Chapter 1

Security Governance Through Principles and Policies

THE CISSP EXAM TOPICS COVERED IN THIS CHAPTER INCLUDE:

✓ **Domain 1: Security and Risk Management**

- 1.1 Understand and apply concepts of confidentiality, integrity and availability
- 1.2 Evaluate and apply security governance principles
  - 1.2.1 Alignment of security function to business strategy, goals, mission, and objectives
  - 1.2.2 Organizational processes
  - 1.2.3 Organizational roles and responsibilities
  - 1.2.4 Security control frameworks
  - 1.2.5 Due care/due diligence
- 1.6 Develop, document, and implement security policy, standards, procedures, and guidelines
- 1.10 Understand and apply threat modeling concepts and methodologies
  - 1.10.1 Threat modeling methodologies
  - 1.10.2 Threat modeling concepts
- 1.11 Apply risk-based management concepts to the supply chain
  - 1.11.1 Risks associated with hardware, software, and services
  - 1.11.2 Third-party assessment and monitoring
  - 1.11.3 Minimum security requirements
  - 1.11.4 Service-level requirements

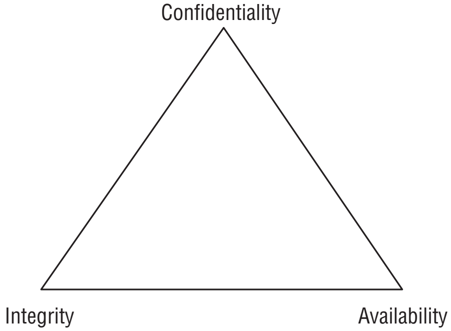
The Security and Risk Management domain of the Common Body of Knowledge (CBK) for the CISSP certification exam deals with many of the foundational elements of security solutions. These include elements essential to the design, implementation, and administration of security mechanisms. Additional elements of this domain are discussed in various chapters: Chapter 2, "Personal Security and Risk Management Concepts"; Chapter 3, "Business Continuity Planning"; Chapter 4, "Laws, Regulations, and Compliance"; and Chapter 19, "Investigations and Ethics." Please be sure to review all of these chapters to have a complete perspective on the topics of this domain.

Understand and Apply Concepts of Confidentiality, Integrity, and Availability

Security management concepts and principles are inherent elements in a security policy and solution deployment. They define the basic parameters needed for a secure environment. They also define the goals and objectives that both policy designers and system implementers must achieve to create a secure solution. It is important for real-world security professionals, as well as CISSP exam students, to understand these items thoroughly. This chapter includes a range of topics related to the governance of security for global enterprises as well as smaller businesses.

Security must start somewhere. Often that somewhere is the list of most important security principles. In such a list, confidentiality, integrity, and availability (CIA) are usually present because these are typically viewed as the primary goals and objectives of a security infrastructure. They are so commonly seen as security essentials that they are referenced by the term *CIA Triad* (see Figure 1.1).

FIGURE 1.1 The CIA Triad



Security controls are typically evaluated on how well they address these three core information security tenets. Overall, a complete security solution should adequately address each of these tenets. Vulnerabilities and risks are also evaluated based on the threat they pose against one or more of the CIA Triad principles. Thus, it is a good idea to be familiar with these principles and use them as guidelines for judging all things related to security.

These three principles are considered the most important within the realm of security. However important each specific principle is to a specific organization depends on the organization's security goals and requirements and on the extent to which the organization's security might be threatened.

Confidentiality

The first principle of the CIA Triad is confidentiality. *Confidentiality* is the concept of the measures used to ensure the protection of the secrecy of data, objects, or resources. The goal of confidentiality protection is to prevent or minimize unauthorized access to data. Confidentiality focuses security measures on ensuring that no one other than the intended recipient of a message receives it or is able to read it. Confidentiality protection provides a means for authorized users to access and interact with resources, but it actively prevents unauthorized users from doing so. A wide range of security controls can provide protection for confidentiality, including, but not limited to, encryption, access controls, and steganography.

If a security mechanism offers confidentiality, it offers a high level of assurance that data, objects, or resources are restricted from unauthorized subjects. If a threat exists against confidentiality, unauthorized disclosure could take place. An object is the passive element in a security relationship, such as files, computers, network connections, and applications. A subject is the active element in a security relationship, such as users, programs, and computers. A subject acts upon or against an object. The management of the relationship between subjects and objects is known as access control.

In general, for confidentiality to be maintained on a network, data must be protected from unauthorized access, use, or disclosure while in storage, in process, and in transit. Unique and specific security controls are required for each of these states of data, resources, and objects to maintain confidentiality.

Numerous attacks focus on the violation of confidentiality. These include capturing network traffic and stealing password files as well as social engineering, port scanning, shoulder surfing, eavesdropping, sniffing, escalation of privileges, and so on.

Violations of confidentiality are not limited to directed intentional attacks. Many instances of unauthorized disclosure of sensitive or confidential information are the result of human error, oversight, or ineptitude. Events that lead to confidentiality breaches include failing to properly encrypt a transmission, failing to fully authenticate a remote system before transferring data, leaving open otherwise secured access points, accessing malicious code that opens a back door, misrouted faxes, documents left on printers, or even walking away from an access terminal while data is displayed on the monitor. Confidentiality violations can result from the actions of an end user or a system administrator. They can also occur because of an oversight in a security policy or a misconfigured security control.

Numerous countermeasures can help ensure confidentiality against possible threats. These include encryption, network traffic padding, strict access control, rigorous authentication procedures, data classification, and extensive personnel training.

Confidentiality and integrity depend on each other. Without object integrity (in other words, the inability of an object to be modified without permission), confidentiality cannot be maintained. Other concepts, conditions, and aspects of confidentiality include the following:

Sensitivity *Sensitivity* refers to the quality of information, which could cause harm or damage if disclosed. Maintaining confidentiality of sensitive information helps to prevent harm or damage.

Discretion *Discretion* is an act of decision where an operator can influence or control disclosure in order to minimize harm or damage.

Criticality The level to which information is mission critical is its measure of *criticality*. The higher the level of criticality, the more likely the need to maintain the confidentiality of the information. High levels of criticality are essential to the operation or function of an organization.

Concealment *Concealment* is the act of hiding or preventing disclosure. Often concealment is viewed as a means of cover, obfuscation, or distraction. A related concept to concealment is security through obscurity, which is the concept of attempting to gain protection through hiding, silence, or secrecy. While security through obscurity is typically not considered a valid security measure, it may still have value in some cases.

Secrecy *Secrecy* is the act of keeping something a secret or preventing the disclosure of information.

Privacy *Privacy* refers to keeping information confidential that is personally identifiable or that might cause harm, embarrassment, or disgrace to someone if revealed.

Seclusion *Seclusion* involves storing something in an out-of-the-way location. This location can also provide strict access controls. Seclusion can help enforcement of confidentiality protections.

Isolation *Isolation* is the act of keeping something separated from others. Isolation can be used to prevent commingling of information or disclosure of information.

Each organization needs to evaluate the nuances of confidentiality they wish to enforce. Tools and technology that implements one form of confidentiality might not support or allow other forms.

Integrity

The second principle of the CIA Triad is integrity. *Integrity* is the concept of protecting the reliability and correctness of data. Integrity protection prevents unauthorized alterations of data. It ensures that data remains correct, unaltered, and preserved. Properly implemented integrity protection provides a means for authorized changes while protecting against intended and malicious unauthorized activities (such as viruses and intrusions) as well as mistakes made by authorized users (such as mistakes or oversights).

For integrity to be maintained, objects must retain their veracity and be intentionally modified by only authorized subjects. If a security mechanism offers integrity, it offers a high level of assurance that the data, objects, and resources are unaltered from their original protected state. Alterations should not occur while the object is in storage, in transit, or in process. Thus, maintaining integrity means the object itself is not altered and the operating system and programming entities that manage and manipulate the object are not compromised.

Integrity can be examined from three perspectives:

- Preventing unauthorized subjects from making modifications
- Preventing authorized subjects from making unauthorized modifications, such as mistakes
- Maintaining the internal and external consistency of objects so that their data is a correct and true reflection of the real world and any relationship with any child, peer, or parent object is valid, consistent, and verifiable

For integrity to be maintained on a system, controls must be in place to restrict access to data, objects, and resources. Additionally, activity logging should be employed to ensure that only authorized users are able to access their respective resources. Maintaining and validating object integrity across storage, transport, and processing requires numerous variations of controls and oversight.

Numerous attacks focus on the violation of integrity. These include viruses, logic bombs, unauthorized access, errors in coding and applications, malicious modification, intentional replacement, and system back doors.

As with confidentiality, integrity violations are not limited to intentional attacks. Human error, oversight, or ineptitude accounts for many instances of unauthorized alteration of sensitive information. Events that lead to integrity breaches include modifying or deleting files; entering invalid data; altering configurations, including errors in commands, codes, and scripts; introducing a virus; and executing malicious code such as a Trojan horse. Integrity violations can occur because of the actions of any user, including administrators. They can also occur because of an oversight in a security policy or a misconfigured security control.

Numerous countermeasures can ensure integrity against possible threats. These include strict access control, rigorous authentication procedures, intrusion detection systems, object/data encryption, hash total verifications (see Chapter 6, “Cryptography and Symmetric Key Algorithms”), interface restrictions, input/function checks, and extensive personnel training.

Integrity is dependent on confidentiality. Other concepts, conditions, and aspects of integrity include the following:

- *Accuracy*: Being correct and precise
- *Truthfulness*: Being a true reflection of reality
- *Authenticity*: Being authentic or genuine

- *Validity*: Being factually or logically sound
- *Nonrepudiation*: Not being able to deny having performed an action or activity or being able to verify the origin of a communication or event
- *Accountability*: Being responsible or obligated for actions and results
- *Responsibility*: Being in charge or having control over something or someone
- *Completeness*: Having all needed and necessary components or parts
- *Comprehensiveness*: Being complete in scope; the full inclusion of all needed elements

Nonrepudiation

Nonrepudiation ensures that the subject of an activity or who caused an event cannot deny that the event occurred. Nonrepudiation prevents a subject from claiming not to have sent a message, not to have performed an action, or not to have been the cause of an event. It is made possible through identification, authentication, authorization, accountability, and auditing. Nonrepudiation can be established using digital certificates, session identifiers, transaction logs, and numerous other transactional and access control mechanisms. A system built without proper enforcement of nonrepudiation does not provide verification that a specific entity performed a certain action. Nonrepudiation is an essential part of accountability. A suspect cannot be held accountable if they can repudiate the claim against them.

Availability

The third principle of the CIA Triad is *availability*, which means authorized subjects are granted timely and uninterrupted access to objects. Often, availability protection controls support sufficient bandwidth and timeliness of processing as deemed necessary by the organization or situation. If a security mechanism offers availability, it offers a high level of assurance that the data, objects, and resources are accessible to authorized subjects. Availability includes efficient uninterrupted access to objects and prevention of denial-of-service (DoS) attacks. Availability also implies that the supporting infrastructure—including network services, communications, and access control mechanisms—is functional and allows authorized users to gain authorized access.

For availability to be maintained on a system, controls must be in place to ensure authorized access and an acceptable level of performance, to quickly handle interruptions, to provide for redundancy, to maintain reliable backups, and to prevent data loss or destruction.

There are numerous threats to availability. These include device failure, software errors, and environmental issues (heat, static, flooding, power loss, and so on). There are also some forms of attacks that focus on the violation of availability, including DoS attacks, object destruction, and communication interruptions.

As with confidentiality and integrity, violations of availability are not limited to intentional attacks. Many instances of unauthorized alteration of sensitive information are caused by human error, oversight, or ineptitude. Some events that lead to availability breaches include accidentally deleting files, overutilizing a hardware or software component, under-allocating resources, and mislabeling or incorrectly classifying objects. Availability violations can occur because of the actions of any user, including administrators. They can also occur because of an oversight in a security policy or a misconfigured security control.

Numerous countermeasures can ensure availability against possible threats. These include designing intermediary delivery systems properly, using access controls effectively, monitoring performance and network traffic, using firewalls and routers to prevent DoS attacks, implementing redundancy for critical systems, and maintaining and testing backup systems. Most security policies, as well as business continuity planning (BCP), focus on the use of fault tolerance features at the various levels of access/storage/security (that is, disk, server, or site) with the goal of eliminating single points of failure to maintain availability of critical systems.

