Securing Users and Processes in Oracle® Solaris 11.2

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Contents

Examples

Using This Documentation

- **Overview** – Describes how to assign additional rights to users, create and use roles, and assign rights to programs and specific resources on Oracle Solaris systems.
- **Audience** – Security administrators.
- **Required knowledge** – Site security requirements.

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♦ ♦ ♦ CHAPTER 1

About Using Rights to Control Users and Processes

Oracle Solaris provides rights that can be assigned to users, roles, processes, and selected resources. These rights provide a more secure administrative alternative to the superuser model.

This chapter provides information about the elements that support user and process rights management and discusses ways to expand users' rights, limit users' rights, add privileges to commands, and limit applications to just the privileges that they require:

- "What's New in Rights in Oracle Solaris 11.2" on page 13
- "User Rights Management" on page 14
- "Process Rights Management" on page 21

What's New in Rights in Oracle Solaris 11.2

This section highlights information for existing customers about important new features in user rights, also called rights based access control (RBAC) and process rights, also called privileges.

- A rights profile that the administrator assigns as an *authenticated* rights profile forces the user to provide a password before running a privileged command. If the user does not supply a password, the command runs without privilege. The password remains effective for a configurable period of time. See Example 3-11.

  You can assign an authenticated rights profile to anyone who logs in to the system by adding the profile as a value of the `AUTH_PROFS_GRANTED` keyword in the `policy.conf` file.
- You can restrict user and group access to hosts by time and timezone by assigning the `access_times` and `access_tz` rights. For an example, see the `user_attr`(4) man page.
- Oracle Solaris provides the Authorization Roles Managed on RBAC (ARMOR) set of standardized roles in the `armor` package. For more information, see "User and Process Rights Provide an Alternative to the Superuser Model" on page 14 and Example 3-1.
- A User Manager GUI is available to manage the rights of users and roles. For more information, see Chapter 3, "Managing User Accounts by Using the User Manager GUI," in "Managing User Accounts and User Environments in Oracle Solaris 11.2 ".

User Rights Management

User rights management is a security feature for controlling user access to tasks that would normally be restricted to the `root` role. By applying security attributes, or *rights*, to processes and to users, the site can divide superuser privileges among several administrators. Process rights management is implemented through *privileges*. User rights management is implemented through *rights profiles*, which collect rights that are then assigned to users or to roles. User rights can also be restricted, such as for kiosks or guest users.

- For a discussion of rights on kernel processes, see "Process Rights Management" on page 21.
- For procedures to manage rights, see Chapter 3, "Assigning Rights in Oracle Solaris".
- For reference information, see Chapter 8, "Reference for Oracle Solaris Rights".

User and Process Rights Provide an Alternative to the Superuser Model

In conventional UNIX systems, the `root` user, also referred to as superuser, is all-powerful. Programs that run as `root`, as do many `setuid` programs, are also all-powerful. The `root` user has the ability to read and write to any file, run all programs, and send kill signals to any process. Effectively, anyone who can become superuser can modify a site's firewall, alter the audit trail, read confidential records, and shut down the entire network. A `setuid root` program that is hijacked can do anything on the system.

Assigning rights to users, resources, and processes provides a more secure alternative to the all-or-nothing superuser model. With rights, you can enforce security policy at a more fine-grained level. Rights follows the security principle of *least privilege*. Least privilege means that a user has precisely the amount of privilege that is necessary to perform a job. Regular users have enough privilege to use their applications, check the status of their jobs, print files, create new files, and so on. Rights beyond regular user rights are grouped into rights profiles. Users who are expected to do jobs that require some of the rights of superuser can be assigned a rights profile.

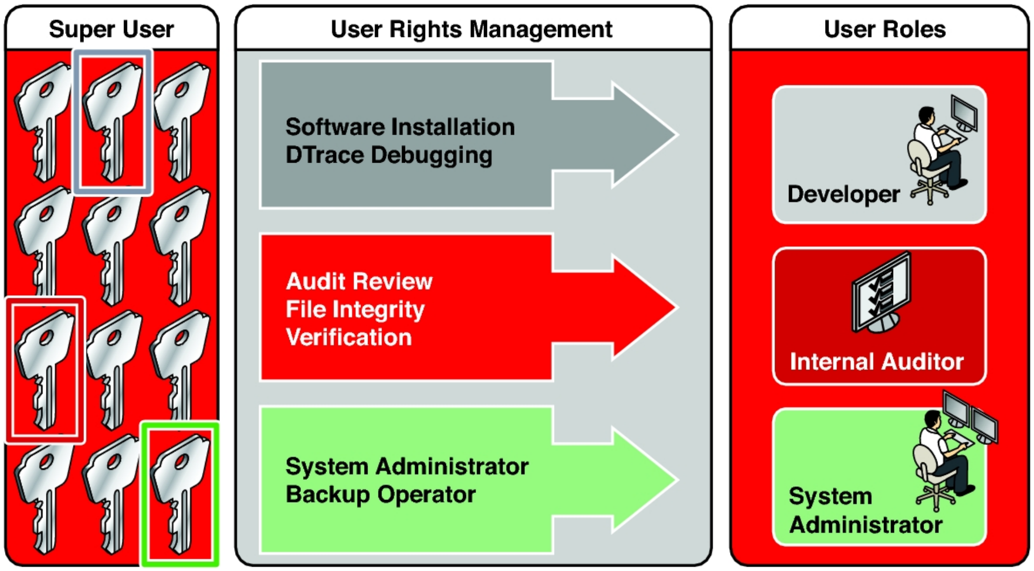
Rights that are grouped into a profile can be assigned directly to users. They can also be indirectly assigned by creating special accounts that are called *roles*. A user can then assume a role to do a job that requires some administrative privileges. Oracle Solaris supplies many predefined rights profiles. You create the roles and assign the profiles.

The ARMOR package provides a set of standardized roles. By auto-installing this package and assigning the roles to users, you can create a system that provides separation of duty at boot. For more information, see Authorization Rules Managed On RBAC (ARMOR), "Following Your Chosen Rights Model" on page 38, and Example 3-1.

Rights profiles can provide broad administrative rights. For example, the System Administrator rights profile enables an account to perform tasks that are not related to security, such as printer management and cron job management. Rights profiles can also be narrowly defined. For example, the Cron Management rights profile manages `at` and `cron` jobs. When you create roles, the roles can be assigned broad administrative rights or narrow rights.

The following figure illustrates how Oracle Solaris can distribute rights to trusted users by creating roles. Superuser can also distribute rights by assigning rights profiles directly to trusted users.

FIGURE 1-1 Distribution of Rights



In the illustrated rights model, superuser creates three roles. The roles are based on rights profiles. Superuser then assigns the roles to users who are trusted to perform the tasks of the role. Users log in with their user names. After login, users assume roles that can run administrative commands and graphical user interface (GUI) tools.

The flexibility in setting up roles enables a variety of security policies. Although few roles are shipped with Oracle Solaris, roles are easily configured. Example 3-1 shows how to use roles that are based on the ARMOR standard. In addition to or in place of ARMOR roles, you can create your own roles based on the rights profiles that Oracle Solaris provides.

- **root –** A powerful role that is equivalent to the `root` user. However, like all roles, the `root` role cannot log in. A regular user must log in, then assume the assigned `root` role. This role is configured and assigned to the initial user by default.

- **System Administrator –** A less powerful role for administration that is not related to security. This role can manage file systems, mail, and software installation. However, this role cannot set passwords.
- **Operator –** A junior administrator role for operations such as backups and printer management.

Note - The Media Backup rights profile provides access to the entire root file system. Therefore, while the Media Backup and Operator rights profiles are designed for a junior administrator, you must ensure that the user can be trusted.

You might also want to configure one or more security roles. Three rights profiles and their supplementary profiles handle security: Information Security, User Security, and Zone Security. Network security is a supplementary profile in the Information Security rights profile.

Note that roles do not have to be implemented. Roles are a function of an organization's security needs. One strategy is to set up roles for special-purpose administrators in areas such as security, networking, or firewall administration. Another strategy is to create a single powerful administrator role along with an advanced user role. The advanced user role would be for users who are permitted to fix portions of their own systems. You can also assign rights profiles directly to users and not create roles at all.

The superuser model and the rights model can co-exist. The following table summarizes the gradations from superuser to restricted regular user that are possible in the rights model. The table includes the administrative actions that can be tracked in both models. For a summary of the effect of process rights, that is, *privileges*, see Table 1-2.

TABLE 1-1 Superuser Model Contrasted With Rights Model

User Capabilities on a System	Superuser Model	Rights Model
Can become superuser with full superuser privileges	Can	Can
Can log in as a user with full user rights	Can	Can
Can become superuser with limited rights	Cannot	Can
Can log in as a user, and have superuser privileges sporadically	Can, with `setuid root` programs only	Can, with `setuid root` programs and with rights
Can log in as a user with administrative rights but without full superuser privileges	Cannot	Can, with rights profiles, roles, and with directly assigned privileges and authorizations
Can log in as a user with fewer rights than a regular user	Cannot	Can, by removing rights
Can track superuser actions	Can, by auditing the `su` command	Can, by auditing calls to `pfexec`

User Capabilities on a System	Superuser Model	Rights Model
		Also, the name of the user who has assumed the `root` role is in the audit trail

Basics of User and Process Rights

The terms *unprivileged* or *without rights* do not apply in Oracle Solaris. Every process in Oracle Solaris, including regular user processes, has at least some privileges or other user rights, such as authorizations. To learn about the basic set of privileges that Oracle Solaris grants to all UNIX processes, see "Process Rights Management" on page 21.

The following elements enforce user rights in Oracle Solaris. These rights can be configured to enforce permissive security policies or restrictive security policies.

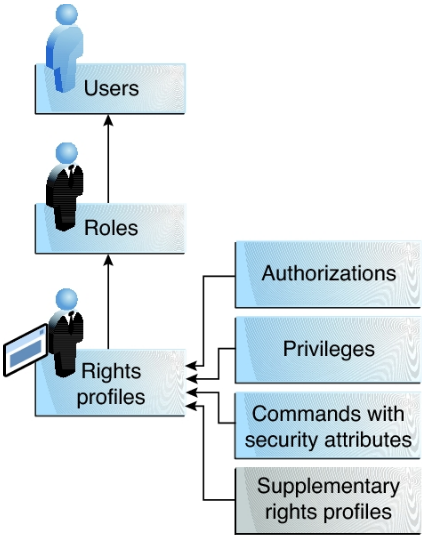
- **Authorization –** A permission that enables a user or role to perform a class of actions that require additional rights. For example, the default security policy gives console users the `solaris.device.cdrw` authorization. This authorization enables users to read and write to a CD-ROM device. For a list of authorizations, use the `auths list` command. Authorizations are enforced at the user application level, not in the kernel. See "More About User Authorizations" on page 20.
- **Privilege –** A right that can be granted to a command, a user, a role, or a specific resources, such as a port or SMF method. Privileges are implemented in the kernel. For example, the `proc_exec` privilege allows a process to call `execve`. Regular users have basic privileges. To see your basic privileges, run the `ppriv -vl basic` command. For more information, see "Process Rights Management" on page 21.
- **Security attributes –** An attribute that enables a process to perform an operation, or the implementation of a right. In a typical UNIX environment, a security attribute enables a process to perform an operation that is otherwise forbidden to regular users. For example, `setuid` and `setgid` programs have security attributes. In the rights model, authorizations and privileges are security attributes in addition to `setuid` and `setgid` programs. These attributes, or rights, can be assigned to a user. For example, a user with the `solaris.device.allocate` authorization can allocate a device for exclusive use. Privileges can be placed on a process. For example, a process with the `file_flag_set` privilege can set immutable, no-unlink, or append-only file attributes.

  Security attributes can also limit rights. For example, the `access_times` and `access_tz` security attributes set the days and times and optionally the timezone when specific security-relevant operations are permitted. You can limit users directly or by assigning them an authenticated rights profile that contains these keywords. For more information, see the `user_attr`(4) man page.
- **Privileged application –** An application or command that can override system controls by checking for rights. For more information, see "Applications That Check for Rights" on page 34 and "Developer's Guide to Oracle Solaris 11 Security ".

- **Rights profile –** A collection of rights that can be assigned to a role or to a user. A rights profile can include authorizations, directly assigned privileges, commands with security attributes, and other rights profiles. Profiles that are within another profile are called *supplementary rights profiles*. Rights profiles offer a convenient way to group rights. They can be directly assigned to users or to special accounts called *roles*. You can use the commands in a a rights profile only if your process recognizes rights. Additionally, you can be required to supply a password. Alternatively, password authentication can be supplied by default. See "More About Rights Profiles" on page 20.
- **Role –** A special identity for running *privileged applications*. The special identity can be assumed by assigned users only. In a system that is run by roles, superuser can be unnecessary after initial configuration. See "More About Roles" on page 21.

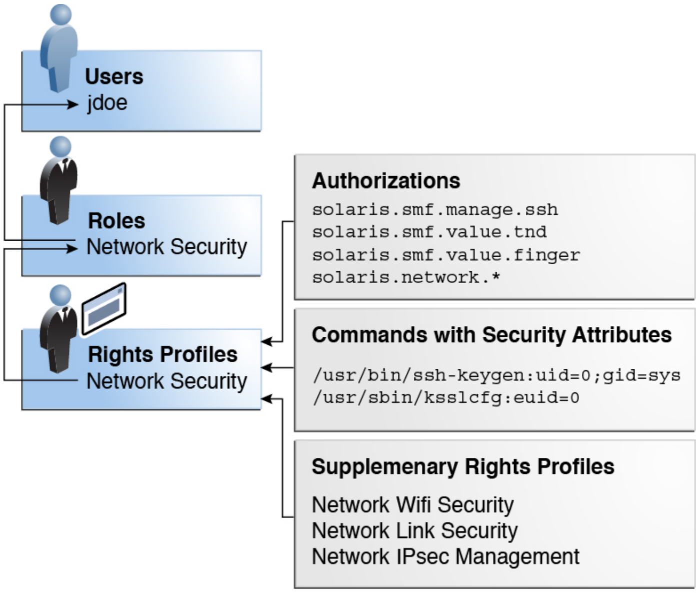
The following figure shows how user rights and process rights work together.

FIGURE 1-2 User Rights and Process Rights Working Together


Users
Roles
Rights profiles
Authorizations
Privileges
Commands with security attributes
Supplementary rights profiles

The following figure uses the Network Security role and the Network Security rights profile to demonstrate how assigned rights work.

FIGURE 1-3 Example of a User Rights and Process Rights Assignment



The Network Security role is used to manage IPsec, wifi, and network links. The role is assigned to the user `jdoe`. `jdoe` can assume the role by switching to the role, and then supplying the role password. The administrator can enable the role to authenticate by using the user password rather than a role password.

In the figure, the Network Security rights profile is assigned to the Network Security role. The Network Security rights profile contains supplementary profiles that are evaluated in order, Network Wifi Security, Network Link Security, and Network IPsec Management. These supplementary profiles contain rights that complete the role's primary tasks.

The Network Security rights profile has three directly assigned authorizations, no directly assigned privileges, and two commands with security attributes. The supplementary rights profiles have directly assigned authorizations, and two of them have commands with security attributes.

When `jdoe` assumes the Network Security role, the shell changes to a profile shell. The profile shell process can evaluate the use of rights, so `jdoe` can administer network security.

More About User Rights

This section provides more details about the implementation and use of rights at the user level.

More About User Authorizations

An *authorization* is a right that can be granted to a role, a program, a zone, or a user. Authorizations enforce policy at the user application level. Like privileges, mistaken assignments of authorizations can result in more rights being granted than originally intended. For more information, see "Privilege Escalation and User Rights" on page 31.

The difference between authorizations and privileges concerns the level at which the security policy is enforced. Without the proper privilege, a process can be prevented from performing privileged operations by the kernel. Without the proper authorizations, a user can be prevented from using a privileged application or from performing security-sensitive operations within a privileged application. For a fuller discussion of privileges, see "Process Rights Management" on page 21.

Rights-compliant applications can check a user's authorizations prior to granting access to the application or specific operations within the application. This check replaces the check in conventional UNIX applications for `UID=0`.

For more information about authorizations, see the following sections:

- "Authorizations Reference" on page 107
- "`auth_attr` Database" on page 110
- "Selected Commands That Require Authorizations" on page 113

More About Rights Profiles

A *rights profile* is a collection of rights that can be assigned to a role or user to perform tasks that require administrative rights. A rights profile can include authorizations, privileges, commands with assigned security attributes, and other rights profiles. Rights profiles can also contain entries to reduce or extend the initial inheritable set of privileges and to reduce the limit set.

An *authenticated rights profile* is a rights profiles that requires the user to supply a password, or to *reauthenticate*. The administrator decides which profiles can be used without reauthentication. A good example of a profile that would not require reauthentication is the Basic Solaris User rights profile. Depending on site security requirements, rights profiles for security-sensitive tasks might require reauthentication.

For reference information about rights profiles, see the following sections:

- "Rights Profiles Reference" on page 105
- "prof_attr Database" on page 110
- "exec_attr Database" on page 111

More About Roles

A *role* is a special type of user account from which you can run privileged applications. Roles are created in the same general manner as user accounts. Roles have a home directory, a group assignment, a password, and so on. Rights profiles and authorizations give the role administrative rights. Roles cannot inherit rights from other roles or from the user who assumes the role. Roles distribute superuser privileges, and thus enable more secure administrative practices.

A role can be assigned to more than one user. All users who can assume the same role have the same role home directory, operate in the same environment, and have access to the same files. Users can assume roles at the command line by running the su command and supplying the role name and the role's password. The administrator can configure the system to enable a user to authenticate by supplying the user's password. See Example 3-16.

A role cannot log in directly. A user logs in, and then assumes a role. Once you have assumed a role, you cannot assume another role without first exiting your current role.

Also, while a rights profile adds rights to the user's environment, a role gives the user a clean execution environment that is shared with other users who can assume that role. When a user switches to a role, none of the user's authorizations or rights profiles applies to the role.

The passwd, shadow, and user_attr databases store static role information. You can and should audit the actions of roles.

For detailed information about setting up roles, see the following sections:

- "Following Your Chosen Rights Model" on page 38
- "Assigning Rights to Users" on page 41

The fact that root is a role in Oracle Solaris prevents anonymous root login. If the profile shell command, pfexec, is being audited, the audit trail contains the login user's real UID, any roles that the user has assumed, and the privileged operations that were performed. To audit the system for privileged operations, see "Auditing Administrative Actions" on page 78.

Process Rights Management

Process rights management in Oracle Solaris is implemented by *privileges*. Privileges enable processes to be restricted at the level of command, user, role, and specific system resource.

Privileges decrease the security risk that is associated with one user or one process having full superuser powers on a system. Process rights and user rights provide a compelling alternative model to the traditional superuser model.

Traditionally, privileges are used to add rights. However, privileges can also be used to restrict rights, for example, changing a `setuid root` program to a program that is privilege-aware. Also, with an *extended privilege policy*, administrators can allow only specified privileges to be used with a file object, user ID, or port. This fine-grained privilege assignment denies all other privileges except basic privileges to these resources.

- For information about extended privilege policy and restrictive privileges, see "Using Extended Privilege Policy to Restrict Privilege Use" on page 30.
- For information about user rights, see "User Rights Management" on page 14.
- For information about how to administer privileges, see Chapter 3, "Assigning Rights in Oracle Solaris".
- For reference information about privileges, see "Privileges Reference" on page 114.

Privileges Protecting Kernel Processes

A privilege is a right that a process requires to perform an operation. The right is enforced in the kernel. A program that operates within the bounds of the *basic set* of privileges operates within the bounds of the system security policy. `setuid root` programs are examples of programs that operate outside the bounds of the system security policy. By using privileges, programs eliminate the need for calls to `setuid root`.

Privileges enumerate the kinds of operations that are possible on a system. Programs can be run with the exact privileges that enable the program to succeed. For example, a program that manipulates files might require the `file_dac_write` and `file_flag_set` privileges. These privileges on the process eliminate the need to run the program as `root`.

Historically, systems have not followed the privilege model, or rights model, as introduced in "Basics of User and Process Rights" on page 17. Rather, systems used the superuser model. In the superuser model, processes were run as `root` or as a user. User processes were limited to acting on the user's directories and files. `root` processes could create directories and files anywhere on the system. A process that required creation of a directory outside the user's directory would run with a `UID=0`, that is, as `root`. Security policy relied on discretionary access control (DAC) to protect system files. Device nodes were protected by DAC. For example, devices owned by the group `sys` could be opened only by members of that group.

However, `setuid` programs, file permissions, and administrative accounts are vulnerable to misuse. The actions that a `setuid` process is permitted are more numerous than the process requires to complete its operation. A `setuid root` program can be compromised by an intruder who then runs as the all-powerful `root` user. Similarly, any user with access to the `root` password can compromise the entire system.

In contrast, a system that enforces policy with privileges provides a gradation between user rights and `root` rights. A user can be granted privileges to perform activities that are beyond the rights of regular users, and `root` can be limited to fewer privileges than `root` currently possesses. With rights, a command that runs with privileges can be isolated in a rights profile and assigned to one user or role. Table 1-1 summarizes the gradation between user rights and root privileges that the rights model provides.

The rights model provides greater security than the superuser model. Privileges that have been removed from a process cannot be exploited. Process privileges can provide an additional safeguard for sensitive files and devices in contrast to DAC protections alone, which can be exploited to gain access.

Privileges, then, can restrict programs and processes to just the rights that the program requires. On a system that implements least privilege, an intruder who captures a process can access only those privileges that the process has. The rest of the system cannot be compromised.

Privilege Descriptions

Privileges are logically grouped on the basis of the area of the privilege.

- **FILE privileges –** Privileges that begin with the string `file` operate on file system objects. For example, the `file_dac_write` privilege overrides discretionary access control when writing to files.
- **IPC privileges –** Privileges that begin with the string `ipc` override IPC object access controls. For example, the `ipc_dac_read` privilege enables a process to read remote shared memory that is protected by DAC.
- **NET privileges –** Privileges that begin with the string `net` give access to specific network functionality. For example, the `net_rawaccess` privilege enables a device to connect to the network.
- **PROC privileges –** Privileges that begin with the string `proc` allow processes to modify restricted properties of the process itself. `PROC` privileges include privileges that have a very limited effect. For example, the `proc_clock_highres` privilege enables a process to use high resolution timers.
- **SYS privileges –** Privileges that begin with the string `sys` give processes unrestricted access to various system properties. For example, the `sys_linkdir` privilege enables a process to make and break hard links to directories.

Other logical groups include CONTRACT, CPC, DTRACE, GRAPHICS, VIRT, and WIN.

Some privileges have a limited effect on the system, and some have a broad effect. The definition of the `proc_taskid` privilege indicates its limited effect:

```
proc_taskid
        Allows a process to assign a new task ID to the calling process.
```

The definition of the `net_rawaccess` privilege indicates its broad effect:

```
net_rawaccess
        Allows a process to have direct access to the network layer.
```

The `privileges`(5) man page provides descriptions of every privilege. See also "Listing Privileges" on page 91.

Administrative Differences on a System With Privileges

A system that has privileges has several visible differences from a system that does not have privileges. The following table lists some of the differences.

TABLE 1-2 Visible Differences Between a System With Privileges and a System Without Privileges

Feature	No Privileges	Privileges
Daemons	Daemons run as `root`.	Daemons run as the user `daemon`. For example, these daemons are assigned limited privileges and run as `daemon`: `lockd` and `rpcbind`.
Log file ownership	Log files are owned by `root`.	Log files are owned by `daemon`, who creates the log file. The `root` user does not own the file.
Error messages	Error messages refer to superuser. For example, `chroot: not superuser`.	Error messages reflect the use of privileges. For example, the equivalent error message for `chroot` failure is `chroot: exec failed`.
`setuid` programs	Programs use `setuid root` to complete tasks that regular users are not allowed to perform.	Many `setuid root` programs run with just the privileges they need. For example, the following commands use privileges: `audit`, `ikeadm`, `ipadm`, `ipsecconf`, `ping`, `traceroute`, and `newtask`.
File permissions	Device permissions are controlled by DAC. For example, members of the group `sys` can open `/dev/ip`.	File permissions (DAC) do not predict who can open a device. Devices are protected with DAC *and* device policy. For example, the `/dev/ip` file has `666` permissions, but the device can only be opened by a process with the appropriate privileges.
Audit events	Auditing the use of the `su` command covers many administrative functions.	Auditing the use of privileges covers most administrative functions. The `cusa` audit class includes audit events that monitor administrative functions.
Processes	Processes are protected by the rights of the process owner.	Processes are protected by privileges. Process privileges and process flags are visible as a new entry in the `/proc/<pid>/priv` directory.

