
Contents

PART ONE ■ OVERVIEW

Chapter 1 Introduction

1.1 What Operating Systems Do	3	1.9 Protection and Security	26
1.2 Computer-System Organization	6	1.10 Distributed Systems	28
1.3 Computer-System Architecture	12	1.11 Special-Purpose Systems	29
1.4 Operating-System Structure	15	1.12 Computing Environments	31
1.5 Operating-System Operations	17	1.13 Summary	34
1.6 Process Management	20	Exercises	36
1.7 Memory Management	21	Bibliographical Notes	38
1.8 Storage Management	22		

Chapter 2 Operating-System Structures

2.1 Operating-System Services	39	2.8 Virtual Machines	64
2.2 User Operating-System Interface	41	2.9 Java	67
2.3 System Calls	43	2.10 Operating-System Generation	73
2.4 Types of System Calls	47	2.11 System Boot	74
2.5 System Programs	55	2.12 Summary	75
2.6 Operating-System Design and Implementation	56	Exercises	76
2.7 Operating-System Structure	58	Bibliographical Notes	81

PART TWO ■ PROCESS MANAGEMENT

Chapter 3 Processes

3.1 Process Concept	85	3.6 Communication in Client- Server Systems	113
3.2 Process Scheduling	89	3.7 Summary	124
3.3 Operations on Processes	94	Exercises	125
3.4 Interprocess Communication	101	Bibliographical Notes	130
3.5 Examples of IPC Systems	110		

Chapter 4 Threads

4.1 Overview	133	4.6 Operating-System Examples	156
4.2 Multithreading Models	135	4.7 Summary	159
4.3 Thread Libraries	137	Exercises	159
4.4 Java Threads	140	Bibliographical Notes	165
4.5 Threading Issues	147		

Chapter 5 CPU Scheduling

5.1 Basic Concepts	167	5.7 Java Scheduling	195
5.2 Scheduling Criteria	171	5.8 Algorithm Evaluation	199
5.3 Scheduling Algorithms	172	5.9 Summary	203
5.4 Multiple-Processor Scheduling	183	Exercises	204
5.5 Thread Scheduling	186	Bibliographical Notes	207
5.6 Operating System Examples	187		

Chapter 6 Process Synchronization

6.1 Background	209	6.7 Monitors	231
6.2 The Critical-Section Problem	211	6.8 Java Synchronization	236
6.3 Peterson's Solution	213	6.9 Synchronization Examples	250
6.4 Synchronization Hardware	214	6.10 Atomic Transactions	255
6.5 Semaphores	217	6.11 Summary	263
6.6 Classic Problems of Synchronization	222	Exercises	264
		Bibliographical Notes	271

Chapter 7 Deadlocks

7.1 System Model	273	7.6 Deadlock Detection	293
7.2 Deadlock Characterization	275	7.7 Recovery from Deadlock	296
7.3 Methods for Handling Deadlocks	280	7.8 Summary	298
7.4 Deadlock Prevention	284	Exercises	299
7.5 Deadlock Avoidance	287	Bibliographical Notes	303

PART THREE ■ MEMORY MANAGEMENT**Chapter 8 Main Memory**

8.1 Background	307	8.6 Segmentation	334
8.2 Swapping	314	8.7 Example: The Intel Pentium	337
8.3 Contiguous Memory Allocation	316	8.8 Summary	341
8.4 Paging	320	Exercises	342
8.5 Structure of the Page Table	329	Bibliographical Notes	344

Chapter 9 Virtual Memory

9.1 Background	347	9.8 Allocating Kernel Memory	384
9.2 Demand Paging	351	9.9 Other Considerations	387
9.3 Copy-on-Write	357	9.10 Operating-System Examples	393
9.4 Page Replacement	359	9.11 Summary	396
9.5 Allocation of Frames	372	Exercises	397
9.6 Thrashing	375	Bibliographical Notes	401
9.7 Memory-Mapped Files	379		

PART FOUR ■ STORAGE MANAGEMENT

Chapter 10 File-System Interface

10.1 The Concept of a File	405	10.6 Protection	434
10.2 Access Methods	413	10.7 Summary	439
10.3 Directory Structure	417	Exercises	440
10.4 File-System Mounting	427	Bibliographical Notes	441
10.5 File Sharing	429		

Chapter 11 File-System Implementation

11.1 File-System Structure	443	11.8 Log-Structured File Systems	469
11.2 File-System Implementation	445	11.9 NFS	470
11.3 Directory Implementation	451	11.10 Example: The WAFL File System	476
11.4 Allocation Methods	453	11.11 Summary	478
11.5 Free-Space Management	461	Exercises	479
11.6 Efficiency and Performance	463	Bibliographical Notes	487
11.7 Recovery	467		

Chapter 12 Mass-Storage Structure

12.1 Overview of Mass-Storage Structure	489	12.7 RAID Structure	506
12.2 Disk Structure	492	12.8 Stable-Storage Implementation	515
12.3 Disk Attachment	493	12.9 Tertiary-Storage Structure	516
12.4 Disk Scheduling	494	12.10 Summary	526
12.5 Disk Management	500	Exercises	527
12.6 Swap-Space Management	504	Bibliographical Notes	533

Chapter 13 I/O Systems

13.1 Overview	535	13.6 STREAMS	560
13.2 I/O Hardware	536	13.7 Performance	562
13.3 Application I/O Interface	545	13.8 Summary	565
13.4 Kernel I/O Subsystem	551	Exercises	566
13.5 Transforming I/O Requests to Hardware Operations	558	Bibliographical Notes	567

