Trusted Extensions Configuration and Administration

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Contents

Figures

Tables

Using This Documentation

- **Overview** – Describes how to enable, configure, and maintain the Trusted Extensions feature of Oracle Solaris on one or more systems. Trusted Extensions software adds labels that implement mandatory access control (MAC) to protect system subjects (processes) and objects (data), including network endpoints and the desktop. Trusted Extensions software provides interfaces to handle label configuration, label assignment, and label policy.
- **Audience** – System administrators of labeled systems and networks.
- **Required knowledge** – Security labels and site security requirements.

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PART I

Initial Configuration of Trusted Extensions

The chapters in this part describe how to prepare Oracle Solaris systems to run Trusted Extensions. The chapters cover installing and enabling Trusted Extensions and the initial configuration tasks.

Chapter 1, “Security Planning for Trusted Extensions” describes the security issues to consider when configuring Trusted Extensions on one or more Oracle Solaris systems.

Chapter 2, “Configuration Roadmap for Trusted Extensions” provides task maps for various Trusted Extensions configurations on Oracle Solaris systems.

Chapter 3, “Adding the Trusted Extensions Feature to Oracle Solaris” provides instructions on preparing an Oracle Solaris system for Trusted Extensions. It describes how to enable Trusted Extensions and log in.

Chapter 4, “Configuring Trusted Extensions” provides instructions for configuring Trusted Extensions on a system with a monitor.

Chapter 5, “Configuring LDAP for Trusted Extensions” provides instructions for configuring the LDAP naming service on Trusted Extensions systems.

♦ ♦ ♦ CHAPTER 1

Security Planning for Trusted Extensions

The Trusted Extensions feature of Oracle Solaris implements a portion of your site's security policy in software. This chapter provides an overview of the security and administrative aspects of configuring the software.

Planning for Security in Trusted Extensions

This section describes the planning that is required before enabling and configuring Trusted Extensions software.

For a checklist of Trusted Extensions configuration tasks, see Appendix B, "Configuration Checklist for Trusted Extensions". If you are interested in localizing your site, see "For

International Customers of Trusted Extensions” on page 21. If you are interested in running an evaluated configuration, see “Understanding Your Site's Security Policy” on page 20.

Understanding Trusted Extensions

The enabling and configuration of Trusted Extensions involves more than loading executable files, specifying your site's data, and setting configuration variables. Considerable background knowledge is required. Trusted Extensions software provides a labeled environment that is based on two Oracle Solaris features:

- Capabilities that in most UNIX® environments are assigned to `root` are handled by several administrative roles.
- The ability to override security policy can be assigned to specific users and applications.

In Trusted Extensions, access to data is controlled by special security tags. These tags are called labels. Labels are assigned to users, processes, and objects, such as data files and directories. These labels supply mandatory access control (MAC), in addition to UNIX permissions, or discretionary access control (DAC).

Understanding Your Site's Security Policy

Trusted Extensions effectively enables you to integrate your site's security policy with the Oracle Solaris OS. Thus, you need to have a good understanding of the scope of your policy and how Trusted Extensions software can implement that policy. A well-planned configuration must provide a balance between consistency with your site security policy and convenience for users who are working on the system.

Trusted Extensions is certified to comply with the Common Criteria Recognition Agreement (CCRA) at Assurance Level EAL4+ against the following protection profiles:

- Advanced Management
- Extended Identification and Authentication
- Labeled Security
- Virtualization

For more information, see the Common Criteria web site (`http://www.commoncriteriaportal.org/`).

Planning Who Will Configure Trusted Extensions

The root role or the System Administrator role is responsible for enabling Trusted Extensions. You can create roles to divide administrative responsibilities among several functional areas:

- The security administrator is responsible for security-related tasks, such as setting up and assigning sensitivity labels, configuring auditing, and setting password policy.
- The system administrator is responsible for the non-security aspects of setup, maintenance, and general administration.
- More limited roles can be configured. For example, an operator could be responsible for backing up files.

As part of your administration strategy, you need to decide the following:

- Which users are handling which administrative responsibilities
- Which non-administrative users are allowed to run trusted applications, meaning which users are permitted to override security policy, when necessary
- Which users have access to which groups of data

Devising a Label Strategy

Planning labels requires setting up a hierarchy of sensitivity levels and a categorization of information on your system. The label_encodings file contains this type of information for your site. You can use one of the label_encodings files that are supplied with Trusted Extensions software. You could also modify one of the supplied files, or create a new label_encodings file that is specific to your site. The file must include the Oracle-specific local extensions, at least the COLOR NAMES section.

Planning labels also involves planning the label configuration. After enabling the Trusted Extensions service, you need to decide if the system must allow logins at multiple labels, or if the system can be configured with one user label only. For example, an LDAP server is a good candidate to have one labeled zone. For local administration of the server, you would create a zone at the minimum label. To administer the system, the administrator logs in as a user, and from the user workspace assumes the appropriate role.

For more information, see *Trusted Extensions Label Administration*. You can also refer to *Compartmented Mode Workstation Labeling: Encodings Format*.

For International Customers of Trusted Extensions

When localizing a label_encodings file, international customers must localize the label names *only*. The administrative label names, ADMIN_HIGH and ADMIN_LOW, must not be localized. All

labeled hosts that you contact, from any vendor, must have label names that match the label names in the `label_encodings` file.

Planning System Hardware and Capacity for Trusted Extensions

System hardware includes the system itself and its attached devices. Such devices include tape drives, microphones, CD-ROM drives, and disk packs. Hardware capacity includes system memory, network interfaces, and disk space.

- Follow the recommendations for installing Oracle Solaris, as described in *Installing Oracle Solaris 11.3 Systems* and the Installation section of the *Release Notes*.
- Trusted Extensions features can add to those recommendations:
  - Memory beyond the suggested minimum is required on the following systems:
    - Systems that run at more than one sensitivity label
    - Systems that are used by users who can assume an administrative role
  - More disk space is required on the following systems:
    - Systems that store files at more than one label
    - Systems whose users can assume an administrative role

Planning Your Trusted Network

For assistance in planning network hardware, see *Planning for Network Deployment in Oracle Solaris 11.3*.

Trusted Extensions software recognizes four host types. Each host type has a default security template, as shown in Table 1, “Default Host Templates in Trusted Extensions,” on page 22.

TABLE 1 Default Host Templates in Trusted Extensions

Host Type	Template Name	Purpose
`unlabeled`	`admin_low`	Identifies untrusted hosts that can communicate with the global zone. Such hosts send packets that do not include labels. For more information, see unlabeled system.
`cipso`	`cipso`	Identifies hosts or networks that send CIPSO packets. CIPSO packets are labeled.
`netif`	`netif`	Identifies hosts that receive packets on a specific network interface from `adaptive` hosts.
`adaptive`	`adapt`	Identifies hosts or networks that are not labeled, but send unlabeled packets to a specific interface on a `netif` host.

If your network can be reached by other networks, you need to specify accessible domains and hosts. You also need to identify which Trusted Extensions hosts are going to serve as gateways. You need to identify the label accreditation range for these gateways, and the sensitivity label at which data from other hosts can be viewed.

The labeling of hosts, gateways, and networks is explained in Chapter 16, "Managing Networks in Trusted Extensions". Assigning labels to remote systems is performed after initial setup.

Planning Your Labeled Zones in Trusted Extensions

Trusted Extensions software is added to Oracle Solaris in the global zone. You then configure non-global zones that are labeled. You can create one or more labeled zones for every unique label, though you do not need to create a zone for every label in your `label_encodings` file. A provided script enables you to easily create two labeled zones for the default user label and the default user clearance in your `label_encodings` file.

After labeled zones are created, regular users can use the configured system, but these users cannot reach other systems. To further isolate services that run at the same label, you can create secondary zones. For more information, see "Primary and Secondary Labeled Zones" on page 159.

- In Trusted Extensions, the local transport to connect to the X server is UNIX domain sockets. By default, the X server does not listen for TCP connections.
- By default, non-global zones cannot communicate with untrusted hosts. You must specify the explicit remote host IP addresses or network masks that can be reached by each zone.

Trusted Extensions Zones and Oracle Solaris Zones

Trusted Extensions zones, that is, labeled zones, are a *brand* of Oracle Solaris Zones. Labeled zones are primarily used to segregate data. In Trusted Extensions, regular users cannot remotely log in to a labeled zone except from an equally labeled zone on another trusted system. Authorized administrators can access a labeled zone from the global zone. For more about zone brands, see the `brands(5)` man page.

Zone Creation in Trusted Extensions

Zone creation in Trusted Extensions is similar to zone creation in Oracle Solaris. Trusted Extensions provides the `txzonemgr` script to step you through the process. The script has several command line options to automate the creation of labeled zones. For more information, see the `txzonemgr(1M)` man page.

Access to Labeled Zones

On a properly configured system, every zone must be able to use a network address to communicate with other zones that share the same label. The following configurations provide labeled zone access to other labeled zones:

- **all-zones interface –** One `all-zones` address is assigned. In this default configuration, only one IP address is required. Every zone, global and labeled, can communicate with identically labeled zones on remote systems over this shared address.

  A refinement of this configuration is to create a second IP instance for the global zone to use exclusively. This second instance would not be an `all-zones` address. The IP instance could be used to host a multilevel service or to provide a route to a private subnet.
- **IP instances –** As in the Oracle Solaris OS, one IP address is assigned to every zone, including the global zone. The zones share the IP stack. In the simplest case, all zones share the same physical interface.

  A refinement of this configuration is to assign a separate network information card (NIC) to each zone. Such a configuration is used to physically separate the single-label networks that are associated with each NIC.

  A further refinement is to use one or more `all-zones` interfaces in addition to an IP instance per zone. This configuration provides the option of using internal interfaces, such as `vni0`, to reach the global zone, thus protecting the global zone from remote attack. For example, a privileged service that binds a multilevel port on an instance of `vni0` in the global zone can only be reached internally by zones that use the shared stack.
- **Exclusive IP stack –** As in Oracle Solaris, one IP address is assigned to every zone, including the global zone. A virtual network interface card (VNIC) is created for each labeled zone.

  A refinement of this configuration is to create each VNIC over a separate network interface. Such a configuration is used to physically separate the single-label networks that are associated with each NIC. Zones that are configured with an exclusive IP stack cannot use the `all-zones` interface.

Applications That Are Restricted to a Labeled Zone

By default, labeled zones share the global zone's name service, and have read-only copies of the global zone's configuration files, including the `/etc/passwd` and `/etc/shadow` files. If you plan to install applications in a labeled zone from the labeled zone, and the package adds users to the zone, you will need writable copies of these files in the zone.

Packages such as `pkg:/service/network/ftp` create user accounts. To install this package by running the `pkg` command inside a labeled zone requires that a separate `nscd` daemon be running in the zone, and that the zone be assigned an exclusive IP address. For more information, see “How to Configure a Separate Name Service for Each Labeled Zone” on page 55.

Planning for Multilevel Services

By default, Trusted Extensions does not provide multilevel services. Most services are easily configured as zone-to-zone services, that is, as single-label services. For example, each labeled zone can connect to the NFS server that runs at the label of the labeled zone.

If your site requires multilevel services, these services are best configured on a system with at least two IP addresses. The multilevel ports that a multilevel service requires can be assigned to the IP address that is associated with the global zone. An `all-zones` address can be used by the labeled zones to reach the services.

Tip - If users in labeled zones must not have access to multilevel services, then you can assign one IP address to the system. A typical use of this Trusted Extensions configuration is on a laptop.

Planning for the LDAP Naming Service in Trusted Extensions

If you are not planning to install a network of labeled systems, then you can skip this section. If you are planning to use LDAP, your systems must be configured as LDAP clients before you add the first labeled zone.

If you plan to run Trusted Extensions on a network of systems, use LDAP as the naming service. For Trusted Extensions. a populated Oracle Directory Server Enterprise Edition (LDAP server) is required when you configure a network of systems. If your site has an existing LDAP server, you can populate the server with Trusted Extensions databases. To access the server, you set up an LDAP proxy on a Trusted Extensions system.

If your site does not have an existing LDAP server, you create an LDAP server on a system that is running Trusted Extensions software. The procedures are described in Chapter 5, “Configuring LDAP for Trusted Extensions”.

Planning for Auditing in Trusted Extensions

By default, auditing is enabled. Therefore, by default, all events in the `login/logout` class are audited. To audit the users who are configuring the system, you can create roles early in the configuration process. When these roles configure the system, the audit records include the login user who assumes the role. See “Creating Roles and Users in Trusted Extensions” on page 57.

Planning auditing in Trusted Extensions is the same as in the Oracle Solaris OS. For details, see *Managing Auditing in Oracle Solaris 11.3*. While Trusted Extensions adds classes, events, and audit tokens, the software does not change how auditing is administered. For Trusted Extensions additions to auditing, see Chapter 22, "Trusted Extensions and Auditing".

Planning User Security in Trusted Extensions

Trusted Extensions software provides reasonable security defaults for users. These security defaults are listed in Table 2, "Trusted Extensions Security Defaults for User Accounts," on page 26. Where two values are listed, the first value is the default. The security administrator can modify these defaults to reflect the site's security policy. After the security administrator sets the defaults, the system administrator can create all the users, who inherit the established defaults. For descriptions of the keywords and values for these defaults, see the `label_encodings`(4) and `policy.conf`(4) man pages.

TABLE 2 Trusted Extensions Security Defaults for User Accounts

File name	Keyword	Value
`/etc/security/policy.conf`	`IDLECMD`	`lock` | `logout`
	`IDLETIME`	`15`
	`CRYPT_ALGORITHMS_ALLOW`	`2a,5,6`
	`CRYPT_DEFAULT`	`5` (`sha256`)
	`LOCK_AFTER_RETRIES`	`no` | `yes`
	`PRIV_DEFAULT`	`basic`
	`PRIV_LIMIT`	`all`
	`AUTHS_GRANTED`	`solaris.device.cdrw`
	`AUTH_PROFS_GRANTED`	
	`CONSOLE_USER`	`Console User`
	`PROFS_GRANTED`	`Basic Solaris User`
LOCAL DEFINITIONS section of `/etc/security/tsol/label_encodings`	Default User Clearance	`CNF INTERNAL USE ONLY`
	Default User Sensitivity Label	`PUBLIC`

Note - The `IDLECMD` and `IDLETIME` variables apply to the login user's session. If the login user assumes a role, the user's `IDLECMD` and `IDLETIME` values are in effect for that role.

The system administrator can set up a standard user template that sets appropriate system defaults for every user. For example, by default each user's initial shell is a bash shell. The system administrator can set up a template that gives each user a `pfbash` shell.

Forming an Install Team for Trusted Extensions

The following describes the configuration strategy from the most secure strategy to the least secure strategy:

- A two-person team configures the software. The configuration process is audited.

  Two people are at the computer when the software is enabled. Early in the configuration process, this team creates administrative roles, and trusted users who can assume those roles. The team also sets up auditing to audit events that are executed by roles. After roles are assigned to users, and the computer is rebooted, the users log in and assume an administrative role. The software enforces task division by role. The audit trail provides a record of the configuration process. For an illustration of a secure configuration process, see Figure 1, “Administering a Trusted Extensions System: Task Division by Role,” on page 28.
- One person enables and configures the software by assuming the appropriate role. The configuration process is audited.

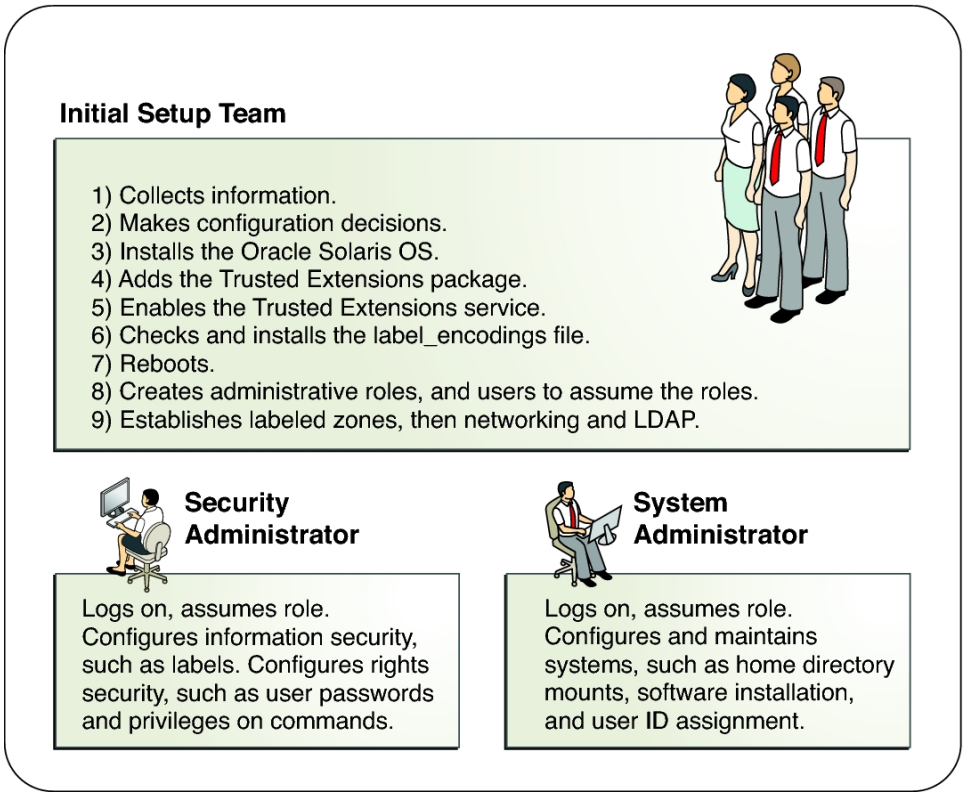
  Early in the configuration process, the `root` role creates additional roles. The `root` role also sets up auditing to audit events that are executed by roles. Once these additional roles have been assigned to the initial user, and the computer is rebooted, the user logs in and assume the appropriate role for the current task. The audit trail provides a record of the configuration process.
- One person enables and configures the software by assuming the `root` role. The configuration process is not audited.

  By using this strategy, no record is kept of the configuration process.
- The initial setup team changes the `root` role into a user.

  No record is kept in the software of the name of the user who is acting as `root`. This setup might be required for remote administration of a headless system.

Task division by role is shown in the following figure. The security administrator configures auditing, protects file systems, sets device policy, determines which programs require privilege to run, and protects users, among other tasks. The system administrator shares and mounts file systems, installs software packages, and creates users, among other tasks.

FIGURE 1 Administering a Trusted Extensions System: Task Division by Role



Resolving Additional Issues Before Enabling Trusted Extensions

Before configuring Trusted Extensions, you must physically protect your systems, decide which labels to attach to zones, and resolve other security issues. For the steps, see "Resolving Security Issues Before Installing Trusted Extensions" on page 35.

Backing Up the System Before Enabling Trusted Extensions

If your system has files that must be saved, perform a backup before enabling the Trusted Extensions service. The safest way to back up files is to do a level 0 dump. If you do not have a backup procedure in place, see the administrator's guide to your current operating system for instructions.

Results of Enabling Trusted Extensions From an Administrator's Perspective

After the Trusted Extensions software is enabled and the system is optionally rebooted, the following security features are in place. Many features are configurable by the security administrator.

- A label_encodings file is installed and configured.
- Three Trusted Extensions network databases, `tnrhdb`, `tnrhtp`, and `tnzonecfg` are added. The `tncfg` command enables administrators to view and modify these trusted databases.
- Devices must be allocated for use.
- If you install the windowing system, the software creates a trusted desktop, Solaris Trusted Extensions (GNOME). This labeled windowing environment provides administrative workspaces in the global zone. These workspaces are protected by the Trusted Path, visible in the trusted stripe.

  Also, Trusted Extensions provides GUIs to administer the system. For a list, see Chapter 7, “Trusted Extensions Administration Tools”.

♦ ♦ ♦ CHAPTER 2

Configuration Roadmap for Trusted Extensions

This chapter outlines the tasks for enabling and configuring the Trusted Extensions feature of Oracle Solaris.

Caution - If you are enabling and configuring Trusted Extensions remotely, carefully review Chapter 12, “Remote Administration in Trusted Extensions” before booting into the Trusted Extensions environment.

Task Map: Preparing for and Enabling Trusted Extensions

To prepare your system and enable Trusted Extensions, complete the following tasks.

Task	For Instructions
Gather information and make decisions about your system and your Trusted Extensions network.	“Resolving Security Issues Before Installing Trusted Extensions” on page 35
Enable Trusted Extensions.	“Enable Trusted Extensions” on page 38

Task Map: Choosing a Trusted Extensions Configuration

Configure Trusted Extensions on your system using one of the methods in the following task map.

Task	For Instructions
Create a demonstration Trusted Extensions system.	“Task Map: Configuring Trusted Extensions With the Provided Defaults” on page 32
Create an enterprise Trusted Extensions system.	“Task Map: Configuring Trusted Extensions to Meet Your Site's Requirements” on page 32

Task	For Instructions
Configure Trusted Extensions on a remote system.	Enable Trusted Extensions but do not reboot. Follow instructions in Chapter 12, "Remote Administration in Trusted Extensions". Then, continue with the instructions for systems with a monitor.
Configure Trusted Extensions on a Sun Ray server from Oracle.	See Sun Ray Products Documentation (`http://www.oracle.com/technetwork/server-storage/sunrayproducts/docs/index.html`) web site. To configure initial client-server communications, see "Labeling Hosts and Networks" on page 205.

Task Map: Configuring Trusted Extensions With the Provided Defaults

For a default configuration, perform the following tasks in sequence.

Task	For Instructions
Load the Trusted Extensions packages.	"Add Trusted Extensions Packages to an Oracle Solaris System" on page 37
Enable Trusted Extensions and reboot.	"Enable Trusted Extensions" on page 38
Log in.	"Log In to Trusted Extensions" on page 39
Create two labeled zones.	"How to Create a Default Trusted Extensions System" on page 46 Or, "How to Create Labeled Zones Interactively" on page 47
Create labeled workspaces for the zones.	"How to Assign Labels to Two Zone Workspaces" on page 49

Task Map: Configuring Trusted Extensions to Meet Your Site's Requirements

Tip - For a secure configuration process, create roles early in the process.

The order of tasks is shown in the following task map.

- The tasks in "Creating Labeled Zones" on page 45 are required.
- Depending on your site's requirements, perform other configuration tasks.

Task	For Instructions
Configure the global zone.	"Setting Up the Global Zone in Trusted Extensions" on page 41

Task	For Instructions
Configure the labeled zones.	“Creating Labeled Zones” on page 45
To communicate with other systems, set up networking.	“Configuring the Network Interfaces in Trusted Extensions” on page 51
Configure the LDAP naming service. **Note -** Skip if you are not using LDAP.	Chapter 5, “Configuring LDAP for Trusted Extensions”
Complete system configuration.	Administration of Trusted Extensions on page 89

♦ ♦ ♦ CHAPTER 3

Adding the Trusted Extensions Feature to Oracle Solaris

This chapter describes how to prepare for and enable the Trusted Extensions service on an Oracle Solaris system. This chapter covers the following topics:

Initial Setup Team Responsibilities

The Trusted Extensions feature is designed to be configured by two people with distinct responsibilities. This task division can be enforced by roles. Because administrative roles and additional users are not created until after installation, it is a good practice to have an initial setup team of at least two people present to enable and configure Trusted Extensions.

Resolving Security Issues Before Installing Trusted Extensions

For each system on which Trusted Extensions will be configured, you need to make some configuration decisions. For example, you need to decide whether to install the default Trusted Extensions configuration or customize your configuration.

Secure System Hardware and Make Security Decisions Before Enabling Trusted Extensions

For each system on which Trusted Extensions is going to be configured, make these configuration decisions before enabling the software.

1. **Decide how securely the system hardware needs to be protected.**

   At a secure site, this step is performed on every Oracle Solaris system.

   - For SPARC systems, choose a PROM security level and provide a password.
   - For x86 systems, protect the BIOS and the GRUB menu.
   - On all systems, protect `root` with a password.

2. **Prepare your `label_encodings` file.**

   If you have a site-specific `label_encodings` file, the file must be checked and installed before other configuration tasks can be started. If your site does not have a `label_encodings` file, you can use the default file that Oracle supplies. Oracle also supplies other `label_encodings` files, which you can find in the `/etc/security/tsol` directory. The Oracle files are demonstration files. They might not be suitable for production systems.

   To customize a file for your site, see *Trusted Extensions Label Administration*. For editing instructions, see "How to Check and Install Your Label Encodings File" on page 42. To install the encodings file after you enable Trusted Extensions but before you reboot, see "Enable Trusted Extensions" on page 38.

3. **From the list of labels in your `label_encodings` file, make a list of the labeled zones that you plan to create.**

   For the default `label_encodings` file, the labels are the following, and the zone names can be similar to the following:

Full Label Name	Proposed Zone Name
PUBLIC	public
CONFIDENTIAL: INTERNAL USE ONLY	internal
CONFIDENTIAL: NEED TO KNOW	needtoknow
CONFIDENTIAL : RESTRICTED	restricted

   Note - The automatic configuration method creates the `public` and `internal` zones.

4. **Decide when to create roles.**

Your site's security policy can require you to administer Trusted Extensions by assuming a role. If so, you must create these roles early in the configuration process. You can create your own roles, you can install the `armor` package of seven roles, or you can create roles in addition to the ARMOR roles. For a description of the ARMOR roles, see the ARMOR standard description.

If you are not required to configure the system by using roles, you can choose to configure the system in the `root` role. This method of configuration is less secure. The `root` role can perform all tasks on the system, while other roles typically perform a more limited set of tasks. Therefore, configuration is more controlled when being performed by the roles that you create.

5. **Decide other security issues for each system and for the network.**

   For example, you might want to consider the following security issues:

   - Determine which devices can be attached to the system and allocated for use.
   - Identify which printers at what labels are accessible from the system.
   - Identify any systems that have a limited label range, such as a gateway system or a public kiosk.
   - Identify which labeled systems can communicate with particular unlabeled systems.

Installing and Enabling Trusted Extensions

In the Oracle Solaris OS, the Trusted Extensions service, `svc:/system/labeld:default`, is disabled by default.

The `labeld` service attaches labels to communications endpoints. For example, the following are labeled:

- All zones and the directories and files within each zone
- All network communications
- All processes including window processes

▼ Add Trusted Extensions Packages to an Oracle Solaris System

Before You Begin You must be assigned the Software Installation rights profile.

1. **After logging in as the initial user, assume the `root` role in a terminal window.**

```
% su -
Enter Password: xxxxxxxx
```

```
#
```

2. **Download and install the Trusted Extensions packages.**

   - **For systems that run a multilevel desktop, install the following package:**

     ```
     # pkg install system/trusted/trusted-extensions
     ```

   - **For a headless system or a server that does not require a multilevel desktop, install the following packages:**

     ```
     # pkg install system/trusted
     # pkg install system/trusted/trusted-global-zone
     ```

3. **To install trusted locales, specify the short name for the locale.**

   For example, the following command installs the Japanese locale:

   ```
   # pkg install system/trusted/locale/ja
   ```

▼ Enable Trusted Extensions

Before You Begin You must be in the `root` role in the global zone.

1. **In a terminal window, enable the `labeld` service.**

   Note - Use the `labeladm` command to control the `labeld` service. Do not manipulate the `labeld` services directly. For more information, see the `labeladm`(1M) man page.

   ```
   # labeladm enable -r
   ```

   The `labeladm` command provides several options when enabling the service.

`-i`	Prevents a confirmation prompt.
`-m`	Sends error messages to syslog and to the console.
`-n`	Tests the command without enabling the service.
`-r`	Delays enabling the service until after a system reboot. This is the same behavior as in previous releases.

2. **Verify that the service is enabled.**

   ```
   # labeladm info
        Labeling status: pending enable on boot
   ```

```
          Latest log: "/var/user/root/trusted-extensions-install-log"
Label encodings file: /etc/security/tsol/label_encodings
```

Caution - If you are enabling and configuring Trusted Extensions remotely, carefully review Chapter 12, “Remote Administration in Trusted Extensions”. Do not reboot until you have configured the system to allow remote administration. If you do not configure the Trusted Extensions system for remote administration, you will be unable to reach it from a remote system.

3. **If you have a customized label encodings file, install it now.**

   ```
   # labeladm encodings path-to-encodings-file
   ```

4. **Reboot the system.**

   You must run this command if you used the `-r` option.

   ```
   # /usr/sbin/reboot
   ```

Next Steps Continue with “Log In to Trusted Extensions” on page 39.

▼ Log In to Trusted Extensions

Logging in places you in the global zone, which is an environment that recognizes and enforces mandatory access control (MAC).

At most sites, two or more administrators serve as an initial setup team and are present when configuring the system.

Before You Begin You have completed “Enable Trusted Extensions” on page 38.

- **Log in by using the user account that you created during Oracle Solaris installation.**

  In the login dialog box, type *username*, then type the password.

  Note - Users must not disclose their passwords to another person, as that person might then have access to the data of the user and will not be uniquely identified or accountable. Note that disclosure can be direct, through the user deliberately disclosing her or his password to another person, or indirect, such as through writing it down or choosing an insecure password. Trusted Extensions provides protection against insecure passwords, but cannot prevent a user from disclosing her or his password or writing it down.

  - **If you did not install the desktop packages, open a terminal and assume the `root` role.**

- **If you installed the desktop packages, perform the following steps.**

  a. **Use the mouse to dismiss the Status window and the Clearance window.**

  b. **Dismiss the dialog box that says that the label `PUBLIC` has no matching zone.**

     You will create the zone after you assume the `root` role.

  c. **Assume the `root` role by clicking your login name in the trusted stripe.**

     Select the `root` role from the pulldown menu.

Security Considerations

You must log out or lock the screen before leaving a system unattended. Otherwise, a person can access the system without having to pass identification and authentication, and that person would not be uniquely identified or accountable.

Next Steps Continue with one of the following:

- To configure the global zone, go to "Setting Up the Global Zone in Trusted Extensions" on page 41.
- To configure a default system, go to "Creating Labeled Zones" on page 45.
- If your system does not have a graphical display, return to Chapter 12, "Remote Administration in Trusted Extensions".

♦ ♦ ♦ CHAPTER 4

Configuring Trusted Extensions

This chapter covers how to configure Trusted Extensions on a system with a monitor. To work properly, Trusted Extensions software requires configuration of labels and zones. You can also configure network communications, roles, and users who can assume roles.

For other configuration tasks, see Administration of Trusted Extensions on page 89.

Setting Up the Global Zone in Trusted Extensions

To customize your Trusted Extensions configuration, perform the procedures in the following task map. To install the default configuration, go to "Creating Labeled Zones" on page 45.

TABLE 3 Setting Up the Global Zone in Trusted Extensions

Task	Description	For Instructions
Protect the hardware.	Protects hardware by requiring a password to change hardware settings.	"Controlling Access to System Hardware" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*
Configure labels.	Labels *must* be configured for your site. If you plan to use the default `label_encodings` file, you can skip this step.	"How to Check and Install Your Label Encodings File" on page 42
Configure an IPv6 network.	Enables compatibility with a Trusted Extensions IPv6 CIPSO network.	"How to Configure an IPv6 CIPSO Network in Trusted Extensions" on page 44
Change the DOI.	Specifies a Domain of Interpretation (DOI) that is not `1`.	"How to Configure a Different Domain of Interpretation" on page 45
Configure the LDAP server.	Configures a Trusted Extensions LDAP directory server.	Chapter 5, "Configuring LDAP for Trusted Extensions"

Task	Description	For Instructions
Configure LDAP clients.	Makes this system a client of the Trusted Extensions LDAP directory server.	“Make the Global Zone an LDAP Client in Trusted Extensions” on page 85

How to Check and Install Your Label Encodings File

Your encodings file must be compatible with any Trusted Extensions host with which you are communicating.

Note - Trusted Extensions installs a default `label_encodings` file. This default file is useful for demonstrations. However, this file might not be a good choice for your use. If you plan to use the default file, you can skip this procedure.

- If you are familiar with encodings files, you can use the following procedure.
- If you are not familiar with encodings files, consult *Trusted Extensions Label Administration* for requirements, procedures, and examples.

Caution - You *must* successfully install labels before continuing, or the configuration will fail.

Before You Begin You are the security administrator. The security administrator is responsible for editing, checking, and maintaining the `label_encodings` file. If you plan to edit the `label_encodings` file, make sure that the file itself is writable. For more information, see the `label_encodings(4)` man page.

To edit the `label_encodings` file, you must be in the `root` role.

1. **Copy the `label_encodings` file to the disk.**

   To copy from portable media, see “How to Copy Files From Portable Media in Trusted Extensions” on page 72.

2. **In a terminal window, check the syntax of the file.**

   a. **Run the `chk_encodings` command.**

   ```
   # /usr/sbin/chk_encodings /full-pathname-of-label-encodings-file
   ```

   b. **Read the output and do one of the following:**

   - **Resolve errors.**

If the command reports errors, the errors *must* be resolved before continuing. For assistance, see Chapter 3, “Creating a Label Encodings File” in *Trusted Extensions Label Administration*.

- **Make the file the active `label_encodings` file.**

  `# labeladm encodings` *full-pathname-of-label-encodings-file*

Caution - Your `label_encodings` file *must* pass the Check Encodings test before you continue.

Example 1 Checking `label_encodings` Syntax on the Command Line

In this example, the administrator tests several `label_encodings` files by using the command line.

```
# /usr/sbin/chk_encodings /tmp/encodings/label_encodings1
No errors found in /tmp/encodings/label_encodings1
# /usr/sbin/chk_encodings /tmp/encodings/label_encodings2
No errors found in /tmp/encodings/label_encodings2
```

When management decides to use the `label_encodings2` file, the administrator runs a semantic analysis of the file.

```
# /usr/sbin/chk_encodings -a /tmp/encodings/label_encodings2
No errors found in /tmp/encodings/label_encodings2

---> VERSION = MYCOMPANY LABEL ENCODINGS  3.0 10/10/2013

---> CLASSIFICATIONS <---

Classification 1: PUBLIC
Initial Compartment bits: 10
Initial Markings bits: NONE

---> COMPARTMENTS AND MARKINGS USAGE ANALYSIS <---
...
---> SENSITIVITY LABEL to COLOR MAPPING <---
...
```

The administrator prints a copy of the semantic analysis for the archive, then installs the file.

```
# labeladm encodings /tmp/encodings/label_encodings2
```

Finally, the administrator verifies that the `label_encodings` file is the company file.

```
# labeladm
     Labeling status: disabled
          Latest log: ""
```

```
Label encodings file: /var/tsol/encodings/label-encodings-file
# /usr/sbin/chk_encodings -a /var/tsol/encodings/label-encodings-file | head -4
No errors found in /var/tsol/encodings/label-encodings-file

---> VERSION = MYCOMPANY LABEL ENCODINGS  3.0 10/10/2013
```

Next Steps You must reboot the system before configuring LDAP or creating labeled zones.

How to Configure an IPv6 CIPSO Network in Trusted Extensions

For IPv6, Trusted Extensions uses the Common Architecture Label IPv6 Security Option (CALIPSO) as the security labeling protocol. No configuration is required. If you must communicate with systems that run the obsolete Trusted Extensions IPv6 CIPSO protocol, perform this procedure. To communicate with other CALIPSO systems, do not perform this procedure.

Caution - A system that uses the CALIPSO for IPv6 protocol cannot communicate with any systems that use the obsolete Trusted Extensions IPv6 CIPSO protocol because these protocols are incompatible.

The obsolete Trusted Extensions IPv6 CIPSO options do not have an Internet Assigned Numbers Authority (IANA) number to use in the IPv6 Option Type field of a packet. The entry that you set in this procedure supplies a number to use on the local network.

Before You Begin Perform this procedure if you must communicate with systems that use the proprietary yet obsolete Trusted Extensions IPv6 CIPSO security labeling option.

You are in the `root` role in the global zone.

- **Type the following entry into the `/etc/system` file:**

```
set ip:ip6opt_ls = 0x0a
```

Troubleshooting If error messages during boot indicate that your IPv6 CIPSO configuration is incorrect, correct the entry. For example, a misspelled entry produces the following message: `sorry, variable 'ip6opt_1d' is not defined in the 'ip' module. Verify that the entry is spelled correctly`.

- Correct the entry.
- Verify that the system has been rebooted after adding the correct entry to the `/etc/system` file.

Next Steps You must reboot the system before configuring LDAP or creating labeled zones.

▼ How to Configure a Different Domain of Interpretation

If your site does not use a Domain of Interpretation (DOI) of `1`, you must modify the `doi` value in every security template. For more information, see "Domain of Interpretation in Security Templates" on page 192.

Before You Begin You are in the `root` role in the global zone.

- **Specify your DOI value in the default security templates.**

```
# tncfg -t cipso set doi=n
# tncfg -t admin_low set doi=n
```

Note - Every security template must specify your DOI value.

See Also
- "Network Security Attributes in Trusted Extensions" on page 190
- "How to Create Security Templates" on page 208

Next Steps If you plan to use LDAP, go to Chapter 5, "Configuring LDAP for Trusted Extensions". You must configure LDAP before you create labeled zones.

Otherwise, continue with "Creating Labeled Zones" on page 45.

Creating Labeled Zones

The instructions in this section configure labeled zones. You have the option of creating two labeled zones automatically or manually creating zones.

Note - If you plan to use LDAP, go to Chapter 5, "Configuring LDAP for Trusted Extensions". You must configure LDAP before you create labeled zones.

TABLE 4 Creating Labeled Zones

Task	Description	For Instructions
1a. Create a default Trusted Extensions configuration.	The `txzonemgr -c` command creates two labeled zones from the `label_encodings` file. This command can be run on a system that does not have a desktop.	"How to Create a Default Trusted Extensions System" on page 46
1b. Create a default Trusted Extensions configuration by using a GUI.	The `txzonemgr` script creates a GUI that presents the appropriate tasks as you configure your system.	"How to Create Labeled Zones Interactively" on page 47

Task	Description	For Instructions
1c. Manually step through zone creation.	The `txzonemgr` script creates a GUI that presents the appropriate tasks as you configure your system.	"How to Create Labeled Zones Interactively" on page 47
Create a labeled zone by using zone commands.	Creates one labeled zone. This procedure can be run on a system that does not have a desktop.	"How to Create Labeled Zones by Using the `zonecfg` Command" on page 50
2. Create a working labeled environment.	In the default configuration, label two workspaces as `PUBLIC` and `INTERNAL USE ONLY`. This procedure works on a desktop system only.	"How to Assign Labels to Two Zone Workspaces" on page 49
3. (Optional) Link to other systems on your network.	Configure labeled zone network interfaces and connect the global zone and labeled zones to other systems.	"Configuring the Network Interfaces in Trusted Extensions" on page 51

How to Create a Default Trusted Extensions System

This procedure creates a working Trusted Extensions system with two labeled zones. Remote hosts have not been assigned to the system's security templates, so this system cannot communicate with any remote hosts.

Before You Begin Either you are in the global zone on a system that does not have a desktop, or you have logged in to your desktop by completing "Log In to Trusted Extensions" on page 39. You have assumed the `root` role.

1. **Open a terminal window.**
   On a desktop, you can use the fourth workspace.

2. **(Optional) Review the `txzonemgr` man page.**

   ```
   # man txzonemgr
   ```

3. **Create a default configuration.**

   ```
   # /usr/sbin/txzonemgr -c
   ```

   This command copies the Oracle Solaris OS and Trusted Extensions software to a zone, creates a snapshot of the zone, labels the original zone, then uses the snapshot to create a second labeled zone. The zones are booted.

   - The first labeled zone is based on the value of `Default User Sensitivity Label` in the `label_encodings` file.
   - The second labeled zone is based on the value of `Default User Clearance` in the `label_encodings` file.

   This step can take about 20 minutes. To install the zones, the script uses the root password from the global zone for the labeled zones.

Next Steps To access a Trusted Extensions labeled zone from a workspace, go to "How to Assign Labels to Two Zone Workspaces" on page 49.

▼ How to Create Labeled Zones Interactively

You do not have to create a zone for every label in your `label_encodings` file, but you can. The administrative GUIs enumerate the labels that can have zones created for them on this system. In this procedure, you create two labeled zones. If you are using the Trusted Extensions `label_encodings` file, you create the default Trusted Extensions configuration.

Before You Begin You have completed "Log In to Trusted Extensions" on page 39. You have assumed the `root` role.

You have not created a zone yet.

1. **Run the `txzonemgr` command without any options.**

```
# txzonemgr &
```

The script opens the `Labeled Zone Manager` dialog box. This `zenity` dialog box prompts you for the appropriate tasks, depending on the current state of your configuration.
To perform a task, you select the menu item, then press the Return key or click OK. When you are prompted for text, type the text then press the Return key or click OK.

Tip - To view the current state of zone completion, click Return to Main Menu in the Labeled Zone Manager. Or, you can click the Cancel button.

---

2. **Install the zones by choosing one of the following methods:**

- **To create two labeled zones, select `public and internal zones` from the dialog box.**
  - The first labeled zone is based on the value of `Default User Sensitivity Label` in the `label_encodings` file.
  - The second labeled zone is based on the value of `Default User Clearance` in the `label_encodings` file

  a. **Answer the prompt to identify the system.**
  If the `public` zone uses an exclusive IP stack, or if it has an IP address which is defined in DNS, use the hostname as defined in DNS. Otherwise, use the name of the system.

  b. **Do not answer the prompt for a root password.**

The root password was set at system installation. The input to this prompt will fail.

c. At the zone login prompt, type your user login and password.

Then, verify that all services are configured by running the `svcs -x` command. If no messages display, all services are configured.

d. Log out of the zone and close the window.

Type exit at the prompt, and choose Close window from the Zone Console.

In another window, the installation of the second zone completes. This zone is built from a snapshot, so it builds quickly.

e. Log in to the second zone console and verify that all services are running.

```
# svcs -x
#
```

If no messages display, all services are configured. The Labeled Zone Manager is visible.

f. Double-click the internal zone in the Labeled Zone Manager.

Select Reboot, then click the Cancel button to return to the main screen. All zones are running. The unlabeled snapshot is not running.

- **To manually create zones, select Main Menu, and then, Create a Zone.**

  Follow the prompts. The GUI steps you through zone creation.

  After the zone is created and booted, you can return to the global zone to create more zones. These zones are created from a snapshot.

Example 2 Creating Another Labeled Zone

In this example, the administrator creates a restricted zone from the default `label_encodings` file.

First, the administrator opens the `txzonemgr` script in interactive mode.

```
# txzonemgr &
```

Then, the administrator navigates to the global zone and creates a zone with the name `restricted`.

```
Create a new zone:restricted
```

Then, the administrator applies the correct label.

```
Select label:CNF : RESTRICTED
```

From the list, the administrator selects the Clone option and then selects `snapshot` as the template for the new zone.

After the `restricted` zone is available, the administrator clicks Boot to boot the second zone.

To enable access to the `restricted` zone, the administrator changes the `Default User Clearance` value in the `label_encodings` file to `CNF RESTRICTED`.

How to Assign Labels to Two Zone Workspaces

This procedure creates two labeled workspaces and opens a labeled window in each labeled workspace. When this task is completed, you have a working, non-networked Trusted Extensions system.

Before You Begin You have completed either "How to Create a Default Trusted Extensions System" on page 46 or "How to Create Labeled Zones Interactively" on page 47.

You are the initial user.

1. **Create a `PUBLIC` workspace.**

   The label of the `PUBLIC` workspace corresponds to the `Default User Sensitivity Label`.

   a. **Switch to the second workspace.**

   b. **Right-click and select Change Workspace Label.**

   c. **Select PUBLIC and click OK.**

2. **Provide your password at the prompt.**

   You are in a `PUBLIC` workspace.

3. **Open a terminal window.**

   The window is labeled `PUBLIC`.

4. **Create an INTERNAL USE ONLY workspace.**

   If you are using a site-specific `label_encodings` file, you are creating a workspace from the value of `Default User Clearance`.

   a. **Switch to the third workspace.**

   b. **Right-click and select Change Workspace Label.**

c. **Select INTERNAL USE ONLY and click OK.**

5. **Provide your password at the prompt.**

   You are in an INTERNAL workspace.

6. **Open a terminal window.**

   The window is labeled CONFIDENTIAL : INTERNAL USE ONLY.

   Your system is ready to use. You have two user workspaces and a role workspace. In this configuration, the labeled zones use the same IP address as the global zone to communicate with other systems. They can do so because, by default, they share the IP address as an all-zones interface.

Next Steps If you plan to have your Trusted Extensions system communicate with other systems, go to "Configuring the Network Interfaces in Trusted Extensions" on page 51.

How to Create Labeled Zones by Using the zonecfg Command

If you are not on a desktop, you must create labeled zones by using regular zone commands. If you are on a desktop, you can also use this method. The -t option specifies the brand of the zone, and the label must be explicitly set. For more information, see the brands(5) man page.

1. **Run the zonecfg command to create a labeled zone.**

   For more information, see the zonecfg(1M) man page.

   This example creates a zone whose name is public.

```
# zonecfg -z public
Use 'create' to begin configuring a new zone.
zonecfg:public> create -t SYStsoldef
zonecfg:public> set zonepath=/system/zones/public
zonecfg:public> exit
```

2. **Set the label by using the tncfg command.**

   For more information, see the tncfg(1M) man page.

   This example labels the public zone with the label public.

```
# tncfg -z public set label=PUBLIC
```

3. **Install the zone by using the zoneadm command.**

   For more information, see the zoneadm(1M) man page.

```
# zoneadm -z public install
```

Configuring the Network Interfaces in Trusted Extensions

Your Trusted Extensions system does not require a network to run a desktop with a directly connected bitmapped display, such as a laptop or workstation. However, network configuration is required to communicate with other systems. By using the `txzonemgr` GUI, you can easily configure the labeled zones and the global zone to connect to other systems. For a description of the configuration options for labeled zones, see "Access to Labeled Zones" on page 24. The following task map describes and links to network configuration tasks.

TABLE 5 Configuring the Network Interfaces in Trusted Extensions Task Map

Task	Description	For Instructions
Configure a default system for regular users.	The system has one IP address and uses an `all-zones` interface to communicate between the labeled zones and the global zone. The same IP address is used to communicate with remote systems.	"How to Share a Single IP Address With All Zones" on page 51
Add an IP address to the global zone.	The system has more than one IP address and uses the global zone's exclusive IP address to reach a private subnet. The labeled zones cannot reach this subnet.	"How to Share a Single IP Address With All Zones" on page 51
Assign an IP address to every zone, where the zones share the IP stack.	The system has more than one IP address. In the simplest case, the zones share a physical interface.	"How to Add an IP Instance to a Labeled Zone" on page 52
Add an `all-zones` interface to the IP instance per zone.	The system can offer its labeled zones privileged services that are protected from remote attack.	"How to Add an IP Instance to a Labeled Zone" on page 52
Assign an IP address to every zone, where the IP stack is exclusive.	One IP address is assigned to every zone, including the global zone. A VNIC is created for each labeled zone.	"How to Add a Virtual Network Interface to a Labeled Zone" on page 53
Connect the zones to remote zones.	This task configures the network interfaces of the labeled zones and the global zone to reach remote systems at the same label.	"How to Connect a Trusted Extensions System to Other Trusted Extensions Systems" on page 54
Run a separate `nscd` daemon per zone.	In an environment where each subnet has its own name server, this task configures one `nscd` daemon per zone.	"How to Configure a Separate Name Service for Each Labeled Zone" on page 55

▼ How to Share a Single IP Address With All Zones

This procedure enables every zone on the system to use one IP address, the IP address of the global zone, to reach other identically labeled zones or hosts. This configuration is the default. You must complete this procedure if you have configured the network interfaces differently, and want to return the system to the default network configuration.

Before You Begin You must be in the `root` role in the global zone.

1. **Run the `txzonemgr` command without any options.**

   ```
   # txzonemgr &
   ```

   The list of zones is displayed in the Labeled Zone Manager. For information about this GUI, see "How to Create Labeled Zones Interactively" on page 47.

2. **Double-click the global zone.**

3. **Double-click Configure Network Interfaces.**

   A list of interfaces is displayed. Look for an interface that is listed with the following characteristics:

   - Type of `phys`
   - IP address of your hostname
   - State of `up`

4. **Select the interface that corresponds to your hostname.**

5. **From the list of commands, select Share with Shared-IP Zones.**

   All zones can use this shared IP address to communicate with remote systems at their label.

6. **Click Cancel to return to the zone command list.**

Next Steps To configure the system's external network, go to "How to Connect a Trusted Extensions System to Other Trusted Extensions Systems" on page 54.

▼ How to Add an IP Instance to a Labeled Zone

This procedure is required if you use a shared IP stack and per zone addresses, and you plan to connect the labeled zones to labeled zones on other systems on the network.

In this procedure, you create an IP instance, that is, a per zone address, for one or more labeled zones. The labeled zones use their per-zone address to communicate with identically labeled zones on the network.

Before You Begin You must be in the `root` role in the global zone.

The list of zones is displayed in the Labeled Zone Manager. To open this GUI, see "How to Create Labeled Zones Interactively" on page 47. The labeled zone that you are configuring must be halted.

1. **In the Labeled Zone Manager, double-click a labeled zone to which to add an IP instance.**

2. **Double-click Configure Network Interfaces.**

   A list of configuration options is displayed.

3. **Select Add an IP instance.**

4. **If your system has more than one IP address, choose the entry with the desired interface.**

5. **For this labeled zone, supply an IP address and a prefix count.**

   For example, type `192.168.1.2/24`. If you do not append the prefix count, you are prompted for a netmask. The equivalent netmask for this example is `255.255.255.0`.

6. **Click OK.**

7. **To add a default router, double-click the entry that you just added.**

   At the prompt, type the IP address of the router, and click OK.

   Note - To remove or modify the default router, remove the entry, then create the IP instance again.

8. **Click Cancel to return to the zone command list.**

Next Steps To configure the system's external network, go to "How to Connect a Trusted Extensions System to Other Trusted Extensions Systems" on page 54.

How to Add a Virtual Network Interface to a Labeled Zone

This procedure is required if you use an exclusive IP stack and per zone addresses, and you plan to connect the labeled zones to labeled zones on other systems on the network.

In this procedure, you create a VNIC and assign it to a labeled zone.

Before You Begin You must be in the `root` role in the global zone.

The list of zones is displayed in the Labeled Zone Manager. To open this GUI, see "How to Create Labeled Zones Interactively" on page 47. The labeled zone that you are configuring must be halted.

1. **In the Labeled Zone Manager, double-click the labeled zone to which you want to add a virtual interface.**

2. **Double-click Configure Network Interfaces.**

   A list of configuration options is displayed.

3. **Double-click Add a virtual interface (VNIC).**

   If your system has more than one VNIC card, more than one choice is displayed. Choose the entry with the desired interface.

4. **Assign a host name, or assign an IP address and a prefix count.**

   For example, type `192.168.1.2/24`. If you do not append the prefix count, you are prompted for a netmask. The equivalent netmask for this example is `255.255.255.0`.

5. **To add a default router, double-click the entry that you just added.**

   At the prompt, type the IP address of the router, and click OK.

   Note - To remove or modify the default router, remove the entry, then create the VNIC again.

6. **Click Cancel to return to the zone command list.**

   The VNIC entry is displayed. The system assigns the name *zonename_n*, as in `internal_0`.

Next Steps To configure the system's external network, go to "How to Connect a Trusted Extensions System to Other Trusted Extensions Systems" on page 54.

How to Connect a Trusted Extensions System to Other Trusted Extensions Systems

In this procedure, you define your Trusted Extensions network by adding remote hosts to which your Trusted Extensions system can connect.

Before You Begin The Labeled Zone Manager is displayed. To open this GUI, see "How to Create Labeled Zones Interactively" on page 47. You are in the `root` role in the global zone.

1. **In the Labeled Zone Manager, double-click the global zone.**

2. **Select Add Multilevel Access to Remote Host.**

   a. **Type the IP address of another Trusted Extensions system.**

b. **Run the corresponding commands on the other Trusted Extensions system.**

3. **Click Cancel to return to the zone command list.**

4. **In the Labeled Zone Manager, double-click a labeled zone.**

5. **Select Add Access to Remote Host.**

   a. **Type the IP address of the identically labeled zone on another Trusted Extensions system.**

   b. **Run the corresponding commands in the zone of the other Trusted Extensions system.**

See Also

- Chapter 15, "Trusted Networking"
- "Labeling Hosts and Networks" on page 205

How to Configure a Separate Name Service for Each Labeled Zone

This procedure configures a separate name service daemon (`nscd`) in each labeled zone. This configuration supports environments where each zone is connected to a subnet that runs at the label of the zone, and the subnetwork has its own naming server for that label. In a labeled zone, if you plan to install packages that require a user account at that label, you might configure a separate name service per zone. For background information, see "Applications That Are Restricted to a Labeled Zone" on page 24 and "Decisions to Make Before Creating Users in Trusted Extensions" on page 127.

Before You Begin The Labeled Zone Manager is displayed. To open this GUI, see "How to Create Labeled Zones Interactively" on page 47. You are in the `root` role in the global zone.

1. **In the Labeled Zone Manager, select Configure per-zone name service, and click OK.**

   Note - This option is intended to be used once, during initial system configuration.

2. **Configure each zone's `nscd` service.**
   For assistance, see the `nscd`(1M) man page.

3. **Reboot the system.**

   ```
   # /usr/sbin/reboot
   ```

After the reboot, the account of the user who assumed the `root` role to run the Labeled Zone Manager in Step 1 is configured in each zone. Other accounts that are specific to a labeled zone must be manually added to the zone.

Note - Accounts that are stored in the LDAP repository are still managed from the global zone.

4. **For every zone, verify the route and the name service daemon.**

   a. **In the Zone Console, list the `nscd` service.**

   ```
   zone-name # svcs -x name-service/cache
   svc:/system/name-service/cache:default (name service cache)
   State: online since September 10, 2012  10:10:12 AM PDT
   See: nscd(1M)
   See: /var/svc/log/system-name-service-cache:default.log
   Impact: None.
   ```

   b. **Verify the route to the subnetwork.**

   ```
   zone-name # netstat -rn
   ```

Example 3 Removing a Name Service Cache From Each Labeled Zone

After testing one name service daemon per zone, the system administrator decides to remove the name service daemons from the labeled zones and run the daemon in the global zone only. To return the system to the default name service configuration, the administrator opens the `txzonemgr` GUI, selects the global zone, and selects `Unconfigure per-zone name service`, then `OK`. This selection removes the `nscd` daemon in every labeled zone. Then, the administrator reboots the system.

Next Steps When configuring user and role accounts for each zone, you have three options.

- You can create LDAP accounts in a multilevel LDAP directory server.
- You can create LDAP accounts in separate LDAP directory servers, one server per label.
- You can create local accounts.

Separately configuring a name service daemon in each labeled zone has password implications for all users. Users must authenticate themselves to gain access to any of their labeled zones, including the zone that corresponds to their default label. Furthermore, either the administrator must create accounts locally in each zone, or the accounts must exist in an LDAP directory where the zone is an LDAP client.

In the special case where an account in the global zone is running the Labeled Zone Manager, `txzonemgr`, the account's information is copied into the labeled zones so that at least that account is able to log in to each zone. By default, this account is the initial user account.

Creating Roles and Users in Trusted Extensions

Role creation in Trusted Extensions is identical to role creation in Oracle Solaris.

TABLE 6 Creating Roles and Users in Trusted Extensions Task Map

Task	Description	For Instructions
Install ARMOR roles.	Creates seven roles that are defined by the ARMOR standard and assigns them.	First example in "Creating a Role" in *Securing Users and Processes in Oracle Solaris 11.3*
Create a security administrator role.	Creates a role to handle security-relevant tasks.	"How to Create the Security Administrator Role in Trusted Extensions" on page 57
Create a system administrator role.	Creates a role to handle system administration tasks that are not related to security.	"How to Create a System Administrator Role" on page 59
Create users to assume the administrative roles.	Creates one or more users who can assume roles.	"How to Create Users Who Can Assume Roles in Trusted Extensions" on page 59
Verify that the roles can perform their tasks.	Tests the roles.	"How to Verify That the Trusted Extensions Roles Work" on page 61
Enable users to log in to a labeled zone.	Starts the `zones` service so that regular users can log in.	"How to Enable Users to Log In to a Labeled Zone" on page 62

▼ How to Create the Security Administrator Role in Trusted Extensions

Before You Begin You are in the `root` role in the global zone.

1. **To create the role, use the `roleadd` command.**

   For information about the command, see the `roleadd`(1M) man page.

   Note - To use ARMOR roles, see the ARMOR example in the "Creating a Role" in *Securing Users and Processes in Oracle Solaris 11.3* section.

   Use the following information as a guide:

   - Role name – `secadmin`
   - `-c` Local Security Officer

     Do not provide proprietary information.
   - `-m` *home-directory*
   - `-u` *role-UID*
   - `-S` *repository*

- -K *key=value*

  Assign the Information Security and User Security rights profiles.

  Note - For all administrative roles, use the administrative labels for the label range, audit uses of administrative commands, set `lock_after_retries=no`, and do not set password expiration dates.

```
# roleadd -c "Local Security Officer" -m \
-u 110 -K profiles="Information Security,User Security" -S files \
-K lock_after_retries=no -K audit_flags=cusa:no secadmin
```

2. **Provide an initial password for the role.**

```
# passwd -r files secadmin
New Password: xxxxxxxx
Re-enter new Password: xxxxxxxx
passwd: password successfully changed for secadmin
#
```

   Assign a password of at least six alphanumeric characters. The password for the Security Administrator role, and all passwords, must be difficult to guess, thus reducing the chance of an adversary gaining unauthorized access by attempting to guess passwords.

