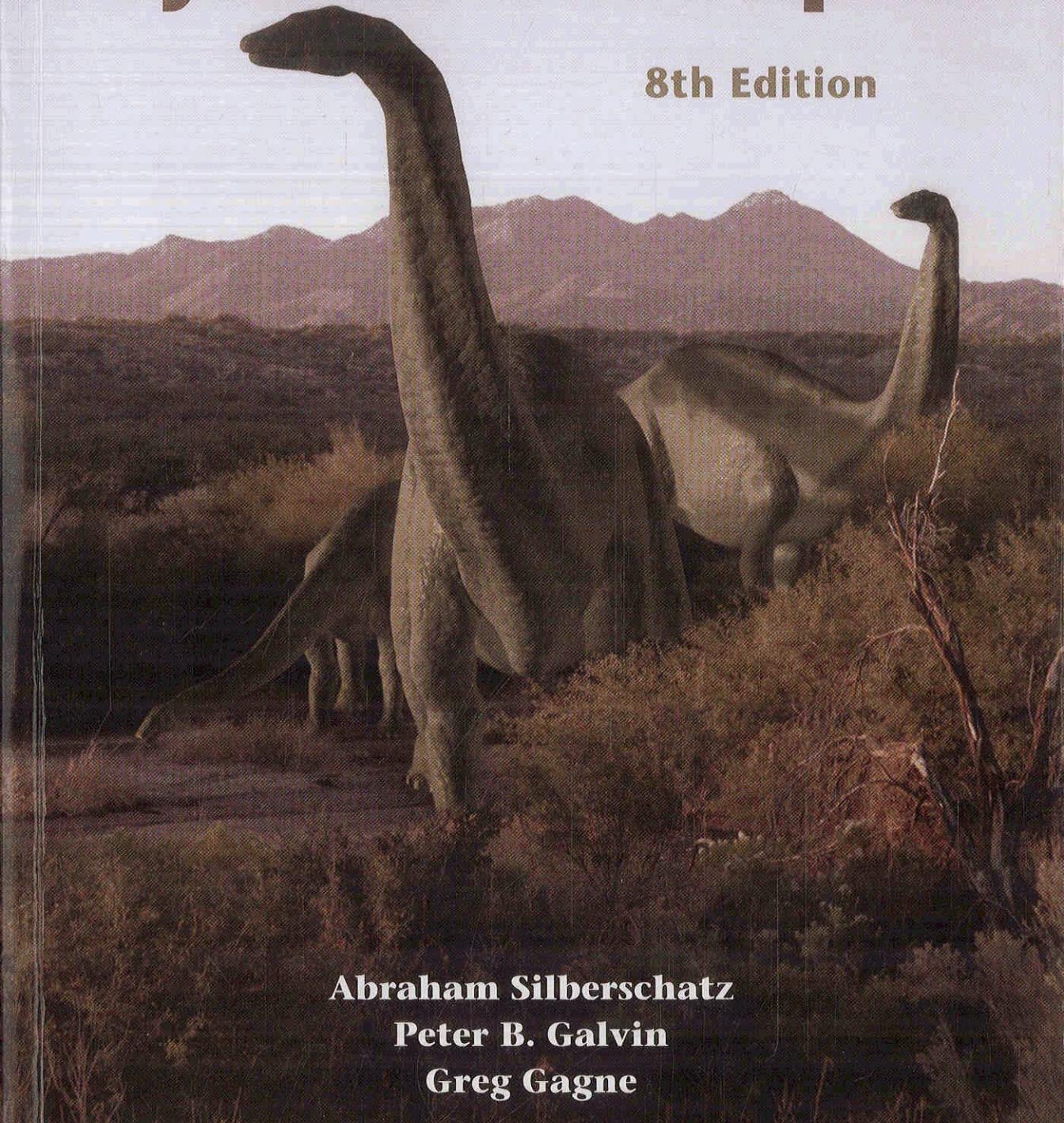


Operating System Concepts

8th Edition



Abraham Silberschatz

Peter B. Galvin

Greg Gagne

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	40
1.7 Memory Management	24	Exercises	42
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 Operating-System Debugging	84
2.3 System Calls	55	2.10 Operating-System Generation	88
2.4 Types of System Calls	58	2.11 System Boot	89
2.5 System Programs	66	2.12 Summary	90
2.6 Operating-System Design and Implementation	68	Exercises	91
2.7 Operating-System Structure	70	Bibliographical Notes	97

