Vulnerabilities

Everything built by humans is vulnerable to something. Our information systems, in particular, are riddled with vulnerabilities even in the best-defended cases. One need only read news accounts of the compromise of the highly protected and classified systems of defense contractors and even governments to see that this universal principle is true. To properly analyze vulnerabilities, it is useful to recall that information systems consist of information, processes, and people that are typically, but not always, interacting with computer systems. Since we discuss computer system vulnerabilities in detail in Chapter 6, we will briefly discuss the other three components here.

Information In almost every case, the information at the core of our information systems is the most valuable asset to a potential adversary. Information within a computer information system (CIS) is represented as data. This information may be stored (data at rest), transported between parts of our system (data in transit), or actively being used by the system (data in use). In each of its three states, the information exhibits different vulnerabilities, as listed in the following examples:

- **Data at rest** Data is copied to a thumb drive and given to unauthorized parties by an insider, thus compromising its confidentiality.
- **Data in transit** Data is modified by an external actor intercepting it on the network and then relaying the altered version (known as a man-in-the-middle or MitM attack), thus compromising its integrity.
- **Data in use** Data is deleted by a malicious process exploiting a "time-of-check to time-of-use" (TOC/TOU) or "race condition" vulnerability, thus compromising its availability.

Processes Most organizations implement standardized processes to ensure the consistency and efficiency of their services and products. It turns out, however, that efficiency is pretty easy to hack. Consider the case of shipping containers. Someone wants to ship something from point A to point B, say a container of bananas from Brazil to Belgium. Once the shipping order is placed and the destination entered, that information flows from the farm to a truck carrier, to the seaport of origin to the ocean carrier, to the destination seaport, to another truck carrier, and finally to its destination at some distribution center in Antwerp. In most cases, nobody pays a lot of attention to the address once it is entered. But what if an attacker knew this and changed the address while the shipment was at sea? The attacker could have the shipment show up at a different destination and even control the arrival time. This technique has actually been used by drug and weapons smuggling gangs to get their "bananas" to where they need them.

This sort of attack is known as *business process compromise (BPC)* and is commonly targeted at the financial sector, where transaction amounts, deposit accounts, or other parameters are changed to funnel money to the attackers' pockets. Since business processes are almost always instantiated in software as part of a CIS, process vulnerabilities can be thought of as a specific kind of software vulnerability. As security professionals, however,

it is important that we take a broader view of the issue and think about the business processes that are implemented in our software systems.

People Many security experts consider humans to be the weakest link in the security chain. Whether or not you agree with this, it is important to consider the specific vulnerabilities that people present in a system. Though there are many ways to exploit the human in the loop, there are three that correspond to the bulk of the attacks, summarized briefly here:

- **Social engineering** This is the process of getting a person to violate a security procedure or policy, and usually involves human interaction or e-mail/text messages.
- **Social networks** The prevalence of social network use provides potential attackers with a wealth of information that can be leveraged directly (e.g., blackmail) or indirectly (e.g., crafting an e-mail with a link that is likely to be clicked) to exploit people.
- **Passwords** Weak passwords can be cracked in milliseconds using rainbow tables and are very susceptible to dictionary or brute-force attacks. Even strong passwords are vulnerable if they are reused across sites and systems.

Threats

As you identify the vulnerabilities that are inherent to your organization and its systems, it is important to also identify the sources that could attack them. The International Organization for Standardization and the International Electrotechnical Commission in their joint ISO/IEC standard 27000 define a *threat* as a "potential cause of an unwanted incident, which can result in harm to a system or organization." While this may sound somewhat vague, it is important to include the full breadth of possibilities. When a threat is one or more humans, we typically use the term *threat actor* or *threat agent*. Let's start with the most obvious: malicious humans.

Cybercriminals Cybercriminals are the most common threat actors encountered by individuals and organizations. Most cybercriminals are motivated by greed, but some just enjoy breaking things. Their skills run the gamut, from so-called *script kiddies* with just a basic grasp of hacking (but access to someone else's scripts or tools) to sophisticated cybercrime gangs who develop and sometimes sell or rent their services and tools to others. Cybercrime is the fastest-growing sector of criminal activity in many countries.

One of the factors that makes cybercrime so pervasive is that every connected device is a target. Some devices are immediately monetizable, such as your personal smartphone or home computer containing credentials, payment card information, and access to your financial institutions. Other targets provide bigger payouts, such as the finance systems in your place of work. Even devices that are not, by themselves, easily monetizable can be hijacked and joined into a botnet to spread malware, conduct distributed denial-of-service (DDoS) attacks, or serve as staging bases from which to attack other targets.

Nation-State Actors Whereas cybercriminals tend to cast a wide net in an effort to maximize their profits, nation-state actors (or simply *state actors*) are very selective in

who they target. They use advanced capabilities to compromise systems and establish a persistent presence to allow them to collect intelligence (e.g., sensitive data, intellectual property, etc.) for extended periods. After their presence is established, state actors may use prepositioned assets to trigger devastating effects in response to world events. Though their main motivations tend to be espionage and gaining persistent access to critical infrastructure, some state actors maintain good relations with cybercrime groups in their own country, mostly for the purposes of plausible deniability. By collaborating with these criminals, state actors can make it look as if an attack against another nation was a crime and not an act of war. At least one country is known to use its national offensive cyber capabilities for financial profit, stealing millions of dollars all over the world.

Many security professionals consider state actors a threat mostly to government organizations, critical infrastructure like power plants, and anyone with sophisticated research and development capabilities. In reality, however, these actors can and do target other organizations, typically to use them as a springboard into their ultimate targets. So, even if you work for a small company that seems uninteresting to a foreign nation, you could find your company in a state actor's crosshairs.

Hacktivists Hacktivists use cyberattacks to effect political or social change. The term covers a diverse ecosystem, encompassing individuals and groups of various skillsets and capabilities. Hacktivists' preferred objectives are highly visible to the public or yield information that, when made public, aims to embarrass government entities or undermine public trust in them.

Internal Actors Internal actors are people within the organization, such as employees, former employees, contractors, or business associates, who have inside information concerning the organization's security practices, data, and computer systems. Broadly speaking, there are two types of insider threats: negligent and malicious. A negligent insider is one who fails to exercise due care, which puts their organization at risk. Sometimes, these individuals knowingly violate policies or disregard procedures, but they are not doing so out of malicious intent. For example, an employee could disregard a policy requiring visitors to be escorted at all times because someone shows up wearing the uniform of a telecommunications company and claiming to be on site to fix an outage. This insider trusts the visitor, which puts the organization at risk, particularly if that person is an impostor.

The second type of insider threat is characterized by malicious intent. Malicious insiders use the knowledge they have about their organization either for their own advantage (e.g., to commit fraud) or to directly cause harm (e.g., by deleting sensitive files). While some malicious insiders plan their criminal activity while they are employees in good standing, others are triggered by impending termination actions. Knowing (or suspecting) that they're about to be fired, they may attempt to steal sensitive data (such as customer contacts or design documents) before their access is revoked. Other malicious insiders may be angry and plant malware or destroy assets in an act of revenge. This insider threat highlights the need for the "zero trust" secure design principle (discussed in Chapter 9). It is also a really good reason to practice the termination processes discussed in Chapter 1.

In the wake of the massive leak of classified data attributed to Edward Snowden in 2012, there's been increased emphasis on techniques and procedures for identifying and mitigating the insider threat source. While the deliberate insider dominates the news, it is important to note that the accidental insider can be just as dangerous, particularly if they fall into one of the vulnerability classes described in the preceding section.

Nature Finally, the nonhuman threat source can be just as important as the ones we've previously discussed. Hurricane Katrina in 2005 and the Tohoku earthquake and tsunami in 2011 serve as reminders that natural events can be more destructive than any human attack. They also force the information systems security professional to consider threats that fall way outside the norm. Though it is easier and, in many cases, cheaper to address likelier natural events such as a water main break or a fire in a facility, one should always look for opportunities to leverage countermeasures that protect against both mild and extreme events for small price differentials.

Identifying Threats and Vulnerabilities

Earlier, it was stated that the definition of a risk is the probability of a threat exploiting a vulnerability to cause harm to an asset and the resulting business impact. Many types of threat actors can take advantage of several types of vulnerabilities, resulting in a variety of specific threats, as outlined in Table 2-1, which represents only a sampling of the risks many organizations should address in their risk management programs.

Other types of threats can arise in an environment that are much harder to identify than those listed in Table 2-1. These other threats have to do with application and user errors. If an application uses several complex equations to produce results, the threat can be difficult to discover and isolate if these equations are incorrect or if the application is using inputted data incorrectly. This can result in *illogical processing* and *cascading errors* as invalid results are passed on to another process. These types of problems can lie within application code and are very hard to identify.

Threat Actor	Can Exploit This Vulnerability	To Cause This Effect
Cybercriminal	Lack of antimalware software	Ransomed data
Nation-state actor	Password reuse in privileged accounts	Unauthorized access to confidential information
Negligent user	Misconfigured parameter in the operating system	Loss of availability due to a system malfunction
Fire	Lack of fire extinguishers	Facility and computer loss or damage, and possibly loss of life
Malicious insider	Poor termination procedures	Deletion of business-critical information
Hacktivist	Poorly written web application	Website defacement
Burglar	Lack of security guard	Breaking windows and stealing computers and devices

Table 2-1 Relationship of Threats and Vulnerabilities

User errors, whether intentional or accidental, are easier to identify by monitoring and auditing users' activities. Audits and reviews must be conducted to discover if employees are inputting values incorrectly into programs, misusing technology, or modifying data in an inappropriate manner.

After the ISRM team has identified the vulnerabilities and associated threats, it must investigate the ramifications of any of those vulnerabilities being exploited. Risks have *loss potential*, meaning that the organization could lose assets or revenues if a threat agent actually exploited a vulnerability. The loss may be corrupted data, destruction of systems and/or the facility, unauthorized disclosure of confidential information, a reduction in employee productivity, and so on. When performing a risk assessment, the team also must look at *delayed loss* when assessing the damages that can occur. Delayed loss is secondary in nature and takes place well after a vulnerability is exploited. Delayed loss may include damage to the organization's reputation, loss of market share, accrued late penalties, civil suits, the delayed collection of funds from customers, resources required to reimage other compromised systems, and so forth.

For example, if a company's web servers are attacked and taken offline, the immediate damage (loss potential) could be data corruption, the man-hours necessary to place the servers back online, and the replacement of any code or components required. The company could lose revenue if it usually accepts orders and payments via its website. If getting the web servers fixed and back online takes a full day, the company could lose a lot more sales and profits. If getting the web servers fixed and back online takes a full week, the company could lose enough sales and profits to not be able to pay other bills and expenses. This would be a delayed loss. If the company's customers lose confidence in it because of this activity, the company could lose business for months or years. This is a more extreme case of delayed loss.

These types of issues make the process of properly quantifying losses that specific threats could cause more complex, but they must be taken into consideration to ensure reality is represented in this type of analysis.

Assessing Risks

A *risk assessment*, which is really a tool for risk management, is a method of identifying vulnerabilities and threats and assessing the possible impacts to determine where to implement security controls. After parts of a risk assessment are carried out, the results are analyzed. *Risk analysis* is a detailed examination of the components of risk that is used to ensure that security is cost-effective, relevant, timely, and responsive to threats. It is easy to apply too much security, not enough security, or the wrong security controls and to spend too much money in the process without attaining the necessary objectives. Risk analysis helps organizations prioritize their risks and shows management the amount of resources that should be applied to protecting against those risks in a sensible manner.

EXAM TIP The terms risk assessment and risk analysis, depending on who you ask, can mean the same thing, or one must follow the other, or one is a subpart of the other. Here, we treat risk assessment as the broader effort, which is reinforced by specific risk analysis tasks as needed. This is how you should think of it for the CISSP exam.

Risk analysis has four main goals:

- Identify assets and their value to the organization.
- Determine the likelihood that a threat exploits a vulnerability.
- Determine the business impact of these potential threats.
- Provide an economic balance between the impact of the threat and the cost of the countermeasure.

Risk analysis provides a *cost/benefit comparison*, which compares the annualized cost of controls to the potential cost of loss. A control, in most cases, should not be implemented unless the annualized cost of loss exceeds the annualized cost of the control itself. This means that if a facility is worth $100,000, it does not make sense to spend $150,000 trying to protect it.

It is important to figure out what you are *supposed* to be doing before you dig right in and start working. Anyone who has worked on a project without a properly defined scope can attest to the truth of this statement. Before an assessment is started, the team must carry out *project sizing* to understand what assets and threats should be evaluated. Most assessments are focused on physical security, technology security, or personnel security. Trying to assess all of them at the same time can be quite an undertaking.

One of the risk assessment team's tasks is to create a report that details the asset valuations. Senior management should review and accept the list and use these values to determine the scope of the risk management project. If management determines at this early stage that some assets are not important, the risk assessment team should not spend additional time or resources evaluating those assets. During discussions with management, everyone involved must have a firm understanding of the value of the security CIA triad—confidentiality, integrity, and availability—and how it directly relates to business needs.

Management should outline the scope of the assessment, which most likely will be dictated by organizational compliance requirements as well as budgetary constraints. Many projects have run out of funds, and consequently stopped, because proper project sizing was not conducted at the onset of the project. Don't let this happen to you.

A risk assessment helps integrate the security program objectives with the organization's business objectives and requirements. The more the business and security objectives are in alignment, the more successful both will be. The assessment also helps the organization draft a proper budget for a security program and its constituent security components. Once an organization knows how much its assets are worth and the possible threats those assets are exposed to, it can make intelligent decisions about how much money to spend protecting those assets.

A risk assessment must be supported and directed by senior management if it is to be successful. Management must define the purpose and scope of the effort, appoint a team to carry out the assessment, and allocate the necessary time and funds to conduct it. It is essential for senior management to review the outcome of the risk assessment and to act on its findings. After all, what good is it to go through all the trouble of a risk assessment and *not* react to its findings? Unfortunately, this does happen all too often.

Asset Valuation

To understand possible losses and how much we may want to invest in preventing them, we must understand the value of an asset that could be impacted by a threat. The value placed on information is relative to the parties involved, what work was required to develop it, how much it costs to maintain, what damage would result if it were lost or destroyed, how much money enemies would pay for it, and what liability penalties could be endured. If an organization does not know the value of the information and the other assets it is trying to protect, it does not know how much money and time it should spend on protecting them. If the calculated value of your company's secret formula is *x*, then the total cost of protecting it should be some value less than *x*. Knowing the value of our information allows us to make quantitative cost/benefit comparisons as we manage our risks.

The preceding logic applies not only to assessing the value of *information* and protecting it but also to assessing the value of the organization's other assets, such as facilities, systems, and even intangibles like the value of the brand, and protecting them. The value of the organization's facilities must be assessed, along with all printers, workstations, servers, peripheral devices, supplies, and employees. You do not know how much is in danger of being lost if you don't know what you have and what it is worth in the first place.

The actual value of an asset is determined by the importance it has to the organization as a whole. The value of an asset should reflect all identifiable costs that would arise if the asset were actually impaired. If a server cost $4,000 to purchase, this value should not be input as the value of the asset in a risk assessment. Rather, the cost of replacing or repairing it, the loss of productivity, and the value of any data that may be corrupted or lost must be accounted for to properly capture the amount the organization would lose if the server were to fail for one reason or another.

The following issues should be considered when assigning values to assets:

- Cost to acquire or develop the asset
- Cost to maintain and protect the asset
- Value of the asset to owners and users
- Value of the asset to adversaries
- Price others are willing to pay for the asset
- Cost to replace the asset if lost
- Operational and production activities affected if the asset is unavailable
- Liability issues if the asset is compromised
- Usefulness and role of the asset in the organization
- Impact of the asset's loss on the organization's brand or reputation

Understanding the value of an asset is the first step to understanding what security mechanisms should be put in place and what funds should go toward protecting it. A very important question is how much it could cost the organization to *not* protect the asset.

Determining the value of assets may be useful to an organization for a variety of reasons, including the following:

- To perform effective cost/benefit analyses
- To select specific countermeasures and safeguards
- To determine the level of insurance coverage to purchase
- To understand what exactly is at risk
- To comply with legal and regulatory requirements

Assets may be tangible (computers, facilities, supplies) or intangible (reputation, data, intellectual property). It is usually harder to quantify the values of intangible assets, which may change over time. How do you put a monetary value on a company's reputation? This is not always an easy question to answer, but it is important to be able to do so.

Risk Assessment Teams

Each organization has different departments, and each department has its own functionality, resources, tasks, and quirks. For the most effective risk assessment, an organization must build a risk assessment team that includes individuals from many or all departments to ensure that all of the threats are identified and addressed. The team members may be part of management, application programmers, IT staff, systems integrators, and operational managers—indeed, any key personnel from key areas of the organization. This mix is necessary because if the team comprises only individuals from the IT department, it may not understand, for example, the types of threats the accounting department faces with data integrity issues, or how the organization as a whole would be affected if the accounting department's data files were wiped out by an accidental or intentional act.

Asking the Right Questions

When looking at risk, it's good to keep several questions in mind. Raising these questions helps ensure that the risk assessment team and senior management know what is important. Team members must ask the following:

- What event could occur (threat event)?
- What could be the potential impact (risk)?
- How often could it happen (frequency)?
- What level of confidence do we have in the answers to the first three questions (certainty)?

A lot of this information is gathered through internal surveys, interviews, or workshops. Viewing threats with these questions in mind helps the team focus on the tasks at hand and assists in making the decisions more accurate and relevant.

Or, as another example, the IT staff may not understand all the risks the employees in the warehouse would face if a natural disaster were to hit, or what it would mean to their productivity and how it would affect the organization overall. If the risk assessment team is unable to include members from various departments, it should, at the very least, make sure to interview people in each department so it fully understands and can quantify all threats.

The risk assessment team must also include people who understand the processes that are part of their individual departments, meaning individuals who are at the right levels of each department. This is a difficult task, since managers sometimes delegate any sort of risk assessment task to lower levels within the department. However, the people who work at these lower levels may not have adequate knowledge and understanding of the processes that the risk assessment team may need to deal with.

Methodologies for Risk Assessment

The industry has different standardized methodologies for carrying out risk assessments. Each of the individual methodologies has the same basic core components (identify vulnerabilities, associate threats, calculate risk values), but each has a specific focus. Keep in mind that the methodologies have a lot of overlapping similarities because each one has the specific goal of identifying things that could hurt the organization (vulnerabilities and threats) so that those things can be addressed (risk reduced). What make these methodologies different from each other are their unique approaches and focuses.

If you need to deploy an organization-wide risk management program and integrate it into your security program, you should follow the OCTAVE method. If you need to focus just on IT security risks during your assessment, you can follow NIST SP 800-30. If you have a limited budget and need to carry out a focused assessment on an individual system or process, you can follow the Facilitated Risk Analysis Process. If you really want to dig into the details of how a security flaw within a specific system could cause negative ramifications, you could use Failure Modes and Effect Analysis or fault tree analysis.

NIST SP 800-30

NIST SP 800-30, Revision 1, *Guide for Conducting Risk Assessments*, is specific to information systems threats and how they relate to information security risks. It lays out the following steps:

1. Prepare for the assessment.
2. Conduct the assessment:
   a. Identify threat sources and events.
   b. Identify vulnerabilities and predisposing conditions.
   c. Determine likelihood of occurrence.
   d. Determine magnitude of impact.
   e. Determine risk.
3. Communicate results.
4. Maintain assessment.

The NIST risk management methodology is mainly focused on computer systems and IT security issues. It does not explicitly cover larger organizational threat types, as in succession planning, environmental issues, or how security risks associate to business risks. It is a methodology that focuses on the operational components of an enterprise, not necessarily the higher strategic level.

FRAP

Facilitated Risk Analysis Process (FRAP) is a second type of risk assessment methodology. The crux of this qualitative methodology is to focus only on the systems that really need assessing, to reduce costs and time obligations. FRAP stresses prescreening activities so that the risk assessment steps are only carried out on the item(s) that needs it the most. FRAP is intended to be used to analyze one system, application, or business process at a time. Data is gathered and threats to business operations are prioritized based upon their criticality. The risk assessment team documents the controls that need to be put into place to reduce the identified risks along with action plans for control implementation efforts.

This methodology does not support the idea of calculating exploitation probability numbers or annualized loss expectancy values. The criticalities of the risks are determined by the team members' experience. The author of this methodology (Thomas Peltier) believes that trying to use mathematical formulas for the calculation of risk is too confusing and time consuming. The goal is to keep the scope of the assessment small and the assessment processes simple to allow for efficiency and cost-effectiveness.

OCTAVE

The *Operationally Critical Threat, Asset, and Vulnerability Evaluation (OCTAVE)* methodology was created by Carnegie Mellon University's Software Engineering Institute (SIE). OCTAVE is intended to be used in situations where people manage and direct the risk evaluation for information security within their organization. This places the people who work inside the organization in the power positions of being able to make the decisions regarding what is the best approach for evaluating the security of their organization. OCTAVE relies on the idea that the people working in these environments best understand what is needed and what kind of risks they are facing. The individuals who make up the risk assessment team go through rounds of facilitated workshops. The facilitator helps the team members understand the risk methodology and how to apply it to the vulnerabilities and threats identified within their specific business units. OCTAVE stresses a self-directed team approach.

The scope of an OCTAVE assessment is usually very wide compared to the more focused approach of FRAP. Where FRAP would be used to assess a system or application, OCTAVE would be used to assess all systems, applications, and business processes within the organization.

The OCTAVE methodology consists of the seven processes (or steps) listed here:

1. Identify enterprise knowledge.
2. Identify operational area knowledge.
3. Identify staff knowledge.

4. Establish security requirements.
5. Map high-priority information assets to information infrastructure.
6. Perform infrastructure vulnerability evaluation.
7. Conduct multidimensional risk analysis.
8. Develop protection strategy.

FMEA

Failure Modes and Effect Analysis (FMEA) is a method for determining functions, identifying functional failures, and assessing the causes of failure and their failure effects through a structured process. FMEA is commonly used in product development and operational environments. The goal is to identify where something is most likely going to break and either fix the flaws that could cause this issue or implement controls to reduce the impact of the break. For example, you might choose to carry out an FMEA on your organization's network to identify single points of failure. These single points of failure represent vulnerabilities that could directly affect the productivity of the network as a whole. You would use this structured approach to identify these issues (vulnerabilities), assess their criticality (risk), and identify the necessary controls that should be put into place (reduce risk).

The FMEA methodology uses failure modes (how something can break or fail) and effects analysis (impact of that break or failure). The application of this process to a chronic failure enables the determination of where exactly the failure is most likely to occur. Think of it as being able to look into the future and locate areas that have the potential for failure and then applying corrective measures to them before they do become actual liabilities.

By following a specific order of steps, the best results can be maximized for an FMEA:

1. Start with a block diagram of a system or control.
2. Consider what happens if each block of the diagram fails.
3. Draw up a table in which failures are paired with their effects and an evaluation of the effects.
4. Correct the design of the system, and adjust the table until the system is not known to have unacceptable problems.
5. Have several engineers review the Failure Modes and Effect Analysis.

Table 2-2 is an example of how an FMEA can be carried out and documented. Although most organizations will not have the resources to do this level of detailed work for every system and control, an organization can carry it out on critical functions and systems that can drastically affect the organization.

FMEA was first developed for systems engineering. Its purpose is to examine the potential failures in products and the processes involved with them. This approach proved to be successful and has been more recently adapted for use in evaluating risk management priorities and mitigating known threat vulnerabilities.

Prepared by:							
Approved by:							
Date:							
Revision:							
				Failure Effect on . . .			
Item Identification	**Function**	**Failure Mode**	**Failure Cause**	**Component or Functional Assembly**	**Next Higher Assembly**	**System**	**Failure Detection Method**
IPS application content filter	Inline perimeter protection	Fails to close	Traffic overload	Single point of failure Denial of service	IPS blocks ingress traffic stream	IPS is brought down	Health check status sent to console and e-mail to security administrator
Central antivirus signature update engine	Push updated signatures to all servers and workstations	Fails to provide adequate, timely protection against malware	Central server goes down	Individual node's antivirus software is not updated	Network is infected with malware	Central server can be infected and/or infect other systems	Heartbeat status check sent to central console, and e-mail to network administrator
Fire suppression water pipes	Suppress fire in building 1 in 5 zones	Fails to close	Water in pipes freezes	None	Building 1 has no suppression agent available	Fire suppression system pipes break	Suppression sensors tied directly into fire system central console
Etc.							

Table 2-2 How an FMEA Can Be Carried Out and Documented

FMEA is used in assurance risk management because of the level of detail, variables, and complexity that continues to rise as corporations understand risk at more granular levels. This methodical way of identifying potential pitfalls is coming into play more as the need for risk awareness—down to the tactical and operational levels—continues to expand.

Fault Tree Analysis

While FMEA is most useful as a survey method to identify major failure modes in a given system, the method is not as useful in discovering complex failure modes that may be involved in multiple systems or subsystems. A *fault tree analysis* usually proves to be a more useful approach to identifying failures that can take place within more complex environments and systems. First, an undesired effect is taken as the root or top event of a tree of logic. Then, each situation that has the potential to cause that effect is added to the tree as a series of logic expressions. Fault trees are then labeled with actual numbers pertaining to failure probabilities. This is typically done by using computer programs that can calculate the failure probabilities from a fault tree.

