
Bibliography

- [Abbot 1984]** C. Abbot, "Intervention Schedules for Real-Time Programming", *IEEE Transactions on Software Engineering*, Volume SE-10, Number 3 (1984), pages 268–274.
- [Accetta et al. 1986]** M. Accetta, R. Baron, W. Bolosky, D. B. Golub, R. Rashid, A. Tevanian, and M. Young, "Mach: A New Kernel Foundation for Unix Development", *Proceedings of the Summer USENIX Conference* (1986), pages 93–112.
- [Agrawal and Abbadi 1991]** D. P. Agrawal and A. E. Abbadi, "An Efficient and Fault-Tolerant Solution of Distributed Mutual Exclusion", *ACM Transactions on Computer Systems*, Volume 9, Number 1 (1991), pages 1–20.
- [Agre 2003]** P. E. Agre, "P2P and the Promise of Internet Equality", *Communications of the ACM*, Volume 46, Number 2 (2003), pages 39–42.
- [Ahituv et al. 1987]** N. Ahituv, Y. Lapid, and S. Neumann, "Processing Encrypted Data", *Communications of the ACM*, Volume 30, Number 9 (1987), pages 777–780.
- [Ahmed 2000]** I. Ahmed, "Cluster Computing: A Glance at Recent Events", *IEEE Concurrency*, Volume 8, Number 1 (2000).
- [Akl 1983]** S. G. Akl, "Digital Signatures: A Tutorial Survey", *Computer*, Volume 16, Number 2 (1983), pages 15–24.
- [Akyurek and Salem 1993]** S. Akyurek and K. Salem, "Adaptive Block Rearrangement", *Proceedings of the International Conference on Data Engineering* (1993), pages 182–189.
- [Alt 1993]** H. Alt, "Removable Media in Solaris", *Proceedings of the Winter USENIX Conference* (1993), pages 281–287.
- [Anderson 1990]** T. E. Anderson, "The Performance of Spin Lock Alternatives for Shared-Memory Multiprocessors", *IEEE Trans. Parallel Distrib. Syst.*, Volume 1, Number 1 (1990), pages 6–16.
- [Anderson et al. 1989]** T. E. Anderson, E. D. Lazowska, and H. M. Levy, "The Performance Implications of Thread Management Alternatives for Shared-

Memory Multiprocessors”, *IEEE Transactions on Computers*, Volume 38, Number 12 (1989), pages 1631–1644.

[Anderson et al. 1991] T. E. Anderson, B. N. Bershad, E. D. Lazowska, and H. M. Levy, “Scheduler Activations: Effective Kernel Support for the User-Level Management of Parallelism”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1991), pages 95–109.

[Anderson et al. 1995] T. E. Anderson, M. D. Dahlin, J. M. Neefe, D. A. Patterson, D. S. Roselli, and R. Y. Wang, “Serverless Network File Systems”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1995), pages 109–126.

[Anderson et al. 2000] D. Anderson, J. Chase, and A. Vahdat, “Interposed Request Routing for Scalable Network Storage”, *Proceedings of the Fourth Symposium on Operating Systems Design and Implementation* (2000).

[Asthana and Finkelstein 1995] P. Asthana and B. Finkelstein, “Superdense Optical Storage”, *IEEE Spectrum*, Volume 32, Number 8 (1995), pages 25–31.

[Audsley et al. 1991] N. C. Audsley, A. Burns, M. F. Richardson, and A. J. Wellings, “Hard Real-Time Scheduling: The Deadline Monotonic Approach”, *Proceedings of the IEEE Workshop on Real-Time Operating Systems and Software* (1991).

[Axelsson 1999] S. Axelsson, “The Base-Rate Fallacy and Its Implications for Intrusion Detection”, *Proceedings of the ACM Conference on Computer and Communications Security* (1999), pages 1–7.

[Babaoglu and Marzullo 1993] O. Babaoglu and K. Marzullo, “Consistent Global States of Distributed Systems: Fundamental Concepts and Mechanisms”, pages 55–96. Addison-Wesley (1993).

[Bach 1987] M. J. Bach, *The Design of the UNIX Operating System*, Prentice Hall (1987).

[Back et al. 2000] G. Back, P. Tullman, L. Stoller, W. C. Hsieh, and J. Lepreau, “Techniques for the Design of Java Operating Systems”, *2000 USENIX Annual Technical Conference* (2000).

[Baker et al. 1991] M. G. Baker, J. H. Hartman, M. D. Kupfer, K. W. Shirriff, and J. K. Ousterhout, “Measurements of a Distributed File System”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1991), pages 198–212.

[Balakrishnan et al. 2003] H. Balakrishnan, M. F. Kaashoek, D. Karger, R. Morris, and I. Stoica, “Looking Up Data in P2P Systems”, *Communications of the ACM*, Volume 46, Number 2 (2003), pages 43–48.

[Baldwin 2002] J. Baldwin, “Locking in the Multithreaded FreeBSD Kernel”, *USENIX BSD* (2002).

[Barnes 1993] G. Barnes, “A Method for Implementing Lock-Free Shared Data Structures”, *Proceedings of the ACM Symposium on Parallel Algorithms and Architectures* (1993), pages 261–270.

[Barrera 1991] J. S. Barrera, “A Fast Mach Network IPC Implementation”, *Proceedings of the USENIX Mach Symposium* (1991), pages 1–12.

- [**Basu et al. 1995**] A. Basu, V. Buch, W. Vogels, and T. von Eicken, “U-Net: A User-Level Network Interface for Parallel and Distributed Computing”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1995).
- [**Bays 1977**] C. Bays, “A Comparison of Next-Fit, First-Fit and Best-Fit”, *Communications of the ACM*, Volume 20, Number 3 (1977), pages 191–192.
- [**Belady 1966**] L. A. Belady, “A Study of Replacement Algorithms for a Virtual-Storage Computer”, *IBM Systems Journal*, Volume 5, Number 2 (1966), pages 78–101.
- [**Belady et al. 1969**] L. A. Belady, R. A. Nelson, and G. S. Shedler, “An Anomaly in Space-Time Characteristics of Certain Programs Running in a Paging Machine”, *Communications of the ACM*, Volume 12, Number 6 (1969), pages 349–353.
- [**Bellovin 1989**] S. M. Bellovin, “Security Problems in the TCP/IP Protocol Suite”, *Computer Communications Review*, Volume 19:2, (1989), pages 32–48.
- [**Ben-Ari 1990**] M. Ben-Ari, *Principles of Concurrent and Distributed Programming*, Prentice Hall (1990).
- [**Benjamin 1990**] C. D. Benjamin, “The Role of Optical Storage Technology for NASA”, *Proceedings, Storage and Retrieval Systems and Applications* (1990), pages 10–17.
- [**Bernstein and Goodman 1980**] P. A. Bernstein and N. Goodman, “Time-Stamp-Based Algorithms for Concurrency Control in Distributed Database Systems”, *Proceedings of the International Conference on Very Large Databases* (1980), pages 285–300.
- [**Bernstein et al. 1987**] A. Bernstein, V. Hadzilacos, and N. Goodman, *Concurrency Control and Recovery in Database Systems*, Addison-Wesley (1987).
- [**Bershad 1993**] B. Bershad, “Practical Considerations for Non-Blocking Concurrent Objects”, *IEEE International Conference on Distributed Computing Systems* (1993), pages 264–273.
- [**Bershad and Pinkerton 1988**] B. N. Bershad and C. B. Pinkerton, “Watchdogs: Extending the Unix File System”, *Proceedings of the Winter USENIX Conference* (1988).
- [**Bershad et al. 1990**] B. N. Bershad, T. E. Anderson, E. D. Lazowska, and H. M. Levy, “Lightweight Remote Procedure Call”, *ACM Transactions on Computer Systems*, Volume 8, Number 1 (1990), pages 37–55.
- [**Bershad et al. 1995**] B. N. Bershad, S. Savage, P. Pardyak, E. G. Sirer, M. Fiuczynski, D. Becker, S. Eggars, and C. Chambers, “Extensibility, Safety and Performance in the SPIN Operating System”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1995), pages 267–284.
- [**Beveridge and Wiener 1997**] J. Beveridge and R. Wiener, *Mutithreading Applications in Win32*, Addison-Wesley (1997).
- [**Birrell 1989**] A. D. Birrell, “An Introduction to Programming with Threads”, Technical Report 35, DEC-SRC (1989).

- [Birrell and Nelson 1984]** A. D. Birrell and B. J. Nelson, “Implementing Remote Procedure Calls”, *ACM Transactions on Computer Systems*, Volume 2, Number 1 (1984), pages 39–59.
- [Black 1990]** D. L. Black, “Scheduling Support for Concurrency and Parallelism in the Mach Operating System”, *IEEE Computer*, Volume 23, Number 5 (1990), pages 35–43.
- [Blumofe and Leiserson 1994]** R. Blumofe and C. Leiserson, “Scheduling Multi-threaded Computations by Work Stealing”, *Proceedings of the Annual Symposium on Foundations of Computer Science* (1994), pages 356–368.
- [Bobrow et al. 1972]** D. G. Bobrow, J. D. Burchfiel, D. L. Murphy, and R. S. Tomlinson, “TENEX, a Paged Time Sharing System for the PDP-10”, *Communications of the ACM*, Volume 15, Number 3 (1972).
- [Bolosky et al. 1997]** W. J. Bolosky, R. P. Fitzgerald, and J. R. Douceur, “Distributed Schedule Management in the Tiger Video Fileserver”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1997), pages 212–223.
- [Bonwick 1994]** J. Bonwick, “The Slab Allocator: An Object-Caching Kernel Memory Allocator”, *USENIX Summer* (1994), pages 87–98.
- [Bonwick and Adams 2001]** J. Bonwick and J. Adams, “Magazines and Vmem: Extending the Slab Allocator to Many CPUs and Arbitrary Resources”, *Proceedings of the 2001 USENIX Annual Technical Conference* (2001).
- [Bovet and Cesati 2002]** D. P. Bovet and M. Cesati, *Understanding the Linux Kernel, Second Edition*, O’Reilly & Associates (2002).
- [Brain 1996]** M. Brain, *Win32 System Services, Second Edition*, Prentice Hall (1996).
- [Brent 1989]** R. Brent, “Efficient Implementation of the First-Fit Strategy for Dynamic Storage Allocation”, *ACM Transactions on Programming Languages and Systems*, Volume 11, Number 3 (1989), pages 388–403.
- [Brereton 1986]** O. P. Brereton, “Management of Replicated Files in a UNIX Environment”, *Software—Practice and Experience*, Volume 16, (1986), pages 771–780.
- [Brinch-Hansen 1970]** P. Brinch-Hansen, “The Nucleus of a Multiprogramming System”, *Communications of the ACM*, Volume 13, Number 4 (1970), pages 238–241 and 250.
- [Brinch-Hansen 1972]** P. Brinch-Hansen, “Structured Multiprogramming”, *Communications of the ACM*, Volume 15, Number 7 (1972), pages 574–578.
- [Brinch-Hansen 1973]** P. Brinch-Hansen, *Operating System Principles*, Prentice Hall (1973).
- [Brooks 2003]** J. G. Brooks, *Computer Science: An Overview, Seventh Edition*, Addison-Wesley (2003).
- [Brownbridge et al. 1982]** D. R. Brownbridge, L. F. Marshall, and B. Randell, “The Newcastle Connection or UNIXes of the World Unite!”, *Software—Practice and Experience*, Volume 12, Number 12 (1982), pages 1147–1162.

- [Burns 1978]** J. E. Burns, "Mutual Exclusion with Linear Waiting Using Binary Shared Variables", *SIGACT News*, Volume 10, Number 2 (1978), pages 42–47.
- [Butenhof 1997]** D. Butenhof, *Programming with POSIX Threads*, Addison-Wesley (1997).
- [Buyya 1999]** R. Buyya, *High Performance Cluster Computing: Architectures and Systems*, Prentice Hall (1999).
- [Callaghan 2000]** B. Callaghan, *NFS Illustrated*, Addison-Wesley (2000).
- [Calvert and Donahoo 2001]** K. Calvert and M. Donahoo, *TCP/IP Sockets in Java: Practical Guide for Programmers*, Morgan Kaufmann (2001).
- [Cantrill et al. 2004]** B. M. Cantrill, M. W. Shapiro, and A. H. Leventhal, "Techniques for the Design of Java Operating Systems", *2004 USENIX Annual Technical Conference* (2004).
- [Carr and Hennessy 1981]** W. R. Carr and J. L. Hennessy, "WSClock—A Simple and Effective Algorithm for Virtual Memory Management", *Proceedings of the ACM Symposium on Operating Systems Principles* (1981), pages 87–95.
- [Carvalho and Roucairol 1983]** O. S. Carvalho and G. Roucairol, "On Mutual Exclusion in Computer Networks", *Communications of the ACM*, Volume 26, Number 2 (1983), pages 146–147.
- [Chandy and Lamport 1985]** K. M. Chandy and L. Lamport, "Distributed Snapshots: Determining Global States of Distributed Systems", *ACM Transactions on Computer Systems*, Volume 3, Number 1 (1985), pages 63–75.
- [Chang 1980]** E. Chang, "N-Philosophers: An Exercise in Distributed Control", *Computer Networks*, Volume 4, Number 2 (1980), pages 71–76.
- [Chang and Mergen 1988]** A. Chang and M. F. Mergen, "801 Storage: Architecture and Programming", *ACM Transactions on Computer Systems*, Volume 6, Number 1 (1988), pages 28–50.
- [Chase et al. 1994]** J. S. Chase, H. M. Levy, M. J. Feeley, and E. D. Lazowska, "Sharing and Protection in a Single-Address-Space Operating System", *ACM Transactions on Computer Systems*, Volume 12, Number 4 (1994), pages 271–307.
- [Chen et al. 1994]** P. M. Chen, E. K. Lee, G. A. Gibson, R. H. Katz, and D. A. Patterson, "RAID: High-Performance, Reliable Secondary Storage", *ACM Computing Survey*, Volume 26, Number 2 (1994), pages 145–185.
- [Cheswick et al. 2003]** W. Cheswick, S. Bellovin, and A. Rubin, *Firewalls and Internet Security: Repelling the Wily Hacker*, second edition, Addison-Wesley (2003).
- [Cheung and Loong 1995]** W. H. Cheung and A. H. S. Loong, "Exploring Issues of Operating Systems Structuring: From Microkernel to Extensible Systems", *Operating Systems Review*, Volume 29, (1995), pages 4–16.
- [Chi 1982]** C. S. Chi, "Advances in Computer Mass Storage Technology", *Computer*, Volume 15, Number 5 (1982), pages 60–74.
- [Coffman et al. 1971]** E. G. Coffman, M. J. Elphick, and A. Shoshani, "System Deadlocks", *Computing Surveys*, Volume 3, Number 2 (1971), pages 67–78.

- [Cohen and Jefferson 1975] E. S. Cohen and D. Jefferson, "Protection in the Hydra Operating System", *Proceedings of the ACM Symposium on Operating Systems Principles* (1975), pages 141–160.
- [Cohen and Woodring 1997] A. Cohen and M. Woodring, *Win32 Multithreaded Programming*, O'Reilly & Associates (1997).
- [Comer 1999] D. Comer, *Internetworking with TCP/IP, Volume II, Third Edition*, Prentice Hall (1999).
- [Comer 2000] D. Comer, *Internetworking with TCP/IP, Volume I, Fourth Edition*, Prentice Hall (2000).
- [Corbato and Vyssotsky 1965] F. J. Corbato and V. A. Vyssotsky, "Introduction and Overview of the MULTICS System", *Proceedings of the AFIPS Fall Joint Computer Conference* (1965), pages 185–196.
- [Corbato et al. 1962] F. J. Corbato, M. Merwin-Daggett, and R. C. Daley, "An Experimental Time-Sharing System", *Proceedings of the AFIPS Fall Joint Computer Conference* (1962), pages 335–344.
- [Coulouris et al. 2001] G. Coulouris, J. Dollimore, and T. Kindberg, *Distributed Systems Concepts and Designs, Third Edition*, Addison Wesley (2001).
- [Courtois et al. 1971] P. J. Courtois, F. Heymans, and D. L. Parnas, "Concurrent Control with 'Readers' and 'Writers'", *Communications of the ACM*, Volume 14, Number 10 (1971), pages 667–668.
- [Culler et al. 1998] D. E. Culler, J. P. Singh, and A. Gupta, *Parallel Computer Architecture: A Hardware/Software Approach*, Morgan Kaufmann Publishers Inc. (1998).
- [Custer 1994] H. Custer, *Inside the Windows NT File System*, Microsoft Press (1994).
- [Dabek et al. 2001] F. Dabek, M. F. Kaashoek, D. Karger, R. Morris, and I. Stoica, "Wide-Area Cooperative Storage with CFS", *Proceedings of the ACM Symposium on Operating Systems Principles* (2001), pages 202–215.
- [Daley and Dennis 1967] R. C. Daley and J. B. Dennis, "Virtual Memory, Processes, and Sharing in Multics", *Proceedings of the ACM Symposium on Operating Systems Principles* (1967), pages 121–128.
- [Davcev and Burkhard 1985] D. Davcev and W. A. Burkhard, "Consistency and Recovery Control for Replicated Files", *Proceedings of the ACM Symposium on Operating Systems Principles* (1985), pages 87–96.
- [Davies 1983] D. W. Davies, "Applying the RSA Digital Signature to Electronic Mail", *Computer*, Volume 16, Number 2 (1983), pages 55–62.
- [deBruijn 1967] N. G. deBruijn, "Additional Comments on a Problem in Concurrent Programming and Control", *Communications of the ACM*, Volume 10, Number 3 (1967), pages 137–138.
- [Deitel 1990] H. M. Deitel, *An Introduction to Operating Systems, Second Edition*, Addison-Wesley (1990).

- [Denning 1968]** P. J. Denning, "The Working Set Model for Program Behavior", *Communications of the ACM*, Volume 11, Number 5 (1968), pages 323–333.
- [Denning 1980]** P. J. Denning, "Working Sets Past and Present", *IEEE Transactions on Software Engineering*, Volume SE-6, Number 1 (1980), pages 64–84.
- [Denning 1982]** D. E. Denning, *Cryptography and Data Security*, Addison-Wesley (1982).
- [Denning 1983]** D. E. Denning, "Protecting Public Keys and Signature Keys", *Computer*, Volume 16, Number 2 (1983), pages 27–35.
- [Denning 1984]** D. E. Denning, "Digital Signatures with RSA and Other Public-Key Cryptosystems", *Communications of the ACM*, Volume 27, Number 4 (1984), pages 388–392.
- [Denning and Denning 1979]** D. E. Denning and P. J. Denning, "Data Security", *ACM Comput. Surv.*, Volume 11, Number 3 (1979), pages 227–249.
- [Dennis 1965]** J. B. Dennis, "Segmentation and the Design of Multiprogrammed Computer Systems", *Communications of the ACM*, Volume 8, Number 4 (1965), pages 589–602.
- [Dennis and Horn 1966]** J. B. Dennis and E. C. V. Horn, "Programming Semantics for Multiprogrammed Computations", *Communications of the ACM*, Volume 9, Number 3 (1966), pages 143–155.
- [Di Pietro and Mancini 2003]** R. Di Pietro and L. V. Mancini, "Security and Privacy Issues of Handheld and Wearable Wireless Devices", *Communications of the ACM*, Volume 46, Number 9 (2003), pages 74–79.
- [Diffie and Hellman 1976]** W. Diffie and M. E. Hellman, "New Directions in Cryptography", *IEEE Transactions on Information Theory*, Volume 22, Number 6 (1976), pages 644–654.
- [Diffie and Hellman 1979]** W. Diffie and M. E. Hellman, "Privacy and Authentication", *Proceedings of the IEEE* (1979), pages 397–427.
- [Dijkstra 1965a]** E. W. Dijkstra, "Cooperating Sequential Processes". Technical Report, Technological University, Eindhoven, the Netherlands (1965).
- [Dijkstra 1965b]** E. W. Dijkstra, "Solution of a Problem in Concurrent Programming Control", *Communications of the ACM*, Volume 8, Number 9 (1965), page 569.
- [Dijkstra 1968]** E. W. Dijkstra, "The Structure of the THE Multiprogramming System", *Communications of the ACM*, Volume 11, Number 5 (1968), pages 341–346.
- [Dijkstra 1971]** E. W. Dijkstra, "Hierarchical Ordering of Sequential Processes", *Acta Informatica*, Volume 1, Number 2 (1971), pages 115–138.
- [DoD 1985]** *Trusted Computer System Evaluation Criteria*. Department of Defense (1985).
- [Dougan et al. 1999]** C. Dougan, P. Mackerras, and V. Yodaiken, "Optimizing the Idle Task and Other MMU Tricks", *Proceedings of the Symposium on Operating System Design and Implementation* (1999).

