

EIGHTH EDITION

Silberschatz
Galvin
Gagne



OPERATING SYSTEM CONCEPTS

with JAVA

International Student Version

Contents

PART ONE ■ OVERVIEW

Chapter 1 Introduction

1.1 What Operating Systems Do	3	1.9 Protection and Security	29
1.2 Computer-System Organization	6	1.10 Distributed Systems	30
1.3 Computer-System Architecture	12	1.11 Special-Purpose Systems	32
1.4 Operating-System Structure	18	1.12 Computing Environments	34
1.5 Operating-System Operations	20	1.13 Open-Source Operating Systems	37
1.6 Process Management	23	1.14 Summary	41
1.7 Memory Management	24	Exercises	43
1.8 Storage Management	25	Bibliographical Notes	46

Chapter 2 System Structures

2.1 Operating-System Services	49	2.8 Virtual Machines	76
2.2 User Operating-System Interface	52	2.9 Java	81
2.3 System Calls	55	2.10 Operating-System Debugging	85
2.4 Types of System Calls	59	2.11 Operating-System Generation	90
2.5 System Programs	67	2.12 System Boot	92
2.6 Operating-System Design and Implementation	68	2.13 Summary	93
2.7 Operating-System Structure	70	Exercises	94
		Bibliographical Notes	100

PART TWO ■ PROCESS MANAGEMENT

Chapter 3 Process Concept

3.1 Process Concept	103	3.6 Communication in Client-Server Systems	131
3.2 Process Scheduling	107	3.7 Summary	142
3.3 Operations on Processes	112	Exercises	143
3.4 Interprocess Communication	119	Bibliographical Notes	152
3.5 Examples of IPC Systems	128		

Chapter 4 Multithreaded Programming

4.1 Overview	153	4.6 Operating-System Examples	178
4.2 Multithreading Models	157	4.7 Summary	180
4.3 Thread Libraries	159	Exercises	181
4.4 Java Threads	162	Bibliographical Notes	191
4.5 Threading Issues	168		

Chapter 5 Process Scheduling

5.1 Basic Concepts	193	5.7 Java Scheduling	223
5.2 Scheduling Criteria	197	5.8 Algorithm Evaluation	227
5.3 Scheduling Algorithms	198	5.9 Summary	233
5.4 Thread Scheduling	209	Exercises	234
5.5 Multiple-Processor Scheduling	212	Bibliographical Notes	238
5.6 Operating System Examples	216		

Chapter 6 Synchronization

6.1 Background	241	6.7 Monitors	264
6.2 The Critical-Section Problem	243	6.8 Java Synchronization	270
6.3 Peterson's Solution	245	6.9 Synchronization Examples	284
6.4 Synchronization Hardware	246	6.10 Atomic Transactions	289
6.5 Semaphores	249	6.11 Summary	298
6.6 Classic Problems of Synchronization	255	Exercises	299
		Bibliographical Notes	311

Chapter 7 Deadlocks

7.1 System Model	313	7.6 Deadlock Detection	334
7.2 Deadlock Characterization	315	7.7 Recovery from Deadlock	338
7.3 Methods for Handling Deadlocks	320	7.8 Summary	339
7.4 Deadlock Prevention	324	Exercises	340
7.5 Deadlock Avoidance	328	Bibliographical Notes	347

PART THREE ■ MEMORY MANAGEMENT**Chapter 8 Memory-Management Strategies**

8.1 Background	351	8.6 Segmentation	378
8.2 Swapping	358	8.7 Example: The Intel Pentium	381
8.3 Contiguous Memory Allocation	360	8.8 Summary	386
8.4 Paging	364	Exercises	387
8.5 Structure of the Page Table	373	Bibliographical Notes	391

Chapter 9 Virtual-Memory Management

9.1 Background	393	9.8 Allocating Kernel Memory	431
9.2 Demand Paging	397	9.9 Other Considerations for Paging Systems	435
9.3 Copy-on-Write	404	9.10 Operating-System Examples	441
9.4 Page Replacement	406	9.11 Summary	443
9.5 Allocation of Frames	418	Exercises	444
9.6 Thrashing	422	Bibliographical Notes	457
9.7 Memory-Mapped Files	426		