3. **Use the Security Administrator role as a guide when you create other roles.**

   Possible roles include the following:

   - admin Role – `System Administrator` rights profile
   - oper Role – `Operator` rights profile

Example 4 Creating the Security Administrator Role in LDAP

After configuring the first system with a local Security Administrator role, the administrator creates the Security Administrator role in the LDAP repository. In this scenario, LDAP clients can be administered by the Security Administrator role that is defined in LDAP.

```
# roleadd -c "Site Security Officer" -d server1:/rpool/pool1/BayArea/secadmin
-u 111 -K profiles="Information Security,User Security" -S ldap \
-K lock_after_retries=no -K audit_flags=cusa:no secadmin
```

The administrator provides an initial password for the role.

```
# passwd -r ldap secadmin
New Password: xxxxxxxx
Re-enter new Password: xxxxxxxx
passwd: password successfully changed for secadmin
```

```
#
```

Next Steps To assign the local role to a local user, see "How to Create Users Who Can Assume Roles in Trusted Extensions" on page 59.

How to Create a System Administrator Role

Before You Begin You are in the `root` role in the global zone.

1. **Assign the System Administrator rights profile to the role.**

```
# roleadd -c "Local System Administrator" -m -u 111  -K audit_flags=cusa:no\
-K profiles="System Administrator" -K lock_after_retries=no sysadmin
```

2. **Provide an initial password for the role.**

```
# passwd -r files sysadmin
New Password: xxxxxxxx
Re-enter new Password: xxxxxxxx
passwd: password successfully changed for sysadmin
#
```

How to Create Users Who Can Assume Roles in Trusted Extensions

Where site security policy permits, you can choose to create a user who can assume more than one administrative role.

For secure user creation, the System Administrator role creates the user and assigns the initial password, and the Security Administrator role assigns security-relevant attributes, such as a role.

Before You Begin You must be in the `root` role in the global zone. Or, if separation of duty is enforced, users who can assume the distinct roles of Security Administrator and System Administrator must be present to assume their roles and perform the appropriate steps in this procedure.

1. **Create a user.**

   Either the `root` role or the System Administrator role performs this step.

   Do not place proprietary information in the comment.

```
# useradd -c "Second User" -u 1201 -d /home/jdoe jdoe
```

2. **After creating the user, modify the user's security attributes.**

   Either the `root` role or the Security Administrator role performs this step.

   Note - For users who can assume roles, turn off account locking, and do not set password expiration dates. Also, audit uses of the `pfexec` command. Only the `root` role can set audit flags on a per user basis.

   ```
   # usermod -K lock_after_retries=no -K idletime=5 -K idlecmd=lock \
   -K audit_flags=lo,ex:no jdoe
   ```

   Note - The values for `idletime` and `idlecmd` continue in effect when the user assumes a role. For more information, see "`policy.conf` File Defaults in Trusted Extensions" on page 128.

3. **Assign a password of at least six alphanumeric characters.**

   ```
   # passwd jdoe
   New Password: xxxxxxxx
   Re-enter new Password: xxxxxxxx
   ```

   Note - When the initial setup team chooses a password, the team must select a password that is difficult to guess, thus reducing the chance of an adversary gaining unauthorized access by attempting to guess passwords.

4. **Assign a role to the user.**

   The `root` role or the Security Administrator role performs this step.

   ```
   # usermod -R oper jdoe
   ```

5. **Customize the user's environment.**

   a. **Assign convenient authorizations.**

      After checking your site security policy, you might want to grant your first users the Convenient Authorizations rights profile. With this profile, users can allocate devices, print without labels, remotely log in, and shut down the system. To create the profile, see "How to Create a Rights Profile for Convenient Authorizations" on page 140.

   b. **Customize user initialization files.**

      See "Customizing the User Environment for Security" on page 133.

   c. **Create multilevel copy and link files.**

      On a multilevel system, users and roles can be set up with files that list user initialization files to be copied or linked to other labels. For more information, see "`.copy_files` and `.link_files` Files" on page 131.

Example 5 Using the `useradd` Command to Create a Local User

In this example, the `root` role creates a local user who can assume the Security Administrator role. For details, see the `useradd`(1M) and `atohexlabel`(1M) man pages.

This user is going to have a label range that is wider than the default label range. So, the `root` role determines the hexadecimal format of the user's minimum label and clearance label.

```
# atohexlabel public
0x0002-08-08
# atohexlabel -c "confidential restricted"
0x0004-08-78
```

Next, the `root` role consults Table 2, “Trusted Extensions Security Defaults for User Accounts,” on page 26, and then creates the user. The administrator places the user's home directory in `/export/home1` rather than the default, `/export/home`.

```
# useradd -c "Local user for Security Admin" -d /export/home1/jandoe -K
 audit_flags=lo,ex:no \
-K  idletime=8 -K idlecmd=lock -K lock_after_retries=no \
-K min_label=0x0002-08-08 -K clearance=0x0004-08-78 jandoe
```

Then, the `root` role assigns an initial password.

```
# passwd -r files jandoe
New Password: xxxxxxxx
Re-enter new Password: xxxxxxxx
passwd: password successfully changed for jandoe
#
```

Finally, the `root` role adds the Security Administrator role to the user's definition. The role was created in “How to Create the Security Administrator Role in Trusted Extensions” on page 57.

```
# usermod -R secadmin jandoe
```

▼ How to Verify That the Trusted Extensions Roles Work

To verify each role, assume the role. Then, perform tasks that only that role can perform and attempt tasks that the role is not permitted to perform.

Before You Begin If you have configured DNS or routing, you must reboot after you create the roles and before you verify that the roles work.

1. **For each role, log in as a user who can assume the role.**

2. **Assume the role.**

   - **On a system that is not running a multilevel desktop, open a terminal window.**

     a. **Switch to the role.**

     ```
     % su - rolename
     ```

     b. **Verify that the `PRIV_PFEXEC` flag is in effect.**

     ```
     # ppriv $$
     ...
     flags = PRIV_PFEXEC
     ...
     ```

   - **On a multilevel desktop, assume the role.**

     In the following trusted stripe, the user name is `tester`.

     a. **Click your user name in the trusted stripe.**

     b. **From the list of roles that are assigned to you, select a role.**

3. **Test the role.**

   For the authorizations that are required to change user properties, see the `passwd(1)` man page.

   - The System Administrator role should be able to create a user and modify user properties that require the `solaris.user.manage` authorization, such as the user's login shell. The System Administrator role should not be able to change user properties that require the `solaris.account.setpolicy` authorization.
   - The Security Administrator role should be able to change user properties that require the `solaris.account.setpolicy` authorization. The Security Administrator should not be able to create a user or change a user's login shell.

▼ How to Enable Users to Log In to a Labeled Zone

When the system is rebooted, the association between the devices and the underlying storage must be re-established.

Before You Begin You have created at least one labeled zone. After configuring the system, you rebooted. You can assume the `root` role.

1. **Log in and assume the `root` role.**
2. **Check the state of the zones service.**

```
# svcs zones
STATE          STIME    FMRI
offline        -        svc:/system/zones:default
```

3. **Restart the service.**

```
# svcadm restart svc:/system/zones:default
```

4. **Log out.**
   Regular users can now log in. Their session is in a labeled zone.

Creating Centralized Home Directories in Trusted Extensions

In Trusted Extensions, users need access to their home directories at every label at which the users work. By default, home directories are created automatically by the automounter that is running in each zone. However, if you use an NFS server to centralize home directories, you must enable home directory access at every label for your users.

▼ How to Create the Home Directory Server in Trusted Extensions

Before You Begin You are in the `root` role in the global zone.

1. **Add Trusted Extensions software to the home directory server and configure its labeled zones.**
   Because users require a home directory at every label that they can log in to, create a home directory server at every user label. For example, if you create a default configuration, you would create a home directory server for the `PUBLIC` label and a server for the `INTERNAL` label.
2. **For every labeled zone, follow the automount procedure in "How to NFS Mount Files in a Labeled Zone" on page 182. Then, return to this procedure.**
3. **Verify that the home directories have been created.**

a. **Log out of the home directory server.**

b. **As a regular user, log in to the home directory server.**

c. **In the login zone, open a terminal.**

d. **In the terminal window, verify that the user's home directory exists.**

e. **Create workspaces for every zone that the user can work in.**

f. **In each zone, open a terminal window to verify that the user's home directory exists.**

4. **Log out of the home directory server.**

How to Enable Users to Access Their Remote Home Directories at Every Label by Logging In to Each NFS Server

In this procedure, you allow users to create a home directory at each label by letting them directly log in to each home directory server. After creating each home directory on the central server, users can access their home directories from any system.

Alternatively, you, as administrator, can create a mount point on each home directory server by running a script, then modifying the automounter. For this method, see "How to Enable Users to Access Their Remote Home Directories by Configuring the Automounter on Each Server" on page 65.

Before You Begin The home directory servers for your Trusted Extensions domain are configured.

- **Enable users to log in directly to each home directory server.**

  Typically, you have created one NFS server per label.

  a. **Instruct each user to log in to each NFS server at the label of the server.**

  b. **When the login is successful, instruct the user to log out of the server.**

     A home directory for the user is available at the label of the server when the login is successful.

  c. **Instruct the users to log in from their regular workstation.**

The home directory for their default label is available from the home directory server. When a user changes the label of a session or adds a workspace at a different label, the user's home directory for that label is mounted.

Next Steps Users can log in at a different label from their default label by choosing a different label from the label builder during login.

▼ How to Enable Users to Access Their Remote Home Directories by Configuring the Automounter on Each Server

In this procedure you run a script that creates a mount point for home directories on each NFS server. Then, you modify the `auto_home` entry at the label of the server to add the mount point. Then, users can log in.

Before You Begin The home directory servers for your Trusted Extensions domain are configured as LDAP clients. User accounts have been created on the LDAP server by using the `useradd` command with the `-S ldap` option. You must be in the `root` role.

1. **Write a script that creates a home directory mount point for every user.**

   The sample script makes the following assumptions:

   - The LDAP server is a different server from the NFS home directory server.
   - The client systems are also different systems.
   - The `hostname` entry specifies the external IP address of the zone, that is, the NFS home directory server for its label.
   - The script will be run on the NFS server in the zone that serves clients at that label.

```
#!/bin/sh
hostname=$(hostname)
scope=ldap

for j in $(getent passwd|tr ' ' _); do
uid=$(echo $j|cut -d: -f3)
if [ $uid -ge 100 ]; then
home=$(echo $j|cut -d: -f6)
if [[ $home == /home/* ]]; then
user=$(echo $j|cut -d: -f1)
echo Updating home directory for $user
homedir=/export/home/$user
usermod -md ${hostname}:$homedir -S $scope $user
mp=$(mount -p|grep  " $homedir zfs" )
dataset=$(echo $mp|cut -d" " -f1)
if [[ -n $dataset ]]; then
```

```
zfs set sharenfs=on $dataset
fi
fi
fi
done
```

2. **On each NFS server, run the preceding script in the labeled zone that serves clients at that label.**

Troubleshooting Your Trusted Extensions Configuration

A misconfigured desktop can prevent use of the system.

▼ How to Move Desktop Panels to the Bottom of the Screen

Note - If you have moved desktop panels to the top of the screen, the Trusted Extensions trusted stripe covers them. The panels must be on the side or at the bottom of the workspace. A default workspace has two desktop panels.

Before You Begin You must be in the `root` role to change the desktop panel location for the system.

1. **If you have one visible desktop panel at the bottom of the screen, perform one of the following actions:**

   - **Use the right mouse button to add applets to the visible panel.**
   - **Move the second, hidden desktop panel to the bottom of the screen by performing the following step.**

2. **Otherwise, create a bottom desktop panel for your login only, or for all users of the system.**

   - **To move the panels for your login only, edit the `top_panel_screen`*n* file in your home directory.**

     a. **Change to the directory that contains the file that defines the panel locations.**

        ```
        % cd $HOME/.gconf/apps/panel/toplevels
        ```

```
% ls
%gconf.xml    bottom_panel_screen0/   top_panel_screen0/
% cd top_panel_screen0
% ls
%gconf.xml             top_panel_screen0/
```

b. Edit the `%gconf.xml` file, which defines the location of the top panels.

```
% vi %gconf.xml
```

c. Find all orientation lines, and replace the string `top` with `bottom`.

For example, make the orientation line appear similar to the following:

```
/toplevels/orientation" type="string">
<stringvalue>bottom</stringvalue>
```

- **To move the panels for all users of the system, modify the desktop configuration.**

  In a terminal window in the `root` role, perform the following commands:

```
# export SETUPPANEL="/etc/gconf/schemas/panel-default-setup.entries"
# export TMPPANEL="/tmp/panel-default-setup.entries"
# sed 's/<string>top<\/string>/<string>bottom<\/string>/' $SETUPPANEL > $TMPPANEL
# cp $TMPPANEL $SETUPPANEL
# svcadm restart gconf-cache
```

3. **Log out of the system and log in again.**

   If you have more than one desktop panel, the panels stack at the bottom of the screen.

Additional Trusted Extensions Configuration Tasks

The following tasks can be helpful in configuring a Trusted Extensions system to your requirements. The final task enables you to remove the Trusted Extensions feature from an Oracle Solaris.

TABLE 7 Additional Trusted Extensions Configuration Task Map

Task	Description	For Instructions
Inform users of site security.	Displays a security message at login.	"How to Place a Security Message in Banner Files" in *Oracle Solaris 11 Security and Hardening Guidelines*
Create a labeled zone to contain a service that operates at the same label as an existing zone.	Creates a secondary zone at the same label as a primary zone.	"How to Create a Secondary Labeled Zone" on page 68

Task	Description	For Instructions
Create a dataset to hold directories and files at all labels.	Creates and mounts a dataset where files can be relabeled with minimal overhead.	"How to Create and Share a Multilevel Dataset" on page 69
Create a home directory server at every label.	Creates several home directory servers, one for every label. Or, creates a multilevel home directory server.	"How to Create the Home Directory Server in Trusted Extensions" on page 63
Create initial users who can assume roles.	Creates users whom you trust to administer the system when they assume a role.	"How to Create Users Who Can Assume Roles in Trusted Extensions" on page 59
Remove Trusted Extensions.	Removes Trusted Extensions and all trusted data from your system. Also readies the Oracle Solaris system to run Trusted Extensions.	"How to Remove Trusted Extensions From the System" on page 73

▼ How to Create a Secondary Labeled Zone

Secondary labeled zones are useful for isolating services in different zones, yet allowing the services to run at the same label. For more information, see "Primary and Secondary Labeled Zones" on page 159.

Before You Begin The primary zone must exist. The secondary zone must have an exclusive IP address and cannot require a desktop.

You must be in the `root` role in the global zone.

1. Create a secondary zone.

You can use the command line or the Labeled Zone GUI, `txzonemgr`.

- **Use the command line.**

```
# tncfg -z secondary-label-service primary=no
# tncfg -z secondary-label-service label=public
```

- **Use `txzonemgr`.**

```
# txzonemgr &
```

Navigate to Create a new zone, and follow the prompts.

Note - The netmask must be entered in prefix form. For example, the prefix equivalent of the `255.255.254.0` netmask is `/23`.

---

2. Verify that the zone is a secondary zone.

```
# tncfg -z zone info primary
primary=no
```

Example 6 Creating a Zone for Public Scripts

In this example, the administrator isolates a public zone that is designed to run scripts and batch jobs.

```
# tncfg -z public-scripts primary=no
# tncfg -z public-scripts label=public
```

▼ How to Create and Share a Multilevel Dataset

Multilevel datasets are useful containers when you downgrade or upgrade information. For more information, see "Multilevel Datasets for Relabeling Files" on page 174. Multilevel datasets are also useful for multilevel NFS file servers to provide files at many labels to a number of NFS clients.

Before You Begin To create a multilevel dataset, you must be in the `root` role in the global zone.

1. **Create a multilevel dataset.**

   ```
   # zfs create -o mountpoint=/multi -o multilevel=on rpool/multi
   ```

   `rpool/multi` is a multilevel dataset that is mounted in the global zone at `/multi`.

   To limit the upper label range of the dataset, see Example 7, "Creating a Multilevel Dataset With a Highest Label Below `ADMIN_HIGH`," on page 70.

2. **Verify that the multilevel dataset is mounted and that the mountpoint has the `ADMIN_LOW` label.**

   ```
   # getlabel /multi
   /multi: ADMIN_LOW
   ```

3. **Protect the parent file system.**

   Set the following ZFS properties to `off` for all file systems in the pool:

   ```
   # zfs set devices=off rpool/multi
   # zfs set exec=off rpool/multi
   # zfs set setuid=off rpool/multi
   ```

4. **(Optional) Set the compression property of the pool.**

   Typically, compression is set in ZFS at the file system level. However, because all the file systems in this pool are data files, compression is set at the top-level dataset for the pool.

   ```
   # zfs set compression=on rpool/multi
   ```

   See also "Interactions Between ZFS Compression, Deduplication, and Encryption Properties" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

5. **Create top-level directories for each label that you want in the multilevel dataset.**

```
# cd /multi
# mkdir public internal
# chmod 777 public internal
# setlabel PUBLIC public
# setlabel "CNF : INTERNAL" internal
```

6. **Use LOFS to mount the multilevel dataset in every labeled zone that is approved to have access.**

   For example, the following series of `zonecfg` commands mounts the dataset in the `public` zone.

```
# zonecfg -z public
zonecfg:public> add fs
zonecfg:public:fs> set dir=/multi
zonecfg:public:fs> set special=/multi
zonecfg:public:fs> set type=lofs
zonecfg:public:fs> end
zonecfg:public> exit
```

   Multilevel datasets permit writing files at the same label as the mounting zone and reading lower-level files. The label of the mounted files can be viewed and set.

7. **To use NFS to share the multilevel dataset with other systems, do the following:**

   a. **Make the NFS service in the global zone into a multilevel service.**

```
# tncfg -z global add mlp_private=2049/tcp
# tncfg -z global add mlp_private=111/udp
# tncfg -z global add mlp_private=111/tcp
```

   b. **Restart the NFS service.**

```
# svcadm restart nfs/server
```

   c. **Share the multilevel dataset.**

```
# share /multi
```

   NFS-mounted multilevel datasets permit writing files at the same label as the mounting zone and reading lower-level files. The label of the mounted files cannot be viewed reliably or set. For more information, see “Mounting Multilevel Datasets From Another System” on page 175.

Example 7 Creating a Multilevel Dataset With a Highest Label Below `ADMIN_HIGH`

In this example, the administrator creates a multilevel dataset with a upper bound, or highest label, that is lower than the default, `ADMIN_HIGH`. At dataset creation, the administrator specifies the upper label bound in the `mslabel` property. This upper bound prevents global zone

processes from creating any files or directories in the multilevel dataset. Only labeled zone processes can create directories and files in the dataset. Because the `multilevel` property is `on`, the `mlslabel` property sets the upper bound, not the label for a single-label dataset.

```
# zfs create -o mountpoint=/multiIUO -o multilevel=on \
   -o mlslabel="CNF : INTERNAL" rpool/multiIUO
```

Then, the administrator logs in to each labeled zone to create a directory at that label in the mounted dataset.

```
# zlogin public
# mkdir /multiIUO
# chmod 777 /multiIUO
# zlogin internal
# mkdir /multiIUO
# chmod 777 /multiIUO
```

The multilevel datasets are visible at the label of the mounting zone to authorized users after the zone is rebooted.

Next Steps To enable users to relabel files, see "How to Enable Files to Be Relabeled From a Labeled Zone" on page 167.

For instructions about relabeling files, see "How to Upgrade Data in a Multilevel Dataset" in *Trusted Extensions User's Guide* and "How to Downgrade Data in a Multilevel Dataset" in *Trusted Extensions User's Guide*.

▼ How to Copy Files to Portable Media in Trusted Extensions

When copying to portable media, label the media with the sensitivity label of the information.

Note - During Trusted Extensions configuration, the `root` role might use portable media to transfer the `label_encodings` files to all systems. Label the media with `Trusted Path`.

Before You Begin To copy administrative files, you must be in the `root` role in the global zone.

1. Allocate the appropriate device.

For example, the following command allocates a removable disk, such as a JAZ or ZIP drive, or USB hot-pluggable media.

```
# allocate rmdisk0
```

On a windowed system, you can use the Device Manager. Open two File Browsers and drag the file from the device to the disk. For details, see "How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.

2. **Deallocate the device.**

```
# deallocate rmdisk0
```

To deallocate the device by using the Device Manager, see "How to Deallocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.

Note - Remember to physically affix a label to the media with the sensitivity label of the copied files.

Example 8 Keeping Configuration Files Identical on All Systems

The system administrator wants to ensure that every system is configured with the same settings. So, on the first system that is configured, the administrator creates a directory that cannot be deleted between reboots. In that directory, the administrator places the files that must be identical or very similar on all systems.

For example, the administrator modifies the `policy.conf` file, and the default `login` and `passwd` files for this site. So, the administrator copies the following files to the permanent directory.

```
# mkdir /export/commonfiles
# cp  /etc/security/policy.conf \
# cp  /etc/default/login \
# cp  /etc/default/passwd \
/export/commonfiles
```

The administrator inserts a CD into the CD-ROM drive and allocates it.

```
# allocate cdrom0
```

After transferring the files to the CD, the administrator affixes a `Trusted Path` label.

▼ How to Copy Files From Portable Media in Trusted Extensions

It is safe practice to rename the original Trusted Extensions file before replacing the file. When configuring a system, the `root` role renames and copies administrative files.

Before You Begin To copy administrative files, you must be in the `root` role in the global zone.

1. **Allocate the appropriate device.**

   ```
   # allocate cdrom0
   ```

   On a windowed system, you can use the Device Manager. For details, see "How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.

2. **If the system has a file of the same name, copy the original file to a new name.**

   For example, add `.orig` to the end of the original file:

   ```
   # cp /etc/security/policy.conf /etc/security/policy.conf.orig
   ```

3. **Copy the files from the allocated media to a location on the disk, then transfer them.**

   For example, transfer the `policy.conf` file.

   ```
   # cp /dev/rdsk/cdrom0/trusted/* /tmp
   # cp /tmp/policy.conf /etc/security/policy.conf
   ```

4. **Deallocate the device.**

   ```
   # deallocate cdrom0
   ```

   To deallocate from the Device Manager, see "How to Deallocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.

5. **Eject and remove the media.**

   ```
   # eject cdrom0
   ```

▼ How to Remove Trusted Extensions From the System

You must perform specific steps to remove the Trusted Extensions feature from an Oracle Solaris system.

Before You Begin You are in the `root` role in the global zone.

1. **Archive any data in the labeled zones that you want to keep.**

   For portable media, affix a physical sticker with the sensitivity label of the zone to each archived zone.

2. **Remove the labeled zones from the system.**

   For details, see "How to Remove a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*.

3. **Disable the Trusted Extensions service.**

   ```
   # labeladm disable -r
   ```

   For more information, see the `labeladm`(1M) man page.

4. **(Optional) Reboot the system.**

5. **Configure the system.**

   Various services might need to be configured for your Oracle Solaris system, such as basic networking, naming services, and file system mounts.

♦ ♦ ♦ CHAPTER 5

Configuring LDAP for Trusted Extensions

This chapter covers how to configure the Oracle Directory Server Enterprise Edition (LDAP Server) for use with Trusted Extensions. The LDAP Server provides LDAP services. LDAP is the supported naming service for Trusted Extensions. The final section, "Creating a Trusted Extensions LDAP Client" on page 85, covers how to configure an LDAP client.

You have two options when configuring the LDAP Server. You can configure an LDAP server on a Trusted Extensions system, or you can use an existing server and connect to it by using a Trusted Extensions proxy server.

To configure the LDAP server, follow the instructions in *one* of the following task maps:

- "Configuring LDAP on a Trusted Extensions Network" on page 75
- "Configuring an LDAP Proxy Server on a Trusted Extensions System" on page 76

Configuring LDAP on a Trusted Extensions Network

TABLE 8 Configuring LDAP on a Trusted Extensions Network Task Map

Task	Description	For Instructions
Set up a Trusted Extensions LDAP server.	If you do not have an existing Oracle Directory Server Enterprise Edition, make your first Trusted Extensions system the LDAP Server. This system has no labeled zones. The other Trusted Extensions systems are clients of this server.	"Collect Information for the LDAP Server" on page 76 "Install the Oracle Directory Server Enterprise Edition" on page 77 "Configure the Logs for the Oracle Directory Server Enterprise Edition" on page 80
Add Trusted Extensions databases to the server.	Populate the LDAP server with data from the Trusted Extensions system files.	"Populate the Oracle Directory Server Enterprise Edition" on page 82
Configure all other Trusted Extensions systems as clients of this server.	When you configure another system with Trusted Extensions, make the system a client of this LDAP server.	"Make the Global Zone an LDAP Client in Trusted Extensions" on page 85

Configuring an LDAP Proxy Server on a Trusted Extensions System

Use this task map if you have an existing Oracle Directory Server Enterprise Edition that is running on an Oracle Solaris system.

TABLE 9 Configuring an LDAP Proxy Server on a Trusted Extensions System Task Map

Task	Description	For Instructions
Add Trusted Extensions databases to the server.	The Trusted Extensions network databases, `tnrhdb` and `tnrhtp`, need to be added to the LDAP server.	"Populate the Oracle Directory Server Enterprise Edition" on page 82
Set up an LDAP proxy server.	Make one Trusted Extensions system the proxy server for the other Trusted Extensions systems. These other systems use this proxy server to reach the LDAP server.	"Create an LDAP Proxy Server" on page 84
Configure the proxy server to have a multilevel port for LDAP.	Enable the Trusted Extensions proxy server to communicate with the LDAP server at specific labels.	"Configure a Multilevel Port for the Oracle Directory Server Enterprise Edition" on page 82
Configure all other Trusted Extensions systems as clients of the LDAP proxy server.	When you configure another system with Trusted Extensions, make the system a client of the LDAP proxy server.	"Make the Global Zone an LDAP Client in Trusted Extensions" on page 85

Configuring the Oracle Directory Server Enterprise Edition on a Trusted Extensions System

The LDAP naming service is the supported naming service for Trusted Extensions. If your site is not yet running the LDAP naming service, configure an Oracle Directory Server Enterprise Edition (Directory Server) on a system that is configured with Trusted Extensions.

If your site is already running an LDAP Server, then you need to add the Trusted Extensions databases to the server. To access the Directory Server, you then set up an LDAP proxy on a Trusted Extensions system.

Note - If you do not use this LDAP server as an NFS server or as a server for Sun Ray clients, then you do not need to install any labeled zones on this server.

▼ Collect Information for the LDAP Server

- **Determine the values for the following items.**

The items are listed in the order of their appearance in the System Install Wizard.

Install Wizard Prompt	Action or Information
Oracle Directory Server Enterprise Edition *version*	
Administrator User ID	The default value is `admin`.
Administrator Password	Create a password, such as `admin123`.
Directory Manager DN	The default value is `cn=Directory Manager`.
Directory Manager Password	Create a password, such as `dirmgr89`.
Directory Server Root	The default value is `/var/Sun/mps`. This path is also used later if the proxy software is installed.
Server Identifier	The default value is the local system.
Server Port	If you plan to use the Directory Server to provide standard LDAP naming services to client systems, use the default value, `389`. If you plan to use the Directory Server to support a subsequent installation of a proxy server, enter a nonstandard port, such as `10389`.
Suffix	Include your domain component, as in `dc=example-domain,dc=com`.
Administration Domain	Construct to correspond to the Suffix, as in, `example-domain.com`.
System User	The default value is `root`.
System Group	The default value is `root`.
Data Storage Location	The default value is `Store configuration data on this server`.
Data Storage Location	The default value is `Store user data and group data on this server`.
Administration Port	The default value is the Server Port. A suggested convention for changing the default is *software-version* times `1000`. For software version `5.2`, this convention would result in port `5200`.

▼ Install the Oracle Directory Server Enterprise Edition

The Directory Server packages are available from the Oracle web site (`http://www.oracle.com/technetwork/middleware/id-mgmt/overview/index-085178.html`).

Before You Begin You are on a Trusted Extensions system with a global zone. The system has no labeled zones. You must be in the `root` role in the global zone.

Trusted Extensions LDAP servers are configured for clients who determine password operations and password policy. Specifically, the policy set by the LDAP server is not used. For the password parameters that you can set on the client, see "Managing Password Information" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*. See also the `pam.conf`(4) man page.

Note - The use of `pam_ldap` on an LDAP client is not an evaluated configuration for Trusted Extensions.

1. **Before you install the Directory Server packages, add the FQDN to your system's hostname entry.**
   The FQDN is the Fully Qualified Domain Name. This name is a combination of the host name and the administration domain, as in:

   ```
   # pfedit /etc/hosts
   ...
   192.168.5.5 myhost myhost.example-domain.com
   ```

2. **Download the Oracle Directory Server Enterprise Edition packages from the Oracle web site (`http://www.oracle.com/technetwork/middleware/id-mgmt/overview/index-085178.html`).**
   Select the most recent software that is appropriate for your platform.

3. **Install the Directory Server packages.**
   Answer the questions by using the information from "Collect Information for the LDAP Server" on page 76. For a full list of questions, defaults, and suggested answers, see Chapter 4, "Setting Up the Oracle Directory Server Enterprise Edition With LDAP Clients" in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP* and Chapter 5, "Setting Up LDAP Clients" in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.

4. **(Optional) Add the environment variables for the Directory Server to your path.**

   ```
   # $PATH
   /usr/sbin:.../opt/SUNWdsee/dsee6/bin:/opt/SUNWdsee/dscc6/bin:/opt/SUNWdsee/ds6/bin:
   /opt/SUNWdsee/dps6/bin
   ```

5. **(Optional) Add the Directory Server man pages to your `MANPATH`.**

   ```
   /opt/SUNWdsee/dsee6/man
   ```

6. **Enable the `cacaoadm` program and verify that the program is enabled.**

   ```
   # /usr/sbin/cacaoadm enable
   # /usr/sbin/cacaoadm start
   start: server (pid n) already running
   ```

7. **Ensure that the Directory Server starts at every boot.**
   Templates for the SMF services for the Directory Server are in the Oracle Directory Server Enterprise Edition packages.

   - **For a Trusted Extensions Directory Server, enable the service.**

```
# dsadm stop /export/home/ds/instances/your-instance
# dsadm enable-service -T SMF /export/home/ds/instances/your-instance
# dsadm start /export/home/ds/instances/your-instance
```

For information about the `dsadm` command, see the `dsadm`(1M) man page.

- **For a proxy Directory Server, enable the service.**

```
# dpadm stop /export/home/ds/instances/your-instance
# dpadm enable-service -T SMF /export/home/ds/instances/your-instance
# dpadm start /export/home/ds/instances/your-instance
```

For information about the `dpadm` command, see the `dpadm`(1M) man page.

8. **Verify your installation.**

```
# dsadm info /export/home/ds/instances/your-instance
Instance Path:         /export/home/ds/instances/your-instance
Owner:                 root(root)
Non-secure port:       389
Secure port:           636
Bit format:            32-bit
State:                 Running
Server PID:            298
DSCC url:              -
SMF application name:  ds--export-home-ds-instances-your-instance
Instance version:      D-A00
```

Troubleshooting For strategies to solve LDAP configuration problems, see Chapter 6, “Troubleshooting LDAP Configurations” in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.

▼ Create an LDAP Client for the LDAP Server

You use this client to populate your LDAP Server for LDAP. You must perform this task before you populate the LDAP Server.

You can create the client temporarily on the Trusted Extensions Directory Server, then remove the client on the server, or you can create an independent client.

Before You Begin You are in the `root` role in the global zone.

1. **Add Trusted Extensions software to a system.**

You can use the Trusted Extensions LDAP Server, or add Trusted Extensions to a separate system. For instructions, see Chapter 3, “Adding the Trusted Extensions Feature to Oracle Solaris”.

2. **On the client, configure LDAP in the `name-service/switch` service.**

   a. **Display the current configuration.**

   ```
   # svccfg -s 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"
   config/netgroup             astring       ldap
   config/printer              astring       "user files ldap"
   ```

   b. **Change the following property from the default:**

   ```
   # svccfg -s name-service/switch setprop config/host = astring: "files ldap dns"
   ```

3. **In the global zone, run the `ldapclient init` command.**

   In this example, the LDAP client is in the `example-domain.com` domain. The server's IP address is `192.168.5.5`.

   ```
   # ldapclient init -a domainName=example-domain.com -a profileName=default \
   > -a proxyDN=cn=proxyagent,ou=profile,dc=example-domain,dc=com \
   > -a proxyDN=cn=proxyPassword={NS1}ecc423aad0 192.168.5.5
   System successfully configured
   ```

4. **Set the server's `enableShadowUpdate` parameter to `TRUE`.**

   ```
   # ldapclient -v mod -a enableShadowUpdate=TRUE \
   > -a adminDN=cn=admin,ou=profile,dc=example-domain,dc=com
   System successfully configured
   ```

   For information about the `enableShadowUpdate` parameter, see "Enabling Shadow Data Updates" in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP* and the `ldapclient`(1M) man page.

▼ Configure the Logs for the Oracle Directory Server Enterprise Edition

This procedure configures three types of logs: access logs, audit logs, and error logs. The following default settings are not changed:

- All logs are enabled and buffered.
- Logs are placed in the appropriate `/export/home/ds/instances/`*your-instance*`/logs/`*LOG_TYPE* directory.
- Events are logged at log level 256.

- Logs are protected with `600` file permissions.
- Access logs are rotated daily.
- Error logs are rotated weekly.

The settings in this procedure meet the following requirements:

- Audit logs are rotated daily.
- Log files that are older than 3 months expire.
- All log files use a maximum of 20,000 MBytes of disk space.
- A maximum of 100 log files is kept, and each file is at most 500 MBytes.
- The oldest logs are deleted if less than 500 MBytes free disk space is available.
- Additional information is collected in the error logs.

Before You Begin You must be in the `root` role in the global zone.

1. Configure the access logs.

The *LOG_TYPE* for access is `ACCESS`. The syntax for configuring logs is the following:

`dsconf set-log-prop` *LOG_TYPE property*`:`*value*

```
# dsconf set-log-prop ACCESS max-age:3M
# dsconf set-log-prop ACCESS max-disk-space-size:20000M
# dsconf set-log-prop ACCESS max-file-count:100
# dsconf set-log-prop ACCESS max-size:500M
# dsconf set-log-prop ACCESS min-free-disk-space:500M
```

2. Configure the audit logs.

```
# dsconf set-log-prop AUDIT max-age:3M
# dsconf set-log-prop AUDIT max-disk-space-size:20000M
# dsconf set-log-prop AUDIT max-file-count:100
# dsconf set-log-prop AUDIT max-size:500M
# dsconf set-log-prop AUDIT min-free-disk-space:500M
# dsconf set-log-prop AUDIT rotation-interval:1d
```

By default, the rotation interval for audit logs is one week.

3. Configure the error logs.

In this configuration, you specify additional data to be collected in the error log.

```
# dsconf set-log-prop ERROR max-age:3M
# dsconf set-log-prop ERROR max-disk-space-size:20000M
# dsconf set-log-prop ERROR max-file-count:30
# dsconf set-log-prop ERROR max-size:500M
# dsconf set-log-prop ERROR min-free-disk-space:500M
# dsconf set-log-prop ERROR verbose-enabled:on
```

4. (Optional) Further configure the logs.

You can also configure the following settings for each log:

```
# dsconf set-log-prop LOG_TYPE rotation-min-file-size:undefined
# dsconf set-log-prop LOG_TYPE rotation-time:undefined
```

For information about the `dsconf` command, see the `dsconf`(1M) man page.

▼ Configure a Multilevel Port for the Oracle Directory Server Enterprise Edition

To work in Trusted Extensions, the server port of the LDAP Server must be configured as a multilevel port (MLP) in the global zone.

Before You Begin You must be in the `root` role in the global zone.

1. **In a terminal window, start the `txzonemgr`.**

   ```
   # /usr/sbin/txzonemgr &
   ```

2. **Add a multilevel port for the TCP protocol to the global zone.**

   The port number is 389.

3. **Add a multilevel port for the UDP protocol to the global zone.**

   The port number is 389.

▼ Populate the Oracle Directory Server Enterprise Edition

Several LDAP databases have been created or modified to hold Trusted Extensions data about label configuration, users, and remote systems. In this procedure, you populate the LDAP Server databases with Trusted Extensions information.

Before You Begin You must be in the `root` role in the global zone. You are on an LDAP client where shadow updating is enabled. For the prerequisites, see "Create an LDAP Client for the LDAP Server" on page 79.

1. **Create a staging area for files that you plan to use to populate the naming service databases.**

   ```
   # mkdir -p /setup/files
   ```

2. **Copy the sample `/etc` files into the staging area.**

```
# cd /etc
# cp aliases group networks netmasks protocols /setup/files
# cp rpc services auto_master /setup/files

# cd /etc/security/tsol
# cp tnrhdb tnrhtp /setup/files
```

Caution - Do not copy the *`attr` files. Rather, use the `-S ldap` option to the commands that add users, roles, and rights profiles to the LDAP repository. These commands add entries for the `user_attr`, `auth_attr`, `exec_attr`, and `prof_attr` databases. For more information, see the `user_attr`(4) and `useradd`(1M) man pages.

3. **Remove the `+auto_master` entry from the `/setup/files/auto_master` file.**

4. **Create the zone automaps in the staging area.**

```
# cp /zone/public/root/etc/auto_home_public /setup/files
# cp /zone/internal/root/etc/auto_home_internal /setup/files
# cp /zone/needtoknow/root/etc/auto_home_needtoknow /setup/files
# cp /zone/restricted/root/etc/auto_home_restricted /setup/files
```

In the following list of automaps, the first of each pair of lines shows the name of the file. The second line of each pair shows the file contents. The zone names identify labels from the default `label_encodings` file that is included with the Trusted Extensions software.

- Substitute your zone names for the zone names in these lines.
- *myNFSserver* identifies the NFS server for the home directories.

```
/setup/files/auto_home_public
* myNFSserver_FQDN:/zone/public/root/export/home/&

/setup/files/auto_home_internal
* myNFSserver_FQDN:/zone/internal/root/export/home/&

/setup/files/auto_home_needtoknow
* myNFSserver_FQDN:/zone/needtoknow/root/export/home/&

/setup/files/auto_home_restricted
* myNFSserver_FQDN:/zone/restricted/root/export/home/&
```

5. **Use the `ldapaddent` command to populate the LDAP Server with every file in the staging area.**

For example, the following command populates the server from the `hosts` file in the staging area.

```
# /usr/sbin/ldapaddent -D "cn=directory manager" \
   -w dirmgr123 -a simple -f /setup/files/hosts hosts
```

6. **If you ran the `ldapclient` command on the Trusted Extensions Directory Server, disable the client on that system.**

   In the global zone, run the `ldapclient uninit` command. Use verbose output to verify that the system is no longer an LDAP client.

   ```
   # ldapclient -v uninit
   ```

   For more information, see the `ldapclient(1M)` man page.

7. **To populate the Trusted Extensions network databases in LDAP, use the `tncfg` command with the `-S ldap` option.**

   For instructions, see "Labeling Hosts and Networks" on page 205.

Creating a Trusted Extensions Proxy for an Existing Oracle Directory Server Enterprise Edition

First, you need to add the Trusted Extensions databases to the existing LDAP Server on an Oracle Solaris system. Second, to enable Trusted Extensions systems to access the LDAP Server, you then need to configure a Trusted Extensions system to be the LDAP proxy server.

▼ Create an LDAP Proxy Server

If an LDAP server already exists at your site, create a proxy server on a Trusted Extensions system.

Before You Begin You have populated the LDAP server from a client that was modified to set the `enableShadowUpdate` parameter to `TRUE`. For the requirement, see "Create an LDAP Client for the LDAP Server" on page 79.

In addition, you have added the databases that contain Trusted Extensions information to the LDAP server from a client where the `enableShadowUpdate` parameter was set to `TRUE`. For details, see "Populate the Oracle Directory Server Enterprise Edition" on page 82.

You must be in the `root` role in the global zone.

1. **On a system that is configured with Trusted Extensions, create a proxy server.**

   Note - You must run two `ldapclient` commands. After you run the `ldapclient init` command, you then run the `ldapclient modify` command to set the `enableShadowUpdate` parameter to `TRUE`.

The following are sample commands. The `ldapclient init` command defines proxy values.

```
# ldapclient init \
  -a proxyDN=cn=proxyagent,ou=profile,dc=west,dc=example,dc=com \
  -a domainName=west.example.com \
  -a profileName=pit1 \
  -a proxyPassword=test1234 192.168.0.1
System successfully configured
```

The `ldapclient mod` command enables shadow updating.

```
# ldapclient mod -a enableShadowUpdate=TRUE \
  -a adminDN=cn=admin,ou=profile,dc=west,dc=example,dc=com \
  -a adminPassword=admin-password
System successfully configured
```

For details, see Chapter 5, “Setting Up LDAP Clients” in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.

2. **Verify that the Trusted Extensions databases can be viewed by the proxy server.**

```
# ldaplist -l database
```

Troubleshooting For strategies to solve LDAP configuration problems, see Chapter 6, “Troubleshooting LDAP Configurations” in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.

Creating a Trusted Extensions LDAP Client

The following procedure creates an LDAP client for an existing Trusted Extensions Directory Server.

▼ Make the Global Zone an LDAP Client in Trusted Extensions

This procedure establishes the LDAP naming service configuration for the global zone on an LDAP client.

Use the `txzonemgr` script.

Note - If you plan to set up a name server in each labeled zone, you are responsible for establishing the LDAP client connection to each labeled zone.

Before You Begin The Oracle Directory Server Enterprise Edition, that is, the LDAP Server, must exist. The server must be populated with Trusted Extensions databases, and this client system must be able to contact the server. So, the LDAP Server must have assigned a security template to this client. A specific assignment is not required, a wildcard assignment is sufficient.

You must be in the `root` role in the global zone.

1. If you are using DNS, add `dns` to the `name-service/switch` configuration.

The standard naming service switch file for LDAP is too restrictive for Trusted Extensions.

a. Display the current configuration.

```
# svccfg -s name-service/switch listprop config
config                      application
config/value_authorization  astring       solaris.smf.value.name-service.switch
config/default              astring       files ldap
config/netgroup             astring       ldap
config/printer              astring       "user files ldap"
```

b. Add `dns` to the `host` property and refresh the service.

```
# svccfg -s name-service/switch setprop config/host = astring: "files dns ldap"
# svccfg -s name-service/switch:default refresh
```

c. Verify the new configuration.

```
# svccfg -s 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 ldap
config/netgroup             astring       ldap
config/printer              astring       "user files ldap"
```

The Trusted Extensions databases use the default configuration `files ldap`, so are not listed.

2. To create an LDAP client, run the `txzonemgr` command without any options.

```
# txzonemgr &
```

a. Double-click the global zone.

b. Select Create LDAP Client.

c. Answer the following prompts and click OK after each answer:

`Enter Domain Name:` *Type the domain name*

```
Enter Hostname of LDAP Server:              Type the name of the server
Enter IP Address of LDAP Server servername:     Type the IP address
Enter LDAP Proxy Password:              Type the password to the server
Confirm LDAP Proxy Password:            Retype the password to the server
Enter LDAP Profile Name:                Type the profile name
```

d. Confirm or cancel the displayed values.

```
Proceed to create LDAP Client?
```

When you confirm, the `txzonemgr` script runs the `ldapclient init` command.

3. Complete client configuration by enabling shadow updates.

```
# ldapclient -v mod -a enableShadowUpdate=TRUE \
> -a adminDN=cn=admin,ou=profile,dc=domain,dc=suffix
System successfully configured
```

4. Verify that the information on the server is correct.

a. Open a terminal window, and query the LDAP server.

```
# ldapclient list
```

The output looks similar to the following:

```
NS_LDAP_FILE_VERSION= 2.0
NS_LDAP_BINDDN= cn=proxyagent,ou=profile,dc=domain-name
...
NS_LDAP_BIND_TIME= number
```

b. Correct any errors.

If you get an error, redo Step 2 through Step 4. For example, the following error can indicate that the system does not have an entry on the LDAP server:

```
LDAP ERROR (91): Can't connect to the LDAP server.
Failed to find defaultSearchBase for domain domain-name
```

To correct this error, you need to check the LDAP server.

PART II

Administration of Trusted Extensions

The chapters in this part describe how to administer Trusted Extensions.

Chapter 6, “Trusted Extensions Administration Concepts” introduces the Trusted Extensions feature.

Chapter 7, “Trusted Extensions Administration Tools” describes the administrative programs that are specific to Trusted Extensions.

Chapter 8, “About Security Requirements on a Trusted Extensions System” describes the fixed and configurable security requirements in Trusted Extensions.

Chapter 9, “Common Tasks in Trusted Extensions” introduces Trusted Extensions administration.

Chapter 10, “About Users, Rights, and Roles in Trusted Extensions” introduces role-based access control (RBAC) in Trusted Extensions.

Chapter 11, “Managing Users, Rights, and Roles in Trusted Extensions” provides instructions on managing regular users of Trusted Extensions.

Chapter 12, “Remote Administration in Trusted Extensions” provides instructions on remotely administering Trusted Extensions.

Chapter 13, “Managing Zones in Trusted Extensions” provides instructions on managing labeled zones.

Chapter 14, “Managing and Mounting Files in Trusted Extensions” provides instructions on managing mounting, backing up the system, and other file-related tasks in Trusted Extensions.

Chapter 15, “Trusted Networking” provides an overview of the network databases and routing in Trusted Extensions.

Chapter 16, “Managing Networks in Trusted Extensions” provides instructions on managing the network databases and routing in Trusted Extensions.

Chapter 17, “About Trusted Extensions and LDAP” describes mail-specific issues in Trusted Extensions.

Chapter 18, “About Multilevel Mail in Trusted Extensions” describes mail-specific issues in Trusted Extensions.

Chapter 19, “Managing Labeled Printing” provides instructions on handling printing in Trusted Extensions.

Chapter 20, “About Devices in Trusted Extensions” describes the extensions Trusted Extensions provides to device protection in Oracle Solaris.

Chapter 21, “Managing Devices for Trusted Extensions” provides instructions on managing devices by using the Device Manager.

Chapter 22, “Trusted Extensions and Auditing” provides Trusted Extensions-specific information about auditing.

Chapter 23, “Software Management in Trusted Extensions” describes how to administer applications on a Trusted Extensions system.

♦ ♦ ♦ CHAPTER 6

Trusted Extensions Administration Concepts

This chapter introduces you to administering a system that is configured with the Trusted Extensions feature.

Trusted Extensions and the Oracle Solaris OS

Trusted Extensions software adds labels to a system that is running the Oracle Solaris OS. Labels implement *mandatory access control* (MAC). MAC, along with discretionary access control (DAC), protects system subjects (processes) and objects (data). Trusted Extensions software provides interfaces to handle label configuration, label assignment, and label policy.

Similarities Between Trusted Extensions and the Oracle Solaris OS

Trusted Extensions software uses rights profiles, roles, auditing, privileges, and other security features of Oracle Solaris. You can use Secure Shell, BART, the Cryptographic Framework, IPsec, and IP Filter with Trusted Extensions. All features of the ZFS file system are available in Trusted Extensions, including snapshots, encryption, and storage.

Differences Between Trusted Extensions and the Oracle Solaris OS

Trusted Extensions software extends the Oracle Solaris OS. The following list provides an overview. See also Appendix C, "Quick Reference to Trusted Extensions Administration".

- Trusted Extensions controls access to data with special security tags that are called *labels*. Labels provide *mandatory access control* (MAC). MAC protection is in addition to UNIX

file permissions, or discretionary access control (DAC). Labels are directly assigned to users, zones, devices, windows, and network endpoints. Labels are implicitly assigned to processes, files, and other system objects.

MAC cannot be overridden by regular users. Trusted Extensions requires regular users to operate in labeled zones. By default, no users or processes in labeled zones can override MAC.

As in the Oracle Solaris OS, the ability to override security policy can be assigned to specific processes or users when MAC can be overridden. For example, users can be authorized to change the label of a file. Such an action upgrades or downgrades the sensitivity of the information in that file.

- Trusted Extensions adds to existing configuration files and commands. For example, Trusted Extensions adds audit events, authorizations, privileges, and rights profiles.
- Some features that are optional on an Oracle Solaris system are required on a Trusted Extensions system. For example, zones and roles are required on a system that is configured with Trusted Extensions.
- Some features that are optional on an Oracle Solaris system are enabled on a Trusted Extensions system. For example, many sites that configure Trusted Extensions require separation of duty when creating users and assigning security attributes.
- Trusted Extensions can change the default behavior of Oracle Solaris. For example, on a system that is configured with Trusted Extensions, device allocation is required.
- Trusted Extensions can narrow the options that are available in Oracle Solaris. For example, in Trusted Extensions, all zones are labeled zones. Unlike in Oracle Solaris, labeled zones must use the same pool of user IDs and group IDs. Additionally, in Trusted Extensions, labeled zones can share one IP address.
- Trusted Extensions provides a multilevel version of the Oracle Solaris desktop, Solaris Trusted Extensions (GNOME) The name can be shortened to Trusted GNOME.
- Trusted Extensions provides additional graphical user interfaces (GUIs) and command line interfaces (CLIs). For example, Trusted Extensions provides the Device Manager GUI to administer devices. In addition, the `updatehome` CLI is used to place startup files in users' home directories at every label.
- In a windowed environment, Trusted Extensions provides GUIs for administration. For example, the Labeled Zone Manager is used to administer labeled zones, in addition to the `zonecfg` command.
- Trusted Extensions limits what users can see. For example, a device that cannot be allocated by a user cannot be seen by that user.
- Trusted Extensions limits users' desktop options. For example, users are allowed a limited time of workstation inactivity before the screen locks. By default, users cannot shut down the system.

Multiheaded Systems and the Trusted Extensions Desktop

When the monitors of a multiheaded Trusted Extensions system are configured horizontally, the trusted stripe stretches across the monitors. When the monitors are configured vertically, the trusted stripe appears in the lowest monitor.

However, when different workspaces are displayed on the monitors of a multiheaded system, Trusted GNOME displays a trusted stripe on each monitor.

Basic Concepts of Trusted Extensions

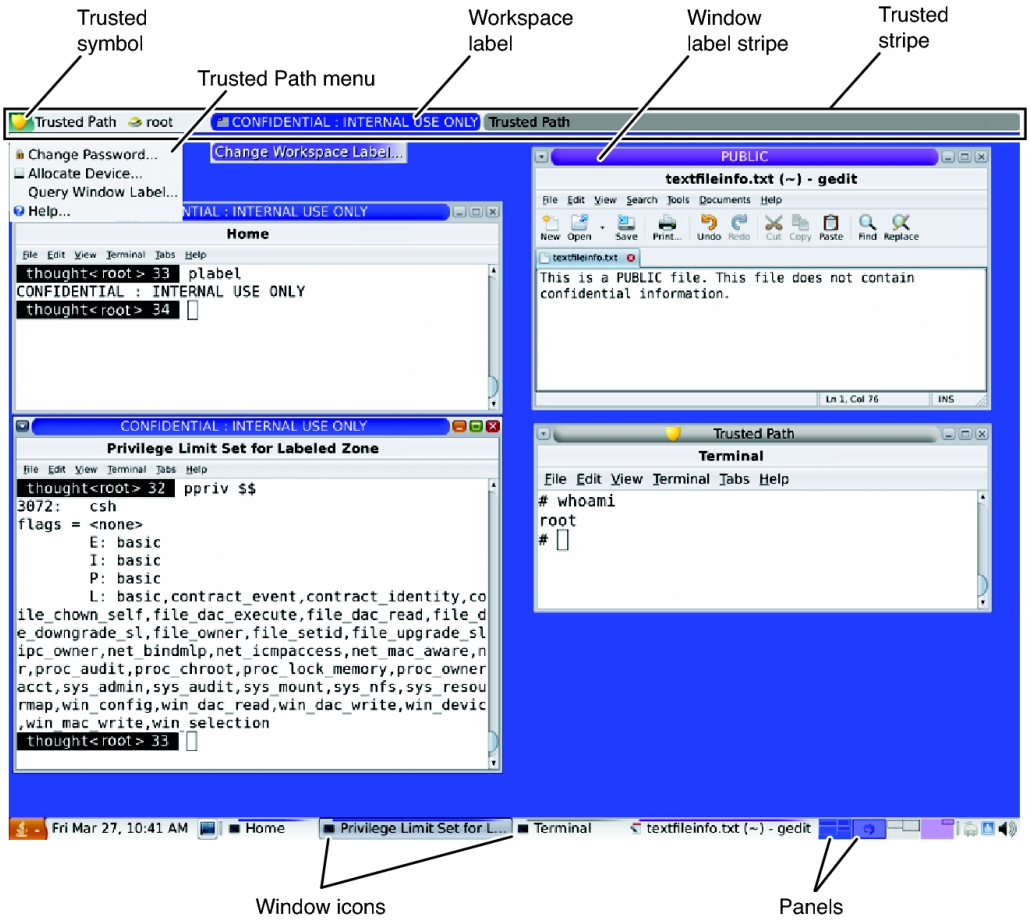
Trusted Extensions software adds labels to an Oracle Solaris system. Labeled workspaces and trusted applications, such as the Label Builder and the Device Manager, are also added. The concepts in this section are necessary to understand Trusted Extensions, both for users and administrators. Users are introduced to these concepts in the *Trusted Extensions User's Guide*.

Trusted Extensions Protections

Trusted Extensions software enhances the protection of the Oracle Solaris OS. Trusted Extensions restricts users and roles to an approved label range. This label range limits the information that users and roles can access.

Trusted Extensions displays the Trusted Path symbol, an unmistakable, tamper-proof emblem that appears at the left of the trusted stripe. In Trusted GNOME, the stripe is at the top of the screen. The Trusted Path symbol indicates to users when they are using security-related parts of the system. If this symbol does not appear when the user is running a trusted application, that version of the application should be checked immediately for authenticity. If the trusted stripe does not appear, the desktop is not trustworthy. For a sample desktop display, see Figure 2, "Trusted Extensions Multilevel Desktop," on page 94.

FIGURE 2 Trusted Extensions Multilevel Desktop



Most security-related software, that is, the Trusted Computing Base (TCB), runs in the global zone. Regular users cannot enter the global zone or view its resources. Users are subject to TCB software, such as when changing passwords. The Trusted Path symbol is displayed whenever the user interacts with the TCB.

Trusted Extensions and Access Control

Trusted Extensions software protects information and other resources through both discretionary access control (DAC) and mandatory access control (MAC). DAC is the

traditional UNIX permission bits and access control lists that are set at the discretion of the owner. MAC is a mechanism that the system enforces automatically. MAC controls all transactions by checking the labels of processes and data in the transaction.

A user's *label* represents the sensitivity level at which the user is permitted to operate and chooses to operate. Typical labels are `Secret` and `Public`. The label determines the information that the user is allowed to access. Both MAC and DAC can be overridden by special permissions that Oracle Solaris provides, *privileges* and *authorizations*. Privileges are special permissions that can be granted to processes. Authorizations are special permissions that can be granted to users and roles by an administrator.

As an administrator, you need to train users on the proper procedures for securing their files and directories, according to your site's security policy. Furthermore, you need to instruct any users who are allowed to upgrade or downgrade labels as to when doing so is appropriate.

Labels in Trusted Extensions Software

Labels and clearances are at the center of mandatory access control (MAC) in Trusted Extensions. They determine which users can access which programs, files, and directories. Labels and clearances consist of one *classification* component and zero or more *compartment* components. The classification component indicates a hierarchical level of security such as `TOP SECRET` to `SECRET` to `PUBLIC`. The compartment component represents a group of users who might need access to a common body of information. Some typical types of compartments are projects, departments, or physical locations. Labels are readable by authorized users, but internally, labels are manipulated as numbers. The numbers and their readable versions are defined in the `label_encodings` file.

Trusted Extensions mediates all attempted security-related transactions. The software compares the labels of the accessing entity, typically a process, and the entity being accessed, usually a filesystem object. The software then permits or disallows the transaction depending on which label is *dominant*. Labels are also used to determine access to other system resources, such as allocatable devices, networks, frame buffers, and other systems.

Dominance Relationships Between Labels

One entity's label is said to *dominate* another label if the following two conditions are met:

- The classification component of the first entity's label is equal to or higher than the second entity's classification. The security administrator assigns numbers to classifications in the `label_encodings` file. The software compares these numbers to determine dominance.
- The set of compartments in the first entity includes all of the second entity's compartments.

Two labels are said to be *equal* if they have the same classification and the same set of compartments. If the labels are equal, they dominate each other and access is permitted.

If one label has a higher classification or if it has the same classification and its compartments are a superset of the second label's compartments, or both, the first label is said to *strictly dominate* the second label.

Two labels are said to be *disjoint* or *noncomparable* if neither label dominates the other label.

The following table presents examples of label comparisons for dominance. In the example, NEED_TO_KNOW is a higher classification than INTERNAL. There are three compartments: Eng, Mkt, and Fin.

TABLE 10 Examples of Label Relationships

Label 1	Relationship	Label 2
NEED_TO_KNOW Eng Mkt	(strictly) dominates	INTERNAL Eng Mkt
NEED_TO_KNOW Eng Mkt	(strictly) dominates	NEED_TO_KNOW Eng
NEED_TO_KNOW Eng Mkt	(strictly) dominates	INTERNAL Eng
NEED_TO_KNOW Eng Mkt	dominates (equals)	NEED_TO_KNOW Eng Mkt
NEED_TO_KNOW Eng Mkt	is disjoint with	NEED_TO_KNOW Eng Fin
NEED_TO_KNOW Eng Mkt	is disjoint with	NEED_TO_KNOW Fin
NEED_TO_KNOW Eng Mkt	is disjoint with	INTERNAL Eng Mkt Fin

Administrative Labels

Trusted Extensions provides two special administrative labels that are used as labels or clearances: ADMIN_HIGH and ADMIN_LOW. These labels are used to protect system resources and are intended for administrators rather than regular users.

