

Raymond R. Panko • Julia A. Panko

# BUSINESS DATA NETWORKS AND SECURITY

## **Business Data Networks and Security, Global Edition**

## **Table of Contents**

_	`	_		_	
l	,	()	W	$\boldsymbol{e}$	r

Title

Copyright

Contents

Preface for Students

About the Authors

Chapter 1 Welcome to the Cloud

#### Box 1: By the Numbers

Netflix Dives into the Amazon

Hosts, Messages, and Addresses

The Internet

Netflix Dives into the Amazon

Virtualization and Agility

Infrastructure as a Service (IaaS) and Software as a Service (SaaS)

Clients Move into the Cloud

Rain Clouds: Security

Networks and the Cloud

Service Level Agreements (SLAs): Speed

## Box 2: Writing Speeds in Metric Notation

#### Messages

**Application Messages** 

Message Fragmentation, Frames, and Packets

Single Networks



Single-Network Host Addresses

Point-to-Point Single Networks, Physical Links, and Data links

Wireless Single Networks

Switched Single Networks

Hybrid Switched/Wireless Single Networks

#### Internet Transmission

Hosts on Different Single Networks

Creating the Internet

Routes and Layer

#### Box 3: Packet Switching

#### Standards Layers

Five Layers

Layers 1 through 3 (Physical, Data Link, and Internet Layers)

Layers 4 and 5 (Transport and Application Layers)

Standards Agencies and Architectures

TCP/IP Supervisory Applications: The Domain Name System (DNS)

#### Conclusion

Synopsis

End-of-Chapter Questions

## Chapter 1a Hands On: A Few Internet Tols

## Chapter 1b Design Exercise: A Small Home Network

#### A Small Home Network

Components

The Wireless Access Router

Services

Configuration

Design Exercise

## Chapter 2 Network Standards

How Internet Standards Came to Be

Box 1: April 1 and RFCs

Introduction



Standard = Protocol

Network Standards

Recap of Chapter 1 Standards Concepts

**Network Standard Characteristics** 

#### **Examples of Message Ordering**

Message Ordering in HTTP

Message Ordering and Reliability in TCP at the Transport Layer

#### Examples of Message Syntax

Syntax: General Message Organization

The Ethernet Frame Syntax

The Internet Protocol (IP) Packet Syntax

Transmission Control Protocol Segment Syntax

User Datagram Protocol Datagram Syntax

Port Numbers

HTTP Request and Response Message Syntax

#### Converting Application Messages Into Bits

Encoding

Encoding Text as ASCII

Converting Integers into Binary Numbers (1s and 0s)

**Encoding Alternatives** 

**Encoding Voice** 

#### Vertical Communication on Hosts

#### Conclusion

Synopsis

**End-of-Chapter Question** 

## Chapter 2a Hands-On: Wireshark Packet Capture

Introduction

Getting Wireshark

Using Wireshark



**Getting Started** 

Starting a Packet Capture

Getting Data

Stopping Data Collection

Looking at Individual Packets

**Options** 

## Chapter 3 Network Security

#### The Target Breach

The Attack

**Damages** 

Perspective

#### Introduction

#### Types of Attacks

Malware Attacks

Vulnerabilities and Patches

Viruses and Worms

Other Types of Malware

Payloads

Attacks on Human Judgment

Human Break-Ins (Hacking)

Stages in the Attack

Denial-of-Service (DOS) Attacks Using Bots

**Advanced Persistent Threats** 

#### Types of Attackers

Hackers

Employees, Ex-Employees, and Other Insiders

Malware Attackers

Cyberterrorists and National Governments

Protecting Dialogues Cryptography



Symmetric Key Encryption for Confidentiality

Electronic Signatures: Message Authentication and Integrity

Host-to-Host Virtual Private Networks (VPNs)

#### Other Forms of Authentication

Terminology and Concepts

Reusable Passwords

Other Forms of Authentication

#### Firewalls

Dropping and Logging Provable Attack Packets

Stateful Packet Inspection (SPI) Firewalls

Next-Generation Firewalls (NGFWs)

Box: Antivirus Protection

#### Conclusion

Synopsis

**End-of-Chapter Questions** 

## Chapter 4 Network and Security Management

Failures in the Target Breach

Introduction

Network Quality of Service (QOS)

Transmission Speed

Rated Speed versus Throughput and Aggregate Throughput

Other Quality-of-Service Metrics

Service Level Agreements (SLAs)

## Network Design

Traffic Analysis

Redundancy

Momentary Traffic Peaks

Strategic Security Planning Principles



Security Is a Management Issue

The PlanProtectRespond Cycle

Security Planning Principles

Policy-Based Security

#### Centralized Network Management

Ping

The Simple Network Management Protocol (SNMP)

Software-Defined Networking (SDN)

#### Centralized Security Management

Conclusion

Synopsis

**End-of-Chapter Questions** 

## Chapter 4a Hands-On: Microsoft Office Visio

What is Visio?

