Week 1 – Introduction

COMP90007

Internet Technologies

Chien Aun Chan

Outline

- Computer Networks
- Network Types
- The Internet

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

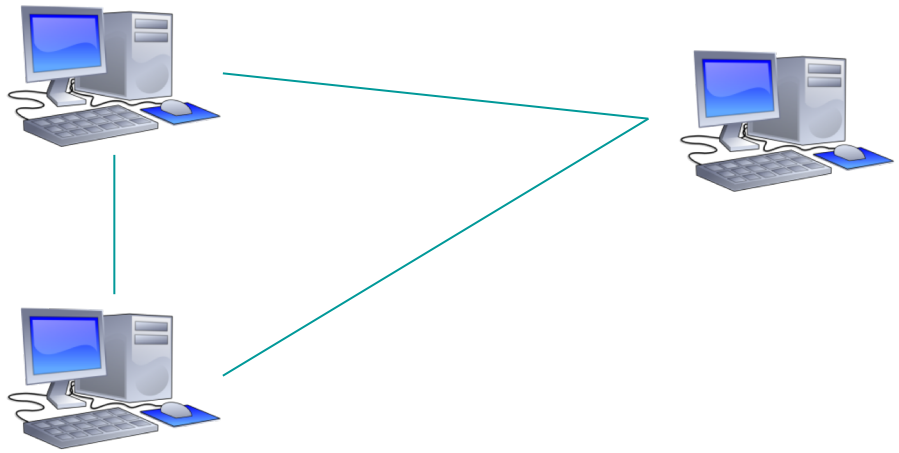
Terminologies

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

What is a 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

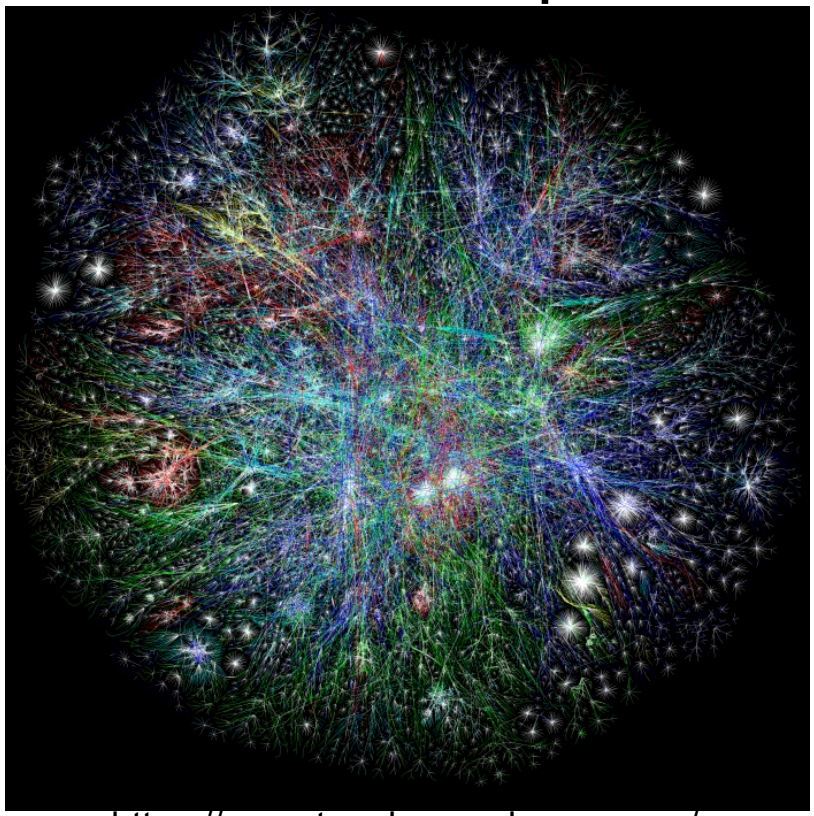
Computer Networks



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/

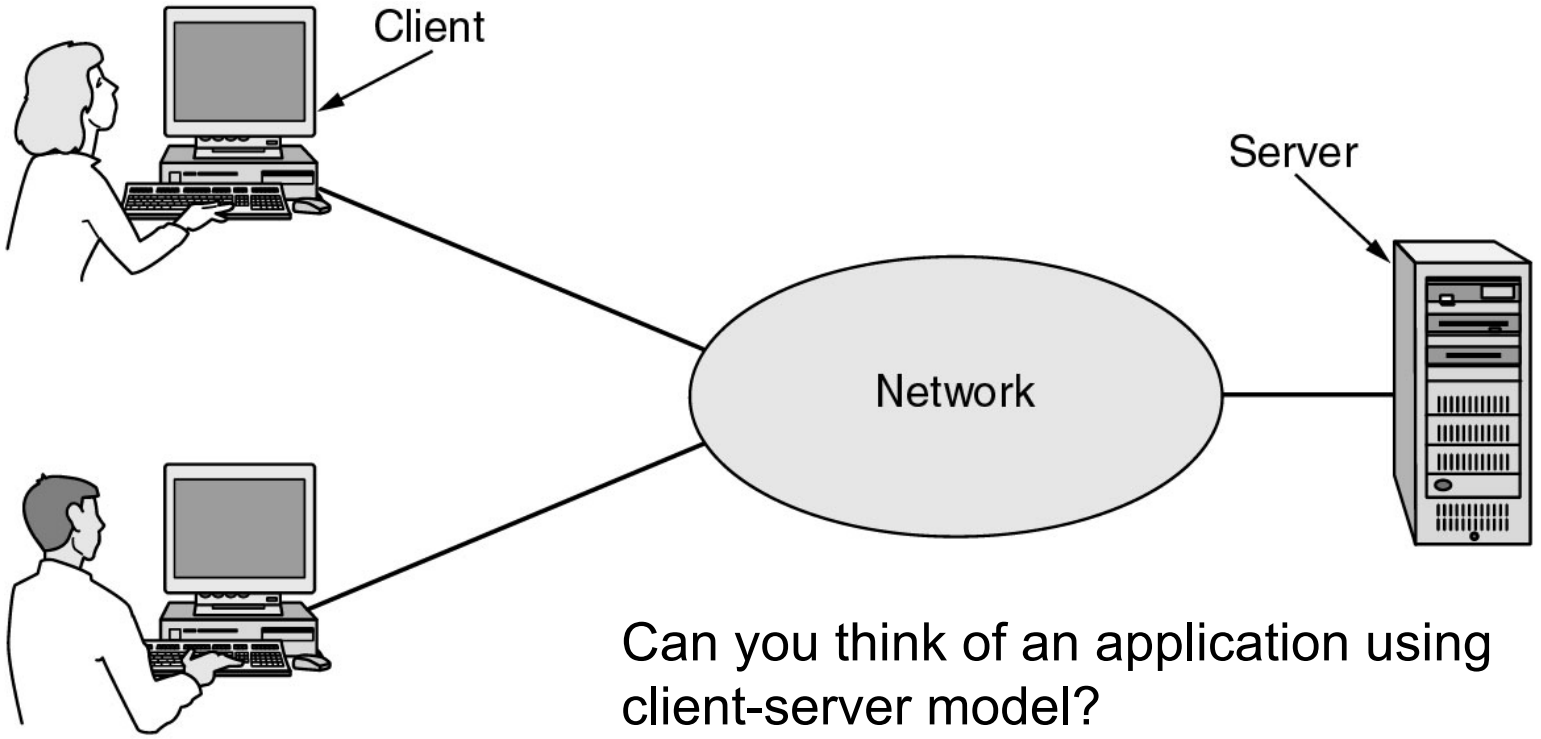
Uses of Computer Networks