ADMIN_HIGH is the highest label. ADMIN_HIGH dominates all other labels in the system and is used to protect system data, such as administration databases or audit trails, from being read. You must be in the global zone to read data that is labeled ADMIN_HIGH.

ADMIN_LOW is the lowest label. ADMIN_LOW is dominated by all other labels in a system, including labels for regular users. Mandatory access control does not permit users to write data to files with labels lower than the user's label. Thus, a file at the label ADMIN_LOW can be read by regular users, but cannot be modified. ADMIN_LOW is typically used to protect public executables that are shared, such as files in /usr/bin.

Label Encodings File

All label components for a system, that is, classifications, compartments, and the associated rules, are stored in an ADMIN_HIGH file, the label_encodings file. The original file is located in the /etc/security/tsol directory. After Trusted Extensions is enabled, the location of the

file is stored as a property of the `labeld` service. The security administrator configures the `label_encodings` file for the site. A label encodings file contains:

- **Component definitions** – Definitions of classifications, compartments, labels, and clearances, including rules for required combinations and constraints
- **Accreditation range definitions** – Specification of the clearances and minimum labels that define the sets of available labels for the entire system and for regular users
- **Printing specifications** – Identification and handling information for print banners, trailers, headers, footers, and other security features on printouts
- **Customizations** – Local definitions including label color codes, and other defaults

For more information, see the `label_encodings(4)` man page. Detailed information can also be found in *Trusted Extensions Label Administration* and *Compartmented Mode Workstation Labeling: Encodings Format*.

Label Ranges

A *label range* is the set of potentially usable labels at which users can operate. Both users and resources have label ranges. Resources that can be protected by label ranges include such things as allocatable devices, networks, interfaces, frame buffers, and commands. A label range is defined by a clearance at the top of the range and a minimum label at the bottom.

A range does not necessarily include all combinations of labels that fall between a maximum and minimum label. Rules in the `label_encodings` file can disqualify certain combinations. A label must be *well-formed*, that is, permitted by all applicable rules in the label encodings file, in order to be included in a range.

However, a clearance does not have to be well-formed. Suppose, for example, that a `label_encodings` file prohibits any combination of compartments `Eng`, `Mkt`, and `Fin` in a label. `INTERNAL Eng Mkt Fin` would be a valid clearance but not a valid label. As a clearance, this combination would let a user access files that are labeled `INTERNAL Eng`, `INTERNAL Mkt`, and `INTERNAL Fin`.

Account Label Range

When you assign a clearance and a minimum label to a user, you define the upper and lower boundaries of the *account label range* in which that user is permitted to operate. The following equation describes the account label range, using ≤ to indicate “dominated by or the same as”:

minimum-label ≤ *permitted-label* ≤ *clearance*

Thus, the user is permitted to operate at any label that is dominated by the clearance as long as that label dominates the minimum label. When a user's clearance or minimum label is not expressly set, the defaults that are defined in the `label_encodings` file take effect.

Users can be assigned a clearance and a minimum label that enable them to operate at more than one label, or at a single label. When a user's clearance and minimum label are equal, the user can operate at only one label.

Session Range

The *session range* is the set of labels that is available to a user during a Trusted Extensions session. The session range must be within the user's account label range and the label range set for the system. At login, if the user selects single-label session mode, the session range is limited to that label. If the user selects multilabel session mode, then the label that the user selects becomes the session clearance. The session clearance defines the upper boundary of the session range. The user's minimum label defines the lower bound. The user begins the session in a workspace at the minimum label. During the session, the user can switch to a workspace at any label within the session range.

What Labels Protect and Where Labels Appear

Labels appear on the desktop and on output that is executed on the desktop, such as printouts.

- **Applications –** Applications start processes. These processes run at the label of the workspace where the application is started. An application in a labeled zone, as a file, is labeled at the label of the zone.
- **Devices –** Data flowing through devices is controlled through device allocation and device label ranges. To use a device, users must be within the label range of the device, and be authorized to allocate the device.
- **File system mount points –** Every mount point has a label. The label is viewable by using the `getlabel` command.
- **IPsec and IKE –** IPsec security associations and IKE rules have labels.
- **Network interfaces –** IP addresses (hosts) are assigned security templates that describe their label range. Unlabeled hosts are also assigned a default label by the communicating Trusted Extensions system.
- **Printers and printing –** Printers have label ranges. Labels are printed on body pages. Labels, handling information, and other security information is printed on the banner and trailer pages. To configure printing in Trusted Extensions, see Chapter 19, “Managing Labeled Printing” and “Labels on Printed Output” in *Trusted Extensions Label Administration*.
- **Processes –** Processes are labeled. Processes run at the label of the workspace where the process originates. The label of a process is visible by using the `plabel` command.
- **Users –** Users are assigned a default label and a label range. The label of the user's workspace indicates the label of the user's processes.

- **Windows –** Labels are visible at the top of desktop windows. The label of the desktop is also indicated by color. The color appears on the workspace panel and above window title bars, as shown in Figure 2, “Trusted Extensions Multilevel Desktop,” on page 94.

  When a window is moved to a differently labeled workspace, the window maintains its original label. Processes that are initiated in that window execute at the original label.
- **Zones –** Every zone has a label. The files and directories that are owned by a zone are at the zone's label. For more information, see the `getzonepath(1)` man page.

Roles and Trusted Extensions

On a system that is running Oracle Solaris software without Trusted Extensions, roles are optional. On a system that is configured with Trusted Extensions, several roles other than `root` administer the system. Typically, the System Administrator role and the Security Administrator role perform most administrative functions. In some cases, the `root` role can administer after initial setup. On a desktop system, the workspace changes to a role workspace when a user assumes a role.

The programs that are available to a role in Trusted Extensions have a special property, the *trusted path attribute*. This attribute indicates that the program is part of the TCB. The trusted path attribute is available when a program is launched from the global zone.

As in Oracle Solaris, rights profiles are the basis of a role's capabilities. For information about rights profiles and roles, see Chapter 1, “About Using Rights to Control Users and Processes” in *Securing Users and Processes in Oracle Solaris 11.3*.

♦ ♦ ♦ CHAPTER 7

Trusted Extensions Administration Tools

This chapter describes the tools that are available in Trusted Extensions, the location of the tools, and the databases on which the tools operate.

Administration Tools for Trusted Extensions

Administration on a system that is configured with Trusted Extensions uses many of the same tools that are available in the Oracle Solaris OS. Trusted Extensions offers security-enhanced tools as well. Administration tools are available only to roles.

On a desktop system in a role workspace, you can access commands, applications, and scripts that are trusted. The following table summarizes these administrative tools. Command line tools are available on systems that are not running a desktop.

TABLE 11 Trusted Extensions Administrative Tools

Tool	Description	For More Information
`/usr/sbin/labeladm`	Enables and disables Trusted Extensions. Also used to install a label encodings file.	See "Installing and Enabling Trusted Extensions" on page 37, "How to Check and Install Your Label Encodings File" on page 42, and the `labeladm`(1M) man page.
`/usr/sbin/txzonemgr`	Creates the Labeled Zone Manager GUI for creating and configuring labeled zones, including networking.	See "Creating Labeled Zones" on page 45 and the `txzonemgr`(1M) man page. `txzonemgr` is a `zenity` (1) script.

Tool	Description	For More Information
	Command-line options enable automatic creation of user-named zones.	
Device Manager	Used to administer the label ranges of devices, and to allocate and deallocate devices.	See "Device Manager" on page 102 and "Handling Devices in Trusted Extensions" on page 273.
Label Builder	Is also a user tool. Appears when a program requires you to choose a label.	For an example, see "How to Modify a User's Label Range" on page 139.
Selection Manager	Is also a tool for users who are authorized to change the security level of data. Appears when a program requires you to change the security level of data.	To authorize users, see "How to Enable a User to Change the Security Level of Data" on page 142. For an illustration, see "How to Move Data Between Windows of Different Labels" in *Trusted Extensions User's Guide*.
Trusted Extensions commands	Used to perform administrative tasks	For the list of administrative commands and configuration files, see Appendix D, "List of Trusted Extensions Man Pages".

`txzonemgr` Script

The `/usr/sbin/txzonemgr` command is a zone and network configuration tool that offers two modes.

- As a CLI, the command creates labeled zones. When run with the `-c` command option, the CLI creates and boots two labeled zones. The `-d` option prompts you to delete all zones one by one.
- As a GUI, the script displays a dialog box with the title Labeled Zone Manager. This GUI guides you through creating and booting labeled zones. The script includes cloning a zone to create a snapshot. Additionally, the GUI provides networking, naming service, and LDAP configuration menus. The script handles IPv4 and IPv6 addresses.

The `txzonemgr` command runs a `zenity`(1) script. The Labeled Zone Manager dialog box displays only valid choices for the current configuration status of a labeled zone. For instance, if a zone is already labeled, the Label menu item is not displayed.

Device Manager

A *device* is either a physical peripheral that is connected to a computer or a software-simulated device called a *pseudo-device*. Because devices provide a means for the import and export of data to and from a system, devices must be controlled to properly protect the data. Trusted Extensions uses device allocation and device label ranges to control data flowing through devices.

Examples of devices that have label ranges are frame buffers, tape drives, CD-ROM drives, printers, and USB devices.

Users allocate devices through the Device Manager. The Device Manager mounts the device, runs a clean script to prepare the device, and performs the allocation. When finished, the user deallocates the device through the Device Manager, which runs another clean script, and unmounts and deallocates the device.

You can manage devices by using the Device Administration tool from the Device Manager. Regular users cannot access the Device Administration tool.

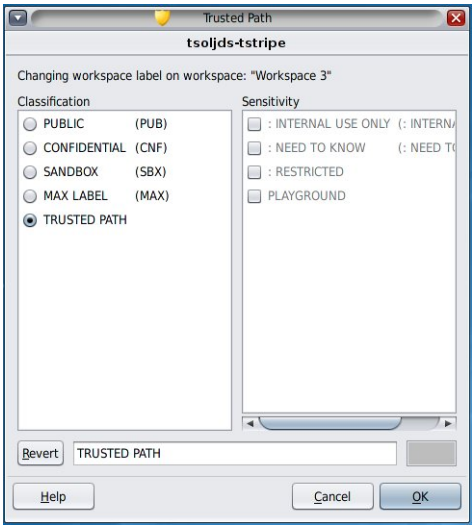
For more information about device protection in Trusted Extensions, see Chapter 21, “Managing Devices for Trusted Extensions”.

Selection Manager in Trusted Extensions

The Selection Manager GUI appears when you attempt to change the label of an object or a selection. For more information, see “Rules When Changing the Level of Security for Data” on page 112.

Label Builder in Trusted Extensions

The label builder GUI supplies your choice of a valid label or clearance when a program requires you to assign a label. For example, a label builder appears during desktop login (see Chapter 2, “Logging In to Trusted Extensions” in *Trusted Extensions User’s Guide*). The label builder also appears when you change the label of a workspace, or when you assign a label to a user, zone, or network interface. The following label builder appears when you assign a label range to a new device.



In the label builder, component names in the Classification column correspond to the `CLASSIFICATIONS` section in the `label_encodings` file. The component names in the Sensitivity column correspond to the `WORDS` section under the `SENSITIVITY` section in the `label_encodings` file.

Developers can construct label builders for their applications by using the `tgnome-selectlabel` command. Type `tgnome-selectlabel -h` to display the online help. Also, see Chapter 6, "Label Builder GUI" in *Trusted Extensions Developer's Guide*.

Command Line Tools in Trusted Extensions

Commands that are unique to Trusted Extensions and commands that are modified by Trusted Extensions are contained in the *Oracle Solaris Reference Manual*. The `man` command finds all the commands. For a description of the commands, links to examples in the Trusted Extensions document set, and a link to the man pages, see Appendix D, "List of Trusted Extensions Man Pages".

Configuration Files in Trusted Extensions

The `/etc/inet/ike/config` file is extended by Trusted Extensions to include label information. The `ike.config(4)` man page describes the `label_aware` global parameter and three Phase 1 transform parameters, `single_label` and `multi_label`, and `wire_label`.

Note - The IKE configuration file contains a keyword, `label`, that is used to make a Phase 1 IKE rule unique. The IKE keyword `label` is distinct from Trusted Extensions labels.

♦ ♦ ♦ CHAPTER 8

About Security Requirements on a Trusted Extensions System

This chapter describes configurable security features on a system that is configured with Trusted Extensions.

Configurable Security Features

Trusted Extensions uses the same security features that Oracle Solaris provides, and adds some features. For example, the Oracle Solaris OS provides `eeprom` protection, password requirements and strong password algorithms, system protection by locking out a user, and protection from keyboard shutdown.

Trusted Extensions differs from Oracle Solaris in that you typically administer systems by assuming a limited role.

Roles in Trusted Extensions

In Trusted Extensions, roles are the conventional way to administer the system. Superuser is the `root` role, and is required for few tasks, such as setting audit flags, changing an account's password, and editing system files. Roles are created just as they are in Oracle Solaris.

The following roles are typical of a Trusted Extensions site:

- `root` **role –** Created at Oracle Solaris installation
- **Security Administrator role –** Created during or after initial configuration by the initial setup team
- **System Administrator role –** Created during or after initial configuration by the initial setup team

Role Creation in Trusted Extensions

To administer Trusted Extensions, you create roles that divide system and security functions.

The process of creating a role in Trusted Extensions is identical to the Oracle Solaris process. By default, roles are assigned the administrative label range of `ADMIN_HIGH` to `ADMIN_LOW`.

- For an overview of role creation, see "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*.
- To create roles, see "Creating Roles and Users in Trusted Extensions" on page 57.

Role Assumption in Trusted Extensions

On the trusted desktop, you can assume an assigned role by clicking your user name in the trusted stripe for the role choices. After confirming the role password, the current workspace is changed into a role workspace. A role workspace is in the global zone and has the trusted path attribute. Role workspaces are administrative workspaces.

Trusted Extensions Interfaces for Configuring Security Features

In Trusted Extensions, you can extend existing security features. Also, Trusted Extensions provides unique security features.

Extension of Oracle Solaris Security Features by Trusted Extensions

The following security mechanisms that Oracle Solaris provides are extensible in Trusted Extensions as they are in Oracle Solaris:

- **Audit classes –** Adding audit classes is described in Chapter 3, "Managing the Audit Service" in *Managing Auditing in Oracle Solaris 11.3*.

  Note - Vendors who want to add *audit events* need to contact an Oracle Solaris representative to reserve event numbers and obtain access to the audit interfaces.

- **Roles and rights profiles –** Adding roles and rights profiles is described in Chapter 3, "Assigning Rights in Oracle Solaris" in *Securing Users and Processes in Oracle Solaris 11.3*.

- **Authorizations –** For an example of adding a new authorization, see “Customizing Device Authorizations in Trusted Extensions” on page 281.

As in Oracle Solaris, privileges cannot be extended.

Unique Trusted Extensions Security Features

Trusted Extensions provides the following unique security features:

- **Labels –** Subjects and objects are labeled. Processes are labeled. Zones and the network are labeled. Workspaces and their objects are labeled.
- **Device Manager –** By default, devices are protected by allocation requirements. The Device Manager GUI is the interface for administrators and for regular users.
- **Change Password menu –** This menu enables you to change your user or role password.
- **Change Workspace Label menu –** Users in multilevel sessions can change the workspace label. Users can be required to provide a password when entering a workspace of a different label.
- **Selection Manager dialog box –** Authorized users in multilevel sessions can upgrade or downgrade information to a different label.
- **TrustedExtensionsPolicy file –** Administrators can change the policy on X server extensions that are unique to Trusted Extensions. For more information, see the `TrustedExtensionsPolicy(4)` man page.

Security Requirements Enforcement

To ensure that the security of the system is not compromised, administrators need to protect passwords, files, and audit data. You must train users to do their part. To be consistent with the requirements for an evaluated configuration, follow the guidelines in this section.

Users and Security Requirements

Each site's security administrator ensures that users are trained in security procedures. The security administrator needs to communicate the following rules to new employees and remind existing employees of these rules on a regular basis:

- Do not tell anyone your password.

  Anyone who knows your password can access the same information that you can without being identified and therefore without being accountable.
- Do not write your password down or include it in an email message.

- Choose passwords that are hard to guess.
- Do not send your password to anyone by email.
- Do not leave your computer unattended without locking the screen or logging off.
- Remember that administrators do not rely on email to send instructions to users. Do not ever follow emailed instructions from an administrator without first double-checking with the administrator.

  Be aware that sender information in email can be forged.
- Because you are responsible for the access permissions on files and directories that you create, make sure that the permissions on your files and directories are set appropriately. Do not allow unauthorized users to read a file, to change a file, to list the contents of a directory, or to add to a directory.

Your site might provide additional suggestions.

Email Usage Guidelines

It is an unsafe practice to use email to instruct users to take an action.

Warn users not to trust email with instructions that purport to come from an administrator. Doing so prevents the possibility that spoofed email messages could be used to fool users into changing a password to a certain value or divulging the password, which could subsequently be used to log in and compromise the system.

Password Enforcement

The System Administrator role must specify a unique user name and user ID when creating a new account. When choosing the name and ID for a new account, you must ensure that both the user name and associated ID are not duplicated anywhere on the network and have not been previously used.

The Security Administrator role is responsible for specifying the original password for each account and for communicating the passwords to users of new accounts. You must consider the following information when administering passwords:

- Make sure that the accounts for users who are able to assume the Security Administrator role are configured so that the account cannot be locked. This practice ensures that at least one account can always log in and assume the Security Administrator role to reopen everyone's account if all other accounts are locked.
- Communicate the password to the user of a new account in such a way that the password cannot be eavesdropped by anyone else.
- Change an account's password if you have any suspicion that the password has been discovered by someone who should not know it.

- Never reuse user names or user IDs over the lifetime of the system.

  Ensuring that user names and user IDs are not reused prevents possible confusion about the following:

  - Which actions were performed by which user when audit records are analyzed
  - Which user owns which files when archived files are restored

Information Protection

You as an administrator are responsible for correctly setting up and maintaining discretionary access control (DAC) and mandatory access control (MAC) protections for security-critical files. Critical files include the following:

- `shadow` **file –** Contains encrypted passwords. See the `shadow`(4) man page.
- `auth_attr` **file –** Contains custom authorizations. See the `auth_attr`(4) man page.
- `prof_attr` **file –** Contains custom rights profiles. See the `prof_attr`(4) man page.
- `exec_attr` **file –** Contains commands with security attributes that the site has added to rights profiles. See the `exec_attr`(4) man page.
- **Audit trail –** Contains the audit records that the audit service has collected. See the `audit.log`(4) man page.

Password Protection

In local files, passwords are protected from viewing by DAC and from modifications by both DAC and MAC. Passwords for local accounts are maintained in the `/etc/shadow` file, which is readable only by `root`. For more information, see the `shadow`(4) man page.

Group Administration Practices

The System Administrator role needs to verify on the local system and on the network that all groups have a unique group ID (GID).

When a local group is deleted from the system, the System Administrator role must ensure the following:

- All objects with the GID of the deleted group must be deleted or assigned to another group.
- All users who have the deleted group as their primary group must be reassigned to another primary group.

User Deletion Practices

When an account is deleted from the system, the System Administrator role and the Security Administrator role must take the following actions:

- Delete the account's home directories in every zone.
- Delete any processes or jobs that are owned by the deleted account:
  - Delete any objects that are owned by the account, or assign the ownership to another user.
  - Delete any `at` or `batch` jobs that are scheduled on behalf of the user. For details, see the `at(1)` and `crontab(1)` man pages.
- Never reuse the user name or user ID.

Rules When Changing the Level of Security for Data

By default, regular users can perform cut-and-paste, copy-and-paste, and drag-and-drop operations on both files and selections. The source and target must be at the same label.

To change the label of files, or the label of information within files requires authorization. When users are authorized to change the security level of data, the Selection Manager application mediates the transfer.

- The `/usr/share/gnome/sel_config` file controls file relabeling actions, and the cutting and copying of information to a different label. For more information, see "`sel_config` File" on page 114 and the `sel_config(4)` man page.
- The `/usr/bin/tsoljdsselmgr` application controls drag-and-drop operations between windows. As the following tables illustrate, the relabeling of a selection is more restrictive than the relabeling of a file.

The following table summarizes the rules for file relabeling. The rules cover cut-and-paste, copy-and-paste, and drag-and-drop operations.

TABLE 12 Conditions for Moving Files to a New Label

Transaction Description	Label Relationship	Owner Relationship	Required Authorization
Copy and paste, cut and paste, or drag and drop of files between File Browsers	Same label	Same UID	None
	Downgrade information	Same UID	`solaris.label.file.downgrade`
	Upgrade information	Same UID	`solaris.label.file.upgrade`
	Downgrade information	Different UIDs	`solaris.label.file.downgrade`
	Upgrade information	Different UIDs	`solaris.label.file.upgrade`

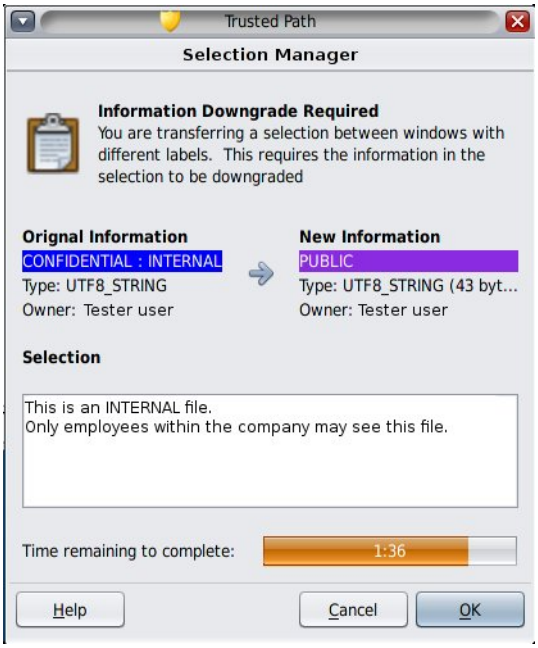
Different rules apply to selections within a window or file. Drag-and-drop of *selections* always requires equality of labels and ownership. Drag-and-drop between windows is mediated by the Selection Manager application, not by the `sel_config` file.

The rules for changing the label of selections are summarized in the following table.

TABLE 13 Conditions for Moving Selections to a New Label

Transaction Description	Label Relationship	Owner Relationship	Required Authorization
Copy and paste, or cut and paste of selections between windows	Same label	Same UID	None
	Downgrade information	Same UID	`solaris.label.win.downgrade`
	Upgrade information	Same UID	`solaris.label.win.upgrade`
	Downgrade information	Different UIDs	`solaris.label.win.downgrade`
	Upgrade information	Different UIDs	`solaris.label.win.upgrade`
Drag and drop of selections between windows	Same label	Same UID	None applicable

On a windowed system, Trusted Extensions provides a Selection Manager to mediate label changes. This dialog box appears when an authorized user attempts to change the label of a file or selection. The user has 120 seconds to confirm the operation. To change the security level of data without this window requires the `solaris.label.win.noview` authorization, in addition to the relabeling authorizations. The following illustration shows a two-line selection in the window.



By default, the Selection Manager displays whenever data is being transferred to a different label. If a selection requires several transfer decisions, the automatic reply mechanism provides a way to reply once to the several transfers. For more information, see the `sel_config`(4) man page and the following section.

`sel_config` File

The `/usr/share/gnome/sel_config` file is checked to determine the behavior of the Selection Manager when an operation would upgrade or downgrade a label.

The `sel_config` file defines the following:

- A list of selection types to which automatic replies are given
- Whether certain types of operations can be automatically confirmed
- Whether a Selection Manager dialog box is displayed

♦ ♦ ♦ CHAPTER 9

Common Tasks in Trusted Extensions

This chapter introduces you to administering Trusted Extensions systems and contains tasks that are commonly performed on these systems.

Getting Started as a Trusted Extensions Administrator on a Desktop System

Familiarize yourself with the following procedures before administering Trusted Extensions.

TABLE 14 Logging In and Using a Trusted Extensions Desktop

Task	Description	For Instructions
Log in to a Trusted Extensions system.	Logs you in securely.	"Logging In to Trusted Extensions" in *Trusted Extensions User's Guide*
Perform common user tasks on a desktop.	These tasks include: ■ Configuring your workspaces ■ Using workspaces at different labels ■ Using Trusted Extensions man pages	"Working on a Labeled System" in *Trusted Extensions User's Guide*
Perform tasks that require the trusted path.	These tasks include: ■ Allocating a device ■ Changing your password ■ Changing the label of a workspace	"Performing Trusted Actions" in *Trusted Extensions User's Guide*
Assume a role.	Places you in the global zone in a role. All administrative tasks are performed in the global zone.	"How to Enter the Global Zone in Trusted Extensions" on page 116
Select a user workspace.	Exits you from the global zone.	"How to Exit the Global Zone in Trusted Extensions" on page 116

How to Enter the Global Zone in Trusted Extensions

By assuming a role, you enter the global zone in Trusted Extensions. Administration of the entire system is possible only from the global zone.

For troubleshooting purposes, you can also enter the global zone by starting a failsafe session. For details, see "How to Log In to a Failsafe Session in Trusted Extensions" on page 138.

Before You Begin You are assigned an administrative role. For pointers, see "Role Creation in Trusted Extensions" on page 108.

1. **Click *account-name* in the trusted stripe.**

   From the list, select a role.

   For the location of Trusted Extensions desktop features, see Figure 2, "Trusted Extensions Multilevel Desktop," on page 94. For an explanation of these features, see Chapter 4, "Elements of Trusted Extensions" in *Trusted Extensions User's Guide*.

2. **At the prompt, type the role password.**

   After authentication, the current workspace changes to the role workspace.

How to Exit the Global Zone in Trusted Extensions

Before You Begin You are in the global zone.

1. **Select a user workspace from the desktop panel at the bottom of the screen.**

2. **Or, click your role name in the trusted stripe, and then select your user name.**

   The current workspace changes to a user workspace. All subsequent windows that you create in this workspace are created at your user label of the user.

   The windows that you created in the role workspace continue to support processes at the label of the role. Processes initiated in those windows execute in the global zone with administrative privileges.

   For more information, see "Working on a Labeled System" in *Trusted Extensions User's Guide*.

Performing Common Tasks in Trusted Extensions

The following task map describes common administrative procedures in Trusted Extensions.

TABLE 15 Performing Common Administrative Tasks in Trusted Extensions Task Map

Task	Description	For Instructions
Change the password for root.	Specifies a new password for the root role.	"How to Change the Password for root on a Desktop System" on page 117
Reflect a password change in a labeled zone.	Reboots the zone to update the zone that a password has changed.	"How to Enforce a New Local User Password in a Labeled Zone" on page 118
Use the Secure Attention key combination.	Gets control of the mouse or keyboard. Also, tests whether the mouse or keyboard is trusted.	"How to Regain Control of the Desktop's Current Focus" on page 119
Determine the hexadecimal number for a label.	Displays the internal representation for a text label.	"How to Obtain the Hexadecimal Equivalent for a Label" on page 120
Determine the text representation for a label.	Displays the text representation for a hexadecimal label.	"How to Obtain a Readable Label From Its Hexadecimal Form" on page 121
Allocate a device.	Enables users to allocate devices. Uses a peripheral device to add information to or remove information from the system.	"How to Authorize Users to Allocate a Device" in *Securing Systems and Attached Devices in Oracle Solaris 11.3* "How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*
Change a system configuration file.	Changes default Trusted Extensions and Oracle Solaris security values.	"How to Change Security Defaults in System Files" on page 122
Administer a system remotely.	Administers Trusted Extensions systems from a remote system.	Chapter 12, "Remote Administration in Trusted Extensions"

▼ How to Change the Password for root on a Desktop System

Trusted Extensions provides a GUI for changing your password.

1. **Assume the root role.**

   For the steps, see "How to Enter the Global Zone in Trusted Extensions" on page 116.

2. **Open the Trusted Path menu by clicking the trusted symbol in the trusted stripe.**

3. **Choose Change Login Password.**

   If separate passwords are created per zone, the menu can read Change Workspace Password.

4. **Change the password, and confirm the change.**

How to Enforce a New Local User Password in a Labeled Zone

Under the following conditions, labeled zones must be rebooted:

- One or more local users have changed their passwords.
- All zones are using a single instance of the naming service cache daemon (`nscd`).
- The system is administered with files, not LDAP.

Before You Begin You must be assigned the Zone Security rights profile.

- **To enforce the password change, reboot the labeled zones that the users can access.**

  Use one of the following methods:

  - **Use the `txzonemgr` GUI.**

    ```
    # txzonemgr &
    ```

    In the Labeled Zone Manager, navigate to the labeled zone and from the list of commands, select Halt, then select Boot.

  - **In a terminal window in the global zone, use zone administration commands.**

    You can choose to shut down or halt the system.

    - The `zlogin` command cleanly shuts down the zone.

      ```
      # zlogin labeled-zone shutdown -i 0
      # zoneadm -z labeled-zone boot
      ```

    - The `halt` subcommand bypasses the shutdown scripts.

      ```
      # zoneadm -z labeled-zone halt
      # zoneadm -z labeled-zone boot
      ```

Troubleshooting To automatically update user passwords for labeled zones, you must either configure LDAP or configure one naming service per zone. You can also configure both.

- To configure LDAP, see Chapter 5, “Configuring LDAP for Trusted Extensions”.
- Configuring one naming service per zone requires advanced networking skills. For the procedure, see “How to Configure a Separate Name Service for Each Labeled Zone” on page 55.

How to Regain Control of the Desktop's Current Focus

The “Secure Attention” key combination can be used to break a pointer grab or a keyboard grab by an untrusted application. The key combination can also be used to verify if a pointer or a keyboard has been grabbed by a trusted application. On a multiheaded system that has been spoofed to display more than one trusted stripe, this key combination warps the pointer to the authorized trusted stripe.

1. **To regain control of a Sun keyboard, use the following key combination.**

   Press the keys simultaneously to regain control of the current desktop focus. On the Sun keyboard, the diamond is the Meta key.

   ```
   <Meta> <Stop>
   ```

   If the grab, such as a pointer, is not trusted, the pointer moves to the stripe. A trusted pointer does not move to the trusted stripe.

2. **If you are not using a Sun keyboard, use the following key combination.**

   ```
   <Alt> <Break>
   ```

   Press the keys simultaneously to regain control of the current desktop focus on your laptop.

Example 9 Testing If the Password Prompt Can Be Trusted

On an x86 system that is using a Sun keyboard, the user has been prompted for a password. The cursor has been grabbed, and is in the password dialog box. To check that the prompt is trusted, the user presses the <Meta> <Stop> keys simultaneously. When the pointer remains in the dialog box, the user knows that the password prompt is trusted.

If the pointer had moved to the trusted stripe, the user would know that the password prompt could not be trusted, and contact the administrator.

Example 10 Forcing the Pointer to the Trusted Stripe

In this example, a user is not running any trusted processes but cannot see the mouse pointer. To bring the pointer to the center of the trusted stripe, the user presses the <Meta> <Stop> keys simultaneously.

How to Obtain the Hexadecimal Equivalent for a Label

This procedure provides an internal hexadecimal representation of a label. This representation is safe for storing in a public directory. For more information, see the `atohexlabel`(1M) man page.

Before You Begin You must be in the Security Administrator role in the global zone. For details, see "How to Enter the Global Zone in Trusted Extensions" on page 116.

- **To obtain the hexadecimal value for a label, do one of the following:**

  - **To obtain the hexadecimal value for a sensitivity label, pass the label to the command.**

    ```
    # atohexlabel "CONFIDENTIAL : INTERNAL USE ONLY"
    0x0004-08-48
    ```

    The string is not case-sensitive, but whitespace must be exact. For example, the following quoted strings return a hexadecimal label:

    - `"CONFIDENTIAL : INTERNAL USE ONLY"`
    - `"cnf : Internal"`
    - `"confidential : internal"`

    The following quoted strings return a parsing error:

    - `"confidential:internal"`
    - `"confidential: internal"`

  - **To obtain the hexadecimal value for a clearance, use the `-c` option.**

    ```
    # atohexlabel -c "CONFIDENTIAL NEED TO KNOW"
    0x0004-08-68
    ```

Note - Human readable sensitivity labels and clearance labels are formed according to rules in the `label_encodings` file. Each type of label uses rules from a separate section of this file. When a sensitivity label and a clearance label both express the same underlying level of sensitivity, the labels have identical hexadecimal forms. However, the labels can have different human readable forms. System interfaces that accept human readable labels as input expect one type of label. If the text strings for the label types differ, these text strings cannot be used interchangeably.

In the `label_encodings` file, the text equivalent of a clearance label does not include a colon (:).

Example 11 Using the `atohexlabel` Command

When you pass a valid label in hexadecimal format, the command returns the argument.

```
# atohexlabel 0x0004-08-68
0x0004-08-68
```

When you pass an administrative label, the command returns the argument.

```
# atohexlabel admin_high
ADMIN_HIGH
atohexlabel admin_low
ADMIN_LOW
```

Troubleshooting The error message `atohexlabel parsing error found in <string> at position 0` indicates that the `<string>` argument that you passed to `atohexlabel` was not a valid label or clearance. Check your typing, and check that the label exists in your installed `label_encodings` file.

How to Obtain a Readable Label From Its Hexadecimal Form

This procedure provides a way to repair labels that are stored in internal databases. For more information, see the `hextoalabel`(1M) man page.

Before You Begin You must be in the Security Administrator role in the global zone.

- **To obtain the text equivalent for an internal representation of a label, do one of the following.**

  - **To obtain the text equivalent for a sensitivity label, pass the hexadecimal form of the label.**

    ```
    # hextoalabel 0x0004-08-68
    CONFIDENTIAL : NEED TO KNOW
    ```

  - **To obtain the text equivalent for a clearance, use the `-c` option.**

    ```
    # hextoalabel -c 0x0004-08-68
    CONFIDENTIAL NEED TO KNOW
    ```

How to Change Security Defaults in System Files

Files in the `/etc/security` and `/etc/default` directories contain security values. For more information, see Chapter 3, "Controlling Access to Systems" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

Caution - Relax system security defaults only if site security policy allows you to.

Before You Begin You are in the global zone and are assigned the `solaris.admin.edit/`*filename* authorization. By default, the `root` role has this authorization.

- **Edit the system file.**

  The following table lists the security files and which security values you might change in the files. The first two files are unique to Trusted Extensions.

File	Task	For More Information
`sel_config` in `/usr/share/gnome/`	Specifies how system behaves when information is moved to a different label.	`sel_config(4)` man page
`TrustedExtensionsPolicy` in `/usr/lib/xorg/`	Modify `SUN_TSOL` security policy enforcement of label separation in the X server.	`TrustedExtensionsPolicy(4)` man page
`/etc/default/login`	Reduce the allowed number of password tries.	`passwd(1)` man page
`/etc/default/kbd`	Disable keyboard shutdown.	"How to Disable a System's Abort Sequence" in *Securing Systems and Attached Devices in Oracle Solaris 11.3* **Note -** On hosts that are used by administrators for debugging, the default setting for `KEYBOARD_ABORT` allows access to the `kadb` kernel debugger. `kadb(1M)` man page
`/etc/security/policy.conf`	Require a more powerful algorithm for user passwords. Remove a basic privilege from all users of this host. Restrict users of this host to Basic Solaris User authorizations.	`policy.conf(4)` man page
`/etc/default/passwd`	Require users to change passwords frequently. Require users to create maximally different passwords. Require a longer user password.	`passwd(1)` man page

File	Task	For More Information
	Require a password that cannot be found in your dictionary.	

♦ ♦ ♦ CHAPTER 10

About Users, Rights, and Roles in Trusted Extensions

This chapter describes essential decisions that you must make before creating regular users, and provides additional background information for managing user accounts. The chapter assumes that the initial setup team has set up roles and a limited number of user accounts. These users can assume the roles that are used to configure and administer Trusted Extensions. For details, see "Creating Roles and Users in Trusted Extensions" on page 57.

User Security Features in Trusted Extensions

Trusted Extensions software adds the following security features to users, roles, or rights profiles:

- A user has a label range within which the user can use the system.
- A role has a label range within which the role can be used to perform administrative tasks.
- Commands in a Trusted Extensions rights profile have a label attribute. The command must be performed within a label range, or at a particular label.
- Trusted Extensions software adds privileges and authorizations to the set of privileges and authorizations that are defined by Oracle Solaris.

Administrator Responsibilities for Users

The System Administrator role creates user accounts. The Security Administrator role sets up the security aspects of an account.

For details on setting up users and roles, see the following:

- "Task Map for Setting Up and Managing User Accounts by Using the CLI" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*
- *Securing Users and Processes in Oracle Solaris 11.3*

System Administrator Responsibilities for Users

In Trusted Extensions, the System Administrator role is responsible for determining who can access the system. The system administrator is responsible for the following tasks:

- Adding and deleting users
- Adding and deleting roles
- Assigning the initial password
- Modifying user and role properties, other than security attributes

Security Administrator Responsibilities for Users

In Trusted Extensions, the Security Administrator role is responsible for all security attributes of a user or role. The security administrator is responsible for the following tasks:

- Assigning and modifying the security attributes of a user, role, or rights profile
- Creating and modifying rights profiles
- Assigning rights profiles to a user or role
- Assigning privileges to a user, role, or rights profile
- Assigning authorizations to a user, a role, or rights profile
- Removing privileges from a user, role, or rights profile
- Removing authorizations from a user, role, or rights profile

Typically, the Security Administrator role creates rights profiles. However, if a profile needs capabilities that the Security Administrator role cannot grant, then the `root` role can create the profile.

Before creating a rights profile, the security administrator needs to analyze whether any of the commands in the new profile need privilege or authorization to be successful. The man pages for individual commands list the privileges and authorizations that might be needed.

Decisions to Make Before Creating Users in Trusted Extensions

The following decisions affect the actions that users can perform in Trusted Extensions and how much effort is required. Some decisions are the same as the decisions that you would make when installing the Oracle Solaris OS. However, decisions that are specific to Trusted Extensions can affect site security and ease of use.

- Decide whether to change default user security attributes in the `policy.conf` file. User defaults in the `label_encodings` file were originally configured by the initial setup team. For a description of the defaults, see "Default User Security Attributes in Trusted Extensions" on page 128.
- Decide which startup files, if any, to copy or link from each user's minimum-label home directory to the user's higher-level home directories. For the procedure, see "How to Configure Startup Files for Users in Trusted Extensions" on page 136.
- Decide if users can access peripheral devices, such as the microphone, CD-ROM drive, and USB devices.

  If access is permitted to some users, decide if your site requires additional authorizations to satisfy site security. For the default list of device-related authorizations, see "How to Assign Device Authorizations" on page 285. To create a finer-grained set of device authorizations, see "Customizing Device Authorizations in Trusted Extensions" on page 281.
- Decide if user accounts must be created separately in labeled zones.

  By default, labeled zones share the global zone's name service configuration. Therefore, user accounts are created in the global zone for all zones. The `/etc/passwd` and `/etc/shadow` files in the labeled zones are read-only views of the global zone files. Similarly, LDAP databases are read-only in labeled zones.

  Applications that you install to a zone from within a zone can require the creation of user accounts, such as `pkg:/service/network/ftp`. To enable a zone-specific application to create a user account, you must configure the per-zone name service daemon, as described in "How to Configure a Separate Name Service for Each Labeled Zone" on page 55. The user accounts that such applications add to a labeled zone must be manually managed by the zone administrator.

Note - Accounts that you store in LDAP are still managed from the global zone.

Default User Security Attributes in Trusted Extensions

Settings in the `label_encodings` and the `policy.conf` files together define default security attributes for user accounts. The values that you explicitly set for a user override these system values. Some values that are set in these files also apply to role accounts. For security attributes that you can explicitly set, see "Configurable User Attributes in Trusted Extensions" on page 129.

`label_encodings` File Defaults

The `label_encodings` file defines a user's minimum label, clearance, and default label view. For details about the file, see the `label_encodings(4)` man page. Your site's `label_encodings` file was installed by your initial setup team. Their decisions were based on "Devising a Label Strategy" on page 21, and examples from *Trusted Extensions Label Administration*.

Label values that the security administrator explicitly sets for individual users override values in the `label_encodings` file.

`policy.conf` File Defaults in Trusted Extensions

The `/etc/security/policy.conf` file contains the default security values for the system. Trusted Extensions adds two keywords to this file. To change the values system-wide, add these *keyword=value* pairs to the file. The following table shows the default values and the possible values for these keywords.

TABLE 16 Trusted Extensions Security Defaults in `policy.conf` File

Keyword	Default Value	Possible Values	Notes
`IDLECMD`	`LOCK`	`LOCK` | `LOGOUT`	Applies to the login user.
`IDLETIME`	`15`	`0` to `120` minutes	Applies to the login user.

The authorizations and rights profiles that are defined in the `policy.conf` file are *in addition* to any authorizations and profiles that are assigned to individual accounts. For the other fields, the individual user's value overrides the system value.

"Planning User Security in Trusted Extensions" on page 26 includes a table of every `policy.conf` keyword. See also the `policy.conf(4)` man page.

Configurable User Attributes in Trusted Extensions

For users who can log in at more than one label, you might want to set up two helper files, `.copy_files` and `.link_files`, in each user's minimum-label home directory. For more information, see “`.copy_files` and `.link_files` Files” on page 131.

Security Attributes That Must Be Assigned to Users

The security administrator can modify the security attributes for new users. For information about the files that contain the default values, see “Default User Security Attributes in Trusted Extensions” on page 128. The following table shows the security attributes that can be assigned to users and the effect of each assignment.

TABLE 17 Security Attributes That Are Assigned After User Creation

User Attribute	Location of Default Value	Is Action Required	Effect of Assignment
Password	None	Required	User has password
Roles	None	Optional	User can assume a role
Authorizations	`policy.conf` file	Optional	User has additional authorizations
Rights Profiles	`policy.conf` file	Optional	User has additional rights profiles
Labels	`label_encodings` file	Optional	User has different default label or accreditation range
Privileges	`policy.conf` file	Optional	User has different set of privileges
Account Usage	`policy.conf` file	Optional	User has different setting for computer when it is idle
Audit	Kernel	Optional	User is audited differently from the system defaults

Security Attribute Assignment to Users in Trusted Extensions

The security administrator assigns security attributes to users after the user accounts are created. If you have set up correct defaults, your next step is to assign security attributes only for users who need exceptions to the defaults.

When assigning security attributes to users, consider the following information:

Assigning Passwords

The system administrator can assign passwords to user accounts during account creation. After this initial assignment, the security administrator or the user can change the password.

Your password change policy should follow industry standards. For password attributes that Oracle Solaris can enforce when a password is changed, see the `passwd(1)` man page.

Note - The passwords for users who can assume roles must not be subject to any password aging constraints.

Assigning Roles

A user is not required to have a role. A user can be assigned more than one role if doing so is consistent with your site's security policy.

Assigning Authorizations

As in the Oracle Solaris OS, assigning authorizations to a user adds those authorizations to existing authorizations. For scalability, add the authorizations to a rights profile, then assign the profile to the user.

Assigning Rights Profiles

As in the Oracle Solaris OS, the order of rights profiles is important. With the exception of authorizations, the profile mechanism uses the value of the first instance of an assigned security attribute. For more information, see "Order of Search for Assigned Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

You can use the sorting order of profiles to your advantage. If you want a command to run with different security attributes from those attributes that are defined for the command in an existing profile, create a new profile with the preferred assignments for the command. Then, insert that new profile before the existing profile.

Note - Do not assign rights profiles that include administrative commands to a regular user. The rights profile cannot work because a regular user cannot enter the global zone.

Changing Privilege Default

The default privilege set can be too liberal for many sites. To restrict the privilege set for any regular user on a system, change the `policy.conf` file setting. To change the privilege set for individual users, see "How to Restrict a User's Set of Privileges" on page 141.

Changing Label Defaults

Changing a user's label defaults creates an exception to the user defaults in the `label_encodings` file.

Changing Audit Defaults

As in the Oracle Solaris OS, assigning audit classes to a user modifies the user's preselection mask. For more information about auditing, see *Managing Auditing in Oracle Solaris 11.3* and Chapter 22, "Trusted Extensions and Auditing".

`.copy_files` and `.link_files` Files

In Trusted Extensions, files are automatically copied from the skeleton directory *only* into the zone that contains the account's minimum label. To ensure that zones at higher labels can use startup files, either the user or the administrator must create the files `.copy_files` and `.link_files`.

The Trusted Extensions files `.copy_files` and `.link_files` help to automate the copying or linking of startup files into every label of an account's home directory. Whenever a user creates a workspace at a new label, the `updatehome` command reads the contents of `.copy_files` and `.link_files` at the account's minimum label. The command then copies or links every listed file into the higher-labeled workspace.

The `.copy_files` file is useful when a user wants a slightly different startup file at different labels. Copying is preferred, for example, when users use different mail aliases at different labels. The `.link_files` file is useful when a startup file should be identical at any label that it is invoked. Linking is preferred, for example, when one printer is used for all labeled print jobs. For example files, see "How to Configure Startup Files for Users in Trusted Extensions" on page 136.

The following lists some startup files that you might want users to be able to link to higher labels or to copy to higher labels:

- `.acrorc`
- `.aliases`
- `.bashrc`
- `.bashrc.user`
- `.cshrc`
- `.emacs`
- `.login`
- `.mailrc`
- `.mime_types`
- `.newsrc`
- `.signature`
- `.soffice`

♦ ♦ ♦ CHAPTER 11

Managing Users, Rights, and Roles in Trusted Extensions

This chapter provides the Trusted Extensions procedures for configuring and managing users, user accounts, and rights profiles.

Customizing the User Environment for Security

The following task map describes common tasks that you can perform when customizing a system for all users, or when customizing an individual user's account. Many of these tasks are performed before regular users can log in.

TABLE 18 Customizing the User Environment for Security Task Map

Task	Description	For Instructions
Change label attributes.	Modify label attributes, such as minimum label and default label view, for a user account.	"How to Modify Default User Label Attributes" on page 134
Change Trusted Extensions policy for all users of a system.	Changes the `policy.conf` file.	"How to Modify `policy.conf` Defaults" on page 134
	Turns on the screensaver or logs out the user after a set amount of time that the system is idle.	Example 12, "Changing the System's Idle Settings," on page 135
	Removes unnecessary privileges from all regular users of a system.	Example 13, "Modifying Every User's Basic Privilege Set," on page 135
	Prevents labels from appearing on printed output at a public kiosk.	Example 14, "Assigning Printing-Related Authorizations to All Users of a System," on page 135
Configure initialization files for users.	Configures startup files, such as `.bashrc`, `.cshrc`, `.copy_files`, and `.soffice` for all users.	"How to Configure Startup Files for Users in Trusted Extensions" on page 136
Log in to a failsafe session.	Fixes faulty user initialization files.	"How to Log In to a Failsafe Session in Trusted Extensions" on page 138

How to Modify Default User Label Attributes

You can modify the default user label attributes during the configuration of the first system. Use the modified encodings file when installing additional Trusted Extensions systems.

Caution - You must complete this task before any regular users access the system.

Before You Begin You must be in the Security Administrator role in the global zone. For details, see "How to Enter the Global Zone in Trusted Extensions" on page 116.

1. **Review the default user attribute settings in the `/etc/security/tsol/label_encodings` file.**

   For the defaults, see Table 2, "Trusted Extensions Security Defaults for User Accounts," on page 26 in "Planning User Security in Trusted Extensions" on page 26.

2. **Edit a copy of the active encodings file.**

   a. **Locate the active file.**

   ```
   # labeladm encodings
   Label encodings file: /var/tsol/encodings/label_encodings.fSaG.L
   ```

   b. **Edit a copy of the active file.**

   ```
   # cp /var/tsol/encodings/label_encodings.fSaG.L /tmp/tmp-encodings
   # pfedit /tmp/tmp-encodings
   ```

3. **Replace the system's label encodings file and reboot the system.**

   ```
   # labeladm encodings /tmp/tmp-encodings
   # /usr/sbin/reboot
   ```

4. **Repeat the procedure on every Trusted Extensions system.**

Caution - The contents of the active label encodings file must be the same on all systems.

How to Modify `policy.conf` Defaults

Changing the `policy.conf` defaults in Trusted Extensions is identical to changing any security-relevant system file in Oracle Solaris. Use this procedure to change the defaults for all users of a system.

Before You Begin You must be in the root role in the global zone. For details, see "How to Enter the Global Zone in Trusted Extensions" on page 116.

1. **Review the default settings in the /etc/security/policy.conf file.**
   For Trusted Extensions keywords, see Table 16, "Trusted Extensions Security Defaults in policy.conf File," on page 128.

2. **Modify the settings.**

   ```
   # pfedit /etc/security/policy.conf
   ```

Example 12 Changing the System's Idle Settings

In this example, the security administrator wants idle systems to return to the login screen. The default locks an idle system. Therefore, the root role adds the IDLECMD *keyword=value* pair to the /etc/security/policy.conf file as follows:

```
IDLECMD=LOGOUT
```

The administrator also wants systems to be idle a shorter amount of time before logout. Therefore, the root role adds the IDLETIME *keyword=value* pair to the policy.conf file as follows:

```
IDLETIME=10
```

The system now logs out the user after the system is idle for 10 minutes.

Note that if the login user assumes a role, the user's IDLECMD and IDLETIME values are in effect for that role.

Example 13 Modifying Every User's Basic Privilege Set

In this example, the security administrator of a large Sun Ray installation does not want regular users to view the processes of other Sun Ray users. Therefore, on every system that is configured with Trusted Extensions, the root role removes proc_info from the basic set of privileges. The PRIV_DEFAULT setting in the /etc/policy.conf file is uncommented and modified as follows:

```
PRIV_DEFAULT=basic,!proc_info
```

Example 14 Assigning Printing-Related Authorizations to All Users of a System

In this example, site security permits a public kiosk computer to print without labels. On the public kiosk, the root role modifies the value for AUTHS_GRANTED in the /etc/security/policy.conf file. At the next boot, print jobs by all users of this kiosk print without page labels.

```
AUTHS_GRANTED=solaris.print.unlabeled
```

Then, the administrator decides to save paper by removing banner and trailer pages. The administrator further modifies the `policy.conf` entry.

```
AUTHS_GRANTED=solaris.print.unlabeled,solaris.print.nobanner
```

After the public kiosk is rebooted, all print jobs are unlabeled, and have no banner or trailer pages.

How to Configure Startup Files for Users in Trusted Extensions

Users can put a `.copy_files` file and `.link_files` file into their home directory at the label that corresponds to their minimum sensitivity label. Users can also modify the existing `.copy_files` and `.link_files` files at the users' minimum label. This procedure is for the administrator role to automate the setup for a site.

Before You Begin You must be in the System Administrator role in the global zone. For details, see "How to Enter the Global Zone in Trusted Extensions" on page 116.

1. **Create two Trusted Extensions startup files.**

   You are going to add `.copy_files` and `.link_files` to your list of startup files.

   ```
   # cd /etc/skel
   # touch .copy_files .link_files
   ```

2. **Customize the `.copy_files` file.**

   a. **In an editor, type the full pathname to the `.copy_files` file.**

      ```
      # pfedit /etc/skel/.copy_files
      ```

   b. **Type into `.copy_files`, one file per line, the files to be copied into the user's home directory at all labels.**

      Use "`.copy_files` and `.link_files` Files" on page 131 for ideas. For sample files, see Example 15, "Customizing Startup Files for Users," on page 137.

3. **Customize the `.link_files` file.**

   a. **In an editor, type the full pathname to the `.link_files`.**

      ```
      # pfedit /etc/skel/.link_files
      ```

   b. **Type into `.link_files`, one file per line, the files to be linked into the user's home directory at all labels.**

4. **Customize the other startup files for your users.**

   - For a discussion of which files to include in startup files, see "About the User's Work Environment" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.
   - For details, see "How to Customize User Initialization Files" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.

5. **(Optional) Create a `skelP` subdirectory for users whose default shell is a profile shell.**

   The `P` indicates the Profile shell.

6. **Copy the customized startup files into the appropriate skeleton directory.**

7. **Use the appropriate `skel`*X* pathname when you create the user.**

   The *X* indicates the letter that begins the shell's name, such as `B` for Bourne, `K` for Korn, `C` for a C shell, and `P` for Profile shell.

Example 15 Customizing Startup Files for Users

In this example, the system administrator configures files for every user's home directory. The files are in place before any user logs in. The files are at the user's minimum label. At this site, the users' default shell is the C shell.

The system administrator creates a `.copy_files` and a `.link_files` file with the following contents:

```
## .copy_files for regular users
## Copy these files to my home directory in every zone
.mailrc
.mozilla
.soffice
:wq

## .link_files for regular users with C shells
## Link these files to my home directory in every zone
.bashrc
.bashrc.user
.cshrc
.login
:wq

## .link_files for regular users with Korn shells
# Link these files to my home directory in every zone
.ksh
.profile
:wq
```

In the shell initialization files, the administrator adds customizations.

```
## .cshrc file
setenv EDITOR emacs
setenv ETOOLS /net/tools/etools

## .ksh file
export EDITOR emacs
export ETOOLS /net/tools/etools
```

The customized files are copied to the appropriate skeleton directory.

```
# cp .copy_files .link_files .bashrc .bashrc.user .cshrc \
.login .profile .mailrc /etc/skelC
# cp .copy_files .link_files .ksh .profile .mailrc \
/etc/skelK
```

Troubleshooting If you create a `.copy_files` files at your lowest label, then log in to a higher zone to run the `updatehome` command and the command fails with an access error, try the following:

- Verify that from the higher-level zone you can view the lower-level directory.

  ```
  higher-level zone# ls /zone/lower-level-zone/home/username
  ACCESS ERROR: there are no files under that directory
  ```

- If you cannot view the directory, then restart the automount service in the higher-level zone:

  ```
  higher-level zone# svcadm restart autofs
  ```

Unless you are using NFS mounts for home directories, the automounter in the higher-level zone should be loopback mounting from `/zone/`*lower-level-zone*`/export/home/`*username* to `/zone/`*lower-level-zone*`/home/`*username*.

▼ How to Log In to a Failsafe Session in Trusted Extensions

In Trusted Extensions, failsafe login is protected. If a regular user has customized shell initialization files and now cannot log in, you can use failsafe login to fix the user's files.

Before You Begin You must know the root password.

1. **Type your user name in the login screen.**
2. **At the bottom of the screen, choose Solaris Trusted Extensions Failsafe Session from the desktop menu.**
3. **When prompted, type your password.**
4. **When prompted for an additional password, type the root password.**

You can now debug the user's initialization files.

Managing Users and Rights

In Trusted Extensions, you assume the Security Administrator role to administer users, authorizations, rights, and roles. The following task map describes common tasks that you perform for users who operate in a labeled environment.

TABLE 19 Managing Users and Rights Task Map

Task	Description	For Instructions
Modify a user's label range.	Modifies the labels at which a user can work. Modifications can restrict or extend the range that the `label_encodings` file permits.	"How to Modify a User's Label Range" on page 139
Create a rights profile for convenient authorizations.	Several authorizations exist that might be useful for regular users. Creates a profile for users who qualify to have these authorizations.	"How to Create a Rights Profile for Convenient Authorizations" on page 140
Modify a user's default privilege set.	Removes a privilege from the user's default privilege set.	"How to Restrict a User's Set of Privileges" on page 141
Prevent account locking for particular users.	Users who can assume a role should have account locking turned off.	"How to Prevent Account Locking for Users" on page 141
Enable a user to relabel data.	Authorizes a user to downgrade information or upgrade information.	"How to Enable a User to Change the Security Level of Data" on page 142
Remove a user from the system.	Completely removes a user and the user's processes.	"How to Delete a User Account From a Trusted Extensions System" on page 143

▼ How to Modify a User's Label Range

You might want to extend a user's label range to give the user read access to an administrative application. For example, a user who can log in to the global zone could then view a list of the systems that run at a particular label. The user could view, but not change the contents.

Alternatively, you might want to restrict the user's label range. For example, a guest user might be limited to one label.

Before You Begin You must be in the Security Administrator role in the global zone.

- **Do one of the following:**
  - **To extend the user's label range, assign a higher clearance.**

```
# usermod -K min_label=INTERNAL -K clearance=ADMIN_HIGH jdoe
```

You can also extend the user's label range by lowering the minimum label.

```
# usermod -K min_label=PUBLIC -K clearance=INTERNAL jdoe
```

For more information, see the `usermod`(1M) and `user_attr`(4) man pages.

- **To restrict the label range to one label, make the clearance equal to the minimum label.**

```
# usermod -K min_label=INTERNAL -K clearance=INTERNAL jdoe
```

How to Create a Rights Profile for Convenient Authorizations

Where site security policy permits, you might want to create a rights profile that contains authorizations for users who can perform tasks that require authorization. To enable every user of a particular system to be authorized, see "How to Modify `policy.conf` Defaults" on page 134.

Before You Begin You must be in the Security Administrator role in the global zone.

1. **Create a rights profile that contains one or more of the following authorizations.**

   For the step-by-step procedure, see "How to Create a Rights Profile" in *Securing Users and Processes in Oracle Solaris 11.3*.

   The following authorizations that might be convenient for users:

   - `solaris.device.allocate` – Authorizes a user to allocate a peripheral device, such as a microphone or CD-ROM.