Feature	No Privileges	Privileges
Debugging	No reference to privileges in core dumps.	The ELF note section of core dumps includes information about process privileges and flags in the NT_PRPRIV and NT_PRPRIVINFO notes. The ppriv command and other commands show the proper number of properly sized sets. The commands correctly map the bits in the bit sets to privilege names.

More About Privileges

This section covers privilege implementation, use, and assignment details.

How Privileges Are Implemented

Every process has four sets of privileges that determine whether a process can use a particular privilege. The kernel automatically calculates the *effective set* of privileges. You can modify the initial *inheritable set* of privileges. A program that is coded to use privileges can reduce the program's *permitted set* of privileges. You can shrink the *limit set* of privileges.

- **Effective privilege set, or E –** The set of privileges that is currently in effect. A process can add privileges that are in the permitted set to the effective set. A process can also remove privileges from E.
- **Permitted privilege set, or P –** The set of privileges that is available for use. Privileges can be available to a program from inheritance or through assignment. An execution profile is one way to assign privileges to a program. The `setuid` command assigns all privileges that `root` has to a program. Privileges can be removed from the permitted set but not added. Privileges that are removed from P are automatically removed from E.

  A *privilege-aware* program removes the privileges that a program never uses from the program's permitted set. In this way, unnecessary privileges cannot be exploited by the program or a malicious process. For more information about privilege-aware programs, see Chapter 2, “Developing Privileged Applications,” in “Developer’s Guide to Oracle Solaris 11 Security ”.
- **Inheritable privilege set, or I –** The set of privileges that a process can inherit across a call to `exec`. After the call to `exec`, the inherited privileges are placed in the permitted set and the effective set, thus making these sets equal, except in the special case of a `setuid` program.

  For a `setuid` program, after the call to `exec`, the inheritable set is first restricted by the limit set. Then, the set of privileges that were inherited (I), minus any privileges that were in the limit set (L), are assigned to P and E for that process.
- **Limit privilege set, or L –** The set that defines the outside limit of which privileges are available to a process and its children. By default, the limit set is all privileges.

Processes can shrink the limit set but can never extend the limit set. L is used to restrict I. Consequently, L restricts P and E at the time of exec.

If a user has been assigned a profile that includes a program that has been assigned privileges, the user can usually run that program. On an unmodified system, the program's assigned privileges are within the user's limit set. The privileges that have been assigned to the program become part of the user's permitted set. To run the program that has been assigned privileges, the user must run the program from a profile shell.

The kernel recognizes a basic privilege set. On an unmodified system, each user's initial inheritable set equals the basic set at login. While you cannot modify the basic set, you can modify which privileges a user inherits from the basic set.

On an unmodified system, a user's privilege sets at login would appear similar to the following:

```
E (Effective): basic
I (Inheritable): basic
P (Permitted): basic
L (Limit): all
```

At login, all users would have the basic set in their inheritable set, their permitted set, and their effective set. A user's limit set is equivalent to the default limit set for the zone, global or non-global.

You can assign additional privileges directly to a user, or more precisely to a user's login process, indirectly to many users through a rights profile, and indirectly by assigning a privileged command to a user. You can also remove privileges from a user's basic set. For procedures and examples, see Chapter 3, “Assigning Rights in Oracle Solaris”.

How Privileges Are Used

Privileges are built into Oracle Solaris. This section describes how Oracle Solaris uses privileges with devices, in resource management, and with legacy applications.

How Processes Get Privileges

Processes can inherit privileges or be assigned privileges. A process inherits privileges from its parent process. At login, the user's initial inheritable set of privileges determines which privileges are available to the user's processes. All child processes of the user's initial login inherit that set.

You can also directly assign privileges to programs, users, roles, and specific resources. When a program requires privileges, you assign the privileges to the program's executable in a rights profile. Users or roles that are permitted to run the program are assigned the profile that includes the program. At login or when a profile shell is opened, the program runs with privilege when the program's executable is typed in the profile shell. For example, a role that includes the Object Access Management profile is able to run the chmod command with the file_chown privilege, and therefore can change the ownership of a file that the role does not own.

When a role or user runs a program that has been directly assigned an additional privilege, the assigned privilege is added to the role or user's inheritable set. Child processes of the program that was assigned privileges inherit the privileges of the parent. If the child process requires more privileges than the parent process, the child process must be directly assigned those privileges.

Programs that are coded to use privileges are called privilege-aware programs. A privilege-aware program enables and disables the use of privilege during program execution. To succeed in a production environment, the program must be assigned the privileges that the program enables and disables. Before you make a privilege-aware program available, you assign to the executable only the privileges that the program needs. You then test the program to see that the program succeeds in performing its tasks. You also check that the program does not abuse its use of privileges.

For examples of privilege-aware code, see Chapter 2, “Developing Privileged Applications,” in “Developer’s Guide to Oracle Solaris 11 Security ”. To assign privileges to a program that requires privileges, see Example 4-1 and Example 5-7.

Privileges and Devices

In the rights model, privileges protect system interfaces that in the superuser model are protected by file permissions alone. In a system with privileges, file permissions are too weak to protect the interfaces. A privilege such as proc_owner could override file permissions and then gain full access to the system.

Therefore, in Oracle Solaris, ownership of the device directory is not sufficient to open a device. For example, members of the group sys are no longer automatically allowed to open the /dev/ip device. The file permissions on /dev/ip are 0666, but the net_rawaccess privilege is also required to open the device.

Because device policy is controlled by privileges, you have more flexibility in granting permission to open devices. Privilege requirements are configurable for the device policy and for the driver proper. You can configure the privilege requirements when installing, adding, or updating a device driver.

For more information, see the add_drv(1M), devfsadm(1M), getdevpolicy(1M), and update_drv(1M) man pages.

Privileges and Resource Management

In Oracle Solaris, you can use the project.max-locked-memory and zone.max-locked-memory resource controls to limit the memory consumption of processes that are assigned the PRIV_PROC_LOCK_MEMORY privilege. This privilege allows a process to lock pages in physical memory.

If you assign the PRIV_PROC_LOCK_MEMORY privilege to a rights profile, you can give the processes that have this privilege the ability to lock all memory. As a safeguard, set a resource control to prevent the user of the privilege from locking all memory. For privileged processes that run in a non-global zone, set the zone.max-locked-memory resource control. For privileged processes that run on a system, create a project and set the project.max-locked-memory resource control. For information about these resource controls, see Chapter 6, “About Resource Controls,” in “Administering Resource Management in Oracle Solaris 11.2 ” and Chapter 2, “Non-Global Zone Configuration Overview,” in “Introduction to Oracle Solaris Zones ”.

Legacy Applications and the Use of Privileges

To accommodate legacy applications, the implementation of privileges works with both the superuser and the rights models. The kernel automatically tracks the PRIV_AWARE flag, which indicates that a program has been designed to work with privileges. Consider a child process that is not aware of privileges. Any privileges that were inherited from the parent process are available in the child's permitted and effective sets. If the child process sets a UID to 0, the child process might not have full superuser rights. The process's effective and permitted sets are restricted to those privileges in the child's limit set. Thus, the limit set of a privilege-aware process restricts the root privileges of child processes that are not aware of privileges.

Debugging Use of Privilege

Oracle Solaris provides tools to debug privilege failure. The ppriv command and the truss command provide debugging output. For examples, see the ppriv(1) man page. For examples, see “Troubleshooting Rights” on page 95. You can also use the dtrace command. For more information, see the dtrace(1M) man page and “Oracle Solaris 11.2 Dynamic Tracing Guide ”.

Privilege Assignment

The term “privilege” traditionally indicates an increase in rights. Because every process on an Oracle Solaris system runs with some rights, you can decrease the rights on a process by removing privileges. In this release, you can also use an *extended privilege policy* to remove most privileges except the ones that are given to certain resources by default.

Assigning Privileges to Users and Processes

In your capacity as security administrator, you are responsible for assigning privileges. Existing rights profiles have privileges already assigned to commands in the profile. You then assign the rights profile to a role or user.

Privileges can also be assigned directly to a user, a role, or a rights profile. If you trust a subset of users to use a privilege responsibly throughout their sessions, you can assign the privilege directly. Good candidates for direct assignment are privileges that have a limited effect, such as `proc_clock_highres`. Poor candidates for direct assignment are privileges that have broader effects, such as `file_dac_write`. For a fuller discussion, see “Security Considerations When Assigning Rights” on page 36.

Privileges can also be denied to a user, role, or process. Care must be taken when removing privileges from the initial inheritable set or the limit set of a user or role.

Expanding a User or Role's Privileges

Users and roles have an inheritable set of privileges. The limit set can only be reduced because the limit set is initially all privileges. The initial inheritable set can be expanded for users, roles, and processes by assigning a privilege that is not in the inheritable set.

You can expand the privileges that are available in three ways:

- A privilege that is not in the initial inheritable set but is in the limit set can be assigned to users and roles. The assignment can be indirect, through a privileged command in a rights profile, or it can be direct.
- A privilege that is not in the inheritable set can be explicitly assigned to a process, such as adding privileges to a script or application.
- A privilege that is not in the inheritable set but is in the limit set can be explicitly assigned to a network port, UID, or file object. This use of privilege is called an *extended privilege policy* and is also a means of restricting available privileges. For more information, see “Using Extended Privilege Policy to Restrict Privilege Use” on page 30.

The assignment of a privilege to just the administrative task that requires the privilege is the most precise way to expand a user or role's privileges. You create a rights profile that includes the command or script with its required privileges. Then, you assign this rights profile to a user or role. Such assignment enables the user or role to run that privileged command. The privilege is otherwise unavailable to the user.

Expanding the initial inheritable set of privileges for users or roles is a less desirable way to assign privileges. All privileges in the inheritable set are in the permitted and effective sets. All commands that the user or role types in a shell can use the directly assigned privileges. For a fuller discussion, see "Security Considerations When Assigning Rights" on page 36.

To reduce unnecessary privilege availability, you can assign *extended privileges* to network ports, UIDs, and file objects. Such assignment removes privileges that are not in the extended privilege assignment from the effective set. For a discussion, see "Using Extended Privilege Policy to Restrict Privilege Use" on page 30.

Restricting Privileges for a User or Role

Privileges and rights profiles can also be applied to untrusted users to restrict their rights. By removing privileges, you can prevent users and roles from performing particular tasks. You can remove privileges from the initial inheritable set and from the limit set. You should carefully test removal of privileges before you distribute an initial inheritable set or a limit set that is smaller than the default set. By removing privileges from the initial inheritable set, you might prevent users from logging in. When privileges are removed from the limit set, a legacy `setuid root` program might fail because the program requires a privilege that was removed. For examples of privilege removal, see Example 3-21 and Example 5-6.

To limit the privileges that are available to a user ID, port, or file object, see "Using Extended Privilege Policy to Restrict Privilege Use" on page 30.

Assigning Privileges to a Script

Scripts are executables, like commands. Therefore, in a rights profile, you can add privileges to a script just as you can add privileges to a command. The script runs with the added privileges when a user or role who has been assigned the rights profile executes the script in a profile shell. If the script contains commands that require privileges, the commands with added privileges must also be in an assigned rights profile. For examples, see "Assigning Rights to Applications and Scripts" on page 59.

Using Extended Privilege Policy to Restrict Privilege Use

Extended privilege policy can restrict access to ports, user IDs, or file objects except for the basic privileges and the privileges that you explicitly grant. With so few privileges, the resource cannot easily be used to attack the system. In fact, users can protect files and directories that they own from access by potentially malicious processes. For examples of extended privilege policy, see "Limiting Applications, Scripts, and Resources to Specific Rights" on page 59.

Privilege Escalation and User Rights

Oracle Solaris provides administrators with a great deal of flexibility when configuring security. As installed, the software prevents privilege escalation. *Privilege escalation* occurs when a user or process gains more administrative rights than you intended to grant. In this sense, "privilege" means all rights, not just kernel privileges. See "Privilege Escalation and Kernel Privileges" on page 31.

Oracle Solaris software includes rights that are assigned to the `root` role only. With other security protections in place, an administrator might assign attributes that are designed for the `root` role to other accounts, but such assignment must be made with care.

The following rights profile and set of authorizations can escalate the privileges of a non-root account:

- **Media Restore rights profile –** This profile is not part of any other rights profile. Because Media Restore provides access to the entire root file system, its use is a possible escalation of privilege. Deliberately altered files or substitute media could be restored. By default, the `root` role includes this rights profile.
- `solaris.*.assign` **authorizations –** These authorizations are not assigned to any rights profile. An account with a `solaris.*.assign` authorization could assign rights to others that the account itself is not assigned. For example, a role with the `solaris.profile.assign` authorization can assign rights profiles to other accounts that the role itself is not assigned. By default, only the `root` role has `solaris.*.assign` authorizations.

  Assign `solaris.*.delegate` authorizations, rather than `solaris.*.assign` authorizations. A `solaris.*.delegate` authorization enables the delegater to assign other accounts only those rights that the delegater possesses. For example, a role that is assigned the `solaris.profile.delegate` authorization can assign rights profiles that the role itself is assigned to other users and roles.

For the prevention of escalation of kernel privileges, see "Privilege Escalation and Kernel Privileges" on page 31.

Privilege Escalation and Kernel Privileges

The kernel prevents privilege escalation. To prevent a process from gaining more privileges than the process should have, the kernel checks that vulnerable system modifications have the full set of privileges. For example, a file or process that is owned by `root` (`UID=0`) can be changed only by a process with the full set of privileges. The `root` account does not require privileges to change a file that `root` owns. However, a non-root user must have all privileges in order to change a file that is owned by `root`.

Similarly, operations that provide access to devices require all privileges in the effective set.

Specifically, the `file_chown_self` and `proc_owner` privileges are subject to privilege escalation.

- The `file_chown_self` privilege allows a process to give away its files. The `proc_owner` privilege allows a process to inspect processes that the process does not own.

  The `file_chown_self` privilege is limited by the `rstchown` system variable. When the `rstchown` variable is set to `0`, the `file_chown_self` privilege is removed from the initial inheritable set of all users of the system image. For more information about the `rstchown` system variable, see the `chown`(1) man page.

  The `file_chown_self` privilege is most safely assigned to a particular command, the command placed in a rights profile, and the profile assigned to a role or a trusted user.
- The `proc_owner` privilege is not sufficient to switch a process UID to `0`. To switch a process from any UID to `UID=0` requires all privileges. Because the `proc_owner` privilege gives unrestricted read access to all files on the system, the privilege is most safely assigned to a particular command, the command placed in a profile, and the profile assigned to a role.

Caution - You can configure a user's account to include the `file_chown_self` privilege or the `proc_owner` privilege in the user's initial inheritable set. However, you should have overriding security reasons for placing such powerful privileges in any user or role's inheritable set.

For information about how privilege escalation is prevented for devices, see "Privileges and Devices" on page 27. For a general discussion, see the `privileges`(5) man page.

Rights Verification

The shell that a process runs in, the scope of the naming service, and the order of search can affect whether assigned rights are evaluated. Processes whose rights cannot be evaluated fail. For assistance in checking for rights assignments, see "Troubleshooting Rights" on page 95.

Profile Shells and Rights Verification

Users and roles can run privileged applications from a profile shell. A *profile shell* is a special shell that recognizes rights. Administrators can assign a profile shell to users as a login shell, or the profile shell is started when a user runs the `pfexec` command or the `su` command to assume a role. In Oracle Solaris, every shell has a profile shell counterpart. For a list of profile shells, see the `pfexec`(1) man page.

Users who are directly assigned a rights profile and whose login shell is not a profile shell must open a profile shell to run the privileged commands that they are assigned. Users and roles who are assigned an authenticated rights profile are prompted to authenticate, that is, to provide a password before the command can execute. For usability and security considerations, see "Considerations When Assigning Rights" on page 36.

Name Service Scope and Rights Verification

Name service scope affects when assigned rights are available. The scope of a role might be limited to an individual host. Alternatively, the scope might include all hosts that are served by a naming service such as LDAP. The name service scope for a system is specified in the name switch service, `svc:/system/name-service/switch`. A lookup stops at the first match. For example, if a rights profile exists in two name service scopes, only the entries in the first name service scope are used. If `files` is the first match, then the scope of the role is limited to the local host. For information about naming services, see the `nsswitch.conf`(4) man page, "Working With Oracle Solaris 11.2 Directory and Naming Services: DNS and NIS ", and "Working With Oracle Solaris 11.2 Directory and Naming Services: LDAP ".

Order of Search for Assigned Rights

A user or role can be assigned security attributes directly or through a rights profile. The order of search affects which security attribute value is used. The value of the first found instance of the attribute is used.

Note - The order of authorizations is not important. Authorizations are cumulative.

When a user logs in, rights are assigned in the following search order:

- **Rights** that are assigned directly to the user with the `useradd` and `usermod` commands. For a list of possible rights assignments, see "`user_attr` Database" on page 108.

- **Rights profiles** that are assigned to the user with the useradd and usermod commands. These assignments are searched in order.
  - First, the authenticated rights profiles are searched.

    The order is the first profile in the authenticated profiles list and then its supplementary profiles, the second profile in the authenticated profiles list and then its supplementary profiles, and so on. The first instance of a value is the one that the system uses, except for auths values, which are cumulative. The attributes that can be assigned to rights profiles include all the rights that can be assigned to users, plus supplementary profiles. For the list, see "user_attr Database" on page 108.
  - Then, the rights profiles that do not require reauthentication are searched in the same fashion.
- **Console User rights profile** value. For a description, see "Rights Profiles Reference" on page 105.
- If the **Stop rights profile** is assigned, the evaluation of security attributes stops. No attributes are assigned after the Stop profile is assigned. The Stop profile is evaluated after the Console User rights profile and before the other security attributes in the policy.conf file, including AUTHS_GRANTED. For a description, see "Rights Profiles Reference" on page 105.
- **Basic Solaris User rights profile** value in the policy.conf file.
- AUTHS_GRANTED value in the policy.conf file.
- AUTH_PROFS_GRANTED value in the policy.conf file.
- PROFS_GRANTED value in the policy.conf file.
- PRIV_DEFAULT value in the policy.conf file.
- PRIV_LIMIT value in the policy.conf file.

Applications That Check for Rights

Applications and commands that can override system controls are considered privileged applications. Security attributes such as UID=0, privileges, and authorizations make an application privileged.

Applications That Check UIDs and GIDs

Privileged applications that check for root (UID=0) or some other special UID or GID have long existed in the UNIX environment. The rights profile mechanism enables you to isolate commands that require a specific ID. Instead of changing the ID on a command that anyone can access, you can place the command with an assigned UID in a rights profile. A user or role with that rights profile can then run the program as that UID without having to become superuser.

IDs can be specified as *real* or *effective*. Assigning effective IDs is preferred over assigning real IDs. Effective IDs are equivalent to the `setuid` feature in the file permission bits. Effective IDs also identify the UID for auditing. However, because some shell scripts and programs require a real UID of `root`, real UIDs can be set as well. For example, the `reboot` command requires a real rather than an effective UID.

Tip - If an effective ID is not sufficient to run a command, assign the real ID to the command.

Applications That Check for Privileges

Privileged applications can check for the use of privileges. The rights profile mechanism enables you to specify the privileges for specific commands that require security attributes. Then, you can isolate the command with assigned security attributes in a rights profile. A user or role with that rights profile can then run the command with just the privileges that the command requires.

Commands that check for privileges include the following:

- Kerberos commands, such as `kadmin`, `kprop`, and `kdb5_util`
- Network commands, such as `ipadm`, `routeadm`, and `snoop`
- File and file system commands, such as `chmod`, `chgrp`, and `mount`
- Commands that control processes, such as `kill`, `pcred`, and `rcapadm`

To add commands with privileges to a rights profile, see "How to Create a Rights Profile" on page 79 and the `profiles`(1) man page. To determine which commands check for privileges in a particular profile, see Chapter 6, "Listing Rights in Oracle Solaris".

Applications That Check Authorizations

Some Oracle Solaris commands check authorizations, including the following:

- Audit administration commands, such as `auditconfig` and `auditreduce`
- Printer administration commands, such as `cupsenable` and `lpadmin`
- Batch job commands, such as `at`, `atq`, `batch`, and `crontab`
- Device-oriented commands, such as `allocate`, `deallocate`, `list_devices`, and `cdrw`.

For guidance about checking a script or program for authorizations, see Example 4-3. To write a program that requires authorizations, see "About Authorizations" in "Developer's Guide to Oracle Solaris 11 Security ".

Considerations When Assigning Rights

Security and usability issues can affect how administrators assign rights.

Security Considerations When Assigning Rights

Typically, users or roles obtain administrative rights through a rights profile, but direct assignment of rights is also possible.

- Privileges can be assigned directly to users and roles.

  Direct assignment of privileges is not a secure practice. Users and roles with a directly assigned privilege can override security policy wherever this privilege is required by the kernel. Also, malicious processes that compromise a user or role's process can use this privilege wherever it is required by the kernel.

  A more secure practice is to assign the privilege as a security attribute of a command in a rights profile. Then, that privilege is available only for that command by someone who has that rights profile.
- Authorizations can be assigned directly to users and roles.

  Because authorizations are evaluated at the user level, direct assignment of authorizations can be less dangerous than direct assignment of privileges. However, authorizations can enable a user to perform highly secure tasks, such as assigning audit flags. For greater security, assign authorizations in an authenticated rights profile where the user must supply a password before the command can execute.

Usability Considerations When Assigning Rights

Direct assignment of rights can affect usability.

- Directly assigned authorizations and the commands and authorizations in a user's rights profile must be interpreted by a profile shell to be effective. By default, users are not assigned a profile shell. Therefore, users must remember to open a profile shell and execute the commands in that shell.
- Singly assigning authorizations is not scalable. Also, directly assigned authorizations might not be sufficient to perform a task. The task might require privileged commands.

  Rights profiles are designed to bundle authorizations and privileged commands together. They also scale well to groups of users.

♦ ♦ ♦ CHAPTER 2

Planning Your Administrative Rights Configuration

This chapter provides information to help you decide whether to use a traditional rights model or to fully take advantage of the Oracle Solaris rights model when administering your system. The chapter covers the following topics:

- "Deciding Which Rights Model to Use for Administration" on page 37
- "Following Your Chosen Rights Model" on page 38

For an overview of rights, see "User Rights Management" on page 14. For reference information, see Chapter 8, "Reference for Oracle Solaris Rights".

Deciding Which Rights Model to Use for Administration

Rights in Oracle Solaris include rights profiles, authorizations, and privileges. Oracle Solaris offers several ways to configure administrative rights on a system.

The following list is ordered from most secure to the less secure traditional superuser model.

1. Divide administrative tasks among several trusted users, each of whom has limited rights. This approach is the Oracle Solaris rights model.

   For information about how to follow this approach, see "Following Your Chosen Rights Model" on page 38.

   For a discussion of the benefits of this approach, see Chapter 1, "About Using Rights to Control Users and Processes".
2. Use the default rights configuration. This approach uses the rights model but does not customize it to your site.

   By default, the initial user has some administrative rights and can assume the `root` role. Optionally, the `root` role could assign the `root` role to another trusted user. For greater security, the `root` role would enable the auditing of administrative commands.

   Tasks that are useful to administrators who use this model are the following:

   - "Using Your Assigned Administrative Rights" on page 74

- "Assigning Rights to Users" on page 41
- "Auditing Administrative Actions" on page 78
- "Changing a Role Password" on page 48
- Chapter 6, "Listing Rights in Oracle Solaris"

3. Use the `sudo` command.

   Administrators who are familiar with the `sudo` command can configure `sudo` and use it. Optionally, they can configure the `/etc/sudoers` file to enable `sudo` users to run administrative commands without reauthentication for a set period of time.

