Chapter 1

General Security Concepts

THE FOLLOWING COMPTIA SECURITY+ EXAM OBJECTIVES ARE COVERED IN THIS CHAPTER:

✓ 1.1 Recognize and be able to differentiate and explain the following access control models
   ▪ MAC (Mandatory Access Control)
   ▪ DAC (Discretionary Access Control)
   ▪ RBAC (Role Based Access Control)

✓ 1.2 Recognize and be able to differentiate and explain the following methods of authentication
   ▪ Kerberos
   ▪ CHAP (Challenge Handshake Authentication Protocol)
   ▪ Certificates
   ▪ Username/Password
   ▪ Tokens
   ▪ Multi-Factor
   ▪ Mutual
   ▪ Biometrics

✓ 1.3 Identify non-essential services and protocols and know what actions to take to reduce the risks of those services and protocols

✓ 3.3 Understand the concepts behind the following kinds of security topologies
   ▪ Security Zones
   ▪ DMZ (Demilitarized Zone)
   ▪ Intranet
   ▪ Extranet
   ▪ VLANs (Virtual Local Area Network)
- NAT (Network Address Translation)
- Tunneling

- 5.7 Understand and be able to explain the following concepts of risk identification
  - Asset Identification
  - Risk Assessment
  - Threat Identification
  - Vulnerabilities
Advances in computer technology have created an acute need for people to help monitor and secure the data and information that other individuals use to accomplish their work. Unfortunately, these advances often put technologies into the hands of people who don’t have the experience and knowledge to protect it. As a computer security professional, you have a primary responsibility to protect and safeguard the information your organization uses. Security is a high growth area in the computer industry, and the need for qualified people is increasing rapidly. Your pursuit of the Security+ certificate is a good first step in this process.

In this chapter, we’ll discuss the various aspects of computer security as they relate to your job. This chapter introduces the basics of computer security and provides several models you can use to understand the risks your organization faces; it also presents steps you must take in order to minimize those risks.

Understanding Information Security

The term *information security* covers a wide array of activities in an organization. It includes both products and processes to prevent unauthorized access to, modification of, and deletion of information. This area also involves protecting resources by preventing them from being disrupted by situations or attacks that may be largely beyond the control of the person responsible for information security.

From the perspective of a computer professional, you’re dealing with issues that are much bigger than protecting computer systems from viruses. You’re also protecting an organization’s most valuable assets from people who are highly motivated to misuse those assets. Some of these people may already be inside your organization and discontented in their present situation. Fortunately, most of them are outsiders who are trying to break in.

Unfortunately, this job isn’t getting any easier. Weaknesses and vulnerabilities in most commercial systems are well known and documented, and more become known each day. Your adversaries can use search engines to find vulnerabilities on virtually any product or operating system. To learn how to exploit the most likely weaknesses that exist in a system, they can buy books on computer hacking, join newsgroups on the Internet, and access websites that offer explicit details.

In many situations, you’ll find yourself dealing with inherent weaknesses in the products you use and depend on. In short, you must assume that you’re under attack right now, even as you read this book. This section discusses in more detail the aspects you must consider in order to
have a reasonable chance of securing your information, networks, and computers. Make sure you understand that we’re always talking about reasonable. There is no such thing as a completely secure network. One of the first things you must develop as a security administrator is a bit of paranoia. It’s important to remember that you’re dealing with both system vulnerabilities and human vulnerabilities—although they aren’t the same, they both affect the organization significantly.

Information security includes three areas of primary focus. These areas address different parts of computer security. An effective computer security plan and process must evaluate the risks and create strategies and methods to address them. This section focuses on three areas:

- Physical security
- Operational security
- Management and policies

Each of these areas is vital to ensure security in an organization. You can think of information security as a three-legged stool: If any one of the legs of your stool breaks, you’ll fall down and hurt yourself. You must look at the overall business and address all the issues the business faces concerning computer security. Figure 1.1 shows how these three components of computer security interact to provide a reasonably secure environment.

Part of your job is to make recommendations to management about needs and deficiencies; to take action to minimize the risks and exposure of your information and systems; and to establish, enforce, and maintain the security of the systems with which you work. This is no small task, and you must do each element well in order to have a reasonable chance of maintaining security in your organization.

**FIGURE 1.1** The security triad
Securing the Physical Environment

Physical security involves the protection of your assets and information from physical access by unauthorized personnel. In other words, you’re trying to protect those items that can be seen, touched, and stolen. These threats often present themselves as service technicians, janitors, customers, vendors, or even employees. They can steal your equipment, damage it, or take documents from offices, garbage cans, or filing cabinets. Their motivation may be as simple as retribution for some perceived misgiving, greed, or a desire to steal your trade secrets to sell to a competitor as an act of vengeance.

Physical security is relatively easy to accomplish. You can secure facilities by controlling access to the office, shredding unneeded documents, installing security systems, and limiting access to sensitive areas of the business. Most office buildings provide perimeter and corridor security during unoccupied hours, and it isn’t difficult to implement commonsense measures during occupied hours as well.

Many office complexes also offer roving security patrols, multiple lock access control methods, and electronic or password access. Typically, the facility managers handle these arrangements. They won’t generally deal with internal security as it relates to your records, computer systems, and papers; that is your responsibility in most situations.

The first component of physical security involves making a physical location less tempting as a target. If the office or building you’re in is open all the time, gaining entry into a business in the building is easy. You must prevent people from seeing your organization as a tempting target. Locking doors and installing surveillance or alarm systems can make a physical location a less desirable target. Plenty of wide-open targets are available, involving less risk on the part of the people involved. Try to make your office not worth the trouble.

The second component of physical security involves detecting a penetration or theft. You want to know what was broken into, what is missing, and how the loss occurred. Passive videotape systems are one good way to obtain this information. Most retail environments routinely tape key areas of the business to identify how thefts occur and who was involved. These tapes are admissible as evidence in most courts. Law enforcement should be involved as soon as a penetration or theft occurs. More important from a deterrent standpoint, you should make it well known that you’ll prosecute anyone caught in the act of theft to the fullest extent of the law.

The third component of physical security involves recovering from a theft or loss of critical information or systems. How will the organization recover from the loss and get on with normal business? If a vandal destroyed your server room with a fire or flood, how long would it take your organization to get back into operation and return to full productivity?

Recovery involves a great deal of planning, thought, and testing. What would happen if the files containing all your bank accounts, purchase orders, and customer information became a pile of ashes in the middle of the smoldering ruins that used to be your office? Ideally, critical copies of records and inventories should be stored off site in a secure facility.

In Exercise 1.1, you’ll survey your physical environment.
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Examining Operational Security

Operational security deals with how your organization does things. This includes computers, networks, and communications systems as well as the management of information. Operational security encompasses a large area, and as a security professional, you’ll be primarily involved here.

Operational security issues include access control, authentication, and security topologies after network installation is complete. These issues include the daily operations of the network, connections to other networks, backup plans, and recovery plans. In short, operations security encompasses everything that isn’t related to design or physical security in your network. Instead of focusing on the physical components where the data is stored, such as the server, the focus is now on the topology and connections.

The issues you address in an operational capacity can seem overwhelming at first. Many of the areas you’ll address are vulnerabilities in the systems you use, or weak or inadequate security policies. For example, if you implemented a comprehensive password expiration policy, you could require users to change their passwords every 30 or 60 days. If the system doesn’t require password rotation (it allows passwords to be reused), you have a vulnerability that you may not be able to eliminate. From an operational perspective, the system has weak password-protection capabilities. There is nothing you can do, short of installing a higher security logon process or

EXERCISE 1.1

Survey Your Physical Environment

As a security administrator, you need to put yourself in the position of an intruder. For this exercise, think of yourself as an outsider who wants to gain access to the company server and damage it. Don’t think of trying to steal data, but rather of trying to pour water into the server. See if you can answer these questions:

1. How would you gain access to the building? Is a key or code required? Is there any security—a guard, a receptionist, or cameras?
2. How would you gain access to the floor the server is on? Is the elevator keyed, or can anyone use it?
3. How would you find the server? Is it sitting in the middle of the office, or is it in a separate room? If the latter, is the door to that room secured?
4. Once you reach the server, would anyone see what you’re doing? Does the server room have glass windows? Is the server viewable from a distance? Would anyone question why you were there?

