Introduction to Oracle® Solaris Zones

Part No: E61038
November 2020

ORACLE

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- **Audience** – System administrators, technicians, and authorized service providers.
- **Required knowledge** – Experience with the Oracle Solaris operating system, including knowledge of network configuration and resource allocation.

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♦ ♦ ♦ CHAPTER 1

Oracle Solaris Zones Introduction

The Oracle Solaris Zones feature in the Oracle Solaris operating system provides an isolated environment in which to run applications on your system. This guide provides an overview of zones covering the following topics:

Guidelines for Oracle Solaris Zones in the Oracle Solaris 11.4 Release

In the June 2019 Oracle Solaris 11.4 release, the `hwprovider` global property enables a `solaris10` zone to move to a system whose hardware string value is different from the `solaris10` zone's default value.

- For a description, see "hwprovider Global Property (solaris10 Only)" in *Oracle Solaris Zones Configuration Resources*.

- For instructions, see "Setting the hwprovider Property to Override the Global Zone Value (solaris10 Only)" in *Creating and Using Oracle Solaris Zones*.

This section provides guidelines and support information for Oracle Solaris Zones features, including Oracle Solaris Kernel Zones, in the Oracle Solaris 11.4 release.

Default zones brand – The default non-global zone in this release is `solaris`, described in this guide and in the `solaris(7)` man page.

- To verify the Oracle Solaris release and the physical machine architecture, type the following command:

```
$ uname -r -m
```

- The `virtinfo` command described in the `virtinfo(8)` man page is used to obtain the following information:
  - Determine system support for Oracle Solaris virtualization technologies
  - Detect the type of virtual environment Oracle Solaris is running in, such as Oracle VM Server for SPARC
- The `solaris` zone uses the branded zones framework described in the `brands(7)` man page to run zones installed with the same software that is installed in the global zone. The system software must always be in sync with the global zone when using a `solaris` zone. The system software packages within the zone are managed using the Image Packaging System (IPS). IPS is the packaging system used beginning in the Oracle Solaris 11 release, and `solaris` zones use this model.
- Each non-global zone specified in the Automated Install (AI) manifest is installed and configured as part of a client installation. Non-global zones are installed and configured on the first reboot after the global zone is installed. When the system first boots, the zones self-assembly SMF service, `svc:/system/zones-install:default`, configures and installs each non-global zone defined in the global zone AI manifest. See *Updating Systems and Adding Software in Oracle Solaris 11.4* for more information. It is also possible to manually configure and install zones on an installed Oracle Solaris system.
- For package updates, persistent proxies should be set in an image by using the `--proxy` option. If a persistent image proxy configuration is not used, `http_proxy` and `https_proxy` environment variables can be set.
- Zones can be configured to be updated in parallel instead of serially. The parallel update provides a significant improvement in the time required to update all the zones on a system.
- By default, zones are created with the exclusive-IP type. Through the `anet` resource, a VNIC is automatically included in the zone configuration if networking configuration is not specified. For more information, see "About Zone Network Interfaces" in *Oracle Solaris Zones Configuration Resources*.
- For information about the `auto-mac-address` used to obtain a `mac-address` for a zone, see the entry `anet` in "Zone Resource Types and Their Properties" in *Oracle Solaris Zones Configuration Resources*.

- A `solaris` zone on shared storage (ZOSS) has a `zonecfg rootzpool` resource. A zone is encapsulated into a dedicated zpool. Zones on shared storage access and manage shared storage resources for zones. Kernel zones do not have `zpool` or `rootzpool` resources. A `solaris` brand zone can use the following shared storage for zone `device` resources, and for `zpool` and `rootzpool` resources.
  - DAS
  - FC LUNs
  - iSCSI
- Properties used to specify IP over InfiniBand (IPoIB) data-links are available for the `zonecfg anet` resource. IPoIB is supported for `solaris` and `solaris10` brand zones.
- The Reliable Datagram Sockets (RDS) IPC protocol is supported in both exclusive-IP and shared-IP non-global zones.
- The `fsstat` utility has been extended to support zones. The `fsstat` utility provides per-zone and aggregate statistics.
- A `solaris` zone can be an NFS server. For more information, see "Running an NFS Server in a Zone" in *Creating and Using Oracle Solaris Zones*.
- The dry-run form of the zone attach command, `zoneadm attach -n`, provides `zonecfg` validation, but does not perform package contents validation.
- All `zoneadm` options that take files as arguments require absolute paths.
- Oracle Solaris 10 Zones provide an Oracle Solaris 10 environment on Oracle Solaris 11. You can transform an Oracle Solaris 10 system or zone into a `solaris10` zone on an Oracle Solaris 11 system. See *Creating and Using Oracle Solaris 10 Zones*.
- The `zonep2vchk` tool identifies issues, including networking issues, that might affect the migration of an Oracle Solaris 11 system or an Oracle Solaris 10 system into a zone on a system running the Oracle Solaris 11.4 release. The `zonep2vchk` tool is executed on the source system before migration begins. The tool also outputs a `zonecfg` script for use on the target system. The script creates a zone that matches the source system's configuration. For more information, see Chapter 9, "Transforming Systems to Oracle Solaris Zones" in *Creating and Using Oracle Solaris Zones* and the `zonep2vchk`(8) man page.

`native` zones from the Oracle Solaris 10 release are `solaris` zones on the Oracle Solaris 11.4 release, and differ in several ways:

- The `solaris` brand is created on Oracle Solaris 11 systems instead of the `native` brand, which is the default on Oracle Solaris 10 systems.
- Oracle Solaris 11.4 `solaris` zones are whole-root type only.

  The sparse-root type of native zone that is available on Oracle Solaris 10 used the SVR4 package management system. IPS does not use this system. A read-only root zone configuration that is similar to the sparse-root type is available in Oracle Solaris 11.4.
- Zones in the Oracle Solaris 11.4 release have software management-related functionality that is different from the Oracle Solaris 10 release in the following areas:

  - IPS rather than SVR4 packaging.
  - Install, detach, attach, and physical-to-virtual conversion capability.
  - The non-global zone root is a ZFS dataset.
  - A package installed in the global zone is no longer installed into all current and future zones. In general, the global zone's package contents no longer dictate each zone's package contents, for both IPS and SVR4 packaging.
- Oracle Solaris 11.4 non-global zones use boot environments. Zones are integrated with `beadm`, the user interface command for managing ZFS Boot Environments (BEs).

