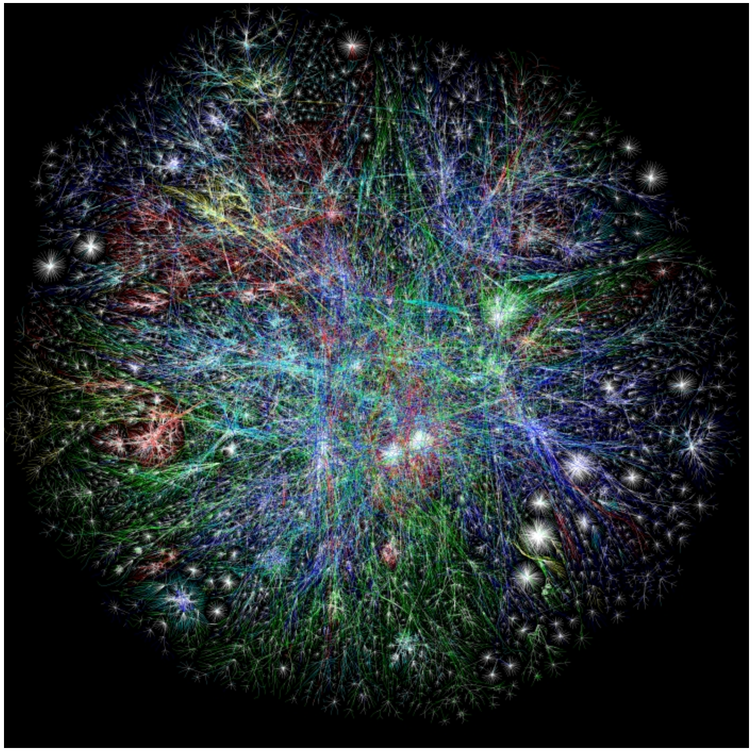
- **Packet**: A message sent between two network devices
- **IP address**: A unique number identifying a network device

Network vs Computer Network

- Network:
  - An intricately connected system of things or people
  - An interconnected or intersecting configuration or system of components
- 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

What are the Internet and the World Wide Web?