PART TWO ■ PROCESS MANAGEMENT

Chapter 3 Process Concept

3.1 Process Concept	101	3.6 Communication in Client– Server Systems	128
3.2 Process Scheduling	105	3.7 Summary	140
3.3 Operations on Processes	110	Exercises	141
3.4 Interprocess Communication	116	Bibliographical Notes	152
3.5 Examples of IPC Systems	123		

Chapter 4 Multithreaded Programming

4.1 Overview	153	4.5 Operating-System Examples	171
4.2 Multithreading Models	157	4.6 Summary	174
4.3 Thread Libraries	159	Exercises	174
4.4 Threading Issues	165	Bibliographical Notes	181

Chapter 5 Process Scheduling

5.1 Basic Concepts	183	5.6 Operating System Examples	206
5.2 Scheduling Criteria	187	5.7 Algorithm Evaluation	213
5.3 Scheduling Algorithms	188	5.8 Summary	217
5.4 Thread Scheduling	199	Exercises	218
5.5 Multiple-Processor Scheduling	200	Bibliographical Notes	222

PART THREE ■ PROCESS COORDINATION

Chapter 6 Synchronization

6.1 Background	225	6.7 Monitors	244
6.2 The Critical-Section Problem	227	6.8 Synchronization Examples	252
6.3 Peterson's Solution	229	6.9 Atomic Transactions	257
6.4 Synchronization Hardware	231	6.10 Summary	267
6.5 Semaphores	234	Exercises	267
6.6 Classic Problems of Synchronization	239	Bibliographical Notes	280

Chapter 7 Deadlocks

7.1 System Model	283	7.6 Deadlock Detection	301
7.2 Deadlock Characterization	285	7.7 Recovery from Deadlock	304
7.3 Methods for Handling Deadlocks	290	7.8 Summary	306
7.4 Deadlock Prevention	291	Exercises	307
7.5 Deadlock Avoidance	294	Bibliographical Notes	310

PART FOUR ■ MEMORY MANAGEMENT

Chapter 8 Memory-Management Strategies

8.1 Background	315	8.6 Segmentation	342
8.2 Swapping	322	8.7 Example: The Intel Pentium	345
8.3 Contiguous Memory Allocation	324	8.8 Summary	349
8.4 Paging	328	Exercises	350
8.5 Structure of the Page Table	337	Bibliographical Notes	354

Chapter 9 Virtual-Memory Management

9.1 Background	357	9.8 Allocating Kernel Memory	396
9.2 Demand Paging	361	9.9 Other Considerations	399
9.3 Copy-on-Write	367	9.10 Operating-System Examples	405
9.4 Page Replacement	369	9.11 Summary	407
9.5 Allocation of Frames	382	Exercises	409
9.6 Thrashing	386	Bibliographical Notes	416
9.7 Memory-Mapped Files	390		

PART FIVE ■ STORAGE MANAGEMENT

Chapter 10 File System

10.1 File Concept	421	10.6 Protection	451
10.2 Access Methods	430	10.7 Summary	456
10.3 Directory and Disk Structure	433	Exercises	457
10.4 File-System Mounting	444	Bibliographical Notes	458
10.5 File Sharing	446		

Chapter 11 Implementing File Systems

11.1 File-System Structure	461	11.7 Recovery	486
11.2 File-System Implementation	464	11.8 NFS	490
11.3 Directory Implementation	470	11.9 Example: The WAFL File System	496
11.4 Allocation Methods	471	11.10 Summary	498
11.5 Free-Space Management	479	Exercises	499
11.6 Efficiency and Performance	482	Bibliographical Notes	502

Chapter 12 Secondary-Storage Structure

12.1 Overview of Mass-Storage Structure	505	12.7 RAID Structure	522
12.2 Disk Structure	508	12.8 Stable-Storage Implementation	533
12.3 Disk Attachment	509	12.9 Tertiary-Storage Structure	534
12.4 Disk Scheduling	510	12.10 Summary	543
12.5 Disk Management	516	Exercises	545
12.6 Swap-Space Management	520	Bibliographical Notes	552

Chapter 13 I/O Systems

13.1 Overview	555	13.6 STREAMS	580
13.2 I/O Hardware	556	13.7 Performance	582
13.3 Application I/O Interface	565	13.8 Summary	585
13.4 Kernel I/O Subsystem	571	Exercises	586
13.5 Transforming I/O Requests to Hardware Operations	578	Bibliographical Notes	588

