CSCI 6431

Lecture 1

GWU - Timothy Kim

Course Overview

- Book
  - Computer Networks (5th edition)
    - Tanenbaum & Wetherall
- Course Material
  - https://github.com/GWU-CSCI-6431/class-material
- Evaluation
  - 5 Homeworks - 25% (5% each)
  - 2 Projects - 25% (10%, 15%)
  - Midterm - 25%
  - Final Exam - 25%

Lecture 1 - Objective

- Learn the different types of networks
- Learn the terminologies involved in networks
- Understand the Layer Model
- Learn how the Internet works at a very high level

Chapter 1 Coverage

1.2 - Networking Hardware

1.3 - Networking Software

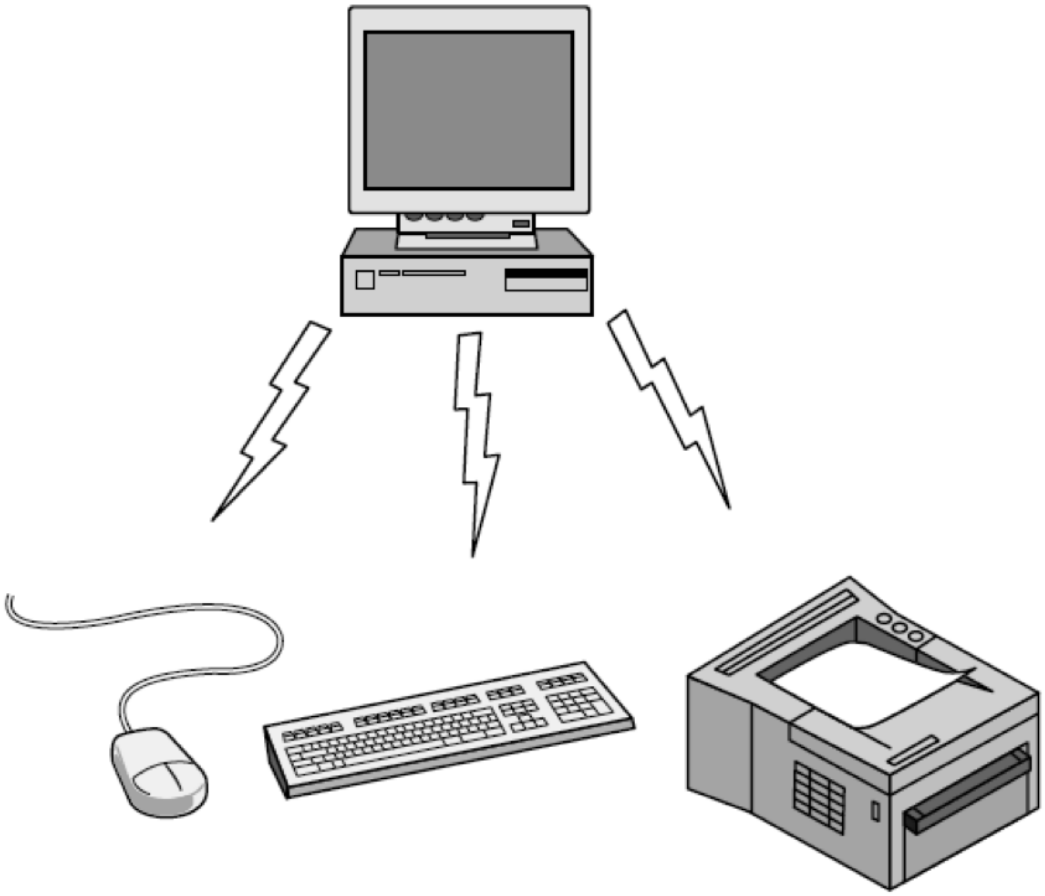
1.4 - Reference Models

1.5.1 - Internet

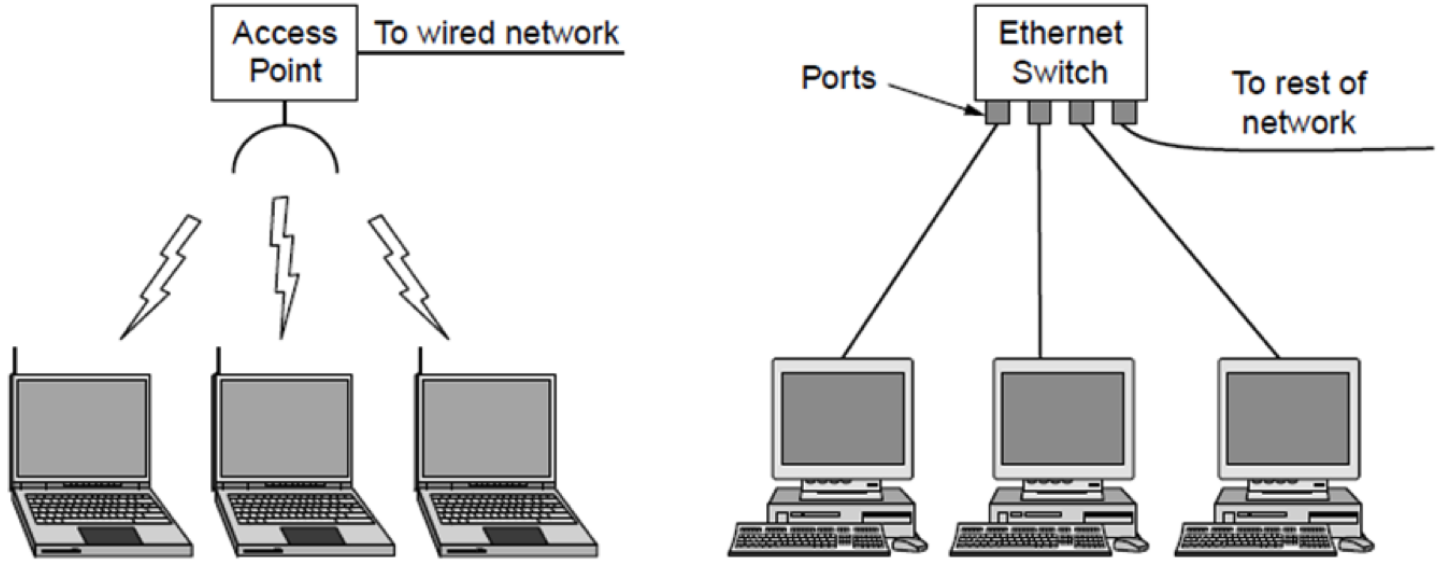
Network "Hardware" Design

- Transmission Technology
  - Broadcast
    - Broadcasting
    - Multicasting
  - Point-to-Point
    - Unicasting
- Scale
  - Classification based on the reach of the network.