     By default, Oracle Solaris users can read and write to a CD-ROM. However, in Trusted Extensions, only users who can allocate a device can access the CD-ROM drive. To allocate the drive for use requires authorization. Therefore, to read and write to a CD-ROM in Trusted Extensions, a user needs the Allocate Device authorization.
   - `solaris.label.file.downgrade` – Authorizes a user to lower the security level of a file
   - `solaris.label.file.upgrade` – Authorizes a user to heighten the security level of a file.
   - `solaris.label.win.downgrade` – Authorizes a user to select information from a higher-level file and place that information in a lower-level file.
   - `solaris.label.win.noview` – Authorizes a user to move information without viewing the information that is being moved.
   - `solaris.label.win.upgrade` – Authorizes a user to select information from a lower-level file and place that information in a higher-level file.
   - `solaris.login.remote` – Authorizes a user to remotely log in.

- `solaris.print.nobanner` - Authorizes a user to print hard copy without a banner page.
- `solaris.print.unlabeled` – Authorizes a user to print hard copy that does not display labels.
- `solaris.system.shutdown` – Authorizes a user to shut down the system and to shut down a zone.

2. **Assign the rights profile to a user or a role.**
   For step-by-step instructions, see "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*.

How to Restrict a User's Set of Privileges

Site security might require that users be permitted fewer privileges than users are assigned by default. For example, at a site that uses Trusted Extensions on Sun Ray systems, you might want to prevent users from viewing other users' processes on the Sun Ray server.

Before You Begin You must be in the Security Administrator role in the global zone.

- **Remove one or more of the privileges in the `basic` set.**

Caution - Do not remove the `proc_fork` or the `proc_exec` privilege. Without these privileges, a user cannot use the system.

```
# usermod -K defaultpriv=basic,!proc_info,!proc_session,!file_link_any
```

By removing the `proc_info` privilege, you prevent the user from examining any processes that do not originate from the user. By removing the `proc_session` privilege, you prevent the user from examining any processes outside the user's current session. By removing the `file_link_any` privilege, you prevent the user from making hard links to files that are not owned by the user.

See Also For an example of collecting the privilege restrictions in a rights profile, see the examples following "How to Create a Rights Profile" in *Securing Users and Processes in Oracle Solaris 11.3*.

To restrict the privileges of all users on a system, see Example 13, "Modifying Every User's Basic Privilege Set," on page 135.

How to Prevent Account Locking for Users

Perform this procedure for all users who can assume a role.

Before You Begin You must be in the Security Administrator role in the global zone.

- **Turn off account locking for a local user.**

```
# usermod -K lock_after_retries=no jdoe
```

To turn off account locking for an LDAP user, specify the LDAP repository.

```
# usermod -S ldap -K lock_after_retries=no jdoe
```

How to Enable a User to Change the Security Level of Data

A regular user or a role can be authorized to change the security level, or labels, of files and directories or of selected text. The user or role, in addition to having the authorization, must be configured to work at more than one label. And, the labeled zones must be configured to permit relabeling. For the procedure, see "How to Enable Files to Be Relabeled From a Labeled Zone" on page 167.

Caution - Changing the security level of data is a privileged operation. This task is for trustworthy users only.

Before You Begin You must be in the Security Administrator role in the global zone.

- **Assign the Object Label Management rights profile to the appropriate users and roles.**

  For a step-by-step procedure, see "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*.

Example 16 Enabling a User to Upgrade But Not to Downgrade a File's Label

The Object Label Management rights profile enables users to upgrade and downgrade labels. In this example, the administrator permits a trusted user to upgrade data, but not to downgrade it.

The administrator creates a rights profile that is based on the Object Label Management profile, and removes the Downgrade File Label and Downgrade DragNDrop or CutPaste Info authorizations in the new profile.

```
# profiles -p "Object Label Management"
profiles:Object Label Management> set name="Object Upgrade"
profiles:Object Upgrade> info auths
...
profiles:Object Upgrade> remove auths="solaris.label.file.downgrade,
solaris.label.win.downgrade"
```

```
profiles:Object Upgrade> commit
profiles:Object Upgrade> end
```

Then, the administrator assigns the profile to a trusted user.

```
# usermod -P +"Object Upgrade" jdoe
```

How to Delete a User Account From a Trusted Extensions System

When a user is removed from the system, you must ensure that the user's home directory and any objects that the user owns are also deleted. As an alternative to deleting objects that are owned by the user, you might change the ownership of these objects to a valid user.

You must also ensure that all batch jobs that are associated with the user are also deleted. No objects or processes belonging to a removed user can remain on the system.

Before You Begin You must be in the System Administrator role in the global zone.

1. **Archive the user's home directory at every label.**
2. **Archive the user's mail files at every label.**
3. **Delete the user account.**

   ```
   # userdel -r jdoe
   ```

4. **In every labeled zone, manually delete the user's directories and mail files.**

Note - You are responsible for finding and deleting the user's temporary files at all labels, such as files in `/tmp` directories.

For further considerations, see “User Deletion Practices” on page 112.

♦ ♦ ♦ CHAPTER 12

Remote Administration in Trusted Extensions

This chapter describes how to set up a Trusted Extensions system for remote administration, and how to log in and administer it.

Note - The configuration methods that headless and other remote systems require do not satisfy the criteria for an evaluated configuration. For more information, see "Understanding Your Site's Security Policy" on page 20.

Remote Administration in Trusted Extensions

Remote administration presents a significant security risk, particularly from users on untrusted systems. By default, Trusted Extensions does not allow remote administration from any system.

Until the network is configured, all remote hosts are assigned the `admin_low` security template, that is, they are recognized as unlabeled hosts. Until the labeled zones are configured, the only zone available is the global zone. In Trusted Extensions, the global zone is the administrative zone. Only a role can access it. Specifically, an account must have a label range from `ADMIN_LOW` to `ADMIN_HIGH` to reach the global zone.

While in this initial state, Trusted Extensions systems are protected from remote attacks by several mechanisms. Mechanisms include `netservices` values, default `ssh` policy, default login policy, and default PAM policy.

- At installation, no remote services except secure shell are enabled to listen on the network.

  However, the `ssh` service cannot be used for remote login by `root` or by role because of `ssh`, login, and PAM policies.
- The `root` account cannot be used for remote logins because `root` is a role. Roles cannot log in, as enforced by PAM.

Even if `root` is changed to a user account, the default login and `ssh` policies prevent remote logins by the `root` user.

- Two default PAM values prevent remote logins.

  The `pam_roles` module rejects local and remote logins from accounts of type `role`.

  A Trusted Extensions PAM module, `pam_tsol_account`, rejects remote logins into the global zone unless the CIPSO protocol is used. The intent of this policy is for remote administration to be performed by another Trusted Extensions system.

So, as on an Oracle Solaris system, remote administration must be configured. Trusted Extensions adds two configuration requirements, the label range that is required to reach the global zone, and the `pam_tsol_account` module.

Methods for Administering Remote Systems in Trusted Extensions

In Trusted Extensions, you must use the Secure Shell protocol with host-based authentication to reach and administer the remote system. Host-based authentication enables an identically-named user account to assume a role on the remote Trusted Extensions.

When host-based authentication is used, the Secure Shell client sends both the original username and the role name to the remote system, the server. With this information, the server can pass sufficient content to the `pam_roles` module to enable role assumption without the user account logging in to the server.

The following methods of remote administration are possible in Trusted Extensions:

- **Administer from a Trusted Extensions system –** For the most secure remote administration, both systems assign their peer to a CIPSO security template. See Example 17, “Assigning the CIPSO Host Type for Remote Administration,” on page 149.
- **Administer from an unlabeled system –** If administration by a Trusted Extensions system is not practical, the network protocol policy can be relaxed by specifying the `allow_unlabeled` option for the `pam_tsol_account` module in the PAM stack.

  If this policy is relaxed, the default security template must be changed so that arbitrary systems cannot reach the global zone. The `admin_low` template should be used sparingly, and the wildcard address `0.0.0.0` must not default to the `ADMIN_LOW` label. For details, see “How to Limit the Hosts That Can Be Contacted on the Trusted Network” on page 219.

In either administrative scenario, to use the `root` role for remote login, you must relax PAM policy by specifying the `allow_remote` option for the `pam_roles` module.

Typically, administrators use the `ssh` command to administer remote systems from the command line. With the `-X` option, Trusted Extensions administrative GUIs can be used.

Also, you can configure the remote Trusted Extensions with the Xvnc server. Then, a Virtual Network Computing (VNC) connection can be used to display the remote multilevel desktop and administer the system. See “How to Configure a Trusted Extensions System With Xvnc for Remote Access” on page 150.

Configuring and Administering Remote Systems in Trusted Extensions

After enabling remote administration and before rebooting the remote system into Trusted Extensions, you can configure the system by using Virtual Network Computing (VNC) or the `ssh` protocol.

TABLE 20 Configuring and Administering Remote Systems in Trusted Extensions Task Map

Task	Description	For Instructions
Enable remote administration of a Trusted Extensions system.	Enables the administration of Trusted Extensions systems from specified `ssh` clients.	“Enable Remote Administration of a Remote Trusted Extensions System” on page 147
Enable Virtual Network Computing (VNC).	From any client, uses the Xvnc server on a remote Trusted Extensions system to display the server's multilevel session back to the client.	“How to Configure a Trusted Extensions System With Xvnc for Remote Access” on page 150
Log in remotely to a Trusted Extensions system.	Assumes a role on the remote system to administer it.	“How to Log In and Administer a Remote Trusted Extensions System” on page 152

Note - Consult your security policy to determine which methods of remote administration are permissible at your site.

▼ Enable Remote Administration of a Remote Trusted Extensions System

In this procedure, you enable host-based authentication on an Oracle Solaris remote system before adding the Trusted Extensions feature to it. The remote system is the Secure Shell server.

Before You Begin The remote system is installed with Oracle Solaris and you can access that system. You must be in the `root` role.

1. **On both systems, enable host-based authentication.**

For the procedure, see "How to Set Up Host-Based Authentication for Secure Shell" in *Managing Secure Shell Access in Oracle Solaris 11.3*.

Note - Do not use the `cat` command. Copy and paste the public key over a Secure Shell connection. If your Secure Shell client is not an Oracle Solaris system, follow your platform's instructions for configuring a Secure Shell client with host-based authentication.

After completing this step, you have a user account on both systems that can assume the `root` role. The accounts are assigned the same UID, GID, and role assignment. You also have generated public/private key pairs and have shared public keys.

2. **On the Secure Shell server, relax `ssh` policy to enable `root` to log in remotely.**

```
# pfedit /etc/ssh/sshd_config
## Permit remote login by root
PermitRootLogin yes
```

A later step limits the `root` login to a particular system and user.

Note - Because the administrator is going to assume the `root` role, you do not need to relax the login policy that prevents remote `root` login.

3. **On the Secure Shell server, restart the `ssh` service.**

```
# svcadm restart ssh
```

4. **On the Secure Shell server, in `root`'s home directory, specify the host and user for host-based authentication.**

```
# cd
# pfedit .shosts
client-host username
```

The `.shosts` file enables *username* on the *client-host* system to assume the `root` role on the server, when a public/private key is shared.

5. **On the Secure Shell server, relax the two PAM policies.**

   a. **Copy the `/etc/pam.d/other` to `/etc/pam.d/other.orig`.**

```
# cp /etc/pam.d/other /etc/pam.d/other.orig
```

   b. **Modify the `pam_roles` entry to allow remote login by roles.**

```
# pfedit /etc/pam.d/other
...
# Default definition for Account management
```

```
# Used when service name is not explicitly mentioned for account management
# ...
#account requisite    pam_roles.so.1
# Enable remote role assumption
account requisite    pam_roles.so.1   allow_remote
...
```

This policy enables *username* on the *client-host* system to assume a role on the server.

c. Modify the `pam_tsol_account` entry to allow unlabeled hosts to contact the Trusted Extensions remote system.

```
# pfedit /etc/pam.d/other
# Default definition for Account management
# Used when service name is not explicitly mentioned for account management
# ...
#account requisite    pam_roles.so.1
# Enable remote role assumption
account requisite    pam_roles.so.1   allow_remote
#
account required     pam_unix_account.so.1
#account required     pam_tsol_account.so.1
# Enable unlabeled access to TX system
account required     pam_tsol_account.so.1  allow_unlabeled
```

6. Test the configuration.

a. Open a new terminal on the remote system.

b. On *client-host*, in a window owned by *username*, assume the `root` role on the remote system.

```
% ssh -l root remote-system
```

7. After the configuration is proved to work, enable Trusted Extensions on the remote system and reboot.

```
# svcadm enable -s labeld
# /usr/sbin/reboot
```

Example 17 Assigning the CIPSO Host Type for Remote Administration

In this example, the administrator is using a Trusted Extensions system to configure a remote Trusted Extensions host. To do so, the administrator uses the `tncfg` command on each system to define the host type of the peer system.

remote-system `# tncfg -t cipso add host=192.168.1.12` *Client-host*

client-host `# tncfg -t cipso add host=192.168.1.22` *Remote system*

To enable an administrator to configure the remote Trusted Extensions host from an unlabeled system, the administrator leaves the `allow_unlabeled` option in the remote host's `pam.d/other` file.

How to Configure a Trusted Extensions System With Xvnc for Remote Access

Virtual Network Computing (VNC) technology connects a client to a remote server, then displays the desktop of the remote server in a window on the client. Xvnc is the UNIX version of VNC, which is based on a standard X server. In Trusted Extensions, a client on any platform can connect to an Xvnc server that is running Trusted Extensions, log in to the Xvnc server, then display and work on a multilevel desktop.

For more information, see the `Xvnc`(1) and `vncconfig`(1) man pages.

Before You Begin You have installed and configured Trusted Extensions on this system that will be used as the Xvnc server. The global zone on this system has a fixed IP address.

This system recognizes the VNC clients by hostname or by IP address. Specifically, the `admin_low` security template identifies either explicitly or by using a wildcard the systems that can be VNC clients of this server. For more information about configuring the connection securely, see "How to Limit the Hosts That Can Be Contacted on the Trusted Network" on page 219.

If you are currently running in a GNOME session on the console of the future Trusted Extensions Xvnc server, you do not have Desktop Sharing enabled.

You are in the `root` role in the global zone of the future Trusted Extensions Xvnc server.

1. **Load or update the Xvnc software.**

```
# pkg search vnc
... set    VNC client based on the TigerVNC open source release that
           displays a session over RFB protocol from a VNC server
           pkg:/desktop/remote-desktop/tigervnc@version
... set    X Window System server based on X.Org Foundation open source
           release and TigerVNC open source release that displays over
           RFB protocol to a VNC client
           pkg:/x11/server/xvnc@version
...
```

One option is the TigerVNC X11/VNC server software.

```
# pkg install server/xvnc
# pkg install remote-desktop/tigervnc
```

Note - If you are unable to open the GUI, add the local `root` account to the X server access control list. Run this command as the user who logged in to the X server.

```
% xhost +si:localuser:root
```

For more information, see the `xhost`(1) and `Xsecurity`(5) man pages.

2. **Enable the X Display Manager Control Protocol.**

   Modify the GNOME Display Manager (gdm) custom configuration file. In the `/etc/gdm/custom.conf` file, type `Enable=true` under the `[xdmcp]` heading.

   ```
   [xdmcp]
   Enable=true
   ```

3. **Insert the following line in the `/etc/gdm/Xsession` file around line 27.**

   Tip - Save a copy of the original `Xsession` file before making the change.

   ```
   DISPLAY=unix:$(echo $DISPLAY|sed -e s/::ffff://|cut -d: -f2)
   ```

   The files in Step 2 and Step 3 are marked with the package attribute `preserve=true`. For information about the effect this attribute has on your modified files during package upgrades and package fixes, see the `pkg`(5) man page.

4. **Enable the Xvnc server service.**

   ```
   # svcadm enable xvnc-inetd
   ```

5. **Log out all active GNOME sessions on this server.**

   ```
   # svcadm restart gdm
   ```

   Wait about one minute for the desktop manager to restart. Then, a VNC client can connect.

6. **Verify that the Xvnc software is enabled.**

   ```
   % svcs | grep vnc
   ```

7. **On every VNC client of this Xvnc server, install the VNC client software.**

   For the client system, you have a choice of software. You can use VNC software from the Oracle Solaris repository.

8. **(Optional) Audit VNC connections.**

   For information about preselecting audit events per system and per user, see "Configuring the Audit Service" in *Managing Auditing in Oracle Solaris 11.3*.

9. **To display the Xvnc server workspace on a VNC client, perform the following steps:**

   a. **In a terminal window on the client, connect to the server.**

      % **/usr/bin/vncviewer** *Xvnc-server-hostname*

      For command options, see the `vncviewer`(1) man page.

   b. **In the window that displays, type your user name and password.**
      Continue with the login procedure. For a description of the remaining steps, see "Logging In to Trusted Extensions" in *Trusted Extensions User's Guide*.

Example 18 Using Vino to Share a Desktop in a Test Environment

In this example, two developers are using the GNOME Vino service to share the display from the Launch → System → Preferences → Desktop Sharing menu. In addition to the preceding steps, they relax Trusted Extensions policy by enabling the `XTEST` extension.

```
# pfedit /usr/X11/lib/X11/xserver/TrustedExtensionsPolicy
## /usr/X11/lib/X11/xserver/TrustedExtensionsPolicy file
...
#extension XTEST
extension XTEST
...
```

How to Log In and Administer a Remote Trusted Extensions System

This procedure enables you to use the command line and the `txzonemgr` GUI to administer a remote Trusted Extensions system.

Before You Begin The user, role, and role assignment are identically defined on the local and remote systems, as described in "Enable Remote Administration of a Remote Trusted Extensions System" on page 147.

1. **On the desktop system, enable processes from the remote system to display.**

   desktop **# xhost +** *remote-sys*

2. **Ensure that you are the user who is identically named on both systems.**

3. **From a terminal window, log in to the remote system.**
   Use the `ssh` command to log in.

```
desktop % ssh -X -l identical-username remote-sys
Password: xxxxxxxx
remote-sys %
```

The -X option enables GUIs to display.

4. **In the same terminal window, assume the role that is defined identically on both systems.**

   For example, assume the root role.

   ```
   remote-sys % su - root
   Password: xxxxxxxx
   ```

   You are now in the global zone. You can now use this terminal window to administer the remote system from the command line. GUIs will display on your screen. For an example, see Example 19, “Configuring Labeled Zones on a Remote System,” on page 153.

Example 19 Configuring Labeled Zones on a Remote System

In this example, the administrator uses the txzonemgr GUI to configure labeled zones on a labeled remote system from a labeled desktop system. As in Oracle Solaris, the administrator enables X server access to the desktop system by using the -X option to the ssh command. The user jandoe is defined identically on both systems and can assume the role remoterole.

```
TXdesk1 # xhost + TXnohead4

TXdesk1 % ssh -X -l jandoe TXnohead4
Password: xxxxxxxx
TXnohead4 %
```

To reach the global zone, the administrator uses the jandoe account to assume the role remoterole. This role is defined identically on both systems.

```
TXnohead4 % su - remoterole
Password: xxxxxxxx
```

In the same terminal, the administrator in the remoterole role starts the txzonemgr GUI.

```
TXnohead4 # /usr/sbin/txzonemgr &
```

The Labeled Zone Manager runs on the remote system and displays on the local system.

Example 20 Logging In to a Remote Labeled Zone

The administrator wants to change a configuration file on a remote system at the PUBLIC label.

The administrator has two options.

- Remotely log in to the global zone, display the remote global zone workspace, then change the workspace to the PUBLIC label, open a terminal window, and edit the file

- Remotely log in to the `PUBLIC` zone by using the `ssh` command from a `PUBLIC` terminal window and then edit the file

Note that if the remote system is running one naming service daemon (`nscd`) for all the zones, *and* the remote system is using the files naming service, the password for the remote `PUBLIC` zone is the password that was in effect when it was last booted. If the password for the remote `PUBLIC` zone was changed, but the zone was not booted after the change, the original password allows access.

Troubleshooting If the `-X` option does not work, you might need to install a package. X11 forwarding is disabled when the `xauth` binary is not installed. The following command loads the binary: **`pkg install pkg:/x11/session/xauth`**.

♦ ♦ ♦ CHAPTER 13

Managing Zones in Trusted Extensions

This chapter describes how non-global, or *labeled*, zones work on a Trusted Extensions system. Also included are procedures that are unique to labeled zones.

Zones in Trusted Extensions

A properly configured Trusted Extensions system consists of a global zone, which is the operating system instance, and one or more labeled non-global zones. During configuration, Trusted Extensions attaches a label to each zone, which creates labeled zones. The labels come from the `label_encodings` file. You can create one or more zones for each label, but are not required to. It is possible to have more labels than labeled zones on a system.

On a Trusted Extensions system, the global zone is solely an administrative zone. The labeled zones are for regular users. Users can work in a zone whose label is within the user's accreditation range.

On a Trusted Extensions system, all zones have a brand of *labeled* and all writable files and directories in a labeled zone are at the label of the zone. By default, a user can view files that are in a zone at a lower label than the user's current label. This configuration enables users to view their home directories at lower labels than the label of the current workspace. Although users can view files at a lower label, they cannot modify them. Users can only modify files from a process that has the same label as the file.

Each zone is a separate ZFS file system. Every zone can have an associated IP address and security attributes. A zone can be configured with multilevel ports (MLPs). Also, a zone can be configured with a policy for Internet Control Message Protocol (ICMP) broadcasts, such as `ping`.

For information about sharing directories from a labeled zone and about mounting directories from labeled zones remotely, see Chapter 14, “Managing and Mounting Files in Trusted Extensions” and “`mlslabel` Property and Mounting Single-Level File Systems” on page 174.

Zones in Trusted Extensions are built on the Oracle Solaris Zones product. For reference, see *Introduction to Oracle Solaris Zones*.

Zones and IP Addresses in Trusted Extensions

Your initial setup team assigned IP addresses to the global zone and the labeled zones. They considered three types of configurations as described in “Access to Labeled Zones” on page 24 and summarized as follows:

- The system has one IP address for the global zone and all labeled zones.

  This default configuration is useful on a system that uses DHCP software to obtain its IP address.
- The system has one IP address for the global zone, and one IP address that is shared by all zones, including the global zone. Any zone can have a combination of a unique address and a shared address.

  This configuration is useful on a networked system that regular users are going to log in to. It can also be used for a printer or an NFS server. This configuration conserves IP addresses.
- The system has one IP address for the global zone, and each labeled zone has a unique IP address.

  This configuration is useful for providing access to separate physical networks of single-level systems. Typically, each zone would have an IP address on a different physical network from the other labeled zones. Because this configuration is implemented with a single IP instance, the global zone controls the physical interfaces and manages global resources, such as the route table.

A fourth type of configuration for a non-global zone is available in Oracle Solaris, exclusive IP instances. In this configuration, a non-global zone is assigned its own IP instance and manages its own physical interfaces. Each zone operates as if it is a distinct system. For a description, see “Zone Network Interfaces” in *Oracle Solaris Zones Configuration Resources*.

If you configure exclusive IP instances in Trusted Extensions, each labeled zone operates as if it is a distinct *single-level* system. The multilevel networking features of Trusted Extensions rely on features of a shared IP stack. This guide assumes that networking is controlled entirely by the global zone. Therefore, if your initial setup team has installed labeled zones with exclusive IP instances, you must provide or refer to site-specific documentation.

Zones and Multilevel Ports

By default, a zone cannot send packets to and receive packets from any other zone. Multilevel ports (MLPs) enable particular services on a port to accept requests within a range of labels or from a set of labels. These privileged services can reply at the label of the request. For example, you might want to create a privileged web browser port that can listen at all labels, but whose replies are restricted by label. By default, labeled zones have no MLPs.

The range of labels or set of labels that constrains the packets that the MLP can accept is based on the zone's IP address. The IP address is assigned a security template by communicating Trusted Extensions systems. The label range or set of labels in the security template constrains the packets that the MLP can accept.

The constraints on MLPs for different IP address configurations are as follows:

- On a system where the global zone has an IP address and each labeled zone has a unique IP address, an MLP for a particular service can be added to every zone. For example, the system could be configured so that the `ssh` service, over TCP port `22`, is an MLP in the global zone and in every labeled zone.
- In a typical configuration, the global zone is assigned one IP address and labeled zones share a second IP address with the global zone. When an MLP is added to a shared interface, the service packet is routed to the labeled zone where the MLP is defined. The packet is accepted only if the label range of the remote host template for the labeled zone includes the label of the packet. If the range is `ADMIN_LOW` to `ADMIN_HIGH`, then all packets are accepted. A narrower range would discard packets that are not within the range.

  At most, one zone can define a particular port to be an MLP on a shared interface. In the preceding scenario, where the `ssh` port is configured as a shared MLP in a non-global zone, no other zone can receive `ssh` connections on the shared address. However, the global zone could define the `ssh` port as a private MLP for receipt of connections on its zone-specific address.
- In the default configuration, where the global zone and the labeled zones share an IP address, an MLP for the `ssh` service could be added to one zone. If the MLP for `ssh` is added to the global zone, then no labeled zone can add an MLP for the `ssh` service. Similarly, if the MLP for the `ssh` service is added to a labeled zone, then the global zone cannot be configured with an `ssh` MLP.

For an example, see “How to Create a Multilevel Port for a Zone” on page 224.

Zones and ICMP in Trusted Extensions

Networks transmit broadcast messages and send ICMP packets to systems on the network. On a multilevel system, these transmissions could flood the system at every label. By default, the network policy for labeled zones requires that ICMP packets be received only at the matching label.

Global Zone Processes and Labeled Zones

In Trusted Extensions, MAC policy applies to all processes, including processes in the global zone. Processes in the global zone run at the label `ADMIN_HIGH`. When files from a global zone are shared, they are shared at the label `ADMIN_LOW`. Therefore, because MAC prevents a higher-labeled process from modifying a lower-level object, the global zone usually cannot write to an NFS-mounted system.

However, in a limited number of cases, actions in a labeled zone can require that a global zone process modify a file in that zone.

A global zone process can mount a remote file system with read/write permissions under the following conditions:

- The mounting system must have a zone at the identical label as the remote file system.
- The system must mount the remote file system under the zone path of the identically labeled zone.

  The system must *not* mount the remote file system under the *zone root path* of the identically labeled zone

Consider a zone that is named `public` at the label `PUBLIC`. The *zone path* is `/zone/public/`. All directories under the zone path are at the label `PUBLIC`, as in:

```
/zone/public/dev
/zone/public/etc
/zone/public/home/username
/zone/public/root
/zone/public/usr
```

Of the directories under the zone path, only files under `/zone/public/root` are visible from the public zone. All other directories and files at the label `PUBLIC` are accessible only from the global zone. The path `/zone/public/root` is the *zone root path*.

From the perspective of the public zone administrator, the zone root path is visible as `/`. Similarly, the public zone administrator cannot access a user's home directory in the zone path, `/zone/public/home/`*username* directory. That directory is visible only from the global zone. The public zone mounts that directory in the zone root path as `/home/`*username*. From the perspective of the global zone, that mount is visible as `/zone/public/root/home/`*username*.

The public zone administrator can modify `/home/`*username*. A global zone process, when files in a user's home directory need to be modified, does not use that path. The global zone uses the user's home directory in the zone path, `/zone/public/home/`*username*.

- Files and directories that are under the zone path, `/zone/`*zonename*`/`, but not under the zone root path, `/zone/`*zonename*`/root` directory, can be modified by a global zone process that runs at the label `ADMIN_HIGH`.

- Files and directories that are under the zone root path, `/zone/public/root`, can be modified by the labeled zone administrator.

For example, when a user allocates a device in the public zone, a global zone process that runs at the label `ADMIN_HIGH` modifies the `dev` directory in the zone path, `/zone/public/dev`. Similarly, when a user saves a desktop configuration, the desktop configuration file is modified by a global zone process in the `/zone/public/home/`*username*. To share a labeled file system, see "How to Share File Systems From a Labeled Zone" on page 180.

Primary and Secondary Labeled Zones

The first zone that you create at a specific label is a primary labeled zone. Its label is unique. You can create no other primary zone at that label.

A secondary zone is a zone at the label of a primary zone. With a secondary zone, you can isolate services in separate zones at the same label. Those services can share network resources such as name servers, printers, and databases without the use of privilege. You can have multiple secondary zones at the same label.

Specifically, secondary zones differ from primary zones in the following ways:

- The label assignments of secondary zones do not need to be unique.
- Secondary zones must use exclusive IP networking.

  This restriction ensures that a labeled packet reaches the correct zone.
- Secondary zones do not have GNOME packages installed.

  Secondary zones are not visible on the GNOME Trusted Desktop.
- Secondary zones cannot be the destination zone for the `setlabel` command.

  If several zones are at the same label, the destination zone cannot be resolved by the command.

For any label, there can be at most one primary labeled zone and an arbitrary number of secondary labeled zones. The global zone remains an exception. It is the only zone that can be assigned the `ADMIN_LOW` label and therefore cannot have a secondary zone. To create a secondary zone, see "How to Create a Secondary Labeled Zone" on page 68 and the `zenity`(1) man page.

Zone Administration Utilities in Trusted Extensions

Zone administration tasks can be performed from the command line. However, the simplest way to administer zones is to use the shell script, `/usr/sbin/txzonemgr` that Trusted Extensions

provides. This script provides a menu-based wizard for creating, installing, initializing, and booting zones. For details, see the `txzonemgr`(1M) and `zenity`(1) man pages.

Managing Zones

The following task map describes zone management tasks that are specific to Trusted Extensions. The map also links to common procedures that are performed in Trusted Extensions just as they are performed on an Oracle Solaris system.

TABLE 21 Managing Zones Task Map

Task	Description	For Instructions
View all zones.	At any label, views the zones that are dominated by the current zone.	"How to Display Ready or Running Zones" on page 161
View mounted directories.	At any label, views the directories that are dominated by the current label.	"How to Display the Labels of Mounted Files" on page 161
Enable regular users to view an `/etc` file.	Loopback mounts a directory or file from the global zone that is not visible by default in a labeled zone.	"How to Loopback Mount a File That Is Usually Not Visible in a Labeled Zone" on page 163
Prevent regular users from viewing a lower-level home directory from a higher label.	By default, lower-level directories are visible from higher-level zones. When you disable the mounting of one lower-level zone, you disable all mounts of lower-level zones.	"How to Disable the Mounting of Lower-Level Files" on page 164
Create a multilevel dataset for the changing of the labels on files.	Enables the relabeling of files in one ZFS dataset, no privilege required.	"How to Create and Share a Multilevel Dataset" on page 69
Configure a zone to enable the changing of the labels on files.	By default, labeled zones do not have the privilege that enables an authorized user to relabel a file. You modify the zone configuration to add the privilege.	"How to Enable Files to Be Relabeled From a Labeled Zone" on page 167
Attach a ZFS dataset to a labeled zone and share it.	Mounts a ZFS dataset with read/write permissions in a labeled zone and shares the dataset read-only with a higher zone.	"How to Share a ZFS Dataset From a Labeled Zone" on page 165.
Configure a new primary zone.	Creates a zone at a label that is not currently being used to label a zone on this system.	See "How to Create Labeled Zones Interactively" on page 47.
Configure a secondary zone.	Creates a zone for isolating services that do not require a desktop.	"How to Create a Secondary Labeled Zone" on page 68.
Create a multilevel port for an application.	Multilevel ports are useful for programs that require a multilevel feed into a labeled zone.	"How to Create a Multilevel Port for a Zone" on page 224 Example 49, "Configuring a Private Multilevel Port for NFSv3 Over `udp`," on page 226
Troubleshoot NFS mount and access problems.	Debugs general access issues for mounts and possibly for zones.	"How to Troubleshoot Mount Failures in Trusted Extensions" on page 183
Remove a labeled zone.	Completely removes a labeled zone from the system.	"How to Remove a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*

How to Display Ready or Running Zones

Before You Begin You must be in the System Administrator role in the global zone.

1. **On a windowed system, run the `txzonemgr &` command.**

   The zone names, their status, and their labels are displayed in a GUI.

2. **You can also use the `zoneadm list -v` command.**

```
# zoneadm list -v
ID NAME       STATUS     PATH              BRAND       IP
0 global     running    /                 ipkg        shared
5 internal   running    /zone/internal    labeled     shared
6 public     running    /zone/public      labeled     shared
```

   The output does not list the labels of the zones.

How to Display the Labels of Mounted Files

This procedure creates a shell script that displays the mounted file systems of the current zone. When run from the global zone, the script displays the labels of all mounted file systems in every zone.

Before You Begin You must be in the System Administrator role in the global zone.

1. **In an editor, create the `getmounts` script.**

   Provide the pathname to the script, such as `/usr/local/scripts/getmounts`.

2. **Add the following content and save the file:**

```
#!/bin/sh
#
for i in `/usr/sbin/mount -p | cut -d " " -f3` ; do
/usr/bin/getlabel $i
done
```

3. **Test the script in the global zone.**

```
# /usr/local/scripts/getmounts
/:      ADMIN_HIGH
/dev:   ADMIN_HIGH
/system/contract:        ADMIN_HIGH
/proc:                   ADMIN_HIGH
```

```
/system/volatile:        ADMIN_HIGH
/system/object:          ADMIN_HIGH
/lib/libc.so.1:          ADMIN_HIGH
/dev/fd:        ADMIN_HIGH
/tmp:           ADMIN_HIGH
/etc/mnttab:    ADMIN_HIGH
/export:        ADMIN_HIGH
/export/home:   ADMIN_HIGH
/export/home/jdoe:   ADMIN_HIGH
/zone/public:        ADMIN_HIGH
/rpool:              ADMIN_HIGH
/zone:               ADMIN_HIGH
/home/jdoe:          ADMIN_HIGH
/zone/public:        ADMIN_HIGH
/zone/snapshot:      ADMIN_HIGH
/zone/internal:      ADMIN_HIGH
...
```

Example 21 Displaying the Labels of File Systems in the `restricted` Zone

When run from a labeled zone by a regular user, the `getmounts` script displays the labels of all the mounted file systems in that zone. On a system where zones are created for every label in the default `label_encodings` file, the following is sample output from the `restricted` zone:

```
# /usr/local/scripts/getmounts
/:      CONFIDENTIAL : RESTRICTED
/dev:   CONFIDENTIAL : RESTRICTED
/kernel:        ADMIN_LOW
/lib:   ADMIN_LOW
/opt:   ADMIN_LOW
/platform:      ADMIN_LOW
/sbin:  ADMIN_LOW
/usr:   ADMIN_LOW
/var/tsol/doors:        ADMIN_LOW
/zone/needtoknow/export/home:   CONFIDENTIAL : NEED TO KNOW
/zone/internal/export/home:     CONFIDENTIAL : INTERNAL USE ONLY
/proc:  CONFIDENTIAL : RESTRICTED
/system/contract:       CONFIDENTIAL : RESTRICTED
/etc/svc/volatile:      CONFIDENTIAL : RESTRICTED
/etc/mnttab:    CONFIDENTIAL : RESTRICTED
/dev/fd:        CONFIDENTIAL : RESTRICTED
/tmp:   CONFIDENTIAL : RESTRICTED
/var/run:       CONFIDENTIAL : RESTRICTED
/zone/public/export/home:       PUBLIC
/home/jdoe:   CONFIDENTIAL : RESTRICTED
```

How to Loopback Mount a File That Is Usually Not Visible in a Labeled Zone

This procedure enables a user in a specified labeled zone to view files that are not exported from the global zone by default.

Before You Begin You must be in the System Administrator role in the global zone.

1. **Halt the zone whose configuration you want to change.**

   ```
   # zoneadm -z zone-name halt
   ```

2. **Loopback mount a file or directory.**

   For example, enable ordinary users to view a file in the `/etc` directory.

   ```
   # zonecfg -z zone-name
   add filesystem
   set special=/etc/filename
   set directory=/etc/filename
   set type=lofs
   add options [ro,nodevices,nosetuid]
   end
   exit
   ```

3. **Start the zone.**

   ```
   # zoneadm -z zone-name boot
   ```

Example 22 Loopback Mounting the `/etc/passwd` file

In this example, the security administrator enables testers and programmers to check that their local passwords are set. After the `sandbox` zone is halted, it is configured to loopback mount the `passwd` file. After the zone is restarted, regular users can view the entries in the `passwd` file.

```
# zoneadm -z sandbox halt
# zonecfg -z sandbox
add filesystem
set special=/etc/passwd
set directory=/etc/passwd
set type=lofs
add options [ro,nodevices,nosetuid]
end
exit
# zoneadm -z sandbox boot
```

How to Disable the Mounting of Lower-Level Files

By default, users can view lower-level files. To prevent the viewing of all lower-level files from a particular zone, remove the `net_mac_aware` privilege from that zone. For a description of the `net_mac_aware` privilege, see the `privileges(5)` man page.

Before You Begin You must be in the System Administrator role in the global zone.

1. **Halt the zone whose configuration you want to change.**

   ```
   # zoneadm -z zone-name halt
   ```

2. **Configure the zone to prevent the viewing of lower-level files.**

   Remove the `net_mac_aware` privilege from the zone.

   ```
   # zonecfg -z zone-name
   set limitpriv=default,!net_mac_aware
   exit
   ```

3. **Restart the zone.**

   ```
   # zoneadm -z zone-name boot
   ```

Example 23 Preventing Users From Viewing Lower-Level Files

In this example, the security administrator prevents users on one system from being confused. Therefore, users can only view files at the label at which the users are working. So, the security administrator prevents the viewing of all lower-level files. On this system, users cannot see publicly available files unless they are working at the `PUBLIC` label. Also, users can only NFS mount files at the label of the zones.

```
# zoneadm -z restricted halt
# zonecfg -z restricted
set limitpriv=default,!net_mac_aware
exit
# zoneadm -z restricted boot

# zoneadm -z needtoknow halt
# zonecfg -z needtoknow
set limitpriv=default,!net_mac_aware
exit
# zoneadm -z needtoknow boot

# zoneadm -z internal halt
# zonecfg -z internal
set limitpriv=default,!net_mac_aware
exit
```

```
# zoneadm -z internal boot
```

Because PUBLIC is the lowest label, the security administrator does not run the commands for the PUBLIC zone.

How to Share a ZFS Dataset From a Labeled Zone

In this procedure, you mount a ZFS dataset with read/write permissions in a labeled zone. Because all commands are executed in the global zone, the global zone administrator controls the addition of ZFS datasets to labeled zones.

At a minimum, the labeled zone must be in the ready state to share a dataset. The zone can be in the running state.

Before You Begin To configure the zone with the dataset, you must first halt the zone. You must be in the root role in the global zone.

1. **Create the ZFS dataset.**

   ```
   # zfs create datasetdir/subdir
   ```

   The name of the dataset can include a directory, such as zone/data.

2. **In the global zone, halt the labeled zone.**

   ```
   # zoneadm -z labeled-zone-name halt
   ```

3. **Set the mount point of the dataset.**

   ```
   # zfs set mountpoint=legacy datasetdir/subdir
   ```

   Setting the ZFS mountpoint property sets the label of the mount point when the mount point corresponds to a labeled zone.

4. **Enable the dataset to be shared.**

   ```
   # zfs set sharenfs=on datasetdir/subdir
   ```

5. **Add the dataset to the zone as a file system.**

   ```
   # zonecfg -z labeled-zone-name
   # zonecfg:labeled-zone-name> add fs
   # zonecfg:labeled-zone-name:dataset> set dir=/subdir
   # zonecfg:labeled-zone-name:dataset> set special=datasetdir/subdir
   # zonecfg:labeled-zone-name:dataset> set type=zfs
   # zonecfg:labeled-zone-name:dataset> end
   ```

```
# zonecfg:labeled-zone-name> exit
```

By adding the dataset as a file system, the dataset is mounted at `/data` in the zone. This step ensures that the dataset is not mounted before the zone is booted.

6. **Boot the labeled zone.**

```
# zoneadm -z labeled-zone-name boot
```

When the zone is booted, the dataset is mounted automatically as a read/write mount point in the *labeled-zone-name* zone with the label of the *labeled-zone-name* zone.

Example 24 Sharing and Mounting a ZFS Dataset From Labeled Zones

In this example, the administrator adds a ZFS dataset to the `needtoknow` zone and shares the dataset. The dataset, `zone/data`, is currently assigned to the `/mnt` mount point. Users in the `restricted` zone can view the dataset.

First, the administrator halts the zone.

```
# zoneadm -z needtoknow halt
```

Because the dataset is currently assigned to a different mount point, the administrator removes the previous assignment, then sets the new mount point.

```
# zfs set zoned=off zone/data
# zfs set mountpoint=legacy zone/data
```

Then, the administrator shares the dataset.

```
# zfs set sharenfs=on zone/data
```

Next, in the `zonecfg` interactive interface, the administrator explicitly adds the dataset to the `needtoknow` zone.

```
# zonecfg -z needtoknow
# zonecfg:needtoknow> add fs
# zonecfg:needtoknow:dataset> set dir=/data
# zonecfg:needtoknow:dataset> set special=zone/data
# zonecfg:needtoknow:dataset> set type=zfs
# zonecfg:needtoknow:dataset> end
# zonecfg:needtoknow> exit
```

Next, the administrator boots the `needtoknow` zone.

```
# zoneadm -z needtoknow boot
```

The dataset is now accessible.

Users in the `restricted` zone, which dominates the `needtoknow` zone, can view the mounted dataset by changing to the `/data` directory. They use the full path to the mounted dataset from the perspective of the global zone. In this example, `system1` is the host name of the system that includes the labeled zone. The administrator assigned this host name to a non-shared IP address.

```
# cd /net/system1/zone/needtoknow/root/data
```

Troubleshooting If the attempt to reach the dataset from the higher label returns the error `not found` or `No such file or directory`, the administrator must restart the automounter service by running the `svcadm restart autofs` command.

How to Enable Files to Be Relabeled From a Labeled Zone

This procedure is a prerequisite for a user to be able to relabel files.

Before You Begin The zone you plan to configure must be halted. You must be in the Security Administrator role in the global zone.

1. **Open the Labeled Zone Manager.**

   ```
   # /usr/sbin/txzonemgr &
   ```

2. **Configure the zone to enable relabeling.**

   a. **Double-click the zone.**

   b. **From the list, select Permit Relabeling.**

3. **Select Boot to restart the zone.**

4. **Click Cancel to return to the zone list.**

   For the user and process requirements that permit relabeling, see the `setflabel`(3TSOL) man page. To authorize a user to relabel files, see "How to Enable a User to Change the Security Level of Data" on page 142.

Example 25 Permitting Downgrades Only From the `internal` Zone

In this example, the security administrator uses the `zonecfg` command to enable the downgrading of information but not the upgrading of information from the `CNF: INTERNAL USE ONLY` zone.

```
# zonecfg -z internal set limitpriv=default,file_downgrade_sl
```

Example 26 Preventing Downgrades From the `internal` Zone

In this example, the security administrator prevents the downgrade of `CNF: INTERNAL USE ONLY` files on a system that previously was used to downgrade files.

The administrator uses the Labeled Zone Manager to halt the `internal` zone, then selects Deny Relabeling from the `internal` zone menu.

♦ ♦ ♦ CHAPTER 14

Managing and Mounting Files in Trusted Extensions

This chapter explains Trusted Extensions policy when sharing and mounting files, and the effect of this policy on ZFS mounts of multilevel datasets, and LOFS and NFS mounts of single-level ZFS datasets. This chapter also covers how to back up and restore files.

Mount Possibilities in Trusted Extensions

Trusted Extensions can mount two kinds of ZFS datasets.

- A *single-level labeled dataset* has the same label as the zone in which the data resides or is mounted. All files and directories in a single-level dataset are at the same label. These datasets are the typical datasets in Trusted Extensions.
- A *multilevel dataset* can contain files and directories at different labels. Such a dataset is efficient for serving NFS clients at many different labels, and can streamline the process of relabeling of files.

The following mounts are possible in Trusted Extensions:

- **ZFS mounts –** Multilevel datasets that the administrator creates can be ZFS-mounted in the global zone. A ZFS-mounted multilevel dataset can be LOFS-mounted into labeled zones on the same system.

  Single-level datasets can also be created and ZFS-mounted by administrators in labeled zones.

- **LOFS mounts –** As stated in the preceding paragraph, the global zone can LOFS mount a single-level dataset into a labeled zone. The label of the mount is `ADMIN_LOW`, therefore, all mounted files are read-only in the labeled zone.

  The global zone can also LOFS mount a multilevel dataset into a labeled zone. The mounted files that are the same label as the zone can be modified. With appropriate permissions, the files can be relabeled. Mounted files that are at a level lower than the label of the zone can be viewed.
- **NFS mounts –** Labeled zones can mount single-level datasets at the label of the zone. These files can originate from another labeled zone or from an untrusted system that is assigned the same label as the labeled zone.

  A global zone can NFS mount a multilevel dataset from another Trusted Extensions system. The mounted files can be viewed and modified, but not relabeled. Also, only files and directories at the label of the mounting zone return the correct label.

  A labeled zone can NFS mount a multilevel dataset from another Trusted Extensions system. NFS-mounted files cannot be relabeled, and the label of the files cannot be determined by the `getlabel` command. However, MAC policy works correctly. The mounted files that are at the same label as the zone can be viewed and modified. Lower-level files can be viewed.

Trusted Extensions Policies for Mounted File Systems

While Trusted Extensions supports the same file systems and file system management commands as Oracle Solaris, mounted file systems in Trusted Extensions are subject to the mandatory access control (MAC) policies for viewing and modifying labeled data. The mount policies and the read and write policies enforce the MAC policies for labeling.

Trusted Extensions Policy for Single-Level Datasets

For single-level datasets, the mount policy prevents any NFS or LOFS mounts that would violate MAC. For example, a zone's label must dominate all of its mounted file system labels, and only equally labeled file systems can be mounted with read-write permissions. Any shared file systems that belong to other zones or to NFS servers are mounted at the label of the owner.

The following summarizes the behavior of NFS-mounted single-level datasets:

- In the global zone, all mounted files can be viewed, but only files that are labeled `ADMIN_HIGH` can be modified.
- In a labeled zone, all mounted files that are equal to or lower than the label of the zone can be viewed, but only files at the label of the zone can be modified.

- On an untrusted system, only file systems from a labeled zone whose label is the same as the untrusted system's assigned label can be viewed and modified.

For LOFS-mounted single-level datasets, the mounted files can be viewed. They are at the label `ADMIN_LOW`, so cannot be modified.

Trusted Extensions Policy for Multilevel Datasets

For multilevel datasets, the MAC read and write policies are enforced at the granularity of files and directories rather than at the granularity of the file system.

Multilevel datasets can only be mounted in the global zone. Labeled zones can only access multilevel datasets by using LOFS mount points that you specify with the `zonecfg` command. For the procedure, see "How to Create and Share a Multilevel Dataset" on page 69. Appropriately privileged processes in the global zone or labeled zones can relabel files and directories. For relabeling examples, see *Trusted Extensions User's Guide*.

- In the global zone, all files in the multilevel dataset can be viewed. Mounted files that are labeled `ADMIN_HIGH` can be modified.
- In a labeled zone, the multilevel dataset is mounted over LOFS. Mounted files at the same label or a lower level as the zone can be viewed. Mounted files at the same label as the zone can be modified.
- Multilevel datasets can also be shared from the global zone over NFS. Remote clients can view files that are dominated by their network label, and modify files with equal labels. However, relabeling is not possible on an NFS-mounted multilevel dataset. For information about NFS mounts, see "Mounting Multilevel Datasets From Another System" on page 175.

For more information, see "Multilevel Datasets for Relabeling Files" on page 174.

No Privilege Overrides for MAC Read-Write Policy

The MAC policy for reading and writing files has no privilege overrides. Single-level datasets can only be mounted read-write if the label of the zone equals the label of the dataset. For read-only mounts, the zone label must dominate the dataset label. For multilevel datasets, all files and directories must be dominated by the `mlslabel` property, which defaults to `ADMIN_HIGH`. For multilevel datasets, MAC policy is enforced at the file and directory level. MAC policy enforcement is invisible to all users. Users cannot see an object unless they have MAC access to the object.

The following summarizes the share and mount policies in Trusted Extensions for single-level datasets:

- For a Trusted Extensions system to mount a file system on another Trusted Extensions system, the server and the client must have compatible remote host templates of type `cipso`.

- For a Trusted Extensions system to mount a file system from an untrusted system, the single label that is assigned to the untrusted system by the Trusted Extensions system must match the label of the global zone.

  Similarly, for a labeled zone to mount a file system from an untrusted system, the single label that is assigned to the untrusted system by the Trusted Extensions system must match the label of the mounting zone.
- Files whose labels differ from the mounting zone and are mounted with LOFS can be viewed, but cannot be modified. For details on NFS mounts, see "NFS Server and Client Configuration in Trusted Extensions" on page 176.

The following summarizes the share and mount policies in Trusted Extensions for multilevel datasets:

- For a Trusted Extensions system to share a multilevel dataset with another system, the NFS server must be configured as a multilevel service.
- For a Trusted Extensions system to share a multilevel dataset with labeled zones on it own system, the global zone must LOFS mount the dataset in the zones.

  The labeled zone has write access to those LOFS-mounted files and directories whose label matches the zone's label, and has read access to the files and directories that it dominates. MAC policy is enforced at the individual file and directory level.

Results of Sharing and Mounting File Systems in Trusted Extensions

In Trusted Extensions, shared files can ease administration, and provide efficiency and speed. MAC is always in force.

- Share single-level datasets from a labeled zone, over NFS – As in Oracle Solaris, shared directories ease administration. For example, you can install the man pages for Oracle Solaris on one system, and share the man page directory with other systems.
- Share multilevel datasets from the global zone, over LOFS – LOFS-mounted datasets provide efficiency and speed when moving files from one label to another. Files are moved within the dataset, so no i/o operations are used.
- Share multilevel datasets from the global zone, over NFS – An NFS server can share a multilevel dataset that contains files at many labels to many clients. Such a configuration eases administration and provides a single location for file distribution. You do not require a server at a particular label to serve clients at that label.

Sharing and Mounting Files in the Global Zone

Mounting files in the global zone is identical to mounting files in Oracle Solaris, subject to MAC policy. Files that are shared from the global zone are shared at the label of the file. Therefore, file systems from a global zone are not usefully shared with the global zones of other Trusted Extensions systems, because all files are shared at the label `ADMIN_LOW`. The files that the global zone usefully shares with other systems are multilevel datasets.

Files and directories in a single-level dataset that are shared over LOFS from the global zone are shared at `ADMIN_LOW`. For example, the `/etc/passwd` and `/etc/shadow` files from the global zone can be LOFS mounted in the labeled zones on the system. Because the files are `ADMIN_LOW`, they are visible and read-only in the labeled zones. Files and directories in multilevel datasets are shared at the label of the object.

The global zone can also share multilevel datasets over NFS. A client can request to mount the dataset when the NFS service is configured to use multilevel ports. The request succeeds when the client label is within the label range that is specified in the `cipso` template for the network interface that handles the client's NFS mount request.

Specifically, the behavior of global zones and mounted files is the following:

- In the global zone on Trusted Extensions clients, everything in the share is readable, and the clients can write at `ADMIN_HIGH`, just as the local global zone processes can.
- When the client is a labeled zone, the mounted files are read-write when the label of the zone matches the label of the shared file.
- When the client is an unlabeled system, the mounted files are read-write when the assigned label of the client matches the label of the shared file.
- Clients at the label `ADMIN_LOW` cannot mount the dataset.
- To share multilevel datasets with labeled zones on the same system, the global zone can use LOFS.

For more information about the viewing and relabeling of files on an NFS mount, see “Mounting Multilevel Datasets From Another System” on page 175.

Sharing and Mounting Files in a Labeled Zone

A labeled zone can share its files with other systems at the label of the zone. Therefore, file systems from a labeled zone can be shared with zones at the same label on other Trusted Extensions systems, and with untrusted systems that are assigned the same label as the zone. For information about the ZFS property that mediates these mounts, see “`mlslabel` Property and Mounting Single-Level File Systems” on page 174.

LOFS mounts from the global zone in a labeled zone are read-only for single-level datasets. For multilevel datasets, MAC policy is enforced per file and directory label, as described in “No Privilege Overrides for MAC Read-Write Policy” on page 171.

`mlslabel` Property and Mounting Single-Level File Systems

ZFS provides a security label property, `mlslabel`, that contains the label of the data in the dataset. The `mlslabel` property is inheritable. When a ZFS dataset has an explicit label, the dataset cannot be mounted on an Oracle Solaris system that is not configured with Trusted Extensions.

If the `mlslabel` property is undefined, it defaults to the string `none`, which indicates no label.

When you mount a ZFS dataset in a labeled zone, the following occurs:

- If the dataset is not labeled, that is, the `mlslabel` property is undefined, the value of the `mlslabel` property is changed to the label of the mounting zone.

  For the global zone, the `mlslabel` property is not set automatically. If you explicitly label the dataset `admin_low`, the dataset must be mounted read-only.
- If the dataset is labeled, the kernel verifies that the dataset label matches the label of the mounting zone. If the labels do not match, the mount fails, unless the zone allows read-down mounts. If the zone allows read-down mounts, a lower-level file system mounts read-only.

To set the `mlslabel` property from the command line, use syntax similar to the following:

```
# zfs set mlslabel=public export/publicinfo
```

The `file_upgrade_sl` privilege is required to set an initial label or to change a non-default label to a higher-level label. The `file_downgrade_sl` privilege is required to remove a label, that is, to set the label to `none`. This privilege is also required to change a non-default label to a lower-level label.

Multilevel Datasets for Relabeling Files

A multilevel ZFS dataset contains files and directories at different labels. Each file and directory is individually labeled, and the labels can be changed without moving or copying the files. Files can be relabeled within the dataset's label range. To create and share multilevel datasets, see “How to Create and Share a Multilevel Dataset” on page 69.

Normally, all the files and directories in a dataset have the same label as the zone in which the dataset is mounted. This label is recorded automatically in a ZFS property called `mlslabel` when the dataset is first mounted in the zone. These datasets are *single-level labeled datasets*. The `mlslabel` property cannot be changed while the dataset is mounted, that is, the mounting zone cannot change the `mlslabel` property.

After the `mlslabel` property is set, the dataset cannot be mounted read-write in a zone unless the zone's label matches the `mlslabel` property of the dataset. Furthermore, a dataset cannot be ZFS-mounted in any zone if it is currently ZFS-mounted in any other zone, including the global zone. Because the labels of files in a single-level labeled dataset are fixed, when you relabel a file with the `setlabel` command, the file is actually moved to the equivalent pathname in the primary zone that corresponds to the target label. This movement across zones can be inefficient and confusing. Multilevel datasets provide an efficient container for relabeling data.

For multilevel datasets that are mounted in the global zone, the default value of the `mlslabel` property is `ADMIN_HIGH`. This value specifies the upper bound of the label range of the dataset. If you specify a lower label, you can only write to the dataset from zones whose labels are dominated by the `mlslabel` property.

Users or roles with the Object Label Management rights profile have the appropriate privileges to upgrade or downgrade files or directories to which they have DAC access. For the procedure, see "How to Enable a User to Change the Security Level of Data" on page 142.

For the user process, additional policy constraints apply.

- By default, no process in a labeled zone can relabel files or directories. To enable relabeling, see "How to Enable Files to Be Relabeled From a Labeled Zone" on page 167. To specify more granular controls, for example, permitting downgrading files but not upgrading files, see Example 25, "Permitting Downgrades Only From the `internal` Zone," on page 167.
- Directories cannot be relabeled unless they are empty.
- Files and directories cannot be downgraded below the label of their containing directory.

  To relabel, you first move the file to the lower-level directory, then relabel it.
- Zones that mount the dataset cannot upgrade a file or directory above the zone label.
- Files cannot be relabeled if they are currently open by a process in any zone.
- File and directories cannot be upgraded above the `mlslabel` value of the dataset.

Mounting Multilevel Datasets From Another System

The global zone can share multilevel datasets over NFS with Trusted Extensions systems and unlabeled systems. The datasets can be mounted in the global zone and in labeled zones, and on unlabeled systems at their assigned label. The exception is an `ADMIN_LOW` unlabeled system. It cannot mount a multilevel dataset.

When a multilevel dataset is created with a label that is lower than `ADMIN_HIGH`, the dataset can be mounted in the global zone of another Trusted Extensions system. However, files can only be viewed in the global zone, not modified. When a labeled zone NFS mounts a multilevel dataset from a different system's global zone, some restrictions apply.

- Some restrictions apply to NFS-mounted multilevel datasets.

- A Trusted Extensions NFS client can view the correct labels only for files that are writable. The `getlabel` command mis-reports the label of lower-level files as being the label of the client. MAC policy is in effect, so the files remain read-only and higher-level files are not visible.
- The NFS server ignores any privileges the client might have.

Because of these restrictions, using LOFS is preferable for labeled zone clients that are being served from their own global zone. NFS works for these clients, but they are subject to the restrictions. For the LOFS mounting procedure, see "How to Create and Share a Multilevel Dataset" on page 69.

NFS Server and Client Configuration in Trusted Extensions

Lower-level directories can be made visible to users in a higher-level zone. The NFS server for the lower-level directories can be a Trusted Extensions system or an untrusted system.

The trusted system requires server configuration. The untrusted system requires client configuration.

