

**NOTE:**

- 1. In this document, I highlight important sections/topics that you SHOULD read in the textbook. It is ONLY a reference to help you to read the textbook.**
- 2. The final exam might have questions out of the following topics.**
- 3. All programming codes in the textbook are NOT required.**

**CHAPTER 1 INTRODUCTION**

- 1.1 USES OF COMPUTER NETWORKS (Only need to know Client/Server and Peer-to-Peer Model)
- 1.3 NETWORK TECHNOLOGY, FROM LOCAL TO GLOBAL (Basic concepts of each network)
- 1.4 EXAMPLES OF NETWORKS
  - 1.4.1 The Internet (Only need to know an overview of the Internet)
- 1.5 NETWORK PROTOCOLS
  - 1.5.1 Design Goals
  - 1.5.2 Protocol Layering
  - 1.5.3 Connections and Reliability (Connection-oriented, connectionless, reliable and unreliable services)
  - 1.5.5 The Relationship of Services to Protocols
- 1.6 REFERENCE MODELS
- 1.9 METRIC UNITS

**CHAPTER 2 THE PHYSICAL LAYER**

- 2.2 WIRELESS TRANSMISSION
  - 2.2.1 The Electromagnetic Spectrum (Only need to know basic concepts)
- 2.4 FROM WAVEFORMS TO BITS
  - 2.4.2 The Maximum Data Rate of a Channel (Only need to know the **results** of Nyquist's and Shannon's Theorems)
  - 2.4.3 Digital Modulation (Basic concept of modulation and baseband/passband, code schemes, e.g., Manchester, NRZ, NRZI and 4B/5B)
  - 2.4.4 Multiplexing (Basic concept of multiplexing, FDM/TDM. Calculation of CDMA)
- 2.5 THE PUBLIC SWITCHED TELEPHONE NETWORK
  - 2.5.1 Structure of the Telephone System (Only need to know basic architecture)
  - 2.5.2 The Local Loop: Telephone Modems, ADSL, and Fiber (Only need to know basic concepts of local loop, modem and DSL)
  - 2.5.4 Switching (Two types of switching)
- 2.10 POLICY AT THE PHYSICAL LAYER
  - 2.10.1 Spectrum Allocation (Only need to know what is ISM bands)

**CHAPTER 3 THE DATA LINK LAYER**

- 3.1 DATA LINK LAYER DESIGN ISSUES
- 3.2 ERROR DETECTION AND CORRECTION

- 3.2.1 Error-Correcting Codes (Only need to know Hamming distance)
- 3.2.2 Error-Detecting Codes (Principle of CRC, basic concepts of Parity and Checksum)
- 3.3 ELEMENTARY DATA LINK PROTOCOLS
  - 3.3.3 Simplex Link-Layer Protocols (Only need to understand basic idea of the Stop-and-Wait ARQ protocol)
- 3.4 IMPROVING EFFICIENCY (Understand basic idea and principle, e.g., link utilization and window size. Understand protocol of both Go-Back-N and Selective Repeat)

## **CHAPTER 4 THE MEDIUM ACCESS CONTROL SUBLAYER**

- 4.2 MULTIPLE ACCESS PROTOCOLS
  - 4.2.1 ALOHA (Only need to know the operations of protocols)
  - 4.2.2 Carrier Sense Multiple Access Protocols (Only need to know the operations of protocols)
- 4.3 ETHERNET
  - 4.3.1 Classic Ethernet Physical Layer
  - 4.3.2 Classic Ethernet MAC Sublayer Protocol
  - 4.3.4 Switched Ethernet
  - 4.3.5 Fast Ethernet
  - 4.3.6 Gigabit Ethernet
- 4.4 WIRELESS LANs (Refer to the lecture slides, e.g., architecture, two problems and their solutions, MACA, IEEE 802.11 CSMA/CA protocol)
- 4.7 DATA LINK LAYER SWITCHING
  - 4.7.2 Learning Bridges (Routing procedure and Backward learning algorithm of switches, two types of switching)
  - 4.7.3 Spanning Tree Bridges (know the loop problem and basic idea of spanning tree)
  - 4.7.4 Repeaters, Hubs, Bridges, Switches, Routers, and Gateways (know functions and layers of different network devices)
  - 4.7.5 Virtual LANs (Only need to know purpose of VLAN, and basics of 802.1Q, e.g., adding additional 4 bytes tag)