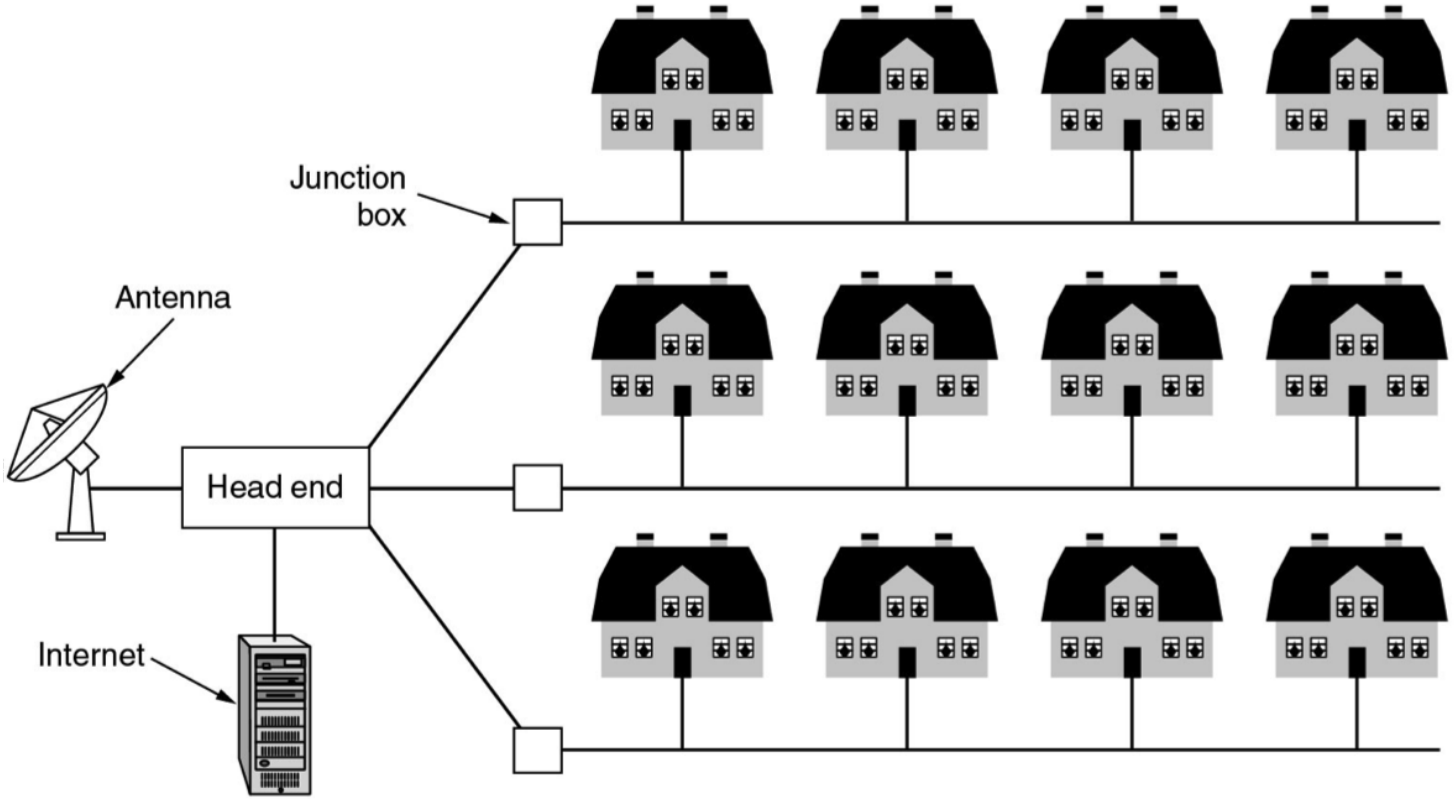
Personal Area Network



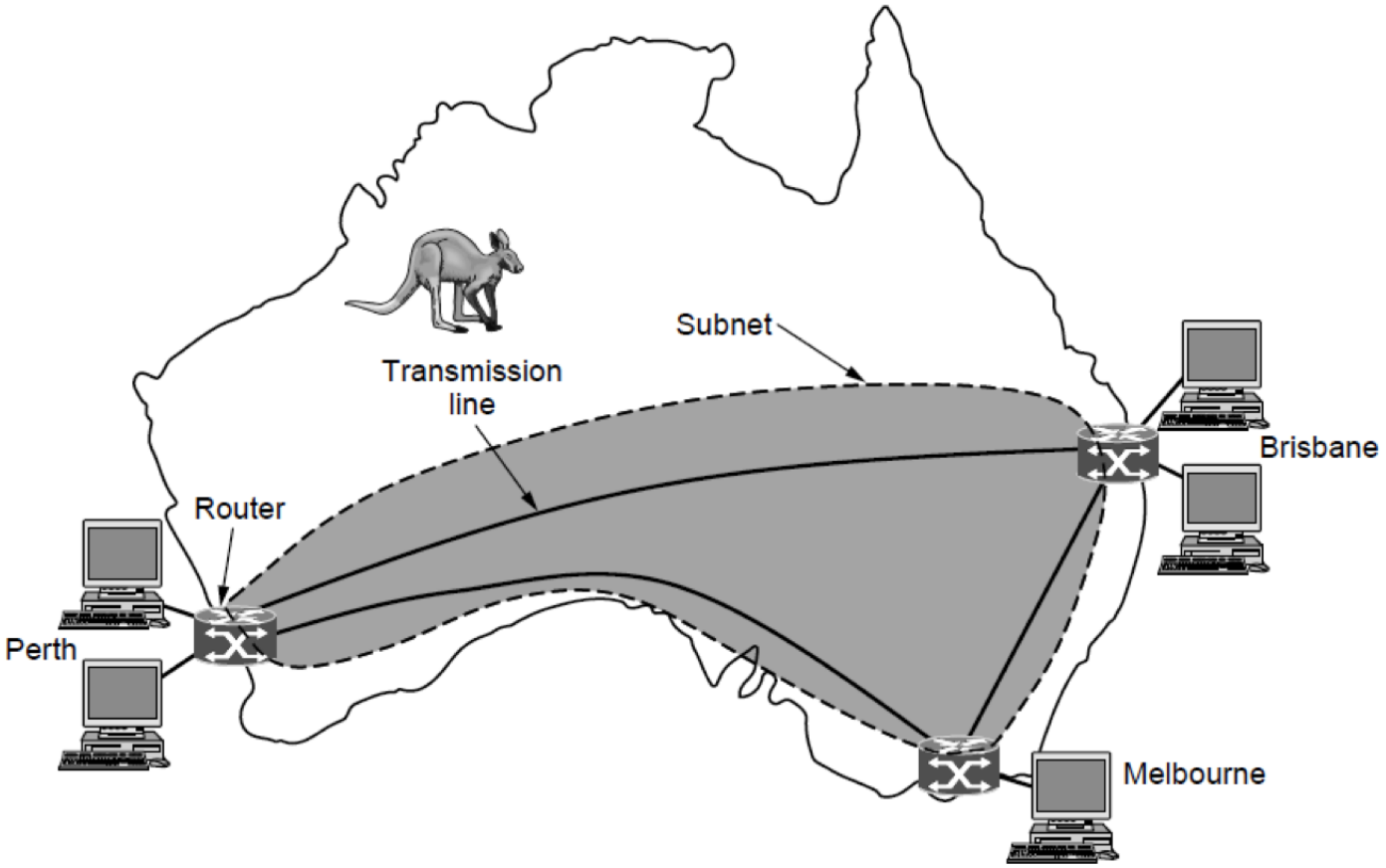
Local Area Network



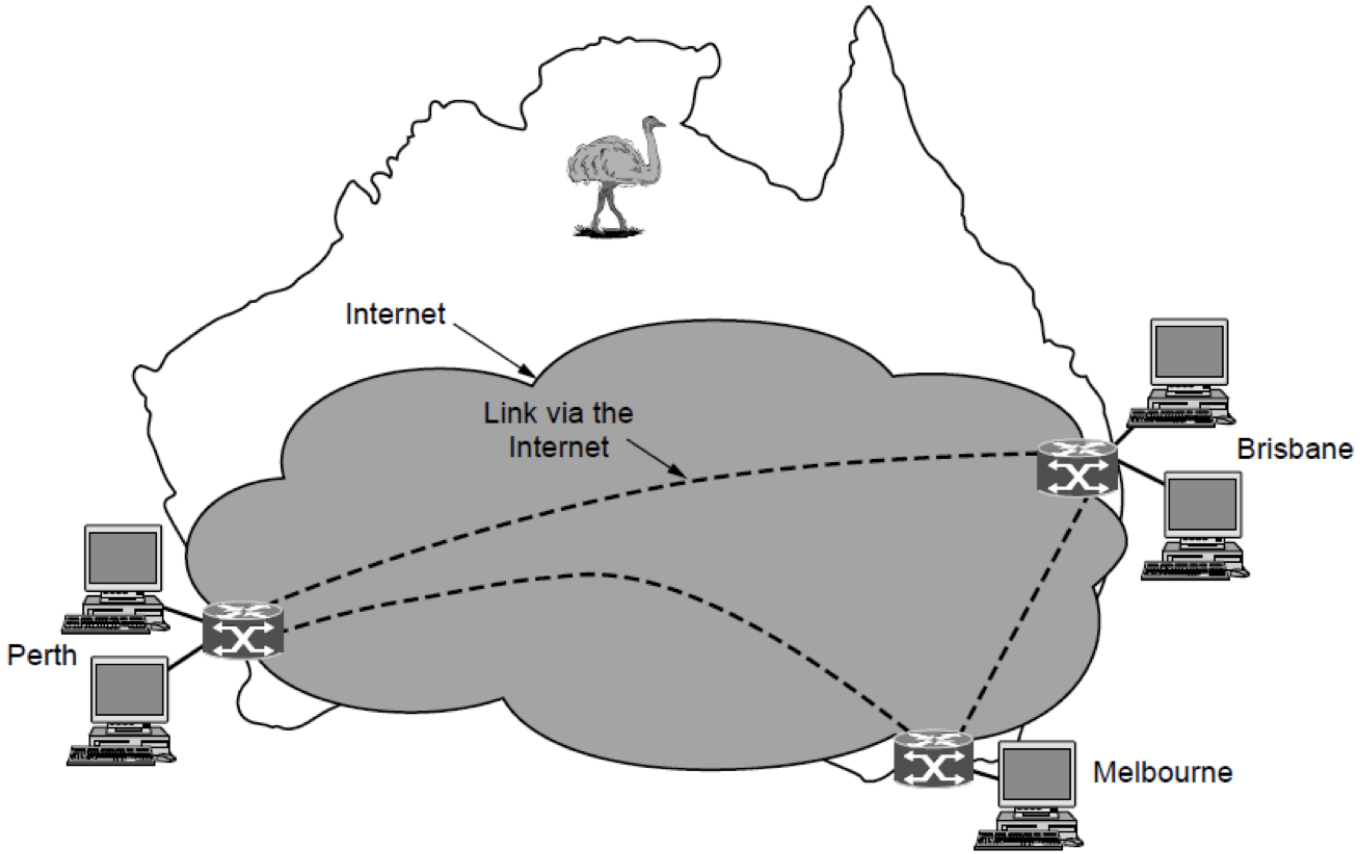
Metropolitan Area Networks



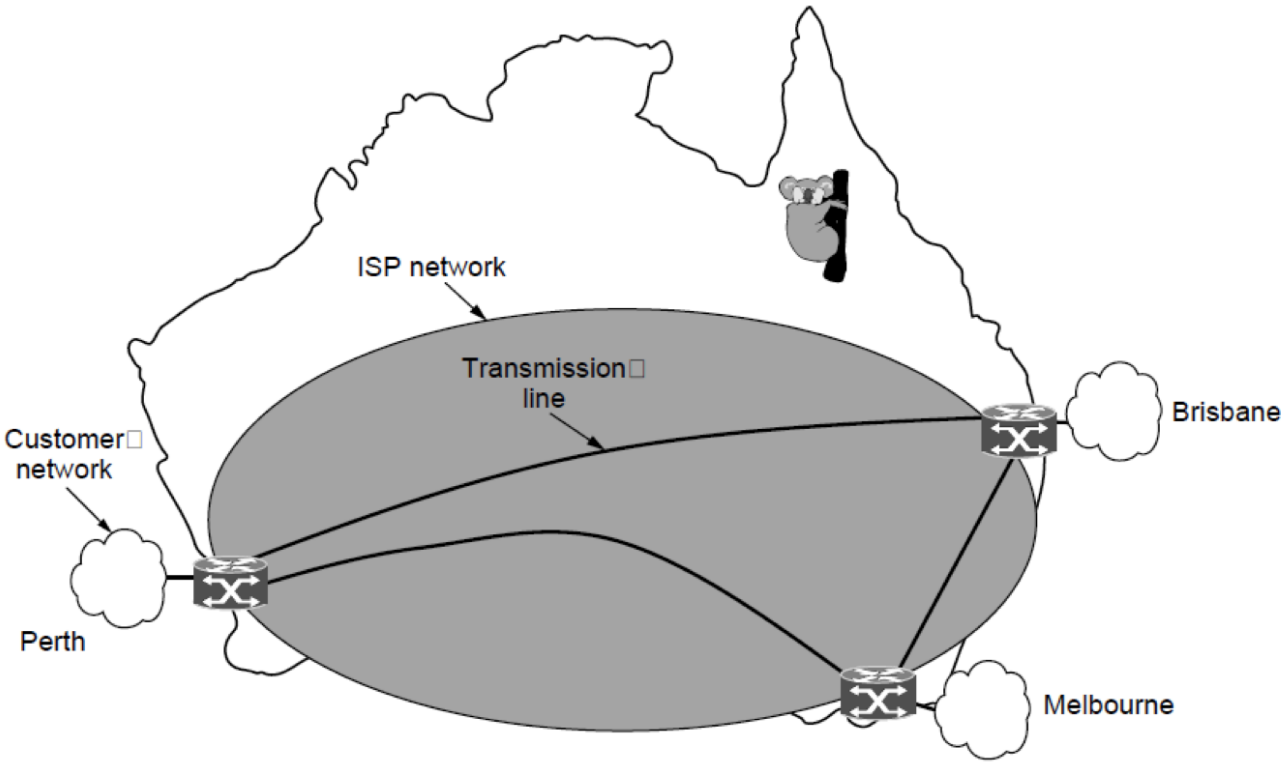
Wide Area Networks



Wide Area Networks



Wide Area Networks



Network 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