- [Douglis and Ousterhout 1991]** F. Douglis and J. K. Ousterhout, “Transparent Process Migration: Design Alternatives and the Sprite Implementation”, *ACM SIGART News*, Volume 21, Number 8 (1991), pages 757–785.
- [Douglis et al. 1994]** F. Douglis, F. Kaashoek, K. Li, R. Caceres, B. Marsh, and J. A. Tauber, “Storage Alternatives for Mobile Computers”, *Proceedings of the Symposium on Operating Systems Design and Implementation* (1994), pages 25–37.
- [Douglis et al. 1995]** F. Douglis, P. Krishnan, and B. Bershad, “Adaptive Disk Spin-Down Policies for Mobile Computers”, *Proceedings of the USENIX Symposium on Mobile and Location Independent Computing* (1995), pages 121–137.
- [Draves et al. 1991]** R. P. Draves, B. N. Bershad, R. F. Rashid, and R. W. Dean, “Using continuations to implement thread management and communication in operating systems”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1991), pages 122–136.
- [Druschel and Peterson 1993]** P. Druschel and L. L. Peterson, “Fbufs: A High-Bandwidth Cross-Domain Transfer Facility”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1993), pages 189–202.
- [Eastlake 1999]** D. Eastlake, “Domain Name System Security Extensions”, *Network Working Group, Request for Comments*: 2535 (1999).
- [Eisenberg and McGuire 1972]** M. A. Eisenberg and M. R. McGuire, “Further Comments on Dijkstra’s Concurrent Programming Control Problem”, *Communications of the ACM*, Volume 15, Number 11 (1972), page 999.
- [Ekanadham and Bernstein 1979]** K. Ekanadham and A. J. Bernstein, “Conditional Capabilities”, *IEEE Transactions on Software Engineering*, Volume SE-5, Number 5 (1979), pages 458–464.
- [Engelschall 2000]** R. Engelschall, “Portable Multithreading: The Signal Stack Trick For User-Space Thread Creation”, *Proceedings of the 2000 USENIX Annual Technical Conference* (2000).
- [Eswaran et al. 1976]** K. P. Eswaran, J. N. Gray, R. A. Lorie, and I. L. Traiger, “The Notions of Consistency and Predicate Locks in a Database System”, *Communications of the ACM*, Volume 19, Number 11 (1976), pages 624–633.
- [Fang et al. 2001]** Z. Fang, L. Zhang, J. B. Carter, W. C. Hsieh, and S. A. McKee, “Reevaluating Online Superpage Promotion with Hardware Support”, *Proceedings of the International Symposium on High-Performance Computer Architecture*, Volume 50, Number 5 (2001).
- [Farrow 1986a]** R. Farrow, “Security for Superusers, or How to Break the UNIX System”, *UNIX World* (May 1986), pages 65–70.
- [Farrow 1986b]** R. Farrow, “Security Issues and Strategies for Users”, *UNIX World* (April 1986), pages 65–71.
- [Feitelson and Rudolph 1990]** D. Feitelson and L. Rudolph, “Mapping and Scheduling in a Shared Parallel Environment Using Distributed Hierarchical Control”, *Proceedings of the International Conference on Parallel Processing* (1990).
- [Fidge 1991]** C. Fidge, “Logical Time in Distributed Computing Systems”, *ACM SIGART News*, Volume 24, Number 8 (1991), pages 28–33.

- [Filipski and Hanko 1986]** A. Filipski and J. Hanko, “Making UNIX Secure”, *Byte* (April 1986), pages 113–128.
- [Fisher 1981]** J. A. Fisher, “Trace Scheduling: A Technique for Global Microcode Compaction”, *IEEE Transactions on Computers*, Volume 30, Number 7 (1981), pages 478–490.
- [Folk and Zoellick 1987]** M. J. Folk and B. Zoellick, *File Structures*, Addison-Wesley (1987).
- [Forrest et al. 1996]** S. Forrest, S. A. Hofmeyr, and T. A. Longstaff, “A Sense of Self for UNIX Processes”, *Proceedings of the IEEE Symposium on Security and Privacy* (1996), pages 120–128.
- [Fortier 1989]** P. J. Fortier, *Handbook of LAN Technology*, McGraw-Hill (1989).
- [Freedman 1983]** D. H. Freedman, “Searching for Denser Disks”, *Infosystems* (1983), page 56.
- [Fuhrt 1994]** B. Fuhrt, “Multimedia Systems: An Overview”, *IEEE MultiMedia*, Volume 1, Number 1 (1994), pages 47–59.
- [Fujitani 1984]** L. Fujitani, “Laser Optical Disk: The Coming Revolution in On-Line Storage”, *Communications of the ACM*, Volume 27, Number 6 (1984), pages 546–554.
- [Gait 1988]** J. Gait, “The Optical File Cabinet: A Random-Access File System for Write-On Optical Disks”, *Computer*, Volume 21, Number 6 (1988).
- [Ganapathy and Schimmel 1998]** N. Ganapathy and C. Schimmel, “General Purpose Operating System Support for Multiple Page Sizes”, *Proceedings of the USENIX Technical Conference* (1998).
- [Ganger et al. 2002]** G. R. Ganger, D. R. Engler, M. F. Kaashoek, H. M. Briceno, R. Hunt, and T. Pinckney, “Fast and Flexible Application-Level Networking on Exokernel Systems”, *ACM Transactions on Computer Systems*, Volume 20, Number 1 (2002), pages 49–83.
- [Garcia-Molina 1982]** H. Garcia-Molina, “Elections in Distributed Computing Systems”, *IEEE Transactions on Computers*, Volume C-31, Number 1 (1982).
- [Garfinkel et al. 2003]** S. Garfinkel, G. Spafford, and A. Schwartz, *Practical UNIX & Internet Security*, O’Reilly & Associates (2003).
- [Gibson et al. 1997a]** G. Gibson, D. Nagle, K. Amiri, F. Chang, H. Gobioff, E. Riedel, D. Rochberg, and J. Zelenka. “Filesystems for Network-Attached Secure Disks”. Technical Report, CMU-CS-97-112 (1997).
- [Gibson et al. 1997b]** G. A. Gibson, D. Nagle, K. Amiri, F. W. Chang, E. M. Feinberg, H. Gobioff, C. Lee, B. Ozceri, E. Riedel, D. Rochberg, and J. Zelenka, “File Server Scaling with Network-Attached Secure Disks”, *Measurement and Modeling of Computer Systems* (1997), pages 272–284.
- [Gifford 1982]** D. K. Gifford, “Cryptographic Sealing for Information Secrecy and Authentication”, *Communications of the ACM*, Volume 25, Number 4 (1982), pages 274–286.

- [Goldberg et al. 1996]** I. Goldberg, D. Wagner, R. Thomas, and E. A. Brewer, “A Secure Environment for Untrusted Helper Applications”, *Proceedings of the 6th Usenix Security Symposium* (1996).
- [Golden and Pechura 1986]** D. Golden and M. Pechura, “The Structure of Microcomputer File Systems”, *Communications of the ACM*, Volume 29, Number 3 (1986), pages 222–230.
- [Golding et al. 1995]** R. A. Golding, P. B. II, C. Staelin, T. Sullivan, and J. Wilkes, “Idleness is Not Sloth”, *USENIX Winter* (1995), pages 201–212.
- [Golm et al. 2002]** M. Golm, M. Felser, C. Wawersich, and J. Kleinoder, “The JX Operating System”, *2002 USENIX Annual Technical Conference* (2002).
- [Gong 2002]** L. Gong, “Peer-to-Peer Networks in Action”, *IEEE Internet Computing*, Volume 6, Number 1 (2002).
- [Gong et al. 1997]** L. Gong, M. Mueller, H. Prafullchandra, and R. Schemers, “Going Beyond the Sandbox: An Overview of the New Security Architecture in the Java Development Kit 1.2”, *Proceedings of the USENIX Symposium on Internet Technologies and Systems* (1997).
- [Goodman et al. 1989]** J. R. Goodman, M. K. Vernon, and P. J. Woest, “Efficient Synchronization Primitives for Large-Scale Cache-Coherent Multiprocessors”, *Proceedings of the International Conference on Architectural Support for Programming Languages and Operating Systems* (1989), pages 64–75.
- [Gosling et al. 1996]** J. Gosling, B. Joy, and G. Steele, *The Java Language Specification*, Addison-Wesley (1996).
- [Govindan and Anderson 1991]** R. Govindan and D. P. Anderson, “Scheduling and IPC Mechanisms for Continuous Media”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1991), pages 68–80.
- [Grampp and Morris 1984]** F. T. Grampp and R. H. Morris, “UNIX Operating-System Security”, *AT&T Bell Laboratories Technical Journal*, Volume 63, (1984), pages 1649–1672.
- [Gray 1978]** J. N. Gray, “Notes on Data Base Operating Systems”, in **[Bayer et al. 1978]** (1978), pages 393–481.
- [Gray 1981]** J. N. Gray, “The Transaction Concept: Virtues and Limitations”, *Proceedings of the International Conference on Very Large Databases* (1981), pages 144–154.
- [Gray 1997]** J. Gray, *Interprocess Communications in UNIX*, Prentice Hall (1997).
- [Gray et al. 1981]** J. N. Gray, P. R. McJones, and M. Blasgen, “The Recovery Manager of the System R Database Manager”, *ACM Computing Survey*, Volume 13, Number 2 (1981), pages 223–242.
- [Greenawalt 1994]** P. Greenawalt, “Modeling Power Management for Hard Disks”, *Proceedings of the Symposium on Modeling and Simulation of Computer Telecommunication Systems* (1994), pages 62–66.
- [Grosshans 1986]** D. Grosshans, *File Systems Design and Implementation*, Prentice Hall (1986).

- [Grosso 2002]** W. Grosso, *Java RMI*, O'Reilly & Associates (2002).
- [Habermann 1969]** A. N. Habermann, "Prevention of System Deadlocks", *Communications of the ACM*, Volume 12, Number 7 (1969), pages 373–377, 385.
- [Hall et al. 1996]** L. Hall, D. Shmoys, and J. Wein, "Scheduling To Minimize Average Completion Time: Off-line and On-line Algorithms", *SODA: ACM-SIAM Symposium on Discrete Algorithms* (1996).
- [Halsall 1992]** F. Halsall, *Data Communications, Computer Networks and Open Systems*, Addison-Wesley (1992).
- [Hamacher et al. 2002]** C. Hamacher, Z. Vranesic, and S. Zaky, *Computer Organization, Fifth Edition*, McGraw-Hill (2002).
- [Han and Ghosh 1998]** K. Han and S. Ghosh, "A Comparative Analysis of Virtual Versus Physical Process-Migration Strategies for Distributed Modeling and Simulation of Mobile Computing Networks", *Wireless Networks*, Volume 4, Number 5 (1998), pages 365–378.
- [Hansen and Atkins 1993]** S. E. Hansen and E. T. Atkins, "Automated System Monitoring and Notification With Swatch", *Proceedings of the USENIX Systems Administration Conference* (1993).
- [Harchol-Balter and Downey 1997]** M. Harchol-Balter and A. B. Downey, "Exploiting Process Lifetime Distributions for Dynamic Load Balancing", *ACM Transactions on Computer Systems*, Volume 15, Number 3 (1997), pages 253–285.
- [Harish and Owens 1999]** V. C. Harish and B. Owens, "Dynamic Load Balancing DNS", *Linux Journal*, Volume 1999, Number 64 (1999).
- [Harker et al. 1981]** J. M. Harker, D. W. Brede, R. E. Pattison, G. R. Santana, and L. G. Taft, "A Quarter Century of Disk File Innovation", *IBM Journal of Research and Development*, Volume 25, Number 5 (1981), pages 677–689.
- [Harrison et al. 1976]** M. A. Harrison, W. L. Ruzzo, and J. D. Ullman, "Protection in Operating Systems", *Communications of the ACM*, Volume 19, Number 8 (1976), pages 461–471.
- [Hartman and Ousterhout 1995]** J. H. Hartman and J. K. Ousterhout, "The Zebra Striped Network File System", *ACM Transactions on Computer Systems*, Volume 13, Number 3 (1995), pages 274–310.
- [Havender 1968]** J. W. Havender, "Avoiding Deadlock in Multitasking Systems", *IBM Systems Journal*, Volume 7, Number 2 (1968), pages 74–84.
- [Hecht et al. 1988]** M. S. Hecht, A. Johri, R. Aditham, and T. J. Wei, "Experience Adding C2 Security Features to UNIX", *Proceedings of the Summer USENIX Conference* (1988), pages 133–146.
- [Hennessy and Patterson 2002]** J. L. Hennessy and D. A. Patterson, *Computer Architecture: A Quantitative Approach, Third Edition*, Morgan Kaufmann Publishers (2002).
- [Henry 1984]** G. Henry, "The Fair Share Scheduler", *AT&T Bell Laboratories Technical Journal* (1984).

- [Herlihy 1993]** M. Herlihy, "A Methodology for Implementing Highly Concurrent Data Objects", *ACM Transactions on Programming Languages and Systems*, Volume 15, Number 5 (1993), pages 745–770.
- [Herlihy and Moss 1993]** M. Herlihy and J. E. B. Moss, "Transactional Memory: Architectural Support For Lock-Free Data Structures", *Proceedings of the Twentieth Annual International Symposium on Computer Architecture* (1993).
- [Hitz et al. 1995]** D. Hitz, J. Lau, and M. Malcolm, "File System Design for an NFS File Server Appliance", *Technical Report TR3002* (http://www.netapp.com/tech_library/3002.html), NetApp (1995).
- [Hoagland 1985]** A. S. Hoagland, "Information Storage Technology—A Look at the Future", *Computer*, Volume 18, Number 7 (1985), pages 60–68.
- [Hoare 1972]** C. A. R. Hoare, "Towards a Theory of Parallel Programming", in **[Hoare and Perrott 1972]** (1972), pages 61–71.
- [Hoare 1974]** C. A. R. Hoare, "Monitors: An Operating System Structuring Concept", *Communications of the ACM*, Volume 17, Number 10 (1974), pages 549–557.
- [Holt 1971]** R. C. Holt, "Comments on Prevention of System Deadlocks", *Communications of the ACM*, Volume 14, Number 1 (1971), pages 36–38.
- [Holt 1972]** R. C. Holt, "Some Deadlock Properties of Computer Systems", *Computing Surveys*, Volume 4, Number 3 (1972), pages 179–196.
- [Holub 2000]** A. Holub, *Taming Java Threads*, Apress (2000).
- [Hong et al. 1989]** J. Hong, X. Tan, and D. Towsley, "A Performance Analysis of Minimum Laxity and Earliest Deadline Scheduling in a Real-Time System", *IEEE Transactions on Computers*, Volume 38, Number 12 (1989), pages 1736–1744.
- [Howard et al. 1988]** J. H. Howard, M. L. Kazar, S. G. Menees, D. A. Nichols, M. Satyanarayanan, and R. N. Sidebotham, "Scale and Performance in a Distributed File System", *ACM Transactions on Computer Systems*, Volume 6, Number 1 (1988), pages 55–81.
- [Howarth et al. 1961]** D. J. Howarth, R. B. Payne, and F. H. Sumner, "The Manchester University Atlas Operating System, Part II: User's Description", *Computer Journal*, Volume 4, Number 3 (1961), pages 226–229.
- [Hsiao et al. 1979]** D. K. Hsiao, D. S. Kerr, and S. E. Madnick, *Computer Security*, Academic Press (1979).
- [Hu and Perrig 2004]** Y.-C. Hu and A. Perrig, "SPV: A Secure Path Vector Routing Scheme for Securing BGP", *Proceedings of ACM SIGCOMM Conference on Data Communication* (2004).
- [Hu et al. 2002]** Y.-C. Hu, A. Perrig, and D. Johnson, "Ariadne: A Secure On-Demand Routing Protocol for Ad Hoc Networks", *Proceedings of the Annual International Conference on Mobile Computing and Networking* (2002).
- [Hyman 1985]** D. Hyman, *The Columbus Chicken Statute and More Bonehead Legislation*, S. Greene Press (1985).

- [Iacobucci 1988] E. Iacobucci, *OS/2 Programmer's Guide*, Osborne McGraw-Hill (1988).
- [IBM 1983] *Technical Reference*. IBM Corporation (1983).
- [Iliffe and Jodeit 1962] J. K. Iliffe and J. G. Jodeit, "A Dynamic Storage Allocation System", *Computer Journal*, Volume 5, Number 3 (1962), pages 200–209.
- [Intel 1985a] *iAPX 286 Programmer's Reference Manual*. Intel Corporation (1985).
- [Intel 1985b] *iAPX 86/88, 186/188 User's Manual Programmer's Reference*. Intel Corporation (1985).
- [Intel 1986] *iAPX 386 Programmer's Reference Manual*. Intel Corporation (1986).
- [Intel 1990] *i486 Microprocessor Programmer's Reference Manual*. Intel Corporation (1990).
- [Intel 1993] *Pentium Processor User's Manual, Volume 3: Architecture and Programming Manual*. Intel Corporation (1993).
- [Iseminger 2000] D. Iseminger, *Active Directory Services for Microsoft Windows 2000. Technical Reference*, Microsoft Press (2000).
- [Jacob and Mudge 1997] B. Jacob and T. Mudge, "Software-Managed Address Translation", *Proceedings of the International Symposium on High Performance Computer Architecture and Implementation* (1997).
- [Jacob and Mudge 1998a] B. Jacob and T. Mudge, "Virtual Memory in Contemporary Microprocessors", *IEEE Micro Magazine*, Volume 18, (1998), pages 60–75.
- [Jacob and Mudge 1998b] B. Jacob and T. Mudge, "Virtual Memory: Issues of Implementation", *IEEE Computer Magazine*, Volume 31, (1998), pages 33–43.
- [Jacob and Mudge 2001] B. Jacob and T. Mudge, "Uniprocessor Virtual Memory Without TLBs", *IEEE Transactions on Computers*, Volume 50, Number 5 (2001).
- [Jacobson and Wilkes 1991] D. M. Jacobson and J. Wilkes. "Disk Scheduling Algorithms Based on Rotational Position". Technical Report HPL-CSP-91-7 (1991).
- [Jensen et al. 1985] E. D. Jensen, C. D. Locke, and H. Tokuda, "A Time-Driven Scheduling Model for Real-Time Operating Systems", *Proceedings of the IEEE Real-Time Systems Symposium* (1985), pages 112–122.
- [Johnstone and Wilson 1998] M. S. Johnstone and P. R. Wilson, "The Memory Fragmentation Problem: Solved?", *Proceedings of the First International Symposium on Memory management* (1998), pages 26–36.
- [Jones and Liskov 1978] A. K. Jones and B. H. Liskov, "A Language Extension for Expressing Constraints on Data Access", *Communications of the ACM*, Volume 21, Number 5 (1978), pages 358–367.
- [Jul et al. 1988] E. Jul, H. Levy, N. Hutchinson, and A. Black, "Fine-Grained Mobility in the Emerald System", *ACM Transactions on Computer Systems*, Volume 6, Number 1 (1988), pages 109–133.

- [Kaashoek et al. 1997]** M. F. Kaashoek, D. R. Engler, G. R. Ganger, H. M. Briceno, R. Hunt, D. Mazieres, T. Pinckney, R. Grimm, J. Jannotti, and K. Mackenzie, “Application performance and flexibility on exokernel systems”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1997), pages 52–65.
- [Katz et al. 1989]** R. H. Katz, G. A. Gibson, and D. A. Patterson, “Disk System Architectures for High Performance Computing”, *Proceedings of the IEEE* (1989).
- [Kay and Lauder 1988]** J. Kay and P. Lauder, “A Fair Share Scheduler”, *Communications of the ACM*, Volume 31, Number 1 (1988), pages 44–55.
- [Kent et al. 2000]** S. Kent, C. Lynn, and K. Seo, “Secure Border Gateway Protocol (Secure-BGP)”, *IEEE Journal on Selected Areas in Communications*, Volume 18, Number 4 (2000), pages 582–592.
- [Kenville 1982]** R. F. Kenville, “Optical Disk Data Storage”, *Computer*, Volume 15, Number 7 (1982), pages 21–26.
- [Kessels 1977]** J. L. W. Kessels, “An Alternative to Event Queues for Synchronization in Monitors”, *Communications of the ACM*, Volume 20, Number 7 (1977), pages 500–503.
- [Khanna et al. 1992]** S. Khanna, M. Sebree, and J. Zolnowsky, “Realtime Scheduling in SunOS 5.0”, *Proceedings of the Winter USENIX Conference* (1992), pages 375–390.
- [Kieburz and Silberschatz 1978]** R. B. Kieburz and A. Silberschatz, “Capability Managers”, *IEEE Transactions on Software Engineering*, Volume SE-4, Number 6 (1978), pages 467–477.
- [Kieburz and Silberschatz 1983]** R. B. Kieburz and A. Silberschatz, “Access Right Expressions”, *ACM Transactions on Programming Languages and Systems*, Volume 5, Number 1 (1983), pages 78–96.
- [Kilburn et al. 1961]** T. Kilburn, D. J. Howarth, R. B. Payne, and F. H. Sumner, “The Manchester University Atlas Operating System, Part I: Internal Organization”, *Computer Journal*, Volume 4, Number 3 (1961), pages 222–225.
- [Kim and Spafford 1993]** G. H. Kim and E. H. Spafford, “The Design and Implementation of Tripwire: A File System Integrity Checker”, *Technical Report, Purdue University* (1993).
- [King 1990]** R. P. King, “Disk Arm Movement in Anticipation of Future Requests”, *ACM Transactions on Computer Systems*, Volume 8, Number 3 (1990), pages 214–229.
- [Kistler and Satyanarayanan 1992]** J. Kistler and M. Satyanarayanan, “Disconnected Operation in the Coda File System”, *ACM Transactions on Computer Systems*, Volume 10, Number 1 (1992), pages 3–25.
- [Knapp 1987]** E. Knapp, “Deadlock Detection in Distributed Databases”, *Computing Surveys*, Volume 19, Number 4 (1987), pages 303–328.
- [Knowlton 1965]** K. C. Knowlton, “A Fast Storage Allocator”, *Communications of the ACM*, Volume 8, Number 10 (1965), pages 623–624.