- **NFS server configuration on a trusted system –** To make lower-level directories from a trusted system visible in a labeled zone, you must configure the server.
  - In the global zone on the NFS server, you must configure the NFS service as a multilevel service.
  - From the global zone, you must add the `net_bindmlp` privilege to the `limitpriv` privilege set of the labeled zone.
  - In the labeled zone, you export the ZFS file system by setting its share properties. When the status of the labeled zone is `running`, the file system is shared at the label of the zone. For the procedure, see "How to Share File Systems From a Labeled Zone" on page 180.
- **NFS client configuration for an untrusted NFS server –** Because the server is not trusted, the NFS client must be trusted. The `net_mac_aware` privilege must be specified in the zone configuration file that is used during initial zone configuration. So, a user who is permitted to view all lower-level home directories must have the `net_mac_aware` privilege in every zone, except the lowest zone. For an example, see "How to NFS Mount Files in a Labeled Zone" on page 182.

Home Directory Creation in Trusted Extensions

Home directories are a special case in Trusted Extensions.

- You need to make sure that the home directories are created in every zone that a user can use.

- Also, the home directory mount points must be created in the zones on the user's system.
- For NFS-mounted home directories to work correctly, the conventional location for directories, `/export/home`, must be used.

  Note - The `txzonemgr` script assumes that home directories are mounted as `/export/home`.

- In Trusted Extensions, the automounter has been modified to handle home directories in every zone, that is, at every label. For details, see "Changes to the Automounter in Trusted Extensions" on page 177.

Home directories are created when users are created. However, the home directories are created in the global zone of the home directory server. On that server, the directories are mounted by LOFS. Home directories are automatically created by the automounter if they are specified as LOFS mounts.

Note - When you delete a user, only the user's home directory in the global zone is deleted. The user's home directories in the labeled zones are not deleted. You are responsible for archiving and deleting the home directories in the labeled zones. For the procedure, see "How to Delete a User Account From a Trusted Extensions System" on page 143.

However, the automounter cannot automatically create home directories on remote NFS servers. Either the user must first log in to the NFS server or administrative intervention is required. To create home directories for users, see "How to Enable Users to Access Their Remote Home Directories at Every Label by Logging In to Each NFS Server" on page 64.

Changes to the Automounter in Trusted Extensions

In Trusted Extensions, each label requires a separate home directory mount. The `automount` command has been modified to handle these labeled automounts. For each zone, the automounter, `autofs`, mounts an `auto_home_`*zone-name* file. For example, the following is the entry for the global zone in the `auto_home_global` file:

```
+auto_home_global
*       -fstype=lofs    :/export/home/&
```

When a zone that permits lower-level zones to be mounted is booted, the following occurs. The home directories of lower-level zones are mounted read only under `/zone/`*zone-name*`/export/home`. The `auto_home_`*zone-name* map specifies the `/zone` path as the source directory for an `lofs` remount onto `/zone/`*zone-name*`/home/`*username*.

For example, the following is an `auto_home_public` entry in an `auto_home_`*zone-at-higher-level* map that is generated from a higher-level zone:

```
+auto_home_public
*    public-zone-IP-address:/export/home/&
```

The `txzonemgr` script sets up this `PUBLIC` entry in the `auto_master` file in the global zone:

```
+auto_master
/net  -hosts  -nosuid,nobrowse
/home  auto_home -nobrowse
/zone/public/home      auto_home_public      -nobrowse
```

When a home directory is referenced and the name does not match any entries in the `auto_home_`*zone-name* map, the map tries to match this loopback mount specification. The software creates the home directory when the following two conditions are met:

1. The map finds the match of the loopback mount specification
2. The home directory name matches a valid user whose home directory does not yet exist in *zone-name*

For details on changes to the automounter, see the `automount`(1M) man page.

Trusted Extensions Software and NFS Protocol Versions

Trusted Extensions software recognizes labels on NFS Version 3 (NFSv3) and NFSv4. You can use one of the following sets of mount options:

```
vers=4 proto=tcp
vers=3 proto=tcp
vers=3 proto=udp
```

Trusted Extensions has no restrictions on mounts over the `tcp` protocol. In NFSv3 and NFSv4, the `tcp` protocol can be used for same-label mounts and for read-down mounts.

For NFSv3, Trusted Extensions behaves like Oracle Solaris. The `udp` protocol is the default for NFSv3, but `udp` is used only for the initial mount operation. For subsequent NFS operations, the system uses `tcp`. Therefore, read-down mounts work for NFSv3 in the default configuration.

In the rare case that you have restricted NFSv3 mounts to use the `udp` protocol for initial and subsequent NFS operations, you must create an MLP for NFS operations that use the `udp` protocol. For the procedure, see Example 49, “Configuring a Private Multilevel Port for NFSv3 Over `udp`,” on page 226.

A Trusted Extensions system can also share its single-level datasets with unlabeled hosts. A file system that is exported to an unlabeled host is *writable* if its label equals the label that is assigned to the remote host by the exporting system. A file system that is exported to an unlabeled host is *readable* only if its label is dominated by the label that is assigned to the remote system.

For multilevel datasets that are shared by the global zone with clients that are running the NFSv4 service, the MAC policy is at the granularity of individual files and directories, not at the label of the entire dataset.

Communication with systems that are running a release of Trusted Solaris software is possible only at a single label. The assigned label of the Trusted Solaris system determines its access to single-level and multilevel datasets.

The NFS protocol that is used is independent of the local file system's type. Rather, the protocol depends on the type of the sharing computer's operating system. The file system type that is specified to the `mount` command for remote file systems is always NFS.

Backing Up, Sharing, and Mounting Labeled Files

The following task map describes common tasks that are used to back up and restore data from labeled file systems, and to share and mount file systems that are labeled.

TABLE 22 Backing Up, Sharing, and Mounting Labeled Files Task Map

Task	Description	For Instructions
Back up files.	Archives your data while preserving labels.	"How to Back Up Files in Trusted Extensions" on page 179
Restore data.	Restores labeled data from a backup.	"How to Restore Files in Trusted Extensions" on page 180
Share a labeled file system.	Allows a labeled file system to be accessed by users on other systems.	"How to Share File Systems From a Labeled Zone" on page 180
Mount a file system that is shared by a labeled zone.	Allows the contents of a file system to be mounted read-write in a labeled zone at the same label. When a higher-level zone mounts the shared directory, the directory mounts read-only.	"How to NFS Mount Files in a Labeled Zone" on page 182
Create home directory mount points.	Creates mount points for every user at every label. This task enables users to access their home directory at every label on a system that is not the NFS home directory server.	"How to Enable Users to Access Their Remote Home Directories at Every Label by Logging In to Each NFS Server" on page 64
Hide lower-level information from a user who is working at a higher label.	Prevents the viewing of lower-level information from a higher level.	"How to Disable the Mounting of Lower-Level Files" on page 164
Troubleshoot file system mounting problems.	Resolves problems with mounting a file system.	"How to Troubleshoot Mount Failures in Trusted Extensions" on page 183

▼ How to Back Up Files in Trusted Extensions

Before You Begin You must be assigned the Media Backup rights profile. You are in the global zone.

- **Perform a backup that preserves labels by using one of the following commands:**
  - `zfs send -r | -R` *filesystem*`@snap` for major backups

    For available methods, including sending the backup to a remote server, see "Saving, Sending, and Receiving ZFS Data" in *Managing ZFS File Systems in Oracle Solaris 11.3*.
  - `/usr/sbin/tar cT` for small backups

    For details on the `T` option to the `tar` command, see the `tar`(1) man page.
  - A script that calls the `zfs` or `tar` backup commands

How to Restore Files in Trusted Extensions

Before You Begin You are in the `root` role in the global zone.

- **Restore a labeled backup by using one of the following commands:**
  - `zfs receive -vF` *filesystem*`@snap` for major restores

    For available methods, including restoring backups from a remote server, see "Saving, Sending, and Receiving ZFS Data" in *Managing ZFS File Systems in Oracle Solaris 11.3*.
  - `/usr/sbin/tar xT` for small restores

    For details on the `T` option to the `tar` command, see the `tar`(1) man page.
  - A script that calls the `zfs` or `tar` restore commands

How to Share File Systems From a Labeled Zone

To mount or share directories that originate in labeled zones, set the appropriate ZFS share properties on the file system. Then, restart the zone to share the labeled directories.

Caution - Do not use proprietary names for shared file systems. The names of shared file systems are visible to every user.

Before You Begin You must be assigned the ZFS File System Management rights profile.

1. **Create a workspace at the label of the file system that is going to be shared.**
   For details, see "How to Add a Workspace at Your Minimum Label" in *Trusted Extensions User's Guide*.

2. **In the zone, create the file system.**

```
# zfs create rpool/wdocs1
```

3. **Share the file system by setting ZFS share properties.**

   For example, the following set of commands shares a documentation file system for writers. The file system is shared read-write so that writers can modify their documents on this server. `setuid` programs are disallowed.

   ```
   # zfs set share=name=wdocs1,path=/wdocs1,prot=nfs,setuid=off,
   exec=off,devices=off rpool/wdocs1
   # zfs set sharenfs=on rpool/wdocs1
   ```

   The command line is wrapped for display purposes.

4. **For each zone, share the directories by starting the zone.**

   In the global zone, run one of the following commands for each zone. Each zone can share its file systems in any of these ways. The actual sharing occurs when each zone is brought into the `ready` or `running` state.

   - **If the zone is not in the running state and you do not want users to log in to the server at the label of the zone, set the zone state to `ready`.**

     ```
     # zoneadm -z zone-name ready
     ```

   - **If the zone is not in the running state and users are allowed to log in to the server at the label of the zone, boot the zone.**

     ```
     # zoneadm -z zone-name boot
     ```

   - **If the zone is already running, reboot the zone.**

     ```
     # zoneadm -z zone-name reboot
     ```

5. **Display the file systems that are shared from your system.**

   In the `root` role in the global zone, run the following command:

   ```
   # zfs get all rpool
   ```

   For more information, see "Querying ZFS File System Information" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

6. **To enable the client to mount the shared file system, see "How to NFS Mount Files in a Labeled Zone" on page 182.**

Example 27 Sharing the `/export/share` File System at the `PUBLIC` Label

For applications that run at the label `PUBLIC`, the system administrator enables users to read the documentation in the `/export/reference` file system of the `public` zone.

First, the administrator changes the workspace label to `public` workspace and opens a terminal window. In the window, the administrator sets selected `share` properties on the `/reference` file system. The following command is wrapped for display purposes.

```
# zfs set share=name=reference,path=/reference,prot=nfs,
setuid=off,exec=off,devices=off,rdonly=on rpool/wdocs1
```

Then, the administrator shares the file system.

```
# zfs set sharenfs=on rpool/reference
```

The administrator leaves the `public` workspace and returns to the Trusted Path workspace. Because users are not allowed to log in to this file server, the administrator shares the file system by putting the zone in the ready state:

```
# zoneadm -z public ready
```

Users can access the shared file system once it is mounted on the users' systems.

How to NFS Mount Files in a Labeled Zone

In Trusted Extensions, a labeled zone manages the mounting of files in its zone. File systems from unlabeled and labeled hosts can be mounted on a Trusted Extensions labeled system. The system must have a route to the file server at the label of the mounting zone.

- To mount the files read-write from a single-label host, the assigned label of the remote host must match the label of the mounting zone. Two remote host configurations are possible.
  - The untrusted remote host is assigned the same label as the mounting zone.
  - The trusted remote host is a multilevel server that includes the label of the mounting zone.
- File systems that are mounted by a higher-level zone are read-only.
- In Trusted Extensions, the `auto_home` configuration file is customized per zone. The file is named by zone name. For example, a system with a global zone and a public zone has two `auto_home` files, `auto_home_global` and `auto_home_public`.

Trusted Extensions uses the same mounting interfaces as Oracle Solaris:

- By default, file systems are mounted at boot.
- To mount file systems dynamically, use the `mount` command in the labeled zone.
- To automount home directories, use the `auto_home_`*zone-name* files.
- To automount other directories, use the standard automount maps.

Before You Begin You must be on the client system, in the zone at the label of the files that you want to mount. Verify that the file system that you want to mount is shared. Unless you are using the automounter, you must be assigned the File System Management rights profile. To mount

from lower-level servers, the zone on this client must be configured with the `net_mac_aware` privilege.

- **To NFS mount files in a labeled zone, use the following procedures.**

  Most procedures include creating a workspace at a particular label. To create a workspace, see "How to Add a Workspace at Your Minimum Label" in *Trusted Extensions User's Guide*.

  - **Mount files dynamically.**

    In the labeled zone, use the `mount` command.

  - **Mount files when the zone boots.**

  - **Mount home directories for systems that are administered with files.**

    a. **Create and populate an `/export/home/auto_home_`*lowest-labeled-zone-name* file.**

    b. **Edit the `/etc/auto_home_`*lowest-labeled-zone-name* file to point to the newly populated file.**

    c. **Modify the `/etc/auto_home_`*lowest-labeled-zone-name* file in every higher-level zone to point to the file that you created in Step a.**

▼ How to Troubleshoot Mount Failures in Trusted Extensions

Before You Begin You must be in the zone at the label of the file system that you want to mount. You must be the `root` role.

1. **Verify that the file systems on the NFS server are shared.**

2. **Check the security attributes of the NFS server.**

   a. **Use the `tninfo` or `tncfg` command to find the IP address of the server or a range of IP addresses that includes the NFS server.**

      The address might be directly assigned, or indirectly assigned through a wildcard mechanism. The address can be in a labeled or unlabeled template.

   b. **Check the label that the template assigns to the NFS server.**

      The label must be consistent with the label at which you are trying to mount the files.

3. **Check the label of the current zone.**

   If the label is higher than the label of the mounted file system, then you cannot write to the mount even if the remote file system is exported with read/write permissions. You can only write to the mounted file system at the label of the mount.

4. **To mount file systems from an NFS server that is running earlier versions of Trusted Solaris software, do the following:**

   - **For a Trusted Solaris 1 NFS server, use the `vers=2` and `proto=udp` options to the `mount` command.**
   - **For a Trusted Solaris 2.5.1 NFS server, use the `vers=2` and `proto=udp` options to the `mount` command.**
   - **For a Trusted Solaris 8 NFS server, use the `vers=3` and `proto=udp` options to the `mount` command.**

   To mount file systems from any of these servers, the server must be assigned to an unlabeled template.

♦ ♦ ♦ CHAPTER 15

Trusted Networking

This chapter describes trusted networking concepts and mechanisms in Trusted Extensions.

About the Trusted Network

Trusted Extensions assigns security attributes to zones, hosts, and networks. These attributes ensure that the following security features are enforced on the network:

- Data is properly labeled in network communications.
- Mandatory access control (MAC) rules are enforced when data is sent or received across a local network and when file systems are mounted.
- MAC rules are enforced when data is routed to distant networks.
- MAC rules are enforced when data is routed to zones.

In Trusted Extensions, network packets are protected by MAC. Labels are used for MAC decisions. Data is labeled explicitly or implicitly with a sensitivity label. A label has an ID field, a classification or "level" field, and a compartment or "category" field. Data must pass an accreditation check. This check determines if the label is well-formed, and if the label lies within the accreditation range of the receiving host. Well-formed packets that are within the receiving host's accreditation range are granted access.

IP packets that are exchanged between trusted systems can be labeled. A label on a packet serves to classify, segregate, and route IP packets. Routing decisions compare the sensitivity label of the data with the label of the destination.

Trusted Extensions supports labels on IPv4 and IPv6 packets.

- For IPv4 packets, Trusted Extensions supports Commercial IP Security Option (CIPSO) labels.
- For IPv6 packets, Trusted Extensions supports Common Architecture Label IPv6 Security Option (CALIPSO) labels.

  If you must interoperate with systems on an IPv6 CIPSO network, see "How to Configure an IPv6 CIPSO Network in Trusted Extensions" on page 44.

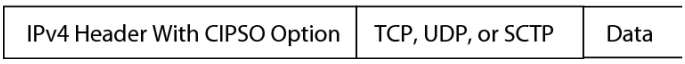
Typically on a trusted network, the label is generated by a sending host and processed by the receiving host. However, a trusted router can also add or strip labels while forwarding packets in a trusted network. A sensitivity label is mapped to a CALIPSO or CIPSO label before transmission. This label is embedded in the IP packet, which is then a *labeled* packet. Typically, a packet sender and the packet's receiver operate at the same label.

Trusted networking software ensures that the Trusted Extensions security policy is enforced even when the subjects (processes) and objects (data) are located on different hosts. Trusted Extensions networking preserves MAC across distributed applications.

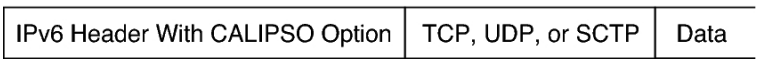
Trusted Extensions Data Packets

Trusted Extensions data packets include a label option. The CIPSO data packets are sent over IPv4 networks. The CALIPSO packets are sent over IPv6 networks.

In the standard IPv4 format, the IPv4 header with options is followed by a TCP, UDP, or SCTP header, and then the actual data. The Trusted Extensions version of an IPv4 packet uses the CIPSO option in the IP header for the security attributes.



In the standard IPv6 format, an IPv6 header with options is followed by a TCP, UDP, or SCTP header and then the actual data. The Trusted Extensions version of an IPv6 packet uses the CALIPSO option in the IP header for security attributes.



Trusted Extensions Multicast Packets

Trusted Extensions can add labels to multicast packets within a LAN. This feature enables you to send labeled multicast packets to CIPSO or CALIPSO systems that operate at the same label or within the label range of the multicast packets. On a heterogeneous LAN, that is, a LAN with both labeled and unlabeled hosts, multicast cannot verify the membership of a multicast group.

Caution - Do not send labeled multicast packets on a heterogeneous LAN. Leakage of labeled information could occur.

Trusted Network Communications

Trusted Extensions supports labeled and unlabeled hosts on a trusted network. The `txzonemgr` GUI and the `tncfg` command are used to configure the network.

Systems that run Trusted Extensions software support network communications between Trusted Extensions systems and any of the following types of hosts:

- Other hosts that are running Trusted Extensions
- Hosts that are running operating systems that do not recognize security attributes, but do support TCP/IP, such as Oracle Solaris systems, other UNIX systems, Microsoft Windows, and Macintosh OS systems
- Hosts that are running other trusted operating systems that recognize CIPSO labels for IPv4 packets and CALIPSO labels for IPv6 packets

As in the Oracle Solaris OS, Trusted Extensions network communications and services can be managed by a naming service. Trusted Extensions adds the following interfaces to Oracle Solaris network interfaces:

- Trusted Extensions adds commands and provides a GUI to administer trusted networking. Trusted Extensions also adds options to the Oracle Solaris network commands. For a description of these commands, see "Network Commands in Trusted Extensions" on page 188.

  The interfaces manage three Trusted Extensions network configuration databases, `tnzonecfg`, `tnrhdb`, and `tnrhtp`. For details, see "Network Configuration Databases in Trusted Extensions" on page 189.
- Trusted Extensions adds the `tnrhtp` and `tnrhdb` databases to the properties of the naming service switch SMF service, `svc:/system/name-service/switch`.
- Initial Configuration of Trusted Extensions on page 17 describes how to define zones and hosts when you configure the network. For additional procedures, see Chapter 16, "Managing Networks in Trusted Extensions".

- Trusted Extensions extends the IKE configuration file, `/etc/inet/ike/config`. For more information, see "Administration of Labeled IPsec" on page 200 and the `ike.config(4)` man page

Network Commands in Trusted Extensions

Trusted Extensions adds the following commands to administer trusted networking:

- `tncfg` – This command creates, modifies, and displays the configuration of your Trusted Extensions network. The `tncfg -t` command is used to view, create, or modify a specified security template. The `tncfg -z` command is used to view or modify the network properties of a specified zone. For details, see the `tncfg(1M)` man page.
- `tnchkdb` – This command is used to verify the correctness of the trusted network databases. The `tnchkdb` command is called whenever you change a security template (`tnrhtp`), a security template assignment (`tnrhdb`), or the configuration of a zone (`tnzonecfg`) by using the `txzonemgr` or the `tncfg` command. For details, see the `tnchkdb(1M)` man page.
- `tnctl` – This command can be used to update the trusted network information in the kernel. `tnctl` is also a system service. A restart with the command `svcadm restart /network/tnctl` refreshes the kernel cache from the trusted network databases on the local system. For details, see the `tnctl(1M)` man page.
- `tnd` – This daemon pulls `tnrhdb` and `tnrhtp` information from the LDAP directory and local files. The order of search is dictated by the `name-service/switch` SMF service. The `tnd` daemon is started at boot time by the `svc:/network/tnd` service. This service is dependent on the `svc:/network/ldap/client`.

  In an LDAP network, the `tnd` command also can be used for debugging and for changing the polling interval. For details, see the `tnd(1M)` man page.
- `tninfo` – This command displays the details of the current state of the trusted network kernel cache. The output can be filtered by host name, zone, or security template. For details, see the `tninfo(1M)` man page.

Trusted Extensions adds options to the following Oracle Solaris network commands:

- `ipadm` – The `all-zones` address property makes the specified interface available to every zone on the system. The appropriate zone to deliver data to is determined by the label that is associated with the data. For details, see the `ipadm(1M)` man page.
- `netstat` – The `-R` option extends Oracle Solaris `netstat` usage to display Trusted Extensions-specific information, such as security attributes for multilevel sockets and routing table entries. The extended security attributes include the label of the peer, and whether the socket is specific to a zone, or available to several zones. For details, see the `netstat(1M)` man page.
- `route` – The `-secattr` option extends Oracle Solaris `route` usage to display the security attributes of the route. The value of the option has the following format:

`min_sl=`*label*`,max_sl=`*label*`,doi=`*integer*`,cipso`

The `cipso` keyword is optional and set by default. For details, see the `route`(1M) man page.

- `snoop` – As in Oracle Solaris, the `-v` option to this command can be used to display the IP headers in detail. In Trusted Extensions, the headers contain label information.
- `ipseckey` – In Trusted Extensions, the following extensions are available to label IPsec-protected packets: `label` *label*, `outer-label` *label*, and `implicit-label` *label*. For details, see the `ipseckey`(1M) man page.

Network Configuration Databases in Trusted Extensions

Trusted Extensions loads three network configuration databases into the kernel. These databases are used in accreditation checks as data is transmitted from host to host.

- `tnzonecfg` – This local database stores zone attributes that are security-related. The `tncfg` command is the interface to access and modify this database.

  The attributes for each zone specify the zone label and the zone's access to single-level and multilevel ports. Another attribute handles responses to control messages, such as `ping`. The labels for zones are defined in the `label_encodings` file. For more information, see the `label_encodings`(4) man page. For a discussion of multilevel ports, see "Zones and Multilevel Ports" on page 157.
- `tnrhtp` – This database stores templates that describe the security attributes of hosts and gateways. The `tncfg` command is the interface to access and modify this database.

  Hosts and gateways use the attributes of the destination host and next-hop gateway to enforce MAC when sending traffic. When receiving traffic, hosts and gateways use the attributes of the sender. However, when an *adaptive* host is the sender, the receiving network interface assigns its default label to the incoming packets. For details of the security attributes, see "Network Security Attributes in Trusted Extensions" on page 190.
- `tnrhdb` – This database holds the IP addresses and ranges of IP addresses that correspond to all hosts that are allowed to communicate with this system. The `tncfg` command is the interface to access and modify this database.

  Each host or range of IP addresses is assigned a security template from the `tnrhtp` database. The attributes in the template define the attributes of the assigned host.

Trusted Network Security Attributes

Network administration in Trusted Extensions is based on security templates. A security template describes a set of hosts that have identical protocols and security attributes.

Security attributes are administratively assigned to remote systems, both hosts and routers, by means of templates. The security administrator administers templates and assigns them to remote systems. If a remote system is not assigned a template, no communications are allowed with that system.

Every template is named and includes the following:

- One of four host types: `unlabeled`, `cipso`, `adaptive`, or `netif`. The protocol that is used for network communications is determined by the host type of the template. See "Host Type and Template Name in Security Templates" on page 191.
- A set of security attributes that are applied to each host type.

For more detail, see "Network Security Attributes in Trusted Extensions" on page 190.

Network Security Attributes in Trusted Extensions

A Trusted Extensions system is installed with a default set of security templates that are used to define the label properties of remote hosts. In Trusted Extensions, both unlabeled hosts and labeled hosts on the network are assigned security attributes by means of a security template. Hosts that are not assigned a template cannot communicate with hosts that are configured with Trusted Extensions. The templates are stored locally.

Hosts can be added to a security template by IP address or as part of a range of IP addresses. For further explanation, see "Trusted Network Fallback Mechanism" on page 193.

Each host type has its own set of additional required and optional security attributes. The following security attributes are specified in security templates:

- **Host type** – Defines whether the packets are labeled with a CALIPSO or CIPSO security label, or not labeled at all.
- **Default label** – Defines the level of trust of the unlabeled host. Packets that are sent by an unlabeled host are read at this label by the receiving Trusted Extensions system or gateway.

  The Default label attribute is specific to the host type `unlabeled`. For details, see "Default Label in Security Templates" on page 192.
- **DOI** – A positive, non-zero integer that identifies the domain of interpretation. The DOI is used to indicate which set of label encodings applies to a network communication or network entity. Labels with different DOIs, even if otherwise identical, are disjoint. For `unlabeled` hosts, the DOI applies to the default label. In Trusted Extensions, the default value is `1`.
- **Minimum label** – Defines the bottom of the label accreditation range. Hosts and next-hop gateways do not receive packets that are below the minimum label that is specified in their template.
- **Maximum label** – Defines the top of the label accreditation range. Hosts and next-hop gateways do not receive packets that are higher than the maximum label that is specified in their template.

- **Auxiliary label set** – Optional. Specifies a discrete set of security labels for a security template. In addition to their accreditation range that is determined by the maximum and minimum labels, hosts that are added to a template with an auxiliary label set can send and receive packets that match any one of the labels in the label set. The maximum number of auxiliary labels that can be specified is four.

Host Type and Template Name in Security Templates

Trusted Extensions supports four host types in the trusted network databases and provides four default templates:

- `cipso` **host type –** Intended for hosts that run labeled trusted operating systems. This host type supports CALIPSO and CIPSO labels.

  For IPv6, the CALIPSO protocol is used to specify security labels that are passed in the IP options field. For IPv4, the CIPSO protocol is used. Labels in CALIPSO and CIPSO headers are derived automatically from the data's label. The derived label is then used to make security checks at the IP level and to label the network packets.
- `unlabeled` **host type –** Intended for hosts that use standard networking protocols but do not support labeled options. Trusted Extensions supplies the template named `admin_low` for this host type.

  This host type is assigned to hosts that run the Oracle Solaris OS or other unlabeled operating systems. This host type provides a default label to apply to communications with the unlabeled host. Also, a label range or a set of discrete labels can be specified to allow the sending of packets to an unlabeled gateway for forwarding.
- `adaptive` **host type –** Intended for subnets of hosts that are not labeled, but that send packets to a specific network interface on a labeled system. The labeled system applies its network interface default label to the incoming packets.

  This host type is assigned to hosts that run the Oracle Solaris OS or other unlabeled operating systems and that are expected to send data to a labeled system. This host type does not provide a default label. The label of communication is derived from the labeled network interface of the receiving system. This host type is assigned to end node systems, not gateways.

  The `adaptive` host type provides flexibility for planning and scaling a trusted network. Administrators can expand the network with new unlabeled systems without having to know the new systems' default label in advance. When an `adaptive` host is configured to send packets to a labeled network interface on a `netif` host, the default label of the interface on that `netif` host assigns the appropriate label to the incoming packets.
- `netif` **host type –** Intended for the host names of interfaces that receive packets on a specific network interface from `adaptive` hosts. This host type is assigned to interfaces on Trusted Extensions systems. The default label of the `netif` interface is applied to the arriving packets.

Caution - The `admin_low` template provides an example for constructing unlabeled templates with site-specific labels. While the `admin_low` template is required for the installation of Trusted Extensions, the security attributes might be too liberal for normal system operations. Retain the provided templates without modification for system maintenance and support reasons.

Default Label in Security Templates

Templates for the `unlabeled` and `netif` host types specify a default label. This label is used to control communications with hosts whose operating systems are not aware of labels, such as Oracle Solaris systems. The default label that is assigned reflects the level of trust that is appropriate for the host and its users.

Because communications with unlabeled hosts are essentially limited to the default label, these hosts are also referred to as *single-label hosts*. A technical reason to call these hosts "single-label" is that these hosts do not have `admin_high` and `admin_low` labels.

Domain of Interpretation in Security Templates

Organizations that use the same Domain of Interpretation (DOI) agree among themselves to interpret label information and other security attributes in the same way. When Trusted Extensions performs a label comparison, a check is made as to whether the DOI is equal.

A Trusted Extensions system enforces label policy on one DOI value. All zones on a Trusted Extensions system must operate at the same DOI. A Trusted Extensions system does not provide exception handling on packets that are received from a system that uses a different DOI.

If your site uses a DOI value that is different from the default value, you must use this value in every security template, as described in "How to Configure a Different Domain of Interpretation" on page 45.

Label Range in Security Templates

The minimum label and maximum label attributes are used to establish the label range for labeled and unlabeled hosts. These attributes are used to do the following:

- To set the label range that can be used when a host communicates with a remote labeled host

  In order for a packet to be sent to a destination host, the label of the packet must be within the label range assigned in the destination host's security template.

- To set a label range for packets that are being forwarded through a labeled gateway or an unlabeled gateway

  The label range can be specified in the template for an unlabeled host type. The label range enables the host to forward packets that are not necessarily at the label of the host, but are within a specified label range.

Auxiliary Labels in Security Templates

The auxiliary label set defines at most four discrete labels at which packets can be accepted, forwarded, or sent by the remote host. This attribute is optional. By default, no auxiliary label set is defined.

Trusted Network Fallback Mechanism

A host IP address can be added to a security template either directly or indirectly. Direct assignment adds a host's IP address. Indirect assignment adds a range of IP addresses that includes the host. To match a particular host, the trusted network software first looks for the specific IP address. If the search does not find a specific entry for the host, it looks for the "longest prefix of matching bits". You can indirectly assign a host to a security template when the IP address of the host falls within the "longest prefix of matching bits" of an IP address with a fixed prefix length.

In IPv4, you can make an indirect assignment by subnet. When you make an indirect assignment by using 4, 3, 2, or 1 trailing zero (0) octets, the software calculates a prefix length of 0, 8, 16, or 24, respectively. For examples, see Table 23, "Trusted Extensions Host Address and Fallback Mechanism Entries," on page 193.

You can also set a fixed prefix length by adding a slash (/) followed by the number of fixed bits. IPv4 network addresses can have a prefix length between 1 – 32. IPv6 network addresses can have a prefix length between 1 – 128.

The following table provides fallback address and host address examples. If an address within the set of fallback addresses is directly assigned, the fallback mechanism is not used for that address.

TABLE 23 Trusted Extensions Host Address and Fallback Mechanism Entries

IP Version	Host Entry for `host_type=cipso`	IP Addresses Covered
IPv4	`192.168.118.57`	`192.168.118.57`
	`192.168.118.57/32`	The `/32` sets a prefix length of 32 fixed bits.
	`192.168.118.128/26`	From `192.168.118.0` through `192.168.118.63`

IP Version	Host Entry for `host_type=cipso`	IP Addresses Covered
	`192.168.118.0` `192.168.118.0/24`	All addresses on `192.168.118.` subnet.
	`192.168.0.0/24`	All addresses on `192.168.0.` subnet.
	`192.168.0.0` `192.168.0.0/16`	All addresses on `192.168.` subnet.
	`192.0.0.0` `192.0.0.0/8`	All addresses on `192.` subnet.
	`192.168.118.0/32`	Host address `192.168.118.0`. Not a range of addresses.
	`192.168.0.0/32`	Host address `192.168.0.0`. Not a range of addresses.
	`192.0.0.0/32`	Host address `192.0.0.0`. Not a range of addresses.
	`0.0.0.0/32`	Host address `0.0.0.0`. Not a range of addresses.
	`0.0.0.0`	All addresses on all networks
IPv6	`2001\:DB8\:22\:5000\:\:21f7`	`2001:DB8:22:5000::21f7`
	`2001\:DB8\:22\:5000\:\:0/52`	From `2001:DB8:22:5000::0` through `2001:DB8:22:5fff:ffff:ffff:ffff:ffff`
	`0\:\:0/0`	All addresses on all networks

Note that the `0.0.0.0/32` address matches the specific address, `0.0.0.0`. By adding the `0.0.0.0/32` entry to a system's unlabeled security template, you enable hosts with the specific address, `0.0.0.0`, to contact the system. For example, DHCP clients contact the DHCP server as `0.0.0.0` before the server provides the clients with an IP address.

To create a `tnrhdb` entry on a Sun Ray server that serves DHCP clients, see Example 46, “Configuring a Valid Initial Address for a Labeled Sun Ray Server,” on page 222. To create a `tnrhdb` entry for an application that serves DHCP clients, see Example 45, “Making the Host Address `0.0.0.0/32` a Valid Initial Address,” on page 221. The `0.0.0.0:admin_low` network is the default entry in the `admin_low` unlabeled host template. Review “How to Limit the Hosts That Can Be Contacted on the Trusted Network” on page 219 for security issues that would require changing this default.

For more information about prefix lengths in IPv4 and IPv6 addresses, see “Deciding on an IP Addressing Format for Your Network” in *Planning for Network Deployment in Oracle Solaris 11.3*.

About Routing in Trusted Extensions

In Trusted Extensions, routes between hosts on different networks must maintain security at each step in the transmission. Trusted Extensions adds extended security attributes to the routing protocols in the Oracle Solaris OS. Unlike Oracle Solaris, Trusted Extensions does not

support dynamic routing. For details about specifying static routing, see the -p option in the route(1M) man page.

Gateways and routers route packets. In this discussion, the terms “gateway” and “router” are used interchangeably.

For communications between hosts on the same subnet, accreditation checks are performed at endpoints only because no routers are involved. Label range checks are performed at the source. If the receiving host is running Trusted Extensions software, label range checks are also performed at the destination.

When the source and destination hosts are on different subnets, the packet is sent from the source host to a gateway. The label range of the destination and the first-hop gateway is checked at the source when a route is selected. The gateway forwards the packet to the network where the destination host is connected. A packet might go through several gateways before reaching the destination.

Note - A labeled gateway that is expected to forward packets from `adaptive` hosts must configure its inbound interface with a `netif` host type template. For definitions of the `adaptive` and `netif` host types, see “Host Type and Template Name in Security Templates” on page 191.

Background on Routing

On Trusted Extensions gateways, label range checks are performed in certain cases. A Trusted Extensions system that is routing a packet between two unlabeled hosts compares the default label of the source host to the default label of the destination host. When the unlabeled hosts share a default label, the packet is routed.

Each gateway maintains a list of routes to all destinations. Standard Oracle Solaris routing makes choices to optimize the route. Trusted Extensions provides additional software to check security requirements that apply to the route choices. The Oracle Solaris choices that do not satisfy security requirements are skipped.

Routing Table Entries in Trusted Extensions

The routing table entries in Trusted Extensions can incorporate security attributes. Security attributes can include a `cipso` keyword. Security attributes must include a maximum label, a minimum label, and a DOI.

For entries that do not provide security attributes, the attributes in the gateway's security template are used.

Trusted Extensions Accreditation Checks

Trusted Extensions software determines the suitability of a route for security purposes. The software runs a series of tests called *accreditation checks* on the source host, the destination host, and the intermediate gateways.

Note - In the following discussion, an accreditation check for a label range also means a check for an auxiliary label set.

The accreditation check verifies the label range and the CALIPSO or CIPSO label information. The security attributes for a route are obtained from the routing table entry, or from the security template of the gateway if the entry has no security attributes.

For incoming communications, the Trusted Extensions software obtains labels from the packets themselves, whenever possible. Obtaining labels from packets is only possible when the messages are sent from hosts that support labels. When a label is not available from the packet, a default label is assigned to the message from the security template. These labels are then used during accreditation checks. Trusted Extensions enforces several checks on outgoing messages, forwarded messages, and incoming messages.

Source Accreditation Checks

The following accreditation checks are performed on the sending process or sending zone:

- For all destinations, the DOI of an outgoing packet must match the DOI of the destination host. The DOI must also match the DOI of all hops along the route, including its first-hop gateway.
- For all destinations, the label of the outgoing packet must be within the label range of the next hop in the route, that is, the first hop. And, the label must be contained in the first-hop gateway's security attributes.
- When the destination host is an unlabeled host, one of the following conditions must be satisfied:
  - The sending host's label must match the destination host's default label.
  - The sending host is privileged to perform cross-label communication, and the sender's label dominates the destination's default label.
  - The sending host is privileged to perform cross-label communication, and the sender's label is `ADMIN_LOW`. That is, the sender is sending from the global zone.

Note - A first-hop check occurs when a message is being sent through a gateway from a host on one network to a host on another network.

Gateway Accreditation Checks

On a Trusted Extensions gateway system, the following accreditation checks are performed for the next-hop gateway:

- If the incoming packet is unlabeled, the packet inherits the source host's default label from the security template. Otherwise, the packet receives the label that is indicated in the CALIPSO or CIPSO option.
- Checks for forwarding a packet proceed similar to source accreditation, as follows:
  - For all destinations, the DOI of an outgoing packet must match the DOI of the destination host. The DOI must also match the DOI of the next-hop host.
  - For all destinations, the label of the outgoing packet must be within the label range of the next hop. And, the label must be contained in the security attributes of the next-hop host.
  - The label of an unlabeled packet must match the destination host's default label.
  - The label of a labeled packet must be within the destination host's label range.
  - A labeled gateway that is expected to forward packets from `adaptive` hosts must configure its inbound interface with a `netif` host type template. For definitions of the `adaptive` and `netif` host types, see "Host Type and Template Name in Security Templates" on page 191.

Destination Accreditation Checks

When a Trusted Extensions system receives data, the software performs the following checks:

- If the incoming packet is unlabeled, the packet inherits the source host's default label from the security template. Otherwise, the packet receives the label that is indicated in the labeled option.
- The label and DOI for the packet must be consistent with the destination zone or destination process's label and DOI. The exception is when a process is listening on a multilevel port. The listening process can receive a packet if the process is privileged to perform cross-label communications, and the process is either in the global zone or has a label that dominates the packet's label.

Administration of Routing in Trusted Extensions

Trusted Extensions supports several methods for routing communications between networks. You can set up routes that enforce the degree of security that your site's security policy requires.

For example, sites can restrict communications outside the local network to a single label. This label is applied to publicly available information. Labels such as `UNCLASSIFIED` or `PUBLIC` can

indicate public information. To enforce the restriction, these sites add the gateway's network interface that is connected to the external network to a single-label template.

For more details about TCP/IP and routing, see "Where to Find More Information About Network Administration in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Choosing Routers in Trusted Extensions

Trusted Extensions hosts offer the highest degree of trust as routers. Other types of routers might not recognize Trusted Extensions security attributes. Without administrative action, packets can be routed through routers that do not provide MAC security protection.

- Labeled routers drop packets when they do not find the correct type of information in the IP options section of the packet. For example, a labeled router drops a packet if it does not find a labeled option in the IP options when the option is required, or when the DOI in the IP options is not consistent with the destination's accreditation.
- Other types of routers that are not running Trusted Extensions software can be configured to either pass the packets or drop the packets that include a labeled option. Only label-aware gateways such as Trusted Extensions can use the contents of the CALIPSO or CIPSO IP option to enforce MAC.

To support trusted routing, the routing tables are extended to include Trusted Extensions security attributes. The attributes are described in "Routing Table Entries in Trusted Extensions" on page 195. Trusted Extensions supports static routing, in which the administrator creates routing table entries manually. For details, see the `-p` option in the `route`(1M) man page.

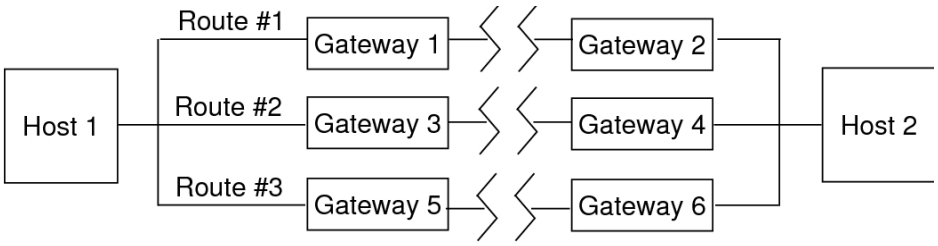
The routing software tries to find a route to the destination host in the routing tables. When the host is not explicitly named, the routing software looks for an entry for the subnet where the host resides. When neither the host nor the subnet is defined, the host sends the packet to a default gateway, if defined. Multiple default gateways can be defined, and each is treated equally.

In this release of Trusted Extensions, the security administrator sets up routes manually, and then manually changes the routing table when conditions change. For example, many sites have a single gateway that communicates with the outside world. In these cases, the single gateway can be statically defined as the *default* on each host on the network.

Gateways in Trusted Extensions

An example of routing in Trusted Extensions follows. The diagram and table show three potential routes between Host 1 and Host 2.

FIGURE 3 Typical Trusted Extensions Routes and Routing Table Entries



Route	First-Hop Gateway	Minimum Label	Maximum Label	DOI
#1	Gateway 1	CONFIDENTIAL	SECRET	1
#2	Gateway 3	ADMIN_LOW	ADMIN_HIGH	1
#3	Gateway 5			

- Route #1 can transmit packets within the label range of `CONFIDENTIAL` to `SECRET`.
- Route #2 can transmit packets from `ADMIN_LOW` to `ADMIN_HIGH`.
- Route #3 does not specify routing information. Therefore, its security attributes are derived from Gateway 5's security template.

Routing Commands in Trusted Extensions

To display labels and extended security attributes for sockets, Trusted Extensions modifies the following Oracle Solaris network commands:

- The `netstat -rR` command displays the security attributes in routing table entries.
- The `netstat -aR` command displays the security attributes for sockets.
- The `route -p` command with the `add` or `delete` option changes the routing table entries.

For details, see the `netstat`(1M) and `route`(1M) man pages.

To change routing table entries, Trusted Extensions provides the following interfaces:

- The `txzonemgr` GUI can be used to assign the default route for an interface.
- The `route -p` command with the `add` or `delete` option can be used to change routing table entries.

For examples, see "How to Add Default Routes" on page 224.

Administration of Labeled IPsec

Trusted Extensions systems can protect labeled network packets with IPsec. The IPsec packets can be sent with explicit or implicit Trusted Extensions labels. Labels are sent explicitly by using CALIPSO or CIPSO IP options. Labels are sent implicitly by using labeled IPsec security associations (SAs). Additionally, IPsec encrypted packets with different implicit labels can be tunneled across an unlabeled network.

For general IPsec concepts and configuration procedures, see *Securing the Network in Oracle Solaris 11.3*. For Trusted Extensions modifications to IPsec procedures, see "Configuring Labeled IPsec" on page 227.

Labels for IPsec-Protected Exchanges

All communications on Trusted Extensions systems, including IPsec-protected communications, must satisfy security label accreditation checks. The checks are described in "Trusted Extensions Accreditation Checks" on page 196.

The labels on IPsec packets from an application in a labeled zone that must pass these checks are the *inner label*, the *wire label*, and the *key management label*:

- **Application security label –** The label of the zone in which the application resides.
- **Inner label –** The label of the unencrypted message data before IPsec AH or ESP headers have been applied. This label can be different from the application security label when the `SO_MAC_EXEMPT` socket option (MAC-exempt) or multilevel port (MLP) features are being used. When selecting security associations (SAs) and IKE rules that are constrained by labels, IPsec and IKE use this inner label.

  By default, the inner label is the same as the application security label. Typically, applications at both ends have the same label. However, for MAC-exempt or MLP communication, this condition might not be true. IPsec configuration settings can define how the inner label is conveyed across the network, that is, they can define the *wire label*. IPsec configuration settings cannot define the value of the inner label.
- **Wire label –** The label of the encrypted message data after IPsec AH or ESP headers have been applied. Depending on the IKE and IPsec configuration files, the wire label might be different from the inner label.
- **Key management label –** All IKE negotiations between two nodes are controlled at a single label, regardless of the label of application messages that trigger the negotiations. The label of IKE negotiations is defined in the `/etc/inet/ike/config` file on a per-IKE rule basis.

Label Extensions for IPsec Security Associations

IPsec *label extensions* are used on Trusted Extensions systems to associate a label with the traffic that is carried inside a security association (SA). By default, IPsec does not use label extensions and therefore ignores labels. All traffic between two systems flows through a single SA, regardless of the Trusted Extensions label.

Label extensions enable you to do the following:

- Configure a different IPsec SA for use with each Trusted Extensions label. This configuration effectively provides an additional mechanism for conveying the label of traffic that travels between two multilevel systems.
- Specify an on-the-wire label for IPsec encrypted message text that is different from the unencrypted form of the text. This configuration supports the transmission of encrypted confidential data through a less secure network.
- Suppress the use of CALIPSO or CIPSO IP options in IP packets. This configuration enables labeled traffic to traverse label-unaware or label-hostile networks.

You can specify whether to use label extensions automatically through IKE as described in "Label Extensions for IKE" on page 201, or manually through the `ipseckey` command. For details on the label extensions features, see the `ipseckey(1M)` man page.

When using label extensions, SA selection for outbound traffic includes the inner sensitivity label as part of the match. The security label of inbound traffic is defined by the security label of received packet's SA.

Label Extensions for IKE

IKE on Trusted Extensions systems supports the negotiation of labels for SAs with label-aware peers. You can control this mechanism by using the following keywords in the `/etc/inet/ike/config` file:

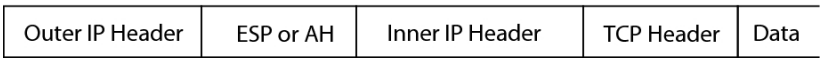
- **label_aware –** Enables the `in.iked` daemon's use of Trusted Extensions label interfaces and the negotiation of labels with peers.
- **single_label –** Indicates that the peer does not support the negotiation of labels for SAs.
- **multi_label –** Indicates that the peer supports the negotiation of labels for SAs. IKE creates a new SA for each additional label that IKE encounters in the traffic between two nodes.
- **wire_label inner –** Causes the `in.iked` daemon to create labeled SAs where the wire label is the same as the inner label. The key management label is `ADMIN_LOW` when the daemon is negotiating with `cipso` peers. The key management label is the peer's default label when the daemon is negotiating with unlabeled peers. Normal Trusted Extensions rules are followed for inclusion of the labeled IP options in transmitted packets.

- **wire_label** *label* **–** Causes the `in.iked` daemon to create labeled SAs where the wire label is set to *label*, regardless of the value of the inner label. The `in.iked` daemon performs key management negotiations at the specified label. Normal Trusted Extensions rules are followed for inclusion of labeled IP options in transmitted packets.
- **wire_label none** *label* **–** Causes behavior similar to `wire_label` *label*, except that labeled IP options are suppressed on transmitted IKE packets and data packets under the SA.

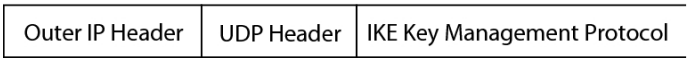
For more information, see the `ike.config(4)` man page.

Labels and Accreditation in Tunnel Mode IPsec

When application data packets are protected by IPsec in tunnel mode, the packets contain multiple IP headers.



The IKE protocol's IP header contains the same source and destination address pair as the application data packet's outer IP header.



Trusted Extensions uses the inner IP header addresses for inner label accreditation checks. Trusted Extensions performs wire and key management label checks by using the outer IP header addresses. For information about the accreditation checks, see "Trusted Extensions Accreditation Checks" on page 196.

Confidentiality and Integrity Protections With Label Extensions

The following table explains how IPsec confidentiality and integrity protections apply to the security label with various configurations of label extensions.

Security Association	Confidentiality	Integrity
Without label extensions	Label is visible in the labeled IP option.	Message label in the labeled IP option is covered by AH, not by ESP. See Note.

Security Association	Confidentiality	Integrity
With label extensions	A labeled IP option is visible, but represents the wire label, which might be different from the inner message label.	Label integrity is implicitly covered by the existence of a label-specific SA. On-the-wire labeled IP option is covered by AH. See Note.
With label extensions and labeled IP option suppressed	Message label is not visible.	Label integrity is implicitly covered by the existence of a label-specific SA.

Note - You cannot use IPsec AH integrity protections to protect the labeled IP option if label-aware routers might strip or add the labeled IP option as a message travels through the network. Any modification to the labeled IP option will invalidate the message and cause a packet that is protected by AH to be dropped at the destination.

♦ ♦ ♦ CHAPTER 16

Managing Networks in Trusted Extensions

This chapter provides implementation details and procedures for securing a Trusted Extensions network.

Labeling Hosts and Networks

A Trusted Extensions system can contact other hosts only after the system has defined the security attributes of those hosts. Because remote hosts can have similar security attributes, Trusted Extensions provides security templates to which you can add hosts.

Determining If You Need Site-Specific Security Templates

You can create site-specific security templates if you want to do any of the following for hosts that you communicate with:

- Limit the label range of a host or a group of hosts.
- Create a single-label host at a label other than `ADMIN_LOW` .
- Require a default label for unlabeled hosts that is not `AD MIN_LOW`.
- Create a host that recognizes a limited set of labels.
- Use a DOI other than `1`.
- Send information from specified unlabeled hosts to a trusted network interface that is configured to assign the correct label to the packets from the unlabeled hosts.

Viewing Existing Security Templates

Before you label remote hosts and networks, review the provided security templates and ensure that you can reach the remote hosts and networks. For instructions, see the following:

- View the security templates. See "How to View Security Templates" on page 206.
- Determine if your site requires customized security templates. See "Determining If You Need Site-Specific Security Templates" on page 205.
- Add systems and networks to the trusted network. See "How to Add Hosts to the System's Known Network" on page 207.

▼ How to View Security Templates

You can view the list of security templates and the contents of each template. The examples shown in this procedure use the default security templates.

1. **List the available security templates.**

```
# tncfg list
cipso
admin_low
adapt
netif
```

2. **View the contents of the listed templates.**

```
# tncfg -t cipso info
name=cipso
host_type=cipso
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=127.0.0.1/32
```

The `127.0.0.1/32` entry in the preceding `cipso` security template identifies this system as labeled. When a peer assigns this system to the peer's remote host template with the `host_type` of `cipso`, the two systems can exchange labeled packets.

```
# tncfg -t admin_low info
name=admin_low
host_type=unlabeled
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=0.0.0.0/0
```

The `0.0.0.0/0` entry in the preceding `admin_low` security template enables all hosts that are not explicitly assigned to a security template to contact this system. These hosts are recognized as unlabeled.

- The advantage of the `0.0.0.0/0` entry is that all hosts that this system requires at boot time, such as servers and gateways, can be found.
- The disadvantage of the `0.0.0.0/0` entry is that any host on this system's network can contact this system. To restrict which hosts can contact this system, see "How to Limit the Hosts That Can Be Contacted on the Trusted Network" on page 219.

```
# tncfg -t adapt info
name=adapt
host_type=adapt
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=0.0.0.0/0
```

An `adapt` template identifies an `adaptive` host, that is, an untrusted system that cannot have a default label. Instead, its label is assigned by its receiving trusted system. The label is derived from the default label of the IP interface that receives the packet, as specified by the labeled system's `netif` template.

```
# tncfg -t netif info
name=netif
host_type=netif
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=127.0.0.1/32
```

A `netif` template specifies a trusted local network interface, *not* a remote host. The default label of a `netif` template must equal the label of every zone with a dedicated network interface whose IP address matches a host address in that template. Additionally, the lower link that corresponds to the matching zone interface can be assigned only to other zones that share the same label.

▼ How to Add Hosts to the System's Known Network

After you add hosts and groups of hosts to a system's `/etc/hosts` file, the hosts are known to the system. Only known hosts can be added to a security template.

Before You Begin You are in the `root` role in the global zone.

1. Add individual hosts to the `/etc/hosts` file.

```
# pfedit /etc/hosts

...
192.168.111.121   ahost
```

2. **Add a group of hosts to the `/etc/hosts` file.**

```
# pfedit /etc/hosts

...
192.168.111.0   111-network
```

Creating Security Templates

This section contains pointers to or examples of creating security templates for the following network configurations:

- The DOI is a value different from 1. See "How to Configure a Different Domain of Interpretation" on page 45.
- Trusted remote hosts are assigned a specific label. See Example 28, "Creating a Security Template for a Gateway That Handles Packets at One Label," on page 210.
- Untrusted remote hosts are assigned a specific label. See Example 29, "Creating an Unlabeled Security Template at the Label `PUBLIC`," on page 210.

For more examples of security templates that address specific requirements, see "Adding Hosts to Security Templates" on page 211.

▼ How to Create Security Templates

Before You Begin You must be in the global zone in a role that can modify network security. For example, roles that are assigned the Information Security or Network Security rights profiles can modify security values. The Security Administrator role includes these rights profiles.

Note - For support purposes, do not alter or delete the default security templates.

- You can copy and modify these templates.
- And you can add and remove hosts that are assigned to these templates. For an example, see "How to Limit the Hosts That Can Be Contacted on the Trusted Network" on page 219.

---

1. **(Optional) Determine the hexadecimal version of any label other than `ADMIN_HIGH` and `ADMIN_LOW`.**

   For labels such as `CONFIDENTIAL`, you can use either the label string or the hexadecimal value as the label value. The `tncfg` command accepts either format.

```
# atohexlabel "confidential : internal use only"
0x0004-08-48
```

For more information, see "How to Obtain the Hexadecimal Equivalent for a Label" on page 120.

2. **Create a security template.**

   The `tncfg -t` command provides three ways to create new templates.

   - **Create a security template from scratch.**

     Use the `tncfg` command in interactive mode. The `info` subcommand displays the values that are supplied by default. Press the Tab key to complete partial properties and values. Type `exit` to complete the template.

```
# tncfg -t newunlabeled
tncfg:newunlabeled> info
name=newunlabeled
host_type=unlabeled
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
tncfg:newunlabeled> set mTab
set max_label=" set min_label="      Auto-complete shows two possible completions
tncfg:newunlabeled> set maTab      User types the letter a
tncfg:newunlabeled> set max_label=ADMIN_LOW
...
tncfg:newunlabeled> commit
tncfg:newunlabeled> exit
```

     You can also supply the complete list of attributes for a security template on the command line. Semicolons separate the `set` subcommands. An omitted attribute receives the default value. For information about network security attributes, see "Network Security Attributes in Trusted Extensions" on page 190.

```
# tncfg -t newunlabeled set host_type=unlabeled;set doi=1; \
set min_label=ADMIN_LOW;set max_label=ADMIN_LOW
```

   - **Copy and modify an existing security template.**

```
# tncfg -t cipso
tncfg:cipso> set name=newcipso
tncfg:newcipso> info
name=newcipso
host_type=cipso
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
```

Hosts that are assigned to the existing security template are not copied to the new template.

- **Use a template file that the `export` subcommand creates.**

```
# tncfg -f unlab_1 -f template-file
tncfg: unlab_1> set host_type=unlabeled
...
# tncfg -f template-file
```

For an example of creating a source template for importing, see the `tncfg`(1M) man page.

Example 28 Creating a Security Template for a Gateway That Handles Packets at One Label

In this example, the security administrator defines a gateway that can only pass packets at the label `PUBLIC`.

```
# tncfg -t cipso_public
tncfg:cipso_public> set host_type=cipso
tncfg:cipso_public> set doi=1
tncfg:cipso_public> set min_label="public"
tncfg:cipso_public> set max_label="public"
tncfg:cipso_public> commit
tncfg:cipso_public> exit
```

The security administrator then adds the gateway host to the security template. For the addition, see Example 31, “Creating a Gateway That Handles Packets at One Label,” on page 213.

Example 29 Creating an Unlabeled Security Template at the Label `PUBLIC`

In this example, the security administrator creates an unlabeled template for untrusted hosts that can receive and send packets at the `PUBLIC` label only. This template might be assigned to hosts whose file systems must be mounted at the `PUBLIC` label by Trusted Extensions systems.

```
# tncfg -t public
tncfg:public> set host_type=unlabeled
tncfg:public> set doi=1
tncfg:public> set def_label="public"
tncfg:public> set min_sl="public"
tncfg:public> set max_sl="public"
tncfg:public> exit
```

The security administrator then adds hosts to the security template. For the addition, see Example 42, “Creating an Unlabeled Subnetwork at the Label `PUBLIC`,” on page 218.

Adding Hosts to Security Templates

This section contains pointers to or examples of adding hosts to security templates. For discontinuous IP addresses, see "How to Add a Host to a Security Template" on page 211. For a range of hosts, see "How to Add a Range of Hosts to a Security Template" on page 217.

The examples in this section illustrate the following remote host label assignments:

- A trusted remote gateway handles `PUBLIC` traffic. See Example 31, "Creating a Gateway That Handles Packets at One Label," on page 213.
- Untrusted remote hosts act as single-label routers – Example 32, "Creating an Unlabeled Router to Route Labeled Packets," on page 213
- Trusted remote hosts restrict traffic to within a narrow label range. See Example 33, "Creating a Gateway With a Limited Label Range," on page 214.
- Trusted remote hosts are assigned a limited set of labels. See Example 34, "Creating Hosts at Discrete Labels," on page 214.
- Trusted remote hosts are assigned labels that are disjoint from the rest of the network. See Example 35, "Creating a Labeled Host for Developers," on page 215.
- A trusted `netif` host labels packets from `adaptive` systems. See Example 36, "Creating a Security Template for a `netif` Host," on page 215.
- An untrusted `adaptive` host sends packets to a `netif` host. See Example 37, "Creating Security Templates for Adaptive Hosts," on page 215.
- A trusted homogeneous network adds a multicast address at a specific label. See Example 38, "Sending Labeled Multicast Messages," on page 216.
- A host is removed from a security template. See Example 39, "Removing Several Hosts From a Security Template," on page 216.
- Untrusted remote hosts and networks are assigned labels. See Example 42, "Creating an Unlabeled Subnetwork at the Label `PUBLIC`," on page 218.

