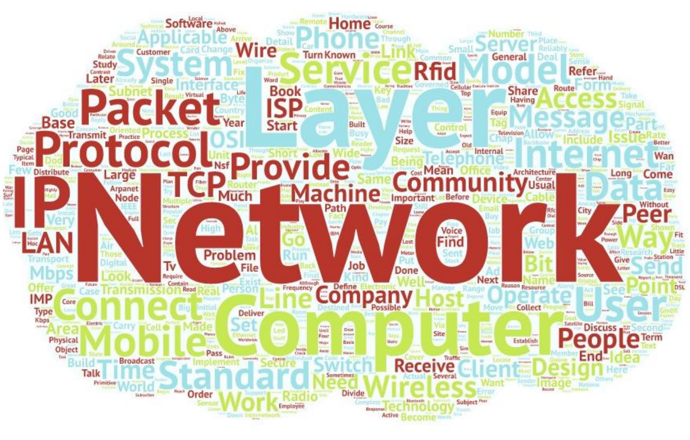
Week 1 – Introduction to Networking

COMP90007

Internet Technologies



Outline

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

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

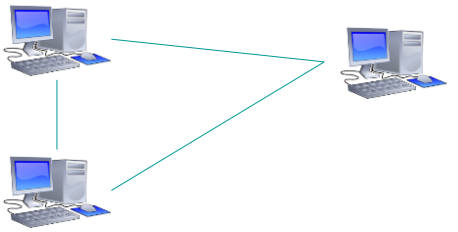
Terminologies

- **Packet**: A message sent between two network devices (more specific definitions will be given during the course)
- **IP address**: A unique number identifying a network device

Network vs Computer Network

- Network (Noun):
  - 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

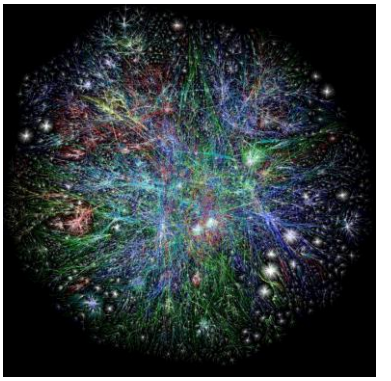
Computer Networks



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

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**



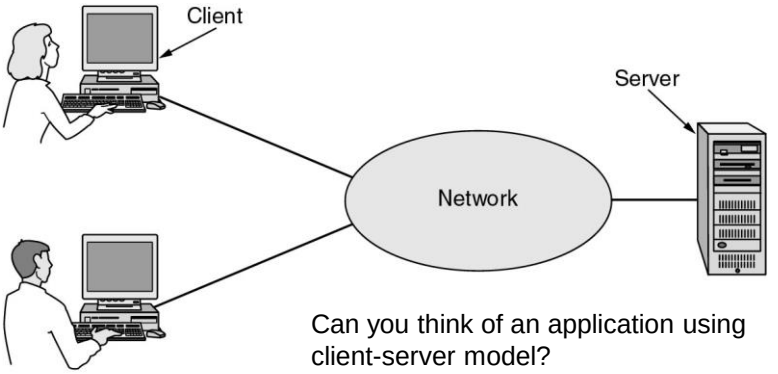
https://mountpeaks.wordpress.com/

Uses of Computer Networks

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

A Core Application Domain: Business Applications of Networks

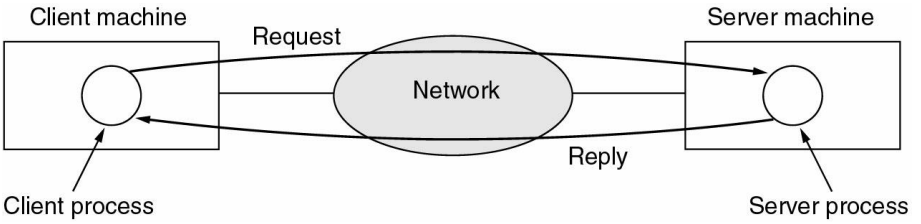
- Origins: Simple Client-Server Network
- A network with two clients and one server



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

Business Applications of Networks (2)

- The client-server model involves requests and replies



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 - 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	
100 m	Building	Local area network
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	
1000 km	Continent	Wide area network
10,000 km	Planet	The Internet