If you can easily answer these questions and spot flaws in the security, then there is a risk that someone could harm your operations.

Finally, try to answer similar questions, but instead of imagining that you’re an outsider to the company, use the perspective of someone from accounting who didn’t get the promotion they thought they should and now wants to hurt the company.
replacing the operating system. Either solution may not be feasible given the costs, conversion times, and possible unwillingness of an organization to make this switch.

Such dependence on a weak system usually stems from the fact that most companies use software that was developed by third parties. These packages may require a specific operating system to be used. If that operating system has significant security problems or vulnerabilities, your duties will be mammoth, because you’ll still be responsible for providing security in that environment. For example, when your secure corporate network is connected to the Internet, it becomes subject to many potential vulnerabilities. You can install hardware and software to improve security, but management may decide these measures cost too much to implement. Again, operationally there may be little you can do.

Much of this book will discuss the technologies and tools used to help ensure operational security. Figure 1.2 illustrates the various concerns you face from an operational perspective.

**FIGURE 1.2** Operational security issues

In Exercise 1.2, you’ll survey your operational environment.

**EXERCISE 1.2**

**Survey Your Operational Environment**

For this exercise, assess the operational environment of your network by looking for “doors” that an outsider could use to gain access to your data. Don’t think of the safeguards that may currently exist, but rather focus on ways someone not on your network might join it. See if you can answer these questions:

1. How do users access the Internet? Do any users use dial-up connections? Are proxy servers in use? Do you use private or public IP addresses?

2. Are there Wireless Access Points on the network? Can a mobile user with a laptop configure their settings to join the network?

3. Are dial-in connections allowed? Can users call in from home?

4. Do you use Terminal Services? Are entire sessions on the server run remotely?

Securing the network involves far more than simply securing what exists within the four walls of your building. Look for openings through which intruders can enter your network without walking through the door.
Working with Management and Policies

Management and policies provide the guidance, rules, and procedures for implementing a security environment. Policies, to be effective, must have the full and uncompromised support of the organization’s management team. Management directions can give security initiatives the teeth they need to be effective. Information security professionals can recommend policies, but they need the support of management to implement them. There is nothing more ineffective than a self-proclaimed security “czar” who has no support from management.

The issues that must be decided at the management and policy level affect the entire company and can greatly impact productivity, morale, and corporate culture. Policies also establish expectations about security-related issues. These policies should be treated no differently than an organization’s vacation, sick leave, or termination policies. Most people can tell you exactly how many days of vacation they get per year; however, many can’t tell you what the company’s information usage or security policies are.

A number of key policies are needed to secure a network. The following list identifies some broad areas that require thought and planning:

- Administrative policies
- Software design requirements
- Disaster recovery plans
- Information policies
- Security policies
- Usage policies
- User management policies

Administrative Policies

Administrative policies lay out guidelines and expectations for upgrades, monitoring, backups, and audits. Systems administrators and maintenance staff use these policies to conduct business. The policies should clearly outline how often and when upgrades appear, when and how monitoring occurs, and how logs are reviewed. They should also identify—not by name, but by title—who is responsible for making decisions on these matters and how often decisions should be reviewed.

The policies must be specific enough to help the administrative staff keep focused on the business of running the systems and networks. At the same time, they must be flexible enough to allow for emergencies and unforeseen circumstances.

Software Design Requirements

Design requirements outline what the capabilities of the system must be. These requirements are typically part of the initial design and greatly affect the solutions you can use. Many vendors will respond to every bid and assure you that they’re secure. You can use the requirements to have vendors explain proposed solutions. This policy should be very specific about security requirements. If your design doesn’t include security as an integral part of the implementation, you can bet that your network has vulnerabilities.
Design requirements should be viewed as a moving target. The requirements that exist today shouldn’t be the same in two years when the network environment has been significantly modified.

**Disaster Recovery Plans**

Disaster recovery plans (DRPs) are one of the biggest headaches that IT professionals face. The DRP is expensive to develop, is expensive to test, and must be kept current.

Many large companies invest huge amounts of money in DRPs, including backup or hot sites. A hot site is a facility designed to provide immediate availability in the event of a system or network failure. (This subject is covered in more depth in Chapter 9, “Security Policies and Procedures.”) These sites are expensive to maintain and sometimes hard to justify. The likelihood that an organization will need a hot site is relatively small, and the site may seem unimportant—right up to the point when you don’t have one and you need it.

A good DRP takes into consideration virtually every type of occurrence or failure possible. It may be as simple as a single system failing, or as complicated as a large multinational company needing to recover from a cataclysmic event. The key to its success is its completeness. For example, if a company is located in the Midwest region of the United States, there is no reason that plans shouldn’t be in place to address tornados, floods, fires, and every conceivable disaster.

**Information Policies**

Information policies refer to the various aspects of information security, including access, classifications, marking and storage, and the transmission and destruction of sensitive information. The development of information policies is critical to security.

As with all other policies, the key is to be as comprehensive as possible. Little should be left to chance or conjecture when you’re writing information policies.

**Security Policies**

Security policies define the configuration of systems and networks, including the installation of software, hardware, and network connections. Security policies also define how Identification and Authentication (I&A) occurs, and they determine access control, audits, and network connectivity. Encryption and antivirus software are usually covered in these policies. The security policies also establish procedures and methods used for password selection, account expiration, failed logon attempts, and related areas.

> Although each security policy is intended for a specific purpose, there is some scope overlap in many of the different policies.

**Usage Policies**

Usage policies cover how information and resources are used. You need to explain to users how they can use organizational resources and for what purposes. These policies lay down the law about computer usage. Usage policies include statements about privacy, ownership, and consequences of improper acts. Your usage policies should clearly explain usage expectations about the Internet and e-mail.
They should also address how users should handle incidents—whom they should contact if they suspect something is awry. The policy should spell out the fact that monitoring can take place and that users agree to it. Consequences for account misuse, whether termination or something less severe, should also be stated.

User Management Policies

User management policies identify the various actions that must occur in the normal course of employee activities. These policies must address how new employees are added to the system, as well as training, orientation, and equipment installation and configuration.

Employee transfers are a normal occurrence within a company. If an employee transfers to a new job, the privileges and access they had in the old position may be inappropriate for the new position. Establishing new access rights allows the employee to continue working. If you forget to revoke the old privileges, this user may have access to more information than they need. Over time, this can result in a situation called privilege creep. The user may acquire administrative privileges to the system by accident.

Terminated employees pose a threat to information security. In some cases, a terminated employee may seek to gain access to customer lists, bank accounts, or other sensitive information. When employees leave the company, it’s imperative that their accounts be either disabled or deleted, and that their access be turned off. You’d be amazed how often systems administrators don’t know about personnel changes. Your user management policies should clearly outline who notifies the IT department about employee terminations as well as when and how the notification occurs.

For Exercise 1.3, you’ll compile a list of your security-related procedures and verify that those that should be available can be found.

EXERCISE 1.3

Assemble and Examine Your Procedures

It’s surprising how many businesses think they have a policy in place when one can’t be produced when needed. See if you can answer these questions:

1. Does your company have administrative policies in place? What are they, and where can they be found?
2. When were the software design requirements last checked and/or updated? Are they routinely given to vendors?
3. When was the last time the disaster recovery plan was checked? Do all administrators know it?
4. Are informational policies easy to locate?
5. Are security policies updated frequently? Are they updated with each software change?
Understanding the Goals of Information Security

The goals of information security are straightforward. They set a framework for developing and maintaining a security plan. They’re easy to express but hard to carry out. These goals are as follows:

**Prevention**  
Prevention refers to preventing computer or information violations from occurring. Security breaches are also referred to as incidents. When an incident occurs, it may be the result of a breakdown in security procedures. Incidents come in all shapes and sizes. Simple incidents include things such as losing a password or leaving a terminal logged on overnight. They can also be quite involved and result in the involvement of local or federal law enforcement personnel. If a group of hackers were to attack and deface your website, you would consider this a major incident. Ideally, your security procedures and policies would make you invulnerable to an attack. Unfortunately, this isn’t always the case. The better your prevention policies, the lower the likelihood of a successful attack occurring.