Figure 2-3 shows a simplistic fault tree and the different logic symbols used to represent what must take place for a specific fault event to occur.

When setting up the tree, you must accurately list all the threats or faults that can occur within a system. The branches of the tree can be divided into general categories, such as physical threats, network threats, software threats, Internet threats, and component failure threats. Then, once all possible general categories are in place, you can trim them and effectively prune from the tree the branches that won't apply to the system in question. In general, if a system is not connected to the Internet by any means, remove that general branch from the tree.

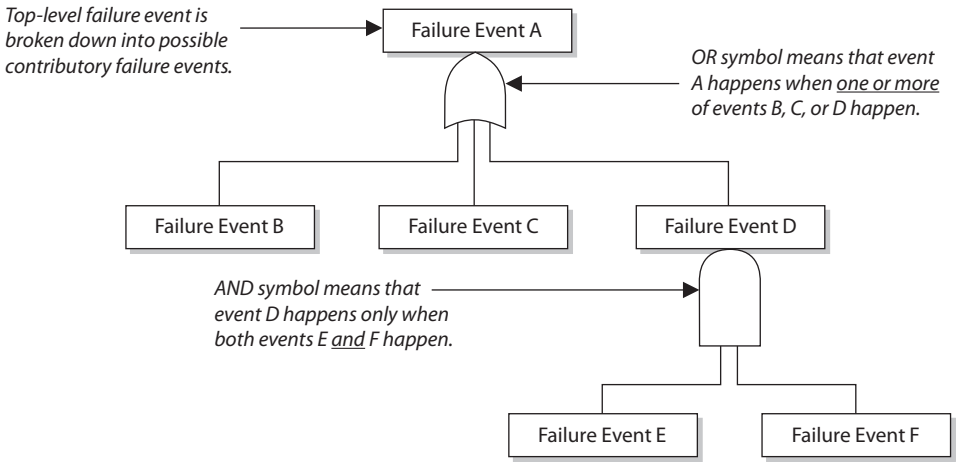


Figure 2-3 Fault tree and logic components

Some of the most common software failure events that can be explored through a fault tree analysis are the following:

- False alarms
- Insufficient error handling
- Sequencing or order
- Incorrect timing outputs
- Valid but unexpected outputs

Of course, because of the complexity of software and heterogeneous environments, this is a very small sample list.

EXAM TIP A risk assessment is used to gather data. A risk analysis examines the gathered data to produce results that can be acted upon.

Risk Analysis Approaches

So up to this point, we have accomplished the following items:

- Developed a risk management policy
- Developed a risk management team
- Identified organizational assets to be assessed
- Calculated the value of each asset
- Identified the vulnerabilities and threats that can affect the identified assets
- Chosen a risk assessment methodology that best fits our needs

The next thing we need to figure out is if our risk analysis approach should be quantitative or qualitative in nature. A *quantitative risk analysis* is used to assign monetary and numeric values to all elements of the risk analysis process. Each element within the analysis (asset value, threat frequency, severity of vulnerability, impact damage, safeguard costs, safeguard effectiveness, uncertainty, and probability items) is quantified and entered into equations to determine total and residual risks. It is more of a scientific or mathematical approach (objective) to risk analysis compared to qualitative. A *qualitative risk analysis* uses a "softer" approach to the data elements of a risk analysis. It does not quantify that data, which means that it does not assign numeric values to the data so that it can be used in equations. As an example, the results of a quantitative risk analysis could be that the organization is at risk of losing $100,000 if a buffer overflow were exploited on a web server, $25,000 if a database were compromised, and $10,000 if a file server were compromised. A qualitative risk analysis would not present these findings in monetary values, but would assign ratings to the risks, as in Red, Yellow, and Green.

A quantitative analysis uses risk calculations that attempt to predict the level of monetary losses and the probability for each type of threat. Qualitative analysis does not

use calculations. Instead, it is more opinion and scenario based (subjective) and uses a rating system to relay the risk criticality levels.

Quantitative and qualitative approaches have their own pros and cons, and each applies more appropriately to some situations than others. An organization's management and risk analysis team, and the tools they decide to use, will determine which approach is best.

In the following sections we will dig into the depths of quantitative analysis and then revisit the qualitative approach. We will then compare and contrast their attributes.

Automated Risk Analysis Methods

Collecting all the necessary data that needs to be plugged into risk analysis equations and properly interpreting the results can be overwhelming if done manually. Several automated risk analysis tools on the market can make this task much less painful and, hopefully, more accurate. The gathered data can be reused, greatly reducing the time required to perform subsequent analyses. The risk analysis team can also print reports and comprehensive graphs to present to management.

EXAM TIP Remember that vulnerability assessments are different from risk assessments. A vulnerability assessment just finds the vulnerabilities (the holes). A risk assessment calculates the probability of the vulnerabilities being exploited and the associated business impact.

The objective of these tools is to reduce the manual effort of these tasks, perform calculations quickly, estimate future expected losses, and determine the effectiveness and benefits of the security countermeasures chosen. Most automatic risk analysis products port information into a database and run several types of scenarios with different parameters to give a panoramic view of what the outcome will be if different threats come to bear. For example, after such a tool has all the necessary information inputted, it can be rerun several times with different parameters to compute the potential outcome if a large fire were to take place; the potential losses if a virus were to damage 40 percent of the data on the main file server; how much the organization would lose if an attacker were to steal all the customer credit card information held in three databases; and so on. Running through the different risk possibilities gives an organization a more detailed understanding of which risks are more critical than others, and thus which ones to address first.

Steps of a Quantitative Risk Analysis

If we choose to carry out a quantitative risk analysis, then we are going to use mathematical equations for our data interpretation process. The most common equations used for this purpose are the *single loss expectancy (SLE)* and the *annualized loss expectancy (ALE)*. The SLE is a monetary value that is assigned to a single event that represents the organization's potential loss amount if a specific threat were to take place. The equation is laid out as follows:

Asset Value × Exposure Factor (EF) = SLE

The *exposure factor (EF)* represents the percentage of loss a realized threat could have on a certain asset. For example, if a data warehouse has the asset value of $150,000, it can be estimated that if a fire were to occur, 25 percent of the warehouse would be damaged, in which case the SLE would be $37,500:

Asset Value ($150,000) × Exposure Factor (25%) = $37,500

This tells us that the organization could potentially lose $37,500 if a fire were to take place. But we need to know what our annual potential loss is, since we develop and use our security budgets on an annual basis. This is where the ALE equation comes into play. The ALE equation is as follows:

SLE × Annualized Rate of Occurrence (ARO) = ALE

The *annualized rate of occurrence (ARO)* is the value that represents the estimated frequency of a specific threat taking place within a 12-month timeframe. The range can be from 0.0 (never) to 1.0 (once a year) to greater than 1 (several times a year), and anywhere in between. For example, if the probability of a fire taking place and damaging our data warehouse is once every 10 years, the ARO value is 0.1.

So, if a fire within an organization's data warehouse facility can cause $37,500 in damages, and the frequency (or ARO) of a fire taking place has an ARO value of 0.1 (indicating once in 10 years), then the ALE value is $3,750 ($37,500 × 0.1 = $3,750).

The ALE value tells the organization that if it wants to put in controls to protect the asset (warehouse) from this threat (fire), it can sensibly spend $3,750 or less per year to provide the necessary level of protection. Knowing the real possibility of a threat and how much damage, in monetary terms, the threat can cause is important in determining how much should be spent to try and protect against that threat in the first place. It would not make good business sense for the organization to spend more than $3,750 per year to protect itself from this threat.

Clearly, this example is overly simplistic in focusing strictly on the structural losses. In the real world, we should include other related impacts such as loss of revenue due to the disruption, potential fines if the fire was caused by a violation of local fire codes, and injuries to employees that would require medical care. The number of factors to consider can be pretty large and, to some of us, not obvious. This is why you want to have a diverse risk assessment team that can think of all the myriad impacts that a simple event might have.

Uncertainty

In risk analysis, uncertainty refers to the degree to which you lack confidence in an estimate. This is expressed as a percentage, from 0 to 100 percent. If you have a 30 percent confidence level in something, then it could be said you have a 70 percent uncertainty level. Capturing the degree of uncertainty when carrying out a risk analysis is important, because it indicates the level of confidence the team and management should have in the resulting figures.

Asset	Threat	Single Loss Expectancy (SLE)	Annualized Rate of Occurrence (ARO)	Annualized Loss Expectancy (ALE)
Facility	Fire	$230,000	0.1	$23,000
Trade secret	Stolen	$40,000	0.01	$400
File server	Failed	$11,500	0.1	$1,150
Business data	Ransomware	$283,000	0.1	$28,300
Customer credit card info	Stolen	$300,000	3.0	$900,000

Table 2-3 Breaking Down How SLE and ALE Values Are Used

Now that we have all these numbers, what do we do with them? Let's look at the example in Table 2-3, which shows the outcome of a quantitative risk analysis. With this data, the organization can make intelligent decisions on what threats must be addressed first because of the severity of the threat, the likelihood of it happening, and how much could be lost if the threat were realized. The organization now also knows how much money it should spend to protect against each threat. This will result in good business decisions, instead of just buying protection here and there without a clear understanding of the big picture. Because the organization's risk from a ransomware incident is $28,300, it would be justified in spending up to this amount providing ransomware preventive measures such as offline file backups, phishing awareness training, malware detection and prevention, or insurance.

When carrying out a quantitative analysis, some people mistakenly think that the process is purely objective and scientific because data is being presented in numeric values. But a purely quantitative analysis is hard to achieve because there is still some subjectivity when it comes to the data. How do we know that a fire will only take place once every 10 years? How do we know that the damage from a fire will be 25 percent of the value of the asset? We don't know these values exactly, but instead of just pulling them out of thin air, they should be based upon historical data and industry experience. In quantitative risk analysis, we can do our best to provide all the correct information, and by doing so we will come close to the risk values, but we cannot predict the future and how much future incidents will cost us or the organization.

Results of a Quantitative Risk Analysis

The risk analysis team should have clearly defined goals. The following is a short list of what generally is expected from the results of a risk analysis:

- Monetary values assigned to assets
- Comprehensive list of all significant threats
- Probability of the occurrence rate of each threat
- Loss potential the organization can endure per threat in a 12-month time span
- Recommended controls

Although this list looks short, there is usually an incredible amount of detail under each bullet item. This report will be presented to senior management, which will be concerned with possible monetary losses and the necessary costs to mitigate these risks. Although the report should be as detailed as possible, it should also include an executive summary so that senior management can quickly understand the overall findings of the analysis.

Qualitative Risk Analysis

Another method of risk analysis is *qualitative*, which does not assign numbers and monetary values to components and losses. Instead, qualitative methods walk through different scenarios of risk possibilities and rank the seriousness of the threats and the validity of the different possible countermeasures based on opinions. (A wide-sweeping analysis can include hundreds of scenarios.) Qualitative analysis techniques include judgment, best practices, intuition, and experience. Examples of qualitative techniques to gather data are Delphi, brainstorming, storyboarding, focus groups, surveys, questionnaires, checklists, one-on-one meetings, and interviews. The risk analysis team will determine the best technique for the threats that need to be assessed, as well as the culture of the organization and individuals involved with the analysis.

The team that is performing the risk analysis gathers personnel who have knowledge of the threats being evaluated. When this group is presented with a scenario that describes threats and loss potential, each member responds with their gut feeling and experience on the likelihood of the threat and the extent of damage that may result. This group explores a scenario of each identified vulnerability and how it would be exploited. The "expert" in the group, who is most familiar with this type of threat, should review the scenario to ensure it reflects how an actual threat would be carried out. Safeguards that would diminish the damage of this threat are then evaluated, and the scenario is played out for each safeguard. The exposure possibility and loss possibility can be ranked as high, medium, or low on a scale of 1 to 5 or 1 to 10.

A common qualitative risk matrix is shown in Figure 2-4. Once the selected personnel rank the likelihood of a threat happening, the loss potential, and the advantages of each

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Severe
Almost certain	M	H	H	E	E
Likely	M	M	H	H	E
Possible	L	M	M	H	E
Unlikely	L	M	M	M	H
Rare	L	L	M	M	H

Figure 2-4 Qualitative risk matrix: likelihood vs. consequences (impact)

The Delphi Technique

The Delphi technique is a group decision method used to ensure that each member gives an honest opinion of what he or she thinks the result of a particular threat will be. This avoids a group of individuals feeling pressured to go along with others' thought processes and enables them to participate in an independent and anonymous way. Each member of the group provides his or her opinion of a certain threat and turns it in to the team that is performing the analysis. The results are compiled and distributed to the group members, who then write down their comments anonymously and return them to the analysis group. The comments are compiled and redistributed for more comments until a consensus is formed. This method is used to obtain an agreement on cost, loss values, and probabilities of occurrence without individuals having to agree verbally.

safeguard, this information is compiled into a report and presented to management to help it make better decisions on how best to implement safeguards into the environment. The benefits of this type of analysis are that communication must happen among team members to rank the risks, evaluate the safeguard strengths, and identify weaknesses, and the people who know these subjects the best provide their opinions to management.

Let's look at a *simple* example of a qualitative risk analysis.

The risk analysis team presents a scenario explaining the threat of a hacker accessing confidential information held on the five file servers within the organization. The risk analysis team then distributes the scenario in a written format to a team of five people (the IT manager, database administrator, application programmer, system operator, and operational manager), who are also given a sheet to rank the threat's severity, loss potential, and each safeguard's effectiveness, with a rating of 1 to 5, 1 being the least severe, effective, or probable. Table 2-4 shows the results.

Threat = Hacker Accessing Confidential Information	Severity of Threat	Probability of Threat Taking Place	Potential Loss to the Organization	Effectiveness of Firewall	Effectiveness of Intrusion Detection System	Effectiveness of Honeypot
IT manager	4	2	4	4	3	2
Database administrator	4	4	4	3	4	1
Application programmer	2	3	3	4	2	1
System operator	3	4	3	4	2	1
Operational manager	5	4	4	4	4	2
Results	3.6	3.4	3.6	3.8	3	1.4

Table 2-4 Example of a Qualitative Analysis

This data is compiled and inserted into a report and presented to management. When management is presented with this information, it will see that its staff (or a chosen set) feels that purchasing a firewall will protect the organization from this threat more than purchasing an intrusion detection system (IDS) or setting up a honeypot system.

This is the result of looking at only one threat, and management will view the severity, probability, and loss potential of each threat so it knows which threats cause the greatest risk and should be addressed first.

Quantitative vs. Qualitative

Each method has its advantages and disadvantages, some of which are outlined in Table 2-5 for purposes of comparison.

The risk analysis team, management, risk analysis tools, and culture of the organization will dictate which approach—quantitative or qualitative—should be used. The goal of either method is to estimate an organization's real risk and to rank the severity of the threats so the correct countermeasures can be put into place within a practical budget.

Table 2-5 refers to some of the positive aspects of the quantitative and qualitative approaches. However, not everything is always easy. In deciding to use either a quantitative or qualitative approach, the following points might need to be considered.

Quantitative Cons:

- Calculations can be complex. Can management understand how these values were derived?
- Without automated tools, this process is extremely laborious.
- More preliminary work is needed to gather detailed information about the environment.
- Standards are not available. Each vendor has its own way of interpreting the processes and their results.

Attribute	Quantitative	Qualitative
Requires no calculations		X
Requires more complex calculations	X	
Involves high degree of guesswork		X
Provides general areas and indications of risk		X
Is easier to automate and evaluate	X	
Used in risk management performance tracking	X	
Allows for cost/benefit analysis	X	
Uses independently verifiable and objective metrics	X	
Provides the opinions of the individuals who know the processes best		X
Shows clear-cut losses that can be accrued within one year's time	X	

Table 2-5 Quantitative vs. Qualitative Characteristics

Qualitative Cons:

- The assessments and results are subjective and opinion based.
- Eliminates the opportunity to create a dollar value for cost/benefit discussions.
- Developing a security budget from the results is difficult because monetary values are not used.
- Standards are not available. Each vendor has its own way of interpreting the processes and their results.

NOTE Since a purely quantitative assessment is close to impossible and a purely qualitative process does not provide enough statistical data for financial decisions, these two risk analysis approaches can be used in a hybrid approach. Quantitative evaluation can be used for tangible assets (monetary values), and a qualitative assessment can be used for intangible assets (priority values).

Responding to Risks

Once an organization knows the amount of total and residual risk it is faced with, it must decide how to handle it. Risk can be dealt with in four basic ways: transfer it, avoid it, reduce it, or accept it.

Many types of insurance are available to organizations to protect their assets. If an organization decides the total risk is too high to gamble with, it can purchase insurance, which would *transfer the risk* to the insurance company.

If an organization decides to terminate the activity that is introducing the risk, this is known as *risk avoidance*. For example, if a company allows employees to use instant messaging (IM), there are many risks surrounding this technology. The company could decide not to allow any IM activity by employees because there is not a strong enough business need for its continued use. Discontinuing this service is an example of risk avoidance.

Another approach is *risk mitigation*, where the risk is reduced to a level considered acceptable enough to continue conducting business. The implementation of firewalls, training, and intrusion/detection protection systems or other control types represent types of risk mitigation efforts.

The last approach is to *accept the risk*, which means the organization understands the level of risk it is faced with, as well as the potential cost of damage, and decides to just live with it and not implement the countermeasure. Many organizations will accept risk when the cost/benefit ratio indicates that the cost of the countermeasure outweighs the potential loss value.

A crucial issue with risk acceptance is understanding why this is the best approach for a specific situation. Unfortunately, today many people in organizations are accepting risk and not understanding fully what they are accepting. This usually has to do with the relative newness of risk management in the security field and the lack of education and experience in those personnel who make risk decisions. When business managers are charged with the responsibility of dealing with risk in their department, most of the time

they will accept whatever risk is put in front of them because their real goals pertain to getting a project finished and out the door. They don't want to be bogged down by this silly and irritating security stuff.

Risk acceptance should be based on several factors. For example, is the potential loss lower than the countermeasure? Can the organization deal with the "pain" that will come with accepting this risk? This second consideration is not purely a cost decision, but may entail noncost issues surrounding the decision. For example, if we accept this risk, we must add three more steps in our production process. Does that make sense for us? Or if we accept this risk, more security incidents may arise from it, and are we prepared to handle those?

The individual or group accepting risk must also understand the potential visibility of this decision. Let's say a company has determined that it is not legally required to protect customers' first names, but that it does have to protect other items like Social Security numbers, account numbers, and so on. So, the company ensures that its current activities are in compliance with the regulations and laws, but what if its customers find out that it is not protecting their full names and they associate this with identity fraud because of their lack of education on the matter? The company may not be able to handle this potential reputation hit, even if it is doing all it is supposed to be doing. Perceptions of a company's customer base are not always rooted in fact, but the possibility that customers will move their business to another company is a potential fact your company must comprehend.

Figure 2-5 shows how a risk management program can be set up, which ties together many of the concepts covered thus far in this chapter.

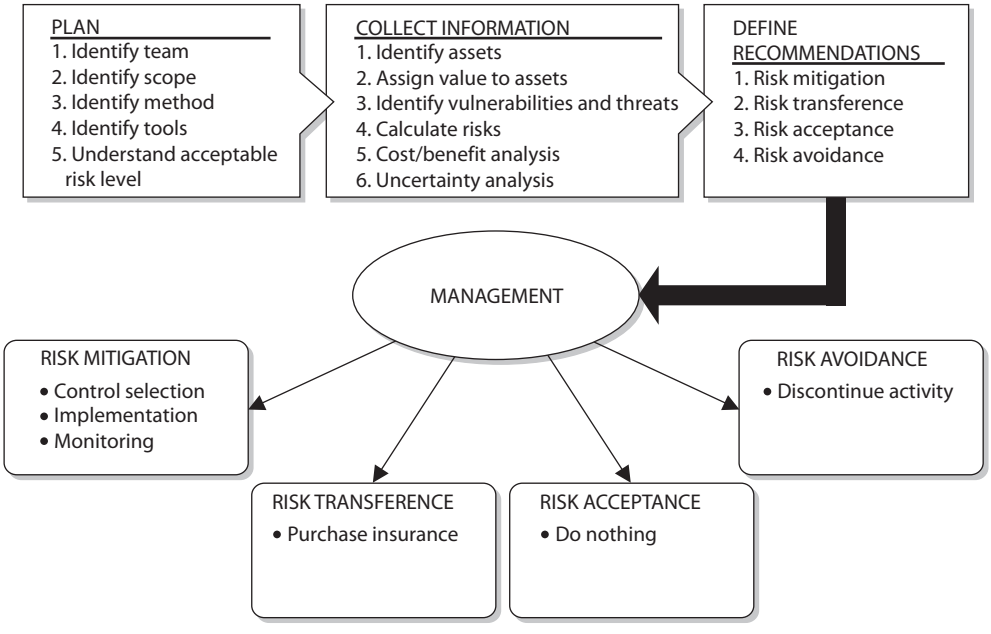


Figure 2-5 How a risk management program can be set up

Total Risk vs. Residual Risk

The reason an organization implements countermeasures is to reduce its overall risk to an acceptable level. As stated earlier, no system or environment is 100 percent secure, which means there is always some risk left over to deal with. This is called *residual risk*.

Residual risk is different from *total risk*, which is the risk an organization faces if it chooses not to implement any type of safeguard. An organization may choose to take on total risk if the cost/benefit analysis results indicate this is the best course of action. For example, if there is a small likelihood that an organization's web servers can be compromised and the necessary safeguards to provide a higher level of protection cost more than the potential loss in the first place, the organization will choose not to implement the safeguard, choosing to deal with the total risk.

There is an important difference between total risk and residual risk and which type of risk an organization is willing to accept. The following are conceptual formulas:

threats × vulnerability × asset value = total risk
(threats × vulnerability × asset value) × controls gap = residual risk

You may also see these concepts illustrated as the following:

total risk – countermeasures = residual risk

NOTE The previous formulas are not constructs you can actually plug numbers into. They are instead used to illustrate the relation of the different items that make up risk in a conceptual manner. This means no multiplication or mathematical functions actually take place. It is a means of understanding what items are involved when defining either total or residual risk.

During a risk assessment, the threats and vulnerabilities are identified. The possibility of a vulnerability being exploited is multiplied by the value of the assets being assessed, which results in the total risk. Once the controls gap (protection the control cannot provide) is factored in, the result is the residual risk. Implementing countermeasures is a way of mitigating risks. Because no organization can remove all threats, there will always be some residual risk. The question is what level of risk the organization is willing to accept.

Countermeasure Selection and Implementation

Countermeasures are the means by which we reduce specific risks to acceptable levels. This section addresses identifying and choosing the right countermeasures for computer systems. It gives the best attributes to look for and the different cost scenarios to investigate when comparing different types of countermeasures. The end product of the analysis of choices should demonstrate why the selected control is the most advantageous to the organization.

NOTE The terms control, countermeasure, safeguard, security mechanism, and protection mechanism are synonymous in the context of information systems security. We use them interchangeably.

Control Selection

A security control must make good business sense, meaning it is cost-effective (its benefit outweighs its cost). This requires another type of analysis: a *cost/benefit analysis*. A commonly used cost/benefit calculation for a given safeguard (control) is

> (ALE before implementing safeguard) – (ALE after implementing safeguard) – (annual cost of safeguard) = value of safeguard to the organization

For example, if the ALE of the threat of a hacker bringing down a web server is $12,000 prior to implementing the suggested safeguard, and the ALE is $3,000 after implementing the safeguard, while the annual cost of maintenance and operation of the safeguard is $650, then the value of this safeguard to the organization is $8,350 each year.

Recall that the ALE has two factors, the single loss expectancy and the annual rate of occurrence, so safeguards can decrease either or both. The countermeasure referenced in the previous example could aim to reduce the costs associated with restoring the web server, or make it less likely that it is brought down, or both. All too often, we focus our attention on making the threat less likely, while, in some cases, it might be less expensive to make it easier to recover.

The cost of a countermeasure is more than just the amount filled out on the purchase order. The following items should be considered and evaluated when deriving the full cost of a countermeasure:

- Product costs
- Design/planning costs
- Implementation costs
- Environment modifications (both physical and logical)
- Compatibility with other countermeasures
- Maintenance requirements
- Testing requirements
- Repair, replacement, or update costs
- Operating and support costs
- Effects on productivity
- Subscription costs
- Extra staff-hours for monitoring and responding to alerts

Many organizations have gone through the pain of purchasing new security products without understanding that they will need the staff to maintain those products. Although tools automate tasks, many organizations were not even carrying out these tasks before, so they do not save on staff-hours, but many times require more hours. For example, Company A decides that to protect many of its resources, purchasing an intrusion detection system is warranted. So, the company pays $5,500 for an IDS. Is that the total cost? Nope. This software should be tested in an environment that is segmented from the production environment to uncover any unexpected activity. After this testing is complete and the security group feels it is safe to insert the IDS into its production environment, the security group must install the monitoring management software, install the sensors, and properly direct the communication paths from the sensors to the management console. The security group may also need to reconfigure the routers to redirect traffic flow, and it definitely needs to ensure that users cannot access the IDS management console. Finally, the security group should configure a database to hold all attack signatures and then run simulations.

Costs associated with an IDS alert response should most definitely be considered. Now that Company A has an IDS in place, security administrators may need additional alerting equipment such as smartphones. And then there are the time costs associated with a response to an IDS event.