PART FOUR ■ STORAGE MANAGEMENT

Chapter 10 File System

10.1 File Concept	461	10.6 Protection	491
10.2 Access Methods	470	10.7 Summary	496
10.3 Directory and Disk Structure	473	Exercises	497
10.4 File-System Mounting	484	Bibliographical Notes	499
10.5 File Sharing	486		

Chapter 11 Implementing File-Systems

11.1 File-System Structure	501	11.7 Recovery	526
11.2 File-System Implementation	504	11.8 NFS	530
11.3 Directory Implementation	510	11.9 Example: The WAFL File System	536
11.4 Allocation Methods	511	11.10 Summary	538
11.5 Free-Space Management	519	Exercises	539
11.6 Efficiency and Performance	522	Bibliographical Notes	548

Chapter 12 Secondary-Storage Structure

12.1 Overview of Mass-Storage Structure	551	12.7 RAID Structure	568
12.2 Disk Structure	554	12.8 Stable-Storage Implementation	578
12.3 Disk Attachment	555	12.9 Tertiary-Storage Structure	580
12.4 Disk Scheduling	556	12.10 Summary	590
12.5 Disk Management	562	Exercises	591
12.6 Swap-Space Management	566	Bibliographical Notes	599

Chapter 13 I/O Systems

13.1 Overview	601	13.6 STREAMS	626
13.2 I/O Hardware	602	13.7 Performance	628
13.3 Application I/O Interface	611	13.8 Summary	631
13.4 Kernel I/O Subsystem	617	Exercises	632
13.5 Transforming I/O Requests to Hardware Operations	624	Bibliographical Notes	634

PART FIVE ■ PROTECTION AND SECURITY**Chapter 14 System Protection**

14.1 Goals of Protection	637	14.7 Revocation of Access Rights	652
14.2 Principles of Protection	638	14.8 Capability-Based Systems	653
14.3 Domain of Protection	639	14.9 Language-Based Protection	656
14.4 Access Matrix	644	14.10 Summary	661
14.5 Implementation of Access Matrix	648	Exercises	663
14.6 Access Control	651	Bibliographical Notes	665

Chapter 15 System Security

15.1 The Security Problem	667	15.8 Computer-Security Classifications	708
15.2 Program Threats	671	15.9 An Example: Windows XP	710
15.3 System and Network Threats	679	15.10 Summary	711
15.4 Cryptography as a Security Tool	684	Exercises	712
15.5 User Authentication	695	Bibliographical Notes	714
15.6 Implementing Security Defenses	700		
15.7 Firewalling to Protect Systems and Networks	707		

PART SIX ■ CASE STUDIES**Chapter 16 The Linux System**

16.1 Linux History	719	16.8 Input and Output	752
16.2 Design Principles	724	16.9 Interprocess Communication	755
16.3 Kernel Modules	727	16.10 Network Structure	756
16.4 Process Management	730	16.11 Security	758
16.5 Scheduling	733	16.12 Summary	761
16.6 Memory Management	738	Exercises	762
16.7 File Systems	746	Bibliographical Notes	763

Chapter 17 Windows XP

17.1 History	765	17.6 Networking	804
17.2 Design Principles	767	17.7 Programmer Interface	810
17.3 System Components	769	17.8 Summary	818
17.4 Environmental Subsystems	792	Exercises	818
17.5 File System	796	Bibliographical Notes	819

Chapter 18 Influential Operating Systems

18.1 Feature Migration	821	18.9 IBM OS/360	833
18.2 Early Systems	822	18.10 TOPS-20	835
18.3 Atlas	829	18.11 CP/M and MS/DOS	835
18.4 XDS-940	830	18.12 Macintosh Operating System and Windows	836
18.5 THE	831	18.13 Mach	837
18.6 RC 4000	831	18.14 Other Systems	838
18.7 CTSS	832	Exercises	839
18.8 MULTICS	833		