   Tasks that are useful to `sudo` users are the following:

   - "Using Your Assigned Administrative Rights" on page 74
   - "Auditing Administrative Actions" on page 78
   - Caching Authentication – Example 5-2

   The `sudo` command is not as hooked into the kernel as rights profiles are. The command runs as `root` with all privileges so that it can grant the rights that are specified for each program in the `/etc/sudoers` file for the current user. Although `sudo` cannot specify the attributes of the program's subsequent child processes, it can block their execution. The Oracle Solaris version of `sudo` removes the `PRIV_PROC_EXEC` privilege from the process. For more information, see the Oracle Solaris version of the `sudo`(1M) man page.

4. Use the superuser model by changing the `root` role into a user.

   Administrators who use the traditional UNIX model must complete "How to Change the `root` Role Into a User" on page 84. Optionally, the `root` user can configure auditing.

Following Your Chosen Rights Model

User and process rights management can be an integral part of managing your systems deployment. Planning requires a thorough knowledge of the security requirements of your organization as well as an understanding of rights in Oracle Solaris. This section describes the general process for planning your site's use of rights.

1. Learn the basic concepts about rights.

   Read Chapter 1, "About Using Rights to Control Users and Processes". Using rights to administer a system is very different from using conventional UNIX administrative practices.

2. Examine your security policy.

   Your organization's security policy details the potential threats to your system, measures the risk of each threat, and provides strategies to counter these threats. Isolating the security-relevant tasks through rights can be a part of the strategy.

For example, your site might require that you separate security administration from non-security administration. To implement separation of duty, see Example 3-3.

If your security policy relies on Authorization Rules Managed On RBAC (ARMOR), you must install and use the ARMOR package. For its use in Oracle Solaris, see Example 3-1.

3. Review the default rights profiles.

   The default rights profiles collect the rights that are required to complete a task. To review available rights profiles, see "Listing Rights Profiles" on page 88

4. Decide whether you are going to use roles or assign rights profiles to users directly.

   Roles can ease the administration of rights. The role name identifies the tasks that the role can perform and isolates role rights from user rights. If you are going to use roles, you have three options:

   - You can install the ARMOR package, which installs the seven roles that the Authorization Roles Managed on RBAC (ARMOR) standard defines. See Example 3-1.
   - You can define your own roles and also use ARMOR roles. See "Creating a Role" on page 42 and Example 3-1.
   - You can define your own roles and not use ARMOR roles. See "Creating a Role" on page 42.

   If roles are not required at your site, you can directly assign rights profiles to users. To require a password when users perform an administrative task from their rights profiles, use authenticated rights profiles. See Example 3-11.

5. Decide whether you need to create additional rights profiles.

   Look for other applications or families of applications at your site that might benefit from restricted access. Applications that affect security, that can cause denial-of-service problems, or that require special administrator training are good candidates for using rights. For example, users of Sun Ray systems do not require all basic privileges. For an example of a rights profile that limits users, see Example 3-22.

   a. Determine which rights are needed for the new task.

   b. Decide whether an existing rights profile is appropriate for this task.

   c. Order the rights profile so that commands execute with their required privileges.

      For information about ordering, see "Order of Search for Assigned Rights" on page 33.

6. Decide which users should be assigned which rights.

   According to the principle of least privilege, you assign users to roles that are appropriate to the user's level of trust. When you prevent users from performing tasks that the users do not need to perform, you reduce potential problems.

Note - Rights that apply to all users of a system image are specified in the `/etc/security/policy.conf` file.

Once you have a plan, create logins for trusted users who can be assigned rights profiles or roles. For details on creating users, see "Task Map for Setting Up and Managing User Accounts by Using the CLI" in "Managing User Accounts and User Environments in Oracle Solaris 11.2 ".

To assign rights, start with the procedures in "Assigning Rights to Users" on page 41. The sections that follow provide examples of expanding rights, limiting rights, assigning rights to resources, and troubleshooting rights assignments.

♦ ♦ ♦ CHAPTER 3

Assigning Rights in Oracle Solaris

This chapter describes tasks for assigning rights to users and roles. The chapter covers the following topics:

- "Assigning Rights to Users" on page 41
- "Expanding Users' Rights" on page 48
- "Restricting Users' Rights" on page 53

For an overview of rights, see "User Rights Management" on page 14. For reference information, see Chapter 8, "Reference for Oracle Solaris Rights".

Assigning Rights to Users

Rights in Oracle Solaris exist on every process. You can add rights to users and roles, and remove rights. Rights include privileges on the user's process, privileges or special IDs on a command that the user runs, and authorizations to perform a particular action. To ease the administrative burden of assigning rights, Oracle Solaris collects rights for services and administrative actions into *rights profiles*. Rather than assign individual rights to users and roles, you can assign a rights profile that includes all the authorizations and privileges that the administrative task requires.

Roles give a name to the administrative task that a user can perform, such as `auditadm`. To perform an administrative action, the user assumes an assigned role to perform the action. Roles can be required by security policy and they can simply be convenient. You can create roles or you can install the `armor` package which creates seven roles and their local home directories. For more information about roles, see "User and Process Rights Provide an Alternative to the Superuser Model" on page 14.

Who Can Assign Rights

Initially, you must be in the `root` role to create users with added rights.

If the root role has distributed administrative tasks to you as a trusted user or by assigning a role to you, the following rights profiles assignments enable you to create users and roles or assign rights to them:

- To create a user or role, you must become an administrator who is assigned the User Management rights profile.
- To assign most rights to a user or role, you must become an administrator who is assigned the User Security rights profile.

  You cannot assign audit flags. Only the root role can assign audit flags to a user or role.

  You cannot change the password of a role. Only the root role can change a role's password.

If you are assigned administrative rights, review "Using Your Assigned Administrative Rights" on page 74 before you try to run administrative commands.

Assigning Rights to Users and Roles

This section describes the commands that create and modify roles and users. To create or modify rights profiles, see "How to Create a Rights Profile" on page 79 and "How to Clone and Modify a System Rights Profile" on page 80.

For information about roles, see "Basics of User and Process Rights" on page 17.

The main actions in creating and modifying roles and users are as follows:

- Creating a role
- Creating a trusted user
- Modifying the rights of a role
- Modifying the rights of a user
- Enabling users to use their own password to assume a role
- Changing a role password
- Deleting a role

Creating a Role

If you are going to use roles, you have several options. You can install the predefined roles from ARMOR and use them exclusively. Also, you can create roles and give them passwords. You can use ARMOR roles with the roles that you create.

To use ARMOR roles, see Example 3-1.

To create your own roles, you use the roleadd command. For a full list of the arguments to this command, see the roleadd(1M) man page.

For example, the following commands create a local User Administrator role with a home directory and a `pfbash` login shell, and create a password for the role:

```
# roleadd -c "User Administrator role, local" \
-m -K profiles="User Security,User Management"  useradm
80 blocks
# ls /export/home/useradm
local.bash_profile     local.login     local.profile
# passwd useradm
Password: xxxxxxxx
Confirm Password: xxxxxxxx
```

where

`-c` *comment* — Describes the role.

`-m` — Creates a home directory.

`-K profiles=` — Assigns one or more rights profiles to the role. For the list of rights profiles, see "Listing Rights Profiles" on page 88.

rolename — The name of the role. For restrictions on acceptable strings, see the `roleadd`(1M) man page.

Note - A role account can be assigned to more than one user. Therefore, an administrator typically creates a role password and provides the users with the role password out of band. For an alternative to the role password, see "Enabling Users to Use Own Password for Role Password" on page 47, Example 3-16, and Example 3-17.

EXAMPLE 3-1 Using ARMOR Roles

In this example, the security administrator installs roles that are defined by the ARMOR standard. The administrator first verifies that the role names do not conflict with any existing accounts, then installs the package, views the role definitions, and assigns the roles to trusted users.

First, the administrator ensures that the following UIDs and names do not exist in the naming service:

- `57 auditadm`
- `55 fsadm`
- `58 pkgadm`
- `53 secadm`
- `56 svcadm`
- `59 sysop`

- `54 useradm`

After verifying that the UIDs and names are not in use, the administrator installs the package.

```
# pkg install system/security/armor
```

The package creates seven roles and local home directories in the `/export/home` directory.

To view the rights of each role, the administrator can list the profiles that are assigned to each role.

```
# profiles auditadm
# profiles fsadm
# profiles pkgadm
# profiles secadm
# profiles svcadm
# profiles sysop
# profiles useradm
```

These rights assignments cannot be modified. To create a different configuration of rights, you must create new roles, then create new rights profiles by following the steps in "How to Clone and Modify a System Rights Profile" on page 80.

Finally, the administrator assigns the roles to trusted users. The users' own passwords are used to authenticate to the role. Some users are assigned more than one role. Roles whose tasks are time-critical are assigned to more than one trusted user.

```
# usermod -R=auditadm adal
# usermod -R=fsadm,pkgadm bdewey
# usermod -R=secadm,useradm cfoure
# usermod -R=svcadm ghamada
# usermod -R=svcadm yjones
# usermod -R=sysop hmurtha
# usermod -R=sysop twong
```

EXAMPLE 3-2 Creating a User Administrator Role in the LDAP Repository

The administrator creates a User Administrator role in LDAP. The user provides a password when assuming the role, then does not need to supply a password for individual commands.

```
# roleadd -c "User Administrator role, LDAP" -m -S ldap \
-K profiles="User Security,User Management"  useradm
```

EXAMPLE 3-3 Creating Roles for Separation of Duty

The administrator creates two roles. The `usermgt` role can create users, give them home directories, and perform other non-security tasks. The `usersec` role cannot create users, but can assign passwords and change other rights assignments. Neither role can set audit flags for users or roles, or change a role's password. The `root` role must perform those actions.

```
# roleadd -c "User Management role, LDAP" -s /usr/bin/pfksh \
-m -S ldap -K profiles="User Management"  usermgt
# roleadd -c "User Security role, LDAP" -s /usr/bin/pfksh \
-m -S ldap -K profiles="User Security"  usersec
```

The administrator ensures that two people are necessary to create every regular user in Example 3-5.

EXAMPLE 3-4 Creating and Assigning a Role to Administer Cryptographic Services

In this example, the administrator on an LDAP network creates a role to administer the Cryptographic Framework, and assigns the role to UID 1111.

```
# roleadd -c "Cryptographic Services manager" \
-g 14 -m -u 104 -S ldap -K profiles="Crypto Management" cryptmgt
# passwd cryptmgt
New Password: xxxxxxxx
Confirm password: xxxxxxxx
# usermod -u 1111 -R +cryptmgt
```

The user with UID 1111 logs in, then assumes the role and displays the assigned rights.

```
% su - cryptmgt
Password: xxxxxxxx
# profiles -l
      Crypto Management
          /usr/bin/kmfcfg            euid=0
          /usr/sbin/cryptoadm        euid=0
          /usr/sfw/bin/CA.pl         euid=0
          /usr/sfw/bin/openssl       euid=0
#
```

For information about the Cryptographic Framework, see Chapter 1, “Cryptographic Framework,” in “Managing Encryption and Certificates in Oracle Solaris 11.2 ”. To administer the framework, see “Administering the Cryptographic Framework” in “Managing Encryption and Certificates in Oracle Solaris 11.2 ”.

Creating a Login for a Trusted User

You use the `useradd` command to create a login. For a full list of the arguments to the `useradd` command, see the `useradd`(1M) man page. The rights-related arguments to the command are similar to the `roleadd` command, with the addition of the `-R` *rolename* option.

If you assign a role to a user, the user can use the role's rights after assuming the role. For example, the following command creates a trusted user who can assume the `useradm` role that you created in “Creating a Login for a Trusted User” on page 45.

```
# useradd -c "Trusted Assistant User Manager user" -m -R useradm jdoe
```

```
80 blocks
# ls /export/home/jdoe
local.bash_profile     local.login     local.profile
```

where

-s *shell* Determines the login shell for *username*. This shell can be a profile shell, such as pfbash. For reasons to assign a profile shell to a trusted user, see "Usability Considerations When Assigning Rights" on page 36. For a list of profile shells, see the pfexec(1) man page.

-R *rolename* Assigns the name of an existing role.

For more examples, see "Task Map for Setting Up and Managing User Accounts by Using the CLI" in "Managing User Accounts and User Environments in Oracle Solaris 11.2 ".

Modifying a User's Rights

You use the usermod command to modify a user account. For a full list of the arguments to the usermod command, see the usermod(1M) man page. The rights-related arguments to the command are similar to the useradd command.

If you assign a rights profile to a user, the user can use the rights after the user opens a profile shell. For example, assign a rights profile to a user:

```
# usermod -K profiles="User Management" kdoe
```

The changes are in effect at the user's next login. For users to learn how to use their assigned rights, refer them to "Using Your Assigned Administrative Rights" on page 74.

EXAMPLE 3-5 Adding a Role to a User

In this example, the administrator ensures that two trusted users are necessary to create regular users. The roles were created in Example 3-3.

```
# usermod -R +useradm jdoe
# usermod -R +usersec mdoe
```

Modifying a Role's Rights

You use the rolemod command to modify a role account. For a full list of the arguments to the rolemod command, see the rolemod(1M) man page. The rights-related arguments to the command are similar to the roleadd command.

The values of *key*=*value* pairs, and the `-A`, `-P`, and `-R` options can be modified by a minus (-) or plus (+) sign. The - sign indicates to subtract the value from the currently assigned values. The + sign indicates to add the value to the currently assigned values. For rights profiles, the value is prepended to the current list of profiles. For the effects of being an earlier rights profile, see "Order of Search for Assigned Rights" on page 33.

EXAMPLE 3-6 Adding a Rights Profile as the Role's First Rights Profile

For example, prepend a rights profile to the `useradm` role:

```
# rolemod -K profiles+="Device Management" useradm
# profiles useradm
useradm:
Device Management
User Management
User Security
```

EXAMPLE 3-7 Replacing a Local Role's Assigned Profiles

In this example, the security administrator modifies the `prtmgt` role to include the VSCAN Management rights profile after the Printer Management profile.

```
# rolemod -c "Handles printers and virus scanning" \
-P "Printer Management,VSCAN Management,All" prtmgt
```

EXAMPLE 3-8 Assigning Privileges Directly to a Role

In this example, the security administrator entrusts the `realtime` role with a very specific privilege that affects system time. To assign the privilege to a user, see Example 3-14.

```
# rolemod -K defaultpriv+='proc_clock_highres' realtime
```

The values for the `defaultpriv` keyword are in the list of privileges in the role's processes at all times.

Enabling Users to Use Own Password for Role Password

To enable users to use their own password rather than a role password when assuming a role, modify the role.

The following command enables all users who are assigned the `useradm` role to use their own own password when assuming any assigned role, including the `useradm` role.

```
# rolemod -K roleauth=user useradm
```

Changing a Role Password

Because a role can be assigned to many users, users who are assigned a role cannot change the role password. You must be in the root role to change a role password.

```
# passwd useradm
Enter useradm's password: xxxxxxxx
New: xxxxxxxx
Confirm: xxxxxxxx
```

If you do not specify a repository, the password is changed in all repositories.

For more command options, see the passwd(1) man page.

EXAMPLE 3-9 Changing the Password of a Role in a Specific Repository

In the following example, the root role changes the password of the local devadmin role.

```
# passwd -r files  devadmin
New password: xxxxxxxx
Confirm password: xxxxxxxx
```

In the following example, the root role changes the password of the devadmin role in the LDAP naming service.

```
# passwd -r ldap devadmin
New password: xxxxxxxx
Confirm password: xxxxxxxx
```

Deleting a Role

When you delete a role, the role immediately becomes unusable.

```
# roledel useradm
```

Users who are currently performing administrative tasks in the role are prevented from continuing. The profiles command shows the following output:

```
useradm # profiles
Unable to get user name
```

Expanding Users' Rights

The tasks and examples in this section add rights to the rights that users receive by default. For information about rights, see Chapter 1, "About Using Rights to Control Users and Processes".

- Assign a role to a trusted user – Example 3-1, Example 3-4, Example 3-5
- Assign a rights profile to a trusted user – Example 3-10, Example 3-19, Example 4-1
- Assign an authenticated rights profile to a trusted user – Example 3-11, Example 4-2
- Assign an authorization to a trusted user or role – Example 3-12, Example 3-13
- Assign privileges directly to a user or role – Example 3-8, Example 3-14, Example 3-15

Caution - Inappropriate use of directly assigned privileges and authorizations can result in unintentional breaches of security. For a discussion, see "Security Considerations When Assigning Rights" on page 36.

- Enable a user to use own password when assuming a role – Example 3-16, Example 3-17
- Modify a rights profile – Example 3-22
- Add security attribute to a command in a rights profile – Example 3-26, Example 3-27, Example 5-7
- Enable a user to read a `root`-owned file – Example 3-19, Example 3-20
- Enable a user or role to edit a `root`-owned file – Example 5-9
- Assign a rights profile that contains a new authorization – Example 5-11

EXAMPLE 3-10 Creating a User Who Can Administer DHCP

The security administrator creates a user who can administer DHCP.

```
# useradd -P "DHCP Management" -s /usr/bin/pfbash -S ldap  jdoe
```

Because the user is assigned `pfbash` as the login shell, the rights in the DHCP Management rights profile are always evaluated, so the DHCP administrative commands succeed.

EXAMPLE 3-11 Requiring a User to Type Password Before Administering DHCP

In this example, the security administrator requires `jdoe` to provide a password before managing DHCP.

```
# usermod -K auth_profiles="DHCP Management" profiles="Edit Administrative Files" jdoe
```

When `jdoe` types a DHCP command, the password prompt appears. After authenticating `jdoe`, the DHCP command completes. In search order, authenticated rights profiles are processed before regular profiles.

```
jdoe% dhcpconfig -R 120.30.33.7,120.30.42.132
Password: xxxxxxxx
      /** Command completes **/
```

EXAMPLE 3-12 Assigning Authorizations Directly to a User

In this example, the security administrator creates a local user who can control screen brightness.

```
# useradd -c "Screened KDoe, local" -s /usr/bin/pfbash \
-A solaris.system.power.brightness  kdoe
```

This authorization is added to the user's existing authorization assignments.

EXAMPLE 3-13 Assigning Authorizations to a Role

In this example, the security administrator creates a role that can change the configuration information for the DNS server service.

```
# roleadd -c "DNS administrator role" -m -A solaris.smf.manage.bind" dnsadmin
```

EXAMPLE 3-14 Assigning Privileges Directly to a User

In this example, the security administrator trusts the user `kdoe` with a very specific privilege that affects system time. To assign the privilege to a role, see Example 3-8.

```
# usermod -K defaultpriv='basic,proc_clock_highres' kdoe
```

The values for the `defaultpriv` keyword replace the existing values. Therefore, for the user to retain the `basic` privileges, the value `basic` is specified. In the default configuration, all users have basic privileges. For the list of basic privileges, see "Listing Privileges" on page 91.

The user can view the added privilege and its definition.

```
kdoe% ppriv -v $$
1800:   pfksh
flags = <none>
        E: file_link_any,…,proc_clock_highres,sys_ib_info
        I: file_link_any,…,proc_clock_highres,sys_ib_info
        P: file_link_any,…,proc_clock_highres,sys_ib_info
        L: cpc_cpu,dtrace_kernel,dtrace_proc,dtrace_user,...,win_upgrade_sl
% ppriv -vl proc_clock_highres
        Allows a process to use high resolution timers.
```

EXAMPLE 3-15 Adding to a Role's Basic Privileges

In the following example, the role `realtime` is directly assigned privileges to handle date and time programs. You assigned the `proc_clock_highres` to `realtime` in Example 3-8.

```
# rolemod -K defaultpriv='basic,sys_time' realtime

% su - realtime
Password: xxxxxxxx
# ppriv -v $$
1600:   pfksh
flags = <none>
        E: file_link_any,...,proc_clock_highres,sys_ib_info,sys_time
        I: file_link_any,...,proc_clock_highres,sys_ib_info,sys_time
        P: file_link_any,...,proc_clock_highres,sys_ib_info,sys_time
        L: cpc_cpu,dtrace_kernel,dtrace_proc,dtrace_user,...,sys_time
```

EXAMPLE 3-16 Enabling a User to Use Own Password for Role Password

By default, users must type the role's password to assume a role. By requiring a user password, the administrator makes assuming a role in Oracle Solaris similar to assuming a role in a Linux environment.

```
# rolemod -K roleauth=user auditrev
```

To assume this role, the assigned users can now use their own passwords, not the password that was created specifically for the role.

If the user has been assigned other roles, the user's password authenticates to those roles, too.

EXAMPLE 3-17 Modifying a Rights Profile to Enable a User to Use Own Password for Role Password

```
# profiles -p "Local System Administrator"
profiles:Local System Administrator> set roleauth="user"
profiles:Local System Administrator> end
profiles:Local System Administrator> exit
```

When a user who is assigned the Local System Administrator rights profile wants to assume the role, the user is prompted for a password. In the following sequence, the role name is `admin`:

```
% su - admin
Password: xxxxxxxx
#       /** You are now in a profile shell with administrative rights**/
```

EXAMPLE 3-18 Changing the Value of `roleauth` for a Role in the LDAP Repository

In this example, the `root` role enables all users who can assume the role `secadmin` to use their own password when assuming a role. This ability is granted to these users for all systems that are managed by the LDAP server.

```
# rolemod -S ldap -K roleauth=user secadmin
```

EXAMPLE 3-19 Enabling a Trusted User to Read Extended Accounting Files

You can enable a trusted user or group of users to read a file that is owned by the `root` account. This right can be useful to users who can run an administrative application that includes a `root`-owned file. This example adds one or more Perl scripts to the Extended Accounting Net Management rights profile.

After assuming the `root` role, the administrator creates a rights profile that adds the ability to read accounting files whose names begin with `network`.

The following profile uses extended privilege policy to grant the `file_dac_read` privilege to a script which can then access `/var/adm/exacct/network*` files only. This profile adds the existing Extended Accounting Net Management rights profile as a supplementary profile.

```
# profiles -p "Extended Accounting Perl Scripts"
profiles:Extended Accounting Perl Scripts >
set desc="Perl Scripts for Extended Accounting"
... Scripts> add profiles="Extended Accounting Net Management"
... Scripts> add cmd=/usr/local/bin/exacctdisp.pl
... Scripts:exacctdisp.pl> set privs={file_dac_read}:/var/adm/exacct/network*
... Scripts:exacctdisp.pl> end
... Scripts> commit
... Scripts> exit
```

For sample scripts, see "Using the Perl Interface to libexacct" in "Administering Resource Management in Oracle Solaris 11.2 ".

After reviewing the rights profile entries for errors such as typographical errors, omissions, or repetition, the administrator assigns the Extended Accounting Perl Scripts rights profile to a role or a user.

```
# profiles -p "Extended Accounting Perl Scripts" info
Found profile in files repository.
name=Extended Accounting Perl Scripts
desc=Perl Scripts for Extended Accounting
profiles=Extended Accounting Net Management
cmd=/usr/local/bin/exacctdisp.pl
privs={file_dac_read}:/var/adm/exacct/network*
```

```
# rolemod -K profiles+="Extended Accounting Perl Scripts" rolename
# usermod -K profiles+="Extended Accounting Perl Scripts" username
```

EXAMPLE 3-20 Enabling a Non-`root` Account to Read a `root`-Owned File

In this example, the administrator creates a rights profile that uses extended privilege policy to enable authorized users and roles to read the `/var/adm/sulog` file that `root` owns. The administrator adds the commands that the user can use to read the file. Unlisted commands cannot be used, such as the `head` command.

```
# profiles -p "Read sulog File"
profiles:Read sulog File
set desc="Read sulog File"
... File> add profiles="Read Log Files"
... File> add cmd=/usr/bin/cat
... File:cat> set privs={file_dac_read}:/var/adm/sulog
... File:cat> end
... File> add cmd=/usr/bin/less
... File:less> set privs={file_dac_read}:/var/adm/sulog
... File:less> end
... File> add cmd=/usr/bin/more
... File:more> set privs={file_dac_read}:/var/adm/sulog
... File:more> end
... File> add cmd=/usr/bin/page
... File:page> set privs={file_dac_read}:/var/adm/sulog
... File:page> end
... File> add cmd=/usr/bin/tail
... File:tail> set privs={file_dac_read}:/var/adm/sulog
... File:tail> end
... File> add cmd=/usr/bin/view
... File:head> set privs={file_dac_read}:/var/adm/sulog
... File:head> end
... File> commit
... File> exit
```

The view command enables the user to read a file but not to edit it.