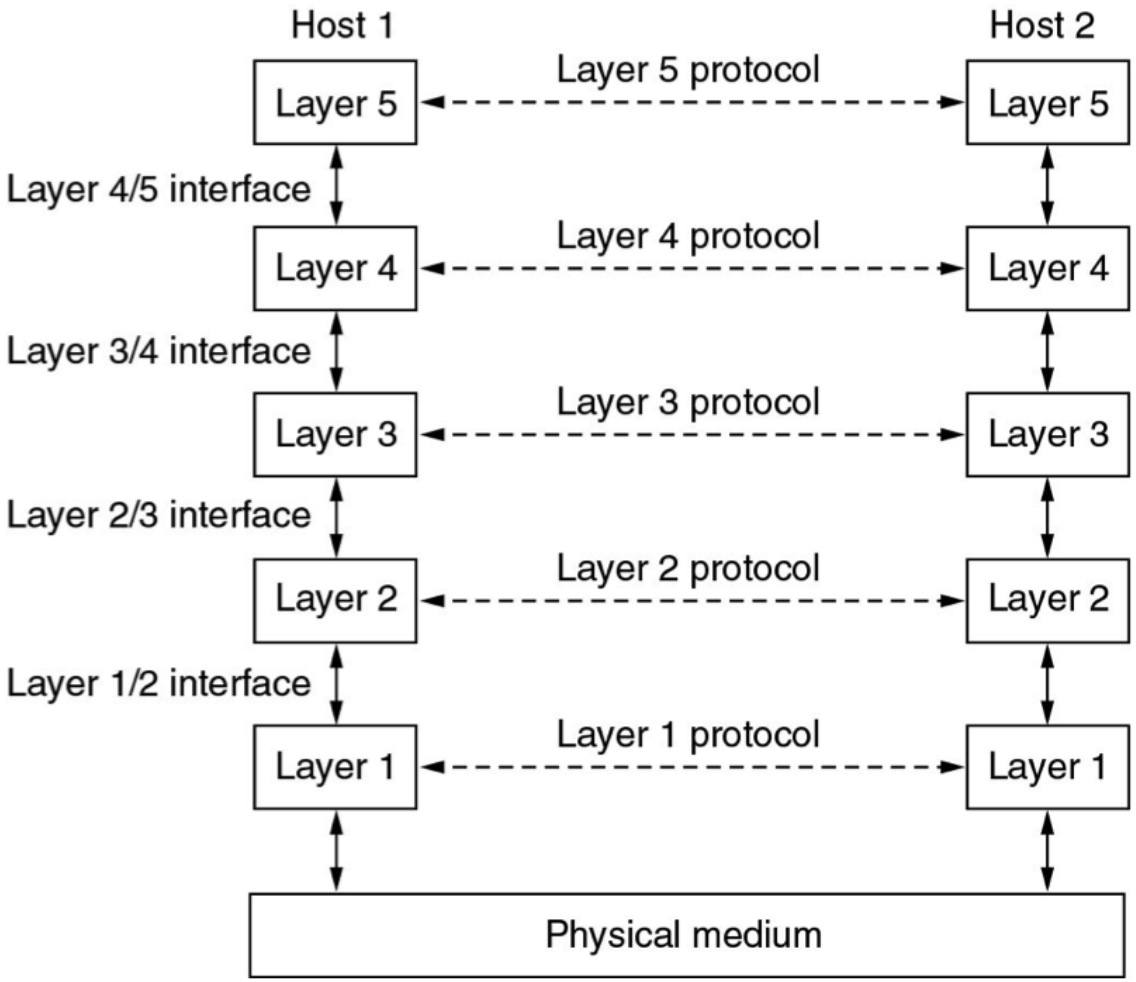
Terminologies ("hardware")

- Hosts
- Access Point
- Packet Switches (routers)
- Communication Links

Network "Software" Design

- Networks are complex
  - hosts
  - routers
  - different links
  - hardware vendors
  - softwares
- How do you organize them?
  - Layers (or levels)
  - Abstraction via server/interface
  - Communication via protocol

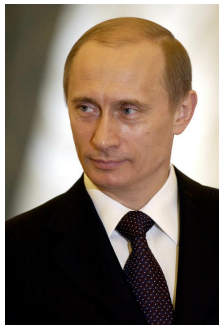
Layer Model


Host 1
Host 2
Layer 5
Layer 5 protocol
Layer 5
Layer 4/5 interface
Layer 4
Layer 4 protocol
Layer 4
Layer 3/4 interface
Layer 3
Layer 3 protocol
Layer 3
Layer 2/3 interface
Layer 2
Layer 2 protocol
Layer 2
Layer 1/2 interface
Layer 1
Layer 1 protocol
Layer 1
Physical medium