  The `beadm` command is supported inside zones for `pkg` update, just as in the global zone. The `beadm` command can delete any inactive zones BE associated with the zone. See the `beadm`(8) man page.
- All enabled IPS package repositories must be accessible while installing a zone. See "Installing a Non-Global Zone" in *Creating and Using Oracle Solaris Zones* for more information.
- Zone software is minimized to start. Any additional packages the zone requires must be added. See *Updating Systems and Adding Software in Oracle Solaris 11.4* for more information.

Zones in the Oracle Solaris 11.4 release can use Oracle Solaris products and features such as the following:

- Oracle Solaris ZFS encryption
- Network virtualization and Quality of Service (QoS)
- CIFS and NFS

The following functions cannot be configured in a `solaris` branded zone in the Oracle Solaris 11.4 release:

- DHCP address assignment in a shared-IP zone
- `ndmpd`
- SMB server
- SSL proxy server
- FC services
- FCoE services
- iSCSI services
- `zpool` commands for administering ZFS pools cannot be used

The following functions cannot be configured in a `solaris-kz` brand zone in the Oracle Solaris 11.4:release.

- FC services
- FCoE services

Zones Support in This Release

Non-global `solaris` zone and `solaris-kz` zones running within a single host global zone are supported on all architectures that are defined as supported platforms for the Oracle Solaris 11.4 release. See the *Oracle Solaris Hardware Compatibility List (HCL)*.

For information about Oracle Solaris Kernel Zones physical machine support and system requirements, see "Software and Hardware Requirements for Oracle Solaris Kernel Zones" in *Creating and Using Oracle Solaris Kernel Zones*.

About Converting `ipkg` Zones to `solaris` Zones

Any zone configured as an `ipkg` zone is converted to a `solaris` zone and reported as `solaris` upon `pkg` update or `zoneadm attach` to Oracle Solaris 11.4. The `ipkg` name will be mapped to the `solaris` name if used when configuring zones. Import of a `zonecfg` file exported from an Oracle Solaris 11 Express system will be supported.

The output of commands such as `zonecfg info` or `zoneadm list -v` displays a brand of `solaris` for default native zones on an Oracle Solaris 11.4 system.

Zones Concepts Overview

Oracle Solaris Zones is a virtualization technology that enables you to consolidate multiple physical machines and services on a single system. Virtualization reduces costs through the sharing of hardware, infrastructure, and administration. Benefits include the following:

- Increased hardware utilization
- Greater flexibility in resource allocation
- Reduced power requirements
- Fewer management costs
- Lower cost of ownership
- Administrative and resource boundaries between applications on a system

The Oracle Solaris Zones partitioning technology is used to virtually divide the resources of a physical machine and its Oracle Solaris operating system operating system to simulate multiple machines and operating systems. Each virtual system that is created in a zone is dedicated to the programs running inside. Zones technology is used to provide an isolated and secure environment for running applications.

Oracle Solaris Zones provides two main types of zones, each having attributes that control how its operating system behaves and how it can be used.

- The instance of the operating system that is running directly on a system is called the *global zone*.
- An instance of a virtual system running inside the global zone is called a *non-global zone*, or simply a *zone*.

A *kernel zone* is a non-global zone that runs a kernel and operating system that is separate from the global zone. The separate kernel and operating system installation in a kernel zone provide for greater independence and enhanced security of operating system instances and applications. Oracle Solaris Kernel Zones can run an Oracle Solaris release, Support Repository Update (SRU), or kernel version that is different from that of the host system. The Oracle Solaris release in a kernel zone must be at least Oracle Solaris 11.2.

Every zone is configured with an associated *brand*. The brand is used to determine behavior when a zone is installed and booted. In addition, a zone's brand is used to identify the correct application type at application launch time. The default brand is `solaris`. The brand for a kernel zone is `solaris-kz`. The brand for a zone running Oracle Solaris 10 is `solaris10`.

When you create a zone, you produce an application execution environment in which processes are isolated from the rest of the system. This isolation prevents processes that are running in one zone from monitoring or affecting processes that are running in other zones. Even a process running with root credentials cannot view or affect activity in other zones. Use Oracle Solaris Zones to maintain the deployment model of one-application-per-server while simultaneously sharing hardware resources.

A zone also provides an abstract layer that separates applications from the physical attributes of the system on which they are deployed. Examples of these attributes include physical device paths.

Zones can be used on any system that is running at least the Oracle Solaris 10 release. The upper limit for the number of `solaris`, `solaris10`, and `solaris-kz` zones on a system is 8192. The number of zones that can be effectively hosted on a single system is determined by the total resource requirements of the application software running in all of the zones, and the size of the system.

System requirement concepts for Oracle Solaris Zones are discussed in Chapter 1, “Before You Begin Working With Oracle Solaris Zones” in *Creating and Using Oracle Solaris Zones*.