▼ How to Add a Host to a Security Template

Before You Begin The following must be in place:

- The IP addresses must exist in the `/etc/hosts` file or be resolvable by DNS.

  For the `hosts` file, see "How to Add Hosts to the System's Known Network" on page 207.

  For DNS, see Chapter 3, "Managing DNS Server and Client Services" in *Working With Oracle Solaris 11.3 Directory and Naming Services: DNS and NIS*.
- The label endpoints must match. For the rules, see "About Routing in Trusted Extensions" on page 194.

- You must be in the Security Administrator role in the global zone.

1. **(Optional) Verify that you can reach the host name or IP address that you are going to add.**

   In this example, you verify that you can reach `192.168.1.2`.

   ```
   # arp 192.168.1.2
   gateway-2.example.com (192.168.1.2) at 0:0:0:1:ad:cd
   ```

   The `arp` command verifies that the host is defined in the system's `/etc/hosts` file or is resolvable by DNS.

2. **Add a host name or IP address to a security template.**

   In this example, you add the `192.168.1.2` IP address.

   ```
   # tncfg -t cipso
   tncfg:cipso> add host=192.168.1.2
   ```

   If you add a host that was previously added to another template, you are notified that you are replacing its security template assignment. For the informational message, see Example 30, “Replacing a Host's Security Template Assignment,” on page 212.

3. **View the changed security template.**

   The following example shows the `192.168.1.2` address added to the `cipso` template:

   ```
   tncfg:cipso> info
   ...
   host=192.168.1.2/32
   ```

   The prefix length of `/32` indicates that the address is exact.

4. **Commit the change and exit the security template.**

   ```
   tncfg:cipso> commit
   tncfg:cipso> exit
   ```

   To remove a host entry, see Example 39, “Removing Several Hosts From a Security Template,” on page 216.

Example 30 Replacing a Host's Security Template Assignment

This example illustrates the informational message that displays when you assign a security template to a host that already has a template assignment.

```
# tncfg -t cipso
tncfg:cipso> add host=192.168.1.2
192.168.1.2 previously matched the admin_low template
tncfg:cipso> info
...
```

```
host=192.168.1.2/32
tncfg:cipso> exit
```

Example 31 Creating a Gateway That Handles Packets at One Label

In Example 28, “Creating a Security Template for a Gateway That Handles Packets at One Label,” on page 210, the security administrator creates a security template that defines a gateway that can only pass packets at the label `PUBLIC`. In this example, the security administrator ensures that the gateway host's IP address can be resolved.

```
# arp 192.168.131.75
gateway-1.example.com (192.168.131.75) at 0:0:0:1:ab:cd
```

The `arp` command verifies that the host is defined in the system's `/etc/hosts` file or is resolvable by DNS.

Then, the administrator adds the `gateway-1` host to the security template.

```
# tncfg -t cipso_public
tncfg:cipso_public> add host=192.168.131.75
tncfg:cipso_public> exit
```

The system can immediately send and receive `public` packets through `gateway-1`.

Example 32 Creating an Unlabeled Router to Route Labeled Packets

Any IP router can forward messages with CALIPSO or CIPSO labels even though the router does not explicitly support labels. Such an unlabeled router requires a default label to define the level at which connections to the router, perhaps for router management, must be handled. In this example, the security administrator creates a router that can forward traffic at any label, but all direct communication with the router is handled at the default label, `PUBLIC`.

First, the security administrator creates the template from scratch.

```
# tncfg -t unl_public_router
tncfg:unl_public_router> set host_type=unlabeled
tncfg:unl_public_router> set doi=1
tncfg:unl_public_router> set def_label="PUBLIC"
tncfg:unl_public_router> set min_label=ADMIN_LOW
tncfg:unl_public_router> set max_label=ADMIN_HIGH
tncfg:unl_public_router> exit
```

Then, the administrator adds the router to the security template.

```
# tncfg -t unl_public_router
tncfg:unl_public_router> add host=192.168.131.82
tncfg:unl_public_router> exit
```

The system can immediately send and receive packets at all labels through `router-1`, the host name of the `192.168.131.82` address.

Example 33 Creating a Gateway With a Limited Label Range

In this example, the security administrator creates a template that restricts packets to a narrow label range and adds the gateway to the template.

```
# arp 192.168.131.78
gateway-ir.example.com (192.168.131.78) at 0:0:0:3:ab:cd

# tncfg -t cipso_iuo_rstrct
tncfg:cipso_iuo_rstrct> set host_type=cipso
tncfg:cipso_iuo_rstrct> set doi=1
tncfg:cipso_iuo_rstrct> set min_label=0x0004-08-48
tncfg:cipso_iuo_rstrct> set max_label=0x0004-08-78
tncfg:cipso_iuo_rstrct> add host=192.168.131.78
tncfg:cipso_iuo_rstrct> exit
```

The system can immediately send and receive packets that are labeled `internal` and `restricted` through `gateway-ir`.

Example 34 Creating Hosts at Discrete Labels

In this example, the security administrator creates a security template that recognizes two labels only, `confidential : internal use only` and `confidential : restricted`. All other traffic is rejected.

First, the security administrator ensures that each host's IP addresses can be resolved.

```
# arp 192.168.132.21
host-auxset1.example.com (192.168.132.21) at 0:0:0:4:ab:cd
# arp 192.168.132.22
host-auxset2.example.com (192.168.132.22) at 0:0:0:5:ab:cd
# arp 192.168.132.23
host-auxset3.example.com (192.168.132.23) at 0:0:0:6:ab:cd
# arp 192.168.132.24
host-auxset4.example.com (192.168.132.24) at 0:0:0:7:ab:cd
```

Then, the administrator is careful to type the labels precisely. The software recognizes labels in uppercase and lowercase letters and by short name, but does not recognize labels where the spacing is inaccurate. For example, the label `cnf :restricted` is not a valid label.

```
# tncfg -t cipso_int_and_rst
tncfg:cipso_int_and_rst> set host_type=cipso
tncfg:cipso_int_and_rst> set doi=1
tncfg:cipso_int_and_rst> set min_label="cnf : internal use only"
tncfg:cipso_int_and_rst> set max_label="cnf : internal use only"
tncfg:cipso_int_and_rst> set aux_label="cnf : restricted"
tncfg:cipso_int_and_rst> exit
```

Then, the administrator assigns the range of IP addresses to the security template by using a prefix length.

```
# tncfg -t cipso_int_rstrct
```

```
tncfg:cipso_int_rstrct> set host=192.168.132.0/24
```

Example 35 Creating a Labeled Host for Developers

In this example, the security administrator creates a `cipso_sandbox` security template. This template is assigned to systems that are used by developers of trusted software. Developer tests do not affect other labeled hosts because the label `SANDBOX` is disjoint from the other labels on the network.

```
# tncfg -t cipso_sandbox
tncfg:cipso_sandbox> set host_type=cipso
tncfg:cipso_sandbox> set doi=1
tncfg:cipso_sandbox> set min_sl="SBX"
tncfg:cipso_sandbox> set max_sl="SBX"
tncfg:cipso_sandbox> add host=196.168.129.102
tncfg:cipso_sandbox> add host=196.168.129.129
tncfg:cipso_sandbox> exit
```

The developers who use the `196.168.129.102` and `196.168.129.129` systems can communicate with each other at the label `SANDBOX`.

Example 36 Creating a Security Template for a `netif` Host

In this example, the security administrator creates a `netif` security template. This template is assigned to the labeled network interface that hosts the IP address `10.121.10.3`. With this assignment, the Trusted Extensions IP module adds the default label, `PUBLIC`, to all incoming packets that arrive from an `adaptive` host.

```
# tncfg -t netif_public
tncfg:netif_public> set host_type=netif
tncfg:netif_public> set doi=1
tncfg:netif_public> set def_label="PUBLIC"
tncfg:netif_public> add host=10.121.10.3
tncfg:netif_public> commit
tncfg:netif_public> exit
```

Example 37 Creating Security Templates for Adaptive Hosts

In this example, the security administrator plans ahead. The administrator creates different subnets for a network that holds public information and a network that holds internal information. The administrator then defines two `adaptive` hosts. Systems in the public subnet are assigned the `PUBLIC` label. Systems in the internal network are assigned the `IUO` label. Because this network is planned ahead of time, each network holds and transmits information at a specific label. Another advantage is that the network is easily debugged when packets are not delivered at the expected interface.

```
# tncfg -t adpub_192_168_10
tncfg:adapt_public> set host_type=adapt
```

```
tncfg:adapt_public> set doi=1
tncfg:adapt_public> set min_label="public"
tncfg:adapt_public> set max_label="public"
tncfg:adapt_public> add host=192.168.10.0
tncfg:adapt_public> commit
tncfg:adapt_public> exit

# tncfg -t adiuo_192_168_20
tncfg:adapt_public> set host_type=adapt
tncfg:adapt_public> set doi=1
tncfg:adapt_public> set min_label="iuo"
tncfg:adapt_public> set max_label="iuo"
tncfg:adapt_public> add host=192.168.20.0
tncfg:adapt_public> commit
tncfg:adapt_public> exit
```

Example 38 Sending Labeled Multicast Messages

In this example on a labeled, homogeneous LAN, the security administrator chooses an available multicast address over which to send packets at the label `PUBLIC`.

```
# tncfg -t cipso_public
tncfg:cipso_public> add host=224.4.4.4
tncfg:cipso_public> exit
```

Example 39 Removing Several Hosts From a Security Template

In this example, the security administrator removes several hosts from the `cipso` security template. The administrator uses the `info` subcommand to display the hosts, then types `remove`, and copies and pastes four `host=` entries.

```
# tncfg -t cipso info
name=cipso
host_type=cipso
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=127.0.0.1/32
host=192.168.1.2/32
host=192.168.113.0/24
host=192.168.113.100/25
host=2001:a08:3903:200::0/56

# tncfg -t cipso
tncfg:cipso> remove host=192.168.1.2/32
tncfg:cipso> remove host=192.168.113.0/24
tncfg:cipso> remove host=192.168.113.100/25
tncfg:cipso> remove host=2001:a08:3903:200::0/56
tncfg:cipso> info
...
max_label=ADMIN_HIGH
```

```
host=127.0.0.1/32
host=192.168.75.0/24
```

After removing the hosts, the administrator commits the changes and exits the security template.

```
tncfg:cipso> commit
tncfg:cipso> exit
#
```

▼ How to Add a Range of Hosts to a Security Template

Before You Begin For the requirements, see "How to Add a Host to a Security Template" on page 211.

1. **To assign a security template to a subnet, add the subnet address to the template.**

   In this example, you add two IPv4 subnets to the `cipso` template, then display the security template.

   ```
   # tncfg -t cipso
   tncfg:cipso> add host=192.168.75.0
   tncfg:cipso> add host=192.168.113.0
   tncfg:cipso> info
   ...
   host=192.168.75.0/24
   host=192.168.113.0/24
   tncfg:cipso> exit
   ```

   The prefix length of `/24` indicates that the address, which ends in `.0`, is a subnet.

   ```
   # tncfg -t cipso
   tncfg:cipso> add host=192.168.113.100/25
   192.168.113.100/25 previously matched the admin_low template
   ```

2. **To assign a security template to a range of addresses, specify the IP address and the prefix length.**

   In the following example, the `/25` prefix length covers contiguous IPv4 addresses from `192.168.113.0` to `192.168.113.127`. The address includes `192.168.113.100`.

   ```
   # tncfg -t cipso
   tncfg:cipso> add host=192.168.113.100/25
   tncfg:cipso> exit
   ```

   In the following example, the `/56` prefix length covers contiguous IPv6 addresses from `2001:a08:3903:200::0` to `2001:a08:3903:2ff:ffff:ffff:ffff:ffff`. The address includes `2001:a08:3903:201:20e:cff:fe08:58c`.

   ```
   # tncfg -t cipso
   tncfg:cipso> add host=2001:a08:3903:200::0/56
   ```

```
tncfg:cipso> info
...
host=2001:a08:3903:200::0/56
tncfg:cipso> exit
```

If you add a host that was previously added to another template, you are notified that you are replacing its security template assignment. For the informational message, see Example 40, “Replacing Security Template for a Range of Hosts,” on page 218.
A mistyped entry also displays an informational message, as shown in Example 41, “Handling a Mistyped IP Address in a Security Template,” on page 218.

Example 40 Replacing Security Template for a Range of Hosts

This example illustrates the informational message that displays when you assign a security template to a range of hosts that already has a template assignment.

```
# tncfg -t cipso
tncfg:cipso> add host=192.168.113.100/32
192.168.113.100/32 previously matched the admin_low template
tncfg:cipso> info
...
host=192.168.113.100/32
tncfg:cipso> exit
```

Trusted Extensions fallback mechanism ensures that this explicit assignment overrides the previous assignment, as discussed in “Trusted Network Fallback Mechanism” on page 193.

Example 41 Handling a Mistyped IP Address in a Security Template

A mistyped entry displays an informational message. The following host addition omits `:200` from the address:

```
# tncfg -t cipso
tncfg:cipso> add host=2001:a08:3903::0/56
Invalid host: 2001:a08:3903::0/56
```

Example 42 Creating an Unlabeled Subnetwork at the Label `PUBLIC`

In Example 29, “Creating an Unlabeled Security Template at the Label PUBLIC,” on page 210, the security administrator creates a security template that assigns the label `PUBLIC` to an untrusted host. In this example, the security administrator assigns a subnet to the `PUBLIC` label. Users on the assigning system can mount file systems from hosts in this subnet into a `PUBLIC` zone.

```
# tncfg -t public
tncfg:public> add host=10.10.0.0/16
tncfg:public> exit
```

The subnet can immediately be reached at the label `PUBLIC`.

Limiting the Hosts That Can Reach the Trusted Network

In this section, you protect the network by limiting the hosts that can reach the network.

- "How to Limit the Hosts That Can Be Contacted on the Trusted Network" on page 219.
- Increase security by specifying systems to contact at boot time. See Example 43, "Changing the Label of the `0.0.0.0/0` IP Address," on page 220.
- Configure an application server to accept the initial contact from a remote client. See Example 45, "Making the Host Address `0.0.0.0/32` a Valid Initial Address," on page 221.
- Configure a labeled Sun Ray server to accept the initial contact from a remote client. See Example 46, "Configuring a Valid Initial Address for a Labeled Sun Ray Server," on page 222.

▼ How to Limit the Hosts That Can Be Contacted on the Trusted Network

This procedure protects labeled hosts from being contacted by arbitrary unlabeled hosts. When Trusted Extensions is installed, the `admin_low` default security template defines every host on the network. Use this procedure to enumerate specific unlabeled hosts.

The local trusted network values on each system are used to contact the network at boot time. By default, every host that is not provided with a `cipso` template is defined by the `admin_low` template. This template assigns every remote host that is not otherwise defined (`0.0.0.0/0`) to be an unlabeled system with the default label of `admin_low`.

Caution - The default `admin_low` template can be a security risk on a Trusted Extensions network. If site security requires strong protection, the security administrator can remove the `0.0.0.0/0` wildcard entry after the system is installed. The entry must be replaced with entries for every host that the system contacts at boot time.

For example, DNS servers, home directory servers, audit servers, broadcast and multicast addresses, and routers must be explicitly added to a template after the `0.0.0.0/0` wildcard entry is removed.

If an application initially recognizes clients at the host address `0.0.0.0/32`, then you must add the `0.0.0.0/32` host entry to the `admin_low` template. For example, to receive initial connection requests from potential Sun Ray clients, Sun Ray servers must include this entry. Then, when the server recognizes the clients, the clients are provided an IP address and connected as labeled clients.

Before You Begin You must be in the Security Administrator role in the global zone.

All hosts that are to be contacted at boot time must exist in the `/etc/hosts` file.

1. **Assign the `admin_low` template to every unlabeled host that must be contacted at boot time.**

   - Include every unlabeled host that must be contacted at boot time.
   - Include every on-link router that is not running Trusted Extensions, through which this system must communicate.
   - Remove the `0.0.0.0/0` assignment.

2. **Add hosts to the `cipso` template.**

   Add each labeled host that must be contacted at boot time.

   - Include every on-link router that is running Trusted Extensions, through which this system must communicate.
   - Make sure that all network interfaces are assigned to the template.
   - Include broadcast addresses.
   - Include the ranges of labeled hosts that must be contacted at boot time.

   See Example 44, “Enumerating Systems for a Trusted Extensions System to Contact at Boot,” on page 221 for a sample database.

3. **Verify that the host assignments allow the system to boot.**

Example 43 Changing the Label of the `0.0.0.0/0` IP Address

In this example, the administrator creates a public gateway system. The administrator removes the `0.0.0.0/0` host entry from the `admin_low` template and adds the `0.0.0.0/0` host entry to the unlabeled `public` template. The system then recognizes any host that is not specifically assigned to another security template as an unlabeled system with the security attributes of the `public` security template.

```
# tncfg -t admin_low info
tncfg:admin_low> remove host=0.0.0.0     Wildcard address
tncfg:admin_low> exit

# tncfg -t public
tncfg:public> set host_type=unlabeled
tncfg:public> set doi=1
tncfg:public> set def_label="public"
tncfg:public> set min_sl="public"
tncfg:public> set max_sl="public"
tncfg:public> add host=0.0.0.0     Wildcard address
tncfg:public> exit
```

Example 44 Enumerating Systems for a Trusted Extensions System to Contact at Boot

In the following example, the administrator configures the trusted network of a Trusted Extensions system with two network interfaces. The system communicates with another network and with routers. The remote hosts are assigned to one of three templates, `cipso`, `admin_low`, or `public`. The following commands are annotated.

```
# tncfg -t cipso
tncfg:admin_low> add host=127.0.0.1      Loopback address
tncfg:admin_low> add host=192.168.112.111      Interface 1 of this host
tncfg:admin_low> add host=192.168.113.111      Interface 2 of this host
tncfg:admin_low> add host=192.168.113.6      File server
tncfg:admin_low> add host=192.168.112.255      Subnet broadcast address
tncfg:admin_low> add host=192.168.113.255      Subnet broadcast address
tncfg:admin_low> add host=192.168.113.1      Router
tncfg:admin_low> add host=192.168.117.0/24      Another Trusted Extensions network
tncfg:admin_low> exit

# tncfg -t public
tncfg:public> add host=192.168.112.12      Specific network router
tncfg:public> add host=192.168.113.12      Specific network router
tncfg:public> add host=224.0.0.2      Multicast address
tncfg:admin_low> exit

# tncfg -t admin_low
tncfg:admin_low> add host=255.255.255.255      Broadcast address
tncfg:admin_low> exit
```

After specifying the hosts to contact at boot time, the administrator removes the `0.0.0.0/0` entry from the `admin_low` template.

```
# tncfg -t admin_low
tncfg:admin_low> remove host=0.0.0.0
tncfg:admin_low> exit
```

Example 45 Making the Host Address `0.0.0.0/32` a Valid Initial Address

In this example, the security administrator configures an application server to accept initial connection requests from potential clients.

The administrator configures the server's trusted network. The server and client entries are annotated.

```
# tncfg -t cipso info
name=cipso
host_type=cipso
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=127.0.0.1/32
host=192.168.128.1/32      Application server address
```

```
host=192.168.128.0/24       Application's client network
    Other addresses to be contacted at boot time
```

```
# tncfg -t admin_low info
name=cipso
host_type=cipso
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=192.168.128.0/24       Application's client network
host=0.0.0.0/0      Wildcard address
    Other addresses to be contacted at boot time
```

After this phase of testing succeeds, the administrator locks down the configuration by removing the default wildcard address, `0.0.0.0/0`, committing the change, and then adding the specific address.

```
# tncfg -t admin_low info
tncfg:admin_low> remove host=0.0.0.0
tncfg:admin_low> commit
tncfg:admin_low> add host=0.0.0.0/32     For initial client contact
tncfg:admin_low> exit
```

The final `admin_low` configuration appears similar to the following:

```
# tncfg -t admin_low
name=cipso
host_type=cipso
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
192.168.128.0/24      Application's client network
host=0.0.0.0/32       For initial client contact
    Other addresses to be contacted at boot time
```

The `0.0.0.0/32` entry allows only the clients of the application to reach the application server.

Example 46 Configuring a Valid Initial Address for a Labeled Sun Ray Server

In this example, the security administrator configures a Sun Ray server to accept initial connection requests from potential clients. The server is using a private topology and the Sun Ray server defaults.

```
# utadm -a net0
```

Then, the administrator configures the server's trusted network. The server and client entries are annotated.

```
# tncfg -t cipso info
name=cipso
```

```
host_type=cipso
doi=1
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=127.0.0.1/32
host=192.168.128.1/32       Sun Ray server address
host=192.168.128.0/24       Sun Ray client network
     Other addresses to be contacted at boot time
```

```
# tncfg -t admin_low info
name=cipso
host_type=cipso
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
host=192.168.128.0/24       Sun Ray client network
host=0.0.0.0/0      Wildcard address
     Other addresses to be contacted at boot time
```

After this phase of testing succeeds, the administrator locks down the configuration by removing the default wildcard address, `0.0.0.0/0`, committing the change, and then adding the specific address.

```
# tncfg -t admin_low info
tncfg:admin_low> remove host=0.0.0.0
tncfg:admin_low> commit
tncfg:admin_low> add host=0.0.0.0/32     For initial client contact
tncfg:admin_low> exit
```

The final `admin_low` configuration appears similar to the following:

```
# tncfg -t admin_low
name=cipso
host_type=cipso
doi=1
def_label=ADMIN_LOW
min_label=ADMIN_LOW
max_label=ADMIN_HIGH
192.168.128.0/24      Sun Ray client network
host=0.0.0.0/32      For initial client contact
     Other addresses to be contacted at boot time
```

The `0.0.0.0/32` entry allows only Sun Ray clients to reach the server.

Configuring Routes and Multilevel Ports

Static routes enable labeled packets to reach their destination through labeled and unlabeled gateways. MLPs enable an application to use one entry point to reach all zones.

How to Add Default Routes

This procedure adds a default route by using the GUI. The example shows how to add a default route by using the command line.

Before You Begin You must be in the Security Administrator role in the global zone.

You have added each destination host, network, and gateway to a security template. For details, see "How to Add a Host to a Security Template" on page 211 and "How to Add a Range of Hosts to a Security Template" on page 217.

1. **Use the `txzonemgr` GUI to create default routes.**

   ```
   # txzonemgr &
   ```

2. **Double-click the zone whose default route you want to set, then double-click its IP address entry.**

   If the zone has more than one IP address, choose the entry with the desired interface.

3. **At the prompt, type the IP address of the router and click OK.**

Note - To remove or modify the default router, remove the entry, create the IP entry again and add the router. If the zone has only one IP address, you must remove the IP instance to remove the entry.

Example 47 Using the `route` Command to Set the Default Route for the Global Zone

In this example, the administrator uses the `route` command to create a default route for the global zone.

```
# route add default 192.168.113.1 -static
```

How to Create a Multilevel Port for a Zone

You can add private and shared MLPs to labeled zones and the global zone.

This procedure is used when an application that runs in a labeled zone requires a multilevel port (MLP) to communicate with the zone. In this procedure, a web proxy communicates with the zone.

Before You Begin You must be in the `root` role in the global zone. The system must have at least two IP addresses and the labeled zone is halted.

1. **Add the proxy host and the web services host to the `/etc/hosts` file.**

   ```
   ## /etc/hosts file
   ...
   proxy-host-name  IP-address
   web-service-host-name IP-address
   ```

2. **Configure the zone.**

   For example, configure the `public` zone to recognize packets that are explicitly labeled `PUBLIC`. For this configuration, the security template is named `webprox`.

   ```
   # tncfg -t webprox
   tncfg:public> set name=webprox
   tncfg:public> set host_type=cipso
   tncfg:public> set min_label=public
   tncfg:public> set max_label=public
   tncfg:public> add host=mywebproxy.oracle.com      host name associated with public zone
   tncfg:public> add host=10.1.2.3/16     IP address of public zone
   tncfg:public> exit
   ```

3. **Configure the MLP.**

   For example, the web proxy service might communicate with the `PUBLIC` zone over the `8080/tcp` interface.

   ```
   # tncfg -z public add mlp_shared=8080/tcp
   # tncfg -z public add mlp_private=8080/tcp
   ```

4. **To add the MLPs to the kernel, boot the zone.**

   ```
   # zoneadm -z zone-name boot
   ```

5. **In the global zone, add routes for the new addresses.**

   To add routes, perform "How to Add Default Routes" on page 224.

Example 48 Configuring an MLP by Using the `txzonemgr` GUI

The administrator configures the web proxy service by opening the Labeled Zone Manager.

```
# txzonemgr &
```

The administrator double-clicks the `PUBLIC` zone, then double-clicks `Configure Multilevel Ports`. Then the administrator selects and double-clicks the `Private interfaces` line. The selection changes to an entry field similar to the following:

```
Private interfaces:111/tcp;111/udp
```

The administrator starts the web proxy entry with a semicolon separator.

```
Private interfaces:111/tcp;111/udp;8080/tcp
```

After completing the private entry, the administrator types the web proxy into the `Shared interfaces` field.

```
Shared interfaces:111/tcp;111/udp;8080/tcp
```

A popup message indicates that the multilevel ports for the `public` zone will be active at the next boot of the zone.

Example 49 Configuring a Private Multilevel Port for NFSv3 Over `udp`

In this example, the administrator enables NFSv3 read-down mounts over `udp`. The administrator has the option of using the `tncfg` command.

```
# tncfg -z global add mlp_private=2049/udp
```

The `txzonemgr` GUI provides another way to define the MLP.

In the Labeled Zone Manager, the administrator double-clicks the `global` zone, then double-clicks `Configure Multilevel Ports`. In the MLP menu, the administrator selects and double-clicks the `Private interfaces` line and adds the port/protocol.

```
Private interfaces:111/tcp;111/udp;8080/tcp
```

A popup message indicates that the multilevel ports for the `global` zone will be active at the next boot.

Example 50 Displaying Multilevel Ports on a System

In this example, a system is configured with several labeled zones. All zones share the same IP address. Some zones are also configured with zone-specific addresses. In this configuration, the TCP port for web browsing, port `8080`, is an MLP on a shared interface in the public zone. The administrator has also set up `telnet`, TCP port `23`, to be an MLP in the public zone. Because these two MLPs are on a shared interface, no other zone, including the global zone, can receive packets on the shared interface on ports `8080` and `23`.

In addition, the TCP port for `ssh`, port `22`, is a per-zone MLP in the public zone. The public zone's `ssh` service can receive any packets on its zone-specific address within the address's label range.

The following command shows the MLPs for the public zone:

```
# tninfo -m public
private: 22/tcp
```

```
shared:  23/tcp;8080/tcp
```

The following command shows the MLPs for the global zone. Note that ports `23` and `8080` cannot be MLPs in the global zone because the global zone shares the same address with the public zone:

```
# tninfo -m global
private: 111/tcp;111/udp;514/tcp;515/tcp;631/tcp;2049/tcp;
6000-6003/tcp;38672/tcp;60770/tcp;
shared:  6000-6003/tcp
```

Configuring Labeled IPsec

The following task map describes tasks that are used to add labels to IPsec protections.

TABLE 24 Configuring Labeled IPsec Task Map

Task	Description	For Instructions
Use IPsec with Trusted Extensions.	Adds labels to IPsec protections.	"How to Apply IPsec Protections in a Multilevel Trusted Extensions Network" on page 227
Use IPsec with Trusted Extensions across an untrusted network.	Tunnels labeled IPsec packets across an unlabeled network.	"How to Configure a Tunnel Across an Untrusted Network" on page 229

▼ How to Apply IPsec Protections in a Multilevel Trusted Extensions Network

In this procedure, you configure IPsec on two Trusted Extensions systems to handle the following conditions:

- The two systems, `enigma` and `partym`, are multilevel Trusted Extensions systems that are operating in a multilevel network.
- Application data is encrypted and protected against unauthorized change within the network.
- The security label of the data is visible in the form of a CALIPSO or CIPSO IP option for use by multilevel routers and security devices on the path between the `enigma` and `partym` systems.
- The security labels that `enigma` and `partym` exchange are protected against unauthorized changes.

Before You Begin You are in the `root` role in the global zone.

1. **Add the `enigma` and `partym` hosts to a `cipso` security template.**
   Follow the procedures in "Labeling Hosts and Networks" on page 205. Use a template with a `cipso` host type.

2. **Configure IPsec for the `enigma` and `partym` systems.**
   For the procedure, see "How to Secure Network Traffic Between Two Servers With IPsec" in *Securing the Network in Oracle Solaris 11.3*. Use IKE for key management, as described in the following step.

3. **Add labels to IKE negotiations.**
   Follow the procedure in "How to Configure IKEv2 With Preshared Keys" in *Securing the Network in Oracle Solaris 11.3*, then modify the `ike/config` file as follows:

   a. **Add the keywords `label_aware`, `multi_label`, and `wire_label inner` to the `enigma` system's `/etc/inet/ike/config` file.**
      The resulting file appears similar to the following. The label additions are highlighted.

```
 ### ike/config file on enigma, 192.168.116.16
## Global parameters
#
## Use IKE to exchange security labels.
label_aware
#
## Defaults that individual rules can override.
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha encr_alg 3des }
p2_pfs 2
#
## The rule to communicate with partym
# Label must be unique
{ label "enigma-partym"
local_addr 192.168.116.16
remote_addr 192.168.13.213
multi_label
wire_label inner
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha1 encr_alg aes }
p2_pfs 5
}
```

   b. **Add the same keywords to the `ike/config` file on the `partym` system.**

```
 ### ike/config file on partym, 192.168.13.213
## Global Parameters
#
## Use IKE to exchange security labels.
label_aware
#
```

```
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha encr_alg 3des }
p2_pfs 2
## The rule to communicate with enigma
# Label must be unique
{ label "partym-enigma"
local_addr 192.168.13.213
remote_addr 192.168.116.16
multi_label
wire_label inner
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha1 encr_alg aes }
p2_pfs 5
}
```

4. **If AH protection of CALIPSO or CIPSO IP options cannot be used on the network, use ESP authentication.**

   Use `encr_auth_algs` rather than `auth_algs` in the `/etc/inet/ipsecinit.conf` file to handle authentication. ESP authentication does not cover the IP header and IP options, but will authenticate all information after the ESP header.

   ```
   {laddr enigma raddr partym} ipsec {encr_algs any encr_auth_algs any sa shared}
   ```

Note - You can also add labels to systems that are protected by certificates. Public key certificates are managed in the global zone on Trusted Extensions systems. Modify the `ike/config` files similarly when completing the procedures in "Configuring IKEv2 With Public Key Certificates" in *Securing the Network in Oracle Solaris 11.3*.

How to Configure a Tunnel Across an Untrusted Network

This procedure configures an IPsec tunnel across a public network between two Trusted Extensions VPN gateway systems. The example that is used in this procedure is based on the configuration that is illustrated in "Description of the Network Topology for the IPsec Tasks to Protect a VPN" in *Securing the Network in Oracle Solaris 11.3*.

Assume the following modifications to the illustration:

- The `10` subnets are multilevel trusted networks. CALIPSO or CIPSO IP option security labels are visible on these LANs.
- The `192.168` subnets are single-label untrusted networks that operate at the `PUBLIC` label. These networks do not support CALIPSO or CIPSO IP options.
- Labeled traffic between `euro-vpn` and `calif-vpn` is protected against unauthorized changes.

Before You Begin You are in the `root` role in the global zone.

1. **Follow the procedures in "Labeling Hosts and Networks" on page 205 to define the following:**

   a. **Add `10.0.0.0/8` IP addresses to a labeled security template.**

      Use a template with a `cipso` host type. Retain the default label range, `ADMIN_LOW` to `ADMIN_HIGH`.

   b. **Add `192.168.0.0/16` IP addresses to an unlabeled security template at label `PUBLIC`.**

      Use a template with an Unlabeled host type. Set the default label to be `PUBLIC`. Retain the default label range, `ADMIN_LOW` to `ADMIN_HIGH`.

   c. **Add the `Calif-vpn` and `Euro-vpn` Internet-facing addresses, `192.168.13.213` and `192.168.116.16`, to a `cipso` template.**

      Retain the default label range.

2. **Create an IPsec tunnel.**

   Follow the procedure in "How to Protect the Connection Between Two LANs With IPsec in Tunnel Mode" in *Securing the Network in Oracle Solaris 11.3*. Use IKE for key management, as described in the following step.

3. **Add labels to IKE negotiations.**

   Follow the procedure in "How to Configure IKEv2 With Preshared Keys" in *Securing the Network in Oracle Solaris 11.3*, then modify the `ike/config` file as follows:

   a. **Add the keywords `label_aware`, `multi_label`, and `wire_label none PUBLIC` to the `euro-vpn` system's `/etc/inet/ike/config` file.**

      The resulting file appears similar to the following. The label additions are highlighted.

```
        ### ike/config file on euro-vpn, 192.168.116.16
## Global parameters
#
## Use IKE to exchange security labels.
label_aware
#
## Defaults that individual rules can override.
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha encr_alg 3des }
p2_pfs 2
#
## The rule to communicate with calif-vpn
# Label must be unique
{ label "eurovpn-califvpn"
local_addr 192.168.116.16
remote_addr 192.168.13.213
```

```
multi_label
wire_label none PUBLIC
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha1 encr_alg aes }
p2_pfs 5
}
```

b. Add the same keywords to the `ike/config` file on the `calif-vpn` system.

```
 ### ike/config file on calif-vpn, 192.168.13.213
## Global Parameters
#
## Use IKE to exchange security labels.
label_aware
#
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha encr_alg 3des }
p2_pfs 2
## The rule to communicate with euro-vpn
# Label must be unique
{ label "califvpn-eurovpn"
local_addr 192.168.13.213
remote_addr 192.168.116.16
multi_label
wire_label none PUBLIC
p1_xform
{ auth_method preshared oakley_group 5 auth_alg sha1 encr_alg aes }
p2_pfs 5
}
```

Note - You can also add labels to systems that are protected by certificates. Modify the `ike/config` files similarly when completing the procedures in "Configuring IKEv2 With Public Key Certificates" in *Securing the Network in Oracle Solaris 11.3*.

Troubleshooting the Trusted Network

The following task map describes tasks to help you debug your Trusted Extensions network.

TABLE 25 Troubleshooting the Trusted Network Task Map

Task	Description	For Instructions
Determine why a system and a remote host cannot communicate.	Checks that the interfaces on a single system are up.	"How to Verify That a System's Interfaces Are Up" on page 232
	Uses debugging tools when a system and a remote host cannot communicate with each other.	"How to Debug the Trusted Extensions Network" on page 233

Task	Description	For Instructions
Determine why an LDAP client cannot reach the LDAP server.	Troubleshoots the loss of connection between an LDAP server and a client.	"How to Debug a Client's Connection to the LDAP Server" on page 236

▼ How to Verify That a System's Interfaces Are Up

Use this procedure if your system does not communicate with other hosts as expected.

Before You Begin You must be in the global zone in a role that can check network attribute values. The Security Administrator role and the System Administrator role can check these values.

1. **Verify that the system's network interface is up.**

   You can use the Labeled Zone Manager GUI or the `ipadm` command to display the system's interfaces.

   - **Open the Labeled Zone Manager, then double-click the zone of interest.**

     ```
     # txzonemgr &
     ```

     Select Configure Network Interfaces and verify that the value of the `Status` column for the zone is `Up`.

   - **Or, use the `ipadm show-addr` command.**

     ```
     # ipadm show-addr
     ...
     ADDROBJ           TYPE      STATE        ADDR
     lo0/v4            static    ok           127.0.0.1/8
     net0/_a           dhcp      down         10.131.132.133/23
     net0:0/_a         dhcp      down         10.131.132.175/23
     ```

     The value of the `net0` interfaces should be `ok`. For more information about the `ipadm` command, see the `ipadm`(1M) man page.

2. **If the interface is not up, bring it up.**

   a. **In the Labeled Zone Manager GUI, double-click the zone whose interface is down.**

   b. **Select Configure Network Interfaces.**

   c. **Double-click the interface whose state is `Down`.**

   d. **Select Bring Up, then OK.**

e. **Click Cancel or OK.**

▼ How to Debug the Trusted Extensions Network

To debug two hosts that should be communicating but are not, you can use Trusted Extensions and Oracle Solaris debugging tools. For example, Oracle Solaris network debugging commands such as `snoop` and `netstat` are available. For details, see the `snoop`(1M) and `netstat`(1M) man pages. For commands that are specific to Trusted Extensions, see Appendix D, "List of Trusted Extensions Man Pages".

- For problems with contacting labeled zones, see "Managing Zones" on page 160.
- For debugging NFS mounts, see "How to Troubleshoot Mount Failures in Trusted Extensions" on page 183.

Before You Begin You must be in the global zone in a role that can check network attribute values. The Security Administrator role or the System Administrator role can check these values. Only the `root` role can edit files.

1. **Check that the hosts that cannot communicate are using the same naming service.**

   a. **On each system, check the values for the Trusted Extensions databases in the `name-service/switch` SMF service.**

   ```
   # svccfg -s name-service/switch listprop config
   config/value_authorization  astring  solaris.smf.value.name-service.switch
   config/default              astring  ldap
   ...
   config/tnrhtp               astring  "files ldap"
   config/tnrhdb               astring  "files ldap"
   ```

   b. **If the values are different on different hosts, correct the values on the offending hosts.**

   ```
   # svccfg -s name-service/switch setprop config/tnrhtp="files ldap"
   # svccfg -s name-service/switch setprop config/tnrhdb="files ldap"
   ```

   c. **Then, restart the naming service daemon on those hosts.**

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

2. **Verify that each host is defined correctly by displaying the security attributes for the source, destination, and gateway hosts in the transmission.**

Use the command line to check that the network information is correct. Verify that the assignment on each host matches the assignment on the other hosts on the network. Depending on the view you want, use the `tncfg` command, the `tninfo` command, or the `txzonemgr` GUI.

- **Display a template definition.**

  The `tninfo -t` command displays the labels in string and hexadecimal format.

  ```
  # tninfo -t template-name
  template: template-name
  host_type: one of cipso or UNLABELED
  doi: 1
  min_sl: minimum-label
  hex: minimum-hex-label
  max_sl: maximum-label
  hex: maximum-hex-label
  ```

- **Display a template and the hosts that are assigned to it.**

  The `tncfg -t` command displays the labels in string format and lists the assigned hosts.

  ```
  # tncfg -t template info
  name=<template-name>
  host_type=<one of cipso or unlabeled>
  doi=1
  min_label=<minimum-label>
  max_label=<maximum-label>
  host=127.0.0.1/32           /** Localhost **/
  host=192.168.1.2/32         /** LDAP server **/
  host=192.168.1.22/32        /** Gateway to LDAP server **/
  host=192.168.113.0/24       /** Additional network **/
  host=192.168.113.100/25           /** Additional network **/
  host=2001:a08:3903:200::0/56     /** Additional network **/
  ```

- **Display the IP address and the assigned security template for a specific host.**

  The `tninfo -h` command displays the IP address of the specified host and the name of its assigned security template.

  ```
  # tninfo -h hostname
  IP Address: IP-address
  Template: template-name
  ```

  The `tncfg get host=` command displays the name of the security template that defines the specified host.

  ```
  # tncfg get host=hostname|IP-address[/prefix]
  template-name
  ```

- **Display the multilevel ports (MLP)s for a zone.**

  The `tncfg -z` command lists one MLP per line.

  ```
  # tncfg -z zone-name info [mlp_private | mlp_shared]
  mlp_private=<port/protocol-that-is-specific-to-this-zone-only>
  mlp_shared=<port/protocol-that-the-zone-shares-with-other-zones>
  ```

  The `tninfo -m` command lists the private MLPs in one line and the shared MLPs on a second line. The MLPs are separated by semicolons.

  ```
  # tninfo -m zone-name
  private: ports-that-are-specific-to-this-zone-only
  shared: ports-that-the-zone-shares-with-other-zones
  ```

  For a GUI display of the MLPs, use the `txzonemgr` command. Double-click the zone, then select Configure Multilevel Ports.

3. **Fix any incorrect information.**

   a. **To change or check network security information, use the trusted network administrative commands, `tncfg` and `txzonemgr`. To verify the syntax of the databases, use the `tnchkdb` command.**

      For example, the following output shows that a template name, `internal_cipso`, is undefined:

      ```
      # tnchkdb
      checking /etc/security/tsol/tnrhtp ...
      checking /etc/security/tsol/tnrhdb ...
      tnchkdb: unknown template name: internal_cipso at line 49
      tnchkdb: unknown template name: internal_cipso at line 50
      tnchkdb: unknown template name: internal_cipso at line 51
      checking /etc/security/tsol/tnzonecfg ...
      ```

      The error indicates that the `tncfg` and `txzonemgr` commands were not used to create and assign the `internal_cipso` security template.

      To repair, replace the `tnrhdb` file with the original file, then use the `tncfg` command to create and assign security templates.

   b. **To clear the kernel cache, reboot.**

      At boot time, the cache is populated with database information. The SMF service, `name-service/switch`, determines if local or LDAP databases are used to populate the kernel.

4. **Collect transmission information to assist in debugging.**

   a. **Verify your routing configuration.**

```
# route get [ip] -secattr sl=label,doi=integer
```

For details, see the route(1M) man page.

b. View the label information in packets.

```
# snoop -v
```

The -v option displays the details of packet headers, including label information. This command provides a lot of detail, so you might want to restrict the packets that the command examines. For details, see the snoop(1M) man page.

c. View the routing table entries and the security attributes on sockets.

```
# netstat -aR
```

The -aR option displays extended security attributes for sockets.

```
# netstat -rR
```

The -rR option displays routing table entries. For details, see the netstat(1M) man page.

How to Debug a Client's Connection to the LDAP Server

Misconfiguration of a client entry on the LDAP server can prevent the client from communicating with the server. Similarly, misconfiguration of files on the client can prevent communication. Check the following entries and files when attempting to debug a client-server communication problem.

Before You Begin You must be in the Security Administrator role in the global zone on the LDAP client.

1. Check that the remote host template for the LDAP server and for the gateway to the LDAP server are correct.

a. Use the `tncfg` or `tninfo` command to view information.

```
# tncfg get host=LDAP-server
# tncfg get host=gateway-to-LDAP-server

# tninfo -h LDAP-server
# tninfo -h gateway-to-LDAP-server
```

b. Determine the route to the server.

```
# route get LDAP-server
```

If a template assignment is incorrect, add the host to the correct template.

2. **Check and if necessary, correct the `/etc/hosts` file.**

   Your system, the interfaces for the labeled zones on your system, the gateway to the LDAP server, and the LDAP server must be listed in the file. You might have more entries.

   Look for duplicate entries. Remove any entries that are labeled zones on other systems. For example, if `Lserver` is the name of your LDAP server, and `LServer-zones` is the shared interface for the labeled zones, remove `LServer-zones` from the `/etc/hosts` file.

3. **If you are using DNS, check the configuration of the `svc:/network/dns/client` service.**

```
# svccfg -s dns/client listprop config
config                      application
config/value_authorization  astring       solaris.smf.value.name-service.dns.switch
config/nameserver           astring       192.168.8.25 192.168.122.7
```

4. **To change the values, use the `svccfg` command.**

```
# svccfg -s dns/client setprop config/search = astring: example1.domain.com
# svccfg -s dns/client setprop config/nameserver = net_address: 192.168.8.35
# svccfg -s dns/client:default refresh
# svccfg -s dns/client:default validate
# svcadm enable dns/client
# svcadm refresh name-service/switch
# nslookup some-system
Server:         192.168.135.35
Address:        192.168.135.35#53

Name:   some-system.example1.domain.com
Address: 10.138.8.22
Name:   some-system.example1.domain.com
Address: 10.138.8.23
```

5. **Verify that the `tnrhdb` and `tnrhtp` entries in the `name-service/switch` service are accurate.**

   In the following output, the `tnrhdb` and `tnrhtp` entries are not listed. Therefore, these databases are using the default, `files ldap` naming services, in that order.

```
# svccfg -s 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"
config/netgroup             astring       ldap
```

6. **Check that the client is correctly configured on the server.**

```
# ldaplist -l tnrhdb client-IP-address
```

7. **Check that the interfaces for your labeled zones are correctly configured on the LDAP server.**

```
# ldaplist -l tnrhdb client-zone-IP-address
```

8. **Verify that you can contact the LDAP server from all currently running zones.**

```
# ldapclient list
...
NS_LDAP_SERVERS= LDAP-server-address
# zlogin zone-name1 ping LDAP-server-address
LDAP-server-address is alive
# zlogin zone-name2 ping LDAP-server-address
LDAP-server-address is alive
...
```

9. **Configure LDAP and reboot.**

   a. **For the procedure, see "Make the Global Zone an LDAP Client in Trusted Extensions" on page 85.**

   b. **In every labeled zone, re-establish the zone as a client of the LDAP server.**

```
# zlogin zone-name1
# ldapclient init \
-a profileName=profileName \
-a domainName=domain \
-a proxyDN=proxyDN \
-a proxyPassword=password LDAP-Server-IP-Address
# exit
# zlogin zone-name2 ...
```

   c. **Halt all zones and reboot.**

```
# zoneadm list
zone1
zone2
,
,
,
# zoneadm -z zone1 halt
# zoneadm -z zone2 halt
.
.
.
# reboot
```

You could instead use the `txzonemgr` GUI to halt the labeled zones.

♦ ♦ ♦ CHAPTER 17

About Trusted Extensions and LDAP

This chapter describes the use of the Oracle Directory Server Enterprise Edition (LDAP Server) for a system that is configured with Trusted Extensions.

Using the LDAP Naming Service in Trusted Extensions

To achieve uniformity of user, host, and network attributes within a security domain with multiple Trusted Extensions systems, a naming service is used for distributing most configuration information. The `svc:/system/name-service/switch` service determines which naming service is used. LDAP is the recommended naming service for Trusted Extensions.

The LDAP Server can provide the LDAP naming service for Trusted Extensions and Oracle Solaris clients. The server must include Trusted Extensions network databases, and the Trusted Extensions clients must connect to the server over a multilevel port. The security administrator specifies the multilevel port during system configuration.

Typically, this multilevel port is configured in the global zone for the global zone. Therefore, a labeled zone does not have write access to the LDAP directory. Rather, labeled zones send read requests through the multilevel proxy service that is running on their system or another trusted system on the network. Trusted Extensions also supports an LDAP configuration of one directory server per label. Such a configuration is required when users have different credentials per label.

Trusted Extensions adds two trusted network databases to the LDAP Server: `tnrhdb` and `tnrhtp`.

- For information about the use of the LDAP naming service in Oracle Solaris, see *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.
- Setting up the LDAP Server for Trusted Extensions is described in Chapter 5, "Configuring LDAP for Trusted Extensions". Trusted Extensions systems can be clients of an Oracle Solaris LDAP Server by using a proxy that is configured with Trusted Extensions.

- Setting up clients of the Trusted Extensions LDAP Server is described in "Creating a Trusted Extensions LDAP Client" on page 85.

Locally Managed Trusted Extensions Systems

If a distributed naming service is not used at a site, administrators must ensure that configuration information for users, systems, and networks is identical on all systems. A change that is made on one system must be made on all systems.

On a locally managed Trusted Extensions system, configuration information is maintained in files in the `/etc`, `/etc/security`, and `/etc/security/tsol` directories, and by configuration properties in the `name-service/switch` SMF service.

Trusted Extensions LDAP Databases

Trusted Extensions extends the LDAP Server's schema to accommodate the `tnrhdb` and `tnrhtp` databases. Trusted Extensions defines two new attributes, `ipTnetNumber` and `ipTnetTemplateName`, and two new object classes, `ipTnetTemplate` and `ipTnetHost`.

The attribute definitions are as follows:

```
ipTnetNumber
( 1.3.6.1.1.1.1.34 NAME 'ipTnetNumber'
DESC 'Trusted network host or subnet address'
EQUALITY caseExactIA5Match
SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
SINGLE-VALUE )

ipTnetTemplateName
( 1.3.6.1.1.1.1.35 NAME 'ipTnetTemplateName'
DESC 'Trusted network template name'
EQUALITY caseExactIA5Match
SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
SINGLE-VALUE )
```

The object class definitions are as follows:

```
ipTnetTemplate
( 1.3.6.1.1.1.2.18 NAME 'ipTnetTemplate' SUP top STRUCTURAL
DESC 'Object class for Trusted network host templates'
MUST ( ipTnetTemplateName )
MAY ( SolarisAttrKeyValue ) )

ipTnetHost
( 1.3.6.1.1.1.2.19 NAME 'ipTnetHost' SUP top AUXILIARY
DESC 'Object class for Trusted network host/subnet address
```

```
to template mapping'
MUST ( ipTnetNumber $ ipTnetTemplateName ) )
```

The `cipso` template definition in LDAP is similar to the following:

```
ou=ipTnet,dc=example,dc=example1,dc=exampleco,dc=com
objectClass=top
objectClass=organizationalUnit
ou=ipTnet

ipTnetTemplateName=cipso,ou=ipTnet,dc=example,dc=example1,dc=exampleco,dc=com
objectClass=top
objectClass=ipTnetTemplate
ipTnetTemplateName=cipso
SolarisAttrKeyValue=host_type=cipso;doi=1;min_sl=ADMIN_LOW;max_sl=ADMIN_HIGH;

ipTnetNumber=0.0.0.0,ou=ipTnet,dc=example,dc=example1,dc=exampleco,dc=com
objectClass=top
objectClass=ipTnetTemplate
objectClass=ipTnetHost
ipTnetNumber=0.0.0.0
ipTnetTemplateName=internal
```

Quick Reference for the LDAP Naming Service in Trusted Extensions

The LDAP naming service is managed in Trusted Extensions as it is managed in Oracle Solaris. The following is a sample of useful commands, and contains references to more detailed information:

- For strategies to solve LDAP configuration problems, see Chapter 6, “Troubleshooting LDAP Configurations” in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.
- To troubleshoot client-to-server LDAP connection problems that are affected by labels, see “How to Debug a Client's Connection to the LDAP Server” on page 236.
- To troubleshoot other client-to-server LDAP connection problems, see Chapter 6, “Troubleshooting LDAP Configurations” in *Working With Oracle Solaris 11.3 Directory and Naming Services: LDAP*.
- To display LDAP entries from an LDAP client, type:

  ```
  # ldaplist -l
  # ldap_cachemgr -g
  ```

- To display LDAP entries from an LDAP server, type:

  ```
  # ldap_cachemgr -g
  # idsconfig -v
  ```

- To list the hosts that LDAP manages, type:

```
# ldaplist -l hosts       Long listing
# ldaplist hosts          One-line listing
```

- To list information in the Directory Information Tree (DIT) on LDAP, type:

```
# ldaplist -l services | more
dn: cn=apocd+ipServiceProtocol=udp,ou=Services,dc=exampleco,dc=com
objectClass: ipService
objectClass: top
cn: apocd
ipServicePort: 38900
ipServiceProtocol: udp

...
# ldaplist services name
dn=cn=name+ipServiceProtocol=udp,ou=Services,dc=exampleco,dc=com
```

- To display the status of the LDAP service on the client, type:

```
% svcs -xv network/ldap/client
svc:/network/ldap/client:default (LDAP client)
State: online since date
See: man -M /usr/share/man -s 1M ldap_cachemgr
See: /var/svc/log/network-ldap-client:default.log
Impact: None.
```

- To start and stop the LDAP client, type:

```
# svcadm enable network/ldap/client

# svcadm disable network/ldap/client
```

- To start and stop the LDAP server in version 6 or 7 of Oracle Directory Server Enterprise Edition software, type:

```
# dsadm start /export/home/ds/instances/your-instance
# dsadm stop /export/home/ds/instances/your-instance
```

- To start and stop a proxy LDAP server in version 6 or 7 of Oracle Directory Server Enterprise Edition software, type:

```
# dpadm start /export/home/ds/instances/your-instance
# dpadm stop /export/home/ds/instances/your-instance
```

♦ ♦ ♦ CHAPTER 18

About Multilevel Mail in Trusted Extensions

This chapter covers security and multilevel mailers on systems that are configured with Trusted Extensions.

Multilevel Mail Service

Trusted Extensions provides multilevel mail for any mail application. When regular users start their mailer, the application opens at the user's current label. If users are operating in a multilevel system, they might want to link or copy their mailer initialization files. For details, see "How to Configure Startup Files for Users in Trusted Extensions" on page 136.

Trusted Extensions Mail Features

In Trusted Extensions, the System Administrator role sets up and administers mail servers according to instructions in *Managing sendmail Services in Oracle Solaris 11.3*. In addition, the security administrator determines how Trusted Extensions mail features need to be configured.

The following aspects of managing mail are specific to Trusted Extensions:

- The user's local configuration file, such as `.mailrc`, is at the user's minimum label.

  Therefore, users who work at multiple labels do not have a `.mailrc` file at the higher labels, unless they copy or link the `.mailrc` file in their minimum-label directory to each higher directory.

  The Security Administrator role or the individual user can add the `.mailrc` file to either `.copy_files` or `.link_files`. For a description of these files, see the `updatehome(1)` man page. For configuration suggestions, see "`.copy_files` and `.link_files` Files" on page 131.

- Your mail reader can run at every label on a system. Some configuration is required to connect a mail client to the server.

  For example, to use Thunderbird mail for multilevel mail requires that you configure a Thunderbird mail client at each label to specify the mail server. The mail server could be the same or different for each label, but the server must be specified.
- Trusted Extensions software checks host and user labels before sending or forwarding mail.
  - The software checks that the mail is within the accreditation range of the host. The checks are described in this list and in "Trusted Extensions Accreditation Checks" on page 196.
  - The software checks that the mail is between the account's clearance and minimum label.
  - Users can read email that is received within their accreditation range. During a session, users can read mail only at their current label.

    To contact regular user by email, an administrative role must send mail from a workspace that is at a label that the user can read. The user's default label is usually a good choice.

♦ ♦ ♦ CHAPTER 19

Managing Labeled Printing

This chapter describes how to use Trusted Extensions to configure labeled printing. It also describes how to configure Trusted Extensions print jobs without the labeling options.

Labels, Printers, and Printing

Trusted Extensions uses labels to control printer access. Labels are used to control access to printers and to information about queued print jobs. The software also labels printouts. Body pages are labeled, and mandatory banner and trailer pages are labeled. Banner and trailer pages can also include handling instructions.

The system administrator handles basic printer administration. The security administrator role manages printer security, which includes labels and how the labeled output is handled. The administrators follow basic Oracle Solaris printer administration procedures. Configuration is required to apply labels, limit the label range of print jobs, configure labeled zones to print, and relax print restrictions.

Trusted Extensions supports both multilevel and single-level printing. By default, a print server that is configured in the global zone of a Trusted Extensions system can print the full range of labels, that is, the print server is multilevel. Any labeled zone or system that can reach that print server can print to the connected printer. A labeled zone can support single-level printing. The zone can connect to the printer by way of the global zone, or the zone can be configured as a print server. Any zone at that label that can reach the labeled zone, and hence its print server, can print to the connected printer. Single-level printing is also possible by using the print server on an unlabeled system that has been assigned an arbitrary label. These print jobs print without a label.

Differences Between Trusted Extensions Printing in Oracle Solaris 10 and Oracle Solaris 11

The default printing protocol for Oracle Solaris 10 is the LP print service. The default for Oracle Solaris 11 is the Common UNIX Printing System (CUPS). For a comprehensive guide to CUPs in Oracle Solaris, see *Configuring and Managing Printing in Oracle Solaris 11.3*. The following table lists salient differences between the CUPS and LP printing protocols.

TABLE 26 CUPS – LP Differences

Area of Difference	CUPS	LP
IANA port number	`631`	`515`
Sided printing	Single-sided	Double-sided
Cascade printing	Must share the printer on the print server	Must configure the route to the printer
Accessing network printers	Must be able to successfully `ping` the IP address of the printer and print server	Must configure the route to the printer
Remote print jobs	Cannot print without labels	Can print without labels
Adding a remote printer to a client	`lpadmin -p` *printer-name* `-E \ -v ipp://`*print-server-IP-address*`/printers/`*printer-name-on-server*	`lpadmin -p` *printer-name* `\ -s` *server-name*
Enabling and accepting the print server	`lpadmin -E` option	`accept` and `enable` commands
PostScript protection	Provided by default	Requires an authorization
Enabling banner pages	`-o job-sheets=labeled` option	Provided by default
Disabling banner and trailer pages	`-o job-sheets=none` option	`-o nobanner` option
`lp -d` *printer* `file1 file2`	One banner page and one trailer page per print job	A banner and a trailer page for each file in a print job
Label orientation on job pages	Always portrait	Always the orientation of the job

Print services	`svc:/application/cups/scheduler`
	`.../in-lpd:default`
		`svc:/application/print/service-selector`
		`.../server`
		`.../rfc1179`
		`.../ipp-listener`
		`svc:/network/device-discovery/printers:snmp`

Restricting Access to Printers and Print Job Information in Trusted Extensions

Users and roles on a system that is configured with Trusted Extensions create print jobs at the label of their session. The print jobs are accepted only by print servers that recognize that label. The label must be in the label range of the print server.

Users and roles can view print jobs whose label is the same as the label of the session. In the global zone, a role can view jobs whose labels are dominated by the label of the zone.