Layer Example - Human

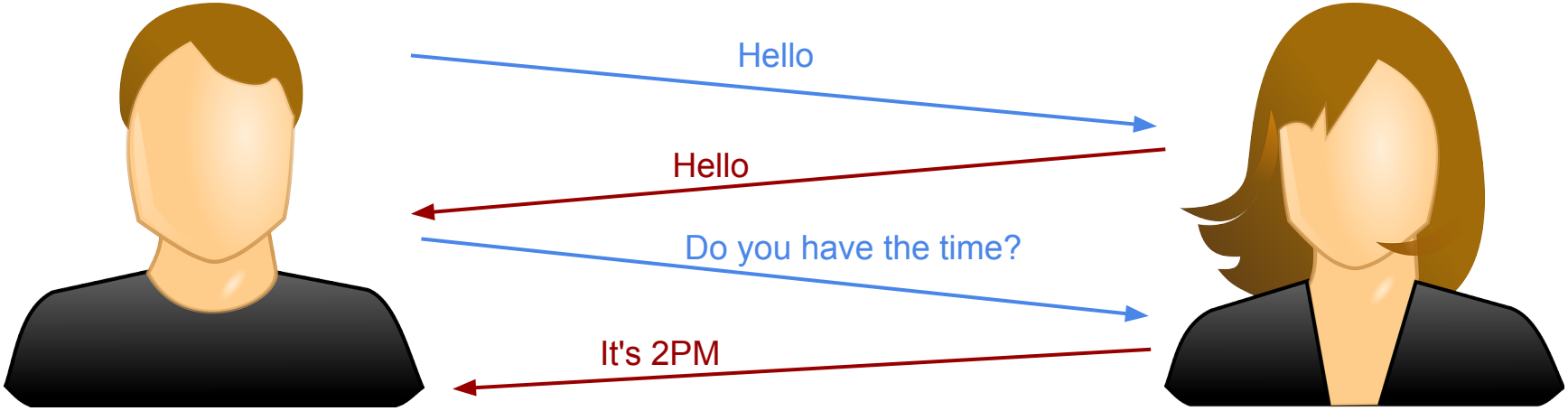
Hello

привет



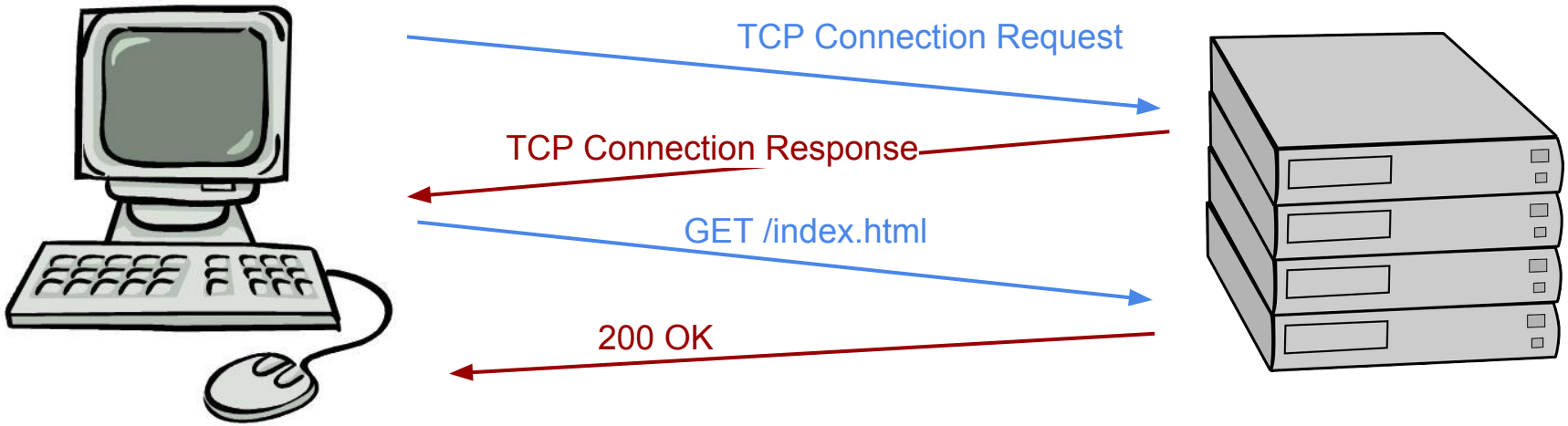
Protocol - Human Example

- An agreement

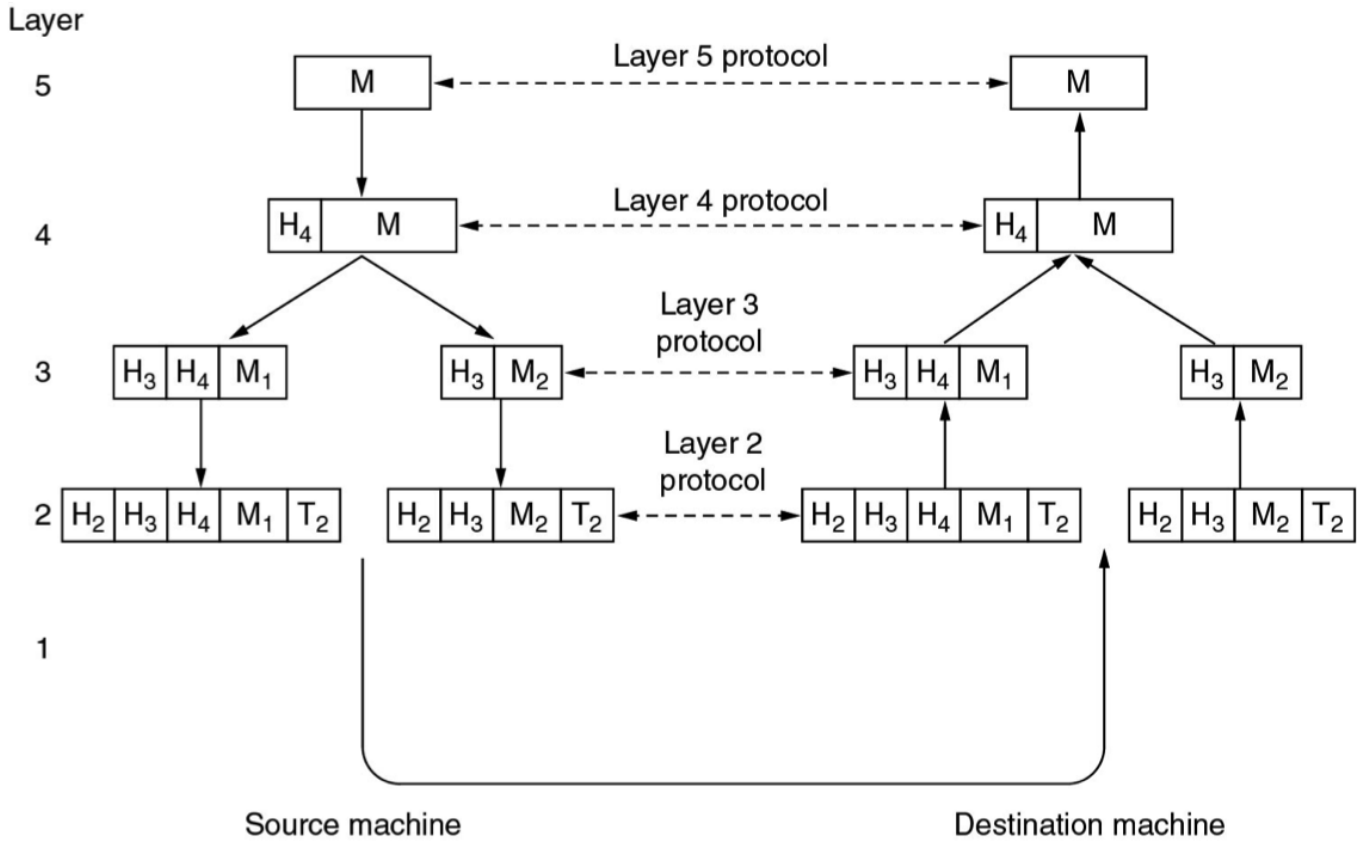


Protocol - Machine Ex.