- [Knuth 1966]** D. E. Knuth, "Additional Comments on a Problem in Concurrent Programming Control", *Communications of the ACM*, Volume 9, Number 5 (1966), pages 321–322.
- [Knuth 1973]** D. E. Knuth, *The Art of Computer Programming, Volume 1: Fundamental Algorithms, Second Edition*, Addison-Wesley (1973).
- [Koch 1987]** P. D. L. Koch, "Disk File Allocation Based on the Buddy System", *ACM Transactions on Computer Systems*, Volume 5, Number 4 (1987), pages 352–370.
- [Kopetz and Reisinger 1993]** H. Kopetz and J. Reisinger, "The Non-Blocking Write Protocol NBW: A Solution to a Real-Time Synchronisation Problem", *IEEE Real-Time Systems Symposium* (1993), pages 131–137.
- [Kosaraju 1973]** S. Kosaraju, "Limitations of Dijkstra's Semaphore Primitives and Petri Nets", *Operating Systems Review*, Volume 7, Number 4 (1973), pages 122–126.
- [Kramer 1988]** S. M. Kramer, "Retaining SUID Programs in a Secure UNIX", *Proceedings of the Summer USENIX Conference* (1988), pages 107–118.
- [Kubiatowicz et al. 2000]** J. Kubiatowicz, D. Bindel, Y. Chen, S. Czerwinski, P. Eaton, D. Geels, R. Gummadi, S. Rhea, H. Weatherspoon, W. Weimer, C. Wells, and B. Zhao, "OceanStore: An Architecture for Global-Scale Persistent Storage", *Proc. of Architectural Support for Programming Languages and Operating Systems* (2000).
- [Kurose and Ross 2005]** J. Kurose and K. Ross, *Computer Networking—A Top-Down Approach Featuring the Internet, Third Edition*, Addison-Wesley (2005).
- [Lamport 1974]** L. Lamport, "A New Solution of Dijkstra's Concurrent Programming Problem", *Communications of the ACM*, Volume 17, Number 8 (1974), pages 453–455.
- [Lamport 1976]** L. Lamport, "Synchronization of Independent Processes", *Acta Informatica*, Volume 7, Number 1 (1976), pages 15–34.
- [Lamport 1977]** L. Lamport, "Concurrent Reading and Writing", *Communications of the ACM*, Volume 20, Number 11 (1977), pages 806–811.
- [Lamport 1978a]** L. Lamport, "The Implementation of Reliable Distributed Multiprocess Systems", *Computer Networks*, Volume 2, Number 2 (1978), pages 95–114.
- [Lamport 1978b]** L. Lamport, "Time, Clocks and the Ordering of Events in a Distributed System", *Communications of the ACM*, Volume 21, Number 7 (1978), pages 558–565.
- [Lamport 1981]** L. Lamport, "Password Authentication with Insecure Communications", *Communications of the ACM*, Volume 24, Number 11 (1981), pages 770–772.
- [Lamport 1986]** L. Lamport, "The Mutual Exclusion Problem", *Communications of the ACM*, Volume 33, Number 2 (1986), pages 313–348.

- [Lamport 1987]** L. Lamport, “A Fast Mutual Exclusion Algorithm”, *ACM Transactions on Computer Systems*, Volume 5, Number 1 (1987), pages 1–11.
- [Lamport 1991]** L. Lamport, “The Mutual Exclusion Problem Has Been Solved”, *Communications of the ACM*, Volume 34, Number 1 (1991), page 110.
- [Lamport et al. 1982]** L. Lamport, R. Shostak, and M. Pease, “The Byzantine Generals Problem”, *ACM Transactions on Programming Languages and Systems*, Volume 4, Number 3 (1982), pages 382–401.
- [Lampson 1969]** B. W. Lampson, “Dynamic Protection Structures”, *Proceedings of the AFIPS Fall Joint Computer Conference* (1969), pages 27–38.
- [Lampson 1971]** B. W. Lampson, “Protection”, *Proceedings of the Fifth Annual Princeton Conference on Information Systems Science* (1971), pages 437–443.
- [Lampson 1973]** B. W. Lampson, “A Note on the Confinement Problem”, *Communications of the ACM*, Volume 10, Number 16 (1973), pages 613–615.
- [Lampson and Redell 1979]** B. W. Lampson and D. D. Redell, “Experience with Processes and Monitors in Mesa”, *Proceedings of the 7th ACM Symposium on Operating Systems Principles (SOSP)* (1979), pages 43–44.
- [Lampson and Sturgis 1976]** B. Lampson and H. Sturgis, “Crash Recovery in a Distributed Data Storage System”, *Technical Report, Xerox Research Center* (1976).
- [Landwehr 1981]** C. E. Landwehr, “Formal Models of Computer Security”, *Computing Surveys*, Volume 13, Number 3 (1981), pages 247–278.
- [Lann 1977]** G. L. Lann, “Distributed Systems—Toward a Formal Approach”, *Proceedings of the IFIP Congress* (1977), pages 155–160.
- [Larson and Kajla 1984]** P. Larson and A. Kajla, “File Organization: Implementation of a Method Guaranteeing Retrieval in One Access”, *Communications of the ACM*, Volume 27, Number 7 (1984), pages 670–677.
- [Lauzac et al. 2003]** S. Lauzac, R. Melhem, and D. Mosse, “An Improved Rate-Monotonic Admission Control and Its Applications”, *IEEE Transactions on Computers*, Volume 52, Number 3 (2003).
- [Lee 2003]** J. Lee, “An End-User Perspective on File-Sharing Systems”, *Communications of the ACM*, Volume 46, Number 2 (2003), pages 49–53.
- [Lee and Thekkath 1996]** E. K. Lee and C. A. Thekkath, “Petal: Distributed Virtual Disks”, *Proceedings of the Seventh International Conference on Architectural Support for Programming Languages and Operating Systems* (1996), pages 84–92.
- [Leffler et al. 1989]** S. J. Leffler, M. K. McKusick, M. J. Karels, and J. S. Quarterman, *The Design and Implementation of the 4.3BSD UNIX Operating System*, Addison-Wesley (1989).
- [Lehmann 1987]** F. Lehmann, “Computer Break-Ins”, *Communications of the ACM*, Volume 30, Number 7 (1987), pages 584–585.
- [Lehoczky et al. 1989]** J. Lehoczky, L. Sha, and Y. Ding, “The Rate Monotonic Scheduling Algorithm: Exact Characterization and Average Case Behaviour”, *Proceedings of 10th IEEE Real-Time Systems Symposium* (1989).

- [Lempel 1979]** A. Lempel, "Cryptology in Transition", *Computing Surveys*, Volume 11, Number 4 (1979), pages 286–303.
- [Leslie et al. 1996]** I. M. Leslie, D. McAuley, R. Black, T. Roscoe, P. T. Barham, D. Evers, R. Fairbairns, and E. Hyden, "The Design and Implementation of an Operating System to Support Distributed Multimedia Applications", *IEEE Journal of Selected Areas in Communications*, Volume 14, Number 7 (1996), pages 1280–1297.
- [Lett and Konigsford 1968]** A. L. Lett and W. L. Konigsford, "TSS/360: A Time-Shared Operating System", *Proceedings of the AFIPS Fall Joint Computer Conference* (1968), pages 15–28.
- [Leutenegger and Vernon 1990]** S. Leutenegger and M. Vernon, "The Performance of Multiprogrammed Multiprocessor Scheduling Policies", *Proceedings of the Conference on Measurement and Modeling of Computer Systems* (1990).
- [Levin et al. 1975]** R. Levin, E. S. Cohen, W. M. Corwin, F. J. Pollack, and W. A. Wulf, "Policy/Mechanism Separation in Hydra", *Proceedings of the ACM Symposium on Operating Systems Principles* (1975), pages 132–140.
- [Levine 2003]** G. Levine, "Defining Deadlock", *Operating Systems Review*, Volume 37, Number 1 (2003).
- [Lewis and Berg 1998]** B. Lewis and D. Berg, *Multithreaded Programming with Pthreads*, Sun Microsystems Press (1998).
- [Lewis and Berg 2000]** B. Lewis and D. Berg, *Multithreaded Programming with Java Technology*, Sun Microsystems Press (2000).
- [Lichtenberger and Pirtle 1965]** W. W. Lichtenberger and M. W. Pirtle, "A Facility for Experimentation in Man-Machine Interaction", *Proceedings of the AFIPS Fall Joint Computer Conference* (1965), pages 589–598.
- [Lindholm and Yellin 1999]** T. Lindholm and F. Yellin, *The Java Virtual Machine Specification, Second Edition*, Addison-Wesley (1999).
- [Ling et al. 2000]** Y. Ling, T. Mullen, and X. Lin, "Analysis of Optimal Thread Pool Size", *Operating System Review*, Volume 34, Number 2 (2000).
- [Lipner 1975]** S. Lipner, "A Comment on the Confinement Problem", *Operating System Review*, Volume 9, Number 5 (1975), pages 192–196.
- [Lipton 1974]** R. Lipton, "On Synchronization Primitive Systems". Ph.D. Thesis, Carnegie-Mellon University (1974).
- [Liskov 1972]** B. H. Liskov, "The Design of the Venus Operating System", *Communications of the ACM*, Volume 15, Number 3 (1972), pages 144–149.
- [Liu and Layland 1973]** C. L. Liu and J. W. Layland, "Scheduling Algorithms for Multiprogramming in a Hard Real-Time Environment", *Communications of the ACM*, Volume 20, Number 1 (1973), pages 46–61.
- [Lobel 1986]** J. Lobel, *Foiling the System Breakers: Computer Security and Access Control*, McGraw-Hill (1986).
- [Loo 2003]** A. W. Loo, "The Future of Peer-to-Peer Computing", *Communications of the ACM*, Volume 46, Number 9 (2003), pages 56–61.

- [Love 2004]** R. Love, *Linux Kernel Development*, Developer's Library (2004).
- [Lowney et al. 1993]** P. G. Lowney, S. M. Freudenberger, T. J. Karzes, W. D. Lichtenstein, R. P. Nix, J. S. O'Donnell, and J. C. Ruttenberg, "The Multiflow Trace Scheduling Compiler", *Journal of Supercomputing*, Volume 7, Number 1-2 (1993), pages 51–142.
- [Lucco 1992]** S. Lucco, "A Dynamic Scheduling Method for Irregular Parallel Programs", *Proceedings of the Conference on Programming Language Design and Implementation* (1992), pages 200–211.
- [Ludwig 1998]** M. Ludwig, *The Giant Black Book of Computer Viruses*, Second Edition, American Eagle Publications (1998).
- [Ludwig 2002]** M. Ludwig, *The Little Black Book of Email Viruses*, American Eagle Publications (2002).
- [Lumb et al. 2000]** C. Lumb, J. Schindler, G. R. Ganger, D. F. Nagle, and E. Riedel, "Towards Higher Disk Head Utilization: Extracting Free Bandwidth From Busy Disk Drives", *Symposium on Operating Systems Design and Implementation* (2000).
- [Maekawa 1985]** M. Maekawa, "A Square Root Algorithm for Mutual Exclusion in Decentralized Systems", *ACM Transactions on Computer Systems*, Volume 3, Number 2 (1985), pages 145–159.
- [Maher et al. 1994]** C. Maher, J. S. Goldick, C. Kerby, and B. Zumach, "The Integration of Distributed File Systems and Mass Storage Systems", *Proceedings of the IEEE Symposium on Mass Storage Systems* (1994), pages 27–31.
- [Marsh et al. 1991]** B. D. Marsh, M. L. Scott, T. J. LeBlanc, and E. P. Markatos, "First-Class User-Level Threads", *Proceedings of the 13th ACM Symposium on Operating Systems Principle* (1991), pages 110–121.
- [Massalin and Pu 1989]** H. Massalin and C. Pu, "Threads and Input/Output in the Synthesis Kernel", *Proceedings of the ACM Symposium on Operating Systems Principles* (1989), pages 191–200.
- [Mattern 1988]** F. Mattern, "Virtual Time and Global States of Distributed Systems", *Workshop on Parallel and Distributed Algorithms* (1988).
- [Mattson et al. 1970]** R. L. Mattson, J. Gecsei, D. R. Slutz, and I. L. Traiger, "Evaluation Techniques for Storage Hierarchies", *IBM Systems Journal*, Volume 9, Number 2 (1970), pages 78–117.
- [Mauro and McDougall 2001]** J. Mauro and R. McDougall, *Solaris Internals: Core Kernel Architecture*, Prentice Hall (2001).
- [McCanne and Jacobson 1993]** S. McCanne and V. Jacobson, "The BSD Packet Filter: A New Architecture for User-level Packet Capture", *USENIX Winter* (1993), pages 259–270.
- [McGraw and Andrews 1979]** J. R. McGraw and G. R. Andrews, "Access Control in Parallel Programs", *IEEE Transactions on Software Engineering*, Volume SE-5, Number 1 (1979), pages 1–9.
- [McKeag and Wilson 1976]** R. M. McKeag and R. Wilson, *Studies in Operating Systems*, Academic Press (1976).

- [McKeon 1985]** B. McKeon, "An Algorithm for Disk Caching with Limited Memory", *Byte*, Volume 10, Number 9 (1985), pages 129–138.
- [McKusick et al. 1984]** M. K. McKusick, W. N. Joy, S. J. Leffler, and R. S. Fabry, "A Fast File System for UNIX", *ACM Transactions on Computer Systems*, Volume 2, Number 3 (1984), pages 181–197.
- [McKusick et al. 1996]** M. K. McKusick, K. Bostic, and M. J. Karels, *The Design and Implementation of the 4.4 BSD UNIX Operating System*, John Wiley and Sons (1996).
- [McVoy and Kleiman 1991]** L. W. McVoy and S. R. Kleiman, "Extent-like Performance from a UNIX File System", *Proceedings of the Winter USENIX Conference* (1991), pages 33–44.
- [Mealy et al. 1966]** G. H. Mealy, B. I. Witt, and W. A. Clark, "The Functional Structure of OS/360", *IBM Systems Journal*, Volume 5, Number 1 (1966).
- [Mellor-Crummey and Scott 1991]** J. M. Mellor-Crummey and M. L. Scott, "Algorithms for Scalable Synchronization on Shared-Memory Multiprocessors", *ACM Transactions on Computer Systems*, Volume 9, Number 1 (1991), pages 21–65.
- [Menasce and Muntz 1979]** D. Menasce and R. R. Muntz, "Locking and Deadlock Detection in Distributed Data Bases", *IEEE Transactions on Software Engineering*, Volume SE-5, Number 3 (1979), pages 195–202.
- [Mercer et al. 1994]** C. W. Mercer, S. Savage, and H. Tokuda, "Processor Capacity Reserves: Operating System Support for Multimedia Applications", *International Conference on Multimedia Computing and Systems* (1994), pages 90–99.
- [Meyer and Seawright 1970]** R. A. Meyer and L. H. Seawright, "A Virtual Machine Time-Sharing System", *IBM Systems Journal*, Volume 9, Number 3 (1970), pages 199–218.
- [Microsoft 1986]** *Microsoft MS-DOS User's Reference and Microsoft MS-DOS Programmer's Reference*. Microsoft Press (1986).
- [Microsoft 1996]** *Microsoft Windows NT Workstation Resource Kit*. Microsoft Press (1996).
- [Microsoft 2000a]** *Microsoft Developer Network Development Library*. Microsoft Press (2000).
- [Microsoft 2000b]** *Microsoft Windows 2000 Server Resource Kit*. Microsoft Press (2000).
- [Microsystems 1995]** S. Microsystems, *Solaris Multithreaded Programming Guide*, Prentice Hall (1995).
- [Milenkovic 1987]** M. Milenkovic, *Operating Systems: Concepts and Design*, McGraw-Hill (1987).
- [Miller and Katz 1993]** E. L. Miller and R. H. Katz, "An Analysis of File Migration in a UNIX Supercomputing Environment", *Proceedings of the Winter USENIX Conference* (1993), pages 421–434.
- [Milojicic et al. 2000]** D. S. Milojicic, F. Douglis, Y. Paindaveine, R. Wheeler, and S. Zhou, "Process Migration", *ACM Comput. Surv.*, Volume 32, Number 3 (2000),

- pages 241–299.
- [Mockapetris 1987]** P. Mockapetris, “Domain Names—Concepts and Facilities”, *Network Working Group, Request for Comments: 1034* (1987).
- [Mohan and Lindsay 1983]** C. Mohan and B. Lindsay, “Efficient Commit Protocols for the Tree of Processes Model of Distributed Transactions”, *Proceedings of the ACM Symposium on Principles of Database Systems* (1983).
- [Mok 1983]** A. K. Mok. “Fundamental Design Problems of Distributed Systems for the Hard Real-Time Environment”. Ph.D. thesis, Massachusetts Institute of Technology, Cambridge, MA (1983).
- [Morris 1973]** J. H. Morris, “Protection in Programming Languages”, *Communications of the ACM*, Volume 16, Number 1 (1973), pages 15–21.
- [Morris and Thompson 1979]** R. Morris and K. Thompson, “Password Security: A Case History”, *Communications of the ACM*, Volume 22, Number 11 (1979), pages 594–597.
- [Morris et al. 1986]** J. H. Morris, M. Satyanarayanan, M. H. Conner, J. H. Howard, D. S. H. Rosenthal, and F. D. Smith, “Andrew: A Distributed Personal Computing Environment”, *Communications of the ACM*, Volume 29, Number 3 (1986), pages 184–201.
- [Morshedian 1986]** D. Morshedian, “How to Fight Password Pirates”, *Computer*, Volume 19, Number 1 (1986).
- [Motorola 1993]** PowerPC 601 RISC Microprocessor User’s Manual. Motorola Inc. (1993).
- [Myers and Beigl 2003]** B. Myers and M. Beigl, “Handheld Computing”, *Computer*, Volume 36, Number 9 (2003), pages 27–29.
- [Navarro et al. 2002]** J. Navarro, S. Lyer, P. Druschel, and A. Cox, “Practical, Transparent Operating System Support for Superpages”, *Proceedings of the USENIX Symposium on Operating Systems Design and Implementation* (2002).
- [Needham and Walker 1977]** R. M. Needham and R. D. H. Walker, “The Cambridge CAP Computer and Its Protection System”, *Proceedings of the Sixth Symposium on Operating System Principles* (1977), pages 1–10.
- [Nelson et al. 1988]** M. Nelson, B. Welch, and J. K. Ousterhout, “Caching in the Sprite Network File System”, *ACM Transactions on Computer Systems*, Volume 6, Number 1 (1988), pages 134–154.
- [Norton and Wilton 1988]** P. Norton and R. Wilton, *The New Peter Norton Programmer’s Guide to the IBM PC & PS/2*, Microsoft Press (1988).
- [Nutt 2004]** G. Nutt, *Operating Systems: A Modern Perspective, Third Edition*, Addison-Wesley (2004).
- [Oaks and Wong 1999]** S. Oaks and H. Wong, *Java Threads, Second Edition*, O’Reilly & Associates (1999).
- [Obermarck 1982]** R. Obermarck, “Distributed Deadlock Detection Algorithm”, *ACM Transactions on Database Systems*, Volume 7, Number 2 (1982), pages 187–208.

- [O'Leary and Kitts 1985]** B. T. O'Leary and D. L. Kitts, "Optical Device for a Mass Storage System", *Computer*, Volume 18, Number 7 (1985).
- [Olsen and Kenley 1989]** R. P. Olsen and G. Kenley, "Virtual Optical Disks Solve the On-Line Storage Crunch", *Computer Design*, Volume 28, Number 1 (1989), pages 93–96.
- [Organick 1972]** E. I. Organick, *The Multics System: An Examination of Its Structure*, MIT Press (1972).
- [Ortiz 2001]** S. Ortiz, "Embedded OSs Gain the Inside Track", *Computer*, Volume 34, Number 11 (2001).
- [Ousterhout 1991]** J. Ousterhout. "The Role of Distributed State". In CMU Computer Science: a 25th Anniversary Commemorative (1991), R. F. Rashid, Ed., Addison-Wesley (1991).
- [Ousterhout et al. 1985]** J. K. Ousterhout, H. D. Costa, D. Harrison, J. A. Kunze, M. Kupfer, and J. G. Thompson, "A Trace-Driven Analysis of the UNIX 4.2 BSD File System", *Proceedings of the ACM Symposium on Operating Systems Principles* (1985), pages 15–24.
- [Ousterhout et al. 1988]** J. K. Ousterhout, A. R. Cherenson, F. Douglis, M. N. Nelson, and B. B. Welch, "The Sprite Network-Operating System", *Computer*, Volume 21, Number 2 (1988), pages 23–36.
- [Parameswaran et al. 2001]** M. Parameswaran, A. Susarla, and A. B. Whinston, "P2P Networking: An Information-Sharing Alternative", *Computer*, Volume 34, Number 7 (2001).
- [Parmelee et al. 1972]** R. P. Parmelee, T. I. Peterson, C. C. Tillman, and D. Hatfield, "Virtual Storage and Virtual Machine Concepts", *IBM Systems Journal*, Volume 11, Number 2 (1972), pages 99–130.
- [Parnas 1975]** D. L. Parnas, "On a Solution to the Cigarette Smokers' Problem Without Conditional Statements", *Communications of the ACM*, Volume 18, Number 3 (1975), pages 181–183.
- [Patil 1971]** S. Patil. "Limitations and Capabilities of Dijkstra's Semaphore Primitives for Coordination Among Processes". Technical Report, MIT (1971).
- [Patterson et al. 1988]** D. A. Patterson, G. Gibson, and R. H. Katz, "A Case for Redundant Arrays of Inexpensive Disks (RAID)", *Proceedings of the ACM SIGMOD International Conference on the Management of Data* (1988).
- [Pease et al. 1980]** M. Pease, R. Shostak, and L. Lamport, "Reaching Agreement in the Presence of Faults", *Communications of the ACM*, Volume 27, Number 2 (1980), pages 228–234.
- [Pechura and Schoeffler 1983]** M. A. Pechura and J. D. Schoeffler, "Estimating File Access Time of Floppy Disks", *Communications of the ACM*, Volume 26, Number 10 (1983), pages 754–763.
- [Perlman 1988]** R. Perlman, *Network Layer Protocols with Byzantine Robustness*. PhD thesis, Massachusetts Institute of Technology (1988).