**Detection**  
Detection refers to identifying events when they occur. Detection is difficult in many situations; an attack on your system may occur over a long period before it’s successful. Incident detection involves identifying the assets under attack, how the incident occurred, and who carried it out. The detection process may involve a variety of complicated tools or a simple examination of the system log files. Detection activities should be ongoing and part of your information security policies and procedures.

**Response**  
Response refers to developing strategies and techniques to deal with an attack or loss. Developing an appropriate response to an incident involves several factors. If the incident was a probe, the attacker may be gathering intelligence about your network or systems. These types of attacks may be random or targeted, and they usually cause little damage. Invariably, though, an attack will be successful. When that happens, it will be helpful to have a well-thought-out and tested plan you can use to respond, restore operation, and neutralize the threat. It’s always better to have a set of procedures and methods in place to recover from an incident than to try to create those processes on-the-fly.

**EXERCISE 1.3 (continued)**

6. Are usage policies part of the employee handbook? Do users sign off that they have seen the policies and are aware of them? How do users receive updates to the policies and signal that they have them and understand them?

7. Can the user management policies be located and adhered to in the event that a situation occurs while the administrator is at a conference?

Policies not only need to exist, but also need to be readily able so they can be referenced by all relevant parties. If this can’t be said of the policies we’ve discussed, then their value is drastically diminished.

**Understanding the Goals of Information Security**

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These goals are an important part of setting benchmarks for an organization. You can’t allow these policies or goals to become insignificant. If you do, you and your organization are setting yourselves up for a surprise. Unfortunately, the surprise won’t be pleasant, and it may be very costly to correct.

Comprehending the Security Process

You need to think of security as a combination of three Ps: *processes, procedures, and policies*. The security of information involves both human and technical factors. The human factors are addressed by the policies that are enforced in the organization, as well as the processes and procedures your organization has in place. The technology components include the tools you install on the systems you work with. There are several parts to this process, and each is described in the following sections.

Appreciating Antivirus Software

Computer *viruses*—applications that carry out malicious actions—are one of the most annoying trends happening today. It seems that almost every day, someone invents a new virus. Some of these viruses do nothing more than give you a big “gotcha”; others destroy systems, contaminate networks, and wreak havoc on computer systems. A virus may act on your data or your operating system, but it’s intent on doing harm, and doing so without your consent. Viruses often include replication as a primary objective and try to infect as many machines as they can, as quickly as possible.

The business of providing software to computer users to protect them from viruses has become a huge industry. Several very good and well-established suppliers of antivirus software exist, and new virus-protection methods come on the scene almost as fast as new viruses. Anti-virus software scans the computer’s memory, disk files, and incoming and outgoing e-mail. The software typically uses a virus definition file that is updated regularly by the manufacturer. If these files are kept up to date, the computer system will be relatively secure. Unfortunately, most people don’t keep their virus definitions up to date. Users will exclaim that a new virus has come out, because they just got it. Upon examination, you’ll often discover that their virus definition file is months out of date. As you can see, the software part of the system will break down if the definition files aren’t updated on a regular basis.

Implementing Access Control

The process of establishing *access control* is critical. Access control defines how users and systems communicate and in what manner. In other words, it limits—or controls—access to system resources, including data, and thus protects information from unauthorized access. Three basic models are used to explain access control. We’ll introduce each in the following sections, and visit them once more in Chapter 9.
Mandatory Access Control (MAC)

*Mandatory Access Control (MAC)* is a static model that uses a predefined set of access privileges to files on the system. The system administrators establish these parameters and associate them with an account, files, or resources.

The MAC model can be very restrictive. In a MAC model, administrators establish access. Administrators are also the only people who can change access. Users can’t share resources dynamically unless the static relationship already exists.

The acronym MAC appears in numerous computer-related contexts. One of the most common is the Media Access Layer in networking. Be careful not to confuse MAC addressing as it relates to network cards with Mandatory Access Control.

MAC uses *labels* to identify the level of sensitivity that applies to objects. When a user attempts to access an object, the label is examined to see if the access should take place or be denied. One key element to remember is that when mandatory control is applied, labels are required and must exist for every object.

Discretionary Access Control (DAC)

The *Discretionary Access Control (DAC)* model allows the owner of a resource to establish privileges to the information they own. The difference between DAC and MAC is that labels are not mandatory but can be applied as needed.

The DAC model allows a user to share a file or use a file that someone else has shared. It establishes an Access Control List (ACL) that identifies the users who have authorization to that information. This allows the owner to grant or revoke access to individuals or groups of individuals based on the situation. This model is dynamic in nature and allows information to be shared easily between users.

Role-Based Access Control (RBAC)

The *Role-Based Access Control (RBAC)* model allows a user to act in a certain predetermined manner based on the role the user holds in the organization. The roles almost always shadow the organizational structure.

Users can be assigned certain roles system wide and can then perform certain functions or duties based on the roles they’re assigned. An example might be a role called *salesperson*. The salesperson can access only the information established for that role. Users may be able to access this information from any station in the network, based strictly on their role. A sales manager may have a different role that allows access to all of the individual salespersons’ information.

The RBAC model is common in network administrative roles. Limited privileges are needed to back up data files on computers, and these privileges are assigned to a person called a *backup operator*. The backup operator only has access to the rights or privileges predefined for that role.
Understanding Authentication

Authentication proves that a user or system is actually who they say they are. This is one of the most critical parts of a security system. It's part of a process that is also referred to as Identification and Authentication (I&A). The identification process starts when a user ID or logon name is typed into a sign-on screen. Authentication is accomplished by challenging the claim about who is accessing the resource. Without authentication, anybody can claim to be anybody.

Authentication systems or methods are based on one or more of these three factors:

- Something you know, such as a password or PIN
- Something you have, such as a smart card or an identification device
- Something physically unique to you, such as your fingerprints or retinal pattern

Systems authenticate each other using similar methods. Frequently, systems pass private information between each other to establish identity. Once authentication has occurred, the two systems can communicate in the manner specified in the design.

Several common methods are used for authentication. Each has advantages and disadvantages that must be considered when you’re evaluating authentication schemes or methods.

Username/Password

A username and password are unique identifiers for a logon process. When users sit down in front of a computer system, the first thing a security system requires is that they establish who they are. Identification is typically confirmed through a logon process. Most operating systems use a user ID and password to accomplish this. These values can be sent across the connection as plain text or can be encrypted.

The logon process identifies to the operating system, and possibly the network, that you are who you say you are. Figure 1.3 illustrates this logon and password process. Notice that the operating system compares this information to the stored information from the security processor and either accepts or denies the logon attempt. The operating system may establish privileges or permissions based on stored data about that particular ID.

**Figure 1.3** A logon process occurring on a workstation
Password Authentication Protocol (PAP)

Password Authentication Protocol (PAP) offers no true security, but it’s one of the simplest forms of authentication. The username and password values are both sent to the server as clear text and checked for a match. If they match, the user is granted access; if they don’t match, the user is denied access. In most modern implementations, PAP is shunned in favor of other, more secure, authentication methods.

Challenge Handshake Authentication Protocol (CHAP)

Challenge Handshake Authentication Protocol (CHAP) challenges a system to verify identity. CHAP doesn’t use a user ID/password mechanism. Instead, the initiator sends a logon request from the client to the server. The server sends a challenge back to the client. The challenge is encrypted and then sent back to the server. The server compares the value from the client and, if the information matches, grants authorization. If the response fails, the session fails, and the request phase starts over. Figure 1.4 illustrates the CHAP procedure. This handshake method involves a number of steps and is usually automatic between systems.

Certificates

Certificates are another common form of authentication. A server or certificate authority (CA) can issue a certificate that will be accepted by the challenging system. Certificates can be either physical access devices, such as smart cards, or electronic certificates that are used as part of the logon process. A Certificate Practice Statement (CPS) outlines the rules used for issuing and managing certificates. A Certificate Revocation List (CRL) lists the revocations that must be addressed (often due to expiration) in order to stay current.

Figure 1.4 CHAP authentication

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This chapter provides only an overview of certificates. Certificates, along with Public-Key Infrastructure (PKI) and related topics, are discussed in detail in Chapters 7, “Cryptography Basics and Methods,” and Chapter 8, “Cryptography Standards.”