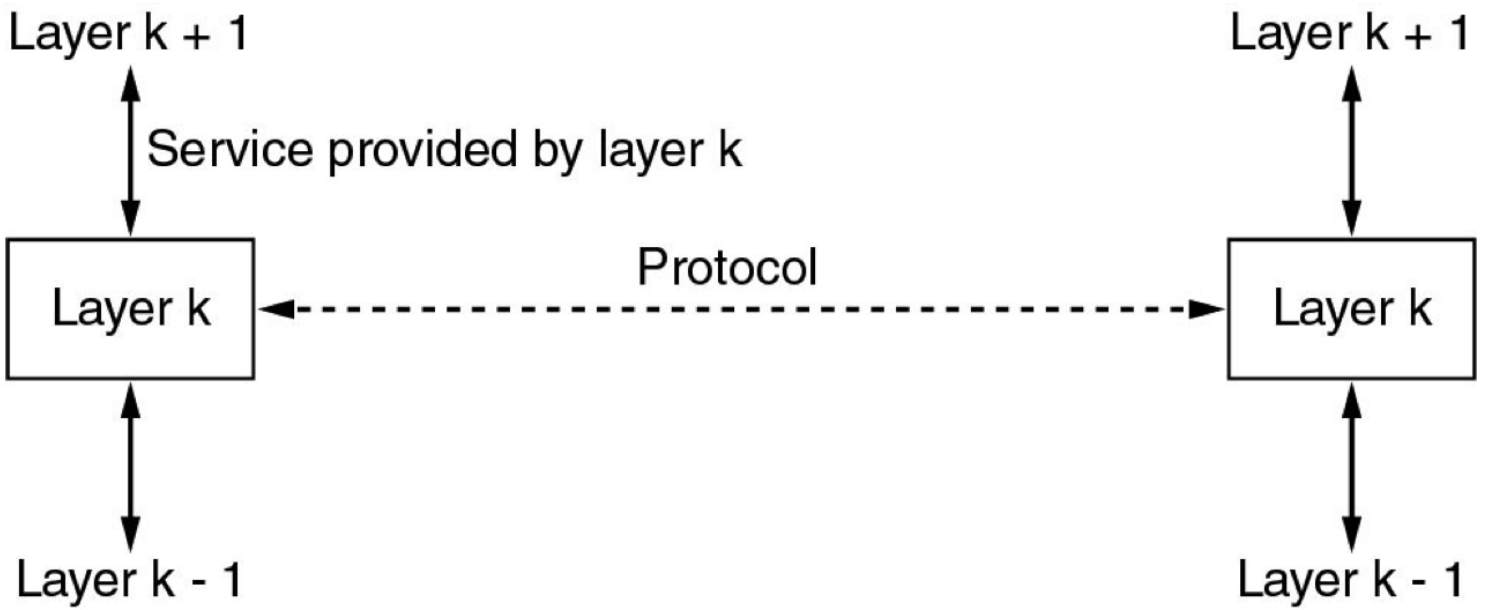
- HTTP



Protocol Hierarchies



Service vs. Protocol



Service Types

- Connection-Oriented
  - Session oriented
  - Semi-permanent connection
  - Typical Method
    - Connection Establishment
    - Negotiation
    - Data Transfer
    - Termination
  - Reliable = no data loss
  - Examples
    - Telephone
    - File Transfer

Service Types

- Connectionless
  - Each packet contains header with destination info
  - Unreliable = data loss is acceptable
  - Examples
    - IP
    - UDP (Video Streaming, VoIP)

Network Design Issues

- Unreliable Components
  - Error Detection/Correction
- Multiple/Faulty Paths
  - Routing Decisions
- Identification
  - Addressing
- Bandwidth Sharing
  - Multiplexing
- Congestion
  - Flow Control / Quality of Service
- Security

OSI Reference Model

Application

Presentation

Session

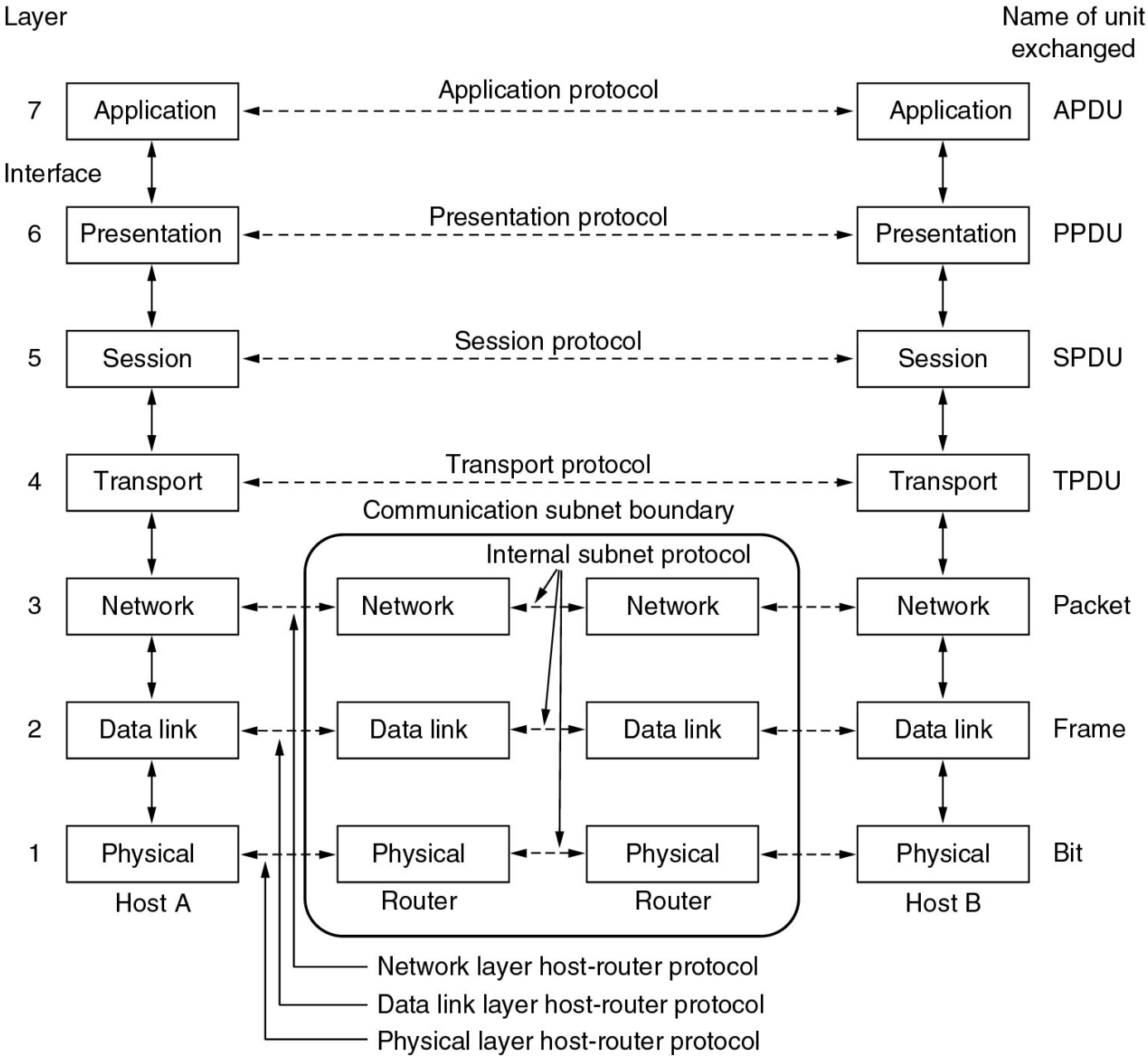
Transport

Network

Data Link

Physical

Please Do Not Throw Sausage Pizza Away


Layer
Name of unit exchanged
7
Application
Application protocol
Application
APDU
Interface
6
Presentation
Presentation protocol
Presentation
PPDU
5
Session
Session protocol
Session
SPDU
4
Transport
Transport protocol
Transport
TPDU
Communication subnet boundary
Internal subnet protocol
3
Network
Network
Network
Network
Packet
2
Data link
Data link
Data link
Data link
Frame
1
Physical
Physical
Physical
Physical
Bit
Host A
Router
Router
Host B
Network layer host-router protocol
Data link layer host-router protocol
Physical layer host-router protocol

