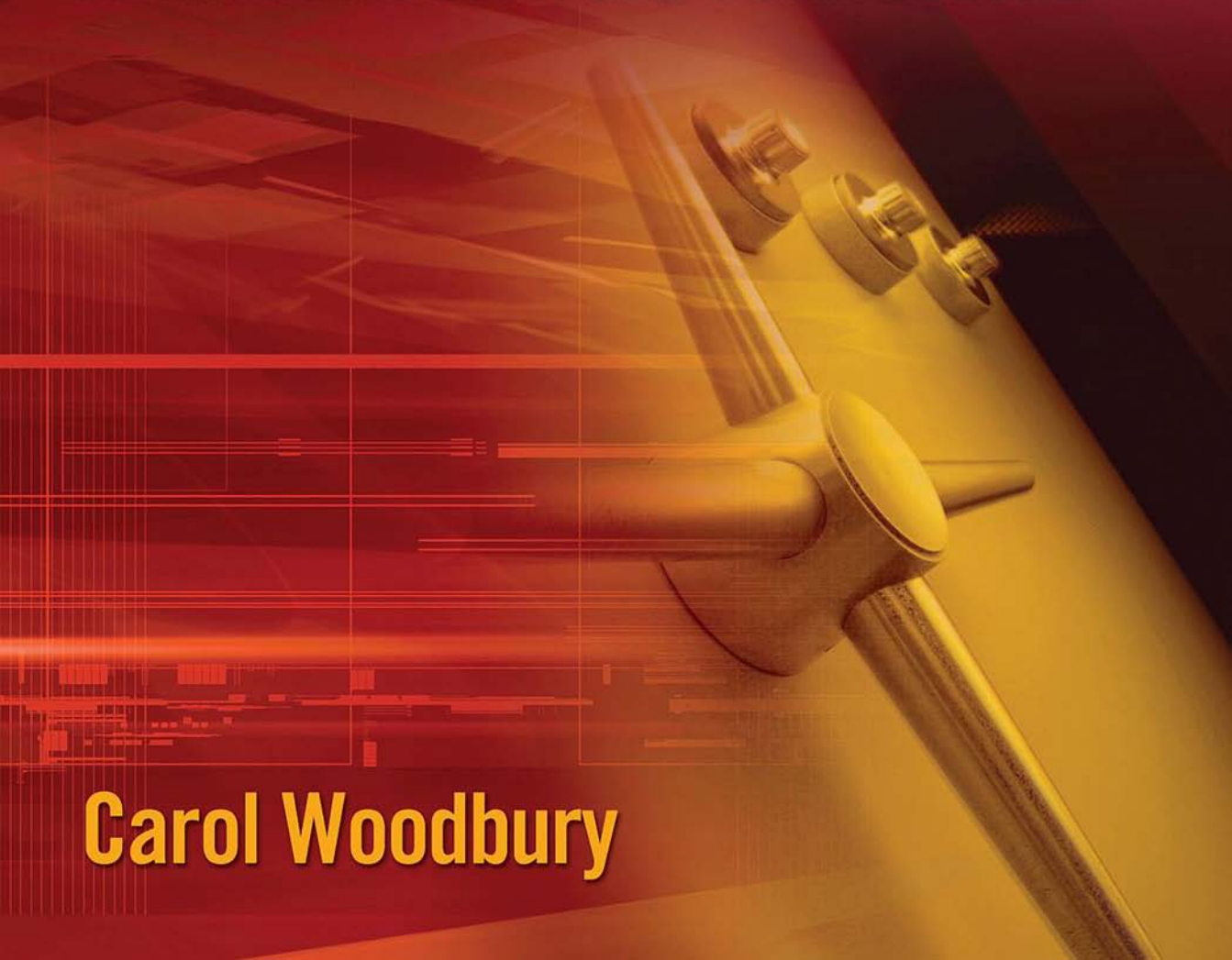
SECOND EDITION

IBM i Security

ADMINISTRATION and COMPLIANCE



Carol Woodbury

IBM i Security Administration and Compliance

Second Edition

Carol Woodbury

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IBM i Security Administration and Compliance: Second Edition

Carol Woodbury

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To the IBM i Security Team in Rochester, MN—both past and present. You are the reason that I have a career. You've created the most securable system available, and you strive to keep it that way. Thank you for your talent and more importantly—your friendship.

"My soul finds rest in God alone;
My salvation comes from him.
He alone is my rock and my salvation;
He is my fortress,
I will never be shaken."

— Psalm 62:1–2

All credit for any achievement or accomplishment goes to Jesus.

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CHAPTER 1

Security—The Reasons You're Reading This Book

When the first version of this book was written by Wayne Madden, the title of this chapter was "Security Is a Business Function." Readers purchased and read the book because they believed in that principle and wanted to learn more. Although that principle is no less significant today, I feel it is important to acknowledge—in the very first chapter—why I believe many of you are reading *this* book.

For many of you, it's because your organization is required to be in compliance with some law or regulation. For others, it's because you've been tasked with implementing a "deny by default" security scheme. Some of you are new security administrators and want to learn the basics of IBM i security. Others may be reading this book because you are auditors assigned to a client running something called an "iSeries" or "IBM i," and you need to understand its security features. Whatever the particular reason, in today's world, implementing a sound security policy is often a forced issue rather than a choice.

So, because you may have picked up this book not so much because you wanted to but because you had no other choice, I've worked hard to make sure reading it will be a good use of your valuable time. To help ensure that it is, I have several goals for this book:

To explain security best practices as they pertain to the IBM i operating system, using clear and understandable terms and concepts. Regardless of the type of

organization to which you belong, in most cases you must comply with some law or regulation. If your organization can implement security best practices, not only will you comply with most current laws and regulations, but you will be in a position to comply with future laws and regulations, or at least not have a difficult time coming into compliance. For this reason, it's important to learn what constitutes security best practices on IBM i.

To give you choices. While I recommend that security best practices be every organization's goal, reality shows that most organizations have some area for which they are unable to implement best practices. This book discusses how to evaluate risks so you can determine which exposures you need to remediate and which you're willing to accept.

To provide practical implementation examples. I've probably seen every range of implementation possible, from the unbelievably open system to the system whose users can barely breathe without permission. Most security implementations lie somewhere in between. This book is full of practical and tested implementations.

To help you gain an understanding of the appropriate security scheme for the organization in which you're working. How am I going to do that? By helping you to identify the type of data being stored on your system and to understand the security implications of maintaining this type of data. Not all systems need to be locked down like Fort Knox. Some systems hold data that can be viewed by all users. Others have data that only a few people should be able to see. Understanding the type of data stored on your system is key to understanding the security requirements you need to apply to that system.

To give you tips for saving time when administering your system. All administrators are pressed for time. I don't want you wasting time discovering for yourself what is important and what can be ignored. I tell you exactly what commands to run to get the information you need—whether the information is required for a report for auditors or you need to get the information so you can perform some task—and I explain how to get the information and what to look for so you aren't left guessing and have to research it yourself.

Now that you understand the goals of this book, let's look at why part of best practices says that security must be a business function.

Suppose you want to know more about your organization's human resources department, so tomorrow you and the rest of the IT staff go on a "tour" of that department. You find the file cabinets that keep all the employees' employment records,

and you start to look through them. In fact, you copy the records of some of the more "interesting" individuals—such as those of your manager, the CIO, and the CEO. Then you scan in these records and post them on your Facebook wall, or you tweet the more interesting bits to your followers.

Although this is an absurd story, it has more basis in reality than most organizations would like to admit. How many members of your IT organization have *ALLOBJ (all object) special authority or access to all production objects on your system? *ALLOBJ authority permits those employees to do electronically what they never would be permitted to do with physical file cabinets. If anyone other than the security administrator has *ALLOBJ special authority, you're permitting that person to violate a written or unwritten guideline that limits access to confidential or private data residing on your system.

Whether you're talking about locks on doors, restrictions on who can access documents in physical file cabinets, limitations on who can access files on your system, or controls over the information your company makes available on the Internet, your organization's policies—formal or informal, written or unwritten—govern your business. You must take those policies into consideration as you architect and implement your security scheme. If you make compliance with your policies a top concern, you'll go a long way toward being in compliance with many of the laws and regulations that govern your organization.

Evaluating Your Risks

It's quite fascinating to compare the amount of money that's invested in securing the physical hardware on which data resides with the amount of money most organizations spend on securing the logical access. In most cases, the amount spent on securing the logical access is miniscule compared with the investment in securing the machine room, when you consider the locked doors, raised floor, alarms, fire suppression equipment, and so on. Why the disparity? My hope is that this book helps raise the awareness that it's just as important to invest in the security of the logical access to the data as it is to the physical access.

As you evaluate the risk to your data, consider all the ways—whether accidental or intentional—in which an inappropriate disclosure, modification, or deletion of your information assets could occur. As you look at the risk, it might be helpful to identify it in terms of risk to the confidentiality, integrity, availability, and privacy of the data.

Confidentiality

Some information is obviously confidential because it consists of private information (such as payroll information) or because it could give a competitor an advantage (for example, early knowledge of an impending acquisition, quarterly financial results, proprietary product information, customer information, vendor lists). You must evaluate your data in terms of its confidentiality and value to the organization to determine how it should be secured. I'm certain you've heard stories about disgruntled employees who have stolen databases and sold the information on the black market. What's scary is how easy it is in most organizations to accomplish this deed. Given the way most systems are configured, some end users and most programmers could walk out the door of their organization's office with a copy of virtually any database file. Or they could email the information from the system or carry it home on a memory stick. How often are briefcases examined on the way out of your office? How many emails are scanned for inappropriate attachments being sent from your company? When it comes to restricting access to information assets, an organization's security implementation often fails.

Integrity

Information security also addresses the integrity of your applications and data. Applications and data must be authentic, accurate, and concurrent with your company's other applications and data. Problems such as order entry programs that lose order items, inventory control programs that introduce errors in replenishing stock, or item pricing records that someone has tampered with can easily bring a business to a crawl or standstill and can endanger profits and even the company's long-term success. You can't afford to risk the integrity of your applications and data because of a nonexistent or weak information security implementation.

For instance, if you let users share user profiles and passwords, you immediately sacrifice your system's ability to authenticate changes to information. In other words, the system can't accurately identify who is doing what on the system because one profile might represent several people. Although limited profile sharing may be acceptable for a specific application, as a rule system integrity requires you to prevent profile sharing.

What if users or management suddenly started doubting the accuracy of the data in your database? Perhaps someone mistakenly uploaded old data from a PC into a file. Or maybe a well-meaning programmer put into production a program that wasn't fully tested, which in turn introduced errors into the database. These two scenarios illustrate the importance of the integrity and accuracy of your programs and data. Your information

security plan must minimize the opportunities for users and IT staff to accidentally or intentionally introduce errors into your application repository or database.

Secure information assets are also vital to your company's integrity and reputation. Any security breach, when publicized, can harm a company's reputation. Say your business depends on the cash flow that its website produces, and you experience a highly publicized security breach in which consumers' credit card numbers are stolen. A well–thought-out and implemented security plan protects a company's integrity and reputation as well as its data. I've started to encourage my clients to take the attitude and assume they *will* be breached rather than hope that it doesn't occur. If you assume that a hack will occur, it's likely that you will take more seriously the security controls you put into place and take steps to ensure that you have set up enough layers of defense to protect your data and reduce your risk to an acceptable level.

Availability

You've probably heard the horror stories—or even experienced them yourself—in which production objects were accidentally deleted. Perhaps a developer thought he or she was deleting a test copy of a program, or a user accidentally hit the "upload" icon instead of the "download" icon and overrode the production sales file with data from a spreadsheet containing last month's sales data.

Regardless of the specific scenario, these types of disasters occur simply because users have too much authority to the data. If the user had sufficient object authority to download data but not to upload it, the possibility of overwriting production data wouldn't exist.

Although these disruptions are typically accidental, malicious attacks can also occur. Malicious or accidental, anytime data is not available to the organization, the organization is harmed. The degree to which it is harmed depends on what data is no longer available and on the length of the outage. A well-architected and -implemented security scheme can significantly reduce the potential of data being unavailable.

Privacy

Recent years have seen a dramatic rise in concerns about privacy, and numerous laws have been written to protect it. Consumers are becoming increasingly worried about how organizations use their personal data, whether it's collected over the Web, on an employment application, or in an electronic healthcare database. When data is gathered and inappropriately released (such as information collected from medical tests and credit

reports), individuals' lives are often adversely affected—either by sheer embarrassment or through identity theft or fraud.

Security alone doesn't guarantee privacy, but you cannot guarantee privacy *without* implementing good security policies and practices. Don't make the mistake of ignoring this area. Many countries, including the United States, Canada, and most of Europe, have legislation that mandates protection of personal information. Financial institutions in the United States must inform their clients about how private data is used and let them opt out of programs that may send that data outside the original institution. In the case of healthcare, the Health Insurance Portability and Accountability Act (HIPAA) requires physicians to tell their patients how private data is used and to obtain patients' permission before sharing that data with other physicians, healthcare organizations, or medical research teams.

Even if you aren't in a regulated industry, I strongly recommend that you evaluate *all* data your organization collects. If any of it is personal information, examine how it is used, ensure it is appropriately secured, and inform individuals (through your privacy statements) about how the data will be used so they can choose whether to give your organization their data.

Securing private data is a vital aspect of keeping private data private. However, it's important to realize that this is only one aspect of keeping private information private. Appropriately securing private data provides access control; that is, it determines who can see the data. However, security cannot enforce a policy of acceptable uses of the private data once that data has been collected or viewed. Nor can security enforce the policy of what data is actually collected. So just because you have the private data secured away from public access, don't think you've handled all aspects of dealing with private data. You don't want your organization to be the next Facebook when it comes to abusing the privacy of the information it gathers!

Another consideration is the aggregation of data. Some data, on its own, may not be considered private data, but when aggregated with other information, it's now private. For example, the State of California has determined that an email address is private data if it's kept in the same database as the answers to your password prompt questions. And the obvious issue of big data—not just the sheer volume, but the amount of data that can be collected on an individual or entity—must also be considered. In other words, you need to look at all uses of data across your organization and protect data appropriately.

Evaluating the Threats

What types of problems pose the greatest threat to your information security plan and implementation? A common thread you may have recognized in the scenarios discussed here is the role accidents can play in breaching confidentiality, accuracy, or availability. A sound security scheme provides significant protection toward reducing threats to your system. If you implement common-sense security measures, such as appropriately securing production data, securing source so that it cannot be updated outside of change management, reducing the number of all-powerful users, auditing the use of critical data and security-relevant actions, and handling data according to the requirements of its data type, you can eliminate many common sources of errors and omissions.

However, you cannot ignore the threat from disgruntled employees and hack attacks from literally all over the world. If you have never addressed security on your IBM i, now is the time. While it's doubtful you'll ever hear about an IBM i being hacked (because the operating systems and applications involved in a hack are rarely revealed), I can assure you that the IBM i *has* been hacked. Many people have a false sense of assurance that the system is secure. Rest assured that the system is secure-able—but the data on the system in not inherently secure, and you must implement the features provided by IBM to protect your system and data. One of the biggest threats to your data is complacency and ignoring the fact that steps need to be taken to secure the system. I see far too many managers and system administrators who continue to insist that they have nothing to worry about because their users are locked into a menu environment and/or their users couldn't possibly know how to access the system any other way than through a menu. These individuals couldn't be more wrong. Management's putting their heads in the sand and refusing to acknowledge the vulnerability of their data is, to me, the biggest threat to an organization's data.

Where do you start? First, develop a security policy; determine how risk-averse your organization is to having its data being lost, stolen, or unavailable; and then implement the appropriate security features to allay the risk.

Managing the Strategic Issues

Evaluating the risks and threats to your information assets is the key to getting management's attention. As you expose risks and threats, management begins to see the possible ramifications of inadequate or inappropriate security. Once you have management buy-in, it's important to follow through by implementing a security awareness program throughout your organization and ensuring that the requirements of

your organization's security policy are considered with all major changes that occur in the organization. In addition to managing upper management's knowledge and expectations of a security policy, you need to manage the access controls to your applications, data, and systems. And you need to establish and carry out security auditing procedures.

These tasks take time. But once completed, they provide the building blocks for the various security implementations you need to undertake for your enterprise's computer systems.

Control Access to Applications, Data, and Systems

Controlling access to your information resources involves physical security, managing user profiles and passwords, defining authorization roles, and implementing resource authorities and specific security programs to enforce and audit access to your system. This particular strategic issue constitutes most of the tasks usually associated with implementing security and consequently occupies the largest portion of this book.

In today's world, access control is a critical part of a security implementation. Perhaps in the past you relied on security measures, such as menu systems, to secure your own application users on the system. That method simply is not sufficient today. With numerous ways to access data that bypass traditional menus—such as File Transfer Protocol (FTP), Open Database Connectivity (ODBC), and Distributed Data Management (DDM), you must incorporate other approaches to ensure your data is secured appropriately.

One subset of access control relates specifically to security within the IT department. IT professionals are often oblivious to the need to secure the system from themselves. Some professionals perceive any form of security aimed at IT as, at best, making IT's job more difficult or, at worst, a personal attack. However, because security is a business function and the IT professional's tasks, like all other users' tasks, require security, IT security requires consideration and careful planning.

Some of the keys to a successful IT security implementation are apparent—committing to separate development, test, and production environments, for example. The production environment on your systems must be stable except for planned changes made using some type of change management system. IT professionals shouldn't have authority to production data and applications. However, there must be a contingency plan that provides access in the case of production emergencies.

IT vendors (e.g., consultants, third-party software providers) should fall under the same guidelines as in-house developers. They should have access only to development

and test environments. And, as in the case of in-house developers, all actions on production systems should be audited.

Red flags should be thrown and warning bells should go off in your head when third-party software providers require users to have *ALLOBJ special authority to run their software (unless, of course, it is security management software). *ALLOBJ should be the absolute exception and definitely not the rule. Make these vendors justify why users need *ALLOBJ special authority to use the software. There are some legitimate reasons for requiring *ALLOBJ authority, such as when an underlying operating system function requires it. However, no vendor should require *ALLOBJ authority simply to access the application's database.

Regardless of whether you're working with IT or end users, your security scheme should be formed according to the principle of "least-privilege access." That is, give users access only to those objects and capabilities that they need to perform their job function—never more.

Review Requirements and Maintain Compliance

In any security implementation, established security requirements and rules become less effective as time passes. Because your security requirements, as well as pieces of the system (e.g., the operating system, application programs, procedures) aren't static, you must periodically review and adapt your security plan to stay current with new threats, changing technology, and recently passed laws and regulations.

To maintain a security implementation, you must proactively monitor the compliance of your security implementation as well as review the security-related events that take place on your system each day. That is, you need to regularly check to make sure your implementation complies with your organization's security policy. Many organizations fail to review their policy and its implementation, instead simply trusting that the security implementation works and that "someone" will know when something isn't "right." Or, they choose to put their head in the sand and ignore the possibility that things may have changed.

Getting Started

The hardest part of implementing a sound security scheme is getting started. As you read the rest of this book, look for simple ways you can begin in your own organization. To do that, you must take these initial steps:

1. First, examine any potential risks to your company's information assets—that is, its data. Is there confidential or private information on the system that your company needs to protect? Can you guarantee the integrity of your organization's data? What would the cost be if this data were lost or stolen? To answer these questions, list the risks of your current implementation. Then, list the cost to the organization should the data be lost or stolen.
2. Next, obtain management support to begin documenting corporate-wide security policies. After defining the organization's policies, start to define the departmental procedures and establish data ownership. For information about writing a security policy, see Chapter 2.

Only after completing these tasks are you ready to begin implementing a new security scheme. It is in the enforcing that you'll use the technical tools described in this book.

The final step in getting started, from a management point of view, is to commit to maintaining your security implementation and plan. The only way to determine whether your implementation is working is to check the compliance of the current system settings against your security policy and continue to do so on an ongoing basis. When you discover gaps in the configuration, you can fix the implementation to bring it back into compliance with your policy.

The remainder of this book gives you the technical details and approaches for implementing security best practices for IBM i.

Technical Note

The operating system that is the subject of this book has undergone several name changes throughout its history. I use the current name, IBM i, but most of what you'll learn about in this book applies equally to recent versions of i5/OS and OS/400 (with the obvious exception of new functionality provided in V7R2 and V7R3). Similarly, I use the latest names for other IBM products and technology, such as Navigator for i (formerly iSeries Navigator), and my screen shots now reflect my use of Access Client Solutions (ACS) rather than Client Access client software, and other current technologies.

Don't Close the Book

Once you've written your security policy, evaluated your risks, implemented or reworked your security scheme, and tightened down your network, your job is done and you can toss out this book, right? Wrong. Security is a not a one-time event. I like to call it a "lifestyle." New technologies are introduced, new applications are installed, you upgrade the operating system, the organization acquires a new company or goes into another line of business. Because security is a business function, and the laws and regulations affecting how confidential and private data is used and secured aren't going away. Whenever your business changes or grows, you must evaluate those changes against the requirements of your security policy and then implement the appropriate security measures to ensure your organization's data remains secured appropriately and that your organization is still in compliance with its policies. In addition, you have to make sure, that amidst the chaos of change, you can effectively and efficiently administer the security of the system. So don't close this book! You'll want to keep it open for future reference.

Don't Get Overwhelmed

If you've found this chapter overwhelming because of the amount of work you see looming, I ask that you stick with the book. My plea is that you start somewhere with some task, be it large or small. Any change that you make reduces risk. So if this is new to you and you don't know where or how to start, don't be afraid to start with a few small tasks. It's far better than doing nothing at all.

CHAPTER 2

Policies and Procedures

Policies and procedures are essential for security. Why? For one thing, many laws and regulations require them. For another, they define the security "rules" against which your organization's decisions should be evaluated. Have you ever watched kids playing soccer before they understand the rules and know how to play the game? The whole team runs after the ball in a swarm. If a goal is scored, it's often more by accident than by skill. Energy is expended, but not much play is actually accomplished.

Trying to implement a security scheme without knowing your organization's "rules"—that is, without having a security policy—is similarly inefficient. Having an up-to-date and enforceable security policy lets you implement a security scheme confidently and provides a clear pathway for resolving issues.

Your security policy is a vital corporate document. It documents the level of investment required for security resources across your organization, and it spells out the rules and requirements for implementing security. Designing your corporate security policy is a critical business practice—much like laying out your employee compensation plan. For example, once you have a policy in place, you can analyze a proposal for enabling a new technology to see whether it fits within the rules. Thus, a security policy can settle arguments and avert power struggles.

A side benefit of a security policy is that it helps retain "corporate memory." Employee turnover and downsizing can devastate an IT department if no one has documented the policies and the processes that implement those policies. A security policy also provides legal documentation should your organization ever need to prosecute someone for violating the security policy.

Finally, buy-in from the highest levels of management on your security policy is critical to its successful implementation and enforcement. A member of the IT staff may develop your organization's security policy, but the policy needs to be approved and communicated to the rest of the company through the highest level of management possible.

Your Security Policy

Some security policies tie all areas of the organization into one document. But most organizations use an approach that sets out the policies in a main document and uses appendices to address the implementation of specific areas, such as the operating system, a firewall, or Active Directory (AD). There is no right or wrong format as long as the policy meets your needs and can be communicated effectively.

In addition, while some laws and regulations (e.g., the Payment Card Industry Data Security Standard—PCI DSS) have requirements regarding specific issues that must be addressed in a policy, no law or regulation mandates how many additional areas are addressed. I tend to see organizations that are just creating a policy start out with a very basic policy, addressing only the bare minimum. Then, in subsequent years, when the policy is up for its annual review, new sections are added. Organizations that have addressed security as a business function for many years tend to have "mature"—that is, very comprehensive—security policies.

The point I'm trying to make is that your policy needs to meet your organization's requirements, and those requirements vary from organization to organization. Let's examine the vital parts of a security policy.

Physical Security

Security policies often start with physical security. Perhaps that's because when thinking about security, many people find it easiest to think of items by working from the "outside" toward the "inside." Whatever the reason, the physical security section of the policy describes the physical measures put in place to ensure physical security. These measures can include:

- Badge readers
- Cipher locks on critical areas (e.g., machine room doors), as well as requirements and procedures for changing lock combinations
- Security cameras for computer rooms
- Laptop security (laptops are high-theft items, both onsite and when users are traveling)

Responsible Parties

Disagreements occur, new ideas are launched, organizations expand and contract. Any of these circumstances can cause someone to experience a conflict between the job they're trying to do and what the security policy mandates. A clear process for resolving such issues, as well as the person or persons empowered to settle conflicts, must be established and documented.

A part of doing business is managing and resolving conflict. The topic of security seems to breed conflict. Programmers, for example, always want more function than they're allowed, and some managers seem to have the attitude that they're entitled to see all data on the system. These issues and others must be settled for business to go forward. Your policy will document who is responsible for such decisions so that conflicts can be resolved. The security policy will also identify the person or persons responsible for the security policy itself and the overall security of the corporation.

Data Classification

Let's face it, the reason you're reading this book is because there's data on some computer and that data has value to the organization. The exact value depends on the type of data; therefore, it is critical that data be *classified*. Data classification entails analyzing the data your organization retains, determining its importance and value, and then assigning it to a category. Data that is considered "top secret" (whether contained in a printed report or stored electronically) needs to be classified. Why? So that it can be handled properly. IT administrators and security administrators can guess how long data should be retained and how it should be secured, but unless the organization has taken the time to classify its data, the data may not be secured correctly or retained for the required time period.

When documenting the classification of data in your security policy, you should address the following areas:

- *Who has access to the data*—Define the roles of people who can access the data. For example, information classified as "company restricted" can be viewed only by upper management.
- *How the data is secured*—Determine whether the data is generally available or, by default, off limits. You'll hear this latter approach referred to in laws and regulations as "deny by default."

Note

Notice that I have not defined what the operating system security setting is to be; I have defined the access in general terms, just as I described who should have access in general terms. Determining who has access and identifying the specific security settings will come when the data custodian (described later) implements this part of the policy. These settings are often documented in the appendices that accompany the policy.

- *How long the data is retained*—Many industries require organizations to retain data for a certain length of time. For example, the finance industry requires a seven-year retention period. Data owners need to know the regulatory requirements for their data; if no requirements exist, they should base the retention period on the needs of the business.
- *What method should be used to dispose of the data*—For some data classifications, the method of disposal won't matter. But some data is so sensitive that data owners will want to dispose of printed reports through cross-shredding or another secure method. Or, they may require employees to use a utility to "scrub" their PCs after erasing files containing sensitive data.
- *Whether the data needs to be encrypted*—Data owners must decide whether their data needs to be encrypted. Many laws and regulations make this decision for them. For example, PCI DSS requires that all cardholder data "at rest" (i.e., in a file) be encrypted.
- *What use of the data is appropriate*—Before data security became such a hot issue for organizations, people in many roles within and outside the company used data

in all types of reports. This aspect of the security policy defines whether data is for use within the organization, is restricted for use by only selected roles, or can be made public to anyone outside the organization. In addition, some data has a legal usage definition; for example, the State of California has defined the appropriate use of a Social Security number (SSN). Your organization's policy should enumerate such restrictions.

What Classifications Should You Use?

There are no hard and fast rules about the titles and number of data classifications. The general guideline is that classification should be defined clearly enough so that it is easy to determine how to classify the data. In other words, little (if any) overlap should exist in the classification definitions. Also, it is helpful to use a term for the title of the classification that indicates the type of data that falls into the particular category.

Here are some examples of categorizing data by title:

- *Private*—data that is defined as private, such as SSNs or Social Insurance Numbers (SINs), bank account numbers, and cardholder data
- *Restricted*—data that is restricted to a subset of employees
- *Confidential*—data that can be viewed by all employees but is not for general use outside the organization
- *Public*—data that can be viewed or used by employees and the general public

Data classifications can also change. For example, IBM will often classify new release information as IBM Confidential Until Announced. The recipients of this information can properly protect and use the information before the announcement and can then more freely use the information after IBM formally announces a new release.

Who's Responsible for Classifying Data?

The individual who owns the data should decide the classification under which the data falls. The committee that wrote the data classification policy can certainly help or provide guidance, but the final determination of the classification should be the data owner's responsibility. The data owner is best qualified to make this decision because he or she has the most knowledge about the use of the data and its value to the organization.

In addition, data owners should review their data's classification at least annually to ensure that the data remains correctly classified. For example, if data owners were

reviewing data classifications for the past few years, they probably moved much of their employees' information—especially information such as SSNs or SINs—from a "confidential" classification to a "private" classification. SSNs and SINs were never considered private until they began being used for identity theft. Since thieves started to steal databases, the classification of these identification numbers has been upgraded to restrict access and more tightly control their use. Recent exploits should have you considering whether email addresses should be reclassified as well.

Data Ownership

In addition to classifying data, an organization needs to assign an owner. The owner is not the user profile that owns the database object on the system; rather, it is the person in the organization who owns the data that is stored in the database. The data owner is typically a director, or at least a department head, who has a vested interest in making sure the data is accurately and appropriately secured. The person who is appointed needs to understand the importance and value of the information to the business, the ramifications of inaccurate storage or inappropriate access, and the laws and regulations that may govern the use and retention period of the data.

The data owner's responsibilities include:

- Setting the policy as to who is (what roles are) allowed to access the data
- Determining how the data is to be secured
- Setting the retention period
- Defining the appropriate disposal methods
- Setting the encryption requirements

The data owner may appoint an administrator to perform the daily tasks associated with these responsibilities. For example, the data owner may appoint someone to approve requests for individuals to have access to the data. The appointed person will act under the direct instructions of the data owner.

Why Not IT?

Unfortunately, IT often ends up being the de facto owner of data. Although the IT department can be the custodian of the data, it should not be the owner. Employees in IT

generally do not know how important the data is to the business, how the data is to be used, and which people (or roles) should access the data.

Another reason IT should not be the owner as well as the custodian of the data is separation of duties. If IT decides who has access to the data and then administers that access, no checks and balances are in place to ensure that access control policies are being followed or that inappropriate access is not being assigned.

IT's role is usually that of data custodian. The custodian is responsible for implementing the policies set by the data owner. For example, IT is usually responsible for ensuring that the database files access controls (e.g., *PUBLIC authority) are set according to the data owner's requirements. IT is also responsible for backing up the data as well as properly disposing of any electronic copies of the data in the department's possession.

Network Connections

Your security policy needs to address several network-related areas:

- Internal network (or intranet)
- Internet
- Extranet (or requirements between your company and vendors or suppliers)
- Wireless

For each area, you'll want to address the required authentication methods and indicate who has authority to authorize users to various resources. For example, your policy may state that to access your internal network, users must have a valid network user ID and password. Network authorizations will be permitted once the network administrator receives notification from the human resources (HR) department that an employee has been hired or a vendor has started a contract. The internal network section of your policy should also define virus-scanning and anti-spam policies as well as discuss the appropriate use of email.

The Internet section will address the hosting of your company's website and any connections back into your internal network. This topic will also cover the use of firewalls and the connectivity requirements of employees connecting from outside a firewall into your internal network. For example, many companies require employees to connect from home (or while traveling) using a virtual private network (VPN) client.

VPNs enable strong authentication of the client (in other words, a very high assurance that the client is who it says it is) as well as encryption of the entire flow of data.

Extranet issues discussed in your policy will include who determines which vendors or suppliers are allowed to connect to your internal network, what (types of) systems they are permitted to access (e.g., non-production systems, development systems, customer relationship management systems), and the connectivity requirements for connecting to your network.

Wireless issues to be documented include who or what areas are allowed to use wireless technology, who is permitted to add wireless access points, and what security measures are to be taken when using wireless technology. In considering wireless use outside your internal network, you'll want to document whether employees can use wireless home networks or the wireless network at their local Starbucks to access your network over the Internet. Or perhaps you permit this type of access only if the employee is using a VPN client.

Application Design

If your company writes its own applications, your security policy should address issues of change control, use of programming best practices (including practices that ensure a secure implementation, for legacy as well as Web programming), testing procedures to ensure security policy compliance, and emergency procedures for programmer access to production data.

Programmers shouldn't by default have authority to debug an application once it's promoted into production. Nor should programmers be able to update production files. However, as we all know, programs fail, and there are times when programmers must debug a production program. In such cases, temporarily give the programmer a profile with sufficient access to debug and correct the problem. Use an automated procedure to ensure that this profile is deleted or disabled afterward so it can't be used on an ongoing basis. You'll probably also want to audit the activities this profile performs, including all commands entered from a command line.

BYOD

One aspect of a policy is that it must be kept current. If your policy hasn't been updated in the last five years, it's likely that it doesn't address the issues associated with a Bring Your Own Device (BYOD) policy. I've talked to some managers who say they don't allow BYOD, and when questioned as to whether their policy states that, they say no.

I have news for those managers. Unless your policy explicitly forbids BYOD, it's happening. Employees handle email via their phone, take notes during meetings via their tablets, store documents in the cloud, and so on. So I encourage you to make sure you've considered all aspects of whether you want to allow users to use their own device within your organization and ensure your security policy reflects your organization's choice in this matter.

Social Media

Another area missing from policies that haven't recently been updated is the use of social media. This section needs to describe whether employees can use social media, such as Facebook or YouTube, during work hours. Your policy should also describe when (if ever) it's appropriate to mention the organization in social media. For example, most organizations forbid employees from representing or speaking on behalf of the organization on social media unless that's their job responsibility.

Platform-Specific Issues

If you take the approach of documenting general principles in the main part of your policy and providing an appendix for each platform or operating system, the platform-specific sections of your security policy will document the specific policy implementation details associated with each platform. For example, for IBM i you may want to document the settings for the security-related system values, the default access (*PUBLIC) authority setting, which type of user (e.g., system operator, security officer, end user) is allowed to have certain special authorities, and the auditing values to be set.

Employee Guidelines

Most likely, your organization has an employee handbook that is updated regularly and given to all employees when they're hired. This book contains policies, guidelines, and information. Often, this handbook documents the employee-relevant security policies. Items covered in this section often document what constitutes appropriate behavior. Let's take a look at examples of some of the issues you'll want to cover in the employee section of your policy:

- All computer equipment, systems, and information residing on the computers are the property of the company and are for business purposes only.
- Activity on computers can and may be logged and tracked.

- Employees can use email facilities during work hours but should have no expectation of privacy regarding any email sent or received.
- Employees must not defame the competition.
- Employees must not access external social networking sites or blogs while on company time.
- Employees cannot blog and attribute the blog contents to the company unless it is their job responsibility to do so.
- Employees will wear identification badges at all times while on company property.

The employee section of the policy is often where password rules are communicated. For example, the policy may have a section that includes the following points:

- Individuals will have their own logon accounts. These accounts and their passwords are not to be shared with other individuals.
- Passwords must be at least seven characters long and must contain a digit and a special character.
- Passwords must be changed on all accounts at least every 90 days.
- Password should not be written down.

The items I've listed here are not meant to be an exhaustive list of issues to be addressed in the employee section of your policy. Rather, they are meant to provide some examples so that your organization can think about and ultimately document what employee policies make sense for your business situation.

Notification, Enforcement, and Compliance

A security policy isn't worth anything unless the people affected by it are notified about and comply with the policy. So be sure to develop notification procedures. For example, many companies perform security awareness training as part of their new-employee orientation. One aspect of your organization's security awareness program could require managers to annually review the employee's security policy with their employees and then require the employees to sign something to acknowledge that they're aware of and agree to adhere to the policy.

Communicate changes to the policy to the affected parties in a timely manner. Having executive-level management handle notifications about the security policy can be an effective way to reinforce the message that security is important to the business and is the responsibility of all employees.

Enforcement can come in many forms. The compliance and enforcement section of your policy will document how your policy is enforced. Some portions of your policy can be enforced with technology. For example, to ensure appropriate Internet use by employees, all visited websites can be logged and reviewed; employees trying to connect to an internal network from outside the firewall will have their connections rejected; and password composition rules will be enforced by setting the appropriate IBM i system values or Microsoft Active Directory (AD) policies.

Realize, however, that not all aspects of a policy can be enforced with technology. Some items rely on the integrity of the individual employee. Obviously, you hope everyone adheres to the policy and guidelines voluntarily. Unfortunately, that doesn't always occur. Non-compliance must be dealt with, and the compliance and enforcement section of your policy should outline the procedures to be followed in the event of non-compliance.

I can't emphasize enough the need to enforce your policy. If a user doesn't comply with the policy and no ramifications occur, there will be no motivation for that employee or any other to follow the policy. It's like a parent telling a child, "Don't do that, or you'll be punished." If the child continues to misbehave and the parent never disciplines the child, what happens? The child learns that it's OK to misbehave.

Effectively communicating your security policy and guidelines sends employees the message that security is important to your business and is part of their job. Top-level management can take this opportunity to show support for information security efforts. Such cooperation ultimately makes your job easier by helping everyone realize—and take to heart—that security is everyone's responsibility.

Business Events and Procedures

Most organizations have established and documented processes for handling changes in employee status—that is, dismissals, leaves of absence, transfers between departments, and so on. The impact on security is often overlooked when these processes are being developed and implemented. Although these processes may not be part of your security policy itself, their security ramifications shouldn't be ignored. For example, the termination of an employee should involve immediate notification of the IT department,

so that the user's profile (or profiles) can be disabled or deleted. In addition, you might want to gather certain "forensic" information at that time. Perhaps look for recent changes to programs or updates to files made by this user.

Similarly, an extended leave of absence requires IT notification, so that the user's profile (or profiles) can be disabled to protect against exploitation during the user's absence. Automated tools can also be updated so that a particular profile isn't flagged as "inactive" and inadvertently deleted while an employee is away.

Although IT is often notified of terminations and leaves of absence, the most overlooked HR activity is when users transfer between departments. When users transfer, their job responsibilities often shift. They usually receive the ability to perform their new job, but rarely are their old capabilities removed—especially when they have to train their replacement and need to retain their capabilities even though they've moved to their new position. To safeguard security in all these cases, a communication process should be put in place between HR and IT, and a regular review of all users on the system, as well as their capabilities, should be performed at least once a year. I've never seen a review of user capabilities that didn't find users with capabilities that weren't appropriate for the current job position.

Getting Started with Your Policy

Here are some pointers to remember if you're just starting to write your organization's policy:

- *Keep it high-level and generic.* That is, don't describe specific settings. Rather, describe the requirement so that it can apply to all operating systems, applications, and so on.
- *Don't add a section of a policy that you aren't doing.* Just because a concept or a particular action would be a good thing to do, if your organization does not currently have it implemented or isn't in the middle of the implementation, don't add it to the policy. Auditors will audit you against your written policy, and audits will go significantly worse when sections have not been implemented than if you have them on a list somewhere to add in the future.
- *Keep it current.* An out-of-date policy is almost as worthless as having no policy. Review policies at least annually and more often if you're involved in a major technology shift or organizational change such as a merger.

- *Don't try writing a policy from scratch.* A number of resources on the Web can at least give you a starting point. For example, SANS Institute (*www.sans.org*) provides free samples of policy topics that you can download and alter to meet your business requirements.

Legal Review

A final word: Because your security policy and, to a certain extent, the business processes that affect security are documents that need to be enforceable and hold up in a court of law, it's imperative that you have your organization's legal counsel review your security policy.

CHAPTER 3

Security at the System Level

A successful security plan considers all available security methods and tools, combining and tailoring them to implement the requirements of a specific security policy. One of the toolsets you'll want to implement are the system's global settings, or *system values*. This chapter focuses on the security-relevant system values, discussing recommended settings and the tradeoffs you may need to consider with some of the settings.

The System Security Level

I like to say that the system's security level sets the tone for security across the entire system. It is the setting that controls whether you have operating system and data integrity or permit everyone to have access to every object on the system. Security levels now range from level 20, which provides only password security, to level 50, which, in addition to password and resource security, provides system integrity security (the ability to prevent users and applications from executing restricted machine-level instructions) as well as specific security features that comply with the Common Criteria security specifications. (The Common Criteria for Information Technology Security Evaluation is an international standard for computer security certification.) Understanding the security

levels and choosing the correct level for your circumstances is the first step in securing your system.

System Value QSECURITY

To control the system security level, you use system value QSECURITY (System Security Level). The possible QSECURITY values of 20, 30, 40, and 50 correspond to the four available security levels. In early OS/400 releases, there existed a security level 10, which provided no password or resource security. IBM removed support for this level in V4R3.

IBM ships all new systems running IBM i or i5/OS with a QSECURITY value of 40. In early releases of the operating system, the shipped default setting was level 10. You can view your system's current QSECURITY value by running the DSPSECA (Display Security Attributes) CL command. This command displays the current and pending values for QSECURITY. If you change QSECURITY, you must perform an Initial Program Load (IPL) of your system to have the new value take effect. The pending value displayed by the DSPSECA command is the value that QSECURITY will have after the next system IPL.

You can also use the DSPSYSVAL (Display System Value) command to display a QSECURITY value. The value reported by this command is equivalent to the DSPSECA command's pending value. DSPSYSVAL doesn't reveal whether the post-IPL value of QSECURITY will differ from the current one.

You can change the security level by running the CHGSYSVAL (Change System Value) command. For example, to change the QSECURITY value to 40, you would enter

```
CHGSYSVAL  SYSVAL(QSECURITY) VALUE('40')
```

Security Level 20

Security level 20 provides "password security." To access the system at level 20, a user must have a user profile and a valid password, but that's all the security this level provides. By default, all users on a system using security level 20 are created with *ALLOBJ special authority (the equivalent of having root authority in UNIX or Administrator rights in Microsoft Windows).

Unfortunately, there are still systems running at security level 20. These systems have significant exposures, and those responsible for them should put a project in place immediately to move to level 40. The challenge in such a project is planning how users

are going to obtain enough authority to access their application's objects. When the system is changed from QSECURITY level 20 to a higher level, during the next IPL *ALLOBJ is removed from all users that are not in the *SECOFR user class. (Chapter 16 provides details about implementing object-level security.)

Table 3.1 lists the default special authorities for each user class at security level 20.

Table 3.1: Special authorities for security level 20

User Class	Special Authorities
*SECOFR (security officer)	*ALLOBJ, *SECADM, *SAVSYS, *JOBCTL, *SERVICE, *SPLCTL, *AUDIT, *IOSYSCFG
*SECADM (security administrator)	*ALLOBJ, *SECADM, *SAVSYS
*PGMR (programmer)	*ALLOBJ, *SAVSYS
*SYSOPR (system operator)	*ALLOBJ, *SAVSYS, *JOBCTL
*USER (user)	*ALLOBJ, *SAVSYS

Technical Note

Resource security (i.e., the system requirement that users have authority to an object to access it) is active at all security levels. In other words, the same authority algorithm to check a user's access to an object is in effect regardless of the security level; however, by default, when a user profile is created at security level 20, it is created with *ALLOBJ special authority. *ALLOBJ grants all users access to every object on the system. At levels 30, 40, and 50, users are not automatically created with *ALLOBJ. So, to access an object, users must obtain authority from another source, such as a private authority, *PUBLIC, or adopted authority.

Security Level 30

By default, security level 30 provides resource security (users don't receive *ALLOBJ authority by default), permitting objects to be accessed only by users who have authority to the objects. Table 3.2 lists the default special authorities for all user classes at level 30. These special authorities are also the defaults at levels 40 and 50.

Table 3.2: Special authorities for security levels 30, 40, and 50	
User Class	**Special Authorities**
*SECOFR	*ALLOBJ, *SECADM, *SAVSYS, *JOBCTL, *SERVICE, *SPLCTL, *AUDIT, *IOSYSCFG
*SECADM	*SECADM
*PGMR	No special authorities
*SYSOPR	*SAVSYS, *JOBCTL
*USER	No special authorities

Notice that *ALLOBJ special authority isn't a default for any user class except *SECOFR, the security officer class. Under level 30, user profiles don't automatically have the authority to create, change, or delete objects on the system. The authority to work with, create, change, or delete objects must be granted either specifically or because it's the default public authority.

Moving from level 20 to the more secure level 30 requires careful thought and planning, as I alluded to earlier. When you move from level 20 to level 30, IBM i removes any special authorities users have that level 30 doesn't allow by default. For planning purposes, compare Table 3.2 with Table 3.1. You can see that levels 30, 40, and 50 grant each user class different default special authorities than level 20 does. So, in addition to planning your object-level security implementation, you need to be aware of the special authorities that are removed when moving off level 20 to ensure your users will be able to continue to perform their required job functions.

Although you might be tempted to think it's sufficient to let systems remain at security level 30, you cannot ensure data integrity or the completeness of the system's audit journal, or be assured users aren't masquerading as other users, if the system remains at level 30. If you get nothing else out of this book, understand that to effectively safeguard data, programs, and other production objects and to prevent unintentional data loss or modification, all systems must be running at security level 40 or above.

Security Recommendation

Run all your systems at least at security level 40.

Security Level 40

To level 30's resource security, level 40 adds operating system integrity. You saw the default special authorities for level 40 in Table 3.2. System integrity strengthens level 30 security in at least five ways:

- By checking program states and object domains
- By preventing use of restricted machine interface (MI) instructions
- By ensuring users have authority to start jobs under a different profile from their own
- By preventing restoration of invalid or modified programs (this happens at all security levels beginning in V6R1)
- By validating parameters passed to system interfaces

State and Domain Restrictions

Regardless of security level, IBM i classifies all objects (e.g., programs, files, commands) into one of two *domains*: system or user. All programs and service programs also have a *state* assignment—again, either system or user. The concepts of object domain and program state work with level 40 to close the integrity issue that exists at level 30. Under level 40, system-state programs can reference (i.e., directly manipulate through pointers) all objects regardless of their domain, and user-state programs can reference only user-domain objects.

At levels 20 and 30, the system tests programs against these rules when the programs are run. If a program violates the rules, the system simply logs the violation in the audit journal (see Chapter 15 for a discussion of the audit journal). But at level 40, the system won't run a program that violates these rules.

Object domain and program state also prevent users from abusing operating system objects by accessing them directly. Most IBM i objects are in the system domain, and most programs and service programs, other than application programming interfaces (APIs), are in the system domain and have the system state. At security levels 40 and 50, operating system objects can't be accessed directly. Why is this important? Some interfaces that are shipped with the operating system can provide authorized pointers, change jobs to run under QSYS or QSECOFR (the security officer profile—the equivalent of root on UNIX/Linux or Windows Admin), modify internal operating system control objects, or let users who run jobs access objects to which they don't have authority. These are legitimate interfaces that IBM i requires in order to run properly. At security levels 40

and 50, these interfaces can't be abused. Security levels 20 and 30 permit these interfaces to be used to harm your system.

Use of Restricted MI Instructions

At security level 40, the system restricts access to certain MI instructions, including those that create system-domain objects, manage processes or events, and access the database. At all security levels, the system detects all attempts to create a program that uses restricted MI instructions and prohibits the program from being compiled. At levels 40 and 50, an attempt to run an existing program that uses restricted instructions causes the program to fail; at all other security levels, the attempt simply causes an entry to be logged in the audit journal.

Job Initiation Validation

At security levels 40 and 50, an attempt to submit a job fails if the user submitting the job lacks authority to the user profile specified in the job description. At all other security levels, the system logs the attempt in the audit journal but lets the profile submit the job.

One attribute of a job description is the USER (User profile) attribute. You can specify this attribute's value by changing the USER parameter on the CRTJOBD (Create Job Description) or CHGJOBD (Change Job Description) command. The possible values are:

- *RQD—The job using the job description must specify a user profile.
- user_profile_name—You can specify a user profile to be associated with the job description. A job can then use this user profile for execution.

Technical Note

Security levels 20 and 30 don't require a user who submits a job to have authority to the job description's default user profile. This means users can use a job description that names a powerful profile and gain authority and capabilities they weren't intended to have.

This vulnerability is quite easy to exploit and underscores the reason it's so important to get all systems running at level 40 or higher.

Restoration of Modified Programs

Whenever a program is created, the system calculates a validation value. This validation value enables the system to determine whether a program being restored is identical to the original. If the program validation fails (e.g., because the program has been modified), the system tries to retranslate the program.

If the retranslation succeeds, the system logs the validation failure and restores the program. If the retranslation is unsuccessful, the system restores the program and logs an entry to the audit journal, regardless of the system's security level. However, when the system is at security level 40 or higher and the ALWOBJDIF (Allow object differences) attribute is specified as *NONE on the RSTOBJ (Restore Object) command, the system changes the program's owner to QDFTOWN (the IBM-supplied default owner) and sets public authority to *EXCLUDE. If the restore command specifies ALWOBJDIF(*ALL), the system restores the program and logs an audit entry but lets the owner and public authorities stay the same.

Security level 40 is your primary defense against Trojan horses. A *Trojan horse* is a program disguised as a legitimate IBM i program, such as QSYS/QSTRUP, the default system startup program that your system runs each time you IPL. Someone with harmful intent could patch a program on another system, name it QSYS/QSTRUP, and save it. If this person had access to a workstation at which another user was signed on with *SAVSYS authority, and if your system were not at level 40 or 50, the hacker could restore the revised version of QSTRUP to your machine. The next time you IPLed, your system would run the Trojan horse QSTRUP program.

Technical Note

System-state programs must have a valid IBM digital signature. If they don't, they cannot be restored (as of V6R1).

Parameter-Passing Validation

At level 40, each time a user application calls an IBM i program that runs in system state (e.g., an API, an application that performs any I/O), the operating system checks every parameter passed between the programs. Both the storage domain and the actual values passed are checked to ensure neither will cause IBM i to perform an operation that compromises system integrity.

Why Use Security Level 40?

Simply put, if you want operating system and data integrity, the system must be running at security level 40 or higher. I cannot emphasize enough how important this is!

Security Level 50

Security level 50 adds additional system integrity features as well as the functions and checks necessary to meet the Common Criteria evaluation requirements. For the level 50 default special authorities, see Table 3.2.

When you use level 50, the system

- Imposes certain message restrictions and removes pointers from messages
- Prevents control-block modification
- Maintains the QTEMP library

Message Restrictions and Pointer Removal

As I explained earlier in the chapter, every IBM i object belongs to either the system domain (*SYSTEM) or the user domain (*USER). Most IBM-supplied objects are in the system domain. All user-created objects and some IBM-supplied objects are in the user domain. In addition, every IBM i program is either a system-state (*SYSTEM) program or a user-state (*USER) program. Most IBM-supplied programs are system-state programs, and all user-created programs are user-state programs. User-state programs can access only user-domain objects, but system-state programs can access both user- and system-domain objects.

The rules of object domains and program states mean that you can access system-domain objects only by using the appropriate command or API. Level 50 imposes the following message restrictions:

- Any system-state program can send a message of any type to any user- or system-state program.
- Any user-state program can send a message of any type to any other user-state program.
- A user-state program can send a non-exception message to any system-state program.

- A user-state program can send an exception-type message to a system-state program only if the system-state program is a request program (e.g., QCMD) or if the system-state program called the user-state program.

In addition, at level 50 IBM i removes the pointers from replacement text in messages sent to a user application from another job. Removing pointers prevents the receiving job from using the pointers to compromise security and bypass system auditing.

Prevention of Control-Block Modification

At level 50, no internal control blocks can be modified. A *control block* is an internal structure available to the operating system. IBM i relies on control blocks to remain unmodified. However, some third-party vendors change internal control blocks so that their code runs instead of IBM i code. Such changes often cause unpredictable results when the system runs, and they frequently require a lengthy debugging process to locate and fix the problem. Although level 40 prevents modification of some control blocks, level 50 covers all control blocks, including the open data path (ODP), the spaces for CL commands and programs, and the System/36E job control blocks. This feature may cause some third-party utilities to cease functioning, so you should check with your application and utility vendors before moving to security level 50.

QTEMP Library Maintenance

On the surface, objects in library QTEMP appear to be temporary. The external view of the QTEMP implementation is that a unique QTEMP library exists for every job on the system, that you can access objects in QTEMP only from within its associated job, and that when a job ends normally, the job's QTEMP library as well as all the objects in it are deleted.

The facts of QTEMP implementation, however, are somewhat different. If your system doesn't run at security level 50, every QTEMP library is actually a permanent object on the system. When a job begins, IBM i creates a QTEMP library for the job and assigns an address for the library and each object in it in the operating system's permanent root address system. If a job or the system ends abnormally, IBM i uses these addresses on the next IPL to locate all stranded QTEMP libraries and objects and clear them from the system. So, internally, QTEMP and the objects in it are permanent.

Level 50 prevents hackers from using IBM i's internal permanent address system to access QTEMP library objects. At level 50, the operating system no longer stores those

addresses. Instead, the system actually does treat every QTEMP library and its objects as temporary.

That sounds fine, of course, but as a result, if a job or the system ends abnormally, IBM i can't automatically locate and delete the "lost" QTEMP library and its objects when you IPL. Therefore, when you implement level 50, you need to run the RCLSTG (Reclaim Storage) command more frequently to recover objects that get "lost" and then specifically delete them.

Why Use Security Level 50?

Organizations that require the highest level of security and integrity should run at level 50. Level 50 provides the best defense against exploitation of internal interfaces and the introduction of Trojan horses and viruses.

Moving to Security Level 40 or 50

Before moving to security level 40 or 50 from level 30, you'll first want to determine whether any applications will fail at the higher security level. Run auditing long enough to assure yourself that most of your applications have been run—for example, over month end or, perhaps, quarter end. You're looking for two types of violations: applications doing something they shouldn't and the use of job descriptions that name a user profile to which the user doesn't have authority. The following steps tell you what to look for and how. For details about auditing and the audit journal, see Chapter 15.

Step 1. Add the *PGMFAIL value to the QAUDLVL (Auditing Level) system value (discussed in more detail later). This setting lets you start gathering information to determine whether any applications need to change. It's unlikely they do, but you'll want to audit to make sure. Otherwise, if an application is doing something it shouldn't, it will fail at level 40 or 50, and you'll have to restore the system value to its previous setting and re-IPL to allow the application to run.

Step 2. Add the *AUTFAIL value to system value QAUDLVL. This setting lets you gather entries for users who use a job description that names a user profile. An audit entry is generated if a user lacks *USE authority to the user profile named in the job description.

Step 3. When you've audited over (at least) month's end, query the audit journal. Both the *PGMFAIL and the *AUTFAIL parameters produce audit entries of type AF. The first letter of an audit entry's specific data determines which type of AF entry it is. Look for the following entries:

- B—Restricted (blocked) instruction violation (not sent starting with V6R1)
- C—Object validation failure
- D—Unsupported interface (domain) violation
- J—Job description and user profile authorization failure (using a job description that names a user profile)
- R—Attempt to access a protected area of disk (enhanced hardware storage protection)
- S—Default sign-on attempt

The type of the entry will determine what action you need to take to ensure a successful move to security level 40 or 50. For example, if you see an entry that begins with D, you'll know that the program is trying to use an unsupported interface (e.g., trying to directly call a command processing program or other operating system program). You'll need to replace the MI instruction or the direct call of the operating system program with either a command or an API call. All J entries indicate the use of a job description that names a user profile to which the user of the job description lacks *USE authority. Note that the entry will name the user profile, not the job description. You'll have to look through your job descriptions that name user profiles to determine which job description needs to be changed. It's my experience that failures usually occur with job descriptions that you've created (versus those supplied by a vendor).

There are several ways to query the audit journal to determine whether your system has logged any of the previously listed entries. Chapter 15 discusses these methods.

Note that sometimes you'll get audit journal entries that indicate third-party application failures. If you encounter this type of entry, contact the vendor. It's likely that the application takes one code path at security levels 20 and 30 and takes another, which does not cause violations, at security level 40 and 50. It is rare today that a third-party application doesn't run at security level 40 or 50. These days, if there are any audit journal entries, they are often the result of an organization's "home-grown" utility or application calling an operating system program directly rather than using a command or an API. A simple change to call an API or command is usually the only program modification required to clear up the issue.

However, the issue I see most often is the use of a job description that specifies a profile. Many times, the profile can simply be removed from the job description. If the

job needs to run as the profile named in the job description, you can authorize the user(s) submitting the job to that one user profile until you can find another solution. You should not let that error delay moving your system to security level 40 or above.

Security-Related System Values

Once you've determined the security level at which you want to run your system, you can use the other security-related system values to enforce other security policy requirements. These system values fall into three categories: general security system values, system values related specifically to password creation and maintenance, and system values that control auditing. Let's take a look.

General Security System Values

The general security-related system values provide a variety of global settings for security functions. For example, by changing a single system value, you can limit the number of successive incorrect sign-on attempts allowed at a workstation or the number of concurrent sessions a user can be signed on to.

Table 3.3 summarizes the general security system values.

Table 3.3: General security system values

System Value	Description
QALWOBJRST	Determines whether security-sensitive objects (i.e., system-state objects, programs that adopt authority) can be restored to the system
QALWUSRDMN	Specifies in which libraries you can place *USRSPC (user space), *USRIDX (user index), and *USRQ (user queue) objects
QAUTOCFG	Determines whether new local controllers and devices are configured manually or the system configures them
QAUTOVRT	Determines whether virtual device descriptions are created automatically
QCRTAUT	Specifies the default public authority for newly created objects
QDSCJOBITV	Indicates the length of time (in minutes) that an interactive job can be disconnected before the system ends the job
QDSPSGNINF	Specifies whether the sign-on information display appears when a user signs on
QFRCCVNRST	Determines whether programs will be retranslated when restored
QINACTITV	Determines the interval (in minutes) that a workstation can remain inactive before the system sends a message to a message queue or terminates the job
QINACTMSGQ	Specifies the name of the message queue that receives messages about the workstation when the inactive time interval is reached, or specifies that the job at the workstation is to be terminated or disconnected when the interval is reached
QLMTDEVSSN	Determines whether users can have more than one device session concurrently

Table 3.3: General security system values (continued)	
System Value	**Description**
QLMTSECOFR	Determines whether users with *ALLOBJ (all object) or *SERVICE (service) special authority can sign on to devices without explicit authority
QMAXSGNACN	Specifies the action taken when a user reaches the maximum number of invalid sign-on attempts
QMAXSIGN	Sets the maximum number of sign-on attempts allowed at a workstation
QRETSRVRSEC	Determines whether decryptable passwords are stored on the system
QRMTSIGN	Specifies whether automatic sign-on from a remote system is allowed
QSCANFS	Determines whether file system scanning takes place
QSCANFSCTL	Provides fine-grained control over the details of file system scans
QSECURITY	Sets the system security level
QSSLCSL	Specifies the cipher algorithms that can be used for Secure Sockets Layer (SSL) connections (V6R1)
QSSLCSLCTL	Specifies whether the operating system controls the list of SSL cipher specifications or a user-defined list is used (V6R1)
QSSLPCL	Specifies the supported protocols available for SSL connections (V6R1)
QUSEADPAUT	Defines which users can create programs that use adopted authority (i.e., set the USEADPAUT(*YES) program attribute)
QVFYOBJRST	Defines the level of object signature verification performed when an object is restored

You've already learned about the QSECURITY system value. Let's look at the details of the other security-relevant system values, including their recommended settings. For more information about any of the security-related system values, visit the IBM i Information Center (*https://www.ibm.com/support/knowledgecenter/api/content/nl/en-us/ssw_ibm_i_73/rzarl/sc415302.pdf*); look under **Security** > **Security reference** > **Security system values**.

QALWOBJRST—Allow Restoration of Security-Sensitive Objects			
System Value	**Description**	**Possible Values**	**Default**
QALWOBJRST	Determines whether security-sensitive objects (i.e., system-state objects, programs that adopt authority) can be restored to the system	*ALL *NONE *ALWSYSST *ALWPGMADP *ALWPTF *ALWSETUID *ALWSETGID *ALWVLDERR	*ALL

System value QALWOBJRST lets you control whether anyone can restore to your system system-state objects or programs that adopt authority. The default value of *ALL lets a user with the appropriate authority restore any object. You can specify *NONE to prevent anyone from restoring security-sensitive objects. Value *ALWSYSST lets anyone restore system-state objects, and *ALWPGMADP lets anyone restore programs that adopt authority. (In V6R1, system-state objects must be digitally signed by IBM, or else they cannot be restored regardless of the QALWOBJRST setting.)

Value *ALWPTF lets you restore system-state programs and programs that adopt authority when you load PTFs. This option makes system value QALWOBJRST more usable because you don't have to change the system value every time you load PTFs.

The *ALWSETUID and *ALWSETGID values pertain to few organizations. *ALWSETUID enables restoration of UNIX programs that have the S_ISUID attribute and run in the IBM i Portable Application Solutions Environment (PASE). *ALWSETGID lets UNIX programs that have the S_ISGID attribute and run in the PASE be restored.

The *ALWVLDERR value permits objects to be restored even if they have validation errors. The addition of this value accommodates the capability of the QFRCCVNRST system value (covered later) to reconvert programs if errors are discovered. Because the errors are corrected when you use QFRCCVNRST in this way, the object should be allowed to be restored.

Security Recommendation

For maximum control over what is being restored to your system, set system value QALWOBJRST to *NONE. In all likelihood, however, this setting will be too restrictive for most organizations. If that is the case, consider using value *ALWPTF so you won't have to change QALWOBJRST every time you load PTFs. If you restore frequently or your change management software promotes programs that adopt authority, set QALWOBJRST to *ALWPGMADP.

QALWUSRDMN—Allow User Domain Objects in These Libraries			
System Value	**Description**	**Possible Values**	**Default**
QALWUSRDMN	Specifies in which libraries you can place *USRSPC, *USRIDX, and *USRQ objects	*ALL *DIR *library_names*	*ALL

System value QALWUSRDMN specifies the names of the libraries that can contain *USRSPC (user space), *USRIDX (user index), and *USRQ (user queue) objects. The default value of *ALL permits these objects to exist in all libraries and is generally acceptable for any system that doesn't need to comply with Common Criteria security specifications. The value *DIR allows user-domain objects in all directories on the system.

You can also name specific libraries into which you want to be able to put *USRSPC, *USRIDX, and *USRQ objects. System administrators who want to be able to easily track these objects might want to specify libraries.

If you need to comply with the Common Criteria requirements, you must use security level 50 and specify the library name QTEMP for system value QALWUSRDMN. (See the next Technical Note, which explains why you must also include library QRCL.) The system can't audit information that moves to and from *USRSPC, *USRIDX, and *USRQ objects. At level 50, library QTEMP is a temporary object, preventing the passing of confidential data between users.

Some people think this system value takes effect at security level 50, but it actually is active at all security levels.

Technical Note

If you specify anything other than *ALL for QALWUSRDMN, you should include library QRCL in the list of libraries. When you run the RCLSTG command, the system might need to move *USRSPC, *USRIDX, or *USRQ objects into this library.

Security Recommendation

Unless you must comply with the Common Criteria level of security, specify *ALL for system value QALWUSRDMN.

QAUTOCFG—Automatic Device Configuration			
System Value	**Description**	**Possible Values**	**Default**
QAUTOCFG	Specifies whether locally attached devices are configured automatically	0 (off) 1 (on)	0 (off)

System value QAUTOCFG determines whether you manually configure new local controllers and devices or let the system configure them for you. QAUTOCFG doesn't affect the creation of virtual devices and thus is becoming less pertinent as virtual devices become more common.

Security Recommendation

Set system value QAUTOCFG to 1 (on) when you install the system and when adding many new devices. Otherwise, leave it at 0 (off), the default.

QAUTOVRT—Automatic Configuration of Virtual Devices			
System Value	**Description**	**Possible Values**	**Default**
QAUTOVRT	Determines whether virtual device descriptions are created automatically	0 (off) 1–32500 *NOMAX *REGFAC	0 (off)

System value QAUTOVRT determines whether incoming Display Station Passthrough (DSPT) and Telnet session requests create virtual devices automatically as needed. A value of 0 tells the system that you'll create the virtual devices to be used and the system shouldn't create them automatically. A numerical value in the range 1–32500 indicates the maximum number of temporary devices that the system can configure automatically. The value *NOMAX specifies that no limit is imposed on the number of automatically created device descriptions. The value *REGFAC specifies that the program registered for the Virtual Device Selection exit point (QIBM_QPA_DEVSEL) is called when a virtual device description is selected or automatically created by the system. If an exit program is not registered or not found, the system behaves as if the system value is set to 0.

Security Recommendation

Set QAUTOVRT to 0 or a number (but not *NOMAX), so you can explicitly control the number and use of virtual devices on your system.

QCRTAUT—Create Authority			
System Value	**Description**	**Possible Values**	**Default**
QCRTAUT	Specifies the default public authority for newly created objects	*ALL *CHANGE *USE *EXCLUDE	*CHANGE

The CRTAUT (Create authority) parameter is available on both the CRTLIB (Create Library) command and the CHGLIB (Change Library) command. This parameter defines the default public authority for all objects created in the library and permits the following values:

- *SYSVAL—The value specified in system value QCRTAUT is used.
- *ALL—The default public authority is *ALL.
- *CHANGE—The default public authority is *CHANGE.
- *USE—The default public authority is *USE.
- *EXCLUDE—The default public authority is *EXCLUDE.
- authorization_list_name—The default public authority is *AUTL, using the specified authorization list (Chapter 6 covers authorization lists).

Parameter CRTAUT's default value is *SYSVAL, which references the QCRTAUT system value. Thus, when you create a library and specify no other value for the CRTAUT parameter, the public authority for new objects created in that library defaults to the authority specified in system value QCRTAUT. When you create objects in the library, the AUT (Public authority) parameter on the create (CRT*xxx*) command defaults to the value *LIBCRTAUT, which instructs the system to refer to the library's CRTAUT parameter to determine the default public authority for the new object.

Security Recommendation

You have two choices for changing the default public authority for objects created in a library. One approach is to change system value QCRTAUT from the default *CHANGE to either *USE or *EXCLUDE. The second approach is to leave QCRTAUT with its default value of *CHANGE and control the public authority at the library level. In other words, change the CRTAUT parameter for user libraries to either *USE or *EXCLUDE, depending on each library's contents.

I often find that I use a combination of these two approaches; that is, I often change QCRTAUT to *USE and then may have to modify the create authority setting of some libraries if the objects being created into those libraries need to be something other than *USE. For example, I often set the create authority of the libraries in which queries and their files are being created to *ALL and authorize only the handful of users running the queries to the library itself. I may also set the create authority setting of vendor libraries to *CHANGE when I'm not sure whether objects are being created into the library or just being read out of them. Setting the QCRTAUT system value to *ALL is never appropriate!

QDSPSGNINF—Display User Sign-on Information			
System Value	**Description**	**Possible Values**	**Default**
QDSPSGNINF	Specifies whether the sign-on information display appears when a user signs on	0 (off) 1 (on)	0 (off)

System value QDSPSGNINF controls the display of user sign-on information. A value of 1 causes the system to display certain information to users when they sign on to the system—specifically, the last date and time when the profile signed on and the number of failed sign-on attempts due to an invalid password.

If you're using IBM i Access and require your users to sign in to IBM i Access before a 5250 emulation session is displayed, the last sign-on for which information is displayed will be the sign-on to IBM i Access. This information isn't at all helpful because that sign-on time is about two seconds before the current sign-on. But the real issue is this: Even when the information is helpful, unless you educate your end users to pay attention

to this data and tell them whom to call if the information looks suspicious, you might as well not bother turning on this system value. However, I believe it's very appropriate to turn on this attribute in powerful profiles. These profiles constitute a much smaller subset of users to educate, and these users are more likely to pay attention to the information than the general user community might be. If you take this approach, enable this setting in the profiles of these users, not via the system value.

Technical Note

QDSPSGNINF controls the display of sign-on information system-wide. To override this system value at the user profile level, change the DSPSGNINF (Display sign-on information) user profile parameter.

Security Recommendation

Set QDSPSGNINF to 0, and control sign-on information at the user profile level by modifying the DSPSGNINF parameter for individual user profiles.

QFRCCVNRST—Force Conversion on Restore of Object			
System Value	**Description**	**Possible Values**	**Default**
QFRCCVNRST	Determines which objects being restored should be converted before being restored	0–7	1

Understanding the behavior of system value QFRCCVNRST and what setting you should use requires you to know a bit about the internal makeup of an executable object on IBM i. When you compile a source program on IBM i, the system creates a "creation template." The trusted translator that resides below the machine interface translates the creation template and produces executable hardware instructions. The trusted translator is guaranteed to produce a program that does not circumvent the integrity of the system. Executables not produced by the trusted translator may circumvent system integrity. A

program that circumvents system integrity is a large security issue and in most cases should not be trusted by the administrator. As an administrator, you cannot afford to allow these types of programs on your system.

It's impossible to determine with 100 percent certainty whether a program was generated by the trusted translator or whether instructions were altered after the program was translated. Nor can it be proved whether an altered program bypasses system integrity. It is possible, however, to retranslate programs using the trusted translator. This process removes any alterations that may have existed. A retranslated program is 100 percent guaranteed not to bypass system integrity. Retranslating programs is a very good thing for security.

Before V5R1, when observability was removed from a program, the source and the creation templates were removed. Since V5R1, removing observability removes only the source code. Anything compiled at V5R1 or later is therefore retranslatable unless someone has taken specific steps to manually remove the creation template. Any program compiled at V5R1 or later that can't be retranslated should be extremely suspect!

You use system value QFRCCVNRST to tell the system which objects it should try to retranslate, or convert. Valid values range from 0 (do not attempt to convert anything) to 7 (try to convert every executable). For all values, any object that meets the criteria for conversion but cannot successfully be converted will not be restored.

Value 0, as noted, instructs the system not to convert any objects.

Value 1, the default, indicates that only objects with validation errors should be converted. Validation errors are found in executable objects. They signal that the executable itself has been modified in an unsupported way; in other words, it has been manually patched, but the person who patched the program didn't successfully cover his or her tracks. These programs are capable of bypassing system integrity and could contain viruses. Although a patched program may be benign, it is nearly impossible to prove that it is. You most likely do not want programs with validation errors on your system.

Value 2, like value 1, causes objects with validation errors to be converted. In addition, it tells the system to convert any objects that require retranslating to be used on the current version of the operating system.

Value 3 is the same as 2 but adds the precaution of converting objects suspected of having been tampered with. These objects have been patched with Display/Alter/Dump but don't appear to have validation errors. This might mean something was changed and then changed back, or it could mean the person who patched the program was able to do so in such a way that the validation process couldn't detect an error. In general, no

program should ever be patched; rather than patching the executable directly, you should change and recompile the source. In effect, a QFRCCVNRST value of 3 says, "Try to convert any object that appears to have been patched."

The remaining values for QFRCCVNRST cause the system to try to retranslate any program that would be retranslated under value 3 as well as some executables that appear to be unaltered.

Value 4 instructs the system to convert objects that have creation templates and are not digitally signed. Unsigned objects that don't have creation templates will be restored.

Value 5 causes the system to try to convert any object that has a creation template, regardless of whether the object is signed or unsigned. The system will not try to convert objects compiled before V5R1 that do not have creation templates (i.e., have had observability removed). It makes the decision to convert regardless of whether the object is signed or unsigned.

Value 6 tells the system to try to convert all objects that lack a valid digital signature.

Value 7 causes the system to try to convert all objects being restored.

Security Recommendation

Set system value QFRCCVNRST to 3 to require the conversion of objects that have been patched or altered.

System Value	Description	Possible Values	Default
QINACTITV—Inactivity Time-out Interval			
QINACTITV	Determines the interval (in minutes) that a workstation can be inactive before the system sends a message to a message queue or ends the job	*NONE 5–300	*NONE
QINACTMSGQ—Inactivity Message Queue			
QINACTMSGQ	Specifies either the action to be taken when the inactivity time-out interval is reached or the name of the message queue that will receive messages about the workstation	*ENDJOB *DSCJOB *message_queue_name*	*DSCJOB
QDSCJOBITV—Disconnect Job Interval			
QDSCJOBITV	Specifies the interval (in minutes) that a job can be disconnected before the system ends the job	*NONE 5–1440	240

The next three system values work together to manage inactive workstations. System value QINACTITV determines the length of time, in minutes, that a workstation is allowed to remain inactive before the system ends the job, disconnects the job, or sends a message to the message queue specified in system value QINACTMSGQ. If QINACTMSGQ is set to *DSCJOB, the system will disconnect, rather than end, a job that times out. The job will remain disconnected for the length of time specified in system value QDSCJOBITV, and then it will end (the system will cancel the job, close all files and programs, and automatically roll back all uncommitted transactions running under commitment control). Users who sign back on to a disconnected job are simply reconnected to the job and can continue processing.

It's important to realize that the term "inactive" refers not to the job itself but to the workstation. Has the user pressed the Enter key? The System request key? Page up or Page down? In other words, a workstation is considered inactive when no user interaction occurs for the specified time. If the workstation job is waiting for a user response, the workstation is inactive.

The QINACTITV system value also monitors the activity of IBM i Access emulation sessions. These sessions might appear inactive if the user isn't directly interacting with the IBM i session, such as when a user is editing a document or spreadsheet using Microsoft Word or Excel.

Another important point to note is that the QINACTITV value applies to all sessions on the system. That is, you can't have one user group—say, tellers—with a time-out value of 5 minutes and another—say loan officers—with a time-out value of 30 minutes. "One size fits all" for this system value. If you want the time to be variable, you'll need to write your own device time-out utility or buy one.

Finally, unless you're using named devices, devices will never be disconnected; after the time-out period, they'll be ended.

Before you change the QINACTITV system value, consider whether your applications can handle having files closed in the middle of a transaction. For applications that have used commitment control, this shouldn't be an issue. Without commitment control, however, data integrity errors may be encountered when a session is closed with transactions partially completed.

For compliance with the Payment Card Industry Data Security Standard (PCI DSS), inactive sessions must be timed out after 15 minutes of inactivity. If you can't implement a time-out function on IBM i, you may be able to achieve compliance by timing out the

entire workstation—not just the IBM i session. This is usually most easily accomplished by setting a group policy and applying it to the computers (PCs) in your network.

Security Recommendation

If possible, set system value QINACTITV to 15, and set system value QINACTMSGQ to *DSCJOB (the default). Be sure to set system value QDSCJOBITV to a reasonable number, such as 30. With QDSCJOBITV set to 30, if the user doesn't sign on again before the job has been disconnected for 30 minutes, the job will end. In addition (or if the IBM i function is too restrictive), consider adding a group policy to time out devices throughout your network.

QLMTDEVSSN—Limit Device Sessions			
System Value	**Description**	**Possible Values**	**Default**
QLMTDEVSSN	Lets you specify whether a user can have concurrent device sessions	0 (off) 1 (on) 2–9 (beginning in V6R1)	0 (off)

System value QLMTDEVSSN determines whether a user profile can be signed on to more than one workstation at once. A value of 0 lets a user profile be signed on to an unlimited number of device sessions simultaneously. A value of 1 permits a user to be signed on to only one workstation at a time. From a security perspective, this restriction is a good thing because it greatly reduces the ability for users to share their user IDs and passwords.

However, there are times when users may need more than one session to effectively do their jobs. Operators, for example, often use one session to monitor system activity and another to perform work from an operator's menu. Application developers often need two sessions, especially when testing or debugging their code.

Technical Note

QLMTDEVSSN controls concurrent device sessions system-wide, but you can override this system value at the user profile level by changing the user profile parameter LMTDEVSSN (Limit device sessions).

Security Recommendation

Use a value of 1 for QLMTDEVSSN to discourage users from sharing user profiles. Before you do, however, plan for which users require multiple sessions, and update their profiles.

New in V6R1

V6R1 offers the ability to set the number of workstations a user can be signed on to simultaneously. In addition to one device or an unlimited number, you can now specify that users can sign on from two to nine devices at a time. As in previous releases, you can override this setting in the user profile.

QLMTSECOFR—Limit Security Officer Access to Workstations			
System Value	**Description**	**Possible Values**	**Default**
QLMTSECOFR	Limits users with *ALLOBJ or *SERVICE special authority to authorized devices	0 (off) 1 (on)	1 (on)

System value QLMTSECOFR determines which workstations can be accessed by user profiles that have *ALLOBJ or *SERVICE special authority, such as QSECOFR and QSRV. If you set the value at 0, users with *ALLOBJ or *SERVICE special authority can use any workstation attached to the system. When the value is 1, these users are limited to

accessing workstations to which they are specifically authorized (by virtue of being granted authority or through ownership).

Quite honestly, system value QLMTSECOFR has lost its usefulness with the advent of TCP/IP and the use of virtual devices. Unless you implement "named devices" by using a Telnet exit program, this system value is totally ineffective. Because you don't know which virtual device you'll be getting when establishing a Telnet session, you would have to grant QSECOFR authority to all virtual devices to ensure you could sign on with an *ALLOBJ profile. The purpose of this system value is to limit where a powerful profile can sign on. But if you have to authorize all devices, the purpose is defeated.

If you're using named devices, you can choose which device is allocated to a particular user and therefore authorize specific users to specific devices. In this case, the QLMTSECOFR system value can be effective.

Security Recommendation

If you're using named devices, set QLMTSECOFR to 1 to limit access to specific devices. Regardless of which value you assign to QLMTSECOFR, the QSECOFR user profile can always sign on at the system console. If you're not using named devices, set this system value to 0.

System Value	Description	Possible Values	Default
QMAXSIGN—Maximum Number of Sign-on Attempts			
QMAXSIGN	Determines the maximum number of sign-on attempts allowed for a workstation	*NOMAX Any number	3
QMAXSGNACN—Maximum Sign-on Action			
QMAXSGNACN	Specifies the action taken when a user reaches the maximum number of failed sign-on attempts	1 2 3	3

System value QMAXSIGN determines the number of invalid sign-on attempts the system allows before taking action to disable the device or user profile being used. Users cause invalid sign-on attempts by mistyping user IDs or by forgetting their password and entering the wrong one.

When you set a numeric value for QMAXSIGN, the system sends a message to the workstation when only one attempt remains. The message warns the user that the next incorrect sign-on will disable the device or user profile.

Setting QMAXSIGN to *NOMAX will cause your organization to be out of compliance with many laws and regulations. But worse, this setting constitutes a serious security exposure. *NOMAX means a hacker or disgruntled employee can make unlimited tries to guess a password. Obviously, you want to set QMAXSIGN to a number that lets users mistype their password a couple of times on Monday morning without having to get things reset. But you don't want to set the value to such a large number that it allows too many guesses at a profile's password.

System value QMAXSGNACN controls the action the system takes when a user reaches the maximum number of failed sign-on attempts specified in QMAXSIGN. QMAXSGNACN has three possible values:

- 1—Disable the display device.
- 2—Disable the user profile.
- 3—Disable both the display device and the user profile.

As you can see, this system value lets you disable the user profile of a user who exceeds the maximum allowed number of sign-on attempts. After a user profile is disabled, you can restore it to active state only by using the STATUS(*ENABLE) parameter on the CHGUSRPRF (Change User Profile) command.

Security Recommendation

Set QMAXSGNACN to either 2 or 3. Setting this system value to 3 (the default) when using virtual devices carries minimal security advantages. If your QAUTOVRT system value is set to *NOMAX, setting QMAXSGNACN to 1 or 3 can actually cause a denial-of-service attack in which a hacker or disgruntled employee disables all virtual devices so that no one can sign on (except at the console).

QRETSVRSEC—Retain Server Security			
System Value	**Description**	**Possible Values**	**Default**
QRETSVRSEC	Determines whether you allow decryptable passwords to be stored on the system	0 (off) 1 (on)	0 (off)

System value QRETSVRSEC was created to let you control whether IBM i stores decryptable passwords. But rest easy; this option doesn't mean IBM i user profile passwords are stored so that they can be decrypted. (These passwords are stored as a hash with no way for the system to decrypt the password.) System value QRETSVRSEC pertains to passwords that are typically used to sign on to other systems that require a password for authentication. In addition, this system value determines whether you can store decryptable passwords in validation lists. (I discuss validation lists in the next chapter.)

The default QRETSVRSEC value of 0 prevents decryptable passwords from being stored. A value of 1 permits decryptable values.

Technical Note

Changing QRETSVRSEC from 1 to 0 disables the stored passwords but does not remove them from the system. If you want to remove the passwords from the system, you'll have to run the CLRSVRSEC (Clear Server Security Data) command after setting QRETSVRSEC to 0.

Security Recommendation

Unfortunately, many system functions require system value QRETSVRSEC to be on (value 1)—that is, to allow decryptable passwords. Service Director and other IBM service functions won't work if you set QRETSVRSEC to 0. Therefore, most organizations will want to set this value to 1.

QRMTSIGN—Remote Sign-on Value			
System Value	**Description**	**Possible Values**	**Default**
QRMTSIGN	Determines whether automatic sign-on from a remote system is allowed	*FRCSIGNON *SAMEPRF *REJECT *VERIFY *program_name*	*FRCSIGNON

The STRPASTHR (Start Pass-Through) command lets a user enter a user profile, password, initial program, initial menu, and current library to bypass the target system's typical sign-on procedures. This capability lets you automate passthrough services. You can also configure your ACS 5250 session to bypass the sign-on screen. System value QRMTSIGN determines how your system handles these requests. The allowed values are:

- *FRCSIGNON (the default)—All passthrough and IBM ACS sessions are presented with a normal sign-on screen. (In other words, the sign-on screen is not bypassed.)
- *SAMEPRF—The session is permitted to bypass the normal sign-on screen but only when the user profile names on the source and target systems are identical.
- *REJECT—All passthrough requests are rejected, and ACS requests are presented with the sign-on screen.
- *VERIFY—Automatic passthrough requests to bypass the sign-on screen and IBM i Access requests must have a valid user profile and password.
- program_name—You can designate the name of a program to be run at the beginning and end of every passthrough session. The specified program controls and logs access for every passthrough request. You can qualify this value by library name.