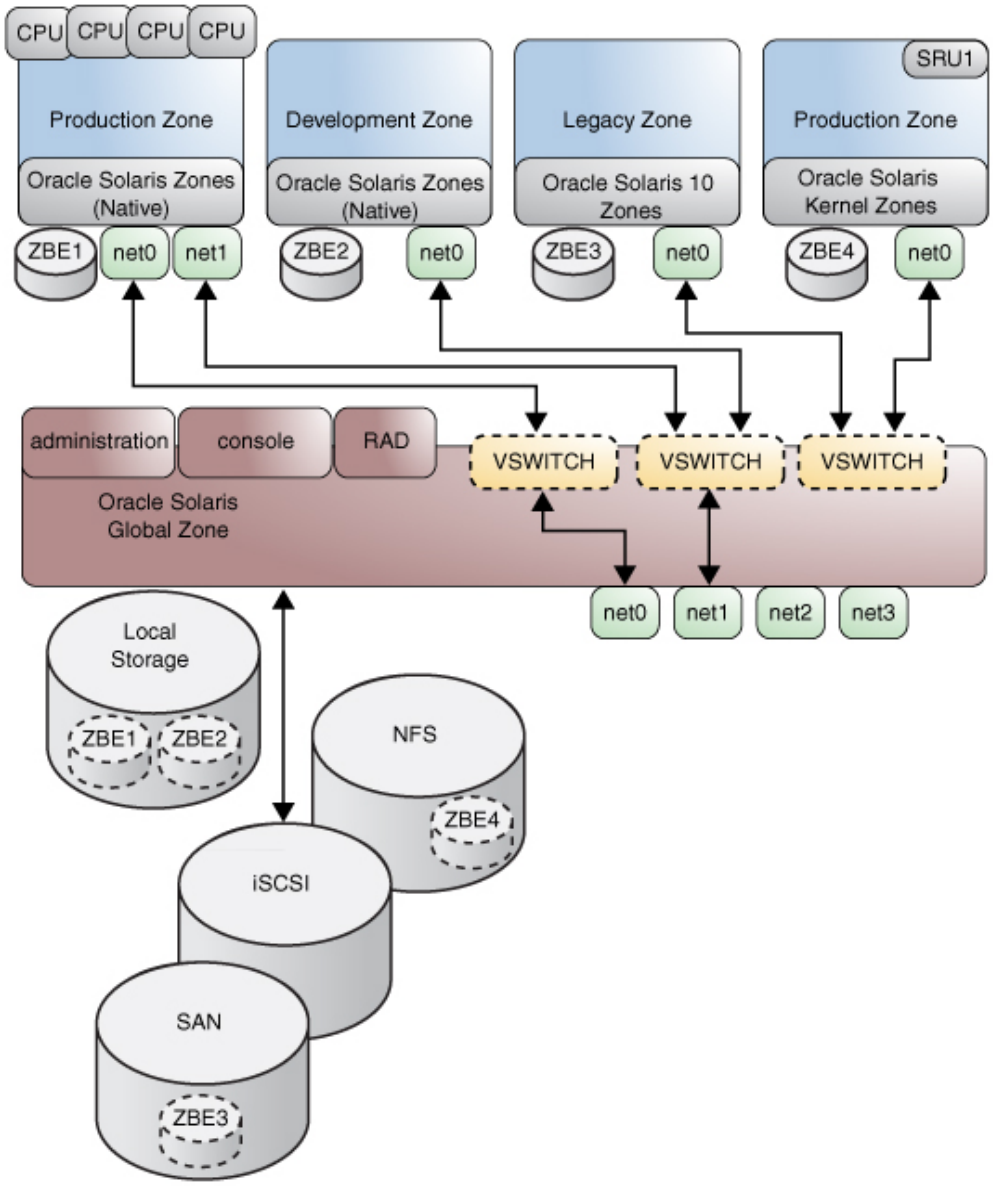
System requirement concepts for Oracle Solaris Kernel Zones are discussed in “Software and Hardware Requirements for Oracle Solaris Kernel Zones” in *Creating and Using Oracle Solaris Kernel Zones*.

When to Use Zones

Zones are ideal for environments that consolidate a number of applications on a single server. The cost and complexity of managing numerous physical machines make it advantageous to consolidate several applications on larger, more scalable systems.

The following figure shows zones that create separate execution environments for running an application in a production environment in a native zone and a kernel zone running a different SRU. Another native zone is used for developing the application. An additional kernel zone is used for testing. An additional zone maintains an environment to run legacy versions on Oracle Solaris 11. All zones run on the same server that is running an Oracle Solaris 11.4 global zone.

FIGURE 1 Zones Server Consolidation Example



Zones enable more efficient resource utilization on your system. Dynamic resource reallocation permits unused resources to be shifted to other zones as needed. Fault and security isolation mean that poorly behaved applications do not require a dedicated and underutilized system. With the use of zones, these applications can be consolidated with other applications.

Zones allow you to delegate some administrative functions while maintaining overall system security.

How Zones Work

One or more applications can run in a zone without interacting with the rest of the system. Zones isolate software applications or services by using flexible, software-defined boundaries. Applications that are running in the same system can then be managed independently of each other as if they were running on different systems. Thus, different versions of the same application can be run in different zones, to match the requirements of your configuration.

A process running in a zone can manipulate, monitor, and directly communicate with other processes that are running in the same zone. The process cannot perform these functions with processes that are running in other zones in the system or with processes that are not running in a zone. Processes that are running in different zones are only able to communicate through network APIs.

IP networking can be configured in two different ways, depending on whether the Each zone has its own exclusive IP stack instance or shares the IP layer configuration and state with the global zone. Exclusive-IP is the default type. For more information about IP types in zones, see "About Zone Network Interfaces" in *Oracle Solaris Zones Configuration Resources*. For zone configuration information, see "How to Create and Deploy a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*.

Every Oracle Solaris system contains a *global zone*. The global zone has a dual function. The global zone is both the default zone for the system and the zone used for system-wide administrative control. All processes execute in the global zone if no *non-global* zones, referred to simply as zones, are created by the *global administrator* or a user with the Zone Security profile.

The global zone is the only zone from which a non-global zone can be configured, installed, managed, or uninstalled. Only the global zone is bootable from the system hardware. Administration of the system infrastructure, such as physical devices, routing in a shared-IP zone, or dynamic reconfiguration, is only possible in the global zone running on a physical system. Appropriately privileged processes running in the global zone can access objects associated with other zones.

In some cases, unprivileged processes in the global zone might be able to perform operations not allowed to privileged processes in a non-global zone. For example, users in the global zone can view information about every process in the system. If this capability presents a problem for your site, you can restrict access to the global zone.

Each zone, including the global zone, is assigned a zone name. The global zone always has the name `global`. Each zone is also given a unique numeric identifier, which is assigned by the system when the zone is booted. The global zone is always mapped to ID `0`. When you log in to a kernel zone by using the `zlogin` command, the kernel zone also reports that it has ID `0`, because it is a virtual global zone. Zone names and numeric IDs are discussed in "How to Create and Deploy a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*.

Each zone also has a hostname or node name that is independent of the zone name. The node name is assigned by the administrator of the zone. For more information, see "Non-Global Zone Node Name" in *Creating and Using Oracle Solaris Zones*.

Each zone has a path to its root directory that is relative to the global zone's root directory. For more information, see "zonecfg and the Global Zone" in *Oracle Solaris Zones Configuration Resources*.

The scheduling class for a non-global zone is set to the scheduling class for the system by default. See "Scheduling Class" in *Oracle Solaris Zones Configuration Resources* for a discussion of methods used to set the scheduling class in a zone.

Block device multipathing is handled by `scsi_vhci(4D)`. The form of the `lu: storage` URI you select for your configuration determines how the configuration is used. For more information about using `lu:` URIs with multipathing, see the `suri(7)` man page.

Comparison of Global Zones, Non-Global Zones, and Kernel Zones

The following table summarizes the operating system characteristics of global and non-global zones along with the differences in the non-global zones that are kernel zones.