Physical Layer

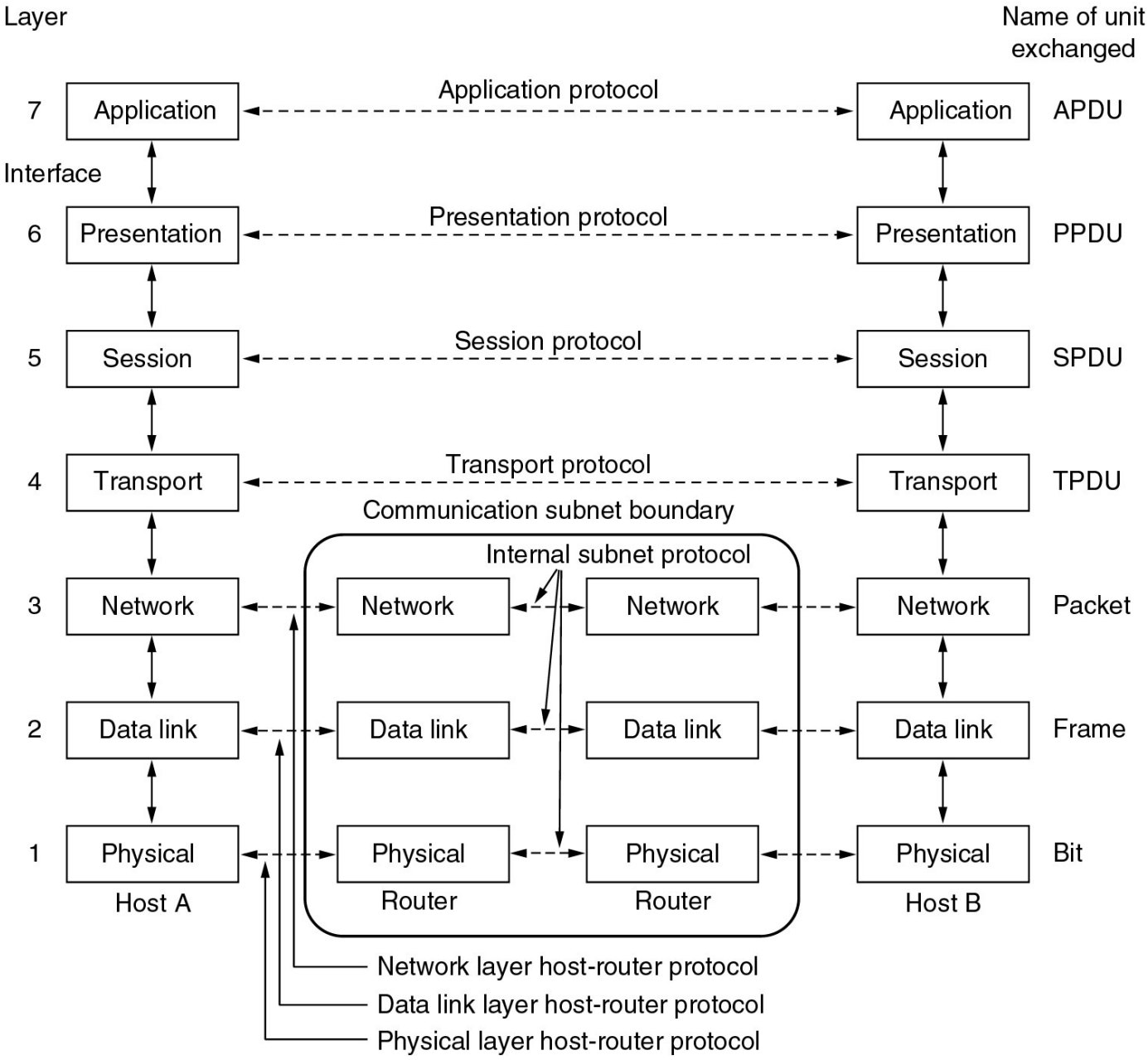
- Transmit raw bits
- Making sure 1 bit and received as 1 bit and 0 bit as 0 bit
- Examples
  - Twisted Pair
  - Optical Fiber
  - Wireless Transmission

Data Link Layer

- Error Correction
- Data Frames
- Connection-oriented vs Connectionless
- Flow Control
- Sublayer for Broadcast networks
  - Medium Access Control (MAC) Layer
    - Control access to shared channel
- Examples
  - Ethernet
  - Bluetooth

Network Layer

- Packet Forwarding
- Routing
- Handling Congestions (Quality of Service)
- Examples:
  - IPv4
  - IPv6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TPDU
Communication subnet boundary
Internal subnet protocol
3
Network
Network
Network
Network
Packet
2
Data link
Data link
Data link
Data link
Frame
1
Physical
Physical
Physical
Physical
Bit
Host A
Router
Router
Host B
Network layer host-router protocol
Data link layer host-router protocol
Physical layer host-router protocol

Transport Layer

- End-to-End communication from application perspective
- User space interface
- Determines the type of the network
  - Connection-oriented vs Connectionless
  - Same order delivery
  - Reliability
  - Flow Control
  - Congestion Control
- Examples:
  - TCP, UDP, APT, etc.

Session Layer

- Session Management
- Authentication
- Authorization
- Synchronization/combination of two source of data to one
- Examples:
  - Web Conferencing
  - Live TV

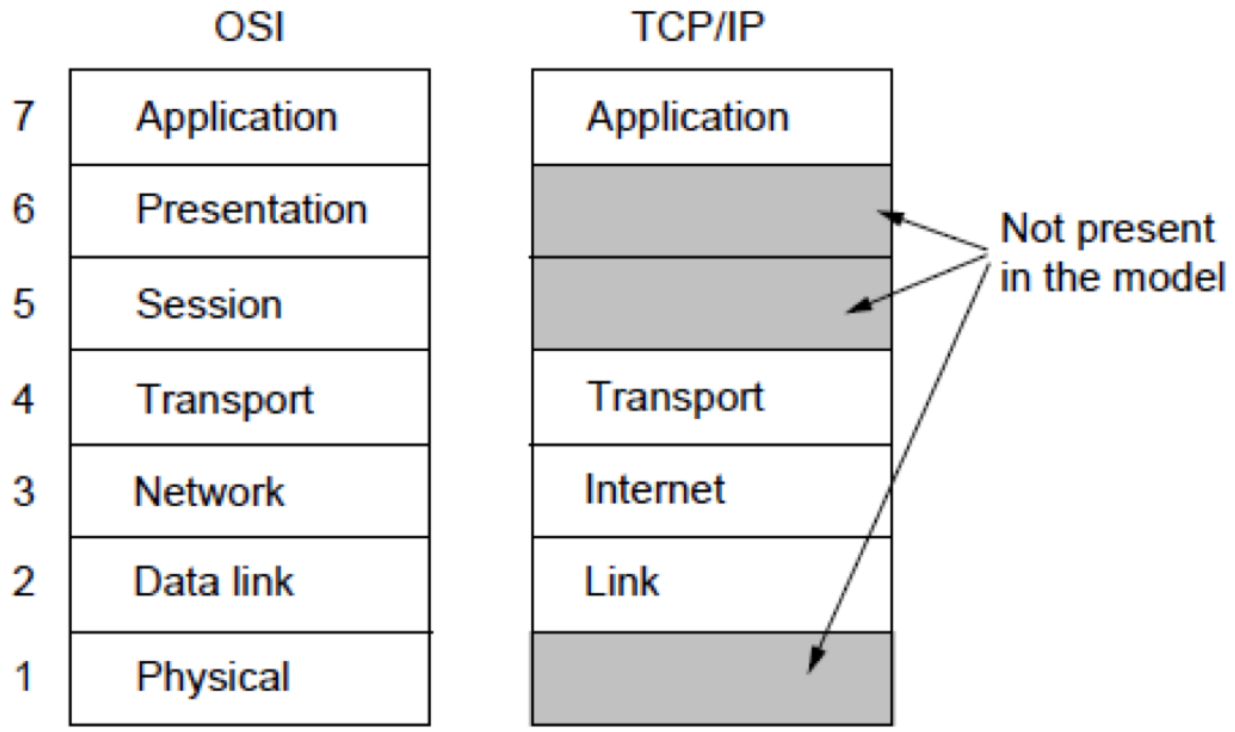
Presentation Layer

- Provides high-level view of the transported data
- Data structure abstraction
- Examples:
  - Telnet
  - Apple Filing Protocol