Security Recommendation

If you don't use passthrough, give system value QRMTSIGN the value *REJECT; otherwise, use *VERIFY to require both a user profile and a password or *SAMEPRF to let IBM i Access bypass the sign-on screen. *SAMEPRF may be preferable to avoid having passwords sent over your network in the clear.

System Value	Description	Possible Values	Default
QSCANFS—Scan File Systems			
QSCANFS	Determines whether file system scanning takes place	*NONE *ROOTOPNUD	*ROOTOPNUD
QSCANFSCTL—Scan File Systems Control			
QSCANFSCTL	Provides fine-grained control of file system scans	*NONE *ERRFAIL *FSVRONLY *NOFAILCLO *NOWRTUPG *NOPOSTRST *USEOCOATR	*NONE

When combined with exit programs, the next two system values can help you prevent or detect PC viruses in objects stored in the integrated file system (IFS).

System value QSCANFS works in conjunction with the QIBM_QP0L_SCAN_OPEN (Scan on Open) and QIBM_QP0L_SCAN_CLOSE (Scan on Close) exit points. The QSCANFS setting tells the system whether objects in the IFS should be scanned when opened, closed, or both. The exit points indicate which programs should be called to perform the scanning. You can set QSCANFS to *NONE (no scanning) or to *ROOTOPNUD, which indicates that every stream file (*STMF) object in the root ('/'), QOpenSys, and user-defined file systems should be passed to the registered exit programs for scanning.

System value QSCANFSCTL provides fine-grained control over matters such as when scans will occur and what should happen when they are attempted. This system value has seven possible values, any or all of which you can specify (with the obvious exception of the default *NONE, which indicates that no controls are being specified).

Setting QSCANFSCTL to *NONE will be sufficient for many organizations. With value *ERRFAIL, if errors occur when the exit program is called (e.g., exit program not found), the system treats the object to be scanned as if it had been scanned and had failed the operation. If you don't specify this value, the system treats the object as if it had not been scanned.

Value *NOWRTUPG instructs the system not to upgrade to write access for the scan exit program, thus preventing the exit program from modifying or repairing the scanned object, if possible. If you don't specify this value, the system ensures that the scan exit program has write access to the object that is to be scanned.

For details about the other QSCANFSCTL values, see IBM's Information Center. For information about exit points QIBM_QP0L_SCAN_OPEN and QIBM_QP0L_SCAN_CLOSE, including all the conditions under which scans will occur, see the API reference information (**Programming** > **Application programming interfaces**) in the Information Center.

Security Recommendation

Leave QSCANFS at the default setting. You can also leave QSCANFSCTL at the default setting unless you have very high security requirements or have specific instructions from your vendor-supplied virus-scanning product to change this value.

QSECURITY—System Security Level			
System Value	**Description**	**Possible Values**	**Default**
QSECURITY	Determines the system security level	20 30 40 50	40

As you learned early in the chapter, system value QSECURITY sets the security level of the system. Level 40—which provides password security, resource security, and operating system integrity (protecting the system from undocumented system interfaces)—is the default setting.

QUSEADPAUT—Use Adopted Authority			
System Value	**Description**	**Possible Values**	**Default**
QUSEADPAUT	Specifies which users can create programs that use adopted authority	*NONE *authorization_list_name*	*NONE

Many people misunderstand the USEADPAUT (Use adopted authority) program attribute. This attribute doesn't control whether a program adopts authority; it controls

whether the program can *use* adopted authority that is passed down to it from another program higher in the call stack.

Many applications use programs that adopt a powerful profile (often QSECOFR) and call other programs but don't library-qualify the program call. If a clever employee or hacker can create a program with the same name and put it into a library that precedes the real program's library in the library list, the impostor program will be called instead of the real program and will be able to use the adopted authority that the calling program provides.

System value QUSEADPAUT lets you prevent users from being able to create programs that use adopted authority. To implement this security measure, you create an authorization list (a topic I cover in Chapter 6), and specify it for QUSEADPAUT. Create the authorization list with *PUBLIC(*EXCLUDE), and grant specific authority to only those users who are allowed to create programs that use adopted authority (such as the person allowed to promote programs or perhaps the profile under which your change management software runs).

It's very appropriate to use system value QUSEADPAUT for a production system; however, if you implement it in an application development environment, it can seriously affect how programmers can do their jobs. Some application designs depend on programs that can use adopted authority.

Security Recommendation

For maximum protection in a production environment, use system value QUSEADPAUT to determine which users (if any) are allowed to create programs that use adopted authority.

QVFYOBJRST—Verify Object on Restore			
System Value	**Description**	**Possible Values**	**Default**
QVFYOBJRST	Verifies the digital signatures of objects being restored and whether they are allowed on the system	1–5	3

System value QVFYOBJRST lets you control whether objects must be digitally signed and what should happen to objects that are signed but have invalid signatures. An object can have an invalid signature for two reasons: if the certificate used to sign the object is not in the system's list of trusted object signers, or if the object was changed since it was signed by the sender. You must decide what your policy is with respect to digitally signed objects.

Value 1 is the least restrictive setting. With this value, the system ignores object signatures at restore time. This setting might be a good choice if you're performing a system restore after a disaster and you just want to get the system back up and running the way it was at the last SAVSYS (Save System) operation.

A value of 2 indicates that signatures for signed objects should be checked during restore and a message issued if any signature validation fails. However, all user-state programs will be restored regardless of the result of the verification and whether the objects are signed or not. This setting is a slightly better choice in the disaster recovery scenario, but it still doesn't provide much protection.

Value 3 is the same as 2, except objects with invalid signatures are not restored. Any unsigned objects are restored. This setting provides better protection than the previous values, but there are more restrictive values that give you better control of your system. Value 3 is the default value.

With value 4, unsigned objects are not restored. Signed objects are restored, whether the signatures are valid or not.

Value 5, the most restrictive setting, gives you the greatest control over your system. With this setting, unsigned objects or objects that are signed with an untrusted signature are not restored. A signature is not trusted if it is invalid or if the certificate authority that signed the certificate used to sign the object is not in the system's list of trusted certificate authorities.

Digital signatures are a great way to ensure that an object you're restoring actually came from who you think it came from and that it hasn't changed since that person or company signed it. If everyone signed their products, the world would be a little safer for system administrators. The reality, however, is that I've seen no vendors other than IBM sign their code.

Security Recommendation

Set system value QVFYOBJRST to 3. That way, if the object is signed, the signature must be valid.

System Value	Description	Possible Values	Default
QSSLCSLCTL—Secure Sockets Layer Cipher Control			
QSSLCSLCTL	Provides the ability to specify whether the operating system will control the list of cipher specifications for encrypted communications or the list will be user-defined.	*OPSYS *USRDFN	*OPSYS
QSSLCSL—Secure Sockets Layer Cipher Specification List			
QSSLCSL	Specifies the ciphers that the system will use for encrypted sessions	Varies by OS level and technology release	Defaults to the list provided by the operating system unless you've specified *USRDFN for QSSLCSLCTL. In this case, you define the list.
QSSLPCL—Secure Sockets Layer Protocols			
QSSLPCL	Specifies the protocols that the system will use for SSL/TLS sessions	*OPSYS or a list of protocols (which varies by OS level and Technology release)	*OPSYS

These system values work together to determine the encryption cipher that will be used when communicating over an SSL or Transport Layer Security (TLS) session. QSSLCSL lists the cipher suites that are available when establishing a connection and the order in which they will be negotiated. In other words, the first cipher listed will be the first one negotiated when establishing a session. If that cipher is not available on the system you're connecting to, it will try the next one in the list and so on.

QSSLCSLCTL determines whether the system (*OPSYS) controls the cipher specification list or the list is user defined (*USRDFN). If you are going to modify the QSSLCSL system value, QSSLCSLCT must be set to *USRDFN.

QSSLPCL determines the protocols that are allowed.

These system values have become quite important recently because of the vulnerabilities discovered in the SSL protocol. In addition, the PCI Council has dictated that all secure communications must use TLS 1.2 no later than July 1, 2018. You should note that TLS 1.2 is only supported on IBM i by default as of V7R2 and on V7R1 with TR 6.0. I will discuss these system values in more detail in chapter 9, which covers encryption.

Security Recommendation

Because of vulnerabilities in the protocols, SSL and TLS 1.0 and TLS 1.1 are not recommended.

Password-Related System Values

The second group of system values sets the rules regarding passwords on your system. The system checks the password-related system values whenever users use the CHGPWD (Change Password) command or the QSYCHGPW (Change Password) API to change their current password. You can use these system values to control the composition of users' passwords. For example, you can require users to include a digit in their passwords, to not use their previous 32 passwords, and so on. If a user's new password violates any of the rules determined by the password system values, the system sends an error message, and the user must select another password.

Remember that passwords should be secret, hard to guess, and changed regularly. However, sometimes "hard to guess" also translates into "hard to remember." When passwords are hard to remember, users tend to write them down and post them near their workstations! Obviously, this is something you want to avoid. Although you can address this situation in your security policy, the fact is that if you make the composition of passwords too difficult, users will likely write down their passwords regardless of the policy. So while you definitely need to set some of the password system values, I caution you against setting too many.

Table 3.4 lists the password-related system values. I'll start by looking at QPWDLVL, the password-level system value.

Table 3.4: Password-related system values

System Value	Description
QPWDCHGBLK	Specifies the time period following a password change during which the password cannot be changed (V6R1)
QPWDEXPITV	Specifies the maximum number of days a password is valid
QPWDEXPWRN	Determines when users start to receive password-expiration warning messages (V6R1)
QPWDLMTAJC	Determines whether passwords can contain adjacent digits
QPWDLMTCHR	Specifies characters that are not allowed in a password
QPWDLMTREP	Determines whether passwords can contain repeating characters

Table 3.4: Password-related system values (continued)	
System Value	**Description**
QPWDLVL	Determines the password level of the system
QPWDMINLEN	Specifies the minimum number of characters in a password
QPWDMAXLEN	Specifies the maximum number of characters in a password
QPWDPOSDIF	Determines whether each position in a new password must contain a different character than the corresponding position in the old password
QPWDRQDDGT	Determines whether a digit is required in the password
QPWDRQDDIF	Determines whether the password must be different from previous passwords
QPWDRULES	Specifies the rules used for valid password formation (V6R1)
QPWDVLDPGM	Specifies the name of a user-written password-approval program

QPWDLVL—Password Level			
System Value	**Description**	**Possible Values**	**Default**
QPWDLVL	Determines the password level of the system	1–3	0

The value of the QPWDLVL system value determines the possible values of passwords on the system. When QPWDLVL is set at its default value of 0, "traditional" IBM i password values are allowed. Possible values for passwords are uppercase A–Z, the numbers 0–9, and the special characters #, $, and @. In addition, weakly encrypted passwords used by the old Microsoft operating systems are stored on the system.

When QPWDLVL is set to 1 (password level 1), possible values for IBM i passwords remain the same, but the weakly encrypted Microsoft passwords are removed from the system. At level 2 (QPWDLVL value 2), possible password values are expanded to include uppercase and lowercase letters, numbers, special characters, punctuation, and spaces. Passwords may be up to 128 characters long (typically called "passphrases"). At level 3 (QPWDLVL value 3), the strongest password security level, possible values are the same as level 2, and the weakly encrypted Microsoft passwords are removed from the system.

Although you might be tempted to immediately set QPWDLVL to 3 and IPL, you need to do a little planning. Here are the things to consider:

- The weakly encrypted Microsoft password was only required when connecting via a file share to the i5/OS NetServer with a client running Windows 95/98 or ME or Windows Server 2000. Because these clients are no longer used by most organizations, it is safe to go to password level 1 or 3.

- Changing system value QPWDLVL requires an IPL. To display the pending value for QPWDLVL, use the DSPSECA command.

Before moving between password levels, take note of the following considerations.

Moving from level 0 to 1. Your risk here is that you could break the connection between your clients and the Windows Network Neighborhood on the IBM i system. If all your clients are running a current operating system, there is no opportunity for failure.

Moving to level 2. Things start to get a bit more interesting. IBM likes to call this stage the "test level." That's because you can leave your maximum-password-length system value (QPWDMAXLEN, covered later) at 10 and limit the character set for passwords to uppercase A–Z, the numbers 0–9, and special characters and test to see whether all the systems in your network will continue to work with the new algorithm. In case they don't, a password using the old encryption algorithm is kept so you can return to level 0 or 1 and get things up and running again.

Moving to level 3. If you move to level 3, you should plan to stay there because returning to a lower level is difficult from here. Once you move to level 3, the old passwords—both the weakly encrypted passwords used by NetServer and the passwords that use the original IBM i password algorithm—are removed from the system. If you need to return to a lower level, you must move to level 2 first so that the system will start retaining passwords using the original algorithm again.

Security Recommendation

At the very least, set system value QPWDLVL to 1 if you want to continue to keep the current IBM i password character set. However, I highly recommend that you consider moving to QPWDLVL for the highest level of password protection.

QPWDEXPITV—Password Expiration Interval			
System Value	**Description**	**Possible Values**	**Default**
QPWDEXPITV	Determines the maximum number of days a password is valid	*NOMAX 1–366	*NOMAX

System value QPWDEXPITV determines the maximum number of days a password is valid. When the limit is exceeded, the password expires and the user's next attempt to sign on causes the system to prompt the CHGPWD command. The user must then select a new password to access the system.

Technical Note

System value QPWDEXPITV controls the password expiration interval system-wide, but you can override it using the user profile parameter PWDEXPITV (Password expiration interval).

Security Recommendation

Set QPWDEXPITV to a value of 60 days or 90 days. This period will be adequate for most users. For powerful profiles (e.g., users with *ALLOBJ special authority), override this value in the user profile and set the PWDEXPITV parameter to 30 days.

QPWDLMTAJC—Limit Use of Adjacent Digits			
System Value	**Description**	**Possible Values**	**Default**
QPWDLMTAJC	Limits the use of digits next to each other in a password	0 (off) 1 (on)	0 (off)

System value QPWDLMTAJC restricts the use of adjacent digits in passwords, thus preventing users from choosing passwords such as 11111111, a telephone number, or a Social Security number.

Security Recommendation

Unless your organization's security policy requires it, leave this value off (set to 0).

QPWDLMTCHR—Limit Use of Specific Characters			
System Value	**Description**	**Possible Values**	**Default**
QPWDLMTCHR	**Limits the use of up to 10 specified characters in passwords**	***NONE** **Up to 10 characters**	***NONE**

You can use system value QPWDLMTCHR to specify up to 10 characters that are not allowed in a valid password. The characters that normally can be used in a password are the uppercase letters A–Z, 0–9, and the special characters #, $, and @.

Technical Note

When the password-level system value, QPWDLVL, is 2 or 3, the system ignores system value QPWDLMTCHR.

Security Recommendation

Using system value QPWDLMTCHR to restrict the valid character set allowed for passwords can actually make passwords easier to guess. That's because prohibiting certain characters reduces the number of combinations that a hacker or disgruntled employee must try before hitting upon a valid password. Thus, I don't recommend using this system value.

QPWDLMTREP—Limit Repeating Characters			
System Value	**Description**	**Possible Values**	**Default**
QPWDLMTREP	**Limits the use of a repeating character in a password**	**0** **1** **2**	**0**

System value QPWDLMTREP lets you prevent more than one occurrence of the same alphabetic character in a password. The default value of 0 lets the same character be repeated in a password.

The value 1 prevents the same character from being repeated anywhere in a password. For instance, the passwords "papaya" and "raspberry" would both be invalid with this QPWDLMTREP setting because a character is repeated in some form in each.

Specifying the value 2 for QPWDLMTREP prohibits only consecutively repeating characters. In that case, the password "raspberry" would not be allowed, but "papaya" would be because its characters aren't repeated consecutively.

Technical Note

When the password level is 2 or 3, this system value's check is case-sensitive. For example, if QPWDLMTREP is set to 1, "Aabcd" would be an allowed password at password level 2 or 3.

Security Recommendation

Set QPWDLMTREP to 2 to prevent users from repeating any character consecutively in a password.

System Value	Description	Possible Values	Default
QPWDMINLEN—Minimum Number of Characters Required			
QPWDMINLEN	Determines the minimum number of characters in a password	1–10 or 1–128, depending on password level	6
QPWDMAXLEN—Maximum Number of Characters Allowed			
QPWDMAXLEN	Determines the maximum number characters in a password	1–10 or 1–128, depending on password level	8

System values QPWDMINLEN and QPWDMAXLEN determine, respectively, the minimum and maximum number of characters a valid password can contain. Every installation should use these password system values.

The possible values for QPWDMINLEN and QPWDMAXLEN vary depending on your system's password level (as specified in system value QPWDLVL). If the password level is 0 or 1, passwords can be from 1 to 10 characters long. If the password level is 2 or 3, passwords can be from 1 to 128 characters long. You can't specify a maximum password length that is smaller than the specified minimum password length (and vice versa).

Security Recommendation

Set QPWDMINLEN to at least 8 to prevent the use of short names and initials. Set QPWDMAXLEN to at least 10.

QPWDPOSDIF—Require Positions to Be Different			
System Value	**Description**	**Possible Values**	**Default**
QPWDPOSDIF	Determines whether each position in a new password must contain a different character than the same position in the old password	0 (off) 1 (on)	0 (off)

System value QPWDPOSDIF lets you prevent the use of a character in a new password in the same position that the character occupied in the old password. This system value was designed to prevent a succession of passwords such as PASSWORD1, PASSWORD2, PASSWORD3.

Again, the idea behind this system value is good, but in practice it can make it difficult for users to come up with new passwords because a password that has nothing to do with the previous password may not be allowed. For example, if the old password is "carolw0od", and the user tries to set the new password to "ja85rtez", the new password will be rejected if QPWDPOSDIF is set on because the second letter is the same in both passwords.

Technical Note

When the password level is set to 2 or 3, the comparison made by QPWDPOSDIF is case-sensitive.

Security Recommendation

Because the use of system value QPWDPOSDIF can make it difficult for users to come up with new passwords, I don't recommend turning on this system value.

QPWDRQDDGT—Require a Digit			
System Value	**Description**	**Possible Values**	**Default**
QPWDRQDDGT	Determines whether a digit is required in passwords	0 (off) 1 (on)	0 (off)

System value QPWDRQDDGT determines whether valid passwords must include at least one digit (0–9). Many regulations require passwords to contain a digit, so you may need to set this value to remain in compliance.

Security Recommendation

Set QPWDRQDDGT to 1 to require users to include at least one digit in their passwords.

QPWDRQDDIF—Require Different Password			
System Value	**Description**	**Possible Values**	**Default**
QPWDRQDDIF	Determines whether new passwords must be different from previous passwords	0–8	0

With system value QPWDRQDDIF, you can prevent users from choosing a new password that is the same as a selected number of previous passwords. You can tell the system to let users duplicate a previous password (to do so, specify the default value of 0) or to prevent users from using the previous 4, 6, 8, 10, 12, 18, 24, or 32 passwords, depending on which nonzero value you enter. Here are the meanings of the nonzero values:

- 1—User can't duplicate previous 32 passwords.
- 2—User can't duplicate previous 24 passwords.
- 3—User can't duplicate previous 18 passwords.
- 4—User can't duplicate previous 12 passwords.
- 5—User can't duplicate previous 10 passwords.
- 6—User can't duplicate previous 8 passwords.
- 7—User can't duplicate previous 6 passwords.
- 8—User can't duplicate previous 4 passwords.

This system value is a must for every organization. You should prevent users from duplicating at least the previous four passwords, and if you want tighter security, you probably should stretch that guideline to cover the previous 32 passwords.

Security Recommendation

Many laws and regulations allow repeated passwords every fourth password. To comply with these laws and regs, you must set QPWDRQDDIF to 8. However, I prefer to be a little more restrictive and recommend you set QPWDRQDDIF to 1 to prevent users from reusing their past 32 passwords.

QPWDVLDPGM—Password Validation Program			
System Value	**Description**	**Possible Values**	**Default**
QPWDVLDPGM	Specifies the name of a user-written password-approval program	*NONE *REGFAC *program_name*	*NONE

System value QPWDVLDPGM provides a way to enforce more stringent rules on user passwords than those supported by the security system values. You can write your own password-validation program, using any rules you want to enforce. The advantage lies in the flexibility such a program provides. For example, using this type of program, you

could check a file containing commonly used words and prevent their use, make sure users don't use their own names or initials, verify that a password doesn't contain part of the previous password, or prevent the use of the local sports team names. Specify the program name as the value for QPWDVLDPGM. Or, to have the system retrieve the program name from the registration facility, specify value *REGFAC and register the program name for the Validate Password exit point (QIBM_QSY_VLD_PASSWRD).

Figure 3.1 shows a simple shell for a password validity-checking CL program. This particular program prevents users from changing their password more than once a day. Some users try to bypass the QPWDRQDDIF system value limitation by changing their password again and again until they can reuse the same password they started with. A validation program such as the one shown here at least forces users to work harder and wait longer to keep their old familiar password.

After you've upgraded your system to V6R1, you can use the QPWDCHGBLK system value (described later) to limit how often a password can be changed.

Figure 3.1: Sample password validity-checking program

```
/*==================================================================*/
/*   Author: Paul Tuohy, ComCon  - 2003                             */
/*==================================================================*/
/*==================================================================*/
/* Password Validity-Checking Program                               */
/* Set system value QPWDVLDPGM to *REGFAC.                          */
/* Register this program at exit point QIBM_QSY_VLD_PASSWRD.        */
/* This program will be called as part of CHGPWD command process.   */
/*==================================================================*/

 Pgm Parm( &InData       /* IN  Data in VLDP0100 Format          */ +
           &RtRtn_Code   /* OUT return code (0 = Good, 1 = Bad)  */ +
          )

 Dcl &InData       *char   320
 Dcl &RtRtn_Code   *lgl     1
 Dcl &User         *char   10
```

Continued

```
 Dcl &SysDate      *char    6
 Dcl &PwdChgDate   *char    6
 Dcl &PwdExpired   *char    4

/* Preset return code                                              */
  ChgVar  &RtRtn_Code '0'

/* Get user profile                                                */
  ChgVar  &User  %SST(&InData 33 10)
/*=================================================================*/
/* Allow only one password change per day.                         */
/*=================================================================*/

/* Get system date                                                 */
  RtvSysVal  SysVal(QDATE) RtnVar(&SysDate)
  CvtDat  Date(&SysDate) FromFmt(*SYSVAL)      +
            ToVar(&SysDate) ToFmt(*YMD) ToSep(*NONE)

/* Retrieve password change date                                   */
  RtvUsrPrf UsrPrf(&User) PwdChgDat(&PwdChgDate) PwdExp(&PwdExpired)

/* If equal and password not expired, reject request               */
  If (&PwdChgDate = &SysDate *AND &PwdExpired = '*NO ') Do
       ChgVar  &RtRtn_Code '1'
       EndDo

 Return
 EndPgm
```

The disadvantage of using a password-validation program is that the validation program provides user passwords in clear text. If you create a password-validation program, be sure to secure its source to ensure no one modifies it to store the clear-text passwords.

Security Recommendation

If you implement a password validity-checking program, be sure to secure the source and program object to prevent anyone from changing the program. If the program is unsecured, someone could use it to record passwords.

V6R1 Password-Related System Values

V6R1 brings many additional ways to configure and ensure strong passwords. Three new system values fine-tune your ability to implement password security.

New in V6R1

V6R1 provides three new system values related to passwords: QPWDRULES (Password Rules), QPWDCHGBLK (Block Password Change), and QPWDEXPWRN (Password Expiration Warning).

QPWDRULES—Password Rules

System Value	Description	Possible Values	Default
QPWDRULES	Specifies the rules used to check whether a password is formed correctly	*PWDSYSVAL *CHRLMTAJC, *CHRLMTREP, *DGTLMTAJC, *DGTLMTFST, *DGTLMTLST, *DGTMAX*n*, *DGTMIN*n*, *LMTSAMPOS, *LMTPRFNAME, *LTRLMTAJC, *LTRLMTFST, *LTRLMTLST, *LTRMAX*n*, *LTRMIN*n*, *MAXLEN*nnn*, *MINLEN*nnn*, *MIXCASE*n*, *REQANY3, *SPCCHRLMTAJC, *SPCCHRLMTFST, *SPCCHRLMTLST, *SPCCHRMAX*n*, *SPCCHRMIN*n* *ALLCRTCHG (new in V7R2)	*PWDSYSVAL

If you've ever turned on all the rules provided by the pre-V6R1 system values, you know how difficult they can make it to come up with a new password. With all the

possibilities you can now specify using V6R1's QPWDRULES system value, you must use even more caution when deciding which values to set, or you risk making it too difficult for users to create new passwords.

Valid values for QPWDRULES are as follows:

- *PWDSYSVAL (the default)—This value instructs the system to use the pre-V6R1 password system values.
- *ALLCRTCHG—Passwords specified on the CRTUSRPRF and CHGUSRPRF (Create User Profile and Change User Profile) commands must adhere to the password rules.
- *CHRLMTAJC—A password can contain repeated characters, but the characters must not be next to each other. This value has the same effect as specifying 2 for system value QPWDLMTREP.
- *CHRLMTREP—Characters cannot be repeated anywhere within a password. This value is the same as specifying 1 for the system value QPWDLMTREP.
- *DGTLMTAJC—A password can contain repeated digits, but the digits must not be next to each other.
- *DGTLMTFST—The first position of a password cannot be a digit.
- *DGTLMTLST—The last position of a password cannot be a digit.
- *DGTMAX*n*—A password can contain at most *n* digits.
- *DGTMIN*n*—A password must contain at least *n* digits. This setting serves the same function as the QPWDRQDDGT system value but lets you require multiple digits in passwords.
- *LMTSAMPOS—A character in a new password cannot be used in the same position it occupied in the previous password. This value is the equivalent of setting on the QPWDPOSDIF system value.
- *LMTPRFNAME—A password cannot contain the user profile name.
- *LTRLMTAJC—A password cannot contain two adjacent letters anywhere in it.
- *LTRLMTFST—The first position of a password cannot be a letter.
- *LTRLMTLST—The last position of a password cannot be a letter.

- *LTRMAX*n*—A password can contain at most *n* letters.
- *LTRMIN*n*—A password must contain at least *n* letters.
- *MAXLEN*nnn*—A password can be a maximum of *nnn* positions long. This setting is equivalent to the QPWDMAXLEN system value.
- *MINLEN*nnn*—A password must be at least *nnn* positions long. This setting is equivalent to the QPWDMINLEN system value.
- *MIXCASE*n*—A password must contain *n* uppercase and n lowercase letters.
- *REQANY3—A password must include three of the following four types of characters: uppercase characters, lowercase characters, special characters, and digits.
- *SPCCHRLMTAJC—A password can repeat special characters, but the repeated characters must not be next to each other.
- *SPCCHRLMTFST—The first position of a password cannot be a special character.
- *SPCCHRLMTLST—The last position of a password cannot be a special character.
- *SPCCHRMAX*n*—A password can contain no more than n special characters.
- *SPCCHRMIN*n*—A password must contain at least n special characters.

Technical Note

If you leave system value QPWDRULES at its default value of *PWDSYSVAL, the system uses the pre-V6R1 system values for the password rules. If you specify some other value (or multiple values) for QPWDRULES, system values QPWDLMTAJC, QPWDLMTCHR, QPWDLMTREP, QPWDMAXLEN, QPWDMINLEN, QPWDPOSDIF, and QPWDRQDDGT are ignored. In other words, if you specify anything other than the default value for QPWDRULES, *all* your password-composition rules must be specified using QPWDRULES.

V7R2 provides the opportunity to prevent default passwords. Specifying *LMTPRFNAME and *ALLCRTCHG prevents user profiles from being created with or changed to have a default password. While this is a powerful function, I encourage you

to think through any processes that may need to be changed (such as help desk password-reset processes) prior to adding *ALLCRTCHG to QPWDRULES.

Security Recommendation

If you choose to use system value QPWDRULES, you'll want to require at least one digit (*DGTMIN1), set the minimum length to at least 8 (*MINLEN8), and set the maximum length to at least 10 (*MAXLEN10). In addition, I recommend adding *LMTPRFNAME so that the user profile name cannot be used as part of the password. Last, to be consistent with some network password requirements, you may need to add *MIXCASE1 or *REQANY3. To prevent profiles from being created with or changed to have a default password, specify *ALLCRTCHG and *LMTPRFNAME.

QPWDCHGBLK—Block Password Change			
System Value	**Description**	**Possible Values**	**Default**
QPWDCHGBLK	Specifies the time period following a password change during which the password cannot be changed	*NONE 1–99	*NONE

System value QPWDCHGBLK lets you specify the number of hours required before a user can change his or her password again. The purpose of this system value is to prevent users from changing their password repeatedly so that they can get back to their original password, thus essentially never having to change their password. I've seen users (usually programmers) write a script that changes their password the number of times required to meet the QPWDRQDDIF system value requirement, so that they can always use the same password.

Security Recommendation

Set QPWDCHGBLK to 24 to require at least one day between password changes.

Technical Note

You can override system value QPWDCHGBLK by using the PWDCHGBLK (Block password change) parameter in a user's profile.

Technical Note

A user's password can always be changed using the CHGUSRPRF command or the QSYCHGPW API. System value QPWDCHGBLK is meant to prevent end users from repeatedly changing their password; it does not prevent administrators from changing it.

QPWDEXPWRN—Password Expiration Warning			
System Value	**Description**	**Possible Values**	**Default**
QPWDEXPWRN	Determines when users start to receive password-expiration warning messages	1–99	7

System value QPWDEXPWRN lets you set the number of days before the expiration of a user's password when the user will start to receive a "password is expiring" warning message.

Security Recommendation

Leave QPWDEXPWRN at the default of 7, or set it to the value that makes the most sense for your organization. (No, you can't turn off the warnings completely!)

Audit-Related System Values

One area that continues to evolve significantly in IBM i security is the auditing capabilities of the operating system. The audit-related system values are key to

implementing IBM i auditing functions. This chapter provides an overview of the audit-related system values, which are listed in Table 3.5. For a complete guide to IBM i auditing, see Chapter 15.

Table 3.5: Auditing system values

System Value	Description
QAUDCTL	Turns IBM i security auditing on or off
QAUDENDACN	Determines the action the system should take if it's unable to continue auditing (i.e., if it can't write another audit record to the journal)
QAUDFRCLVL	Determines when new auditing journal entries are physically written to disk from memory
QAUDLVL	Determines which security-related events are recorded in the security audit journal for all system users
QAUDLVL2	Specifies additional values that, in conjunction with those specified in system value QAUDLVL, determine which security-related events are logged
QCRTOBJAUD	Specifies the default auditing level for any new object

QAUDCTL—Auditing Control

System Value	Description	Possible Values	Default
QAUDCTL	Turns security auditing on or off	*NONE *AUDLVL *OBJAUD *NOQTEMP	*NONE

System value QAUDCTL is the on/off switch for IBM i security auditing. The default value, *NONE, tells the operating system to perform no security auditing. The values *AUDLVL and *OBJAUD tell IBM i to perform auditing. You can specify either or both of these values for QAUDCTL. *AUDLVL activates action auditing across the entire system or by individual user, and *OBJAUD activates object auditing. The other available value, *NOQTEMP, prevents extraneous auditing entries for objects in library QTEMP when you specify auditing with *AUDLVL and/or *OBJAUD.

Security Recommendation

Set QAUDCTL to at least *AUDLVL and *NOQTEMP. If you need to enable object auditing, add *OBJAUD.

QAUDENDACN—Auditing End Action			
System Value	**Description**	**Possible Values**	**Default**
QAUDENDACN	Determines the action the system should take it it's unable to continue auditing (i.e., if the system can't write another audit record to the journal)	*NOTIFY *PWRDWNSYS	*NOTIFY

IBM i can help the security officer audit security by logging data about security-related events to a journal named QAUDJRN. System value QAUDENDACN determines the action the system should take if it can't write another audit record to the journal and thus is unable to continue auditing. The default value, *NOTIFY, causes IBM i to send a message to the system operator and continue processing. The system also sends the message to QSYS/QSYSMSG if that message queue exists. The other choice is *PWRDWNSYS, which instructs the system to immediately power down.

Both *NOTIFY and *PWRDWNSYS trigger an automatic change to *NONE in the QAUDCTL system value, causing auditing to be turned off. You must turn auditing back on manually after correcting the problem that prevented the system from writing to the journal. (For more information about the implications of the *PWRDWNSYS value, see Chapter 15.)

Security Recommendation

Unless you must comply with the Common Criteria security requirements, use the default value for QAUDENDACN, *NOTIFY.

QAUDFRCLVL—Auditing Force Level			
System Value	**Description**	**Possible Values**	**Default**
QAUDFRCLVL	Determines when new auditing journal entries are physically written to disk from memory	*SYS *number_of_records* (1–100)	*SYS

System value QAUDFRCLVL determines the maximum number of audit records the system can cache before forcing the records to disk. You can specify any number in the range 1–100, or you can set QAUDFRCLVL to *SYS to let the operating system control this number dynamically for performance purposes.

If a system failure occurs, you might lose any audit records not yet written to disk. Systems that require Common Criteria compliance must specify 1 for this system value. For all other systems, however, I recommend the value *SYS, which maximizes performance when you use auditing.

Security Recommendation

Unless you must comply with Common Criteria security requirements, use the QAUDFRCLVL default of *SYS.

QAUDLVL—Auditing Level			
System Value	**Description**	**Possible Values**	**Default**
QAUDLVL	Determines which security-related events are logged to the security audit journal (QAUDJRN)	*NONE *ATNEVT, *AUDLVL2, *AUTFAIL, *CREATE, *DELETE, *JOBDTA, *NETCMN, *OBJMGT, *OFCSRV, *OPTICAL, *PGMADP, *PGMFAIL, *PRTDTA, *SAVRST, *SECURITY, *SERVICE, *SPLFDTA, *SYSMGT *PTFOBJ, *PTFOPR (New in V7R2) *NETSCK, *NETSECURE, *NETTELSVR, *NETUDP (New in V7R3)	*NONE

System value QAUDLVL determines the type of auditing the system performs. You can specify one or more values (unless one of the values is *NONE, which causes other values

to be ignored). The following list describes the types of journal entries made for each QAUDLVL value.

- *NONE—Perform no auditing on the system.
- *ATNEVT—Audit intrusion detection events.
- *AUTFAIL—Audit authority failures (e.g., user doesn't have authority to open a file, user doesn't have authority to run a program).
- *CREATE—Audit object-creation operations.
- *DELETE—Audit object-deletion operations.
- *JOBDTA—Audit job start and end. Specify *JOBDTA to cause both of the following types of audits to be performed, or specify either or both of these subset values:
  - *JOBBAS—Audit actions taken on a job.
  - *JOBCHGUSR—Audit changes to the job's user or group.
- *NETCMN—Network and communication functions are audited. Specify *NETCMN to audit all of the following, or specify one or more of these subsets:
  - *NETBAS—Basic network events are audited. These include IP rules changes, SSL connections, APPN directory search filter, and APPN endpoint filter.
  - *NETCLU—Events associated with cluster or cluster resource group operations are audited.
  - *NETFAIL—Events associated with network failures are audited (e.g., secure socket port not available).
  - *NETSCK—Tasks associated with sockets are audited. These include accept, connect, Dynamic Host Configuration Protocol (DHCP) address assigned or not assigned, mail filtered, and mail rejected. As of V7R3, *NETSCK is no longer considered a subset of *NETCMN. When specifying *NETCMN, only the DHCP and mail entries from *NETSCK are logged.
  - *NETSECURE—Secure network connections are audited (new in V7R3). To log secure Telnet sessions, you'll also need to specify *NETTELSVR.
  - *NETTELSVR—Telnet server connections are audited (new in V7R3).

  - *NETUDP—User Datagram Protocol (UDP) traffic is audited (new in V7R3). Note: To log all connections coming into or going out of the system, specify *NETSCK, *NETUDP, and *NETTELSVR.

- *OBJMGT—Audit object management operations (e.g., move an object, rename an object).
- *OFCSRV—Audit office mail actions and changes to the system distribution directory.
- *OPTICAL—Audit use of optical storage volumes.
- *PGMADP—Audit use of programs that adopt authority.
- *PGMFAIL—Audit system integrity violations (e.g., use or attempted use of restricted machine instructions).
- *PRTDTA—Audit direct and spooled printing.
- *PTFOBJ—Audit changes to PTF objects (new in V7R2).
- *PTFOPR—Audit PTF operations (new in V7R2).
- *SAVRST—Audit restore operations.
- *SECURITY—Audit changes to security controls (e.g., system value changes, object authority changes, auditing control changes). Specify *SECURITY to audit all of the following, or specify one or more of these subsets:
  - *SECCFG—The security-related configuration is audited. This includes user profile events; changes to system values, environment variables, and network attributes; and more.
  - *SECDIRSRV—Use of directory service functions is audited.
  - *SECIPC—Use of interprocess communications is audited.
  - *SECNAS—Events associated with Network Authentication Service ticket verification are audited.
  - *SECRUN—Runtime functions associated with changes of object ownership, changes to authorization list or object authority, or changes in the primary group of an object are audited.

  - *SECSCKD—Events associated with secure socket descriptors are audited.
  - *SECVFY—Events associated with the use of user profile verification events are audited. This includes events related to profile handles, tokens, and more.
  - *SECVLDL—Events associated with use of validation list object entries are audited.

- *SERVICE—Audit use of the service tools (i.e., the STRSST, or Start System Service Tools, command and options).
- *SPLFDTA—Audit spooled file control (e.g., moving a spooled file, releasing a spooled file).
- *SYSMGT—Audit system management activities (e.g., changes to the power on/off schedule, system reply list, backup options, Distributed Relational Database Architecture).
- *AUDLVL2—As you can see from this list, you can assign a lot of values in the QAUDLVL system value. If you need to specify more values than the system value's limit of 16, include *AUDLVL2 as one of the values in QAUDLVL. This setting instructs the system to look for additional action auditing settings in system value QAUDLVL2 (Auditing Level Extension).

When configuring auditing for the first time, follow the recommendations given below for the initial settings. Then, make sure you spot-check to determine how quickly a new audit journal receiver is being created. On busy systems, journal receivers can fill up quickly, causing a new journal receiver to be generated. Make sure you have a plan for managing journal receivers and a save strategy that accommodates your organization's compliance requirements. For more details and guidance about auditing, see Chapter 15.

Security Recommendation

Start by setting QAUDLVL to *AUTFAIL, *CREATE, *DELETE, *SAVRST, *SECCFG, *SECRUN, and *SERVICE. Add *PTFOPR when the system is at V7R2 or higher. To prepare for moving the system to security level 40, add *PGMFAIL to determine whether there are any issues to resolve before changing system value QSECURITY and IPLing the system.

Technical Note

If you are using high-availability (HA) software, you may need to specify more values for QAUDLVL. That's because some HA products rely heavily on the audit journal to know what to replicate to the target system. If you are using an HA product, do not remove values from QAUDLVL without first checking with the vendor.

QAUDLVL2—Auditing Level Extension			
System Value	**Description**	**Possible Values**	**Default**
QAUDLVL2	Holds additional values that, in conjunction with those specified in system value QAUDLVL, determine which security-related events are logged to the security audit journal (QAUDJRN)	*NONE *ATNEVT, *AUTFAIL, *CREATE, *DELETE, *JOBDTA, *NETCMN, *OBJMGT, *OFCSRV, *OPTICAL, *PGMADP, *PGMFAIL, *PRTDTA, *SAVRST, *SECURITY, *SERVICE, *SPLFDTA, *SYSMGT, *PTFOBJ, *PTFOPR (New in V7R2) *NETSCK, *NETSECURE, *NETTELSVR, *NETUDP (New in V7R3)	*NONE

As noted previously, you use system value QAUDLVL2 in conjunction with system value QAUDLVL to indicate the type of auditing to be performed on the system.

Technical Note

Unless *AUDLVL2 is specified for QAUDLVL, any value specified in QAUDLVL2 is ignored.

QCRTOBJAUD—Auditing for New Objects			
System Value	**Description**	**Possible Values**	**Default**
QCRTOBJAUD	Specifies the default auditing level for new objects	*NONE *USRPRF *CHANGE *ALL	*NONE

System value QCRTOBJAUD and the library attribute CRTOBJAUD (Create object auditing) together determine the default object auditing level for new objects. QCRTOBJAUD works much like the QCRTAUT system value, which determines the default public authorities for new objects. When you create a new object, IBM i checks the CRTOBJAUD attribute for the library in which the new object will reside. If the attribute's value is *SYSVAL, IBM i refers to system value QCRTOBJAUD to determine which of the object auditing values (*NONE, *USRPRF, *CHANGE, or *ALL) to assign to the new object's OBJAUD (Object auditing) attribute.

The default value for the CRTOBJAUD attribute of all libraries is *SYSVAL. As a consequence, you could use the QCRTOBJAUD system value to control the object auditing level for every new object on your system. However, for existing objects, you must use the CHGOBJAUD (Change Object Auditing) command to change the OBJAUD value.

Security Recommendation

Use system value QCRTOBJAUD with caution. Specifying *ALL for this system value has the potential to produce massive numbers of audit journal entries. That's because the system will generate an audit journal entry every time a new object is touched (read) or modified. If you are using objects such as data queues, user queues, or user spaces that are modified or read frequently, an audit journal entry will be generated for each action. Setting the value to *CHANGE produces fewer values, but the number can still be significant.

Technical Note

Some HA software requires a change to system value QCRTOBJAUD. If that is the case for you, be ready to manage more audit journal receivers as a result.

Locking Down Security-Related System Values

As a safeguard against unintended changes to your system values, it is possible to put a "lock" on system value settings. This practice prevents even system administrators with authority to the CHGSYSVAL command from changing any security-related system value setting. When you choose the lock-down option (accomplished via a service tools menu selection), the only way someone can change these values is by first logging in to the service tools (either System Service Tools or Dedicated Service Tools) and unlocking the security-related system values.

A Helpful Tool

IBM i provides a set of integrated security tools that can help you manage your security environment. One tool that relates specifically to this chapter is the PRTSYSSECA (Print System Security Attributes) command, which is available on the SECTOOLS and SECBATCH menus. This command prints a list of the current settings for security-related system values and network attributes. It also shows IBM's recommended system value and network attribute settings.

CHAPTER 4

The Facts About User Profiles

When we think about how people access an IBM i system, we normally think of the system object called a user profile. However, IBM i actually provides at least three different kinds of user identities: user profiles, service tools user identities, and validation list users. Although the most used and recognized of these identities are certainly user profiles, all three types are important for security.

User profiles are the entities by which users log on to the system and under which all jobs are run. *Service tools user IDs* identify those users who are allowed to use the low-level operating system tools, including Dedicated Service Tools (DST), System Service Tools (SST), and IBM Navigator for i (formerly System i Navigator) logical partitioning and disk unit management. *Validation list users* are created, managed, and used by applications on the system as a secure way to store user IDs and passwords—especially when an application needs access to a clear-text password. For example, some people will use a validation list to store the user ID and password used in an FTP script. This way, rather than the password being stored in the FTP script, it is retrieved from the validation list and then used to sign on to the FTP server.

In this chapter, we discuss user profiles and validation list users. Chapter 5 covers the service tools user IDs.

What Are User Profiles?

User profiles are the mechanism used to identify users to the system. They provide the means to authenticate a user (proving that the user is who he or she claims to be), they define the user's capabilities and the group profiles to which the user belongs, and they are the identity the system checks to verify whether the user has the authority required to run a particular function or perform a specific task. But more than defining the security information associated with a user, the user profile defines the environment in which the user operates, including the user's initial menu, initial program, and national language preference.

With a profile defined for each user, you have the ability to create a sound security implementation. You can ensure that users have access to only those functions required to perform their jobs. And you can configure the system to log (audit) user actions.

In IBM i terms, a user profile is an object (type *USRPRF). Although the object's name (e.g., CJW, VANDERWALL) is what you normally think of as the user profile, a user profile is much more than a name. The attributes of each user profile object define a particular user to the system, enabling the system to establish a custom initial session (i.e., job) for that user at sign-on. To make the best use of user profiles, you need to understand these attributes and how they can help you implement your security strategy.

Technical Note

IBM ships a number of predefined user profiles with the operating system, including some that I've mentioned previously, such as the powerful QSECOFR profile. These IBM-supplied profiles are used as object owners for various system functions. Some system functions also run under IBM-supplied user profiles. For details about these profiles and their default attributes, see the IBM i Information Center (go to **Security** > **Security reference** > **IBM-supplied user profiles**) or Appendix B of the System i Security Reference (available as a PDF file under the InfoCenter's Security topic).

To create and maintain user profiles on your system, you must have *SECADM (security administrator) special authority. The commands you use to accomplish these tasks are

CRTUSRPRF (Create User Profile), CHGUSRPRF (Change User Profile), and DLTUSRPRF (Delete User Profile).

User Profile Attributes

You use the CRTUSRPRF command to create a user profile. When you prompt the command and press F10, the system displays the command's parameters, which are shown (with the default values in most cases) in Figure 4.1. In the figure, the parameters that relate directly to security are highlighted. The parameters shown in italics are new or changed in V6R1 or V7R1. In the following sections, I discuss each of these parameters in detail. (Note that the figure reflects the V6R1 and V7R1 user profile attributes. If your system is on an earlier release, you will see fewer parameters.)

Figure 4.1: CRTUSRPRF parameters

```
                    Create User Profile (CRTUSRPRF)

Type choices, press Enter.

User profile . . . . . . . . . . > NEW_PROF__    Name
User password  . . . . . . . . .   *USRPRF___    Character value, *USRPRF...
Set password to expired  . . . . > *YES          *NO, *YES
Status . . . . . . . . . . . . .   *ENABLED_     *ENABLED, *DISABLED
User class . . . . . . . . . . .   *USER__       *USER, *SYSOPR, *PGMR...
Assistance level . . . . . . . .   *SYSVAL__     *SYSVAL, *BASIC, *INTERMED...
Current library  . . . . . . . .   *CRTDFT___    Name, *CRTDFT
Initial program to call  . . . . > APP_INIT__    Name, *NONE
  Library  . . . . . . . . . . . >   APP_LIB___  Name, *LIBL, *CURLIB
Initial menu . . . . . . . . . . > *SIGNOFF__    Name, *SIGNOFF
  Library  . . . . . . . . . . .     __________  Name, *LIBL, *CURLIB
Limit capabilities . . . . . . . > *YES          *NO, *PARTIAL, *YES
Text 'description' . . . . . . . > 'Make this meaningful!'____________________
_____

                                                                  Continued
```

```
Special authority  . . . . . . .   *USRCLS__      *USRCLS, *NONE, *ALLOBJ...
                + for more values   __________
Special environment  . . . . . .   *SYSVAL        *SYSVAL, *NONE, *S36
Display sign-on information  . .   *SYSVAL        *SYSVAL, *NO, *YES
Password expiration interval . .   *SYSVAL        1-366, *SYSVAL, *NOMAX
Block password change  . . . . .   *SYSVAL        1-99, *SYSVAL, *NONE
Local password management  . . .   *YES           *YES, *NO
Limit device sessions  . . . . .   *SYSVAL        *SYSVAL, *YES, *NO, 0, 1...
Keyboard buffering . . . . . . .   *SYSVAL___     *SYSVAL, *NO, *TYPEAHEAD...
Maximum allowed storage  . . . .   *NOMAX_____    Kilobytes, *NOMAX
Highest schedule priority  . . .   3              0-9
Job description  . . . . . . . .   QDFTJOBD__     Name
  Library  . . . . . . . . . . .     *LIBL_____   Name, *LIBL, *CURLIB

Group profile  . . . . . . . . . > GROUP1____     Name, *NONE
Owner  . . . . . . . . . . . . . > *GRPPRF        *USRPRF, *GRPPRF
Group authority  . . . . . . . .   *NONE___       *NONE, *ALL, *CHANGE, *USE...
Group authority type . . . . . .   *PRIVATE       *PRIVATE, *PGP
Supplemental groups  . . . . . . > GROUP2____     Name, *NONE
                + for more values > GROUP3____
Accounting code . . . . . . . .    *BLANK__________
Document password . . . . . . .    *NONE___       Name, *NONE
Message queue . . . . . . . . .    *USRPRF___     Name, *USRPRF
  Library  . . . . . . . . . . .     __________   Name, *LIBL, *CURLIB
Delivery . . . . . . . . . . . .   *NOTIFY        *NOTIFY, *BREAK, *HOLD, *DFT
Severity code filter . . . . . .   0_____         0-99
Print device . . . . . . . . . .   *WRKSTN___     Name, *WRKSTN, *SYSVAL
Output queue . . . . . . . . . .   *WRKSTN___     Name, *WRKSTN, *DEV
  Library   . . . . . . . . . . .    __________   Name, *LIBL, *CURLIB

Attention program  . . . . . . .   *SYSVAL___     Name, *NONE, *SYSVAL, *ASSIST
  Library  . . . . . . . . . . .     __________   Name, *LIBL, *CURLIB
```

Continued

```
Sort sequence  . . . . . . . . .   *SYSVAL___    Name, *SYSVAL, *HEX...
  Library  . . . . . . . . . . .     __________  Name, *LIBL, *CURLIB
Language ID  . . . . . . . . . .   *SYSVAL       *SYSVAL...
Country or region ID . . . . . .   *SYSVAL       *SYSVAL...
Coded character set ID . . . . .   *SYSVAL____   *SYSVAL, *HEX...
Character identifier control . .   *SYSVAL__     *SYSVAL, *DEVD, *JOBCCSID
Locale job attributes  . . . . .   *SYSVAL       *SYSVAL, *NONE, *CCSID...
               + for more values   _______
Locale . . . . . . . . . . . . .   *SYSVAL_________________________________
_____
User options . . . . . . . . . .   *NONE____     *NONE, *CLKWD, *EXPERT...
               + for more values   _________
User ID number . . . . . . . . .   *GEN________  1-4294967294, *GEN
Group ID number  . . . . . . . .   *NONE_______  1-4294967294,*NONE, *GEN

Home directory . . . . . . . . .   *USRPRF_________________________________
_____
EIM association:
  EIM identifier . . . . . . . .   *NOCHG_________________________
  Association type . . . . . . .   _______       *TARGET, *SOURCE, *TGTSRC...
  Association action . . . . . .   ________      *REPLACE, *ADD, *REMOVE
  Create EIM identifier  . . . .   __________    *NOCRTEIMID, *CRTEIMID
User expiration date . . . . . .   *NONE         Date, *NONE, *USREXPITV
User expiration interval . . . .                 1-366
Authority  . . . . . . . . . . .   *EXCLUDE__    *ALL, *CHANGE, *USE, *EXCLUDE
```

USRPRF (User Profile)

The USRPRF parameter of the CRTUSRPRF command specifies the name of the user profile. What's in a user profile name? Although selecting names for user profiles might seem simple enough, developing and following a naming strategy can help immensely in implementing and maintaining your security plan.

One approach to user profile names is to make each one as similar as possible to the name of the person to whom it belongs (e.g., AYOUNG, JBROWNING). This is the approach followed by most organizations, but it has some drawbacks:

- Profiles can be guessed easily. A disgruntled employee then has half of the equation and only needs to guess at the password to gain access to the system as a powerful profile.
- When a user changes his or her name (e.g., after getting married), it's difficult to change the profile name. (IBM i provides no method for completely copying one profile to another.) So the user either has to live with the old profile name or make do with not having ownership of all the old profile's objects (such as spooled files).

Another approach holds that user profile names should be completely meaningless (e.g., ABC9876, Q12345, RST0152). Meaningless names make profiles hard to guess and don't link the profile name to a department or location that might change as the employee moves within the company. The correlation between the user's name and his or her profile obviously must be kept somewhere, though—in a file or another user repository, such as Active Directory. Although this naming method is the most secure, it is rarely used because it makes administering the system and maintaining user profiles so difficult.

A third approach is to use a naming strategy that aids system administration. Under this strategy, each user profile name identifies the user's location and perhaps function or department. To implement this strategy, your naming convention should incorporate the user's location or department and a unique identifier for the user's name. For example, if Sven O. Johanson works at your Minnesota distribution center in the procurement department, you might assign one of the following profiles:

User Profile Name	Naming Scheme
MNSJOHANSO	The first two letters of this 10-character profile represent the location (MN for Minnesota). The remainder consists of the first letter of the user's first name (S) followed by as much of the last name as will fit in the remaining seven characters.
MNPRSOJ	This profile name is similar to the first, but the branch (MN) is followed by a department abbreviation (PR for procurement) and then the user's initials (SOJ). This method provides more departmental information while reducing the unique name identifier to initials.
B25PRSOJ	This example is identical to the second, but the Minnesota branch is designated using a letter–number combination (B25) rather than letters.

When profile names provide this type of information, programs in your system that supply user menus or functions can resolve the profiles at run time based on location, department, or group. Auditing can also be more effective if you take the time to analyze departmental trends. However, just like the first method, these types of profile names are less secure than meaningless profile names because someone who understands the naming scheme can easily deduce them, leaving only the password to guess.

A final consideration in choosing a naming convention for user profiles is whether your users will have access to multiple systems, including multiple operating systems. If they will, you might consider using the same name across all systems. To do so, however, you must take into consideration all limitations that the other systems in the network place on usernames and apply those limitations when you create the user profiles for your system. For example, another platform in your network might limit the number of characters allowed for usernames.

I have had to review the security configuration of a system on which all profiles were numbers relating to the employee number. Not only could this practice come back to haunt the organization (if, for example, employee number comes to be considered private information someday, as Social Security numbers and Social Insurance numbers are now), it also made it very difficult to recognize issues such as users that had inappropriate special authorities, because I had to constantly display the user profile and read the text description to determine whether the profile belonged to an end user, a programmer, or an administrator.

This is an example of the kind of tradeoff one has to make when designing security. More secure often equates to less usable for an administrator. Obviously, there's no perfect way to name user profiles. It's up to you to decide which user-profile naming convention will work best for your organization.

PASSWORD (User Password)

As I stressed in Chapter 3, passwords should be secret, hard to guess, and changed regularly. You can't ensure users keep their passwords secret, but you can help make the passwords hard to guess by controlling password format, and you can require users to change their passwords regularly. Several user profile parameters relate to passwords.

This discussion assumes that you require users to select and maintain their own passwords. No one in IT should ever know user passwords. When administrators ask us why they can't see clear-text passwords on the system, I ask them, "Why would you want to?" If a breach occurred and you, as an administrator, knew every user's password

or had the ability to discover it, you would be put in the position of having to prove that you didn't commit the breach. In other words, accountability for who did what on your system would be gone. IBM i does not permit the retrieval of user passwords into a clear-text form, and you as an administrator should not maintain a list of clear-text passwords.

For the PASSWORD parameter, you can specify a value of *NONE, *USRPRF, or the password itself. *NONE means that the user profile can't sign on to the system. Unfortunately, the default parameter value, *USRPRF, creates a password that is the same as the user profile name. This is what is known as a "default" password. Default passwords constitute a huge security exposure. I prefer profiles to be created with the password parameter set to *NONE—meaning no password. That way, if the person for whom the profile was created never shows up for work, you don't have user profiles on the system that have default passwords. In addition, profiles such as group profiles and profiles that own objects are not meant to represent individuals and, therefore, should not be used for sign-on. Creating those profiles with PASSWORD(*NONE) enforces this policy.

An alternative, as discussed in the previous chapter, is to add *ALLCRTCHG to the list of rules specified in the QPWDRULES system value. This requires that all passwords—even those specified when creating or changing user profiles—adhere to the password rules. If, when creating a user profile, you leave the password as *USRPRF and *ALLCRTCHG and *LMTPRFNAME are both specified in QPWDRULES, the profile isn't created until you change the password parameter to a value that meets the password rules.

Security Recommendation

Consider changing the CRTUSRPRF command's default value for the PASSWORD parameter from *USRPRF to *NONE. When a profile is created for an individual, have the individual call the help desk to have a password assigned to the profile.

Security Recommendation

IBM-supplied profiles QPGMR, QSRV, QSRVBAS, QSYSOPR, and QUSER can have passwords, but IBM ships these profiles with PASSWORD(*NONE) so that no one can use them to sign on. In early releases of OS/400, these profiles were shipped with default

passwords that were the same as the profile name. Those passwords were common knowledge in the hacker community, and, if left unchanged, were a very serious security exposure. To ensure that none of these profiles have passwords on your system, analyze the password section of the report produced by the PRTUSRPRF (Print User Profile) command.

The QSECOFR profile is still shipped with a default password, but the first time you sign on as QSECOFR, you must change the password. Use the ANZDFTPWD (Analyze Default Passwords) command to determine whether QSECOFR (as well as any other profile) has a default password. Avoid signing on with QSECOFR. Rather, create a profile with the same authorities. You should not have to sign on with QSECOFR unless you are upgrading the system.

PWDEXP (Set Password to Expired)

The PWDEXP parameter lets you set the user profile's password to the expired state. When you create new user profiles, if you don't set the password to *NONE, you should specify PWDEXP(*YES) so that new users are prompted to choose a new password the first time they sign on. You should also specify PWDEXP(*YES) when passwords are reset for users who have forgotten theirs. (IBM i doesn't allow a profile to be created or changed to have password *NONE and password expired set to *YES.)

Security Recommendation

When giving a user a password—either for the first time or when the user calls in because he or she has forgotten the password, specify PWDEXP(*YES) to ensure that the user changes the initial password when he or she signs on.

LCLPWDMGT (Local Password Management)

The LCLPWDMGT (Local password management) parameter comes into play for users who exploit the single sign-on capabilities of IBM i. This parameter's value indicates whether the user's password will be stored on the local (IBM i) system. The default value is *YES. A value of *NO indicates that the password will be passed to other IBM products that

perform password synchronization (e.g., i5/OS Integration for Windows Server) but will not be stored on the local system.

When LCLPWDMGT is set to *NO, the user profile's PASSWORD value on IBM i is automatically set to *NONE. The user won't be able to sign on directly to the IBM i system through a green-screen interface, but he or she will be able to exploit the system's single sign-on capabilities (e.g., from a Windows workstation) to access IBM i. In addition, use of the CHGPWD (Change Password) command to change the user's password will cause the password to be changed remotely, but the local system will continue to have *NONE as the PASSWORD value.

PWDEXPITV (Password Expiration Interval)

This parameter controls how often the user must change his or her password. The default value, *SYSVAL, means the user must change the password at the frequency specified in the QPWDEXPITV (Password Expiration Interval) system value. However, this value can be overridden in the user's profile. Here are two legitimate reasons for overriding this value:

- You want the user to change the password more frequently than the frequency defined in the system value. For example, a good practice is to have powerful users (such as those with *ALLOBJ special authority) change their passwords more frequently than average users (e.g., every 30 days).
- Another time to consider overriding this value is for profiles that I call "service accounts." Examples of service accounts include profiles used to connect to the system via Open Database Connectivity (ODBC) or remote Structured Query Language (SQL) statements. While these profiles' passwords should be changed regularly, having the system warn that the password is expiring and then expire the password if the password isn't changed can cause the application to fail, especially if the process is automated. Another process must be put into place to change these profiles' passwords on a regular basis; setting this parameter to *NOMAX is then acceptable.

However, is it *not* legitimate to set parameter PWDEXPITV to *NOMAX because you don't want to change your password! I have seen many systems where the administrators' and QSECOFR's password expiration interval was set to *NOMAX. This is not an acceptable security practice. Why? In addition to the fact that it violates many laws and regulations, should someone learn the password for these profiles, that person can use (and abuse) the

password forever (or until caught) because the password is never changed. If you are one of those administrators who has changed your expiration interval to *NOMAX, I highly recommend you set it back to *SYSVAL or even to 30 (days) and change your password, as you're asking the rest of your users to do!

Technical Note

When the password is set to *NONE, the password expiration interval is never examined by the system, so the PWDEXPITV should be left at *SYSVAL.

Security Recommendation

Set all profiles whose password is *NONE to PWDEXPITV(*SYSVAL).

PWDCHGBLK (Block Password Change)

V6R1 introduces the PWDCHGBLK (Block password change) parameter, whose purpose is to prevent the user from changing his or her password multiple times in order to reuse the same password all the time. For example, if the system's QPWDLMTREP (Limit Repeating Characters) system value is set to 1, users must come up with 32 unique passwords before they can reuse their current passwords. Some users have realized that they can simply change their password 32 times in rapid succession and be able to reuse the same password. In fact, they have often written scripts to automate this process. The net effect is that the password never changes. The PWDCHGBLK user profile parameter lets you control how much time (in hours) must pass between password changes, defeating the intentions of those users with the automated scripts. (The V6R1 system value QPWDCHGBLK, or Block Password Change, provides similar functionality at the system value level.)

This parameter affects only interfaces that let users change their password themselves, such as the CHGPWD command or the QSYCHGPW (Change Password) API. You can always change user passwords through the CHGUSRPRF command if there is a legitimate need to reset or change a password.

STATUS (Profile Status)

The STATUS parameter specifies whether a user profile is enabled or disabled for sign-on. When the value is *ENABLED (the default), the system lets the user sign on. If the value is *DISABLED, the system doesn't let the user sign on until the profile is re-enabled by a user with authority to do so (i.e., change the value of STATUS to *ENABLED).

This parameter is used with the QMAXSGNACN (Maximum Sign-on Action) system value. When you set QMAXSGNACN to 2 or 3, the system disables a profile that attempts too many invalid sign-ons. (System value QMAXSIGN, or Maximum Number of Sign-on Attempts, determines how many attempts are allowed.) When the system disables a profile, the system changes the value of the STATUS parameter to *DISABLED. Unlike some operating systems, a profile must be reset to STATUS(*ENABLED) by a user with sufficient authority. The profile will not automatically be reset after a period of time.

In addition, many organizations have a policy that requires inactive profiles to be set to STATUS(*DISABLED) after a certain number of days; then, after another period of time, they are to be removed from the system. This practice ensures that profiles that are no longer needed are removed from the system in a timely way.

Technical Note

If the QSECOFR profile is disabled, you can always sign on as QSECOFR at the console and enable the profile (assuming, of course, that you know the password). QSECOFR's password cannot be set to *NONE like other IBM-supplied profiles, so the way to protect QSECOFR from abuse is to purposely set the profile to status *DISABLED.

Security Recommendation

Disable profiles after no more than 90 days of inactivity. This practice will bring your system into compliance with many laws and regulations and will ensure that inactive profiles cannot be used.

USRCLS (User Class) and SPCAUT (Special Authority)

The USRCLS and SPCAUT parameters work together to determine the special authorities granted to the user. Special authorities give the user the right to perform a function or task, such as being able to save or restore objects, control (end or reprioritize) any job on the system, work with any spooled file on the system, work with user profiles, or configure TCP/IP. I'll discuss the details of the special authorities themselves in a moment. First, let's look at how the USRCLS and SPCAUT parameters work.

The USRCLS parameter lets you classify users by type according to their special authorities. Five user classes are recognized on IBM i:

- *SECOFR (security officer)
- *SECADM (security administrator)
- *PGMR (programmer)
- *SYSOPR (system operator)
- *USER (user)

Technical Note

The user class parameter is used to default the special authorities when a profile is created. It is also used to determine what menu options appear on IBM menus displayed to the user. Lastly, the user class determines the special authorities that the profile should have when the system moves from QSECURITY level 20 to level 30 or higher. Note that the parameter is *not* used when the system checks to see whether the user is allowed to access an object.

When you assign a profile to a user class, the profile by default is granted the special authorities associated with that class. Table 4.1 lists the default special authorities associated with each user class under security levels 30, 40, and 50. You can override these special authorities using the SPCAUT parameter, but you'll find that the default authorities are usually appropriate.

Table 4.1: User classes (levels 30, 40, and 50)	
User Class	**Special Authorities**
*SECOFR	*ALLOBJ, *SECADM, *SAVSYS, *JOBCTL, *SERVICE, *SPLCTL, *AUDIT, *IOSYSCFG
*SECADM	*SECADM
*PGMR	No special authorities
*SYSOPR	*SAVSYS, *JOBCTL
*USER	No special authorities

Table 4.2 lists the permitted SPCAUT values and the meaning of each. The default SPCAUT value is *USRCLS, which instructs the system to refer to the USRCLS parameter and assign the predetermined set of special authorities.

Table 4.2: SPCAUT parameter values	
Value	**Description**
*USRCLS	The user class determines the set of special authorities for the user profile. This value is the default.
*NONE	No special authorities are assigned.
*ALLOBJ	The user is allowed to access any object on the system. A user with *ALLOBJ special authority cannot be denied access to any object. Thus, *ALLOBJ should be given to only a few very trusted individuals.
*AUDIT	The user is allowed to manage all aspects of auditing on the system, including changing the auditing system values and running the auditing commands.
*IOSYSCFG	The user is allowed to configure TCP/IP and all other aspects of communications on the system.
*JOBCTL	The user can change, display, hold, release, cancel, and clear all jobs on the system. Spooled files must be in an output queue that specifies OPRCTL(*YES).
*SAVSYS	The user can save, restore, and free storage for all objects—regardless of whether the user has the authority to access or manipulate the objects.
*SECADM	The user can create and change user profiles.
*SERVICE	The user can perform functions in the System Service Tools.
*SPLCTL	The user can delete, display, hold, and release all spooled files on the system.

Technical Note

Navigator for i refers to special authorities as *privileges*. For an example of a privilege in Navigator, see the Navigator discussion later in this chapter.

You can override the default SPCAUT setting by typing from one to eight individual special authorities that you want to assign to the user profile. After sending a message that the special authorities assigned don't match the user class, the system creates the user profile as requested. (Just ignore the message!)

When granting special authorities, you want to do so based on the user's job responsibilities or role and grant only the authority the user requires to do his or her job—not more. Many special authorities give the holder great power and control over all or parts of your system. For example, *ALLOBJ special authority gives a user unlimited access to and control over *all* objects—a user with *ALLOBJ special authority can perform any function on any object on your system. Obviously, you want to give this special authority only to someone whose job responsibility is to administer the system.

To appropriately assign special authorities, you need some understanding of the user's job function or role in the organization. In large organizations, new profiles are usually created with no special authorities unless they fall into a specific job category, such as system operator or user profile administrator. The roles and their special authorities must be predefined; it is not up to the new user or manager requesting the profile to determine which special authorities the user is to be assigned.

You should design your security implementation so users are assigned only the special authority that they need to perform their job functions. Avoid—at all costs—an implementation where all users require *ALLOBJ special authority. *ALLOBJ should be assigned only to system administrators—not programmers, not operators, and definitely not end users. In later chapters, I discuss how to provide these users with the capabilities they need to perform their job responsibilities without giving them *ALLOBJ.

Security Recommendation

Applications running on your system shouldn't require a profile with *ALLOBJ authority to manage the application or its objects. For example, vendors should not have to have an *ALLOBJ profile on your system that they use to sign on and maintain their application. If they insist on this, it is because they are lazy and just want to make sure they don't run into any security issues when signing on your system. Do not let them talk you into having a profile with *ALLOBJ unless they are administering the system itself. We'll discuss other ways to manage access for application maintenance in later chapters.

*SECADM special authority enables a user profile to create and maintain user profiles without requiring the profile to be in the *SECOFR user class or giving it *ALLOBJ authority.

The *SAVSYS special authority lets a user save off or restore any object to the system regardless of whether he or she has authority to access the object. Although *SAVSYS may seem powerful, your alternative is to give your operations staff *ALLOBJ special authority so they have sufficient authority to save all the objects on the system. The better option is obviously to give them *SAVSYS instead. However, *SAVSYS authority is not without risks. If you secure a library (set its *PUBLIC authority to *EXCLUDE) but don't secure a file within it that contains confidential information, a user with *SAVSYS could save the file out of the secured library, restore it into a library to which they have authority, and thereby gain access to the confidential data.

*IOSYSCFG special authority lets the user create, delete, and manage devices, lines, and controllers and configure and start any TCP/IP server, such as a Web server. *IOSYSCFG has become a powerful authority that you should assign with care.

*SPLCTL special authority is the "*ALLOBJ" of spooled files and should be granted sparingly. With this authority, a user can delete, display, hold, and release all spooled files on the system. There is no way to prevent a user with *SPLCTL from accessing a spooled file. I usually see *SPLCTL given to users because one person has created a report that another person needs to see; without *SPLCTL authority, IBM i does not allow this. Unfortunately, because *SPLCTL lets users see *any* spooled file on the system, granting this authority when you need to keep some spooled files confidential or private is not appropriate. In Chapter 8, I describe other methods for sharing spooled files without giving users *SPLCTL.

*SERVICE is another special authority you should guard. *SERVICE lets a user perform a communications trace (which includes clear-text passwords from a 5250 emulation sign-on screen), debug a program, and configure and manage logical partitions (LPARs). Fortunately, you now need a service tools ID as well as *SERVICE special authority to be able to access the service tools. This restriction limits the power of *SERVICE special authority. In addition, one of the host functions within Application Administration (a component of Navigator for i that we discuss in Chapter 6) lets you selectively permit certain users to perform these functions without having to give them *SERVICE special authority. Consider taking this approach rather than giving a user the full capabilities associated with *SERVICE special authority.

Security Recommendation

One of the IBM-supplied profiles, QSRV, has *SERVICE special authority. I often see this profile with a password and find out, after questioning the administrator, that every IBM service person knows this password. A more secure method is to set the profile's password to *NONE and assign a password only when IBM comes onsite. When the service person leaves, set the password back to *NONE.

Initial Sign-on Options

Three user profile parameters work together to determine the user's initial sign-on options. The CURLIB (Current library), INLPGM (Initial program to call), and INLMNU (Initial menu) parameters determine the user profile's current library, initial program, and initial menu, respectively. Together, these parameters establish the user's environment when the user signs on to the system. The menu or program that is run at sign-on determines which menus and programs are available to the user. Let's look at two examples.

First, consider the user profile USER, which has the following values:

```
Current library . . . . . . . . CURLIB    ICLIB_____
Initial program to call . . . . INLPGM    *NONE_____
  Library . . . . . . . . . . .             __________
Initial menu  . . . . . . . . . INLMNU    ICMENU____
  Library . . . . . . . . . . .             ICLIB_____
```

When USER signs on, the user's current library is set to ICLIB, and the display shows menu ICMENU from library ICLIB.

Now, let's say USER instead has these values:

```
Current library . . . . . . . . CURLIB    ICLIB_____
Initial program to call . . . . INLPGM    ICUSERON__
  Library . . . . . . . . . . .             SYSLIB____
Initial menu  . . . . . . . . . INLMNU    *SIGNOFF__
  Library . . . . . . . . . . .             __________
```

When USER signs on in this scenario, ICLIB is again the user's current library, and the system runs program ICUSERON from library SYSLIB. But in this case, the initial menu is set to *SIGNOFF. When a user signs on, the initial program is run first, and then the initial menu is presented. If the initial menu is set to *SIGNOFF, the user's session is signed off once the initial program is completed.

LMTCPB (Limit Capabilities)

Parameters CURLIB, INLPGM, and INLMNU are significant to security because the sign-on screen as shipped with the system permits users to change the values of these parameters at sign-on. Users can also run commands when presented with a command line. Obviously, permitting all users to make these changes and run commands isn't a good security practice. The LMTCPB (Limit capabilities) user profile parameter lets you control these user functions. Specifically, it controls users' ability to:

- Define (using the CHGPRF, or Change Profile, command) or change (at sign-on) their own initial program
- Define (using CHGPRF) or change (at sign-on) their own initial menu
- Define (using CHGPRF) or change (at sign-on) their own current library
- Define (using CHGPRF) or change (at sign-on) their own attention key program
- Run IBM i or user-created commands from a command line

Table 4.3 shows the effects of the possible values for LMTCPB.

Table 4.3: Effects of the LMTCPB parameter

	User can define, change, and execute:				
LMTCPB	**Initial Program**	**Initial Menu**	**Current Library**	**Attention Program**	**Commands**
***NO**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
***PARTIAL**	**No**	**Yes**	**No**	**No**	**Yes**
***YES**	**No**	**No**	**No**	**No**	**Limited**[1]

[1] A user with LMTCPB(*YES) is limited to the SIGNOFF, SNDMSG (Send a Message), DSPMSG (Display Messages), DSPJOB (Display Job), DSPJOBLOG (Display Job Log), STRPCO (Start PC Organizer), and WRKMSG (Work with Messages) commands and to other commands that you create or change to specify ALWLMTUSR(*YES).

Technical Note

If you want to permit users with LMTCPB(*YES) to use a particular command, you can change the command using the CHGCMD (Change Command) command, specifying ALWLMTCPB(*YES). However, carefully consider the fact that changing this value allows the command to be run by all users on the system.

Most users on production systems should have their LMTCPB parameter set to *YES. The profiles that need LMTCPB(*NO) are typically in a role that needs to run many commands from the command line. These may include users in the administrator, database administrator, or system analyst roles. In addition, the programmers that need to debug production issues may also need LMTCPB(*NO).

Technical Note

Although the LMTCPB parameter possesses value for green-screen menu environments and should continue to be used, current technology has limited its effectiveness. Many interfaces—such as SQL, ODBC, remote command, and Distributed Data Management (DDM)—bypass menus altogether. The limited-capabilities setting is ignored in most cases when the user doesn't actually sign on at a menu. Don't make the mistake of thinking that limited capabilities provide more protection than they do.

Security Recommendation

Change the LMTCPB parameter to *YES unless the user specifically needs the additional capabilities provided by LMTCPB(*NO). Don't bother using the value of *PARTIAL. Very little benefit is obtained by this setting, and I—as well as most administrators—find it more confusing than helpful.

System Value Overrides

As I mentioned in Chapter 3, you can override system values QDSPSGNINF (Display User Sign-on Information), QPWDEXPITV (Password Expiration Interval), QPWDCHGBLK (Block Password Change), and QLMTDEVSSN (Limit Device Sessions) by using the user profile parameters DSPSGNINF (Display sign-on information), PWDEXPITV (Password expiration interval), PWDCHGBLK (Block password change), and LMTDEVSSN (Limit device sessions), respectively. From Figure 4.1, you can see that these four parameters all have the default value *SYSVAL, which lets the respective system value control these functions. To override a system value, specify the desired value in the associated user profile parameter. The available choices are the same as those for the system values themselves.

Group Profiles

All the parameters we've discussed so far are used to define profiles for individual users. The next few parameters—GRPPRF (Group profile), OWNER (Owner), GRPAUT (Group authority), GRPAUTTYP (Group authority type), and SUPGRPPRF (Supplemental groups)—let you associate an individual user profile with one or more *group profiles*.

IBM i provides group profiles as a tool to make security administration easier. Group profiles are also the method you'll use to implement "role-based" access. When you have a set of user profiles that all need the same capabilities or require access to the same objects, you'll want to define a group profile (role) for those users. Examples of roles include the operations staff, all users in the payroll department, and programmers. When you assign a special authority to a group profile or give a group profile access to an object, everyone in that role has the special authority or object access. Therefore, it is much simpler to assign the capability or access to the group rather than to each individual in the group. User profile creation and maintenance are also easier. For example, if a new operator is hired, all you have to do is put that user in the Operator group. Doing so gives that person all the capabilities and access he or she needs to perform the responsibilities of the operator role, and it is much easier than assigning them individually. If a user changes position within the company, you can simply add that user to the group associated with the new role and remove him or her from the group associated with the old role.

Creating Group Profiles

Before you can make a user a member of a group, you first must create the group profile. The confusing part of this step is that you create a group profile using the same command

you use to create a user profile—that is, CRTUSRPRF. The following list shows the CRTUSRPRF parameters that are especially meaningful for group profiles.

- USRPRF—Carefully consider the name of the group profile. I like to use a naming convention that makes it very obvious that the profile is a group profile as well as what role it represents (e.g., GRP_OPER, GRP_PGMR, GRP_HR).
- PASSWORD—The next parameter to pay attention to is PASSWORD. Group profiles are created to represent a role or a set of users, not an individual user; therefore, you don't want this profile used for sign-on. To enforce this rule, set the profile to have no password—in other words, set PASSWORD to *NONE.
- PWDEXPITV—Leave the password expiration interval at its default of *SYSVAL. Some people think this setting will cause a problem when the password is *NONE, but that's not the case. When the password is *NONE, the system never checks the expiration interval.
- INLPGM—Set this value to *NONE since the profile is not intended to be used for sign-on.
- INLMNU—Set this value to *SIGNOFF since the profile is not intended to be used for sign-on.
- LMTCPB—You can set the LMTCPB parameter to *YES, but because the profile shouldn't be used for sign-on, it shouldn't matter what the setting is. However, if you are generating reports that list the users with LMTCPB(*NO), setting a group profile's LMTCPB parameter to *YES will mean one less profile on the list (and, therefore, one less profile to justify/explain to an auditor).
- TEXT—Use the Text field to further explain the purpose of the group profile.
- SPCAUT—Assign the special authorities required to accomplish the tasks of the role. These special authorities may or may not match the user class in which you place the group. The important thing is to assign the exact special authorities required by the role—no more and no fewer.
- GRPPRF—You cannot nest groups. In other words, a group profile cannot be a member of another group. Therefore, when you create a group profile, the GRPPRF parameter must be set to *NONE.

Assigning a Group to a User Profile

Now that you've created the group profile, you'll want to assign users to the group. In other words, you are making particular users members of the group.

Use the CRTUSRPRF command's GRPPRF parameter to specify the name of the group that represents the user's primary role. For users who perform more than one role in your organization, you can use the SUPGRPPRF parameter to specify up to 15 additional groups. (You may be wondering which access the system checks first, the user's individual access or the group's. I discuss this topic in detail in Chapter 6.)

Three other user profile parameters work with the GRPPRF parameter: OWNER, GRPAUT, and GRPAUTTYP. Let's take a look at how these parameters interact.

By default, when a user creates an object, the user owns the object. However, you may choose to have the user's group own all objects that are created by the members of the group. To set up this configuration, specify *GRPPRF for the user profile's OWNER parameter.

There are times when this approach is an efficient and desirable one. For example, when you have a set of developers all working on the same project, you may want to have their group profile (e.g., GRP_PGMRHR) own all the objects that each developer is currently working on. Another example is when everyone in a department needs to access and manipulate the same queries and their work files. A final example is to have your system administrators in a group, so as they create system objects (such as devices, printers, and output queues), their group—rather than the individual—owns the objects. This makes it easier to remove these profiles from the system if the individual leaves the organization.

However, this configuration can be a very dangerous security scenario. That's because when the group owns an object, all members of the group also own the object, which means that all group members have *ALL authority to those objects. The danger comes when a group profile owns a production application. That is, each user is a member of the profile that owns the application, and, therefore, all application users have *ALL authority to all application objects—including the production application's data files. This is a configuration you want to avoid.

Technical Note

The OWNER, GRPAUT, and GRPAUTTYP parameters apply only to the group specified in the GRPPRF parameter, not to any group profiles specified in the SUPGRPPRF parameter.

Technical Note

Objects created in the integrated file system (IFS) are owned by the user profile regardless of the value of the OWNER parameter.

If you don't want the group owning the objects, but other group members need authority to the objects, you can have the system grant a private authority to the group. The GRPAUT parameter specifies the authority granted to the group profile when the value for OWNER is *USRPRF. Valid values for GRPAUT are *ALL, *CHANGE, *USE, *EXCLUDE, and *NONE. The first four values are authorities, which we'll discuss in detail in Chapter 6. If you specify one of these four values for the GRPAUT parameter, the individual user profile that creates an object owns it, and the group profile has the specified authority. (Note that you must leave the GRPAUT parameter set to *NONE if you specify OWNER(*GRPPRF). In other words, you can have the group either own the objects or be authorized to them, but you can't do both.)

The GRPAUTTYP parameter determines the type of authority (i.e., private authority or primary group authority) that the user's group profile has to objects the user creates. If you specify GRPAUTTYP(*PRIVATE), IBM i grants the group profile the private authority specified in the GRPAUT parameter. If you specify GRPAUTTYP(*PGP), IBM i assigns the group profile specified in the GRPPRF parameter as the primary group for the new object, and the primary group authorities will be those designated by the GRPAUT parameter's value.

Assigning private authorities or primary group authorities yields the same results in terms of authorization; however, the performance implications differ slightly. For more information about using primary group authority, see Chapter 6.

Security Recommendation

While described here, in practice I believe I've seen only one IBM i shop use the feature of granting a private authority to users' group profiles. This is not the most effective way to grant group profiles authority to users' objects, and I don't recommend this approach.

UID and GID

The way the IFS was implemented, when a user accesses an object, the system uses the user's User Identification (UID) number rather than the profile name to verify the user's authority to access objects in the IFS. IBM chose this implementation to comply with the POSIX standards and make it easier to port applications written for UNIX systems to run on IBM i. When you create a user profile, IBM i automatically assigns a UID to the profile. Each user must have a unique UID. If you choose to assign users a UID rather than have the system generate one, the UID must be a number between `1` and `4294967294`, and no other profile can already have that number.

The Group Identification Number (GID) is identical in purpose to the UID except that it is assigned only to group profiles.