TABLE 1 Comparison of Zone Characteristics

Characteristic	Global Zone	Non-Global Zone	Kernel Zone
ID	Assigned ID `0` by the system	Assigned a zone ID by the host system when the zone is booted	Assigned a zone ID by the host system when the zone is booted, but from inside the kernel zone its ID is `0`

Characteristic	Global Zone	Non-Global Zone	Kernel Zone
Kernel status	Provides the main instance of the Oracle Solaris kernel that is bootable and running on the system	Shares operation under the Oracle Solaris kernel booted from the global zone	Provides its own Oracle Solaris kernel
Oracle Solaris operating system packages	Contains a complete installation of the Oracle Solaris operating system software packages	Contains an installed subset of the complete Oracle Solaris operating system software packages	Contains a complete installation of the Oracle Solaris operating system software packages
Additional software permitted	Can contain additional software packages or additional software, directories, files, and other data that is not installed through packages	Can contain additional software, directories, files, and other data created on the non-global zone that are not installed through packages Can contain additional installed software packages Might require software to be installed in the global zone in order to provide some functionality	Can contain additional software, directories, files, and other data created on the non-global zone that are not installed through packages Can contain additional installed software packages
Product database	Provides a complete and consistent product database that contains information about all software components installed in the global zone	Has a complete and consistent product database that contains information about all software components installed on the non-global zone	Has a complete and consistent product database that contains information about all software components installed on the kernel zone
Configuration information access	Holds configuration information specific to the global zone only, such as the global zone host name and file system table	Has configuration information specific to that non-global zone only, such as the non-global zone host name and file system table	Has configuration information specific to that kernel zone only, such as the kernel zone host name and file system table
Awareness of devices and file systems	Is the only zone that is aware of all devices and all file systems	Is aware of its own file systems only	Is aware of some devices but not file systems of the global zone
Awareness of other zones on system	Is the only zone with knowledge of non-global zone existence and configuration	Is not aware of the existence of any other zones on its hosting global zone	Is not aware of the existence of any other zones on its hosting global zone
Zone installation and management capabilities	Is the only zone from which a non-global zone can be configured, installed, managed, or uninstalled	Cannot install, manage, or uninstall zones on its hosting global zone	Cannot install, manage, or uninstall zones on its hosting global zone. Can act as a global zone to contain non-global zones that are not kernel zones
Time zone information	Has its own time zone that does not need to be used by non-global zones	Can have its own time zone setting that is different from the global zone	Can have its own time zone setting that is different from the global zone
Immutable read-only capability	Can be configured as an immutable zone with read-only access to the root	Can be configured as an immutable zone with read-only access to the root	Can be configured as an immutable zone with read-only access to the root

Capabilities Provided by Non-Global Zones

Non-global zones provide the following features:

Security

Once a process has been placed in a zone other than the global zone, neither the process nor any of its subsequent children can change zones.

Network services can be run in a zone. By running network services in a zone, you limit the damage possible in the event of a security violation. An intruder who successfully exploits a security flaw in software running within a zone is confined to the restricted set of actions possible within that zone. The privileges available within a zone are a subset of those available in the system as a whole.

Isolation

Zones allow the deployment of multiple applications on the same system, even if those applications operate in different trust domains, require exclusive access to a global resource, or present difficulties with global configurations. The applications are also prevented from monitoring or intercepting each other's network traffic, file system data, or process activity.

Network Isolation

Zones are configured as exclusive-IP type by default. The zones are isolated from the global zone and from each other at the IP layer. This isolation is useful for both operational and security reasons. Zones can be used to consolidate applications that must communicate on different subnets using their own LANs or VLANs. Each zone can also define its own IP layer security rules.

Virtualization

Zones provide a virtualized environment that can hide details such as physical devices and the system's primary IP address and host name from applications. The same application environment can be maintained on different physical machines. The virtualized environment allows separate administration of each zone. Actions taken by a zone administrator in a non-global zone do not affect the rest of the system.

Granularity

A zone can provide isolation at almost any level of granularity. See “Non-Global Zone Isolation” on page 31 for more information.

Environment

Zones do not change the environment in which applications execute except when necessary to achieve the goals of security and isolation. Zones do not present a new API or ABI to

which applications must be ported. Instead, zones provide the standard Oracle Solaris interfaces and application environment, with some restrictions. The restrictions primarily affect applications that attempt to perform privileged operations.

Applications in the global zone run without modification, whether or not additional zones are configured.

Zone Brands Overview

This section describes the types of zones available in this release and compares their features.

Native Oracle Solaris Zones

The Oracle Solaris Zones feature is a complete runtime environment for applications. The default `solaris` branded zone is also known as the *native* zone. Native zones are managed from the global zone by using the tools `zonecfg`, `zoneadm`, and `zlogin`.

A zone provides a virtual mapping from the application to the platform resources. Zones enable application components to be isolated from one another even though the zones share a single instance of the Oracle Solaris operating system. Zones use resource management components to control how applications use available system resources. For additional information about resource management features, see *Administering Resource Management in Oracle Solaris 11.4*.

The zone establishes boundaries for resource consumption, such as CPU. These boundaries can be expanded to adapt to changing processing requirements of the application running in the zone.

Native `solaris` zones cannot contain any other zones within them.

For additional isolation, you can configure zones with a read-only root, called Immutable Zones. See "Immutable Zones" on page 33 for more information.

Oracle Solaris Kernel Zones

The Oracle Solaris Zones feature provides a full kernel and user environment within a zone, and also increases kernel separation between the host system and the zone. The brand name is `solaris-kz`.

Kernel zones are managed from the global zone by using the existing tools `zonecfg`, `zoneadm`, and `zlogin`. The administrator of a kernel zone has greater flexibility in configuring and managing the zone than the administrator of a native zone. For example, you can fully update and modify the kernel zone's installed packages, including the kernel version, without being limited to the packages installed in the global zone. You can manage storage private to the zone, create and destroy ZFS pools, and configure iSCSI and CIFS.

You can install `solaris` and `solaris10` zones within the kernel zone.

A kernel zone installation is independent of that of the global zone; it is not a `pkg`(7) linked image and can be modified regardless of the global zone content. A kernel zone can be installed directly from the global zone, from a Universal Archive, or from a boot image.

When specifying a manifest for installation, use a manifest that is suitable for a global zone installation. Because kernel zones always install into a known location for the root pool, do not specify an installation target disk in the manifest.

Boot environment (BE) management is independent of the global zone.

