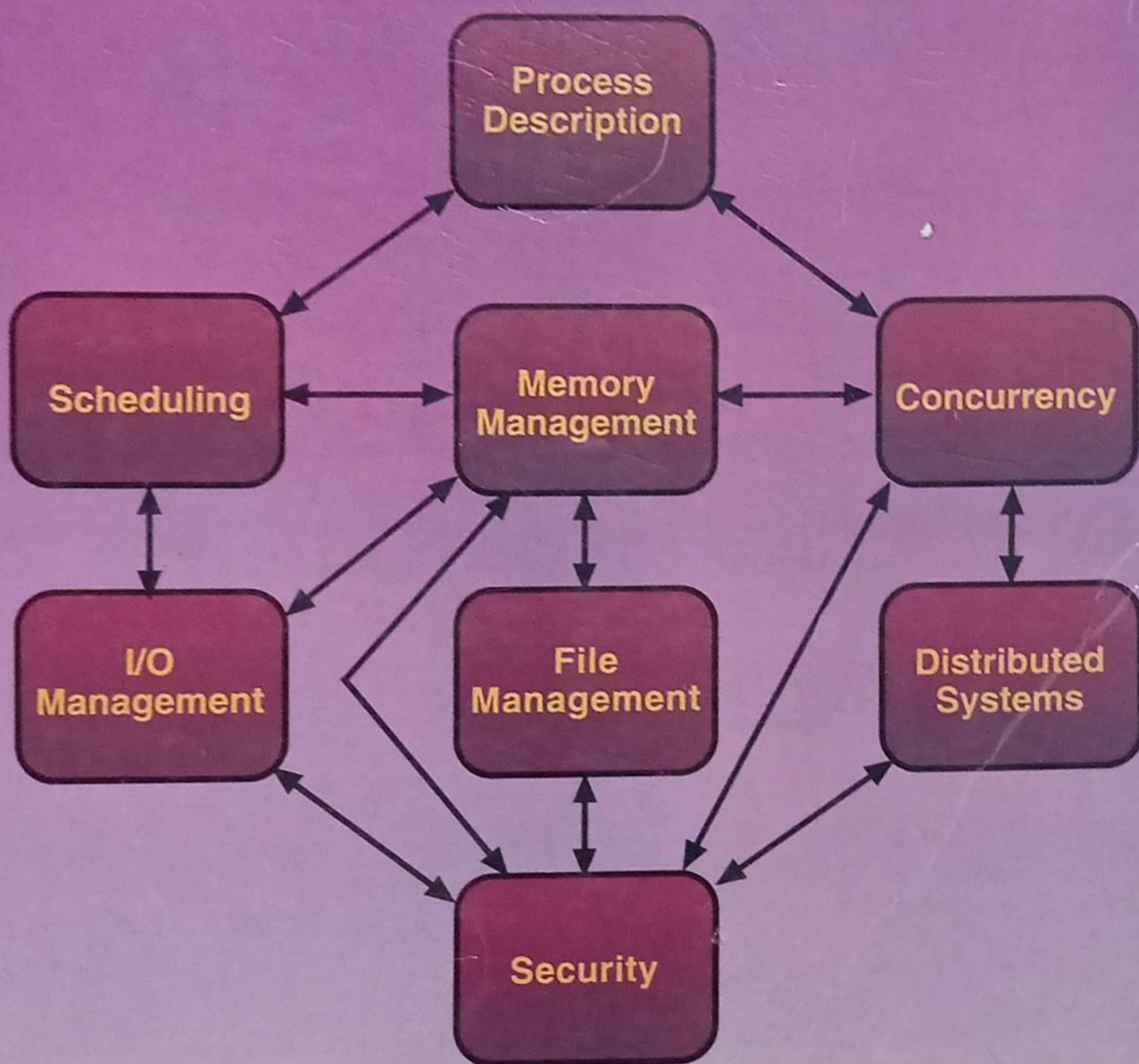


Second Edition

SECOND EDITION

OPERATING SYSTEMS



WILLIAM STALLINGS



001.552

Contents

PREFACE xiii

CHAPTER 1 COMPUTER SYSTEM OVERVIEW 1

- 1.1 Basic Elements 1
- 1.2 Processor Registers 2
- 1.3 Instruction Execution 5
- 1.4 Interrupts 9
- 1.5 The Memory Hierarchy 20
- 1.6 Cache Memory 25
- 1.7 I/O Communication Techniques 29
- 1.8 Recommended Reading 33
- 1.9 Problems 34
- Appendix 1A Performance Characteristics of Two-Level Memory 36
- Appendix 1B Procedure Control 42

CHAPTER 2 OPERATING SYSTEM OVERVIEW 47

- 2.1 Operating-Systems Objectives and Functions 47
- 2.2 The Evolution of Operating Systems 52
- 2.3 Major Achievements 62
- 2.4 Example Systems 75
- 2.5 Outline of the Remainder of the Book 90
- 2.6 Recommended Reading 94
- 2.7 Problems 96