Availability depends on both integrity and confidentiality. Without integrity and confidentiality, availability cannot be maintained. Other concepts, conditions, and aspects of availability include the following:

- *Usability*: The state of being easy to use or learn or being able to be understood and controlled by a subject
- *Accessibility*: The assurance that the widest range of subjects can interact with a resource regardless of their capabilities or limitations
- *Timeliness*: Being prompt, on time, within a reasonable time frame, or providing low-latency response

Real World Scenario

CIA Priority

Every organization has unique security requirements. On the CISSP exam, most security concepts are discussed in general terms, but in the real world, general concepts and best practices don't get the job done. The management team and security team must work together to prioritize an organization's security needs. This includes establishing a budget and spending plan, allocating expertise and hours, and focusing the information technology (IT) and security staff efforts. One key aspect of this effort is to prioritize the security requirements of the organization. Knowing which tenet or asset is more important than another guides the creation of a security stance and ultimately the deployment of a security solution. Often, getting started in establishing priorities is a challenge. A possible solution to this challenge is to start with prioritizing the three primary security tenets of confidentiality, integrity, and availability. Defining which of these elements is most important to the organization is essential in crafting a sufficient security solution. This establishes a pattern that can be replicated from concept through design, architecture, deployment, and finally, maintenance.

Do you know the priority your organization places on each of the components of the CIA Triad? If not, find out.

An interesting generalization of this concept of CIA prioritization is that in many cases military and government organizations tend to prioritize confidentiality above integrity and availability, whereas private companies tend to prioritize availability above confidentiality and integrity. Although such prioritization focuses efforts on one aspect of security over another, it does not imply that the second or third prioritized items are ignored or improperly addressed. Another perspective on this is discovered when comparing standard IT systems with Operational Technology (OT) systems such as programmable logic controllers (PLCs), supervisory control and data acquisition (SCADA), and MES (Manufacturing Execution Systems) devices and systems used on manufacturing plant floors. IT systems, even in private companies, tend to follow the CIA Triad; however, OT systems tend to follow the AIC Triad, where availability is prioritized overall and integrity is valued over confidentiality. Again, this is just a generalization but one that may serve you well in deciphering questions on the CISSP exam. Each individual organization decides its own security priorities.

Other Security Concepts

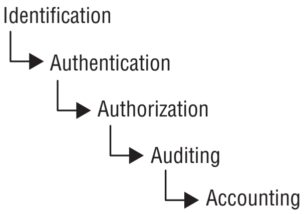
In addition to the CIA Triad, you need to consider a plethora of other security-related concepts and principles when designing a security policy and deploying a security solution.

You may have heard of the concept of *AAA services*. The three A's in this abbreviation refer to authentication, authorization, and accounting (or sometimes auditing). However, what is not as clear is that although there are three letters in the acronym, it actually refers to five elements: identification, authentication, authorization, auditing, and accounting. These five elements represent the following processes of security:

- *Identification*: Claiming to be an identity when attempting to access a secured area or system
- *Authentication*: Proving that you are that identity
- *Authorization*: Defining the permissions (i.e., allow/grant and/or deny) of a resource and object access for a specific identity
- *Auditing*: Recording a log of the events and activities related to the system and subjects
- *Accounting* (aka *accountability*): Reviewing log files to check for compliance and violations in order to hold subjects accountable for their actions

Although AAA is typically referenced in relation to authentication systems, it is actually a foundational concept for security. Missing any of these five elements can result in an incomplete security mechanism. The following sections discuss identification, authentication, authorization, auditing, and accountability (see Figure 1.2).

FIGURE 1.2 The five elements of AAA services



Identification

Identification is the process by which a subject professes an identity and accountability is initiated. A *subject* must provide an identity to a system to start the process of authentication, authorization, and accountability (AAA). Providing an identity can involve typing in a username; swiping a smart card; waving a proximity device; speaking a phrase; or positioning your face, hand, or finger for a camera or scanning device. Providing a process ID number also represents the identification process. Without an identity, a system has no way to correlate an authentication factor with the subject.

Once a subject has been identified (that is, once the subject's identity has been recognized and verified), the identity is accountable for any further actions by that subject. IT systems track activity by identities, not by the subjects themselves. A computer doesn't know one human from another, but it does know that your user account is different from all other user accounts. A subject's identity is typically labeled as, or considered to be, public information. However, simply claiming an identity does not imply access or authority. The identity must be proven (authentication) or verified (ensuring nonrepudiation) before access to controlled resources is allowed (verifying authorization). That process is authentication.

Authentication

The process of verifying or testing that the claimed identity is valid is authentication. Authentication requires the subject to provide additional information that corresponds to the identity they are claiming. The most common form of authentication is using a password (this includes the password variations of personal identification numbers (PINs) and passphrases). Authentication verifies the identity of the subject by comparing one or more factors against the database of valid identities (that is, user accounts). The *authentication factor* used to verify identity is typically labeled as, or considered to be, private information. The capability of the subject and system to maintain the secrecy of the authentication factors for identities directly reflects the level of security of that system. If the process of illegitimately obtaining and using the authentication factor of a target user is relatively easy, then the authentication system is insecure. If that process is relatively difficult, then the authentication system is reasonably secure.

Identification and authentication are often used together as a single two-step process. Providing an identity is the first step, and providing the authentication factors is the second step. Without both, a subject cannot gain access to a system—neither element alone is useful in terms of security. In some systems, it may seem as if you are providing only one element but gaining access, such as when keying in an ID code or a PIN. However, in these cases either the identification is handled by another means, such as physical location, or authentication is assumed by your ability to access the system physically. Both identification and authentication take place, but you might not be as aware of them as when you manually type in both a name and a password.

A subject can provide several types of authentication—for example, something you know (e.g., passwords, PINs), something you have (e.g., keys, tokens, smart cards), something you are (e.g., biometrics, such as fingerprints, iris, or voice recognition), and so on. Each authentication technique or factor has its unique benefits and drawbacks. Thus, it is important to evaluate each mechanism in light of the environment in which it will be deployed to determine viability. (We discuss authentication at length in Chapter 13, "Managing Identity and Authentication.")

Authorization

Once a subject is authenticated, access must be authorized. The process of authorization ensures that the requested activity or access to an object is possible given the rights and *privileges* assigned to the authenticated identity. In most cases, the system evaluates an *access control matrix* that compares the subject, the object, and the intended activity. If the specific action is allowed, the subject is authorized. If the specific action is not allowed, the subject is not authorized.

Keep in mind that just because a subject has been identified and authenticated does not mean they have been authorized to perform any function or access all resources within the controlled environment. It is possible for a subject to be logged onto a network (that is, identified and authenticated) but to be blocked from accessing a file or printing to a printer (that is, by not being authorized to perform that activity). Most network users are authorized to perform only a limited number of activities on a specific collection of resources. Identification and authentication are all-or-nothing aspects of access control. Authorization has a wide range of variations between all or nothing for each object within the environment. A user may be able to read a file but not delete it, print a document but not alter the print queue, or log on to a system but not access any resources. Authorization is usually defined using one of the models of access control, such as *Discretionary Access Control (DAC)*, *Mandatory Access Control (MAC)*, or *Role Based Access Control (RBAC or role-BAC)*; see Chapter 14, "Controlling and Monitoring Access."

Auditing

Auditing, or *monitoring*, is the programmatic means by which a subject's actions are tracked and recorded for the purpose of holding the subject accountable for their actions while authenticated on a system. It is also the process by which unauthorized or abnormal activities are detected on a system. Auditing is recording activities of a subject and its objects as well as recording the activities of core system functions that maintain the operating environment and the security mechanisms. The audit trails created by recording system events to logs can be used to evaluate the health and performance of a system. System crashes may indicate faulty programs, corrupt drivers, or intrusion attempts. The event logs leading up to a crash can often be used to discover the reason a system failed. Log files provide an audit trail for re-creating the history of an event, intrusion, or system failure. Auditing is needed to detect malicious actions by subjects, attempted intrusions, and system failures and to reconstruct events, provide evidence for prosecution, and produce problem reports and analysis. Auditing is usually a native feature of operating systems and most applications and services. Thus, configuring the system to record information about specific types of events is fairly straightforward.

NOTE

Monitoring is part of what is needed for audits, and audit logs are part of a monitoring system, but the two terms have different meanings. Monitoring is a type of watching or oversight, while auditing is a recording of the information into a record or file. It is possible to monitor without auditing, but you can't audit without some form of monitoring. But even so, these terms are often used interchangeably in casual discussions of these topics.

Accountability

An organization's security policy can be properly enforced only if accountability is maintained. In other words, you can maintain security only if subjects are held accountable for their actions. Effective accountability relies on the capability to prove a subject's identity and track their activities. Accountability is established by linking a human to the activities of an online identity through the security services and mechanisms of auditing, authorization, authentication, and identification. Thus, human accountability is ultimately dependent on the strength of the authentication process. Without a strong authentication process, there is doubt that the human associated with a specific user account was the actual entity controlling that user account when the undesired action took place.

To have viable accountability, you may need to be able to support your security decisions and their implementation in a court of law. If you are unable to legally support your security efforts, then you will be unlikely to be able to hold a human accountable for actions linked to a user account. With only a password as authentication, there is significant room for doubt. Passwords are the least secure form of authentication, with dozens of different methods available to compromise them. However, with the use of multifactor authentication, such as a password, smartcard, and fingerprint scan in combination, there is very little possibility that any other human could have compromised the authentication process in order to impersonate the human responsible for the user account.

Legally Defensible Security

The point of security is to keep bad things from happening while supporting the occurrence of good things. When bad things do happen, organizations often desire assistance from law enforcement and the legal system for compensation. To obtain legal restitution, you must demonstrate that a crime was committed, that the suspect committed that crime, and that you took reasonable efforts to prevent the crime. This means your organization's security needs to be legally defensible. If you are unable to convince a court that your log files are accurate and that no other person other than the subject could have committed the crime, you will not obtain restitution. Ultimately, this requires a complete security solution that has strong multifactor authentication techniques, solid authorization mechanisms, and impeccable auditing systems. Additionally, you must show that the organization complied with all applicable laws and regulations, that proper warnings and notifications were posted, that both logical and physical security were not otherwise compromised, and that there are no other possible reasonable interpretations of the electronic evidence. This is a fairly challenging standard to meet. Thus, an organization should evaluate its security infrastructure and redouble its effort to design and implement legally defensible security.

Protection Mechanisms

Another aspect of understanding and applying concepts of confidentiality, integrity, and availability is the concept of protection mechanisms or protection controls. Protection mechanisms are common characteristics of security controls. Not all *security controls* must have them, but many controls offer their protection for confidentiality, integrity, and availability through the use of these mechanisms. Some common examples of these mechanisms include using multiple layers or levels of access, employing abstraction, hiding data, and using encryption.

Layering

Layering, also known as *defense in depth*, is simply the use of multiple controls in a series. No one control can protect against all possible threats. Using a multilayered solution allows for numerous, different controls to guard against whatever threats come to pass. When security solutions are designed in layers, a failed control should not result in exposure of systems or data.

Using layers in a series rather than in parallel is important. Performing security restrictions in a series means to perform one after the other in a linear fashion. Only through a series configuration will each attack be scanned, evaluated, or mitigated by every security control. In a series configuration, failure of a single security control does not render the entire solution ineffective. If security controls were implemented in parallel, a threat could pass through a single checkpoint that did not address its particular malicious activity.

Serial configurations are very narrow but very deep, whereas parallel configurations are very wide but very shallow. Parallel systems are useful in distributed computing applications, but parallelism is not often a useful concept in the realm of security.

Think of physical entrances to buildings. A parallel configuration is used for shopping malls. There are many doors in many locations around the entire perimeter of the mall. A series configuration would most likely be used in a bank or an airport. A single entrance is provided, and that entrance is actually several gateways or checkpoints that must be passed in sequential order to gain entry into active areas of the building.

Layering also includes the concept that networks comprise numerous separate entities, each with its own unique security controls and vulnerabilities. In an effective security solution, there is a synergy between all networked systems that creates a single security front. Using separate security systems creates a layered security solution.