Kernel zones support live migration and warm migration for running zones and support cold migration for non-running zones. . For successful migration, the zone storage must be accessible by both the source and target systems. Supported storage URI types for migration are NFS, iSCSI and LU.. See “About Zone Migration” on page 35 for more information.

Kernel zones also support evacuation, a migration and return of all zones. See “Zone Evacuation” on page 36 for more information.

To use Oracle Solaris Kernel Zones, the package `brand-solaris-kz` must be installed on your system.

- To determine whether your system supports kernel zones, see “Software and Hardware Requirements for Oracle Solaris Kernel Zones” in *Creating and Using Oracle Solaris Kernel Zones*.
- You can also run the `virtinfo` command on your system. For more information about the `virtinfo` command, see “How to Verify That a System Can Support Kernel Zones” in *Creating and Using Oracle Solaris Kernel Zones* and the `virtinfo`(8) man page.

For more information about Oracle Solaris Kernel Zones, see *Creating and Using Oracle Solaris Kernel Zones* and the `solaris-kz`(7) man page.

Oracle Solaris 10 Zones

Oracle Solaris 10 Zones, also known as `solaris10` branded non-global zones, use BrandZ technology to run Oracle Solaris 10 applications on the Oracle Solaris 11 operating system. Applications run unmodified in the secure environment provided by the non-global zone. This enables you to use the Oracle Solaris 10 system to develop, test, and deploy applications. Workloads running within these branded zones can take advantage of the enhancements made to the kernel and utilize some of the innovative technologies available only on the Oracle Solaris 11 release. These zones are used to convert Oracle Solaris 10 systems into zones on Oracle Solaris 11. A `solaris10` branded zone cannot be an NFS server.

Oracle Solaris 10 Zones cannot contain any other zones within them.

For more information, see *Creating and Using Oracle Solaris 10 Zones*.

Zone Brand Comparison

Differences between `solaris-kz` kernel zones and `solaris` and `solaris10` native zones are as follows.

TABLE 2 Comparison of Kernel Zone and Native Zone Features

Component	`solaris-kz` Zone	`solaris` and `solaris10` Zone
Supported Hardware	Supported on specified hardware. See "Software and Hardware Requirements for Oracle Solaris Kernel Zones" in *Creating and Using Oracle Solaris Kernel Zones*.	Supported on all systems that support the Oracle Solaris 11.4 release.
Memory Management	A fixed amount of physical RAM must be allocated to the `solaris-kz` virtual platform.	Can share the physical RAM allocated to the global zone.
Kernel Version	A kernel zone can run a different kernel version or SRU level than the host system.	Kernel version is the same as that of the global zone.
Storage and Device Management	Performs all storage access. Kernel zones do not support `zpool` or `rootzpool` resources.	Storage can be made available at the file system level though the `fs`, `zpool`, and `dataset` `zonecfg` resources.
Networking	Only exclusive-IP zones are supported.	Exclusive-IP and shared-IP zones are supported.
Migration	Supports live, warm, and cold migration.	Supports cold migration.

Zone Brands In Related Oracle Solaris Products

This section provides information about Oracle Solaris Zones used in other Oracle Solaris family products.

Oracle Solaris Zones on an Oracle Solaris Trusted Extensions System

Oracle Solaris Trusted Extensions use a zone brand called `labeled`.

For information about using zones on an Oracle Solaris Trusted Extensions system, see Chapter 13, "Managing Zones in Trusted Extensions" in *Trusted Extensions Configuration and Administration*. Note that only the `labeled` brand can be booted on an Oracle Solaris Trusted Extensions system.

Oracle Solaris Cluster Zone Clusters

Zone clusters are a feature of Oracle Solaris Cluster software. A zone cluster is a group of non-global zones that serve as the nodes of the zone cluster. One non-global zone is created on each global-cluster node that is configured with the zone cluster.

The nodes of a zone cluster can be of either the `solaris` brand or the `solaris10` brand, and use the `cluster` attribute. The `cluster` attribute can only be set by the Oracle Solaris Cluster `clzonecluster` command at the time the zone cluster or zone-cluster node is created. No other brand type is permitted except `labeled` for a zone cluster that uses Oracle Solaris Trusted Extensions.

You can run supported services on the zone cluster in the same way as on a global cluster, with the isolation that is provided by zones. For more information about zone clusters, see "Working With a Zone Cluster" in *Administering an Oracle Solaris Cluster 4.4 Configuration*.

Zone Administration Overview

This section provides an overview of zone administration information for non-global zones.

How Non-Global Zones Are Created

You can specify the configuration and installation of non-global zones as part of an Automated Install (AI) client installation. See *Automatically Installing Oracle Solaris 11.4 Systems* for more information. Oracle Solaris Zones primarily are created using the direct installation method. Kernel zone creation methods are documented in "Installing a Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones*.

To create a zone on an Oracle Solaris system, the global administrator uses the `zonecfg` command to configure a zone by specifying various parameters for the zone's virtual platform and application environment. The zone is then installed by the global administrator, who uses the zone administration command `zoneadm` to install software at the package level into the file system hierarchy established for the zone. The `zoneadm` command is used to boot the zone. The global administrator or authorized user can then log in to the installed zone by using the `zlogin` command. If role-based access control (RBAC) is in use, the zone administrator must have the authorization `solaris.zone.manage/`*zonename*.

For more information, see the following documentation:

- For information about zone configuration, see Chapter 1, "Non-Global Zone Configuration Command and Resources" in *Oracle Solaris Zones Configuration Resources*.
- For information about zone installation, see Chapter 6, "About Non-Global Zone Installation and Packages" in *Creating and Using Oracle Solaris Zones*.
- For information about zone login, see Chapter 2, "Setting Up a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*.
- To configure and install Oracle Solaris Kernel Zones, see *Creating and Using Oracle Solaris Kernel Zones*.

How Non-Global Zones Are Administered

Administrators who are assigned the rights to administer the global zone can monitor and control the system as a whole. Limited administrative rights enable a user to administer a non-global zone. This *zone administrator* is assigned these rights, as described in "admin Resource Type" in *Oracle Solaris Zones Configuration Resources*. The rights of a zone administrator are confined to a specific non-global zone.

Non-Global Zone State Model

A non-global zone can be in one of the following states:

`CONFIGURED`

The zone's configuration is complete and committed to stable storage. However, those elements of the zone's application environment that must be specified after initial boot are not yet present.

`INCOMPLETE`

During an install or uninstall operation, `zoneadm` sets the state of the target zone to `INCOMPLETE`. Upon successful completion of the operation, the state is set to the correct state.