Technical Note

If you use or plan to use independent auxiliary storage pools (IASPs), you'll want to have the UID be the same for any profile that exists on multiple systems. If the UIDs are the same, bringing an IASP online will occur much faster than if the system has to reassign the UIDs to make the UID of the owners of objects on the IASP the same as the UID of the owner on the new system.

USREXPDATE (User Expiration Date) and USREXPITV (User Expiration Interval)

IBM added two parameters in V7R1 to make it easier for administrators to create temporary profiles. For example, suppose you have a contractor coming in for a two-week project. You can now create a profile for this person and name either a specific expiration date or the number of days after which the profile's status will be set to `*DISABLED`. This function is available in earlier releases through the Change Expiration Schedule Entry (`CHGEXPSCDE`) security tool, which I describe later in this chapter.

AUT (Authority)

The `AUT` parameter is the `*PUBLIC` authority setting on the user profile itself. By default, IBM i sets the user profile to `*PUBLIC *EXCLUDE`. I do not recommend changing this value.

I've seen numerous situations where the *PUBLIC authority of some or all profiles was set to *USE or greater. With this authority setting, anyone with a sign-on to the system can submit a job as one of these profiles or use a job description that names one of these profiles. This capability lets users run as a more powerful user than themselves. To ensure that one user cannot abuse the power of another profile's capabilities and access, it's vital that you leave the *PUBLIC authority of profiles at *EXCLUDE.

In some cases, however, certain users need to see profiles' attributes. This is often the case when help desk personnel or programmers are debugging production issues and need to view users' group profiles, special authorities, and text descriptions. In this case, you can grant the group profiles of those users (e.g., GRP_HELP, GRP_PGMR) *READ authority to all profiles. This authority lets the group members see the attributes of a profile but not submit a job or otherwise use the profile. While some organizations choose to set the *PUBLIC authority of profiles to *READ, most organizations don't want to expose all profiles' attributes to being viewed by all other users on the system.

Private Authorities and User Profiles

When you create a user profile, IBM i gives the profile *CHANGE plus *OBJMGT (object management) authority to itself. When you make a profile a member of a group profile, IBM i grants the member profile *OBJOPR (object operation), *OBJMGT, *READ, *ADD, *UPDATE, and *DLT authorities to the group profile. In both cases, these private authorities are required for normal system operations and should not be removed. For example, if you remove the authority to a user's group profile, the user won't be able to sign on. Likewise, you shouldn't add authorities. I've seen some organizations add *EXECUTE to the authorities that users have been given to their group profile. This authority lets each group member submit a job that runs as the group profile rather than being restricted to running jobs only under their own profile.

You'll learn more about private authorities in Chapter 6.

Helpful Tools

Several security tools can help you manage user profiles on your system. Table 4.4 lists and describes each of these commands. You can find these tools on the SECTOOLS and SECBATCH menus.

Table 4.4: Tools for managing user profiles

Security Tool	Description
ANZDFTPWD (Analyze Default Passwords)	Prints a report listing each user profile whose password is equal to the user profile name. Such profiles aren't secure, and they require attention.
ANZPRFACT (Analyze Profile Activity)	Checks user profiles' last sign-on date and last-used date every day and disables any profiles that haven't been used in a specified number of days (you supply the number). However, some applications that use profiles don't update the last sign-on or last-used date, making the profile look as though it's been inactive. To exempt a profile from ANZPRFACT processing, use the CHGACTPRFL command to add the profile to the exemption list.
CHGACTPRFL (Change Active Profiles List)	Lets you add and remove user profiles from the ANZPRFACT command's active profile (i.e., exemption) list. ANZPRFACT ignores any profiles that are on the exemption list.
DSPACTPRFL (Display Active Profiles List)	Lists the user profiles that are on the ANZPRFACT exemption list.
DSPACTSCD (Display Activation Schedule)	Lists the schedule information that controls enabling and disabling user profiles by date and time. This information includes the user profile and the valid inactive day and time you've specified for that user on the CHGACTSCDE command.
CHGACTSCDE (Change Activation Schedule Entry)	Creates and maintains user profile entries and their activation day and time periods. For each user profile, you can schedule days and times for which the user profile is inactive, thus controlling that user's system use.
DSPEXPSCD (Display Expiration Schedule)	Lists user profiles that are scheduled to be removed or disabled.
CHGEXPSCDE (Change Expiration Schedule Entry)	Lets you create and maintain a list of user profiles that you want to remove or disable at some point in the future. This tool makes managing temporary profiles easier by scheduling their removal so you don't have to remember to remove them. Each day at one minute after midnight, the system runs a job that examines this list and takes the appropriate action.
PRTUSRPRF (Print User Profile)	Lets you print information about user profiles based on selection criteria that you supply (e.g., special authorities, user class, mismatch between user class and special authorities). You can print authority information, environment information, and password information.
PRTPRFINT (Print Profile Internals)	Lets you print information about how "full" a user profile is. User profiles contain an entry for each object owned, each private authority the user has, each private authority another user has to objects this user owns, and each primary group authority assigned. If there are too many of these entries, the user profile becomes full. (If a user profile is full, it can't own more objects, be authorized to additional objects, allow any objects it owns to be authorized to another user, or become the primary group of an object.) This command produces a report indicating how full the profile is and the percentage of each type of entry.

Navigator for i

You can use IBM Navigator for i instead of the CRTUSRPRF command to create user profiles. To do so, expand the directory for the system on which you want to create the user, and open **Users and Groups**; then select **All Users** and **Create User**. Figure 4.2 shows the Create User configuration screen.

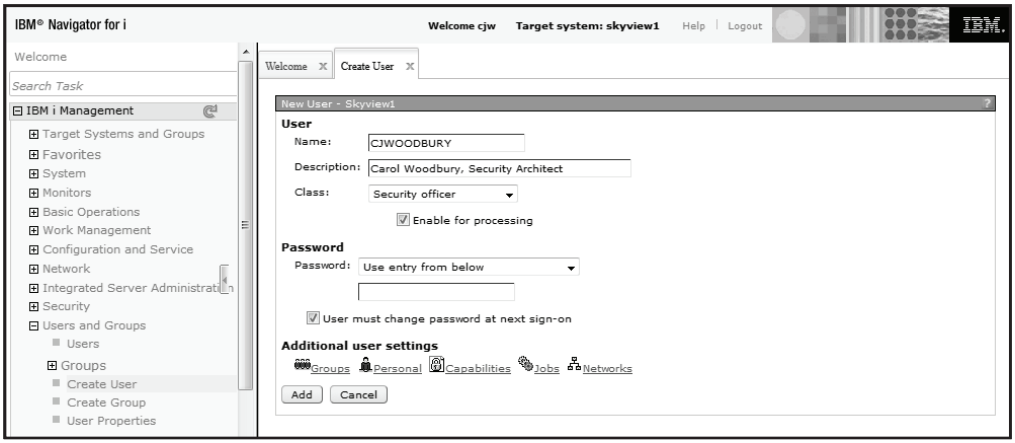

Figure 4.2: Create User configuration screen

When you use this interface, you'll notice that Navigator's terminology for user profile attributes differs from that of the CRTUSRPRF command. For example, the option *User must change password at next sign-on* is equivalent to the CRTUSRPRF command's PWDEXP (Set password to expired) parameter. You might find this difference a bit confusing if you're moving between Navigator for i and green-screen commands, but IBM's intent with Navigator is to better describe the attribute.

In contrast to the way you create a group profile through the command-line ("green-screen") interface, Navigator provides a separate interface for creating group profiles. To create a new group profile, expand the directory for the system on which you want to create the new group profile; then open **Users and Groups**, and select **Create Group**. Figure 4.3 shows the Create Group configuration screen.

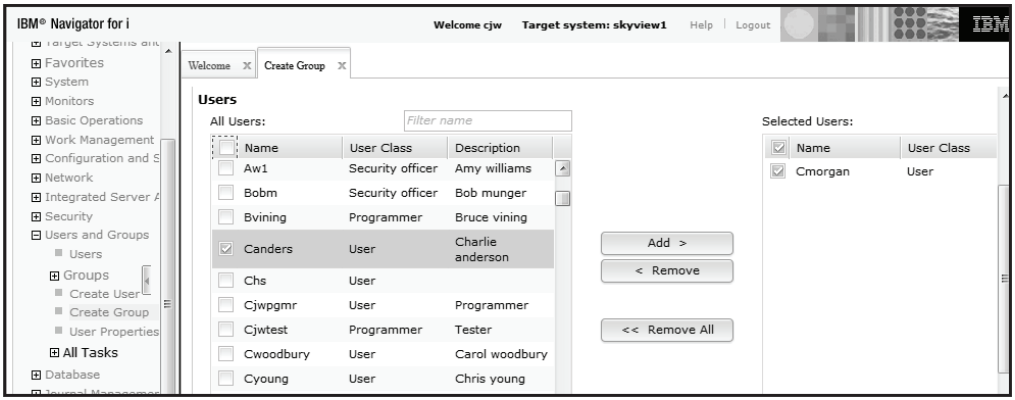

Figure 4.3: Create Group configuration screen

Notice that Navigator doesn't include most of the user profile attributes in this interface. That's because many of the user profile parameters don't make sense for or don't apply to group profiles. For example, Navigator doesn't let you specify a password for a group profile because group profiles shouldn't be used to sign on.

Another benefit of using Navigator to create user profiles is the other things Navigator lets you do at the same time or does automatically for you. For example, it automatically creates a system distribution entry for a user profile. You can also choose to create a Lotus Notes client for a user profile.

If you need to create the same user on multiple systems, you can use Management Central (a component of Navigator for i that lets you manage tasks across multiple servers simultaneously) to get that profile created on all systems being managed by Management Central.

Copying User Profiles

Although most of this chapter has discussed creating user profiles "from scratch," in reality I have found very few organizations that create user profiles by using the `CRTUSRPRF` command or Navigator's New User interface. Instead, most organizations copy an existing user profile or base the new profile on an existing profile. Often, the profile being copied is the profile of another user in the same area of the organization. Although convenient, this method often propagates special authorities and data access to the new profile even when they are not required for the new user to complete his or her job requirements. That's because many existing profiles were created with more special authorities than necessary. And in most cases, organizations don't go back and remove the

excess special authorities. So when an existing profile is copied, the excess capabilities are propagated to the new profile.

A slightly different method that avoids this propagation issue copies a profile that you've created as a "template." The template profile has only the necessary special authorities (if any) and accesses. I recommend you create a template profile for each role on your system. This approach to creating user profiles ensures that each profile gets created with only the capability and access required for that role—and no more.

Validation List Users

Let's turn our attention now to one of the other types of user identities I listed at the beginning of this chapter: validation list users. Validation list users are defined and managed in validation list (`*VLDL`) objects by applications and the Apache Web server. The Apache server refers to these users as "Internet users." Validation list users can be authenticated by applications, but they cannot be used as the profile under which an IBM i job is run. The purpose of a validation list user is to give applications a way to define application users or functions without requiring the user to have an IBM i user profile.

Validation list users are useful for certain applications, especially Internet applications, where you need to authenticate users (e.g., customers, members, or frequent website visitors) who don't work for your organization and therefore have no need for a full IBM i user profile. Because validation list users can't be used to run jobs on your system, it is more secure for applications to use validation list users rather than user profiles.

Another application for a validation list is to store a password that needs to be used or passed in clear-text. For example, rather than hard-coding the user ID and password needed to run an automated FTP script, you can store the password in a validation list and retrieve it prior to running the FTP log-on command.

A validation list user is an entry in a validation list object. The entry consists of an identifier, data that is encrypted when stored in a validation list entry (encrypted data), and other unformatted data (entry data). Any of these fields can be defined in any coded character set ID (CCSID) in the range of `1` to `65535` and can use any available character. An identifier can be up to 100 characters long. Encrypted data can be up to 600 characters. The entry data field can be up to 1,000 characters. The encrypted data field is intended for applications to use to store passwords. This field is sometimes used to store other kinds of sensitive information.

Applications are responsible for managing all aspects of validation list users, including password composition rules, aging, and expiration and invalid sign-on attempts.

Applications can choose whether passwords in validation list entries can be used only for password verification (i.e., one-way encrypted) or can also be returned in unencrypted form (two-way encrypted).

No commands exist to add, remove, change, or verify encrypted data; only APIs are provided. Figures 4.4A through 4.4D show the code for command PRTVLDL, which uses the validation list APIs to retrieve the user attributes. Figure 4.4E shows the entry screen presented by the command, and Figure 4.4F shows the results of running the command against a sample validation list.

Figure 4.4A: CL command PRTVLDL

```
/*==================================================================*/
/*   Author: Paul Tuohy, ComCon  - 2003                             */
/*==================================================================*/

Cmd  'Print Validation List'

   Parm  VLDL  Q1                                          +
         Min( 1 )                                          +
         Prompt( 'Validation List')

Q1:                                                        +
      Qual  *NAME  10                                      +
            Min( 1 )                                       +
            Expr( *YES )
      Qual  *NAME  10                                      +
            Dft( *LIBL )                                   +
            SpcVal( ( *LIBL ) )                            +
            Expr( *YES )                                   +
            Prompt( 'Library' )
```

Figure 4.4B: DDS for command PRTVLDL

```
A*-------------------------------------------------------------------
A*    Author: Paul Tuohy, ComCon  - 2003
A*-------------------------------------------------------------------
A          R HEAD
A                                     SKIPB(5)
A                                    13DATE
A                                     EDTCDE(Y)
A                                    53'List Validation List Entries'
A                                   116'Page'
A                                    +1PAGNBR
A                                     SPACEA(2)
A                                     3'Validation List:'
A            QUALNAME      21   O    21SPACEA(2)
A                                     3'Create'
A                                    15'Last'
A                                     SPACEA(1)
A                                     3'Date'
A                                    15'Used'
A                                    28'User Id'
A          R DETAIL
A                                     SPACEB(1)
A            PRTCREATE       L  O     3DATFMT(*USA)
A N90        PRTUSED         L  O    15DATFMT(*USA)
A  90                                15'Not Used'
A            USERID       100   O    28SPACEA(1)
A          R FOOTER
A                                     SPACEB(1)
A                                    54'***** End of Report *****'
A                                     SPACEA(1)
```

Figure 4.4c: RPG IV prototypes for command PRTVLDL

```
  //-------------------------------------------------------------------
  //   Author: Paul Tuohy, ComCon - 2003
  //-------------------------------------------------------------------

  // Prototypes and structures for PRTVLDL
  //
  // Standard API Error Data Structure

D APIError        DS
D  EBytesP                      10I 0 INZ(40)
D  EBytesA                      10I 0
D  EMsgID                        7A
D  EReserved                     1A
D  EData                        40A
  // Prototype for Call to System API
  //     QWCCVTDT - Convert Date and Time Format
  //     Refer to API Documentation for Parameter Descriptions.

D ConvertDate     PR                  ExtPgm('QWCCVTDT')
D  InputFormat                  10    Const
D  InputVar                      8    Const
D  OutputFormat                 10    Const
D  OutPutVar                    17
D  Error                              Like(APIError)

  //-------------------------------------------------------------------
  //
  // The following are the structures, parameters, and prototypes for
  // the validation list APIs,
  //          QsyFindFirstValidationLstEntry
  //          QsyFindNextValidationLstEntry
```

Continued

```
  //          QsyFindValidationLstEntryAttrs
  //
  //     Refer to API Documentation for Parameter Descriptions.
  //     Refer to QSYSINC/H(QSYVLDL) for C equivalents.

  // Parameter Fields and Structures

D Validation_Lst  S             20

 // Qsy_Entry_Id_Info
D Entry_Id        DS                  Qualified Align
D  Len                          10I 0
D  CCSID                        10U 0
D  EntryId                     100

D Entry_Id_Info   DS                  LikeDS(Entry_Id)

 // Qsy_Entry_Encr_Data_Info_T
D Encr_Data_Info  DS                  Qualified Align
D  Len                          10I 0
D  CCSID                        10U 0
D  Data                        600

 // Qsy_Entry_Data_Info_T
D Entry_Data_Info...
D                 DS                  Qualified Align
D  Len                          10I 0
D  CCSID                        10U 0
D  Data                       1000

 // Qsy_Rtn_Vld_Lst_Ent_T
D Rtn_Entry       DS                  Qualified Align
D  EntryIdInfo                        Like(Entry_Id)
```

Continued

```
D  EncrDataInfo                          Like(Encr_Data_Info)
D  EntryDataInfo                         Like(Entry_Data_Info)
D                                  4
D  MoreInfo                         *

 // Qsy_Attr_Info_T
D Rtn_Attributes  DS                     Qualified
D  NumberAttrs                    10I 0 Inz(1)
D                                 12
D  AttrDesc                              Like(Attr_Desc)

 // Qsy_Attr_Descr_T
D pAttr_Desc      S                 *
D Attr_Desc       DS                     Qualified
D                                        Based(pAttr_Desc)
D  Location                       10I 0
D  Type                           10I 0
D  Res1                            8
D  AttrId                           *
D  OtherDescr                     32
D  DataInfo                       96
D  InVLDL                                Like(In_VLDL)
D                                        Overlay(DataInfo)
D  OtherData                      32

 // Qsy_In_VLDL
D pIn_VLDL        S                 *
D In_VLDL         DS                     Qualified
D                                        Based(pIn_VLDL)
D  CCSID                          10I 0
D  Len                            10I 0
D  Res1                            8
D  AttrValue                        *
```

Continued

```
 // Qsy_Rtn_VLDL_Attr_T
D Rtn_VLDL_Attr   DS                  Qualified Align
D  BytesReturn                  10I 0
D  BytesAvail                   10I 0
D  AttrLen                      10I 0
D  AttrCCSID                    10I 0
D  AttrData                     28

 // Qsy_Rtn_Entry_Usage_Attr_T
D Rtn_Rtn_Entry_Usage...
D                 DS                  Qualified Align
D  CreateDate                    8
D  LastUsedDate                  8
D  EncrDataChgDt                 8
D  NotVldVerify                 10I 0


 //
 // Prototypes


D FirstLstEntry   PR            10I 0 ExtProc('QsyFindFirst-
D                                     ValidationLstEntry')
D  Qsy_Qual_Name_T...
D                               20    Const
D  Qsy_Rtn_Vld_Lst_Ent_T...
D                                     Like(Entry_Id)

D NextLstEntry    PR            10I 0 ExtProc('QsyFindNextValidation-
D                                     LstEntry')
D  Qsy_Qual_Name_T...
D                               20    Const
```

Continued

```
D  Qsy_Entry_ID_Info_T...
D                                    Like(Entry_Id_Info) Const
D  Qsy_Rtn_Vld_Lst_Ent_T...
D                                    Like(Entry_Id)

D GetVldLstEntry  PR            10I 0 ExtProc('QsyFindValidationLstEnt-
D                                    ryAttrs')
D  Qsy_Qual_Name_T...
D                               20    Const
D  Qsy_Entry_ID_Info_T...
D                                    Like(Entry_Id) Const
D  Qsy_Rtn_Vld_Lst_Ent_T...
D                                    Like(Rtn_Entry)
D  Qsy_Attr_Info_T...
D                                    Like(Rtn_Attributes)

D errno           PR              *   EXTPROC('__errno')

D errno_value     S             10I 0 based(errno_ptr)
D errno_ptr       S               *
```

Figure 4.4D: PRTVLDL command processing program

```
H DftActGrp(*NO) Option(*SrcStmt:*NoDebugIO) BNDDIR('QC2LE') ACTGRP(*NEW)

 //-------------------------------------------------------------------
 //   Author: Paul Tuohy  - 2003
 //-------------------------------------------------------------------
 //
 //   PRTVLDL - Print Validation List
 //
 //   With many thanks to Simon Coulter for help with
```

Continued

```
 //   deciphering the C structures.
 //
 //-----------------------------------------------------------------
FPrtVLDLP  O    E             Printer OFLInd(OverFlow)

 /COPY PRTVLDLPR

 //_______________________________
 // Program Fields.
D  rc             S             10I 0
D  QsyEntryUsage  S             20    Inz('QsyEntryUsage')
D  DateVar        S             17

 //*****************************************************************
 // Mainline.                                                      *
 //*****************************************************************
C     *ENTRY        Plist
C                   Parm                    Validation_Lst

 /Free

    QualName = %TrimR(%SubSt(Validation_Lst:11:10)) + '/' +
                 %SubSt(Validation_Lst:1:10);
    Write Head;
   // Set the parameters for the validation list APIs
    ExSR SetParms;

   // Get the first entry in the list then
    rc = FirstLstEntry(Validation_Lst:Rtn_Entry);
    Entry_Id = Rtn_Entry.EntryIdInfo;
    DoW  rc = 0;

      // Print Details
```

Continued

```
      ExSR PrintDetail;

     // Get the next entry in the list
      rc = NextLstEntry(Validation_Lst:Entry_Id:Rtn_Entry);
      Entry_Id = Rtn_Entry.EntryIdInfo;
  EndDo;

  *InLR = *On;

//_____________________________________________________
// Set parameters for Validation List APIs
BegSR SetParms;

   QsyEntryUsage = %Trim(QsyEntryUsage) + x'00';

   pAttr_Desc = %Addr(Rtn_Attributes.AttrDesc);
   Attr_Desc.Location = 0;
   Attr_Desc.Type = 0;
   Attr_Desc.Res1 = *Allx'00';
   Attr_Desc.AttrId = %Addr(QsyEntryUsage);
   Attr_Desc.OtherDescr = *Allx'00';
   Attr_Desc.DataInfo = *Allx'00';
   Attr_Desc.OtherData = *Allx'00';

   pIn_VLDL = %Addr(Attr_Desc.InVLDL);
   In_VLDL.CCSID = -1;
   In_VLDL.Len = %Len(Rtn_VLDL_Attr);
   In_VLDL.Res1 = *Allx'00';
   In_VLDL.AttrValue = %Addr(Rtn_VLDL_Attr);

EndSR;
```

Continued

```
 //_____________________________________________________
 // Print Details for every entry
 BegSR PrintDetail;

   // Get the entry attributes
    rc = GetVldLstEntry(Validation_Lst:Entry_Id:
                        Rtn_Entry:Rtn_Attributes);

   // Store the attributes returned
    Rtn_Rtn_Entry_Usage = Rtn_VLDL_Attr.AttrData;

   // Convert dates from system format (*DTS) to printable format
    ConvertDate('*DTS':Rtn_Rtn_Entry_Usage.CreateDate:
                '*YYMD':DateVar:APIError);
    PrtCreate = %Date(%SubSt(DateVar:1:8):*ISO0);
    ConvertDate('*DTS':Rtn_Rtn_Entry_Usage.LastUsedDate:
                '*YYMD':DateVar:APIError);
    PrtUsed = %Date(%SubSt(DateVar:1:8):*ISO0);

   // Check for not used
    *In90 = (PrtUsed = D'1928-08-23');

    UserId = %SubSt(Entry_Id.EntryId:1:Entry_Id.Len);

    Write Detail;
    If OverFlow;
        Write Head;
        OverFlow = *Off;
    EndIf;

 EndSR;

/END-FREE
```

```
Session A - [24 x 80]
                         Print Validation List (PRTVLDL)

Type choices, press Enter.

Validation List  . . . . . . . .   [redacted]     Name
  Library  . . . . . . . . . . .     *LIBL        Name, *LIBL

                                                                  Bottom
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys
Parameter VLDL required.
MA    a                  MW
```

Figure 4.4E: Print Validation List command screen

Figure 4.4F: Validation list entries report

```
3/08/03              List Validation List Entries              Page 0001
Validation List:  *LIBL/TEST
Create       Last
Date         Used          User Id
06/25/2003   Not Used      joan
06/25/2003   Not Used      mary
06/21/2003   Not Used      paul
```

Security Implications of Validation List Users

As an administrator, you need to be aware of validation list users. Find out whether any applications use them and, if so, whether the applications manage those users according to your security policy requirements.

While administrators can control whether authentication information stored in validation lists can be decrypted, it is impractical to change the system value that controls

whether validation list passwords are decryptable (QRETSVRSEC—Retain Server Security). Too many system functions use this capability, and you risk breaking a function if you change QRETSVRSEC from 1 to 0. When QRETSVRSEC is set to 0 (the default), the authentication information cannot be decrypted. A value of 1 permits the information to be stored and decrypted. A value of 0 still lets the data be stored, but it cannot be decrypted.

When you change QRETSVRSEC to 0, existing validation list user information cannot be decrypted, but the information isn't removed from the entries. If QRETSVRSEC is set back to 1, the entries can once again be decrypted.

To remove the encrypted data from all validation list entries in all validation list objects, set system value QRETSVRSEC to 0 and then run the CLRSVRSEC (Clear Server Security Data) command. Doing so will leave the entries but remove the decryptable data.

Technical Note

Data stored in validation lists as non-decryptable is not cleared by the CLRSVRSEC command and is not affected when system value QRETSVRSEC is changed.

CHAPTER 5

Service Tools Security

The third type of user identity I mentioned at the beginning of Chapter 4, service tools user identities, helps you secure a critical part of the system known as service tools. The service tools are a set of low-level tools provided by IBM i through the Dedicated Service Tools (DST), System Service Tools (SST), and IBM Navigator for i logical partitioning and disk unit management functions. Among other things, the functions available in the service tools include the capability to see or change nearly everything stored on disk!

Service functions are a set of capabilities within the service tools that are normally used for problem determination and problem solving, usually with the guidance of IBM support. Examples of service functions include the Licensed Internal Code (LIC) trace, LIC log, and display/alter/dump functions.

DST is available only from the console and can even be used when only the LIC is available and not IBM i. SST lets you access service tools and functions from IBM i by running the `STRSST` (Start System Service Tools) CL command. Most, but not all, of the service tool features are available through SST.

Service tools are very powerful, and improper use of them can damage your server. Controlling access to the service tools is therefore vital to protecting your system and the security of your data. Service tools security consists of three primary elements:

service tools user IDs, functional privileges, and device IDs. Let's start with service tools user IDs.

Service Tools User IDs

Service tools user IDs are separate, and different, from IBM i user profiles. Created through DST or SST, service tools user IDs have their own password and can be assigned service tools *functional privileges* that permit a user to perform selected service tool functions. You can define up to 100 service tools user IDs. Included in this total are four IBM-supplied user IDs that are built in to the service tools: `11111111`, `22222222`, `QSECOFR`, and `QSRV`.

Technical Note

The QSECOFR user profile and the QSECOFR service tools user ID are completely different entities. This fact is often (and understandably) a point of confusion. For example, changing the IBM i QSECOFR user profile password has absolutely no effect on the QSECOFR service tools user ID password.

You create service tools user IDs for users who need to perform service functions for the same reason you create a unique IBM i user profile for each user: to provide accountability and separation of duties. For example, you can create a service tools user ID that lets one person administer the configuration of one LPAR and create another ID that lets a different user administer a different LPAR. Just as you should create user profiles with only the capabilities needed to perform the required job functions, you should create service tools user IDs and grant only the functional privileges required to perform the services or tasks appropriate for each user's job function.

Figures 5.1 and 5.2 show the SST screens used to work with and create service tools user IDs. To use the `STRSST` command, you must have a valid service tools user ID and password.

```
                        Work with Service Tools User IDs
                                                                System:   SKYVIEW3
Type option, press Enter.
  1=Create              2=Change password      3=Delete
  4=Display             5=Enable               6=Disable
  7=Change privileges   8=Change description   9=Link/Remove link

Opt User ID     Description                                        Status
 1  sstuser
 _  AMY         AMY WILLIAMS                                       Enabled
 _  CJW         CAROL WOODBURY                                     Enabled
 _  LDB         DRFRANKEN                                          Enabled
 _  QSECOFR     QSECOFR                                            Enabled
 _  QSRV        QSRV                                               Enabled
 _  11111111    11111111                                           Enabled
 _  22222222    22222222                                           Enabled

F3=Exit   F5=Refresh   F12=Cancel
```

Figure 5.1: Work with Service Tools User IDs panel

```
                          Create Service Tools User ID
                                                                System:   SKYVIEW3
Service tools user ID name  . . . . . . . :  SSTUSER

Type choices, press Enter
  Password  . . . . . . . . . . . . . . . .


  Set password to expire  . . . . . . . . .  1   1=Yes, 2=No
  Description . . . . . . . . . . . . . . .  New SST User _____________________
_____________________________
  Linked user profile . . . . . . . . . . .  ___________

F3=Exit   F5=Change privilege   F12=Cancel
```

Figure 5.2: Create Service Tools User ID panel

Service Tools User ID Passwords

Two sets of password policies are available for service tools user IDs. The default password policy uses Data Encryption Standard (DES) encryption.

The other password policy uses Secure Hash Algorithm (SHA) encryption, supports a much longer password length, and greatly expands the password character set. This password policy enables significantly stronger passwords than the default password policy.

Service tools user ID passwords are initially set to *expired* unless they are explicitly set otherwise. Whenever an administrator sets or changes a password for another user, by default the password is set to *expired*. The administrator can override this setting by specifying option **2** (No) for the **Set password to expire** option when creating a service tools user ID. This option is also available on the Change Service Tools User Password for Another User panel, reached by selecting option **2** (Change password) on the Work with Service Tools User IDs panel.

Passwords for the IBM-supplied service tools user IDs `22222222`, `QSECOFR`, and `QSRV` are also initially set to default and expired, which means you're required to change the password before you can sign on using one of these IDs. You can always sign on to DST using the `QSECOFR` service tools user ID and password even if that password is expired.

Security Recommendation

Of the four predefined service tools user IDs that are shipped with IBM i—`11111111`, `22222222`, `QSECOFR`, and `QSRV`—each one except `11111111` comes with a default and expired password. `11111111` is shipped with a default and unexpired password. It should go without saying that you should immediately change the `11111111` password to something other than the default.

Default Password Policy Details

The default password policy has the following attributes:

- Uppercase user IDs, maximum 10 characters in length.
- *Case-sensitive* passwords, maximum eight characters in length. At user ID creation time, the password must be at least one character long. When a password is changed, the new password must be at least six characters long.
- Passwords for user IDs do not expire due to the passage of time; however, they can be set to *expired* by an administrator. (By default, passwords are expired when the profile is created.)

- With the exception of `11111111`, initial passwords for IBM-shipped service tools user IDs default to being the same as the name of the service tools user ID and *expired*.
- By default, service tools user IDs cannot repeat their past 18 passwords. You can change this interval by selecting option **10** (Duplicate password control) on the Work with Service Tools Security Data menu. The value can be any number in the range `0-32`.
- By default, user IDs are disabled after three incorrect passwords are entered. You can change the maximum number of failed sign-on attempts using option **9** (Maximum sign-on attempts allowed) on the Work with Service Tools Security Data menu. The value can be set to `2-99`.

Alternate Password Policy Details

The alternate password policy has the following attributes:

- Uppercase user IDs, maximum 10 characters in length.
- 128-digit, case-sensitive passwords. At user ID creation time, passwords must be at least one character long. When passwords are changed, they must be at least six characters.
- By default, passwords for user IDs expire after 180 days; however, you can change the expiration interval using option **8** (Password expiration interval in days) on the Work with Service Tools Security Data menu. The value can be `0` for `*NOMAX` or up to `999` days.
- By default, passwords cannot be repeated for 18 passwords. You can change this interval using option **10** (Duplicate password control) on the Work with Service Tools Security Data menu. The value can be set to `0-32`.
- By default, user IDs are disabled after three incorrect passwords are entered. You can change the maximum number of failed sign-on attempts using option **9** (Maximum sign-on attempts allowed) on the Work with Service Tools Security Data menu. The value can be set to `2-99`.

Be aware that if you change to the alternate password policy, you cannot change back to the default policy! To change to use the alternate password policy, use DST to perform the following steps:

1. Sign on to DST using your service tools user ID.
2. On the Use Dedicated Service Tools (DST) menu, select option **5** (Work with DST environment).
3. On the Work with DST Environment menu, select option **6** (Service tools security data).
4. On the Work with Service Tools Security Data menu, select option **6** (Password level).
5. A message asking whether you want to change to the new password policy will appear. Press **Enter**.

Technical Note

To change the password policy (or any of the other password rules), a service tools user ID must have the **Dedicated Service Tools (DST) environment** privilege and the **Service tool security** privilege. Only QSECOFR is shipped with both of these privileges (which are described in the next section).

Choosing a Password Policy

Which password policy should you use? The alternate password policy provides much stronger password protection than the default policy. Its strength comes primarily from the larger set of characters that can be used in your passwords. I recommend using the alternate password policy unless clients running a pre-V5R1 version of Navigator need to access your system. (These clients support only the weaker algorithm.)

Service Tools Functional Privileges

Service tools functional privileges let you control which panels of SST and DST an individual service tools user ID can access. By controlling which panels a service tools

user is permitted to see, you can control which functions within SST and DST the user is allowed to run. IBM provides a large number of privileges, enabling you to create service tools user IDs that are limited to just the specific tasks you want a user to be able to accomplish. Although no auditor would ever know to ask about service tools user ID settings and there are no laws or regulations requiring this, it is simply a good security practice to create user IDs with only the privileges required to perform their job responsibilities. Functional privileges let you do this.

Each of the four predefined service tools user IDs that IBM ships with IBM i comes with a default set of functional privileges. We cover those defaults later. First, let's take a look at the full set of privileges available and how you access them.

In the panels used to work with and create service tools user IDs (Figures 5.1 and 5.2), you may have noticed the option to **Change privilege(s)** (by typing option **7** or pressing **F5**, respectively). Choosing this option produces a series of screens similar to those shown in Figures 5.3A through 5.3C.

```
                          Change Service Tools User Privileges
                                                          System:   SKYVIEW
Service tools user ID name  . . . . . . . . :  CAROL

Type option, press Enter.
  1=Revoke   2=Grant

Option   Functions                                          Status
  -      Disk units - operations                            Revoked
  _      Disk units - administration                        Revoked
  _      Disk units - read only                             Revoked
  _      System partitions - operations                     Revoked
  _      System partitions - administration                 Revoked
  _      Partition remote panel key                         Revoked
  _      Operator panel functions                           Revoked
  _      Operating system initial program load(IPL)         Revoked
  _      Install                                            Revoked
  _      Performance data collector                         Granted
  _      Hardware service manager                           Revoked
  _      Display/Alter/Dump                                 Revoked
  _      Main storage dump                                  Granted
                                                                  More...
F3=Exit   F5=Reset   F9=Defaults   F12=Cancel
```

Figure 5.3A: Change Service Tools User Privileges—Screen 1

```
                          Change Service Tools User Privileges
                                                              System:   SKYVIEW
 Service tools user ID name  . . . . . . . . :  CAROL

 Type option, press Enter.
   1=Revoke   2=Grant

 Option   Functions                                            Status
   _      Product activity log                                 Revoked
   _      Licensed Internal Code log                           Granted
   _      Licensed Internal Code fixes                         Granted
   _      Trace privilege                                      Revoked
   _      Dedicated Service Tools (DST) environment             Revoked
   _      Remote service support                               Revoked
   _      Service tool security                                Revoked
   _      Service tool save and restore                        Revoked
   _      Debug                                                Revoked
   _      System capacity - operations                         Revoked
   _      System capacity - administrator                      Revoked
   _      System security                                      Revoked
   _      Start Service Tools                                  Revoked
                                                                      More...
 F3=Exit   F5=Reset   F9=Defaults   F12=Cancel
```

Figure 5.3B: Change Service Tools User Privileges—Screen 2

```
                          Change Service Tools User Privileges
                                                              System:   SKYVIEW
 Service tools user ID name  . . . . . . . . :  CAROL

 Type option, press Enter.
   1=Revoke   2=Grant

 Option   Functions                                            Status
   _      Take over console                                    Revoked









                                                                     Bottom
 F3=Exit   F5=Reset   F9=Defaults   F12=Cancel
```

Figure 5.3C: Change Service Tools User Privileges—Screen 3

The Change Service Tools User Privileges screens list the functional privileges that can be granted or revoked:

- Disk units – operations
- Disk units – administration
- Disk units – read only
- System partitions – operations—This privilege lets the user access panels that control most attributes of existing partitions. (This privilege is valid only on pre-POWER5 systems.)
- System partitions – administration—This privilege lets the user access all functions related to managing a partition. (This privilege is valid only on pre-POWER5 systems.)
- Partition remote panel key *XXXXXXXX* (0–7)—(This privilege is valid only on pre-POWER5 systems.)
- Operator panel functions
- Operating system initial program load (IPL)
- Install
- Performance data collector—New service tools users are granted this privilege by default.
- Hardware service manager
- Display/Alter/Dump
- Main storage dump—New service tools users are granted this privilege by default.
- Product activity log
- Licensed Internal Code log—New service tools users are granted this privilege by default.
- Licensed Internal Code fixes—New service tools users are granted this privilege by default.
- Trace privilege—Communications trace
- Dedicated Service Tools (DST) environment—This privilege controls access to panels in DST from which users can access security functions related to DST. To be

able to perform security-related functions in DST, a user must possess this privilege as well as the **Service tool security** privilege.

- Remote service support
- Service tool security—This privilege is required to manage service tools security, which includes managing service tools users, privileges, and device profiles.
- Service tool save and restore
- Debug
- System capacity – operations
- System capacity – administrator
- System security—This privilege controls access to the Work with System Security panel (described later). By tightly controlling access to this panel, you can tightly control your overall security configuration (e.g., security-related system value settings) and who is allowed to change it.
- Start Service Tools—You can create user IDs that are allowed to run DST from a console but not from SST. Because the DST panels contain more function than SST, you can use this privilege to split responsibility among different people. An individual with an IBM i user profile that has `*SERVICE` special authority and a valid service tools user ID will not be allowed to successfully run the `STRSST` CL command unless the user's service tools user ID has this privilege.
- Take over console

Table 5.1 shows the default functional privileges that are shipped with each service tools user ID.

Table 5.1: Default functional privileges

	Service Tools User IDs				
Privilege	**11111111**	**22222222**	**QSECOFR**	**QSRV**	**New***
System partitions – operations		X	X	X	
System partitions – administration		X	X	X	
Disk units – operations		X	X	X	
Disk units – administration		X	X	X	
Disk units – read only		X	X		
Trace privilege	X	X	X	X	

Table 5.1: Default functional privileges (continued)

	Service Tools User IDs				
Privilege	**11111111**	**22222222**	**QSECOFR**	**QSRV**	**New***
Display/Alter/Dump		X	X		
Licensed Internal Code log		X	X	X	X
Hardware service manager		X	X	X	
Product activity log	X	X	X	X	
Main storage dump	X	X	X	X	X
Install		X	X	X	
Performance data collector	X	X	X	X	X
Operating system initial program load (IPL)	X	X	X	X	
Licensed Internal Code fixes	X	X	X	X	X
Dedicated Service Tools (DST) environment	X	X	X	X	
Debug		X	X	X	
Service tool save and restore		X	X	X	
Remote service support		X	X	X	
Partition remote panel key 0	X	X	X	X	
Operator panel functions	X	X	X	X	
Service tool security			X		
System capacity – operations		X	X	X	
System capacity – administrator		X	X	X	
System security			X		
Start Service Tools		X	X	X	
Take over console			X	X	

* These privileges are granted by default to newly created service tools user IDs.

Technical Note

Because service tools user ID `11111111` is granted the **Dedicated Service Tools (DST) environment** privilege by default, it can be used to change the security environment of the service tools. For example, it can be used to change the expired passwords of the other predefined service tools IDs. Coupled with the fact that `11111111` is shipped with a default and unexpired password, this ability constitutes a security exposure until you change the ID's password.

Service Tools Features

V6R1 introduced the concept of "linking" a service tools user ID with an IBM i user profile. This capability is provided to enable functions that require one or more of the service privileges but are actually run from a command line rather than from SST or DST. These functions are typically run when you're on the phone with IBM debugging a problem and not something you'd run as a normal part of your daily activities.

Technical Note

The IBM i QSECOFR profile is linked to the QSECOFR service tools user ID, and this link cannot be removed or changed.

You can link an individual's service tools user ID to the individual's IBM i profile or, if you have several IBM i profiles that need the service privilege, you can create a service tools user ID, grant it the required privilege, and then link it to group profile of the IBM i user profiles. When you link a service tools user ID to an IBM i group profile, every profile in the group is linked to the service tools user ID and has that privilege when running the IBM i functions that require it.

Technical Note

Because the IBM i QSECOFR profile is linked to the QSECOFR service tools user ID, every IBM i profile that is a member of QSECOFR is linked to the QSECOFR service tools ID.

V6R1 also provides a long-awaited method of displaying the attributes of service tools user IDs from IBM i. In prior releases, you had to go into SST or DST to view the attributes of individual service tools user IDs. The DSPSSTUSR (Display Service Tools User ID) command lets you display or print the attributes of one or all service tools user IDs. Figure 5.4 shows the information provided for every service tools user ID.

```
                                                   Display Service Tools User ID
Service tools user ID  . . . . . . . . . . . :   QSECOFR
Previous sign-on . . . . . . . . . . . . . . :   11/28/15  10:21:46
Password verification not valid  . . . . . . :   0
Status . . . . . . . . . . . . . . . . . . . :   *ENABLED
Linked user profile  . . . . . . . . . . . . :   QSECOFR
  Linked user profile exists . . . . . . . . :     Yes
Date password last changed . . . . . . . . . :   11/28/15
Date password expires  . . . . . . . . . . . :   None
Password is set expired  . . . . . . . . . . :   No
Description  . . . . . . . . . . . . . . . . :   QSECOFR
Privileges:
  Disk units - operations  . . . . . . . . . :   *GRANTED
  Disk units - administration  . . . . . . . :   *GRANTED
  Disk units - read only . . . . . . . . . . :   *GRANTED
  System partitions - operations . . . . . . :   *GRANTED
  System partitions - administration . . . . :   *GRANTED
  Partition remote panel key . . . . . . . . :   *GRANTED
  Operator panel functions . . . . . . . . . :   *GRANTED
  Operating system initial program load
    (IPL)  . . . . . . . . . . . . . . . . . :   *GRANTED
  Install  . . . . . . . . . . . . . . . . . :   *GRANTED
  Performance data collector . . . . . . . . :   *GRANTED
  Hardware service manager . . . . . . . . . :   *GRANTED
  Display/Alter/Dump . . . . . . . . . . . . :   *GRANTED
  Main storage dump  . . . . . . . . . . . . :   *GRANTED
  Product activity log . . . . . . . . . . . :   *GRANTED
  Licensed Internal Code log . . . . . . . . :   *GRANTED
  Licensed Internal Code fixes . . . . . . . :   *GRANTED
  Trace  . . . . . . . . . . . . . . . . . . :   *GRANTED
  Dedicated service tools (DST) environment:     *GRANTED
  Remote service support . . . . . . . . . . :   *GRANTED
  Service tools security . . . . . . . . . . :   *GRANTED
  Service tools save and restore . . . . . . :   *GRANTED
  Debug  . . . . . . . . . . . . . . . . . . :   *GRANTED
  System capacity - operations . . . . . . . :   *GRANTED
  System capacity - administrator  . . . . . :   *GRANTED
  System security  . . . . . . . . . . . . . :   *GRANTED
  Start service tools  . . . . . . . . . . . :   *GRANTED
  Take over console  . . . . . . . . . . . . :   *GRANTED
```

Figure 5.4: Display Service Tools User ID panel

Device Profiles

To identify and control which PCs are allowed to act as the console for a system or a partition using a LAN console, you use service tools *device profiles*. Device profiles provide a way to authenticate a device that is trying to act as the console. Once the PC is authenticated, the user trying to run Operations Console at the PC must provide his or her service tools user ID and password and must have the appropriate privileges to perform Operations Console functions.

Operations Console with LAN connectivity uses a version of the Secure Sockets Layer (SSL) protocol but does so without using digital certificates. Instead, device authentication is accomplished via service tools device profiles. These profiles, which are stored on the IBM i system, contain a cryptographic key (i.e., password) that the PC

trying to act as the console must provide to authenticate itself to the IBM i service tools server.

Information about the device profile associated with a particular PC is stored on the PC. This information consists of the device profile name and the same key that is stored in the device profile itself back on the IBM i system. The information stored on the PC is encrypted with a different password, which is provided during configuration. In other words, using device profiles involves two passwords. One password is used to protect the device profile information on the PC, and the other is contained in the device profile itself and is used to authenticate the device to the IBM i system. IBM i servers are shipped with a default service tools device profile named QCONSOLE and an associated default password of QCONSOLE.

To configure a PC to be allowed to run Operations Console, you use the Operations Console setup wizard. The wizard adds the necessary device profile information to the PC. It asks for the service tools device profile name, the service tools device profile password (i.e., the one stored in the device profile), and a password to protect the service tools device profile information. The first two pieces of data must match an existing IBM i device profile. Operations Console with LAN connectivity will change the password stored in the device profile during each successful connection.

In V6R1 and later, you can choose to allow automatic creation of device profiles. To auto-create device profiles, go to DST, and on the Work with Service Tools Security Data menu, specify a value (1–49) in the **Autocreate service tools device IDs** field.

Technical Note

If no cryptographic products are installed, data (i.e., the device profile passwords) flowing over the LAN between the Operations Console device and the IBM i system is not protected.

You can configure SST to permit the management of Operations Console device profiles from SST; however, as shipped, this capability is disabled. To enable this option, go to DST and display the Work with DST Environment menu; select the option to display the Work with Service Tools Security Data menu, and choose option **7** (Work with lock for device IDs from SST).

Unlocking the SST device IDs menu item introduces some additional security exposure because it allows some SST users to create device ID profiles for their own

PCs. This is one of those tradeoffs you'll have to consider—a bit more risk versus the convenience of managing device profiles from SST.

The Work with System Security Panel

You reach the Work with System Security panel (Figure 5.5) by selecting option **7** (Work with system security) from DST or SST. This panel provides three important options that can help you manage the security of your entire system:

- Allow system value security changes
- Allow new digital certificates
- Allow a service tools user ID with a default and expired password to change its own password

```
                    Work with System Security
                                                          System:   SKYVIEW
Type choices, press Enter.

  Allow system value security changes . . . . .  1  1=Yes, 2=No
  Allow new digital certificates  . . . . . . .  1  1=Yes, 2=No
  Allow a service tools user ID with a
   default and expired password to change
   its own password . . . . . . . . . . . . . .  1  1=Yes, 2=No









F3=Exit   F12=Cancel
```

Figure 5.5: Work with System Security panel

I briefly mentioned this panel's **Allow system value security changes** function at the end of Chapter 3. Setting this option to `2` (No) prohibits many system values from being changed—period. Unless you set this value back to `1` (Yes), these system values cannot be changed, even by a user signed on as `QSECOFR`. This option protects the system values from being changed by other administrators (as long as you haven't given them a

service tools user ID with the ability to change this setting). It also prevents vendors from changing these system values during their installation process. The list of system values affected by this setting can change with each release. To see the current list for your system, press **F1=Help** while your cursor is on the **Allow system value security changes** parameter on the Work with System Security display.

The **Allow new digital certificates** option lets you control whether new trusted certificate authority (CA) certificates can be added to your system. When this option is set to 2 (No), no program or person can add a new trusted CA to the system. This setting helps prevent someone from adding a trusted CA to your system without your explicit consent. You might turn on this option if you were concerned about where digital certificates were created for use in client-side SSL/TLS authentication or if you were running applications that are digitally signed.

The **Allow a service tools user ID with a default and expired password to change its own password** option controls whether such service tools user IDs with are permitted to change their own passwords. When you leave this option at its default value, 2 (No), the password can be changed only by another service tools user ID with the appropriate functional privileges or from DST. Leaving this value at the default prevents someone from gaining access to SST by using the well-known service tools user IDs. Such an attempt will be successful if you haven't changed these user IDs from their default passwords and you change this value to 1 (Yes).

Monitoring Service Tools Use

You can use the service tools security log or the IBM i audit journal to monitor use of the service tools. Any use of the service tools via SST is added to the audit journal.

To work with the service tools security log, you use DST with a service tools user ID that has the **Dedicated Service Tools (DST) environment** privilege. Follow these steps:

1. From the Use DST menu, select option **5** (Work with DST environment).
2. From the Work with DST Environment menu, select option **6** (Work with service tools security data).
3. From the Work with Service Tools Security Data menu, select option **3** (Work with service tools security log) to display the Work with Service Tools Security Log screen. This screen shows security-related activity by date and time.

From the security log display, you can print the log by pressing **F6**. Enter **5** in the Option field of a particular entry to display additional details about that entry. If the activity noted in the entry is related to a granted or revoked privilege, the Display Service Tools Security Log Details display appears, showing the following information:

- Time of activity
- Activity description
- User ID of the person who made the change
- Affected user ID
- Privilege description

If the activity is related to enabling or disabling a user ID, the details screen shows the following information:

- Time of activity
- Activity description
- User ID of the person who made the change
- Affected user ID

If the activity is related to any other type of event, the details screen shows the following information:

- Time of activity
- Activity description
- Affected user ID

Unfortunately, there is no way to get at this log without going into DST; thus you'll have to note this activity on your calendar so you remember to review this log. In addition to using the service tools log, you can use the security audit journal to record service tools actions. To audit the use of service tools, make sure the value *SERVICE is specified for the QAUDLVL system value.

You can view audit entries related to service tools just as you can any other audit entry. On a command line, enter the CPYAUDJRNE (Copy Audit Journal Entries) CL command, specifying ENTTYP(ST). Then run a query or an SQL statement to view the information.

The audit entries include attempts to use SST without a service tools user ID, entering an invalid service tools user ID password, tracing a job, and more.

Service Tools Security Recommendations

In case you find the contents of this chapter a bit overwhelming, here are some suggestions for managing service tools security. This advice can be divided into two parts: recommendations that help you retain control over your system's security configuration, and recommendations that can help protect you against people trying to compromise your system by distributing rogue programs to the system.

Here are the minimum recommendations to help you control your security configuration:

- ✓ Define the minimum number of service tools user IDs that are absolutely necessary; however, each user that accesses the service tools should have his or her own user ID so that there can be accountability for user actions in the log and audit journal.
  - ○ Monitor the log and audit journal for appropriate use of service tools.
  - ○ Create user IDs with only the functional privileges needed to perform the required job functions.
  - ○ Create user IDs with expired passwords, so that users are required to change their password upon first use.
- ✓ Give only one or two service tools user IDs the ability to manage service tools security.
- ✓ For users who need only occasional access to service tools, consider disabling their service tools user ID after each use and re-enabling it the next time access is needed.
- ✓ Change all the IBM-supplied service tools user ID passwords to something other than the shipped (default) value.
- ✓ Consider setting some or all of the IBM-supplied service tools user IDs to *DISABLED status.
- ✓ If you permit service tools user IDs with expired and defaulted passwords to change their own passwords, make sure no user IDs with default passwords exist.

For organizations with a very restrictive security policy, take the following steps in addition to those listed above:

- ✓ Create your own service tools user ID with the same functional privileges as the QSECOFR service tools user ID. Disable the QSECOFR service tools user ID, and use the one you created instead.
- ✓ Lock down the security-related system values.
- ✓ Use the alternate service tools password policy.
- ✓ Do not permit service tools user IDs with expired and defaulted passwords to change their own passwords.
- ✓ Do not enable the automatic creation of device profiles.

Frankly, I have rarely seen these service tools features used. Perhaps it's because they are hardly ever written about or promoted, or maybe it's the thought that if someone is using service tools, they must need all the authority available. Or it could be because organizations are under the impression that this type of control is overkill. Regardless of the reason, I encourage you to consider implementing some or all of these features.

For more details about using service tools user IDs, see the IBM publication *Security Service Tools*, available in the Information Center under **Security** > **Service** tools.

CHAPTER 6

Object-Level Security

Once again, I want to acknowledge the reason you are reading this book. It is because there is data, either on systems you've been tasked to administer or on systems you are auditing, that needs to be protected. How tightly that data should be protected depends on its classification. Some data will require "deny by default" protection so that only users with a specific job requirement can access it. Other data might be classified such that all users can read the data but not update it. This chapter introduces you to the features available in IBM i for protecting data. Later in the book, I provide some practical examples that use these features to implement security schemes such as deny by default and read-only access.

Before a user can access an object, the user's profile must have authority to the object. Authority can come from several places: an object's *PUBLIC authority, private authority given to the user's individual or group profile, a group profile, an authorization list securing the object, adopted authority, or (as you learned in Chapter 4) *ALLOBJ special authority. In this chapter, I discuss each source of authority, how to manage the various options, and why you might use each one. The examples I'll discuss use the QSYS file system (which uses the traditional library/object structure). Authority considerations for the integrated file system (IFS) are discussed in Chapter 7.

Private Authorities

Authorities granted to individual or group profiles—often called *private authorities*—permit users to access and use specific objects. You can grant (give) or revoke (take away) specific authorities by using one of the following commands:

- GRTOBJAUT (Grant Object Authority)
- RVKOBJAUT (Revoke Object Authority)
- EDTOBJAUT (Edit Object Authority)

As the diagram in Figure 6.1 illustrates, IBM i provides two categories of authorities: object authorities and data authorities. *Object authorities* authorize actions that affect an entire object, such as renaming, changing, saving, and deleting the object, as well as a few functions for specific types of objects, such as defining referential integrity rules for database files. *Data authorities* apply at the content level for objects (e.g., database files, data queues, libraries, output queues) and authorize very specific actions, such as adding, updating, reading, and deleting object contents (e.g., records, entries).

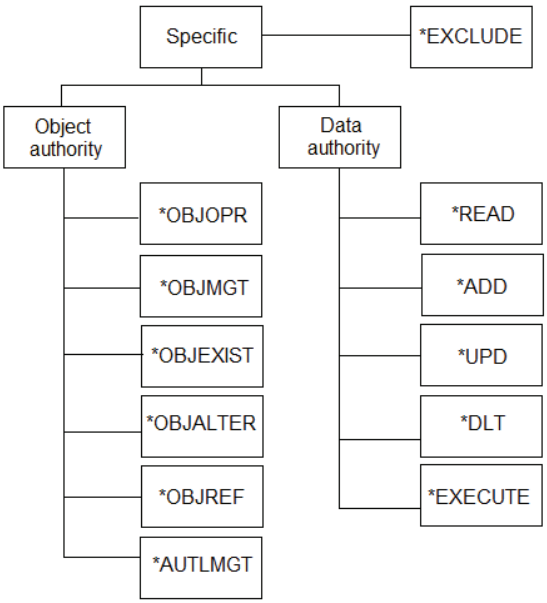

Figure 6.1: Authority categories

Object Authorities

IBM i provides six object authorities, which I'll group into three categories for purposes of explaining their functions. The first category consists of three object authorities that apply to all the objects on your system: *OBJOPR, *OBJMGT, and *OBJEXIST.

Object Authority	Description
*OBJOPR	*Object operation* authority authorizes the use of an object.
*OBJMGT	*Object management* authority authorizes the user to move and rename the object, change its attributes, and grant and revoke the authority of other user profiles to the object.
*OBJEXIST	*Object existence* authority lets the user delete, save, and restore the object and transfer ownership of the object.

Users who have *OBJOPR authority to an object can use the object. What exactly does it mean to be able to "use" an object? *OBJOPR authority lets the user view the object's description, regardless of the object's type. If the object contains data or executable code, the user can access the object's description but cannot access the data or run the program without having the appropriate data authority.

*OBJMGT authority lets the user change the object's attributes, including the authorities that other users have to the object. *OBJMGT is a superset of the object authorities *OBJALTER and *OBJREF (which I discuss momentarily). If you don't want a user to have *OBJALTER or *OBJREF authority, you must revoke not only *OBJMGT authority but also the *OBJALTER and *OBJREF authorities specifically.

*OBJEXIST authority lets the user perform save/restore operations on the object, transfer object ownership, and delete the object.

To reduce the risk of an object being improperly used or inadvertently deleted, you should restrict *OBJMGT and *OBJEXIST authorities to the object's owner. Unfortunately, this recommendation can make some operations a challenge, such as when a file is deleted, a physical file member is added or cleared, or a file is recreated when a query is run. In later chapters, I'll discuss techniques for managing these scenarios.

The second category of object authorities consists of those that apply primarily to database files. These authorities are the aforementioned *OBJALTER and *OBJREF authorities.

Object Authority	Description
*OBJALTER	*Object alter* authority authorizes the user to add, clear, reorganize, and initialize database file members and to alter the attributes of database files (SQL tables or physical and logical files). Authorized actions include adding and removing triggers and changing the attributes of tables, files, and SQL packages.
*OBJREF	*Object reference* authority lets the user specify a database file or table as the parent file in a referential constraint.

A user with *OBJALTER authority to a database file can change the file's attributes and can add and remove database file triggers. If you want to avoid granting a database administrator or programmer *OBJMGT authority, you can grant only *OBJALTER authority to limit the user to database-specific functions.

You should grant *OBJREF object authority to only the database administrator or the programmer responsible for enforcing referential integrity constraints. This authority is necessary only for the parent file in a referential constraint. For example, say you want to ensure that every new order record in the ORD_MAST file references an existing customer in the CUST_MAST file. You can do so by adding a referential constraint that links the two files by the customer number that is common to both files. In this case, you must have *OBJREF authority to the CUST_MAST file to add the constraint.

The third category of object authorities consists of just one authority, *AUTLMGT (authorization list management), and it applies only to authorization lists. *AUTLMGT authority lets you add and remove users' authorities to an authorization list. I cover authorization lists in more detail later in this chapter.

Data Authorities

Data authorities apply to all object types, but they are most easily explained by using objects that have contents. For example, a physical file (or table) has an object description, and a physical file has contents: records. Other examples of objects that have contents include libraries (object type *LIB), data queues (object type *DTAQ), data areas (object type *DTAARA), and output queues (object type *OUTQ).

There are five data authorities:

Data Authority	Description
*READ	Lets the user read and retrieve data and entries
*ADD	Lets the user insert a new data record or entry
*UPD	Lets the user modify existing data and entries.

Data Authority	Description
*DLT	Lets the user delete and remove data and entries. (Remember that *OBJEXIST is required to delete the object itself.)
*EXECUTE	Lets the user locate an object in a library or directory and execute a program, a service program, or an SQL package

The first four data authorities let you read and manipulate the contents of an object. You would typically grant users who need to manipulate data all four of these data authorities. However, if you prefer, you can grant users only a subset of the four.

*EXECUTE authority lets you search the contents of a library or directory. To access an object, you need not only authority to the object itself but also at least *EXECUTE authority to the library or directory in which the object resides. *EXECUTE authority is also one of the authorities you need to run a program, service program, or SQL package (you also need *OBJOPR authority).

As I mentioned earlier, data authorities also apply to objects that don't have contents. For example, to submit a job that uses a job description, you need *OBJOPR, *READ, and *EXECUTE authorities to that job description.

Authority Relationships

One point of confusion for many people when they first encounter IBM i's object security implementation is the difference between having authority to a library and having authority to objects within the library. To access or use an object, you must have authority both to the library in which the object resides and to the object itself. If you don't have authority to the library, you won't be able to access the objects in the library. However, having authority to a library does not give you authority to the objects within it. You need authority to both in order to access an object in a library.

Think of library-level authority as a gate to what goes on with the objects that reside in the library. To access the objects, you must first open the gate; that is, you must have appropriate authority to the library for the request being made. For example, to look for objects in the library, you must have *OBJOPR authority to the library. To read the description of objects in the library, you must also have *READ authority to the library. To add objects to the library, you must have *ADD authority. And so on.

*DLT authority can also be confusing. You would think that if you had *DLT authority to a library, you could delete objects from the library. However, to delete an object from a library, you need only *USE authority to the library. Whether you can delete an object is

determined by the authority you have to the object itself. To delete an object, you must have *OBJEXIST authority to that object and *EXECUTE authority to the library where it resides.

Now for a quick preview of the next chapter. If you work with directories on the system—that is, if you work with file systems other than the QSYS file system (i.e., libraries), you need to know that the relationship between directory and object authorities is nearly identical to the relationship I just described between library and object authorities. The only difference is that to access an object in the file system, you must have *EXECUTE authority to all directories in the directory path. For example, to access the file /My_Company/HR/Reports/August_Payroll.pdf, you must have authority to every directory in the path that leads to the file (i.e., to the My_Company, HR, and Reports directories) as well as proper authority to the August_Payroll.pdf file itself.

Authority Groupings

To make object and data authorities easier to manage, IBM i defines several authority groupings. You can think of these groupings as shorthand: they let you specify commonly used combinations of object and data authorities using a single value. Except when working with database files, most security administrators use one of these authority groups rather than individual object and data authorities. Table 6.1 lists the authority groupings you can use with libraries and their objects.

Table 6.1: Authority groupings for use with authority commands for libraries and objects

	Authority Classes			
Object and Data Authorities	***ALL**	***CHANGE**	***USE**	***EXCLUDE**
*OBJOPR	X	X	X	None
*OBJMGT	X			
*OBJEXIST	X			
*OBJALTER	X			
*OBJREF	X			
*READ	X	X	X	
*ADD	X	X		
*UPD	X	X		
*DLT	X	X		
*EXECUTE	X	X	X	

To use authority groupings to grant user profile CYOUNG object operational and all data rights to physical file ACCTPAY_PF in the QSYS file system, you could use this GRTOBJAUT command:

```
GRTOBJAUT  OBJ(MYLIB/ACCTPAY_PF) OBJTYPE(*FILE) USER(CYOUNG) +
           AUT(*OBJOPR *READ *ADD *UPD *DLT *EXECUTE)
```

Or, you could use

```
GRTOBJAUT  OBJ(MYLIB/ACCTPAY_PF) OBJTYPE(*FILE) USER(CYOUNG) +
           AUT(*CHANGE)
```

Both commands have the same effect.

*EXCLUDE authority is a bit odd in that users who have this authority are actually prevented from accessing the object rather than being given some type of access rights. Some operating systems, such as UNIX, prevent users from accessing a file simply by not granting them any authority to the file. In other words, the absence of authority prevents the users from accessing the file. IBM i works differently. With IBM i, users always have some authority to the object. If they don't have authority through another means, they will, by default, have authority to the object's *PUBLIC authority. (I explain *PUBLIC authority a bit later in this chapter.) To prevent a user from accessing an object, you must grant that user *EXCLUDE authority to the object. To set the object's access to "deny by default," you would set the object's *PUBLIC authority to *EXCLUDE.

Group Profiles

Not only can you grant or revoke private authorities to or from individual users, but you can do the same for group profiles. Group profiles, as you learned in Chapter 4, are a management tool that provides an efficient way to allow all the members of a group (or role) to have the same access to an object. You use the same commands to grant or revoke authority to group profiles. Simply specify the name of the group profile instead of an individual user profile name on the commands.

Multiple Group Profiles

Recall from Chapter 4 that you can specify a user profile as a member of up to 16 groups. To do so, you first specify a group in the user profile's GRPPRF (Group profile) parameter.

Then you use the SUPGRPPRF (Supplemental groups) parameter to specify any other group profiles you want the user to be a member of.

When a member of multiple groups creates an object, IBM i refers to the user profile's OWNER (Owner), GRPAUT (Group authority), and GRPAUTTYP (Group authority type) parameters to determine the authority, if any, that the first group (i.e., the group profile named in the GRPPRF parameter) has to the new object. When you assign multiple groups to users, you should assign the most frequently used groups first. When the operating system determines whether a user has sufficient authority to access an object, it searches each group profile listed in the user profile's GRPPRF and SUPGRPPRF parameters until it finds enough authority to perform the task (or determines that the user lacks sufficient authority). The fewer groups the system has to search to accumulate sufficient authority, the better the performance. (Although the system is so fast today that it's highly unlikely you'd ever notice a difference even if you placed the most-used group profile last in the list.)

Why Grant Authority to Group Profiles?

Group profiles simplify security management by letting you grant similar authorities to multiple user profiles that perform similar functions (i.e., to a role). Many user profiles in your organization probably have similar basic authorities. Combining similar user profiles into a single group profile lets you administer authorities for the entire group instead of for each user individually. Because many users—especially in IT—have many roles, the ability to make a user profile a member of more than one group is particularly helpful.

When you grant authority to a group profile, an option you have is to use *primary group authority* rather than a private authority. The effect of granting primary group authority is the same as granting a private authority to the group. Only a couple of differences exist between the two authorities. One difference is that primary group authority is stored with the object itself, while private authorities are stored in the user's user profile object. This point has two ramifications. First, primary group authority goes with the object when it is saved and restored. To associate a private authority with an object, you must either save the object by running the SAVSECDTA (Save Security Data) command and then running the RSTAUT (Restore Authority) command after the object is restored, or you must specify to save private authorities when you save the object and specify to restore the private authorities when you restore the object. (The ability to save/restore private authorities with the object was added in V6R1.) The second ramification is that retrieving the authority from the object's header is ever so slightly faster than

retrieving the private authority from the user's profile. You can grant primary group authority for an object to only one group. Rather than give the group profile private authority to the object, you can grant the group primary group authority by using the CHGOBJPGP (Change Object Primary Group) or WRKOBJPGP (Work with Objects by Primary Group) command.

From a performance standpoint, primary group authority is a *slightly* faster version of private authority for group profiles. Primary group authority isn't considered a private authority. Rather, it is stored with the object itself, thus shortening the time the system needs to find the proper authorities during an authorization search. However, the performance gain is negligible, so if you find the concept of primary group authority too confusing, go ahead and grant the group private authority if it makes management easier.

Note

I have seen only one IBM i site that used primary group authority to grant groups authority to libraries and files. I have encountered a few more instances in which primary group authority was granted to files and directories in the IFS. The bottom line is this: Unless this concept makes your security administration easier, you shouldn't bother with implementing (or even attempting to understand) primary group authority.

Public Authority

The *PUBLIC authority of an object is assigned when a user creates the object. This is the authority users have to an object if they don't obtain authority from any other source. To view an object's authorities, including *PUBLIC authority, you can use the EDTOBJAUT command or the DSPOBJAUT (Display Object Authority) command.

Establishing Public Authority

All objects on the system are created either by using one of the many create (CRT*xxx*) commands or by restoring the object from a save file or save media. The initial public authority for an object is determined when the object is created. (You can always change it later if the original setting isn't appropriate.) When you use a create command to create

an object, the command's AUT (Authority) parameter establishes the object's public authorities. The AUT parameter has the following possible values:

AUT Value	Description
*LIBCRTAUT	Uses the library's CRTAUT (Create authority) attribute to determine the object's *PUBLIC authorities
*ALL	Grants all object and data rights
*CHANGE	Grants *OBJOPR object authority and all data authorities
*USE	Grants *OBJOPR object authority and *READ and *EXECUTE data authorities
*EXCLUDE	Grants *PUBLIC *EXCLUDE authority
Authorization_list_name	Secures the object with an authorization list. *PUBLIC authority for the object comes from the authorization list's *PUBLIC authority. (You can't specify an authorization list for the AUT parameter of a user profile or of another authorization list.)

For most create commands, the default value for the AUT parameter is *LIBCRTAUT, which causes the system to use the object library's CRTAUT (Create authority) attribute to determine the object's public authority. Thus, the CRTAUT library attribute specifies the default public authority that all new objects in the library will have unless you override the default authority on the create command.

You can use the library's CRTAUT parameter to define the default public authority for all objects subsequently created in that library (existing objects aren't affected). The CRTAUT parameter allows the following values:

CRTAUT Value	Description
*SYSVAL	Uses the value specified in the QCRTAUT (Create Authority) system value
*ALL	Grants all object and data rights
*CHANGE	Grants *OBJOPR and all data rights
*USE	Grants *OBJOPR, *READ, and *EXECUTE rights
*EXCLUDE	Grants *PUBLIC *EXCLUDE authority
Authorization_list_name	Uses the specified authorization list to determine public authorities

The default value for the CRTAUT parameter is *SYSVAL, which instructs the operating system to reference the QCRTAUT system value to determine the default public authorities for the objects in the library. When you create a library and don't specify a CRTAUT

value, the *SYSVAL default value causes the library to use the value found in the QCRTAUT system value.

Technical Note

System value QCRTAUT has no effect on objects created in directories.

Technical Note

Changing the QCRTAUT system value has no effect on objects that already exist. A change to QCRTAUT affects only objects that are created after the system value is changed.

Figure 6.2 illustrates the trickle effect of the default values for the library's CRTAUT attribute and the object's AUT attribute. From bottom to top, the values shown for AUT, CRTAUT, and QCRTAUT are the defaults shipped with IBM i. As you can see, if you don't change these defaults, the system automatically gives the public *CHANGE authority to almost every object created on the system.

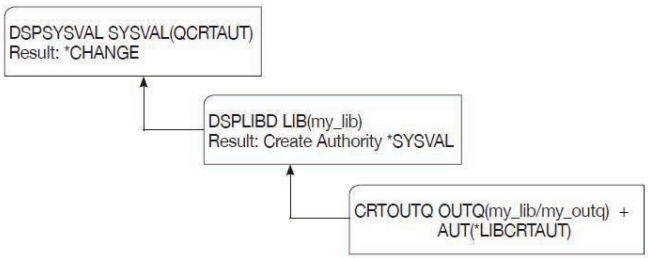

*Figure 6.2: How *PUBLIC authority is determined*

The only tricky part of how *PUBLIC authority is determined comes when you create a library. As implemented, IBM i actually creates all libraries in library QSYS. You can think of QSYS as the "master" library. So, when you create a new library— say, PAYLIB—and specify *LIBCRTAUT for the library's AUT parameter, PAYLIB's public authority comes from the QSYS library's CRTAUT value.

Technical Note

A library's CRTAUT parameter has no effect when you move, duplicate, or restore an object to a library. Instead, the object's public authority is the public authority that the object had before you moved, duplicated, or restored it.

Technical Note

When you create an object and specify REPLACE(*YES), the new object will have the public authority of the replaced object instead of the authority specified in the library's CRTAUT parameter.

Using Default Public Authority

Because IBM ships the QCRTAUT system value set to *CHANGE, the default public authority for most objects created in any library is *CHANGE. In today's environment, where users have access to tools such as File Transfer Protocol (FTP), Open Database Connectivity (ODBC), and SQL and where applications can use sockets or the HTTP server to connect to the system, public authority *CHANGE isn't appropriate—especially for database files or tables. You'll probably want to set the QCRTAUT system value to *USE or even *EXCLUDE to limit public authority to new libraries and objects.

*USE is the most appropriate public authority in today's environment. If you want to change QCRTAUT to *EXCLUDE, you'll have many more considerations. The exact procedure will depend on your applications and system configuration.

Although *ALL is also a valid QCRTAUT value, there is no reason you should ever set this system value to *ALL. This is *not* a wise choice. The obvious reason is because, with this setting, all newly created objects on the system would be created with *PUBLIC *ALL, giving all users the ability to modify or even delete the objects. The other reason to avoid setting QCRTAUT to *ALL is because it is very difficult to know what's going to break if you change this value from *ALL to another value. Avoid setting QCRTAUT to *ALL at all costs.

An alternative is to leave QCRTAUT set to *CHANGE and then change each library's CRTAUT attribute to determine the public authority to new objects created in the library.

This approach allows much more flexibility because you can set some libraries to *USE while setting others that contain highly sensitive data to *EXCLUDE.

When helping clients address their concerns with the QCRTAUT system value, I typically choose either *USE or *EXCLUDE for the QCRTAUT value and determine the appropriate public authority for each non-system library. (I always leave IBM-supplied libraries' create authority value alone. And I often leave vendor applications that are used for system administration job schedulers, performance tools, change management applications, and so on at their existing *PUBLIC authority settings.) For all other libraries, I check each library to see whether the currently defined public authority is right for the objects in the library as well as for the library itself. Then I modify the CRTAUT attribute of each library to reflect the appropriate default public authority for objects created in that library.

Perhaps one library contains only utility program objects (e.g., date-conversion routines, a binary-to-decimal conversion program, a check object/authority program) that various applications use. Because all the programs should be available for execution, it makes sense to set this library's CRTAUT attribute to *USE so that new objects created in the library will have *USE default public authority.

Suppose another library contains the payroll and employee data files. You probably want to restrict public access to this library and secure it by granting only selected users or groups authority. Any new objects created in this library should probably also have *EXCLUDE public authority unless the program or person creating the object specifically selects another public authority using the object's AUT attribute. This library should have a CRTAUT attribute value of *EXCLUDE.

Last, if all the objects in the library are secured with an authorization list (explained in the next section), you can specify the name of the authorization list for the CRTAUT attribute. All objects created into the library will then automatically be secured with the authorization list, and the *PUBLIC authority of the object will come from the authorization list.

If you follow these suggestions for the QCRTAUT system value and the CRTAUT library attribute, an AUT value of *LIBCRTAUT works well as a default. In many cases, public authority at the object level coincides with the public authorities that the CRTAUT attribute establishes at the library level. However, be sure you make this a planned decision instead of a default decision.

Understanding IBM i's implementation of object security can help you plan your authorization scheme. You can secure many or most objects on your system simply

through the objects' *PUBLIC authority. You can then protect more sensitive objects by specifying *EXCLUDE authority for *PUBLIC and authorizing only certain user or group profiles. Understanding IBM i's authority search order will also help you make these decisions. You'll learn about the search order later in this chapter.

Authorization Lists

An *authorization list* is a management tool that helps you secure objects that require the same access control settings or authorities. The objects associated with an application, for example, usually all need the same access control or authority settings. Figure 6.3 shows an accounts receivable application that creates a new file each month. The same users need to have the same authority to each monthly file. The best way to secure these files is to use an authorization list.

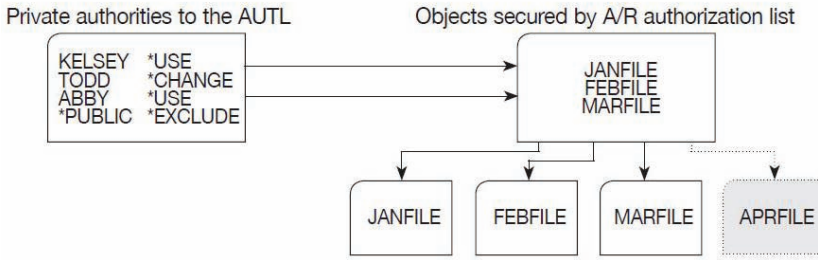

Figure 6.3: Securing similar objects with an authorization list

To create an authorization list to secure an object, you run the CRTAUTL (Create Authorization List) command. Then, run the EDTAUTL (Edit Authorization List) command to give selected user or group profiles authority to the authorization list. Next, you associate the authorization list with all the application's files by specifying the authorization list name on the AUTL (Authorization list) parameter on the GRTOBJAUT command. Last, you can set each file's *PUBLIC authority to come from the authorization list by specifying *AUTL in the AUT parameter on GRTOBJAUT.

By virtue of having authority to the authorization list, the users have authority to the objects. The type of authority that each user has to the object is the same as the authority you grant the user to the authorization list. For example, in Figure 6.3, Todd has *CHANGE authority to the authorization list; therefore, he has *CHANGE authority to all objects associated with the authorization list.

Authorization lists have several advantages. They are a wonderful tool for securing files. Many organizations now run a 24 × 7 shop. For these organizations, managing authorities to files that are always in use can be a challenge because you can't modify the access control settings on a file that's open (in use). By associating an authorization list with those files, you can manage the authorities on open files by managing the authorities on the authorization list, which you can do even when a file is open. Another advantage is that you only have to manage the access controls on the authorization list (i.e., you only manage authorities once) rather than managing access to all the individual files (objects).

Security Recommendation

If you have trouble maintaining authorities for a file because the file is always open, secure the file with an authorization list during the next downtime (when the file is not in use). You can grant and revoke authority to the authorization list even when the file is open.

Another advantage of authorization lists is that they save room in the internal structure of user profiles. In other words, they reduce the number of private authorities and, therefore, reduce the size of the user profile object itself. Rather than putting into a user profile an entry for each object to which the profile has private authority, you put only an entry for the authorization list. In addition to reducing the size of the profile, having fewer entries in a user's profile saves time when you run the SAVSECDTA and RSTAUT commands.

Authorization lists don't preclude using private authorities. You can still grant and revoke private authorities to an object using the GRTOBJAUT, RVKOBJAUT, and EDTOBJAUT commands. A user profile's private authorities supersede any authority the user has to an authorization list. However, as a matter of practice, I try to avoid granting both private authorities and securing the object with an authorization list. While technically possible, using both of these methods tends to add complexity to a security scheme's implementation. This complexity then often leads to mismanagement of the authorities. If I ever grant a private authority in addition to securing an object with an authorization list, it's an exceptional case and not part of a typical implementation.

I often am asked whether it's better to use group profiles or authorization lists. Neither method is inherently better than the other. You should use the option that makes the most sense for what you're trying to do. I often end up using a combination of both methods—granting a group profile authority to an authorization list, for example. Table 6.2 compares the use of authorization lists and group profiles.

Table 6.2: Comparison of authorization lists and group profiles

Authorization List	Group Profile
Secures and helps you manage access to multiple *objects* that need the same authority settings.	Helps you manage multiple *user profiles* that need the same access and capabilities.
Lets each profile have a different authority to the authorization list.	Gives all users in the group the same authorities.
An object can be secured by only one authorization list.	A profile can be a member of multiple group profiles.

How IBM i Checks Authority

We've discussed the fact that before you can access an object, you need to have sufficient authority, and you've learned where the authority can come from. The question many of you probably have at this point is, "In what order are the authority sources checked?"

The order in which authority is checked is a mystery to many people. But unless you understand how it works, securing your system will be a change-something-and-hope-it-works process that will be prone to error and impossible to explain or maintain.

The authorization search order is really quite simple once you see it. Figure 6.4 illustrates the progression of IBM i's authority search algorithm.

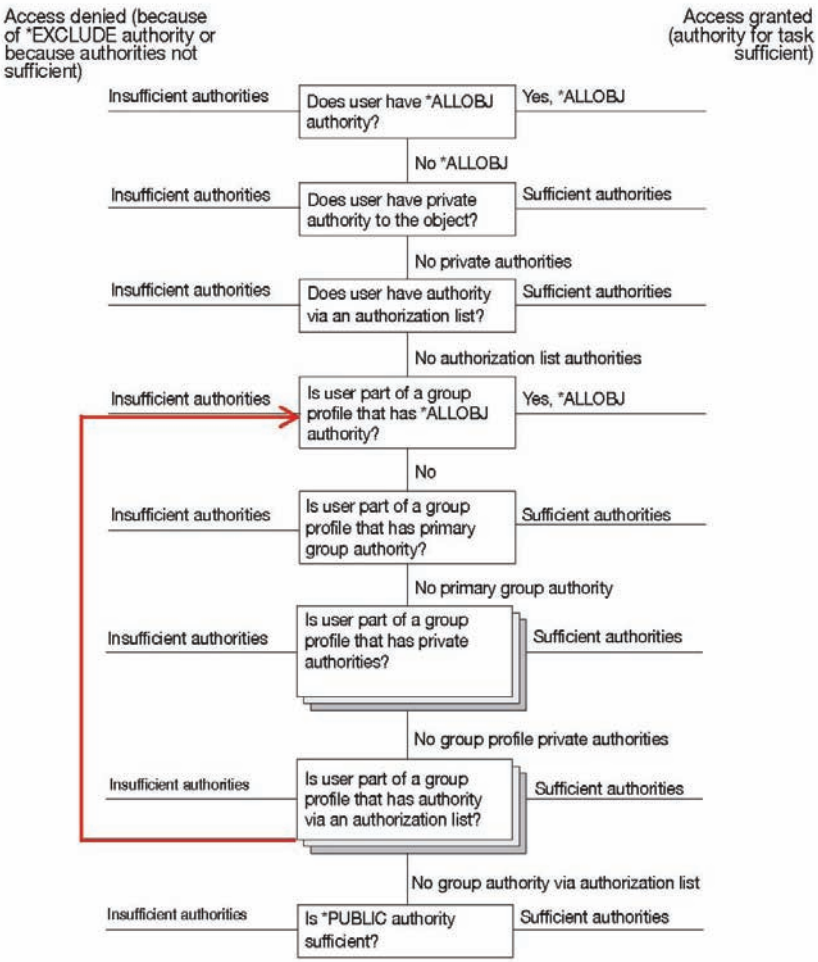

Figure 6.4: Authorization search progression

As you can see, the system first determines whether the profile has *ALLOBJ special authority. If it does, the system lets the user access the object because *ALLOBJ gives the user profile *ALL authority to every object on the system.

If the profile does not have *ALLOBJ authority, the system performs an authority lookup to determine whether the user profile has a private authority to the object. If the user has a private authority, even if it is *EXCLUDE, the system uses that authority, and the check stops. It doesn't go on to check group or *PUBLIC authorities.

If the user has no private authority, the system then determines whether the object is secured with an authorization list and whether the user has authority to the authorization list. If not, the system checks the user's first group profile, if there is one, for *ALLOBJ special authority, then for primary group authority to the object, and then for a private authority to the object. If none of these authorities is available, the system checks whether the group has authority to the authorization list if one has been used to secure the object.

If the first group profile doesn't have sufficient authority, the system checks the user's next group and so on until either sufficient authority is found or all groups have been checked. If a user has multiple group profiles, IBM i sums the groups' authorities, if necessary, as it checks the groups. For example, if GROUP_TWO has *OBJOPR private authority and *READ authority to the file, GROUP_THREE has *ADD, *UPDATE, and *DLT private authority, and GROUP_SIX has *EXECUTE authority to the file, the system accumulates the authorities and determines that the user has *CHANGE authority to the file.