Abstraction

Abstraction is used for efficiency. Similar elements are put into groups, classes, or roles that are assigned security controls, restrictions, or permissions as a collective. Thus, the concept of abstraction is used when classifying objects or assigning roles to subjects. The concept of abstraction also includes the definition of object and subject types or of objects themselves (that is, a data structure used to define a template for a class of entities). Abstraction is used to define what types of data an object can contain, what types of functions can be performed on or by that object, and what capabilities that object has. Abstraction simplifies security by enabling you to assign security controls to a group of objects collected by type or function.

Data Hiding

Data hiding is exactly what it sounds like: preventing data from being discovered or accessed by a subject by positioning the data in a logical storage compartment that is not accessible or seen by the subject. Forms of data hiding include keeping a database from being accessed by unauthorized visitors and restricting a subject at a lower classification level from accessing data at a higher classification level. Preventing an application from accessing hardware directly is also a form of data hiding. Data hiding is often a key element in security controls as well as in programming.

The term *security through obscurity* may seem relevant here. However, that concept is different. Data hiding is the act of intentionally positioning data so that it is not viewable or accessible to an unauthorized subject, while security through obscurity is the idea of not informing a subject about an object being present and thus hoping that the subject will not discover the object. Security through obscurity does not actually implement any form of protection. It is instead an attempt to hope something important is not discovered by keeping knowledge of it a secret. An example of security though obscurity is when a programmer is aware of a flaw in their software code, but they release the product anyway hoping that no one discovers the issue and exploits it.

Encryption

Encryption is the art and science of hiding the meaning or intent of a communication from unintended recipients. Encryption can take many forms and be applied to every type of electronic communication, including text, audio, and video files as well as applications themselves. Encryption is an important element in security controls, especially in regard to the transmission of data between systems. There are various strengths of encryption, each of which is designed and/or appropriate for a specific use or purpose. Weak or poor encryption can be considered as nothing more than obfuscation or potentially even security through obscurity. Encryption is discussed at length in Chapter 6, "Cryptography and Symmetric Key Algorithms," and Chapter 7, "PKI and Cryptographic Applications."

Evaluate and Apply Security Governance Principles

Security governance is the collection of practices related to supporting, defining, and directing the security efforts of an organization. Security governance principles are often closely related to and often intertwined with corporate and IT governance. The goals of these three governance agendas are often the same or interrelated. For example, a common goal of organizational governance is to ensure that the organization will continue to exist and will grow or expand over time. Thus, the common goal of governance is to maintain business processes while striving toward growth and resiliency.

Some aspects of governance are imposed on organizations due to legislative and regulatory compliance needs, whereas others are imposed by industry guidelines or license requirements. All forms of governance, including security governance, must be assessed and verified from time to time. Various requirements for auditing and validation may be present due to government regulations or industry best practices. Governance compliance issues often vary from industry to industry and from country to country. As many organizations expand and adapt to deal with a global market, governance issues become more complex. This is especially problematic when laws in different countries differ or in fact conflict. The organization as a whole should be given the direction, guidance, and tools to provide sufficient oversight and management to address threats and risks with a focus on eliminating downtime and keeping potential loss or damage to a minimum.

As you can tell, the definitions of security governance are often rather stilted and high level. Ultimately, security governance is the implementation of a security solution and a management method that are tightly interconnected. Security governance directly oversees and gets involved in all levels of security. Security is not and should not be treated as an IT issue only. Instead, security affects every aspect of an organization. It is no longer just something the IT staff can handle on their own. Security is a business operations issue. Security is an organizational process, not just something the IT geeks do behind the scenes. Using the term "security governance" is an attempt to emphasize this point by indicating that security needs to be managed and governed throughout the organization, not just in the IT department.

Security governance is commonly managed by a governance committee or at least a board of directors. This is the group of influential knowledge experts whose primary task is to oversee and guide the actions of security and operations for an organization. Security is a complex task. Organizations are often large and difficult to understand from a single viewpoint. Having a group of experts work together toward the goal of reliable security governance is a solid strategy.

There are numerous security frameworks and governance guidelines, including NIST 800-53 or 800-100. While the NIST guidance is focused on government and military use, it can be adopted and adapted by other types of organization as well. Many organizations adopt security frameworks in an effort to standardize and organize what can become a complex and bewilderingly messy activity, namely, attempting to implement reasonable security governance.

Alignment of Security Function to Business Strategy, Goals, Mission, and Objectives

Security management planning ensures proper creation, implementation, and enforcement of a *security policy*. Security management planning aligns the security functions to the strategy, goals, mission, and objectives of the organization. This includes designing and implementing security based on business cases, budget restrictions, or scarcity of resources. A *business case* is usually a documented argument or stated position in order to define a need to make a decision or take some form of action. To make a business case is to demonstrate a business-specific need to alter an existing process or choose an approach to a business task. A business case is often made to justify the start of a new project, especially a project related to security. It is also important to consider the budget that can be allocated to a business need–based security project. Security can be expensive but is most often less costly than the absence of that security. Thus, security becomes an essential element of reliable and long-term business operation. In most organizations, money and resources, such as people, technology, and space, are limited. Due to resource limitations like these, the maximum benefit needs to be obtained from any endeavor.

One of the most effective ways to tackle security management planning is to use a *top-down approach*. Upper, or senior, management is responsible for initiating and defining policies for the organization. Security policies provide direction for all levels of the organization's hierarchy. It is the responsibility of middle management to flesh out the security policy into standards, baselines, guidelines, and procedures. The operational managers or security professionals must then implement the configurations prescribed in the security management documentation. Finally, the end users must comply with all the security policies of the organization.

NOTE

The opposite of the top-down approach is the bottom-up approach. In a *bottom-up approach* environment, the IT staff makes security decisions directly without input from senior management. The bottom-up approach is rarely used in organizations and is considered problematic in the IT industry.

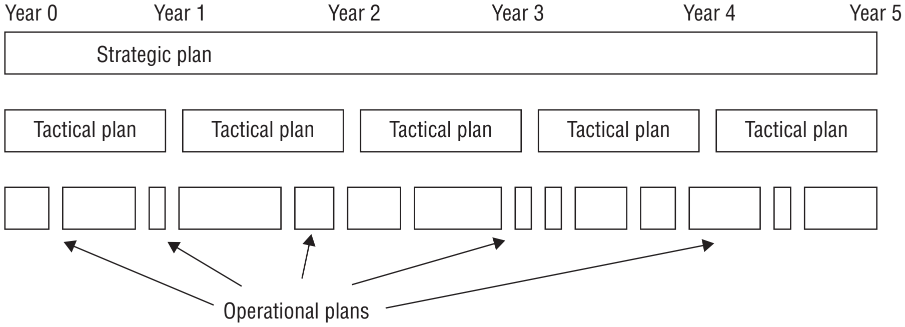
Security management is a responsibility of upper management, not of the IT staff, and is considered an issue of business operations rather than IT administration. The team or department responsible for security within an organization should be autonomous. The *information security (InfoSec) team* should be led by a designated *chief information security officer (CISO)* who must report directly to senior management. Placing the autonomy of the CISO and the CISO's team outside the typical hierarchical structure in an organization can improve security management across the entire organization. It also helps to avoid cross-department and internal political issues. The term *chief security officer (CSO)* is sometimes used as an alternative to *CISO*, but in many organizations the CSO position is a subposition under the CISO that focuses on physical security. Another potential term for the CISO is *information security officer (ISO)*, but this also can be used as a subposition under the CISO.

Elements of security management planning include defining security roles; prescribing how security will be managed, who will be responsible for security, and how security will be tested for effectiveness; developing security policies; performing risk analysis; and requiring security education for employees. These efforts are guided through the development of management plans.

The best security plan is useless without one key factor: approval by *senior management*. Without senior management's approval of and commitment to the security policy, the policy will not succeed. It is the responsibility of the policy development team to educate senior management sufficiently so it understands the risks, liabilities, and exposures that remain even after security measures prescribed in the policy are deployed. Developing and implementing a security policy is evidence of due care and due diligence on the part of senior management. If a company does not practice due care and due diligence, managers can be held liable for negligence and held accountable for both asset and financial losses.

A security management planning team should develop three types of plans, as shown in Figure 1.3.

FIGURE 1.3 Strategic, tactical, and operational plan timeline comparison



Strategic Plan A *strategic plan* is a long-term plan that is fairly stable. It defines the organization's security purpose. It also helps to understand security function and align it to the goals, mission, and objectives of the organization. It's useful for about five years if it is maintained and updated annually. The strategic plan also serves as the planning horizon. Long-term goals and visions for the future are discussed in a strategic plan. A strategic plan should include a risk assessment.

Tactical Plan The *tactical plan* is a midterm plan developed to provide more details on accomplishing the goals set forth in the strategic plan or can be crafted ad hoc based upon unpredicted events. A tactical plan is typically useful for about a year and often prescribes and schedules the tasks necessary to accomplish organizational goals. Some examples of tactical plans are project plans, acquisition plans, hiring plans, budget plans, maintenance plans, support plans, and system development plans.

Operational Plan An *operational plan* is a short-term, highly detailed plan based on the strategic and tactical plans. It is valid or useful only for a short time. Operational plans must be updated often (such as monthly or quarterly) to retain compliance with tactical plans. Operational plans spell out how to accomplish the various goals of the organization. They include resource allotments, budgetary requirements, staffing assignments, scheduling, and step-by-step or implementation procedures. Operational plans include details on how the implementation processes are in compliance with the organization's security policy. Examples of operational plans are training plans, system deployment plans, and product design plans.

Security is a continuous process. Thus, the activity of security management planning may have a definitive initiation point, but its tasks and work are never fully accomplished or complete. Effective security plans focus attention on specific and achievable objectives, anticipate change and potential problems, and serve as a basis for decision making for the entire organization. Security documentation should be concrete, well defined, and clearly stated. For a security plan to be effective, it must be developed, maintained, and actually used.

Organizational Processes

Security governance needs to address every aspect of an organization. This includes the organizational processes of acquisitions, divestitures, and governance committees. Acquisitions and mergers place an organization at an increased level of risk. Such risks include inappropriate information disclosure, data loss, downtime, or failure to achieve sufficient return on investment (ROI). In addition to all the typical business and financial aspects of mergers and acquisitions, a healthy dose of security oversight and increased scrutiny is often essential to reduce the likelihood of losses during such a period of transformation.

Similarly, a divestiture or any form of asset or employee reduction is another time period of increased risk and thus increased need for focused security governance. Assets need to be sanitized to prevent data leakage. Storage media should be removed and destroyed, because media sanitization techniques do not guarantee against data remnant recovery. Employees released from duty need to be debriefed. This process is often called an exit interview. This process usually involves reviewing any nondisclosure agreements as well as any other binding contracts or agreements that will continue after employment has ceased.

Two additional examples of organizational processes that are essential to strong security governance are change control/change management and data classification.

Change Control/Management

Another important aspect of security management is the control or management of change. Change in a secure environment can introduce loopholes, overlaps, missing objects, and oversights that can lead to new vulnerabilities. The only way to maintain security in the face of change is to systematically manage change. This usually involves extensive planning, testing, logging, auditing, and monitoring of activities related to security controls and mechanisms. The records of changes to an environment are then used to identify agents of change, whether those agents are objects, subjects, programs, communication pathways, or even the network itself.

The goal of *change management* is to ensure that any change does not lead to reduced or compromised security. Change management is also responsible for making it possible to roll back any change to a previous secured state. Change management can be implemented on any system despite the level of security. Ultimately, change management improves the security of an environment by protecting implemented security from unintentional, tangential, or affected reductions in security. Although an important goal of change management is to prevent unwanted reductions in security, its primary purpose is to make all changes subject to detailed documentation and auditing and thus able to be reviewed and scrutinized by management.

Change management should be used to oversee alterations to every aspect of a system, including hardware configuration and operating system (OS) and application software. Change management should be included in design, development, testing, evaluation, implementation, distribution, evolution, growth, ongoing operation, and modification. It requires a detailed inventory of every component and configuration. It also requires the collection and maintenance of complete documentation for every system component, from hardware to software and from configuration settings to security features.