A damaged installed zone can be marked incomplete by using the `mark` subcommand of `zoneadm`. Zones in the `INCOMPLETE` state are shown in the output of the `zoneadm list -iv` command.

`INSTALLED`

The zone's configuration is instantiated on the system. The `zoneadm` command is used to verify that the configuration can be successfully used on the designated Oracle Solaris system. Packages are installed under the zone's root path. In the `INSTALLED` state, the zone has no associated virtual platform.

`READY`

The virtual platform for the zone is established. The kernel creates the `zsched` process, network interfaces are set up and made available to the zone, file systems are mounted, and devices are configured. A unique zone ID is assigned by the system. At this stage, no processes associated with the zone have been started.

`RUNNING`

User processes associated with the zone application environment are running. The zone enters the running state as soon as the first user process associated with the application environment (`init`) is created.

`SHUTTING DOWN` and `DOWN`

These states are transitional states that are visible while the zone is being halted. However, a zone that is unable to shut down for any reason will stop in one of these states.

`UNAVAILABLE`

Indicates that the zone is installed, but cannot be verified, made ready, booted, or moved. A zone enters the unavailable state at the following times:

- When the zone's storage is unavailable and `svc:/system/zones:default` begins, such as during system boot
- When the zone's storage is unavailable
- When archive-based installations fail after successful archive extraction
- When the zone's software is incompatible with the global zone's software, such as after an improper `-F` (force) attach

The zoneadm(8) man page describes how to use the zoneadm command to initiate transitions between these states. See also Chapter 11, "Troubleshooting Miscellaneous Oracle Solaris Zones Problems" in *Creating and Using Oracle Solaris Zones*.

Auxiliary States for Kernel Zones

In addition to the states available to all non-global zones, Oracle Solaris Kernel Zones have *auxiliary states* which provide the host system with additional information about the current zone state. Auxiliary states are set during migration, debugging, and kernel maintenance operations.

DEBUGGING

The zone is in the kernel debugger, kmdb. The zone is running, but the zone cannot respond to external events, such as networking. The zlogin command checks for this state and waits until the state is cleared before starting a zlogin session.

MIGRATING-IN

The zone has been booted on the target host and the zone is receiving the live migration image. The zone will be running when migration is complete.

MIGRATING-OUT

The zone is running and being live migrated to another host system.

NO-CONFIG

The zone is known to the system, but its configuration is missing. State of the zone is always INCOMPLETE.

PANICKED

The zone has panicked. The zone cannot respond to external events until it is shut down or rebooted. You must use the console login to log into a zone in this state.

SUSPENDED

When a kernel zone is suspended with the zoneadm suspend command, the zone is in the INSTALLED state with the suspended auxiliary state. In the case of warm migration, the zoneadm detach command clears the suspended auxiliary state on the source system. The zoneadm attach command on the target system brings the zone from CONFIGURED to INSTALLED with the suspended auxiliary state. The zone resumes on the next boot.

For additional information, see *Creating and Using Oracle Solaris Kernel Zones* and the solaris-kz(7) man page.

Zone States and Zone Commands

The zone state determines which `zonecfg`, `zoneadm`, and `zlogin` commands can be used on the zone.

`CONFIGURED`

```
zonecfg -z zonename attach
zonecfg -z zonename clone
zonecfg -z zonename commit
zonecfg -z zonename delete
zonecfg -z zonename install
zonecfg -z zonename mark incomplete
zonecfg -z zonename mark unavailable
zonecfg -z zonename verify

zonecfg -z zonename
   zonecfg:zonename> set zonename=newname
```

`INCOMPLETE`

```
zoneadm -z zonename uninstall
```

`INSTALLED`

```
zoneadm -z zonename boot
zoneadm -z zonename detach
zoneadm -z zonename mark incomplete
zoneadm -z zonename mark unavailable
zoneadm -z zonename migrate rad-uri
zoneadm -z zonename move path
zoneadm -z zonename ready
zoneadm -z zonename rename newname
zoneadm -z zonename uninstall

zonecfg -z zonename
   zonecfg:zonename> add resource-type
   zonecfg:zonename> remove resource-type
```

Note - For a list of resource types, see "Configurable Resource Types and Global Properties" in *Oracle Solaris Zones Configuration Resources*.

`READY`

```
zoneadm -z zonename boot
```

`zoneadm halt` returns the zone to the `INSTALLED` state, as does system reboot.

```
zonecfg -z zonename
   zonecfg:zonename> add resource-type
   zonecfg:zonename> remove resource-type
```

`RUNNING`

```
zlogin options zonename
```

```
zoneadm -z zonename migrate -t live rad-uri
zoneadm -z zonename reboot
zoneadm -z shutdown
```

`zoneadm halt` returns the zone to the `INSTALLED` state, as does system reboot.

`sysadm evacuate` can be used to mass migrate running kernel zones to another host and optionally return them to the original system.

```
zonecfg -z zonename
   zonecfg:zonename> add resource-type
   zonecfg:zonename> remove resource-type
```

Note - If set, the `zonepath` resource cannot be changed in a running zone.

`UNAVAILABLE`

```
zoneadm -z zonename uninstall
```

`zoneadm -z zonename attach` changes a zone to the `INSTALLED` state. If the attachment fails, the zone remains unavailable.

```
zonecfg -z zonename
   zonecfg:zonename> add resource-type
   zonecfg:zonename> remove resource-type
```

The `add` and `remove` subcommands can be used to change a property or resource that cannot be changed when a zone is in the `INSTALLED` state.

Non-Global Zone Isolation

A zone provides isolation at almost any level of granularity you require. A zone does not need a dedicated CPU, a physical device, or a portion of physical memory. These resources can either be multiplexed across a number of zones running within a single domain or system, or allocated on a per-zone basis using the resource management features available in the operating system.

Each zone can provide a customized set of services. To enforce basic process isolation, a process can see or signal only those processes that exist in the same zone. Basic communication between zones is accomplished by giving each zone IP network connectivity. An application running in one zone cannot observe the network traffic of another zone. This isolation is maintained even though the respective streams of packets travel through the same physical interface.

Each zone is given a portion of the file system hierarchy. Because each zone is confined to its subtree of the file system hierarchy, a workload running in a particular zone cannot access the on-disk data of another workload running in a different zone.

Files used by naming services reside within a zone's own root file system view. Thus, naming services in different zones are isolated from one other and the services can be configured differently.