Anyone who has worked in an IT group knows that some adverse reaction almost always takes place in this type of scenario. Network performance can take an unacceptable hit after installing a product if it is an inline or proactive product. Users may no longer be able to access a server for some mysterious reason. The IDS vendor may not have explained that two more service patches are necessary for the whole thing to work correctly. Staff time will need to be allocated for training and to respond to all of the alerts (true or false) the new IDS sends out.

So, for example, the cost of this countermeasure could be $23,500 for the product and licenses; $2,500 for training; $3,400 for testing; $2,600 for the loss in user productivity once the product is introduced into production; and $4,000 in labor for router reconfiguration, product installation, troubleshooting, and installation of the two service patches. The real cost of this countermeasure is $36,000. If our total potential loss was calculated at $9,000, we went over budget by 300 percent when applying this countermeasure for the identified risk. Some of these costs may be hard or impossible to identify before they are incurred, but an experienced risk analyst would account for many of these possibilities.

Types of Controls

In our examples so far, we've focused on countermeasures like firewalls and IDSs, but there are many more options. Controls come in three main categories: administrative, technical, and physical. *Administrative controls* are commonly referred to as "soft controls" because they are more management oriented. Examples of administrative controls are security documentation, risk management, personnel security, and training. *Technical controls* (also called logical controls) are software or hardware components, as in firewalls, IDS, encryption, and identification and authentication mechanisms. And *physical controls*

are items put into place to protect facilities, personnel, and resources. Examples of physical controls are security guards, locks, fencing, and lighting.

These control categories need to be put into place to provide *defense-in-depth*, which is the coordinated use of multiple security controls in a layered approach, as shown in Figure 2-6. A multilayered defense system minimizes the probability of successful penetration and compromise because an attacker would have to get through several different types of protection mechanisms before she gained access to the critical assets. For example, Company A can have the following physical controls in place that work in a layered model:

- Fence
- Locked external doors
- Closed-circuit TV (CCTV)
- Security guard
- Locked internal doors
- Locked server room
- Physically secured computers (cable locks)

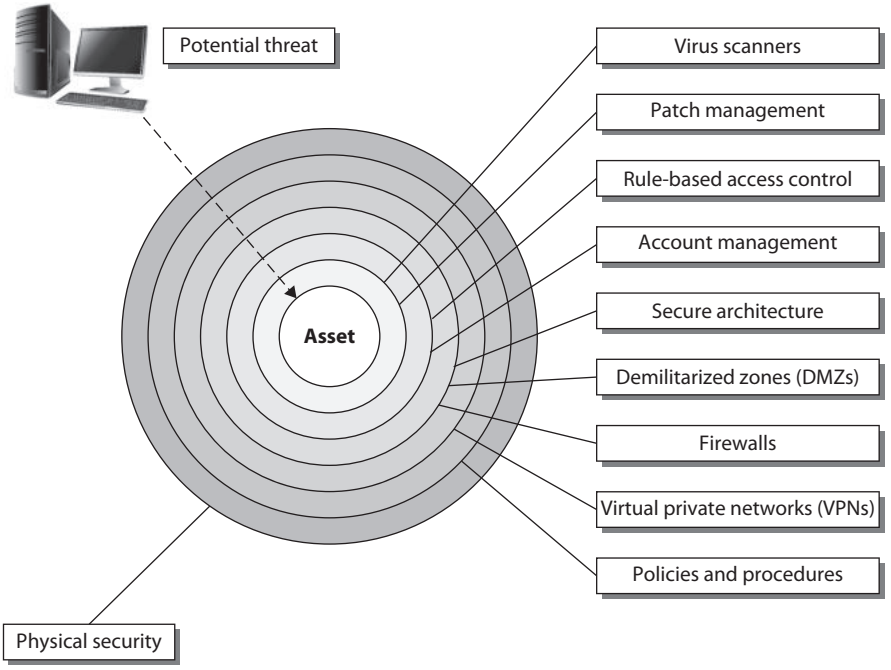


Figure 2-6 Defense-in-depth

Technical controls that are commonly put into place to provide this type of layered approach are

- Firewalls
- Intrusion detection system
- Intrusion prevention system
- Antimalware
- Access control
- Encryption

The types of controls that are actually implemented must map to the threats the organization faces, and the number of layers that are put into place must map to the sensitivity of the asset. The rule of thumb is the more sensitive the asset, the more layers of protection that must be put into place.

So the different *categories* of controls that can be used are administrative, technical, and physical. But what do these controls actually *do* for us? We need to understand what the different control types can provide us in our quest to secure our environments.

The different types of security controls are *preventive*, *detective*, *corrective*, *deterrent*, *recovery*, and *compensating*. By having a better understanding of the different control types, you will be able to make more informed decisions about what controls will be best used in specific situations. The six different control types are as follows:

- **Preventive** Intended to avoid an incident from occurring
- **Detective** Helps identify an incident's activities and potentially an intruder
- **Corrective** Fixes components or systems after an incident has occurred
- **Deterrent** Intended to discourage a potential attacker
- **Recovery** Intended to bring the environment back to regular operations
- **Compensating** Provides an alternative measure of control

Once you understand fully what the different controls do, you can use them in the right locations for specific risks.

When looking at a security structure of an environment, it is most productive to use a preventive model and then use detective, corrective, and recovery mechanisms to help support this model. Basically, you want to stop any trouble before it starts, but you must be able to quickly react and combat trouble if it does find you. It is not feasible to prevent everything; therefore, what you cannot prevent, you should be able to quickly detect. That's why preventive and detective controls should always be implemented together and should complement each other. To take this concept further: what you can't prevent, you should be able to detect, and if you detect something, it means you weren't able to prevent it, and therefore you should take corrective action to make sure it is indeed prevented the next time around. Therefore, all three types work together: preventive, detective, and corrective.

The control types described next (administrative, physical, and technical) are preventive in nature. These are important to understand when developing an enterprise-wide security program. Obviously, these are only provided as illustrative examples. Keep in mind as you go over them that a specific control may fall within multiple classifications. For example, most security cameras could be considered preventive (since they may dissuade criminals from breaking in if they are highly visible), detective (if there is a person monitoring them live), and corrective (if they are used to track a criminal that breached your physical perimeter).

Preventive: Administrative

- Policies and procedures
- Effective hiring practices
- Pre-employment background checks
- Controlled termination processes
- Data classification and labeling
- Security awareness

Preventive: Physical

- Badges, swipe cards
- Guards, dogs
- Fences, locks, mantraps

Preventive: Technical

- Passwords, biometrics, smart cards
- Encryption, secure protocols, call-back systems, database views, constrained user interfaces
- Antimalware software, access control lists, firewalls, IPS

Table 2-6 shows how these types of control mechanisms perform different security functions. Many students get themselves wrapped around the axle when trying to get their mind around which control provides which functionality. This is how this train of thought usually takes place: "A security camera system is a detective control, but if an attacker sees its cameras, it could be a deterrent." Let's stop right here. Do not make this any harder than it has to be. When trying to map the functionality requirement to a control, think of the *main* reason that control would be put into place. A firewall tries to prevent something bad from taking place, so it is a preventive control. Auditing logs is done after an event took place, so it is detective. A data backup system is developed so that data can be recovered; thus, this is a recovery control. Computer images are created so that if software gets corrupted, they can be reloaded; thus, this is a corrective control.

Note that some controls can serve different functions. Security guards can deter would-be attackers, but if they don't deter all of them, they can also stop (prevent)

Control Type:	Preventive	Detective	Corrective	Deterrent	Recovery	Compensating
Controls by Category:						
Physical						
Fences				X		
Locks	X					
Badge system	X					
Security guard	X	X	X	X		
Mantrap doors	X					
Lighting				X		
Motion detectors		X				
Closed-circuit TVs		X				
Offsite facility					X	X
Administrative						
Security policy	X					X
Monitoring and supervising		X				X
Separation of duties	X					
Job rotation		X		X		
Information classification	X					
Investigations		X				
Security awareness training	X					
Technical						
ACLs	X					
Encryption	X					
Audit logs		X				
IDS		X				
Antimalware software	X	X				
Workstation images			X			
Smart cards	X					
Data backup					X	

Table 2-6 Control Categories and Types

the ones that try to get into a facility. Perhaps the attacker was particularly sneaky and he managed to get into an office building, in which case the security guards can be detective controls as they make the rounds and even corrective controls when they find the intruder, call law enforcement, and escort the attacker out of the building and into the backseat of a police car. When taking the CISSP exam, look for clues in the question to determine which functionality is most relevant.

One control functionality that some people struggle with is a compensating control. Let's look at some examples of compensating controls to best explain their function. If your organization needed to implement strong physical security, you might suggest to management that they employ security guards. But after calculating all the costs of security guards, your organization might decide to use a compensating (alternative) control that provides similar protection but is more affordable—as in a fence. In another example, let's say you are a security administrator and you are in charge of maintaining the organization's firewalls. Management tells you that a certain protocol that you know is vulnerable to exploitation has to be allowed through the firewall for business reasons. The network needs to be protected by a compensating (alternative) control pertaining to this protocol, which may be setting up a proxy server for that specific traffic type to ensure that it is properly inspected and controlled. So a compensating control is just an alternative control that provides similar protection as the original control but has to be used because it is more affordable or allows specifically required business functionality.

Several types of security controls exist, and they all need to work together. The complexity of the controls and of the environment they are in can cause the controls to contradict each other or leave gaps in security. This can introduce unforeseen holes in the organization's protection that are not fully understood by the implementers. An organization may have very strict technical access controls in place and all the necessary administrative controls up to snuff, but if any person is allowed to physically access any system in the facility, then clear security dangers are present within the environment. Together, these controls should work in harmony to provide a healthy, safe, and productive environment.

The risk assessment team must evaluate the security controls' functionality and effectiveness. When selecting a security control, some attributes are more favorable than others. Table 2-7 lists and describes attributes that should be considered before purchasing and committing to a security control.

Security controls can provide deterrence attributes if they are highly visible. This tells potential evildoers that adequate protection is in place and that they should move on to an easier target. Although the control may be highly visible, attackers should not be able to discover the way it works, thus enabling them to attempt to modify it, or know how to get around the protection mechanism. If users know how to disable the antimalware program that is taking up CPU cycles or know how to bypass a proxy server to get to the Internet without restrictions, they will do so.

Control Assessments

Once you select the administrative, technical, and physical controls that you think will reduce your risks to acceptable levels, you have to ensure that this is actually the case.

Characteristic	Description
Modular	The control can be installed or removed from an environment without adversely affecting other mechanisms.
Provides uniform protection	A security level is applied in a standardized method to all mechanisms the control is designed to protect.
Provides override functionality	An administrator can override the restriction if necessary.
Defaults to least privilege	When installed, the control defaults to a lack of permissions and rights instead of installing with everyone having full control.
Independence of control and the asset it is protecting	The given control can protect multiple assets, and a given asset can be protected by multiple controls.
Flexibility and security	The more security the control provides, the better. This functionality should come with flexibility, which enables you to choose different functions instead of all or none.
Usability	The control does not needlessly interfere with users' work.
Asset protection	The asset is still protected even if the countermeasure needs to be reset.
Easily upgraded	Software continues to evolve, and updates should be able to happen painlessly.
Auditing functionality	The control includes a mechanism that provides auditing at various levels of verbosity.
Minimizes dependence on other components	The control should be flexible and not have strict requirements about the environment into which it will be installed.
Must produce output in usable and understandable format	The control should present important information in a format easy for humans to understand and use for trend analysis.
Testable	The control should be able to be tested in different environments under different situations.
Does not introduce other compromises	The control should not provide any covert channels or back doors.
System and user performance	System and user performance should not be greatly affected by the control.
Proper alerting	The control should have the capability for thresholds to be set as to when to alert personnel of a security breach, and this type of alert should be acceptable.
Does not affect assets	The assets in the environment should not be adversely affected by the control.

Table 2-7 Characteristics to Consider When Assessing Security Controls

A *control assessment* is an evaluation of one or more controls to determine the extent to which they are implemented correctly, operating as intended, and producing the desired outcome. Let's look at each of those test elements in turn using anonymized examples from the real world.

You may have chosen the right control for a given risk, but you also need *verification* that the manner in which it is implemented is correct too. Let's suppose you decide to upgrade a firewall to mitigate a number of risks you've identified. You invest a ton of money in the latest and greatest firewall and apply a bunch of rules to filter out the good from the bad. And yet, you forget to change the administrator's default password, and an attacker is able to log into your firewall, lock out the security team by changing the password, and then change the rules to allow malicious traffic through. The technical control was good, it just wasn't implemented correctly. You avoid this by developing a thorough set of tests that look at every aspect of the implementation and ensure no steps were skipped or done wrong.

Another aspect of verification is to ensure that the controls are operating as intended. You may have implemented the control correctly, but there are many reasons why it may not work as you expected it would. For example, suppose you implement a policy that all personnel in a facility must wear identification badges. Employees, contractors, and visitors each get their own unique badge design to differentiate them. The policy is implemented, and all staff are trained on it, but after a few weeks people get complacent and stop noticing whether they (or others) are wearing badges. The administrative control was properly implemented but is not working as intended. The control assessment should include operational checks, such as having different people (perhaps some who are well known in the organization and some who are not part of it) walk through the facility with no badges and see whether they are challenged or reported.

Finally, we want *validation* that the controls are producing the desired outcomes. Controls are selected for the purpose of reducing risk…so are they? Suppose you install temperature sensors in your data center that generate alarms whenever they get too hot. You are trying to reduce the risk of hardware failures due to high temperatures. These physical controls are properly installed and work as intended. In fact, they generate alarms every day during peak usage hours. Are they reducing the risk? Unless you upgrade the underpowered air conditioning unit, all these alarms will do nothing to help you avoid outages. Any assessment of your controls must explicitly test whether the risk for which they were selected is actually being reduced.

EXAM TIP An easy way to differentiate verification and validation is that verification answers the question "did we implement the control right?" while validation answers the question "did we implement the right control?"

Security and Privacy

Security effectiveness deals with metrics such as meeting service level agreement (SLA) requirements, achieving returns on investment (ROIs), meeting set baselines, and providing management with a dashboard or balanced scorecard system. These are ways to determine how useful the current security solutions and architecture as a whole are performing.

Another side to assessing security controls is ensuring that they do not violate our privacy policies and regulations. It does us no good to implement the best security controls if they require gross violations of people's right to keep certain information

about themselves from being known or used in inappropriate ways. For example, an organization could have a policy that allows employees to use the organization's assets for personal purposes while they are on breaks. The same organization has implemented Transport Layer Security (TLS) proxies that decrypt all network traffic in order to conduct deep packet analysis and mitigate the risk that a threat actor is using encryption to hide her malicious deeds. Normally, the process is fully automated and no other staff members look at the decrypted communications. Periodically, however, security staff manually check the system to ensure everything is working properly. Now, suppose an employee reveals some very private health information to a friend over her personal webmail and that traffic is monitored and observed by a security staffer. That breach of privacy could cause a multitude of ethical, regulatory, and even legal problems for the organization.

When implementing security controls, it is critical to consider their privacy implications. If your organization has a chief privacy officer (or other privacy professional), that person should be part of the process of selecting and implementing security controls to ensure they don't unduly (or even illegally) violate employee privacy.

Monitoring Risks

We really can't just build a risk management program (or any program, for that matter), call it good, and go home. We need a way to assess the effectiveness of our work, identify deficiencies, and prioritize the things that still need work. We need a way to facilitate decision making, performance improvement, and accountability through collection, analysis, and reporting of the necessary information. More importantly, we need to be able to identify changes in the environment and be able to understand their impacts on our risk posture. All this needs to be based on facts and metrics. As the saying goes, "You can't manage something you can't measure."

Risk monitoring is the ongoing process of adding new risks, reevaluating existing ones, removing moot ones, and continuously assessing the effectiveness of our controls at mitigating all risks to tolerable levels. Risk monitoring activities should be focused on three key areas: effectiveness, change, and compliance. The risk management team should continually look for improvement opportunities, periodically analyze the data gathered from each key area, and report its findings to senior management. Let's take a closer look at how we might go about monitoring and measuring each area.

Effectiveness Monitoring

There are many reasons why the effectiveness of our security controls decreases. Technical controls may not adapt quickly to changing threat actor behaviors. Employees may lose awareness of (or interest in) administrative controls. Physical controls may not keep up with changing behaviors as people move in and through our facilities. How do we measure this decline in the effectiveness of our controls and, more importantly, the rising risks to our organizations? This is the crux of effectiveness monitoring.

One approach is to keep track of the number of security incidents by severity. Let's say that we implemented controls to reduce the risk of ransomware attacks. We redesigned our security awareness training, deployed a new endpoint detection and

response (EDR) solution, and implemented an automated offline backup system. Subsequently, the number of ransomware-related incidents sharply declined across all severity categories. While we still see a handful of localized cases here and there, no data is lost, nobody is forced offline, and business is humming. However, recently we are noticing that the number of low-severity incidents has started to increase. These are cases where the ransomware makes it onto a workstation but is stopped as it attempts to encrypt files. If we're not paying attention to this trend, we may miss the fact that the malware is evolving and becoming more effective at evading our EDR solution. We'd be giving the adversary a huge advantage by letting them experiment and improve while we do nothing about it. This is why effectiveness monitoring is important, and why it has to be tied to specific metrics that can be quantified and analyzed over time.

In the previous example, the metric was the number of incidents related to ransomware in our environment. There are many other metrics you could use, depending on the control in question. You could use a red team and measure the number of times it is successful at compromising various assets. You could use the number of suspected phishing attacks reported by alert employees. Whatever your approach, you should determine the effectiveness metrics you'll use to monitor controls when you decide to use those controls. Then, you really need to track those metrics over time to identify trends. Failure to do so will result, almost inevitably, in the gradual (or perhaps sudden) increase in risk until, one sad day, it is realized.

NOTE The Center for Internet Security (CIS) publishes a helpful (and free) document titled "CIS Controls Measures and Metrics," currently in its seventh version. It provides specific measures for each control as well as goals for their values in your organization.

A good way to enable effectiveness monitoring is to establish a standing group that periodically checks known threats and the controls that are meant to mitigate them. An example of this is a threat working group (TWG), which consists of members of all major parts of the organization, meeting regularly (say, monthly) to review the list of risks (sometimes called a risk registry) and ensure that threats and controls remain valid. The TWG assigns owners to each risk and ensures those persons or groups are keeping up their responsibilities. The TWG can also be the focal point for scheduling security assessments, be they internal or external, to verify and validate the controls.

Change Monitoring

Even if you keep track of known threats and the risks they pose, it is likely that changes in your organization's environment will introduce new risks. There are two major sources of change that impact your overall risk: information systems and business. The first is perhaps the most obvious to cybersecurity professionals. A new system is introduced, an old one retired, or an existing one updated or reconfigured. Any of these changes can produce new risks or change those you are already tracking. Another source of changes that introduce risks is the business itself. Over time, your organization will embark on new ventures, change internal processes, or perhaps merge with or acquire another organization.

All these changes need to be carefully analyzed to ensure an accurate understanding of their effects on the overall risk posture.

Monitoring changes to your environment and dealing with the risks they could introduce is part of a good change management process. Typically, organizations will have a change advisory board (CAB) or a similarly named standing group that reviews and approves any changes such as the development of new policies, systems, and business processes. The CAB measures changes through a variety of metrics that also are used to monitor risks, such as the following:

- Number of unauthorized changes
- Average time to implement a change
- Number of failed changes
- Number of security incidents attributable to changes

NOTE We will discuss change management in more detail in Chapter 19.

Compliance Monitoring

Something else that could change in your organization and affect your risk are legal, regulatory, and policy requirements. Compliance monitoring is a bit easier than effectiveness monitoring and change monitoring, because compliance tends to change fairly infrequently. Laws and external regulations usually take years to change, while internal regulations and policies should be part of the change management process we discussed previously. Though the frequency of compliance changes is fairly low, these changes can have significant impacts in the organization. A great example of this is the General Data Protection Regulation (GDPR) that came into effect in May 2018. It was years in the making, but it has had huge effects on any organization that stores or processes data belonging to a person from the European Union (EU).

Another aspect of compliance monitoring is responding to audit findings. Whether it is an external or internal audit, any findings dealing with compliance need to be addressed. If the audit reveals risks that are improperly mitigated, the risk team needs to respond to them. Failure to do so could result in significant fines or even criminal charges.

So, what can we measure to monitor our compliance? It varies among organizations, but here are some common metrics to consider:

- Number of audit findings
- Ratio of internal (i.e., self-discovered) to external (i.e., audit) inquiries
- Average time to close an inquiry
- Number of internal disciplinary actions related to compliance

No organization is perfectly compliant all the time, so there is always an element of compliance risk. These risks, however, increase dramatically if there is no formal process for searching for and dealing with issues that violate policies, regulations, or laws.

Risk Reporting

Risk reporting is an essential component of risk management in general and risk monitoring in particular. (Recall that risk management encompasses framing, assessing, responding to, and monitoring the risks.) Reporting enables organizational decision-making, security governance, and day-to-day operations. It is also important for compliance purposes.

So, how *should* we report risks? There is no set formula for reporting, but there are a couple of guiding principles. The first one is to understand the audience. There are at least three groups at which you may target risk reports: executives (and board members), managers, and risk owners. Each requires a different approach.

Executives and Board Members

Senior leaders in an organization are generally not interested in the details, nor should they be. Their role is to set and monitor the strategic direction, not to run day-to-day operations. These leaders want to know whether risks can be properly mitigated or require change to the organizational strategy. They will be interested in the biggest risks to the organization and will want to know what is being done to address them. Executives and board members should also be briefed on risks that have been "accepted" and what their potential impacts could be.

When dealing with senior decision makers, risk heat maps, such as illustrated in Figure 2-7, are typically used rather than verbose descriptions. This is to ensure that these leaders can get the information they need at a glance in order to decide whether strategic adjustments may be needed. In Figure 2-7, board members likely would be interested in

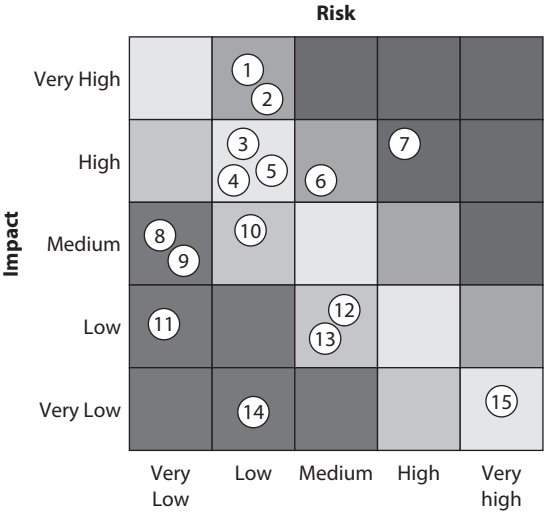


Figure 2-7 Sample risk heat map

discussing risk item #7 first since it is particularly significant. That is the point of a heat map: it allows senior-level audiences to home in on the important topics for discussion.

Managers

Managers across the organization will need much more detailed reports because they are responsible for, well, managing the risks. They will want to know current risks and how they've been trending over time. Are risks decreasing or increasing? Either way, why? Where does progress seem to be stuck? These are some of the questions managers will want the report to answer. They will also want to be able to drill into specific items of interest to get into the details, such as who owns the risk, how we are responding to the risk, and why the current approach may not be working.

Many organizations rely on risk management dashboards for this level of reporting. These dashboards may be part of a risk management tool, in which case they'd be interactive and allow drilling into specific items in the report. Organizations without these automated tools typically use spreadsheets to generate graphs (showing trends over time) or even manually developed slides. Whatever the approach, the idea is to present actionable information allowing business unit managers to track their progress over time with respect to risks.

Risk Owners

This is the internal audience that needs the most detailed reporting, because the risk owners are the staff members responsible for managing individual risks. They take direction from management as they respond to specific risks. For example, if the organization decides to transfer a given risk, the risk owner will be responsible for ensuring the insurance policy is developed and acquired effectively. This will include performance indicators, such as cost, coverage, and responsiveness. Cybersecurity insurance companies often require that certain controls be in place in order to provide coverage, so the risk owner must also ensure that these conditions are met so that the premiums are not being paid in vain.

Continuous Improvement

Only by reassessing the risks on a periodic basis can the risk management team's statements on security control performance be trusted. If the risk has not changed and the safeguards implemented are functioning in good order, then it can be said that the risk is being properly mitigated. Regular risk management monitoring will support the information security risk ratings.

Vulnerability analysis and continued asset identification and valuation are also important tasks of risk management monitoring and performance. The cycle of continued risk analysis is a very important part of determining whether the safeguard controls that have been put in place are appropriate and necessary to safeguard the assets and environment.

Continuous improvement is the practice of identifying opportunities, mitigating threats, improving quality, and reducing waste as an ongoing effort. It is the hallmark of mature and effective organizations.

Level	Maturity	Characteristics
1	Initial	Risk activities are ad hoc, reactive, and poorly controlled.
2	Repeatable	Procedures are documented and (mostly) followed.
3	Defined	Standard procedures, tools, and methods are applied consistently.
4	Managed	Quantitative methods are applied both to risk management and to the program.
5	Optimizing	Data-driven innovation occurs across the entire organization.

Table 2-8 Typical Maturity Model

Risk Maturity Modeling

Maturity models are tools that allow us to determine the ability of our organizations for continuous improvement. We generally assess the maturity of an organization's risk management on a scale of 1 to 5, as shown in Table 2-8. There is actually a level 0, which is where the organization is not managing risk at all.