Finally, if neither the user nor his or her group (or groups) has sufficient authority, the system checks *PUBLIC authority. *PUBLIC authority can come either from the object itself *or* from an authorization list that secures the object. If the *PUBLIC authority of the object specifies *AUTL, then the authority comes from the authorization list securing the object. Otherwise, the *PUBLIC authority comes from the object itself.

During each step of the check at the user level and after all group profiles have been checked, when IBM i finds some authority, sufficient or not, the system discontinues the search unless a program in the call stack adopts authority. (I explain adopted authority in detail later in this chapter.) In that case, the system checks the adopting program's owner for authority to the object. The system checks the program owner's authority for *ALLOBJ, private, and authorization list authority (the first three boxes in the figure). It does not continue on to the program owner's groups (if any).

This is how the authorization search works conceptually. However, IBM has made some enhancements to refine the search performance. First, the system determines whether any private authorities exist for the object (i.e., via a private authority granted to a user profile, to a group profile, or to an authorization list securing the object). If no private authorities are present (determined simply by checking a flag in the object's header), the system immediately examines the *PUBLIC authorities. Every object has an internal part called a *header* that IBM i maintains. The header contains basic object attributes, including security-related attributes such as the owner and the owner's authorities, name of the primary group profile and its authorities, name of the

authorization list securing the object (if any), object auditing setting, and the *PUBLIC authority. Another flag in the object header indicates whether existing private authorities are less restrictive than the public authorities. If existing private authorities are no less restrictive than the public authorities, the system bypasses the rest of the authority search algorithm and immediately checks whether public authority is sufficient. These modifications to the search algorithm speed search performance significantly.

Authority Checking Example: Precedence Between Users and Groups

The following example shows the net effect of users being in a group profile and the precedence that applies when both the user and one of the user's groups has authority to the same object. Take a look at Figure 6.5.

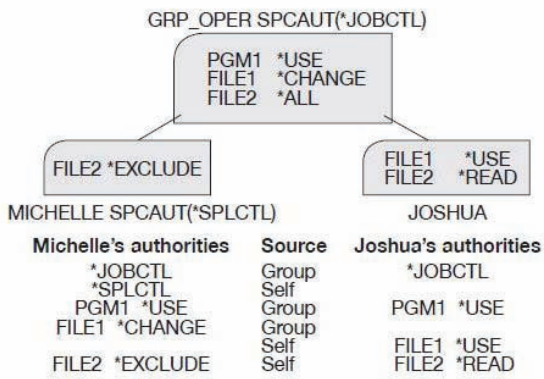

Figure 6.5: Sample group profile implementation

The figure illustrates an implementation of a sample group profile, GRP_OPER. Two users, MICHELLE and JOSHUA, are members of this group. When MICHELLE performs IBM i functions, she will do so with both *SPLCTL and *JOBCTL special authorities. MICHELLE has *SPLCTL authority and inherits *JOBCTL from the group. JOSHUA has no special authorities himself but inherits *JOBCTL from the group.

When either MICHELLE or JOSHUA calls program PGM1, the system will determine that the user has *USE authority to the program through the GRP_OPER group.

When MICHELLE accesses FILE1, she will be able to do so with *CHANGE authority from the group. However, because JOSHUA was granted a private authority of *USE to FILE1,

he will access the file with *USE authority. The authority that a user has takes precedence over any authority that the group has.

When MICHELLE tries to access FILE2, her access will be denied because she was granted private authority *EXCLUDE. JOSHUA, on the other hand, will be able to access the file with *READ authority. Once again, his user authority takes precedence over the group authority.

Group profiles are a great tool to help deal with the complexities of managing objects' access controls. Many organizations have implemented group profiles, and users within those groups commonly need the same authority to the same objects. Granting authority to the group profile makes this task very easy. Chapter 16 discusses how to use group profiles to implement the security strategy you design for your system.

Authority Cache

IBM i uses an *authority cache* to look up private authorities to objects and authorization lists. The first time the system performs an authority lookup to determine whether a user has specific authority to an object, IBM i creates a cache for the user and adds the specific authority to the cache. The next time the system performs a lookup, it checks the user's cache before checking the profile. This procedure results in a much faster check than looking in the user profile. The cache contains up to 32 private authorities to objects and 32 authorities to authorization lists. Whenever a user's authority changes, the system automatically updates the user's cache. All users' authority caches are cleared at IPL.

The effect of the authority cache is that if users generally access the same objects and have private or authorization list authority to those objects, the performance impact of checking for private authorities is negligible. The authority cache gives you more flexibility in securing your objects, but it doesn't give you license to go wild with private authorities. Massive numbers of private authorities are still difficult to manage and maintain, still cause user profile objects to grow very large, and still affect performance when you save and restore user profiles or perform a system save.

Adopted Authority

Another way a user can gain authority to an object is through *adopted authority*. You can use adopted authority to temporarily give a user sufficient authority to accomplish a sensitive task. For example, many people write a CL program that adopts and is owned by a profile with *ALLOBJ and *SECADM authority that lets their help desk personnel reset

user's passwords. This technique gives help desk personnel the capability to perform the task but doesn't require them to be permanently assigned *ALLOBJ and *SECADM.

When you compile a program on the system (using the CRT*xxx*PGM commands), you can supply a value of either *USER or *OWNER for the USRPRF (User profile) parameter. The default value, *USER, instructs the system to run the program under the authority of the user who is running the program. A value of *OWNER instructs the system to run the program under the authority of the program's owner if the user's profile doesn't have enough authority to perform the program's tasks. Adopted authority remains in effect until the program ends—in other words, for as long as the program is in the program call stack. Any programs called by the program that adopts authority also use the adopted authority unless the called programs specifically use the USEADPAUT(*NO) parameter to block propagation of the adopted authority.

Figure 6.6 illustrates the concepts and implementation of adopted authority.

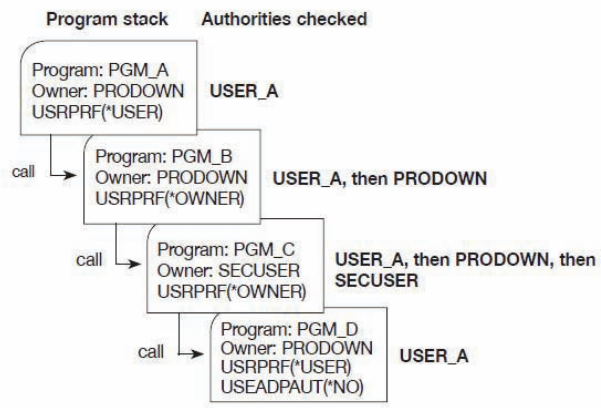

Figure 6.6: Adopted authority concepts

In this scenario, because PGM_A doesn't adopt authority (notice USRPRF(*USER)), IBM i can use only USER_A's authority when the program is run. When PGM_A calls PGM_B, the system uses USER_A's authority. If USER_A's authority is not sufficient, the program owner's (PRODOWN's) authority is used to complete the tasks. When PGM_B calls PGM_C, the authorities available to complete the tasks continue to add up. PGM_C specifies USRPRF(*OWNER), and the owner of PGM_C is SECUSER. The system first determines whether USER_A has sufficient authority to perform the tasks in PGM_C. Then, if necessary, it checks the authority of PRODOWN and SECUSER, in turn, to obtain the needed

authorities. Finally, when PGM_C calls PGM_D, two things change. First, PGM_D ignores previously adopted authorities (due to USEADPAUT(*NO)). Second, because program PGM_D doesn't specify USRPRF(*OWNER), PGM_D does not adopt the program owner's authorities. As a result, PGM_D uses only USER_A's authorities.

Technical Note

Many people confuse the purpose of the two program attributes that control adopted authority. It is the URSPRF (User profile) parameter that determines whether the program adopts. The USEADPAUT (Use adopted authority) parameter determines whether the program will "consume," or use, the adopted authority being passed to it from a program higher in the call stack.

Adopted Authority Example

Let's consider another example. A help desk needs to be able to reset users' forgotten passwords and reset the status of the disabled profiles to *ENABLED. To perform these functions, each person on the help desk would need *OBJMGT and *USE authority to the profiles as well as *SECADM special authority. Profiles, by default, are created as *PUBLIC *EXCLUDE, so to set this up you'd have to grant each help desk user or the group these authorities to every user profile. This proposition is problematic on a couple of fronts. First, how do you keep up with granting these authorities as new profiles are created? Second, granting users *USE authority to other individuals' profiles would permit help desk personnel to submit jobs and run as another profile—not a good security practice. In addition, giving them *SECADM special authority would let them create user profiles—again, not a task this role should be performing. How do you allow the help desk to reset passwords and profile status yet not grant the authorities permanently?

First, write a CL program. Let's call it PWDRESET. This program would prompt a help desk member to enter the name of the profile whose password is being changed, along with the new password. The program would then run the CHGUSRPRF (Change User Profile) command, making sure the password expired attribute is set to *YES (so the user will have to change the password upon first use) and setting the profile's status back to

*ENABLED. If desired, you could add logic to prevent the help desk from changing specific profiles, such as QSECOFR or other profiles with *ALLOBJ.

Next, create the program, specifying user profile *OWNER on the CRTCLPGM (Create CL Program) command and making sure the owning profile has *ALLOBJ and *SECADM special authorities. Set the program's *PUBLIC authority to *EXCLUDE, and grant the help desk group (e.g., GRP_HDESK) *USE authority to the program. Then, assign this program to an option on a help desk menu, if one exists. When a member of the help desk group selected this menu option, he or she would be able to change a user's password but would not be able to perform any other tasks as this profile. Nor would this person have *ALLOBJ or *SECADM specify authorities assigned to his or her profile. This is just one example of the type of utilities you can write that permit users to perform tasks while avoiding permanent assignment of special authorities or granting authority to objects on the system.

Here's a summary of some things to keep in mind when you use programs that adopt authority:

- The owner's special authorities (e.g., *ALLOBJ, *SECADM) are adopted.
- The owner's private authorities are adopted.
- The owner's group authorities are not adopted.
- Adopted authority is active as long as:
  - The program that adopts authority is in the program stack. (You can use the USEADPAUT program attribute to block a program from using adopted authority from a program higher in the call stack.)
  - The program is interrupted by the **System request** or **Attention** key, transfer to a group job, a break-message-handling program, or debug functions. (In any of these events, adopted authority is not passed on.)
- Adopted authority cannot be passed to submitted jobs.
- Adopted authority cannot be used to run the CHGJOB (Change Job) command.
- Adopted authority cannot provide sufficient authority to specify a group profile on the CHGUSRPRF (Change User Profile) command.

Security Recommendation

If you use programs that adopt authority to provide users with the ability to perform a specific task, make sure each program performs only one task (e.g., changes a password, updates prices, retrieves personnel information) and doesn't call other programs (which might propagate authority unnecessarily), or calls only programs that have USEADPAUT(*NO) specified. Also, make sure that programs that adopt do not present a command line or call commands that provide a command line, so that the adopted authority is not available when running all commands. Be sure to document the programs thoroughly and make them easy to identify.
Create user profiles specifically to own the programs that adopt authority. Implement these profiles with PASSWORD(*NONE) and with only enough authority for the programs to perform their tasks (Programs that adopt do not have to be owned by profiles with *ALLOBJ special authority.) Don't use QSECOFR to own programs that adopt authority.

Technical Note

Dynamic SQL ignores the *User profile* parameter of programs and service programs. While the program containing the dynamic SQL statement will use the *User profile* parameter and adopt the owner's authority, the SQL statement itself will not. Therefore, if you want to allow access via adopted authority to an object upon which a dynamic SQL statement is acting, you must specify *OWNER on the *Dynamic user profile* parameter when the program is created.

Authorities and Save/Restore Functions

One subtlety in the issue of public and private authorities concerns how the authorities are saved and restored. IBM i saves and restores public authorities with the object, as part of the object header. In contrast, it maintains private authorities as part of the user profile; private authorities aren't saved with the object. When you restore an object and it already exists on the system (i.e., when the object you restore replaces an existing object), IBM

i maintains the existing object's public authorities, which may or may not be the same as the authorities of the object on the media as well as the object's private authorities. When you restore a new object, IBM i restores the public authority from the media along with the object, but if the object had private authorities when it was saved, they are not saved in releases prior to V6R1. In V6R1, if you have *SAVSYS or *ALLOBJ special authority, you can specify that the private authorities associated with the object be saved. Then, if you have *ALLOBJ, you can restore the private authorities when restoring the object.

What happens when you restore a user profile? When you restore one or more user profiles, you must also run the RSTAUT command to restore the user profiles' private authorities. This explains why, if you restore your complete system, including all user profiles and objects, but don't run the RSTAUT command, only the public and primary group authorities work. No private authorities exist until you run RSTAUT.

Another interesting point concerning the private and public authorities' save/restore functions relates to users who have *SAVSYS special authority. Let's assume you've given your system operator *SAVSYS authority. Let's also assume that you have a library called PAYROLL that holds all payroll files and that you've used library authority to secure those files. In other words, the library's public authority is *EXCLUDE, and you've authorized only a few users (not including your system operator) to the library. However, you've specified *CHANGE public authority to the files in library PAYROLL. In effect, you've secured the library from all users except those with private authorities. But if an unauthorized user can get inside the library, he or she can have public access to the files.

This security scenario is a "normal" and somewhat typical practice for securing some libraries. However, you need to be aware of a security exposure in this scenario related to saving and restoring the files that reside in the library. If the system operator (who has *SAVSYS authority) were to restore to a nonsecure library files saved from the PAYROLL library, he or she would then have complete public access to the files in the unsecured library. Because public authorities are saved with the object, the files' public *CHANGE authority would be restored with the files to the unsecured library, and the system operator (or any other role or individual with *SAVSYS) could retrieve, modify, and delete records in that library. The system operator could then simply save the modified version of the file and restore that version to the PAYROLL library.

You will probably want to give *SAVSYS special authority to system operators so they can perform system backups, so what's the solution to this exposure? First, you must have some level of trust in the system operator. Second, you should audit the restore operations performed on your system and monitor for any unusual restoration of files into

libraries—unscheduled restores or restores into nonsecure libraries, for example. Last, using object-level security for objects that contain private or confidential data (e.g., files containing salary information or cardholder data) will eliminate this exposure.

Object Ownership

Every object on the system has an owner. When an object is created, the object's owner is the user profile that created the object. You can use the CHGOBJOWN (Change Object Owner) command to change the ownership of an object. But what exactly does it mean to "own" an object?

The user profile that owns an object is automatically granted *ALL authority to the object when the object is created or when ownership is transferred to a new owner. Having *ALL authority gives the owner all object and data rights. The owner or another user who has sufficient authority (e.g., *ALLOBJ special authority) can revoke one or more of the owner's authorities to the object. For example, the owner can revoke his or her own data rights to the object, thus protecting the data but retaining the ability to control the object. If for some reason the owner lacks sufficient authority to the library in which the object resides, the owner can't access or manage the object regardless of which object and data authorities the owner has to the object itself.

Object ownership isn't an authority per se, but because ownership is so powerful, you need to control and audit it as you would authority settings. In general, the best way to do so is to create a few user profiles to own specific applications.

Let's say your system has the following libraries, applications, and files:

- FINOLIB—All financial applications
- FINFLIB—All financial database files
- MFGOLIB—All manufacturing applications
- MFGFLIB—All manufacturing database files
- DEVLIB—All development files and applications

In this scenario, I recommend three owners: one for all financial objects, one for all manufacturing objects, and one for the development objects. I would implement this strategy in two steps:

1. Create three user profiles with PASSWORD(*NONE), SPCAUT(*NONE):
   - FINOWNER (financial owner)
   - MFGOWNER (manufacturing owner)
   - DEVOWNER (development owner)
2. Change the ownership of the libraries and corresponding objects as follows:
   - FINOWNER owns libraries FINOLIB and FINFLIB.
   - MFGOWNER owns libraries MFGOLIB and MFGFLIB.
   - DEVOWNER owns library DEVLIB.

The names of the user profiles used as owners should indicate their use. The sole purpose of these profiles is to own the applications and associated objects. The profiles should not be group profiles, and users should not use them to sign on. Create the profiles with the following attributes:

```
PASSWORD(*NONE)
INLPGM(*NONE)
INLMNU(*SIGNOFF)
LMTCPB(*YES)
PWDEXPITV(*SYSVAL)
TEXT('Owner of xxx Application Objects')
```

If you use purchased software, you'll notice that most third-party applications use one user profile to own all the application's objects.

In a development environment, depending on how your change-control software works, you may need to assign ownership of development objects to a group profile. This approach lets programmers easily work with objects created by other members of the team without requiring you to implement an elaborate authority scheme. When each member of the development team is a member of the group profile, the group profile does all the work. Some organizations create their developers' profiles with OWNER(*GRPPRF), so that when a developer creates an object, the object is owned by the developer's first

group profile. This method works fairly well if all the users create objects in the QSYS file system. However, IBM i ignores the OWNER parameter for objects in other file systems, and the user retains ownership. Given today's environment, in which programmers might be writing Java programs and creating stream files, this method falls short. In this case, you may want to create an automated nightly process that sweeps application directories and sets the ownership to the developers' group profile.

Many organizations use QSECOFR as the owner of production objects. This strategy is unwise for two reasons. First, it encourages the use of the QSECOFR profile to implement and modify production objects. QSECOFR should be used only to install or upgrade the operating system or in the case of a system emergency. Second, when QSECOFR owns production objects, there's a temptation to use that profile to create programs that adopt authority. Allowing programs to adopt the authority of QSECOFR, the most powerful profile on the system, is very dangerous. Programs that adopt authority should be owned by a profile with limited authority created specifically for that task.

Security Recommendation

Don't have QSECOFR or other IBM-supplied profiles own production objects.

This chapter has described the specific authorities defined by IBM i along with the features available for implementing these authorities. What I haven't discussed yet is how to implement these features in a comprehensive security scheme that meets your organization's requirements for securing the data that resides on the system. That discussion begins in Chapter 12, after an explanation in Chapters 7 through 11 of the tools available for securing the IFS, securing output queues and spooled files, implementing encryption, and establishing network and Internet security.

Limit User Function (Application Administration)

When you're designing the security aspects of a new application, you need to determine the ownership and *PUBLIC authority of the application's objects and decide how to control users' abilities to perform tasks within the application. A user's ability to perform a task, or function, within an application often depends on whether the user has authority to an object, such as a command or a file. However, sometimes you need to control whether a user can perform a function within an application when there is no associated

object to which you can check the user's authority. The User Function Registration APIs let you define and register a function. You use the APIs in the application to determine whether the user has authority to perform the registered function.

Function definition isn't limited to user-written applications. For example, IBM i Access defines several functions that let you control which of its features are displayed on a user's desktop when using i Access for Windows or when using Navigator for i. IBM i defines functions to control access to some service tools, such as some DASD management functions and Backup, Recovery and Media Services (BRMS). You should consider functions defined to control what appears on the desktop (e.g., data transfer) to be a modern-day implementation of menu security. In other words, in this case, the support is more a usability enhancement than a security mechanism, and you shouldn't count on those functions to secure your system. However, functions that control access in IBM i (e.g., the DASD management, Service trace, and BRMS functions) are relevant to security and can be considered part of the implementation of your security scheme.

To administer the IBM i functions, you use IBM Navigator for i—either the client or Web version. If you're still using the client version, right-click the name of the system you're connected to in Navigator, and select **Application Administration**. The resulting dialog box, shown in Figure 6.7, lists all registered functions, categorizing them under three tabs. The first tab (labeled **System i Navigator** in the figure) lists functions defined by Navigator and its plug-ins. The second tab, **Client Applications**, lists all other client functions (sometimes referred to as applications), for IBM i Access for Windows. The third tab, **Host Applications**, lists applications that reside on IBM i, not on the client. Business partners and other application providers can define and register their own functions.

Technical Note

If you are using Access Client Solutions, the settings in the Client Applications tab have no effect on what ACS features the user has access to. What features a user has access to is controlled by the deployment of ACS. If the user isn't supposed to have access to Data Transfer, for example, then use the ACS deployment wizard to customize access—that is, not include Data Transfer—in the executable that is sent to the user's workstation.

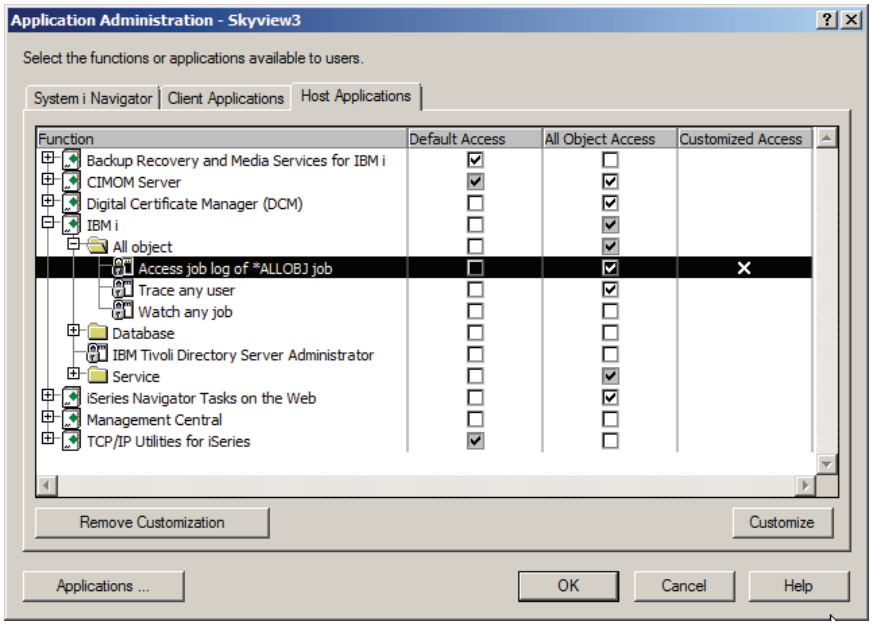

Figure 6.7: Navigator for i Application Administration window

From Navigator for i, you can see which functions a particular user is allowed to perform. To do so, select the system you're connected to, expand **Users and Groups**, select **All Users**, right-click the user you're interested in, select **Capabilities**, and click the **Applications** tab. Figure 6.8 shows a sample window.

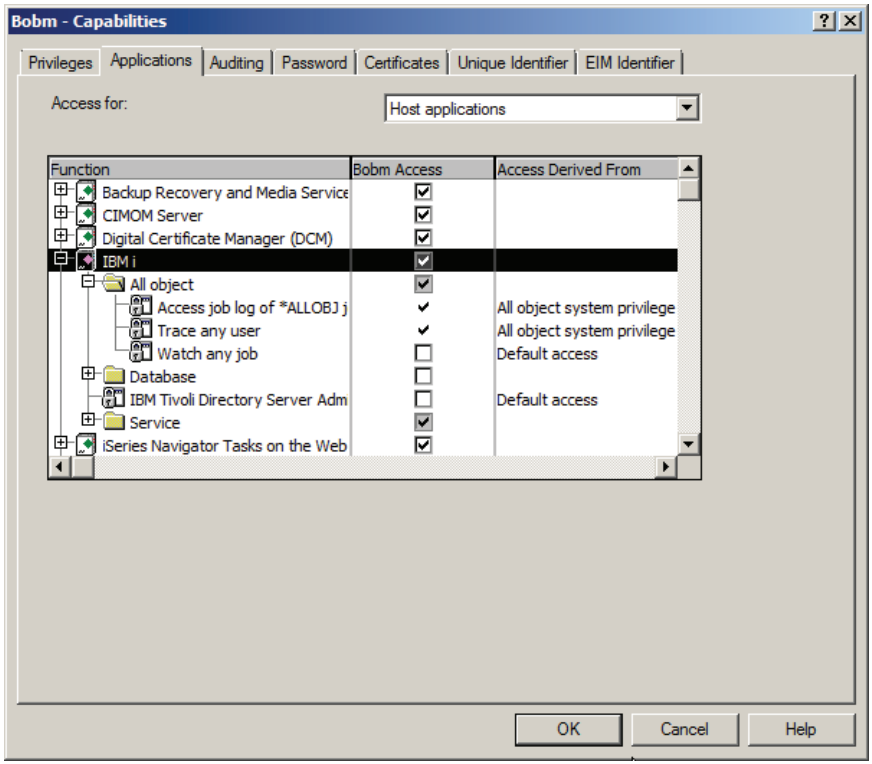

Figure 6.8: Viewing a user's capabilities in Navigator for i

If you're using the Web version of Navigator for i, you can reach Application Administration by opening **System**, then clicking on **Application Administration**, as shown in Figure 6.9. The functionality is the same, whether you're using the client version or the Web version.

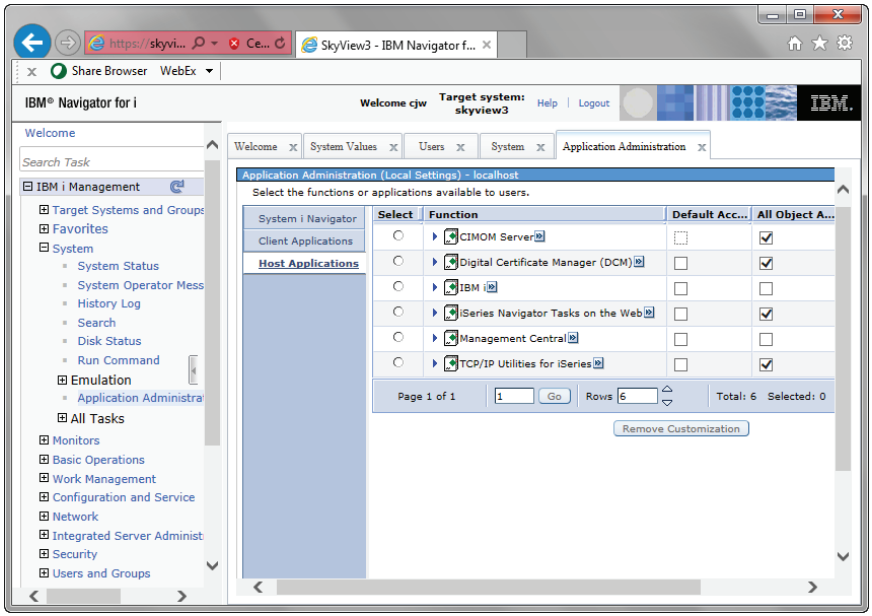

Figure 6.9: Navigator for i Application Administration display

IBM also provides three CL commands for managing application administration: DSPFCNUSG (Display Function Usage), CHGFCNUSG (Change Function Usage), and WRKFCNUSG (Work with Function Usage). You may wonder why the command names use the words "Function Usage" rather than "Application Administration." The commands provide a quick user interface into the Function Usage APIs. These APIs are also used to implement Application Administration. But because "AppAdmin" is easier to say, pronounce, and remember than "Function Usage," (!), I prefer to refer to this function as AppAdmin.

Administrators and auditors who want to determine who is allowed to access which AppAdmin functions (e.g., trace, cluster administration, disk units, service dump) will find the DSPFCNUSG command useful. The CHGFCNUSG command lets an administrator change who is allowed to access which AppAdmin functions and other attributes, such as whether *ALLOBJ authority should be honored when a check is performed. The WRKFCNUSG command lists the AppAdmin functions for which current settings can be displayed or changed.

Here's an example of the CHGFCNUSG command, using my favorite function in Application Administration:

```
CHGFCNUSG  FCNID(QIBM_ACCESS_ALLOBJ_JOBLOG) +
           DEFAULT(*DENIED)                 +
           USER(ALLISONB)                   +
           USAGE(*ALLOWED)
```

This command denies access to the QIBM_ACCESS_ALLOBJ_JOBLOG function for the default user. (Think of the default user as the "*PUBLIC" authority for the function.) The command also allows the ALLISONB user profile to use the function. Why is this my favorite function? Because it gives users who have *JOBCTL special authority the ability to see the job log of an *ALLOBJ user. This feature has allowed many of my clients to remove *ALLOBJ authority from their on-call programmer profiles. Without this feature, if you want to view the job log of a failed job that is running as an *ALLOBJ user, you must have *ALLOBJ authority yourself.

Row and Column Access Control (RCAC)

Row and Column Access Control (RCAC) was introduced in V7R2 and brings the security implementation more in line with other DB2 implementations, providing administrators a way to filter what information is available without having to develop and manage logical files. As one might imagine from the name, there are two aspects to RCAC: what can happen at the row level and what can happen at the column level. At the row level, you can select which users (or groups) see which records. The column controls allow you to mask data or show the entire field. For example, users belonging to the HR group get to see full Social Security numbers, but everyone else sees a masked value. We'll talk more specifics in a minute, but this gives you an idea of the functions of each. If it's not obvious, let me say that this is powerful stuff. However, it does take significant planning before implementation. So the focus of this section is to help you understand the implications of and plan for the security aspects of an RCAC implementation.

Prerequisites

Before you can implement RCAC, BOSS option 47 - IBM Advanced Data Security for i must be installed. This is a no-charge option, but it must be installed for you to configure or use RCAC. Next, someone must be assigned the Security Administration function usage or QIBM_DB_SECADM. That last sentence probably makes no sense, does it? Let me back up and explain. There's a function within iNavigator and Navigator for i called Application Administration. To reach it, launch iNavigator and right-click on the system

name. (This example uses the client version of iNavigator provided with i Access for Windows. This function is also available via Navigator for i provided with Access Client Solutions—ACS.) From there, choose Application Administration. Once that's launched, you'll see three sections of Application Administration; the one we're interested in is under the Host Applications tab. The Host section allows you to give access to perform certain functions—in this case, the ability to administer RCAC. Cursor down to the Database Security Administration line and click the Customize button (see Figure 6.10).

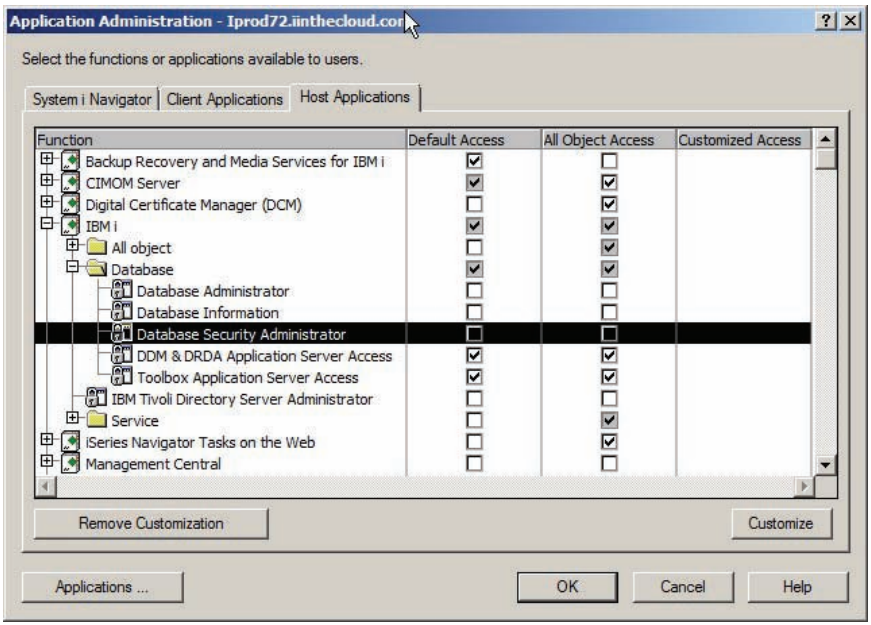

Figure 6.10: The Application Administration's Host Applications tab

As you'll see in Figure 6.11, under the **Access** heading are two check boxes. Checking the **Default access** box allows anyone to manage RCAC. The only time I can even imagine checking this box is on a server that's truly a sandbox system and contains no production data. Otherwise, leave it unchecked. The other check box, **Users with all object system privilege**, means any user with *ALLOBJ special authority. So here's the interesting thing. If you leave the *ALLOBJ box unchecked, users with *ALLOBJ will not be able to administer RCAC. Think about that for a moment: this provides you with a way to separate database access administration from your system administrators. You'll need an administrator (someone with *SECADM special authority) to give the QIBM_DB_SECADM function usage. But once you've done that, if you avoid giving QIBM_DB_SECADM to your

system administrators and they're not authorized through RCAC, they will not be able to see the contents of the database file. Clearly, you'll want to monitor who has been given the QIBM_DB_SECADM function and what the settings are (that is, whether *ALLOBJ users have been given access).

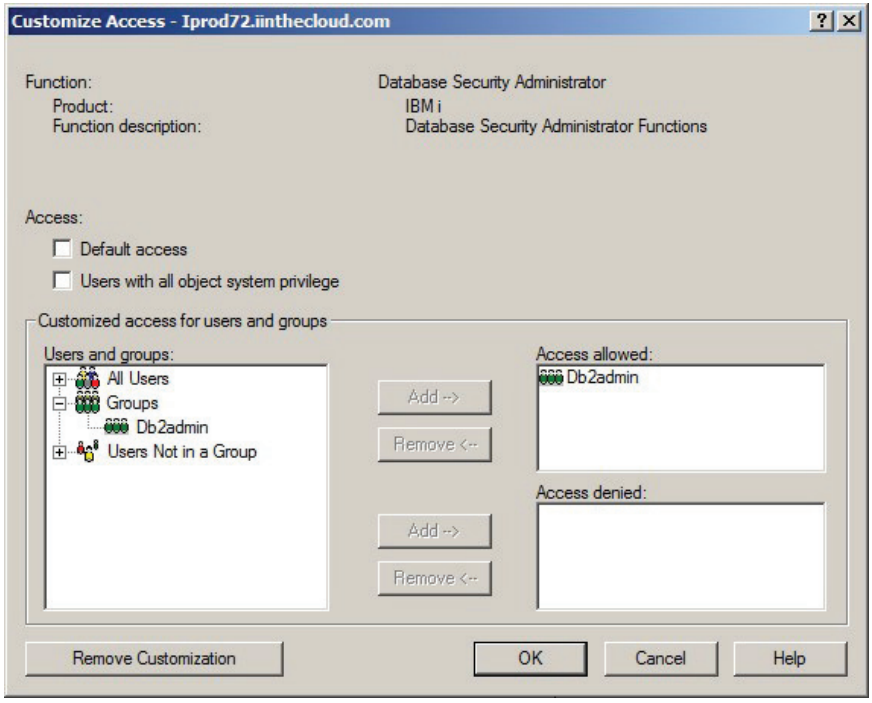

Figure 6.11: Customizing users' access

Once you've given the appropriate users Database Security Administrator function, you're ready to give RCAC a try.

Understanding RCAC

RCAC is not a replacement for the traditional object-level security settings; rather, it's the second pass in the process of the system determining the user's access to the data in the file. Therefore, even if users have been granted permission through RCAC, they must first be able to pass the test of the regular IBM i authority-checking algorithm. Object-level security is in effect regardless of how the data is accessed, and the same is true for RCAC. Once RCAC is activated on a file, the row permissions and column masks are in effect for every access method—ODBC, FTP, DDM, commands such as RUNQRY (Run

Query) and UPDDTA (Update Data) and via SQL statements—which is the behavior you'd want and expect. But the access you may forget to consider in your planning is access via normal application interfaces such as a green-screen menu. Because—as I stated before—once activated, RCAC is in effect regardless of how the data is being accessed. Before I discuss some specific considerations regarding this functionality, let me provide you with an example.

Imagine that you want salespeople to see sales figures only for their region. Right now, when salespeople download information into a spreadsheet, all sales figures are downloaded. To accomplish your goal, the example below can be used. Adding these permissions would enforce that users in the NORTHSALES group will see all rows where the region is set to 001 (which is how their region is identified in the database). Likewise, users in the SOUTHSALES group will see all rows where the region is set to 002. And users in the MANAGER group see all rows in the SALES file.

```
CREATE PERMISSION sales_info ON sales
FOR ROWS WHERE
(
  VERIFY_GROUP_FOR_USER(SESSION_USER,'NORTHSALES') = 1
  AND region = '001'
)
OR
(
  VERIFY_GROUP_FOR_USER (SESSION_USER,'SOUTHSALES') = 1
  AND region = '002'
)
OR
(
  VERIFY_GROUP_FOR_USER (SESSION_USER,'MANAGER') = 1
)
ENFORCED FOR ALL ACCESS
ENABLE;
COMMIT;
ALTER TABLE sales ACTIVATE ROW ACCESS CONTROL;
COMMIT;
```

Now let's look at the things you need to plan for when considering this example:

- In RCAC, it's the absence of a permission that denies access. In other words, if you don't have permission to access a row, you're inherently denied access. This is a very important concept to remember when designing permissions.
- If you add another region, CENTRAL, for example, you must remember to add another row permission for the group and any other group you add in the future that needs filtered access to the data. So consider the ongoing maintenance when designing row permissions.
- A lot of people are tempted to think of RCAC in terms of what it can do for filtering data when using interfaces such as ODBC. But as I've said several times already, once activated on a file, RCAC is effect through every interface by which the data is accessed; therefore, you must ensure all users of the application have permission to the data. In our example, if application users aren't in the NORTHSALES, SOUTHSALES, or MANAGER group, when they take an option off of the application's green-screen menu, they will have no access to the application data. What do the non-members see? You might think they'd see some type of "not authorized" message, but that's not the case. They just don't get data. It's as if the table (file) is empty. (Can you even imagine the help desk calls that would come pouring in if this happened on your production system?!) Understanding the fact that all users of the data need a row permission when implementing RCAC is another very important concept to remember when designing permissions.
- Building on the scenario we've discussed for our example, some of you will want all your application users to have unrestricted access to all rows as long as they are within the application's interfaces—e.g., via a green-screen menu. But as previously described, access to the sales data from outside of the application (e.g., via ODBC, the RUNQRY command) must be filtered by regions and permission given only to select individuals—that is, members of the NORTHSALES, SOUTHSALES, and MANAGER groups. To keep the application working as it does today for users coming through the green-screen menu, you can use adopted authority.

Yes, adopted authority works in the RCAC phase of authority checking. If the permission is defined to check the CURRENT_USER rather than the SESSION_USER, the last profile being adopted (that is, the owner of the last program in the program stack that

is configured to adopt its owner) is evaluated. In the example above, if the application programs are owned by APP_OWN and are configured to adopt (user profile is set to *OWNER), you'll want to add the following so that there is a permission that will ensure the application users continue to have full access to the data. That is, the adopted authority will provide the permission to access all rows.

```
OR
(
CURRENT_USER = 'APP_OWN'
)
```

- Row and column access controls will not take effect until the ALTER TABLE statement has been run to activate the row permission and the column masks. If you inadvertently activate the row permission but you haven't defined any permissions, you will block everyone from using the data. Note to self: have the row permissions in place prior to activating, especially on your production servers!
- There may already be logic within an application to limit the data a user can see. With row permissions, you may now be able to remove this logic. Regardless of whether you leave this logic or remove it, you'll want to consider whether adding row permissions will have any effect on how application users are used to seeing and using data. Thorough testing will be required to make sure application users continue to see the data they're supposed to see—or not see.

Programmer Considerations

- Again, once RCAC has been activated for the file, users without permission have no access to the data and cannot take actions on the file. Now I know I've already discussed this, but I want you to consider it in a slightly different context. Think of this restriction in the context of programmers needing to fix a production data issue. Many of you use utilities that swap to a profile with elevated privileges, often a profile with *ALLOBJ special authority. Since row permissions also enforce that you must have access to read any row that you insert or update, you'll have to make sure that the profile being swapped to has row permission to all rows; otherwise,

it's likely the programmers won't be able to make the update. I found this out myself. While exploring RCAC, I wanted to add some more rows to a table I had created to test with. But I had already activated the permissions; therefore, even though my profile had *ALLOBJ special authority (so I had sufficient object authority to perform the task), I could not insert new rows because I didn't have the row permissions to do so.

- Production database files are often copied to other systems. When the system is a Quality Assurance (QA) or test system, the user profiles are often the same as on production. Therefore, the permissions you've added through RCAC may not have to be modified. However, once you move this data to a development system, you may have to add more permissions or modify the permissions to allow the developers access to the data. You'll also want to consider adding column masks as you move production data to non-production systems, but I'll discuss that in the next section.

Column Masks

Column masks do exactly as the name sounds: they allow you to mask data in a column based on some criteria. The column mask capabilities are quite flexible and powerful, but for this article I've chosen a very simple example. If users are members of the CUSTSERV group, they'll see the last four digits of the credit card number. If not, the field will be blank.

```
CREATE MASK CC_mask ON customer
    FOR COLUMN CC RETURN
      CASE
            WHEN (VERIFY_GROUP_FOR_USER(SESSION_USER,'CUSTSERV') = 1)
                  THEN 'XXX-XX-' CONCAT SUBSTR(CC,12,4)
            ELSE NULL
      END;
    ENABLE;
COMMIT;
ALTER TABLE customer ACTIVATE COLUMN ACCESS CONTROL;
```

Column Mask Considerations

- Column masks are not the same as encrypting the data. The data "at rest"—that is, the data in the physical database file—is stored in clear text. Column masks can be deactivated or removed, leaving the data fully viewable. In addition, masking the data will never allow you to pass an audit if the requirement is to encrypt the data. Column masks limit who can see values, but as a protection measure it's not as strong as encryption and will definitely not meet compliance requirements if the data must be encrypted.
- When encryption is not an option and not required by law or regulation, column masks are a fantastic way to reduce the exposure of sensitive data. In my opinion, they should be defined for any column that contains personally identifiable information (PII) or other confidential data to reduce the risk to this data. This especially applies to test and development systems, where object-level security is not usually enforced with the same rigor as on production systems.
- However, once again, careful planning and application testing is required. For example, you'll want to seriously consider adding a check constraint to prevent writing the masked data back into the database record, especially when implementing column masks on a production system.

Managing RCAC

Defining row permissions and column masks is done exclusively through SQL. While there's an indication when you run the DSPOBJAUT or EDTOBJAUT (Display/Edit Object Authority) commands that RCAC is active on a file, as shown in Figure 6.12, there's no command that allows you to modify or even display the permissions or masks. That's strictly done through the Row Permissions and Column Masks functions in iNavigator under **Database** > **Schema**. Or you can display the permissions or masks by querying the QSYS2/SYSCONTROLS catalog using the Run SQL Scripts function.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                          Display Object Authority

Object . . . . . . . :   HR              Owner  . . . . . . . :   DBA1
  Library  . . . . . :     HRDATA        Primary group  . . . :   *NONE
Object type  . . . . :   *FILE           ASP device . . . . . :   *SYSBAS
Row or column access control  . . . . . . . . . . . . . . . . :   Active
Object secured by authorization list  . . . . . . . . . . . . :   *NONE

                          Object
User         Group       Authority
*PUBLIC                  *EXCLUDE
DBA1                     *ALL

                                                                  Bottom
Press Enter to continue.

F3=Exit   F11=Display detail object authorities   F12=Cancel   F17=Top
F18=Bottom
(C) COPYRIGHT IBM CORP. 1980, 2013.
MA    A                                                          01/001
I902 - Session successfully started
```

Figure 6.12: Display Object Authority showing that RCAC is active

A new audit entry type, AX, has been added to log the creation, removal, enabling, disabling, and so on of row permissions and column masks. Included in the audit entry is the SQL statement used to define the permission or mask. The new entry has also been added to the CPYAUDJRNE (Copy Audit Journal Entries) command to allow you to easily query the IBM i audit journal for these types of entries.

Save/Restore Considerations

When planning for the implementation of RCAC, another point to consider is the save/restore issues you can encounter. For example, the save operation will not work for a target release of a previous version (that is, a release prior to V7R2) if row permissions or column masks have been defined. They will have to be removed by someone granted the QIBM_DB_SECADM function to have a successful save to a previous release. Another scenario you can encounter is when you save a file with activated RCAC controls and you restore it to a V7R2 system that doesn't have BOSS option 47 installed. In this case, all attempts to open the file will fail. The resolution is to install IBM Advanced Data Security for i or have someone with QIBM_DB_SECADM function deactivate the row permissions and column masks.

Note

If you're using a High Availability (HA) solution that depends on replication of data and system settings, check with your vendor to determine if the version you're using supports replication of RCAC permissions.

More Information

My discussion has focused primarily on the security aspects of RCAC, but there are others—such as performance—that you'll want to understand and consider as part of your planning. Here are some references to help you:

- Details of the SQL syntax to implement RCAC can be found in the *DB2 for i SQL Reference* manual, *http://www.ibm.com/support/knowledgecenter/ssw_ibm_i_73/db2/rbafzintro.htm*.
- IBM Redpaper for more details on implementing RCAC: *www.redbooks.ibm.com/redpieces/pdfs/redp5110.pdf*
- Details of the new AX audit journal entry can be found in Appendix F of the *IBM i Security Reference* manual: *https://www.ibm.com/support/knowledgecenter/api/content/nl/en-us/ssw_ibm_i_73/rzarl/sc415302.pdf*.

Summary

RCAC provides you with options for adding another layer of protection to your IBM i data beyond what regular object-level authorities provide. However, RCAC is not something that should be implemented without planning and testing for potential side effects. A thorough understanding and much planning need to occur before rolling out an implementation of this V7R2 feature.

Authority Collection

V7R3 introduced a feature called authority collection. Unlike RCAC, authority collection is part of the base operating system and requires no additional operating system features. Authority collection provides a way to determine exactly what authority is required when an object (such as a program, file, or directory) is accessed. The motivation behind IBM's providing this function is to provide a tool to help security administrators and application providers understand the minimum authority required when accessing objects. If you think about the security scheme of most IBM i applications, they were designed with menu security but did not take care to properly secure the application objects (e.g., files, programs, data areas). As a result, many applications' objects are set with *PUBLIC authority of *CHANGE or *ALL when a more restrictive setting would be sufficient. Authority collection will make changing the authority settings less risky because you can tell—prior to changing any settings—exactly what authority is required for each application function.

To use authority collection to rework an application's security settings, choose one of your power users and run the STRAUTCOL (Start Authority Collection) command (see Figure 6.13). You have many options for specifying what data you want to collect. I'm guessing that you'll be like I was when I first started to use this feature and specify that you want to collect EVERYTHING! Once you do that and start to look at the data, you'll quickly find out that the analysis is far less overwhelming if you narrow down what is collected. So in this example, I have specified that I want to collect the authority information whenever user CWOODBURY accesses *PGM and *FILE objects in the APPDTALIB, APPOBJLIB, and LOCLIB libraries.

Once you run this command, the collection starts immediately—no need to have CWOODBURY log off, then on again. You can also view the collected data at any time—no need to end the collection prior to viewing it. Once CWOODBURY has run through her tasks, you can examine what has been collected by running a query against the AUTHORITY_COLLECTION view.

```
File  Edit  View  Communication  Actions  Window  Help

                    Start Authority Collection (STRAUTCOL)

 Type choices, press Enter.

 User profile . . . . . . . . . . . > CWOODBURY     Name
 Library and ASP device:
   Library  . . . . . . . . . . . . > APPDTALIB     Name, *NONE, *ALL
   ASP device . . . . . . . . . . .   *SYSBAS       Name, *SYSBAS

   Library  . . . . . . . . . . . . > APPOBJLIB     Name
   ASP device . . . . . . . . . . .   *SYSBAS       Name, *SYSBAS

   Library  . . . . . . . . . . . . > LOCLIB        Name
   ASP device . . . . . . . . . . .   *SYSBAS       Name, *SYSBAS
                 + for more values
 Object . . . . . . . . . . . . . .   *ALL          Name, generic*, *ALL
                 + for more values
 Object type  . . . . . . . . . . . > *FILE         *ALL, *CMD, *DTAARA...
                 + for more values > *PGM

                                                                   More...
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys

MA    a                                                            05/037
```

Figure 6.13: The STRAUTCOL *(Start Authority Collection) command*

The amount of information recorded for each entry in the collection has more details than you'll likely ever need or want to know. However, some information is invaluable—specifically the DETAILED_REQUIRED_AUTHORITY and DETAILED_CURRENT_AUTHORITY fields. The field names perfectly describe their contents. With the DETAILED_REQUIRED_AUTHORITY field, gone is the guessing game or trial and error when trying to determine how much authority to assign. Also incredibly useful are the AUTHORITY_SOURCE and ADOPTED_AUTHORITY_SOURCE fields, which list where the authority named in the DETAILED_CURRENT_AUTHORITY field comes from.

Authority collection is not limited to libraries and objects in libraries. You can also collect authority information about directories and objects in directories as well as Document Library Objects (DLOs) and folder objects.

I wish the authority collection feature had been available at one of our clients when we were trying to secure a directory containing sensitive information. Before we could secure the directory, we had to determine what authority the service account writing into the directory required. We thought we had granted the profile the correct authority, but when we ran the process, it failed with an authority error. Through trial and error, we finally got the authority set correctly. If authority collection had been available, we could have simply turned on authority collection for the service account, specifying the directory being secured, run the process, examined the DETAILED_REQUIRED_AUTHORITY field, granted the authority listed to the service account, set *PUBLIC authority to *DTAAUT(*EXCLUDE) OBJAUT(*NONE), and then know that the process would continue to work as it did previously.

Figure 6.14 shows the result of running a query against the AUTHORTY_COLLECTION view. In this case, I wanted to see only the pathname, authority required, and the current authority. The first line of Figure 6.14 shows the entry that is logged when the attempt to list the contents of a directory failed. The second and third lines show the entries when the access completed successfully after I granted the user DTAAUT(*RX) OBJAUT(*NONE) to the /SkyView directory.

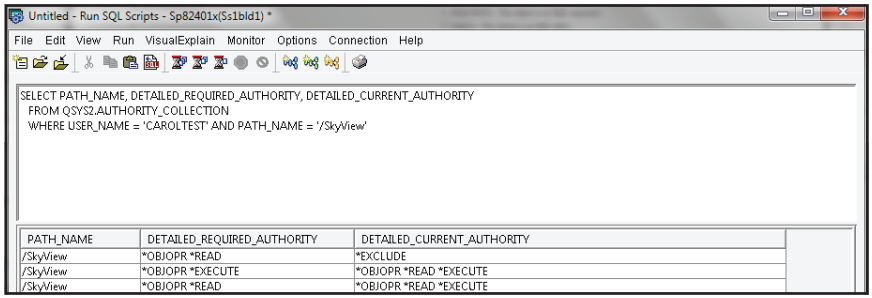

Figure 6.14: Using Run SQL Scripts to query the contents of the authority collection

Technical Note

The collection is not a log. In other words, the entries are not added to the collection in timestamp order. When I first began using the function, I assumed that new entries would be added at the end of the collection. I didn't realize that I was incorrect in that assumption and thought the function wasn't working correctly. The secret to working with the collection is to query on the objects you're interested in. Don't look at the full collection top to bottom (as you would a log file) and attempt to make sense of it!

Authority collection can be used to simply and verify the authority settings in many situations. Here are just a few:

- Run a query before rolling out a new security implementation to your entire user base and ensure your test users have all the authority required to run the application and that it's coming from the source you intended.
- Determine which application objects (especially *FILE objects) can have their authority immediately set to a more restricted authority setting, without fear that the

application will stop working. This is especially helpful when the QCRTAUT system value has been set to *ALL. Some file accesses (such as when adding a physical file member) require more than *CHANGE authority. So it's difficult to know what will break if you change QCRTAUT from *ALL to the system default of *CHANGE. You can query the authority collection and list the files that require more than *CHANGE authority to run the application. You may want to secure the files even further, but you can at least make this initial step to start to reduce your risk.

- Determine the exact authority required to work with IFS objects prior to implementing a new FTP process or ODBC connection on production.
- Determine the authority required for service accounts to work with database files. Service accounts are often created with *ALLOBJ special authority because the authority that's required is unknown. Simply turn on the authority collection for the service account, examine the entries, and determine the authority required. Undoubtedly it will not require *ALLOBJ!
- Use the authority-required fields to prove to developers and application providers that *ALL authority is not required!

Here's some additional information about authority collection:

- To run the authority collection commands, you must have either *ALLOBJ special authority or be authorized to the Database Security Administrator function (QIBM_DB_SECADM) previously described in the RCAC section of this chapter.
- The Limit User Function (Application Administration) settings are not recorded.
- For those features where authority to an object plus some special authority is required, the special authority requirement is not recorded. For example, the CRTUSRPRF (Create User Profile) command requires the user to have *SECADM special authority. The special authority requirement is not in the authority collection.
- To display whether a collection is active and/or an authority collection repository exists for a user, run the DSPUSRPRF (Display User Profile) command and scroll to the end of the display.
- While a user's collection setting is saved when running the SAVSECDTA (Save Security Data) command, the actual collection data is not. If you want to save the

collection data, you'll have to save it into a file, which can then be saved/restored through normal IBM i interfaces.

- If an authority collection exists and the profile is deleted, its authority collection is also deleted.
- If you specify to collect authority for all objects in all libraries, some objects, such as operating system programs, are omitted from the collection; however, objects such as IBM-supplied commands will be included in the collection data.
- See Chapter 10 of the *IBM i Security Reference* manual for more details of the authority collection, including the complete layout of the authority collection view.

Helpful Tools

The SECTOOLS and SECBATCH menus provide three security tools to help you effectively manage object authorities on your system (Table 6.3).

Table 6.3: Tools for managing object authorities

Security Tool	Description
PRTADPOBJ (Print Adopting Objects)	Use this command to print a list of objects that adopt the authority of a specified user profile. You can specify one profile or specify a set of profiles generically (e.g., specify PGMR* to see all user profiles that begin with PGMR).
PRTPUBAUT (Print Public Authorities)	You can use this command to list all objects whose public authority is not *EXCLUDE. You can select objects by type and library or directory.
PRTPVTAUT (Print Private Authorities)	This report lists the private authorities that exist for a specified type of object in a library or directory. The command can list all objects of the specified type and their private authorities, list only changes to the objects since the last time you ran the report, or even list the private authorities that have been deleted since the last time you ran the report.

Navigator for i

Both the client version (i Access) and Web version (ACS) of Navigator for i provide an interface for managing object authorities. To manage object authorities, which Navigator refers to as a user's *permissions* to an object, navigate to the object, right-click it, and select **Permissions**. Navigator will display a window similar to the one shown in Figure 6.15.

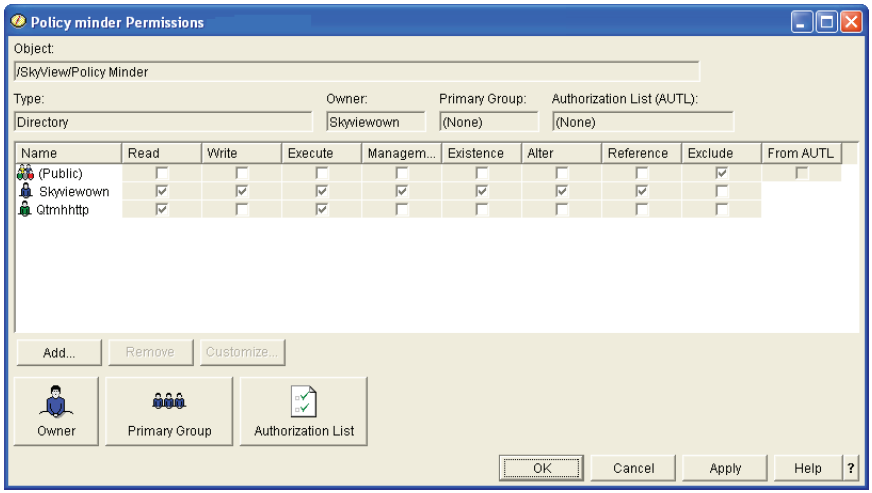

Figure 6.15: Navigator for i Permissions window

When using the Web version of Navigator for i, you have the option to use **Security** > **Change Object Permissions**, then specify the path of the object you wish to change, as shown in Figure 6.16.

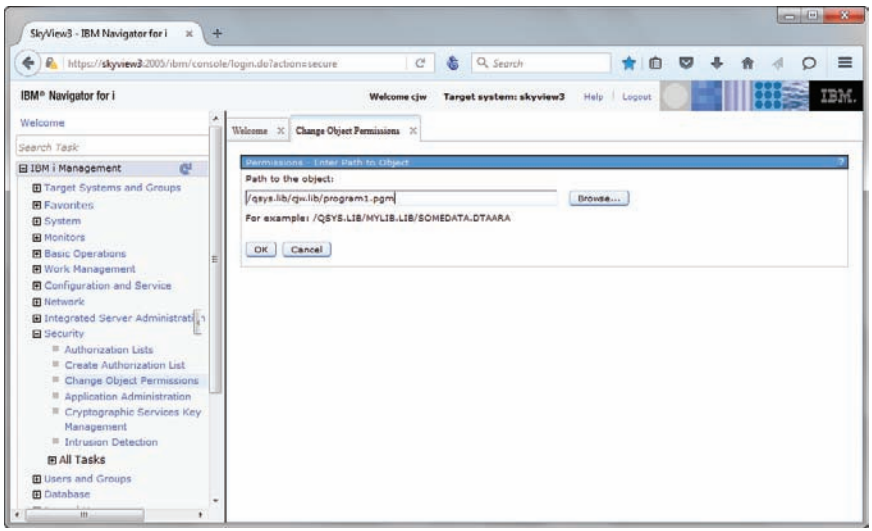

Figure 6.16: Specifying an object's pathname when changing its permissions

CHAPTER 7

Security Considerations for the IFS

The *integrated file system*, or IFS, is really a set of file systems that are available on IBM i. The primary use of the IFS is to store objects such as stream files, images, Hypertext Markup Language (HTML), and Portable Document Format (PDF) content that cannot be stored in traditional IBM i libraries.

Table 7.1 lists the file systems encompassed by the IFS. The IFS always includes the root ('/') and QSYS.LIB file systems (the latter uses the traditional *library_name/object_name *objtype* syntax to refer to objects) and may include the Network File System (NFS), the QNTC file system, and other file systems.

Table 7.1: File systems in the IFS
/ —"Root" file system *Serves as an "umbrella" over the other file systems*
QOpenSys—Open systems file system *Contains UNIX-based files and directories*
UDFS—User-defined file system *Contains user-defined and -managed file system(s)*
QSYS.LIB—Library file system *Contains IBM i libraries and other types of IBM i objects*
Independent ASP QSYS.LIB—Independent ASP library file system *Supports the server library structure in any independent auxiliary storage pools (ASPs) you create and define*

Table 7.1: File systems in the IFS (continued)
QDLS—Document library services file system *Contains Document Library Objects (DLOs) and folders*
QOPT—Optical file system *Contains stream files stored on optical media*
QNTC—Windows NT Server file system *Provides access to data and objects stored on a server running Windows NT (4.0 or higher), including Integrated System x Servers or System x servers attached via the Integrated System x Adapter*
QFileSvr.400—i5/OS File Server file system *Provides access to other file systems that reside on remote System i systems*
NFS—Network file system *Provides access to data and objects stored on a remote Network File System (NFS) server*

Most people use the term "IFS" to refer to the parts of the IFS that include the root, QOpenSys, and user-defined file systems. These file systems use a different authority scheme than QSYS.LIB uses—one based on UNIX. Other file systems use their own authorization method. This chapter describes the security considerations for root and the other file systems that follow the UNIX authority scheme. When I use the term "IFS" here, I'll be referring to the file systems that follow the UNIX approach to security.

Security for the IFS is an issue that should concern all IBM i security administrators because of the way the IFS comes secured—or, to be more accurate, *not* secured—from IBM. By default, the IFS is shipped wide open. That is, its *PUBLIC authority is set to DTAAUT(*RWX) OBJAUT(*ALL), which is the equivalent of *PUBLIC(*ALL). Unfortunately, when it comes to managing access and appropriate authorities, the IFS is one of the most ignored areas of the system. Although it's rarely necessary to rework the security scheme of the *entire* IFS, most systems usually have one or two application directories, directories containing WebSphere or other Web application configuration files, or directories with stream files containing payroll, tax, credit card, images of healthcare information, or other sensitive information that need to be secured. This chapter should help you determine how best to secure these directories and their objects.

IFS Authorities

The UNIX security scheme used by the IFS file systems defines three authorities:

- ***R** (read authority) permits a user to list the contents of a directory or read an object (e.g., a stream file).

- ***W** (write authority) lets a user add a new object (e.g., a stream file, a subdirectory) to a directory.
- ***X** (execute authority) permits a user to traverse a directory.

You can use these three basic authorities in combination to provide different levels of access to IFS objects and data. *RWX authority, for example, is equivalent to the IBM i authority of *CHANGE. *RX authority equates to *USE. Table 7.2 shows how the IFS's UNIX authorities map to the IBM i authorities you're accustomed to using.

Table 7.2: IFS authorities and IBM i authorities

Authority	*RWX	*RW	*RX	*R	*WX	*W	*X
Object							
*OBJMGT	–	–	–	–	–	–	–
*OBJEXIST	–	–	–	–	–	–	–
*OBJALTER	–	–	–	–	–	–	–
*OBJREF	–	–	–	–	–	–	–
*AUTLMGT	–	–	–	–	–	–	–
*OBJOPR	X	X	X	X	X	X	X
*READ	X	X	X	X	–	–	–
*ADD	X	X	–	–	X	X	–
*UPD	X	X	–	–	X	X	–
*DLT	X	X	–	–	–	–	–
*EXECUTE	X	–	X	–	X	–	X

When managing access to objects in the IFS (remember, I'm talking about objects in the file systems that use the UNIX security scheme), you must deal with two sets of authorities: object authorities and data authorities. As you can see in the table, the UNIX authorities *R, *W, and *X (and their combinations) map to data authorities. (Note that the table lists *OBJOPR authority, which is an "object authority" in IBM terms, with the data authorities that make up the implementation of the UNIX authorities on IBM i.) However, even though you may be working with a UNIX application and its objects, "under the covers" the objects are still IBM i objects, so you can't ignore the fact that all IBM i authorities must be accounted for—thus, the presence of the object authorities in the table.

Managing Authorities to IFS Objects

To manage the authorities to objects in the IFS, you can use either green-screen CL commands or the Navigator for i interface.

The WRKAUT (Work with Authority), CHGAUT (Change Authority), and DSPAUT (Display Authority) commands provide the green-screen interface. When issuing these commands, you identify the object by specifying a pathname rather than using the traditional *library_name/object_name *objtype* naming convention you're accustomed to. For example, to work with the authorities to the object proj1.txt in the directory /home/cjw/projects, you'd use this command:

```
WRKAUT  '/home/cjw/projects/proj1.txt'
```

If you're uncomfortable typing a pathname with the CL commands, you can opt to use the WRKLNK (Work with Object Links) command to navigate through the directory structure to the desired directory or object. When you reach the directory or object for which you want to view or change authorities, enter option **9** (Work with authority) beside it. The WRKAUT command screen will be displayed with the pathname filled in for you.

Your other choice for managing IFS objects is to use Navigator for i. To view the authorities for the root directory using this method, go to **My Connections** > ***System_name*** > **File Systems** > **Integrated File System**. Right-click on **Root**, and choose **Permissions**. Navigator will display a window equivalent to the WRKAUT command display.

Figure 7.1 shows the WRKAUT command's display of the default access for the root directory as IBM ships it. Note that *PUBLIC has data authorities *RWX and all object authorities. In "traditional" IBM i security terms, this authority is equivalent to *PUBLIC(*ALL). Figure 7.2 shows Navigator's view of the same information—the authorities in force for root.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                              Work with Authority

Object . . . . . . . . . . . . :   /
Type . . . . . . . . . . . . . :   DIR
Owner  . . . . . . . . . . . . :   QSYS
Primary group  . . . . . . . . :   *NONE
Authorization list . . . . . . :   *NONE

Type options, press Enter.
  1=Add user   2=Change user authority   4=Remove user

                    Data     --Object Authorities--
Opt  User         Authority  Exist  Mgt  Alter  Ref
 -   ________     ________
 _   *PUBLIC       *RWX        X     X     X     X
 _   QSYS          *RWX        X     X     X     X
 _   QDIRSRV       *X

                                                          Bottom
Parameters or command
===> ____________________________________________________________________
F3=Exit   F4=Prompt   F5=Refresh      F9=Retrieve
F11=Display detail data authorities   F12=Cancel   F24=More keys

MA  a                    MW
```

Figure 7.1: WRKAUT command display: default authority to root ('/')

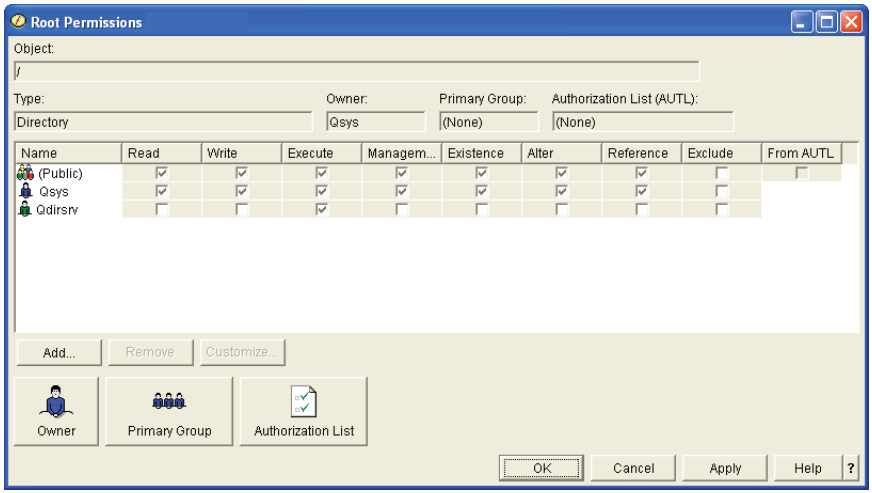

Figure 7.2: Navigator for i permissions window: default access for root ('/')

You can use the green-screen or Navigator interface to manage the authority of any object, including objects in the QSYS.LIB file system. For example, the screen shown in Figure 7.3 lets you manage authority to all programs in the PROD library. In the following example, all program objects in the PROD library will be set to *PUBLIC *USE.

```
                              Change Authority (CHGAUT)

Type choices, press Enter.

Object . . . . . . . . . . . . .   /qsys.lib/prod.lib/*.file
User . . . . . . . . . . . . . .   *PUBLIC     Name, *PUBLIC
                 + for more values
New data authorities . . . . . .   *RX        *SAME, *NONE, *RWX, *RX...
New object authorities . . . . .   *none       *SAME, *NONE, *ALL...
                 + for more values
Authorization list . . . . . . .               Name, *NONE
Directory subtree  . . . . . . .   *all        *NONE, *ALL
Symbolic link  . . . . . . . . .   *NO         *NO, *YES

                                                                   Bottom
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys
```

Figure 7.3: Managing authorities to IBM i objects with the CHGAUT command

File Attributes

Objects in the IFS possess some PC-like properties called *file attributes* that contribute to the way their access is determined and how the objects are managed. File attributes are properties of a file that work in addition to (not as a replacement for) the IBM i authority settings for the file. There are six file attributes:

- *Read-only*—The file or folder can only be read. It cannot be updated, changed, or deleted when this attribute is on.
- *Hidden*—The file or folder is hidden and can't be worked with unless you know its name.
- *System*—The file is a system file. (A folder cannot have this attribute set.)
- *Archive*—This attribute indicates whether the file or folder should be archived. Some programs use this attribute to determine which objects are backed up.
- *Archive (i5/OS attribute)*—This attribute has the same meaning as the Archive attribute. It cannot be changed.
- *Allow save*—Determines whether the file will be saved.

To set the file attributes for a file in the IFS, navigate through the IFS to the desired file or folder. Right-click on the object, and select **Properties**. A window similar to the one shown in Figure 7.4 is displayed. You use the check boxes at the bottom of the window to set the file attributes of the object.

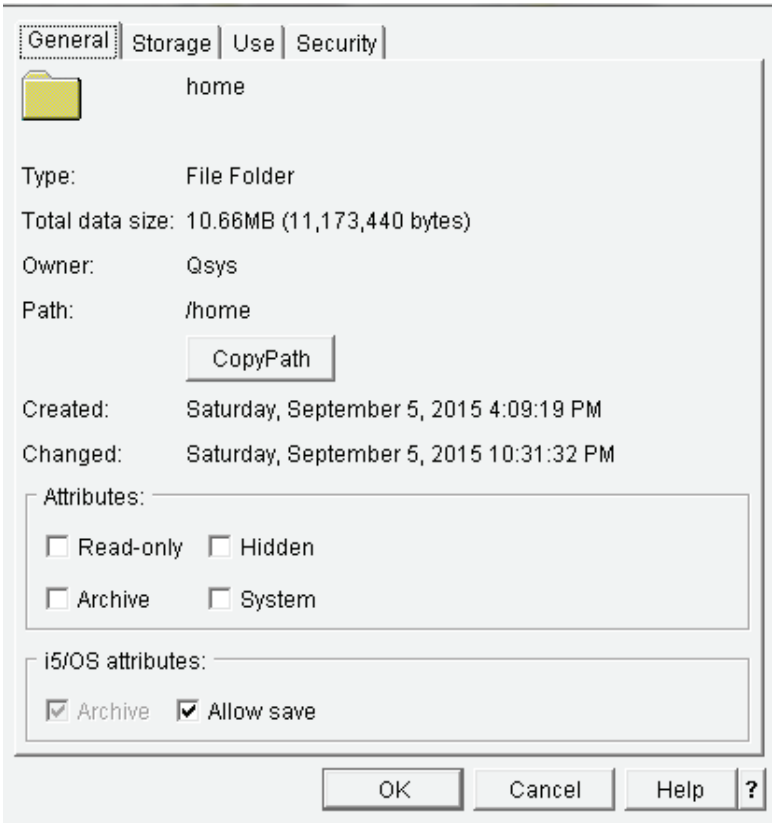

Figure 7.4: Setting file attributes for an IFS file

You can set the file attributes for objects that reside on IBM i by using PC interfaces or by running the CHGATR (Change Attribute) CL command.

Adopted Authority and the IFS

If you've written a traditional application that runs with adopted authority, you know that as long as the owner of the program that's running either owns or has authority to the object (e.g., a file) being accessed, the person running the program can access the file. However, this scheme doesn't work for accessing objects in the IFS because the IFS ignores adopted authority.

To access an object in the IFS, the user running the process must have authority to the object. For such applications, you'll need to either explicitly authorize your users (e.g., give them a private authority) to the required objects or change the process or thread

so that it runs as a different user who has sufficient authority to the IFS objects being accessed. To run as a different user, you have several choices: profile swap, profile token, or the UID and GID family of APIs. Chapter 12 discusses these approaches in detail.

Security Recommendation

Unless you need to allow directory access through an application (such as a user selecting a menu option to access a file in the IFS), I usually take the approach of granting authority to the users who need access to the directory. In most cases, only a handful of users or groups need access to a directory that is being locked down, and they typically need access for a File Transfer Protocol (FTP) or Open Database Connectivity (ODBC) connection rather than through an IBM i application. When the access is a direct access rather than application access, I find it easier to grant the users authority rather than writing the code to switch the process to run as a different profile.

Auditing Objects in the IFS

Just as you can audit objects in IBM i (or the QSYS.LIB file system), you can audit objects in the IFS. The challenge comes when you try to read the audit journal entries for these objects. The objects' names are actually pathnames and can vary quite a bit in length; therefore, they don't fit in the audit journal's 10-character object and library entry fields.

You'll recognize an audit entry for an IFS object by the *N that appears in place of the object name. To determine the object name for such entries, refer to the Absolute Path Name field, which appears at the end of the audit journal entry. If the pathname is longer than 5,002 bytes, you'll see the first 5,002 bytes of the pathname in this field. If you want to see the rest of the pathname, you'll need to use the file ID (FID), a number that uniquely identifies the object. To obtain the pathname from an FID, you must use the API Qp0lGetPathFromFileID() (Get Path Name of Object from Its File ID). Fortunately, not too many pathnames exceed 5,002 bytes!

File Shares: Accessing Objects in the IFS

File shares are what make the IFS, or part of the IFS, available for viewing or manipulation via the network. You use file shares when you want all users on the

network to have access to something. For example, you may want to use the QIBM file share (which is shipped with IBM i Access) so that users can easily find and download the latest version of IBM i Access or the more modern client—Access Client Solutions (ACS)—unless letting users download updates is totally against your policy. If that is the case, you probably want to remove that share.

It's important to note that although an individual file or the entire root directory may be shared on the network, users who attempt access still need the appropriate authority to a directory or file to perform the intended request. Just because a file is shared doesn't mean everyone can read it. That ability is still determined by the object authority settings on the directory or library being shared. (Yes, you can share a library!)

When you view directories or libraries under **Integrated File System** in Navigator, a hand beneath a directory or library name indicates a share. In Figure 7.5, the hand under the QIBM directory in the left pane indicates that a share has been defined for QIBM (as shown in the pane on the right). (You may find the hand a little hard to recognize in the figure.)

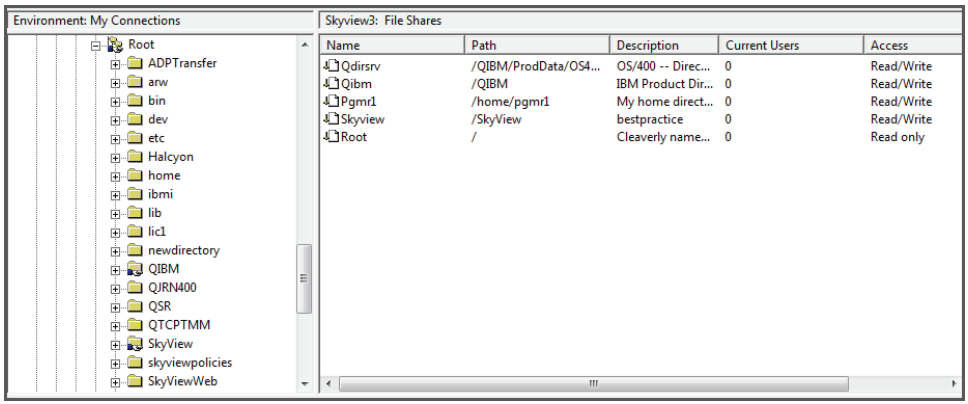

Figure 7.5: Share defined for directory QIBM

A file share can be defined as either read-only or read/write. The IBM-shipped file shares Qdirsrv and Qibm are read/write shares. That means that if you map a drive to the IBM i system, users can write to these directories (assuming the users have sufficient IBM i authority to do so). A share that ships with older versions of IBM i, the Qca400 file share, is read-only; users can read from this directory, but they can't write to it. Even if a user has *W (write) authority that lets the user write to the directory through IBM i interfaces, defining the share as a read-only share permits that user to read from the directory but not to write to it.

You can choose to remove any of the IBM-defined file shares and/or create file shares of your own. To create a new file share, you use Navigator. Go to **My Connections** > ***system_name*** > **File Systems** > **Integrated File System**, right-click the directory or library you want to share, and select **Sharing**. You can choose to make the share read-only or read/write. Obviously, the more secure setting is read-only because it lets users only read the data and not update it. (Again, even if you do create a read/write share and a user uses it, the user has to have IBM i object authority to the directory as well as to any object for which access is attempted.) You can also choose how many users can use the share at one time.

To see the existing file shares and the type of access defined for them, go to **My Connections** > ***system_name*** > **File Systems** > **File Shares**. Right-click a share, and choose **Properties** to see whether the share is defined as read-only or read/write. Figure 7.6 shows the share properties defined for the root directory. As you can see, in this example root is defined with read/write access, and an unlimited number of users can use this share.

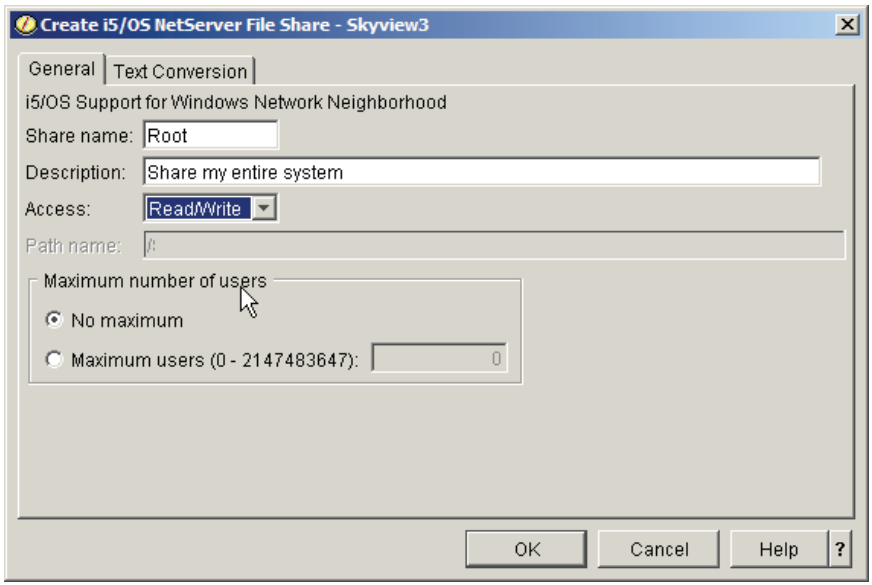

Figure 7.6: Share properties defined for the root ('/') directory

Creating a file share to the root directory can cause *significant* risk to your system. Sharing root ('/') exposes the directory structure of your entire IBM i system onto your network. If you don't have object-level authority set properly, any user who can map a drive can access any file on the system whose `*PUBLIC` authority is set to `*R` (read)

authority or *USE authority. On many systems, this would mean that most, if not all, files were accessible. Unlike on Windows, you can't define particular shares for particular users. Once you've created a share, it is available for all network users who possess an IBM i user profile and password.

Gotchas and Helpful Hints

This next section is meant to help you avoid some of the common "gotchas" associated with the IFS.

General Cautions

- It is very easy to over-secure the IFS. Be sure to document the authorization steps you take in case you need to back out of them. For example, you cannot set '/' to *PUBLIC *EXCLUDE because functions within the operation system rely on having access to the IFS.
- As I've said, adopted authority isn't honored within the IFS. If a user lacks authority to an object, the application must accommodate that user through a version of a profile swap or (my preference) through a private authority to the user's or the group's profile.
- The IFS does not honor the attribute of a user profile that automatically assigns ownership of newly created objects to the user's group (the OWNER parameter). The user—not the group—always owns a newly created object in the IFS.
- Displaying the contents of a directory object requires *RX data authority to every directory in the object's path. Changing the current directory requires only *R data authority to the directory. Therefore, it's possible for users to change their working directory to a directory for which they can't display the contents!
- Don't remove the private authorities that IBM i grants for some IBM-supplied profiles unless you know why they've been added.

Creating New Objects

- In general, a new object inherits the authorities of its directory. (The exception is when you create IFS objects through APIs such as mkdir(), open(), or creat(). With these APIs, you can specify the data authorities for the owner, primary group,

and public authorities.) Inherited authorities include the primary group authority, authorization list, and private authorities. The only difference would be the owner if a user other than the directory owner creates the object.

- Removing the owner's authority to a directory can produce undesirable results when users create objects into that directory. When an object is created into a directory, the owner of the new object receives the same authority as the owner of the directory. Therefore, if a user creates a file into a directory whose owner has had his or her authority removed, the user will have no authority to the newly created object.
- Given that most IFS APIs let you specify the data authority settings for the owner, primary group, and *PUBLIC on the API call, you may need to educate your developers to ensure that they specify appropriate values for these parameters. Note that because most of these APIs are UNIX APIs, there is no concept of object authorities; therefore, the object authorities are inherited from the parent directory.
- You have the option of specifying to have the primary group and its authorities set based on the user creating the object.

Copying Objects

- The CL COPY command creates an exact duplicate of an object, including its authorities (except for the owner, of course). The CPY command does the same thing. COPY is actually an alias of the CPY command, and you can use these two commands interchangeably.
- Because the copy commands duplicate authorities, to retrieve the authority information about the original object a user must be the owner or have *OBJMGT authority to the object being copied.
- Both the COPY and CPY commands let you make the owner of a copied object the same as the owner of the object being copied. However, the default is to make the user who is making the copy the owner. Depending on how these commands are used in your environment, it may be helpful to educate developers about this fact and retain the ownership of the object being copied (or you could change the command default).

Appendix D of IBM's *System i Security Reference* (available as a PDF file under the InfoCenter's Security topic) lists other authority requirements for objects, under the

heading "Integrated File System Commands." This documentation can be very useful in determining what authority is required.

CPYTOSTMF and CPYTOIMPF

The biggest IFS-related issue that I see in most organizations occurs when they are running the CPYTOSTMF (Copy to Stream File) and CPYTOIMPF (Copy to Import File) commands. That's because, by design, these commands default the owner's authority to *RWX and set the primary group and *PUBLIC authorities to *EXCLUDE. If the directory into which the files are being created is secured with an authorization list or has private authorities, neither of these authorities is copied. Subsequent attempts to access the objects will work only if the user is the one who created the objects—which usually is not the case. So, what do you do?

If your organization has written the code, you'll want to immediately follow the creation of these files with a CHGOWN (to change the owner) or CHGAUT (to change the *PUBLIC authority) command. If the files in question are created via a vendor package, your choices are to implement the IFS exit points and write a program that fixes the authorities after the file is created, write your own routine that runs periodically to fix the ownership/authority, or buy a vendor package that resets the authorities.

