Security

Protection, as we discussed in Chapter 13, is strictly an ***internal*** problem: How do we provide controlled access to programs and data stored in a computer system? **Security**, on the other hand, requires not only an adequate protection system but also consideration of the ***external*** environment within which the system operates. A protection system is ineffective if user authentication is compromised or a program is run by an unauthorized user.

Computer resources must be guarded against unauthorized access, malicious destruction or alteration, and accidental introduction of inconsistency. These resources include information stored in the system (both data and code), as well as the CPU, memory, disks, tapes, and networking that are the computer. In this chapter, we start by examining ways in which resources may be accidentally or purposely misused. We then explore a key security enabler —cryptography. Finally, we look at mechanisms to guard against or detect attacks.

Bibliographical Notes

General discussions concerning security are given by [Denning (1982)], [Pfleeger and Pfleeger (2006)] and [Tanenbaum (2010)]. Computer networking is discussed in [Kurose and Ross (2013)].

Issues concerning the design and verification of secure systems are discussed by [Rushby (1981)] and by [Silverman (1983)]. A security kernel for a multiprocessor microcomputer is described by [Schell (1983)]. A distributed secure system is described by [Rushby and Randell (1983)].

[Morris and Thompson (1979)] discuss password security. [Morshedian (1986)] presents methods to fight password pirates. Password authentication with insecure communications is considered by [Lamport (1981)]. The issue of password cracking is examined by [Seely (1989)]. Computer break-ins are discussed by [Lehmann (1987)] and by [Reid (1987)]. Issues related to trusting computer programs are discussed in [Thompson (1984)].

Discussions concerning UNIX security are offered by [Grampp and Morris (1984)], [Wood and Kochan (1985)], [Farrow (1986)], [Filipski and Hanko

(1986)], [Hecht et al. (1988)], [Kramer (1988)], and [Garfinkel et al. (2003)]. [Bershad and Pinkerton (1988)] present the watchdog extension to BSD UNIX.

[Spafford (1989)] presents a detailed technical discussion of the Internet worm. The Spafford article appears with three others in a special section on the Morris Internet worm in *Communications of the ACM* (Volume 32, Number 6, June 1989).

Security problems associated with the TCP/IP protocol suite are described in [Bellovin (1989)]. The mechanisms commonly used to prevent such attacks are discussed in [Cheswick et al. (2003)]. Another approach to protecting networks from insider attacks is to secure topology or route discovery. [Kent et al. (2000)], [Hu et al. (2002)], [Zapata and Asokan (2002)], and [Hu and Perrig (2004)] present solutions for secure routing. [Savage et al. (2000)] examine the distributed denial-of-service attack and propose IP trace-back solutions to address the problem. [Perlman (1988)] proposes an approach to diagnose faults when the network contains malicious routers.

[Ludwig (1998)] and [Ludwig (2002)] discuss viruses and worms. A website that provides information about viruses and worms can be found at http://www.securelist.com, Another web sites containing up-to-date security information is http://www.eeye.com. A paper on the dangers of a computer monoculture can be found at http://www.ccianet.org/CCIA/files/ccLibraryFiles/Filename/000000000061/cyberinsecurity.pdf.

[Diffie and Hellman (1976)] and [Diffie and Hellman (1979)] were the first researchers to propose the use of the public-key encryption scheme. The algorithm presented in Section 14.4.1 is based on the public-key encryption scheme; it was developed by [Rivest et al. (1978)]. [C. Kaufman (2002)] and [Stallings (2011)] explore the use of cryptography in computer systems. Discussions concerning protection of digital signatures are offered by [Akl (1983)], [Davies (1983)], [Denning (1983)], and [Denning (1984)]. Complete cryptography information is presented in [Schneier (1996)] and [Katz and Lindell (2008)].

The RSA algorithm is presented in [Rivest et al. (1978)]. Information about NIST's AES activities can be found at http://www.nist.gov/aes; information about other cryptographic standards for the United States can also be found at that site. More complete coverage of SSL 3.0 can be found at http://www.mozilla.org/projects/security/pki/nss/ssl/draft302.txt. In 1999, SSL 3.0 was modified slightly and presented in an IETF Request for Comments (RFC) under the name TLS.

The example in Section 14.6.3 illustrating the impact of false-alarm rate on the effectiveness of IDSs is based on [Axelsson (1999)]. The description of Tripwire in Section 14.6.5 is based on [Kim and Spafford (1993)]. Research into system-call-based anomaly detection is described in [Forrest et al. (1996)].

The U.S. government is, of course, concerned about security. The *Department of Defense Trusted Computer System Evaluation Criteria* ([DoD (1985)]), known also as the **Orange Book,** describes a set of security levels and the features that an operating system must have to qualify for each security rating. Reading it is a good starting point for understanding security concerns. The *Microsoft Windows NT Workstation Resource Kit* ([Microsoft (1996)]) describes the security model of NT and how to use that model.

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