Resource Management With Non-Global Zones

If you use resource management features, you should align the boundaries of the resource management controls with those of the zones. This alignment creates a more complete model of a virtual machine, where namespace access, security isolation, and resource usage are all controlled.

Any special requirements for using the various resource management features with zones are addressed in the individual chapters of this guide that document those features.

Zones-Related SMF Services

The Service Management Facility (SMF) manages system and application services. For more information, see *Managing System Services in Oracle Solaris 11.4*.

Zones-related SMF services in the global zone include the following:

`svc:/system/zones:default`

Starts each zone that has `autoboot=true`. This service is a zones delegated restarter and provides the ability to prioritize and manage zone booting order. See "Zones Delegated Restarter" in *Creating and Using Oracle Solaris Zones*and the `svc.zones`(8) and `zonecfg`(8) man pages.

The zones restarter is notified of the state of the `milestone/goals` service of each non-global zone that supports it. The `milestone/goals` service provides an unambiguous point where a system or zone can be considered up and running.

`svc:/system/zones-install:default`

Performs zone installation on first boot, if needed.

`svc:/system/zones-monitoring:default`

Controls `zonestatd`.

`svc:/system/zones/zone:`*zonename*

Represents the service instance of a non-global zone named *zonename*.

`svc:/application/pkg/system-repository:default`

Caching proxy server that caches `pkg` data and metadata used during zone installation and other `pkg` operations. See the `pkg(1)` and `pkg(7)` man pages.

`svc:/application/pkg/zones-proxyd:default`

Used by the packaging system to provide zones access to the system repository.

The `svc:/application/pkg/zones-proxy-client:default` zones proxy client SMF service runs only in the non-global zone. The service is used by the packaging system to provide zones access to the system repository.

Monitoring Non-Global Zones

To report on the CPU, memory, and resource control utilization of the currently running zones, see "Reporting Resource Usage in a Non-Global Zone" in *Creating and Using Oracle Solaris Zones*. The `zonestat` utility also reports on network bandwidth utilization in exclusive-IP zones. An exclusive-IP zone has its own IP-related state and one or more dedicated data-links.

The `fsstat` utility can be used to report file operations statistics for non-global zones. See the `fsstat(8)` man page and "Monitoring Non-Global Zones With the fsstat Utility" in *Creating and Using Oracle Solaris Zones*.

Immutable Zones

Immutable zones are `solaris` zones with read-only roots. Both global and non-global zones can be immutable zones. An immutable zone can be configured by setting the `file-mac-profile` property. Several configurations are available. The read-only zone root expands the secure runtime boundary.

Immutable global zones extend the immutable zones feature to the global zone. For immutable zones and immutable kernel zones, the Trusted Path login can be invoked through the `zlogin` command. For more information, see the `zlogin(1)` man page.

Zones that are given additional datasets using the `zonecfg add dataset` command still have full control over those datasets. Zones that are given additional file systems using the `zonecfg add fs` command have full control over those file systems, unless the file systems are set to read-only.

See Chapter 10, “Configuring and Administering Immutable Zones” in *Creating and Using Oracle Solaris Zones* for more information.

Live Zone Reconfiguration

Use Live Zone Reconfiguration to report live configuration information or to reconfigure running zones without rebooting. Changes can be made on a temporary or persistent basis.

Live zone reconfiguration is shown in examples after persistent configuration in Chapter 3, “Managing Zone Resources and Properties” in *Creating and Using Oracle Solaris Zones*.

For kernel zones live reconfiguration, see “Live Zone Reconfiguration of Kernel Zones” in *Creating and Using Oracle Solaris Kernel Zones*.

About Zone Conversion

Zone conversion is the transformation of systems to and from zones, and includes the following processes:

- Transforming global zones into non-global zones, also known as physical to virtual (P2V) conversion
- Transforming non-global zones into global zones
- Transforming non-global zones into non-global zones on a new system
- Transforming Oracle Solaris 10 `native` zones to `solaris10` branded zones on an upgraded host by using an archive

On Oracle Solaris 11.4, zone transformation makes use of unified archives, which enable you to archive systems or zones and deploy them to other systems or zones from the archives. Zone transformations can be used as part of a strategy to migrate your data processing and applications from physical machines to a virtual environment, such as moving from on-premises systems to the cloud.

For more information, see “About Zone Transformations” in *Creating and Using Oracle Solaris Zones*.

About Zone Migration

A zone migration transfers an existing zone or global zone into a zone on another system. The three types of zone migrations are live migration, warm migration, and cold migration.

All kernel zone migrations require the zone to use shared storage that can be accessed by the source host and the target host.

For warm and live migration of kernel zones, the zone configuration must be compatible for use on both source and target hosts. Requirements and information about configuration compatibility are described in Chapter 8, "Migrating an Oracle Solaris Zone" in *Creating and Using Oracle Solaris Zones*.

Native zones can only perform a cold migration.

solaris-kz Only: About Live and Warm Migration

In a kernel zone *live migration*, the memory state of the migrated zone is copied to the destination host while the zone is running. Live zone migration has a brief outage time that is not noticeable to most applications or end-users.

In a kernel zone *warm migration*, you first suspend the zone and the zone memory state is written to disk. During migration, the zone is moved from the source host to the destination host where you resume it after migration is complete by booting it in the usual way.

See Chapter 5, "Migrating an Oracle Solaris Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones* for information about live and warm migration requirements, preparing compatible zone configurations for migration, and how to determine which migration type is appropriate for the application.

See "Using Live Migration to Migrate a Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones* for live migration procedures.

For more information, see "Using Warm Migration to Migrate a Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones* for warm migration procedures.

About Cold Migration

All zone brands support cold migration.

In a *cold migration*, a zone is shut down on the source host and rebooted on a target host. Use cold migration for applications that provide time-critical services or applications that have a large memory footprint. Cold migration is recommended for transferring existing zones or systems.

See "Using Cold Migration to Migrate a Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones* and "Using Cold Migration to Migrate a solaris Zone" in *Creating and Using Oracle Solaris Zones* for more information.

Zone Evacuation

Evacuation is the process of live migrating all the running kernel zones off a system at once, and optionally returning them to the system later. A primary use for evacuation is zero-downtime system maintenance. By live migrating all kernel zones from a host system onto other systems temporarily, you can perform maintenance on the host system without having to take down hosted applications that are running in those kernel zones. You can optionally evacuate all zones, including kernel zones and native `solaris` zones that are not running and are in the `INSTALLED` state.