- [Peterson 1981]** G. L. Peterson, "Myths About the Mutual Exclusion Problem", *Information Processing Letters*, Volume 12, Number 3 (1981).
- [Peterson and Davie 1996]** L. L. Peterson and B. S. Davie, *Computer Networks: a Systems Approach*, Morgan Kaufmann Publishers Inc. (1996).
- [Peterson and Norman 1977]** J. L. Peterson and T. A. Norman, "Buddy Systems", *Communications of the ACM*, Volume 20, Number 6 (1977), pages 421–431.
- [Pfleeger and Pfleeger 2003]** C. Pfleeger and S. Pfleeger, *Security in Computing, Third Edition*, Prentice Hall (2003).
- [Philbin et al. 1996]** J. Philbin, J. Edler, O. J. Anshus, C. C. Douglas, and K. Li, "Thread Scheduling for Cache Locality", *Architectural Support for Programming Languages and Operating Systems* (1996), pages 60–71.
- [Pinilla and Gill 2003]** R. Pinilla and M. Gill, "JVM: Platform Independent vs. Performance Dependent", *Operating System Review* (2003).
- [Polychronopoulos and Kuck 1987]** C. D. Polychronopoulos and D. J. Kuck, "Guided Self-Scheduling: A Practical Scheduling Scheme for Parallel Supercomputers", *IEEE Transactions on Computers*, Volume 36, Number 12 (1987), pages 1425–1439.
- [Popek 1974]** G. J. Popek, "Protection Structures", *Computer*, Volume 7, Number 6 (1974), pages 22–33.
- [Popek and Walker 1985]** G. Popek and B. Walker, editors, *The LOCUS Distributed System Architecture*, MIT Press (1985).
- [Prieve and Fabry 1976]** B. G. Prieve and R. S. Fabry, "VMIN—An Optimal Variable Space Page-Replacement Algorithm", *Communications of the ACM*, Volume 19, Number 5 (1976), pages 295–297.
- [Psaltis and Mok 1995]** D. Psaltis and F. Mok, "Holographic Memories", *Scientific American*, Volume 273, Number 5 (1995), pages 70–76.
- [Purdin et al. 1987]** T. D. M. Purdin, R. D. Schlichting, and G. R. Andrews, "A File Replication Facility for Berkeley UNIX", *Software—Practice and Experience*, Volume 17, (1987), pages 923–940.
- [Purdom, Jr. and Stigler 1970]** P. W. Purdom, Jr. and S. M. Stigler, "Statistical Properties of the Buddy System", *J. ACM*, Volume 17, Number 4 (1970), pages 683–697.
- [Quinlan 1991]** S. Quinlan, "A Cached WORM", *Software—Practice and Experience*, Volume 21, Number 12 (1991), pages 1289–1299.
- [Rago 1993]** S. Rago, *UNIX System V Network Programming*, Addison-Wesley (1993).
- [Rashid 1986]** R. F. Rashid, "From RIG to Accent to Mach: The Evolution of a Network Operating System", *Proceedings of the ACM/IEEE Computer Society, Fall Joint Computer Conference* (1986).
- [Rashid and Robertson 1981]** R. Rashid and G. Robertson, "Accent: A Communication-Oriented Network Operating System Kernel", *Proceedings of the ACM Symposium on Operating System Principles* (1981).

- [Raynal 1986] M. Raynal, *Algorithms for Mutual Exclusion*, MIT Press (1986).
- [Raynal 1991] M. Raynal, “A Simple Taxonomy for Distributed Mutual Exclusion Algorithms”, *Operating Systems Review*, Volume 25, Number 1 (1991), pages 47–50.
- [Raynal and Singhal 1996] M. Raynal and M. Singhal, “Logical Time: Capturing Causality in Distributed Systems”, *Computer*, Volume 29, Number 2 (1996), pages 49–56.
- [Reddy and Wyllie 1994] A. L. N. Reddy and J. C. Wyllie, “I/O issues in a Multimedia System”, *Computer*, Volume 27, Number 3 (1994), pages 69–74.
- [Redell and Fabry 1974] D. D. Redell and R. S. Fabry, “Selective Revocation of Capabilities”, *Proceedings of the IRIA International Workshop on Protection in Operating Systems* (1974), pages 197–210.
- [Reed 1983] D. P. Reed, “Implementing Atomic Actions on Decentralized Data”, *ACM Transactions on Computer Systems*, Volume 1, Number 1 (1983), pages 3–23.
- [Reed and Kanodia 1979] D. P. Reed and R. K. Kanodia, “Synchronization with Eventcounts and Sequences”, *Communications of the ACM*, Volume 22, Number 2 (1979), pages 115–123.
- [Regehr et al. 2000] J. Regehr, M. B. Jones, and J. A. Stankovic, “Operating System Support for Multimedia: The Programming Model Matters”, *Technical Report MSR-TR-2000-89, Microsoft Research* (2000).
- [Reid 1987] B. Reid, “Reflections on Some Recent Widespread Computer Break-Ins”, *Communications of the ACM*, Volume 30, Number 2 (1987), pages 103–105.
- [Ricart and Agrawala 1981] G. Ricart and A. K. Agrawala, “An Optimal Algorithm for Mutual Exclusion in Computer Networks”, *Communications of the ACM*, Volume 24, Number 1 (1981), pages 9–17.
- [Richards 1990] A. E. Richards, “A File System Approach for Integrating Removable Media Devices and Jukeboxes”, *Optical Information Systems*, Volume 10, Number 5 (1990), pages 270–274.
- [Richter 1997] J. Richter, *Advanced Windows*, Microsoft Press (1997).
- [Riedel et al. 1998] E. Riedel, G. A. Gibson, and C. Faloutsos, “Active Storage for Large-Scale Data Mining and Multimedia”, *Proceedings of 24th International Conference on Very Large Data Bases* (1998), pages 62–73.
- [Ripeanu et al. 2002] M. Ripeanu, A. Imrnitchi, and I. Foster, “Mapping the Gnutella Network”, *IEEE Internet Computing*, Volume 6, Number 1 (2002).
- [Rivest et al. 1978] R. L. Rivest, A. Shamir, and L. Adleman, “On Digital Signatures and Public Key Cryptosystems”, *Communications of the ACM*, Volume 21, Number 2 (1978), pages 120–126.
- [Rodeheffer and Schroeder 1991] T. L. Rodeheffer and M. D. Schroeder, “Automatic reconfiguration in Autonet”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1991), pages 183–97.
- [Rosenblum and Ousterhout 1991] M. Rosenblum and J. K. Ousterhout, “The Design and Implementation of a Log-Structured File System”, *Proceedings of the*

ACM Symposium on Operating Systems Principles (1991), pages 1–15.

[Rosenkrantz et al. 1978] D. J. Rosenkrantz, R. E. Stearns, and P. M. Lewis, “System Level Concurrency Control for Distributed Database Systems”, *ACM Transactions on Database Systems*, Volume 3, Number 2 (1978), pages 178–198.

[Ruemmler and Wilkes 1991] C. Ruemmler and J. Wilkes. “Disk Shuffling”. Technical Report, Hewlett-Packard Laboratories (1991).

[Ruemmler and Wilkes 1993] C. Ruemmler and J. Wilkes, “Unix Disk Access Patterns”, *Proceedings of the Winter USENIX Conference* (1993), pages 405–420.

[Ruemmler and Wilkes 1994] C. Ruemmler and J. Wilkes, “An Introduction to Disk Drive Modeling”, *Computer*, Volume 27, Number 3 (1994), pages 17–29.

[Rushby 1981] J. M. Rushby, “Design and Verification of Secure Systems”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1981), pages 12–21.

[Rushby and Randell 1983] J. Rushby and B. Randell, “A Distributed Secure System”, *Computer*, Volume 16, Number 7 (1983), pages 55–67.

[Russell and Gangemi 1991] D. Russell and G. T. Gangemi, *Computer Security Basics*, O'Reilly & Associates (1991).

[Saltzer and Schroeder 1975] J. H. Saltzer and M. D. Schroeder, “The Protection of Information in Computer Systems”, *Proceedings of the IEEE* (1975), pages 1278–1308.

[Sandberg 1987] R. Sandberg, *The Sun Network File System: Design, Implementation and Experience*, Sun Microsystems (1987).

[Sandberg et al. 1985] R. Sandberg, D. Goldberg, S. Kleiman, D. Walsh, and B. Lyon, “Design and Implementation of the Sun Network Filesystem”, *Proceedings of the Summer USENIX Conference* (1985), pages 119–130.

[Sargent and Shoemaker 1995] M. Sargent and R. Shoemaker, *The Personal Computer from the Inside Out, Third Edition*, Addison-Wesley (1995).

[Sarisky 1983] L. Sarisky, “Will Removable Hard Disks Replace the Floppy?”, *Byte* (1983), pages 110–117.

[Satyanarayanan 1990] M. Satyanarayanan, “Scalable, Secure and Highly Available Distributed File Access”, *Computer*, Volume 23, Number 5 (1990), pages 9–21.

[Savage et al. 2000] S. Savage, D. Wetherall, A. R. Karlin, and T. Anderson, “Practical Network Support for IP Traceback”, *Proceedings of ACM SIGCOMM Conference on Data Communication* (2000), pages 295–306.

[Schell 1983] R. R. Schell, “A Security Kernel for a Multiprocessor Microcomputer”, *Computer* (1983), pages 47–53.

[Schindler and Gregory 1999] J. Schindler and G. Gregory, “Automated Disk Drive Characterization”, *Technical Report, Carnegie-Mellon University* (1999).

[Schlichting and Schneider 1982] R. D. Schlichting and F. B. Schneider, “Understanding and Using Asynchronous Message Passing Primitives”, *Proceedings of*

- the Symposium on Principles of Distributed Computing* (1982), pages 141–147.
- [Schneider 1982]** F. B. Schneider, “Synchronization in Distributed Programs”, *ACM Transactions on Programming Languages and Systems*, Volume 4, Number 2 (1982), pages 125–148.
- [Schneier 1996]** B. Schneier, *Applied Cryptography, Second Edition*, John Wiley and Sons (1996).
- [Schrage 1967]** L. E. Schrage, “The Queue M/G/I with Feedback to Lower Priority Queues”, *Management Science*, Volume 13, (1967), pages 466–474.
- [Schwarz and Mattern 1994]** R. Schwarz and F. Mattern, “Detecting Causal Relationships in Distributed Computations: In Search of the Holy Grail”, *Distributed Computing*, Volume 7, Number 3 (1994), pages 149–174.
- [Seely 1989]** D. Seely, “Password Cracking: A Game of Wits”, *Communications of the ACM*, Volume 32, Number 6 (1989), pages 700–704.
- [Seltzer et al. 1990]** M. Seltzer, P. Chen, and J. Ousterhout, “Disk Scheduling Revisited”, *Proceedings of the Winter USENIX Conference* (1990), pages 313–323.
- [Seltzer et al. 1993]** M. I. Seltzer, K. Bostic, M. K. McKusick, and C. Staelin, “An Implementation of a Log-Structured File System for UNIX”, *USENIX Winter* (1993), pages 307–326.
- [Seltzer et al. 1995]** M. I. Seltzer, K. A. Smith, H. Balakrishnan, J. Chang, S. McMains, and V. N. Padmanabhan, “File System Logging versus Clustering: A Performance Comparison”, *USENIX Winter* (1995), pages 249–264.
- [Shrivastava and Panzieri 1982]** S. K. Shrivastava and F. Panzieri, “The Design of a Reliable Remote Procedure Call Mechanism”, *IEEE Transactions on Computers*, Volume C-31, Number 7 (1982), pages 692–697.
- [Silberschatz et al. 2001]** A. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts, Fourth Edition*, McGraw-Hill (2001).
- [Silverman 1983]** J. M. Silverman, “Reflections on the Verification of the Security of an Operating System Kernel”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1983), pages 143–154.
- [Silvers 2000]** C. Silvers, “UBC: An Efficient Unified I/O and Memory Caching Subsystem for NetBSD”, *USENIX Annual Technical Conference—FREENIX Track* (2000).
- [Simmons 1979]** G. J. Simmons, “Symmetric and Asymmetric Encryption”, *Computing Surveys*, Volume 11, Number 4 (1979), pages 304–330.
- [Sincerbox 1994]** G. T. Sincerbox, editor, *Selected Papers on Holographic Storage*, Optical Engineering Press (1994).
- [Singhal 1989]** M. Singhal, “Deadlock Detection in Distributed Systems”, *Computer*, Volume 22, Number 11 (1989), pages 37–48.
- [Sirer et al. 1999]** E. G. Sirer, R. Grimm, A. J. Gregory, and B. N. Bershad, “Design and Implementation of a Distributed Virtual Machine for Networked Computers”, *Symposium on Operating Systems Principles* (1999), pages 202–216.

- [Smith 1982] A. J. Smith, "Cache Memories", *ACM Computing Surveys*, Volume 14, Number 3 (1982), pages 473–530.
- [Smith 1985] A. J. Smith, "Disk Cache-Miss Ratio Analysis and Design Considerations", *ACM Transactions on Computer Systems*, Volume 3, Number 3 (1985), pages 161–203.
- [Sobti et al. 2004] S. Sobti, N. Garg, F. Zheng, J. Lai, Y. Shao, C. Zhang, E. Ziskind, A. Krishnamurthy, and R. Wang, "Segank: A Distributed Mobile Storage System", *Proceedings of the Third USENIX Conference on File and Storage Technologies* (2004).
- [Solomon 1998] D. A. Solomon, *Inside Windows NT, Second Edition*, Microsoft Press (1998).
- [Solomon and Russinovich 2000] D. A. Solomon and M. E. Russinovich, *Inside Microsoft Windows 2000, Third Edition*, Microsoft Press (2000).
- [Spafford 1989] E. H. Spafford, "The Internet Worm: Crisis and Aftermath", *Communications of the ACM*, Volume 32, Number 6 (1989), pages 678–687.
- [Spector and Schwarz 1983] A. Z. Spector and P. M. Schwarz, "Transactions: A Construct for Reliable Distributed Computing", *ACM SIGOPS Operating Systems Review*, Volume 17, Number 2 (1983), pages 18–35.
- [Stallings 2000a] W. Stallings, *Local and Metropolitan Area Networks*, Prentice Hall (2000).
- [Stallings 2000b] W. Stallings, *Operating Systems, Fourth Edition*, Prentice Hall (2000).
- [Stallings 2003] W. Stallings, *Cryptography and Network Security: Principles and Practice, Third Edition*, Prentice Hall (2003).
- [Stankovic 1982] J. S. Stankovic, "Software Communication Mechanisms: Procedure Calls Versus Messages", *Computer*, Volume 15, Number 4 (1982).
- [Stankovic 1996] J. A. Stankovic, "Strategic Directions in Real-Time and Embedded Systems", *ACM Computing Surveys*, Volume 28, Number 4 (1996), pages 751–763.
- [Staunstrup 1982] J. Staunstrup, "Message Passing Communication Versus Procedure Call Communication", *Software—Practice and Experience*, Volume 12, Number 3 (1982), pages 223–234.
- [Steinmetz 1995] R. Steinmetz, "Analyzing the Multimedia Operating System", *IEEE MultiMedia*, Volume 2, Number 1 (1995), pages 68–84.
- [Stephenson 1983] C. J. Stephenson, "Fast Fits: A New Method for Dynamic Storage Allocation", *Proceedings of the Ninth Symposium on Operating Systems Principles* (1983), pages 30–32.
- [Stevens 1992] R. Stevens, *Advanced Programming in the UNIX Environment*, Addison-Wesley (1992).
- [Stevens 1994] R. Stevens, *TCP/IP Illustrated Volume 1: The Protocols*, Addison-Wesley (1994).

- [**Stevens 1995**] R. Stevens, *TCP/IP Illustrated, Volume 2: The Implementation*, Addison-Wesley (1995).
- [**Stevens 1997**] W. R. Stevens, *UNIX Network Programming—Volume I*, Prentice Hall (1997).
- [**Stevens 1998**] W. R. Stevens, *UNIX Network Programming—Volume II*, Prentice Hall (1998).
- [**Stevens 1999**] W. R. Stevens, *UNIX Network Programming Interprocess Communications—Volume 2*, Prentice Hall (1999).
- [**Stoica et al. 1996**] I. Stoica, H. Abdel-Wahab, K. Jeffay, S. Baruah, J. Gehrke, and G. Plaxton, “A Proportional Share Resource Allocation Algorithm for Real-Time, Time-Shared Systems”, *IEEE Real-Time Systems Symposium* (1996).
- [**Su 1982**] Z. Su, “A Distributed System for Internet Name Service”, *Network Working Group, Request for Comments: 830* (1982).
- [**Sugerman et al. 2001**] J. Sugerman, G. Venkitachalam, and B. Lim, “Virtualizing I/O Devices on VMware Workstation’s Hosted Virtual Machine Monitor”, *2001 USENIX Annual Technical Conference* (2001).
- [**Sun 1990**] *Network Programming Guide*. Sun Microsystems (1990).
- [**Svobodova 1984**] L. Svobodova, “File Servers for Network-Based Distributed Systems”, *ACM Computing Survey*, Volume 16, Number 4 (1984), pages 353–398.
- [**Talluri et al. 1995**] M. Talluri, M. D. Hill, and Y. A. Khalidi, “A New Page Table for 64-bit Address Spaces”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1995).
- [**Tamches and Miller 1999**] A. Tamches and B. P. Miller, “Fine-Grained Dynamic Instrumentation of Commodity Operating System Kernels”, *USENIX Symposium on Operating Systems Design and Implementation* (1999).
- [**Tanenbaum 1990**] A. S. Tanenbaum, *Structured Computer Organization, Third Edition*, Prentice Hall (1990).
- [**Tanenbaum 2001**] A. S. Tanenbaum, *Modern Operating Systems*, Prentice Hall (2001).
- [**Tanenbaum 2003**] A. S. Tanenbaum, *Computer Networks, Fourth Edition*, Prentice Hall (2003).
- [**Tanenbaum and Van Renesse 1985**] A. S. Tanenbaum and R. Van Renesse, “Distributed Operating Systems”, *ACM Computing Survey*, Volume 17, Number 4 (1985), pages 419–470.
- [**Tanenbaum and van Steen 2002**] A. Tanenbaum and M. van Steen, *Distributed Systems: Principles and Paradigms*, Prentice Hall (2002).
- [**Tanenbaum and Woodhull 1997**] A. S. Tanenbaum and A. S. Woodhull, *Operating System Design and Implementation, Second Edition*, Prentice Hall (1997).
- [**Tate 2000**] S. Tate, *Windows 2000 Essential Reference*, New Riders (2000).
- [**Tay and Ananda 1990**] B. H. Tay and A. L. Ananda, “A Survey of Remote Procedure Calls”, *Operating Systems Review*, Volume 24, Number 3 (1990), pages

68–79.

- [Teorey and Pinkerton 1972]** T. J. Teorey and T. B. Pinkerton, “A Comparative Analysis of Disk Scheduling Policies”, *Communications of the ACM*, Volume 15, Number 3 (1972), pages 177–184.
- [Tevanian et al. 1987a]** A. Tevanian, Jr., R. F. Rashid, D. B. Golub, D. L. Black, E. Cooper, and M. W. Young, “Mach Threads and the Unix Kernel: The Battle for Control”, *Proceedings of the Summer USENIX Conference* (1987).
- [Tevanian et al. 1987b]** A. Tevanian, Jr., R. F. Rashid, M. W. Young, D. B. Golub, M. R. Thompson, W. Bolosky, and R. Sanzi. “A UNIX Interface for Shared Memory and Memory Mapped Files Under Mach”. Technical Report, Carnegie-Mellon University (1987).
- [Tevanian et al. 1989]** A. Tevanian, Jr., and B. Smith, “Mach: The Model for Future Unix”, *Byte* (1989).
- [Thekkath et al. 1997]** C. A. Thekkath, T. Mann, and E. K. Lee, “Frangipani: A Scalable Distributed File System”, *Symposium on Operating Systems Principles* (1997), pages 224–237.
- [Thompson 1984]** K. Thompson, “Reflections on Trusting Trust”, *Communications of ACM*, Volume 27, Number 8 (1984), pages 761–763.
- [Thorn 1997]** T. Thorn, “Programming Languages for Mobile Code”, *ACM Computing Surveys*, Volume 29, Number 3 (1997), pages 213–239.
- [Toigo 2000]** J. Toigo, “Avoiding a Data Crunch”, *Scientific American*, Volume 282, Number 5 (2000), pages 58–74.
- [Traiger et al. 1982]** I. L. Traiger, J. N. Gray, C. A. Galtieri, and B. G. Lindsay, “Transactions and Consistency in Distributed Database Management Systems”, *ACM Transactions on Database Systems*, Volume 7, Number 3 (1982), pages 323–342.
- [Tucker and Gupta 1989]** A. Tucker and A. Gupta, “Process Control and Scheduling Issues for Multiprogrammed Shared-Memory Multiprocessors”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1989).
- [Tudor 1995]** P. N. Tudor. “MPEG-2 video compression tutorial”. IEEE Colloquium on MPEG-2 - What it is and What it isn’t (1995).
- [Vahalia 1996]** U. Vahalia, *Unix Internals: The New Frontiers*, Prentice Hall (1996).
- [Vee and Hsu 2000]** V. Vee and W. Hsu, “Locality-Preserving Load-Balancing Mechanisms for Synchronous Simulations on Shared-Memory Multiprocessors”, *Proceedings of the Fourteenth Workshop on Parallel and Distributed Simulation* (2000), pages 131–138.
- [Venners 1998]** B. Venners, *Inside the Java Virtual Machine*, McGraw-Hill (1998).
- [Wah 1984]** B. W. Wah, “File Placement on Distributed Computer Systems”, *Computer*, Volume 17, Number 1 (1984), pages 23–32.
- [Wahbe et al. 1993a]** R. Wahbe, S. Lucco, T. E. Anderson, and S. L. Graham, “Efficient Software-Based Fault Isolation”, *ACM SIGOPS Operating Systems Review*, Volume 27, Number 5 (1993), pages 203–216.