CHAPTER 3 PROCESS DESCRIPTION AND CONTROL 97

- 3.1 Process States 98
- 3.2 Process Description 116

3.3	Process Control	126
3.4	Processes and Threads	135
3.5	Examples of Process Description and Control	141
3.6	Summary	155
3.7	Recommended Reading	156
3.8	Problems	156

CHAPTER 4 CONCURRENTNESS: MUTUAL EXCLUSION AND SYNCHRONIZATION 160

4.1	Principles of Concurrency	161
4.2	Mutual Exclusion—Software Approaches	170
4.3	Mutual Exclusion—Hardware Approaches	176
4.4	Semaphores	181
4.5	Monitors	198
4.6	Message-Passing	204
4.7	Readers/Writers Problem	210
4.8	Summary	217
4.9	Recommended Reading	217
4.10	Problems	218

CHAPTER 5 CONCURRENTNESS: DEADLOCK AND STARVATION 228

5.1	Principles of Deadlock	228
5.2	Deadlock Prevention	233
5.3	Deadlock Detection	234
5.4	Deadlock Avoidance	235
5.5	Dining Philosophers Problem	242
5.6	Example Systems	244
5.7	Summary	250
5.8	Recommended Reading	252
5.9	Problems	252

CHAPTER 6 MEMORY MANAGEMENT 256

6.1	Memory Management Requirements	257
6.2	Loading Programs into Main Memory	260
6.3	Summary	275
6.4	Recommended Reading	276
6.5	Problems	277
Appendix 6A	Loading and Linking	278

CHAPTER 7 VIRTUAL MEMORY 286

7.1	Hardware and Control Structures	286
7.2	Operating-System Software	305

7.3	Examples of Memory Management	325
7.4	Summary	337
7.5	Recommended Reading	338
7.6	Problems	338
Appendix 7A	Hash Tables	341

CHAPTER 8 UNIPROCESSOR SCHEDULING 345

8.1	Types of Scheduling	345
8.2	Scheduling Algorithms	349
8.3	Summary	373
8.4	Recommended Reading	374
8.5	Problems	375
Appendix 8A	Response Time	378

CHAPTER 9 MULTIPROCESSOR AND REAL-TIME SCHEDULING 381

9.1	Multiprocessor Scheduling	381
9.2	Real-Time Scheduling	394
9.3	Example Systems	407
9.4	Summary	413
9.5	Recommended Reading	414

CHAPTER 10 I/O MANAGEMENT AND DISK SCHEDULING 415

10.1	I/O Devices	415
10.2	Organization of the I/O Function	417
10.3	Operating-System Design Issues	421
10.4	I/O Buffering	425
10.5	Disk I/O	429
10.6	Example Systems	440
10.7	Summary	447
10.8	Recommended Reading	447
10.9	Problems	448

CHAPTER 11 FILE MANAGEMENT 450

11.1	Overview	450
11.2	File Organization and Access	456
11.3	File Directories	462
11.4	File Sharing	467
11.5	Record Blocking	468
11.6	Secondary Storage Management	470

11.7	Example System—UNIX System V	479
11.8	Summary	481
11.9	Recommended Reading	483
11.10	Problems	484

CHAPTER 12 NETWORKING AND DISTRIBUTED PROCESSING 487

12.1	Communications Architecture	488
12.2	The TCP/IP Protocol Suite	505
12.3	Client/Server Computing	509
12.4	Distributed Message-Passing	521
12.5	Remote Procedure Calls	525
12.6	Summary	529
12.7	Recommended Reading	530
12.8	Problems	531

CHAPTER 13 DISTRIBUTED PROCESS MANAGEMENT 533

13.1	Process Migration	533
13.2	Distributed Global States	541
13.3	Distributed Process Management— Mutual Exclusion	545
13.4	Distributed Deadlock	556
13.5	Summary	568
13.6	Recommended Reading	568
13.7	Problems	570

CHAPTER 14 SECURITY 572

14.1	Security Threats	574
14.2	Protection	579
14.3	Intruders	588
14.4	Viruses and Related Threats	602
14.5	Trusted Systems	614
14.6	Network Security	618
14.7	Summary	625
14.8	Recommended Reading	626
14.9	Problems	627
Appendix 14A	Encryption	629

APPENDIX A QUEUING ANALYSIS 633

A.1	Why Queuing Analysis?	633
A.2	Queuing Models	636

A.3	Single-Server Queues	640
A.4	Multiserver Queues	643
A.5	Networks of Queues	644
A.6	Examples	648
A.7	Other Queuing Models	651
A.8	Recommended Reading	652
Annex A	Just Enough Probability and Statistics	653

APPENDIX B OBJECT-ORIENTED DESIGN 658

B.1	Motivation	658
B.2	Object-Oriented Concepts	658
B.3	Benefits of Object-Oriented Design	663

GLOSSARY 664

REFERENCES 672

LIST OF ACRONYMS 686

INDEX 687