A simple way to think of certificates is like hall passes at school. Figure 1.5 illustrates a certificate being handed from the server to the client once authentication has been established. If you have a hall pass, you can wander the halls of your school. If your pass is invalid, the hallway monitor can send you to the principal’s office. Similarly, if you have a certificate, then you can prove to the system that you are who you say you are and are authenticated to work with the resources.

Security Tokens

Security tokens are similar to certificates. They contain the rights and access privileges of the token bearer as part of the token. Think of a token as a small piece of data that holds a sliver of information about the user.

Many operating systems generate a token that is applied to every action taken on the computer system. If your token doesn’t grant you access to certain information, then either that information won’t be displayed or your access will be denied. The authentication system creates a token every time a user connects or a session begins. At the completion of a session, the token is destroyed. Figure 1.6 shows the security token process.

Kerberos

Kerberos is an authentication protocol named after the mythical three-headed dog that stood at the gates of Hades. Originally designed by MIT, Kerberos is becoming very popular as an authentication method. It allows for a single sign-on to a distributed network.

**Figure 1.5** A certificate being issued once identification has been verified
Comprehending the Security Process

**FIGURE 1.6** Security token authentication

Kerberos authentication uses a *Key Distribution Center (KDC)* to orchestrate the process. The KDC authenticates the *principle* (which can be a user, a program, or a system) and provides it with a ticket. Once this ticket is issued, it can be used to authenticate against other principles. This occurs automatically when a request or service is performed by another principle.

Kerberos is quickly becoming a common standard in network environments. Its only significant weakness is that the KDC can be a single point of failure. If the KDC goes down, the authentication process will stop. Figure 1.7 shows the Kerberos authentication process and the ticket being presented to systems that are authorized by the KDC.

**Multi-Factor Authentication**

When two or more access methods are included as part of the authentication process, you’re implementing a *multi-factor* system. A system that uses smart cards and passwords is referred to as a *two-factor authentication* system. Two-factor authentication is shown in Figure 1.8. This example requires both a smart card and a logon password process.

**Smart Cards**

A *smart card* is a type of badge or card that gives you access to resources including buildings, parking lots, and computers. It contains information about your identity and access privileges. Each area or computer has a card scanner or a reader in which you insert your card.

Figure 1.9 depicts a user inserting a smart card into a reader to verify identity. The reader is connected to the workstation and validates against the security system. This increases the security of the authentication process because you must be in physical possession of the smart card to use the resources. Of course, if the card is lost or stolen, the person who finds the card can access the resources allowed by the smart card.
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**FIGURE 1.7** Kerberos authentication process

1. User requests access to service running on a different server.
2. KDC authenticates user and sends a ticket to be used between the user and the service on the server.
3. User’s workstation sends a ticket to the service.

**FIGURE 1.8** Two-factor authentication

Both factors must be valid:
- User ID and Password
- Smart Card
Biometrics

*Biometric devices* use physical characteristics to identify the user. Such devices are becoming more common in the business environment. Biometric systems include hand scanners, retinal scanners, and soon, possibly, DNA scanners. In order to gain access to resources, you must pass a physical screening process. In the case of a hand scanner, this may include fingerprints, scars, and markings on your hand. Retinal scanners compare your eye’s retinal pattern to a stored retinal pattern to verify your identity. DNA scanners will examine a unique portion of your DNA structure in order to verify that you are who you say you are.

**Authentication Issues to Consider**

You can set up many different parameters and standards to force the people in your organization to conform. In establishing these parameters, it’s important that you consider the capabilities of the people who will be working with these policies. If you’re working in an environment where people aren’t computer savvy, you may spend a lot of time helping them remember and recover passwords. Many organizations have had to re-evaluate their security guidelines after they’ve already gone to great time and expense to implement high-security systems.

Setting authentication security, especially in supporting users, can become a high-maintenance activity for network administrators. On one hand, you want people to be able to authenticate themselves easily; on the other hand, you want to establish security that protects your company’s resources.

Be wary of popular names or current trends that make certain passwords predictable. For example, during the first release of *Star Wars*, two of the most popular passwords used on college campuses were C3PO and R2D2. This created a security problem for campus computer centers.
Understanding Networking Services and Protocols

Many services and protocols are available for computer users to utilize. Web, mail, and other protocols facilitate communications between systems. Each protocol or service you support in a computer network opens increased vulnerabilities and potential security problems.

Every day, someone finds a new vulnerability in the commonly used services and protocols in computer systems and networks. This makes it extremely important to identify non-essential protocols and services that may be running on your systems and to remove them from the network.

The following sections present a few of the common protocols and explain why services and protocols are such a key part of security.

### Common Protocols and Services

If your environment is like most, you’ll need to offer several protocols for your users. Some of the more common protocols you should offer include mail, Web, Internet access, and some control protocols. Offering these services is normal in an Internet-enabled environment:

- **Mail**: Most customers will want to enable e-mail systems for use in an organization. This means your security plan must include support for both inbound and outbound e-mail traffic. Several ports are used in the e-mail process, depending on the software in use. E-mail topics, including its vulnerabilities, are addressed in Chapter 3, “Infrastructure and Connectivity.”

- **Web**: Many businesses are implementing web-based strategies for communications. These strategies include a server-based product and a client-based product (a browser). Browsers can

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### Multi-Factor Authentication and Security

The owner of your company is becoming increasingly concerned about computer security and the laxness of users. She reports that users are regularly leaving the office at the end of the day without signing out of their accounts. The company is attempting to win a contract that involves working with the government and that will require additional security measures. What would you suggest to the owner?

The best suggestion is to consider implementing a multi-factor authentication system. This system could consist of a smart card and a logon/password process. Most smart card readers can be configured to require that the card remain inserted in the reader while the user is logged on. If the smart card is removed, say at the end of the day, the workstation will automatically log the user out. By requiring a logon/password process, you can still provide security if the smart card is stolen.

This solution provides reasonable security, and it doesn’t significantly increase security costs. The government will probably require additional access control, such as perimeter alarms and physical access control to sensitive areas. However, these measures won’t force users to log out when they leave their workstations.
communicate with services using several ports. These ports allow information to be sent and received by the client or server. Chapter 3 looks at the Web and the various protocols it uses, as well as its vulnerabilities.

**Telnet**  
Telnet is a service that allows remote users to access a system using terminal emulation. Telnet is becoming less common today, but it’s still in use on a large scale. Telnet connections are generally unsecured and unprotected and should be shunned where possible in favor of similar utilities that offer more security.

**File Transfer Protocol (FTP)**  
FTP is used extensively on the Internet. FTP sessions aren’t encrypted, and many FTP implementations don’t encrypt the logon or passwords at the beginning of the session. Many Unix systems also allow for an anonymous version of FTP to run, Trivial File Transfer Protocol (TFTP), and its use should be guarded at all costs. File transfers are examined in more detail in Chapter 3.

**Network News Transfer Protocol (NNTP)**  
NNTP allows employees to access news servers over the Internet. This is accomplished by sending messages to and receiving messages from Usenet servers that store and forward messages. More than 20,000 Usenet forums, or newsgroups, are in use.

**Domain Name Service (DNS)**  
DNS is used to resolve system names to Internet addresses. It’s a common service and in use on most networks. If you have a website to advertise your products or services, DNS allows you tell external users where your server is located. DNS translates web addresses, such as www.sybex.com, to TCP/IP addresses, such as 192.168.0.110.

**Instant Messaging (IM)**  
Instant messaging is a form of immediate e-mail that takes place between two or more users. IM clients are often prone to hostile code (usually in the form of file transfers) and subject to social engineering attacks, wherein a hacker plays upon the culpability of a user to get what they need.

**Internet Control Message Protocol (ICMP)**  
ICMP provides network messaging tools, such as Ping. Ping is a utility that allows you to verify whether a system is reachable or up by echoing packets to it. ICMP makes many aspects of communications easier in the Internet environment.

### Nonessential Protocols and Services to Avoid

Many networks support a large number of protocols and services for information access. Nonessential protocols should be disabled or turned off, including services and protocols that are inherently unsecured.

The best approach to take when addressing this issue is to determine which services are required for the functionality you needed and then to disable all others.