- [Wahbe et al. 1993b]** R. Wahbe, S. Lucco, T. E. Anderson, and S. L. Graham, “Efficient Software-Based Fault Isolation”, *ACM SIGOPS Operating Systems Review*, Volume 27, Number 5 (1993), pages 203–216.
- [Wallach et al. 1997]** D. S. Wallach, D. Balfanz, D. Dean, and E. W. Felten, “Extensible Security Architectures for Java”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1997).
- [Wilkes et al. 1996]** J. Wilkes, R. Golding, C. Staelin, and T. Sullivan, “The HP AutoRAID Hierarchical Storage System”, *ACM Transactions on Computer Systems*, Volume 14, Number 1 (1996), pages 108–136.
- [Williams 2001]** R. Williams, *Computer Systems Architecture—A Networking Approach*, Addison-Wesley (2001).
- [Williams 2002]** N. Williams, “An Implementation of Scheduler Activations on the NetBSD Operating System”, *2002 USENIX Annual Technical Conference, FREENIX Track* (2002).
- [Wilson et al. 1995]** P. R. Wilson, M. S. Johnstone, M. Neely, and D. Boles, “Dynamic Storage Allocation: A Survey and Critical Review”, *Proceedings of the International Workshop on Memory Management* (1995), pages 1–116.
- [Wolf 2003]** W. Wolf, “A Decade of Hardware/Software Codesign”, *Computer*, Volume 36, Number 4 (2003), pages 38–43.
- [Wood and Kochan 1985]** P. Wood and S. Kochan, *UNIX System Security*, Hayden (1985).
- [Woodside 1986]** C. Woodside, “Controllability of Computer Performance Tradeoffs Obtained Using Controlled-Share Queue Schedulers”, *IEEE Transactions on Software Engineering*, Volume SE-12, Number 10 (1986), pages 1041–1048.
- [Worthington et al. 1994]** B. L. Worthington, G. R. Ganger, and Y. N. Patt, “Scheduling Algorithms for Modern Disk Drives”, *Proceedings of the ACM Sigmetrics Conference on Measurement and Modeling of Computer Systems* (1994), pages 241–251.
- [Worthington et al. 1995]** B. L. Worthington, G. R. Ganger, Y. N. Patt, and J. Wilkes, “On-Line Extraction of SCSI Disk Drive Parameters”, *Proceedings of the ACM Sigmetrics Conference on Measurement and Modeling of Computer Systems* (1995), pages 146–156.
- [Wulf 1969]** W. A. Wulf, “Performance Monitors for Multiprogramming Systems”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1969), pages 175–181.
- [Wulf et al. 1981]** W. A. Wulf, R. Levin, and S. P. Harbison, *Hydra/C.mmp: An Experimental Computer System*, McGraw-Hill (1981).
- [Yeong et al. 1995]** W. Yeong, T. Howes, and S. Kille, “Lightweight Directory Access Protocol”, *Network Working Group, Request for Comments: 1777* (1995).
- [Young et al. 1987]** M. Young, A. Tevanian, R. Rashid, D. Golub, and J. Eppinger, “The Duality of Memory and Communication in the Implementation of a Multiprocessor Operating System”, *Proceedings of the ACM Symposium on Operating Systems Principles* (1987), pages 63–76.

- [Yu et al. 2000] X. Yu, B. Guo, Y. Chen, R. Y. Wang, K. Li, A. Krishnamurthy, and T. E. Anderson, “Trading Capacity for Performance in a Disk Array”, *Proceedings of the 2000 Symposium on Operating Systems Design and Implementation* (2000), pages 243–258.
- [Zabatta and Young 1998] F. Zabatta and K. Young, “A Thread Performance Comparison: Windows NT and Solaris on a Symmetric Multiprocessor”, *Proceedings of the 2nd USENIX Windows NT Symposium* (1998).
- [Zahorjan and McCann 1990] J. Zahorjan and C. McCann, “Processor Scheduling in Shared-Memory Multiprocessors”, *Proceedings of the Conference on Measurement and Modeling of Computer Systems* (1990).
- [Zapata and Asokan 2002] M. Zapata and N. Asokan, “Securing Ad Hoc Routing Protocols”, *Proc. 2002 ACM Workshop on Wireless Security* (2002).
- [Zhao 1989] W. Zhao, editor, *Special Issue on Real-Time Operating Systems, Operating System Review* (1989).

Credits

Figure 1.9: From Hennessy and Patterson, *Computer Architecture: A Quantitative Approach, Third Edition*, © 2002, Morgan Kaufmann Publishers, Figure 5.3, p. 394. Reprinted with permission of the publisher.

Figure 3.9: From Iacobucci, *OS/2 Programmer's Guide*, © 1988, McGraw-Hill, Inc., New York, New York. Figure 1.7, p. 20. Reprinted with permission of the publisher.

Figure 6.8: From Khanna/Sebree/Zolnowsky, "Realtime Scheduling in SunOS 5.0," Proceedings of Winter USENIX, January 1992, San Francisco, California. Derived with permission of the authors.

Figure 6.10 adapted with permission from Sun Microsystems, Inc.

Figure 9.21: From *80386 Programmer's Reference Manual*, Figure 5-12, p. 5-12. Reprinted by permission of Intel Corporation, Copyright / Intel Corporation 1986.

Figure 10.16: From *IBM Systems Journal*, Vol. 10, No. 3, © 1971, International Business Machines Corporation. Reprinted by permission of IBM Corporation.

Figure 12.9: From Leffler/McKusick/Karels/Quartermann, *The Design and Implementation of the 4.3BSD UNIX Operating System*, © 1989 by Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Figure 7.6, p. 196. Reprinted with permission of the publisher.

Figure 13.9: From *Pentium Processor User's Manual: Architecture and Programming Manual*, Volume 3, Copyright 1993. Reprinted by permission of Intel Corporation.

Figures 15.4, 15.5, and 15.7: From Halsall, *Data Communications, Computer Networks, and Open Systems, Third Edition*, © 1992, Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Figure 1.9, p. 14, Figure 1.10, p. 15, and Figure 1.11, p. 18. Reprinted with permission of the publisher.

Sections of chapter 7 and 17 from Silberschatz/Korth, *Database System Concepts, Third Edition*, Copyright 1997, McGraw-Hill, Inc., New York, New York. Section 13.5, p. 451-454, 14.1.1, p. 471-742, 14.1.3, p. 476-479, 14.2, p. 482-485, 15.2.1, p. 512-513, 15.4, p. 517-518, 15.4.3, p. 523-524, 18.7, p. 613-617, 18.8, p. 617-622. Reprinted with permission of the publisher.

Figure A.1: From Quarterman/Wilhelm, *UNIX, POSIX and Open Systems: The Open Standards Puzzle*, © 1993, by Addison-Wesley Publishing Co., Inc. Reading, Massachusetts. Figure 2.1, p. 31. Reprinted with permission of the publisher.

Index

2PC protocol, *see* two-phase commit protocol
10BaseT Ethernet, 520
16-bit Windows environment, 788
32-bit Windows environment, 788
100BaseT Ethernet, 520

A

aborted transactions, 218
absolute code, 269
absolute path names, 375
abstract data type, 361
access:
 anonymous, 382
 controlled, 387
 file, *see* file access
access control, in Linux, 753–755
access-control list (ACL), 388
access latency, 466
access lists, 557
access matrix, 602–606
 and access control, 609
 defined, 602
 implementation of, 605–609
 and revocation of access rights, 609–611
access rights, 598, 609–611
accounting (operating system service), 41
accreditation, 665
ACL (access-control list), 388
active array (Linux), 728
Active Directory (Windows XP), 804

active list, 585
acyclic graph, 376
acyclic-graph directories, 376–378
adaptive mutex, 214
additional-reference-bits algorithm, 324
additional sense code, 497
additional sense-code qualifier, 497
address(es):
 defined, 483
 Internet, 525
 linear, 296–297
 logical, 269
 physical, 269
 virtual, 269
address binding, 267–269
address resolution protocol (ARP), 538
address space:
 logical vs. physical, 269–270
 virtual, 304, 736–737
address-space identifiers (ASIDs), 283
administrative complexity, 547
admission control, 699, 707–708
admission-control algorithms, 683
advanced encryption standard (AES), 643
advanced technology attachment (ATA)
 buses, 436
AES (advanced encryption standard), 643
affinity, processor, 166
aging, 159, 538
allocation:
 buddy-system, 341, 342
 of disk space, 404–413

- allocation: (*continued*)
 - contiguous allocation, 405–407
 - indexed allocation, 409–411
 - linked allocation, 407–409
 - and performance, 412–413
 - equal, 329
 - as problem, 368
 - proportional, 329–330
 - slab, 341–343
- analytic evaluation, 177
- Andrew file system (AFS), 555–560
 - file operations in, 558–559
 - implementation of, 559–560
 - shared name space in, 557–558
- anomaly detection, 659
- anonymous access, 382
- anonymous memory, 451
- APCs, *see* asynchronous procedure calls
- API, *see* application program interface
- Apple Computers, 42
- AppleTalk protocol, 799
- application interface (I/O systems), 487–493
 - block and character devices, 489–490
 - blocking and nonblocking I/O, 491–493
 - clocks and timers, 491
 - network devices, 490–491
- application layer, 531
- application programs, 3
 - disinfection of, 660
 - multistep processing of, 268–269
 - processes vs., 21
 - system utilities, 53
- application program interface (API), 44–45
- application proxy firewalls, 663
- arbitrated loop (FC-AL), 438
- architecture(s), 12–15
 - clustered systems, 14–15
 - multiprocessor systems, 12–13
 - single-processor systems, 12–14
 - of Windows XP, 763–764
- architecture state, 167
- archived to tape, 462
- argument vector, 725
- armored viruses, 635
- ARP (address resolution protocol), 538
- arrays, 304
- ASIDs, *see* address-space identifiers
- assignment edge, 241
- asymmetric clustering, 14–15
- asymmetric encryption, 644
- asymmetric multiprocessing, 13, 165
- asynchronous devices, 489
- asynchronous (nonblocking) message passing, 99
- asynchronous procedure calls (APCs), 135–136, 766–767
- asynchronous thread cancellation, 134
- asynchronous writes, 418
- ATA buses, 436
- Atlas operating system, 821–822
- atomicity, 568–572
- atomic transactions, 194, 217–218
 - and checkpoints, 220–221
 - concurrent, 221–223
 - and locking protocols, 223–224
 - and serializability, 221–223
 - and timestamp-based protocols, 224–225
 - system model for, 217–218
 - write-ahead logging of, 219–220
- attacks, 624. *See also* denial-of-service attacks
 - man-in-the-middle, 624, 625
 - replay, 624
 - zero-day, 659
- attributes, 791
- authentication:
 - breaching of, 624
 - and encryption, 644–647
 - in Linux, 753
 - two-factor, 655
 - in Windows, 790
- automatic job sequencing, 817
- automatic variables, 630
- automatic work-set trimming (Windows XP), 356
- automount feature, 547
- autoprobes, 723
- auxiliary rights (Hydra), 611

-
- back door, 489
- background processes, 162
- backing store, 272
- backups, 420–421
- bad blocks, 448–449
- bandwidth:
 - disk, 440
 - effective, 466
 - sustained, 466
- banker's algorithm, 251–253
- base file record, 791
- base register, 266, 267
- basic file systems, 396
- batch files, 364
- Bayes' theorem, 660
- Belady's anomaly, 320
- best-fit strategy, 276
- biased protocol, 574
- binary semaphore, 197
- binding, 268, 269
- biometrics, 655–656
- bit(s):
 - mode, 18
 - modify (dirty), 317
 - reference, 324
 - valid-invalid, 285–286
- bit-interleaved parity organization, 455
- bit-level striping, 453
- bit vector (bit map), 413–414
- black-box transformations, 643
- blade servers, 14
- block(s), 46, 276, 366–367
 - bad, 448–449
 - boot, 67–68, 447–448
 - boot control, 397
 - defined, 747
 - direct, 411
 - file-control, 397
 - index, 409, 410
 - index to, 69
 - indirect, 411
 - logical, 437
 - volume control, 398
- lock ciphers, 643
- lock devices, 488, 489–490, 747–748
- lock groups, 743
- blocking, indefinite, 159
- blocking I/O, 491–493
- blocking (synchronous) message passing, 99
- block-interleaved distributed parity, 456
- block-interleaved parity organization, 455
- block-level striping, 453
- block number, relative, 368
- boot block, 68, 397, 447–448
- boot control block, 397
- boot disk (system disk), 68, 447
- booting, 67–68, 786
- boot partition, 447
- boot sector, 448
- bootstrap programs, 447, 636
- bootstrap programs (bootstrap loaders), 6, 7, 67–68
- boot viruses, 633, 634
- bottom half interrupt service routines, 731
- bounded-buffer problem, 201
- bounded capacity (of queue), 99
- breach of availability, 624
- breach of confidentiality, 624
- breach of integrity, 624
- broadcasting, 538, 703
- B+ tree (NTFS), 791–792
- buddy heap (Linux), 733
- buddy-system allocation, 341, 342
- buddy system (Linux), 732
- buffer, 747
 - circular, 421
 - defined, 494
- buffer cache, 416–417
- buffering, 99, 494–495
- buffer-overflow attacks, 629–632
- bully algorithm, 584–585
- bus, 436
 - defined, 478
 - expansion, 478
 - PCI, 478
- bus architecture, 11
- bus-mastering I/O boards, 485
- busy waiting, 198, 481
- bytecode, 65
- Byzantine generals problem, 586

C

- cache:
- buffer, 416–417
 - defined, 495
 - in Linux, 734
 - as memory buffer, 266
 - nonvolatile RAM, 452
 - page, 417
 - and performance improvement, 416–419
 - and remote file access:
 - and consistency, 551–552
 - location of cache, 549–550
 - update policy, 550–551
 - slabs in, 341–343
 - unified buffer, 417
 - in Windows XP, 782–784
- cache coherency, 26
- cache-consistency problem, 549
- cachefs file system, 550, 551
- cache management, 24–25
- caching, 24–26, 495–496
- client-side, 802
 - double, 417
 - remote service vs., 552–553
 - write-back, 550
- callbacks, 558
- Cambridge CAP system, 613
- cancellation, thread, 134
- cancellation points, 135
- capability-based protection systems, 611–613
- Cambridge CAP system, 613
 - Hydra, 611–613
- capability(-ies), 607, 613
- capability lists, 606–607
- carrier sense with multiple access (CSMA), 529–530
- cascading termination, 92
- CAV (constant angular velocity), 438
- CD, *see* collision detection
- central processing unit, *see under* CPU
- certificate authorities, 648
- certification, 665
- challenging (passwords), 654
- change journal (Windows XP), 797
- character devices (Linux), 747–749
- character-stream devices, 488, 490
- checkpoints, 220
- checksum, 538, 539
- child processes, 771
- children, 87
- CIFS (common internet file system), 384
- CineBlitz, 706–708
- cipher-block chaining, 643
- circuit switching, 528
- circular buffer, 421
- circular SCAN (C-SCAN) scheduling algorithm, 443
- circular-wait condition (deadlocks), 246–247
- claim edge, 249
- classes (Java), 617
- class loader, 65
- CLI (command-line interface), 41
- client(s):
- defined, 543
 - diskless, 546
 - in SSL, 650
- client interface, 543
- client-server model, 383
- client-side caching (CSC), 802
- clock, logical, 565
- clock algorithm, *see* second-chance page-replacement algorithm
- clocks, 491
- C-LOOK scheduling algorithm, 443, 444
- close() operation, 362
- clusters, 446, 537, 790–791
- clustered page tables, 290
- clustered systems, 14–15
- clustering, 537
- asymmetric, 14–15
 - in Windows XP, 350
- cluster remapping, 796
- cluster server, 556
- CLV (constant linear velocity), 437
- code:
- absolute, 269
 - reentrant, 286–287
- code books, 655
- collisions (of file names), 404
- collision detection (CD), 529–530
- COM, *see* component object model
- combined scheme index block, 411
- command interpreter, 41–42
- command-line interface (CLI), 41
- commit protocol, 569

- committed transactions**, 218
- common internet file system (CIFS)**, 384
- communication(s)**:
 - direct, 97
 - in distributed operating systems, 515
 - indirect, 97
 - interprocess, *see* interprocess communication
 - systems programs for, 52
 - unreliable, 586–587
- communications (operating system service)**, 40
- communication links**, 96
- communication processors**, 521
- communications sessions**, 528
- communication system calls**, 51–52
- compaction**, 277–278, 406
- compiler-based enforcement**, 614–617
- compile time**, 269
- complexity, administrative**, 547
- component object model (COM)**, 801
- component units**, 544
- compression**:
 - in multimedia systems, 696–697
 - in Windows XP, 796–797
- compression ratio**, 696
- compression units**, 796
- computation migration**, 518
- computation speedup**, 514
- computer environments**, 31–34
 - client-server computing, 32–33
 - peer-to-peer computing, 33–34
 - traditional, 31–32
 - Web-based computing, 34
- computer programs**, *see* application programs
- computer system(s)**:
 - architecture of:
 - clustered systems, 14–15
 - multiprocessor systems, 12–13
 - single-processor systems, 12–14
 - distributed systems, 28–29
 - file-system management in, 22–23
 - I/O structure in, 10–11
 - memory management in, 21–22
 - operating system viewed by, 5
 - operation of, 6–8
- process management** in, 20–21
- protection** in, 26–27
- secure**, 623
- security** in, 27
- special-purpose systems**, 29–31
 - handheld systems, 30–31
 - multimedia systems, 30
 - real-time embedded systems, 29–30
- storage** in, 8–10
- storage management** in, 22–26
 - caching, 24–26
 - I/O systems, 26
 - mass-storage management, 23–24
- threats to**, 635–640
- computing**, safe, 661
- concurrency control**, 572–576
 - with locking protocols, 572
 - with timestamping, 575–576
- concurrency-control algorithms**, 221
- conditional-wait construct**, 211
- confidentiality**, breach of, 624
- confinement problem**, 605
- conflicting operations**, 222
- conflict phase** (of dispatch latency), 681
- conflict resolution module (Linux)**, 723
- connectionless messages**, 528
- connectionless (UDP) sockets**, 106
- connection-oriented (TCP) sockets**, 106
- conservative timestamp-ordering scheme**, 576
- consistency**, 551–552
- consistency checking**, 419
- consistency semantics**, 385–386
- constant angular velocity (CAV)**, 438
- constant linear velocity (CLV)**, 437
- container objects (Windows XP)**, 666
- contention**, 529–530
- contention scope**, 168
- context (of process)**, 86
- context switches**, 86, 504
- contiguous disk space allocation**, 405–407
- contiguous memory allocation**, 274
- continuous-media data**, 694
- control cards**, 48, 818, 819
- control-card interpreter**, 818
- controlled access**, 387

- controller(s), 436–437, 478
 - defined, 478
 - direct-memory-access, 485
 - disk, 436–437
 - host, 436
- control programs, 5
- control register, 480
- convenience, 3
- convoy effect, 155
- cooperating processes, 93
- cooperative scheduling, 152
- copy-on-write technique, 312–315
- copy semantics, 495
- core memory, 822
- counting, 415
- counting-based page replacement algorithm, 326
- counting semaphore, 197
- covert channels, 628
- CPU-bound processes, 85, 86
- CPU burst, 150
- CPU (central processing unit), 3, 265–267
- CPU clock, 266
- CPU-I/O burst cycle, 149–150
- CPU scheduler, *see* short-term scheduler
- CPU scheduling, 17
 - about, 149
 - algorithms for, 153–164
 - criteria, 153–154
 - evaluation of, 176–181
 - first-come, first-served scheduling of, 154–155
 - implementation of, 180–181
 - multilevel feedback-queue scheduling of, 163–165
 - multilevel queue scheduling of, 161–163
 - priority scheduling of, 158–159
 - round-robin scheduling of, 159–161
 - shortest-job-first scheduling of, 155–158
 - dispatcher, role of, 152
 - and I/O-CPU burst cycle, 149–150
 - models for, 176–181
 - deterministic modeling, 177–178
 - and implementation, 180–181
 - queueing-network analysis, 179
 - simulations, 179–180
- in multimedia systems, 700–701
- multiprocessor scheduling, 165–167
 - approaches to, 165
 - and load balancing, 166
 - and processor affinity, 165–166
 - symmetric multithreading, 166–167
- preemptive scheduling, 151–152
- in real-time systems, 682–686
 - earliest-deadline-first scheduling, 685
 - proportional share scheduling, 685–686
 - Pthread scheduling, 686–687
 - rate-monotonic scheduling, 683–684
- short-term scheduler, role of, 150–151
- crackers, 624
- creation:
 - of files, 361
 - process, 87–92
- critical sections, 189
- critical-section problem, 189–191
 - Peterson’s solution to, 191–192
 - and semaphores, 196–200
 - deadlocks, 200
 - implementation, 198–200
 - starvation, 200
 - usage, 197
 - and synchronization hardware, 193–196
- cross-link trust, 803
- cryptography, 640–651
 - and encryption, 641–648
 - implementation of, 648–649
 - SSL example of, 649–651
- C-SCAN scheduling algorithm, 443
- CSC (client-side caching), 802
- CSMA, *see* carrier sense with multiple access
- CTSS operating system, 825
- current directory, 374–375
- current-file-position pointer, 361
- cycles:
 - in CineBlitz, 706
 - CPU-I/O burst, 149–150
 - cycle stealing, 485
- cylinder groups, 743

D

- daemon process, 600
- daisy chain, 478
- data:
 - multimedia, 30
 - recovery of, 419–420
 - thread-specific, 137–138
- database systems, 217
- data capability, 613
- data-encryption standard (DES), 643
- data files, 359
- data fork, 366
- datagrams, 528
- data-in register, 480
- data-link layer, 530
- data loss, mean time to, 452
- data migration, 517–518
- data-out register, 480
- data section (of process), 80
- data striping, 453
- DCOM, 801
- DDOS attacks, 640
- deadline I/O scheduler, 748
- deadlock(s), 200, 576–583
 - avoidance of, 244, 247–253
 - with banker's algorithm, 251–253
 - with resource-allocation-graph algorithm, 249–250
 - with safe-state algorithm, 248–249
 - defined, 237
 - detection of, 253–256, 578–583
 - algorithm usage, 256–257
 - several instances of a resource type, 255–256
 - single instance of each resource type, 254–255
 - methods for handling, 243–244
 - with mutex locks, 239–240
 - necessary conditions for, 240
 - prevention/avoidance of, 576–578
 - prevention of, 244–247
 - and circular-wait condition, 246–247
 - and hold-and-wait condition, 245
 - and mutual-exclusion condition, 245
- and no-preemption condition, 245–246
- recovery from, 257–258
 - by process termination, 257–258
 - by resource preemption, 258–259
- system model for, 237–238
- system resource-allocation graphs
 - for describing, 240–243
- deadlock-detection coordinator, 579
- debuggers, 48
- dedicated devices, 488, 489
- default signal handlers, 135
- deferred procedure calls (DPCs), 766
- deferred thread cancellation, 134
- degree of multiprogramming, 85
- delay, 698
- delay-write policy, 550
- deletion, file, 361
- demand paging, 307–313
 - basic mechanism, 307–311
 - defined, 307
 - with inverted page tables, 346–347
 - and I/O interlock, 348–349
 - and page size, 344–345
 - and performance, 311–313
 - and prepaging, 344
 - and program structure, 347–348
 - pure, 309
 - and restarting instructions, 310–311
 - and TLB reach, 345–346
- demand-zero memory, 736
- demilitarized zone (DMZ), 662
- denial-of-service (DOS) attacks, 624, 639–640
- dentry objects, 403, 741
- DES (data-encryption standard), 643
- design of operating systems:
 - distributed operating systems, 535–537
 - goals, 53–54
 - Linux, 717–720
 - mechanisms and policies, 54–55
 - Windows XP, 760–763
- desktop, 42
- deterministic modeling, 177–178
- development kernels (Linux), 714
- device controllers, 6–7, 499–500. *See also* I/O systems