The change control process of configuration or change management has several goals or requirements:

- Implement changes in a monitored and orderly manner. Changes are always controlled.
- A formalized testing process is included to verify that a change produces expected results.
- All changes can be reversed (also known as backout or rollback plans/procedures).
- Users are informed of changes before they occur to prevent loss of productivity.
- The effects of changes are systematically analyzed to determine whether security or business processes are negatively affected.
- The negative impact of changes on capabilities, functionality, and performance is minimized.
- Changes are reviewed and approved by a *Change Advisory Board (CAB)*.

One example of a change management process is a parallel run, which is a type of new system deployment testing where the new system and the old system are run in parallel. Each major or significant user process is performed on each system simultaneously to ensure that the new system supports all required business functionality that the old system supported or provided.

Data Classification

Data classification, or categorization, is the primary means by which data is protected based on its need for secrecy, sensitivity, or confidentiality. It is inefficient to treat all data the same way when designing and implementing a security system because some data items need more security than others. Securing everything at a low security level means sensitive data is easily accessible. Securing everything at a high security level is too expensive and restricts access to unclassified, noncritical data. Data classification is used to determine how much effort, money, and resources are allocated to protect the data and control access to it. Data classification, or categorization, is the process of organizing items, objects, subjects, and so on into groups, categories, or collections with similarities. These similarities could include value, cost, sensitivity, risk, vulnerability, power, privilege, possible levels of loss or damage, or need to know.

The primary objective of data classification schemes is to formalize and stratify the process of securing data based on assigned labels of importance and sensitivity. Data classification is used to provide security mechanisms for storing, processing, and transferring data. It also addresses how data is removed from a system and destroyed.

The following are benefits of using a data classification scheme:

- It demonstrates an organization's commitment to protecting valuable resources and assets.
- It assists in identifying those assets that are most critical or valuable to the organization.
- It lends credence to the selection of protection mechanisms.
- It is often required for regulatory compliance or legal restrictions.
- It helps to define access levels, types of authorized uses, and parameters for declassification and/or destruction of resources that are no longer valuable.
- It helps with data lifecycle management which in part is the storage length (retention), usage, and destruction of the data.

The criteria by which data is classified vary based on the organization performing the classification. However, you can glean numerous generalities from common or standardized classification systems:

- Usefulness of the data
- Timeliness of the data
- Value or cost of the data
- Maturity or age of the data
- Lifetime of the data (or when it expires)

- Association with personnel
- Data disclosure damage assessment (that is, how the disclosure of the data would affect the organization)
- Data modification damage assessment (that is, how the modification of the data would affect the organization)
- National security implications of the data
- Authorized access to the data (that is, who has access to the data)
- Restriction from the data (that is, who is restricted from the data)
- Maintenance and monitoring of the data (that is, who should maintain and monitor the data)
- Storage of the data

Using whatever criteria is appropriate for the organization, data is evaluated, and an appropriate data classification label is assigned to it. In some cases, the label is added to the data object. In other cases, labeling occurs automatically when the data is placed into a storage mechanism or behind a security protection mechanism.

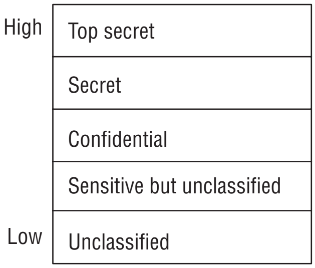
To implement a classification scheme, you must perform seven major steps, or phases:

1. Identify the custodian, and define their responsibilities.
2. Specify the evaluation criteria of how the information will be classified and labeled.
3. Classify and label each resource. (The owner conducts this step, but a supervisor should review it.)
4. Document any exceptions to the classification policy that are discovered, and integrate them into the evaluation criteria.
5. Select the security controls that will be applied to each classification level to provide the necessary level of protection.
6. Specify the procedures for declassifying resources and the procedures for transferring custody of a resource to an external entity.
7. Create an enterprise-wide awareness program to instruct all personnel about the classification system.

Declassification is often overlooked when designing a classification system and documenting the usage procedures. Declassification is required once an asset no longer warrants or needs the protection of its currently assigned classification or sensitivity level. In other words, if the asset were new, it would be assigned a lower sensitivity label than it currently is assigned. When assets fail to be declassified as needed, security resources are wasted, and the value and protection of the higher sensitivity levels is degraded.

The two common classification schemes are government/military classification (Figure 1.4) and commercial business/private sector classification. There are five levels of government/military classification (listed here from highest to lowest):

FIGURE 1.4 Levels of government/military classification



Top Secret *Top secret* is the highest level of classification. The unauthorized disclosure of top-secret data will have drastic effects and cause grave damage to national security. Top-secret data is compartmentalized on a need-to-know basis such that a user could have top-secret clearance and have access to no data until the user has a need to know.

Secret *Secret* is used for data of a restricted nature. The unauthorized disclosure of data classified as secret will have significant effects and cause critical damage to national security.

Confidential *Confidential* is used for data of a sensitive, proprietary, or highly valuable nature. The unauthorized disclosure of data classified as confidential will have noticeable effects and cause serious damage to national security. This classification is used for all data between secret and sensitive but unclassified classifications.

Sensitive But Unclassified *Sensitive but unclassified (SBU)* is used for data that is for internal use or for office use only (FOUO). Often SBU is used to protect information that could violate the privacy rights of individuals. This is not technically a classification label; instead, it is a marking or label used to indicate use or management.

Unclassified *Unclassified* is used for data that is neither sensitive nor classified. The disclosure of unclassified data does not compromise confidentiality or cause any noticeable damage. This is not technically a classification label; instead, it is a marking or label used to indicate use or management.

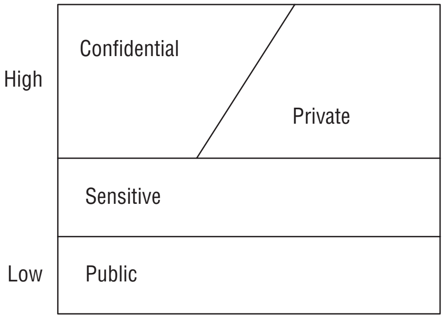
TIP

An easy way to remember the names of the five levels of the government or military classification scheme in least secure to most secure order is with a memorization acronym: U.S. Can Stop Terrorism. Notice that the five uppercase letters represent the five named classification levels, from least secure on the left to most secure on the right (or from bottom to top in the preceding list of items).

Items labeled as confidential, secret, and top secret are collectively known as classified. Often, revealing the actual classification of data to unauthorized individuals is a violation of that data. Thus, the term *classified* is generally used to refer to any data that is ranked above the unclassified level. All classified data is exempt from the Freedom of Information Act as well as many other laws and regulations. The United States (U.S.) military classification scheme is most concerned with the sensitivity of data and focuses on the protection of confidentiality (that is, the prevention of disclosure). You can roughly define each level or label of classification by the level of damage that would be caused in the event of a confidentiality violation. Data from the top-secret level would cause grave damage to national security, whereas data from the unclassified level would not cause any serious damage to national or localized security.

Commercial business/private sector classification systems can vary widely because they typically do not have to adhere to a standard or regulation. The CISSP exam focuses on four common or possible business classification levels (listed highest to lowest and shown in Figure 1.5):

FIGURE 1.5 Commercial business/private sector classification levels



Confidential *Confidential* is the highest level of classification. This is used for data that is extremely sensitive and for internal use only. A significant negative impact could occur for a company if confidential data is disclosed. Sometimes the label *proprietary* is substituted for *confidential*. Sometimes proprietary data is considered a specific form of confidential information. If proprietary data is disclosed, it can have drastic effects on the competitive edge of an organization.

Private *Private* is used for data that is of a private or personal nature and intended for internal use only. A significant negative impact could occur for the company or individuals if private data is disclosed.

NOTE

Confidential and private data in a commercial business/private sector classification scheme both require roughly the same level of security protection. The real difference between the two labels is that confidential data is company data whereas private data is data related to individuals, such as medical data.

Sensitive *Sensitive* is used for data that is more classified than public data. A negative impact could occur for the company if sensitive data is disclosed.

Public *Public* is the lowest level of classification. This is used for all data that does not fit in one of the higher classifications. Its disclosure does not have a serious negative impact on the organization.

Another consideration related to data classification or categorization is ownership. *Ownership* is the formal assignment of responsibility to an individual or group. Ownership can be made clear and distinct within an operating system where files or other types of objects can be assigned an owner. Often, an owner has full capabilities and privileges over the object they own. The ability to take ownership is often granted to the most powerful accounts in an operating system, such as the administrator in Windows or root in Unix or Linux. In most cases, the subject that creates a new object is by default the owner of that object. In some environments, the security policy mandates that when new objects are created, a formal change of ownership from end users to an administrator or management user is necessary. In this situation, the admin account can simply take ownership of the new objects.

Ownership of objects outside formal IT structures is often not as obvious. A company document can define owners for the facility, business tasks, processes, assets, and so on. However, such documentation does not always "enforce" this ownership in the real world. The ownership of a file object is enforced by the operating system and file system, whereas ownership of a physical object, intangible asset, or organizational concept (such as the research department or a development project) is defined only on paper and can be more easily undermined. Additional security governance must be implemented to provide enforcement of ownership in the physical world.

Organizational Roles and Responsibilities

A *security role* is the part an individual plays in the overall scheme of security implementation and administration within an organization. Security roles are not necessarily prescribed in job descriptions because they are not always distinct or static. Familiarity with security roles will help in establishing a communications and support structure within an organization. This structure will enable the deployment and enforcement of the security policy. The following six roles are presented in the logical order in which they appear in a secured environment:

Senior Manager The organizational owner (*senior manager*) role is assigned to the person who is ultimately responsible for the security maintained by an organization and who should be most concerned about the protection of its assets. The senior manager must sign off on all policy issues. In fact, all activities must be approved by and signed off on by the senior manager before they can be carried out. There is no effective security policy if the senior manager does not authorize and support it. The senior manager's endorsement of the security policy indicates the accepted ownership of the implemented security within the organization. The senior manager is the person who will be held liable for the overall success or failure of a security solution and is responsible for exercising due care and due diligence in establishing security for an organization.

Even though senior managers are ultimately responsible for security, they rarely implement security solutions. In most cases, that responsibility is delegated to security professionals within the organization.

Security Professional The *security professional*, *information security (InfoSec) officer*, or *computer incident response team (CIRT)* role is assigned to a trained and experienced network, systems, and security engineer who is responsible for following the directives mandated by senior management. The security professional has the functional responsibility for security, including writing the security policy and implementing it. The role of security professional can be labeled as an IS/IT function role. The security professional role is often filled by a team that is responsible for designing and implementing security solutions based on the approved security policy. Security professionals are not decision makers; they are implementers. All decisions must be left to the senior manager.

Data Owner The *data owner* role is assigned to the person who is responsible for classifying information for placement and protection within the security solution. The data owner is typically a high-level manager who is ultimately responsible for data protection. However, the data owner usually delegates the responsibility of the actual data management tasks to a data custodian.

Data Custodian The *data custodian* role is assigned to the user who is responsible for the tasks of implementing the prescribed protection defined by the security policy and senior management. The data custodian performs all activities necessary to provide adequate protection for the CIA Triad (confidentiality, integrity, and availability) of data and to fulfill the requirements and responsibilities delegated from upper management. These activities can include performing and testing backups, validating data integrity, deploying security solutions, and managing data storage based on classification.

User The *user* (*end user* or *operator*) role is assigned to any person who has access to the secured system. A user's access is tied to their work tasks and is limited so they have only enough access to perform the tasks necessary for their job position (the principle of least privilege). Users are responsible for understanding and upholding the security policy of an organization by following prescribed operational procedures and operating within defined security parameters.

Auditor An *auditor* is responsible for reviewing and verifying that the security policy is properly implemented and the derived security solutions are adequate. The auditor role may be assigned to a security professional or a trained user. The auditor produces compliance and effectiveness reports that are reviewed by the senior manager. Issues discovered through these reports are transformed into new directives assigned by the senior manager to security professionals or data custodians. However, the auditor is listed as the final role because the auditor needs a source of activity (that is, users or operators working in an environment) to audit or monitor.