- 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**



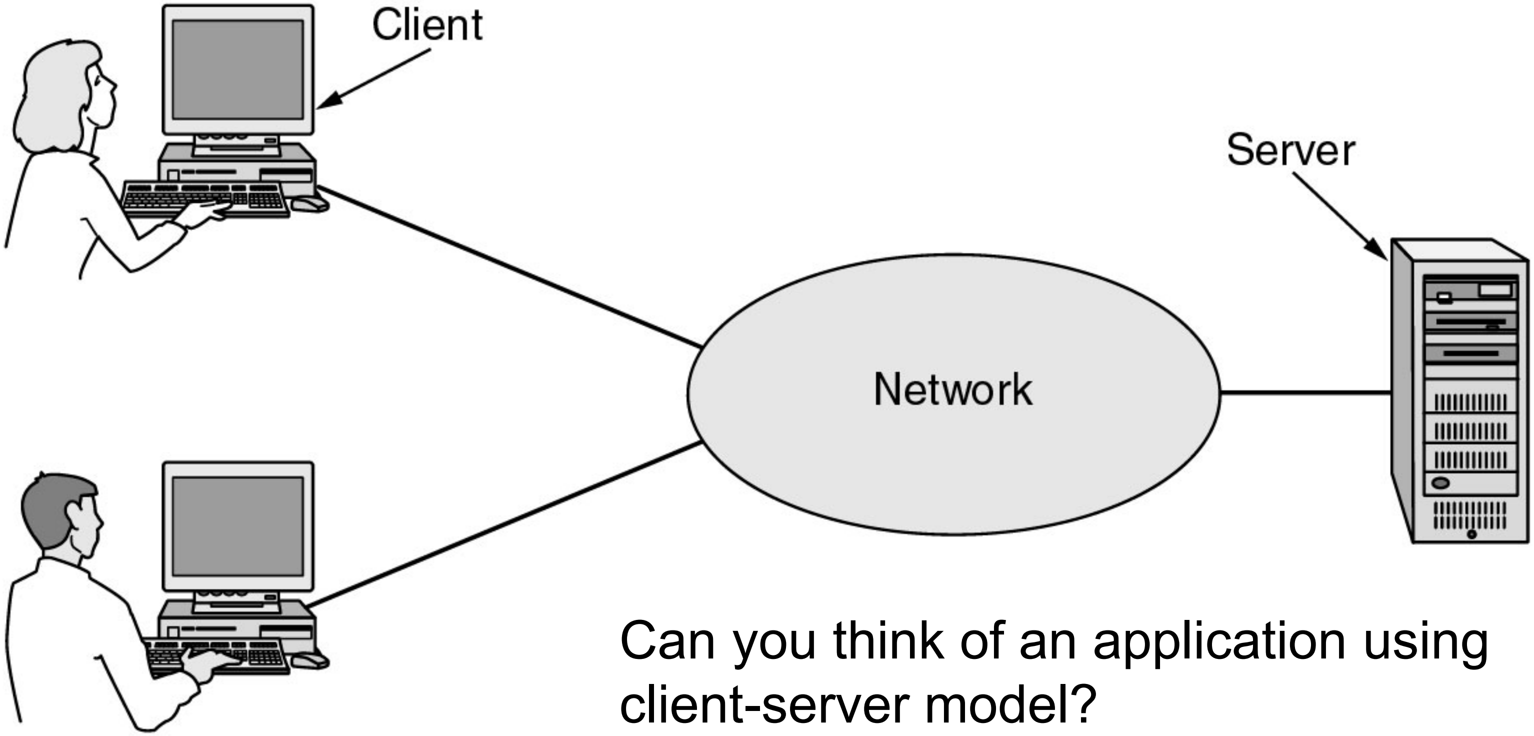
https://mountpeaks.wordpress.com/

Uses of Computer Networks

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

A Core Application Domain: Business Applications of Networks

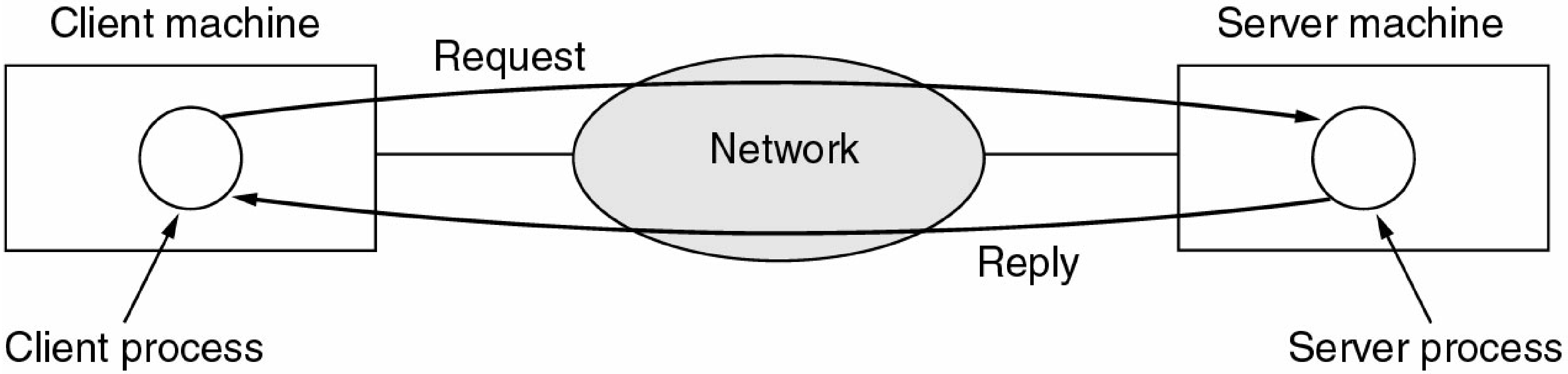
- Origins: Simple Client-Server Network
- A network with two clients and one server



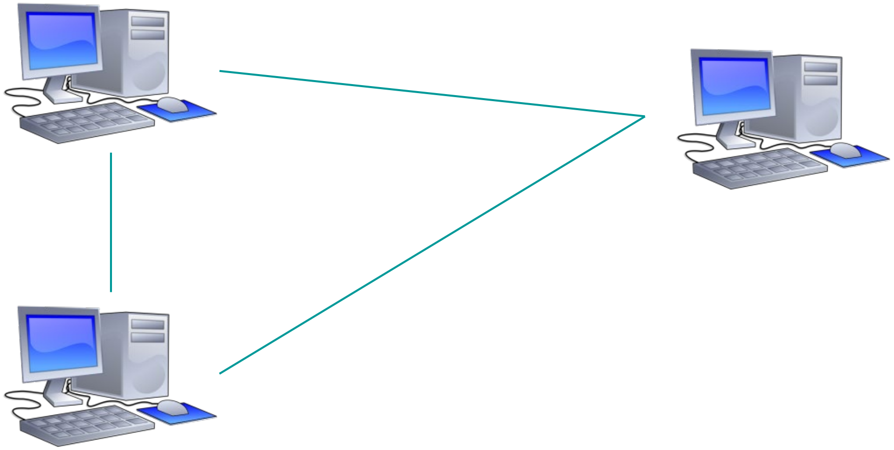
Can you think of an application using client-server model?

Business Applications of Networks (2)

- The client-server model involves requests and replies



Computer Networks



How does it scale to billions of devices?
What about distances?