- device directory**, 370. *See also* directories
device drivers, 10, 11, 396, 478,
 499–500, 818
device-management system calls, 51
device queues, 84–85
device reservation, 496
device-status table, 493
DFSs, *see* distributed file systems
digital certificates, 647–648
digital signatures, 646
digital-signature algorithm, 646
dining philosophers problem, 203–205,
 208–210
direct access (files), 368–369
direct blocks, 411
direct communication, 97
direct I/O, 490
direct memory access (DMA), 11, 485–486
direct-memory-access (DMA)
 controller, 485
directories, 369–379
 acyclic-graph, 376–378
 general graph, 378–379
 implementation of, 403–404
 recovery of, 419–420
 single-level, 371–372
 tree-structured, 374–376
 two-level, 372–374
directory objects (Windows XP), 769
direct virtual memory access (DVMA),
 485–486
dirty bits (modify bits), 317
disinfection, program, 660
disk(s), 435–437. *See also* mass-storage
 structure
 allocation of space on, 404–413
 contiguous allocation,
 405–407
 indexed allocation, 409–411
 linked allocation, 407–409
 and performance, 412–413
 bad blocks, 448–449
 boot, 68, 447
 boot block, 447–448
 efficient use of, 415–416
 electronic, 10
 floppy, 436
 formatting, 445–446
 free-space management for, 413–415
 host-attached, 438
 low-level formatted, 437
 magnetic, 9
 magneto-optic, 461
 network-attached, 439
 performance improvement for,
 416–419
 phase-change, 461
 raw, 327
 read-only, 462
 read-write, 462
 removable, 460–463
 scheduling algorithms, 440–445
 C-SCAN, 443
 FCFS, 441
 LOOK, 443–444
 SCAN, 442–443
 selecting, 444–445
 SSTF, 441–442
 solid-state, 25
 storage-area network, 439–440
 structure of, 437–438
 system, 447
 WORM, 462
disk arm, 435
disk controller, 36–437
diskless clients, 546
disk mirroring, 795–796
disk scheduling
 CineBlitz, 706
 in multimedia systems, 701–702
disk striping, 794
dispatched process, 84
dispatcher, 152
dispatcher objects, 215
 Windows XP, 766
 in Windows XP, 769
dispatch latency, 153, 681
distributed coordination, 563–589
 and atomicity, 568–572
 and concurrency control, 572–576
 and deadlocks, 576–583
 detection, 578–583
 prevention/avoidance,
 576–578
 election algorithms for, 583–586
 and event ordering, 563–565
 and mutual exclusion, 563–568
 reaching algorithms for, 586–588
distributed denial-of-service (DDOS)
 attacks, 640

- distributed file systems (DFSes), 382, 543–561
 - AFS example of, 555–560
 - file operations, 558–559
 - implementation, 559–560
 - shared name space, 557–558
 - defined, 543
 - naming in, 544–548
 - remote file access in, 548–553
 - basic scheme for, 548–549
 - and cache-update policy, 550–551
 - and caching vs. remote service, 552–553
 - and consistency, 551–552
 - replication of files in, 554–555
 - stateful vs. stateless service in, 553–554
 - stateless, 385
 - Windows XP, 802
 - distributed information systems
 - (distributed naming services), 383–384
 - distributed lock manager (DLM), 15
 - distributed naming services, *see*
 - distributed information systems
 - distributed operating systems, 517–519
 - distributed-processing mechanisms, 800–801
 - distributed systems, 28–29
 - benefits of, 513–515
 - defined, 513
 - distributed operating systems as, 517–519
 - network operating systems as, 515–517
 - DLLs, *see* dynamic link libraries
 - DLM (distributed lock manager), 15
 - DMA, *see* direct memory access
 - DMA controller, *see* direct-memory-access controller
 - DMZ (demilitarized zone), 662
 - domains, 384, 803–804
 - domain-name system (DNS), 383–384, 525
 - domain switching, 598
 - domain trees, 803
 - DOS attacks, *see* denial-of-service attacks
 - double buffering, 494, 707
 - double caching, 417
 - double indirect blocks, 411
 - downsizing, 515
 - down time, 406
 - d (page offset), 279
 - DPCs (deferred procedure calls), 766
 - DRAM, *see* dynamic random-access memory
 - driver end (STREAM), 502
 - driver registration module (Linux), 722–723
 - dual-booted systems, 400–401
 - dumpster diving, 626
 - duplex set, 796
 - DVMA, *See* Direct virtual memory access
 - dynamic linking, 740
 - dynamic link libraries (DLLs), 271, 763
 - dynamic loading, 270–271
 - dynamic priority, 700
 - dynamic protection, 598
 - dynamic random-access memory (DRAM), 8
 - dynamic routing, 527
 - dynamic storage-allocation problem, 276, 406
- E**
- earliest-deadline-first (EDF) scheduling, 685, 701
 - ease of use, 4, 760
 - ECC, *see* error-correcting code
 - EDF scheduling, *see* earliest-deadline-first scheduling
 - effective access time, 311
 - effective bandwidth, 466
 - effective memory-access time, 284
 - effective UID, 27
 - efficiency, 3, 415–416
 - EIDE buses, 436
 - election, 530
 - election algorithms, 583–586
 - electronic disk, 10
 - elevator algorithm, *see* SCAN scheduling algorithm
 - embedded systems, 673–674
 - encapsulation (Java), 619
 - encoded files, 696
 - encrypted passwords, 653–654

encrypted viruses, 634
 encryption, 641–648
 asymmetric, 644
 authentication, 644–647
 key distribution, 647–648
 symmetric, 643–644
 Windows XP, 796–797
 enhanced integrated drive electronics (EIDE) buses, 436
 entry section, 189
 environmental subsystems, 762
 environment vector, 725
 EPROM (erasable programmable read-only memory), 68
 equal allocation, 329
 erasable programmable read-only memory (EPROM), 68
 error(s), 496–497
 hard, 449
 soft, 446
 error conditions, 303
 error-correcting code (ECC), 446, 454
 error detection, 40
 escalate privileges, 27
 escape (operating systems), 489
 events, 215
 event latency, 680
 event objects (Windows XP), 766
 event ordering, 563–565
 exceptions (with interrupts), 484
 exclusive lock mode, 572
 exclusive locks, 363
 exec() system call, 134
 executable files, 80, 360
 execution of user programs, 738–740
 execution time, 269
 exit section, 189
 expansion bus, 478
 expired array (Linux), 728
 expired tasks (Linux), 728
 exponential average, 156
 export list, 44–425
 ext2fs, *see* second extended file system
 extended file system, 397, 742
 extent (contiguous space), 407
 extents, 791
 external data representation (XDR), 109
 external fragmentation, 277–278, 406

F

failure:
 detection of, 534
 mean time to, 452
 recovery from, 535
 during writing of block, 459–460
 failure handling (2PC protocol), 570–572
 failure modes (directories), 384–385
 fair share (Solaris), 172
 false negatives, 659
 false positives, 659
 fast I/O mechanism, 783
 FAT (file-allocation table), 408–409
 fault tolerance, 13, 536, 794–796
 fault-tolerant systems, 536
 FC-AL (arbitrated loop), 438
 FCB (file-control block), 397
 FC buses, 436
 FC (fiber channel), 438
 FCFS scheduling algorithm, *see* first-come, first-served scheduling algorithm
 fibers, 809
 fiber channel (FC), 438
 fiber channel (FC) buses, 436
 fids, 557
 FIFO page replacement algorithm, 319–320
 50-percent rule, 277
 file(s), 22, 359–360. *See also* directories
 accessing information on, 367–369
 direct access, 368–369
 sequential access, 367
 attributes of, 360
 batch, 364
 defined, 359
 executable, 80
 extensions of, 364–365
 internal structure of, 366–367
 operations on, 361–363
 protecting, 386–391
 via file access, 387–389
 via passwords/permissions, 389–390
 recovery of, 419–420
 storage structure for, 370, 371
 file access, 363, 387–389
 file-allocation table (FAT), 408–409
 file-control block (FCB), 397
 file descriptor, 400
 file handle, 400

- file management, 52
- file-management system calls, 51
- file mapping, 337
- file migration, 545
- file modification, 53
- file objects, 403, 741
- file-organization module, 396
- file pointers, 362
- file reference, 791
- file replication (distributed file systems), 554–555
- file-server systems, 31
- file session, 386
- file sharing, 381–386
 - and consistency semantics, 385–386
 - with multiple users, 381–382
 - with networks, 382–385
 - and client-server model, 383
 - and distributed information systems, 383–384
 - and failure modes, 384–385
- file systems, 359, 395–396
 - basic, 396
 - creation of, 371
 - design problems with, 395–396
 - distributed, *see* distributed file systems
 - extended, 397
 - implementation of, 397–403
 - mounting, 401
 - partitions, 400–401
 - virtual systems, 401–403
 - levels of, 396
 - Linux, 740–746
 - log-based transaction-oriented, 421–422
 - logical, 397
 - mounting of, 379–381
 - network, 422–428
 - remote, 383
 - WAFL, 428–430
- File System Hierarchy Standard document, 716
- file-system management, 22–23
- file-system manipulation (operating system service), 40
- file transfer, 516–517
- file transfer protocol (FTP), 516–517
- file viruses, 633
- filter drivers, 781
- firewalls, 32, 662–663
- firewall chains, 752
- firewall management, 752
- firmware, 7, 68
- first-come, first-served (FCFS) scheduling algorithm, 154–155, 441
- first-fit strategy, 276
- fixed-partition scheme, 275
- fixed priority (Solaris), 172
- fixed routing, 527
- floppy disks, 436
- flow control, 502
- flushing, 283
- folders, 42
- footprint, 675
- foreground processes, 162
- forests, 803
- fork() and exec() process model (Linux), 724–726
- fork() system call, 134
- formatting, 445–446
- forwarding, 448
- forward-mapped page tables, 288
- fragments, packet, 752
- fragmentation, 277–278
 - external, 277–278, 406
 - internal, 277, 367
- frame(s), 279, 528, 694
 - stack, 630–631
 - victim, 316
- frame allocation, 327–330
 - equal allocation, 329
 - global vs. local, 330
 - proportional allocation, 329–330
- frame-allocation algorithm, 318
- frame pointers, 630–631
- free-behind technique, 418
- free objects, 343, 734
- free-space list, 413
- free-space management (disks), 413–415
 - bit vector, 413–414
 - counting, 415
 - grouping, 414–415
 - linked list, 414
- front-end processors, 505
- FTP, *see* file transfer protocol
- ftp, 382
- full backup, 420
- fully distributed deadlock-detection algorithm, 581–583

G

Gantt chart, 154, 155
 garbage collection, 66, 379
 gateways, 527
 GB (gigabyte), 6
 gcc (GNU C compiler), 716
 GDT (global descriptor table), 296
 general graph directories, 378–379
 gigabyte (GB), 6
 global descriptor table (GDT), 296
 global ordering, 565
 global replacement, 330
 GNU C compiler (gcc), 716
 GNU Portable Threads, 125
 graceful degradation, 13
 graphs, acyclic, 376
 graphical user interfaces (GUIs), 41–43
 grappling hook, 636
 Green threads, 125
 group identifiers, 27
 grouping, 414–415
 group policies, 804
 group rights (Linux), 754
 guest operating systems, 64
 GUIs, *see* graphical user interfaces

H

HAL, *see* hardware-abstraction layer
 handheld computers, 5
 handheld systems, 30–31
 handles, 769, 771
 handling (of signals), 120
 handshaking, 480, 500
 hands-on computer systems, *see*
 interactive computer systems
 happened-before relation, 563–565
 hard affinity, 166
 hard-coding techniques, 97
 hard errors, 449
 hard links, 378
 hard real-time systems, 674, 700
 hardware, 3
 I/O systems, 478–487
 direct memory access, 485–486
 interrupts, 481–485
 polling, 480–481
 for storing page tables, 282–284
 synchronization, 193–196

hardware-abstraction layer (HAL), 763–764
 hardware objects, 597
 hashed page tables, 290
 hash functions, 646
 hash tables, 404
 hash value (message digest), 646
 heaps, 80, 811
 heavyweight processes, 123
 hierarchical paging, 288–290
 hierarchical storage management
 (HSM), 466
 high availability, 14
 high performance, 762
 hijacking, session, 624
 hit ratio, 284, 345
 hive, 785–786
 hold-and-wait condition (deadlocks),
 245
 holes, 276
 holographic storage, 462–463
 homogeneity, 165
 host adapter, 478
 host-attached storage, 438
 host controller, 436
 hot spare disks, 458
 hot-standby mode, 14
 HSM (hierarchical storage management),
 466
 human security, 625–626
 Hydra, 611–613
 hyperspace, 773
 hyperthreading technology, 167

I

IBM OS/360, 826–827
 identifiers:
 file, 360
 group, 27
 user, 27
 idle threads, 173
 IDSs, *see* intrusion-detection systems
 IKE protocol, 649
 ILM (information life-cycle management),
 466
 immutable shared files, 386
 implementation:
 of CPU scheduling algorithms,
 180–181
 of operating systems, 55–56

- of real-time operating systems, 678–682
 - and minimizing latency, 679–682
 - and preemptive kernels, 679
 - and priority-based scheduling, 678–679
- of transparent naming techniques, 547–548
- of virtual machines, 63
- incremental backup, 420
- indefinite blocking (starvation), 159, 200
- independence, location, 545
- independent disks, 452
- independent processes, 93
- index, 69
 - index block, 409, 410
 - indexed disk space allocation, 409–411
 - index root, 791
 - indirect blocks, 411
 - indirect communication, 97
 - information life-cycle management (ILM), 466
 - information-maintenance system calls, 51
 - inode objects, 403, 741
 - input/output, *see under I/O*
 - input queue, 268
 - instance handles, 807
 - instruction-execution cycle, 265
 - instruction-execution unit, 787
 - instruction register, 8
 - integrity, breach of, 624
 - intellimirror, 804
 - Intel Pentium processor, 295–299
 - interactive (hands-on) computer systems, 16
 - interface(s):
 - batch, 41
 - client, 543
 - defined, 488
 - intermachine, 543
 - Windows XP networking, 798
 - interlock, I/O, 348–349
 - intermachine interface, 543
 - internal fragmentation, 277, 367
 - international use, 763
 - Internet address, 525
 - Internet Protocol (IP), 648–649
 - interprocess communication (IPC), 93–99
 - in client-server systems, 105–113
 - remote method invocation, 111–112
 - remote procedure calls, 108–111
 - sockets, 105–107
 - in Linux, 714, 749–750
 - Mach example of, 101–103
 - in message-passing systems, 96–99
 - POSIX shared-memory example of, 100–101
 - in shared-memory systems, 94–96
 - Windows XP example of, 104, 105
 - interrupt(s), 7–8, 481–485
 - defined, 481
 - in Linux, 730–731
 - interrupt chaining, 483
 - interrupt-controller hardware, 482
 - interrupt-dispatch table (Windows XP), 768
 - interrupt-driven data transfer, 340
 - interrupt-driven operating systems, 17–18
 - interrupt latency, 680–681
 - interrupt priority levels, 483
 - interrupt-request line, 481
 - interrupt vector, 8, 274, 483
 - intruders, 624
 - intrusion detection, 658–660
 - intrusion-detection systems (IDSs), 658
 - intrusion-prevention systems (IPSs), 658
 - inverted page tables, 290–292, 346–347
 - I/O-bound processes, 85, 86
 - I/O burst, 150
 - I/O channel, 505
 - I/O (input/output), 3, 10–11
 - memory-mapped, 340
 - overlapped, 819–821
 - programmed, 340
 - I/O interlock, 348–349
 - I/O manager, 781–782
 - I/O operations (operating system service), 40
 - I/O ports, 340
 - I/O request packet (IRP), 781
 - I/O subsystem(s), 26
 - kernels in, 5–6, 492–499
 - procedures supervised by, 498–499

- I/O system(s), 477–478**
- application interface, 487–493
 - block and character devices, 489–490
 - blocking and nonblocking I/O, 491–493
 - clocks and timers, 491
 - network devices, 490–491
 - hardware, 478–487
 - direct memory access, 485–486
 - interrupts, 481–485
 - polling, 480–481
 - kernels, 492–499
 - buffering, 494–495
 - caching, 495–496
 - data structures, 497–499
 - error handling, 496–497
 - I/O scheduling, 493–494
 - and I/O subsystems, 498–499
 - protection, 497, 498
 - spooling and device reservation, 496
 - Linux, 746–749
 - block devices, 747–748
 - character devices, 748–749
 - STREAMS mechanism, 502–504
 - and system performance, 504–507
 - transformation of requests to hardware operations, 499–502
- IP, *see* Internet Protocol**
- IPC, *see* interprocess communication**
- IPSec, 649**
- IPSs (intrusion-prevention systems), 658**
- IRP (I/O request packet), 781**
- ISCSI, 439**
- ISO protocol stack, 531–532**
- ISO Reference Model, 649**
- J**
- Java:**
- language-based protection in, 617–619
- Java threads, 130–133
- Java Virtual Machine (JVM), 65
- JIT compiler, 66
- jitter, 699
- jobs, processes vs., 79
- job objects, 778
- job pool, 17
- job queues, 84
- job scheduler, 85
- job scheduling, 17
- journaling, 744–745
- journaling file systems, *see* log-based transaction-oriented file systems
- just-in-time (JIT) compiler, 66
- JVM (Java Virtual Machine), 65
- K**
- KB (kilobyte), 6
- Kerberos, 790
- kernel(s), 6, 492–499
- buffering, 494–495
 - caching, 495–496
 - data structures, 497–499
 - error handling, 496–497
 - I/O scheduling, 493–494
 - and I/O subsystems, 498–499
 - Linux, 718, 719
 - multimedia systems, 698–700
 - nonpreemptive, 190–191
 - preemptive, 190–191, 679
 - protection, 497, 498
 - real-time, 676–678
 - spooling and device reservation, 496
 - task synchronization (in Linux), 729–731
 - Windows XP, 764–768, 805
- kernel extensions, 61
- kernel memory allocation, 340–343
- kernel mode, 18–19, 719
- kernel modules, 720–722
- conflict resolution, 723
 - driver registration, 722–723
 - management of, 721–722
- kernel threads, 125
- Kerr effect, 461
- keys, 607–608, 610–611, 641
- private, 644
 - public, 644
- key distribution, 647–648
- key ring, 647
- keystreams, 644
- keystroke logger, 635
- kilobyte (KB), 6

L

- language-based protection systems, 614–619
 - compiler-based enforcement, 614–617
 - Java, 617–619
- LANs, *see* local-area networks
- latency, in real-time systems, 679–682
- layers (of network protocols), 648
- layered approach (operating system structure), 57–59
- lazy swapper, 307
- LCNs (logical cluster numbers), 791
- LDAP, *see* lightweight directory-access protocol
- LDT (local descriptor table), 296
- least-frequently used (LFU) page-replacement algorithm, 326
- least privilege, principle of, 596–597
- least-recently-used (LRU) page-replacement algorithm, 321–323
- levels, 697
- LFU page-replacement algorithm, 326
- libraries:
 - Linux system, 719, 720
 - shared, 271, 306
- lightweight directory-access protocol (LDAP), 384, 804
- limit register, 266, 267
- linear addresses, 296–297
- linear lists (files), 403–404
- line discipline, 748
- link(s):
 - communication, 96
 - defined, 377
 - hard, 378
 - resolving, 377
 - symbolic, 770
- linked disk space allocation, 407–409
- linked lists, 414
- linked scheme index block, 410
- linking, dynamic vs. static, 271, 740
- Linux, 713–755
 - adding system call to Linux kernel (project), 70–74
 - design principles for, 717–720
 - file systems, 740–746
 - ext2fs, 742–744
 - journaling, 744–745
- process, 745–746
 - virtual, 741–742
- history of, 713–717
 - distributions, 716–717
 - first kernel, 714–716
 - licensing, 717
 - system description, 716
- interprocess communication, 749–750
- I/O system, 746–749
 - block devices, 747–748
 - character devices, 748–749
- kernel modules, 720–722
- memory management, 732–740
 - execution and loading of user programs, 738–740
 - physical memory, 732–735
 - virtual memory, 735–738
- network structure, 750–752
- on Pentium systems, 298–299
- process management, 723–727
 - fork() and exec() process model, 724–726
 - processes and threads, 726–727
- scheduling, 727–732
 - kernel synchronization, 729–731
 - process, 727–729
 - symmetric multiprocessing, 731–732
- scheduling example, 175, 176
- security model, 752–75
 - access control, 753–755
 - authentication, 753
- swap-space management in, 451
- synchronization in, 216–217
- threads example, 140–141
- Linux distributions, 714, 716–717
- Linux kernel, 714–716
- Linux system, components of, 713–714, 718–720
- lists, 304
- Little's formula, 179
- live streaming, 695
- load balancers, 34
- load balancing, 166
- loader, 818
- loading:
 - dynamic, 270–271
 - in Linux, 738–740

load sharing, 165, 514
 load time, 269
 local-area networks (LANs), 14, 28, 519–521
 local descriptor table (LDT), 296
 locality model, 333
 locality of reference, 310
 local name space, 556
 local (nonremote) objects, 112
 local playback, 694
 local procedure calls (LPCs), 762, 779–781
 local replacement, 330
 local replacement algorithm (priority replacement algorithm), 333
 location, file, 360
 location independence, 545
 location-independent file identifiers, 547–548
 location transparency, 545
 lock(s), 193, 607
 advisory, 363
 exclusive, 363
 mandatory, 363
 mutex, 197, 239–240
 reader-writer, 203
 shared, 363
 locking protocols, 223–224, 572–574
 lock-key scheme, 607–608
 lock() operation, 363
 log-based transaction-oriented file systems, 421–422
 log-file service, 793
 logging, write-ahead, 219–220
 logging area, 793
 logical address, 269
 logical address space, 269–270
 logical blocks, 437
 logical clock, 565
 logical cluster numbers (LCNs), 791
 logical file system, 397
 logical formatting, 446
 logical memory, 17, 305. *See also* virtual memory
 logical records, 368
 logical units, 438
 login, network, 384
 long-term scheduler (job scheduler), 85
 LOOK scheduling algorithm, 443–444
 loopback, 107
 lossless compression, 696–697
 lossy compression, 696, 697

low-level formatted disks, 437
 low-level formatting (disks), 446
 LPCs, *see* local procedure calls
 LRU-approximation page replacement algorithm, 323–326