- Business Applications
  - Resource sharing (e.g., printer, scanner)
- 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

How many different types of networks have you used?

Business Applications of Networks

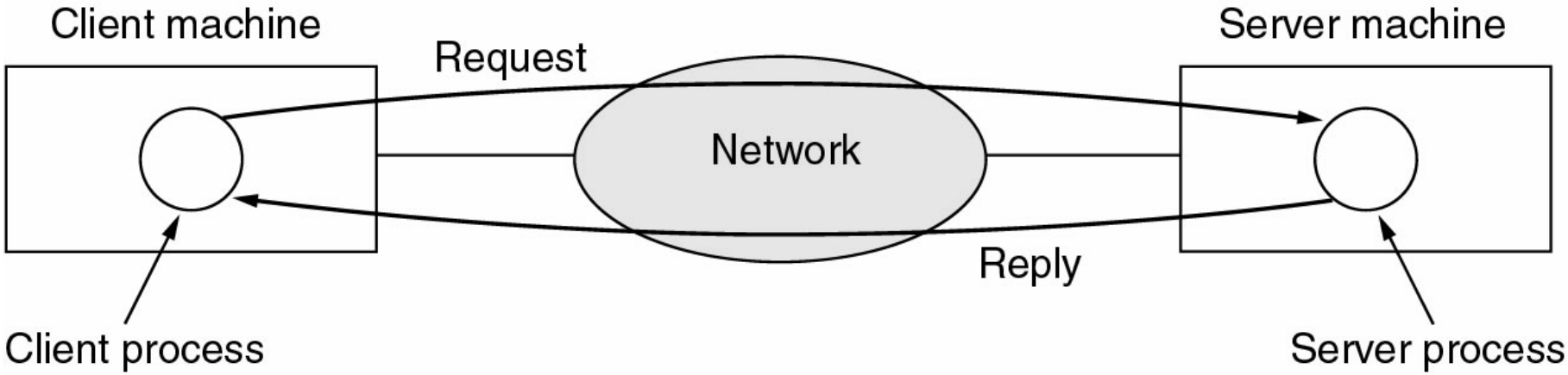
- A Simple Client-Server Network
- A network with two clients and one server



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 process 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

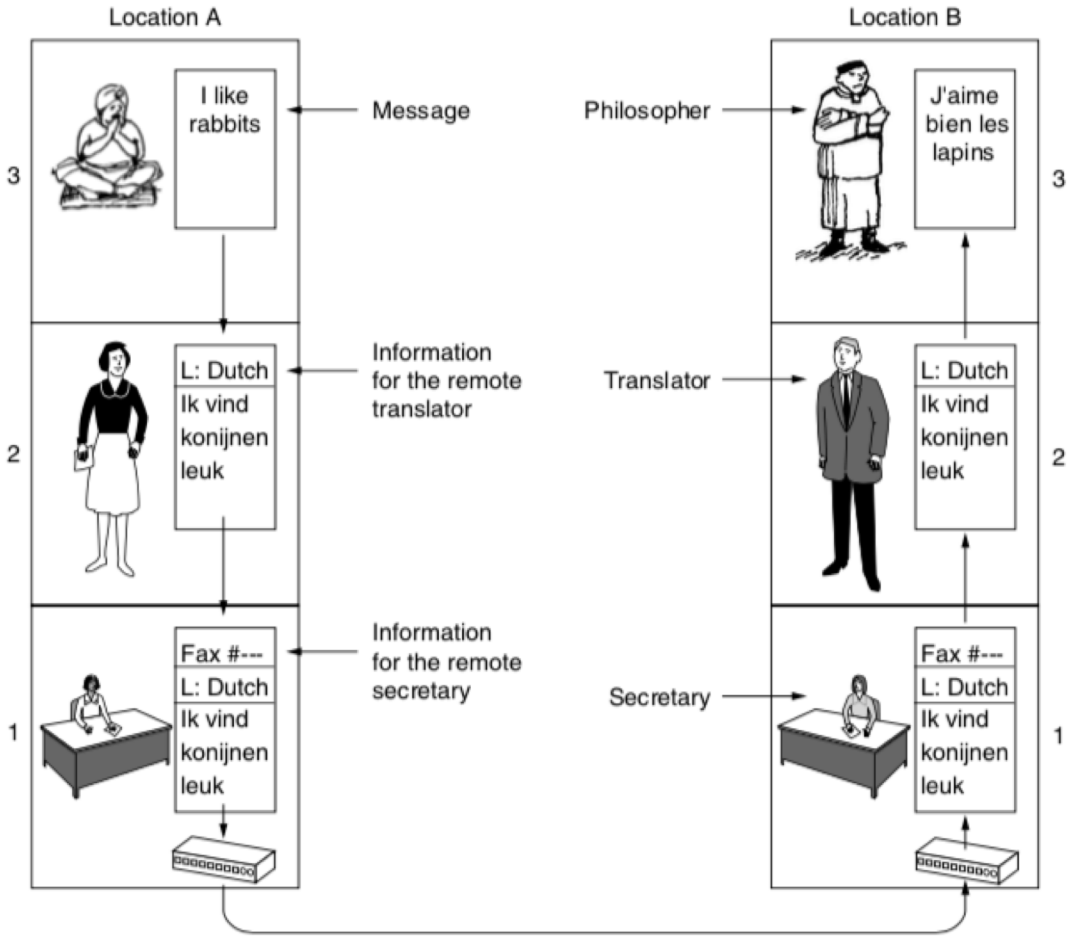
- Classification of interconnected processors by scale.