All of these roles serve an important function within a secured environment. They are useful for identifying liability and responsibility as well as for identifying the hierarchical management and delegation scheme.

Security Control Frameworks

Crafting a security stance for an organization often involves a lot more than just writing down a few lofty ideals. In most cases, a significant amount of planning goes into developing a solid security policy. Many Dilbert fans may recognize the seemingly absurd concept of holding a meeting to plan a meeting for a future meeting. But it turns out that planning for security must start with planning to plan, then move into planning for standards and compliance, and finally move into the actual plan development and design. Skipping any of these "planning to plan" steps can derail an organization's security solution before it even gets started.

One of the first and most important security planning steps is to consider the overall *security control framework* or structure of the security solution desired by the organization. You can choose from several options in regard to security concept infrastructure; however, one of the more widely used security control frameworks is *Control Objectives for Information and Related Technology (COBIT)*. COBIT is a documented set of best IT security practices crafted by the Information Systems Audit and Control Association (ISACA). It prescribes goals and requirements for security controls and encourages the mapping of IT security ideals to business objectives. COBIT 5 is based on five key principles for governance and management of enterprise IT:

- *Principle 1*: Meeting Stakeholder Needs
- *Principle 2*: Covering the Enterprise End-to-End
- *Principle 3*: Applying a Single, Integrated Framework
- *Principle 4*: Enabling a Holistic Approach
- *Principle 5*: Separating Governance From Management

COBIT is used not only to plan the IT security of an organization but also as a guideline for auditors. COBIT is a widely recognized and respected security control framework.

Fortunately, COBIT is only modestly referenced on the exam, so further details are not necessary. However, if you have interest in this concept, please visit the ISACA website (`www.isaca.org`), or if you want a general overview, read the COBIT entry on Wikipedia.

There are many other standards and guidelines for IT security. A few of these are:

- Open Source Security Testing Methodology Manual (OSSTMM) (`www.isecom.org/research/`): A peer-reviewed guide for the testing and analysis of a security infrastructure
- ISO/IEC 27002 (which replaced ISO 17799) (`https://www.iso.org/standard/54533.html`): An international standard that can be the basis of implementing organizational security and related management practices
- Information Technology Infrastructure Library (ITIL) (`www.itlibrary.org`): Initially crafted by the British government, ITIL is a set of recommended best practices for core IT security and operational processes and is often used as a starting point for the crafting of a customized IT security solution

Due Care and Due Diligence

Why is planning to plan security so important? One reason is the requirement for *due care* and *due diligence*. Due care is using reasonable care to protect the interests of an organization. Due diligence is practicing the activities that maintain the due care effort. For example, due care is developing a formalized security structure containing a security policy, standards, baselines, guidelines, and procedures. Due diligence is the continued application of this security structure onto the IT infrastructure of an organization. Operational security is the ongoing maintenance of continued due care and due diligence by all responsible parties within an organization.

In today's business environment, prudence is mandatory. Showing due care and due diligence is the only way to disprove negligence in an occurrence of loss. Senior management must show due care and due diligence to reduce their culpability and liability when a loss occurs.

Develop, Document, and Implement Security Policy, Standards, Procedures, and Guidelines

For most organizations, maintaining security is an essential part of ongoing business. If their security were seriously compromised, many organizations would fail. To reduce the likelihood of a security failure, the process of implementing security has been somewhat formalized with a hierarchical organization of documentation. Each level focuses on a specific type or category of information and issues. Developing and implementing documented security policy, standards, procedures, and guidelines produces a solid and reliable security infrastructure. This formalization has greatly reduced the chaos and complexity of designing and implementing security solutions for IT infrastructures.

Security Policies

The top tier of the formalization is known as a security policy. A *security policy* is a document that defines the scope of security needed by the organization and discusses the assets that require protection and the extent to which security solutions should go to provide the necessary protection. The security policy is an overview or generalization of an organization's security needs. It defines the main security objectives and outlines the security framework of an organization. It also identifies the major functional areas of data processing and clarifies and defines all relevant terminology. It should clearly define why security is important and what assets are valuable. It is a strategic plan for implementing security. It should broadly outline the security goals and practices that should be employed to protect the organization's vital interests. The document discusses the importance of security to every aspect of daily business operation and the importance of the support of the senior staff for the implementation of security. The security policy is used to assign responsibilities, define roles, specify audit requirements, outline enforcement processes, indicate compliance requirements, and define acceptable risk levels. This document is often used as the proof that senior management has exercised due care in protecting itself against intrusion, attack, and disaster. Security policies are compulsory.

Many organizations employ several types of security policies to define or outline their overall security strategy. An *organizational security policy* focuses on issues relevant to every aspect of an organization. An *issue-specific security policy* focuses on a specific network service, department, function, or other aspect that is distinct from the organization as a whole. A *system-specific security policy* focuses on individual systems or types of systems and prescribes approved hardware and software, outlines methods for locking down a system, and even mandates firewall or other specific security controls.

In addition to these focused types of security policies, there are three overall categories of security policies: regulatory, advisory, and informative. A *regulatory policy* is required whenever industry or legal standards are applicable to your organization. This policy discusses the regulations that must be followed and outlines the procedures that should be used to elicit compliance. An *advisory policy* discusses behaviors and activities that are acceptable and defines consequences of violations. It explains senior management's desires for security and compliance within an organization. Most policies are advisory. An *informative policy* is designed to provide information or knowledge about a specific subject, such as company goals, mission statements, or how the organization interacts with partners and customers. An informative policy provides support, research, or background information relevant to the specific elements of the overall policy.

From the security policies flow many other documents or sub-elements necessary for a complete security solution. Policies are broad overviews, whereas standards, baselines, guidelines, and procedures include more specific, detailed information on the actual security solution. Standards are the next level below security policies.

Security Policies and Individuals

As a rule of thumb, security policies (as well as standards, guidelines, and procedures) should not address specific individuals. Instead of assigning tasks and responsibilities to a person, the policy should define tasks and responsibilities to fit a role. That role is a function of administrative control or personnel management. Thus, a security policy does not define who is to do what but rather defines what must be done by the various roles within the security infrastructure. Then these defined security roles are assigned to individuals as a job description or an assigned work task.

Acceptable Use Policy

An *acceptable use policy* is a commonly produced document that exists as part of the overall security documentation infrastructure. The acceptable use policy is specifically designed to assign security roles within the organization as well as ensure the responsibilities tied to those roles. This policy defines a level of acceptable performance and expectation of behavior and activity. Failure to comply with the policy may result in job action warnings, penalties, or termination.

Security Standards, Baselines, and Guidelines

Once the main security policies are set, then the remaining security documentation can be crafted under the guidance of those policies. *Standards* define compulsory requirements for the homogenous use of hardware, software, technology, and security controls. They provide a course of action by which technology and procedures are uniformly implemented throughout an organization. Standards are tactical documents that define steps or methods to accomplish the goals and overall direction defined by security policies.

At the next level are baselines. A *baseline* defines a minimum level of security that every system throughout the organization must meet. A baseline is a more operationally focused form of a standard. It takes the goals of a security policy and the requirements of the standards and defines them specifically in the baseline as a rule against which to implement and compare IT systems. All systems not complying with the baseline should be taken out of production until they can be brought up to the baseline. The baseline establishes a common foundational secure state on which all additional and more stringent security measures can be built. Baselines are usually system specific and often refer to an industry or government standard, like the Trusted Computer System Evaluation Criteria (TCSEC) or Information Technology Security Evaluation and Criteria (ITSEC) or NIST (National Institute of Standards and Technology) standards.

Guidelines are the next element of the formalized security policy structure. A *guideline* offers recommendations on how standards and baselines are implemented and serves as an operational guide for both security professionals and users. Guidelines are flexible so they can be customized for each unique system or condition and can be used in the creation of new procedures. They state which security mechanisms should be deployed instead of prescribing a specific product or control and detailing configuration settings. They outline methodologies, include suggested actions, and are not compulsory.

Security Procedures

Procedures are the final element of the formalized security policy structure. A *procedure* or *standard operating procedure (SOP)* is a detailed, step-by-step how-to document that describes the exact actions necessary to implement a specific security mechanism, control, or solution. A procedure could discuss the entire system deployment operation or focus on a single product or aspect, such as deploying a firewall or updating virus definitions. In most cases, procedures are system and software specific. They must be updated as the hardware and software of a system evolve. The purpose of a procedure is to ensure the integrity of business processes. If everything is accomplished by following a detailed procedure, then all activities should be in compliance with policies, standards, and guidelines. Procedures help ensure standardization of security across all systems.

All too often, policies, standards, baselines, guidelines, and procedures are developed only as an afterthought at the urging of a consultant or auditor. If these documents are not used and updated, the administration of a secured environment will be unable to use them as guides. And without the planning, design, structure, and oversight provided by these documents, no environment will remain secure or represent proper diligent due care.

It is also common practice to develop a single document containing aspects of all these elements. This should be avoided. Each of these structures must exist as a separate entity because each performs a different specialized function. At the top of the formalization security policy documentation structure there are fewer documents because they contain general broad discussions of overview and goals. There are more documents further down the formalization structure (in other words, guidelines and procedures) because they contain details specific to a limited number of systems, networks, divisions, and areas.

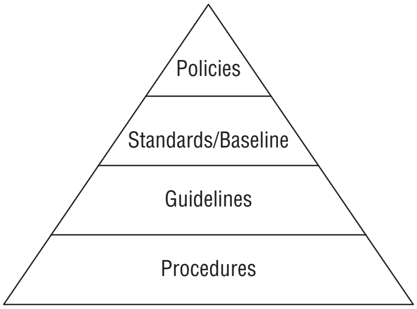
Keeping these documents as separate entities provides several benefits:

- Not all users need to know the security standards, baselines, guidelines, and procedures for all security classification levels.
- When changes occur, it is easier to update and redistribute only the affected material rather than updating a monolithic policy and redistributing it throughout the organization.

Crafting the totality of security policy and all supporting documentation can be a daunting task. Many organizations struggle just to define the foundational parameters of their security, much less detail every single aspect of their day-to-day activities. However, in theory, a detailed and complete security policy supports real-world security in a directed, efficient, and specific manner. Once the security policy documentation is reasonably complete, it can be used to guide decisions, train new users, respond to problems, and predict trends for future expansion. A security policy should not be an afterthought but a key part of establishing an organization.

There are a few additional perspectives to understand about the documentation that comprises a complete security policy. Figure 1.6 shows the dependencies of these components: policies, standards, guidelines, and procedures. The security policies define the overall structure of organized security documentation. Then, standards are based on those policies as well as mandated by regulations and contracts. From these the guidelines are derived. Finally, procedures are based on the three other components. The inverted pyramid is used to convey the volume or size of each of these documents. There are typically significantly more procedures than any other element in a complete security policy. Comparatively, there are fewer guidelines than procedures, fewer still standards, and usually even fewer still of overarching or organization-wide security policies.

FIGURE 1.6 The comparative relationships of security policy components



Understand and Apply Threat Modeling Concepts and Methodologies

Threat modeling is the security process where potential threats are identified, categorized, and analyzed. *Threat modeling* can be performed as a proactive measure during design and development or as a reactive measure once a product has been deployed. In either case, the process identifies the potential harm, the probability of occurrence, the priority of concern, and the means to eradicate or reduce the threat. In this section we present various examples of threat modeling concepts as well as several threat modeling methodologies.

Threat modeling isn't meant to be a single event. Instead it's common for an organization to begin threat modeling early in the design process of a system and continue throughout its lifecycle. For example, Microsoft uses a *Security Development Lifecycle (SDL)* process to consider and implement security at each stage of a product's development. This supports the motto of "Secure by Design, Secure by Default, Secure in Deployment and Communication" (also known as *SD3+C*). It has two goals in mind with this process:

- To reduce the number of security-related design and coding defects
- To reduce the severity of any remaining defects

In other words, it attempts to reduce vulnerabilities and reduce the impact of any vulnerabilities that remain. The overall result is reduced risk.

A *proactive approach* to threat modeling takes place during the early stages of systems development, specifically during initial design and specifications establishment. This type of threat modeling is also known as a defensive approach. This method is based on predicting threats and designing in specific defenses during the coding and crafting process, rather than relying on post-deployment updates and patches. In most cases, integrated security solutions are more cost effective and more successful than those shoehorned in later. Unfortunately, not all threats can be predicted during the design phase, so reactive approach threat modeling is still needed to address unforeseen issues.