While it may be tempting to think that we should all strive to achieve the highest level of maturity with regard to risk management, the reality is that we should reach the right level of maturity given our resources, strategies, and business environment. It would make little sense for a very small retail company to strive for level 5, because doing so would require a level of resource investment that is not realistic. Conversely, it would be a very bad idea for a large enterprise in the defense industry to be satisfied with a maturity level 1, because the risks it faces are substantial. Ultimately, the level of maturity that makes sense is a business decision, not a cybersecurity one.

Supply Chain Risk Management

Many organizations fail to consider their supply chain when managing risk, despite the fact that it often presents a convenient and easier back door to an attacker. So what is a supply chain anyway? A supply chain is a sequence of suppliers involved in delivering some product. If your company manufactures laptops, your supply chain will include the vendor that supplies your video cards. It will also include whoever makes the integrated circuits that go on those cards, as well as the supplier of the raw chemicals that are involved in that process. The supply chain also includes suppliers of services, such as the company that maintains the heating, ventilation, and air conditioning (HVAC) systems needed to keep your assembly lines running.

The various organizations that make up your supply chain will have a different outlook on security than you do. For one thing, their threat modeling will include different threats than yours. Why would a criminal looking to steal credit card information target an HVAC service provider? This is exactly what happened in 2013 when Target had over 40 million credit cards compromised. Target had done a reasonable job at securing its perimeter, but not its internal networks. The attacker, unable (or maybe just unwilling) to penetrate Target's outer shell head-on, decided to exploit the vulnerable network of one of Target's HVAC service providers and steal its credentials. Armed with these, the

thieves were able to gain access to the point of sale terminals and, from there, the credit card information.

The basic processes you'll need to implement to manage risk in your supply chain are the same ones you use in the rest of your risk management program. The differences are mainly in what you look at (that is, the scope of your assessments) and what you can do about it (legally and contractually). A good resource to help integrate supply chain risk into your risk management program is NIST SP 800-161, *Supply Chain Risk Management Practices for Federal Information Systems and Organizations*.

One of the first things you'll need to do is to create a supply chain map for your organization. This is essentially a network diagram of who supplies what to whom, down to your ultimate customers. Figure 2-8 depicts a simplified systems integrator company ("Your Company"). It has a hardware components manufacturer that supplies it hardware and is, in turn, supplied by a materials producer. Your Company receives software from a developer and receives managed security from an external service provider. The hardware and software components are integrated and configured into Your Company's product, which is then shipped to its distributor and on to its customers. In this example, the company has four suppliers on which to base its supply chain risk assessment. It is also considered a supplier to its distributor.

Now, suppose the software developer in Figure 2-8 is attacked and the threat actors insert malicious code into the developer's software product. Anyone who receives that application from Your Company, or perhaps through an otherwise legitimate software update, also gets a very stealthy piece of malware that "phones home" to these actors, telling them where the malware is and what its host network looks like. These are sophisticated, nation-state spies intent on remaining undetected while they penetrate some very specific targets. If an infected organization is of interest to them, they'll deliver the next stage of malware with which to quietly explore and steal files. Otherwise, they'll

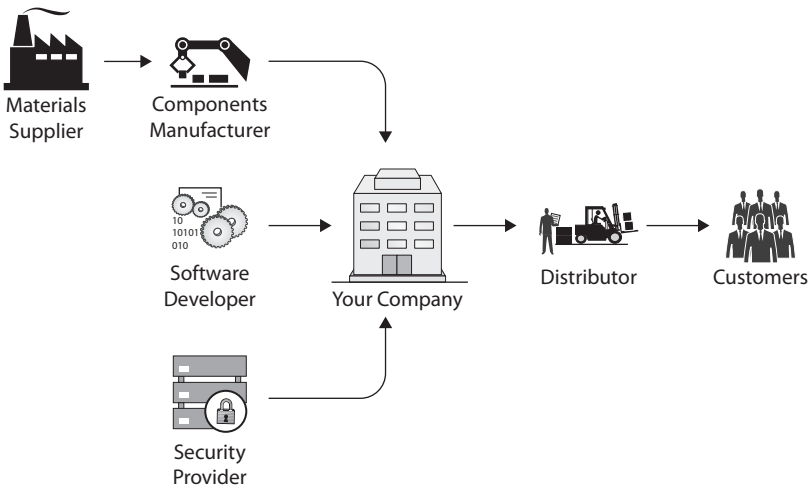


Figure 2-8 Simplified supply chain

tell the malware to go dormant, making their actions extremely difficult to detect. This is a high-level description of a cyber campaign discovered in late 2020 that exploited the Orion software developed by U.S.-based firm SolarWinds. The magnitude of this series of attacks underscores the importance of managing risk introduced by your suppliers.

Upstream and Downstream Suppliers

Suppliers are "upstream" from your company if they supply materials, goods, or services to your company and your company uses those in turn to provide whatever it is that it supplies to others. The core vulnerability that exists in these supply arrangements is that you could allow untrusted hardware, software, or services into your organization or products, where they could cause security problems. The Greeks used this to their advantage against the Trojans.

Conversely, your company may be upstream from others in the same supply chain. These would be your company's downstream suppliers. While it may be tempting to think that you should be concerned only about supply chain security upstream, those who follow your company in the supply chain may have their own set of upstream requirements for your firm. Furthermore, your customers may not care that a security issue was caused by your downstream distributor; your brand name could be damaged all the same.

Risks Associated with Hardware, Software, and Services

While we explore risks inherent in *any* hardware, software, and services later in this book, for now let's consider those risks that are specifically tied to supply chains. That is to say, what risks do you face when you acquire something (or someone's service) and insert it into your information systems?

Hardware

One of the major supply chain risks is the addition of hardware Trojans to electronic components. A hardware Trojan is an electronic circuit that is added to an existing device in order to compromise its security or provide unauthorized functionality. Depending on the attacker's access, these mechanisms can be inserted at any stage of the hardware development process (specification, design, fabrication, testing, assembly, or packaging). It is also possible to add them after the hardware is packaged by intercepting shipments in the supply chain. In this case, the Trojan may be noticeable if the device is opened and visually inspected. The earlier in the supply chain that hardware Trojans are inserted, the more difficult they are to detect.

Another supply chain risk to hardware is the substitution of counterfeit components. The problems with these clones are many, but from a security perspective one of the most important is that they don't go through the same quality controls that the real ones do. This leads to lower reliability and abnormal behavior. It could also lead to undetected hardware Trojans (perhaps inserted by the illicit manufacturers themselves). Obviously, using counterfeits could have legal implications and will definitely be a problem when you need customer support from the manufacturer.

Software

Like hardware, third-party software can be Trojaned by an adversary in your supply chain, particularly if it is custom-made for your organization. This could happen if your supplier reuses components (like libraries) developed elsewhere and to which the attacker has access. It can also be done by a malicious insider working for the supplier or by a remote attacker who has gained access to the supplier's software repositories. Failing all that, the software could be intercepted in transit to you, modified, and then sent on its way. This last approach could be made more difficult for the adversary by using code signing or hashes, but it is still possible.

Services

More organizations are outsourcing services to allow them to focus on their core business functions. Organizations use hosting companies to maintain websites and e-mail servers, service providers for various telecommunication connections, disaster recovery companies for co-location capabilities, cloud computing providers for infrastructure or application services, developers for software creation, and security companies to carry out vulnerability management. It is important to realize that while you can outsource functionality, you cannot outsource risk. When your organization is using these third-party service providers, it can still be ultimately responsible if something like a data breach takes place. The following are some things an organization should do to reduce its risk when outsourcing:

- Review the service provider's security program
- Conduct onsite inspection and interviews
- Review contracts to ensure security and protection levels are agreed upon
- Ensure service level agreements are in place
- Review internal and external audit reports and third-party reviews
- Review references and communicate with former and existing customers
- Review Better Business Bureau reports
- Ensure the service provider has a business continuity plan (BCP) in place
- Implement a nondisclosure agreement (NDA)
- Understand the provider's legal and regulatory requirements

Service outsourcing is prevalent within organizations today but is commonly forgotten about when it comes to security and compliance requirements. It may be economical to outsource certain functionalities, but if this allows security breaches to take place, it can turn out to be a very costly decision.

Other Third-Party Risks

An organization's supply chain is not its only source of third-party risks. There are many other ways in which organizations may be dependent on each other that don't really fit the

supplier–consumer model. For example, many companies have a network of channel partners that help them directly or indirectly sell products. Others engage in general or limited partnerships for specific projects, and these relationships require sharing some resources and risks. Most organizations nowadays have a complex web of (sometimes not so obvious) third parties on whom they rely to some extent and who, therefore, introduce risks.

Minimum Security Requirements

The key to effectively mitigating risks to an organization introduced by its suppliers is to clearly state each party's requirements in the contract or agreement that governs their relationship. In terms of cybersecurity, this includes whatever measures are needed to protect sensitive data at rest, in transit, and in use. It also includes the actions the supplier shall perform should the data become compromised, as well as the means through which the purchasing organization may proactively verify compliance. In summary, the critical classes of requirements that should be included in a contractual agreement are as follows.

- **Data protection** Proactive cybersecurity measures
- **Incident response** Reactive cybersecurity measures
- **Verification means** Ways in which the customer may verify the preceding requirements

If any requirements are missing, ambiguously stated, or otherwise vitiated, the supplier agreement can become void, voidable, or unenforceable. So, how do you verify that your supplier is complying with all contractual requirements dealing with risk? Third-party assessments are considered best practice and may be required for compliance (e.g., with PCI DSS). The following are some examples of external evaluations that would indicate a supplier's ability to comply with its contractual obligations:

- ISO 27001 certification
- U.S. Department of Defense Cybersecurity Maturity Model Certification (CMMC)
- Payment Card Industry Digital Security Standard (PCI DSS) certification
- Service Organization Control 1 (SOC1) or 2 (SOC2) report
- U.S. Federal Risk and Authorization Management Program (FedRAMP) authorization

NOTE We will discuss these third-party evaluations in subsequent chapters.

Other third-party evaluations, such as vulnerability assessments and penetration tests, are helpful in establishing a baseline of security in the organization. However, by themselves, these limited-scope tests are insufficient to verify that the supplier is able to fulfill its contractual obligations.

Service Level Agreements

A *service level agreement (SLA)* is a contractual agreement that states that a service provider guarantees a certain level of service. If the service is not delivered at the agreed-upon level (or better), then there are consequences (typically financial) for the service provider. SLAs provide a mechanism to mitigate some of the risk from service providers in the supply chain. For example, an Internet service provider (ISP) may sign an SLA of 99.999 percent (commonly called "five nines") uptime to the Internet backbone. That means that the ISP guarantees less than 26 seconds of downtime per month.

Business Continuity

Though we strive to drive down the risks of negative effects in our organizations, we can be sure that sooner or later an event will slip through and cause negative impacts. Ideally, the losses are contained and won't affect the major business efforts. However, as security professionals we need to have plans in place for when the unthinkable happens. Under those extreme (and sometimes unpredictable) conditions, we need to ensure that our organizations continue to operate at some minimum acceptable threshold capacity and quickly bounce back to full productivity.

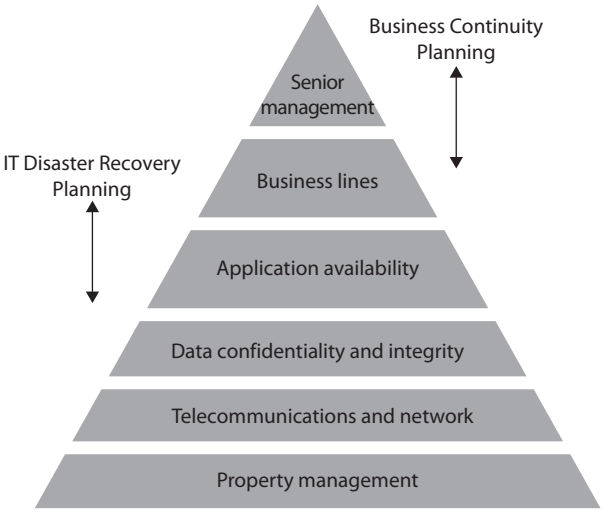
Business continuity (BC) is an organization's ability to maintain business functions or quickly resume them in the event that risks are realized and result in disruptions. The events can be pretty mundane, such as a temporary power outage, loss of network connectivity, or a critical employee (such as a systems administrator) suddenly becoming ill. These events could also be major disasters, such as an earthquake, explosion, or energy grid failure. *Disaster recovery (DR)*, by contrast to BC, is the process of minimizing the effects of a disaster or major disruption. It means taking the necessary steps to ensure that the resources, personnel, and business processes are safe and able to resume operation in a timely manner. So, DR is part of BC and the *disaster recovery plan (DRP)* covers a subset of events compared to the broader *business continuity plan (BCP)*.

EXAM TIP A business continuity plan (BCP) and a disaster recovery plan (DRP) are related but different. The DRP is a subset of the BCP and is focused on the immediate aftermath of a disaster. The BCP is much broader and covers any disruption including (but not limited to) disasters.

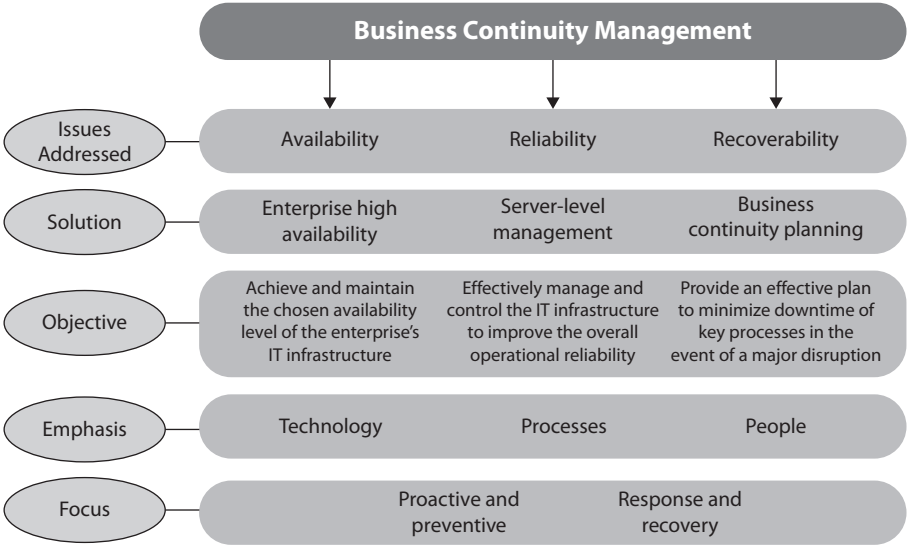
NOTE We discuss disaster recovery plans in detail in Chapter 23.

A BCP can include getting critical systems to another environment while repair of the original facilities is underway, getting the right people to the right places during this time, and performing business in a different mode until regular conditions are back in place. A BCP also involves dealing with customers, partners, and shareholders through different channels until everything returns to normal. So, disaster recovery deals with,

"Oh my goodness, the sky is falling," and continuity planning deals with, "Okay, the sky fell. Now, how do we stay in business until someone can put the sky back where it belongs?"



While disaster recovery and business continuity planning are directed at the development of plans, *business continuity management (BCM)* is the holistic management process that should cover both of them. BCM provides a framework for integrating resilience with the capability for effective responses in a manner that protects the interests of an organization's key stakeholders. The main objective of BCM is to allow the organization to continue to perform business operations under various conditions.



Certain characteristics run through many of the chapters in this book: availability, integrity, and confidentiality. Here, we point out that integrity and confidentiality must be considered not only in everyday procedures but also in those procedures undertaken immediately after a disaster or disruption. For instance, it may not be appropriate to leave a server that holds confidential information in one building while everyone else moves to another building. Equipment that provides secure VPN connections may be destroyed and the team might respond by focusing on enabling remote access functionality while forgetting about the needs of encryption. In most situations the organization is purely focused on getting back up and running, thus focusing on functionality. If security is not integrated and implemented properly, the effects of the physical disaster can be amplified as threat actors come in and steal sensitive information. Many times an organization is much more vulnerable *after* a disaster hits, because the security services used to protect it may be unavailable or operating at a reduced capacity. Therefore, it is important that if the organization has secret stuff, it stays secret.

Availability is one of the main themes behind business continuity planning, in that it ensures that the resources required to keep the business going will continue to be available to the people and systems that rely upon them. This may mean backups need to be done religiously and that redundancy needs to be factored into the architecture of the systems, networks, and operations. If communication lines are disabled or if a service is rendered unusable for any significant period of time, there must be a quick and tested way of establishing alternative communications and services. We will be diving into the many ways organizations can implement availability solutions for continuity and recovery purposes throughout this section.

When looking at business continuity planning, some organizations focus mainly on backing up data and providing redundant hardware. Although these items are extremely important, they are just small pieces of the organization's overall operations pie. Hardware and computers need people to configure and operate them, and data is usually not useful unless it is accessible by other systems and possibly outside entities. Thus, a larger picture

Business Continuity Planning

Preplanned procedures allow an organization to

- Provide an immediate and appropriate response to emergency situations
- Protect lives and ensure safety
- Reduce business impact
- Resume critical business functions
- Work with outside vendors and partners during the recovery period
- Reduce confusion during a crisis
- Ensure survivability of the organization
- Get "up and running" quickly after a disaster

of how the various processes within an organization work together needs to be understood. Planning must include getting the right people to the right places, documenting the necessary configurations, establishing alternative communications channels (voice and data), providing power, and making sure all dependencies are properly understood and taken into account.

It is also important to understand how automated tasks can be carried out manually, if necessary, and how business processes can be safely altered to keep the operation of the organization going. This may be critical in ensuring the organization survives the event with the least impact to its operations. Without this type of vision and planning, when a disaster hits, an organization could have its backup data and redundant servers physically available at the alternative facility, but the people responsible for activating them may be standing around in a daze, not knowing where to start or how to perform in such a different environment.

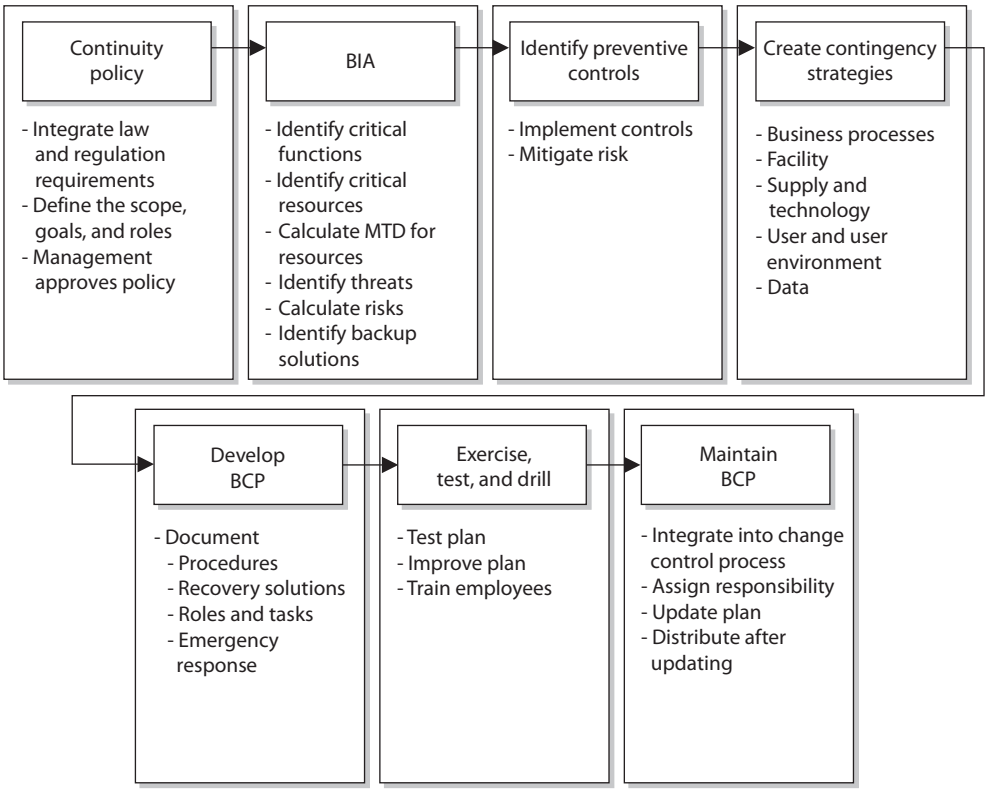
Standards and Best Practices

Although no specific scientific equation must be followed to create continuity plans, certain best practices have proven themselves over time. The National Institute of Standards and Technology is responsible for developing best practices and standards as they pertain to U.S. government and military environments. It is common for NIST to document the requirements for these types of environments, and then everyone else in the industry uses NIST's documents as guidelines. So these are "musts" for U.S. government organizations and "good to have" for other, nongovernment entities.

NIST outlines the following steps in SP 800-34, Rev. 1, *Contingency Planning Guide for Federal Information Systems*:

1. *Develop the continuity planning policy statement.* Write a policy that provides the guidance necessary to develop a BCP and that assigns authority to the necessary roles to carry out these tasks.
2. *Conduct the business impact analysis (BIA).* Identify critical functions and systems and allow the organization to prioritize them based on necessity. Identify vulnerabilities and threats, and calculate risks.
3. *Identify preventive controls.* Once threats are recognized, identify and implement controls and countermeasures to reduce the organization's risk level in an economical manner.
4. *Create contingency strategies.* Formulate methods to ensure systems and critical functions can be brought online quickly.
5. *Develop an information system contingency plan.* Write procedures and guidelines for how the organization can still stay functional in a crippled state.
6. *Ensure plan testing, training, and exercises.* Test the plan to identify deficiencies in the BCP, and conduct training to properly prepare individuals on their expected tasks.
7. *Ensure plan maintenance.* Put in place steps to ensure the BCP is a living document that is updated regularly.

Although NIST SP 800-34 deals specifically with IT contingency plans, these steps are similar when creating enterprise-wide BCPs and BCM programs.



Since BCM is so critical, it is actually addressed by other standards-based organizations, listed here:

ISO/IEC 27031:2011 Guidelines for information and communications technology readiness for business continuity. This ISO/IEC standard is a component of the overall ISO/IEC 27000 series.

ISO 22301:2019 International standard for business continuity management systems. The specification document against which organizations will seek certification.

Business Continuity Institute's Good Practice Guidelines (GPG) Represents the consensus view of an international group of BC practitioners. As of this writing, the latest edition was published in 2018. It is organized around six Professional Practices (PP):

- **Policy and Program Management (PP1)** Focuses on governance
- **Embedding Business Continuity (PP2)** Provides guidance on embedding BCM in the organization's culture, which includes awareness and training

- **Analysis (PP3)** Addresses organizational review, risk assessment, and business impact analysis, among other topics
- **Design (PP4)** Focuses on identifying and selecting the right BC solutions
- **Implementation (PP5)** Addresses what should go into the BC plan
- **Validation (PP6)** Covers exercising, maintaining, and reviewing the program

DRI International Institute's Professional Practices for Business Continuity Management Best practices and framework to allow for BCM processes, which are broken down into the following sections:

- Program Initiation and Management
- Risk Assessment
- Business Impact Analysis
- Business Continuity Strategies
- Incident Response
- Plan Development and Implementation
- Awareness and Training Programs
- Business Continuity Plan Exercise, Assessment, and Maintenance
- Crisis Communications
- Coordination with External Agencies

Why are there so many sets of best practices and which is the best for your organization? If your organization is part of the U.S. government or a government contracting organization, then you need to comply with the NIST standards. If your organization is in Europe or your organization does business with other organizations in Europe, then you might need to follow the European Union Agency for Cybersecurity (ENISA) requirements. While we are not listing all of them here, there are other country-based BCM standards that your organization might need to comply with if it is residing in or does business in one of those specific countries. If your organization needs to get ISO certified, then ISO/IEC 27031 and ISO 22301 could be the standards to follow. While the first of these is focused on IT, the second is broader in scope and addresses the needs of the entire organization.

Making BCM Part of the Enterprise Security Program

As we already explained, every organization should have security policies, procedures, standards, and guidelines. People who are new to information security commonly think that this is one pile of documentation that addresses all issues pertaining to security, but it is more complicated than that—of course.

Business continuity planning ought to be fully integrated into the organization as a regular management process, just like auditing or strategic planning or other "normal"

Understanding the Organization First

An organization has no real hope of rebuilding itself and its processes after a disaster if it does not have a good understanding of how its organization works in the first place. This notion might seem absurd at first. You might think, "Well, of course an organization knows how it works." But you would be surprised at how difficult it is to fully understand an organization down to the level of detail required to rebuild it. Each individual may know and understand his or her little world within the organization, but hardly anyone at any organization can fully explain how each and every business process takes place.

processes. Instead of being considered an outsider, BCP should be "part of the team." Further, final responsibility for BCP should belong not to the BCP team or its leader, but to a high-level executive manager, preferably a member of the executive board. This will reinforce the image and reality of continuity planning as a function seen as vital to the organizational chiefs.

By analyzing and planning for potential disruptions to the organization, the BCP team can assist other business disciplines in their own efforts to effectively plan for and respond effectively and with resilience to emergencies. Given that the ability to respond depends on operations and management personnel throughout the organization, such capability should be developed organization-wide. It should extend throughout every location of the organization and up the employee ranks to top-tier management.