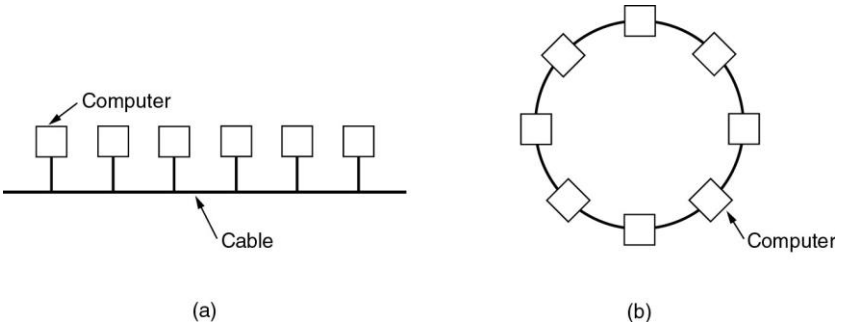
Other Differentiations Exist…

- E.g., Speed, Topology

Further Examples: Local Area Networks Commonly Distinguished by 3 factors

- 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



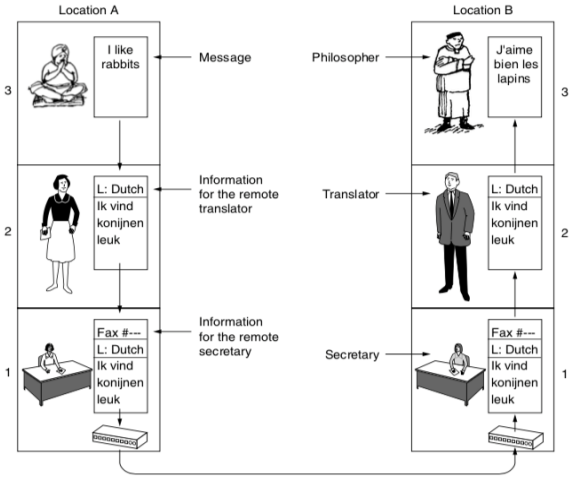
(a) (b)

- (a) Bus
- (b) Ring

But What Makes the Internet Work

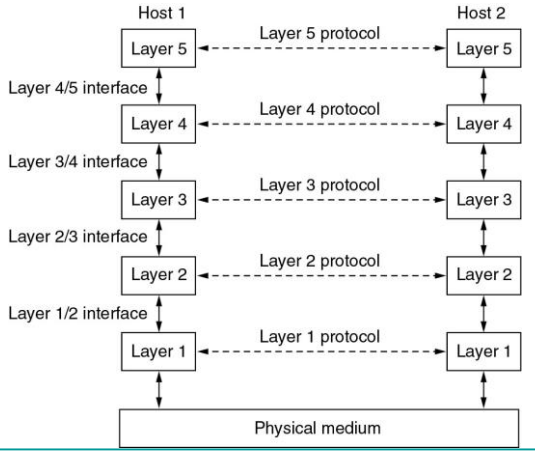
- Protocols, Layers and Services
  - Protocol Hierarchies
  - Design of Layer Models
  - Connection-Oriented and Connectionless Services
  - Services Primitives
  - Services and Protocols
- Network Reference Models
  - Open Systems Interconnect
  - TCP/IP
- Network Standards

The Philosopher-translator-secretary Architecture



Network Software: Protocol Hierarchies

- Layers, protocols and interfaces



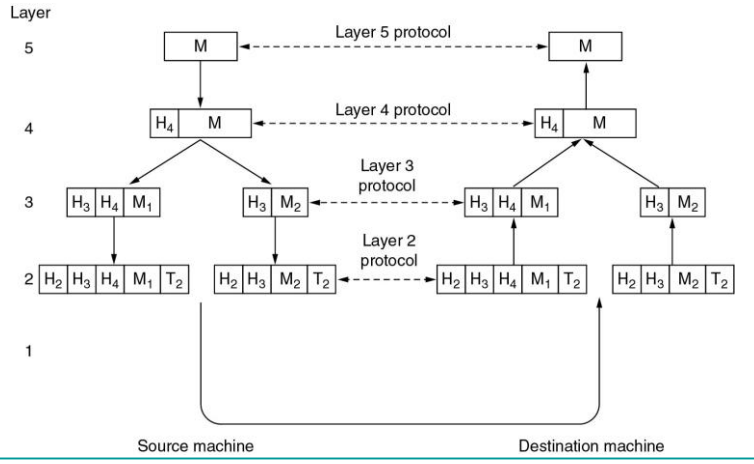
Consider the network as a stack of **layers**

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

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

Protocol Hierarchies (2)

- Example information flow supporting virtual communication in layer 5



Design Issues for the Layers

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

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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
- 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

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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

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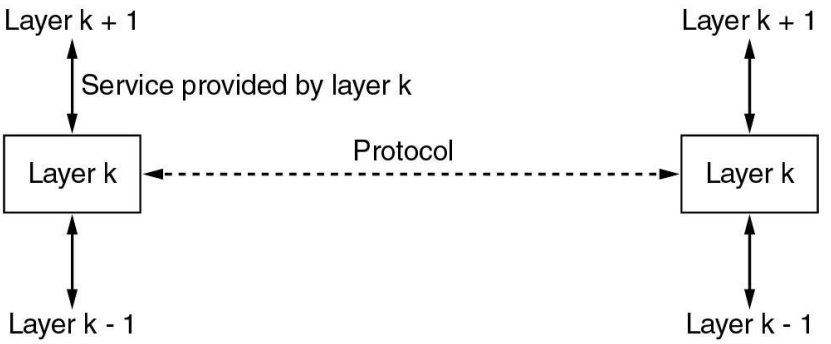
Services to Protocols Relationship

- The relationship between a service and a protocol.



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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