

***Computer Networking: A Top-Down Approach, 8<sup>th</sup> edition***  
**Table of Contents**

**Chapter 1 Computer Networks and the Internet**

- 1.1 What Is the Internet?
    - 1.1.1 A Nuts-and-Bolts Description
    - 1.1.2 A Services Description
    - 1.1.3 What Is a Protocol?
  - 1.2 The Network Edge
    - 1.2.1 Access Networks
    - 1.2.2 Physical Media
  - 1.3 The Network Core
    - 1.3.1 Packet Switching
    - 1.3.2 Circuit Switching
    - 1.3.3 A Network of Networks
  - 1.4 Delay, Loss, and Throughput in Packet-Switched Networks
    - 1.4.1 Overview of Delay in Packet-Switched Networks
    - 1.4.2 Queuing Delay and Packet Loss
    - 1.4.3 End-to-End Delay
    - 1.4.4 Throughput in Computer Networks
  - 1.5 Protocol Layers and Their Service Models
    - 1.5.1 Layered Architecture
    - 1.5.2 Encapsulation
  - 1.6 Networks Under Attack
  - 1.7 History of Computer Networking and the Internet
    - 1.7.1 The Development of Packet Switching: 1961–1972
    - 1.7.2 Proprietary Networks and Internetworking: 1972–1980
    - 1.7.3 A Proliferation of Networks: 1980–1990
    - 1.7.4 The Internet Explosion: The 1990s
    - 1.7.5 The New Millennium
  - 1.8 Summary
- Homework Problems and Questions  
Wireshark Lab

**Chapter 2 Application Layer**

- 2.1 Principles of Network Applications
  - 2.1.1 Network Application Architectures
  - 2.1.2 Processes Communicating
  - 2.1.3 Transport Services Available to Applications
  - 2.1.4 Transport Services Provided by the Internet
  - 2.1.5 Application-Layer Protocols
  - 2.1.6 Network Applications Covered in This Book
- 2.2 The Web and HTTP
  - 2.2.1 Overview of HTTP

- 2.2.2 Non-Persistent and Persistent Connections
- 2.2.3 HTTP Message Format
- 2.2.4 User-Server Interaction: Cookies
- 2.2.5 Web Caching
- 2.2.6 HTTP/2
- 2.3 Electronic Mail in the Internet
  - 2.3.1 SMTP
  - 2.3.2 Mail Message Formats
  - 2.3.3 Mail Access Protocols
- 2.4 DNS—The Internet’s Directory Service
  - 2.4.1 Services Provided by DNS
  - 2.4.2 Overview of How DNS Works
  - 2.4.3 DNS Records and Messages
- 2.5 Peer-to-Peer Applications
  - 2.5.1 P2P File Distribution
- 2.6 Video Streaming and Content Distribution Networks
  - 2.6.1 Internet Video
  - 2.6.2 HTTP Streaming and DASH
  - 2.6.3 Content Distribution Networks
  - 2.6.4 Case Studies: Netflix, YouTube, and Kankan
- 2.7 Socket Programming: Creating Network Applications
  - 2.7.1 Socket Programming with UDP
  - 2.7.2 Socket Programming with TCP
- 2.8 Summary

Homework Problems and Questions

Socket Programming Assignments

Wireshark Labs: HTTP, DNS

## **Chapter 3 Transport Layer**

- 3.1 Introduction and Transport-Layer Services
  - 3.1.1 Relationship Between Transport and Network Layers
  - 3.1.2 Overview of the Transport Layer in the Internet
- 3.2 Multiplexing and Demultiplexing
- 3.3 Connectionless Transport: UDP
  - 3.3.1 UDP Segment Structure
  - 3.3.2 UDP Checksum
- 3.4 Principles of Reliable Data Transfer
  - 3.4.1 Building a Reliable Data Transfer Protocol
  - 3.4.2 Pipelined Reliable Data Transfer Protocols
  - 3.4.3 Go-Back-N (GBN)
  - 3.4.4 Selective Repeat (SR)
- 3.5 Connection-Oriented Transport: TCP
  - 3.5.1 The TCP Connection
  - 3.5.2 TCP Segment Structure
  - 3.5.3 Round-Trip Time Estimation and Timeout
  - 3.5.4 Reliable Data Transfer