Restricting Users' Rights

The examples in this section limit the rights of regular users, or remove some administrative rights from an administrator. They show how to modify users, roles, and rights profiles. For information about rights, see Chapter 1, “About Using Rights to Control Users and Processes”.

- Remove limit privileges from a user – Example 3-21
- Remove basic privileges from a user – Example 3-22
- Remove basic privileges from your own shell process – Example 3-23
- Create a system for restricted use – Example 3-24
- Restrict an administrator to explicitly assigned rights – Example 3-25
- Remove rights from all users of a system – Example 3-24, Example 3-28
- Prevent applications from creating subprocesses – Example 3-26
- Prevent user processes from spawning subprocesses – Example 3-27
- Create a restricted editor for guests – Example 3-27
- Assign the restricted editor to a public system – Example 3-28
- Remove privileges from the limit set of a rights profile – Example 5-6

- Create a rights profile for Sun Ray users – Example 5-6
- Remove rights from a rights profile – Example 5-6, Example 5-9
- Remove an authorization from a user – Example 5-10
- Remove a role assignment – Example 5-13

EXAMPLE 3-21 Removing Privileges From a User's Limit Set

In the following example, all sessions that originate from jdoe's initial login are prevented from using the sys_linkdir privilege. The user cannot make hard links to directories or unlink directories even after running the su command.

```
# usermod -K 'limitpriv=all,!sys_linkdir' jdoe
# userattr limitpriv jdoe
all,!sys_linkdir
```

EXAMPLE 3-22 Removing a Basic Privilege From a Rights Profile

In the following example, after thorough testing, the security administrator removes another basic privilege from the Sun Ray Users rights profile. When the administrator created the profile in Example 5-6, the administrator removed one privilege from the limit set. This time, the administrator removes two basic privileges. Users who are assigned this profile cannot examine any processes outside their current session, and they cannot add another session.

```
# profiles -p "Sun Ray Users"
profiles:Sun Ray Users> set defaultpriv="basic,!proc_session,!proc_info"
profiles:Sun Ray Users> end
profiles:Sun Ray Users> exit
```

EXAMPLE 3-23 Removing a Basic Privilege From Yourself

In the following example, a regular user modifies .bash_profile to remove the proc_info basic privilege. The output of programs like ps and prstat contain only the user's own processes, which can highlight useful information.

```
##  .bash_profile
## Remove proc_info privilege from my shell
##
ppriv -s EI-proc_info $$
```

The ppriv line removes the proc_info privilege from the user's effective and inheritable privilege sets (EI-) in the current shell process ($$).

In the following prstat output, the totals shrink from 74 to three processes:

```
## With all basic privileges
```

```
Total: 74 processes, 527 lwps, load averages: 0.01, 0.00, 0.00

## With proc_info removed from the effective and inheritable set
Total: 3 processes, 3 lwps, load averages: 0.00, 0.00, 0.00
```

EXAMPLE 3-24 Modifying a System to Limit the Rights Available to Its Users

In this example, the administrator creates a system that is useful only to administer the network. The administrator removes the Basic Solaris User rights profile and any authorizations from the `policy.conf` file. The Console User rights profile is not removed. The affected lines in the resulting `policy.conf` file are the following:

```
...
##AUTHS_GRANTED=
##AUTH_PROFS_GRANTED=
##PROFS_GRANTED=Basic Solaris User
CONSOLE_USER=Console User
...
```

Only a user who has been explicitly assigned authorizations, commands, or rights profiles is able to use this system. After login, the authorized user can perform administrative duties. If the authorized user is sitting at the system console, the user has the rights of the Console User.

EXAMPLE 3-25 Restricting an Administrator to Explicitly Assigned Rights

You can restrict a role or user to a limited number of administrative actions in two ways.

- Assign the Stop rights profile as the last profile in the user's list of profiles.

  The Stop rights profile is the simplest way to create a restricted shell. The authorizations and rights profiles in the `policy.conf` file are not assigned to the user or role.
- Modify the `policy.conf` file on a system, and require the role or user to use that system for administrative tasks. See Example 3-24.

The following command limits the `auditrev` role to performing only audit reviews.

```
# rolemod -P "Audit Review,Stop" auditrev
```

Because the `auditrev` role does not have the Console User rights profile, the auditor cannot shut down the system. Because this role does not have the `solaris.device.cdrw` authorization, the auditor cannot read from or write to the CD-ROM drive. Because this role does not have the Basic Solaris User rights profile, no commands from that profile can be run in this role. Because the All rights profile is not assigned, the `ls` command will not run. The role uses the File Browser to select the audit files for review.

For more information, see "Order of Search for Assigned Rights" on page 33 and "Rights Profiles Reference" on page 105.

EXAMPLE 3-26 Preventing Selected Applications From Spawning New Processes

In this example, the administrator creates a rights profile for applications that do not require subprocesses for correct operation. For convenience, the administrator creates a directory to hold these executables. When new applications are added that do not require subprocesses, the executables can be added to this directory. Or, if the executable is required to be in a specific directory, the administrator can link to it from `/opt/local/noex/`*app-executable*.

```
# profiles -p "Prevent App Subprocess"
profiles:Prevent App Subprocess> set desc="Keep apps from execing processes"
profiles:Prevent App Subprocess> add cmd=/opt/local/noex/mkmod
... Subprocess:mkmod> set limitprivs=all,!proc_exec
... Subprocess:mkmod> end
... Subprocess> add cmd=/opt/local/noex/gomap
... Subprocess:gomap> set limitprivs=all,!proc_exec
... Subprocess:gomap> end
... Subprocess> commit
... Subprocess> exit
```

EXAMPLE 3-27 Preventing Guests From Spawning Editor Subprocesses

In this example, the administrator prevents users from creating subshells from one or more editors by removing the `proc_exec` basic privilege from the editor command.

1. The administrator creates a rights profile that removes `proc_exec` from the limit privilege set of the `vim` editor.

   ```
   # profiles -p -S ldap "Editor Restrictions"
   profiles:Editor Restrictions> set desc="Site Editor Restrictions"
   ... Restrictions> add cmd=/usr/bin/vim
   ... Restrictions:vim> set limitprivs=all,!proc_exec
   ... Restrictions:vim> end
   ... Restrictions> commit
   ... Restrictions> exit
   ```

2. The administrator adds other popular editors to the rights profile.

   ```
   # profiles -p "Editor Restrictions"
   profiles:Editor Restrictions> add cmd=/usr/bin/gedit
   ... Restrictions:gedit> set limitprivs=all,!proc_exec
   ... Restrictions:gedit> end
   ... Restrictions> add cmd=/usr/bin/gconf-editor
   ... Restrictions:gconf-editor> set limitprivs=all,!proc_exec
   ... Restrictions:gconf-editor> end
   ... Restrictions> add cmd=/usr/bin/ed
   ... Restrictions:ed> set limitprivs=all,!proc_exec
   ```

```
... Restrictions:ed> end
... Restrictions> add cmd=/usr/bin/ex
... Restrictions:ex> set limitprivs=all,!proc_exec
... Restrictions:ex> end
... Restrictions> add cmd=/usr/bin/edit
... Restrictions:edit> set limitprivs=all,!proc_exec
... Restrictions:edit> end
... Restrictions> commit
... Restrictions> exit
```

3. The administrator reviews the rights profile entries for errors such as typographical errors, omissions, or repetition.

   ```
   # profiles -p "Editor Restrictions" info
   Found profile in files repository.
   name=Editor Restrictions
   desc=Site Editor Restrictions
   cmd=/usr/bin/vim
   limitprivs=all,!proc_exec
   ...
   ```

4. The administrator assigns the Editor Restrictions rights profile to the `guest` user.

   ```
   # usermod -K profiles+="Editor Restrictions" guest
   ```

   By using `profiles+`, the administrator adds this rights profile to the account's current rights profiles.

5. To verify that the editor privileges are limited, the administrator opens the editor and in a separate window, examines the privileges on the editor process.

   ```
   # ppriv -S $(pgrep vi)
   2805:   vi .bash_profile
   flags = PRIV_PFEXEC       User is running a profile shell
           E: basic,!proc_info        proc_info is removed from basic set
           I: basic,!proc_info
           P: basic,!proc_info
           L: all,!proc_exec        proc_exec is removed from limit set
   ```

EXAMPLE 3-28 Assigning the Editor Restrictions Rights Profile to All Users

In this example, the administrator adds the Editor Restrictions rights profile to the `policy.conf` file. The administrator ensures that this file is distributed to all public systems where guests can log in.

```
# cd /etc/security; cp policy.conf policy.conf.orig
# pfedit /etc/security/policy.conf
...
AUTHS_GRANTED=
```

```
AUTH_PROFS_GRANTED=
#PROFS_GRANTED=Basic Solaris User
PROFS_GRANTED=Editor Restrictions,Basic Solaris User
```

The User Security administrator has assigned a profile shell to every user. For the reasons and the procedure, see "Assigning Rights to Users" on page 41.

♦ ♦ ♦ CHAPTER 4

Assigning Rights to Applications, Scripts, and Resources

This chapter covers tasks that apply privileges, extended privilege policy, and other rights to users, ports, and applications:

- "Assigning Rights to Applications and Scripts" on page 59
- "Locking Down Resources by Using Extended Privileges" on page 62
- "Users Locking Down the Applications That They Run" on page 68

For an overview of rights, see "User Rights Management" on page 14.

Limiting Applications, Scripts, and Resources to Specific Rights

The tasks and examples in this section assign privileges to executables and system resources. Typically, you assign a privilege to an executable to enable a trusted user to run that executable. In "Assigning Rights to Applications and Scripts" on page 59, the privilege assignment enables the application or script to be run by a trusted user in a profile shell. In "Locking Down Resources by Using Extended Privileges" on page 62, extended privilege policy limits a user ID, port, or file object, to a smaller set of privileges than the default effective set. Privileges that are unspecified are denied to that user's process, port, or object. Such an assignment approximates least privilege policy.

Assigning Rights to Applications and Scripts

Applications and scripts execute one command or a series of commands. To assign rights, you set the security attributes, such as set IDs or privileges, for each command in a rights profile. Applications can check for authorizations, if appropriate.

Note - If a command in a script needs to have the `setuid` bit or `setgid` bit set to succeed, the script executable *and* the command must have the security attributes added in a rights profile. When the script is executed in a profile shell, the command runs with the security attributes.

- Run a script that needs rights – "How to Run a Shell Script With Privileged Commands" on page 60
- Enable privilege-aware applications to be run by non-`root` users – Example 4-1
- Enable `root`-owned applications to be run by non-`root` users – Example 4-2
- Check for authorizations in a script – Example 4-3

▼ How to Run a Shell Script With Privileged Commands

To run a privileged shell script, you add privileges to the script and to the commands in the script. Then, the appropriate rights profile must contain the commands with privileges assigned to them.

Before You Begin You must assume the `root` role. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Create the script with `/bin/pfsh`, or any other profile shell, on the first line.**

```
#!/bin/pfsh
# Copyright (c) 2013 by Oracle
```

2. **As a regular user, determine the privileges that the commands in the script need.**

   By running the script with no privileges, the `debug` option to the `ppriv` command lists the missing privileges.

```
% ppriv -eD script-full-path
```

   For more information, see "How to Determine Which Privileges a Program Requires" on page 101.

3. **Create or modify a rights profile for the script.**

   Add the shell script, and the commands in the shell script, with their required security attributes to the rights profile. See "How to Create a Rights Profile" on page 79.

4. **Assign the rights profile to a trusted user or role.**

   For examples, see "Assigning Rights to Users" on page 41.

5. **To run the script, do one of the following:**

- **If you are assigned the script as a user, open a profile shell and run the script.**

  ```
  % pfexec script-full-path
  ```

- **If you are assigned the script as a role, assume the role and run the script.**

  ```
  % su - rolename
  Password: xxxxxxxx
  # script-full-path
  ```

Example 4-1 Assigning Security Attributes to a Legacy Application

Because a legacy application is not privilege-aware, the administrator assigns the `euid=0` security attribute to the application executable in a rights profile. Then, the administrator assigns it to a trusted user.

```
# profiles -p LegacyApp
profiles:LegacyApp> set desc="Legacy application"
profiles:LegacyApp> add cmd=/opt/legacy-app/bin/legacy-cmd
profiles:LegacyApp:legacy-cmd> set euid=0
profiles:LegacyApp:legacy-cmd> end
profiles:LegacyApp> exit
# profiles -p LegacyApp 'select cmd=/opt/legacy-app/bin/legacy-cmd;info;end'
 id=/opt/legacy-app/bin/legacy-cmd
 euid=0

# usermod -K profiles+="Legacy application" jdoe
```

Example 4-2 Running an Application With Assigned Rights

In this example, the administrator assigns the rights profile from Example 5-7 to a trusted user.The user must provide a password when executing the script.

```
# usermod -K auth_profiles+="Site application" jdoe
```

Example 4-3 Checking for Authorizations in a Script or Program

To check for authorizations, write a test that is based on the `auths` command. For detailed information about this command, see the `auths`(1) man page.

For example, the following line tests whether the user has the authorization that is supplied as the `$1` argument:

```
if [ `/usr/bin/auths|/usr/xpg4/bin/grep $1` ]; then
        echo Auth granted
else
        echo Auth denied
fi
```

A more complete test includes logic that checks for the use of wildcards. For example, to test whether the user has the `solaris.system.date` authorization, you would need to check for the following strings:

- `solaris.system.date`
- `solaris.system.*`
- `solaris.*`

If you are writing a program, use the function `getauthattr` to test for the authorization.

Locking Down Resources by Using Extended Privileges

Extended privilege policy can limit attacker access to a system when an attack on an application is successful. An extended policy rule limits the scope of the effect of a privilege assignment to just the resource that is in the rule. Extended policy rules are expressed by enclosing the privileges between curly braces, followed by a colon and the associated resource. For more discussion, see "Expanding a User or Role's Privileges" on page 29. For examples of the syntax, see the `ppriv`(1) and `privileges`(5) man pages.

Both administrators and regular users can lock down resources by using extended privileges. Administrators can create extended privilege rules for users, ports, and applications. Regular users can use the command line or write scripts that use the `ppriv -r` command to prevent applications from writing files outside of user-specified directories.

- Limit the access available to a malicious user who enters by a port – "How to Apply Extended Privilege Policy to a Port" on page 62
- Run a database as a non-`root` daemon – "How to Lock Down the MySQL Service" on page 64
- Run the Apache web server as a non-`root` daemon – "How to Assign Specific Privileges to the Apache Web Server" on page 66
- Verify that the Apache web server is running with privileges – "How to Determine Which Privileges the Apache Web Server Is Using" on page 67
- Prevent Firefox from writing to directories on your system – Example 4-4
- Limit your applications to specific directories on your system – Example 4-5

▼ How to Apply Extended Privilege Policy to a Port

The service for the Network Time Protocol (NTP) uses the privileged port `123` for `udp` traffic. Privileges are required for this service to run. This example procedure modifies the service manifest to protect other ports from being accessed by a malicious user who might gain the privileges that are assigned to this port.

Before You Begin You must assume the `root` role. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Read the default service manifest entry for the port.**

   From the following `/lib/svc/manifest/network/ntp.xml` `start` method entry, the `net_privaddr`, `proc_lock_memory`, and `sys_time` privileges could be used on other processes:

   ```
   privileges='basic,!file_link_any,!proc_info,!proc_session,net_privaddr,
   proc_lock_memory,sys_time'
   ```

   The removed privileges specified by `!file_link_any,!proc_info,!proc_session` prevent the service from signaling or observing any other processes, and from creating hard links as a way of renaming files. That is, the process that is started by the service is only able to bind to NTP's port `123`, not to any of the other privileged ports.

   If a hacker could exploit the service to start another process, that process would be similarly limited.

2. **Modify the `start` and `restart` methods to limit the `net_privaddr` privilege to this port only.**

   ```
   # svccfg -s ntp editprop
   ```

   a. **Search for the string `net_privaddr`.**

   b. **Uncomment the entries that contain `net_privaddr`.**

   c. **In both entries, replace `net_privaddr` with `{net_privaddr}:123/udp`.**

      The extended privilege policy removes all privileges from this service except the specified privileges plus the basic privileges that are not specified. Therefore, the set of over eighty potentially exploitable privileges is reduced to less than eight.

3. **Restart the service to use the extended privilege policy.**

   ```
   # svcadm restart ntp
   ```

4. **Verify that the service is using extended privilege.**

   ```
   # svccfg -s ntp listprop | grep privileges
   start/privileges    astring  basic,!file_link_any,!proc_info,!proc_session,
                       {net_privaddr}:123/udp,proc_lock_memory,sys_time
   restart/privileges  astring  basic,!file_link_any,!proc_info,!proc_session,
                       {net_privaddr}:123/udp,proc_lock_memory,sys_time
   ```

How to Lock Down the MySQL Service

At installation, the MySQL database is configured to run with the full privileges of `root` over an unprotected port. In this task, you assign extended privilege policy to the MySQL service in a rights profile. After the rights profile becomes the `exec` method of the service, MySQL runs over a protected port as the user `mysql` with limited database access by non-MySQL processes.

Before You Begin The initial user can install the package. The remaining steps must be performed by the `root` role. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Install the MySQL package.**

```
# pkg search basename:mysql
...
basename ... pkg:/database/mysql-51@version
# pfexec pkg install mysql-51
```

Note - If you upgrade to version 5.5 of the MySQL database, then modify all steps to use `5.5` and `55` rather than `5.1` and `51`.

---

2. **Display the FMRI and state of the MySQL service.**

```
# svcs mysql
STATE          STIME    FMRI
disabled       May_15   svc:/application/database/mysql:version_51
```

3. **Create a rights profile that modifies the execution method of the service.**

The service manifest for this service specifies that the execution method is a shell script wrapper, `/lib/svc/method/mysql_51`.

```
# svccfg -s mysql listprop | grep manifest
... astring     /lib/svc/manifest/application/database/mysql_51.xml
# grep exec= /lib/svc/manifest/application/database/mysql_51.xml
                exec='/lib/svc/method/mysql_51 start'
                exec='/lib/svc/method/mysql_51 stop'
```

Use the `/lib/svc/method/mysql_51` wrapper for the command in the profile.

```
% su -
Password: xxxxxxxx
# profiles -p "MySQL Service"
MySQL Service> set desc="Locking down the MySQL Service"
MySQL Service> add cmd=/lib/svc/method/mysql_51
MySQL Service:mysql_51> set privs=basic
MySQL Service:mysql_51> add privs={net_privaddr}:3306/tcp
MySQL Service:mysql_51> add privs={file_write}:/var/mysql/5.1/data/*
MySQL Service:mysql_51> add privs={file_write}:/tmp/mysql.sock
MySQL Service:mysql_51> add privs={file_write}:/var/tmp/ib*
MySQL Service:mysql_51> end
MySQL Service> set uid=mysql
MySQL Service> set gid=mysql
MySQL Service> exit
```

The `file_write` privilege is a basic privilege granted by default to all processes. By explicitly enumerating the writable paths, write access is restricted to just those paths. This constraint applies to the specified executable and its child processes.

4. **Make the default port for MySQL a privileged port.**

```
# ipadm set-prop -p extra_priv_ports+=3306 tcp
# ipadm show-prop -p extra_priv_ports tcp
PROTO PROPERTY           PERM CURRENT     PERSISTENT   DEFAULT    POSSIBLE
tcp   extra_priv_ports    rw   2049,4045,  3306         2049,4045  1-65535
                                 3306
```

The `net_privaddr` privilege is required to bind to a privileged port. In the case of MySQL, binding to the default port number, 3306, does not normally require this privilege.

5. **Assign the rights profile to the MySQL service and tell the service to use it.**

```
# svccfg -s mysql:version_51
...version_51> setprop method_context/profile="MySQLService"
...version_51> setprop method_context/use_profile=true
...version_51> refresh
...version_51> exit
```

6. **Enable the service.**

The last component of the FMRI, `mysql:version_51`, is sufficient to uniquely specify the service.

```
# svcadm enable mysql:version_5
```

7. **(Optional) Verify that the service is running with the rights that are specified in the MySQL Service rights profile.**

```
# ppriv $(pgrep mysql)
103697:   /usr/mysql/5.1/bin/mysqld --basedir=/usr/mysql/5.1
                                    --datadir=/var/mysql/5.1/data
flags =   PRIV_XPOLICY
    Extended policies:
             {net_privaddr}:3306/tcp
             {file_write}:/var/mysql/5.1/data/*
             {file_write}:/tmp/mysql.sock
             {file_write}:/var/tmp/ib*
        E: basic,!file_write
        I: basic,!file_write
        P: basic,!file_write
        L: all
103609:  /bin/sh /usr/mysql/5.1/bin/mysqld_safe --user=mysql
```

```
                               --datadir=/var/mysql/5.1/data
flags =  PRIV_XPOLICY
    Extended policies:
             {net_privaddr}:3306/tcp
             {file_write}:/var/mysql/5.1/data/*
             {file_write}:/tmp/mysql.sock
             {file_write}:/var/tmp/ib*
        E: basic,!file_write
        I: basic,!file_write
        P: basic,!file_write
        L: all
```

How to Assign Specific Privileges to the Apache Web Server

This procedure locks down the web server daemon by assigning to it only the privileges it needs. The web server can only bind to port 80, and can only write to files that the `webservd` daemon owns. No `apache22` service processes run as `root`.

Before You Begin You must assume the `root` role. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Create the web server rights profile.**

```
# profiles -p "Apache2"
profiles:Apache2> set desc="Apache Web Server Extended Privilege"
profiles:Apache2> add cmd=/lib/svc/method/http-apache22
profiles:Apache2:http-apache22> add privs={net_privaddr}:80/tcp
...http-apache22> add privs={zone}:/system/volatile/apache2
...http-apache22> add privs={zone}:/var/apache2/2.2/logs/*
...http-apache22> add privs={zone}:/var/user
...http-apache22> add privs={file_write}:/var/user/webserv*
...http-apache22> add privs={file_write}:/tmp/*
...http-apache22> add privs={file_write}:/system/volatile/apache*
...http-apache22> add privs={file_write}:/proc/*
...http-apache22> add privs=basic,proc_priocntl
...http-apache22> set uid=webservd
...http-apache22> set gid=webservd
...http-apache22> end
---Apache2> exit
```

2. **(Optional) If you are using the SSL kernel proxy with Apache2, you must add the SSL ports to your `webservd` extended policy.**

```
# profiles -p "Apache2"
profiles:Apache2> add privs={net_privaddr}:443/tcp
profiles:Apache2> add privs={net_privaddr}:8443/tcp
profiles:Apache2:http-apache22> end
```

The SSL kernel proxy procedure is described in "How to Configure an Apache 2.2 Web Server to Use the SSL Kernel Proxy" in "Securing the Network in Oracle Solaris 11.2 ".

3. **Add the rights profile to the apache22 SMF start method.**

```
# svccfg -s apache22
svc:/network/http:Apache2> listprop start/exec
start/exec  astring "/lib/svc/method/http-apache22 start"
...
svc:/network/http:Apache2> setprop start/profile="Apache2"
svc:/network/http:Apache2> setprop start/use_profile=true
svc:/network/http:Apache2> refresh
svc:/network/http:Apache2> exit
```

When the apache22 service is enabled, the Apache2 profile will be used.

4. **Enable the apache22 service.**

```
# svcadm enable apache22
```

5. **Verify that web server is working.**

Open a browser and type localhost in the Firefox URL field.