M

Mach operating system, 59, 101–103, 827–829
 Macintosh operating system, 366
 MAC (medium access control) address, 538
 MAC (message-authentication code), 646
 macro viruses, 633
 magic number (files), 365
 magnetic disk(s), 9, 435–437. *See also* disk(s)
 magnetic tapes, 437, 462
 magneto-optic disks, 461
 mailboxes, 97
 mailbox sets, 103
 mailslots, 800
 mainframes, 4
 main memory, 8–9
 and address binding, 267–269
 contiguous allocation of, 274
 and fragmentation, 277–278
 methods, 275–277
 protection, 275
 and dynamic linking, 271
 and dynamic loading, 270–271
 and hardware, 266–267
 Intel Pentium example:
 with Linux, 298–299
 paging, 297–298
 segmentation, 296–297
 and logical vs. physical address space, 269–270
 paging for management of, 278–292
 basic method, 279–282
 hardware, 282–284
 hashed page tables, 290
 hierarchical paging, 288–290
 Intel Pentium example, 297–298
 inverted page tables, 290–292
 protection, 284–286
 and shared pages, 286–287

- segmentation for management of, 292–295
 - basic method, 292–293
 - hardware, 294–295
 - Intel Pentium example, 296–297
 - and swapping, 272–274
- majority protocol, 573–574
- MANs (metropolitan-area networks), 28
- mandatory file-locking mechanisms, 363
- man-in-the-middle attack, 624, 625
- many-to-many multithreading model, 126–127
- many-to-one multithreading model, 125–126
- marshalling, 801
- maskable interrupts, 483
- masquerading, 624, 625
- mass-storage management, 23–24
- mass-storage structure, 435–437
 - disk attachment:
 - host-attached, 438
 - network-attached, 439
 - storage-area network, 439–440
 - disk management:
 - bad blocks, 448–449
 - boot block, 447–448
 - formatting of disks, 445–446
 - disk scheduling algorithms, 440–445
 - C-SCAN, 443
 - FCFS, 441
 - LOOK, 443–444
 - SCAN, 442–443
 - selecting, 444–445
 - SSTF, 441–442
 - disk structure, 437–438
 - extensions, 459
 - magnetic disks, 435–437
 - magnetic tapes, 437
 - RAID structure, 451–459
 - performance improvement, 453
 - problems with, 459
 - RAID levels, 453–458
 - reliability improvement, 452
 - stable-storage implementation, 459–460
 - swap-space management, 449–451
- tertiary-storage, 460–463
 - future technology for, 462–463
 - magnetic tapes, 462
 - and operating system support, 463–466
 - performance issues with, 466–470
 - removable disks, 460–463
- master book record (MBR), 447
- master file directory (MFD), 372
- master file table, 398
- master key, 610–611
- master secret (SSL), 650
- matchmakers, 110
- matrix product, 144
- MB (megabyte), 6
- MBR (master book record), 447
- MCP operating system, 829
- mean time to data loss, 452
- mean time to failure, 452
- mean time to repair, 452
- mechanisms, 54–55
- media players, 704
- medium access control (MAC)
 - address, 538
- medium-term scheduler, 86
- megabyte (MB), 6
- memory:
 - anonymous, 451
 - core, 822
 - direct memory access, 11
 - direct virtual memory access, 485–486
 - logical, 17, 305
 - main, *see* main memory
 - over-allocation of, 315
 - physical, 17
 - secondary, 310
 - semiconductor, 9–10
 - shared, 93, 306
 - unified virtual memory, 417
 - virtual, *see* virtual memory
- memory-address register, 269
- memory allocation, 275–277
- memory management, 21–22
 - in Linux, 732–740
 - execution and loading of user programs, 738–740
 - physical memory, 732–735
 - virtual memory, 735–738

- memory management (*continued*)
 in Windows XP, 810–811
 heaps, 811
 memory-mapping files, 810
 thread-local storage, 811
 virtual memory, 810
- memory-management unit (MMU), 269, 775
- memory-mapped files, 773
- memory-mapped I/O, 340, 479
- memory mapping, 275, 335–340
 basic mechanism, 335–337
 defined, 335
 I/O, memory-mapped, 340
 in Linux, 739–740
 in Win32 API, 337–340
- memory-mapping files, 810
- memory protection, 275
- memory-resident pages, 308
- memory-style error-correcting organization, 454
- MEMS (micro-electronic mechanical systems), 463
- messages:
 connectionless, 528
 in distributed operating systems, 515
- message-authentication code (MAC), 646
- message digest (hash value), 646
- message modification, 624
- message passing, 93
- message-passing model, 51, 96–99
- message queue, 824
- message switching, 528–529
- metadata, 384, 792
- metafiles, 704
- methods (Java), 617
- metropolitan-area networks (MANs), 28
- MFD (master file directory), 372
- MFU page-replacement algorithm, 326
- micro-electronic mechanical systems (MEMS), 463
- microkernels, 59–61
- Microsoft Interface Definition Language, 801
- Microsoft Windows, *see under* Windows migration:
 computation, 518
 data, 517–518
 file, 545
 process, 518–519
- minicomputers, 4
- minidisks, 370
- miniport driver, 782
- mirroring, 452
- mirror set, 795
- MMU, *see* memory-management unit
- mobility, user, 423
- mode bit, 18
- modify bits (dirty bits), 317
- modules, 60–61
- monitors, 205–213
 dining-philosophers solution using, 208–210
 implementation of, using semaphores, 210–211
 resumption of processes within, 211–213
 usage of, 206–208
- monitor calls, *see* system calls
- monoculture, 635
- monotonic, 565
- Morris, Robert, 636–638
- most-frequently used (MFU) page-replacement algorithm, 326
- mounting, 401
- mount points, 379
- mount protocol, 424–425
- mount table, 401, 500
- MPEG files, 697
- MS-DOS, 787–788
- multicasting, 703
- MULTICS operating system, 600–602, 825–826
- multilevel feedback-queue scheduling algorithm, 163–165
- multilevel index, 410–411
- multilevel queue scheduling algorithm, 161–163
- multimedia, 693
 operating system issues with, 696
 as term, 693
- multimedia data, 30, 693
- multimedia systems, 30, 693–706
 characteristics of, 695
 CineBlitz example, 706–708
 compression in, 696–697
 CPU scheduling in, 700–701
 disk scheduling in, 701–702
 kernels in, 698–700
 network management in, 703–706

- multinational use, 763
 multipartite viruses, 635
 multiple-coordinator approach
 (concurrency control), 573
 multiple-partition method, 275–276
 multiple universal-naming-convention provider (MUP), 802
 multiprocessing:
 asymmetric, 165
 symmetric, 165, 166–167
 multiprocessor scheduling, 165–167
 approaches to, 165
 examples of:
 Linux, 175, 176
 Solaris, 170–172
 Windows XP, 172–175
 and load balancing, 166
 and processor affinity, 165–166
 symmetric multithreading,
 166–167
 multiprocessor systems (parallel systems, tightly coupled systems), 12–13
 multiprogramming, 15–17, 85
 multitasking, *see* time sharing
 multithreading:
 benefits of, 123–125
 cancellation, thread, 134
 and `exec()` system call, 134
 and `fork()` system call, 134
 models of, 125–127
 pools, thread, 136–137
 and scheduler activations,
 138–139
 and signal handling, 135–136
 symmetric, 166–167
 and thread-specific data, 137–138
 MUP (multiple universal-naming-convention provider), 802
 mutex:
 adaptive, 214
 in Windows XP, 766
 mutex locks, 197, 239–240
 mutual exclusion, 240, 565–568
 centralized approach to, 566
 fully-distributed approach to,
 566–568
 token-passing approach to, 568
 mutual-exclusion condition (deadlocks), 245
 names:
 resolution of, 524–525, 804
 in Windows XP, 769
 named pipes, 800
 naming, 97–98, 383–384
 defined, 544
 domain name system, 383–384
 of files, 360
 lightweight directory-access protocol, 384
 and network communication,
 524–527
 national-language-support (NLS) API, 763
 NDIS (network device interface specification), 798
 near-line storage, 462
 negotiation, 699
 NetBEUI (NetBIOSextended user interface), 799
 NetBIOSextended user interface (NetBEUI), 799
 NetBIOS (network basic input/output system), 798–800
 network(s). *See also* local-area networks (LANs); wide-area networks (WANs)
 communication protocols in,
 530–533
 communication structure of,
 524–530
 and connection strategies,
 528–529
 and contention, 529–530
 and naming/name resolution,
 524–527
 and packet strategies, 528
 and routing strategies,
 527–528
 defined, 28
 design issues with, 535–537
 example, 537–539
 in Linux, 750–752
 metropolitan-area (MANs), 28
 robustness of, 534–535
 security in, 626
 small-area, 28
 threats to, 635–640

- network(s). (*continued*)
 topology of, 522–524
 types of, 519–522
 in Windows XP, 798–804
 Active Directory, 804
 distributed-processing mechanisms, 800–801
 domains, 803–804
 interfaces, 798
 name resolution, 804
 protocols, 798–799
 redirectors and servers, 801–802
 wireless, 31
 network-attached storage, 439
 network basic input/output system, *see* NetBIOS
 network computers, 32
 network devices, 490–491, 747
 network device interface specification (NDIS), 798
 network file systems (NFS), 422–428
 mount protocol, 424–425
 NFS protocol, 425–427
 path-name translation, 427
 remote operations, 427–428
 network information service (NIS), 384
 networking:
 name resolution, 804
 network layer, 531
 network-layer protocol, 648
 network login, 384
 network management, in multimedia systems, 703–706
 network operating systems, 28, 515–517
 network virtual memory, 549
 new state, 81
 NFS, *see* network file systems
 NFS protocol, 425–427
 nice value (Linux), 175, 727
 NIS (network information service), 384
 NLS (national-language-support) API, 763
 nonblocking (asynchronous) message passing, 99
 nonblocking I/O, 491–493
 noncontainer objects (Windows XP), 666
 nonmaskable interrupt, 482
 nonpreemptive kernels, 190–191
 nonpreemptive scheduling, 152
 non-real-time clients, 706
 nonremote (local) objects, 112
 nonrepudiation, 647
 nonresident attributes, 791
 nonserial schedule, 222
 nonsignaled state, 215
 nonvolatile RAM (NVRAM), 10
 nonvolatile RAM (NVRAM) cache, 452
 nonvolatile storage, 10, 218
 no-preemption condition (deadlocks), 245–246
 Novell NetWare protocols, 799
 NTFS, 790–792
 NVRAM (nonvolatile RAM), 10
 NVRAM (nonvolatile RAM) cache, 452
- O**
- objects:
 access lists for, 606
 in cache, 342
 free, 343
 hardware vs. software, 597
 in Linux, 734
 used, 343
 in Windows XP, 769–772
 object files, 360
 object serialization, 112
 object table, 771
 object types, 403, 771
 off-line compaction of space, 406
 OLE, *see* object linking and embedding
 on-demand streaming, 695
 one-time pad, 655
 one-time passwords, 654–655
 one-to-one multithreading model, 125
 one-way trust, 803
 on-line compaction of space, 406
 open-file table, 362
 open() operation, 362
 operating system(s), 1
 defined, 3, 5–6
 design goals for, 53–54
 early, 815–821
 dedicated computer systems, 815–816
 overlapped I/O, 819–821
 shared computer systems, 817–819
 features of, 3
 functioning of, 3–6

- guest, 64
- implementation of, 55–56
- interrupt-driven, 17–18
- mechanisms for, 54–55
- network, 28
- operations of:
 - modes, 18–20
 - and timer, 20
- policies for, 54–55
- real-time, 29–30
- as resource allocator, 5
- security in, 626
- services provided by, 39–41
- structure of, 15–17, 56–61
 - layered approach, 57–59
 - microkernels, 59–61
 - modules, 60–61
 - simple structure, 56–57
- system's view of, 5
- user interface with, 4–5, 41–43
- optimal page replacement algorithm, 321
- ordering, event, *see* event ordering
- orphan detection and elimination, 554
- OS/2 operating system, 759
- out-of-band key delivery, 647
- over allocation (of memory), 315
- overlapped I/O, 819–821
- overprovisioning, 698
- owner rights (Linux), 754

- packets, 528, 752
- packet switching, 529
- packing, 366
- pages:
 - defined, 279
 - shared, 286–287
- page allocator (Linux), 733
- page-buffering algorithms, 326–327
- page cache, 417, 735
- page directory, 774
- page-directory entries (PDEs), 774
- page-fault-frequency (PFF), 335
- page-fault rate, 312
- page-fault traps, 308
- page frames, 774
- page-frame database, 777
- page number (p), 279
- page offset (d), 279
- pageout policy (Linux), 737
- pageout (Solaris), 350–351
- page replacement, 315–327. *See also* frame allocation
 - and application performance, 327
 - basic mechanism, 316–319
 - counting-based page replacement, 326
 - FIFO page replacement, 319–320
 - global vs. local, 330
 - LRU-approximation page replacement, 323–326
 - LRU page replacement, 321–323
 - optimal page replacement, 321
 - and page-buffering algorithms, 326–327
- page replacement algorithm, 318
- pager (term), 307
- page size, 344–345
- page slots, 451
- page table(s), 279–282, 310, 774
 - clustered, 290
 - forward-mapped, 288
 - hardware for storing, 282–284
 - hashed, 290
 - inverted, 290–292, 346–347
- page-table base register (PTBR), 283
- page-table length register (PTLR), 286
- page-table self-map, 773
- paging, 278–292
 - basic method of, 279–282
 - hardware support for, 282–284
 - hashed page tables, 290
 - hierarchical, 288–290
 - Intel Pentium example, 297–298
 - inverted, 290–292
 - in Linux, 737
 - and memory protection, 284–286
 - priority, 352
 - and shared pages, 286–287
 - swapping vs., 449
- paging files (Windows XP), 773
- paired passwords, 654
- PAM (pluggable authentication modules), 753
- parallel systems, *see* multiprocessor systems
- parcels, 111
- parent process, 87, 771–772
- partially connected networks, 523–524

- partition(s), 275–276, 370, 400–401
 - boot, 447
 - raw, 450
 - root, 401
- partition boot sector, 397
- partitioning, disk, 446
- passwords, 651–655
 - encrypted, 653–654
 - one-time, 654–655
 - vulnerabilities of, 652–653
- path name, 373
- path names:
 - absolute, 375
 - relative, 375
- path-name translation, 427
- PCBs, *see* process control blocks
- PCI bus, 478
- PCS (process-contention scope), 168
- PC systems, 3
- PDAs, *see* personal digital assistants
- PDEs (page-directory entries), 774
- peer-to-peer computing, 33–34
- penetration test, 656–657
- performance:
 - and allocation of disk space, 412–413
 - and I/O system, 504–507
 - with tertiary-storage, 466–470
 - cost, 468–470
 - reliability, 467–468
 - speed, 466–467
 - of Windows XP, 762
- performance improvement, 416–419, 453
- periods, 698
- periodic processes, 698
- per-process open-file table, 398
- persistence of vision, 694
- personal computer (PC) systems, 3
- personal digital assistants (PDAs), 10, 30
- personal firewalls, 663
- personal identification number (PIN), 655
- Peterson’s solution, 191–192
- PFF, *see* page-fault-frequency
- phase-change disks, 461
- phishing, 626
- physical address, 269
- physical address space, 269–270
- physical formatting, 446
- physical layer, 530
- physical memory, 17, 303, 304, 732–735
- physical security, 625
- PIC (position-independent code), 740
- pid (process identifier), 87
- pinning, 783–784
- PIN (personal identification number), 655
- PIO, *see* programmed I/O
- pipe mechanism, 750
- platter (disks), 435
- plug-and-play and (PnP) managers, 784–785
- pluggable authentication modules (PAM), 753
- PnP managers, *see* plug-and-play and managers
- point-to-point tunneling protocol (PPTP), 799
- policy algorithm (Linux), 737
- policy(ies), 54–55
 - group, 804
 - security, 656
- polling, 480–481
- polymorphic viruses, 633–634
- pools:
 - of free pages, 314
 - thread, 136–137
- pop-up browser windows, 628
- ports, 340, 478
- portability, 763
- portals, 32
- port driver, 782
- port scanning, 639
- position-independent code (PIC), 740
- positioning time (disks), 436
- POSIX, 759, 761
 - interprocess communication
 - example, 100–101
 - in Windows XP, 789
- possession (of capability), 607
- power-of-2 allocator, 341
- p (page number), 279
- PPTP (point-to-point tunneling protocol), 799
- P + Q redundancy scheme, 456
- preemption points, 679
- preemptive kernels, 190–191, 679
- preemptive scheduling, 151–152
- premaster secret (SSL), 650
- prepaging, 344
- presentation layer, 531
- primary thread, 806
- principle of least privilege, 596–597

- priority-based scheduling, 678–679
- priority-inheritance protocol, 214, 682
- priority inversion, 214, 682
- priority number, 212
- priority paging, 352
- priority replacement algorithm, 333
- priority scheduling algorithm, 158–159
- private keys, 644
- privileged instructions, 19
- privileged mode, *see* kernel mode
- process(es), 17
 - background, 162
 - communication between, *see* interprocess communication
 - components of, 80
 - context of, 86, 725–726
 - and context switches, 86–87
 - cooperating, 93
 - defined, 79
 - environment of, 725
 - faulty, 587–588
 - foreground, 162
 - heavyweight, 123
 - independent, 93
 - I/O-bound vs. CPU-bound, 85–86
 - job vs., 79
 - in Linux, 726–727
 - multithreaded, *see* multithreading
 - operations on, 87–92
 - creation, 87–92
 - termination, 92
 - programs vs., 21, 80, 81
 - scheduling of, 83–87
 - single-threaded, 123
 - state of, 81
 - as term, 79
 - threads performed by, 83
 - in Windows XP, 806–807
- process-contention scope (PCS), 168
- process control blocks (PCBs, task control blocks), 81–82
- process-control system calls, 46–50
- process file systems (Linux), 745–746
- process identifier (pid), 87
- process identity (Linux), 724–725
- process management, 20–21
 - in Linux, 723–727
 - `fork()` and `exec()` process model, 724–726
 - processes and threads, 726–727
- process manager (Windows XP), 778–779
- process migration, 518–519
- process mix, 85, 86
- process objects (Windows XP), 766
- processor affinity, 165–166
- processor sharing, 160
- process scheduler, 83
- process scheduling:
 - in Linux, 727–729
 - thread scheduling vs., 149
- process synchronization:
 - about, 187–189
 - and atomic transactions, 217–218
 - checkpoints, 220–221
 - concurrent transactions, 221–223
 - log-based recovery, 218–220
 - system model, 217–218
 - bounded-buffer problem, 201
 - critical-section problem, 189–191
 - hardware solution to, 193–196
 - Peterson's solution to, 191–192
 - dining-philosophers problem, 203–205, 208–210
- examples of:
 - Linux, 216–217
 - PThreads, 217
 - Solaris, 213–215
 - Windows XP, 215–216
- monitors for, 205–213
 - dining-philosophers solution, 208–210
 - resumption of processes within, 211–213
 - semaphores, implementation using, 210–211, 214–215
 - usage, 206–208
- readers-writers problem, 202–203
- semaphores for, 196–200
- process termination, deadlock recovery by, 257–258
- producer-consumer problem (project), 229–235
- production kernels (Linux), 714
- profiles, 697
- programs, processes vs., 80, 81. *See also* application programs
- program counters, 21, 80

program execution (operating system service), 40
 program files, 359–360
 program loading and execution, 53
 programmable interval timer, 491
 programmed I/O (PIO), 340, 485
 programming-language support, 53
 program threats, 627–635
 logic bombs, 628–629
 stack- or buffer overflow attacks, 629–632
 trap doors, 628
 Trojan horses, 627–628
 viruses, 632–635
 progressive download, 694
 projects, 172
 proportional allocation, 329–330
 proportional share scheduling, 685–686
 protection, 595–620
 access control for, 387–389
 access matrix as model of, 602–606
 control, access, 609
 implementation, 605–609
 capability-based systems, 611–613
 Cambridge CAP system, 613
 Hydra, 611–613
 in computer systems, 26–27
 domain of, 597–602
 MULTICS example, 600–602
 structure, 598–599
 UNIX example, 599–600
 error handling, 496–497
 file, 360
 of file systems, 386–391
 goals of, 595–596
 I/O, 497, 498
 language-based systems, 614–619
 compiler-based enforcement, 614–617
 Java, 617–619
 as operating system service, 41
 in paged environment, 284–286
 and principle of least privilege, 596–597
 retrofitted, 390
 and revocation of access rights, 609–611
 security vs., 623
 static vs. dynamic, 598
 from viruses, 660–661

protection domain, 598
 protection mask (Linux), 754
 protection subsystems (Windows XP), 763
 protocols, Windows XP networking, 798–799
 PTBR (page-table base register), 283
 Pthreads, 128–130
 scheduling, 168–170
 synchronization in, 217
 Pthread scheduling, 686–687
 PTLR (page-table length register), 286
 public domain, 717
 public keys, 644
 pull migration, 166
 pure code, 286
 pure demand paging, 309
 push migration, 166, 546