PART FIVE ■ PROTECTION AND SECURITY

Chapter 14 Protection

14.1 Goals of Protection	571	14.7 Revocation of Access Rights	586
14.2 Principles of Protection	572	14.8 Capability-Based Systems	587
14.3 Domain of Protection	573	14.9 Language-Based Protection	590
14.4 Access Matrix	578	14.10 Summary	595
14.5 Implementation of Access Matrix	582	Exercises	596
14.6 Access Control	585	Bibliographical Notes	597

Chapter 15 Security

15.1 The Security Problem	599	15.8 Computer-Security Classifications	641
15.2 Program Threats	603	15.9 An Example: Windows XP	642
15.3 System and Network Threats	611	15.10 Summary	644
15.4 Cryptography as a Security Tool	617	Exercises	645
15.5 User Authentication	628	Bibliographical Notes	646
15.6 Implementing Security Defenses	632		
15.7 Firewalling to Protect Systems and Networks	639		

PART SIX ■ DISTRIBUTED SYSTEMS

Chapter 16 Distributed System Structures

16.1 Motivation	651	16.7 Robustness	671
16.2 Types of Network-based Operating Systems	653	16.8 Design Issues	673
16.3 Network Structure	657	16.9 An Example: Networking	676
16.4 Network Topology	660	16.10 Summary	677
16.5 Communication Structure	662	Exercises	678
16.6 Communication Protocols	668	Bibliographical Notes	684

Chapter 17 Distributed File Systems

17.1 Background	685	17.6 An Example: AFS	698
17.2 Naming and Transparency	687	17.7 Summary	703
17.3 Remote File Access	690	Exercises	704
17.4 Stateful Versus Stateless Service	695	Bibliographical Notes	705
17.5 File Replication	696		

Chapter 18 Distributed Coordination

18.1 Event Ordering	707	18.6 Election Algorithms	727
18.2 Mutual Exclusion	710	18.7 Reaching Agreement	730
18.3 Atomicity	713	18.8 Summary	732
18.4 Concurrency Control	716	Exercises	733
18.5 Deadlock Handling	720	Bibliographical Notes	734

PART SEVEN ■ SPECIAL PURPOSE SYSTEMS

Chapter 19 Real-Time Systems

19.1 Overview	739	19.5 Real-Time CPU Scheduling	748
19.2 System Characteristics	740	19.6 VxWorks 5.x	754
19.3 Features of Real-Time Kernels	742	19.7 Summary	756
19.4 Implementing Real-Time Operating Systems	744	Exercises	757
		Bibliographical Notes	757

Chapter 20 Multimedia Systems

20.1 What Is Multimedia?	759	20.6 Network Management	769
20.2 Compression	762	20.7 An Example: CineBlitz	772
20.3 Requirements of Multimedia Kernels	764	20.8 Summary	774
20.4 CPU Scheduling	766	Exercises	775
20.5 Disk Scheduling	767	Bibliographical Notes	777

PART EIGHT ■ CASE STUDIES

Chapter 21 The Linux System

21.1 Linux History	781	21.8 Input and Output	814
21.2 Design Principles	786	21.9 Interprocess Communication	817
21.3 Kernel Modules	789	21.10 Network Structure	818
21.4 Process Management	792	21.11 Security	821
21.5 Scheduling	795	21.12 Summary	823
21.6 Memory Management	800	Exercises	824
21.7 File Systems	808	Bibliographical Notes	825

Chapter 22 Windows XP

22.1 History	827	22.6 Networking	866
22.2 Design Principles	829	22.7 Programmer Interface	873
22.3 System Components	831	22.8 Summary	880
22.4 Environmental Subsystems	855	Exercises	880
22.5 File System	858	Bibliographical Notes	881

Chapter 23 Influential Operating Systems

23.1 Early Systems	883	23.7 MULTICS	893
23.2 Atlas	889	23.8 IBM OS/360	894
23.3 XDS-940	890	23.9 Mach	895
23.4 THE	891	23.10 Other Systems	897
23.5 RC 4000	892	Exercises	897
23.6 CTSS	893		

PART EIGHT ■ APPENDICES**Appendix A BSD UNIX (contents online)**

A.1 UNIX History	899	A.7 File System	922
A.2 Design Principles	904	A.8 I/O System	930
A.3 Programmer Interface	906	A.9 Interprocess Communication	933
A.4 User Interface	913	A.10 Summary	938
A.5 Process Management	916	Exercises	939
A.6 Memory Management	920	Bibliographical Notes	940

Appendix B The Mach System (contents online)

B.1 History of the Mach System	941	B.7 Programmer Interface	963
B.2 Design Principles	943	B.8 Summary	964
B.3 System Components	944	Exercises	965
B.4 Process Management	947	Bibliographical Notes	966
B.5 Interprocess Communication	953	Credits	967
B.6 Memory Management	958		

Appendix C Windows 2000 (contents online)

C.1 History	969	C.6 Networking	996
C.2 Design Principles	970	C.7 Programmer Interface	1001
C.3 System Components	971	C.8 Summary	1008
C.4 Environmental Subsystems	987	Exercises	1008
C.5 File System	989	Bibliographical Notes	1009

Appendix D Distributed Communication (contents online)

D.1 Sockets	1011	D.5 Web Services	1029
D.2 UDP Sockets	1018	D.6 Summary	1033
D.3 Remote Method Invocation	1022	Exercises	1034
D.4 Other Aspects of Distributed Communication	1027	Bibliographical Notes	1035

Appendix E Java Primer (contents online)

E.1 Basics	1037	E.5 Applications and Applets	1053
E.2 Inheritance	1046	E.6 Summary	1055
E.3 Interfaces and Abstract Classes	1048	Bibliographical Notes	1055
E.4 Exception Handling	1052		

Bibliography 899**Credits 929****Index 929**