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

Outline

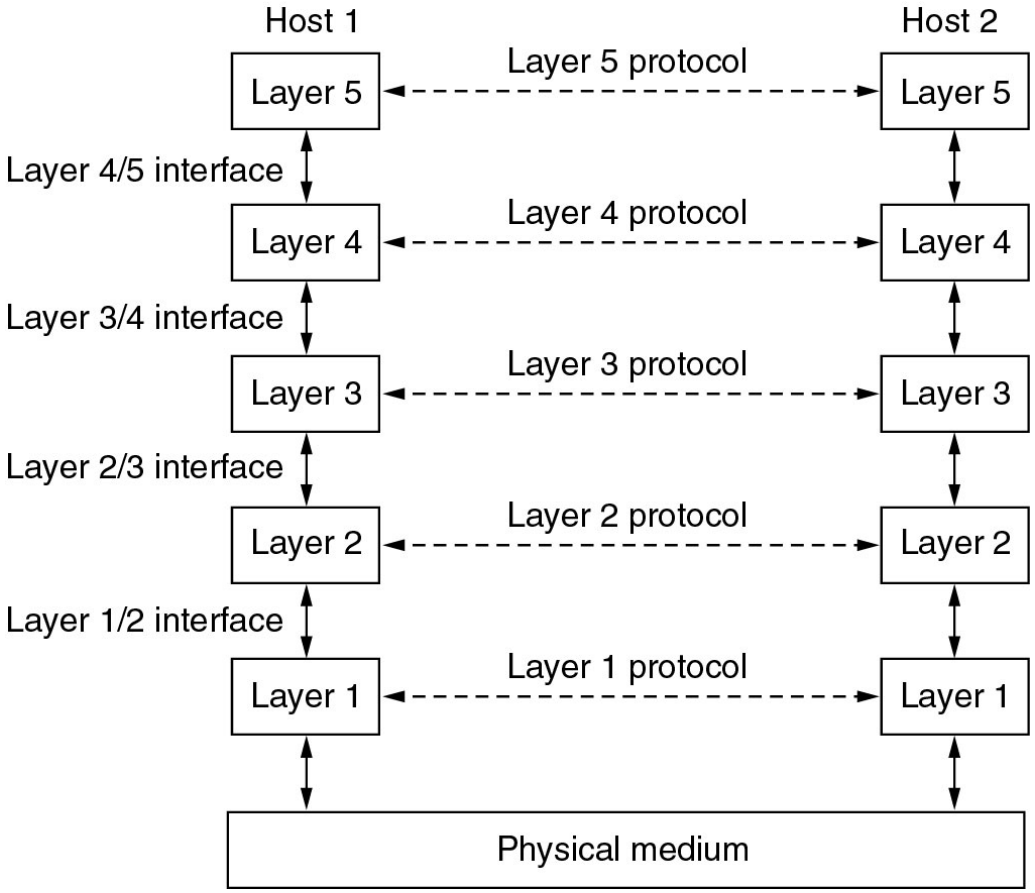
- Protocols, Layers and Services
  - Protocol Hierarchies
  - Design of Layer Models
  - Connection-Oriented and Connectionless Services
  - Services Primitives
  - Services and Protocols
- Network Reference Models
  - Open Systems Interconnect
  - TCP/IP
- Network Standards

The Philosopher-translator-secretary Architecture



Network Software

Protocol Hierarchies



Consider the network as a stack of layers

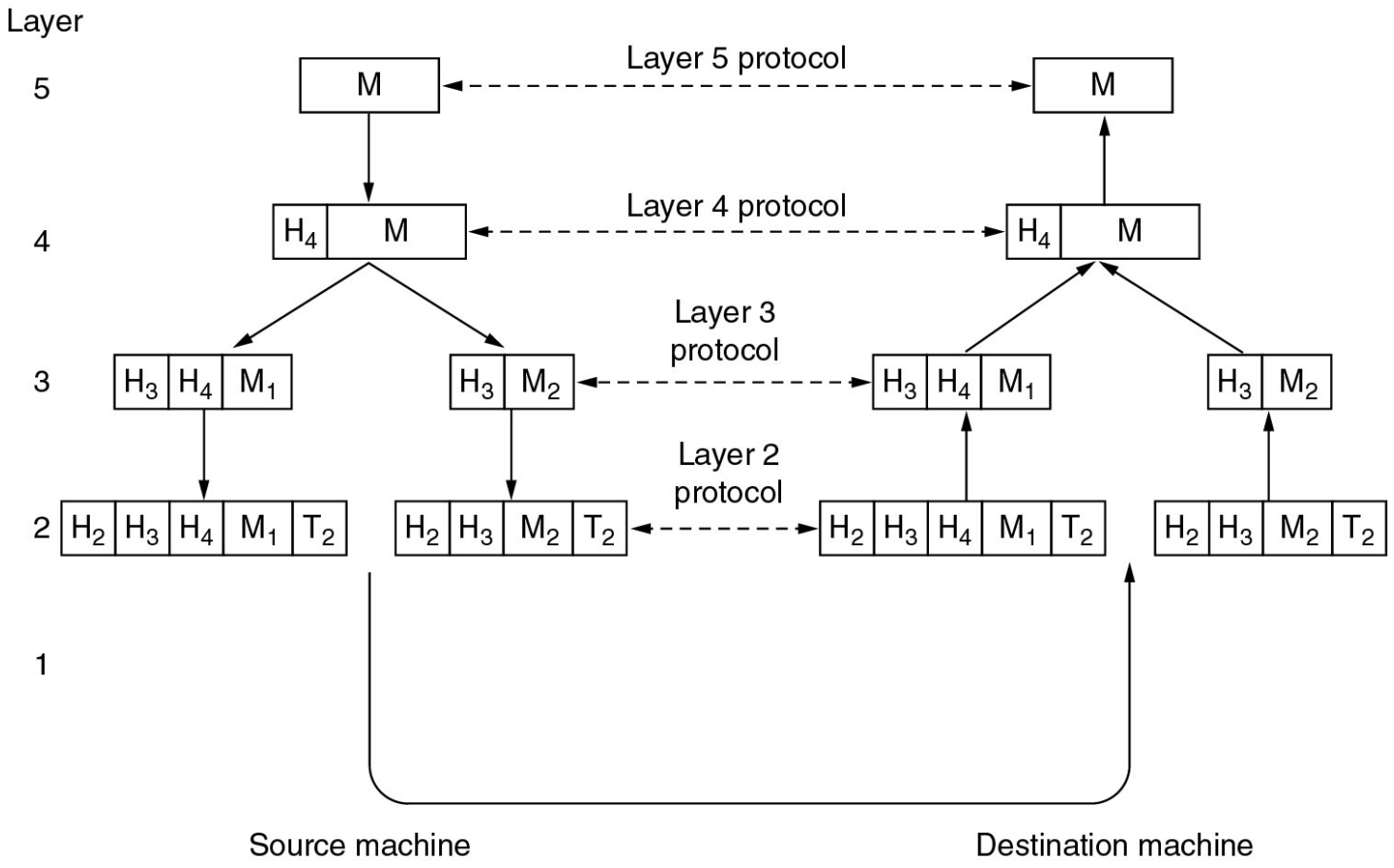
Each layer offers services to layers above it