Using Visio

## Chapter 5 Ethernet (802.3) Switched LANs

**Ethernet Begins** 

Introduction

Local Area Networks

Switched Technology

**Ethernet Standards Development** 

Physical and Data Link Layer Operation

## Ethernet Physical Layer Standards

Signaling

4-Pair Unshielded Twisted Pair Copper Wiring

Serial and Parallel Transmission

**UTP Installation Limitations** 

Optical Fiber



Multimode Optical Fiber Quality Standards

Link Aggregation (Bonding)

Ethernet Physical Layer Standards and Network Design

#### Ethernet Data Link Layer Standards

The Ethernet Frame

Basic Ethernet Data Link Layer Switch Operation

#### Advanced Ethernet Switch Operation

The Rapid Spanning Tree Protocol (RSTP)

**Priority** 

Manageability

Power over Ethernet (POE)

#### **Ethernet Security**

Port-Based Access Control (802.1X)

Man in the Middle Attack in an Ethernet LAN

#### Conclusion

Synopsis

**End-of-Chapter Questions** 

## Chapter 5a Hands-On: Cutting and Connectorizing UTP1

Introduction

#### Solid and Stranded Wiring

Solid-Wire UTP versus Stranded-Wire UTP

Relative Advantages

**Adding Connectors** 

Cutting the Cord

Stripping the Cord

Working with the Exposed Pairs

Pair Colors

Untwisting the Pairs



Ordering the Pairs

**Cutting the Wires** 

Adding the Connector

Holding the Connector

Sliding in the Wires

Some Jacket Inside the Connector

#### Crimping

Pressing Down

Making Electrical Contact

Strain Relief

#### Testing

**Testing with Continuity Testers** 

Testing for Signal Quality

## Chapter 5b Hands-On: Ethernet Switching

#### The Exercise

What You Will Need

Creating the Network

Creating a Loop

## Chapter 6 Wireless LANs I

#### Introduction

**OSI Standards** 

802.11 versus Wi-Fi

Wireless LAN Operation

## Radio Signal Propagation

Frequencies

Antennas

Wireless Propagation Problems

## Radio Bands, Bandwidth, and Spread Spectrum Transmission

Service Bands

Signal and Channel Bandwidth



The 2.4 GHz and 5 GHz Service Bands

## Normal and Spread Spectrum Transmission

Spread Spectrum Transmission

Licensed and Unlicensed Radio Bands

Implementing Spread Spectrum Transmission

#### 802.11 WLAN Operation

Wireless Access Points

Basic Service Sets (BSSs)

Extended Service Sets (ESSs), Handoffs, and Roaming

Media Access Control

#### Box 1: Media Access Control (MAC)

#### 802.11 Transmission Standards

Characteristics of 802.11g, 602.11a, 802.11n, and 802.11ac

Bands and Channel Bandwidth

MIMO

Beamforming and Multiuser MIMO

Speed, Throughput, and Distance

**Backward Compatibility** 

Standards and Options

#### Wireless Mesh Networking

Conclusion

Synopsis

End-of-Chapter Questions

## Chapter 6a Using Xirrus Wi-Fi Inspector

#### Introduction

#### The Four Windows

The Radar Window (Read the Fine Print)

Connection Window

The Networks Window

Signal History



Other Groups on the Ribbon

#### **Tests**

Connection Test

Speed Test

**Quality Test** 

#### Activities

Activity

## Chapter 7 Wireless LANs II

The TJX Breach

Introduction

#### 802.11i WLAN Security

WLAN Security Threats

The 802.11i WLAN Security Standard

Pre-Shared Key (PSK) Mode in 802.11i

802.1X Mode Operation

## Beyond 802.11i Security

Rogue Access Points

Evil Twin Access Points and Virtual Private Networks (VPNs)

## 802.11 Wi-Fi Wireless LAN Management

Access Point Placement

Remote Management

#### Bluetooth

#### Box 1: Expressing Power Ratios in Decibels

Two Modes of Operation

One-to-One, MasterSlave Operation

Bluetooth Profiles

#### Other Local Wireless Technologies

Near Field Communication (NFC)

Wi-Fi Direct



Security in Emerging Local Wireless Technologies

#### Conclusion

Synopsis

End-of-Chapter Questions

## Chapter 8 TCP/IP Internetworking I

#### Introduction

#### **IP** Routing

Hierarchical IP Addressing

Routers, Networks, and Subnets

Network and Subnet Masks

#### How Routers Process Packets

Switching versus Routing

**Routing Table** 

Rows Are Routes for All IP Addresses in a Range

Step 1: Finding All Row Matches

Step 2: Selecting the Best-Match Row

Step 3: Sending the Packet Back Out

Cheating (Decision Caching)

## Box 1: Masking When Masks Do Not Break at 8-Bit Boundaries

#### Box 2: The Address Resolution Protocol

The Internet Protocol Version 4 (IPV4) Fields

The First Row

The Second Row

The Third Row

IP Options

#### IP Version 6 (IPV6)

Outgrowing IPv4

IPv6

Writing 128-Bit IPv6 Addresses

The IPv6 Header



**Extension Headers** 

The Transmission Control Protocol (TCP)