Next Steps To verify that the privileges are applied correctly, continue with "How to Determine Which Privileges the Apache Web Server Is Using" on page 67.

How to Determine Which Privileges the Apache Web Server Is Using

In this task, you determine which privileges the web server is using by creating a debug version of the Apache2 rights profile.

Before You Begin You have completed "How to Assign Specific Privileges to the Apache Web Server" on page 66. The apache22 service is disabled. You are in the root role.

1. **Clone the Apache2 profile to call a different command.**

Debugging a command is simpler than debugging an SMF service. The apachectl command starts the Apache service interactively.

```
# profiles -p "Apache2"
profiles:Apache2> set name="Apache-debug"
profiles:Apache-debug> sel <Tab><Tab>
profiles:Apache-debug:http-apache22> set id=/usr/apache2/2.2/bin/apachectl
profiles:Apache-debug:apachectl> end
profiles:Apache-debug> exit
```

For more information, see the `apachectl`(8) man page.

2. **Assign the cloned profile to the `webservd` account.**

```
# usermod -K profiles+=Apache-debug webservd
```

3. **Switch to the `webservd` identity.**

```
# su - webservd
```

4. **(Optional) Verify the identity.**

```
# id
uid=80(webservd) gid=80(webservd)
```

5. **Start the web service in debug mode in a profile shell.**

   Do not use SMF directly. Use the command in the `Apache-debug` rights profile.

```
% pfbash
# ppriv -De /usr/apache2/2.2/bin/apachectl start
```

6. **In the `root` role, examine the privileges of the first `http` daemon.**

```
# ppriv $(pgrep httpd|head -1)
2999:   httpd
flags = PRIV_DEBUG|PRIV_XPOLICY|PRIV_EXEC
            Extended policies:
                    {net_privaddr}:80/tcp
                    {zone}:/system/volatile/apache2
                    {zone}:/var/apache2/2.2/logs/*
                    {zone}:/var/user
                    {file_write}:/var/user/webserv*
                    {file_write}:/tmp/*
                    {file_write}:/system/volatile/apache*
                    {file_write}:/proc/*
            E: basic,!file_write,!proc_info,proc_priocntl
            I: basic,!file_write,!proc_info,proc_priocntl
            P: basic,!file_write,!proc_info,proc_priocntl
            L: all
```

Users Locking Down the Applications That They Run

Users can remove basic privileges from applications by using extended privilege policy. The policy prevents access to directories that the applications should not access.

Note - Order is important. Broader privileges for directories such as `$HOME/Download*` must be assigned after narrower privileges for most `$HOME/.*` directories.

EXAMPLE 4-4 Running a Browser in a Protected Environment

This example illustrates how users can run the Firefox browser in a protected environment. In this configuration, the user's `Documents` directory is hidden from Firefox.

By using the following command, the user removes basic privileges from the `/usr/bin/firefox` command. The extended privilege arguments to the `ppriv -r` command limit the browser to reading and writing in only the directories that the user specifies. The `-e` option and its arguments open the browser with the extended privilege policy.

```
% ppriv -r "\
{file_read}:/dev/*,\
{file_read}:/etc/*,\
{file_read}:/lib/*,\
{file_read}:/usr/*,\
{file_read}:/var/*,\
{file_read}:/proc,\
{file_read}:/proc/*,\
{file_read}:/system/volatile/*,\
{file_write}:$HOME,\
{file_read}:$HOME/.*,\
{file_read,file_write}:$HOME/.mozill*,\
{file_read,file_write}:$HOME/.gnome*,\
{file_read,file_write}:$HOME/Downloa*,\
{file_read,file_write}:/tmp,\
{file_read,file_write}:/tmp/*,\
{file_read,file_write}:/var/tmp,\
{file_read,file_write}:/var/tmp/*,\
{proc_exec}:/usr/*\
" -e /usr/bin/firefox file:///$HOME/Desktop
```

When the `file_read` and `file_write` privileges are used in an extended policy, you must grant explicit access to every file that should be read or written. The use of the wildcard character, `*`, is essential in such policies.

To handle automounted home directories, the user would add an explicit entry for the automount path, for example:

```
{file_read,file_write}:/export/home/$USER
```

If the site is not using the `automount` facility, the initial list of protected directories is sufficient.

Users can automate this command-line protected browser by creating a shell script. Then, to launch a browser, the user calls the script, not the `/usr/bin/firefox` command.

EXAMPLE 4-5 Protecting Directories on Your System From Application Processes

In this example, a regular user creates a sandbox for applications by using a shell script wrapper. The first part of the script limits applications to certain directories. Exceptions, such as Firefox, are handled later in the script. Comments about parts of the script follow the script.

```
1 #!/bin/bash
2
3 # Using bash because ksh misinterprets extended policy syntax
4
5 PATH=/usr/bin:/usr/sbin:/usr/gnu/bin
6
7 DENY=file_read,file_write,proc_exec,proc_info
8
9 SANDBOX="\
10 {file_read}:/dev/*,\
11 {file_read}:/etc/*,\
12 {file_read}:/lib/*,\
13 {file_read,file_write}:/usr/*,\
14 {file_read}:/proc,\
15 {file_read,file_write}:/proc/*,\
16 {file_read}:/system/volatile/*,\
17 {file_read,file_write}:/tmp,\
18 {file_read,file_write}:/tmp/*,\
19 {file_read,file_write}:/var/*,\
20 {file_write}:$HOME,\
21 {file_read}:$HOME/.*,\
22 {file_read,file_write}:$PWD,\
23 {file_read,file_write}:$PWD/*,\
24 {proc_exec}:/usr/*\
25 "
26
27 # Default program is restricted bash shell
28
29 if [[ ! -n $1 ]]; then
30     program="/usr/bin/bash --login --noprofile
        --restricted"
31 else
32     program="$@"
33 fi
34
35
36 # Firefox needs more file and network access
37 if [[ "$program" =~ firefox ]]; then
38     SANDBOX+=",\
39 {file_read,file_write}:$HOME/.gnome*,\
40 {file_read,file_write}:$HOME/.mozill*,\
41 {file_read,file_write}:$HOME/.dbu*,\
42 {file_read,file_write}:$HOME/.puls*\
43 "
44
45 else
46     DENY+=",net_access"
47 fi
48
```

```
49 echo Starting $program in sandbox
50 ppriv -s I-$DENY -r $SANDBOX -De $program
```

The policy can be adjusted to permit specific applications more or less access. One adjustment is in lines 38-42, where Firefox is granted write access to several dot files that maintain session information in the user's home directory. Also, Firefox is not subject to line 46, which removes network access. However, Firefox is still restricted from reading arbitrary files in the user's home directory, and can save files only in its current directory.

As an extra level of protection, the default program, at line 30, is a restricted Bash shell. A restricted shell cannot change its current directory or execute the user's dot files. Therefore, any commands that are started from this shell are similarly locked into the sandbox.

In the final line of the script the `ppriv` command is passed two privilege sets as shell variables, `$DENY` and `$SANDBOX`.

The first set, `$DENY`, prevents the process from reading or writing any file, executing any subprocess, observing other user's processes, and (conditionally) accessing the network. These restrictions are too severe, so in the second set, `$SANDBOX`, the policy is refined by enumerating the directories which are available for reading, writing, and executing.

Also, in line 50 the debug option, `-D`, is specified. Access failures display in the terminal window in real time and include the named object and the corresponding privilege that is required for success. This debugging information can help the user customize the policy for other applications.

♦ ♦ ♦ CHAPTER 5

Managing the Use of Rights

This chapter covers tasks that maintain systems that use the rights model for administration. Several tasks extend the rights that Oracle Solaris provides by creating new rights profiles and authorizations.

The chapter covers the following topics:

- “Using Your Assigned Administrative Rights” on page 74
- “Auditing Administrative Actions” on page 78
- “Creating Rights Profiles and Authorizations” on page 78
- “Changing Whether `root` Is a User or a Role” on page 84

For information about rights, see Chapter 1, “About Using Rights to Control Users and Processes”. For information about maintaining the assigned rights of users and roles, see Chapter 3, “Assigning Rights in Oracle Solaris”.

Managing the Use of Rights

The tasks and examples in this section describe how to use the rights that you have been assigned, and how to change the rights configuration that is provided by default.

Note - For troubleshooting assistance, see “Troubleshooting Rights” on page 95.

- Use your assigned rights – “Using Your Assigned Administrative Rights” on page 74
- Audit administrative actions – Example 5-5
- Add rights profiles and authorizations – “Creating Rights Profiles and Authorizations” on page 78
- Configure `root` to be a user – “How to Change the `root` Role Into a User” on page 84
- Change `root` back into a role – Example 5-12
- Prevent `root` from administering a system – Example 5-13

Using Your Assigned Administrative Rights

In the root role, the initial user has all administrative rights. As root, this user can assign administrative rights, such as a role, a rights profile, or specific privileges and authorizations to trusted users. This section describes how these users can use their assigned rights.

Note - Oracle Solaris provides a special editor for administrative files. When editing administrative files, use the pfedit command. Example 5-1 shows how to enable non-root users to edit specified system files.

To perform your administrative tasks, open a terminal window and choose from the following options:

- If you are using sudo, type the sudo command.

  For administrators who are familiar with the sudo command, run the command with the name of an administrative command that you are assigned in the sudoers file. For more information, see the sudo(1M) and sudoers(4) man pages.
- If your task requires superuser privileges, become root.

  ```
  % su -
  Password: xxxxxxxx
  #
  ```

Note - This command works whether root is a user or a role. The pound sign (#) prompt indicates that you are now root.

- If your task is assigned to a role, assume the role that can perform that task.

  In the following example, you assume an audit configuration role. This role includes the Audit Configuration rights profile. You received the role password from your administrator.

  ```
  % su - audadmin
  Password: xxxxxxxx
  #
  ```

Tip - If you did not receive a role password, your administrator has configured the role to require your user password. Type your user password to assume the role. For more information about this option, see Example 3-16.

The shell in which you typed this command is now a profile shell. In this shell, you can run the `auditconfig` command. For more about profile shells, see "Profile Shells and Rights Verification" on page 33.

Tip - To view the rights of your role, see "Listing Rights Profiles" on page 88.

- If your task is assigned directly to you as a user, create a profile shell in one of the following ways:
  - Use the `pfbash` command to create a shell that evaluates administrative rights.

    In the following example, you have been directly assigned the Audit Configuration rights profile. The following set of commands enables you to view audit preselection values and audit policy in the `pfbash` profile shell:

    ```
    % pfbash
    # auditconfig -getflags
    active user default audit flags = ua,ap,lo(0x45000,0x45000)
    configured user default audit flags = ua,ap,lo(0x45000,0x45000)
    # auditconfig -getpolicy
    configured audit policies = cnt
    active audit policies = cnt
    ```

  - Use the `pfexec` command to run one administrative command.

    In the following example, you have been directly assigned the Audit Configuration rights profile as an authenticated rights profile. You can run a privileged command from this profile by using the `pfexec` command with the name of that command. For example, you can view the user's preselected audit flags:

    ```
    % pfexec auditconfig -getflags
    Enter password:       Type your user password
    active user default audit flags = ua,ap,lo(0x45000,0x45000)
    configured user default audit flags = ua,ap,lo(0x45000,0x45000)
    ```

    Typically, to run another privileged command that is included in your rights, you must type `pfexec` again before you type the privileged command. For more information, see the `pfexec(1)` man page. If you are configured with password caching, you can run subsequent commands within a configurable interval without providing a password, as shown in Example 5-2.

EXAMPLE 5-1 Editing a System File

If you are not `root` with the UID of `0`, by default you cannot edit system files. However, if you are assigned the `solaris.admin.edit/`*path-to-system-file* authorization, you can edit *system-*

file. For example, if you are assigned the solaris.admin.edit/etc/security/audit_warn authorization, you can edit the audit_warn file by using the pfedit command.

```
# pfedit /etc/security/audit_warn
```

For more information, see the pfedit(4) man page. This command is for use by all administrators.

EXAMPLE 5-2 Caching Authentication for Ease of Role Use

In this example, the administrator configures a role to manage audit configuration, but provides ease of use by caching the user's authentication. First, the administrator creates and assigns the role.

```
# roleadd -K roleauth=user -P "Audit Configuration" audadmin
# usermod -R +audadmin jdoe
```

When jdoe uses the -c option when switching to the role, a password is required before the auditconfig output is displayed:

```
% su - audadmin -c auditconfig option
Password: xxxxxxxx
    auditconfig output
```

If authentication is not being cached, when jdoe runs the command again, a password prompt appears.

The administrator creates a file in the pam.d directory to hold an su stack that enables the caching of authentication. When authentication is cached, a password is initially required but not thereafter until a certain amount of time has passed.

```
# pfedit /etc/pam.d/su
## Cache authentication for switched user
#
auth required           pam_unix_cred.so.1
auth sufficient         pam_tty_tickets.so.1
auth requisite          pam_authtok_get.so.1
auth required           pam_dhkeys.so.1
auth required           pam_unix_auth.so.1
```

After creating the file, the administrator checks the entries for typos, omissions, or repetitions.

The administrator must provide the entire preceding su stack. The pam_tty_tickets.so.1 module implements the cache. For more about PAM, see the pam_tty_tickets(5) and pam.conf(4) man pages and Chapter 1, "Using Pluggable Authentication Modules," in "Managing Kerberos and Other Authentication Services in Oracle Solaris 11.2 ".

After the administrator adds the su PAM file and reboots the system, all roles including the audadmin role are prompted only once for a password when running a series of commands.

```
% su - audadmin -c auditconfig option
Password: xxxxxxxx
      auditconfig output
% su - audadmin -c auditconfig option
      auditconfig output
...
```

EXAMPLE 5-3 Assuming the `root` Role

In the following example, the initial user assumes the `root` role and lists the privileges in the role's shell.

```
% roles
root
% su - root
Password: xxxxxxxx
#       Prompt changes to root prompt
# ppriv $$
1200:   pfksh
flags = <none>
        E: all
        I: basic
        P: all
        L: all
```

For information about privileges, see "Process Rights Management" on page 21 and the `ppriv`(1) man page.

EXAMPLE 5-4 Assuming an ARMOR Role

In this example, the user assumes an ARMOR role that the administrator assigned.

In a terminal window, the user determines which roles are assigned.

```
% roles
fsadm
sysop
```

The user then assumes the `fsadm` role and supplies the user's password.

```
% su - fsadm
Password: xxxxxxxx
#
```

The `su -` *rolename* command changes the terminal's shell to a profile shell. The user is now the `fsadm` role in this terminal window.

To determine which commands can be run in this role, the user follows the instructions in "Listing Rights Profiles" on page 88.

Auditing Administrative Actions

Site security policy often requires that you audit administrative actions. The `116:AUE_PFEXEC:execve(2) with pfexec enabled:ps,ex,ua,as` audit event captures these actions. The `cusa` metaclass, which provides a group of events that is appropriate for use with roles, is another option when auditing administrative actions. For more information, review the comments in the `/etc/security/audit_class` file.

EXAMPLE 5-5 Using Two Roles to Configure Auditing

In this example, two administrators implement the audit configuration plan of their site security officer. The plan is to use the `pf` class for all users, and specify the `cusa` metaclass for individual roles. The `root` role will assign the audit flags to the roles. The first administrator configures auditing and the second enables the new configuration.

The first administrator is assigned the Audit Configuration rights profile. This administrator views the current audit configuration:

```
# auditconfig -getflags
active user default audit flags = lo(0x1000,0x1000)
configured user default audit flags = lo(0x1000,0x1000)
```

Because the `pf` class does not include the `lo` class, the administrator adds the class to the system configuration.

```
# auditconfig -setflags lo,pf
```

To read the new audit configuration into the kernel, the administrator who is assigned the Audit Control rights profile refreshes the audit service.

```
# audit -s
```

Creating Rights Profiles and Authorizations

You can create or change a rights profile when the provided rights profiles do not contain the collection of rights that you need. You might create a rights profile for users with limited rights, for a new application, or various other reasons.

The rights profiles that Oracle Solaris provides are read-only. You can clone a provided rights profile for modification if its collection of rights is insufficient. For example, you might want to add the `solaris.admin.edit/`*path-to-system-file* authorization to a provided rights profile. For background, see "More About Rights Profiles" on page 20.

You can create an authorization when the provided authorizations do not include the authorizations that are coded in your privileged applications. You cannot change an existing authorization. For background, see "More About User Authorizations" on page 20.

▼ How to Create a Rights Profile

Before You Begin To create a rights profile, you must become an administrator who is assigned the File Security rights profile. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Create a rights profile.**

   ```
   # profiles -p [-S repository] profile-name
   ```

   You are prompted for a description.

2. **Add contents to the rights profile.**

   Use the `set` subcommand for profile properties that have a single value, such as `set desc`. Use the `add` subcommand for properties that can can have more than one value, such as `add cmd`.

   The following command creates the custom PAM rights profile in "How to Assign a Modified PAM Policy" in "Managing Kerberos and Other Authentication Services in Oracle Solaris 11.2 ". The name is shortened for display purposes.

   ```
   # profiles -p -S LDAP "Site PAM LDAP"
   profiles:Site PAM LDAP> set desc="Profile which sets pam_policy=ldap"
   ...LDAP> set pam_policy=ldap
   ...LDAP> commit
   ...LDAP> end
   ...LDAP> exit
   ```

Example 5-6 Creating a Sun Ray Users Rights Profile

In this example, the administrator creates a rights profile for Sun Ray users in the LDAP repository. The administrator has already created a Sun Ray version of the Basic Solaris User rights profile, and has removed all rights profiles from the `policy.conf` file on the Sun Ray server.

```
# profiles -p -S LDAP "Sun Ray Users"
profiles:Sun Ray Users> set desc="For all users of Sun Rays"
... Ray Users> add profiles="Sun Ray Basic User"
... Ray Users> set defaultpriv="basic,!proc_info"
... Ray Users> set limitpriv="basic,!proc_info"
... Ray Users> end
... Ray Users> exit
```

The administrator verifies the contents.

```
# profiles -p "Sun Ray Users" info
Found profile in LDAP repository.
        name=Sun Ray Users
        desc=For all users of Sun Rays
        defaultpriv=basic,!proc_info,
        limitpriv=basic,!proc_info,
        profiles=Sun Ray Basic User
```

Example 5-7 Creating a Rights Profile That Includes Privileged Commands

In this example, the security administrator adds privileges to an application in a rights profile that the administrator creates. The application is privilege-aware.

```
# profiles -p SiteApp
profiles:SiteApp> set desc="Site application"
profiles:SiteApp> add cmd="/opt/site-app/bin/site-cmd"
profiles:SiteApp:site-cmd> add privs="proc_fork,proc_taskid"
profiles:SiteApp:site-cmd> end
profiles:SiteApp> exit
```

To verify, the administrator selects the `site-cmd`.

```
# profiles -p SiteApp "select cmd=/opt/site-app/bin/site-cmd; info;end"
Found profile in files repository.
  id=/opt/site-app/bin/site-cmd
  privs=proc_fork,proc_taskid
```

Next Steps Assign the rights profile to a trusted user or role. For examples, see Example 3-10 and Example 3-19.

See Also To troubleshoot rights assignment, see "How to Troubleshoot Rights Assignments" on page 95. For background, see "Order of Search for Assigned Rights" on page 33.

▼ How to Clone and Modify a System Rights Profile

Before You Begin To create or change a rights profile, you must become an administrator who is assigned the File Security rights profile. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Create a new rights profile from an existing profile.**

   ```
   # profiles -p [-S repository] existing-profile-name
   ```

   - **To add content to an existing rights profile, create a new profile.**

     Add the existing rights profile as a supplementary rights profile to the new profile, then add the enhancements. See Example 5-8.

- **To remove content from an existing rights profile, clone the profile and then rename it and modify.**

  See Example 5-9.

2. **Modify the new rights profile by adding or removing supplementary rights profiles, authorizations, and other rights.**

Example 5-8 Cloning and Enhancing the Network IPsec Management Rights Profile

In this example, the administrator adds a `solaris.admin.edit` authorization to a site IPsec Management rights profile so that the `root` role is not required. This rights profile will be assigned only to users who are trusted to modify the `/etc/hosts` file.

1. The administrator verifies that the Network IPsec Management rights profile cannot be modified.

```
# profiles -p "Network IPsec Management"
profiles:Network IPsec Management> add auths="solaris.admin.edit/etc/hosts"
Cannot add. Profile cannot be modified
```

2. The administrator creates a rights profile that includes the Network IPsec Management profile.

```
# profiles -p "Total IPsec Mgt"
... IPsec Mgt> set desc="Network IPsec Mgt plus /etc/hosts"
... IPsec Mgt> add profiles="Network IPsec Management"
... IPsec Mgt> add auths="solaris.admin.edit/etc/hosts"
... IPsec Mgt> end
... IPsec Mgt> exit
```

3. The administrator verifies the contents.

```
# profiles -p "Total IPsec Mgt" info
        name=Total IPsec Mgt
        desc=Network IPsec Mgt plus /etc/hosts
        auths=solaris.admin.edit/etc/hosts
        profiles=Network IPsec Management
```

Example 5-9 Cloning and Removing Selected Rights From a Rights Profile

In this example, the administrator separates managing the properties of the VSCAN service from the ability to enable and disable the service.

First, the administrator lists the contents of the rights profile that Oracle Solaris provides.

```
# profiles -p "VSCAN Management" info
```

```
        name=VSCAN Management
        desc=Manage the VSCAN service
        auths=solaris.smf.manage.vscan,solaris.smf.value.vscan,
              solaris.smf.modify.application
        help=RtVscanMngmnt.html
```

Then, the administrator creates a rights profile that can enable and disable the service.

```
# profiles -p "VSCAN Management"
profiles:VSCAN Management> set name="VSCAN Control"
profiles:VSCAN Control> set desc="Start and stop the VSCAN service"
... VSCAN Control> remove auths="solaris.smf.value.vscan"
... VSCAN Control> remove auths="solaris.smf.modify.application"
... VSCAN Control> end
... VSCAN Control> exit
```

Then, the administrator creates a rights profile that can change the properties of the service.

```
# profiles -p "VSCAN Management"
profiles:VSCAN Management> set name="VSCAN Properties"
profiles:VSCAN Properties> set desc="Modify VSCAN service properties"
... VSCAN Properties> remove auths="solaris.smf.manage.vscan"
... VSCAN Properties> end
... VSCAN Properties> exit
```

The administrator verifies the contents of the new rights profiles.

```
# profiles -p "VSCAN Control" info
        name=VSCAN Control
        desc=Start and stop the VSCAN service
        auths=solaris.smf.manage.vscan
# profiles -p "VSCAN Properties" info
        name=VSCAN Properties
        desc=Modify VSCAN service properties
        auths=solaris.smf.value.vscan,solaris.smf.modify.application
```

Next Steps Assign the rights profile to a trusted user or role. For examples, see Example 3-10 and Example 3-19.

See Also To troubleshoot rights assignment, see “How to Troubleshoot Rights Assignments” on page 95. For background, see “Order of Search for Assigned Rights” on page 33.

▼ How to Create an Authorization

Before You Begin Developers have defined and used the authorization in the applications that you are installing. For instructions, see “Developer’s Guide to Oracle Solaris 11 Security ” and “About Authorizations” in “Developer’s Guide to Oracle Solaris 11 Security ”.

1. **(Optional) Create the help file for your new authorization.**

For example, create the help file for an authorization to enable the user to modify the data in an application.

```
# pfedit /docs/helps/NewcoSiteAppModData.html
<HTML>
-- Copyright 2013 Newco.  All rights reserved.
-- NewcoSiteAppModData.html
-->
<HEAD>
     <TITLE>NewCo Modify SiteApp Data Authorization</TITLE>
</HEAD>
<BODY>
The com.newco.siteapp.data.modify authorization authorizes you
to modify existing data in the application.
<p>
Only authorized accounts are permitted to modify data.
Use this authorization with care.
<p>
</BODY>
</HTML>
```

2. **Create the authorization by using the `auths add` command.**

   For example, the following command creates the `com.newco.siteapp.data.modify` authorization on the local system.