- 3.5.5 Flow Control
  - 3.5.6 TCP Connection Management
  - 3.6 Principles of Congestion Control
    - 3.6.1 The Causes and the Costs of Congestion
    - 3.6.2 Approaches to Congestion Control
  - 3.7 TCP Congestion Control
    - 3.7.1 Classic TCP congestion Control
    - 3.7.2 Network-Assisted Explicit Congestion Notification and Delay-based Congestion Control
    - 3.7.3 Fairness
  - 3.8 Evolution of transport-layer functionality
  - 3.9 Summary
- Homework Problems and Questions
- Programming Assignments
- Wireshark Labs: Exploring TCP, UDP

## **Chapter 4 The Network Layer: Data Plane**

- 4.1 Overview of Network Layer
  - 4.1.1 Forwarding and Routing: The Network Data and Control Planes
  - 4.1.2 Network Service Models
- 4.2 What's Inside a Router?
  - 4.2.1 Input Port Processing and Destination-Based Forwarding
  - 4.2.2 Switching
  - 4.2.3 Output Port Processing
  - 4.2.4 Where Does Queuing Occur?
  - 4.2.5 Packet Scheduling
- 4.3 The Internet Protocol (IP): IPv4, Addressing, IPv6, and More
  - 4.3.1 IPv4 Datagram Format
  - 4.3.2 IPv4 Addressing
  - 4.3.3 Network Address Translation (NAT)
  - 4.3.4 IPv6
- 4.4 Generalized Forwarding and SDN
  - 4.4.1 Match
  - 4.4.2 Action
  - 4.4.3 OpenFlow Examples of Match-plus-action in Action
- 4.6 Middleboxes
- 4.5 Summary

Homework Problems and Questions

Wireshark Lab: IP

## **Chapter 5 The Network Layer: Control Plane**

- 5.1 Introduction
- 5.2 Routing Algorithms
  - 5.2.1 The Link-State (LS) Routing Algorithm
  - 5.2.2 The Distance-Vector (DV) Routing Algorithm

- 5.3 Intra-AS Routing in the Internet: OSPF
  - 5.4 Routing Among the ISPs: BGP
    - 5.4.1 The Role of BGP
    - 5.4.2 Advertising BGP Route Information
    - 5.4.3 Determining the Best Routes
    - 5.4.4 IP-Anycast
    - 5.4.5 Routing Policy
    - 5.4.6 Putting the Pieces Together: Obtaining Internet Presence
  - 5.5 The SDN Control Plane
    - 5.5.1 The SDN Control Plane: SDN Controller and SDN Control Applications
    - 5.5.2 OpenFlow Protocol
    - 5.5.3 Data and Control Plane Interaction: An Example
    - 5.5.4 SDN: Past and Future
  - 5.6 ICMP: The Internet Control Message Protocol
  - 5.7 Network Management, SNMP, and NETCONF/YANG
    - 5.7.1 The Network Management Framework
    - 5.7.2 The Simple Network Management Protocol (SNMP) and the Management Information Base (MIB)
    - 5.7.3 NETCONF and YANG
  - 5.8 Summary
- Homework Problems and Questions  
Socket Programming Assignment  
Programming Assignment  
Wireshark Lab: ICMP

## **Chapter 6 The Link Layer and LANs**

- 6.1 Introduction to the Link Layer
  - 6.1.1 The Services Provided by the Link Layer
  - 6.1.2 Where Is the Link Layer Implemented?
- 6.2 Error-Detection and -Correction Techniques
  - 6.2.1 Parity Checks
  - 6.2.2 Checksumming Methods
  - 6.2.3 Cyclic Redundancy Check (CRC)
- 6.3 Multiple Access Links and Protocols
  - 6.3.1 Channel Partitioning Protocols
  - 6.3.2 Random Access Protocols
  - 6.3.3 Taking-Turns Protocols
  - 6.3.4 DOCSIS: The Link-Layer Protocol for Cable Internet Access
- 6.4 Switched Local Area Networks
  - 6.4.1 Link-Layer Addressing and ARP
  - 6.4.2 Ethernet
  - 6.4.3 Link-Layer Switches
  - 6.4.4 Virtual Local Area Networks (VLANs)
- 6.5 Link Virtualization: A Network as a Link Layer