Following is a partial list of services that, as a general rule, shouldn’t be offered on your primary servers:

- NetBIOS services
- Unix Remote Procedure Call (RPC)
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- Network File System (NFS)
- X Windows services
- R services, such as rlogin and rexec
- Telnet
- FTP
- TFTP
- NetMeeting
- Remote control systems
- Simple Network Management Protocol (SNMP)

These protocols aren’t recommended because they send passwords over the network unencrypted, they have little if any security capability, or they expose the system to vulnerabilities because of the very nature of the activities they perform. Later chapters discuss these protocols in more detail.

Distinguishing Between Security Topologies

The security topology of your network defines the network design and implementation from a security perspective. Unlike a network topology, here we’re concerned with access methods, security, and technologies used. Security topology covers four primary areas of concern:

- Design goals
- Security zones
- Technologies
- Business requirements

Setting Design Goals

The design goals of a security topology must deal with issues of confidentiality, integrity, availability, and accountability, all four of which are discussed continually throughout this book as they apply to various topics. Addressing these four issues as an initial part of your network design will help you ensure tighter security. You’ll often see confidentiality, integrity, and availability referred to as the CIA of network security, but the accountability component is equally important—design goals must identify who is responsible for the various aspects of computer security. The next few sections introduce these four security components.

Confidentiality

The goal of confidentiality is to prevent or minimize unauthorized access to and disclosure of data and information. In many instances, laws and regulations require specific information
confidentiality. For example, Social Security records, payroll and employee records, medical records, and corporate information are high-value assets. This information could create liability issues or embarrassment if it fell into the wrong hands. Over the last few years, there have been a number of cases in which bank account and credit card numbers were published on the Internet. The costs of these types of breaches of confidentiality far exceed the actual losses from the misuse of this information.

Confidentiality entails ensuring that data expected to remain private is seen only by those who should see it. Confidentiality is implemented through authentication and access controls.

If you address confidentiality issues early in the design phase, the steps that must be taken to minimize this exposure will become clear.

Integrity
The goal of integrity is to make sure that the data being worked with is the correct data. Information integrity is critical to a secure topology. Organizations work with and make decisions using the data they have available. If this information isn’t accurate or is tampered with by an unauthorized person, the consequences can be devastating.

Take the case of a school district that lost all the payroll and employment records for the employees in the district. When the problem was discovered, the school district had no choice but to send out applications and forms to all the employees, asking them how long they had worked in the school district and how much they were paid. Integrity was jeopardized because the data was vulnerable and then lost.

You can think of integrity as the level of confidence you have that the data is what it’s supposed to be—untampered with and unchanged. Authentic, complete, and trustworthy are often used to describe integrity in terms of data.

Availability
The goal of availability is to protect data and prevent its loss. Data that can’t be accessed is of little value. If a mishap or attack brings down a key server or database, that information won’t be available to the people who need it. This can cause havoc in an organization. Your job is to provide maximum availability to your users while ensuring integrity and confidentiality. The hardest part of this process is determining what balance of these three aspects must be maintained to provide acceptable security for the organization’s information and resources.

The key to availability is that the data must be available when it’s needed and accessible by those who need it.
In Exercise 1.4, you'll compute data availability.

**EXERCISE 1.4**

**Compute Availability**

Availability is often expressed in terms of *uptime*. High availability strives for 99.9999% uptime over the course of the year (24 hours a day, 7 days a week, 365 days a year). For this exercise, compute how long data wouldn't be available over the course of the year with the following availability percentages. For example, with 98% uptime, there is a 2% downtime of the 525,600 minutes in a year. That means the data would be down for 10,512 minutes, or 7-1/3 days! Try your math on the following:

1. 99%
2. 99.9%
3. 99.99%
4. 99.999%
5. 99.9999%

The increments may seem small, but over the course of a year they represent a significant difference in the amount of time data is and isn’t available.

**Accountability**

The final and often overlooked goal of design concerns *accountability*. Many of the resources used by an organization are shared between departments and individuals. If an error or incident occurs, who is responsible for fixing it? Who determines whether information is correct?

It’s a good idea to be clear about who owns the data or is responsible for making sure that it’s accurate. You should also be able to track and monitor data changes to detect and repair the data in the event of loss or damage. Most systems will track and store logs on system activities and data manipulation, and they will also provide reports on problems.

**Creating Security Zones**

Over time, networks can become complex beasts. What may have started as a handful of computers sharing resources can quickly grow to something resembling an electrician’s nightmare. The networks may even appear to have lives of their own. It’s common for a network to have connections between departments, companies, countries, and public access using private communication paths and through the Internet.

Not everyone in a network needs access to all the assets in the network. The term *security zone* describes design methods that isolate systems from other systems or networks. You can isolate networks from each other using hardware and software. A router is a good example of
a hardware solution: You can configure some machines on the network to be in a certain address range and others to be in a different address range. This separation makes the two networks invisible to each other unless a router connects them. Some of the newer data switches also allow you to partition networks into smaller networks or private zones.

When discussing security zones in a network, it’s helpful to think of them as rooms. You may have some rooms in your house or office that anyone can enter. For other rooms, access is limited to specific individuals for specific purposes. Establishing security zones is a similar process in a network: Security zones allow you to isolate systems from unauthorized users. Here are the four most common security zones you’ll encounter:

- Internet
- Intranet
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- Extranet
- Demilitarized zone (DMZ)

The next few sections identify the topologies used to create security zones to provide security. The Internet has become a boon to individuals and to businesses, but it creates a challenge for security. By implementing intranets, extranets, and DMZs, you can create a reasonably secure environment for your organization.

The Internet

The Internet is a global network that connects computer and individual networks. The Internet can be used by anybody who has access to an Internet portal or an Internet Service Provider (ISP). In this environment, you should have a low level of trust in the people who use the Internet. You must always assume that the people visiting your website may have bad intentions; they may want to buy your product, hire your firm, or bring your servers to a screaming halt.Externally, you have no way of knowing until you monitor their actions. Because the Internet involves such a high level of anonymity, you must always safeguard your data with the utmost precautions.

Figure 1.10 illustrates an Internet network and its connections.

Intranets

Intranets are private networks implemented and maintained by an individual company or organization. You can think of an intranet as an Internet that doesn’t leave your company; it’s internal to the company, and access is limited to systems within the intranet. Intranets use the same technologies used by the Internet. Intranets can be connected to the Internet but can’t be accessed by users who aren’t authorized to be part of the intranet; the anonymous user of the Internet is instead an authorized user of the intranet. Access to the intranet is granted to trusted users inside the corporate network or to users in remote locations.

Figure 1.11 displays an intranet network.
Extranets

Extranets extend intranets to include outside connections to partners. The partners can be vendors, suppliers, or similar parties who need access to your data for legitimate reasons. An extranet allows you to connect to a partner via a private network or a connection using a secure communications channel using the Internet. Extranet connections involve connections between trustworthy organizations.

An extranet is illustrated in Figure 1.12. Note that this network provides a connection between the two organizations. This connection may be through the Internet; if so, these networks would use a tunneling protocol to accomplish a secure connection.
Demilitarized Zone (DMZ)

A demilitarized zone (DMZ) is an area where you can place a public server for access by people you might not trust otherwise. By isolating a server in a DMZ, you can hide or remove access to other areas of your network. You can still access the server using your network, but others aren’t able to access further network resources. This can be accomplished using firewalls to isolate your network.

When establishing a DMZ, you assume that the person accessing the resource isn’t necessarily someone you would trust with other information. Figure 1.13 shows a server placed in a DMZ. Notice that the rest of the network isn’t visible to external users. This lowers the threat of intrusion in the internal network.

Anytime you want to separate public information from private information, a DMZ is an acceptable option.

The easiest way to create a DMZ is to use a firewall that can transmit in three directions: to the internal network, to the external world (Internet), and to the public information you’re sharing (the DMZ). From there, you can decide what traffic goes where; for example, HTTP traffic would be sent to the DMZ, and e-mail would go to the internal network.

Designing Security Zones

Security zone design is an important aspect of computer security. You can use many different approaches to accomplish a good solid design. Some of the design tradeoffs involve risk and money. You can create layers of security to protect systems from less secure connections, and you can use Network Address Translation (discussed in the next section) to hide resources. New methods and tools to design secure networks are being introduced on a regular basis. It’s important to remember that once you have a good security design, you should revisit it on a regular basis based on what you learn about your security risks.