Inter-layer exchanges are conducted according to a protocol

- Layers, protocols, and interfaces

Protocol Hierarchies (3)

- 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: use (similar to postal service)
- Choice of service type has a corresponding impact on the reliability and quality of the service itself

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

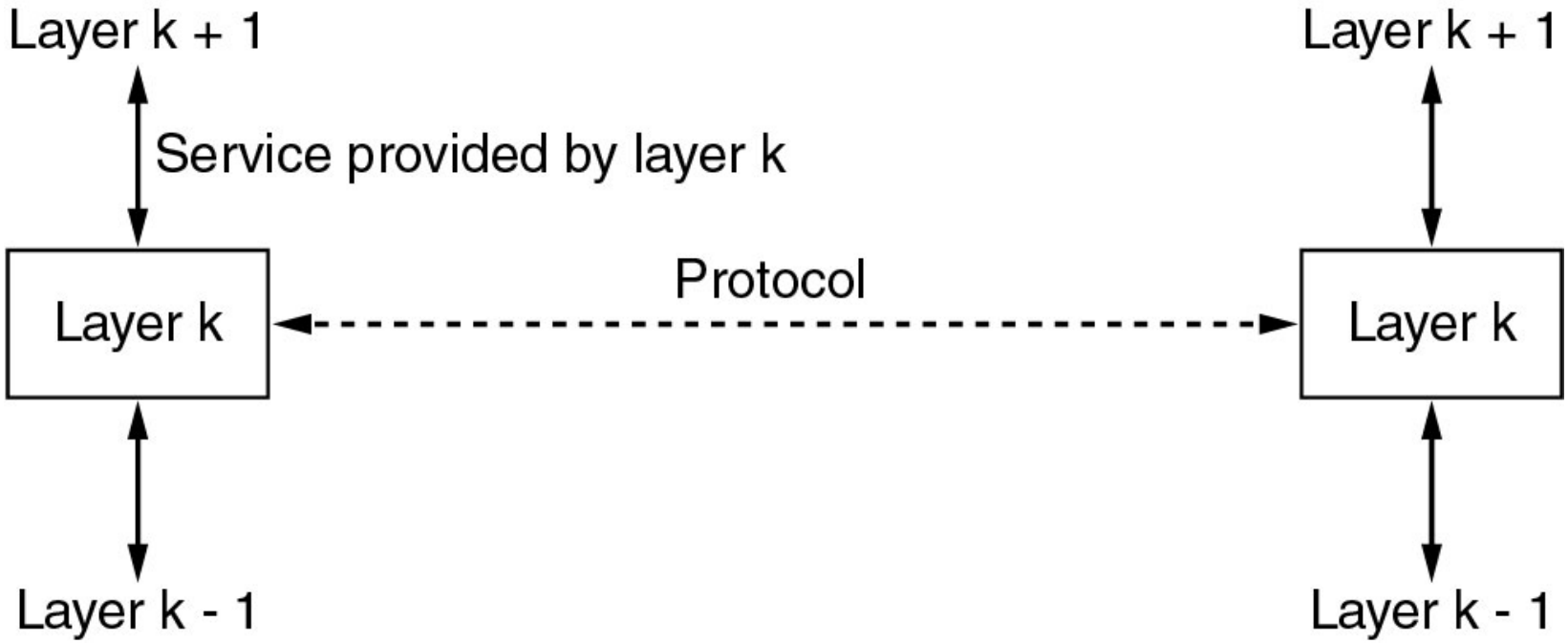
Relationship of Services and Protocols

- 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.



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 multi-dimensional, 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