PART SEVEN ■ DISTRIBUTED SYSTEMS

Chapter 19 Distributed System Structures (On WileyPlus)

19.1 Motivation	1	19.7 Robustness	22
19.2 Types of Network-based Operating Systems	3	19.8 Design Issues	25
19.3 Network Structure	7	19.9 An Example: Networking	27
19.4 Network Topology	11	19.10 Summary	29
19.5 Communication Structure	12	Exercises	29
19.6 Communication Protocols	18	Bibliographical Notes	37

Chapter 20 Distributed File Systems (On WileyPlus)

20.1 Background	1	20.6 An Example: AFS	14
20.2 Naming and Transparency	3	20.7 Summary	19
20.3 Remote File Access	6	Exercises	20
20.4 Stateful versus Stateless Service	11	Bibliographical Notes	21
20.5 File Replication	12		

Chapter 21 Distributed Coordination (On WileyPlus)

21.1 Event Ordering	1	21.6 Election Algorithms	22
21.2 Mutual Exclusion	4	21.7 Reaching Agreement	24
21.3 Atomicity	7	21.8 Summary	26
21.4 Concurrency Control	10	Exercises	27
21.5 Deadlock Handling	14	Bibliographical Notes	29

PART EIGHT ■ SPECIAL PURPOSE SYSTEMS

Chapter 22 Real-Time Systems (On WileyPlus)

22.1 Overview	1	22.5 Real-Time CPU Scheduling	10
22.2 System Characteristics	2	22.6 An Example: VxWorks 5.x	16
22.3 Features of Real-Time Kernels	4	22.7 Summary	18
22.4 Implementing Real-Time Operating Systems	6	Exercises	19
		Bibliographical Notes	20

Chapter 23 Multimedia Systems (On WileyPlus)

23.1 What Is Multimedia?	1	23.6 Network Management	11
23.2 Compression	4	23.7 An Example: CineBlitz	14
23.3 Requirements of Multimedia Kernels	6	23.8 Summary	17
23.4 CPU Scheduling	8	Exercises	17
23.5 Disk Scheduling	9	Bibliographical Notes	19

PART NINE ■ APPENDICES

Appendix A BSD UNIX (Online)

A.1 UNIX History	1	A.7 File System	25
A.2 Design Principles	6	A.8 I/O System	32
A.3 Programmer Interface	8	A.9 Interprocess Communication	35
A.4 User Interface	15	A.10 Summary	40
A.5 Process Management	18	Exercises	41
A.6 Memory Management	22	Bibliographical Notes	42

Appendix B The Mach System (Online)

B.1 History of the Mach System	1	B.7 Programmer Interface	23
B.2 Design Principles	3	B.8 Summary	24
B.3 System Components	4	Exercises	25
B.4 Process Management	7	Bibliographical Notes	26
B.5 Interprocess Communication	13	Credits	27
B.6 Memory Management	18		

Appendix C Windows 2000 (Online)

C.1 History	1	C.6 Networking	28
C.2 Design Principles	2	C.7 Programmer Interface	33
C.3 System Components	3	C.8 Summary	40
C.4 Environmental Subsystems	19	Exercises	40
C.5 File System	22	Bibliographical Notes	41

Appendix D Distributed Communication (Online)

D.1 Sockets 1	D.5 Web Services 19
D.2 UDP Sockets 8	D.6 Summary 24
D.3 Remote Method Invocation 11	Exercises 24
D.4	Bibliographical Notes 25
Other Aspects of Distributed Communication 16	

Appendix E Java Primer (Online)

E.1 Basics 1	E.5 Applications and Applets 17
E.2 Inheritance 9	E.6 Summary 19
E.3 Interfaces and Abstract Classes 12	Bibliographical Notes 20
E.4 Exception Handling 16	

Bibliography 841

Credits 873

Index 875