PART SIX ■ PROTECTION AND SECURITY

Chapter 14 System Protection

14.1 Goals of Protection	591	14.7 Revocation of Access Rights	606
14.2 Principles of Protection	592	14.8 Capability-Based Systems	607
14.3 Domain of Protection	593	14.9 Language-Based Protection	610
14.4 Access Matrix	598	14.10 Summary	615
14.5 Implementation of Access Matrix	602	Exercises	616
14.6 Access Control	605	Bibliographical Notes	618

Chapter 15 System Security

15.1 The Security Problem	621	15.8 Computer-Security Classifications	662
15.2 Program Threats	625	15.9 An Example: Windows XP	664
15.3 System and Network Threats	633	15.10 Summary	665
15.4 Cryptography as a Security Tool	638	Exercises	666
15.5 User Authentication	649	Bibliographical Notes	667
15.6 Implementing Security Defenses	654		
15.7 Firewalling to Protect Systems and Networks	661		

PART SEVEN ■ DISTRIBUTED SYSTEMS

Chapter 16 Distributed Operating Systems

16.1 Motivation	673	16.7 Robustness	694
16.2 Types of Network-based Operating Systems	675	16.8 Design Issues	697
16.3 Network Structure	679	16.9 An Example: Networking	699
16.4 Network Topology	683	16.10 Summary	701
16.5 Communication Structure	684	Exercises	701
16.6 Communication Protocols	690	Bibliographical Notes	703

Chapter 17 Distributed File Systems

17.1 Background	705	17.6 An Example: AFS	718
17.2 Naming and Transparency	707	17.7 Summary	723
17.3 Remote File Access	710	Exercises	724
17.4 Stateful versus Stateless Service	715	Bibliographical Notes	725
17.5 File Replication	716		

Chapter 18 Distributed Synchronization

18.1 Event Ordering	727	18.6 Election Algorithms	747
18.2 Mutual Exclusion	730	18.7 Reaching Agreement	750
18.3 Atomicity	733	18.8 Summary	752
18.4 Concurrency Control	736	Exercises	753
18.5 Deadlock Handling	740	Bibliographical Notes	754

PART EIGHT ■ SPECIAL PURPOSE SYSTEMS

Chapter 19 Real-Time Systems

19.1 Overview	759	19.5 Real-Time CPU Scheduling	768
19.2 System Characteristics	760	19.6 An Example: VxWorks 5.x	774
19.3 Features of Real-Time Kernels	762	19.7 Summary	776
19.4 Implementing Real-Time Operating Systems	764	Exercises	777
		Bibliographical Notes	777

Chapter 20 Multimedia Systems

20.1 What Is Multimedia?	779	20.6 Network Management	789
20.2 Compression	782	20.7 An Example: CineBlitz	792
20.3 Requirements of Multimedia Kernels	784	20.8 Summary	795
20.4 CPU Scheduling	786	Exercises	795
20.5 Disk Scheduling	787	Bibliographical Notes	797

PART NINE ■ CASE STUDIES

Chapter 21 The Linux System

21.1 Linux History	801	21.8 Input and Output	834
21.2 Design Principles	806	21.9 Interprocess Communication	837
21.3 Kernel Modules	809	21.10 Network Structure	838
21.4 Process Management	812	21.11 Security	840
21.5 Scheduling	815	21.12 Summary	843
21.6 Memory Management	820	Exercises	844
21.7 File Systems	828	Bibliographical Notes	845

Chapter 22 Windows XP

22.1 History	847	22.6 Networking	886
22.2 Design Principles	849	22.7 Programmer Interface	892
22.3 System Components	851	22.8 Summary	900
22.4 Environmental Subsystems	874	Exercises	900
22.5 File System	878	Bibliographical Notes	901

Chapter 23 Influential Operating Systems

23.1 Feature Migration	903	23.9 IBM OS/360	915
23.2 Early Systems	904	23.10 TOPS-20	917
23.3 Atlas	911	23.11 CP/M and MS/DOS	917
23.4 XDS-940	912	23.12 Macintosh Operating System and Windows	918
23.5 THE	913	23.13 Mach	919
23.6 RC 4000	913	23.14 Other Systems	920
23.7 CTSS	914	Exercises	921
23.8 MULTICS	915		

Chapter A BSD UNIX

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

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

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

Bibliography 923

Credits 941

Index 943