   ```
   # auths add -t "SiteApp Data Modify Authorized" \
   -h /docs/helps/NewcoSiteAppModData.html com.newco.siteapp.data.modify
   ```

   You can now test the authorization, then add it to a rights profile and assign the profile to a role or user.

Example 5-10 Testing a New Authorization

In this example, the administrator tests the `com.newco.siteapp.data.modify` authorization with the SiteApp rights profile from Example 5-7.

```
# usermod -A com.newco.siteapp.data.modify -P SiteApp tester1
```

When the test succeeds, the administrator removes the authorization.

```
# rolemod -A-=com.newco.siteapp.data.modify siteapptester
```

For ease of maintenance, the administrator adds the authorization to the SiteApp rights profile in Example 5-11.

Example 5-11 Adding Authorizations to a Rights Profile

After testing that the authorization works correctly, the security administrator adds the `com.newco.siteapp.data.modify` authorization to an existing rights profile. Example 5-7 shows how the administrator created the profile.

```
# profiles -p "SiteApp"
profiles:SiteApp> add auths="com.newco.siteapp.data.modify"
profiles:SiteApp> end
profiles:SiteApp> exit
```

To verify, the administrator lists the contents of the profile.

```
# profiles -p SiteApp
Found profile in files repository.
  id=/opt/site-app/bin/site-cmd
  auths=com.newco.siteapp.data.modify
```

Next Steps Assign the rights profile to a trusted user or role. For examples, see Example 3-10 and Example 3-19.

See Also To troubleshoot rights assignment, see "How to Troubleshoot Rights Assignments" on page 95. For background, see "Order of Search for Assigned Rights" on page 33.

Changing Whether `root` Is a User or a Role

By default, `root` is a role in Oracle Solaris. You have the option to change it to a user, change it back in to a role, or remove it from use.

You must change `root` to a user if you are using Oracle Enterprise Manager or are following the traditional superuser model of administration rather than the rights model. For background, see "Deciding Which Rights Model to Use for Administration" on page 37.

If you are following the rights model, you might change `root` to a user when decommissioning a system that has been removed from the network. In this scenario, logging in to the system as `root` simplifies the cleanup.

Note - If you administer remotely with the `root` role, see "How to Remotely Administer ZFS With Secure Shell" in "Managing Secure Shell Access in Oracle Solaris 11.2 " for secure remote login instructions.

At some sites, `root` is not a legitimate account on production systems. To remove root from use, see Example 5-13.

▼ How to Change the `root` Role Into a User

This procedure is required on systems where `root` must be able to log in directly to the system.

Before You Begin You must assume the root role.

1. **Remove the root role assignment from local users.**

   For example, remove the role assignment from two users.

   ```
   % su -
   Password: xxxxxxxx
   # roles jdoe
   root
   # roles kdoe
   root
   # roles ldoe
   secadmin
   # usermod -R "" jdoe
   # usermod -R "" kdoe
   #
   ```

2. **Change the root role into a user.**

   ```
   # rolemod -K type=normal root
   ```

   Users who are currently in the root role remain so, Other users who have root access can su to root or log in to the system as the root user.

3. **Verify the change.**

   You can use one of the following commands.

   - **Examine the user_attr entry for root.**

     ```
     # getent user_attr root
     root::::auths=solaris.*;profiles=All;audit_flags=lo\:no;lock_after_retries=no;
     min_label=admin_low;clearance=admin_high
     ```

     If the type keyword is missing in the output or is equal to normal, the account is not a role.

   - **View the output from the userattr command.**

     ```
     # userattr type root
     ```

     If the output is empty or lists normal, the account is not a role.

Example 5-12 Changing the root User Into the root Role

In this example, the root user turns the root user back into a role.

First, the root user changes the root account into a role and verifies the change.

```
# usermod -K type=role root
# getent user_attr root
```

```
root::::type=role...
```

Then, root assigns the root role to a local user.

```
# usermod -R root jdoe
```

Example 5-13 Preventing the root Role From Being Used to Maintain a System

In this example, site security policy requires that the root account be prevented from maintaining the system. The administrator has created and tested the roles which maintain the system. These roles include every security profile and the System Administrator rights profile. A trusted user has been assigned a role that can restore a backup. No role can change the audit flags for a user, role, or a rights profile or change the password of a role.

To prevent the root account from being used to maintain the system, the security administrator removes the root role assignment. Because the root account must be able to log in to the system in single-user mode, the account retains a password.

```
# usermod -K roles= jdoe
# userattr roles jdoe
```

Troubleshooting

In a desktop environment, you cannot directly log in as root when root is a role. A diagnostic message indicates that root is a role on your system.

If you do not have a local account that can assume the root role by performing the following steps:

- As root, log in to the system in single-user mode, create a local user account and password.
- Assign the root role to the new account.
- Log in as the new user and assume the root role.

♦ ♦ ♦ CHAPTER 6

Listing Rights in Oracle Solaris

This chapter describes how to list all rights on the system, rights that are assigned to specific users, and your own rights:

- "Listing Authorizations" on page 87
- "Listing Rights Profiles" on page 88
- "Listing Roles" on page 91
- "Listing Privileges" on page 91
- "Listing Qualified Attributes" on page 94

For an overview of rights, see "User Rights Management" on page 14. For reference information, see Chapter 8, "Reference for Oracle Solaris Rights".

Listing Rights and Their Definitions

The commands in this section enable you to find rights that are defined on the system, and list the rights that are in effect on a user's process.

For a full description of the commands in this section, see the following man pages:

- `auths`(1)
- `getent`(1M)
- `ppriv`(1)
- `profiles`(1)
- `privileges`(5)
- `roles`(1)

Listing Authorizations

- `auths` – Lists the current user's authorizations

- `auths list` – Lists the current user's authorizations
- `auths list -u` *username* – Lists the authorizations for *username*
- `auths list -x` – Lists the current user's authorizations that require authentication
- `auths list -xu` *username* – Lists the *username*'s authorizations that require authentication
- `auths info` – Lists all authorization names in the naming service
- `getent auth_attr` – Lists the full definition of all authorizations in the naming service

EXAMPLE 6-1 Listing All Authorizations

```
$ auths info
    solaris.account.activate
    solaris.account.setpolicy
    solaris.admin.edit
...
    solaris.zone.login
    solaris.zone.manage
```

EXAMPLE 6-2 Listing the Content of the Authorizations Database

```
$ getent auth_attr | more
solaris.:::All Solaris Authorizations::help=AllSolAuthsHeader.html
solaris.account.:::Account Management::help=AccountHeader.html
...
solaris.zone.login:::Zone Login::help=ZoneLogin.html
solaris.zone.manage:::Zone Deployment::help=ZoneManage.html
```

EXAMPLE 6-3 Listing the Default Authorizations of Users

The following authorizations are included in the rights profiles that are assigned to all users by default.

```
$ auths
solaris.device.cdrw,solaris.device.mount.removable,solaris.mail.mailq
solaris.network.autoconf.read,solaris.admin.wusb.read
solaris.smf.manage.vbiosd,solaris.smf.value.vbiosd
```

Listing Rights Profiles

- `profiles` – Lists the current user's rights profiles
- `profiles -a` – Lists all rights profiles names
- `profiles -l` – Lists the full definition of the current user's rights profiles
- `profiles` *username* – Lists the rights profiles for *username*

- `profiles -x` – Lists the current user's rights profiles that require authentication
- `profiles -x` *username* – Lists the *username*'s rights profiles that require authentication
- `profiles -p` *profile-name* `info` – Pretty prints the contents of specified rights profile
- `getent prof_attr` – Lists the full definition of all rights profiles in the naming service

EXAMPLE 6-4 Listing the Names of All Rights Profiles

```
$ profiles -a
        Console User
        CUPS Administration
        Desktop Removable Media User
...
        VSCAN Management
        WUSB Management
```

EXAMPLE 6-5 Listing the Contents of the Rights Profiles Database

```
$ getent prof_attr | more
All:::Execute any command as the user or role:help=RtAll.html
Audit Configuration:::Configure Solaris Audit:auths=solaris.smf.value.audit;
help=RtAuditCfg.html
...
Zone Management:::Zones Virtual Application Environment Administration:
help=RtZoneMngmnt.html
Zone Security:::Zones Virtual Application Environment Security:auths=solaris.zone.*,
solaris.auth.delegate;help=RtZoneSecurity.html ...
```

EXAMPLE 6-6 Listing the Default Rights Profiles of Users

List your rights profiles. The following rights profiles are assigned to all users by default.

```
$ profiles
Basic Solaris User
All
```

EXAMPLE 6-7 Listing the Rights Profiles of the Initial User

The initial user is assigned several rights profiles.

```
$ profiles Initial user
System Administrator
Audit Review
...
CPU Power Management
Basic Solaris User
All
```

To show all the security attributes that are assigned to the initial user's profiles, use the `-l` option.

```
$ profiles -l Initial user | more
Initial user:
System Administrator
 profiles=Install Service Management,Audit Review,Extended Accounting
Flow Management,Extended Accounting Net Management,Extended Accounting Process
Management,Extended Accounting Task Management,Printer Management,Cron Managem
ent,Device Management,File System Management,Log Management,Mail Management,
Maintenance and Repair,Media Catalog,Name Service Management,Network Management,
Project Management,RAD Management,Service Operator,Shadow Migration Monitor,So
Software Installation,System Configuration,User Management,ZFS Storage Management
          /usr/sbin/gparted          uid=0
Install Service Management
 auths=solaris.autoinstall.service
 profiles=Install Manifest Management,Install Profile Management,
Install Client Management
...
```

EXAMPLE 6-8 Listing the Contents of an Assigned Rights Profile

The initial user lists the rights that are granted by the Audit Review profile.

```
$ profiles -l
Audit Review
  solaris.audit.read

  /usr/sbin/auditreduce  euid=0
  /usr/sbin/auditstat    privs=proc_audit
  /usr/sbin/praudit      privs=file_dac_read
```

EXAMPLE 6-9 Listing the Security Attributes of a Command in a Rights Profile

This variant of the `profiles` command is useful for viewing the security attributes of a command in a rights profile that is not assigned to you.

First, list the commands in the profile.

```
% profiles -p "Audit Review" info
 name=Audit Review
 desc=Review Solaris Auditing logs
 help=RtAuditReview.html
 cmd=/usr/sbin/auditreduce
 cmd=/usr/sbin/auditstat
 cmd=/usr/sbin/praudit
```

Then, list the security attributes of one of the commands in the profile.

```
% profiles -p "Audit Review" "select cmd=/usr/sbin/praudit ; info; end;"
select: command is read-only
 id=/usr/sbin/praudit
 privs=file_dac_read
end: command is read-only
```

EXAMPLE 6-10 Listing the Contents of Rights Profiles That Are Recently Created

The `less` option displays the most recently added rights profiles first. This variant of the `profiles` command is useful when you create or modify rights profiles at your site. The following output shows the contents of the profile that was added in Example 4-1. A regular user can run this command.

```
$ profiles -la | less
LegacyApp
          /opt/legacy-app/bin/legacy-cmd
                                 euid=0
OpenLDAP...
```

Listing Roles

- `roles` – Lists the current user's roles
- `roles` *username* – Lists the roles for *username*
- `logins -r` – Lists all available roles

EXAMPLE 6-11 Listing Your Assigned Roles

The `root` role is assigned to the initial user by default. `No roles` indicates that you are not assigned a role.

```
$ roles
root
```

Listing Privileges

- `man privileges` – Lists privilege definitions and their names as they are used by developers
- `ppriv -vl` – Lists privilege definitions and their names as they are used by administrators
- `ppriv -vl basic` – Lists names and definitions of privileges in the basic set of privileges
- `ppriv $$` – Lists the privileges in the current shell (`$$`)
- `getent exec_attr` – Lists all commands that have security attributes (`setuid` or privileges) by rights profile name

```
$ getent exec_attr | more
All:solaris:cmd:::*:
Audit Configuration:solaris:cmd:::/usr/sbin/auditconfig:privs=sys_audit
...
```

```
Zone Security:solaris:cmd:::/usr/sbin/txzonemgr:uid=0
Zone Security:solaris:cmd:::/usr/sbin/zonecfg:uid=0 ...
```

EXAMPLE 6-12 Listing All Privileges and Their Definitions

The privilege format described in the privileges(5) man page is used by developers.

```
$ man privileges
Standards, Environments, and Macros                 privileges(5)

NAME
     privileges - process privilege model
...
     The defined privileges are:

     PRIV_CONTRACT_EVENT

         Allow a process to request reliable delivery  of  events
         to an event endpoint.

         Allow a process to include events in the critical  event
         set  term  of  a  template  which  could be generated in
         volume by the user.
...
```

EXAMPLE 6-13 Listing Privileges That Are Used in Privilege Assignment

The ppriv command lists all privileges by name. For a definition, use the -v option.

This privilege format is used to assign privileges to users and roles with the useradd, roleadd, usermod, and rolemod commands, and to rights profiles with the profiles command.

```
$ ppriv -lv | more
contract_event
 Allows a process to request critical events without limitation.
 Allows a process to request reliable delivery of all events on
 any event queue.
...
win_upgrade_sl
        Allows a process to set the sensitivity label of a window
        resource to a sensitivity label that dominates the existing
        sensitivity label.
        This privilege is interpreted only if the system is configured
        with Trusted Extensions.
```

EXAMPLE 6-14 Listing the Privileges in Your Current Shell

Every user is assigned the basic privilege set by default. The default limit set is all privileges.

The single letters in the output refer to the following privilege sets:

E	Effective privilege set
I	Inheritable privilege set
P	Permitted privilege set
L	Limit privilege set

```
$ ppriv $$
1200:   -bash
flags = <none>
        E: basic
        I: basic
        P: basic
        L: all
$ ppriv -v $$
1200:   -bash
flags = <none>
 E: file_link_any,file_read,file_write,net_access,proc_exec,proc_fork,
           proc_info,proc_session,sys_ib_info
 I: file_link_any,file_read,...,sys_ib_info
 P: file_link_any,file_read,...,sys_ib_info
 L: contract_event,contract_identity,...,sys_time
```

The double dollar sign ($$) passes the process number of the parent shell to the command. This listing does not include privileges that are restricted to commands in an assigned rights profile.

EXAMPLE 6-15 Listing the Basic Privileges and Their Definitions

```
$ ppriv -vl basic
file_link_any
 Allows a process to create hardlinks to files owned by a uid
 different from the process' effective uid.
file_read
 Allows a process to read objects in the filesystem.
file_write
 Allows a process to modify objects in the filesystem.
net_access
 Allows a process to open a TCP, UDP, SDP or SCTP network endpoint.
proc_exec
 Allows a process to call execve().
proc_fork
 Allows a process to call fork1()/forkall()/vfork()
proc_info
 Allows a process to examine the status of processes other
 than those it can send signals to.  Processes which cannot
 be examined cannot be seen in /proc and appear not to exist.
proc_session
 Allows a process to send signals or trace processes outside its
 session.
sys_ib_info
 Allows a process to perform read InfiniBand MAD (Management Datagram)
 operations.
```

EXAMPLE 6-16 Listing the Commands With Security Attributes in Your Rights Profiles

The Basic Solaris User profile includes commands that enable users to read and write to CD-ROMs.

```
$ profiles -l
  Basic Solaris User
...
   /usr/bin/cdrecord.bin   privs=file_dac_read,sys_devices,
     proc_lock_memory,proc_priocntl,net_privaddr
   /usr/bin/readcd.bin     privs=file_dac_read,sys_devices,net_privaddr
   /usr/bin/cdda2wav.bin   privs=file_dac_read,sys_devices,
     proc_priocntl,net_privaddr
  All
   *
```

Listing Qualified Attributes

- `man user_attr` – Defines qualifiers of security attributes
- `getent` – Lists qualified security attributes of a user or role on the system where the command is run
- `ldapaddent` – Lists all qualified security attributes of a user or role

EXAMPLE 6-17 Listing a User's Qualified Attributes on This System

```
machine1$ getent user_attr | jdoe:
jdoe:machine1:::profiles=System Administrator
```

EXAMPLE 6-18 Listing All Qualified Attributes for a User in LDAP

```
machine1$ ldapaddent -d user_attr | grep ^jdoe:
jdoe:machine1:::profiles=System Administrator
jdoe:sysopgroup:::profiles=System Operator
```

♦ ♦ ♦ CHAPTER 7

Troubleshooting Rights in Oracle Solaris

This chapter provides troubleshooting suggestions when managing and using administrative rights in Oracle Solaris:

- "How to Troubleshoot Rights Assignments" on page 95
- "How to Reorder Assigned Rights" on page 100
- "How to Determine Which Privileges a Program Requires" on page 101

For information about using rights, review the following information:

- Chapter 3, "Assigning Rights in Oracle Solaris"
- "Who Can Assign Rights" on page 41
- "User Rights Management" on page 14
- "Process Rights Management" on page 21

Troubleshooting Rights

The tasks and examples in this section suggest ways to solve problems with rights assignments. For background information, see "Rights Verification" on page 32.

▼ How to Troubleshoot Rights Assignments

Several factors can affect why rights are not being evaluated and correctly applied. This procedure helps you debug why assigned rights might not be available to users, roles, or processes. Several of the steps are based on "Order of Search for Assigned Rights" on page 33.

Before You Begin You must assume the `root` role. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **Verify and restart the naming service.**

a. **Verify that the security assignments for the user or role are in the naming service that is enabled on the system.**

```
# svccfg -s name-service/switch

svc:/system/name-service/switch>
listprop config

config                      application
config/value_authorization  astring  solaris.smf.value.name-service.switch
config/default              astring  files ldap
config/host                 astring  "files dns mdns ldap"
config/netgroup             astring  ldap
config/printer              astring  "user files"
```

In this output, all services that are not explicitly mentioned inherit the value of the default, `files ldap`. Therefore, `passwd` and its related attribute databases, `user_attr`, `auth_attr`, and `prof_attr`, are searched first in files, then in LDAP.

b. **Restart the name service cache, `svc:/system/name-service/cache`.**

The `nscd` daemon can have a lengthy time-to-live interval. By restarting the daemon, you update the naming service with current data.

```
# svcadm restart name-service/cache
```

2. **Determine where a right is assigned to the user by running the `userattr -v` command.**

For example, the following commands indicate which rights are assigned and where the assignment was made for the user `jdoe`. No output indicates that `jdoe` is using the defaults.

```
% userattr -v access_times jdoe
% userattr -v access_tz jdoe
% userattr -v auth_profiles jdoe
% userattr -v defaultpriv jdoe
% userattr -v limitpriv jdoe
% userattr -v idlecmd jdoe
% userattr -v idletime jdoe
% userattr -v lock_after_retries jdoe
% userattr -v pam_policy jdoe

% userattr -v auths jdoe       Output indicates authorizations from rights profiles
Basic Solaris User :solaris.mail.mailq,solaris.network.autoconf.read,
solaris.admin.wusb.read
Console User :solaris.system.shutdown,solaris.device.cdrw,
solaris.device.mount.removable,solaris.smf.manage.vbiosd,solaris.smf.value.vbiosd
% userattr -v audit_flags jdoe
user_attr: fw:no        Output indicates jdoe is individually assigned audit flags
# userattr -v profiles jdoe
user_attr: Audit Review,Stop        Output indicates two assigned rights profiles
# userattr roles jdoe
```

```
user_attr : cryptomgt,infosec        Output indicates two assigned roles
```

The output indicates that `jdoe` is directly assigned audit flags, two rights profiles, and two roles. The assigned authorizations are from default rights profiles in the `policy.conf` file.

- Because `jdoe` is directly assigned audit flags, no audit flag values in the rights profiles will be used.
- The rights profiles are evaluated in order, first the Audit Review rights profile, then the Stop profile.
- All other rights are assigned to `jdoe` in the roles `cryptomgt`and `infosec`. To view those rights, `jdoe` must assume each role, then list the rights.

If the right is not directly assigned to the user, continue with the following checks.

3. **Verify that the assigned authorizations are spelled correctly.**

   The source of an authorization assignment is not important because authorizations accumulate for users. However, a misspelled authorization fails silently.

4. **For rights profiles that you have created, verify that you have assigned the appropriate security attributes to the commands in that profile.**

   For example, some commands require `uid=0` rather than `euid=0` to succeed. Review the man page for the command to determine whether the command or any of its options require authorizations.

5. **Check the rights in the user's rights profiles.**

   a. **In order, check for the rights in the list of authenticated rights profiles.**

      The value of the attribute in the earliest rights profile in the list is the value in the kernel. If this value is incorrect, either change the value in that rights profile, or reassign the profiles in the correct order. See "How to Reorder Assigned Rights" on page 100.

      For privileged commands, check that the privileges are not removed from the `defaultpriv` or `limitpriv` keyword.

   b. **In order, check for the rights in the list of regular rights profiles.**

      Follow the same checks as you performed for authenticated rights profiles.

   c. **If the rights you are searching for are not listed, check the roles that the user is assigned.**

      If the right is assigned to a role, the user must assume the role to obtain the rights.

6. **Check whether a failed command requires authorizations to succeed.**

a. **Check whether an existing rights profile includes the required authorization.**

   If the profile exists, use it. Assign it to the user as an authenticated rights profile or a regular rights profile. Order the profile before any other rights profile that includes the command that requires this authorization to succeed.

b. **Check whether an option to the command requires authorization.**

   Assign the privilege to the command that requires it, add the required authorizations, place the command and authorizations in a rights profile, and assign the profile to the user.

7. **If a command continues to fail for a user, verify that the user is executing the command in a profile shell.**

   Administrative commands must be executed in a profile shell. Example 7-1 shows how to test for a profile shell.

   To reduce the likelihood of user error, you can try the following:

   - Assign a profile shell as the user's login shell.
   - Instruct users to precede all privileged commands with the `pfexec` command.
   - Remind the user to run administrative commands in a profile shell.
   - If your site is using roles, remind the user to assume the role before running administrative commands. For an example of successful command execution as a role rather than as a user, see Example 7-3.

8. **If a command fails for a role, assume the role and perform the same steps that you performed when checking for a user's rights.**

Example 7-1 Determining Whether You Are Using a Profile Shell

When a privileged command does not work, the user tests for the `PRIV_PFEXEC` flag, then runs the command. The error message might not indicate that the problem is a privilege problem.

```
% praudit 20120814200247.20120912213421.example-system
praudit: Cannot associate stdin with 20120814200247.20120912213421.example-system:
Permission denied

% ppriv $$
107219: bash
flags = <none>
...

% pfbash
# ppriv $$
1072232: bash
flags = PRIV_PFEXEC
...
```

```
# praudit 20120814200247.20120912213421.example-system
    /** Command succeeds **/
```

Example 7-2 Determining the Privileged Commands of a Role

In this example, a user assumes an assigned role and lists the rights that are included in one of the rights profiles. The rights are truncated to emphasize the commands.

```
% roles
devadmin

% su - devadmin
Password: xxxxxxxx

# profiles -l
Device Security
        ...
 profiles=Service Configuration
          /usr/sbin/add_drv          uid=0
          /usr/sbin/devfsadm         uid=0
                                     privs=sys_devices,sys_config,
                                           sys_resource,file_owner,
                                           file_chown,file_chown_self,
                                           file_dac_read
          /usr/sbin/eeprom           uid=0
          /usr/bin/kbd
          /usr/sbin/list_devices     euid=0
          /usr/sbin/rem_drv          uid=0
          /usr/sbin/strace           euid=0
          /usr/sbin/update_drv       uid=0
          /usr/sbin/add_allocatable  euid=0
          /usr/sbin/remove_allocatable   euid=0
Service Configuration
          /usr/sbin/svcadm
          /usr/sbin/svccfg
```

Example 7-3 Running the Privileged Commands in Your Role

In the following example, the `admin` role can change the permissions on the `useful.script` file.

```
% whoami
jdoe
% ls -l useful.script
-rwxr-xr-- 1 elsee eng 262 Apr 2 10:52 useful.script

% chgrp admin useful.script
chgrp: useful.script: Not owner

% su - admin
Password: xxxxxxxx

# chgrp admin useful.script
# chown admin useful.script
# ls -l useful.script
-rwxr-xr-- 1 admin admin 262 Apr 2 10:53 useful.script
```

▼ How to Reorder Assigned Rights

You must reorder a user's rights profiles assignments when an unprivileged command is in effect for the user rather than its privileged version. For more information, see "Order of Search for Assigned Rights" on page 33.