A *reactive approach* to threat modeling takes place after a product has been created and deployed. This deployment could be in a test or laboratory environment or to the general marketplace. This type of threat modeling is also known as the adversarial approach. This technique of threat modeling is the core concept behind ethical hacking, penetration testing, source code review, and fuzz testing. Although these processes are often useful in finding flaws and threats that need to be addressed, they unfortunately result in additional effort in coding to add in new countermeasures. Returning back to the design phase might produce better products in the long run, but starting over from scratch is massively expensive and causes significant time delays to product release. Thus, the shortcut is to craft updates or patches to be added to the product after deployment. This results in less effective security improvements (over-proactive threat modeling) at the cost of potentially reducing functionality and user-friendliness.

NOTE

Fuzz testing is a specialized dynamic testing technique that provides many different types of input to software to stress its limits and find previously undetected flaws. Fuzz testing software supplies invalid input to the software, either randomly generated or specially crafted to trigger known software vulnerabilities. The fuzz tester then monitors the performance of the application, watching for software crashes, buffer overflows, or other undesirable and/or unpredictable outcomes. See Chapter 15, "Security Assessment and Testing," for more on fuzz testing.

Identifying Threats

There's an almost infinite possibility of threats, so it's important to use a structured approach to accurately identify relevant threats. For example, some organizations use one or more of the following three approaches:

Focused on Assets This method uses asset valuation results and attempts to identify threats to the valuable assets. For example, a specific asset can be evaluated to determine if it is susceptible to an attack. If the asset hosts data, access controls can be evaluated to identify threats that can bypass authentication or authorization mechanisms.

Focused on Attackers Some organizations are able to identify potential attackers and can identify the threats they represent based on the attacker's goals. For example, a government is often able to identify potential attackers and recognize what the attackers want to achieve. They can then use this knowledge to identify and protect their relevant assets. A challenge with this approach is that new attackers can appear that weren't previously considered a threat.

Focused on Software If an organization develops software, it can consider potential threats against the software. Although organizations didn't commonly develop their own software years ago, it's common to do so today. Specifically, most organizations have a web presence, and many create their own web pages. Fancy web pages drive more traffic, but they also require more sophisticated programming and present additional threats.

If the threat is identified as an attacker (as opposed to a natural threat), threat modeling attempts to identify what the attacker may be trying to accomplish. Some attackers may want to disable a system, whereas other attackers may want to steal data. Once such threats are identified, they are categorized based on their goals or motivations. Additionally, it's common to pair threats with vulnerabilities to identify threats that can exploit vulnerabilities and represent significant risks to the organization. An ultimate goal of threat modeling is to prioritize the potential threats against an organization's valuable assets.

When attempting to inventory and categorize threats, it is often helpful to use a guide or reference. Microsoft developed a threat categorization scheme known as the STRIDE threat model. STRIDE is often used in relation to assessing threats against applications or operating systems. However, it can also be used in other contexts as well. *STRIDE* is an acronym standing for the following:

- *Spoofing*: An attack with the goal of gaining access to a target system through the use of a falsified identity. Spoofing can be used against Internet Protocol (IP) addresses, MAC addresses, usernames, system names, wireless network service set identifiers (SSIDs), email addresses, and many other types of logical identification. When an attacker spoofs their identity as a valid or authorized entity, they are often able to bypass filters and blockades against unauthorized access. Once a spoofing attack has successfully granted an attacker access to a target system, subsequent attacks of abuse, data theft, or privilege escalation can be initiated.
- *Tampering*: Any action resulting in unauthorized changes or manipulation of data, whether in transit or in storage. Tampering is used to falsify communications or alter static information. Such attacks are a violation of integrity as well as availability.
- *Repudiation*: The ability of a user or attacker to deny having performed an action or activity. Often attackers engage in repudiation attacks in order to maintain plausible deniability so as not to be held accountable for their actions. Repudiation attacks can also result in innocent third parties being blamed for security violations.
- *Information disclosure*: The revelation or distribution of private, confidential, or controlled information to external or unauthorized entities. This could include customer identity information, financial information, or proprietary business operation details. Information disclosure can take advantage of system design and implementation mistakes, such as failing to remove debugging code, leaving sample applications and accounts, not sanitizing programming notes from client-visible content (such as comments in Hypertext Markup Language (HTML) documents), using hidden form fields, or allowing overly detailed error messages to be shown to users.
- *Denial of service (DoS)*: An attack that attempts to prevent authorized use of a resource. This can be done through flaw exploitation, connection overloading, or traffic flooding. A DoS attack does not necessarily result in full interruption to a resource; it could instead reduce throughput or introduce latency in order to hamper productive use of a resource. Although most DoS attacks are temporary and last only as long as the attacker maintains the onslaught, there are some permanent DoS attacks. A permanent DoS attack might involve the destruction of a dataset, the replacement of software with malicious alternatives, or forcing a firmware flash operation that could be

interrupted or that installs faulty firmware. Any of these DoS attacks would render a permanently damaged system that is not able to be restored to normal operation with a simple reboot or by waiting out the attackers. A full system repair and backup restoration would be required to recover from a permanent DoS attack.

- *Elevation of privilege*: An attack where a limited user account is transformed into an account with greater privileges, powers, and access. This might be accomplished through theft or exploitation of the credentials of a higher-level account, such as that of an administrator or root. It also might be accomplished through a system or application exploit that temporarily or permanently grants additional powers to an otherwise limited account.

Although STRIDE is typically used to focus on application threats, it is applicable to other situations, such as network threats and host threats. Other attacks may be more specific to network and host concerns, such as sniffing and hijacking for networks and malware and arbitrary code execution for hosts, but the six threat concepts of STRIDE are fairly broadly applicable.

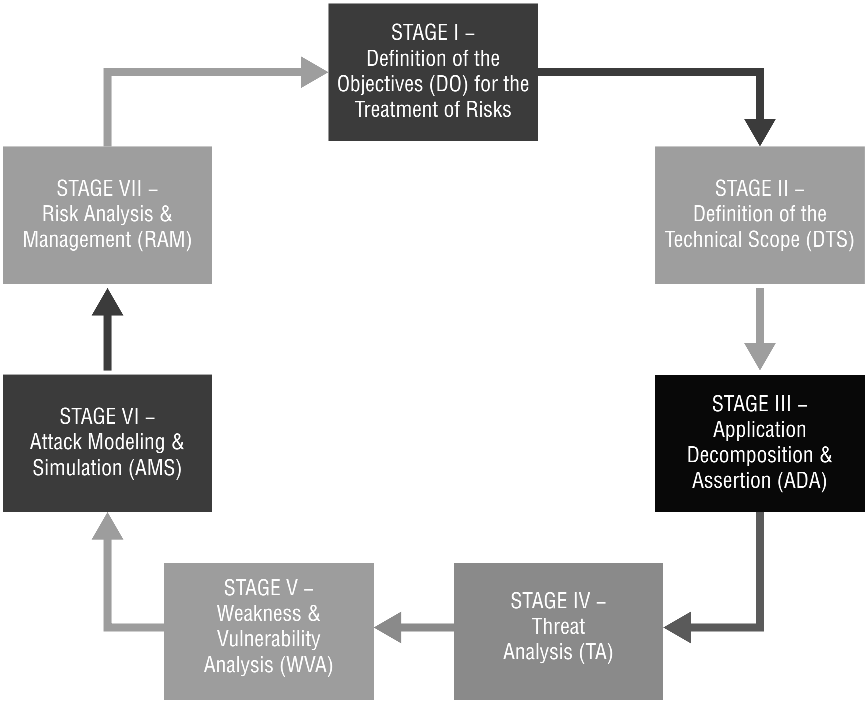
Process for Attack Simulation and Threat Analysis (PASTA) is a seven-stage (Figure 1.7) threat modeling methodology. PASTA is a risk-centric approach that aims at selecting or developing countermeasures in relation to the value of the assets to be protected. The following are the seven steps of PASTA:

- *Stage I*: Definition of the Objectives (DO) for the Analysis of Risks
- *Stage II*: Definition of the Technical Scope (DTS)
- *Stage III*: Application Decomposition and Analysis (ADA)
- *Stage IV*: Threat Analysis (TA)
- *Stage V*: Weakness and Vulnerability Analysis (WVA)
- *Stage VI*: Attack Modeling & Simulation (AMS)
- *Stage VII*: Risk Analysis & Management (RAM)

Each stage of PASTA has a specific list of objectives to achieve and deliverables to produce in order to complete the stage. For more information on PASTA, please see the book *Risk Centric Threat Modeling: Process for Attack Simulation and Threat Analysis*, first edition, by Tony UcedaVelez and Marco M. Morana. (You can view the appendix of this book online where PASTA is explored at `http://www.isaca.org/chapters5/Ireland/Documents/2013%20Presentations/PASTA%20Methodology%20Appendix%20-%20November%202013.pdf.)`

Trike is another threat modeling methodology that focuses on a risk-based approach instead of depending upon the aggregated threat model used in STRIDE and Disaster, Reproducibility, Exploitability, Affected Users, and Discoverability (DREAD) (see the “Prioritization and Response” section later in this chapter). Trike provides a method of performing a security audit in a reliable and repeatable procedure. It also provides a consistent framework for communication and collaboration among security workers. Trike is used to craft an assessment of an acceptable level of risk for each class of asset that is then used to determine appropriate risk response actions.

FIGURE 1.7 An example of diagramming to reveal threat concerns


STAGE I – Definition of the Objectives (DO) for the Treatment of Risks
STAGE II – Definition of the Technical Scope (DTS)
STAGE III – Application Decomposition & Assertion (ADA)
STAGE IV – Threat Analysis (TA)
STAGE V – Weakness & Vulnerability Analysis (WVA)
STAGE VI – Attack Modeling & Simulation (AMS)
STAGE VII – Risk Analysis & Management (RAM)

Visual, Agile, and Simple Threat (VAST) is a threat modeling concept based on Agile project management and programming principles. The goal of VAST is to integrate threat and risk management into an Agile programming environment on a scalable basis.

These are just a few of the vast array of threat modeling concepts and methodologies available from community groups, commercial entities, government agencies, and international associations.

Generally, the purpose of STRIDE and other threat modeling methodologies is to consider the range of compromise concerns and to focus on the goal or end results of an attack. Attempting to identify each and every specific attack method and technique is an impossible task—new attacks are being developed constantly. Although the goals or purposes of attacks can be loosely categorized and grouped, they remain relatively constant over time.

Be Alert for Individual Threats

Competition is often a key part of business growth, but overly adversarial competition can increase the threat level from individuals. In addition to criminal hackers and disgruntled employees, adversaries, contractors, employees, and even trusted partners can be a threat to an organization if relationships go sour.

- Never assume that a consultant or contractor has the same loyalty to your organization as a long-term employee. Contractors and consultants are effectively mercenaries who will work for the highest bidder. Don't take employee loyalty for granted either. Employees who are frustrated with their working environment or feel they've been treated unfairly may attempt to retaliate. An employee experiencing financial hardship may consider unethical and illegal activities that pose a threat to your business for their own gain.
- A trusted partner is only a trusted partner as long as it is in your mutual self-interest to be friendly and cooperative toward each other. Eventually a partnership might sour or become adversarial; then, your former partner might take actions that pose a threat to your business.