Differentiating Factors of Networks

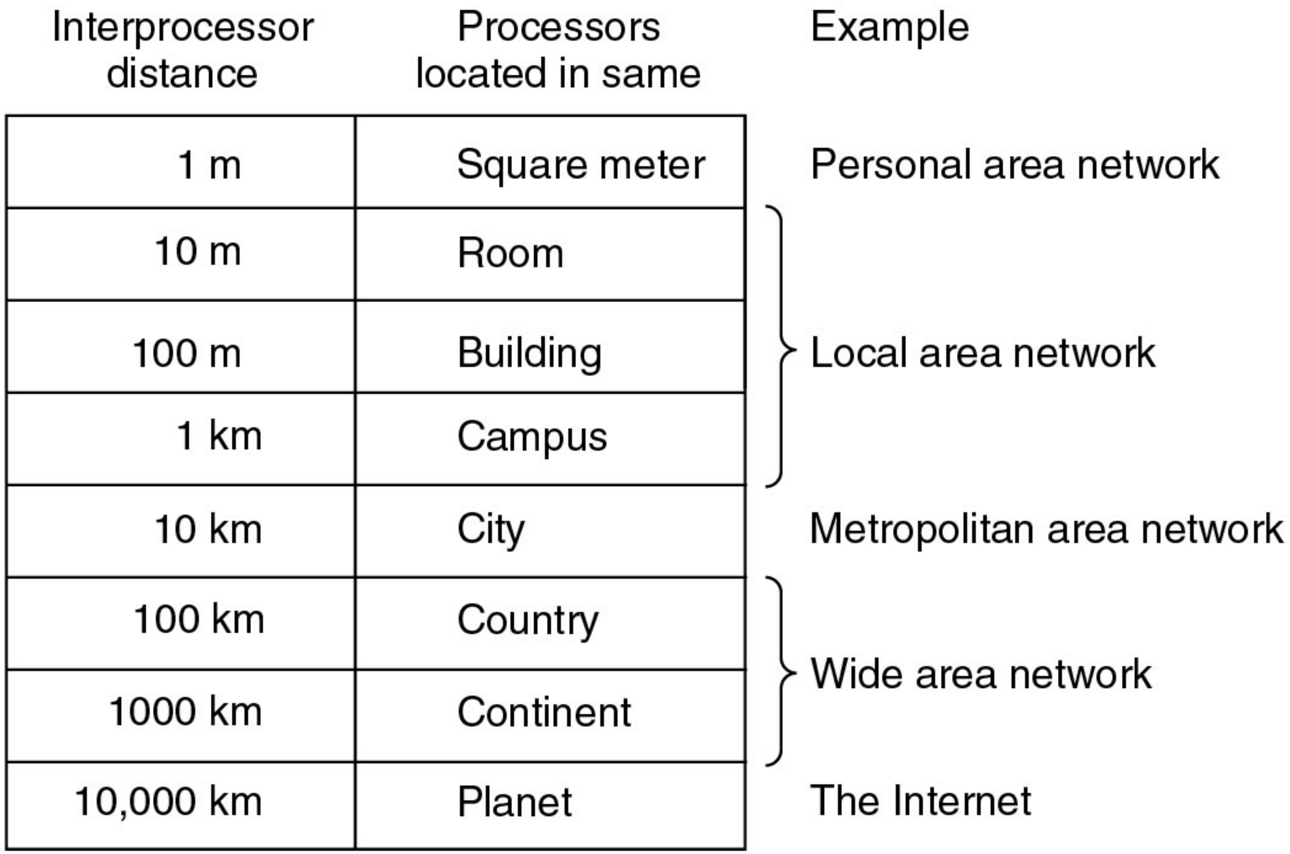
- Types of transmission technology
  - Broadcast link
    - Broadcast networks have a single communication channel shared by all machines on a network. Packets sent by any machine are received by all others, an address field in the packet specifies the intended recipient. Intended recipients process 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

- Types of transmission technology
  - 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.
    - 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 Factors of Networks

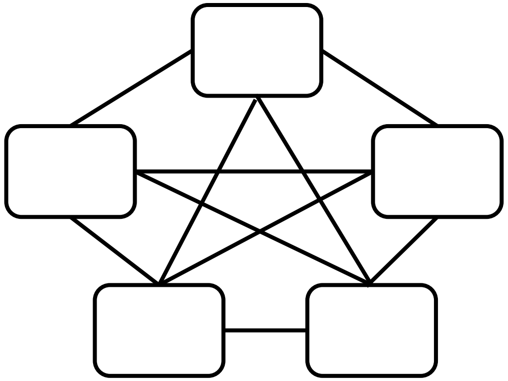
- By Scale



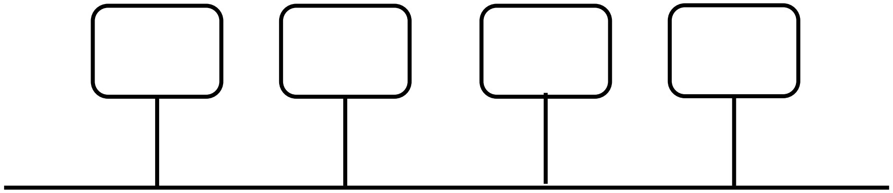
Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Differentiating Factors of Networks