Q

quantum, 765
 queue(s), 84–85
 capacity of, 99
 input, 268
 message, 824
 ready, 83, 84, 273

queueing-network analysis, 179

R

race condition, 189
 RAID levels, 453–458
 RAID (redundant arrays of inexpensive disks), 451–459
 levels of, 453–458
 performance improvement, 453
 problems with, 459
 reliability improvement, 452
 RAM (random-access memory), 8
 random access, 694
 random-access devices, 488, 820
 random-access memory (RAM), 8
 random-access time (disks), 436
 rate-monotonic scheduling algorithm, 683–684
 raw disk, 327, 400
 raw disk space, 370
 raw I/O, 489–490

- raw partitions, 450
- RBAC (role-based access control), 609
- RC 4000 operating system, 824–825
- reaching algorithms, 586–588
- read-ahead technique, 418
- readers, 202
- readers-writers problem, 202–203
- reader-writer locks, 203
- reading files, 361
- read-modify-write cycle, 456
- read only devices, 488, 489
- read-only disks, 462
- read-only memory (ROM), 68, 447
- read queue, 748
- read-write devices, 489
- read-write disks, 462
- ready queue, 83, 84, 273
- ready state, 81
- ready thread state (Windows XP), 765
- real-addressing mode, 677
- real-time class, 173
- real-time clients, 706
- real-time operating systems, 29–30
- real-time range (Linux schedulers), 727
- real-time streaming, 694, 704–706
- real-time systems, 29–30, 673–690
 - address translation in, 677–678
 - characteristics of, 674–676
 - CPU scheduling in, 682–686
 - defined, 673
 - features not needed in, 676
 - footprint of, 675
 - hard, 674, 700
 - implementation of, 678–682
 - and minimizing latency, 679–682
 - and preemptive kernels, 679
 - and priority-based scheduling, 678–679
 - soft, 674, 700
 - VxWorks example, 688–689
- real-time transport protocol (RTP), 703
- real-time value (Linux), 175
- reconfiguration, 534–535
- records:
 - logical, 368
 - master boot, 447
- recovery:
 - backup and restore, 420–421
 - consistency checking, 419
- from deadlock, 257–258
 - by process termination, 257–258
 - by resource preemption, 258–259
- from failure, 535
- of files and directories, 419–420
 - Windows XP, 792–793
- redirectors, 801
- redundancy, 452. *See also RAID*
- redundant arrays of inexpensive disks, *see RAID*
- Reed-Solomon codes, 456
- reentrant code (pure code), 286–287
- reference bits, 324
- Reference Model, ISO, 649
- reference string, 318
- register(s), 46
 - base, 266, 267
 - limit, 266, 267
 - memory-address, 269
 - page-table base, 283
 - page-table length, 286
 - for page tables, 282–284
 - relocation, 269–270
- registry, 53, 785–786
- relative block number, 368
- relative path names, 375
- relative speed, 190
- reliability, 528
 - of distributed operating systems, 514–515
 - in multimedia systems, 699
 - of Windows XP, 761
- relocation register, 269–270
- remainder section, 189
- remote file access (distributed file systems), 548–553
 - basic scheme for, 548–549
 - and cache location, 549–550
 - and cache-update policy, 550–551
 - and caching vs. remote service, 552–553
 - and consistency, 551–552
- remote file systems, 383
- remote file transfer, 516–517
- remote login, 515–516
- remote method invocation (RMI), 111–112
- remote operations, 427–428
- remote procedure calls (RPCs), 800–801

- remote-service mechanism, 548
 removable storage media, 463–465
 application interface with, 463–464
 disks, 460–463
 and file naming, 464–465
 and hierarchical storage
 management, 466
 magnetic disks, 435–437
 magnetic tapes, 437, 462
 rendezvous, 99
 repair, mean time to, 452
 replay attacks, 624
 replication, 458
 repositioning (in files), 361
 request edge, 241
 request manager, 747
 resident attributes, 791
 resident monitor, 817
 resolution:
 name, 524–525
 and page size, 345
 resolving links, 377
 resource-allocation graph algorithm, 249–250
 resource allocation (operating system service), 40–41
 resource allocator, operating system as, 5
 resource fork, 366
 resource manager, 700
 resource preemption, deadlock recovery by, 258–259
 resource-request algorithm, 252
 resource reservations, 699–700
 resource sharing, 513–514
 resource utilization, 4
 response time, 16, 153
 restart area, 793
 restore:
 data, 420–421
 state, 86
 retrofitted protection mechanisms, 390
 revocation of access rights, 609–611
 rich text format (RTF), 661
 rights amplification (Hydra), 611–612
 ring algorithm, 585–586
 ring structure, 568
 risk assessment, 656
 RMI, *see* remote method invocation
 roaming profiles, 802
 robotic jukebox, 465
 robustness, 534–535
 roles, 609
 role-based access control (RBAC), 609
 rolled-back transactions, 218
 roll out, roll in, 272
 ROM, *see* read-only memory
 root partitions, 401
 root uid (Linux), 754
 rotational latency (disks), 436, 440
 round-robin (RR) scheduling algorithm, 159–161
 routing:
 and network communication, 527–528
 in partially connected networks, 523
 routing protocols, 528
 routing table, 527
 RR scheduling algorithm, *see* round-robin scheduling algorithm
 RSX operating system, 829
 RTF (rich text format), 661
 R-timestamp, 224
 RTP (real-time transport protocol), 703
 running state, 81
 running system, 68
 running thread state (Windows XP), 765
 runqueue data structure, 176, 728
 RW (read-write) format, 24

S

- safe computing, 661
 safe sequence, 248
 safety algorithm, 251–252
 safety-critical systems, 674
 sandbox, 661
 SANs, *see* storage-area networks
 SATA buses, 436
 save, state, 86
 scalability, 536–537
 SCAN (elevator) scheduling algorithm, 442–443, 702
 schedules, 221
 scheduler(s), 85, 86
 long-term, 85
 medium-term, 86
 short-term, 85
 scheduler activation, 138–139

- scheduling:
- cooperative, 152
 - CPU, *see* CPU scheduling
 - disk scheduling algorithms, 440–445
 - C-SCAN, 443
 - FCFS, 441
 - LOOK, 443–444
 - SCAN, 442–443
 - selecting, 444–445
 - SSTF, 441–442
 - earliest-deadline-first, 685
 - I/O, 493–494
 - job, 17
 - in Linux, 727–732
 - kernel synchronization, 729–731
 - process, 727–729
 - symmetric multiprocessing, 731–732
 - nonpreemptive, 152
 - preemptive, 151–152
 - priority-based, 678–679
 - proportional share, 685–686
 - Pthread, 686–687
 - rate-monotonic, 683–684
 - thread, 167–170
 - in Windows XP, 765–766
- SCOPE operating system, 829
- script kiddies, 632
- SCSI buses, 436
- SCSI initiator, 438
- SCSI (small computer-systems interface), 10
- SCSI targets, 438
- SCS (system-contention scope), 168
- search path, 374
- secondary memory, 310
- secondary storage, 9, 395. *See also* disk(s)
- second-chance page-replacement algorithm (clock algorithm), 324–326
- second extended file system (ext2fs), 742–744
- section objects, 104
- sectors, disk, 435
- sector slipping, 448–449
- sector sparing, 448, 796
- secure single sign-on, 384
- secure systems, 623
- security, 789–790. *See also* file access; program threats; protection; user authentication
- classifications of, 663–665
 - in computer systems, 27
 - and firewalling, 662–663
 - implementation of, 656–662
 - and accounting, 662
 - and auditing, 661–662
 - and intrusion detection, 658–660
 - and logging, 661–662
 - and security policy, 656
 - and virus protection, 660–661
 - and vulnerability assessment, 656–658
 - levels of, 625–626
 - in Linux, 752–75
 - access control, 753–755
 - authentication, 753
 - as operating system service, 41
 - as problem, 623–626
 - protection vs., 623
 - and system/network threats, 635–640
 - denial of service, 639–640
 - port scanning, 639
 - worms, 636–639
 - use of cryptography for, 640–651
 - and encryption, 641–648
 - implementation, 648–649
 - SSL example, 649–651
 - via user authentication, 651–656
 - biometrics, 655–656
 - passwords, 651–655
 - Windows XP, 794
 - in Windows XP, 665–666, 761
- security access tokens (Windows XP), 665
- security context (Windows XP), 665
- security descriptor (Windows XP), 666
- security domains, 662
- security policy, 656
- security reference monitor (SRM), 784
- security-through-obscurity approach, 658
- seeds, 654–655
- seek, file, 361
- seek time (disks), 436, 440

- segmentation, 292–295
 - basic method, 292–293
 - defined, 293
 - hardware, 294–295
 - Intel Pentium example, 296–297
- segment base, 294
- segment limit, 294
- segment tables, 294
- semantics:
 - consistency, 385–386
 - copy, 495
 - immutable-shared-files, 386
 - session, 386
- semaphore(s), 196–200
 - binary, 197
 - counting, 197
 - and deadlocks, 200
 - defined, 196
 - implementation, 198–200
 - implementation of monitors using, 210–211, 214–215
 - and starvation, 200
 - usage of, 197
 - Windows XP, 766
- semiconductor memory, 9–10
- sense key, 497
- sequential-access devices, 820
- sequential access (files), 367
- sequential devices, 488
- serial ATA (SATA) buses, 436
- serializability, 221–223
- serial schedule, 221
- server(s), 5
 - cluster, 556
 - defined, 543
 - in SSL, 650
- server-message-block (SMB), 798
- server subject (Windows XP), 665
- services, operating system, 39–41
- session hijacking, 624
- session layer, 531
- session object, 773
- session semantics, 386
- session space, 773
- sharable devices, 488, 489
- shares, 172
- shared files, immutable, 386
- shared libraries, 271, 306
- shared lock, 363
- shared lock mode, 572
- shared memory, 93, 306
- shared-memory model, 52, 94–96
- shared name space, 556
- sharing:
 - load, 165, 514
 - and paging, 286–287
 - resource, 513–514
 - time, 16
- shells, 41, 117–119
- shell script, 365
- shortest-job-first (SJF) scheduling
 - algorithm, 155–158
- shortest-remaining-time-first scheduling, 157
- shortest-seek-time (SSTF) scheduling
 - algorithm, 441–442
- short-term scheduler (CPU scheduler), 85, 150–151
- shoulder surfing, 652
- signals:
 - Linux, 749
 - UNIX, 120, 135–136
- signaled state, 215
- signal handlers, 135–136
- signal-safe functions, 120
- signatures, 659
- signature-based detection, 659
- simple operating system structure, 56–57
- simple subject (Windows XP), 665
- simulations, 179–180
- single indirect blocks, 411
- single-level directories, 371–372
- single-processor systems, 12–14, 149
- single-threaded processes, 123
- SJF scheduling algorithm, *see* shortest-job-first scheduling algorithm
- skeleton, 111
- slab allocation, 341–343, 734
- Sleeping-Barber Problem, 227
- slices, 370
- small-area networks, 28
- small computer-systems interface, *see under* SCSI
- SMB, *see* server-message-block
- SMP, *see* symmetric multiprocessing
- sniffing, 652
- social engineering, 626
- sockets, 105–107
- socket interface, 490
- SOC strategy, *see* system-on-chip strategy

- soft affinity, 166
 soft error, 446
 soft real-time systems, 674, 700
 software capability, 613
 software interrupts (traps), 484
 software objects, 597
 Solaris:
 scheduling example, 170–172
 swap-space management in, 450–451
 synchronization in, 213–215
 virtual memory in, 350–352
 solid-state disks, 25
 sorted queue, 748
 source-code viruses, 633
 source files, 360
 sparseness, 290, 305
 special-purpose computer systems, 29–31
 handheld systems, 30–31
 multimedia systems, 30
 real-time embedded systems, 29–30
 speed, relative, 190
 speed of operations:
 for I/O devices, 488–489
 spinlock, 198
 spoofed client identification, 383
 spoofing, 663
 spool, 496
 spooling, 496, 820–821
 spyware, 627–628
 SRM, *see* security reference monitor
 SSL 3.0, 649–651
 SSTF scheduling algorithm, *see* shortest-seek-time scheduling algorithm
 stable storage, 218, 459–460
 stack, 46, 80
 stack algorithms, 323
 stack frame, 630–631
 stack inspection, 618–619
 stack-overflow attacks, 629–632
 stage (magnetic tape), 462
 stalling, 266
 standby thread state (Windows XP), 76
 starvation, *see* indefinite blocking
 stateful file service, 553–554
 state information, 39–41
 stateless DFS, 385
 stateless file service, 553
 stateless protocols, 704
 state (of process), 81
 state restore, 86
 state save, 86
 static linking, 271, 740
 static priority, 700
 static protection, 598
 status information, 52
 status register, 480
 stealth viruses, 634
 storage. *See also* mass-storage structure
 holographic, 463
 nonvolatile, 10, 218
 secondary, 9, 395
 stable, 218
 tertiary, 23–24
 volatile, 10, 218
 storage-area networks (SANs), 15, 438, 439–440
 storage management, 22–26
 caching, 24–26
 I/O systems, 26
 mass-storage management, 23–24
 stream ciphers, 643–644
 stream head, 502
 streaming, 694–695
 stream modules, 502
 STREAMS mechanism, 502–504
 string, reference, 318
 stripe set, 794
 stubs, 111, 271
 stub routines, 800
 superblock, 398
 superblock objects, 403, 741
 supervisor mode, *see* kernel mode
 suspended state, 808
 sustained bandwidth, 466
 swap map, 451
 swapper (term), 307
 swapping, 17, 86, 272–274, 307
 in Linux, 737
 paging vs., 449
 swap space, 310
 swap-space management, 449–451
 switch architecture, 11
 switching:
 circuit, 528
 domain, 598
 message, 528–529
 packet, 529
 symbolic links, 770
 symbolic-link objects, 770

- symmetric encryption, 643–644
 symmetric mode, 15
 symmetric multiprocessing (SMP), 13–14, 165, 166–167, 731–732
 synchronization, 99. *See also* process synchronization
 synchronous devices, 489
 synchronous message passing, 99
 synchronous writes, 418
 SYSGEN, *see* system generation
 system boot, 67–68
 system calls (monitor calls), 7, 43–52
 and API, 44–46
 for communication, 51–52
 for device management, 51
 for file management, 51
 functioning of, 43–44
 for information maintenance, 51
 for process control, 46–50
 system-call firewalls, 663
 system-call interface, 45
 system-contention scope (SCS), 168
 system device, 786
 system disk, *see* boot disk
 system files, 373–374
 system generation (SYSGEN), 66–67
 system hive, 786
 system libraries (Linux), 719, 720
 system mode, *see* kernel mode
 system-on-chip (SOC) strategy, 675
 system process (Windows XP), 786
 system programs, 52–53
 system resource-allocation graph, 240–243
 system restore, 786
 systems layer, 697
 system utilities, 53, 719–720
 system-wide open-file table, 398
- T**
- table(s), 304
 file-allocation, 408–409
 hash, 404
 master file, 398
 mount, 401, 500
 object, 771
 open-file, 362
 page, 310, 774
 per-process open-file, 398
 routing, 527
- segment, 294
 system-wide open-file, 398
 tags, 607
 tapes, magnetic, 437, 462
 target thread, 134
 tasks:
 Linux, 726–727
 VxWorks, 688
 task control blocks, *see* process control blocks
 TCB (trusted computer base), 664
 TCP/IP, *see* Transmission Control Protocol/Internet Protocol
 TCP sockets, 106
 TDI (transport driver interface), 798
 telnet, 515–516
 Tenex operating system, 829
 terminal concentrators, 505
 terminated state, 81
 terminated thread state (Windows XP), 765
 termination:
 cascading, 92
 process, 87–92, 257–258
 tertiary-storage, 460–463
 future technology for, 462–463
 and operating system support, 463–466
 performance issues with, 466–470
 removable disks, 460–463
 tapes, 462
 tertiary storage devices, 23–24
 text files, 360
 text section (of process), 80
 theft of service, 624
 THE operating system, 823–824
 thrashing, 330–335
 cause of, 331–333
 defined, 331
 and page-fault-frequency strategy, 335
 and working-set model, 333–334
 threads. *See also* multithreading
 cancellation, thread, 134
 components of, 123
 functions of, 123–125
 idle, 173
 kernel, 125
 in Linux, 140–141, 726–727
 pools, thread, 136–137
 and process model, 83

- scheduling of, 167–170
 - target, 134
 - user, 125
 - in Windows XP, 139, 140, 765–766, 806–808
 - thread libraries, 127–132
 - about, 127, 128
 - Java threads, 130–133
 - Pthreads, 128–130
 - Win32 threads, 130
 - thread pool, 809
 - thread scheduling, 149
 - thread-specific data, 137–138
 - threats, 624. *See also* program threats
 - throughput, 153, 698
 - thunking, 788
 - tightly coupled systems, *see* multiprocessor systems
 - time:
 - compile, 269
 - effective access, 311
 - effective memory-access, 284
 - execution, 269
 - of file creation/use, 360
 - load, 269
 - response, 16, 153
 - turnaround, 153
 - waiting, 153
 - time-out schemes, 534, 586–587
 - time quantum, 159
 - timer:
 - programmable interval, 491
 - variable, 20
 - timers, 491
 - timer objects, 766
 - time sharing (multitasking), 16
 - timestamp-based protocols, 224–225
 - timestamping, 575–576
 - timestamps, 565
 - TLB, *see* translation look-aside buffer
 - TLB miss, 283
 - TLB reach, 345–346
 - tokens, 530, 568
 - token passing, 530, 568
 - top half interrupt service routines, 730
 - topology, network, 522–524
 - Torvalds, Linus, 713
 - trace tapes 180
 - tracks, disk, 435
 - traditional computing, 31–32
 - transactions, 217. *See also* atomic transactions
 - defined, 744
 - in Linux, 744–745
 - in log-structured file systems, 421–422
 - Transarc DFS, 555
 - transfer rate (disks), 435–436
 - transition thread state (Windows XP), 765
 - transitive trust, 803
 - translation look-aside buffer (TLB), 283, 284, 775
 - Transmission Control Protocol/Internet Protocol (TCP/IP), 799
 - transmission control protocol (TCP), 532–533
 - transparency, 535, 544, 545
 - transport driver interface (TDI), 798
 - transport layer, 531
 - transport-layer protocol (TCP), 648
 - traps, 17, 308, 484
 - trap doors, 628
 - tree-structured directories, 374–376
 - triple DES, 643
 - triple indirect blocks, 411
 - Trojan horses, 627–628
 - trusted computer base (TCB), 664
 - trust relationships, 803–804
 - tunneling viruses, 634
 - turnaround time, 153
 - turnstile, 214
 - two-factor authentication, 655
 - twofish algorithm, 643
 - two-level directories, 372–374
 - two-phase commit (2PC) protocol, 569–572
 - two-phase locking protocol, 223
 - two tuple, 293
 - type safety (Java), 619
- U**
- UDP sockets, 106
 - UDP (user datagram protocol), 532
 - UFD (user file directory), *See* User file directory
 - UFS (UNIX file system), 397
 - UI, *see* user interface
 - unbounded capacity (of queue), 99
 - UNC (uniform naming convention), 800
 - unformatted disk space, 370

- unicasting, 703
- UNICODE**, 763
- unified buffer cache, 417
- unified virtual memory, 417
- uniform naming convention (UNC), 800
- universal serial buses (USBs), 436
- UNIX file system (UFS), 397
- UNIX operating system:
 - consistency semantics for, 386
 - domain switching in, 599–600
 - and Linux, 713
 - shell and history feature (project), 117–121
 - signals in, 120, 135–136
 - swapping in, 274
- unreliability, 528
- unreliable communications, 586–587
- upcalls, 138
- upcall handler, 138
- USBs, *see* universal serial buses
- used objects, 343, 734
- users, 4–5, 381–382
- user accounts, 665
- user authentication, 651–656
 - with biometrics, 655–656
 - with passwords, 651–655
- user datagram protocol (UDP), 532
- user-defined signal handlers, 135
- user file directory (UFD), 372–374
- user identifiers (user IDs), 27
 - effective, 27
 - for files, 360
- user interface (UI), 39–43
- user mobility, 423
- user mode, 18
- user programs (user tasks), 79, 738
- user rights (Linux), 754
- user threads, 125
- utilization, 816
- V**
- VACB, *see* virtual address control block
- VADs (virtual address descriptors), 778
- valid-invalid bit, 285–286
- variable class, 173
- variables, automatic, 630
- variable timer, 20
- VDM**, *see* virtual DOS machine
- vector programs, 636
- vfork()** (virtual memory fork), 315
- VFS, *see* virtual file system
- victim frames, 316
- views, 773
- virtual address, 269
- virtual address control block (VACB), 782, 783
- virtual address descriptors (VADs), 778
- virtual address space, 305, 736–737
- virtual DOS machine (VDM), 787–788
- virtual file system (VFS), 401–403, 741–742
- virtual machines, 62–66
 - basic idea of, 61
 - benefits of, 63–64
 - implementation of, 63
 - Java Virtual Machine as example of, 65
 - VMware as example of, 64
- virtual memory, 17, 303–306
 - and copy-on-write technique, 312–313
 - demand paging for conserving, 307–313
 - basic mechanism, 307–311
 - with inverted page tables, 346–347
 - and I/O interlock, 348–349
 - and page size, 344–345
 - and performance, 311–313
 - and prepaging, 344
 - and program structure, 347–348
 - pure demand paging, 309
 - and restarting instructions, 310–311
 - and TLB reach, 345–346
- direct virtual memory access, 485–486
- and frame allocation, 327–330
 - equal allocation, 329
 - global vs. local allocation, 330
 - proportional allocation, 329–330
- kernel, 738
 - and kernel memory allocation, 340–343
 - in Linux, 735–738
 - and memory mapping, 335–340
 - basic mechanism, 335–337
 - I/O, memory-mapped, 340
 - in Win32 API, 337–340