Fields in TCP/IP Segments

Openings and Abrupt TCP Closes

The User Datagram Protocol (UDP)

Conclusion

Synopsis

End-of-Chapter Questions

## Chapter 9 TCP/IP Internetworking II

Introduction

#### Core TCP/IP Management Tasks

IP Subnet Planning

Network Address Translation (NAT)

The Domain Name System (DNS)

Simple Network Management Protocol (SNMP)

## Securing Internet Transmission

Virtual Private Networks

**IPsec VPNs** 

**IPsec Transport Mode** 

**IPsec Tunnel Mode** 

Remote-Site-Access and Site-to-Site VPNs

IPsec Security Associations and Policy Servers

SSL/TLS VPNs

#### Managing IP Version 6 (IPV6)

Internet Layer Protocol Stacks

**IPv6** Subnetting

The Domain Name System for IPv6

#### Other TCP/IP Standards

**Dynamic Routing Protocols** 



Internet Control Message Protocol (ICMP) for Supervisory Messagesat the Internet Layer

#### Conclusion

Synopsis

**End-of-Chapter Questions** 

## Chapter 10 Carrier Wide Area Networks (WANs)

### Lans and Wans (and Mans)

LANs versus MANs and WANs

Other Aspects of WANs

Carrier WAN Components and Business Uses

The Telephone System

#### Residential Wired Internet Access

Residential Asymmetric Digital Subscriber Line (ADSL) Service

Cable Modem Service

ADSL versus Cable Modem Service

#### Cellular Data Service

Cellular Service

Why Cells?

Cellular Data Speeds

#### Wired Business WANs

Leased Lines

Reaching the ISP via a Leased Line

Leased Line Private Corporate WANs

Public Switched Data Network (PSDN) Carrier WANs

Multiprotocol Label Switching (MPLS)

WAN Optimization

### Software Defined Networking (SDN)

Concepts and Benefits

Forwarding Tables



**SDN Applications** 

Application Program Interfaces (APIs)

#### Conclusion

Synopsis

**End-of-Chapter Questions** 

## Chapter 11 Networked Aplications

#### **GhostNet**

#### Introduction

**Networked Applications** 

The Evolution of Client Devices and Networking

**Application Security** 

Cross-Site Scripting (XSS)

**SQL Injection Attacks** 

#### Electronic Mail (E-Mail)

E-Mail Standards

Message Body Standards

Simple Mail Transfer Protocol (SMTP)

Receiving Mail (POP and IMAP)

Web-Enabled E-Mail

SMTP for Transmission between Mail Hosts

Malware Filtering in E-Mail

Encryption for Confidentiality in E-Mail Transmission

## Voice Over IP (VOIP)

**Basics** 

**VoIP Signaling** 

**VoIP Transport** 

#### The World Wide Web

HTTP and HTML Standards

Complex Webpages



## Peer-to-Peer (P2P) Application Architectures

Traditional Client/Server Applications

P2P Applications

P2P File-Sharing Applications: BitTorrent

P2P Communication Applications: Skype

P2P Processing Applications: SETI@Home

Privacy Protection: Tor

Facilitating Servers and P2P Applications

#### Conclusion

Synopsis

**End-of-Chapter Questions** 

#### Online Modules

#### Module A More on TCP

**Numbering Octets** 

Ordering TCP Segments upon Arrival

The TCP Acknowledgment Process

Flow Control: Window Size

**Review Questions** 

#### Module B More on Modulation

#### Modulation

Frequency Modulation

Amplitude Modulation

Phase Modulation

Quadrature Amplitude Modulation (QAM)

**Review Questions** 

#### Module C More on Telecomunications

Introduction

The PSTN Transport Core and Signaling

The Transport Core

Time Division Multiplexing (TDM) Lines



Leased Lines and Trunk Lines

Asynchronous Transfer Mode (ATM) Transport

Signaling

#### Communication Satellites

Microwave Transmission

Satellite Transmission

Geosynchronous Earth Orbit (GEO) Satellites

Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) Satellites

**VSAT Satellites** 

#### Wiring The First Bank of Paradise Headquarters Building

**Facilities** 

Telephone Wiring

Data Wiring

#### Plenum Cabling

**PBX Services** 

#### Carrier Services and Pricing

**Basic Voice Services** 

**Advanced Services** 

Call Waiting

Voice Mail

#### Telephone Carriers and Regulation

PTTs and Ministries of Telecommunications

AT&T, the FCC, and PUCs

Deregulation

Voice Over IP

## Module D Directory Servers

Introduction

Hierarchical Organization

Lightweight Directory Access Protocol (LDAP)

Directory Servers and The Networking Staff

Microsofts Active Directory (AD)



Active Directory Domains

Domain Controllers

Domains in an Active Directory Tree

Complex Structures

Authentication and Directory Servers

Glossary Index