- By Topology
  - Mesh
    - Fully mesh: each device has a dedicated point-to-point link to every other device.
  - Bus
    - All devices are attached to a shared medium.
    - Only a single device on the network can transmit at any point in time. Requires a negotiation mechanism to resolve transmission conflicts.
    - e.g. Ethernet is the most common bus network.



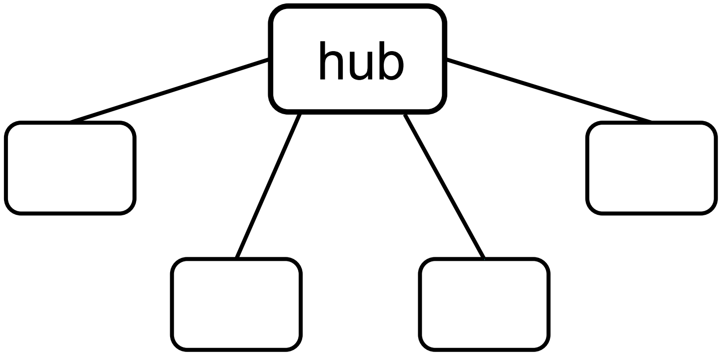
(a) mesh



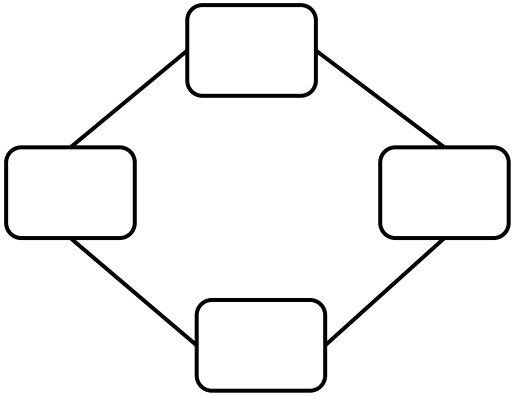
(b) bus

Differentiating Factors of Networks

- By Topology
  - Star
    - All devices are attached to a central device (hub).
  - Ring
    - Each device on the ring receives the data from the previous device and forwards it to the next device.
    - Requires access control to resolve propagation queuing.
    - e.g., Token ring.