## **CHAPTER 5 THE NETWORK LAYER**

- 5.1 NETWORK LAYER DESIGN ISSUES (Basic concepts)
  - 5.1.1 Store-and-Forward Packet Switching
  - 5.1.3 Implementation of Connectionless Service
  - 5.1.4 Implementation of Connection-Oriented Service
  - 5.1.5 Comparison of Virtual-Circuit and Datagram Networks
- 5.2 ROUTING ALGORITHMS IN A SINGLE NETWORK
  - 5.2.2 Shortest Path Algorithm (Basic concepts)
  - 5.2.3 Flooding (Basic concepts)
  - 5.2.4 Distance Vector Routing
  - 5.2.5 Link State Routing

- 5.2.7 Broadcast Routing (Basic concepts)
- 5.2.8 Multicast Routing (Basic concepts)
- 5.5 INTERNETWORKING (Basic concepts)
  - 5.5.3 Connecting Heterogeneous Networks
  - 5.5.4 Connecting Endpoints Across Heterogeneous Networks
  - 5.5.6 Supporting Different Packet Sizes: Packet Fragmentation
- 5.6 SOFTWARE-DEFINED NETWORKING (Check the end of this list and refer to lecture slides for SDN)
- 5.7 THE NETWORK LAYER IN THE INTERNET
  - 5.7.1 The IP Version 4 Protocol
  - 5.7.2 IP Addresses
  - 5.7.3 IP Version 6 (Only need to know the basic differences with IPv4, header format, IPv6 addresses, transition from IPv4 to IPv6)
  - 5.7.4 Internet Control Protocols
  - 5.7.6 OSPF--An Interior Gateway Routing Protocol (Only need to know the basic concepts)
  - 5.7.7 BGP--The Exterior Gateway Routing Protocol (Only need to know the basic concepts)

## **CHAPTER 6 THE TRANSPORT LAYER**

- 6.1 THE TRANSPORT SERVICE (Only need to know the basic concepts)
  - 6.1.1 Services Provided to the Upper Layers
- 6.2 ELEMENTS OF TRANSPORT PROTOCOLS (Only need to know the basic concepts)
  - 6.2.1 Addressing
  - 6.2.2 Connection Establishment
  - 6.2.3 Connection Release
  - 6.2.4 Flow Control and Buffering
  - 6.2.5 Multiplexing
- 6.3 CONGESTION CONTROL ALGORITHMS (Only need to know the basic concepts)
  - 6.3.1 Desirable Bandwidth Allocation
  - 6.3.2 Regulating the Sending Rate
- 6.4 THE INTERNET TRANSPORT PROTOCOLS: UDP
  - 6.4.1 Introduction to UDP
- 6.5 THE INTERNET TRANSPORT PROTOCOLS: TCP
  - 6.5.1 Introduction to TCP
  - 6.5.2 The TCP Service Model
  - 6.5.3 The TCP Protocol
  - 6.5.4 The TCP Segment Header
  - 6.5.5 TCP Connection Establishment
  - 6.5.6 TCP Connection Release
  - 6.5.7 TCP Connection Management Modeling
  - 6.5.8 TCP Sliding Window

- 6.5.9 TCP Timer Management
- 6.5.10 TCP Congestion Control
- 6.5.11 TCP CUBIC (Only need to know that CUBIC is a popular congestion control algorithm, default in the Linux kernels  $\geq 2.6.19$  and modern versions of Microsoft Windows)

## 6.6 TRANSPORT PROTOCOLS AND CONGESTION CONTROL 587

- 6.6.1 QUIC: Quick UDP Internet Connections (Only need to know QUIC basics, e.g., it's a transport protocol based on UDP)
- 6.6.2 BBR: Congestion Control Based on Bottleneck Bandwidth (Only need to know that BBR is a new congestion control algorithm)
- 6.6.3 The Future of TCP 590

## CHAPTER 7 THE APPLICATION LAYER

### 7.1 THE DOMAIN NAME SYSTEM (DNS) (Know basic concepts of DNS and name space. Understand DNS queries process, i.e., recursive query and iterative query)

- 7.1.2 The DNS Lookup Process
- 7.1.3 The DNS Name Space and Hierarchy
- 7.1.4 DNS Queries and Responses
- 7.1.5 Name Resolution

### 7.2 ELECTRONIC MAIL (Only need to know the basic architecture and protocols of email)

- 7.2.1 Architecture and Services
- 7.2.2 The User Agent
- 7.2.3 Message Formats
- 7.2.4 Message Transfer
- 7.2.5 Final Delivery

### 7.3 THE WORLD WIDE WEB

- 7.3.1 Architectural Overview (Basic concepts)
- 7.3.2 Static Web Pages (Basic concepts)
- 7.3.3 Dynamic Web Pages and Web Applications (Basic concepts)
- 7.3.4 HTTP and HTTPS

### Topic: Software Defined Networking (SDN) (Refer to lecture slides)

- Overview of SDN
- Control plane and data plane
- Basic idea of OpenFlow