- 6.5.1 Multiprotocol Label Switching (MPLS)
  - 6.6 Data Center Networking
    - 6.6.1 Data Center Architectures
    - 6.6.2 Trends in Data Center Networking
  - 6.7 Retrospective: A Day in the Life of a Web Page Request
    - 6.7.1 Getting Started: DHCP, UDP, IP, and Ethernet
    - 6.7.2 Still Getting Started: DNS and ARP
    - 6.7.3 Still Getting Started: Intra-Domain Routing to the DNS Server
    - 6.7.4 Web Client-Server Interaction: TCP and HTTP
  - 6.8 Summary
- Homework Problems and Questions
- Wireshark Labs: Ethernet and Home Networking

## **Chapter 7 Wireless and Mobile Networks**

- 7.1 Introduction
  - 7.2 Wireless Links and Network Characteristics
    - 7.2.1 CDMA
  - 7.3 Wireless LANs
    - 7.3.1 The 802.11 Architecture
    - 7.3.2 The 802.11 MAC Protocol
    - 7.3.3 The IEEE 802.11 Frame
    - 7.3.4 Mobility in the Same IP Subnet
    - 7.3.5 Advanced Features in 802.11
    - 7.3.6 Bluetooth
  - 7.4 Cellular Networks: 4G and 5G
    - 7.4.1 An Overview of Cellular Network Architecture
    - 7.4.2 4G: LTE
    - 7.4.3 5G
  - 7.5 Mobility Management: Principles
    - 7.5.1 Device mobility: a network-layer perspective
    - 7.5.2 Home Networks and Roaming on Visited Networks
    - 7.5.3 Direct and Indirect Routing to/from a Mobile Device
  - 7.6 Mobility Management in Practice
    - 7.6.1 Mobility Management in 4G/5G Networks
    - 7.6.2 Mobile IP
  - 7.7 Wireless and Mobility: Impact on Higher-Layer Protocols
  - 7.8 Summary
- Homework Problems and Questions
- Wireshark Lab: 802.11

## **Chapter 8 Security in Computer Networks**

- 8.1 What Is Network Security?
- 8.2 Principles of Cryptography

- 8.2.1 Symmetric Key Cryptography
  - 8.2.2 Public Key Encryption
  - 8.3 Message Integrity and Digital Signatures
    - 8.3.1 Cryptographic Hash Functions
    - 8.3.2 Message Authentication Code
    - 8.3.3 Digital Signatures
  - 8.4 End-Point Authentication
    - 8.4.1 Building an Authentication Protocol
  - 8.5 Securing E-Mail
    - 8.5.1 Secure E-Mail
    - 8.5.2 PGP
  - 8.6 Securing TCP Connections: SSL
    - 8.6.1 The Big Picture
    - 8.6.2 A More Complete Picture
  - 8.7 Network-Layer Security: IPsec and Virtual Private Networks
    - 8.7.1 IPsec and Virtual Private Networks (VPNs)
    - 8.7.2 The AH and ESP Protocols
    - 8.7.3 Security Associations
    - 8.7.4 The IPsec Datagram
    - 8.7.5 IKE: Key Management in IPsec
  - 8.8 Securing Wireless LANs and 4G/5G Cellular Networks
    - 8.8.1 Authentication and Key Agreement in 802.11 Wireless LANs
    - 8.8.2 Authentication and Key Agreement in 4G/5G Cellular Networks
  - 8.9 Operational Security: Firewalls and Intrusion Detection Systems
    - 8.9.1 Firewalls
    - 8.9.2 Intrusion Detection Systems
  - 8.10 Summary
- Homework Problems and Questions  
Wireshark Lab: SSL  
IPsec Lab