As such, the BCP program needs to be a living entity. As an organization goes through changes, so should the program, thereby ensuring it stays current, usable, and effective. When properly integrated with change management processes, the program stands a much better chance of being continually updated and improved upon. Business continuity is a foundational piece of an effective security program and is critical to ensuring relevance in time of need.

A very important question to ask when first developing a BCP is *why* it is being developed. This may seem silly and the answer may at first appear obvious, but that is not always the case. You might think that the reason to have these plans is to deal with an unexpected disaster and to get people back to their tasks as quickly and as safely as possible, but the full story is often a bit different. Why are most companies in business? To make money and be profitable. If these are usually the main goals of businesses, then any BCP needs to be developed to help achieve and, more importantly, maintain these goals. The main reason to develop these plans in the first place is to reduce the risk of financial loss by improving the company's ability to recover and restore operations. This encompasses the goals of mitigating the effects of the disaster.

Not all organizations are businesses that exist to make profits. Government agencies, military units, nonprofit organizations, and the like exist to provide some type of protection or service to a nation or society. Whereas a company must create its BCP to ensure that revenue continues to come in so that the company can stay in business,

other types of organizations must create their BCPs to make sure they can still carry out their critical tasks. Although the focus and business drivers of the organizations and companies may differ, their BCPs often have similar constructs—which is to get their critical processes up and running.

Protecting what is most important to a company is rather difficult if what is most important is not first identified. Senior management is usually involved with this step because it has a point of view that extends beyond each functional manager's focus area of responsibility. Senior management has the visibility needed to establish the scope of the plan. The company's BCP should be focused on the company's critical mission and business functions. And, conversely, the BCP must support the organization's overall strategy. The functions must have priorities set upon them to indicate which is most crucial to a company's survival. The scope of the BCP is defined by which of these functions are considered important enough to warrant the investment of resources required for BC.

As stated previously, for many companies, financial operations are most critical. As an example, an automotive company would be affected far more seriously if its credit and loan services were unavailable for a day than if, say, an assembly line went down for a day, since credit and loan services are where it generates the biggest revenues. For other organizations, customer service might be the most critical area to ensure that order processing is not negatively affected. For example, if a company makes heart pacemakers and its physician services department is unavailable at a time when an operating room surgeon needs to contact it because of a complication, the results could be disastrous for the patient. The surgeon and the company would likely be sued, and the company would likely never again be able to sell another pacemaker to that surgeon, her colleagues, or perhaps even the patient's health maintenance organization (HMO). It would be very difficult to rebuild reputation and sales after something like that happened.

Advanced planning for emergencies covers issues that were thought of and foreseen. Many other problems may arise that are not covered in the BCP; thus, flexibility in the plan is crucial. The plan is a systematic way of providing a checklist of actions that should take place right after a disaster. These actions have been thought through to help the people involved be more efficient and effective in dealing with traumatic situations.

The most critical part of establishing and maintaining a current BCP is management support. Management must be convinced of the necessity of such a plan. Therefore, a business case must be made to obtain this support. The business case may include current vulnerabilities, regulatory and legal obligations, the current status of recovery plans, and recommendations. Management is mostly concerned with cost/benefit issues, so preliminary numbers need to be gathered and potential losses estimated. A cost/benefit analysis should include shareholder, stakeholder, regulatory, and legislative impacts, as well as impacts on products, services, and personnel. The decision of how a company should recover is commonly a business decision and should always be treated as such.

Business Impact Analysis

Business continuity planning deals with uncertainty and chance. What is important to note here is that even though you cannot predict whether or when a disaster will happen,

that doesn't mean you can't plan for it. Just because we are not planning for an earthquake to hit us tomorrow morning at 10 A.M. doesn't mean we can't plan the activities required to successfully survive when an earthquake (or a similar disaster) does hit. The point of making these plans is to try to think of all the possible disasters that could take place, estimate the potential damage and loss, categorize and prioritize the potential disasters, and develop viable alternatives in case those events do actually happen.

A *business impact analysis (BIA)* is considered a *functional analysis*, in which a team collects data through interviews and documentary sources; documents business functions, activities, and transactions; develops a hierarchy of business functions; and finally applies a classification scheme to indicate each individual function's criticality level. But how do we determine a classification scheme based on criticality levels?

The BCP committee must identify the threats to the organization and map them to the following characteristics:

- Maximum tolerable downtime and disruption for activities
- Operational disruption and productivity
- Financial considerations
- Regulatory responsibilities
- Reputation

The committee will not truly understand all business processes, the steps that must take place, or the resources and supplies these processes require. So the committee must gather this information from the people who do know—department managers and specific employees throughout the organization. The committee starts by identifying the people who will be part of the BIA data-gathering sessions. The committee needs to identify how it will collect the data from the selected employees, be it through surveys, interviews, or workshops. Next, the team needs to collect the information by actually conducting surveys, interviews, and workshops. Data points obtained as part of the information gathering will be used later during analysis. It is important that the team members ask about how different tasks—whether processes, transactions, or services, along with any relevant dependencies—get accomplished within the organization. The team should build process flow diagrams, which will be used throughout the BIA and plan development stages.

Upon completion of the data collection phase, the BCP committee needs to conduct a BIA to establish which processes, devices, or operational activities are critical. If a system stands on its own, doesn't affect other systems, and is of low criticality, then it can be classified as a tier-two or tier-three recovery step. This means these resources will not be dealt with during the recovery stages until the most critical (tier one) resources are up and running. This analysis can be completed using a standard risk assessment as illustrated in Figure 2-9.

Risk Assessment

To achieve success, the organization should systematically plan and execute a formal BCP-related risk assessment. The assessment fully takes into account the organization's

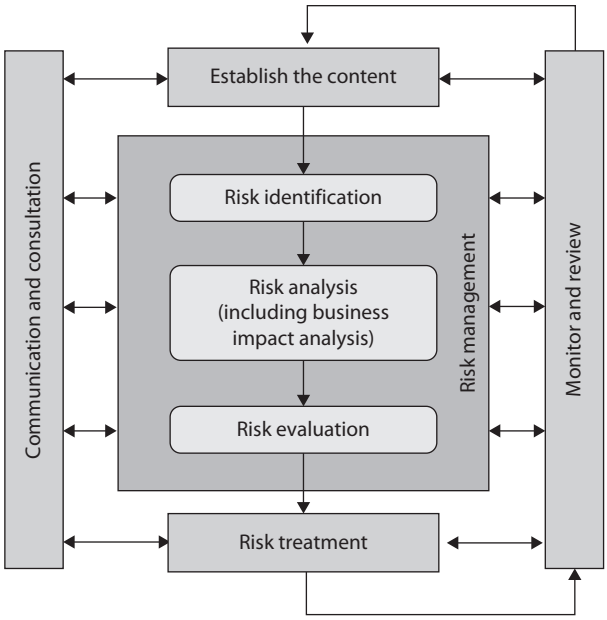


Figure 2-9 Risk assessment process

tolerance for continuity risks. The risk assessment also makes use of the data in the BIA to supply a consistent estimate of exposure.

As indicators of success, the risk assessment should identify, evaluate, and record all relevant items, which may include

- Vulnerabilities for all of the organization's most time-sensitive resources and activities
- Threats and hazards to the organization's most urgent resources and activities
- Measures that cut the possibility, length, or effect of a disruption on critical services and products
- Single points of failure; that is, concentrations of risk that threaten business continuity
- Continuity risks from concentrations of critical skills or critical shortages of skills
- Continuity risks due to outsourced vendors and suppliers
- Continuity risks that the BCP program has accepted, that are handled elsewhere, or that the BCP program does not address

Risk Assessment Evaluation and Process

In a BCP setting, a risk assessment looks at the impact and likelihood of various threats that could trigger a business disruption. The tools, techniques, and methods of risk assessment include determining threats, assessing probabilities, tabulating threats, and analyzing costs and benefits.

The end goals of a business continuity–focused risk assessment include

- Identifying and documenting single points of failure
- Making a prioritized list of threats to the particular business processes of the organization
- Putting together information for developing a management strategy for risk control and for developing action plans for addressing risks
- Documenting acceptance of identified risks, or documenting acknowledgment of risks that will not be addressed

The risk assessment is assumed to take the form of the equation Risk = Threat × Impact × Probability. However, the BIA adds the dimension of time to this equation. In other words, risk mitigation measures should be geared toward those things that might most rapidly disrupt critical business processes and commercial activities.

The main parts of a risk assessment are

- Review the existing strategies for risk management
- Construct a numerical scoring system for probabilities and impacts
- Make use of a numerical score to gauge the effect of the threat
- Estimate the probability of each threat
- Weigh each threat through the scoring system
- Calculate the risk by combining the scores of likelihood and impact of each threat
- Get the organization's sponsor to sign off on these risk priorities
- Weigh appropriate measures
- Make sure that planned measures that alleviate risk do not heighten other risks
- Present the assessment's findings to executive management

Threats can be man-made, natural, or technical. A man-made threat may be an arsonist, a terrorist, or a simple mistake that can have serious outcomes. Natural threats may be tornadoes, floods, hurricanes, or earthquakes. Technical threats may be data corruption, loss of power, device failure, or loss of a data communications line. It is important to identify all possible threats and estimate the probability of them happening. Some issues may not immediately come to mind when developing these plans, such as an employee strike, vandals, disgruntled employees, or hackers, but they do need to be identified. These issues are often best addressed in a group with scenario-based exercises. This ensures that if a threat becomes reality, the plan includes the ramifications on *all* business tasks, departments, and critical operations. The more issues that are thought of and planned for, the better prepared an organization will be if and when these events take place.

The BCP committee needs to step through scenarios in which the following problems result:

- Equipment malfunction or unavailable equipment
- Unavailable utilities (HVAC, power, communications lines)
- Facility becomes unavailable
- Critical personnel become unavailable
- Vendor and service providers become unavailable
- Software and/or data corruption

The specific scenarios and damage types can vary from organization to organization.

Assigning Values to Assets

Qualitative and quantitative impact information should be gathered and then properly analyzed and interpreted. The goal is to see exactly how an organization will be affected by different threats. The effects can be economical, operational, or both. Upon completion of the data analysis, it should be reviewed with the most knowledgeable people within the organization to ensure that the findings are appropriate and that it describes the real risks and impacts the organization faces. This will help flush out any additional data points not originally obtained and will give a fuller understanding of all the possible business impacts.

Loss criteria must be applied to the individual threats that were identified. The criteria may include the following:

- Loss in reputation and public confidence
- Loss of competitive advantages

BIA Steps

The more detailed and granular steps of a BIA are outlined here:

1. Select individuals to interview for data gathering.
2. Create data-gathering techniques (surveys, questionnaires, qualitative and quantitative approaches).
3. Identify the organization's critical business functions.
4. Identify the resources these functions depend upon.
5. Calculate how long these functions can survive without these resources.
6. Identify vulnerabilities and threats to these functions.
7. Calculate the risk for each different business function.
8. Document findings and report them to management.

We cover each of these steps in this chapter.

- Increase in operational expenses
- Violations of contract agreements
- Violations of legal and regulatory requirements
- Delayed-income costs
- Loss in revenue
- Loss in productivity

These costs can be direct or indirect and must be properly accounted for.

For instance, if the BCP team is looking at the threat of a terrorist bombing, it is important to identify which business function most likely would be targeted, how all business functions could be affected, and how each bulleted item in the loss criteria would be directly or indirectly involved. The timeliness of the recovery can be critical for business processes and the company's survival. For example, it may be acceptable to have the customer-support functionality out of commission for two days, whereas five days may leave the company in financial ruin.

After identifying the critical functions, it is necessary to find out exactly what is required for these individual business processes to take place. The resources that are required for the identified business processes are not necessarily just computer systems, but may include personnel, procedures, tasks, supplies, and vendor support. It must be understood that if one or more of these support mechanisms is not available, the critical function may be doomed. The team must determine what type of effect unavailable resources and systems will have on these critical functions.

The BIA identifies which of the organization's critical systems are needed for survival and estimates the outage time that can be tolerated by the organization as a result of various unfortunate events. The outage time that can be endured by an organization is referred to as the *maximum tolerable downtime (MTD)* or *maximum tolerable period of disruption (MTPD)*, which is illustrated in Figure 2-10.

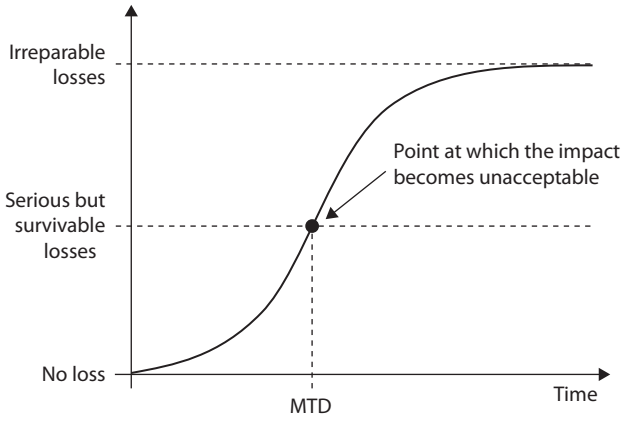


Figure 2-10 Maximum tolerable downtime

The following are some MTD estimates that an organization may use. Note that these are sample estimates that will vary from organization to organization and from business unit to business unit.

- **Nonessential** 30 days
- **Normal** 7 days
- **Important** 72 hours
- **Urgent** 24 hours
- **Critical** Minutes to hours

Each business function and asset should be placed in one of these categories, depending upon how long the organization can survive without it. These estimates will help the organization determine what backup solutions are necessary to ensure the availability of these resources. The shorter the MTD, the higher priority of recovery for the function in question. Thus, the items classified as Urgent should be addressed before those classified as Normal.

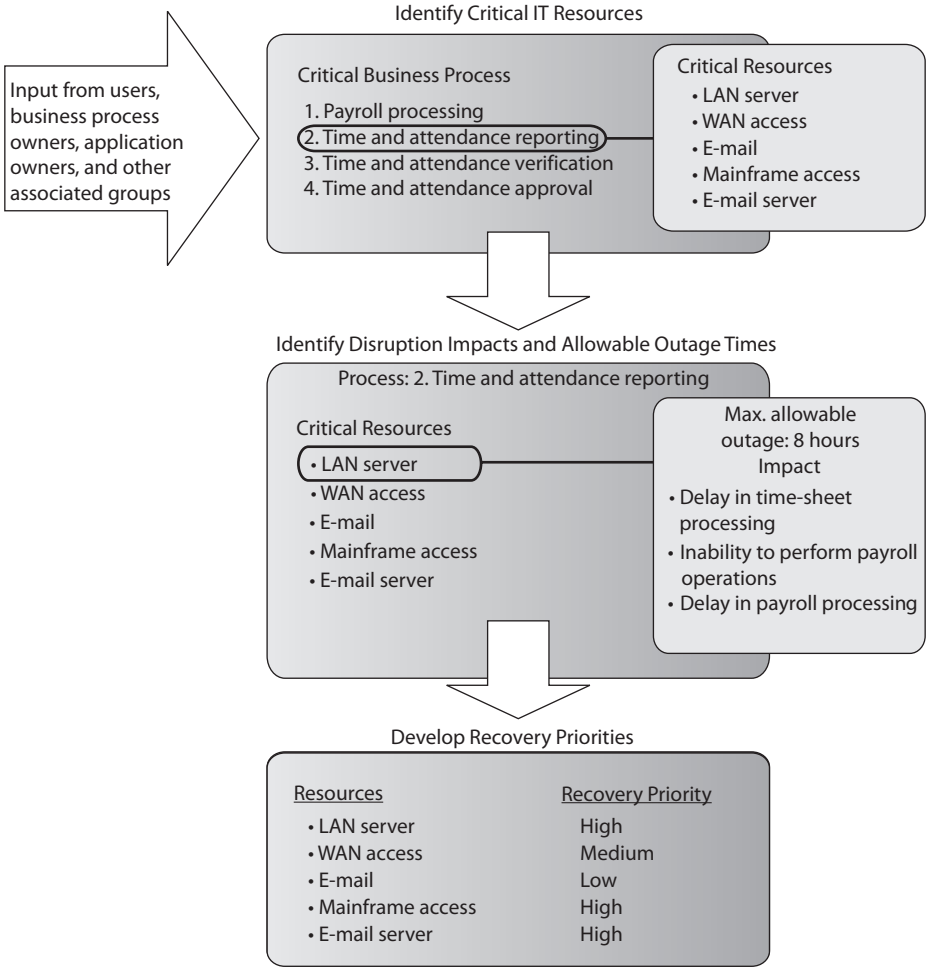
For example, if being without a T1 communication line for three hours would cost the company $130,000, the T1 line could be considered Critical, and thus the company should put in a backup T1 line from a different carrier. If a server going down and being unavailable for ten days will only cost the company $250 in revenue, this would fall into the Normal category, and thus the company may not need to have a fully redundant server waiting to be swapped out. Instead, the company may choose to count on its vendor's SLA, which may promise to have it back online in eight days.

Sometimes the MTD will depend in large measure on the type of organization in question. For instance, a call center—a vital link to current and prospective clients—will have a short MTD, perhaps measured in minutes instead of weeks. A common solution is to split up the calls through multiple call centers placed in differing locales. If one call center is knocked out of service, the other one can temporarily pick up the load. Manufacturing can be handled in various ways. Examples include subcontracting the making of products to an outside vendor, manufacturing at multiple sites, and warehousing an extra supply of products to fill gaps in supply in case of disruptions to normal manufacturing.

The BCP team must try to think of all possible events that might occur that could turn out to be detrimental to an organization. The BCP team also must understand it cannot possibly contemplate all events, and thus protection may not be available for every scenario introduced. Being properly prepared specifically for a flood, earthquake, terrorist attack, or lightning strike is not as important as being properly prepared to respond to *anything* that damages or disrupts critical business functions.

All of the previously mentioned disasters could cause these results, but so could a meteor strike, a tornado, or a wing falling off a plane passing overhead. So the moral of the story is to be prepared for the loss of any or all business resources, instead of focusing on the events that could cause the loss.

EXAM TIP A BIA is performed at the beginning of business continuity planning to identify the areas that would suffer the greatest financial or operational loss in the event of a disaster or disruption. It identifies the organization's critical systems needed for survival and estimates the outage time that can be tolerated by the organization as a result of a disaster or disruption.



Chapter Review

We took a very detailed look at the way in which we manage risk to our information systems. We know that no system is truly secure, so our job is to find the most likely and the most dangerous threat actions so that we can address them first. The process of quantifying losses and their probabilities of occurring is at the heart of risk assessments. Armed with that information, we are able to make good decisions in terms of controls, processes, and costs. Our approach is focused not solely on the human adversary but also on any source of loss to our organizations. Most importantly, we use this information to devise ways in which to ensure we can continue business operations in the face of any reasonable threat.

Quick Review

- Risk management is the process of identifying and assessing risk, reducing it to an acceptable level, and ensuring it remains at that level.
- An information systems risk management (ISRM) policy provides the foundation and direction for the organization's security risk management processes and procedures and should address all issues of information security.
- A threat is a potential cause of an unwanted incident, which may result in harm to a system or organization.
- Four risk assessment methodologies with which you should be familiar are NIST SP 800-30; Facilitated Risk Analysis Process (FRAP); Operationally Critical Threat, Asset, and Vulnerability Evaluation (OCTAVE); and Failure Modes and Effect Analysis (FMEA).
- Failure Modes and Effect Analysis (FMEA) is a method for determining functions, identifying functional failures, and assessing the causes of failure and their effects through a structured process.
- A fault tree analysis is a useful approach to detect failures that can take place within complex environments and systems.
- A quantitative risk analysis attempts to assign monetary values to components within the analysis.
- A purely quantitative risk analysis is not possible because qualitative items cannot be quantified with precision.
- Qualitative risk analysis uses judgment and intuition instead of numbers.
- Qualitative risk analysis involves people with the requisite experience and education evaluating threat scenarios and rating the probability, potential loss, and severity of each threat based on their personal experience.
- Single loss expectancy × frequency per year = annualized loss expectancy (SLE × ARO = ALE)

- The main goals of risk analysis are the following: identify assets and assign values to them, identify vulnerabilities and threats, quantify the impact of potential threats, and provide an economic balance between the impact of the risk and the cost of the safeguards.
- Capturing the degree of uncertainty when carrying out a risk analysis is important, because it indicates the level of confidence the team and management should have in the resulting figures.
- Automated risk analysis tools reduce the amount of manual work involved in the analysis. They can be used to estimate future expected losses and calculate the benefits of different security measures.
- The risk management team should include individuals from different departments within the organization, not just technical personnel.
- Risk can be transferred, avoided, reduced, or accepted.
- Threats × vulnerability × asset value = total risk.
- (Threats × vulnerability × asset value) × controls gap = residual risk.
- When choosing the right safeguard to reduce a specific risk, the cost, functionality, and effectiveness must be evaluated and a cost/benefit analysis performed.
- There are three main categories of controls: administrative, technical, and physical.
- Controls can also be grouped by types, depending on their intended purpose, as preventive, detective, corrective, deterrent, recovery, and compensating.
- A control assessment is an evaluation of one or more controls to determine the extent to which they are implemented correctly, operating as intended, and producing the desired outcome.
- Security control verification answers the question "did we implement the control right?" while validation answers the question "did we implement the right control?"
- Risk monitoring is the ongoing process of adding new risks, reevaluating existing ones, removing moot ones, and continuously assessing the effectiveness of your controls at mitigating all risks to tolerable levels.
- Change management processes deal with monitoring changes to your environment and dealing with the risks they could introduce.
- Continuous improvement is the practice of identifying opportunities, mitigating threats, improving quality, and reducing waste as an ongoing effort. It is the hallmark of mature and effective organizations.
- A supply chain is a sequence of suppliers involved in delivering some product.
- Business continuity management (BCM) is the overarching approach to managing all aspects of BCP and DRP.
- A business continuity plan (BCP) contains strategy documents that provide detailed procedures that ensure critical business functions are maintained and that help minimize losses of life, operations, and systems.

- A BCP provides procedures for emergency responses, extended backup operations, and post-disaster recovery.
- A BCP should have an enterprise-wide reach, with each individual organizational unit having its own detailed continuity and contingency plans.
- A BCP needs to prioritize critical applications and provide a sequence for efficient recovery.
- A BCP requires senior executive management support for initiating the plan and final approval.
- BCPs can quickly become outdated due to personnel turnover, reorganizations, and undocumented changes.
- Executives may be held liable if proper BCPs are not developed and used.
- Threats can be natural, man-made, or technical.
- The business impact analysis (BIA) is one of the most important first steps in the planning development. Qualitative and quantitative data on the business impact of a disaster need to be gathered, analyzed, interpreted, and presented to management.
- Executive commitment and support are the most critical elements in developing the BCP.
- A business case must be presented to gain executive support. This is done by explaining regulatory and legal requirements, exposing vulnerabilities, and providing solutions.
- Plans should be prepared by the people who will actually carry them out.
- The planning group should comprise representatives from all departments or organizational units.
- The BCP team should identify the individuals who will interact with external players, such as the reporters, shareholders, customers, and civic officials. Response to the disaster should be done quickly and honestly, and should be consistent with any other organizational response.

Questions

Please remember that these questions are formatted and asked in a certain way for a reason. Keep in mind that the CISSP exam is asking questions at a conceptual level. Questions may not always have the perfect answer, and the candidate is advised against always looking for the perfect answer. Instead, the candidate should look for the best answer in the list.

1. When is it acceptable to not take action on an identified risk?

A. Never. Good security addresses and reduces all risks.

B. When political issues prevent this type of risk from being addressed.

C. When the necessary countermeasure is complex.

D. When the cost of the countermeasure outweighs the value of the asset and potential loss.

2. Which is the most valuable technique when determining if a specific security control should be implemented?
   - **A.** Risk analysis
   - **B.** Cost/benefit analysis
   - **C.** ALE results
   - **D.** Identifying the vulnerabilities and threats causing the risk
3. Which best describes the purpose of the ALE calculation?
   - **A.** Quantifies the security level of the environment
   - **B.** Estimates the loss possible for a countermeasure
   - **C.** Quantifies the cost/benefit result
   - **D.** Estimates the loss potential of a threat in a span of a year
4. How do you calculate residual risk?
   - **A.** Threats × risks × asset value
   - **B.** (Threats × asset value × vulnerability) × risks
   - **C.** SLE × frequency = ALE
   - **D.** (Threats × vulnerability × asset value) × controls gap
5. Why should the team that will perform and review the risk analysis information be made up of people in different departments?
   - **A.** To make sure the process is fair and that no one is left out.
   - **B.** It shouldn't. It should be a small group brought in from outside the organization because otherwise the analysis is biased and unusable.
   - **C.** Because people in different departments understand the risks of their department. Thus, it ensures the data going into the analysis is as close to reality as possible.
   - **D.** Because the people in the different departments are the ones causing the risks, so they should be the ones held accountable.
6. Which best describes a quantitative risk analysis?
   - **A.** A scenario-based analysis to research different security threats
   - **B.** A method used to apply severity levels to potential loss, probability of loss, and risks
   - **C.** A method that assigns monetary values to components in the risk assessment
   - **D.** A method that is based on gut feelings and opinions
7. Why is a truly quantitative risk analysis not possible to achieve?
   - **A.** It is possible, which is why it is used.
   - **B.** It assigns severity levels. Thus, it is hard to translate into monetary values.
   - **C.** It is dealing with purely quantitative elements.
   - **D.** Quantitative measures must be applied to qualitative elements.