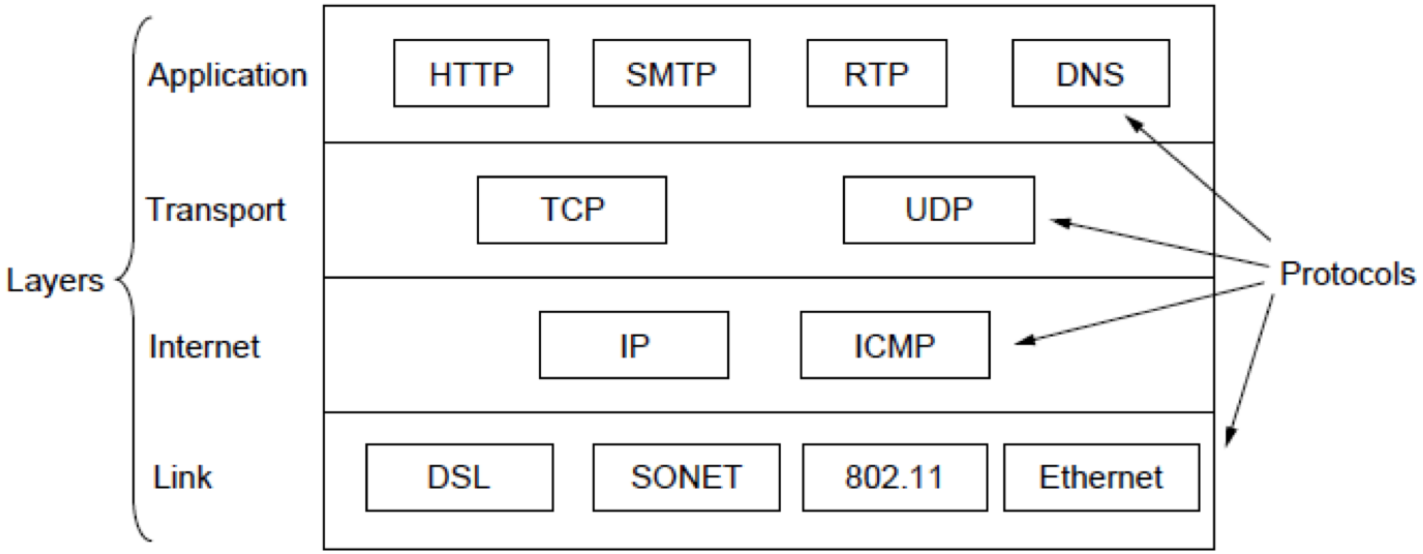
Application Layer

- User interface to the data
- Different meaning when talking about the Internet's TCP/IP Reference Model
- Examples:
  - DNS
  - FTP

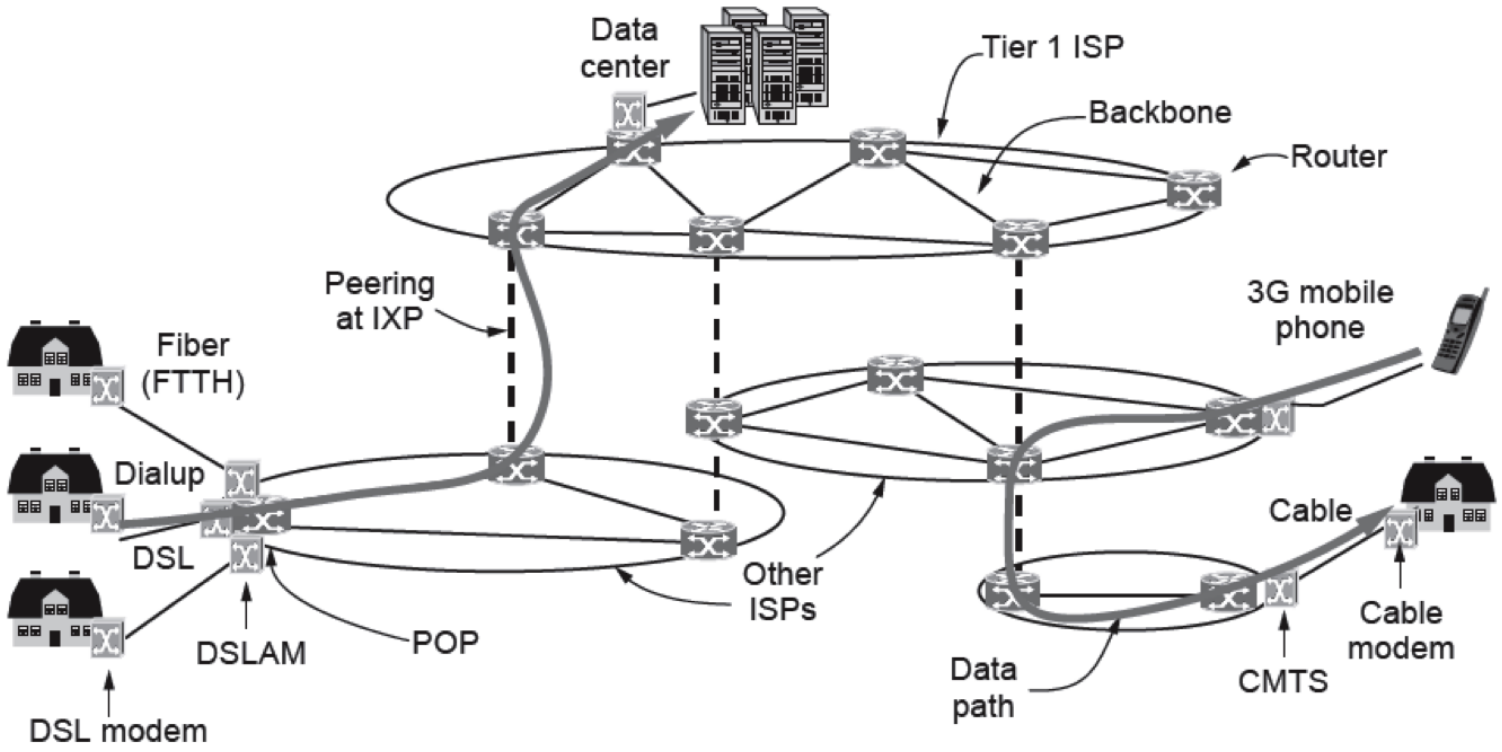
TCP/IP Reference Model



TCP/IP Reference Model



The Internet



Homework 1

- Read
  - 2.1, 2.2, 2.3, 2.5, 2.6
- Problems
  - Chapter 1
    - #1, 6, 13, 16, 17, 20, 23, 27, 28, 33
  - Chapter 2
    - #2, 3, 4, 5, 22, 32, 33, 38, 44, 46