V6R1 provides the ability to specify where authorities are to come from when running the CPYTOSTMF and CPYTOIMPF commands. Options include that the authorities should come from the file being copied, from the directory, or work as they do today.

Virus Scanning

Although IBM i itself isn't affected by PC- or UNIX-based viruses and worms, the objects stored in the IFS can be. In addition, the IFS has proven many times that it can very efficiently and effectively store and propagate viruses. Today, most viruses are caught by firewalls, routers, or email scanners and never reach the IFS. But some organizations still require that the IFS be scanned for viruses. You can accomplish this by purchasing a vendor package or by pointing your Linux or UNIX antivirus solution toward the IFS or porting it to run natively in the Portable Application Solutions Environment (PASE).

Two security-related system values pertain directly to the IFS: QSCANFS (Scan File Systems) and QSCANFSCTL (Scan File Systems Control). These system values work in conjunction with some file system exit points and are described in more detail in Chapter 4. While the motivation for IBM to provide this capability was to give vendors the ability

to perform real-time virus scanning, use of QSCANFS and QSCANFSCTL is not restricted to that function. With a little imagination and some programming, you could write a program to fix the authorities and ownership of objects, solving some of the pre-V6R1 trials involved with creating stream and import files.

Security Recommendations

I conclude this chapter with some advice for securing the IFS appropriately. For more information about the IFS itself, see the **Files and file systems** > **Integrated file system** topic in IBM's Information Center.

**PUBLIC Authority for Application and User Directories*

The approach you take to setting authorities on directories should be no different from the approach taken with libraries and applications whose objects reside in libraries. Just as you can set the *PUBLIC authority of an application library to *EXCLUDE and grant authority only to the group whose users have a business need to run the application, you can do the same for directories. This translates into setting directories that contain private or confidential data to *PUBLIC authority OBJAUT(*NONE) DTAAUT(*EXCLUDE) and granting authority to only those users (or, my preference, their group) who have a specific business need to access objects in the directories.

A good example is a directory containing a stream file or text file of credit card transactions to be sent to the bank for processing, a file containing payroll information about to be sent to an outsourced payroll processor, or an uploaded file of users' tax information. Obviously, such a directory should be available only to the group of users who have a direct need to access or process this information. To ensure the appropriate users can access the information, grant their group DTAAUT(*RWX) OBJAUT(*ALL), or have the group own the directory and the files in it.

**PUBLIC Authority for IBM-Supplied Directories*

Setting authorities on IBM-supplied application directories is much like setting authorities on system-supplied libraries. Just as many operations would fail if you were to set *PUBLIC(*EXCLUDE) on QSYS, many applications—especially Web and Lotus Domino applications—will fail if you exclude *PUBLIC from the root directory.

IBM's recommended *PUBLIC authority setting for root is OBJAUT(*NONE) DTAAUT(*RX). (You can also apply this recommendation to the /QOpenSys directory.) It's possible to get by with DTAAUT(*X), but some applications need to read the contents of

the root directory and therefore need *R authority. Setting DTAAUT to *RX will prevent users and applications from creating subdirectories into the root directory.

Technical Note

Before changing the *PUBLIC authority of root, first determine whether there are any processes writing directly to root. I sometimes find that there are old, established email processes that write a temporary file to root and delete it once the email is sent. Examining the audit journal for Creation of Objects (CO) and Deletion of Objects (DO) into root will tell you whether this is the case on your system. If it is, then the process will need to be changed to write these temporary files to another directory. If there are no audit journal entries for '/', the *PUBLIC authority can safely be changed.

With the exception of root and QOpenSys, most IBM-supplied directories have their *PUBLIC authorities set appropriately—that is, *PUBLIC OBJAUT(*NONE) DTAAUT(*RX). However, you'll want to review each of these directories to make sure. None of them should default to *PUBLIC OBJAUT(*ALL) DTAAUT(*RWX).

In addition, most IBM application directories have given the necessary private authorities to the appropriate system-supplied user profiles. For example, the QTMHHTTP profile has been given private authority to the directories and objects it needs to run the Apache Web server. You do not want to remove or otherwise alter these private authorities unless you've thoroughly researched the ramifications of doing so.

Determining Appropriate Authority

To determine the appropriate authority setting for a directory, you first need to determine the directory's purpose. If a directory is associated with an application, set *PUBLIC authority as noted above. Users who need to access the application require the following settings:

- OBJAUT(*NONE) and DTAAUT(*X) to all directories in the path to the application objects
- OBJAUT(*NONE) and DTAAUT(*X) for the directories containing the application objects (users may need DTAAUT(*RX) if the application needs to read the contents of the directory)

- OBJAUT(*NONE) and DTAAUT(*RWX) for the directory if the application creates objects into it
- OBJAUT(*NONE) and DTAAUT(*WX) for the directory if the application renames or deletes objects
- OBJAUT(*OBJMGT) at the object level for objects being copied or renamed
- OBJAUT(*OBJEXIST) at the object level for objects being deleted

Home Directory

You may want to create a home directory for each of your developers (e.g., /home/cjw) and let them use that directory as their "playground." Doing so is analogous to giving developers their own IBM i library to use. Do you let your developers create whatever libraries they want to create? Usually not—especially not on a production machine. Therefore, you'll probably want to establish the following structure:

- Set *PUBLIC authority to /home to OBJAUT(*NONE) and DTAAUT(*X).
- Set *PUBLIC authority to /home/*developer_name* to OBJAUT(*NONE) and DTAAUT(*EXCLUDE). If other users need to be able to access objects in the user's directory, you can give them (or their group) DTAAUT(*RX) to /home/*developer_name.*
- Have the developer either own or grant OBJAUT(*ALL) DTAAUT(*RWX) to /home/*developer_name.*

Web Applications

The QTMHHTTP user profile needs authority to the directories containing the Web server configuration files. The profile under which a Web application runs needs authority—at least DTAAUT(*X), if not DTAAUT (*RX)—to the directories containing the HTML, graphics, and so on. This profile is typically QTMHHTTP; however, an application profile can be specified, or the application can run under the IBM i user profile of the user requesting access to the application (i.e., the URL). The user profile under which the Web server accesses resources for an application is specified as part of the Web server configuration directives in the Web server configuration file. (QTMHHTTP has already been given the appropriate private authorities.)

QPWFSERVER Authorization List

If you want to prevent users from accessing the QSYS.LIB file system through IBM i Access file serving (i.e., via Navigator for i), NetServer file serving, and file serving between IBM i systems, you can do so by removing the users' authority to the QPWFSERVER authorization list, which IBM ships with IBM i. The *PUBLIC authority to QPWFSERVER defaults to *USE. Setting *PUBLIC to *EXCLUDE prevents users from accessing QSYS.LIB through interfaces such as Navigator.

Another way to think of this restriction is as preventing access through directory structure interfaces such as Windows Explorer. Interfaces such as File Transfer Protocol (FTP), Open Database Connectivity (ODBC), and Distributed Data Management (DDM) do not check the authority to the QPWFSERVER authorization list.

I recommend setting the *PUBLIC authority to the QPWFSERVER authorization list to *EXCLUDE and giving only those users who have a business need *USE authority to the authorization list.

Review (and Remove) File Shares

Many systems—especially development systems—have an overabundance of file shares. Most of the shares have been added without any realization as to what is being made available to the entire network. You should review the file shares that have been defined on your systems and remove those that are inappropriate—especially those shares to root!

You'll also want to add a section to your security policy regarding shares:

- Determine the policy for who can create shares.
- Determine the policy for what should be shared across the network.
- Communicate these policies to developers, network administration, tech support, and security officers.
- Set appropriate authorities on all directories and their objects, especially those that are shared across the network.

If at all possible, do not share the root directory. (I've said this numerous times now. Do you get the idea that I'm very serious about this issue?) If you must share it, make sure you have an appropriate object-level security scheme in place. In addition, place a dollar sign ($) at the end of the share name (e.g., root$) to prevent its name from being broadcast throughout the network via Windows Network Neighborhood. And

be more clever than naming the share 'root'. When I review the list of file shares, most organizations that have shared root have named the share 'root'. It's the first name I'd try if I wanted to attempt to map a drive to an organization's IBM i.

To prevent users from being able to create file shares, change the QZLSADFS (Add File Share) and QZLSCHRS (Change File Share) APIs from their default setting of *USE to *PUBLIC *EXCLUDE.

IBM i NetServer

The IBM i NetServer is what makes IBM i a file server. Two aspects of the NetServer have security implications. The first is that the NetServer can have a guest profile assigned to it. The functionality is as it sounds: when someone connects to the system via a file share, when a guest profile has been assigned to the NetServer, they don't have to authenticate. They simply map a drive to a file share, and then they have access to whatever the guest profile has authority to access.

Two obvious problems arise from this. First, if multiple people connect as the same user, accountability is lost. Second, if you have not implemented a "deny by default" object security model, users will have whatever the *PUBLIC authority setting happens to be. For example, if the *PUBLIC authority of all database files is *ALL and the root directory has been shared, then every person who has access to your organization's network can map a drive using the root share, connect without entering a valid IBM i user ID and password, and delete any file on your system!

To review the configuration of the NetServer and the list of users currently connected via a file share, open Navigator for i. (In this example, I'm using the Web version.) Open **Network**, then **Servers**, then click on **All Tasks**. Open IBM i NetServer and choose **Properties**; when the properties are displayed, choose **Security**. Figure 7.7 shows that a guest profile—GUESTPROF—has been assigned to the NetServer.

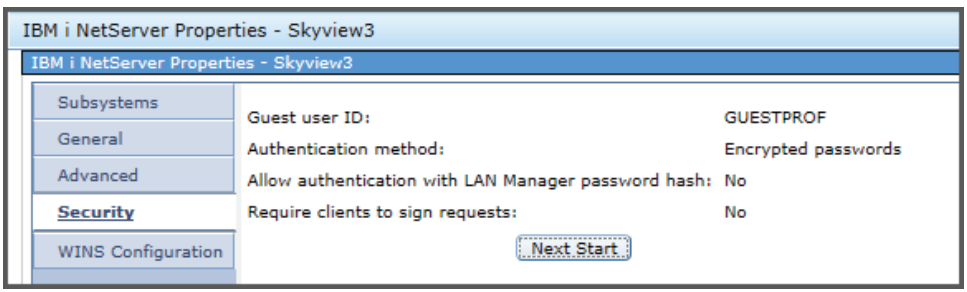

Figure 7.7: Reviewing the NetServer configuration

To remove the guest profile, click **Next Start**, then blank out the **Guest user ID** field. Click **OK**, then stop and restart the server. To review the list of connected sessions, choose **Sessions** rather than **Properties**.

Final Advice

As I said at the beginning of this chapter, the IFS is the most ignored part of IBM i—especially when it comes to security. Don't propagate the problem! Just because you may be unsure how to clean up what's already been placed into the IFS, don't let it get worse. Go ahead and change the settings on the directories, set the standards, and then communicate them to the appropriate groups (e.g., development, tech support, security team) within your organization. As you communicate and enforce these standards, some of the "fallout" will help you determine what is already in the IFS and how you need to clean it up. At this point, the worst action is no action.

Helpful Tools

The IBM i SECTOOLS menu provides two tools to help you manage authorities to IFS objects. Both the PRTPUBAUT (Print Public Authority) command and the PRTPVTAUT (Print Private Authority) command let you specify a pathname for the object name. When specifying a directory, you also have the option to search the subdirectories and include those objects in the report. Warning: if you run the report for root ('/'), the printed report for either command can be huge.

Two other commands can be helpful in determining ownership and other object attributes for objects in a directory. The RTVDIRINF (Retrieve Directory Information) command produces an intermediate file of information, which you can then print using the PRTDIRINF (Print Directory Information) command. Unfortunately, the file produced by running RTVDIRINF is in a format that renders the command unusable for running queries or using SQL statements to produce customized reports.

CHAPTER 8

Securing Your Printed Output

Many organizations fail to consider the fact that they may have confidential or private information that gets printed. If your security policy requires you to secure all confidential or private information, you need to think about whether or not this type of data appears in any reports printed from the IBM i. If it does, you'll need to assess the security settings on the output queues that contain the spooled files (printed output).

In many organizations, printers are everywhere—in public areas as well as on employees' desks—and they can produce documents and reports containing confidential customer and corporate information. For some companies, what is printed could constitute a vulnerability and a compliance issue. Most organizations lack the physical security that would stop users from printing a report containing confidential information and walking out of the building with it. And hackers have been known to "dumpster dive"—to literally sift through the garbage in a dumpster, looking for reports that include private information (e.g., credit card numbers, Social Security numbers, Social Insurance numbers).

Even in organizations that have gone "green," some reports are still printed. Therefore, to reduce the chances of printed output getting into the wrong hands, you may need to secure output queues, reorganize menus, and even move printers to more secure locations. Then, after the information has been printed and reviewed, the printouts should be destroyed appropriately—most likely through cross-cut shredding. As part of your

employee awareness program and training about your organization's security policy, users need to be educated to not just toss these reports into their wastebaskets.

Output queues (outqs) are a functional necessity in IBM i, but that doesn't mean all users need to have access to data in all output queues. Yet that's exactly the way many organizations' outqs are configured. To appreciate the importance of controlling access to output queues, remember that you can use output queues not only to print spooled files but also to display them. Output queue security is one of the least obvious forms of security in IBM i. To achieve the desired results, you must carefully plan and design your output queue strategy.

Security-Related Output Queue Attributes

You create output queues using the CRTOUTQ (Create Output Queue) command. The values you specify for a few security-related CRTOUTQ command parameters determine how you control user access to output queues and spooled data. You can change these output queue attributes using the CHGOUTQ (Change Output Queue) and WRKOUTQD (Work with Output Queue Description) commands. (Before you can change the attributes for an output queue, you must first stop any writers attached to it.)

Four CRTOUTQ command parameters—DSPDTA (Display Data), OPRCTL (Operator control), AUTCHK (Authority check), and AUT (Authority)—work with an output queue's existing public and private authorities to determine who can and cannot view and manipulate the output queue's spooled files. Before you start to design your output queue security strategy, you need to fully comprehend the role of each of these attributes. You'll also want to understand the authority required to start and stop the writers.

Don't feel badly if you don't grasp all the nuances of securing outqs the first time you read this chapter. The attributes interact with each other differently depending on the value of each attribute. I often have to go back and look at the charts before I can achieve the desired results.

DSPDTA (Display Data)

The CRTOUTQ command's DSPDTA parameter specifies the access that users with at least *READ authority have to the outq. A value of *YES means that users who have *READ access can display, copy, and send the data from any spooled file on the queue—using the CPYSPLF (Copy Spooled File) or SNDTCPSPLF (Send TCP/IP Spooled File) command, for example. A value of *NO specifies that users who have *READ authority to the output queue can display, copy, and send the output data only from their own spooled files, unless:

- They have *JOBCTL special authority and the output queue's OPRCTL attribute value is *YES, or
- They have *CHANGE authority to the output queue and the output queue's AUTCHK attribute value is *DTAAUT, or
- They own the output queue and the AUTCHK value is *OWNER.

If the DSPDTA value is *OWNER, only the owner of a spooled file can display, copy, send, or move the spooled file. *OWNER is the appropriate DSPDTA value for operators who manage output queue entries but shouldn't be able to view the contents of spooled files. When you specify OPRCTL(*YES) and DSPDTA(*OWNER) for an output queue, a user profile with *JOBCTL special authority can hold, change, delete, and release spooled files on that output queue but cannot display, copy, send, or move the spooled files.

OPRCTL (Operator Control)

The CRTOUTQ command's OPRCTL parameter specifies whether a user who has *JOBCTL special authority can manage or control the files on an output queue. When you specify OPRCTL(*YES), a user profile with *JOBCTL special authority can control the output queue (e.g., hold, release, start a writer to the queue) and manage the spooled file entries (e.g., hold, release, change, delete). As described, when the output queue's DSPDTA attribute value is *NO, user profiles with *JOBCTL special authority can still display, copy, send, and move all users' spooled files but not see their contents.

Before assigning *JOBCTL special authority to users' profiles to give them the capability of starting their own print writer, you should consider providing them with a program that adopts authority and starts the writer for them. Programs that adopt authority also adopt the owner's special authorities, such as *JOBCTL. Assigning users *JOBCTL gives them significantly more capabilities than just starting and stopping writers. *JOBCTL lets users hold, change the priority of, or even end any job on the system. Providing a program that performs the starting and stopping of writers permits users to take these actions but doesn't give them the full capabilities associated with assigning *JOBCTL to their user profiles.

AUTCHK (Authority Check)

The CRTOUTQ command's AUTCHK parameter specifies whether the commands that check a requesting user's authority to an output queue should check whether the user owns the output queue (*OWNER) or just has data authority (*DTAAUT) to the output queue. When

the AUTCHK value is *OWNER, only the user who owns the output queue can change or delete spooled files owned by other user profiles. When the value is *DTAAUT, any user with *READ, *ADD, and *DLT authority to the output queue can change or delete other users' spooled files on that output queue.

AUT (Authority)

Last, the CRTOUTQ command's AUT parameter specifies the *PUBLIC authority of the outq. You can use the EDTOBJAUT (Edit Object Authority), GRTOBJAUT (Grant Object Authority), or RVKOBJAUT (Revoke Object Authority) command to modify this authority.

**SPLCTL Special Authority*

The last, and perhaps most important, point to remember regarding output queue security is that a user who has *SPLCTL special authority has complete access to all output queues and spooled files, regardless of which outq attributes and authorities are specified. Think of *SPLCTL as the "*ALLOBJ" of spooled files. This means that if any user on your system has *SPLCTL special authority, you truly can't secure any output—that person *will* have authority to view everything in every outq. Some organizations may not have any confidential or private data in their spooled files. However, if you have even one outq that contains confidential reports, you need to take action (i.e., alter the attributes of the outq) and remove the user's *SPLCTL authority.

Technical Note

Even if a user if a user has *EXCLUDE authority to the outq, a user with *SPLCTL is not prevented from accessing the spooled files in it. While they may not be able to access the files using the WRKOUTQ (Work with Output Queues) command, they will be able to access all spooled files using WRKSPLF (Work with Spooled Files).

Table 8.1 reproduces a chart from IBM's *IBM i Security Reference* that describes the printing functions and the parameter values required to run them. I sometimes get confused reading this table, so here's a hint: the Printing function column lists the commands available for working with outqs, spooled files, and writers. The other columns list the values that must be set if you are to run one of the commands. You can read the Printing function column to determine the commands that can be run, but to

make sense of what values must be set, read the rest of the columns straight across, one line at a time—as you'd read a book.

For example, to run the DSPSPLF (Display Spooled File), CPYSPLF (Copy Spooled File), SNDNETSPLF, or SNDTCPSPLF command, the DSPDTA parameter must be set to *YES and the user must have at least *READ authority to the outq (and it doesn't matter what the values of the AUTCHK and OPRCTL parameters are, nor does the user require any special authorities) *or* the DSPDTA parameter can be *NO, but in that case the AUTCHK parameter must be *DTAAUT and the user must have *READ, *ADD, and *DLT authority to the outq, and so forth.

Table 8.1: Authority required to perform printing functions

	Output queue parameters				
Printing function	**DSPDTA**	**AUTCHK**	**OPRCTL**	**Output queue authority**	**Special authority**
Add spooled files to queue[1]	Any Any	Any Any	Any *YES	*READ Any	None *JOBCTL
View list of spooled files (WRKOUTQ command[2])	Any Any	Any Any	Any *YES	*READ Any	None *JOBCTL
Display, copy, or send spooled files (DSPSPLF, CPYSPLF, SNDNETSPLF, SNDTCPSPLF[2])	*YES *NO *NO *YES *NO *OWNER	Any *DTAAUT *OWNER Any Any Any	Any Any Any *YES *YES Any	*READ *READ, *ADD, *DLT Owner[3] Any Any Any	None None None *JOBCTL *JOBCTL Any
Change, delete, hold, and release spooled file (CHGSPLFA, DLTSPLF, HLDSPLF, RLSSPLF[2])	Any Any Any	*DTAAUT *OWNER Any	Any Any *YES	*READ, *ADD, *DLT Owner[3] Any	None None *JOBCTL
Change, clear, hold, and release output queue (CHGOUTQ, CLROUTQ, HLDOUTQ, RLSOUTQ[2])	Any Any Any	*DTAAUT *OWNER Any	Any Any *YES	*READ, *ADD, *DLT Owner[3] Any	None None *JOBCTL
Start a writer for the queue (STRPRTWTR, STRRMTWTR[2])	Any Any	*DTAAUT Any	Any *YES	*CHANGE Any	None *JOBCTL

[1] This authority is required to direct output to an output queue.
[2] Using these commands or equivalent options from a display.
[3] You must own the output queue.
Source: System i Security Reference, V6R1, *Copyright 2008, International Business Machines Corporation.*

Output Queue Ownership

The issue of output queue security also raises the question of who should own output queues. This may seem like a simple question, but it's important for two reasons: First, the owner of the output queue can modify the outq's attributes as well as grant and revoke authorities to the outq, which means the owner controls who can view and work with

spooled files on that queue. Second, the AUTCHK parameter checks the ownership of the output queue as part of the authorization test when the queue is accessed.

The system operator should be responsible for creating and controlling output queues that hold data considered public or unsecured. You can use this ownership with the authority parameters on the CRTOUTQ command to create an environment that lets users control their own print files and print on various printers in their work areas.

For secured data (e.g., payroll, human resources, financial statements), the department supervisor profile or the supervisor's role (i.e., his or her group profile) is a good candidate for owning the outq. This person (or role) is the one that determines which users should be allowed to see the reports contained in the outq.

Sample Output Queue Security Implementation

As an example, consider an organization that has outqs in the IT department; the financial area (e.g., accounts payable, accounts receivable, general ledger); human resources (HR); the order/sales departments; and the warehouse. Let's assume you want to secure the financial spooled files—an output queue named FINOUTQ, but you want the operator to manage the queues. Let's also say you want to secure the HR output queue—output queue HROUTQ—and spooled files. You want no one except HR personnel to manage this output queue and its spooled files. The remaining outqs should have minimum security and allow complete access to any spooled file and to the outq itself. How do you accomplish this?

First, create all the outqs except FINOUTQ and HROUTQ, and make the system operator profile the owner of the queues. You'd enter the following CRTOUTQ command for each output queue you create:

```
CRTOUTQ  OUTQ(outq_lib/outq_name) +
         DSPDTA(*YES)             +
         OPRCTL(*YES)             +
         AUTCHK(*OWNER)           +
         AUT(*USE)
```

The combination of DSPDTA(*YES), AUTCHK(*OWNER), and AUT(*USE) for the public authority means that any user can display, copy, or send any spooled files on the output queue and that only spooled file owners can change, hold, release, or delete their own spooled files. (The owner of the output queue can change, hold, release, or delete any spooled file in the queue, regardless of who owns it.) The one exception to the limitation

of AUTCHK(*OWNER) is that a user profile that has *JOBCTL special authority and OPRCTL(*YES) can change, hold, release, or delete any spooled file. This implementation lets you give system operators *JOBCTL authority to manage these outqs while limiting other users to managing their own spooled files. However, all users with at least *READ data authority can display, copy, and send any spooled file on the queue.

Next, create FINOUTQ, which will hold confidential financial reports. You want all profiles to have access only to their own reports, and you want the operator to manage the queue without being able to view the spooled files. You'd create FINOUTQ as follows, with FINUSER as the owner:

```
CRTOUTQ  OUTQ(outq_lib/FINOUTQ) +
         DSPDTA(*OWNER)         +
         OPRCTL(*YES)           +
         AUTCHK(*OWNER)         +
         AUT(*USE)
```

Although everyone, including the system operator, can access this output queue, each user profile can display, copy, or send only their own spooled files. The system operator, by virtue of *JOBCTL special authority and the OPRCTL(*YES) attribute on the output queue, can manage the queue but can't look at any reports other than the ones the system operator places on the queue. The DSPDTA(*OWNER) attribute ensures that only the owner of a spooled file can display, copy, or send that spooled file.

The last output queue is HROUTQ, which is extremely confidential. Only those in the HRUSER group should be able to access this output queue or these spooled files. To create this output queue, you'd use the following CRTOUTQ command:

```
CRTOUTQ  OUTQ(outq_lib/HROUTQ) +
         DSPDTA(*YES)          +
         OPRCTL(*NO)           +
         AUTCHK(*DTAAUT)       +
         AUT(*EXCLUDE)
```

Make the HRUSER group profile the owner, and revoke all other authorities from the queue.

Profiles with *JOBCTL authority can't access this queue because of the queue's OPRCTL(*NO) attribute. Only the owner has any object or data authority to the queue.

Only the owner can start or stop a writer to the outq. All users in the HRUSER group can display, copy, or send any spooled file on the outq. As a result of the AUTCHK(*DTAAUT) attribute and the fact that the HRUSER group profile owns the output queue, all users in the group can also change, hold, move, or delete any spooled file.

Helpful Tools

The PRTQAUT (Print Queue Authority Report) security tool, available on the SECTOOLS and SECBATCH menus, prints the security settings for both output queues and job queues on your system. The full report lists all the queues that meet the selection criteria. The command also provides a report that lists any changes since the last time you ran the report and any new output or job queues that have been added in the interim.

Navigator for i

One use of Navigator for i is to manage spooled files. If you need to email a job log to IBM or your vendor for debugging, it's a snap. Simply click on the name of your system in Navigator and choose **Basic Operations** > **Printer Output**. Your spooled files will be displayed in the panel at the right, as shown in Figure 8.1. From there, you can select the desired spooled file and drag it to your desktop.

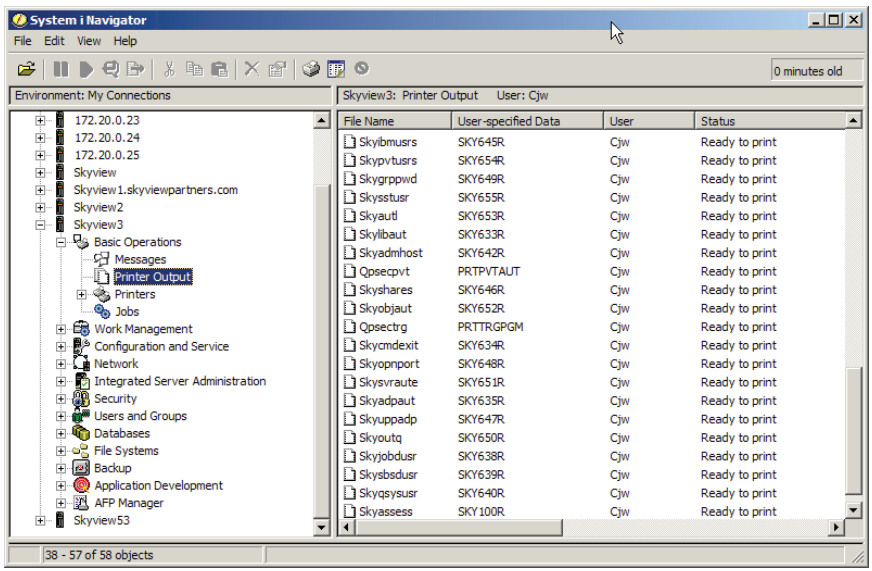

Figure 8.1: Managing spooled files in Navigator for i

CHAPTER 9

Encryption

The need to implement encryption is often driven by the need to be in compliance with some law or regulation. This chapter discusses the issues you'll have to consider to ensure a sound encryption implementation.

I typically see encryption implemented in four areas:

- Transmission of data
- Data in a file (either all or selected fields in the file)
- Backups
- Disk

I'll discuss each of these areas in detail. First, though, let's go over some basic encryption concepts.

Encryption Basics

Encryption consists of three components: an encryption algorithm, a key, and the data to be encrypted. The algorithm you use is typically dictated by the situation. For example, some algorithms are more efficient (perform better) for encrypting large amounts of data than others. I discuss the common algorithms and their characteristics a bit later.

The encryption key is (pun intended) key to the whole encryption process. Without it, you're missing part of the encryption equation, and data cannot be encrypted or decrypted. Should the key fall into the wrong hands or be discovered, the person possessing it can decrypt your encrypted data. In other words, it's not the algorithm that must be kept secret when you encrypt data; it's the encryption key. Therefore, you should limit those with knowledge of or access to the key to those who have a business need—in other words, to only a very few people. In addition, the "strength" of an encryption key determines how quickly someone without knowledge of the key may be able to determine the key and therefore be able to decrypt the data.

Before we take a look at the types of encryption algorithms available, let me stress that you should never—ever—attempt to create your own encryption algorithm if you ever hope to have encryption add any measure of security to your data, much less be in compliance with any law or regulation. Cryptologists spend years developing their algorithms, which other cryptologists then spend years trying to break. Instead of creating your own, use a well-known algorithm. As I said earlier, it's not the algorithm that needs to be kept a secret—it's the encryption key.

Now, let's take a look at the types of encryption algorithms in use, along with the situations in which they are typically employed. In Chapter 10, you'll learn about the various ways you can use encryption to provide secure communications to and from your IBM i system.

Public Key Infrastructure

Public key infrastructure (PKI) uses encryption to let you send data securely and privately. When you use an encryption algorithm, you feed the algorithm the encryption key, which is used to encrypt the data. Figure 9.1 illustrates the differences between symmetric keys, asymmetric keys, and hash algorithms.

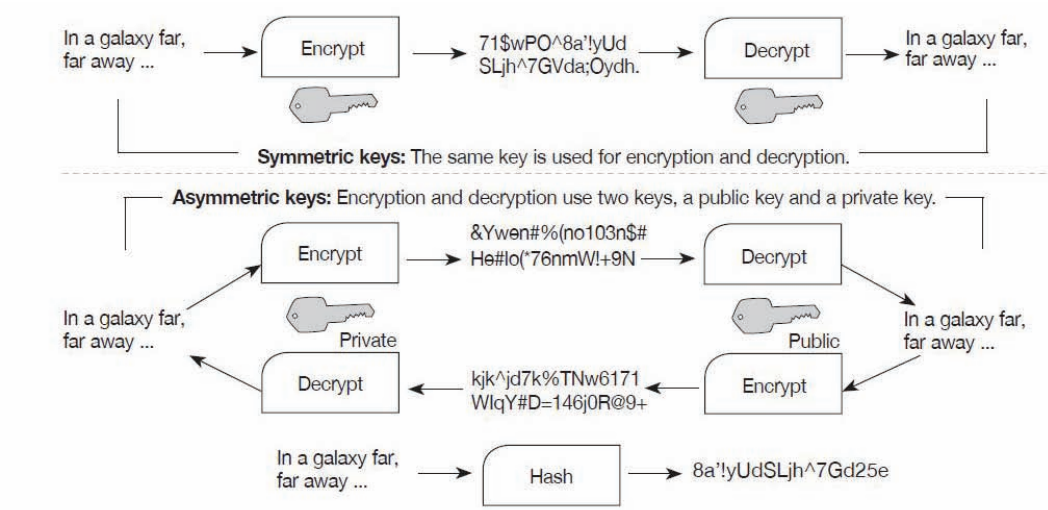

Figure 9.1: Types of encryption

Symmetric key algorithms use the same key to both encrypt and decrypt data. These algorithms are generally faster than asymmetric key algorithms and are often used to encrypt large amounts of information. Some symmetric key algorithms you'll hear mentioned include AES (the standard for the U.S. government), RC5, and TripleDES.

Although symmetric keys are simple and fast, they have drawbacks. Say you encrypt an email message with a symmetric key. How do you securely give that key to the email recipient? Send it in another email? Not very secure. You might instead choose to use an algorithm that requires an asymmetric key.

Asymmetric key algorithms use one key to perform one function and another key to perform the opposite function. In other words, the same key cannot be used to both encrypt and decrypt the data. The two keys, one a *private key* and the other a *public key*, are together known as a *public/private key-pair*. Asymmetric key algorithms are typically used for authentication. For example, they are used during a Transport Layer Security (TLS) "handshake" to verify that the client knows the server to which it is trying to connect. RSA and Elliptic Curve are two common asymmetric key algorithms.

Hash algorithms produce a result that is not decryptable. They are typically used to compare two values to ensure that the values are the same. For example, the verification of a digital signature uses a hash function to ensure that the signed document hasn't been altered. Because a hashed value cannot return the original value, this method provides the most secure form of data storage and is the most appropriate method when the

data's original form (i.e., clear-text data) is not required. SHA-3 is an example of a hash algorithm.

Transmission of Data

Whether it is making the connection from home to your office, collecting or sending confidential or private data via a Web application, or transmitting a file to a trading partner, bank, or government entity, the most familiar form of encryption is that in which the session is encrypted so that any data flowing over the connection is encrypted and not sent in clear text.

Encrypting the transmission of data is something most of you have already implemented for access to your systems from outside your organizations—probably via some type of virtual private network (VPN) connection. Also, many of you have implemented secure connections internally to comply with the Payment Card Industry Data Security Standard (PCI DSS) requirement that all non-console access by administrators be encrypted. In the next chapter, I'll go into a more detailed description about how these types of connections work, but suffice it to say for now that encrypted sessions typically use two types of encryption algorithms: one for authentication and another to encrypt the data. For example, when a TLS connection is being established, the client making the request uses an asymmetric algorithm to authenticate the server to which the connection is being made. Once the client knows it can trust the server to which the connection has been made, the two ends of the session exchange "session keys" and switch to a symmetric algorithm because such algorithms are significantly faster for encrypting and decrypting data. In fact, the slowest part of an SSL session is the initial authentication phase, or handshake.

Encrypting Data in Files

IBM provides several native options for encrypting data in a database field. The most rudimentary one is coding to the CIPHER machine instruction. IBM i APIs provide software encryption functionality. The ENCRYPT_RC2 keyword is also available, but use of this function (along with any other "roll-your-own" solution) requires careful attention to the key management implementation.

For the most secure method, as well as the most complex, you can install a Federal Information Processing Standards (FIPS)–compliant cryptographic coprocessor card and write to the APIs provided with the card. Although the crypto card is the most complex option, in V6R1 IBM has added some user-friendly commands and APIs that

make using and managing the crypto card significantly easier. Note that this is the only option available should you need to implement the separation of duties between the administrator of the crypto card and your IBM i security administrator.

In V5R4, IBM added integrated encryption key management to i5/OS, along with the APIs required for implementation. These APIs give those of you implementing your own solution a secure way to create, store, and manage the encryption keys.

Last, in V7R1, IBM added IBM i functionality to enable columns in a table (database) to be encrypted automatically. Together with ISV-provided encryption functionality, this capability makes encrypting data "at rest" even easier and less intrusive to an application's current database design.

Identify the Scope of Your Project

As with most encryption projects, one of the biggest challenges when you encrypt data in files is ensuring that the solution is architected correctly. Another challenge is the management of the encryption key. If you are considering encrypting file data, one of the first steps I encourage you to take is to identify the scope of your project. This may seem like an obvious step, but I've found that many organizations don't actually know where all the data that should be encrypted resides. To understand the project's true scope and ensure that all the data that should be encrypted actually is, you need to know where all the data is.

This typically is not a question one person can answer. It normally requires input from many individuals with a variety of roles. Why? Because no single person is aware of all the regulations that determine what constitutes private data, nor of the laws and regulations that govern the protection of private data, the ramifications of compromising or not protecting the data, all the places where the data is stored, and how the data is used. Only after gathering this input from all your sources can you know the true scope of your encryption project and decide how to proceed. Let's look at the steps you need to take to determine project scope.

Step 1: Determine what data needs to be encrypted. The laws and regulations with which your organization must comply might dictate what data needs to be encrypted. For example, if your organization stores cardholder data, PCI DSS dictates what data must be encrypted. Increasingly, data owners are choosing to encrypt data even though it may not be required by law to do so. The V7R1 feature enabling the ability to encrypt at the column level has made this a more viable option for data residing on IBM i.

Step 2: Determine where the data is stored. Figuring out which data to encrypt is the easy step. The more difficult task is determining all—and I do mean *all*—the places

where the data resides. Without fail, private or confidential data is located in more places than first seems obvious. To make sure your list is complete, you'll probably need to assemble a group of programmers, system administrators, data owners, database administrators, system analysts, and even representatives from your third-party software vendors. In making your list of all data occurrences, don't forget private information that resides in spooled files, outfiles, query files, text files, stream files, and printed reports. Also make note of databases that are replicated to high-availability (HA) systems, databases residing on development machines (including copies of the production database made into developers' libraries), logical files that include the fields requiring encryption, and data residing on network servers and in desktop or cloud-based applications (e.g., Microsoft Excel spreadsheets).

After listing all the places where the private data resides, examine each instance and determine whether the data is actually required for that specific instance or can be eliminated. In many cases, you can significantly reduce the scope of your project (as well as the exposure to your organization's private data) if you stop storing the private data on servers, stop letting it be included in queries, create a logical file that does not include the fields containing private data, and eliminate the private data from printed reports and spreadsheets. Often, the data is included in these places simply because it's part of the information in the original file structure, not because it's actually necessary. In some cases, the data has only recently come to be considered susceptible to abuse. At one time, information such as Social Security numbers was not considered sensitive. How times have changed!

For example, do you really need to include credit card numbers on a printed report of all returns to a store if the person viewing the report is interested only in what's being returned and the reasons for the returns? No, you don't. Viewing credit card information isn't part of this person's job function, and therefore these details should be removed from the report. And, without question, removing the credit card numbers from the report is much easier than adding logic to the application to permit this individual to see a masked or partial credit card number. It also eliminates the need to put appropriate access controls on the file, add routines to encrypt the credit card numbers, and deal with the proper disposal (shredding) of the printed reports.

Step 3: Determine how the information is being used. This step, while easier than step 2, still usually takes an assembly of individuals to complete. You want to understand how the data is being used so you can determine what type of encryption is needed. For example, if the data is a Canadian Social Insurance number or a driver's license number

used only for verification purposes, you can likely store it in a one-way hash. A hash cannot return the original data; it is one-way only. For this reason, hashing private data is much easier to implement and, even more important, more secure than implementing more complex encryption algorithms that allow decryption of data.

To ensure that encryption provides an added layer of protection on top of the access controls you have on the files containing your data, you'll want to limit the scenarios for which the data must be decrypted. For example, if the data is being sent to a bank for transaction processing or to a clearinghouse for verification, it is likely that the clear-text data is required. For this scenario, you'll need to determine how and when to decrypt the data so that the data is in clear text for as short a time as possible. Also, after transmitting the clear-text data over an encrypted session, you should remove or clear it as soon as possible.

Architecting Your Application to Use Encryption

Whatever method you choose for encrypting data in files, some amount of application changes may be necessary. The ideal solution is to re-architect your application and move the private data into its own database, using a separate database for each type of private data (e.g., one for cardholder data, another for human resources data). This approach makes it much easier to ensure that the encryption/decryption functions are called only when necessary, helping to keep the data secure. This technique also helps minimize encryption's effect on system performance because the data is decrypted only when necessary, not on every file open. In addition, it puts you in a much better position to respond quickly should encryption requirements change in the future.

However, this type of re-architecture is usually not an option for most organizations. If that is your case, you may need to declare a new field to hold the encrypted value because an encrypted value is often larger than the original value. Unfortunately, this means you'll have to recompile all programs that use the file in question. In addition, once you've populated the encrypted field, you'll need to take steps to neutralize or otherwise "wipe out" the clear-text version of the private data that currently resides in the file.

Several vendors offer solutions for database encryption, and some provide options that do not require adding a field to the file. Purchasing a solution often gives your organization more flexibility, especially if re-architecting isn't an option. When investigating these solutions, make sure you understand their key management capabilities to ensure they meet your organization's compliance requirements. Many vendor solutions offer robust key management, often providing the ability to change keys

without having to decrypt and re-encrypt data all at once. For most shops, it will be easier to buy an encryption solution than to try to implement one using the features provided in IBM i and i5/OS.

The Key Is Key Management

When you encrypt data in files—or data "at rest," as the laws and regulations often refer to such data—good encryption key management is essential. In fact, the key is so important to a secure encryption implementation that PCI DSS includes specific requirements for encryption key management. I expect this issue to only grow in importance. In other words, it won't go away, so it's best to understand what constitutes best practices for key management and to implement those practices if at all possible. I cannot emphasize enough that without good key management, your encryption project will likely be a disaster and will provide no security benefit to your organization's data. I'll stop my lecture for now and start the discussion of what constitutes best practices for encryption key management.

Key Generation

Use a random number generator to generate the key. Using your child's name, the name of your favorite sports team, or even a seemingly random string of numbers and letters does *not* constitute a random number. Truly random encryption keys are significantly stronger than keys based on a phrase or what seems to you to be a random string.

Separation of Duties

The same person should not create the keys, use the keys (i.e., write programs to use the keys for encryption or decryption), and be the custodian of the keys. For large shops, this requirement shouldn't be an issue, but for small shops it may present a challenge. Either way, be prepared to explain your separation of key management duties to any auditor who asks.

Storing the Keys

Appropriate placement and access control of stored keys is vital. Storing keys in clear text in the program source or a data area or as the first record in the file is not acceptable. You should use the integrated key management APIs and create your own key management system, use a hardware crypto card that provides key management, install a key management appliance (a separate piece of hardware that securely stores

and serves the keys), or use a vendor product that includes key management. The critical components of a key management system are that the keys are separated from the data they are encrypting and that the keys are stored securely.

Controlling Access to Keys and Encryption/Decryption Routines

Without good access controls on the key storage facility itself (this means you've implemented object-level security if you're using a software implementation), the mechanism that retrieves the key, and the encryption routines (especially the decryption routine), you gain no additional security benefit by encrypting data. If everyone on the system has access to the encryption key, what's the point? In addition, if you have a software-based key management system, it's likely that everyone with *ALLOBJ can retrieve the encryption key. That's because users with *ALLOBJ special authority can access any object on the system. (That's one reason it's good to use hashes wherever you don't need the clear-text data.)

About the best you can do to thwart retrieval by *ALLOBJ users is to throw up some roadblock in an attempt to make retrieving the encryption key and accessing the decryption routines more difficult. One such roadblock is to check the process to see whether it's running with *ALLOBJ; if it is, reject the retrieval or decryption request. Another is to check the program that's calling the decryption routine and decrypt only if the calling program is named in an approved list. Understand, though, that if your organization is required to restrict access to keys by *ALLOBJ users, you'll probably need to implement some type of hardware key management system, such as an encryption appliance or a hardware crypto card.

Backing Up the Keys

Careful planning must go into your strategy for backing up the encryption keys. The keys should not be on the same media as the data. However, you must develop a scheme so that you can associate which key was used on which date, or you may not be able to retrieve your data if you need to bring it back from long-term storage or perform a disaster recovery.

Changing the Keys

I've saved discussion of this aspect of key management for last because it's one of the least-settled when it comes to what constitutes best practices. In addition, depending on your implementation, it can be one of the more difficult aspects to implement as an

administrator. I'm talking about the process of changing the encryption key that's been used to encrypt data in files.

One advantage of moving the encrypted data to another file or adding another field to your files is that you can add a field that keeps track of the encryption key used. Note that this field does *not* contain the encryption key itself. Rather, it contains a key name or "token"—that is, some other information used to identify the key used to encrypt the data. If your implementation includes a way to identify the key, you can change the encryption key, the application can start to use it, and then you can run a background job to decrypt and re-encrypt the records using the new key.

If you don't have a way to keep track of the key, you'll have to decrypt all files and then re-encrypt them with the new key. This task can be tricky because the update must take place when no application processes are using the file. If any are, or if an application starts to use the file before the key change is complete, the application may not be able to access some information because the application will be using the new key but not all of the data has been decrypted and re-encrypted.

When encryption first became popular, this aspect of key management wasn't such a huge effort. At that time, best practices said you should change the key every year or two. The exception to this rule was if you felt that the chance of compromising the data by decrypting and re-encrypting it was greater than leaving it encrypted with an old key. However, best practices are evolving, and it's becoming more common to see auditors require keys to be changed annually—at the very least—and often more frequently. Look for continued guidance from the PCI council on this topic.

There is one issue, though, about which there is no debate: if a breach occurs or you become aware that the encryption key has been compromised, you must change it immediately. Whether or not you change keys on a regular basis, you need to establish and document a policy reflecting your key management change practices.

If you have to change the key, the question arises, "Do I need to go get my backup media and decrypt and then re-encrypt that data?" The answer is that no law or regulation requires this—at least not now.

Encrypting Backup Media

The most popular methods for encrypting backup media are to use a hardware solution (typically called an appliance) that encrypts the data before it's written to media, to use Backup Recovery Media Services (BRMS) to perform software encryption before

performing the save, or to use a tape drive that performs the encryption when the save is being performed.

Whichever method you select, a significant factor in your planning must, again, be key management. The best practices described in the preceding section must be applied here—even the requirement to periodically change the keys. But because you're encrypting backups, you must take special care to keep track of which encryption key you used for which backup. In other words, you need a process in place that ensures you can retrieve the key should you have to retrieve the media from your storage facility or perform a disaster recovery.

Another consideration to key retrieval is where your key management system is run. You cannot run a key management system on the same system and have it be backed up with the rest of your backup. If you do, you won't be able to recover your system because you'll never be able to access the key management system—because it's encrypted and the key to decrypt it is in the encrypted key management facility!

Last, although it's not a security issue, when planning you'll want to consider the performance impact of encrypting backups and the subsequent impact on your system operators' schedules.

What IBM Provides

IBM provides several options for encrypting backup data. Certain IBM tape drives implement encrypted backups. Also, BRMS provides software-encrypted backups. You'll want to contact IBM to determine the options that are currently available for the version of IBM i your organization is running.

Encrypted Auxiliary Storage Pools

In V6R1, IBM introduced the concept of *encrypted disk*—specifically, the ability to encrypt auxiliary storage pools (ASPs) and independent auxiliary storage pools (IASPs). The benefit of encrypting ASPs is an additional layer of security, which is especially valuable in a storage area network (SAN) environment, in situations where a disk drive might be stolen, or in the event that a drive fails and you're unable to wipe the drive of your organization's data.

Disaster Recovery Considerations

Regardless of the type of encryption project, don't forget to take into account its impact on your disaster recovery plans. If the media is encrypted, you'll need to have keys

available at your alternate location so that the media can be read and data restored. If you used a hardware encryption method (either for encrypted backups or for encrypting data in database files), the same hardware must also be available at your recovery site. If you have encrypted ASPs, your key management system will need to be available. Last, if you encrypt data while it's being transmitted, the appropriate digital certificates must be installed in your servers or VPN configurations.

Success Depends on Planning

Don't undertake an encryption project lightly. Significant planning and a well-architected implementation are necessary to ensure success. Determining the regulatory issues with which you must comply as well as the scope of your project are critical to the project's success. This information will then help you decide whether to implement one of the options from IBM or to evaluate vendor solutions.

Helpful Resources

Documentation for all the hardware and software encryption APIs provided by IBM can be found in IBM's Information Center. In addition, you may want to read the IBM Redbook *IBM System i Security: Protecting i5/OS Data with Encryption* (SG24-7399).

CHAPTER 10

Connecting to the System

To understand security problems and solutions in today's world, you must comprehend a variety of security issues, including those associated with physical network security, network configuration, network attributes, the nuances of TCP/IP and some TCP/IP applications, IBM i Access for Windows and for Web, secure communications, and wireless technology. This discussion covers quite a few topics, so grab some caffeine, sit tight, and we'll get through this rather lengthy chapter together!

Physical Security

Physical network security helps prevent inadvertent damage, as well as intentional abuse and misuse. If you don't physically secure your network, inevitably a janitor, an employee's child, or someone else will trip over a wire and possibly sustain personal injury as well as damage your equipment. Some parts of a network can't be physically secured (e.g., telephone lines, underground high-speed Internet connections, ISP-controlled routers), but by taking some practical, common-sense steps, you can achieve an acceptable level of physical security.

To begin, you should put all network equipment in a secure location. The principle of allowing access only to users who have a business requirement applies to physical components as well as to database files. If you operate a computer that supports remote

access, place all communications equipment (e.g., firewalls, routers, cables) in your locked computer room or at least in a locked closet.

Similar precautions are also necessary—and often even more important—at remote sites. Many remote sites that have access to the host have a small remote controller, router, or system but no IT personnel on site. In such cases, you must rely on the people at the site to keep the network equipment secure. With a little planning and by moving equipment to a safe and secure location, you can prevent many accidents.

System Values

Two system values control whether network devices are auto-created, and thus have implications for security. System value QAUTOCFG (Automatic Device Configuration) determines whether devices such as printers, tape drives, and optical drives are configured automatically. While I'd never propose that you configure these devices by hand, in most organizations it's rare for new devices to be added frequently. So I recommend leaving this system value off (0) unless you are specifically installing devices.

The more interesting system value in today's environment is QAUTOVRT (Automatic Configuration of Virtual Devices), which controls whether virtual devices are auto-configured (as well as how many can be configured). If QAUTOVRT has been set to *NOMAX for a while, you probably have all the virtual devices you need, and you should be able to change the value to a number or to 0 (off) without any adverse effects. IBM advises setting QAUTOVRT to a value that is double the current number of virtual devices on your system. However, only you can determine how many virtual devices your organization needs. If you feel you have enough devices, set QAUTOVRT to 0. The system won't delete any virtual devices that have already been configured; it just will prevent the configuration of additional devices. By turning off QAUTOVRT, you can prevent someone from overloading your system with thousands of unwanted virtual devices.

*IOSYSCFG Special Authority

*IOSYSCFG special authority is required to configure all lines, controllers, and devices on the system, as well as to configure and manage all TCP/IP servers and configurations. *IOSYSCFG is quite powerful, and you'll want to carefully manage and monitor who has this special authority. In other words, only grant this special authority to individuals who need to configure or manage your network or IBM i communications.

Network Security Attributes

Some of the network configuration settings from the original days of OS/400 are defined in the system's network attributes. Three network attributes relate specifically to security:

- JOBACN (Job action)
- PCSACC (PC Support access)
- DDMACC (DDM access)

You can use the DSPNETA (Display Network Attributes) command to view the values for these attributes. If you want to change the network attributes, you must have *ALLOBJ and *SECADM authority to run the CHGNETA (Change Network Attributes) command. Let's look at each of the security-related network attributes.

JOBACN

JOBACN is an attribute used with the old Systems Network Architecture (SNA) communications that determines how the OS/400 operating system responds to incoming job streams from other systems in your network. In other words, it probably is not very applicable to today's environment. This network attribute can have one of three values: *REJECT, *FILE, or *SEARCH.

*REJECT causes the target system to reject the input job stream. When a job is rejected, the system sends a message to both the originating user profile and the intended recipient stating that the input stream was rejected.

*FILE causes the system to file the input job stream in the recipient's network file queue. The intended recipient (a user profile) can display the job stream, cancel it, receive it into a database file, or submit it to a job queue for processing. Again, the system sends a message to the sender and receiver notifying them that the incoming stream was filed.

*SEARCH instructs the system to search the network job action table for information about how to control the incoming job stream. The network job action table holds information about how the system is to handle specific requests. Each record in the table consists of the sender's ID, the action the local system is to take for that sender's requests, the user profile to use when submitting the job if the desired action is *SUBMIT, and the job queue to use for submitting the job.

Security Recommendation

Specify a value of *REJECT for the JOBACN network attribute unless the remote system uses Systems Network Architecture Distribution Services (SNADS) to submit jobs to your system. If SNADS is used, specify a value of *SEARCH to explicitly control the job actions.

PCSACC

The PCSACC attribute was created to control actions from PC Support and the original Client Access clients. PCSACC can have one of four values: *REJECT, *REGFAC, *OBJAUT, or the name of an exit program. The only value that has any meaning in today's environment is *REGFAC. This value tells IBM i Access clients to look in the registration facility for exit programs that may be defined for the exit points associated with IBM i Access. The system ignores all other settings for PCSACC.

DDMACC

The DDMACC attribute determines how your system processes Distributed Data Management (DDM) requests from remote systems. The local system receives a DDM request when a remote system tries to access data using a file, data area, or data queue whose type is *DDM. The three possible values for the DDMACC attribute are *REJECT, *OBJAUT, or the name of an exit program.

Security Recommendation

If you don't use DDM or Distributed Relational Database Architecture (DRDA) or you run either of them over TCP/IP (rather than SNA), set the DDMACC network attribute to *REJECT.

Security Considerations for TCP/IP

I still see some use of SNA, but thankfully, it's becoming fewer and farther between instances. TCP/IP (which stands for Transmission Control Protocol/Internet Protocol) is the clearly the standard for today's networks, and there are some fundamental

configuration steps you'll want to take to protect your system. After discussing these steps, I'll go over a few features of TCP/IP as well as some of the more well-known TCP/IP applications and their associated security issues. Chapter 11 discusses security considerations for a Web server.

Starting TCP/IP Servers

The basic security rule for TCP/IP servers is this: Until you need the function, don't start the server. To follow this rule, you need to understand and control which application servers are started when you start TCP/IP. If you are more familiar with a UNIX or Windows environment, you'll typically see a server that runs a different TCP/IP function. For example, you'll have a database server, another to run your Web server, another for Lightweight Directory Access Protocol (LDAP) or Active Directory, and so on. Not so with IBM i. This is a multifunction server, so you'll always see multiple TCP/IP servers started on each LPAR.

Two CL commands control which TCP/IP servers are started: STRTCP (Start TCP/IP) and STRTCPSVR (Start TCP/IP Servers). When you run the STRTCP command, the system examines each server's AUTOSTART (Autostart server) attribute and starts the servers whose AUTOSTART value is *YES. (You can set the AUTOSTART value using the appropriate change command, such as CHGFTPA—Change FTP Attributes.) Several of the TCP/IP servers—including DDM, File Transfer Protocol (FTP), Line Printer Daemon (LPD), Simple Mail Transfer Protocol (SMTP), Simple Network Management Protocol (SNMP), and Telnet—default to auto-start. If you don't want them to start automatically, you can change their AUTOSTART value to *NO.

The STRTCPSVR command, however, overrides the auto-start setting of all servers and starts all servers. To ensure that you don't start servers you don't need, you can use the CHGCMDDFT (Change Command Default) command to change the STRTCPSVR command's SERVER (Server) parameter to specify which server you want to start. (You can specify only one server to start on the CHGCMDDFT command.) For example, the command

```
CHGCMDDFT  CMD(STRTCPSVR) NEWDFT('SERVER(*FTP)')
```

starts only the FTP server. Another option is to set the STRTCPSVR command's SERVER parameter to *AUTOSTART to have only those servers with AUTOSTART(*YES) started.

IBM ships the STRTCP and STRTCPSVR commands as *PUBLIC(*EXCLUDE), and the IBM-supplied profiles QPGMR, QSRV, QSRVBAS, and QSYSOPR are granted *USE

private authority to these commands. You'll want to monitor who can run STRTCP and STRTCPSVR. (This is one example of the type of task programmers can run when you make them a member of QPGMR. You must ask yourself whether starting and stopping TCP/IP is really a function the programmer role should perform. In some organizations—typically smaller ones, programmers may have this responsibility. But they typically will not in larger organizations.)

Session Time-out Value

While considering the auto-start attribute of the TCP/IP servers, you should also think about the session time-out value. The Telnet server takes its value from the QINACTITV (Inactivity Time-out Interval) system value, but servers such as FTP define their own time-out value. You'll need to evaluate the appropriateness of this setting by considering possible performance impacts and how you use these servers. (By the way, not all servers have a time-out value.)

Securing Ports

The Internet Assigned Numbers Authority (IANA) assigns specific ports to well-known TCP/IP applications. To determine the ports defined on IBM i, run the CFGTCP (Configure TCP/IP) command and select option **21** (Configure related tables) followed by option **1** (Work with service table entries).

All users can use programs that listen on ports. To limit the damage someone could do by eavesdropping on a port, you can restrict any ports you don't use. You can restrict a port by configuring it to run under a profile that has been deleted. To do so, first be sure that you don't want to use the port's application, because restricting the port causes the application not to start. Then, create a profile:

```
CRTUSRPRF  TCP_USER PASSWORD(*NONE)
```

After creating the profile, follow these steps to restrict the port:

1. Go to the TCP/IP Configuration menu (**GO CFGTCP**).
2. Select option **4** (Work with TCP/IP port restrictions).
3. Select option **1** (Add).
4. On the Add TCP/IP Port Entry display, enter the port number associated with the application you're restricting as the lower port range value.

5. For the upper value, specify ***ONLY**.
6. For the protocol, specify ***TCP**.
7. Specify the user profile you just created to use this port.
8. Repeat these steps, specifying ***UDP** for the protocol.

After following these steps for each port you want to secure, delete the user profile:

```
DLTUSRPRF   TCP_USER
```

The port restriction will take effect the next time TCP/IP is started. If an application then issues a bind() operation to that port, the bind will fail because the profile no longer exists.

Internal Addresses

Network administrators protect their internal network by using internal or "private" addresses. Private addresses are outside the range of addresses that are valid for use on the Internet. (In other words, they are in reserved ranges, such as 10.*x*.*x*.*x* or 192.168.*x*.*x*.) Several security mechanisms let you control processing based on IP address. The common practice of using private addresses within your organization helps you separate "inside" requests from "outside" requests.

IP Packet Filtering

IP packet filtering—a function typically implemented in a firewall or router—is also integrated into IBM i. Just like packet filtering in a firewall, the integrated function lets you prevent unwanted packets from coming onto or leaving your system. To filter packets, you set up filter rules that specify the types of packets you want to allow. The information you filter is contained in the packet's header and can include source IP address; protocol (e.g., TCP, User Datagram Protocol—UDP); destination IP address; source port; destination port; IP datagram direction (i.e., inbound, outbound, or both); forwarded or local; packet fragments; and TCP SYN (synchronization) bit. For example, you might want to allow inbound FTP requests only when they come from a particular TCP/IP address in your network.

After you define filters, any request that doesn't match a filter is expressly denied. Therefore, if someone requests a Telnet connection to your system and your filter rules don't allow Telnet, the request is denied.

Although I don't recommend using packet filtering as the sole replacement for a standalone firewall product, native IP packet filtering provides another layer of defense in your network security configuration.

NAT

Using Network Address Translation (NAT), you can hide or map TCP/IP addresses. NAT lets you join networks that implement different addressing schemes and hide internal TCP/IP addresses from the outside world by mapping them to public addresses. It's important to keep your internal addresses private. If you publish your internal addresses externally, you give intruders a roadmap to your network and make it easier for them to launch an attack. I recommend you use private TCP/IP addresses internally and map them to a public address when going outside your internal network.

Packet filtering and NAT are discussed under the same topic in IBM's Information Center. If you are considering using this integrated function, be sure to review the planning and configuration information under the **Networking** > **TCP/IP applications, protocols, and services** > **IP filtering and network address translation** topic. Specific planning and implementation guides are described there in detail.

FTP

FTP lets users download files from and upload files to your system. FTP also provides facilities to rename, add, and delete files as well as run commands. Before manipulating a file, the user must provide a valid IBM i user ID and password (this information is sent in clear text). Remember, however, that because the user doesn't sign on via a sign-on display, the user's initial program and initial menu are never run. This is another case in which menu-based security is insufficient.

FTP ignores the setting of the QMAXSIGN (Maximum Number of Sign-on Attempts) system value. It permits five attempts to provide a valid user ID and password before dropping the connection (this limit is hard-coded, and you can't change it). However, FTP does honor the QMAXSGNACN (Maximum Sign-on Action) system value when you set it to 2 or 3 (the values that disable a user profile). In other words, if a user hits FTP's limit of five unsuccessful attempts to provide a user ID and password, the system can disable the user ID.

FTP uses the INACTTIMO (Inactivity timeout) parameter in its configuration to set the length of time an FTP session can be inactive before the system closes the connection. It ignores the QINACTITV system value.

FTP lets users submit remote commands through its RCMD (Remote Command Facility) subcommand. However, unlike with the IBM i Access for Windows remote command server, limited-capability users can't run FTP remote commands.

You can use exit points to implement *anonymous FTP*, which lets a system define a well-known user ID and password for guests to use to sign on and download data. You can use these exit points to enable a tightly controlled FTP environment that lets users download only a predefined set of files. For example, a software company might enable anonymous FTP to let customers download beta code for its newest product.

You can also use exit programs to disable downloading of specific files and to prevent execution of RCMD while still permitting file transfer. Or you can use the TCP/IP Utilities, one of the Host Applications defined in Navigator's Application Administration function, to control access. This feature has the basic characteristics of the vendor software packages that let you control FTP. Figure 10.1 shows Application Administration's Host Applications tab, which lists the host applications and the FTP server settings you can use. To reach Application Administration, right-click the name of the system you're connected to in Navigator, select **Application Administration** from the shortcut menu, and go to the Host Applications tab.

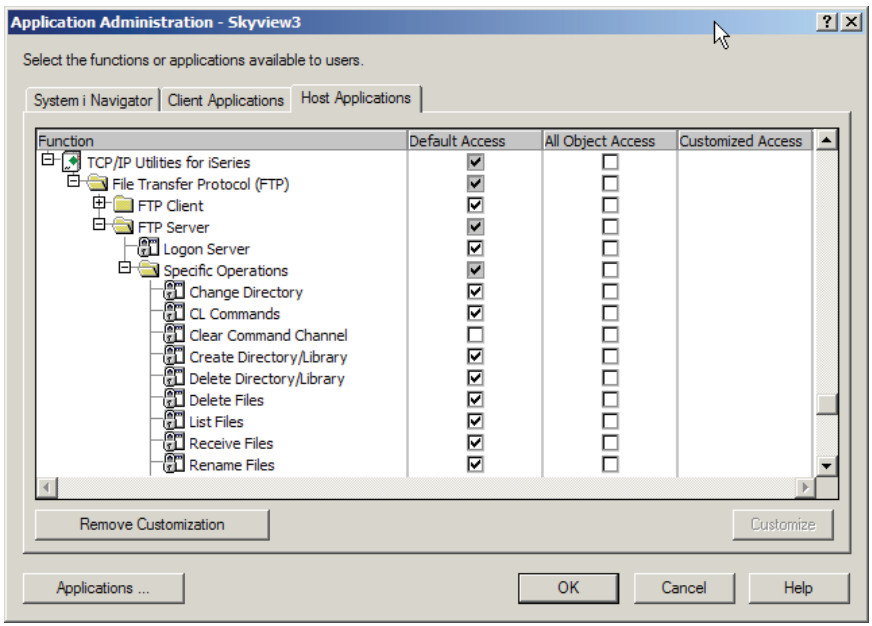

Figure 10.1: Host applications: TCP/IP utilities

FTP is an example of why it is so critical to implement object-level security appropriately. Any user with *USE authority to a file can download it. Any user who has *CHANGE authority can download or upload the file. So, a file that contains inventory data and has *PUBLIC(*CHANGE) authority can be downloaded, changed using a PC spreadsheet, and then uploaded, compromising the integrity of your production data.

One tactic intruders like to use is to store stolen data (e.g., credit card numbers, pornographic photographs) on someone else's system or FTP site. This practice is called *parking*. If your IBM i system serves as a Web server on the Internet (versus your internal intranet), is in the cloud, or is part of an outsourced system, you may want to put controls in place to make sure a user can't execute both PUT and GET subcommands to the same library or directory (In other words, if you allow PUTs to a directory, disallow GETs, and vice versa.) This precaution removes some of the allure of using your system because intruders can't retrieve any information they store on your system.

SMTP

Simple Mail Transfer Protocol lets you send and receive email. Flooding a system with misdirected email (i.e., email addressed to an invalid recipient) is a popular denial-of-service (DoS) attack. To protect your system from being a router for misdirected email, don't use the *ANY *ANY entry in the system distribution directory. Removing this entry causes IBM i to reject misdirected email when it isn't addressed to a user in your network.

You can also have a problem if your system redirects misdirected email to another system on the Internet. If your system has been found to do this, other systems on the Internet may "blackball" or "blacklist" your system or domain and refuse to accept email from it. If the blackballed system is your Web server, which is sending out order confirmations via email, you have a problem. On the other hand, you want to protect your own system from systems that are known to route misdirected email by configuring your system to control SMTP's RELAY and CONNECTIONS functions.

Another hacker trick is to *email-bomb* a system, flooding it with email from many locations. This is one form of a distributed denial-of-service (DDoS) attack. If you configure SMTP to automatically register users in the system distribution directory, such an attack will also flood the system distribution directory. To avoid this exposure, specify *NO for the AUTOADD (Automatic registration) parameter in the SMTP configuration.

Viruses attached to email also can be a real nightmare. You can configure the SMTP server through either Navigator or the CHGSMTPA (Change SMTP Attributes) command to scan email attachments and the subject line of all email that comes in or goes out

through the SMTP (or POP) server. This support lets you define a filter; the system then scans all incoming and outgoing mail. When a match is found, you can either delete the attachment or send it to a specified location for possible repair.

You can also use an alias table to hide the profile name of IBM i users who send and receive email. If hackers can find user profile names, they're halfway to signing on to your system. Use the WRKNAMSMTP (Work with Names for SMTP) command to define aliases.

POP

The name of this TCP/IP application, Post Office Protocol, pretty well describes its function. POP is an electronic mailbox that receives email and stores it until the user retrieves it. To retrieve email, a user must have an entry in the system distribution directory and an IBM i user profile and password. The password is passed to the operating system as clear text. You can't control whether clients (e.g., Web browsers) store the IBM i user profile and password. If a user has a reason to access your system other than to access email, you might want to create two profiles: one for accessing the user's personal mailbox and another for the user to use to sign on and access IBM i applications. If you use this approach, create the mailbox profile with the attributes shown in the following table, so that the user can't use the mailbox profile to sign on to and exploit your system.

Attribute	Value
Initial program	INLPGM(*NONE)
Initial menu	INLMNU(*SIGNOFF)
Limited capabilities	LMTCPB(*YES)
Special authorities	SPCAUT(*NONE)
Group profiles	GRPPRF(*NONE)

Unfortunately, a user who can't sign on also can't change passwords. Therefore, you need to set the password expiration interval to *NOMAX (so it never expires) or write a program that changes the password and runs at a regular interval (the latter approach is preferred).

To prevent your system from being email-bombed, be sure to set the size of your ASPs to an appropriate value. The value should be large enough to store and serve your users' email but small enough so that the limit is reached without wasting too much space on unwanted email in the event of an email bomb.

POP stores email in the integrated file system (IFS). To prevent users from snooping through other users' email, you'll need to monitor the authority of the IFS subdirectory /QTCPTMM/SMTPBOX. Email sent to the system through SMTP is stored here before being delivered to a user's mailbox. The files that store the email use the naming convention QTCPTMM/MAIL/user_profile_name. Anyone who has *RX authority can see the contents of these files, and anyone who has *RW authority can update or change the files. Navigate to the subdirectory using the WRKLNK (Work with Object Links) command, and take option **9** to modify or see who has authority to these files.

DNS

TCP/IP's Domain Name Service (DNS) provides name lookups: Given a host name, DNS finds the corresponding IP address, and vice versa. IBM recommends that the DNS server integrated into IBM i be used within your intranet only. That's because it may not be able to be updated quickly enough when vulnerabilities in this protocol are discovered for use outside your network.

You shouldn't use the same DNS for both intranet and Internet (or public) systems. Think of DNS as a telephone directory. You typically don't publish your employees' internal phone extensions in a public directory, but you publish your company's toll-free telephone number widely. The DNS on IBM i is your "private" directory; your "public" directory resides on your firewall or is provided by an Internet Service Provider (ISP). To an intruder, a DNS server provides a topology of your network, complete with IP addresses.

Many networks are partitioned into subnets. You might not want users in one subnet to know the topology of the other subnets. To define which IP addresses or network interfaces can view your topology, you can define protection directives for your DNS.

To protect your DNS configuration, monitor who has authority to the \QIBM\UserData\OS400\DNS and \QIBM\UserData\OS400\DNS\TMP directories and the files they contain. Only the user who created the DNS files or users who must maintain those files should have authority to them. Public authority should be *EXCLUDE.

REXEC

TCP/IP's Remote Execution (REXEC) facility provides the same type of function as FTP's RCMD subcommand. Just like FTP, REXEC requires a user ID and password and checks the value of the user profile's LMTCPB (Limit capabilities) parameter before running any commands. If the user profile is a limited-capability user (LMTCPB is set to *YES), REXEC rejects the request. You can also use exit points to validate incoming requests.

REXEC is typically used to run an IBM i command from another operating system such as Windows, UNIX, or Linux. You can also run a command *from* IBM i to another server—including another IBM i—using the Run Remote Command (RUNRMTCMD) command. Unless you have a requirement for this type of interoperability, don't start the REXEC server.

SNMP

Simple Network Management Protocol lets IBM i act as an agent to manage gateways, routers, and hosts in the network. An SNMP agent gathers information about the system and performs functions requested by remote SNMP network managers. Some of the information gathered could be information you've hidden by using aliases or your DNS server. An intruder could use SNMP to gain information about the topology of your network and possibly to alter the network.

Access to SNMP requires a *community name*. A community name is somewhat analogous to a password, but it isn't encrypted. To limit the possibility of someone masquerading as a legitimate SNMP network manager, change the value of the INTNETADR (Internet address) parameter on the ADDCOMSNMP (Add Community for SNMP) command from *ANY to the IP address of your SNMP network manager.

SNTP

Simple Network Time Protocol (SNTP) lets IBM i act as a client or server for synchronizing device clocks. The PCI DSS standard requires that clocks in your network be synchronized. This is so that audit and log entries can be coordinated across systems. If clocks aren't synchronized, recreating the sequence of events when investigating an incident becomes very difficult. In addition, if you're going to use Kerberos for authentication, you'll need to synchronize clocks to minimize problems with Kerberos tickets timing out. Regardless of whether you have to be PCI compliant or you are using Kerberos, coordinating the time across all servers in your network makes good sense, and I encourage you to implement this function.

DRDA and DDM

Distributed Relational Database Architecture defines the protocols for communications between an application program and a remote relational database. DRDA on IBM i uses Distributed Data Management to communicate with the remote system that contains the relational database.

The security aspects of DDM and DRDA running over TCP/IP differ significantly from running over SNA. That's because SNA had some inherent security features of which DDM and DRDA were able to take advantage. TCP/IP doesn't have these security features, though, so you don't have as many security configuration options when running either DDM or DRDA over TCP/IP.

DDM

When you configure DDM, you must configure security on both the source system and the remote system. On the source system, the user making the DDM request must have a Server Authentication Entry, defined using the ADDSVRAUTE (Add Server Authentication Entry) command. For example:

```
ADDSVRAUTE  USRPRF(application_requester_job_profile) +
            SERVER('QDDMSERVER')                      +
            USERID(server_job_profile)                +
            PASSWORD(password)
```

The USRPRF (User profile) parameter specifies the user on the source system. The USERID (User ID) parameter names the user under which the request will run on the remote system. This user needn't be the same as the user on the source system. In fact, you may not want users on the source system to have a profile on the remote system. In this case, name a different profile under which to run the remote request. Depending on the configuration on the remote system, a password may or may not be required.

To configure security on the remote system, you modify the remote client authentication properties of the DDM server using either Navigator or the CHGDDMTCPA (Change DDM TCP/IP Attributes) command. You have six options for specifying what is required on the connection:

- No password is required on the connection.
- A password is not required, but if one is passed it must be valid.
- A password is required (this is the default).
- An encrypted password is required.
- An encrypted user ID and encrypted password are required.
- A Kerberos ticket is required.

You must use the "no password" option if the profile on the remote system doesn't have a password—that is, if it is defined as PASSWORD(*NONE). However, I don't recommend this setting. Consider this: The ADDSVRAUTE command authority is *PUBLIC(*USE). That means that any user on the system has access to the command. No authority checking is performed if you leave the USRPRF parameter at the default value of *CURRENT. No authority checking is ever done on the USERID parameter. Therefore, with the remote system client authentication set to "no password required," anyone can run the ADDSVRAUTE command and specify that the user's request run as QSECOFR on the remote system. Now, when the user submits a DDM remote command, it will run on the remote system as QSECOFR.

With the "no password required" setting, if a password is passed, the remote system ignores it. The last option—that no password is required, but if one is passed it must be valid—isn't much better than the "no password required" setting; therefore, I don't recommend its use, either.

Requiring a password (the default setting) is a much better choice. Unfortunately, this setting introduces a synchronization problem. The user's password on the remote system must match the password specified in the server authentication entry. So either you define a password that never changes (not something I recommend or that would pass any type of formal audit or comply with PCI DSS or other regulations), or you have the challenge of changing the password on the remote system and having to remember to also change it in the server authentication entry on the source system.

Requiring an encrypted password is one of the better options, but it still presents the challenge of keeping passwords in sync, as does the encrypted user ID and encrypted password option (which is the best option described so far). The most secure option is to configure the source and remote systems to use a Kerberos ticket for authentication. (For more information about using Enterprise Identity Mapping, or EIM, and using Kerberos for authentication, see the Security topic under the appropriate release of the operating system in the IBM Information Center.)

Technical Note

If you configure the remote client authentication to require a password, you must set system value QRETSVRSEC (Retain Server Security) to 1 (allow decryptable passwords) so that the clear-text password can be obtained from the server authentication entry.

DRDA

When you run DRDA over TCP/IP, it uses the connections provided by DDM. The remote client authentication setting on the remote system then determines the authentication requirements. As I noted, the default is to require a username and password to be sent to the system on which the relational database resides. The user can provide the user ID and password on the SQL CONNECT statement when connecting to the relational database. Or, you can use the ADDSVRAUTE command to define a server authorization entry, as described previously.

If you choose to use the encrypted password option, you must use a client that supports something called *password substitution*, a technique that lets the server and client pass the password in a secure fashion. The Java Toolbox and IBM i Access OLE DB Provider are clients that support password substitution. DRDA also supports Kerberos as an authentication mechanism; just as it was with DDM, this is the most secure method of authentication.

Security Considerations for PCs and Mobile Devices

The technology enabled by PCs and mobile devices is one of the biggest challenges facing IBM i security administrators. Nothing underscores the inadequacies of menu-based security more than using mobile-device–based software to access IBM i databases. If you still rely solely on menu security to control your sensitive and confidential information (in other words, if you don't use object-level security), your security configuration has holes. Let's look at IBM's Access Client Solutions (ACS) and some of the security issues you'll have to deal with there.

Access Client Solutions

ACS provides several applications, including Open Database Connectivity (ODBC), data transfer, Navigator for i, and 5250 emulation. ACS is the replacement for the old Client Access or current i Access for Windows products. i Access is not supported on Windows 10, so if you're currently using i Access for Windows, you will need to change your users over to ACS. ACS has several advantages over i Access for Windows. First, ACS is an executable and is not actually installed on the client; therefore, it's much easier to stay current with ACS because it can be maintained using the same process you're using for keeping your desktops up to date. Another benefit is that ACS runs on more than just Windows; ACS runs on Linux and Mac operating systems, as well.

ACS, like IBM i Access for Windows, presents some security challenges, but neither application poses security exposures in and of itself. What both do is expose a system that does not have a sound object security implementation. Users cannot access any object through IBM i Access or ACS that they don't have authority to. Depending on how you or your vendor software has implemented object-level authorities, your data might now be accessible through client applications because the default access (i.e., *PUBLIC authority) has been left wide open (i.e., set to something other than *EXCLUDE).

You must couple the use of ACS or IBM i Access for Windows with good resource security to ensure users can access only the data you want them to access. I encourage you to monitor the IBM ACS website at *www-03.ibm.com/systems/power/software/i/access/solutions.html* to stay current with the latest updates and features.

Data Transfer and Remote Command Issues

ACS and i Access provide the ability to transfer data and run remote commands. If you let users use these capabilities, you need to be aware of the consequences for the confidentiality of your data. Remember, all files with *PUBLIC(*USE) authority can be downloaded. Files with *PUBLIC(*CHANGE) authority can be downloaded, changed, and uploaded. You cannot guarantee the integrity of the data in files left at *PUBLIC(*CHANGE).

Letting users run remote commands is like letting users submit batch commands: IBM i doesn't check the user profile's LMTCPB parameter. If you're tempted to use an exit program to totally disallow use of the remote command server or to change its auto-start feature and never start it, you'll effectively disable most of Navigator for i as well because IBM uses the remote command server to implement Navigator. That's another reason I prefer to use object-level security to protect data.

Technical Note

See Informational APAR II12227 for a list of IBM i Access for Windows functions and the servers required to perform each function. This APAR can help you identify which functions will no longer work if you choose not to start a server.

Host Servers

Running the STRTCP command starts all host servers whose auto-start value is *YES. (These are the servers used by ACS and i Access for Windows to process requests, such as the license management server, sign-on server, database server, and so on.) You can use Navigator to customize which servers are started when you run STRTCP, or you can edit the QATOCSTART file in QUSRSYS to customize which servers you want to start. Note that if TCP/IP fails or the ENDTCP (End TCP/IP) command is run, you must use the ENDHOSTSVR (End Host Server) command manually to end the host servers.

Limiting What Users See from the Desktop

Both ACS and IBM i Access for Windows provide several ways, including Microsoft Group Policy Objects (GPOs), Application Administration, and selective install, to limit what users can do from their desktops. You should think of these alternatives as modern-day forms of menu access control. In other words, none of these methods is a substitute for object-level security. Nevertheless, limiting what appears on a user's desktop is a good practice because it reduces complexity and confusion for the end user. Also, for some users, if they don't see a function, they won't be tempted to go look for it.

Microsoft Policies

Support for Microsoft GPOs is inherent to the Windows operating system. Just as an administrator can control whether new software can be loaded onto the PC, an administrator can set a group policy for which IBM i Access or ACS functions are allowed.

Application Administration

The Application Administration interface, which is included in both System i Navigator (the client-based version) and the Web-based IBM Navigator for i, lets you administer parts of ACS and IBM i Access. The effect is the same as enforcing Microsoft policies, except that an IBM i system administrator rather than a Windows administrator usually configures Application Administration.

Several CL commands help you manage application administration: DSPFCNUSG (Display Function Usage), CHGFCNUSG (Change Function Usage), and WRKFCNUSG (Work with Function Usage). These commands let you manage the same information that you can manage using Application Administration in Navigator. However, I find it much simpler to use the Application Administration interface rather than these commands.

Selective Install

System administrators can selectively configure which components of IBM i Access for Windows they want installed on users' PCs. You can also build a select set of features to be executed as part of ACS. This is a good place to begin to control what function is available from users' desktops, but this configuration isn't foolproof. Unless users' rights to install software on their workstation are removed, they may be able to download additional features or a full install from either the Internet or another user's device.

ODBC Security Considerations

Open Database Connectivity is a set of standard interfaces developed to provide easy access to databases. Many applications use ODBC or the Java-compatible Java Database Connectivity (JDBC). Again, any database file that has public authority of at least `*USE` can be read through ODBC.

Some organizations attempt to use an exit program to help control unauthorized use of ODBC. The problem is that depending on the function being requested, somewhere between three and five host servers are used. There is no server named "ODBC" for which you can write one exit program and gain control. In addition, vendors using ODBC may use the DDM or DRDA server, or they may write their own server. In other words, it's difficult to administer and securely control ODBC requests. At the risk of sounding like a broken record, I must remind you that this is a reason to make sure you have a sound object security implementation.

IBM i Access for Web

IBM i Access for Web appears to be much less of a security challenge for administrators when all you're trying to do is give users 5250 access to IBM i. It provides much more administrative control than IBM i Access for Windows over which users can perform extended functions such as running remote commands or transferring data. This control isn't "smoke and mirrors," like Application Administration. If the user doesn't see a function in his or her browser interface, that function is not available to the user. That's because the checks for the function occur within IBM i and not on the user's PC, as they do when the system checks Application Administration to see whether functions should appear on a user's desktop.

IBM i Access for Web also eliminates the need for some exit programs because the function runs through the Web server and there are no exit points associated with the Web server. But IBM i Access for Web definitely needs some of your attention. As shipped,

it provides access to all its functions. Before deployment, you'll want to remove access from the *PUBLIC group for all functions you don't want to provide to your end users. Figure 10.2 shows the window you use to set security policies in IBM i Access for Web.

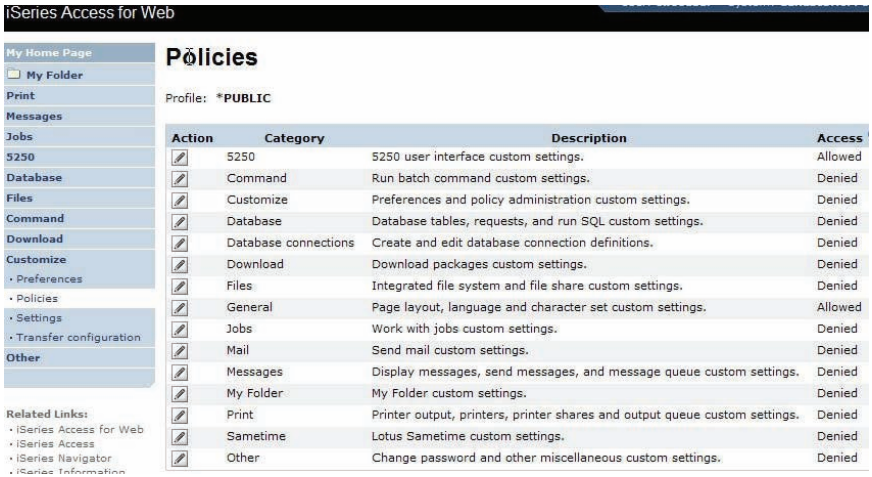

Figure 10.2: IBM i Access for Web

The configuration files for IBM i Access for Web reside in the IFS. Depending on how you've implemented this function, you may need to look down a different path to monitor authority to these configuration files.