Use the following scenario to answer Questions 9–11. A company has an e-commerce website that carries out 60 percent of its annual revenue. Under the current circumstances, the annualized loss expectancy for a website against the threat of attack is $92,000. After implementing a new application-layer firewall, the new ALE would be $30,000. The firewall costs $65,000 per year to implement and maintain.

8. How much does the firewall save the company in loss expenses?

A. $62,000

B. $3,000

C. $65,000

D. $30,000

9. What is the value of the firewall to the company?

A. $62,000

B. $3,000

C. –$62,000

D. –$3,000

10. Which of the following describes the company's approach to risk management?

A. Risk transference

B. Risk avoidance

C. Risk acceptance

D. Risk mitigation

Use the following scenario to answer Questions 11–13. A small remote office for a company is valued at $800,000. It is estimated, based on historical data, that a fire is likely to occur once every ten years at a facility in this area. It is estimated that such a fire would destroy 60 percent of the facility under the current circumstances and with the current detective and preventive controls in place.

11. What is the single loss expectancy (SLE) for the facility suffering from a fire?

A. $80,000

B. $480,000

C. $320,000

D. 60%

12. What is the annualized rate of occurrence (ARO)?

A. 1

B. 10

C. .1

D. .01

13. What is the annualized loss expectancy (ALE)?
    - **A.** $480,000
    - **B.** $32,000
    - **C.** $48,000
    - **D.** .6
14. Which of the following is not one of the three key areas for risk monitoring?
    - **A.** Threat
    - **B.** Effectiveness
    - **C.** Change
    - **D.** Compliance
15. What is one of the first steps in developing a business continuity plan?
    - **A.** Identify a backup solution.
    - **B.** Perform a simulation test.
    - **C.** Perform a business impact analysis.
    - **D.** Develop a business resumption plan.

Answers

1. **D.** Organizations may decide to live with specific risks they are faced with if the cost of trying to protect themselves would be greater than the potential loss if the threat were to become real. Countermeasures are usually complex to a degree, and there are almost always political issues surrounding different risks, but these are not reasons to not implement a countermeasure.
2. **B.** Although the other answers may seem correct, B is the best answer here. This is because a risk analysis is performed to identify risks and come up with suggested countermeasures. The annualized loss expectancy (ALE) tells the organization how much it could lose if a specific threat became real. The ALE value will go into the cost/benefit analysis, but the ALE does not address the cost of the countermeasure and the benefit of a countermeasure. All the data captured in answers A, C, and D is inserted into a cost/benefit analysis.
3. **D.** The ALE calculation estimates the potential loss that can affect one asset from a specific threat within a one-year time span. This value is used to figure out the amount of money that should be earmarked to protect this asset from this threat.
4. **D.** The equation is more conceptual than practical. It is hard to assign a number to an individual vulnerability or threat. This equation enables you to look at the potential loss of a specific asset, as well as the controls gap (what the specific countermeasure cannot protect against). What remains is the residual risk, which is what is left over after a countermeasure is implemented.

5. **C.** An analysis is only as good as the data that goes into it. Data pertaining to risks the organization faces should be extracted from the people who understand best the business functions and environment of the organization. Each department understands its own threats and resources, and may have possible solutions to specific threats that affect its part of the organization.
6. **C.** A quantitative risk analysis assigns monetary values and percentages to the different components within the assessment. A qualitative analysis uses opinions of individuals and a rating system to gauge the severity level of different threats and the benefits of specific countermeasures.
7. **D.** During a risk analysis, the team is trying to properly predict the future and all the risks that future may bring. It is somewhat of a subjective exercise and requires educated guessing. It is very hard to properly predict that a flood will take place once in ten years and cost a company up to $40,000 in damages, but this is what a quantitative analysis tries to accomplish.
8. **A.** $62,000 is the correct answer. The firewall reduced the annualized loss expectancy (ALE) from $92,000 to $30,000 for a savings of $62,000. The formula for ALE is single loss expectancy × annualized rate of occurrence = ALE. Subtracting the ALE value after the firewall is implemented from the value before it was implemented results in the potential loss savings this type of control provides.
9. **D.** –$3,000 is the correct answer. The firewall saves $62,000, but costs $65,000 per year. 62,000 – 65,000 = –3,000. The firewall actually costs the company more than the original expected loss, and thus the value to the company is a negative number. The formula for this calculation is (ALE before the control is implemented) – (ALE after the control is implemented) – (annual cost of control) = value of control.
10. **D.** Risk mitigation involves employing controls in an attempt to reduce either the likelihood or damage associated with an incident, or both. The four ways of dealing with risk are accept, avoid, transfer, and mitigate (reduce). A firewall is a countermeasure installed to reduce the risk of a threat.
11. **B.** $480,000 is the correct answer. The formula for single loss expectancy (SLE) is asset value × exposure factor (EF) = SLE. In this situation the formula would work out as asset value ($800,000) × exposure factor (60%) = $480,000. This means that the company has a potential loss value of $480,000 pertaining to this one asset (facility) and this one threat type (fire).
12. **C.** The annualized rate occurrence (ARO) is the frequency that a threat will most likely occur within a 12-month period. It is a value used in the ALE formula, which is SLE × ARO = ALE.
13. **C.** $48,000 is the correct answer. The annualized loss expectancy formula (SLE × ARO = ALE) is used to calculate the loss potential for one asset experiencing one threat in a 12-month period. The resulting ALE value helps to determine the amount that can reasonably be spent in the protection of that asset. In this situation, the company should not spend over $48,000 on protecting this

asset from the threat of fire. ALE values help organizations rank the severity level of the risks they face so they know which ones to deal with first and how much to spend on each.

14. **A.** Risk monitoring activities should be focused on three key areas: effectiveness, change, and compliance. Changes to the threat landscape should be incorporated directly into the first two, and indirectly into compliance monitoring.
15. **C.** A business impact analysis includes identifying critical systems and functions of an organization and interviewing representatives from each department. Once management's support is solidified, a BIA needs to be performed to identify the threats the company faces and the potential costs of these threats.

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CHAPTER 3

Compliance

This chapter presents the following:

- Regulations, laws, and crimes involving computers
- Intellectual property
- Data breaches
- Compliance requirements
- Investigations

If you think compliance is expensive, try noncompliance.

—Paul McNulty

Rules, formal or otherwise, are essential for prosperity in any context. This is particularly true when it comes to cybersecurity. Even if our adversaries don't follow the rules (and clearly they don't), we must understand the rules that apply to us and follow them carefully. In this chapter, we discuss the various laws and regulations that deal with computer information systems. We can't really address each piece of legislation around the world, since that would take multiple books longer than this one. However, we will offer as examples some of the most impactful laws and regulations affecting multinational enterprises. These include laws and regulations applicable to cybercrimes, privacy, and intellectual property, among others. The point of this chapter is not to turn you into a cyberlaw expert, but to make you aware of some of the topics about which you should have conversations with your legal counsel and compliance colleagues as you develop and mature your cybersecurity program.

Laws and Regulations

Before we get into the details of what you, as a cybersecurity leader, are required to do, let's start by reviewing some foundational concepts about what laws and regulations are, exploring how they vary around the world, and then putting them into a holistic context.

Law is a system of rules created by either a government or a society, recognized as binding by that group, and enforced by some specific authority. Laws apply equally to everyone in the country or society. It is important to keep in mind that laws are not always written down and may be customary, as discussed shortly. *Regulations*, by contrast, are written rules dealing with specific details or procedures, issued by an executive body

and having the force of law. Regulations apply only to the specific entities that fall under the authority of the agency that issues them. So, while any U.S.-based organization is subject to a U.S. law called the Computer Fraud and Abuse Act (CFAA), only U.S. organizations that deal with data concerning persons in the European Union (EU) would also be subject to the General Data Protection Regulation (GDPR).

Types of Legal Systems

Your organization may be subject to laws and regulations from multiple jurisdictions. As just mentioned, if your organization is based in the United States but handles data of citizens of the EU, your organization is subject to both the CFAA and the GDPR. It is important to keep in mind that different countries can have very different legal systems. Your legal department will figure out jurisdictions and applicability, but you need to be aware of what this disparity of legal systems means to your cybersecurity program. To this end, it is helpful to become familiar with the major legal systems you may come across. In this section, we cover the core components of the various legal systems and what differentiates them.

Civil (Code) Law System

- System of law used in continental European countries such as France and Spain.
- Different legal system from the common law system used in the United Kingdom and United States.
- Civil law system is rule-based law, not precedent-based.
- For the most part, a civil law system is focused on codified law—or written laws.
- The history of the civil law system dates to the sixth century when the Byzantine emperor Justinian codified the laws of Rome.
- Civil *legal systems* should not be confused with the civil (or tort) *laws* found in the United States.
- The civil legal system was established by states or nations for self-regulation; thus, the civil law system can be divided into subdivisions, such as French civil law, German civil law, and so on.
- It is the most widespread legal system in the world and the most common legal system in Europe.
- Under the civil legal system, lower courts are not compelled to follow the decisions made by higher courts.

Common Law System

- Developed in England.
- Based on previous interpretations of laws:
  - In the past, judges would walk throughout the country enforcing laws and settling disputes.

  - The judges did not have a written set of laws, so they based their laws on custom and precedent.
  - In the 12th century, the king of England (Henry II) imposed a unified legal system that was "common" to the entire country.
  - Reflects the community's morals and expectations.
  - Led to the creation of barristers, or lawyers, who actively participate in the litigation process through the presentation of evidence and arguments.
- Today, the common law system uses judges and juries of peers. If the jury trial is waived, the judge decides the facts.
- Typical systems consist of a higher court, several intermediate appellate courts, and many local trial courts. Precedent flows down through this system. Tradition also allows for "magistrate's courts," which address administrative decisions.
- The common law system is broken down into criminal, civil/tort, and administrative.

Criminal Law System

- Based on common law, statutory law, or a combination of both.
- Addresses behavior that is considered harmful to society.
- Punishment usually involves a loss of freedom, such as incarceration, or monetary fines.
- Responsibility is on the prosecution to prove guilt beyond a reasonable doubt (innocent until proven guilty).

Civil/Tort Law System

- Offshoot of criminal law.
- Under civil law, the defendant owes a legal duty to the victim. In other words, the defendant is obligated to conform to a particular standard of conduct, usually set by what a "reasonable person of ordinary prudence" would do to prevent foreseeable injury to the victim.
- The defendant's breach of that duty causes injury to the victim; usually physical or financial.
- Categories of civil law:
  - **Intentional** Examples include assault, intentional infliction of emotional distress, or false imprisonment.
  - **Wrongs against property** An example is nuisance against landowner.
  - **Wrongs against a person** Examples include car accidents, dog bites, and a slip and fall.
  - **Negligence** An example is wrongful death.
  - **Nuisance** An example is trespassing.

- **Dignitary wrongs** Include invasion of privacy and civil rights violations.
- **Economic wrongs** Examples include patent, copyright, and trademark infringement.
- **Strict liability** Examples include a failure to warn of risks and defects in product manufacturing or design.

Administrative (Regulatory) Law System

- Laws and legal principles created by administrative agencies to address a number of areas, including international trade, manufacturing, environment, and immigration.

Customary Law System

- Deals mainly with personal conduct and patterns of behavior.
- Based on traditions and customs of the region.
- Emerged when cooperation of individuals became necessary as communities merged.
- Not many countries work under a purely customary law system, but instead use a mixed system where customary law is an integrated component. (Codified civil law systems emerged from customary law.)
- Mainly used in regions of the world that have mixed legal systems (for example, China and India).
- Restitution is commonly in the form of a monetary fine or service.

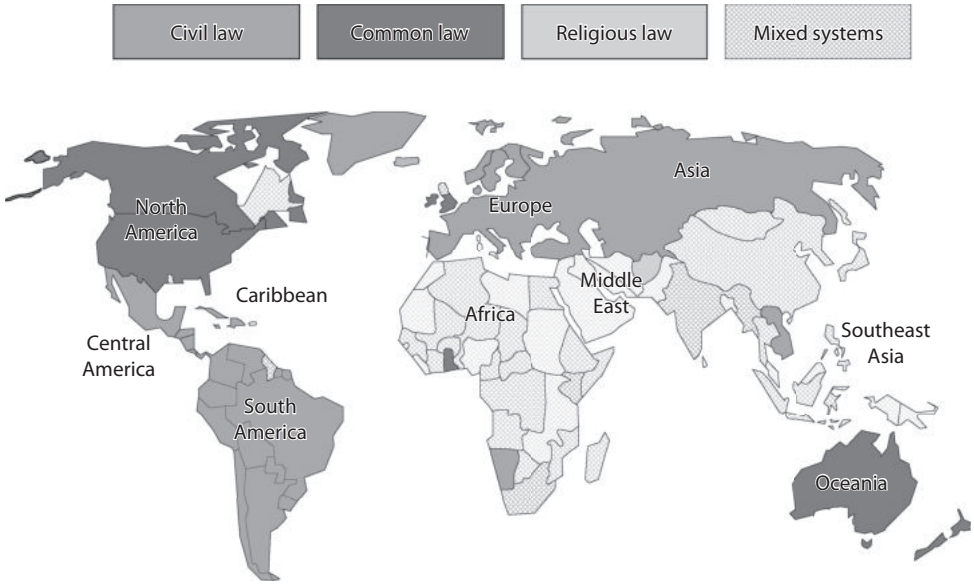
Religious Law System

- Based on religious beliefs of the region.
  - In Islamic countries, the law is based on the rules of the Koran.
  - The law, however, is different in every Islamic country.
  - Jurists and clerics have a high degree of authority.
- Covers all aspects of human life, but commonly divided into
  - Responsibilities and obligations to others.
  - Religious duties.
- Knowledge and rules as revealed by God, which define and govern human affairs.
- Rather than create laws, lawmakers and scholars attempt to discover the truth of law.
- Law, in the religious sense, also includes codes of ethics and morality, which are upheld and required by God. For example, Hindu law, Sharia (Islamic law), Halakha (Jewish law), and so on.

Mixed Law System

- Two or more legal systems are used together and apply cumulatively or interactively.

- Most often mixed law systems consist of civil and common law.
- A combination of systems is used as a result of more or less clearly defined fields of application.
- Civil law may apply to certain types of crimes, while religious law may apply to other types within the same region.
- Examples of mixed law systems include those in Holland, Canada, and South Africa.



Common Law Revisited

These different legal systems are certainly complex, and while you are not expected to be a lawyer to pass the CISSP exam, having a high-level understanding of the different types (civil, common, customary, religious, mixed) is important. The exam will dig more into the specifics of the common law legal system and its components. Under the common law legal system, *civil law* deals with wrongs against individuals or organizations that result in damages or loss. This is referred to as *tort law*. Examples include trespassing, battery, negligence, and product liability. A successful civil lawsuit against a defendant would result in financial restitution and/or community service instead of a jail sentence. When someone sues another person in civil court, the jury decides upon *liability* instead of innocence or guilt. If the jury determines the defendant is liable for the act, then the jury decides upon the compensatory and/or punitive damages of the case.

Criminal law is used when an individual's conduct violates the government laws, which have been developed to protect the public. Jail sentences are commonly the punishment for criminal law cases that result in conviction, whereas in civil law cases the punishment is usually an amount of money that the liable individual must pay the victim. For example, in the O.J. Simpson case, the defendant was first tried and found

not guilty in the criminal law case, but then was found liable in the civil law case. This seeming contradiction can happen because the burden of proof is lower in civil cases than in criminal cases.

EXAM TIP Civil law generally is derived from common law (case law), cases are initiated by private parties, and the defendant is found liable or not liable for damages. Criminal law typically is statutory, cases are initiated by government prosecutors, and the defendant is found guilty or not guilty.

Administrative/regulatory law deals with regulatory standards that regulate performance and conduct. Government agencies create these standards, which are usually applied to companies and individuals within those specific industries. Some examples of administrative laws could be that every building used for business must have a fire detection and suppression system, must have clearly visible exit signs, and cannot have blocked doors, in case of a fire. Companies that produce and package food and drug products are regulated by many standards so that the public is protected and aware of their actions. If an administrative law case determines that a company did not abide by specific regulatory standards, officials in the company could even be held accountable. For example, if a company makes tires that shred after a couple of years of use because the company doesn't comply with manufacturing safety standards, the officers in that company could be liable under administrative, civil, or even criminal law if they were aware of the issue but chose to ignore it to keep profits up.

Cybercrimes and Data Breaches

So far, we've discussed laws and regulations only in a general way to provide a bit of context. Let's now dive into the laws and regulations that are most relevant to our roles as cybersecurity leaders. Computer crime laws (sometimes collectively referred to as *cyberlaw*) around the world deal with some of the core issues: unauthorized access, modification or destruction of assets, disclosure of sensitive information, and the use of malware (malicious software).

Although we usually only think of the victims and their systems that were attacked during a crime, laws have been created to combat three categories of crimes. A *computer-assisted crime* is where a computer was used as a tool to help carry out a crime. A *computer-targeted crime* concerns incidents where a computer was the victim of an attack crafted to harm it (and its owners) specifically. The last type of crime is where a computer is not necessarily the attacker or the target, but just happened to be involved when a crime was carried out. This category is referred to as *computer is incidental*.

Some examples of computer-assisted crimes are

- Exploiting financial systems to conduct fraud
- Stealing military and intelligence material from government computer systems
- Conducting industrial espionage by attacking competitors and gathering confidential business data

- Carrying out information warfare activities by leveraging compromised influential accounts
- Engaging in hacktivism, which is protesting a government's or organization's activities by attacking its systems and/or defacing its website

Some examples of computer-targeted crimes include

- Distributed denial-of-service (DDoS) attacks
- Stealing passwords or other sensitive data from servers
- Installing cryptominers to mine cryptocurrency on someone else's computers
- Conducting a ransomware attack

NOTE The main issues addressed in computer crime laws are unauthorized modification, disclosure, destruction, or access and inserting malicious programming code.

Some confusion typically exists between the two categories—computer-assisted crimes and computer-targeted crimes—because intuitively it would seem any attack would fall into both of these categories. One system is carrying out the attacking, while the other system is being attacked. The difference is that in computer-assisted crimes, the computer is only being used as a tool to carry out a traditional type of crime. Without computers, people still steal, cause destruction, protest against organizations (for example, companies that carry out experiments upon animals), obtain competitor information, and go to war. So these crimes would take place anyway; the computer is simply one of the tools available to the attacker. As such, it helps that threat actor become more efficient at carrying out a crime.

Computer-assisted crimes are usually covered by regular criminal laws in that they are not always considered a "computer crime." One way to look at it is that a computer-*targeted* crime could not take place without a computer, whereas a computer-*assisted* crime could. Thus, a computer-targeted crime is one that did not, and could not, exist before use of computers became common. In other words, in the good old days, you could not carry out a buffer overflow on your neighbor or install malware on your enemy's system. These crimes require that computers be involved.

If a crime falls into the "computer is incidental" category, this means a computer just happened to be involved in some secondary manner, but its involvement is still significant. For example, if you have a friend who works for a company that runs the state lottery and he gives you a printout of the next three winning numbers and you type them into your computer, your computer is just the storage place. You could have just kept the piece of paper and not put the data in a computer. Another example is child pornography. The actual crime is obtaining and sharing child pornography pictures or graphics. The pictures could be stored on a file server or they could be kept in a physical file in someone's desk. So if a crime falls within this category, the computer is not attacking another computer and a computer is not being attacked, but the computer is still used in some significant manner.

Because computing devices are everywhere in modern society, computers are incidental to most crimes today. In a fatal car crash, the police may seize the drivers' mobile devices to look for evidence that either driver was texting at the time of the accident. In a domestic assault case, investigators may seek a court order to obtain the contents of the home's virtual assistant, such as Amazon Alexa, because it may contain recorded evidence of the crime.

You may say, "So what? A crime is a crime. Why break it down into these types of categories?" The reason these types of categories are created is to allow current laws to apply to these types of crimes, even though they are in the digital world. Let's say someone is on your computer just looking around, not causing any damage, but she should not be there. Should legislators have to create a new law stating, "Thou shall not browse around in someone else's computer," or should law enforcement and the courts just apply the already created trespassing law? What if a hacker got into a traffic-control system and made all of the traffic lights turn green at the exact same time? Should legislators go through the hassle of creating a new law for this type of activity, or should law enforcement and the courts use the already created (and understood) manslaughter and murder laws? Remember, a crime is a crime, and a computer is just a new tool to carry out traditional criminal activities.

Now, this in no way means countries can just depend upon the laws on the books and that every computer crime can be countered by an existing law. Many countries have had to come up with new laws that deal specifically with different types of computer crimes. For example, the following are just *some* of the laws that have been created or modified in the United States to cover the various types of computer crimes:

- 18 USC 1029: Fraud and Related Activity in Connection with Access Devices
- 18 USC 1030: Fraud and Related Activity in Connection with Computers
- 18 USC 2510 et seq.: Wire and Electronic Communications Interception and Interception of Oral Communications
- 18 USC 2701 et seq.: Stored Wire and Electronic Communications and Transactional Records Access
- Digital Millennium Copyright Act
- Cyber Security Enhancement Act of 2002

EXAM TIP You do not need to know these laws for the CISSP exam; they are just examples.

Complexities in Cybercrime

Since we have a bunch of laws to get the digital bad guys, this means we have this whole cybercrime thing under control, right? Alas, cybercrimes have only increased over the years and will not stop anytime soon. Several contributing factors explain why these activities have not been properly stopped or even curbed. These include issues related

to proper attribution of the attacks, the necessary level of protection for networks, and successful prosecution once an attacker is captured.

Many attackers are never caught because they spoof their addresses and identities and use methods to cover their digital footsteps. Many attackers break into networks, take whatever resources they were after, and clean the logs that tracked their movements and activities. Because of this, many organizations do not even know their systems have been violated. Even if an attacker's activities are detected, it does not usually lead to the true identity of the individual, though it does alert the organization that a specific vulnerability was exploited.

Attackers commonly hop through several systems before attacking their victim so that tracking down the attackers will be more difficult. This is exemplified by a threat actor approach known as an *island-hopping attack*, which is when the attacker compromises an easier target that is somehow connected to the ultimate one. For instance, consider a major corporation like the one depicted on the right side of Figure 3-1. It has robust cybersecurity and relies on a regional supplier for certain widgets. Since logistics are oftentimes automated, these two companies have trusted channels of communication between them so their computers can talk to each other about when more widgets might be needed and where. The supplier, in turn, relies on a small company that produces special screws for the widgets. This screw manufacturer employs just a couple of people working out of the owner's garage and is a trivial target for an attacker. So, rather than target the major corporation directly, a cybercriminal could attack the screw manufacturer's unsecured computers, use them to gain a foothold in the supplier, and then use that company's trusted relationship with the well-defended target to ultimately get into its systems. This particular type of island-hopping attack is also known as a *supply-chain attack* because it exploits trust mechanisms inherent in supply chains.

Many companies that are victims of an attack usually just want to ensure that the vulnerability the attacker exploited is fixed, instead of spending the time and money to go after and prosecute the attacker. This is a huge contributing factor as to why cybercriminals get away with their activities. Some regulated organizations—for instance, financial institutions—by law, must report breaches. However, most organizations do not have to report breaches or computer crimes. No company wants its dirty laundry out in the open for everyone to see. The customer base will lose confidence, as will

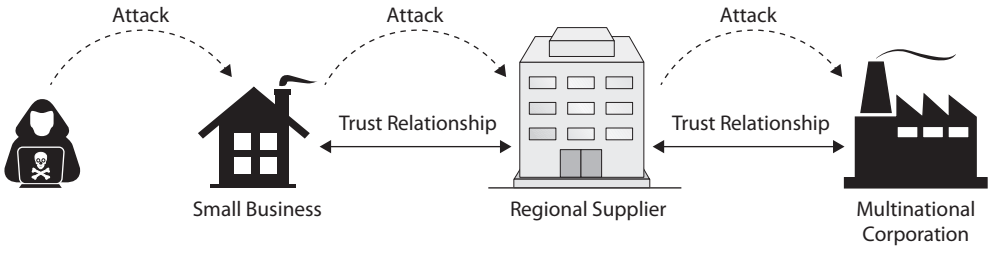


Figure 3-1 A typical island-hopping attack

the shareholders and investors. We do not actually have true computer crime statistics because most are not reported.

Although regulations, laws, and attacks help make senior management more aware of security issues, when their company ends up in the headlines with reports of how they lost control of over 100,000 credit card numbers, security suddenly becomes very important to them.

NOTE Even though some institutions must, by law, report security breaches and crimes, that does not mean they all follow this law. Some of these institutions, just like many other organizations, often simply fix the vulnerability and sweep the details of the attack under the carpet.

The Evolution of Attacks

Perpetrators of cybercrime have evolved from bored teenagers with too much time on their hands to organized crime rings with very defined targets and goals. In the early 1990s, hackers were mainly made up of people who just enjoyed the thrill of hacking. It was seen as a challenging game without any real intent of harm. Hackers used to take down large websites (e.g., Yahoo!, MSN, Excite) so their activities made the headlines and they won bragging rights among their fellow hackers. Back then, virus writers created viruses that simply replicated or carried out some benign activity, instead of the more malicious actions they could have carried out. Unfortunately, today, these trends have taken on more sinister objectives as the Internet has become a place of business. This evolution is what drove the creation of the antivirus (now antimalware) industry.