OSI Reference Model

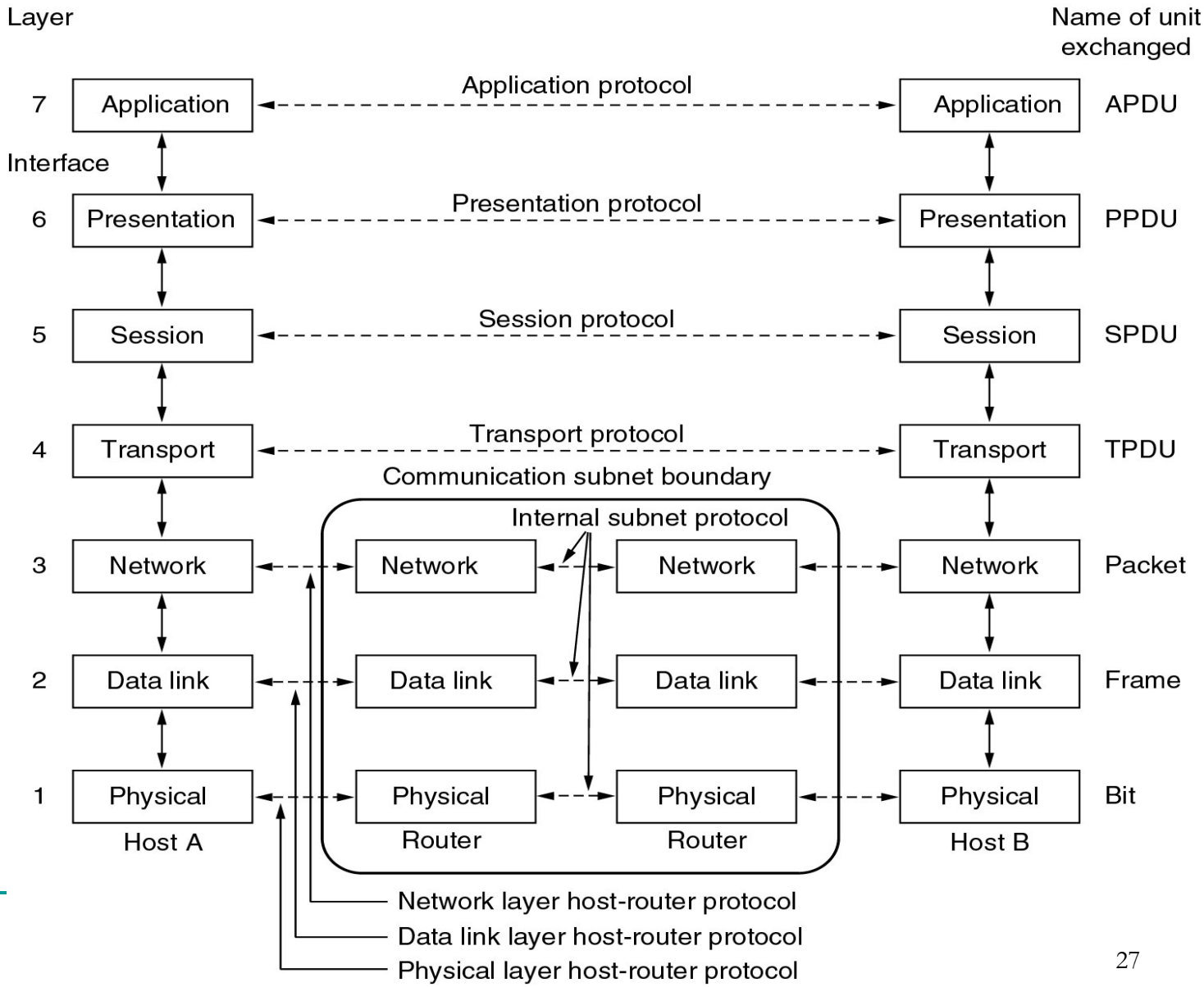
- Open Systems Interconnection (OSI)
- ISO, Day (revised 1995)
- 7 Layers
- Layer divisions based on principled decisions

OSI Layer Division Principles

1. A layer should be created where a different abstraction is needed
2. Each layer should perform a well defined function
3. The function of each layer should be chosen with a view toward defining internationally standardised protocols
4. The layer boundaries should be chosen to minimise the information flow across the interfaces
5. The number of layers should be large enough that distinct functions need not to be thrown together in the same layer out of necessity, and small enough that the architecture does not become unwieldy