Labeled Printer Output

Trusted Extensions prints security information on body pages and banner and trailer pages. The information comes from the `/etc/security/tsol/label_encodings` file and from the `/usr/lib/cups/filter/tsol_separator.ps` file. Labels that are longer than 80 characters are printed truncated at the top and bottom of all pages. The truncation is indicated by an arrow (->). The header and footer labels are printed in portrait orientation even when the body pages are printed in landscape. For an example, see Figure 7, “Job's Label Prints in Portrait Mode When the Body Page Is Printed in Landscape Mode,” on page 253.

The text, labels, and warnings that appear on print jobs are configurable. The text can also be replaced with text in another language for localization. The security administrator can configure the following:

- Localize or customize the text on the banner and trailer pages
- Specify alternate labels to be printed on body pages or in the various fields of the banner and trailer pages
- Change or omit any of the text or labels

Users who are directed to an unlabeled printer can print output with no labels. Users in a labeled zone with its own print server can print output with no labels if they are assigned the `solaris.print.unlabeled` authorization. Roles can be configured to print output with no labels to a local printer that is controlled by a Trusted Extensions print server. For assistance, see “Reducing Printing Restrictions in Trusted Extensions” on page 262.

Labeled Banner and Trailer Pages

The following figures show a default banner page and how the default trailer page differs. Callouts identify the various sections. For an explanation of the source of the text in these

sections, see Chapter 4, “Labeling Printer Output” in *Trusted Extensions Label Administration*. Note that the trailer page uses a different outer line.

FIGURE 4 Typical Banner Page of a Labeled Print Job

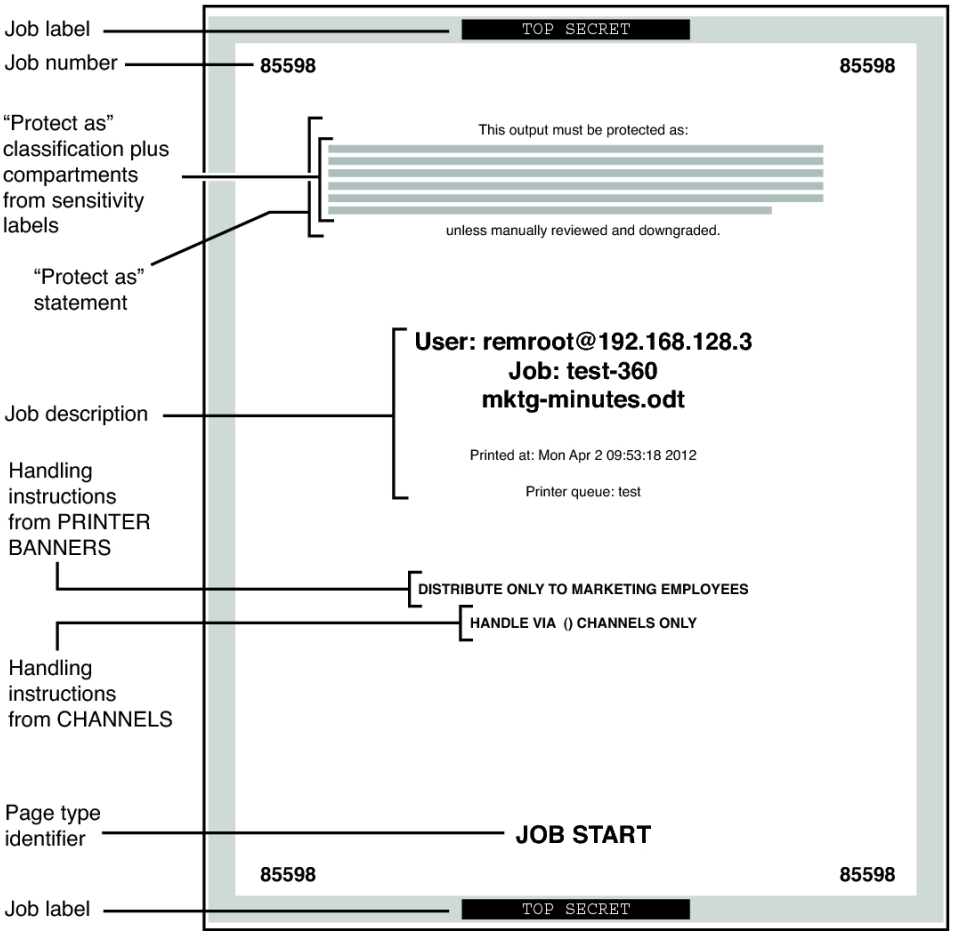
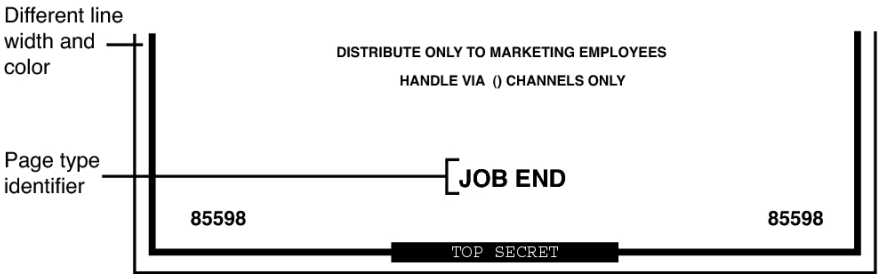


FIGURE 5 Differences on a Trailer Page

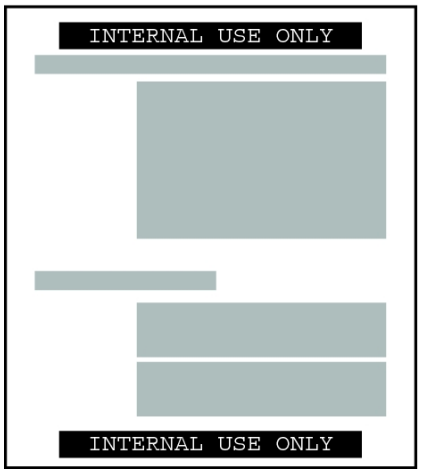


Labeled Body Pages

By default, the “Protect as” classification is printed at the top and bottom of every body page. The “Protect as” classification is the dominant classification when the classification from the job's label is compared to the `minimum protect as` classification. The `minimum protect as` classification is defined in the `label_encodings` file.

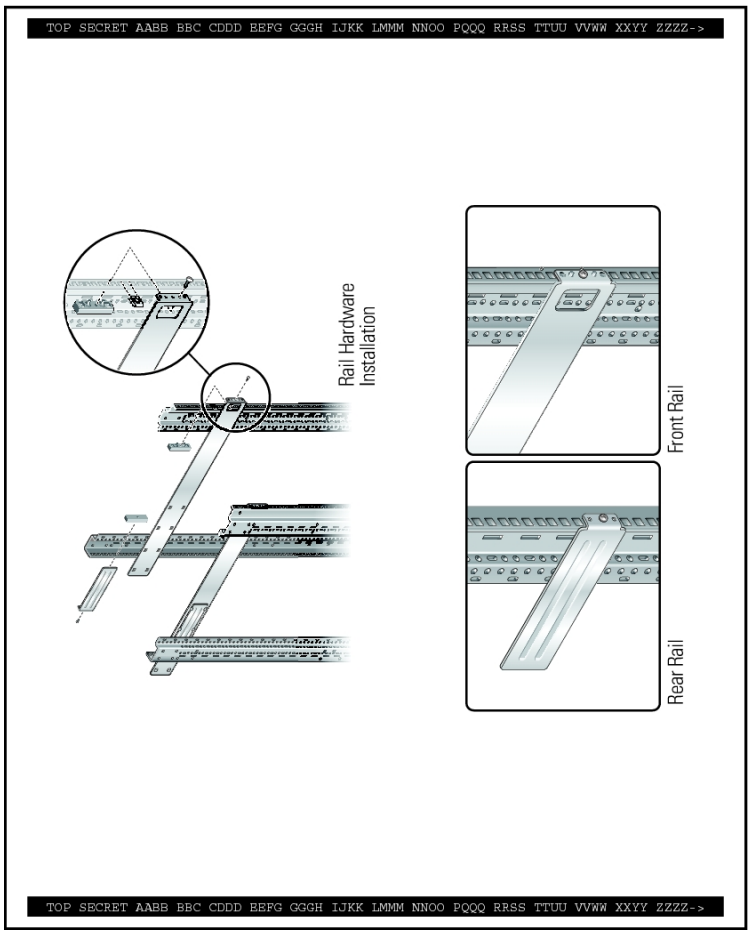
For example, if the user is logged in to an `Internal Use Only` session, then the user's print jobs are at that label. If the `minimum protect as` classification in the `label_encodings` file is `Public`, then the `Internal Use Only` label is printed on the body pages.

FIGURE 6 Job's Label Printed at the Top and Bottom of a Body Page



When the body pages are printed in landscape mode, the label prints in portrait mode. The following figure illustrates a body page, printed in landscape mode, whose Protect As label extends past the page boundaries. The label is truncated to 80 characters.

FIGURE 7 Job's Label Prints in Portrait Mode When the Body Page Is Printed in Landscape Mode



`tsol_separator.ps` Configuration File

The following table shows aspects of trusted printing that the security administrator can change by modifying the `/usr/lib/cups/filter/tsol_separator.ps` file.

TABLE 27 Configurable Values in the `tsol_separator.ps` File

Output	Default Value	How Defined	To Change
`PRINTER BANNERS`	`/Caveats Job_Caveats`	`/Caveats Job_Caveats`	See "Specifying Printer Banners" in *Trusted Extensions Label Administration*.
`CHANNELS`	`/Channels Job_Channels`	`/Channels Job_Channels`	See "Specifying Channels" in *Trusted Extensions Label Administration*.
Label at the top of banner and trailer pages	`/HeadLabel Job_Protect def`	See `/PageLabel` description.	The same as changing `/PageLabel`. Also see "Specifying the "Protect As" Classification" in *Trusted Extensions Label Administration*.
Label at the top and bottom of body pages	`/PageLabel Job_Protect def`	Compares the label of the job to the `minimum protect as classification` in the `label_encodings` file. Prints the more dominant classification. Contains compartments if the print job's label has compartments.	Change the `/PageLabel` definition to specify another value. Or, type a string of your choosing. Or, print nothing at all.

Text and label in the "Protect as" classification statement	`/Protect Job_Protect def`
	`/Protect_Text1 () def`
	`/Protect_Text2 () def`
		See `/PageLabel` description.
		Text to appear above label.
		Text to appear below label.
			The same as changing `/PageLabel`.
			Replace `()` in `Protect_Text1` and `Protect_Text2` with text string.

PostScript Printing of Security Information

Labeled printing in Trusted Extensions relies on features from Oracle Solaris printing. As in the Oracle Solaris OS, the `job-sheets` option handles banner page creation. To implement labeling, a filter converts the print job to a PostScript file. Then, the PostScript file is manipulated to insert labels on body pages, and to create banner and trailer pages.

Note - CUPS prevents any alteration of PostScript files. Therefore, a knowledgeable PostScript programmer cannot create a PostScript file that modifies the labels on the printout.

Trusted Extensions Print Interfaces (Reference)

Trusted Extensions adds the following print authorizations to implement Trusted Extensions security policy. These authorizations are checked on the print server. Therefore, remote users, such as users in labeled zones, cannot pass the authorization check.

- `solaris.print.admin` – Enables a role to administer printing

- `solaris.print.list` – Enables a role to view print jobs that do not belong to the role
- `solaris.print.nobanner` – Enables a role to print jobs without banner and trailer pages from the global zone
- `solaris.print.unlabeled` – Enables a role to print jobs without page labels from the global zone

The following user commands are extended to conform with Trusted Extensions security policy:

- `cancel` – The caller must be equal to the label of the print job to cancel a job. Regular users can cancel only their own jobs.
- `lp` – The `-o nolabel` option, which prints body pages without labels, requires the `solaris.print.unlabeled` authorization. The `-o job-sheets=none` option, which prints the job without a banner or trailer page, requires the `solaris.print.nobanner` authorization.
- `lpstat` – The caller must be equal to the label of the print job to obtain the status of a job. Regular users can view only their own print jobs.

The following administrative commands are extended to conform with Trusted Extensions security policy. As in the Oracle Solaris OS, these commands can only be run by a role that includes the Printer Management rights profile.

- `lpmove` – The caller must be equal to the label of the print job to move a job. By default, regular users can move only their own print jobs.
- `lpadmin` – In the global zone, this command works for all jobs. In a labeled zone, the caller must dominate the print job's label to view a job, and be equal to change a job.
- `lpsched` – In the global zone, this command is always successful. As in the Oracle Solaris OS, use the `svcadm` command to enable, disable, start, or restart the print service. In a labeled zone, the caller must be equal to the label of the print service to change the print service. For details about the service management facility, see the `smf`(5), `svcadm`(1M), and `svcs`(1) man pages.

Managing Printing in Trusted Extensions

You perform Trusted Extensions procedures for configuring printing after completing Oracle Solaris printer setup. Some basic setup is included in these procedures. For more information, see Chapter 2, “Setting Up Printers by Using CUPS (Tasks)” in *Configuring and Managing Printing in Oracle Solaris 11.3*. The following links point to the major tasks that manage labeled printing:

- “Configuring Labeled Printing” on page 256
- “Reducing Printing Restrictions in Trusted Extensions” on page 262

Configuring Labeled Printing

The following task map describes common configuration procedures that are related to labeled printing.

TABLE 28 Configuring Labeled Printing Task Map

Task	Description	For Instructions
Configure printing from the global zone.	Creates a multilevel print server in the global zone.	"How to Configure a Multilevel Print Server and Its Printers" on page 256
Configure a network printer.	Shares a printer.	"How to Configure a Network Printer" on page 258
Configure printing from a labeled zone.	Creates a single-label print server for a labeled zone.	"How to Configure a Zone as a Single-Level Print Server" on page 259
Configure a multilevel print client.	Connects a Trusted Extensions host to a printer.	"How to Enable a Trusted Extensions Client to Access a Printer" on page 260

▼ How to Configure a Multilevel Print Server and Its Printers

Printers that are connected to a Trusted Extensions print server print labels on body pages, banner pages, and trailer pages. Such printers can print jobs within the label range of the print server. If the printer is shared, any Trusted Extensions host that can reach the print server can use the shared printer.

Before You Begin You must be in the System Administrator role in the global zone on this print server.

1. **Determine the printer make and model.**

   ```
   # lpinfo -m | grep printer-manufacturer
   ```

   For example, the following syntax finds all the Xerox printers:

   ```
   # lpinfo -m | grep Xerox
   gutenprint.5.2://xerox-able_1406/expert Xerox Able 1406 - CUPS+Gutenprint v5.2.4
   gutenprint.5.2://xerox-able_1406/simple Xerox Able 1406 - CUPS+Gutenprint v5.2.4 ...
   gutenprint.5.2://xerox-dc_400/expert Xerox Document Centre 400 - ...
   gutenprint.5.2://xerox-dc_400/simple Xerox Document Centre 400 - ...
   gutenprint.5.2://xerox-dp_4508/expert Xerox DocuPrint 4508 - ...
   gutenprint.5.2://xerox-dp_4508/simple Xerox DocuPrint 4508 - ...
   ...
   ```

2. **Define the characteristics of every connected printer.**

```
# lpadmin -p printer-name -E -v socket://printer-IP-address -m printer-make-and-model
```

The `-E` option allows the named printers to accept a queue of printing requests. It also activates or enables the printers.

3. **To create a network printer, share the printer.**

```
# lpadmin -p printer-name -o printer-is-shared=true
```

To prevent the printer from being used by other systems, skip this step.

4. **Display the printer defaults.**

```
# lpoptions -p printer-name
```

5. **Adjust the defaults.**

For example, you could print double-sided and two-up.

Tip - You can use the CUPS web interface, `http://localhost:631`, to configure the printer.

---

6. **Configure each printer that is connected to the print server with a labeled banner and trailer page.**

```
# lpadmin -p printer-name -o job-sheets=labeled
```

If the default printer label range of `ADMIN_LOW` to `ADMIN_HIGH` is acceptable for every printer, then your label configuration is done.

7. **In every labeled zone where printing is allowed, configure the printer.**

Use the `all-zones` IP address for the global zone as the print server.

   a. **Log in as `root` to the zone console of the labeled zone.**

```
# zlogin -C labeled-zone
```

   b. **Add the printer.**

```
# lpadmin -p zone-printer-name -E \
-v ipp://global-zone-IP-address/printers/printer-name-in-global-zone
```

   c. **(Optional) Set the printer as the default.**

```
# lpadmin -d zone-printer-name
```

8. **In every labeled zone, test the printer.**

As `root` and as a regular user, perform the following steps:

a. **Print text and PostScript files from the command line.**

```
# lp /etc/motd ~/PostScriptTest.ps
% lp $HOME/file1.txt $HOME/PublicTest.ps
```

b. **Print files from your applications, such as mail, Oracle OpenOffice, Adobe Reader, and your browser.**

c. **Verify that banner pages, trailer pages, and body page labels print correctly.**

See Also

- **Prevent labeled output –** "Reducing Printing Restrictions in Trusted Extensions" on page 262
- **Use this zone as a print server –** "How to Enable a Trusted Extensions Client to Access a Printer" on page 260

▼ How to Configure a Network Printer

When a printer is shared, any Trusted Extensions host that can reach the print server can use the shared printer.

Before You Begin You must be in the System Administrator role in the global zone on this print server.

1. **Define the characteristics of your network printer.**

   Follow Step 1 through Step 6 in "How to Configure a Multilevel Print Server and Its Printers" on page 256 to configure your network printer.

   After the printer is shared in Step 3, all systems on the network that can reach this print server can print to this printer.

2. **Test the network printer.**

   As `root` and as a regular user, perform the following steps from systems that use this print server:

   a. **Print text and PostScript files from the command line.**

```
# lp /etc/motd ~/PostScriptTest.ps
% lp $HOME/file1.txt $HOME/PublicTest.ps
```

   b. **Print files from your applications, such as mail, Oracle OpenOffice, Adobe Reader, and your browser.**

   c. **Verify that banner pages, trailer pages, and body page labels print correctly.**

See Also To prevent labeled output, see "Reducing Printing Restrictions in Trusted Extensions" on page 262.

▼ How to Configure a Zone as a Single-Level Print Server

Before You Begin The zone must not be sharing an IP address with the global zone. You must be in the System Administrator role in the global zone.

1. **Add a workspace.**
   For details, see "How to Add a Workspace at Your Minimum Label" in *Trusted Extensions User's Guide*.
2. **Change the label of the new workspace to the label of the zone that will be the print server for that label.**
   For details, see "How to Change the Label of a Workspace" in *Trusted Extensions User's Guide*.
3. **Define the characteristics of every connected printer.**
   Follow Step 1 through Step 6 in "How to Configure a Multilevel Print Server and Its Printers" on page 256 to configure your zone printer.
   The attached printers can print jobs only at the label of the zone.
4. **Test the printer.**

   Note - For security reasons, files with an administrative label, `ADMIN_HIGH` or `ADMIN_LOW`, print `ADMIN_HIGH` on the body of the printout. The banner and trailer pages are labeled with the highest label and compartments in the `label_encodings` file.

   As `root` and as a regular user, perform the following steps:

   a. **Print text and PostScript files from the command line.**

   ```
   # lp /etc/motd ~/PostScriptTest.ps
   % lp $HOME/file1.txt $HOME/PublicTest.ps
   ```

   b. **Print files from your applications, such as mail, Oracle OpenOffice, Adobe Reader, and your browser.**

   c. **Verify that banner pages, trailer pages, and body page labels print correctly.**

See Also
- **Prevent labeled output –** "Reducing Printing Restrictions in Trusted Extensions" on page 262

- **Use this zone as a print server –** "How to Enable a Trusted Extensions Client to Access a Printer" on page 260

How to Enable a Trusted Extensions Client to Access a Printer

Initially, only the zone in which a print server was configured can print to the printers of that print server. The system administrator must explicitly add access to those printers for other zones and systems. The possibilities are as follows:

- For a global zone, add access to the shared printers that are connected to a global zone on a different system.
- For a labeled zone, add access to the shared printers that are connected to the global zone of its system.
- For a labeled zone, add access to a shared printer that a remote zone at the same label is configured for.
- For a labeled zone, add access to the shared printers that are connected to a global zone on a different system.

Before You Begin A print server has been configured with a label range or a single label. In addition, the printers that are connected to the print server have been configured and shared. For details, see the following:

- "How to Configure a Multilevel Print Server and Its Printers" on page 256
- "How to Configure a Zone as a Single-Level Print Server" on page 259
- "How to Assign a Label to an Unlabeled Print Server" on page 263

You must be in the System Administrator role in the global zone.

1. **Verify that you can ping the printer.**

   `# ping` *printer-IP-address*

   If this command fails, you have a network connection problem. Fix the connection problem, then return to this procedure. For assistance, see "Troubleshooting the Trusted Network" on page 231.

2. **Complete one or more procedures that enable your systems to access a printer.**

   - **Configure the global zone on a system that is not a print server to use another system's global zone for printer access.**

     a. **On the system that does not have printer access, assume the System Administrator role.**

b. Add access to the printer that is connected to the remote Trusted Extensions print server.

```
# lpadmin -p printer-name -E \
-v ipp://print-server-IP-address/printers/printer-name-on-server
```

- **Configure a labeled zone to use its global zone for printer access.**

  a. Change the label of the role workspace to the label of the labeled zone.

  For details, see "How to Change the Label of a Workspace" in *Trusted Extensions User's Guide*.

  b. Add access to the printer.

  ```
  # lpadmin -p printer-name -E \
  -v ipp://print-server-IP-address/printers/printer-name-on-print-server
  ```

- **Configure a labeled zone to use another system's labeled zone for printer access.**

  The labels of the zones must be identical.

  a. On the system that does not have printer access, assume the System Administrator role.

  b. Change the label of the role workspace to the label of the labeled zone.

  c. Add access to the printer that is connected to the print server of the remote labeled zone.

  ```
  # lpadmin -p printer-name -E \
  -v ipp://zone-print-server-IP-address/printers/printer-name-on-zone-print-server
  ```

- **Configure a labeled zone to use an unlabeled print server for printing output with no security information.**

  For instructions, see "How to Assign a Label to an Unlabeled Print Server" on page 263.

3. Test the printers.

Note - For security reasons, files with an administrative label, `ADMIN_HIGH` or `ADMIN_LOW`, print `ADMIN_HIGH` on the body pages of the printout. The banner and trailer pages are labeled with the highest label and compartments in the `label_encodings` file.

On every client, test that printing works for all accounts that can access the global zone and for all accounts that can access labeled zones.

a. Print text and PostScript files from the command line.

```
# lp /etc/motd ~/PostScriptTest.ps
% lp $HOME/file1.txt $HOME/PublicTest.ps
```

b. Print files from your applications, such as mail, Oracle OpenOffice, Adobe Reader, and your browser.

c. Verify that banner pages, trailer pages, and body page labels print correctly.

Reducing Printing Restrictions in Trusted Extensions

The following tasks are optional. They reduce the printing security that Trusted Extensions provides.

TABLE 29 Reducing Printing Restrictions in Trusted Extensions Task Map

Task	Description	For Instructions
Configure a printer to not label output.	Prevents security information from printing on printouts from the global zone.	"How to Remove Banner and Trailer Pages" on page 262
Configure printers at a single label without labeled output.	Enables users to print at a specific label. The print jobs are not marked with labels.	"How to Assign a Label to an Unlabeled Print Server" on page 263
Remove visible labeling of body pages.	Prints to an unlabeled print server. Assigns print authorizations that suppress labeling.	"How to Assign a Label to an Unlabeled Print Server" on page 263 "How to Enable Specific Users and Roles to Bypass Labeling Printed Output" on page 264
Suppress banner and trailer pages.	Removes banner and trailer pages, thus removing the additional security information on those pages.	"How to Remove Banner and Trailer Pages" on page 262
Assign print authorizations.	Authorizes specific users and roles to print jobs without labels.	"How to Enable Specific Users and Roles to Bypass Labeling Printed Output" on page 264

▼ How to Remove Banner and Trailer Pages

Printers that have the `job-sheets` option set to `none` do *not* print banner or trailer pages.

Before You Begin You must be in the Security Administrator role in the global zone.

- **At the appropriate label, configure the printer with no banner or trailer pages.**

  ```
  # lpadmin -p print-server-IP-address -o job-sheets=none,none
  ```

  Or, you can specify `none` once.

  ```
  # lpadmin -p print-server-IP-address -o job-sheets=none
  ```

  The body pages are still labeled. To remove labels from body pages, see "How to Enable Specific Users and Roles to Bypass Labeling Printed Output" on page 264.

How to Assign a Label to an Unlabeled Print Server

An Oracle Solaris print server can be assigned a label by a Trusted Extensions system for access to a printer at that label. Jobs print at the assigned label without labels. If a job prints with a banner page, the page does not contain any security information.

A Trusted Extensions system can be configured to submit jobs to a printer that is managed by an unlabeled print server. Users can print jobs on the unlabeled printer at the assigned label.

Before You Begin You must be in the Security Administrator role in the global zone.

1. **Assign an unlabeled template to the print server.**

   For details, see "How to Add a Host to a Security Template" on page 211.

   Users who are working at the label that is assigned to the print server in the unlabeled template can send print jobs to the Oracle Solaris printer at that label.

2. **On the system that does not have printer access, assume the System Administrator role.**

3. **Change the label of the role workspace to the label of the labeled zone.**

   For details, see "How to Change the Label of a Workspace" in *Trusted Extensions User's Guide*.

4. **Add access to the printer that is connected to the arbitrarily labeled print server.**

   ```
   # lpadmin -p printer-name -E \
   -v ipp://print-server-IP-address/printers/printer-name-on-print-server
   ```

Example 51 Sending Public Print Jobs to an Unlabeled Printer

Files that are available to the general public are suitable for printing to an unlabeled printer. In this example, marketing writers need to produce documents that do not have labels printed on the top and bottom of the pages.

The security administrator assigns an unlabeled host type template to the Oracle Solaris print server. The template is described in "How to Configure a Tunnel Across an Untrusted Network" on page 229. The arbitrary label of the template is `PUBLIC`. The printer `pr-nolabel1` is connected to this print server. Print jobs from users in a `PUBLIC` zone print on the `pr-nolabel1` printer with no labels. Depending on the settings for the printer, the jobs might or might not have banner pages. The banner pages do not contain security information.

▼ How to Enable Specific Users and Roles to Bypass Labeling Printed Output

To enable users and roles to print jobs without labels requires authorization by the Security Administrator and action on the part of the authorized user or role when submitting a print job.

Before You Begin You must be in the Security Administrator role in the global zone.

1. **Assign print authorizations to a user or role.**

   - **To enable the user or role to remove labels from banner and trailer pages, assign the `solaris.print.nobanner` authorization.**

     ```
     # usermod -A +solaris.print.nobanner username
     ```

     ```
     # rolemod -A +solaris.print.nobanner rolename
     ```

   - **To enable the user or role to remove labels from body pages, assign the `solaris.print.unlabeled` authorization.**

     ```
     # usermod -A +solaris.print.unlabeled username
     ```

     ```
     # rolemod -A +solaris.print.unlabeled rolename
     ```

   - **To enable the user or role to remove all labels from printouts, assign both authorizations.**

     ```
     # usermod -A +solaris.print.unlabeled,+solaris.print.nobanner username
     ```

     ```
     # rolemod -A +solaris.print.unlabeled,+solaris.print.nobanner rolename
     ```

2. **Prepare to print unlabeled output.**

   Ensure that the printer is local.

   For the user, that means that the user must be printing from a labeled zone that has a print server for that zone. A role can print from the global zone or a labeled zone.

3. **To print unlabeled output, specify the options that remove the labels on the command line.**

   You must be authorized to print unlabeled output.

   - **To print without banners, use the `job-sheets=none` option.**

     ```
     # lp -o job-sheets=none file
     ```

   - **To print without labels on body pages, use the `nolabel` option.**

     ```
     # lp -o nolabels file
     ```

   - **To print without labels on the output, use both options.**

     ```
     # lp -o job-sheets=none -o nolabels file
     ```

♦ ♦ ♦ CHAPTER 20

About Devices in Trusted Extensions

This chapter describes the protections to peripheral devices on a Trusted Extensions system.

Device Protection With Trusted Extensions Software

On an Oracle Solaris system, devices can be protected by allocation and by authorization. By default, devices are available to regular users without an authorization. A system that is configured with the Trusted Extensions feature uses the device protection mechanisms of the Oracle Solaris OS.

However, by default, Trusted Extensions requires that a device be allocated for use, and that the user be authorized to use the device. In addition, devices are protected by labels. Trusted Extensions provides a graphical user interface (GUI) for administrators to manage devices. The same interface is used by users to allocate devices.

Note - In Trusted Extensions, users cannot use the `allocate` and `deallocate` commands. Users must use the Device Manager.

For information about device protection in Oracle Solaris, see Chapter 4, "Controlling Access to Devices" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

On a system that is configured with Trusted Extensions, two roles protect devices.

- The System Administrator role controls access to peripheral devices.

  The system administrator makes a device allocatable. Devices that the system administrator makes nonallocatable cannot be used by anyone. Allocatable devices can be allocated only by authorized users.
- The Security Administrator role restricts the labels at which a device can be accessed and sets device policy. The security administrator decides who is authorized to allocate a device.

The following are the main features of device control with Trusted Extensions software:

- By default, an unauthorized user on a Trusted Extensions system cannot allocate devices such as tape drives or CD-ROM drives.

  A regular user with the Allocate Device authorization can import or export information at the label at which the user allocates the device.
- Users invoke the Device Allocation Manager to allocate devices when they are logged in directly. To allocate a device remotely, users must have access to the global zone. Typically, only roles have access to the global zone.
- The label range of each device can be restricted by the security administrator. Regular users are limited to accessing devices whose label range includes the labels at which the users are allowed to work. The default label range of a device is `ADMIN_LOW` to `ADMIN_HIGH`.
- Label ranges can be restricted for both allocatable and nonallocatable devices. Nonallocatable devices are devices such as frame buffers and printers.

Device Label Ranges

To prevent users from copying sensitive information, each allocatable device has a label range. To use an allocatable device, the user must be currently operating at a label within the device's label range. If the user is not, allocation is denied. The user's current label is applied to data that is imported or exported while the device is allocated to the user. The label of exported data is displayed when the device is deallocated. The user must physically label the medium that contains the exported data.

Effects of Label Range on a Device

To restrict direct login access through the console, the security administrator can set a restricted label range on the frame buffer.

For example, a restricted label range might be specified to limit access to a publicly accessible system. The label range enables users to access the system only at a label within the frame buffer's label range.

When a host has a local printer, a restricted label range on the printer limits the jobs that can be printed on the printer.

Device Access Policies

Trusted Extensions follows the same device policies as Oracle Solaris. The security administrator can change default policies and define new policies. The `getdevpolicy` command

retrieves information about device policy, and the `update_drv` command changes device policy. For more information, see "Configuring Device Policy" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*. See also the `getdevpolicy`(1M) and `update_drv`(1M) man pages.

Device-Clean Scripts

A device-clean script is run when a device is allocated or deallocated. Oracle Solaris provides scripts for tape drives and CD-ROM drives. If your site adds allocatable device types to the system, the added devices might need scripts. To see existing scripts, go to the `/etc/security/lib` directory. For more information, see "Device-Clean Scripts" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

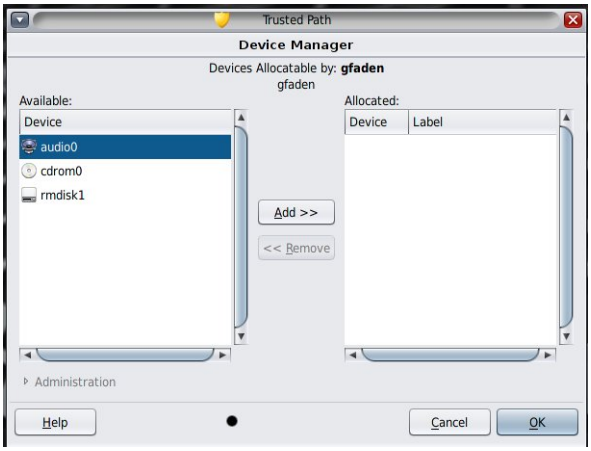
For Trusted Extensions software, device-clean scripts must satisfy certain requirements. These requirements are described in the `device_clean`(5) man page.

Device Manager GUI

The Device Manager is used by administrators to administer allocatable and nonallocatable devices. The Device Manager is also used by regular users to allocate and deallocate devices. The users must have the Allocate Device authorization.

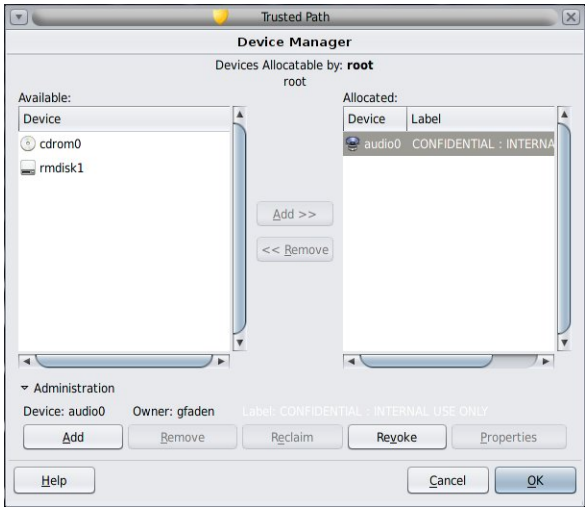
The GUI is called the Device Manager. This GUI is started from the Trusted Path menu by selecting Allocate Device. The following figure shows a Device Manager that was opened by a user who can allocate the `audio` device.

FIGURE 8 Device Manager Opened by a User



Users see an empty list when they are not authorized to allocate devices. Or, an empty list might indicate that the allocatable devices are currently allocated by another user or are in an error state. If a user cannot see a device in the Available Devices list, the user needs to contact the responsible administrator.

The Device Administration feature is available to roles that have either one or both of the authorizations that are needed to administer devices. The administration authorizations are Configure Device Attributes, and Revoke or Reclaim Device. The following figure shows a Device Allocation Administration dialog box.



Enforcement of Device Security in Trusted Extensions

The security administrator decides who can allocate devices and makes sure that any user who is authorized to use devices is trained. The user is trusted to do the following:

- Properly label and handle any media containing exported sensitive information so that the information does not become available to anyone who should not see it.

  For example, if information at a label of `NEED TO KNOW ENGINEERING` is stored on a CD, the person who exports the information must physically label the disk with the `NEED TO KNOW ENGINEERING` label. The CD must be stored where it is accessible only to members of the engineering group with a need to know.
- Ensure that labels are properly maintained on any information being imported (read) from media on these devices.

  An authorized user must allocate the device at the label that matches the label of the information that is being imported. For example, if a user allocates a CD-ROM drive at `PUBLIC`, the user must only import information labeled `PUBLIC`.

The security administrator is also responsible for enforcing proper compliance with these security requirements.

Devices in Trusted Extensions (Reference)

Trusted Extensions device protection uses Oracle Solaris interfaces and Trusted Extensions interfaces.

For Oracle Solaris command-line interfaces, see "Device Protection Reference" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

Administrators who do not have access to the Device Allocation Manager can administer allocatable devices by using the command line. The `allocate` and `deallocate` commands have administrative options. For examples, see "Forcibly Allocating or Deallocating a Device" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

For Trusted Extensions command-line interfaces, see the `add_allocatable`(1M) and `remove_allocatable`(1M) man pages.

♦ ♦ ♦ CHAPTER 21

Managing Devices for Trusted Extensions

This chapter describes how to administer and use devices on a system that is configured with Trusted Extensions.

Handling Devices in Trusted Extensions

The following task map links to task maps for administrators and users for handling peripheral devices.

TABLE 30 Handling Devices in Trusted Extensions Task Map

Task	Description	For Instructions
Use devices.	Uses a device as a role or as a regular user.	"Using Devices in Trusted Extensions Task Map" on page 273
Administer devices.	Configures devices for regular users.	"Managing Devices in Trusted Extensions" on page 274
Customize device authorizations.	The Security Administrator role creates new device authorizations, adds them to the device, places them in a rights profile and assigns this profile to the user.	"Customizing Device Authorizations in Trusted Extensions" on page 281

Using Devices in Trusted Extensions Task Map

In Trusted Extensions, all roles are authorized to allocate a device. Like users, roles must use the Device Manager. The Oracle Solaris `allocate` command does not work in Trusted

Extensions. The following task map links to user procedures for using devices in Trusted Extensions.

TABLE 31 Using Devices in Trusted Extensions Task Map

Task	For Instructions
Allocate and deallocate a device.	"How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*
Use portable media to transfer files.	"How to Copy Files From Portable Media in Trusted Extensions" on page 72 "How to Copy Files to Portable Media in Trusted Extensions" on page 71

Managing Devices in Trusted Extensions

The following task map describes procedures to protect devices at your site.

TABLE 32 Managing Devices in Trusted Extensions Task Map

Task	Description	For Instructions
Set or modify device policy.	Changes the privileges that are required to access a device.	"Configuring Device Policy" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*
Authorize users to allocate a device.	The Security Administrator role assigns a rights profile with the Allocate Device authorization to the user.	"How to Authorize Users to Allocate a Device" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*
	The Security Administrator role assigns a profile with the site-specific authorizations to the user.	"Customizing Device Authorizations in Trusted Extensions" on page 281
Configure a device.	Chooses security features to protect the device.	"How to Configure a Device by Using the Device Manager in Trusted Extensions" on page 275
Revoke or reclaim a device.	Uses the Device Manager to make a device available for use.	"How to Revoke or Reclaim a Device in Trusted Extensions" on page 278
	Uses Oracle Solaris commands to make a device available or unavailable for use.	"Forcibly Allocating or Deallocating a Device" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*
Prevent access to an allocatable device.	Provides fine–grained access control to a device.	Example 53, "Creating Fine-Grained Device Authorizations," on page 282
	Denies everyone access to an allocatable device.	Example 52, "Preventing Remote Allocation of the Audio Device," on page 280
Protect printers and frame buffers.	Ensures that nonallocatable devices are not allocatable.	"How to Protect Nonallocatable Devices in Trusted Extensions" on page 279
Use a new device-clean script.	Places a new script in the appropriate places.	"How to Add a Device_Clean Script in Trusted Extensions" on page 280

How to Configure a Device by Using the Device Manager in Trusted Extensions

By default, an allocatable device has a label range from `ADMIN_LOW` to `ADMIN_HIGH` and must be allocated for use. Also, users must be authorized to allocate the device. These defaults can be changed on a windowed system. On a system without a desktop, only roles in the global zone can configure and use allocatable devices.

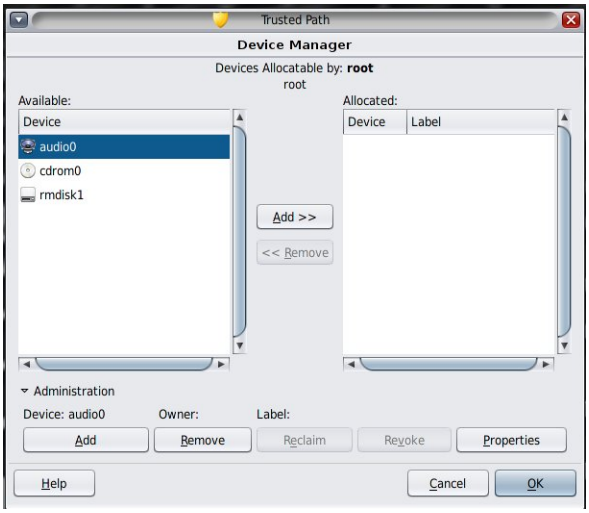
On a windowed system, the following devices can be allocated for use:

- `audio`*n* – Indicates a microphone and speaker
- `cdrom`*n* – Indicates a CD-ROM drive
- `mag_tape`*n* – Indicates a tape drive (streaming)
- `rmdisk`*n* – Indicates a removable disk, such as a JAZ or ZIP drive, or USB hot-pluggable media

Before You Begin You must be in the Security Administrator role in the global zone.

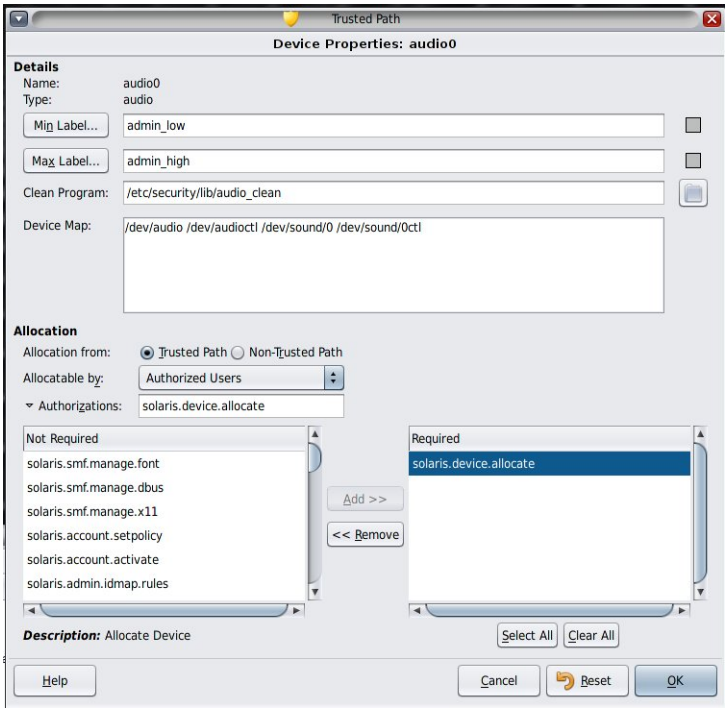
1. **From the Trusted Path menu, select Allocate Device.**

   The Device Manager appears.



2. **View the default security settings.**

Click Administration, then highlight the device. The following figure shows an audio device that is being viewed by the `root` role.



3. (Optional) Restrict the label range on the device.

a. Set the minimum label.

Click the Min Label button. Choose a minimum label from the label builder. For information about the label builder, see "Label Builder in Trusted Extensions" on page 103.

b. Set the maximum label.

Click the Max Label... button. Choose a maximum label from the label builder.

4. Specify if the device can be allocated locally.

In the Device Configuration dialog box, under For Allocations From Trusted Path, select an option from the Allocatable By list. By default, the Authorized Users option is checked. Therefore, the device is allocatable and users must be authorized.

- **To make the device nonallocatable, click No Users.**

When configuring a frame buffer or other device that must not be allocatable, select No Users.

Note - You cannot configure a printer for allocation.

- **To make the device allocatable, but to not require authorization, click All Users.**

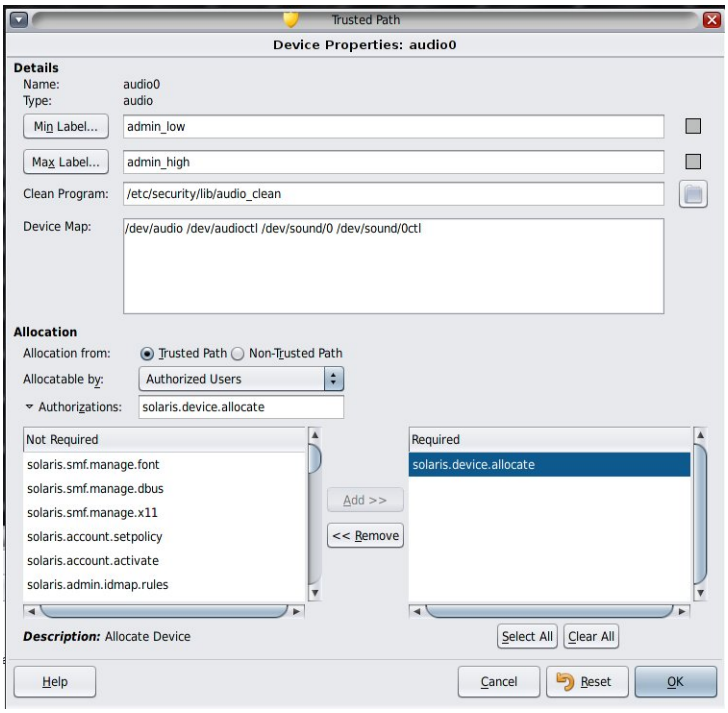
5. **Specify if the device can be allocated remotely.**

   In the For Allocations From Non-Trusted Path section, select an option from the Allocatable By list. By default, the Same As Trusted Path option is checked.

   - **To require user authorization, select Allocatable by Authorized Users.**
   - **To make the device nonallocatable by remote users, select No Users.**
   - **To make the device allocatable by anyone, select All Users.**

6. **If the device is allocatable,** *and* **your site has created new device authorizations, select the appropriate authorization.**

The following dialog box shows the `solaris.device.allocate` authorization is required to allocate the `cdrom0` device.



To create and use site-specific device authorizations, see "Customizing Device Authorizations in Trusted Extensions" on page 281.

7. **To save your changes, click OK.**

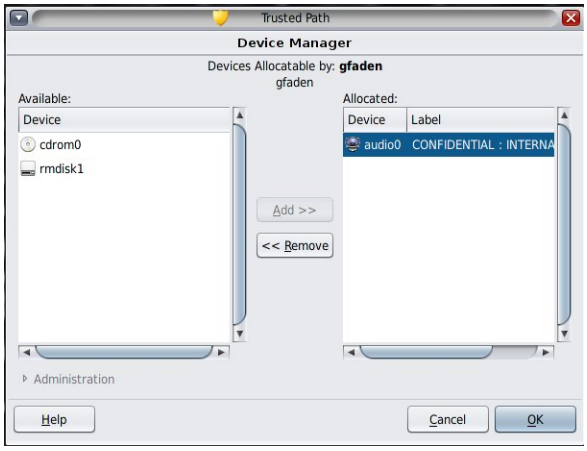
How to Revoke or Reclaim a Device in Trusted Extensions

If a device is not listed in the Device Manager, it might already be allocated or it might be in an allocate error state. The system administrator can recover the device for use.

Before You Begin You must be in the System Administrator role in the global zone. This role includes the `solaris.device.revoke` authorization.

1. **From the Trusted Path menu, select Allocate Device.**

In the following figure, the audio device is already allocated to a user.



2. **Click the Administration button.**

3. **Check the status of a device.**

   Select the device name and check the State field.

   - **If the State field is Allocate Error State, click the Reclaim button.**
   - **If the State field is Allocated, do one of the following:**
     - **Ask the user in the Owner field to deallocate the device.**
     - **Force deallocation of the device by clicking the Revoke button.**

4. **Close the Device Manager.**

How to Protect Nonallocatable Devices in Trusted Extensions

The No Users option in the Allocatable By section of the Device Configuration dialog box is used most often for the frame buffer and printer, which do not have to be allocated to be used.

Before You Begin You must be in the Security Administrator role in the global zone.

1. **From the Trusted Path menu, select Allocate Device.**
2. **In the Device Manager, click the Administration button.**
3. **Select the new printer or frame buffer.**
   a. **To make the device nonallocatable, click No Users.**
   b. **(Optional) Restrict the label range on the device.**
      i. **Set the minimum label.**

         Click the Min Label... button. Choose a minimum label from the label builder. For information about the label builder, see "Label Builder in Trusted Extensions" on page 103.

      ii. **Set the maximum label.**

         Click the Max Label... button. Choose a maximum label from the label builder.

Example 52 Preventing Remote Allocation of the Audio Device

The No Users option in the Allocatable By section prevents remote users from hearing conversations around a remote system.

The security administrator configures the audio device in the Device Manager as follows:

```
Device Name: audio
For Allocations From: Trusted Path
Allocatable By: Authorized Users
Authorizations: solaris.device.allocate

Device Name: audio
For Allocations From: Non-Trusted Path
Allocatable By: No Users
```

▼ How to Add a Device_Clean Script in Trusted Extensions

If no `device_clean` script is specified at the time a device is created, the default script, `/bin/true`, is used.

Before You Begin Have ready a script that purges all usable data from the physical device and that returns `0` for success. For devices with removable media, the script attempts to eject the media if the user

does not do so. The script puts the device into the allocate error state if the medium is not ejected. For details about the requirements, see the `device_clean(5)` man page.

You must be in the `root` role in the global zone.

1. **Copy the script into the `/etc/security/lib` directory.**
2. **In the Device Properties dialog box, specify the full path to the script.**
   a. **Open the Device Manager.**
   b. **Click the Administration button.**
   c. **Select the name of the device, and click the Configure button.**
   d. **In the Clean Program field, type the full path to the script.**
3. **Save your changes.**

Customizing Device Authorizations in Trusted Extensions

The following task map describes procedures to change device authorizations at your site.

TABLE 33 Customizing Device Authorizations in Trusted Extensions Task Map

Task	Description	For Instructions
Create new device authorizations.	Creates site-specific authorizations.	"How to Create New Device Authorizations" on page 281
Add authorizations to a device.	Adds site-specific authorizations to selected devices.	"How to Add Site-Specific Authorizations to a Device in Trusted Extensions" on page 285
Assign device authorizations to users and roles.	Enables users and roles to use the new authorizations.	"How to Assign Device Authorizations" on page 285

▼ How to Create New Device Authorizations

If a device does not require an authorization, then, by default, all users can use the device. If an authorization is required, then only authorized users can use the device.

To deny all access to an allocatable device, see Example 52, "Preventing Remote Allocation of the Audio Device," on page 280. To create and use a new authorization, see Example 54,

"Creating and Assigning Trusted Path and Non-Trusted Path Device Authorizations," on page 283.

Before You Begin You must be in the Security Administrator role in the global zone.

1. **(Optional) Create a help file for each new device authorization.**

   Help files are in HTML format. The naming convention is *AuthName*`.html`, as in `DeviceAllocateCD.html`.

2. **Create the device authorizations.**

   ```
   # auths add -t "Authorization description" -h /full/path/to/helpfile.html authorization-name
   ```

3. **Add the new authorizations to the appropriate rights profiles.**

   ```
   # profiles rights-profile
   profiles:rights-profile > add auths="authorization-name"...
   ```

4. **Assign the profiles to users and roles.**

   ```
   # usermod -P "rights-profile" username
   # rolemod -P "rights-profile" rolename
   ```

5. **Use the authorizations to restrict access to selected devices.**

   Add the new authorizations to the list of required authorizations in the Device Manager. For the procedure, see "How to Add Site-Specific Authorizations to a Device in Trusted Extensions" on page 285.

Example 53 Creating Fine-Grained Device Authorizations

In this example, a security administrator for NewCo needs to construct fine-grained device authorizations for the company.

First, the administrator creates the following help files:

```
Newco.html
NewcoDevAllocateCDVD.html
NewcoDevAllocateUSB.html
```

Next, the administrator creates a template help file from which the other help files are copied and modified.

```
<HTML>
-- Copyright 2012 Newco.  All rights reserved.
-- NewcoDevAllocateCDVD.html
-->
<HEAD>
```

```
<TITLE>Newco Allocate CD or DVD Authorization</TITLE>
</HEAD>
<BODY>
The com.newco.dev.allocate.cdvd authorization enables you to allocate the
CD drive on your system for your exclusive use.
<p>
The use of this authorization by a user other than the authorized account
is a security violation.
<p>
</BODY>
</HTML>
```

After creating the help files, the administrator uses the `auths` command to create each device authorization. Because the authorizations are used throughout the company, the administrator places the authorizations in the LDAP repository. The command includes the pathname to the help files.

The administrator creates two device authorizations and a Newco authorization header.

- One authorization authorizes the user to allocate a CD-ROM or DVD drive.

  ```
  # auths add -S ldap -t "Allocate CD or DVD" \
    -h /docs/helps/NewcoDevAllocateCDVD.html com.newco.dev.allocate.cdvd
  ```

- One authorization authorizes the user to allocate a USB device.

  ```
  # auths add -S ldap -t "Allocate USB" \
    -h /docs/helps/NewcoDevAllocateUSB.html com.newco.dev.allocate.usb
  ```

- The Newco authorization header identifies all Newco authorizations.

  ```
  # auths add -S ldap -t "Newco Auth Header" \
    -h /docs/helps/Newco.html com.newco
  ```

Example 54 Creating and Assigning Trusted Path and Non-Trusted Path Device Authorizations

By default, the Allocate Devices authorization enables allocation from the Trusted Path and from outside the Trusted Path.

In the following example, site security policy requires restricting remote CD-ROM and DVD allocation. The security administrator creates the `com.newco.dev.allocate.cdvd.local` authorization. This authorization is for CD-ROM and DVD drives that are allocated with the Trusted Path. The `com.newco.dev.allocate.cdvd.remote` authorization is for those few users who are allowed to allocate a CD-ROM or DVD drive outside the Trusted Path.

The security administrator creates the help files, adds the device authorizations to the `auth_attr` database, adds the authorizations to the devices, and then places the authorizations in rights profiles. The `root` role assigns the profiles to users who are allowed to allocate devices.

- The following commands add the device authorizations to the `auth_attr` database:

```
# auths add -S ldap -t "Allocate Local DVD or CD" \
  -h /docs/helps/NewcoDevAllocateCDVDLocal.html \
  com.newco.dev.allocate.cdvd.local
# auths add -S ldap -t "Allocate Remote DVD or CD" \
  -h /docs/helps/NewcoDevAllocateCDVDRemote.html \
  com.newco.dev.allocate.cdvd.remote
```

- The following shows the Device Manager assignment:

  Local allocation of the CD-ROM drive is protected by the Trusted Path.

  ```
  Device Name: cdrom_0
  For Allocations From: Trusted Path
  Allocatable By: Authorized Users
  Authorizations: com.newco.dev.allocate.cdvd.local
  ```

  Remote allocation is not protected by the Trusted Path, therefore, remote users must be trustworthy. In the final step, the administrator will authorize remote allocation for two roles only.

  ```
  Device Name: cdrom_0
  For Allocations From: Non-Trusted Path
  Allocatable By: Authorized Users
  Authorizations: com.newco.dev.allocate.cdvd.remote
  ```

- The following commands create the Newco rights profiles for these authorizations and add the authorizations to the profiles:

  ```
  # profiles -S ldap "Remote Allocator"
  profiles:Remote Allocator > set desc="Allocate Remote CDs and DVDs"
  profiles:Remote Allocator > set help="/docs/helps/NewcoDevRemoteCDVD.html"
  profiles:Remote Allocator > add auths="com.newco.dev.allocate.cdvd.remote"
  profiles:Remote Allocator > end
  profiles:Remote Allocator > exit

  # profiles -S ldap "Local Only Allocator"
  profiles:Local Only Allocator > set desc="Allocate Local CDs and DVDs"
  profiles:Local Only Allocator > set help="/docs/helps/NewcoDevLocalCDVD.html"
  profiles:Local Only Allocator > add auths="com.newco.dev.allocate.cdvd.local"
  profiles:Local Only Allocator > end
  profiles:Local Only Allocator > exit
  ```

- The following commands assign the rights profiles to authorized users. The `root` role assigns the profiles. At this site, only roles are authorized to remotely allocate peripheral devices.

  ```
  # usermod -P "Local Only Allocator" jdoe
  # usermod -P "Local Only Allocator" kdoe

  # rolemod -P "Remote Allocator" secadmin
  ```

```
# rolemod -P "Remote Allocator" sysadmin
```

How to Add Site-Specific Authorizations to a Device in Trusted Extensions

Before You Begin You must be in the Security Administrator role, or in a role that includes the Configure Device Attributes authorization. You must have already created site-specific authorizations, as described in "How to Create New Device Authorizations" on page 281.

1. **Follow the "How to Configure a Device by Using the Device Manager in Trusted Extensions" on page 275 procedure.**

   a. **Select a device that needs to be protected with your new authorizations.**

   b. **Click the Administration button.**

   c. **Click the Authorizations button.**

      The new authorizations are displayed in the Not Required list.

   d. **Add the new authorizations to the Required list of authorizations.**

2. **To save your changes, click OK.**

How to Assign Device Authorizations

The Allocate Device authorization enables users to allocate a device. The Allocate Device authorization, and the Revoke or Reclaim Device authorization, are appropriate for administrative roles.

Before You Begin You must be in the Security Administrator role in the global zone.

If the existing profiles are not appropriate, the security administrator can create a new profile. For an example, see "How to Create a Rights Profile for Convenient Authorizations" on page 140.

- **Assign to the user a rights profile that contains the Allocate Device authorization.**

  For the step-by-step procedure, see "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*.

The following rights profiles enable a role to allocate devices:

- All Authorizations
- Device Management
- Media Backup
- Object Label Management
- Software Installation

The following rights profiles enable a role to revoke or reclaim devices:

- All Authorizations
- Device Management

The following rights profiles enable a role to create or configure devices:

- All Authorizations
- Device Security

Example 53, “Creating Fine-Grained Device Authorizations,” on page 282 shows how to assign the authorizations.

♦ ♦ ♦ CHAPTER 22

Trusted Extensions and Auditing

This chapter describes the additions to auditing that Trusted Extensions provides.

Auditing in Trusted Extensions

On a system that is configured with Trusted Extensions software, auditing is configured and is administered similarly to auditing on an Oracle Solaris system. However, the following are some differences:

- Trusted Extensions software adds audit classes, audit events, audit tokens, and audit policy options to the system.
- Per-zone auditing is discouraged, because it requires a `root` account in a labeled zone.
- Two roles, System Administrator and Security Administrator, are used to configure and administer auditing in Trusted Extensions.

  The security administrator plans what to audit and any site-specific, event-to-class mappings. The system administrator plans disk space requirements for the audit files, creates an audit administration server, and reviews audit logs.

Audit Management by Role in Trusted Extensions

Auditing in Trusted Extensions requires the same planning as in the Oracle Solaris OS. For details about planning, see Chapter 2, "Planning for Auditing" in *Managing Auditing in Oracle Solaris 11.3*.