Three powerful forces converged in the mid to late 1990s to catapult cybercrime forward. First, with the explosive growth in the use of the Internet, computers became much more lucrative targets for criminals. Second, there was an abundance of computer experts who had lost their livelihoods with the end of the Soviet Union. Some of these bright minds turned to cybercrime as a way to survive the tough times in which they found themselves. Finally, with increased demand for computing systems, many software developers were rushing to be first to market, all but ignoring the security (or lack thereof) of their products and creating fertile ground for remote attacks from all over the world. These forces resulted in the emergence of a new breed of cybercriminal possessing knowledge and skills that quickly overwhelmed many defenders. As the impact of the increased threat was realized, organizations around the world started paying more attention to security in a desperate bid to stop their cybercrime losses.

In the early 2000s, there was a shift from cybercriminals working by themselves to the formation of organized cybercrime gangs. This change dramatically improved the capabilities of these threat actors and allowed them to go after targets that, by then, were very well defended. This shift also led to the creation of vast, persistent attack infrastructures on a global scale. After cybercriminals attacked and exploited computers, they maintained a presence for use in support of later attacks. Nowadays, these exploited targets are known as malicious *bots*, and they are usually organized into *botnets*. These botnets can be used to carry out DDoS attacks, transfer spam or pornography, or do whatever the attacker commands the bot software to do. Figure 3-2 shows the many uses cybercriminals have for compromised computers.

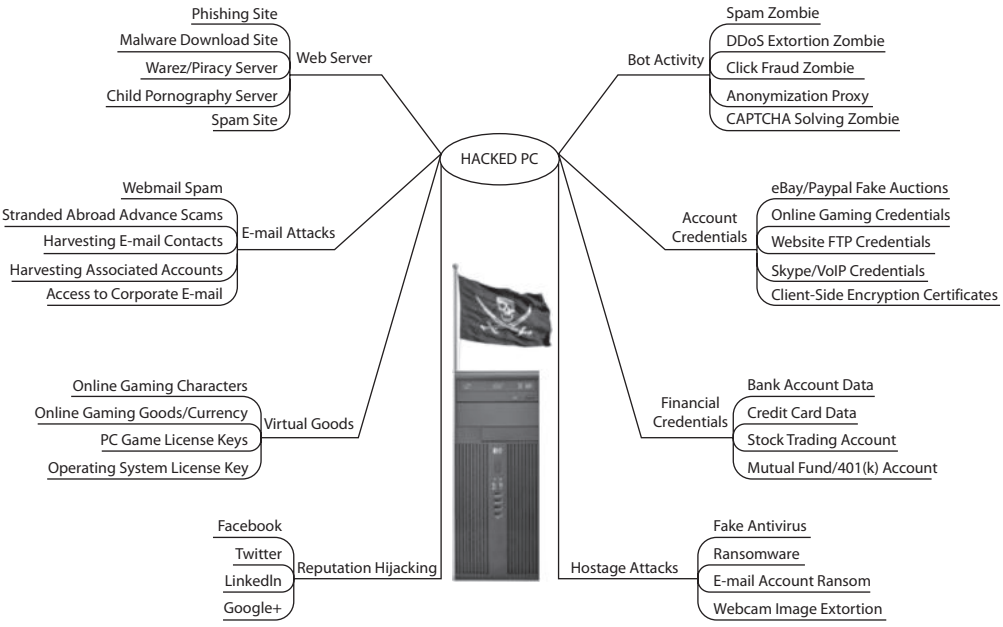


Figure 3-2 Malicious uses for a compromised computer (Source: www.krebsonsecurity.com)

EXAM TIP You may see the term *script kiddies* on the exam (or elsewhere). It refers to hackers who do not have the requisite skills to carry out specific attacks without the tools provided on the Internet or through friends.

A recent development in organized cybercrime is the emergence of so-called Hacking as a Service (HaaS), which is a play on cloud computing services such as Software as a Service (SaaS). HaaS represents the commercialization of hacking skills, providing access to tools, target lists, credentials, hackers for hire, and even customer support. In the last couple of years, there has been a significant increase in the number of marketplaces in which HaaS is available.

Many times hackers are just scanning systems looking for a vulnerable running service or sending out malicious links in e-mails to unsuspecting victims. They are just looking for any way to get into any network. This would be the shotgun approach to network attacks. Another, more dangerous, attacker has you in the proverbial crosshairs and is determined to identify your weakest point and exploit it. As an analogy, the thief that goes around rattling door knobs to find one that is not locked is not half as dangerous as the one who will watch you day in and day out to learn your activity patterns, where you work, what type of car you drive, and who your family is and patiently wait for your most vulnerable moment to ensure a successful and devastating attack.

We call this second type of attacker an *advanced persistent threat (APT)*. This is a military term that has been around for ages, but since the digital world is effectively a

battleground, this term is more relevant each and every day. How an APT differs from the plain old vanilla attacker is that the APT is commonly a group of attackers, not just one hacker, that combine their knowledge and abilities to carry out whatever exploit will get them into the environment they are seeking. The APT is very focused and motivated to aggressively and successfully penetrate a network with various different attack methods and then clandestinely hide its presence while achieving a well-developed, multilevel foothold in the environment.

The "advanced" aspect of the term APT pertains to the expansive knowledge, capabilities, and skill base of the APT. The "persistent" component has to do with the fact that the group of attackers is not in a hurry to launch an attack quickly, but will wait for the most beneficial moment and attack vector to ensure that its activities go unnoticed. This is what we refer to as a "low-and-slow" attack. This type of attack is coordinated by human involvement, rather than just a virus type of threat that goes through automated steps to inject its payload. The APT has specific objectives and goals and is commonly highly organized and well funded, which makes it the biggest threat of all.

APTs commonly use custom-developed malicious code that is built specifically for its target, has multiple ways of hiding itself once it infiltrates the environment, may be able to polymorph itself in replication capabilities, and has several different "anchors" to make it hard to eradicate even if it is discovered. Once the code is installed, it commonly sets up a covert back channel (as regular bots do) so that it can be remotely controlled by the group of attackers. The remote control functionality allows the attackers to traverse the network with the goal of gaining continuous access to critical assets.

APT infiltrations are usually very hard to detect with host-based solutions because the attackers put the code through a barrage of tests against the most up-to-date detection applications on the market. A common way to detect these types of threats is through network traffic changes. For example, changes in DNS queries coming out of your network could indicate that an APT has breached your environment and is using DNS tunneling to establish command and control over the compromised hosts. The APT will likely have multiple control servers and techniques to communicate so that if one connection gets detected and removed, the APT still has an active channel to use. The APT may implement encrypted tunnels over HTTPS so that its data that is in transmission cannot be inspected. Figure 3-3 illustrates the common steps and results of APT activity.

The ways of getting into a network are basically endless (exploit a web service, induce users to open e-mail links and attachments, gain access through remote maintenance accounts, exploit operating systems and application vulnerabilities, compromise connections from home users, etc.). Each of these vulnerabilities has its own fixes (patches, proper configuration, awareness, proper credential practices, encryption, etc.). It is not only these fixes that need to be put in place; we need to move to a more effective situational awareness model. We need to have better capabilities of knowing what is happening throughout our network in near to real time so that our defenses can react quickly and precisely.

The landscape continues to evolve, and the lines between threat actors are sometimes blurry. We already mentioned the difficulty in attributing an attack to a specific individual so that criminal charges may be filed. Something that makes this even harder is the practice among some governments of collaborating with criminal groups in their countries.

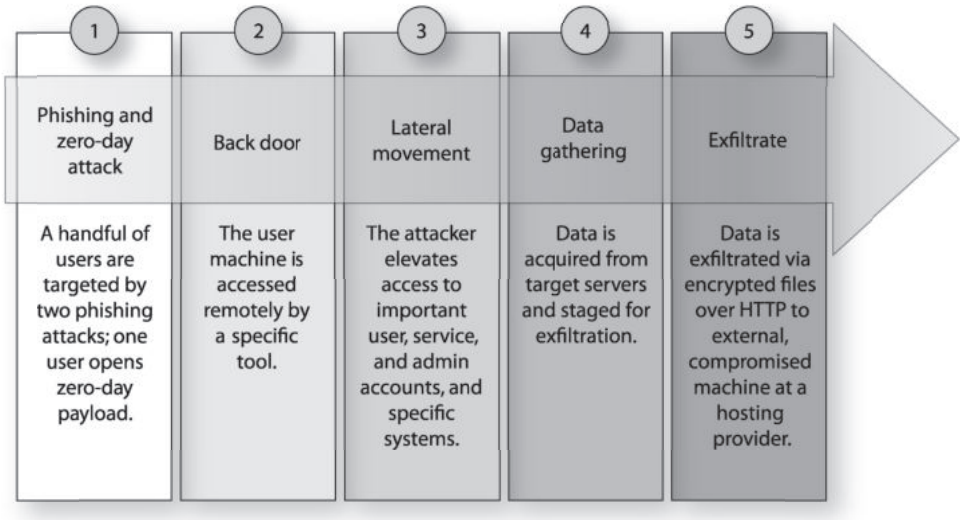


Figure 3-3 Gaining access into an environment and extracting sensitive data

Common Internet Crime Schemes

- Business e-mail compromise
- Business fraud
- Charity and disaster fraud
- Counterfeit prescription drugs
- Credit card fraud
- Election crimes and security
- Identity theft
- Illegal sports betting
- Nigerian letter, or "419"
- Ponzi/pyramid
- Ransomware
- Sextortion

Find out how these types of computer crimes are carried out by visiting https://www.fbi.gov/scams-and-safety/common-scams-and-crimes.

Do You Trust Your Neighbor?

Most organizations do not like to think about the fact that the enemy might be inside the organization and working internally. It is more natural to view threats as the faceless unknowns that reside on the outside of our environment. Employees have direct and privileged access to an organization's assets, and they are commonly not as highly monitored compared to traffic that is entering the network from external entities. The combination of too much trust, direct access, and the lack of monitoring allows for a lot of internal fraud and abuse to go unnoticed.

There have been many criminal cases over the years where employees at various organizations have carried out embezzlement or have launched revenge attacks after they were fired or laid off. While it is important to have fortified walls to protect us from the outside forces that want to cause us harm, it is also important to realize that our underbelly is more vulnerable. Employees, contractors, and temporary workers who have direct access to critical resources introduce risks that need to be understood and countermeasured.

The way it works is that the government looks the other way as long as the crimes are committed in other countries. When the government needs a bit of help to obfuscate what it's doing to another government, it enlists the help of the cybercrime gang they've been protecting (or at least tolerating) and tell them what to do and to whom. To the target, it looks like a cybercrime but in reality it had nation-state goals.

So while the sophistication of the attacks continues to increase, so does the danger of these attacks. Isn't that just peachy?

Up until now, we have listed some difficulties of fighting cybercrime: the anonymity the Internet provides the attacker; attackers are organizing and carrying out more sophisticated attacks; the legal system is running to catch up with these types of crimes; and organizations are just now viewing their data as something that must be protected. All these complexities aid the bad guys, but what if we throw in the complexity of attacks taking place between different countries?

International Issues

If a hacker in Ukraine attacks a bank in France, whose legal jurisdiction is that? How do these countries work together to identify the criminal and carry out justice? Which country is required to track down the criminal? And which country should take this person to court? Well, the short answer is: it depends.

When computer crime crosses international boundaries, the complexity of such issues shoots up considerably and the chances of the criminal being brought to any court decreases. This is because different countries have different legal systems, some countries have no laws pertaining to computer crime, jurisdiction disputes may erupt, and some governments may not want to play nice with each other. For example, if someone in Iran attacked a system in Israel, do you think the Iranian government would help Israel track down the attacker? What if someone in North Korea attacked a military system in the

United States? Do you think these two countries would work together to find the hacker? Maybe or maybe not—or perhaps the attack was carried out by a government agency pretending to be a cybercrime gang.

There have been efforts to standardize the different countries' approaches to computer crimes because they happen so easily over international boundaries. Although it is very easy for an attacker in China to send packets through the Internet to a bank in Saudi Arabia, it is very difficult (because of legal systems, cultures, and politics) to motivate these governments to work together.

The *Council of Europe (CoE) Convention on Cybercrime*, also known as the Budapest Convention, is one example of an attempt to create a standard international response to cybercrime. In fact, it is the first international treaty seeking to address computer crimes by coordinating national laws and improving investigative techniques and international cooperation. One of the requirements of the treaty is that signatories develop national legislation outlawing a series of cybercrimes, such as hacking, computer-related fraud, and child pornography. The convention's objectives also include the creation of a framework for establishing jurisdiction and extradition of the accused. For example, extradition can only take place when the event is a crime in both jurisdictions. As of April 2021, 68 countries around the world (not just in Europe) have signed or ratified the treaty, contributing to the global growth in effective cybercrime legislation that is internationally interoperable. According to the United Nations (UN), 79 percent of the world's countries (that's 154) now have cybercrime laws. All these laws vary, of course, but they may impact your own organization depending on where you do business and with whom.

Data Breaches

Among the most common cybercrimes are those relating to the theft of sensitive data. In fact, it is a rare month indeed when one doesn't read or hear about a major data breach. Information is the lifeblood of most major corporations nowadays, and threat actors know this. They have been devoting a lot of effort over the past several years to compromising and exploiting the data stores that, in many ways, are more valuable to organizations than any vault full of cash. This trend continues unabated, which makes data breaches one of the most important issues in cybersecurity today.

In a way, data breaches can be thought of as the opposite of privacy: data owners lose control of who has the ability to access their data. When an organization fails to properly protect the privacy of its customers' data, it increases the likelihood of experiencing a data breach. It should not be surprising, therefore, that some of the same legal and regulatory issues that apply to privacy also apply to data breaches.

It is important to note that data breaches need not involve a violation of personal privacy. Indeed, some of the most publicized data breaches have had nothing to do with personally identifiable information (PII) but with intellectual property (IP). It is worth pausing to properly define the term *data breach* as a security event that results in the actual or potential compromise of the confidentiality or integrity of protected information by unauthorized actors. Protected information can be PII, IP, protected health information (PHI), classified information, or any other information that can cause damage to an individual or organization.

Personally Identifiable Information

Personally identifiable information (PII) is data that can be used to uniquely identify, contact, or locate a single person or can be used with other sources to uniquely identify a single individual. PII needs to be highly protected because it is commonly used in identity theft, financial crimes, and various criminal activities.

While it seems as though defining and identifying PII should be easy and straightforward, what different countries, federal governments, and state governments consider to be PII differs.

The U.S. Office of Management and Budget in its memorandum M-07-16, "Safeguarding Against and Responding to the Breach of Personally Identifiable Information," defines PII as "information that can be used to distinguish or trace an individual's identity, either alone or when combined with other personal or identifying information that is linked or linkable to a specific individual." Determining what constitutes PII, then, depends on a specific risk assessment of the likelihood that the information can be used to uniquely identify an individual. This is all good and well, but doesn't really help us recognize information that might be considered PII. Typical components are listed here:

- Full name (if not common)
- National identification number
- Home address
- IP address (in some cases)
- Vehicle registration plate number
- Driver's license number
- Face, fingerprints, or handwriting
- Credit card numbers
- Digital identity
- Birthday
- Birthplace
- Genetic information

The following items are less often used because they are commonly shared by so many people, but they can fall into the PII classification and may require protection from improper disclosure:

- First or last name, if common
- Country, state, or city of residence
- Age, especially if nonspecific

- Gender or race
- Name of the school they attend or workplace
- Grades, salary, or job position
- Criminal record

As a security professional, it is important to understand which legal and regulatory requirements are triggered by data breaches. To further complicate matters, most U.S. states, as well as many other countries, have enacted distinct laws with subtle but important differences in notification stipulations. As always when dealing with legal issues, it is best to consult with an attorney. This section is simply an overview of some of the legal requirements of which you should be aware.

U.S. Laws Pertaining to Data Breaches

We've already mentioned various U.S. federal statutes dealing with cybercrimes. Despite our best efforts, there will be times when our information systems are compromised and personal information security controls are breached. Let's briefly highlight some of the laws that are most relevant to data breaches:

- California Consumer Privacy Act (CCPA)
- Health Insurance Portability and Accountability Act (HIPAA)
- Health Information Technology for Economic and Clinical Health (HI-TECH) Act
- Gramm-Leach-Bliley Act of 1999
- Economic Espionage Act of 1996

It is worth recalling here that data breaches are not only violations of customer privacy. When a threat actor compromises a target corporation's network and exposes its intellectual property, a breach has occurred. While the other laws we have discussed in this section deal with protecting customers' PII, the Economic Espionage Act protects corporations' IP. When you think of data breaches, it is critical that you consider both PII and IP exposure.

Almost every U.S. state has enacted legislation that requires government and private entities to disclose data breaches involving PII. The most important of these is probably the California Consumer Privacy Act, which went into effect in 2020. The CCPA is perhaps the broadest and most far-reaching of U.S. state laws around PII breaches, but it is certainly not the only one. In almost every case, PII is defined by the states as the combination of first and last name with any of the following:

- Social Security number
- Driver's license number
- Credit or debit card number with the security code or PIN

Unfortunately, that is where the commonalities end. The laws are so different that compliance with all of them is a difficult and costly issue for most corporations. In some states, simple access to files containing PII triggers a notification requirement, while in other states the organization must only notify affected parties if the breach is reasonably likely to result in illegal use of the information. Many experts believe that the CCPA will set an example for other states and may provide a template for other countries.

European Union Laws Pertaining to Data Breaches

Global organizations that move data across other country boundaries must be aware of and follow the Organisation for Economic Co-operation and Development (OECD) *Guidelines on the Protection of Privacy and Transborder Flows of Personal Data*. Since most countries have a different set of laws pertaining to the definition of private data and how it should be protected, international trade and business get more convoluted and can negatively affect the economy of nations. The OECD is an international organization that helps different governments come together and tackle the economic, social, and governance challenges of a globalized economy. Because of this, the OECD came up with guidelines for the various countries to follow so that data is properly protected and everyone follows the same type of rules.

The core principles defined by the OECD are as follows:

- **Collection Limitation Principle** Collection of personal data should be limited, obtained by lawful and fair means, and with the knowledge of the subject.
- **Data Quality Principle** Personal data should be kept complete and current and be relevant to the purposes for which it is being used.
- **Purpose Specification Principle** Subjects should be notified of the reason for the collection of their personal information at the time that it is collected, and organizations should only use it for that stated purpose.
- **Use Limitation Principle** Only with the consent of the subject or by the authority of law should personal data be disclosed, made available, or used for purposes other than those previously stated.
- **Security Safeguards Principle** Reasonable safeguards should be put in place to protect personal data against risks such as loss, unauthorized access, modification, and disclosure.
- **Openness Principle** Developments, practices, and policies regarding personal data should be openly communicated. In addition, subjects should be able to easily establish the existence and nature of personal data, its use, and the identity and usual residence of the organization in possession of that data.
- **Individual Participation Principle** Subjects should be able to find out whether an organization has their personal information and what that information is, to correct erroneous data, and to challenge denied requests to do so.
- **Accountability Principle** Organizations should be accountable for complying with measures that support the previous principles.

NOTE Information on the OECD Guidelines can be found at www.oecd.org/internet/ieconomy/privacy-guidelines.htm.

Although the OECD Guidelines were a great start, they were not enforceable or uniformly applied. The European Union in many cases takes individual privacy much more seriously than most other countries in the world, so in 1995 it enacted the Data Protection Directive (DPD). As a directive, it was not directly enforceable, but EU member states were required to enact laws that were consistent with it. The intent of this was to create a set of laws across the EU that controlled the way in which European organizations had to protect the personal data and privacy of EU citizens. The Safe Harbor Privacy Principles were then developed to outline how U.S.-based organizations could comply with European privacy laws. For a variety of reasons, this system of directives, laws, and principles failed to work well in practice and had to be replaced.

The General Data Protection Regulation (GDPR) was adopted by the EU in April 2016 and became enforceable in May 2018. It protects the personal data and privacy of EU citizens. The GDPR, unlike a directive such as the DPD, has the full weight of a law in all 27 member states of the EU. This means that each state does not have to write its own version, which harmonizes data protection regulations and makes it easier for organizations to know exactly what is expected of them throughout the bloc. The catch is that these requirements are quite stringent, and violating them exposes an organization to a maximum fine of 4 percent of that organization's global turnover. For a company like Google, that would equate to over $4 billion if they were ever shown to not be in compliance. Ouch!

The GDPR defines three relevant entities:

- **Data subject** The individual to whom the data pertains
- **Data controller** Any organization that collects data on EU residents
- **Data processor** Any organization that processes data for a data controller

The regulation applies if any one of the three entities is based in the EU, but it also applies if a data controller or processor has data pertaining to an EU resident. The GDPR impacts every organization that holds or uses European personal data both inside and outside of Europe. In other words, if your organization is a U.S.-based company that has never done business with the EU, but it has an EU citizen working as a summer intern, it probably has to comply with the GDPR or risk facing stiff penalties.

The GDPR set of protected types of privacy data is more inclusive than regulations and laws outside the EU. Among others, protected privacy data includes

- Name
- Address
- ID numbers

- Web data (location, IP address, cookies)
- Health and genetic data
- Biometric data
- Racial or ethnic data
- Political opinions
- Sexual orientation

To ensure this data is protected, the GDPR requires that most data controllers and data processors formally designate a Data Protection Officer (DPO). DPOs are internal compliance officers that act semi-independently to ensure that their organizations follow the letter of the regulation. While DPOs are not ultimately responsible if their organizations are not in compliance (at least according to the GDPR), in practice they are charged with monitoring compliance, advising controllers on when and how to conduct data protection impact assessments, and maintaining all required records.

Key provisions of the GDPR include

- **Consent** Data controllers and data processors cannot use personal data without explicit consent of the data subjects.
- **Right to be informed** Data controllers and data processors must inform data subjects about how their data is, will, or could be used.
- **Right to restrict processing** Data subjects can agree to have their data stored by a collector but disallow it to be processed.
- **Right to be forgotten** Data subjects can request that their personal data be permanently deleted.
- **Data breaches** Data controllers must report a data breach to the supervisory authority of the EU member state involved within 72 hours of becoming aware of it.

Other Nations' Laws Pertaining to Data Breaches

As might be expected, the rest of the world is a hodgepodge of laws with varying data breach notification conditions and requirements. As of this writing, the United Nations lists at least 62 countries that have no legally mandated notification requirements whatsoever. This is concerning because unscrupulous organizations have been known to outsource their data-handling operations to countries with no data breach laws in order to circumvent the difficulties in reconciling the different country and state requirements.

The EU's GDPR, though it has been called too restrictive and costly by some, has served as a model for other countries to implement similar legislation. For example, the two newest data protection laws, which came into full effect in 2020, are Brazil's General Personal Data Protection Law (Lei Geral de Proteção de Dados, or LGPD) and Thailand's Personal Data Protection Act (PDPA). Both apply to all organizations that handle the personal information of these countries' residents, whether they are physically located within the country or not. Thailand's PDPA further provides for jail time in particularly egregious cases.

Again, you do not need to know all these international laws to become a CISSP. However, you need to be aware that they exist and may impact your business and cybersecurity even if you didn't know your organization had interests in those countries. It is best to consult your organization's legal or compliance team to determine which laws apply to your own team.

Import/Export Controls

Another complexity that comes into play when an organization is attempting to work with organizations in other parts of the world is import and export laws. Each country has its own specifications when it comes to what is allowed in its borders and what is allowed out. For example, the *Wassenaar Arrangement* implements export controls for "Conventional Arms and Dual-Use Goods and Technologies." It is currently made up of 42 countries and lays out rules on how the following items can be exported from country to country:

- **Category 1** Special Materials and Related Equipment
- **Category 2** Material Processing
- **Category 3** Electronics
- **Category 4** Computers
- **Category 5** Part 1: Telecommunications
- **Category 5** Part 2: Information Security
- **Category 6** Sensors and Lasers
- **Category 7** Navigation and Avionics
- **Category 8** Marine
- **Category 9** Aerospace and Propulsion

The main goal of the Wassenaar Arrangement is to prevent the buildup of military capabilities that could threaten regional and international security and stability. So, everyone is keeping an eye on each other to make sure no one country's weapons can take everyone else out. The idea is to try and make sure everyone has similar offensive and defensive military capabilities with the hope that we won't end up blowing each other up.

One item the agreement deals with is cryptography, which is considered a *dual-use good* because it can be used for both military and civilian purposes. The agreement recognizes the danger of exporting products with cryptographic functionality to countries that are in the "offensive" column, meaning that they are thought to have friendly ties with terrorist organizations and/or want to take over the world through the use of weapons of mass destruction. If the "good" countries allow the "bad" countries to use cryptography, then the "good" countries cannot snoop and keep tabs on what the "bad" countries are up to.

The specifications of the Wassenaar Arrangement are complex and always changing. Which countries fall within the "good" and "bad" categories changes, and what can be exported to whom and how changes. In some cases, no products that contain

cryptographic functions can be exported to a specific country; some countries are allowed to import only products with limited cryptographic functions; some countries require certain licenses to be granted; and other countries (the "good" countries) have no restrictions.

While the Wassenaar Arrangement deals mainly with the exportation of items, some countries (China, Russia, Iran, etc.) have cryptographic *import* restrictions that have to be understood and followed. These countries do not allow their citizens to use cryptography because they believe that the ability to monitor many aspects of a citizen's online activities is essential to effectively governing people. This obviously gets very complex for companies who sell products that use integrated cryptographic functionality. One version of the product may be sold to China if it has no cryptographic functionality. Another version may be sold to Russia if a certain international license is in place. A fully functioning product can be sold to Canada, because who are they ever going to hurt?