**Figure 1.13** A typical DMZ
Working with Newer Technologies

One of the nice things about technology is that it’s always changing. One of the bad things about technology is that it’s always changing. Several relatively new technologies have become available to help you create a less vulnerable system. The three technologies this section will focus on are virtual local area networks (VLANs), Network Address Translation (NAT), and tunneling. These technologies allow you to improve security in your network at little additional cost.

Virtual Local Area Networks (VLANs)

A virtual local area network (VLAN) allows you to create groups of users and systems and segment them on the network. This segmentation lets you hide segments of the network from other segments and thereby control access. You can also set up VLANs to control the paths that data takes to get from one point to another. A VLAN is a good way to contain network traffic to a certain area in a network.

Think of a VLAN as a network of hosts that act as if they’re connected by a physical wire even though there is no such wire between them.

On a LAN, hosts can communicate with each other through broadcasts, and no forwarding devices, such as routers, are needed. As the LAN grows, so too does the number of broadcasts. Shrinking the size of the LAN by segmenting it into smaller groups (VLANs) reduces the size of the broadcast domains. The advantages of doing this include reducing the scope of the broadcasts, improving performance and manageability, and decreasing dependence on the physical topology. From the standpoint of this exam, however, the key benefit is that VLANs can increase security by allowing users with similar data sensitivity levels to be segmented together.

Figure 1.14 illustrates the creation of three VLANs in a single network.

Network Address Translation (NAT)

Network Address Translation (NAT) creates a unique opportunity to assist in the security of a network. Originally, NAT extended the number of usable Internet addresses. Now it allows an organization to present a single address to the Internet for all computer connections. The NAT server provides IP addresses to the hosts or systems in the network and tracks inbound and outbound traffic.

A company that uses NAT presents a single connection to the network. This connection may be through a router or a NAT server. The only information that an intruder will be able to get is that the connection has a single address.

NAT effectively hides your network from the world, making it much harder to determine what systems exist on the other side of the router. The NAT server effectively operates as a firewall for the network. Most new routers support NAT translation; it provides a simple inexpensive firewall for small networks.

It’s important to understand that NAT acts as a proxy between the local area network (which can be using private IP addresses) and the Internet. Not only can NAT save IP addresses, but it can also act as a firewall.
Most NAT implementations assign internal hosts private IP address numbers and use public addresses only for the NAT to translate to and communicate with the outside world. The private address ranges are:

- 10.0.0.0—10.255.255.255
- 172.16.0.0—172.31.255.255
- 192.168.0.0—192.168.255.255

Figure 1.15 shows a router providing NAT services to a network. The router presents a single address for all external connections on the Internet.

**Tunneling**

*Tunneling* refers creating a virtual dedicated connection between two systems or networks. You create the tunnel between the two ends by encapsulating the data in a mutually-agreed-upon protocol for transmission. In most tunnels, the data passed through the tunnel appears at the other side as part of the network.
Tunneling protocols usually include data security as well as encryption. Several popular standards have emerged for tunneling; these protocols are covered in greater depth in Chapter 3, “Infrastructure and Connectivity.”

Tunneling sends private data across a public network by placing (encapsulating) that data into other packets. Most tunnels are virtual private networks (VPNs).

Figure 1.16 shows a connection being made between two networks across the Internet. To each end of the network, this appears to be a single connection.
Business Concerns to Be Aware Of

An organization or business is well served if it makes a conscious examination of its security situation. This examination includes identifying assets, doing a comprehensive risk assessment, identifying threats, and evaluating vulnerabilities. These four components will help the business principals understand what they’re up against and how to cost-effectively address these issues.

The following sections explain the various business requirements you need to address when designing a security topology. The failure to consider any one of these aspects can cause the entire design to be flawed and ineffective.

Asset Identification

Every business or organization has valuable assets and resources. These assets must be accounted for, both physically and functionally. Asset identification is the process in which a company attempts to place a value on the information and systems it has in place. In some cases, the process may be as simple as counting systems and software licenses. These types of physical asset evaluations are part of the normal accounting procedures a business must perform routinely.

The more difficult part of an asset identification process is attempting to assign values to information. In some cases, you may only be able to determine what would happen if the information were to become unavailable or be lost. If absence of this information would effectively shut down the business, the information is priceless. If you have this type of information, determining which methods and approaches you should take to safeguard it becomes easier.

You wouldn’t necessarily assign the same value to the formula for Coca-Cola that you’d to your mother’s chicken and rice recipe. The Coke formula would be worth a fortune to a person who stole it; they could sell it to competitors and retire. Your mother’s recipe would make a nice dinner, but it wouldn’t be valuable from a financial perspective.
In Exercise 1.5, you’ll assign a value to the data on your network.

**EXERCISE 1.5**

**Assign a Value to Data Assets**

For this exercise, think of yourself as a collection of data elements. Some of the data about you, such as your last name, isn’t of great value since it’s known by almost everyone you come into contact with. Other data, such as your Social Security number, should be closely guarded and is worth more than your name, because you stand to lose more if it falls into the wrong hands. See if you can assign a value to each of these items and rank which is worth the most according to what would be most harmful in the hands of a miscreant:

1. Full name
2. Birth date
3. Telephone number
4. Passport number

If this data were spread across a number of databases on a computer system, you would naturally want to assign higher value to the databases containing the most sensitive data and then take more drastic steps to protect them than those containing generic information.

**Risk Assessment**

There are several ways to perform a risk assessment or risk analysis. They range from highly scientific formula-based methods to a conversation with the owner. In general, you should attempt to identify the costs of replacing stolen data or systems, the costs of downtime, and virtually any risk factor you can imagine.

You can move to risk assessment only after completing the asset identification. Once you know that databases containing information from freely available sources (such as the U.S. Census) can always be re-created if need be and shouldn’t be viewed in the same light as those containing business-specific data, you can start computing costs.

After you’ve determined the costs, you can then evaluate the likelihood that certain types of events will occur and the most likely outcome if they do occur. If you work in New York City, what is the likelihood of damage to your business from an earthquake? Will your risk assessment place the high probability of an earthquake on your list of primary concerns?

**Threat Identification**

Implementing a security policy requires that you evaluate the risks of both internal and external threats to the data and network. It does little good to implement a high-security environment to protect your company from the outside if the threat is mostly internal. If a member of your team brings a disk containing a virus into the office and loads it onto a computer, the virus may
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spread throughout the entire network and effectively be immune to your external security measures. This is a common problem in schools, libraries, and environments where people regularly use shared resources. If a library offers computers for public use, and those computers are in a network, a virus could infect all of the systems throughout the network. External security measures won’t prevent potential damage or data loss.

Internal threats also include employee fraud, abuse or alteration of data, and theft of property. These threats require that both policies and systems be put into place to detect and mitigate these possibilities. Investigating and making recommendations to management on procedural changes and policies is a key role for computer security professionals. Figure 1.17 depicts some examples of internal and external threats.

**Internal Threats**
Most well publicized internal threats involve financial abuses. Some of these abuses are outright fraud or theft. These types of threats, especially in a computer-intensive environment, can be difficult to detect and investigate. These threats are typically ongoing and involve small transactions over long periods. A recent incident of fraud that occurred in a large software manufacturer involved an accounting professional who generated bogus checks in payment for work that never occurred. Over a few months, this employee was able to make over $100,000 in fraudulent payments to companies that she or relatives had created. It took considerable investigation by computer and financial auditors to determine how this theft occurred. From a computer security perspective, this was an internal threat that was the result of failures in financial, operational, and computer security controls. These types of incidents probably occur more frequently than anyone wants to admit, and many times more often than anyone becomes aware of.

**Figure 1.17** Internal and external threats to an organization
Another incident involved an employee who was using corporate computer resources to operate a financial accounting service. This employee had been running this business for several years. When the company found out, it immediately fired the employee and confiscated his records. During the investigation, the process used to collect evidence inadvertently tainted it. The chain of evidence in this case was broken. When the employee went to court over this situation, his attorney was able to have the evidence thrown out of court. Even though the employee was clearly guilty, the judge dismissed the case due to a lack of admissible evidence. The employee then sued the company for wrongful discharge, harassment, and several other charges. He won those suits, and he got his old job back. In this instance, the internal policies and systems put into place to detect, investigate, and correct the problem broke down. It cost the company a huge amount of money and allowed a known embezzler back into the company.