Role Responsibilities for Audit Administration

In Trusted Extensions, auditing is the responsibility of separate roles.

- The `root` role assigns audit flags to users and rights profiles, and edits system files, such as the `audit_warn` script.
- The System Administrator role sets up the disks and the network of audit storage. This role can also review the audit records.
- The Security Administrator role decides what is to be audited and configures auditing. The initial setup team created this role by completing"How to Create the Security Administrator Role in Trusted Extensions" on page 57.

Note - A system only records the events in audit classes that the security administrator has preselected. Therefore, any subsequent audit review can only consider the events that have been recorded. As a result of misconfiguration, attempts to breach the security of the system can go undetected, or the administrator is unable to detect the user who is responsible for an attempted breach of security. Administrators must regularly analyze audit trails to check for breaches of security.

Audit Tasks in Trusted Extensions

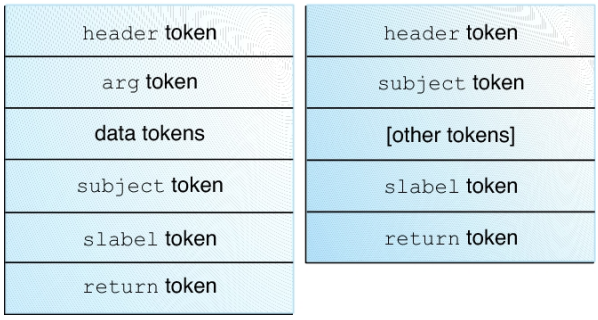
The procedures to configure and manage auditing in Trusted Extensions differ only slightly from Oracle Solaris procedures. In Trusted Extensions, audit configuration is performed in the global zone. Because per-zone auditing is not configured, user actions are audited identically in the global zone and in labeled zones. The label of every audited event is included in the audit record.

- The security administrator can select audit policies that are specific to Trusted Extensions, `windata_down` and `windata_up`.
- When reviewing audit records, the system administrator can select audit records by label. For more information, see the `auditreduce`(1M) man page.

Trusted Extensions Audit Reference

Trusted Extensions software adds audit classes, audit events, audit tokens, and audit policy options to Oracle Solaris. Several auditing commands are extended to handle labels. The following figure shows a typical Trusted Extensions kernel audit record and user-level audit record.

FIGURE 9 Typical Audit Record Structures on a Labeled System



Trusted Extensions Audit Classes

Trusted Extensions adds X windows audit classes to Oracle Solaris. The classes are listed in the `/etc/security/audit_class` file. For more information about audit classes, see the `audit_class(4)` man page.

The X server audit events are mapped to these classes according to the following criteria:

- **xa –** This class audits access to the X server, that is, X client connection and X client disconnection.
- **xc –** This class audits server objects for creation or for destruction. For example, this class audits `CreateWindow()`.
- **xp –** This class audits for use of privilege. Privilege use can be successful or unsuccessful. For example, `ChangeWindowAttributes()` is audited when a client attempts to change the attributes of another client's window. This class also includes administrative routines such as `SetAccessControl()`.
- **xs –** This class audits routines that do not return X error messages to clients on failure when security attributes cause the failure. For example, `GetImage()` does not return a `BadWindow` error if it cannot read from a window for lack of privilege.

  These events should be selected for audit on success only. When xs events are selected for failure, the audit trail fills with irrelevant records.
- **xx –** This class includes all of the X audit classes.

Trusted Extensions Audit Events

Trusted Extensions software adds audit events to the system. The new audit events and the audit classes to which the events belong are listed in the `/etc/security/audit_event` file. The audit event numbers for Trusted Extensions are between 9000 and 10000. For more information about audit events, see the `audit_event`(4) man page.

Trusted Extensions Audit Tokens

The audit tokens that Trusted Extensions software adds to Oracle Solaris are listed alphabetically in the following table. The token definitions are listed in the `audit.log`(4) man page.

TABLE 34 Trusted Extensions Audit Tokens

Token Name	Description
“`label` Token” on page 290	Sensitivity label
“`xatom` Token” on page 290	X window atom identification
“`xcolormap` Token” on page 291	X window color information
“`xcursor` Token” on page 291	X window cursor information
“`xfont` Token” on page 291	X window font information
“`xgc` Token” on page 291	X window graphical context information
“`xpixmap` Token” on page 292	X window pixel mapping information
“`xproperty` Token” on page 292	X window property information
“`xselect` Token” on page 292	X window data information
“`xwindow` Token” on page 292	X window's window information

`label` Token

The `label` token contains a sensitivity label.

A `label` token is displayed by the `praudit -x` command as follows:

```
<sensitivity_label>ADMIN_LOW</sensitivity_label>
```

`xatom` Token

The `xatom` token identifies an X atom.

An `xatom` token is displayed by `praudit` as follows:

```
X atom,_DT_SAVE_MODE
```

`xcolormap` Token

The `xcolormap` token contains information about the use of colormaps, including the X server identifier and the creator's user ID.

An `xcolormap` token is displayed by `praudit` as follows:

```
<X_colormap xid="0x08c00005" xcreator-uid="srv"/>
```

`xcursor` Token

The `xcursor` token contains information about cursor use, including the X server identifier and the creator's user ID.

An `xcursor` token is displayed by `praudit` as follows:

```
X cursor,0x0f400006,srv
```

`xfont` Token

The `xfont` token contains information about the font use, including the X server identifier and the creator's user ID.

An `xfont` token is displayed by `praudit` as follows:

```
<X_font xid="0x08c00001" xcreator-uid="srv"/>
```

`xgc` Token

The `xgc` token contains information about the graphic context of an X window.

An `xgc` token is displayed by `praudit` as follows:

```
Xgraphic context,0x002f2ca0,srv

<X_graphic_context xid="0x30002804" xcreator-uid="srv"/>
```

`xpixmap` Token

The `xpixmap` token contains information about the use of pixel mappings, including the X server identifier and the creator's user ID.

An `xpixmap` token is displayed by `praudit -x` as follows:

```
<X_pixmap xid="0x2f002004" xcreator-uid="srv"/>
```

`xproperty` Token

The `xproperty` token contains information about various properties of a window, such as the X server identifier, the creator's user ID, and an atom identifier.

An `xproperty` token is displayed by `praudit` as follows:

```
X_property,0x000075d5,root,_MOTIF_DEFAULT_BINDINGS
```

`xselect` Token

The `xselect` token contains the data that is moved between windows. This data is a byte stream with no assumed internal structure and a property string.

An `xselect` token is displayed by `praudit` as follows:

```
X selection,entryfield,halogen
```

`xwindow` Token

The `xwindow` token identifies the Xserver and the creator's user ID.

An `xwindow` token is displayed by `praudit` as follows:

```
<X_window xid="0x07400001" xcreator-uid="srv"/>
```

Trusted Extensions Audit Policy Options

Trusted Extensions adds two window audit policy options to existing audit policy options.

```
# auditconfig -lspolicy
...
windata_down Include downgraded window information in audit records
windata_up   Include upgraded window information in audit records
...
```

Extensions to Auditing Commands in Trusted Extensions

The `auditconfig`, `auditreduce`, and `auditrecord` commands are extended to handle Trusted Extensions information:

- The `auditconfig` command includes the Trusted Extensions audit policies. For details, see the `auditconfig`(1M) man page.
- The `auditreduce` command adds the `-l` option for filtering records according to the label. For details, see the `auditreduce`(1M) man page.
- The `auditrecord` command includes the Trusted Extensions audit events.

♦ ♦ ♦ CHAPTER 23

Software Management in Trusted Extensions

This chapter contains information about ensuring that third-party software runs in a trustworthy manner on a Trusted Extensions system.

Adding Software to Trusted Extensions

Any software that can be added to an Oracle Solaris system can be added to a system that is configured with Trusted Extensions. Additionally, programs that use Trusted Extensions APIs can be added. Adding software to a Trusted Extensions system is similar to adding software to an Oracle Solaris system that is running non-global zones.

In Trusted Extensions, programs are typically installed in the global zone for use by regular users in labeled zones. However, you can install packages in a labeled zone by running the `pkg` command in the zone. If you do so, you must ensure that the zone can handle administrative accounts and password prompts. For a discussion, see "Applications That Are Restricted to a Labeled Zone" on page 24. For details about packages and zones, see Chapter 8, "About Automatic Installation and Packages on an Oracle Solaris 11.2 System With Zones Installed" in *Creating and Using Oracle Solaris Zones*.

At a Trusted Extensions site, the system administrator and the security administrator work together to install software. The security administrator evaluates software additions for adherence to security policy. When the software requires privileges or authorizations to succeed, the Security Administrator role assigns an appropriate rights profile to the users of that software.

To import software from removable media requires authorization. An account with the Allocate Device authorization can import or export data from removable media. Data can include executable code. A regular user can only import data at a label within that user's clearance.

The System Administrator role is responsible for adding the programs that the security administrator approves.

Security Mechanisms for Oracle Solaris Software

Trusted Extensions uses the same security mechanisms as Oracle Solaris. The mechanisms include the following:

- **Authorizations –** Users of a program can be required to have a particular authorization. For information about authorizations, see "Basics of User and Process Rights" in *Securing Users and Processes in Oracle Solaris 11.3*. Also, see the `auth_attr`(4) man page.
- **Privileges –** Programs and processes can be assigned privileges. For information about privileges, see Chapter 1, "About Using Rights to Control Users and Processes" in *Securing Users and Processes in Oracle Solaris 11.3*. Also, see the `privileges`(5) man page.

  The `ppriv` command provides a debugging utility. For details, see the `ppriv`(1) man page. For instructions on using this utility with programs that work in non-global zones, see "Using the ppriv Utility" in *Creating and Using Oracle Solaris Zones*.
- **Right Profiles –** Rights profiles collect security attributes in one place for assignment to users or roles. For information about rights profiles, see "More About Rights Profiles" in *Securing Users and Processes in Oracle Solaris 11.3*.
- **Trusted libraries –** Dynamically shared libraries that are used by `setuid`, `setgid`, and privileged programs can be loaded only from trusted directories. As in Oracle Solaris, the `crle` command is used to add a privileged program's shared library directories to the list of trusted directories. For details, see the `crle`(1) man page.

Evaluating Software for Security

When software has been assigned privileges or when it runs with an alternate user ID or group ID, the software becomes *trusted*. Trusted software can bypass aspects of the Trusted Extensions security policy. Be aware that you can make software trusted even though it might not be worthy of trust. The security administrator must wait to give privileges to software until careful scrutiny has revealed that the software uses the privileges in a trustworthy manner.

Programs fall into three categories on a trusted system:

- **Programs that require no security attributes –** Some programs run at a single level and require no privileges. These programs can be installed in a public directory, such as `/usr/local`. For access, assign the programs as commands in the rights profiles of users and roles.
- **Programs that run as root –** Some programs execute with `setuid 0`. Such programs can be assigned an effective UID of `0` in a rights profile. The security administrator then assigns the profile to an administrative role.

Tip - If the application can use privileges in a trustworthy manner, assign the needed privileges to the application, and do not execute the program as `root`.

- **Programs that require privileges –** Some programs might need privileges for reasons that are not obvious. Even if a program is not performing any function that seems to violate system security policy, the program might be doing something internally that violates security. For example, the program could be using a shared log file, or the program could be reading from `/dev/kmem`. For security concerns, see the `mem`(7D) man page.

  Sometimes, an internal policy override is not particularly important to the application's correct operation. Rather, the override provides a convenient feature for users.

  If your organization has access to the source code, check if you can remove the operations that require policy overrides without affecting the application's performance.

Developer Responsibilities When Creating Trusted Programs

Even though a program's developer can manipulate privilege sets in the source code, if the security administrator does not assign the required privileges to the program, the program will fail. The developer and security administrator need to cooperate when creating trusted programs.

A developer who writes a trusted program must do the following:

1. Understand where the program requires privileges to do its work.
2. Know and follow techniques, such as privilege bracketing, for safely using privileges in programs.
3. Be aware of the security implications when assigning privileges to a program. The program must not violate security policy.
4. Compile the program by using shared libraries that are linked to the program from a trusted directory.

   For additional information, see *Developer's Guide to Oracle Solaris 11 Security*. For examples of code for Trusted Extensions, see *Trusted Extensions Developer's Guide*.

Security Administrator Responsibilities for Trusted Programs

The security administrator is responsible for testing and evaluating new software. After determining that the software is trustworthy, the security administrator configures rights profiles and other security-relevant attributes for the program.

The security administrator responsibilities include the following:

1. Make sure that the programmer and the program distribution process is trusted.

2. From one of the following sources, determine which privileges are required by the program:
   - Ask the programmer.
   - Search the source code for any privileges that the program expects to use.
   - Search the source code for any authorizations that the program requires of its users.
   - Use the debugging options to the `ppriv` command to search for use of privilege. For examples, see the `ppriv(1)` man page. You can also use `dtrace` to evaluate privilege and authorization use.
3. Examine the source code to make sure that the code behaves in a trustworthy manner regarding the privileges that the program needs to operate.

   If the program fails to use privilege in a trustworthy manner, and you can modify the program's source code, then modify the code. A security consultant or developer who is knowledgeable about security can modify the code. Modifications might include privilege bracketing or checking for authorizations.

   The assignment of privileges must be manual. A program that fails due to lack of privilege can be assigned privileges. Alternatively, the security administrator might decide to assign an effective UID or GID to make the privilege unnecessary.
4. Create and assign rights profiles for the new program.

♦ ♦ ♦ APPENDIX A

Site Security Policy

This appendix discusses site security policy issues, and suggests reference books and web sites for further information:

Creating and Managing a Security Policy

Each Trusted Extensions site is unique and must determine its own security policy. Perform the following tasks when creating and managing a security policy.

- Establish a security team. The security team needs to have representation from top-level management, personnel management, computer system management and administrators, and facilities management. The team must review Trusted Extensions administrators' policies and procedures, and recommend general security policies that apply to all system users.
- Educate management and administration personnel about the site security policy. All personnel involved in the management and administration of the site must be educated about the security policy. Security policies must not be made available to regular users because this policy information has direct bearing on the security of the computer systems.
- Educate users about Trusted Extensions software and the security policy. All users must be familiar with the *Trusted Extensions User's Guide*. Because the users are usually the first to know when a system is not functioning normally, the user must become acquainted with the system and report any problems to a system administrator. A secure environment needs the users to notify the system administrators immediately if they notice any of the following:
  - A discrepancy in the last login time that is reported at the beginning of each session
  - An unusual change to file data

    - A lost or stolen human-readable printout
    - The inability to operate a user function
- Enforce the security policy. If the security policy is not followed and enforced, the data contained in the system that is configured with Trusted Extensions is not secure. Procedures must be established to record any problems and the measures that were taken to resolve the incidents.
- Periodically review the security policy. The security team must perform a periodic review of the security policy and all incidents that occurred since the last review. Adjustments to the policy can then lead to increased security.

Site Security Policy and Trusted Extensions

The security administrator must design the Trusted Extensions network based on the site's security policy. The security policy dictates configuration decisions, such as the following:

- How much auditing is done for all users and for which classes of events
- How much auditing is done for users in roles and for which classes of events
- How audit data is managed, archived, and reviewed
- Which labels are used in the system and whether the `ADMIN_LOW` and `ADMIN_HIGH` labels will viewable by regular users
- Which user clearances are assigned to individuals
- Which devices (if any) can be allocated by which regular users
- Which label ranges are defined for systems, printers, and other devices
- Whether Trusted Extensions is used in an evaluated configuration or not

Computer Security Recommendations

Consider the following list of guidelines when you develop a security policy for your site.

- Assign the maximum label of a system that is configured with Trusted Extensions to not be greater than the maximum security level of work being done at the site.
- Manually record system reboots, power failures, and shutdowns in a site log.
- Document file system damage, and analyze all affected files for potential security policy violations.
- Restrict operating manuals and administrator documentation to individuals with a valid need for access to that information.
- Report and document unusual or unexpected behavior of any Trusted Extensions software, and determine the cause.

- If possible, assign at least two individuals to administer systems that are configured with Trusted Extensions. Assign one person the security administrator authorization for security-related decisions. Assign the other person the system administrator authorization for system management tasks.
- Establish a regular backup routine.
- Assign authorizations only to users who need them and who can be trusted to use them properly.
- Assign privileges to programs only they need the privileges to do their work, and only when the programs have been scrutinized and proven to be trustworthy in their use of privilege. Review the privileges on existing Trusted Extensions programs as a guide to setting privileges on new programs.
- Review and analyze audit information regularly. Investigate any irregular events to determine the cause of the event.
- Minimize the number of administration IDs.
- Minimize the number of setuid and setgid programs. Use authorizations, privileges, and roles to execute the program and to prevent misuse.
- Ensure that an administrator regularly verifies that regular users have a valid login shell.
- Ensure that an administrator must regularly verifies that regular users have valid user ID values and not system administration ID values.

Physical Security Recommendations

Consider the following list of guidelines when you develop a security policy for your site.

- Restrict access to the systems that are configured with Trusted Extensions. The most secure locations are generally interior rooms that are not on the ground floor.
- Monitor and document access to systems that are configured with Trusted Extensions.
- Secure computer equipment to large objects such as tables and desks to prevent theft. When equipment is secured to a wooden object, increase the strength of the object by adding metal plates.
- Consider removable storage media for sensitive information. Lock up all removable media when the media are not in use.
- Store system backups and archives in a secure location that is separate from the location of the systems.
- Restrict physical access to the backup and archival media in the same manner as you restrict access to the systems.
- Install a high-temperature alarm in the computer facility to indicate when the temperature is outside the range of the manufacturer's specifications. A suggested range is 10°C to 32°C (50°F to 90°F).
- Install a water alarm in the computer facility to indicate water on the floor, in the subfloor cavity, and in the ceiling.

- Install a smoke alarm to indicate fire, and install a fire-suppression system.
- Install a humidity alarm to indicate too much or too little humidity.
- Consider TEMPEST shielding if machines do not have it. TEMPEST shielding might be appropriate for facility walls, floors, and ceilings.
- Allow only certified technicians to open and close TEMPEST equipment to ensure its ability to shield electromagnetic radiation.
- Check for physical gaps that allow entrance to the facility or to the rooms that contain computer equipment. Look for openings under raised floors, in suspended ceilings, in roof ventilation equipment, and in adjoining walls between original and secondary additions.
- Prohibit eating, drinking, and smoking in computer facilities or near computer equipment. Establish areas where these activities can occur without threat to the computer equipment.
- Protect architectural drawings and diagrams of the computer facility.
- Restrict the use of building diagrams, floor maps, and photographs of the computer facility.

Personnel Security Recommendations

Consider the following list of guidelines when you develop a security policy for your site.

- Inspect packages, documents, and storage media when they arrive and before they leave a secure site.
- Require identification badges on all personnel and visitors at all times.
- Use identification badges that are difficult to copy or counterfeit.
- Establish areas that are prohibited for visitors, and clearly mark the areas.
- Escort visitors at all times.

Common Security Violations

Because no computer is completely secure, a computer facility is only as secure as the people who use it. Most actions that violate security are easily resolved by careful users or additional equipment. However, the following list gives examples of problems that can occur:

- Users give passwords to other individuals who should not have access to the system.
- Users write down passwords, and lose or leave the passwords in insecure locations.
- Users set their passwords to easily guessed words or easily guessed names.
- Users learn passwords by watching other users type a password.
- Unauthorized users remove, replace, or physically tamper with hardware.
- Users leave their systems unattended without locking the screen.
- Users change the permissions on a file to allow other users to read the file.

- Users change the labels on a file to allow other users to read the file.
- Users discard sensitive hardcopy documents without shredding them, or users leave sensitive hardcopy documents in insecure locations.
- Users leave access doors unlocked.
- Users lose their keys.
- Users do not lock up removable storage media.
- Computer screens are visible through exterior windows.
- Network cables are tapped.
- Electronic eavesdropping captures signals emitted from computer equipment.
- Power outages, surges, and spikes destroy data.
- Earthquakes, floods, tornadoes, hurricanes, and lightning destroy data.
- External electromagnetic radiation interference such as sun-spot activity scrambles files.

Additional Security References

Government publications describe in detail the standards, policies, methods, and terminology associated with computer security. Other security publications are useful in gaining a thorough understanding of UNIX security problems and solutions.

The web also provides resources. In particular, the CERT (`http://www.cert.org`) web site alerts companies and users to security holes in the software. The SANS Institute (`http://www.sans.org/`) offers training, an extensive glossary of terms, and an updated list of top threats from the Internet.

U.S. Government Publications

The U.S. government offers many of its publications on the web. The U.S. Department of Homeland Security (`http://www.us-cert.gov/security-publications`) publishes security information. Also, the Computer Security Resource Center (CSRC) of the National Institute of Standards and Technology (NIST) publishes articles on computer security. The following are a sample of the publications that can be downloaded from the NIST site (`http://csrc.nist.gov/index.html`).

- *An Introduction to Computer Security: The NIST Handbook*. SP 800-12, October 1995.
- *Standard Security Label for Information Transfer*. FIPS-188, September 1994.
- Swanson, Marianne and Barbara Guttman. *Generally Accepted Principles and Practices for Securing Information Technology Systems*. SP 800-14, September 1996.
- Tracy, Miles, Wayne Jensen, and Scott Bisker. *Guidelines on Electronic Mail Security*. SP 800-45, September 2002. Section E.7 concerns securely configuring LDAP for mail.

- Wilson, Mark and Joan Hash. *Building an Information Technology Security Awareness and Training Program*. SP 800-61, January 2004. Includes a useful glossary.
- Grace, Tim, Karen Kent, and Brian Kim. *Computer Security Incident Handling Guidelines*. SP 800-50, September 2002. Section E.7 concerns securely configuring LDAP for mail.
- Scarfone, Karen,Wayne Jansen, and Miles Tracy. *Guide to General Server Security* SP 800-123, July 2008.
- Souppaya, Murugiah, John Wack, and Karen Kent. *Security Configuration Checklists Program for IT Products*. SP 800-70, May 2005.

UNIX Publications

Sun Microsystems Security Engineers. *Solaris 10 Security Essentials*. Prentice Hall, 2009.

Garfinkel, Simson, Gene Spafford, and Alan Schwartz. *Practical UNIX and Internet Security, 3rd Edition*. O'Reilly & Associates, Inc, Sebastopol, CA, 2006.

Nemeth, Evi, Garth Snyder, Trent R. Hein, and Ben Whaley. *UNIX and Linux System Administration Handbook (4th Edition)* Pearson Education, Inc. 2010.

General Computer Security Publications

Brunette, Glenn M. *Toward Systemically Secure IT Architectures*. Archived Oracle Technical Paper, June 2006.

Kaufman, Charlie, Radia Perlman, and Mike Speciner. *Network Security: Private Communication in a Public World, 2nd Edition*. Prentice-Hall, 2002.

Pfleeger, Charles P. and Shari Lawrence Pfleeger. *Security in Computing*. Prentice Hall PTR, 2006.

Privacy for Pragmatists: A Privacy Practitioner's Guide to Sustainable Compliance. Sun Microsystems, Inc, August 2005.

Rhodes-Ousley, Mark, Roberta Bragg, and Keith Strassberg. *Network Security: The Complete Reference*. McGraw-Hill/Osborne, 2004.

McClure, Stuart, Joel Scambray, George Kurtz. *Hacking Exposed 7: Network Security Secrets & Solutions, Seventh Edition*. McGraw-Hill, 2012.

Stoll, Cliff. *The Cuckoo's Egg*. Doubleday, 1989.

♦ ♦ ♦ APPENDIX B

Configuration Checklist for Trusted Extensions

This checklist provides an overall view of the major configuration tasks for Trusted Extensions. The smaller tasks are outlined within the major tasks. The checklist does not replace following the steps in this guide.

Checklist for Configuring Trusted Extensions

The following list summarizes what is required to enable and configure Trusted Extensions at your site. Tasks that are covered elsewhere are cross-referenced.

1. Read.
   - Read the first five chapters of Administration of Trusted Extensions on page 89.
   - Understand site security requirements.
   - Read "Site Security Policy and Trusted Extensions" on page 300.
2. Prepare.
   - Decide the `root` password.
   - Decide the PROM or BIOS security level.
   - Decide the PROM or BIOS password.
   - Decide if attached peripherals are permitted.
   - Decide if access to remote printers is permitted.
   - Decide if access to unlabeled networks is permitted.
   - Install the Oracle Solaris OS.
3. Enable Trusted Extensions. See "Installing and Enabling Trusted Extensions" on page 37.
   a. Load the appropriate Trusted Extensions package set, either for a system that runs a multilevel desktop or for a system that does not.
   b. Run the `labeladm enable` *options* command to enable the Trusted Extensions service.
   c. (Optional) Run the `labeladm encodings` *encodings-file* command to install your encodings file.
   d. Reboot.

4. (Optional) Customize the global zone. See "Setting Up the Global Zone in Trusted Extensions" on page 41.

    a. If using a DOI different from `1`, set the DOI in the `/etc/system` file and in every security template.
    b. Verify and install your site's `label_encodings` file.
    c. Reboot.
5. Add labeled zones. See "Creating Labeled Zones" on page 45.

    a. Configure two labeled zones automatically.
    b. Configure your labeled zones manually.
    c. Create labeled workspace.
6. Configure the LDAP naming service. See Chapter 5, "Configuring LDAP for Trusted Extensions".

    Create either a Trusted Extensions proxy server or a Trusted Extensions LDAP server. The files naming service requires no configuration.
7. Configure interfaces and routing for the global zone and for labeled zones. See "Configuring the Network Interfaces in Trusted Extensions" on page 51.
8. Configure the network. See "Labeling Hosts and Networks" on page 205.
    - Identify single-label hosts and limited-range hosts.
    - Determine the labels to apply to incoming data from unlabeled hosts.
    - Customize the security templates.
    - Assign individual hosts to security templates.
    - Assign subnets to security templates.
9. Perform further configurations.

    a. Configure network connections for LDAP.
        - Assign the LDAP server or proxy server to the `cipso` host type in all security templates.
        - Assign LDAP clients to the `cipso` host type in all security templates.
        - Make the local system a client of the LDAP server.
    b. Configure local users and local administrative roles. See "Creating Roles and Users in Trusted Extensions" on page 57.
        - Create the Security Administrator role.
        - Create a local user who can assume the Security Administrator role.
        - Create other roles and possibly other local users to assume these roles.
    c. Create home directories at every label that the user can access. See "Creating Centralized Home Directories in Trusted Extensions" on page 63.
        - Create home directories on an NFS server.
        - Create local ZFS home directories that can be encrypted.
        - (Optional) Prevent users from reading their lower-level home directories.

d. Configure printing. See “Configuring Labeled Printing” on page 256.

e. Configure devices. See “Handling Devices in Trusted Extensions” on page 273.

   i. Assign the Device Management profile or the System Administrator profile to a role.

   ii. To make devices usable, do one of the following:

   - Per system, make devices allocatable.
   - Assign the Allocate Device authorization to selected users and roles.

f. Configure Oracle Solaris features.

   - Configure auditing.
   - Configure system security values.
   - Enable particular LDAP clients to administer LDAP.
   - Configure users in LDAP.
   - Configure network roles in LDAP.

g. Mount and share file systems. See Chapter 14, “Managing and Mounting Files in Trusted Extensions”.

♦ ♦ ♦ APPENDIX C

Quick Reference to Trusted Extensions Administration

Trusted Extensions interfaces extend the Oracle Solaris OS. This appendix provides a quick reference of the differences. For a detailed list of interfaces, including library routines and system calls, see Appendix D, “List of Trusted Extensions Man Pages”.

Administrative Interfaces in Trusted Extensions

Trusted Extensions provides interfaces for its software. The `labeladm` command enables and disables the `labeld` service, and sets the `label_encodings` file for a Trusted Extensions system. The following interfaces are available only when Trusted Extensions software is running:

`txzonemgr` script	Provides a menu-based wizard for creating, installing, initializing, and booting labeled zones. The title of the menu is Labeled Zone Manager. This script also provides menu items for networking options, naming services options, and for making the global zone a client of an existing LDAP server. In the Oracle Solaris 11 release, the `txzonemgr -c` command bypasses the menus to create the first two labeled zones.
Device Manager	In Trusted Extensions, this GUI is used to administer devices. The Device Administration dialog box is used by administrators to configure devices. The Device Allocation Manager is used by roles and regular users to allocate devices. The GUI is available from the Trusted Path menu.
Label Builder	This application is invoked when the user can choose a label or a clearance. This application also appears when a role assigns labels or label ranges to devices, zones, users, or roles. The `tgnome-selectlabel` utility allows you to customize a label builder. See “tgnome-selectlabel Utility” in *Trusted Extensions Developer’s Guide*,

Selection Manager	This application is invoked when an authorized user or authorized role attempts to upgrade or downgrade information.
Trusted Path menu	This menu handles interactions with the trusted computing base (TCB). For example, this menu has a Change (Login/Workspace) Password menu item. In Trusted GNOME, you access the Trusted Path menu by clicking the trusted symbol at the left of the trusted stripe.
Administrative commands	Trusted Extensions provides commands to obtain labels and perform other tasks. For a list of the commands, see "Command Line Tools in Trusted Extensions" on page 104.

Oracle Solaris Interfaces Extended by Trusted Extensions

Trusted Extensions adds to existing Oracle Solaris configuration files, commands, and GUIs.

Administrative commands	Trusted Extensions adds options to selected Oracle Solaris commands. For a list of all Trusted Extensions interfaces, see Appendix D, "List of Trusted Extensions Man Pages".
Configuration files	Trusted Extensions adds two privileges, `net_mac_aware` and `net_mlp`. For the use of `net_mac_aware`, see "NFS Server and Client Configuration in Trusted Extensions" on page 176. Trusted Extensions adds authorizations to the `auth_attr` database. Trusted Extensions adds executables to the `exec_attr` database. Trusted Extensions modifies existing rights profiles in the `prof_attr` database. It also adds profiles to the database. Trusted Extensions adds fields to the `policy.conf` database. For the fields, see "`policy.conf` File Defaults in Trusted Extensions" on page 128. Trusted Extensions adds audit tokens, audit events, audit classes, and audit policy options. For a list, see "Trusted Extensions Audit Reference" on page 288.
Shared directories from zones	Trusted Extensions enables you to share directories from labeled zones. The directories are shared at the label of the zone by creating an `/etc/dfs/dfstab` file from the global zone.

Tighter Security Defaults in Trusted Extensions

Trusted Extensions establishes tighter security defaults than the Oracle Solaris OS:

Devices	By default, device allocation is enabled. By default, device allocation requires authorization. Therefore, by default, regular users cannot use removable media. An administrator can remove the authorization requirement. However, device allocation is typically required at sites that install Trusted Extensions.
Printing	Regular users can print only to printers that include the user's label in the printer's label range. By default, printed output has trailer and banner pages. These pages, and the body pages, include the label of the print job.
Roles	Roles are available in the Oracle Solaris OS, but their use is optional. In Trusted Extensions, roles are required for proper administration.

Limited Options in Trusted Extensions

Trusted Extensions narrows the range of Oracle Solaris configuration options:

Naming service	The LDAP naming service is supported. All zones must be administered from one naming service.
Zones	The global zone is an administrative zone. Only the `root` user or a role can enter the global zone. Therefore, administrative interfaces that are available to regular Oracle Solaris users are not available to regular Trusted Extensions users. Non-global zones are labeled zones. Users work in labeled zones.

♦ ♦ ♦ APPENDIX D

List of Trusted Extensions Man Pages

Trusted Extensions is a configuration of the Oracle Solaris OS. This appendix provides a description of the man pages that include Trusted Extensions information.

Trusted Extensions Man Pages in Alphabetical Order

The following man pages are relevant only on a system that is configured with Trusted Extensions. The description includes links to examples or explanations of these features in the Trusted Extensions document set.

Trusted Extensions Man Page	Purpose and Links to Additional Information
`add_allocatable`(1M)	Enables a device to be allocated by adding the device to device allocation databases. By default, removable devices are allocatable. See "How to Configure a Device by Using the Device Manager in Trusted Extensions" on page 275.
`atohexlabel`(1M)	Converts a human-readable label to its internal text equivalent. For an example, see "How to Obtain the Hexadecimal Equivalent for a Label" on page 120.
`blcompare`(3TSOL)	Compares binary labels.
`blminmax`(3TSOL)	Determines the bound of two labels.
`chk_encodings`(1M)	Checks the label encodings file syntax.

	For examples, see "How to Debug a label_encodings File" in *Trusted Extensions Label Administration* and Example 1, "Checking `label_encodings` Syntax on the Command Line," on page 43.
`fgetlabel`(2)	Gets the file's label
`getlabel`(1)	Displays the label of the selected files or directories. For an example, see "How to Display the Labels of Mounted Files" on page 161.
`getlabel`(2)	Gets the label of a file
`getpathbylabel`(3TSOL)	Gets the zone pathname
`getplabel`(3TSOL)	Gets the label of a process
`getuserrange`(3TSOL)	Gets the label range of a user
`getzoneidbylabel`(3TSOL)	Gets zone ID from zone label
`getzonelabelbyid`(3TSOL)	Gets zone label from zone ID
`getzonelabelbyname`(3TSOL)	Gets zone label from zone name
`getzonepath`(1)	Displays the root path of the zone that corresponds to the specified label. "Acquiring a Sensitivity Label" in *Trusted Extensions Developer's Guide*
`getzonerootbyid`(3TSOL)	Gets zone root pathname from zone root ID
`getzonerootbylabel`(3TSOL)	Gets zone root pathname from zone label
`getzonerootbyname`(3TSOL)	Gets zone root pathname from zone name
`hextoalabel`(1M)	Converts an internal text label to its human-readable equivalent For an example, see "How to Obtain a Readable Label From Its Hexadecimal Form" on page 121.
`labeladm`(1M)	Enables and disables the Trusted Extensions labeling service and can set the `label_encodings` file

labelclipping(3TSOL)	Translates a binary label and clips the label to the specified width
label_encodings(4)	Describes the label encodings file
label_to_str(3TSOL)	Converts labels to human-readable strings
labels(5)	Describes Trusted Extensions label attributes
libtsnet(3LIB)	Is the Trusted Extensions network library
libtsol(3LIB)	Is the Trusted Extensions library
m_label(3TSOL)	Allocates and frees resources for a new label
pam_tsol_account(5)	Checks account limitations that are due to labels For an example of its use, see "How to Log In and Administer a Remote Trusted Extensions System" on page 152.
plabel(1)	Gets the label of a process
remove_allocatable(1M)	Prevents allocation of a device by removing its entry from device allocation databases For an example, see "How to Configure a Device by Using the Device Manager in Trusted Extensions" on page 275.
sel_config(4)	Is the selection rules for copy, cut, paste, and drag-and-drop operations See "Rules When Changing the Level of Security for Data" on page 112.
setflabel(3TSOL)	Moves a file to a zone with the corresponding sensitivity label
setlabel(1)	Relabels the selected item. Requires the `solaris.label.file.downgrade` or `solaris.label.file.upgrade` authorization. These authorizations are in the Object Label Management rights profile.
str_to_label(3TSOL)	Parses human-readable strings to a label
tncfg(1M)	Manages the trusted network databases. An alternative to the `txzonmgr` GUI for managing the

	trusted network. The `list` subcommand displays the security characteristics of network interfaces. `tncfg` provides more complete information than the `tninfo` command. For many examples, see Chapter 16, "Managing Networks in Trusted Extensions".
`tnctl`(1M)	Configures Trusted Extensions network parameters. You can also use the `tncfg` command. For an example, see Example 17, "Assigning the CIPSO Host Type for Remote Administration," on page 149.
`tnd`(1M)	Executes the trusted network daemon when the LDAP naming service is enabled.
`tninfo`(1M)	Displays kernel-level Trusted Extensions network information and statistics. "How to Debug the Trusted Extensions Network" on page 233. You can also use the `tncfg` command and the `txzonemgr` GUI. For a comparison with the `tncfg` command, see "How to Troubleshoot Mount Failures in Trusted Extensions" on page 183.
`trusted_extensions`(5)	Introduces Trusted Extensions
`txzonemgr`(1M)	Manages labeled zones and network interfaces. Command-line options enable automatic creation of two zones. This command accepts a configuration file as input and enables the deletion of zones. `txzonemgr` is a `zenity` (1) script. See "Creating Labeled Zones" on page 45 and "Troubleshooting the Trusted Network" on page 231.
`TrustedExtensionsPolicy`(4)	Is the configuration file for Trusted Extensions X Server Extension
`tsol_getrhtype`(3TSOL)	Gets the host type from Trusted Extensions network information
`tgnome-selectlabel` utility	Enables you to create a label builder GUI

	For more information, see "tgnome-selectlabel Utility" in *Trusted Extensions Developer's Guide*.
`updatehome`(1)	Updates the home directory copy and link files for the current label See "How to Configure Startup Files for Users in Trusted Extensions" on page 136.
`XTSOLgetClientAttributes`(3XTSOL)	Gets the label attributes of an X client
`XTSOLgetPropAttributes`(3XTSOL)	Gets the label attributes of a window property
`XTSOLgetPropLabel`(3XTSOL)	Gets the label of a window property
`XTSOLgetPropUID`(3XTSOL)	Gets the UID of a window property
`XTSOLgetResAttributes`(3XTSOL)	Gets all label attributes of a window or a pixmap
`XTSOLgetResLabel`(3XTSOL)	Gets the label of a window, a pixmap, or a colormap
`XTSOLgetResUID`(3XTSOL)	Gets the UID of a window or a pixmap
`XTSOLgetSSHeight`(3XTSOL)	Gets the height of the screen stripe
`XTSOLgetWorkstationOwner`(3XTSOL)	Gets the ownership of the workstation
`XTSOLIsWindowTrusted`(3XTSOL)	Determines if a window is created by a trusted client
`XTSOLMakeTPWindow`(3XTSOL)	Make this window a Trusted Path window
`XTSOLsetPolyInstInfo`(3XTSOL)	Sets polyinstantiation information
`XTSOLsetPropLabel`(3XTSOL)	Sets the label of a window property
`XTSOLsetPropUID`(3XTSOL)	Sets the UID of a window property
`XTSOLsetResLabel`(3XTSOL)	Sets the label of a window or a pixmap
`XTSOLsetResUID`(3XTSOL)	Sets the UID of a window, a pixmap, or a colormap
`XTSOLsetSessionHI`(3XTSOL)	Sets the session high sensitivity label to the window server

XTSOLsetSessionLO(3XTSOL)	Sets the session low sensitivity label to the window server
XTSOLsetSSHeight(3XTSOL)	Sets the height of the screen stripe
XTSOLsetWorkstationOwner(3XTSOL)	Sets the ownership of the workstation

Oracle Solaris Man Pages That Are Modified by Trusted Extensions

Trusted Extensions adds information to the following Oracle Solaris man pages.

Oracle Solaris Man Page	Trusted Extensions Modification and Links to Additional Information
allocate(1)	Adds options to support allocating a device in a zone and cleaning the device in a windowed environment. In Trusted Extensions, regular users do not use this command. For the user procedure, see "How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.
auditconfig(1M)	Adds the window policy, audit classes, audit events, and audit tokens for labeled information.
auditreduce(1M)	Adds the `-l` option to select audit records by label. For examples, see "Selecting Audit Events to Be Displayed" in *Managing Auditing in Oracle Solaris 11.3*.
auth_attr(4)	Adds label authorizations
automount(1M)	Adds the capability to mount, and therefore view, lower-level home directories. Modifies the names and contents of `auto_home` maps to account for zone names and zone visibility from higher labels. For more information, see "Changes to the Automounter in Trusted Extensions" on page 177.
deallocate(1)	Adds options to support deallocating a device in a zone, cleaning the device in a windowed environment, and specifying the type of device to deallocate. In Trusted Extensions, regular users do not use this command. For the user procedure, see "How to Allocate a Device in Trusted Extensions" in *Trusted Extensions User's Guide*.
device_clean(5)	Is invoked by default in Trusted Extensions

getpflags(2)	Recognizes the NET_MAC_AWARE and NET_MAC_AWARE_INHERIT process flags
getsockopt(3SOCKET)	Gets the mandatory access control status, SO_MAC_EXEMPT, of the socket
getsockopt(3XNET)	Gets the mandatory access control status, SO_MAC_EXEMPT, of the socket
ikeadm(1M)	Adds a debug flag, 0x0400, for labeled IKE processes.
ike.config(4)	Adds the label_aware global parameter and three Phase 1 transform keywords, single_label, multi_label, and wire_label
in.iked(1M)	Supports the negotiation of labeled security associations through multilevel UDP ports 500 and 4500 in the global zone. Also, see the ike.config(4) man page.
ipadm(1M)	Adds the all-zones interface as a permanent property value. For an example, see "How to Verify That a System's Interfaces Are Up" on page 232.
ipseckey(1M)	Adds the label, outer-label, and implicit-label extensions. These extensions associate Trusted Extensions labels with the traffic that is carried inside a security association.
is_system_labeled(3C)	Determines whether the system is configured with Trusted Extensions
ldaplist(1)	Adds Trusted Extensions network databases in LDAP
list_devices(1)	Adds attributes, such as labels, that are associated with a device. Adds the -a option to display device attributes, such as authorizations and labels. Adds the -d option to display the default attributes of an allocated device type. Adds the -z option to display available devices that can be allocated to a labeled zone.
netstat(1M)	Adds the -R option to display extended security attributes for sockets and routing table entries.. For an example, see "How to Troubleshoot Mount Failures in Trusted Extensions" on page 183.
pf_key(7P)	Adds labels to IPsec security associations (SAs)
privileges(5)	Adds Trusted Extensions privileges, such as PRIV_FILE_DOWNGRADE_SL
prof_attr(4)	Adds rights profiles, such as Object Label Management

route(1M)	Adds the -secattr option to add extended security attributes to a route. Adds the -secattr option to display the security attributes of the route: cipso, doi, max_sl, and min_sl. For an example, see "How to Troubleshoot Mount Failures in Trusted Extensions" on page 183.
setpflags(2)	Sets the NET_MAC_AWARE per-process flag
setsockopt(3SOCKET)	Sets the SO_MAC_EXEMPT option
setsockopt(3XNET)	Sets the mandatory access control, SO_MAC_EXEMPT, on the socket
socket.h(3HEAD)	Supports the SO_MAC_EXEMPT option for unlabeled peers
tar(1)	Adds the -T option to archive and extract files and directories that are labeled. See "How to Back Up Files in Trusted Extensions" on page 179 and "How to Restore Files in Trusted Extensions" on page 180.
tar.h(3HEAD)	Adds attribute types that are used in labeled tar files
ucred_getlabel(3C)	Adds getting the label value on a user credential
user_attr(4)	Adds the clearance and min_label user security attributes that are specific to Trusted Extensions See "Planning User Security in Trusted Extensions" on page 26.

Trusted Extensions Glossary

.copy_files file An optional setup file on a multilabel system. This file contains a list of startup files, such as `.cshrc` or `.firefox`, that the user environment or user applications require in order for the system or application to behave well. The files that are listed in `.copy_files` are then *copied* to the user's home directory at higher labels, when those directories are created. See also .link_files file.

.link_files file An optional setup file on a multilabel system. This file contains a list of startup files, such as `.cshrc` or `.firefox`, that the user environment or user applications require in order for the system or application to behave well. The files that are listed in `.link_files` are then *linked* to the user's home directory at higher labels, when those directories are created. See also .copy_files file.

accreditation range A set of sensitivity labels that are approved for a class of users or resources. A set of valid labels. See also system accreditation range and user accreditation range.

administrative role A role that gives required authorizations, privileged commands, and the Trusted Path security attribute to allow the role to perform administrative tasks. Roles perform a subset of Oracle Solaris `root`'s capabilities, such as backup or auditing.

allocation A mechanism by which access to a device is controlled. See device allocation.

authorization A right granted to a user or role to perform an action that would otherwise not be allowed by security policy. Authorizations are granted in rights profiles. Certain commands require the user to have specific authorizations to succeed.

branded zone In Trusted Extensions, a labeled non-global zone. More generally, a non-global zone that contains non-native operating environments. See the `brands(5)` man page.

CIPSO label Common IP Security Option. CIPSO is the label standard that Trusted Extensions implements.

classification The hierarchical component of a clearance or a label. A classification indicates a hierarchical level of security, for example, `TOP SECRET` or `UNCLASSIFIED`.

clearance The upper limit of the set of labels at which a user can work. The lower limit is the minimum label that is assigned by the security administrator. A clearance can be one of two types, a session clearance or a user clearance.

client A system connected to a network.

closed network A network of systems that are configured with Trusted Extensions. The network is cut off from any non-Trusted Extensions host. The cutoff can be physical, where no wire extends past the Trusted Extensions network. The cutoff can be in the software, where the Trusted Extensions hosts recognize only Trusted Extensions hosts. Data entry from outside the network is restricted to peripherals attached to Trusted Extensions hosts. Contrast with open network.

compartment A nonhierarchical component of a label that is used with the classification component to form a clearance or a label. A compartment represents a collection of information, such as would be used by an engineering department or a multidisciplinary project team.

DAC See discretionary access control.

device Devices include printers, computers, tape drives, CD-ROM drives, DVD drives, audio devices, and internal pseudo terminal devices. Devices are subject to the read equal write equal MAC policy. Access to removable devices, such as DVD drives, are controlled bydevice allocation.

device allocation A mechanism for protecting the information on an allocatable device from access by anybody except the user who allocates the device. Until a device is deallocated, no one but the user who allocated a device can access any information that is associated with the device. For a user to allocate a device, that user must have been granted the Device Allocation authorization by the security administrator.

discretionary access control The type of access that is granted or that is denied by the owner of a file or directory at the discretion of the owner. Trusted Extensions provides two kinds of discretionary access controls (DAC), UNIX permission bits and ACLs.

domain A part of the Internet naming hierarchy. It represents a group of systems on a local network that share administrative files.

domain name The identification of a group of systems. A domain name consists of a sequence of component names separated by periods (for example: `example1.town.state.country.org`). As you read a domain name from left to right, the component names identify more general, and usually remote, areas of administrative authority.

domain of interpretation (DOI) On an Oracle Solaris system that is configured with Trusted Extensions, the domain of interpretation is used to differentiate between different `label_encodings` files that might have similar labels defined. The DOI is a set of rules that translates the security attributes on network packets to the representation of those security attributes by the local `label_encodings` file. When systems have the same DOI, they share that set of rules and can translate the labeled network packets.

evaluated configuration One or more Trusted Extensions hosts that are running in a configuration that has been certified as meeting specific criteria by a certification authority.

In Oracle Solaris 11, Trusted Extensions is certified under the Canadian Common Criteria Scheme at Evaluation Assurance Level 4 (EAL4) against a number of protection profiles and augmented by flaw remediation (EAL4+). EAL4 is the highest level of evaluation mutually recognized by 26 countries under the Common Criteria Recognition Arrangement (CCRA).

file system A collection of files and directories that, when set into a logical hierarchy, make up an organized, structured set of information. File systems can be mounted from your local system or a remote system.

GFI Government Furnished Information. In this manual, it refers to a U.S. government-provided label_encodings file. In order to use a GFI with Trusted Extensions software, you must add the Oracle-specific `LOCAL DEFINITIONS` section to the end of the GFI. For details, see Chapter 5, "Customizing the LOCAL DEFINITIONS Section" in *Trusted Extensions Label Administration*.

host name The name by which a system is known to other systems on a network. This name must be unique among all the systems within a given domain. Usually, a domain identifies a single organization. A host name can be any combination of letters, numbers, and minus sign (−), but it cannot begin or end with a minus sign.

initial label The minimum label assigned to a user or role, and the label of the user's initial workspace. The initial label is the lowest label at which the user or role can work.

initial setup team A team of at least two people who together oversee the enabling and configuration of Trusted Extensions software. One team member is responsible for security decisions, and the other for system administration decisions.

IP address Internet protocol address. A unique number that identifies a networked system so it can communicate by means of Internet protocols. In IPv4, the address consists of four numbers separated by periods. Most often, each part of the IP address is a number between 0 and 225. However, the first number must be less than 224 and the last number cannot be 0.

IP addresses are logically divided into two parts: the network, and the system on the network. The network number is similar to a telephone area code. In relation to the network, the system number is similar to a phone number.

label A security identifier that is assigned to an object. The label is based on the level at which the information in that object should be protected. Depending on how the security administrator has configured the user, a user can see the sensitivity label, or no labels at all. Labels are defined in the label_encodings file.

label configuration A Trusted Extensions installation choice of single-label or multilabel sensitivity labels. In most circumstances, label configuration is identical on all systems at your site.

label range A set of sensitivity labels that are assigned to commands, zones, and allocatable devices. The range is specified by designating a maximum label and a minimum label. For commands, the minimum and maximum labels limit the labels at which the command can be executed. Remote hosts that do not recognize labels are assigned a single sensitivity label, as are any other hosts that the security administrator wants to restrict to a single label. A label range limits the labels at which devices can be allocated and restrict the labels at which information can be stored or processed when using the device.

label relationships On an Oracle Solaris system that is configured with Trusted Extensions, a label can dominate another label, be equal to another label, or be disjoint from another label. For example, the

label `Top Secret` dominates the label `Secret`. For two systems with the same domain of interpretation (DOI), the label `Top Secret` on one system is equal to the label `Top Secret` on the other system.

label set See security label set.

label_encodings file The file where the complete sensitivity label is defined, as are accreditation ranges, label view, default label visibility, default user clearance, and other aspects of labels.

labeled host A labeled system that is part of a trusted network of labeled systems.

labeled system A labeled system is a system that is running a multilevel operating system, such as Trusted Extensions or SELinux with MLS enabled. The system can send and receive network packets that are labeled with a Common IP Security Option (CIPSO) in the header of the packet.

labeled zone On an Oracle Solaris system that is configured with Trusted Extensions, every zone is assigned a label. Although the global zone is labeled, *labeled zone* typically refers to a non-global zone that is assigned a label. Labeled zones have two different characteristics from non-global zones on an Oracle Solaris system that is not configured with labels. First, labeled zones must use the same pool of user IDs and group IDs. Second, labeled zones can share IP addresses.

MAC See mandatory access control.

mandatory access control Access control that is based on comparing the sensitivity label of a file, directory, or device to the sensitivity label of the process that is trying to access it. The MAC rule, read equal–read down, applies when a process at one label attempts to read a file at a lower label. The MAC rule, write equal-read down, applies when a process at one label attempts to write to a directory at another label.

minimum label The lower bound of a user's sensitivity labels and the lower bound of the system's sensitivity labels. The minimum label set by the security administrator when specifying a user's security attributes is the sensitivity label of the user's first workspace at first login. The sensitivity label that is specified in the minimum label field by the security administrator in the `label_encodings` file sets the lower bound for the system.

multilevel desktop On an Oracle Solaris system that is configured with Trusted Extensions, users can run a desktop at a particular label. If the user is authorized to work at more than one label, the user can create a separate workspace to work at each label. On this multilevel desktop, authorized users can cut and paste between windows at different labels, receive mail at different labels, and view and use labeled windows in workspaces of a different label.

multilevel port (MLP) On an Oracle Solaris system that is configured with Trusted Extensions, an MLP is used to provide multilevel service in a zone. By default, the X server is a multilevel service that is defined in the global zone. An MLP is specified by port number and protocol. For example, the MLP of the X server for the multilevel desktop is specified by 6000-6003 and TCP.

naming service A distributed network database that contains key system information about all the systems on a network, so that the systems can communicate with each other. Without such a service, each system has to maintain its own copy of the system information in the local `/etc` files.

networked systems A group of systems that are connected through hardware and software, sometimes referred to as a local area network (LAN). One or more servers are usually needed when systems are networked.

non-networked systems Computers that are not connected to a network or do not rely on other hosts.

open network A network of Trusted Extensions hosts that is connected physically to other networks and that uses Trusted Extensions software to communicate with non-Trusted Extensions hosts. Contrast with closed network.

outside the evaluated configuration When software that has been proved to be able satisfy the criteria for an evaluated configuration, is configured with settings that do not satisfy security criteria, the software is described as being *outside the evaluated configuration*.

permission bits A type of discretionary access control in which the owner specifies a set of bits to signify who can read, write, or execute a file or directory. Three different sets of permissions are assigned to each file or directory: one set for the owner, one set for the owner's group, and one set for all others.

privilege Powers that are granted to a process that is executing a command. The full set of privileges describes the full capabilities of the system, from basic capabilities to administrative capabilities. Privileges that bypass security policy, such as setting the clock on a system, can be granted by a site's security administrator.

process An action that executes a command on behalf of the user who invokes the command. A process receives a number of security attributes from the user, including the user ID (UID), the group ID (GID), the supplementary group list, and the user's audit ID (AUID). Security attributes received by a process include any privileges that are available to the command being executed and the sensitivity label of the current workspace.

profile shell A special shell that recognizes security attributes, such as privileges, authorizations, and special UIDs and GIDs. A profile shell typically limits users to fewer commands, but can allow these commands to run with more rights. The profile shell is the default shell of a trusted role.

remote host A different system than the local system. A remote host can be an unlabeled host or a labeled host.

rights profile A bundling mechanism for commands and for the security attributes that are assigned to these executables. Rights profiles allow Oracle Solaris administrators to control who can execute which commands and to control the attributes these commands have when they are executed. When a user logs in, all rights assigned to that user are in effect, and the user has access to all the commands and authorizations assigned in all of that user's rights profiles.

role A role is like a user, except that a role cannot log in. Typically, a role is used to assign administrative capabilities. Roles are limited to a particular set of commands and authorizations. See administrative role.

security administrator In an organization where sensitive information must be protected, the person or persons who define and enforce the site's security policy. These persons are cleared to access all information that is being processed at the site. In software, the Security Administrator administrative role is assigned to one or more individuals who have the proper clearance. These administrators configure the security attributes of all users and hosts so that the software enforces the site's security policy. In contrast, see system administrator.

security attribute An attribute that is used to enforce Trusted Extensions security policy. Various sets of security attributes are assigned to processes, users, zones, hosts, allocatable devices, and other objects.

security label set Specifies a discrete set of security labels for a tnrhtp database entry. Hosts that are assigned to a template with a security label set can send and receive packets that match any one of the labels in the label set.

security policy On a Trusted Extensions host, the set of DAC, MAC, and labeling rules that define how information can be accessed. At a customer site, the set of rules that define the sensitivity of the information being processed at that site and the measures that are used to protect the information from unauthorized access.

security template A record in the `tnrhtp` database that defines the security attributes of a class of hosts that can access the Trusted Extensions network.

sensitivity label A security label that is assigned to an object or a process. The label is used to limit access according to the security level of the data that is contained.

separation of duty The security policy that two administrators or roles be required to create and authenticate a user. One administrator or role is responsible for creating the user, the user's home directory, and other basic administration. The other administrator or role is responsible for the user's security attributes, such as the password and the label range.

system Generic name for a computer. After installation, a system on a network is often referred to as a host.

system accreditation range The set of all valid labels that are created according to the rules that the security administrator defines in the label_encodings file, plus the two administrative labels that are used on every system that is configured with Trusted Extensions. The administrative labels are `ADMIN_LOW` and `ADMIN_HIGH`.

system administrator In Trusted Extensions, the trusted role assigned to the user or users who are responsible for performing standard system management tasks such as setting up the non-security-relevant portions of user accounts. In contrast, see security administrator.

tnrhdb database The trusted network remote host database. This database assigns a set of label characteristics to a remote host. The database is accessible as a file in `/etc/security/tsol/tnrhdb`.

tnrhtp database The trusted network remote host template. This database defines the set of label characteristics that a remote host can be assigned. The database is accessible either as a file in `/etc/security/tsol/tnrhtp`.

Trusted Network databases — `tnrhtp`, the trusted network remote host template and `tnrhdb`, the trusted network remote host database together define the remote hosts that a Trusted Extensions system can communicate with.

trusted path — On an Oracle Solaris system that is configured with Trusted Extensions, the trusted path is a reliable, tamper-proof way to interact with the system. The trusted path is used to ensure that administrative functions cannot be compromised. User functions that must be protected, such as changing a password, also use the trusted path. When the trusted path is active, the desktop displays a tamper-proof indicator.

trusted role — See administrative role.

trusted stripe — A region that cannot be spoofed. In Trusted GNOME the stripe is at the top. The stripe provides visual feedback about the state of the window system: a trusted path indicator and window sensitivity label. When sensitivity labels are configured to not be viewable for a user, the trusted stripe is reduced to an icon that displays only the trusted path indicator.

txzonemgr script — The `/usr/sbin/txzonemgr` script provides a simple GUI for managing labeled zones. The script also provides menu items for networking options. `txzonemgr` is run by root in the global zone.

unlabeled host — A networked system that sends unlabeled network packets, such as a system that is running the Oracle Solaris OS.

unlabeled system — To an Oracle Solaris system that is configured with Trusted Extensions, an unlabeled system is a system that is not running a multilevel operating system, such as Trusted Extensions or SELinux with MLS enabled. An unlabeled system does not send labeled packets. If the communicating Trusted Extensions system has assigned to the unlabeled system a single label, then network communication between the Trusted Extensions system and the unlabeled system happens at that label. An unlabeled system is also called a “single-level system”.

user accreditation range — The set of all possible labels at which a regular user can work on the system. The site's security administrator specifies the range in the label_encodings file file. The rules for well-formed labels that define the system accreditation range are additionally restricted by the values in the `ACCREDITATION RANGE` section of the file: the upper bound, the lower bound, the combination constraints and other restrictions.

user clearance — The clearance assigned by the security administrator that sets the upper bound of the set of labels at which a user can work at any time. The user can decide to accept the default, or can further restrict that clearance during any particular login session.

Index

B

C

D

E

K

L

M

N

O

P

R

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