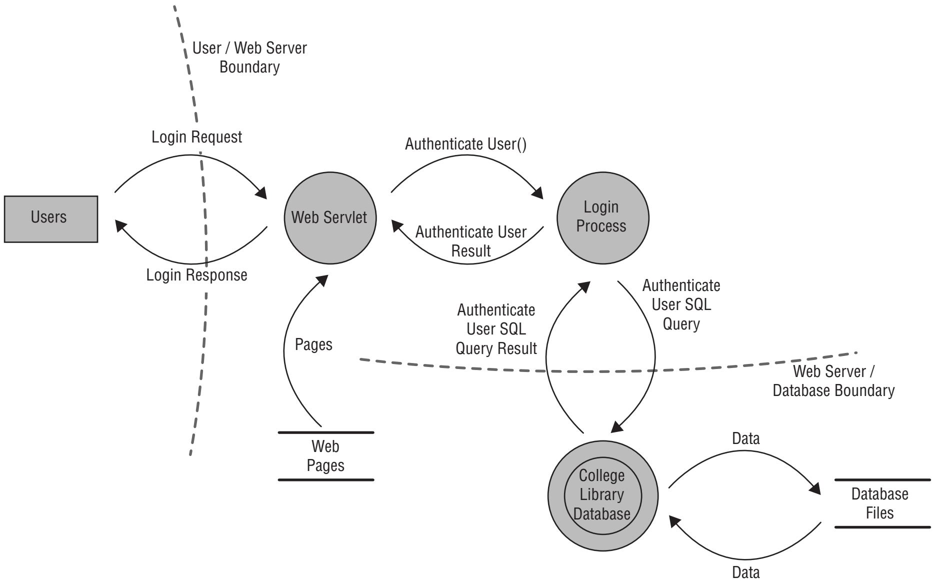
Potential threats to your business are broad and varied. A company faces threats from nature, technology, and people. Most businesses focus on natural disasters and IT attacks in preparing for threats, but it's also important to consider threat potential from individuals. Always consider the best and worst possible outcomes of your organization's activities, decisions, and interactions. Identifying threats is the first step toward designing defenses to help reduce or eliminate downtime, compromise, and loss.

Determining and Diagramming Potential Attacks

Once an understanding has been gained in regard to the threats facing your development project or deployed infrastructure, the next step in threat modeling is to determine the potential attack concepts that could be realized. This is often accomplished through the creation of a diagram of the elements involved in a transaction along with indications of data flow and privilege boundaries (Figure 1.8). This image is an example of a data flow diagram that shows each major component of a system, the boundaries between security zones, and the potential flow or movement of information and data. By crafting such a diagram for each environment or system, it is possible to more closely examine each point where a compromise could occur.

Such data flow diagrams are useful in gaining a better understanding of the relationships of resources and movement of data through a visual representation. This process of diagramming is also known as crafting an architecture diagram. The creation of the diagram helps to detail the functions and purpose of each element of a business task, development process, or work activity. It is important to include users, processors, applications, data-stores, and all other essential elements needed to perform the specific task or operation. This is a high-level overview and not a detailed evaluation of the coding logic. However, for more complex systems, multiple diagrams may need to be created at various focus points and at varying levels of detail magnification.

FIGURE 1.8 An example of diagramming to reveal threat concerns



Once a diagram has been crafted, identify all of the technologies involved. This would include operating systems, applications (network service and client based), and protocols. Be specific as to the version numbers and update/patch level in use.

Next, identify attacks that could be targeted at each element of the diagram. Keep in mind that all forms of attacks should be considered, including logical/technical, physical, and social. For example, be sure to include spoofing, tampering, and social engineering. This process will quickly lead you into the next phase of threat modeling: reduction analysis.

Performing Reduction Analysis

The next step in threat modeling is to perform reduction analysis. *Reduction analysis* is also known as *decomposing* the application, system, or environment. The purpose of this task is to gain a greater understanding of the logic of the product as well as its interactions with external elements. Whether an application, a system, or an entire environment, it needs to be divided into smaller containers or compartments. Those might be subroutines, modules, or objects if you're focusing on software, computers, or operating systems; they might be protocols if you're focusing on systems or networks; or they might be departments, tasks, and networks if you're focusing on an entire business infrastructure. Each identified sub-element should be evaluated in order to understand inputs, processing, security, data management, storage, and outputs.

In the decomposition process, you must identify five key concepts:

Trust Boundaries Any location where the level of trust or security changes

Data Flow Paths The movement of data between locations

Input Points Locations where external input is received

Privileged Operations Any activity that requires greater privileges than of a standard user account or process, typically required to make system changes or alter security

Details about Security Stance and Approach The declaration of the security policy, security foundations, and security assumptions

Breaking down a system into its constituent parts makes it much easier to identity the essential components of each element as well as take notice of vulnerabilities and points of attack. The more you understand exactly how a program, system, or environment operates, the easier it is to identity threats to it.

Prioritization and Response

As threats are identified through the threat modeling procedure, additional activities are prescribed to round out the process. Next is to fully document the threats. In this documentation, you should define the means, target, and consequences of a threat. Consider including the techniques required to implement an exploitation as well as list potential countermeasures and safeguards.

After documentation, rank or rate the threats. This can be accomplished using a wide range of techniques, such as Probability × Damage Potential ranking, high/medium/low rating, or the DREAD system.

The ranking technique of Probability × Damage Potential produces a risk severity number on a scale of 1 to 100, with 100 the most severe risk possible. Each of the two initial values can be assigned numbers between 1 and 10, with 1 being lowest and 10 being highest. These rankings can be somewhat arbitrary and subjective, but since the same person or team will be assigning the numbers for their own organization, it should still result in assessment values that are accurate on a relative basis.

The high/medium/low rating process is even simpler. Each threat is assigned one of these three priority labels. Those given the high-priority label need to be addressed immediately. Those given the medium-priority label should be addressed eventually, but they don't require immediate action. Those given the low-priority level might be addressed, but they could be deemed optional if they require too much effort or expense in comparison to the project as a whole.

The *DREAD* rating system is designed to provide a flexible rating solution that is based on the answers to five main questions about each threat:

- *Damage potential*: How severe is the damage likely to be if the threat is realized?
- *Reproducibility*: How complicated is it for attackers to reproduce the exploit?

- *Exploitability*: How hard is it to perform the attack?
- *Affected users*: How many users are likely to be affected by the attack (as a percentage)?
- *Discoverability*: How hard is it for an attacker to discover the weakness?

By asking these and potentially additional customized questions, along with assigning H/M/L or 3/2/1 values to the answers, you can establish a detailed threat prioritization.

Once threat priorities are set, responses to those threats need to be determined. Technologies and processes to remediate threats should be considered and weighted according to their cost and effectiveness. Response options should include making adjustments to software architecture, altering operations and processes, and implementing defensive and detective components.

Apply Risk-Based Management Concepts to the Supply Chain

Applying risk-based management concepts to the supply chain is a means to ensure a more robust and successful security strategy in organizations of all sizes. A *supply chain* is the concept that most computers, devices, networks, and systems are not built by a single entity. In fact, most of the companies we know of as computer and equipment manufacturers, such as Dell, Cisco, Extreme Networks, Juniper, Asus, Acer, and Apple, generally perform the final assembly rather than manufacture all of the individual components. Often the CPU, memory, drive controllers, hard drives, SSDs, and video cards are created by other third-party vendors. Even these commodity vendors are unlikely to have mined their own metals or processed the oil for plastics or etched the silicon of their chips. Thus, any finished system has a long and complex history, known as its *supply chain*, that enabled it to come into existence.

A secure supply chain is one in which all of the vendors or links in the chain are reliable, trustworthy, reputable organizations that disclose their practices and security requirements to their business partners (although not necessarily to the public). Each link in the chain is responsible and accountable to the next link in the chain. Each hand-off from raw materials to refined products to electronics parts to computer components to the finished product is properly organized, documented, managed, and audited. The goal of a secure supply chain is to ensure that the finished product is of sufficient quality, meets performance and operational goals, and provides stated security mechanisms, and that at no point in the process was any element counterfeited or subjected to unauthorized or malicious manipulation or sabotage. For an additional perspective on supply chain risk, view a NIST case study located at `https://www.nist.gov/sites/default/files/documents/itl/csd/NIST_USRP-Boeing-Exostar-Case-Study.pdf`.

When acquisitions and mergers are made without security considerations, the risks inherent in those products remain throughout their deployment life span. Minimizing inherent threats in acquired elements will reduce security management costs and likely reduce security violations.

It is important to evaluate the risks associated with hardware, software, and services. Products and solutions that have resilient integrated security are often more expensive than those that fail to have a security foundation. However, this additional initial expense is often a much more cost-effective expenditure than addressing security needs over the life of a poorly designed product. Thus, when considering the cost of a merger/acquisition, it is important to consider the total cost of ownership over the life of the product's deployment rather than just initial purchase and implementation.

Acquisition does not relate exclusively to hardware and software. Outsourcing, contracting with suppliers, and engaging consultants are also elements of acquisition. Integrating security assessments when working with external entities is just as important as ensuring a product was designed with security in mind.

In many cases, ongoing security monitoring, management, and assessment may be required. This could be an industry best practice or a regulation. Such assessment and monitoring might be performed by the organization internally or may require the use of external auditors. When engaging third-party assessment and monitoring services, keep in mind that the external entity needs to show security-mindedness in their business operations. If an external organization is unable to manage their own internal operations on a secure basis, how can they provide reliable security management functions for yours?

When evaluating a third party for your security integration, consider the following processes:

On-Site Assessment Visit the site of the organization to interview personnel and observe their operating habits.

Document Exchange and Review Investigate the means by which datasets and documentation are exchanged as well as the formal processes by which they perform assessments and reviews.

Process/Policy Review Request copies of their security policies, processes/procedures, and documentation of incidents and responses for review.

Third-Party Audit Having an independent third-party auditor, as defined by the American Institute of Certified Public Accountants (AICPA), can provide an unbiased review of an entity's security infrastructure, based on Service Organization Control (SOC) (SOC) reports. Statement on Standards for Attestation Engagements (SSAE) is a regulation that defines how service organizations report on their compliance using the various SOC reports. The SSAE 16 version of the regulation, effective June 15, 2011, was replaced by SSAE 18 as of May 1, 2017. The SOC1 and SOC2 auditing frameworks are worth considering for the purpose of a security assessment. The SOC1 audit focuses on a description of security mechanisms to assess their suitability. The SOC2 audit focuses on implemented security controls in relation to availability, security, integrity, privacy, and confidentiality. For more on SOC audits, see `https://www.aicpa.org/interestareas/frc/assuranceadvisoryservices/socguidesandpublications.html`.

For all acquisitions, establish minimum security requirements. These should be modeled from your existing security policy. The security requirements for new hardware, software, or services should always meet or exceed the security of your existing infrastructure. When working with an external service, be sure to review any *service-level agreement (SLA)* to ensure that security is a prescribed component of the contracted services. This could include customization of service-level requirements for your specific needs.

Here are some excellent resources related to security integrated with acquisition:

- Improving Cybersecurity and Resilience through Acquisition. Final Report of the Department of Defense and General Services Administration, published November 2013 (`www.gsa.gov/portal/getMediaData?mediaId=185371`)
- NIST Special Publication 800-64 Revision 2: Security Considerations in the System Development Life Cycle (`http://csrc.nist.gov/publications/nistpubs/800-64-Rev2/SP800-64-Revision2.pdf`)

Summary

Security governance, management concepts, and principles are inherent elements in a security policy and in solution deployment. They define the basic parameters needed for a secure environment. They also define the goals and objectives that both policy designers and system implementers must achieve in order to create a secure solution.

The primary goals and objectives of security are contained within the CIA Triad: confidentiality, integrity, and availability. These three principles are considered the most important within the realm of security. Their importance to an organization depends on the organization's security goals and requirements and on how much of a threat to security exists in its environment.

The first principle from the CIA Triad is confidentiality, the principle that objects are not disclosed to unauthorized subjects. Security mechanisms that offer confidentiality offer a high level of assurance that data, objects, or resources are not exposed to unauthorized subjects. If a threat exists against confidentiality, there is the possibility that unauthorized disclosure could take place.

The second principle from the CIA Triad is integrity, the principle that objects retain their veracity and are intentionally modified by only authorized subjects. Security mechanisms that offer integrity offer a high level of assurance that the data, objects, and resources are unaltered from their original protected state. This includes alterations occurring while the object is in storage, in transit, or in process. Maintaining integrity means the object itself is not altered and the operating system and programming entities that manage and manipulate the object are not compromised.

The third principle from the CIA Triad is availability, the principle that authorized subjects are granted timely and uninterrupted access to objects. Security mechanisms that offer availability offer a high level of assurance that the data, objects, and resources are accessible to authorized subjects. Availability includes efficient uninterrupted access to objects and prevention of denial-of-service attacks. It also implies that the supporting infrastructure is functional and allows authorized users to gain authorized access.