We’ll discuss chains of evidence, incident response, and the proper way to conduct investigations later in the book. For now, it’s important to know that finding and dealing with internal threats is a key aspect of the computer security job.

**External Threats**

Many of the internal threats that a company must deal with involve procedures and methods that are standard across industries. *External threats*, on the other hand, are increasing at an alarming rate. A few years ago, most computer incidents were caused by groups of kids or hobbyists who were primarily in it for fun. Most of the time, these incidents were not intentionally malicious in nature. A few of them did involve alteration or destruction of data and records.

Today, many companies use online databases, take orders, process payments, track shipments, manage inventory, and administer other key information using complicated systems. These systems are connected to other systems that contain private corporate records, trade secrets, strategic plans, and many other types of valuable information.

Unfortunately, when these systems are compromised, an entire business or industry can be compromised. Incidents have occurred where security breaches remained open for years, and the companies involved had no knowledge that a compromise ever took place. One of a professional criminal’s greatest joys is creating and exploiting this type of security breach.

Early methods of cracking systems were primitive and labor intensive. Today, software packages exist that find targets automatically and then systematically attack the targets to find their vulnerabilities. Many of these tools use graphical user interfaces that require little technical expertise on the part of the would-be hacker. Many computer systems are being repeatedly and methodically attacked by the curious or by criminals attempting to commit a crime.

The job of a computer security professional in this situation is to detect the attack, find ways to counter it, and assist law-enforcement personnel in investigating the activity. This type of work is interesting and involves many of the skills you’ll learn in this book.

**Vulnerabilities**

A computer security specialist’s main area of concern will probably revolve around the security capabilities of the software and systems used in the business. Until recently, many operating system manufacturers only paid lip service to security. One popular operating system used a logon
and password scheme for security. When the logon prompt occurred, all you had to do was click the Cancel button, and the system would provide most of the network capabilities and local access to all resources. If the screensaver was password protected, you could either enter the password to unlock the system or reboot the computer to have the system be unsecure. This was worse than having no security. Many users thought they had a secure computer system, but they didn’t—and many thefts of data by coworkers occurred as a result.

The Transmission Control Protocol/Internet Protocol (TCP/IP) network protocol used by most corporate networks was designed to allow communications in a trustful environment. This protocol was primarily experimental and was used by schools and governmental agencies for research. Although it’s robust in its error handling, by its nature it’s unsecured. Many modern network attacks occur through the TCP/IP protocol. Chapter 2, “Know Your Enemy,” discusses TCP/IP and the security issues associated with it. Unfortunately, TCP/IP is still more secure than many of the other protocols installed on PC networks today.

Operating systems and applications programs have long been vulnerable to external and internal attacks. Software companies want to sell software that is easy to use, graphically driven, and easily configured. Users want the same thing. Unfortunately, this creates additional security problems in many networks.

One of the most popular products in use today allows e-mail and attachments to begin executing programs or instructions embedded in a message. This functionality allows e-mail messages to have fancy formatting, but it also lets e-mails carry viruses that can damage networks or spread to other networks. The manufacturer of this software is now releasing security updates, but it seems that every time they introduce a security update, someone comes up with a new way around it.

Many operating system manufacturers are completely rethinking security measures. They’ve recognized that the products they produce can’t protect the companies that use them from data loss or abuse. It has become such a problem for many customers that security support is now made available by most operating system and network software manufacturers. In the past, software manufacturers hid security vulnerabilities; now those vulnerabilities are published, and solutions are provided as soon as a vulnerability is discovered. Of course, this situation helps hackers who know that these changes won’t be made on many computer systems for a while.

In the most basic sense, progress is the computer security expert’s worst nightmare. As a Security+ holder, you’re part of the team that must evaluate threats to the systems currently installed.

Summary

In this chapter, we covered the key elements that an information security specialist should consider. Every organization has a different set of priorities and a different focus when it comes to security. Your responsibility is to take this information and create or maintain a security-oriented environment to address these priorities and concerns.
The primary areas of responsibility you'll encounter include:

- Physical security
- Operational security
- Management and policies

You should consider actions that you perform in this environment to accomplish one or more of the goals of information security:

- Prevention
- Detection
- Response

Security is a set of processes and products. In order for a security program to be effective, all of its parts must work and be coordinated by the organization. This includes:

- Antivirus software
- Access control
- Authentication

Typically, your network will run many different protocols and services. These protocols allow connections to other networks and products. However, they also create potential vulnerabilities that must be understood. You must work to find ways to minimize the vulnerabilities. Many protocols and services offered by modern operating systems are highly vulnerable to attack. New methods of attacking these systems are developed every day.

Security topologies provide a mechanism to design networks that have multiple ways of implementing security. Design goals for a security topology must address these four areas of security to be effective:

- Confidentiality
- Integrity
- Availability
- Accountability

Your network can be made more secure by considering the impact of security zones and access. Here are the three most common security zones you'll encounter in the workplace:

- Internets
- Intranets
- Extranets

You can improve the likelihood of a successful security implementation if you consider putting externally accessed servers into areas called DMZs.

Your network can take advantage of several technologies to minimize your network’s risk of being compromised. These technologies include:

- VLANs
- NAT
- Tunneling
The final part of this chapter discussed business requirements in a security environment. These requirements include:

- Identifying assets
- Assessing risks
- Identifying threats
- Evaluating vulnerabilities

### Exam Essentials

**Be able to describe the various aspects of information security.** Ensuring a secure network involves good design, implementation, and maintenance. The information in your organization is potentially vulnerable to both internal and external threats. Identify these threats and create methods of countering them before they happen.

**Be able to identify the potential physical, operational, and management policy decisions that affect your information security efforts.** It isn’t good enough to have a plan if the plan is unsound or has gaping holes. You must make sure that the plans you develop and the procedures you follow to ensure security make sense for the organization and are effective in addressing the organization’s needs.

**Be able to explain the relative advantages of the technologies available to you for authentication.** You have many tools available to establish authentication processes. Some of these tools start with a password and user ID. Others involve physical devices or the physical characteristics of the person who is requesting authentication. This area is referred to as I&A.

**Be able to explain the relative capabilities of the technologies available to you for network security.** In most situations, you can create virtual LANs, create connections that are encrypted, and isolate high-risk assets from low-risk assets. You can do so using tunneling, DMZs, and network segmenting.

**Be able to identify and describe the goals of information security.** The three primary goals of information security are prevention, detection, and response. Your policies and systems must include these three aspects in order to be effective. Ideally, you want to prevent a security breach. If a breach happens, you should have methods to detect and respond to them as quickly as possible.

**Be able to describe the processes and mechanisms that can be used to implement a secure environment.** Antivirus software, access control, and authentication are the three primary methods you have to implement a secure environment.

**Be able to identify the various access control methods used in systems and networks.** Three primary access control methods are used in computer systems today: MAC, DAC, and RBAC. The MAC method establishes all connections and relationships between users statically. The DAC method allows the user to have some control over what information and resources are accessible. The RBAC method sets access levels and permissions based on the role the user plays in a particular situation or job.
Be able to identify which services and protocols should be offered and which should not. Many protocols and services offered in modern operating systems offer little if any security. These protocols and services may also be vulnerable to attack or offer no encryption in the logon process. Services that should be offered include only those that are necessary for legitimate business needs.

Be able to identify the design goals of any security topology. The design goals of a security topology must take into consideration the need for confidentiality, integrity, and availability. These three aspects are called the CIA of security topology. Additionally, you must consider issues of accountability. Who owns the data or is responsible for verifying that it is accurate?

Be able to identify the characteristics of the three types of commonly used security zones. The three common security zones in place are the Internet, intranets, and extranets. The Internet offers low security. Intranets are considered high security, and extranets may be low to high security. Any time you connect your network to another network, you increase the vulnerability of your network. One of the primary tools you can use to isolate less secure resources from more secure resources is a DMZ.

Be able to identify the differences and characteristics of the technologies available to you. A network can be segmented and VLANs can be created to improve security. NAT presents only one Internet address to the world, hiding the other elements of the network. Tunneling allows you to make relatively secure connections to other networks using the Internet.