See Chapter 6, "Evacuating Oracle Solaris Kernel Zones to a Target Host" in *Creating and Using Oracle Solaris Kernel Zones* for more information.

For More Information About Oracle Solaris Zones

For more in-depth information about zones, see the following documentation:

Creating and Using Oracle Solaris Zones

To start creating zones on your system.

Creating and Using Oracle Solaris Kernel Zones

To learn more about kernel zones and kernel zone migration.

Creating and Using Oracle Solaris 10 Zones

To convert a system running Oracle Solaris 10 into a zone on an Oracle Solaris 11 system.

Oracle Solaris Zones Configuration Resources

To learn more about zone configuration resources and properties.

Chapter 13, “Managing Zones in Trusted Extensions” in *Trusted Extensions Configuration and Administration*

To learn about using zones on an Oracle Solaris Trusted Extensions system.

Glossary for Zones Technology

auxiliary zone state For Oracle Solaris Kernel Zones, used to communicate additional state information about the zone state to the system. See also zone state.

brand An instance of the BrandZ functionality, which provides non-global zones that contain non-native operating environments used for running applications.

branded zone An isolated environment in which to run non-native applications in non-global zones.

cap A limit that is placed on system resource usage.

capping The process of placing a limit on system resource usage.

CMT resources CPUS, cores, and sockets.

conversion Transform global zones into non-global zones, or non-global zones into global zones, or Oracle Solaris 10 `native` zones to `solaris10` branded zones on an upgraded host by using an archive. See also migration.

CPU In the zones context, refers to a hardware thread.

data-link An interface at Layer 2 of the OSI protocol stack, which is represented in a system as a STREAMS DLPI (v2) interface. This interface can be plumbed under protocol stacks such as TCP/IP. In the context of Oracle Solaris 10 zones, data-links are physical interfaces, aggregations, or VLAN-tagged interfaces. A data-link can also be referred to as a physical interface, for example, when referring to a NIC or a VNIC.

default pool The pool created by the system when pools are enabled.

See also resource pool.

default processor set The processor set created by the system when pools are enabled.

See also processor set.

disjoint A type of set in which the members of the set do not overlap and are not duplicated.

dynamic configuration	Information about the disposition of resources within the resource pools framework for a given system at a point in time.
dynamic reconfiguration	On SPARC based systems, the ability to reconfigure hardware while the system is running.
extended accounting	A flexible way to record resource consumption on a task basis or process basis in the Solaris operating system.
fair share scheduler (FSS)	A scheduling class, also known as FSS, that allows you to allocate CPU time that is based on shares. Shares define the portion of the system's CPU resources allocated to a project.
global administrator	An administrator in the global zone with limited or unlimited rights to administer the system. A global administrator who is assigned a zones rights profile can administer non-global zones as well as the global zone. See also zone administrator.
global scope	Actions that apply to resource control values for every resource control on the system.
global zone	The zone contained on every Oracle Solaris system. When non-global zones are in use, the global zone is both the default zone for the system and the zone used for system-wide administrative control. See also non-global zone.
heap	Process-allocated scratch memory.
Immutable Zone	A zone configured with a read-only root.
Live Zone Reconfiguration	Reconfigure or report on the live configuration of non-global zones while the zones are running.
local scope	Local actions taken on a process that attempts to exceed the control value.
locked memory	Memory that cannot be paged.
memory cap enforcement threshold	The percentage of physical memory utilization on the system that will trigger cap enforcement by the resource capping daemon.
migration	Transfers an existing zone or global zone into a zone on another system. Also see conversion.

naming service database In Chapter 2, “About Projects and Tasks” in *Administering Resource Management in Oracle Solaris 11.4*, a reference to both LDAP containers and NIS maps.

non-global zone A virtualized operating system environment created within a single instance of the Oracle Solaris operating system. The Oracle Solaris Zones software partitioning technology is used to virtualize operating system services.

non-global zone administrator See zone administrator.

Oracle Solaris 10 Zones A software partitioning technology that provides a complete runtime environment for Solaris 10 applications executing in a `solaris10` branded zone on a system running the Oracle Solaris 11 release.

Oracle Solaris Kernel Zones A software partitioning technology that provides a full kernel and user environment within a zone, and also increases kernel separation between the host system and the zone.

Oracle Solaris Zones A software partitioning technology used to virtualize operating system services and provide an isolated, secure environment in which to run applications.

partitioning A software technology that is used to dedicate a subset of system resources to a defined workload.

pool See resource pool.

pool daemon The `poold` system daemon that is active when dynamic resource allocation is required.

processor set A disjoint grouping of CPUs. Each processor set can contain zero or more processors. A processor set is represented in the resource pools configuration as a resource element, `pset`.

See also disjoint.

project A network-wide administrative identifier for related work.

resident set size The size of the resident set. The resident set is the set of pages that are resident in physical memory.

resource An aspect of the computing system that can be manipulated with the intent to change application behavior.

resource capping daemon A daemon that regulates the consumption of physical memory by processes running in projects that have resource caps defined.

resource consumer	Fundamentally, an Oracle Solaris process. Process model entities such as the project and the task provide ways of discussing resource consumption in terms of aggregated resource consumption.
resource control	A per-process, per-task, or per-project limit on the consumption of a resource.
resource management	A functionality that enables you to control how applications use available system resources.
resource partition	An exclusive subset of a resource. All of the partitions of a resource sum to represent the total amount of the resource available in a single executing Solaris instance.
resource pool	A configuration mechanism that is used to partition system resources. A resource pool represents an association between groups of resources that can be partitioned.
resource set	A process-bindable resource. Most often used to refer to the objects constructed by a kernel subsystem offering some form of partitioning. Examples of resource sets include scheduling classes and processor sets.
RSS	See resident set size.
scanner	A kernel thread that identifies infrequently used pages. During low memory conditions, the scanner reclaims pages that have not been recently used.
static pools configuration	A representation of the way in which an administrator would like a system to be configured with respect to resource pools functionality.
task	In resource management, a process collective that represents a set of work over time. Each task is associated with one project.
working set size	The size of the working set. The working set is the set of pages that the project workload actively uses during its processing cycle.
workload	An aggregation of all processes of an application or group of applications.
WSS	See working set size.
zone administrator	The rights of a zone administrator are confined to a non-global zone. See also global administrator.
zone state	The status of a non-global zone. The zone state is one of `Configured`, `Down`, `Incomplete`, `Installed`, `Ready`, `Running`, `Shutting down`, or `Unavailable`.

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