Reference Models

The OSI reference model

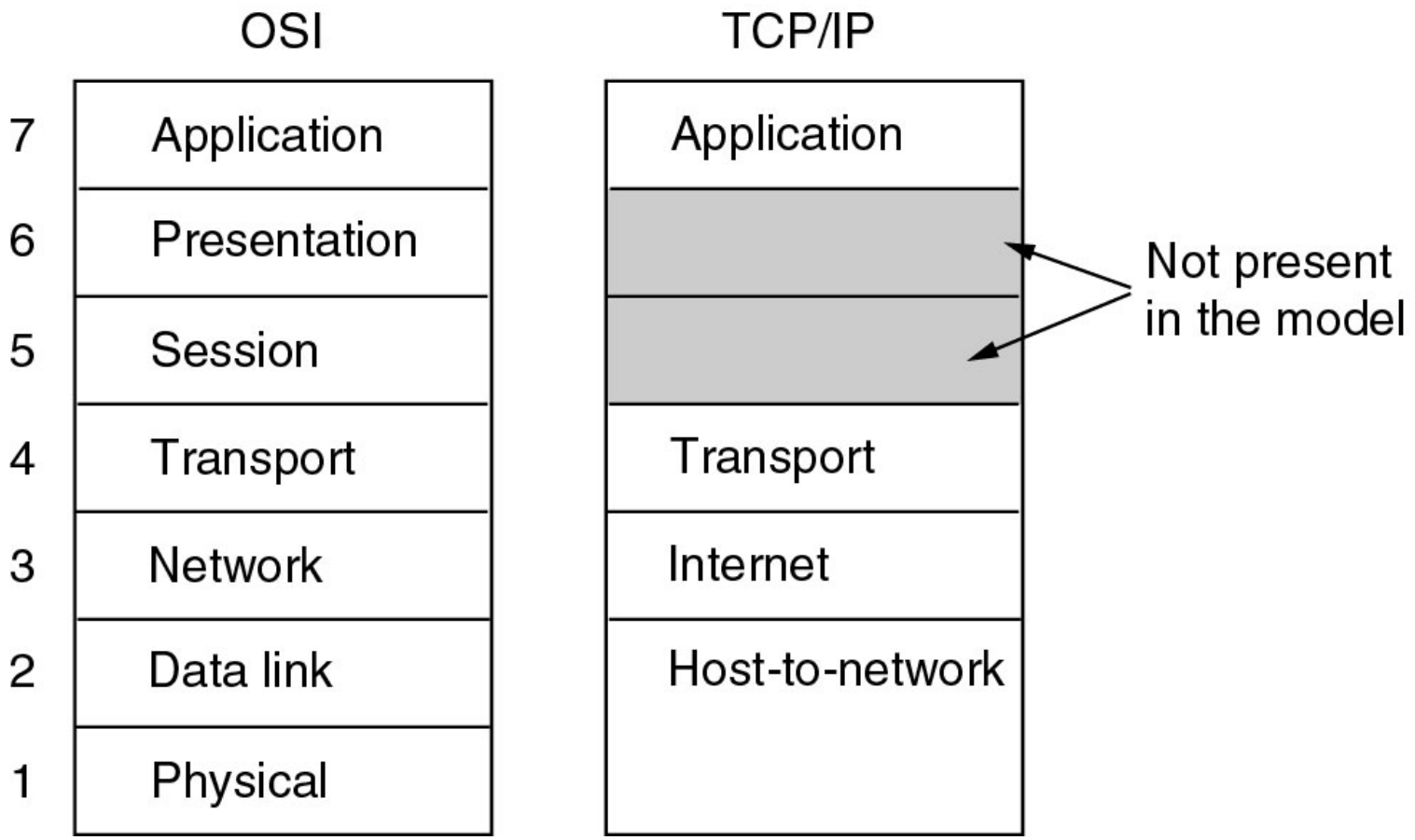


TCP/IP Reference Model

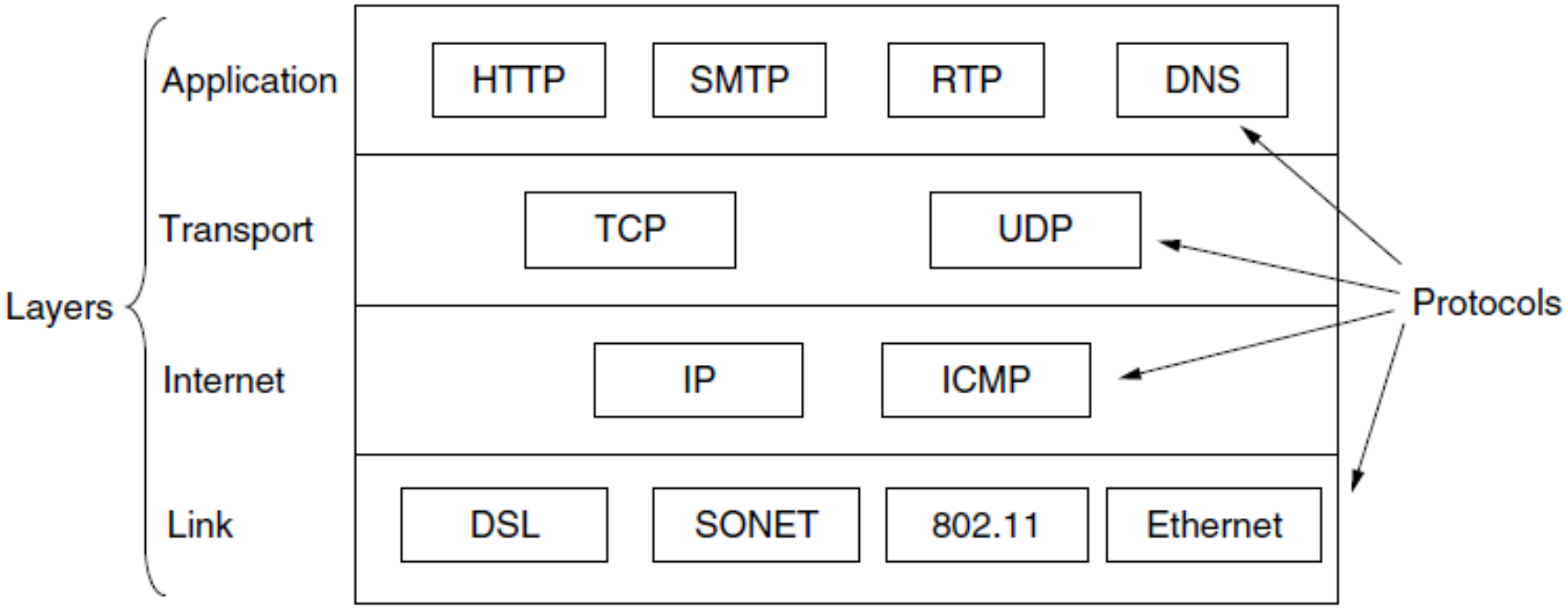
- Transmission Control Protocol/Internet Protocol
- Cerf & Kahn (1974)
- 4 layers

TCP/IP Model Illustrated

- The TCP/IP reference model.



Reference Models (3)



Comparing OSI and TCP/IP Models

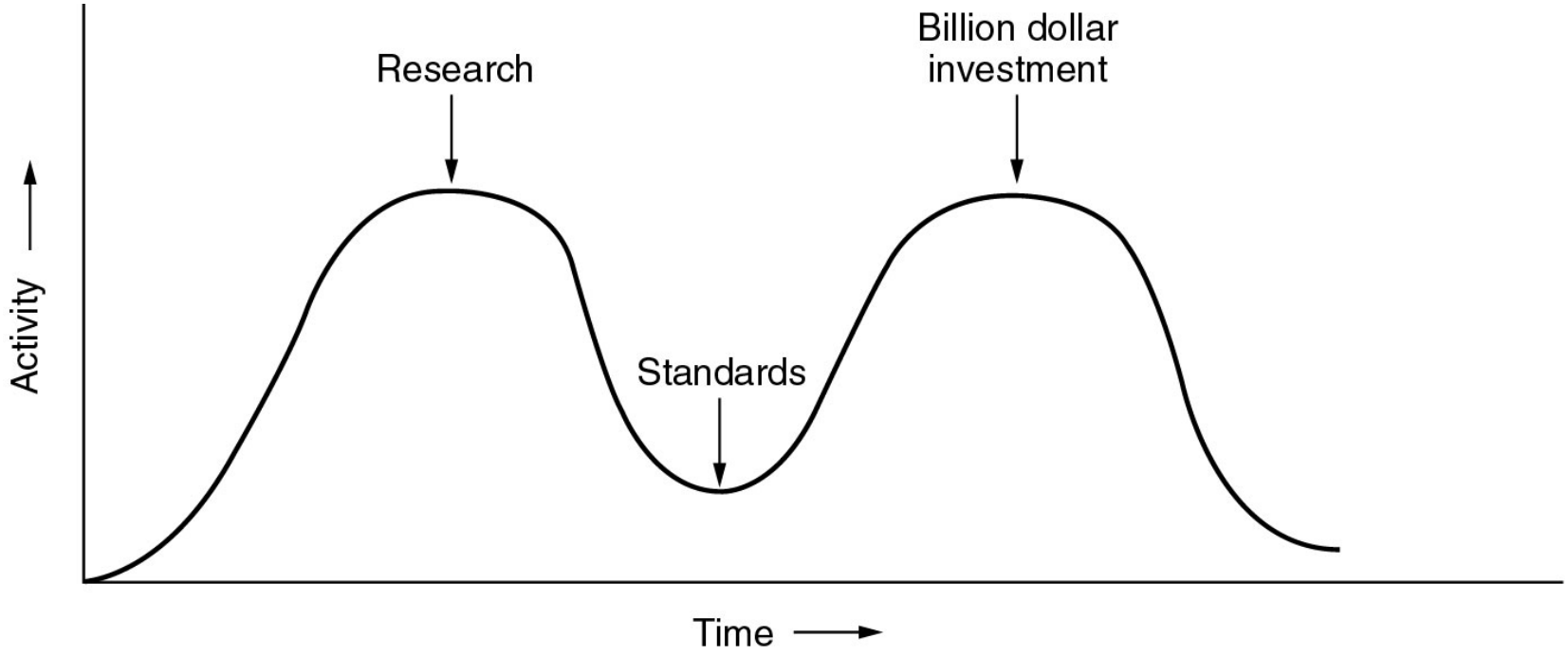
- Concepts central to the OSI model
- Services
- Interfaces
- Protocols