Before You Begin You must become an administrator who is assigned the User Security rights profile. For more information, see "Using Your Assigned Administrative Rights" on page 74.

1. **View the list of rights profiles that are currently assigned to the user or role.**

   The list displays in order.

   ```
   % profiles username | rolename
   ```

2. **Assign the rights profiles in the correct order.**

   ```
   # usermod | rolemod -P "list-of-profiles"
   ```

Example 7-4 Assigning Rights Profiles in a Specific Order

In this example, the administrator determines that a rights profile with privileged commands is listed after the All rights profile for the role devadmin.

```
# profiles devadmin

    Basic Solaris User
    All
    Device Management
```

Therefore, the devadmin role cannot run the device management commands with the role's assigned privileges.

The administrator reassigns the rights profiles to devadmin. In the new order of assignment, the device management commands run with their assigned privileges.

```
# rolemod -P "Device Management,Basic Solaris User,All"

# profiles devadmin

    Device Management
    Basic Solaris User
    All
```

▼ How to Determine Which Privileges a Program Requires

Use this debugging procedure when a command or process is failing. After finding the first privilege failure and fixing it, you might need to run the `ppriv -eD` *command* command again to find additional privilege requirements.

1. **Type the command that is failing as an argument to the `ppriv` debugging command.**

```
% ppriv -eD touch /etc/acct/yearly

touch[5245]: missing privilege "file_dac_write"
     (euid = 130, syscall = 224) needed at zfs_zaccess+0x258
touch: cannot create /etc/acct/yearly: Permission denied
```

2. **Use the `syscall` number from the debugging output to determine which system call is failing.**

   You find the name of the `syscall` number in the `/etc/name_to_sysnum` file.

```
% grep 224 /etc/name_to_sysnum

creat64                 224
```

   In this example, the `creat64` call is failing. To succeed, the process must be assigned the right to create a file in the `/etc/acct/yearly` directory.

Example 7-5 Using the `truss` Command to Examine Privilege Use

The `truss` command can debug privilege use in a regular shell. For example, the following command debugs the failing `touch` process:

```
% truss -t creat touch /etc/acct/yearly

creat64("/etc/acct/yearly", 0666)
                       Err#13 EACCES [file_dac_write
]
touch: /etc/acct/yearly cannot create
```

The extended `/proc` interfaces report the missing `file_dac_write` privilege after the error code in `truss` output.

Example 7-6 Using the ppriv Command to Examine Privilege Use in a Profile Shell

In this example, the jdoe user can assume the role objadmin. The objadmin role includes the Object Access Management rights profile. This rights profile allows the objadmin role to change permissions on files that objadmin does not own.

In the following excerpt, jdoe fails to change the permissions on the useful.script file:

```
jdoe% ls -l useful.script

-rw-r--r--  1 aloe  staff  2303 Apr 10 10:10 useful.script
jdoe%
chown objadmin useful.script

chown: useful.script: Not owner
jdoe%
ppriv -eD chown objadmin useful.script

chown[11444]: missing privilege "file_chown"
            (euid = 130, syscall = 16) needed at zfs_zaccess+0x258
chown: useful.script: Not owner
```

When jdoe assumes the objadmin role, the permissions on the file are changed:

```
jdoe% su - objadmin
Password: xxxxxxxx

# ls -l useful.script
-rw-r--r--  1 aloe  staff  2303 Apr 10 10:10 useful.script

# chown objadmin useful.script
# ls -l useful.script
-rw-r--r--  1 objadmin  staff  2303 Apr 10 10:10 useful.script
# chgrp admin useful.script

# ls -l objadmin.script
-rw-r--r--  1 objadmin  admin  2303 Apr 10 10:11 useful.script
```

Example 7-7 Changing a File Owned by the root User

This example illustrates the protections against privilege escalation. For a discussion, see "Privilege Escalation and Kernel Privileges" on page 31. The file is owned by the root user. The less powerful role, objadmin role needs all privileges to change the file's ownership, so the operation fails.

```
jdoe% su - objadmin
Password: xxxxxxxx

# cd /etc; ls -l system
-rw-r--r--  1 root  sys   1883 Oct 10 10:20 system

# chown objadmin system
```

```
chown: system: Not owner
# ppriv -eD chown objadmin system
chown[11481]: missing privilege "ALL"
     (euid = 101, syscall = 16) needed at zfs_zaccess+0x258
chown: system: Not owner
```

♦ ♦ ♦ CHAPTER 8

Reference for Oracle Solaris Rights

This chapter provides reference material about the use of administrative rights in Oracle Solaris:

- "Rights Profiles Reference" on page 105
- "Authorizations Reference" on page 107
- "Rights Databases" on page 108
- "Commands for Administering Rights" on page 111
- "Privileges Reference" on page 114

For information about using rights, including privileges, see Chapter 3, "Assigning Rights in Oracle Solaris". For overview information, see "User Rights Management" on page 14 and "Process Rights Management" on page 21.

Rights Profiles Reference

This section describes some typical rights profiles. Rights profiles are convenient collections of authorizations and other security attributes, commands with security attributes, and supplementary rights profiles. Oracle Solaris provides many rights profiles. If they are not sufficient for your needs, you can modify existing ones and create new ones.

Rights profiles must be assigned in order, from most to least powerful. For more information, see "Order of Search for Assigned Rights" on page 33.

To view the contents of the following rights profiles, see "Viewing the Contents of Rights Profiles" on page 106.

- **System Administrator rights profile –** Provides access to most tasks that are not connected with security. This profile includes several other profiles to create a powerful role. Note that the All rights profile is assigned at the end of the list of supplementary rights profiles.
- **Operator rights profile –** Provides limited rights to manage files and offline media. This profile includes supplementary rights profiles to create a simple role.
- **Printer Management rights profile –** Provides a limited number of commands and authorizations to handle printing. This profile is one of several profiles that cover a single area of administration.

- **Basic Solaris User rights profile –** Enables users to use the system within the bounds of security policy. This profile is listed by default in the `policy.conf` file. Note that the convenience that is offered by the Basic Solaris User rights profile must be balanced against site security requirements. Sites that need stricter security might prefer to remove this profile from the `policy.conf` file or assign the Stop rights profile. For the implementation of the Basic Solaris User rights profile, see Example 6-16.
- **Console User rights profile –** For the workstation owner, provides access to authorizations, commands, and actions for the person who is seated at the computer.
- **All rights profile –** For roles, provides access to commands that do not have security attributes. This profile can be appropriate for users with limited rights.
- **Stop rights profile –** A special rights profile that stops the evaluation of further profiles. This profile prevents the evaluation of the `AUTHS_GRANTED`, `PROFS_GRANTED`, and `CONSOLE_USER` variables in the `policy.conf` file. With this profile, you can provide roles and users with a restricted profile shell.

Note - The Stop profile affects privilege assignment indirectly. Rights profiles that are listed after the Stop profile are not evaluated. Therefore, the commands with privileges in those profiles are not in effect. See Example 3-25.

Each rights profile has an associated help file. The help files are in HTML and are customizable. The files reside in the `/usr/lib/help/profiles/locale/C` directory.

Viewing the Contents of Rights Profiles

You have three views into the contents of rights profiles:

- The `getent` command enables you to view the contents of all of the rights profiles on the system. For sample output, see Chapter 6, “Listing Rights in Oracle Solaris”.
- The `profiles -p "`*Profile Name*`" info` command enables you to view the contents of a specific rights profile.
- The `profiles -l` *account-name* command enables you to view the contents of the rights profiles that are assigned to a specific user or role.

For more information, see Chapter 6, “Listing Rights in Oracle Solaris” and the `getent`(1M) and `profiles`(1) man pages.

Authorizations Reference

An *authorization* is a discrete right that can be granted to a role or a user. Authorizations are checked by compliant applications before a user gets access to the application or specific operations within the application.

Authorizations are user-level, and therefore extensible. You can write a program that requires authorization, add the authorizations to your system, create a rights profile for these authorizations, and assign the rights profile to users or roles who are allowed to use the program.

Authorization Naming Conventions

An authorization has a name that is used internally. For example, `solaris.system.date` is the name of an authorization. An authorization has a short description that appears in the graphical user interfaces (GUIs). For example, `Set Date & Time` is the description of the `solaris.system.date` authorization.

By convention, authorization names consist of the reverse order of the Internet name of the supplier, the subject area, any subareas, and the function. The parts of the authorization name are separated by dots. An example would be `com.xyzcorp.device.access`. Exceptions to this convention are the authorizations from Oracle, which use the prefix `solaris` instead of an Internet name. The naming convention enables administrators to apply authorizations in a hierarchical fashion. A wildcard (*) can represent any strings to the right of a dot.

As an example of how authorizations are used, the Network Link Security rights profile has the `solaris.network.link.security` authorization only, while the Network Security rights profile has the Network Link Security profile as a supplementary profile, plus the `solaris.network.*` and `solaris.smf.manage.ssh` authorizations.

Delegation Authority in Authorizations

An authorization that ends with the suffix `delegate` enables a user or a role to delegate to other users any assigned authorizations that begin with the same prefix.

The `solaris auth.delegate` authorization enables a user or a role to delegate to other users any authorizations that the delegating users or roles are assigned. For example, a role with the `solaris auth.delegate` and `solaris.network.wifi.wep` authorizations can delegate the `solaris.network.wifi.wep` authorization to another user or role.

Rights Databases

The following databases store the data for rights in Oracle Solaris:

- **Extended user attributes database** (user_attr) – Associates users and roles with authorizations, privileges, and rights profiles, among other keywords.
- **Rights profile attributes database** (prof_attr) – Defines rights profiles, lists the profiles' assigned authorizations, privileges, and keywords, and identifies the associated help file
- **Authorization attributes database** (auth_attr) – Defines authorizations and their attributes, and identifies the associated help file
- **Execution attributes database** (exec_attr) – Identifies the commands with security attributes that are assigned to specific rights profiles

The policy.conf database contains authorizations, privileges, and rights profiles that are applied to all users. For more information, see "policy.conf File" on page 111.

Rights Databases and the Naming Services

The name service scope of the rights databases is defined in the SMF service for the naming service switch, svc:/system/name-service/switch. The properties in this service for the rights databases are auth_attr, password, and prof_attr. The password property sets the naming service precedence for the passwd and user_attr databases. The prof_attr property sets the naming service precedence for the prof_attr and exec_attr databases.

In the following output, the auth_attr, password, and prof_attr entries are not listed. Therefore, the rights databases are using the files naming service.

```
# svccfg -s name-service/switch listprop config
config                       application
config/value_authorization   astring       solaris.smf.value.name-service.switch
config/default               astring       files
config/host                  astring       "files ldap dns"
config/printer               astring       "user files ldap"
```

user_attr Database

The user_attr database contains user and role information that supplements the passwd and shadow databases. The *attr* field contains security attributes and the *qualifier* field contains attributes that qualify or limit the effect of security attributes to a system or group of systems.

The security attributes in the attr field can be set by using the roleadd, rolemod, useradd, usermod, and profiles commands. They can be set locally and in the LDAP naming scope.

- For a user, the roles keyword assigns one or more defined roles.
- For a role, the user value to the roleauth keyword enables the role to authenticate with the user password rather than with the role password. By default, the value is role.
- For a user or role, the following attributes can be set:
  - access_times keyword – Specifies the days and times that specified applications and services can be accessed. For more information, see the getaccess_times(3C) man page.
  - access_tz keyword – Specifies the time zone to use when interpreting the times in access_times entries. For more information, see the pam_unix_account(5) man page.
  - audit_flags keyword – Modifies the audit mask. For more information, see the audit_flags(5) man page.
  - auths keyword – Assigns authorizations. For more information, see the auths(1) man page.
  - auth_profiles keyword – Assigns authenticated rights profiles. For reference, see the profiles(1) man page.
  - defaultpriv keyword – Adds privileges or removes them from the default basic set of privileges.
  - limitpriv keyword – Adds privileges or removes them from the default limit set of privileges.

    The defaultpriv and limitpriv privileges are always in effect because they are assigned to the user's initial process. For more information, see the privileges(5) man page and "How Privileges Are Implemented" on page 25.
  - idlecmd keyword – Logs out the user or locks the screen after idletime is reached.
  - idletime keyword – Sets the time that the system is available after no keyboard activity. Set idletime when you specify a value for idlecmd.
  - lock_after_retries keyword – If the value is yes, the system is locked after the number of retries exceeds the number that is allowed in the /etc/default/login file. For more information, see the login(1) man page
  - profiles keyword – Assigns rights profiles. For more information, see the profiles(1) man page.
  - project keyword – Adds a default project. For more information, see the project(4) man page.

Note - Because the access_times and access_tz attributes are PAM attributes, they are checked during authentication. Therefore, they must be assigned either directly to a user or role, or in an authenticated rights profile. They are ignored in a regular rights profile.

The qualified attributes can be set for users and roles in the LDAP naming scope only. These qualifiers limit a user or role's attribute assignment, such as a rights profile, to one or more systems. For examples, see the useradd(1M) and user_attr(4) man pages.

The qualifiers are host and netgroup:

- host qualifier – Identifies the system where the user or role can perform specified actions.
- netgroup qualifier – Lists systems where the user or role can perform specified actions. host assignments have priority over netgroup assignments.

For more information, see the user_attr(4) man page. To view the contents of this database, use the getent user_attr command. For more information, see the getent(1M) man page and Chapter 6, “Listing Rights in Oracle Solaris”.

auth_attr Database

The auth_attr database stores authorization definitions. Authorizations can be assigned to users, to roles, or to rights profiles. The preferred method is to place authorizations in a rights profile, then to assign the rights profile to a role or user.

To view the contents of this database, use the getent auth_attr command. For more information, see the getent(1M) man page and Chapter 6, “Listing Rights in Oracle Solaris”.

prof_attr Database

The prof_attr database stores the name, description, help file location, privileges, and authorizations that are assigned to rights profiles. The commands and security attributes that are assigned to rights profiles are stored in the exec_attr database. For more information, see “exec_attr Database” on page 111.

For more information, see the prof_attr(4) man page. To view the contents of this database, use the getent exec_attr command. For more information, see the getent(1M) man page and Chapter 6, “Listing Rights in Oracle Solaris”.

exec_attr Database

The exec_attr database defines commands that require security attributes to succeed. The commands are part of a rights profile. A command with its security attributes can be run by roles or users to whom the profile is assigned.

For more information, see the exec_attr(4) man page. To view the contents of this database, use the getent command. For more information, see the getent(1M) man page and Chapter 6, "Listing Rights in Oracle Solaris".

policy.conf File

The /etc/security/policy.conf file provides a way of granting specific rights profiles, specific authorizations, and specific privileges to all users of a system. The relevant entries in the file consist of *key*=*value* pairs:

- AUTHS_GRANTED=*authorizations* – Refers to one or more authorizations.
- AUTH_PROFS_GRANTED=*rights profiles* – Refers to one or more authenticated rights profiles.
- PROFS_GRANTED=*rights profiles* – Refers to one or more rights profiles that are not authenticated.
- CONSOLE_USER=Console User– Refers to the Console User rights profile. This profile is delivered with a convenient set of authorizations for the console user. You can customize this profile.
- PRIV_DEFAULT=*privileges* – Refers to one or more privileges.
- PRIV_LIMIT=*privileges* – Refers to all privileges.

The following example shows some rights values from a policy.conf database:

```
##
AUTHS_GRANTED=
AUTH_PROFS_GRANTED=
CONSOLE_USER=Console User
PROFS_GRANTED=Basic Solaris User
#PRIV_DEFAULT=basic
#PRIV_LIMIT=all
```

Commands for Administering Rights

This section lists commands that are used to administer rights. It also includes a table of commands whose access can be controlled by authorizations.

Commands That Manage Authorizations, Rights Profiles, and Roles

The commands listed in the following table retrieve and set rights on user processes.

TABLE 8-1 Rights Administration Commands

Command	Description
`auths`(1)	Displays authorizations for a user. Creates new authorizations.
`getent`(1M)	Lists the contents of the rights databases.
`nscd`(1M)	Name service cache daemon, useful for caching the rights databases. Use the `svcadm` command to restart the daemon.
`pam_roles`(5)	Role account management module for PAM. Checks for the authorization to assume a role.
`pam_unix_account`(5)	UNIX account management module for PAM. Checks for account restrictions, such as time restrictions and inactivity.
`pfbash`(1)	Used to create a profile shell process that can evaluate rights.
`pfedit`(1M)	Used to edit administrative files.
`pfexec`(1)	Used to execute a command with security attributes.
`policy.conf`(4)	Configuration file for system security policy. Lists granted authorizations, granted privileges, and other security information.
`profiles`(1)	Displays rights profiles for a specified user. Creates or modifies a rights profile.
`roles`(1)	Displays roles that a specified user can assume.
`roleadd`(1M)	Adds a role to a local system or to an LDAP network.
`roleadd`(1M)	Adds a role to a local system or to an LDAP network.
`rolemod`(1M)	Modifies a role's properties on a local system or on an LDAP network.
`userattr`(1)	Displays the value of a specific right that is assigned to a user or role account.
`useradd`(1M)	Adds a user account to the system or to an LDAP network. The `-R` option assigns a role to a user's account.
`userdel`(1M)	Deletes a user's login from the system or from an LDAP network.
`usermod`(1M)	Modifies a user's account properties on the system.

Selected Commands That Require Authorizations

The following table provides examples of how authorizations are used to limit command options on an Oracle Solaris system. For more discussion of authorizations, see "Authorizations Reference" on page 107.

TABLE 8-2 Commands and Associated Authorizations

Command	Authorization Requirements
at(1)	solaris.jobs.user required for all options (when neither at.allow nor at.deny files exist)
atq(1)	solaris.jobs.admin required for all options
cdrw(1)	solaris.device.cdrw required for all options, which is granted by default in the policy.conf file
crontab(1)	solaris.jobs.user required for the option to submit a job (when neither crontab.allow nor crontab.deny files exist)
	solaris.jobs.admin required for the options to list or modify other users' crontab files
allocate(1)	solaris.device.allocate (or other authorization as specified in device_allocate file) required to allocate a device
	solaris.device.revoke (or other authorization as specified in device_allocate file) required to allocate a device to another user (-F option)
deallocate(1)	solaris.device.allocate (or other authorization as specified in device_allocate file) required to deallocate another user's device
	solaris.device.revoke (or other authorization as specified in device_allocate) required to force deallocation of the specified device (-F option) or all devices (-I option)
list_devices(1)	solaris.device.revoke required to list another user's devices (-U option)
roleadd(1M)	solaris.user.manage required to create a role. solaris.account.activate required to set the initial password. solaris.account.setpolicy required to set password policy, such as account locking and password aging.
roledel(1M)	solaris.passwd.assign authorization required to delete the password.
rolemod(1M)	solaris.passwd.assign authorization required to change the password. solaris.account.setpolicy required to change password policy, such as account locking and password aging.
sendmail(1M)	solaris.mail required to access mail subsystem functions; solaris.mail.mailq required to view mail queue
useradd(1M)	solaris.user.manage required to create a user. solaris.account.activate required to set the initial password. solaris.account.setpolicy required to set password policy, such as account locking and password aging.
userdel(1M)	solaris.passwd.assign authorization required to delete the password.

Command	Authorization Requirements
usermod(1M)	solaris.passwd.assign authorization required to change the password. solaris.account.setpolicy required to change password policy, such as account locking and password aging.

Privileges Reference

Privileges restrict processes are implemented in the kernel, and can restrict processes at the command, user, role, or system level.

Commands for Handling Privileges

The following table lists the commands that are available to handle privileges.

TABLE 8-3 Commands for Handling Privileges

Purpose	Command	Man Page
Debug privilege failure	`ppriv -eD` *failed-operation*	ppriv(1)
List the privileges on the system	`ppriv -l`	ppriv(1)
List a privilege and its description	`ppriv -lv` *priv*	ppriv(1)
List extended privilege policy on a UID, process, or port	`ppriv -lv` *extended-policy*	ppriv(1)
Examine process privileges	`ppriv -v` *pid*	ppriv(1)
Add extended privilege policy to a UID, process, or port	`ppriv -r` *rule*	privileges(5)
Set process privileges	`ppriv -s` *spec*	ppriv(1)
Remove an extended privilege policy rule	`ppriv -X` *rule*	privileges(5)
Assign privileges to a rights profile	`profiles -p` *profile-name*	profiles(1)
Assign privileges to a new role	`roleadd -K defaultpriv=`	roleadd(1M)
Add privileges to an existing role	`rolemod -K defaultpriv+=`	rolemod(1M)
Assign privileges to a new user	`useradd -K defaultpriv=`	useradd(1M)
Add privileges to an existing user	`usermod -K defaultpriv+=`	usermod(1M)
Add device policy to a device	`add_drv -p` *policy driver*	add_drv(1M)

Purpose	Command	Man Page
Set device policy	`devfsadm`	`devfsadm`(1M)
View device policy	`getdevpolicy`	`getdevpolicy`(1M)
Update device policy on open devices	`update_drv -p` *policy driver*	`update_drv`(1M)

Files That Contain Privilege Information

The `policy.conf` and `syslog.conf` files contain information about privileges.

- `/etc/security/policy.conf` contains the following privilege information:
  - `PRIV_DEFAULT` – Inheritable set of privileges for the system
  - `PRIV_LIMIT` – Limit set of privileges for the system

  For more information, see the `policy.conf`(4) man page.
- `/etc/syslog.conf` is the system log file for debug messages that are related to privilege debugging. The path for debug messages is set in the `priv.debug` entry.

  For more information, see the `syslog.conf`(4) man page.

Privileged Actions in the Audit Record

Privilege use can be audited. Any time that a process uses a privilege, the use of privilege is recorded in the audit trail in the `upriv` audit token. When privilege names are part of the record, their textual representation is used. The following audit events record use of privilege:

- `AUE_SETPPRIV` **audit event –** Generates an audit record when a privilege set is changed. The `AUE_SETPPRIV` audit event is in the `pm` class.
- `AUE_MODALLOCPRIV` **audit event –** Generates an audit record when a privilege is added from outside the kernel. The `AUE_MODALLOCPRIV` audit event is in the `ad` class.
- `AUE_MODDEVPLCY` **audit event –** Generates an audit record when the device policy is changed. The `AUE_MODDEVPLCY` audit event is in the `ad` class.
- `AUE_PFEXEC` **audit event –** Generates an audit record when a call is made to `execve` with `pfexec` enabled. The `AUE_PFEXEC` audit event is in the `as`, `ex`, `ps`, and `ua` audit classes. The names of the privileges are included in the audit record.

The successful use of privileges that are in the basic set is not audited. An attempt to use a basic privilege that has been removed from a user's basic set is audited.

Security Glossary

Access Control List (ACL) An access control list (ACL) provides finer-grained file security than traditional UNIX file protection provides. For example, an ACL enables you to allow group read access to a file, while allowing only one member of that group to write to the file.

admin principal A user principal with a name of the form *username*`/admin` (as in `jdoe/admin`). An admin principal can have more privileges (for example, to change policies) than a regular user principal. See also principal name, user principal.