Other security-related concepts and principles that should be considered and addressed when designing a security policy and deploying a security solution are privacy, identification, authentication, authorization, accountability, nonrepudiation, and auditing.

Other aspects of security solution concepts and principles are the elements of protection mechanisms: layering, abstraction, data hiding, and encryption. These are common characteristics of security controls, and although not all security controls must have them, many controls use these mechanisms to protect confidentiality, integrity, and availability.

Security roles determine who is responsible for the security of an organization's assets. Those assigned the senior management role are ultimately responsible and liable for any asset loss, and they are the ones who define security policy. Security professionals are responsible for implementing security policy, and users are responsible for complying with the security policy. The person assigned the data owner role is responsible for classifying information, and a data custodian is responsible for maintaining the secure environment and backing up data. An auditor is responsible for making sure a secure environment is properly protecting assets.

A formalized security policy structure consists of policies, standards, baselines, guidelines, and procedures. These individual documents are essential elements to the design and implementation of security in any environment.

The control or management of change is an important aspect of security management practices. When a secure environment is changed, loopholes, overlaps, missing objects, and oversights can lead to new vulnerabilities. You can, however, maintain security by systematically managing change. This typically involves extensive logging, auditing, and monitoring of activities related to security controls and security mechanisms. The resulting data is then used to identify agents of change, whether objects, subjects, programs, communication pathways, or even the network itself.

Data classification is the primary means by which data is protected based on its secrecy, sensitivity, or confidentiality. Because some data items need more security than others, it is inefficient to treat all data the same when designing and implementing a security system. If everything is secured at a low security level, sensitive data is easily accessible, but securing everything at a high security level is too expensive and restricts access to unclassified, noncritical data. Data classification is used to determine how much effort, money, and resources are allocated to protect the data and control access to it.

An important aspect of security management planning is the proper implementation of a security policy. To be effective, the approach to security management must be a top-down approach. The responsibility of initiating and defining a security policy lies with upper or senior management. Security policies provide direction for the lower levels of the organization's hierarchy. Middle management is responsible for fleshing out the security policy into standards, baselines, guidelines, and procedures. It is the responsibility of the operational managers or security professionals to implement the configurations prescribed in the security management documentation. Finally, the end users' responsibility is to comply with all security policies of the organization.

Security management planning includes defining security roles, developing security policies, performing risk analysis, and requiring security education for employees. These responsibilities are guided by the developments of management plans. The security management team should develop strategic, tactical, and operational plans.

Threat modeling is the security process where potential threats are identified, categorized, and analyzed. Threat modeling can be performed as a proactive measure during design and development or as a reactive measure once a product has been deployed. In either case, the process identifies the potential harm, the probability of occurrence, the priority of concern, and the means to eradicate or reduce the threat.

Integrating cyber security risk management with supply chain, acquisition strategies, and business practices is a means to ensure a more robust and successful security strategy in organizations of all sizes. When purchases are made without security considerations, the risks inherent in those products remain throughout their deployment life span.

Exam Essentials

Understand the CIA Triad elements of confidentiality, integrity, and availability. Confidentiality is the principle that objects are not disclosed to unauthorized subjects. Integrity is the principle that objects retain their veracity and are intentionally modified by only authorized subjects. Availability is the principle that authorized subjects are granted timely and uninterrupted access to objects. Know why these are important, the mechanisms that support them, the attacks that focus on each, and the effective countermeasures.

Be able to explain how identification works. Identification is the process by which a subject professes an identity and accountability is initiated. A subject must provide an identity to a system to start the process of authentication, authorization, and accountability.

Understand the process of authentication. Authentication is the process of verifying or testing that a claimed identity is valid. Authentication requires information from the subject that must exactly correspond to the identity indicated.

Know how authorization fits into a security plan. Once a subject is authenticated, its access must be authorized. The process of authorization ensures that the requested activity or object access is possible given the rights and privileges assigned to the authenticated identity.

Understand security governance. Security governance is the collection of practices related to supporting, defining, and directing the security efforts of an organization.

Be able to explain the auditing process. Auditing, or monitoring, is the programmatic means by which subjects are held accountable for their actions while authenticated on a system. Auditing is also the process by which unauthorized or abnormal activities are detected on a system. Auditing is needed to detect malicious actions by subjects, attempted intrusions, and system failures and to reconstruct events, provide evidence for prosecution, and produce problem reports and analysis.

Understand the importance of accountability. An organization's security policy can be properly enforced only if accountability is maintained. In other words, security can be maintained only if subjects are held accountable for their actions. Effective accountability relies on the capability to prove a subject's identity and track their activities.

Be able to explain nonrepudiation. Nonrepudiation ensures that the subject of an activity or event cannot deny that the event occurred. It prevents a subject from claiming not to have sent a message, not to have performed an action, or not to have been the cause of an event.

Understand security management planning. Security management is based on three types of plans: strategic, tactical, and operational. A strategic plan is a long-term plan that is fairly stable. It defines the organization's goals, mission, and objectives. The tactical plan is a midterm plan developed to provide more details on accomplishing the goals set forth in the strategic plan. Operational plans are short-term and highly detailed plans based on the strategic and tactical plans.

Know the elements of a formalized security policy structure. To create a comprehensive security plan, you need the following items in place: security policy, standards, baselines, guidelines, and procedures. Such documentation clearly states security requirements and creates due diligence on the part of the responsible parties.

Understand key security roles. The primary security roles are senior manager, organizational owner, upper management, security professional, user, data owner, data custodian, and auditor. By creating a security role hierarchy, you limit risk overall.

Know how to implement security awareness training. Before actual training can take place, awareness of security as a recognized entity must be created for users. Once this is accomplished, training, or teaching employees to perform their work tasks and to comply with the security policy, can begin. All new employees require some level of training so they will be able to comply with all standards, guidelines, and procedures mandated by the security policy. Education is a more detailed endeavor in which students/users learn much more than they actually need to know to perform their work tasks. Education is most often associated with users pursuing certification or seeking job promotion.

Know how layering simplifies security. Layering is the use of multiple controls in series. Using a multilayered solution allows for numerous controls to guard against threats.

Be able to explain the concept of abstraction. Abstraction is used to collect similar elements into groups, classes, or roles that are assigned security controls, restrictions, or permissions as a collective. It adds efficiency to carrying out a security plan.

Understand data hiding. Data hiding is exactly what it sounds like: preventing data from being discovered or accessed by a subject. It is often a key element in security controls as well as in programming.

Understand the need for encryption. Encryption is the art and science of hiding the meaning or intent of a communication from unintended recipients. It can take many forms and be applied to every type of electronic communication, including text, audio, and video files, as well as programs themselves. Encryption is an important element in security controls, especially in regard to the transmission of data between systems.

Be able to explain the concepts of change control and change management. Change in a secure environment can introduce loopholes, overlaps, missing objects, and oversights that can lead to new vulnerabilities. The only way to maintain security in the face of change is to systematically manage change.

Know why and how data is classified. Data is classified to simplify the process of assigning security controls to groups of objects rather than to individual objects. The two common classification schemes are government/military and commercial business/private sector. Know the five levels of government/military classification and the four levels of commercial business/private sector classification.

Understand the importance of declassification. Declassification is required once an asset no longer warrants the protection of its currently assigned classification or sensitivity level.

Know the basics of COBIT. Control Objectives for Information and Related Technologies (COBIT) is a security concept infrastructure used to organize the complex security solutions of companies.

Know the basics of threat modeling. Threat modeling is the security process where potential threats are identified, categorized, and analyzed. Threat modeling can be performed as a proactive measure during design and development or as a reactive measure once a product has been deployed. Key concepts include assets/attackers/software, STRIDE, PASTA, Trike, VAST, diagramming, reduction/decomposing, and DREAD.

Understand the need to apply risk-based management concepts to the supply chain. Applying risk-based management concepts to the supply chain is a means to ensure a more robust and successful security strategy in organizations of all sizes. When purchases and acquisitions are made without security considerations, the risks inherent in those products remain throughout their deployment life span.

Written Lab

1. Discuss and describe the CIA Triad.
2. What are the requirements to hold a person accountable for the actions of their user account?
3. Describe the benefits of change control management.
4. What are the seven major steps or phases in the implementation of a classification scheme?
5. Name the six primary security roles as defined by (ISC)^2 for CISSP.
6. What are the four components of a complete organizational security policy and their basic purpose?

Review Questions

1. Which of the following contains the primary goals and objectives of security?
   - **A.** A network's border perimeter
   - **B.** The CIA Triad
   - **C.** A stand-alone system
   - **D.** The internet

2. Vulnerabilities and risks are evaluated based on their threats against which of the following?
   - **A.** One or more of the CIA Triad principles
   - **B.** Data usefulness
   - **C.** Due care
   - **D.** Extent of liability

3. Which of the following is a principle of the CIA Triad that means authorized subjects are granted timely and uninterrupted access to objects?
   - **A.** Identification
   - **B.** Availability
   - **C.** Encryption
   - **D.** Layering

4. Which of the following is *not* considered a violation of confidentiality?
   - **A.** Stealing passwords
   - **B.** Eavesdropping
   - **C.** Hardware destruction
   - **D.** Social engineering

5. Which of the following is not true?
   - **A.** Violations of confidentiality include human error.
   - **B.** Violations of confidentiality include management oversight.
   - **C.** Violations of confidentiality are limited to direct intentional attacks.
   - **D.** Violations of confidentiality can occur when a transmission is not properly encrypted.

6. STRIDE is often used in relation to assessing threats against applications or operating systems. Which of the following is not an element of STRIDE?
   - **A.** Spoofing
   - **B.** Elevation of privilege
   - **C.** Repudiation
   - **D.** Disclosure

7. If a security mechanism offers availability, then it offers a high level of assurance that authorized subjects can ______________________ the data, objects, and resources.
   - A. Control
   - B. Audit
   - C. Access
   - D. Repudiate

8. ____________ refers to keeping information confidential that is personally identifiable or that might cause harm, embarrassment, or disgrace to someone if revealed.
   - A. Seclusion
   - B. Concealment
   - C. Privacy
   - D. Criticality

9. All but which of the following items requires awareness for all individuals affected?
   - A. Restricting personal email
   - B. Recording phone conversations
   - C. Gathering information about surfing habits
   - D. The backup mechanism used to retain email messages

10. What element of data categorization management can override all other forms of access control?
    - A. Classification
    - B. Physical access
    - C. Custodian responsibilities
    - D. Taking ownership

11. What ensures that the subject of an activity or event cannot deny that the event occurred?
    - A. CIA Triad
    - B. Abstraction
    - C. Nonrepudiation
    - D. Hash totals

12. Which of the following is the most important and distinctive concept in relation to layered security?
    - A. Multiple
    - B. Series
    - C. Parallel
    - D. Filter

13. Which of the following is *not* considered an example of data hiding?

A. Preventing an authorized reader of an object from deleting that object

B. Keeping a database from being accessed by unauthorized visitors

C. Restricting a subject at a lower classification level from accessing data at a higher classification level

D. Preventing an application from accessing hardware directly

14. What is the primary goal of change management?

A. Maintaining documentation

B. Keeping users informed of changes

C. Allowing rollback of failed changes

D. Preventing security compromises

15. What is the primary objective of data classification schemes?

A. To control access to objects for authorized subjects

B. To formalize and stratify the process of securing data based on assigned labels of importance and sensitivity

C. To establish a transaction trail for auditing accountability

D. To manipulate access controls to provide for the most efficient means to grant or restrict functionality

16. Which of the following is typically *not* a characteristic considered when classifying data?

A. Value

B. Size of object

C. Useful lifetime

D. National security implications

17. What are the two common data classification schemes?

A. Military and private sector

B. Personal and government

C. Private sector and unrestricted sector

D. Classified and unclassified

18. Which of the following is the lowest military data classification for classified data?

A. Sensitive

B. Secret

C. Proprietary

D. Private

19. Which commercial business/private sector data classification is used to control information about individuals within an organization?

    A. Confidential

    B. Private

    C. Sensitive

    D. Proprietary

20. Data classifications are used to focus security controls over all but which of the following?

    A. Storage

    B. Processing

    C. Layering

    D. Transfer