Be able to identify the four business requirements of a network security design. Asset Identification, Risk Assessment, Threat identification, and Vulnerabilities are the four primary business requirements that must be considered in a security design.
Review Questions

1. Of the following types of security, which would be primarily concerned with someone stealing the server from the premises?
   A. Physical security
   B. Operational security
   C. Management and policy
   D. Authentication

2. Upper management has suddenly become concerned about security. As the senior network administrator, you are asked to suggest changes that should be implemented. Which of the following access methods should you recommend if the method is to be one that is primarily based on preestablished access and can’t be changed by users?
   A. MAC
   B. DAC
   C. RBAC
   D. Kerberos

3. Your office administrator is being trained to perform server backups. Which authentication method would be ideal for this situation?
   A. MAC
   B. DAC
   C. RBAC
   D. Security tokens

4. You’ve been assigned to mentor a junior administrator and bring him up to speed quickly. The topic you’re currently explaining is authentication. Which method uses a KDC to accomplish authentication for users, programs, or systems?
   A. CHAP
   B. Kerberos
   C. Biometrics
   D. Smart cards

5. Which authentication method sends a challenge to the client that is encrypted and then sent back to the server?
   A. Kerberos
   B. PAP
   C. DAC
   D. CHAP
6. After a careful risk analysis, the value of your company’s data has been increased. Accordingly, you’re expected to implement authentication solutions that reflect the increased value of the data. Which of the following authentication methods uses more than one authentication process for a logon?
   A. Multi-factor
   B. Biometrics
   C. Smart card
   D. Kerberos

7. Which of the following services or protocols should be avoided in a network if possible in order to increase security?
   A. E-mail
   B. Telnet
   C. WWW
   D. ICMP

8. After acquiring another company, your organization is in a unique position to create a new—much larger—network from scratch. You want to take advantage of this reorganization to implement the most secure environment that users, and managers, can live with. You’ve already decided that the only way this will be possible is to implement security zones. Which of the following isn’t an example of a type of security zone?
   A. Internet
   B. Intranet
   C. Extranet
   D. NAT

9. Which of the following protocols allows an organization to present a single TCP/IP address to the Internet while utilizing private IP addressing across the LAN?
   A. NAT
   B. VLAN
   C. DMZ
   D. Extranet

10. You’re the administrator for Mercury Technical. Due to several expansions, the network has grown exponentially in size within the past two years. Which of the following is a popular method for breaking a network into smaller private networks that can coexist on the same wiring and yet be unaware of each other?
    A. VLAN
    B. NAT
    C. MAC
    D. Security zone
11. Of the following services, which one would be most likely to utilize a retinal scan?
   A. Auditing
   B. Authentication
   C. Access control
   D. Data confidentiality

12. One of the vice presidents of the company calls a meeting with information technology after a recent trip to competitors’ sites. She reports that many of the companies she visited granted access to their buildings only after fingerprint scans, and she wants similar technology employed at this company. Of the following, which technology relies on a physical attribute of the user for authentication?
   A. Smart card
   B. Biometrics
   C. Mutual authentication
   D. Tokens

13. Which technology allows a connection to be made between two networks using a secure protocol?
   A. Tunneling
   B. VLAN
   C. Internet
   D. Extranet

14. A new director of information technology has been hired and you report directly to him. At the first meeting, he assigns you the task of identifying all the company resources that IT is responsible for and assigning a value to each. The process of determining the value of information or equipment in an organization is referred to as which of the following?
   A. Asset identification
   B. Risk assessment
   C. Thread identification
   D. Vulnerabilities scan

15. You have been asked to address a management meeting and present the types of threats your organization could face from hackers. Which of the following would best categorize this type of information?
   A. Asset identification
   B. Risk assessment
   C. Threat identification
   D. Vulnerabilities
16. Over the years, your company has upgraded its operating systems and networks as it has grown. A recent survey shows that numerous databases on the network haven’t been accessed in more than a year. Unfortunately, the survey doesn’t identify who created or last accessed those databases. What is the process of determining who owns a particular database file called?
   A. Auditing
   B. Access control
   C. Threat analysis
   D. Accountability

17. A user just complained to you that his system has been infected with a new virus. Which of the following would be a first step to take in addressing and correcting this problem?
   A. Verifying the most current virus definition file is installed
   B. Reformatting the hard disk
   C. Reinstalling the operating system
   D. Disabling the user’s e-mail account

18. You’re awakened in the middle of the night by a frantic junior administrator. The caller reports that the guest account—which you have forbidden anyone to use—suddenly logged in and out of the network, and the administrator believes an attack occurred. Which of the following would be the most useful in determining what was accessed during an external attack?
   A. System logs
   B. Antivirus software
   C. Kerberos
   D. Biometrics

19. You want to install a server in the network area that provides web services to Internet clients. You don’t want to expose your internal network to additional risks. Which method should you implement to accomplish this?
   A. Install the server in an intranet.
   B. Install the server in a DMZ.
   C. Install the server in a VLAN.
   D. Install the server in an extranet.

20. Your company provides medical data to doctors from a worldwide database. Because of the sensitive nature of the data you work with, it’s imperative that authentication be established on each session and be valid only for that session. Which of the following authentication methods provides credentials that are valid only during a single session?
   A. Tokens
   B. Certificate
   C. Smart card
   D. Kerberos
Chapter 1 • General Security Concepts

Answers to Review Questions

1. A. Physical security is primarily concerned with the loss or theft of physical assets. This would include theft, fire, and other acts that physically deny a service or information to the organization.

2. A. Mandatory Access Control (MAC) is oriented toward preestablished access. This access is typically established by network administrators and can’t be changed by users.

3. C. Role Based Access Control (RBAC) allows specific people to be assigned to specific roles with specific privileges. A backup operator would need administrative privileges to back up a server. This privilege would be limited to the role and wouldn’t be present during the employee’s normal job functions.

4. B. Kerberos uses a Key Distribution Center to authenticate a principal. The KDC provides a credential that can be used by all Kerberos-enabled servers and applications.

5. D. Challenge Handshake Authentication Protocol (CHAP) sends a challenge to the originating client. This challenge is sent back to the server, and the encryption results are compared. If the challenge is successful, the client is logged on.

6. A. A multi-factor authentication process uses two or more processes for logon. A two-factor method might use smart cards and biometrics for logon.

7. B. Telnet shouldn’t be used if possible. Telnet sends user ID and password information to the Telnet server unencrypted. This creates a potential security problem in an Internet environment.

8. D. Network Address Translation (NAT) is a method of hiding TCP/IP addresses from other networks. The Internet, intranets, and extranets are the three most common security zones in use.

9. A. Network Address Translation (NAT) allows an organization to present a single address to the Internet. Typically, the router or NAT server accomplishes this. The router or NAT server maps all inbound and outbound requests and maintains a table for returned messages.

10. A. Virtual Local Area Networks (VLANs) break a large network into smaller networks. These networks can coexist on the same wiring and be unaware of each other. A router or other routing-type device would be needed to connect these VLANs.

11. B. Authentication is a service that requests the principal user to provide proof of their identity. A retinal scan is a very secure form of evidence used in high-security companies and government agencies.

12. B. Biometric technologies rely on a physical characteristic of the user to verify identity. Biometric devices typically use either a hand pattern or a retinal scan to accomplish this.

13. A. Tunneling allows a network to make a secure connection to another network through the Internet or other network. Tunnels are usually secure and present themselves as extensions of both networks.

14. A. Asset identification is the process of identifying the types and values of assets in an organization.
15. C. A threat assessment examines the potential for internal and external threats to your systems and information.

16. D. Accountability identifies who owns or is responsible for the accuracy of certain information in an organization. The department or individual that is accountable for certain information would also be responsible for verifying accuracy in the event of a data-tampering incident.

17. A. Your first step would be to verify that the user’s antivirus software is the most current version. This includes checking the virus definition files.

18. A. System logs will frequently tell you what was accessed and in what manner. These logs are usually explicit in describing the events that occurred during a security violation.

19. B. A DMZ is an area in a network that allows access to outside users while not exposing your internal users to additional threats.

20. A. Tokens are created when a user or system successfully authenticates. The token is destroyed when the session is over.