AES Advanced Encryption Standard. A symmetric 128-bit block data encryption technique. The U.S. government adopted the Rijndael variant of the algorithm as its encryption standard in October 2000. AES replaces user principal encryption as the government standard.

algorithm A cryptographic algorithm. This is an established, recursive computational procedure that encrypts or hashes input.

application server See network application server.

asynchronous audit event Asynchronous events are the minority of system events. These events are not associated with any process, so no process is available to be blocked and later woken up. Initial system boot and PROM enter and exit events are examples of asynchronous events.

audit files Binary audit logs. Audit files are stored separately in an audit file system.

audit policy The global and per-user settings that determine which audit events are recorded. The global settings that apply to the audit service typically affect which pieces of optional information are included in the audit trail. Two settings, `cnt` and `ahlt`, affect the operation of the system when the audit queue fills. For example, audit policy might require that a sequence number be part of every audit record.

audit trail The collection of all audit files from all hosts.

authenticated rights profile A rights profile that requires the assigned user or role to type a password before executing an operation from the profile. This behavior is similar to `sudo` behavior. The length of time that the password is valid is configurable.

authentication The process of verifying the claimed identity of a principal.

authenticator Authenticators are passed by clients when requesting tickets (from a KDC) and services (from a server). They contain information that is generated by using a session key known only by the client and server, that can be verified as of recent origin, thus indicating that the transaction is secure. When used with a ticket, an authenticator can be used to authenticate a user principal. An authenticator includes the principal name of the user, the IP address of the user's host, and a time stamp. Unlike a ticket, an authenticator can be used only once, usually when access to a service is requested. An authenticator is encrypted by using the session key for that client and that server.

authorization 1. In Kerberos, the process of determining if a principal can use a service, which objects the principal is allowed to access, and the type of access that is allowed for each object.

2. In user rights management, a right that can be assigned to a role or user (or embedded in a rights profile) for performing a class of operations that are otherwise prohibited by security policy. Authorizations are enforced at the user application level, not in the kernel.

basic set The set of privileges that are assigned to a user's process at login. On an unmodified system, each user's initial inheritable set equals the basic set at login.

Blowfish A symmetric block cipher algorithm that takes a variable-length key from 32 bits to 448 bits. Its author, Bruce Schneier, claims that Blowfish is optimized for applications where the key does not change often.

client Narrowly, a process that makes use of a network service on behalf of a user; for example, an application that uses `rlogin`. In some cases, a server can itself be a client of some other server or service.

More broadly, a host that a) receives a Kerberos credential, and b) makes use of a service that is provided by a server.

Informally, a principal that makes use of a service.

client principal (RPCSEC_GSS API) A client (a user or an application) that uses RPCSEC_GSS-secured network services. Client principal names are stored in the form of `rpc_gss_principal_t` structures.

clock skew The maximum amount of time that the internal system clocks on all hosts that are participating in the Kerberos authentication system can differ. If the clock skew is exceeded between any of the participating hosts, requests are rejected. Clock skew can be specified in the `krb5.conf` file.

confidentiality See privacy.

consumer In the Cryptographic Framework feature of Oracle Solaris, a consumer is a user of the cryptographic services that come from providers. Consumers can be applications, end users, or kernel operations. Kerberos, IKE, and IPsec are examples of consumers. For examples of providers, see provider.

credential An information package that includes a ticket and a matching session key. Used to authenticate the identity of a principal. See also ticket, session key.

credential cache A storage space (usually a file) that contains credentials that are received from the KDC.

cryptographic algorithm See algorithm.

DES Data Encryption Standard. A symmetric-key encryption method developed in 1975 and standardized by ANSI in 1981 as ANSI X.3.92. DES uses a 56-bit key.

device allocation Device protection at the user level. Device allocation enforces the exclusive use of a device by one user at a time. Device data is purged before device reuse. Authorizations can be used to limit who is permitted to allocate a device.

device policy Device protection at the kernel level. Device policy is implemented as two sets of privileges on a device. One set of privileges controls read access to the device. The second set of privileges controls write access to the device. See also policy.

Diffie-Hellman protocol Also known as public key cryptography. An asymmetric cryptographic key agreement protocol that was developed by Diffie and Hellman in 1976. The protocol enables two users to exchange a secret key over an insecure medium without any prior secrets. Diffie-Hellman is used by Kerberos.

digest See message digest.

DSA Digital Signature Algorithm. A public key algorithm with a variable key size from 512 to 4096 bits. The U.S. Government standard, DSS, goes up to 1024 bits. DSA relies on SHA1 for input.

ECDSA Elliptic Curve Digital Signature Algorithm. A public key algorithm that is based on elliptic curve mathematics. An ECDSA key size is significantly smaller than the size of a DSA public key needed to generate a signature of the same length.

effective set The set of privileges that are currently in effect on a process.

flavor Historically, *security flavor* and *authentication flavor* had the same meaning, as a flavor that indicated a type of authentication (AUTH_UNIX, AUTH_DES, AUTH_KERB). RPCSEC_GSS is also a security flavor, even though it provides integrity and privacy services in addition to authentication.

forwardable ticket A ticket that a client can use to request a ticket on a remote host without requiring the client to go through the full authentication process on that host. For example, if the user `david` obtains a forwardable ticket while on user `jennifer`'s machine, `david` can log in to his own machine without being required to get a new ticket (and thus authenticate himself again). See also proxiable ticket.

FQDN Fully qualified domain name. For example, `central.example.com` (as opposed to simply `denver`).

GSS-API The Generic Security Service Application Programming Interface. A network layer that provides support for various modular security services, including the Kerberos service.

GSS-API provides for security authentication, integrity, and privacy services. See also authentication, integrity, privacy.

hardening The modification of the default configuration of the operating system to remove security vulnerabilities that are inherent in the host.

hardware provider In the Cryptographic Framework feature of Oracle Solaris, a device driver and its hardware accelerator. Hardware providers offload expensive cryptographic operations from the computer system, thus freeing CPU resources for other uses. See also provider.

host A system that is accessible over a network.

host principal A particular instance of a service principal in which the principal (signified by the primary name `host`) is set up to provide a range of network services, such as `ftp`, `rcp`, or `rlogin`. An example of a host principal is `host/central.example.com@EXAMPLE.COM`. See also server principal.

inheritable set The set of privileges that a process can inherit across a call to `exec`.

initial ticket A ticket that is issued directly (that is, not based on an existing ticket-granting ticket). Some services, such as applications that change passwords, might require tickets to be marked `initial` so as to assure themselves that the client can demonstrate a knowledge of its secret key. This assurance is important because an initial ticket indicates that the client has recently authenticated itself (instead of relying on a ticket-granting ticket, which might existed for a long time).

instance The second part of a principal name, an instance qualifies the principal's primary. In the case of a service principal, the instance is required. The instance is the host's fully qualified domain name, as in `host/central.example.com`. For user principals, an instance is optional. Note, however, that `jdoe` and `jdoe/admin` are unique principals. See also primary, principal name, service principal, user principal.

integrity A security service that, in addition to user authentication, provides for the validity of transmitted data through cryptographic checksumming. See also authentication, privacy.

invalid ticket A postdated ticket that has not yet become usable. An invalid ticket is rejected by an application server until it becomes validated. To be validated, an invalid ticket must be presented to the KDC by the client in a TGS request, with the `VALIDATE` flag set, after its start time has passed. See also postdated ticket.

KDC Key Distribution Center. A machine that has three Kerberos V5 components:

- Principal and key database
- Authentication service
- Ticket-granting service

Each realm has a master KDC and should have one or more slave KDCs.

Kerberos An authentication service, the protocol that is used by that service, or the code that is used to implement that service.

The Kerberos implementation in Oracle Solaris that is closely based on Kerberos V5 implementation.

While technically different, “Kerberos” and “Kerberos V5” are often used interchangeably in the Kerberos documentation.

Kerberos (also spelled Cerberus) was a fierce, three-headed mastiff who guarded the gates of Hades in Greek mythology.

Kerberos policy A set of rules that governs password usage in the Kerberos service. Policies can regulate principals' accesses, or ticket parameters, such as lifetime.

key 1. Generally, one of two main types of keys:

- A *symmetric key* – An encryption key that is identical to the decryption key. Symmetric keys are used to encrypt files.
- An *asymmetric key* or *public key* – A key that is used in public key algorithms, such as Diffie-Hellman or RSA. Public keys include a private key that is known only by one user, a public key that is used by the server or general resource, and a private-public key pair that combines the two. A private key is also called a *secret* key. The public key is also called a *shared* key or *common* key.

2. An entry (principal name) in a keytab file. See also keytab file.

3. In Kerberos, an encryption key, of which there are three types:

- A *private key* – An encryption key that is shared by a principal and the KDC, and distributed outside the bounds of the system. See also private key.
- A *service key* – This key serves the same purpose as the private key, but is used by servers and services. See also service key.
- A *session key* – A temporary encryption key that is used between two principals, with a lifetime limited to the duration of a single login session. See also session key.

keystore A keystore holds passwords, passphrases, certificates, and other authentication objects for retrieval by applications. A keystore can be specific to a technology, or a location that several applications use.

keytab file A key table file that contains one or more keys (principals). A host or service uses a keytab file in the much the same way that a user uses a password.

kvno Key version number. A sequence number that tracks a particular key in order of generation. The highest kvno is the latest and most current key.

least privilege A security model which gives a specified process only a subset of superuser powers. The least privilege model assigns enough privilege to regular users that they can perform personal administrative tasks, such as mount file systems and change the ownership of files. On the other hand, processes run with just those privileges that they need to complete the task, rather than with the full power of superuser, that is, all privileges. Damage due to programming errors like buffer overflows can be contained to a non-root user, which has no access to critical abilities like reading or writing protected system files or halting the machine.

limit set The outside limit of what privileges are available to a process and its children.

MAC 1. See message authentication code (MAC).

2. Also called labeling. In government security terminology, MAC is Mandatory Access Control. Labels such as Top Secret and Confidential are examples of MAC. MAC contrasts with DAC, which is Discretionary Access Control. UNIX permissions are an example of DAC.

3. In hardware, the unique system address on a LAN. If the system is on an Ethernet, the MAC is the Ethernet address.

master KDC The main KDC in each realm, which includes a Kerberos administration server, `kadmind`, and an authentication and ticket-granting daemon, `krb5kdc`. Each realm must have at least one master KDC, and can have many duplicate, or slave, KDCs that provide authentication services to clients.

MD5 An iterative cryptographic hash function that is used for message authentication, including digital signatures. The function was developed in 1991 by Rivest. Its use is deprecated.

mechanism 1. A software package that specifies cryptographic techniques to achieve data authentication or confidentiality. Examples: Kerberos V5, Diffie-Hellman public key.

2. In the Cryptographic Framework feature of Oracle Solaris, an implementation of an algorithm for a particular purpose. For example, a DES mechanism that is applied to authentication, such as CKM_DES_MAC, is a separate mechanism from a DES mechanism that is applied to encryption, CKM_DES_CBC_PAD.

message authentication code (MAC) MAC provides assurance of data integrity and authenticates data origin. MAC does not protect against eavesdropping.

message digest A message digest is a hash value that is computed from a message. The hash value almost uniquely identifies the message. A digest is useful for verifying the integrity of a file.

minimization The installation of the minimal operating system that is necessary to run the server. Any software that does not directly relate to the operation of the server is either not installed, or deleted after the installation.

name service scope The scope in which a role is permitted to operate, that is, an individual host or all hosts that are served by a specified naming service such as NIS LDAP.

network application server A server that provides a network application, such as `ftp`. A realm can contain several network application servers.

network policies The settings that network utilities configure to protect network traffic. For information about network security, see "Securing the Network in Oracle Solaris 11.2 ".

nonattributable audit event An audit event whose initiator cannot be determined, such as the AUE_BOOT event.

NTP Network Time Protocol. Software from the University of Delaware that enables you to manage precise time or network clock synchronization, or both, in a network environment. You can use NTP to maintain clock skew in a Kerberos environment. See also clock skew.

PAM Pluggable Authentication Module. A framework that allows for multiple authentication mechanisms to be used without having to recompile the services that use them. PAM enables Kerberos session initialization at login.

passphrase A phrase that is used to verify that a private key was created by the passphrase user. A good passphrase is 10-30 characters long, mixes alphabetic and numeric characters, and avoids simple prose and simple names. You are prompted for the passphrase to authenticate use of the private key to encrypt and decrypt communications.

password policy The encryption algorithms that can be used to generate passwords. Can also refer to more general issues around passwords, such as how often the passwords must be changed, how many password attempts are permitted, and other security considerations. Security policy requires passwords. Password policy might require passwords to be encrypted with the AES algorithm, and might make further requirements related to password strength.

permitted set The set of privileges that are available for use by a process.

policy Generally, a plan or course of action that influences or determines decisions and actions. For computer systems, policy typically means security policy. Your site's security policy is the set of rules that define the sensitivity of the information that is being processed and the measures that are used to protect the information from unauthorized access. For example, security policy might require that systems be audited, that devices must be allocated for use, and that passwords be changed every six weeks.

For the implementation of policy in specific areas of the Oracle Solaris OS, see audit policy, policy in the Cryptographic Framework, device policy, Kerberos policy, password policy, and rights policy.

policy for public key technologies In the Key Management Framework (KMF), policy is the management of certificate usage. The KMF policy database can put constraints on the use of the keys and certificates that are managed by the KMF library.

policy in the Cryptographic Framework In the Cryptographic Framework feature of Oracle Solaris, policy is the disabling of existing cryptographic mechanisms. The mechanisms then cannot be used. Policy in the Cryptographic Framework might prevent the use of a particular mechanism, such as `CKM_DES_CBC`, from a provider, such as DES.

postdated ticket A postdated ticket does not become valid until some specified time after its creation. Such a ticket is useful, for example, for batch jobs that are intended to run late at night, since the ticket, if stolen, cannot be used until the batch job is run. When a postdated ticket is issued, it is issued as `invalid` and remains that way until a) its start time has passed, and b) the client requests validation by the KDC. A postdated ticket is normally valid until the expiration time of the ticket-granting ticket. However, if the postdated ticket is marked `renewable`, its lifetime is normally set to be equal to the duration of the full life time of the ticket-granting ticket. See also invalid ticket, renewable ticket.

primary

The first part of a principal name. See also instance, principal name, realm.

principal

1. A uniquely named client/user or server/service instance that participates in a network communication. Kerberos transactions involve interactions between principals (service principals and user principals) or between principals and KDCs. In other words, a principal is a unique entity to which Kerberos can assign tickets. See also principal name, service principal, user principal.

2. (RPCSEC_GSS API) See client principal, server principal.

principal name

1. The name of a principal, in the format *primary/instance@REALM*. See also instance, primary, realm.

2. (RPCSEC_GSS API) See client principal, server principal.

principle of least privilege

See least privilege.

privacy

A security service, in which transmitted data is encrypted before being sent. Privacy also includes data integrity and user authentication. See also authentication, integrity, service.

private key

A key that is given to each user principal, and known only to the user of the principal and to the KDC. For user principals, the key is based on the user's password. See also key.

private-key encryption

In private-key encryption, the sender and receiver use the same key for encryption. See also public-key encryption.

privilege

1. In general, a power or capability to perform an operation on a computer system that is beyond the powers of a regular user. Superuser privileges are all the rights that superuser is granted. A privileged user or privileged application is a user or application that has been granted additional rights.

2. A discrete right on a process in an Oracle Solaris system. Privileges offer a finer-grained control of processes than does `root`. Privileges are defined and enforced in the kernel. Privileges are also called *process privileges* or *kernel privileges*. For a full description of privileges, see the `privileges(5)` man page.

privilege escalation

Gaining access to resources that are outside the range of resources that your assigned rights, including rights that override the defaults, permit. The result is that a process can perform unauthorized operations.

privilege model A stricter model of security on a computer system than the superuser model. In the privilege model, processes require privilege to run. Administration of the system can be divided into discrete parts that are based on the privileges that administrators have in their processes. Privileges can be assigned to an administrator's login process. Or, privileges can be assigned to be in effect for certain commands only.

privilege set A collection of privileges. Every process has four sets of privileges that determine whether a process can use a particular privilege. See limit set, effective set set, permitted set set, and inheritable set set.

Also, the basic set set of privileges is the collection of privileges that are assigned to a user's process at login.

privilege-aware Programs, scripts, and commands that turn on and off the use of privilege in their code. In a production environment, the privileges that are turned on must be supplied to the process, for example, by requiring users of the program to use a rights profile that adds the privileges to the program. For a full description of privileges, see the `privileges`(5) man page.

privileged application An application that can override system controls. The application checks for security attributes, such as specific UIDs, GIDs, authorizations, or privileges.

privileged user A user who is assigned rights beyond the rights of regular user on a computer system. See also trusted users.

profile shell In rights management, a shell that enables a role (or user) to run from the command line any privileged applications that are assigned to the role's rights profiles. The profile shell versions correspond to the available shells on the system, such as the `pfbash` version of `bash`.

provider In the Cryptographic Framework feature of Oracle Solaris, a cryptographic service that is provided to consumers. PKCS #11 libraries, kernel cryptographic modules, and hardware accelerators are examples of providers. Providers plug in to the Cryptographic Framework, so are also called *plugins*. For examples of consumers, see consumer.

proxiable ticket A ticket that can be used by a service on behalf of a client to perform an operation for the client. Thus, the service is said to act as the client's proxy. With the ticket, the service can take on the identity of the client. The service can use a proxiable ticket to obtain a service ticket to another service, but it cannot obtain a ticket-granting ticket. The difference between a proxiable ticket and a forwardable ticket is that a proxiable ticket is only valid for a single operation. See also forwardable ticket.

public object A file that is owned by the `root` user and readable by the world, such as any file in the `/etc` directory.

public-key encryption An encryption scheme in which each user has two keys, one public key and one private key. In public-key encryption, the sender uses the receiver's public key to encrypt the message, and the receiver uses a private key to decrypt it. The Kerberos service is a private-key system. See also private-key encryption.

QOP Quality of Protection. A parameter that is used to select the cryptographic algorithms that are used in conjunction with the integrity service or privacy service.

RBAC Role-based access control, the user rights management feature of Oracle Solaris. See rights.

RBAC policy See rights policy.

realm 1. The logical network that is served by a single Kerberos database and a set of Key Distribution Centers (KDCs).

2. The third part of a principal name. For the principal name `jdoe/admin@CORP.EXAMPLE.COM`, the realm is `CORP.EXAMPLE.COM`. See also principal name.

reauthentication The requirement to provide a password to perform a computer operation. Typically, `sudo` operations require reauthentication. Authenticated rights profiles can contain commands that require reauthentication. See authenticated rights profile.

relation A configuration variable or relationship that is defined in the `kdc.conf` or `krb5.conf` files.

renewable ticket Because having tickets with very long lives is a security risk, tickets can be designated as `renewable`. A renewable ticket has two expiration times: a) the time at which the current instance of the ticket expires, and b) maximum lifetime for any ticket. If a client wants to continue to use a ticket, the client renews the ticket before the first expiration occurs. For example, a ticket can be valid for one hour, with all tickets having a maximum lifetime of ten hours. If the client that holds the ticket wants to keep it for more than an hour, the client must renew the ticket. When a ticket reaches the maximum ticket lifetime, it automatically expires and cannot be renewed.

rights An alternative to the all-or-nothing superuser model. User rights management and process rights management enable an organization to divide up superuser's privileges and assign them to users or roles. Rights in Oracle Solaris are implemented as kernel privileges, authorizations, and the ability to run a process as a specific UID or GID. Rights can be collected in a rights profile and a role.

rights policy The security policy that is associated with a command. Currently, `solaris` is the valid policy for Oracle Solaris. The `solaris` policy recognizes privileges and extended privilege policy, authorizations, and `setuid` security attributes.

rights profile Also referred to as a profile. A collection of security overrides that can be assigned to a role or user. A rights profile can include authorizations, privileges, commands with security attributes, and other rights profiles that are called supplementary profiles.

role A special identity for running privileged applications that only assigned users can assume.

RSA A method for obtaining digital signatures and public key cryptosystems. The method was first described in 1978 by its developers, Rivest, Shamir, and Adleman.

scan engine A third-party application, residing on an external host, that examines a file for known viruses.

SEAM
The product name for the initial version of Kerberos on Solaris systems. This product is based on the Kerberos V5 technology that was developed at the Massachusetts Institute of Technology. SEAM is now called the Kerberos service. It continues to differ slightly from the MIT version.

secret key
See private key.

Secure Shell
A special protocol for secure remote login and other secure network services over an insecure network.

security attributes
Overrides to security policy that enable an administrative command to succeed when the command is run by a user other than superuser. In the superuser model, the `setuid root` and `setgid` programs are security attributes. When these attributes are applied to a command, the command succeeds no matter who runs the command. In the privilege model, kernel privileges and other rights replace `setuid root` programs as security attributes. The privilege model is compatible with the superuser model, in that the privilege model also recognizes the `setuid` and `setgid` programs as security attributes.

security flavor
See flavor.

security mechanism
See mechanism.

security policy
See policy.

security service
See service.

seed
A numeric starter for generating random numbers. When the starter originates from a random source, the seed is called a *random seed*.

separation of duty
Part of the notion of least privilege. Separation of duty prevents one user from performing or approving all operations that complete a transaction. For example, in RBAC, you can separate the creation of a login user from the assignment of security overrides. One role creates the user. A separate role can assign security attributes, such as rights profiles, roles, and privileges to existing users.

server
A principal that provides a resource to network clients. For example, if you `ssh` to the system `central.example.com`, then that system is the server that provides the `ssh` service. See also service principal.

server principal
(RPCSEC_GSS API) A principal that provides a service. The server principal is stored as an ASCII string in the form *service@host*. See also client principal.

service
1. A resource that is provided to network clients, often by more than one server. For example, if you `rlogin` to the machine `central.example.com`, then that machine is the server that provides the `rlogin` service.

2. A security service (either integrity or privacy) that provides a level of protection beyond authentication. See also integrity and privacy.

service key An encryption key that is shared by a service principal and the KDC, and is distributed outside the bounds of the system. See also key.

service principal A principal that provides Kerberos authentication for a service or services. For service principals, the primary name is a name of a service, such as `ftp`, and its instance is the fully qualified host name of the system that provides the service. See also host principal, user principal.

session key A key that is generated by the authentication service or the ticket-granting service. A session key is generated to provide secure transactions between a client and a service. The lifetime of a session key is limited to a single login session. See also key.

SHA1 Secure Hashing Algorithm. The algorithm operates on any input length less than 2^{64} to produce a message digest. The SHA1 algorithm is input to DSA.

single-system image A single-system image is used in Oracle Solaris auditing to describe a group of audited systems that use the same naming service. These systems send their audit records to a central audit server, where the records can be compared as if the records came from one system.

slave KDC A copy of a master KDC, which is capable of performing most functions of the master. Each realm usually has several slave KDCs (and only one master KDC). See also KDC, master KDC.

software provider In the Cryptographic Framework feature of Oracle Solaris, a kernel software module or a PKCS #11 library that provides cryptographic services. See also provider.

stash file A stash file contains an encrypted copy of the master key for the KDC. This master key is used when a server is rebooted to automatically authenticate the KDC before it starts the `kadmind` and `krb5kdc` processes. Because the stash file includes the master key, the stash file and any backups of it should be kept secure. If the encryption is compromised, then the key could be used to access or modify the KDC database.

superuser model The typical UNIX model of security on a computer system. In the superuser model, an administrator has all-or-nothing control of the system. Typically, to administer the machine, a user becomes superuser (`root`) and can do all administrative activities.

synchronous audit event The majority of audit events. These events are associated with a process in the system. A non-attributable event that is associated with a process is a synchronous event, such as a failed login.

TGS Ticket-Granting Service. That portion of the KDC that is responsible for issuing tickets.

TGT Ticket-Granting Ticket. A ticket that is issued by the KDC that enables a client to request tickets for other services.

ticket An information packet that is used to securely pass the identity of a user to a server or service. A ticket is valid for only a single client and a particular service on a specific server. A ticket contains the principal name of the service, the principal name of the user, the IP address of the user's host, a time stamp, and a value that defines the lifetime of the ticket. A ticket is created with a random session key to be used by the client and the service. Once a ticket has been created, it can be reused until the ticket expires. A ticket only serves to authenticate a client when it is presented along with a fresh authenticator. See also authenticator, credential, service, session key.

ticket file See credential cache.

trusted users Users whom you have decided can perform administrative tasks at some level of trust. Typically, administrators create logins for trusted users first and assign administrative rights that match the users' level of trust and ability. These users then help configure and maintain the system. Also called *privileged users*.

user principal A principal that is attributed to a particular user. A user principal's primary name is a user name, and its optional instance is a name that is used to described the intended use of the corresponding credentials (for example, `jdoe` or `jdoe/admin`). Also known as a user instance. See also service principal.

virtual private network (VPN) A network that provides secure communication by using encryption and tunneling to connect users over a public network.

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