(c) star

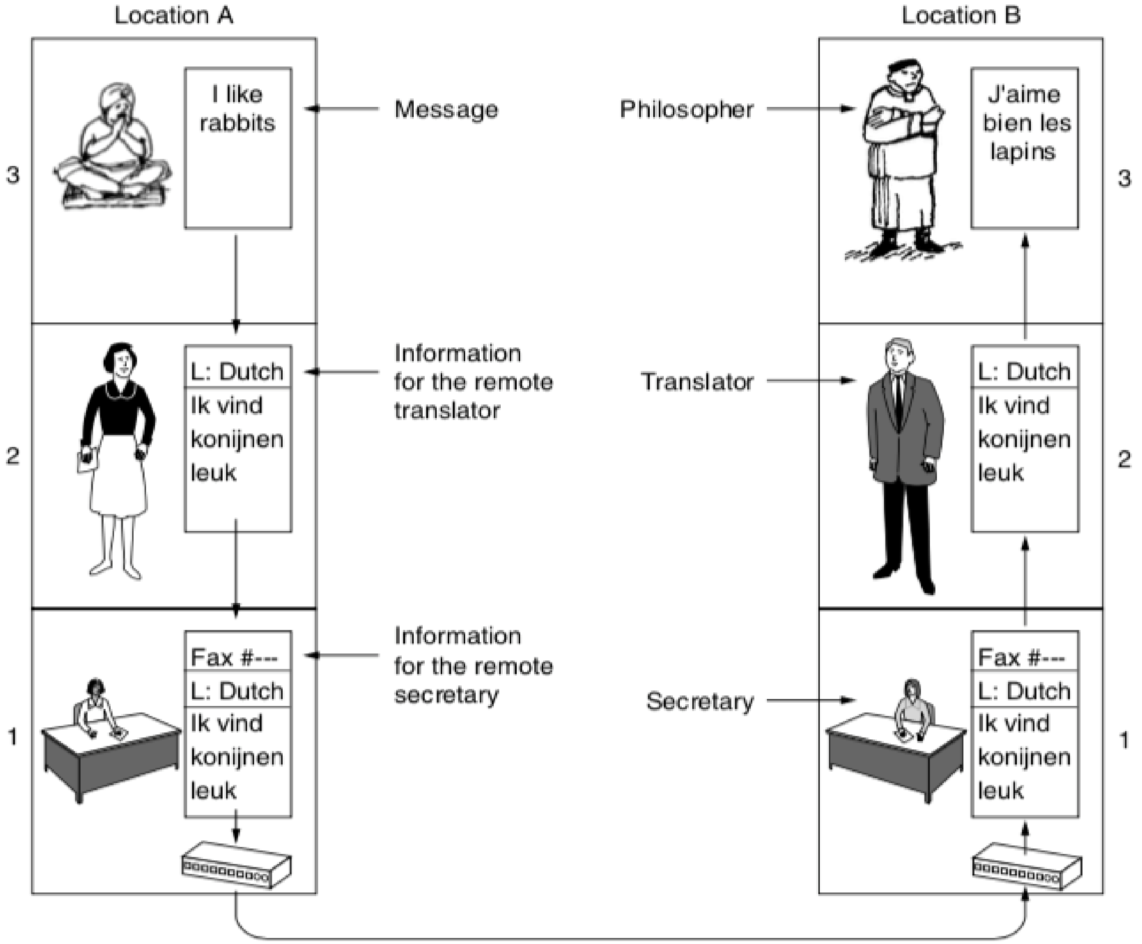


(d) ring

What Makes the Internet Work

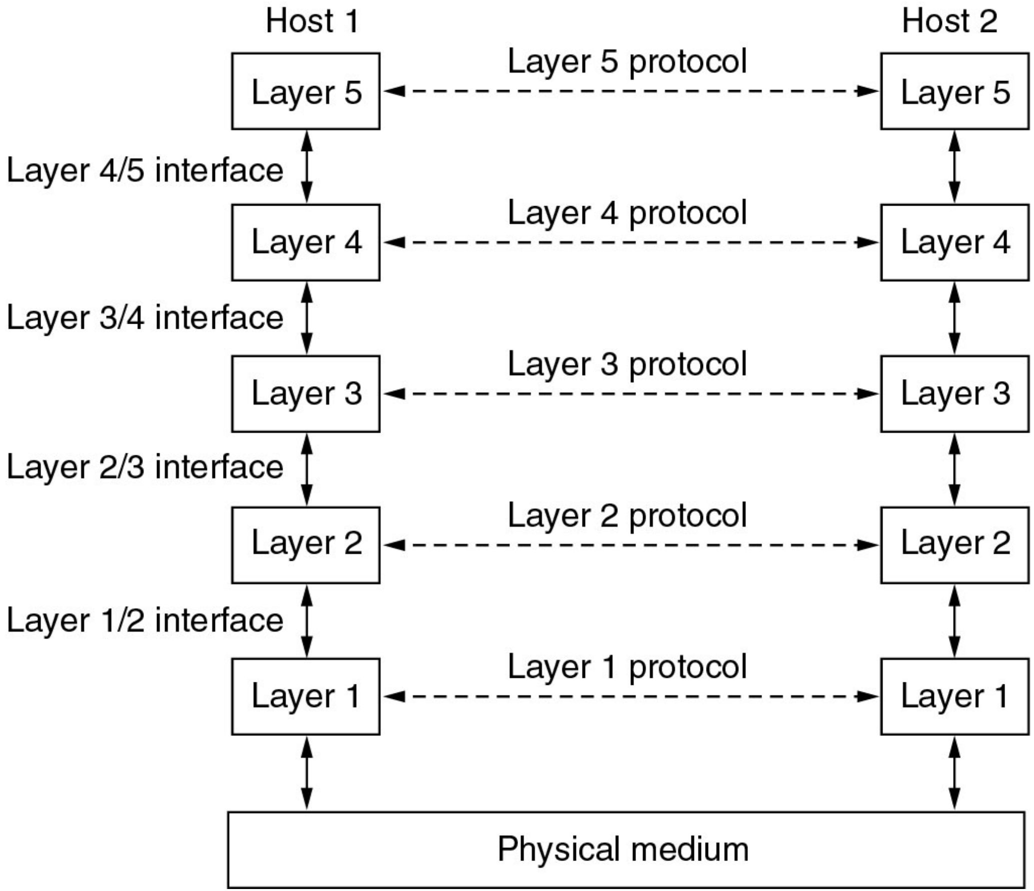
- Protocols, Layers and Services
  - Protocol Hierarchies
  - Design of Layer Models
  - Connection-Oriented and Connectionless Services
  - Services Primitives
  - Services and Protocols
- Network Reference Models
  - Open Systems Interconnect
  - TCP/IP
- Network Standards