A Critique of the OSI Model and Protocols

- Why OSI did not take over the world?
- Bad timing
- Bad technology
- Bad implementations
- Bad politics

Bad Timing

- The apocalypse of the two elephants



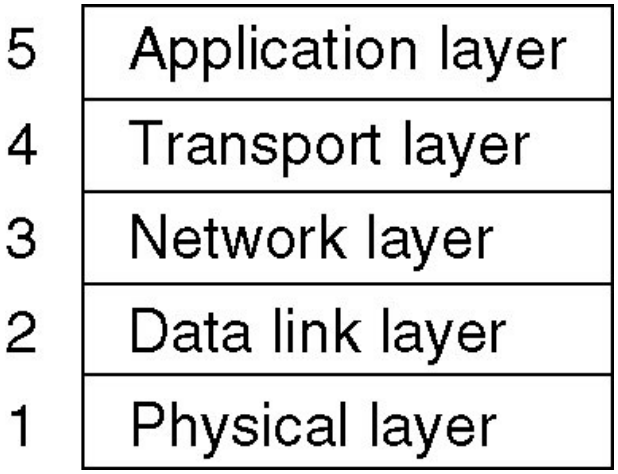
A Critique of the TCP/IP Reference Model

Problems:

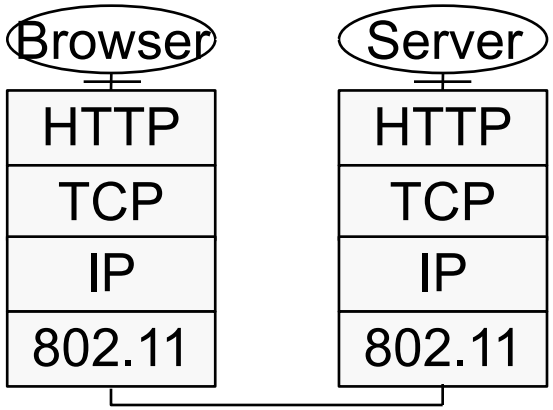
- Service, interface, and protocol not distinguished
- Not a general model
- Host-to-network “layer” not really a layer – interface between network and data link layers
- No mention of physical and data link layers
- Minor protocols deeply entrenched, hard to replace

Hybrid Model

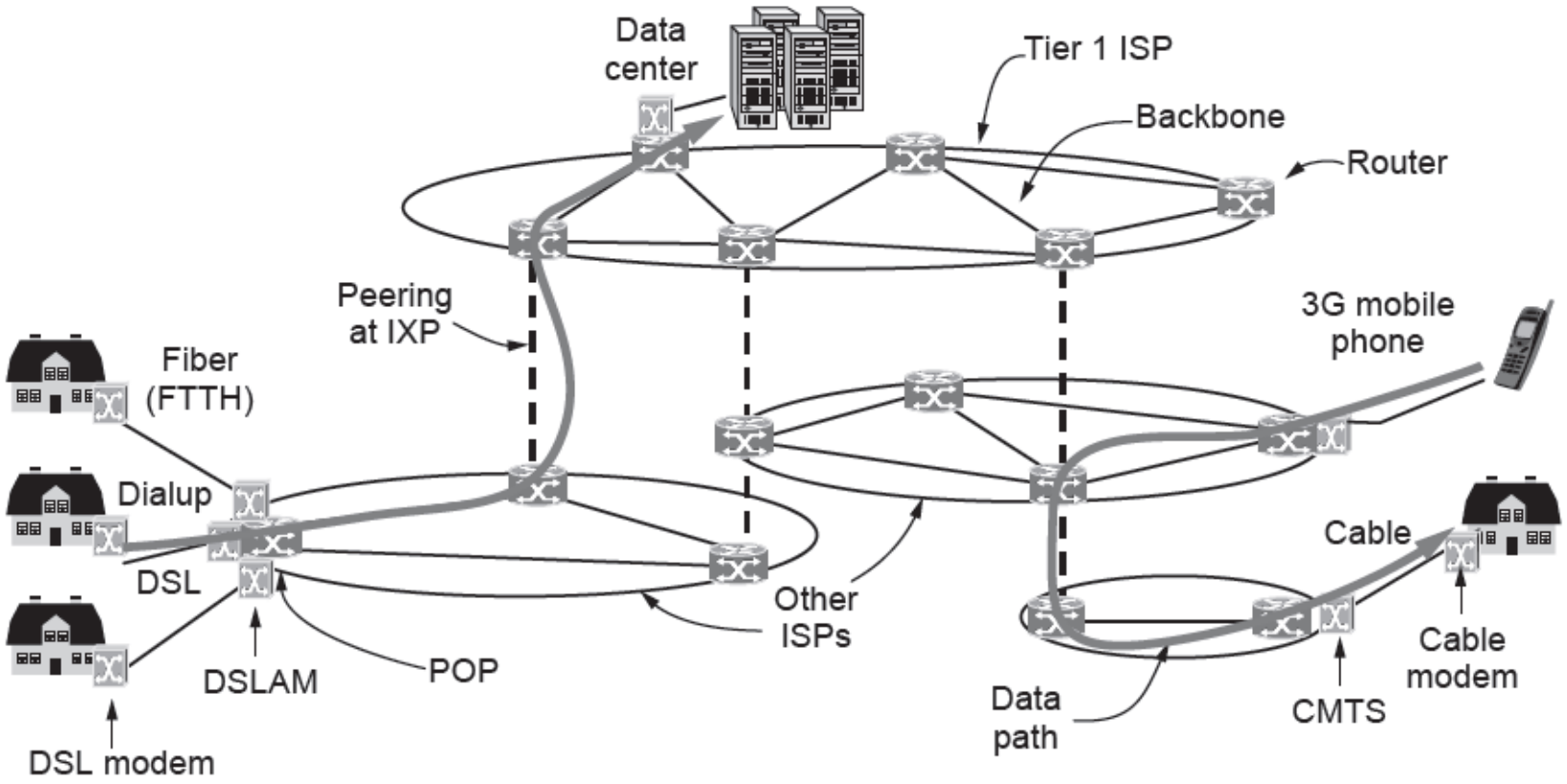
- The hybrid reference model to be used in this book. We follow this in this semester