It is important to understand the import and export requirements your organization must meet when interacting with entities in other parts of the world. You could inadvertently break a country's law or an international treaty if you do not get the right type of lawyers involved in the beginning and follow the approved processes.

Transborder Data Flow

While import and export controls apply to products, a much more common asset that constantly moves in and out of every country is data, and, as you might imagine at this point, there are laws, regulations, and processes that address what data can be moved where, when, why, how, and by whom. A *transborder data flow (TDF)* is the movement of machine-readable data across a political boundary such a country's border. This data is generated or acquired in one country but may be stored and processed in other countries as a result of TDFs. In a modern, connected world, this happens all the time. For example, just imagine all the places your personal data will go when you make an airline reservation to travel overseas, especially if you have a layover along the way.

NOTE Transborder data flows are sometimes called cross-border data flows.

Some governments control transborder data flows by enacting *data localization* laws that require certain types of data to be stored and processed within the borders of their respective country, sometimes exclusively. There are many reasons for these laws, but they pretty much boil down to protecting their citizens, either by ensuring a higher standard of privacy protection or by allowing easier monitoring of their actions (typically the things citizens try to do overseas). Data localization can increase the cost of doing business in some countries because your organization may have to provision (and protect) information systems in that country that it otherwise wouldn't.

Ironically, the very technology trend that initially fueled data localization concerns, cloud computing services, ultimately became an important tool to address those concerns

in a cost-effective manner. At their onset, cloud computing services promised affordable access to resources around the globe, sometimes by shifting loads and storage from one region to another. In recent years, the major cloud service providers have adapted to localization laws by offering an increasing number of regions (sometimes down to individual countries) where the data is guaranteed to remain.

Privacy

Privacy is becoming more threatened as the world increasingly relies on computing technology. There are several approaches to addressing privacy, including the generic approach and regulation by industry. The generic approach is *horizontal enactment*—rules that stretch across all industry boundaries. It affects all industries, including government. Regulation by industry is *vertical enactment*. It defines requirements for specific verticals, such as the financial sector and health care. In both cases, the overall objective is twofold. First, the initiatives seek to protect citizens' personally identifiable information. Second, the initiatives seek to balance the needs of government and businesses to collect and use PII with consideration of security issues.

In response, countries have enacted privacy laws. For example, although the United States already had the Federal Privacy Act of 1974, it has enacted new laws, such as the Gramm-Leach-Bliley Act of 1999 and HIPAA, in response to an increased need to protect personal privacy information. These are examples of a vertical approach to addressing privacy, whereas the EU's GDPR, Canada's Personal Information Protection and Electronic Documents Act, and New Zealand's Privacy Act of 1993 are horizontal approaches. Most countries nowadays have some sort of privacy requirements in their laws and regulations, so we need to be aware of their impact on our information systems and their security to avoid nasty legal surprises.

Licensing and Intellectual Property Requirements

Another way to get into trouble, whether domestically or internationally, is to run afoul of intellectual property laws. As previously introduced, *intellectual property (IP)* is a type of property created by human intellect. It consists of ideas, inventions, and expressions that are uniquely created by a person and can be protected from unauthorized use by others. Examples are song lyrics, inventions, logos, and secret recipes. IP laws do not necessarily look at who is right or wrong, but rather how an organization or individual can protect what it rightfully owns from unauthorized duplication or use and what it can do if these laws are violated.

So who designates what constitutes authorized use? The owner of the IP does this by granting licenses. A *license* is an agreement between an IP owner (the licensor) and somebody else (the licensee), granting that party the right to use the IP in very specific ways. For example, the licensee can only use the IP for a year unless they renew the license (presumably after paying a subscription fee). A license can also be, and frequently is, nontransferable, meaning only the licensees, and not their family members or friends, can use it. Another common provision in the agreement is whether or not the license will be exclusive to the licensee.

Licenses can become moot if the IP is not properly protected by the licensor. An organization must implement safeguards to protect resources that it claims to be intellectual property and must show that it exercised due care (reasonable acts of protection) in its efforts to protect those resources. For example, if an employee sends a file to a friend and the company terminates the employee based on the activity of illegally sharing IP, then in a wrongful termination case brought by the employee, the company must show the court why this file is so important to the company, what type of damage could be or has been caused as a result of the file being shared, and, most important, what the company had done to protect that file. If the company did not secure the file and tell its employees that they were not allowed to copy and share that file, then the company will most likely lose the case. However, if the company implemented safeguards to protect that file and had an acceptable use policy in its employee manual that explained that copying and sharing the information within the file was prohibited and that the punishment for doing so could be termination, then the company could not be found liable of wrongfully terminating the employee.

Intellectual property can be protected by different legal mechanisms, depending upon the type of resource it is. As a CISSP, you should be knowledgeable of four types of IP laws: trade secrets, copyrights, trademarks, and patents. These topics are addressed in depth in the following sections, followed by tips on protecting IP internally and combating software piracy.

Trade Secret

Trade secret law protects certain types of information or resources from unauthorized use or disclosure. For a company to have its resource qualify as a trade secret, the resource must provide the company with some type of competitive value or advantage. A trade secret can be protected by law if developing it requires special skill, ingenuity, and/or expenditure of money and effort. This means that a company cannot say the sky is blue and call it a trade secret.

A *trade secret* is something that is proprietary to a company and important for its survival and profitability. An example of a trade secret is the formula used for a soft drink, such as Coke or Pepsi. The resource that is claimed to be a trade secret must be confidential and protected with certain security precautions and actions. A trade secret could also be a new form of mathematics, the source code of a program, a method of making the perfect jelly bean, or ingredients for a special secret sauce. A trade secret has no expiration date unless the information is no longer secret or no longer provides economic benefit to the company.

Many companies require their employees to sign a nondisclosure agreement (NDA), confirming that they understand its contents and promise not to share the company's trade secrets with competitors or any unauthorized individuals. Companies require an NDA both to inform the employees of the importance of keeping certain information secret and to deter them from sharing this information. Having employees sign the NDA also gives the company the right to fire an employee or bring charges if the employee discloses a trade secret.

A low-level engineer working at Intel took trade secret information that was valued by Intel at $1 billion when he left his position at the company and went to work at his new employer, rival chipmaker Advanced Micro Devices (AMD). Intel discovered that this person still had access to Intel's most confidential information even after starting work at AMD. He even used the laptop that Intel provided to him to download 13 critical documents that contained extensive information about the company's new processor developments and product releases. Unfortunately, these stories are not rare, and companies are constantly dealing with challenges of protecting the very data that keeps them in business.

Copyright

In the United States, *copyright law* protects the right of the creator of an original work to control the public distribution, reproduction, display, and adaptation of that original work. The law covers many categories of work: pictorial, graphic, musical, dramatic, literary, pantomime, motion picture, sculptural, sound recording, and architectural. Copyright law does not cover the specific resource, as does trade secret law. It protects the *expression* of the idea of the resource instead of the resource itself. A copyright is usually used to protect an author's writings, an artist's drawings, a programmer's source code, or specific rhythms and structures of a musician's creation. Computer programs and manuals are just two examples of items protected under the Federal Copyright Act. The program or manual is covered under copyright law once it has been written. Although including a warning and the copyright symbol (©) is not required, doing so is encouraged so others cannot claim innocence after copying another's work.

Copyright protection does not extend to any method of operations, process, concept, or procedure, but it does protect against unauthorized copying and distribution of a protected work. It protects the form of expression rather than the subject matter. A patent deals more with the subject matter of an invention; copyright deals with how that invention is represented. In that respect, copyright is weaker than patent protection, but the duration of copyright protection is longer. Copyright protection exists for the life of the creator plus 70 years. If the work was created jointly by multiple authors, the 70 years start counting after the death of the last surviving one.

Computer programs can be protected under the copyright law as literary works. The law protects both the source code and object code, which can be an operating system, application, or database. In some instances, the law can protect not only the code but also the structure, sequence, and organization. The user interface is part of the definition of a software application structure; therefore, one vendor cannot copy the exact composition of another vendor's user interface.

Copyright infringement cases have exploded in numbers since the rise of "warez" sites that use the common BitTorrent protocol. BitTorrent is a peer-to-peer file sharing protocol and is one of the most common protocols for transferring large files. Warez is a term that refers to copyrighted works distributed or traded without fees or royalties, in general violation of the copyright law. The term generally refers to unauthorized releases by groups, as opposed to file sharing between friends.

Once a warez site posts copyrighted material, it is very difficult to have it removed because law enforcement is commonly overwhelmed with larger criminal cases and does not have the bandwidth to go after these "small fish." Another issue with warez sites is that the actual servers may reside in another country; thus, legal jurisdiction makes things more difficult and the country that the server resides within may not even have a copyright law. Film and music recording companies have had the most success in going after these types of offenders because they have the funds and vested interest to do so.

Trademark

A *trademark* is slightly different from a copyright in that it is used to protect a word, name, symbol, sound, shape, color, or combination of these. The reason a company would trademark one of these, or a combination, is that it represents the company (brand identity) to a group of people or to the world. Companies have marketing departments that work very hard to create something new that will cause the company to be noticed and stand out in a crowd of competitors, and trademarking the result of this work with a government registrar is a way of properly protecting it and ensuring others cannot copy and use it.

Companies cannot trademark a number or common word. This is why companies create new names—for example, Intel's Pentium and Apple's iPhone. However, unique colors can be trademarked, as well as identifiable packaging, which is referred to as "trade dress." Thus, Novell Red and UPS Brown are trademarked, as are some candy wrappers.

Registered trademarks are generally protected for ten years, but can be renewed for another ten years indefinitely. In the United States, you must file paperwork with the U.S. Patent and Trademark Office (USPTO) between the fifth and sixth years showing that you are actually using the trademark. This means that you can't just create a trademark you don't ever use and still keep others from using it. You have to file another "Declaration of Use" between the ninth and tenth year, and then every nine to ten years thereafter.

NOTE In 1883, international harmonization of trademark laws began with the Paris Convention, which in turn prompted the Madrid Agreement of 1891. Today, international trademark law efforts and international registration are overseen by the World Intellectual Property Organization (WIPO), an agency of the United Nations. The United States is a party to this agreement.

There have been many interesting trademark legal battles over the years. In one case a person named Paul Specht started a company named "Android Data" and had his company's trademark approved in 2002. Specht's company failed, and although he attempted to sell it and the trademark, he had no buyers. When Google announced that it was going to release a new mobile operating system called Android, Specht built a new website using his old company's name to try and prove that he was indeed still using this trademark. Specht took Google to court and asked for $94 million in trademark infringement damages. The court ruled in Google's favor and found that Google was not liable for damages.

Patent

Patents are given to individuals or organizations to grant them legal ownership of, and enable them to exclude others from using or copying, the invention covered by the patent. The invention must be novel, useful, and not obvious—which means, for example, that a company could not patent air. Thank goodness. If a company figured out how to patent air, we would have to pay for each and every breath we took!

After the inventor completes an application for a patent and it is approved, the patent grants a limited property right to exclude others from making, using, or selling the invention for a specific period of time. For example, when a pharmaceutical company develops a specific drug and acquires a patent for it, that company is the only one that can manufacture and sell this drug until the stated year in which the patent is up (usually 20 years from the date of approval). After that, the information is in the public domain, enabling all companies to manufacture and sell this product, which is why the price of a drug drops substantially after its patent expires and generic versions hit the market.

The patent process also applies to algorithms. If an inventor of an algorithm acquires a patent, she has full control over who can use the algorithm in their products. If the inventor lets a vendor incorporate the algorithm, she will most likely get a fee and possibly a license fee on each instance of the product that is sold.

Patents are ways of providing economic incentives to individuals and organizations to continue research and development efforts that will most likely benefit society in some fashion. Patent infringement is huge within the technology world today. Large and small product vendors seem to be suing each other constantly with claims of patent infringement. The problem is that many patents are written at a very high level. For example, if Inge developed a technology that accomplishes functionality A, B, and C, you could actually develop your own technology in your own way that also accomplished A, B, and C. You might not even know that Inge's method or patent existed; you just developed this solution on your own. Yet if Inge did this type of work first and obtained the patent, then she could go after you legally for infringement.

EXAM TIP A patent is the strongest form of intellectual property protection.

The amount of patent litigation in the technology world is remarkable. In October 2020, Centripetal Networks won a $1.9 billion award against Cisco Systems involving network threat detection technologies. In April of the same year, Apple and Broadcom were ordered to pay Caltech $1.1 billion because they infringed multiple Caltech patents pertaining to wireless error correction codes. Even though the amounts of these awards are certainly eye-popping, they are not the only notable ones. It turns out that 2020 was a pretty rough year for Apple, because it was also ordered to pay $506 million to PanOptis and another $109 million to WiLAN in two other infringement cases.

This is just a brief list of recent patent litigation. These patent cases are like watching 100 Ping-Pong matches going on all at the same time, each containing its own characters and dramas, and involving millions and billions of dollars.

Figure 3-4 Defendants added to litigation campaigns by year (Data provided by RPX Corporation on 12/14/20. © 2020 RPX Corporation)

While the various vendors are fighting for market share in their respective industries, another reason for the increase in patent litigation is the emergence of nonpracticing entities (NPEs), also known as patent trolls. NPE (or patent troll) is a term used to describe a person or company who obtains patents, not to protect their invention, but to aggressively and opportunistically go after another entity that tries to create something based upon them. A patent troll has no intention of manufacturing an item based upon their patent, but wants to get licensing fees from an entity that does manufacture the item. For example, let's say that Donald has ten new ideas for ten different technologies. He puts them through the patent process and gets them approved, but he has no intention of putting in all the money and risk it takes to actually create these technologies and attempt to bring them to market. He is going to wait until you do this and then he is going to sue you for infringing upon his patent. If he wins the court case, you have to pay him licensing fees for the product you developed and brought to market.

It is important to do a patent search before putting effort into developing a new methodology, technology, or business method. As you can see in Figure 3-4, there is a lot of litigation due to patent infringement, and thousands of new defendants are being added to the party each year. These cases are very costly but can oftentimes be avoided with a bit of homework.

Internal Protection of Intellectual Property

Ensuring that specific resources are protected by the previously mentioned laws is very important, but other measures must be taken internally to make sure the resources that are confidential in nature are properly identified and protected.

The resources protected by one of the previously mentioned laws need to be identified and integrated into the organization's data classification scheme. This should be directed by management and carried out by the IT staff. The identified resources should have the necessary level of access control protection, auditing enabled, and a proper

storage environment. If a resource is deemed secret, then not everyone in the organization should be able to access it. Once the individuals who are allowed to have access are identified, their level of access and interaction with the resource should be defined in a granular method. Attempts to access and manipulate the resource should be properly audited, and the resource should be stored on a protected system with the necessary security mechanisms.

Employees must be informed of the level of secrecy or confidentiality of the resource and of their expected behavior pertaining to that resource.

If an organization fails in one or all of these steps, it may not be covered by the laws described previously, because it may have failed to practice due care and properly protect the resource that it has claimed to be so important to the survival and competitiveness of the organization.

Software Piracy

Software piracy occurs when the intellectual or creative work of an author is used or duplicated without permission or compensation to the author. It is an act of infringement on ownership rights, and if the pirate is caught, he could be sued civilly for damages, be criminally prosecuted, or both.

When a vendor develops an application, it usually licenses the program rather than sells it outright. The license agreement contains provisions relating to the approved use of the software and the corresponding manuals. If an individual or organization fails to observe and abide by those requirements, the license may be terminated and, depending on the actions, criminal charges may be leveled. The risk to the vendor that develops and licenses the software is the loss of profits it would have earned.

There are four categories of software licensing. *Freeware* is software that is publicly available free of charge and can be used, copied, studied, modified, and redistributed without restriction. *Shareware*, or *trialware*, is used by vendors to market their software. Users obtain a free, trial version of the software. Once the user tries out the program, the user is asked to purchase a copy of it. *Commercial* software is, quite simply, software that is sold for or serves commercial purposes. And, finally, *academic* software is software that is provided for academic purposes at a reduced cost. It can be open source, freeware, or commercial software.

Some software vendors sell bulk licenses, which enable several users to use the product simultaneously. These master agreements define proper use of the software along with restrictions, such as whether corporate software can also be used by employees on their home machines. One other prevalent form of software licensing is the End User License Agreement (EULA). It specifies more granular conditions and restrictions than a master agreement. Other vendors incorporate third-party license-metering software that keeps track of software usability to ensure that the customer stays within the license limit and otherwise complies with the software licensing agreement.

The information security officer should be aware of all these types of contractual commitments required by software companies. This person needs to be educated on the restrictions the organization is under and make sure proper enforcement mechanisms are in place. If an organization is found guilty of illegally copying software or using

more copies than its license permits, the security officer in charge of this task may be primarily responsible.

Thanks to easy access to high-speed Internet, employees' ability—if not the temptation—to download and use pirated software has greatly increased. The June 2018 BSA Global Software Survey, a study conducted by the Business Software Alliance (BSA) and International Data Corporation (IDC), found that 37 percent of the software installed on personal computers globally was not properly licensed. This means that for every two dollars' worth of legal software that is purchased, one dollar's worth is pirated. Software developers often use these numbers to calculate losses resulting from pirated copies. The assumption is that if the pirated copy had not been available, then everyone who is using a pirated copy would have instead purchased it legally.

Not every country recognizes software piracy as a crime, but several international organizations have made strides in curbing the practice. The Federation Against Software Theft (FAST) and the Business Software Alliance (author of the Global Software Survey) are organizations that promote the enforcement of proprietary rights of software. This is a huge issue for companies that develop and produce software, because a majority of their revenue comes from licensing fees. The study also estimates that the total economic damage experienced by the industry was $46.3 billion in losses in 2018.

One of the offenses an individual or organization can commit is to decompile vendor object code. This is usually done to figure out how the application works by obtaining the original source code, which is confidential, and perhaps to reverse-engineer it in the hope of understanding the intricate details of its functionality. Another purpose of reverse-engineering products is to detect security flaws within the code that can later be exploited. This is how some buffer overflow vulnerabilities are discovered.

Many times, an individual decompiles the object code into source code and either finds security holes to exploit or alters the source code to produce some type of functionality that the original vendor did not intend. In one example, an individual decompiled a program that protects and displays e-books and publications. The vendor did not want anyone to be able to copy the e-publications its product displayed and thus inserted an encoder within the object code of its product that enforced this limitation. The individual decompiled the object code and figured out how to create a decoder that would overcome this restriction and enable users to make copies of the e-publications, which infringed upon those authors' and publishers' copyrights.

The individual was arrested and prosecuted under the *Digital Millennium Copyright Act (DMCA)*, which makes it illegal to create products that circumvent copyright protection mechanisms. Interestingly enough, many computer-oriented individuals protested this person's arrest, and the company prosecuting (Adobe) quickly decided to drop all charges.

DMCA is a U.S. copyright law that criminalizes the production and dissemination of technology, devices, or services that circumvent access control measures that are put into place to protect copyright material. So if you figure out a way to "unlock" the proprietary way that Barnes & Noble protects its e-books, you can be charged under this act. Even if you don't share the actual copyright-protected books with someone, you still broke this specific law and can be found guilty.

NOTE The European Union passed a similar law called the Copyright Directive.

Compliance Requirements

While it is important to know *which* specific laws and regulations your organization needs to be compliant with, it is also important to know *how* to ensure that compliance is being met and how to properly convey that to the necessary stakeholders. If it hasn't already done so, your organization should develop a compliance program that outlines what needs to be put into place to be compliant with the necessary internal and external drivers. Then, an audit team should periodically assess how well the organization is doing to meet the identified requirements.

The first step is to identify which laws and regulations your organization needs to be compliant with (e.g., GDPR, HIPAA, PCI DSS, etc.). This will give you the specific requirements that the laws and regulations impose on your organization. The requirements, in turn, inform your risk assessment and allow you to select the appropriate controls to ensure compliance. Once this is all done and tested, the auditors have stuff to audit. These auditors can be internal or external to the organization and will have long checklists of items that correspond with the legal, regulatory, and policy requirements the organization must meet.

NOTE Audits and auditors will be covered in detail in Chapter 18.

It is common for organizations to develop *governance, risk, and compliance (GRC)* programs, which allow for the integration and alignment of the activities that take place in each one of these silos of a security program. If the same *key performance indicators (KPIs)* are used in the governance, risk, and compliance auditing activities, then the resulting reports can effectively illustrate the overlap and integration of these different concepts. For example, if a healthcare organization is not compliant with various HIPAA requirements, this is a type of risk that management must be aware of so that it can ensure the right activities and controls are put into place. Also, how does executive management carry out security governance if it does not understand the risks the organization is facing and the outstanding compliance issues? It is important for all of these things to be understood by the decision makers in a holistic manner so that they can make the best decisions pertaining to protecting the organization as a whole. The agreed-upon KPI values are commonly provided to executive management in dashboards or scorecard formats, which allow management to quickly understand the health of the organization from a GRC point of view.

Contractual, Legal, Industry Standards, and Regulatory Requirements

Regulations in computer and information security cover many areas for many different reasons. We've already covered some of these areas, such as data privacy, computer misuse, software copyright, data protection, and controls on cryptography. These regulations can be implemented in various arenas, such as government and private sectors, for reasons dealing with environmental protection, intellectual property, national security, personal privacy, public order, health and safety, and prevention of fraudulent activities.

Security professionals have so much to keep up with these days, from understanding how the latest ransomware attacks work and how to properly protect against them, to inventorying sensitive data and ensuring it only exists in approved places with the right protections. Professionals also need to follow which new security products are released and how they compare to the existing products. This is followed up by keeping track of new technologies, service patches, hotfixes, encryption methods, access control mechanisms, telecommunications security issues, social engineering, and physical security. Laws and regulations have been ascending the list of things that security professionals also need to be aware of. This is because organizations must be compliant with more and more laws and regulations, both domestically and internationally, and noncompliance can result in a fine or a company going out of business, and in some cases certain executive management individuals ending up in jail.

Laws, regulations, and directives developed by governments or appointed agencies do not usually provide detailed instructions to follow to properly protect computers and company assets. Each environment is too diverse in topology, technology, infrastructure, requirements, functionality, and personnel. Because technology changes at such a fast pace, these laws and regulations could never successfully represent reality if they were too detailed. Instead, they state high-level requirements that commonly puzzle organizations about how to be compliant with them. This is where the security professional comes to the rescue.

In the past, security professionals were expected to know how to carry out penetration tests, configure firewalls, and deal only with the technology issues of security. Today, security professionals are being pulled out of the server rooms and asked to be more involved in business-oriented issues. As a security professional, you need to understand the laws and regulations that your organization must comply with and what controls must be put in place to accomplish compliance. This means the security professional now must have a foot in both the technical world and the business world.

But it's not just laws and regulations you need to be aware of. Your organization may also need to be compliant with certain standards in order to be competitive (or even do business) in certain sectors. If your organization processes credit cards, then it has to comply with the Payment Card Industry Data Security Standard (PCI DSS). This is not a law or even a government regulation; instead, it is an example of a mandatory industry standard. If your organization is a financial institution that is considered part of the critical national infrastructure of the United Kingdom, then it may have to comply with the CBEST standard even though any reputable organization in that

sector is expected to do so voluntarily. And, finally, if your organization wants to sell cloud services to the U.S. government, it won't even be considered unless it is Federal Risk and Authorization Management Program (FedRAMP) certified. So, compliance is not just about laws and regulations. There are many other standards that may be critical to the success of your organization.

Another compliance requirement that is sometimes missed by cybersecurity professionals is related to contracts and other legally binding agreements. In the course of doing business, your organization may enter into agreements that may have security requirements. For example, your organization may partner with another organization and thereby gain access to its sensitive data. The partnering agreement may have a clause requiring both organizations to ensure that they have certain controls in place to protect that data. If these protections are not already part of your own security architecture and you fail to implement them (or even become aware of them), you would not be in compliance with the contractual obligations, which could make your organization liable in the event of a breach. The point is that we need to have open lines of communication with our legal and business colleagues to ensure we are made aware of any security clauses before we enter into a contract.

If You Are Not a Lawyer, You Are Not a Lawyer

Many times organizations ask their security professionals to help them figure out how to be compliant with the necessary laws and regulations. While you might be aware of and have experience with some of these laws and regulations, there is a high likelihood that you are not aware of all the necessary federal and state laws, regulations, and international requirements your organization must meet. These laws, regulations, and directives morph over time and new ones are added, and while you may think you are interpreting them correctly, you may be wrong. It is critical that an organization get its legal department involved with compliancy issues. Many security professionals have been in this situation over many years. At many organizations, the legal staff does not know enough about all of these issues to ensure the organization is properly protected. In this situation, advise the organization to contact outside counsel to help them with these issues.

Organizations look to security professionals to have all the answers, especially in consulting situations. You will be brought in as the expert. But if you are not a lawyer, you are not a lawyer and should advise your customer properly in obtaining legal help to ensure proper compliance in all matters. The increasing use of cloud computing is adding an incredible amount of legal and regulatory compliance confusion to current situations.

It is a good idea to have a clause in any type of consulting agreement you use that explicitly outlines these issues so that if and when the organization gets hauled to court after a computer breach, your involvement will be understood and previously documented.