The Philosopher-translator-secretary Architecture



Network Software: Protocol Hierarchies (1)

- Layers, protocols and interfaces



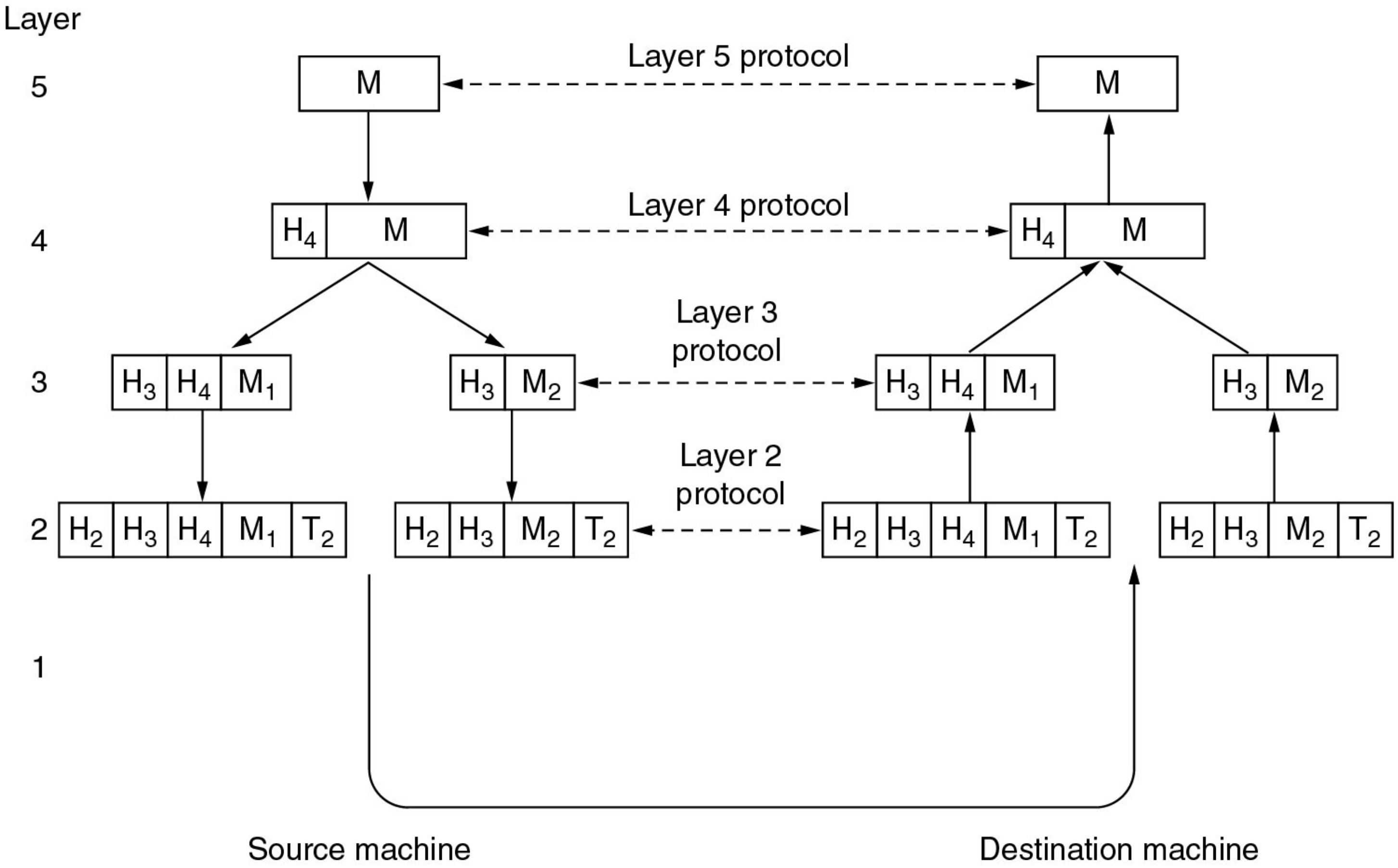
Consider the network as a stack of **layers**

Each layer offers **services** to layers above it through **interface**

Protocol is an agreement between the communicating parties on how communication is to proceed

Network Software: Protocol Hierarchies (2)