If you're using the Integrated Web Application Server *ADMIN instance with the IWADFT Apache HTTP server, look at

```
/QIBM/UserData/Access/Web2/intappsvr/Admin/...
```

If you're using an Integrated Web Application Server instance created via the Web Admin pages, substitute the name of the Integrated Web Application Server instance in place of <instance> in the following path:

```
/QIBM/UserData/Access/Web2/intappsvr/<instance>/...
```

Last, if you're using WebSphere, substitute the appropriate values for <appsvrtype>, <wasprf>, and <appsvr> in the following path based on the values used for those parameters on the CFGACCWEB2 (Configure Access for Web) command:

```
/QIBM/UserData/Access/Web2/<appsvrtype>/<wasprf>/<appsvr/...
```

You'll want to monitor the permissions to these files to ensure they remain DTAAUT(*RX) and OBJAUT(*NONE).

Using Exit Points

I've mentioned exit points and exit programs several times thus far. Exit points are places throughout IBM i where the operating system "exits" its processing and calls a user-written program if one is registered. This user-written program is given control for a moment, and then control is returned to the operating system. The concept of an exit program is unique to IBM i. Exit points are defined for servers, such as FTP and Telnet, as well as for functions, such as creating a user profile or changing a password. You register most exit programs in the Registration Facility (using the WRKREGINF, or Work with Registration Information, command), although some legacy exits are defined in network attributes (CHGNETA command) and system values (WRKSYSVAL, Work with System Values, command).

Some security vendors claim to be able to secure your system *solely* by using exit points. And sometimes the vendors claim you must have exit programs in place, or else your system isn't secure. Contrary to these claims, native IBM i object security is the key to a sound security implementation. There is *no* substitute for object-level security—no matter what any security vendor tells you. And … you do NOT need exit programs to achieve a secured IBM i! That said, there are times when you might choose to implement an exit program. If you want to add an extra layer of security beyond object-level security, exit programs can be a good choice.

If I'm going to use an exit program, it typically is not to add an extra layer of security; it is to take advantage of the additional logging of network traffic, beyond what is available through IBM i auditing, that exit programs provide. IBM i doesn't log transactions that occur through these network interfaces. The information provided by exit programs is very useful when you're reworking an application security scheme, helping you understand which processes and users are accessing the application database files from outside the application itself. (For more information about using this information, see Chapter 16.)

As I've said, exit programs are *not* a substitute for object authority, but they do have their place in some security configurations. If you're going to use exit programs, I don't recommend writing your own. Exit point formats—especially the ones dealing with database access and SQL—are complex and vary from exit point to exit point. Numerous vendors provide this type of function, and there is likely a solution available that meets your requirements as well as your budget.

For those adventurous types out there who want to write their own exit programs, you'll find the exit point documentation and examples scattered throughout IBM's Information Center. In the InfoCenter, the TCP/IP exit points are discussed under the individual servers, as in **Networking** > **TCP/IP applications, protocols, and services** > **FTP on IBM i** > **FTP reference information** > **FTP exit programs**. Telnet isn't quite so buried; you'll find the Telnet exit point documentation under **Networking** > **TCP/IP applications, protocols, and services** > **Telnet** > **Managing the Telnet server** > **Using Telnet exit point programs**.

To find the exit point formats for the host servers for IBM i Access for Windows, follow these InfoCenter links: **Connecting to your system** > **IBM i Access** > **IBM i Access Client Solutions** > **Setting up the IBM i platform** > **Host server administration** > **Use server exit programs**. The other exit point formats are documented under their respective topics in **Programming** > **application programming interfaces**. For example, if you want to look up the security-related exit points, go to **Programming** > **Application programming interfaces** > **APIs by category**; then click **Security APIs** to see the list.

Management Central

Management Central has several features that let you manage users across multiple installations of IBM i. You can create a user on one system and schedule a task within Management Central to have the user profile propagated to specific systems in your network—including the user's password. Or, you can take an existing profile and propagate it to another system. This method is much easier than taking the results of your last SAVSECDTA (Save Security Data) command execution and restoring that to another system.

Despite its usefulness, Management Central has several aspects that you should keep your eye on. One feature of creating profiles on systems around your network is that once the task is complete, you can have a "post" command run. This command could call a program or run a command. You'll want to monitor what is run during this post command so that no one alters it to run malicious commands. Monitor who has authority to file QAYPSJDFN in QMGTC, and monitor the file's contents as well. The file should be set to *PUBLIC(*EXCLUDE) with no private authorities.

Secure Communications

Various laws and regulations have raised the bar for secure communications. Many require that private data (e.g., credit card numbers) be transmitted over public networks

in encrypted form. The easiest way to implement this requirement is to encrypt the entire transmission. In addition, many recent breaches were successful because they were able to capture clear-text passwords flowing through the network. Using encrypted sessions will defeat that part of the attack. Chapter 9 discussed encryption basics. In this section, I focus on how you can use encryption for communicating to or from your IBM i system.

Digital Certificates

A digital certificate has many similarities to the passport that you use to get into other countries—but in electronic form. Like a passport, a digital certificate must be issued by a particular agency—in this case, a Certificate Authority (CA)—and is valid for a particular time period. You must present some form of identification to have a CA issue you a digital certificate. Once issued, the certificate can be used to identify a user, server, company, or another entity. And just as some countries don't allow entry by people holding passports from certain other countries, servers can choose to disallow digital certificates issued by particular CAs.

Part of the process of creating a digital certificate includes the generation of a public/private key-pair. A public key is included as part of the digital certificate. The private key should be stored in such a way that it cannot be easily accessed (because, as the name indicates, it's supposed to be kept private.) Let's look at how a very common Internet technology makes use of digital certificates and the public/private key-pairs associated with them.

Transport Layer Security

Transport Layer Security (TLS) is a protocol that encrypts a communications flow. TLS is the more modern version of the Secure Sockets Layer (SSL) protocol. FTP, Telnet, and HTTP (Hypertext Transfer Protocol) are examples of applications that use TLS to encrypt the data that flows between a client and server.

When an application requests TLS services from a server, the client always verifies the server. To do this, the client sends some random data to the server, along with a challenge that in effect says, "Tell me who you are." When the server receives the challenge from the client, the server uses its private key to encrypt the random data and then returns the encrypted data and the server's digital certificate to the client. The client then takes the public key from the server's digital certificate, decrypts the random data, and compares it with the data originally sent.

Also, as part of verification, the client determines what CA signed or issued the server's digital certificate and checks whether the CA is included in the client's list of trusted signers. In other words, the client makes sure it trusts the CA that issued the server's digital certificate. If the random data wasn't decrypted properly or if the server's digital certificate isn't in the client's list of trusted CAs, the connection isn't established.

When the decrypted random data is the same as the original data and the server trusts the CA that issued the digital certificate, the client and server negotiate a session key. The client and server then encrypt the rest of the transmission using the session key, which is a symmetric key (making the rest of the transmission perform much faster than if the session used an asymmetric key).

These steps are always followed when a client requests a TLS session. Optionally, after server authentication, you can have TLS authenticate the client. For client authentication, the steps just described are reversed; in other words, the server sends the client random data and a "Tell me who you are" request, and authentication proceeds as it did in the other direction.

Most of IBM's servers are enabled for TLS—Apache, Telnet, FTP, DDM, DRDA, LDAP, Management Central, Java Toolbox, ODBC, and all the IBM i Access for Windows and Access Client Solutions servers (e.g., data transfer, data queues, remote queues, print servers). To configure these servers to use TLS, you must use IBM i's digital certificate facility, called Digital Certificate Manager (DCM), which I'll discuss in a moment.

For encrypted Web sessions, you must go into the *ADMIN instance of the Web server and enable each server instance to use TLS. Then, in your HTML, you code the link to the page that requires a TLS connection to be HTTPS (HTTP secure) rather than HTTP. You can also use a protection directive to ensure certain pages aren't served if the connection isn't TLS.

For the IBM i Access for Windows servers as well as Access Client Solutions, you must assign a digital certificate for the various servers to use for authentication. Then, you need to configure each client to make TLS requests for the appropriate connections (e.g., ODBC).

Some of the IBM i servers allow client-side authentication. Client-side TLS authentication requires users who make a request of one of these servers to have a digital certificate so that the server can validate the users. Client-side TLS authentication is a powerful feature that lets the system administrator very tightly control who can access the system. As system administrator, you can configure the server to accept only digital

certificates issued by a particular CA. You could, for example, choose to set up the IBM i system as your CA and then issue the certificates to only the individuals you want to connect to your system.

For instructions on configuring your HTTP server instance to be TLS (SSL) enabled, follow the IBM i InfoCenter links to **Electronic business and Web serving** > **HTTP Server** > **Scenarios** > **Adding Secure Sockets Layer (SSL) protection**. Configuring encrypted (TLS/SSL) sessions for your client connections is much easier when using Access Client Solutions than with i Access for Windows. If you have not yet configured your clients to use encrypted sessions, I encourage you to first switch to ACS.

Moving Away from Using Secure Sockets Layer (SSL)

If your organization is still using the SSL protocol, you'll want to quickly start investigating what it will take to switch and to use TLS instead. That's because several vulnerabilities have been identified in SSL and "early TLS" (i.e., TLS 1.0). In fact, the PCI Council requires that you stop using SSL and TLS 1.0 no later than July 1, 2018, to remain in compliance with PCI DSS. And while TLS 1.1 is allowed, the PCI Council highly recommends that only TLS 1.2 be used, whenever possible.

Please note: For those of you with systems still running V5R4, TLS is not supported, and only TLS 1.0 is supported on V6R1. That means that you must be running a release no earlier than V7R1 with Technology Release 6 (or later) installed to use a protocol that does not have known vulnerabilities and to be in compliance with PCI DSS.

As mentioned in Chapter 3, there are three system values that control the protocol and cipher suites used for secure connections. To eliminate the use of SSL, you'll need to modify these system values from their default settings.

System Value	Description	Possible Values
QSSLCSLCTL	Provides the ability to specify whether the operating system will control the list of cipher specifications for encrypted communications or the list will be user-defined.	*OPSYS *USRDFN – if you need to modify the list of ciphers in the QSSLCSL system value, you will need to specify *USRDFN. To ensure your system is updated with the new ciphers, change this value back to *OPSYS prior to upgrading.

System Value	Description	Possible Values (Continued)
QSSLCSL	Specifies the ciphers that the system will use for encrypted sessions	Varies by OS level and technology release. See the IBM Information Center for the list of ciphers available with your system's OS level. (Note: The order the ciphers are listed in is the order in which the session will be negotiated. List the most secure algorithms at the top of the list. If the server with which you're communicating supports the cipher, that's what will be used. If it doesn't, the next cipher will be attempted.)
QSSLPCL	Specifies the protocols that the system will use for SSL/TLS sessions	*TLS1.1 *TLS1.2 Notes: Order is not important for this system value. The system will always attempt to use the strongest protocol first. By default, SSLv3 and TLS1.0 are disabled as of V7R1. When upgrading the OS, you may need to add back those protocols until you eliminate the communications using these old protocols.

Note

Changing these system values **cannot** be done without first doing some investigation and planning. If you don't, it's likely that connections could fail. Also, you will have to talk with entities you're communicating with and may wait until they support the stronger protocol and ciphers. It may actually take several months before this issue can be fully remediated.

Here's a Security Bulletin that does a good job of describing the vulnerability known as "POODLE" and how it affects IBM i—including PTFs you may need to apply because some internal issues may arise when you disable SSL: *www-01.ibm.com/support/docview.wss?uid=nas8N1020451*. Some parts of the operating system, such as LDAP, may break when you disable SSL. Toward the end of the bulletin are the instructions for turning on the counter to find out if you have any SSLv3 connections.

Also, IBM has released a set of PTFs that will allow you to more easily run a communications trace and determine what job or process is using SSL—especially helpful if you turn on the counter and find you have SSLv3 connections. You can

find instructions for performing the trace at *www-01.ibm.com/support/docview.wss?uid=nas8N1020594*.

Digital Certificate Manager

The Digital Certificate Manager lets you set up your IBM i system as a CA, create digital certificates, and receive digital certificates from well-known CAs, such as VeriSign and Thawte. You use DCM to associate a digital certificate with TLS-enabled servers, such as Telnet, IBM HTTP Server, Java Toolbox, and various IBM i Access for Windows or ACS servers, so that your system knows which digital certificate to use when a client makes a TLS request. For instructions on configuring your system as a CA, see the **Security** > **Digital Certificate Manager** topic in the Information Center.

Using your IBM i system as a CA is a good option when first implementing TLS connections. That's because you can try the function and understand the configuration requirements before buying a digital certificate from a well-known CA. But because an IBM i CA is not in the clients' list of trusted signers, rolling out an implementation across your entire organization using your system as the CA will likely be more work than you want—especially when using i Access for Windows. In this case, it will be more cost-effective to buy a certificate from a well-known CA. If you are rolling out the implementation only to your administrators, using your system as a CA may be a viable solution because there aren't many administrators and this type of user is more comfortable changing the configuration of client software.

Virtual Private Networks

Virtual private networks (VPNs) are another method of ensuring that data is encrypted during transmission. VPNs let you establish a secure, private connection over a network. Although IBM i has integrated VPN capabilities, most people establish a VPN connection elsewhere in their network.

The difference between a VPN and TLS is that VPNs encrypt in the TCP/IP stack, so that once the session is established, everything that flows is encrypted. With TLS, every application using a connection must be enabled for encryption. VPNs are often used for employees who work remotely or for administrators who are on-call and must connect to the organization's network from home.

Secure Shell

An alternative to SSL for some applications is Secure Shell (SSH). This function is available for IBM i through the IBM Portable Utilities for i5/OS (product 5733-SC1). OpenSSH is the open source implementation of the SSH protocol suite. OpenSSH is widely available for use on many other platforms, including AIX, Linux, and z/OS.

The OpenSSH portion of 5733-SC1 that you might consider includes the following utilities:

- `ssh`—A secure Telnet replacement that lets an IBM i user connect as a client to a server running the sshd daemon. You can use this tool to connect to the Hardware Management Console (HMC) on the eServer 5*xx* iSeries models.
- `sftp`—A secure FTP replacement.
- `scp`—A secure file copy program; basically an alternative to `sftp` for copying a single file in the IFS.

For more information about SSH on IBM i, go to *www-03.ibm.com/servers/enable/site/porting/tools/openssh.html*. Or reference the Redpaper, "Securing Communications with OpenSSH on IBM i5/OS" at *www.redbooks.ibm.com/redpapers/pdfs/redp4163.pdf*.

Wireless Considerations

Technology for securing wireless communications is evolving rapidly. Because of that, I'm not going to talk about specific technologies here. Rather, I'll point out some of the general issues with which to concern yourself.

First, familiarize yourself with the technology and what is currently available to secure wireless connections. Use all techniques that make sense and are cost-effective for your organization. Don't limit your research to just wireless LAN connections. Smartphones and other mobile devices as well as standalone hotspots can all be sources of data loss.

Second, understand the threat. If you or your employees are using wireless devices, the security threat is very real. *Sniffers* are available for wireless networks, and tools are available for detecting access points. There are documented cases of people driving around neighborhoods (a practice known as "wardriving") and hopping on ("LANjacking") any network they detect. Imagine that one of your employees has a

wireless network in her home that provides Internet access from any room in her house. From the comfort of one of her deck chairs, she can log into your corporate network and catch up on her email. Unfortunately, you have no requirement to use an encrypted session, so the teenager next door also has access to your corporate network. Don't believe it? My friend often has a better connection to his neighbor's wireless network than to his own. The threat is real.

Third, understand your compliance requirements. PCI DSS has specific requirements for wireless networks and tests that must be performed quarterly. In addition to being a compliance requirement, these tests are simply good security practices. Some of the worst cases of ID theft have originated with the thieves gaining access to corporate networks through wireless devices.

Last, make sure your security policy accounts for wireless technology. Whether you permit its use at all is the first consideration. If you do, you'll want to define its appropriate use and the appropriate placement of access points as well as address the following questions:

- Whether employees who use wireless networks at home have any additional security requirements (e.g., mandatory use of a VPN when accessing corporate networks from home over a wireless network)
- Whether accessing the corporate network from public "hotspots," such as those found in coffee shops and airports, is allowed
- Whether additional security considerations are required (e.g., file sharing is not allowed, confidential data stored on laptops must be encrypted)

Helpful Tools

The WRKREGINF (Work with Registration Information) command is a tool that can help you monitor aspects of network security. This command prints a list of all registered exit points and the programs associated with them. You can use it to track exit programs in the registration facility.

Navigator for i

Navigator for i can simplify the management of TCP/IP servers. In fact, you can administer some functions, such as IP packet filtering and VPN configuration, only through Navigator. Figure 10.3 shows the view of TCP/IP servers presented by Navigator.

To manage TCP/IP through Navigator, expand the icon for the system to which you're connected, and then expand **Network**. Expand **IP Policies** to configure IP packet filtering as well as VPN connections. Expand **Servers** and then select either **TCP/IP** or **System i Access** to manage the respective servers. To change the auto-start or inactivity time-out value, right-click one of the servers and choose **Properties**.

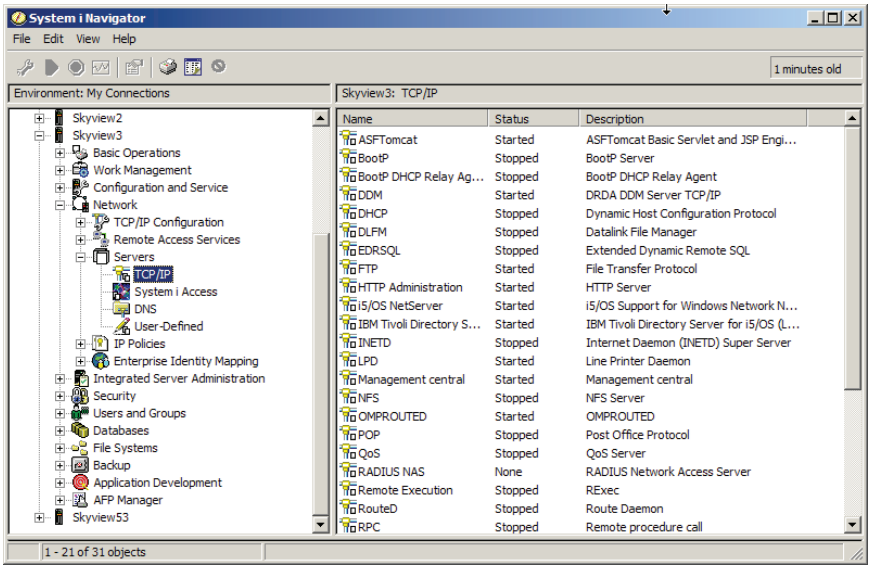

Figure 10.3: Viewing TCP/IP servers

IBM Navigator for i

Another method for managing your IBM i system is to use the Web-based IBM Navigator for i. IBM Navigator for i is rapidly becoming the utility of choice for administrators as a replacement for the client-based System i Navigator—especially as IBM provides more and more features similar to System i Navigator. Because the Web-based Navigator for i is IBM's strategic interface for managing servers, you'll want to familiarize yourself with the interface if you haven't previously. Go to *www-03.ibm.com/systems/power/software/i/navigator/* to learn more about IBM Navigator for i and to stay current with new features.

CHAPTER 11

Internet Security

When I first started writing about the topic of Internet security, it was rare to find an organization that allowed an Internet connection directly into its business. Today, it is virtually unheard of to not have an Internet connection. With Internet access now a given, the implications for the security of your network and, more important, your data cannot be ignored. Let's walk through some of the issues to make sure they're being addressed appropriately in your organization.

Determine Your Risk

Your first task in assessing your Internet security needs is determining the risk to your organization should your data be compromised. Of course, this assessment needs to occur even without consideration of the Internet. You need to determine the data's value to your organization, identify the vulnerabilities—both from external hackers and from internal threats (e.g., a disgruntled employee)—and then, based on those assessments, determine the lengths to which you'll go to protect the data.

This is one of those times when you must weigh the risks against the cost of securing systems and data. That cost might be the additional funds required to buy more tools or hardware devices to secure the data. It might be the extra personnel needed to implement and maintain a more robust security scheme. Or it might be the cost of lost opportunity if

the proposed interface is rejected because of the expense of securing it or the risk it poses to the organization's data. Few absolutes exist in the world of security. Developing and implementing a security policy consists of a series of tradeoffs.

In the past, Internet access was one of those decision points or tradeoffs—added function versus a significant risk of exposure to data. Obviously, with very few exceptions, organizations have an Internet presence; it's a requirement for doing business in today's connected world. To mitigate the risks associated with exposing the business to the Internet, most organizations have implemented numerous layers of security—sometimes you'll hear this referred to as "implementing multiple layers of defense" or "defense in depth." So, what you need to do now is determine whether your organization's current security scheme provides a sufficient number of layers to reduce the risk of data loss to a tolerable level. The rest of this chapter discusses the considerations you'll want to make during this risk-determination process.

The Process

Where do you start? The most important step is the first one: determining your level of risk tolerance. In other words, how resolved are you, and to what lengths are you willing to go, to prevent the data on your system from being compromised? To help you answer this question, first imagine that someone breaks into your system. What damage could they do? What data would they have access to? What laws might be broken? Whom would you need to notify about the breach: the board of directors, the government, the people whose information was compromised?

What data stored on your system is accessible via the Internet? If the data is sensitive (e.g., credit card numbers), highly confidential (e.g., business data that your competitors or other countries would like to get their hands on), or private (e.g., patient medical records), or if laws or regulations have the potential to be violated, your risk tolerance will be lower than if you don't have this type of data residing on your IBM i.

What is the cost to your business if your system or network is breached—both the cost to your reputation and the cost of recovering from the breach (the forensics that must be performed, immediate reactions required to recover from a breach, legal counsel, and so on)?

Your level of risk tolerance will determine how many layers of defense you need to implement to protect your network, systems, and data. If you were dressing for a cold January day in Rochester, Minnesota, you'd need many layers of clothing—long underwear, thermal socks, turtleneck, wool sweater, flannel-lined pants, down coat, scarf, hat, mittens, and boots—to stay warm. Likewise, the lower your security risk tolerance,

the more layers of defense you need to dress your system and network in to be as safe as possible from outside attack. Your risk-tolerance level feeds directly into your security policy requirements.

Corporate Security Policy

Chapter 2 touched on the fact that you need to update your corporate security policy to take into account your use of Internet technology. The lower your risk tolerance, the more restrictive your security policy will be, and the more layers of protection your systems will require.

To formulate your policy, you need to decide what access will be allowed throughout your network and identify what security technology will be included. Here are some of the topics you may want to address in your policy:

- Where will you deploy firewalls—between your network and the Internet? Within your internal network as well?
- What TCP/IP protocols will be allowed?
- Will you allow unencrypted downloads from or uploads to an external site?
- Does your website require real-time data from systems in your internal network (as is the case with many WebSphere applications that use IBM i as their back-end data store)? If so, how will you implement the connection to your internal network? Must it be an encrypted connection?
- Will you let users remotely connect to your internal network? How will you protect that connection? With a virtual private network (VPN)? Does your policy require two-factor authentication to make this connection?
- Will you let employees access the Internet? Some organizations by default permit no access but grant access to users in roles that require it—for example, to let programmers search for problem resolutions or to let administrators obtain information about new technologies or download patches. Or some organizations block access to certain sites, for example, pornographic or social media websites such as Facebook and Twitter.
- Will you monitor the websites your users visit?
- What does the company want to do if objectionable material is found on users' workstations or if users repeatedly visit inappropriate websites?

- How should employees handle suspected "social engineering" probes? That is, do employees understand what to do with email or telephone calls that solicit personal or confidential corporate information?

After you've determined your level of risk tolerance and updated your security policy, it's time to decide how you're going to implement the policy. The rest of this chapter describes some of the layers of defense you can use to protect your network. You'll need to examine each potential layer and determine whether it makes sense for your organization to deploy it. Understand that there isn't one right answer. Each business must determine for itself what approach will serve its business needs. Not every company will find it practical or necessary to implement every defense layer. You might also discover and want to deploy some layers of defense I don't discuss here. The important thing is that, given your business needs, you and your management feel comfortable with the layers of protection you put in place and are confident that enough layers are in place to mitigate the business risk to your organization's risk-tolerance level.

Internet Service Provider

Your first layer of defense lies with your Internet Service Provider (ISP). When choosing an ISP, one of the first features you'll want to understand is the security benefits of the ISP's service. For example, what will the ISP do for you if your organization comes under a denial-of-service (DoS) attack or if you suspect the organization has been hacked? A cooperative ISP is a must when you're trying to track down a breach or discover where a DoS attack originated. For example, an ISP our company used notified us when our site was coming under a DoS attack. They worked with us and blocked the IP address of the entity launching the attack.

Another question to ask prospective ISPs is what their business continuity plans are. And I encourage you to validate that they are following them. The ISP that we used several years ago claimed to back up its clients' websites, but at some point after signing the contract, the ISP stopped doing that and didn't bother to inform the clients! The ISP subsequently suffered a major hardware failure. Fortunately, we had a backup of our website, but I'm certain that other, less prepared clients lost their entire sites.

Firewalls

Firewall technology has evolved significantly over the years. The functions of very basic firewalls include using Network Address Translation (NAT) to hide your system's TCP/

IP address from the rest of the Internet world (thereby protecting the system's identity) and filtering unwanted incoming and outgoing requests or IP packets. Firewalls can also monitor for attacks and take action if an attack is detected. In addition, some firewalls include VPN capabilities and virus scanners and spam filters to scan incoming email. Where you implement the technology in your network depends on the functions you want, how much network traffic you anticipate, and how many layers of defense you want to employ.

To determine where to implement firewall technology, you must take into consideration your network configuration. Figure 11.1 depicts a network configuration that uses a dedicated IBM i system as a Web server for a company that provides an online catalog. To protect the production system in this scenario, you'd put the firewall between the Web server and the internal network. Note that these systems could be physically separate systems, or they could be separate logical partitions (LPARs) on the same physical piece of hardware. Depending on the number of connections coming back into the internal network, a firewall appliance might be sufficient. Usually, though, you'll need a more traditional hardware firewall. You might also want to use IP packet filtering in either your router or your dedicated IBM i system to block unwanted IP traffic.

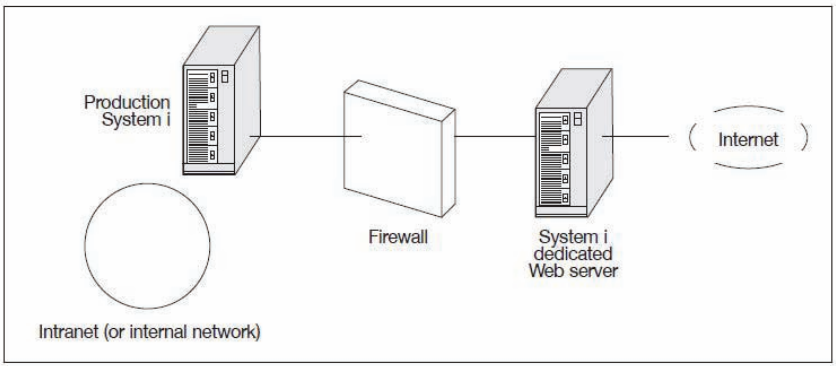

Figure 11.1: Dedicated Web server running IBM i

The configuration depicted in Figure 11.2 provides Internet access as well as production operations from a single IBM i system. I see this configuration becoming more and more prevalent. An enterprise that uses this type of network configuration might have a VPN connection from the production system to suppliers over the Internet. Another configuration might have the production system doing double duty as a Web server.

Although doing Web serving and production work on the same server isn't as secure a configuration as having separate Web server and production systems, I've seen some companies that have made the business decision to use this configuration. In the case of a VPN connection, a router with IP packet filtering might meet your needs in this scenario. However, if your production system also acts as a Web server, you probably want the kind of services, such as proxy or SOCKS servers, that are found in traditional firewalls.

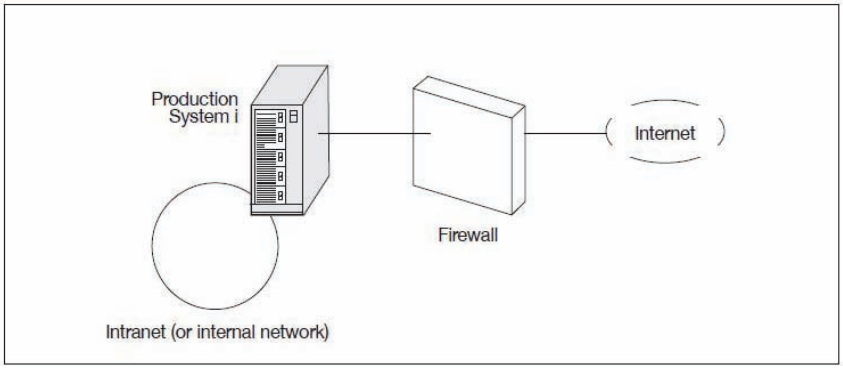

Figure 11.2: Production system running IBM i

Before you buy a firewall, determine which features you really need and decide where to implement the technology. If you need a traditional firewall (a standalone system with firewall software), compare several vendors' firewalls that provide the features you need. Keep one thing in mind: the more functions and capabilities built into the firewall, the more complex it can be to configure. Most firewall breaches occur because of configuration errors, not bugs in the firewall software. Prior to purchasing, consider your process for keeping the firewall up to date. New vulnerabilities are often discovered and must be patched. Make sure that a software patch strategy and hardware maintenance are included in the firewall plan and implementation. If you don't have firewall expertise within your organization, consider hiring a reputable firm that specializes in firewall configuration and maintenance.

System Values

Although a firewall is your primary line of defense when connecting your system to the Internet, a firewall alone won't protect you. Errors in firewall configuration can leave your system vulnerable. And hackers are always looking for new ways to penetrate firewalls or fool them into thinking that an intruder's requests are valid ones. You need to

assume that, at some point, your firewall won't keep out intruders. In other words, your first layer of defense fails. What then? What's your next line of defense?

Setting the IBM i system values to the recommended settings given in Chapter 3 is critical if you are concerned about your IBM i being accessed from the Internet or your network being breached. At the risk of sounding like a broken record, I cannot emphasize enough to you the importance of the system running at security level 40 or 50. You cannot secure a system at the lower security levels.

Note

If your system is directly available on the Internet, QSECURITY must be set to 40 or 50 for the system to be securable.

In today's world, whether or not your IBM i is directly available on the Internet, it's vital that strong passwords are implemented. The stricter your password composition requirements are, the less likely that a hacker or an internal user with intent to do harm will be able to guess a valid password. This is an excellent scenario for implementing passphrases—that is, setting the QPWDLVL (Password Level) system value to 3 to enable passwords that can be up to 128 characters long. Using passphrases makes guessing passwords extremely difficult. Just remember that when you make it hard for a hacker to guess a password, you also make it hard for legitimate users to compose passwords and to remember them once they do. This is an example of making a tradeoff between a more secure implementation and convenience for your users.

Passwords must be changed regularly. Much of the malware that is inserted into a network by a hacker scrapes passwords by examining network traffic. If passwords are never changed, they can be used forever. That's why it's critical that all administrator passwords (for all operating systems) be changed regularly.

In addition to setting the system values as recommended, you'll want to examine the INACTTIMO (Inactivity timeout) attribute for each TCP/IP application and make sure the setting makes sense for your configuration. To set the timeout value, you use the appropriate change command to change the application's attributes. For example, to set INACTTIMO for a File Transfer Protocol (FTP) application, you'd use the CHGFTPA (Change FTP Attributes) command. Note that not all TCP/IP applications support the INACTTIMO parameter. For some applications, a timeout value doesn't make sense; others, such as Telnet, rely on the system value QINACTITV (Inactivity Timeout Interval) setting.

After you've considered the settings of your system values, you need to examine your next line of defense: the users you've defined for the system.

User Profiles

As you learned in Chapter 4, you must have a user profile to sign on to IBM i. To reduce the possibility of someone maliciously reaching your system that's directly connected to the Internet, you want to restrict the number of user profiles on the system. In other words, don't perform a SAVSECDTA (Save Security Data) command on your production system and then do a RSTUSRPRF(*ALL) on your Web server system to restore all user profiles there.

You also want to ensure that the IBM-supplied profiles aren't usable. IBM profiles are well-documented in both IBM and hacker publications and websites. Allowing IBM-supplied profiles to sign on provides a wide-open door for hackers to exploit. Run the ANZDFTPWD (Analyze Default Password) command, and make sure the passwords for QPGMR, QSRV, QSRVBAS, QSYSOPR, and QUSER are set to *NONE.

QSECOFR is another well-published profile. To make it unusable to hackers, create a profile and make QSECOFR its group profile. Then set QSECOFR to a status of *DISABLED. In the event of an emergency, you can always sign on as QSECOFR at the console even when QSECOFR's status is *DISABLED.

For the few remaining user profiles on your system, consider using a cryptic naming convention. Profile names such as ALAN, MARY, MASTER, OPERATOR, and SECOFR are too easily guessed. User profile names can always be guessed, but the more cryptic they are, the longer the guessing will take. Increase the odds that an intruder will run out of time before making a successful guess on your system.

For those of you whose system doubles as a Web server and a production system, make sure you are very timely in removing the profiles of users who leave the company. It's even more critical to quickly delete the profiles when users are dismissed or laid off. To protect all active profiles on your system, you can use the CHGACTSCDE (Change Activation Schedule Entry) command to set the status of these profiles to *DISABLED during hours when you don't expect them to be used.

Resource Security

A vital layer of defense—especially if you are using your production IBM i system for your Web server—is to implement object-level security. Although more organizations are addressing this issue, most organizations I talk to have not. In other words, the access control settings on most objects allow users too much access.

My recommended approach is that of "least privilege" access or "deny by default." In other words, objects—especially files containing private or confidential data — are set to *PUBLIC *EXCLUDE, and only those users with an explicit business need to access the data from outside an application are given direct access to the objects.

By locking down your system, you also prevent hackers from using it to store inappropriate data. Hackers don't always keep stolen data, pornography, illegal copies of software, or hacking tools on their own systems; they often find other systems—including yours, if they can get to it—and store such data there. As you learned in Chapter 10, the term for this illegal activity is *parking*.

Controlling What Goes On

Don't be lax about what happens on your system. If you don't want an intruder to be able to perform some function and you don't need the function for business purposes, don't allow it on the system. The more services and applications available on your system, the more likely it is that an unintentional avenue exists into it. If a tool or application doesn't exist on the system, a hacker can't use it to break in or cause damage.

In addition to the system value recommendations provided in Chapter 3, I advise taking the following steps:

- ✓ Limit the number of administrator profiles (that is, any profile with *ALLOBJ or that is a member of a group with *ALLOBJ.
- ✓ Promptly remove inactive profiles.
- ✓ Set all IBM-supplied profiles to PASSWORD(*NONE) and set QSECOFR to *DISABLED.
- ✓ Implement passphrases.
- ✓ Change passwords regularly.
- ✓ Implement object-level security for any data residing on the system.
- ✓ Consider adding an exit point solution to at least log, but preferably to reject, unwanted accesses through TCP/IP interfaces.
- ✓ Start the TCP/IP servers for only the applications you're running. For example, if you don't use Line Printer Daemon (LPD), don't start it. Or, start the FTP server only when you need to use it; don't leave it on all the time.
- ✓ Only allow encrypted sessions when connecting to or transmitting data off of the system.

- ✓ Follow the directions in Chapter 10 to ensure that you start only the TCP/IP servers you need, and secure the ports used by any TCP/IP applications you don't use.
- ✓ Remove or secure compilers on your system, and secure the program-creation (CRT*xxx*PGM) commands.
- ✓ Turn off IP packet forwarding by specifying N (No) for the **Allow IP datagram forwarding** option when you add or change a configuration profile from the Work with Point-to-Point TCP/IP (WRKTCPPTP) display.
- ✓ Delete any software that is not being used.
- ✓ Remove unneeded libraries and directories.

Secure Web Applications

The Apache Web server shipped with IBM i gives you another layer of Internet defense by providing the following mechanisms:

- Directives within the configuration file that provide access control to Web server resources
- Separation of who can access HTML source and programs doing the work of the Web application
- Secure Sockets Layer (SSL)

The Web server doesn't serve information unless you specifically tell it to. The only Web page you'll see when you first start the Apache Web server is a welcome page. To tell the Web server what information to serve and to whom, you use directives within a configuration file. The Web server by itself can't grab confidential information out of your database files and serve it to the world.

Just as I recommend that you have a separate library for each of your native applications, I advise you to separate your HTML source and RPG or Java programs from other applications that might exist on your Web server. By default, IBM i serves all CGI-BIN programs out of the QTCP library. *Don't* propagate this design. Instead, create a library for each Web application, and put that application's programs there. Set public access for these libraries to *USE or *EXCLUDE to control who can add programs to the libraries. You should also create a separate directory for all your HTML source. Set public access for this directory to *R (the equivalent of *READ).

Separating HTML source and Web programs from other applications is necessary because the directives in the configuration file allow wild cards or generic rules. For example, you can add a directive to let users execute any program in a particular library. When you do that, any program in that library is accessible over the Internet. Another reason not to mix applications is that if you have programs and files with the same name or that both fit a generic directive, you might not be able to predict which program or file the system will serve.

Other directives enable basic authentication. An application that enables basic authentication challenges the requester for a user ID and password when a request comes to the server. For example, when checking the balance of a bank account, customers must enter a name and password to obtain the information. The Apache Web server lets you enable basic authentication in two ways: one way with IBM i users and another way with Internet users.

You can configure your Web application to require requesters to provide a valid IBM i user profile and password before serving any information to them. Although browsers do not transmit passwords in clear text over the connection, the passwords are not encrypted. I don't recommend requiring IBM i user profiles and passwords for authentication unless you're using an encrypted session (preferably TLS 1.2 or later).

Internet users aren't "real" IBM i users because they don't have a corresponding `*USRPRF` object, so an IBM i job can't run as one of these users. As you learned in Chapter 4, you implement Internet users using an object type called a validation list (`*VLDL`). Validation lists associate an entity (typically a user) with authentication information (e.g., a password, account number, digital certificate). You can specify a validation list for your Web application to use to authenticate users. When your application requires basic authentication, the system checks the username and password against the information in the specified validation list. The Web application doesn't have to store or know the actual authentication information because the browser and server handle authentication between themselves.

Another feature of the Web server is the ability to configure Web pages to be served using an encrypted session. When a secure HTTP (HTTPS) request initiates an encrypted session, the browser verifies that it is talking to the server you pointed to. After the browser validates the server, the connection is established, and all subsequent flows are encrypted. Encryption is critical for ensuring privacy and integrity of confidential data over the Internet. All data sent via a unencrypted connection is passed in clear text and is subject to being altered or sniffed (i.e., read from the communications flow). Because

the Internet is a public network, you can't determine how many or which systems your data is routed through. (While sniffing throughout the Internet certainly occurs, it's more likely to occur from malware being inserted into your internal network.) Using encrypted sessions for both external and internal connections protects your data from both external and internal hackers.

Another feature of TLS—and an HTTP server configuration option—is client-side authentication. When you configure client-side authentication, the browser establishes a connection as described previously, and then the server challenges the browser for a digital certificate with which to authenticate the user at the browser. Client-side authentication uses digital certificates. A digital certificate can be associated with either a real IBM i user profile or an Internet user.

Whether you're using basic authentication with IDs and passwords or TLS client-side authentication with digital certificates, if the user you're authenticating is a real IBM i user, you can configure your Web server to run as that user. This is a powerful feature for intranet applications because it lets you use traditional IBM i object security to secure your data.

WebSphere applications present their own challenges—especially when it comes to passwords. WebSphere configuration files often contain the user ID and password used to connect to the database that is serving as the back-end data store. WebSphere does provide a facility to encrypt this password, but it's my experience that this feature is rarely used. The configuration files are in the application configuration directories in the integrated file system (IFS). You'll want to make sure that your programmers use the facilities provided by WebSphere to encrypt these passwords and that you've secured the configuration files appropriately.

If you must be in compliance with Payment Card Industry Data Security Standard (PCI DSS), your Web application must comply with PCI's Web application security standards. Even if your Web application doesn't accept credit cards, I suggest you read these requirements and implement them as appropriate for a more secure application. (For more information about PCI's Web application requirements, go to *https://www.pcisecuritystandards.org*.)

Exit Programs

You can use exit programs to provide another layer of defense. Exit programs are best not for controlling access to objects, but for logging the activity that occurs for IBM i servers such as FTP, Distributed Data Management (DDM), and so on. Some vendors may claim

that a system can be secured solely through the use of exit points, neglecting object-level security, but that is absolutely not true. If you use exit points to control access to objects, use them as another layer of defense on top of, but never as a replacement for, IBM i object-level security.

Monitoring

It's one thing to set up your system for an Internet connection, but it's another thing entirely to maintain the security of that system. To ensure that your security mechanisms remain effective and adequate, you'll want to perform several types of monitoring.

Intrusion Detection

Intrusion detection isn't just one type of monitoring, but three. First, you should analyze your system proactively for known vulnerabilities. Perform a security assessment and make a plan to address the issues identified. It is also critical to keep your software current. New vulnerabilities are being identified in established protocols (witness the vulnerabilities identified in SSL) as well as open source utilities such as OpenSSL. Java is also a vulnerable language, and fixes for IBM i features using Java are released regularly. Make sure you stay current with integrity PTFs, Group PTFs, and all vendor patches.

The second type of intrusion-detection monitoring is active monitoring. In V5R4, IBM added the ability to detect when the system is under attack at the IP stack level. Turning on auditing for intrusion-detection events (by specifying `*ATNEVT` for the auditing-level system value, `QAUDLVL`) and further configuring what is being monitored via Navigator for i will enable you to be alerted when the system is experiencing a DoS attack, for example. You can also monitor the audit journal for other types of events—invalid sign-on attempts by `QSECOFR` or access attempts for secured database files, for example. This can be accomplished either by writing your own monitoring program or purchasing a vendor package that enables real-time alerts. In addition, you can monitor IBM i message queues such as `QSYSMSG` for messages about invalid sign-on attempts. Then, if you use a message-management software package, you can set thresholds and send an alert when, for example, 50 invalid sign-on attempts occur in one minute.

For active monitoring to be successful, it must include a plan of action that you'll follow if you do detect an intrusion. Identifying the fact that your system is being attacked won't do you much good if you don't know what to do about it.

The third type of intrusion-detection monitoring is after-the-fact detection that someone has accessed your system without your permission. Part of this analysis includes

determining what was accessed, changed, or stolen. IBM i provides several ways to log system accesses. The auditing capabilities that are integrated into the operating system (which I cover in Chapter 15) provide good information related to this type of intrusion detection. The Apache Web server also includes access and error logs that are useful in determining who accessed your system.

Typically, the problem isn't an inability to monitor. Rather, many companies that don't audit extensively or don't log Web accesses think that they don't need this type of information and consider such monitoring a waste of system resources. Unfortunately, you can't go back and recreate the audit entries after a break-in has occurred. Which objects and actions you're going to audit are choices you must make based on the needs of your business and your security policy—*before* a break-in occurs.

Security Configuration

Organizations aren't static; they change. And their systems and security needs change with them. You should regularly monitor the status of your security configuration—your user profiles, system values, and object authorities—to be sure they remain valid. You can use IBM i's integrated security tools or a third-party product (such as Policy Minder for i) to detect changes to your security configuration and to keep it current. Regardless of the method you choose for maintaining your configuration, the point is that you do it. I've seen too many systems where the security scheme had "degraded" because no process was in place to ensure it was maintained.

Security Considerations for Outsourcing and the Cloud

Whether you're talking about a new technology or a new concept, you should take advantage of it only if it fits your business needs. Specifically, you must examine both the technology and the technology provider to ensure they can meet your organization's security policy and legal requirements for the type of data.

A lot has been written about security and the cloud, but I've seen little related to security considerations when outsourcing computing resources. In my opinion, the security concerns that you may have, and the factors to consider, are the same whether you're putting your data in (or consuming computer power from) the cloud or moving your data center to an outsourcer. In both cases, you're moving your data out of your direct control and making it someone else's responsibility.

Here are some considerations to keep in mind to make sure the cloud provider or outsourcer meets your organization's data security requirements.

Consideration #1: Will the Legal and Regulatory Requirements Be Met for Your Data?

Many of the considerations involved in using cloud resources or an outsourcer depend on the type of data being stored, manipulated, or shared. For example, are you moving cardholder data? If so, is the cloud provider or outsourcer PCI-compliant? For each type of data you're moving—personally identifiable information (PII), payment card information, healthcare information, or confidential company information, you'll need to ensure that the provider can meet your requirements for the data's confidentiality, privacy, encryption, logging, and access controls. And remember, some privacy laws are state- or country-based. Will moving the location of your data cause regulatory issues?

Consideration #2: What Are the Provider's Security Practices, and Can They Match Your Security Policy Requirements?

Does the cloud provider or outsourcer follow security best practices? For example, is administrator (root) access limited to only those requiring that power? Do administrators access the servers via encrypted sessions? What is the provider's patch (PTF) management strategy? Does it run antivirus and malware-protection software? Are its server configurations in compliance with PCI (or HIPAA or Sarbanes–Oxley or [insert your law or regulation here])? What are the password requirements and composition rules? Can the password rules be set to match your organization's requirements?

Consideration #3: Can the Provider Meet Your Organization's User-Provisioning Requirements?

Most organizations' security policies address the actions that are to be taken should a person's employment with the organization be terminated or someone be made redundant. Within your organization, these actions are typically taken simultaneously with the employment action. You'll want to ask the cloud provider

or outsourcer whether it has a way to quickly identify and shut down the accounts used by former employees to ensure their access can be removed immediately.

Consideration #4: Can Logging Requirements Be Met?

Compliance with many laws and regulations usually requires some level of logging (auditing) to be performed. Your security policy may require the logging of administrator functions, authority failures, reads of healthcare data, failed log-in attempts, and more. Can the cloud provider or outsourcer furnish the level of logging your organization requires?

Consideration #5: What Happens If Your Data or Computing Resources Aren't Available Because of an Outage?

Most outsourcers have this consideration covered. In fact, this very issue may be one of the reasons you're going to an outsourcer—because it has the technology to provide 24 × 7 computing resources. But, obviously, this is something you'll want to talk about to understand the provider's exact method of providing you with backup systems.

If you're using spreadsheets or other collaborative tools in the cloud, or if you've moved your sales information into a cloud application, what will happen to your organization if an application or data stored in the cloud isn't available because the servicer experiences an outage?

Consideration #6: Can the Provider Satisfy Your Data-Retention Policies?

Different types of data typically require different retention policies. Make sure the provider can meet those requirements. Also, verify that the provider will be able to restore the data in the time frame you need if data has to be recalled and restored.

Consideration #7: What If the Provider Comes Under Attack?

This consideration is probably more meaningful when you're evaluating using the cloud. What happens if the cloud provider becomes the center of a targeted hacking

attack or DoS attack? Does it have the technology and knowledge to prevent and fend off these types of attacks? What happens if your data is compromised as the result of the provider being hacked? Who is liable?

Consideration #8: What Happens to Your Data If the Provider Goes Out of Business?

A provider may go out of business for a variety of reasons; what happens to your data if this occurs to your provider? If the provider's equipment is sold, is your data deleted beforehand? And what happens to backups of the data?

Consideration #9: What Happens If You Decide to Change Providers or Move Your Data Out of the Cloud?

Does the contract provide the capability for you to easily "take back" your data and get it removed from all the provider's servers?

Choosing to use cloud technology or an outsourcer is truly a business decision. I hope these considerations will help you make the right choice from a security perspective.

Testing and Evaluation

Test, test, and retest! Certainly you should test your network configuration for holes before you go live with your Internet connection. But testing and evaluation is even more important after the Web application has been in place for a while. As proof of this point, PCI requires regular vulnerability scans for Web application and wireless networks as well as penetration testing for your network and any server directly involved with PCI data or transactions. PCI as well as the Health Insurance Portability and Accountability Act (HIPAA) and other laws and regulations require an annual vulnerability assessment of your system. Why? Because things change. You acquire a company and systems are merged. You implement a new enterprise resource planning application. You upgrade to the latest version of the operating system. All these events can cause vulnerabilities to appear. Unless you test and evaluate, these vulnerabilities will most likely go undetected and could be exploited.

Business Contingency Plan

Last, but certainly not least, are the changes you need to make to your business contingency plan. Here are some of the areas to consider:

- Does your backup or hot site have Internet access and the hardware needed to run your Web application? Does it have the bandwidth you require to support your critical business needs? Does it have the necessary encryption hardware or certificates needed to provide encrypted sessions?
- Do you have an alternative route to your ISP or an alternative ISP if your current ISP's connection is severed?
- In the event that you suspect or are informed that you've suffered a breach, do you have an incident response plan in place? For an in-depth discussion of creating an incident response plan, see Chapter 18.

Be Careful Out There

Risk is part of life, and it is also part of doing business. It's impossible to do business today without your network being connected to the Internet. However, IBM i is robust and provides many layers of defense for you to implement. As we've discussed in in this chapter, the secret to doing business safely in this highly vulnerable, networked world is to analyze your risks thoughtfully and then mitigate them by putting in place as many layers of defense as your business requirements dictate.

CHAPTER 12

Evaluating Applications' Current Implementations and Designing New Ones

We're now to the point of being able to put together all the topics we've talked about in earlier chapters: system value settings, user profile attributes, and object authorities. Separately, these might be interesting topics, but they aren't very useful in the practical sense. That's because they all must work together and be in balance to achieve the appropriate level of security that your organization requires and a level that supports and complies with the organization's security policy. Also, you don't purchase an IBM i system to look at file permissions, system values, or user profile attributes. You purchase the system to store data, run applications, and work with the data. So, it's time we take a look at how your applications have incorporated security and whether their authorization scheme complies with the requirements of your organization's security policy.

It's important to understand each application's authorization scheme—that is, to know how users obtain authority to run the application and access its objects. It's also important to understand how securely the application has been implemented—in IBM i terms, what is the *PUBLIC authority setting on the libraries, directories, and files? Unfortunately, most vendors don't implement their applications securely. Many leave their application

objects at the default *PUBLIC authority of *CHANGE. The result is often that confidential or private data is available to anyone who has a user profile.

It's easiest to describe the principles of an application's security methods in the context of implementing an application the "right way." Even if you're not actually writing a new application, this explanation should help you understand what you need to look for in your existing applications to determine whether there are issues with the implementation of their security scheme.

From the Beginning

The right way to design an application recognizes that the security of the data, as well as secure coding practices, is one of the critical architecture design points. With this approach, data security is considered and evaluated at implementation as well as throughout the various testing phases. Security should be addressed at every phase of application development by default. Although it is becoming more prevalent, this is not a widespread practice. Often, entire applications pass through design, implementation, and testing with no regard for security. Then, at some point, someone discovers huge holes in the application's security scheme that must be fixed.

Those of you who've found yourselves in this situation know that it's very difficult to retrofit security into an application. Successful design and implementation of security methods within an application require thinking about security throughout the application development cycle. Beginning with the requirements phase and proceeding through design, implementation, and test, you need to ask—and answer—certain questions to be sure you're covering all the bases. Such questions include the following:

- Who needs to use the application?
- Do you need to allow the capability to define users within the application?
- Do you need to provide the ability to define roles within the application?
- How will you authenticate those users?
- Do the users or processes need access to the application data from outside the logic of the application—such as downloading to a spreadsheet or via a secure connection (SFTP) to an outside entity?
- What is the classification of the application data? Internal use only? Confidential?

- Does the application contain data whose security requirements come from a law or regulation—such as personally identifiable information (PII), cardholder data, or healthcare data? If so, make sure those requirements are well understood.
- What exposures exist in the chosen application runtime environment?
- How will the security architecture of the application be verified, both at initial deployment and over the application's lifetime?

Addressing these questions across the duration of an application project will keep security in its rightful place as an essential design element.

Design Considerations

Security needs to be considered at the very beginning of an application's design: the requirements phase. To do this, make sure that at least one point in your list of requirements talks about security. For example, say you're writing an application to take customer orders over the Web. Among its requirements, your application might have the following:

- Retention and processing of cardholder data will be in compliance with PCI DSS requirements.
- Only the appropriate information will be retained.
- Information will be retained only for the life of transaction processing.
- Cardholder data will be encrypted at all phases, including storage in the database.
- Back-end data store systems (systems on which orders and status information are actually stored) can't be accessed directly from the Internet.
- Only authorized users can place orders, and orders must record each user who works on them.
- User authentication is always required and should time out after a short period of inactivity.

It's critical that the type of data (e.g., private, confidential) be identified in the application's initial design. That's so the design can be sure to include all the requirements of the laws and regulations for which this type of data must comply. Next,

make security part of your application design template. This is what IBM has done for years to make security so robust in IBM i and its predecessors. Every IBM i team leader must address a set of security design points each time an enhancement or change is made to the operating system code that the team leader owns.

Here are some of the questions you should include in your application design template:

- Who (what roles) will use the application?
- What authorization scheme will be used?
- Which user profile owns the application?
- Under what profile(s) does the application run?
- Does the application need to adopt or swap to a "powerful" profile and, if so, for what functions?
- What kind of audit trail does the application require?

By forcing the application's designer to answer these questions, you can force a discussion of the security design at a design review and ensure that the design meets requirements. You should also provide documentation that shows the security choices and tradeoffs made.

The following sections expand on some of these design questions.

What Roles Will Use the Application?

It's surprising how often designers overlook this critical question. After all, the type of application user will influence everything from your authentication model to how security limits an end user's activities. For example, an application intended for use by an order entry clerk likely won't require complex authentication, such as a digital certificate, and probably will restrict the user from entering system commands directly. On the other hand, an application to be used by a security officer may well have multiple levels of authentication and typically gives the user the ability to run commands.

Different roles will have different security requirements, depending on the data classification. A hotel reservations clerk likely won't need to have access to proprietary enterprise financial data. However, a manager in the same organization may need such access occasionally. In this case, the application would need to be able to accommodate

multiple roles to control which role could perform which functions. It would also need to accommodate appropriate audit trails.

So take time to carefully consider what roles will be using your application. Determine from the outset what their various access methods will be (e.g., FTP, ODBC, 5250 emulation, browser, mobile device app), and develop appropriate security policies that the application can support. Perhaps the most important aspect of any security design is how your application will enforce your organization's security policy.

Common Authorization Schemes

After working with clients and talking with many of you at conferences, I've determined that there are three basic authorization schemes that user-written and vendor-written applications typically use. Some applications use more than one of these schemes, and I've seen some applications require all three! By authorization scheme, I mean the method used to ensure that users of the application have sufficient authority to perform the tasks within the application.

While some authorization schemes are quite secure, they are, unfortunately, not what is implemented in most IBM i organizations. I'm going to first discuss the typical authorization schemes and why they are problematic; then I'll discuss the schemes that are secure.

Menu Access Control

Menu access control is the way most end users see the system. It's typically a "green-screen" application that, when the user first signs on to the system, launches the user directly into the initial menu of the application. This is the "front end" for most of the authorization schemes I'll discuss. Menu access control assumes that security is achieved simply by presenting to each user only menus that provide the functions that the user needs to perform his or her job. Users can access anything on their set of menus and can access the objects and data associated with those menu options.

To ensure that application users have sufficient authority to perform their job functions, one of the three authorization schemes described next must be implemented for menu access control. That is, most application writers require that the application objects' *PUBLIC authority is left wide open (typically either *CHANGE or *ALL), that the application users are members of the profile that owns the application, or that the users have *ALLOBJ special authority. Figure 12.1 depicts the menu access control model.

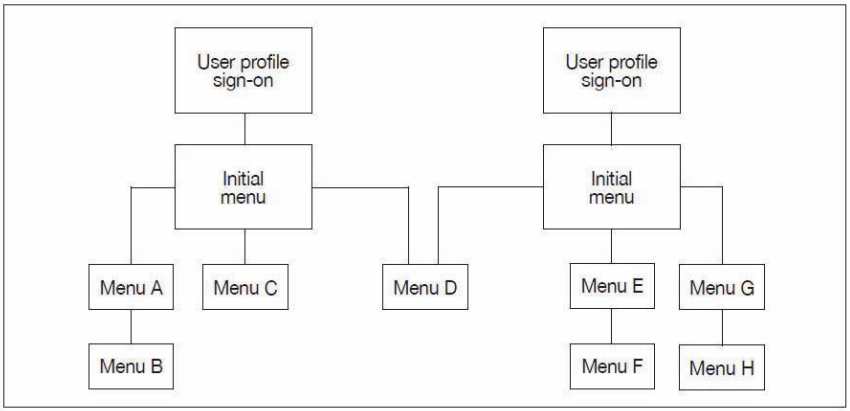

Figure 12.1: Menu access control model

To implement menu access control for an application using a 5250 emulation, each user's initial menu is the "entry point" into the application. You design the initial menu for each user individually using the INLPGM (Initial program) or INLMNU (Initial menu) parameter of the user profile or, in the case of some packaged software applications or browser-based applications, by means of initial user data entered and maintained by your organization's employees. In addition, application users are configured in their user profiles as limited-capability users (LMTCPB(*YES)), so that they can enter only a handful of commands if presented with a command line. The menu authorization model is the method of choice for many software vendors simply because it's the least complex for both them and their customers to implement.

I'm not trying to imply that you should get rid of your application's menu structure. Menus are a logical way to provide access to software applications. Because you don't want end users entering commands from a command line, you provide menus that logically group end-user functions. Whether the menu is a pull-down, pop-up, or plain full-screen menu, end users are much more productive when they can select tasks from a list than when they must memorize cryptic commands or program names. Also, by logically grouping the tasks users can perform, menus secure the system by restricting users to the tasks on the menus.

Now, let's take a look at the most popular authorization schemes that implement the access controls for users' menus.

**PUBLIC Authority*

In the *PUBLIC authority model, application objects' *PUBLIC authority is set so as to allow all application tasks. This translates into a setting of either *CHANGE or the one I see most, which is *ALL.

The problem with this scheme should be obvious. Literally any user on the system with access to a command line, such as operators, database administrators, programmers, and the handful of application users who might be allowed command-line access, can change application data from outside the protection of the application. Why do I say the "protection" of the application? Because most applications have logic built into them that prevents certain users from updating certain database fields. Or there may be application logic that lets fields be updated only within a certain range (e.g., a price field), and anything outside that range must be done by a supervisor. But in the case of wide-open *PUBLIC authority, the access is provided to literally every profile on the system, and every profile has the capability to at least update and possibly change any application object. And as I'll discuss in a bit, many ways are available to access data on IBM i beyond an application menu.

Group Authority

In the group authority model, one group profile owns the application. Users who want to use the application must be members of this group. Each group member also owns any object that the group profile owns.

The problem with this scheme is that ownership of objects is passed from the group to all users. In other words, if a group profile owns an object, every member of the group also owns the object. So when application users are required to be a member of the group that owns the application, every application user owns each application object—including all database files. That means that their access to these objects—including any sensitive or private data—is *ALL. Therefore, if users can get to the data from outside the application, they can replace programs with their own versions, read the data, update the data, or perhaps even delete the entire file.

**ALLOBJ*

In the *ALLOBJ authority scheme, application users are required to be assigned *ALLOBJ special authority in their user profiles.

The dangers of this scheme should be obvious. *ALLOBJ should be assigned only to the administrator role—never to end users. Users with *ALLOBJ can access every object on the system—in both libraries and directories.

Excuses and Justifications

I hear many excuses from administrators for why these schemes do not present an exposure to their organization. One popular excuse is that their users have been configured as limited capability users (LMTCPB(*YES)), so the users don't have access to a command line; therefore, they can't access application data except through the menu options they're allowed to take. Anyone who still actually believes this statement truly has their head in the sand. IBM i has become so open and supports so many protocols that there are numerous ways for users to directly access application objects—including via Distributed Data Management (DDM), File Transfer Protocol (FTP), Java Database Connectivity (JDBC), Open Database Connectivity (ODBC), Web applications, sockets, and IBM i Access data transfer, to name a few.

Another excuse is, "Our users don't know how to access the data from outside of the application." Really? Have you heard of Google or Bing or any other search engine? I'm guessing that most of you discover how to implement new technology from researching the topic on the Internet. If you think this type of research is limited to IT users, you are sadly mistaken. Employees under the age of 40 have grown up with computers and know how to find information. Also, if you have any employees who were once in IT and are now working in the business side of the organization, those employees definitely know that data is accessible using interfaces other than the application menus.

The bottom line is this: leaving application users as members of the group profile that owns the application, allowing *ALLOBJ special authority, or leaving application objects with a *PUBLIC authority setting of *CHANGE or *ALL poses a significant risk to the application data.

A justification I hear from administrators for not doing anything about wide-open application schemes is that they have an exit point solution in place. While exit points provide a great secondary line of defense, even a fully implemented exit point solution does not protect against inappropriate access from a command line or Web applications or sockets (until V7R2), so some exposures to your application data may still exist. But the sad truth is this: most organizations that have purchased an exit point solution do not have it fully implemented. If anything, the logging provided by the solution has been implemented. But rarely are rules in place to prevent access. So if you're going to

justify not taking action on a wide-open security scheme because you have an exit point solution, rules must be in place to prevent access. Otherwise, you're not being truthful to yourself ... or your management.

Authorization Schemes That Are Secure

Now that I've blown apart most of the IBM i application security schemes (!), let's take a look at a couple of schemes that provide for a secure implementation.

Application-only Access

One approach is to have a single profile own the application. This profile is authorized to access the data files associated with the application. Public access to the application objects is *EXCLUDE. Users are authorized to the initial menu or to run the command that invokes the application. Because the application uses adopted authority, end users can access the application data, but only through the application and not using other outside accesses such as DDM, FTP, ODBC, and so on. This model is very secure, but in today's world it is not very practical. I haven't seen a system in many years that is not accessed using one of these outside access methods. Fundamentally, though, this is a good approach, so let's look at some variations that provide more flexibility.

Application-only Access with a Twist

This is the approach that I typically use when we help our clients to rework their applications' security schemes. We use adopted authority so that the application users will have sufficient authority to run all parts of the application. But we accommodate the fact that there are users and processes that need to read, and sometimes update, some application database files. To accommodate this access, we secure all physical and logical files with an authorization list. Users and processes that need access are given authority to the authorization list. They are granted *USE authority if they need only to read the data and *CHANGE authority if the need is to update.

This is just the very high-level description of how this authorization scheme works and is implemented. I've developed a specific methodology that I use to take an application from using one of the three authorization schemes previously described to an authorization scheme in which the *PUBLIC access is set appropriately for the organization's security policy, approved users and processes can access the application data from outside the application, and application users have sufficient authority to run their application menu options. I'll describe this methodology in detail in later chapters.

Changing the Process

If you're accessing objects in the integrated file system (IFS), such as stream files or Hypertext Markup Language (HTML), adopted authority won't work because the IFS doesn't honor adopted authority. Your options in that case are to authorize the end user to the IFS objects or to change the process or thread so it runs as a different user—one with the authority to access the IFS object—when accessing these objects. To change the process to run as a different user, you have several choices: profile swap, profile token, and the UID and GID APIs. Let's take a brief look at each of these options.

Profile-swap APIs have been around for quite a while. These are the APIs that the IBM i servers (e.g., FTP, Telnet) use to get a job to run as the requesting user profile rather than the user profile under which the server was started. When a process's profile is swapped, all security attributes are swapped in, including the new user's special authorities, limited-capability attribute, group profile(s), and audit settings. The "swapped to" user owns any new objects created. Use of the profile handle that's generated before the profile is actually swapped is limited to the process that generated the handle.

Profile-token APIs have the same effect as the profile swap APIs, but they generate a token that can be passed between jobs. APIs can generate tokens as one-time use, multi-use, or multi-use regenerable types. These tokens time out and become invalid after a specified time.

The *UID and GID APIs* were added to aid in the porting of UNIX applications running in the Portable Application Solutions Environment (PASE). The native IBM i versions—qsyseteuid(), qsysetegid(), and so on—give IBM i application developers a different option for an application's authorization model. Unlike what happens with the profile swap or profile token APIs, the UID and GID APIs swap in only a user profile (in the case of the UID APIs) or a group profile (in the case of the GID APIs). The UID is a numeric representation of the user rather than the user profile name. The GID is the numeric representation of a group profile.

How do these options help the application designer? Now, when a user accesses an application, part of the application startup can set the GID to the application owner. The application-owning profile is now the user's first group. The beauty of this solution is that the application owner becomes the end user's group for *that thread only*. The user's profile is never updated—just the thread. Before these APIs were introduced (in V4R5), the only way you could implement a similar model was to make a change to the user's group profile attribute in the user's profile (using the CHGUSRPRF, or Change User Profile,

command, for example) and then use the swap APIs to swap to the same user to make the new group profile take effect in the current thread.

The problem with this old method is that if a user can start another process, the application profile is the user's first group profile in the new process, which lets the user access all the application objects with owner rights. This situation poses risks similar to those experienced when the user is directly defined as a member of the application owner's profile. You eliminate these risks when you use the GID APIs. Because the user's profile is never updated, starting a new job is done using the user's group profile list as defined in its profile, and it will not include the group profile specified in the GID API. Of all the profile-swap options, this method is my favorite because, like adopted authority, it provides temporary authority to application objects and, unlike adopted authority, it provides temporary authority to IFS objects—not just "traditional" IBM i objects.

Application Ownership

Getting back to the issues you need to address during the design phase, we turn now to the ownership of applications. Many IBM i administrators are livid when they discover third-party applications owned by IBM-supplied profiles, such as QPGMR and QSYSOPR. Especially irritating is when the application is owned by QSECOFR. If you're creating your own application, *do not* make one of these profiles the owner. Create a specific profile whose sole purpose is to act as the owner of the application. Create this profile with the following attributes:

- PASSWORD(*NONE)—You don't want people signing on using this profile.
- SPCAUT(*NONE)—Assign special authorities only if the application needs them to run its tasks.
- STATUS(*DISABLED)
- INLPGM(*NONE)
- INLMNU(*SIGNOFF)
- PWDEXPITV(*SYSVAL)—Some administrators set this attribute to *NOMAX, but that's not necessary.
- LMTCPB(*YES)

Which Profile Runs the Application, and Is There Adequate Logging?

This may seem like a strange question when designing a traditional IBM i application because the user running the application always signs on to the system. But the issue becomes important when you consider Web and client/server applications.

If you're writing a Web application, you may want all the requests to run as an application profile rather than requiring the thousands of users logging on to your website to have valid IBM i user profiles. In this case, you can use validation lists as a secure way to store user identification and authentication information. Then the Web application's protection directives name an application profile under which the application will run.

In the case of client/server or WebSphere applications, most requests are, again, run as one profile. The problem with this model is that because all requests are run under the same IBM i user profile, the audit entries as well as all journal entries (if you're journaling the application files) are logged as this profile. Therefore, auditing these applications from the IBM i perspective is difficult. That is, it's very difficult to determine which user actually made a specific transaction. In this case, make sure sufficient logging occurs on the client side of the application to ensure you have an adequate audit trail of who performed each transaction and when.

Does the Application Require a "Powerful" Profile?

The authorization methods I've described suggest that developers create an application profile with little or no special authorities. But what happens when an application needs to use an IBM i function that requires, for example, *IOSYSCFG or *ALLOBJ special authority? In these cases, you must swap to or adopt a powerful profile. If you're using adopted authority, the best way to do this is to create a program that is owned by a profile that has the required special authorities, performs only those actions that require the extra authority, and then immediately returns. If you're swapping profiles, obtain the profile handle, perform the swap, perform the required functions, swap back to the original user, and release the profile handles so they can't be used again. Also, make sure the swap back is part of the program's error-handling routine. (If the program ends abnormally, you want to make sure that the process returns to run as the original user, not the swapped-to user.)

This requirement often arises when creating "utilities" for operators or help desk personnel. Operators may need to be able to specify a parameter on one of the restore commands that requires *ALLOBJ special authority. A short CL program that adopts an

*ALLOBJ profile lets them perform this type of function without having to have *ALLOBJ assigned to their profile. Or help desk personnel may need to re-enable user profiles. In this case, you can create a program that is owned by a profile with *ALLOBJ and *SECADM special authorities and runs the CHGUSRPRF (Change User Profile) command with only the STATUS field available. When calling the program, the help desk personnel can reset the profile, but the capabilities have not been assigned to their profiles.

What Kind of Audit Trail Does the Application Require?

Audit trails are often an afterthought in application design. IBM i includes a broad set of auditing features. However, depending on the application you're writing, it might be advantageous to supplement the operating system auditing with audit entries of your own. You can configure IBM i to send an audit entry whenever a file is updated or changed, but the audit entry may not provide all the information you need, or it may not be specific enough for your particular application.

For example, you can configure IBM i to send an audit entry logging the activity if Linda downloads the entire human resources (HR) file. The audit entry will tell you the name of the file and the fact that Linda read it. It will also list the day and time when she read it. If Linda updates the field in the HR file containing Social Security numbers, the audit entry will give you the same information, noting that the file was changed (rather than read). But it won't tell you *what* changed.

Government regulations may require you to make a record of everyone who reads a particular field of a file or to maintain separate records of a field's original contents and its subsequently changed contents. For example, if John runs a query against a file of patient information, reading all fields except the one containing medical test results, no record is necessary. However, the moment he either changes or reads the field that contains the test results, a record of that fact must be logged. The system administrator running the application can enable this capability under IBM i by enabling journaling on the database file or by using a trigger program, but it's much easier for system administrators if this type of function is built into the application in the first place.

To meet the record-keeping requirements for most regulations, the record must identify the person causing the event and must include an accurate timestamp of the event. To have a record stand up to legal scrutiny, you must be able to show that the audit records couldn't be altered. The easiest way to do that under IBM i is to use the operating system's journaling features. If you send a journal entry with your application information, even a security officer can't alter that information. IBM i handles the

timestamp and user identification. All you need to do is provide entry-specific data—that is, data that makes sense according to the application data being updated or read.

Implementation Details

Next, let's look at some specific IBM i implementation details that will help ensure a secure implementation of your application. These recommendations can also serve as a good checklist when you're evaluating vendor application implementations.

Set IBM i Authorities

What authority is required to run your application? Use Appendix D of the *IBM i Security Reference* manual (available under **Security** > **Security reference** > **PDF file for Security reference** in the Information Center) as your guide. This appendix lists all IBM i commands and the authorities required to run each one. If your application resembles some IBM i function, check this appendix to find the authority requirement, and then require the same authority for your application.

It's easy to write your applications to demand too much authority. For example, as I've noted, some popular vendor applications require all users to have *ALLOBJ special authority. But unless your application is targeted exclusively at your system administrator, requiring *ALLOBJ is not appropriate. Similarly, some vendor applications require you to sign on with the QSECOFR profile; this is an especially popular requirement for product installation. But no application should require this profile's use unless the application performs a function for which IBM i requires QSECOFR as the process profile. I can think of only a couple functions that make this a requirement: resetting the security officer password for the Dedicated Service Tools (DST) and instructions that must run with UID 0. (QSECOFR is the only profile that has UID 0.)

The questionnaire on pages 297–298 will help you assess the security impact of a third-party application. Have the vendor answer these questions before you make any new software selection.

*Define *PUBLIC Authority*

Application security used to be so easy. As long as you confined users to a menu and never let them access a command line, you had all the security you needed. But, as I discussed earlier, the fact that you can access application data from command lines and using other access methods (e.g., FTP, ODBC) means you must use an appropriate *PUBLIC authority setting for your application objects. The *PUBLIC authority setting

Security Questionnaire for Vendors

1. Is a special profile required to install the application? [*QSECOFR should not be required for installation.*]
2. What special authorities are required:
   a. to install the application?
   b. to run the application?
3. Does the application modify or require modification of system values:
   a. to install the application?
   b. to run the application?
4. Does the application create a profile (or profiles) at installation time? If so:
   a. What is the profile name?
   b. Is the profile created with special authorities? If so, please justify the need for each special authority.
5. Does the application have any programs that adopt a powerful profile such as QSECOFR? If yes, describe what they do.
6. Does the profile need a password, or can the password parameter be set to *NONE? If a password is needed, are there special considerations when changing it? [*Some auditors require you to change application profile passwords on the same schedule as your user profiles. You may need this information to change the password from a default password, so that you know how to change it regularly.*]
7. Is System Service Tools (SST) or Dedicated System Tools (DST) used or required to install, configure, or manage the application? If so, why? [*The answer should be No.*]
8. Does the application register any exit programs? If yes, what do they do?

9. Does the application run at security levels 40 and 50? If not, why not?
10. How do you ensure that your application contains no Trojan horses, viruses, or backdoors? [*You're looking for an explanation of the vendor's development process. A sound process will involve code reviews, strict use of change control, virus scanning of computers creating product executables, and so on.*]
11. What security scheme does your application follow? [*You're looking for a method of authorizing the user to run the application without requiring the user to be a member of the owning profile or have* *ALLOBJ *authority.*]
12. What is the *PUBLIC authority of the application's:
    a. programs? [*should be* *USE]
    b. data files? [*should be* *USE *or* *EXCLUDE *if the files contain sensitive information*]
    c. libraries? [*should be no more than* *USE]
    d. directories? [*should be no more than* *RX]
    e. all other application objects? [*should be no more than* *USE]
13. Does the application provide data encryption? If so, what algorithm is used, and how is the encryption key managed?
14. Does the application require that users authenticate to the application (in addition to or instead of authenticating to IBM i)? If so, does it provide a method for changing the password and define a method for defining password composition rules?
15. If this is a client/server or Web application, is the connection to the IBM i encrypted, or can it be configured as a secure connection? That is, does it use SFTP to transfer files or run over TLS 1.2 or higher to establish a connection?
16. Do you have references who can be called?

is dictated by the classification of the data and your organization's security policy. Although you may think that *PUBLIC authority must always be set to *EXCLUDE, that's not always the case. Yes, it will be the case for human resources data, cardholder details, and healthcare information. But, depending on the organization's security policy, there are times when I've seen all other data on a system be set to *PUBLIC *USE. These organizations made sure that they had data integrity—that is, that the data could be changed only through the protection of the application logic—but all users of the system could view the data.

Secure Job Descriptions

Even though we'd all like to believe otherwise, there are still systems running at security levels 20 and 30. For this reason, application providers should secure any job descriptions shipped with their products; in other words, set *PUBLIC to *EXCLUDE. At security levels 20 and 30, you don't have to specify authority for a user profile in a job description to use the job description. So, if you create a job description that names your security administrator's user profile, any user could use that job description and exploit your security administrator's user profile. By creating job descriptions with *PUBLIC(EXCLUDE), you can prevent such exploitation.

At security levels 40 and 50, you can't use a job description that names a user profile unless you have authority to the profile.

Manage Your Library List

If your application adds a library to a library list, make sure you remove the library from the list when the application ends or abends. Once a library is added to a library list, the system doesn't check a user's authority to the library when the user (or a program the user is running) specifies *LIBL/*object_name* to access an object or call another program. This means that a user who runs the application retains authority to the library—even when the application isn't running.

Make Library-Qualified Calls

To ensure that your application calls the correct program or accesses the correct object, use library-qualified calls. If you make non–library-qualified calls, such as CALL *LIBL/PROGRAM_1, and someone inserts another program named PROGRAM_1 into a library higher in the library list than your application library, your application calls the first PROGRAM_1. This is one way for an intruder to insert a Trojan horse or another impostor

program to perform devious deeds. Making non–library-qualified calls is especially dangerous when your application adopts authority because an impostor program could exploit the adopted authority.

I know that making library-qualified calls is a controversial recommendation. Hard-coding library names in programs can be very limiting, especially when you're testing multiple language versions or releases of an application on the same system. To enable this type of testing, you can write your application to read the name of the library from a data area and then set the library variable to that value before making any calls. You'll also want to secure the data area (i.e., set public authority to *EXCLUDE) in the production version of the application. This way, when testing, the developer or tester can update the data area with the name of the library that contains the version of the application being tested.

Don't Store Passwords in Clear Text

Some applications require users to authenticate themselves to the application. Rather than storing the authentication information (typically a password) in clear text in a database file or in a configuration file in the IFS, as some applications do (!), you should use a validation list to store this information. For each application user, a validation list contains a user identifier (e.g., a user name) and authentication information (e.g., a password). You can use the validation list APIs to encrypt and verify passwords. IBM documents these APIs in the **Programming** > **Application programming interfaces** > **APIs by category** > **Security APIs** section of the Information Center. When storing passwords, make sure you provide a way for users to easily change their passwords. Also, make sure you provide the ability to impose password composition rules. To ignore either of these features may cause the organization to be out of compliance.

Testing, Testing

Now that I've addressed the design template questions and some implementation details, let's examine the final phase of the application development process: testing. Testing is usually necessary at several points in the development cycle, and you should consider security at every test point. This principle is especially true during the final test phase, which I call the *system test*. The system test is where it all comes together. Not only do you make sure the application works functionally, but you also verify that it meets security requirements.

Remember the requirements for the order-entry Web application—credit cards can't be compromised, and legacy systems can't be accessed from the Internet? System-test time is when you verify that the application meets such requirements. Some developers refer to this stage as "trying to hack the application." Whatever you call it, your test plans should include predefined test cases that specifically address your application's security requirements.

Last, be sure you test with the same authorities that will be given to actual application users. It does no good to test an application while the tester is signed on with a profile that has *ALLOBJ authority. Doing so only masks security issues and lets problems slip through to the user community. Ultimately, it creates a need for difficult and expensive debugging to fix security holes.

Moving Forward

I've introduced a lot of issues in this chapter, and you may have recognized that the applications on your systems have the "wrong" authorization scheme and the application data is exposed. You may be thinking, "Now what?" Keep reading. The next chapters will guide you through the process of redefining and implementing a new application security scheme so that it complies with your organization's security policy requirements.

CHAPTER 13

Role-Based Access

Several laws, regulations, and standards—ISO 27001, HIPAA, the Gramm-Leach-Bliley Act (GLBA), and PCI DSS—all have specific requirements when it comes to user access. The fundamental requirement is to grant users access to only the exact applications and capabilities needed to perform their job tasks—and no more. To do so is to implement the concept of *least-privilege access*.

While many organizations have taken the time to go through their applications and make sure users have access to only the menu options they need to perform their job functions, it's rare to see this principle extended to the user profile attributes and authorizations to application objects. Yet that is what implementing least-privilege access demands.

How do you implement least-privilege access in the IBM i world? Let's take a look.

Roles

The easiest way to set up least-privilege access is to break down your user community into roles. In the security world, this approach is called *role-based access*, or RBAC. The premise of role-based access is that users are given capabilities and access to applications or system resources based on their job function, or "role." Separating role authorizations also enforces the separation of duties among roles, something that's important for companies that must comply with the U.S. Sarbanes-Oxley Act (SOX).

The type and number of applications you have will determine how many roles you have. As an example, consider an organization with the following roles: accounts payable clerk, accounts receivable clerk, finance manager, HR manager, and HR staff. Each role has a set of tasks its users are expected to perform. Therefore, access to specific application functions or to specific database files is permitted or denied based on the role in which a user has been defined.

Defining the Roles

To implement RBAC and the concept of least-privilege access, you must first define what roles are required. Common sense will dictate how many roles to define. Too few, and you'll end up giving users more authority or access than they need to perform their job function; too many, and management of the roles becomes unwieldy.

The next step is to list the tasks that the roles perform. You might want to use a spreadsheet to keep the list organized. Table 13.1 shows an example.

Table 13.1: Sample roles and tasks

Role	Tasks
HR Staff	Accepts job applications, performs initial job interviews
HR Manager	Assists management with HR issues, oversees payroll operations
Finance Manager	Oversees all accounting functions, approves new accounts, approves check requests
AP Clerk	Processes invoices, submits check requests
AR Clerk	Generates invoices
Internal Audit	Audits system configurations, reviews compliance reports
Accounting Download	Downloads specific files within the accounting application to a spreadsheet for further processing

Notice that I've listed only the roles and the tasks they perform. I haven't yet identified which authorities are required—either within the application or for the IBM i user profiles. That's because you need to gain agreement about what tasks each role is supposed to perform. Don't be surprised if this step is a bit controversial. Different people may have different ideas about what tasks a particular role should perform.

After obtaining agreement about the tasks associated with each role, you can start listing the capabilities, application menu options, and specific authorities required for each role. In addition, you'll want to note any functions within IBM i Access for Windows or IBM i Access for Web that each role should be able to perform. Last, if a role is to have explicit authority to download or upload a specific file, list this fact as well.

For every role, document its purpose, capability (special authorities), and access requirements, as shown in Table 13.2.

Table 13.2: Sample roles, special authorities, and access requirements

Role	Description	Special Authorities	Access Requirements
HR Staff	HR staff role	None	All HR application options except Payroll and Master
HR Manager	HR manager role	None	All HR application options
Finance Manager	Finance manager role	None	All accounting application options
AP Clerk	AP clerk role	None	All accounts payable options in the accounting application
AR Clerk	AR clerk role	None	All accounts receivable options in the accounting application
Internal Audit	Internal audit role	*AUDIT	Access to the WRKSYSVAL command, *RX authority to the /SkyView/Policy Minder directory to review compliance reports
Accounting Download	Users who need to download accounting data	None	*USE authority to the ACCTG authorization list securing the accounting files

Group Profiles

For IBM i, roles are implemented most easily through the use of group profiles. You create a group for each role and assign the group the special authorities required to perform the role's tasks. In addition, the group (role) is granted any private authorities required to application objects such as menus, files, authorization lists, commands, and so forth.