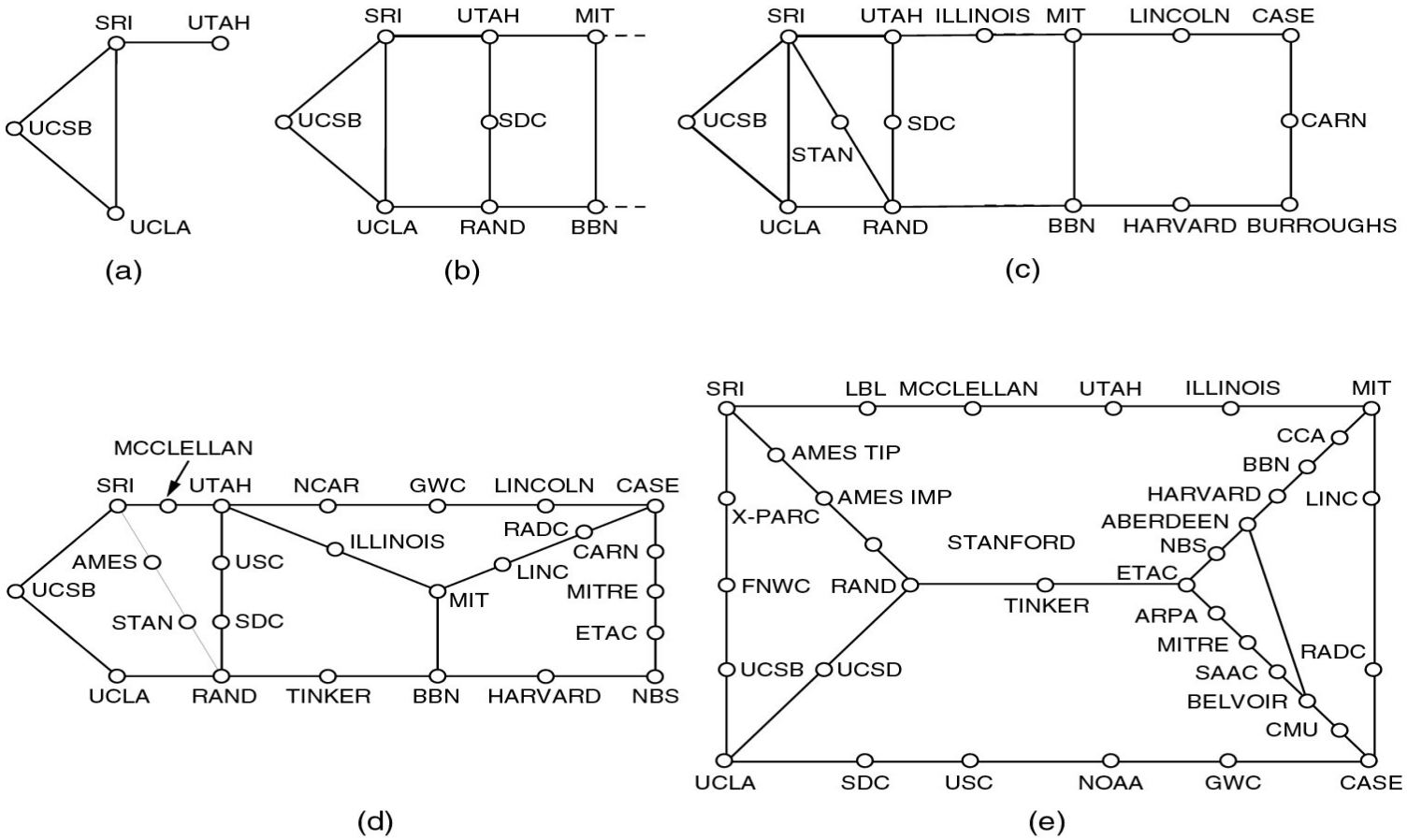
A typical network scenario



Architecture of the Internet



The ARPANET (3) Advanced Research Project Agency



- Growth of the ARPANET (a) December 1969. (b) July 1970.
- (c) March 1971. (d) April 1972. (e) September 1972.

Network Standardization

Body	Area	Examples
ITU (International Telecommunication Union)	Telecommunications	ADSL PON MPEG4
IEEE (Institute of Electrical and Electronics Engineers)	Communications	Ethernet, WiFi
IETF (Internet Engineering Task Force)	Internet	HTTP/1.1 DNS
W3C (The World Wide Web Consortium)	Web	HTML5 standard

Summary

- Computer network
- Simple client-server model
- Differentiating factors of networks
  - Transmission technology types
  - Scale
- Protocols, layers, services, & interfaces
- Protocol hierarchies
- Design issues of layers
  - E.g., connection-oriented, connectionless
  - Impact on reliability and quality of the service
- OSI vs TCP/IP