- Information flow supporting virtual communication in layer 5



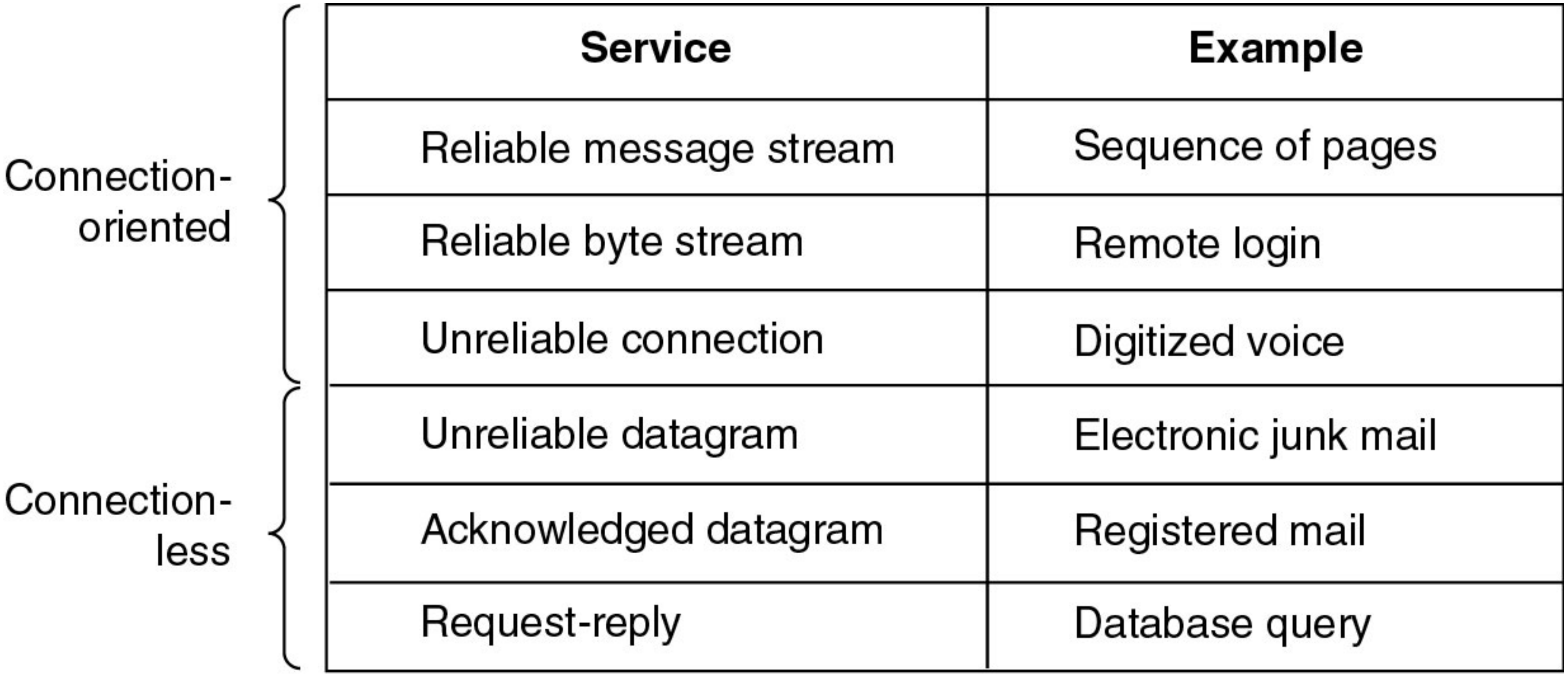
Services

- Choice of service type has a corresponding impact on the reliability and quality of the service

- Connection-Oriented vs. Connectionless
  - Connection-Oriented: connect, use, disconnect (similar to telephone service). Negotiation inherent in connection setup
  - Connectionless: just send (similar to postal service)