Here are a few tips to keep in mind when creating group profiles:

- ✓ When creating a group profile on IBM i, create the profile without a password (set the password parameter to *NONE) so the profile cannot be used for sign-on. Group profiles are supposed to represent a role, not an individual.
- ✓ To prevent group profiles from appearing on reports that auditors may ask for:
  - ○ Set limited capabilities to *YES so that the group doesn't appear on a report listing profiles with limited capabilities set to *NO.
  - ○ Set the password expiration interval to *SYSVAL.
  - ○ Set the initial menu to *SIGNOFF.

- ✓ If the role being represented isn't obvious from the group profile's name, add an explanation to the Text field.
- ✓ If the tasks that the role performs require IBM i special authorities, grant the special authorities to the group, not the individuals.

Table 13.3 shows the group profiles created to represent the roles in our example.

Table 13.3: Sample roles and group profiles

Role	Group Profile	Special Authorities	Text Description
HR Staff	GRPHRSTAFF	None	HR staff role
HR Manager	GRPHRMGR	None	HR manager role
Finance Manager	GRPFINMGR	None	Finance manager role
AP Clerk	GRPAPCLK	None	AP clerk role
AR Clerk	GRPARCLK	None	AR clerk role
Internal Audit	GRPAUDIT	*AUDIT	Internal audit role
Accounting Download	GRPACTDOWN	None	Users who need to download accounting data

Now you can go back to the role definition form and add the name of the group profile used to implement the role, as shown in Table 13.4.

Table 13.4: Role definitions with associated group profiles

Role	Description	Special Authorities	Access Requirements	Group Profile
HR Staff	HR staff role	None	All HR application options except for Payroll and Master	GRPHRSTAFF
HR Manager	HR manager role	None	All HR application options	GRPHRMGR
Finance Manager	Finance manager role	None	All accounting application options	GRPFINMGR
AP Clerk	AP clerk role	None	All accounts payable options in the accounting application	GRPAPCLK
AR Clerk	AR clerk role	None	All accounts receivable options in the accounting application	GRPARCLK
Internal Audit	Internal audit role	*AUDIT	Access to the WRKSYSVAL command, *RX authority to the /SkyView/Policy Minder directory to review compliance reports	GRPAUDIT
Accounting Download	Users who need to download accounting data	None	*USE authority to the ACCTG authorization list securing the accounting files	GRPACTDOWN

Why Group Profiles?

Implementing roles via a group profile (whether within an application or for IBM i access) also provides an easy reporting and reviewing mechanism. Many laws and regulations, as well as internal and external auditors, require user access to be reviewed on a regular basis. If you cannot easily produce reports that list user access, the review process becomes confusing for all involved and, frankly, is often ineffective in reaching the objective (which is to remove access from users who no longer require it). When you implement roles, the appropriate manager reviews the capabilities and access associated with each role and then reviews the users in the role to determine 1) whether the role still requires the current access and capabilities and 2) whether each user should remain assigned to the role. Without roles, users and their individual access rights and capabilities must be reviewed individually, which can be a very tedious and time-consuming process.

Another reason to implement roles via group profiles is to keep a record of the access rights and capabilities of each role. I encourage you to provide access and capabilities only through roles (groups). This practice will ensure that if a user leaves the company, you have a clear and accurate picture of the access that whoever replaces that individual needs—simply place the new person in the former employee's role (group).

When helping our clients implement role-based access, I am often asked the question, "If there's only one user in the role, do you still go ahead and create the group profile?" In my opinion, the answer is yes. That's because if you discipline yourself to only grant access to the group (role), the group will always have the authorities required to perform the role's functions. This benefit is very helpful when the one person in the role is on vacation, takes sick leave, is dismissed from the company, or otherwise is away from the office for an extended period. All you need to do to allow someone to take over the role is to add that person to the group. If you haven't implemented the capabilities and access at the group profile, you have to try to determine what authority the individual profile has been granted (or revoked) and replicate that for the person just placed into the role.

Implementation

To implement role-based access:

1. Create a group profile for each role using the recommended settings listed previously.

2. Assign the group profile the appropriate special authorities required by the tasks to be performed by the role.
3. Grant authority to the group for all the menu options, commands, authorization lists, and functions allowed in Navigator for i or IBM i Access for Windows or Web.
4. For each user, assign the appropriate group profile (or group profiles, for users who belong to more than one role).

Table 13.5 shows an example of the final spreadsheet you'll work from to perform the actual implementation, including the users assigned to each role.

Table 13.5: Implementation spreadsheet for sample roles

Role	Description	Special Authorities	Access Requirements	Group Profile	Users
HR Staff	HR staff role	None	All HR application options except for Payroll and Master	GRPHRSTAFF	Ava Gracie
HR Manager	HR manager role	None	All HR application options	GRPHRMGR	Abigail Mareen
Finance Manager	Finance manager role	None	All accounting application options	GRPFINMGR	Mia Catherson
AP Clerk	AP clerk role	None	All accounts payable options in the accounting application	GRPAPCLK	Alan Walker
AR Clerk	AR clerk role	None	All accounts receivable options in the accounting application	GRPARCLK	Grant Thomas
Internal Audit	Internal audit role	*AUDIT	Access to the WRKSYSVAL command, *RX authority to the /SkyView/Policy Minder directory to review compliance reports	GRPAUDIT	Sam Johnson
Accounting Download	Users who need to download accounting data	None	*USE authority to the ACCTG authorization list securing the accounting files	GRPACTDOWN	Mia Catherson Alan Walker

CHAPTER 14

Role-Based Access for IT

Until now, this book has focused primarily on end-user security. We've discussed how to identify user authorization roles and how to use system and application security to implement those roles. But one particular group of users requires further attention: the IT department. Included in this group are the IT professionals on staff—including operators, help desk personnel, network administrators for IBM i, administrators, and programmers—as well as software vendors who supply applications used on your system and IT consultants.

Security and Your IT Staff

IT is one of the most difficult departments to establish a security strategy for, yet IT personnel pose the greatest threat to your organization. As with all other employees, IT personnel should be authorized to just those objects and functions they need to perform their jobs. For example, you should no more let IT staff view or manipulate production data at will than you should any other employee. This simply makes good business sense.

Implementing role-based access is also a compliance requirement in many organizations. While many people loathe the extra burden the Sarbanes-Oxley Act (SOX) has placed on most companies, one good outcome is that many organizations have had to restrict how and when programmers access production. But implementing these new

restrictions has been difficult for most. Why? Programmers—especially in the IBM i world—seem to take this restriction personally and feel their employers no longer trust them. They tend not to understand that the requirement has nothing to do with trust but everything to do with compliance with the law.

So, even though many in IT chafe over the restrictions, role-based access for IT is a requirement in many organizations. This chapter is devoted to helping you successfully implement role-based access across IT with the least amount of disruption possible.

Note

Although I describe the roles individually, I realize that in most organizations, the same person will perform some of these individual roles. While I think it would be unwieldy and highly impractical to create a separate user profile for each role that a user performs and expect that person to sign on using a different profile depending on the task, I do think it's wise to create a separate group profile that represents each role.

Identify the Roles

The first step toward achieving role-based access in the IT department is the same as I described in Chapter 13. That chapter presented a series of exercises designed to help you develop roles for non-IT users. You'll want to use the same method to define roles in IT.

For most organizations, the roles are probably similar to those listed in Table 14.1. Depending on the size, some organizations will have more roles in IT, and some will have fewer, but this list serves a general starting point.

Table 14.1: Typical IT authorization roles

Role	Job Functions	Required Capabilities
Operator	Monitor for and answer messages, start and stop writers, submit batch jobs, monitor active jobs, save objects, restore objects upon request	• *SAVSYS, *JOBCTL special authorities • Authority to the RST*xxx* commands
Network Administrator	Create lines, controllers, and devices; change TCP/IP server configurations; manage TCP/IP configuration	• *IOSYSCFG special authority

Table 14.1: Typical IT authorization roles (continued)

Role	Job Functions	Required Capabilities
Help Desk	Reset forgotten passwords, re-enable *DISABLED profiles	• No special authorities • Authority to utilities written to reset profiles and passwords
Programmer/Analyst	Design and code new applications, update existing applications, debug production application issues	• *JOBCTL special authority • Authority to the Application • Administration feature that lets users with *JOBCTL see the job log of a user with *ALLOBJ • Authority to the debug commands
System Administrator	Manage all aspects of the system except the security configuration: performance, installation and configuration of new products, save/restore strategy, disaster recovery planning, hardware and operating system upgrades	• All special authorities except *AUDIT
Security Administrator	Manage the QSECOFR profile, create (or manage the team that creates) user profiles; run compliance checks to ensure the system, user profile, and application settings remain set to the appropriate settings; maintain the system's security architecture; review reports from the audit journal	• All special authorities (*AUDIT, *ALLOBJ, *JOBCTL, *IOSYSCFG, *SAVSYS, *SECADM, *SERVICE, *SPLCTL)

Define a Secure Environment for Each Business Function

After identifying the business authorization roles within IT, you need to determine what authorities are required to perform each job function—giving each role sufficient authority but not more authority or capabilities than it needs.

Operator

The first decision to make about the operator role is whether you should assign (or keep the assignment of) the QSYSOPR user profile (the IBM-supplied system operator user profile) as the operators' group profile. Doing so is certainly a handy approach because QSYSOPR is authorized to many system functions. However, it may surprise you to learn just how much power QSYSOPR has. So I recommend that you look at the objects QSYSOPR owns and is authorized to; any user who is given QSYSOPR as a group profile will own or be authorized to all these objects as well.

To determine which objects QSYSOPR owns, run this DSPUSRPRF (Display User Profile) command:

```
DSPUSRPRF  QSYSOPR *OBJOWN
```

To determine which objects QSYSOPR is authorized to, run this command:

```
DSPUSRPRF  QSYSOPR *OBJAUT
```

Given what you see after running the DSPUSRPRF command, decide whether QSYSOPR is an appropriate group assignment. If it provides too much power and it is already your operators' group, you may want to consider changing that assignment.

For organizations that have more than one system operator, it's essential for each operator to have his or her own user profile. I realize this may be difficult, but it is necessary to ensure that the history log, message queues, and audit journal entries provide an audit trail of actions taken by each individual, thus providing accountability. Although many operators are used to logging on to the system and leaving their workstations signed on all day to monitor for messages, this behavior may have to be altered. This goal should be attainable with the use of a Hardware Management Console (HMC) rather than a hard-wired terminal for the console.

After ensuring that all operators have individual profiles, you need to consider what special authorities and individual authorizations the operator role requires. Because the operator role's responsibilities usually include working with messages, devices, jobs, and printers, this role needs capabilities that allow it to work with these areas of the system. *JOBCTL is usually sufficient for this. I don't recommend giving operators *SPLCTL authority because that allows them to view any spooled file on the system. If you have any spooled file that needs to remain private, granting the role *SPLCTL defeats any controls you try to place on restricting access.

Another operator role function is performing save/restore operations. Once you've given the operator role *SAVSYS special authority, the operator will require no specific authority to any production or development libraries or directories to save or restore them. The default public authority for all restore (RST*xxx*) commands is *EXCLUDE. If you want all roles that have *SAVSYS special authority (including the operator role) to be able to restore anything to your system, you can change the public authority for these commands to *USE or make these users part of the QSYSOPR group. However, the approach I recommend is to secure all restore commands with an authorization list and grant *USE access to each role entrusted with this function.

Technical Note

A profile that has *SAVSYS special authority could access a secured object via the save/restore function. If the object is secured by public authorities but resides in a library secured by private authorities, a user with *SAVSYS authority could save the object and restore it to a library to which the user has authority. Because the object isn't secured by private authorities at the object level, the user could then access the restored object. This is why you want to ensure that objects' *PUBLIC authority is set appropriately and also periodically review the actions of the operators.

Last, the operator role often has to submit batch jobs. Rather than authorizing the role to the production programs and files that these jobs work with, you can create CL-driven menus that contain the options the operator needs to submit batch jobs. These menu programs should adopt the application data owner's authority and should be authorized only to operators. When an operator selects an option, the program should submit the job using a job description that specifies a user profile to be used for the batch job. For instance, the job description for the batch job might be PRODJOBD, and the user profile defined for that job description might be PRODUSER. The SBMJOB (Submit Job) command would use the parameters JOBD(PRODJOBD) and USRPRF(*JOBD) to submit the job. The job would then run under the PRODUSER user profile.

This implementation has several key elements. First, it is critical that the menu options call programs that adopt. In many cases, it will be sufficient for the programs to be owned by the application's owning profile. However, depending on the task being performed, a more powerful profile may be required—for example, if the menu option is one taken when the operator has to restore an object and specify the restore command's ALWOBJDIF (Allow object differences) parameter. Because specifying this parameter requires the user to have *ALLOBJ authority, this menu option's program will have to be owned and adopt an *ALLOBJ profile.

In addition, because the menu options call programs that adopt, the operator role does not need authority to the application owner's profile or more powerful profiles. I've seen examples where organizations have given the operator role *USE authority to the application owner's profile so that the operators can submit jobs to run as this profile. This technique gives operators the ability to submit any task and run with these profiles'

capabilities, including tasks not approved by an administrator and tasks that have not gone through a change management review. This is more capability than I prefer to give operators, so I recommend that you avoid this approach.

An alternative to creating an operator menu is to use the IBM Advanced Job Scheduler or a vendor-supplied job scheduler. Using these tools, administrators can schedule jobs that will run as a profile with sufficient authority to perform the task. Operators are then authorized within the job scheduler to release those jobs, thus accomplishing their tasks without having to have additional capabilities assigned to their profiles or requiring private authorities to other user profiles.

Implementing security for system operators requires a little work on your part, but the security and risk reduction you'll achieve is well worth the effort.

Network Administrator for IBM i

The network administrator role is responsible for the communications configuration of the system with the rest of the network. This includes all TCP/IP configuration, working with other network administrators to determine the appropriate routes and TCP/IP addresses, and so on. This role determines which TCP/IP servers should auto-start when the rest of the system starts. All tasks usually performed by this role on IBM i are available without granting private authorities, as long as the role has been given *IOSYSCFG special authority.

Help Desk

Most organizations have some type of help desk. In organizations where the help desk is a separate group from administrators, I prefer to assign these users to a separate group (role). Then, rather than give this role special authorities such as *SECADM to allow them to work with user profiles, I prefer to write utilities—typically short CL programs that adopt and are owned by a profile with sufficient authority to perform the task. Tasks this role usually performs include resetting user profiles when a user has disabled his or her profile after too many invalid sign-on attempts and assigning a new password when a user can't remember the current one.

If you give this role *SECADM and sufficient authority to work with all user profiles, help desk personnel end up with a lot of power. I prefer to provide the functionality through utilities and then assign these utilities to a menu specifically created to contain all the tasks the help desk role needs to perform. Using this approach also means that the profiles in this role can be set to be limited-capability users because they will be

taking menu options, not running commands from a command line. This strategy further confines them to be able to run just the tasks required by their job function.

Programmer/Analyst

The programmer/analyst role is usually the most difficult to implement, from both a technical and an employee-relations point of view. Programmers typically resist security because they see it only as a limitation. Their jobs call for designing applications and writing, testing, and debugging the code to implement those applications. However, although programmers provide the physical framework for the data, the data itself belongs to those who administer it. For example, although the programmers may provide the application to manage human resources (HR) information, it's the HR department that owns the data and should be the one to determine who should be able to access it—not the programmer.

When creating the role (group profile) for the programmers—whether it's on a development or a production system, resist using the IBM-supplied profile QPGMR. QPGMR has authority to and owns many IBM i objects that programmers most likely don't need—and that you don't want them to have authority to. In addition, many vendor applications are owned by QPGMR. If your programmers are a member of QPGMR, they own these vendor applications. Last, QPGMR has been given *JOBCTL and *SAVSYS special authorities. Do you really want your programmers to have the ability to save any object off your system or to restore any object onto your system? I don't think so! But by making QPGMR your programmers' group profile, you give them these special authorities. Programmers may need *JOBCTL special authority, but they should not need *SAVSYS. And, regardless of what the programmers tell you, they do *not* need *ALLOBJ!

Let's talk about how to set up the development system, and then I'll go over the options for granting programmers access to production.

On development, I usually put all programmers in one group. If you have a large programming staff, it may make sense to have more than one group and divide the programmers' group membership according to the project on which they're working. After creating the group (with, at most, *JOBCTL special authority), I set that as each programmer's first group profile and then specify the OWNER user profile attribute as *GRPPRF. This way, everything that a programmer creates is owned by the group, and the rest of the group is free to use these objects.

I typically let programmers have "free reign" at this level of development. But, once again, this doesn't mean I give them *ALLOBJ. It's just that when they're developing

code, they need to be able to test freely. That's why, on a development system, the programmer's group should not be the profile that owns the application. If it is, they own not just the application objects still in the development stage but the application objects that are in the "production" stage as well. If programmers own the production stage objects, they can bypass any change management software or process you might have in place. This, for most organizations, will constitute a SOX compliance issue and is just not a wise business practice.

Once you've created the programmer's group profile, you need to make sure programmers have access to all the programming and debug commands so that they can do their jobs. The easiest way to find out what those commands are is to find out what the QPGMR user profile is authorized to. Do that by running the following DSPUSRPRF command:

```
DSPUSRPRF  QPGMR *OBJAUT
```

Some of these commands are shipped by IBM as *PUBLIC *EXCLUDE. For the ones your programmers need, you'll want to grant their group a private authority of *USE.

Now, let's talk about programmer access to production. Although auditors would like to prevent programmers from ever accessing production, that approach is just not practical. Reality says that there are times when a programmer must go on to the production system to debug failures. So, how do you do that with the minimum risk to your production data? Here are some options. It should be noted, however, that none are completely without risk.

First, let me state right up front that I don't believe programmers should have continuous access to production. Programmers should be allowed on a production system only when there's a production issue. So, one of the first issues you're going to have to resolve is how to give access to programmers. There are several approaches:

- Create a profile for each developer but leave it with a status of *DISABLED. When the programmer is on call, enable the profile.
- A more controlled approach, and the one I prefer, is to have the help desk enable the programmer's profile when the help desk receives a call that requires production access.

In either case, access is temporary. That is, the profile is set to *DISABLED again once the programmer goes off call or when the problem is resolved. Another approach

I've seen is that when the programmer signs on, a job is submitted that automatically disables the profile after two hours' use. Whatever way you implement it, make sure the programmer's access is not permanent.

The next issue you have to resolve is that of what authority the programmer has once he or she is allowed to sign on to production. Again, you have options. One option you do *not* have is to give the programmer *ALLOBJ. For the occasions when programmers might run a command that requires *ALLOBJ, you can write utilities that they can use to obtain the *ALLOBJ temporarily. And Application Administration can be used to let programmers see the job log of an *ALLOBJ user without having *ALLOBJ themselves. *Programmers do not need *ALLOBJ*—have I mentioned that recently?!? OK, on to the real options:

- You can make the programmer a member of the profile that owns the application. The programmer doesn't have *ALLOBJ but still has all authority to all application objects. This is the most flexible approach, but also the most risky (because the programmer, in effect, owns the application while signed on).
- If you've used authorization lists to secure the application data, you can add the programmer's group to the list with *CHANGE authority. This lets the group's members make data updates but does not give them the authority to clear or remove data or replace application objects. If you take this approach, you'll have to make sure programmers have sufficient authority to debug programs; they need either *USE and *SERVICE special authority or *CHANGE to the programs to run debug against them. Although this approach requires a bit more setup, it is less risky because your programmers have only *CHANGE authority to application data—not *ALL authority to all application objects.

Last, you'll want to consider logging programmers' activity while on production. Auditors would love for you to review these logs, but in reality most of you won't have time to do that. But the logs can provide valuable information should an investigation need to occur. You don't have to respecify any value you've already specified in the QAUDLVL (Auditing Level) system value, but it's possible you'll want to specify to log all commands that the programmers enter. To configure this, run the following CHGUSRAUD (Change User Audit) command for each developer's individual profile:

```
CHGUSRAUD  USRPRF(PGMR1 PGMR2 PGMR3) AUDLVL(*CMD)
```

(I'll explain more about IBM i auditing features in Chapter 15.)

Now, I've stated (several times) that programmers don't need *ALLOBJ. There are some exceptions, however. In very small shops, programmers sometimes also play the administrator role—at least on occasion. In that case, it's likely the programmer will need to have *ALLOBJ—at least on occasion.

System and Security Administrators

Of all the IT roles in the average business, the system and security administrators might be the most poorly implemented. In most organizations, the security or system administrator is whoever possesses the QSECOFR profile and password, and that person often does all his or her work, whether security-related or not, under that profile. This is not appropriate.

Each administrator should have a separate profile from QSECOFR. QSECOFR should be used only in the situations in which it is required (by IBM). The security officer role will likely have all special authorities. The system administrator will have all special authorities but *AUDIT. This way, the system administrator cannot manipulate the auditing system values. My preference is to assign these special authorities to a group and to have the OWNER attribute be set to *GRPPRF, so that anything created by the administrators (with the exception of IFS objects, as noted in Chapter 4) will be owned by their group, not the administrators themselves. This approach makes it much easier to delete an administrator's profile if the person leaves the organization.

Security Recommendation

Don't use the QSECOFR profile as an administrator profile. Instead, create a unique and distinct profile for each administrator.

Because *ALLOBJ provides for the opportunity to make accidental errors, I've seen some administrators have two profiles—one with and one without *ALLOBJ. This approach works well, especially when an individual performs multiple roles. In cases where *ALLOBJ isn't necessary, the administrator signs on with the "lower power" profile, using the profile with *ALLOBJ only when a task requires it. In larger shops, however, many administrators are constantly performing tasks that require *ALLOBJ, so this strategy might not be practical in those situations.

Many auditors want to know what the administrator profiles are doing and so require more logging for them. I think turning on *CMD auditing is a good practice for all profiles assigned *ALLOBJ or for profiles that are members of a group that has *ALLOBJ. To configure this auditing, run the following command for all administrator profiles, including QSECOFR:

```
CHGUSRAUD  USRPRF(QSECOFR ADMIN1 SECADMIN1) AUDLVL(*CMD)
```

Some auditors prefer that administrators never have *ALLOBJ assigned to their profile. In this situation, they are looking for a method of elevating the administrators' profile so that they only have the additional authority temporarily. Many software vendors have products that provide this function, but there are a couple of problems with these utilities. First, one of the methods of elevating privileges is often to swap to a profile with elevated privileges. This is effective, except when multiple people are swapping to the same profile. In this case, accountability is lost. That is, it is very difficult to know who performed the task as the elevated profile and, in my opinion, is a far worse situation than having the capabilities assigned directly to the administrators' profile.

The other issue is when all the tasks the administrator performs require an elevated privilege. Then, unless the purpose of the utility is to perform additional logging, such as screen captures, there's no point of elevating to gain the additional authority. Finally, most utilities do not work outside of green-screen 5250 access. Many administrators use functions that reside only in Navigator for i. In this case, the utilities are worthless, and the administrator must be given authority directly to their profile.

Security for Vendors and Consultants

Consultants and third-party software vendors are an integral part of most IT environments. All third-party packages bring a new element to your IT shop: menus, applications, and usually some form of security as part of the package. With these packages come some security risks. Not only do you need to be aware of these risks, but as the security administrator you must manage them, obtaining help from the vendors when necessary. Remember that although you've purchased software from a vendor, the data belongs to the enterprise, and that is where your responsibility lies. You can't afford to surrender the enterprise's security to a vendor or consultant.

A few basic weaknesses commonly occur in vendor applications and with consultant practices. I want to point out these areas and make a few recommendations for how to deal with these potential security threats. (Chapter 12 provides a vendor questionnaire

that can help you assess the security impact of third-party applications before you make any new software selection.)

Vendor Support

Some vendors support their software packages by remotely accessing your system. I've found that they often claim to need more authority than they do. I see them usually requiring that they have at least *ALLOBJ special authority. But trust me, unless a vendor is managing your entire system, this "requirement" is out of convenience, not necessity.

You should use the same approach you use for the programmer role for vendors accessing your systems. Make the access available (i.e., enable the profile) only after the vendor has called you and let you know it needs access and has explained why. Give only enough authority for the task being performed. For example, if a vendor is performing maintenance on its application, you could consider making the profile a member of the group that owns the application. With this approach, vendors should have sufficient authority to do their maintenance, but you've reduced the risk of their accessing your system by not giving them *ALLOBJ (even though that would be their preference). Remember, this is *your* system, not theirs. Vendors need to follow your security requirements—not the other way around. As with the programmers' profile used to access production, remove the access (i.e., set the profile status to *DISABLED) when the maintenance is completed.

Last, make sure vendors don't install programs that adopt a powerful profile and then put up a command line when called. I've seen vendors do this so they have a "back door" into the system in the event the organization attempts to place controls on them. Obviously, you'll want to configure auditing for these profiles. To ensure they are not gaining authority through adopted authority, I recommend you look for authority coming through adopted authority in addition to auditing the commands these profiles enter. To configure this, run the following command:

```
CHGUSRAUD  USRPRF(VENDOR1 VENDOR2) AUDLVL(*CMD *PGMADP)
```

Consultant Practices

Many organizations employ consultants for their expertise in a specific area in which their current staff lacks proficiency. Consulting firms often offer specialists in particular areas who can help develop and maintain application software on your system. Be wary of consultants who claim to need or insist on having *ALLOBJ special authority.

Consultants usually try to get as much authority as they can on your system—it makes their job easier. However, consultants should justify this requirement. In the case of my firm, the services—performing security assessments—require the consultant to have *ALLOBJ special authority because most of the IBM i functions being run require *ALLOBJ. However, this is not the case for most consultants. You should evaluate the business function of each consultant as you would for any IT staff position and then create specific user profiles, assigning them to the appropriate group (role) that reflects their job function.

If a consultant is creating programs on or restoring programs or objects to your system, require documentation for every program he or she creates or restores. Understand the purpose and function of each. If a consultant asks to load a tool kit on your system, obtain documentation that explains exactly which tools are being loaded, and be sure you know whether any of them adopt the authority of any powerful profiles (i.e., profiles that have *ALLOBJ special authority).

And it should go without saying that you should also turn on auditing for profiles assigned to consultants, just as those used for vendor access, with both *CMD and *PGMADP configured.

Role-Based IT Access

Developing role-based access for IT will help you ensure that you are not assigning profiles more authority than is required to perform the relevant job function. Regular (I recommend at least annual) review of the duties performed by each role, the authorities required, and the users assigned to the roles will ensure users continue to have just enough authority to do their jobs—but not more.

CHAPTER 15

Auditing

The IBM i operating system provides extensive auditing features. Before I get into the details of how to implement these features, let's discuss why you might need or want to enable them:

- As with the implementation of other security features, compliance with various laws and regulations often drives the requirement to enable auditing. For example, the payment card industry requires auditing to be enabled and the resulting audit journal entries to be retained for at least a year, with the most recent 90 days' worth of activity available on the system or quickly and easily retrievable (should an investigation need to occur).
- Laws driving auditing requirements include the Sarbanes-Oxley Act (SOX) in the United States and its counterpart in Japan, the Financial Instruments and Exchange Law (JSOX). Many of you know that readying for one of these audits often requires the preparation of reports stemming from the activity logged in the audit journal.
- As I discussed in Chapter 14, you may want to log all the commands run by programmers who access production, as well as the actions of any user with *ALLOBJ authority and actions taken by your vendors and consultants.

- A proactive stance to security often drives the requirement to enable auditing. Although you may examine only a small set of the audit journal entries, you know that the information is available should you have to investigate an incident (more on this topic in Chapter 18).
- Last, even if you're not interested in the contents of the audit journal, your organization may have implemented a high-availability (HA) solution that requires auditing to be enabled. Some HA solutions use the audit journal to know what and when to replicate to the target or failover system. If this is your situation, don't change your system's auditing configuration without first checking with your vendor (even after reading this chapter). Any change—but especially disabling some auditing—may produce significant problems in your HA solution.

I'd also like you to keep in mind a non–security-related benefit of turning on auditing, and that is the wealth of information the audit log provides when debugging system problems. For you system administrators, the information in the audit journal can save you significant time and frustration. I can't tell you how many times I've been working with an administrator at a client site when someone walks into the office, calls, or sends an email with a complaint or a plea for help that is resolved by examining information provided in the audit journal. Situations such as determining who or what process deleted a file or program are easily resolved by examining the deletion of objects (DO) audit journal entries. Unfortunately, most administrators don't use this information because they are unaware or forget that it's available! So I'm going to remind you several times throughout this chapter in hopes that this tip "sticks."

Security Recommendation

Once you understand what type of information is available in the audit journal, don't forget to use it as one of your sources of information when debugging problems.

The primary tool for auditing is the IBM i security audit journal. Before discussing the audit journal, though, let's briefly look at another useful tool: the history log.

The History Log

The history log records high-level activities that occur on your system, such as the start and completion of jobs, device status changes, system operator messages, and failed sign-on attempts. The history log records these events in the form of messages and stores the messages in system-created files.

Most security events are now logged only to the audit journal, but you can still learn from your system's history log. The history log helps you monitor system activities and reconstruct events to aid problem-determination and debugging efforts. The text description maintained by the system contains the beginning and ending date and time for the messages in the file—information that's useful when investigating events or activities.

You can display the contents of the history log by running the DSPLOG (Display Log) command:

```
DSPLOG  LOG(QHST)
```

The resulting display resembles the screen shown in Figure 15.1. Because system events such as job completions, invalid sign-on attempts, and users connecting via ODBC (known by their QZDASOINIT job names) are stored as messages in file QHST, you can place the cursor on a particular message and press the **Help** key to display second-level help text for the message.

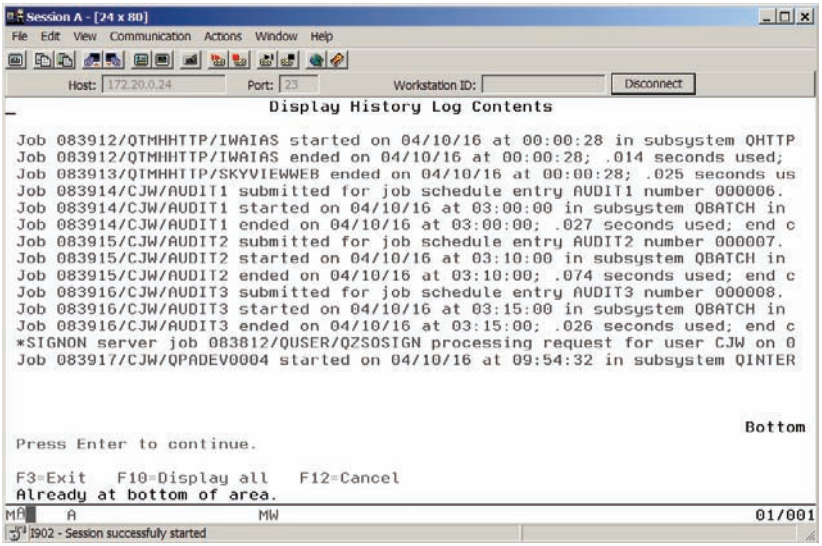

Figure 15.1: Sample history log

The DSPLOG command has several parameters that provide flexibility when you look through the log. These parameters, shown in Table 15.1, are fairly self-explanatory.

Table 15.1: DSPLOG command parameters

Parameter	Description
LOG	The default history log is QHST.
PERIOD	You can enter a specific time period for which log entries should be shown or accept the defaults for the beginning and ending dates and times. The default beginning time is the earliest available time, and the default beginning date is the current date.
JOB	You can use the JOB parameter to search for messages associated with a specific job name. You can enter just a job name, in which case the system might find several jobs with the same name that ran during a given time period. Or you can enter a specific job name, username, and job number to retrieve history information for a specific job.
MSGID	Like the JOB parameter, the MSGID (Message ID) parameter helps narrow the search. You can specify one or more messages or a range of messages.
OUTPUT	The asterisk value (*) sends output to the screen. The *PRINT and *PRT*xxx* values give you a variety of options for sending information to a spooled file.

History Log Housekeeping

The history log consists of a message queue and system files that store history messages. The files reside in library QSYS and have names that follow the convention QHST*yydddn*, where *yydd* stands for the Julian date on which the log was created and *n* is a sequence number (0–9 or A–Z) appended to the date. The system creates a new file whenever the existing file reaches its size limit, a number controlled by system value QHSTLOGSIZ (History Log Size). Another option is to specify *DAILY for this system value, so that the system starts a new log each day. Because the system doesn't automatically delete history log files, you'll want to develop a strategy for deleting the files and for using the data before you delete the files.

It's wise to save previous versions of the history log to media so you can retrieve them if you need to investigate an event. I recommend making the QHST files part of your regular save strategy and retaining the files offsite for at least a year.

Inside Information

Just like the audit journal, the history log contains a lot of information that can be used to investigate a security event as well as help debug security or system administration issues. For example, a look through the log might surface a message such as "Receiver ACG0239 in JRNLIB never fully saved (I C)"; the second-level help text tells you which

program was trying to delete the journal receiver. If you see the message "Password from device QPADEV007 not correct for user QSECOFR," you might want to investigate who is trying to sign on as the security officer.

One especially useful DSPLOG command option is the ability to select all security-related messages by specifying one parameter. All such messages (excluding some network and communications messages that might relate indirectly to security) fall within the message identifier range of CPF2200 to CPF2299. By entering the following command, you can view security-related messages for the specified period.

```
DSPLOG  LOG(QHST) MSGID(CPF2200) PERIOD(time_period)
```

As I mentioned earlier, the most complete repository of security event information is the security audit journal. Even so, the history log is one piece of the puzzle when you're reconstructing a scenario to allow investigation of an event.

The Security Audit Journal

The IBM i security audit journal is a system-supplied journaling function that records specific security-related events based on your configuration of auditing controls (e.g., system values, user profile parameters, object-auditing attributes). When you use the security audit journal, you can take advantage of many configuration options and features. To aid in your understanding and implementation of a successful auditing strategy, I'll discuss the following eight topics:

- The audit journal
- Auditing controls
- System-wide auditing
- User auditing
- Object auditing
- Event-auditing recommendations
- Working with the audit journal
- Displaying and printing audit journal entries

The Audit Journal

When an IBM i system is shipped, no audit journal exists. You must create the security audit journal before implementing any of its auditing features. IBM i requires you to create a journal named QAUDJRN, and it must reside in library QSYS. Creating this journal is actually a two-part process: First you create a journal receiver, and then you create the journal itself.

You can use the CRTJRNRCV (Create Journal Receiver) command to create a journal receiver (of any name) in a library of your choice. You then use the CRTJRN (Create Journal) command to create the QSYS/QAUDJRN journal and associate it with the journal receiver you defined in the previous step.

The QAUDJRN journal and the associated receiver function exactly like a normal database journal and receiver except that this journal is used only for audit journal entries. For more information about journals and managing journals and receivers, see the **Database** > **PDF files for Database** > **Journal management** topic in the IBM i Information Center.

The easiest way to configure auditing on your system is to use the system-supplied CHGSECAUD (Change Security Auditing) command, whose prompt screen is shown in Figure 15.2. This command creates the audit journal and a receiver and sets the appropriate system values for you.

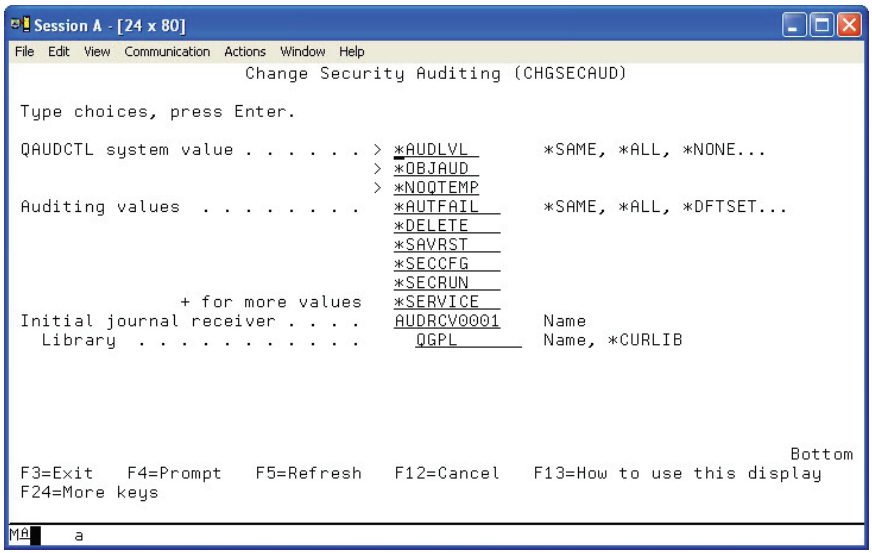

Figure 15.2: Sample CHGSECAUD prompt screen

Auditing Controls

Now, let's discuss how you configure what is actually going to be audited. (Note that if you're following along on your own system, your user profile must be assigned *AUDIT special authority to configure auditing, display objects' auditing values, or work with audit entries.)

Several system values play a role in audit configuration. Recall from Chapter 3 that system value QAUDCTL (Auditing Control) is the on/off switch for IBM i auditing. The default QAUDCTL value of *NONE says that auditing is off. Specifying *AUDLVL in the QAUDCTL system value enables action auditing. Specifying *OBJAUD enables object auditing.

The oddly named value *NOQTEMP tells the system not to log actions (e.g., creations, deletions) for objects in the QTEMP library. This value is useful because it eliminates entries that you may not care about. However, specifying this value does carry some risks. Someone intending to do harm could compile a program into QTEMP, run it, and then delete it—and you wouldn't have the audit records to detect it. You can specify any or all of these values (other than *NONE) for QAUDCTL.

Two other system values control aspects of auditing, but let me say right up front that you don't want to change either of these settings. The only reason to change these values is if your organization requires the highest security and integrity settings. QAUDFRCLVL (Auditing Force Level) determines the maximum number of audit records the system will cache before forcing the records to disk. I recommend leaving the value as *SYS to maximize performance when auditing.

QAUDENDACN (Auditing End Action) determines the action the system will take when it's unable to continue auditing (i.e., when the system can't write another audit record to the journal). The default value *NOTIFY causes IBM i to send a message to the system operator and to the QSYS/QSYSMSG message queue, if it exists. Specifying *PWRDWNSYS tells the system to power down immediately—in effect, this setting runs the PWRDWNSYS (Power Down System) command with the *IMMED option! Also, the next IPL returns the system in a restricted state, and a user profile with *ALLOBJ and *AUDIT authority must sign on to restore auditing before the system can be restarted. Obviously, most installations will want to leave this system value at the default of *NOTIFY!

System-Wide Auditing

The system value QAUDLVL (Auditing Level)—and its companion, QAUDLVL2 (Auditing Level Extension)—determine which actions are going to be audited. Table 15.2 lists the

possible QAUDLVL/QAUDLVL2 values, with a notation as to those new in V7R2 and V7R3. The table also lists values for the AUDLVL (User action auditing) user profile attribute, which provides similar functions at the user profile level (we'll talk more about AUDLVL in a moment). You can specify one or more of the listed values (or *NONE, which causes other values to be ignored). Some values, such as *JOBDTA, *NETCMN, and *SECURITY, have subsets. Using a subset value rather than the full value lets you customize the audit entries so that only the ones you need are generated.

Table 15.2: QAUDLVL and AUDLVL values

Value	Subsetted Value	Description	QAUDLVL/ QAUDLVL2	User Profile Attribute AUDLVL
*ATNEVT		Intrusion detection	X	
*AUTFAIL		Authority failure	X	X
*CMD		Command strings		X
*CREATE		Creation of objects	X	X
*DELETE		Deletion of objects	X	X
*JOBDTA		Actions affecting jobs	X	X
	*JOBBAS[1]	Basic job changes	X	X
	*JOBCHGUSR[1]	Changes to job user	X	X
*NETCMN		Network communications	X	X
	*NETBAS	Basic network functions	X	X
	*NETCLU	Cluster functions	X	X
	*NETFAIL	Network failures	X	X
	*NETSCK	Socket tasks	X[2]	X[2]
*NETSECURE		Secure connections	X[3]	X[3]
*NETTELSVR		Telnet server connections	X[3]	
*NETUDP		UDP connections	X[3]	X[3]
*OBJMGT		Object management	X	X
*OPTICAL		Optical	X	X
*PGMADP		Program adopt	X	X
*PGMFAIL		Program fail	X	X
*PRTDTA		Print data	X	X
*PTFOBJ		Changes to PTF objects	X[1]	
*PTFOPR		PTF operations	X[1]	
*SAVRST		Restore operations	X	X
*SECURITY		Security operations	X	X

Table 15.2: QAUDLVL and AUDLVL values (continued)				
Value	**Subsetted Value**	**Description**	**QAUDLVL/ QAUDLVL2**	**User Profile Attribute AUDLVL**
	*SECCFG	Security configuration	X	X[1]
	*SECDIRSRV	Directory services	X	X[1]
	*SECIPC	Interprocess communications	X	X[1]
	*SECNAS	Network authentication (Kerberos) actions	X	X[1]
	*SECRUN	Runtime security changes	X	X[1]
	*SECSCKD	Socket descriptors	X	X[1]
	*SECVFY	Verification functions	X	X[1]
	*SECVLDL	Validation list functions	X	X[1]
*SERVICE		Service functions	X	X
*SPLFDTA		Spooled file functions	X	X
*SYSMGT		System management	X	X

[1] New in V7R2
[2] New in V7R3: *NETSCK is now a full auditing value and no longer considered a subset of *NETCMN.
[3] New in V7R3

Let's look more closely at some of the most important QAUDLVL values:

- *AUTFAIL
- *CREATE
- *DELETE
- *PTFOPR (beginning in V7R2)
- *SAVRST
- *SECCFG
- *SECRUN
- *SERVICE

These seven values represent the minimum set of values that I recommend you specify for this system value. The thought behind specifying these values is that they will produce information that you need without generating so much data that it's overwhelming. My preference is to audit for the exceptions, not for what normally occurs every day.

AUTFAIL. The *AUTFAIL setting for system value QAUDLVL instructs the system to audit events related to insufficient authorities—events such as a user entering an incorrect user ID or password or attempts to access an object such as a database file without sufficient authority. Entries generated by the *AUTFAIL value can help you debug which object a user lacks authority to when a "Not authorized" message is issued. Applications can be written in ways that make it difficult to determine the actual object to which a user is not authorized. The details of this audit entry list the specific object as well as the profile that lacks sufficient authority.

For example, I was at a client site once when a user signed on using the QSECOFR profile. A few screens into an application, the user received a "Not authorized" message. How could that be when the user had signed on as QSECOFR? When we examined the audit journal entry, we found that a profile swap had occurred, and the user receiving the message was actually a different profile—not QSECOFR. The audit entry also listed the object for which the profile lacked authority.

CREATE. The *CREATE value instructs the system to create a journal entry each time someone creates (e.g., compiles, duplicates) a new object on your system, including the replacement of objects that already exist on the system. Knowing about new objects on your system can help you manage the activities of programmers, consultants, and vendors. This entry is also helpful when proving to auditors what programs are actually changed. As you've probably discovered, the last-change date of an object—including programs—can be updated by the system even though the actual program logic was never changed. If you have this auditing value specified, an audit entry will be created every time a new program is added to a production library. In addition, every time a program is recompiled, an entry will be generated, with an indication that it's a replacement, not a new program.

DELETE. *DELETE falls into the same category as *CREATE, only in reverse: The system creates an audit journal entry whenever an object is deleted. Such entries are vital when you're trying to determine the actions taken by a disgruntled employee on a production system. They're also extremely helpful in debugging errant programs and test cases that delete the wrong object.

PTFOPR. Specifying *PTFOPR will allow you to prove to your auditors that you are complying with your patch management (PTF) process.

SAVRST. Specify *SAVRST—especially on production systems—to monitor what objects are being restored onto your system.

SECURITY. The *SECURITY value provides a record of security-relevant changes to user profiles, changes to the authority of objects, and other security events. Fortunately, IBM has subsetted this value so that you don't have to generate the full scope of all the entries that *SECURITY produces. I recommend that you use the *SECCFG and *SECRUN subset values rather than the *SECURITY value, to monitor security configuration and runtime security changes, respectively.

SERVICE. The *SERVICE value provides a record of anyone who uses service tools or performs other service functions on your system. Given the power of these tools, you'll want to closely monitor their use.

Other Auditing Values

*PGMADP is an audit value you may want to specify occasionally. This value causes the system to generate an audit journal entry when a user's authority comes from adopted authority. You can specify this value when you suspect that someone is abusing adopted authority and using it to perform operations that he or she is not normally authorized to perform. But rather than turning on this value for QAUDLVL, I enable it at the user level (more about user auditing shortly). (Recall that I recommended, in discussing role-based access for IT in Chapter 14, that you might want to enable *PGMADP for vendor and consultant profiles.) Specifying this value only for selected users is especially important when one or more applications are configured to provide application users' access to objects via adopted authority. Turning on *PGMADP in this case has the potential to produce massive numbers of audit journal entries, all of which reflect "normal" behavior.

The *JOBDTA, *PRTDTA, and *SPLFDTA values can provide useful information, but they generally produce large numbers of audit journal entries, most of which you won't often be interested in. To determine whether these values will provide information that will be useful for your organization, take a look at the security audit journal description in Chapter 9 of the *IBM i Security Reference* (available under the IBM i Information Center's **Security** > **Security reference** > **PDF file for Security reference** topic).

Technical Note

Rather than specifying these values in QAUDLVL, you may want to specify them for selected users, as I describe next. For example, I often specify *JOBBAS for QSECOFR so I can track when QSECOFR is used for an interactive sign-on.

User Auditing

In addition to configuring auditing for the entire system, you can configure auditing at the user level. Using the CHGUSRAUD (Change User Audit) command, you can turn on action auditing for an individual or configure auditing of users' access or modification of specific objects. Figure 15.3 shows the CHGUSRAUD prompt screen.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                         Change User Auditing (CHGUSRAUD)

 Type choices, press Enter.

 User profile . . . . . . . . . . > VENDOR1     Name
                 + for more values
 Object auditing value  . . . . .   *SAME       *SAME, *NONE, *CHANGE, *ALL
 User action auditing . . . . . . > *CMD        *SAME, *NONE, *CMD...
                 + for more values > *PGMADP

                                                                      Bottom
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys

MA    a
```

Figure 15.3: CHGUSRAUD prompt screen

Note

Configuring auditing for a specific user is separate from the CRTUSRPRF (Create User Profile) and CHGUSRPRF (Change User Profile) commands, to enable the separation of security duties from auditing duties.

The AUDLVL (User action auditing) attribute is similar to the QAUDLVL system value in that it enables actions to be audited. There's no need to repeat the values specified in the QAUDLVL system value in the AUDLVL parameter. Rather, use this parameter to specify additional actions to be audited. Also, there's one value, *CMD, that can be specified only at the user level. Specifying *CMD causes every command string a user enters or runs from a CL program to be audited (i.e., logged in the audit journal). This

setting is especially useful if you must comply with a law or regulation that requires you to log or monitor administrators' activities. Given the volume of audit entries this setting generates, you'll want to assign this value only for user profiles that are required to be monitored—for example, users who have been assigned *ALLOBJ special authority, programmers accessing production (as I discussed in Chapter 14), and any other user who is not a limited-capability user. You should not turn on this setting for all users. That's why this value is available only at the user level and not at the system level.

Object Auditing

IBM i's object auditing lets you track which users read or modify a particular object. To configure auditing for a specific object, use the CHGOBJAUD (Change Object Auditing) command (Figure 15.4). Two types of actions cause an object-auditing audit journal entry to be generated: a user reads or uses an object, or a user changes an object.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                        Change Object Auditing (CHGOBJAUD)

Type choices, press Enter.

Object . . . . . . . . . . . . .   HRMASTER    Name, generic*, *ALL
  Library  . . . . . . . . . . .     HRDBFA    Name, *LIBL, *USRLIBL...
Object type  . . . . . . . . . .   *FILE      *ALL, *ALRTBL, *AUTHLR...
ASP device . . . . . . . . . . .   *          Name, *, *SYSBAS
Object auditing value  . . . . .   *ALL        *NONE, *USRPRF, *CHANGE, *ALL

                                                                    Bottom
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys

MA    a
```

Figure 15.4: CHGOBJAUD prompt screen

An OBJAUD (Object auditing) parameter value of *NONE means that use of the object will not be audited. *CHANGE tells IBM i to generate an audit journal entry when the object is modified. *ALL tells the system to audit all accesses (read or change) to the object. A final value, *USRPRF, tells IBM i to refer to the OBJAUD attribute of the user profile to determine what auditing to perform.

To change the auditing attribute of an object in one of the file systems (i.e., an object that's specified with a pathname), use the CHGAUD (Change Auditing Value) command (Figure 15.5).

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                         Change Auditing Value (CHGAUD)

 Type choices, press Enter.

 Object . . . . . . . . . . . . .   /BankTransfers

 Object auditing value  . . . . .   *CHANGE       *NONE, *USRPRF, *CHANGE, *ALL
 Directory subtree  . . . . . . .   *NONE         *NONE, *ALL
 Symbolic link  . . . . . . . . .   *NO           *NO, *YES

                                                                        Bottom
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys

MA    a
```

Figure 15.5: CHGAUD prompt screen

If you specify *USRPRF for the OBJAUD value on the CHGAUD or CHGOBJAUD command, IBM i looks at the object-auditing value specified in the user profile to determine whether to generate an object-auditing journal entry. A value of *NONE activates no object auditing for the user. *CHANGE tells the system to audit only the user's changes to objects. *ALL tells it to audit all accesses (read or change) of an object for that user.

The relationship between the object OBJAUD attribute and the user profile OBJAUD attribute is the key to understanding the control of object auditing on your system. Remember this rule: The OBJAUD value for an object takes precedence over the OBJAUD value of a user profile. This means that when you specify *NONE for the object OBJAUD attribute, IBM i doesn't generate an object-auditing entry for that object, regardless of the value specified for the OBJAUD attribute of the user profile accessing or changing the object. If you specify *CHANGE or *ALL for the object OBJAUD attribute, IBM i generates an object-auditing entry, regardless of the value of OBJAUD on the user profile. The operating system uses the user profile OBJAUD value only when you specify *USRPRF as

the value for the object OBJAUD attribute. Table 15.3 lists the read and change operations that are audited when you configure the various combinations of OBJAUD values.

Table 15.3: OBJAUD values

Object OBJAUD	User Profile OBJAUD		
	*NONE	*CHANGE	*ALL
*NONE	None	None	None
*CHANGE	Change	Change	Change
*ALL	Change/Use	Change/Use	Change/Use
*USRPRF	None	Change	Change/Use

The implications of this rule are simple. To implement user-specific auditing for object accesses, you must first specify OBJAUD(*USRPRF) for the objects you want to audit and then specify either OBJAUD(*CHANGE) or OBJAUD(*ALL) for the user profile for which you want to monitor activity. If you want to audit specific access to one or more objects regardless of which user profile is accessing the objects, simply modify the OBJAUD attribute of the objects. The diagram in Figure 15.6 summarizes your options as you use system value QAUDCTL and the OBJAUD attributes to control your auditing implementation.

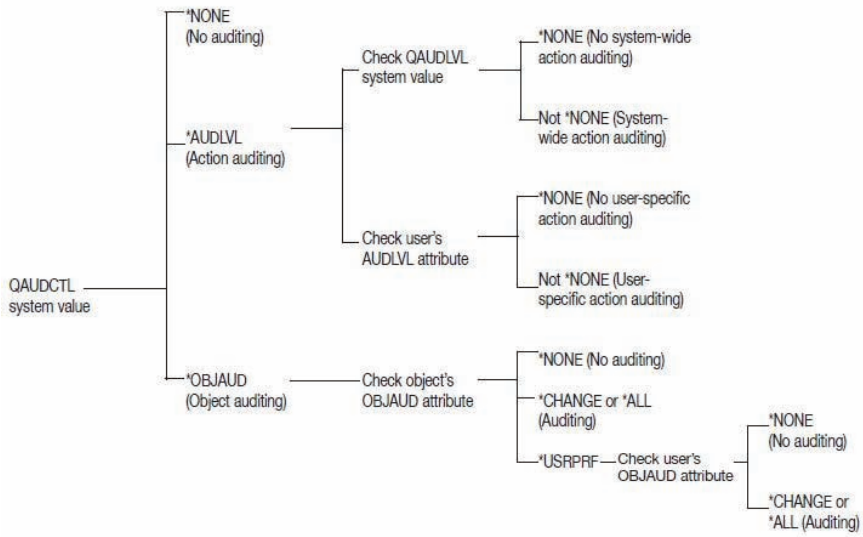

Figure 15.6: How IBM i determines whether auditing should occur

Object Auditing for New Objects

The auditing value for new objects is set based on the values in the CRTOBJAUD (Create object auditing) library attribute and the QCRTOBJAUD (Auditing for New Objects) system value. QCRTOBJAUD works much like the QCRTAUT (Create Authority) system value, which determines the default public authorities for new objects. When you create a new object, IBM i checks the CRTOBJAUD attribute for the library in which the new object will reside. If this value is *SYSVAL, IBM i takes the object's auditing value from the QCRTOBJAUD system value to determine which object-auditing value (*NONE, *CHANGE, *ALL, or *USRPRF) to assign to the OBJAUD attribute of the new object. Because the QCRTOBJAUD system value defaults to *NONE, newly created objects will be created with no object auditing enabled.

Before you change QCRTOBJAUD, I encourage you to think of the ramifications of doing so. Specifying *CHANGE for this system value will cause *all* newly created objects to be created with an object-auditing value of *CHANGE—this include user spaces, data queues, and data areas as well as programs and files. Sometimes, this is more auditing than is desirable. However, some high-availability vendors require QCRTOBJAUD to be set to *CHANGE so that their software knows when objects have been changed.

Even more consideration needs to be made when setting QCRTOBJAUD to *ALL. With this setting, when newly created objects are changed or read, an audit journal entry is generated. Setting QCRTOBJAUD to *ALL may cause massive numbers of audit journal entries to be generated. So although you may think this setting is a good idea, you'll want to closely monitor your audit journal receivers and save them off quickly so as not to cause a storage problem if you choose to implement this value.

My preferred approach for this system value, if you don't leave it at *NONE, is to set it to *USRPRF and turn on object auditing for selected user profiles. I typically turn on object auditing for the members of the administrator, programmer (on production), vendor, and consultant roles.

Event-Auditing Recommendations

Technology is generally worthless if you don't use it properly, and this maxim holds true for the auditing technologies available on IBM i. If you don't configure auditing, you lose important information for debugging problems, as well as valuable forensic information you will require if a breach occurs. We were called in to investigate a potential breach at

a new client site. Unfortunately, the client had no auditing turned on, kept no job logs, and deleted its history logs. Needless to say, the investigation didn't take long because the data needed to make any type of investigation simply was not available.

The following sections list my recommendations concerning the use of the IBM i auditing functions.

Auditing Controls Security Recommendations

- ✓ For the QAUDCTL system value, specify both *AUDLVL and *OBJAUD so you can perform both types of auditing.
- ✓ Leave system values QAUDFRCLVL and QAUDENDACN at their respective default values of *SYS and *NOTIFY.

System and User Event-Auditing Security Recommendations

- ✓ For the QAUDLVL system value, specify *AUTFAIL, *CREATE, *DELETE, *PTFOPR, *SAVRST, *SECCFG, *SECRUN, and *SERVICE. You can specify additional values, but this group is my recommended "base set."
- ✓ To determine whether you have issues you need to resolve before going to security level 40 or 50, specify *AUTFAIL and *PGMFAIL for system value QAUDLVL. (For more details about moving to security level 40 or 50, see Chapter 3.)
- ✓ Use the AUDLVL attribute at the user profile level to monitor the activities of powerful profiles such as QSECOFR, profiles that have *ALLOBJ special authority, profiles used by programmers to access production systems, and profiles used by consultants and vendors who access your systems. Spreading the net a bit further, you may also want to consider configuring auditing for all non–limited-capability users.

Object-Auditing Recommendations

- ✓ Turn on *ALL object auditing for files that contain private or critical data. Files containing cardholder data (encrypted credit cards), human resources information such as salaries, personal identifying numbers such as Social Security or Social Insurance numbers, healthcare information, or files containing restricted company information are all candidates for object auditing.

Technical Note

Some actions that you might think would cause an object read or change audit journal entry to be generated, don't do so. If you're considering enabling object auditing on a specific object, make sure you understand which actions will cause audit journal entries to be generated for that object type. Consult Appendix E of the *IBM i Security Reference* to learn the actions that cause object auditing to occur on each object type.

Working with the Audit Journal

Once you've configured auditing, the next step is to examine the audit journal entries regularly for specific events, trends, or possible security breaches and exposures. The remainder of this chapter provides the information you need to accomplish this task. First, we'll look at what a journal entry is and how it's formatted. Then, I'll describe methods for getting the information out of the audit journal.

For detailed information about and specifications for IBM i audit journal entries, I encourage you to become familiar with the information available in the *IBM i Security Reference*. Chapter 9 of this manual describes the values available for specification on the QAUDLVL system value as well as at the user level on the AUDLVL parameter of the CHGUSRAUD command. Appendix F includes the layout of the model output files (outfiles) provided for each audit journal entry type. These model files give you an easier way to use SQL or Query to find the exact information you're looking for without manually examining every entry in the journal. Last, the *Security Reference* gives you the details and specifications you need to perform some of the operations referred to below.

Understanding Journal Entry Formats

All journal entries have common fields (e.g., date, time, entry type, job name, IP address) followed by data specific to the type of entry. The standard journal entry fields are documented at the beginning of Appendix F in the *IBM i Security Reference*. These fields appear at the beginning of every security audit journal entry. Although the security manual documents the journal entries for previous releases, you need to use the most recent layout—that is, the layout for the *TYPE5 entry.

When examining the audit journal or narrowing your search of audit journal entries, you'll want to identify an *entry type*. Each journal entry type is identified by a two-character abbreviation. Table 15.4 lists the 75 types of journal entries possible in QAUDJRN. Each event action you might audit (e.g., *AUTFAIL, *CMD, *SECURITY) using the QAUDLVL system value, user-action auditing, or object-access auditing has one or more entry types that IBM i creates when adding a journal entry for those events.

Table 15.4: Audit journal entry types

Entry Type	Description
AD	Auditing changes
AF	Authority failure
AP	Obtaining adopted authority
AU	Enterprise Identity Mapping configuration change
AX	Row and Column Access Control (RCAC) changes
CA	Authority changes
CD	Command string audit
CO	Create object
CP	User profile changed, created, or restored
CQ	Change of Change Request Description (*CRQD) object
CU	Cluster operations
CV	Connection verification
CY	Cryptographic configuration changes
DI	Directory services
DO	Delete object
DS	Dedicated Service Tools security password reset
EV	System environment variables
GR	Generic records
GS	Give descriptor
IM	Intrusion monitor
IP	Interprocess communication
IR	Actions on IP rules
IS	Internet security management
JD	Change to user parameter of a job description
JS	Actions that affect jobs
KF	Key ring file
LD	Link, unlink, or look up directory entry
ML	Office services mail actions

Table 15.4: Audit journal entry types (continued)	
Entry Type	**Description**
NA	Network attribute changed
ND	APPN directory search filter violation
NE	APPN endpoint filter violation
OM	Object move or rename
OR	Object restore
OW	Object ownership changed
O1	(Optical Access) Single file or directory
O2	(Optical Access) Dual file or directory
O3	(Optical Access) Volume
PA	Program changed to adopt authority
PF	PTF operations
PG	Change of an object's primary group
PO	Printed output
PS	Profile swap
PU	PTF object changes
PW	Invalid password
RA	Authority change during restore
RJ	Restoring job description with user profile specified
RO	Change of object owner during restore
RP	Restoring adopted authority program
RQ	Restoring a *CRQD object
RU	Restoring user profile authority
RZ	Changing a primary group during restore
SD	Changes to system distribution directory
SE	Subsystem routing entry changed
SF	Actions to spooled files
SG	Asynchronous signals processed
SK	Secure sockets connections
SM	System management changes
SO	Server security user information actions
ST	Use of System Service Tools
SV	System value changed
VA	Changing an access control list
VC	Starting or ending a connection
VF	Closing server files

Table 15.4: Audit journal entry types (continued)	
Entry Type	**Description**
VL	Account limit exceeded
VN	Logging on and off the network
VO	Validation list actions
VP	Network password error
VR	Network resource access
VS	Starting or ending a server session
VU	Changing a network profile
VV	Changing service status
X0	Network authentication
X1	Identity token
X2	Query Manager profile changes
XD	Directory server extension
YC	Document Library Object (DLO) accessed (change)
YR	DLO object accessed (read)
ZC	Object accessed (change)
ZR	Object accessed (read)

Displaying and Printing Audit Journal Entries

You have at least three options for displaying or printing QAUDJRN's contents. You can use the DSPAUDJRNE (Display Audit Journal Entries) command, the DSPJRN (Display Journal) command, or the CPYAUDJRNE (Copy Audit Journal Entries) command. DSPAUDJRNE is a simplified version of the DSPJRN command with parameters that pertain only to displaying audit journal entries out of QAUDJRN. DSPJRN provides a richer set of options for displaying and printing audit journal contents. CPYAUDJRNE makes it easy to retrieve audit journal entries and then run an SQL statement or query to refine information being displayed or printed.

Using the DSPAUDJRNE Command to Display Entries

To view journal entries, run the command DSPAUDJRNE. The command defaults to running a report of the AF (authority failure) entries. However, if you prompt the command, you can specify to see a list of the other types of entries (e.g., CP for changes to profiles, SV for changes to system values, and so forth.) Figure 15.7 shows an example of this command.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                    Display Audit Journal Entries (DSPAUDJRNE)

Type choices, press Enter.

Journal entry types  . . . . . .   cp            AF, CA, CD, CO, CP, CU, CV...
                + for more values  _
User profile . . . . . . . . . .   *ALL         Name, *ALL
Journal receiver searched:
  Starting journal receiver  . .   *CURRENT     Name, *CURRENT, *CURCHAIN
    Library  . . . . . . . . . .    __________  Name, *LIBL, *CURLIB
  Ending journal receiver  . . .   __________   Name, *CURRENT
    Library  . . . . . . . . . .    __________  Name, *LIBL, *CURLIB
Starting date and time:
  Starting date  . . . . . . . .   *FIRST       Date, *FIRST
  Starting time  . . . . . . . .   ________      Time
Ending date and time:
  Ending date  . . . . . . . . .   *LAST        Date, *LAST
  Ending time  . . . . . . . . .   ________      Time
Output . . . . . . . . . . . . .   *            *PRINT, *
                                                                     Bottom
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys

MA    a
```

Figure 15.7: DSPAUDJRNE prompt screen

There are limitations with this option. First, there's no way to sort or query the results of running the command. You get either a spooled file or a list that appears on your display. Second, the command doesn't support all the audit types. Worse, it doesn't support Integrated File System (IFS) objects.

Figure 15.8 shows the output of the DSPAUDJRNE command. Notice the *N values in the Object name field. This indicates that these objects are IFS objects (whose pathnames are too long for the 10-character Object name field). To view an object's pathname, you'll have to use the next technique.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                                 Display Report
Query . . . :   QSYS/QSECAF                  Report width . . . . . :     208
Position to line  . . . . .   ______      Shift to column  . . . . . .   _____
Line   ....+....1....+....2....+....3....+....4....+....5....+....6....+....7..
         Violation User       Object     Library    Object   Office     DLO
         type      profile    name       name       type     user       name

000155 AF    A     QUSER      *N         *N         *DIR
000156 AF    A     QUSER      *N         *N         *DIR
000157 AF    A     QUSER      *N         *N         *DIR
000158 AF    A     QUSER      *N         *N         *DIR
000159 AF    A     QUSER      *N         *N         *DIR
000160 AF    A     QUSER      *N         *N         *DIR
000161 AF    A     QPM400     *N         *N         *DIR
000162 AF    A     CWOODBURY  SKYVIEWOUT R_SKYVWPMD *OUTQ
000163 AF    K     CWOODBURY  QP0FEPFS   QSYS       *SRVPGM
000164 AF    A     QTMHHTTP   *N         *N         *DIR
000165 AF    K     CWOODBURY  QP0FEPFS   QSYS       *SRVPGM
000166 AF    A     QTMHHTTP   *N         *N         *DIR
000167 AF    A     QPM400     *N         *N         *DIR
000168 AF    A     QPM400     *N         *N         *DIR
                                                                   More...
F3=Exit      F12=Cancel      F19=Left      F20=Right      F21=Split

MA    a
```

Figure 15.8: DSPAUDJRNE command output

Using the DSPJRN Command to Display Entries

To view journal entries using the DSPJRN command, enter the command

```
DSPJRN   QAUDJRN
```

This command generates a screen similar to the one shown in Figure 15.9. Typing a **5** (Display entire entry) in the option column for an entry here produces a detail screen similar to the one shown in Figure 15.10. In this example, a profile (LINDAV) was changed.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                          Display Journal Entries

Journal  . . . . . . :   QAUDJRN        Library  . . . . . . :   QSYS
Largest sequence number on this screen  . . . . . . : 00000000000001234736
Type options, press Enter.
  5=Display entire entry


Opt     Sequence  Code  Type  Object      Library     Job         Time
 _       1234725   T     CA                            QGLDPUBA    11:04:12
 _       1234726   T     DO                            QGLDPUBA    11:04:12
 _       1234727   T     CD                            QPADEV0002  11:04:40
 _       1234728   T     CD                            QPADEV0002  11:04:40
 _       1234729   T     CD                            QPADEV0002  11:04:40
 _       1234730   T     CD                            QPADEV0002  11:05:35
 _       1234731   T     CD                            QPADEV0002  11:05:35
 _       1234732   T     CD                            QPADEV0002  11:05:54
 _       1234733   T     CP                            QPADEV0002  11:05:54
 _       1234734   T     SO                            QPADEV0002  11:05:54
 _       1234735   T     CD                            QPADEV0002  11:06:24
 _       1234736   T     ZC                            QPADEV0002  11:06:27
                                                                        More...
F3=Exit   F12=Cancel

MA    a
```

Figure 15.9: Sample DSPJRN screen

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                          Display Journal Entry

Object . . . . . . . :                  Library  . . . . . . :
Member . . . . . . . :
Incomplete data  . . :   No             Minimized entry data :   *NONE
Sequence . . . . . . :   1234733
Code . . . . . . . . :   T  - Audit trail entry
Type . . . . . . . . :   CP - User profile changed

            Entry specific data
Column      *...+....1....+....2....+....3....+....4....+....5
00001      'ALINDAV    QSYS      *USRPRF CHG Y                 '
00051      '                                                   '
00101      '      MAIN      *LIBL                             '
00151      '                                                   '
00201      '                                                   '
00251      '                                                   '
00301      '                                                   '
                                                                        More...
Press Enter to continue.

F3=Exit   F6=Display only entry specific data
F10=Display only entry details   F12=Cancel   F24=More keys

MA    a
```

Figure 15.10: Display Journal Entry screen

Pressing **F10** (Display only entry details) on the Display Journal Entry screen displays a series of detail screens providing further information about the event.

You can use parameters on the DSPJRN command to select only specific entry types or to narrow your search based on a specific time period, job, or—in some cases—user profile. If you know the exact time of the entry you're looking for, this method may be the easiest way to look at and find details about the entry. However, this approach provides no way to sort the entries and produce a report of the entries—not to mention, it's very difficult to read, so often this method is not practical.

Using the CPYAUDJRNE Command

Your third option (and my favorite) is to use the CPYAUDJRNE command. This command combines copying a model outfile for the specific type of audit journal entry being examined with the DSPJRN command and sending the results to the copy of the outfile. For example, if you're looking for all AF entries, the outfile that will contain the entries after CPYAUDJRNE is run will be based on the model outfile QASYAFJ5 that is shipped in library QSYS. Appendix F of the *IBM i Security Reference* lists the format of all outfiles provided with the system. Review this appendix to know what information is available for each audit journal entry type. After using the CPYAUDJRNE command, it's quite easy to run a query or SQL statement to find the exact entries you're looking for or to further narrow down the results and print a report of the activity.

Figure 15.11 shows the prompt for the CPYAUDJRNE command. By default, the file containing the audit journal entries will be called QAUDIT*xx*, where *xx* is the two-letter audit journal entry type. For example, the filename for the AF (authority failure) entries would be QAUDITAF. Also, the file will be in library QTEMP unless you specify otherwise.

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help
                    Copy Audit Journal Entries (CPYAUDJRNE)

Type choices, press Enter.

Journal entry types  . . . . . .   AF          *ALL, AD, AF, AP, AU, CA...
                + for more values  ____
Output file prefix . . . . . . .   QAUDIT      Name
  Library  . . . . . . . . . . .     QTEMP     Name, *CURLIB
Output member options:
  Member to receive output . . .   *FIRST      Name, *FIRST
  Replace or add records . . . .   *REPLACE    *REPLACE, *ADD
User profile . . . . . . . . . .   *ALL        Name, *ALL
Journal receiver searched:
  Starting journal receiver  . .   *CURRENT    Name, *CURRENT, *CURCHAIN
    Library  . . . . . . . . . .     __________ Name, *LIBL, *CURLIB
  Ending journal receiver  . . .   __________  Name, *CURRENT
    Library  . . . . . . . . . .     __________ Name, *LIBL, *CURLIB
Starting date and time:
  Starting date  . . . . . . . .   *FIRST      Date, *FIRST
  Starting time  . . . . . . . .   ________    Time
                                                                  More...
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys

MA    a
```

Figure 15.11: CPYAUDJRNE prompt screen

Reporting on Activities from the Information in the Audit Journal

Although I would never recommend that someone examine every entry in the audit journal (unless I was trying to torture them!), there are some entries I think you should examine—or at least look for—on a regular basis. You can use any of the techniques described previously to view these entries, but I tend to use the CPYAUDJRNE command and then write a query to narrow my search and produce a report that can be reviewed on a weekly basis. Keep in mind that the purpose of reviewing these reports is not to review known or approved activity. You're looking for exceptions and indications of inappropriate activity.

Here are the entries that I recommend you regularly review:

- AF
  - ✓ Authority failures to files containing private or confidential data
- CP
  - ✓ Password changes for powerful profiles such as QSECOFR and QSRV
  - ✓ Dedicated Service Tools (DST) QSECOFR reset
  - ✓ Creation of or changes to profiles by users not in the approved team

- JS
  - ✓ Interactive sign-ons for profiles such as QSECOFR, vendor profiles, or profiles that should not generally be used for sign-on
- PW
  - ✓ Invalid password attempts for powerful users (subtype P entries)
  - ✓ Invalid service tools ID (subtype Y entries)
  - ✓ Invalid service tools password (subtype Z entries)
- ST
  - ✓ Use of various service tools
- SV
  - ✓ Changes to system values (omitting changes to the performance system values because these are managed by IBM i itself)

I generate the following reports upon special request—typically when an issue is being investigated, an incident has occurred, or an auditor requests them:

- CD
  - ✓ Use of specific commands
  - ✓ All commands run by a specific user
- AP
  - ✓ Use of adopted authority by one or more specific users

When analyzing which users and processes are accessing or changing a specific object or set of objects, I generate reports for the following type:

- ZC
  - ✓ Object has been modified
- ZR
  - ✓ Object has been read

Benefits of the IBM i Architecture

Before I close this chapter, I would be remiss not to describe the benefits of the implementation of the IBM i audit features. At least one regulation—PCI DSS—requires you to use log integrity software that ensures that logs (audit journal receivers, in IBM i terms) are preserved and that a mechanism is in place to detect changes to the log. While the history log is a file that can be modified, an audit journal receiver is not. The audit journal (QAUDJRN) determines what goes into the receivers, but it's the audit journal receivers that contain the actual entries. IBM specifically architected the audit function to be retained in journal receivers so that there is no possibility of an audit journal entry being modified or deleted. The inherent architecture of a journal receiver prevents this from happening. That's the reason why all security-critical messages were changed from being logged to the history log to being audit journal entries—or they're logged to both the history log and the audit journal.

Even if someone deleted an entire journal receiver, you could detect that. The receivers are numbered sequentially, so you would know one was missing. Also, when auditing is turned off, an entry is written in the journal to document this action. So, if you detect that auditing is not active, you can go back to the last entry written to determine who turned it off.

So, chalk up another benefit of running IBM i: Your audit journal entries are safe, and their integrity is assured.

Helpful Tools

Auditing security-related events daily is one of the most significant auditing tasks you can perform. Monitoring events as they occur gives you insight into the effectiveness of your security implementation and helps you manage the changes that naturally occur on your system. You'll find the four tools listed in Table 15.5 useful for performing auditing tasks.

Table 15.5: Tools for performing auditing tasks

Security Tool	Description
CHGSECAUD (Change Security Auditing)	Lets you set up auditing using a single command.
DSPAUDJRNE (Display Audit Journal Entries)	Provides a simplified version of the DSPJRN command with parameters that pertain only to displaying audit journal entries out of QAUDJRN. Although IBM no longer updates this command (for example, the command provides only *TYPE4 information and doesn't support all the entry types currently available), DSPAUDJRNE remains a convenient command if you want a quick look at the most popular entries, such as authority failures or creations and deletions.

Table 15.5: Tools for performing auditing tasks (continued)	
Security Tool	**Description**
DSPSECAUD (Display Security Auditing)	Displays or prints a report of the current settings for system values QAUDCTL and QAUDLVL as well as the journal receiver currently attached to the audit journal.
CPYAUDJRNE (Copy Audit Journal Entries)	Combines the process of duplicating the model outfile for the type of audit journal entry you're looking for with running the results of the DSPJRN command to an outfile. Makes the gathering of audit journal entries substantially easier.

Navigator for i

You can use Navigator for i to change the auditing system values. Using the Web version, open your system name, then **Configuration and Service** > **System values**. Right-click **Audit Policy** in the right panel and choose Properties. You'll see a screen similar to the one shown in Figure 15.12, where you can specify auditing system values.

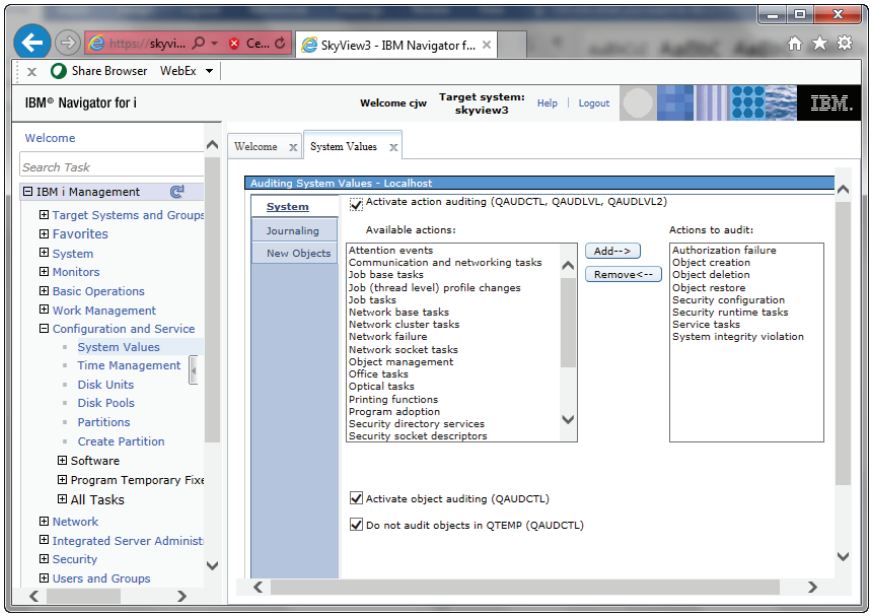

Figure 15.12: Auditing System Values dialog box

Navigator also lets you manage the auditing attributes of user profiles. To perform this task, open your system name, then **Users and Groups**, and click either **Users** or **Groups**. In the right panel, right-click the name of the user or group being changed and choose

Properties. Click the **Capabilities** link at the bottom of the dialog, then choose **Auditing** from the left panel to make your updates.

Technical Note

Although actions taken through Navigator for i are audited, as are objects accessed through Navigator, Navigator provides no command-string auditing. This applies to both the client and Web versions.

Security Recommendation

One last and final reminder! Don't forget that a wealth of information is at your fingertips. All you have to do is get it out of the audit journal and use it to make your life as an administrator much easier when debugging system issues.

CHAPTER 16

Implementing Object-Level Security

Until now, we've been talking a lot of theory and a lot of facts, but we haven't gotten into much practical application. This is the chapter where all the information you've learned thus far in the book will be pulled together into practical implementation advice.

The focus of this chapter is implementing object-level security. Very few of you get the luxury of starting an application from "scratch" and designing its security scheme the right way from the beginning. Instead, most of you are stuck with one or more applications that use poorly architected security schemes. I've heard from many of you who have tried to implement object security, but the project has failed and you've had to back out of your changes. This chapter's goal is to give you the information you need to successfully implement object-level security with as little "breakage" as possible. I'll describe the methodology I use with our clients to take a poorly designed security architecture and change it into one that meets the organization's security policy and compliance requirements.

So follow closely, and if you're tempted to skip a step or take steps out of order, don't. In many cases, the order in which you perform the steps is important to the success of the project. Also, be sure to read the *entire* chapter before making any changes. Although I cannot guarantee that your project will be implemented with no breakage, following this methodology should reduce the frequency of its occurrence.

Determine the Scope of Your Project

The first step in implementing object-level security is to determine what it is you're going to be changing and what security requirements you're trying to achieve. For example, you may only want to ensure that your employee master database is properly secured. Or perhaps your organization needs to comply with PCI DSS, so you need to make sure access to the files that contain cardholder data is "deny by default." In these cases, you're most likely required to set the *PUBLIC authority of the objects to *PUBLIC(*EXCLUDE). But that may not always be the case. In some situations, you might be concerned not with the confidentiality of the data but with the integrity of the data. Let me explain.

We've had several customers whose security policy allowed any user on the system to view and download all the data on the system. But the customers wanted to make sure that no user was able to change the data from outside the application—through Database Utility (DBU) or File Transfer Protocol (FTP), by uploading a modified spreadsheet, or using any other means. That goal required that we architect a solution so that the *PUBLIC authority was *USE. This solution provided data integrity, but it did not keep the data private or away from the systems' users.

Last, you might have one or more applications that use one of the common application security schemes described in Chapter 12 that requires users to have *ALLOBJ, be members of the group that owns the application, or have a wide-open *PUBLIC authority setting.

As you go through this chapter, it's helpful to have a specific project in mind. So, I'd like you to pause for a moment and decide which file or application you're going to address. Then, decide what the requirement for the data is—*PUBLIC authority of *EXCLUDE? *USE?

Now that you've thought about your own situation, here's the scenario I will use as an example for the rest of the chapter:

- Application to be remediated:
  - Accounting, which includes accounts receivable (AR), accounts payable (AP), and general ledger (GL)
- Current security scheme:
  - The application is owned by the profile ACCTNG.
  - The ACCTNG profile has *JOBCTL, *SAVSYS, and *SECADM special authorities.

  - Each application user is a member of the ACCTNG profile.
  - The *PUBLIC authority of all application objects (including all database files) is *CHANGE.
  - Authority to the application directory is *PUBLIC DTAAUT(*RWX) OBJAUT(*ALL).
- Requirements of this project:
  - Security settings must enforce separation of duties.
  - PCI data must be deny by default.
  - Users must be able to rely on the integrity of the data.
  - No one should be able to change the data outside the protection of the application's logic (in other words, all changes must be made through an application interface, such as a menu option).
  - Only approved users should be able to view accounting data or download it.

High-Level Design of the Architecture

To remediate the open security scheme, we'll take the following approach, which remediates all the requirements listed above.

- All application programs except the initial program will be changed to adopt authority (programs will be set to USRPRF(*OWNER)). It is through this adopted authority that application users will have sufficient authority to run the application. (The initial program is the one that presents the menu as well as a command line. To avoid propagating the adopted authority out to the command line, the initial program will be set to not adopt—USRPRF(*USER)).
- The ACCTNG profile will be changed to have only *JOBCTL special authority. Examining the function of the application reveals that it performs no tasks requiring either *SECADM or *SAVSYS. Therefore, these authorities will be removed so that there's no possibility of application users exploiting the capabilities of adopting *SAVSYS or *SECADM special authority.
- The ACCTNG profile will also explicitly be set to PASSWORD(*NONE), so there's no possibility of someone using the profile for sign-on; PWDEXPITV(*SYSVAL), so it doesn't show up on the list of profiles with a non-expiring password; and

LMTCPB(*YES), so there's no possibility of overriding the values on the sign-on screen if the profile is ever assigned a password.

- All database files will be secured with an authorization list. There will be three authorization lists: AR, AP, and GL.
- All application objects, including authorization lists, will be owned by the ACCTNG profile.
- Application users will be removed from the ACCTNG group and placed into a different group profile.

Note

Regardless of whether you intend to rework an entire application or secure one file, you'll want to follow the methodology outlined in this chapter. If you're only changing the authority on one or several files rather than an entire application, the amount of effort involved may be less, but you should work through each of these steps to be as certain as possible that your rollout will be successful.

Building the Big Picture

This phase of your project is the most critical. It is the information-gathering portion of the effort. This phase is where you determine what is currently happening to the application data—that is, what processes and which users are viewing or updating the data—not through application interfaces, but from outside the application. The access may come from another application that needs to read a file, a WebSphere application that updates a file via a Java Database Connectivity (JDBC) connection, a batch process that reads a file and creates a stream file in the integrated file system (IFS), or end users downloading data into spreadsheets. I call this process "building the big picture" (Figure 16.1). The more complete you make this picture, the greater the likelihood that you'll avoid breakage when you roll out the new security scheme.

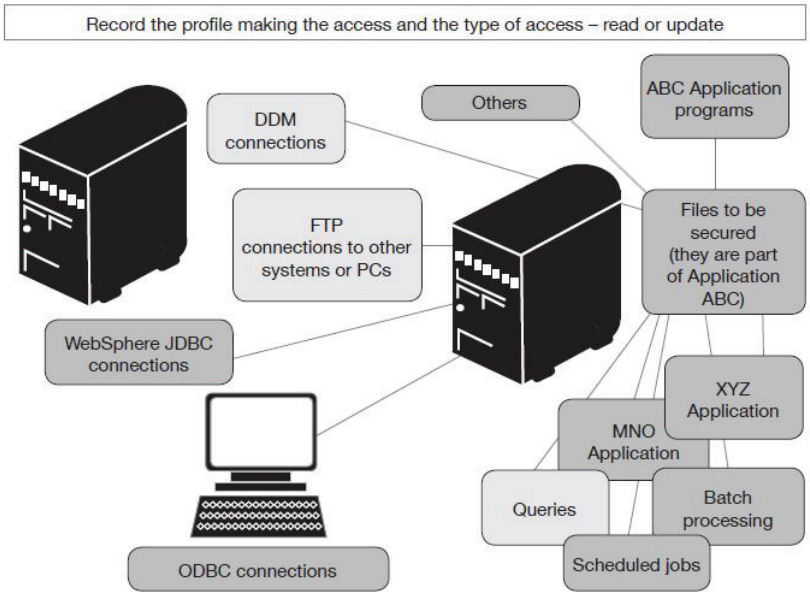

Figure 16.1: Building the big picture

Personally, I don't like it when things "break"—that is, when some aspect of an application has an error, such as a batch job failing, a user receiving an error when choosing a menu option, or a program receiving a function check. There's enough management attention on these types of projects that I want to avoid the negative attention such failures cause. That's why it's critical to document all known accesses of application data so that you can determine whether and how to accommodate that access in your new security architecture. Remember, the data is no longer going to be wide open. It will be either *PUBLIC *EXCLUDE or *USE. In either case, any process that needs to update the data will fail unless you do something to accommodate that process. It's unlikely your picture will be 100 percent complete—a process or two may fail (especially ones that only run quarterly or annually) or a user may experience a problem taking a menu option. But with this up-front investigation, the failure should not be so great as to cause a rollback of the implementation or abandonment of the project altogether. Also, with the architecture I use, recovery from failures is usually swift and relatively painless.

I'll talk about techniques for gathering information that will help you build the big picture in a moment. But first, let me describe the information you need to obtain. I

usually use a spreadsheet, but the format you use doesn't matter. The important thing is to collect the following pieces of information:

- Name of the file being accessed (including the library or directory path)
- Name of the profile accessing the data
- A short description of the task so you can tell the tasks apart (make this description sufficient to know which task to run to test your settings during rollout of the new security architecture)
- Name of the program or type of access (e.g., APPLIB/PGMUPD2 if a program is accessing the data, or DDM, FTP, IBM i Access data transfer, ODBC, and so on if it's an interface)
- Whether the access is a read or an update (if the process both reads and updates, just record the update)

You'll use this information during the rollout phase to accommodate these existing accesses so they don't break when you make the file's access more restrictive than its current setting. Although this process may seem a bit daunting, remember that you don't have to list the files being accessed by the application programs. You'll set these programs to adopt authority, so they will have sufficient authority to access the files. List only the tasks that are not calling the application's programs. Table 16.1 records this information for our sample scenario. (I'll talk about the authorization list column a bit later in this chapter.)

Table 16.1: Sample file access information

File Library/ Name	Accessing Profile	Description of Task	Program or Access Type	Read or Update	Authorization List Name(s)
APLIB/MASTER	INVPROF	Inventory update	INVLIB/UPD	Update	AP_AUTL
APLIB/VENDOR	QEJBSRV	WebSphere Vendor AP app	JDBC	Read	AP_AUTL
GLLIB/BANK	FTPOUT	FTP bank process	FTP	Read	GL_AUTL

Collecting the Information

There are several ways to collect the required information. If you're just changing one or a handful of files, you can turn on object auditing on the file(s) and query the audit journal on a frequent basis to find the processes that are either reading (these will be ZR audit entries) or updating (ZC entries) the data.

We took this approach with one client that needed to change its cardholder data files from *PUBLIC *CHANGE to *PUBLIC *EXCLUDE. For each file, we ran the following command to enable auditing:

```
CHGOBJAUD  OBJ(ARLIB/AUTOPAY) OBJTYPE(*FILE) OBJAUD(*ALL)
```

Then, we ran the CPYAUDJRNE (Copy Audit Journal Entries) command for the ZR entries and ran it again for the ZC entries. We ran some queries against the data to eliminate application programs and processes being run by *ALLOBJ users. Next, we downloaded the results into two spreadsheets: one for processes updating the data and another for processes just reading the data. After sorting the results to list only unique entries, we had our list of profiles that needed to be authorized to the files' authorization list so that the processes they ran would continue to work.

If you're changing an entire application, gathering the information is more difficult. Turning on object auditing for all application files is usually too overwhelming—the sheer amount of generated data makes this approach impractical. If you have an exit point solution installed, I recommend you use the logging feature to log the activity that occurs from outside the system (e.g., the DDM, FTP, and ODBC connections). If the application is a client/server or WebSphere application for which all transactions occur as the same IBM i user profile (usually as the owner of the database file), you'll want to configure the logging to ignore the "known" transactions (i.e., the application transactions) and log all others.

Regardless of whether you have another way to gather the information for the big picture, I recommend that you sit down with the application's developers or the application vendor as well as the system administrators, operators, and perhaps the application's power users and talk through the issue you're trying to solve. It's amazing how close you'll come to generating a complete list of tasks simply by getting the right people in the room.

After generating the initial list, you'll also want to look through the following items.

Job schedulers. Review the IBM and any vendor job scheduler you have installed, looking for jobs that access the application files. Remember that you can ignore any job running an application program (because adopted authority will be used to gain access to the application files). You can also ignore any job that runs as a profile with *ALLOBJ special authority.

Job descriptions. If you've decided to set libraries to *PUBLIC *EXCLUDE, you'll want to look through job descriptions to ensure that the libraries aren't listed in the library

list for the job description or, if they are, that the users using the job description are authorized to the library. If the users aren't authorized to the library, the job won't start.

Queries. Look through your queries, specifically queries that generate files into the application's library. I recommend separating these out and creating the files in a different library (more about queries later in the chapter).

The current configuration. You can use a vendor product such as Policy Minder or write your own routine to obtain a listing of the current security configuration on your application objects. At this phase, you'll want to pay specific attention to the private authorities that have been granted to the application objects. If there are individual or group profiles that have been granted a private authority to application objects—especially files, you'll want to investigate why the authority was granted. Perhaps it was granted to enable a specific feature or to resolve an issue with a failing process. If you can find out why the authority was granted, you can make a determination as to whether the access needs to be accommodated after you've changed the application's security configuration. I often find that most private authorities are removed in the process of implementing this type of project. Often, organizations determine that the individuals or groups really shouldn't be allowed to have direct access any more. Or they determine that the authority was granted in an effort to resolve an issue, but when it didn't solve the issue, the authority was never removed, or the object ownership was changed but the old owner's authority was never revoked.

Another area in the current configuration to examine is authorization lists. Again, you'll want to determine what problem the authorizations lists were intended to solve and whether that problem (of access control) still exists or will be accommodated with the new security scheme. I find that authorization lists are often attached to application objects and then never maintained. Many times, the current administrators don't even know why they're in place or what type of access they were originally meant to provide. As you can see, this type of project often results in the cleanup of extraneous private authorities and objects that are no longer used.

Finally, the Authority Collection function added in V7R3 provides a definitive way of determining all the objects a particular user or process accesses. And because it provides an indication of the exact authority required, this a key tool that I use to collect information during this phase of an object-level security project. For more information about Authority Collection, see Chapter 6.

Dynamic SQL

Dynamic SQL presents an interesting challenge. For programs containing dynamic SQL, it's not sufficient to set the user profile attribute to *OWNER when compiling or changing the program. This setting causes the program to adopt, but it does not cause the dynamic SQL statement to adopt authority. To get the dynamic SQL statement to adopt, you have to set the DYNUSRPRF (Dynamic user profile) attribute to *OWNER when you compile the program. The only time you can specify this parameter is when the program is compiled.

For programs without dynamic SQL, run the CHGPGM (Change Program) command for all programs in the application libraries to configure the programs to adopt. But because CHGPGM has no dynamic user profile parameter, you'll need to identify the programs that contain dynamic SQL and recompile them before starting your tests.

To know which programs to recompile, you must identify the programs containing dynamic SQL. IBM provides the PRTSQLINF (Print SQL Information) command, but you have to run this command against a particular program, service program, or SQL package and then examine the resulting spooled file for dynamic SQL statements. You can either do this one at a time for each program in a library or write a CL program that gets the list of all the programs, service programs, and SQL packages in the library and loops through each of them to run the PRTSQLINF command. Then, you need to look through each generated spooled file to find the programs that contain dynamic SQL statements (note that you're looking for dynamic SQL statements, not embedded SQL statements). (This process is so time-consuming and painful that after going through it with one client I had the feature added to the Policy Minder product to perform this analysis for you and to generate a report of the programs containing dynamic SQL and the current user profile and dynamic user profile settings.) Once you determine which programs contain dynamic SQL, you need to recompile them, specifying *OWNER for the DYNUSRPRF parameter.

Security Recommendation

To avoid authority problems with programs containing dynamic SQL, consider changing the command default for all CRTSQL*xxx*I commands from DYNUSRPRF(*USER) to DYNUSRPRF(*OWNER).

Decision Points

This type of project involves several decisions, many of which require tradeoffs—for example, reduced risk to your data versus less opportunity for organizational growth, or a more secure implementation versus the convenience and maintainability of the application. The following paragraphs discuss some of the decisions—and associated tradeoffs—that this type of project requires you to make.

Owning All Application Objects Rather Than Being Authorized

The solution I've described for our sample application scenario assumes that all application objects are owned by the profile ACCTNG. This means that the ACCTNG profile has *ALL authority to all application objects. A slightly more secure method would be to separate ownership. In this approach, all data objects (*FILE, *DTAARA, and so on) are owned by one profile, and another profile owns the rest of the application objects, including *PGM objects. The programs are still configured to adopt. But rather than having the program owner possess all authority to the data (because it owns the files), the program owner is granted only enough authority to the files to run the application. This typically requires at least *CHANGE authority.

However, if the application performs any operations, such as adding or changing a physical file member or deleting a file and replacing it, the program owner will need not just *CHANGE authority to the file but *OBJMGT or *OBJEXIST (in the case of the delete and recreate) as well. Although possible, I've found that this configuration is usually not worth the slight exposure that accompanies it, given the fact that most program owners end up with close to the equivalent of *ALL anyway.

What Adopts

The debate with adopted authority is exactly which application programs adopt. One approach is to have all the application programs adopt authority—that is, have their USRPRF (User profile) attribute set to *OWNER. The concern is that if a programmer or other user with command-line access can call a program, they'll do so with adopted authority.

If this risk is unacceptable, one alternative is to have the "initial" programs adopt. You might think that there is only one initial program—the program that generates the application's menu. That's one of the programs, but the other initial programs are all the programs that are called on a SBMJOB (Submit Job) command or run in batch or through a job scheduler. All these programs must be configured to adopt because they all run in

their own unique job; therefore, the adopted authority must be established by the first program called in that job. Finding all these programs can be time-consuming and is often a point of failure on rollout. Also, it's often difficult to maintain going forward.

A slightly different approach is to have all programs adopt except for the program that generates the application menus. This way, the application's command line does not have adopted authority—something that reduces the risk of exploiting the authority of the application owner by users who have command-line access. (When all programs adopt, including the program that generates the menus, any command line that is on the menu usually also adopts. Therefore, you must ensure that all application users are set to limited capability *YES so they cannot exploit this authority.)

A potential problem with having all programs adopt except the program that generates the menu occurs when menu options are either commands or queries. Now, this may be the exact effect you want. You may want commands to run with only the users' authority. Commands such as WRKSPLF (Work with Spooled Files) and WRKQRY (Work with Queries) are generally best run with only the users' authority (and no adopted authority). The same issue exists if menu options contain queries. You may want them to run with only the users' authority. However, if you want either a command or a query to run with adopted authority, you'll need to place it in a CL program, have the application owner own the program, and create the program to adopt authority.

Finally, another variation is to have all programs adopt (i.e., have their user profile parameter set to *OWNER) and change their USEADPAUT (Use adopted authority) attribute from the default of *YES to *NO. With this setting, if a user creates a program with the same name as an application program and adds it to a library that's in the library list ahead of the application library, the user can't exploit or use the adopted authority from the previous application program. To completely prevent the use of adopted authority—that is, a program gaining adopted authority from a program higher in the call stack, you create an authorization list, specify it in the QUSEADPAUT (Use Adopted Authority) system value, and set its *PUBLIC authority to *EXCLUDE. Be sure to authorize any profile that is used to create or promote programs that need to set programs' USEADPAUT attribute to *YES.

I typically use the approach that all programs except the initial program adopt authority. This approach provides the greatest flexibility to ensure that only the menu options that I want to adopt do so and that the command-line and menu options such as queries are run with only the authority of the user.

Authorization Lists

I leave my customers no option but to secure physical and logical files with an authorization list. That's because an authorization list provides a "fail-safe" when rolling out the new security scheme. You can't change the owner or *PUBLIC authority or grant a private authority to a file that's in use. But if the file is secured with an authorization list, you can modify the authorization list. Therefore, if a user who needs direct access to a file is missed during your discovery or a new application is developed that needs access, you can add the access immediately without having to bring down the application, so that the files won't be locked and you can modify the authorizations.

*PUBLIC Authority

When I use an authorization list, I also have the *PUBLIC authority of the objects that are secured by the list come from the authorization list. You do this by first securing the object with the authorization list and then specifying *AUTL for the object's *PUBLIC authority. The choice you need to make when securing your files with authorization lists is whether to set the *PUBLIC authority of the authorization lists to *USE or *EXCLUDE. This decision will, of course, depend on the type of data and your organization's security policy requirements.

How Many Authorization Lists?

When securing only a handful of files, it probably makes sense to use the same authorization list to secure those files. However, when reworking an entire application, I've seen people get paralyzed over trying to decide how many authorization lists to use.

There is not a "right choice" as to how many authorization lists to use. Some will choose to use one authorization list across an entire application, acknowledging that users authorized to the list will have authority to all files secured by the authorization list, including some files to which they really don't need authority. Some will choose to have multiple authorization lists so that users have explicit authority to the files only if there is a business justification to give the authority. Most implementations end up somewhere in between.

Don't let the decision of how many authorization lists paralyze you. If you're having trouble deciding how many authorization lists to use, start with fewer authorization lists rather than more. If you use too many lists, your implementation is going to make it hard to maintain them and remember the purpose of each. I encourage you to choose an approach and implement it, realizing that this architecture lets you easily change

the number of authorization lists in the future. All you have to do is switch which authorization list is securing a particular file.

I usually start out our clients' projects assuming that there will be a minimum of two authorization lists. One authorization list will secure the files that are accessed directly—by ODBC or FTP or files that individual users download to spreadsheets. The other authorization list will secure all the other files in the libraries being secured. While you could choose not to secure the rest of the files with an authorization list, I purposely choose to do so in the event that an outside process wasn't identified during the investigation phase or to easily accommodate a new process. This way I can grant the access in real time and then later, during a down time, I can switch the file to be secured with a more appropriate authorization list.

*PUBLIC Authority

*PUBLIC authority is another area where you have some choices to make in providing secure access. You must consider separately the *PUBLIC authority that should be granted to programs, libraries, and other application objects.

*PUBLIC Authority of Programs

If your programmers ever perform debug operations on programs on your production system, you're going to have to determine how they get authority to do so. Debugging a program requires the programmer to have either *CHANGE to the program or *USE to the program plus *SERVICE special authority. If you don't provide a service tools user ID to the programmer, giving him or her *SERVICE special authority is not as dangerous as it once was. However, if you're not comfortable with this, setting programs and service programs to *PUBLIC *CHANGE may be an option. About the only things you can do when you have *CHANGE authority to a program that *USE doesn't allow are debugging the program and changing the program's description. Given that end users shouldn't have authority to the debug commands, this alternative might be a viable option.

Another option is to secure the programs with an authorization list. You can then grant the programmer group *CHANGE authority to the list so they can debug the programs without having *SERVICE special authority. The choice you'll have to make with this implementation is what the *PUBLIC authority of the authorization list is set to. In this case, you have the option of setting *PUBLIC authority to *EXCLUDE as long as you're sure you've identified all the groups of users and application profiles that need to call the programs. Make sure you grant those profiles *USE authority to the authorization list.

Securing Libraries

Although it may seem obvious to set the *PUBLIC authority of a library to *EXCLUDE to keep users out of the library, this setting may not be the best choice from a practical standpoint. If only a handful or small group of users needs access to an application or library (e.g., an HR application), setting the libraries that make up this application to *EXCLUDE makes sense. However, if most users on the system use the libraries, it doesn't make sense. That's because all the users end up having authority to the library so that they can use the application. Also, if the libraries are in the users' library list, the users must have authority to the libraries or they can't sign on to the system. So it makes more sense to set the library to *PUBLIC *USE and appropriately secure the objects in the library (i.e., set all application objects—at least the files—to *PUBLIC *EXCLUDE).

*PUBLIC Authority of Other Application Objects

I've discussed the fact that application files' *PUBLIC authority will come from authorization lists, and I've talked about the *PUBLIC authority setting for libraries. But what about the rest of the application objects? One question you can ask is whether you're even going to bother with setting the *PUBLIC authority of the rest of the objects since it's really the data in the files that you're trying to protect. Some people will make sure to set the ownership of all application objects properly (so that the adopted authority is assured of working correctly) and leave it at that. My preference is to also address the *PUBLIC authority of the rest of the application objects. Here are some guidelines for you to follow:

- The following objects can generally be set to *PUBLIC *USE:
  - Libraries whose objects the general public can use
  - Directories—DTAAUT(*RX) OBJAUT(*NONE) (for directories containing objects with private data, use DTAAUT(*EXCLUDE) OBJAUT(*NONE))
  - Display files
  - Message files
  - Data areas
  - Data queues
- The following objects may need to be *PUBLIC *CHANGE:
  - Libraries in which temporary objects (e.g., queries) are created

- Output queues (object type OUTQ), message queues (MSGQ)
- Device descriptions (DEVD)

Queries

I've left the matter of queries to the end because this is a difficult area to manage. Why is securing queries so hard? In the case where a user runs a predefined query from a menu option that produces a report, it isn't. The trouble comes when users have the ability to modify the queries or use a file as the output option. When either of these activities can occur, that's when the difficulties start.

One of the options of a query is to produce a file rather than a printed report. If the same person always runs the query, things are fine. But if a different person runs the query on Monday morning and another person runs it on Wednesday afternoon, that's typically where problems arise. Why? Because the query is often written to delete and recreate the file produced by the query. Say Mira owns the file after running the query. If the *PUBLIC authority of the file isn't *ALL, when Alan then goes to run the query, he doesn't have sufficient authority to delete and recreate the file. Compounding the problem is that the query file is often being created into the same file as all production data. That's a problem when your new security architecture has set the production libraries to *PUBLIC *USE or *EXCLUDE.

I highly recommend moving these query files into a separate library from your production data. This approach gives you options for securing the files that you don't have if you leave the files in the same library. (It also allows production libraries to remain secured more appropriately.) I also recommend that you don't lump all your users' query files into the same library. That's because query files are often downloaded to a PC or sent to a server. When queries are downloaded to PCs, the user running a query to gather inventory information is most likely not the same person who runs a query related to your organization's financial data. For that reason, one user shouldn't have the ability to see—or download—the other person's data. If all query files reside in the same library, it becomes much more difficult to secure files to ensure only the appropriate people see the appropriate data. If you direct the query files to be created into separate libraries by area, you can easily allow the accounting group to have access to their own library and set *PUBLIC to *EXCLUDE. Likewise, you can have a different library for queries generated by HR, for example.

Another reason to separate the queries out of the production data file is because of the authority required to the library. If the file is being deleted and recreated, the users need

*CHANGE authority to the library. You typically don't want to have your production data library set to *CHANGE. For query libraries, you can set the *PUBLIC authority to *EXCLUDE (to prevent unauthorized access of the data) and authorize the user or the group with *CHANGE authority.

Here are some methods I've implemented when securing queries:

- *Option 1*: The query files are owned by the application owner, the query is called from a program that adopts the application owner's authority, and the query specifies to replace the member rather than replace the entire file. This technique doesn't change the ownership of the file itself, and because the query is running with adopted authority of the file owner, there will be no authority issues.
- *Option 2*: If the users running a query are in the same group profile, consider configuring the users' profiles so that any new objects they create are owned by their group profile. In other words, set the OWNER parameter of the user profile to *GRPPRF. Note: This option will not work if the query is run by users in different group profiles.
- *Option 3*: Once you've separated the queries into different libraries, you have the option to specify the CRTAUT (Create authority) parameter on the library. In this case, you can specify an authorization list for that parameter so that any new object created into the library is secured with the authorization list. You typically grant the users or groups running the query *ALL authority and set *PUBLIC authority to *EXCLUDE. This option works well when users in different groups need access to the query files.

Making Changes to the Application

Now that you've done all your investigation, you're ready to make changes to the application configuration. Several of the changes you'll be making need to occur when the application objects aren't in use. You'll want to take advantage of down time to make these modifications. Fortunately, most of the changes can be done far in advance of the time when you actually start to lock down the files. Done in the right order, the following steps impose very little risk of affecting application processing when you make these changes ahead of the start of your project.

Step 1: Identify any objects that need to be owned by an* *ALLOBJ *profile. Some *PGM objects may have been architected to be owned by a powerful profile (that is, a profile

that has *ALLOBJ.) For example, you may have created a CL program to be used by your help desk that re-enables disabled profiles. In this case, you'll want to make sure that these objects are set aside and not changed in the following steps.

Step 2: Ownership of objects. Next, get all other application objects owned by the right profile. As you looked at the current configuration settings, you may have noticed that profiles other than the desired profile owned application objects. Because you want to have the authority come from adopted authority, it's critical that the program owner own the rest of the application objects.

Step 3: Program adoption. The next step is to change the application programs to adopt authority. You'll need to run the CHGPGM command against all the programs and service programs—except the initial program—in your application libraries, specifying *OWNER for the USRPRF parameter.

If you haven't already done so, perform the analysis to determine whether any application programs contain dynamic SQL. Dynamic SQL is becoming more prevalent in the programming community, so this is not a step you should skip. If you have programs that contain dynamic SQL, recompile them and specify *OWNER for the DYNUSRPRF parameter.

Step 4: Create the authorization lists. Next, create the authorization lists that you'll use to secure your application files. I recommend using a naming convention that makes it obvious what each authorization list is being used for. If the naming convention doesn't reflect its purpose, make sure its text description does.

When creating the authorization lists, consider creating them with *PUBLIC authority set to *ALL. Although this setting might be slightly more open than the current application settings, it's not much more so, and it's a temporary setting you can use to ensure that no processes are affected until you're ready.

Step 5: Attach the authorization lists to the file. The next part of the setup that you can perform ahead of your scheduled rollout is to attach the authorization list to the appropriate files. You must perform this step when the application is not active because you can't modify the security attributes of a file that's open. The process involves two steps: First, associate the authorization list with the files. Then, set the *PUBLIC authority of the files to come from the authorization list. Again, assuming that you've created the authorization lists with a wide-open security setting rather than the security setting you'll ultimately end up with, this step should not have any effect on your application.

Step 6: Set the *PUBLIC authority of the application objects. Last, you'll want to set the *PUBLIC authority of the rest of the application objects to their appropriate settings.

At this point, you've done nothing that should make any processes break or fail. Although nothing is foolproof, there is very little that could be failing at this point. The data continues to have wide-open access, so processes and users that need direct access should have sufficient authority. In addition, application users are still members of the group that owns the application or they have *ALLOBJ, so they, too, have sufficient authority.

Rolling Out the Changes

As you roll out your changes, order is once again important. If you follow the steps in the order given here, you'll limit which users or processes are affected by the changes, and you'll have a controlled rollout of your new security scheme.

Take the following steps if you're changing an application for which users must be members of the group that owns the application or must be assigned *ALLOBJ special authority.

Step 7: Authorize the outside processes and set the *PUBLIC authority of the authorization lists. Here's where you use Table 16.1. For every entry, grant the profile the required authority to the appropriate authorization list. In our example, you would add the authorities documented in the table *one at a time* to the appropriate authorization list. After adding each authority, you would then have the process tested or make sure the user can still access the data.

Up to this point, the only users or processes that could have been affected are the ones added to the authorization lists. The next step is to change the *PUBLIC authority setting of the authorization lists from wide-open to either *USE or *EXCLUDE. At this point, if you have missed any processes or users that need direct access to the application data, these will fail. After making this change, you may want to wait a couple of days before making other changes so that you can see whether anything is going to fail. Limiting the number of changes you make at once will allow you to more easily and quickly debug the failure because you'll have a better idea of where the error is originating.

Step 8: Remove excess special authorities of the owning profile. If you review the current capabilities of the application's owning profile and realize that it has more authorities than appropriate (in the example, the profile currently has *JOBCTL, *SAVSYS, and *SECADM but needs only *JOBCTL), now is the time to remove the excess special authorities. Again, you might want to wait a day or so to see whether there is any fallout from this step before proceeding.

Step 9: Modifying application users' access. It's now time to start removing users' *ALLOBJ authority or removing them from the group that owns the application. In both cases, I move the users into a new group. (This step is done to facilitate other security management practices, such as having the user's group own any objects that the user creates.) I usually find some power users scattered around the organization and move them out of the group that owns the application into their new group and/or remove their *ALLOBJ special authority. I tell these power users that some changes have been made, but that everything should work as it did before and to notify me if that's not the case. I let them run in their new configuration for a day or two before removing more users. Once the power users are working correctly, I start to move more and more users into the new group and/or remove their *ALLOBJ special authority until, by the end of the week, all users are in their new configuration.

Important note! If the application is using *PUBLIC authority to provide authority to application users, follow this additional step: Before you make any changes—even the setup changes—make each application user a member of the group that owns the application. This is a temporary assignment, but it's done to ensure that application users aren't affected as you change the application's security configuration and lock down the authorization lists. So make this your very first step in the entire process, and then proceed as documented above.

Changes to Change Management

Don't forget to make sure that any changes you've made to the application's security scheme are reflected in the application's change management settings. For example, if you've changed the public authority settings of some types of application objects from *ALL to *USE, you'll need to modify your change management software to create new objects of these types with the appropriate *PUBLIC authority setting. In addition, you'll want to make sure files continue to be secured with the appropriate authorization list, and so on. Last, you'll want to make sure the adopted authority attributes of programs are specified accurately so that programs—especially programs that make use of dynamic SQL—are compiled and promoted with the correct attributes.

When Something Breaks: Debugging and Recovery Techniques

Hint 1. If you make a change and everything starts to fail and the phone begins to ring off the hook, you have several things you can do to recover and get things working again

while you debug the issue. First, you can set the *PUBLIC authority of the authorization lists back to *ALL. Second, you can put the users back in the group that owns the application or give back their *ALLOBJ special authority. Note that the users will have to sign off and sign back on to have the change to their profile take effect, but once they do, the profiles will work as they did before. Either or both of these steps can be done quickly and will stop the failures while you determine and correct the cause.

Hint 2. Use Appendix D of the *IBM i Security Reference* to determine the authority or special authorities required to perform a command or task.

Hint 3. Don't forget to look in the audit journal to obtain more details about the failure—or to prove that it's not a security issue. Changing the application's security scheme gets a lot of attention. Unfortunately, until the changes are complete and have been in place for a few weeks, people will attribute *every* (and I do mean every!) problem to the security project.

As I roll out the changes, I proactively use the DSPAUDJRNE (Display Audit Journal Entries) command to check the audit journal every 15 minutes or so. Often, I catch the failure before the user calls in to report a problem. I pay special attention to the user profile and object fields in the audit journal entry. Sometimes, the error that the user sees is not the real failure. The audit journal entry will report the actual user profile experiencing the failure and the exact object for which the failure occurred. If I need even more details from the audit journal entry, I look to the far right of the entry on DSPAUDJRNE to find the exact time. Then I use the CPYAUDJRNE (Copy Audit Journal Entry) command to look for additional details, such as the program running. (For more information about using the audit journal, see Chapter 15.)

Hint 4. If the violation type (using DSPAUDJRNE) is an A, the failure is an authority failure. If the character is a K, the user lacked some special authority. For example, if the first character is K and the object name is CRTUSRPRF (object type *CMD), look for the CRTUSRPRF command in Appendix D of the *IBM i Security Reference*; you'll see that *SECADM special authority is required to run the command.

Hint 5. If you see a "Not authorized ..." message in the job log, look at the message details. If the message ID begins with CPF, the error is an authority failure; that is, a user doesn't have sufficient authority to some object. If the error message begins with SQL, the cause of the error is that a program that contains dynamic SQL has not been compiled with its DYNUSRPRF attribute set to *OWNER. In other words, a program has run that contains dynamic SQL, and the user doesn't have sufficient authority to something in the dynamic SQL statement. If the application's security scheme is to adopt authority, the

program will need to be recompiled with the DYNUSRPRF attribute set to *OWNER so that the SQL adopts authority.

Making Sure the Changes "Stick"

Suppose a production issue arises and programmers need to promote an emergency fix. This emergency process bypasses change management, and the program ends up being owned by the programmer. How are you going to discover this?

Worse, imagine that a vendor updates its application. In doing so, the vendor replaces the entire application, and all the changes you've so carefully architected, tested, and implemented are gone. You need some method of documenting your changes and being able to re-implement them when things change. You can either use the CL programs that you used to implement the changes the first time or buy a product to do this for you. I'm going to unashamedly promote the Policy Minder product for this because that's really where this product shines. You cannot ignore this issue, so whether you purchase Policy Minder or write the routine yourself, you must determine how you're going to maintain the settings you've just configured. Otherwise, you'll be doing this project all over again.

Gotchas

I try to do everything I can to avoid "breakage." This entire chapter is designed to help you do that as well. You can never identify everything before you start making changes. However, here are some of the issues to be sure you watch out for.

- Make the appropriate updates to your change management software and processes to reflect the applications' new security setup. Imagine forgetting this step, getting all application objects changed and the new configuration tested, and then having all new object promotions be done with the old security settings!
- Look in the audit journal before you make any configuration changes. Some AF (authority failure) entries occur "naturally" on your system. Consider these as false positives. No one complains and processes don't fail, even though these failures occur. I've chased a problem for 20 minutes that I, in time, concluded was one of those naturally occurring audit entries and wasn't caused by the application changes that our client and I had just implemented. Looking at the audit journal prior to making changes will familiarize you with what is currently happening on your system and avoid chasing the cause of audit entries that aren't actually causing problems.

- Don't forget to change the *PUBLIC authority of the authorization lists from their wide-open setting. A lot of testing time can be wasted testing with the wrong authority setting!
- Be sure to make the changes in the order described. Perform them in the wrong order, and you'll be affecting all users and all processes all at once. If you've covered everything, you'll be fine, but if not, the phone will be ringing off the hook and your inbox will be flooded with incoming problems.
- Identify the processes that are difficult to rerun if they fail, and make sure you test these on a development or quality assurance machine that's configured with the new security scheme before running them with the new security scheme in production. I've seen multistep processes that can easily be rerun if they fail in step 3, but if the procedure gets all the way to step 7, the databases updated to that point have to be hand corrected. These are the types of processes you'll want to make absolutely certain are tested before your rollout on production.
- Review the authority-checking algorithm before making any changes. When trying to debug why something isn't working correctly, it's imperative that you understand the order in which authorities are checked.
- When changing the security scheme of a vendor application, contact the vendor before making any changes. Some vendors have documents that will help you modify their application. And you want to make sure you won't be violating any license or maintenance agreements by making the changes.

Summary

I realize that this is an intense chapter with a lot of information. If you aren't comfortable or don't feel that you understand it, reread it until you understand the information before making any changes. Also, know that there are no guarantees. While this methodology has worked for me, I cannot promise it will work for you. But I hope I've provided enough information so that you'll be able to successfully implement an object-level security project of your own.

CHAPTER 17

Security Administration

One focus of this book is security administration. All security administrators have more than enough to do. The goal of this chapter is to point out the areas that need attention so you can manage them effectively.

Remove Obsolete Objects

While removing obsolete objects might seem like an area to be left to the system administrator, the security administrator may need to spearhead the effort to ensure obsolete objects are removed from the system. One of the first things I do with our clients when we perform a remediation engagement is to look at the system and determine whether obsolete objects need to be removed. Any object on the system has security implications, so if an object is not being used, it should be removed from the system. Doing so not only will free up disk space and reduce backup times, but it's also likely to reduce risk. I can't tell you how many times we've found copies of production data—often clear-text credit cards or payroll data—in developer or test libraries. The copies typically were made to debug a problem or test a fix and then were forgotten about. If you remove obsolete objects from your system regularly, these extraneous copies of production data will be eliminated from the system.

One way to remove old objects is to use the archive function of IBM Backup, Recovery, and Media Services (BRMS). BRMS lets you define a policy for what should be archived. Archiving data objects such as physical files and data areas removes them to media and frees their storage, but it retains enough of the object on the system so that, in the rare instance in which a file that was really needed has been removed, it can be accessed. Eventually, you can remove these objects fully from the system and media. This technique may keep some skeptics at bay and enable you to clean up your system. (I've heard many objections arise as administrators tried to remove obsolete objects—even when the last-used date indicated the object hadn't been used in over a year!)

System Values

Several system values are critical to the security of your system. But of very high importance are QSECURITY (make sure it remains set to 40 or 50), the auditing system values QAUDCTL and QAUDLVL (make sure they are not set to *NONE), and QPWDLVL (make sure it's either 1 or 3). Of somewhat lesser priority is the QPWDEXPITV system value (make sure it doesn't get set to *NONE, which means that passwords are not required to be changed). If you monitor for no other system value changes, you'll want to regularly check to make sure these five critical settings have not changed.

To monitor this aspect of your system, you can write a query to retrieve system value changes that are logged to the audit journal and then generate and check this report daily. Or, you can purchase a vendor-written package that monitors system values—even better if you can be notified of a change to these critical values in real time.

Strong warning! If you're administering a system where QSECURITY is less than 40, you need to make a high-priority project to get your systems to level 40 or 50. You *cannot* ensure the integrity of your data running at anything less than security level 40. I've heard people try to justify running at a lower level, saying they've taken this precaution or that. But facts are facts. IBM clearly states that you cannot have a secure system, or operating system integrity or data integrity, unless the system is at security level 40 or 50.

Other system values that have become important are those that control the encryption algorithms used when connecting via an encrypted session. See Chapter 10 for details on how the QSSL* system values work together and their importance.

User Profiles

Many of the issues surrounding user profiles can be avoided if you create them correctly in the first place. I recommend setting up template profiles that represent each type or

role being created. Create these profiles without a password (PASSWORD(*NONE)) and with only the special authorities required to perform the various job functions. The proliferation of excess special authorities is due primarily to administrators copying someone's profile—typically someone who has been with the organization for some time and has been given special authorities (often *JOBCTL, *SAVSYS, and/or *SPLCTL) somewhere along the way. Copying this profile adds the unnecessary special authorities to yet another user. In contrast, creating a new profile by copying a template assures you that the profile is created with the exact configuration required for the individual to perform his or her job functions ... and nothing more.

Many of you realize that you have many users with excess special authorities. Cleaning up all existing profiles may require a large effort. However, if you take the approach just described (to create new profiles with only the special authorities required to perform the relevant job function), the problem won't get any worse. As you have time, you can then remove other profiles' excess authorities so that, eventually, all profiles will be left with just the required special authorities.

Creating profiles with excessive authorities is also a problem when creating service profiles. These profiles typically are used to establish a connection to another system. Just because they're service profiles does not remove the requirement to create these profiles with only the authorities they require. I often see profiles created with all special authorities; then, after some investigation, it's often determined that those profiles should have no special authorities. Service accounts present a risk to the system because they're usually created with a non-expiring password. I recommend that you not increase that risk by creating the profile with excessive capabilities.

Another issue with profiles is that of default passwords. As I mentioned, create new profiles without a password and assign a password only when the employee or vendor appears for work and the person's identity has been verified. Then assign a unique password, and require the user to change it the first time he or she signs on.

In addition to removing obsolete objects in general, we need to specifically focus on the issue of removing inactive profiles from the system. Inactive profiles—especially those left active—present a significant risk. Even worse is when the profiles were created—and left—with a default password. I think many administrators are hesitant to remove inactive profiles because they have removed profiles in the past only to have to quickly restore or recreate them. That's likely because the wrong date was being examined to determine inactivity. The last-used date (rather than the last sign-on date)

needs to be examined to ensure profiles used on ODBC connections, in FTP scripts, or by batch jobs are not flagged as inactive.

To discover and manage inactive profiles, you can obtain a list of profiles and their last-used date by running DSPUSRPRF *ALL and sending the results to an outfile. From that output, you can determine whether the status should be set to *DISABLED or the profile should be removed from the system. You can also use the **Change active profile list** and **Analyze profile activity** options within the integrated security tools (SECTOOLS) to set inactive profiles to a status of *DISABLED. (Type **GO SECTOOLS** and use options **3** and **4**.)

Several security-relevant system values can be overridden at the user level. Two attributes should be of specific concern to you: "Block password change" and "Password expiration interval." The password expiration interval attribute overrides the QPWDEXPITV system value. It's important that this attribute *not* be set to *NOMAX for any profile that represents a person (versus a group profile, an application owner profile, or a profile that's used for connections such as FTP or ODBC). Make sure this attribute remains set at *SYSVAL, and for powerful profiles (such as your own and QSECOFR), consider setting this value to require the password to be changed even more frequently.

The block password change attribute states how long, in hours, a user has to wait before changing his or her password again (using an interface such as the CHGPWD, or Change Password, command). No users—and especially not operators, DBAs, or programmers—should be given the opportunity to change their password right away and revert to the same password they've been using when they received the "password expired" notification. Make sure the QPWDBLKPWD system value is set to at least 24, and make sure this user profile attribute remains set to *SYSVAL.

While the limited capability attribute does not completely limit profiles' abilities as it did before the world of TCP/IP, it's still a good practice to set users to be limited capability *YES. There's no good reason to give users, especially end users, the ability to run any command from a command line.

Once again I want to call your attention to service account configuration. In most cases, service accounts are not intended to be used for sign-on. To enforce that, most administrators set the Initial program of the profile to be *NONE and the Initial menu to *SIGNOFF. However, if you use the default sign-on screen as shipped by IBM, you will also want to make sure you've set the Limited capability attribute to *YES. This ensures that no one can enter the service account's user ID and password and override the Program or Menu parameters on the sign-on display, giving them the ability to use the service account for interactive sign-on. Setting LMTCPB to *YES or *PARTIAL prevents this.

Finally, you need to control who has a private authority to profiles and profiles' *PUBLIC authority setting. With the exception of a few IBM profiles, the *PUBLIC authority of profiles should be *EXCLUDE. If you run the DSPOBJAUT (Display Object Authority) command for a user profile, you'll see that the owner of the profile object will have *ALL authority and the profile will have *CHANGE and *OBJMGT authority to itself. If the profile is a group profile, each member will have *OBJOPR, *OBJMGT, *READ, *ADD, *UPD, and *DELETE authorities to the group profile. These authorities are granted by the operating system and should not be removed. However, I often see group members that have been granted *EXECUTE authority or profiles granted *USE authority to another profile. This authority allows the person authorized to the profile to submit a job and run with the privileges and authorities of that profile—something you typically want to avoid. In one case, the person in charge of change management somehow got *USE authority to the QSECOFR profile. This allowed him to add a job scheduler entry and run with the authority of QSECOFR. This and other excess authorities he somehow obtained caused many application files, programs, and authorization lists to be set to a wide-open setting, causing significant risk to the confidentiality and integrity of the organization's data.

Managing Authorities

Make managing the authorities to objects as simple as possible. Go ahead and use authorization lists and group profiles to help you manage who gets authority to specific objects. There has been hesitation in the past to use these management tools because of the fear of affecting performance. While that may have been an issue in the first releases of OS/400, that fear is based on very, very old information. These days, you really have to *try* to have your security implementation be a performance issue. So, if it makes your life easier as an administrator, go ahead and use the tool provided by the operating system.

Regular Reviews

One thing I know that's difficult to manage is finding the time to review the user and object settings on the system. Using group profiles and authorization lists will facilitate this review. But I can't emphasize enough the need to review your configuration periodically. If you only do this review prior to your annual audit, your systems or data may be vulnerable for months. In chapters 4 and 6, I've listed the integrated tools provided with the operating system to help you review user profile attributes and object authorities—*use them*!

Unless you have something that will help you automate periodic checks, this task will overwhelm you and consume all your time. So my first recommendation is to automate these tasks. If you don't have that option, make a list of the files containing personally identifiable information (PII) data and data that is highly confidential to your organization. Check to make sure these files are owned appropriately, that the *PUBLIC authority is set based on your security policy requirements, and that only the users with a job requirement to access the files from outside the application have authority. For user profiles, make sure you're checking the attributes I've mentioned in this chapter and periodically review the members of group profiles and users authorized to authorization lists

Controlling Who Can Do What

Your system will be easier to administer, and you'll be less likely to have to remove excess authorities and find a vulnerability when you perform a periodic review, if you simply control who can do what on the system. One way to do that is to make sure users have only the special authorities required for their job function. Take *SAVSYS special authority. No end user or programmer should be able to save anything off the system or restore anything onto the system, regardless of their authority to the object. That's not their job function. But permitting a profile to have *SAVSYS special authority provides that capability.

Some tasks don't require a special authority, so you need to look at another approach. For example, you may want to limit what can be created on the system by setting the *PUBLIC authority of commands such as CRTDIR (Create Directory), CRTLIB (Create Library), and MKDIR (Make Directory) to be *PUBLIC *EXCLUDE; thus allowing only administrators (that is, users with *ALLOBJ) and users explicitly authorized to the commands to create directories or libraries.

You may also want to limit who can create programs on the system. Setting the CRT*xxx*PGM commands to be *PUBLIC *EXCLUDE will prohibit programmers from creating programs on production systems and force them to go through the approved change management process.

Integrated File System (IFS)

One method for taking control of your system is to set root ('/') to a more appropriate setting than how it's shipped. When shipped, root is set to the equivalent of *PUBLIC *ALL. A more appropriate value—and one that will control what's created directly into root—is *PUBLIC authority DTAAUT(*RX) OBJAUT(*NONE). This setting can also be applied to the /QOpenSys file system and the /home directories in both root and QOpenSys. However,

before locking down any of these, you'll want to examine the "Creation of objects" and "Deletion of objects" audit journal entries to make sure you're not going to break a process that is currently writing to one of these directories.

When thinking of the IFS, I also think of file shares. I understand that as an administrator, it makes your life easier if you share root. But don't succumb to that temptation! Shares on the IBM i are usable by all profiles on the system. When you share root, you've also shared all of the QSYS.LIB file system—in other words, all of your libraries are also shared. Define the shares at the lowest level possible.

Stay Current

While IBM does not issue many security-related PTFs, some are issued. These fixes are classified as "integrity" PTFs and should be applied as soon as possible to remove the vulnerability. I suggest that you use the PTF subscription service provided by IBM to be notified when a security-relevant PTF is issued.

In addition, it's also good practice to stay current with other PTFs. For example, Java is in widespread use by various operating system functions and products. While they may not be classified as integrity PTFs, some Java PTFs close vulnerabilities. So regardless of the classification, it's good to stay current on PTFs.

Another aspect of staying current is to use the current version of IBM and vendor products. This includes the client software used to access the system. Make sure you are using a version that allows encrypted sessions. And for those of you who have been using Client or iSeries Access, you'll need to change to using Access Client Solutions. As I discussed in Chapter 10, IBM will not support the older software on Windows 10. The good news is that it will be much easier to keep ACS updated than keep the older software updated. I encourage you to switch to ACS as soon as possible and make plans to keep up with updates as they become available from IBM.

Summary

Security administrators often wear multiple hats—some of which may conflict with or outweigh others. Many times, the security administrator is also the system administrator. While it would be easier—from a system administrator point of view—to avoid security best practices and simply open up the system (e.g., give all users *ALLOBJ special authority—which, by the way, I've seen happen), I hope that your security administrator hat will get more use and outweigh the temptation to ignore your security administration duties.

CHAPTER 18

Maintaining Compliance

One focus of this book has been about implementing IBM i security so that the system's configuration will be in compliance with your organization's security policy. The focus of this chapter is maintaining that configuration, or maintaining compliance. Compliance is not a one-time event. Compliance is a continuous process—or, as I like to describe it, a "lifestyle."

Unfortunately, unless you make an effort to keep your system's configuration in compliance, it's likely to drift out of compliance. How does that happen? You install a new application, and the installation process changes system values. Or, you install a new version of a vendor product and, because the vendor deletes the old libraries and restores the new product version, all the security changes you've made to the application objects are gone. Or, one or more systems are consolidated onto the same LPAR. Or, objects are promoted into production because an emergency fix was required, and now the ownership and object authorities aren't correct. Or, additional authorities are added to an authorization list in the quest to solve a production issue but are never removed when the issue ends up being unrelated to security. A variety of occurrences can cause your security configuration to drift.

So, how do you maintain a compliance lifestyle? By putting processes in place that regularly check security settings. Now, I have to be honest. I designed my company's Policy Minder (works with AIX and Linux) and Policy Minder for IBM i products to

do this type of checking and automate compliance tasks. So I no longer monitor the compliance of a system "by hand." But I know that some of you would prefer to build your own processes. So let's look at what parts of the system need to be examined regularly.

Evaluating the Key Areas

Three areas of the system are key for maintaining compliance with your organization's security policy. Before we take a look at these areas, here are some reminders:

- The only way you can know you're in compliance is to compare the current settings with the values required by your security policy. If you don't know what these values are supposed to be, there's little point in examining the settings regularly. My point is that you must first determine the appropriate settings—in other words, the values that support or implement your organization's security policy requirements.
- Document your exceptions (that is, write risk acceptance statements). I have never seen a system implemented entirely with best practices settings—there are always exceptions. You'll want to document those exceptions, explaining why the best practices setting can't be achieved and noting any mitigating factors (issues or situations that cause the current setting to not be a significant risk), along with any compensating controls (other technologies, processes, or settings in place that reduce or eliminate the risk of the current setting). This documentation is useful in at least two situations:
    - For auditors—Documenting your risk acceptance means that you have evaluated the situation and have an understanding of the risk the setting poses to your organization. In other words, you've thought through the situation.
    - For future administrators or security officers—Documented risk acceptance statements provide important information for future employees or consultants when they examine the security configuration of the system. From experience, I can tell you that it's very helpful to know why a specific setting was chosen. With this information, you know what needs to be accommodated, if you're considering changing the value.
- Throughout this book, I've espoused best practices. If you're looking for guidance, see the chapters in which these topics have been discussed in detail to find the recommended best practices setting.

Now, let's take a look at what you'll want to examine on a regular basis—in other words, what you'll want to check to maintain a compliance lifestyle.

System Values

Although you may not want to look at *all* system values, you at least want to examine the security-relevant system values that I discussed back in Chapter 3 to make sure they don't change. There are a variety of ways you can examine system value settings, the easiest being to run the DSPSYSVAL (Display System Value) command and compare the current settings to those required by your policy. If you want to guarantee that no one other than those with a service tools user ID can change system values, consider using the system value "lock-down" feature I described near the end of Chapter 3.

User Profiles

I've found that unless you have automated processes in place, user profiles are one of the first areas of the system to drift out of compliance. When examining user profiles for compliance, you'll want to look at several things. The first issue to look for is the configuration of the user profiles as they get created. In other words, as new profiles are created, do they have the correct special authorities, group assignment, initial program, initial menu, and limited capability setting? Profiles are often created by copying an existing user's profile. Creating profiles using this method often results in profiles being created with excess special authorities and group assignments.

Next, look at the attributes of the user profile that could be issues during an audit—things such as profiles with default passwords, profiles with password expiration intervals set to *NOMAX (in other words, the users never have to change their passwords), and profiles with the limited-capability attribute set to *NO or *PARTIAL. In addition, auditors usually want you to keep a list of the users who have been assigned a special authority—especially those with *ALLOBJ—and to be aware if that list changes. Another list to keep track of is the users who have been made members of QSECOFR or other powerful profiles (that is, group profiles with *ALLOBJ or *SECADM special authority). Checking these attributes should not be an event that happens the week or two before the auditor appears. Not only are these attributes relevant to an audit; they're also relevant to the security of your systems. The easiest way to list the attributes of all profiles is to run the DSPUSRPRF *ALL command and send the results to an outfile, which you can then query or download to a spreadsheet for further examination.

Table 18.1 lists some commands you can use to examine user profiles.

Table 18.1: Commands for examining user profiles	
Command	**Description**
ANZDFTPWD (Analyze Default Passwords)	Lists the profiles with default passwords
DSPAUTUSR (Display Authorized Users)	Prints a report of all users and the groups they belong to (if any) or a report of all groups and their members
DSPUSRPRF (Display User Profile)	Can display an individual user profile or can send the details of all user profiles to an outfile
PRTUSRPRF (Print User Profile)	Sends the details of all user profiles to a spooled file

The user profile issue that I see affecting compliance most quickly is that of inactive profiles. Many laws and regulations require profiles to be disabled or removed from the system on a timely basis. For example, PCI DSS requires any inactive profile to be disabled or removed after 90 days of inactivity.

But aside from being a compliance issue, inactive profiles are a significant security issue. To leave profiles on the system in a configuration such that they are usable is opening your organization up for trouble. Many breaches have occurred by exploiting the accounts of individuals who have been dismissed from the company or who no longer need access.

If you decide to manage inactive profiles with your own automated process, make sure you're looking at the right dates associated with the profile. You'll need to examine the profile's creation, last-restore, and last-used dates, with the last-used date being the critical date. These dates are obtained by running the DSPOBJD (Display Object Description) command—not the DSPUSRPRF (Display User Profile) command. Many people have gotten "burned" by designing a process around the profile's last sign-on date (which is the date shown when you run DSPUSRPRF). The problem with this approach is that the last sign-on date is updated only when the profile signs on to the system via a 5250 sign-on screen. It is not updated when the profile is used only to run batch jobs or to sign on via a DDM or ODBC connection; however, the last-used date is updated in these cases.

IBM profiles are another area you need to monitor. I often see special authorities added to or removed from IBM profiles. Removing a special authority is typically not a problem, but adding a special authority (e.g., adding *ALLOBJ to QPGMR) can create a significant exposure. Another thing to check is to ensure all IBM-supplied profiles (with the exception of QSECOFR) remain set at PASSWORD(*NONE). (All IBM profiles other than QSECOFR are shipped without a password.) You can check both of these items by looking through the report created by the PRTUSRPRF (Print User Profile) command.

Object Authority

Which object authorities you need to examine will depend on your security policy. Perhaps your examination can be limited to only a handful of files, such as your employee master database or the files containing cardholder (PCI) data. Or, it's possible you need to regularly check the authorities to files containing private data. Or, you may need to evaluate the ownership, adopted authority attributes, authorization list association, *PUBLIC authority, and private authorities associated with all objects in an entire application. Regardless of the scope of the requirement, having an automated process to evaluate whether the objects' security attributes are set correctly is key to compliance. I have seen well-meaning administrators try to keep objects secured appropriately, but without an automated process, other projects took priority and the authorities they meant to examine every Monday morning were forgotten or reprioritized. As an administrator, you have way too much to do to check these settings "by hand."

In addition to libraries and database files, make sure you don't neglect the directories and objects in the IFS. There are usually a handful of directories that need to be secured in a specific way so that private data is not exposed. You should examine these directories' security attributes along with those of the libraries and their objects.

Table 18.2 lists some commands you can use to examine object authorities.

Table 18.2: Commands for examining object authorities

Command	Description
DSPOBJAUT (Display Object Authority)	Displays an object's owner, owner's authority, primary group and its authority, authorization list assignment, *PUBLIC authority setting, and any private authorities assigned to the object. You can specify to display the authorities of all objects of a particular type or all objects in a particular library and send the results to an outfile. You can then compare these results with the known or previously approved settings.
DSPAUT (Display Authority)	Displays the same attributes as DSPOBJAUT except for objects named using a pathname (e.g., '/home/cjw').
PRTPUBAUT (Print Public Authority)	Prints a report of the *PUBLIC authority of all objects of the specified type.
PRTPVTAUT (Print Private Authorities)	Prints a report of the private authorities assigned to the objects of the specified type.
DSPAUTL (Display Authorization List)	Displays the users authorized to the authorization list.
DSPAUTLOBJ (Display Authorization List Objects)	Displays the objects secured by the authorization list.

An Annual Security Assessment

Just as we all should go to the doctor for an annual physical, our systems need an annual checkup as well. Several laws and regulations require a comprehensive security assessment. In addition to being a compliance requirement, it's a wise thing to do. An assessment is significantly broader than the compliance checking described earlier in this chapter. A security assessment looks for vulnerabilities across the system's configuration. Aside from the compliance requirements, why perform a security assessment? Because changes to your systems' configuration may have opened up vulnerabilities. These changes can occur when a new application is installed, the operating system is upgraded, systems are consolidated, or companies are merged.

Our Risk Assessor product performs an automated security assessment, so I no longer do this work "by hand." But if you're going to do the assessment yourself, I suggest you examine at least the following areas:

- All security-relevant system values (making sure to check for new system values after an operating system upgrade)
- User profiles settings (checking for extraneous private authorities, changes to IBM profiles, making IBM profiles groups, IBM profiles with passwords, and so on, in addition to the configuration items noted previously)
- Service tools user IDs (making sure the passwords of all service tools user IDs, including IBM-supplied IDs, are changed regularly)
- Object authorities of objects in both libraries and directories (including the create authority of libraries and the auditing values of both libraries and directory objects)
- File shares (making sure that only the appropriate directories and libraries are shared)
- TCP/IP settings (checking auto-start and time-out values)
- Navigator for i settings (using Application Administration to limit what parts of Navigator and IBM i Access or Access Client Solution users are allowed to see on their desktops)
- NetServer settings (making sure no guest profile is assigned)
- Adopted authorities (especially examining programs and service programs that adopt an *ALLOBJ owner)

- Programs registered for exit points (making sure no programs have been removed or added—this is critical if you are depending on exit programs to prevent inappropriate access of data from network interfaces such as FTP and ODBC)
- Commands that limited-capability users can run
- Job descriptions
- Subsystem descriptions
- Output queue and job queue descriptions
- DDM settings
- Web server configurations

You'll also want to run the CHKOBJITG (Check Object Integrity) command on at least an annual, if not a quarterly, basis. This command performs a "self-check" of the operating system. It will identify any altered operating system objects as well as user-written programs that have been modified to run in system state. At the very least, you'll want to run this command for the objects owned by QSYS (if not all profiles on the system). The command can be CPU-consuming, however, so you'll want to submit it and run it in a low-priority subsystem so it doesn't affect other processing.

Regular Reviews

Even when items are known to be in compliance—that is, they match your security policy requirements—some areas of the system should be examined regularly to determine whether the settings are still appropriate. Just as you need to review your security policy to see whether it should be modified for changing business situations, so too do you need to review the following areas: group profile membership, special authority assignments, authorities to authorization lists, and the objects that authorization lists secure. Reviewing these items will ensure that your systems' configuration is in compliance with the requirement of "least-privilege access"—that is, that users have only the capabilities and access required to perform their job functions. While an administrator or a security officer can facilitate these reviews, they typically should be performed by someone else because these roles may not be aware of changes that would cause these areas or assignments to be modified or removed. I recommend that these areas be reviewed at least annually, if not quarterly.

Group Profile Membership and Special Authority Assignments

If you have implemented role-based access (as described in Chapter 13), this review is fairly easy. Just print the configuration of the group profile (DSPUSRPRF group_name) to list the special authorities associated with the group. Then, print the members of the group (DSPUSRPRF group_name TYPE(*GRPMBR)). Give the appropriate manager a description or characterization of the types of functions allowed by each special authority assigned to the role (if any), along with the list of the users in the role. The manager should be able to quickly discern whether the list continues to be appropriate or adjustments need to be made. This is typically where you find out that users have changed positions within the organization. These users will often remain in their old group (role) until a review such as this is performed.

If you haven't implemented role-based access, you'll need to print every user's special authorities and group assignments and give all this information to each user's manager. This review is significantly more time-consuming for the manager and is far less likely to result in an accurate or comprehensive review (due to the overwhelming amount of information presented to each manager).

I encourage you not to neglect the review of group membership. I've helped clients rework group assignments after several years of neglect. Before being reworked, users who had moved to other departments had remained in their groups, giving them access to information that they had no longer had a business justification to access. The longer the group list remains unmaintained, the harder it is to "untangle."

Authorization Lists

Although it's good to know that no additional authorities have been granted to an authorization list (in other words, it is in compliance), the present authorities need to be reviewed to ensure they are still appropriate for the current business needs. To perform this review, print the users authorized to the list (using the DSPAUTL, or Display Authorization List, command). You may also want to print the objects associated with the list (using the DSPAUTLOBJ, or Display Authorization List Objects, command). Present this information to the owner of the data that the authorization list secures.

For example, if there's an authorization list that secures all HR data, give the list to the head of HR. It's likely the HR head will delegate the task of reviewing the users authorized to this information, and it's also likely that you (as an administrator) may have to explain the types of actions the authorities allow the user (for example, *USE permits viewing and downloading of data). But this is one way to get data owners to gain an

understanding of the types of actions that can occur when they allow access to their data. After this, they tend to take the responsibility for approving users' access to the data more seriously.

Authorization lists are something that I find fall out of compliance quite quickly and quite often. Newly implemented authorization lists always start out with just the users who need authority; however, inevitably, users are added to the list, often to help debug a production issue or to allow access to a file. Even when the profile should be given access, access is rarely added with "least-privilege" access' rights—the authority granted is often excessive. To be honest, the "authority creep" that occurs with most authorization lists is a pet peeve of mine! If you regularly review the users and the authority they have to the list, this won't happen to your organization.

Policies and Processes

Just as checking the compliance status of your system values, user profiles, and object authorities is not a one-time event, writing a security policy is not a one-time event. As I mentioned in Chapter 2, a security policy needs to be updated at least annually. And just like your security policy, your processes need to be up to date. Auditors will often take a process that implements a part of your organization's policy and follow it through to ensure it's being complied with. If what the auditor observes is different from the written policy, the auditor will know that something is wrong. However, the auditor won't know if the problem is out-of-date documentation or a person who is ignoring the written process; therefore, the matter will typically be written up as an audit finding. Here's the list of processes that I recommend you review and update at least annually:

- *Backup strategy*—Make sure you're backing up all pieces of your application as well as audit journal receivers and any other information needed for compliance.
- *Disaster recovery*—While your backup process is part of your disaster recovery documentation, your disaster recovery process is far more comprehensive, takes significant planning, and should be tested at least annually.
- *Patch strategy*—In IBM i terms, this is your strategy for obtaining and applying PTFs.
- *Change management*—This process should include the process of promoting application changes, enhancements, and fixes into production.

- *User account management*:
  - *Creation*—Documentation for this process should include the original request for access, proof that the request was approved, and confirmation that the request was fulfilled.
  - *Removal*—This process documents the steps taken when you remove an account from the organization's system(s) and network. The process should have different steps, depending on why the account is being removed. For example, if the person has been let go (regardless of the reason), the steps taken will probably be implemented with a greater sense of urgency than if the person has retired or has taken an extended leave.
  - *Requests for additional access*—This process documents the steps to be taken when users need to request access or capabilities in addition to their current settings.

Summary

While I highly recommend an automated approach to maintaining compliance, the important message in this chapter is that compliance is not a one-time event. Regardless of the method you use, it's important to verify compliance on a regular basis; otherwise, it's guaranteed that your system will fall out of compliance. In addition, both your organization's security policy and processes need to be reviewed for potential updates annually—and more frequently with the addition of new technology, consolidation of systems, merging of companies, and so on.

CHAPTER 19

Preparing for the Worst: Creating a Security Incident Response Plan

No one wants to think about the fact that a breach could occur. In fact, most people are in total denial about the possibility. They use the excuse that the system is "secure"—never mind that the system is "secure-able" and that you actually have to use the features provided by IBM to make it secure. Or, they say they trust their employees and fellow workers. Are you telling me that you're willing to vouch for every employee, contractor, and vendor who has access to the system and that you'll guarantee they won't use the data available to them in an inappropriate way? If you're willing to guarantee this from now to eternity, then you don't have to read the rest of this chapter.

Still reading? That's what I thought, because when they're willing to let their minds go there, most people admit that they need some help putting together a plan. I encourage organizations to plan that a breach *will* occur and not just consider and plan for the *possibility*. I've found that when organizations assume that a breach is going to occur, planning becomes more serious and more steps are taken to prevent a breach from occurring.

Be Prepared

Many laws and regulations (including PCI DSS) require that a section of your security policy address the need for a security incident response plan. But it simply makes

good business sense to have plans in place in case a breach occurs. I've seen several organizations live through the aftermath of a significant breach. Even though plans were in place before the breach, the aftermath of the breach was brutal—from the need to immediately lock down access to certain information; to preventing some parts of the information reaching other parts of the organization; to dealing with various legal entities—law enforcement officials, the Federal Bureau of Investigation (FBI), the Federal Trade Commission (or FTC, the branch of the U.S. government that investigates breaches), and the board of directors; to not sleeping or catching only naps for several weeks. Dealing with the breach was definitely worse when no security incident response plan was in place. Breaches are occurring more frequently and to organizations representing every sector. It's in your best interest to be prepared.

Assembling the Incident Response Team

The first step is to assemble an incident response team. You'll need to include individuals who represent the following areas: information security, internal audit, risk management, fraud detection, and administrators from all system types—firewall, servers, IBM i, AIX, Linux, and so on. You'll also need to include selected members of management and perhaps the data owners. Appoint a team leader who is cool under pressure and can bring order in the midst of chaos. In fact, it's best to choose people who work well under pressure and can function effectively as a team.

Depending on the size of your organization, one person may fulfill several of the roles. That's not a problem as long as, in the case of an event, that person is physically able to fulfill all the roles in the stress-filled situation of investigating and handling an incident. Larger organizations may already have this team formed to some degree. Many larger organizations proactively monitor for network intruders or virus outbreaks. They are most familiar with responding to network-based attacks. They may not have thought to (nor may they be able to) address the theft or loss of data.

You'll want to seriously consider retaining a firm that specializes in forensics and investigating breaches. Having this contract in place *prior* to a breach will ensure the investigation starts as soon after discovering the breach as possible. And you'll be assured the investigation will be conducted in a thorough and legally submittable manner.

Another consideration is cyber insurance. This is what is sounds like: an insurance policy that will reimburse your organization for costs incurred should the organization be breached. Costs covered are the "hard" costs. For example, the cost of notifying individuals when their private data is breached, costs for rebuilding servers that have

become infected, fees for failing to meet service level agreements (SLAs) with partners, and so on. What is not covered by these insurance policies are the intangible costs, such as the damage to the organization's reputation. The firm selling the insurance policy may be the same firm that performs forensic investigations, as noted previously, or it may be separate. Regardless, both aspects need to be considered and contracts must be in place *prior* to a breach.

Two other critical members of the team are a representative from your organization's legal counsel and a public relations/media contact. Legal counsel is required to ensure that the company is complying with the law, as well as to protect the company and its contracts with customers and vendors. (In other words, you need to take SLAs into account if services must be stopped or access denied.) The media contact is vital if you have to make a public announcement about the breach. Depending on where your organization does business, many U.S. states and European countries require organizations to notify individuals if their private data or health information has been lost or stolen. Therefore, if this data has been breached, it's likely that a public announcement and individual notification will be required. This type of notification could significantly affect your organization's reputation and image; therefore, the situation must be handled carefully and professionally. The media representative may not be the person who actually appears in front of the media, but he or she would be the one to field all media inquiries, write any statement released to the press, and prepare the person who makes the public statements.

Responding to an Incident

One important aspect to responding to an incident is being aware of the laws and regulations with which your organization must comply when data is lost or stolen. For example, do you have to notify the individuals of the loss? If the lost information was cardholder data, do you know whom to contact? You might need to contact law enforcement, other government entities (e.g., the FTC in the United States if cardholder data was stolen), the bank your organization uses for processing credit cards, and the credit card companies themselves. If private data or health information was breached, the individuals most likely need to be notified as well.

Another aspect to consider is where and how you start to investigate the incident. To determine which members of the incident response team should be notified and assembled, you'll need to make an initial determination of the type of incident. For example, if the incident is a virus, worm, or network breach, the team members you

assemble will differ from those assembled if the IBM i audit journal shows that a programmer inappropriately accessed the routines that decrypt credit card information. Obviously, the media won't have to be notified if the incident is a virus, assuming that it is quickly contained and no loss of service to your customers occurs. However, if malware has been introduced into your network, administrator credentials have been compromised, and a database containing private data is breached, everyone on the team will need to be gathered and previously defined action plans put into motion.

Last, it's important to assign the breach an "owner"—a point person who manages the overall incident response process and ensures nothing falls through the cracks.

Data Preservation

Critical to an incident investigation is data preservation. How you preserve data depends on the type of computer. For a PC, tools exist that let you obtain a mirror image of the contents of the PC's hard drive without affecting the files' dates. However, taking a "picture" of IBM i necessitates a system save. Unless you're using a FlashCopy technology, it means bringing your organization's business to a screeching halt, kicking all users off the system, and going into restricted state. Before taking this step, however, you'll want to talk with your legal counsel to determine whether doing this will violate any SLAs you might have with any of your customers or trading partners.

Because data preservation is critical when investigating breaches, it's best to gain an understanding of exactly what is required before a breach occurs and what will stand up in a court of law should your organization press charges or should charges be levied against your organization. For example, once a system save has been performed or a FlashCopy made, it's critical to establish a "chain of possession" for the media containing the save. You don't want to leave the media unattended because this might cause it to be inadmissible in a court of law. The best place to get the exact details about what data and system configuration information are required to perform a criminal investigation is the computer crime division of your local law enforcement office.

Performing the Investigation

IBM i provides many resources to aid in the investigation of an incident. Let's assume for the moment that data was inappropriately taken from your system. At a minimum, the resources you'll want to have available include job logs, the history log, journal receivers for both database files and the IBM i audit journal, and exit point logs if you've written or purchased exit programs that log network traffic. Because these sources of historical

information are often cleared, deleted, or removed from the system during normal system maintenance, as part of planning for an incident you'll want to re-evaluate your processes to determine whether you need to alter your save strategy to preserve a copy of this information before performing system cleanup. The more complete a picture you can reconstruct, the more thorough the investigation can be.

Be Proactive

Before an incident occurs, assemble the team and role-play various incidents. Then create the policy, and document the incident reporting processes. It's likely to take several meetings before you've defined processes well enough to be followed.

Make Sure You're Saving the Right Information

Whether you're investigating a breach and need to reconstruct the system or you are in disaster recovery mode and need to restore your security information at a hot site or on a backup system, it's critical that you are saving the right pieces of information. The rest of this chapter focuses on saving and being able to accurately restore security data.

Saving Security Data

First, let me describe what I mean by "security data." Then I'll discuss how and when this data is saved. The security data that I'm about to discuss includes user profiles, passwords, private authorities, and authorization lists. How do you save this data? Either by running the SAVSECDTA (Save Security Data) command or by doing a SAVSYS (Save System). I'll also address the need for a save strategy for audit journal receivers.

How Often Should You Save Security Data?

How often you save your security data depends on how dynamic your system is. If you work for an organization that daily creates or changes numerous user profiles, grants new authorities to individuals or group profiles, or alters the authority to authorization lists, you probably want to save your security data on a nightly basis. If you are in the process of remediating your security architecture, you may want to save nightly or at least weekly to make sure you capture all the changes you're making. If your environment is not that dynamic and you have the "paper" trail of all requests for changes so that you could redo any changes not included in the save, you can consider saving this data less frequently. However, the overriding decision for save frequency should be made with the thought of rebuilding your system in the case of a breach.

How Often Should You Save Audit Journal Receivers?

I've found that, in most shops, the saving of audit journal receivers is not well planned. In fact, some organizations remove them from the system without saving them at all. From a compliance point of view, not saving audit journal receivers may put you out of compliance. For example, PCI DSS requires that audit information be retained for at least one year. Some industries, such as the finance industry, have data retention requirements that may cause you to have to retain audit journal receivers for seven years. Given your current save strategy for audit journal receivers, would you be in compliance with the laws and regulations that govern your organization?

When you consider your save strategy, evaluate how easy or difficult it would be to retrieve a particular day's worth of audit information. Some organizations find it easiest to generate a new receiver and then save all the journal receivers from the previous day until the time of the save. That way, you know you have all the information for a particular day. Some organizations save their audit journal receivers on the same media as the rest of their save information. Others save their audit journal receivers on separate media. There is no "right way." The important thing is to make sure you're saving the journal receivers in a way that meets compliance requirements and lets you easily restore them should you need to investigate an issue.

Restoring Security Data

Now, let's turn our attention to the restoration of the security data.

Order Is Important

As with many processes, it's important to get the order right when restoring security information. If you're rebuilding a system to investigate a breach or rebuilding a system because you're in disaster recovery mode, the last thing you want to do is have to start the process over again because you didn't follow the directions. You *must* follow the instructions in the *IBM i Systems Management: Recovering Your System* manual (available in the Information Center under **Systems management** > **Backup and recovery** > **Recovering your system** > **PDF file for recovering your system**). *Do not* deviate from the order described in this manual! In general, the manual will have you restore your security information using the `RSTUSRPRF` (Restore User Profile) command (`RSTUSRPRF *ALL`), then restore your objects, and then perform a `RSTAUT` (Restore Authority) operation. Restoring the user profiles first will make sure all the objects' owning profiles and authorization lists exist before the objects are restored to the system.

Performing the RSTUSRPRF before restoring your objects is critical. If you restore the objects before the user profiles, all objects owned by the non-IBM profiles will be owned by QDFTOWN. If you do these steps in reverse order, you'll have to start over. Once the ownership of the objects is established, it will stay that way unless you delete an object and restore it again—this time with all the profiles on the system before the objects are restored. It's a painful process, but it's the only way to get ownership corrected.

Restoring user profiles first also means that any authorization lists that secure the objects exist on the system. When you restore an object that is secured by an authorization list on the media but the authorization list doesn't exist on the system, IBM i changes the object so that it is no longer secured by an authorization list (i.e., it sets the authorization list attribute to *NONE) and changes *PUBLIC authority to *EXCLUDE. These may seem like harsh configuration changes, but to do anything else has the potential to open data up to public access when it was supposed to be tightly secured. *Note:* The only way to restore an authorization list is to restore all user profiles (RSTUSRPRF *ALL).

Once you've restored your user profiles (and authorization lists), you can restore your objects. Then, after your objects are restored, you'll want to perform one final step: Run the RSTAUT command for all profiles (RSTAUT *ALL). When user profiles are restored to the system, a temporary object is built that contains the profiles' private authorities. After the objects are restored and you run RSTAUT, IBM i reads that temporary object and grants all the private authorities that the user profile had to objects and authorization lists. If you don't perform this step, when you run the DSPUSRPRF (Display User Profile) command, you'll receive the message "CPD2206 Private authorities not restored," which is an indication that RSTAUT hasn't been run. Running RSTAUT is an important step that should not be overlooked. Skipping this step means that some users may not have the authority they need to certain objects to perform their job function. Or, users may be able to access objects you don't intend for them to access.

Security Data Restored with an Object

If you take a close look at the security data saved with SAVSECDTA and SAVSYS, you may realize that there are some other pieces of security data we haven't talked about. Some security data is stored in an object itself and therefore is restored to the system when you restore the object. The following information is stored with an object:

- The name of the object's owner
- The owner's authority

- *PUBLIC authority
- The name of the object's primary group
- The primary group's authority
- The authorization list name
- The object's object audit setting

Seeing this list, you can probably understand why it is critical to have the profiles and authorization lists restored before restoring an object. Because the object keeps the names of the owner and authorization list (if the object is secured with an authorization list), those items need to be on the system when the object is restored.

Recreating the System After a Breach

Let's get back to the original topic of this chapter: breaches. Now that you know how restoring security data works, let's talk about recreating the system after a breach.

If your organization suffers a breach, you may need to rebuild the system. Now that you've seen all the security parts that are required and how restoring this data works, you will want to consider what other "pieces" are required to reconstruct the entire picture. As I said earlier, you may need to be able to trace the activity through history logs, Web server logs, job logs, spooled files, and journal receivers associated with database files. The more completely you can recreate the system, the better. But this is one of those tradeoff situations. Many of you don't save job logs, the history log, or spooled files so that your backup doesn't get to be huge and take forever to complete. This is one of the issues you'll want to discuss with your security incident response team to determine whether the business requirement of reducing the backup meets the recovery requirements of this team.

CHAPTER 20

Creating a Security Awareness Program

A security awareness program is an official or recognized project, typically under the "jurisdiction" of the Chief Security Officer (CSO), that is created for the purpose of educating individuals such as the organization's employees, contractors, vendors, and volunteers about the organization's security policies. The education should explain how the policies relate to each individual, and it should be performed on an ongoing basis.

A security awareness program is a requirement of many laws and regulations. But, beyond that, it simply makes good business sense to develop a security awareness program. By training your organization, you are mobilizing your entire workforce to help fight the security compliance battle and help you wage the war against inappropriate use of data.

Security awareness training typically starts the day an employee is hired, a contractor begins a project, or a volunteer starts. This is when the employee portion of your organization's security policy is explained and the person is required to read and sign it, acknowledging that he or she understands its contents and meaning. Although many organizations take advantage of this initial opportunity, that's often where the security awareness training stops. Everyone in the organization needs to develop a security "lifestyle." To ensure that this happens, security awareness training should take place regularly, so that people receive periodic reminders of the organization's security

requirements. They should also receive the appropriate training if they change positions and the requirements of the new position differ from the previous one.

Another reason for ongoing education is because new threats arise and new technology is developed. For example, when you first started working with email, did you have to worry about users downloading and subsequently leaving unencrypted confidential or private information on their mobile devices? Did you have to concern yourself with whether people were blogging during work hours or inappropriately posting statements as representatives of the organization? Without an ongoing security awareness program, you have no effective way of communicating the requirements of new or updated policies.

Another reason for periodic education is to update those in the organization about new or changed laws or regulations that affect the organization. For example, California expanded its breach notification law to include the loss of email addresses if the data lost also contains the answers to the security questions that are asked when someone loses their password. Privacy laws in Europe are becoming more restrictive in regard to the use of peoples' private data, how long it can be retained, and the purpose of retaining the data. The expansion of laws and regulations may be known to your compliance team, but unless the rest of the organization is educated, it's very easy for an organization to unknowingly be out of compliance. Educating your workforce is key in helping detect fraud and other situations that can damage or otherwise put your organization out of compliance.

What Method Do I Use to Communicate?

Because we don't all learn in the same way, your security awareness program should include all types of learning. Giving security awareness training and tips using audio, graphics, and text will provide opportunities for everyone to absorb the information.

I've seen some of our clients use posters to communicate a "security slogan" of the month. The posters are often of high quality, featuring professional-looking images that capture the eye and draw you into the message. Other clients have used a lighter approach; their posters feature a cartoon conveying the message of the month through humor. In both cases, the companies obviously know their "audience" and the type of messaging their workforce responds to. Because messages get stale and people start to ignore them, most organizations change their security message about once a month.

For the technology learner, you can have short YouTube videos that illustrate the security tip or message. This method works well in the high-tech industry and any

organization that hires Millennials. For more "traditional" or staid organizations, provide material for managers to present at their next department or team meeting.

As for the folks who read everything that comes their way, you can send out a monthly newsletter. Another approach is to change the network or IBM i sign-on screen to reflect the current month's security emphasis.

Finally, it's a good practice to have each employee annually review and re-sign the employee security policy. To accomplish this, some organizations use a secure website on their intranet where employees can read the policy and then digitally sign to indicate that the policy was reviewed. I've also seen organizations require management to present the policy to each employee individually or to the entire department during an in-person or online department meeting. Regardless of the method, I highly recommend that you obtain some type of proof indicating that employees received the education and understand the updates and new requirements.

To assess the effectiveness of their security awareness programs, some organizations hire an outside firm to conduct tests to measure how well their organization has been trained. Firms can be hired that will attempt to gain physical access to your location testing visitor and no-tailgating policies. Others firms are hired to conduct phishing tests. Emails that appear to be coming from within the organization are sent to the workforce. Often the email requests that the individual reply back and include their password. Upon clicking Send, the user is presented with a Web page that explains the test and what their response should have been. Tests can be repeated and the test emails made to appear more and more "real." I've even seen an organization have a contest between locations to see which one would have the lowest rate of click-throughs.

Getting Started

If you need help getting your security awareness program started, look to the Internet for help. There are companies that provide security awareness training packages—videos, posters, newsletters, monthly security themes, and so on. In addition, organizations that focus on training for security professionals often have online security awareness training courses that you can buy. Both provide good places to start.

Whether you use one of these resources or create your own program, I encourage you to make your training "real." Provide scenarios that are meaningful to your organization, so that the workforce can more easily relate to the concepts being explained. In addition, make sure you provide the right training for your audience. Talking about data classification and proper disposal of media containing private data

will make manufacturing workers' eyes glaze over! However, such employees do need to understand that the proper use of social media—that is, whether they can post comments about the company, watch YouTube videos or play online games during work hours, and so on.

In addition to addressing topics that the entire organization will benefit from, it's important not to ignore the education aspects that should be targeted to a specific audience. For example, I believe it's vital to educate programmers and developers about the current and upcoming laws and regulations that affect your organization's data. Engaging these individuals as soon as you're aware of a new compliance requirement lets them better plan for application changes. In addition, if you see trends—such as the potential for healthcare information to be encrypted—you should warn them that this requirement might be coming. When equipped with this type of information, your programmers and developers can design their architecture to accommodate the requirement should it become law. In addition, engaging them early has the potential to make them feel as if they are part of the information security team rather than having requirements foisted upon them without any input or warning. Most programmers have no interest in security—they feel it's an impediment to getting their work done. So the sooner you can engage them, the more successful the project will be.

If you want to begin a security awareness program and need a list of topics to get started, here are a few ideas:

- A reminder of what constitutes confidential information, using examples that are meaningful for the organization.
- A reminder to keep confidential data confidential—even between coworkers (and even if they're good friends) when there is no business reason for another person to "need to know" the information.
- A reminder that family members are not employees and confidential data should not be shared with them.
- Reminders about what constitutes the "appropriate use of systems." For example, an organization's resources are not to be used to play games, gamble, or store personal information or data such as photos, music, or videos.
- Tips about how to recognize the signs of a security incident (or the potential for a security incident) and whom to call if one is suspected.

- Information about how to recognize fraud and whom to call if it's suspected.
- A reminder not to open email attachments unless they are expected.
- Instructions on what to do if they suspect an email contains a virus or they've opened an email containing a virus.
- Instructions on how to recognize a phishing attempt.
- An explanation of what constitutes spam, what the organization is doing to control spam, and what action users should take if spam still ends up in their inboxes.
- A reminder that no company employee—even upper management—will ever ask for a password, credit card, Social Security, or Social Insurance number over the phone or via email and that if employees see this type of request, they should report it.
- A reminder about appropriate use of the Internet while at work (along with a reminder that user actions are logged).
- Education about blogging and the requirements (if any) of adding a disclaimer so that it doesn't look like an employee is speaking for the organization.
- Security tips for laptops and other mobile devices.
- A reminder about appropriate disposal methods for printed reports or media that contain private or confidential data.
- A reminder that employees should wear badges at all times while on company property.
- A reminder or instructions about locking their workstation (e.g., invoking a screen saver) when employees leave their desks.
- Tips addressing safety and security when traveling.
- Details about what type of data is allowed (or not allowed) to be stored on mobile devices.
- Encryption requirements for data downloaded to mobile devices.
- Actions to take when a mobile device containing an organization's data is lost or stolen.

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