Connection-Oriented and Connectionless

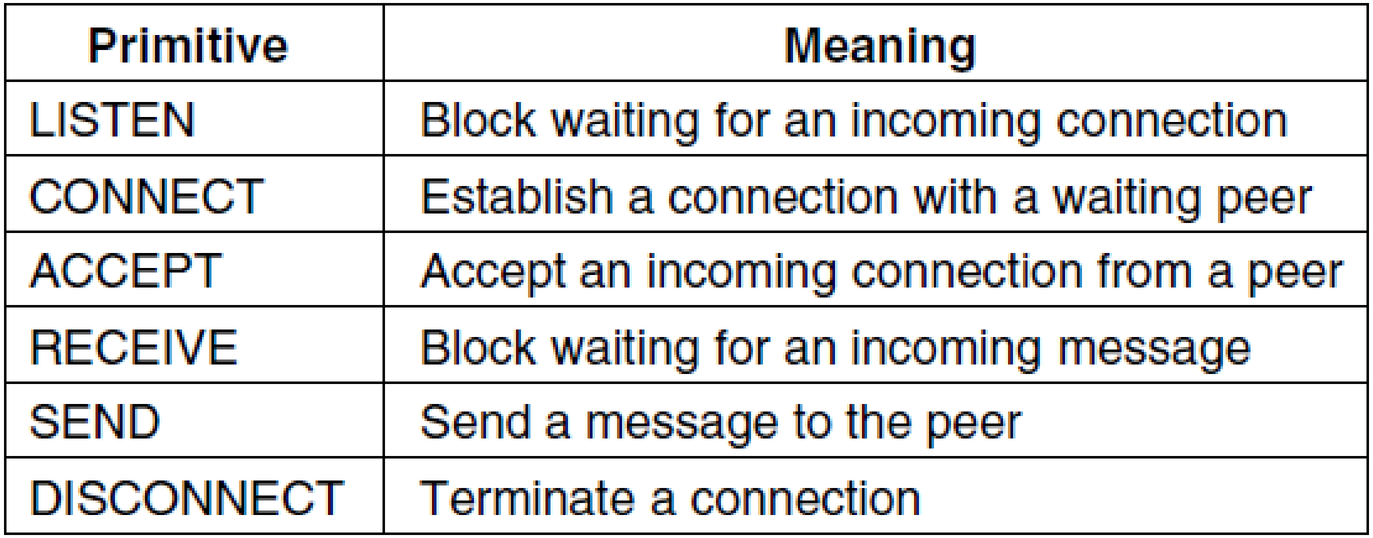
- Six different types of services



	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

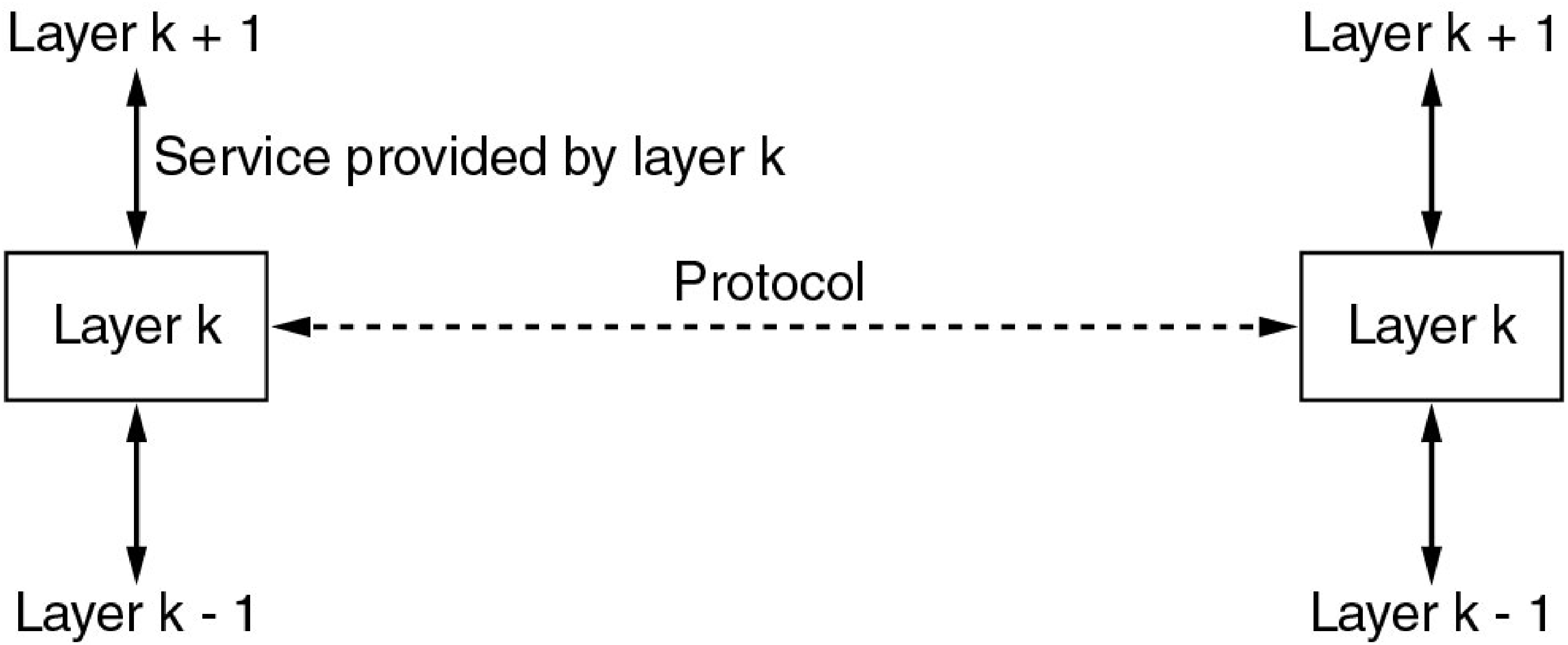
Service Primitives

- Primitives are a formal set of operations for services
- The number and type of primitives in any particular context depends on the nature of service - in general more complex services require more service primitives
- Six service primitives for implementing a simple connection-oriented 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

Relationship of Services and Protocols



Relationship of Services and Protocols

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

- **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

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 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